How advanced software reduces Ultrasonic Sensor set-up time and cost

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Simply easy!

Telemecanique
Sensors

Ultrasonic Sensor Technology: An introduction

An ultrasonic sensor is an electronic device used to measure the distance to a target by emitting ultrasonic sound waves. This is the same technique animals such as bats and dolphins use: They send out ultrasound waves and use their echoes, or reflected waves, to identify the locations of objects they cannot see (Figure 1 on opposite page).

The ultrasonic sensor is made up of two parts (See Figure 2):

1) the transmitter: which sends controlled ultrasonic sound bursts, and
2) the receiver: which encounters the signal reflected from the object.

To calculate the distance to the object, the sensor measures the time it takes between the emission of the signal to its contact with the receiver. This measurement is called the Time of Flight (TOF).

Splitting the total Time of Flight in half allows a proper measurement of the distance to the object. The calculation can be indicated by:

$$d = \frac{t \times v}{2}$$

d: Distance between the object and the sensor
t: Time between emission and reception of signal
v: Velocity of sound waves in air (in meter per second)

If an engineer set up an ultrasonic sensor aimed at the side of a conveyor and it took 0.005 seconds for the sound to bounce back, the distance between the ultrasonic sensor and the side of the conveyor would be: d = 0.005 x 343 / 2, or about 0.8575 meters (343 is the speed of sound traveling through air in meters-per-second). Any signal calculation with a distance less than this would indicate a box or other object on the conveyor.

"An ultrasonic sensor is an electronic device used to measure the distance to a target by emitting ultrasonic sound waves."

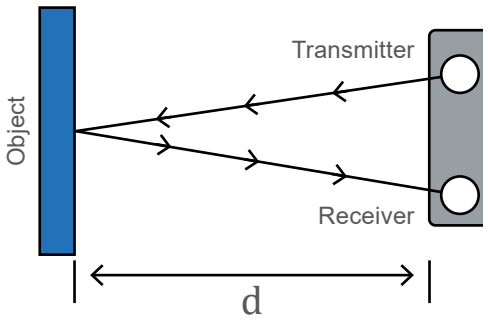


Figure 2

Ultrasonic Sensors are made up of two parts: the Transmitter and the Receiver. The "d" represents the distance from the sensor to the object.

Figure 1

Bats and Dolphins send out ultrasound waves and use the echoes to identify the locations of objects they cannot see.

As with any detection technology, Ultrasonic Sensors have specific advantages and limitations. The significant advantages of Ultrasonic Sensor technology include its ability to reliably detect almost any type of object, whether metallic, non-metallic, transparent, or liquid, at distances up to 8 meters (See Figure 3).

Ultrasonic Sensors can detect complex targets (such as mesh) and can function in dirty, misty, or corrosive environments. They are not affected by bright lights or darkness. Ultrasonic Sensors provide the flexibility to set-up and control different variables like sensitivity, burst count, and thresholds, making it a viable solution for innumerable detection applications (See Figures 4, 5, and 6 on opposite page).

The limitations to using Ultrasonic Sensors (within the standard 8 meter range) include an inability to measure through physical barriers such as a plastic wall or pipe. Ultrasonic Sensors cannot operate in a vacuum and are affected by high temperatures and/or background noise. Considering sound does not travel as fast as light, their response rate is relatively slower than that of photoelectric sensors. Ultrasonic Sensors are not ideal for high-risk applications where safety is critical.

Finally, even when these few limitations are not present and circumstances dictate Ultrasonic Sensors as the most appropriate solution, the remaining limitation is the installation and set-up time typically required. Ultrasonic Sensors installations usually require a relatively complex process which includes setting the near and far distances, adjusting sensitivity and thresholds, and eliminating interference for each individual sensor.

It is this specific limitation that Ultrasonic Sensor manufacturers have targeted to further enhance the viability and favorable cost of Ultrasonic Sensor technology.

"Ultrasonic Sensors can reliably detect almost any type of object at distances up to 8 meters."

Figure 3

A diagram representing the sensing range of Ultrasonic Sensors.

Figure 4

Airports use Ultrasonic Sensors to detect baggage on conveyor belts.

