Senix®
Distance Measurement

ToughSonic® CHEM Series

Ultrasonic Level Sensors

- ***PC Configurable***
- ***Chemically Resistant PVDF Housings***
- ***Multiple Outputs or Serial Only***
- ***Attached Cable***
- ***Dual Threads***
- ***AirWire compatible***



ToughSonic CHEM 10 LVL 100, 10ft
ToughSonic CHEM 12 LVL 120, 12ft
ToughSonic CHEM 20 LVL 300, 20ft
ToughSonic CHEM 35 LVL 500, 35ft

Installation and Operating Instructions

Senix Corporation
Date: 1 Dec 2020 v3.6.300
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Product Declarations

Document Revisions

Initial release	31 May 2015
Updated for new models	5 Sep 2019
Updated for new models	1 Dec 2020

Related Products

SenixVIEW for Windows

A setup tool for TSPC and CHEM series sensors, this software installs on a PC and is used to configure sensor options, select and calibrate outputs, view and analyze measurements, and save the result to a PC hard drive. Recalled configurations can restore or duplicate an application without recalibration. View, chart, log, and analyze sensor operation. Sensor firmware upgrades can be done easily through SenixVIEW too. Download SenixVIEW at no charge from: https://www.senix.com/technical-support/documentation.

Configuration and Setup Kits

Used for bench viewing or configuring sensors, kits include power supply, terminal board and cables to interconnect with your PC. Everything needed to connect to and customize a ToughSonic product.

CE Compliance

ToughSonic® family of ultrasonic sensors are compliant with the CE Electromagnetic Compatibility Directives and Standards listed below: Directives: Electromagnetic Compatibility (2004/108/EC)
Low-Voltage (2006/95/EC)Standards: EMC: EN 61326-1:2006 Industrial Safety: EN 61010-1:2001

Warranty

Senix makes no warranty, representation, or guarantee regarding the suitability of the products for any particular purpose. All specifications are subject to change without notice.

Senix, Inc. will repair or replace, at our option, any part found by us to be defective in material or workmanship if the product is received by Senix, freight prepaid, within one year from the date of original shipment to buyer.

Disclaimer and Release. The warranties, obligations and liabilities of Senix and the remedies of buyer set forth above are exclusive and in substitution for, and buyer hereby waives, releases and renounces all other warranties, obligations and liabilities of Senix and all other rights, claim, and remedies of buyer against Senix, expressed or implied, arising by law or otherwise, including but not limited to: (A) Any implied warranty or merchantability or fitness; (B) Any implied warranty arising from course of performance, course of dealing or usage of trade; (C) Any obligation, liability, right, claim or remedy in tort, whether or not arising from the negligence of Senix (whether active, passive or imputed); and (D) Any obligation, liability, right, claim or remedy for loss or damage to any product.

Exclusion of Consequential and Other Damages. Senix shall have no obligation or liability, whether arising in contract (including warranty), tort (including active, passive or imputed negligence) or otherwise, for loss of use, revenue or profit with respect to any nonconformance or defect in any product delivered under this agreement, or for any other direct, incidental or consequential damages.

Governing Law. The terms and conditions of this agreement shall be governed by the domestic law of the State of Vermont, U.S.A.

Repairs and Returns

Any returns must have a Return Material Authorization (RMA) number. Contact us at:

Mail: Senix Corporation
10516 Route 116 Suite 300
Hinesburg, VT 05461 USA
Web: http://senix.com/contact-us/

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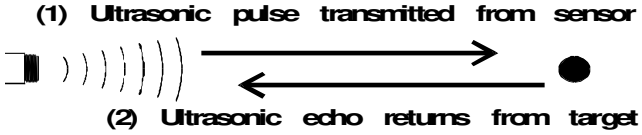
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Ultrasonics Overview

Introduction

Senix sensors measure the distance to a liquid or solid surface by sending a sound wave, above the range of hearing, at the target surface and measuring the time for the echo to return. The sensor determines the distance to the target through the air. A liquid level can be determined as analog volts or current if the surface is within the *analog windo*w.



Advantages

- **Non-contact**

  Measures through the air without touching the target material.

- **Easy to Install**

  Threaded mounting from above means simple installation without entering the tank.

- **Point Level Outputs**

  Solid state switch outputs provide control or alarm features that are user selectable.

- **Distance Proportional Outputs**

  Three proportional analog outputs provide standard interfaces to PLCs or displays.

- **Unaffected by Target's Optical Characteristics**

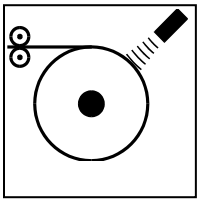
  Sensor operation is not sensitive to ambient light levels, the color of the target, or whether the target is optically transparent or reflective.

- **Remote Adjustment**

  SenixVIEW software allows remote monitoring and adjustment for convenience and safety.

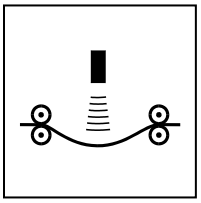
Other Applications

In addition to level control our ultrasonic sensors can be used in many other applications such as:



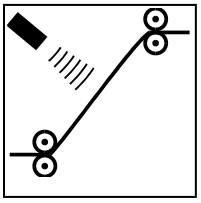
Roll Diameter

Measure the size of a roll to control tension or speed, or determine when full or empty.



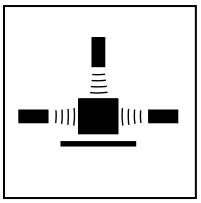
Loop Control

Precisely control the position of material loops, including wires, tubes and webs.



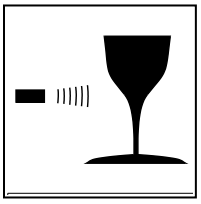
Web Break

Rapidly detect a broken web in a printing press or paper machine.



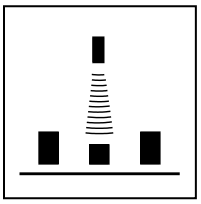
Dimensioning

Determine the size of an object for information or to determine its volume or width.



Proximity

Determine the presence of objects to count or control their movement.



Sort/Select

Sort or select objects based on differences in their physical dimensions ….***and many more...***

Terminology

Terms listed here are shown in *italics* throughout this document. An asterisk (*) indicates a SenixVIEW configurable parameter.

Analog An electrical output type that varies in proportion to measured distance. Analog output types can be either *current loop* or *voltage*.

Analog Window* A range of distances between two *endpoints*, within which the analog output will vary between the analog high and low limits in proportion to measured distance.

Current High Value* The maximum (highest) value of both current loop outputs, typically 20 mA but adjustable using SenixVIEW.

Current Loop Output* An *analog* output type that drives an electrical current proportional to measured distance. CHEM sensors provide two standard 4-20 mA (sourcing and sinking) or SenixVIEW customized output ranges.

Current Low Value* The minimum (lowest) value of both current loop outputs, typically 4 mA but adjustable using SenixVIEW.

Deadband The small distance near the sensor face within which distance cannot be measured.

Endpoint* One of two end distances representing the outer limits of the *analog window*.

Hysteresis* The reverse distance a target must change to turn a switch OFF after the switch has turned ON at a *Setpoint*.

Ingress Rating An enclosure rating that identifies how susceptible a product is to the entry (ingress) of external objects or liquids.

Measurement Rate* The repetitive rate that the sensor measures distance (see *response time*).

Measurement Interval* The time between measurements, or [1 / *Measurement Rate*].

Measurement Process* The measurement, filtering and time delays that affect sensor outputs (p 26).

Maximum Range The maximum target detection distance of a sensor model; may be overridden by *Range MAX* (p 25).

Operating Range* The range of distances between the *range MIN* and *range MAX* values (p 25).

Optimum Range The range of target distances recommended for optimum performance in varying environmental conditions.

Range MAX* The farthest distance of the Operating Range; user adjustable in SenixVIEW.

Range MIN* The nearest distance of the Operating Range; user adjustable in SenixVIEW.

RS-232* An electrical interface standard used to transfer information using *serial data* communications. This is a single ended interface with a specified maximum range of 50 feet (15 meters) that typically supports one device.

RS-485* An electrical interface standard used to transfer information using *serial data* communications. This is a long distance differential interface capable of supporting multiple addressable devices.

Response Time* The time required for sensor outputs to respond to measurements; affected by *measurement rate* and filter selections.

Serial Data A method of transferring information using a sequential (serial) on/off pattern to encode the data. Two common industry standards are *RS-232* and *RS-485*.

Setpoint* The distance a *switch* output turns ON.

Sinking Current Loop* (vs. sourcing current loop) Analog 4-20 mA output where the current source is external and the sensor sinks that current loop to ground.

Sinking Switch* (vs. Sourcing Switch) One that sinks current from an external load to ground when turned ON. An ON sinking switch output measures a low voltage.

SenixVIEW Senix PC-based software used to configure and ToughSonic® sensors.

Sourcing Current Loop* (vs. sinking current loop) Analog 4-20 mA output where the sensor is the source of current that flows out of the sensor.

Sourcing Switch* (vs. Sinking Switch) One that sources current from the sensor to the load when turned ON. An ON sourcing switch output measures a high voltage.

Switch* An electrical output type that is either ON or OFF. ToughSonic® switches are solid state and can be either sinking or sourcing type.

SYNC* A wired configuration that synchronizes the timing of two or more sensors to prevent crosstalk or ensure simultaneous measurements. This feature is generally not used in level measurement applications.

Target Any object or material that reflects *ultrasonic* energy back to the sensor thus allowing the sensor to measure its distance.

Time Delay* A time period triggered by a set of conditions and, after those conditions persist for the entire period, cause a secondary event to occur. There are several user-selected time delay features available.

Ultrasonic A sound wave of a frequency greater than 20,000 Hz, typically above the range of human hearing.

Voltage High Value* The maximum (highest) value of the voltage outputs, typically 10 VDC but adjustable using SenixVIEW.

Voltage Low Value* The minimum (lowest) value of the voltage output, typically 0 VDC but adjustable using SenixVIEW.

Voltage Output* An *analog* output type that drives an electrical voltage proportional to measured distance. CHEM series sensors provide industry standard or SenixVIEW customized output ranges.

Sensor Overview

CHEM Product Features

ToughSonic® CHEM sensors measure distance without contact and are designed for tough industrial environments.

Rapid PC Setup & Control



PC setup gives you control over all sensor outputs and features. View, analyze and save sensor setups for rapid implementation or cloning.

Chemically Resistant Packaging

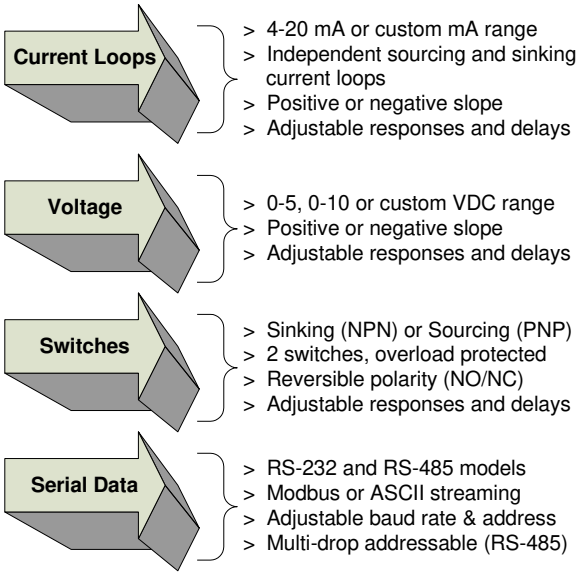
Rugged Kynar® PVDF housings are completely sealed and impervious to most chemicals and operate over a wide temperature range. A PUR jacketed interface cable is potted into each housing.



KYNAR® is a registered trademark of Arkema Inc. For chemical resistance information refer to https://senix.com/technical-support/documentation/

Industry Standard Interfaces

Serial-only or multiple simultaneous outputs, each with many SenixVIEW adjustable features.



CHEM Series Part Numbers

CHEM 10, 12, 20, and 35 have these part numbers. CHEM 10 has a 10ft maximum range etc.

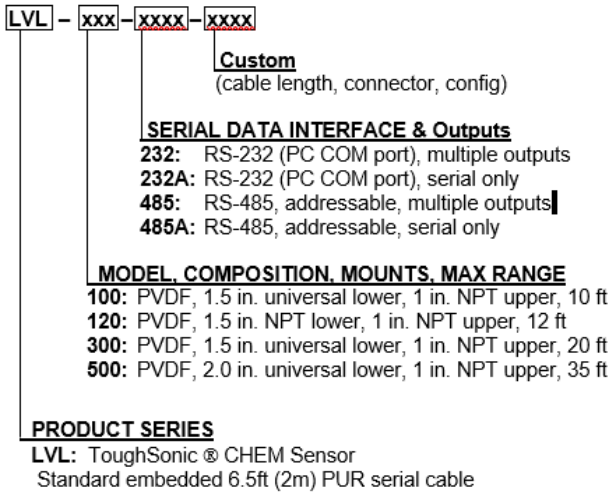


Figure 1 - Part Number Structure

*M12 connector or Extended embedded cable available

Identification

The ToughSonic® model number and serial number are printed on the label on the side of the housing.

Specifications

A summary of sensor specifications is shown in the following table.

	ToughSonic CHEM 10-xxx	**ToughSonic CHEM 12-xxx**	**ToughSonic CHEM 20-xxx**	**ToughSonic CHEM 35-xxx**
Photo				
Maximum Range Deadband (minimum)	10 ft. (3.1 m) 4 in. (10 cm)	12 ft (3.7m) <4 in (10 cm)	20 ft. (6.1 m) 8 in. (20.3 cm)	35 ft. (10.7 m) 12 in. (31 cm)
Optimum Range (small targets, dry materials, hot)	80 in. (203 cm)	10 ft. (3 m)	13 ft. (4.1 m)	25 ft. (7.6 m)
Resolution *(serial data)*	0.003384 in. (0.086 mm)	0.003384 in. (0.086 mm)	0.006768 in. (0.1719 mm)	0.013536 in. (0.3438 mm)
Default: RangeMIN *RangeMAX* *Switch #1 Setpoint* *Switch #2 Setpoint* *Analog Low Endpoint* *Analog High Endpoint*	4.0 in. (10.2 cm) 10 ft. (3.1 m) 80 in. (203 cm) 8 in. (20.3 cm) 80 in. (203 cm) 4.0 in. (10.2 cm)	4.0 in. (10 cm) 12ft. (3.7 m) 100 in. (254 cm) 8 in. (20.3 cm)) 100 in. (254 cm) 4.0 in. (10.2 cm)	8 in. (20.3 cm) 20 ft. (6.1 m) 160 in. (406 cm) 18 in. (45.7 cm) 160 in. (406 cm) 8 in. (20.3 cm)	12 in. (31.5 cm) 35 ft. (10.7 m) 280 in. (711 cm) 18 in. (45.7 cm) 280 in. (711 cm) 12 in. (30.5 cm)
Performance	Repeatability: Greater of +/-0.03 in. (0.76 mm) or 0.2% of target distance in stable environment Accuracy: Better than 0.5% of target distance in stable, homogeneous environment; affected by temperature gradients, target echo strength, speed of sound in vapors.			
Resolution (*analog)*	4100 steps 0-10 VDC and 3279 steps 4-20 mA (scaled between user-set distance endpoints)			
Measurement Interval	Default 50 msec (20 Hz)	Default 50 msec (20 Hz)	Default 100 msec (10 Hz)	Default 200 msec (5 Hz)
	Adjustable from 5 mS to 2.8 hours; affected by filter selections; faster rates limit max target distance			Adjustable from 100 mS to 2.8 hours
Outputs, full-featured models	Two switches: 150 mA, SenixVIEW configured as PNP (@ input voltage) or default NPN (external 40 VDC max.), setpoint mode or window mode			
	One voltage**:** 0-10 vdc or SenixVIEW configured, 10 mA max (min 15 VDC input for full 10 VDC output)			
	Two current loops**:** one sourcing and one sinking loop, 4-20 mA or SenixVIEW configured, 450Ω max @ >15VDC, 250Ω max @ 10 VDC			
Serial Output only, all models	RS-232 or RS-485, Modbus RTU or ASCII stream. Designated by letter “A” at end of part number			
Serial interface, Interface protocol	Modbus slave, ASCII, or SYNCH. RS-232 or RS-485 interface, specify model. RS-485 models are 2-wire multi-drop addressable (addresses 1-247). RS232 is point to point, 50ft max cable. Baud rates 9600 - 115200, no parity, 8 bits, one stop bit. SenixVIEW configured.			

