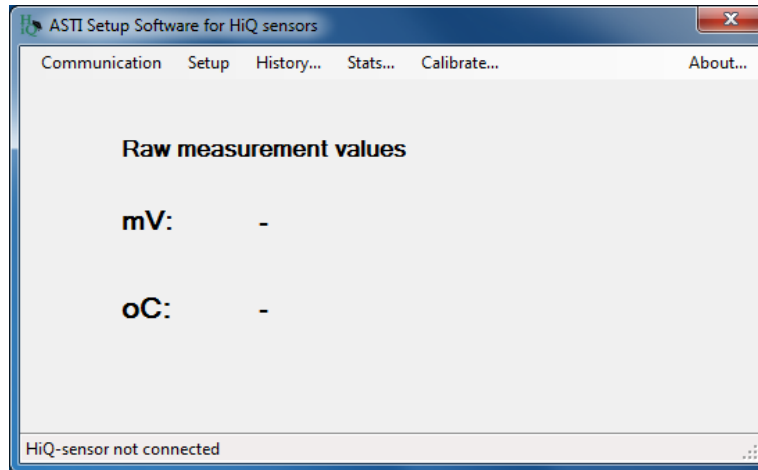# HiQ Digital System Setup & Calibration Windows Software Install and User Guide

Calibrate IOTRON™ & ZEUS ™ Smart Digital Sensors & Setup Configuration for 3TX-HiQ Intelligent Transmitters

Version 1.03

If no HiQ sensor is connected there will be dash blanks placeholders for the absolute raw mV and temperature readings (see screenshot above)

INSTALLATION GUIDE

Welcome to the ASTI Windows software package for smart digital sensor calibration and 3TX-HiQ intelligent transmitter setup and configuration. This software and guide are provided free of charge for use with the IOTRON™ series smart digital sensors and 3TX-HiQ intelligent transmitters. The HiQ software installer is self explanatory & requires no license or registration code. To receive the software installer complete the form at the following URL:

http://www.astisensor.com/cgi-bin/ttx.cgi

There are **two requirements** to use this software with ASTI 3TX-HiQ calibration, setup and configuration software:

1) First, you must have a **Windows computer or tablet with a .NET framework 4.0 and a compatible operating system (OS)** AND an available USB port. Only these Windows operating systems are currently supported:

- Windows XP SP3 (Not Officially Supported, Use on Best Faith Legacy Basis Only)
- Windows Server 2003 SP2
- Windows Vista SP1 or later
- Windows Server 2008 (not supported on Server Core Role)
- Windows Server 2008 R2 & Windows Server 2008 R2 SP1 (also not supported on Server Core Role)
- Windows 7 & Windows 7 SP1 or later
- Windows 8 & Windows 8.1
- Windows Server 2012
- Window 10 Professional (Tested on Microsoft Surface Pro Tablet for Touchscreen Compatibility)

Windows 7 and above computers & tablets already have the .NET framework 4.0 (or higher compatible version) installed. If your computer does not already have it, the software installer will automatically prompt you to install this dependency.

2) Your must have an ASTI supplied NEMA4X rated HiQ to Windows bridge box assembly. This assembly is available for use both in the lab or shop as well as out in the field with the portability package option. This HiQ to Windows bridge box assembly receives the HiQ4M snap connector termination of your IOTRON™ smart digital sensor via the installed HiQ4F female panel mount connector as the input signal. Power is supplied to the IOTRON™ smart digital HiQ sensor via a 9V battery inside of the assembly that has been pre-wired into the installed HiQ4F female panel mount connector. This assembly contains the necessary industrial grade RS-485 to USB converter pre-wired into a Q6FP female panel USB snap connector which serves as the output signal. Connection to the Windows computer or tablet is made with a USB male "A" cable terminated with a Q6M snap connector to interface with the output port on the HiQ to Windows bridge box. Find below a link to download additional details about this HiQ to Windows bridge box hardware assembly:

http://www.astisensor.com/Windows_Interface_Bridge_Box_for_Smart_Digital_HiQ_Sensors.pdf

HARDWARE INSTALLATION SEQUENCE FOR INTERFACING HiQ SENSOR TO SOFTWARE

1) Download and run installer for ASTI 3TX-HiQ calibration, setup and configuration software on a supported Windows computer or tablet (see page 1 in this manual for details).

2) Connect USB male "A" to Q6M snap connector to output port on bridge box. The output port is labeled & keyed so that the sensor input and the USB output cable cannot be accidentally cross-wired.

3) Connect USB cable male "A" cable to Windows computer or tablet. The driver for the RS-485 to USB converter in the HiQ to Windows bridge box assembly was loaded by the ASTI 3TX-HiQ installer.

4) Select COM port in "Communication" menu (see page 4 in this manual for details)

5) Connect IOTRON™ series smart digital HiQ sensor to HiQ4F panel mount input port on bridge box. The sensor input port is labeled & keyed so that the USB output cable cannot be accidentally connected.

6) Remove the protective cap from the sensor and rinse the tip with distilled or deionzied water.

7) Place sensing tip in solution to be measured. Allow sufficient time for the temperature and pH reading to stabilize. If the sensor was removed from active hot/cold field service this may take significant time.

8) If the hardware installation was successful the absolute raw mV and °C from the connector sensor will be shown in the main window display mode (see page 3 in this manual for details and for an example).

USER GUIDE

The ASTI Setup for HiQ Sensors Windows Software is specifically designed to be used with IOTRON™ series smart digital sensors and 3TX-HiQ intelligent transmitters. All functions performed by this software can also be accomplished by interfacing with a 3TX-HiQ intelligent transmitter instead. The choice to use this Windows software to accomplish the various tasks is simply a matter of choice and preference for the customer and facility.

As an overview, the software contains the following **menus** and **fields**, all of which are accessible starting with the main window once the application has been installed and launched.

MENUS (Top, left to right in the main window):	See page(s):
"Communication" menu • Select COM Port	4

"Setup" menu
• Configuration, Download to Sensor & Save to File all of the 3TX-HiQ Intelligent Transmitter Parameter Settings
    o   For IOTRON & ZEUS Smart Digital HiQ **pH** Sensors
    o   For IOTRON & ZEUS Smart Digital HiQ **ORP** Sensors
	
	4-6
	7

"History" menu • Shows the last five calibrations	17
"Stats" menu • Snapshot of the current sensor status	8
"Calibrate" menu • Fields, Options & "Measure" mode • Temperature considerations for pH buffers • Setup pH Buffer Values for Calibrations • Perform Calibrations on Smart Digital pH Sensors • Transfer Calibration Values to Digital pH Sensors • Perform & Transfer Calibrations on Smart Digital ORP Sensors	9 10-11 12-13 14 15 16

These menus and all available features therein are discussed in more detail in the following pages in the approximate order in which you will likely use them. The program loads to the main window from which the various menu options can be accessed. The raw absolute mV and temperature values will be displayed when a smart digital HiQ sensor is connected, the COM port is properly configured and all cable & wiring connections are correct (see screenshot below).
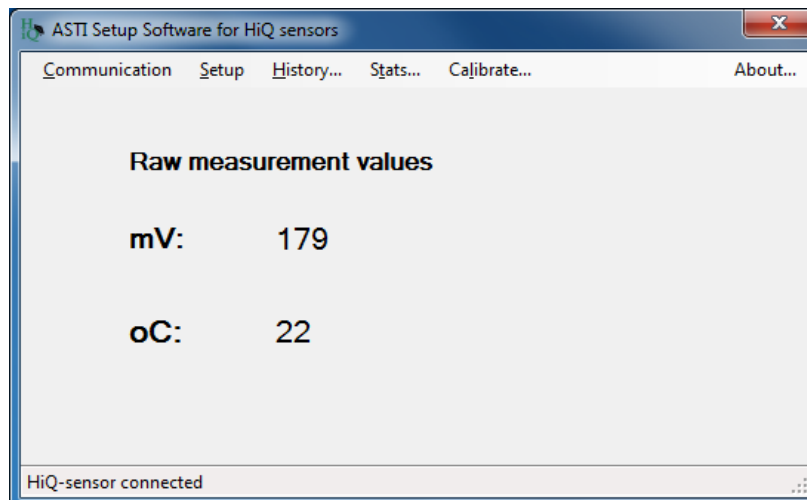
"Communication" Menu

Clicking on this menu will reveal all addressable COM port on the Windows PC or tablet on which this Setup Software for HiQ sensors is installed. Please select the COM port to which your industrial grade USB to RS-485 converter has been assigned. The FTDI driver is automatically loaded by the software installer. The COM port shown as "VCPX" should be selected where X is some integer that the virtual COM port "VCP" driver has assigned to your USB to RS-485 device. Please allow about one minute after connecting this USB cable from the HiQ to Windows bridge box assembly before starting the Setup Software for HiQ sensors so that the Windows OS has sufficient time to assign this COM port. When the COM port is properly selected the raw mV & temperature values will be shown from the connected HiQ sensor. The USB cable for this connection for the industrial grade USB to RS-485 converter inside your HiQ to Windows bridge box assembly is plug and play and so may be inserted and removed at will. Obviously the cable must stay connected for the entire time that the software is in use. Removing the cable and reinserting it may cause the virtual COM port assignment to change so please check that you COM port selection is correct from this communication menu each time.