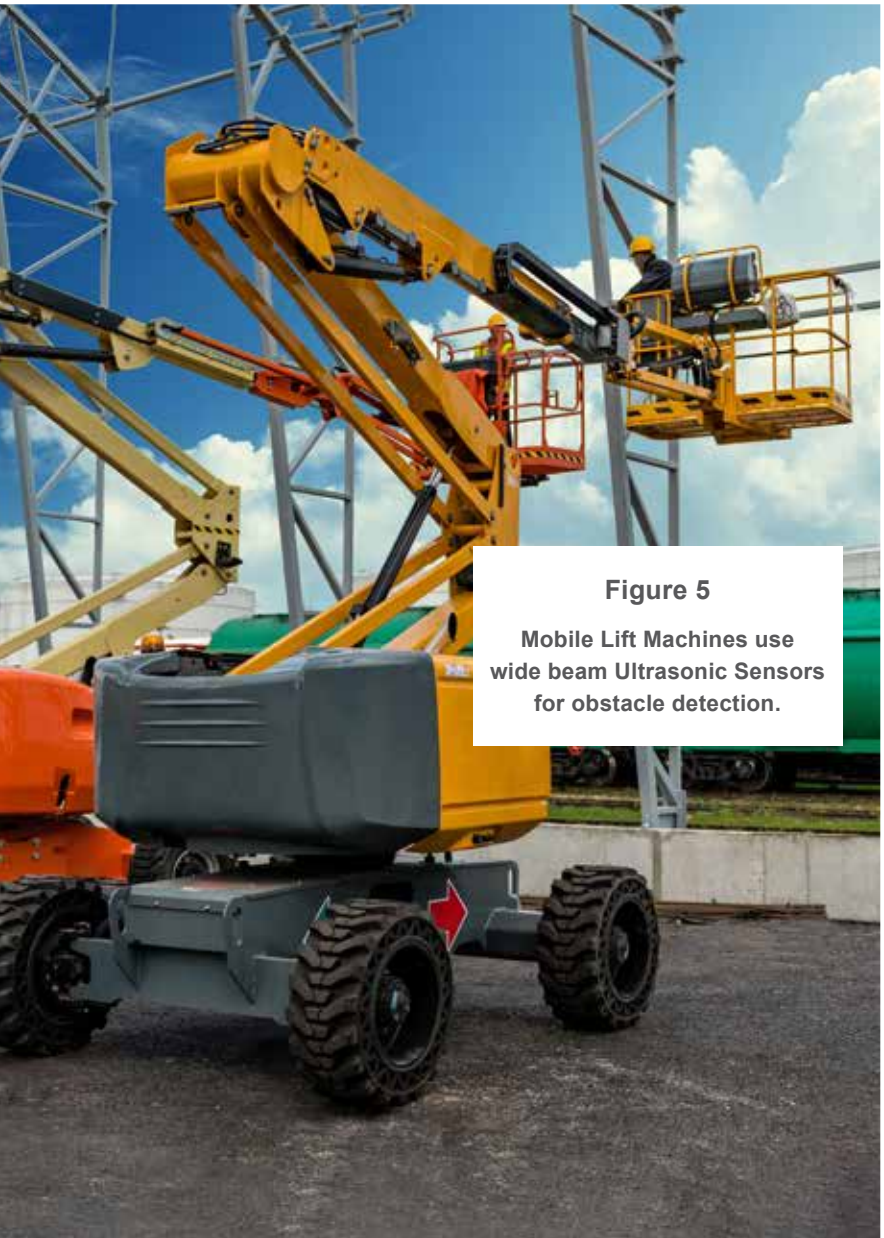


Figure 5

Mobile Lift Machines use wide beam Ultrasonic Sensors for obstacle detection.

