July 11, 2025

ERQOS TECHNOLOGIES

EQXPHxx

pH Sensor Expansion Module for EQSP32 IIoT PLC Controller

The **EQXPH01** is a compact, easy-to-install pH measurement module designed for seamless integration with the EQSP32 Industrial IoT controller. Fitting into any standard DIN-rail cabinet, this expansion module enhances your automation system's functionality by adding precise pH monitoring capabilities. With its simple slide-to-connect approach, incorporating pH measurement into both new and existing setups is straightforward and efficient.

The module features a **standard BNC connector**, allowing quick and secure attachment of a wide range of pH probes. This ensures compatibility with most commercially available probes, making it versatile for various industrial, environmental, and laboratory applications.

The EQXPH01 is **automatically detected** by the EQSP32 controller upon power-up, functioning as a native peripheral. This plug-and-play capability simplifies setup, allowing users to expand their system with minimal configuration.

The ph module supports an easy **1-point, 2-point or 3-point calibration** process using **Erqos' pH calibration utility**, ensuring precise and reliable pH measurements tailored to the specific probe being used. The calibration parameters are automatically calculated by the utility and, once stored in the unit, they are used to automatically convert the analog input values into pH measurements.

The **visual indicator** provides feedback for **unit status**, ensuring easy monitoring during installation and operation. **Firmware updates** are simple to apply using the front-facing **USB-C port**, giving you access to the latest features and improvements. This ensures the module maintains **optimal performance** and continues to enhance its functionality throughout its use.

Supported by the **EQ-AI generative AI model**, users can easily generate the necessary code by simply describing their setup and functionality needs. This approach enables quick and seamless integration of the **EQXPH01** into new or existing **EQSP32**-based automation systems, significantly reducing the need for extensive programming knowledge.

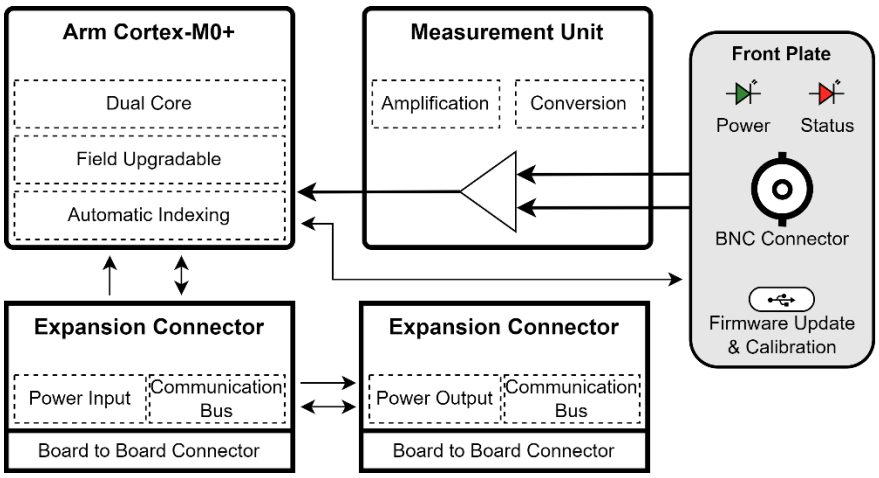
KEY FEATURES

- Quick and secure BNC attachment for pH probes
- Accurate pH measurements with 1, 2 and 3-point calibration using Erqos' utility
- Automatic module detection by EQSP32
- LED indicator for power and module status
- Easy firmware updates via front-facing USB-C port
- Up to 15 pH sensors supported on a single EQSP32 controller
- Generative AI Coding Assistant trained with EQSP32 Library and EQXPH features.
- Compact, 2SU-wide (36mm), DIN-rail mount enclosure
- Fit inside standard DIN-rail cabinets for neat and organized installations
- IP20 Protection
- -20 Min to 55o Max Ambient temperature

APPLICATIONS

- Agricultural applications like hydroponics
- Water quality monitoring in industrial processes
- Environmental monitoring of pH levels in natural waters
- Chemical balancing in laboratory applications
- Wastewater treatment and management
- Industrial pH monitoring for manufacturing processes
- Educational projects
- Smart connected recreational systems like pools and hot tubs

