



SensorView™

Installation & Operating Instructions
for ToughSonic® sensors

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Overview

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

Install SensorView™

SensorView™ runs on a Windows PC and connects to a ToughSonic® sensor via a serial data COM port or, with a suitable adapter, via USB port.

Get SensorView™: <https://www.senix.com/technical-support/documentation/#>

Application Setups

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



You have two screens available: Workspace view and Sensor view. Sensor view contains current measurement, switch status and analog level. Setup parameters are viewed and changed in the workspace screen by clicking icons on the taskbar below.



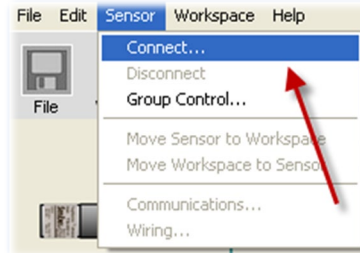
Connect a Sensor

SensorView™ requires both a physical and logical sensor-to-PC connection. Physical options include a USB-to-COM adapter, of which, we provide several products. Contact us and ask about our available USB-to-COM adapters.

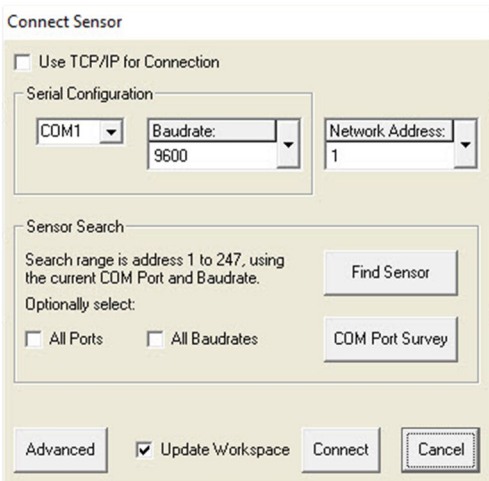


ToughSonic® sensors require a USB to RS-232 or USB to RS-485 adaptor. Check out our website for our serial adaptor products.

1. Install a serial adapter between the sensor and USB port on the PC. Use the adapter included with a Setup kit.
2. Connect the sensor wires by color to the adapter's terminals. Do not let unconnected wires contact each other or any other conductive material.
3. Apply sensor power: The rear target indicator should be lit.
4. Complete the Connection: Connect SensorView™ to the sensor using menu selections **Sensor > Connect**.



5. The Connect Sensor dialog then appears. Choose the COM port, Baud rate, and Network Address and click Connect. If the COM port is unknown, unplug your USB cable and click COM Port Survey and note the reported ports. Plug in the USB cable again and repeat the survey. The COM port that appears is the correct one. A default sensor has 9600 Baud rate and a Network Address of "1".



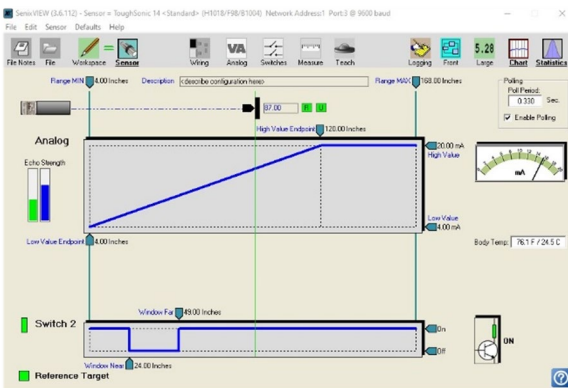
If the 'Update Workspace' box is checked then a copy of sensor parameters will be uploaded to SensorView™. If you intend to clone a sensor with the current Workspace, be sure it is unselected.

6. When a sensor is found this message appears:



Click Yes and the Connect Sensor dialog is redrawn with the correct parameters (step 4). If the sensor isn't found, check that the serial to USB converter matches the sensor serial type found on the label.

Sensor Screen View



The main screen displays a *setup* of (a) an attached sensor, (b) a file stored on the computer disk, 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 dialog 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. This 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, or vice versa. All movement must be in or out of the workspace. For example, to move the workspace to the sensor drag the Workspace icon as shown below:



2. Moving setups can also be achieved by using menu selections on the top taskbar:
 - 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** SensorView™ asks if you want the setup copied to the workspace. Click **Yes** to copy it, or **No** to keep the existing workspace setup.

Creating a Setup

Setups are created or modified in the workspace. There are three ways to create a new Setup:

1. Start with a Factory Default – Click **Workspace > Default Settings**. Select the model of the sensor you intend to use with the new setup. When a sensor is connected, only the associated factory default can be selected.
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, parameters can be modified, then moved to a file, or uploaded to a sensor.



If the setup is not uploaded or saved it is lost when exiting SensorView™.

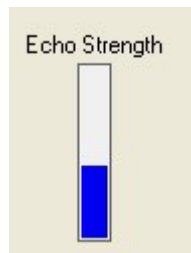


Loading a Factory Default setup on a sensor with an existing setup will erase the existing setup from the sensor.

Saving a Setup

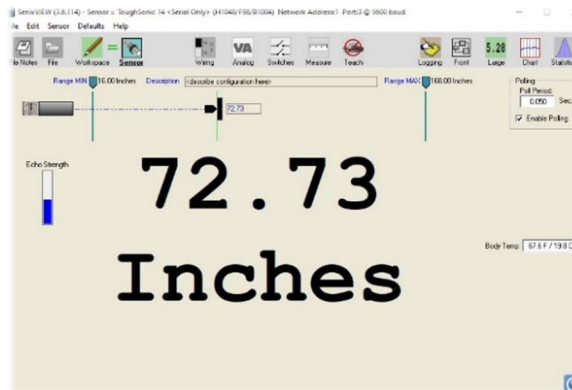
Make the workspace changes you want to test, saving them to the sensor as often as needed until the sensor is operating as desired. When finished, save the workspace to a disk file for future reference or cloning (see Moving a Setup). Using a meaningful filename when saving is recommended. You are given opportunity to enter notes during the save operation. **Notes are saved with the file and NOT loaded into the sensor with the setup later.**

Echo Strength Indicators



The Sensor screen includes an Echo Strength indicator. It will be BLUE when the echo strength is sufficient. If echo strength drops low, it turns RED. Improving the target size and orientation, or an adjustment of sensor parameters such as power or sensitivity settings can improve echo strength.

Serial Only Models



The SensorView™ sensor view screen will display just the digital distance value in the user's selected unit.


Sensor Screen

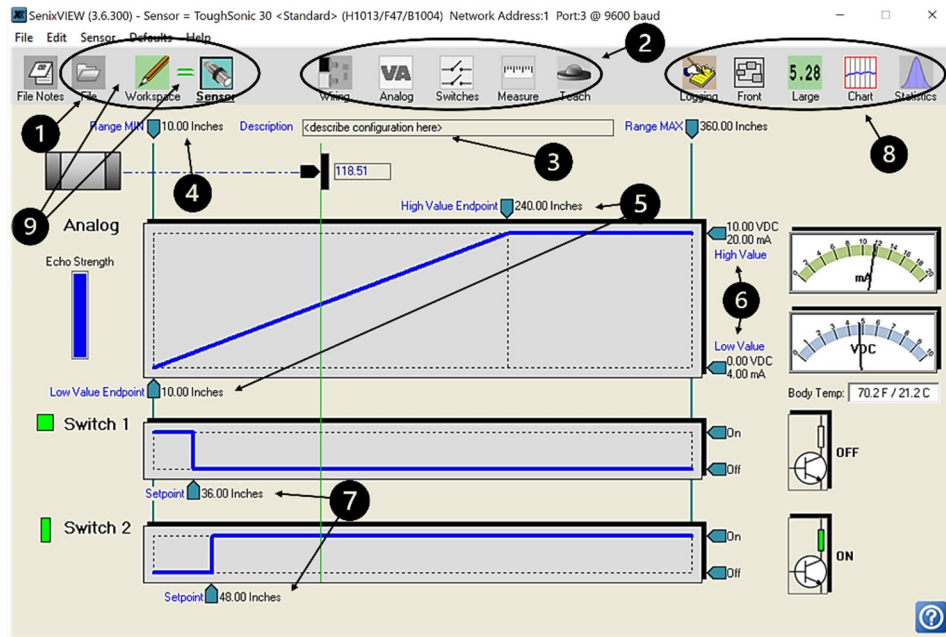
Below is a walkthrough of basic SensorView™ functions:

- 1) Setups can be moved between the Workspace and a disk file or sensor.



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

- 2) Click one of these ICONS for extended features associated with the analog outputs, switch outputs, measurements or TEACH button.
- 3) 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.
- 4) Enter a new value then press <Enter>. 
- 5) Click the distance text of high and/or low analog endpoints to calibrate the analog outputs. The voltage and current outputs share the endpoints. Right-click the high or low value to **reverse the slope**.
- 6) Click text of the high and/or low values to change the output range. The voltage and current loop outputs are independently adjustable.
- 7) 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 (pg. 17). Right-click the value to **toggle the switch state**.
- 8) These icons are grayed out in **Workspace** but operate when connected to a sensor (click **Sensor** icon). See Analysis Tools on pg. 8.
- 9) Equality symbols indicate whether the Workspace is equal or not to the File and Sensor. Click on an unequal sign to reveal a printable list of differences. Click an equal sign to get a printable list of all parameters.



