

SELECTING CONTINUOUS LEVEL SENSORS a practical approach

Selecting the right sensor for your bin level monitoring application can seem like ordering off of a menu when you don't speak the language. There are volumes of information about different types of continuous level measurement technologies and technical data about how they work.



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KEYWORDS

grain bins, concrete silos, bulk measurement, food industry

OBJECTIVE

Learn to combine sensor and software technology to automate level measurement.

CONSIDER

Manual bulk measurement is risky, material overflow costly, and labor short.

ONLINE

<https://www.binmaster.com/products/continuous-level/3d-level-scanner.html>

 <https://www.binmaster.com/support/sales/contact-form>

About continuous level sensors

Although helpful, it's likely you don't have time to digest so much information, and bin level sensors are only a fraction of the equipment you need to worry about. This article will arm you with some high-level knowledge about your options, and let you know what you need to know before calling someone to discuss your needs.

Your investment in being prepared with a few facts will pay off in ruling out technologies that won't work in your application or won't fit your budget. When you contact your vendor, you'll save time if you're prepared with 10 key pieces of information about your application:

- Material being measured
- Bulk density of the material in lb/ft³
- Material's propensity to be sticky or create buildup
- Corrosiveness of the material
- Amount of moisture present
- Temperature and pressure in the silo
- Excessive noise or vibration
- Presence of dust, foam, steam or vapor
- Size and shape of the silo
- Limitations where the sensor can be mounted on the silo

A few other things you might want to consider for continuous inventory management are:

- How often do I need to measure or access the data?
- How many people need access to the data? How will the information be shared?
- Is viewing one bin at a time OK, or do I need to monitor multiple bins simultaneously?
- Do I need notification or alerts if levels reach a certain high or low point?
- What are my budgetary constraints for equipment?

When the level of material needs to be monitored on an ongoing basis and the information needs to be accurate, continuous level measurement sensors can output data to a console, using specialized software, send the information to a PLC or the Internet for anywhere, anytime access. Advanced systems can report the data from all of the bins on site or multiple sites, making it easy to monitor inventory status for an entire operation.

What is a dead zone?

Radar, ultrasonic, and 3DLevelScanners have a default blanking distance commonly referred to as a dead zone. That distance is not accounted for, or measured by the sensor. So, you need to account for this distance when setting up the device to trigger alerts when the full level is reached.

For example, if using a 3DLevelScanner, the area from the process connection to the bottom of the device (19 inches) is a dead zone. A measurement to the bottom of the dead zone would be considered a full tank.

Dead zones can be increased if a lower full point is desired. Most manufacturers have the dead zone preset in the controller, based on the unit selected.

Weight-and-Cable

A weight-and-cable sensor, plumb bob sensor, works like an automatic-measuring tape, without the danger and hassle of climbing bins to take measurements. The sensor is mounted on the top of the bin, generally 1/6 of the way in from the outer perimeter for the best accuracy.

The sensors are programmed to take measurements at predetermined intervals, such as every 30 minutes, once an hour, every 6 or 8 hours, or once a day. SmartBob measurements are highly accurate, taking the measurement in the same location with reliable repeatability. Depending on the system selected and operational needs, data is sent to a PLC, console, PC or to the Internet.

Measuring range is from the tip of the bob (also referred to as a probe or weight) when the cable is fully retracted to where the bob contacts material at the bottom of the vessel. The dead zone is minimal, just 4 to 8 inches measured from the process connection to the tip of the sensor probe hanging from the cable when the unit is fully retracted.

Weight-and-cable sensors measure the level of headroom from a single point on the material surface directly below the sensor's mounting location.



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Table 1. Pros and cons of weight-and-cable level sensors

Pros	Cons
Not affected by dust or other adverse process conditions	On-demand system, does not provide an instantaneous response to change in the material level
Not affected by material buildup on the sensor	Seasonal maintenance may be required to clean out mechanical cavity in very dusty conditions, if air-purge is not used
Performs in extremely light, signal-absorbing materials	Not recommended for use in high pressure bins
Can be used to measure tall bins with cable lengths up to 180 feet	
Not affected by material characteristics, such as low dielectric constant or angle of repose	
Sensor requires no calibration	
High temperature models available up to 1,000°F	
Low purchase cost relative to most other continuous level sensors	
Very simple setup and installation	
Consistent, repeatable, and accurate measurements	
Minimal contact with stored material	
Networkable PC software can be used for monitoring levels	
A variety of digital and analog outputs accommodate different types of operations	
Wireless interfaces are available to reduce cabling costs	
Hazardous location approvals are available for high dust environments	

3DLevelScanner

The acoustic technology used in sensors like BinMaster's 3DLevelScanners, generically called scanners, is very different from other types of sensors. As the name implies, these devices scan the material surface to take multiple measurements, taking into account the high and low spots in the silo.

