Reference Manual
00809-0100-4032, Rev AA
November 2005

Rosemount 5400 Series

Two-wire Radar Level Transmitter with FOUNDATION™ Fieldbus

FOUNDATION

ROSEMOUNT®

www.rosemount.com

EMERSON™
Process Management

Reference Manual
00809-0100-4032, Rev AA
November 2005

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.

Cover Photo: 5400_08

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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 powering a FOUNDATION fieldbus segment 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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Describes the operation and parameters of the Analog Input transducer block.

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

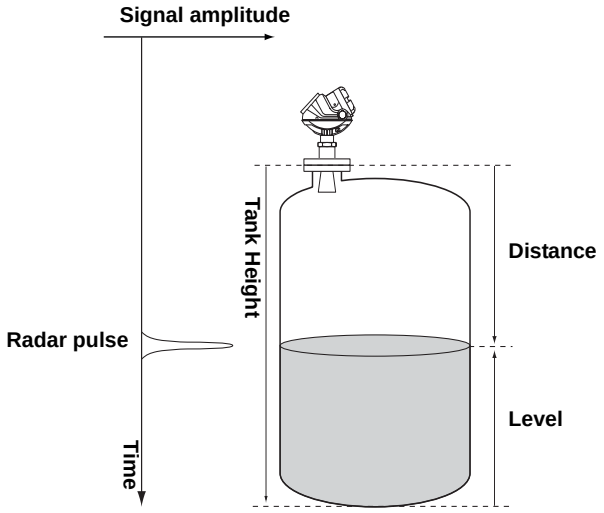
THEORY OF OPERATION

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

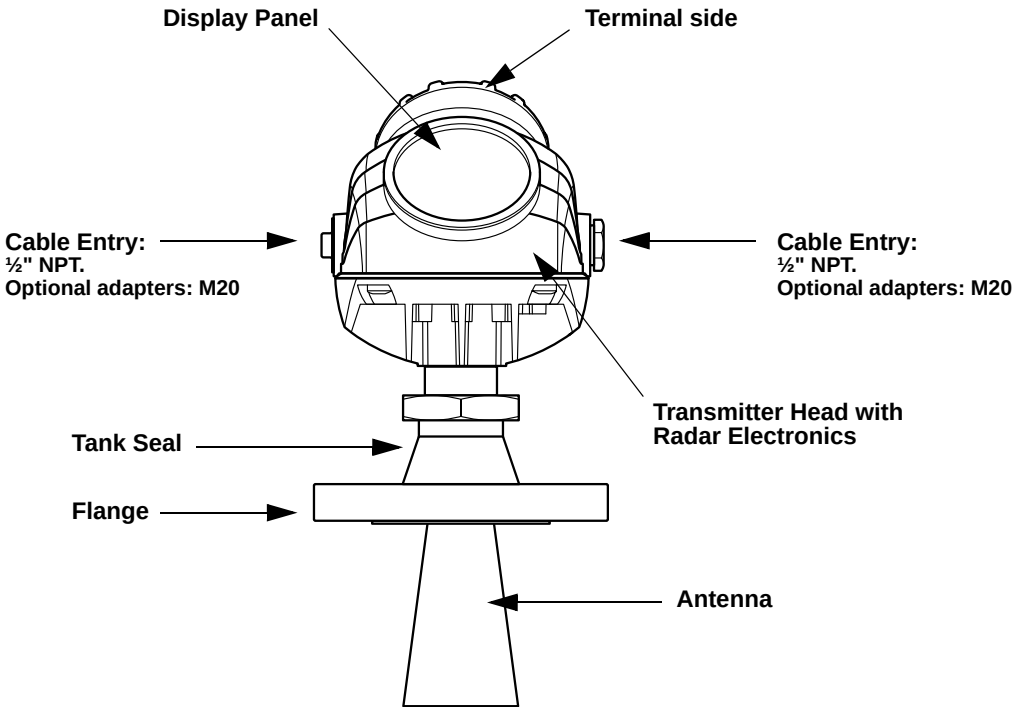
The Rosemount 5400 Series Radar Transmitter has a die-cast aluminum housing which contains advanced electronics for signal processing.

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.



TRANSMITTER_COMPONENTS.EPS

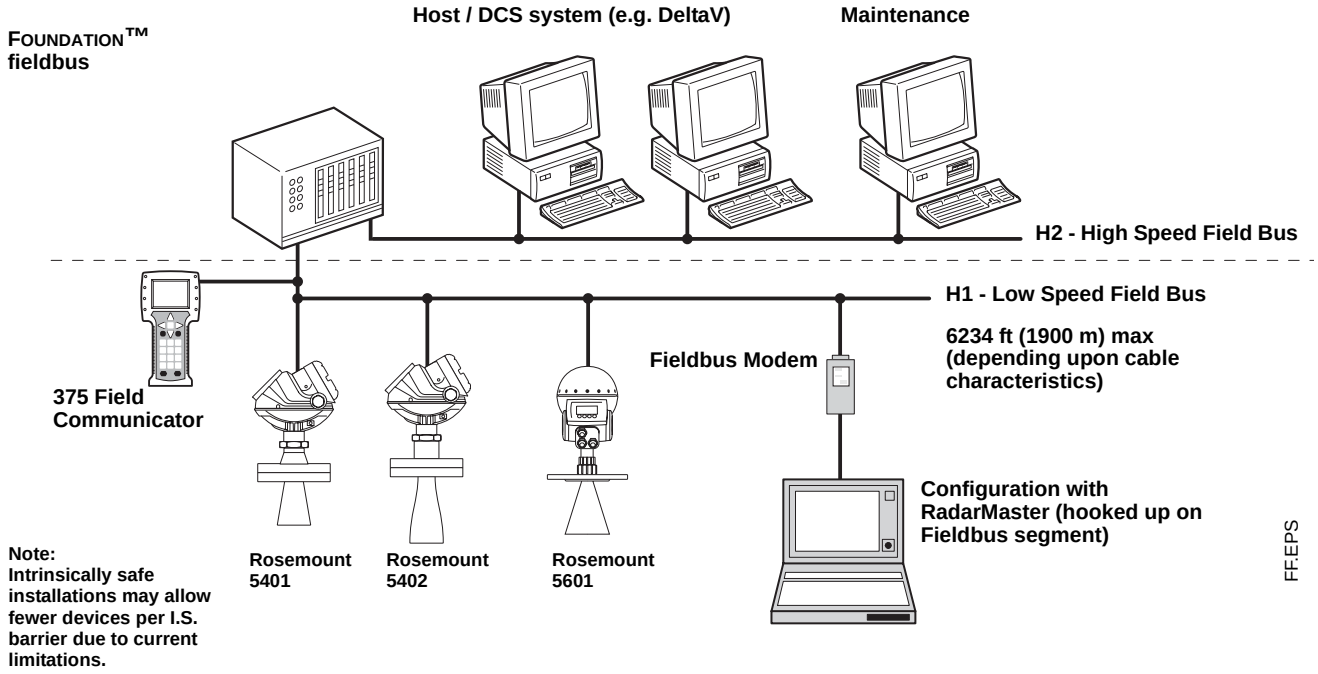
SYSTEM ARCHITECTURE

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 FOUNDATION™ fieldbus signal. For HART® based systems the output is a 4-20 mA analog signal superimposed with a digital HART signal.

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 375 Field 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.

Figure 2-3. System Integration.



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 Table 2-1 on page 2-5 and Table 2-2 on page 2-5 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 insensensitive to product density and vapor.

Condensation

For applications where heavy condensation 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 3-8.

ANTENNA SELECTION GUIDE/MEASURING RANGE

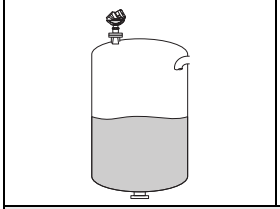
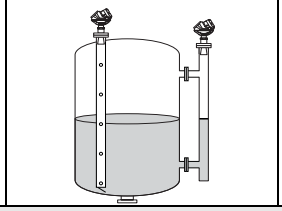
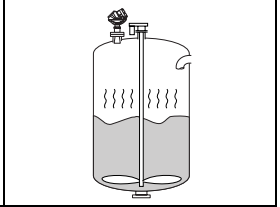
The measuring range primarily depends on the antenna type and size, the dielectric constant (ε_r) of the liquid and process conditions. For optimum performance, make sure not to exceed the maximum measuring range values below.

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).

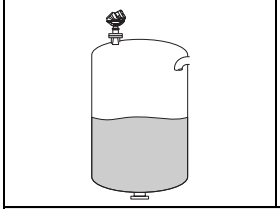
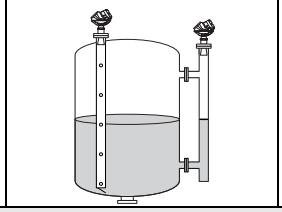
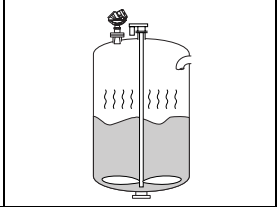
C. Conductive liquids, e.g. water based solutions, dilute acids and alkalis (ε_r>10.0).

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

Low Frequency Antennas **Units: feet (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	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.

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

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

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 powering a FOUNDATION fieldbus segment 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.

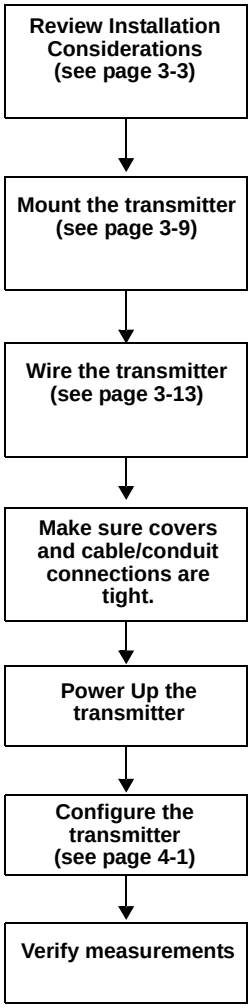
Make sure the main power to the 5400 transmitter is off and the lines to any other external power source are disconnected or not powered while wiring the gauge.

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 conditions. 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 the Rosemount 5400 Series, 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.

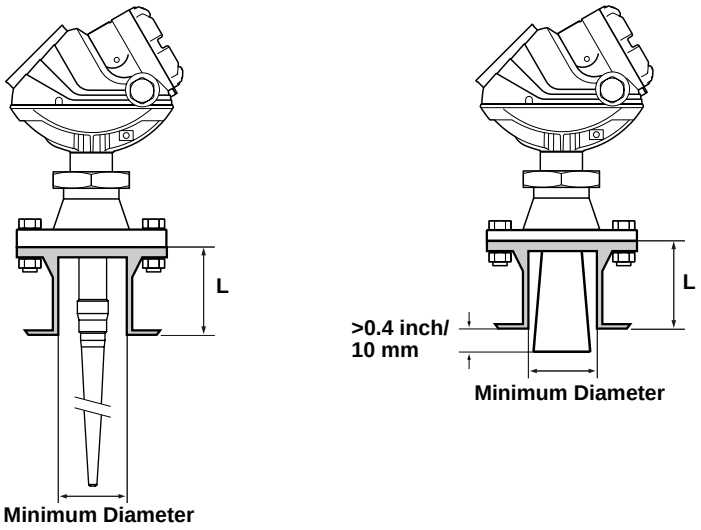


Table 3-1. Requirements on socket height and width.

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.	5.5 (140)	2.2 (55)
	Cone 3 in.	5.5 (140)	2.8 (72)
	Cone 4 in.	8.5 (215)	3.8 (97)

The transmitter should be installed as follows:

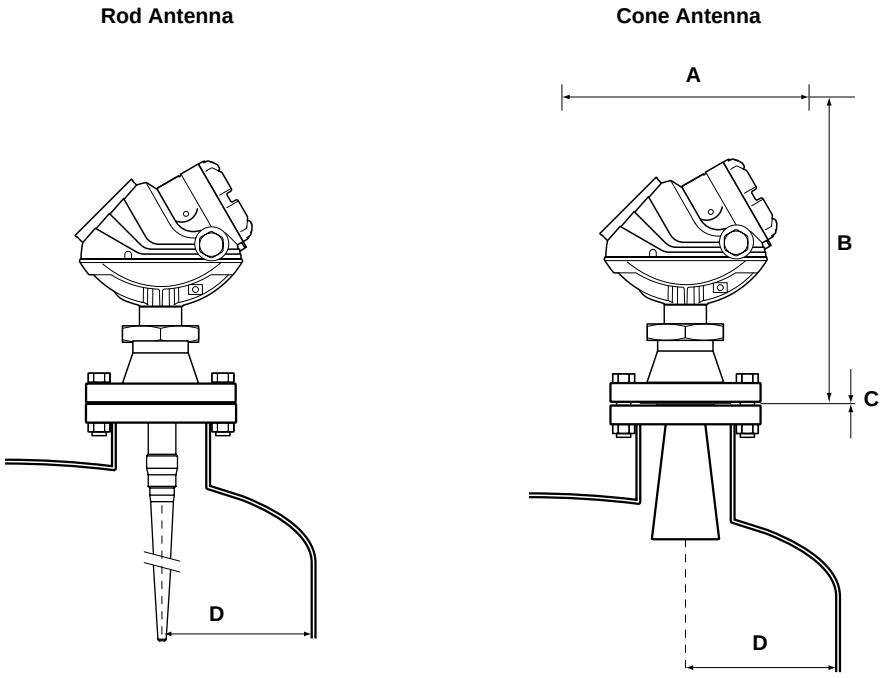
- The antenna must be aligned vertically.
- Choose as large antenna diameter as possible. A larger receiving area concentrates the radar beam and ensures maximum antenna gain. Increased antenna gain means greater margin for weak surface echoes. A larger antenna also results in a smaller beam angle and thereby, less interference from any internal obstructions.
- For best measurement performance, the antenna should extend below the nozzle by 0.4 inches (10 mm) or more.
- For the 5402 model 3-in. and 4-in. antennas can be used 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.



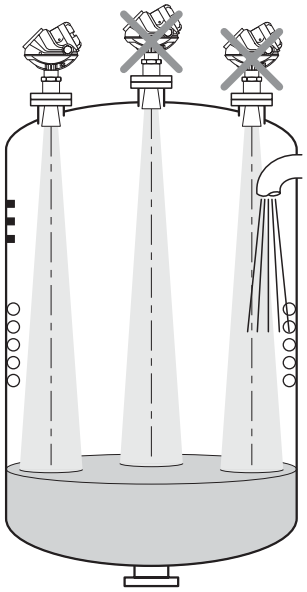
FREESPACE_ROD.EPS/FREESPACE.EPS

Service space	Distance inch (mm)
A	20 (500)
B	24 (600)
C. Inclination	**Maximum angle**
Cone antenna	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)

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 kept 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 beam width 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.

Beam Width

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. Beam width at various distances from the flange.

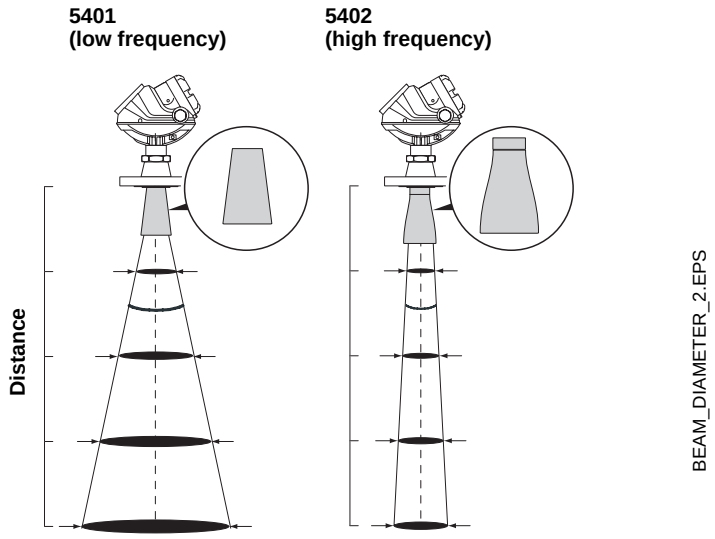


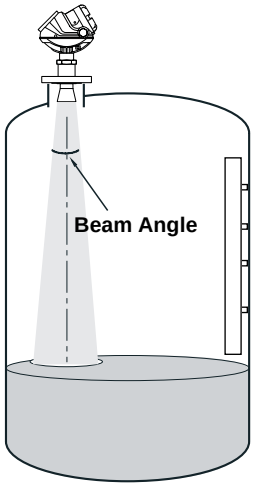
Table 3-2. Beamwidth for the Rosemount 5401 model.

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)

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

Distance	Antenna		
	2 in. (DN 50) Cone	3 in. (DN 80) Cone	4 in. (DN 100) Cone
	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)

Figure 3-5. Beam angle.



BEAMWIDTH2.EPSS

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

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 model.

Antenna	Half Power Beam Width
2 in. Cone	19°
3 in. Cone	14°
4 in. Cone	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 4-7).

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 of 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.

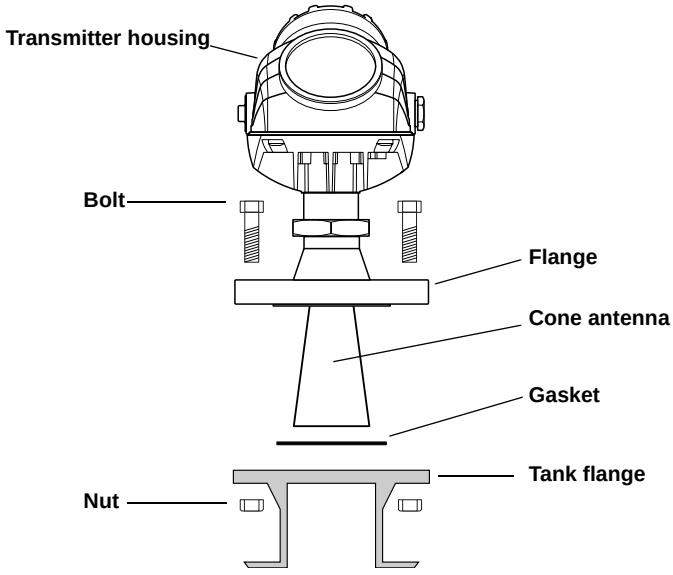
MECHANICAL INSTALLATION

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

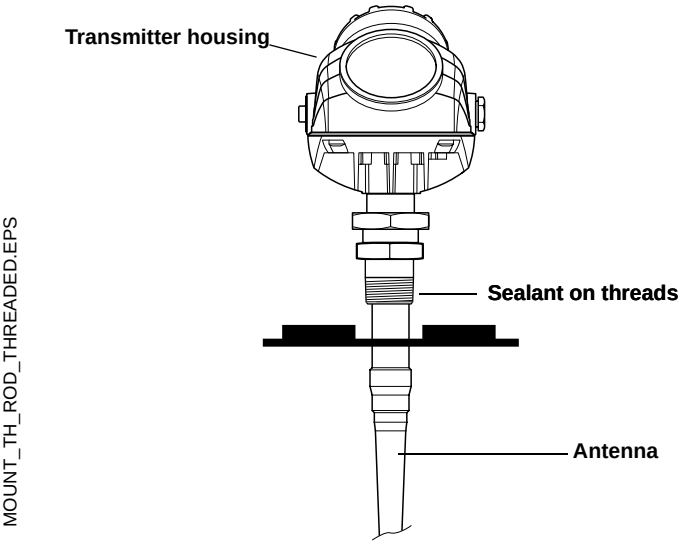
If the transmitter housing must be removed for service, make sure that the Teflon® sealing is carefully protected against dust and water.

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



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-4.

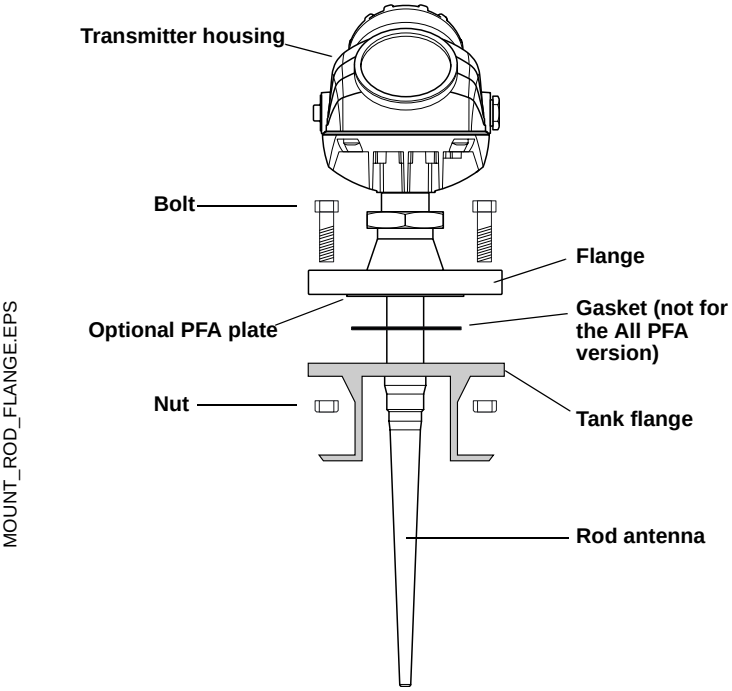
Figure 3-7. Mounting the 5400 transmitter with rod antenna and threaded tank connection.



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

NOTE!
Tank connections with NPT threads require a sealant for pressure-tight joints.

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



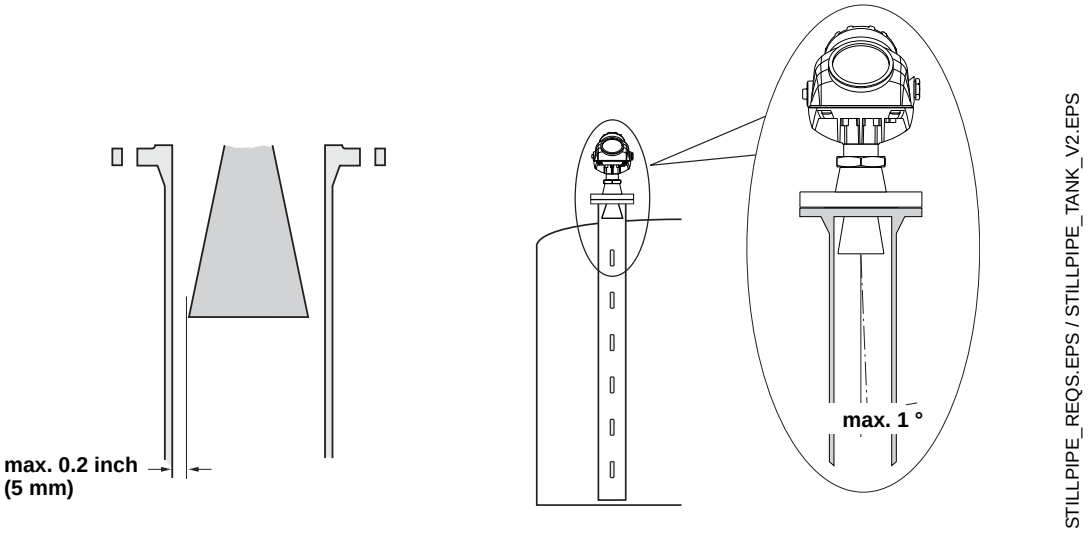
1. Place a gasket with thickness and of material suitable to the process on top of the tank flange.
   Note: For the *All PFA* version (tank sealing model code=PD) no gasket is used.
2. Lower the transmitter with antenna and flange into the tank nozzle.
3. Tighten the bolts and nuts with sufficient torque regarding flange and gasket choice. See also Process Temperature and Pressure Rating on page A-4.

Mounting in Pipes

Still Pipe mounting is recommended for tanks where surface conditions are extremely turbulent. All cone antenna sizes for the 5400 Series transmitter can be used for Still Pipe installations. The 2 and 3 inch antennas for 5401 are designed for use in Still Pipes and Bypass Pipes only.

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

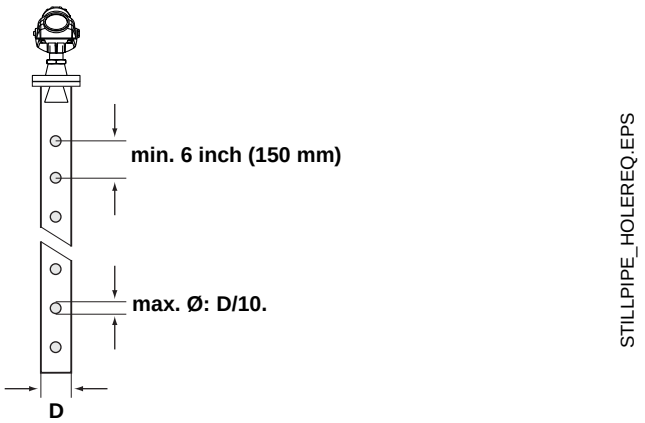
Figure 3-9. Mount the transmitter vertically.



