Reference Manual
00809-0100-4026, Rev DA
March 2006

Rosemount 5400 Series

Two-wire Radar Level Transmitter

HART® FIELD COMMUNICATIONS PROTOCOL

ROSEMOUNT®

www.rosemount.com

EMERSON™
Process Management

Reference Manual
00809-0100-4026, Rev DA
March 2006

Rosemount 5400 Series

NOTICE

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

Within the United States, Rosemount Inc. has two toll-free assistance numbers.

Customer Central: 1-800-999-9307(*7:00 a.m. to 7:00 p.m. CST)*
Technical support, quoting, and order-related questions.

North American Response Center:

Equipment service needs.

1-800-654-7768 (*24 hours a day – Includes Canada*)

For equipment service or support needs outside the United States, contact your local Rosemount representative.

NOTICE

There are no health hazards from the Rosemount 5400 Series transmitter. The microwave power density in the tank is only a small fraction of the allowed power density according to international standards.

⚠CAUTION

The products described in this document are NOT designed for nuclear-qualified applications.

Using non-nuclear qualified products in applications that require nuclear-qualified hardware or products may cause inaccurate readings.

For information on Rosemount nuclear-qualified products, contact your local Rosemount Sales Representative.

This product is designed to meet FCC and R&TTE requirements.

This device complies with part 15 of the FCC rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

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Section 1 Introduction

SAFETY MESSAGES

Procedures and instructions in this manual may require special precautions to ensure the safety of the personnel performing the operations. Information that raises potential safety issues is indicated by a warning symbol (⚠). Refer to the safety messages listed at the beginning of each section before performing an operation preceded by this symbol.

⚠WARNING

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

- Make sure 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 transmitter is consistent with the appropriate hazardous locations certifications.
- Before connecting a 275/375 Handheld Communicator in an explosive atmosphere, make sure the instruments in the loop are installed in accordance with intrinsically safe or non-incendive field wiring practices.

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 etc., may also jeopardize safety and is under no circumstances allowed.

MANUAL OVERVIEW

This manual provides installation, configuration and maintenance information for the Rosemount 5400 Series Radar Transmitter.

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SERVICE SUPPORT

To expedite the return process outside of the United States, contact the nearest Rosemount representative.

Within the United States, call the Rosemount National Response Center using the 1-800-654-RSMT (7768) toll-free number. This center, available 24 hours a day, will assist you with any needed information or materials.

The center will ask for product model and serial numbers, and will provide a Return Material Authorization (RMA) number. The center will also ask for the process material to which the product was last exposed.

Rosemount National Response Center representatives will explain the additional information and procedures necessary to return goods exposed to hazardous substance can avoid injury if they are informed of and understand the hazard. If the product being returned was exposed to a hazardous substance as defined by Occupational Safety and Health Administration (OSHA), a copy of the required Material Safety Data Sheet (MSDS) for each hazardous substance identified must be included with the returned goods.

Section 2 Transmitter Overview

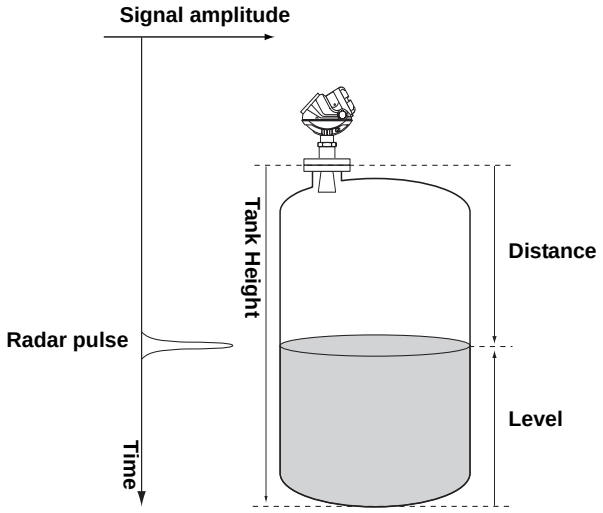
THEORY OF OPERATION

The Rosemount 5400 Series Radar Transmitter is a smart, two-wire continuous level transmitter. A 5400 transmitter is installed at the tank top and emits short microwave pulses towards the product surface in the tank. When a pulse reaches the surface of the material it is measuring, part of the energy is reflected back to the antenna for subsequent processing by the transmitter electronics. The time difference between the transmitted and reflected pulse is detected by a micro-processor and is converted into a distance from which the level is calculated.

The product level is related to the tank height and the measured distance by the following expression:

Level=Tank Height - Distance.

Figure 2-1. Measurement principle for the 5400 Series.



COMPONENTS OF THE TRANSMITTER

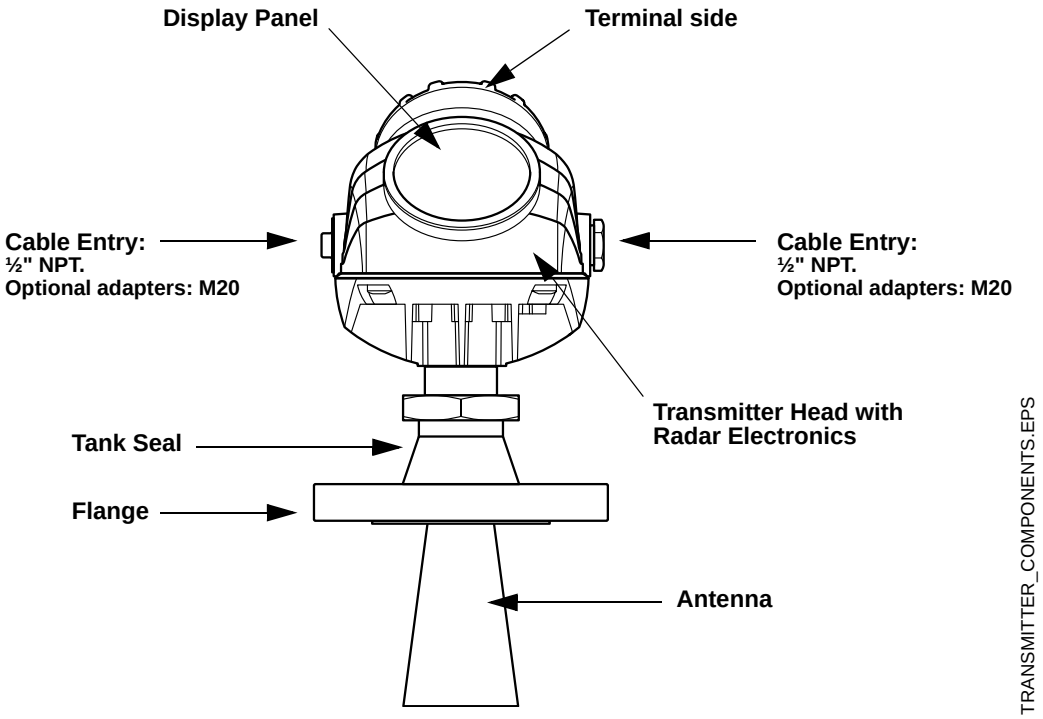
The Rosemount 5400 Series Radar Transmitter has a die-cast aluminum housing which contains advanced electronics for signal processing.

The radar electronics produces the electromagnetic pulse that is emitted through the antenna. There are different antenna types and sizes available for various applications.

The transmitter head has separate compartments for electronics and terminals. The head can be removed without opening the tank. The head has two entries for conduit/cable connections.

The tank connection consists of a Tank Seal and a flange (ANSI, EN (DIN) or JIS).

Figure 2-2. Transmitter components.

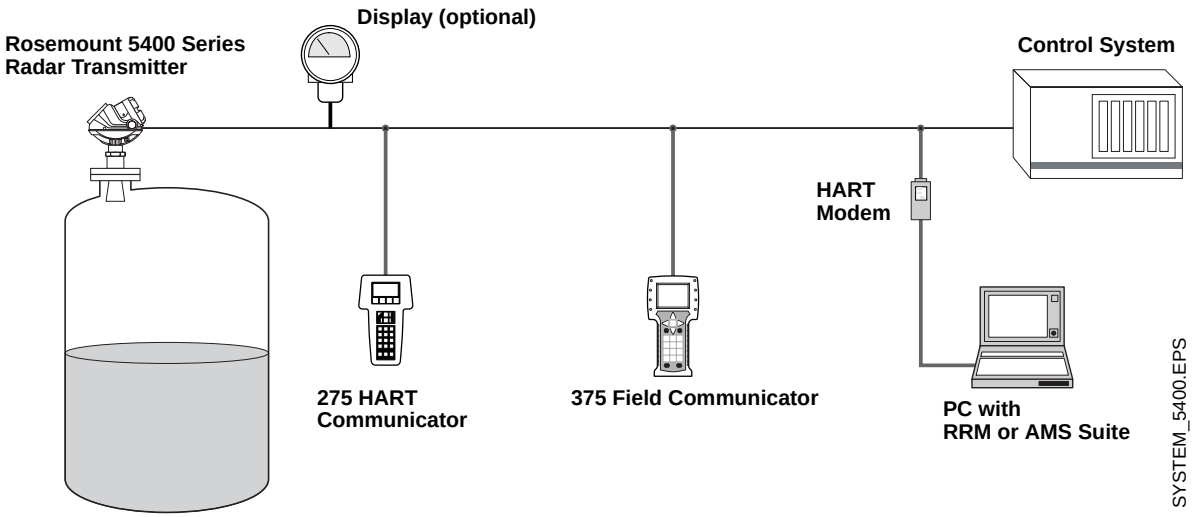


SYSTEM ARCHITECTURE

The 5400 Series Radar Level Transmitter is a powerful radar level transmitter suitable for non-contact level measurements in process tanks and other types of tanks. It is designed for easy installation and maintenance free operation.

The Rosemount 5400 Series Radar Transmitter is loop-powered which means it uses the same two wires for both power supply and output signal. The output is a 4-20 mA analog signal superimposed with a digital HART signal.

Figure 2-3. System Integration.



The Rosemount 5400 Series Radar Transmitter can easily be configured by using a PC and the Rosemount Radar Master (RRM) software package or via a 275/375 Handheld Communicator. RRM offers configuration and service capabilities and functions for presentation of measurement data. The transmitter is also compatible with the AMS™ Suite software which can be used for configuration.

For stand-alone systems, or as a complement to a PC or a control system, you can monitor level data using an analog output. As an option, the Rosemount 5400 Series Radar Level Transmitter can be equipped with a Display for monitoring measurement data.

PROCESS CHARACTERISTICS

Dielectric constant

The reflectivity of the product is a key parameter for measurement performance. A high dielectric constant of the media gives better reflection and thus enables a longer measuring range.

Foam

How well the Rosemount 5400 Series Radar Transmitter measures in foamy applications depends upon the properties of the foam; light and airy or dense and heavy, high or low dielectrics, etc. If the foam is conductive and creamy the transmitter will probably measure the surface of the foam. If the foam is less conductive the microwaves will probably penetrate the foam and measure the liquid surface.

Turbulence

A calm surface gives better reflection than a turbulent surface. For turbulent applications, the maximum range of the radar transmitters is reduced. The range is dependent upon the frequency, the antenna size, the dielectric of the material and the degree of turbulence. Consult tables 2-1and 2-2 for the expected maximum range with the variables listed.

Temperature/Pressure/ Density and Vapor

Temperature and pressure generally have no impact on measurements. Measurements are also insensitive to product density and vapor.

Condensation

For applications where heavy condensation and vapors may occur the low frequency version Rosemount 5401 is recommended.

Tank Characteristics

The conditions inside the tank have a significant impact on measurement performance. For more information see “Vessel Characteristics” on page 3-9.

ANTENNA SELECTION GUIDE/MEASURING RANGE

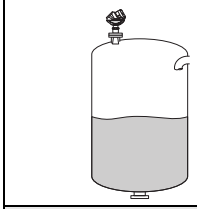
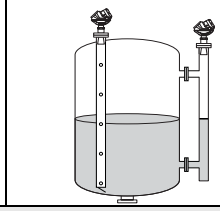
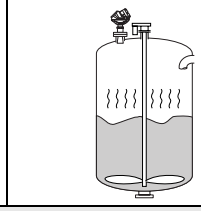
The measuring range primarily depends on the antenna type and size, the dielectric constant (ε_r) of the liquid and process conditions. For optimum performance, make sure not to exceed the maximum measuring range values below.

A. Oil, gasoline and other hydrocarbons, petrochemicals (ε_r =1.9-4.0).

B. Alcohols, concentrated acids, organic solvents, oil/water mixtures and acetone (ε_r =4.0-10.0).

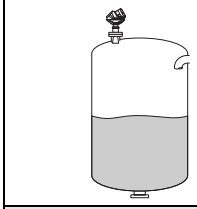
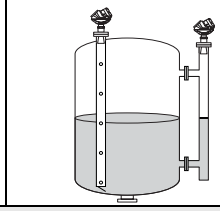
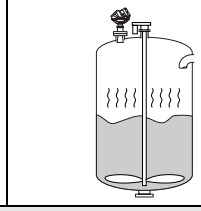
C. Conductive liquids, e.g. water based solutions, dilute acids and alkalis (ε_r>10.0).

Table 2-1. Measuring range for the Rosemount 5401 model.

Low Frequency Device **Units: ft (m)**									
	Dielectric Constant								
	A	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**
Cone, 3 in(1)	NA	NA	NA	66 (20)	66 (20)	66 (20)	NA	NA	NA
Cone, 4 in/ Rod(2)	20 (6)	33 (10)	43 (13)	66 (20)	66 (20)	66 (20)	9.9 (3)	16 (5)	23 (7)
Cone, 6 in	33 (10)	49 (15)	66 (20)	66 (20)	66 (20)	66 (20)	16 (5)	23 (7)	30 (9)
Cone, 8 in	49 (15)	66 (20)	98 (30)	66 (20)	66 (20)	98 (30)	23 (7)	30 (9)	36 (11)

(1) Pipe installations only. NA=Not Applicable.
(2) Pipe installations are not allowed with Rod antennas.

Table 2-2. Measuring range for the Rosemount 5402 model.

High Frequency Antennas **Units: ft (m)**									
	Dielectric Constant								
	A	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**
Cone, 2 in/ Process Seal(1)	16 (5)	33 (10)	49 (15)	66 (20)	66 (20)	66 (20)	6.6 (2)	9.8 (3)	13 (4)
Cone, 3 in/ Process Seal(1)	33 (10)	49 (15)	66 (20)	66 (20)	66 (20)	66 (20)	9.8 (3)	13 (4)	20 (6)
Cone, 4 in/ Process Seal(1)	49 (15)	66 (20)	98 (30)	66 (20)	66 (20)	98 (30)	13 (4)	20 (6)	26 (8)

(1) Pipe installations are not allowed with Process Seal antennas.

Section 3 Installation

SAFETY MESSAGES

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

⚠WARNING

Explosions could result in death or serious injury:

Verify that the operating environment of the transmitter is consistent with the appropriate hazardous locations certifications.

Before connecting a HART-based Field Communicator in an explosive atmosphere, make sure 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.

⚠WARNING

Failure to follow safe installation and servicing guidelines could result in death or serious injury:

Make sure 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.

Do not perform any service other than those contained in this manual unless you are qualified.

⚠WARNING

High voltage that may be present on leads could cause electrical shock:

Avoid contact with leads and terminals.

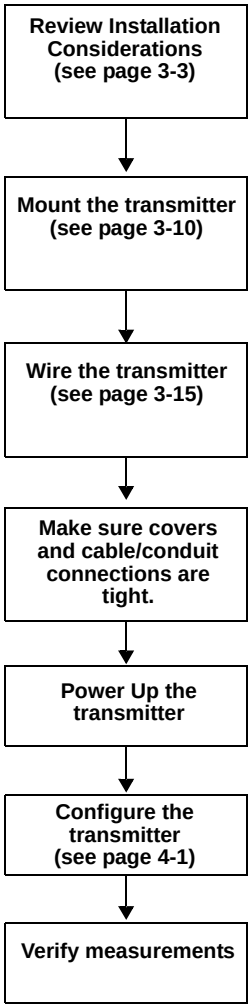
Make sure the main power to the 5400 transmitter is off and the lines to any other external power source are disconnected or not powered while wiring the gauge.

To prevent ignition of flammable or combustible atmospheres, disconnect power before servicing.

Antennas with non-conducting surfaces (e.g. Rod antenna and All PTFE antenna) may generate an ignition-capable level of electrostatic charge under extreme condtions. Therefore, when the antenna is used in a potentially explosive atmoshpere, appropriate measures must be taken to prevent electrostatic discharge.

INSTALLATION PROCEDURE

Follow these steps for proper installation:



MOUNTING CONSIDERATIONS

Before you install a Rosemount 5400 Series transmitter, be sure to consider specific mounting requirements, vessel characteristics and process characteristics.

Socket Recommendation

The Rosemount 5400 Series is mounted on a nozzle by using appropriate flanges. For best performance it is recommended that the socket meets the following recommendations:

Figure 3-1. Mounting of the 5400 Series transmitter.

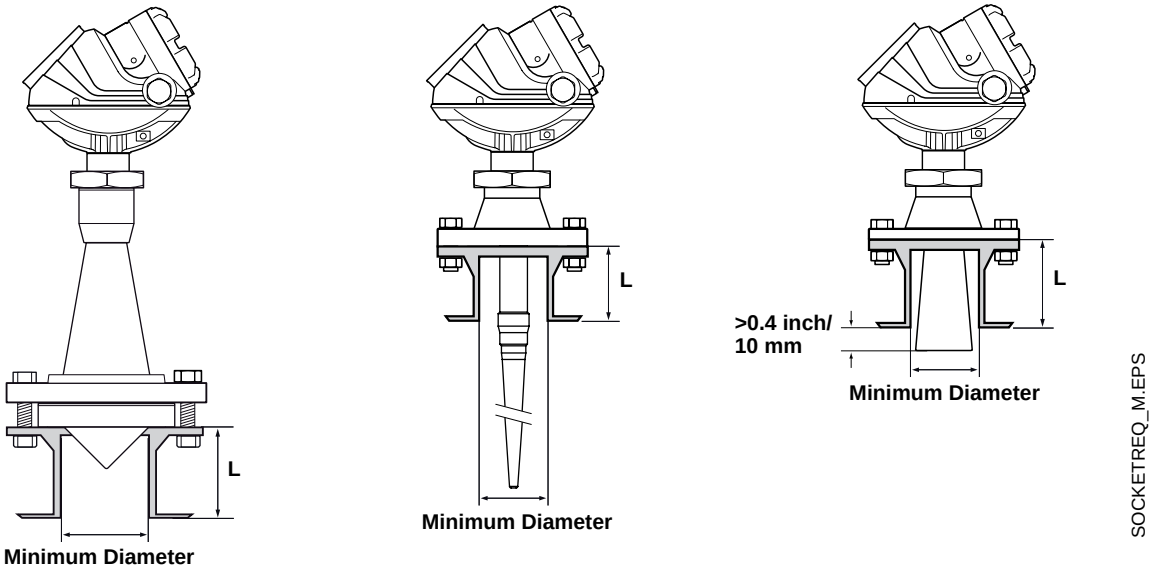


Table 3-1. Requirements on socket height and width.

5401	Antenna	L_{max} inch (mm)	Min. Diameter inch (mm)
	Cone 4 in.	5.5 (140)	3.8 (97)
	Cone 6 in.	6.9 (175)	5.7 (145)
	Cone 8 in.	10.2 (260)	7.6 (193)
	Rod (short)	4.0 (100)	1.5 (38)
	Rod (long)	10 (250)	1.5 (38)
5402	**Antenna**	L_{max} inch (mm)	**Min. Diameter inch (mm)**
	Cone 2 in. SST	6.1 (155)	2.2 (55)
	Cone 2 in. Hastelloy®, Monel®	5.5 (140)	2.2 (55)
	Cone 3 in. SST	5.5 (140)	2.8 (72)
	Cone 3 in. Hastelloy®, Monel®	6.5 (165)	2.8 (72)
	Cone 4 in. SST	8.5 (215)	3.8 (97)
	Cone 4 in. Hastelloy®, Monel®	9.4 (240)	3.8 (97)
	Process Seal 2 in.	19.7 (500)	2.0 (51)
	Process Seal 3 in.	19.7 (500)	3.0 (77)
	Process Seal 4 in.	19.7 (500)	4.0 (102)

Install the transmitter as follows:

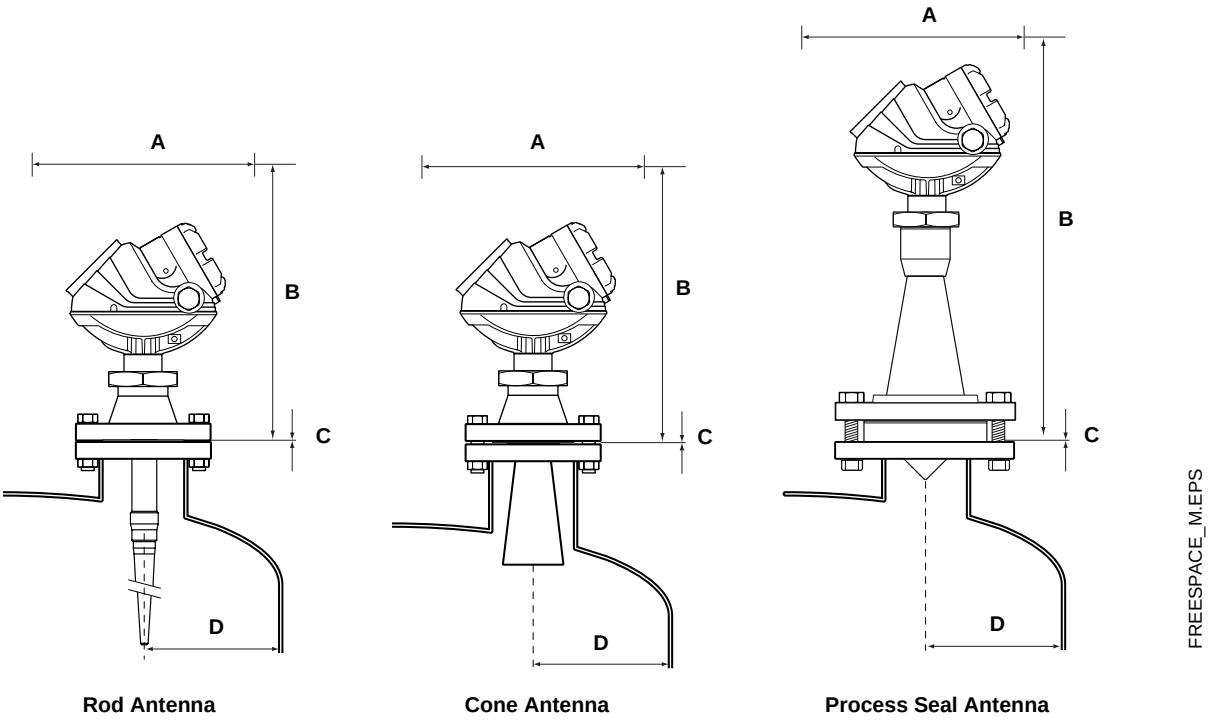
- Align the antenna vertically.
- Choose as large antenna diameter as possible. A larger receiving area concentrates the radar beam and ensures maximum antenna gain. Increased antenna gain means greater margin for weak surface echoes. A larger antenna also results in smaller beam angle and thereby, less interference from any internal structures in the tank.
- For best measurement performance, the antenna should extend below the nozzle 0.4 inches (10 mm) or more.
- In exceptional cases the Rosemount 5402 can be installed in nozzles which don’t fulfill the recommendations in Table 3-1. In those cases the 5402 with 3-in. and 4-in. antennas can be installed in nozzles with an unobstructed length of up to 39 in. (1 m). The 2-in. antenna may be used in nozzles where the total length is less than 12 in. (0.3) m.

Free Space

For easy access to the transmitter make sure that it is mounted with sufficient service space.

Mounting close to a tank wall, nozzle or obstruction may have a negative influence on measurement perfomance. For maximum measurement performance the transmitter should be mounted according to the following recommendations:

Figure 3-2. Free space recommendations.



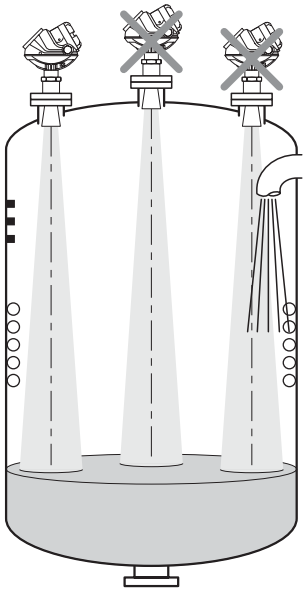
Rod Antenna **Cone Antenna** **Process Seal Antenna**

Service space		Distance inch (mm)
A Cone, Rod, Process Seal		20 (500)
B	Cone, Rod	24 (600)
	Process Seal	33 (850)
C. Inclination		**Maximum angle**
Cone, Rod, Process Seal		3°
D. Minimum distance to tank wall		**Distance inch (mm)**
Cone antenna, 5401		20 (500)
Cone antenna, 5402		10 (250)
Rod antenna, 5401		20 (500)
Process Seal, 5402		10 (250)

Recommended Mounting Position

When finding an appropriate mounting position for the transmitter the conditions of the tank must be carefully considered. The transmitter should be mounted so that the influence of disturbing objects is reduced to a minimum.

Figure 3-3. It is important to consider the proper mounting position.



MOUNTING_RESTRICTIONS.EPS

- Disturbing objects and filling inlets creating turbulence should be kept at a distance, outside the signal beam (see Figure 3-4 for beamwidth information).
- Avoid installing the transmitter at the center of the tank roof.
- A bridle / still pipe can be used to avoid interference from disturbing objects, turbulence or foam.

Beamwidth

The following recommendations should be considered when mounting the transmitter:

- The transmitter should be mounted with as few internal structures as possible within the beam angle.
- The flat tank wall can be located within the antenna beam angle as long as there is a minimum distance from the transmitter to the tank wall (see Figure 3-2 for preferred installation).

Figure 3-4. Beamwidth at various distances from the flange.

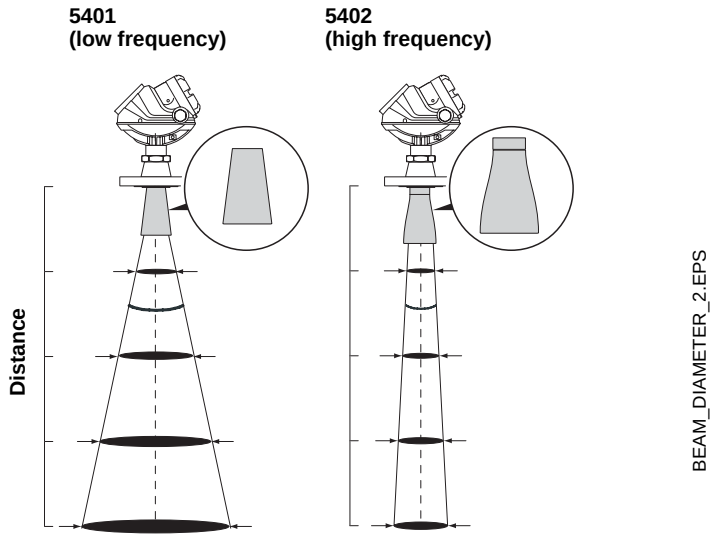


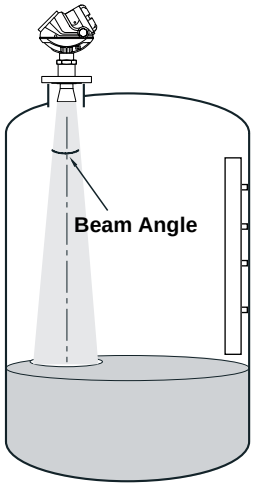
Table 3-2. Beamwidth for the Rosemount 5401 model.

Distance	Antenna		
	4 in. (DN 100) Cone /Rod	6 in. (DN 150) Cone	8 in. (DN 200) Cone
	Beam Diameter, ft (m)		
16 ft (5 m)	11.5 (3.5)	6.6 (2.0)	4.9 (1.5)
33 ft (10 m)	23.0 (7.0)	13.1 (4.0)	9.8 (3.0)
49 ft (15 m)	32.8 (10)	19.7 (6.0)	14.8 (4.5)
66 ft (20 m)	42.7 (13)	26.2 (8.0)	19.7 (6.0)
99 ft (30 m)	65.7 (20)	39.3 (12)	29.5 (9.0)

Table 3-3. Beamwidth for the Rosemount 5402 model.

Distance	Antenna		
	2 in. (DN 50) Cone/ Process Seal	3 in. (DN 80) Cone/ Process Seal	4 in. (DN 100) Cone/ Process Seal
	Beam Diameter, ft (m)		
16 ft (5 m)	4.9 (1.5)	3.3 (1.0)	3.3 (1.0)
33 ft (10 m)	9.8 (3.0)	6.6 (2.0)	4.9 (1.5)
49 ft (15 m)	14.8 (4.5)	9.8 (3.0)	8.2 (2.5)
66 ft (20 m)	19.7 (6.0)	13.1 (4.0)	9.8 (3.0)
99 ft (30 m)	29.5 (9.0)	19.7 (6.0)	14.8 (4.5)

Figure 3-5. Beam angle.



BEAMWIDTH2.EPSS

Table 3-4. Beam Angle for the Rosemount 5401.

Antenna	Half Power Beam Width
3 in. Cone	(Still Pipe)
4 in. Cone / Rod	37°
6 in. Cone	23°
8 in. Cone	17°

Table 3-5. Beam Angle for the Rosemount 5402.

Antenna	Half Power Beamwidth
Cone 2 in. / Process Seal	19°
Cone 3 in. / Process Seal	14°
Cone 4 in. / Process Seal	9°

Vessel Characteristics

Heating coils, agitators and other objects in the tank may lead to disturbing echoes and noise in the measurement signal. Vertical structures cause minimal effect since the radar signal is scattered rather than directed back to the antenna.

The shape of the tank bottom affects the measurement signal when the product surface is close to the tank bottom. The Rosemount 5400 Series has built-in functions which optimize measurement performance for various bottom shapes (see “Tank Type and Tank Bottom Type” on page 4-4).

Disturbing Objects

The Rosemount 5400 Series transmitter should be mounted so that objects such as heating coils, ladders, etc. are not within the radar signal path. These objects may cause false echoes resulting in reduced measurement performance. However, the transmitter has built-in functions designed to reduce the influence from disturbing objects in case such objects can not be totally avoided.

The Rosemount 5402 with its more narrow radar beam is particularly suitable in installations that have tall or narrow nozzles or nozzles close to the tank wall. It may also be used to avoid disturbing objects in the tank.

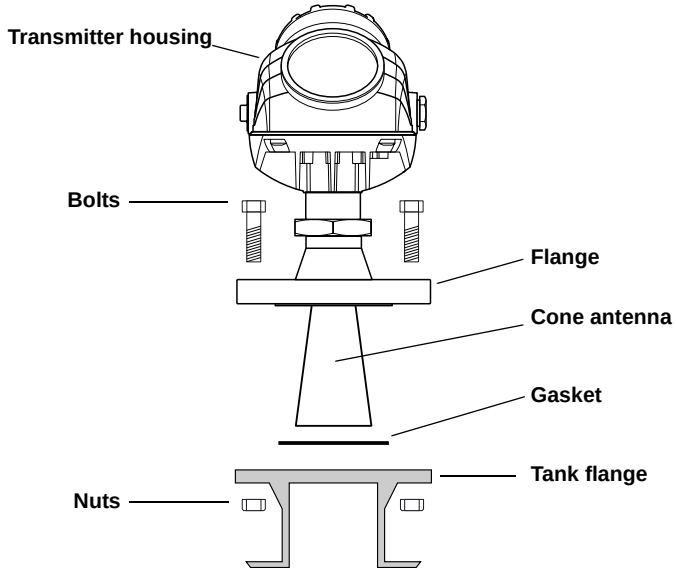
MECHANICAL INSTALLATION

Mount the transmitter on a nozzle on top of the tank. Make sure only qualified personnel performs the installation.

⚠ The transmitter housing must not be opened. If a software update or other service action is required that involves opening the housing, it must be done by a suitably trained service technician. Maintenance work that involves opening the housing must not be done when the transmitter is mounted on the tank.

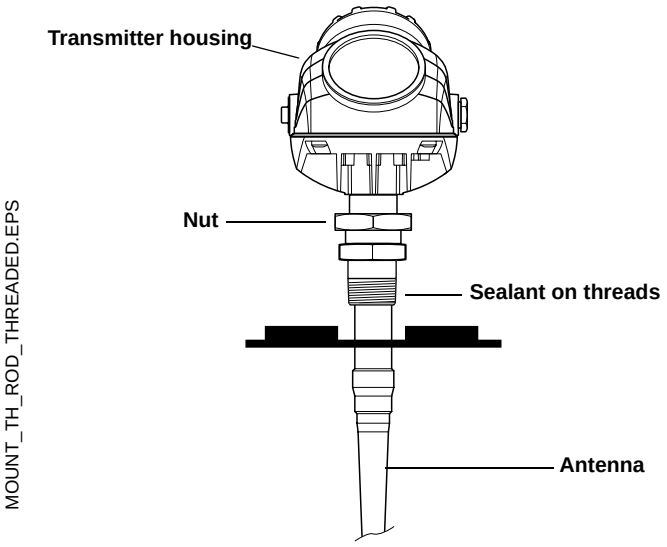
If the transmitter housing must be removed for service, make sure that the Teflon® sealing is carefully protected against dust and water.

Figure 3-6. Mounting the 5400 with cone antenna and flange.



1. Place a gasket with thickness and of material suitable to the process on top of the tank flange.
2. Lower the transmitter with antenna and flange into the tank nozzle.
3. Tighten the bolts and nuts with sufficient torque regarding flange and gasket choice. See also “Process Temperature and Pressure Rating” on page A-3.

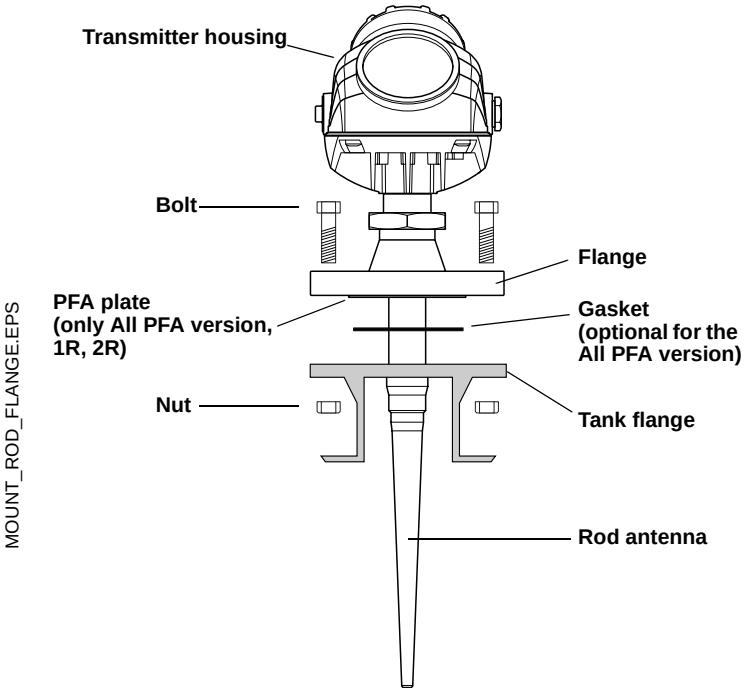
Figure 3-7. Mounting the 5400 with rod antenna and threaded tank connection.