The data from multiple measuring points is processed using advanced firmware and algorithms, and when combined with the silo's parameters loaded into the software, provides highly accurate level and volume information.

The measuring range starts at 19" below the threads on the process connection (upper deadzone).

Unlike any other technology, the 3DLevelScanner takes measurements from multiple points within the silo.

These points take into account irregular material topography to determine the volume of material in the bin. Measurement points are not simply averaged to calculate bin volume - instead, an advanced algorithm assigns each point a "weight" to determine the true volume of material in the bin.

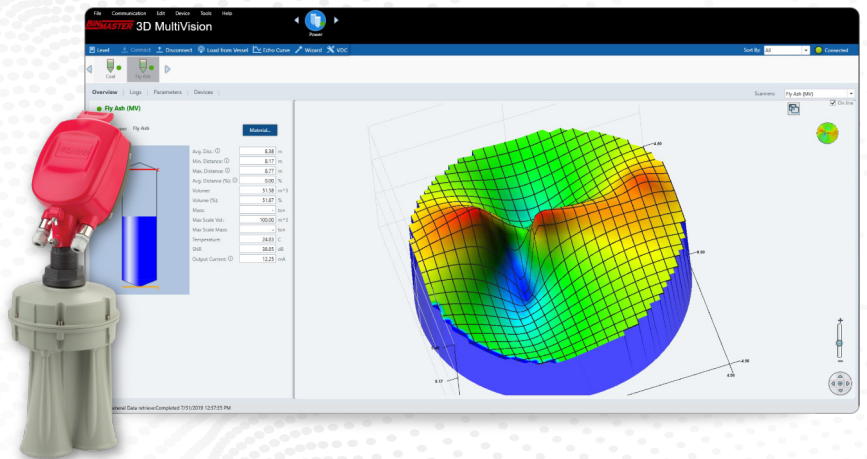
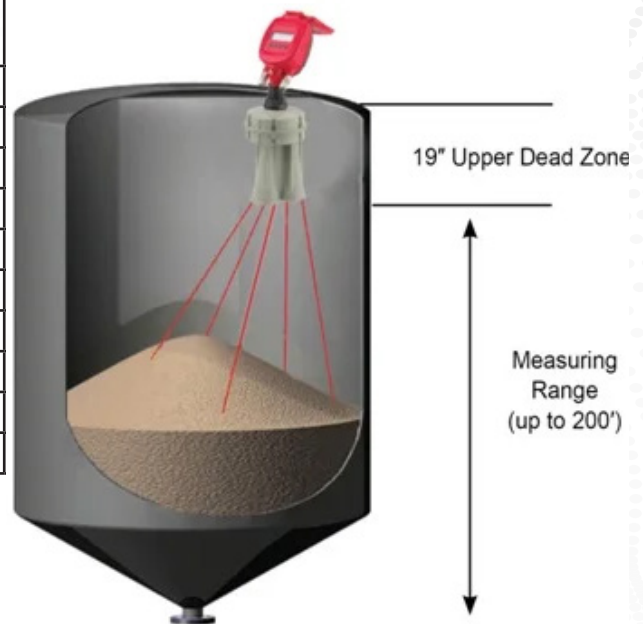


Table 2. Pros and cons of acoustic (3DLevelScanner) sensors

Pros	Cons
Multiple point measurement	Elevated background noise can impact performance of acoustics technology
Continuous level measurement	Setup requires care in mounting the sensor in the proper location and Accurately mapping the vessel dimensions
Non-intrusive, non-contact design	Time required to process multiple pulse echoes limits the sample rate
Measures uneven powder or solid material surfaces	Not recommended for liquid applications
Detects cone up, cone down and sidewall buildup	Corrugation on small vessel walls can cause false echoes
Provides minimum, maximum and average distances	Not recommended for materials with a bulk density under 11 lb./cu. ft. due to absorbing the acoustic pulse
Performs in extreme levels of dust	
Calculates highly accurate bin volume due to mapping the surface of the material with multiple measuring points	
Measuring range up to 200 feet	
Self-cleaning with minimal maintenance	
Models for high temperature applications available	
Automatic compensation for temperature changes	
Analog and digital communication options	
Networkable PC software available for multiple vessel monitoring	
Can generate a 3D image of material surface	
Wireless interfaces available to reduce the need for cabling	
Approved for hazardous locations	
Not affected by material characteristics or low dielectric constants	