Endpoints and Slope

The voltage and current loop(s) are spanned between the same two *endpoint* distances (see b & c on the following page). *Endpoints* can be set anywhere in the sensor's *operating range* using SensorView™ (pg. 9).


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 SensorView™ for voltage and current loops.

Response Time

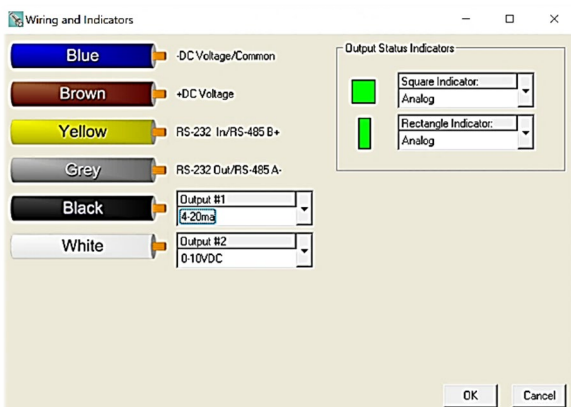
Analog response time is affected by measurement rate and filter selections. See Measurement Process on pg. 9.

Outputs & Indicator Configuration

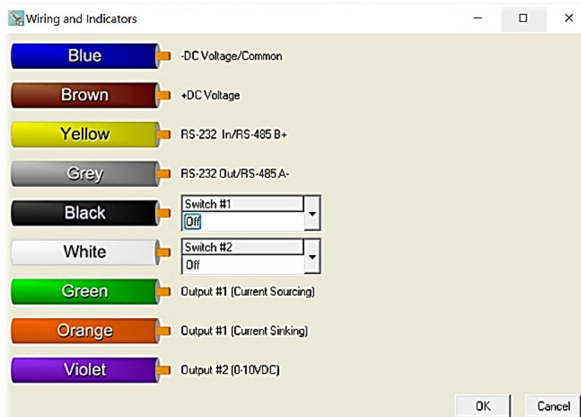
ToughSonic® sensors are factory configured with the voltage and current loop outputs selected. Other selections are possible.

 After connecting a sensor, click this icon to select or reconfigure the outputs and indicators.

For certain ToughSonic® sensors, the following 6-wire dialog appears. The factory default outputs are 4-20 mA current loop (black wire) and 0-10 VDC (White wire), and the square indicator displays analog status and the rectangular serial data TX.



For other ToughSonic® sensors the following 9-wire dialog appears. Note that each output has a separate wire in these models. Certain models such as Chem



ToughSonic® sensors do not have output status indicators and are thus not displayed in the Wiring and Indicators dialog. SensorView™ will automatically

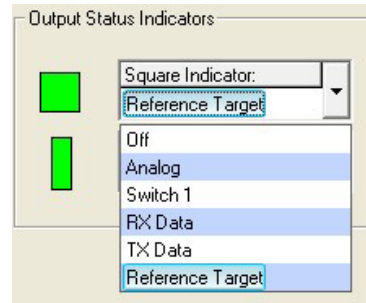
detect the wiring and output indicator configuration of any connected ToughSonic® sensor.



Select the outputs before connecting your equipment. Do not change outputs when connected to operating equipment!

Output Indicator Selection

For ToughSonic® sensors that are configured with output status indicators, one can choose which function will be shown by each output indicator

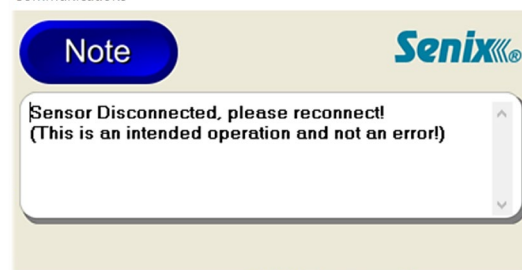


found on the rear of the sensor (except serial-only models). Reference Target can only be selected once Reference Target mode is enabled in the Measure window. Switch choices are only accepted when the output has been designated a switch output in the Wiring window. The choices for the Square and the Rectangular indicator are the same, however the square indicator can only indicate Switch #1 while the rectangular indicator can only indicate Switch #2.

If Indicator or wiring changes are made on either of these dialogs and the OK button clicked, the changes are made, and the sensor automatically disconnects from SensorView™.

Reconnect SensorView™ to the sensor (pg. 3) to resume SensorView™ with the new outputs.

Communications



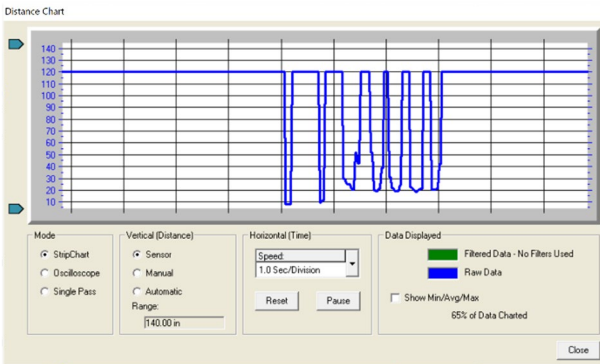
Analysis Tools

Several tools are available in SensorView™ which are very useful in viewing sensor performance while tuning the sensors performance or using S SensorView™ to collect and analyze data.

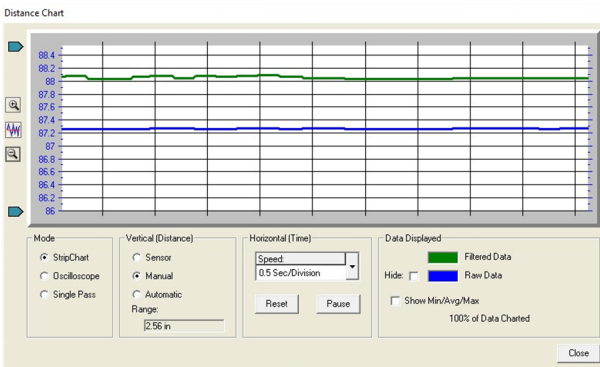


Strip Chart

Click the **Chart** icon to view data in strip chart format. Both filtered and unfiltered data can be displayed depending on the filter configuration (pg. 19). The strip chart is very handy to see target stability over shorter time windows.

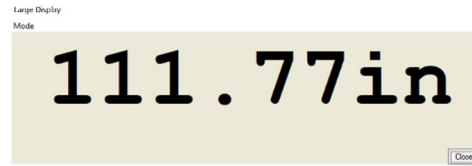


When Reference Target Temperature Compensation mode is selected (pg. 13) and calibration has been done, the Chart tool can show the unfiltered data in blue and the filtered (or compensated) data in green. The chart tool is useful to track compensation performance as ambient temperatures rise and fall.



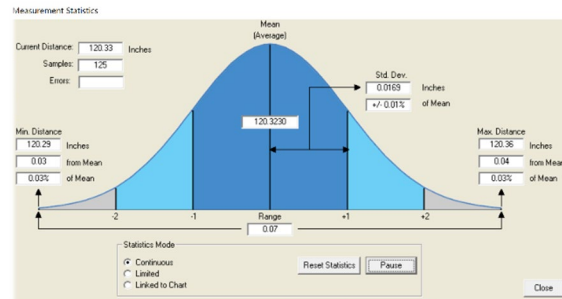
Large Display

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 “Large” icon.



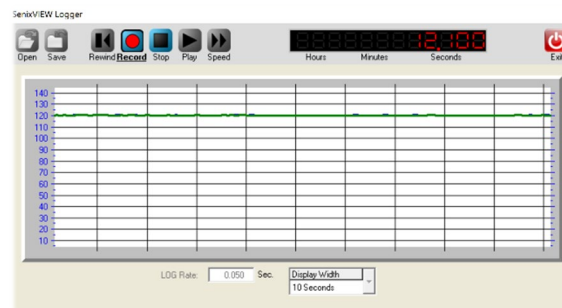
Statistics

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.

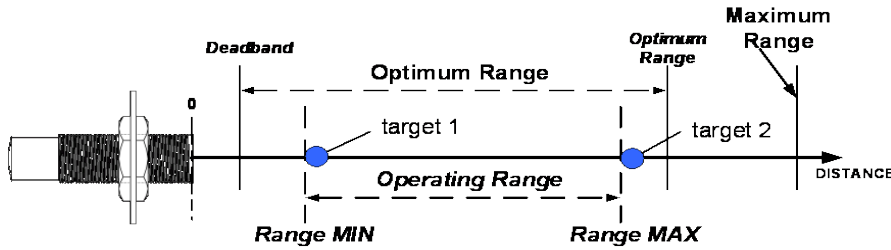


Data logging

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



Operating Range



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

Range Min

The *Range MIN* (also called *Deadband*) is the closest distance that the sensor will report an accurate distance (see Specifications). Targets closer than *Range MIN* may be detected, especially at close range, but the measured distance will be *Range MIN* (or greater for secondary echoes). If the near distance is important keep the target 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. If a target is not detected closer than *Range MAX* a “No Target” condition exists.