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.

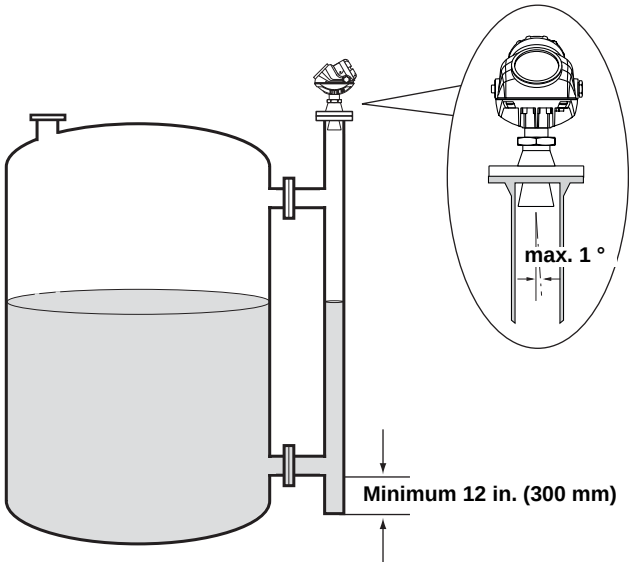
Figure 3-10. Recommended hole size for pipe installations.



Mounting in Bypass Pipes

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

Figure 3-11. Bridle mounting is recommended for tanks with extremely turbulent surface conditions.

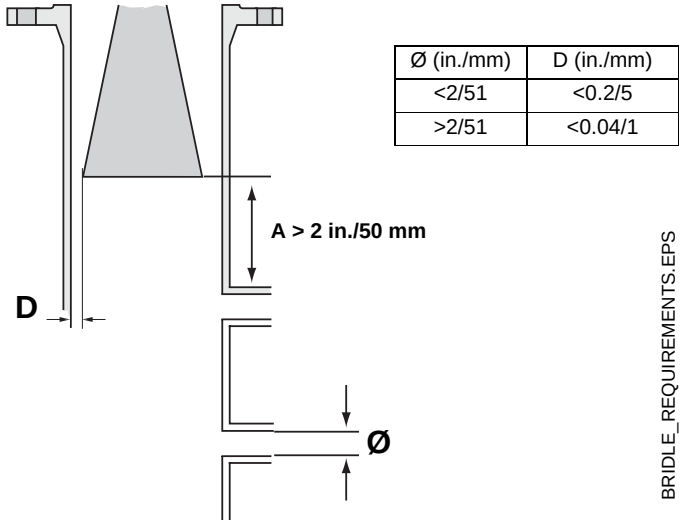


In pipes with inlet pipe diameter Ø<2 inch (51 mm) the gap D between pipe and antenna should be less than 0.2 inch (5 mm).

If the inlet pipe diameter Ø>2 inch (51 mm) the gap D between pipe and antenna should be less than 0.04 inch (1 mm).

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

Figure 3-12. 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

⚠ For best installation practices use a fieldbus type A cable. All power to the transmitter is supplied over the signal wiring. For the Rosemount 5400 Series signal wiring should be shielded, twisted pair for best results in electrically noisy environments. Do not use unshielded signal wiring in open trays with power wiring or near heavy electrical equipment. The cables must be suitable for the supply voltage and approved for use in hazardous areas, where applicable. For instance, in the U.S., explosionproof 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.

Do not remove the transmitter cover in explosive atmospheres when the circuit is alive.

Hazardous Areas

When the Rosemount 5400 Series transmitter is installed in 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 is powered over FOUNDATION fieldbus with standard fielbus power supplies.

The transmitter operates with the following power supplies:

Approval Type	Power Supply (V dc)
IS	9 - 30
Explosion Proof/Flame Proof	16 - 32
None	9 - 32

Connecting the Transmitter

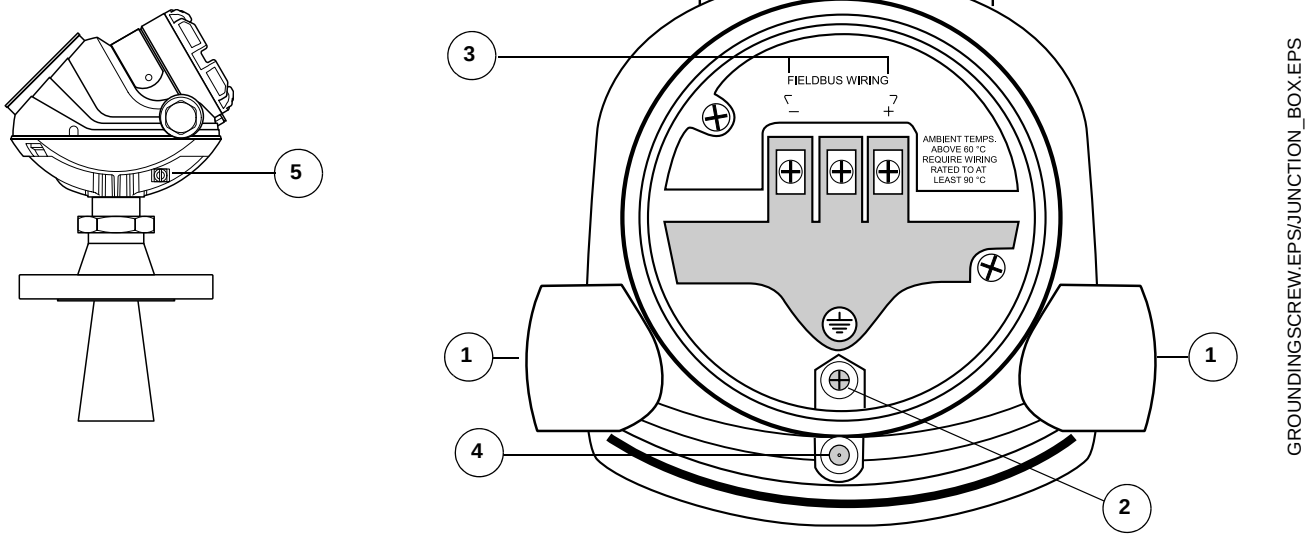
The Rosemount 5400 Series with Foundation Fieldbus accepts power supplies ranging from 9 V dc to 32 V dc.

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 3-15 for non-intrinsically safe power supplies and according to Figure 3-16 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 version).
8. Switch on the power supply.

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

Figure 3-13. 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

Grounding

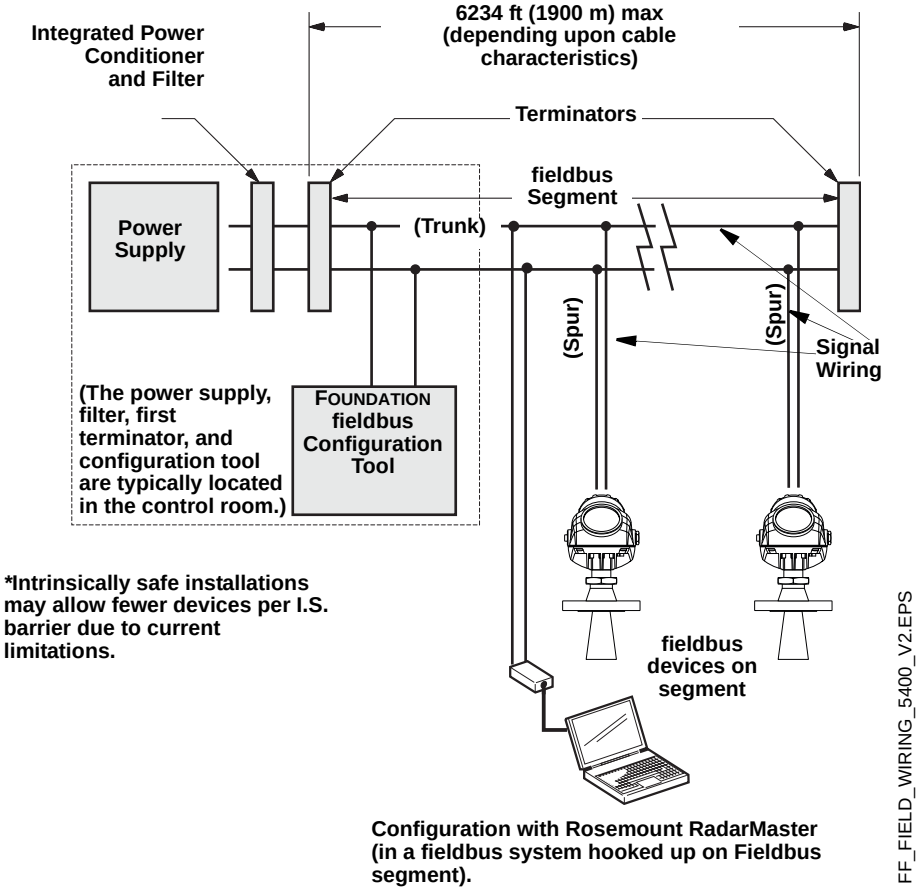
Signal wiring of the fieldbus segment can not be grounded. Grounding out one of the signal wires will shut down the entire fieldbus segment.

Shield Wire Ground

To protect the fieldbus segment from noise, grounding techniques for shield wire usually require a single grounding point for shield wire to avoid creating a ground loop. The ground point is typically at the power supply.

Connecting Fieldbus Devices

Figure 3-14. Rosemount 5400 Radar Transmitter field wiring

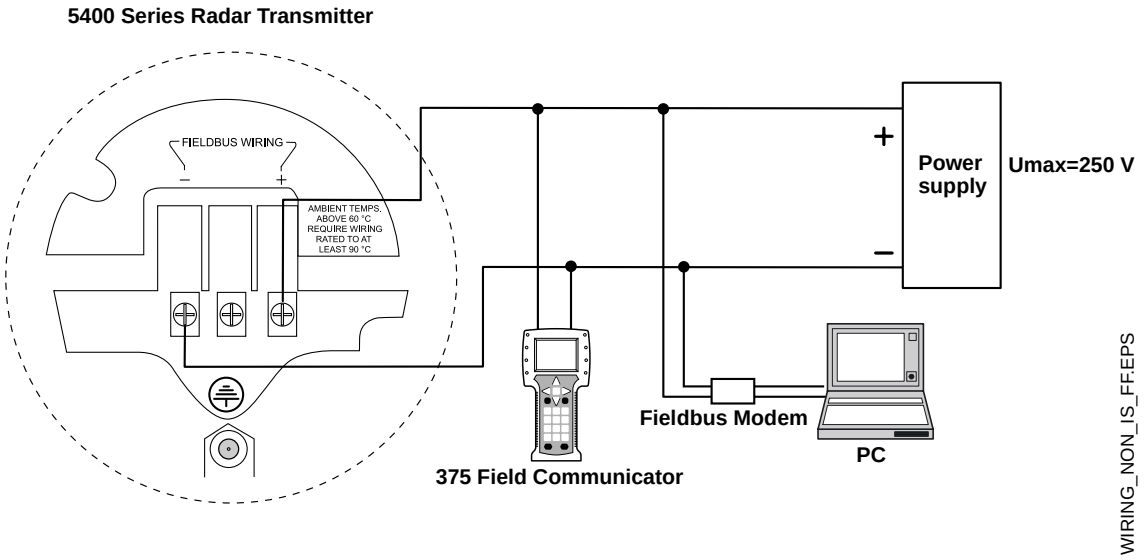


Non-Intrinsically Safe Power Supply

With non-intrinsically safe power supply in Non-hazardous installations or Explosion-proof/Flameproof installations, wire the transmitter as shown in Figure 3-15.

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

Figure 3-15. Wiring for non-intrinsically safe power supply.



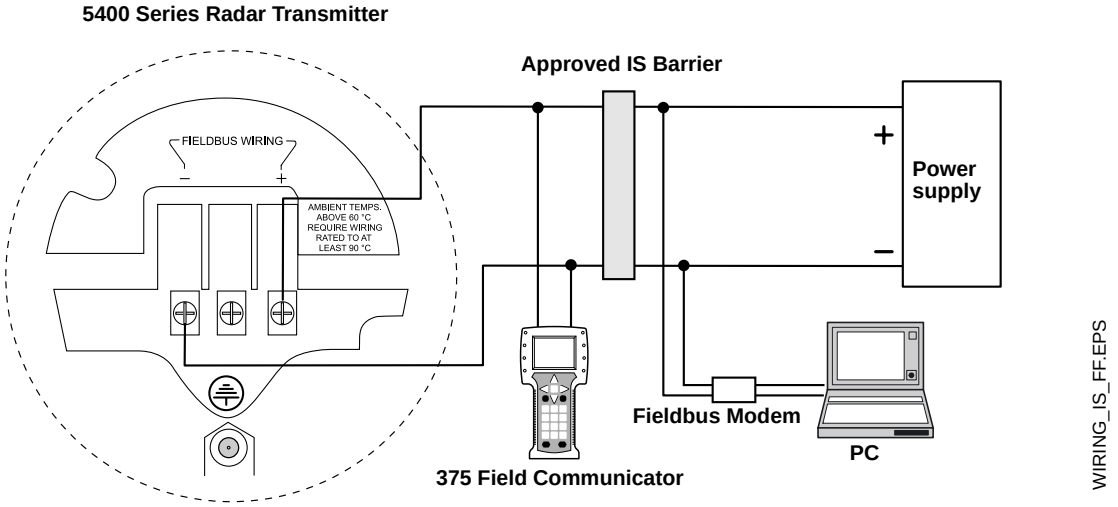
NOTE!
For Explosion Proof/Flame Proof installations make sure that the transmitter is grounded to the I.S. ground terminal inside the terminal compartment in accordance with national and local electrical codes.

Intrinsically Safe Power Supply

When your power supply is intrinsically safe, wire the transmitter as shown in Figure 3-16.

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

Figure 3-16. Wiring diagram for intrinsically safe power supply.



For information on I.S. parameters see *Section B: Product Certifications*.

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 powering a FOUNDATION fieldbus segment 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.

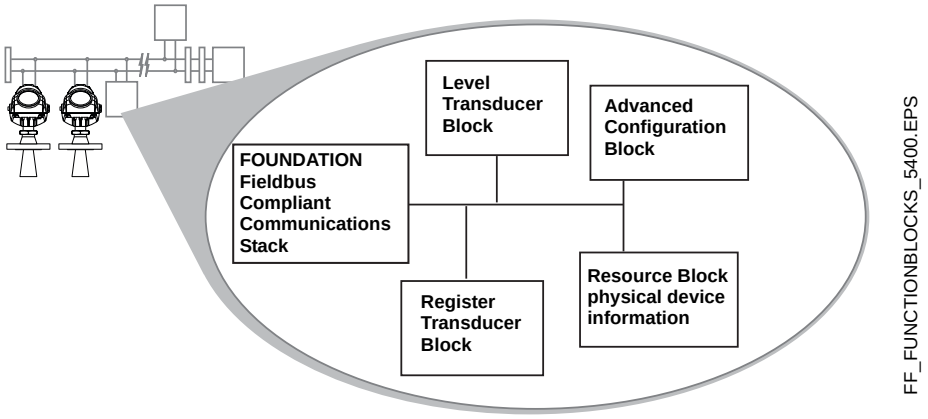
Do not perform any service other than those contained in this manual unless you are qualified.

OVERVIEW

Configuration of a Rosemount 5400 transmitter is normally a simple and straight-forward task. If the transmitter is pre-configured at the 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.

Figure 4-1 illustrates how the signals are channeled through the gauge.

Figure 4-1. Function Block Diagram for the Rosemount 5400 Series Radar Level Transmitters with FOUNDATION fieldbus.



⚠WARNING

It is highly recommended that you limit the number of periodic writes to all static or non-volatile parameters such as HI_HI_LIM, LOW_CUT, SP, TRACK_IN_D, OUT, IO_OPTS, BIAS, STATUS_OPTS, SP_HI_LIM, and so on. Static parameter writes increment the static revision counter, ST_REV, and are written to the device's non-volatile memory. Fieldbus devices have a non-volatile memory write limit. If a static or non-volatile parameter is configured to be written periodically, the device can stop its normal operation after it reaches its limit or fail to accept new values.

Each FOUNDATION fieldbus configuration tool or host device has a different way of displaying and performing configurations. Some will use Device Descriptions (DD) and DD Methods to make configuration and displaying of data consistent across host platforms. Since there is no requirement that a configuration tool or host support these features, this section will describe how to reconfigure the device manually. Appendix H: Operation with Delta V shows the Delta V implementation of these common functions.

This section covers basic operation, software functionality, and basic configuration procedures for the Rosemount 5400 Series Level Transmitter with FOUNDATION fieldbus (Device Revision 1). For detailed information about FOUNDATION fieldbus technology and function blocks used in the Rosemount 5400 Series, refer to the FOUNDATION fieldbus Block manual (Ref. no. 00809-0100-4783).

Assigning Device Tag and Node Address

A Saab Rosemount 5400 Series transmitter is shipped with a blank tag and a temporary address (unless specifically ordered with both) to allow a host to automatically assign an address and a tag. If the tag or address need to be changed, use the features of the configuration tool. The tool basically does the following:

1. Changes the address to a temporary address (248-251).
2. Changes the tag to new value.
3. Changes the address to a new address.

When the transmitter is at a temporary address, only the tag and address can be changed or written to. The resource, transducer, and function blocks are all disabled.

FOUNDATION Fieldbus Block Operation

Function blocks within the fieldbus device perform the various functions required for process control. Function blocks perform process control functions, such as analog input (AI) functions, as well as proportional-integralderivative (PID) functions. The standard function blocks provide a common structure for defining function block inputs, outputs, control parameters, events, alarms, and modes, and combining them into a process that can be implemented within a single device or over the fieldbus network. This simplifies the identification of characteristics that are common to function blocks.

In addition to function blocks, fieldbus devices contain two other block types to support the function blocks. These are the **Resource block** and the **Transducer block**.

Resource blocks contain the hardware specific characteristics associated with a device; they have no input or output parameters. The algorithm within a resource block monitors and controls the general operation of the physical device hardware. There is only one resource block defined for a device.

Transducer blocks connect function blocks to local input/output functions. They read sensor hardware and write to effector (actuator) hardware.

Level Transducer Block

The Level Transducer block contains transmitter information including diagnostics and the ability to configure, set to factory defaults and restarting the transmitter.

Register Transducer Block

The Register Transducer Block allows a service engineer to access all database registers in the device.

Advanced ConfigurationTransducer Block

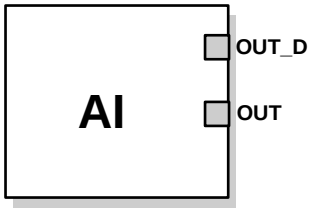
The Advanced Configuration Transducer Block contains functions such as amplitude threshold settings for filtering of disturbing echoes and noise, simulation of measurement values and strapping table for volume measurements.

Resource Block

The Resource block contains diagnostic, hardware, electronics, and mode handling information. There are no linkable inputs or outputs to the Resource Block.

Analog Input Block

Figure 4-2. Analog-Input Block



OUT=The block output value and status
OUT_D=Discrete output that signals a selected alarm condition

FF_AIBLOCK

The Analog Input (AI) function block processes field device measurements and makes them available to other function blocks. The output value from the AI block is in engineering units and contains a status indicating the quality of the measurement. The measuring device may have several measurements or derived values available in different channels. Use the channel number to define the variable that the AI block processes and passes on to linked blocks. For further information refer to Appendix E: Analog-Input Block.

For more information on the different function blocks refer to *Appendix D: Level Transducer Block*, *Appendix E: Register Transducer Block*, *Appendix F: Advanced Configuration Transducer Block*, *Appendix G: Resource Transducer Block* and *Appendix H: Analog-Input Block*.

Function Blocks

The following function blocks are available for the Rosemount 5400 Series:

- Proportional/Integral/Derivative (PID)
- Input Selector (ISEL)
- Signal Characterizer (SGCR)
- Arithmetic (ARTH)
- Output Splitter (OS)

For detailed information about FOUNDATION fieldbus technology and function blocks used in the Rosemount 5400 Series, refer to the FOUNDATION fieldbus Block manual (Ref. no. 00809-0100-4783).

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

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 4-18 for information on how to use RRM for configuration of the 5400 Series.
- Rosemount 375 Field Communicator.
- DeltaV.

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

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 4-4 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 4-3. Tank Geometry

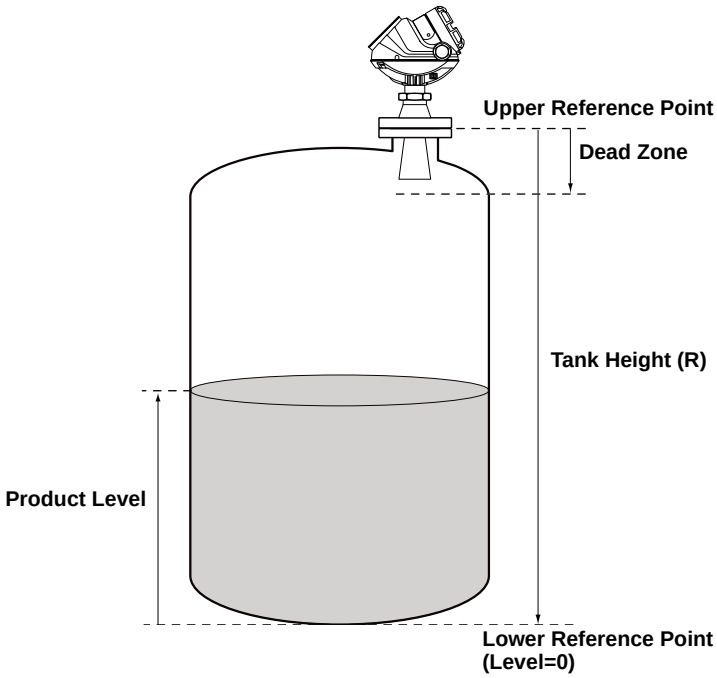
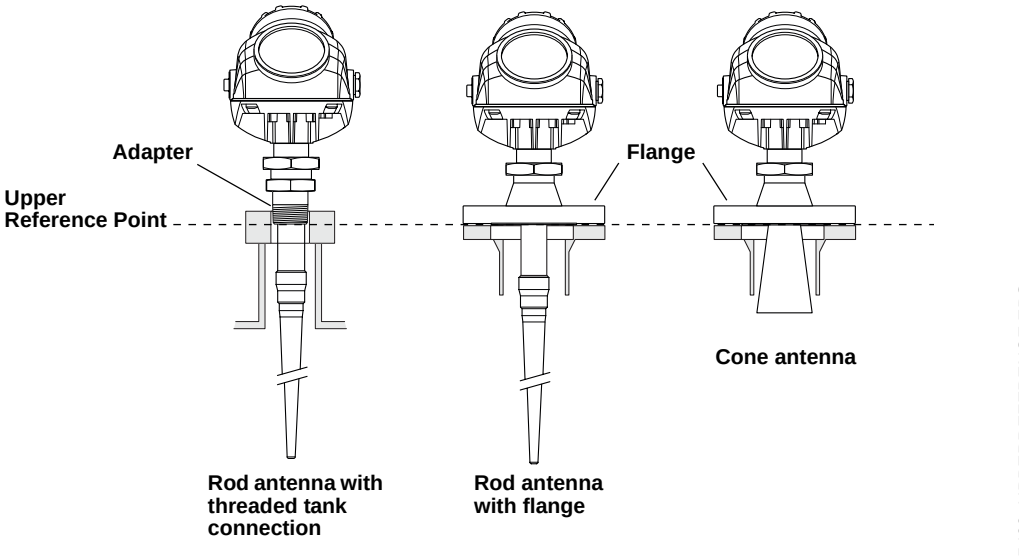


Figure 4-4. Upper Reference Point



Tank Type and Tank Bottom Type

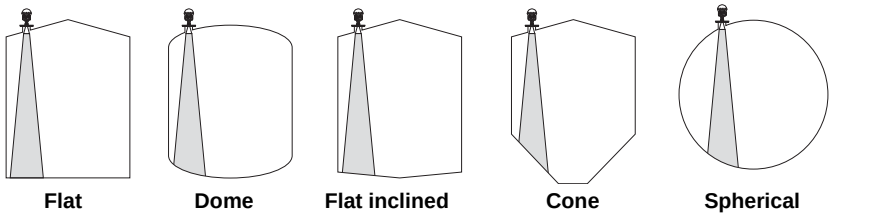
The 5400 transmitter is optimized according to the *Tank Type* and *Tank Bottom Type* configuration by automatically setting some parameters to pre-defined default values.

