The pHionics STs series sensor/transmitters

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pHionics inc

1.1 Introduction

Thank you for purchasing a **pHionics** STs series sensor/transmitter. It will give you years of service if you maintain it according to the guidelines suggested in these instructions.

The entire sensor can be submersed in your fluid of interest to a depth of 200 feet, including the cable. The sensor cartridge, transmitter, and cable assembly can be interchanged from a spare unit – to reconstruct a damaged assembly in minutes.

The **STsxxxx** is an isolated 2-wire, 4-20 ma transmitter integrated into an industrial sensor, resulting in a state-of-the-art design. By incorporating the sensor and transmitter into a small package, the integrity of the components is enhanced, while the cost of manufacturing is significantly reduced. This allows **pHionics** to offer a highly stable design at a very low cost.

The STsxxxx**T** is the same as the STsxxxx mentioned above, but has a completely independent, isolated 2-wire, 4-20 ma transmitter that outputs temperature in the same package (0-50 °C). It requires a 4-conductor cable for the additional 2-wire output. Therefore the STsxxxxT yields both the primary parameter and temperature outputs independently and concurrently.

The STsxxxx**N** is a **non-isolated** 2-wire, 4-20 ma transmitter designed for the less demanding applications that do not require the added expense of isolation. This version is also available with the temperature output option – the ST**s**xxxx**TN.** All specifications are shared with the STsxxxx with the exception of the isolation.

The STsxxxx**B** is a non-isolated, **battery-powered** transmitter with a differential amplifier input and a 0-1 volt output that measures the parameter of interest. It has a replaceable battery module that will typically last six to eighteen months in continuous use – up to ten years if used intermittently. This unit works very well with battery operated dataloggers that must be left unattended for extended periods of time.

1.2 Applications

The sensor/transmitter is ideal for applications such as:

- data acquisition
- distributed control systems
- process control
- groundwater monitoring
- remediation
- hydrology studies

2.1 Unpacking and Inspection

- Confirm that all of the parts appear to have sustained no detectable damage in shipment.

- Retain the packing carton, vinyl boots, and packing materials in the event that the sensor needs to be returned to the factory for credit or repair.

2.2 Preparing the Sensor/Transmitter for Use

The sensor/transmitter is typically shipped ready to use – except for the removal of the protective boots and attachment of the cable assembly.

- The vinyl boot (usually black or gray in color) on the sensor cartridge should remain on until the unit is to be calibrated or applied to the application of interest.

- Remove the vinyl boot from the cable assembly. Inspect the gold strip across the end of the connector to verify that it is free of dirt or contaminants that may interfere with an electrical connection. Inspect the external o-rings on the cable assembly – verify that they also are free of dirt or particulate that could preclude a proper seal when attached to the sensor/transmitter.

- Remove the vinyl boot from the cable end of the sensor/transmitter. Inspect the cable end of the unit to verify that the transmitter connector rings appear to be free of debris, and that the housing has not been damaged on the connector end.

- Insert the cable assembly into the sensor/transmitter until a resistance is met. With a slight inward pressure urging the cable and sensor/transmitter together -- turn the sensor/transmitter in a clockwise manner to engage the threads – do not turn the cable unless absolutely necessary -- as this is more difficult and can cause twisting of the cable – resulting in possible cable or seal damage. Continue to turn the sensor until the body on the cable abuts the stainless steel housing – covering the two o-rings. The seal is made -- no undue force is required.

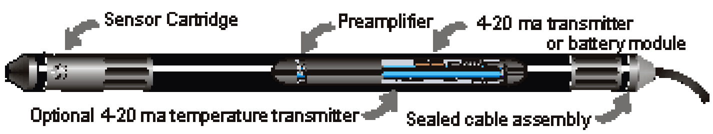
- If calibration is required, proceed to the appropriate parameter in section 3. If further assembly or disassembly is desired – proceed to section 2.3.

2.3 Assembly or disassembly of the sensor/transmitter

The sensor cartridge, transmitter (or battery module) and the cable assembly of your sensor/transmitter are removable and replaceable. To inspect, change or confirm proper installation of the sensor cartridge, transmitter (or battery module) and the cable assembly, please read the following overview and then proceed to the appropriate section (2.3.1 for the *sensor cartridge*, 2.3.2 for the *preamp*, 2.3.3 for the *transmitter* or *battery module*, and/or 2.3.4 for the *cable assembly*).

Overview of sensor/transmitter components and assembly

The sensor/transmitter consists of the following components assembled in the following order:



- **sensor cartridge** – contains the electro-chemical device that measures the parameter of interest. *Physical description* -- this unit will typically be enclosed within an external guard with threads and o-rings on the body. The sensor cartridge is the portion inserted through the spring attached to the guard. The sensor cartridge is approximately 0.5 inches in diameter by 5 inches long. It has the gold elastomeric connector on the end opposite the sensing element.

- **preamp** – conditions the voltage or current derived from the sensor cartridge to be compatible with the ensuing transmitter. *Physical description* -- the preamp is approximately two inches (50 mm) in and is usually attached to the transmitter. The preamp is on the end that is more deeply recessed to receive the sensor cartridge. It will have a round printed circuit board with gold, annular rings on the end facing the sensor cartridge.

- **transmitter** or **battery module** – the *transmitter* interfaces the measurement parameter to the outside world through a current, voltage or digital means. The replaceable *battery module* provides the internal power required for the self-powered configurations (such as the STsxxxx**B**). *Physical description* -- the transmitter or battery module is approximately 2.7 inches (70 mm) in length – typically consisting of two, piggy-backed printed circuit boards that are attached to the preamp board. On the transmitter there will be a round printed circuit board with gold, annular rings on the end facing the cable assembly. The *battery module* will typically consist of a battery carrier that is designed in such a fashion that it cannot be inserted incorrectly.

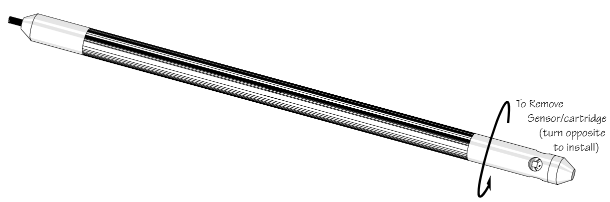
- **cable assembly –** the replaceable and submersible cable that provides the physical connection for the transport of the signal generated by the transmitter to the data logger or control device. *Physical description* – a unit approximately three inches (75 mm) in length (when observed out of the sensor/transmitter) with o-rings and threads on the external portion of the body. A gold elastomeric strip (the connector) is visible on one end – with the cable containing the wires exiting from the other end.

The *preamp* and the *transmitter* or *battery module* are designed in such a way as to prevent power from being applied accidentally to the wrong end of each component, but some care must still be taken to assure proper connection and sequence of the internal components.

2.3.1 Installation or removal of *sensor cartridge*

Removal of *sensor cartridge*

To remove the *sensor cartridge* -- follow all prudent precautions regarding gloves and face shields that may pertain to your particular application (especially if it is hazardous). Perform this operation in a manner in which any parts that may be dropped – can easily be recovered – and not lost in the solution or contaminated by falling on the ground, etc. Dry the outside of the sensor/transmitter with a paper towel -- this is very important for this will prevent any solution from accidentally entering into the electronics of the sensor cartridge or the transmitter. With the sensing end of the sensor/transmitter facing toward the ground (again, to prevent any solution from entering the electronics upon removal of the cartridge) grasp the stainless steel housing with one hand, and with your preferred hand, grasp the main body of the sensor guard beyond the stainless steel housing. Rotate the body of *the sensor guard* counter-clockwise a few turns until the o-rings (2) are visible (approximately 0.25 inches or 6 mm) and the *sensor guard* appears to spin freely. Pull lightly on the sensor guard while continuing to turn it until the *sensor guard and the sensor cartridge* pulls away freely from the stainless steel housing.



While holding the guard firmly, grasp the sensor cartridge on the connector end beyond the spring. Pull gently until the sensor cartridge becomes free. Be careful not to drop the sensor cartridge – as they are easily damaged.

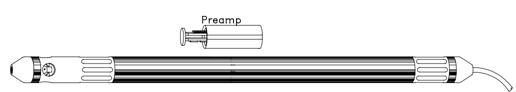
Installation or replacement of *sensor cartridge*

To replace or reinstall the *sensor cartridge* -- verify that the inside of the stainless steel housing surface is free of liquid, dust or other particulate that may impair the sealing of the o-ring seals. Clean with a ‘Q-tip’ or a soft cloth if necessary. Inspect the *sensor guard* for any particulate on the o-rings -- wipe and relubricate with silicone grease if necessary. Also verify that the *sensor guard and spring* is dry beyond the o-rings to the connector. *The previous precautions are important to observe -- the sensors are tested extensively during manufacturing and cannot be warranted against leaks once they leave the factory due to improper removal and insertion of sensor cartridge and cable assemblies. However if a leak does occur the components can typically be recovered by drying in an oven at 50 to 70 °C.*

Reversing the order as described in the removal of the sensor cartridge, carefully insert the sensor cartridge through the spring in the sensor guard. Push gently with a slight twisting motion until the sensor cartridge slides past the internal o-rings of the sensor guard and touches the spring.

Push the *sensor cartridge* and guard into the sensor/transmitter until it is impeded by the dimple -- at this time push lightly while turning the *sensor guard* counter-clockwise (if the transmitter is pointing down) until the *sensor guard* abuts the stainless steel housing.

2.3.2 Removal or installation of *preamp*



Removal of *preamp*

The preamp is not removable in this version.

Installation of *preamp*

The preamp is factory installed

2.3.3 Removal or installation of *transmitter* or *battery module*

Removal of *transmitter module* (or *battery module*)

The transmitter is factory installed, and is not intended to be user-serviceable.

To remove the *battery module* -- with the cable assembly removed (see section 2.3.4), the *battery module* is free to slide out of the stainless steel housing, by tilting the cable end of the sensor/transmitter down.

Installation of *transmitter module* (or *battery module*)

The transmitter is factory installed, and is not intended to be user-serviceable.

To install the *battery module*, reverse the above procedure. Simply drop the *battery module* into the housing. The battery module is designed in such a fashion as to make it impossible to install it improperly – it is polarity insensitive.

Reinstall the cable assembly. The sensor/transmitter should once again be operable.

2.3.4 Removal or installation of *cable assembly*

Removal of *cable assembly*

To remove the *cable assembly* -- follow all prudent precautions regarding gloves and face shields that may pertain to your particular application (especially if it is hazardous). Perform this operation in a manner where any parts (battery modules, etc.) that may slide out or may be dropped – can easily be recovered – and not lost in the solution or contaminated by falling on the ground, etc. Dry the outside of the sensor/transmitter and *cable assembly* with a paper towel -- this is very important -- for this will prevent any solution from accidentally entering into the electronics of the sensor/cartridge or the transmitter.

Removal of the *cable assembly* is performed in the same manner as the removal of the *sensor cartridge*. However, to prevent twisting of the cable and possible damage to the cable seal, the *cable assembly* should be grasped in a stationary manner while turning the stainless steel housing in a direction necessary to accomplish the given task (this is a right-hand thread – therefore if one grasps the cable body with the left hand – the stainless steel housing will be removed by turning the housing with the right hand in a counter-clockwise manner). Approximately two complete turns will expose the two o-rings and allow the *cable assembly* to be pulled freely from the sensor/cartridge.

Caution: Be careful to keep the cable end of the sensor/transmitter pointed up unless the removal of a *battery module* is also desired. The *battery module* can fall out unexpectedly if the unit is accidentally tilted down.

Installation of *cable assembly*

If this is the first time that the cable assembly has been installed upon receiving the unit – please refer to section 2.2 – *preparing the sensor/transmitter for use.* This will point out any special considerations concerning first time installation.

Inspect the gold elastomeric strip of the connector to verify that it is free of dirt or contaminants that may interfere with an electrical connection. Inspect the external o-rings on the *cable assembly* – verify that they also are free of dirt or particulate that could preclude a proper seal when attached to the sensor/transmitter. Clean and lubricate with silicone grease if necessary.

Holding the sensor/transmitter with the *sensor cartridge* facing down, inspect the cable end of the unit to verify that the area where the o-rings contact the seal is also free of dirt or contaminants that may interfere with the seal of the *cable assembly*. Also verify that the gold annular rings of the transmitter or battery module are free of debris. If a *battery module* is installed, do not tilt the unit until the cable has been installed -- as the *battery module* can fall out unexpectedly.