Under “No Target” conditions the analog and switch output values or states can be configured to either hold their prior state before the loss of target or return to specified values immediately or after a user adjustable period.

The “No Target” controls can be an important and useful tool to control system response by limiting the distance the sensor will consider a valid target.

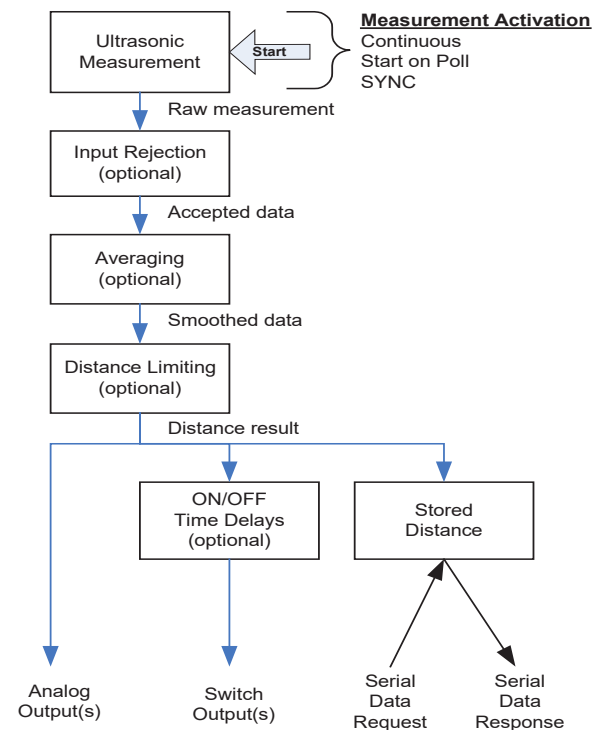
Factory Defaults

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 (pg. 19), then any switch time delays (pg. 22) before the result is reflected in the sensor outputs.



In Start on Poll activation the entire process is performed once per poll, i.e., M Input Rejection X N Averaging measurements (pg. 21). Some filters are disallowed in Start on Poll. 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 most recent distance result can also be requested by an external controller over the serial data bus (Serial Protocols, pg. 25).

Measurement Rate

The *measurement rate* is how often the sensor measures the target distance. It does not require adjustment in most applications. Default rates are:

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)

- ❖ TS 3, 14: 20 Hz (50 ms *measurement interval*)
- ❖ TS-30: 10 Hz (100 ms interval)
- ❖ TS 50, 50RM: 5 Hz (200 ms interval)
- ❖ TS 50P: 5 Hz (200 ms interval)
- ❖ LVL-100, 20 Hz (50 ms interval)
- ❖ LVL-140, 20 Hz (50 ms interval)
- ❖ LVL-300, 10 Hz (100 ms interval)
- ❖ LVL-500, 5 Hz (200 ms interval)

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 SensorView™.



Note: Sensor current consumption increases significantly at the smallest measurement intervals (fastest cycling).

SYNC activation directly reduces the *measurement rate* by the number of master SYNC phases. For example, a ToughSonic® 14 sensor (20 Hz default rate) set for 3 SYNC phases has the measurement rate reduced to 6.66/sec (20 divided by 3).

Maximum Target Distance Effects

The time required to detect a target is affected by the speed of sound in air. 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 must 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.

Measurement Stability Effects

If the measurement rate is set too fast the sensor may detect residual echoes from a prior measurement cycle, causing measurement instability. This is more common in liquid tanks and presents as jumpy targets or short measurements. This effect is more prevalent at cold temperatures because sound absorption in cold air is less, and it takes more time for echoes to decay. Multi-echo issues are minimized by slowing the measurement rate, reducing the sensitivity, 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 (serial data is not available in SYNC operation).

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

1. The *measurement rate* can be used to directly increase or decrease response time. See *measurement activation*, pg. 11.
2. *Filters* (pg. 19) 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. 22) 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.
4. For SYNC master and slaves, the *Sync interval* increases as a multiple of the *measurement interval* times the *number of sync phases*.



The factory default settings are all *filters* off and every *time delay* set to 0. **When testing a new application keep filters and time delays off for best visibility of measurement stability!**

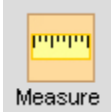
Measurement Activation

Sensor measurements can be activated in four ways – *continuous*, *start-on-poll*, *master*, and *slave*. The factory default and most common is *continuous*. The activation options are set using SensorView™ by clicking the **Measure** icon then using the Measurement Activation selector (next page).

Sensor features affected by the activation mode are summarized in the table below.

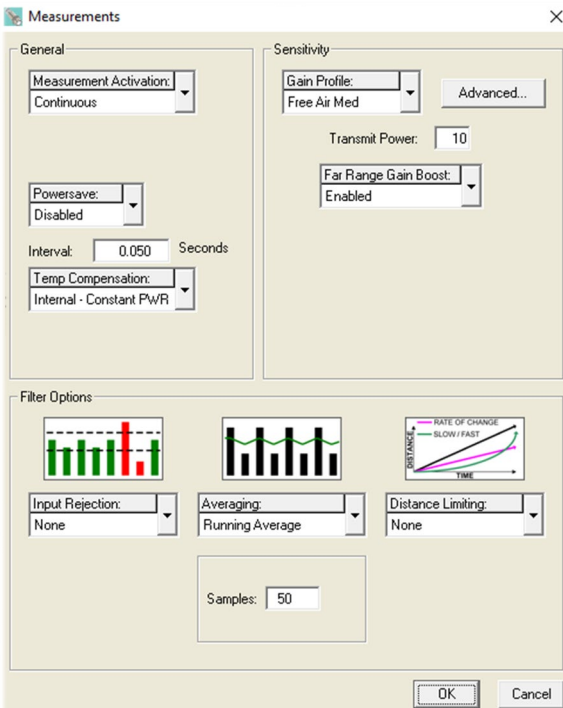
Measurement Activation Mode Selected	When the Measurement Starts	Features Allowed							When the Analog and Switch outputs are updated	Serial Data Bus (RS-232 or RS-485)
		TEACH	Filters							
			X of Y	Closer of M	Farther of M	Averaging	Rate of change	Slow-Fast		
Continuous (Factory default)	Repetitively at the <i>measurement interval</i>	•	•	•	•	•	•	•	After each measurement or <i>measurement process</i>	Last <i>measurement process</i> distance sent in response to distance poll
Start on Poll	Distance poll received (& current <i>measurement process</i> finishes)			•	•	•			After the <i>measurement process</i> triggered by the distance poll	Last <i>measurement process</i> distance sent in response to distance poll
SYNC Master	Repetitively at the [<i>measurement interval</i> * <i>SYNC phases</i>]	•	•	•	•	•	•	•	After each measurement	Sends SYNC commands (distance not sent)
SYNC Slave	Upon receiving a master SYNC command.	•	•	•	•	•	•	•	After each measurement	Receives SYNC commands (distance not sent)

Measurements Dialog



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

This dialog is used to change activation, Continuous, SYNC, or Start on Poll), the rate of measurement, temperature compensation mode (pg. 13), sensitivity, and to apply filters. Refer to pg. 19 for in-depth information about data filtering.



Activation Modes

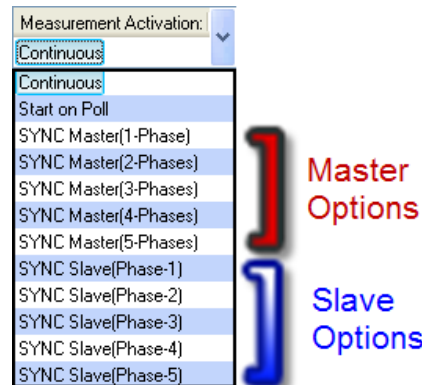
The sensor can run continuously or only when polled for data as an application requires. It can be run in the SYNC mode to measure either in phase or out of phase with other nearby networked sensors or to solve an interference issue.

Interval: Seconds

The measurement rate is adjustable by changing the interval between measurements. A sensor will run at that rate continuously, or if filters are being used, will accumulate samples at the interval spacing.

Activation Selection

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



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 (see SYNC modes, 27)

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

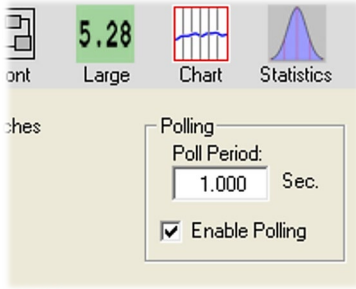
Start on Poll Activation

Measurement begins when the sensor receives a serial data distance read poll from an external controller (or SensorView™). Upon completing the *measurement process* the analog and switch outputs are updated, the distance measurement stored, and the sensor stops measuring. The data retrieved by the poll is that of the prior distance measurement.



TEACH and several filters are disabled in Start on Poll activation.