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 4-5. 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. See Specifications on page A-1 for more information.

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 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

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.

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:

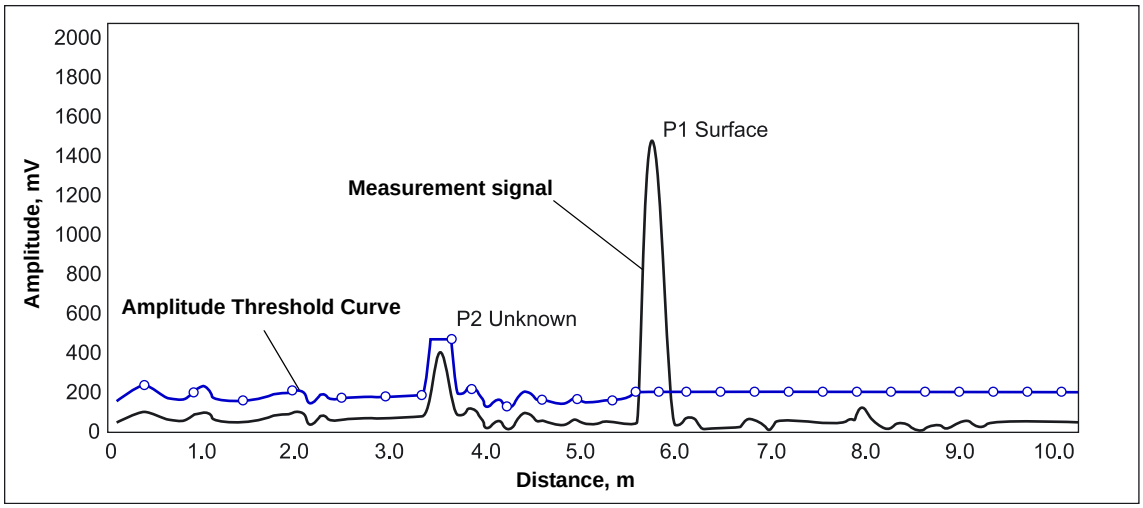
- Amplitude Threshold Curve (ATC)
- False Echo registration

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 4-21).

Amplitude Threshold Curve

Setting up an Amplitude Threshold Curve makes tracking of the product surface more robust. Weak disturbing echoes, i.e. echoes with an amplitude that is smaller than the amplitude of the product surface echo, can be filtered out by creating an amplitude threshold.

Figure 4-6. Setting up an Amplitude Threshold Curve.

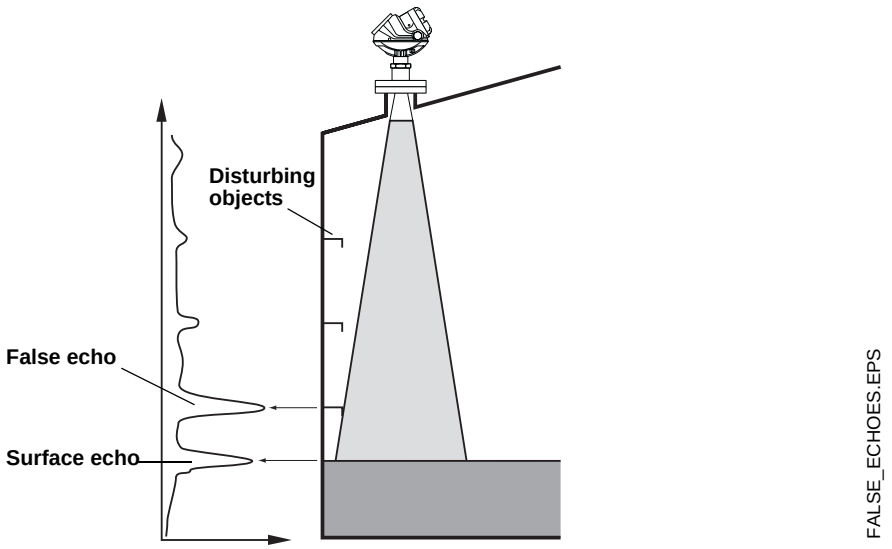


The Amplitude Threshold Curve function is available in the Rosemount Radar Master (RRM) program.

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.

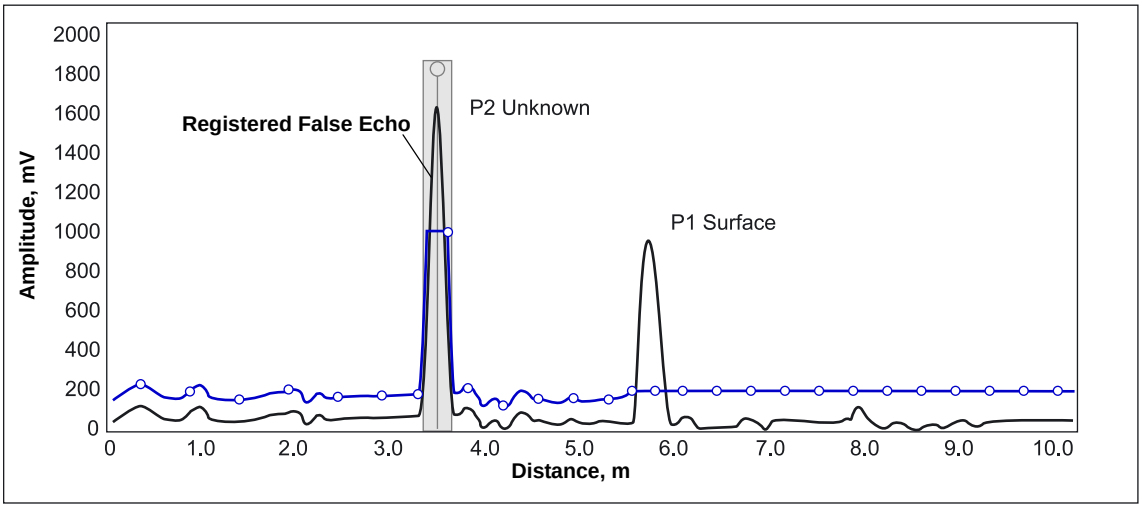
Figure 4-7. The Rosemount 5400 can handle disturbing radar echoes.



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 4-10).
- 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 4-8. Disturbing echoes can be filtered out by registration as False Echoes.



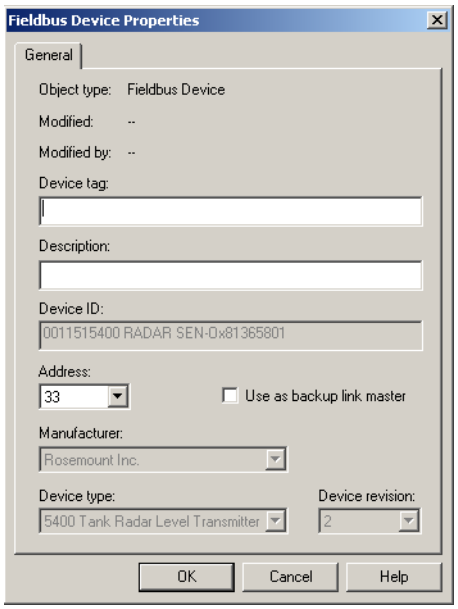
FALSEECHO_REGISTRATION.EPS

The False Echo Registration function is available in the Rosemount Radar Master (RRM) program.

CONFIGURATION USING DELTAV

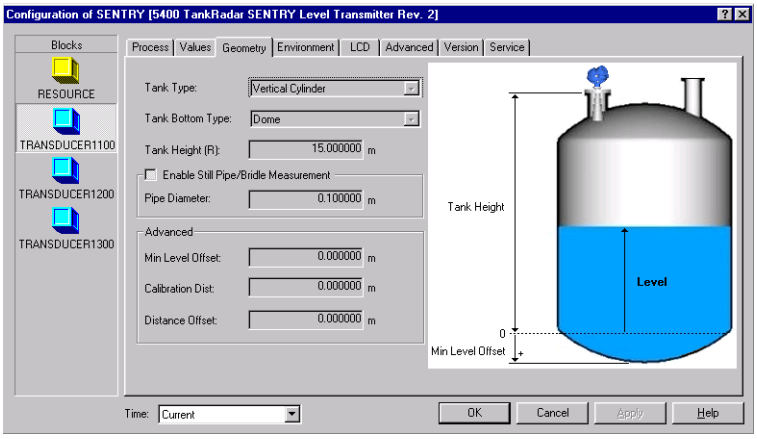
The following description shows how to configure a 5400 Series transmitter using DeltaV. The corresponding FOUNDATION Fieldbus commands are also shown. The Rosemount 5400 Series supports DD Methods for DeltaV in order to facilitate transmitter configuration. The following description shows how to use DeltaV with the AMS application to configure the Rosemount 5400 Series.

1. Select DeltaV>Engineering>DeltaV Explorer from the Start menu.
2. Navigate through the file structure to find the 5400 transmitter.



FIELDBUSDEVICE_PROPERTIES.TIF

3. The Fieldbus Device Properties window lets you enter Device Tag and Description. This information is not required for the operation of the transmitter and can be left out if desired.
   General information such as device type (5400), manufacturer, device ID are presented. The Rosemount 5400 Series device ID consists of the following components:
   Manufacturer ID-Model-Serial Number.
   Example: 001151-5400 Radar SEN-0x81365801.
   Check that the information complies with the ordering information
4. Select the desired transmitter in the **DeltaV Explorer** and choose the **Configure** option.
5. Select the TRANSDUCER1100 block and choose the **Geometry** tab.



TB1100GEOMETRY.TIF

6. Choose the **Tank Type** which corresponds to the actual tank. If none of the available options matches the actual tank choose Unknown.

   FOUNDATION™ fieldbus parameter:
   TRANSDUCER 1100>GEOM_TANK_TYPE.

7. **Tank Bottom Type** is important for the measurement performance close to the tank bottom.

   FOUNDATION™ fieldbus parameter:
   TRANSDUCER 1100>GEOM_TANK_BOTTOM_TYPE.

8. **Tank Height** is the distance from the Upper Reference Point to the tank bottom (see Tank Geometry on page 4-6). Make sure that this number is as accurate as possible.

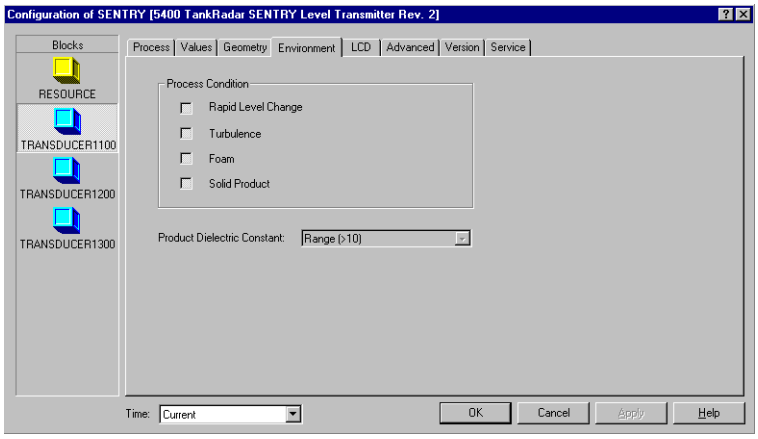
   FOUNDATION™ fieldbus parameter:
   TRANSDUCER 1100>GEOM_TANK_HEIGHT.

9. If the transmitter is mounted in a Still Pipe or Bridle, select the *Enable Still Pipe Measurement* check box and enter the **Pipe Diameter**.

   FOUNDATION™ fieldbus parameter:
   TRANSDUCER 1100>SIGN_PROC_CONFIG/Pipe Measurement Enable,
   TRANSDUCER 1100>ANTENNA_PIPE_DIAM.

   See Tank Geometry on page 4-6 for more information.

10. Select the **Environment** tab.



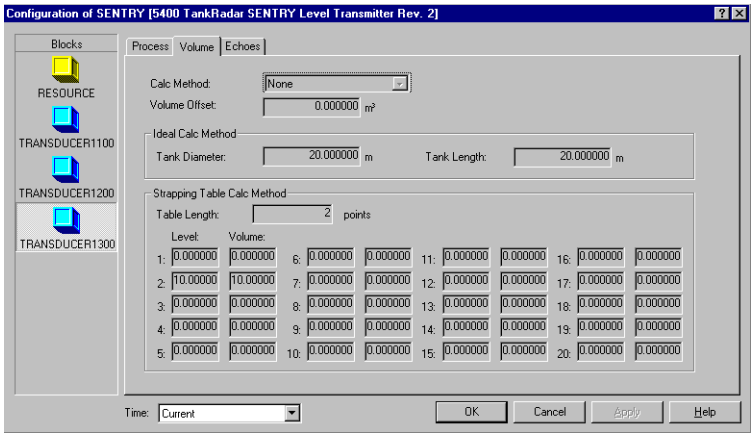
TB1100ENVIRONMENT.TIF

11. 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 4-8 for more information.
FOUNDATION™ fieldbus parameter:
TRANSDUCER 1100>ENV_ENVIRONMENT.

    Choose the **Product Dielectric Constant** 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.

    FOUNDATION™ fieldbus parameter:
    TRANSDUCER 1100>ENV_DIELECTR_CONST.

12. To configure volume calculation, select the TRANSDUCER1300 block and choose the Volume tab.



TB1300VOLUME.TIF

13. Choose a pre-defined calculation method based on a tank shape that corresponds to the actual tank. Choose None if volume calculation is not desired.
Use Volume Offset if you do not want zero volume and zero level to match (for example if you want to include the product volume below the zero level).
The Strapping Table option is used if the actual tank does not match any of the available options for pre-defined tanks or if a higher calculation accuracy is desired.

    Calculation Method:
    FOUNDATION™ fieldbus parameter:
    TRANSDUCER 1300>VOL_VOLUME_CALC_METHOD.

    Diameter:
    FOUNDATION™ fieldbus parameter:
    TRANSDUCER 1300>VOL_IDEAL_DIAMETER.

    Tank Length:
    FOUNDATION™ fieldbus parameter:
    TRANSDUCER 1300>VOL_IDEAL_LENGTH.

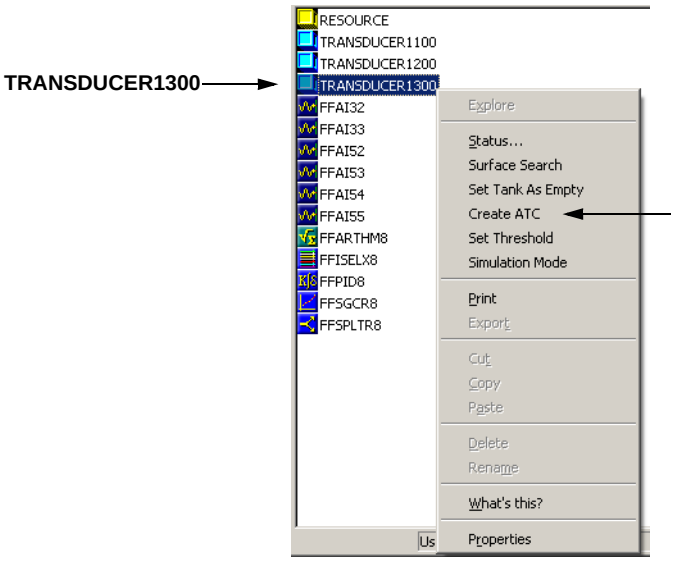
    Volume Offset:
    FOUNDATION™ fieldbus parameter:
    TRANSDUCER 1300>VOL_VOLUME_OFFSET.

    See Volume on page 4-9 for more information.

Advanced Configuration

Amplitude Threshold Curve

1. In the DeltaV Explorer select the desired transmitter icon, click the right mouse button on the **Transducer 1300** block icon.

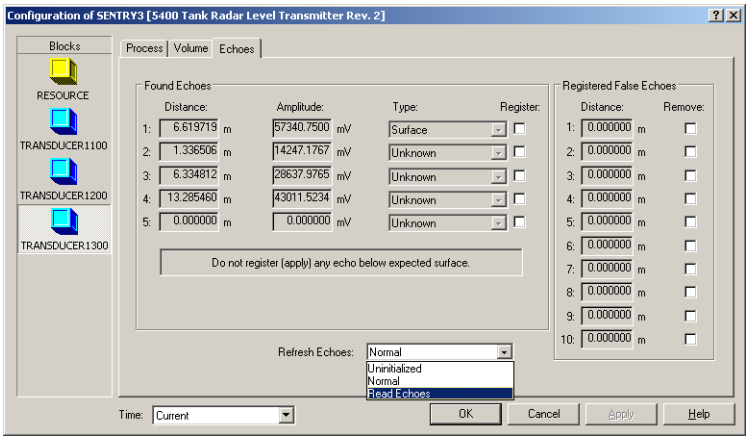


DELTA_V / TR1300_MENU.TIF

2. Choose the **Create ATC** option. See *Amplitude Threshold Curve on page 4-10* for more information.

False Echo Registration

1. In the DeltaV Explorer select the desired transmitter icon, click the right mouse button and choose the Configure option.



DELTA_V / TB1300_ECHOES.TIF

2. Select the **Echoes** tab.
3. Choose echoes (Register check box) which can be identified as disturbing objects in the tank. Leave the other echoes unselected. The Remove check box can be used to remove registered False Echoes. This may be useful if, for example, a disturbing object was removed from the tank.
4. Click the OK button to register the selected echoes. See *Registration of False Echoes on page 4-11* for more information.

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 if you are unfamiliar with the 5400 transmitter (see page 4-21).
- 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 4-26).

System Requirements

Hardware

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

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

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

Hard drive space: 100 MB

Foundation Fieldbus Interface: National Instruments PCMCIA-FBUS(1), National Instruments AT-FBUS or National Instruments PCI-FBUS(1)

Software

Operating Systems supported:

Windows 98 - service pack 3 and above

Windows NT 4 - service pack 6 and above

Windows 2000 - service pack 3 and above

Windows XP

National Instruments Communication Manager version 3.0 or later (the NI-FBUS Configurator is not required).

Help In RRM

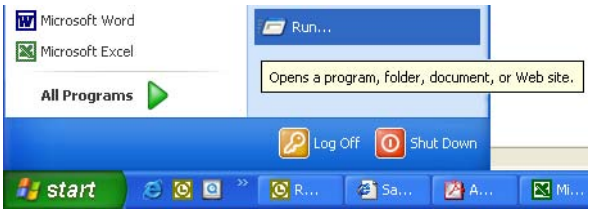
Help is accessed by selecting the Contents option from the Help menu. Help is also available via a Help button in most windows.

(1) The PCMCIA-FBUS FOUNDATION Fieldbus Interface Card from National Instruments with appropriate cables for connection to existing FOUNDATION Fieldbus segment is available from Rosemount Inc. Part number: 03095-5108-0001.

Installing the RRM Software for Foundation Fieldbus

To install the Rosemount Radar Master:

1. Install the National Instruments Communication Manager software. See National Instruments manual (*Getting started with your PCMCIA-FBUS and the NI-FBUS™ software*) for more information.
2. Insert the RRM installation CD into your CD-ROM drive.
3. If the installation program is not automatically started, choose Run from the Windows Start bar.

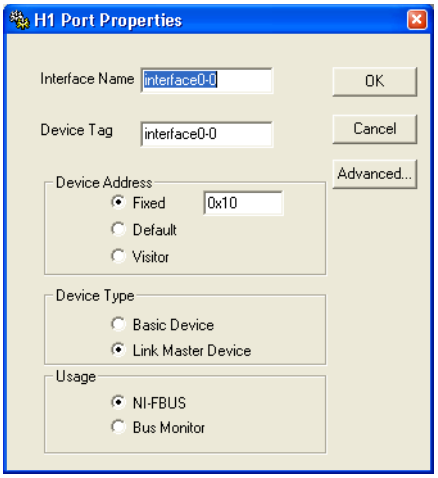


RRM/START_BAR_RUN.TIF

4. Type D:\RRM**Setup.exe** where D is the CD-ROM drive.
5. Follow the instructions on the screen.

Getting Started

1. Before starting RRM make sure that appropriate settings are made with the *National Instruments Interface Configuration Utility*:

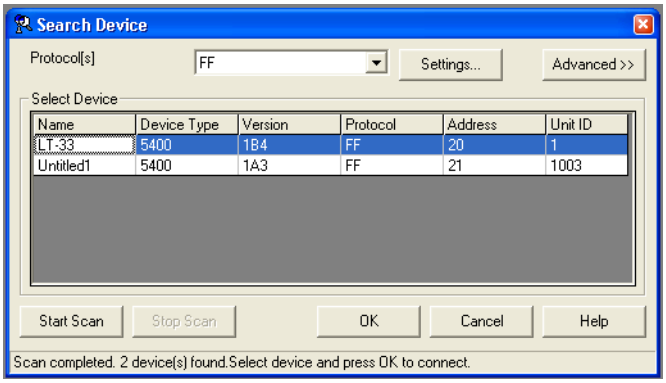


NIINTERFACECONFIGUTILPROPERTIES.TIF

If only Rosemount Radar Master is connected to the bus:
Device address=Fixed.
Device Type=Link Master Device.
Usage=NI-FBUS.

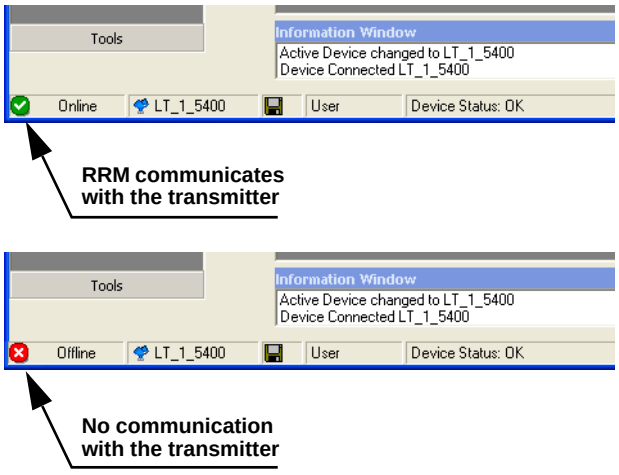
If other host systems are connected to the bus:
Device address=Visitor.
Device Type=Basic Device.
Usage=NI-FBUS.

2. Start Rosemount Radar Master (RRM): from the Start menu click *Programs>Saab Rosemount>Rosemount Radar Master* or click the RRM icon in the MS Windows workspace.
3. If the National Instruments Communication Manager server is not running, click Yes when RRM displays a request for starting the server.
4. In the Search Device window choose communication protocol Foundation Fieldbus.
5. Click OK. Now RRM searches for the transmitter. After a while RRM shows the transmitters found on the bus:



SEARCHDEVICE.TIF

6. Select the desired transmitter and click OK to connect.
   In the RRM Status Bar verify that RRM communicates with the transmitter:



RRM/STATUSBAR.TIF/STATUSBAR_OFFLINE.TIF

Specifying Measurement Units

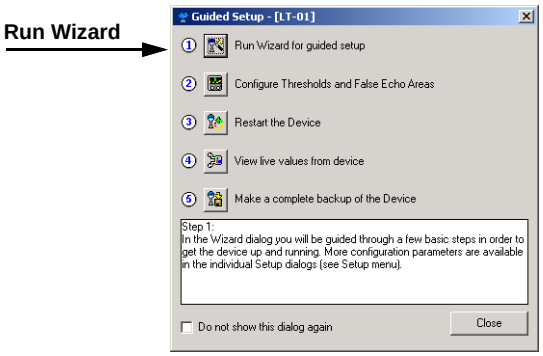
Measurement units for data presentation in RRM can be specified when the RRM program is installed. Units can also be changed as follows:

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 FOUNDATION™ fieldbus parameters for the 375 Field Communicator are also shown. The Guided Setup is specially useful if you are un-familiar with the 5400 transmitter.

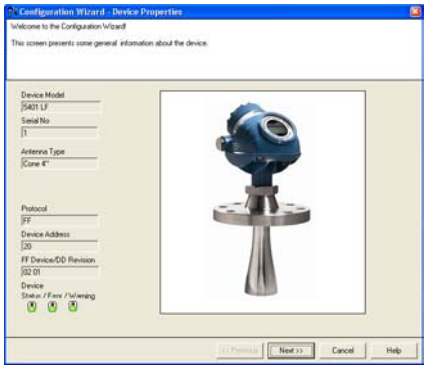
WIZARD_ICON.TIF/RRM/WIZARD_ST1.TIF



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.
   Make sure that the transmitter is in **Out of Service** mode before starting the configuration wizard.
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.