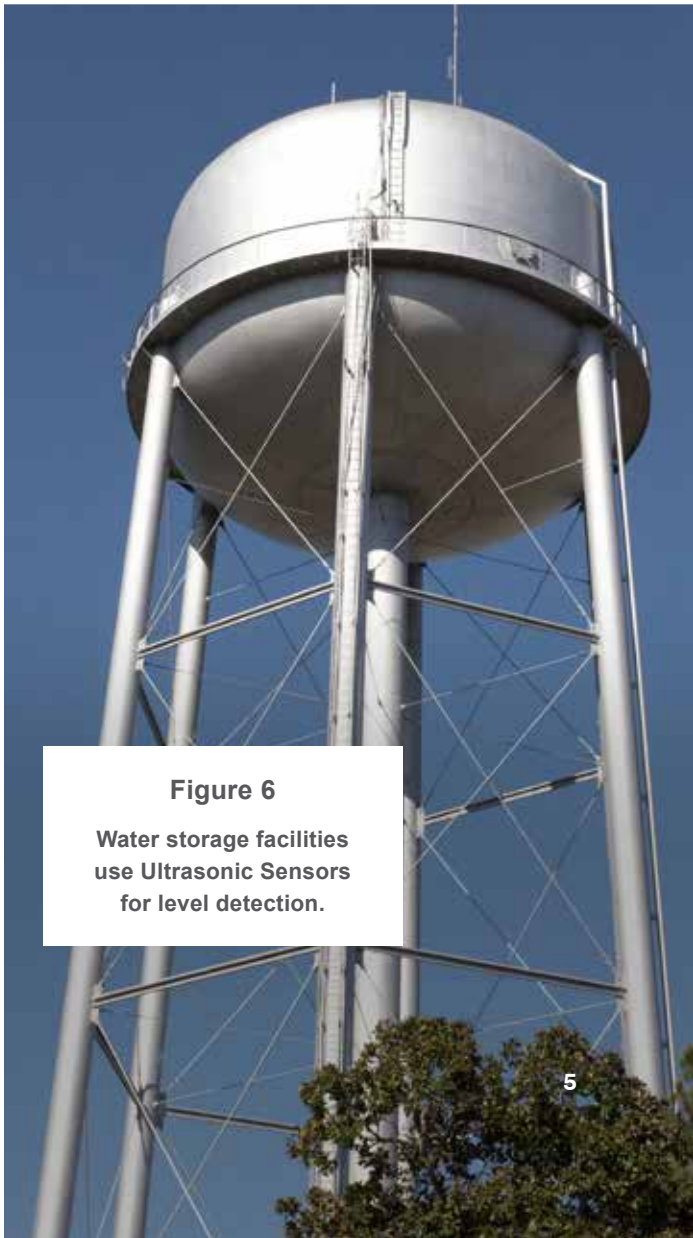


Figure 6

Water storage facilities use Ultrasonic Sensors for level detection.

The value of time

In the world of automated production, time is money. The most profitable automation systems are typically found in companies continually uncovering methods to minimize maintenance and unplanned downtime.

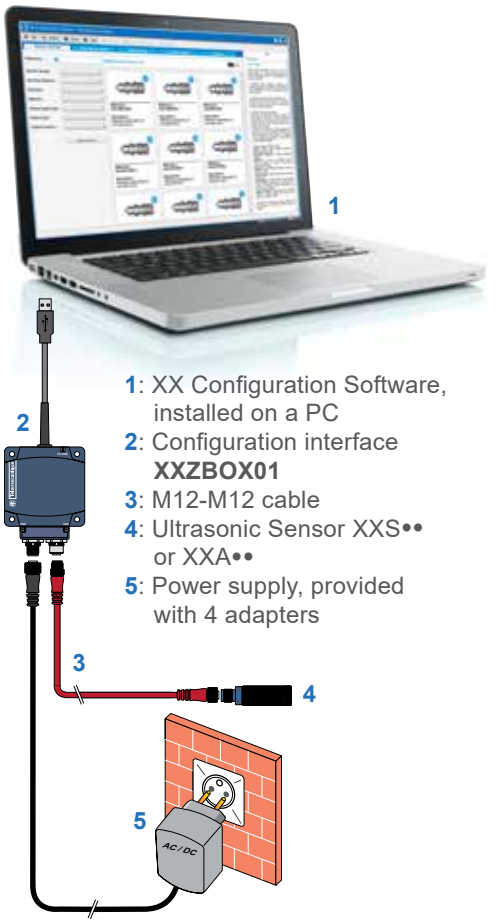
For optimized profitability, the machines *must* keep running.

