General Installation & Calibration Guide to Installation & Calibration of ASTI pH Sensors with the 3TX-pH Transmitter

Power Wiring
Before energizing any 3TX transmitter, please read the relevant recommendations and warnings on page 1 & 2 of the 3TX FAQ write-up (see link below):

http://www.astisensor.com/3TX-FAQ-pH_ORP_Ion_Selective_ISE_Conductivity_Transmitter_Controller_Application_Notes.pdf

Before starting, if you are concerned that any setting have been inappropriately or accidentally modified you can reset the unit back to the factory defaults by turning P01 to 'Off' (this disables the software lock) and then toggle over to P23 and invoke a reset (set value to 'Def' and then press the mode key to accomplish this).

The general stepwise checklist for installation and calibration of ASTI pH sensors on the 3TX-pH transmitter is as follows:

Sensor Wiring
Confirm that the wiring is correct. There exists two basic categorties of pH sensor that can be interfaced with the 3TX-pH transmitters. The first is a pH sensor without any integral preamplifier. This type of pH sensor is connected to the model 3TX-pH-A or 3TX-pH-D type transmitters. The second is an installation that either has an integral preamplifier inside the sensor or else an external preamplifier installed between the sensor and the transmitter. This type of pH sensor/installation is connected to the model 3TX-pH-X-A or 3TX-pH-X-D type transmitters. In either case, an integral Pt100 or P1000 element is required to have automatic temperature compensation with the 3TX-pH transmitter.

Wiring for pH Sensor to 3TX-pH without preamplifier

http://www.astisensor.com/ASTI_3TX-pH_3TX-ISE_Sensor_Wiring_Schematic.pdf

Wiring for pH sensor with integral preamplifier to 3TX-pH-X with tinned lead wire terminations

http://www.astisensor.com/ASTI_3TX-pH-X_3TX-ISE-X_Sensor_Preamp_Wiring_Schematic.pdf

Wiring for pH sensor with integral preamplifier to 3TX-pH-X with quick disconnect Q5M/Q5F terminations employed

http://www.astisensor.com/ASTI_3TX-pH-X_3TX-ISE-X_Sensor_Q5M_Q5F_Quick_Disconnect_Preamp_Wiring_Schematic.pdf

Wiring for pH sensor without integral preamplifier to 3TX-pH-X when external preamplifier is employed

http://www.astisensor.com/ASTI_3TX-pH-X_3TX-ISE-X_with_Mini_External_Preamp_Hookup.pdf

3TX-pH Documentation
The calibration instructions for the pH sensors with the 3TX-pH transmitters can be found at the top of page 3 of the document linked below:

http://www.astisensor.com/3TX-pH.pdf

Addional information and details regarding performing pH sensor calibration with the 3TX-pH transmitters is provided in the following pages. **As always, please note that to make ANY changes at all on ANY 3TX transmitter, the parameter P01 software lock needs to be toggled from the default 'On' to the 'Off' setting. This P01 software lock will reset after a period of inactivity back to the default 'On' state and must then be disabled again to make any setting or calibration changes.**

Buffer / Slope Adjustment Typical Installation:
Using 'Mode' select 'Buffer' and calibrate to first desired value using Up/Down keys. The recommend pH buffer for calibration in the 'Buffer' mode is 6.86 (preferred) or 7.00. Next using 'Mode' select 'Slope' and use Up/Down keys until display reads the second desired value which is typically pH buffer 4.01 when the measured pH will be normally below 7 and typically 9.18 (preferred) or 10.00 when the measured pH will be normally above 7. Enabling dual slope mode is recommended when the process media frequently crosses pH 7 boundary. The dual slope mode is disabled ('Off') by default, but can be enabled by setting the parameter P08 to the 'On' state. When dual slope is enabled, the pH sensor is calibrated at three points: one near pH 7 (in 'Buffer' mode), then in a pH buffer below pH7 (in 'Slope' mode) and then in a pH buffer above pH7 (in 'Slope' mode). **You must exit the 'Slope' mode by using the mode key after completing the acidic slope (below pH7) calibration before entering the alkaline slope (above pH7) calibration.** The 'Buffer' calibration can achieve a process offset whereby the online reading can be made to agree with any grab sample analysis. All calibrations are saved instanteously as they are performed so there is no "save" or "enter" operation required. Note that a two (2) second dampener exists for both calibrate modes and a ten (10) second dampener for the measure mode.

Display Features:
NOTE: The raw uncompensated (a.k.a. "absolute") mV potential of the pH sensor is displayed by pressing the "Down" key in the main pH/mV display mode. The display now changes from pH to absolute mV units. Negative values will be displayed as flashing. **The temperature can be calibrated by pushing the "Up" or "Down" buttons when in the temperature display (°C) mode.**

There are very many potential issues that are involved in the uncertainty of an online pH measurement. Some of the most common possible issues are summarized below and may be applicable to your particular installation.