BLOCK DIAGRAM



SYSTEM SPECIFICATIONS

Section	Features
Power Management	Supplied by the board-to-board connector
pH Probe Connector	Standard BNC connector for secure attachment of pH probes
	Compatible with most commercial and professional probes
Measurements	Range 0 to 14 pH
	Accuracy ±0.1 pH (after calibration)
Calibration	1-point, 2-point or 3-point calibration for optimized accuracy
	Calibration utility available for easy connection and calibration parameter calculation
Indications	Green LED for power indication
	Red LED for device status
Enclosure	Easy standard DIN rail push-fit mounting with spring mechanism
	IP20
Expandability	Push fit expansion module mounting
	Automatic module detection and characterization
Firmware Update	Front-facing USB-C for easy firmware upgrades
Environment	-20°C to +55°C (-4°F to 131°F)

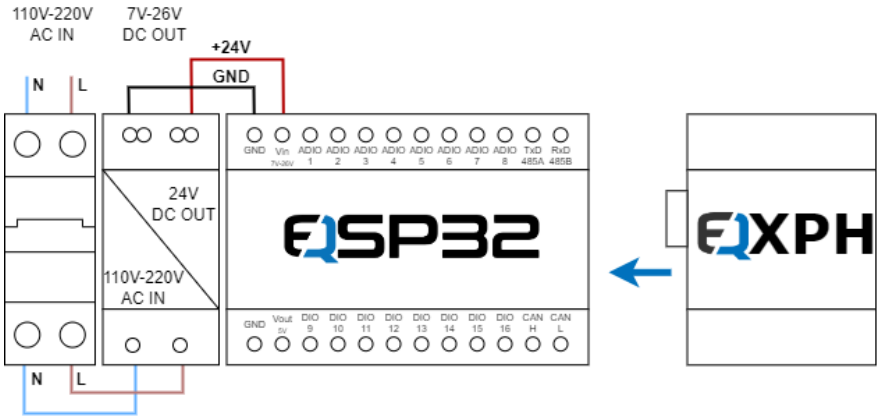
CONNECTING EQXPH

To use the EQXPH pH measurement expansion module, mount it next to the EQSP32 controller on the DIN rail and simply slide it until the board-to-board connector is fully inserted into EQSP32.

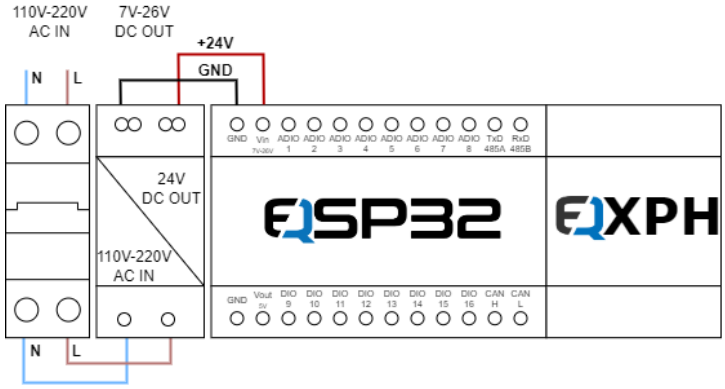
The expansion module is powered by the board-to-board connector and does not require external power supply.

When adding additional modules, it is recommended that the power is disconnected from the system. After adding the expansion modules and powering up the system, EQSP32 will start the automatic detection and indexing process.

For safety and ease of use, it is strongly recommended that a main circuit breaker is used to completely isolate the AC/DC from the grid.



Slide EQXPH to connect on EQSP32



Connected EQXPH on EQSP32

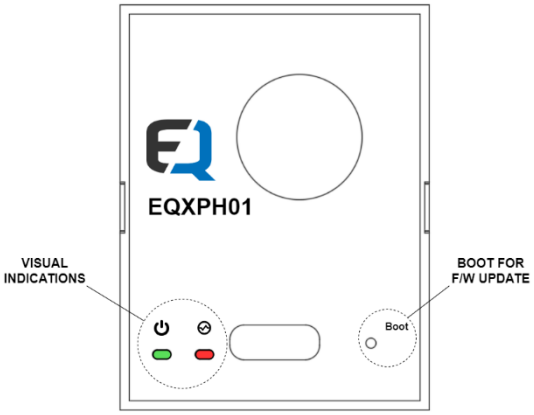
Warning: Make sure that the appropriate ground fault circuit breaker, fuses or circuit breakers and any other necessary protective components are used if there is any risk of user electrocution.