Insert the cable assembly into the sensor/transmitter until a resistance is met. With a slight inward pressure urging the cable and sensor/transmitter together -- turn the sensor/transmitter in a clockwise manner to engage the threads – do not turn the cable unless absolutely necessary -- as this is more difficult and can cause twisting of the cable – resulting in possible cable or seal damage. Continue to turn the sensor until the body on the cable abuts the stainless steel housing – covering the two o-rings. The seal is made -- no undue force is required.

3.1 Conductivity

3.1.1 Conductivity calibration

3.1.1.1 Conductivity calibration of 4-20 ma

Before performing the following steps, please follow all company, local, state, or national laws and/or regulations regarding proper safety precautions in handling liquids with respect to protective goggles, gloves, or clothing and proximity to eye washes, etc. Buffers are relatively harmless in most situations, but, it is always better to be on the safe side**.**

- *Remove the protective boot from the end of the sensor. Do not twist the boot to remove it --gently work it directly away from the sensor.*
- Rinse the electrode end of the sensor/transmitter by squirting with water from a wash-bottle or by immersing the end in a container of clean water (such as tap-water).
- Immerse the sensor far enough into a fresh solution of distilled water to totally cover the holes while concurrently contacting the Stainless Steel on the sensor housing, allowing for complete wetting of the sensor and contacting of the solution ground. ***The sensor will not work properly if the solution does not contact the metal housing!***
- Connect the black sensor lead to the negative side of a 24V power supply.

- Connect the red sensor lead to the negative lead (usually denoted as the black lead) of a digital voltmeter (DVM) with the leads in the position for ***current*** measurement.

- Connect the positive lead of the DVM (usually denoted as the red lead) to the positive side of the 24V supply. The leads are connected this way to allow for a positive current reading -- as long as your ammeter is not polarity conscious, the polarity of the reading is of little consequence.

- Turn the DVM on and set the DVM to a range that will resolve 19.99 milliamps.

- If the power supply is not already turned on, turn it on now.

- Swish the sensor around in the distilled water and allow the DVM reading to stabilize (less than .01 milliamps change per minute).

  The extent to which you allow the electrode to stabilize can be determined by the degree of accuracy that you require.

- A reading of approximately 3.80 to 4.20 ma should be observed. Record this number or if your software allows you to assign values -- denote this as 0.0 uSiemens.

- Rinse the electrode end as described previously.

- Immerse the sensor into a fresh conductivity standard and allow to stabilize until a change of less than 0.01 ma per minute is observed.

- If the full-scale range of the conductivity sensor is 1000 uSiemens, and the conductivity standard is 700 uSiemens -- a reading of approximately 14.70 to 15.70 ma should be observed. This can be derived from: ((700/1000) x (20-4)) + 4 = (0.700 x 16) + 4 = 11.20 + 4 = 15.20 ma Record this number or if your software allows you to assign values -- denote this as 700 uSiemens (or 700/1000 (.700) of fullscale).

- Using the recorded values, span the recorder, datalogger, data acquisition system or distributed control system according to the manual regarding such system.

  Calibration is now complete. Follow this procedure anytime calibration of the sensor/transmitter is required.

  If you are using the calibration kit to standardize the sensor/transmitter, the following procedure can be used substituting the following steps when immersed in 0.0 and 700 uSiemen standards as previously described.

- With a small screwdriver, after the sensor has stabilized in distilled water, turn the *ZERO* adjust until a reading of 4.00 ± 0.01 milliamps is obtained.

- Rinse the electrode end as described previously.

- Immerse the sensor into the 700 uSiemen standard (or other appropriate standard) and allow to stabilize until a change of less than 0.01 ma per minute is observed.

- To adjust the output to yield 4.00 to 20.00 milliamps for 0 to 1000 uSiemens, use the screwdriver to turn the *SPAN* adjust until a reading of 15.20 milliamps is obtained.

  After the sensor is put into service, the electronics will prove to be very stable, but a recalibration schedule must be determined empirically for each application.

If there are problems calibrating the Sensor/Transmitter:

Confirm that the problems are not related to the system to which the unit is being interfaced by simulating the input as called out in the operator manuals that are supplied with your respective hardware and/or software. If problems persist, call us at **1-800-964-0063**.

3.1.1.2 Conductivity calibration of 0-1.0, 0-2.50 or 0-5.0 volt

Before performing the following steps, please follow all company, local, state, or national laws and/or regulations regarding proper safety precautions in handling liquids with respect to protective goggles, gloves, or clothing and proximity to eye washes, etc. Conductivity standards are relatively harmless in most situations, but, it is always better to be on the safe side**.**

- *Remove the protective boot from the end of the sensor. Do not twist the boot to remove it --gently work it directly away from the sensor.*

- Rinse the electrode end of the sensor/transmitter by squirting with water from a wash-bottle or by immersing the end in a container of clean water (such as tap-water).

- Immerse the sensor far enough into a fresh solution of distilled water to totally cover the holes while concurrently contacting the Stainless Steel on the sensor housing, allowing for complete wetting of the sensor and contacting of the solution ground. ***The sensor will not work properly if the solution does not contact the metal housing!***

- If the unit is externally powered, connect the black lead of the sensor/transmitter to the negative side of your battery or power supply – being careful not to short any of the leads on the sensor cable. Connect the orange lead of the cable to the positive side of the battery or power supply.

- If the unit is powered by an internal battery, proceed to the following steps.

- Connect the black sensor lead to the negative lead (usually denoted as the black lead) of a digital voltmeter (DVM) with the leads in the position for ***voltage*** measurement.

- Connect the red sensor lead to the positive lead of the DVM (usually denoted as the red lead). The leads are connected this way to allow for a positive voltage reading -- the polarity of the reading is of little consequence.

- Turn the DVM on and set the DVM to a range that will resolve 1.00, 2.50 or 5.00 volts as required for your range (or autorange).

- If the power supply is not already turned on, turn it on now. If the unit is powered by an internal battery, proceed to the following steps.

- Swish the sensor around in the distilled water and allow the DVM reading to stabilize (less than .01 millivolts change per minute).

  The extent to which you allow the electrode to stabilize can be determined by the degree of accuracy that you require.

- A reading of approximately 0.00 volts should be observed. Record this number or if your software allows you to assign values -- denote this as 0.0 uSiemens.

- Rinse the electrode end as described previously.

- Immerse the sensor into a fresh conductivity standard and allow to stabilize until a change of less than 0.01 millivolts per minute is observed.

- If the full-scale range of the conductivity sensor is 1000 uSiemens, and the conductivity standard is 700 uSiemens -- a reading of approximately 0.700 volts should be observed for the 0-1.0 volt output. This can be derived from: ((700/1000) x 1.0) = (0.700 x 1.0) = 0.700 volts. For the 2.50 volt range, this would be: ((700/1000) x 2.50) = (0.700 x 2.50) = 1.75 volts. For the 5.00 volt range, this would be: ((700/1000) x 5.00) = (0.700 x 5.00) = 3.50 volts. Record this number or if your software allows you to assign values -- denote this as 700 uSiemens (or 700/1000 (.700) of full-scale).

- Using the recorded values, span the recorder, datalogger, data acquisition system or distributed control system according to the manual regarding such system.

  Calibration is now complete. Follow this procedure anytime calibration of the sensor/transmitter is required.

  If you are using the calibration kit to standardize the sensor/transmitter, the following procedure can be used substituting the following steps when immersed in 0.0 and 700 uSiemen standards as previously described.

- With a small screwdriver, after the sensor has stabilized in distilled water, turn the *ZERO* adjust until a reading of 0.00 $\pm$ 0.01 millivolts is obtained.

- Rinse the electrode end as described previously.

- Immerse the sensor into the 700 uSiemen standard (or other appropriate standard) and allow to stabilize until a change of less than 0.01 mv per minute is observed.

- To adjust the output to yield 1.0 volts for 0 to 1000 uSiemens, use the screwdriver to turn the *SPAN* adjust until a reading of 0.700 millivolts is obtained. For the 2.50 volt range, this would be: ((700/1000) x 2.50) = (0.700 x 2.50) = 1.75 volts. For the 5.00 volt range, this would be: ((700/1000) x 5.00) = (0.700 x 5.00) = 3.50 volts.

  After the sensor is put into service, the electronics will prove to be very stable, but a recalibration schedule must be determined empirically for each application.

If there are problems calibrating the Sensor/Transmitter:

Confirm that the problems are not related to the system to which the unit is being interfaced by simulating the input as called out in the operator manuals that are supplied with your respective hardware and/or software. If problems persist, call us at **1-800-964-0063**.

3.1.2 Conductivity care

Do not allow grease, foreign material or finger prints to contact the electrodes – as this will degrade the performance of the unit – resulting in lower or erratic readings.

Rinse the unit in distilled or clean water prior to storage. Store dry.

If the unit is battery operated, disengage the cable or remove the battery module to prevent further drain during the time of transport or storage. See *special considerations* regarding the battery.

It is always recommended to use new silicone grease on the o-rings of the cable assembly and the sensor cartridge. This allows for easy assembly and disassembly, while concurrently preventing abrasion or other damage that may result to the o-rings.

3.1.3 Conductivity special considerations

If the unit is battery operated, care should be taken to avoid shorting the red and black lead of the sensor/transmitter cable together -- once the cable has been attached to the unit. Typically a 1 megohm resistor is in series with the output to prevent the rapid discharge of the battery if accidentally shorted, however in some applications a smaller value or zero resistance is substituted for input impedance compatibility for the DVM, datalogger or other input device. Shorting the leads can result in fire, explosion or at the very least – rapid discharge of the battery module.

The output impedance of the battery or voltage operated preamp can also have a bearing on the readings observed during calibration or datalogging depending on the input impedance of the device. For instance, if the DVM or datalogger has an input impedance of 10 megohms, a 1.00 volt output would actually appear to be lower. If the output impedance is 1 megohm, the reading would be (10M/(10M + 1M)) x 1.00 = .909 volts. If your application is critical, please let us know when you order the device – so appropriate recommendations can be made.

3.1.4 Conductivity recommended spare parts

These units are designed for serviceability, and consequently are very easy to assemble and disassemble. For this reason the recommended spare parts would consist of another identical unit with matching cable length as a backup.

If the unit is battery operated, two spare battery modules would also be recommended.

3.1.5 Conductivity specifications

Series STs4xxx, 2-Wire, 4-20 ma conductivity sensor/transmitters

Output	**4 to 20 ma**
Power Supply Voltage	**7 to 40 VDC**
Loop Impedance (Max)	**250 ohms at 12 VDC, 1650 ohms at 40 VDC**
Cable from Transmitter to Power Supply	**2 or 4 Conductor, twisted pair, 3 Mile Maximum**
Isolation	**600 VDC, >70 db at 50/60 Hz**

Series STs4xxxT, 2-wire, 4-20 ma conductivity sensor/transmitters with optional, additional 2-wire, 4-20 ma temperature output

Output	**4 to 20 ma**
Range	**0-50 Degrees Celsius**
Power Supply Voltage	**7 to 40 VDC**
Loop Impedance (Max)	**250 ohms at 12 VDC, 1650 ohms at 40 VDC**
Cable from Transmitter to Power Supply	**4 Conductor, twisted pair, 3 Mile Maximum**
Isolation	**600 VDC, >70 db at 50/60 Hz**

The following data pertains to all configurations:

Linearity	± 0.2% of Full Scale
Accuracy	± 0.2% of Full Scale
Sensitivity	± 0.05% of Full Scale
Stability	± 0.1% of Full Scale
Repeatability	± 0.1% of Full Scale
Response Time (Including Electrodes)	90% < 5 seconds
Temperature Compensation	2% per degree C
Input Range	0-100,200,500,1000,2000,5000,10000 uSiemens* see below
Conductivity Sensing Range	0-100,200,500,1000,2000,5000,10000 uSiemens* see below
Pressure	0-100 PSI
Humidity	0-100%
Wetted Materials	316 SS, PVDF, Viton
Length	343 mm (13.5 in.)
Diameter	19 mm (0.750 in.) Maximum
Standard Cable Length	10 meters (approx 33 feet)
Shipping Weight (Excluding Cable)	< 2.2 kg (1 lb.)