Common Thermal Related Issues
Make sure that the online industrial sensor is in thermal and chemical equilibrium with the process before making any one-point offset calibration. Please note that sensors that run in hot processes should be allowed to cool down to room temperature before performing a 2-point calibration. The temperature indicated on the sensor can be used as a gauge of when it is ready to proceed with a calibration having reached a thermal equilibrium with ambient conditions. Calibrating a pH sensor when it is not at thermal equilibrium is a very common cause of calibration error and uncertainty that is altogether avoidable. If you are interested in performing reproducible online pH measurements, you may want to review our technical article on this subject which is accessible from the link below:

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

Common Offset Type Issues
If the displayed by the online sensor diverges from the lab expected reference value it is possible to force agree between these two reading with the 3TX-pH transmitter even after a calibration has been performed with pH buffers. Such a one-point grab sample type offset calibration is performed when in the 'Buffer' LED mode. Navigate with the 'Mode' key to the 'Buffer' mode while the pH sensor is installed into the process and the reading is quite stable and use the 'Up' and 'Down' keys to adjust the displayed value to agree with the laboratory determined reference value if desired. Such a grab sample offset type calibration should only be performed after all pH buffer calibrations have been completed.

pH Buffer Accuracy & Stability Issues
It is important to consider that some pH buffers degrade in quality much more quickly than offers when left open to air, or else with exposure to heat and/or light. In particular, both commonly used pH buffer 7.00 and 10.00 are notorious about losing the accuracy of their values when exposed to the air, sunlight or just simply degrade with time. In contrast, the 4.01 pH buffer is a well known VERY stable pH buffer and so is the industry default standard for both conditioning and spot 1-point tests for pH sensors. One important step to ensure accurate calibrations with pH buffers is to be sure to check whether you buffers employed are still within the expiry period and the make sure that they were stored in a cool dry storage location away from sunlight.

In addition to the 4.01pH sensor, the 6.86 and 9.18 pH buffers are amongst the most stable pH buffers available. It is strongly recommend purchase colorless pH buffers rather than the more common colored pH buffers. If colored pH buffers are used for calibrations, it is important that they are NOT also used as the conditioning solution in which pH sensors are stored (this should be reserved for colorless type pH buffers). For higher value pH buffers (10+) it is recommended to purchase only smaller amounts (to ensure that they stay in code) and keeping them stored in a sealed container (make sure that they cap is on tight) in a cool, dry place to minimie the absorption of carbon dioxide from the air that can alter the value of these high pH buffers. In general, the higher value pH buffers are notorious very unstable, much as the very low pH buffers also tend to be rather more unstable. The best available option for calibration of pH above 10 is the 12.45 type pH buffer. The best available option for calibration of pH below 4 is the 1.68 type pH buffer. For general purpose calibrations, the MOST stable pH buffers are 4.01 and 6.86 and to a lesser degree 9.18. If the preferred 6.86 or 9.18 buffers are not available, the 7.00 and 10.00 buffers can be substituted with some slight loss of precision due to the differences in relative pH buffer stabilities.

pH BUFFER DURING CALIBRATION NOTE:: Since the 3TX-pH transmitter does not automatically correct for the temperature effects on your particular pH buffer, you will need to manually enter the correct buffer pH value at your particular temperature manually to ensure optimum accuracy during the calibration step. Each pH buffer solution is always labeled with the pH value at various temperatures so that you can adjust the pH to the appropriate number. Temperature compensation on the 3TX-pH does NOT account for the change in the pH buffer values due to temperature and so this correction must be done manually.

Temperature effects on pH Reading

More generally, note that temperature compensation for pH mode ONLY accounts for the change in potential of the pH sensor itself due to temperature. Any other temperature induced changes to the pH of any given solution (such as changing the effective mean activity coefficient or equilibrium of the process media or pH buffer) are NOT accounted by temperature compensation and thus must all be considered separately. Lastly, for ORP measurements there exists no temperature compensation at all meaning that temperature displayed is simply for reference purposes.

Dual Slope / Three-Point Calibration Feature of 3TX-pH Transmitters

Most transmitters will only use a single slope for the pH sensor response. In this way, the user should select the pH buffers to most resemble their typical pH value in the process. For acidic type applications, the pH buffers of 4.01 and 6.86 are best (or 7.00 if the better 6.86 is not available). For alkaline applications, the pH buffers of 6.86 and 9.18 are best (or 7.00 & 10 if the better 6.86 & 9.18 are not available). The cumulative uncertainty from using two poor buffers (such as 7.00 & 10.00) is not negligible. In the acidic case if at least the good 4.01 pH buffer is used then the uncertainty due to using the more poor 7.00 is somewhat muted (obviously 4.01 and 6.86 would better pairing). For calibration of applications consistently below pH4, the 1.68pH buffer is employed to obtain better slope values in the lower pH range. Calibration for applications consistently above pH10, the 12.45pH buffer is employed to obtain better slope values in the higher pH range. For inquiries about the best choice of pH buffers, please submit a support ticket about such questions.

While most continuous multi-stage processes do not tend to cross the neutral pH7 threshold, this CAN occur much more commonly for batch type applications. In this case, it is best practice to have both an acidic and alkaline slope calibrated separately. Unforunately, most modern pH transmitter do not offer this option. Thankfully, the 3TX-pH transmitter DOES offer such as dual slope option (a.k.a. three point calibration). This is enabled by changing the parameter P08 from the default "Off" to "On" state. When this 3-point calibration (dual slope) now enabled you will have:

P16 - Display and/or adjust AP (mV offset @ pH7)
P17 - Display and/or adjust acidic slope (mV per decade response below 7)
P18 - Display and/or adjust alkaline slope (mV per decade response above 7)

When P08 is "Off" then the mV per decade response shown in P17 is used in both the acidic and alkaline range.

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