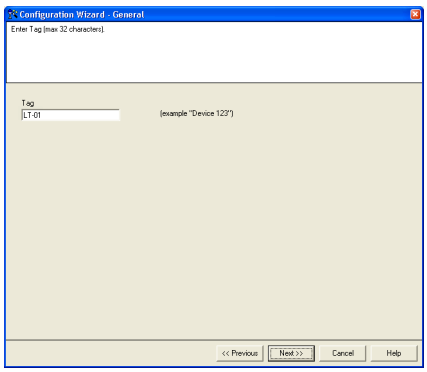
   Note! The *Guided Setup* is an extended installation guide that includes more than just the configuration Wizard. It can be disabled by deselecting the *Open Guided Setup dialog after connect* check box in the *Application Settings* window (menu option View>Application Preferences).

RRM/WIZARD_ST2_FF.TIF



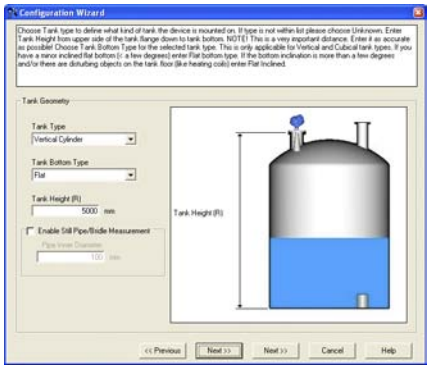
3. The first window in the configuration wizard presents general information such as device type (5400), device model, antenna type, serial number and communication protocol. Check that the information complies with the ordering information.

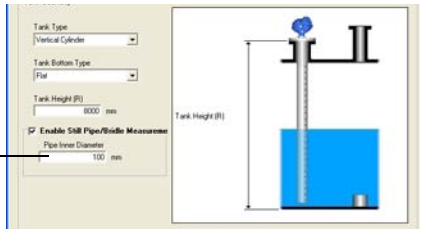
RRM/WIZARD_GENERAL_FF.TIF



4. This window lets you enter a Tag. A maximum of 32 characters can be entered.

WIZARD_TANKGEOMETRY.TIF/WIZARD_TANKGEOMETRY_PIPE.TIF





Enter inner diameter of the pipe

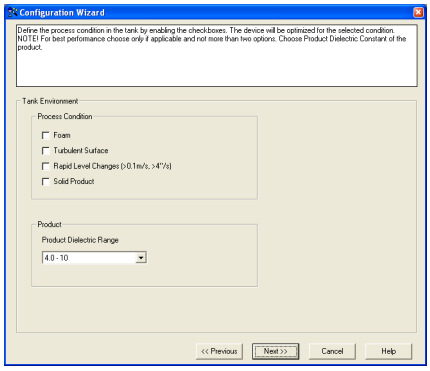
5. Choose the **Tank Type** which corresponds to the actual tank. If none of the available options matches the actual tank choose Unknown.
FOUNDATION™ fieldbus parameter: TRANSDUCER 1100>GEOM_TANK_TYPE.

   Tank Bottom Type is important for the measurement performance close to the tank bottom.
FOUNDATION™ fieldbus parameter: TRANSDUCER 1100> GEOM_TANK_BOTTOM_TYPE.

   Tank Height is the distance from the Upper Reference Point to the tank bottom (see Tank Geometry on page 4-6). Make sure that this number is as accurate as possible.
FOUNDATION™ fieldbus parameter: TRANSDUCER 1100> GEOM_TANK_HEIGHT.

   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.
FOUNDATION™ fieldbus parameter: TRANSDUCER 1100> SIGNAL_PROC_CONFIG (Enable), ANTENNA_PIPE_DIAM.
See Tank Geometry on page 4-6 for more information.

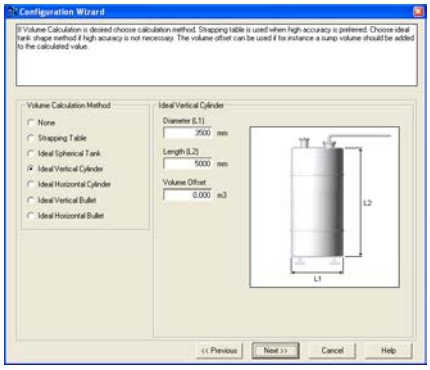
WIZARD_ENVIRONMENT.TIF



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 4-8 for more information.
FOUNDATION™ fieldbus parameter: TRANSDUCER 1100>ENV_ENVIRONMENT.

   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.
FOUNDATION™ fieldbus parameter: TRANSDUCER 1100> ENV_DIELECTR_CONST.

WIZARD_VOLUME.TIF

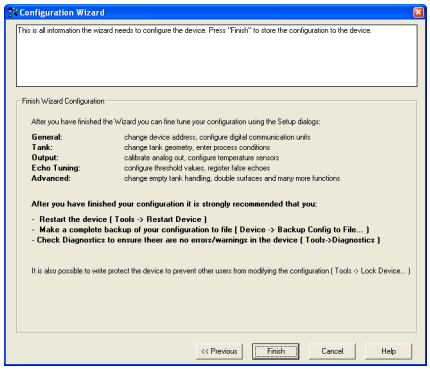


7. If volume calculation is desired choose a pre-defined calculation method that is based on a tank shape that corresponds to the actual tank. Choose None if volume calculation is not desired.
   The Strapping Table option is used if the actual tank does not match any of the available options for pre-defined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

   FOUNDATION™ fieldbus parameters:
   TRANSDUCER 1300>
   VOL_VOLUME_CALC_METHOD/
   VOL_IDEAL_DIAMETER/
   VOL_IDEAL_LENGTH/
   VOL_VOLUME_OFFSET.

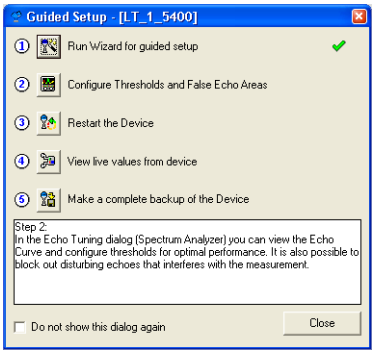
   See Volume on page 4-9 for more information.

WIZARD_FINISH.TIF



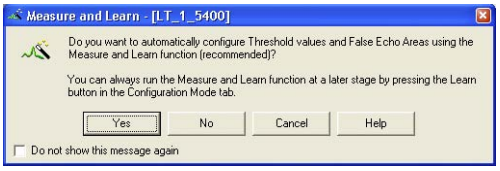
8. This is the last window in the Configuration Wizard concluding the basic configuration. The current configuration can be changed at any time by using the Setup windows (General, Tank, Output etc.). The Setup windows contain further options not available in the configuration wizard.
   Click the Finish button and continue with the next step in the Guided Setup.

GUIDED_STEP2.TIF



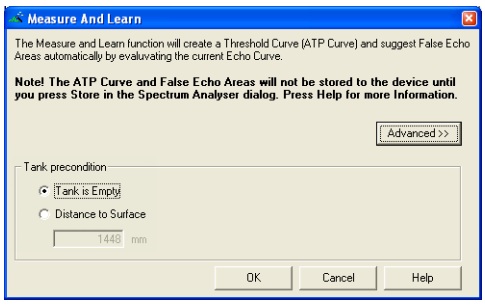
9. Step 2 in the Guided Setup allows you to automatically configure an Amplitude Threshold Curve and to register false echoes by running the *Measure and Learn* function. See *Echo Tuning on page 4-10* for more information on amplitude thresholds and false echoes.
   Click button 2 to start the *Measure 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



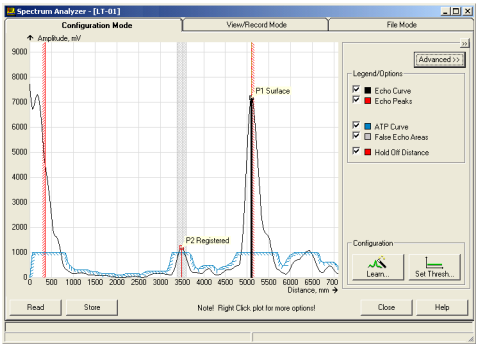
10. Click the Yes button if you want to run the *Measure and Learn* function. If you click No you can run this function at a later stage by using the Spectrum Analyzer in RRM.
Make sure that there is no filling or emptying going on when the *Measure and Learn* function is used.

GUIDED_MEASLEARN_2.TIF



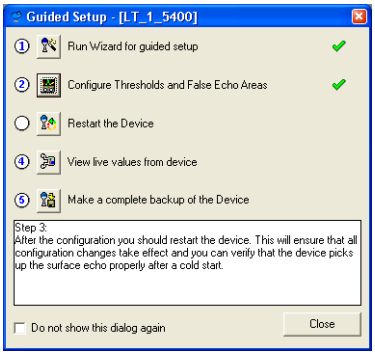
11. The Measure and Learn function automatically creates an Amplitude Threshold Curve (ATC) and suggests False Echo Areas, see also Echo Tuning on page 4-10.
(By clicking the Advanced button you can choose one of the options or both by selecting the corresponding check box).
Verify the Tank Precondition 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



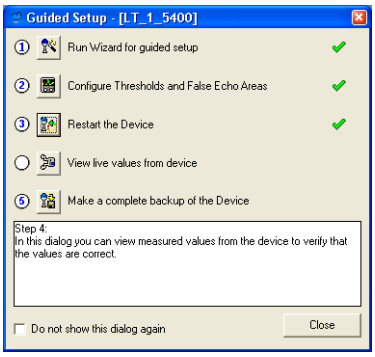
12. The automatically created Amplitude Threshold Curve (ATC) and False Echo Areas are shown in the Spectrum Plot. False Echo Areas are presented as shaded areas, and represent tank levels where RRM has found interfering echoes to be blocked out. False Echo Areas can be moved or removed before storing 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 4-10 for more information.
Click the Store button to save the ATC and the registered disturbance echoes.

GUIDED_STEP3.TIF



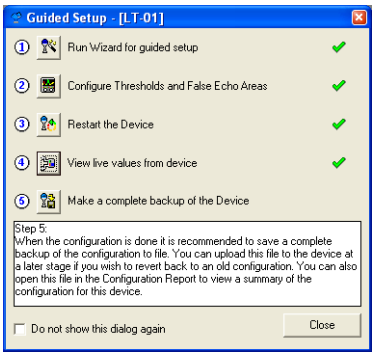
13. Restart the transmitter to make sure that all configuration changes are properly activated. It may take up to 60 seconds after the restart button is pressed until measurement values are updated.

GUIDED_STEP4.TIF



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

GUIDED_STEP5.TIF

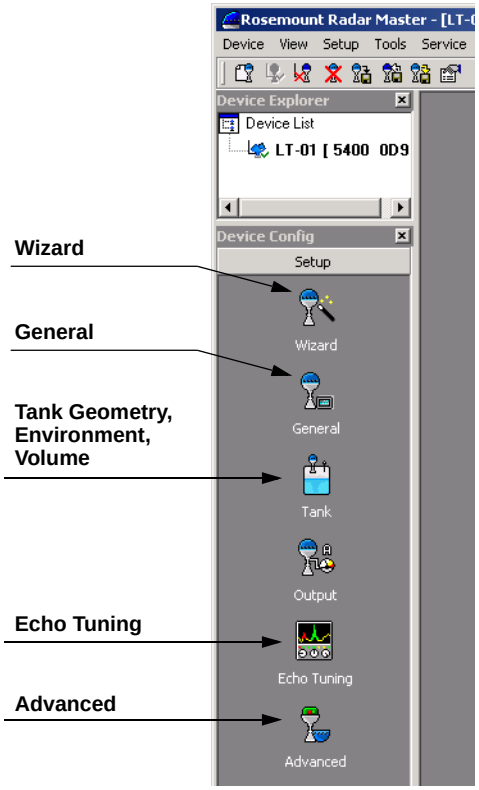


15. When configuration is finished it is recommended that the configuration is saved to a backup file.
    This information is useful:
    - for installing a similar device since the file can be directly uploaded to a new device,
    - to restore the configuration if for any reason configuration data 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.
   - **Echo Tuning**: disturbance echo handling.
   - **Advanced**: advanced configuration.

CONFIGURE THE AI BLOCK

⚠ A minimum of four parameters are required to configure the AI Block. The parameters are described below with example configurations shown at the end of this section.

CHANNEL

Select the channel that corresponds to the desired sensor measurement. The Rosemount 5400 measures Level (channel 1), Distance (channel 2), Level Rate (channel 3), Signal Strength (channel 4), Volume (channel 5), and Internal Temperature (channel 6).

AI Block	TB Channel Value	Process Variable
Level	1	CHANNEL_RADAR_LEVEL
Ullage	2	CHANNEL_RADAR_ULLAGE
Level Rate	3	CHANNEL_RADAR_LEVELRATE
Signal Strength	4	CHANNEL_RADAR_SIGNAL_STRENGTH
Volume	5	CHANNEL_RADAR_VOLUME
Internal Temperature	6	CHANNEL_RADAR_INTERNAL_TEMPERATURE

L_TYPE

The L_TYPE parameter defines the relationship of the transmitter measurement (Level, Distance, Level Rate, Signal Strength, Volume, and Average Temperature) to the desired output of the AI Block. The relationship can be direct or indirect root.

Direct
Select direct when the desired output will be the same as the transmitter measurement (Level, Distance, Level Rate, Signal Strength, Volume, and Average Temperature).

Indirect
Select indirect when the desired output is a calculated measurement based on the transmitter measurement (Level, Distance, Level Rate, Signal Strength, Volume, and Average Temperature). The relationship between the transmitter measurement and the calculated measurement will be linear.

Indirect Square Root
Select indirect square root when the desired output is an inferred measurement based on the transmitter measurement and the relationship between the sensor measurement and the inferred measurement is square root (e.g. level).

XD_SCALE and OUT_SCALE

The XD_SCALE and OUT_SCALE each include three parameters: 0%, 100%, and, engineering units. Set these based on the L_TYPE:

L_TYPE is Direct
When the desired output is the measured variable, set the XD_SCALE to represent the operating range of the process. Set OUT_SCALE to match XD_SCALE.

L_TYPE is Indirect
When an inferred measurement is made based on the sensor measurement, set the XD_SCALE to represent the operating range that the sensor will see in the process. Determine the inferred measurement values that correspond to the XD_SCALE 0 and 100% points and set these for the OUT_SCALE.

L_TYPE is Indirect Square Root
When an inferred measurement is made based on the transmitter measurement and the relationship between the inferred measurement and sensor measurement is square root, set the XD_SCALE to represent the operating range that the sensor will see in the process. Determine the inferred measurement values that correspond to the XD_SCALE 0 and 100% points and set these for the OUT_SCALE.

Engineering Units

NOTE
To avoid configuration errors, only select Engineering Units for XD_SCALE and OUT_SCALE that are supported by the device.

The supported units are:

Table 4-2. Length

Display	Description
m	meter
cm	centimeter
mm	millimeter
ft	feet
in	inch

Table 4-3. Level Rate

Display	Description
m/s	meter per second
m/h	meter per hour
ft/s	feet per second
in/m	inch per minute

Table 4-4. Temperature

Display	Description
°C	Degree Celsius
°F	Degree Fahrenheit

Table 4-5. Signal Strength

Display	Description
mV	millivolt

Table 4-6. Volume

Display	Description
m^3	Cubic meter
L	Liter
in^3	Cubic inch
ft^3	Cubic feet
Yd^3	Cubic yard
Gallon	US gallon
ImpGall	Imperial gallon
Bbl	Barrel

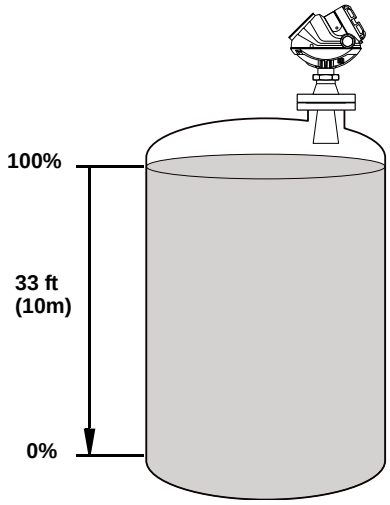
APPLICATION EXAMPLES

Radar Level Transmitter, Level Value

Situation

A level gauge is measuring the level in a 33ft (10m) high tank.

Figure 4-10. Situation Diagram



FF_CONFIGURATIONEXAMPLES_5400.EPS

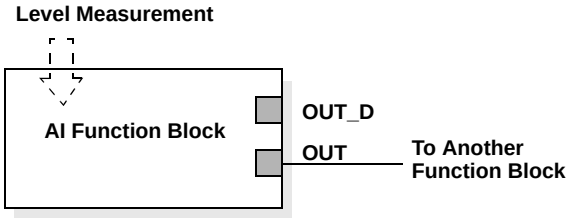
Solution

Table 4-7 lists the appropriate configuration settings, and Figure 4-11 illustrates the correct function block configuration.

Table 4-7. Analog Input Function Block Configuration for a Typical Level Gauge

Parameter	Configured Values
L_TYPE	Direct
XD_SCALE	Not Used
OUT_SCALE	Not Used
CHANNEL	CH1: Level

Figure 4-11. Analog Input Function Block Diagram for a typical Level Transmitter

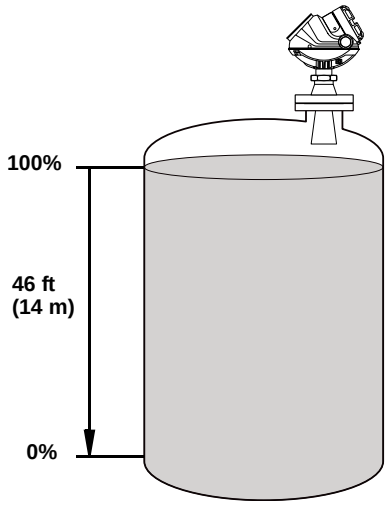


Radar Level Gauge, Level value in percent (%)

Situation

The level of a tank is to be measured using the Radar Level gauge mounted on a nozzle on the top of the tank. The maximum level in the tank is 46ft (14m). The level value shall be displayed in percentage of the full span (see Figure 4-12).

Figure 4-12. Situation Diagram



FF_CONFIGURATIONEXAMPLES_5400.EPS

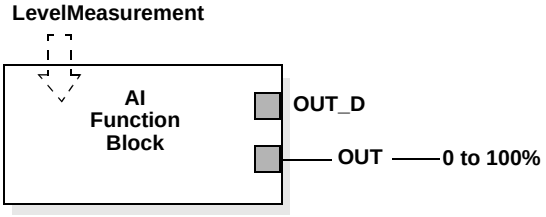
Solution

Table 4-8 lists the appropriate configuration settings, and Figure 4-13 illustrates the correct function block configuration.

Table 4-8. Analog Input Function Block Configuration for a Level Gauge where level output is scaled between 0-100%

Parameter	Configured Values
L_TYPE	Indirect
XD_SCALE	0 to 14 m
OUT_SCALE	0 to 100%
CHANNEL	CH1: Level

Figure 4-13. Function Block Diagram for a Level Gauge where level output is scaled between 0-100%



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 powering a FOUNDATION fieldbus segment 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

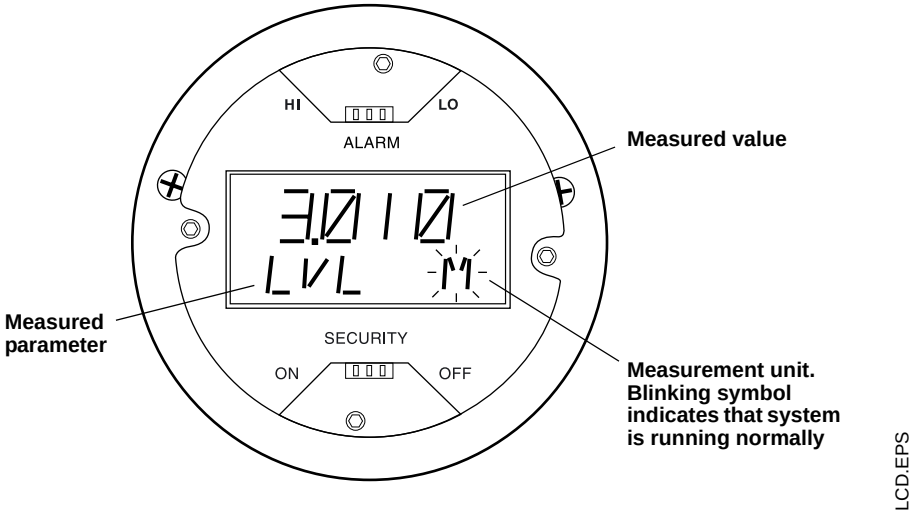
Using the Display Panel

The 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 second 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 375 Field Communicator, DeltaV or 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).

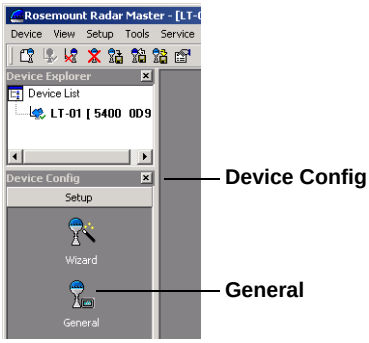
Using a Field Communicator

For the 375 Field Communicator the LCD settings are available with FOUNDATION™ fieldbus parameters:
TRANSDUCER 1100>LCD_PARAMETERS.

Using Rosemount Radar Master (RRM)

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

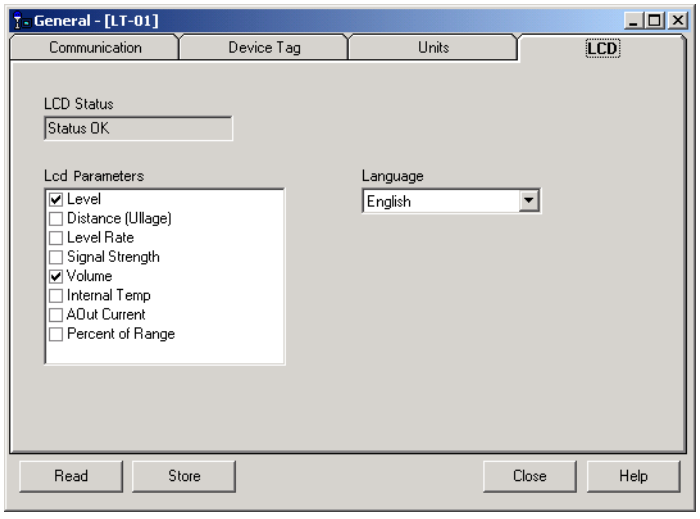
1. Choose the **General** option from the **Setup** menu, or click the General icon in the Device Configuration window



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.

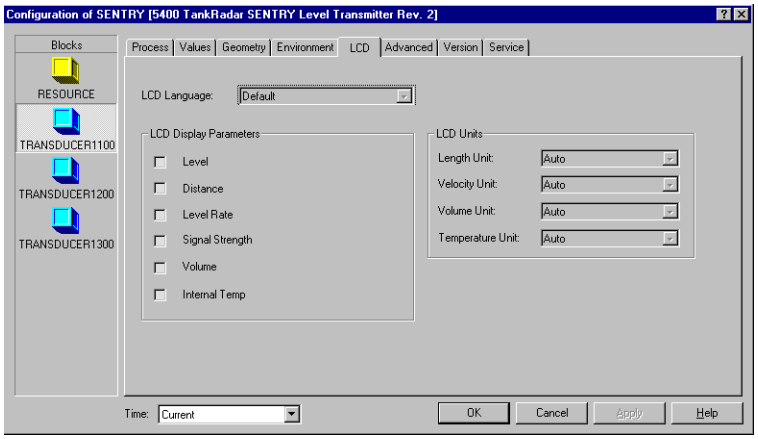
   Note! AOut Current and Percent of Range are not available for Foundation Fieldbus.

4. Click the **Store** button to save the LCD settings in the transmitter database.

Using DeltaV

1. Click the right mouse button on the transmitter icon and choose the **Properties** option.
2. Select Transducer 1100 block.
3. Select the **LCD** tab.

Figure 5-3. The Transducer 1100 block lets you specify variables for the 5400 Display Panel.



