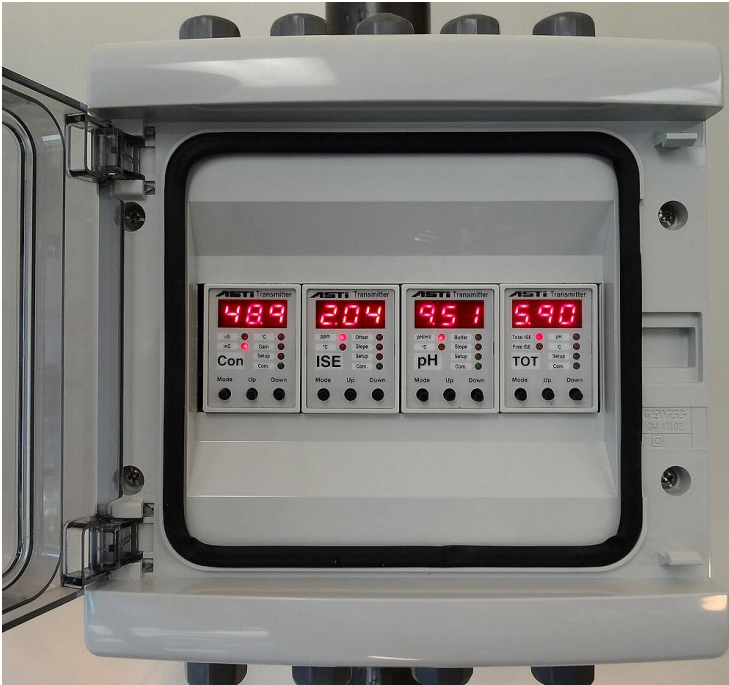


3TX-ISE Ammonia, Nitrate, Nitrite Transmitter, Controller & Datalogger



A typical system is shown above with free ammonia (ISE) and pH as inputs for the TOT to compute total ammonia. The 3TX-CON conductivity is shown as the third optional input above but this could just as easily be a DO, ORP or ISE measurement module.

- The 3TX-ISE online analyzer with ion selective electrodes for Ammonia Nitrogen (NH₃-N), Nitrate (NO₃-N), and Nitrite (NO₂-N), can be reliably used as a monitor and method of control in the nitrification and nitrogen removal process, or to monitor drinking water chloramination.
- The 3TX-ISE is a simpler, lower cost alternative to many sample conditioning analyzers while providing reliable real time measurements in the conditions commonly found in most municipal wastewater and potable water applications.
- The modular design allows you to select a single channel or multi-channel transmitter, analyzer, or controller for any combination of available measurement parameters.
- Standard 4-20mA analog output and optional MODbus digital output for full integration with your existing SCADA or process control system

3TX-ISE Features & Benefits

- Unique membrane technology results in a rugged sensor that does not need rebuilding or maintenance. You can typically expect twice the sensor life compared to competitive sensors for most applications.
- Flexibility to configure the 3TX as a simple transmitter or a controller *for any combination of measurements and functions* to suit your needs. You can configure one system to monitor ammonia nitrogen, nitrite & ORP and another nitrate with alarm functions, and monitor pH with alarm and control functions.
- Nitrate/nitrite sensors don't suffer interference from turbidity or COD unlike optical ISE sensors
- Minimize maintenance and ownership costs due to rugged ISE sensors that require no reagents, no sample preparation & no rebuilding. Standard weekly cleaning is sufficient for secondary WWTP use.
- 1-point grab sample offset calibration quickly standardizes the inline ISE instrument with your lab's analysis used for reporting WITHOUT removing the sensor from service.

Unique Membrane Technology

Engineered from the ground up and extensively field tested, unique proprietary membrane technology provides significantly improved sensor life and selectivity of ammonia over potassium; and nitrate over chloride ions, versus traditional ion selective electrode (ISE) membranes while offering substantial improvements in service longevity. Industry leading solid-state conductive polymer industrial reference system completes the ISE design to ensure low-maintenance and cleaning frequency.