* How specified: Replace the xxx model number with the corresponding range desired:

0-100 uS	STs4102 or STs4102T	(1.0 * 102)
0-200 uS	STs4202 or STs4202T	(2.0 * 102)
0-500 uS	STs4502 or STs4502T	(5.0 * 102)
0-1000 uS	STs4103 or STs4103T	(1.0 * 103)
0-2000 uS	STs4203 or STs4203T	(2.0 * 103)
0-5000 uS	STs4503 or STs4503T	(5.0 * 103)
0-10000 uS	STs4104 or STs4104T	(1.0 * 104)
0-specify uS	STs4xxx or STs4xxxT Replace xxx with appropriate numbers -- see examples below*	

* To determine your custom range, observe the following examples or contact pHionics at the numbers listed below:

Desired Range	Decimal Notation	Appropriate Model Number
0-250	2.5 * 102	ST4252 or ST4252T
0-2500	2.5 * 103	ST4253 or ST4253T
0-300	3.0 * 102	ST4302 or ST4302T
0-3000	3.0 * 103	ST4303 or ST4303T

3.2 Dissolved oxygen

3.2.1 Dissolved oxygen calibration

3.2.1.1 Dissolved oxygen calibration of 4-20 ma

Before performing the following steps, please follow all company, local, state, or national laws and/or regulations regarding proper safety precautions in handling liquids with respect to protective goggles, gloves, or clothing and proximity to eye washes, etc.

- *Remove the protective boot from the end of the sensor. Do not twist the boot to remove it --gently work it directly away from the sensor.*

- Rinse the electrode end of the sensor/transmitter by squirting with water from a wash-bottle or by immersing the end in a container of clean water (such as tap-water).

- Immerse the sensor far enough into a solution of pure water saturated with nitrogen or a freshly prepared 2% sodium bisulphite solution to totally cover the holes while concurrently contacting the Stainless Steel on the sensor housing, allowing for complete wetting of the membrane and contacting of the solution ground. ***The sensor will not work properly if the solution does not contact the metal housing!***

- Connect one of the sensor leads to the negative side of a 24V power supply (polarity of sensor leads is automatically steered to prevent the chance of improperly connecting the sensor).

- Connect the other sensor lead to the negative lead (usually denoted as the black lead) of a digital voltmeter (DVM) with the leads in the position for ***current*** measurement.

- Connect the positive lead of the DVM (usually denoted as the red lead) to the positive side of the 24V supply. The leads are connected this way to allow for a positive current reading -- as long as your ammeter is not polarity conscious, the polarity of the reading is of little consequence.

- Turn the DVM on and set the DVM to a range that will resolve 19.99 milliamps.

- If the power supply is not already turned on, turn it on now.

- Let the sensor remain in the solution and allow the DVM reading to stabilize (less than .01 milliamps change per minute).

  The extent to which you allow the electrode to stabilize can be determined by the degree of accuracy that you require. The saturation of water with nitrogen takes several minutes. The zero point can usually be obtained after approximately five minutes.

- A reading of approximately 3.90 to 4.10 ma should be observed. Record this number or if your software allows you to assign values -- denote this as 0 mg/l O_2.

- Rinse the electrode end as described previously.

- Immerse the sensor into air saturated water and allow to stabilize until a change of less than 0.01 ma per minute is observed.

- A reading of approximately 18.60 ma should be observed at sea level and at 20 °C. Record this number or if your software allows you to assign values -- denote this as 9.1 mg/l O_2. For greater accuracy refer to the following chart.

Solubility of oxygen (mg/l) at various
temperatures and elevations
(based on sea level barometric pressure of 760 mm Hg)

Temperature	Elevation, Feet above Sea Level						
°C	**0**	**1000**	**2000**	**3000**	**4000**	**5000**	**6000**
0	14.6	14.1	13.6	13.2	12.7	12.3	11.8
2	13.8	13.3	12.9	12.4	12.0	11.6	11.2
4	13.1	12.7	12.2	11.9	11.4	11.0	10.6
6	12.4	12.0	11.6	11.2	10.8	10.4	10.1
8	11.8	11.4	11.0	10.6	10.3	9.9	9.6
10	11.3	10.9	10.5	10.2	9.8	9.5	9.2
12	10.8	10.4	10.1	9.7	9.4	9.1	8.8
14	10.3	9.9	9.6	9.3	9.0	8.7	8.3
16	9.9	9.7	9.2	8.9	8.6	8.3	8.0
18	9.5	9.2	8.7	8.6	8.3	8.0	7.7
20	9.1	8.8	8.5	8.2	7.9	7.7	7.4
22	8.7	8.4	8.1	7.8	7.7	7.3	7.1
24	8.4	8.1	7.8	7.6	7.3	7.1	6.8
26	8.1	7.8	7.6	7.3	7.0	6.8	6.6
28	7.8	7.5	7.3	7.0	6.8	6.6	6.3
30	7.5	7.2	7.0	6.8	6.5	6.3	6.1

For greater accuracies, if the temperature is 24 and the elevation is 1000 feet, the saturated value should be 8.1 mg/l. This would yield an output of approximately (0.81 x 16 ma) + 4 ma = 16.96 ma.

- Using the recorded values, span the recorder, datalogger, data acquisition system or distributed control system according to the manual regarding such system.

  Calibration is now complete. Follow this procedure anytime calibration of the sensor/transmitter is required.

  If you are using the calibration kit to standardize the sensor/transmitter, the following procedure can be used substituting the following steps when immersed in nitrogen or oxygen saturated water as previously described.

- With a small screwdriver, after the sensor has stabilized in saturated nitrogen, turn the *ZERO* adjust until a reading of 4.00 ± 0.01 milliamps is obtained. The zero point of the dissolved oxygen electrode should prove to be fairly stable, and if a big variance is observed, the membrane is possibly damaged or improperly affixed.

- Rinse the electrode end as described previously.

- Immerse the sensor into the saturated air solution and allow to stabilize until a change of less than 0.01 ma per minute is observed.

- To adjust the output to yield 4.00 to 20.00 milliamps for 0 to 10 mg/l, use the screwdriver to turn the *SPAN* adjust until a reading of approximately 18.60 ma is obtained representing 9.1 mg/l O_2 -- as should be observed at sea level and at 20 °C. Again if the number is to be something else as derived from the chart the current should be set to ((mg/l)/10 x 16 ma) + 4 ma.

  After the sensor is put into service, the electronics will prove to be very stable, but a recalibration schedule must be determined empirically for each application.

If there are problems calibrating the Sensor/Transmitter:

Confirm that the problems are not related to the system to which the unit is being interfaced by simulating the input as called out in the operator manuals that are supplied with your respective hardware and/or software. If problems persist, call us at **1-800-964-0063**.

3.2.1.2 Dissolved oxygen calibration of 0-1.0, 0-2.50 or 0-5.0 volt

Before performing the following steps, please follow all company, local, state, or national laws and/or regulations regarding proper safety precautions in handling liquids with respect to protective goggles, gloves, or clothing and proximity to eye washes, etc.

- *Remove the protective boot from the end of the sensor. Do not twist the boot to remove it --gently work it directly away from the sensor.*

- Rinse the electrode end of the sensor/transmitter by squirting with water from a wash-bottle or by immersing the end in a container of clean water (such as tap-water).

- Immerse the sensor far enough into a solution of pure water saturated with nitrogen or a freshly prepared 2% sodium bisulphite solution to totally cover the holes while concurrently contacting the Stainless Steel on the sensor housing, allowing for complete wetting of the membrane and contacting of the solution ground. ***The sensor will not work properly if the solution does not contact the metal housing!***

- If the unit is externally powered, connect the black lead of the sensor/transmitter to the negative side of your battery or power supply – being careful not to short any of the leads on the sensor cable. Connect the orange lead of the cable to the positive side of the battery or power supply.

- If the unit is powered by an internal battery, proceed to the following steps.

- Connect the black sensor lead to the negative lead (usually denoted as the black lead) of a digital voltmeter (DVM) with the leads in the position for ***voltage*** measurement.

- Connect the red sensor lead to the positive lead of the DVM (usually denoted as the red lead). The leads are connected this way to allow for a positive voltage reading -- the polarity of the reading is of little consequence.

- Turn the DVM on and set the DVM to a range that will resolve 1.00, 2.50 or 5.00 volts as required for your range (or autorange).

- If the power supply is not already turned on, turn it on now. If the unit is powered by an internal battery, proceed to the following steps.

- Let the sensor remain in the solution and allow the DVM reading to stabilize (less than .01 millivolts change per minute).

  The extent to which you allow the electrode to stabilize can be determined by the degree of accuracy that you require. The saturation of water with nitrogen takes several minutes. The zero point can usually be obtained after approximately five minutes.

- A reading of approximately 0.00 millivolts should be observed. Record this number or if your software allows you to assign values -- denote this as 0 mg/l O_2.

- Rinse the electrode end as described previously.

- Immerse the sensor into air saturated water and allow to stabilize until a change of less than 0.01 mv per minute is observed.

- A reading of approximately 0.91 millivolts should be observed at sea level and at 20 °C. This can be derived from: ((9.1/10) x 1.0) = (0.910 x 1.0) = 0.910 volts. For the 2.50 volt range, this would be: ((9.1/10) x 2.50) = (0.910 x 2.50) = 2.275 volts. For the 5.00 volt range, this would be: ((9.1/10) x 5.00) = (0.910 x 5.00) = 4.55 volts. Record this number or if your software allows you to assign values -- denote this as 9.1 mg/l O_2. For greater accuracy refer to the following chart.

Solubility of oxygen (mg/l) at various
temperatures and elevations
(based on sea level barometric pressure of 760 mm Hg)

Temperature	Elevation, Feet above Sea Level						
°C	**0**	**1000**	**2000**	**3000**	**4000**	**5000**	**6000**
0	14.6	14.1	13.6	13.2	12.7	12.3	11.8
2	13.8	13.3	12.9	12.4	12.0	11.6	11.2
4	13.1	12.7	12.2	11.9	11.4	11.0	10.6
6	12.4	12.0	11.6	11.2	10.8	10.4	10.1
8	11.8	11.4	11.0	10.6	10.3	9.9	9.6
10	11.3	10.9	10.5	10.2	9.8	9.5	9.2
12	10.8	10.4	10.1	9.7	9.4	9.1	8.8
14	10.3	9.9	9.6	9.3	9.0	8.7	8.3
16	9.9	9.7	9.2	8.9	8.6	8.3	8.0
18	9.5	9.2	8.7	8.6	8.3	8.0	7.7
20	9.1	8.8	8.5	8.2	7.9	7.7	7.4
22	8.7	8.4	8.1	7.8	7.7	7.3	7.1
24	8.4	8.1	7.8	7.6	7.3	7.1	6.8
26	8.1	7.8	7.6	7.3	7.0	6.8	6.6
28	7.8	7.5	7.3	7.0	6.8	6.6	6.3
30	7.5	7.2	7.0	6.8	6.5	6.3	6.1

For greater accuracies, if the temperature is 24 and the elevation is 1000 feet, the saturated value should be 8.1 mg/l. This would yield an output of approximately (0.81 x 1.00) = 0.810 on the 1.00 volt range.

- Using the recorded values, span the recorder, datalogger, data acquisition system or distributed control system according to the manual regarding such system.

  Calibration is now complete. Follow this procedure anytime calibration of the sensor/transmitter is required.

  If you are using the calibration kit to standardize the sensor/transmitter, the following procedure can be used substituting the following steps when immersed in nitrogen or oxygen saturated water as previously described.

- With a small screwdriver, after the sensor has stabilized in saturated nitrogen, turn the *ZERO* adjust until a reading of 0.00 ± 0.01 millivolts is obtained. The zero point of the dissolved oxygen electrode should prove to be fairly stable, and if a big variance is observed, the membrane is possibly damaged or improperly affixed.

- Rinse the electrode end as described previously.

- Immerse the sensor into the saturated air solution and allow to stabilize until a change of less than 0.01 mv per minute is observed.

- To adjust the output to yield 0.00 to 1.00 volt for 0 to 10 mg/l, use the screwdriver to turn the *SPAN* adjust until a reading of approximately 0.910 volts is obtained representing 9.1 mg/l O_2 -- as should be observed at sea level and at 20 °C. Again if the number is to be something else as derived from the chart the current should be set to ((mg/l)/10 x full-scale range).

  After the sensor is put into service, the electronics will prove to be very stable, but a recalibration schedule must be determined empirically for each application.

If there are problems calibrating the Sensor/Transmitter:

Confirm that the problems are not related to the system to which the unit is being interfaced by simulating the input as called out in the operator manuals that are supplied with your respective hardware and/or software. If problems persist, call us at **1-800-964-0063**.

3.2.2 Dissolved oxygen care

Do not attempt to clean the sensing membrane with any foreign object – it will tear the membrane.