"Setup" Menu – Part 1 of 3

Clicking on this menu will access the drop-down to select the HiQ-pH (shown below) or HiQ-ORP configuration screen. Although you can attempt to select any available sensor type from the drop-down, only the setup screen appropriate to your connected sensor type (pH or ORP) will successfully load with all other choices returning an error notification. If you are unsure of the type of HiQ sensor that you are connecting, this information can be found at the top of the "Stats" menu.
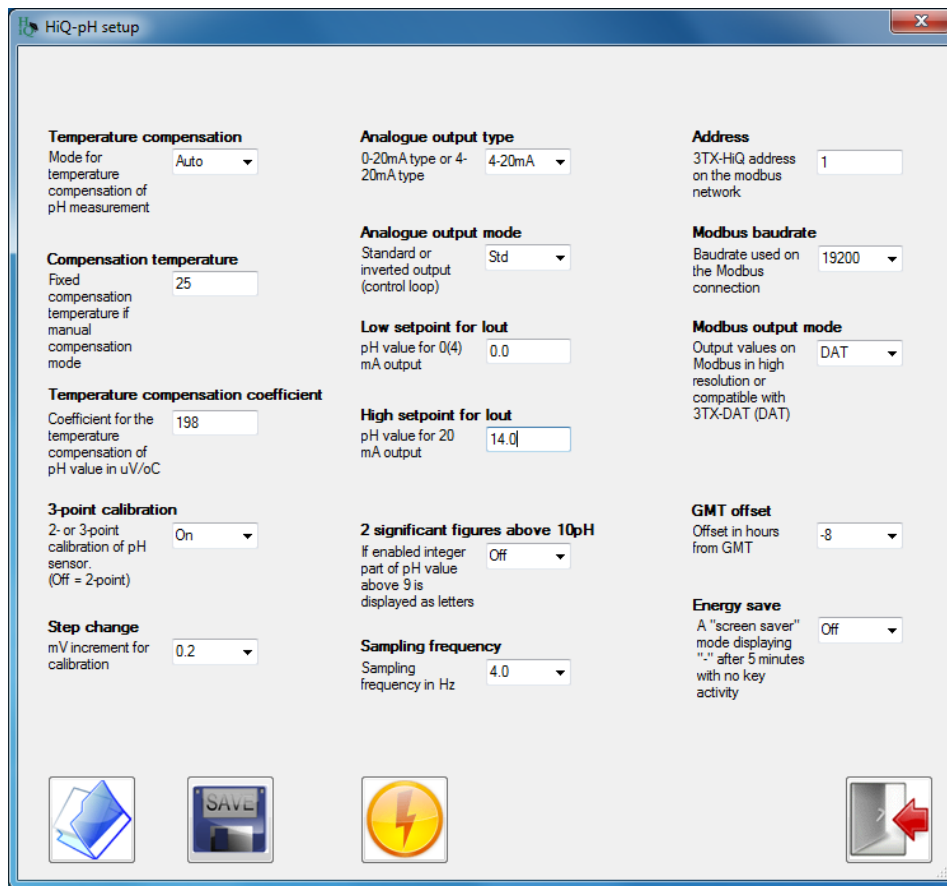
The values for your connected HiQ sensor may differ from what is shown above depending upon the configuration that was performed at the ASTI factory and/or your local distributor or agent. The assigned value or setting can be modified for any given parameter to an alternate choice within the permissible range or limits at any time as desired. Refer to the 3TX-HiQ transmitter documentation for a more detailed explanation of each parameter available in the given setup menu.

4

"HiQ-pH Setup" Menu – Part 2 of 3
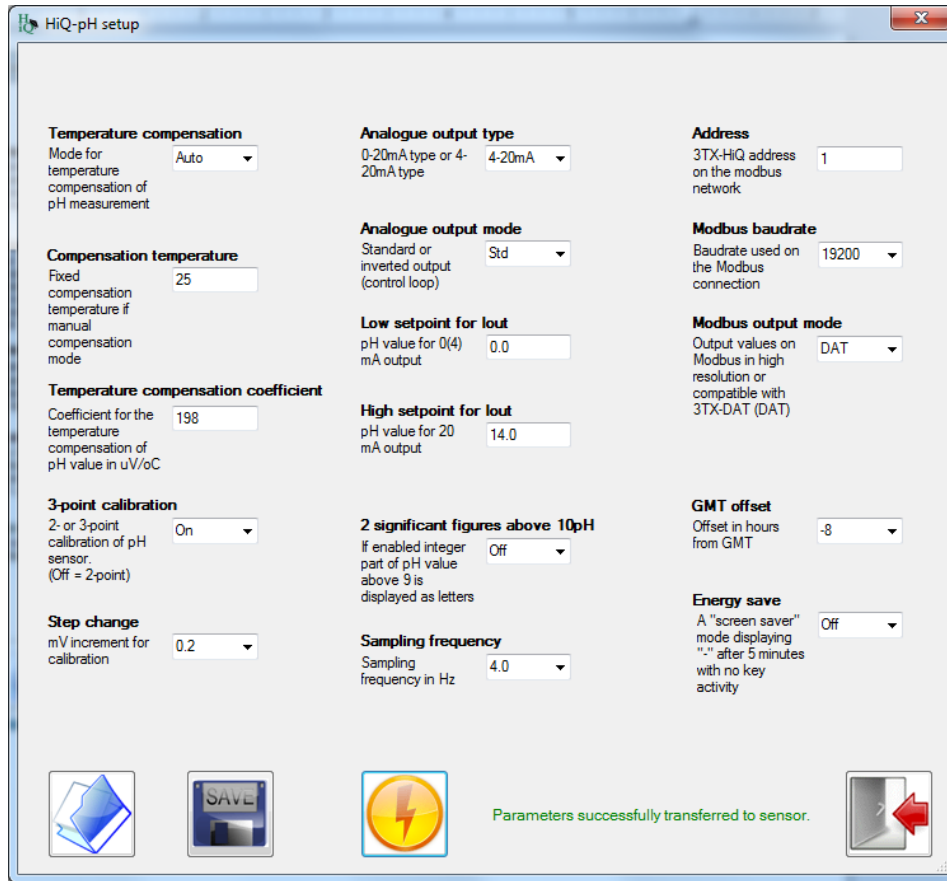
The setup values for the 3TX-HiQ-pH transmitter configuration as shown in this menu are a working copy. The values were initially loaded from the connected HiQ sensor. Any of the parameter settings and values may be changed as desired but these changes will not be reflected in the connected sensor until the values are loaded using the "flash" icon. When the configuration is loaded a message indicating "Parameters successfully transferred to sensor" will be briefly shown. It is best practice to save a configuration to file before loading it onto the connected HiQ sensor for tracking purposes. The filename chosen for the configuration in this displayed screenshot is shown for reference purposes.

The setup configuration file created is in ASCII text format. This configuration file can later be imported as a complete 3TX-HiQ-pH configuration to be loaded onto other HiQ-pH sensors to create a multiple smart digital pH sensors with the same 3TX-HiQ-pH transmitter configuration. Alternatively these configuration files can be used for purposes of tracking the 3TX-HiQ-pH transmitter configurations of a given installation location over the course of time including the ability to revert to a previous setup if desired. In this second archival tracking type use, it is recommended to name the file in a logical manner to reflect the date the configuration file was created and the associated installation point in the plant.