Indicators	None			
Model Name	**ToughSonic CHEM 10**	**ToughSonic CHEM 12**	**ToughSonic CHEM 20**	**ToughSonic CHEM 35**
Construction	Chemically resistant Kynar PVDF housing, threaded both ends, potted-in 4-conductor (serial only) or 9-conductor shielded PUR cable with tinned ends, 6.5 ft. (2 m). Other length, connectors available			
Transducer Beam	Rugged piezoelectric, nominal beam width 12-14 degrees @ -3 dB boundary, conical			
Transducer Frequency	125 kHz	125 kHz	75 kHz	50 kHz
Cable, full outputs	6.5-ft (2m) 9-wire with shield, tinned ends, PUR			
Cable, serial-only	6.5-ft (2m) 4-wire with shield, tinned ends, PUR			
Max. cable length advised	RS-232: 50ft (15 m), RS-485: 3937ft (1200m)			
Cable, M12 option	12” cable with 5-pin M12 male connector, 6ft mating cable available. M12 option limited to one output. Pin assignment by user. This is a custom accessory			
Power Input	10-30 VDC @ 55 mA max			
DC Current @ typical 24VDC input + I/O, at default rep rate	45 mA typical at default rate. Add 20 mA if using sourcing current loop. Add sourcing switch loads.			
DC Current, Serial Only @ 24VDC input	29 mA at default rate			
Environmental	Ingress: IP-68, NEMA-4X Humidity: 0-100% (avoid heavy condensation) Temp: -40 F to 158F (-40 C to +70 C)			
Temperature Compensation	SenixVIEW configured: Internal sensor (constant power), Internal sensor (periodic power), Custom offset, Reference Target (external), or None			
Threads, Upper	1” NPT	1” NPT	1” NPT	1” NPT
Threads, Lower	1.5” universal non-tapered	1.5” NPT	1.5” universal non-tapered	1.5” universal non-tapered
Dimensions (Dia x Length)	3.05 (77mm) x 5.62 (143mm), 2.60 (66mm) inserted length	3.05 (77mm) x 7.5 in (193mm) 2.0 in (5.08 cm) Inserted length	3.05 (77mm) x 5.62 (143mm) 2.60 (66mm) inserted length	3.05 (77mm) x 5.59 (142mm) 2.60 (66mm) inserted length
Weight	21.2 oz. 0.60 kg.	21.2 oz. (0.60 kg)	21.7 oz. 0.62 kg.	24.7 oz. 0.70 kg.
Ordering: Full Outputs Ordering: Serial Only	LVL-100-232 LVL-100-485 LVL-100-232A LVL-100-485A	LVL-120-232 LVL-120-485 LVL-120-232A LVL-120-485A	LVL-300-232 LVL-300-485 LVL-300-232A LVL-300-485A	LVL-500-232 LVL-500-485 LVL-500-232A LVL-500-485A

Table 1 - Specification

Startup Tips

New or first-time users can use this condensed guide for assembly, connection to a PC, and basic sensor changes from default values before installation.

The sensor communicates with a Windows PC through the serial port or USB port. A UAN-Kit from Senix is recommended for connecting to your PC. It includes software, a termination board, and cables (see page 12).

- **Install the Software**

Download the latest SenixVIEW from the Senix.com website. Run the SenixVIEW Setup.exe to install. Start SenixVIEW.

- **Connect the Components**

The sensor has an attached cable of 4- or 9-conductors. Four conductors are used to power and communicate with the sensor. The rest are outputs.

a. Brown for DC power (DC+)
b. Blue for ground (GND and digital reference)
c. Gray and Yellow for digital communication.

Connect them to the labeled Senix termination board. Protect any bare wires from contacting one another whether connected or not. Ensure the terminal grips the stripped wire, not its colored jacket. *M12 connectorized cables are 5-pin, for the above four functions plus one output on the remaining pin. An identification label is found on the cable. A mating cable is required.*

Plug the data communication cable into the termination board RJ jack and your USB adapter. See page 12 for USB adapters.

Put the DC power supply cable into the jack on the termination board, and the supply into an AC source. All sensors will faintly tick when powered.

- **Connect to Your Sensor (using a USB port)**

1. Start SenixVIEW.
2. Menu bar: Sensor >Connect for a dialog box. All new sensors have network address 1 and default 9600 Baud rate. Select the COM port from the drop list or run Com Port Survey. The correct port will appear when the USB cable is inserted in the PC's USB socket. For more detail, see "Connect a Sensor", page 37. Click Connect.

- When the sensor is found, its configuration will be copied to the Workspace if the box is checked on the Connect screen. **SenixVIEW Quick Tour**

Once a sensor is connected, it can be viewed in the SENSOR view in real time. Any parameter changes are done in the WORKSPACE view and transferred (uploaded) to the sensor.

Basic layout of the main screen:

a. Range and basic setup values, all editable.
b. Workspace and Sensor views
c. File saving and retrieval button
d. Dialog screens for additional setup
e. Analysis tools
f. Output setup and simulated meters (editable)

Setup Basics

To make changes, click the WORKSPACE button.
-To change a Range, Endpoint, or output value, select it and enter a new one.
-To reverse the analog slope, right-click the High- or Low-value endpoint.
-To configure switches, click WIRING and assign black and white wires as needed. Any changes in Workspace make it different than the Sensor, shown by the unequal symbol.

-Preset analog endpoints and slope before installation.

- **Save the Setup to the Sensor**

To move changes to sensor, right click and drag WORKSPACE to SENSOR. Any changes not sent to the sensor will be lost when closing SenixVIEW.

- **Save the Setup to the PC.**

Right click WORKSPACE and drag it to FILE. Name the setup and add any notes you may want when asked.

- **Mounting Tips and Operation Tips**
  - Sensor must be mounted perpendicular to the object
  - Sound is emitted in a cone which widens with distance
  - The sensor cannot sense in a space less than the default Minimum Range value
  - Sensor will ignore targets or surfaces beyond the Max Range value
  - Avoid interfering echoes from pipe fittings, welds, and fixed objects
  - The sensor will return a distance value from the first surface found within range

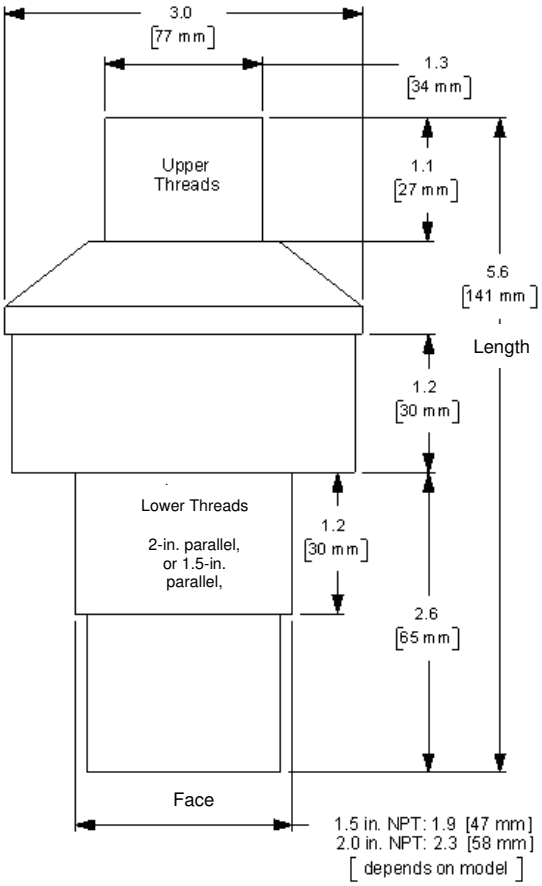
Mechanical Details

Dimensions are inches [mm]. LVL-100 (CHEM 10) and LVL-300 (CHEM 20) have 1.0" NPT upper and 1.5-in Parallel lower threads. LVL-500 (CHEM 35) has 1.0" NPT upper and 2.0-in Parallel lower thread.

CHEM 10 (LVL 100)

CHEM 20 (LVL 300)

CHEM 35 (LVL 500)



Below: LVL-120 (CHEM 12) has 1" NPT upper and 1.5-in NPT lower thread plus a strain relief.

CHEM 12 (LVL 120)

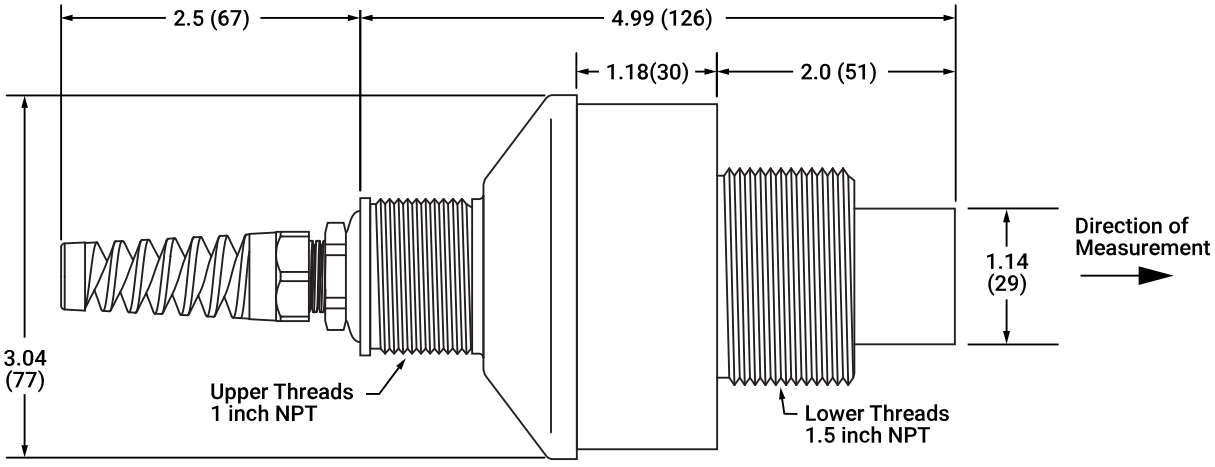


Figure 2 – Housing Dimensions

Installation

Precautions

- Keep unintended targets from the transducer's field of view in its acoustic cone area. Keep the beam shape in mind.
- Keep the transducer away from ultrasonic noise sources, such as pressurized air nozzles.
- Do not allow material to build up on the sensor face or sensor performance may be affected.

Orientation

Orient the sensor perpendicular to the liquid surface or target object for best results as shown in Figure 3.

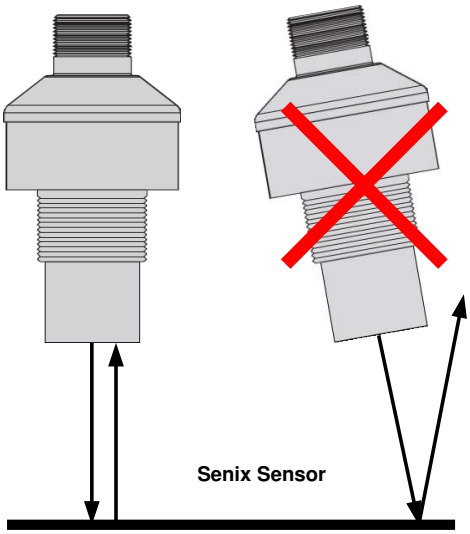
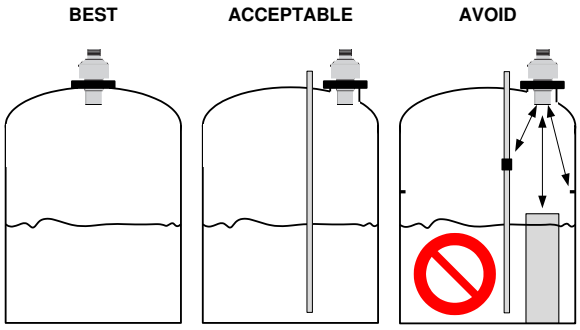


Figure 3 - Sensor Orientation

Ultrasound energy must reflect back to the sensor or the sensor will not detect the target and may detect a later multi-bounce echo (which would "measure" as a lower tank level).

Location and Obstacles

The sensor mounting location should be chosen so there are no obstacles in the beam path that reflect the ultrasound beam back to the sensor.



The sensor can be mounted close to a vertical pipe or tank wall if the wall or pipe surfaces are smooth (see "Acceptable" above).

Make sure that unintended targets between the sensor and liquid surface are not in the sensor's beam area. Keep the sensor away from horizontal pipes, inflow points, vertical pipe seams, or tank seams if they are large enough to reflect the ultrasound. The sensor measures to the closest target and will detect submerged equipment if the level drops below the equipment. Position the sensor to avoid these issues (see "Avoid" illustration above).

Mounting





Figure 4 – Flange Mounting *Figure 5 - Nipple Mounting*

Typical tank installations have the sensor threaded into a flange as shown above or threaded into a nipple welded to the top of the tank. A plastic nipple or flange adapter is preferred. In both cases the mounting should ensure that the sensor is facing perpendicular to the liquid surface. Use no wrenches when screwing the sensor into the nipple or flange.

Maintenance & Cleaning

Dust accumulation on the sensor face can be cleaned by blowing pressurized air across the sensor face. The sensor face can be cleaned with alcohol or any cleaner compatible with Kynar (PVDF).

Accessories

The following accessories are available.

	**SenixVIEW Software** Configure, test and clone sensors. Compatible with all ToughSonic models. Download free from www.senix.com
	**UAN-KIT-USB-232** **UAN-KIT-USB-485** PC Interface kits. Choose RS-232 or RS-485 to match sensor. Converter, terminal block, power supply, data cable included.
	**UAN-KIT-USBM12-232** **UAN-KIT-USBM12-485** PC Interface kits for sensors with M12 connectors. Serial converter, M12 mate, power supply, data cable. For either RS-232 or RS-485 sensors.
	**UA-USB-232-ISO** Serial converter, isolated inputs for permanent installation. Use with UA-CC-232. 3 ft USB cable
	**UA-USB-485-ISO** Serial converter, isolated inputs for permanent installation. Use with UA-CC-485. 3 ft USB cable
	**UA-CC-232** **UA-CC-485** DB9 adapter and 6-ft data cable. Joins ISO converter to termination boards.
	**UA-USB-232-TB** **UA-USB-485-TB** Non-isolated serial converter to USB with termination board and 3-ft USB cable
	**UA-TS-TB** Termination Board to connect any model sensor, user equipment, power, and serial interface cable. DIN rail mounts included
	**UA-TS-TB-2RYC** Termination board with 2 relays (driven by sensor switch outputs), power input, serial interface jack. For any model sensor

	**UA-JBOX-485** RS-485 Serial and Power wiring junction box, used on all serial-only sensor networks
	**UA-DATACORD** 6-ft with RJ11 each end. For patching termination board and serial converter.
	**UA-FM-15** Gray PVC flange. Fits CHEM 10, CHEM 12, CHEM 20 lower thread
	**UA-FM-20** Gray PVC flange. Fits CHEM 35 lower thread
	**UA-FM-SS-15** Stainless steel flange. CHEM 10, CHEM 20 lower thread
	**UA-FM-20-SS** Stainless steel flange. Fits CHEM 35 lower thread
	**AIR-L-TX-NAV** **AirWire Transmitter. CHEM Serial-Only compatible, wireless data sent to gateway**
	**AIR-LA-TX-MB-1** **Transmitter mount bracket for AirWire system, fits all CHEM sensors, stainless steel holds sensor and transmitter**

AirWire Wireless Data Transmission

ToughSonic CHEM serial-only sensors are compatible with AirWire transmitters and receiver-gateways. See AirWire at www.senix.com or contact Senix.

INTERFACES

Wiring

All CHEM sensors have a potted-in shielded cable with the following wire assignments:

Wire Color	Wire Function
Brown	+DC input voltage (Power Input)
Blue	-DC input and signal common (Ground)
Gray *(data #1)* *(note 1)*	LVL-xxxx-232: RS-232 out
	LVL-xxxx-485: RS-485 -
Yellow *(data #2)* *(note 1)*	LVL-xxxx-232: RS-232 in
	LVL-xxxx-485: RS-485 +
Silver	Cable shield (bare stranded wire)
Full build models have 5 additional conductors with the following assignments	
Black	**Sinking Switch #1** *(note 2)* Sourcing Switch #1 (page 17) or None (default)
White	**Sinking Switch #2** *(note 2)* Sourcing Switch #2 (page 17) or None (default)
Green	4-20 mA sourcing loop (page 14)
Orange	4-20 mA sinking loop (page14)
Violet	0-10 VDC (page 14)
***Notes**:* *(1) The gray and yellow wire functions depend on sensor model, and can be used for synchronization (page24)* *(2) Factory **default selections** (can be changed using SenixVIEW)*	

Table 2 - Wire Assignments

Note: The following descriptions apply to standard sensor cables with bare wire leads. Sensors with M12 connectors and mating cables may have different color conductors depending on function and pin assignments.

Power Input (brown wire)

Connect a DC power supply to the DC+ (Brown) and GND (Blue) wires. These colors conform to EU standards. Reversing the power connections will not damage the sensor. A power supply voltage between 15-30 VDC is recommended. A +24 VDC supply is a commonly used standard. Target sensitivity and the maximum voltage output value is reduced at power supply voltages below 15 VDC. When power is applied the sensor operates as described on page 24.

Ground (blue wire)

The blue ground wire is common to both the power supply and the output circuits, analog and switches.

