**Introduction**

The 700 ULTRA pH/Redox sensor is designed specifically for power and potable water industry applications, where the measurement is critical.

The flowing reference junction provides a very stable junction potential in high purity applications.

The **analog** sensor is designed for use with ABB’s AWT210 and AWT420 transmitters with analog-capable inputs.

The **digital** sensor is designed for use with ABB’s AWT420 and AWT440 multi-input transmitters featuring EZLink connectivity. EZLink enables new or replacement sensors to be connected easily without the need to power down the transmitter.

The digital sensor features advanced warning of electrode poisoning giving the user advanced warning of electrode failure.
For more information

Publications for the associated transmitters are available for free download from:

www.abb.com/measurement

or by scanning these codes:

<table>
<thead>
<tr>
<th>AWT420</th>
<th>AWT440</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Search for or click on:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Sheet</td>
</tr>
<tr>
<td>Data Sheet</td>
</tr>
<tr>
<td>Data Sheet</td>
</tr>
<tr>
<td>Operating Instruction</td>
</tr>
<tr>
<td>Operating Instruction</td>
</tr>
<tr>
<td>Operating Instruction</td>
</tr>
<tr>
<td>Parts List</td>
</tr>
</tbody>
</table>
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1 Health & Safety

Document symbols
Symbols that appear in this document are explained below:

⚠️ WARNING
The signal word ‘WARNING’ indicates an imminent danger. Failure to observe this information may result in death or severe injury.

NOTICE
The signal word ‘NOTICE’ indicates potential material damage.

Note
‘Note’ indicates useful or important information about the product.

Safety precautions
Be sure to read, understand and follow the instructions contained within this manual before and during use of the equipment. Failure to do so could result in bodily harm or damage to the equipment.

Potential safety hazards
The sensor operates on 3.3 V DC. There are no hazardous voltages present in the sensor.

⚠️ WARNING
Before removing a sensor from the process, reduce process pressure to zero and ensure the sensor is cool enough to handle.

⚠️ WARNING
ATEX/IECEx
All 500 Pro and 500 Pro-D electrodes are certified to ATEX/IECEx. The plastic enclosure is a potential electrostatic hazard. Clean with a damp cloth only and do not mount in a high-velocity dust laden atmosphere.

Product symbols
Symbols that may appear on this product are shown below:

---
Direct current supply only.

⚠️ This symbol identifies a risk of chemical harm and indicates that only individuals qualified and trained to work with chemicals should handle chemicals or perform maintenance on chemical delivery systems associated with the equipment.

👁 This symbol indicates the need for protective eye wear.

🧤 This symbol indicates the need for protective hand wear.

Recycle separately from general waste under the WEEE directive.

Product recycling and disposal (Europe only)
Electrical equipment marked with this symbol may not be disposed of in European public disposal systems after 12 August 2005. To conform to European local and national regulations (EU Directive 2002/96/EC), European electrical equipment users must now return old or end-of-life equipment to the manufacturer for disposal at no charge to the user. ABB is committed to ensuring that the risk of any environmental damage or pollution caused by any of its products is minimized as far as possible.

⚠️ NOTICE
For return for recycling, please contact the equipment manufacturer or supplier for instructions on how to return end-of-life equipment for proper disposal.

Information on RoHS Directive 2011/65/EU (RoHS II)
ABB, Industrial Automation, Measurement & Analytics, UK, fully supports the objectives of the ROHS II directive. All in-scope products placed on the market by IAMA UK on and following the 22nd of July 2017 and without any specific exemption, will be compliant to the ROHS II directive, 2011/65/EU.
2 System overview

<table>
<thead>
<tr>
<th>Item</th>
<th>Component</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Glass sensor</td>
</tr>
<tr>
<td>B</td>
<td>Temperature sensor (Pt100)</td>
</tr>
<tr>
<td>C</td>
<td>Reference electrode</td>
</tr>
<tr>
<td>D</td>
<td>Electrolyte side arm</td>
</tr>
<tr>
<td>E</td>
<td>VarioPin (VP) connector (illustrated) or integral cable</td>
</tr>
<tr>
<td>F</td>
<td>Sensor body</td>
</tr>
<tr>
<td>G</td>
<td>PG13.5 nut</td>
</tr>
</tbody>
</table>

Figure 1 Analog pH sensor components

<table>
<thead>
<tr>
<th>Item</th>
<th>Component</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Glass sensor</td>
</tr>
<tr>
<td>B</td>
<td>Temperature sensor (Pt1000)</td>
</tr>
<tr>
<td>C</td>
<td>Dual reference electrode</td>
</tr>
<tr>
<td>D</td>
<td>Electrolyte side arm</td>
</tr>
<tr>
<td>E</td>
<td>EZLink connector (illustrated) or integral cable</td>
</tr>
<tr>
<td>F</td>
<td>Sensor body</td>
</tr>
<tr>
<td>G</td>
<td>PG13.5 nut</td>
</tr>
<tr>
<td>H</td>
<td>Reference electrode</td>
</tr>
</tbody>
</table>

Figure 2 Digital pH sensor components
3 Dimensions

Dimensions in mm (in)

Dimensions in mm (in)

4 Installation

ABB’s 700 ULTRA sensors are designed for use with ABB’s flow cells and reservoirs. Refer to Accessories and spares on page 27 for part numbers.