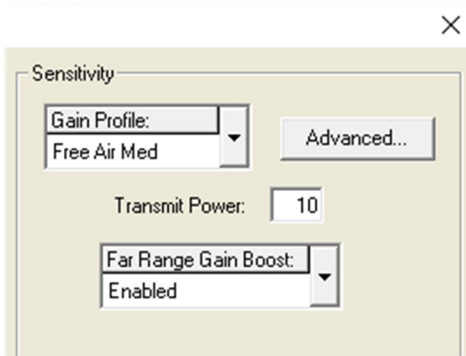
SensorView™ detects start-on-poll mode when the **Sensor** icon is clicked and displays polling controls in the upper right corner of the screen (below).



Be sure that your polling period is longer than the measurement interval set in the “Measurements” window. This can lead to inconsistent sensor connection and data retrieval.

Transducer Gain and Sensitivity

In the measurements window, these parameters are displayed in the top right corner of the window and are shown below:



Gain Profile: This parameter modulates the gain profile that is applied to the echo signal returning to the sensor. Echo intensity and clarity vary based on the environment the sensor is operating within.

Transmit Power: This parameter determines the gain applied to the transmit ultrasonic pulse.

Far Range Gain Boost: This parameter allows for the gain profile to boost echo returns of lower amplitude, or in other words, for targets that are approaching the maximum range of the sensor model.

Advanced: This option launches a dialogue that allows one to manually tailor their gain profile over distance.

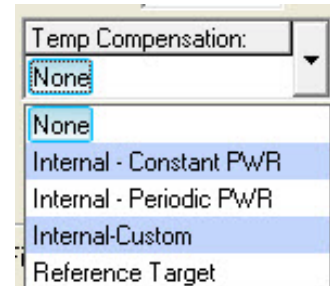
Temperature Compensation

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. These 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 SensorView™ >Measure > Temperature Compensation selector. 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.



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.



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

External Temperature Compensation Using RTTC

Reference Target Temperature Compensation (RTTC) is available in SensorView™ version 3.6.300 and higher. Your sensor firmware must be version v47 or higher which can be installed from SensorView™ 3.6.300 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 install an accessory reference target from BinMaster or utilize a target that is added to the sensor mount. 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

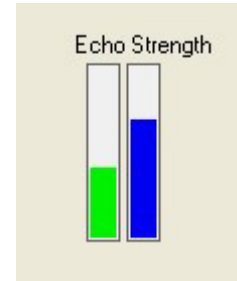
Once the reference target position has been calibrated in sensor memory, any deviation in its position later is attributed to a temperature effect on the speed of sound. The correction applied to the reference target distance is proportionately applied to the user target distance, thereby correcting 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, refer to the respective technical documentation for a given sensor. Accessory reference targets are available from BinMaster. A custom target can be installed at a non-standard distance. It must be carefully placed in the sound detection area, be a flat surface or curved, and if a rod it should be perpendicular to the sensor 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 is calibration using the RTTC calibration routine found in SensorView™.

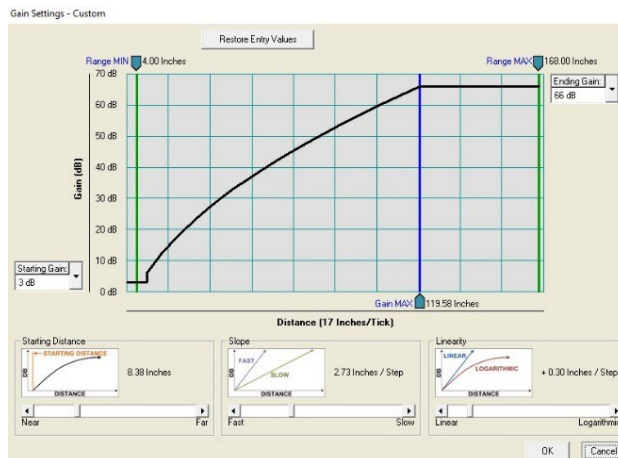
Step 1: Optimize the User Target echo.

When Reference Target Temperature Compensation mode is used, an additional echo strength indicator is displayed for the Reference Target in GREEN. If the Reference Target echo strength is low that bar turns RED and should be corrected by running a new calibration.



The sensor should be mounted in a secure way for calibration. A tape measurement must be made of the true distance from sensor 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 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 value is not correct it will be corrected in the next step.

Step 2: Calibration

Reference Target Calibration

Reference Target Validation

Starting Gain: 3 dB

Hi Limit:

Target:

Low Limit:

Limit Range (6.00 to 8.00 in)

Statistics:

Min: 7.97

Max: 7.98

Range: 0.01

Std Dev: 0.0028

Errors: 0

Reset

Goto Step 2 >>

Cancel

Start in Sensor view. Navigate to menu item *Sensor >Reference Target Calibration....* The first window is calibration 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*.

Reference Target Calibration

Distance Test

Reference Status:

87.00

Statistics:

Min: 86.99

Max: 87.05

Range: 0.06

Std Dev: 0.0091

Errors: 0

Reset

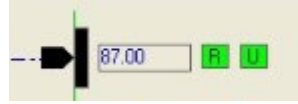
<< Return to Step 1

Finish

Cancel

In Calibration 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 in the far region.

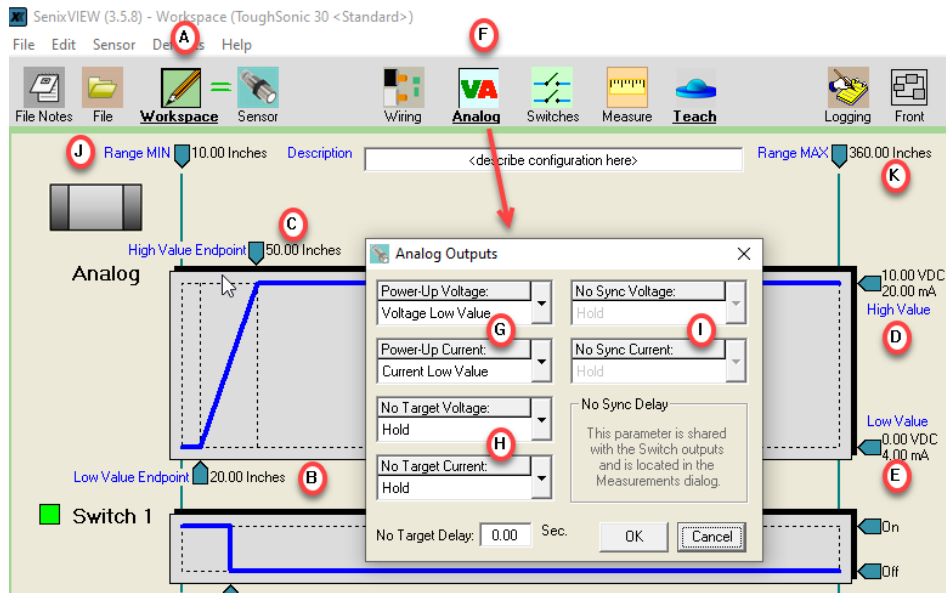
A significant improvement in measurement stability and accuracy is possible with Reference Target Temperature Compensation. Temperature changes, sunshine on the sensor, heating of tank interiors etc. do not affect the sensor measurement as they could with the internal compensation modes. Sensor installation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

Analog Options

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

SensorView™ Analog Adjustments

Use SensorView™ to tailor the sensor for the best results in the application. Analog features are shown above. The letters used below are keyed to this figure.



- a) Click the **Workspace** icon to edit parameters.
- b) *Low Endpoint*: Click the numeric value to set the distance of the low analog values (e).
- c) *High Endpoint*: Click the numeric value to set the distance of the high analog values (d).



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

- d) *High Value*: Click the numeric value to change the maximum voltage or current value. The voltage and current limits are independent.
- e) *Low Value*: Click the numeric value to change the minimum voltage or current value. The voltage and current limits 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) If this sensor is a synchronized slave (pg. 15) select the output values to be set if the master SYNC input is missing. These selections are grayed out if the sensor is not a slave.

- j) *Range MIN*: The closest distance the sensor will measure distance.
- k) *Range MAX*: The farthest distance the sensor will detect a target.

TEACH Enable / Disable



The TEACH feature is available on ToughSonic® 3 and 14 series. Once connected to SensorView™, the TEACH button will be displayed for these models.

The button can be disabled for security so that changes cannot be made at the sensor.

To disable the TEACH-button, click this icon. The left version of the icon shows TEACH enabled and the right version disabled. ***The button is disabled only after the configuration is moved to the sensor!***

Switch Options



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



Switch Outputs

In ToughSonic® series sensors the switch outputs must be selected using SensorView™. If selected, switch #1 is on the black wire and/or switch #2 on the white wire. In all other models they are permanently wired to the black and white wires as NPN type. In all models the switch type can be selected as either sinking (NPN), sourcing (PNP) or OFF using SensorView™ (pg. 18).