Typical Applications

- Single channel Ammonia Nitrogen (NH₃-N), pH, nitrate (NO₃-N), nitrite (NO₂-N), conductivity or ORP for secondary or tertiary wastewater treatment monitoring and process control.
- Potable water nitrate reduction – 3-channel nitrate, pH, conductivity monitoring,
- Wastewater influent monitoring – dual channel ammonia nitrogen, pH.
- Wastewater nitrification & denitrification – 3 or 4-channel ammonia nitrogen, pH, nitrate, nitrite monitoring to assure full nitrification and prevent excessive chlorine consumption due to high nitrite.
- Wastewater final effluent – 3-channel monitoring of nitrate, pH, conductivity.
- Drinking water distribution systems– low level ammonia & nitrate monitoring.
- Industrial wastewater treatment including ammonia sparging and air scrubber applications.

Available Parameters & Measuring Ranges

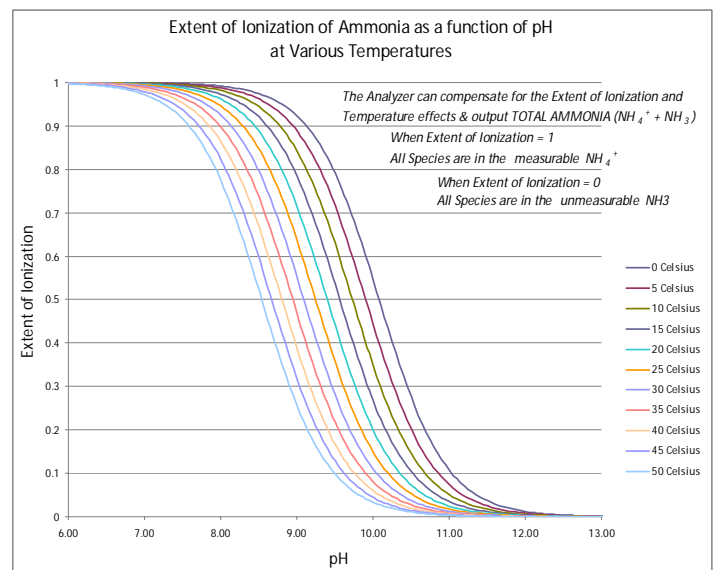
3TX-ISE for NH₃-N: Ammonium ion concentration in clean potable water to wastewater & industrial use.

Ammonia as nitrogen NH₃-N: Municipal & Industrial wastewater range: 1 ppm to 999 ppm

Municipal drinking water range: 0.2 ppm to 999 ppm

Ammonium (NH₄⁺) free ion activity units for ranges detailed above (for NH₃-N units divide by 1.29). It is readily possible to measure down to 1ppm of ammonium even in the presence of 20 to 30 ppm of potassium ions, which is a common sample composition for many second wastewater effluent streams.

The graphs to the right show the impact of pH and temperature on the extent of ionization of ammonia gas to ammonium ion. The extent of ionization defines the percent of the weak base ammonia that the ion selective sensor can detect. On the vertical axes if the extent of ionization is 0.00 then none of the species is in the measurable form while if 1.00 then all is in the measurable form. The multiple shifted extent of ionization colored lines demonstrate the impact of temperature on this equilibrium physical chemistry process. The portion which is in the measurable form at that given pH and temperature (the extent of ionization) is called the "Free ISE". The "Total ISE" computed by TOT module (in this case total ammonia) is the value as though all 100% of ammonia were in the measurable form for the sensor.



3TX-ISE for NO₃-N: Nitrate ion concentration in clean potable water through wastewater & industrial use. Nitrate as nitrogen, range 0.62 ppm to 999 ppm units in nitrate ion, (for NO₃-N units divide ion units by 4.43). It is possible to measure down to 1ppm nitrate ion in 400ppm chloride ions. Nitrite is not a significant interference for the measurement of nitrate ions in typical municipal wastewater conditions.