Be very careful when inserting the Sensor cartridge through the sensor guard and spring – any tear or hole will render the sensor cartridge inoperable.

Do not allow grease, foreign material or finger prints to contact the membrane – as this will degrade the performance of the unit – resulting in lower or erratic readings.

Rinse the unit in distilled or clean water prior to storage. Store dry.

If the unit is battery operated, disengage the cable or remove the battery module to prevent further drain during the time of transport or storage. See *special considerations* regarding the battery.

It is always recommended to use new silicone grease on the o-rings of the cable assembly and the sensor cartridge. This allows for easy assembly and disassembly, while concurrently preventing abrasion or other damage that may result to the o-rings.

3.2.3 Dissolved oxygen special considerations

If the unit is battery operated, care should be taken to avoid shorting the red and black lead of the sensor/transmitter cable together -- once the cable has been attached to the unit. Typically a 1 megohm resistor is in series with the output to prevent the rapid discharge of the battery if accidentally shorted, however in some applications a smaller value or zero resistance is substituted for input impedance compatibility for the DVM, datalogger or other input device. Shorting the leads can result in fire, explosion or at the very least – rapid discharge of the battery module.

The output impedance of the battery or voltage operated preamp can also have a bearing on the readings observed during calibration or datalogging depending on the input impedance of the device. For instance, if the DVM or datalogger has an input impedance of 10 megohms, a 1.00 volt output would actually appear to be lower. If the output impedance is 1 megohm, the reading would be (10M/(10M + 1M)) x 1.00 = .909 volts. If your application is critical, please let us know when you order the device – so appropriate recommendations can be made.

3.2.4 Dissolved oxygen recommended spare parts

These units are designed for serviceability, and consequently are very easy to assemble and disassemble. For this reason the recommended spare parts would consist of another identical unit with matching cable length as a backup.

If the unit is battery operated, two spare battery modules would also be recommended.

A spare sensor cartridge is also recommended.

3.2.5 Dissolved oxygen specifications

Series STs6010, 2-Wire, 4-20 ma Dissolved Oxygen Sensor/Transmitters

Output	**4 to 20 ma**
Power Supply Voltage	**7 to 40 VDC**
Loop Impedance (Max)	**250 ohms at 12 VDC, 1650 ohms at 40 VDC**
Cable from Transmitter to Power Supply	**2 or 4 Conductor, twisted pair, 3 Mile Maximum**
Isolation	**600 VDC, >70 db at 50/60 Hz**

Series STs6010B, 0-1V Dissolved Oxygen Sensor/Transmitters with Replaceable Batteries

Output	0-1 Volt
Power Supply Voltage	Self Contained, Replaceable Battery Module
Output Impedance (Max)	1 Megohm (Prevents premature failure of battery if leads are shorted)
Cable from Transmitter to Power Supply	2 or 4 Conductor, twisted pair, 1,000 Feet Maximum
Isolation	None

Series STs6010T, 2-Wire, 4-20 ma Dissolved Oxygen Sensor/Transmitters with optional, additional 2-Wire, 4-20 ma Temperature Output

Output	4 to 20 ma
Range	0-50 Degrees Celsius
Power Supply Voltage	7 to 40 VDC
Loop Impedance (Max)	250 ohms at 12 VDC, 1650 ohms at 40 VDC
Cable from Transmitter to Power Supply	4 Conductor, twisted pair, 3 Mile Maximum
Isolation	600 VDC, >70 db at 50/60 Hz

The following data pertains to all configurations:

Linearity	± 0.5% of Full Scale
Accuracy	± 2.0% of Full Scale
Sensitivity	± 0.05% of Full Scale
Stability	± 2.0% of Full Scale
Repeatability	± 1.0% of Full Scale
Response Time (Including Electrodes)	98% < 60 seconds
Temperature Compensation	An optional temperature output is available see STs6010T above
Input Range	0-20 ppm (mg/l)
Pressure	0-100 PSI
Humidity	0-100%
Wetted Materials	316 SS, PVDF, Viton
Length	343 mm (13.5 in.)
Diameter	19 mm (0.750 in.) Maximum
Standard Cable Length	10 meters (approx 33 feet)
Shipping Weight (Excluding Cable)	< 2.2 kg (1 lb.)

3.3 ORP

3.3.1 ORP calibration

3.3.1.1 ORP calibration of 4-20 ma

Keep in mind that ORP is a very general reading obtained by a noble metal reacting with the world. It cannot differentiate one ion from another except in very controlled environments and varies significantly with pH. Therefore, calibration that has been performed at the factory will often suffice for most applications. The major reason for calibration is to determine if the electrode is dying or is poisoned – otherwise, cleaning the platinum or gold element will often suffice as a calibration practice, but if a little more depth is necessary – follow the following procedures.

Before performing the following steps, please follow all company, local, state, or national laws and/or regulations regarding proper safety precautions in handling liquids with respect to protective goggles, gloves, or clothing and proximity to eye washes, etc. Buffers are relatively harmless in most situations, but, it is always better to be on the safe side**.**

- *Remove the protective boot from the end of the sensor. Do not twist the boot to remove it --gently work it directly away from the sensor.*
- Rinse the electrode end of the sensor/transmitter by squirting with water from a wash-bottle or by immersing the end in a container of clean water (such as tap-water).

- Immerse the sensor far enough into a fresh solution of ORP standard to totally cover the holes while concurrently contacting the Stainless Steel on the sensor housing, allowing for complete wetting of the reference junction and the glass electrode and contacting of the solution ground. ***The sensor will not work properly if the solution does not contact the metal housing!***

- Connect one of the sensor leads to the negative side of a 24V power supply (polarity of sensor leads is automatically steered to prevent the chance of improperly connecting the sensor).

- Connect the other sensor lead to the negative lead (usually denoted as the black lead) of a digital voltmeter (DVM) with the leads in the position for ***current*** measurement.

- Connect the positive lead of the DVM (usually denoted as the red lead) to the positive side of the 24V supply. The leads are connected this way to allow for a positive current reading -- as long as your ammeter is not polarity conscious, the polarity of the reading is of little consequence.

- Turn the DVM on and set the DVM to a range that will resolve 19.99 milliamps.

- If the power supply is not already turned on, turn it on now.

- Swish the sensor around in the standard solution and allow the DVM reading to stabilize (less than .01 milliamps change per minute).

  The extent to which you allow the electrode to stabilize can be determined by the degree of accuracy that you require.

- Depending on the standard used, a reading will be generated between 4.00 ma and 20.00 ma for the range of –1000 to +1000 millivolts. Record the milliamp number or if your software allows you to assign values -- denote this as the standard value (if a +265 millivolts standard is used – record this as +265 mv – this would yield approximately a 14.12 ma reading).

- Rinse the electrode end as described previously.

- Immerse the sensor into a fresh standard representing another ORP value and allow to stabilize until a change of less than 0.01 ma per minute is observed.

- Record this number or if your software allows you to assign values -- denote this as the standard value (again if it is a +500 mv standard, record this as +500 millivolts – this would yield approximately a 16 ma reading).

- Using the recorded values, span the recorder, datalogger, data acquisition system or distributed control system according to the manual regarding such system.

Calibration is now complete. Follow this procedure anytime calibration of the sensor/transmitter is required.

If you are using the calibration kit to standardize the sensor/transmitter, the following procedure can be used substituting the following steps when immersed in an ORP standard solution as previously described. A single point calibration is recommended – due to the fact that any standard used that is not zero will cause an interaction between the zero and span adjustments.

- With a small screwdriver, after the sensor has stabilized in ORP standard, say +265 mv, turn the *ZERO* adjust until a reading of 14.12 ± 0.01 milliamps is obtained. This is derived from a range of -1000 to + 1000 mv for the 4.00 to 20.00 ma span. –1000 would correspond to 4.00 ma, 0 mv would yield 12.00 ma and +1000 mv would yield 20.00 ma. Therefore a simple way to derive the current would be ((–1000 – (ORP value)) / (-2000)) x 16) + 4.00 = ma.

- Rinse the electrode end as described previously.

- Immerse the sensor into another fresh ORP standard to confirm spanning and allow to stabilize until a change of less than 0.01 ma per minute is observed.

- Observe that the amount of change is what would be expected – do not adjust the span.

  After the sensor is put into service, the electronics will prove to be very stable, but a recalibration schedule must be determined empirically for each application.

If there are problems calibrating the Sensor/Transmitter:

Confirm that the problems are not related to the system to which the unit is being interfaced by simulating the input as called out in the operator manuals that are supplied with your respective hardware and/or software. If problems persist, call us at **1-800-964-0063**.

3.3.1.2 ORP calibration of 0-1, 0-2.5 and 0-5 volt

Keep in mind that ORP is a very general reading obtained by a noble metal reacting with the world. It cannot differentiate one ion from another except in very controlled environments and varies significantly with pH. Therefore, calibration that has been performed at the factory will often suffice for most applications. The major reason for calibration is to determine if the electrode is dying or is poisoned – otherwise, cleaning the platinum or gold element will often suffice as a calibration practice, but if a little more depth is necessary – follow the following procedures.

Before performing the following steps, please follow all company, local, state, or national laws and/or regulations regarding proper safety precautions in handling liquids with respect to protective goggles, gloves, or clothing and proximity to eye washes, etc. ORP standards are relatively harmless in most situations, but, it is always better to be on the safe side**.**

- *Remove the protective boot from the end of the sensor. Do not twist the boot to remove it --gently work it directly away from the sensor.*

- Rinse the electrode end of the sensor/transmitter by squirting with water from a wash-bottle or by immersing the end in a container of clean water (such as tap-water).

- Immerse the sensor far enough into a fresh solution of ORP standard to totally cover the holes while concurrently contacting the Stainless Steel on the sensor housing, allowing for complete wetting of the reference junction and the glass electrode and contacting of the solution ground. ***The sensor will not work properly if the solution does not contact the metal housing!***

- If the unit is externally powered, connect the black lead of the sensor/transmitter to the negative side of your battery or power supply – being careful not to short any of the leads on the sensor cable. Connect the orange lead of the cable to the positive side of the battery or power supply.

- If the unit is powered by an internal battery, proceed to the following steps.

- Connect the black sensor lead to the negative lead (usually denoted as the black lead) of a digital voltmeter (DVM) with the leads in the position for ***voltage*** measurement.

- Connect the red sensor lead to the positive lead of the DVM (usually denoted as the red lead). The leads are connected this way to allow for a positive voltage reading -- the polarity of the reading is of little consequence.

- Turn the DVM on and set the DVM to a range that will resolve 1.00, 2.50 or 5.00 volts as required for your range (or autorange).

- If the power supply is not already turned on, turn it on now. If the unit is powered by an internal battery, proceed to the following steps.

- Swish the sensor around in the ORP standard solution and allow the DVM reading to stabilize (less than .01 millivolts change per minute).

  The extent to which you allow the electrode to stabilize can be determined by the degree of accuracy that you require.

- Depending on the standard used, a reading will be generated between 0.00 and 1.00 volt for the range of –1000 to +1000 millivolts. Record the millivolt number or if your software allows you to assign values -- denote this as the standard value (if a +265 millivolts standard is used – record this as +265 mv – this would yield approximately a .632 mv reading for 0-1.00 volt, 1.58 for 0-2.500, and, 3.16 for the 0-5.00 volt calibration).

- Rinse the electrode end as described previously.

- Immerse the sensor into a fresh standard representing another ORP value and allow to stabilize until a change of less than 0.01 ma per minute is observed.

- Record this number or if your software allows you to assign values -- denote this as the standard value (again if it is a +500 mv standard, record this as +500 millivolts – this would yield approximately a 0.750 mv output on 0-1.00 volt, 1.875 for 0-2.500 volts and 3.75 volts for the 0-5.00 volt calibration).

- Using the recorded values, span the recorder, datalogger, data acquisition system or distributed control system according to the manual regarding such system.

Calibration is now complete. Follow this procedure anytime calibration of the sensor/transmitter is required.

If you are using the calibration kit to standardize the sensor/transmitter, the following procedure can be used substituting the following steps when immersed in an ORP standard solution as previously described. A single point calibration is recommended – due to the fact that any standard used that is not zero will cause an interaction between the zero and span adjustments.