WARNING

- Sensors must be installed and maintained by suitably trained personnel only.
- Shut down and de-pressurize process lines before inserting or removing sensors.

Referring to Figure 3:

1. Unscrew cap A, remove sensor from storage bottle B and rinse the end of the sensor with clean water.
2. Remove knurled nut C, remove ferrule D and pull bung E from the side arm. Retain the bung for future use.
3. Insert the sensor into the flow cell F and secure with PG13.5 nut G.
4. Set up the required sample flow rate into the flow cell.
5. Close reservoir tube clip H.
6. Remove reservoir lid I and fill the reservoir with 3.5M KCl solution.
7. Replace the reservoir lid and unscrew filler plug J to avoid creating a vacuum in the reservoir.
8. Place the end of reservoir tube K in a beaker and open tube clip H. When the flow of solution is free of air bubbles, close the tube clip.
9. Referring to inset, slide knurled nut C and ferrule D over the end of reservoir tube K and push the end of the tube over the spigot in the side arm. Secure with knurled nut C.
10. Open tube clip H to allow KCl solution to flow into the sensor.
11. Calibrate the sensor – see Calibration on page 12.
Figure 3  Installing the sensor
...4 Installation

Mounting options

Dimensions in mm (in)

Figure 4 Reservoir

Figure 5 Flow cell

Figure 6 700 ULTRA panel
Electrical connections

Digital sensors
All digital sensors come with EZLink connectivity

Analog sensors – pH with temperature compensation

<table>
<thead>
<tr>
<th>Wire color</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blue</td>
<td>Glass sensor</td>
</tr>
<tr>
<td>Yellow</td>
<td>Guard</td>
</tr>
<tr>
<td>Black</td>
<td>Reference sensor</td>
</tr>
<tr>
<td>Red</td>
<td>2-wire compensation</td>
</tr>
<tr>
<td>White</td>
<td>2-wire compensation</td>
</tr>
<tr>
<td>Grey</td>
<td>3rd wire</td>
</tr>
</tbody>
</table>
5 Sensor setup

Notes.
- Perform this procedure when connecting a new/replacement sensor to an AWT420 or AWT440 transmitter.
- If connecting to a transmitter other than an AWT420 or AWT440, refer to the appropriate Operating Instruction.

1 Connect the sensor to the transmitter. The following menu prompt is displayed:

To enter Easy Setup level, press the key (below the icon).

The Easy Setup start screen is displayed:

2 Press the key (below the Select prompt).

3 Press the key (below the Edit prompt) to change the default value to the required value/selection.

4 Press the key (below the Next prompt) to accept the value/selection displayed and advance to the next configuration parameter.

The following Configuration parameters are set at Easy Setup level:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tag</td>
<td>16-character user-defined tag</td>
</tr>
<tr>
<td>Range High</td>
<td>Customizable range high</td>
</tr>
<tr>
<td>Range Low</td>
<td>Customizable range low</td>
</tr>
<tr>
<td>Cleaning</td>
<td>Configure an external cleaner</td>
</tr>
<tr>
<td>Filter type</td>
<td>Low, Medium, High</td>
</tr>
<tr>
<td>Temperature compensation</td>
<td>Automatic solution, Automatic</td>
</tr>
<tr>
<td>Analog output</td>
<td>Configure the analog output channels</td>
</tr>
</tbody>
</table>

Note. Refer to page 11 for parameter details – not all parameters are displayed at Easy Setup level.

5 Continue with configuration of the required parameters.

6 On completion the Easy Setup start screen is displayed:

7 To exit Easy Setup, press the key (below the Exit prompt) to display the Operator Page.

Pressing the key (below the Select prompt) re-enters the Easy Setup level where parameters can be reviewed or modified after first-time connection.