VISUAL INDICATIONS

When the module is connected and the system is powered on, the POWER LED should light up solid green.

If the STATUS LED remains solid red after the automatic detection, it means that the EQXPH module has encountered an internal issue.

During data exchange between the main EQSP32 unit and the EQXPH module, the STATUS LED will be flashing for each transaction.



Power LED

On	- Powered On	
Off	- No Power	

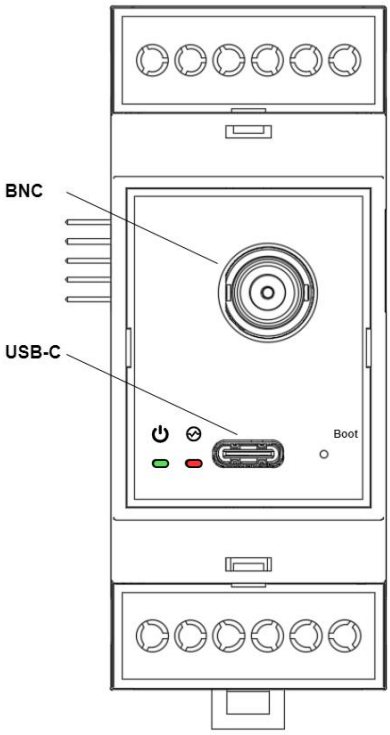
Status LED

Off	- No errors, no communication	
Fast Flashing	- Data exchange	
Blinking	- Auto indexing issue	
Blink Off	- Hardware detection failed	
On	- Internal error	

PINOUT

BNC – BNC pH probe connector

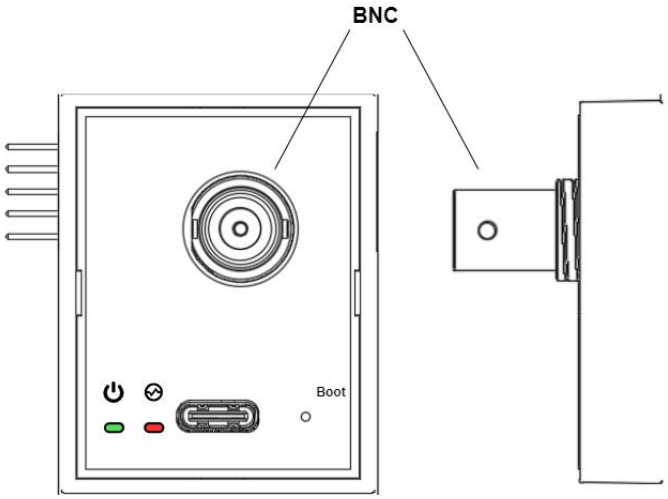
USB-C – Firmware update port



BNC – pH probe BNC connector

The BNC connector on the EQXPH01 is designed for secure and quick attachment of a wide range of commercial and professional pH probes. This single connector allows the connected pH probe to send analog signals to the module for accurate pH measurement.

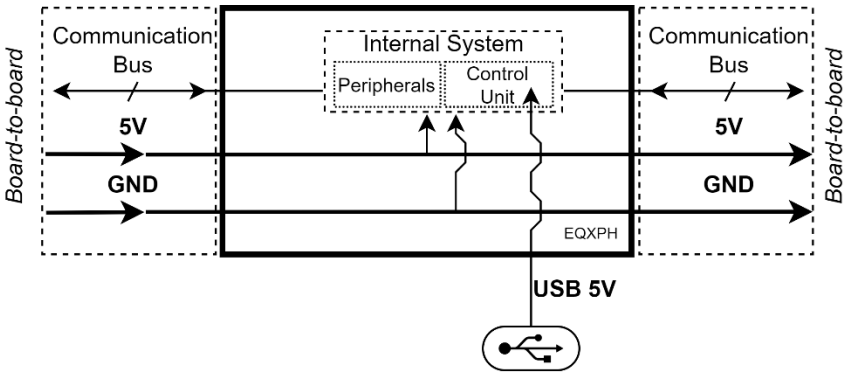
Calibration may be required when a different brand or model of pH probe is used, ensuring precise readings tailored to the specific probe.



