White Paper

# Cutting Complexity in Radar Level Transmitters

## How latest developments optimize ease-of-use

EMERSON

## Abstract

Radar level measurement has been widely adopted across multiple industries, with end users appreciating the technology's outstanding dependability as well as its extremely low maintenance requirements. However, since non-contacting radar devices were first launched, the focus has been on developing products that provide increased accuracy and reliability in challenging applications, and ease-of-use has sometimes been overlooked. This white paper explains why addressing this concern is so important to end users today. It also discusses the functionality provided by the latest non-contacting radar transmitters to enable simple configuration, operation, verification, proof-testing and device replacement, and how that helps to increase safety and optimize operations.


## The Development Of Radar Technology

The concept of using radar technology for level measurement originated in the late 1960s. Tanker ship operators were having problems with mechanical tank level gauging systems. These systems required frequent maintenance and performing this task was proving dangerous because washing the tanks created static electricity, which could lead to sparks and explosions in tanks that contained flammable materials, such as fuel. A number of accidents occurred, creating an immediate need for reliable, maintenance-free level measurement that could increase safety.

At this time, a division of Saab Aerospace in Sweden was working on the use of radar to measure the altitude of planes in flight. The project team wondered if the technology could be applied to marine tank gauging. There were certain challenges that needed to be met if the project was to be a success. For example, the accuracy requirement in the marine application was a few hundredths of a percent compared to a few percent in the aerospace application, and the technology would need to be robust enough to cope with the harsh and hazardous environment at sea. However, the team worked through these challenges and in 1976, the first radar level measurement system was installed on a commercial oil tanker.

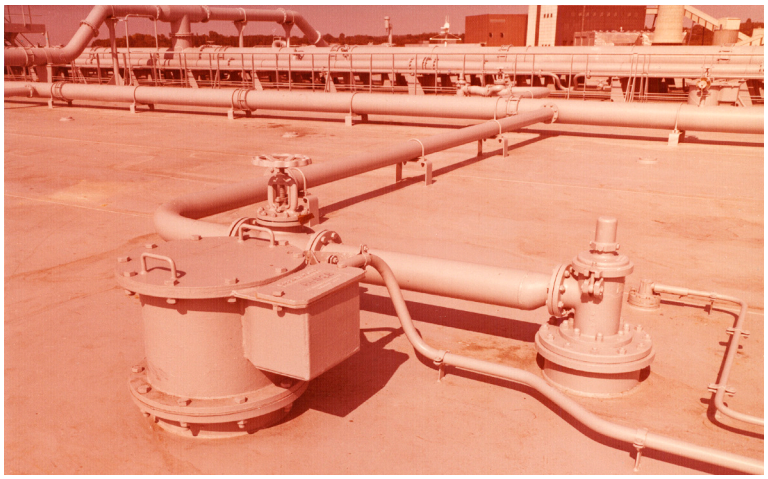

**Figure 1.** In 1976, the first radar level measurement system was installed on a commercial oil tanker.

## Advancements in Accuracy and Reliability

The next two decades saw advancements made in the accuracy and reliability of radar level measurement technology. This enabled an expansion of its use to include refinery tank farms, offshore platform safety applications, niche applications in the steel industry and even to measure the height of waves to support the marine industry further.

Emerson acquired Saab Marine Electronics in 2001 and over the following years, radar technology advanced from four-wire to standard two-wire connections, further increasing the range of suitable applications. Emerson launched the Rosemount™ 3300 Series – the first two-wire level and interface guided wave radar (GWR) transmitter – followed by the Rosemount 5300 Level Transmitter (GWR) and Rosemount 5400 Level Transmitter (non-contacting radar). Both guided wave radar and non-contacting radar devices were capable of measuring the level of almost any liquid in a tank or vessel. The non-contacting radar was ideal for aggressive and corrosive liquids, while GWR was particularly suitable for low dielectric, high temperature and high pressure liquids, such as hydrocarbons, and solids such as plastic pellets.

Radar level measurement instruments were initially based on pulse modulation, but a step change saw the introduction of devices based on frequency modulated continuous wave (FMCW) technology. The sensitivity of the latest transmitters based on FMCW technology is significantly stronger than in devices based on pulse modulation. This maximizes their signal strength and enables them to provide superior measurement accuracy and reliability. Further supporting increased measurement accuracy and reliability, the latest non-contacting radar transmitters use Fast Sweep Technology to provide a continuous echo against the material surface. This enables them to collect more measurement data, resulting in more reliable outputs than legacy radar devices.