After completing the Easy Setup level, pressing the or key enters the Advanced Configuration level, where all available sensor and transmitter parameters can be reviewed or modified.
<table>
<thead>
<tr>
<th>Menu</th>
<th>Comment</th>
<th>Default</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1(to 4):pH/Redox(ORP)</td>
<td>Select the pH/Redox sensor to set up.</td>
<td></td>
</tr>
<tr>
<td>Tag</td>
<td>Enter an alphanumeric sensor tag (16 characters maximum) to identify the sensor on the Operator Pages</td>
<td>TAG1</td>
</tr>
<tr>
<td>Filter Type</td>
<td>Set the filter type:</td>
<td>Off</td>
</tr>
<tr>
<td></td>
<td>• Off</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Low</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Medium</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• High</td>
<td></td>
</tr>
<tr>
<td>Temp. Compensation</td>
<td>Set the temperature compensation type *</td>
<td>Automatic Sol</td>
</tr>
<tr>
<td></td>
<td>• Automatic Sol.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Automatic</td>
<td></td>
</tr>
<tr>
<td>Sample Coefficient</td>
<td>Set the sample coefficient for solution compensation *</td>
<td>0.0 pH/10 °C</td>
</tr>
<tr>
<td>Low pH Slope Limit</td>
<td>Set the low slope level for pH calibrations. Calibrations fail at this level. Diagnostic warning is displayed at 20 % above this level</td>
<td>40 %</td>
</tr>
<tr>
<td>pH Diagnostics</td>
<td>Enable/disable the following diagnostics:</td>
<td>Enabled</td>
</tr>
<tr>
<td></td>
<td>• Out of solution</td>
<td>Enabled</td>
</tr>
<tr>
<td></td>
<td>• Broken glass</td>
<td></td>
</tr>
<tr>
<td>Clean Interval</td>
<td>Set the interval between cleans: Off/15 mins/30 mins/45 mins/1 to 24 hours</td>
<td>Off</td>
</tr>
<tr>
<td>Clean Type</td>
<td>None or External.</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>The external option enables the transmitter to control an external cleaning device through the digital I/O lines. <strong>Note.</strong> Refer to Aztec ADS430 EZCLEAN operating instructions (OI/ADS430/EZCLN-EN) for an example of the use of this facility</td>
<td></td>
</tr>
<tr>
<td>Clean On Time</td>
<td>Set the duration of the clean: 1 to 60s</td>
<td>30 s</td>
</tr>
<tr>
<td>Clean Off Time</td>
<td>Set the duration between cleans: 1 to 60s</td>
<td>30 s</td>
</tr>
<tr>
<td>Recovery Time</td>
<td>Set the time delay between the completion of cleaning and the display of a new reading on the operator page: 1 to 10 min</td>
<td>1 min</td>
</tr>
<tr>
<td>Clean Duration</td>
<td>Display the total duration of the clean:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Clean type set to continuous = clean on time + recovery time</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Clean type set to pulsed = (clean on time + clean off time) * number of pulses + recovery time</td>
<td></td>
</tr>
<tr>
<td>Clean Output</td>
<td>Displays the output signal the clean is assigned to. This can be set to relay 1 to 6 or digital output 1 to 6</td>
<td>Not assigned</td>
</tr>
<tr>
<td>Restore Defaults</td>
<td>Restores the sensor back to default configuration</td>
<td></td>
</tr>
</tbody>
</table>

* Available only for pH sensors
6 Calibration

This section describes how to calibrate the sensor and involves measuring the sensor’s sensitivity to pH and temperature by exposing the sensor to samples of known pH/temperature values.

Calibrations are initiated via the Cal prompt displayed on the main page or via the Operator pages or Calibrate and Advanced menu items on the Access Level page – refer to the transmitter’s Operating Instruction OI/AWT420-EN or OI/AWT440-EN for all transmitter menu options.

Note. Before removing the sensor for calibration purposes, set the currents outputs and alarms to Hold (enabled via the Operator Menu/Manual Hold function).

Calibration procedure

pH sensor
When the sensor has been correctly connected and all electrical connections made to the transmitter, the sensor is ready for calibration by immersing the sensor (using suitably sized beakers) in either:
• a calibration solution (buffer) of known pH value for a single-point calibration
or
• sequentially in two separate calibration solutions of known pH values for a two-point calibration

For sensors already in use:

WARNING
Before removing a sensor from a flow line, ensure that all isolating valves have been closed.

1 Remove the sensor from the flow line.
2 Wash the visible surface of the sensor with demineralized water.
3 Perform a single- or two-point calibration.

To have agreement with a measured sample, there may be times when an in-process calibration is necessary.
1 Perform a buffer calibration.
2 Return the sensor to the process for a minimum of 10 minutes before performing an in-process calibration.

3 To minimize solution temperature effects, measure the sample at the same temperature as the process.

Refer to the Operating Instruction for the pH transmitter for full details of the calibration procedures.

Note. To ensure measurement accuracy when buffering:
• clean the visible surfaces of the sensors using demineralized water
• wash the sensors and dry them carefully using a soft tissue when moving from one buffer solution to the next

Redox/ORP sensor
When the sensor has been correctly connected and all electrical connections made to the transmitter, the sensor is ready for calibration. Follow the calibration procedure in the transmitter instruction manual.

For sensors that are connected to transmitters that do not have Redox calibration capabilities, it is possible to check the response as follows:
1 Prepare standard 4 and 7 pH buffer solutions. Add one gram (heaped spatula) of analar quinhydrone to 100 ml of each buffer solution. Let them stand for 30 minutes.
2 Immerse the sensor in each solution in turn and note the mV value when stable.
Calibrate menu

Used to calibrate the sensor. Access to the Calibrate menu is via the Calibrate and Advanced levels only.

Note. During calibration, current outputs and alarms are set to Hold automatically if Hold Outputs is enabled (see below).

