Safety Manual
00809-0400-5100, Rev AF
November 2021

Rosemount™ 5900 Radar Level Gauge and 2410 Tank Hub

Safety Manual for Use in Safety Instrumented Systems SIL 2
Model Code Option S

ROSEMOUNT™

EMERSON™

NOTICE

Read this manual before working with the product. For personal and system safety, and for optimum product performance, ensure you thoroughly understand the contents before installing, using, or maintaining this product.

For equipment service or support needs, contact your local Emerson Automation Solutions/Rosemount Tank Gauging representative.

Spare Parts

Any substitution of non-recognized spare parts may jeopardize safety. Repair, e.g. substitution of components etc, may also jeopardize safety and is under no circumstances allowed.

Rosemount Tank Radar AB will not take any responsibility for faults, accidents, etc caused by non-recognized spare parts or any repair which is not made by Rosemount Tank Radar AB.

Contents

1 Safety Instrumented System

1.1 Safety messages

Instructions and procedures in this section may require special precautions to ensure the safety of the personnel performing the operations. Information that potentially raises safety issues is indicated by a warning symbol (⚠). Refer to the following safety messages before performing an operation preceded by this symbol.

⚠ WARNING

Failure to follow these installation guidelines could result in death or serious injury.

- Ensure only qualified personnel perform the installation.
- Use the equipment only as specified in this manual. Failure to do so may impair the protection provided by the equipment.

Explosions could result in death or serious injury.

- Verify that the operating environment of the device is consistent with the appropriate hazardous locations certifications.
- Before connecting a handheld communicator in an explosive atmosphere, ensure that the instruments in the loop are installed in accordance with intrinsically safe or non-incendive field wiring practices.
- Do not remove the gauge cover in explosive atmospheres when the circuit is alive.

Electrical shock could cause death or serious injury.

- Use extreme caution when making contact with the leads and terminals.

⚠ WARNING

Any substitution of non-recognized parts may jeopardize safety. Repair (e.g. substitution of components) may also jeopardize safety and is not allowed under any circumstances.

⚠ WARNING

Physical access

Unauthorized personnel may potentially cause significant damage to and/or misconfiguration of end users' equipment. This could be intentional or unintentional and needs to be protected against.

Physical security is an important part of any security program and fundamental to protecting your system. Restrict physical access by unauthorized personnel to protect end users' assets. This is true for all systems used within the facility.

1.2 Introduction

The purpose of the safety manual is to document all the information, relating to the Rosemount Tank Gauging system, which is required to enable integration into a safety-related system, in compliance with the requirements of IEC 61508.

1.2.1 Purpose of the product

The Rosemount™ Tank Gauging Safety System is designed for high performance level gauging in various types of storage tanks. It measures the distance to a liquid in a tank for Safety Instrumented Systems. Two relays and one 4-20 mA analog output are available for alarm indication and overfill and dry run risk. Non safety-related instruments such as level transmitters, temperature sensors, remote display units, water level sensors, pressure sensors, and other instruments can be connected.

The Rosemount Tank Gauging Safety System is intended for use as a level measurement sensor in safety instrumented functions (SIF) designed per IEC 61511. It is comprised of the following main elements:

Rosemount 5900

The Rosemount 5900 is a radar level gauge developed for a wide range of applications at bulk liquid storage facilities. Different antennas can be used in order to meet the requirements of different applications. The 2-in-1 version of the Rosemount 5900 has two independent and galvanically isolated radar modules in the same transmitter enclosure using a single antenna.

Rosemount 2410

The Rosemount 2410 acts as a power supply to the connected Rosemount 5900 using the intrinsically safe Tankbus. The Rosemount 2410 provides the analog 4-20 mA outputs and relay output and digital communication allowing connection of configuration tools or safety control system.

1.2.2 Assumptions and restrictions

Note that the Rosemount™ 5900 is not safety-rated during maintenance work, configuration changes, or other activity that affects the Safety Function. Alternative means should be used to ensure process safety during such activities.

False echoes within the radar beam from flat obstructions with a sharp edge may lead to a situation where the Rosemount 5900 can no longer be used for safety related functions with the listed failure rates, Safe Failure Fraction and PFD_{AVG}. However, reduced proof test intervals can help to detect such unwanted causes.

1.3 Safety Instrumented System (SIS) certification

The Rosemount Tank Gauging Safety System is designed for applications in high demand mode operation (demand rate of 1 per week). The Rosemount Tank Gauging Safety System is certified to:

- Low and High Demand of operation
- Systematic Capability: SC 3 (SIL 3 capable)
- Random Capability for type B device:
  - 1 in 1 SIL 2 @ HFT=0
  - 2 in 1 SIL 2 @ HFT=0

Note
Refer to the Rosemount 5900/2410 FMEDA report for failure rate data, assessment details, and assumptions regarding failure rate analysis.

It is important that the Rosemount Tank Gauging Safety System is installed and used in appropriate applications as described in relevant installation instructions. Otherwise the required functional safety may not be maintained.

The instruments in a Rosemount Tank Gauging System must be operated within specified environmental conditions. Operating conditions are available in the Rosemount Tank Gauging System Data Sheet, Document No. 00813-0100-5100.

If there are any echoes measured by the Rosemount 5900 which cannot be traced back to the product surface, note if there are any objects such as beams, heating coils etc. in the tank, that correspond to the found echoes. Appropriate action has to be taken if the disturbing echoes affect measurement performed, please contact Emerson Process Management/ Rosemount Tank Gauging for advice.

1.3.1 Still-pipe Array Antenna with hinged hatch

The Rosemount™ 5900 Radar Level Gauge including the SIL alarm output is not safety-rated during maintenance work. This includes opening of the Rosemount 5900 Still-pipe Array antenna, hinged hatch version during for example manual gauging (hand-dip) or product sampling.

During hatch opening, system may go to de-energized state (alarm). If needed, alternative means should be used to ensure process safety during opening of hatch.

1.4 Safety-certified identification

All Rosemount™ 5900 Radar Level Gauges and Rosemount 2410 Tank Hubs must be identified as safety-certified before installing into SIS systems. Table 1-1 lists the versions of the Rosemount 5900/2410 Series devices that have been considered for the functional safety assessment, to which this manual applies.

- Models with the S option code are IEC 61508 certified by an accredited 3rd party agency for use in safety instrumented systems up to SIL 2.

Table 1-1: Rosemount Tank Gauging System (4-20 mA Analog Output)

Hardware	Rosemount 5900 Radar Level Gauge (type B)	Model Code S
	Rosemount 2410 Tank Hub	Model Code S
	Primary Field Bus	Model Code B
	Secondary Field Bus	Model Code A, B, C, D
Software/Firmware	Rosemount 5900 Radar Level Gauge (type B)	Sw 1.B5 and further
	Rosemount 2410 Tank Hub	Sw 1.B1 and further

Table 1-2: Rosemount Tank Gauging System (Standard K1/K2 Relay Output)

Hardware	Rosemount 5900 Radar Level Gauge (type B)	Model Code S
	Rosemount 2410 Tank Hub	Model Code S
	Relay Option 1xSPST	Model Code 1
	Relay Option 2xSPST	Model Code 2
Software/Firmware	Rosemount 5900 Radar Level Gauge (type B)	Sw 1.B5 and further
	Rosemount 2410 Tank Hub	Sw 1.B1 and further

To identify a Rosemount 5900 and Rosemount 2410 safety-certified device:

- Verify the option code S in the model code, on the label affixed to the outside of the transmitter head.
- Check if a yellow label is affixed to the transmitter head for option code **SIL S**.
- Before doing any configuration, write down the Device Id from the label, and make sure you are connected to the correct transmitter by verifying the same Device Id in your communication device.

1.5 Functional specification of the safety function

The safety function is based on the analog output 4-20 mA or K1/K2 relay outputs.

If a measured value goes beyond the measurement range, the transmitter enters saturation mode (limit alarm is disabled) or alarm mode, depending on the current configuration.

The Rosemount Tank Gauging Safety System provides either:

- one or two relay outputs, and/or
- one 4-20 mA output.

The Rosemount Tank Gauging Safety System measures the distance from the Gauge reference point to the surface of a liquid in a tank. The system contains advanced self-diagnostics with internal monitoring features, and is programmed to go to de-energized state (alarm) upon detection of an internal failure.

1.5.1 Safety architecture

The Rosemount Tank Gauging Safety System offers various models in order to support different system configurations.