Data Connections (gray & yellow)

Serial data interfaces are described on page 20. They are used for:

- SenixVIEW PC configuration (page 37)
- Synchronization (page 24)
- User communications between the sensor and an external data communications device

LVL-xxxx-232 models require an RS-232 serial interface and connect directly to a PC COM (serial) port for SenixVIEW configuration as shown below, or by USB converter as in the UAN-KIT-USB-232 kit.

Cable Shield (bare wire)

The cable shield is not terminated at the sensor. This wire should be terminated to equipment ground near the user equipment, preferably to a single point ground for all equipment. This is important if the cable is lengthened and/or routed near electrically noisy wiring or equipment.

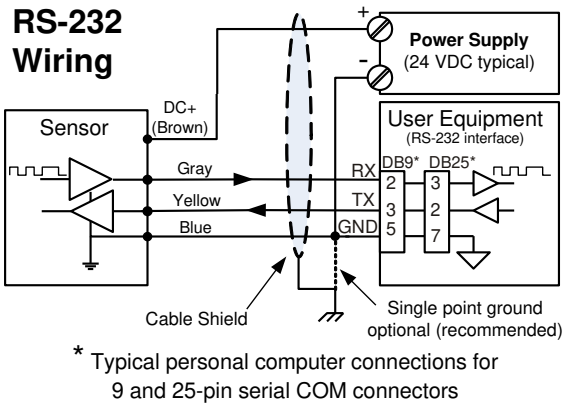


Figure 6 - RS-232 PC COM Port Connections

LVL-xxx-485 models require a RS-485 serial interface, like the Senix UAN-KIT-USB-485 interface kit. See Accessories on page 12.

Analog Outputs

CHEM sensors have three analog outputs - voltage, sourcing current loop and sinking current loop. They all share the same *endpoints* and slope (decreasing or increasing with distance). They are simultaneously available on separate wires.

Voltage Output (violet wire)

This figure shows a voltage output connection:

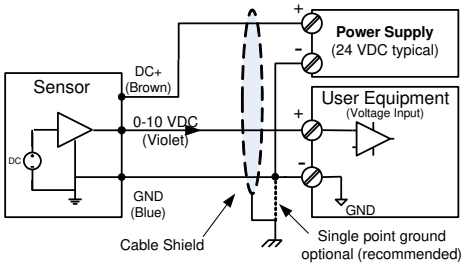


Figure 7 - Voltage Output Wiring

The default voltage output is a 0 to 10 volt DC signal proportional to the measured distance between the *endpoints* set by the user. The voltage range limits are adjustable to values between 0 and 10 volts using SenixVIEW (see d & e in Figure *10*). The voltage is measured relative to GND (BLUE wire). The 0 and 10 volt *endpoint* distances affect all voltage and current loop outputs, and can be set anywhere in the sensor's *operating range* using SenixVIEW.

Sourcing Current Loop (green wire)

This figure shows a sourcing current loop connection:

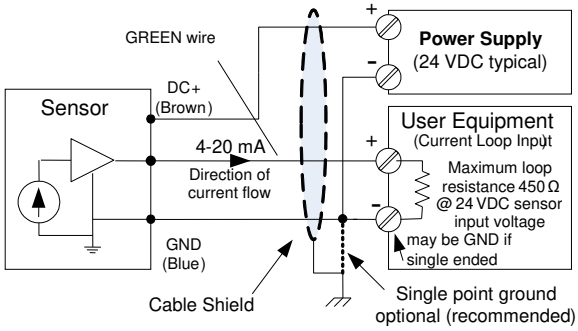


Figure 8 - Sourcing Current Loop Wiring

The default sourcing loop output is a 4 to 20 mA signal proportional to the measured distance between two endpoints set by the user. The *current low/high values* are adjustable to any values between 0 and 20 mA using SenixVIEW (see d & e in Figure *10*) (4 mA minimum is recommended). In a sourcing loop current flows out of the sensor, through the user equipment and back via the sensor's ground (BLUE wire).

Sinking Current Loop (orange wire)

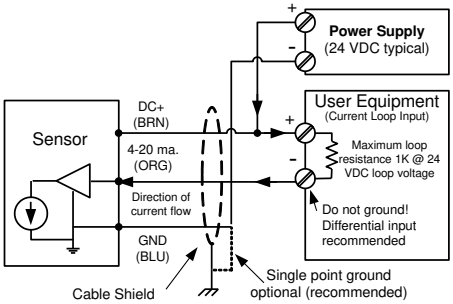


Figure 9 - Sinking Current Loop Wiring

The default sinking loop output is a 4 to 20 mA signal proportional to the measured distance between two endpoints set by the user. The *current low/high values* are SenixVIEW adjustable and match those of the sourcing loop. Current flows from the power supply through the user equipment then INTO the sensor (ORG wire) as shown in Figure 9.

The analog inputs of User Equipment in Figure 9 are either differential (both + and – terminals) or single ended (+ and GND terminals). A differential input is recommended at the user equipment. If the user equipment is single ended (+ input and GND) the sensor and user equipment cannot share a common ground or the current loop will not work.

Endpoints and Slope

The voltage and current loop(s) are spanned between the same two *endpoint* distances (see b & c in Figure *10*). *Endpoints* can be set anywhere in the sensor's *operating range* using SenixVIEW.

All analog outputs must have the same slope, i.e., increase or decrease in value in proportion to distance. The high and low output values (voltages and currents), however, are independently adjustable in SenixVIEW for the voltage and current loops.

Response Time

Analog response time is affected by measurement rate and filter selections (pg.29).

Analog Displays in SenixVIEW

The sensor's calculated analog output values are shown in real time on the SenixVIEW meter displays (page 26).

SenixVIEW Analog Adjustments

Use SenixVIEW to tailor the sensor for best results in the application. Analog features are shown in Figure *10*. The letters used below are keyed to that figure:

a) Click the **Workspace** icon to edit parameters

b) *Low Endpoint*: Click the numeric value (b) to set the end distance where the low limits (e) occur.

c) *High Endpoint*: Click the numeric value (c) to set the end distance where the high limits (d) occur.



The analog slope will automatically reverse if the Low and High Endpoint distances (b & c) are set in reverse order

d) *High Values*: Click the numeric value to change the highest voltage or current value. The voltage and current entries are independent.

e) *Low Values*: Click the numeric value to change the lowest voltage or current value. The voltage and current entries are independent.

f) Click the **Analog** icon for additional features.

g) Select the output values set at power-on. These values exist until the first *measurement process* is completed.

h) Select the output values to be set if no target is detected in the *Operating Range* (j to k).

i) Applies to synchronization (page 24) and is grayed out if the sensor is not a slave.

j) *Range MIN*: The closest distance the sensor will report a correct distance (see page 25).

k) *Range MAX*: The farthest distance the sensor will detect a target (see page 25).

All sensor parameters are described on page 41. **Workspace** parameter changes must be saved to the sensor to take effect, and can also be saved to disk for later recall as described on page 36.

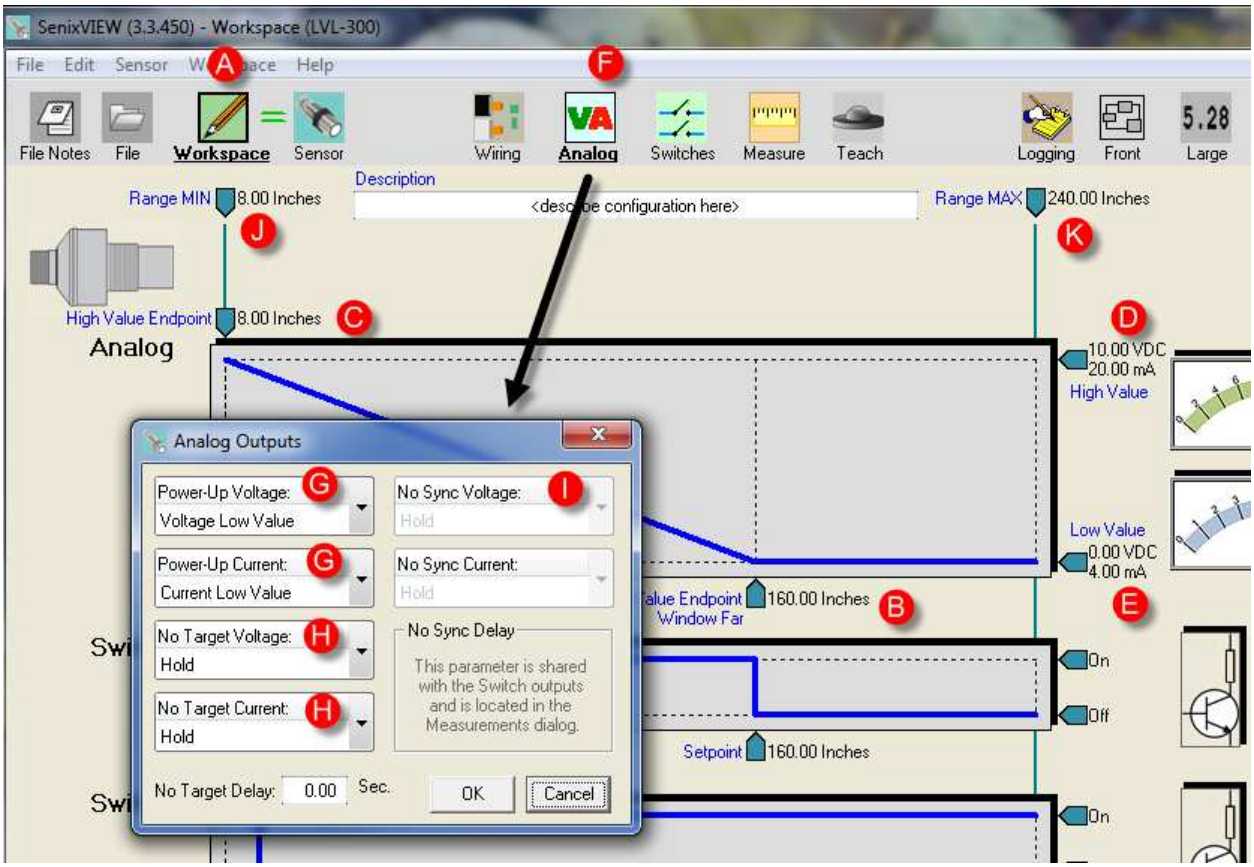


Figure 10 - *SenixVIEW Analog AdjustmentSwitch Outputs*

CHEM sensors have two solid-state switch outputs. Switch #1 is on the black wire and switch #2 on the white wire. The default switch types are NONE or off. Both can be configured. The switch type can be selected as either sinking (NPN), sourcing (PNP) or OFF using SenixVIEW.

Low and High Alarms

The factory default settings for the switches are typical LOW and HIGH ALARMS. Switch #1 set as a LOW ALARM (switch OFF when level drops below the Optimum range) and Switch #2 set as a HIGH ALARM (switch OFF when level is above a high setpoint). Both levels are adjustable using SenixVIEW.

The ALARM condition is defined as SWITCH OFF so that a broken alarm wire also causes an alarm (*fail-safe)*. All of this can be altered using SenixVIEW.

Loss of Echo Monitor

A switch can be configured to switch on or off in the event of a loss of target echo. An optional time delay can be used before this response. This is a useful output to maintain the last analog output while monitoring for an echo loss.

Switch Output Voltage

When a sinking switch is ON the voltage of the switch wire will be near 0 VDC, and when OFF will be near the voltage of the external "pull-up" source.

When a sourcing switch is ON the voltage of the switch wire will be near the sensor's power supply voltage and when OFF will be near 0 VDC.

Sinking Switch Output (NPN)

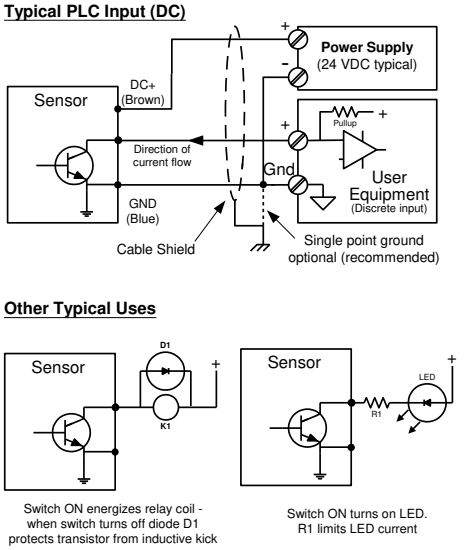


Figure 11 - Sinking Switch Output Wiring

A *sinking switch* is an open collector transistor (solid state *switch*) that sinks current through an external load to GND when ON. The external device can be powered from a source different than the sensor.

Sourcing Switch Output (PNP)

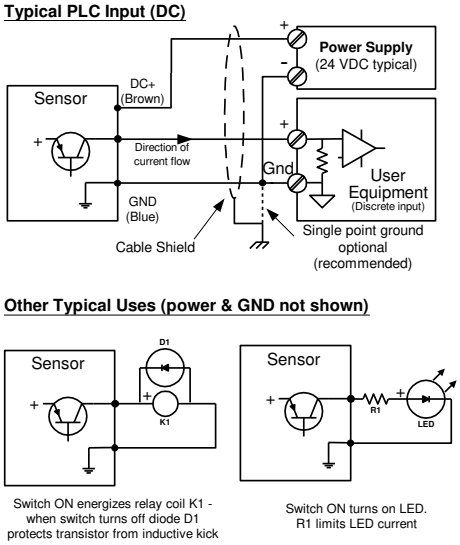


Figure 12 - Sourcing Switch Output Wiring

A sourcing switch provides current to an external load to turn that load ON or OFF as shown.

Current is sourced by the sensor's power supply, and must be considered when determining the sensor's maximum current draw.

Switch Response Time

Switch response times are affected by measurement rate and filter selections (pg. 32).

Switch Displays in SenixVIEW

The sensor's switch output states are displayed in real time in SenixVIEW (page 26).

SenixVIEW Adjustable Switch Features

Basic and extended features assure optimum system settings and control functions that otherwise require external logic or time delay relays. Each switch has the following configurable features:

- Setpoint (ON switching distance)
- Polarity (ON closer or farther than setpoint)
- Mode = Setpoint (with Hysteresis) or Window (see Figure 13)
- ON and OFF time delays for state changes
- "No Target" state and time delay
- Power-up state

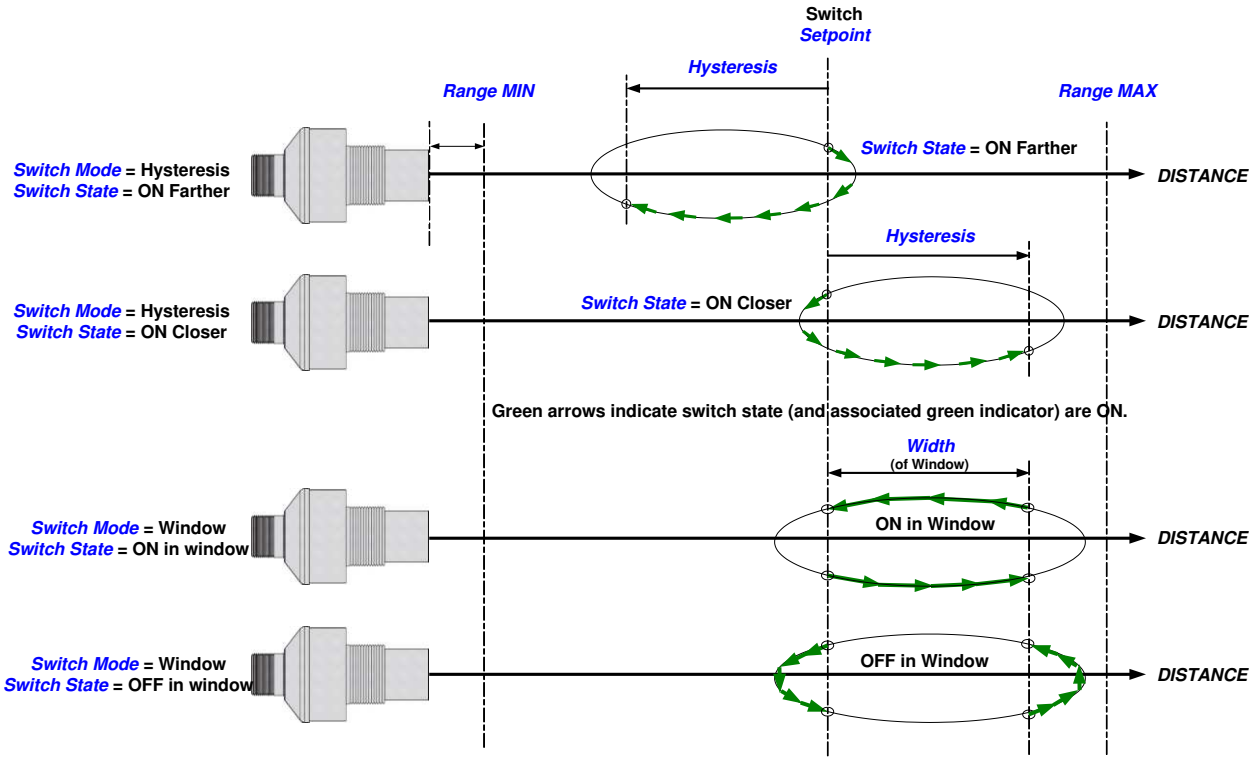


Figure 13 - Switch Hysteresis & Window Modes

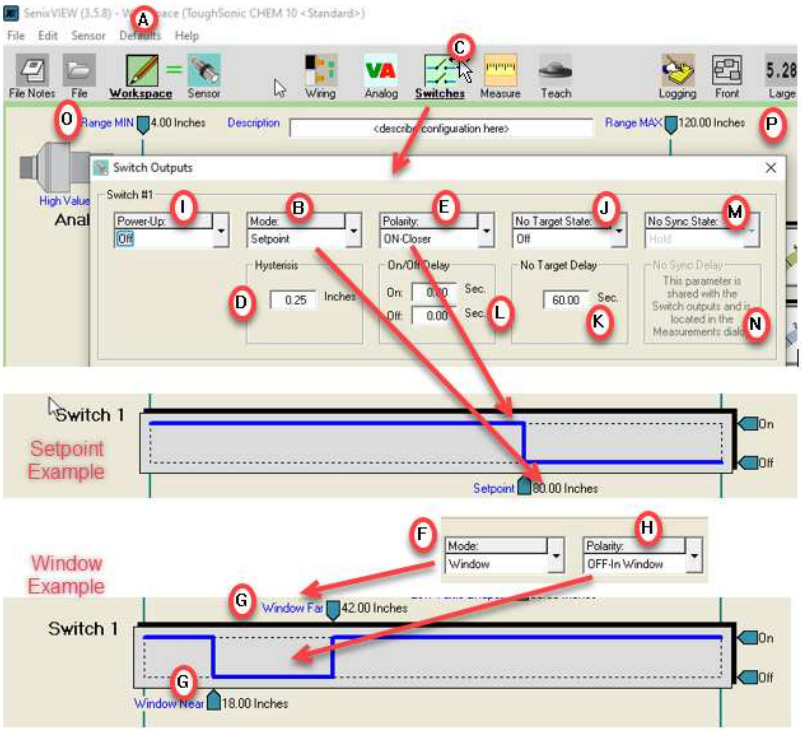


Figure 14 - SenixVIEW Switch Adjustment

SenixVIEW Switch Adjustments

Use SenixVIEW to tailor the sensor for best results. Switch features are shown In Figure 14. The letters used below are keyed to that figure:

a) Click the **Workspace** icon to edit parameters

b) *Setpoint*: Click the numeric value to set the distance where the switch turns ON (the switch turns OFF by reverse *hysteresis* distance (d))

c) Click the **Switches** icon for additional features.

d) Hysteresis is the distance the target must move in the reverse direction of the Setpoint to turn OFF.

e) The polarity can be either ON CLOSER or ON FARTHER than the *Setpoint*. This is like setting a normally open or normally closed condition.

Reversing the switch polarity also reverses the hysteresis (d) direction!

f) **Window** is an alternate mode where the switch state is *Polarity* (h) inside the window (over a range of distances) and the reverse if outside.

g) Click these numbers to enter the window SIZE. The size is added to the *Setpoint* distance to become the far window distance.

h) The Polarity can be either ON or OFF for targets within the window. This example shows OFF

i) Select the switch state to set at power-on. This state exists until the first measurement process is completed.

j) If the sensor loses the target the state can be **held** or set **on** or **off** (after delay k).

k) If the sensor loses a target for this time period the no target state (j) is set (0 = immediate)

l) Time delays can be required before turning a switch on or off. A switch state is set if a target continuously satisfies that state's requirements for the full delay time period.

m) Applies to synchronization (page 24) and is grayed out when the sensor is not a SYNC slave.

n) Applies to synchronization (page 24). Set in the **Measure** window as it also affects the analogs.

o) *Range MIN*: The closest distance the sensor will report a correct distance (page 25).

p) *Range MAX*: The farthest distance the sensor will detect a target. See page 25 for a detailed description of the sensor *Operating Range*.

Serial Data Interface

The YELLOW and GRAY serial data communications wires are used for three purposes:

1. **Setup** – Connect to a PC running SenixVIEW™ software for setup, calibration, analysis and rapid sensor cloning.
2. **User Applications** – Connect to an external system and provide distance measurement data. Several operating modes are available.
3. **Synchronization (SYNC)** – Time synchronize a group of 2-32 sensors (see page 24).

The electrical interface can be RS-232 or RS-485:

- LVL-xxxx-232 sensors are RS-232
- LVL-xxxx-485 sensors are RS-485
- All models are RS-485 in SYNC modes

RS-232 (PC COM Port)

LVL-xxxx-232 models use a serial data RS-232 interface directly compatible with a PC COM port. The PC COM wiring is shown in Figure 15.

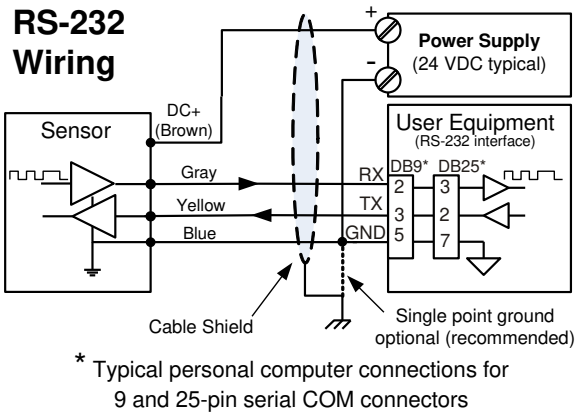


Figure 15 - RS-232 PC COM Port Connections

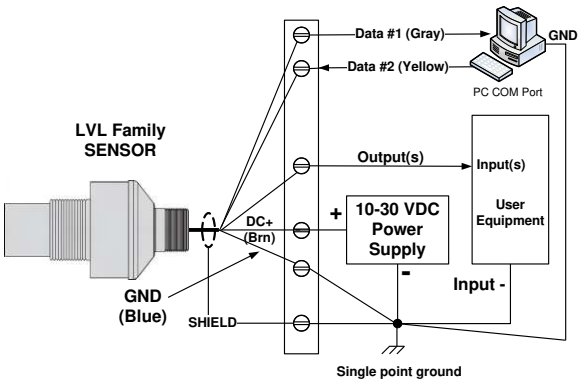


Figure 16 - LVL-xxxx-232 Connections

RS-485 & Addressable Networks

LVL-xxx-485 models use a serial data RS-485 interface that can be used over long distances. A single sensor is shown below connected to an RS-485 port. To use SenixVIEW with these models the PC must have an RS-485 adapter connected. Adapters are available to convert COM or USB ports to RS-485.

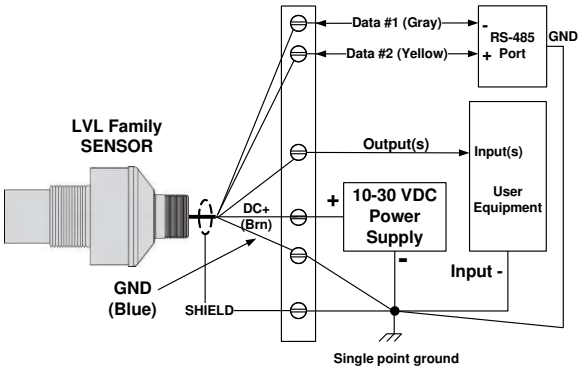


Figure 17 - LVL-xxxx-485 Connections

Up to 32 addressable sensors can connected to the RS-485 bus. Sensors can be configured into RS-485 addressable multi-drop networks as shown below.

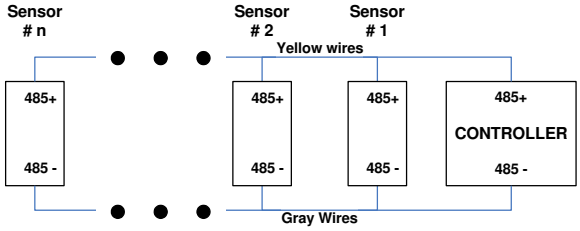


Figure 18 - RS-485 Network Wiring

Before connecting to a network each sensor must be assigned a unique address and all sensors must be

configured to the baud rate of the network controller, as described in the following. The address assignments must also be unique from other connected (non-Senix) devices.

Sensors used in a network must be configured in *continuous* or *start-on-poll* measurement activation depending on the needs of the system (page 24). They may also be used in SYNCH mode.

Serial Parameters

Baud Rate, Parity, Stop Bits

The default parameters are 9600 baud, no parity, and one stop bit (8N1). The baud rate is SenixVIEW adjustable to 9600, 19200, 38400, 57,600, or 115,200 baud. The parity and stop bit cannot be changed. The parameters affect both the Modbus and ASCII streaming protocols.

Sensor Address

The default sensor address is 1. The address is SenixVIEW adjustable from 1 to 247. Sensor address 0 is a special broadcast address that all sensors respond to.

SenixVIEW requires a correct sensor address to establish a connection. In general, leave the address at the default of 1 unless using the sensor in a network.

Each sensor being connected to a multi-sensor addressable network must first be assigned a unique address. Sensors with the same address will conflict and appear non-functional. Addressable multi-sensor networks are only possible with an RS-485 interface (requires LVL-xxx-485x models).

The sensor address is not used in the ASCII streaming protocol.

Changing Communications Settings

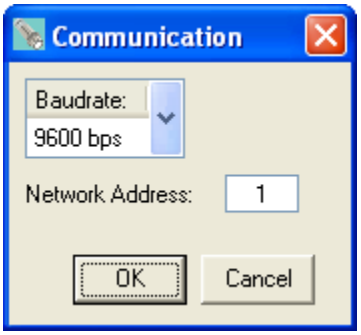
A single sensor in the factory configuration, wired to either an RS-232 or RS-485 interface, connects to SenixVIEW using the default 9600 baud rate and sensor address #1.

*Baud rate and address settings are not affected by selecting the factory default configuration (menu: **Workspace** – **Default LVL Setting**)*

If multiple sensors are connected into an RS-485 network each must be assigned a unique address.

The baud rate and address are changed in SenixVIEW as:

1. Connect to the sensor (menu: **Sensor** – **Connect**), described on page 37.
2. Select the communications parameters (menu: **Sensor** – **Communications**) and see:



3. Select a different baud rate, or enter a unique address from 1 and 247, then click OK and see:



4. The sensor will now connect (menu: **Sensor** – **Connect**) using the new parameter values.

SenixVIEW Network Connect

SenixVIEW is fully functional when connected to a single CHEM sensor on an RS-485 network (menu: **Sensor** – **Connect**). Simply enter the correct baud rate and network address to establish the connection. The serial converter must match the serial configuration on the sensor label.

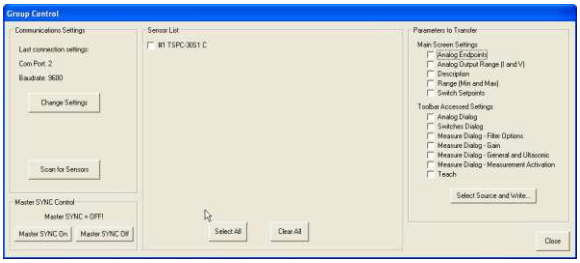
SenixVIEW Group Control

Group control is for global parameter changes made to a network of sensors. SenixVIEW can update selected parameters quickly to a group of RS-485 connected sensors using menu: **Sensor** – **Group**

Control. The group is first scanned and a list of connected sensors produced. Selected parameters can then be written to selected sensors.

To Use Group Control

1. First, enter the parameter values to be transferred into the Workspace.
2. Select menu: **Sensor** – **Group Control** to produce the following control window:



3. Click Scan to initiate a sensor search of all network addresses. Up to 32 found sensors will be listed in the center display area with (a) a check box, (b) the model number and (c) the activation mode. (C=continuous, P=start on poll, Mx=master x phases, Sx=slave phase X). The check boxes can be individually selected, all checked using Select All, or all cleared using Clear All.
4. The "Parameters to Transfer" section on the right side lists parameter collections that can be selected for upload to all checked sensors. Check the desired collection(s).
5. Click Write to begin the batch transfer.

Group operations require SenixVIEW to operate as the bus Master. Any other bus master must first be disabled or disconnected.

Serial Data Protocols

CHEM sensors offer these protocol options:

1. **Modbus Slave** – This default protocol is used by SenixVIEW and supports sensor communications by address, typically in RS-485 networks.
2. **ASCII Streaming** – A simpler continuous ASCII protocol for one-way transmission of data to external devices (page 22).
3. **SYNC** – SYNC master and slave sensors use the serial interface for synchronization (page 24).

Modbus Protocol

CHEM sensors and SenixVIEW use the industry standard Modbus protocol for all serial data bus communications except SYNC (page 24). Other user controllers can use this interface to obtain distance measurements or control sensor parameters. Request document *Senix ToughSonic Sensor Serial Communications Formats.*

ASCII Streaming Protocol

A Senix ASCII protocol is also available that transmits an ASCII string after each measurement under continuous measurement activation. This provides a simpler method of transferring measurement data to displays or other devices without using Modbus. SenixVIEW version 3.0.108 or later includes a feature to enable this protocol in menu item Sensor – Connect – Advanced features.

After each measurement or measurement process the sensor transmits five ASCII numbers terminated with a carriage return. For example, 05261 <CR>, or in equivalent hexadecimal: 30H - 35H - 32H - 36H - 31H - 0DH. This number represents a count value proportional to the detected target distance (except 00000 which means no target was detected). The user equipment can either display the ASCII data directly, such as viewing the output data on Windows HyperTerminal, or calculate distance by converting the data to binary and multiplying by a scale factor. The scale factor varies with the sensor series. The scale factors at 69 degrees F (or with temperature compensation enabled) for each sensor series are listed in Table 1 on page 8 at Resolution (serial data).

As an example, the scale factor for an LVL-100 or LVL-120 sensor is 0.003384 inches per count. If the count value is 05251, the distance is calculated as 5251 x 0.003384 = 17.77 inches.

An output of 00000 means no target was detected in the latest measurement process. Use 00000 to signify a target echo problem.

Polling the sensor for data

A user can obtain data directly from sensor holding registers using Modbus RTU commands. Writing to sensor registers directly is discouraged in favor of using SenixVIEW to make configuration changes. Request document *ToughSonic Serial Communications Formats* for more information.

MODBUS Registers Available

Available registers on all ToughSonic sensor models.

Hex Address	Field
0x0220	Raw Counts
0x0221	Filtered Counts
0x0222	Millimeters
0x0223	Temperature **
0x0224	User Target Width (counts)
0x0225	Reference Target Width (counts)
0x0226	Reference Target Distance (counts)
0x0227	Scale Top
0x0228	Scale Bottom ***

**(C * 10) (i.e for 33.5 °C it will show 335)

***Where Scale Top / Scale Bottom = 0.085954 for a TS14. This lets the user read the conversion factor.

Example: Raw or Filtered Counts (0x220 or 0x221) * Scale Top (0x227) / Scale Bottom (0x228) = Millimeters (0x222)

Reading any of these registers will cause the sensor to take a measurement in Start On Poll activation mode.

The following registers may be read either as single registers or as a group:

Hex Address	Field
0x0208	Distance Field
0x0209	Cycle Count
0x020A	Voltage
0x020B	Current
0x020C	Switch States
0x020D	Sensor Temperature
0x020E	Unfiltered Distance

Product IDs

Senix products hold product ID in register 0x320 or 800 decimal.

Product ID	Sensor
2000	ToughSonic 3
2001	ToughSonic 3 Serial only
1003	ToughSonic 12
1004	ToughSonic 12 Serial only
1000	ToughSonic 14
1002	ToughSonic 14 Serial only
3000	ToughSonic 30
3002	ToughSonic 30 Serial only
4000	ToughSonic 50
4003	ToughSonic 50 Serial only
4002	ToughSonic 50P
4006	ToughSonic 50P Serial only
1001	ToughSonic CHEM 10
1005	ToughSonic CHEM 10 Serial only
1008	ToughSonic CHEM 12
1009	ToughSonic CHEM 12 Serial only
3001	ToughSonic CHEM 20
3003	ToughSonic CHEM 20 Serial only
4001	ToughSonic CHEM 35
4005	ToughSonic CHEM 35 Serial Only
1006	ToughSonic CHEM ProE 12
1007	ToughSonic CHEM Pro 12

Scale Factors for 1X, 2X, and 4X

Sensor type	in/count	ft/count	mm/count	cm/count
T3,T12,T14, L100, L120	0.003384	0.000282	0.085954	0.008595
T30, L300	0.006768	0.000564	0.171907	0.017191
T50, L500	0.013536	0.001128	0.343814	0.034381

Operation

Power Up

The following occurs within 1200 ms of power ON:

- Outputs are set to their power-up states (SenixVIEW selected)
- Sensor begins first measurement or becomes available for *start-on-poll* activation
- The analog and switch outputs are set, and distance data becomes available, after completing the first measurement process

All sensor outputs remain in their power-up conditions until the first *measurement process* has completed.