<table>
<thead>
<tr>
<th>Menu</th>
<th>Comment</th>
<th>Default</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Menu</td>
<td>Calibrate</td>
<td>Select</td>
</tr>
<tr>
<td>2. Menu</td>
<td>Exit</td>
<td>Select</td>
</tr>
<tr>
<td>3. Menu</td>
<td>Calibrate</td>
<td>Select</td>
</tr>
<tr>
<td>4. Menu</td>
<td>Exit</td>
<td>Select</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Comment</th>
<th>Default</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH/Redox (ORP)</td>
<td>Select the pH/Redox (ORP) sensor to calibrate.</td>
</tr>
<tr>
<td>Automatic Cal</td>
<td>Calibration using standard buffers with automatic temperature compensation. Note. Displayed only if pH sensor connected.</td>
</tr>
<tr>
<td>1 Point Cal</td>
<td>Perform a 1-point automatic calibration</td>
</tr>
<tr>
<td>2 Point Cal</td>
<td>Perform a 2-point automatic calibration</td>
</tr>
<tr>
<td>Manual Cal</td>
<td>Manual calibration of pH and Redox sensors</td>
</tr>
<tr>
<td>1 Pt Manual Cal</td>
<td>Perform a 1-point manual calibration</td>
</tr>
<tr>
<td>2 Pt Manual Cal</td>
<td>Perform a 2-point manual calibration</td>
</tr>
<tr>
<td>Edit Cal</td>
<td>Manually edit the calibration values</td>
</tr>
<tr>
<td>pH Slope</td>
<td>Edit the pH slope Note. Displayed only if pH sensor connected</td>
</tr>
<tr>
<td>pH Offset</td>
<td>Edit the pH offset Note. Displayed only if pH sensor connected</td>
</tr>
<tr>
<td>mV Slope</td>
<td>Edit the mV slope Note. Displayed only if Redox sensor connected</td>
</tr>
<tr>
<td>mV Offset</td>
<td>Edit the mV offset Note. Displayed only if Redox sensor connected</td>
</tr>
<tr>
<td>Sample Collection</td>
<td>Perform the sample collection procedure</td>
</tr>
<tr>
<td>Sample Complete</td>
<td>Perform the sample complete procedure</td>
</tr>
<tr>
<td>Restore Defaults</td>
<td>Restores values to default factory settings</td>
</tr>
<tr>
<td>Set Auto pH Buffers</td>
<td>Sets the buffer type to be used. Also enables a custom buffer to be defined.</td>
</tr>
<tr>
<td>Hold Outputs</td>
<td>Enable/disable the hold outputs function. The current outputs and alarm functions are held during calibrations. Enabled</td>
</tr>
</tbody>
</table>

Note. Displayed only if pH sensor connected. Displayed only if pH sensor connected.
...6 Calibration

Automatic calibration

**Note.** Automatic calibration is applicable only to pH sensors.

Automatic calibration calibrates the sensor to measure pH using pH buffers. Automatic calibration provides automatic temperature compensation to the selected buffer. There are two possible calibration modes:

- 1-point calibration
- 2-point calibration

A 1-point calibration adjusts the calibration offset value.
A 2-point calibration adjusts the calibration offset and slope values.

Before starting the calibration procedure ensure that the automatic buffer is set to the correct buffer (see Automatic calibration buffers on page 15)

1. At the Calibrate level, press the ↗️ key (below the Select prompt)

   The sensor selection menu is displayed:

   ![Sensor selection menu](image)

2. Highlight the sensor to be calibrated (for example, S1:pH/Redox(ORP)) and press the ↗️ key (below the Select prompt)

   The menu options for S1:pH/Redox(ORP) are displayed:

   ![Menu options for sensor](image)

3. Select Automatic Cal

   ![Automatic cal selection](image)

4. Select 1 Point Auto or 2 Point Auto as required

   ![Calibration modes](image)

5. Immerse the sensor in the buffer of the value displayed on the screen.

6. Press the ↗️ key (below the Continue prompt) to perform the calibration. The calibration process screen is displayed. The calibration can be canceled at any time during the process by pressing the ↗️ key (below the Abort prompt)

   If 1 Point Cal was selected, the result screen is displayed. If 2 Point Cal was selected, repeat steps 5 and 6 for the second buffer.

   On completion of the calibration the result is displayed on the screen automatically. If the calibration passes, the slope and offset is displayed. If the calibration fails, the reason for failure is displayed on the screen. See pH/Redox calibration failure reasons on page 23 for explanation of calibration failure reasons.
Automatic calibration buffers

Automatic calibration uses buffer tables programmed into the sensor to provide more accurate calibrations.

The following buffers are supported by the sensor:

### ABB capsules
- 4.01
- 7.00
- 9.00
- 10.00

### Technical
- 4.01
- 7.00
- 10.01

### DIN19266
- 1.679
- 4.005
- 6.865
- 9.180
- 10.012

### ABB sachets
- Phthalate free
- 4.01
- 7.00
- 9.18

1. At the Calibrate level, press the key (below the Select prompt).

2. Highlight Set Auto pH Buffers and press the key (below the Select prompt).

3. Select the buffer to be set and press the key (below the Select prompt). The Set Buffer X menu is displayed:

4. Press the key (below the Edit prompt). The buffer selection menu is displayed:

5. Highlight the buffer to use.

6. Repeat for buffer 2 if performing a two point calibration.

**Note.** Buffer 1 is used for single point calibrations.
...6 Calibration

User-defined automatic calibration buffers

Two user-defined buffers may be used for automatic calibrations. Automatic buffers are defined using a table that relates the value of the buffer to a given temperature point. The software extrapolates between the user-defined points during the calibration. The graph below shows an example of the data required to define a buffer.

Note.
- If the temperature of the buffer is below the minimum value entered, the pH of the buffer is set to the value that corresponds with the minimum temperature value entered.
- If the temperature of the buffer is above the maximum value entered, the pH of the buffer is set to the value that corresponds with the maximum value entered.
- pH/Temperature pairs must be entered such that the temperature increases from pair 0 to pair 4.