SIL 2 1-in-1 (1oo1D)	Single channel architecture (1oo1D) complying with SIL 2. This version includes one Rosemount 5900 Radar Level Gauge, one antenna, and one Rosemount 2410 Tank Hub.
SIL 2 2-in-1 (1oo1D)	Single channel architecture (1oo1D) complying with SIL 2. This version includes one “2-in-1” Rosemount 5900 Radar Level Gauge, one antenna, and one Rosemount 2410 Tank Hub.

2 Installation and Configuration

2.1 Safety messages

Instructions and procedures in this section may require special precautions to ensure the safety of the personnel performing the operations. Information that potentially raises safety issues is indicated by a warning symbol (⚠). Refer to the following safety messages before performing an operation preceded by this symbol.

⚠ WARNING

Failure to follow these installation guidelines could result in death or serious injury.

- Ensure only qualified personnel perform the installation.
- Use the equipment only as specified in this manual. Failure to do so may impair the protection provided by the equipment.

Explosions could result in death or serious injury.

- Verify that the operating environment of the device is consistent with the appropriate hazardous locations certifications.
- Before connecting a handheld communicator in an explosive atmosphere, ensure that the instruments in the loop are installed in accordance with intrinsically safe or non-incendive field wiring practices.
- Do not remove the gauge cover in explosive atmospheres when the circuit is alive.

Electrical shock could cause death or serious injury.

- Use extreme caution when making contact with the leads and terminals.

⚠ WARNING

Any substitution of non-recognized parts may jeopardize safety. Repair (e.g. substitution of components) may also jeopardize safety and is not allowed under any circumstances.

2.2 Installation in SIS applications

The Rosemount™ 5900 Radar Level Gauge and Rosemount 2410 Tank Hub should be installed and configured as described in the reference manual.

The materials must be compatible with process conditions and process fluids. No special installation is required in addition to the standard installation practices outlined in the reference manuals:

- Rosemount 2410 Tank Hub Reference Manual
  (Document No. 00809-0100-2410)
- Rosemount 5900S Radar Level Gauge Reference Manual
  (Document No. 00809-0100-5900)
- Rosemount 5900C Radar Level Gauge Reference Manual
  (Document No. 00809-0100-5901)
- Rosemount Tank Gauging System Configuration Manual
  (Document No. 00809-0300-5100)

Note
Installation drawings must be considered for installation of devices in a Rosemount Tank Gauging Safety System.

Note
The Rosemount 5900 Radar Level Gauge and Rosemount 2410 Tank Hub are not safety-rated during maintenance work, configuration changes, or other activity that affects the Safety Function. Alternative means should be used to ensure process safety during such activities.

2.3 Analog output configuration in SIS applications

2.3.1 Alarm and saturation levels

DCS or safety logic solver should be configured to handle both High alarm and Low alarm. It is also required that the transmitter is configured for High or Low alarm. Table 2-1 identifies the alarm levels available and their operation values.

Table 2-2: Alarm Levels and Operation Values

Rosemount Alarm Level		
	Normal Operation 4 -20 mA	
	Low saturation - High saturation 3.9 - 20.8 mA	
Transmitter failure 3.75(1) / 21.75(2) mA		
Namur Alarm Level		
	Normal Operation 4 -20 mA	
	Low saturation - High saturation 3.8 - 20.5 mA	
Transmitter failure 3. 6 mA(1) / 22.5 mA(2)		

(1) Transmitter Failure, hardware or software alarm in Low position
(2) Transmitter Failure, hardware or software alarm in High position.

It is assumed that the current output signal is fed to a SIL 2-compliant analog input board of a safety logic solver.

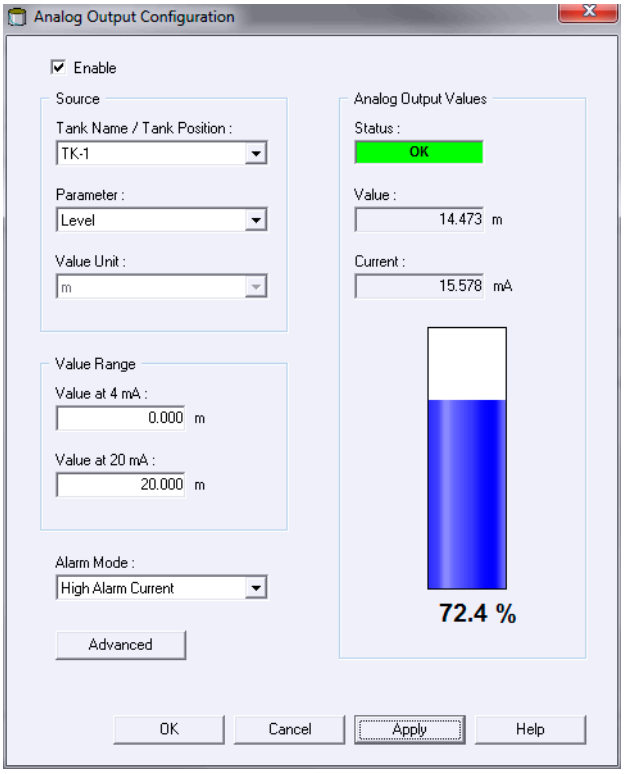
Note
Only the High or Low Alarm Mode can be used for the safety function. Do not choose Freeze Current.

Note
A Low Alarm will be triggered in case of a hardware fault on the Analog Output card.

2.3.2 Analog output configuration in TankMaster

Procedure

1. In the WinSetup workspace click the right mouse button on the tank hub icon and choose the **Properties** option.
2. Select the ***Configuration*** tab.
3. Click the **Analog Output** button to open the ***Analog Output Configuration*** window(1).



4. Check the **Enable** box to activate the analog output option.
5. Configure Source Parameter, Value Range, and Alarm Mode.

Note
In case a Proof Test Reference Reflector is used, make sure that **Value at 20 mA** is set above the position of the reflector.

Related information

Rosemount 2410 Tank Hub Reference Manual

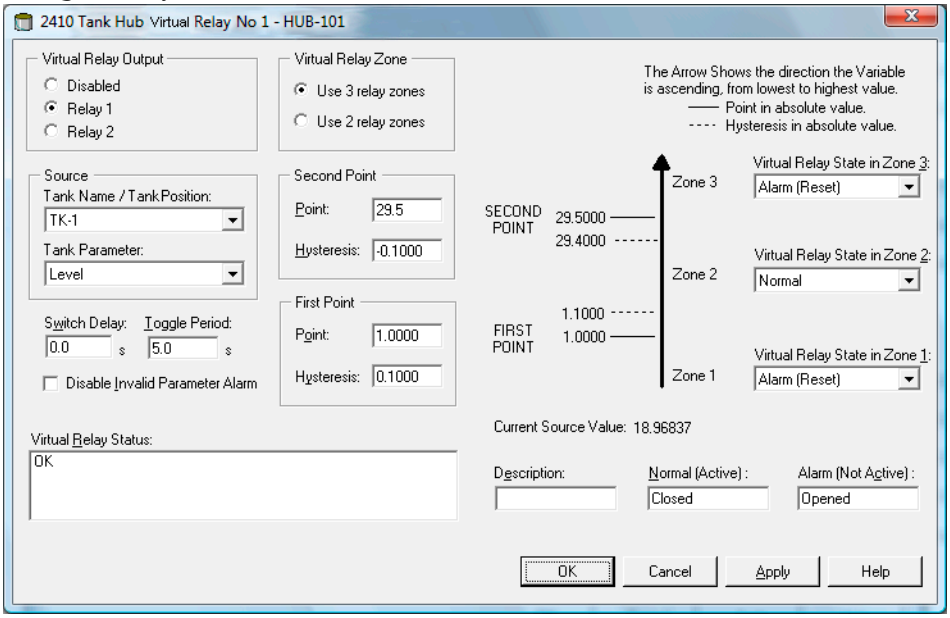
(1) *Note that this button is available if the Analog Output option is activated for the Rosemount 2410 Tank Hub.*

2.4 Relay configuration in SIS applications

To configure Rosemount 2410 Tank Hub relays:

Procedure

1. In the WinSetup workspace click the right mouse button on the Rosemount 2410 Tank Hub icon, select **Properties** and the ***Configuration*** tab.
2. Click one of the **Virtual Relay No.** buttons. for more information on how to configure relays.



Related information

Rosemount 2410 Tank Hub Reference Manual

2.4.1 Normally Open/Normally Closed

Normally Open (NO) is the default setting for the Rosemount 5900 and Rosemount 2410 in Safety Instrumented Systems (SIS). Verify the relay configuration by, for example, using the proof test function Relays K1/K2 Verification Test. See “Maintenance” on page 35 for more information.