Switch Status & Output Voltage

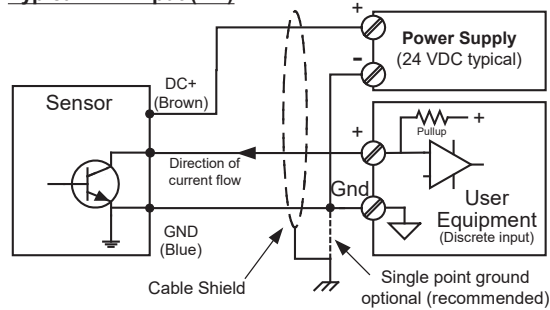
Switch outputs normally have a corresponding rear *output status* indicator (■ = #1, ■ = #2) that is lit when the switch is ON and vice versa. The indicators also provide warning of a safe shutdown under overload or over temperature conditions. They can, however, be reassigned using SensorView™ as mentioned on the previous page.

Sinking Switch Output

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 from the sensor.

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.

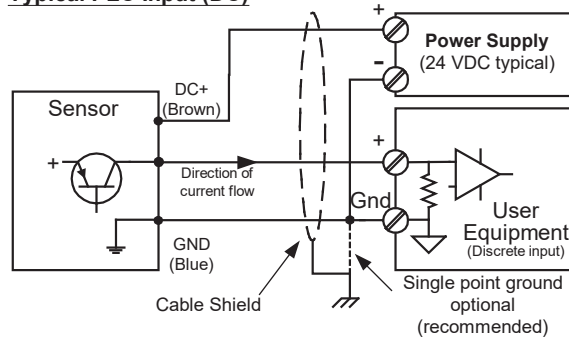
Typical PLC Input (DC)



Sourcing Switch Output

A *sourcing switch* provides current to an external load to turn that load ON or OFF as shown to the left. Current is sourced by the sensor’s power supply. 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.

Typical PLC Input (DC)



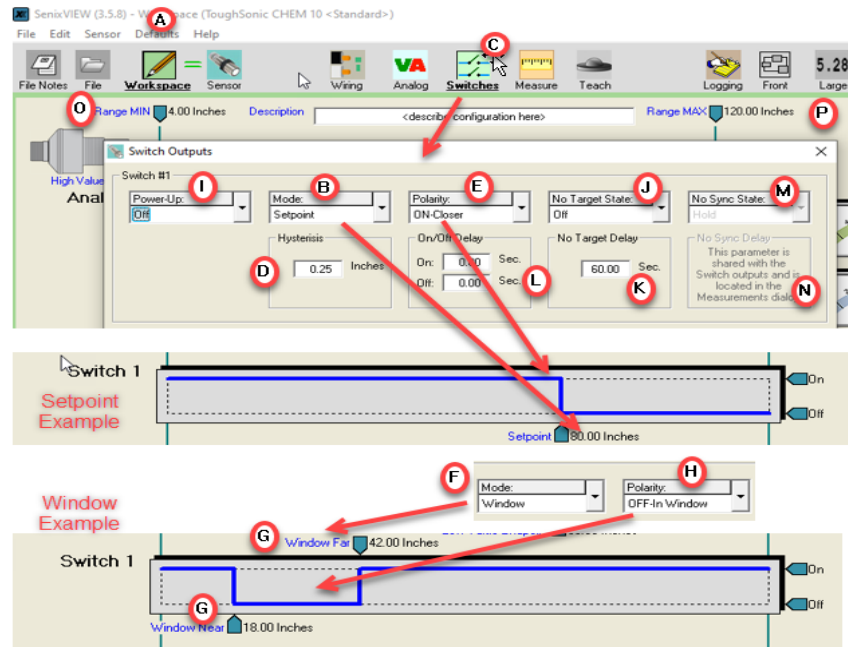
Switch Response Time

Switch response times are affected by measurement rate and filter selections. Any filters that delay the measurement output period will consequently reduce the response time of switches. Likewise, slower measurement rates will reduce switch response time.

SensorView™ 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.
- ❖ ON and OFF time delays for state changes
- ❖ No Target state and time delay
- ❖ Power-up state
- ❖ No SYNC states.



The letters used below are keyed to the figure above.

- 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 to become the *window far 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 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 period.
- m) If this sensor is a synchronized slave (pg. 27) select the output state to set if the master SYNC input is missing (**on**, **off** or **hold**, and after time delay (n)). These selections are grayed out when the sensor is not a slave.
- n) If the sensor is a synchronized slave, a time delay can be required before engaging the No Sync response (m). This delay is set in the **Measure** dialog since it also affects the analog outputs.
- o) *Range MIN*: The closest point the sensor will measure distance.
- p) *Range MAX*: The farthest distance the sensor will detect a target.

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 is all filters OFF, where the sensor outputs are set immediately in response to each measurement (not including any switch time delays).



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

Overview

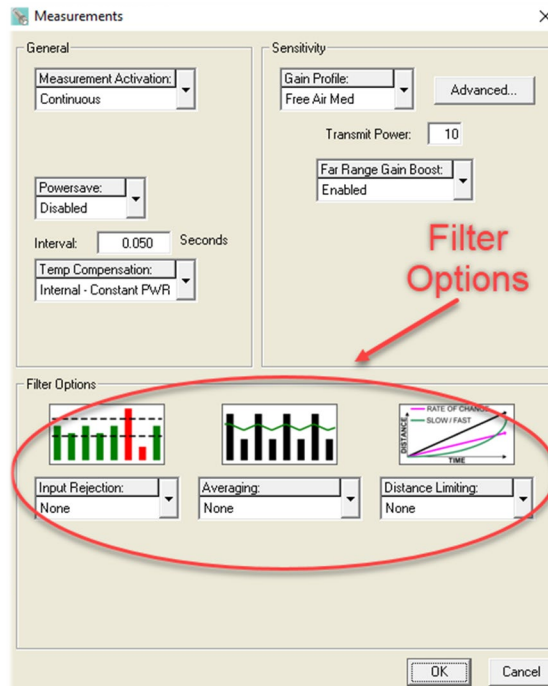
The figure on the following page shows the flow of distance measurements through the filters to the outputs. Filters are applied in order of flow from left to right (input to output). None or one selection can be made from each category (Input Rejection, Averaging and Distance Limiting). As filters are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

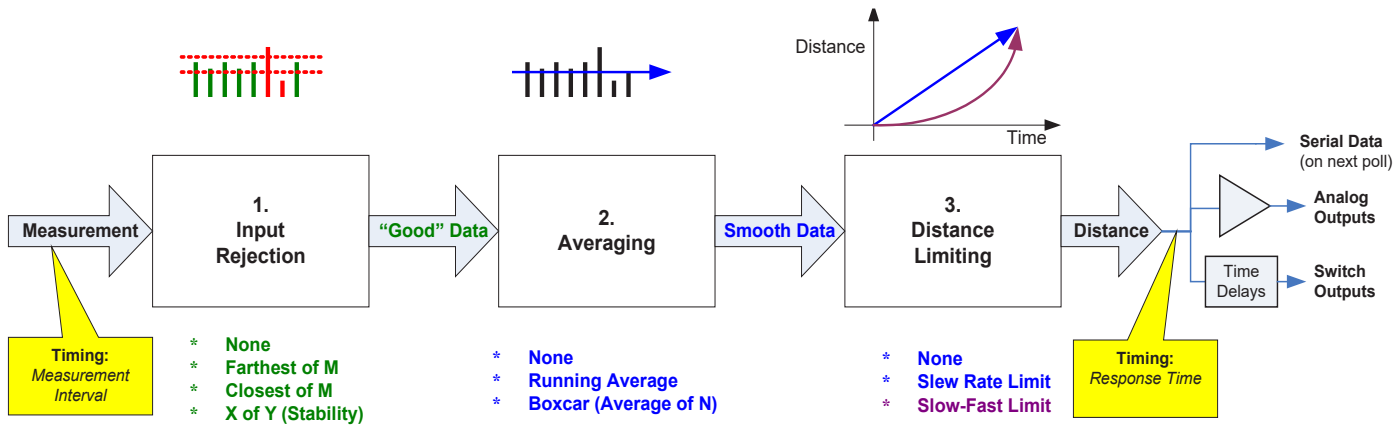
S SensorView™ Filter Selection

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



All filters are turned off when the sensor is unlocked (TEACH mode). 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.





Input Rejection Filters

As seen above, input rejection filtering precedes any averaging filtering. 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 an 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 each period. 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).

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 latest 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 (red target indicator). A perfectly detected target (green) may be in motion and thereby unstable.

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.

If 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. 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 $50 \times 3 \times 10 = 1500$ 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.

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. The limited distance then drives the sensor outputs (not including switch time delays).

Rate of Change

A maximum rate of change of distance (DD/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.

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 1 - Filter Response Time

Slow-Fast

In 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 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.

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
- ❖ Off Delay
- ❖ No-Target Delay

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).

Example uses include:

- ❖ Set an alarm if the sensor loses the target for an excessive 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

Analog outputs can be set to their high value, low value or not change if no target is detected. The current loop and voltage have independent selections.