POWER DISTRIBUTION

EQXPH's internal systems are powered by EQSP32's power management unit via the board-to-board connector. The board-to-board connector carries the power lines for system operation and the communication bus for allowing the expansion modules to interact with the main EQSP32 unit.

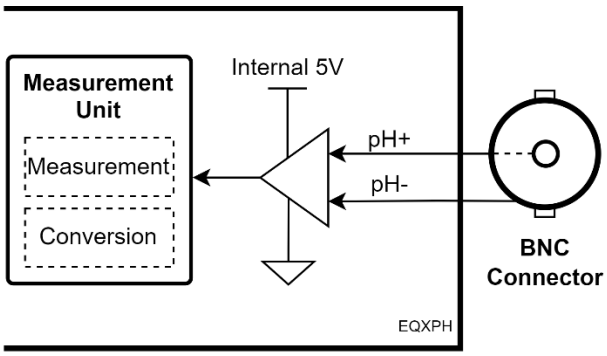
EQXPH's control unit may also be powered by the front facing USB-C port. By connecting the pH sensor expansion module via the USB port, the system's core will be powered on, allowing for easy firmware update without any external power supply.



Power distribution

PH MEASUREMENTS

Equivalent pH Measurement Circuit



Equivalent ADIO Circuit

The EQXPH module does not have terminal pins, thus the only available channel is the pH measurements from the BNC connector.

The mode of operation is always set as pH sensor (PH) and may only be read by the user, not changed.

This implementation allows for the EQSP32 library functions to be uniform and offer a native-like handling of the expansion modules.

Mode	Type	Function
pH Sensor (PH)	Input	Analog

pH Sensor (PH)

When reading the pH sensor value, the returned value may range from 0 to 1400. This integer reflects to the measured pH value multiplied by 100, to preserve the two decimals precision of the sensor.

Library Reference	
Usage	
eqsp32.readPin(EQXPH(ii, 1))	Returns 0 to 1400 for 0 pH to 14.00 pH ii: number (index) of EQXPH module on the chain ***(*)*** 1: EQXPH has only 1 user available pin, the BNC connector

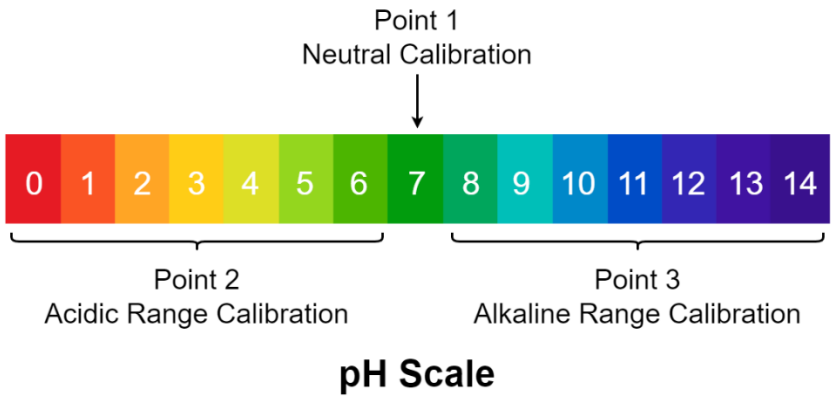
Note:

(*) For 2 EQXPH modules connected on the main unit, the first one (closer to the main unit) will have an index of 1, the second EQXPH index of 2 etc.

The index refers only to the same type of modules. Different type of modules will be indexed with its own type.