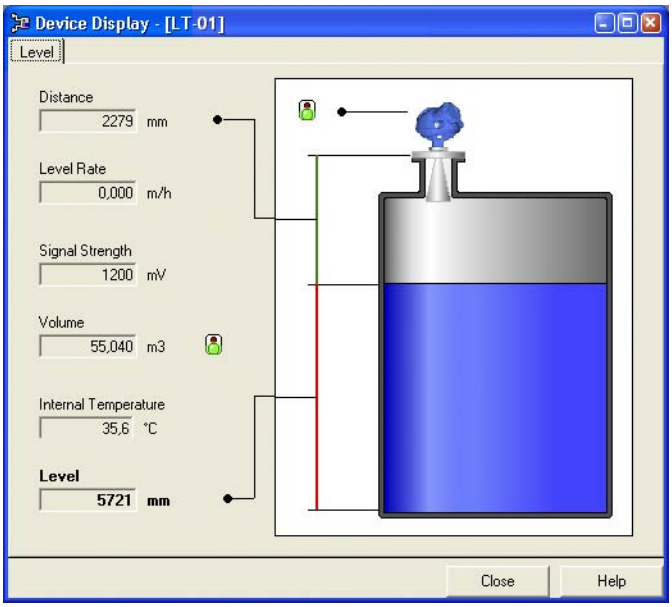
DELTA_V/TB1100LCD.TIF

4. Choose the variables you want to appear on the Display Panel and the corresponding measurement units. You can use the same measurement unit as selected in the *Values* tab by setting the LCD Unit to **Auto**. The LCD will alternate between the selected display parameters.
5. Click the OK button to save the LCD settings in the transmitter database.

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

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 saftey 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 powering a FOUNDATION fieldbus segment 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

Radar Master

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.

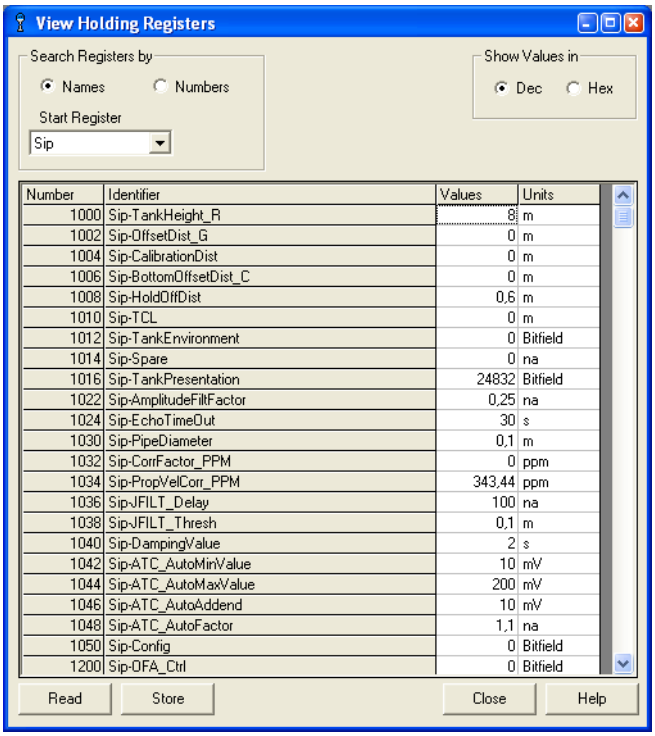
The **Holding Registers** store various transmitter parameters such as configuration data used to control the measurement performance.

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.



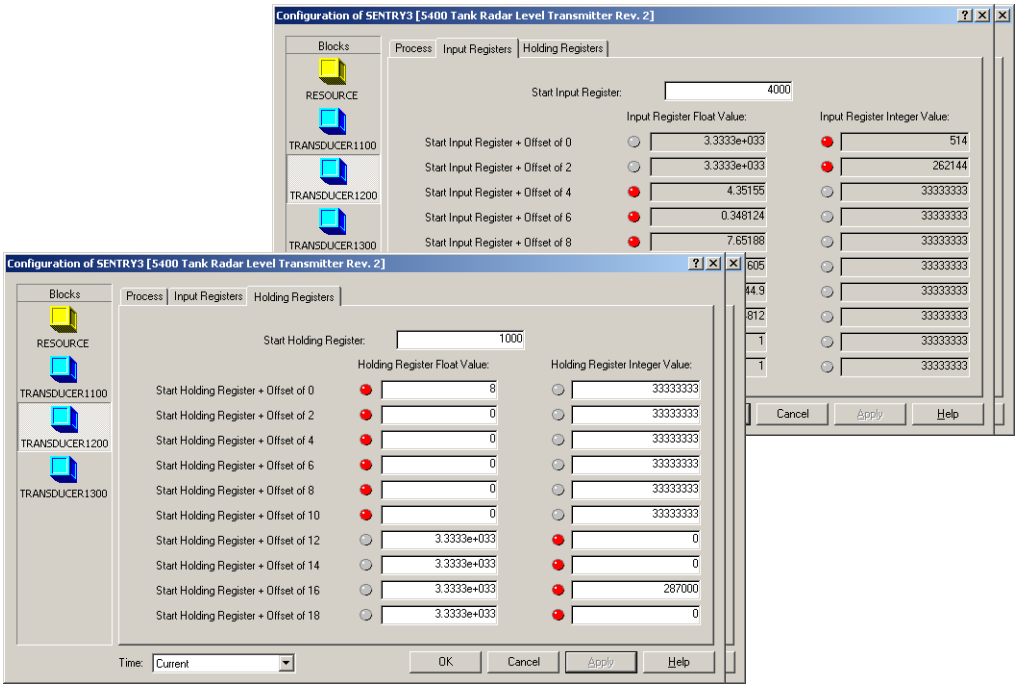
VIEWHOLDREG.TIF

DeltaV

Measurement data is stored in Input Registers and configuration data is stored in Holding Registers. Both type of registers can be viewed in DeltaV:

1. Click the right mouse button on the transmitter icon and choose the **Properties** option.
2. Select the Transducer 1200 block.
3. Select the Input Registers/Holding Registers tab. Red buttons indicate valid data as Float Value or Integer Value depending on the parameter type.
   The contents of a Holding Register can be changed by typing a new value in the corresponding field if the transmitter mode is set to Out of Service. Changing Holding Register data will affect the performance of the transmitter and should only be done by qualified service personnel.

Figure 6-2. Holding and Input Registers in DeltaV.



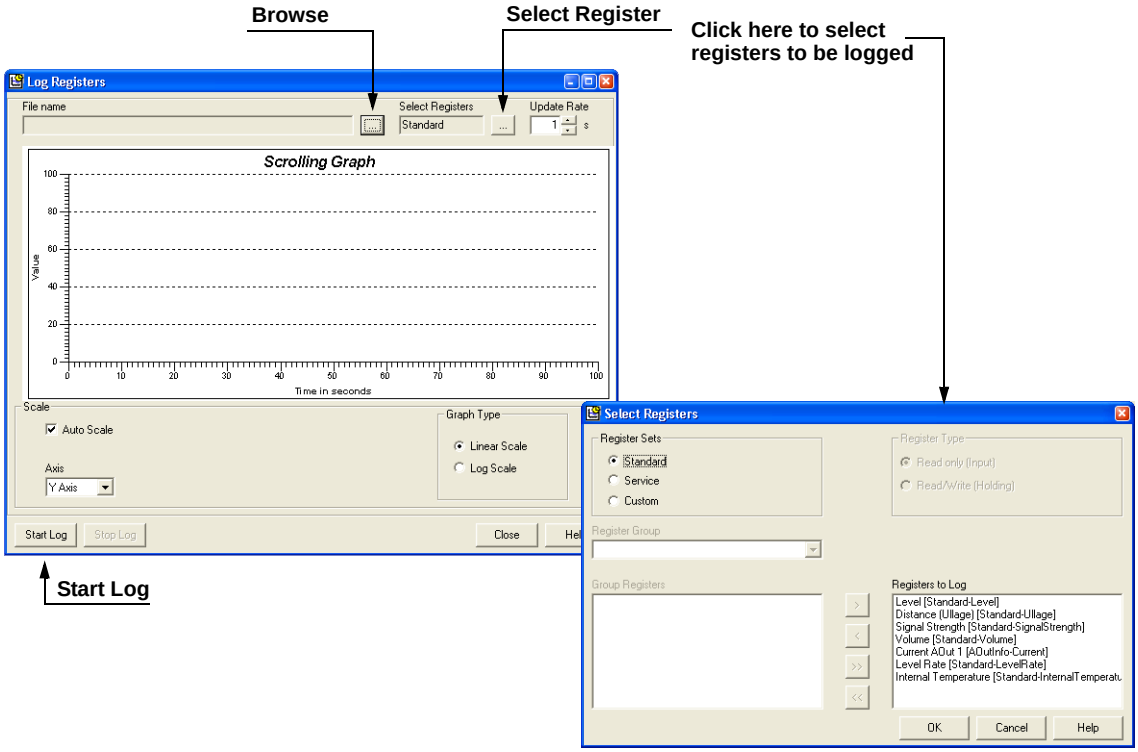
TRANSD1200_HOLDINGREG.TIF/TRANSD1200_INPUTREG.TIF

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 6-3. 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.

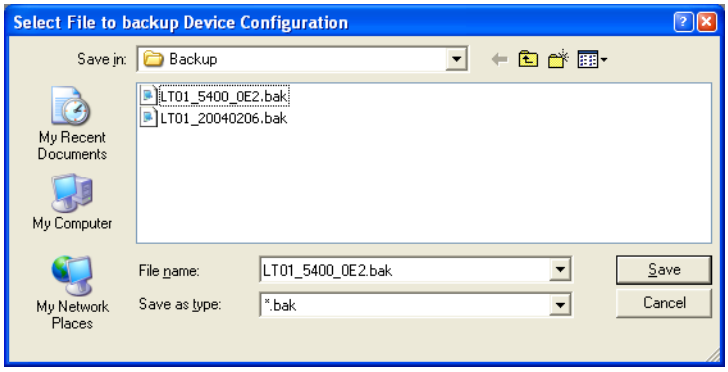
Backing Up the Transmitter Configuration

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.

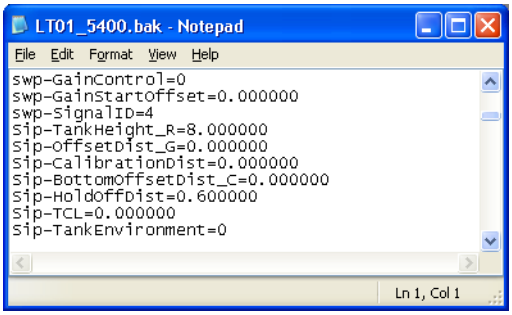
Figure 6-4. It is recommended that the transmitter configuration is stored in a backup file.



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 accidently 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 6-5. The configuration backup file can be viewed in a word processor.



RRM/BACKUP_VIEW.TIF

Diagnostics

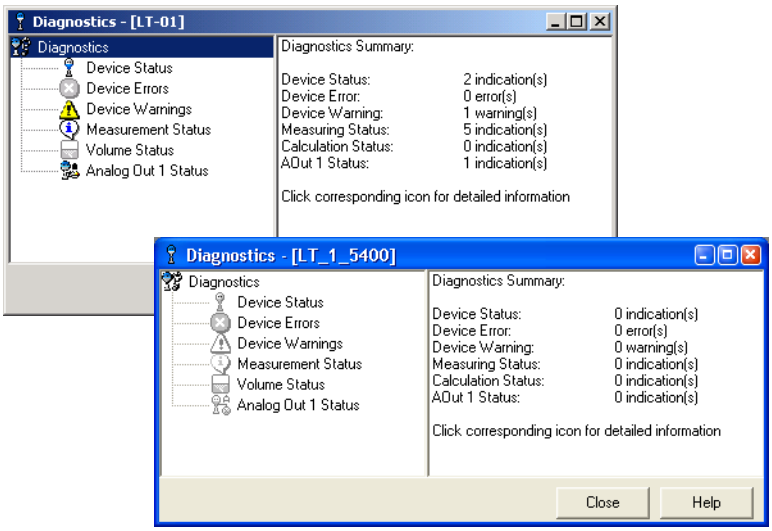
Rosemount Radar Master

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

- device status, see “Device Status” on page 6-18.
- device errors, see “Errors” on page 6-19.
- device warnings, see “Warnings” on page 6-20.
- measurement status, see “Measurement Status” on page 6-21.
- volume status, see “Volume Calculation Status” on page 6-22.

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

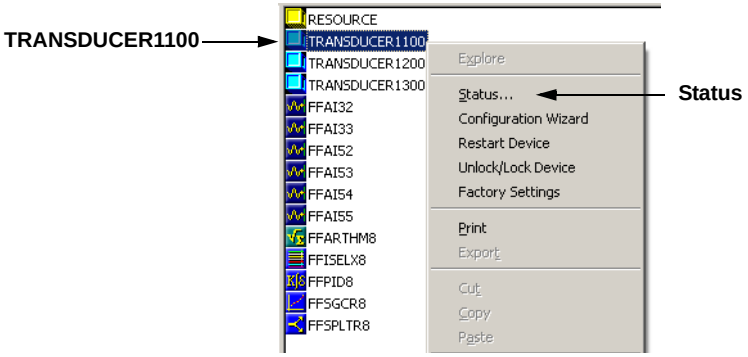
Figure 6-6. The Diagnostics window in Rosemount Radar Master.



RRM/DIAGNOSTICS.TIF, DIAGNOSTICS_WARNING.TIF

DeltaV

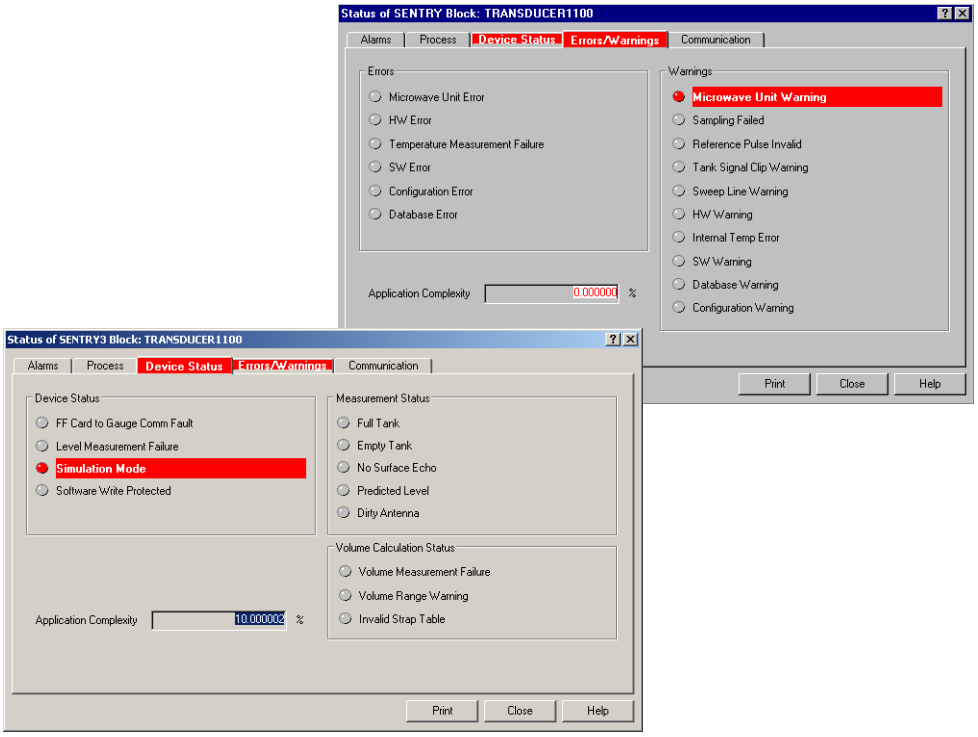
1. In the DeltaV Explorer select the desired transmitter icon and click the right mouse button on the **Transducer 1100** block icon.



DELTA_V / TR1100_MENU.TIF

2. Choose the **Status** option.
3. Select the Device Status tab for information on measurement status. Select the Errors/Warnings tab for information on errors and warnings.

Figure 6-7. Status windows in DeltaV.

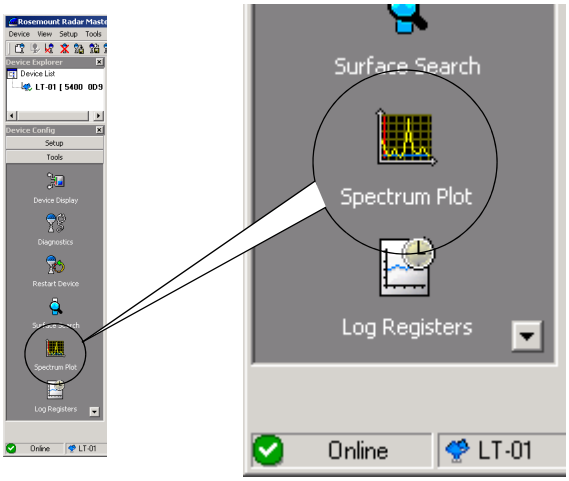


TR1100_DEVICESTATUS.TIF/STATUSERROR.TIF

Using the Spectrum Plot in RRM

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 4-10 for more information on false echo handling).

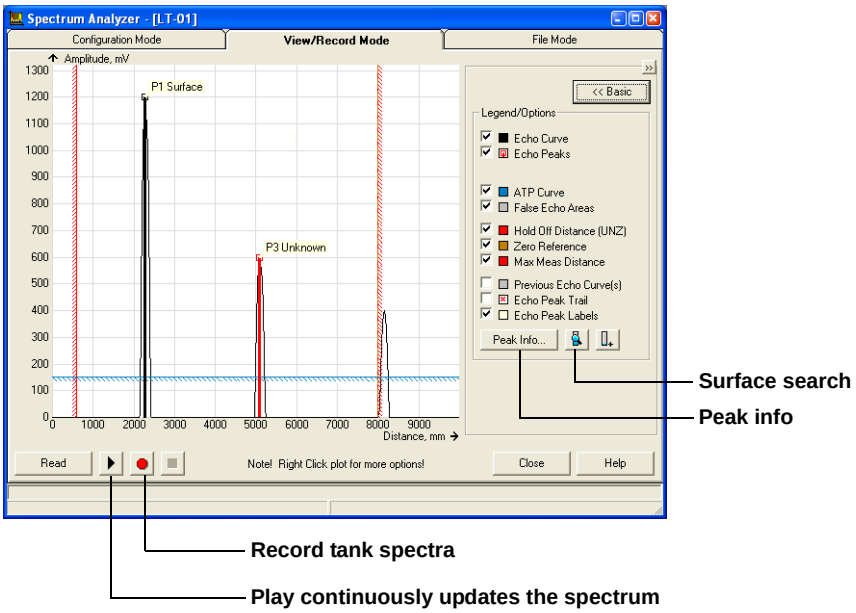
Figure 6-8. The Spectrum Plot function is a useful tool for signal analysis.



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 6-9. 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 like to study the tank signal when filling or emptying the tank.

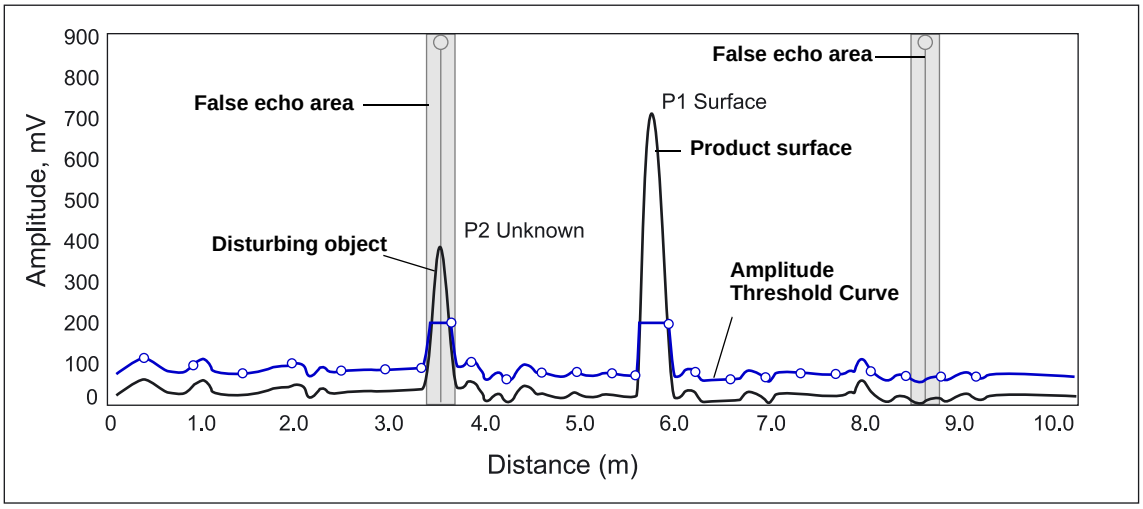
Play

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 4-10. Figure 6-10 illustrates the type information that can be shown in the Spectrum Analyzer window in this mode.

Figure 6-10. The Spectrum Plot presents all visible echoes in the tank.



SPECTRUM.EPS

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

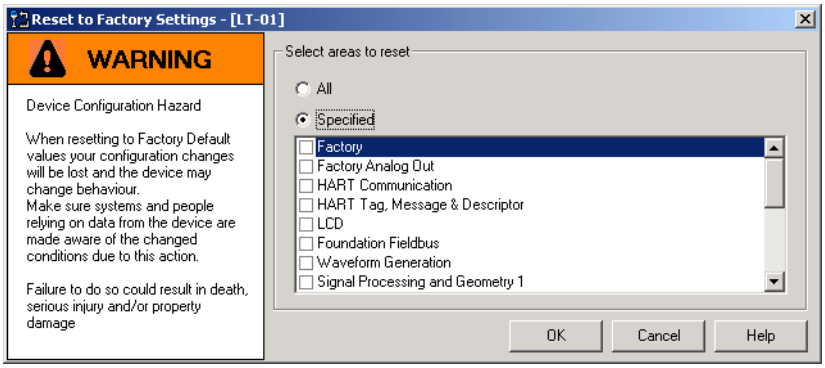
In the File Mode you can open saved snapshots/movies from file and present in the spectrum plot. If it is a movie you can play the movie and the spectrum plot is updated at the desired update rate.

Reset to Factory Settings

Rosemount Radar Master

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.

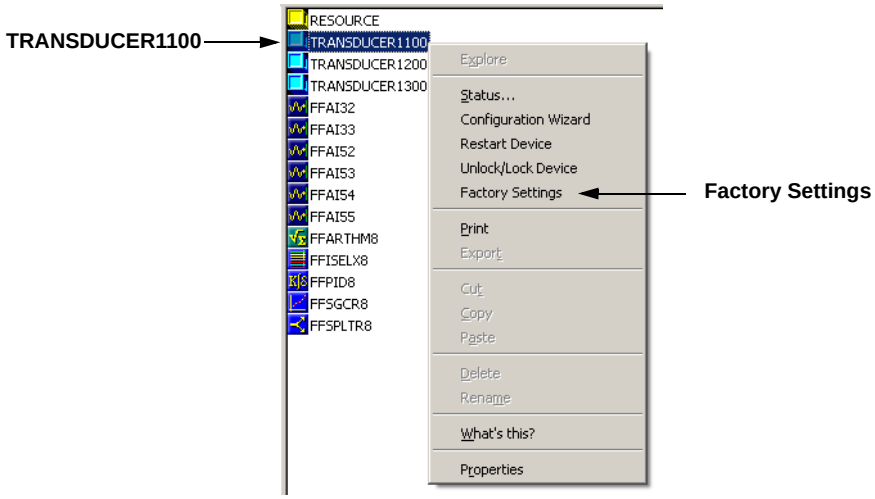
Figure 6-11. The Reset to Factory Settings window in RRM.



RESETFACTORYSETTINGS.TIF

DeltaV

1. In the DeltaV Explorer select the desired transmitter icon, click the right mouse button on the **Transducer 1100** block icon.