With this concept in mind, industry-leading Ultrasonic Sensor manufacturers are not only focusing on sensor effectiveness and reliability, but on the speed and efficiency with which they can be installed and configured. They have realized even top performing Ultrasonic Sensors can become a liability if the process to install or replace them causes excessive downtime.

An effective solution is using advanced software to configure ultrasonic sensors (See Figure 7). With the proper software application, considerations unique to ultrasonic sensor technology can be easily addressed and optimum settings can be quickly set and retained for future replacement sensors. With advanced software, the user can set the near and far distances for all the connected sensors (regardless of range), they can quickly copy the configuration of one sensor to another, they can synchronize multiple sensors, and they can perform diagnostic functions to quickly identify issues with any of the connected sensors. It virtually eliminates the common installation limitation typically associated with the technology.

The following sections explain how advanced software assists with each of these tasks and how it vastly improves upon and reduces the cost compared to traditional processes.

"For optimized profitability, the machines must keep running."



1: XX Configuration Software, installed on a PC
2: Configuration interface **XXZBOX01**
3: M12-M12 cable
4: Ultrasonic Sensor XXS•• or XXA••
5: Power supply, provided with 4 adapters

Figure 7

The above diagram depicts the connection of an XXS or XXA Telemecanique Sensors Ultrasonic Sensor to a laptop using advanced software.

Setting near and far distances

In the past, setting the near and far distances for an ultrasonic sensor required physical objects to be placed in front of the sensor beam and a manual accessing of the sensor's programming interface. This interface was typically some type of push-button system with varying levels of complexity based on the sensor brand. The detection industry's movement towards software-based programming was an initial step towards efficiency and increased installation speed.

While using software to set near and far distances has been going on for some time, one caveat to this functionality is understanding that ultrasonic sensors with different ranges often come with different software platforms. An ultrasonic sensor with a 4m range may come with unique configuration software, while an ultrasonic sensor with an 8m range will come with a different configuration software. Not only does this prohibit transferring some of common settings between the two sensors, but it requires logging into two different platforms to configure some of the very same settings! Advanced ultrasonic sensor software addresses all the ranges of the connected sensors through the same interface, eliminating the redundancy of multiple software applications.

One example of how this benefit works is a facility that must continually monitor and maintain the water level in each of its large tanks [See Figures 8 & 9]. The far distance setting on the ultrasonic sensor measures when a pump needs to start filling the tank and the near setting measures when the pump should shut off.

This water management facility installed XX Ultrasonic Sensors from Telemecanique Sensors, a sensor company providing an advanced software platform along with their Ultrasonic Sensor range [see Figure 10]. Using this advanced software system, the water management facility was able

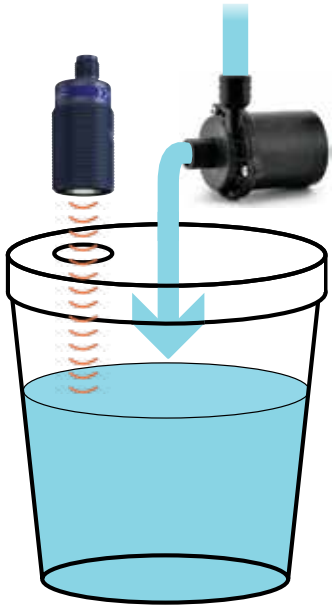


Figure 8

Diagram of a water tank for a company that must continually monitor the water levels using the process illustrated above.

Figure 9 (opposite page top)

Multiple water tanks requiring a consistent method of water level detection for each one.

Figure 10

Telemecanique Sensors' XX Ultrasonic Sensor, which can be provided with FREE, advanced configuration software.