A configuration saved onto the HiQ-pH sensor can be loaded onto a 3TX-HiQ-pH transmitter. This is done by parameter P50 (follow instructions in the 3TX-HiQ-pH manual). Loading a configuration requires an affirmative user action via parameter P50 and is not done automatically. In contrast the calibration values are automatically loaded whenever a smart digital HiQ sensor is connected to a 3TX-HiQ-pH intelligent pH transmitter. Automatic loading for the calibration values but NOT automatically loading the configuration is an intentional design scheme. The automatic loading of the calibration values means that no interaction of any kind is needed once the IOTRON™ series smart digital pH sensor is calibrated with this Windows software or else with a spare 3TX-HiQ-pH intelligent pH transmitter. The configuration, on the other hand, should not be modified on the transmitter unless specifically desired by the user to ensure interoperability of sensors for installations with differing configurations. The 3TX-HiQ-pH transmitter configuration can be loaded onto a connected HiQ sensor via P47 by following instructions in 3TX-HiQ-pH manual and then saved to file with this software.
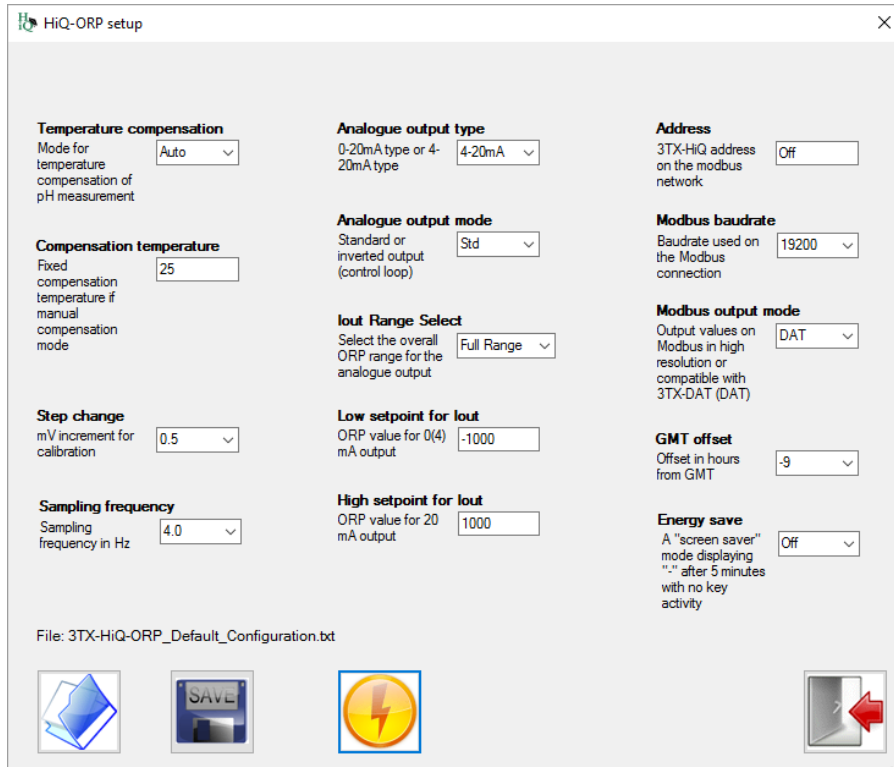
"HiQ-pH Setup" Menu – Part 3 of 3
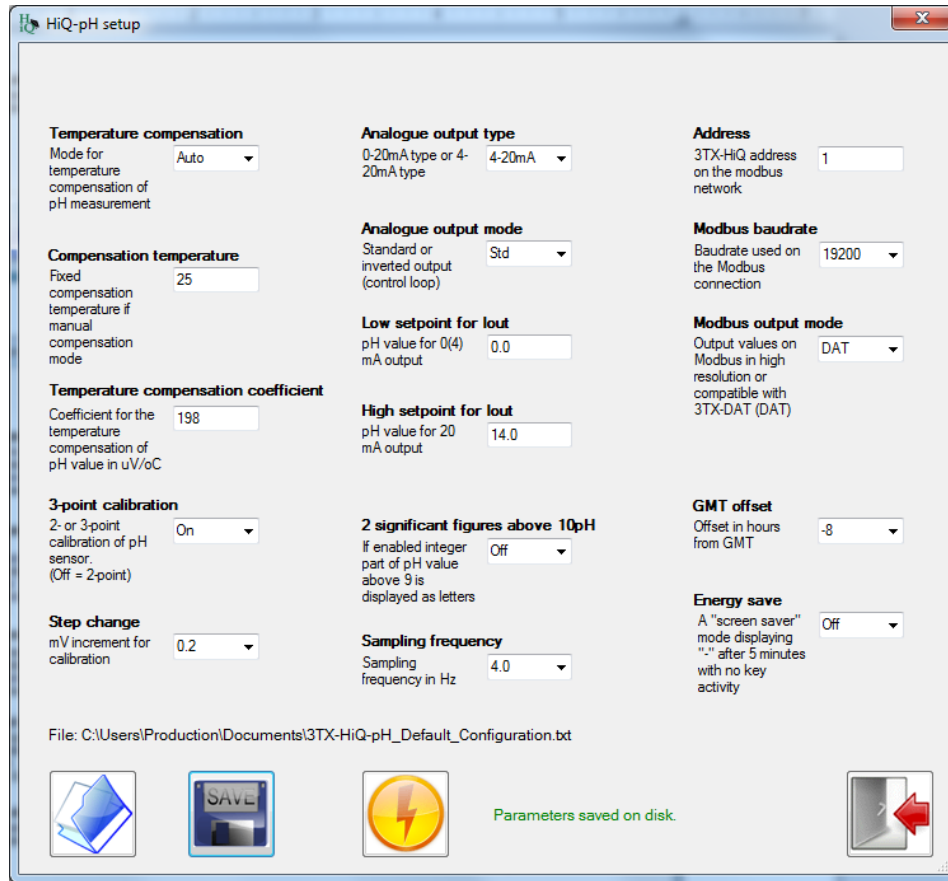
Shown above is a screen where the values for each parameter from this setup menu are saved to a setup configuration file in ASCII text format. The file extension should be *.txt and the location where this file is saved is shown in the window. When the configuration is saved a message indicating "Parameters saved on disk" will be briefly shown. The various uses of this configuration are described in the preceding page.

If you desire to load a different configuration on your IOTRON™ series smart digital pH sensor than what is presently loaded and displayed on this HiQ-pH setup window from a previously prepared configuration this can be done by selecting the "open" file icon. From this dialog box select the configuration file of your choice that you wish to load. The ASTI factory may request that the currently employed configuration for your 3TX-HiQ-pH transmitter to be emailed for support and diagnostic purposes. The ability to save the HiQ transmitter configuration to a text file through this menu facilitates this type of remote support capability to assist with optimization and troubleshooting of your field setup.

The HiQ configuration system features are available by pairing the smart digital HiQ sensor with the intelligent 3TX-HiQ transmitter, selecting the desired parameter settings and saving this configuration to a Windows file or else invoking a shadow copy on the 3TX-HiQ transmitter. The HiQ configuration system provides systematic & advanced management of the your field installations without the high cost and complexity of the HART®, Profibus or FOUNDATION™ fieldbus digital protocols. In addition, all 3TX-HiQ transmitters come standard with the RS-485 MODBUS RTU digital output so commissioning is as simple as daisy-chain wiring together all installed 3TX-HiQ transmitters and assigning the node address for each module. The MODBUS protocol allows for the flexibility to add or remove nodes at will and avoid any potential ground loops issues. The HiQ configuration system allows for very detailed tracking of both the current and previous complete transmitter configuration for each installation point in a simple and low-cost manner.

When completed with this menu simply click on the "exit" icon to return back to the main menu.
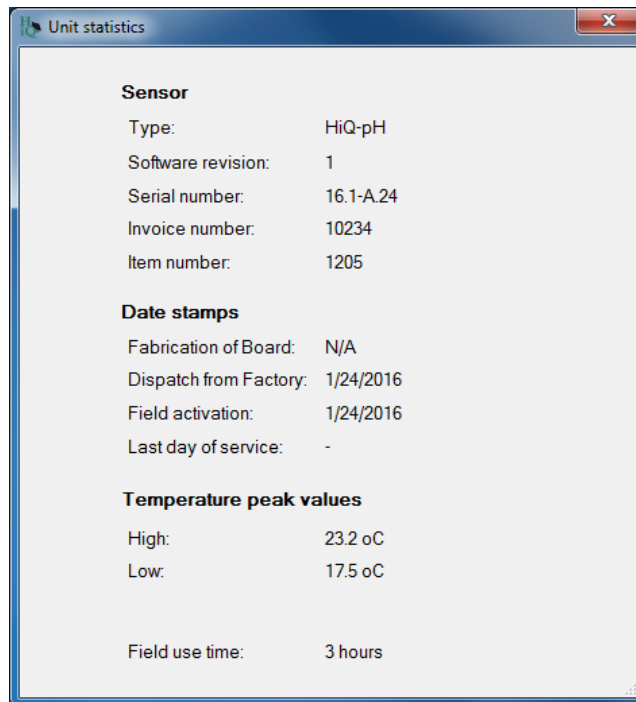
"HiQ-ORP Setup" Menu

While all of the comments and notes from the preceding three pages for the setup of the HiQ-pH sensors are generally also applicable to the setup of the HiQ-ORP sensors there are naturally some differences owing to the nature of the ORP versus pH sensor type. For example the ORP measurement is not temperature compensated. While the ORP is in fact very temperature dependent (much more than for pH) there exists no systematic or universal temperature compensation scheme that can be employed since each particular system will have its on behavior. If temperature mode chosen is manual ("set") the temperature from the sensor will not be recorded and the fixed temperature entered will be reported.