CALIBRATION

When using the EQXPH module for the first time, when replacing the measurement probe, or when the recommended recalibration interval has elapsed, the module must be recalibrated. Calibration ensures that the sensor system accurately converts the raw electrode signal into a reliable pH value.



pH Scale showing Neutral (Point 1), Acidic (Point 2) and Alkaline (Point 3) calibration points

The calibration process establishes one, two, or three known reference pH points to define the system's offset and measurement slopes. While a single-point calibration (neutral only) may be sufficient if measurements stay near pH 7.00, it is not recommended for general use. The second point sets the acidic slope correction and the third point sets the alkaline slope correction, providing maximum measurement accuracy across the full pH range.

Calibration Procedure

General preparation

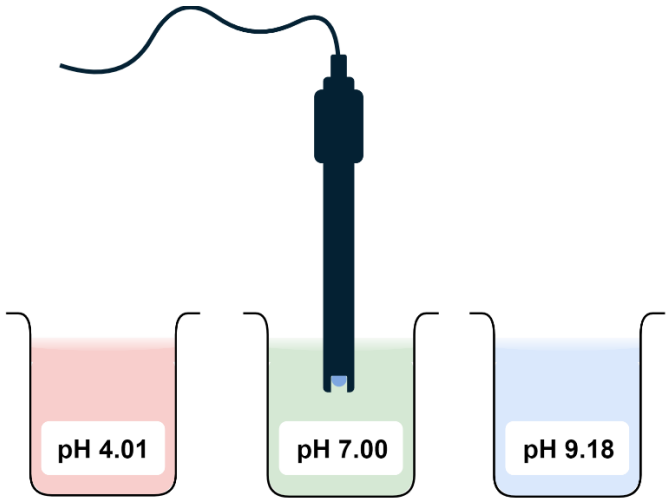
- Use fresh, high-quality pH buffer solutions for all calibration points.
- Rinse the probe with distilled water and gently blot dry with a lint-free tissue between solutions.
- Allow readings to stabilize fully at each point before saving.
- Store calibration data in the module and record the calibration date.
- Repeat calibration periodically, according to probe manufacturer recommendations or your application's accuracy requirements.

1-point calibration (Offset calibration)

A single-point calibration defines the **system offset** relative to a neutral pH value (pH 7.0).

Recommended procedure:

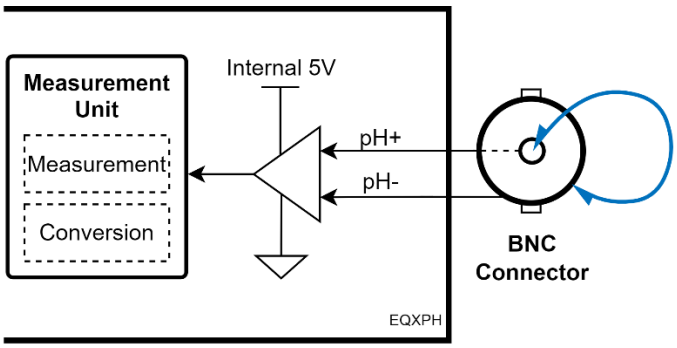
- Immerse the probe in a pH 7.00 buffer solution.
- Wait until the reading stabilizes.
- Store the reading as the neutral reference point.
- The probe does not need to output exactly 0 mV; the module uses the measured value to correct the offset internally.



Probe stabilizes in neutral (pH 7.00) calibration solution

Alternative procedure (direct short):

- To verify or adjust the electronic zero point of the measurement input stage, disconnect the probe and short the BNC connector's signal pin to the connector's ground/shield.
- This should produce a direct input of 0 mV.
- Store this value as the neutral reference.
- This method calibrates only the input electronics and does not include probe-specific offsets.