- With a small screwdriver, after the sensor has stabilized in ORP standard, say +265 mv, turn the *ZERO* adjust until a reading of .632 ± 0.01 millivolts is obtained. This is derived from a range of -1000 to + 1000 mv for 1.00 volt span. –1000 would correspond to 0.00 volts, 0 mv would yield 0.500 volts and +1000 mv would yield 1.000 volt. Therefore a simple way to derive the current would be ((–1000 – (ORP value)) / (-2000)) x 1.000) = mv. Substitute 2.500 or 5.000 in place of the 1.000 for the various range options.

- Rinse the electrode end as described previously.

- Immerse the sensor into another fresh ORP standard to confirm spanning and allow to stabilize until a change of less than 0.01 ma per minute is observed.

- Observe that the amount of change is what would be expected – do not adjust the span.

After the sensor is put into service, the electronics will prove to be very stable, but a recalibration schedule must be determined empirically for each application.

If there are problems calibrating the Sensor/Transmitter:

Confirm that the problems are not related to the system to which the unit is being interfaced by simulating the input as called out in the operator manuals that are supplied with your respective hardware and/or software. If problems persist, call us at **1-800-964-0063**.

3.3.2 ORP care

Do not allow grease, foreign material or finger prints to contact the electrodes – as this will degrade the performance of the unit – resulting in erratic readings.

Rinse the unit in distilled or clean water prior to storage. Store with the boot on in a KCl solution. *Do not store in deionized water! It will dramatically decrease the life of the electrode.*

If the unit is battery operated, disengage the cable or remove the battery module to prevent further drain during the time of transport or storage. See *special considerations* regarding the battery.

It is always recommended to use new silicone grease on the o-rings of the cable assembly and the sensor cartridge. This allows for easy assembly and disassembly, while concurrently preventing abrasion or other damage that may result to the o-rings.

3.3.3 ORP special considerations

Keep in mind that ORP is a very general reading obtained by a noble metal reacting with the world. It cannot differentiate one ion from another except in very controlled environments and varies significantly with pH. Therefore, calibration that has been performed at the factory will often suffice for most applications. The major reason for calibration is to determine if the electrode is dying or is poisoned – otherwise, cleaning the platinum or gold element will often suffice as a calibration practice, but if a little more depth is necessary – follow the following procedures.

If the unit is battery operated, care should be taken to avoid shorting the red and black lead of the sensor/transmitter cable together -- once the cable has been attached to the unit. Typically a 1 megohm resistor is in series with the output to prevent the rapid discharge of the battery if accidentally shorted, however in some applications a smaller value or zero resistance is substituted for input impedance compatibility for the DVM, datalogger or other input device. Shorting the leads can result in fire, explosion or at the very least – rapid discharge of the battery module.

The output impedance of the battery or voltage operated preamp can also have a bearing on the readings observed during calibration or datalogging depending on the input impedance of the device. For instance, if the DVM or datalogger has an input impedance of 10 megohms, a 1.00 volt output would actually appear to be lower. If the output impedance is 1 megohm, the reading would be (10M/(10M + 1M)) x 1.00 = .909 volts. If your application is critical, please let us know when you order the device – so appropriate recommendations can be made.

3.3.4 ORP recommended spare parts

These units are designed for serviceability, and consequently are very easy to assemble and disassemble. For this reason the recommended spare parts would consist of another identical unit with matching cable length as a backup.

If the unit is battery operated, two spare battery modules would also be recommended.

3.3.5 ORP specifications

Series STs2010, 2-Wire, 4-20 ma ORP Sensor/Transmitters

Output	**4 to 20 ma**
Power Supply Voltage	**7 to 40 VDC**
Loop Impedance (Max)	**250 ohms at 12 VDC, 850 ohms at 24 VDC, 1650 ohms at 40 VDC**
Cable from Transmitter to Power Supply	**2 or 4 Conductor, twisted pair, 3 Mile Maximum**
Isolation	**600 VDC, >70 db at 50/60 Hz**

Series STs2010B, 0-1V ORP Sensor/Transmitters with Replaceable Batteries

Output	**0-1 Volt**
Power Supply Voltage	**Self Contained, Replaceable Battery Module**
Output Impedance (Max)	**1 Megohm (Prevents premature failure of battery if leads are shorted)**
Cable from Transmitter to Power Supply	**2 or 4 Conductor, twisted pair, 1,000 Feet Maximum**
Isolation	**None**

Series STs2010T, 2-Wire, 4-20 ma ORP Sensor/Transmitters with Optional, additional 2-Wire, 4-20 ma Temperature Output

Output	4 to 20 ma
Range	0-50 Degrees Celsius
Power Supply Voltage	7 to 40 VDC
Loop Impedance (Max)	250 ohms at 12 VDC, 850 ohms at 24 VDC, 1650 ohms at 40 VDC
Cable from Transmitter to Power Supply	4 Conductor, twisted pair, 3 Mile Maximum
Isolation	600 VDC, >70 db at 50/60 Hz

The following data pertains to all configurations:

Linearity (of Electronics)	± 4 mv
Accuracy	± 4 mv
Sensitivity	± 1 mv
Stability	± 2 mv
Repeatability	± 10 mv
Response Time (Including Electrodes)	95% < 20 seconds
Temperature Compensation	None
Input Range	-1000 to +1000 mv
ORP Sensing Range	-1000 to +1000 mv
Pressure	0-100 PSI
Humidity	0-100%
Wetted Materials	316 SS, PVDF, Viton, Glass
Length	343 mm (13.5 in.)
Diameter	19 mm (0.750 in.) Maximum
Standard Cable Length	10 meters (approx 33 feet)
Shipping Weight (Excluding Cable)	< 2.2 kg (1 lb.)

3.4 pH

3.4.1 pH calibration

3.4.1.1 pH calibration of 4-20 ma

Before performing the following steps, please follow all company, local, state, or national laws and/or regulations regarding proper safety precautions in handling liquids with respect to protective goggles, gloves, or clothing and proximity to eye washes, etc. Buffers are relatively harmless in most situations, but, it is always better to be on the safe side**.**

- *Remove the protective boot from the end of the sensor. Do not twist the boot to remove it --gently work it directly away from the sensor.*
- Rinse the electrode end of the sensor/transmitter by squirting with water from a wash-bottle or by immersing the end in a container of clean water (such as tap-water).
- Immerse the sensor far enough into a fresh solution of 7.0 pH buffer to totally cover the holes while concurrently contacting the Stainless Steel on the sensor housing, allowing for complete wetting of the reference junction and the glass electrode and contacting of the solution ground. ***The sensor will not work properly if the solution does not contact the metal housing!***

- Connect one of the sensor leads to the negative side of a 24V power supply (polarity of sensor leads is automatically steered to prevent the chance of improperly connecting the sensor).

- Connect the other sensor lead to the negative lead (usually denoted as the black lead) of a digital voltmeter (DVM) with the leads in the position for ***current*** measurement.

- Connect the positive lead of the DVM (usually denoted as the red lead) to the positive side of the 24V supply. The leads are connected this way to allow for a positive current reading -- as long as your ammeter is not polarity conscious, the polarity of the reading is of little consequence.

- Turn the DVM on and set the DVM to a range that will resolve 19.99 milliamps.

- If the power supply is not already turned on, turn it on now.

- Swish the sensor around in the buffer solution and allow the DVM reading to stabilize (less than .01 milliamps change per minute).

  The extent to which you allow the electrode to stabilize can be determined by the degree of accuracy that you require.

- A reading of approximately 11.50 to 12.50 ma should be observed. Record this number or if your software allows you to assign values -- denote this as 7.0 pH (or midscale).

- Rinse the electrode end as described previously.

- Immerse the sensor into a fresh 4.0 pH buffer and allow to stabilize until a change of less than 0.01 ma per minute is observed.

- A reading of approximately 8.30 to 9.30 ma should be observed. Record this number or if your software allows you to assign values -- denote this as 4.0 pH (or 4/14 (.285) of fullscale).

- Using the recorded values, span the recorder, datalogger, data acquisition system or distributed control system according to the manual regarding such system.

  Calibration is now complete. Follow this procedure anytime calibration of the sensor/transmitter is required.

  If you are using the calibration kit to standardize the sensor/transmitter, the following procedure can be used substituting the following steps when immersed in 7.0 and 4.0 pH buffers as previously described.

- With a small screwdriver, after the sensor has stabilized in 7.0 pH buffer, turn the *ZERO* adjust until a reading of 12.00 $\pm$ 0.01 milliamps is obtained.

- Rinse the electrode end as described previously.
- Immerse the sensor into a fresh 4.0 pH buffer and allow to stabilize until a change of less than 0.01 ma per minute is observed.
- To adjust the output to yield 4.00 to 20.00 milliamps for 0 to 14 pH, use the screwdriver to turn the *SPAN* adjust until a reading of 8.57 milliamps is obtained. If an output of 4.00 to 20.00 milliamps for 2 to 12 pH is desired, turn the *SPAN* adjust until a reading of 7.20 milliamps is obtained.

  After the sensor is put into service, the electronics will prove to be very stable, but a recalibration schedule must be determined empirically for each application.

If there are problems calibrating the Sensor/Transmitter:

Confirm that the problems are not related to the system to which the unit is being interfaced by simulating the input as called out in the operator manuals that are supplied with your respective hardware and/or software. If problems persist, call your local representative or **pHionics** at **1-800-964-0063**.

3.4.1.2 pH calibration of 0-1. 0-2.5 or 0-5 volt output

Before performing the following steps, please follow all company, local, state, or national laws and/or regulations regarding proper safety precautions in handling liquids with respect to protective goggles, gloves, or clothing and proximity to eye washes, etc. pH buffers are relatively harmless in most situations, but, it is always better to be on the safe side**.**

- *Remove the protective boot from the end of the sensor. Do not twist the boot to remove it --gently work it directly away from the sensor.*
- Rinse the electrode end of the sensor/transmitter by squirting with water from a wash-bottle or by immersing the end in a container of clean water (such as tap-water).
- Immerse the sensor far enough into a fresh solution of 7.0 pH buffer to totally cover the holes while concurrently contacting the Stainless Steel on the sensor housing, allowing for complete wetting of the reference junction and the glass electrode and contacting of the solution ground. ***The sensor will not work properly if the solution does not contact the metal housing!***
- If the unit is externally powered, connect the black lead of the sensor/transmitter to the negative side of your battery or power supply – being careful not to short any of the leads on the sensor cable. Connect the orange lead of the cable to the positive side of the battery or power supply.

- If the unit is powered by an internal battery, proceed to the following steps.

- Connect the black sensor lead to the negative lead (usually denoted as the black lead) of a digital voltmeter (DVM) with the leads in the position for ***voltage*** measurement.

- Connect the red sensor lead to the positive lead of the DVM (usually denoted as the red lead). The leads are connected this way to allow for a positive voltage reading -- the polarity of the reading is of little consequence.

- Turn the DVM on and set the DVM to a range that will resolve 1.00, 2.50 or 5.00 volts as required for your range (or autorange).

- If the power supply is not already turned on, turn it on now. If the unit is powered by an internal battery, proceed to the following steps.

- Swish the sensor around in the buffer solution and allow the DVM reading to stabilize (less than .01 millivolts change per minute).

  The extent to which you allow the electrode to stabilize can be determined by the degree of accuracy that you require.

- A reading of approximately 0.500 volts should be observed. Record this number or if your software allows you to assign values -- denote this as 7.0 pH.

- Rinse the electrode end as described previously.

- Immerse the sensor into a fresh 4.0 pH buffer and allow to stabilize until a change of less than 0.01 mv per minute is observed.

- If the full-scale range of the pH sensor is 1.00, a reading of approximately 0.286 volts should be observed for the 0-1.0 volt output. This can be derived from: ((4/14) x 1.0) = (0.286 x 1.0) = 0.286 volts. For the 2.50 volt range, this would be: ((4/14) x 2.50) = (0.286 x 2.50) = 0.715 volts. For the 5.00 volt range, this would be: ((4/14) x 5.00) = (0.286 x 5.00) = 1.43 volts. Record this number or if your software allows you to assign values -- denote this as 4 pH (or 4/14 (.286) of full-scale).

- Using the recorded values, span the recorder, datalogger, data acquisition system or distributed control system according to the manual regarding such system.

  Calibration is now complete. Follow this procedure anytime calibration of the sensor/transmitter is required.

If you are using the calibration kit to standardize the sensor/transmitter, the following procedure can be used substituting the following steps when immersed in 7.0 and 4.0 pH buffers as previously described.