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

Analog “No Target” time delay is configured in the Analog Outputs window. Example uses include:

- ❖ Force a system shutdown on loss of a target.
- ❖ Controller detection of no target by setting the output value outside the normal range

No SYNC Time Delay

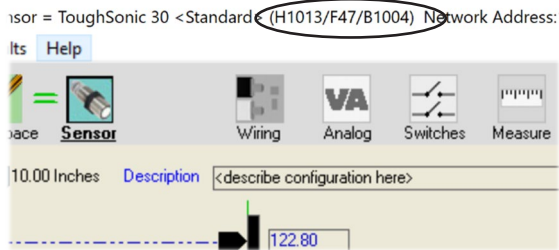
Under SYNC Slave activation (pg. 27) the slave sensor measurement is triggered by a master input. If that input is missing for a period exceeding the *No SYNC Time Delay* the switches and analogs are set to their “No SYNC” states and values respectively.

User Maintenance

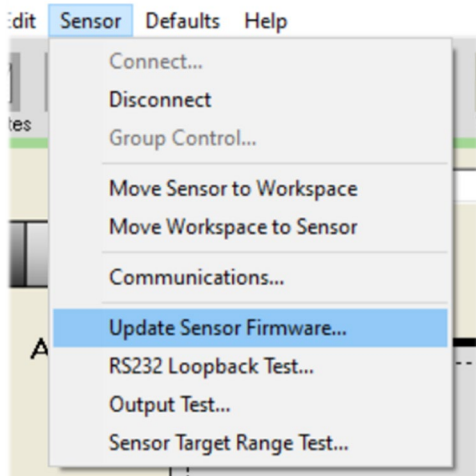
Updating Sensor Firmware

SensorView™ allows the user to update their respective sensors firmware as new firmware becomes available. It is always ideal to have the latest version of the firmware possible as small bugs or inconsistencies are corrected in firmware releases.

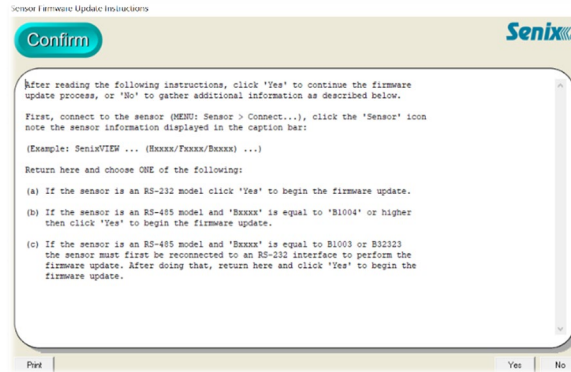
1. Begin with the sensor connected to SensorView™. In sensor view, take note of the information on the caption bar of the window, shown below.



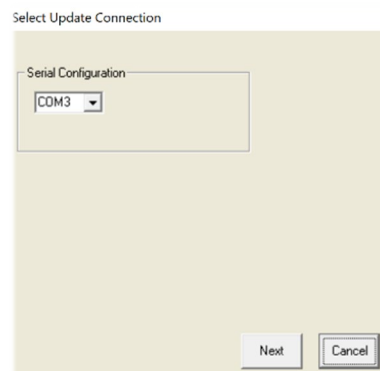
2. Then, disconnect the sensor by selecting **Sensor > Disconnect**.
3. Select the sensor dropdown menu from the top taskbar and select **Update Sensor Firmware...**



4. The window below will populate:

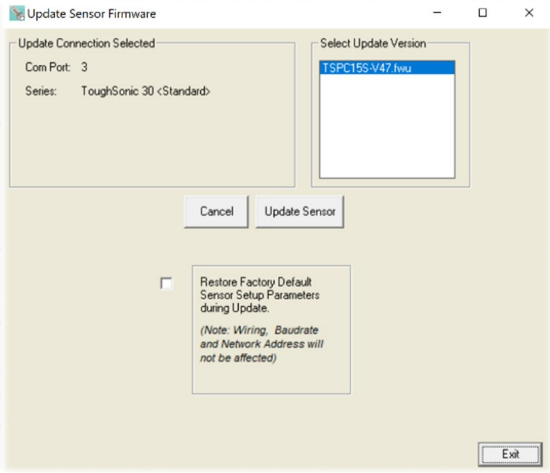


5. Follow the prompts:
 - a. If the sensor is an RS-232 model, click 'Yes' to begin the firmware update.
 - b. If the sensor is an RS-485 model and 'Bxxxx' is equal to 'B1004' or higher than click 'Yes' to begin the firmware update.
 - c. If the sensor is an RS-485 model and 'Bxxxx' is equal to B1003 or B32323 the sensor must first be reconnected to an RS-232 interface to perform the firmware update. After doing that, return here and click 'Yes' to begin the firmware update.
6. Select Update Connection, the following window will populate:

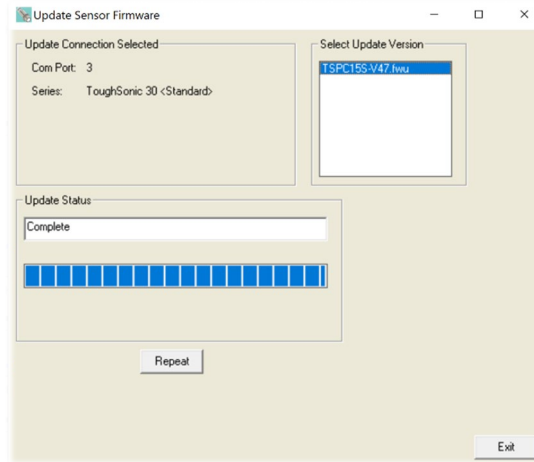


Select the COM port that the sensor was previously connected to in SensorView™.

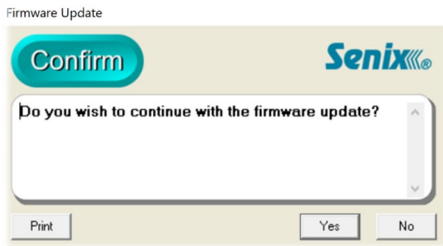
- In the following window, select 'Update' to begin updating the firmware. The checkbox 'Restore Factory Default Settings...' is selected to restore default sensor parameters during the update. Leave this unchecked if you like to retain the original sensor parameters.



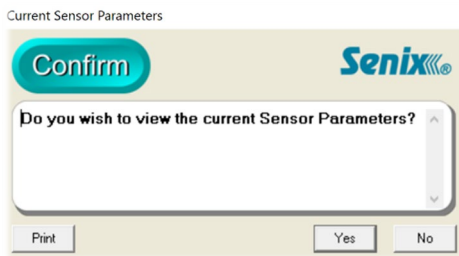
- The progress bar will display the progress of the update, and display 'complete' upon completion. Press 'Exit' to leave the Firmware update window.



- The following prompt will display, select 'Yes' to continue, 'No' to return to the Update Sensor Firmware dialog.

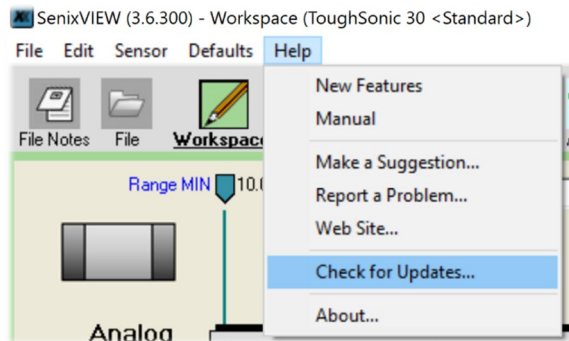


- SensorView™ will then present the following prompt. If you would like to see the active configuration for the sensor, click 'Yes', otherwise select 'No' to continue with the update.



Updating SensorView™

Within SensorView™, an updater is available to ensure that the most recent version of SensorView™ is installed. Click **Help > Check for Updates**. Here, SensorView™ will check for updates to sensor firmware while also checking for SensorView™ updates. Follow the following prompts to update SensorView™.



Serial Protocols

ToughSonic® sensors offer these protocol options:

1. **SYNC** – SYNC master and slave sensors use the serial interface for synchronization (pg. 27).
2. **Modbus Slave** – This default protocol is used by SensorView™ and supports sensor communications by address, typically in RS-485 networks.
3. **ASCII Streaming** – A simpler continuous ASCII protocol for one-way transmission of data to external devices (pg. 29).

The default parameters are 9600 baud, no parity, one stop bit (8N1), and sensor address 1.

Baud Rate Options

The baud rate in SensorView™ is adjustable to 9600, 19200, 38400, 57600 or 115200 baud. The slower 9600 baud rate is recommended for best performance over longer cables. The 115200 baud rate is only available if measurement activation is “Start on Poll”. The selected baud rate is used for all protocols (Modbus, ASCII streaming and SYNC).

Parity

The default parity is “none”. Sensors with V27 firmware or later will automatically change parity to even based on the incoming packet. One packet error will occur, then the sensor will operate on even parity.

Sensor Address

The default sensor address is 1. The address is SensorView™ adjustable from 1 to 247.

SensorView™ requires a correct sensor address to establish a connection. In general, leave the address at 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 serial RS-485 models).