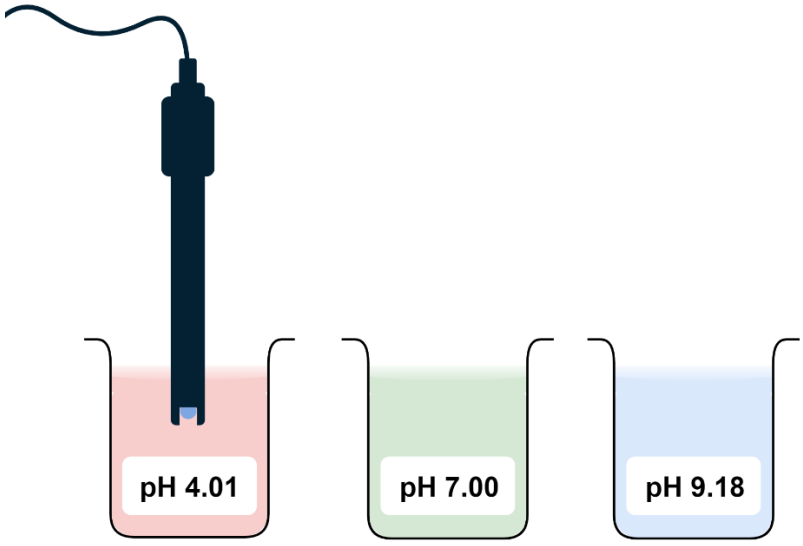


Short the BNC connector's signal input and ground/shield to generate the 0 mV (ideal 7.00 pH) reference

2-point calibration (Acidic slope)

The **second calibration point** sets the system conversion slope from the probe-generated millivolt (mV) signal to an accurate pH value for the **acidic slope**.

- Perform the **1-point calibration** procedure (neutral point at pH 7.00).
- Rinse the probe with distilled water and blot dry with a lint-free tissue.
- Immerse the probe in a second buffer solution, typically **pH 4.01** (acidic reference).
- Wait until the reading stabilizes.
- Store this reading as the **second calibration point** to define the acidic slope.



Probe stabilizes in acidic (pH 4.01) calibration solution

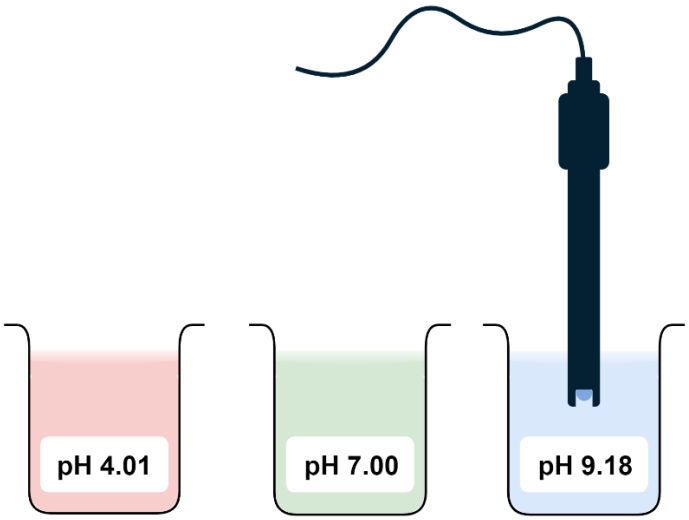
Note:

If the third calibration point is omitted, the calculated **acidic slope** should be manually applied to the **alkaline slope** as well to ensure consistent conversion accuracy across the full measurement range.

3-point calibration (Alkaline slope)

The **third calibration point** sets the system conversion slope for the **alkaline region**, providing full-range linearization and improved measurement accuracy for basic pH values.

- Complete the **2-point calibration** procedure (neutral point and acidic slope).
- Rinse the probe with distilled water and blot dry with a lint-free tissue.
- Immerse the probe in a third buffer solution, typically **pH 9.18** or **pH 10.01** (alkaline reference).
- Wait until the reading stabilizes.
- Store this reading as the **third calibration point** to define the **alkaline slope correction**.