The typical HiQ-ORP setup values for the 3TX-HiQ-pH transmitter configuration as shown in this menu above are a working copy. The values were initially loaded from the connected HiQ-ORP sensor. The particular values for your sensor may vary depending upon how it was setup at the ASTI factory and/or if any changes were made after time of dispatch. All of the values for each parameter can be modified as desired within the boundary condition limits detailed in the 3TX-HiQ-pH transmitter documentation. As one example the minimum difference between the low and high setpoints for the analog 0-20 or 4-20 current loop output is 100mV. The default full range configuration of -1,000 to +1,000mV is shown above. The HiQ-ORP setup can be saved as a file or else an existing previously saved configuration can be loaded just as with the HiQ-pH setup. Any of the parameter settings and values may be changed as desired but these changes will not be reflected in the connected sensor until the values are loaded using the "flash" icon. When the configuration is loaded a message indicating "Parameters successfully transferred to sensor" will be briefly shown.

The HiQ configuration system features are available by pairing the smart digital HiQ sensor with the intelligent 3TX-HiQ transmitter, selecting the desired parameter settings and saving this configuration to a Windows file or else invoking a shadow copy on the 3TX-HiQ transmitter. The HiQ configuration system provides systematic & advanced management of the your field installations without the high cost and complexity of the HART®, Profibus or FOUNDATION™ fieldbus digital protocols. In addition, all 3TX-HiQ transmitters come standard with the RS-485 MODBUS RTU digital output so commissioning is as simple as daisy-chain wiring together all installed 3TX-HiQ transmitters and assigning the node address for each module. The HiQ configuration system allows for very detailed tracking of both the current and previous complete transmitter configuration for each installation point in a simple and low-cost manner.

When completed with this menu simply click on the "exit" icon to return back to the main menu.

HiQ-pH & HiQ-ORP "Stats" Menu

Unit statistics

Sensor

Type:	HiQ-pH
Software revision:	1
Serial number:	16.1-A.24
Invoice number:	10234
Item number:	1205

Date stamps

Fabrication of Board:	N/A
Dispatch from Factory:	1/24/2016
Field activation:	1/24/2016
Last day of service:	-

Temperature peak values

High:	23.2 oC
Low:	17.5 oC

Field use time:	3 hours

An explanation for each field in this Windows "Stats" menu is below along with the parameter on your 3TX-HiQ-pH transmitter that corresponds for cross-reference purposes shown in parentheses (PXX). None of the fields in this menu can be modified. The information shown is to provide as a "snapshot" of the connected sensor. To share a screen of this "Stats" menu simply click on the window with your mouse and then use the "Alt+PrintScreen" key sequence on your keyboard. This will capture an image of this "Stats" menu as you see it on your screen and allow you to copy it into a document or email to send for support & collaboration purposes. The ASTI factory or agent may request a screenshot of this "Stats" menu to assist with any questions regarding the field commissioning and use to date of the HiQ sensor.

Sensor Statistics:
- Type: — Either HiQ-pH or HiQ-ORP depending upon the type of connected sensor
- Software Revision (P33): — Per firmware that has been loaded onto your HiQ digital sensor board
- Serial Number (P04): — For complete traceability of the individual sensor through the service life-cycle
- Invoice Number (P30): — For traceability of procurement and ordering back to the ASTI factory
- Item Number (P03): — Completely defines all features and capabilities of given sensor

Date Stamps:
- Dispatch from Factory (P26): — When the smart digital HiQ-pH or HiQ-ORP sensor was shipped
  - The ASTI factory 1-year shelf-life warranty begins from this date
- Field Activation (P27): — The first date that your pH/ORP sensor was connected to a 3TX-HiQ transmitter
- Last day of service (P28): — The last date that your pH/ORP sensor was connected to a 3TX-HiQ transmitter
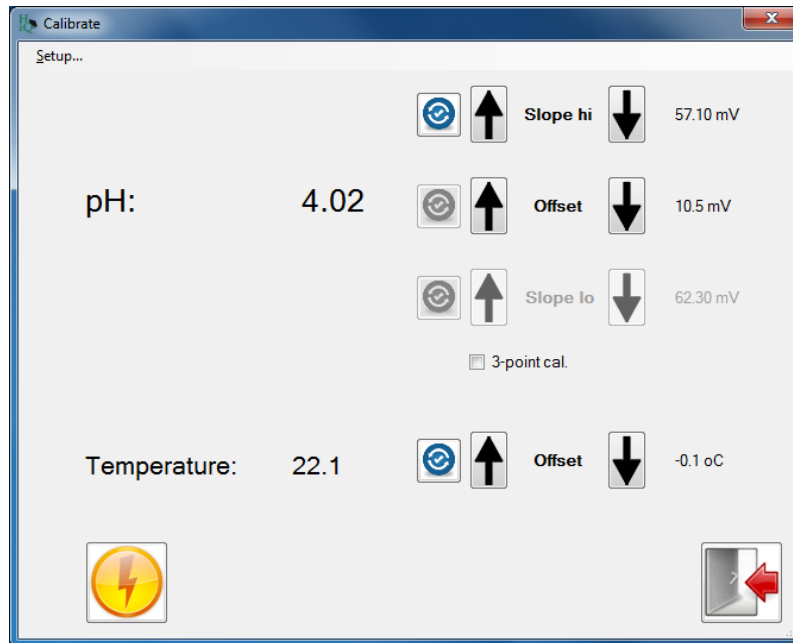
Temperature Peak Values:
- High (P39): — Highest temperature ever experienced by sensor after field activation (P27)
- Low (P40): — Lowest temperature ever experienced by sensor after field activation (P27)

Field Use Time:
- Parameter (P29): — The total time HiQ sensor has been energized after field activation (P27)

HiQ-pH "Calibrate" Menu – Overview of Fields, Options & "Measure Mode"

Clicking on this menu will load the screen shown above when a HiQ-pH sensor is connected. The pH and temperature values displayed are based upon the currently stored calibrations for the connected sensor. Before performing a calibration click on the "Setup" menu to allow you to configure the calibration scheme to be employed for your connected IOTRON™ series smart digital HiQ-pH sensor. The setup of the calibration scheme is critical to achieving an optimal measurement result and discussed in depth in subsequent sections with best practice recommendations. The best practice calibration procedures for various types of pH measurement installations are detailed in later sections of manual.

Overview of Display Fields:
Displayed **pH:** and **Temperature**: values shown are computed based upon the current calibration values as shown on the far right. Calibration values display upon launch in this window are loaded from the connected sensor. Changes to the calibrations in this menu are not used in the 3TX-HiQ-pH transmitter until loaded onto sensor with "flash" icon which is detailed in the later "Transfer Calibration Values to pH sensor" section.

Slope Calibration Options:
Your smart digital HiQ pH sensor is capable of operating in two slope modes:
1) The first mode is when the P08 3-point calibration option is disabled ("Off"). In this mode a single slope is used across the entire pH range. This mode is sometimes also called 2-point calibration or single-slope. This mode is only recommended for applications where you will rarely if ever cross the pH7 reading.
2) The second mode is when P08 3-point calibration option is enabled ("On"). In this case click on the "3-point cal" checkbox & perform a separate slope calibration for acidic (below pH7) and alkaline (above pH7) conditions. This mode is often called "Dual-Slope" because one slope is used when below pH7 and another above pH7.

"Grab Sample" Calibration:
The HiQ pH sensor can be adjusted to agree with a separate laboratory determined reference value for any given process solution. Such adjustment should always be done in the 'Offset' mode after all pH buffer calibrations are performed.

"Measure" Mode:
This calibrate menu can be used as a "measure" mode. This requires that the pH sensor already has been properly calibrated before and that no changes are made to the calibration values before measurement of the unknown sample. The displayed pH and temperatures values can be recorded as would be the case for any laboratory or portable pH meter.

Temperature Considerations for Calibrating pH Sensors with pH Buffers – Part 1 of 2

Exact pH Values of the NIST Traceable pH buffers at Various Temperatures
Nominal pH Buffer Designation @ 25°C Shown in Gray at Top of Column