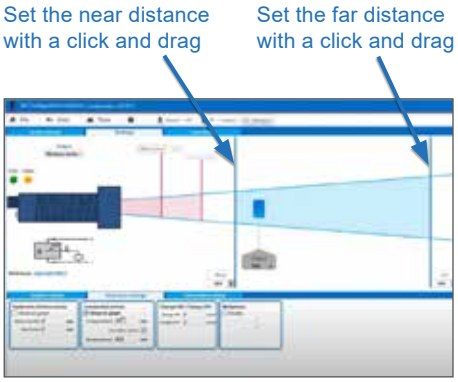


Figure 11

The Telemecanique Sensors XX Ultrasonic Sensor software interface. The advanced software allows the setting of near and far distances for all ranges in the XX line by simply clicking on the appropriate line and dragging it to the appropriate position.

to rapidly set the near and far distances by simply clicking a software interface line and dragging it to the appropriate distance setting [See Figure 11]. The target in the middle of the screen allowed the company to quickly test the output of the sensor. The water management facility was able to implement this rapid process on Ultrasonic Sensors with a 4m range and on Ultrasonic Sensors with an 8m range. Only an advanced software system allows this process regardless of the presence of Ultrasonic Sensors with different detection ranges.

This time-saving measure was further magnified once the near and far distance settings of those initial Ultrasonic Sensors were finalized. This introduces us to the second advantage of an advanced software platform:

Copying configurations from sensor to sensor

The second benefit to using advanced software for ultrasonic sensor configuration begins when the configuration of the first sensor ends. With all the sensors connected to one software application, the settings from one sensor can be quickly copied to each subsequent sensor performing the same function (See Figure 12). The Telemecanique Sensors advanced software for the XX Ultrasonic Sensors, mentioned in the previous section, comes with this feature.

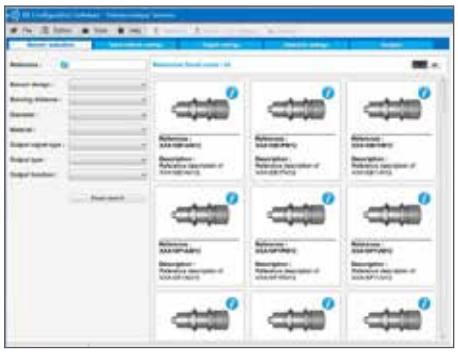


Figure 12

The Telemecanique Sensors XX Ultrasonic Sensor software allows the user to copy the settings of one configured sensor and apply them to other sensors.

The significant advantage of this feature can be applied to the Water Management Facility in the previous section. Once the near and far limits are established for a sensor in one tank, those settings can be quickly copied and applied to another sensor performing the same function in a different tank.

The best part is that these settings – once established – will be retained; not only so they can be copied to sensors performing the same functions in other areas of the application, but so the eventual replacement sensors in each location can be quickly updated with the established settings.

The settings for the four cage-mounted sensors in Figure 13 will be virtually identical and can be easily duplicated, while the settings for all five sensors, once defined in the software, will make replacing those sensors fast and efficient. As long as the parameters of the application remain the same, installing replacement sensors is a quick copy and paste of existing settings, rather than a repeat entry of the same configuration.

Figure 13

A mobile lift machine using multiple wide beam ultrasonic sensors.

The advanced software reduces time and, therefore, cost from the initial near and far distance configurations. It then reduces time and cost for like sensor set-up and replacement. But advanced software also makes a significant difference when addressing those issues unique to ultrasonic technology, which leads to our next advanced software benefit:

Synchronizing multiple ultrasonic sensors

One of the important considerations when using ultrasonic technology is the fact that ultrasonic sensors placed in proximity to each other can generate “cross-talk,” a scenario where the multiple signals begin interfering with each other resulting in detection errors [See Figure 14].

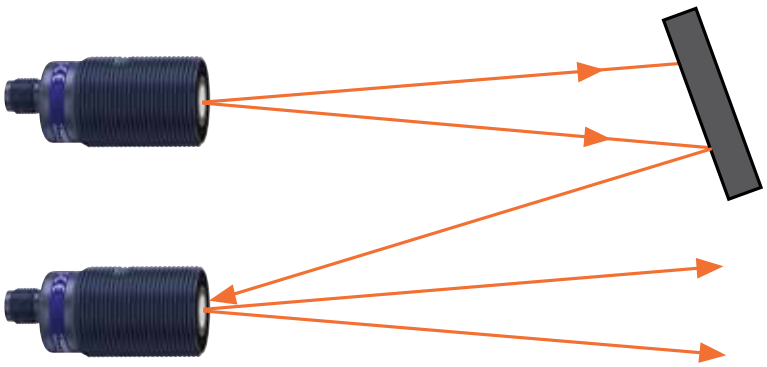
This hurdle to reliable detection when using multiple ultrasonic sensors can, at times, take an extensive amount of trial and error. In the past, slight adjustments would have to be made to each sensor’s settings, followed by involved testing. In most scenarios, this process had to be repeated numerous times until the exact, interference-free settings could be determined.