Note
In case a Proof Test Reference Reflector is used, make sure that the relay set point is set below the position of the reflector.

Related information

Rosemount 2410 Tank Hub Reference Manual

2.5 Write protection

A Rosemount Tank Gauging safety-certified system should always be write protected in order to avoid unintentional configuration changes. The Rosemount 5900 Radar Level Gauge as well as the Rosemount 2410 Tank Hub should be write protected.

It is recommended to use one of the following write protection options:

- Hardware switch
- Software password protected function

See the appropriate device reference manuals for more information on how to enable write protection.

Related information

Installation in SIS applications

2.6 Site acceptance

After installation and/or configuration, proper operation of the transmitter (including verification of all configuration changes) must be verified. A site acceptance test is therefore required. The proof test outlined in this document can be used for this.

3 Operation and Maintenance

3.1 Safety messages

Instructions and procedures in this section may require special precautions to ensure the safety of the personnel performing the operations. Information that potentially raises safety issues is indicated by a warning symbol (⚠). Refer to the following safety messages before performing an operation preceded by this symbol.

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- Verify that the operating environment of the device is consistent with the appropriate hazardous locations certifications.
- Before connecting a handheld communicator in an explosive atmosphere, ensure that the instruments in the loop are installed in accordance with intrinsically safe or non-incendive field wiring practices.
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3.2 Proof test

The purpose of proof testing is to identify dangerous undetected failures. Proof testing may be divided into comprehensive and partial testing. For the Rosemount™ 5900 Radar Level Gauge and the Rosemount 2410 Tank Hub, a comprehensive proof test includes the following functional elements:

- Output circuitry (relay, analog output)
- Measurement electronics (digital signal processing)
- Sensing element (antenna, microwave unit)

A partial test may include one or more of these elements.

The Rosemount TankMaster software supports proof testing of the Rosemount 5900 Level Gauge and the Rosemount 2410 Tank Hub.

The Rosemount Tank Gauging Safety System should be checked at regular intervals in order to detect Dangerous Undetected (DU) failures. The time periods depend on the PFD_{avg} value.

Note
Proof test for PFD_{avg} calculations is only applicable for Low Demand mode.

One or more of the proof tests described below are recommended.

Make sure to enable write protection as soon as you are finished.

Note
The Rosemount 5900 gauge is not safety-rated during maintenance work, configuration changes, or other activity that affects the Safety Function. Alternative means should be used to ensure process safety during such activities.

Note
Before every test, make sure you are connected to the correct transmitter by verifying **S** in the model code on the label and your software version. Also verify that the Device Id on the label matches the one in your configuration tool.

Note
High level alarm test with reference reflector and High level alarm test with simulated reference reflector are not available via *Wireless*HART® communication.

3.3 Proof test methods

The effectiveness of a proof test in finding undetected failures is the proof test coverage. Table 3-1 lists the coverage factor for various proof test methods including combinations of partial proof tests. For LPG/LNG tanks a verification pin can be used with the same functionality as a reference reflector. Coverage factors that include reference reflector are applicable for LPG/LNG verification pin as well.

Table 3-1: Level Sensor Proof Test Methods

				Test coverage			
Proof Test	**Type**	**Proof test coverage (% of DU)**	**Remaining DU failures [FIT]**	**Output**	**Electronics**	**Sensing Element Antenna**	**Can be performed remotely**
A	Comprehensive (Partial combination)	73	53	Y	Y	Y	Y
B		69	68	Y	Y	Y	Y
C		73	53	Y	Y	Y	Y
D		69	68	Y	Y	Y	Y
E		73	53	Y	Y	Y	Y
F		69	68	Y	Y	Y	Y
G	Partial	30	135	Y	N	N	Y
H		29	155	Y	N	N	Y

A High level alarm Reference reflector + relay output verification

B High level alarm Reference reflector + analog output verification

C High level alarm Simulated reflector + relay output and 1-point level verification

D High level alarm Simulated reflector + analog output and 1-point level verification

E 1-point level and relay output verification

F 1-point level and analog output verification

G Relay output verification

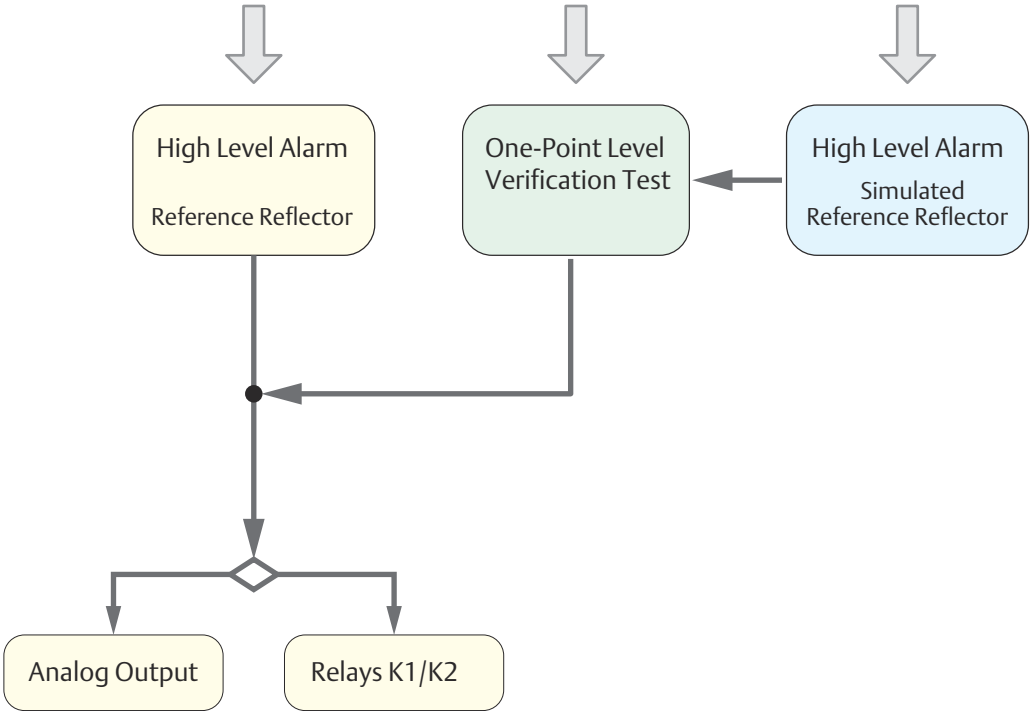
H Analog output verification

Related information

Comprehensive proof test
Partial proof test

3.3.1 Proof test combinations

Figure 3-1: Flowchart with Combination of Partial Proof Tests



3.4 Comprehensive proof test

Comprehensive proof tests of the Rosemount 5900 and Rosemount 2410 can be achieved by combining several partial proof tests, and include all the functional elements:

- Output circuitry (relay, analog output)
- Measurement electronics (digital signal processing)
- Sensing element (antenna, microwave unit)

Comprehensive proof tests are implemented as follows in Rosemount TankMaster:

- High level alarm test with Reference reflector[(2)(3)] combined with analog output or relay output verification
- High level alarm test with Simulated reference reflector [(2)] combined with One-point level verification and analog output or relay output verification
- One-point level verification combined with analog output or relay output verification

(2) High level alarm test with reference reflector and High level alarm test with simulated reference reflector are not available via WirelessHART ® communication.
(3) For LPG/LNG tanks the Verification Pin can be used as reference reflector.

3.4.1 High level alarm test with reference reflector

The High Alarm Test must be combined with suitable output verification test such as Analog Output or Relays K1/K2.

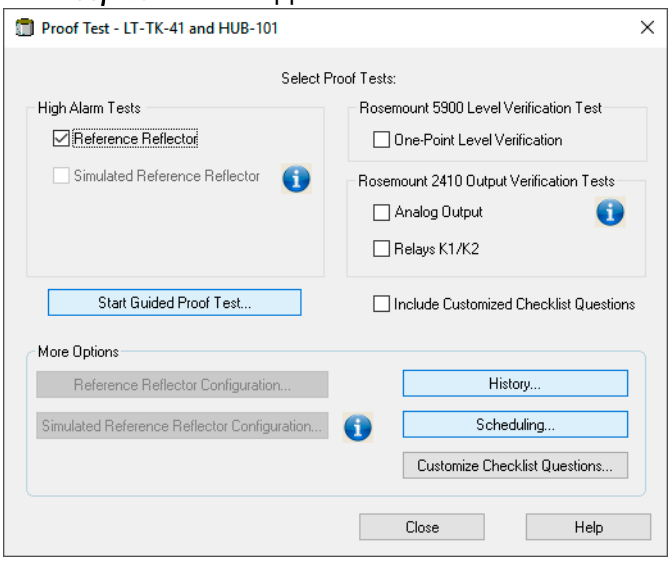
Prerequisites

Prior to running a proof test you will have to ensure that a Proof Test Reference Reflector is installed and properly calibrated and configured(4). For LPG/LNG tanks you may use the Verification Pin instead of a reference reflector.