DELTA_V / TR1100_MENU.TIF

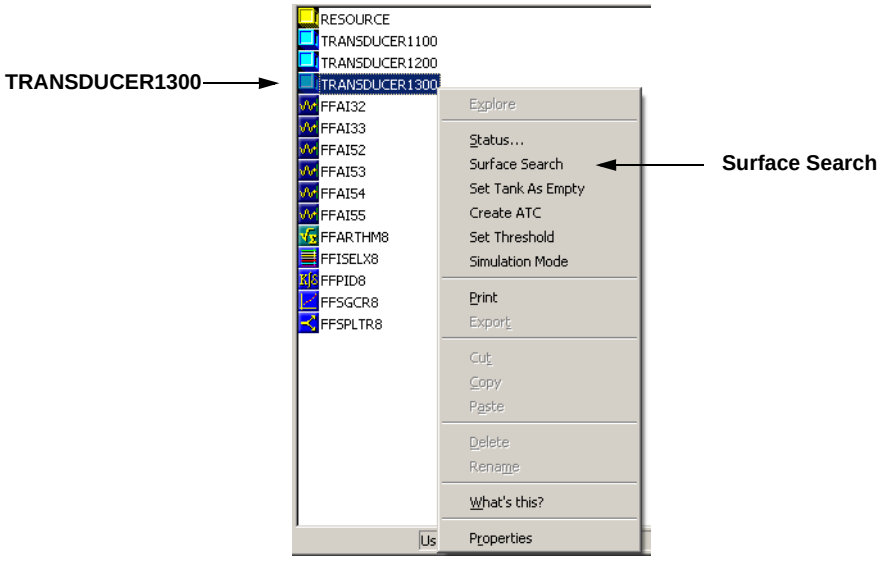
2. Choose the **Factory Settings** option.

Surface Search

The *Surface Search* command triggers a search for the product surface. Use this function if, for example, the measured level is stuck on a disturbing object in the tank (see “Using the Spectrum Plot in RRM” on page 6-8).

DeltaV

1. In the DeltaV Explorer select the desired transmitter icon, click the right mouse button on the **Transducer 1300** block icon.



DELTA_V / TR1300_MENU.TIF

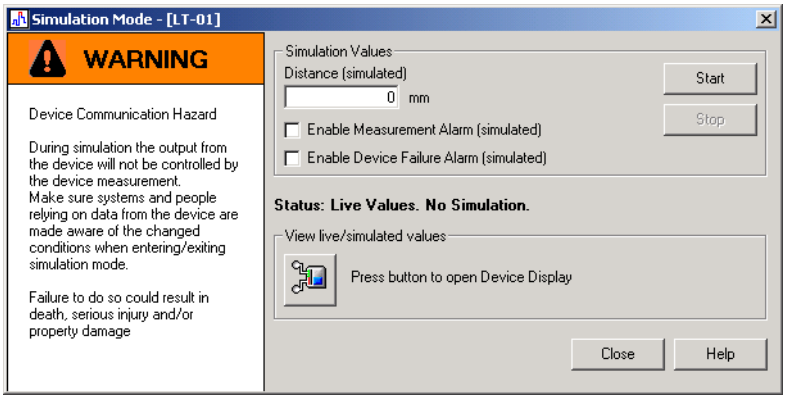
2. Choose the **Surface Search** option.

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:

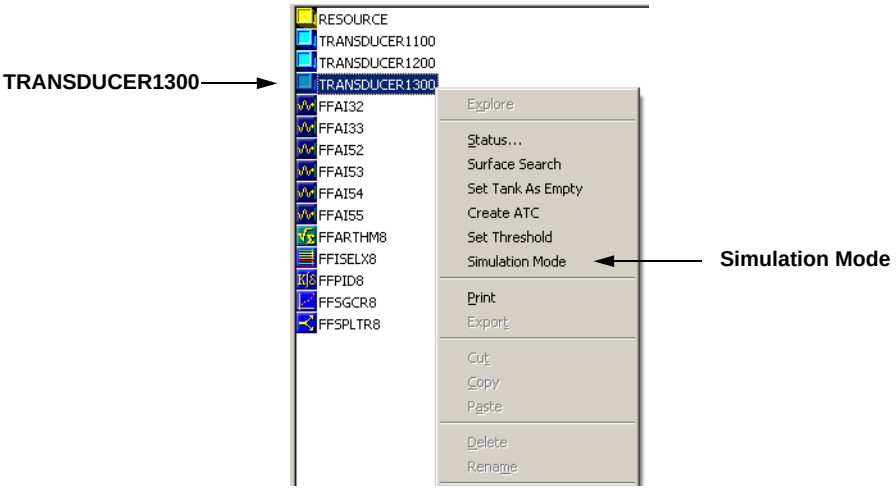
Figure 6-12. The Simulation Mode window in RRM.



SIMULATIONMODE.TIF

DeltaV

1. In the DeltaV Explorer select the desired transmitter icon, click the right mouse button on the **Transducer 1300** block icon.



DELTA_V / TR1300_MENU.TIF

2. Choose the **Simulation Mode** option.

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. In Rosemount Radar Master this function is available in the Tools menu:

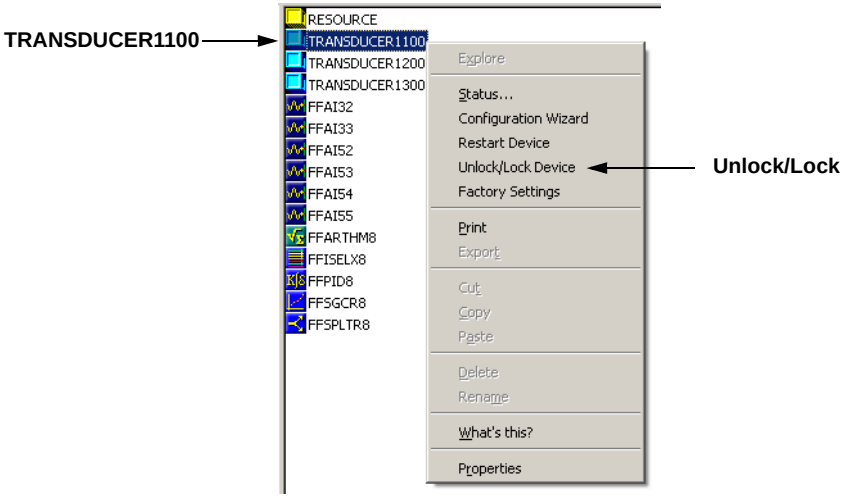
Tools>Lock/Unlock Configuration Area.

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.

DeltaV

Write protection is available in DeltaV as well:

1. In the DeltaV Explorer select the desired transmitter icon, click the right mouse button on the **Transducer 1100** block icon.



DELTA_V / TR1100_MENU.TIF

2. Choose the **Unlock/Lock Device** option.

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® seal 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.
Incorrect level reading.	• Configuration error. • Disturbing objects in the tank. • See “Application Errors” on page 6-23.	• Check the Tank Height parameter; RRM>Setup>Tank. • Check status information and diagnostics information, see “Diagnostics” on page 6-6. • Check that the transmitter has not locked on an interfering object, see “Using the Spectrum Plot in RRM” on page 6-8.
Integral display does not work.		• Check the display configuration; RRM>Setup>General. • Diagnostics. • Contact Rosemount Service Department(1)
FOUNDATION fieldbus Card to Transmitter Communication Fault		• Verify Device Mode setting, should be FOUNDATION fieldbus (Parameter: ENV_DEVICE_MODE) • Restart method from Resource Block • Reboot gauge (Cycle Power)
Level Measurement Failure		• Check Power Supply • Check the gauge configuration (Transducer Block) • Check that the mechanical installation is correct
Temperature Measurement Failure		• Check temperature electrical installation • Check configuration (Transducer Block) • Restart the transmitter
Volume Measurement Failure		• Restart gauge • Check gauge configuration using PC Based configuration tool
No surface echo		• Check signal strength • Restart transmitter
Tank Signal Clip Warning		Restart transmitter
Empty Tank/ Full Tank		Information of tank status

Symptom	Possible cause	Action
Configuration Reg Password Enabled		Information, Ready Write Data
DB Error/ Microwave Unit Error/ Configuration Error/ Other Error		• Restart transmitter • Download Application Software • Set database to default; load default Database • Call Service Center
SW Error/ Display Error/ Analog Out Error		• Restart transmitter • Call Service Center

(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.

Resource Block

This section describes error conditions found in the Resource block. Read Table 6-2 through Table 6-4 to determine the appropriate corrective action.

Block Errors

Table 6-2 lists conditions reported in the BLOCK_ERR parameter.

Table 6-2. Resource Block BLOCK_ERR messages

Condition Name and Description
Other
Simulate Active: This indicates that the simulation switch is in place. This is not an indication that the I/O blocks are using simulated data
Device Fault State Set
Device Needs Maintenance Soon
Memory Failure: A memory failure has occurred in FLASH, RAM, or EEPROM memory
Lost Static Data: Static data that is stored in non-volatile memory has been lost
Lost NV Data: Non-volatile data that is stored in non-volatile memory has been lost
Device Needs Maintenance Now
Out of Service: The actual mode is out of service

Table 6-3. Resource Block SUMMARY_STATUS messages

Condition Name
Uninitialized
No repair needed
Repairable
Call Service Center

Table 6-4. Resource Block DETAILED_STATUS with recommended action messages

Condition Name	Recommended Action
LOI Transducer block error	1. Restart processor 2. Check display connection 3. Call service center
Sensor Transducer block error	1. Restart processor 2. Check Rosemount 5400 cable 3. Call service center
Mfg. Block integrity error	1. Restart processor 2. Call service center
Non-Volatile memory integrity error	1. Restart processor 2.Call service center
ROM integrity error	1. Restart processor 2. Call service center

Transducer Block

This section describes error conditions found in the Sensor Transducer Block.

Table 6-5. Transducer Block BLOCK_ERR messages

Condition Name and Description
Other
Out of Service: The actual mode is out of service

Table 6-6. Transducer Block XD_ERR messages

Condition Name and Description
Electronics Failure: An electrical component failed
I/O Failure: An I/O failure occurred
Data Integrity Error: Data stored in the device is no longer valid due to a non-volatile memory checksum failure, a data verify after write failure, etc.
Algorithm Error: The algorithm used in the transducer block produced an error due to overflow, data reasonableness failure, etc.

Analog Input (AI) Function Block

This section describes error conditions that are supported by the AI Block. Read Table 6-8 to determine the appropriate corrective action.

Table 6-7. AI BLOCK_ERR Conditions

.

Condition Number	Condition Name and Description
0	Other
1	**Block Configuration Error:** the selected channel carries a measurement that is incompatible with the engineering units selected in XD_SCALE, the L_TYPE parameter is not configured, or CHANNEL = zero
3	**Simulate Active:** Simulation is enabled and the block is using a simulated value in its execution
7	**Input Failure/Process Variable has Bad Status:** The hardware is bad, or a bad status is being simulated
14	**Power Up**
15	**Out of Service:** The actual mode is out of service

Table 6-8. Troubleshooting the AI block

Symptom	Possible Causes	Recommended Actions
Bad or no level readings (Read the AI “BLOCK_ERR” parameter)	BLOCK_ERR reads OUT OF SERVICE (OOS)	1. AI Block target mode target mode set to OOS. 2. Resource Block OUT OF SERVICE.
	BLOCK_ERR reads CONFIGURATION ERROR	1. Check CHANNEL parameter (see “CHANNEL” on page 4-27). 2. Check L_TYPE parameter (see “L_TYPE” on page 4-27) 3. Check XD_SCALE engineering units. (see “XD_SCALE and OUT_SCALE” on page 4-28
	BLOCK_ERR reads POWERUP	Download Schedule into block. Refer to host for downloading procedure.
	BLOCK_ERR reads BAD INPUT	1. Sensor Transducer Block Out Of Service (OOS) 2. Resource Block Out of Service (OOS)
	No BLOCK_ERR but readings are not correct. If using Indirect mode, scaling could be wrong	1. Check XD_SCALE parameter. 2. Check OUT_SCALE parameter. (see “XD_SCALE and OUT_SCALE” on page 4-28)
OUT parameter status reads UNCERTAIN and substatus reads EngUnitRangViolation	Out_ScaleEU_0 and EU_100 settings are incorrect.	See “XD_SCALE and OUT_SCALE” on page 4-28.
Mode will not leave OOS	Target mode not set	Set target mode to something other than OOS.
	Configuration error	BLOCK_ERR will show the configuration error bit set. The following are parameters that must be set before the block is allowed out of OOS: CHANNEL must be set to a valid value and cannot be left at initial value of 0. XD_SCALE.UNITS_INDX must match the units in the transducer block channel value. L_TYPE must be set to Direct, Indirect, or Indirect Square Root and cannot be left at initial value of 0.
	Resource block	The actual mode of the Resource block is OOS. See Resource Block Diagnostics for corrective action.
	Schedule	Block is not scheduled and therefore cannot execute to go to Target Mode. Schedule the block to execute.
Process and/or block alarms will not work	Features	FEATURES_SEL does not have Alerts enabled. Enable the Alerts bit.
	Notification	LIM_NOTIFY is not high enough. Set equal to MAX_NOTIFY.
	Status Options	STATUS_OPTS has Propagate Fault Forward bit set. This should be cleared to cause an alarm to occur.
Value of output does not make sense	Linearization Type	L_TYPE must be set to Direct, Indirect, or Indirect Square Root and cannot be left at initial value of 0.
	Scaling	Scaling parameters are set incorrectly: XD_SCALE.EU0 and EU100 should match that of the transducer block channel value. OUT_SCALE.EU0 and EU100 are not set properly.
Cannot set HI_LIMIT, HI_HI_LIMIT, LO_LIMIT, or LO_LO_LIMIT Values	Scaling	Limit values are outside the OUT_SCALE.EU0 and OUT_SCALE.EU100 values. Change OUT_SCALE or set values within range.

Device Status

Device Status messages that may appear in the Rosemount Radar Master (RRM) program are shown in Table 6-9:

Table 6-9. Device status.

Message	Description	Action
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 6-13).
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 in the Rosemount Radar Master (RRM) program, are shown in Table 6-10. Errors normally result in Analog Output alarm.

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

Table 6-10. 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	En error in the LCD.	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 6-10). • Configure the transmitter or upload a backup configuration file (see “Backing Up the Transmitter Configuration” on page 6-5). • 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 6-11 is a list of diagnostic messages that may be displayed in the Rosemount Radar Master (RRM) program. Warnings are less serious than errors.

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

Table 6-11. Warning messages.

Message	Description	Action
RAM warning	See Diagnostics (RRM: Tools>Diagnostics) for further information on a warning message. See also “Diagnostics” on page 6-6.	
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 in the Rosemount Radar Master (RRM) program are shown in Table 6-12.

Table 6-12. 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-4 and “Full Tank Handling” on page C-10,
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-3 and “Empty Tank Handling” on page C-7,
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 MWM (MicroWave Module) 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 (MicroWave Module) 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 (MicroWave Module) 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 tanksignal 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-4 and page C-9.
Bottom Projection	The bottom projection function is active.	See “Tank Bottom Projection” on page C-3.
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 4-10).
Sudden level jump detected.	This may result from various measurement problems.	Check the tank to find out what causes problem tracking the surface.

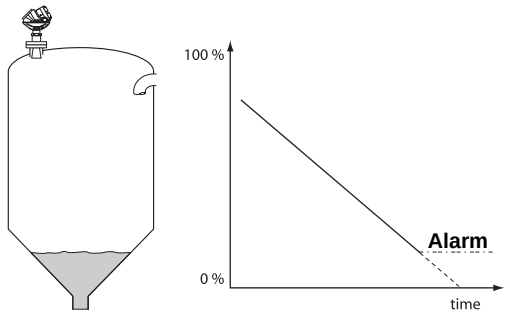
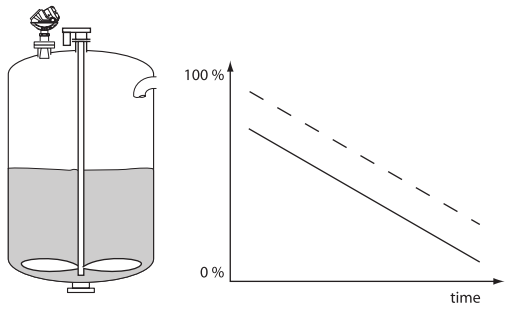
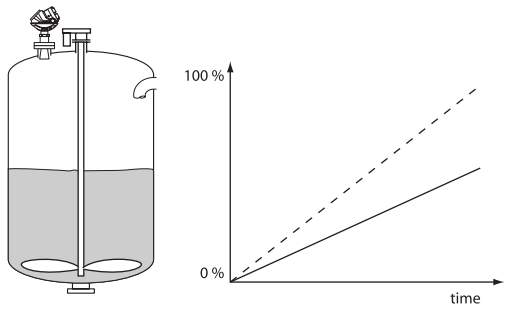
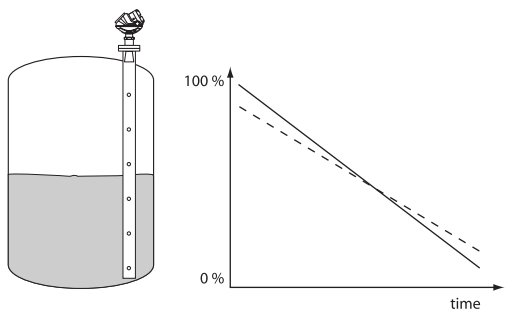
Volume Calculation Status

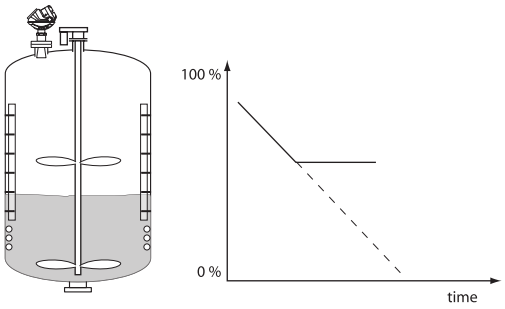
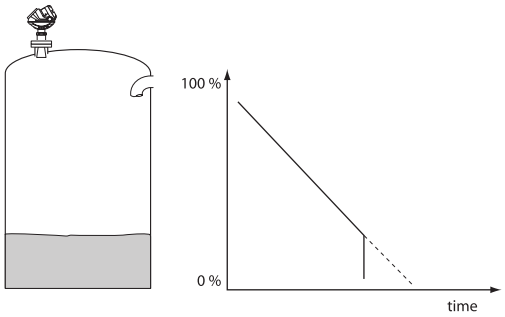
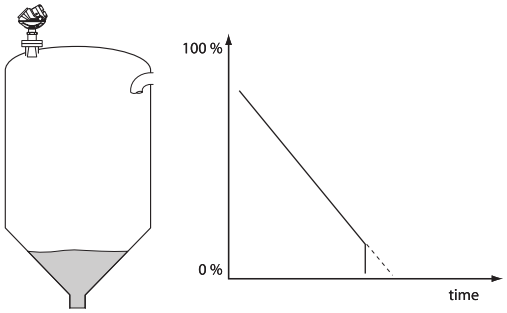
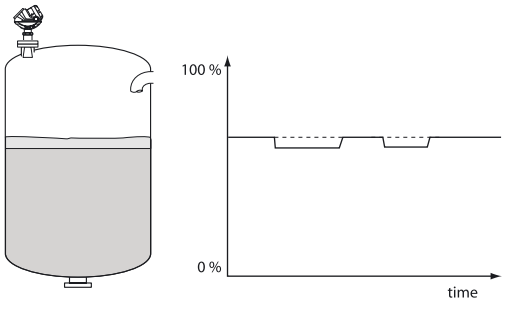
Volume Calculation Status messages that may appear in the Rosemount Radar Master (RRM) program are shown in Table 6-13.

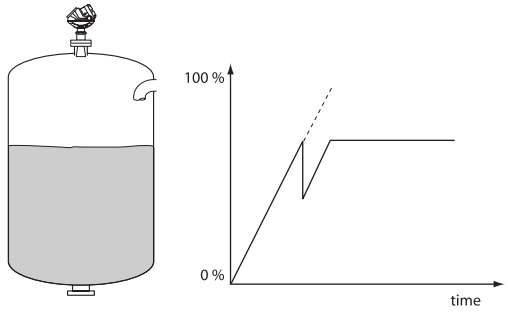
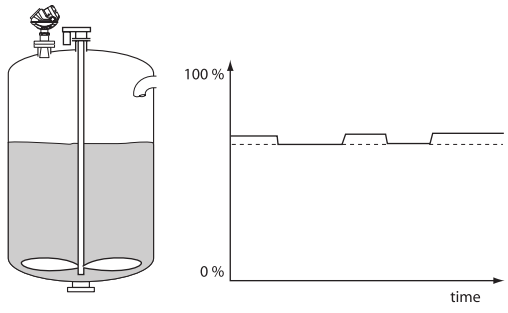
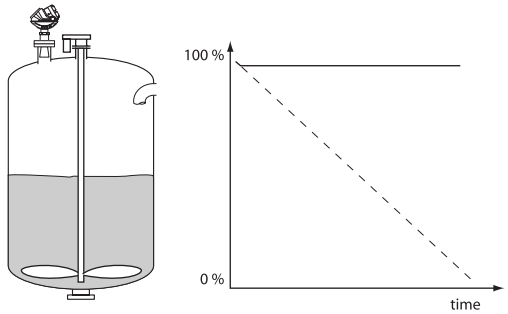
Table 6-13. Volume status.

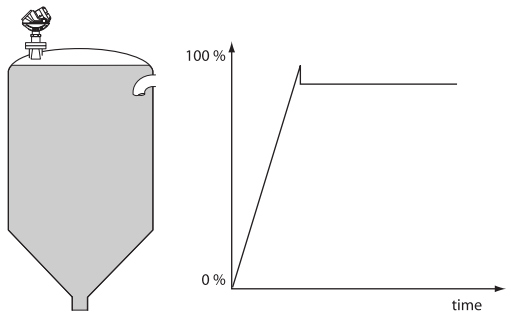
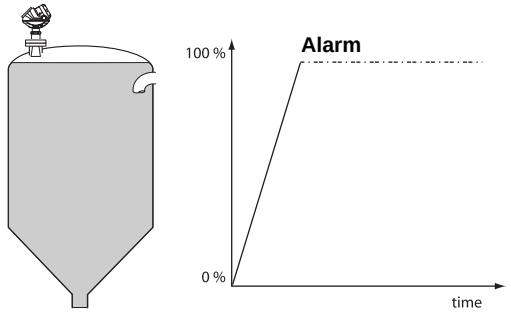
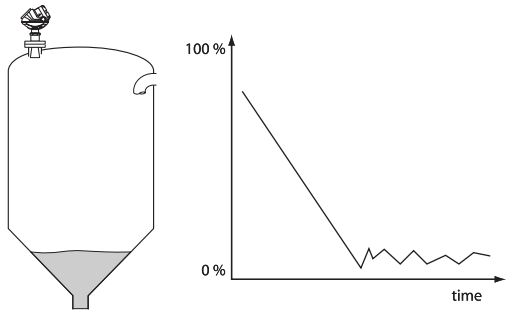
Message	Description	Action
Level is below lowest strapping point.	The measured level is below the lowest point in the given strapping table.	For a correct volume calculation in this region change the strapping table.
Level is above highest strapping point.	The measured level is above the highest point 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 to 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.

Application Errors

APPLICATION_ERROR_1.EPS 	When product surface is close to the tank bottom the transmitter enters alarm mode.	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-3 and C-8. • Make sure that the *Bottom Echo Visible* parameter is not set, see “Bottom Echo Visible” on page C-3 and C-7.
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-6.
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 4-10. • 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-3 and C-7. • 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-3 and C-8. 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-5. 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-4 and C-11. 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. FF: TRANSDUCER 1100>ENV_ENVIRONMENT • Enable the Tank Environment *Turbulent Surface* parameter. RRM: Setup>Tank>Environment. FF: TRANSDUCER 1100>ENV_ENVIRONMENT
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.

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-4 and C-10.
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-4 and C-10.
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 4-10.