An advanced software application for Ultrasonic sensors, such as the Telemecanique Sensors software, can significantly minimize this involved synchronization process. Once all the closely placed ultrasonic sensors are connected to the advanced software application, the software will automatically account for the proximity of the sensors. While some slight adjustments may be necessary, ensuring approximately 1 to 2 meters between the sensors, the set-up time is significantly reduced. Multiple testing exercises are eliminated because the advanced software accounts for and identifies any issues.

“The advanced software reduces time and, therefore, cost during the initial configurations, then reduces time and cost for like sensor set-up and replacement.”

Figure 14 (below)

An illustration showing “cross-talk,” a scenario where an ultrasonic sensor placed in close proximity to another sensor can interfere with its signal.



One example application where the cross-talk of ultrasonic sensors had to be eliminated is in a factory that uses automated carriers to transport materials [See Figure 15]. In this scenario, the units are equipped with ultrasonic sensors to avoid transport collisions. With multiple carriers traveling into innumerable positions, manually accounting for and testing each carrier's possible positioning would be almost insurmountable. Having the advanced software account for each connected sensor's position – and the potential interference with other connected sensors – lifts a large burden (and expense) from the set-up process!

This leads us to our final, highlighted benefit of advanced Ultrasonic Sensors software.

"Having advanced software account for each connected sensor's position lifts a large burden (and expense) from the set-up process."