1. Lower the transmitter and antenna into the tank.
2. Screw the transmitter into the process connection.

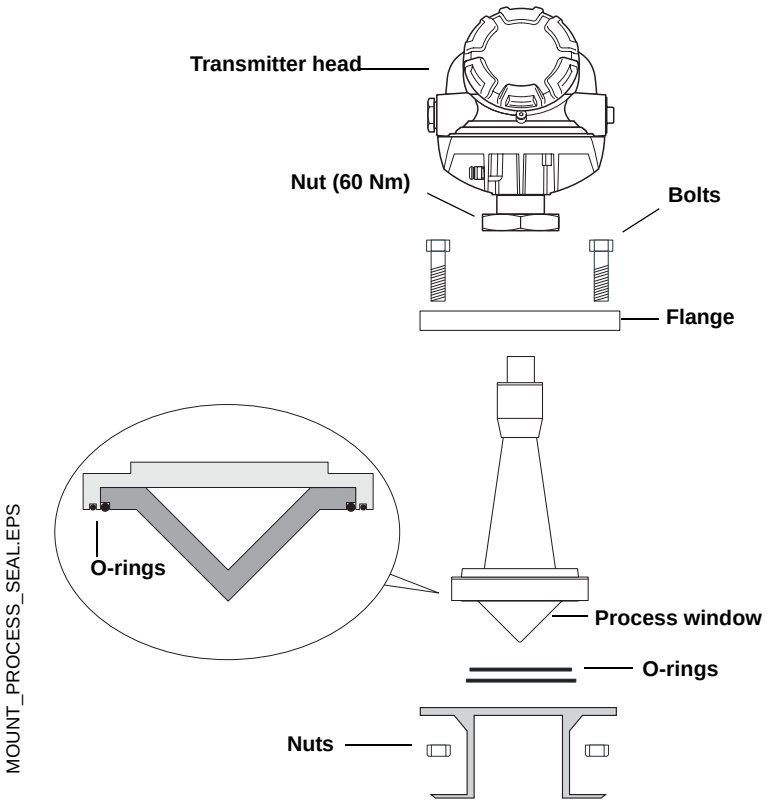
NOTE!
For adapters with NPT threads, pressure-tight joints require a sealant.

Figure 3-8. Mounting the 5400 with rod antenna and flange.



1. Place a gasket with thickness and of material suitable to the process on top of the tank flange.
   Note! For the All PFA version (tank sealing model code=PD) gasket is optional.
2. Lower the transmitter with antenna and flange into the tank nozzle.
3. Tighten the bolts and nuts with sufficient torque regarding flange and gasket choice. See also “Process Temperature and Pressure Rating” on page A-3.

Figure 3-9. Mounting the 5400 with Process Seal.



1. Put the two O-rings into the corresponding grooves on the antenna process window. See Table A-2 on page A-4 for more information on temperature range for the O-rings.
2. Place the antenna on top of the nozzle.
3. Mount the flange and tighten the bolts cross-wise according to Table 3-6.
4. Mount the transmitter head and tighten the nut to 60 Nm.
5. Retighten the flange bolts after 24 hours.

Table 3-6. Tightening torque for Process Seal flanges.

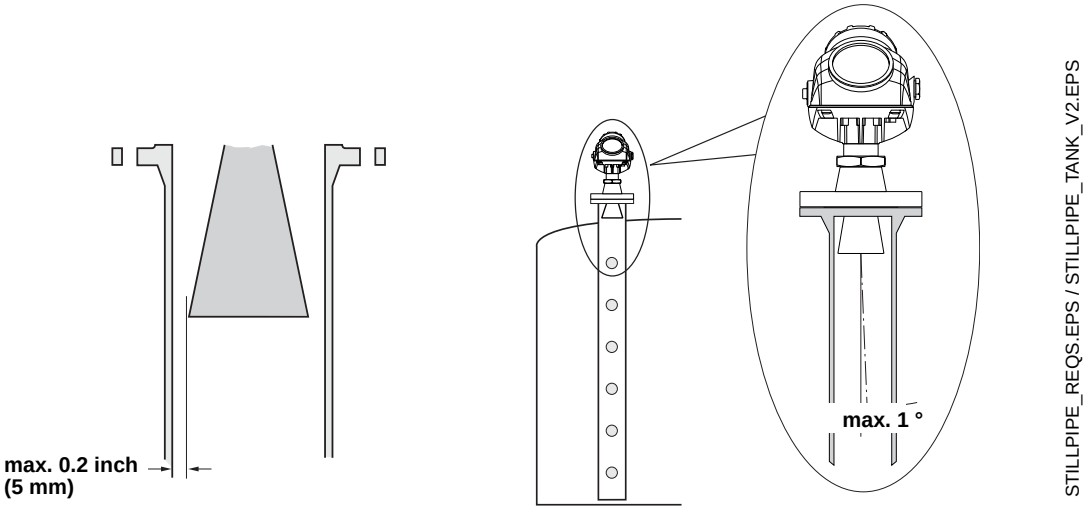
Flange	Torque (Nm)
2 inch, 150lbs	80
2 inch, 300lbs	80
3 inch, 150lbs	80
3 inch, 300lbs	125
4 inch, 150 lbs	80
4 inch, 300 lbs	125
DN 50 PN 40	109
DN 80 PN 40	109
DN 100 PN 16	109
DN 100 PN 40	135

Mounting in Pipes

Still Pipe mounting is recommended for tanks where surface conditions are extremely turbulent. All cone antenna sizes for the Rosemount 5400 Series of transmitters can be used for Still Pipe installations. The 3 inch antenna for the 5401 is designed for use in Still Pipes and Bypass Pipes only. Process Seal and Rod antennas are not recommended for Still Pipes.

When the transmitter is mounted in a Still Pipe the inclination should be within 1°. The gap between the antenna and the Still Pipe may be up to 0.2 in. (5 mm).

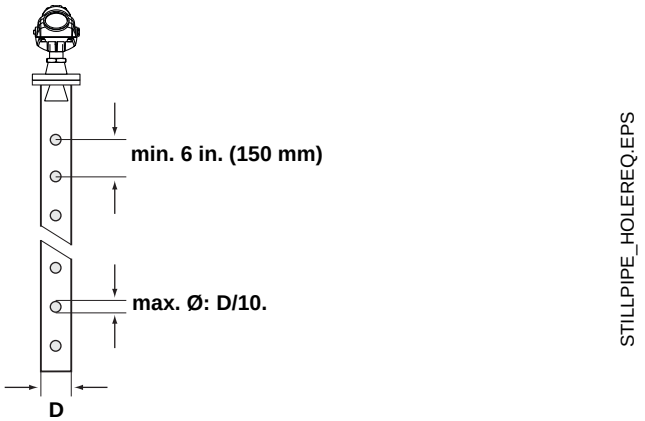
Figure 3-10. Mount the transmitter vertically.



Recommendations for pipe installations

- The pipe must be smooth on the inside.
- Not suitable for adhesive products.
- Make sure that at least one hole is above the product surface.
- The hole diameter Ø should not exceed 10% of the pipe diameter **D**.
- Holes should be drilled on one side.

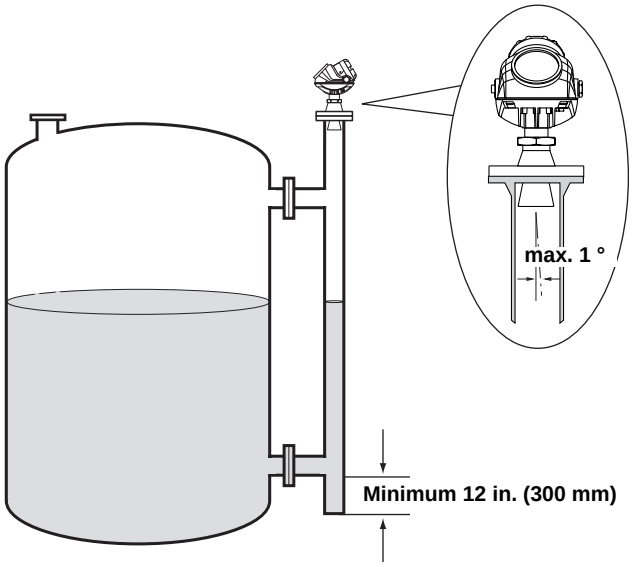
Figure 3-11. Recommended hole size for pipe installations.



Mounting in Bypass Pipes

In tanks with turbulent conditions it is recommended to mount the transmitter on a bridle pipe.

Figure 3-12. Bridle mounting is recommended for tanks with extremely turbulent surface conditions.

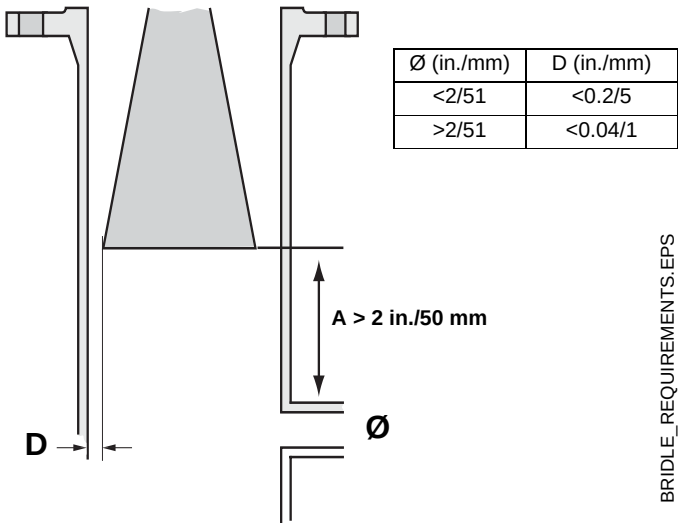


In pipes with inlet pipe diameter Ø<2 in. (50 mm) the gap D between pipe and antenna should be less than 0.2 in. (5 mm).

If the inlet pipe diameter Ø>2 in. (50 mm) the gap D between pipe and antenna should be less than 0.04 in. (1 mm).

The distance A between the antenna and the nearest inlet pipe should be at least 2 in. (50 mm).

Figure 3-13. Recommended specifications for bridles with pipe inlets.



Ø (in./mm)	D (in./mm)
<2/51	<0.2/5
>2/51	<0.04/1

ELECTRICAL INSTALLATION

Cable/Conduit Entries

The electronics housing has two entries with ½ - 14 NPT threads. Optional M20×1.5 adapters are also available. The connections are made in accordance with national, local and plant electrical codes.

Make sure that unused ports are properly sealed to prevent moisture or other contamination from entering the terminal compartment of the electronics housing. Install wiring with a drip loop. The bottom of the loop must be lower than the cable/conduit entry.

NOTE!
Use the enclosed metal plug to seal any unused port.

Grounding

The housing should always be grounded in accordance with national and local electrical codes. Failure to do so may impair the protection provided by the equipment. The most effective grounding method is direct connection to earth ground with minimal impedance. There are two grounding screw connections provided. One is inside the Terminal compartment of the housing and the other is located on one of the cooling fins below the housing. The internal ground screw is identified by a ground symbol: ⏚.

NOTE!
Grounding the transmitter via threaded conduit connection may not provide sufficient ground.

NOTE!
After installation and commissioning make sure that no ground currents exist due to high ground potential differences in the installation.

Cable Selection

Use shielded twisted pair wiring for the Rosemount 5400 Series. The cables must be suitable for the supply voltage and approved for use in hazardous areas, where applicable. For instance, in the U.S., explosion-proof conduits must be used in the vicinity of the vessel. For the ATEX flameproof approval version of the Rosemount 5400 Series, suitable conduits with sealing device or flameproof (EEx d) cable glands must be used depending on local requirements.

Use 18 AWG to 12 AWG wiring in order to minimize the voltage drop to the transmitter.

Hazardous Areas

When the Rosemount 5400 Series transmitter is installed in a hazardous area, national and local regulations and specifications in applicable certificates must be observed.

External Circuit Breaker

For complicance with Low Voltage Directive 73/23/EEG an external circuit breaker should be installed.

Power Requirements

Terminals in the transmitter housing provide connections for signal wiring.

The 5400 transmitter operates with the following power supplies:

Approval Type	Power Supply (VDC)
IS	16 - 30
Explosion-Proof/Flameproof	20 - 42.4
None	16 - 42.4

Maximum Loop Resistance

The maximum current loop resistance can be obtained from the following diagrams:

Figure 3-14. Intrinsically Safe installation.

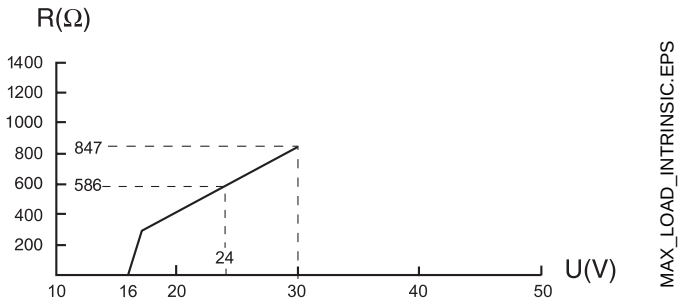
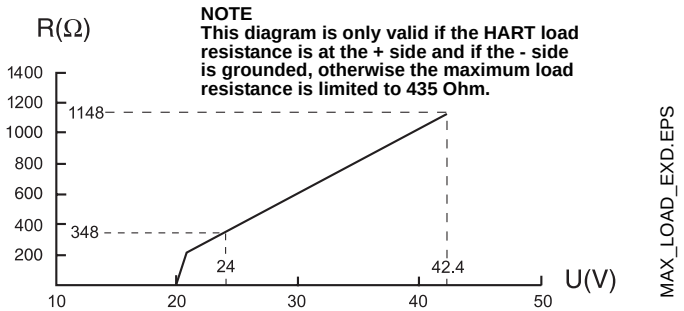
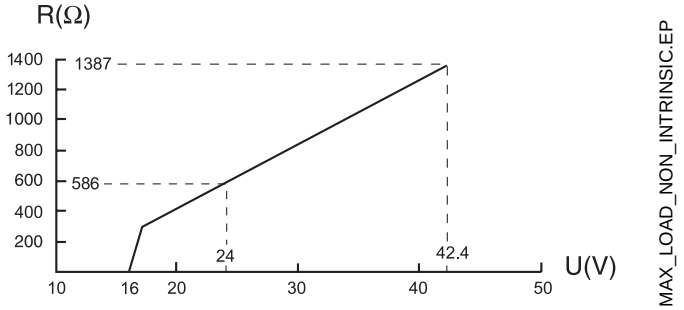


Figure 3-15. Explosion-Proof/ Flameproof installation.



See Figure 3-19 for wiring information.

Figure 3-16. Non-hazardous installation.



See Figure 3-18 for wiring information.

Connecting the Transmitter

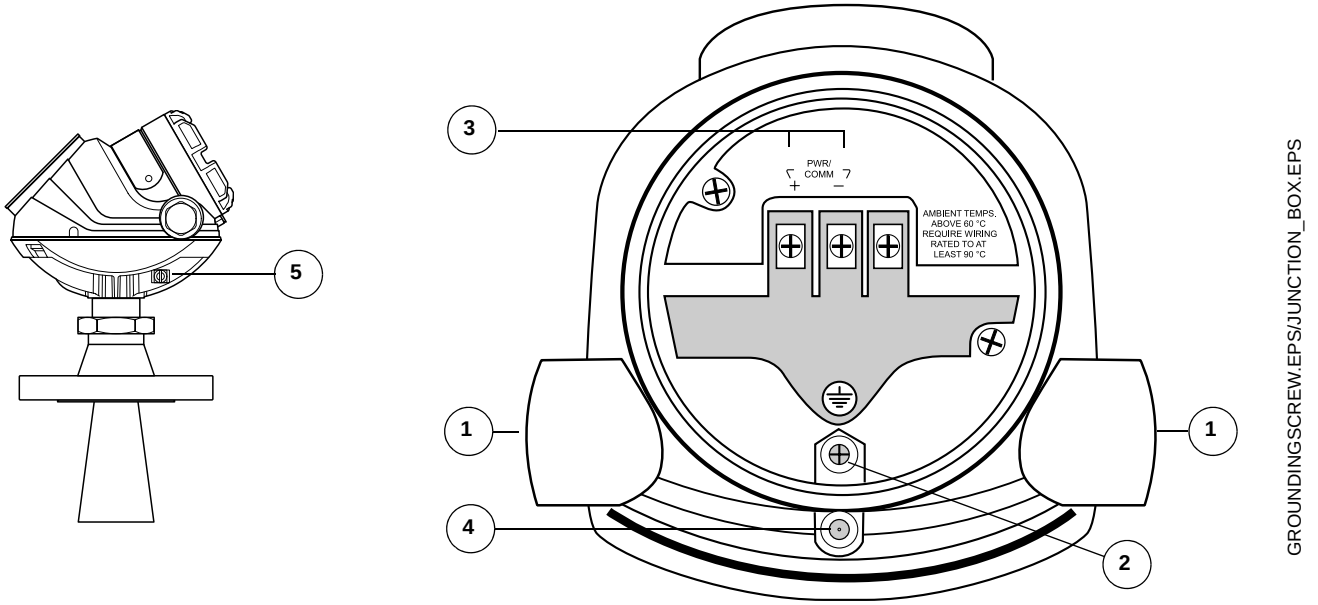
The Rosemount 5400 Series accepts power supplies ranging from 16 V dc to 42.4 V dc. It uses 4-20 mA power superimposed with a HART signal.

To connect the transmitter:

1. Make sure that the power supply is switched off.
2. Remove the terminal block cover.
3. Pull the cable through the cable gland/conduit. Install wiring with a drip loop. The bottom of the loop must be lower than the cable/conduit entry.
4. Connect wires according to Figure 3-18 for non-intrinsically safe power supplies and according to Figure 3-19 for intrinsically safe power supplies.
5. Use the enclosed metal plug to seal any unused port.
6. ⚠ Mount the cover and tighten the cable gland. Make sure that the cover is fully engaged to meet explosion-proof requirements.
   Note that adapters are required if M20 glands are used.
7. Tighten the Locking Screw ④ (ATEX Flameproof and IECEx versions).
8. Switch on the power supply.

NOTE!
Use Teflon® tape or other sealant at the NPT threads in the Cable Entries.

Figure 3-17. Terminal compartment and external ground screw.



① Cable entries.

② Internal Ground screw.

③ Terminals for signal and power supply.

④ Locking screw.

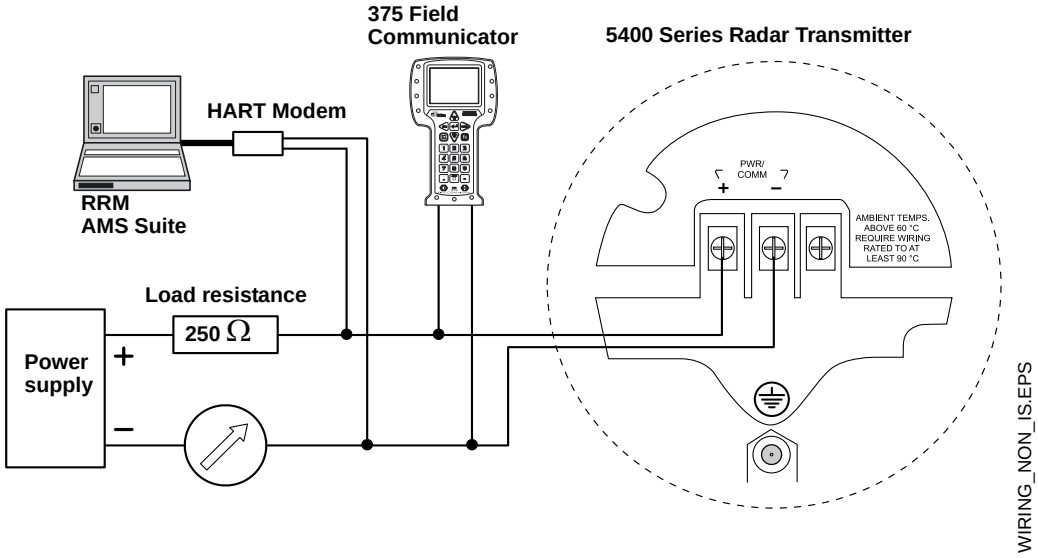
⑤ External Ground screw

Non-Intrinsically Safe Power Supply

With non-intrinsically safe power supply in non-hazardous installations or Explosion-proof/Flameproof installations, wire the transmitter as shown in Figure 3-18.

NOTE!
Make sure that the power supply is off when connecting the transmitter.

Figure 3-18. Wiring for non-intrinsically safe power supply.



The 375 Field Communicator and the HART Modem require a minimum load resistance of 250 Ohms within the loop in order to function properly. For maximum loop resistance see Figure 3-16.

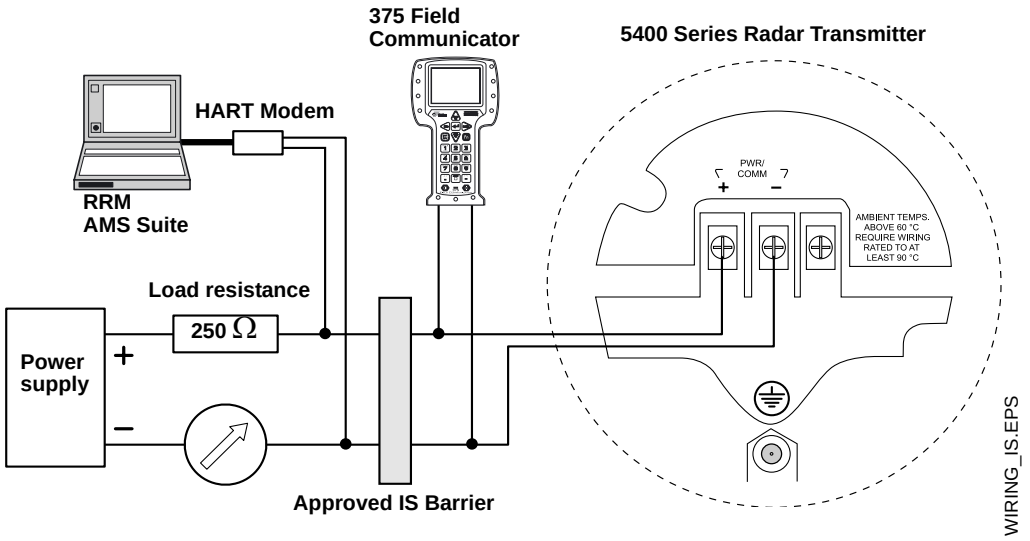
NOTE!
For Explosion-proof/Flameproof installations make sure that the transmitter is grounded to the I.S. ground terminal inside the terminal compartment in accordance with national and local electrical codes.

Intrinsically Safe Power Supply

When your power supply is intrinsically safe, wire the transmitter as shown in Figure 3-19.

NOTE!
Make sure that the instruments in the loop are installed in accordance with intrinsically safe field wiring practices.

Figure 3-19. Wiring diagram for intrinsically safe power supply.



The 375 Field Communicator and the HART Modem require a minimum load resistance within the loop of 250 Ω in order to function properly. For maximum load resistance see Figure 3-14.

IS parameters

Ui=30 V.

Ii=130 mA.

Pi=1.0 W.

Ci=7.26 nF.

Li=0.

Section 4 Configuration/Start-Up

SAFETY MESSAGES

Procedures and instructions in this section may require special precautions to ensure the safety of the personnel performing the operations. Information that raises potential safety issues is indicated by a warning symbol (⚠). Refer to the safety messages listed at the beginning of each section before performing an operation preceded by this symbol.

⚠WARNING

Explosions could result in death or serious injury:

Verify that the operating environment of the gauge is consistent with the appropriate hazardous locations certifications.

Before connecting a HART-based communicator in an explosive atmosphere, make sure 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.

All connection head covers must be fully engaged to meet explosion-proof requirements.

⚠WARNING

Failure to follow safe installation and servicing guidelines could result in death or serious injury:

Make sure 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.

Do not perform any service other than those contained in this manual unless you are qualified.

OVERVIEW

Configuration of a Rosemount 5400 transmitter is normally a simple and straight-forward task. If the transmitter is pre-configured at factory according to the ordering specifications in the Configuration Data Sheet, no further Basic Configuration is required unless tank conditions have changed. The 5400 Series supports a set of advanced configuration options as well, which can be used to handle special tank conditions and applications.

Basic Configuration

The Basic Configuration includes parameters for a standard configuration which is sufficient in most cases. The Basic Configuration comprises the following items:

- Measurement Units
- Tank Configuration
  - Tank Geometry
  - Environment
  - Volume
- Analog Output

Echo Tuning

Echo Tuning is used to handle special situations when there are objects in the tank which cause disturbing echoes that are stronger than the surface echo. The following tools are available to handle such situations:

- Amplitude Threshold Curve (ATC)
- False Echo registration

Advanced Configuration

For some applications further configuration is needed in addition to the Basic Configuration. This may be due to the properties of the product or the shape of the tank. Disturbing objects and turbulent conditions in the tank may also require that advanced measures are taken. See *Appendix C: Advanced Configuration* for more information.

Configuration Tools

There are several tools available for basic configuration of a 5400 transmitter:

- Rosemount Radar Master (RRM). Note that RRM is required for advanced configuration features.
  See “Configuration Using Rosemount Radar Master” on page 4-12 for information on how to use RRM for configuration of the 5400 Series.
- Rosemount 275/375 Handheld Communicator.
  See “Configuration Using a 375 Field Communicator” on page 4-21 for the Field Communicator Menu Tree.
- AMS Suite software.

RRM is a user-friendly, Windows® based software package including waveform plots, off-line/on-line configuration Wizard, logging, and extensive on-line help.

To communicate with the transmitter using RRM, a HART® modem (part number 03300-7004-0001) is required.

BASIC CONFIGURATION

This chapter describes the basic parameters that need to be configured for a Rosemount 5400 transmitter. If the transmitter is pre-configured at factory according to the ordering specifications in the Configuration Data Sheet, no further basic configuration is needed unless conditions have changed since the ordering date.

At the end of this section different configuration tools are described.

Measurement Units

Measurement units can be specified for presentation of Level, Level Rate, Volume and Temperature values.

Tank Geometry

Tank Height

The Tank Height is the distance between the Upper Reference Point at the underside of the transmitter flange or the threaded adapter, and the Lower Reference Point close to or at the bottom of the tank (see Figure 4-2 for further information on Upper Reference Points for various tank connections). The transmitter measures the distance to the product surface and subtracts this value from the Tank Height to determine the product level.

Figure 4-1. Tank Geometry.

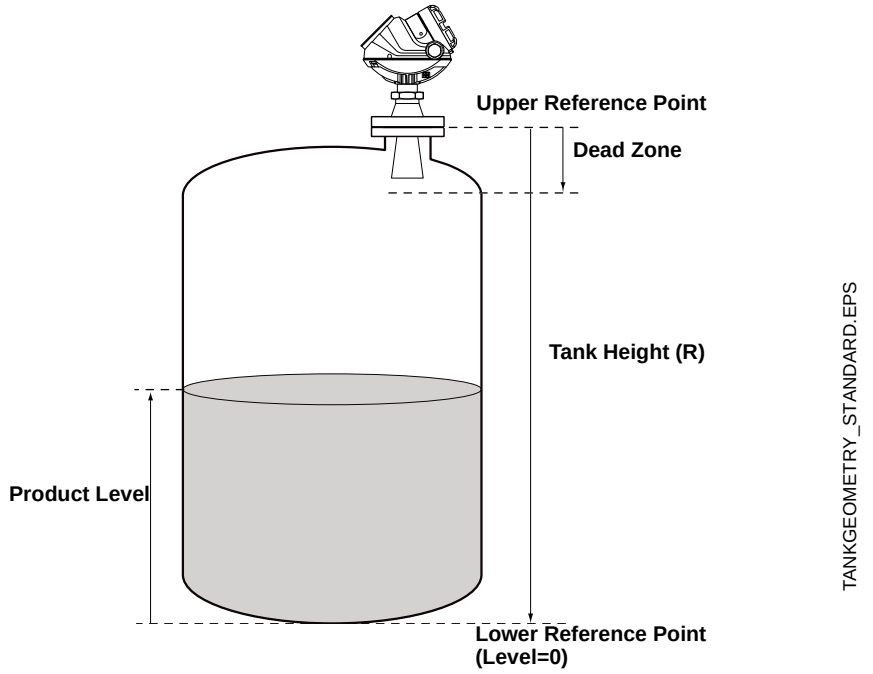
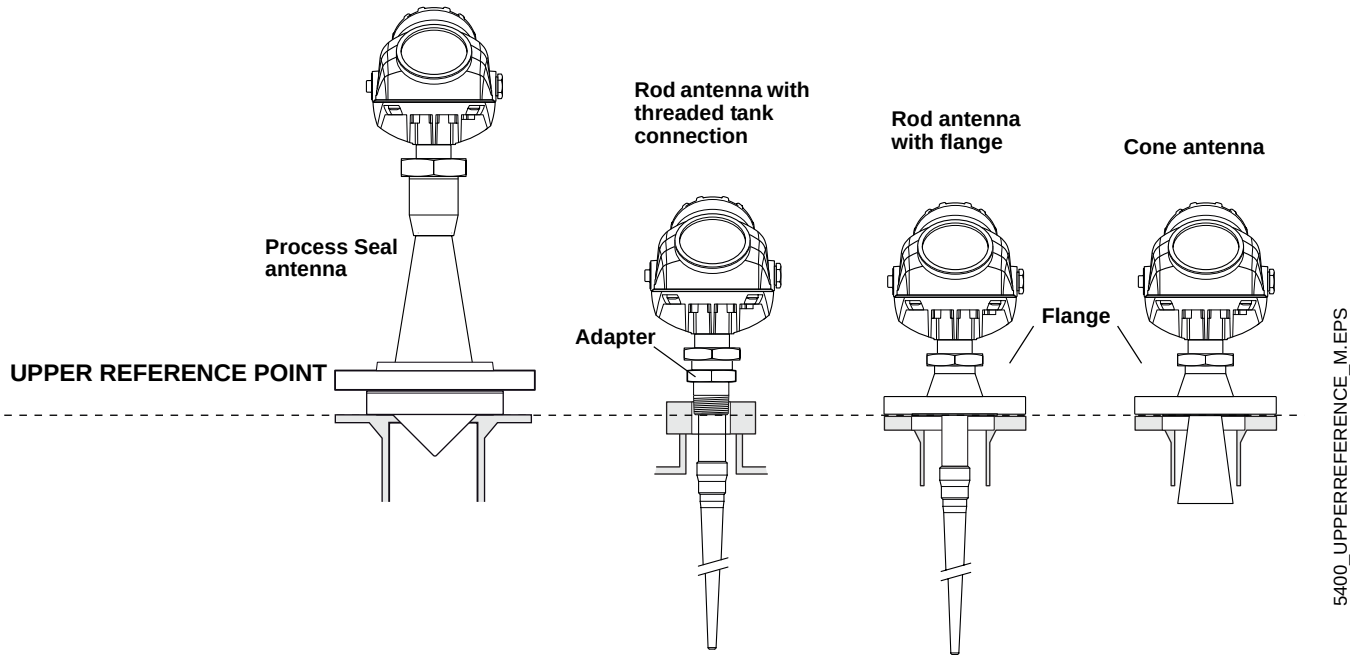


Figure 4-2. Upper Reference Point



Tank Type and Tank Bottom Type

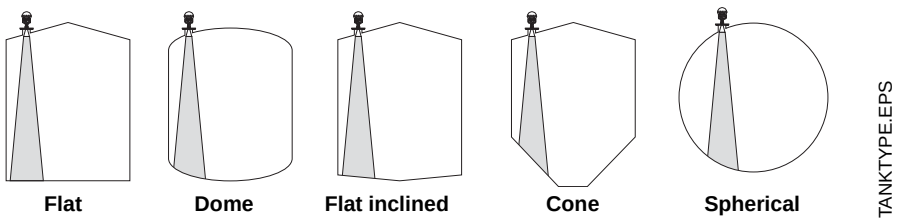
The 5400 transmitter is optimized according to the *Tank Type* and *Tank Bottom Type* configuration by automatically setting some parameters to predefined default values.

Select Tank Bottom Type *Flat Inclined* if the bottom inclination is between 10 and 30 degrees. If the inclination is less than 10 degrees but there are disturbing objects on the tank floor (like heating coils) within the radar beam, this selection should also be used. If inclination is greater than 30 degrees use Tank Bottom Type *Cone*.

Table 4-1. Tank Type and Tank Bottom Type

Tank Type	Tank Bottom Type
Vertical Cylinder	Flat, Dome, Cone, Flat inclined
Horizontal Cylinder	*Not used*
Spherical	*Not used*
Cubical	Flat, Dome, Cone, Flat inclined

Figure 4-3. The transmitter can be optimized for different tank types and bottom shapes.



Pipe Diameter

When the transmitter is mounted in a still pipe the inner diameter of the pipe must be specified. The Pipe Diameter is used to compensate for the lower microwave propagation speed inside the pipe. An incorrect value will give a scale factor error. If locally supplied still pipes are used, make sure the inner diameter is noted before the pipe is installed.

Dead Zone

The measurement accuracy is reduced within the Dead Zone region close to the antenna. It is recommended that the Upper Range Value (20 mA) is set outside the Dead Zone.

Process Conditions

Describe the conditions in your tank according to the Tank Environment parameters for Process Conditions listed below. For best performance, choose only if applicable and not more than two options.

Rapid Level Changes

Optimize the transmitter for measurement conditions where the level changes quickly due to filling and emptying of the tank. As a default standard a 5400 transmitter is able to track level changes of up to 1.5 inch/s (40 mm/s). When the Rapid Level Changes check box is marked, the transmitter can track level changes of up to 8 inch/s (200 mm/s).

Turbulent Surface

This parameter should be used if the tank shows a turbulent surface. The reason for the turbulence might be splash loading, agitators, mixers, or boiling product. Normally the waves in a tank are quite small and cause local rapid level changes. By setting this parameter the performance of the transmitter will be improved when there are small and quickly changing amplitudes and levels.

Foam

Setting this parameter optimizes the gauge for conditions with weak and varying surface echo amplitudes such as foam. When the foam is light and airy the actual product level is measured. For heavy and dense foam the transmitter measures the level of the upper surface of the foam.

Solid Products (*Future*)

Setting this parameter optimizes the transmitter for solid products, for example concrete or grains, which are not transparent for radar signals. For instance, this parameter can be used when the application is a silo with product build-up.

Product Dielectric Range

The Dielectric Constant is related to the reflectivity of the product. By setting this parameter measurement performance can be optimized. However, the transmitter will still be able to perform well even if the actual Dielectric Constant differs from the configured value.

Volume

To configure the Rosemount 5400 transmitter for volume calculations you have to choose the desired calculation method.

Volume calculation is performed by using a strapping table or a predefined tank shape. You can choose one of the following standard tank shapes:

Sphere, Horizontal Cylinder, Vertical Cylinder, Horizontal Bullet or Vertical Bullet.