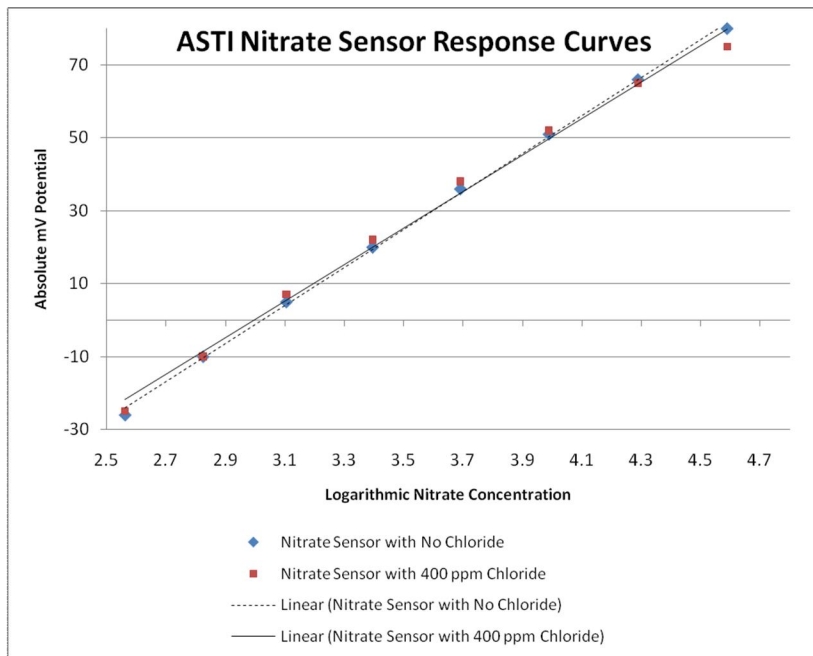
3TX-ISE for NO₂-N: Nitrite ion concentration in drinking water through wastewater and industrial processes. Nitrite as nitrogen, range 0.46 ppm to 999 ppm units in nitrite ion, (for NO₂-N units divide ion units by 3.29). Nitrate is not a significant interference for measurement of nitrite in typical municipal wastewater conditions

Interfering Ion Compensation For ISE Electrodes Is Not a Valid Solution

Measuring ammonium and nitrate ions using traditional older ISE membrane technology has been problematic due to interfering potassium and chloride ions that are present in concentrations typically found in processes outside of the laboratory. Often the “solution” has been to measure the interfering ion with a second electrode and “compensate” for the effect of the error on the primary measurement. This is altogether unlike pH compensation described on the previous page that details a well grounded pH compensation due to the change in the extent of ionization equilibrium for ammonia converting to the ammonium ion which is purely due to a physical chemistry issue (and not related to any issues of the ISE sensor itself).

However, there is no widely accepted scientific consensus that an ion selective sensor can be compensated for interferences with a second ISE sensor in continuous field applications. Interference is a degenerative process, exposure to levels outside the range of the sensor gradually degrades the sensor to the point it becomes unresponsive. Online process streams can have varying analyte and interfering ion levels, temperature, and sample background. Such continuous change in the sensor characteristics and sample, combined with potential uncertainty of a second “compensation” electrode, is a complex process to measure properly even in lab conditions. This just can’t be corrected in the field with a simple mathematical factor.

Sensors used with the 3TX-ISE do not require compensation, and are capable of measuring ammonia down to 1ppm in the presence of 20 to 30 ppm potassium ions, or nitrate as low as 1 ppm in the presence of up to 400 pm chloride ions, while maintaining linearity and stability. Such high selectivity over chloride is necessary in many secondary municipal wastewater applications to make nitrate measurement useful.