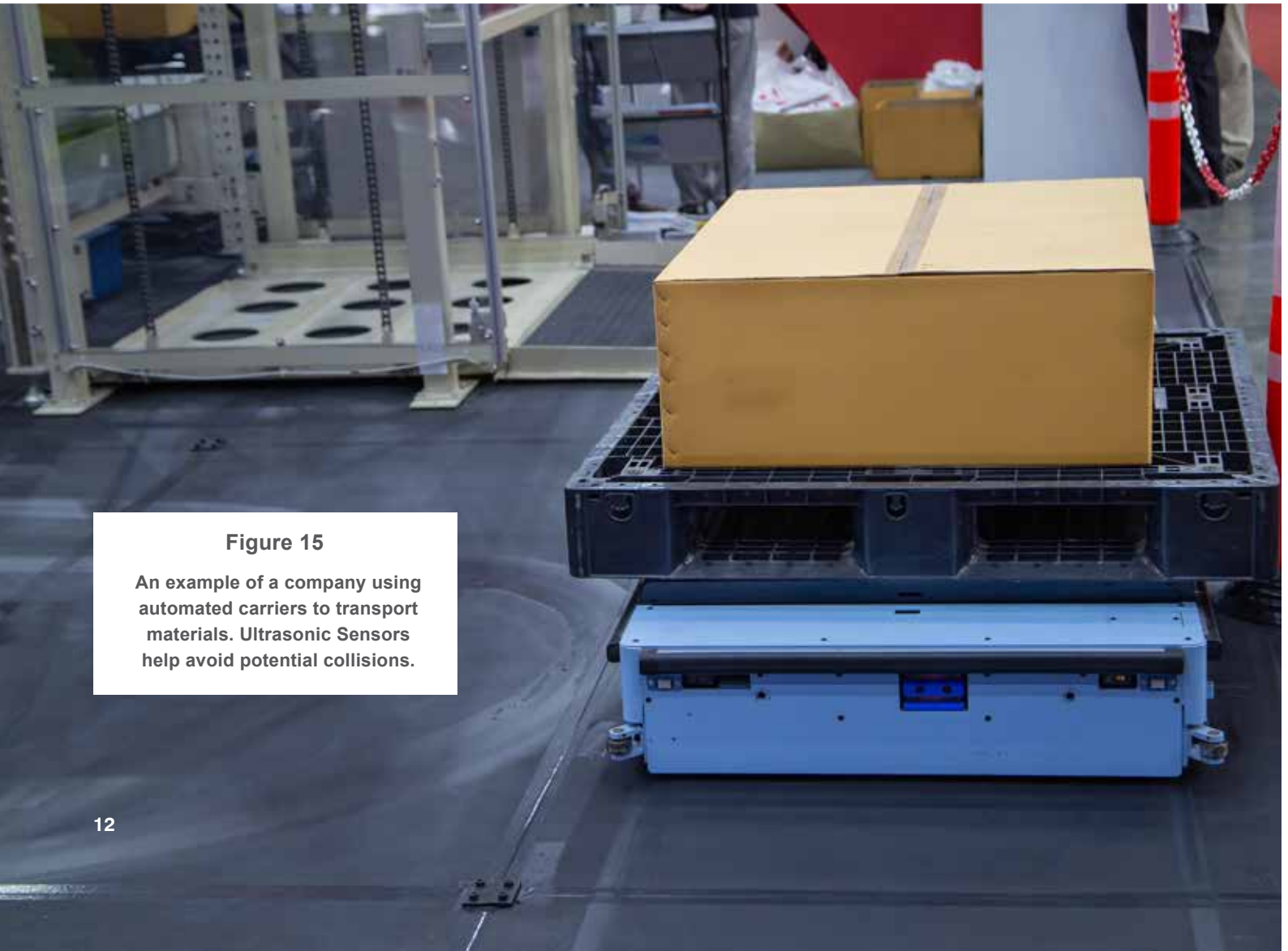


Figure 15

An example of a company using automated carriers to transport materials. Ultrasonic Sensors help avoid potential collisions.

Using advanced software for diagnostic functions

Figure 16 (below)

Advanced software for Ultrasonic Sensors allows quick access to diagnostic information for all the connected sensors. Downtime is significantly reduced because the software pinpoints the issue(s) and the specific sensor(s) from which those issues are originating.

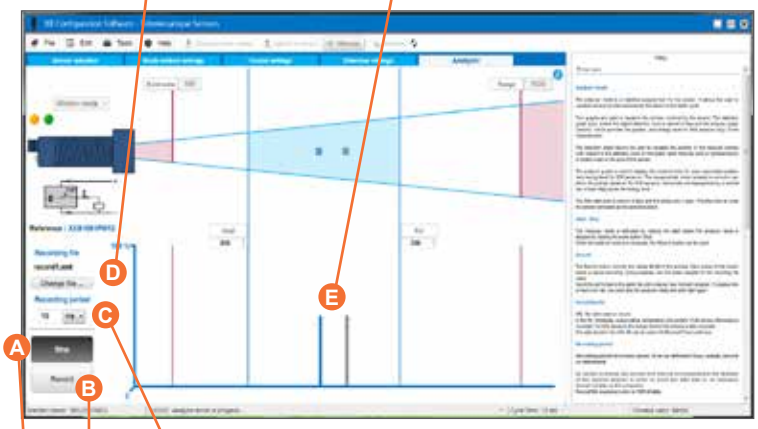
The final advantage to an advanced software platform for ultrasonic sensors is the ability it grants to quickly access diagnostic information (See Figure 16). In most cases, the software can not only identify when an issue has occurred with the sensors, but it will immediately identify the specific sensor(s) from which the problem is originating. This feature alone shortens downtime when, for example, a damaged sensor has temporarily ceased detection and stopped production.

In the past, anomalies or detection failures would initiate sending the ultrasonic sensor(s) back to the factory for evaluation and testing. Downtime would be incurred switching out the sensor(s) and – in many instances – the anomaly or failure would repeat with the replacement sensor.

With advanced software connected to each sensor, diagnostic information is available in real time (See Figure 17). The software can identify the specific sensor(s) generating an issue and can give a detailed analysis of when the sensor sends the ultrasonic pulse and when it receives the signal back. Diagnostic information can be acted upon without waiting for the sensor to travel back to the factory or waiting for the factory to test the sensor.

Providing this real-time information, advanced software minimizes the time and cost involved in diagnosing issues.

"Providing real-time information, advanced software minimizes the time and cost involved in diagnosing issues."