The following parameters must be entered for a standard tank shape:

- Tank diameter.
- Tank height (not for spherical tanks).
- Volume Offset: use this parameter if you do not want zero volume and zero level to match (for example if you want to include volume below the zero level).

Strapping Table

The Strapping Table option should be used when the tank shape deviates significantly from an ideal sphere or cylinder, or when high volume accuracy is required.

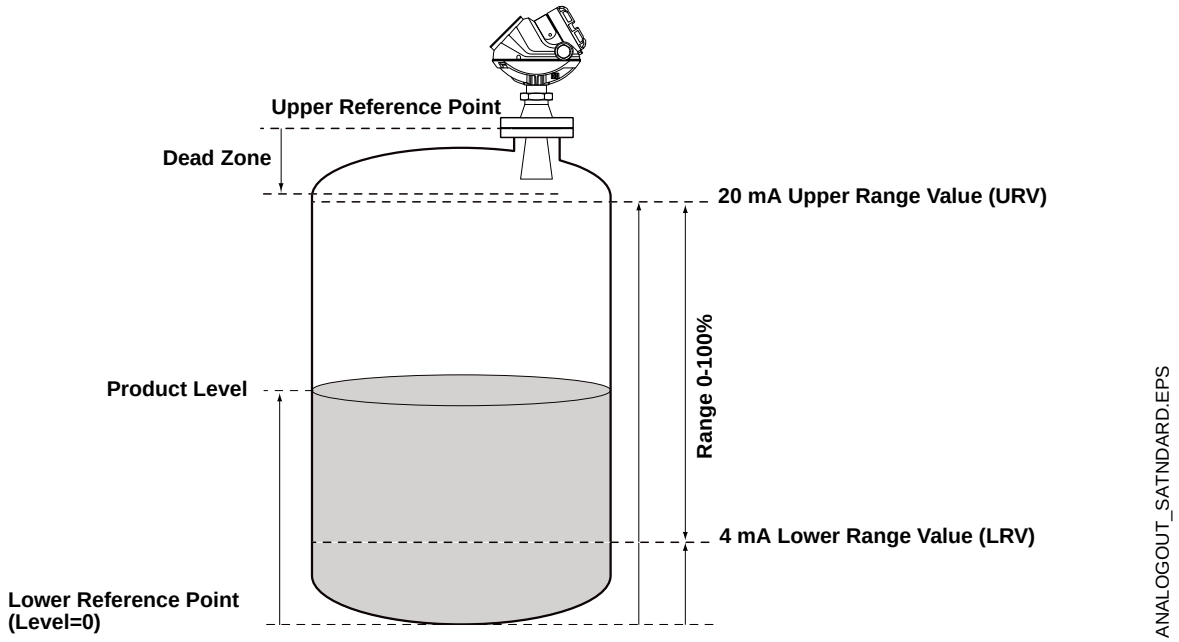
The Strapping Table divides the tank into segments. Level values and corresponding volumes are entered starting at the bottom of the tank. These figures can typically be obtained from tank drawings or from a certificate provided by the tank manufacturer. A maximum of 20 strapping points can be entered. For each level value the corresponding total volume up to the specified level is entered.

The volume value is interpolated if the product surface is between two level values in the table.

Analog Output

For the analog output the Output Source (Primary Value), Range Values and Alarm Mode are specified.

Figure 4-4. Standard Range Value settings.



Output Source/Primary Variable

Specify the source to control the analog output. Typically the Primary Value is configured to be Product Level.

Upper/Lower Range Value

Enter the range values that correspond to the analog output values 4 and 20 mA. It is recommended that the 20 mA point is set below the Dead Zone since the measurement accuracy is reduced in this region. See “Specifications” on page A-1 for information on the Dead Zone.

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.

Alarm Mode

Choose the desired Alarm mode to specify the analog output state when there is a failure or a measurement error.

High: the output current is set to the High Alarm Limit.

Low: the output current is set to the Low Alarm Limit.

Freeze Current: the output current is set to the last valid value at the time when the error occurs.

Default settings for alarm mode:

- Measurement errors: Output current=High.
- Measured value out of range: transmitter enters saturation mode (if Limit Alarm is disabled).

Table 4-2. Analog Output: Standard Alarm Values vs. Saturation Values.

Level	4–20 mA Saturation Values	4–20 mA Alarm Value
Low	3.9 mA	3.75 mA
High	20.8 mA	21.75 mA

Table 4-3. Analog Output: NAMUR-Compliant Alarm Values vs. Saturation Values

Level	4–20 mA Saturation Values	4–20 mA Alarm Value
High	20.5 mA	22.5 mA

ECHO TUNING

When the Basic Configuration is performed the transmitter may need to be tuned to handle disturbing objects in the tank. There are different methods available for disturbance echo handling with the Rosemount 5400 Series Transmitter:

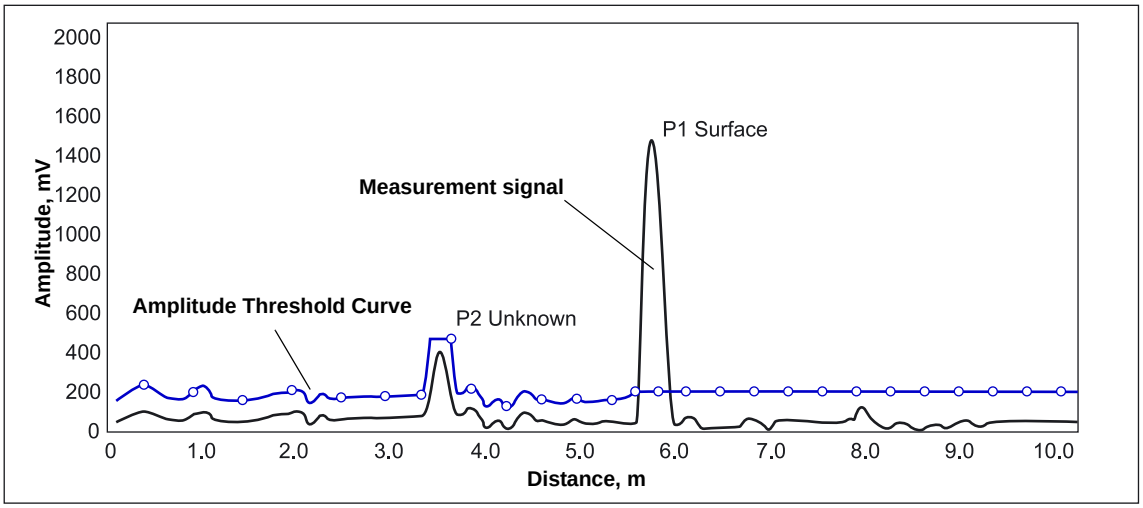
- Amplitude Threshold Curve (ATC)
- False Echo registration

The *Guided Setup* in the configuration program *Rosemount Radar Master* includes a Measure and Learn function which automatically registers false echoes and creates an ATC (see “Guided Setup” on page 4-15).

Amplitude Threshold Curve

Setting up an Amplitude Threshold Curve makes tracking of the product surface more robust in the presence of noise and weak disturbing echoes. The ATC is normally used for filtering out disturbances with an amplitude that is smaller than the amplitude of the product surface echo.

Figure 4-5. Weak disturbing echoes can be filtered out by creating an amplitude threshold.

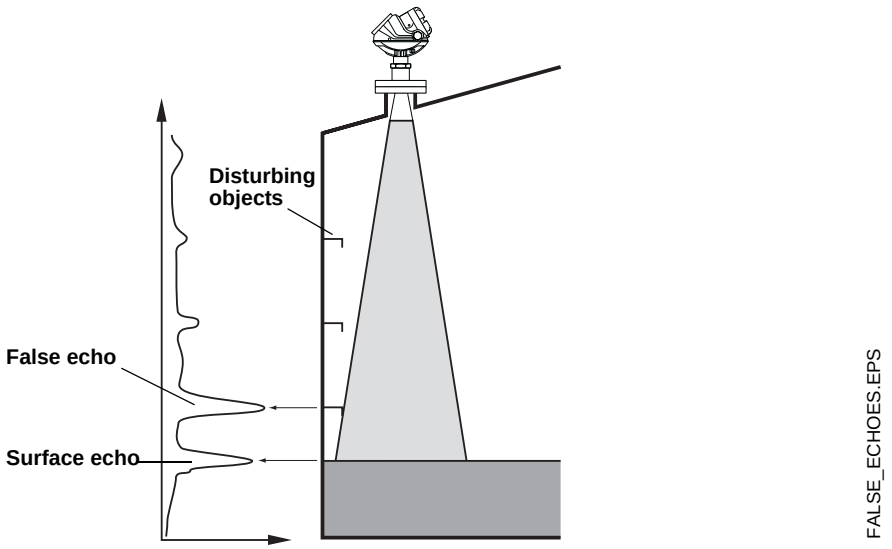


The Amplitude Threshold Curve function is available in the Rosemount Radar Master (RRM) program.

Registration of False Echoes

The False Echo function is used to improve the performance of the gauge when the surface is close to a horizontal surface of a stationary object in the tank. The object causes an echo when it is above the surface. When the echoes from the surface and the object are close to each other, they might interfere and cause a decrease in performance.

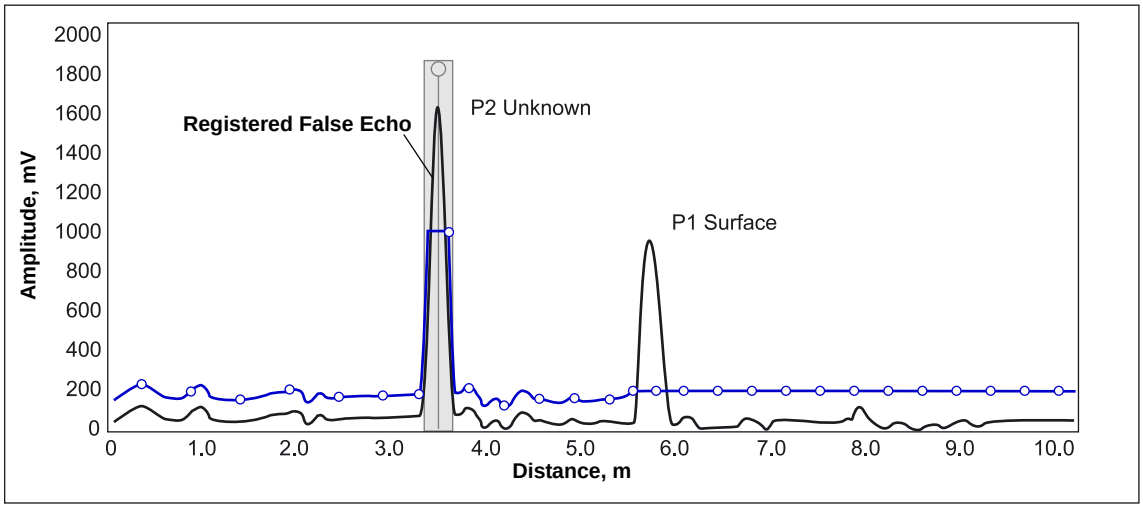
Figure 4-6. The Rosemount 5400 can handle disturbing radar echoes.



The False Echo function allows you to register disturbing echoes caused by objects in the tank. When the surface is passing by a disturbing object, the gauge can measure with higher reliability, when the position of the object is registered. This makes it possible to detect a product surface close to a disturbance echo even if the surface echo is weaker than the disturbing echo. See the following recommendations before you register new interfering echoes:

- Make sure that a correct amplitude threshold curve is set before you register any disturbance echoes (see “Amplitude Threshold Curve” on page 4-9).
- Compare the list of interfering echoes with the tank drawing or by visual inspection of the tank. Note if there are objects like beams, heating coils, agitators, etc. which correspond to the found echoes. Only register echoes above the Amplitude Threshold Curve which can be clearly identified as objects in the tank, keeping the number of registered echoes to a minimum.
- Make sure the level is stable before you register a disturbance echo. A fluctuating level may indicate a temporary disturbance which is not due to an interfering object.
- Do not register False Echoes located below the product surface. It is recommended that registration is done when the tank is empty.

Figure 4-7. Disturbing echoes can be filtered out by registration as False Echoes.



The False Echo Registration function is available in the Rosemount Radar Master (RRM) program, in the AMS Suite as well as for the 275/375 Handheld Communicator.

CONFIGURATION USING ROSEMOUNT RADAR MASTER

The *Rosemount Radar Master* (RRM) is a user-friendly software tool that allows you to configure the Rosemount 5400 transmitter. You can choose either of the following two methods to configure a Rosemount 5400 transmitter with RRM:

- Guided Setup Start if you are unfamiliar with the 5400 transmitter (see page 4-15).
- Use the Setup function if you are already familiar with the configuration process or if you just want to change the current settings (see page 4-20).

System Requirements

Hardware

Processor (minimum/recommended): Pentium 200 MHz/1 GHz

Memory (minimum/recommended): 64/128 MB RAM

COM Port: 1 serial COM port

Graphical Card (minimum/recommended):
screen resolution 800 x 600/1024 x 768.

Hard drive space: 100 MB

Software

Operating Systems supported:

Windows 98 - service pack 3 and above

Windows NT 4 - service pack 6 and above

Windows 2000

Windows XP

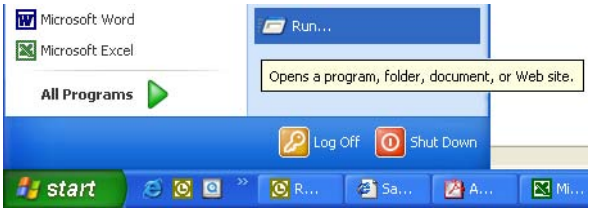
Help In RRM

Help is accessed by selecting the Contents option from the Help menu. Help is also available via a Help button in most windows.

Installing the RRM software

To install the Rosemount Radar Master:

1. Insert the installation CD into your CD-ROM drive.
2. If the installation program is not automatically started, choose Run from the Windows Start bar.

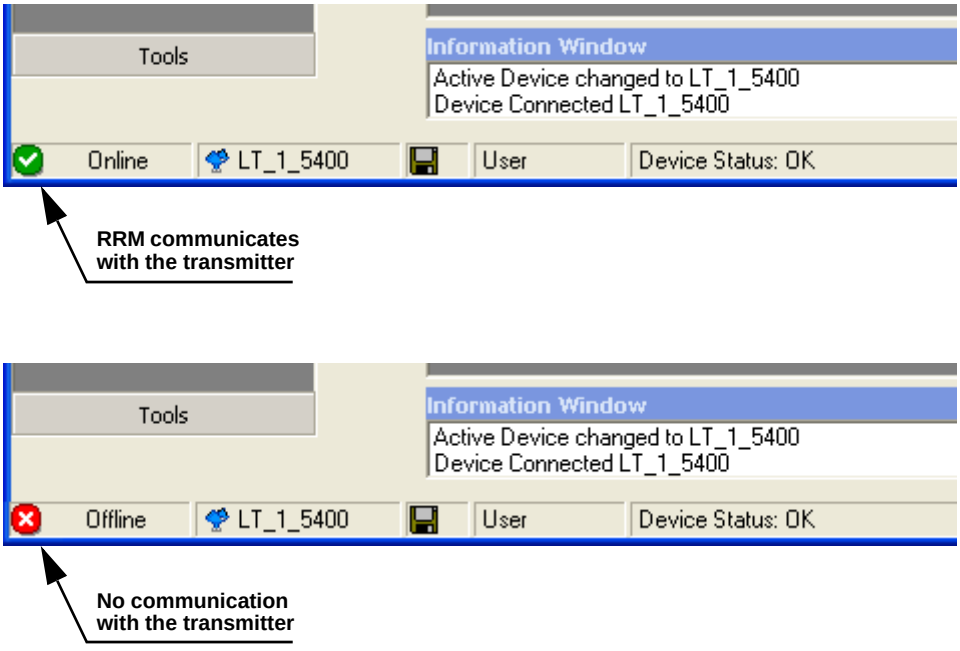


RRM/START_BAR_RUN.TIF

3. Type D:\RRM**Setup.exe** where D is the CD-ROM drive.
4. Follow the instructions on the screen.
5. For Windows 2000/XP set COM Port Buffers to 1, see page 4-14.

To start the RRM:

1. From the Start menu click *Programs>Saab Rosemount>Rosemount Radar Master* or click the RRM icon in the Windows workspace. Now RRM searches for the transmitter.
2. When the transmitter is found press Yes to connect. If communication does not work check that the correct COM port is connected on the computer and that the COM port is properly configured, see “Specifying the COM Port” on page 4-14.
3. In the RRM Status Bar verify that RRM communicates with the transmitter.



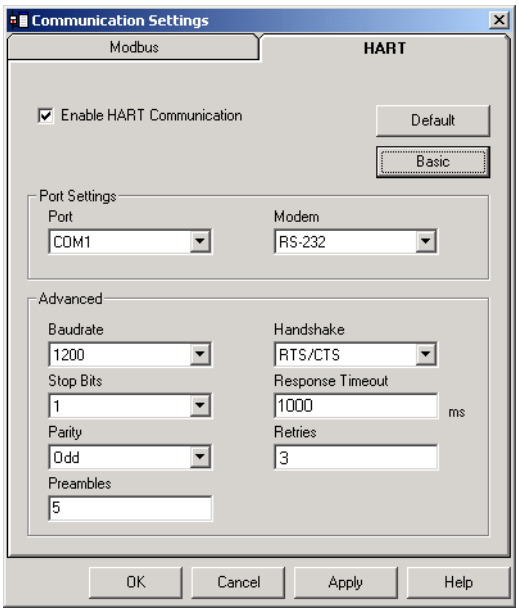
RRM/STATUSBAR.TIF/STATUSBAR_OFFLINE.TIF

Specifying the COM Port

If communication is not established open the *Communication Preferences* window and check that the correct COM Port is selected:

1. From the **View** menu select Communication Preferences in RRM.

Figure 4-8. Communication Settings.



RRM/COMMUNICATIONSETTINGS.TIF

2. Make sure that HART communication is enabled.
3. Check which COM port that the modem is connected to.
4. Choose the COM Port option that matches the actual COM Port on the PC that the transmitter is connected to.

To set the COM port buffers

For Windows 2000/XP the COM port Receive Buffer and Transmit Buffer need to be set to 1. To set the COM port buffers do the following:

1. In the MS Windows Control Panel open the **System** option.
2. Choose the **Hardware** tab and click the **Device Manager** button.
3. Expand the **Ports** node in the tree view.
4. Click the right mouse button on the selected COM port and choose **Properties**.
5. Select the **Port Settings** tab and click the **Advanced** button.
6. Drag the *Receive Buffer* and *Transmit Buffer* slides to 1.
7. Click the **OK** button.
8. **Reboot the computer**.

Specifying Measurement Units

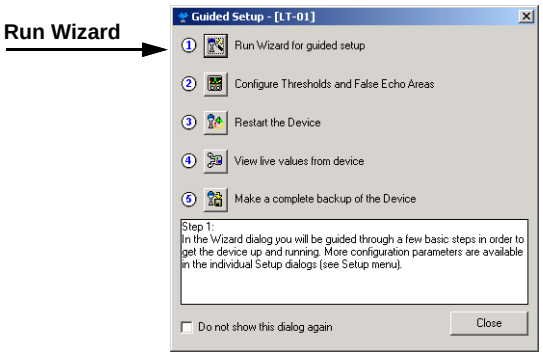
Measurement units for data presentation in RRM can be specified when the RRM program is installed. Units can also be changed as follows:

1. From the View menu, choose the Application Preferences option.
2. Select the **Measurement Units** tab.
3. Choose the desired units for Length, Level Rate, Volume and Temperature.

Guided Setup

The following description shows how to use the RRM Guided Setup. The corresponding HART commands (275/375 Handheld Communicator Fast Key Sequence) are also shown. The Guided Setup is specially useful if you are unfamiliar with the 5400 transmitter.

WIZARD_ICON.TIF/RRM/WIZARD_ST1.TIF

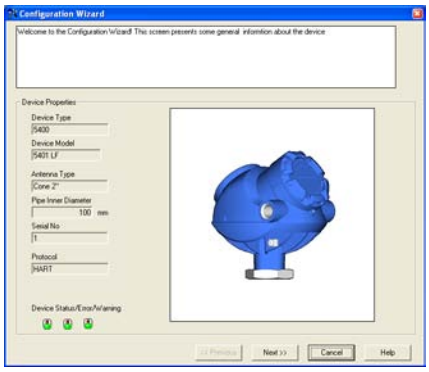


1. Start the RRM program. RRM automatically presents a list of available transmitters. Select the desired transmitter. Now the transmitter is connected and the *Guided Setup* window appears automatically.
2. In the *Guided Setup* window , click the **Run Wizard...** button and follow the instructions.

   Now you will be guided through a short transmitter installation procedure.

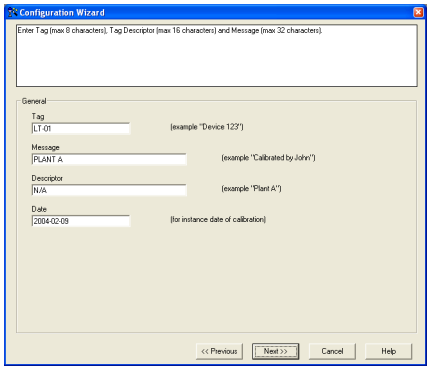
   Note! The *Guided Setup* is an extended installation guide that includes more than just the configuration Wizard. It can be disabled by deselecting the *Show Introduction Dialog after Connect* check box in the *Application Settings* window (menu option View>Application Preferences).

RRM/WIZARD_ST2.TIF



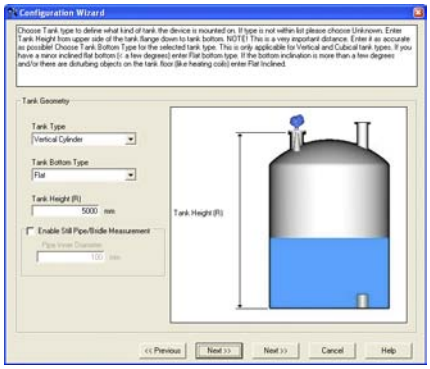
3. The first window in the configuration wizard presents general information such as device type (5400), device model, antenna type, serial number and communication protocol. Check that the information complies with the ordering information.

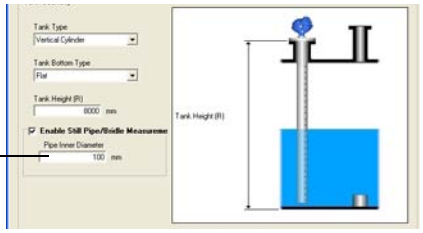
WIZARD_GENERAL.TIF



4. This window lets you enter Tag, Tag Descriptor, Message and Date. This information is not required for the operation of the transmitter and can be left out if desired. HART command: [1,4,1].

WIZARD_TANKGEOMETRY.TIF/WIZARD_TANKGEOMETRY_PIPE.TIF





Enter inner diameter of the pipe

5. Choose the **Tank Type** which corresponds to the actual tank. If none of the available options matches the actual tank choose Unknown.
   HART command: [1,3,4,1].

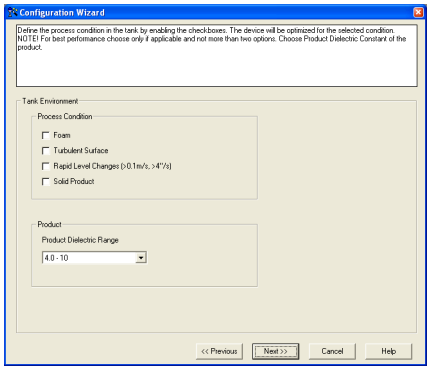
   Tank Bottom Type is important for the measurement performance close to the tank bottom.
   HART command: [1,3,4,2].

   Tank Height is the distance from the Upper Reference Point to the tank bottom (see “Tank Geometry” on page 4-3). Make sure that this number is as accurate as possible.
   HART command: [1,3,4,3].

   Select the **Enable Still Pipe/Bridle Measurement** check box and enter the **Pipe Inner Diameter** if the transmitter is mounted in a Still Pipe or Bridle.
   HART command: [1,3,4,4]/[1,3,4,5].

   See “Tank Geometry” on page 4-3 for more information.

WIZARD_ENVIRONMENT.TIF

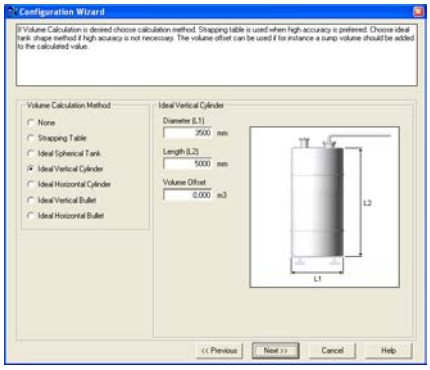


6. In the Process Conditions box select the check boxes that correspond to the conditions in your tank. You should select as few options as possible and not more than two. See “Process Conditions” on page 4-5 for more information.

   Choose the **Product Dielectric Range** that corresponds to the current product. If you are uncertain about the correct range value for this parameter, or if the contents in the tank is changing on a regular basis, choose Unknown.

   HART command: [1,3,4,6].

WIZARD_VOLUME.TIF

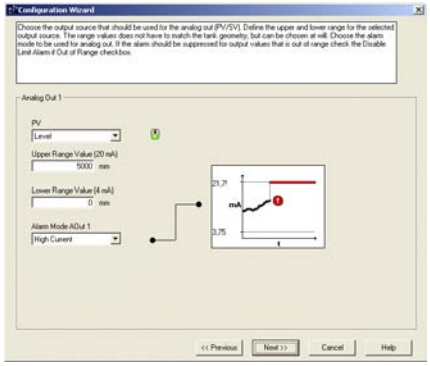


7. If volume calculation is desired choose a pre-defined calculation method that is based on a tank shape that corresponds to the actual tank. Choose None if volume calculation is not desired.
   The Strapping Table option is used if the actual tank does not match any of the available options for pre-defined tanks or if higher calculation accuracy is desired.

   HART command: [1,3,4,7].

   See “Volume” on page 4-6 for more information.

WIZARD_ANALOGOUT.TIF

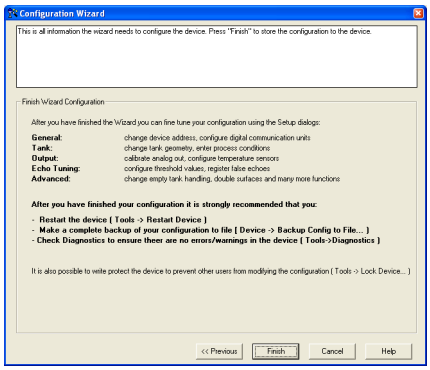


8. Typically, the **Primary Variable** (PV) is configured to be Product Level or Volume. Specify the analog output range by setting the **Lower Range Value** (4 mA) and the **Upper Range Value** (20 mA) to the desired values. The **Alarm Mode** specifies the output state when a measurement error occurs.

   HART command: [1,3,5].

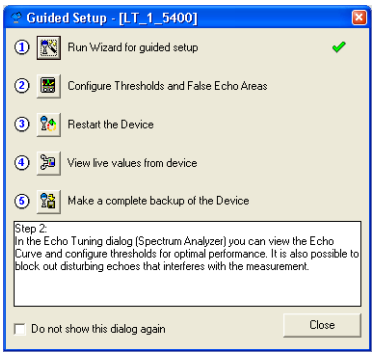
   See “Analog Output” on page 4-7 for more information on Analog Output configuration and Alarm Mode settings.

WIZARD_FINISH.TIF



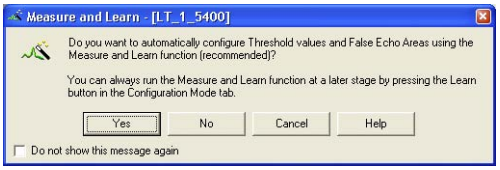
9. This is the last window in the Configuration Wizard concluding the basic configuration. The current configuration can be changed at any time by using the Setup windows (General, Tank, Output etc., see “Using the Setup Functions” on page 4-20).
   The Setup windows contain further options not available in the configuration wizard.
   Click the Finish button and continue with the next step in the Guided Setup.

GUIDED_STEP2.TIF



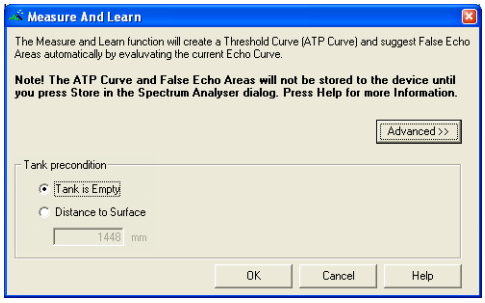
10. Step 2 in the Guided Setup allows you to automatically configure an Amplitude Threshold Curve and to register false echoes by running the *Measure and Learn* function. See *“Echo Tuning” on page 4-9* for more information on amplitude thresholds and false echoes.
Click button 2 to start the *Measure and Learn* function.
(If there is no need for Echo Tuning, or if you want to do this at a later stage, go on to step 3 in the Guided Setup).

GUIDED_MEASLEARN.TIF



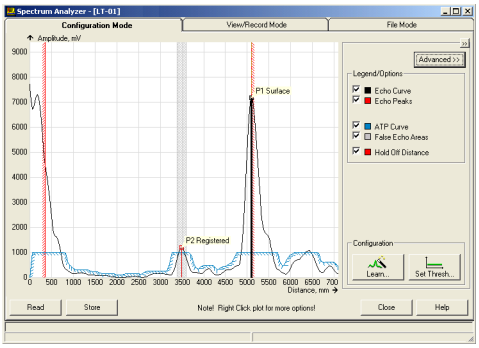
11. Click the Yes button if you want to run the *Measure and Learn* function. If you click No you can run this function at a later stage by using the Spectrum Analyzer in RRM.
Make sure that there is no filling or emptying going on when the *Measure and Learn* function is used.

GUIDED_MEASLEARN_2.TIF



12. The Measure and Learn function automatically creates an Amplitude Threshold Curve (ATC) and suggests False Echo Areas, see also “Echo Tuning” on page 4-9.
(By clicking the Advanced button you can choose one of the options or both by selecting the corresponding check box).
Verify the Tank Precondition settings. Check that the *Distance to Surface* value is correct (if not it may be due to a disturbing object in the tank). Choose Empty Tank if the tank is empty.

GUIDED_MEASLEARN_3.TIF

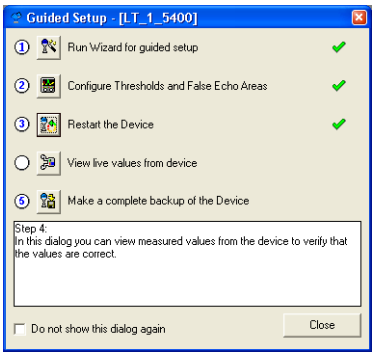


13. The automatically created Amplitude Threshold Curve (ATC) and False Echo Areas are shown in the Spectrum Plot. False Echo Areas are presented as shaded areas, and represent tank levels where RRM has found interfering echoes to be blocked out. False Echo Areas can be moved or removed before storing to the transmitter database. Make sure that each False Echo Area can be identified as an object in the tank that gives rise to a disturbing echo. See “Echo Tuning” on page 4-9 for more information.
Click the Store button to save the ATC and the registered disturbance echoes.

GUIDED_STEP3.TIF

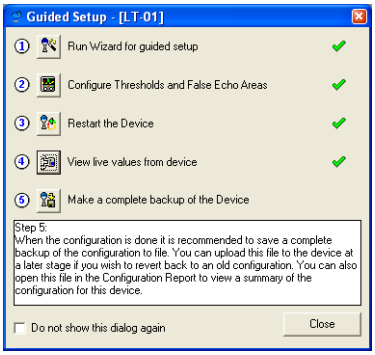
14. Restart the transmitter to make sure that all configuration changes are properly activated. It may take up to 60 seconds after the restart button is pressed until measurement values are updated.

GUIDED_STEP4.TIF



15. Step four lets you view measurement values in order to verify that the transmitter works correctly. If the measured values seem incorrect, configuration settings may need to be adjusted.

GUIDED_STEP5.TIF

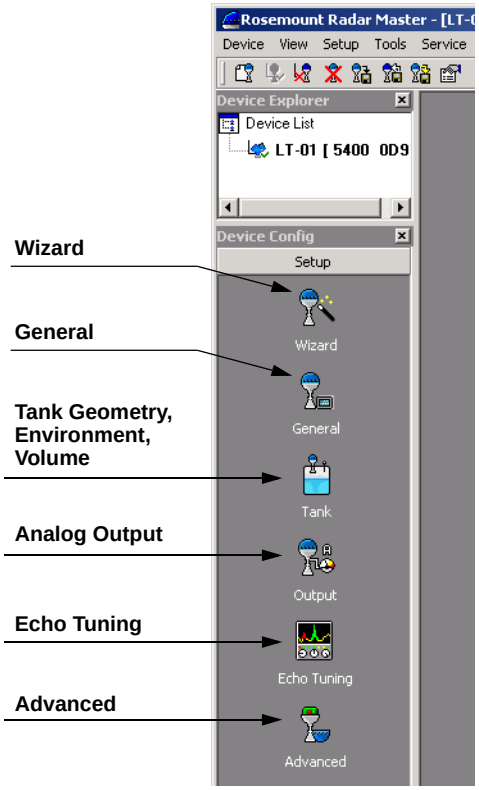


16. When configuration is finished it is recommended that the configuration is saved to a backup file.
    This information is useful:
    - for installing another 5400 in a similar tank since the file can be directly uploaded to a new device.
    - to restore the configuration if for any reason configuration data is lost or accidentally modified making the device inoperable.
    When the backup is completed the *Configuration Report* window appears automatically.

Using the Setup Functions

Use the **Setup** function if you are already familiar with the configuration process for the 5400 transmitter or if you just want to change the current settings:

Figure 4-9. Setup functions in RRM.



WORKSPACESETUP.TIF

1. Start the RRM software.
2. In the RRM workspace choose the appropriate icon for configuration of transmitter parameters:
   - **Wizard**: the Wizard is a tool that guides you through the basic configuration procedure of a 5400 transmitter.
   - **General**: configuration of general settings such as measurement units and communication parameters. This window also lets you configure which LCD variables to be displayed.
   - **Tank**: configuration of Tank Geometry, Tank Environment and Volume.
   - **Output**: configuration of Analog Output.
   - **Echo Tuning**: disturbance echo handling.
   - **Advanced**: advanced configuration.

CONFIGURATION USING A 375 FIELD COMMUNICATOR

The 5400 transmitter can be configured by using a 375 Field Communicator. A 275 HART Communicator may also be used. All HART commands are available for the 375 Field Communicator as well as for the 275 HART Communicator.

The menu tree with the various configuration parameters is shown in *Figure 4-11 on page 4-22*. Section *"Basic Configuration" on page 4-3* presents a description of the basic configuration parameters. See also sections "Echo Tuning" on page 4-9 and "Advanced Configuration" on page C-1 for information on disturbance echo handling and advanced configuration.

For information on all the capabilities, refer to the 375 Field Communicator Product Manual (document 00809-0100-4276).

Figure 4-10. The 375 Field Communicator.