Ensure that High Alarm is set to an appropriate level below the Proof Test Reference Reflector. A Reference Reflector can be used with the Rosemount 5900 Parabolic and Array antennas.

Procedure

1. Ensure that the TankMaster WinSetup program is up and running.
2. In the WinSetup workspace, click the right mouse button on the Rosemount 5900 device icon and select the **Proof Test** option.
   The ***Proof Test*** window appears:

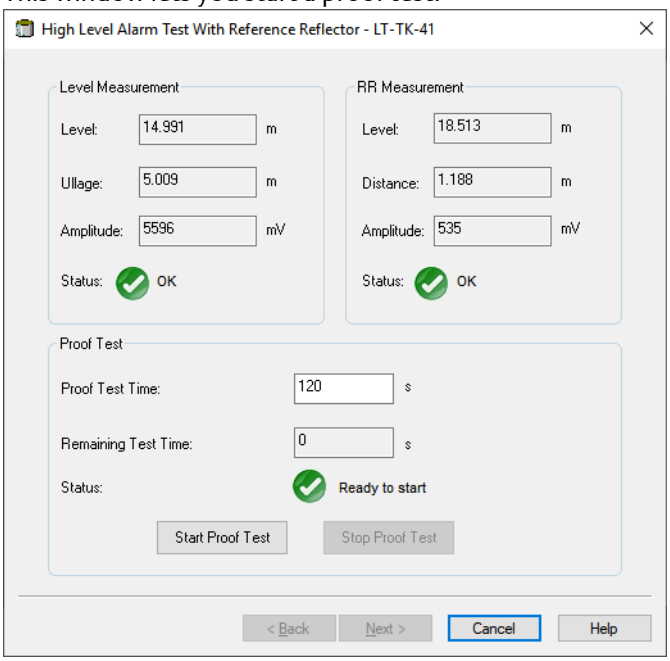


Note
The reference reflector must be configured(4) for the Guided Proof Test function to be enabled.

3. Select the **Reference Reflector** check box.
4. Select one of the check boxes for **Rosemount 2410 Output Verification Tests** depending on the output option that is used:
   - Analog Output
   - Relays K1/K2

(4) *See the Rosemount 5900 Proof Test Manual Supplement for more information.*

5. Click the **Start Guided Proof Test** button.
   This window lets you start a proof test:

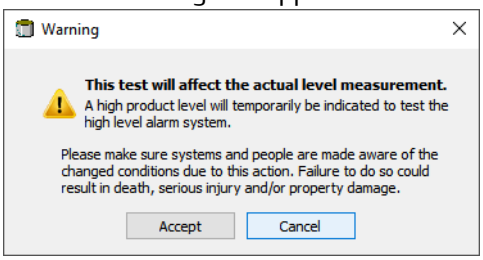


   The following measurement data is presented:

Parameter	Description
Level	Distance from the **Zero Reference Point** to the product surface or the Reference Reflector, respectively
Ullage	Distance from the **Tank Reference Point** to the product surface
Distance	Distance from the **Gauge Reference Point** to the Reference Reflector
Amplitude	Amplitude of the radar signal reflected by the product surface or the Reference Reflector, respectively

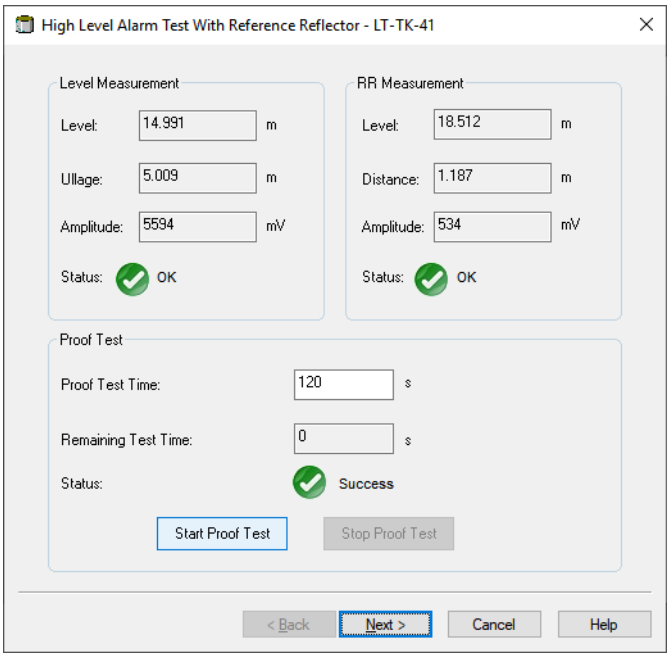
6. Specify duration of the test in the **Proof Test Time** field. It can be set to any value between 30 seconds and 60 minutes. The default value is 120 seconds. Ensure that enough time is provided for verification of the safety loop response.
7. Ensure that device status is **OK** (Ready to start).
8. Click the **Start Proof Test** button to perform a test for the specified proof test time.

9. Note the Warning that appears when starting the Proof Test:



Note
Ensure that the necessary actions are taken in order to maintain safety during the test.

10. Click the **Accept** button to run the test. Now the gauge will measure the actual distance to the reference reflector.
11. Verify that the safety loop is set to alarm state during the proof test.
12. Once a successful **High Level Alarm** proof test is finished, it will be confirmed. Now the gauge will return to normal operation.



13. Click the **Next** button to proceed with the appropriate output verification test depending on the selected option in the ***Proof Test*** window:
    - Relay output verification, or
    - Analog output verification
14. When the complete proof test is finished, click the **Next** button to open the ***Proof Test Summary*** window. You will have to sign this form in order to finish the test. A report in PDF format will be created automatically. It may be printed and saved in the desired network location. The report will be available from the ***Proof Test History*** window as well.

Related information

Rosemount 5900 Proof Test Manual Supplement

3.4.2 High level alarm test with simulated reference reflector

The High Alarm Test with simulated reference reflector should be combined with:

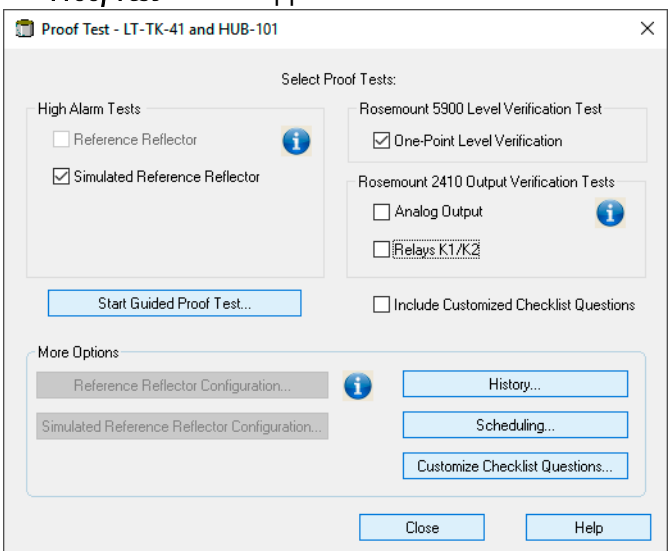
- One-point level proof test
- Output verification test such as Analog Output or Relays K1/K2

Prerequisites

Prior to running a proof test you will have to ensure that the **Simulated Reference Reflector** is properly calibrated and configured(5). Ensure that High Alarm is set to an appropriate level below the Proof Test Reference Reflector.