D The Record File(s):

XML files are stored here including recorded timestamp, output status, temperature and position of all echoes during the analysis.

E The Echoes:

Shows real echoes seen by the sensor. The first echo seen will be in blue and all others will display in gray.

C The Recording Period:

The recording period of the echo values can be defined in hours, minutes, seconds or milliseconds.

B The Record Button:

This button records the values of the echoes. Each press of this button starts or stops the recording. XML recording files to be saved are named at the beginning of the analysis.

A Start / Stop:

The Analyzer mode is activated by clicking this button (which will be labeled "start") and stopped by clicking the same button (which will be labeled 'Stop').

Figure 17

The Analyzer mode of Telemecanique Sensors XX Ultrasonic software is a real-time analysis tool. It allows the user to visualize several echoes received by the sensor in the same cycle. The many functions of the software are detailed in the diagram's callouts at left.

Sourcing ultrasonic sensors with advanced software

> *"Quality detection is no longer the sole criteria for choosing an Ultrasonic Sensor."*

In conclusion, quality detection is no longer the sole criteria for choosing an Ultrasonic Sensor. As Ultrasonic Sensors have continued to advance technologically, so, too, have the methods and expertise for utilizing that technology. Detection industry leaders who have recognized the need to address the unique challenges inherent with Ultrasonic Sensors place themselves at the forefront of reliable ultrasonic technology resources. But this is not the sole criteria for selecting an ideal Ultrasonic Sensor resource.

Coupled with this proactive expertise in ultrasonic technology should be a firm history of reliable automation solutions and close availability of assistance. Telemecanique Sensors, almost a century old and available worldwide, is a prime example of this type of resource.

The line of Ultrasonic Sensors developed by Telemecanique Sensors is comprehensive, addressing the sensing distances, modes, and outputs necessary worldwide (See Figure 18).

Figure 18 (below)

An overview of the range of Ultrasonic Sensors available from Telemecanique Sensors.

Cylindrical Sensors	Range description	Sensing distance	Detection mode(s)*	Output(s)**	Software
	XX•30 8m	0.3...8m	D R	Digi Ana	✓
	XX•30 4m	0.4...4m	D R	Digi Ana	✓
	XXW54 3m	0.4...3m	D R	Digi Ana	✓
	XX•30 2m	0.15...2m	D R	Digi Ana	✓
	XX•30 1m	0.1...1m	D R	Digi Ana	✓
	XX•18 1m	0.1...1m	D R	Digi Ana	✓
	XX•18 short range	0.02...0.5m	D R TB	Digi Ana	
	XX•12	0.1...0.2m	D TB	Digi	
Rectangular Sensors	**Range description**	**Sensing distance**	**Detection mode(s)**	**Output(s)**	**Software**
	XX8/9D1	0.02...1m	D R	Digi Ana	
	XX7V1	0.02...0.5m	D R	Digi	
	XX7K1	0.25...1m	D TB	Digi	
	XX7F1	0.1...0.2m	D TB	Digi	

* Detection modes: **D** = Diffuse **R** = Reflex **TB** = Thru-Beam **Outputs: Digi = Digital Ana = Analog

The cost-saving Ultrasonic Sensors software developed by Telemecanique Sensors also addresses the concerns of multiple automation industries (See Figure 19).

For more information on XX Ultrasonic Sensors and the advanced software developed for them, please go to: www.tesensors.com/XXUltrasonic

				
XX Advanced Software features	**Material handling**	**Mobile equipment**	**Machine tools**	**Conveying**
Loss of echo adjustments It allows choosing the sensor behavior when the echo is not detected	✓			✓
Hysteresis accommodation Allows tolerances if the target tends to move back and forth	✓			
Unexpected echo suppression Allows 'masking' of disturbances due to highly reflective environments	✓	✓	✓	✓
Multiplexer functionality Multiplexing is a function that controls the sequential order of sensors	✓	✓		
Echo display mode The "Echo display" mode allows the user to visualize several echoes received by the sensor in the same cycle.	✓	✓	✓	✓

Figure 19 (at left)

A chart showing how XX Ultrasonic Sensors advanced software from Telemecanique Sensors applies to multiple automation applications.

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