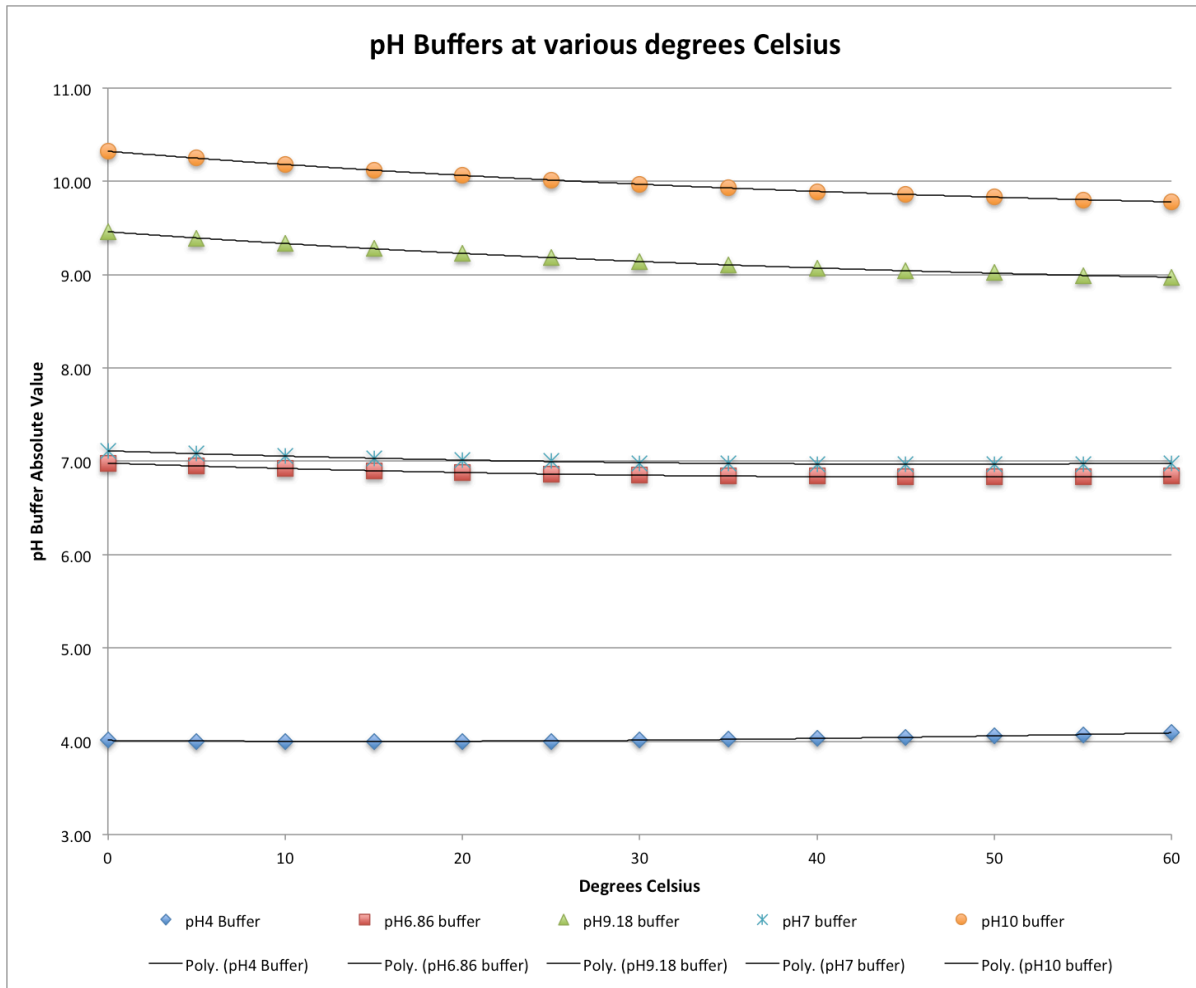| Temp °C	1.68	4.00	6.86	7.00	9.18	10.01*	12.45*
0	1.67	4.01	6.98	7.11	9.46	10.32	13.42
5	1.67	4.00	6.95	7.08	9.39	10.25	13.21
10	1.67	4.00	6.92	7.06	9.33	10.18	13.00
15	1.67	4.00	6.90	7.03	9.28	10.12	12.81
20	1.68	4.00	6.88	7.01	9.23	10.06	12.63
25	1.68	4.00	6.86	7.00	9.18	10.01	12.45
30	1.68	4.01	6.85	6.98	9.14	9.97	12.29
35	1.69	4.02	6.84	6.98	9.10	9.93	12.13
40	1.69	4.03	6.84	6.97	9.07	9.89	11.98
45	1.70	4.04	6.83	6.97	9.04	9.86	11.84
50	1.71	4.06	6.83	6.97	9.02	9.83	11.71
55	1.72	4.07	6.83	6.97	8.99	9.80	11.57
60	1.72	4.09	6.84	6.98	8.97	9.78	11.45

NIST traceable pH buffers are the most commonly used methods for calibration of industrial pH sensors. On each pH buffer bottle is written the exact pH value of the buffer at variety of temperature conditions. Listed above are the exact pH values for the most commonly used pH buffers between 0 and 60 °C. When using the ASTI Windows HiQ Digital System Setup & Calibration Software for calibration of your IOTRON™ series Smart Digital HiQ type digital pH sensors you should enter the exact pH value at the temperature for your calibration conditions. Using the temperature reported from the sensor find the exact pH value for the buffer that you are using and enter this into the "Setup" portion of your calibrate menu (subsequent section details how to do this).

NOTE: The the 3TX-HiQ-pH intelligent transmitter corrects for the temperature induced change to the exact pH value of the buffer automatically when pH sensor calibrations are done in the autoread mode for the 4.00, 6.86, 7.00, 9.18 and 10.01 pH buffers shaded in green above. See page 3 of 3TX-HiQ-pH manual for additional details and instructions.

To use any pH buffer besides 4.00, 6.86, 7.00, 9.18 or 10.01 you will need to account for the temperature induced shift of the pH value for the buffer in both the Windows software and the 3TX-HiQ-pH transmitter. Two examples are above for such alternate pH buffers. On the far left is the 1.68 pH buffer for calibration of sensors for low pH measurements and on the far right is the 12.45 pH buffer for calibration of sensors for high pH measurements. There are no reliable pH buffers below 1.69 and above 12.45 and so specialized and custom calibration schemes needed to be used for these situations. Inquire to the ASTI factory if you plan to measure consistently below pH=1.0 or above pH=13.0 for special assistance. As can be seen from mere inspection the temperature dependence of low pH buffers is much more significant than for high pH buffers. Similarly for process solutions with high pH the temperature induced pH dependence may be quite significant and should be considered when trying to control such systems with fluctuating temperature. Process solutions with relatively weak ionic strength (low conductivity) are also rather prone to higher temperature induced pH shifts.

When calibrating with these pH buffers it is recommended to set P23 variable to "On" to show two decimals above pH10

Temperature Considerations for Calibrating pH Sensors with pH Buffers – Part 2 of 2

pH Buffers at various degrees Celsius

Legend: pH4 Buffer, pH6.86 buffer, pH9.18 buffer, pH7 buffer, pH10 buffer, Poly. (pH4 Buffer), Poly. (pH6.86 buffer), Poly. (pH9.18 buffer), Poly. (pH7 buffer), Poly. (pH10 buffer)

The 3TX-HiQ-pH intelligent pH transmitter corrects for the temperature dependence of the pH 4.00. 6.86, 7.00. 9.18 and 10.00 buffers in the automatic calibration mode. In contrast the temperature impact of exact pH value of the buffer must be addressed in the calibration setup window when performing the pH sensor calibration with this Windows software. The examples for the pH buffer schemes in the following pages show how this is done for visualization purposes at temperatures of 15, 25 and 35 °C. This Windows software can autoread to any arbitrary user defined pH value for Offset, Slope Low (Acidic) or Slope High (Alkaline). In this way this Windows software is not limited to 4.00. 6.86, 7.00. 9.18 and 10.00 pH buffers for calibration in the convenient autoread mode.

Temperature compensation only accounts for the change in the mV response of the pH sensor itself with temperature. The type of temperature induced shifts such as those demonstrated in the table above for the pH buffers are NOT corrected in default Nernstian temperature compensation scheme. For process solutions the change in the pH value with temperature can be significantly more pronounced than for pH buffers which are inherently designed to shift in only the most minimal way due to changes in temperature, dilution, evaporation and other typical conditions in field use. Thankfully the 3TX-HiQ-pH transmitter allows for a user defined temperature compensation coefficient to account for the NET temperature effects. The temperature impact on the pH sensor and the temperature impact on the measured solution cannot be cleanly separated (deconvoluted). It is, however, possible to determine the effective net mV per °C change and enter this as a custom temperature compensation coefficient (P32). Contact the ASTI factory for assistance with such situations requiring special temperature compensation schemes. The default value for the P32 temperature compensation variable is the classical Nernstian 198µV (0.198mV) per °C with the allowable range of 000-999 µV to support most any custom value for your given process installation situation.
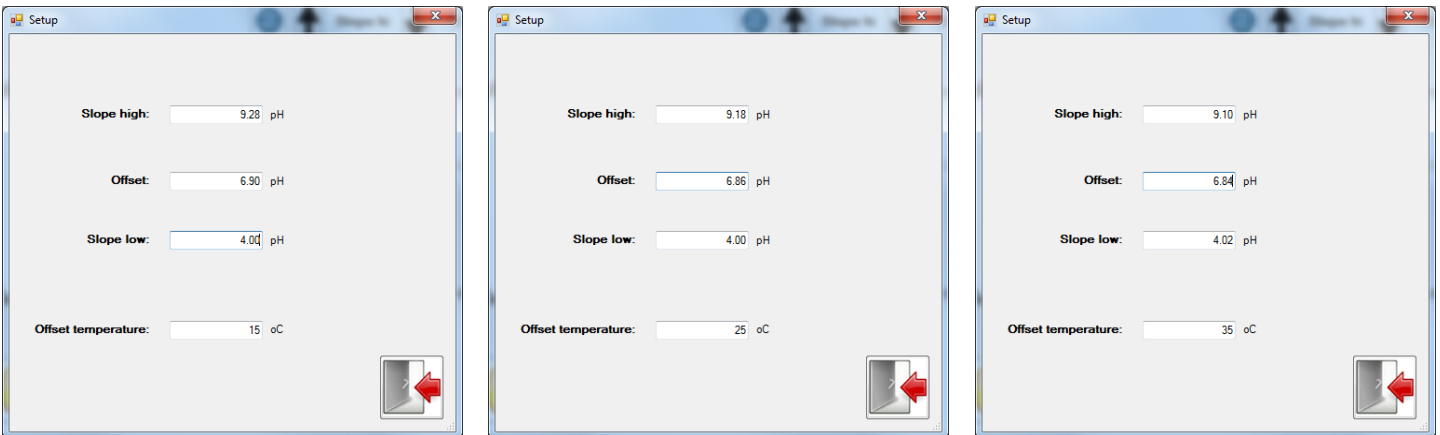
HiQ-pH "Calibrate" Menu – Sample pH buffer schemes for Autoread Setup – Part 1 of 2