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 “Beam Width” on page 3-6
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
Near Zone Distance	1.3 ft (0.4 m) from antenna lower end
Near Zone Accuracy	5401: ± 1.2 in. (± 30 mm). 5402: ±0.6 in (±15 mm)
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(3) Current and % of Range(3)
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 RadarMaster, 275/375 Handheld Communicator, AMS Suite FOUNDATION™ fieldbus: Rosemount RadarMaster, 375 Handheld Communicator, DeltaV® or any other DD (Device Description) compatible host system
FOUNDATION™ fieldbus Blocks	Resource block, 3 Transducer blocks, 6 AI blocks, PID block, ISEL block, SGCR block, ARTH block and OS block
FOUNDATION™ fieldbusClass (Basic or Link Master)	Link Master (LAS)
FOUNDATION™ fieldbus Block Execution Time	AI-block: 30 ms. PID-block: 40 ms. ARTH-, ISEL-, OSPL-block: 65 ms. CHAR-block: 75 ms.
FOUNDATION™ fieldbus Instantiation	Yes (all activated)
Conforming FOUNDATION™ fieldbus	ITK 4.6
FOUNDATION™ fieldbus PlantWeb Alert Support	Yes

Electric	
Power Supply	HART®: 16-42.4 V dc (16-30 V dc in IS applications, 20-42.4 V dc in Explosionproof / Flameproof applications). FOUNDATION™ fieldbus: 9-32 V dc (9-30 V dc in IS applications and 16-32 V dc in Explosionproof / Flameproof applications). FISCO, IS applications: 9-17.5 V dc.
Internal Power Consumption	< 50 mW in normal operation
Output	HART® 4-20 mA current loop or FOUNDATION™ fieldbus
Signal on Alarm (configurable), HART®	Standard: Low=3.75 mA, High=21.75 mA. Namur NE43: High=22.5 mA.
Saturation Levels, HART®	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
Quiescent Current Draw (FOUNDATION™ fieldbus)	21 mA
Mechanical	
Antennas	See page A-5 and page A-7. Antenna material exposed to tank atmosphere: depends on antenna type, see “Ordering Information” on page A-7.
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) • PTFE • O-ring material **Rod Antenna, Two versions** • All-PFA(4) fluoropolymer • PFA(4) fluoropolymer, 316 / 316 L SST (EN 1.4404) and O-ring material For more information see “Ordering Information” on page A-7
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	Non-Hazardous, HART® communication: -40°F to 176 °F (-40 °C to 80 °C)(5). IS/EEx ia and XP/EEx d, HART® communication: -40°F to 158 °F (-40 °C to 70 °C)(5). IS/EEx ia and XP/EEx d FOUNDATION™ fieldbus: -40°F to 140°F (-40°C to 60°C)(6). 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(7)	See “Process Temperature and Pressure Rating” on page A-4
Process Pressure(7)	See “Process Temperature and Pressure Rating” on page A-4
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)(8)	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) 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.

(3) Not applicable for FOUNDATION™ fieldbus.

(4) PFA is a fluoropolymer with properties similar to PTFE.

(5) 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.

(6) 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 0.54°F /0.3°C.

(7) Final rating depends on flange and O-ring selection. See “Process Temperature and Pressure Rating” on page A-4 and “Ordering Information” on page A-7.

(8) The 5402 is authorized for use in tank-mounted applications, including metal tanks, as well as concrete, plastic, glass and other non-conductive tanks.

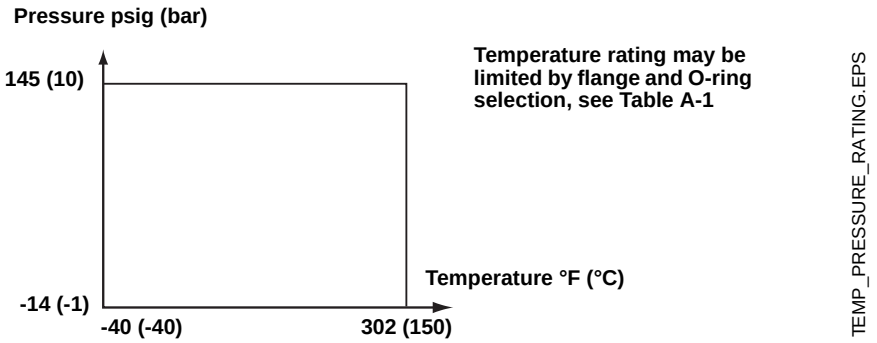
Process Temperature and Pressure Rating

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

Working Pressure

Max Working Pressure is 10 bar/145 psi.

Figure A-1. Process temperature and pressure diagram for Rosemount 5400 Series.



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. Temperature range for different Tank Seal 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:

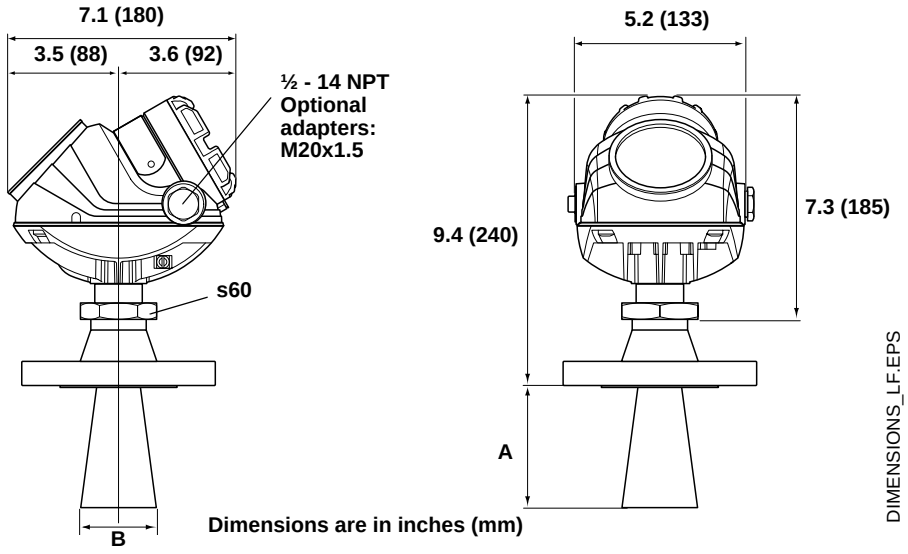
ANSI: according to ANSI B16.5 Table 2-2.3.

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

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

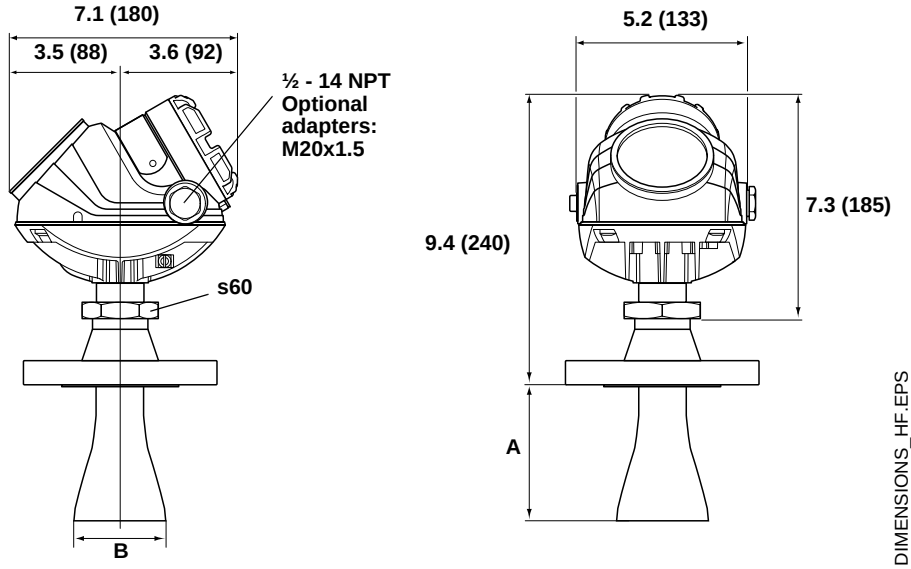
DIMENSIONAL DRAWINGS

Figure A-2. Model 5401 (Low Frequency version) transmitter with cone antenna.



Dimensions are in inches (mm)

Figure A-3. Model 5402 (High Frequency version) transmitter with cone antenna.

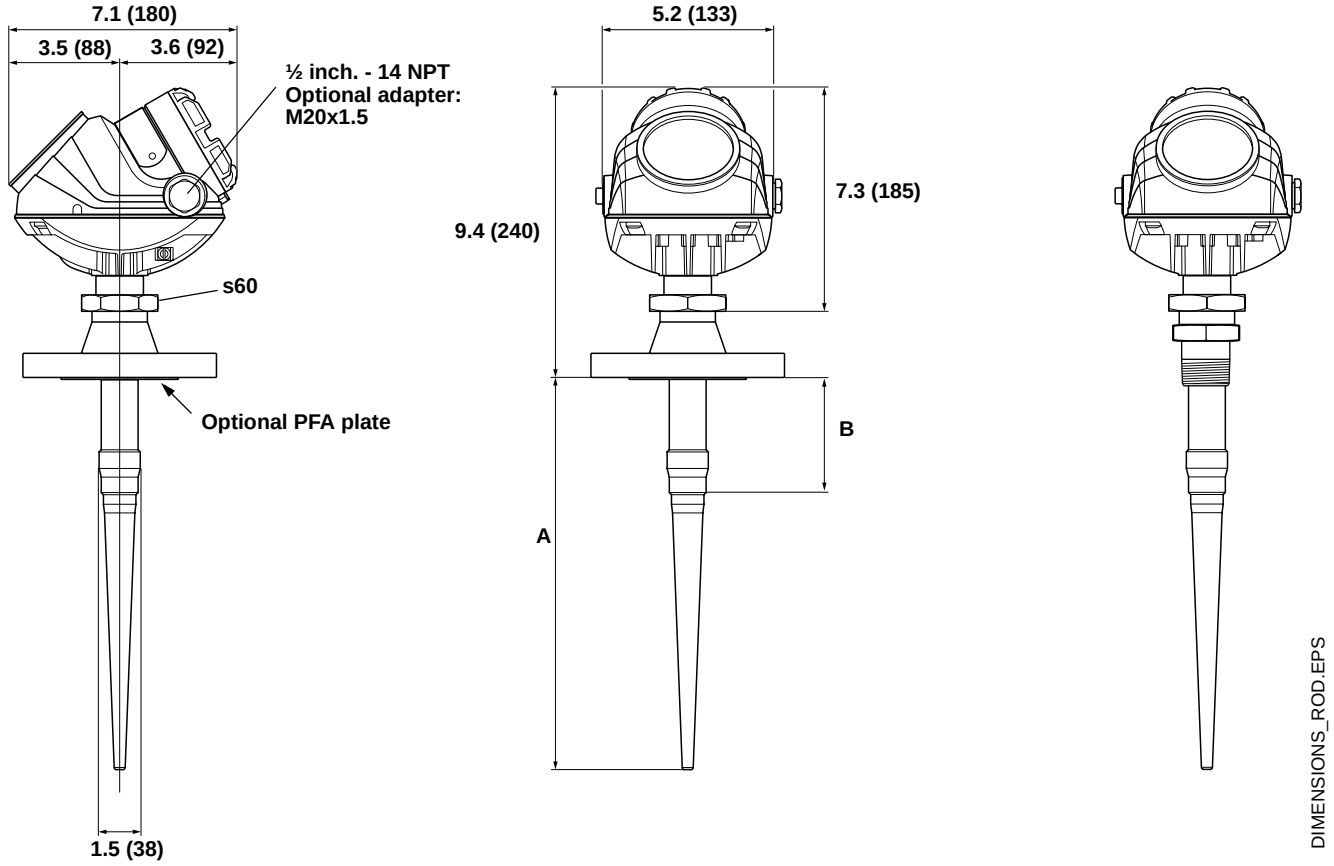


Dimensions are in inches (mm)

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-4. 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.

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)
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, pipe installations only
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 metal 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)
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
	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(3)
AB	2 inch, 300 lbs, 316 / 316 L SST(3)
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)(3)
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(4) (standard Rosemount alarm and saturation levels)
	Special Certificates
Q4	Calibration Data Certificate
Q8	Material Traceability Certification per EN 10204 3.1B(5)
	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 a 2 inch antenna (code 2S).
(4) Standard alarm setting is high.
(5) Option available for pressure retaining metal 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 powering a FOUNDATION fieldbus segment 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 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 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 Fieldbus model

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 T63˚C
- EEx ia IIC T4 (-40 °C ≤ Ta ≤ +60 °C(1))
- FOUNDATION™ fieldbus model: Ui=30 V dc, Ii=300 mA, Pi=1.5 W, Ci=0 nF, Li=0 H.
- 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) +70 °C with HART option.

Figure B-2. Approval Label
ATEX FISCO model

IA 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 T63˚C**
- EEx ia IIC T4 (-40 °C ≤ Ta ≤ +60 °C(1))
- FISCO model: Ui=17.5 V dc, Ii=380 mA, Pi=5.32 W, Li=Ci=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.

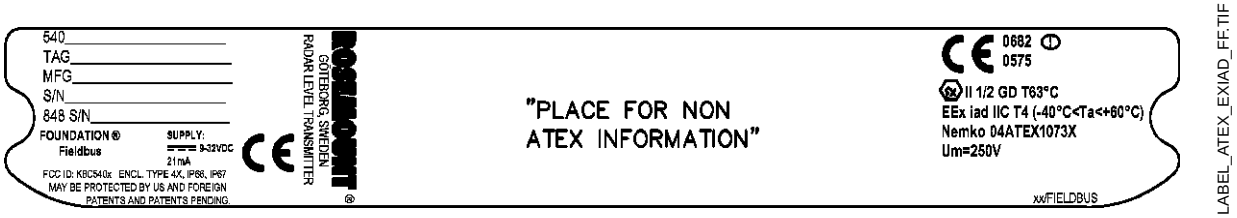
Impact and friction hazards need then to be considered according to EN 50284 clause 4.3.1 when the transmitter and part of antennas exposed to the exterior atmosphere of the tank is made with light metal alloys and used in category II 1 G.

(1) +70 °C with HART option.

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-3. 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 T63˚C

- EEx iad IIC T4 (-40 °C<Ta< +60 °C(1))
- 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.

(1) +70 °C with HART option.

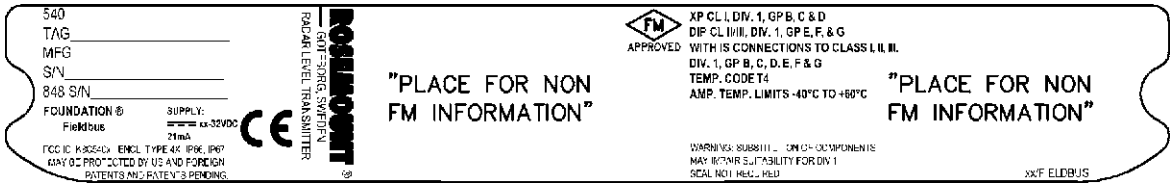
HAZARDOUS LOCATIONS CERTIFICATIONS

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-4. Approval Label Factory Mutual (FM) Explosion-Proof



LABEL_FM_XP_DIP_FF.T

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

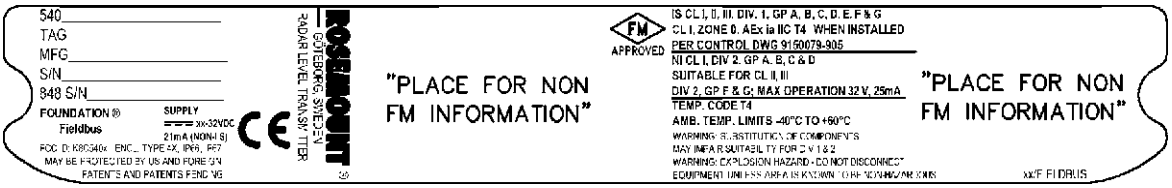
Dust-Ignition proof for Class II/III, Division 1, Groups E, F and G with intrinsically safe connections to Class I, II, III, Div 1, Groups B, C, D, E, F and G.

Temperature code T4.

Ambient temperature limits: -40°C to + 60°C(1).

Seal not required.

Figure B-5. Approval Label Factory Mutual (FM) Intrinsic Safety



LABEL_FM_IS_NI_FF.TIF

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.

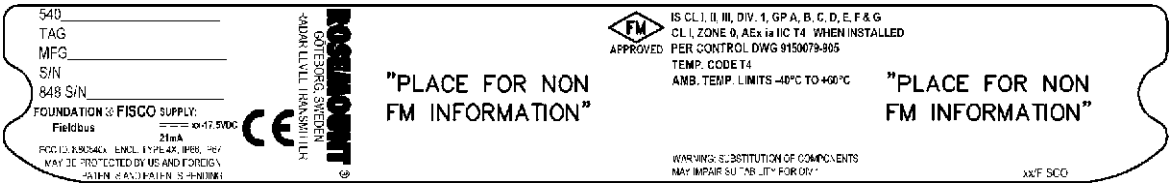
Suitable for Class II, III, Division 2, Groups F and G;

FOUNDATION™ fieldbus model: Ui=30 V dc, Ii=300 mA, Pi=1.3 W, Ci=0 nF, Li=0 H. Max operation 32 V, 25 mA.

Temperature code T4.
Ambient Temperature Limits: -40 °C to + 60 °C(1).

(1) +70 °C with HART option.

Figure B-6. Approval Label
Factory Mutual (FM) FISCO
Intrinsic Safety



IE 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.

FISCO model: Ui=17.5 V dc, Ii=380 mA, Pi=5.32 W, Li=Ci=0.

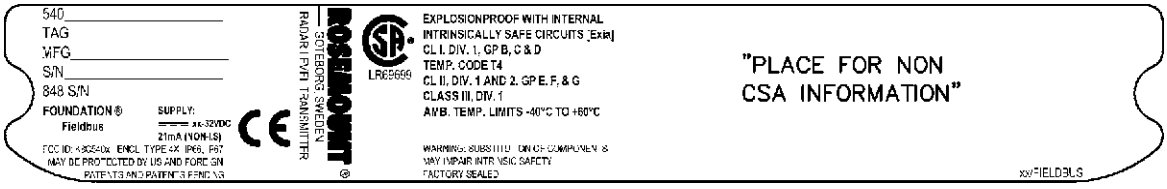
Temperature code T4.
Ambient Temperature Limits: -40 °C to + 60 °C(1).

(1) +70 °C with HART option.

Canadian Standards Association (CSA) Approval

Cert. no. 1514653.

Figure B-7. Approval Label Canadian Standards Association (CSA) Explosion Proof



LABEL_CSA_XP_DIP_FIELDBUS.TIF

E6 Explosionproof with internal Intrinsically Safe Circuits [Exia].

Class I, Div. 1, Groups B, C and D.

Temperature Code T4.

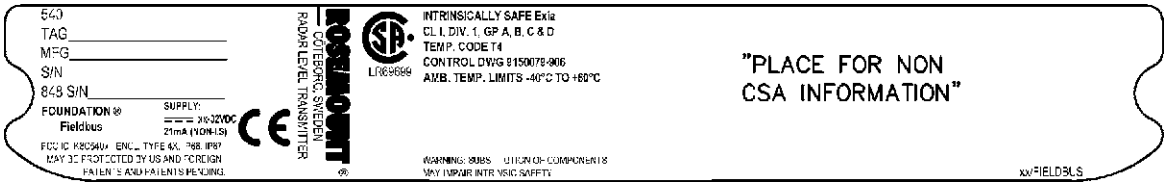
Class II, Div. 1 and 2, Groups E, F and G;

Class III, Div. 1

Ambient temperature limits -40°C to +60 °C(1).

Factory sealed.

Figure B-8. Approval Label Canadian Standards Association (CSA) Intrinsic Safety



LABEL_CSA_IS_FIELDBUS.TIF

I6 Intrinsically Safe Ex ia.

Class I, Division 1, Groups A, B, C and D.

Temperature code T4.

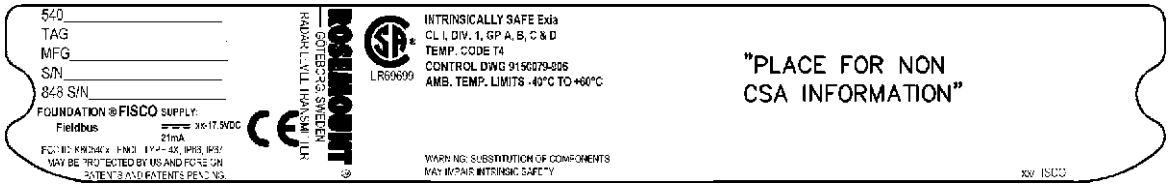
FOUNDATION™ fieldbus model: Ui=30 V dc, Ii=300 mA, Pi=1.3 W, Ci=0 nF, Li=0 H.

Control Drawing: 9150 079-906.

Ambient temperature limits: -40 °C to + 60 °C(1).

(1) +70 °C with HART option.

Figure B-9. Approval Label
Canadian Standards Association
(CSA) FISCO Intrinsic Safety



IF Intrinsically Safe Ex ia.
Class I, Division 1, Groups A, B, C and D.
Temperature code T4.
FISCO model: Ui=17.5 V dc, Ii=380 mA, Pi=5.32 W, Li=Ci=0.
Control Drawing: 9150 079-906.
Ambient temperature limits: -40 °C to + 60 °C(1).

(1) +70 °C with HART option.

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.

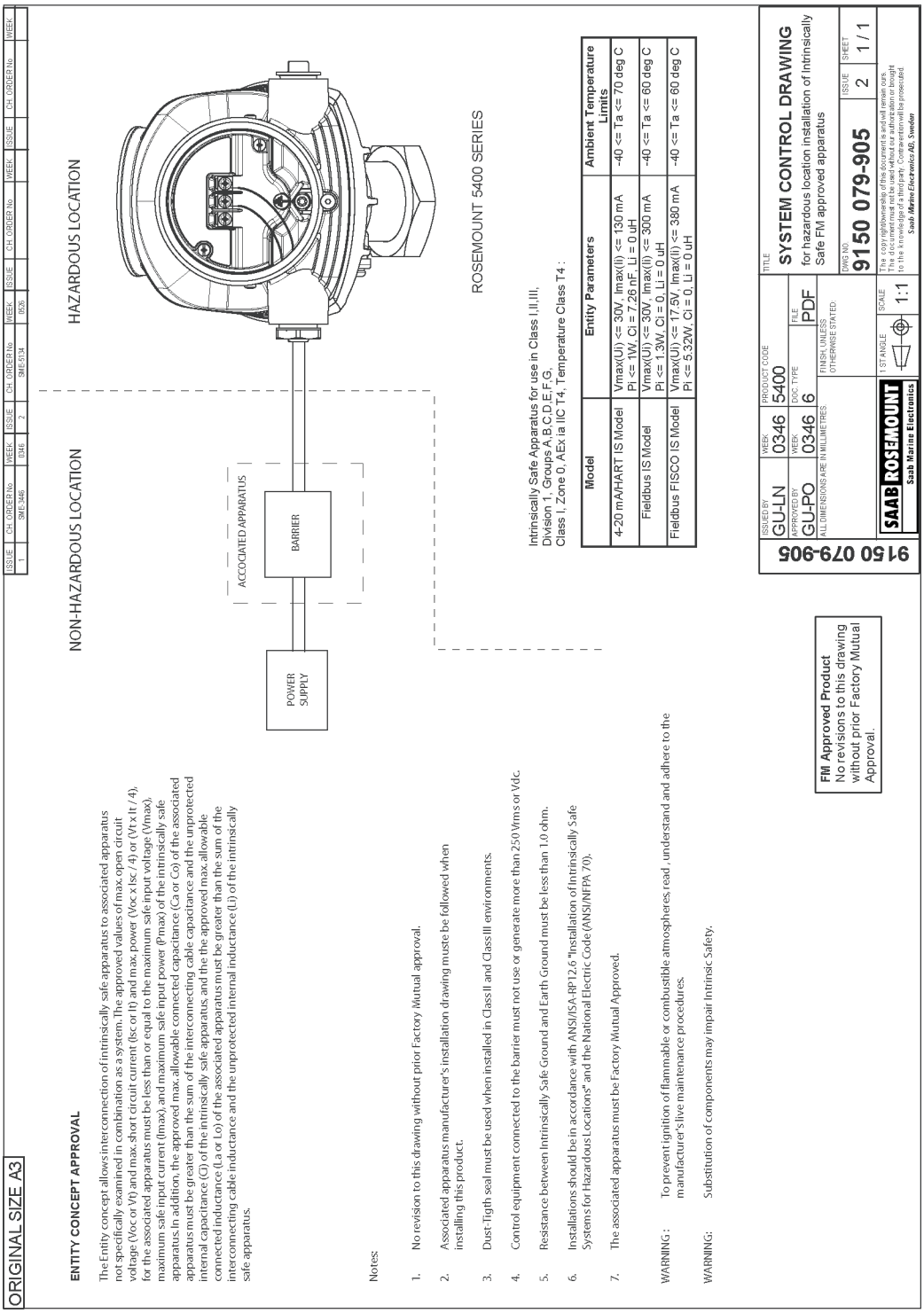
Saab Rosemount drawing 9150079-906:

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

Saab Rosemount drawing 9150079-907:

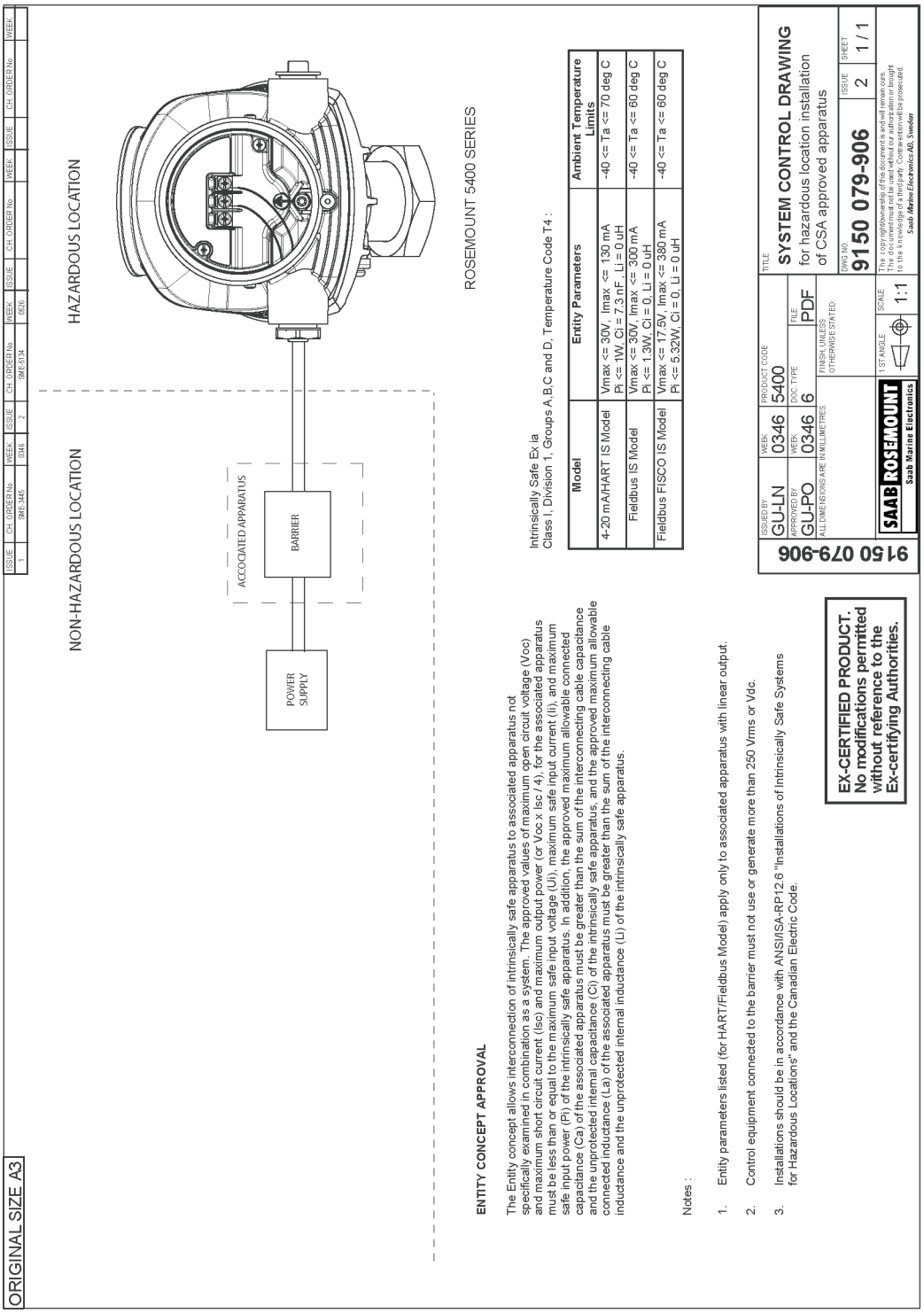
Installation Drawing for hazardous location installation of ATEX approved apparatus.