Guided Wave Radar

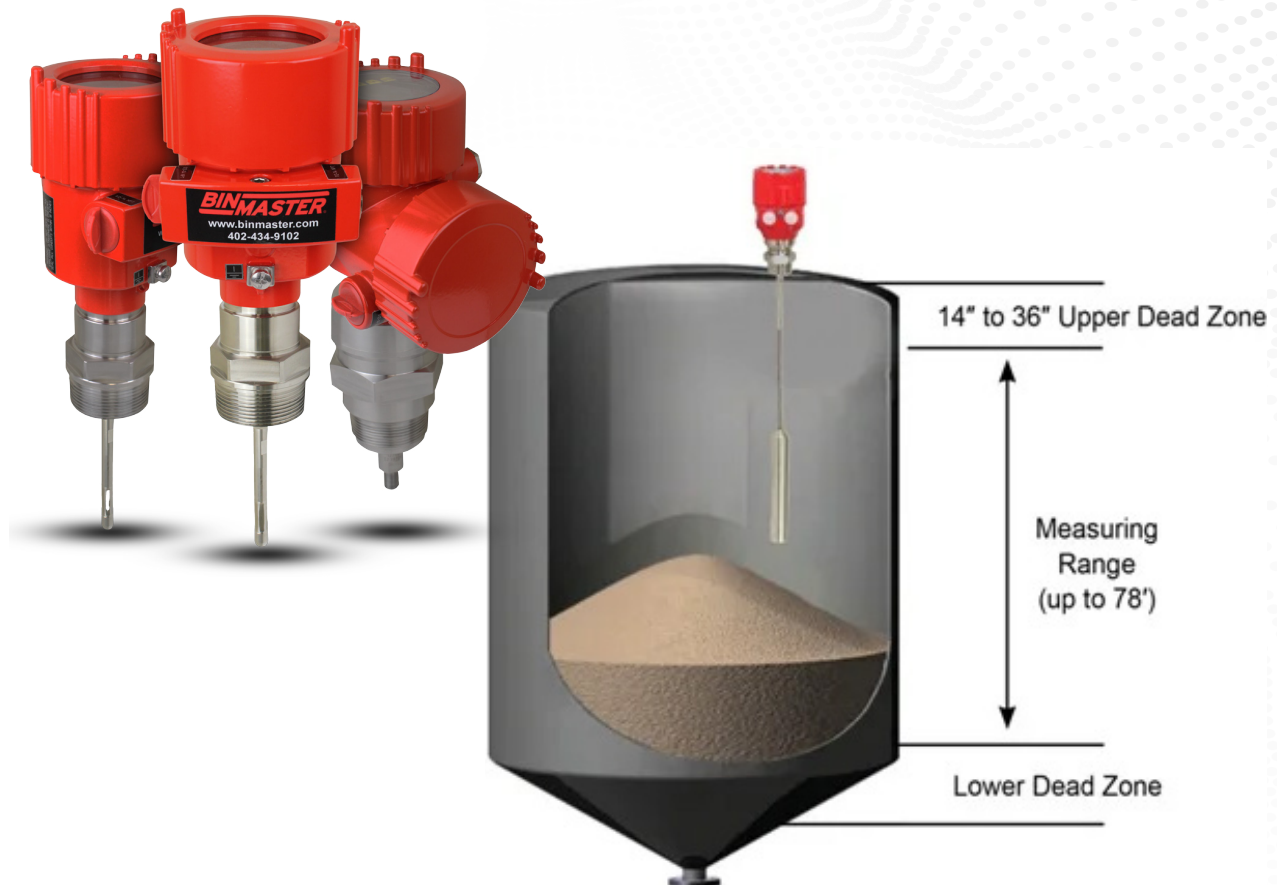
Guided wave radar utilizes time domain reflectometry (TDR) to measure the distance to the material by sending a low power microwave signal along a cable and calculating the level based upon the time of flight.

Guided wave radar is used to measure powders, bulk solids and liquids. A variety of different diameters and lengths of cables are used dependent of the materials characteristics. Measurement data is output to a PLC, a graphical display on the device, or a local display unit.

The measuring range generally starts from 14" to 36" below the threads on the process connection (upper dead zone), although some of the newer models available state smaller dead zones. Guided wave radar also has a lower dead zone, generally to about 4" above the top of the counterbalance weight. It measures the level of headroom at a single point where the cable is located in the vessel to the top of the lower dead zone.