1. Check that the desired Measurement Units are selected.
2. Start the Guided Setup. HART command: [1,3,3]. This is a guided installation procedure which lets you configure Tank Geometry, Process Conditions, Primary Variable, Upper/Lower Range Values and Alarm Mode.
3. Check the Application Complexity. HART command: [1,3,1]. If this value is too high the configuration should be fine tuned by using the Rosemount Radar Master configuration program.
4. If desired configure for Volume calculations. HART command: [1,3,4,6].
5. Echo Tuning. HART command: [1,4,4]. This function lets you create an Amplitude Threshold Curve (ATC) and register false echoes.
6. Restart the transmitter. HART command: [1,2,5].

Figure 4-11. HART Menu Tree

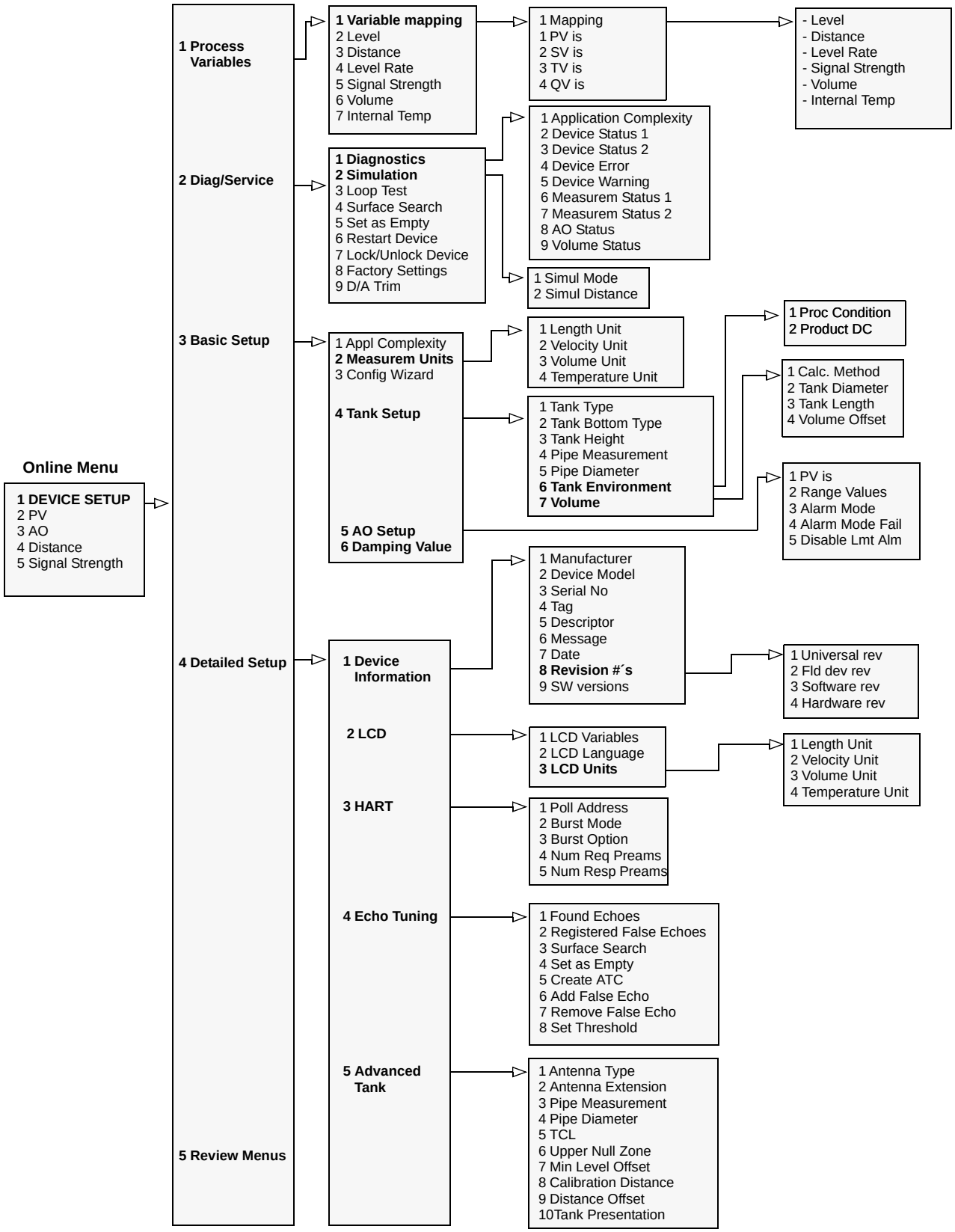


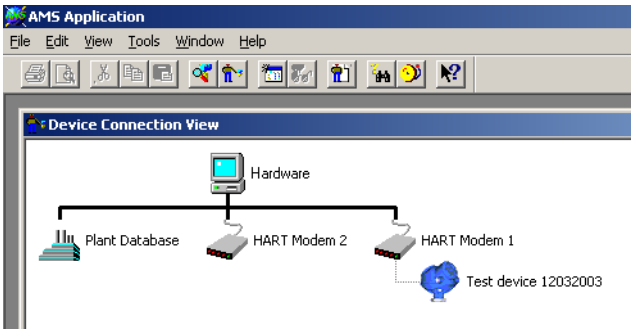
Table 4-4. HART Fast Key Sequences

Function	HART Fast Key
Alarm Mode	1, 3, 5, 3
Antenna Type	1, 4, 5, 1
Device Information	1, 4, 1
LCD Language	1, 4, 2, 2
LCD Variables	1, 4, 2, 1
Length Unit	1, 3, 2, 1
Lower Range Value (LRV) (4 mA)	1, 3, 5, 2
Pipe Diameter	1, 3, 4, 5
Poll Address	1, 4, 3,1
Primary Variable	1, 1, 1, 1
Product Dielectric Constant	1, 3, 4, 6, 2
Range Values (LRV/URV)	1, 3, 5, 2
Tag	1, 4, 1, 4
Tank Bottom Type	1, 3, 4, 2
Tank Height	1, 3, 4, 3
Tank Type	1, 3, 4, 1
Temperature Unit	1, 3, 2, 4
Hold Off Distance/Upper Null Zone	1, 4, 5, 6
Upper Range Value (URV) (20 mA)	1, 3, 5, 2
Volume Configuration	1, 3, 4, 7
Volume Unit	1, 3, 2, 3

AMS SUITE

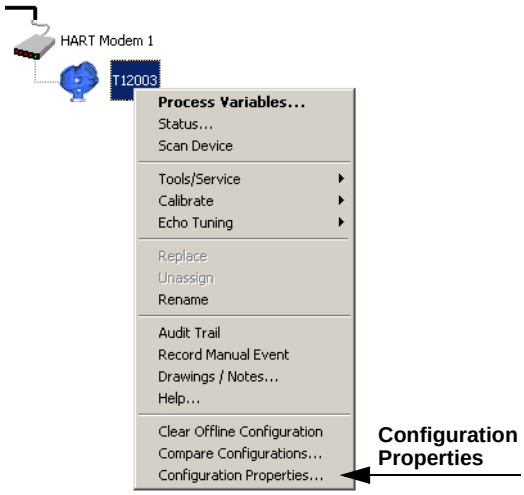
The 5400 Series transmitter can be configured by using the AMS Suite software:

01_AMS_START.TIF



1. Start the AMS software and connect to the desired transmitter. The transmitter is shown in the Device Connection View window.

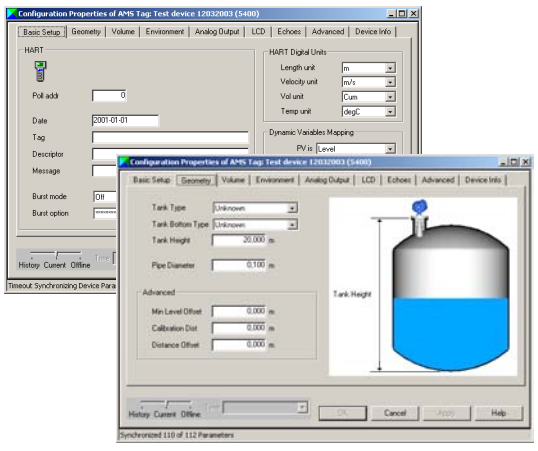
AMS_CONFIG.TIF



2. To configure the 5400 transmitter:
   1. Select the transmitter
   2. Click the right mouse button
   3. Choose the **Configuration Properties** option.

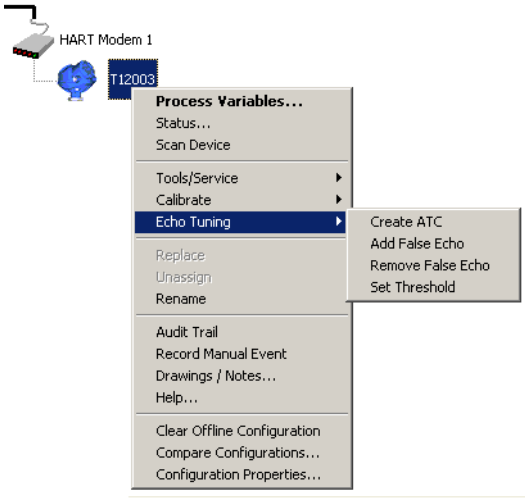
   As an alternative you may run the Configuration Wizard for a quick start.

12_AMS_CONFIG_PROPERTIES.TIF/
13_AMS_CONFIG_PROPERTIES.TIF



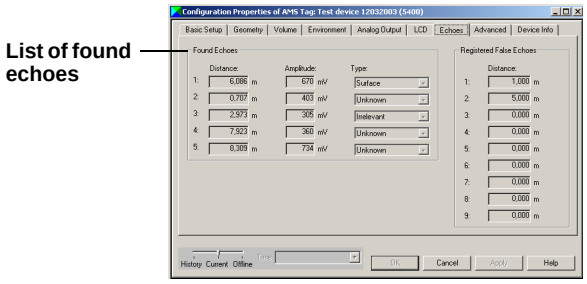
3. Configure the transmitter by selecting the appropriate tab in the *Configuration Properties* window. See “Basic Configuration” on page 4-3 for more information.
   Basic: configuration of measurement units, Variable mapping (PV etc.), Tag, Tag Descriptor, Message and Date.
   Geometry: Tank type, tank height and other tank related settings.
   Volume: volume calculation method can be chosen in this window. Choose None if volume calculation is not desired.
   Environment: process condition settings and dielectric constant range that corresponds to the current product.
   Analog Output: range values and alarm mode settings.

AMS/AMS_ECHOTUNING.TIF



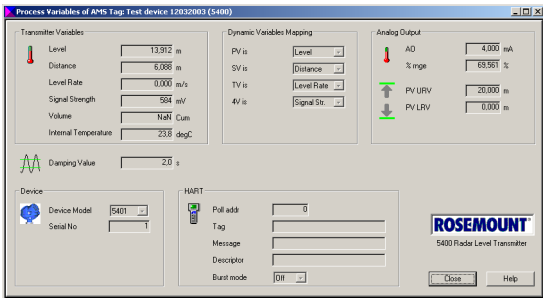
4. The Echo Tuning function offers the option to fine tune the transmitter if there are disturbing objects in the tank (see “Echo Tuning” on page 4-9):
   1. Select the transmitter and click the right mouse button.
   2. Choose the **Echo Tuning** option.
   3. Select the **Create ATC** option to create an Amplitude Threshold Curve.

AMS/AMS_ECHOES.TIF



5. Choose the **Echo Tuning** option and select **Add False Echo** to register the desired false echoes.
   A list of disturbing echoes can be viewed by opening the **Configuration Properties/Echoes** window. Before adding a false echo check that the found echo corresponds to a disturbing object in the tank.

AMS/03_AMS_PROCESS_VAR.TIF



6. When Echo Tuning is finished restart the transmitter by choosing the Tools/Service>**Restart** option.
7. Confirm the configuration by viewing measured values:
   1. Right-click the transmitter icon.
   2. Choose the Process Variables menu option.
   3. In the Process Variables window verify that the measured values are valid.

Section 5 Operation

SAFETY MESSAGES

Procedures and instructions in this manual may require special precautions to ensure the safety of the personnel performing the operations. Information that raises potential safety issues is indicated by a warning symbol (⚠). Refer to the safety messages listed at the beginning of each section before performing an operation preceded by this symbol.

⚠WARNING

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

- Make sure 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 transmitter is consistent with the appropriate hazardous locations certifications.
- Before connecting a HART®-based communicator in an explosive atmosphere, make sure the instruments in the loop are installed in accordance with intrinsically safe or non-incendive field wiring practices.

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 etc., may also jeopardize safety and is under no circumstances allowed.

VIEWING MEASUREMENT DATA

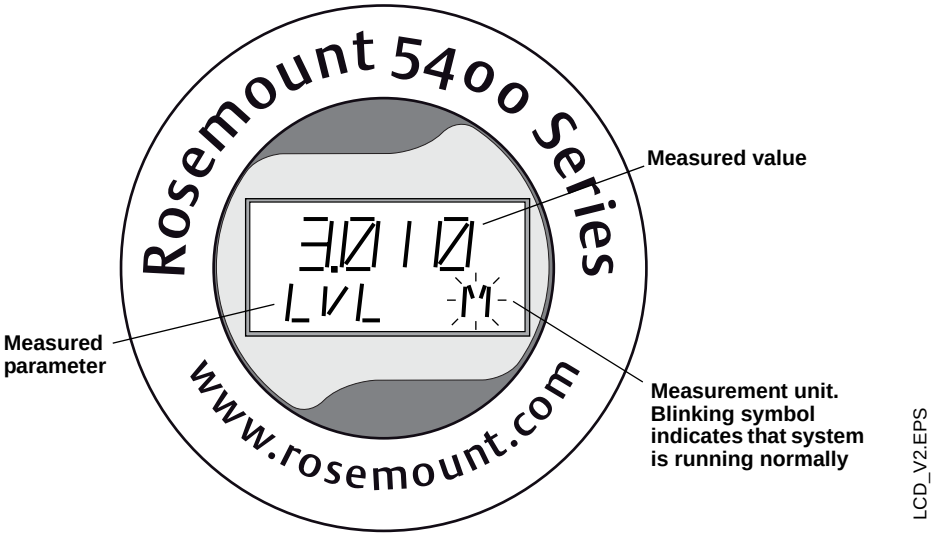
Using the Display Panel

The Rosemount 5400 transmitter uses an optional Display Panel for presentation of measurement data. When the transmitter is switched on the Display Panel presents information such as transmitter model, measurement frequency, software version, communication type (HART, FF), serial number, HART identification tag, setting of write protection switch and Analog Output settings.

When the transmitter is up and running the Display Panel presents Level, Signal Amplitude, Volume and other measurement data depending on the Display Panel configuration (see “Specifying Display Panel Variables” on page 5-3).

The display has two rows, the upper row shows the measured value and the lower row shows the parameter name and measurement unit. The display toggles between the different variables every 2 seconds. Variables to be presented are configurable by using a 275/375 Handheld Communicator or by using the Rosemount Radar Master software.

Figure 5-1. The 5400 Display Panel.



NOTE!
A malfunctioning display panel may only be replaced by service personnel at Rosemount Service Department. A display must not be replaced when the transmitter is in operation.

Specifying Display Panel Variables

It is possible to specify the variables to be presented on the Display Panel (LCD).

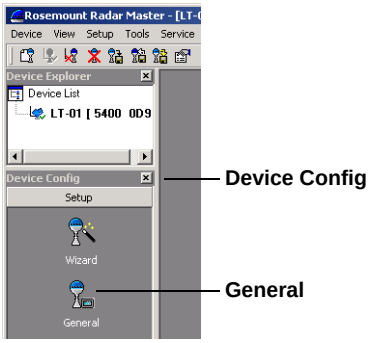
Using a Field Communicator

For a 275/375 Handheld Communicator the LCD settings are available with HART command [1,4,2].

Using Rosemount Radar Master (RRM)

The LCD tab in the *General* window lets you specify which variables to view on the Display Panel screen:

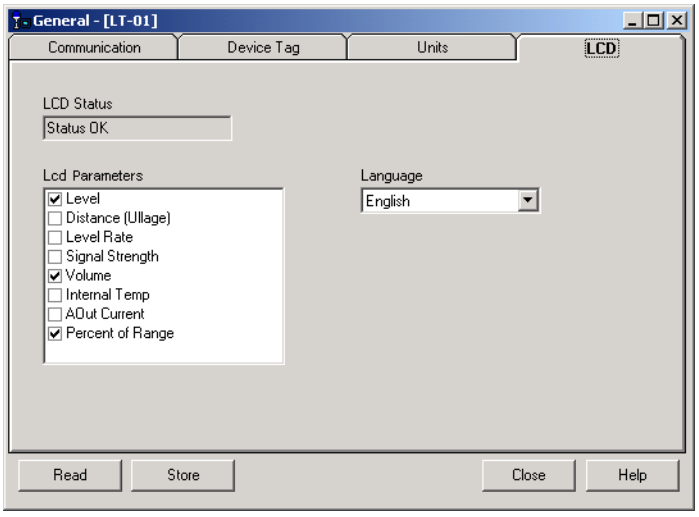
1. Choose the **General** option from the **Setup** menu, or click the General icon in the Device Configuration window.



WORKSPACESETUP_GENERAL.TIF

2. Select the **LCD** tab.

Figure 5-2. RRM lets you specify variables for the 5400 Display Panel.



RRM/RRM_GENERAL_LCD_TOGGLE.TIF

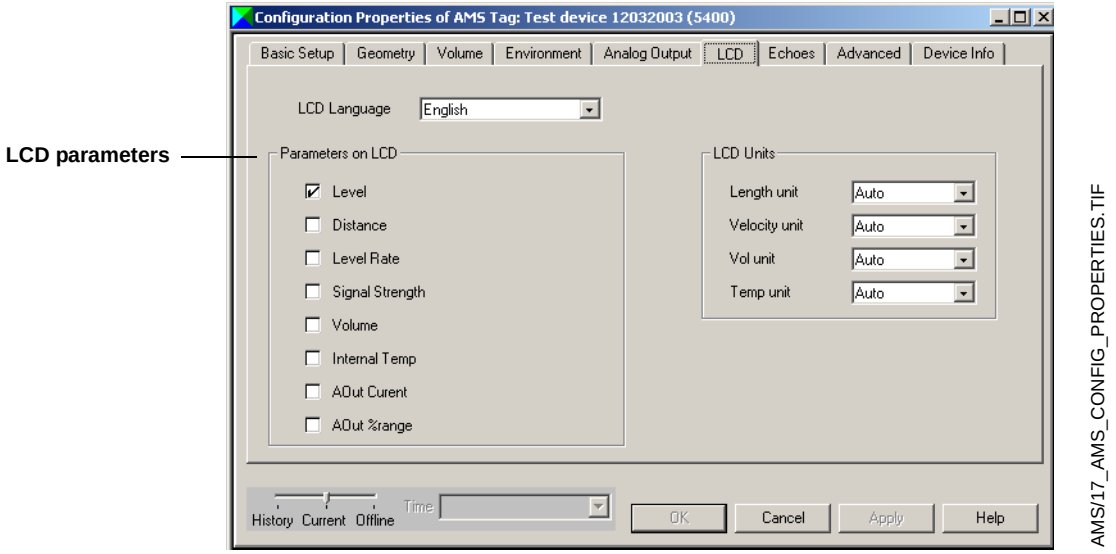
3. Select the variables you want to appear on the Display Panel. The LCD will alternate between the selected items.
4. Click the **Store** button to save the LCD settings in the transmitter database.

Using AMS

The LCD tab in the *Configuration Properties* window lets you specify which variables to view on the Display Panel screen:

1. To configure the 5400 transmitter:
   1. In the *Device Connection View* window click the right mouse button on the transmitter icon.
   2. Choose the **Configuration Properties** option.
2. Select the LCD tab and select the desired LCD parameters.
3. Click the OK button to save the configuration and close the window.

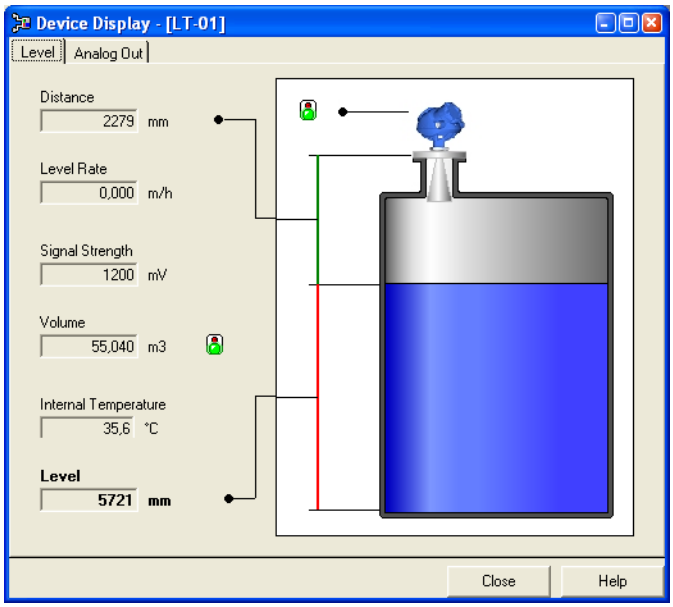
Figure 5-3. The LCD tab in the AMS configuaration window lets you configure parameters to be presented on the Display Panel.



Viewing Measurement Data in RRM

To view measurement data such as Level, Signal Strength, etc. in Rosemount Radar Master choose the **Tools>Device Display** option and select the Level tab:

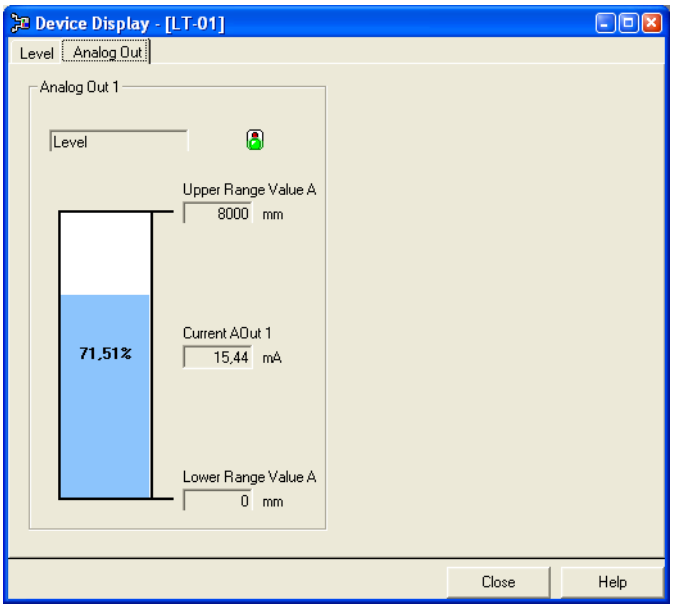
Figure 5-4. Presentation of measurement data in RRM.



RRM/DEVICEDISPLAY_LEVEL.TIF

To view Analog Output signal choose the **Tools>Device Display** option and select the Analog Out tab:

Figure 5-5. Presentation of Analog Output value in RRM.



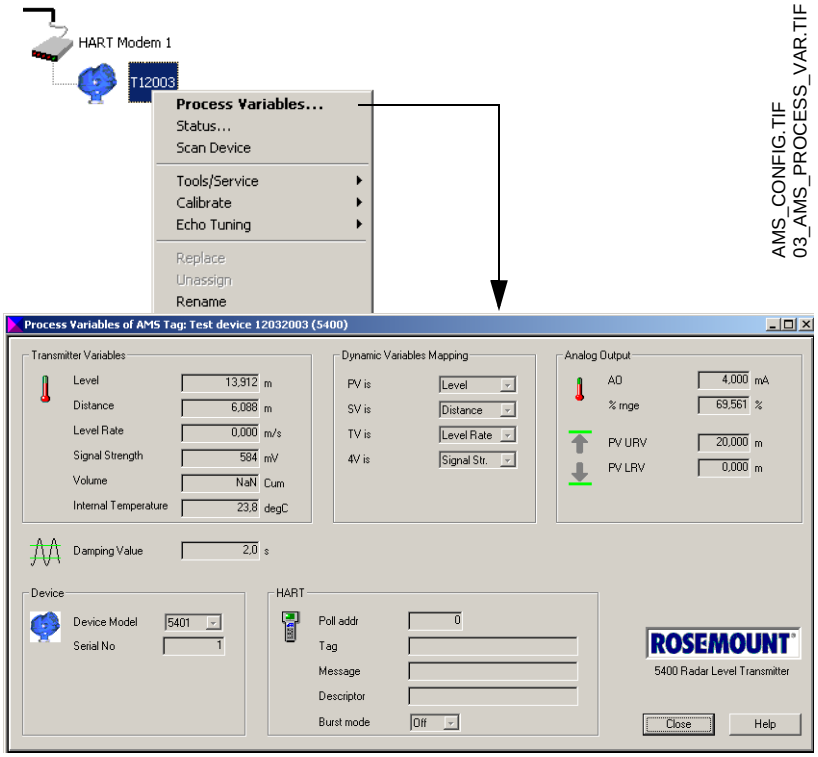
DEVICEDISPLAY_ANALOGOUT.TIF

Viewing Measurement Data in AMS Suite

To view measurement data such as Level, Signal Strength, etc. in the AMS Suite do the following:

1. Select the transmitter in the *Device Connection View* window.
2. Click the right mouse button and choose the **Process Variables** option.

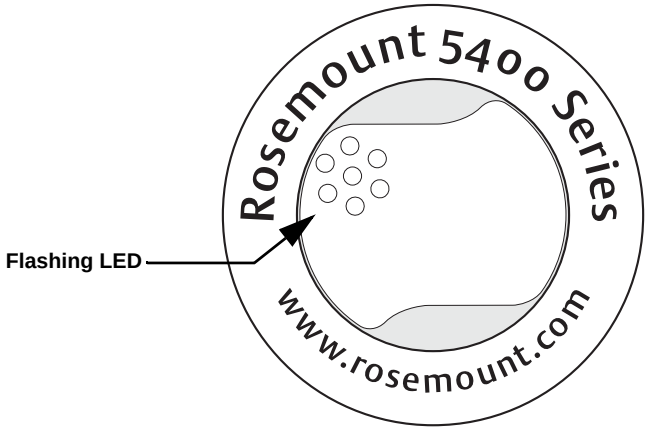
Figure 5-6. Presentation of measurement data in AMS Suite.



LED ERROR MESSAGES

For Rosemount 5400 transmitters without display a flashing Light Emitting Diode (LED) is used for presentation of error messages.

Figure 5-7. Rosemount 5400 transmitters without display use a LED for presentation of error messages.



In normal operation the LED flashes once every other second. When an error occurs, the LED flashes a sequence that corresponds to the Code number followed by a five second pause. This sequence is continuously repeated.

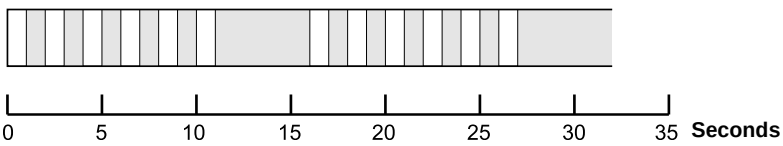
The following errors can be displayed:

Table 5-1. LED error codes.

Code	Error
0	Ram Failure
1	FPROM
2	HREG
4	Microwave Module
5	Display
6	Modem
7	Analog Out
8	Internal Temperature
11	Hardware
12	Measurement
14	Configuration
15	Software

Example

Modem error (code 6) is displayed as the following flash sequence:



Section 6 Service and Troubleshooting

SAFETY MESSAGES

Procedures and instructions in this manual may require special precautions to ensure the safety of the personnel performing the operations. Information that raises potential safety issues is indicated by a warning symbol (⚠). Refer to the safety messages listed at the beginning of each section before performing an operation preceded by this symbol.

⚠WARNING

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

- Make sure 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 transmitter is consistent with the appropriate hazardous locations certifications.
- Before connecting a HART®-based communicator in an explosive atmosphere, make sure the instruments in the loop are installed in accordance with intrinsically safe or non-incendive field wiring practices.
- Any substitution of non-recognized parts may jeopardize safety. Repair, e.g. substitution of components etc., may also jeopardize safety and is under no circumstances allowed.
- Substitution of components may impair Intrinsic Safety.

Electrical shock could cause death or serious injury.

- Use extreme caution when making contact with the leads and terminals.
- To prevent ignition of flammable or combustible atmospheres, disconnect power before servicing.

High voltage that may be present on leads could cause electrical shock:

- Avoid contact with leads and terminals.
- Make sure the main power to the 5400 transmitter is off and the lines to any other external power source are disconnected or not powered while wiring the gauge.

SERVICE

The functions mentioned in this section are all available in the *Rosemount Radar Master* (RRM) configuration program.

Viewing Input and Holding Registers

Measured data is continuously stored in the **Input Registers**. By viewing the contents of the Input Registers you can check that the transmitter works properly.

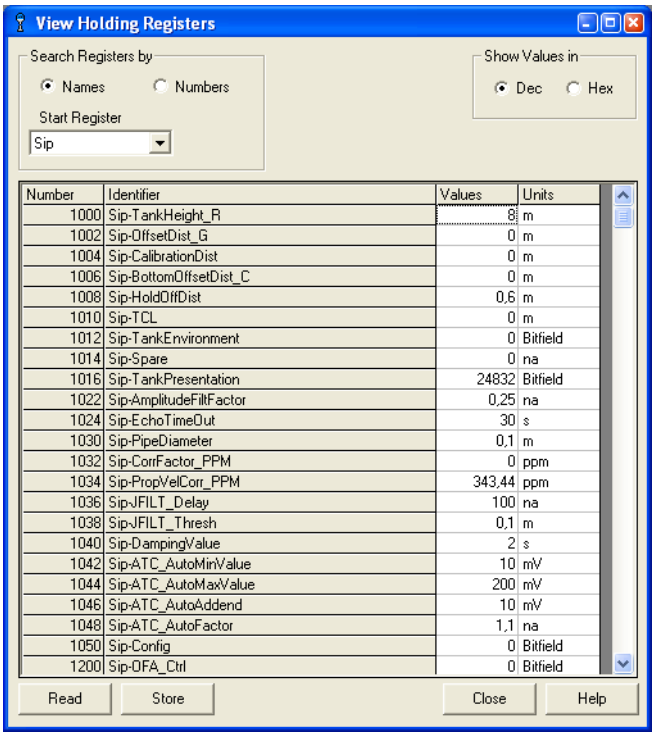
The **Holding Registers** store various transmitter parameters such as configuration data used to control the measurement performance.

By using the RRM program most Holding Registers can be edited by simply typing a new value in the appropriate Value input field. Some Holding Registers can be edited in a separate window. In this case you can change individual data bits.

In order to be able to view the Input/Holding registers in RRM, the Service Mode must be activated:

1. Choose the **Enter Service Mode** option from the **Service** menu.
2. Type the password (default password is “admin”). Now the View Input and View Holding Registers options are available.
3. Choose the View Input/Holding Registers option from the Service menu.
4. Click the Read button. To change a Holding register value just type a new value in the corresponding Value field. The new value is not stored until the Store button is clicked.

Figure 6-1. Holding and Input Registers can be viewed in RRM.



RRM_VIEWHOLDREG.TIF

Analog Output Calibration

This function lets you calibrate the Analog Output by comparing the actual output current with the nominal 4 mA and 20 mA currents. Calibration is done at factory and normally the transmitter does not need to be recalibrated.

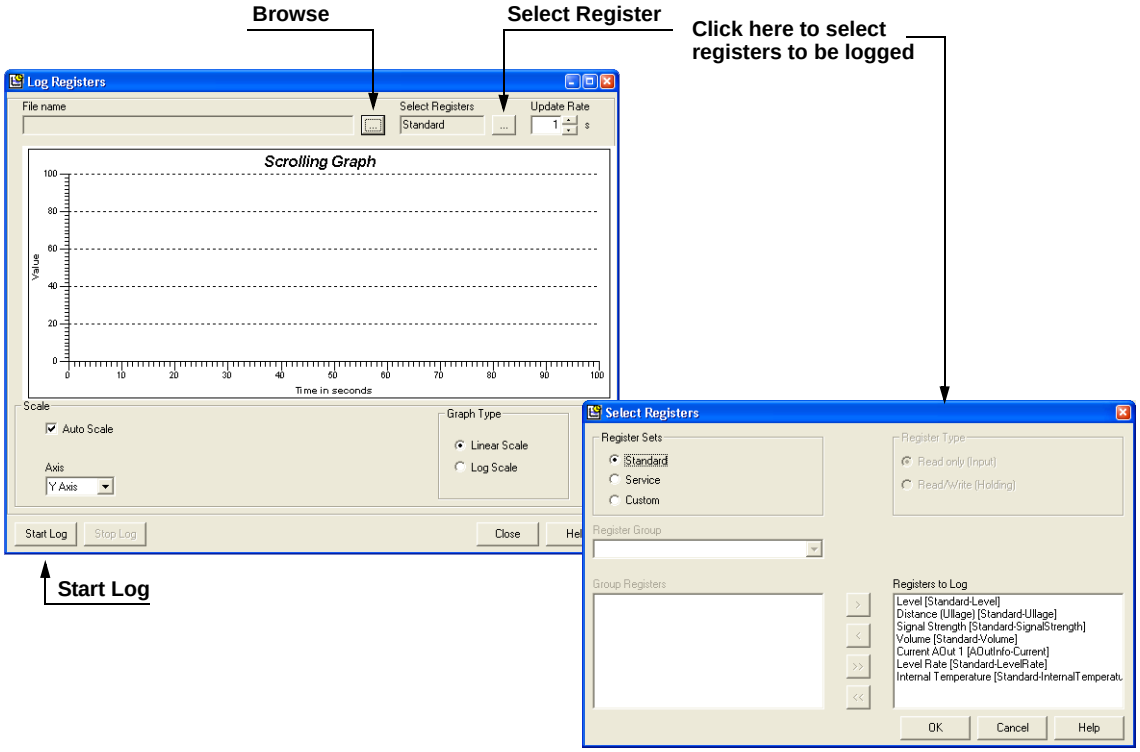
In RRM this function is available via Setup>Output.

Logging Measurement Data

By using the Log Device Registers function in the RRM software you can log Input and Holding registers over time. It is possible to choose from different pre-defined sets of registers. This function is useful for verifying that the transmitter works properly.

To log device registers choose the Tools>Log Device Registers option to open the *Log Registers* window:

Figure 6-2. The Log Registers function can be used to verify that the transmitter works properly.



LOGREGISTERS.TIF/LOGREGISTERSSELECTREGISTERS.TIF

To start logging do the following:

1. Click the Browse button, select a directory to store the log file and type a log file title.
2. Click the Select Register button and choose the desired range of registers to be logged.
3. Enter the update rate. An update rate of 10 seconds means that the plot will be updated every 10 seconds.
4. Click the Start Log button.