Measurement Activation

Sensor measurements can be activated in two ways – *continuous* or *start-on-poll*. The factory default and most common is *continuous*. The activation options are set using SenixVIEW by clicking the **Measure** icon then using the Measurement Activation selector (Figure 19).

Sensor features affected by the activation mode are summarized in Table 3 below. Refer to the *measurement process* definition on page 26.

Measurement Activation Mode Selected	When the Measurement Starts	• Features Allowed							When the Analog and Switch outputs are updated	Serial Data Bus (RS-232 or RS-485)
			Filters							
			X of Y	Closer of M	Farther of M	Averaging	Rate of change	Slow-Fast		
Continuous *(factory default)*	Repetitively at the *measurement interval*		•	•	•	•	•	•	After each measurement or *measurement process*	Last *measurement process* distance sent in response to distance poll
Start on Poll	Distance poll received (& current *measurement process* finishes)			•	•	•			After the measurement or *measurement process* triggered by the distance poll	Last *measurement process* distance sent in response to distance poll

Table 3 - Measurement Activation Summary

Activation Selection

Click the SenixVIEW **Measure** icon then locate the following Measurement Activation drop down menu:

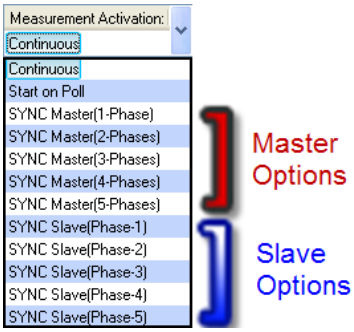


Figure 19 - Measurement Activation Selections

Synchronization

Groups of 2 to 32 sensors can be networked and time synchronized for these purposes:

- Prevent sensors in close proximity from interfering with one another ("cross-talk")
- Enable a group of sensors to measure a common target(s) at the highest possible rate

This feature is generally not used in level sensing applications and therefore not detailed in this document. Contact Senix for additional information.

Continuous Activation

This is the factory default. Measurements repeat continuously at the *measurement interval*. The analog and switch outputs are updated, and the distance data is stored, at the end of each *measurement process*. At any time a serial data controller can retrieve the last stored distance data by issuing a serial data read poll without effecting ongoing measurements. Continuous mode is generally used unless:

- There is an advantage to having the sensors measure only on request (see Start on Poll)
- Multiple sensors are connected in a synchronized group (page 24).

SenixVIEW will detect this mode when the **Sensor** icon is clicked, then repeatedly issue read polls to display the distance measurements.

Start on Poll Activation

Measurement begins when the sensor receives a serial data distance read poll from an external controller (or SenixVIEW). Upon completing the *measurement process* the analog and switch outputs are updated, the distance measurement stored, and the sensor stops measuring.

Several filters are disabled in Start on Poll activation (page 24).

To Poll from SenixVIEW

SenixVIEW detects start-on-poll mode when the **Sensor** icon is clicked, and displays polling controls in the upper right corner of the screen (Figure 20). The polling rate is only active when viewing in SenixVIEW and independent of the interval value set in the Measure window.

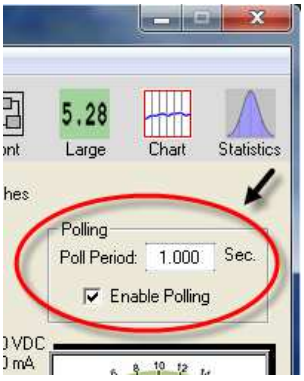
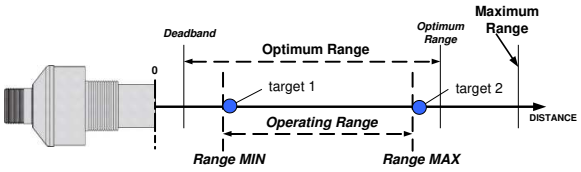


Figure 20 - SenixVIEW Polling Controls

SYNC Master and Slave Activation

Used only for synchronization.

Operating Range



The sensor measures the distance to targets within the *Operating Range* (target 1 to target 2). This range can be set in SenixVIEW by adjusting the *Range MIN* and *Range MAX* parameters. The factory default is the widest possible, *deadband* to *maximum range* (see specifications, page 7).

Range Min

The *Range MIN* is the closest distance that the sensor will report an accurate distance. Targets closer than *Range MIN* may be detected at close range, but display as double the actual distance if they are secondary echoes. If the near distance is important, mount the sensor so the target is beyond *Range MIN*.

Range Max

The *Range MAX* is the farthest distance that the sensor will detect a target. Targets farther than *Range MAX* are ignored. SenixVIEW prevents setting the *Range MAX* parameter to a value greater than Maximum Range for the sensor product.

Under "No Target" conditions the analog and switch output values or states can be configured to either hold their prior level or set specific values or states, either immediately or after adjustable time periods.

The "Range MIN and Range Max" controls can be an important and useful tool to control system response by defining the window the sensor will consider a target valid.

Factory Defaults

The factory default range values are:

- Range MIN = deadband
- Analog far setpoint = Optimum range
- Range MAX = Maximum Range

Measurement Process

The *measurement process* includes the raw distance measurement, followed by one or more filter options (page 30), then any switch time delays (page 33) before the result is reflected in the sensor outputs.

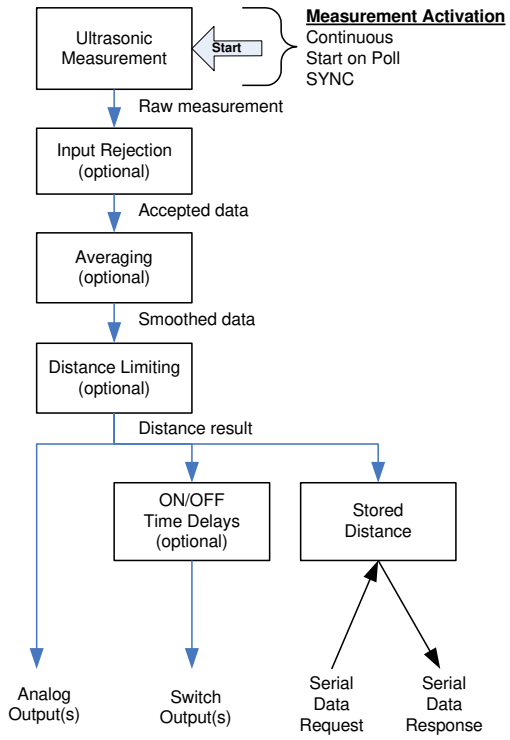


Figure 21 - Measurement Process Diagram

In Start on Poll activation the entire process is performed once per poll, i.e., M Input Rejection x N Averaging measurements (page 32). Some filters are disallowed in Start on Poll (page 24). If a poll is received before an ongoing *measurement process* finishes, the ongoing process will run to completion then another *measurement process* will begin.

Switch time delays can be set to implement special control functions. The latest distance, switch status, and analog levels can be requested by an external controller over the serial data bus using Modbus commands (page 22).

Sensor Viewing

When connected to a sensor (**Sensor** icon clicked), distance measurements are viewed in SenixVIEW in several ways. SenixVIEW obtains the measurements via serial data interface requests in the *continuous* or *start-on-poll* mode. The values or states of the selected output(s) are also displayed.

Sensor View

Connect SenixVIEW to the sensor (menu: **Sensor** – **Connect**) as described on page 36. SenixVIEW automatically selects the **Sensor** icon ①, displays distance in real-time with a repositioning target symbol ②, shows analog output value(s) on meters ③ and shows switch state(s) graphically ④, and echo strength. Additional display icons ⑤ offer features described below.

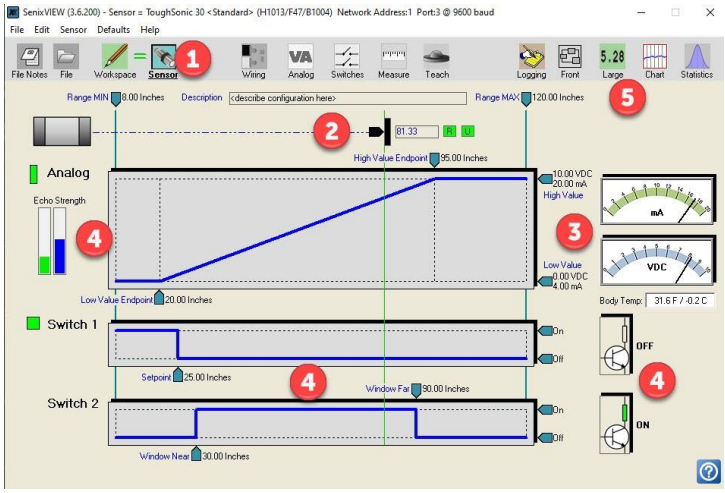
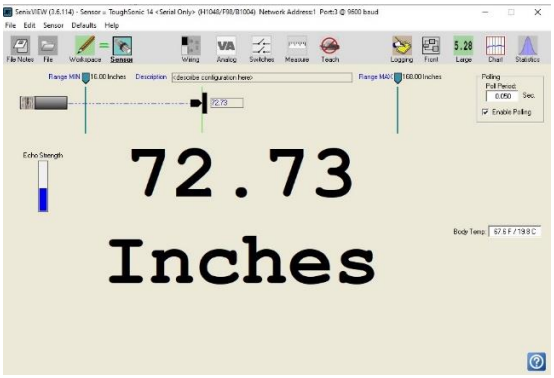


Figure 22 - SenixVIEW Distance Displays

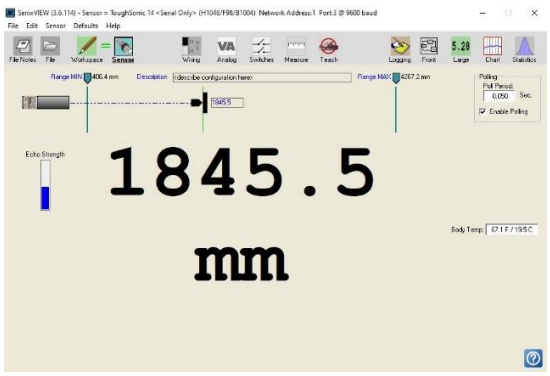
Serial Only Models

The SenixVIEW sensor view screen will display just the digital distance value in the user's selected units. Available units are Inches, Feet, Yards, Millimeters, Centimers, Meters, and Counts. Set units in User Preferences under the Edit menu.

Examples include



Or,

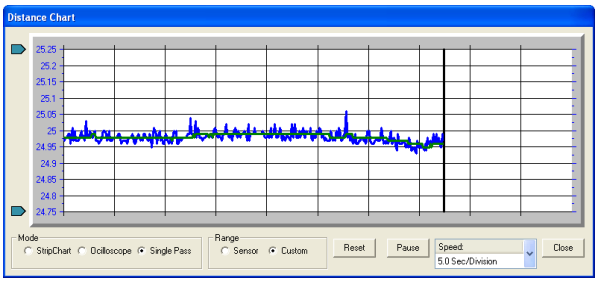


Analysis Tools

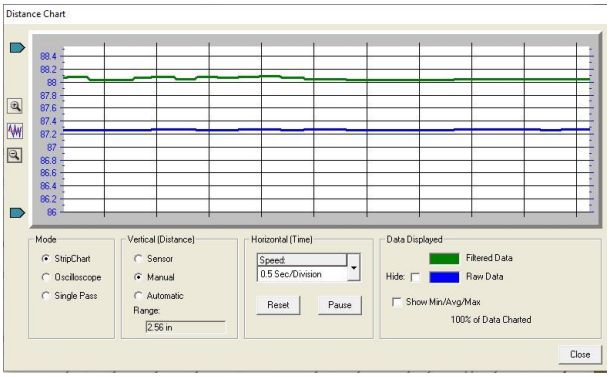
Several tools are available in SenixVIEW which are very useful in viewing sensor performance while tuning or using SenixVIEW.

Strip Chart

Click the **Chart** icon to view data in strip chart format. Both filtered and unfiltered data are displayed. The strip chart is very handy to see target stability over shorter time windows.

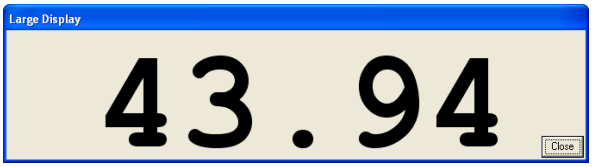


When Reference Target Temperature Compensation mode is selected and calibration has been done, the Chart tool can show the unfiltered data in blue and the filtered (or compensated) data in green. The chart tool is useful to track compensation performance as ambient temperatures rise and fall.



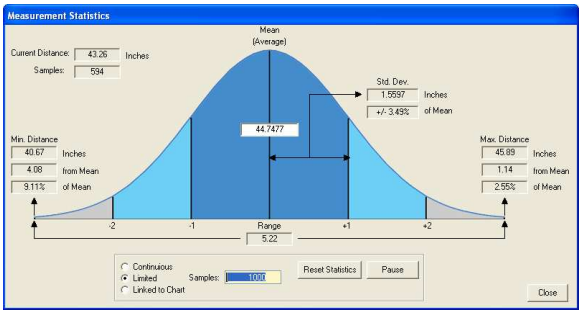
Large Display

Click the **Large** icon to pop up a large digital display that can be viewed from afar. The display can be configured to show distance, volts, current, or switch status in a large format for easy viewing. It can be positioned anywhere and enlarged or shrunk. To bring it up any time click the Front icon.



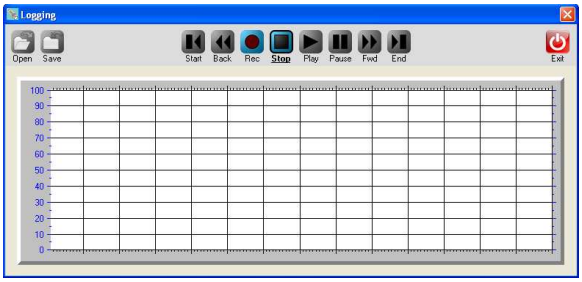
Statistics

Click the **Statistics** icon to view statistics calculations. The statistics tool is very handy to see target stability over longer time windows. Both the Strip Chart and Stability windows can be displayed at once, and even linked.



Data logging

Click the **Logging** icon to record data to disk for view or export to Excel.



Measurement Rate

The *measurement rate* is how often the sensor measures the target distance. It does not require adjustment in most applications. Default rates for each model are listed in Table 1 on page 8.

To accommodate special requirements the rate can be adjusted from .0001 to 200 meas./sec (*measurement intervals* from 2.78 hours to 5 ms) using SenixVIEW.

Maximum Target Distance Effects

The time required to detect a target is determined by the speed of sound. Sound travels at about 1 ms/ft. (3.3 ms/meter) so a target at 10 feet (3m) results in an echo delay of about 20 ms (the sound has to travel out then back). If the *measurement interval* is less than that time the target echo will go undetected, or may be detected in the next cycle, causing erratic measurements.

The maximum distance a sensor can detect a target is the shorter of (a) the sensor model's maximum range, (b) the user-adjustable RangeMAX parameter, or **(c) the farthest distance a target echo can return before the next measurement begins (measurement rate limited)**.

Setting the *measurement interval* faster than the default may restrict the maximum detectable target distance (see Table 4).

Measurements per second	Measurement Interval ms	*Approximate Max Range* in. (cm)
5	200	1080 (2743)
10	100	540 (1372)
20	50	288 (732)
40	25	144 (366)
100	10	54(137)
200	5	24 (61)

Table 4 - Maximum Range vs. Measure Rate

Measurement Stability Effects

If the measurement rate is set too fast the sensor may detect 2nd echoes from a prior measurement cycle, causing measurement instability. This is more common at short distances but can also occur in large liquid tanks. Slower measurement rates are recommended for tank installations to allow for dissipation.

A delayed echo can be a more distant target or a multi-bounce echo from the primary target (echoes can bounce back and forth between two surfaces). This effect is also more prevalent at cold temperatures because sound absorption in air is lower and it takes longer for the echoes to decay.

Multi-echo issues are minimized by slowing the measurement rate, reducing the sensitivity, repositioning the sensor, and/or using materials to absorb or deflect the ultrasound.

Output Response Time

The default response time for all outputs is the *measurement interval*. The analog, switch and serial ASCII streaming (if enabled) outputs are updated after each measurement cycle.

The response time is affected by several sensor user-adjustable features using SenixVIEW:

1. The *measurement rate* (pg. 29) can be used to directly increase or decrease response time.
2. *Filters* (pg. 30) can be selected to process measurements for improved stability. Some *filters* update outputs after each *measurement interval* while others require several intervals. Filters can decrease response time.
3. *Time Delays* (pg. 33) can be used to create system responses that might otherwise require external controllers or time delay relays. They directly delay the response of the output(s) to which they are applied.

The factory default settings are listed in Filters on page 30 and Time Delays on page 33.