Conversion Table for Logarithmic pNO₃
Nitrate to ppm Nitrate

2.5	196.1 ppm
2.7	123.7 ppm
2.9	78.05 ppm
3.1	49.25 ppm
3.3	31.07 ppm
3.5	19.61 ppm
3.7	12.37 ppm
3.9	7.805 ppm
4.1	4.925 ppm
4.3	3.107 ppm
4.5	1.961 ppm
4.7	1.237 ppm

The linear response plot of our nitrate sensors in the presence of chloride at such concentrations and in the complete absence of chloride at such concentrations is statistically identical in terms of absolute response and slope (sensitivity). This means that chloride ion interference can be ignored when measuring nitrate under the most common conditions found in nitrification and denitrification monitoring processes. By contrast, there are known problems with optical nitrate and nitrite sensors experiencing significant interference from both ions being present in the same process whereas the novel ASTI ISE membranes do not have this issue.



Description & Options:

The ion selective modules in the 3TX-ISE include measurement and temperature transmission, integral temperature compensation, LED display of ppm or temperature, and configurable 0-20mA or 4-20mA output of ppm or temperature. Sensors are supplied as standard with a 10-ft cable with tinned lead ends, and feature industrial grade construction with the best reference lifetime in process industry through nonporous cross linked conductive polymer. Sensors are available with a protective guard and can be mounted inline in a pipe tee, immersion mounted in a tank, or submerged in a basin. A variety of waterproofing options are available to suit almost any application. Waterproof NEMA 4X Enclosures (CSA/UL Listed) supporting 2, 3, 4, 6, or 7 modules for Wall, Panel or Pipe Field Mounting are available in any mix of configurations and options for both 24VDC and 115/230VAC power operation installations.

Measurement / Transmitter Modules: Modules are available to measure pH, ORP, mV, Temperature, Conductivity, Dissolved Oxygen (DO), Ammonium ion (NH_4^+), Ammonia Nitrogen ($\text{NH}_3\text{-N}$), Nitrate ($\text{NO}_3\text{-N}$), and Nitrite ($\text{NO}_2\text{-N}$), Calcium (used as a proxy for water hardness), Potassium, Perchlorate, Chloride, and Sodium among other ion selective parameters. Includes a 3-digit display and (6) LED's for setup and value display. Includes scalable 0-20mA or 4-20mA output. All analog outputs have built-in trim calibration support, including both offset and span adjustments. Calibration of temperature element is available for all measurement modules.

Preamplifier Support: Unlike many low cost systems, the 3TX-ISE series supports optional external sensor preamplifiers for operation in noisy environments and eliminates the need to open the analyzer enclosure for sensor service, thus preventing accidental damage to the analyzer. Sensors with preamp can be located up to a maximum 300 feet away. The option to use an integral or external preamplifier is only at time of order.

3TX-REL Option: Alarm and relay controller module with two independent configurable limits. One module required for each measurement module. Providing (2) each 250VAC / 5 amp dry contact relays with hold function for sensor calibration, and control functions that are fully configurable for control mode and variables for each control algorithm. Control modes include: 1) Alarm functions only; 2) On/Off control with a user-configurable dead band; 3) Time proportional control; 4) Proportional frequency control (variable pulse controller). Alarms include configurable startup timer and reaction timer to avoid alarming if limits are exceeded for a short time.

3TX-DAT Data Logging Option: MODbus 3TX-DAT field datalogger module can support simultaneously datalogging from any 3TX module with MODbus output option (3TX-pH, 3TX-ISE, 3TX-CON, 3TX-DO, 3TX-TOT) at frequencies from every second to every hour. 3TX-DAT can be turned on and of at will allowing for intermittent battery powered use with a timer switch. Configuration of 3TX-DAT datalogger and downloading of data done via freely supply mating Windows PC software.

3TX-TOT Option: Computes total ammonia $\text{NH}_3\text{-N}$ using an algorithm with the NH_4^+ free ion activity, pH and temperature as inputs and sends the computed total ammonia value by 4-20mA output. All of the inputs used as well as the computed total ammonia value are sent by RS-485 Modbus digital output protocol.