CALIBRATION SCHEME # 1 – Typical for most installations in the USA
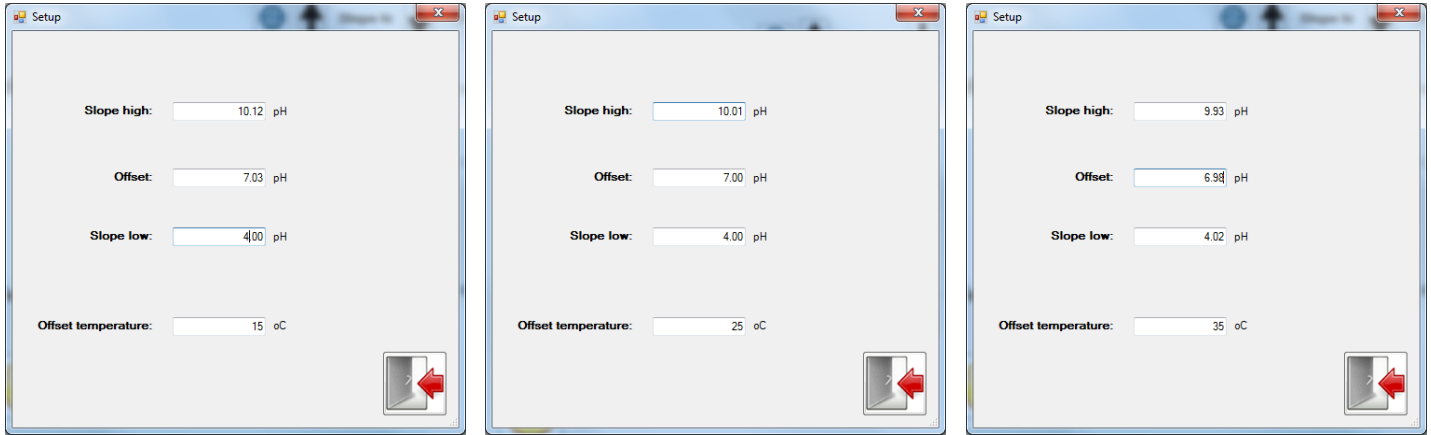
Sample calibration value setups for 4.00, 7.00 and 10.01 pH buffers at 15, 25 & 35 °C are shown above for visualization purposes. This is the most common pH buffer scheme for most customers in the USA. The 10.01 pH buffer must be used carefully since it is more prone to shifting substantially more than the very stable 4.00 or even the 7.00 pH buffer. Intrusion of carbon dioxide into the 10.01 pH buffer from the atmosphere is the main culprit creating an erroneous non-temperature induced shift in pH by exceeding the buffer capacity.
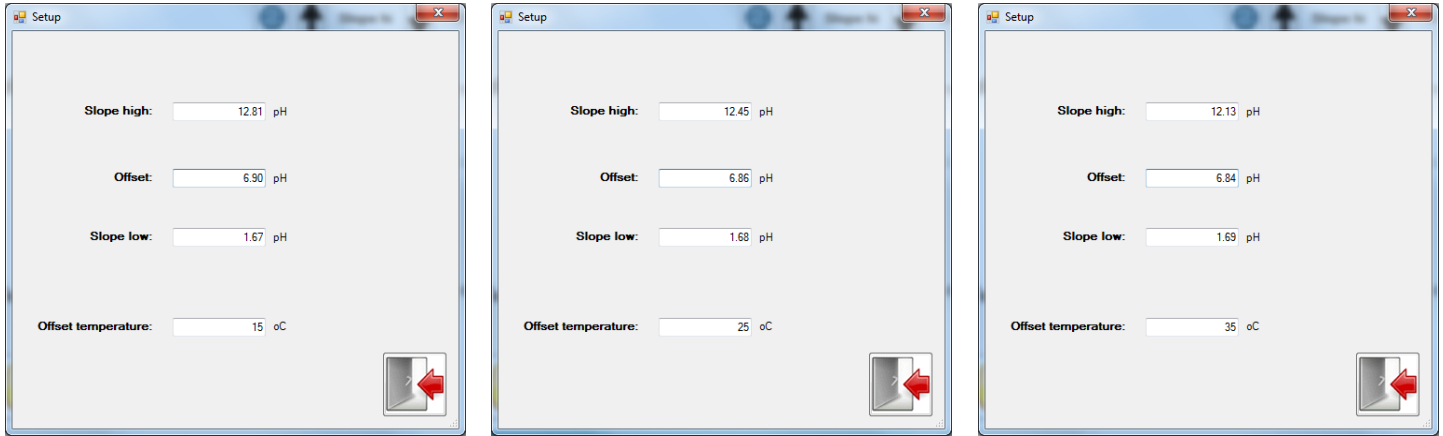
CALIBRATION SCHEME # 2 – Typical for most installations in Europe

Sample calibration value setups for 4.00, 6.86 and 9.18 pH buffers at 15, 25 & 35 °C are shown above for visualization purposes. This is the best practice pH buffer scheme for most pH measurements that do not commonly go much below pH4 and or else much above pH10. The 6.86 & 9.18 pH buffers are most stable than the 7.00 & 10.01 pH buffer counterparts but are still more prone to shifting then the very stable 4.00 pH buffer.

HiQ-pH "Calibrate" Menu – Sample pH buffer schemes for Autoread Setup – Part 2 of 2

CALIBRATION SCHEME # 3 – For batch style installations where pH can vary quite considerably

Setup	Setup	Setup
Slope high: 12.81 pH	Slope high: 12.45 pH	Slope high: 12.13 pH
Offset: 6.90 pH	Offset: 6.86 pH	Offset: 6.84 pH
Slope low: 1.67 pH	Slope low: 1.68 pH	Slope low: 1.69 pH
Offset temperature: 15 oC	Offset temperature: 25 oC	Offset temperature: 35 oC

Sample calibration value setups for 1.69, 6.86 and 12.45 pH buffers at 15, 25 & 35 °C are shown above for visualization purposes. This is the best practice pH buffer scheme for batch type process applications that can often go below pH2 and above pH12. The 1.69 and 6.86 pH buffers are quite stable but the 12.45 pH buffer shifts in value quite easily. Great care should be taken when using the 12.45 buffer to ensure accurate results.

TEMPERATURE OFFSET CALIBRATION SETUP FOR AUTOREAD:

The autoread value for the temperature offset calibration is entered in the same window as the settings for the three pH buffer values. **Selection of the setup temperature should always be done <u>FIRST</u> as it is necessary to properly define the pH values of the buffers used to ensure best calibration results.** It is best practice to wait until the temperature reading on the sensor is no longer moving before selecting the setup temperature and starting calibration(s) with pH buffers. The temperature of the sensor may take some time to reach the ambient conditions of the pH buffer solution(s) if it was previously installed into field service at conditions that are significantly below or above the ambient temperature.

GENERAL BEST PRACTICE COMMENTS FOR CALIBRATION WITH pH BUFFERS

Only the amount of buffer required for the given calibration should be dispensed. Buffers should not be reused to avoid dilution & cross-contamination. Buffers should not be left exposed to air for prolonged periods of time to avoid the impact of dissolved carbon dioxide from the atmosphere and other potential decomposition pathways. Buffers should be stored in a cool, dry location away from light and chemicals. The pH sensor should at a stable ambient temperature before entering the exact values for the pH buffers used.