1 At the Calibrate level, press the key (below the Select prompt).

The sensor selection menu is displayed:

2 Highlight Set Auto pH Buffers and press the key (below the Select prompt).

The menu options for Set Auto pH Buffers are displayed:

3 Select the buffer to be set and press the key (below the Select prompt). The Set Buffer X menu is displayed:

4 Select User Defined X and press the key (below the Edit prompt). The buffer selection menu is displayed:

5 Select User Buffer 1 and press the key (below the Select prompt). The buffer edit screen is displayed:

Note. Pressing the key cycles between the point number, temperature input and pH input.
6 With point 00 selected, press the \( \text{key} \) to select the temperature input and press the \( \text{key} \) to edit the temperature.

![User Buffer 1](image)

7 Use the \( \text{keys} \) to select a required temperature value between the limits shown on the screen and press the \( \text{key} \) to accept it.

![User Buffer 1](image)

8 Repeat steps 6 and 7 to select a required pH value.

9 Press the \( \text{key} \) to highlight the point number followed by the \( \text{keys} \) to select the next point to edit and press the \( \text{key} \).

10 Repeat steps 6 to 9 to edit the remaining points as required or press the \( \text{key} \) to exit the buffer edit page.

---

**Manual calibration**

Manual calibration calibrates the pH or Redox value to a value defined by the user. There are two possible calibration modes:

- 1-point calibration
- 2-point calibration

A 1-point calibration adjusts the pH offset value. A 2-point calibration adjusts the pH offset and slope values.

1 At the **Calibrate** level, press the \( \text{key} \) (below the **Select** prompt).

![Calibrate](image)

The sensor select menu is displayed:

![Calibrate](image)

2 Highlight the sensor to be calibrated (for example, **S1:pH/Redox(ORP)**) and press the \( \text{key} \) (below the **Select** prompt).

The menu options for **S1:pH/Redox(ORP)** are displayed:
...6 Calibration

...Manual calibration

3 Select Manual Cal.

4 Select 1 Point Manual or 2 Point Manual as required.

5 Immerse the sensor in buffer of the value displayed on the screen and press the \( \text{key} \) (below the Next prompt).

6 Press the \( \text{key} \) (below the Continue prompt) to perform the calibration. The calibration process screen is displayed. The calibration can be canceled at any time during the process by pressing the \( \text{key} \) (below the Abort prompt)

If 1 Point Cal was selected, the result screen is displayed. If 2 Point Cal was selected repeat steps 5 and 6 for the second buffer.

On completion of the calibration the result is displayed on the screen automatically. If the calibration passes, the slope and offset are displayed. If the calibration fails, the reason for failure is displayed on the screen. See pH/Redox calibration failure reasons on page 23 for explanation of calibration failure reasons.

Edit calibration

Edit calibration enables the user to enter the calibration coefficients directly. The following calibration coefficients can be entered:

- **pH slope and offset**
  Note. Available only if a pH sensor is connected to the transmitter
  - The following formula is used to calculate pH from the measured millivolts:
    \[
    \text{pH} = \text{offset} - \frac{\text{slope} \times \text{mv}}{100 \times 59.15296}
    \]
    Where:
    - \( \text{pH} \) = the measured pH of the solution
    - \( \text{offset} \) = calibration offset (an ideal sensor has an offset value of 7.00 pH)
    - \( \text{slope} \) = calibration slope (an ideal sensor has a slope value of 100.0 %)
    - \( \text{mV} \) = measured millivolts of the solution

- **Redox slope and offset**
  Note. Available only if a Redox sensor is connected to the transmitter.
  - The following formula is used to calculate ORP from the measured millivolts:
    \[
    \text{Redox} = \text{offset} + \frac{\text{slope} \times \text{mv}}{100}
    \]
    Where:
    - \( \text{Redox} \) = the calibrated ORP mV of the solution
    - \( \text{offset} \) = calibration offset (an ideal sensor has an offset value of 0.0 mV)
    - \( \text{slope} \) = calibration slope (an ideal sensor has a slope value of 100.0 %)
    - \( \text{mV} \) = measured millivolts of the solution
1. At the **Calibrate** level, press the **Enter** key (below the **Select** prompt).

![Calibrate Menu](image1)

The sensor selection menu is displayed:

![Sensor Selection Menu](image2)

2. Highlight the sensor to be calibrated (for example, **S1:pH/Redox(ORP)**) and press the **Enter** key (below the **Select** prompt).

The menu options for **S1:pH/Redox(ORP)** are displayed:

![Menu Options](image3)

3. Select **Manual Cal**

4. To enter a coefficient, select the required coefficient from the menu and press the **Enter** key (below the **Select** prompt).

![Coefficient Menu](image4)

5. Press the **Enter** key (below the **Edit** prompt) to enter the value of a coefficient and press the **Enter** key (below the **OK** prompt) when complete.

![Coefficient Value](image5)
...6 Calibration

In-process calibration

In-process calibration is used when it is not possible to remove the sensor from the process to perform the calibration. In this calibration mode the sample is used to calibrate the sensor.

In-process calibration takes place in two steps. During the first step, a grab sample is taken from the process and the sensor records the measured value of the sample at that time. The pH of the sample is then measured in the laboratory and entered into the transmitter in the second step.