## Two-wire FMCW Technology

Although FMCW technology provides greater sensitivity and accuracy than the pulse technique, its need for more processing power was a drawback. Devices were regarded as 'power-hungry' and as a result, FMCW was typically deployed only in four-wire devices. Installing such devices often required additional cable infrastructure, which was costly and time-consuming. This led to some users sacrificing the additional accuracy and reliability of FMCW devices and instead installing two-wire gauges based on pulse technology.

The problem of the high processing power requirements of FMCW technology was overcome by Emerson. When it introduced the Rosemount 5408 Level Transmitter, it featured unique radar-on-chip technology, which replaced the traditional circuit board. This enabled the device to be less power-hungry and more energy-efficient. As a result, the required communications and power can be provided by two wires, typically already deployed within process plants, enabling end users to benefit from the superior accuracy and sensitivity of FMCW technology without needing to install additional infrastructure.

## 80 GHz Devices

A further advantage of using FMCW technology for loop-powered radar level measurement transmitters was being able to utilize a higher operating frequency. Using an 80 GHz frequency can, in some applications, be an advantage due to the narrow beam angle used by such devices, which helps in avoiding internal tank obstructions such as agitators. These high frequency devices support antennas for very small nozzles and they can measure very short ranges. This makes them a suitable choice for use in smaller tanks and space-constrained skids, where the size and placement of nozzles can be a limitation.

## The Importance of Increased Ease-of-Use

When radar level measurement devices were first launched, process and manufacturing organizations were simply looking for automation technology that could replace manual practices that increased the safety risk to workers and would provide greater measurement accuracy and reliability to support improved operational performance. In general, users accepted that this more advanced technology would require a significant amount of training to understand how to implement and use it successfully. As radar technology developed, the industry focus was on further enhancing measurement accuracy and reliability, and expanding the range of suitable applications.

However, industry demands have changed in recent years. Increasing digitization – both in the industry and in society in general – has led to an expectation that modern automation technologies should be highly intuitive and easy to use. It has therefore been the responsibility of automation vendors to find ways of reducing complexity within level measurement devices, to meet the demands of the modern workforce and ensure that devices are easy to install, configure, operate and maintain.

With this in mind, the latest radar devices, such as the non-contacting Rosemount 3408 Level Transmitter from Emerson, have been designed to optimize ease-of-use at every touchpoint, thereby providing an excellent example of the industry trend towards reduced complexity. Let us look at the functionality provided by these devices and how it can lead to significant improvements in worker efficiency, operational performance and plant safety.


**Figure 2.** The Rosemount 3408 Level Transmitter is designed for ease-of-use.

## Device Standardization

Many organizations are looking to standardize on their level measurement instrumentation as a means of reducing both complexity and inventory costs. The latest radar devices are suitable for use in a wide range of industries and applications, such as storage tanks, reactors and mixers, as well as in safety-critical applications such as overfill prevention. This high level of versatility enables companies to increase their opportunities to standardize on a single device rather than having to use different instrumentation for different applications. As a result, both training requirements and maintenance complexity can be significantly reduced.

## Configuration

Configuration must be performed for all level measurement devices, but the procedure for radar devices, which is performed manually, has traditionally been time-consuming (with each device having many configurable parameters), tedious and prone to errors. With potentially thousands of devices to configure, technicians have vast amounts of parameters to enter. In addition, after completing the configuration tasks, technicians must spend further time verifying that they have performed the procedure correctly and the device is operating safely and correctly.

Modern device management software packages make it much easier to configure the latest radar devices. Clear pictorial instructions are provided on highly intuitive software interfaces, enabling operators to be easily guided through not just configuration processes, but also installation, proof-testing, operation and maintenance.