Procedure

1. Ensure that the TankMaster WinSetup program is up and running.
2. In the WinSetup workspace, click the right mouse button on the Rosemount 5900 device icon and select the **Proof Test** option.
   The ***Proof Test*** window appears:

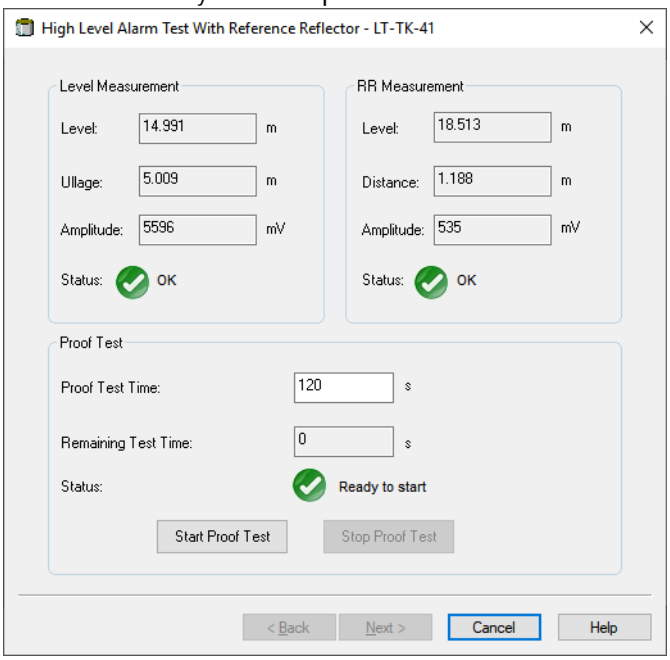


Note
The reference reflector must be configured(5) for the Guided Proof Test function to be enabled.

3. Select the **Simulated Reference Reflector** check box.
4. Select the **One-Point Level Verification** check box.

(5) *See the Rosemount 5900 Proof Test Manual Supplement for more information.*

5. Select one of the check boxes depending on the option for **Output Verification Tests** that is used:
   - Analog Output
   - Relays K1/K2
6. Click the **Start Guided Proof Test** button.
   This window lets you start a proof test:

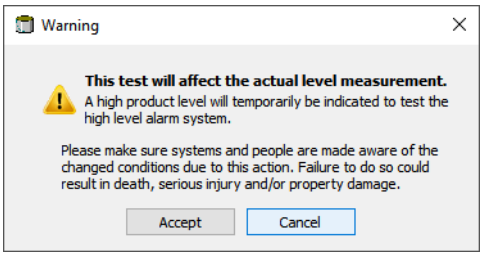


   The following measurement data is presented:

Parameter	Description
Level	Distance from the **Zero Reference Point** to the product surface or the Reference Reflector, respectively
Ullage	Distance from the **Tank Reference Point** to the product surface
Distance	Distance from the **Gauge Reference Point** to the Reference Reflector
Amplitude	Amplitude of the radar signal reflected by the product surface or the Reference Reflector, respectively

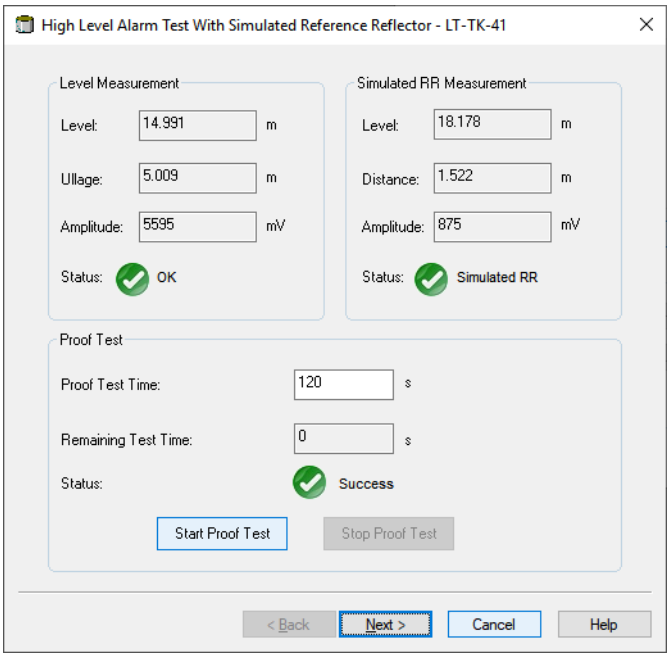
7. Specify duration of the test in the **Proof Test Time** field. It can be set to any value between 30 seconds and 60 minutes. The default value is 120 seconds. Ensure that enough time is provided for verification of the safety loop response.
8. Ensure that device status is **OK** (Ready to start).
9. Click the **Start Proof Test** button to perform a test for the specified proof test time.

10. Note the **Warning** that appears when starting the Proof Test:



Note
Ensure that the necessary actions are taken in order to maintain safety during the test.

11. Click the **Accept** button to run the test. Now the gauge will measure the actual distance to the reference reflector.
12. Verify that the safety loop is set to alarm state during the proof test.
13. Once a successful **High Level Alarm** proof test is finished, it will be confirmed. Now the gauge will return to normal operation.



14. Click the **Next** button to proceed with the **One-point Verification** test.
15. When the **One-point Verification** test is finished, the proof test procedure continues with the appropriate output verification test depending on the type of test performed:
    - Relay output verification, or
    - Analog output verification
16. When the complete proof test is finished, click the **Next** button to open the ***Proof Test Summary*** window. You will have to sign this form in order to finish the test. A

report in PDF format will be created automatically. It may be printed and saved in the desired network location. The report will be available from the ***Proof Test History*** window as well.

Related information

Rosemount 5900 Proof Test Manual Supplement

3.4.3 One-point level test

The One-point level test should be combined with one of the following output verification tests:

- Analog Output
- Relays K1/K2

Procedure

1. Ensure that the TankMaster WinSetup program is up and running.
2. In the WinSetup workspace, click the right mouse button on the Rosemount 5900 device icon and select the **Proof Test** option.
   The ***Proof Test*** window appears.
3. Select the **One-Point Level Verification** check box.
4. Select one of the check boxes for **Analog Output** or **Relays K1/K2** verification tests depending on the output option that is used.
5. Click the **Start Guided Proof Test** button and follow the instructions in the ***Guided Proof Test*** wizard.
   Now the One-point level test will be performed followed by the selected output verification test.
6. Compare the level presented in TankMaster with a second reference such as the BPCS level sensor or a manual hand dip(6).
7. Once the One-point verification test is finished, TankMaster will automatically proceed with the appropriate output verification test depending on the selected option in the ***Proof Test*** window:
   - Relays K1/K2: verify energized and de-energized states for each relay K1and K2.
   - Analog output: verify current value, High alarm current, and Low alarm current.

Related information

Relay output verification
Analog output verification

(6) See the Rosemount 5900S Radar Level Gauge Reference Manual for a description of how to perform hand dipping

3.5 Partial proof test

Partial proof tests are implemented as follows in Rosemount TankMaster:

- Relay output verification
- Analog output verification

A comprehensive test can be achieved by combining several partial proof tests.

Related information

Proof test methods

3.5.1 Relay output verification

This proof test verifies the relay output, i.e. whether the relay is able to open and close.

The relay output may be verified by using a multimeter or the SIF logic solver (Safety PLC) to ensure that relay output from the Rosemount 2410 corresponds to indicated relay state in TankMaster.

Procedure

1. Ensure that the TankMaster WinSetup program is up and running.
2. In the WinSetup workspace, click the right mouse button on the Rosemount 5900 device icon and select the **Proof Test** option.
   The ***Proof Test*** window appears.
3. Select the **Relays K1/K2** check box.
4. Click the **Start Guided Proof Test** button and follow the instructions in the ***Guided Proof Test*** wizard.
   a) Verify that K1 relay output corresponds to the presented relay state.
   b) Manually change relay state and verify that relay state changed and corresponds to the presented state for K1.
   c) Verify that K2 relay output corresponds to the presented relay state.
   d) Manually change relay state and verify that relay state changed and corresponds to the presented state for K2.

3.5.2 Analog output verification

This test verifies that the 4-20 mA analog output responds to level measurement failure by switching to the configured alarm mode.

The analog output may be verified by using a multimeter or the SIF logic solver (Safety PLC) to measure and verify that the analog output current value from the Rosemount 2410 corresponds to the current value indicated in Rosemount TankMaster. The test includes verification of output current, High Alarm current, and Low Alarm current.

Procedure

1. Ensure that the TankMaster WinSetup program is up and running.
2. In the WinSetup workspace, click the right mouse button on the Rosemount 5900 device icon and select the **Proof Test** option.
   The ***Proof Test*** window appears.
3. Select the **Analog Output** check box.
4. Click the **Start Guided Proof Test** button and follow the instructions in the ***Guided Proof Test*** wizard.
   a) Verify the **Output current** value from the Rosemount 2410 Tank Hub.
   b) Verify the **High alarm current** value from the Rosemount 2410 Tank Hub.
   c) Verify the **Low alarm current** value from the Rosemount 2410 Tank Hub.

3.5.3 High Level alarm test using the Rosemount 2230 display

A partial proof test can be started from a Rosemount 2230 Graphical Field Display. It allows the user to initiate a High Level alarm test from the tank instead of the control room. It is a partial proof test which can be combined with other tests for a comprehensive proof test.