Note.
- An in-process calibration adjusts the calibration offset only.
- Take care when collecting, transferring and storing the collected sample; any contamination could result in an inaccurate calibration. This is especially important for low conductivity solutions.

1 At the Calibrate level, press the key (below the Select prompt)

The sensor selection menu is displayed:

2 Highlight the sensor to be calibrated (for example, S1:pH/Redox(ORP)) and press the key (below the Select prompt)

The menu options for S1:pH/Redox(ORP) are displayed:

3 Select Sample Collection and press the key (below the Select prompt).

Note. Performing this step erases any sample data stored previously for the selected sensor. Only the data from the last sample collection is stored in each sensor.

The Collect Sample screen is displayed:

4 Press the key (below the Continue prompt) to initiate sample collection.

The menu options for Sample Collection are displayed:

5 Collect a sample from the process for laboratory analysis as close to the sensor as possible to ensure accurate results.
6 When acquisition is complete, press the key (below the Exit prompt) to return to the main menu.

7 When the result of the laboratory analysis has been obtained, select Sample Complete:

8 Press the key (below the Next prompt).

9 Enter the lab pH value.

10 Enter the lab temperature value

In-process calibration is now complete.
7 Calibration log (digital sensors)

The calibration log stored in the sensor holds a record of the last 15 sensor calibration operations performed. To view the calibration log in the transmitter, logs must be enabled. Refer to the transmitter’s Operating Instruction OI/AWT420-EN or OI/AWT440-EN for details of how to enable logs.

When logs are enabled, a calibration log page is available for each of the sensors connected to the transmitter. To access the calibration log, press the View key on the transmitter’s keypad to display the result from the first most recent calibration.

Use the group key on the keypad to cycle through the calibration logs for each sensor. Calibration results can be:

- **Calibration aborted**
  - the calibration was stopped by the user
- **Calibration failed**
  - the log entry displays the reason for the calibration failure
- **Calibration successful**
  - the log entry displays the new calibration parameters

Each entry displays the date and time of the calibration.

**Note.** The date and time are taken from the transmitter. To ensure the date and time stored in the log are accurate, ensure the date and time set in the transmitter are correct.

8 Device information (digital sensors)

This section describes the information available within the Device Information menu for digital pH sensors.

1 Connect the sensor to the transmitter’s EZLink connector – refer to the transmitter’s Operating Instruction OI/AWT420-EN or OI/AWT440-EN.

2 Press the transmitter’s key to display the Operator Page menu, then select Enter Configuration to display the Access Level page.

Use the key to select Advanced and press the key (below the Select prompt).

If the Device Information menu is not displayed use the / keys to scroll to it:

![Device Information Menu](image)

3 Press the key (below the Select prompt)

The Sensor Setup page is displayed.

![Sensor Setup Page](image)

4 Select the desired sensor and press the key (below the Select prompt)

The sensor’s device information page is displayed:

<table>
<thead>
<tr>
<th>Menu</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>Sensor type (pH/Redox)</td>
</tr>
<tr>
<td>Sensor Type</td>
<td>Sensor type (100GP/100Ultra/500Pro)</td>
</tr>
<tr>
<td>Sensor Type</td>
<td>Sensor type (pH/Redox)</td>
</tr>
<tr>
<td>Glass Type</td>
<td>Glass type (standard/low temperature)</td>
</tr>
<tr>
<td>Serial Number</td>
<td>Factory programmed serial number (3KXA...)</td>
</tr>
<tr>
<td>Date of Manufacture</td>
<td>Sensor’s date of manufacture</td>
</tr>
</tbody>
</table>
9 Diagnostics

Diagnostic messages

The table below shows sensor-specific icon types, diagnostic messages and possible causes/suggested remedial action.

**Note.** The diagnostic icons in the following table conform to NAMUR 107.

For transmitter-specific diagnostic messages, refer to the transmitter's Operating Instruction OI/AWT210-EN, OI/AWT420-EN or OI/AWT440-EN.

<table>
<thead>
<tr>
<th>Icon</th>
<th>Message</th>
<th>Possible cause</th>
<th>Remedial action</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADC failure</td>
<td>An error has been reported by the on board ADC.</td>
<td>Cycle power to the sensor.</td>
<td></td>
</tr>
<tr>
<td>NV failure</td>
<td>Failure of non-volatile memory on the sensor board.</td>
<td>Cycle power to the sensor. If power cycling fails, reset the sensor configuration to default and reconfigure as required.</td>
<td></td>
</tr>
<tr>
<td>Temperature failure</td>
<td>Failure detected in the temperature measurement circuit.</td>
<td>Cycle power to the sensor.</td>
<td></td>
</tr>
<tr>
<td>Calibration failed</td>
<td>The last calibration failed.</td>
<td>Check buffer solutions Repeat the calibration procedure.</td>
<td></td>
</tr>
<tr>
<td>PV out of range</td>
<td>The measured process value is out of range.</td>
<td>Change the PV of the sample to a value that is within the sensor's operating range.</td>
<td></td>
</tr>
<tr>
<td>Process temperature out of range</td>
<td>The measured process temperature is out of range.</td>
<td>Change the process temperature to a value that is within the sensor's operating range.</td>
<td></td>
</tr>
<tr>
<td>Internal temperature out of range</td>
<td>The internal temperature of the electronics is out of range.</td>
<td>Move the sensor to a position where the temperature is within the sensor's operating range.</td>
<td></td>
</tr>
<tr>
<td>Out of solution*</td>
<td>The sensor has detected it is out of solution.</td>
<td>Move the sensor into the solution.</td>
<td></td>
</tr>
<tr>
<td>Broken glass*</td>
<td>The sensor has detected that the pH glass is broken.</td>
<td>Replace the sensor.</td>
<td></td>
</tr>
<tr>
<td>Low electrolyte warning*</td>
<td>The electrolyte is low.</td>
<td>Refill the sensor reservoir.</td>
<td></td>
</tr>
<tr>
<td>Low pH slope warning</td>
<td>The last calibration slope was below the user set level.</td>
<td>Prepare to replace the sensor.</td>
<td></td>
</tr>
</tbody>
</table>