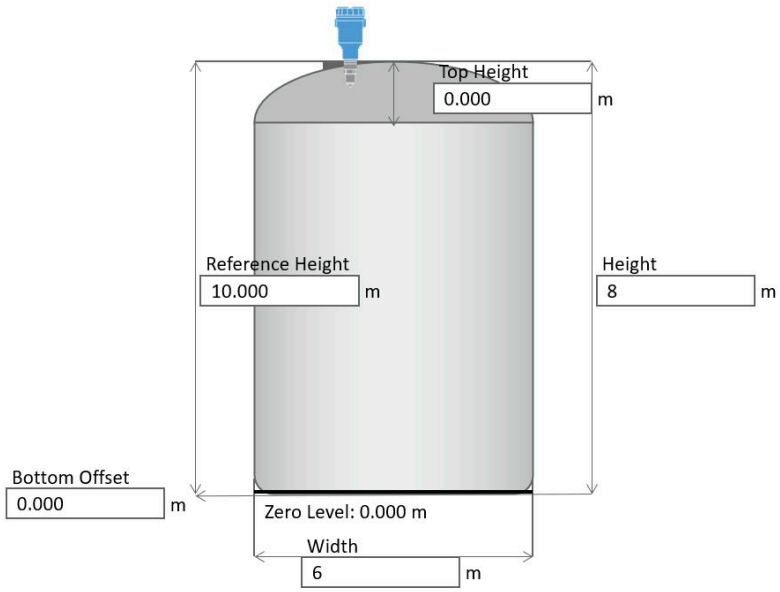


**Figure 3.** Modern device software packages with intuitive graphical interfaces guide operators through processes at every step of commissioning, operation and troubleshooting.

This helps to prevent errors and ensure reliable measurements. Wireless communication via Bluetooth® technology and dedicated apps enable operators to quickly and easily access the device remotely, so configuration and servicing tasks may be carried out without the need for a physical connection.

**Figure 4.** Operators are now able to communicate remotely with devices in the field via Bluetooth® enabled technology and dedicated apps, reducing time and increasing efficiency.

## Operation and Verification

Reliable operation is a key factor when selecting automation technology. It is essential to know of a device health issue that could affect the accuracy and reliability of measurements. The latest radar level measurement devices feature advanced diagnostics suites that enable the continuous monitoring of key device health and process parameters. Signal quality metrics technology, for example, continuously monitors the integrity of the measurement by assessing the surface signal strength, noise level and user settings. This functionality can be used to detect abnormal conditions in the process such as probe contamination or sudden loss of signal strength. If this occurs, an alarm is triggered, enabling operators to be alerted to any potential measurement problems and allowing maintenance needs to be predicted and scheduled.

One of the main concerns voiced by process and manufacturing organizations in recent years has been the need for a better means of verifying that their radar level transmitters were working correctly over the course of their lifespan. Verifying the accuracy and functionality of radar transmitters used to be a labor-intensive, cumbersome and costly operation that involved operators climbing tanks and risking their safety, breaking process seals and transferring products. However, the latest devices offer smart meter verification functionality, which provides an easy way to verify the health of the device and that it is operating correctly. Smart meter verification addresses a number of different end user requirements and can be used to evaluate the need for maintenance and enable preventive maintenance to be performed.

Automatic verifications can be scheduled as required, without requiring manual work or interrupting the process, thereby reducing costs and increasing plant availability and worker efficiency. The functionality tracks any configuration changes and adjustments made throughout the lifecycle of the device. In addition, official records of device verification are generated and saved, meeting the need for documented testing.

## In Situ Proof-Testing

In safety applications, such as overfill prevention, it is essential to ensure that level measurement devices within a safety instrumented system will work correctly when required. This verification is achieved by performing proof-tests at regular intervals. Proof-tests uncover dangerous undetected failures (DUs) which prevent the device from performing its primary function and remain undetected by the device's diagnostics during normal operation.

Proof-testing has traditionally been conducted on location. However, functionality in the latest radar level measurement transmitters enables operators to perform proof-tests remotely instead, with the device remaining installed. Simulated overfill conditions activate the detector and generate an alarm signal. This enables the test to be performed without the need for fluid to be moved in and out of the tank. As a result, the risk of spills is avoided, a significant amount of time is saved, and the need for workers to climb tanks and/or be exposed to tank contents is eliminated, thereby increasing worker safety and efficiency.

**Figure 5.** The ability to perform proof-tests remotely from the control room increases worker safety and efficiency.

## Upgrading and Replacement

All level measurement devices will inevitably reach a point in their lifecycle where they need to be upgraded or replaced, and the latest radar transmitters make this as straightforward as possible. Previously, when a device needed to be upgraded or replaced, this typically involved exchanging an entire transmitter head. However, in the latest devices, the 'brain' of the transmitter is contained within a pre-calibrated cassette that can quickly and easily be removed from its housing and replaced by a new cassette.

This exchangeable design is an easy maintenance solution that saves time and materials and is therefore much more cost-effective than replacing a whole device. Further reducing complexity, the cassettes have been standardized so that a single version can be used for all types of approvals and certifications, rather than them all requiring their own version.

## Conclusion

Radar level measurement devices have been able to deliver outstanding accuracy and reliability for many years – the focus is now on increasing their ease-of-use to meet the current demands of the process industry. Through a range of functions that increase ease-of-use at every touchpoint, the latest radar level measurement transmitters simplify configuration, operation, verification, proof-testing, maintenance and replacement, leading to reduced costs, increased site and worker safety and enhanced plant performance.

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