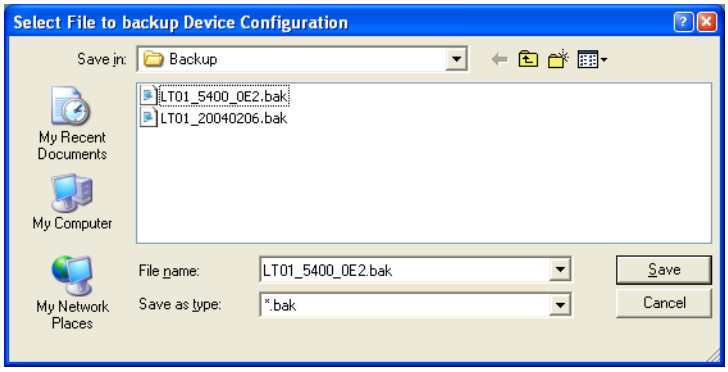
Backing Up the Transmitter Configuration

Use this RRM option to make a backup copy of the configuration parameters in the transmitter database. The backup file can be used to restore the transmitter configuration. It can also be used for configuration of a transmitter in a similar application. Parameters in the saved file can be uploaded directly to the new device.

The backup function is available from the *Device* menu in RRM.

1. Choose the **Backup Config to File** option from the **Device** menu.

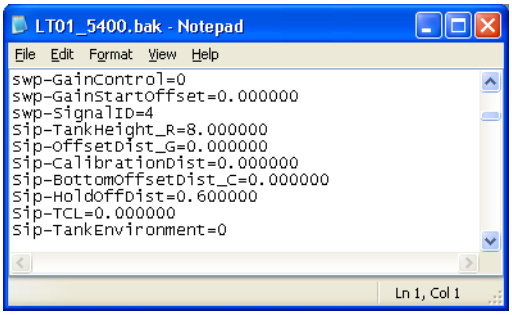
Figure 6-3. It is recommended that the transmitter configuration is stored in a backup file.



RRM/BACKUP.TIF

2. Browse to the desired directory.
3. Type a name of the backup file and click the **Save** button.
   Now the transmitter configuration is stored. The backup file can be used at a later stage to restore a configuration which has been accidentally changed. The backup file can also be used to quickly configure transmitters which are installed on similar tanks.To upload a backup configuration choose the **Upload Config to Device** option from the **Device** menu.
   The backup file can be viewed as a text file in a word processing program:

Figure 6-4. The configuration backup file can be viewed in a word processor program.



RRM/BACKUP_VIEW.TIF

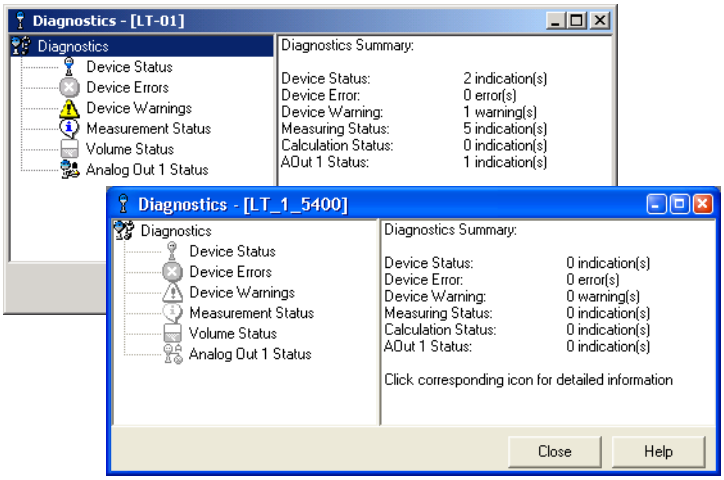
Diagnostics

By using the RRM software the following information about the device can be retrieved:

- device status, see “Device Status” on page 6-11.
- device errors, see “Errors” on page 6-12.
- device warnings, see “Warnings” on page 6-13.
- measurement status, see “Measurement Status” on page 6-14.
- volume status, see “Volume Calculation Status” on page 6-15.
- analog output status, see “Analog Output Status” on page 6-15.

To open the Diagnostics window in RRM choose the **Diagnostics** option from the **Tools** menu.

Figure 6-5. The Diagnostics window in Rosemount Radar Master.

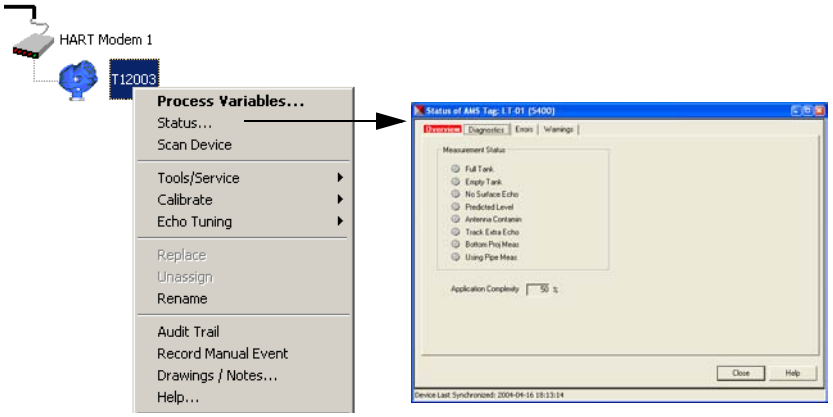


RRM/DIAGNOSTICS.TIF, DIAGNOSTICS_WARNING.TIF

For a 275/375 Handheld Communicator the corresponding HART command for the Diagnostics option is [1,2,1].

To view the Diagnostics window in AMS Suite click the right mouse button on the desired transmitter and choose the **Status** option:

Figure 6-6. Diagnostics window in AMS Suite.

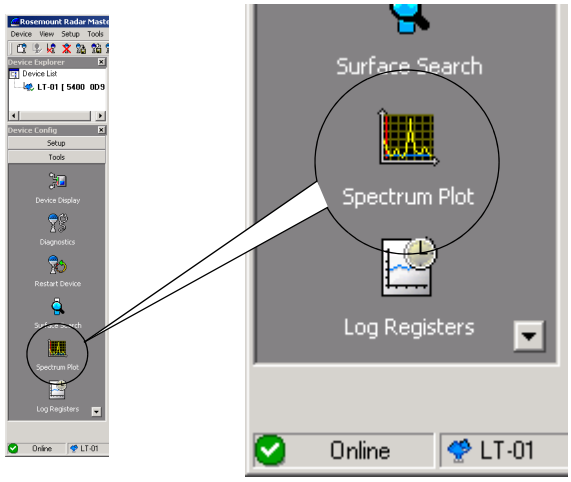


AMS/AMS_CONFIG.TIF, AMS_DIAGNOSTICS.TIF

Using the Spectrum Plot

The Spectrum Plot in *Rosemount Radar Master* (RRM) lets you view the measurement signal amplitude in the tank and includes the Echo Tuning functionality (see “Echo Tuning” on page 4-9 for more information on false echo handling).

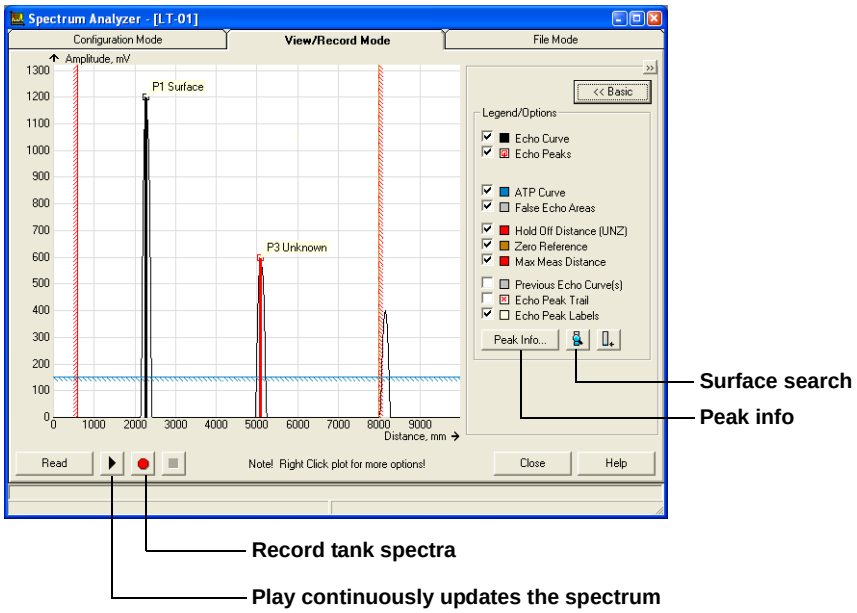
Figure 6-7. The Spectrum Plot function is a useful tool for signal analysis.



WORKSPACE_TOOLS1.TIF

Each radar echo is displayed as a peak in the signal plot. This is a useful tool for obtaining a view of the tank conditions. The Spectrum Analyzer also lets you register disturbing echoes and create an Amplitude Threshold Curve (see Section 4: Echo Tuning for further information). When clicking the **Spectrum Plot** icon the *Spectrum Analyzer* window appears with the **View/Record** tab selected.

Figure 6-8. A spectrum plot in View mode.



RRM/SPECTRUM_VIEW_ADVANCED.TIF

Surface Search

This function can be used to trigger the transmitter to search for the product surface.

Peak Info

This function lists all echoes in the tank.

Record Tank Spectra

This function allows you to record tank spectra over time. This can be a useful function if, for example, you want to study the tank signal when filling or emptying the tank.

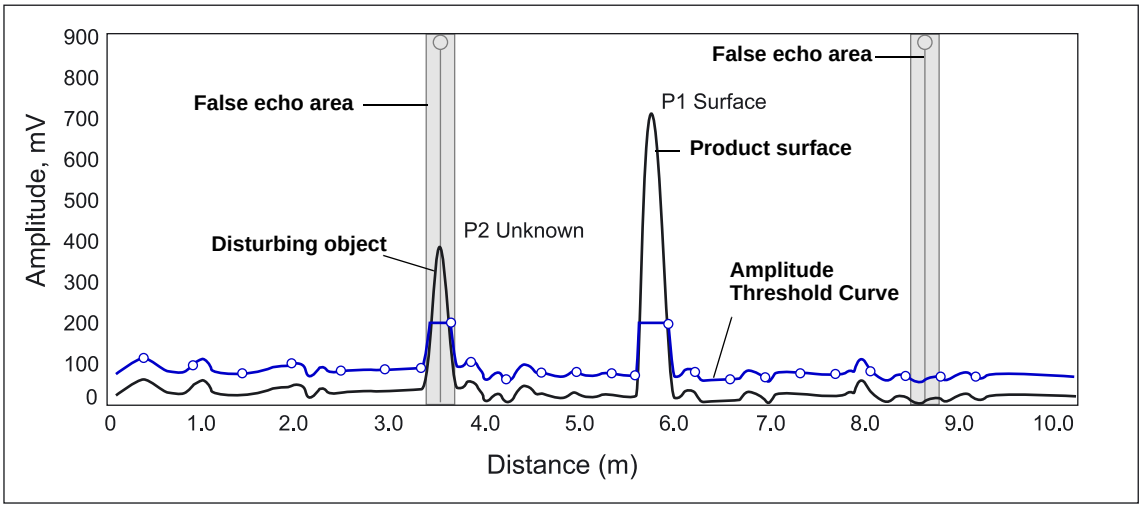
Play

When the Play button is clicked the tank spectrum is continuously updated without being stored.

Configuration Mode Tab

This tab lets you use the Echo Tuning functions as described in section “Echo Tuning” on page 4-9. Figure 6-9 illustrates the type information that can be shown in the Spectrum Analyzer window in this mode.

Figure 6-9. The Spectrum Plot presents all visible echoes in the tank.



To create an Amplitude Threshold Curve (ATC) and to register false echoes click the Learn button in the Spectrum Analyzer/Configuration Mode window.

File Mode Tab

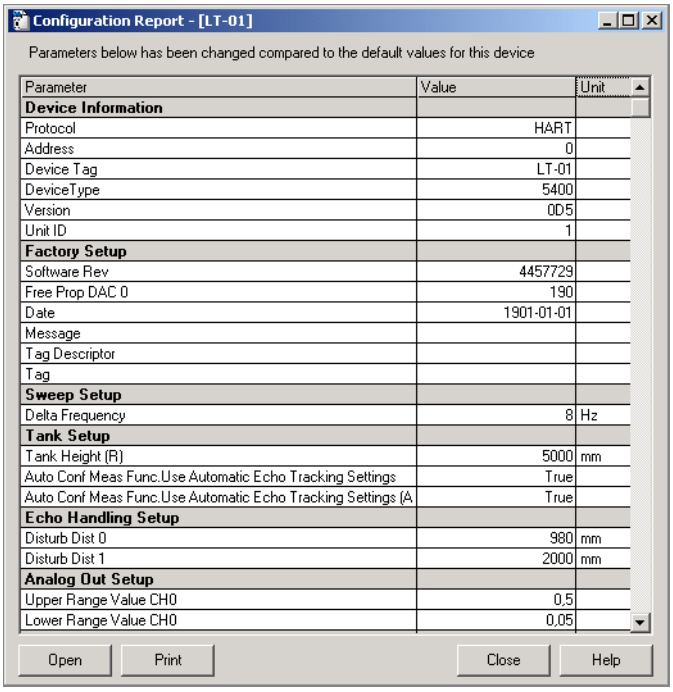
In the File Mode you can open saved snapshots/movies from file and present in the spectrum plot. If it is a movie you can play the movie and the spectrum plot is updated at desired update rate.

Configuration Report

This function in *Rosemount Radar Master* (RRM) shows what configuration changes have been done to the transmitter compared to the factory configuration. The report compares a specified backup file with the default transmitter configuration.

Information on antenna type, software versions, software and hardware configuration and unit code is presented.

Figure 6-10. The Configuration Report window in Rosemount Radar Master.

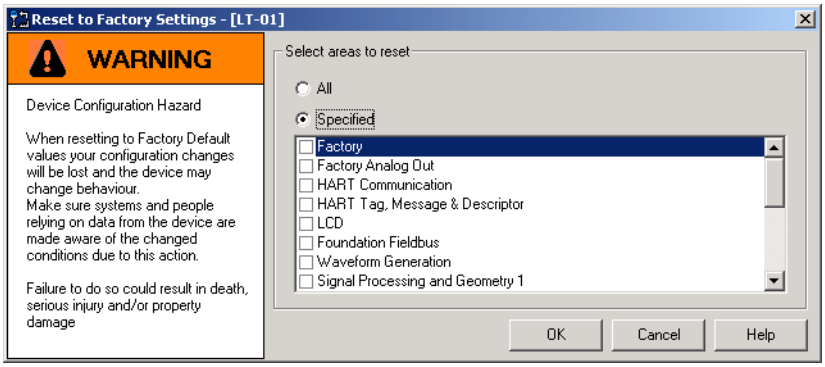


CONFIGREPORT.TIF

Reset to Factory Settings

This function resets all or a specific part of the holding registers to factory settings. It is recommended that a backup of the configuration is made before the factory reset is done. Then the old transmitter configuration can be loaded if necessary. To use this function in RRM choose Tools>Factory Settings.

Figure 6-11. The Reset to Factory Settings window in RRM.



RESETFACTORYSETTINGS.TIF

In AMS Suite: Tools/Service>Factory Settings.

275/375 Handheld Communicator: HART Command [1,2,8].

Surface Search

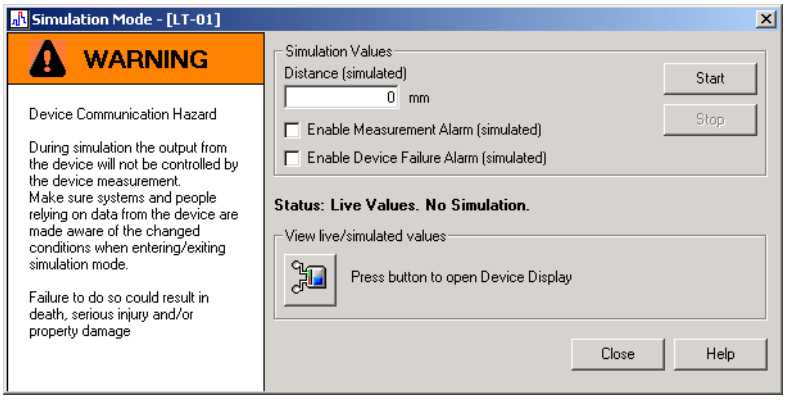
The *Surface Search* command triggers a search for the product surface. Use this function if, for example, the measured level has stuck on a disturbing object in the tank (see “Using the Spectrum Plot” on page 6-6).

Using the Simulation Mode

This function can be used to simulate measurements and alarms.

To open the Simulation Mode window in RRM choose Tools>Simulation Mode:

Figure 6-12. The Simulation Mode window in RRM.



SIMULATIONMODE.TIF

AMS Suite: Tools>Service>Simulation Mode.

275/375 Handheld Communicator: HART Command [1,2,2].

Enter Service Mode in RRM

In *Rosemount Radar Master* (RRM) some useful service functions are available for the 5400 Series transmitter. By setting RRM into the Service Mode all the Service menu options in RRM are enabled. The default password for enabling the Service Mode is “admin”. The password can be changed by selecting the *Change Password* option from the Service menu.

Write Protecting a Transmitter

A 5400 Series transmitter can be protected from unintentional configuration changes by a password protected function.

RRM: Tools>Lock/Unlock Configuration Area.

AMS Suite: Tools>Service>Lock/Unlock Device.

275/375 Handheld Communicator: HART Command [1,2,7].

If a 5400 Series transmitter is ordered with write protection enabled the default password is **12345**. It is recommended that this password is not changed in order to facilitate service and maintenance of the transmitter.

TROUBLESHOOTING

Troubleshooting

If there is a malfunction despite the absence of diagnostic messages, see Table 6-1 for information on possible causes.

NOTE!
If the transmitter housing must be removed for service, make sure that the Teflon sealing is carefully protected against dust and water.

Table 6-1. Troubleshooting chart

Symptom	Possible cause	Action
No level reading	• Power disconnected • Data communication cables disconnected	• Check the power supply. • Check the cables for serial data communication.
No HART communication.	• COM Port configuration does not match the connected COM Port. • Cables may be disconnected. • Wrong HART address is used. • Hardware failure.	• Check that correct COM Port is selected in the HART server (see “Specifying the COM Port” on page 4-14). • Check the COM port buffer, “Specifying the COM Port” on page 4-14. • Check wiring diagram. • Verify that the 250 Ohm resistor is in the loop. • Check cables. • Make sure that correct HART short address is used. Try address=0. • Check the COM Port Buffer setting, see page 4-14. • Check Analog Output current value to verify that transmitter hardware works.
Analog Out is set in Alarm.	Measurement Failure or Transmitter Failure.	Open the Diagnostics window in RRM to check active errors and alarms, see “Diagnostics” on page 6-5. See also “Analog Output Status” on page 6-15.
Incorrect level reading.	• Configuration error. • Disturbing objects in the tank. • See “Application Errors” on page 6-16.	• Check the Tank Height parameter; RRM>Setup>Tank. • Check status information and diagnostics information, see “Diagnostics” on page 6-5. • Check that the transmitter has not locked on an interfering object, see “Using the Spectrum Plot” on page 6-6.
Integral display does not work.		• Check the display configuration in Rosemount Radar Master (open menu Setup>General). • Diagnostics. • Contact Rosemount Service Department(1).

(1) A malfunctioning display panel may only be replaced by service personnel at Rosemount Service Department. A display must not be replaced when the transmitter is in operation.

Device Status

Device Status messages that may appear on the Integral Display, on the 275/375 Handheld Communicator or in the Rosemount Radar Master (RRM) program are shown in Table 6-2:

Table 6-2. Device status.

Message	Description	Action
Running Boot Software	The application software could not be started.	Contact Rosemount Service Department.
Device Warning	A device warning is active.	See Warning Messages for details.
Device Error	A device error is active.	See Error Messages for details.
Simulation Mode	The simulation mode is active.	Turn off the simulation mode.
Advanced Simulation Mode	The advanced simulation mode is active.	To turn off the Advanced Simulation mode set Holding Register 3600=0 (see “Viewing Input and Holding Registers” on page 6-2).
Invalid Measurement	The level measurement is invalid.	Check Error Messages, Warning Messages and Measurement Status for details.
Software Write Protected	The configuration registers are write protected.	Use the Lock/Unlock function to turn off the write protection (see “Write Protecting a Transmitter” on page 6-9).
Hardware Write Protected	The Write Protection switch is enabled.	Set the Write Protection switch to Off. Contact Rosemount service department for information.
Factory settings used	The factory default configuration is used.	The transmitter calibration is lost. Contact Rosemount Service Department.
Antenna Contamination	The antenna is extremely contaminated resulting in degradation of measurement signal strength.	Clean the antenna.

Errors

Error messages that may be displayed on the Integral Display, on a 275/375 Handheld Communicator, in AMS or in the Rosemount Radar Master (RRM) program, are shown in Table 6-3. Errors normally result in Analog Output alarm.

Errors are indicated in RRM in the *Diagnostics* window.

Table 6-3. Error messages.

Message	Description	Action
RAM error	An error in the gauge data memory (RAM) has been detected during the startup tests. Note: this automatically resets the gauge.	Contact Rosemount service department.
FPROM error	An error in the gauge program memory (FPROM) has been detected during the startup tests. Note: this automatically resets the gauge.	Contact Rosemount service department.
Hreg error	An error in the transmitter configuration memory (EEPROM) has been detected. The error is either a checksum error that can be solved by loading the default database or a hardware error. NOTE: the default values are used until the problem is solved.	Load default database and restart the transmitter. Contact Rosemount service department if the problem persists.
MWM error	An error in the microwave module.	Contact Rosemount service department.
LCD error	An error in the LCD.	Contact Rosemount service department.
Modem error	Modem hardware failure.	Contact Rosemount service department.
Analog out error	An error in the Analog Out Module.	Contact Rosemount service department.
Internal temperature error	An error in the internal temperature measurement.	Contact Rosemount service department.
Other hardware error	An unspecified hardware error has been detected.	Contact Rosemount service department.
Measurement error	A serious measurement error has been detected.	Contact Rosemount service department.
Configuration error	At least one configuration parameter is outside allowed range. NOTE: the default values are used until the problem is solved.	• Load the default database and restart the transmitter (see “Reset to Factory Settings” on page 6-8). • Configure the transmitter or upload a backup configuration file (see “Backing Up the Transmitter Configuration” on page 6-4). • Contact Rosemount service department if the problem persists.
Software error	An error has been detected in the transmitter software.	Contact Rosemount service department.

Warnings

Table 6-4 is a list of diagnostic messages that may be displayed on the Integral Display, on the 275/375 Handheld Communicator or in the Rosemount Radar Master (RRM) program. Warnings are less serious than errors and in most cases do not result in Analog Output alarms.

Warnings are indicated in RRM in the *Diagnostics* window.

Table 6-4. Warning messages.

Message	Description	Action
RAM warning	See Diagnostics (RRM: Tools>Diagnostics) for further information on a warning message. See also “Diagnostics” on page 6-5.	
FPROM warning		
Hreg warning		
MWM warning		
LCD warning		
Modem warning		
Analog out warning		
Internal temperature warning		
Other hardware warning		
Measurement warning		
Config warning		
SW warning		

Measurement Status

Measurement Status messages that may appear on the Integral Display, on the 275/375 Handheld Communicator or in the Rosemount Radar Master (RRM) program are shown in Table 6-5:

Table 6-5. Measurement status.

Message	Description	Action
Full tank	The level measurement is in Full Tank state. The transmitter waits for the surface echo to be detected at the top of the tank.	The transmitter leaves the Full Tank state when the product surface gets below the Full Tank Detection Area, see “Full Tank Handling” on page C-5 and “Full Tank Handling” on page C-11.
Empty tank	The level measurement is in Empty Tank state. The transmitter waits for the surface echo to be detected at the bottom of the tank.	The transmitter leaves the Empty Tank state when the product surface gets above the Empty Tank Detection Area, see “Empty Tank Handling” on page C-4 and “Empty Tank Handling” on page C-8.
Antenna Contamination	The antenna is so contaminated that the level measurement might be affected.	Clean the antenna.
Reference pulse invalid	An error in the reference pulse in the last sampled tank signal.	Check Warning messages. If MicroWave Module (MWM) Warning is active this might indicate a transmitter error. Contact Rosemount service department.
Sweep linearization warning	The sweep is not correctly linearized.	Check Warning messages. If MWM Warning is active this might indicate a transmitter error. Contact Rosemount service department.
Tank signal clip warning	The last Tank Signal was clipped.	Check Warning Messages. If MWM Warning is active this might indicate a transmitter error. Contact Rosemount service department.
No surface echo	The Surface Echo Pulse can not be detected.	Check if the configuration can be changed so that the surface echo can be tracked in this current region.
Predicted level	The presented level is predicted. The surface echo could not be detected.	See *No surface echo* above.
Sampling failed	The sampling of the last tank signal failed.	Check Warning Messages.
Invalid volume value	The given volume value is invalid.	Check Volume Status for details.
Simulation Mode	The simulation mode is active. The presented measurement values are simulated.	No action needed.
Advanced Simulation Mode	The advanced simulation mode is active. The given measurements are simulated.	To turn off the Advanced Simulation mode set Holding Register 3600=0 (see “Viewing Input and Holding Registers” on page 6-2).
Tracking Extra Echo	The transmitter is in the empty tank state tracking an extra echo.	See “Extra Echo” on page C-5 and page C-10.
Bottom Projection	The bottom projection function is active.	See “Tank Bottom Projection” on page C-4.
Using pipe measurement	Pipe Measurement is active.	No action needed.
Surface close to registered false echo.	Close to a registered false echo measurement accuracy may be slightly reduced.	By using the Register False Echo function the transmitter can track the product surface in the vicinity of disturbing objects (see “Echo Tuning” on page 4-9).
Sudden level jump detected.	This may result from various measurement problems.	Check the tank to find out what causes problem tracking the surface.

Volume Calculation Status

Volume Calculation Status messages that may appear on the Integral Display, on the 275/375 Handheld Communicator or in the Rosemount Radar Master (RRM) program are shown in Table 6-6:

Table 6-6. Volume status.

Message	Description	Action
Level is below lowest strapping point.	The measured level is below the lowest point in the given strapping table.	For a correct volume calculation in this region change the strapping table.
Level is above highest strapping point.	The measured level is above the highest point in the given strapping table.	For a correct volume calculation in this region change the strapping table.
Level out of range.	The measured level is outside the given tank shape.	Check if the correct tank type is chosen and check the configured Tank Height.
Strap table length not valid.	The configured strap table length is too small or too large.	Change the strapping table size to a valid number of strapping points. A maximum number of 20 strapping points can be entered.
Strap table not valid.	The strapping table is not correctly configured.	Check that both level and volume values in the strapping table are increasing with strapping table index.
Level not valid.	The measured level is not valid. No volume value can be calculated.	Check Measurement Status, Warning and Error Messages.
Volume configuration missing.	No volume calculation method is chosen.	Do a volume configuration.
Volume not valid.	The calculated volume is not valid.	Check the other volume status messages for the reason.

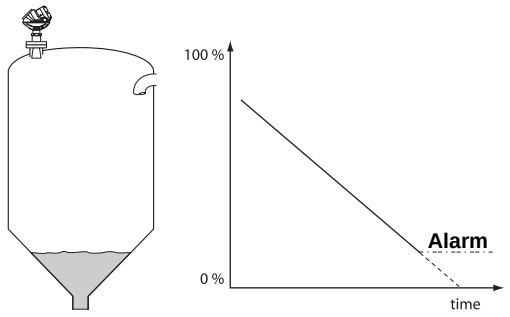
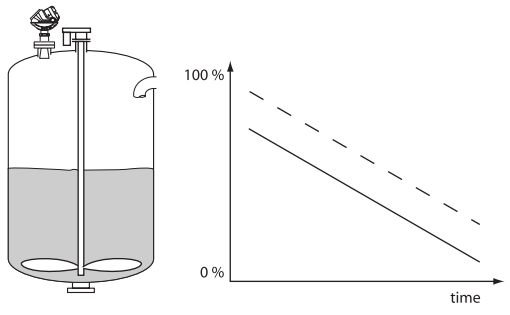
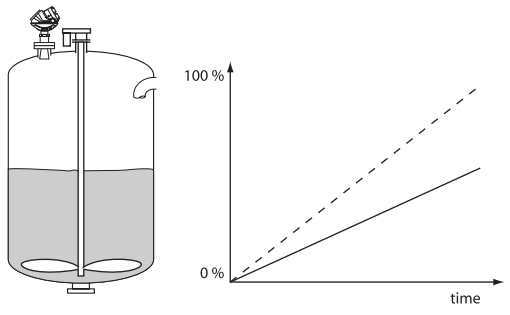
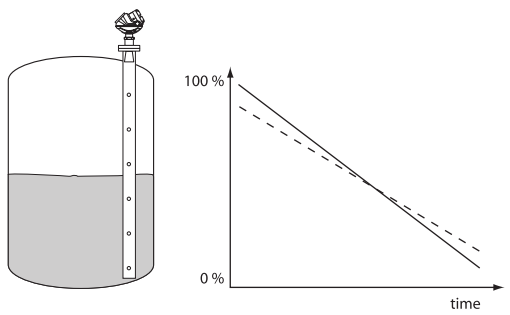
Analog Output Status

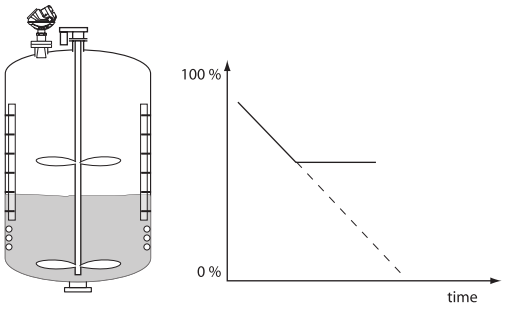
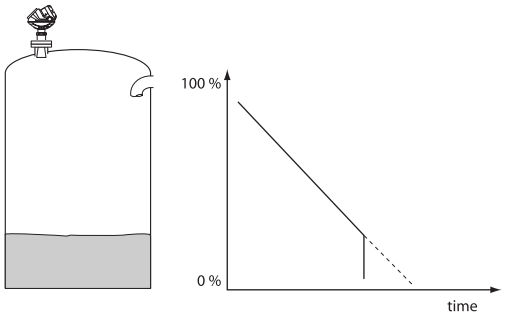
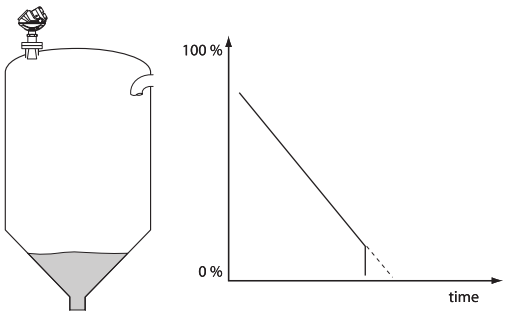
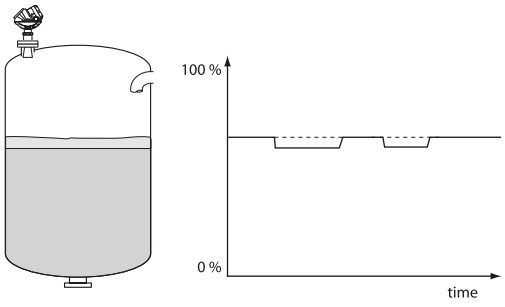
Analog Output Status messages that may appear on the Integral Display, on the 275/375 Handheld Communicator or in the Rosemount Radar Master (RRM) program are shown in Table 6-7:

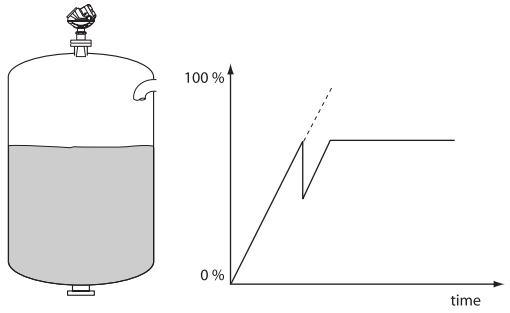
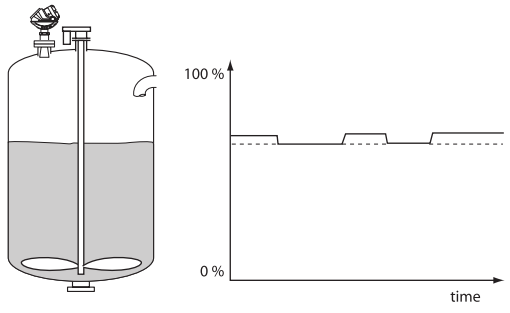
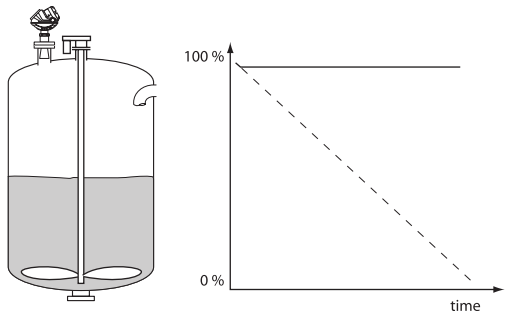
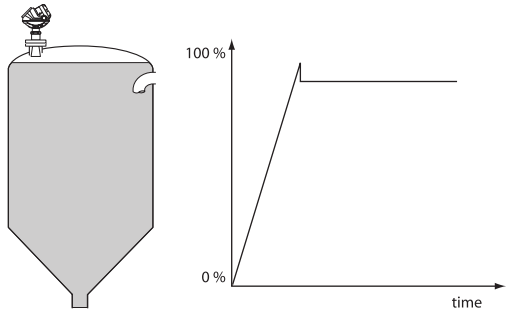
Table 6-7. Analog Output status.

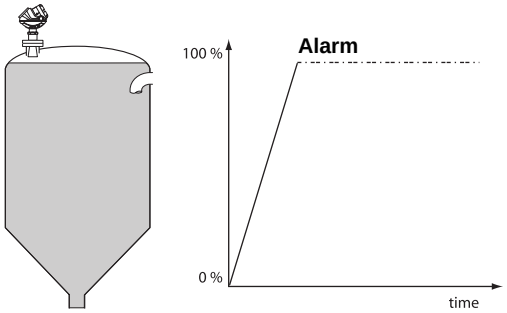
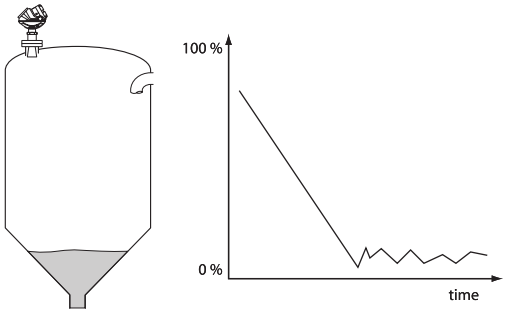
Message	Description	Action
Not connected	Analog output hardware is not connected.	
Alarm Mode	The analog output is in Alarm Mode.	Check Error and Warning Messages to find the reason for the Alarm.
Saturated	The analog output signal value is saturated, i.e. equal to the saturation value.	No action needed.
Multidrop	The transmitter is in Multidrop Mode. The analog output is fixed at 4 mA.	This is the normal setting when a device is used in Multidrop configuration.
Fixed Current mode	The analog output is in fixed current mode.	This mode is used when calibrating the Analog Output channel.
Invalid Limits	The given Upper and Lower Range Values are invalid.	Check that the difference between the Upper and Lower Range Value is greater than the Minimum Span.