* These diagnostics may be enabled/disabled by the user.

pH/Redox calibration failure reasons

The table below shows the various reasons for pH/Redox calibration failure together with possible causes/remedial action.

<table>
<thead>
<tr>
<th>Failure reason</th>
<th>Possible cause</th>
<th>Remedial action</th>
</tr>
</thead>
<tbody>
<tr>
<td>No response*</td>
<td>No difference in millivolts was seen between the two calibration points.</td>
<td>Ensure that two different buffers were used.</td>
</tr>
<tr>
<td>Low slope*</td>
<td>The slope is below the user-set low slope limit.</td>
<td>Re-calibrate with fresh buffers Clean the sensor Replace the sensor.</td>
</tr>
<tr>
<td>High slope*</td>
<td>The slope exceeds 110%.</td>
<td>Replace the sensor.</td>
</tr>
<tr>
<td>Unstable temperature</td>
<td>Stability could not be achieved within 1 minute due to temperature variations.</td>
<td>Clean the sensor and ensure probe and solution are at the same temperature.</td>
</tr>
<tr>
<td>Unstable mV</td>
<td>Stability could not be achieved within 1 minute due to millivolt variations.</td>
<td>Clean the sensor.</td>
</tr>
<tr>
<td>Slow response</td>
<td>A response has been detected but it has not reached steady state within 1 minute.</td>
<td>Clean the sensor.</td>
</tr>
</tbody>
</table>

* These failure reasons are applicable only to 2-point calibrations.
10 Sensor maintenance

General cleaning

**WARNING**

Before removing a sensor from a flow line, ensure that all isolating valves have been closed.

To ensure accurate monitoring, keep the sensor free of contaminants by periodic cleaning, the frequency of which depends on the particular application.

Methods of removing various types of deposits are detailed below. Replace the sensor if its performance does not improve after cleaning.

<table>
<thead>
<tr>
<th>Application</th>
<th>Cleaning agent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grease and oils</td>
<td>Alkaline detergents or water soluble solvents such as alcohols</td>
</tr>
<tr>
<td>Resins</td>
<td>Dilute alkalis</td>
</tr>
<tr>
<td>Limestone/Carbonated</td>
<td>1M nitric acid</td>
</tr>
<tr>
<td>Metal hydroxides, cyanides, heavy biological</td>
<td>1M sulphuric or nitric acid</td>
</tr>
<tr>
<td>Proteins</td>
<td>Mixture of 1M sulphuric or nitric acid and pepsin (saturated)</td>
</tr>
</tbody>
</table>

**Checking the electrolyte level**

It is recommended that the electrolyte level is checked every three months. Refill the electrolyte solution when the level is low. Refer to the Flow chamber accessories and free-standing reservoir instruction ([IN/ANAINST/040-EN](#)) for additional information.

11 Fault finding

Listed below are some common symptoms of sensor malfunction together with possible cures.

- **Short scaling (low slope) or sluggish response**
  - Glass sensor membrane dirty or coated – clean sensor
  - Poor insulation on cable connectors, possibly due to moisture – dry connector with warm dry air (analog sensor only)
  - Replace the sensor if no improvement is seen. It may also be necessary to replace the extension cable (analog sensor only)

- **No response to pH buffer or sample**
  - Check the sensor has been connected correctly to the transmitter (analog sensors only)
  - Check the glass sensor membrane is not broken or cracked
  - Replace the sensor if no improvement

- **Unstable readings or drift**
  - Check the sensor has been connected correctly to the transmitter (analog sensors only)
  - Dry or dirty reference junction – clean the junction
  - Replace the sensor if no improvement

- **Stable but incorrect readings**
  - Recalibrate using fresh buffer solutions
  - Check temperature compensation settings are correct
  - The sensor responds correctly to pH changes, but if there is an offset (<1.0 to >0.2 pH) perform a one point process calibration

**Note.** All the above symptoms could be caused by a faulty cable (analog sensors only).
12 Storage

**NOTICE**

- Always store the sensor in its original packaging until required for use.
- Store the sensor between 15 and 35 °C (59 and 95 °F).
- For long term storage, store the sensor in the original sensor storage bottle.
- Ensure that the glass membrane and the reference junction do not dry out as this may irreversibly affect the response of the sensor.
- Do not store sensors in de-ionized water.