When testing a new application turn all filters and time delays off for best visibility of measurement stability!

Filters

Filters are processing features that reject and/or smooth measurements, and/or limit the rate of change of the sensor distance (and therefore outputs). Their purpose is to improve sensor performance in real-world applications. The factory default has a running average of 50 enabled to slow down the response to liquid level fluctuations.

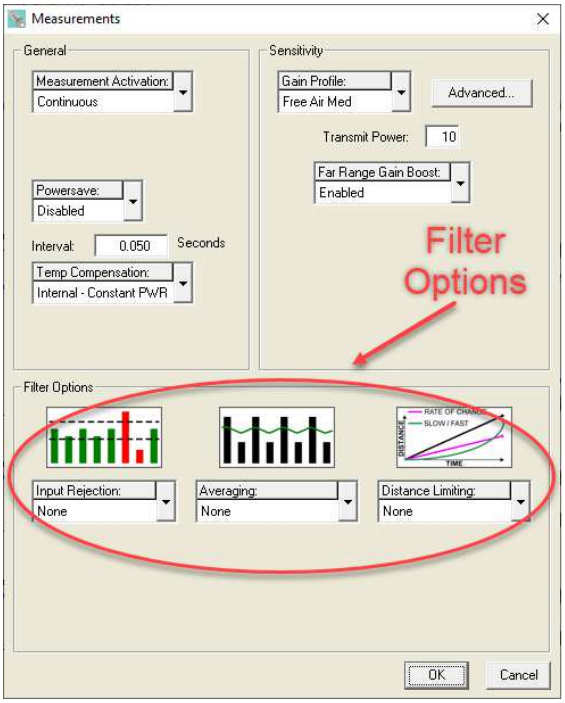
Turn filters off during setup to test measurement stability, then enable filters as required for the application.

Overview

Figure 23 shows the flow of distance measurements through the filters to the outputs. Filters are applied in order of flow from left to right (input to output). None or one selection can be made from each category (Input Rejection, Averaging and Distance Limiting). As filters are enabled the output response time is generally slower. Some filter settings are not usable in applications requiring a fast response time.

SenixVIEW Filter Selection

Click the **Measure** icon on the main screen to open the Measurements window. The location of the Filter Options is shown below.



When using filters, the first valid measurement after power ON becomes the initial condition for all further processing. The Filter Options are shown in block diagram below, followed by a description of each.

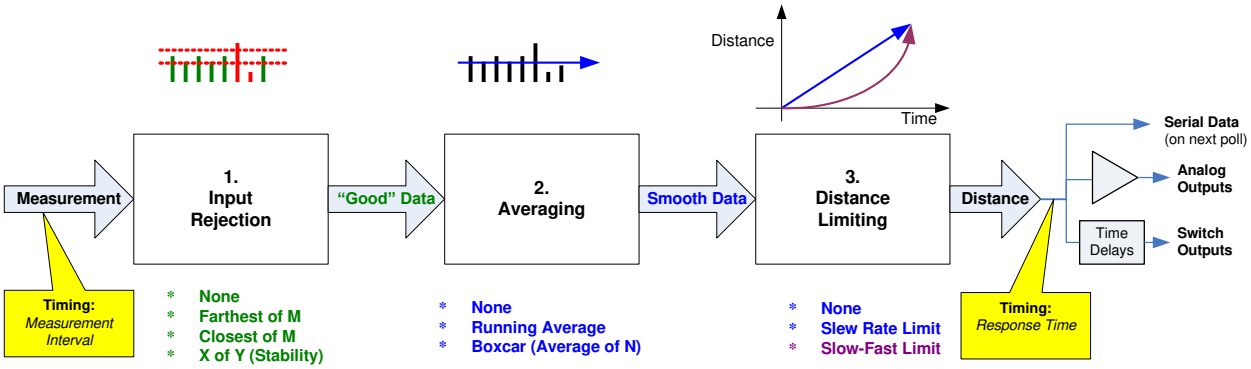


Figure 23 - Filters Block Diagram

Input Rejection Filters

Input rejection filters ignore some measurements. The input to these filters is the raw sensor distance measurement. The output ("Good" data) is then input to a averaging filter (if used).

Closest of M Measurements

The sensor performs M distance measurements and rejects all except the closest. The number of samples (M) can be set to any value from 2 to 999. The *response time* is slowed by a factor of M. For example, if M=3 and the *measurement interval* is 50 ms the *response time* is 150 ms (not including any successive filters or switch time delays).

This filter is useful for applications where the desired result is the closest object detected in a given period of time. Examples include detecting the peak value of material flowing on a conveyor, or maintaining a measurement value of a poor target (weak or intermittent echo as in coarse bulk materials).

Farthest of M Measurements

The sensor performs M distance measurements and rejects all except the farthest. It is otherwise identical to the Closest of M filter described above.

This filter is useful to ignore an unintended or unwanted target that occasionally passes between the sensor and the intended target. Examples include ignoring mixer blades in tanks, ignoring traversing objects (not the intended target), or rejecting sporadic interference (electrical, physical or acoustic).

X of Y Filter (Stability)

At least X measurements of the previous Y must be within +/- 6.25% of the most recent measurement. All measurements are ignored until this condition is satisfied, i.e., the target must remain stable before the sensor will process it. If the target remains unstable a new distance measurement *will never be established*.



Instability is different from the "no target" condition. A perfectly detected target may be in motion and thereby unstable. Stable sensor mounting is also required.

The degree of stability required is user adjustable by changing the values of X and Y. The range of values for X is 1 to 7 and for Y is 2 to 7.

As long as each new measurement X falls within bounds the sensor response time is unaffected and the latest X is available for output (excluding averaging and switch time delays used). If the input data fall out of bounds then a delay will occur before the filter criteria can again be satisfied. The delay for a re-stabilized target could range from 1 to X measurement intervals depending on the history of the prior Y measurements.

This filter is disallowed when using Start on Poll measurement activation.

Averaging Filters

The averaging filters receive their distance data from the input rejection filters (Figure 23). The averaging filter response time is therefore affected by the rejection filter selections. If an unstable target is detected by the stability filter (x of y), the averaging filter and subsequent processing are suspended at the current distance until stability returns. The distance output of the averaging filters is rate-of-change restricted by a distance restriction filter (if used).

Boxcar Average

This filter calculates the average of N inputs (N = 2 to 255) passing through the rejection filter. The process is repeated every N inputs. The *response time* is therefore slowed by a factor of N. For example, if M=3 for a rejection filter and N=10 for the Boxcar average then the update period at a 50 ms *measurement interval* is 50 x 3 x 10 = 1500 ms.

Running Average

This filter calculates the average of N inputs (N = 2 to 255) passing through the rejection filter. The average is updated after each input rather than after N inputs as for the boxcar average. The output response of this filter is therefore smoother than the boxcar filter since the output is updated more frequently.

This filter is disallowed when using Start on Poll measurement activation.

Distance Limiting Filters

The distance limiting filters clamp the rate of change of measured distance before setting sensor outputs. These filters limit the rate of change of data received from the input rejection and/or averaging filters (Figure 23). The limited distance then drives the sensor outputs (not including switch time delays).

Rate of Change

A maximum rate of change of distance (ΔD/sec) is limited to a maximum value, whether increasing or decreasing. The maximum value is a user-entered parameter with a range of .003 in./sec to 173 in./sec.

An example use of this filter is limiting the rate of change allowed when driving a motor or other mechanical system.

Slow-Fast

If the target position changes quickly, the sensor assumes it is a false change but starts to recalculate slowly toward the new position. If the new position remains stable the sensor gradually increases the rate of change of measurement toward the new position until it is reached.

This filter is disallowed when using Start on Poll measurement activation.

This filter is used for targets that change position slowly but have occasional interruptions. Examples:

- Measuring a roll diameter - holds a stable roll measurement yet readjusts the measurement in a reasonable time during changeovers
- Mixer tanks - Ignores rotating mixer blades that pass occasionally between the sensor and liquid.
- Ignore unintended targets passing between the sensor and the intended target, such as a traversing mechanism on a printer ink well.

Output Response Time

The output update rate is a function of the *measurement interval*, filter selections and parameters, and switch time delays (page 33).

Filter (2)	**Update Interval Multiplier (of measurement interval)**
Closest of M Farthest of M	M
X of Y (1)	1 (stable target) 0 (unstable target)
Boxcar Average	N
Running Average	1
Rate of Change Slow-Fast	1

(1) Once detected, regaining a target will be delayed by 1 to Y measurement intervals.

(2) During setup, turn off filters for best visibility of real-time measurements.

Table 5 - Filter Response Time

Assuming measurement interval **I** with a default of 50 ms, here are some example response times:

- **No filters**
  Response time = I (50 ms)
- **Closest or Farthest of 20 measurements**
  Response time = I * M = .05 * 20 = 1 sec
- **Boxcar Average of 10 measurements**
  Response time = I * N = .05 * 10 = 500 ms
- **Running Average**
  Response time = I * 1 = 50 ms
- **Closest of 20 and Boxcar average of 10**
  Response time = I * M * N = .05 * 20 * 10
  Response time = 10 seconds

Time Delays

Time Delays are used to cause actions that might otherwise require external controllers or time delay relays. They delay the response of the output(s) to which they are applied, and are useful for control and alarm functions. All time delays are adjustable between 0 ms to 5.46 minutes at a 5 ms resolution.

Switch Time Delays

Each switch has 3 independently adjustable delays:

- On Delay (default = 0 sec)
- Off Delay (default = 0 sec)
- No-Target Delay (default = 60 sec)

A time delay begins when the condition that triggers it first occurs (a distance measurement that could turn a switch ON or OFF, or no target). Time delays are re-triggered, i.e., the trigger condition must remain active for the full time delay period or the time delay will be reset to zero. If the trigger condition remains for the full time delay period then the corresponding action takes place (switch turns on or off).

Switch time delay setup is shown on page 19. Examples uses include:

- Set an alarm if the sensor loses the target for an excessive time period, or material stops flowing on a conveyor (jam condition)
- Force a switch state for a minimum time to assure correct operation of other equipment

Analog "No Target" Time Delay

The analog "no target" delay affects all 3 analog outputs (default = 0 sec). If the no target delay expires the analog outputs are set to their "no target" selections (high value, low value, or no change). The current loop and voltage have independent selections.

A time delay begins when the no target condition first occurs. The time delay is re-triggered, i.e., no target must exist for the full delay period or the time delay will be reset to zero. If the no target condition remains for the time delay period then the analog outputs are set to their no target values.

Analog time delay setup is shown on page 16. Example uses include:

- Force a system shutdown on loss of a target
- Controller detection of sensor's *no target* condition by setting the output value outside the normal range

No SYNC Time Delay

Used only for synchronization (page 24). The default is 0 seconds.

Temperature Compensation

At room temperatures, a change of 10 degrees Fahrenheit will result in approximately 1% change in the speed of sound and therefore the measured distance. Senix sensors have two types of temperature compensation available, internal and external. Either can be used to reduce the impact of ambient temperature changes. They can be enabled under the SenixVIEW > Measure > Temperature Compensation selector, or by using TEACH 32/33. The default is DISABLED.

Temperature compensation is less important if the temperature environment in which the sensor is used remains constant.

Internal Temperature Compensation

ToughSonic® sensors have an internal temperature sensor used in temperature compensation. The sensor will not compensate for rapid temperature changes or for temperature variations between the sensor and target. Best performance is obtained when the sensor body tracks the surrounding air temperature.



The sensor should be protected from the sun or other forms of radiant or conducted heating when using the internal temp compensation method.

Choose Internal – Constant PWR if the sensor remains powered. Several degrees of self-heating are allowed for in this compensation mode. A warm-up period of approximately 30 minutes should be allowed when using Internal – Constant PWR mode.

Choose Internal – Periodic PWR if the sensor is only powered to take a measurement. Temperature compensation will be done without allowance for self-heating.

External Temperature Compensation Using RTTC

Reference Target Temperature Compensation (RTTC) is available in SenixVIEW version 3.6.200 and higher. Your sensor firmware must be version v47 or higher which can be installed from SenixVIEW 3.6.200 or higher at menu item *Sensor >Update Sensor Firmware…* before you can use RTTC.

RTTC is a temperature compensation method that uses a fixed reference target in the measurement beam to allow the sensor to correct for temperature in the measurement path. RTTC takes two measurements each cycle. One is of the reference target near the sensor and the other is the user target at some distance. This method is best for removing diurnal temperature effects that cause measurement drift in applications where more critical measurements are required. It requires a reference target coupled to the sensor. The user can utilize a target that is added to the sensor mount. The sensor must be raised to allow the additional minimum working distance when using Reference Target mode. This method can track rapid changes in temperature and is not affected by sun or artificial heating sources acting on the sensor.

A calibration must be done when enabling RTTC. Calibration can be done at any time or temperature. A separate document on RTTC is available at the Senix.com website in Support.

Reference Target Calibration

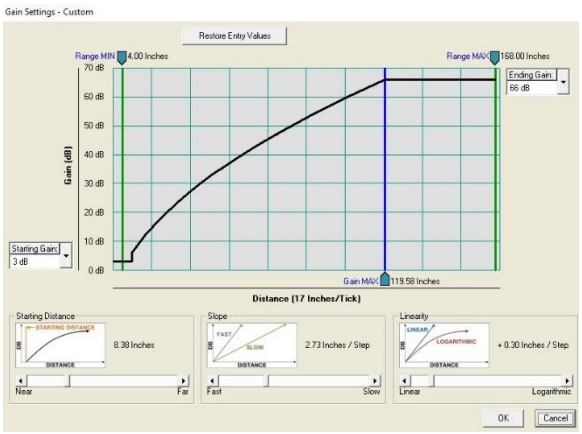
Once the reference target position has been calibrated in sensor memory, any deviation in its position later is attributed to a temperature effect on the speed of sound. The correction applied to the reference target distance is proportionately applied to the user target distance, thereby correcting for temperature effects over that greater distance.

A reference target is a small surface or rod in the sensor's sound cone at a standard distance of about 7", 14", or 21" from the sensor face depending on model (7" for the LVL 100 and 120; 14" for the LVL 300, 21" for the LVL 500). A custom target can be installed at a non-standard distance. It must be carefully placed in the sound detection area, provide a reflecting surface, and if a rod it should be perpendicular to the sensor's long axis. See the RTTC article at senix.com/support.

There are two basic steps to calibration. In the first step, before enabling Reference Target, the far (user) target is acquired and its echo stabilized. The second step is calibration using the RTTC calibration routine found in SenixVIEW.

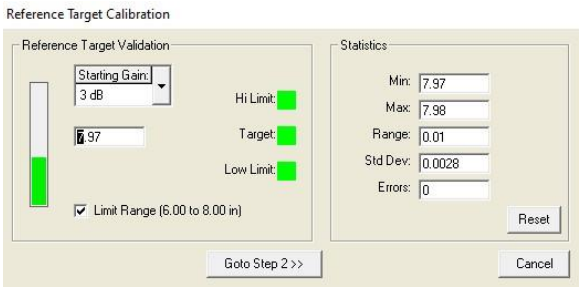
Step 1: Optimize the User Target echo

The sensor should be mounted in a secure way for calibration. A tape measurement must be made of the true distance from the sensor face to the user target. The sensor must be perpendicular to the target surface. The sensor or the user target should not move during the calibration process. Choose a user target at a distance of at least 1/4 the sensor's maximum working distance and greater if possible. **If the user target is not detected correctly due to the reference target, increase the Range MIN term to blank the reference target.** A Range MIN value greater than the reference target's distance is required to blank that echo and it must be uploaded to the sensor.

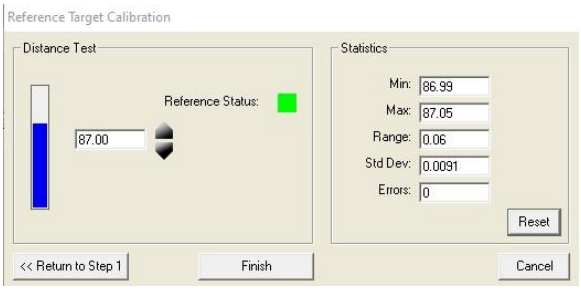


Open the advanced window found by clicking *Workspace > Measure > Advanced...* A graphic of sensor sensitivity over time (distance) is displayed. Below are three slide adjustments, Starting Distance, Slope and Linearity. Move the slope slider until MAX Gain occurs at the sensor's Optimal distance found in the Specifications section of this manual. Click *OK > OK* and *Upload Workspace to Sensor*. The intended user target should now be seen in the Sensor view. If the measured value is not correct it will be corrected in the next step.

Step 2: Calibration



Start in Sensor view. Navigate to menu item *Sensor >Reference Target Calibration….* The first window is Cal step one for Reference Target Validation. The MIN Range and MAX Range parameters are automatically adjusted to allow the standard reference target to be captured. If it is not captured, uncheck the Limit Range box for non-standard user-supplied reference target use. The echo strength graph should be green. If red, increase the Starting Gain to 6 or 9dB and click the Reset button. When there is a green echo strength seen, low standard deviation and no errors, click *Go to Cal step two*.