Application Errors

APPLICATION_ERROR_1.EPS 	When product surface is close to the tank bottom the transmitter enters alarm mode (see “Alarm Mode” on page 4-7).	May be caused by reduction of projected surface area close to sloping tank bottom. Action: • Increase parameter *Empty Tank Detection Area* if measurement in this region is not crucial, see “Empty Tank Detection Area” on page C-4 and C-9. • Make sure that the *Bottom Echo Visible* parameter is not set, see “Bottom Echo Visible” on page C-4 and C-8.
APPLICATION_ERROR_2.EPS 	Incorrect level.	Action: • Check the Tank Height configuration. • If there are rapid level changes check the Damping Value, see “Damping Value” on page C-7.
APPLICATION_ERROR_RANGEVALUE.EPS 	Incorrect level.	May be caused by wrong Range Value settings. Action: • Check that the Upper Range Value matches the 100 % level in the tank.
APPLICATION_ERROR_RANGEVALUE.EPS 	Incorrect level when using a pipe.	May be caused by wrong configuration of Pipe Inner Diameter. Action: • Check that the actual Pipe Inner Diameter matches the configured Inner Diameter.

APPLICATION_ERROR_3.EPS 	Measured value gets stuck.	May be caused by disturbing object in the tank Action: • Remove disturbing object in the tank. • Move the transmitter to another position or turn the transmitter 90°. • Use the Echo Tuning function in RRM to register the false echo that causes the transmitter to lock on the wrong level, see “Echo Tuning” on page 4-9. • Put an inclined metal plate on top of the disturbing object.
APPLICATION_ERROR_EMPTY.EPS 	Measured value drops to zero level.	May be caused by strong echoes from the tank bottom when product is slightly transparent. Action: • Check Tank Height. • Make sure that the *Bottom Echo Visible* parameter is enabled, see “Bottom Echo Visible” on page C-4 and C-8. • Try using the *Tank Bottom Projection* function if the following conditions are fulfilled: - The product is transparent. - The tank bottom echo is visible. - The *Bottom Echo Visible* parameter is enabled.
APPLICATION_ERROR_EMPTYTANK.EPS 	Measured value drops to zero level. (You can verify Empty Tank state by opening the *Tank Display* window in RRM).	If the transmitter loses track of the surface within the Empty Tank Detection Area the tank is considered empty. See section “Empty Tank Detection Area” on page C-4 and C-9. Action: If possible try another mounting position.
APPLICATION_ERROR_JUMPLOW.EPS 	Measured level jumps to a lower value.	May be caused by: • Two products layered in the tank. Action: • Enable the *Double Surface* function, see “Surface Echo Tracking” on page C-6. RRM: Setup>Advanced.

APPLICATION_ERROR_DOUBLEBOUNCE.EPS 	Incorrect level when the product surface is above the 50% level.	May be caused by: • Radar echo bouncing off from the surface to the tank roof and back to the surface. • Product with very high reflectivity causing very strong echoes. Action: • Move the transmitter away from the center of the tank roof. • Enable the *Double Bounce* function, see “Double Bounce” on page C-5 and C-12. RRM: Setup>Advanced.
APPLICATION_ERROR_AROUNDSTABLE.EPS 	Measured level jumps to a higher value.	May be caused by: • Foam on the product surface. • Turbulent product surface. Action: • Enable the Tank Environment *Foam* parameter. RRM: Setup>Tank>Environment. HART: [1,3,4,5,1]. • Enable the Tank Environment *Turbulent Surface* parameter. RRM: Setup>Tank>Environment. HART: [1,3,4,5,1].
APPLICATION_ERROR_TOP.EPS 	Measured level gets stuck near the top of the tank.	May be caused by: • Antenna tip ends inside the tank nozzle. • Disturbing objects near the antenna. Action: • If possible mount the transmitter on another nozzle. • Increase the *Hold Off* distance. RRM: Setup>Advanced. HART: [1,4,5,4].
APPLICATION_ERROR_FULLTANK.EPS 	The level value drops to a lower value when the product surface is close to the antenna.	May be caused by: • Product level is within the Hold Off region, i.e. outside the approved measuring range, and the transmitter picks up secondary signal reflections. Action: • Avoid filling the tank to levels very close to the antenna. • If possible, move the transmitter to increase the distance between maximum product level and antenna. • Activate the Full Tank Handling function if measurements up to the antenna are required, see “Full Tank Handling” on page C-5 and C-11.

APPLICATION_ERROR_FULLTANK_ALARM.EPS 	The transmitter presents “measurement error” and activates Measurement Alarm when the product level is close to the antenna.	May be caused by: • Product level is within the Hold Off region, i.e. outside the approved measuring range. Action: • Avoid filling the tank to levels very close to the antenna. • If possible, move the transmitter to increase the distance between maximum product level and antenna. • Activate the Full Tank Handling function if measurements up to the antenna are required, see “Full Tank Handling” on page C-5 and C-11.
APPLICATION_ERROR_UNSTABLE.EPS 	The measured level is unstable.	May be caused by: • The tank is empty and the Amplitude Threshold is too low. • Product surface is close to a registered False Echo. Action: • Create a new Amplitude Threshold Curve, see “Echo Tuning” on page 4-9.

Appendix A Reference Data

SPECIFICATIONS

General	
Product	Rosemount 5400 Series Radar Level Transmitter.
Measurement Principle	Pulsed, free propagating radar. 5401: ~6 GHz 5402: ~26 GHz
Microwave Output Power	< 1 mW
Beam Angle	See “Beamwidth” on page 3-7.
Measuring Performance	
Measuring Range	98 ft (30 m) from flange.
Instrument Accuracy(1)	5401: ± 0.4 in. (± 10 mm). 5402: ± 0.1 in. (± 3 mm).
Dead Zone(2)	Cone antenna: 5.9 in. (150 mm) from antenna lower end. Rod antenna: 2.0 in. (50 mm) from antenna lower end. Process Seal: lowest value of 150 mm under antenna lower end and from lower end of nozzle.
Near Zone Distance	Cone and Rod antennas: 1.3 ft (0.4 m) from antenna lower end. Process Seal antennas: lower end of nozzle.
Near Zone Accuracy	5401: ± 1.2 in. (± 30 mm). 5402: ±0.6 in (±15 mm) for all antennas except the 2-in. Process Seal antenna which has ± 1.2 in. (± 30 mm) accuracy.
Resolution	0.04 in. (1 mm)
Repeatability	± 0.04 in. (± 1 mm) at 16 ft (5 m) distance.
Temperature Drift	0.05 %/10 K in temperature range -40°F to 176°F (-40 °C to 80 °C).
Update Interval	1 second.
Max Level Rate	1.6 in./s (40 mm/s) as default, adjustable to 7.9 in./s (200 mm/s).
Display / Configuration	
Integral Display	5-digit integral display. The process variables listed below can be presented. If more than one variable is chosen, carousel toggling of data is used. The display also shows diagnostics and error information.
Output Variables	Level, Distance, Volume, Level Rate, Signal Strength, Internal Temperature, Analog Output Current and % of Range.
Output Units	Level and Distance: ft, inch, m, cm or mm Level Rate: m/s, ft/s Volume: ft^3, $inch^3$, US gals, Imp gals, barrels, yd^3, m^3 or liters Temperature: degree Fahrenheit, degree Celcius
Configuration Tools	HART®: Rosemount Radar Master (RRM), 275/375 Handheld Communicator, AMS Suite, or any DD- or EDDL-compatible host.

(1) Reference conditions:
Temperature: 68 °F (20 °C).
Pressure: 14-15 psi (960-1060 mBar).
Humidity: 25-75 % RH.
Metal plate, no disturbing objects.
(2) Dead zones are areas where measurements are not recommended.

Electric	
Power Supply	16-42.4 VDC (16-30 VDC in IS applications and 20-42.4 VDC in Explosion-proof/Flameproof applications).
Internal Power Consumption	< 50 mW in normal operation.
Output	HART® 4-20 mA current loop.
Signal on Alarm (configurable)	Standard: Low=3.75 mA, High=21.75 mA. Namur NE43: High=22.5 mA.
Saturation Levels	Standard: Low=3.9 mA, High=20.8 mA. Namur NE43: High=20.5 mA.
IS Parameters	See Section B: Product Certifications.
Cable Entry	1/2 in. NPT or optional M20x1.5 adapter.
Output Cabling	24-12 AWG, twisted shielded pairs.
Mechanical	
Antennas	See page A-8. Antenna material exposed to tank atmosphere: depends on antenna type, see “Ordering Information” on page A-8.
Material exposed to Tank Atmosphere	**Cone Antenna** • 316 / 316 L SST (EN 1.4404) or Monel® 400 (UNS NO4400) or Hastelloy® C-276 (UNS N10276). Monel® and Hastelloy® antennas have a plate design. • PTFE fluoropolymer • O-ring material **Rod Antenna, Two versions** • All-PFA(1) fluoropolymer • PFA(1) fluoropolymer, 316 / 316 L SST (EN 1.4404) and O-ring material **Process Seal Antenna** • PTFE fluoropolymer • O-ring material For more information see “Ordering Information” on page A-8.
Housing / Enclosure	Polyurethane-covered Aluminum
Dimensions	See “Dimensional Drawings” on page A-5.
Weight, excl. flange	2.0 kg (4.4 lb)
Environment	
Ambient Temperature(2)	Non-Hazardous: -40°F to 176 °F (-40 °C to 80 °C). IS/EEx ia and XP/EEx d, HART® communication: -40°F to 158 °F (-40 °C to 70 °C). LCD readable in -4 °F to 158 °F (-20°C to 70 °C).
Storage Temperature	-58°F to 194°F (-50°C to 90°C). LCD: -40°F to 185°F (-40°C to 85°C).
Process Temperature(3)	See “Process Temperature and Pressure Rating” on page A-3.
Process Pressure(3)	See “Process Temperature and Pressure Rating” on page A-3.
Humidity	0 - 100% Relative Humidity, non condensating.
Factory Sealed	Yes
Ingress Protection	Type 4X, IP66, IP67.
EU Directive compliance	CE mark, 93/68/EEC
Telecommunication (FCC and R&TTE)(4)	FCC part 15C (1998) and R&TTE (EU directive 1999/5/EC).
Electromagnetic Compatibility	Emission and Immunity: EMC directive 89/336/EEC. EN61326-1:1997 incl. A1:1998 and A2:2001. NAMUR recommendations NE21.
Transient / Built-in Lightning Protection	EN61326, IEC 801-5, level 1 kV. T1 option: complies with IEEE 587 Category B transient protection and IEEE 472 surge protection.
Pressure Equipment Directive (PED)	97/23/EC.

(1) PFA is a fluoropolymer with properties similar to PTFE.
(2) Depends on O-ring selection. The maximum ambient temperature also depends on the process temperature: for every process temperature degree above 185 °F (85 °C) the maximum ambient temperature is reduced by 0.27 °F/0.15 °C.
(3) Final rating depends on flange and O-ring selection. See “Process Temperature and Pressure Rating” on page A-3 and “Ordering Information” on page A-8.
(4) The 5402 is authorized for use in tank-mounted applications, including metal tanks, as well as concrete, plastic, glass and other non-conductive tanks.

PROCESS TEMPERATURE AND PRESSURE RATING

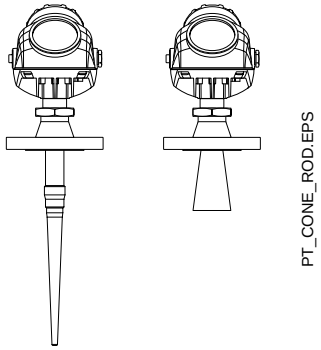
The temperature/pressure rating depends on the design of the transmitter in combination with Tank Seal O-ring, flange and gasket materials.

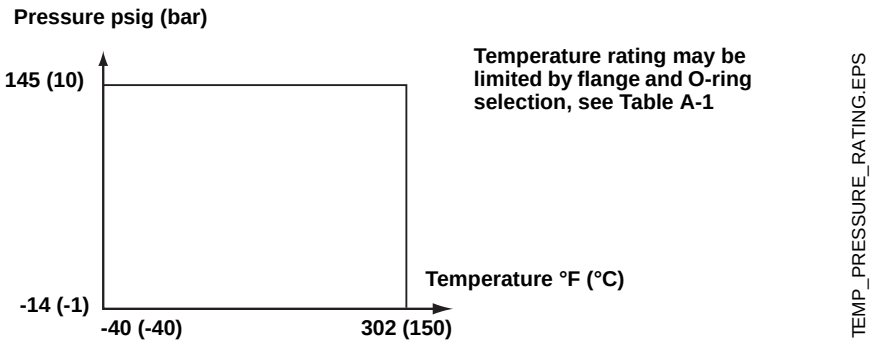
Rod and Cone Antenna

Working Pressure

Max Working Pressure for the Rosemount 5400 with Rod or Cone antenna is 145 PSI/10 bar.

Figure A-1. Process temperature and pressure diagram for Rosemount 5400 Series with Cone or Rod antenna.





Temperature restrictions due to O-ring selection

The Tank Seal has an O-ring sealing which is selected depending on the specific temperature and product requirements. The following table(1) presents the applicable temperature ranges:

Table A-1. Tank Seal temperature range depending on selection of O-ring materials.

Tank Seal of different O-ring materials	Min. Temperature °F (°C) in air	Max. Temperature °F (°C) in air
Viton®	-4 (-20)	302 (150)
Ethylene Propylene (EPDM)	-40 (-40)	302 (150)
Kalrez 6375	5 (-15)	302 (150)
Buna-N	-40 (-40)	230 (110)

Pressure restrictions due to flange selection

The maximum allowed pressure may also be limited by the flange rating. The 5400 Series flange has the same p/T rating as the corresponding blind flange:

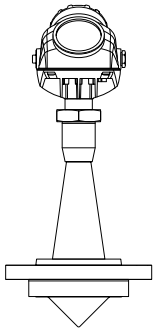
ANSI: according to ANSI B16.5 Table 2-2.3.

EN: according to EN 1092-1 Table 18, material group 13E0.

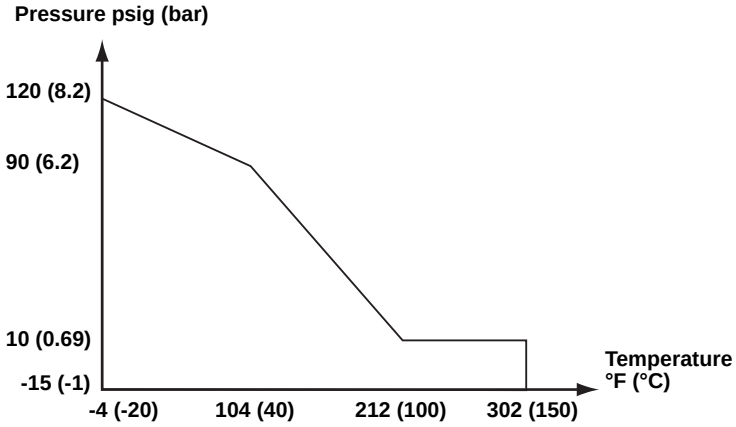
(1) Not applicable for the All-PFA rod antennas (1R and 2R).

Process Seal Antenna

Figure A-2. Process temperature and pressure diagram for Rosemount 5400 Series with Process Seal antenna.



PT_PROCESSSEAL.EPS



TEMP_PRESSURE_PROCESSSEAL.EPS

Temperature restrictions due to O-ring selection

The Process Seal window has a process O-ring which is selected depending on the specific temperature and product requirements. The following table presents the applicable temperature ranges:

Table A-2. Process Seal temperature range depending on selection of O-ring materials.

O-ring materials	Min. Temperature °F (°C) in air	Max. Temperature °F (°C) in air
Viton®	-4 (-20)	302 (150)
Ethylene Propylene (EPDM)	-4 (-20)	275 (135)
Kalrez 6375	23 (-5)	302 (150)
Buna-N	-4 (-20)	257 (125)

DIMENSIONAL DRAWINGS

Figure A-3. Model 5401 (Low Frequency version) transmitter with cone antenna.

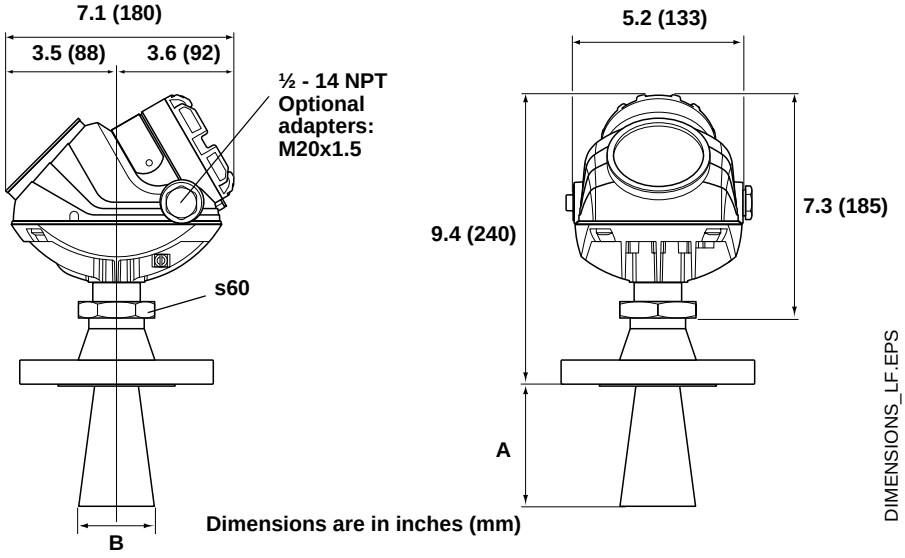
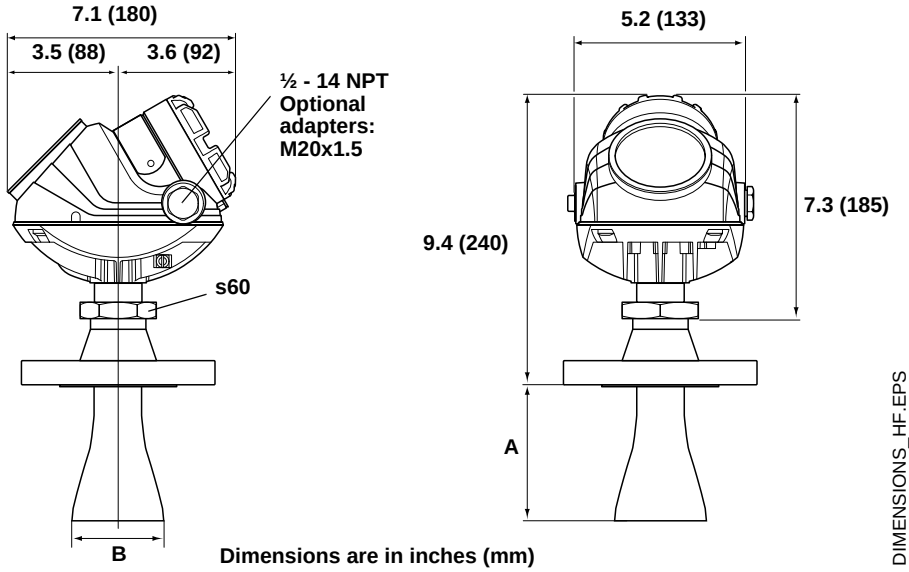


Figure A-4. Model 5402 (High Frequency version) transmitter with cone antenna.

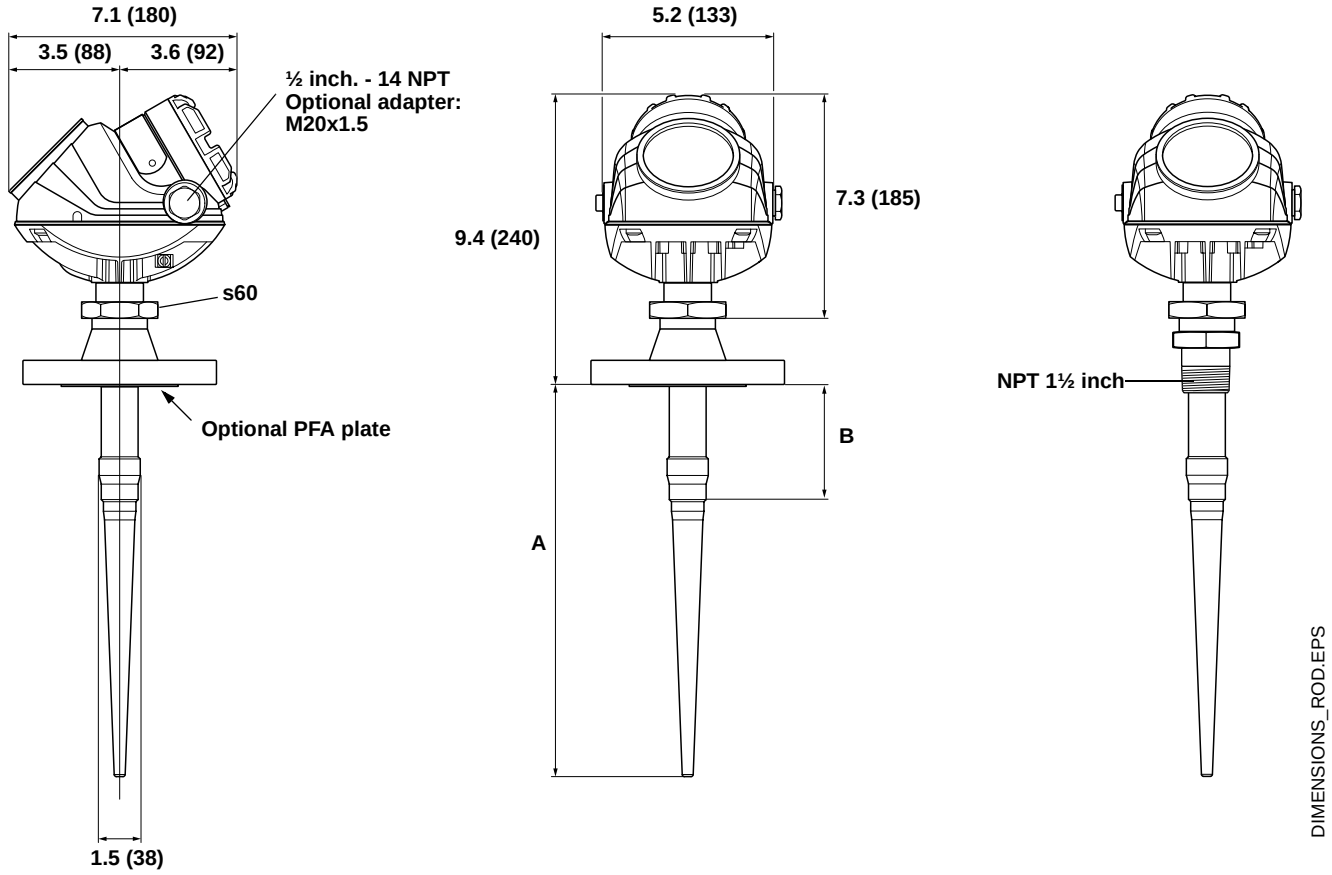


NOTE
Hastelloy® and Monel® antennas have a plate design.

5401			
Material	**Cone size (inch)**	**A inch (mm)**	**B inch (mm)**
SST, Hastelloy® and Monel®	3	3.3 (84)	2.6 (67)
	4	5.9 (150)	3.6 (92)
	6	7.3 (185)	5.5 (140)
	8	10.6 (270)	7.4 (188)

5402			
Material	**Cone size (inch)**	**A inch (mm)**	**B inch (mm)**
SST	2	6.5 (165)	2.0 (50)
	3	5.9 (150)	2.6 (67)
	4	8.8 (225)	3.6 (92)
Hastelloy® and Monel®	2	5.9 (150)	2.0 (50)
	3	6.9 (175)	2.6 (67)
	4	9.8 (250)	3.6 (92)

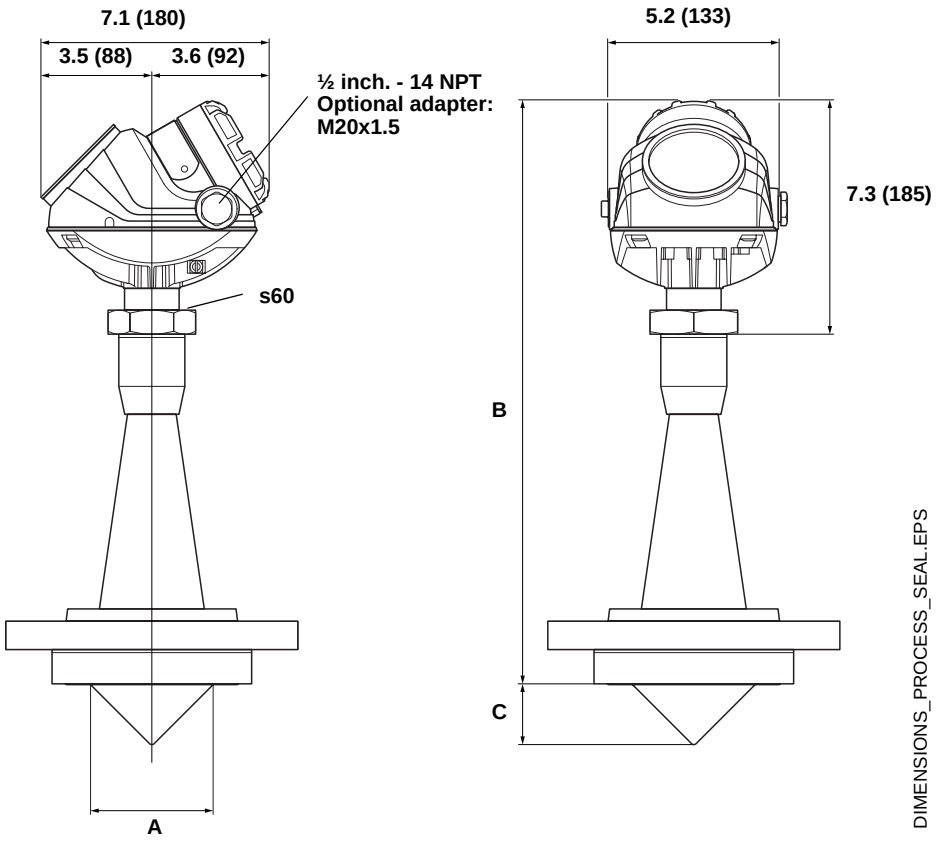
Figure A-5. 5400 Series transmitter with rod antenna.



Rod size	A inch (mm)	B inch (mm)
Short	14.4 (365)	3.94 (100)
Long	20.3 (515)	9.84 (250)

NOTE
All-PFA rod antennas (1R and 2R) have a PFA plate and are therefor only available with flanged connection. SST+PFA rod antennas (3R and 4R), which are not equipped with a PFA plate, are available either with flanged or threaded connection.

Figure A-6. 5400 Series transmitter with Process Seal antenna.



Process Seal size (inch)	A	B	C
2	1.8 (46)	14.2 (360)	0.9 (22)
3	2.8 (72)	17.3 (440)	1.4 (35)
4	3.8 (97)	18.9 (480)	1.9 (48)

ORDERING INFORMATION

Model Code for Rosemount 5401 Radar Level Transmitter

Model	Product Description
5401	Low frequency version (~6 GHz)
Code	**Housing Material**
A	Polyurethane-covered Aluminum
Code	**Signal Output**
H	4-20 mA with HART® communication
F	FOUNDATION™ fieldbus
Code	**Conduit / Cable Threads**
1	1/2 inch - 14 NPT
2	M20 x 1.5 adapter
Code	**Product Certifications**
NA	No Hazardous Locations Certifications
E1	ATEX Flameproof
I1	ATEX Intrinsic Safety
IA	ATEX FISCO Intrinsic Safety(1)
E5	FM Explosion-Proof
I5	FM Intrinsic Safety and Non-incendive
IE	FM FISCO Intrinsic Safety(1)
E6	CSA Explosionproof
I6	CSA Intrinsic Safety
IF	CSA FISCO Intrinsic Safety(1)
E7	IECEx Flameproof
I7	IECEx Intrinsic Safety
IG	IECEx FISCO Intrinsic Safety(1)
Code	**Antenna - Size and Material**
	Cone Antennas
3S	3 in. DN 80, 316 L SST (EN 1.4404), pipe installations only
4S	4 in. DN 100, 316 L SST (EN 1.4404)
6S	6 in. DN 150, 316 L SST (EN 1.4404)
8S	8 in. DN 200, 316 L SST (EN 1.4404)
3H	3 in. DN 80, Hastelloy® C-276 (UNS N10276)(2) with plate design, pipe installations only
4H	4 in. DN 100, Hastelloy® C-276 (UNS N10276)(2) with plate design
6H	6 in. DN 150, Hastelloy® C-276 (UNS N10276)(2) with plate design
8H	8 in. DN 200, Hastelloy® C-276 (UNS N10276)(2) with plate design
3M	3 in. DN 80, Monel® 400 (UNS N04400)(2) with plate design
4M	4 in. DN 100, Monel® 400 (UNS N04400)(2) with plate design
6M	6 in. DN 150, Monel® 400 (UNS N04400)(2) with plate design
8M	8 in. DN 200, Monel® 400 (UNS N04400)(2) with plate design
	Rod Antennas
1R	100 mm inactive length, all-PFA(3)(4)
2R	250 mm inactive length, all-PFA(3)(4)
3R	100 mm inactive length, SST+ PFA(3)
4R	250 mm inactive length, SST+ PFA(3)
	Other Antennas
XX	Customer specific
Code	**Tank Sealing**
PV	PTFE with Viton® fluoroelastomer o-rings
PK	PTFE with Kalrez® 6375 perfluoroelastomer o-rings
PE	PTFE with EPDM o-rings
PB	PTFE with Buna-N o-rings
PD	All-PFA(3)(5)

Code	Process Connection and Material
	ANSI Flanges
AA	2 inch, 150 lbs, 316 / 316 L SST(6)
AB	2 inch, 300 lbs, 316 / 316 L SST(6)
BA	3 inch, 150lbs, 316 / 316 L SST
BB	3 inch, 300 lbs, 316 / 316 L SST
CA	4 inch, 150 lbs, 316 / 316 L SST
CB	4 inch, 300 lbs, 316 / 316 L SST
DA	6 inch, 150 lbs, 316 / 316 L SST
EA	8 inch, 150 lbs, 316 / 316 L SST
	EN (DIN) Flanges
HB	DN 50 PN 40, SST (EN 1.4404)(6)
IB	DN 80 PN 40, SST (EN 1.4404)
JA	DN 100 PN 16, SST (EN 1.4404)
JB	DN 100 PN 40, SST (EN 1.4404)
KA	DN 150 PN 16, SST (EN 1.4404)
LA	DN 200 PN 16, SST (EN 1.4404)
	Threaded
RA	1.5-in. NPT, 316 L SST (EN 1.4404)(7)
	Other Flanges
XX	Customer specific
Code	**Options**
M1	Integral digital display
BT	Bar Code Tag with tag number and purchase order number
T1	Transient Protection Terminal Block (standard with FISCO options)
	Software Configuration
C1	Factory configuration (CDS required with order)
	Alarm Limit Configuration
C4	NAMUR alarm and saturation levels, high alarm
C8	Low alarm(8) (standard Rosemount alarm and saturation levels)
	Special Certificates
Q4	Calibration Data Certificate
Q8	Material Traceability Certification per EN 10204 3.1B(9)
	Special Procedures
P1	Hydrostatic testing
Typical Model Number: 5401 A H 1 E5 4S PV CA - M1 C1	

(1) Requires Foundation™ fieldbus signal output (U_i parameter listed in "Product Certifications").
(2) Requires flange of same size.
(3) PFA is a fluoropolymer with properties similar to PTFE.
(4) Requires All-PFA tank seal (PD).
(5) Requires All-PFA Rod antennas (1R or 2R).
(6) Requires Rod antennas (1R, 2R, 3R or 4R)
(7) Requires Rod antenna in SST+Teflon (3R or 4R).
(8) Standard alarm setting is high.
(9) Option available for pressure retaining wetted parts.

Model Code for Rosemount 5402 Radar Level Transmitter

Model	Product Description
5402	High frequency version (~26 GHz)
Code	**Housing Material**
A	Polyurethane-covered Aluminum
Code	**Signal Output**
H	4-20 mA with HART® communication
F	FOUNDATION™ fieldbus
Code	**Conduit / Cable Threads**
1	1/2 inch - 14 NPT
2	M20 x 1.5 adapter
Code	**Product Certifications**
NA	No Hazardous Locations Certifications
E1	ATEX Flameproof
I1	ATEX Intrinsic Safety
IA	ATEX FISCO Intrinsic Safety(1)
E5	FM Explosion-Proof
I5	FM Intrinsic Safety and Non-incendive
IE	FM FISCO Intrinsic Safety(1)
E6	CSA Explosionproof
I6	CSA Intrinsic Safety
IF	CSA FISCO Intrinsic Safety(1)
E7	IECEx Flameproof
I7	IECEx Intrinsic Safety
IG	IECEx FISCO Intrinsic Safety(1)
Code	**Antenna - Size and Material**
	Cone Antennas
2S	2 in. DN 50, 316 L SST (EN 1.4404)(2)
3S	3 in. DN 80, 316 L SST (EN 1.4404)
4S	4 in. DN 100, 316 L SST (EN 1.4404)
2H	2 in. DN 50, Hastelloy® C-276 (UNS N10276)(2) with plate design
3H	3 in. DN 80, Hastelloy® C-276 (UNS N10276)(2) with plate design
4H	4 in. DN 100, Hastelloy® C-276 (UNS N10276)(2) with plate design
2M	2 in. DN 50, Monel® 400 (UNS N04400)(2) with plate design
3M	3 in. DN 80, Monel® 400 (UNS N04400)(2) with plate design
4M	4 in. DN 100, Monel® 400 (UNS N04400)(2) with plate design
	Process Seal Antennas
2P	2 in. DN 50, PTFE(3)
3P	3 in. DN 80, PTFE(4)
4P	4 in. DN 100, PTFE(5)
	Other Antennas
XX	Customer specific
Code	**Tank Sealing**
PV	PTFE with Viton® fluoroelastomer o-rings
PK	PTFE with Kalrez® 6375 perfluoroelastomer o-rings
PE	PTFE with EPDM o-rings
PB	PTFE with Buna-N o-rings

Code	Process Connection and Material
	ANSI Flanges
AA	2 inch, 150lbs, 316 / 316 L SST(6)
AB	2 inch, 300 lbs, 316 / 316 L SST(6)
BA	3 inch, 150lbs, 316 / 316 L SST
BB	3 inch, 300 lbs, 316 / 316 L SST
CA	4 inch, 150 lbs, 316 / 316 L SST
CB	4 inch, 300 lbs, 316 / 316 L SST
DA	6 inch, 150 lbs, 316 / 316 L SST
EA	8 inch, 150 lbs, 316 / 316 L SST
	EN (DIN) Flanges
HB	DN 50 PN 40, SST (EN 1.4404)(6)
IB	DN 80 PN 40, SST (EN 1.4404)
JA	DN 100 PN 16, SST (EN 1.4404)
JB	DN 100 PN 40, SST (EN 1.4404)
KA	DN 150 PN 16, SST (EN 1.4404)
LA	DN 200 PN 16, SST (EN 1.4404)
	Other Flanges
XX	Customer specific
Code	**Options**
M1	Integral digital display
BT	Bar Code Tag with tag number and purchase order number
T1	Transient Protection Terminal Block (standard with FISCO options)
	Software Configuration
C1	Factory configuration (CDS required with order)
	Alarm Limit Configuration
C4	NAMUR alarm and saturation levels, high alarm
C8	Low alarm(7) (standard Rosemount alarm and saturation levels)
	Special Certificates
Q4	Calibration Data Certificate
Q8	Material Traceability Certification per EN 10204 3.1B(8)
	Special Procedures
P1	Hydrostatic testing
Typical Model Number: 5402 A H 1 E5 4S PV CA - M1 C1	

(1) Requires Foundation™ fieldbus signal output (U_i parameter listed in "Product Certifications").
(2) Requires flange of same size.
(3) Requires 2 in. / DN 50 flanges (AA, AB or HB).
(4) Requires 3 in. / DN 80 flanges (BA, BB or IB).
(5) Requires 4 in. / DN 100 flanges (CA, CB, JA or JB).
(6) Requires a 2 inch antenna (code 2S).
(7) Standard alarm setting is high.
(8) Option available for pressure retaining wetted parts.