Before running this remote test, be sure to read this manual on how to perform ***High level alarm tests with reference reflector*** and ***High level alarm tests with simulated reference reflector***.

Prior to running a proof test you will have to ensure that a **Proof Test Reference Reflector** is installed and properly calibrated and configured(7). A Reference Reflector can be used in combination with the Rosemount 5900 Parabolic and Array antennas.

Alternatively you may use a **Simulated Reference Reflector**. In both cases you must ensure that proper calibration and configuration is performed.

Ensure that High Alarm is set to an appropriate level below the **Proof Test Reference Reflector**.

See the Rosemount 5900 Proof Test Manual Supplement for instructions on how to install and configure a proof test Reference Reflector.

Related information

Proof test methods
High level alarm test with reference reflector
High level alarm test with simulated reference reflector

Preparations

Prior to performing the proof test it is recommended that you:

- Prepare a test protocol in order to fill in the result of the test
- Ensure that the control room is made aware of the proof test
- Note the level reading on the display before starting the test
- Enable the remote proof test function
- Configure Proof test time (optional)
- Configure Password (optional)

Requirements

Ensure that all devices meet the firmware requirements:

- Model code SIL S for Rosemount 5900S and 2410
- Proof test Reference Reflector(8) or Simulated Reference Reflector
- Rosemount TankMaster version 6.F0 or later

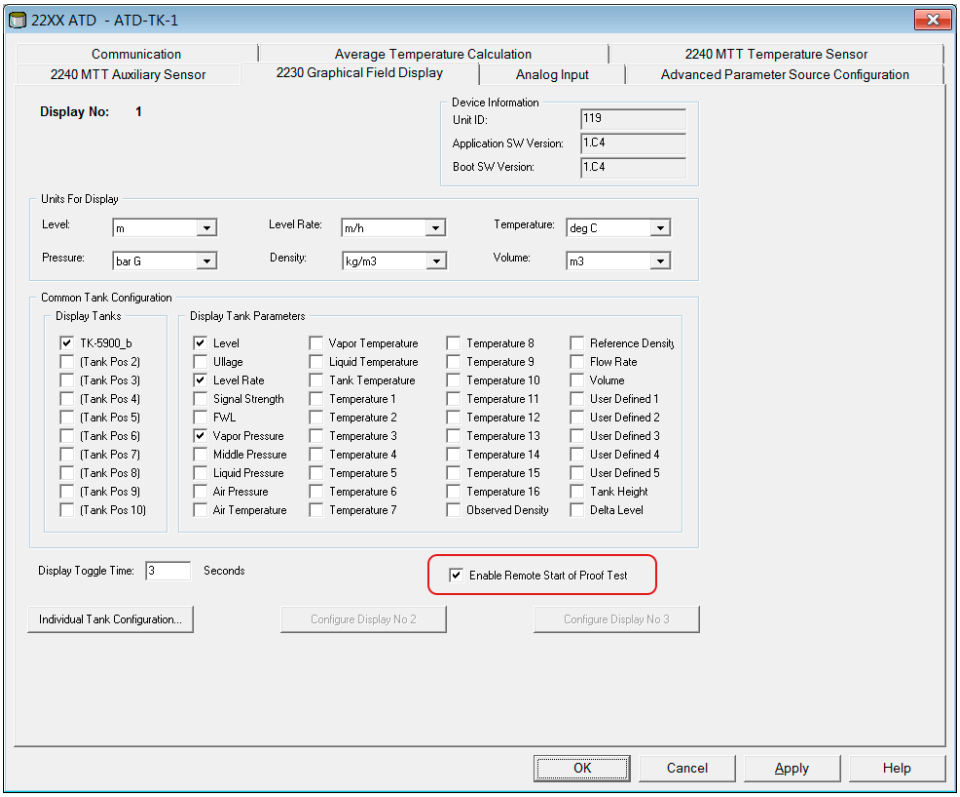
(7) See the Rosemount 5900 Proof Test Manual Supplement for more information.
(8) For LPG/LNG tanks the Verification Pin can be used as a reference reflector.

- Rosemount 2410: firmware version 1.G5 or later
- Rosemount 5900 with Physical reference reflector: firmware version 1.B9 or later
- Rosemount 5900 with Simulated reference reflector: firmware version 1.F0 or later
- Rosemount 2230: firmware 1.C0 or later

Enable remote proof test

Procedure

1. In TankMaster WinSetup, right-click the **ATD** device icon.
2. Select **Properties** and select the ***2230 Graphical Field Display*** tab.
3. Locate and select the check box named **Enable Remote Start of Proof Test**.



4. Select **Apply** to save the current configuration.
5. Select **OK** to close the window. The **Remote Start of Proof Test** function remains enabled until the box is unchecked.

Proof test time

The default proof test time is 120 seconds. If you don't need to change the test time you may skip this step.

Procedure

1. In TankMaster WinSetup, right-click the **Rosemount 2410 Tank Hub** device icon, select **Properties**, and open the ***View Holding Registers*** window.

2. Locate register **6088 SysCtrl-ProofTestTime**.
3. Set the desired test time and select the **Apply** button.

Password

The default password is “000”. In case you don’t need to change it, you may skip this step.

Procedure

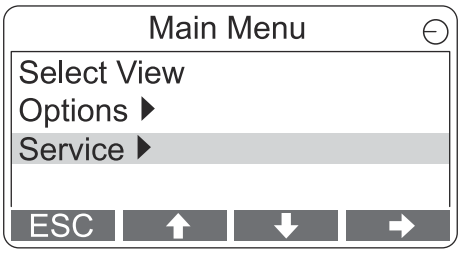
1. In TankMaster WinSetup, right-click the **ATD** device icon, select **Properties**, and open the ***View Holding Registers*** window.
2. Locate register **16238 Display_Ctrl.ProofTestPassword**.
3. Type the desired password. It can be set between “0” and “999”.
4. Select the **Apply** button.

Initiate proof test from a Rosemount 2230 Display

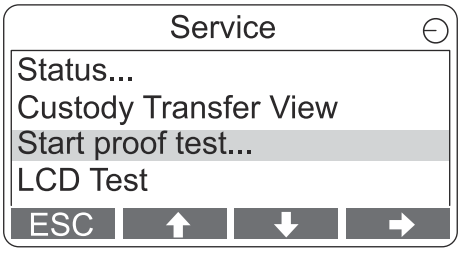
Follow this procedure to perform a proof test. Note that the relay and/or analog output is active during the proof test.

Procedure

1. In the display tank view, select **Menu** to open the ***Main Menu*** view.
2. Select the **Service** option.

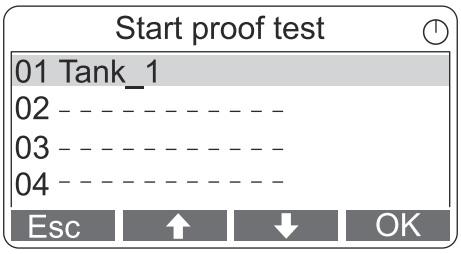


3. Select **Start proof test**.

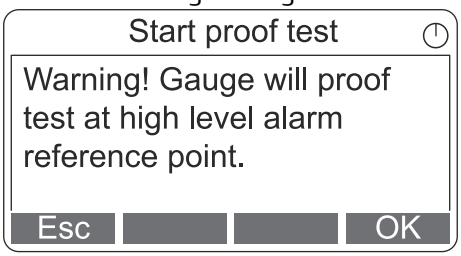


4. Enter password. Note that default password is “000”.

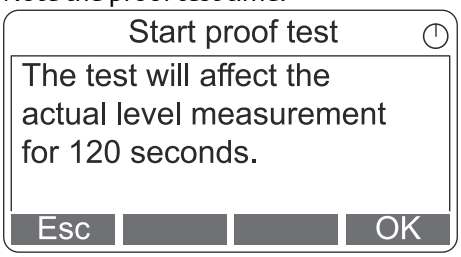
5. Choose the desired tank.