A unique address is not required for SYNC groups; however, a SYNC group can also be an addressable network when the SYNC Master is turned off. SensorView™ includes a *Group Control* feature to disable the SYNC Master to allow sensor reconfiguration and/or monitoring, then re-enable the Master and resume.

Changing Communications Settings

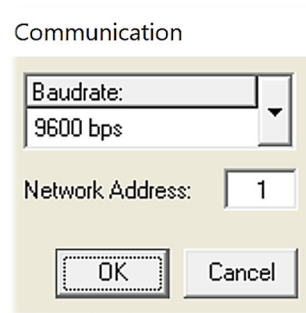
A single sensor in the factory configuration, wired to either an RS-232 or RS-485 interface, connects to SensorView™ using the default serial parameters.



*Serial data parameters are not affected by selecting the factory default configuration (menu: **Workspace – Default Settings**)*

If multiple sensors are connected into an RS-485 network each must be assigned a unique network address. The baud rate and address are changed in SensorView™ as:

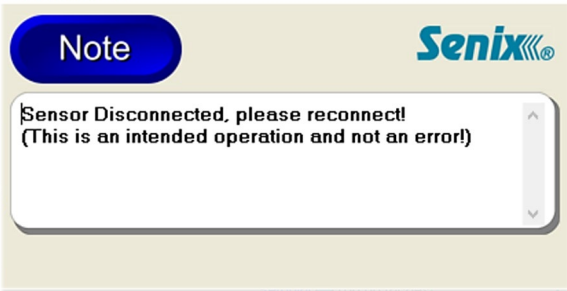
1. Connect to the sensor (menu: **Sensor – Connect**), described on pg. 3.
2. Select the communications parameters (menu: **Sensor – Communications**) and see:



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

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

Communications



- All sensors must use the same Baud rate.

SensorView™ Network Connect

SensorView™ is fully functional when connected to a single ToughSonic® sensor on an RS-485 network (menu: **Sensor – Connect**). Simply enter the correct baud rate and network address to establish the connection.

SensorView™ Group Control

SensorView™ can update selected parameters quickly to a group of RS-485 connected sensors using menu: **Sensor – Group Control**. When Master SYNC is turned OFF (lower left), the group is scanned, and a list of connected sensors produced. Selected parameters can then be written to selected sensors.

First, enter the parameter values to transfer into the Workspace, disconnect the current sensor, and then

select menu: **Sensor – Group Control** to produce the following control dialog below:

Click Scan to initiate a sensor search of all network addresses. Master SYNC must be OFF to search. Use the buttons in the lower left of the dialog to control the Master Synch. 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*. 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) then click *Write* to begin the batch transfer.

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

Group Control



Sensor Synchronization

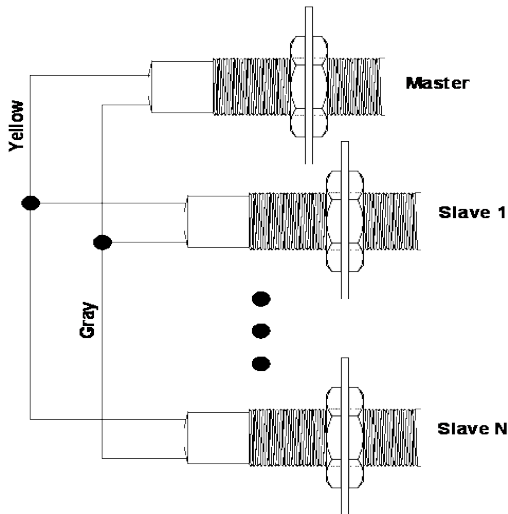
Groups of 2 to 32 sensors can be connected and time synchronized for these purposes:

- ❖ Prevent sensors in proximity from interfering with one another (“crosstalk”)
- ❖ Enable a group of sensors to measure a common target(s) at the highest possible rate.

This guide continues past sensor synchronization at pg. 29.

The symptom of sensor interference is an output (*analog* or *switch*) jumping intermittently but usually somewhat periodically to a value or state representing a target closer to the sensor than the actual target. This symptom may disappear or be less severe when filters are used (pg. 19). If interference is suspected, turn power off to all but one sensor to determine if the powered sensor’s output stabilizes (keep filters off).

A SYNC group is created by connecting all yellow wires of all sensors, then all gray wires of all sensors, as shown below (the power, analog and/or switches are wired as required for the application). One (and ONLY one) sensor is defined as Master and all others as Slaves.



Master and slave assignments can be set in advance in the SensorView™ *Measure* dialog (pg. 11).

SensorView™ must be used to (a) set a master to generate 1, 3, 4 or 5 *SYNC* phases (the default is 2), or (b) to set a slave to phase 3, 4 or 5 (see following).

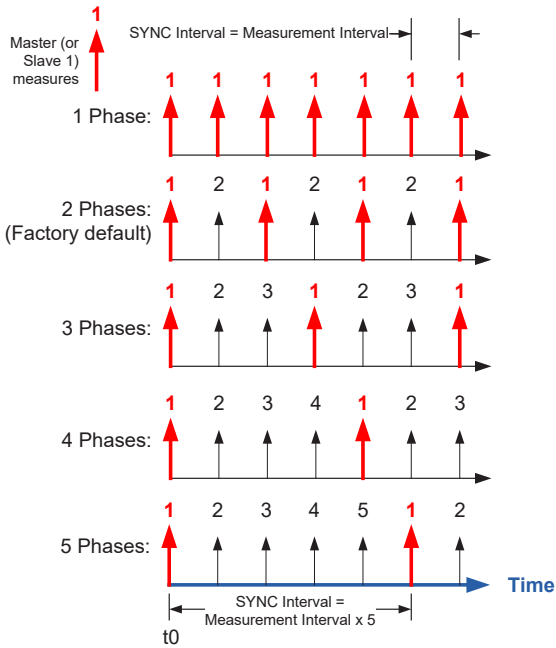
Master sensors cannot communicate with SensorView™ until *Group Control* turns off the master. However, analog and switch outputs remain active on all sensors in SYNC mode grouping. Group Control is found in SensorView™ under the Sensor pull-down menu.



Master measurements repeat continuously at the *sync interval* which is the *sync phases x measurement interval* (next page).

Slave measurements are similarly affected but offset in time according to their phase assignment (1 through 5). The *sync interval* increases as the number of *sync phases* increases, therefore slowing the *measurement process* timing for all sensors in the group.

With a master in 1-Phase and slaves in slave phase 1 all sensors operate simultaneously as shown in 1 phase below. When the master is in 2 through 5 phases, each slave must be set for phase 2, 3, 4, or 5. Do not set a slave phase higher than the number of phases of the master or it will not operate.



SYNC and serial data communications cannot occur simultaneously. Removing the master re-enables communications.

If the master input is missing the slave sensors stop measuring, begin flashing the *target indicator* red/green as a warning, and after the *no sync delay* time set analog outputs to their *no sync values* and switch outputs to their *no sync states*. These conditions reverse when SYNC is reestablished.

SYNC Master and Slave Activation

Using the Measurement Activation drop down menu (pg. 11) configure one master to the desired number of SYNC phases, and each slave sensor to its required phase. The master's serial data interface is used only to control slave sensor timing and no distance data is transmitted or available to SensorView™. Sensor analog and switch outputs continue normally in SYNC mode, including from the master.

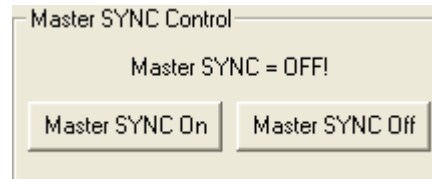
Hints & Recommendations:

- ❖ Setup and test each sensor in SensorView™ before selecting SYNC and connecting it to the SYNC group.
- ❖ After setting SYNC activation, ToughSonic® serial RS-232 slave models lose communications with the SensorView™ PC because the serial interface changes to RS-485. To restore communications, disconnect the sensor from the SYNC group, use TEACH 15 to turn SYNC off, and reconnect to the PC using RS-232 equipment.
- ❖ With an RS-485 PC connection, SensorView™ can communicate with an operating SYNC group using the **Sensor – Group Control** menu selections. To allow this ability each sensor in the group must be assigned a unique network address (**Sensor – Communications** menu) before connecting it to the SYNC group.

SYNC Group

Regardless of the model, when ToughSonic® sensors are connected in a SYNC group the communications interface operates as RS-485. With an RS-485 connection, SensorView™ can communicate with the sensors using **Group Control** (pg. 26).

In a SYNC group one sensor operates as a master control. The master must be shut down



before SensorView™ can take control. SensorView™ will automatically detect an active SYNC master and provides the following indication and controls:

If a Master is detected, click “Master SYNC off” then confirm the status as “No Active Master!” to enable the **Group Control** features. When finished, click “Master SYNC On” to restore SYNC operation.

Serial Protocols Continued

The ToughSonic® sensors and SensorView™ use the industry standard Modbus RTU protocol for all serial data bus communications except SYNC. Other user controllers can use this interface to obtain distance measurements, switch and analog status, temperature, Target quality, and scale factors. Request document ToughSonic® *Serial Communications Formats*. A brief description follows.