Probe stabilizes in alkaline (pH 9.18) calibration solution

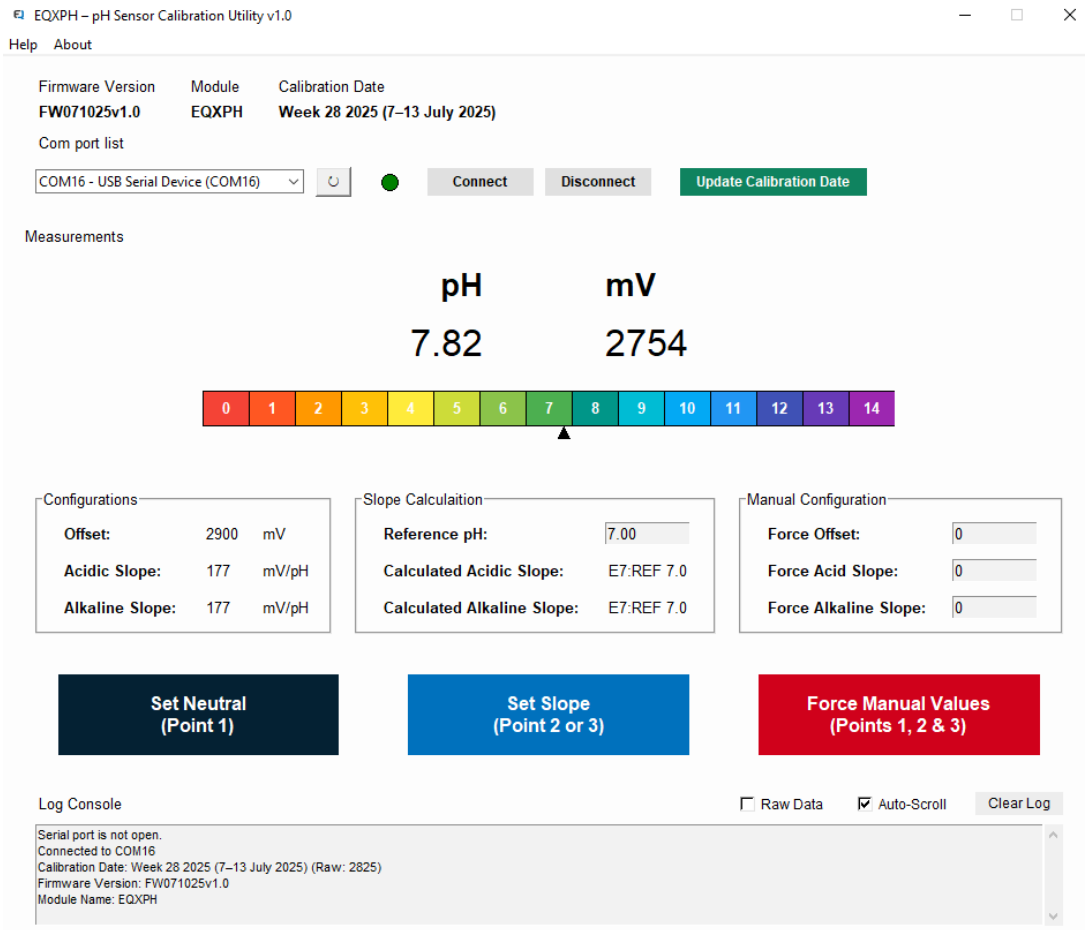
Calibration Utility

The pH calibration utility offers an easy intuitive UI for monitoring the measurements and pH conversions of the EQXPH module, for easy calibration.

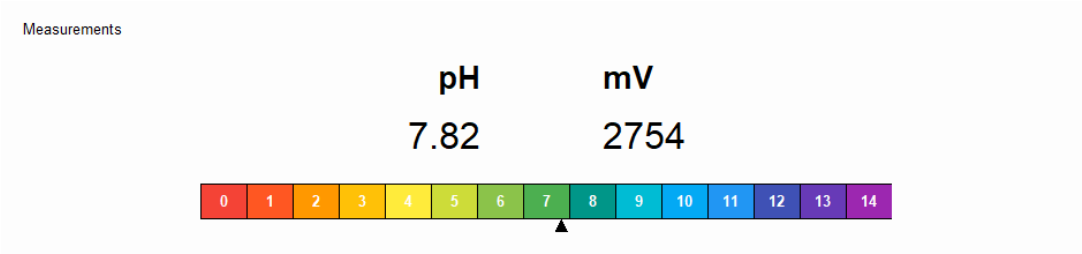
To run the EQXPH Calibration Utility, double click the .exe file.

First the EQXPH module must be connected on the EQSP32 unit and powered up. While the system is in normal operation, connect it to your laptop or PC via the USB-C cable, refresh the COM port list and select the EQXPH module's port.

When you press the "Connect" button, the connection indicator will turn green and the module's firmware version, module name and last calibration date will appear at the top of the window.