6. Read the warning message.

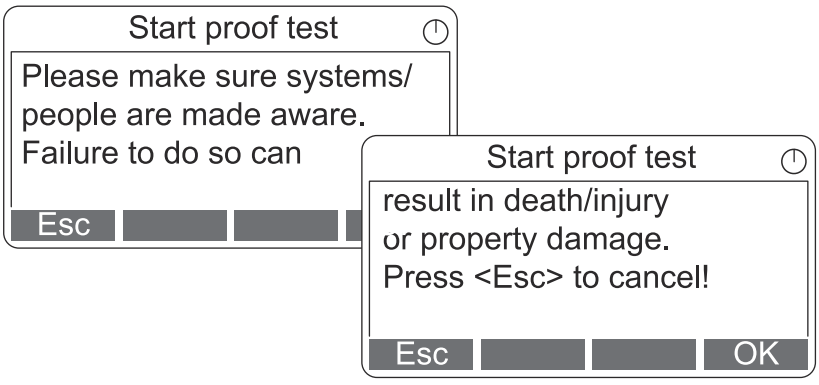


7. Note the proof test time.



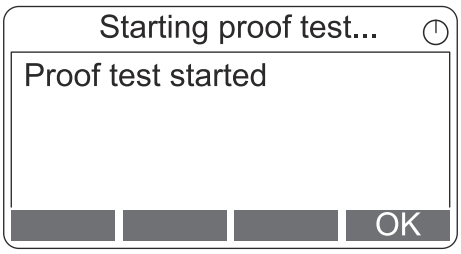
Important
Ensure that the control room staff is notified.

8. In this step you will confirm that the proof test is to be started. Please follow the instructions on the screens and click **OK**. You may abort the proof text by selecting **Esc** at anyone of these screens.



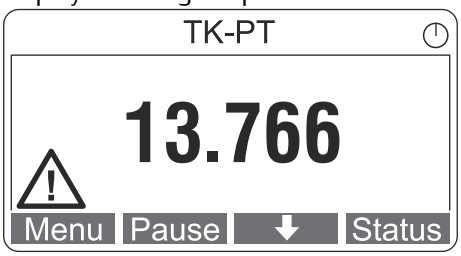
9. Select **OK** to start activating the proof test.

10. Wait for the display to show **Proof test started**. Now the proof test is activated.

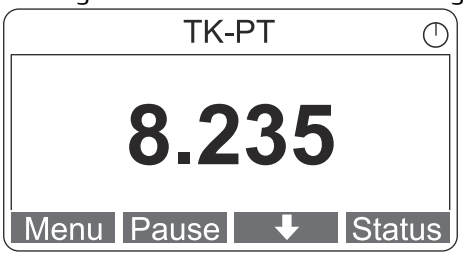


11. Select **OK** to return to the main menu.

    Now the proof test is up and running. Note that the simulated value icon ⚠ is displayed during the proof test.



12. When the proof test is finished, verify that the level reading returns to its normal reading and the simulated value icon is gone.



Proof test protocol

Once the proof test is finished, a report should be created. It is the end user's responsibility to execute the proof tests and keep records.

3.6 Maintenance

The proof test procedure should be carried out at regular intervals.

The devices in the Rosemount Tank Gauging Safety System may only be repaired or modified by authorized personnel trained by Emerson Automation Solutions / Rosemount Tank Gauging.

For firmware upgrade use the procedure in the Rosemount 5900S Radar Level Gauge Reference Manual. Check release notes prior to upgrade. See the Rosemount Tank Gauging web site Emerson.com for more information.

A Specifications and Reference Data

For general specifications see technical documentation for the Rosemount™ 5900 Radar Level Gauge and the Rosemount 2410 Tank Hub:

- Rosemount 2410 Tank Hub (reference manual)
- Rosemount 5900S Radar Level Gauge (reference manual)
- Rosemount 5900C Radar Level Gauge (reference manual)
- Rosemount Tank Gauging System (system data sheet)

A.1 SIS reference

Failure rate data

The FMEDA report includes failure rates.

Failure values

- Self-diagnostics test interval: at least every 90 minute
- Safety response time 20 seconds

A.2 Product life

50 years.

Based on worst case component wear-out mechanisms not based on wear-out of process wetted materials.

B Terms and Definitions

The following list describes terms and definitions used in this manual.

Table B-1: Terms Used in Safety Instrumented Systems

Term	Description
BPCS	Basic Process Control System
Demand rate	How often it will be required from a safety integrity system (or the safety function) to react on inputs from process to bring it into a safe state, i.e. to issue an alarm
FIT	Failure in Time (1 FIT = 1failure/10^9 h)
FMEDA	Failure Modes, Effects and Diagnostics Analysis
HFT	Hardware Fault Tolerance
High mode of operation	The safety function is only performed on demand, in order to transfer the EUC into a specified safe state, and the frequency of demands is greater than one per year
LAHH	Level Alarm High High
Low mode of operation	The safety function is only performed on demand, in order to transfer the EUC into a specified safe state, and the frequency of demands is no greater than one per year
Mode of operation	The way in which a safety function operates, which may be either low mode of operation or high mode of operation
PFD_{avg}	Average probability of Failure on Demand
PFH (average frequency of a dangerous failure per hour)	Average frequency of a dangerous failure of an E/E/PE safety related system to perform the specified safety function over a given period of time.
SFF	Safe Failure Fraction summarizes the fraction of failures, which lead to a safe state and the fraction of failures which will be detected by diagnostic measures and lead to a defined safety action.
SIF	Safety Instrumented Function
SIL	Safety Integrity Level
SIS	Safety Instrumented System
Type B component	Complex component (using micro controllers or programmable logic)
1oo1D	Architecture consisting of a single channel with additional diagnostic capabilities.

C Dry-run Configuration

This section describes the recommended procedure to configure the Safety System for Dry-run applications.

C.1 Configure dry-run

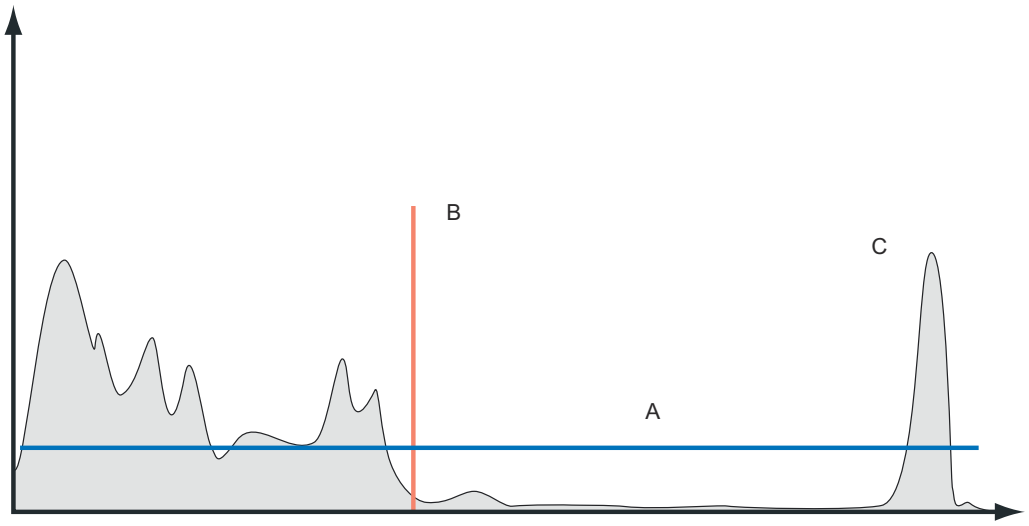
Prerequisites

Prior to setting up the Safety System for Dry-run it has to be installed and configured as a standard Rosemount™ Tank Gauging system. The Dry-run configuration aims at specifying the Low Alarm Limit as well as optimizing the Hold Off Distance and Amplitude Thresholds.

The Hold Off Distance should be as large as possible to avoid impact from noise in the upper part of the tank.

It is recommended to use the **Tank Scan**(9) function in TankMaster™ WinSetup for configuration of various amplitude thresholds. By creating an **Amplitude Threshold Point** (ATP) curve, noise will be filtered out to ensure that the product surface is detected at all times.

Figure C-1: Tank Scan

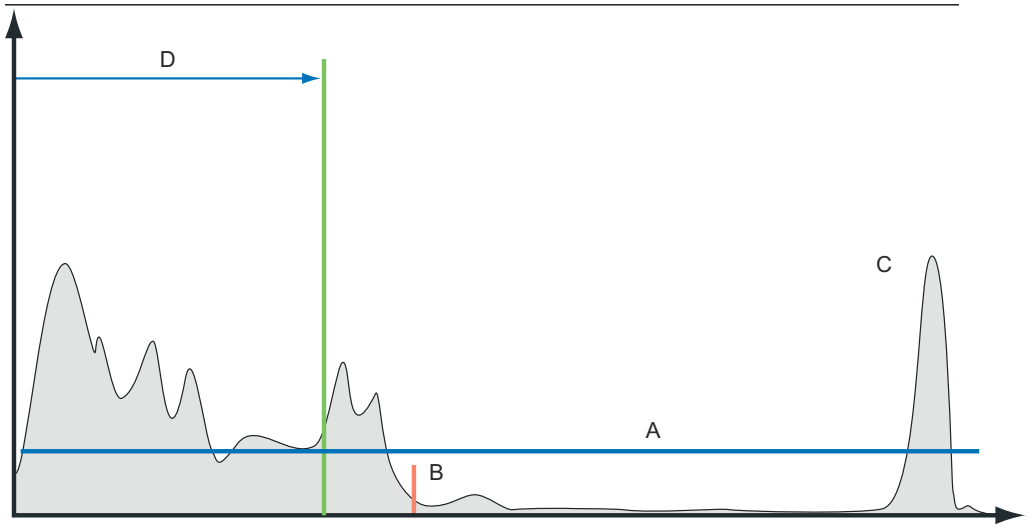


A. Amplitude threshold
B. High Alarm Limit
C. Product surface

(9) To open the Tank Scan window: in TankMaster WinSetup, right-click the 5900 gauge icon, choose Properties, select the Advanced Configuration tab and click the Tank Scan button.