Appendix B Product Certifications

SAFETY MESSAGES

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

⚠WARNING

Explosions could result in death or serious injury:

Verify that the operating environment of the gauge is consistent with the appropriate hazardous locations certifications.

Before connecting a HART-based communicator in an explosive atmosphere, make sure 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.

⚠WARNING

Failure to follow safe installation and servicing guidelines could result in death or serious injury:

Make sure the transmitter is installed by qualified personnel and in accordance with applicable code of practice.

Use the equipment only as specified in this manual. Failure to do so may impair the protection provided by the equipment.

Do not perform any service other than those contained in this manual unless you are qualified.

Substitution of components may impair Intrinsic Safety.

To prevent ignition of flammable or combustible atmospheres, disconnect power before servicing.

⚠WARNING

High voltage that may be present on leads could cause electrical shock:

Avoid contact with leads and terminals.

Make sure the main power to the Radar Transmitter is off and the lines to any other external power source are disconnected or not powered while wiring the gauge.

Antennas with non-conducting surfaces (e.g. Rod Antenna and All PTFE antenna) may generate an ignition-capable level of electrostatic charge under certain extreme conditions. Therefore, when the antenna is used in a potentially explosive atmoshpere, appropriate measures must be taken to prevent electrostatic discharge.

EU CONFORMITY

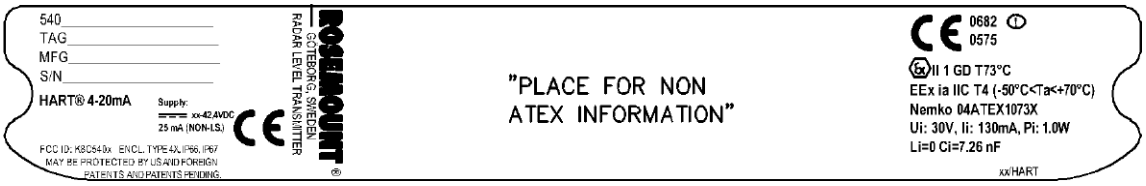
The EC declaration of conformity for all applicable European directives for this product can be found on the Rosemount website at www.rosemount.com. A hard copy may be obtained by contacting our local sales representative.

EUROPEAN ATEX DIRECTIVE INFORMATION

Intrinsic Safety

The Rosemount 5400 Series Transmitter that has the following label attached has been certified to comply with Directive 94/9/EC of the European Parliament and the Council as published in the Official Journal of the European Communities No. L 100/1 on 19-April-1994.

Figure B-1. Approval Label ATEX



LABEL_ATEX_EXI_V2.TIF

I1 The following information is provided as part of the label of the transmitter:

- Name and address of the manufacturer (Rosemount).
- CE Conformity Marking

  CE 0575
- Complete model number
- The serial number of the device
- Year of construction
- Marking for explosion protection:

  Ex II 1 GD T73˚C
- EEx ia IIC T4 (-50 °C ≤ Ta ≤ +70 °C)(1)
- 4-20 mA/HART model: Ui=30 V, Ii=130 mA, Pi=1.0 W, Ci=7.26 nF, Li=0.
- Nemko ATEX certificate number: Nemko 04ATEX1073X
- Installation Drawing: 9150 079-907

Special Conditions for Safe Use (X):

The intrinsically safe circuits do not withstand the 500V AC test as specified in EN 50020 clause 6.4.12.

Parts of the rod-antenna and the All PTFE antenna are non-conducting and the area of the non-conducting part exceeds the maximum permissible areas for Group IIC according to EN 50014 clause 7.3 (20 cm^2) and Category II 1 G according to EN 50284 clause 4.4.3 (4 cm^2). Therefore, when the antenna is used in a potentially explosive atmosphere, appropriate measures must be taken to prevent electrostatic discharge.

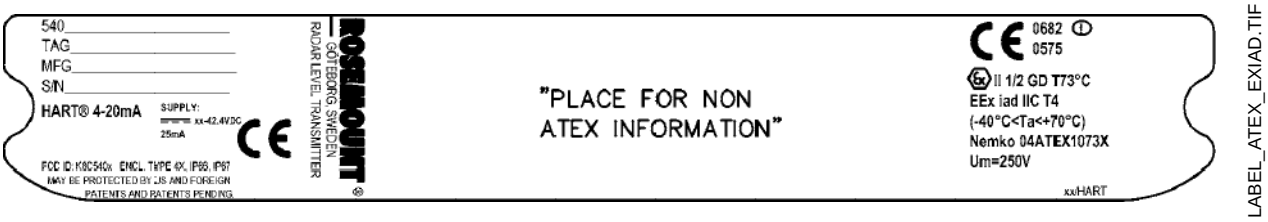
Impact and friction hazards need then to be considered according to EN 50284 clause 4.3.1 when the transmitter and part of antennas exposed to the exterior atmosphere of the tank is made with light metal alloys and used in category II 1 G.

(1) Other temperature restrictions may apply, please refer to "Specifications" on page A-1.

Flameproof

The Rosemount 5400 Series Transmitter that has the following label attached has been certified to comply with Directive 94/9/EC of the European Parliament and the Council as published in the Official Journal of the European Communities No. L 100/1 on 19-April-1994.

Figure B-2. Approval Label ATEX



E1 The following information is provided as part of the label of the transmitter:

- Name and address of the manufacturer (Rosemount).
- CE Conformity Marking

  CE 0575

- Complete model number
- The serial number of the device
- Year of construction
- Marking for explosion protection:

  Ex II 1/2 GD T73˚C

- EEx iad IIC T4 (-40 °C<Ta< +70 °C)
- Nemko ATEX certificate number: Nemko 04ATEX1073X

Special Conditions for Safe Use (X):

The intrinsically safe circuits do not withstand the 500V AC test as specified in EN 50020 clause 6.4.12.

Parts of the rod-antenna and the All PTFE antenna are non-conducting and the area of the non-conducting part exceeds the maximum permissible areas for Group IIC according to EN 50014 clause 7.3 (20 cm^2) and Category II 1 G according to EN 50284 clause 4.4.3 (4 cm^2). Therefore, when the antenna is used in a potentially explosive atmosphere, appropriate measures must be taken to prevent electrostatic discharge.

Impact and friction hazards need then to be considered according to EN 50284 clause 4.3.1 when the transmitter and part of antennas exposed to the exterior atmosphere of the tank is made with light metal alloys and used in category II 1 G.

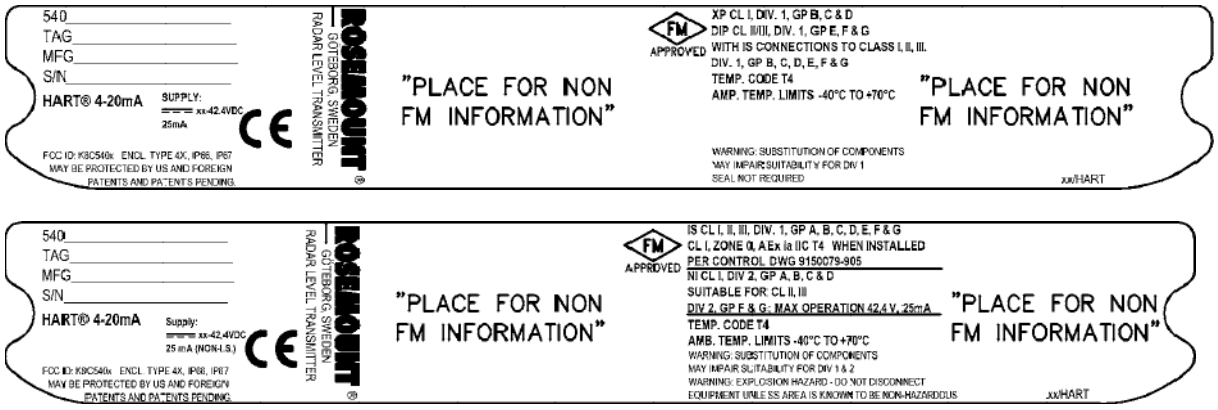
HAZARDOUS LOCATIONS CERTIFICATIONS

The Rosemount 5400 Series Transmitters that have the following labels attached have been certified to comply with the requirements of the approval agencies noted.

Factory Mutual (FM) Approvals

Project ID: 3020497.

Figure B-3. Approval Labels
Factory Mutual (FM)



E5 Explosion-Proof for Class I, Division 1, Groups B, C and D.

Dust-Ignition proof for Class II/III, Division 1, Groups E, F and G with intrinsically safe connections to Class I, II, III, Div 1, Groups B, C, D, E, F and G.

Temperature code T4.

Ambient temperature limits: -40 °C to + 70 °C.

Seal not required.

I5 Intrinsically Safe for Class I, II, III, Division 1, Groups A, B, C, D, E, F and G.
Class I, Zone 0, AEX ia IIC T4 when installed per Control Drawing: 9150079-905.

Non-incendive for Class I, Division 2, Groups A, B, C and D.

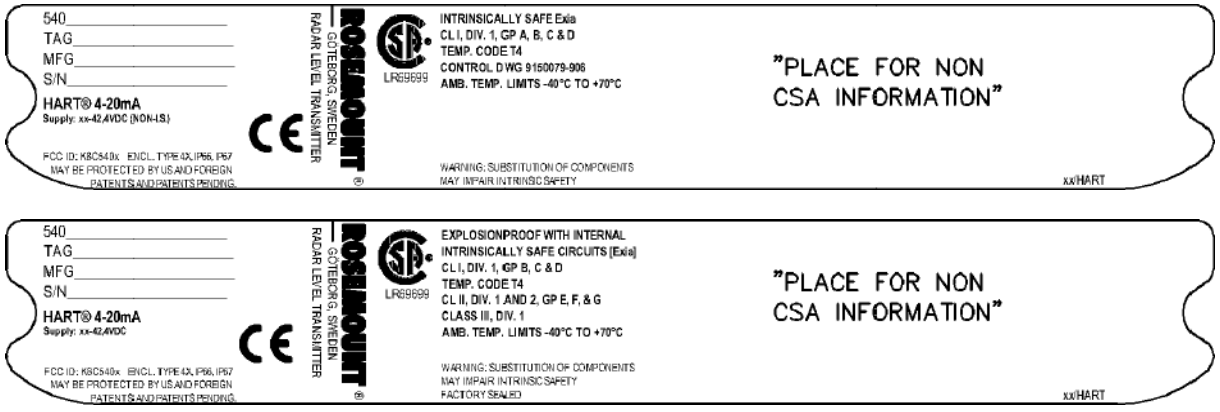
Suitable for Class II, III, Division 2, Groups F and G;
Max operation 42.4 V, 25 mA.

Temperature code T4.
Ambient Temperature Limits: -40 °C to + 70 °C.

Canadian Standards Association (CSA) Approval

Cert. no. 1514653.

Figure B-4. Approval Label Canadian Standards Association (CSA)



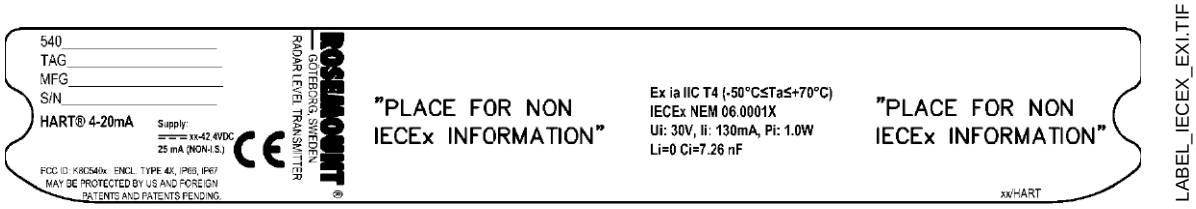
I6 Intrinsically Safe Ex ia.
Class I, Division 1, Groups A, B, C and D.
Temperature code T4.
Control Drawing: 9150 079-906.
Ambient temperature limits: -40 °C to + 70 °C.

E6 Explosionproof with internal Intrinsically Safe Circuits [Exia].
Class I, Div. 1, Groups B, C and D.
Temperature Code T4.
Class II, Div. 1 and 2, Groups E, F and G;
Class III, Div. 1
Ambient temperature limits -40 °C to +70 °C.
Factory sealed.

IECEx Approval

I7 Intrinsic Safety

Figure B-5. Approval Label
IECEx Intrinsic Safety



Ex ia IIC T4 (T_{amb} = -50 °C to +70 °C)(1).

IECEx NEM 06.0001X.

Ui=30 V, Ii=130 mA, Pi=1 W, Ci=7.25 nF, Li=0 mH.

Installation Drawing: 9150 079-907.

Conditions of Certification

The intrinsically safe circuits do not withstand the 500V AC test as specified in EN 50020 clause 6.4.12.

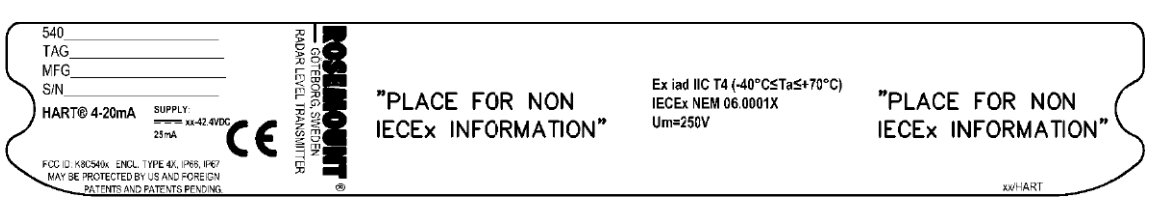
Impact and friction hazards need then to be considered according to IEC 60079-0 clause 8.1.2 when the transmitter and part of antennas exposed to the exterior atmosphere of the tank is made with light metal alloys and used in Zone 0.

Parts of the rod-antenna and the All PTFE antenna are non-conducting and the area of the non-conducting part exceeds the maximum permissible areas for Group IIC according to IEC 60079-1 clause 7.3: 20 cm^2 for Zone 1 and 4 cm^2 for Zone 0. Therefore, when the antenna is used in a potentially explosive atmosphere, appropriate measures must be taken to prevent electrostatic discharge.

(1) Other temperature restrictions may apply, please refer to “Specifications” on page A-1.

E7 Flameproof

Figure B-6. Approval Labels
IECEx Flameproof



Ex iad IIC T4 (T_{amb} :-40° C to +70 °C).

IECEx NEM 06.0001X.

Conditions of Certification

The intrinsically safe circuits do not withstand the 500V AC test as specified in EN 50020 clause 6.4.12.

Impact and friction hazards need then to be considered according to IEC 60079-0 clause 8.1.2 when the transmitter and part of antennas exposed to the exterior atmosphere of the tank is made with light metal alloys and used in Zone 0.

Parts of the rod-antenna and the All PTFE antenna are non-conducting and the area of the non-conducting part exceeds the maximum permissible areas for Group IIC according to IEC 60079-1 clause 7.3: 20 cm^2 for Zone 1 and 4 cm^2 for Zone 0. Therefore, when the antenna is used in a potentially explosive atmosphere, appropriate measures must be taken to prevent electrostatic discharge.

APPROVAL DRAWINGS

This section contains Factory Mutual and Canadian Standards Association system control drawings and an ATEX installation drawing. You must follow the installation guidelines presented in order to maintain certified ratings for installed transmitters.

This section contains the following drawings:

Saab Rosemount drawing 9150079-905:

System Control Drawing for hazardous location installation of intrinsically safe FM approved apparatus.

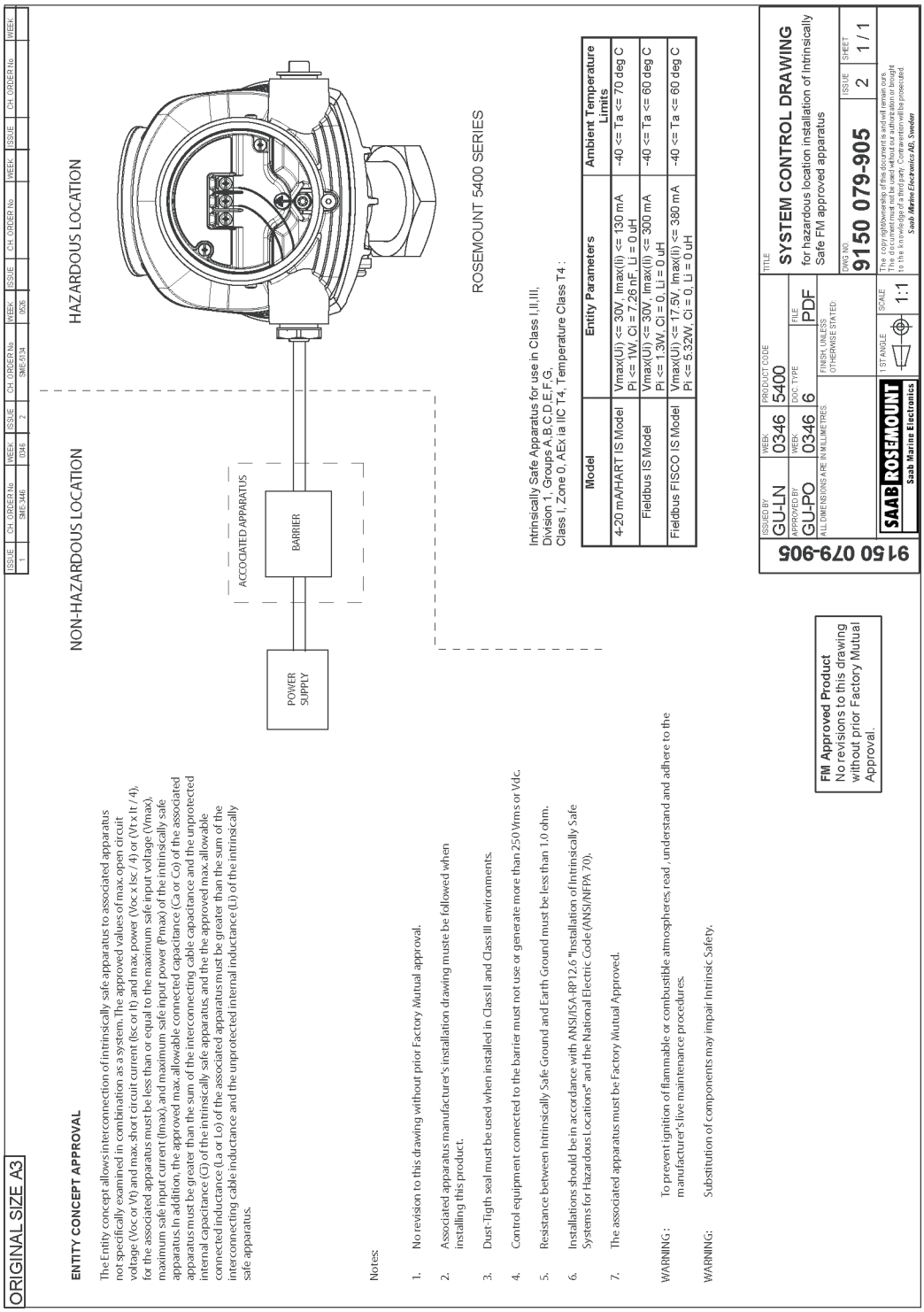
Saab Rosemount drawing 9150079-906:

System Control Drawing for hazardous location installation of CSA approved apparatus.

Saab Rosemount drawing 9150079-907:

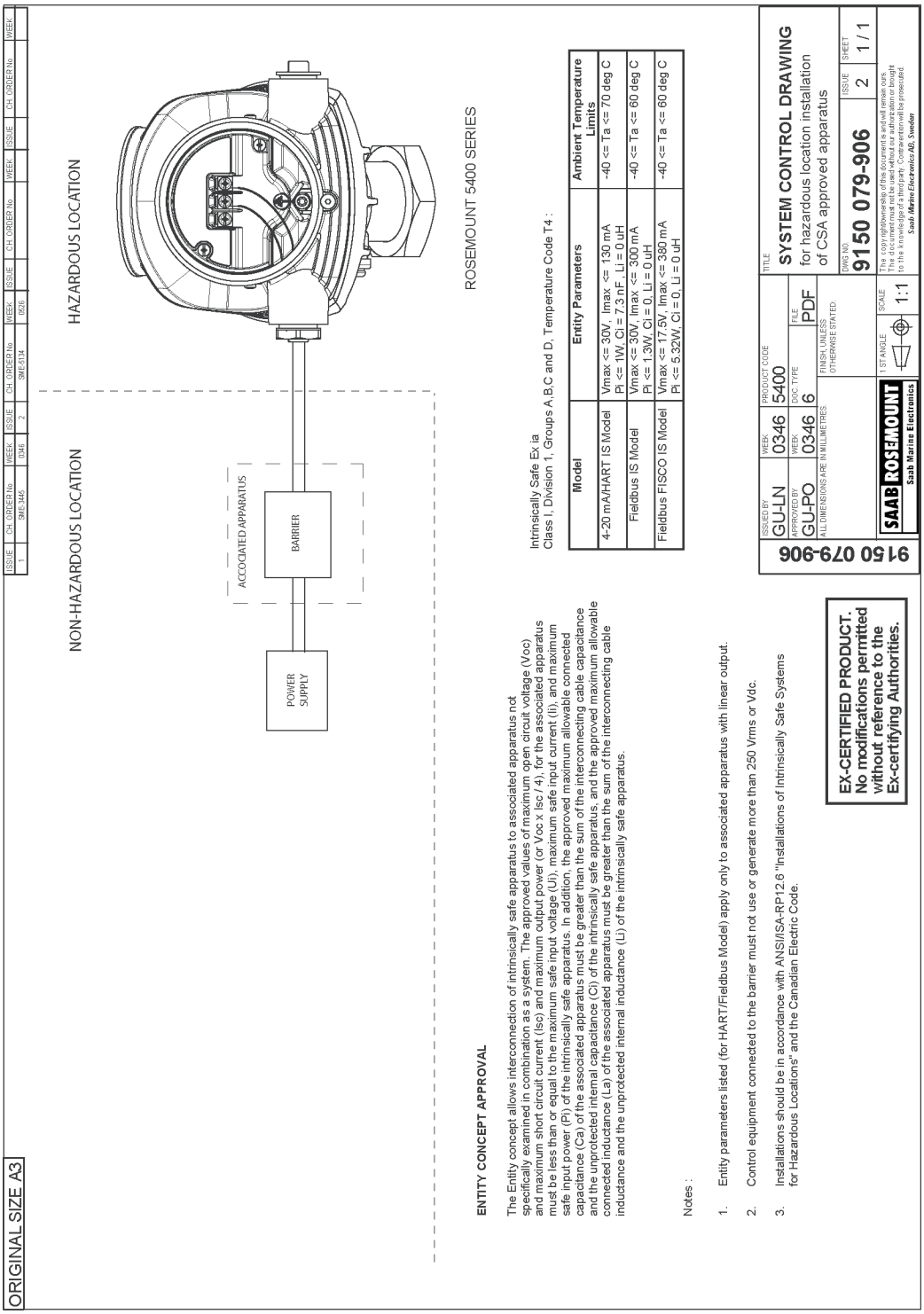
Installation Drawing for hazardous location installation of ATEX and IECEx approved apparatus.

Figure B-7. System Control Drawing for hazardous location installation of intrinsically safe FM approved apparatus.



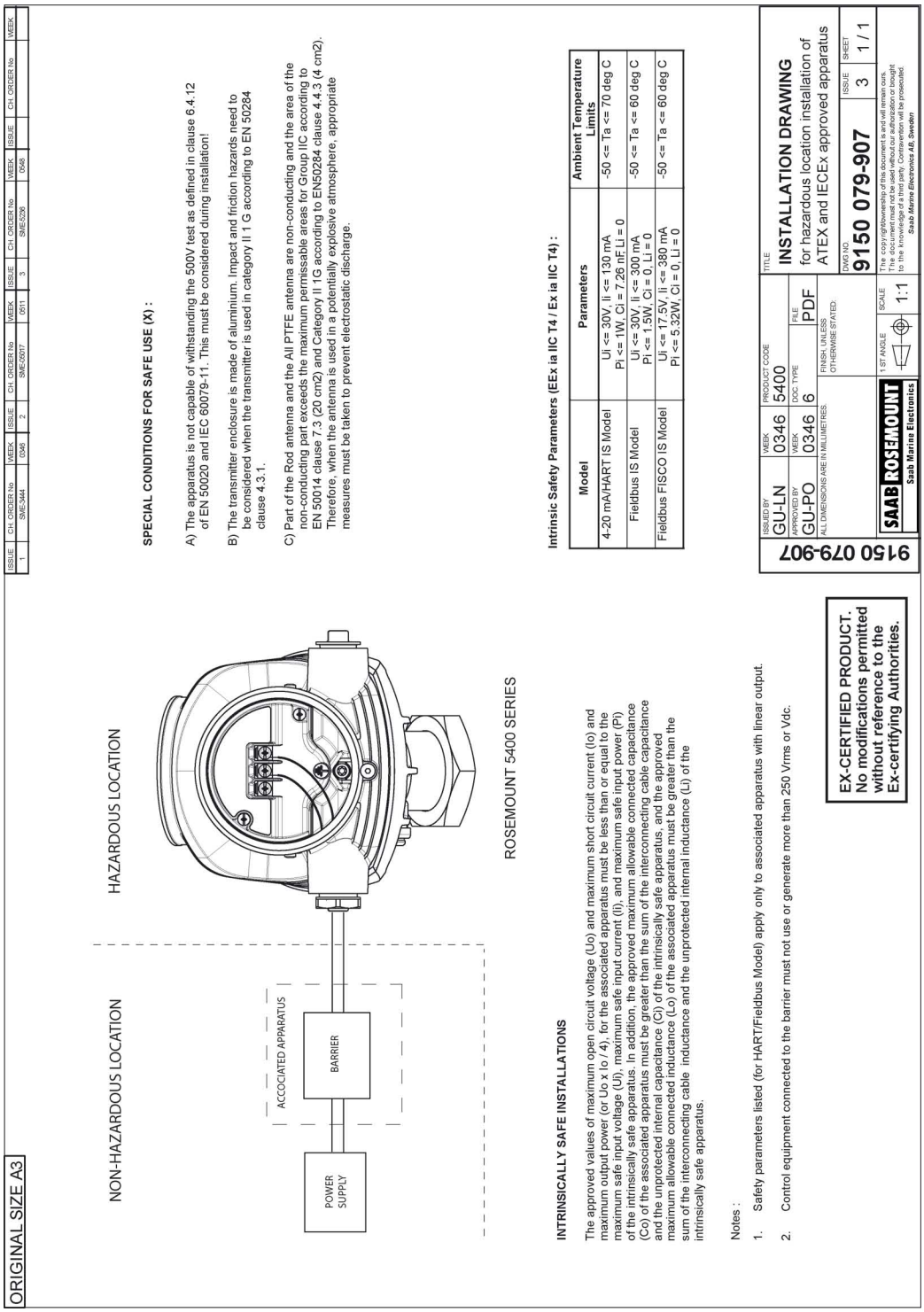
9150079-905_I02.TIF

Figure B-8. System Control Drawing for hazardous location installation of CSA approved apparatus.



9150079-906_I02.TIF

Figure B-9. Installation Drawing for hazardous location installation of ATEX and IECEx approved apparatus.



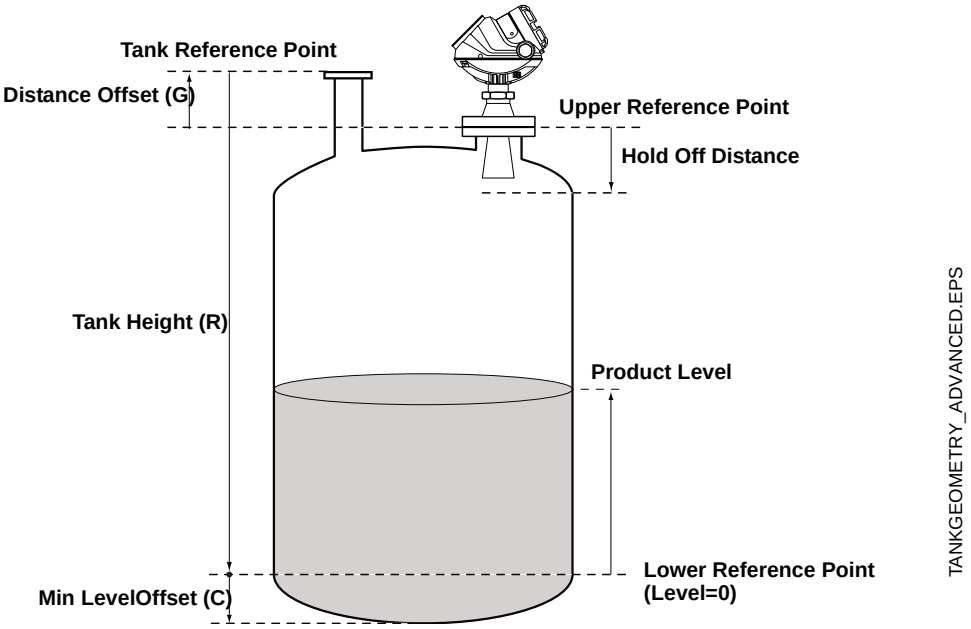
9150079-907_I03.TIF

Appendix C Advanced Configuration

The advanced transmitter configuration includes settings which can be used to fine tune the transmitter for special applications. Normally, the standard settings are sufficient.

TANK GEOMETRY

Figure C-1. Advanced Tank Geometry



Distance Offset (G)

The Distance Offset is used when hand-dipping is done at a separate nozzle. By setting the Distance Offset the measured level by the gauge can be adjusted to correspond with the level value obtained by hand-dipping.

The Distance Offset (G) is defined as the distance between the upper reference point and the flange (the flange is referred to as the Transmitter's Reference Point). You can use the Distance Offset to specify your own reference point at the top of the tank. Set the Distance Offset to zero if you want the flange as upper reference point. The Distance Offset is defined as positive if you use an upper reference point above the Upper Reference Point.

Minimum Level Offset (C)

The Minimum Level Offset (C) defines a lower null zone which extends the measurement range beyond the Lower Reference Point down to the tank bottom. The Minimum Level Offset is defined as the distance between the Lower Reference Point (Level=0) and the minimum accepted level at the tank bottom. Set the Minimum Level Offset to zero if you use the tank bottom as Lower Reference Point. This case corresponds to the standard Tank Geometry configuration.

Note that the Tank Height must be measured down to the Lower Reference Point regardless if it is located at the tank bottom or at an elevated point.

Hold Off Distance

This parameter should only be changed if there are disturbing objects close to the antenna. No valid measurements are possible above the Hold Off Distance. By increasing the Hold Off Distance the measuring range is reduced. See "Hold Off Setting" on page C-14 for more information.

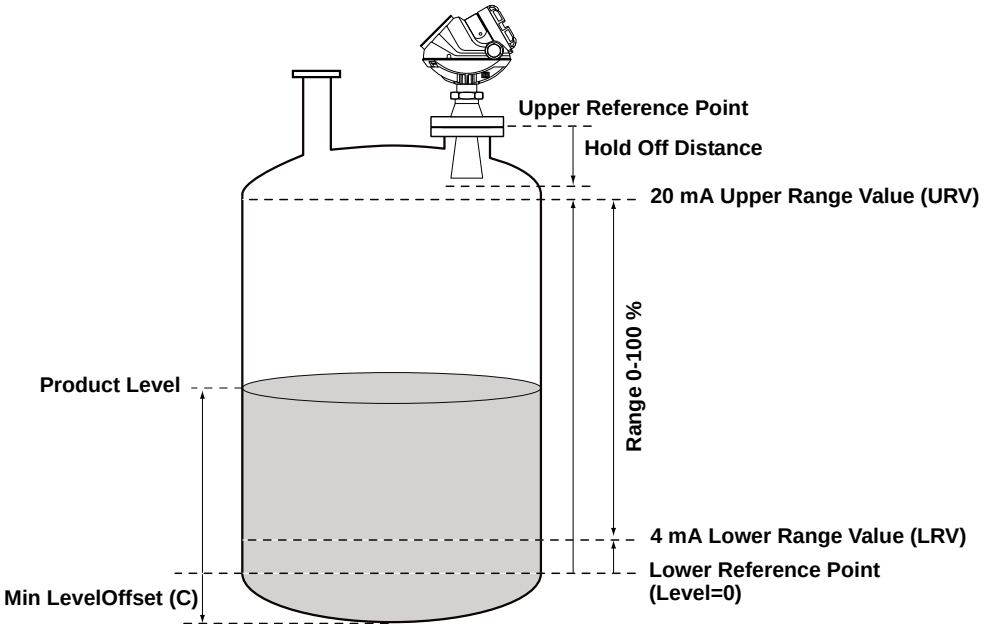
Calibration Distance

The Calibration Distance is by default set to zero. It is used to adjust the transmitter so that measured levels match hand-dipped or otherwise known product levels. Normally a minor adjustment is necessary. There may, for example, be a deviation between the actual tank height and the value obtained from tank drawings, which usually gets stored in the transmitter database.

ADVANCED ANALOG OUTPUT SETTINGS

The 20 mA Upper Range Value should be outside the Hold Off Distance (see “Hold Off Distance” on page C-2) in order to utilize the full range of the analog output.

Figure C-2. Advanced Range Value settings



ADVANCED TRANSMITTER SETTINGS

Antenna Type

The transmitter is designed to optimize measurement performance for each available antenna type.

This parameter is pre-configured at factory but may need to be set if a non-standard antenna is used.

Tank Connection Length

The Tank Connection Length (TCL) parameter is adjusted for each antenna type in order to optimize measurement performance. TCL is set automatically for standard antennas. For non-standard antennas (antenna type User Defined) the TCL value needs to be manually adjusted.

Empty Tank Handling

The Empty Tank Handling functions handle situations when the surface echo is close to the tank bottom:

- Tracking of weak product echoes
- Handling lost echoes

If the surface echo is lost this function makes the transmitter present a zero-level measurement, and an alarm is activated unless the alarm has been blocked.