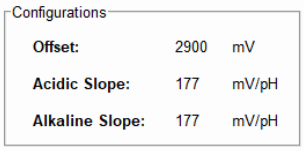
Measurements



The **Measurements** section shows the real-time pH value and the raw mV signal from the electrode after amplification. A color gauge below the values provides a quick visual reference of the pH level.

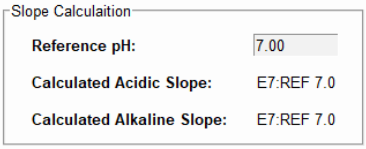
Configurations

The **Configurations** section displays the module's current **offset**, **acidic slope** and **alkaline slope** values stored in memory. These values define how the module converts the amplified electrode signal into a calibrated pH reading.



Slope calculation

The **Slope Calculation** section automatically calculates the new slope values by comparing the current electrode reading to your reference buffer solution. Enter the buffer's pH value, let the probe stabilize and the utility will display the calculated slope.



Manual configuration

The **Manual Configuration** section lets you manually enter offset and slope values if you prefer to override the calculated ones. Any parameter set as zero, is omitted from the force update. For example, if only offset and acid slope values are non-zero during manual entry, the alkaline slope will remain as is.

Calibration buttons

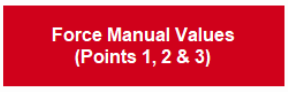
Below these sections, there are the three **calibration buttons**:

Set Neutral (Point 1): Saves the current measured mV value as the neutral offset, "zero" point. Follow "1-point calibration (Offset calibration)" procedure.

Set Slope (Point 2 or 3): After inserting the probe into a reference solution (Acidic or Alkaline), enter the reference pH value of the solution into "Reference pH" parameter of "Slope calculation".

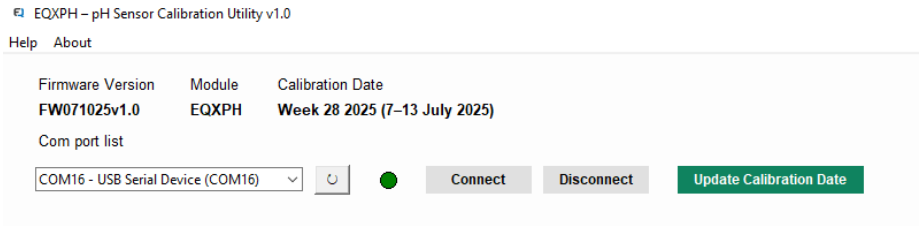
While the probe is stabilizing, the utility will display the calculated slope for this reference buffer. In around 1 to 2 minutes the probe will be stable. By pressing "Set Slope", the calculated value is stored in the module's flash memory.

Follow "2-point and 3-point calibration" procedures.



Force Manual Values: Send any values entered in the **Manual Configuration** section directly to the module.

After completing your calibration, click **"Update Calibration Date"** to save the current date in the module's memory. This helps track when the last calibration was performed.



The **Log Console** at the bottom records all commands, responses, and messages. You can toggle **Raw Data** to display all incoming lines from the module, enable or disable **Auto-Scroll**, and use **Clear Log** to clear the console.

BOOT BUTTON & FIRMWARE UPDATE

Boot Button

The boot button is only used for entering EQXPH module into firmware update/maintenance mode. To enter maintenance mode, disconnect all power sources from the EQXPH module (power down the EQSP32 and disconnect the USB-C from the module). Press and keep the boot button pressed using the pin. Then connect the module via USB-C to your laptop or PC. The module will then be powered on and enter maintenance mode.

Another option is to keep the boot button pressed while sending a reset command to the module via the serial terminal.

Once the module is in maintenance mode, it will be shown as a storage device. Drag and drop the desired .uf2 firmware file into the RPI-RP2 storage device. The new firmware will be flashed automatically.

Once the update is done, the unit will be automatically rebooted and ready to use.

After powering on the EQSP32 unit, the system will trigger the automatic detection process and the will be ready for normal operation.

MECHANICAL DIMENSIONS

All dimensions are measured in mm with a +/-0.1 tolerance.