Table 3. Pros and cons of guided wave radar level sensors

Pros	Cons
Continuous level measurement in powders, granules, bulk solids, and liquids	Sensing probe is in constant contact with material
Performs in vessels prone to dust, humidity, temperature, pressure and bulk density changes	Does not perform in materials with a very low dielectric constant
Microwave energy is focused and travels along a wave guide, concentrating the radar beam within a small diameter	Measurement range is limited by maximum cable length stated by manufacturer
Suitable for vessels of most any shape or diameter, including narrow tanks	Use in heavier materials may be limited due to tensile load on cable
Can be used on high pressure vessels	Materials such as large rock may damage probe and be difficult to sense
Models available for high temperature applications	
Highly accuratedistance measurement	



Open Air Radar

Open air radar transmits radio-frequency (RF) energy to the material surface and the energy is reflected back, much with sound waves. A small portion of the reflected energy returns to the radar. This returned energy, which is called an echo, is processed to determine the distance to the material in the bin.

There are many different models of open air radar devices, using different types of antennas and operating frequencies, primarily ranging from 6 GHz to 76 GHz. The model of open air radar device that will perform successfully in an operation will be dependent on the parameters of the material and container.

Measuring range varies, with the upper dead zone generally ranging from 14" to 36" dependent on the type of antenna and horn installed on the device.

Open air radar measures the level of headroom at a single point on the material surface directly below where the unit is aimed.

For liquids it is generally pointed straight down (vertical), and for bulk solids it is aimed at the discharge to prevent the signal from bouncing off an angled hopper bottom, as this can cause false reflections.

Table 4. Pros and cons of open-air wave radar level sensors

Pros	Cons
Continuous level measurement	Low dielectric materials are difficult to measure as there is not enough radar energy to be reflected from the product surface
Non-intrusive, non-contact design	Frequent maintenance for air purging of the horn, requiring air to be run to the top of the bin, plus the cost of air
Ranges generally up to 100 feet for 26 GHz or less, over 300 feet for 76 GHz	May not perform reliably in environments with excessive dust
Models for high temperature applications are available	Susceptible to condensation and product buildup on the antenna, which may cause signal attenuation that adversely affects performance. The higher the frequency, the more signal attenuation. Higher frequency units have smaller antennas, thus the same level of coating or condensation on a smaller antenna naturally has a greater effect on the performance
In liquid applications, radar is not adversely affected by steam or foam	Measuring distance may be impeded in units with wide beam angle.
Measurement is virtually unaffected by changes in process temperature, pressure, density or gas/vapor composition within the vessel	Cone-bottom vessels can sometimes be problematic when nearing empty. The cone acts as an excellent reflector, throwing energy around the vessel sometimes confusing the transmitter



Ultrasonic transmitters

Ultrasonic sensors are used for continuous, non-contact level measurement in tanks, bins, silos and conveyors. They work by transmitting an ultrasonic pulse of pressurized air to the surface of the material in a vessel.

The pulse reflects off the material and returns to the sensor in the form of an echo that is received by a microphone. The sensor then sends the measurement data directly to a control system or display module, with some systems allowing data to be sent to a PC running utility and diagnostic software.

The measuring range generally starts from 4" to 14" below the threads on the process connection (upper dead zone). Ultrasonic measures the level of headroom from a single point on the material surface directly below where the unit is aimed.

For liquids it is generally pointed straight down (vertical), and for bulk solids it is aimed at the discharge to prevent the signal from bouncing off an angled hopper bottom causing false reflections.



Table 5. Pros and cons of ultrasonic level sensors

Pros	Cons
Continuous level measurement	Performance affected by dusty conditions, pressure fluctuations, turbulence in vessel, and large particulate size
Non-intrusive, non-contact design	Can be problematic when used for measuring solids
Performs very well in liquids with ranges from a few feet up to 90 feet	Not recommended if steam will be present in vessel
High temperature models are offered by many manufacturers	Will measure the surface of the foam, if present
Sanitary models are available with tri-clover fittings for use in food and pharmaceutical applications	Performance affected by high pressure, follow manufacturer specifications
Tend to be lower purchase cost than radar and acoustics	
Self-cleaning transducer face for minimal maintenance	
Automatic compensation for temperature changes	
Analog and digital communication options	
PC software available to diagnose and calibrate sensor generally available	
Very easy to install and calibrate	
Most manufacturers offer multiple voltages and units for varying distances	