- With a small screwdriver, after the sensor has stabilized in 7.0 pH buffer, turn the *ZERO* adjust until a reading of 0.500 ± 0.01 millivolts is obtained. This would be 1.250 for the 2.50 volt range and 2.500 for the 5.00 volt range.
- Rinse the electrode end as described previously.
- Immerse the sensor into a fresh 4.0 pH buffer and allow to stabilize until a change of less than 0.01 mv per minute is observed.
- If the full-scale range of the pH sensor is 1.00, adjust the *SPAN* until a reading of approximately 0.286 volts is obtained for the 0-1.0 volt output. This can be derived from: ((4/14) x 1.0) = (0.286 x 1.0) = 0.286 volts. For the 2.50 volt range, this would be: ((4/14) x 2.50) = (0.286 x 2.50) = 0.715 volts. For the 5.00 volt range, this would be: ((4/14) x 5.00) = (0.286 x 5.00) = 1.43 volts.

  After the sensor is put into service, the electronics will prove to be very stable, but a recalibration schedule must be determined empirically for each application.

If there are problems calibrating the Sensor/Transmitter:

Confirm that the problems are not related to the system to which the unit is being interfaced by simulating the input as called out in the operator manuals that are supplied with your respective hardware and/or software. If problems persist, call us at **1-800-964-0063**.

3.4.2 pH care

Do not allow grease, foreign material or finger prints to contact the electrodes – as this will degrade the performance of the unit – resulting in erratic readings.

Rinse the unit in distilled or clean water prior to storage. Store with the boot on in a KCl (potassium chloride) solution. *Do not store in deionized water! It will dramatically decrease the life of the electrode.*

If the unit is battery operated, disengage the cable or remove the battery module to prevent further drain during the time of transport or storage. See *special considerations* regarding the battery.

It is always recommended to use new silicone grease on the o-rings of the cable assembly and the sensor cartridge. This allows for easy assembly and disassembly, while concurrently preventing abrasion or other damage that may result to the o-rings.

3.4.3 pH special considerations

If the unit is battery operated, care should be taken to avoid shorting the red and black lead of the sensor/transmitter cable together -- once the cable has been attached to the unit. Typically a 1 megohm resistor is in series with the output to prevent the rapid discharge of the battery if accidentally shorted, however in some applications a smaller value or zero resistance is substituted for input impedance compatibility for the DVM, datalogger or other input device. Shorting the leads can result in fire, explosion or at the very least – rapid discharge of the battery module.

The output impedance of the battery or voltage operated preamp can also have a bearing on the readings observed during calibration or datalogging depending on the input impedance of the device. For instance, if the DVM or datalogger has an input impedance of 10 megohms, a 1.00 volt output would actually appear to be lower. If the output impedance is 1 megohm, the reading would be (10M/(10M + 1M)) x 1.00 = .909 volts. If your application is critical, please let us know when you order the device – so appropriate recommendations can be made.

3.4.4 pH recommended spare parts

These units are designed for serviceability, and consequently are very easy to assemble and disassemble. For this reason the recommended spare parts would consist of another identical unit with matching cable length as a backup.

If the unit is battery operated, two spare battery modules would also be recommended.

3.4.5 pH specifications

Series STs1010, 2-Wire, 4-20 ma pH Sensor/Transmitters

Output	**4 to 20 ma**
Power Supply Voltage	**7 to 40 VDC**
Loop Impedance (Max)	**250 ohms at 12 VDC, 1650 ohms at 40 VDC**
Cable from Transmitter to Power Supply	**2 or 4 Conductor, twisted pair, 3 Mile Maximum**
Isolation	**600 VDC, >70 db at 50/60 Hz**

Series STs1010B, 0-1V pH Sensor/Transmitters with Replaceable Batteries

Output	0-1 Volt
Power Supply Voltage	Self Contained, Replaceable Battery Module
Output Impedance (Max)	1 Megohm (Prevents premature failure of battery if leads are shorted)
Cable from Transmitter to Power Supply	2 or 4 Conductor, twisted pair, 1,000 Feet Maximum
Isolation	None

Series STs1010T, 2-Wire, 4-20 ma pH Sensor/Transmitters with Optional, additional 2-Wire, 4-20 ma Temperature Output

Output	4 to 20 ma
Range	0-50 Degrees Celsius
Power Supply Voltage	7 to 40 VDC
Loop Impedance (Max)	250 ohms at 12 VDC, 1650 ohms at 40 VDC
Cable from Transmitter to Power Supply	4 Conductor, twisted pair, 3 Mile Maximum
Isolation	600 VDC, >70 db at 50/60 Hz

The following data pertains to all configurations:

Linearity	± 0.004 pH
Accuracy	± 0.014 pH
Sensitivity	± 0.01 pH
Stability	± 0.03 pH per year
Repeatability	± 0.01 pH
Response Time (Including Electrodes)	95% < 5 seconds
Temperature Compensation	Automatic, 0-50 ° C
Input Range	0-14 pH
pH Sensing Range	0-14 pH
Pressure	0-100 PSI
Humidity	0-100%
Wetted Materials	316 SS, PVDF, Viton, Glass
Length	343 mm (13.5 in.)
Diameter	19 mm (0.750 in.) Maximum
Standard Cable Length	10 meters (approx 33 feet)
Shipping Weight (Excluding Cable)	< 2.2 kg (1 lb.)

3.5 Specific ion

3.5.1 Specific ion calibration

3.5.1.1 Specific ion calibration of 4-20 ma output

Specific ion sensor/transmitters are typically for custom ranges or optimized for the ion in question and can prove quite problematic to calibrate – if you have any questions – please contact us.

Before performing the following steps, please follow all company, local, state, or national laws and/or regulations regarding proper safety precautions in handling liquids with respect to protective goggles, gloves, or clothing and proximity to eye washes, etc. Buffers are relatively harmless in most situations, but, it is always better to be on the safe side**.**

- *Remove the protective boot from the end of the sensor. Do not twist the boot to remove it --gently work it directly away from the sensor.*
- Rinse the electrode end of the sensor/transmitter by squirting with water from a wash-bottle or by immersing the end in a container of clean water (such as tap-water).
- Immerse the sensor far enough into a fresh solution of known ionic strength to totally cover the holes while concurrently contacting the Stainless Steel on the sensor housing, allowing for complete wetting of the reference junction (if it has one) and the membrane and contacting of the solution ground.

The sensor will not work properly if the solution does not contact the metal housing!

- Connect one of the sensor leads to the negative side of a 24V power supply (polarity of sensor leads is automatically steered to prevent the chance of improperly connecting the sensor).

- Connect the other sensor lead to the negative lead (usually denoted as the black lead) of a digital voltmeter (DVM) with the leads in the position for ***current*** measurement.

- Connect the positive lead of the DVM (usually denoted as the red lead) to the positive side of the 24V supply. The leads are connected this way to allow for a positive current reading -- as long as your ammeter is not polarity conscious, the polarity of the reading is of little consequence.

- Turn the DVM on and set the DVM to a range that will resolve 19.99 milliamps.

- If the power supply is not already turned on, turn it on now.

- Swish the sensor around in the known ion solution and allow the DVM reading to stabilize (less than .01 milliamps change per minute).

  The extent to which you allow the electrode to stabilize can be determined by the degree of accuracy that you require.

- A reading between 4 and 20 ma should be observed. Record this number or if your software allows you to assign values -- denote this as the known ion value.

- Rinse the electrode end as described previously.

- Immerse the sensor into a different known ion solution and allow to stabilize until a change of less than 0.01 ma per minute is observed.

- A reading between 4 and 20 ma will be observed. Record this number or if your software allows you to assign values -- denote this as denote this as the known ion value.

- Using the recorded values, span the recorder, datalogger, data acquisition system or distributed control system according to the manual regarding such system.

  Calibration is now complete. Follow this procedure anytime calibration of the sensor/transmitter is required.

If there are problems calibrating the Sensor/Transmitter:

Confirm that the problems are not related to the system to which the unit is being interfaced by simulating the input as called out in the operator manuals that are supplied with your respective hardware and/or software. If problems persist, call your local representative or **pHionics** at **1-800-964-0063**.

3.5.1.2 Specific ion calibration of 0-1. 0-2.5 or 0-5 volt output

Specific ion sensor/transmitters are typically for custom ranges or optimized for the ion in question and can prove quite problematic to calibrate – if you have any questions – please contact us.

Before performing the following steps, please follow all company, local, state, or national laws and/or regulations regarding proper safety precautions in handling liquids with respect to protective goggles, gloves, or clothing and proximity to eye washes, etc. Buffers are relatively harmless in most situations, but, it is always better to be on the safe side**.**

- *Remove the protective boot from the end of the sensor. Do not twist the boot to remove it --gently work it directly away from the sensor.*

- Rinse the electrode end of the sensor/transmitter by squirting with water from a wash-bottle or by immersing the end in a container of clean water (such as tap-water).

- Immerse the sensor far enough into a fresh solution of known ionic strength to totally cover the holes while concurrently contacting the Stainless Steel on the sensor housing, allowing for complete wetting of the reference junction (if it has one) and the membrane and contacting of the solution ground. ***The sensor will not work properly if the solution does not contact the metal housing!***

- If the unit is externally powered, connect the black lead of the sensor/transmitter to the negative side of your battery or power supply – being careful not to short any of the leads on the sensor cable. Connect the orange lead of the cable to the positive side of the battery or power supply.

- If the unit is powered by an internal battery, proceed to the following steps.

- Connect the black sensor lead to the negative lead (usually denoted as the black lead) of a digital voltmeter (DVM) with the leads in the position for ***voltage*** measurement.

- Connect the red sensor lead to the positive lead of the DVM (usually denoted as the red lead). The leads are connected this way to allow for a positive voltage reading -- the polarity of the reading is of little consequence.

- Turn the DVM on and set the DVM to a range that will resolve 1.00, 2.50 or 5.00 volts as required for your range (or autorange).

- If the power supply is not already turned on, turn it on now. If the unit is powered by an internal battery, proceed to the following steps.

- Swish the sensor around in the known ionic strength solution and allow the DVM reading to stabilize (less than .01 millivolts change per minute).

  The extent to which you allow the electrode to stabilize can be determined by the degree of accuracy that you require.

- A reading of between 0.00 to 1.00 volts (0-2.50 for the 2.50 range, and 0-5.00 for the 5.00 range) will be observed. Record this number or if your software allows you to assign values -- denote this as the value of the ion in question.

- Rinse the electrode end as described previously.

- Immerse the sensor into a different known ion solution and allow to stabilize until a change of less than 0.01 mv per minute is observed.

- A reading of between 0.00 to 1.00 volts (0-2.50 for the 2.50 range, and 0-5.00 for the 5.00 range) will be observed. Record this number or if your software allows you to assign values -- denote this as the value of the ion in question.

- Using the recorded values, span the recorder, datalogger, data acquisition system or distributed control system according to the manual regarding such system.

  Calibration is now complete. Follow this procedure anytime calibration of the sensor/transmitter is required.

If there are problems calibrating the Sensor/Transmitter:

Confirm that the problems are not related to the system to which the unit is being interfaced by simulating the input as called out in the operator manuals that are supplied with your respective hardware and/or software. If problems persist, call your local representative or **pHionics** at **1-800-964-0063**.

3.5.2 Specific ion care

Do not allow grease, foreign material or finger prints to contact the membranes – as this will degrade the performance of the unit – resulting in erratic readings.

Rinse the unit in distilled or clean water prior to storage. Store dry.

If the unit is battery operated, disengage the cable or remove the battery module to prevent further drain during the time of transport or storage. See *special considerations* regarding the battery.

It is always recommended to use new silicone grease on the o-rings of the cable assembly and the sensor cartridge. This allows for easy assembly and disassembly, while concurrently preventing abrasion or other damage that may result to the o-rings.

3.5.3 Specific ion special considerations

Specific ion sensor/transmitters are typically for custom ranges or optimized for the ion in question and can prove quite problematic to calibrate – if you have any questions – please contact us.

If the unit is battery operated, care should be taken to avoid shorting the red and black lead of the sensor/transmitter cable together -- once the cable has been attached to the unit. Typically a 1 megohm resistor is in series with the output to prevent the rapid discharge of the battery if accidentally shorted, however in some applications a smaller value or zero resistance is substituted for input impedance compatibility for the DVM, datalogger or other input device. Shorting the leads can result in fire, explosion or at the very least – rapid discharge of the battery module.

The output impedance of the battery or voltage operated preamp can also have a bearing on the readings observed during calibration or datalogging depending on the input impedance of the device. For instance, if the DVM or datalogger has an input impedance of 10 megohms, a 1.00 volt output would actually appear to be lower. If the output impedance is 1 megohm, the reading would be (10M/(10M + 1M)) x 1.00 = .909 volts. If your application is critical, please let us know when you order the device – so appropriate recommendations can be made.