Empty Tank Detection Area

The Empty Tank Detection Area defines a range within a lower limit of 16 in. (400 mm) and a higher limit of 39 in. (1000 mm) above the tank bottom. If the surface echo is lost in this region, the tank is considered empty (the device enters Empty Tank State) and the transmitter presents a zero level reading.

If the tank is empty the transmitter looks in 2 x Empty Tank Detection Area for the product surface. When a new echo is found it is considered to be the product surface.

It is important that there are no disturbances in this area. If there are disturbances they may need to be filtered out.

This function requires that the Bottom Echo Visible function is disabled. The current Empty Tank Detection Area value is shown in Advanced Setup in RRM and can be adjusted manually if required, see “Empty Tank Detection Area” on page C-9.

Bottom Echo Visible

Only set this parameter if the bottom echo is visible. By setting this parameter the bottom echo will be treated as a disturbance echo to facilitate tracking of weak surface echoes close to the tank bottom.

Check if the gauge detects the tank bottom when the tank is empty before activating this function, see “Bottom Echo Visible” on page C-8.

Tank Bottom Projection

This function handles situations close to the tank bottom and may enhance measurement performance in the tank bottom region. In this region the signal from the actual tank bottom may in some cases be significantly stronger than the measurement signal from the product surface.

Extra Echo

Extra Echo Detection is used for tanks with domed or conical bottom types and when no strong echo from the tank bottom exists when the tank is empty. When the tank is empty an echo beneath the actual tank bottom can sometimes be seen, see “Extra Echo Function” on page C-10.

Level Alarm is not set when Tank is Empty

If the echo from the product is lost in an area close to the tank bottom (Empty Tank Detection Area), the device will enter empty tank state and an alarm is triggered. Two types of alarms are triggered:

- Invalid Level (can be seen in the Diagnostics window).
- The Analog Output enters Alarm Mode.

Full Tank Handling

Full Tank Detection Area

This parameter defines a range where it is accepted to loose the surface echo. If the echo is lost in this range the tank is considered full (the device enters Full Tank State) and the device will present max level indication.

When the tank is full the device looks in 2 x Full Tank Detection Area for the product surface. When a new echo is found in this range it is considered to be the product surface.

It is important that any disturbances in this area are filtered out.

Level above Hold Off Distance Possible

Enable this function if the level can rise above the Hold Off Distance/UNZ and you want to display the tank as full in that case. Normally the device will always be able to track the surface and the product level will never rise that high. If the checkbox is not enabled and the surface is lost at the top of the tank the device searches for a surface echo within the whole tank.

Level Alarm is Not Set when Tank is Full

If the surface echo is lost close to the top of the tank, the level value will normally be displayed as “invalid.” Set this parameter to suppress the “invalid” display.

NOTE
By setting this parameter the analog output will not enter alarm mode for invalid levels close to the antenna.

See “Full Tank Handling” on page C-11 for more information.

Double Bounce

Some radar waves, after reflection at the surface, are reflected against the tank roof and back to the surface before they are detected by the transmitter. Normally, these signals have a low amplitude and are therefore neglected by the transmitter. For spherical and horizontal cylinder tanks however, in some cases the amplitude may be strong enough to lead the transmitter to interpret the double bounce as the surface echo. By setting the *Double Bounce Possible* parameter this type of measurement situation can be solved. This function should only be used if the problem of double bounces can not be solved by changing the mechanical installation, see “Double Bounce” on page C-12 for more information.

Surface Echo Tracking

Slow Search

This variable controls how to search for the surface if a surface echo is lost. With this parameter set, the transmitter starts searching for the surface at the last known level, and gradually increases the width of the search region until the surface is found. If this variable is not set the transmitter searches through the whole tank. This parameter may typically be used for tanks with turbulent conditions.

Slow Search Speed

This parameter indicates how quickly the search region (Slow Search window) is expanded when the *Slow Search* function is active.

Double Surface

Indicates that there are two liquids or foam in the tank resulting in two reflecting surfaces. The upper liquid or foam layer must be partly transparent to the radar signal.

If this function is activated, you can specify which surface to select by using the *Select Lower Surface* parameter.

Upper Product Dielectric Constant

This is the dielectric constant for the upper product if there is a double surface situation. A more precise value results in better accuracy for the lower surface level.

Select Lower Surface

This function should only be used if *Double Surface* is set. If *Select Lower Surface* is set the lower surface will be presented as the product surface. If not set the upper surface is tracked.

Echo Timeout

Use Echo Timeout to define the time in seconds before the transmitter will start to search for a surface echo after it has been lost. After an echo has been lost, the transmitter will not start searching, or trigger any alarms, until this time has elapsed.

Close Distance Window

This parameter defines a window centered at the current surface position in which new surface echo candidates can be selected. The size of the window is ±CloseDist. Echoes outside this window will not be considered as surface echoes. The transmitter will without delay jump to the strongest echo inside this window. If there are rapid level changes in the tank, the value of the Close Distance Window could be increased to prevent the transmitter from missing level changes. On the other hand, a too large value might cause the transmitter to select an invalid echo as the surface echo.

Filter Settings

Damping Value

The Damping Value parameter determines how quickly the transmitter responds to level changes and how robust the measurement signal is against noise. Technically, a damping value of 10 means that in 10 seconds the output from the transmitter is about 63% of the new level value. Consequently, when there are rapid level changes in the tank, it may be necessary to decrease the Damping value for the transmitter to be able to track the surface. On the other hand, in noisy environments, and if level rates are low, it may be better to increase the damping value to have a stable output signal.

Activate Jump Filter

The Jump Filter is typically used for applications with turbulent surface and makes the echo tracking work smoother as the level passes, for example, an agitator. If the surface echo is lost and a new surface echo is found, the Jump Filter makes the transmitter wait some time before it jumps to the new echo. During that time the new echo has to be considered a valid echo.

ADVANCED FUNCTIONS IN RRM

Empty Tank Handling

Bottom Echo Visible

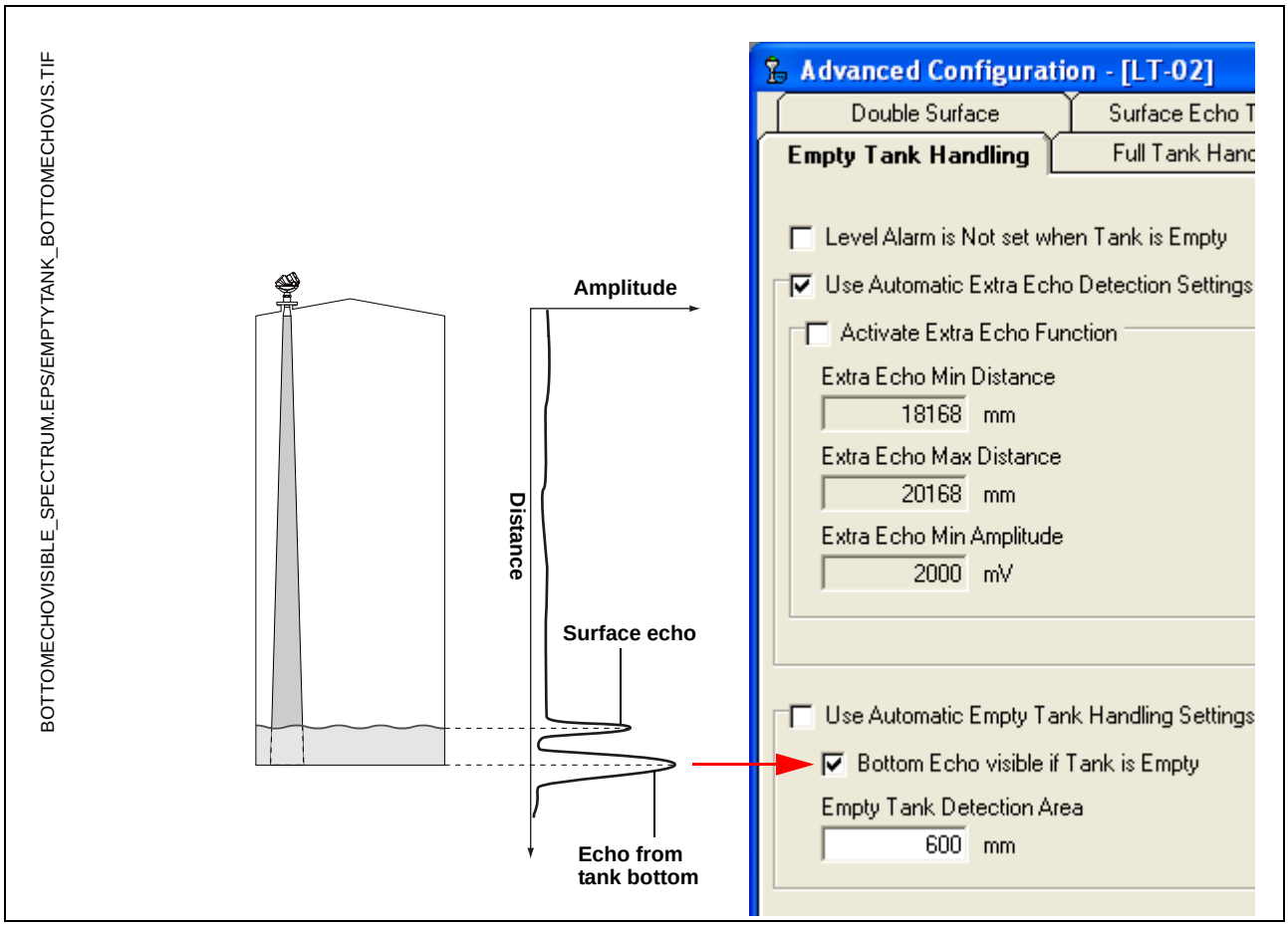
By enabling the *Bottom Echo Visible...* parameter the transmitter is able to separate the product surface from the tank bottom by treating the bottom echo as a disturbance echo. This is useful for products which are relatively transparent for microwaves such as oil. For non-transparent products such as water there is no visible bottom echo until the tank is empty.

To enable this function:

1. Disable the *Use Automatic Empty Tank Handling Settings* option.
2. Select the *Bottom Echo Visible if Tank is Empty* check box.

Only use this function for tanks with bottom type Flat where the radar echo from the tank bottom is clearly visible. If there is no distinct bottom echo even when the tank is empty this parameter should be disabled. Otherwise, if the surface echo is temporarily lost, the transmitter starts searching for the product surface anywhere in the tank and may incorrectly interpret any object as the surface.

The spectrum function in the RRM program can be used to check if the gauge detects the tank bottom when the tank is empty.



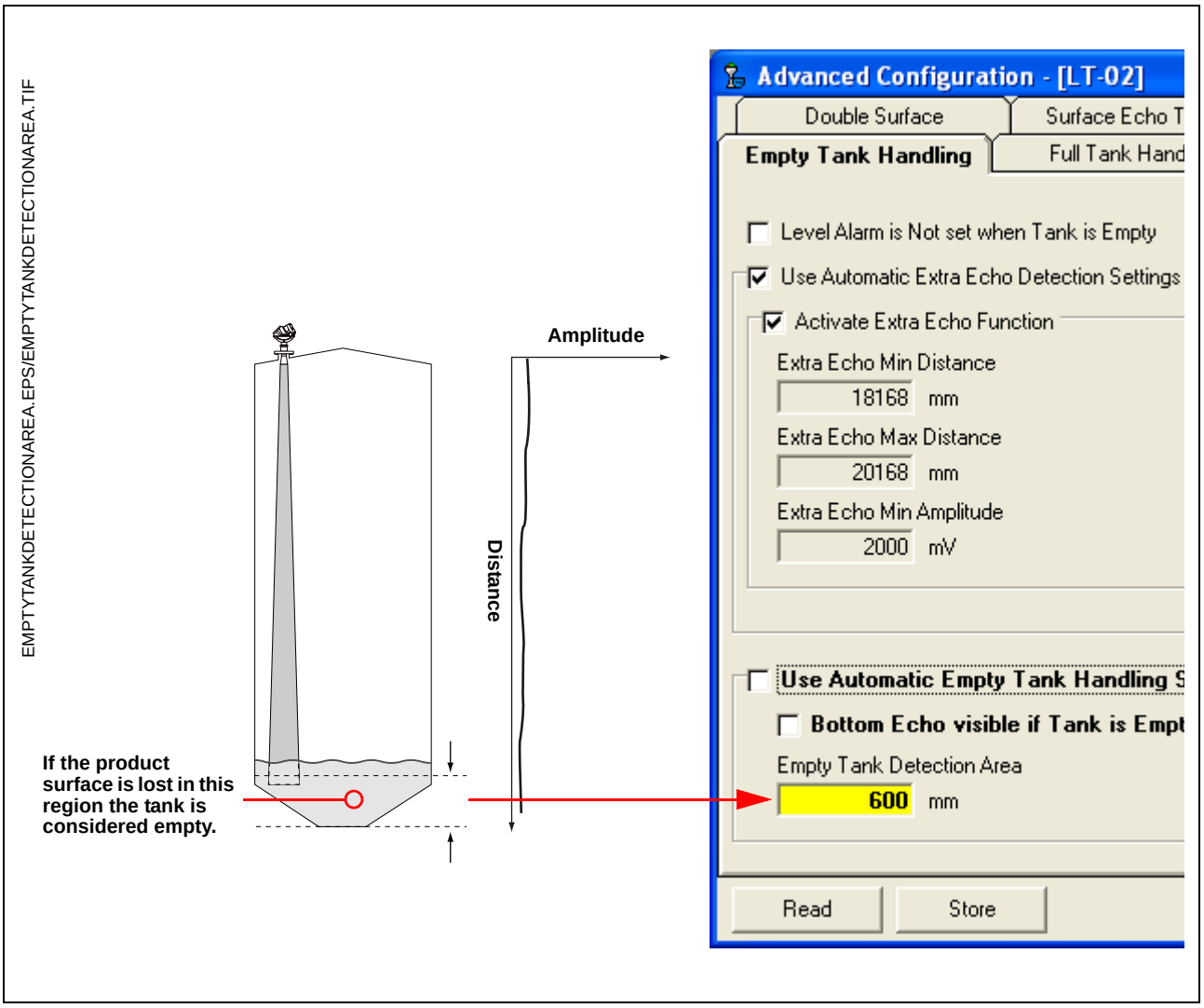
Empty Tank Detection Area

The tank is considered empty and the product level is presented as equal to zero if the signal from the product surface is lost within the region given by the parameter *Empty Tank Detection Area*.

If the surface is lost above the Empty Tank Detection Area the transmitter starts searching for the surface in the entire tank.

You may increase the Empty Tank Detection Area if the surface is lost outside the *Empty Tank Detection Area* in a non-critical region of the tank.

1. Disable *Use Automatic Empty Tank Handling Settings*.
2. Type the desired value in the *Empty Tank Detection Area* input field.



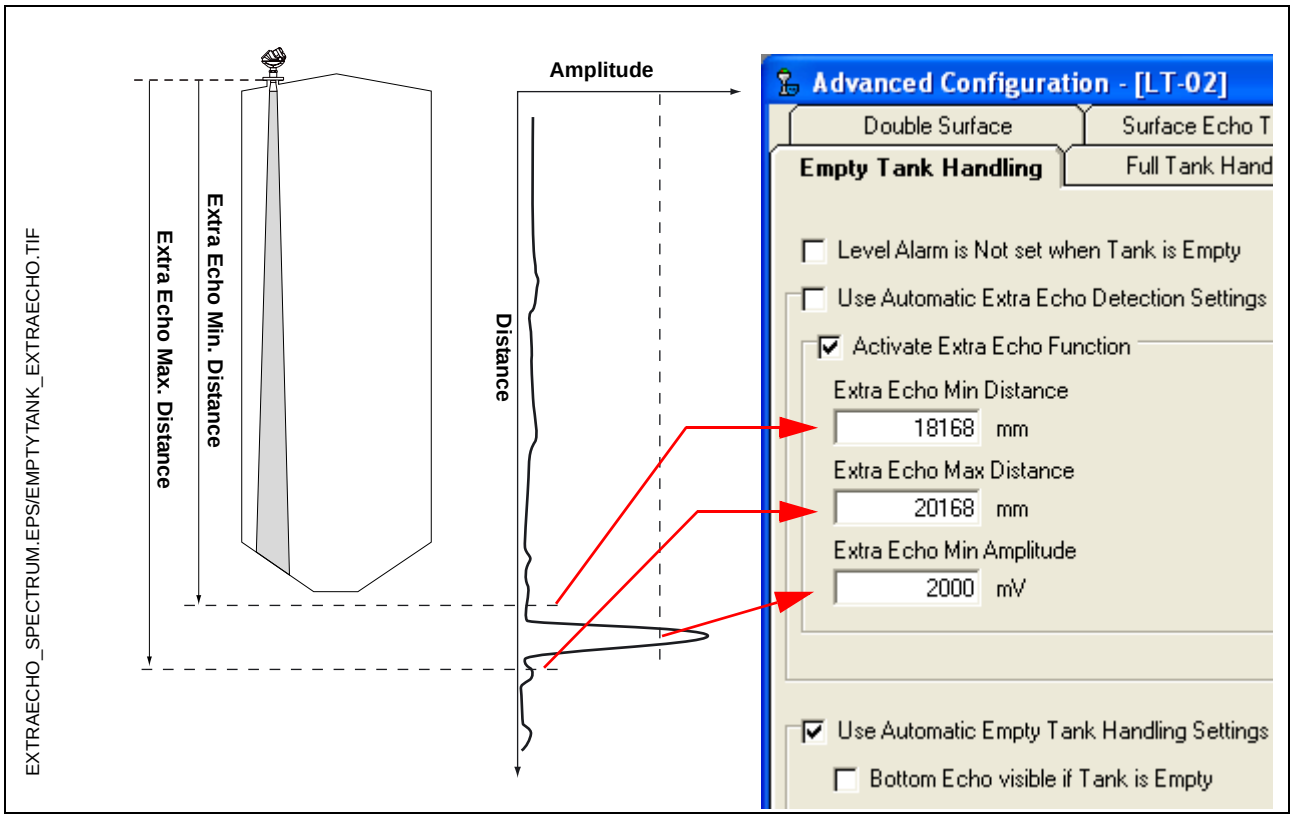
See “Empty Tank Detection Area” on page C-4 for further information.

Extra Echo Function

The Extra Echo Detection function makes measurements in the bottom region more robust for tanks with conical or domed bottom shape. In this case there is no strong echo from the tank bottom when the tank is empty, and a virtual echo beneath the actual tank bottom can sometimes be seen.

If the transmitter is not able to detect the tank bottom, this function can be used to ensure that the transmitter stays in Empty Tank state as long as an extra echo is present.

Use the spectrum function in Rosemount Radar Master when the tank is empty to verify if such an echo exists or not. Make sure you enter a distance that exceeds the tank bottom. In the spectrum you can also view the suitable values for Extra Echo Min Distance, Extra Echo Max Distance and Extra Echo Min Amplitude. The tank is considered empty when there is an echo within the minimum and maximum distance and the amplitude is above the specified limit.

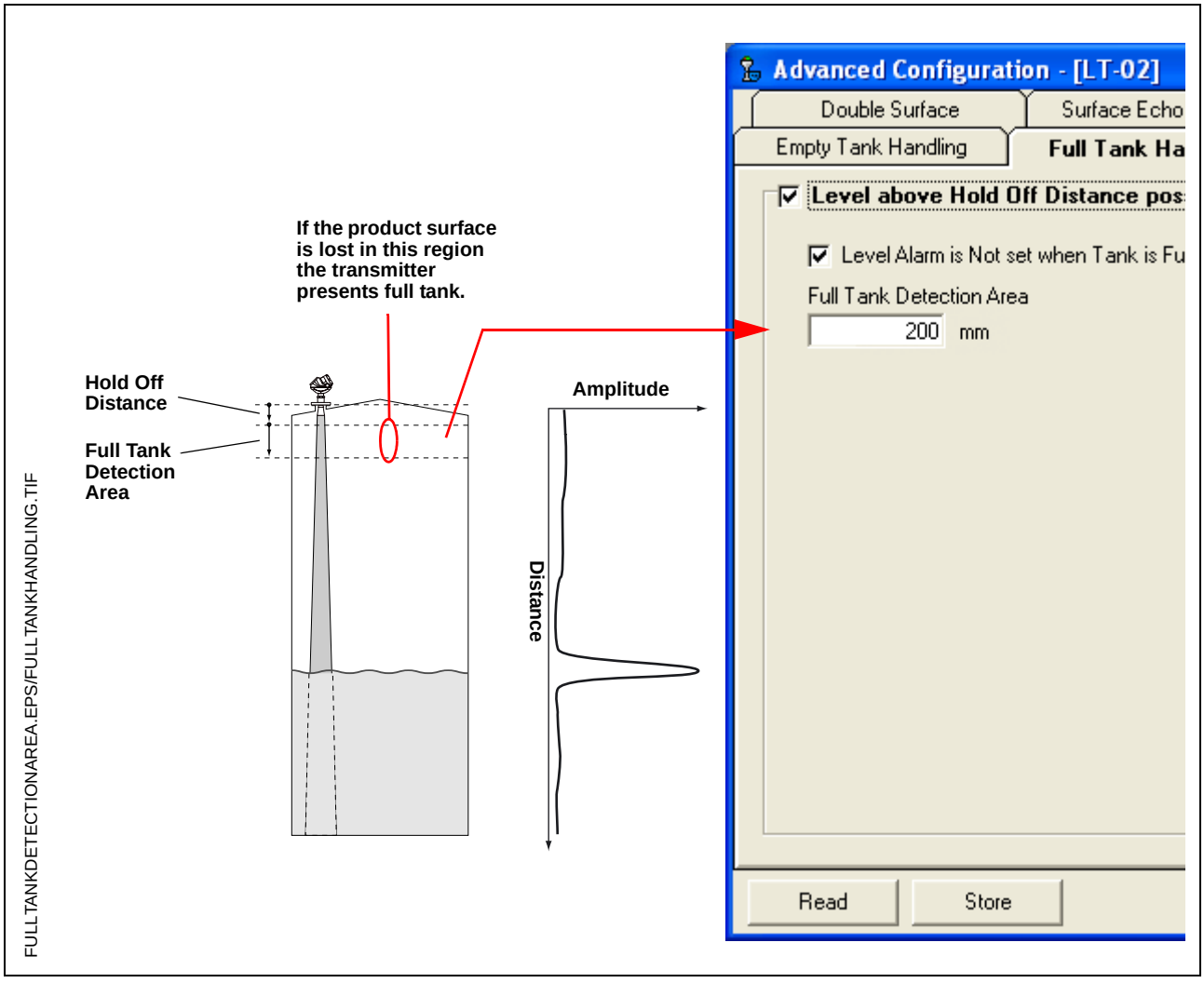


Full Tank Handling

The Full Tank Handling function can be used if you want product levels close to the antenna to be reported as **Full Tank**. Normally measurements are not allowed closer to the antenna than specified by the *Hold Off Distance* parameter. If the product level enters the *Hold Off Distance* region, the transmitter reports *Measurement Error* and starts searching for the surface.

By setting the *Level above Hold Off Distance possible* parameter, the transmitter reports **Full Tank** when the product level enters the *Hold Off Distance* region. Note that:

- The region in which the tank is considered full is specified by the *Full Tank Detection Area*.
- The level alarm for Full Tank is normally disabled.



Double Bounce

A double bounce echo is an echo that has been reflected against the tank roof and down to the surface before it is detected by the transmitter.

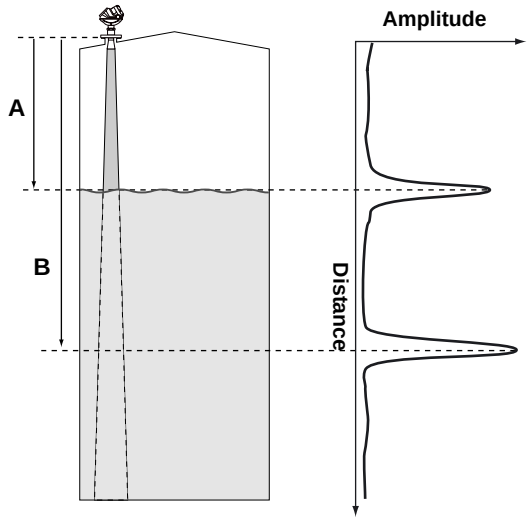
Double bounces are most commonly present in spherical or horizontal cylinder tanks. The tank roof in this case can sometimes amplify the double bounce echo amplitude. Normally double bounce echoes appear when the tank is about 60-70% filled. In these cases the double bounce echo can cause the transmitter to lock onto the wrong echo.

The Double Bounce function is used for managing problems with echoes that appear in the tank as a result of the tank shape and that are stronger than the surface echo itself.

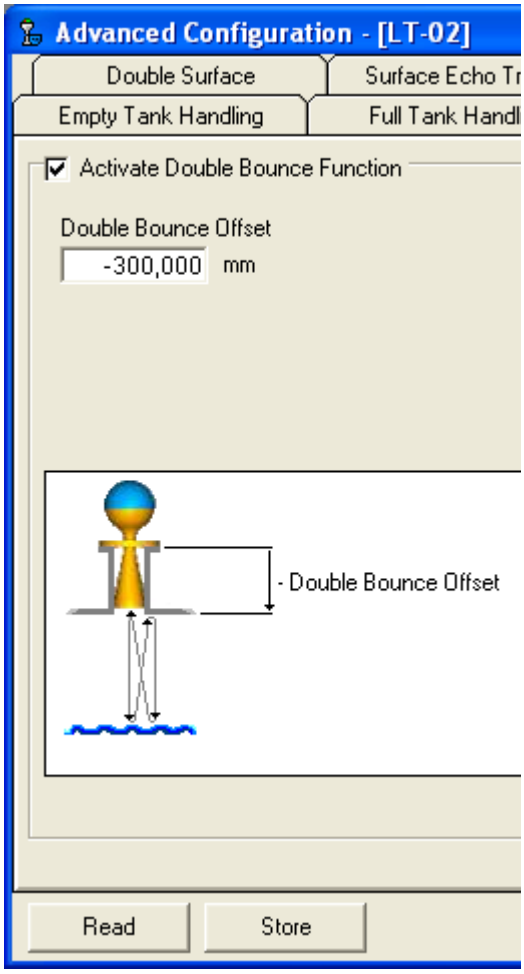
The Double Bounce Offset is given by the following formula:

Double Bounce Offset=B - 2*A,

where A is equal to the distance from the Tank Reference Point to the product surface, and B is equal to the distance from the Tank Reference Point to the Double Bounce echo. In many cases the Double Bounce Offset is approximately given by the height of the nozzle.



Double Bounce Offset=B - 2*A

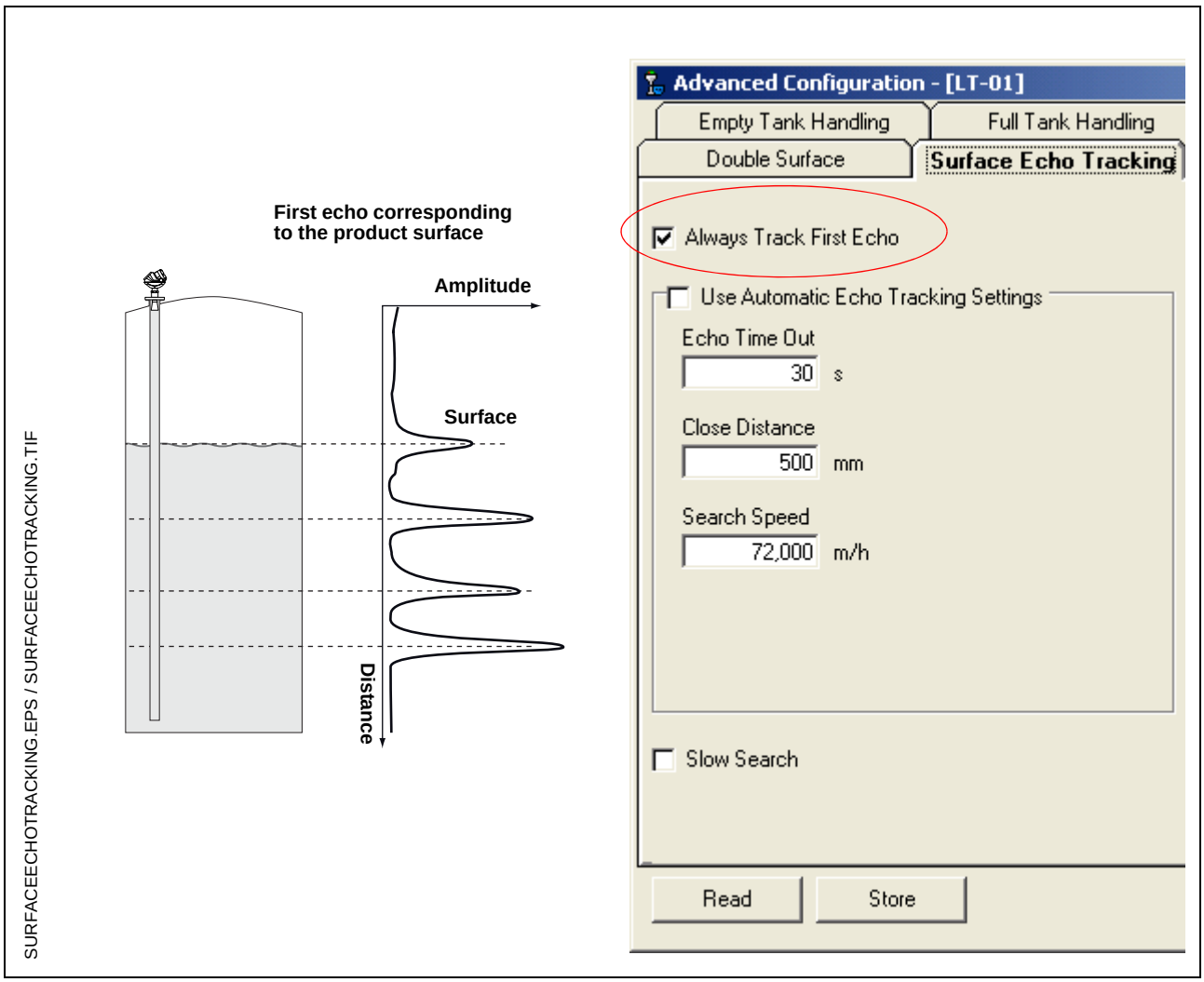


DOUBLEBOUNCE.EPS/DOUBLEBOUNCE.TIF

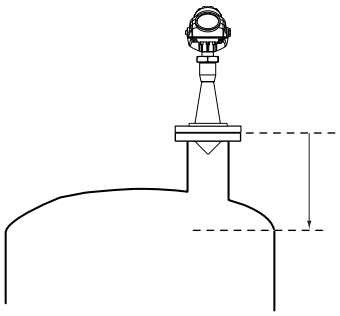
Surface Echo Tracking

The Surface Echo Tracking function can be used to eliminate problems with certain types of ghost echoes below the product surface. This may, for example, occur in Still-pipes because of multiple reflections between the pipe wall, flange and antenna. In the tank spectrum these echoes appear as amplitude peaks at various distances below the product surface.

To activate this funciton select the *Always Track First Echo* check box. Make sure that there are no disturbing echoes above the product surface when this function is activated.



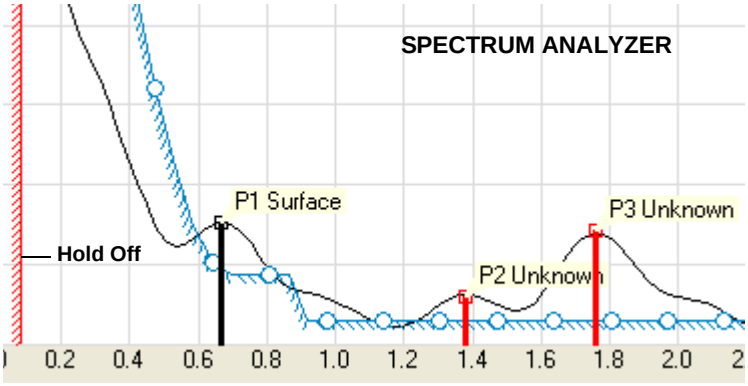
Hold Off Setting



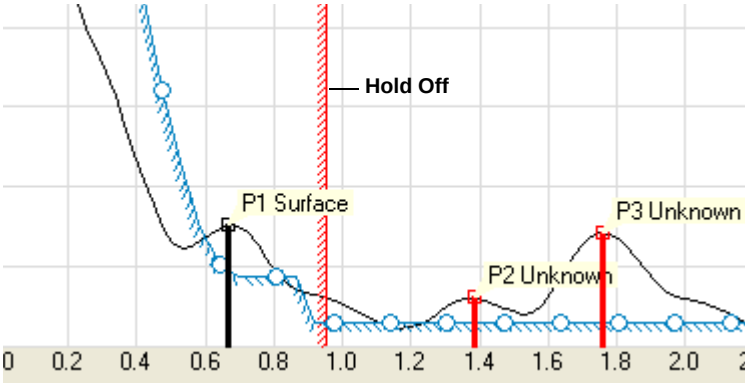
The Hold Off parameter is set to a default value which rarely needs any adjustment (see “Hold Off Distance” on page C-2 for definition of Hold Off distance). The Process Seal antenna is slightly more affected by disturbances in the nozzle than the cone and rod antennas. If necessary a small Hold Off adjustment may be sufficient to solve the problem.

In a typical situation a small object such as a weld joint may give rise to a disturbing echo. If this disturbance is strong enough the transmitter may misinterpret this echo as the product surface. By setting the Hold Off large enough to avoid measurement within and close to the nozzle, the problem is solved as illustrated below.

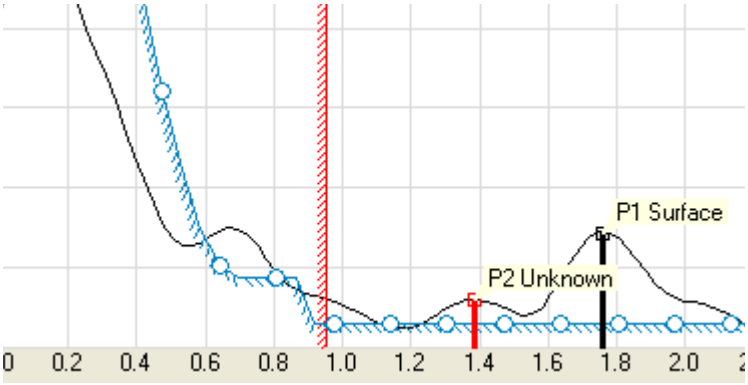
The Spectrum Plot function in Rosemount Radar Master (RRM) allows you to easily adjust the Hold Off distance:



1. In RRM click the Spectrum Plot icon to open the Spectrum Analyzer window.
2. Select the Configuration Mode tab.
3. Click the Read button and study the amplitude versus distance graph. If there is a disturbance caused by an object in the nozzle, the transmitter may misinterpret the position of the surface as shown to the left. In this example the true surface position is at amplitude peak P3.



4. Move the Hold Off distance line away from the transmitter i.e. to a position below the nozzle.
5. Click the Store button.



6. Now the transmitter disregards any disturbing echoes in the nozzle and finds the product surface.

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Reference Manual
00809-0100-4026, Rev DA
March 2006

Rosemount 5400 Series

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