The sensor determines distance in Counts which are held in registers and used by SensorView™ or the user's own program. A register is now available that shows the current measurement in millimeters regardless of sensor model, product ID, or scale factor.

ASCII Streaming Protocol

A ASCII protocol is also available that transmits an ASCII string after each measurement under continuous measurement activation. This can be used for input to displays or other devices. Use SensorView™ to enable this protocol in menu item **Sensor > Connect > Advanced features** to switch between ASCII streaming and Modbus protocols.

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 Telnet 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 shown on pg. 30. For example, if the count value from a TS 14 sensor is 05251, the distance is calculated as $5251 \times 0.003384 = 17.77$ inches.

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 ***

**($C \times 10$) (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)

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 SensorView™ to make configuration changes. Request document ToughSonic® *Serial Communications Formats* for more information.

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

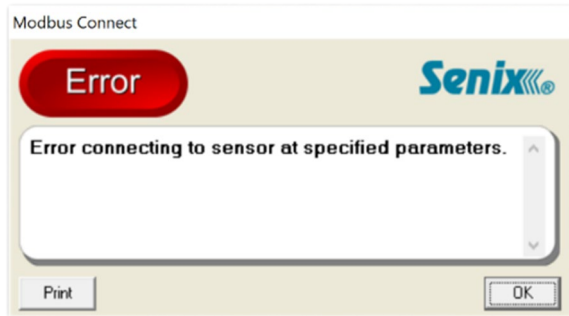
Product ID	Sensor
1000	TS-100.14
1002	TS-100 14 Serial Only
3000	TS-100.30
3002	TS-100 30 Serial Only
4000	TS-100.50
4003	TS-100 50 Serial Only
4002	TS-100 50P
4006	TS-100 50P Serial Only
1008	TS-200.14
1009	TS-200.14 Serial Only
3001	TS-200.20
3003	TS-200.20 Serial Only
4001	TS-200.35
4005	TS-200.35 Serial Only

Scale Factors				
Sensor type	in/count	ft/count	mm/count	cm/count
TS-100.14				
TS-200.14	.003384	.000282	.085954	.008595
TS-100.30				
TS-200.20	.006768	.000564	.171907	.017191
TS-100-50				
TS-200.35	.013536	.001128	.343814	.034381

Troubleshooting

Sensor Connection

If the following message appears check the (a) wiring, (b) power and (c) interface selections. Check **All Ports** or **All Baud rates** and use **Find Sensor** to scan all sensor addresses. SensorView™ will identify the first sensor found.



Loss of Target Response

ToughSonic® sensors need an echo from an object or liquid surface to make measurements. When the echo is missing the sensor responds according to its configuration. Since ToughSonic® sensors have multiple outputs, there are several types of response possible at a loss of target echo. For analog current loop or voltage output (4-20mA or 0-10v), the response choices include:

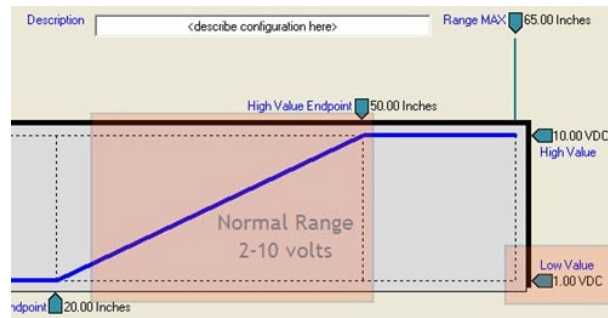
- ❖ Goes to the highest level.
- ❖ Goes to the lowest level, or
- ❖ Holds the last level.

For switches the response choices include:

- ❖ Force the switch to ON.
- ❖ Force the switch to OFF, or
- ❖ No reaction

For Modbus polled data or ASCII streaming output, a distance measurement of 00000 signifies no echo was received. A time delay can be used before the analog or switch reaction occurs.

ToughSonic® general purpose sensors have a status LED that is GREEN or RED any time the sensor is powered. GREEN means an echo was received on the last cycle while RED means no echo was received.



The output levels or switch states are maintained in the response position for as long as the echo loss persists. That steady output might be missed or not interpreted as a no echo response. A switch that controls a valve or motor might activate incorrectly when the echo is lost. A way to monitor for the presence of target echo is desirable.

ToughSonic® sensors have multiple outputs, so they offer three possible methods:

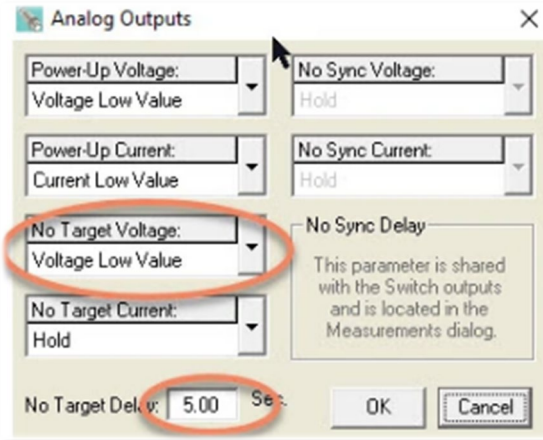
1. Set the analog range endpoints wider than the expected measurement range and respond with a maximum or minimum value when loss of echo occurs (after an optional delay)
2. Set one switch to monitor over the whole operating range and configure it to react only to a loss of target echo (after an optional delay)
3. Respond to a digital counts value of zero as a loss of target echo.

In method #1 above, the analog output may only reach 6-18mA normally. Then a Loss of Target response might be to go to 4mA or 20mA. A PLC would be set to interpret that as a missing echo situation.

In method #2, if the full 0-10v or 4-20mA range is needed, a switch is configured to respond only to a Loss of Target event. It is a handy feature to use while also taking analog 4-20mA or 0-10v from the sensor. Configure it to either go to ON or OFF as appropriate upon a loss of target. The user knows the echo status independent of the other outputs, and he can use the switch to light an indicator.

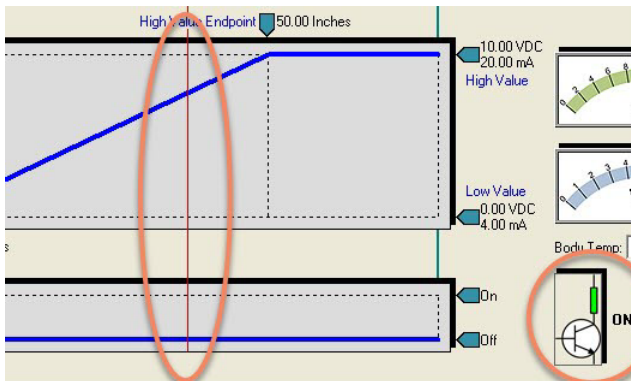
Method #1 example is below. The analog response to loss of echo is configured to go to the low value after 5 seconds of no echo. Low value is outside normal analog range used.

Endpoints set wider than expected operating range. Output goes to Low Value if target echo is lost. One volt chosen for confidence.



Analog setup for Loss of Echo after 5 seconds:

A method #2 example is below. Full analog range is needed. The analog loss of echo response it to hold the last value, and a switch monitoring the echo goes ON after 10 seconds of no echo. This can be used to control an alert light. The Analog holding last value when echo was lost while switch #1 went active at loss.



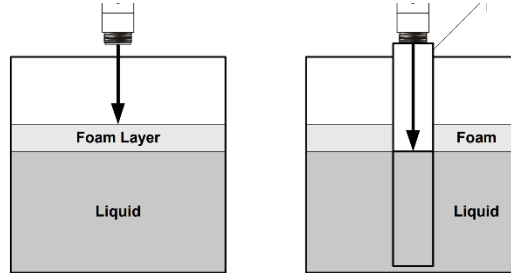
Detecting Liquid Surface Under Foam

In general, if there is a foam layer on top of a liquid surface an ultrasonic sensor will detect the surface of the foam rather than the liquid surface. This is not a problem in many applications, but if it is important to detect only the liquid surface this can often be accomplished using a standpipe as shown in the figure below.

The sensor is mounted to the top of a standpipe and the sound travels down the tube until it reaches the liquid surface. The standpipe must be vented to atmosphere at the top to let the air out as the liquid surface rises. The liquid will rise in the standpipe to match the level outside of the standpipe. The foam should not be present inside the standpipe.

Some things to keep in mind when using a standpipe:

1. Since the sound remains inside the tube the ultrasonic energy is higher than needed. It may be necessary to turn down the sensor gain (sensitivity).



Most sensor models have an adjustable gain potentiometer (refer to the sensor's installation instructions).

2. The ultrasonic energy will bounce several times inside the tube. At longer distances it may be necessary to increase the measurement interval (slow down the measurement process) so that the measurement echo from the prior measurement has disappeared by the time of the current measurement.
3. If the liquid rising and falling leaves a residue inside the standpipe, that residue may form a ring that may eventually be detected by the sensor when the liquid level is below the ring. This will prevent the sensor from detecting liquid levels below the residue. Reducing the gain may help or cleaning the pipe.
4. If for some reason the foam accumulates inside the standpipe, this approach will not work