If it is necessary to remove the sensor from the sample line, fill the retaining solution cap with buffer solution and fit it to the sensor.
13 Specification

700 ULTRA/700 ULTRA-D

Measurements
- pH or ORP (Platinum)
- Temperature

Measurement range
High performance (S) glass
0 to 14 pH
Low temperature (LT) glass
0 to 10 pH
ORP
–2000 to 2000 mV

Temperature range
High performance (S) glass
0 to 100 °C (32 to 212 °F)
(typical glass impedance at 25 °C (77°F) = 250 MΩ)
Low temperature (LT) glass
–5 to 50 °C (23 to 122 °F)
(typical glass impedance at 25 °C (77 °F) = 25 MΩ)
ORP platinum electrode
0 to 60 °C (32 to 140 °F)

Temperature sensor
700 ULTRA (analog)
Pt100 (Class B, IEC 60751)
700 ULTRA-D (digital)
Pt1000 (Class B, IEC 60751)

Reference system
Flowing KCl electrolyte with Ag/AgCl double junction

Process connections
PG 13.5

Wetted materials
Sensor body
Glass
Reference junction system
Ceramic
Measure system
pH: Glass
ORP: Platinum

Approvals, certification and safety
CE Mark
Covers EMC+LV directives
(including latest version of EN61010)
Regulation 31
Drinking water approval: Complies to DWI Regulation 31(4)(b)
Additional tests: BS6920 parts 2.2 and 2.4 on all wetted parts
EMC
Meets requirements of IEC61326 for an industrial environment

Recommended minimum sample conductivity
0.2 μS/cm

Recommended sensor storage
Between 15 and 35 °C (59 and 95 °F)

Isothermal point at 25 °C (77 °F)
pH 7
14 Accessories and spares

### Accessories

<table>
<thead>
<tr>
<th>Part number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>3KXA163000L0013</td>
<td>NPT stainless steel flow-cell + PG13.5 adapter</td>
</tr>
<tr>
<td>3KXA163000L0014</td>
<td>NPT polycarbonate flow-cell + PG13.5 adapter</td>
</tr>
<tr>
<td>3KXA163700L0001</td>
<td>Reservoir complete with mounting bracket assembly</td>
</tr>
<tr>
<td>3KXA163000L0120</td>
<td>Calibration kit (includes calibration beaker and holder)</td>
</tr>
<tr>
<td>3KXA163700L0002</td>
<td>700ULTRA panel assembly (316 stainless steel panel and tubing)</td>
</tr>
</tbody>
</table>
...14 Accessories and spares

Spares

Flow cell

<table>
<thead>
<tr>
<th>Part number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>3KXA163000L0113</td>
<td>Pack of flow cell O-rings</td>
</tr>
<tr>
<td>3KXA163000L0117</td>
<td>Flow cell PG13.5 adapter kit</td>
</tr>
<tr>
<td>3KXA163000L0111</td>
<td>Flow cell locking ring</td>
</tr>
</tbody>
</table>

Reservoir

<table>
<thead>
<tr>
<th>Part number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>3KXA163700L0113</td>
<td>Reservoir tubing with connectors</td>
</tr>
<tr>
<td>3KXA163700L0111</td>
<td>Replacement reservoir</td>
</tr>
<tr>
<td>3KXA163700L0112</td>
<td>Replacement reservoir lid</td>
</tr>
<tr>
<td>3KXA163700L0115</td>
<td>Reservoir mounting bracket assembly</td>
</tr>
</tbody>
</table>

Panel

<table>
<thead>
<tr>
<th>Part number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>3KXA163700L0003</td>
<td>VA flowmeter</td>
</tr>
<tr>
<td>3KXA163700L0004</td>
<td>Flow switch</td>
</tr>
</tbody>
</table>

Extension cables

<table>
<thead>
<tr>
<th>Part number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>3KXA163000L0051</td>
<td>VP cable 1 m (3.3 ft)</td>
</tr>
<tr>
<td>3KXA163000L0052</td>
<td>VP cable 3 m (9.9 ft)</td>
</tr>
<tr>
<td>3KXA163000L0053</td>
<td>VP cable 5 m (16.4 ft)</td>
</tr>
<tr>
<td>3KXA163000L0054</td>
<td>VP cable 10 m (32.8 ft)</td>
</tr>
<tr>
<td>3KXA163000L0055</td>
<td>VP cable 15 m (49.2 ft)</td>
</tr>
<tr>
<td>3KXA163000L0056</td>
<td>VP cable 30 m (98.4 ft)</td>
</tr>
<tr>
<td>CM40-0185</td>
<td>EZLink cable 1 m (3.3 ft)</td>
</tr>
<tr>
<td>CM40-0186</td>
<td>EZLink cable 5 m (16.4 ft)</td>
</tr>
<tr>
<td>CM40-0187</td>
<td>EZLink cable 10 m (32.8 ft)</td>
</tr>
<tr>
<td>CM40-0188</td>
<td>EZLink cable 15 m (49.2 ft)</td>
</tr>
<tr>
<td>CM40-0189</td>
<td>EZLink cable 25 m (82 ft)</td>
</tr>
<tr>
<td>CM40-0190</td>
<td>EZLink cable 50 m (164 ft)</td>
</tr>
</tbody>
</table>
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