Modbus Option: Available by ordering the measurement module to include Modbus (only at time of initial order) or by adding the separate 3TX-TOT module anytime. The 3TX-TOT module can support a maximum of three measurement module inputs with the first two always being free ISE and pH. The third input can be any other module (3TX-pH, 3TX-ISE, 3TX-CON, 3TX-DO) not involved with the determination of total ISE.

Power: Universal 115/230 VAC power supply or a dedicated 24VDC power supply (not 2-wire loop power).



General Ion Selective Sensor Specifications

Integrated Ammonium (NH₄⁺) Ion Selective Sensor:

Concentration Range: * 1 to 5 X 10⁻⁶ Molar, (18,000 to 0.090 ppm)
Lowest Limit of Detection: 2X10⁻⁷ Molar, .004 ppm
pH Range: 2.5 to 9.0 pH (Max 11.0 pH when used with 3TX-TOT module)
Temperature Range: 5 to 40 °C Pressure Range: 1 to 10 psig
Body Materials: CPVC, Ultem Junction: HDPE
Reference System: Double junction, Porous Ceramic & Porous HDPE, Saturated KCl in cross-linked polymer
Configurations: 3/4" - 3/4" MNPT, 3/4" - 1" MNPT, 1" MNPT Twistlock
Installations: Indoor or Outdoor; Inline, Immersion or Submersible (Specify required style when ordering)
Interfering Ion Ratio Limits: ** Na⁺ (5X10³), K⁺ (10), H⁺ (1X10⁵)

Integrated Nitrate (NO₃⁻) Ion Selective Sensor:

Concentration Range: * 1 to 5 X 10⁻⁵ Molar, (62,000 to 0.620 ppm)
Lowest Limit of Detection: 0.080 ppm (80 ppb)
pH Range: 4 to 9.0 pH
Temperature Range: 5 to 40 °C Pressure Range: 1 to 10 psig
Body Materials: CPVC, Ultem Junction: HDPE
Reference System: Double junction, Porous Ceramic & Porous HDPE, Saturated KCl in cross-linked polymer
Configurations: 3/4" - 3/4" MNPT, 3/4" - 1" MNPT, 1" MNPT Twistlock
Installations: Indoor or Outdoor; Inline, Immersion or Submersible (Specify required style when ordering)
Interfering Ion Ratio Limits: ** ClO₄⁻ (0.006), I⁻ (0.42), Br⁻ (74), NO₂⁻ (219), Cl⁻ (2,754)

Integrated Nitrite (NO₂⁻) Ion Selective Sensor:

Concentration Range: * 1 to 5 X 10⁻⁵ Molar, (46,000 to 0.460 ppm)
Lowest Limit of Detection: 0.276 ppm (276 ppb)
pH Range: 4 to 9.0 pH
Temperature Range: 5 to 40 °C Pressure Range: 1 to 10 psig
Body Materials: CPVC, Ultem Junction: HDPE
Reference System: Double junction, Porous Ceramic & Porous HDPE, Saturated KCl in cross-linked polymer
Configurations: 3/4" - 3/4" MNPT, 3/4" - 1" MNPT, 1" MNPT Twistlock
Installations: Indoor or Outdoor; Inline, Immersion or Submersible (Specify required style when ordering)
Interfering Ion Ratio Limits: ** SCN⁻ (5), ClO₄⁻ (25), Br⁻ (230), NO₃⁻ (760), Cl⁻ (6,400)

* All linear measurement ranges for ISE sensors are given in the absence of any interfering ions. For any given specific measurement of interest for a given background of interfering ions, you should consult the factory for recommendations.

** Interfering ion ratio limits given in permissible ratios of Molar excess of interfering ion to the analyte (measured) ion.

The 3TX-ISE max range of 999 will limit the useable upper bound range of any of the given ISE sensor specified above. For measurement above 999 ppm range please inquire to factory for assistance. Although support for installations beyond 10 psig is not possible, it is possible to support installations above 40 degrees Celsius for these ISE sensor types above although the sensor lifetime will suffer somewhat accordingly. You can inquire to the factory for any such special installation or application requirements.

Last Revised November 27, 2012