HiQ-pH "Calibrate" Menu – Perform Temperature & pH Calibrations

<u>*SUMMARY OF CORRECT SEQUENCE FOR CALIBRATION OF HiQ pH SENSORS WITH BUFFERS*</u>

1. **Enter exact pH values** at the stable ambient temperature for autoread pH calibration setup *(see page 9)*
2. Perform **pH 'Offset'** Calibration (Autoread or Manual)
3. Perform **pH 'Slope lo'** Calibration (Autoread or Manual)   *AND/OR*
4. Perform **pH 'Slope hi'** Calibration (Autoread or Manual)
5. If desired, perform adjustment for agreement with laboratory reference value of process grab sample with pH 'Offset' mode. Account for all temperature induced effects if this last step is performed.
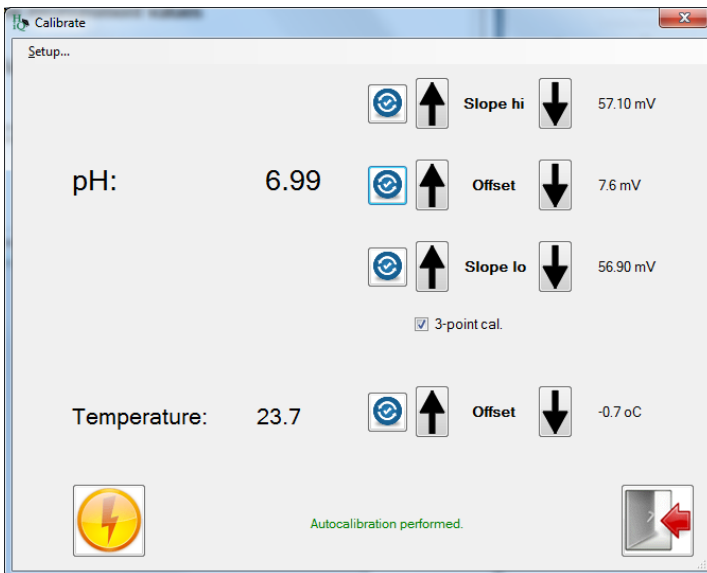
*Step 1 - Perform the pH buffer "Offset" calibration near pH7*
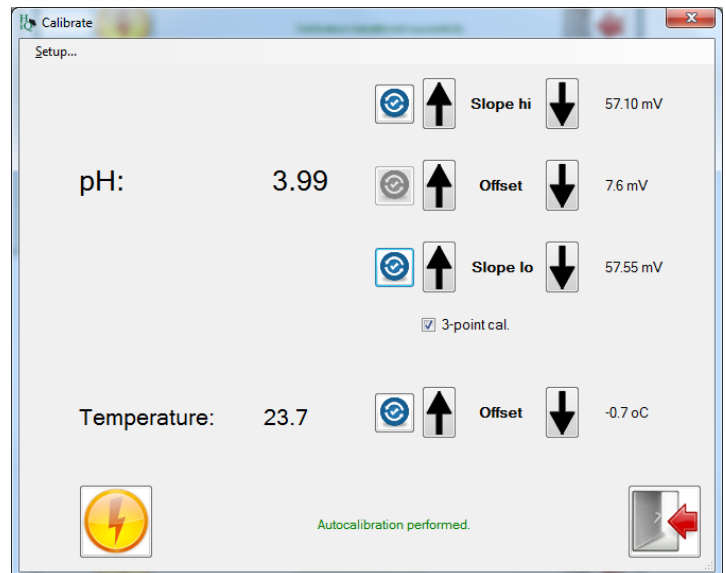
Step 2 - Perform the "Slope Lo" calibration in the acidic range
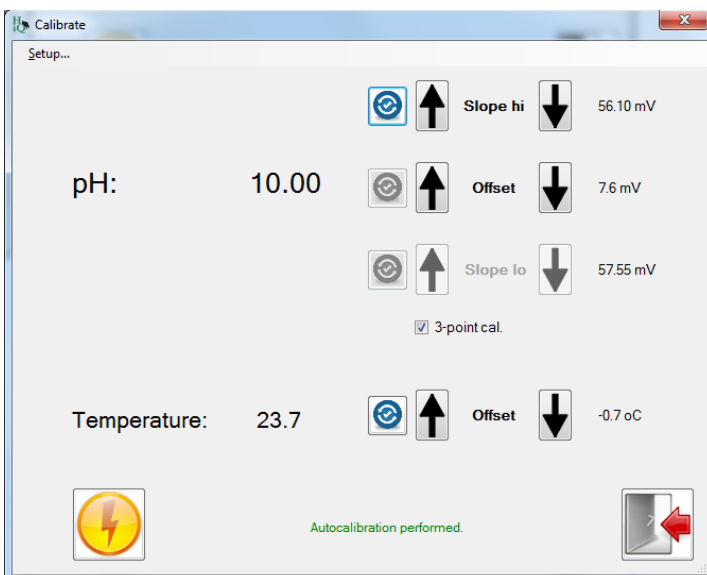
Step 3 - Perform the "Slope Hi" calibration in the alkaline range

- Temperature stability of both the sensor and measured solution is required for good calibration of pH sensor. Sensor temperature should be stable and the same as ambient condition for best results. **Temperature offset calibration (if it is performed at all) should always be done BEFORE ALL pH buffer calibrations.**

- Manual calibration is done by clicking on the 'Up' or 'Down' buttons until the desired value is achieved.

- Automatic calibration (a.k.a. autoread) is done by clicking on the blue icon next to the calibration to be performed. The software will not allow any other actions while this autoread calibration is in process.

- If the autoread calibration was successful the message "Autocalibration performed" will be displayed for a brief period of time as notification.

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HiQ-pH "Calibrate" Menu – Transfer Calibration Values to pH sensor
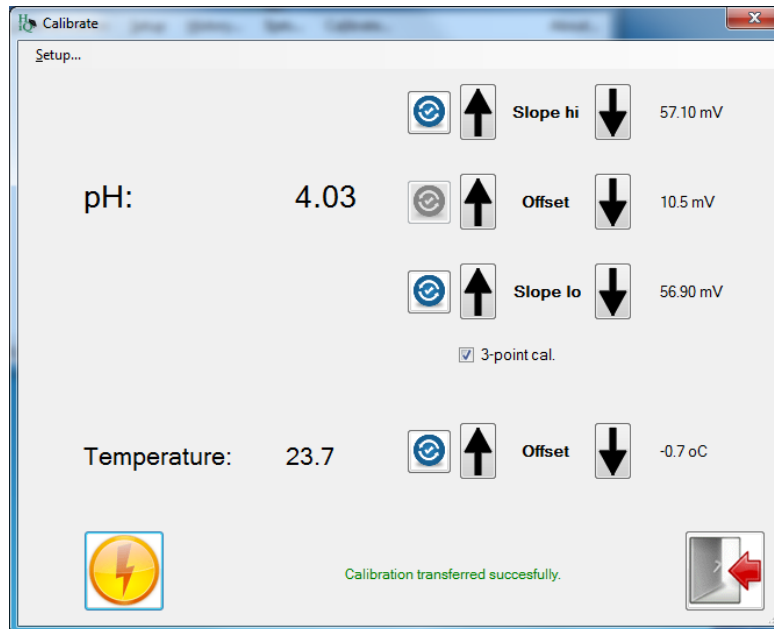
The calibration values are loaded onto the connected sensor by clicking on the "flash" icon. If this operation succeeds the message "Calibration transferred successfully" is displayed for a period of time as notification.

The **pH 'Offset'** calibration shown becomes **P16**, the **pH 'Slope lo'** value shown becomes **P17** and the **pH 'Slope hi'** shown becomes **P18** after calibration values are transferred to the smart digital HiQ pH sensor and it is connected to the mating field 3TX-HiQ-pH intelligent transmitter. The **Temperature 'Offset'** value shown will also loaded and can be seen as **P38**. There also exists display features to see these calibration values from the main LED modes of the 3TX-HiQ-pH intelligent transmitter as detailed on page 4 of the respective manual.

Calibration values are loaded AUTOMATICALLY when the smart digital HiQ pH sensor is connected to mating field 3TX-HiQ-pH intelligent transmitter. This means that no user action of any kind whatsoever is required when swapping out HiQ smart digital sensors in the field. After interfacing the snap connectors all loading of calibration values is completely automated. The 3TX-HiQ-pH intelligent transmitter does not need to be touched at all & so in this way it could even be behind lock and key if desired.

Calibrations performed with this Windows software do not get written to Calibration History until after field activation (the date this occurs is shown as **P27**) which occurs when the HiQ smart digital sensor is connected to the 3TX-HiQ-pH intelligent transmitter. As a corollary, calibrations performed with this Windows software will not induce the initial installation date (field activation) to be written. This makes the Windows software a good choice to perform initial testing to ensure sensor operation and functionality prior to installation or commissioning without effecting the integrity of the field activation date stamp.