3.5.4 Specific ion recommended spare parts

These units are designed for serviceability, and consequently are very easy to assemble and disassemble. For this reason the recommended spare parts would consist of another identical unit with matching cable length as a backup.

If the unit is battery operated, two spare battery modules would also be recommended.

3.5.5 Specific ion specifications

Available Specific Ions for ST3xxx Sensor Transmitters

(User must assume responsibility for application)

Parameter	Model	Range (ppm)	pH Range
Ammonium	STs3010	18000-0.1	4-10
Ammonia	STs3020	Call	4-10
Bromide	STs3030	79900-0.4	2-14
Cadmium	STs3040	11200-0.01	2-12
Calcium	STs3050	40000-0.02	3-10
Chloride	STs3060	35500-1.8	2-12
Copper	STs3070	6350-.0006	2-12
Cyanide	STs3080	260-0.13	11-13
Flouride	STs3090	Saturated-0.02	5-8
Flouroborate	STs3100	10900-0.1	2.5-11
Iodide	STs3110	127000-6x10-3	0-14
Lead	STs3120	20700-0.2	3-8
Lithium	STs3130	6900-0.7	5-10
Nitrate	STs3140	62000-0.5	2.5-11
Perchlorate	STs3150	98000-0.7	2.5-11
Potassium	STs3160	39000-0.04	2-12
Silver	STs3170	107900-0.01	2-12
Sodium	STs3180	Saturated-0.02	5-12
Sulfide	STs3190	32100-0.003	2-12
Thiocyanate	STs3200	58000-0.3	2-10
Water Hardness	STs3210	40000-0.4	5-10

Series STs3xxx, 2-Wire, 4-20 ma Specific Ion Sensor/Transmitters

Output	4 to 20 ma
Power Supply Voltage	7 to 40 VDC
Loop Impedance (Max)	250 ohms at 12 VDC, 850 ohms at 24 VDC, 1650 ohms at 40 VDC
Cable from Transmitter to Power Supply	2 or 4 Conductor, twisted pair, 3 Mile Maximum
Isolation	600 VDC, >70 db at 50/60 Hz

Series STs3xxxB, 0-1V Specific Ion Sensor/Transmitters with Replaceable Batteries

Output	0-1 Volt
Power Supply Voltage	Self Contained, Replaceable Battery Module
Output Impedance (Max)	1 Megohm (Prevents premature failure of battery if leads are shorted)
Cable from Transmitter to Power Supply	2 or 4 Conductor, twisted pair, 1,000 Feet Maximum
Isolation	None

Series STs3xxxT, 2-Wire, 4-20 ma Specific Ion Sensor/Transmitters with Optional, additional 2-Wire, 4-20 ma Temperature Output

Output	4 to 20 ma
Range	0-50 Degrees Celsius
Power Supply Voltage	7 to 40 VDC
Loop Impedance (Max)	250 ohms at 12 VDC, 850 ohms at 24 VDC, 1650 ohms at 40 VDC
Cable from Transmitter to Power Supply	4 Conductor, twisted pair, 3 Mile Maximum
Isolation	600 VDC, >70 db at 50/60 Hz

The following data pertains to all configurations:

Linearity (of Electronics)	± 0.2% of Full Scale
Accuracy	± 0.2% of Full Scale
Sensitivity	± 0.05% of Full Scale
Stability	± 0.1% of Full Scale
Repeatability	± 0.1% of Full Scale
Response Time (Including Electrodes)	95% < 20 seconds
Temperature Compensation	None
Input Range	Optimized for Individual Parameter
Pressure	0-100 PSI
Humidity	0-100%
Wetted Materials	316 SS, PVDF, Viton, Membrane
Length	343 mm (13.5 in.)
Diameter	19 mm (0.750 in.) Maximum
Standard Cable Length	10 meters (approx 33 feet)
Shipping Weight (Excluding Cable)	< 2.2 kg (1 lb.)

3.6 Temperature

3.6.1 Temperature calibration

3.6.1.1 Temperature calibration of 4-20 ma

Before performing the following steps, please follow all company, local, state, or national laws and/or regulations regarding proper safety precautions in handling liquids with respect to protective goggles, gloves, or clothing and proximity to eye washes, etc. Buffers are relatively harmless in most situations, but, it is always better to be on the safe side**.**

- *Remove the protective boot from the end of the sensor. Do not twist the boot to remove it --gently work it directly away from the sensor.*

- Immerse the sensor far enough into a temperature controlled bath at 0 °C (or a homogeneous mix of ice and water being stirred constantly) to totally cover the holes while concurrently contacting the Stainless Steel on the sensor housing, allowing for complete wetting of sensing element and contacting of the solution ground. ***The sensor will not work properly if the solution does not contact the metal housing!***

- Connect one of the sensor leads to the negative side of a 24V power supply (polarity of sensor leads is automatically steered to prevent the chance of improperly connecting the sensor).

- Connect the other sensor lead to the negative lead (usually denoted as the black lead) of a digital voltmeter (DVM) with the leads in the position for ***current*** measurement.

- Connect the positive lead of the DVM (usually denoted as the red lead) to the positive side of the 24V supply. The leads are connected this way to allow for a positive current reading -- as long as your ammeter is not polarity conscious, the polarity of the reading is of little consequence.

- Turn the DVM on and set the DVM to a range that will resolve 19.99 milliamps.

- If the power supply is not already turned on, turn it on now.

- Allow the DVM reading to stabilize (less than .01 milliamps change per minute).

  The extent to which you allow the electrode to stabilize can be determined by the degree of accuracy that you require.

- A reading of approximately 3.90 to 4.10 ma should be observed. Record this number or if your software allows you to assign values -- denote this as 0.0 °C.

- Rinse the electrode end as described previously.

- Immerse the sensor into a temperature controlled bath and allow to stabilize until a change of less than 0.01 ma per minute is observed.

- A reading proportional to the 50.0 °C full-scale range should be observed. For 37 °C this would correspond to approximately ((37/50) x 16) + 4.00. Record this number or if your software allows you to assign values -- denote this as the measured temperature).

- Using the recorded values, span the recorder, datalogger, data acquisition system or distributed control system according to the manual regarding such system.

  Calibration is now complete. Follow this procedure anytime calibration of the sensor/transmitter is required.

  If you are using the calibration kit to standardize the sensor/transmitter, the following procedure can be used substituting the following steps when immersed in 0.0 °C and 37 °C as previously described.

- With a small screwdriver, after the sensor has stabilized in the 0.0 °C bath, turn the *ZERO* adjust until a reading of 4.00 ± 0.01 milliamps is obtained.

- Immerse the sensor into the 37 °C bath and allow to stabilize until a change of less than 0.01 ma per minute is observed.

- To adjust the output to yield 4.00 to 20.00 milliamps for 0 to 50 °C, use the screwdriver to turn the *SPAN* adjust until a reading of ((37/50) x 16) + 4.00 = 15.84 milliamps is obtained.

  After the sensor is put into service, the electronics will prove to be very stable, but a recalibration schedule must be determined empirically for each application.

If there are problems calibrating the Sensor/Transmitter:

Confirm that the problems are not related to the system to which the unit is being interfaced by simulating the input as called out in the operator manuals that are supplied with your respective hardware and/or software. If problems persist, call your local representative or **pHionics** at **1-800-964-0063**.

3.6.1.2 Temperature calibration of 0-1. 0-2.5 or 0-5 volt output

Before performing the following steps, please follow all company, local, state, or national laws and/or regulations regarding proper safety precautions in handling liquids with respect to protective goggles, gloves, or clothing and proximity to eye washes, etc. Buffers are relatively harmless in most situations, but, it is always better to be on the safe side**.**

- *Remove the protective boot from the end of the sensor. Do not twist the boot to remove it --gently work it directly away from the sensor.*

- Immerse the sensor far enough into a temperature controlled bath at 0 °C (or a homogeneous mix of ice and water being stirred constantly) to totally cover the holes while concurrently contacting the Stainless Steel on the sensor housing, allowing for complete wetting of sensing element and contacting of the solution ground. ***The sensor will not work properly if the solution does not contact the metal housing!***

- If the unit is externally powered, connect the black lead of the sensor/transmitter to the negative side of your battery or power supply – being careful not to short any of the leads on the sensor cable. Connect the orange lead of the cable to the positive side of the battery or power supply.

- If the unit is powered by an internal battery, proceed to the following steps.

- Connect the black sensor lead to the negative lead (usually denoted as the black lead) of a digital voltmeter (DVM) with the leads in the position for ***voltage*** measurement.

- Connect the red sensor lead to the positive lead of the DVM (usually denoted as the red lead). The leads are connected this way to allow for a positive voltage reading -- the polarity of the reading is of little consequence.

- Turn the DVM on and set the DVM to a range that will resolve 1.00, 2.50 or 5.00 volts as required for your range (or autorange).

- If the power supply is not already turned on, turn it on now. If the unit is powered by an internal battery, proceed to the following steps.

- Allow the DVM reading to stabilize (less than .01 milliamps change per minute).

  The extent to which you allow the electrode to stabilize can be determined by the degree of accuracy that you require.

- A reading of 0.00 volts should be observed. Record this number or if your software allows you to assign values -- denote this as 0.0 °C.

- Immerse the sensor into a temperature controlled bath and allow to stabilize until a change of less than 0.01 mv per minute is observed.

- A reading proportional to the 50.0 °C full-scale range should be observed. For 37 °C this would correspond to approximately ((37/50) x 1.00) = 0.740. This would be 1.850 for the 2.50 range and 3.700 for the 5.00 range. Record this number or if your software allows you to assign values -- denote this as the measured temperature).

- Using the recorded values, span the recorder, datalogger, data acquisition system or distributed control system according to the manual regarding such system.

  Calibration is now complete. Follow this procedure anytime calibration of the sensor/transmitter is required.

  If you are using the calibration kit to standardize the sensor/transmitter, the following procedure can be used substituting the following steps when immersed in 0.0 °C and 37 °C as previously described.

- With a small screwdriver, after the sensor has stabilized in the 0.0 °C bath, turn the *ZERO* adjust until a reading of 0.00 ± 0.01 millivolts is obtained.

- Immerse the sensor into the 37 °C bath and allow to stabilize until a change of less than 0.01 mv per minute is observed.

- To adjust the output to yield 0 to 1.00 volt out for 0 to 50 °C, use the screwdriver to turn the *SPAN* adjust until a reading of ((37/50) x 1.00 volt is obtained. This would be 1.850 for the 2.50 range and 3.700 for the 5.00 range.

If there are problems calibrating the Sensor/Transmitter:

Confirm that the problems are not related to the system to which the unit is being interfaced by simulating the input as called out in the operator manuals that are supplied with your respective hardware and/or software. If problems persist, call your local representative or **pHionics** at **1-800-964-0063**.

3.6.2 Temperature care

If the unit is battery operated, disengage the cable or remove the battery module to prevent further drain during the time of transport or storage. See *special considerations* regarding the battery.

It is always recommended to use new silicone grease on the o-rings of the cable assembly and the sensor cartridge. This allows for easy assembly and disassembly, while concurrently preventing abrasion or other damage that may result to the o-rings.

3.6.3 Temperature special considerations

If the unit is battery operated, care should be taken to avoid shorting the red and black lead of the sensor/transmitter cable together -- once the cable has been attached to the unit. Typically a 1 megohm resistor is in series with the output to prevent the rapid discharge of the battery if accidentally shorted, however in some applications a smaller value or zero resistance is substituted for input impedance compatibility for the DVM, datalogger or other input device. Shorting the leads can result in fire, explosion or at the very least – rapid discharge of the battery module.

The output impedance of the battery or voltage operated preamp can also have a bearing on the readings observed during calibration or datalogging depending on the input impedance of the device. For instance, if the DVM or datalogger has an input impedance of 10 megohms, a 1.00 volt output would actually appear to be lower. If the output impedance is 1 megohm, the reading would be (10M/(10M + 1M)) x 1.00 = .909 volts. If your application is critical, please let us know when you order the device – so appropriate recommendations can be made.

3.6.4 Temperature recommended spare parts

These units are designed for serviceability, and consequently are very easy to assemble and disassemble. For this reason the recommended spare parts would consist of another identical unit with matching cable length as a backup.

If the unit is battery operated, two spare battery modules would also be recommended.