In Cal step two the user target distance is shown. If the value is approximately correct continue by clicking the up or down arrows to bring the distance to the known value taken by tape measurement. Use the Reset button to assist in settling the distance value. When it agrees with the known distance and is stable with no errors, click *FINISH*.

If Cal step two is unsuccessful because the proper user target is not showing, click *CANCEL* and return to the *Measure >Advanced…* window and move the Slope slider left if no target was found or farther to the right if the target was the wrong one. Hit *OK > OK* and *Upload Workspace to Sensor*. Restart Step 1.

When finished, Reference Target mode will display two boxes in Sensor view beside the distance display box. The R box is green if the reference target is being detected; red if it is not. The U box is green if the more distant user target is detected; red if it is not.

If the Reference box goes red the sensor will continue to use the last known position of the reference target in its calculations. Correct the missing target and repeat the calibration above. If there are any adjustments to sensor speed, power, or sensitivity a new calibration should be done. If the sensor is changed or the reference target removed and replaced redo the calibration. If the wrong User target is occasionally detected, increase the Range MIN term for foreground interference, or lengthen the SLOPE distance if detecting in the far region.

A significant improvement in measurement stability and accuracy is possible with Reference Target Temperature Compensation. Rapid temperature changes, sunshine on the sensor, heating of tank interiors etc. do not affect the sensor measurement as they could with the internal compensation method. Sensor installation requires the extra working length associated with the reference target and allowance for this change in sensor height must be made by the installer.



SenixVIEW Software

SenixVIEW software allows you to select and calibrate sensor outputs; modify sensor features (parameters); view, analyze and/or log measurements for performance evaluation; and save the resulting setups to disk for later recall and application cloning.

Install SenixVIEW

SenixVIEW runs on a Windows PC and connects to a CHEM sensor via a serial data COM port. Download SenixVIEW from https://www.senix.com/technical-support/documentation/# Run setup.exe and follow the directions.

Application Setups

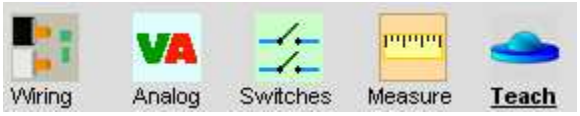
A *setup* is a combination of sensor parameters that you establish for an application. Setups can be created or changed in the SenixVIEW workspace, or moved in/out of the workspace from/to the sensor or file as shown below:



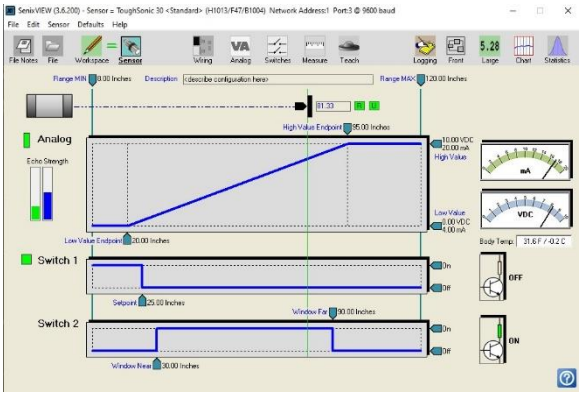
- **Main SenixVIEW Screen**

You have two screens available: Workspace view and Sensor view. Setup parameters are viewed and changed on the Workspace screen

or in pop-up dialogs by clicking one of these icons:



Sensor view contains current measurement, switch status and analog level.



- **Workspace Screen View**

The main screen displays a *setup* of (a) an attached sensor, (b) a file stored on the computer, or (c) the workspace, as selected by these icons:



In this example the **Workspace** is displaying on the main screen (icon is outlined, with **bold underlined** title), and the workspace matches the file but not the attached sensor. Click the EQUAL sign to see a printable list of all sensor parameters. Click the NOT EQUAL sign to see which parameters aren't equal between views.

If the File icon is grayed out, clicking it will open a window to select a file from the computer disk. If the Sensor icon is grayed out, clicking it will open a Sensor Connect dialog to connect a sensor.

Moving a Setup

Setups can be moved between the Workspace and a disk file, or between the Workspace and a sensor. Movement is accomplished in three ways:

1. **Using Icons** - use the mouse to either (a) **right-drag** or (b) shift-left-drag the **Workspace** icon to either the **File** or **Sensor** icon. All movement must be in or out of the workspace. For example, to move workspace parameters to the sensor *right drag* the Workspace icon as shown below:



2. **Using Menu selections:**

   File – Read File to Workspace
   File – Write Workspace to File
   Sensor – Move Sensor to Workspace
   Sensor – Move Workspace to Sensor

3. **When connecting a Sensor** – When using menu **Sensor** – **Connect** check the box if you want the setup copied to the workspace.

Creating a Setup

Setups are created or modified in the Workspace. All Workspace setups are temporary and must be moved to the sensor or saved to disk. There are 3 ways to create a new Setup:

1. Start with a Factory Default – Click **Workspace** icon, then select menu: **Workspace** – **Default LVL-XXXX Settings.** Select the model of the sensor you intend to use with the new setup.

2. Start with a Sensor – Move a setup from a connected sensor into the workspace.

3. Start with a File – Move a previously stored disk file into the workspace.

After loading the workspace, the parameters can be modified, then moved to a file or sensor. ***If the setup is not moved it is lost when exiting SenixVIEW.***

Saving a Setup

Make the workspace changes you want to test, saving them to the sensor as often as needed until the sensor is operating as needed. When finished, save the workspace to a disk file for future reference or cloning (see Moving a Setup). Use a meaningful filename when saving.

Connect a Sensor

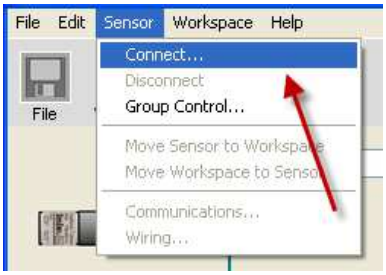
SenixVIEW requires both a physical and logical sensor-to-PC connection. Physical options include a USB-to-COM adapter (see Senix offerings on page 11).

LVL-xxxx-485 models require a RS-485 interface converter or dedicated RS-485 interface.

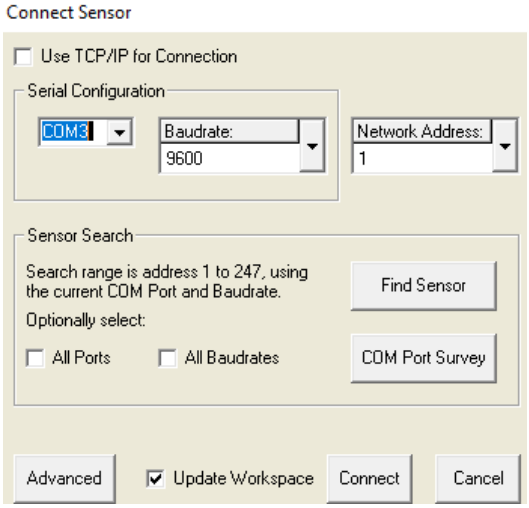
1. Install a cable between the sensor and COM port. Use the termination board and serial to USB converter in the Senix Configuration kit (page 12).

2. Apply sensor power.

3. Logical Connection: Connect SenixVIEW to the sensor using menu selections **Sensor** – **Connect**.



4. The Connect Sensor dialog then appears with either the default values or your previous selections. Used this dialog to choose COM port, Baudrate, sensor address, and to determine the correct COM port to use. Do this by using the COM Port Survey, note results, remove the converter's USB plug and repeat the survey. The results will not include the COM port to use. Reinstall the USB and use that port.



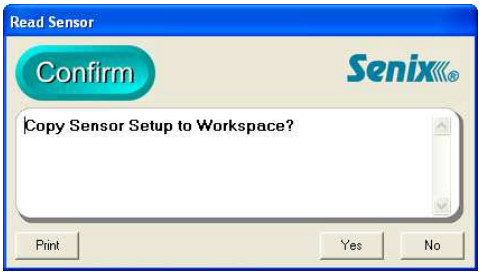
5. This dialog allows you to automatically update Workspace once connected with all the sensor's

parameters. Uncheck the box if you do not want the parameters to overwrite Workspace.

You can also switch modes from Modbus to ASCII streaming in this window. Click the Advanced key to open the selector window. Make any changes then click **Connect.**

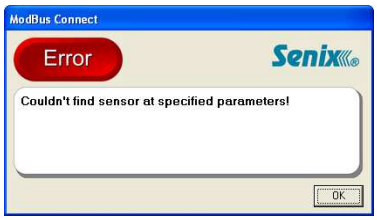
SenixVIEW then connects to the sensor (**Sensor** icon automatically selected) and offers sensor viewing as described on page 26.

6. When the sensor is found, this message appears:



Move the parameters to the Workspace to (a) change them or (b) save them to disk. You can also move them later.

7. If the following message appears check the (a) wiring, (b) power and (c) interface selections, or use Find Sensor to scan all sensor addresses:



8. If the above error continues, use Find Sensor to scan all sensor interface combinations. The default is address is 1. Check the "All Ports" and/or "All Baud Rates" boxes if you are unsure of those. SenixVIEW will identify the first Sensor Model found, starting at address 1 through 247.

9. When a sensor is found this message appears:



Click OK and the Connect Sensor dialog is redrawn with the correct parameters (step 4).

10. **Cannot Find Sensor**: Check the following:

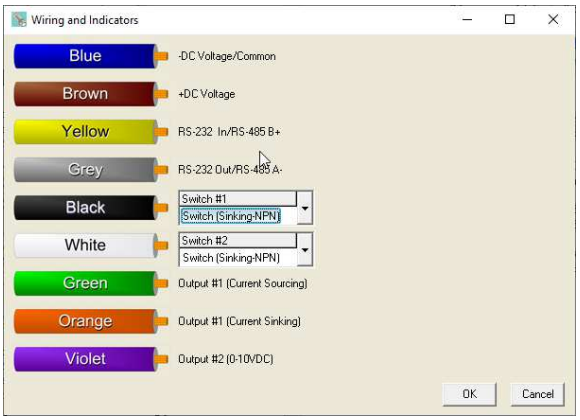
- Is the sensor powered?
- Check the wiring connections
- Is the correct COM port selected?
- Is COM port working?
- Does the interface match the sensor model? LVL-xxxx-232 models use RS-232 and LVL-xxxx-485 models use RS-485.

Outputs



After connecting a sensor, click this icon to reconfigure the outputs.

The following 9-wire dialog appears, making it possible to reconfigure the switch outputs type to sinking (NPN), sourcing (PNP) or OFF.





Make output changes before connecting your equipment. Do not change outputs when connected to operating equipment!

If wiring changes are made and the OK button clicked, the changes are made and the sensor automatically disconnects from SenixVIEW:

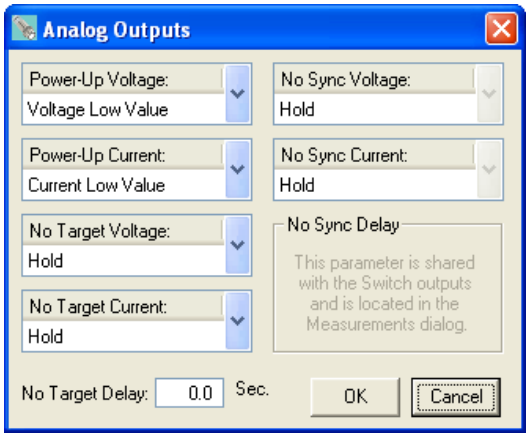


Reconnect SenixVIEW to the sensor (page 37) to resume SenixVIEW with the new outputs.

Analog Dialog



To modify analog output features not available on the Main Screen, click this icon to display the Analog dialog.



For more information, see the Analog No Target Delay section on page 33.

Switch Dialog



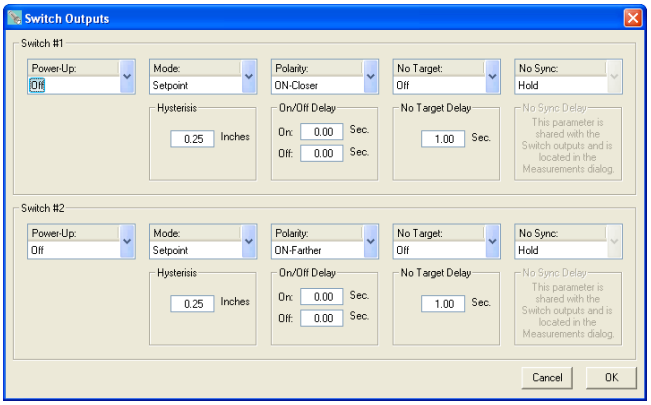
To modify switch output features not available on the Main Screen, click this icon to display the Switch dialog.

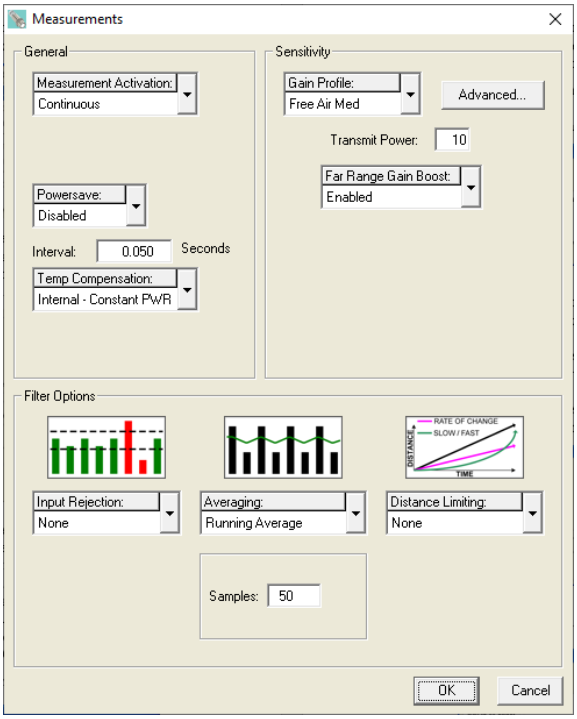
For more information, see the Switch Adjustment section on page 19.

Measure Dialog



To modify measurement parameters not available on the Main Screen, click this icon to display the Measure dialog.





For more information see the Filter section on page 30.

TEACH Enable / Disable



A TEACH button is not included in CHEM sensors and this selection has no effect.

Sensor Adjustment

Sensor setups are made in the workspace then transferred to the sensor. The screen shot below shows the screen with the **Workspace** icon selected.

(a) Setups can be moved between the Workspace and a disk file or sensor (see page 36).

Setup changes do not take effect until moved to the sensor! *Remember to save setups to disk for future recall.*

(b) Click one of these ICONS for extended features associated with the analog outputs, switch outputs or measurements.

Wiring adjustments: see page 13.
Analog adjustments: see page 15
Switch adjustments: see page 19
Measurement adjustments: see page 39

(c) Enter up to 32 characters to describe a setup. This reminder text is stored in the sensor or disk file when the parameters are moved or saved.

(d) Click the distance text to edit the *Operating Range* (see page 25). Range MIN is the left parameter and Range MAX the right, e.g., clicking the 4.00 inch (left) value yields:



Enter a new value then type <Enter>.

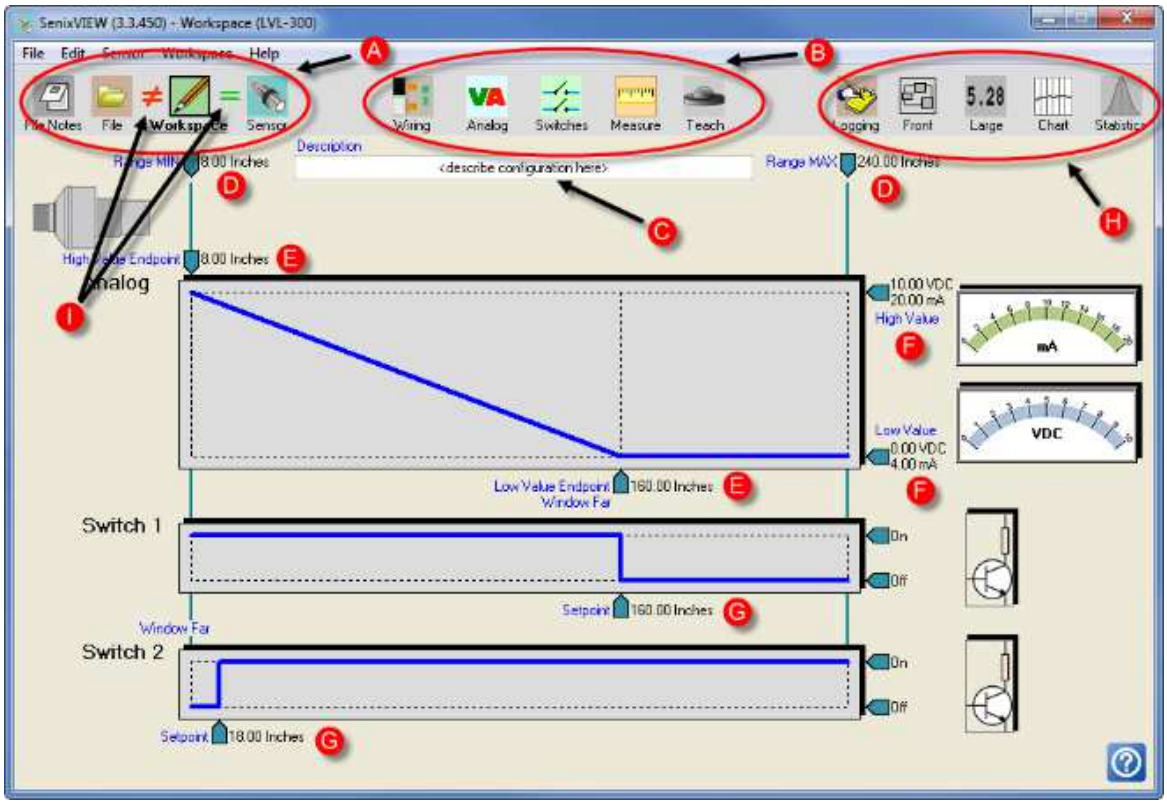
(e) Click the distance text of high and/or low analog endpoints to calibrate the analog outputs. The voltage and current outputs share the endpoints.