When completed with this menu simply click on the "exit" icon to return back to the main menu

HiQ-ORP "Calibrate" Menu – Perform & Load Temperature & ORP mV Offset Calibrations
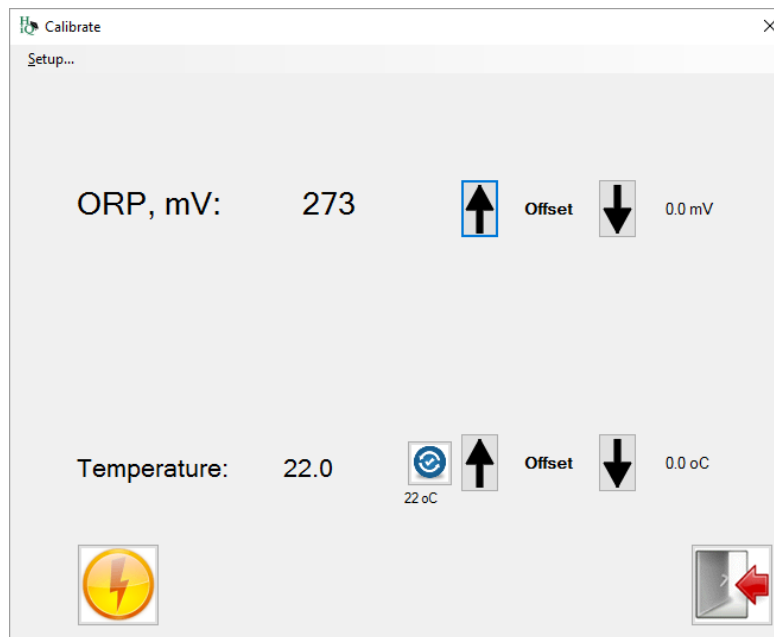
- Temperature stability of both the sensor and measured solution is required for good calibration of ORP sensor. Sensor temperature should be stable and the same as ambient condition for best results.

- ORP offset calibration is done by clicking on the 'Up' or 'Down' buttons until the desired value is achieved.

- Contact ASTI factory for assistance to choose the best ORP standard solution for your application. Offset calibration for ORP can also be used to adjust the reading to a laboratory grab sample reference value.

- Calibration values are loaded onto the connected sensor by clicking on the "flash" icon. If this operation succeeds then "Calibration transferred successfully" is displayed for a period of time as notification.
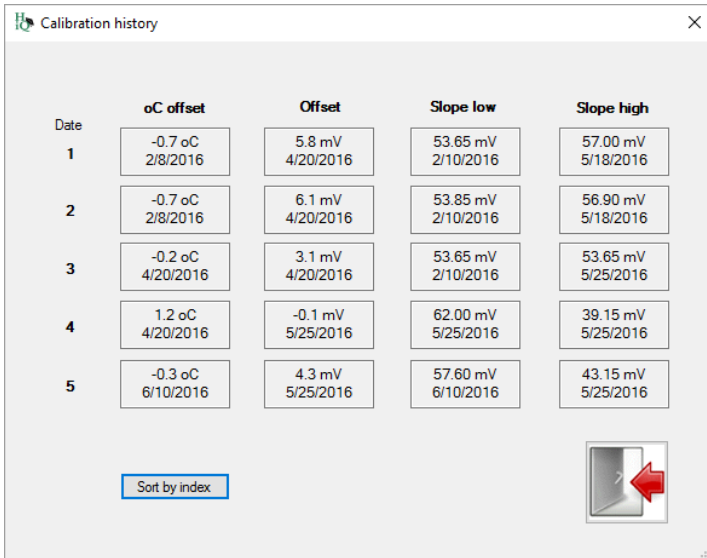
Calibration values are loaded AUTOMATICALLY when the smart digital HiQ ORP sensor is connected to mating field 3TX-HiQ-pH intelligent transmitter. This means that no user action of any kind whatsoever is required when swapping out HiQ smart digital sensors in the field. After interfacing the snap connectors all loading of calibration values is completely automated. The 3TX-HiQ-pH intelligent transmitter does not need to be touched at all & so in this way it could even be behind lock and key if desired.

Calibrations performed with this Windows software do not get written to Calibration History until after field activation (the date this occurs is shown as **P27**) which occurs when the HiQ smart digital sensor is connected to the 3TX-HiQ-pH intelligent transmitter. As a corollary, calibrations performed with this Windows software will not induce the initial installation date (field activation) to be written. This makes the Windows software a good choice to perform initial testing to ensure sensor operation and functionality prior to installation or commissioning without effecting the integrity of the field activation date stamp.

When completed with this menu simply click on the "exit" icon to return back to the main menu
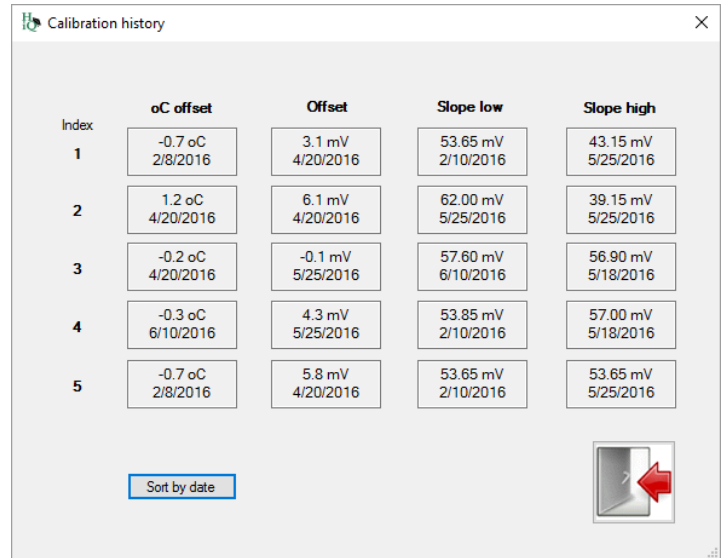
HiQ-pH & HiQ-ORP "Calibration History" Menu

Calibration history — sorted by date

Date	oC offset	Offset	Slope low	Slope high
1	-0.7 oC 2/8/2016	5.8 mV 4/20/2016	53.65 mV 2/10/2016	57.00 mV 5/18/2016
2	-0.7 oC 2/8/2016	6.1 mV 4/20/2016	53.85 mV 2/10/2016	56.90 mV 5/18/2016
3	-0.2 oC 4/20/2016	3.1 mV 4/20/2016	53.65 mV 2/10/2016	53.65 mV 5/25/2016
4	1.2 oC 4/20/2016	-0.1 mV 5/25/2016	62.00 mV 5/25/2016	39.15 mV 5/25/2016
5	-0.3 oC 6/10/2016	4.3 mV 5/25/2016	57.60 mV 6/10/2016	43.15 mV 5/25/2016

Sort by index

Calibration history — sorted by index

Index	oC offset	Offset	Slope low	Slope high
1	-0.7 oC 2/8/2016	3.1 mV 4/20/2016	53.65 mV 2/10/2016	43.15 mV 5/25/2016
2	1.2 oC 4/20/2016	6.1 mV 4/20/2016	62.00 mV 5/25/2016	39.15 mV 5/25/2016
3	-0.2 oC 4/20/2016	-0.1 mV 5/25/2016	57.60 mV 6/10/2016	56.90 mV 5/18/2016
4	-0.3 oC 6/10/2016	4.3 mV 5/25/2016	53.85 mV 2/10/2016	57.00 mV 5/18/2016
5	-0.7 oC 2/8/2016	5.8 mV 4/20/2016	53.65 mV 2/10/2016	53.65 mV 5/25/2016

Sort by date

Calibration history shown sorted by date   *Calibration history sorted by P34 calibration index number*

Calibrations performed with either the Windows software or 3TX-HiQ-pH transmitter after field activation will be written to the 'Calibration history'. This 'Calibration history' can be viewed in the Windows software in this menu as well as on the 3TX-HiQ-pH transmitter. On the 3TX-HiQ-pH transmitter the following cross-reference parameters corresponding to what is shown in this menu can be quite useful:

Calibration Number	→	Parameter **P34**	Value ranges from 1, 2, 3, 4 to 5
°C Offset	→	Parameter **P38**	For both HiQ-pH & HiQ-ORP sensors
mV Offset	→	Parameter **P35**	For both HiQ-pH & HiQ-ORP sensors
Slope low	→	Parameter **P36**	For HiQ-pH sensors only
Slope high	→	Parameter **P37**	For HiQ-pH sensors only when P08 is set to "On" value

To share a screen of this "Calibration History" menu simply click on the window with your mouse and then use the "Alt+PrintScreen" key sequence on your keyboard. This will capture an image of this "Calibration History" menu on your screen and allow you to copy it into a document or email to send for support & collaboration purposes. The ASTI factory or agent may request a screenshot of this "Calibration History" menu to assist with any questions regarding calibrations to date of the HiQ sensor in question.

There exists no way to wipe clean the 'Calibration History' stored in the HiQ sensor. This 'Calibration History' is a FIFO stack stored in secure EEPROM that is continuously updated with each calibration performed on the integral HiQ smart digital sensor inside the sensor itself. As shown in the screenshots above the calibration history information can be displayed either sorted by P34 calibration index number or calibration date.

When completed with this menu simply click on the "exit" icon to return back to the main menu.

Last Modified June 23, 2016

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3TX-HiQ Smart Digital Systems License Agreement

Version 1.0 February 2016

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