3.6.5 Temperature specifications

Series STs7050, 2-Wire, 4-20 ma Temperature Sensor/Transmitters

Output	4 to 20 ma
Power Supply Voltage	7 to 40 VDC
Loop Impedance (Max)	250 ohms at 12 VDC, 850 ohms at 24 VDC, 1650 ohms at 40 VDC
Cable from Transmitter to Power Supply	2 or 4 Conductor, twisted pair, 3 Mile Maximum
Isolation	600 VDC, >70 db at 50/60 Hz

Series STs7050T, 2-Wire, 4-20 ma Temperature Sensor/Transmitters with Optional, 2-Wire, 4-20 ma Temperature Output

Output	4 to 20 ma
Range	0-50 Degrees Celsius
Accuracy of Redundant Sensor	± 2° C
Response Time of Sensor	Approx 1 minute
Power Supply Voltage	7 to 40 VDC
Loop Impedance (Max)	250 ohms at 12 VDC, 850 ohms at 24 VDC, 1650 ohms at 40 VDC
Cable from Transmitter to Power Supply	4 Conductor, twisted pair, 3 Mile Maximum
Isolation	600 VDC, >70 db at 50/60 Hz

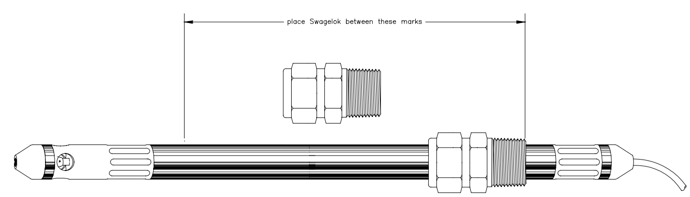
The following data pertains to all configurations:

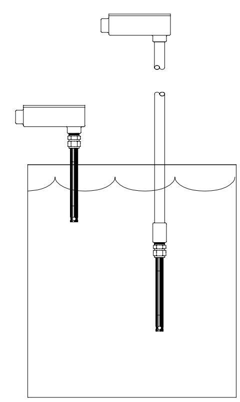
Linearity	± 0.15 °C
Accuracy	± 0.2 °C
Sensitivity	± 0.01 °C
Stability	± 0.05 °C per year
Repeatability	± 0.01 °C
Response Time (Including Electrodes)	90% < 20 seconds
Temperature Compensation	N/A
Temperature Sensing Type	Semiconductor
Input Range	0-50 °C
Temperature Sensing Range	0-50 °C
Pressure	0-100 PSI
Humidity	0-100%
Wetted Materials	316 SS, PVDF, Viton
Length	343 mm (13.5 in.)
Diameter	19 mm (0.750 in.) Maximum
Standard Cable Length	10 meters (approx 33 feet)
Shipping Weight (Excluding Cable)	< 2.2 kg (1 lb.)

4.1 Mounting of the sensor/transmitter

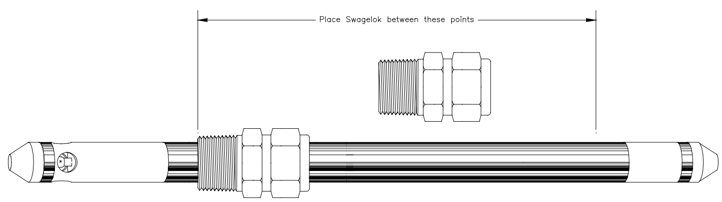
The sensor can be mounted in an insertion or submersion manner simply by placing a 3/4" NPT gland (compression) fitting in the position desired.

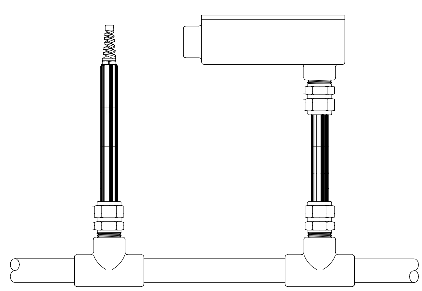
For *submersion* applications, the best placement of the gland fitting is between the dimples of the sensor with the threads directed toward the *cable end* of the sensor. Tighten the fitting until it firmly grasps the sensor – *do not over-tighten or clamp down upon the o-rings* – potentially damaging the seals. The fitting would then be threaded and sealed into a 3/4" NPT female fitting attached to a section of pipe extending to the length desired for monitoring or controlling a process in a tank or well, for example. The material selected for this should be compatible with the solution in which it is submersed. Inexpensive 3/4" PVC will work quite well for a majority of applications.





For *insertion* applications, the best placement of the gland fitting is between the dimples of the sensor with the threads directed toward the *sensor end* of the sensor/transmitter. Tighten the fitting until it firmly grasps the sensor – *do not over-tighten or clamp down upon the o-rings* – potentially damaging the seals. The fitting would then be threaded and sealed into a 3/4" NPT female tee or a tank adapter extending to the length desired for monitoring or controlling a process in a tank or pipe, for example. The material selected for this should be compatible with the solution in which it is in contact. For most parameters (with the exception of conductivity and temperature) the sensor end of the sensor/transmitter should be angled at least thirty degrees below the cable to prevent air entrapment in the reference solutions or measurement electrode. *Care must be taken to assure that the stainless steel housing is contacting the solution to be measured – or the differential amplifiers will not perform properly – making the measurements appear to be erratic.* A metal tee can sometimes assist in assuring this connection. **In insertion applications, extreme care must be observed when inserting or removing the sensor/transmitter – 100 psi can turn the sensor/transmitter into a lethal projectile – ripping conduit off of walls – as well as causing serious injury due to trauma or contact with the solution. Phionics is not responsible and does not warrant insertion applications – proceed with due caution.**





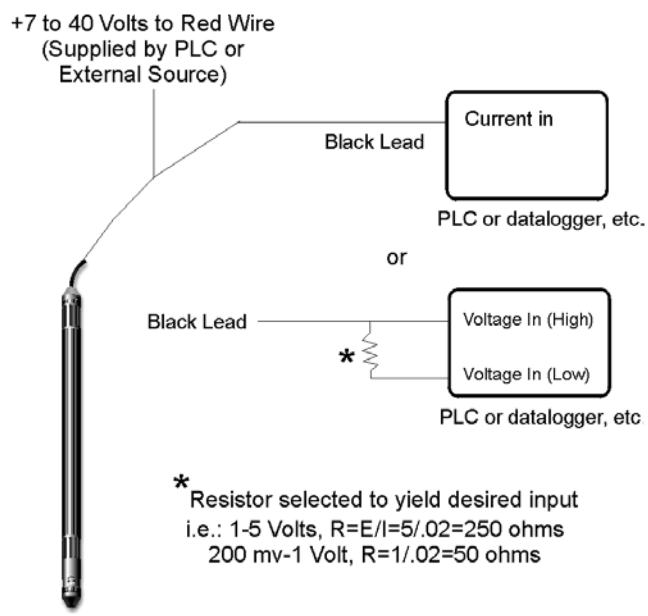
For *well* or *river* applications the sensor can be dropped in place -- due to the sealed cable – the only consideration being to place the sensor/transmitter in a stable location where turbulence will not introduce air bubbles or cause the sensor/transmitter to be damaged.

4.2 Wiring Considerations

4 to 20 ma transmitters have become an industry standard due to their inherently forgiving nature with respect to cabling configurations.

For short runs (less than 100 feet) almost any wire or cable, twisted or non-twisted, will suffice. However, good wiring practices should be followed on longer or critical applications (such as interfacing to A/D cards) to minimize noise or lightning generated problems.

Long runs can be achieved if a cable such as Belden 8451 or equivalent is used and the shield is properly terminated. For critical runs the drain wire of the sensor shield and the drain wire of the additional run of cabling should be tied together to maintain the integrity of the shield.



For voltage or battery operated applications, cables should be kept less than 1000 feet in length due to capacitance and impedance of the cable. Also, the linear, finite resistance associated with the additional length of the cable should be taken into consideration.

4.2.1 4-20 ma, 2-wire

Connect +7 to +40 vdc from your current loop to the red lead of the sensor/transmitter, connect the return to the black lead.

4.2.2 4-20 ma, with optional temperature output

Connect +7 to +40 vdc from your current loop to the orange lead of the sensor/transmitter, connect the return to the brown lead.

4.2.3 Battery –powered versions

The black lead of the sensor/transmitter is the reference side of the output, the orange lead of the sensor/transmitter is the positive output of the measured parameter. The battery voltage can be read between black and red -- the black lead again being the reference.

4.2.4 Externally powered versions

The black lead of the sensor/transmitter is the reference side of the output, the orange lead of the sensor/transmitter is the positive output of the measured parameter.

To power the unit a voltage must be applied between the red and black leads of the sensor/transmitter cable. The black lead should be attached to the negative source of power, and the red lead should be attached to the positive source of power. The voltage source should be in the range of 4 – 16 vdc.

5.1 Warranty

pHionics warrants its instruments to be free from defect in material and workmanship under normal use for a period of twenty-four months from date of purchase by the initial owner (the warranty excludes the sensor cartridge). ***If the object of warranty is a sensor or sensor/transmitter, please test the unit before using it in your application. We cannot accept the return of a sensor or sensor/transmitter after application for reasons other than warranty. Nor do we warrant the sensor or sensor/transmitter for any specific application. Determination of application compatibility is the sole responsibility of the procurer. pH, specific ion, ORP and similar electro-chemical sensor cartridges are not warranted against failure. If the sensor or sensor/transmitter is stained or disfigured in such a manner as to preclude it from being sold as new -- the unit cannot be accepted as a return and the procurer will remain responsible for any monies owed.***

The sensors are tested extensively during manufacturing and cannot be warranted against leaks once they leave the factory due to improper removal and insertion of sensor/cartridge and cable assemblies.

Warranty does not cover defects caused by abuse or electrical damage. **pHionics** will not cover under warranty any instruments damaged during shipment to the factory improperly packed. Repair attempts by other than authorized service personnel will void warranty. Proof of date of purchase will be required.

If within the warranty period, the equipment does not meet the specifications at time of purchase, **pHionics** shall correct any such defect or non conformance by (at our option) repairing any defective part or parts that are returned to us, or by making available at your facility (via lowest freight rate) a repaired or replacement part, or by crediting your account, if we deem it appropriate.

Items returned for warranty repair must be prepaid and insured for shipment. Warranty claims are processed on the condition that prompt notification of a defect is given to **pHionics** within the warranty period. **pHionics** shall have the sole right to determine if in fact a warranty situation exists.

pHionics' warranty does not cover travel expenses, travel time, mileage expenses, removal, reinstallation, or calibration.

The foregoing warranty is exclusive and in lieu of all other warranties whether written, oral or implied, and we make *no warranty of merchantability or fitness for a particular purpose.*

Our liability to you arising out of supplying of this equipment or its use whether based on warranty, contract or negligence shall not in any case exceed the cost of correcting defects in the equipment as herein provided and upon the expiration of the applicable warranty period as aforementioned, all such liability shallterminate. The foregoing shall constitute your sole remedy and our sole liability. *In no event shall we be liable for special or consequential damages.*

5.2 Return of Material

Material returned for repair, whether in or out of warranty **(please read warranty section regarding types of material which cannot be accepted back for environmental and/or safety reasons)**, should be shipped prepaid, insured to:

Phionics, Inc.
6680 Alhambra Avenue, #504
Martinez, CA 94553

RMA No: (call for return of merchandise authorization number -- material cannot be accepted without an RMA number – merchandise returned for credit may be subject to a twenty percent restocking fee – at the discretion of **pHionics**).

The returned material should be accompanied by a letter of transmittal that should include the following:

Subject: Return of Materials for Repair

1. Location, type of service, and length of time in service of device.
2. Description of the faulty operation of the device and the circumstances of the failure.
3. Name, telephone and FAX number of the person to contact if there are questions regarding the returned material.
4. Statement as to whether warranty or non warranty service is requested.
5. Complete instructions as to how you would like any problems resolved, etc.
6. Complete shipping instructions for return of the material.

Adherence to these procedures will expedite handling of the returned material, and will prevent unnecessary additional charges for inspection and testing to determine the problem with the device. If the material is returned for out of warranty repairs, a purchase order for repairs should be enclosed with the letter of transmittal.

Statement of pHionics product policy

It is a primary objective of **pHionics**, Inc. to provide a product and/or service to our customers of outstanding value, safety, reliability and quality. In our concern for the world that we share, we will attempt to package and design our products in an environmentally conscious manner.