(f) Click text of the high and/or low values to change the output range. The voltage and current loop outputs are independently adjustable.

(g) Click the distance text of the switch setpoints to calibrate the switch ON distances. Hysteresis and window options are found by clicking the Switches icon (page 19).

(h) These icons are grayed out in **Workspace** but operate when connected to a sensor (click **Sensor** icon). See Sensor Viewing on page 26.

(i) Equality symbols indicate whether the Workspace is equal or not to the File and Sensor. Click to see differences or view the entire parameter set for printing.



Appendix A – List of Adjustable Features

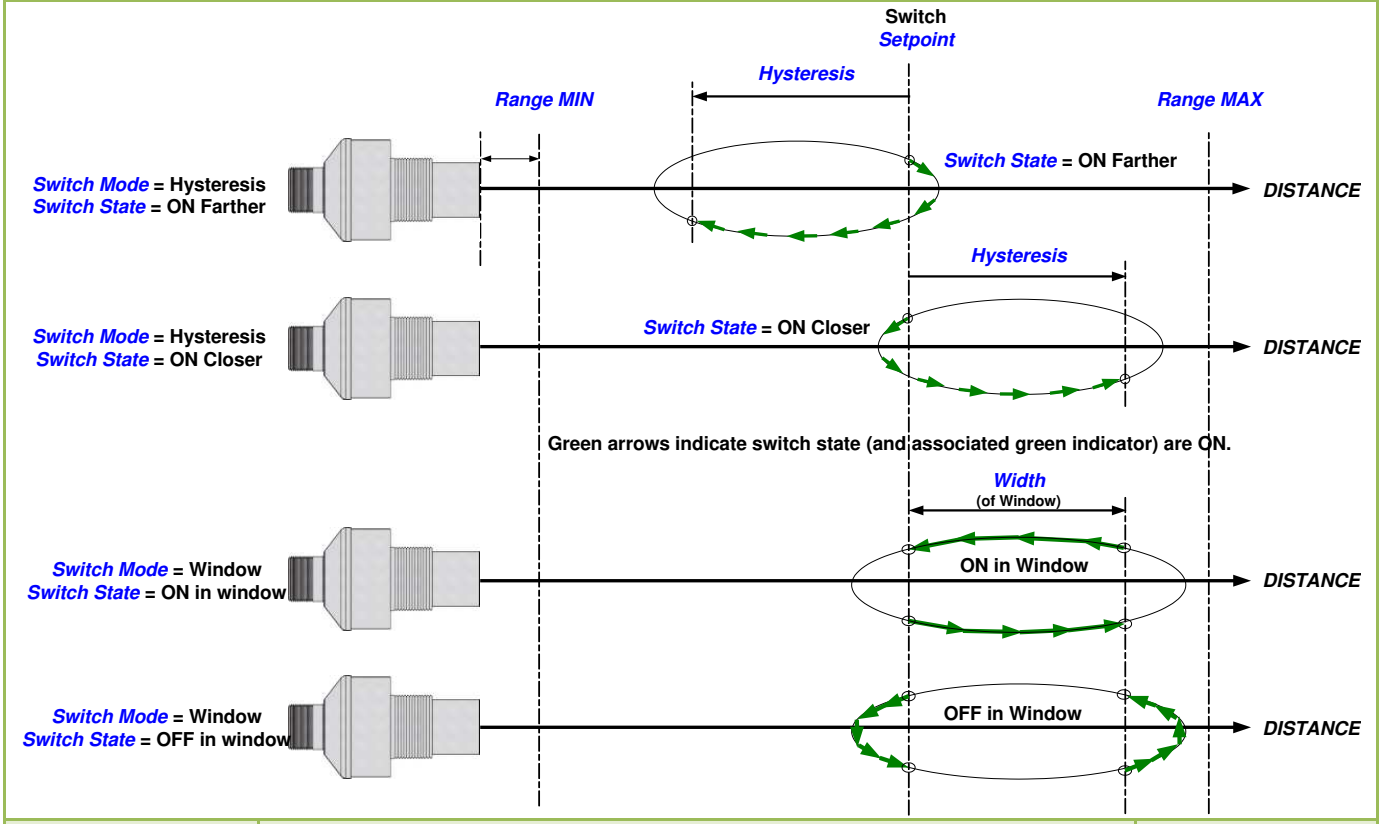
These parameters can be changed using Senix SenixVIEW™. Parameters are permanently stored in the sensor memory.
♦ = implied parameters (not directly settable)

Feature	Description	As Shipped from Factory
General Parameters **These parameters are available on the SenixVIEW Main Screen.**		
Description	A 32-character text field to describe the application setup. This serves as a reminder when a setup is retrieved from a sensor or disk file. It is only for reference and does not affect sensor operation.	This text: <describe configuration here>
Range Min	The shortest distance the sensor will provide target measurements. Closer targets may have multiple reflections resulting in an incorrect measurement at a multiple of the actual distance.	See Table 1 page 8
Range Max	The farthest distance the sensor will provide target measurements.	See Table 1 page 8
Operating Range ♦	The range of distances between the ***Range Min*** and ***Range Max***, between which the sensor will detect a target. Targets closer than Range Min may still be detected (at incorrect distance) due to multiple reflections.	
Parameters that Affect Measurements **These parameters are available by clicking the SenixVIEW MEASURE icon.**		
Measurement Interval (p 29)	The period between measurements. Values can range from 5 ms to 1.275 sec at 5 ms resolution.	See Table 1 page 8
Temperature Compensation (p 33)	Temperature compensation can be turned ON or OFF	ON
Filters (p 30)	Filter options include Closest or Farthest of M, X of Y, Running or Boxcar average of N, Max Rate and Slow/Fast Rate	All filters OFF
Measurement Activation (p24)	**Continuous** (at *measurement interval*) **Start on Poll** (Measure upon receiving serial data read poll) **SYNC Master** (continuous at *sync interval*) **SYNC Slave 1, 2, 3, 4 or 5** (at *sync interval*, measures when receive associated SYNC input from SYNC Master) (*sync interval* = *measurement interval* x *SYNC phases*)	Continuous
SYNC Phases	The number of SYNC phases generated by a SYNC Master (pg. 24)	2
No Sync Delay	The time a SYNC Slave sensor must continuously fail to detect a SYNC input before setting the No SYNC switch state(s) or analog value(s). Values: 0 ms to 5.46 minutes (resolution 5 ms)	0 ms
PowerSave	PowerSave reduces average power consumption. Options: **Enabled** and **Disabled**.	Disabled

Parameters that Affect Switch Outputs (if selected)

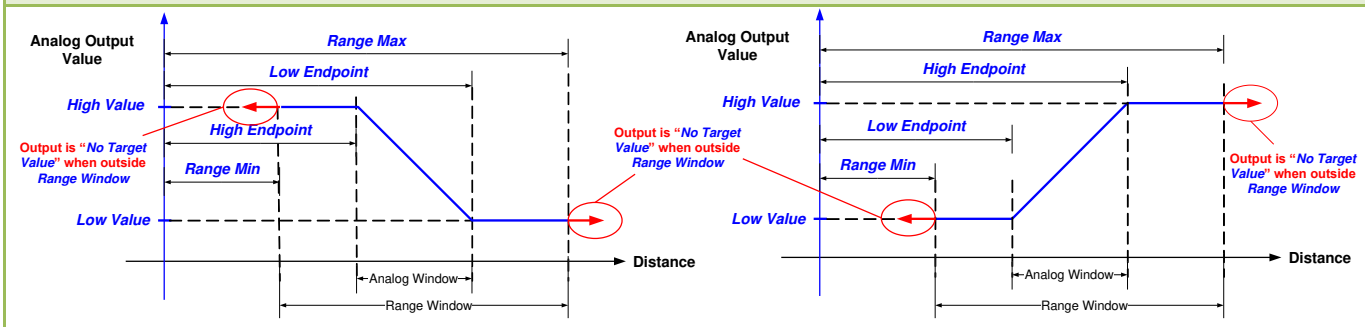
Setpoints are available on the SenixVIEW Main Screen, other parameters by clicking the Switches icon.

Switch Output Selection	There are two switch outputs (see page 38). The factory default is both switches configured as sinking (NPN) outputs. Switch #1 is on the BLACK wire. Switch #2 is on the WHITE wire. Switches are configurable as sinking (NPN) or sourcing (PNP) type. If both are selected they each are independently adjustable.	Reconfigure switch type menu selection **Sensor - Wiring**



Switch Mode	**Hysteresis**: Switch turns ON at the ***Setpoint*** and OFF after the distance reverses direction by at least ***Hysteresis*** **Window**: The Switch State is set in a distance window beginning at ***Setpoint*** and ending at ***Setpoint*** + **Width** from the sensor Options: **Setpoint** or **Window**	SW #1:Setpoint SW #2:Setpoint
Power-Up State	The switch state set when power is first applied. This state remains until completion of the first ***Measurement Cycle*** or ***Measurement Process***. Options: **ON** and **OFF**	SW #1: OFF SW #2: OFF
Setpoint	The distance where a switch changes from OFF to ON.	See Table 1 page 8
Polarity	If Switch Mode = Hyst: Direction of target through Setpoint causing ON Options: **On Closer** or **ON Farther** If Switch Mode = Wind: Switch state when target is detected in window Options: **ON** or **OFF**	SW #1: ON Closer SW #2: ON Farther

No Target State		Switch action if no target is detected (TARGET LED = RED) for a time period exceeding the switch's No Target Delay. Options: **ON**, **OFF** and **HOLD** (no change)	SW #1: OFF SW #2: OFF
No Target Delay		The minimum time the sensor must continuously fail to detect a target before setting the No Target State Values: 5 ms to 5.46 minutes (resolution 5 ms)	SW #1: 0 ms SW #2: 0 ms
Hysteresis or Width		A distance value representing either the amount of Hysteresis (Setpoint Mode) or the length of the Window (Window Mode) Values: 0 to 221.77 in. (5.63 m) (Warning if result surpasses ***Range Window*** for selected ***Switch Mode***)	SW #1: 0.25 in. (6.4 mm) SW #2: 0.25 in. (6.4 mm)
On Delay		The minimum time the sensor must continuously measure a distance representing an ON condition before setting the Switch State to ON Values: 0 ms to 5.46 minutes (resolution 5 ms)	SW #1: 0 ms SW #2: 0 ms
Off Delay		The minimum time the sensor must continuously measure a distance representing an OFF condition before setting the Switch State to OFF. Values: 0 ms to 5.46 minutes (resolution 5 ms)	SW #1: 0 ms SW #2: 0 ms
No Sync State		Switch state set by a SYNC Slave sensor with no master SYNC input for a period exceeding ***No Sync Delay***. Options: **ON**, **OFF** and **HOLD** (no change)	SW #1: OFF SW #2: OFF
No Sync Delay		See description under ***Parameters that Affect Measurements.*** This parameter is shared by all analog and switch outputs.	0 ms

Feature	Description	As Shipped from Factory
	Parameters that Affect Analog Outputs (if selected) **Endpoints are available on the SenixVIEW Main Screen, other parameters by clicking the Analog icon.**	
	 Decreasing ***Analog Slope*** Increasing ***Analog Slope***	
Analog Selections	There are three analog outputs (see page 14) on these wires. Voltage output is on the VIOLET wire. 4-20 mA current SOURCING output is on the GREEN wire. 4-20 mA current SINKING output is on the ORANGE wire. Note: The voltage and current share the same ***Analog Window***, ***Analog Slope***, ***No-Target Delay*** and ***No Sync Delay***.	
Analog Window (analog shared) ♦	The range of distances between the ***Low Endpoint*** and ***High Endpoint***, between which the voltage and current outputs are linearly scaled to change between their Low Values and High Values respectively.	Between the *endpoints* listed below
Analog Slope (analog shared) ♦	The analog slope either increases or decreases with distance depending on the relative positions of the ***Low Endpoint*** and ***High Endpoint***. The current and voltage must have the same slope. The voltage min and max values must be separated by at least 0.1 VDC. The current min and max values must be separated by at least 0.2 mA.	Increasing
Low Endpoint (analog shared)	One end of the range of distances over which the analog outputs are scaled. At the ***Low Endpoint*** distance the outputs are the ***Low Voltage Value*** and/or ***Low Current Value***. If this distance is outside the sensor's ***Operating Range*** the value will not be reached but the sensor operates properly for in-range targets.	See Table 1 page 8
High Endpoint (analog shared)	One end of the range of distances over which the analog outputs are scaled. At the ***High Endpoint*** distance the outputs are the ***High Voltage Value*** and/or ***High Current Value***. If this distance is outside the sensor's ***Operating Range*** the value will never be reached but the sensor operates properly for in-range targets.	See Table 1 page 8

High Voltage Value	Voltage output for targets detected at the ***High Endpoint*** (and outside the ***High Endpoint*** side of the analog range) Either the standard default 10 VDC or a custom value can be entered. Values: 0.1 to 10 VDC in 50 mV steps Value must be at least 1.0 volts above the ***Low Voltage Value***.	10 VDC
Low Voltage Value	Voltage output for targets detected at the ***Low Endpoint*** (and outside the ***Low Endpoint*** side of the analog range) Either the standard default 0 VDC or a custom value can be entered. Values: 0 VDC to 9.9 VDC in 50 mV steps Value must be at least 1.0 volts below the ***High Voltage Value***.	0 VDC
High Current Value	Current output for targets detected at the ***High Endpoint*** distance (and outside the ***High Endpoint*** side of the analog range) Either the standard default 20 mA or a custom value can be entered. Values: 2.2 to 20 mA in 0.1 mA steps Value must be at least 2.0 mA above the ***Low Current Value***.	20 mA
Low Current Value	Current output for targets detected at the ***Low Endpoint*** distance (and outside the ***Low Endpoint*** side of the analog range) Either the standard default 4 mA or a custom value can be entered. Values: 2 mA to 19.9 mA in 0.1 ma steps Value must be at least 2.0 mA below the ***High Current Value***.	4 mA
Power-Up Voltage	The voltage output value set when power is first applied; remains until completion of the first ***Measurement Cycle*** or ***Measurement Process.*** Options: **LOW** or **HIGH** analog output value Voltage goes to ***Low Voltage Value*** or ***High Voltage Value***.	LOW
Power-Up Current	Current loop output value set when power is first applied; remains until completion of the first ***Measurement Cycle*** or ***Measurement Process.*** Options: **LOW** or **HIGH** analog output value Current goes to ***Low Current Value*** or ***High Current Value***.	LOW
No Target Voltage	Voltage value if no target is detected (TARGET LED = RED) for a time period exceeding the analog ***No Target Delay***. Options: **LOW**, **HIGH**, and **HOLD** (no change)	HOLD
No Target Current	Current loop output value if no target is detected (TARGET LED = RED) for a time period exceeding the analog ***No Target Delay***. Options: **LOW**, **HIGH**, and **HOLD** (no change)	HOLD
No-Target Delay (shared)	The minimum time the sensor must continuously fail to detect a target before setting the No Target Value. Values: 0 ms to 5.46 minutes (resolution 5 ms)	0 ms
No Sync Voltage	Voltage value set by a SYNC Slave sensor with no master SYNC input for a period exceeding ***No Sync Delay***. Options: **LOW**, **HIGH**, and **HOLD** (no change)	HOLD
No Sync Current	Current loop value set by a SYNC Slave with no master SYNC input for a period exceeding ***No Sync Delay***. Options: **LOW**, **HIGH**, and **HOLD** (no change)	HOLD
No Sync Delay	See description under ***Parameters that Affect Measurements.*** This parameter is shared by all analog and switch outputs.	0 ms
(analog shared)	Indicates parameter applies to all current loop and voltage outputs.	