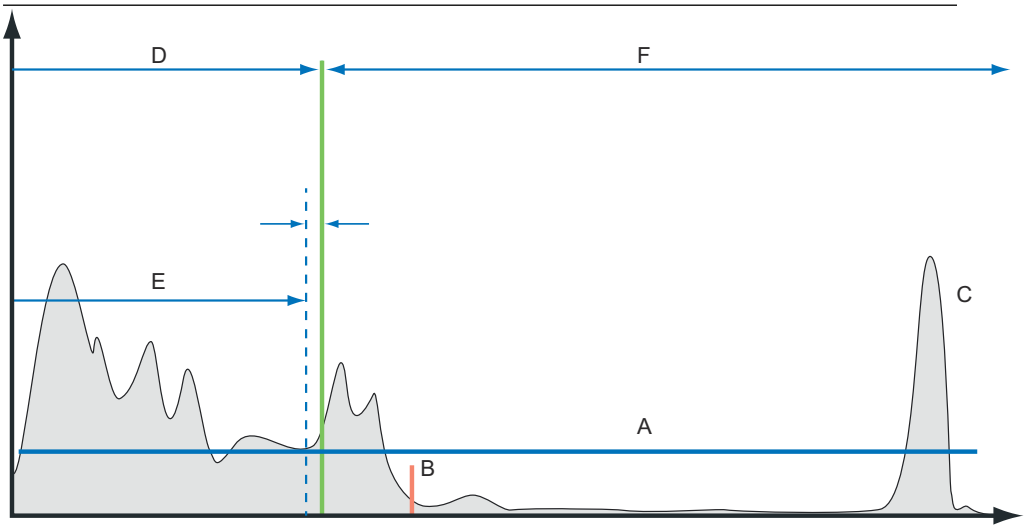
Procedure

1. Define the **Minimum Operation Distance** for the application. This is the distance from the bottom of the flange to the maximum filling point of the tank in normal operation.



A. Amplitude threshold
B. High Alarm Limit
C. Product surface
D. Minimum operation distance

2. Specify a safety margin to ensure a sufficient gap between the **Hold Off Distance** and the **Minimum Operation Distance**. A margin of 50 -100 mm should be sufficient in most cases to make sure that no false alarms are triggered in case of minor measurement errors near the maximum filling point.



A. Amplitude threshold
B. High Alarm Limit
C. Product surface
D. Minimum Operation Distance
E. Hold Off Distance
F. Measurement range

3. Set the **Hold Off Distance**(10) equal to: **Minimum Operation Distance - Safety Margin**.

(10) To set the Hold Off Distance: in TankMaster WinSetup, right-click the Rosemount 5900 gauge icon, select Properties, select the Antenna tab.

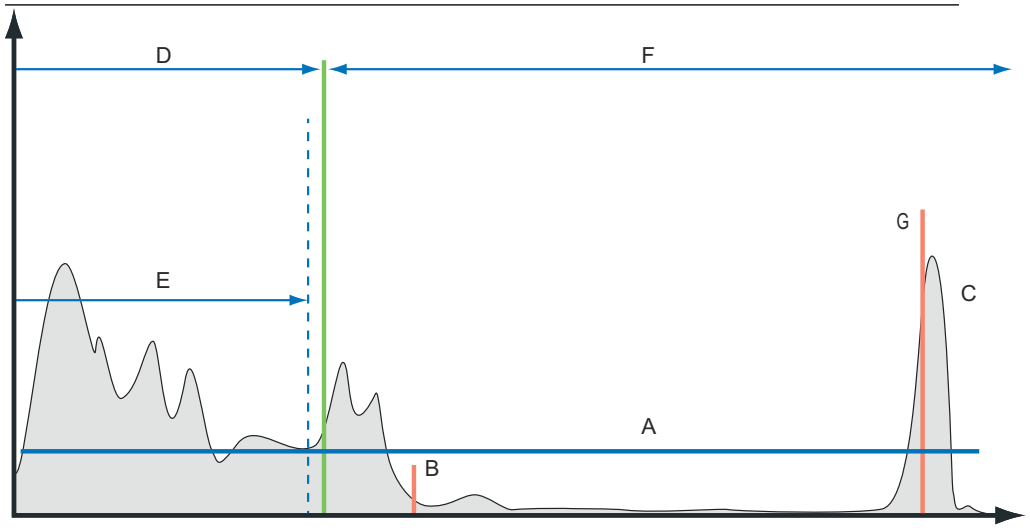
4. Specify and configure the **Low Alarm Limit**. Ensure that the **Amplitude Threshold** is less than 25% of the amplitude of the **Product Surface** echo. The default value is 400mV.

Note
The product surface should be slightly below the **Low Alarm Limit** in the Tank.

There are two reasons for this:

a) calibration should be performed at this point in the tank to ensure highest accuracy at the Low Alarm Limit

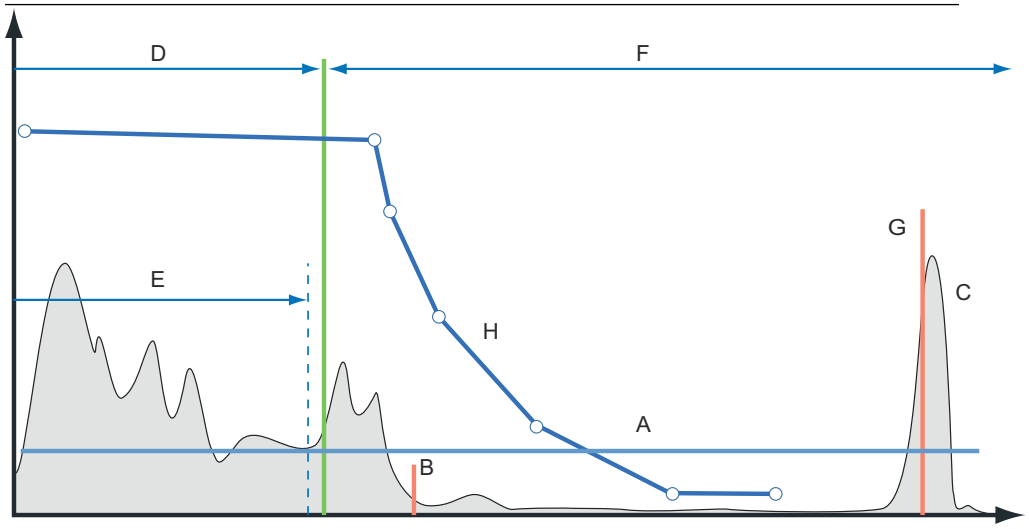
b) to make sure that appropriate Amplitude Thresholds will be set based on the signal strength at this point



A. Amplitude threshold
B. High Alarm Limit
C. Product surface
D. Minimum Operation Distance
E. Hold Off Distance
F. Measurement range
G. Low Alarm Limit

5. Check the ***Tank Scan*** window for an overview of how much noise there is in the **Near Zone** region below the **Hold Off Distance**.

Tip
To open ***Tank Scan***: right-click the Rosemount 5900 icon and select **Properties** → **Advanced Configuration** → **Tank Scan**.



A. Amplitude threshold
B. High Alarm Limit
C. Product surface
D. Minimum operation distance
E. Hold Off Distance
F. Measurement range
G. Low Alarm Limit
H. Amplitude Threshold Point (ATP)

6. Filter out noise in the **Near Zone** region by adding an **ATP** curve in TankMaster. The **ATP** should be approximately four times the amplitude of the noise amplitude.
7. Click the **Apply** button to download the ATP to the Rosemount 5900 level gauge.

00809-0400-5100
Rev. AF
2021

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