Figure B-10. System Control Drawing for hazardous location installation of intrinsically safe FM approved apparatus.



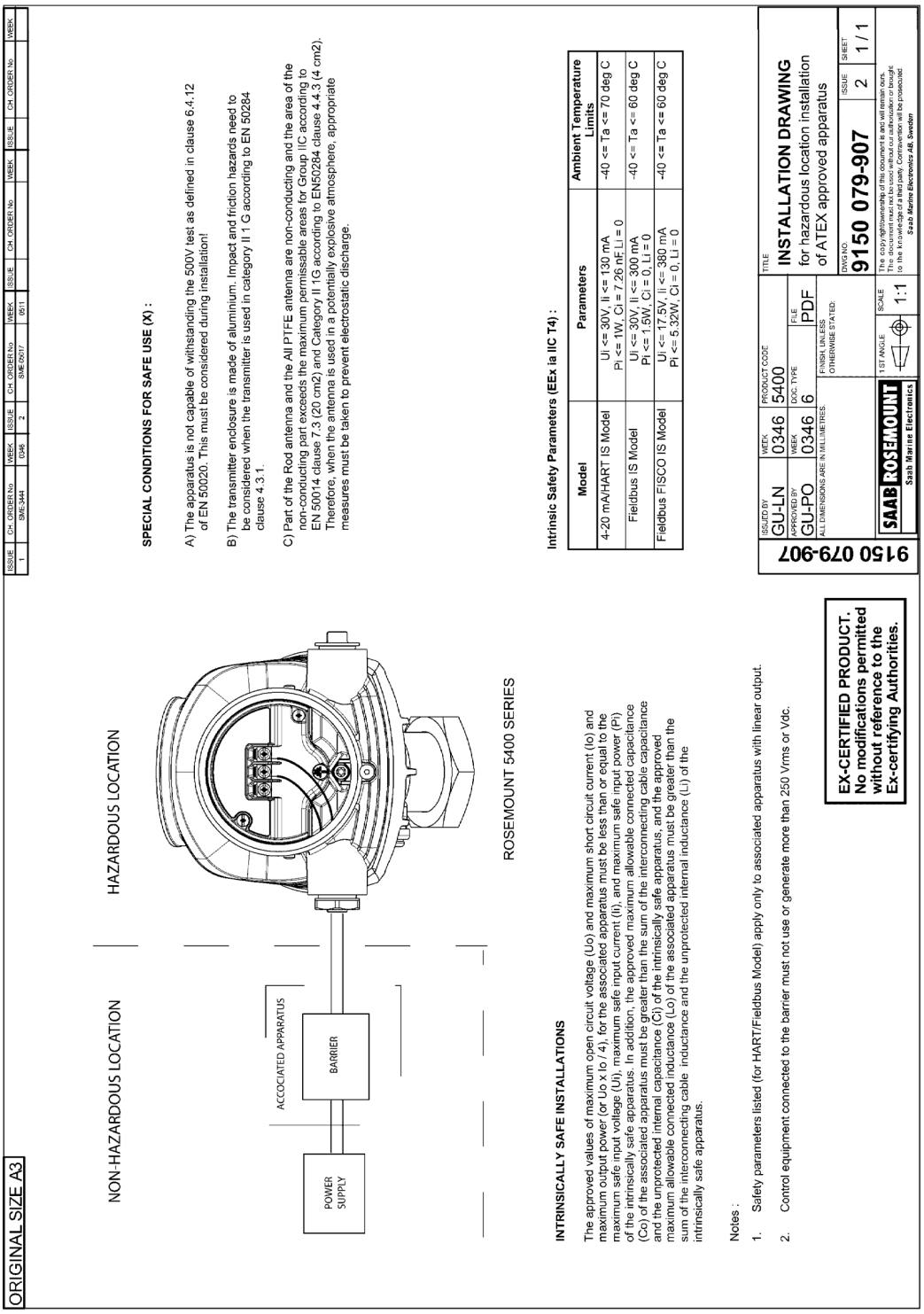
9150079-905_I02.TIF

Figure B-11. System Control Drawing for hazardous location installation of CSA approved apparatus.



9150079-906_I02.TIF

Figure B-12. Installation Drawing for hazardous location installation of ATEX approved apparatus.



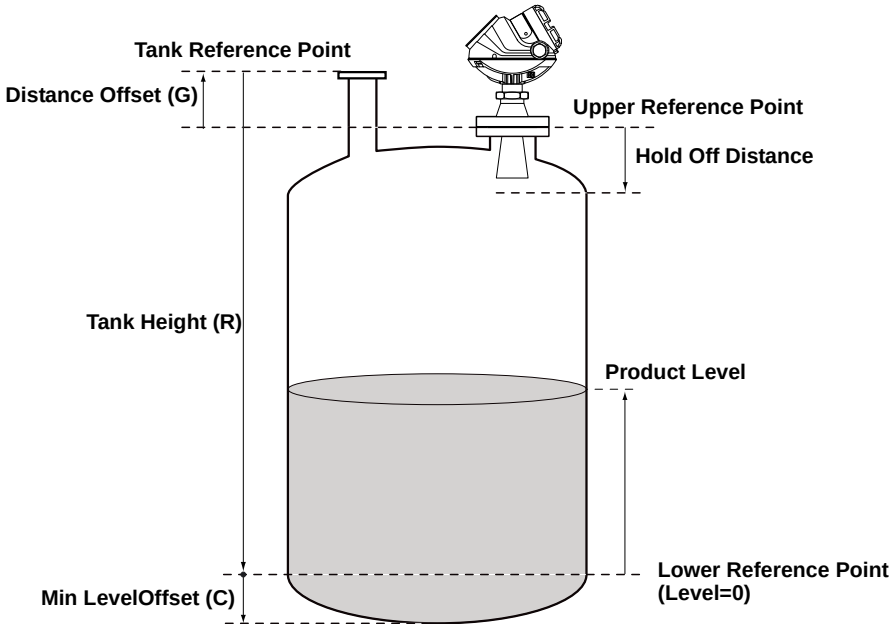
9150079-907_I02_P01.TIF

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.

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 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 400 mm and a higher limit of 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-8.

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-7.

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-9.

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 acceptable to lose 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-10 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-11 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

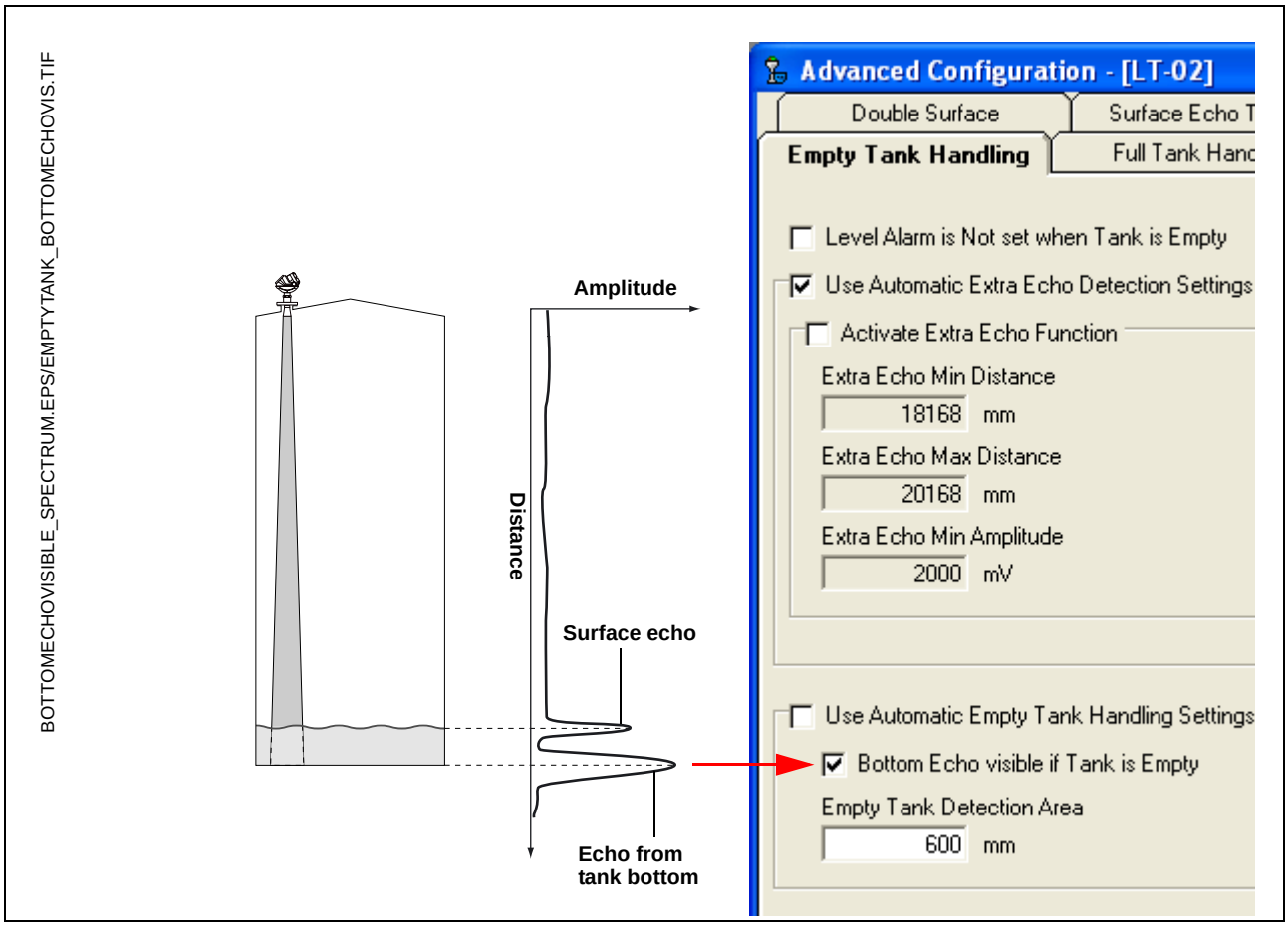
By enabling the *Bottom Echo Visible...* parameter the transmitter is able to separate the product surface from the tank bottom by treating the bottom echo as a disturbance echo. This is useful for products which are relatively transparent for microwaves such as oil. For non-transparent products such 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.



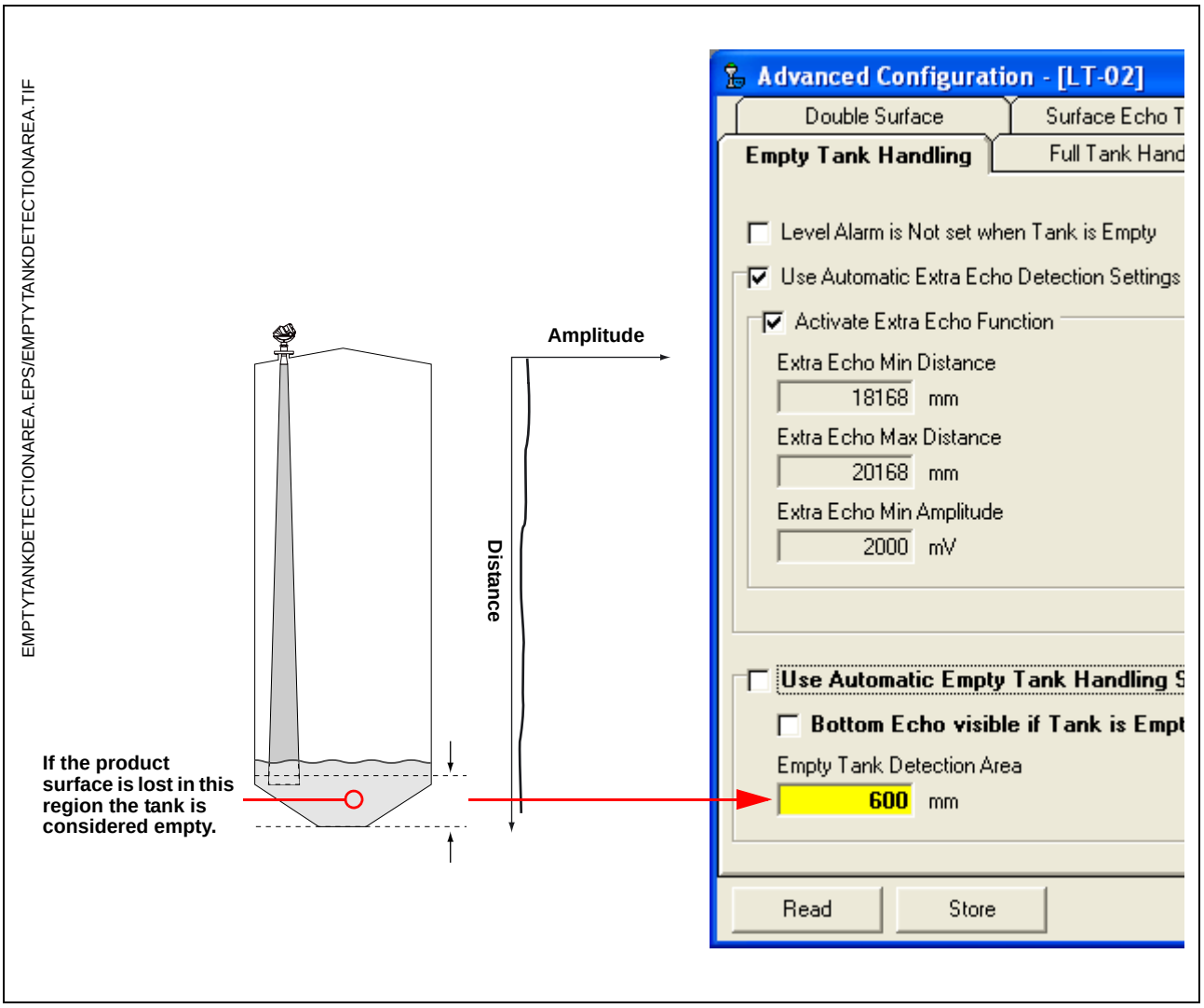
Empty Tank Detection Area

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.



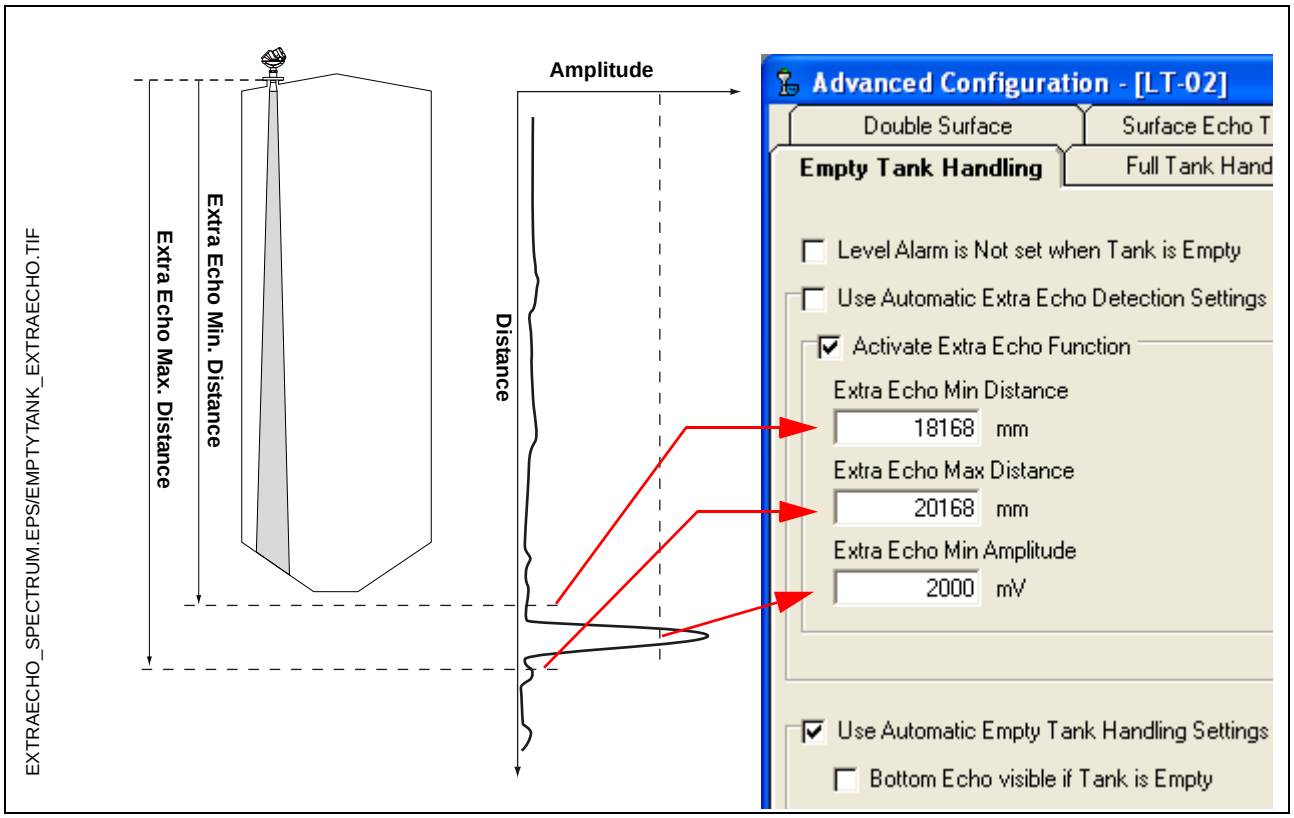
See Empty Tank Detection Area on page C-3 for further information.

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.

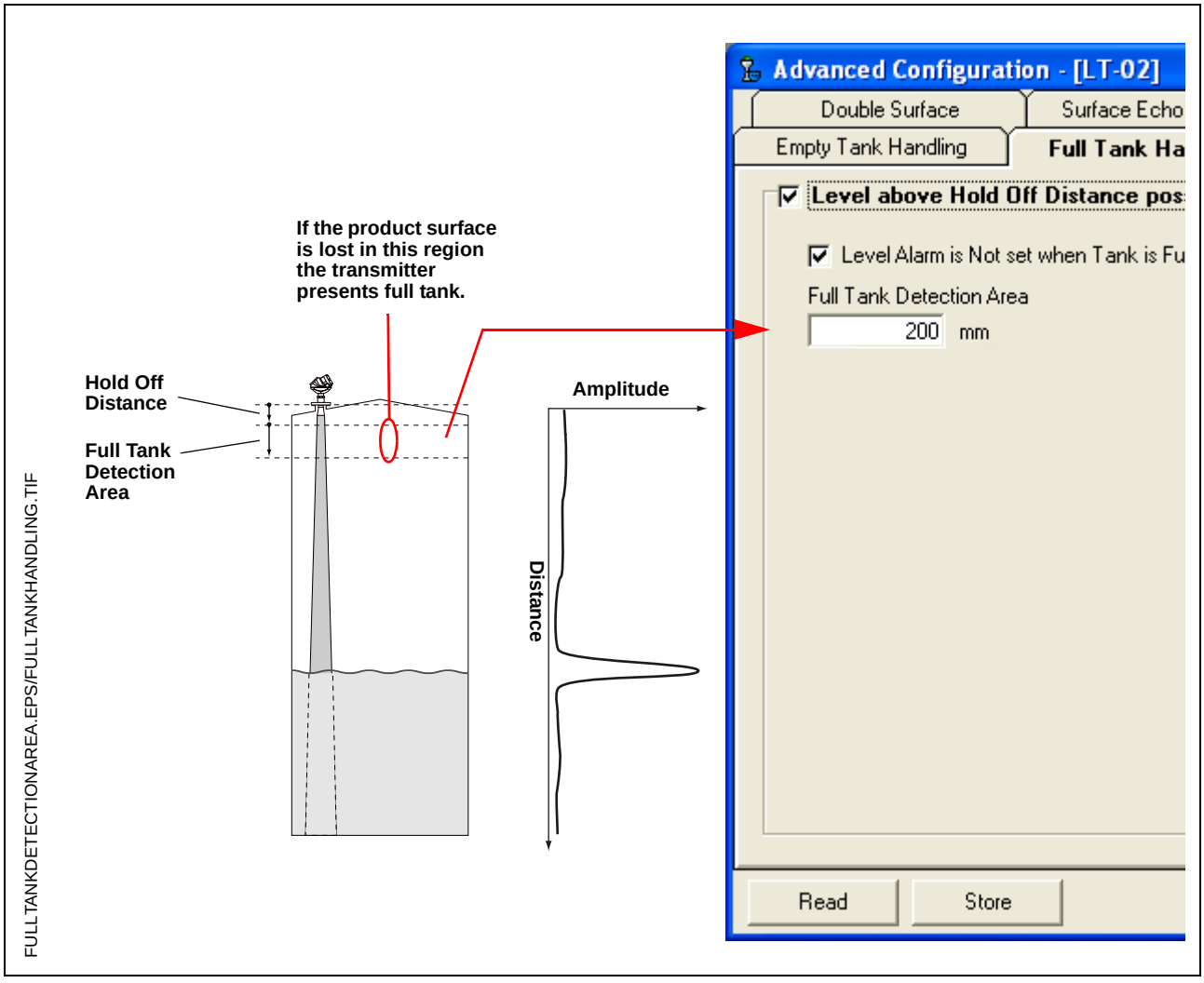


Full Tank Handling

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.

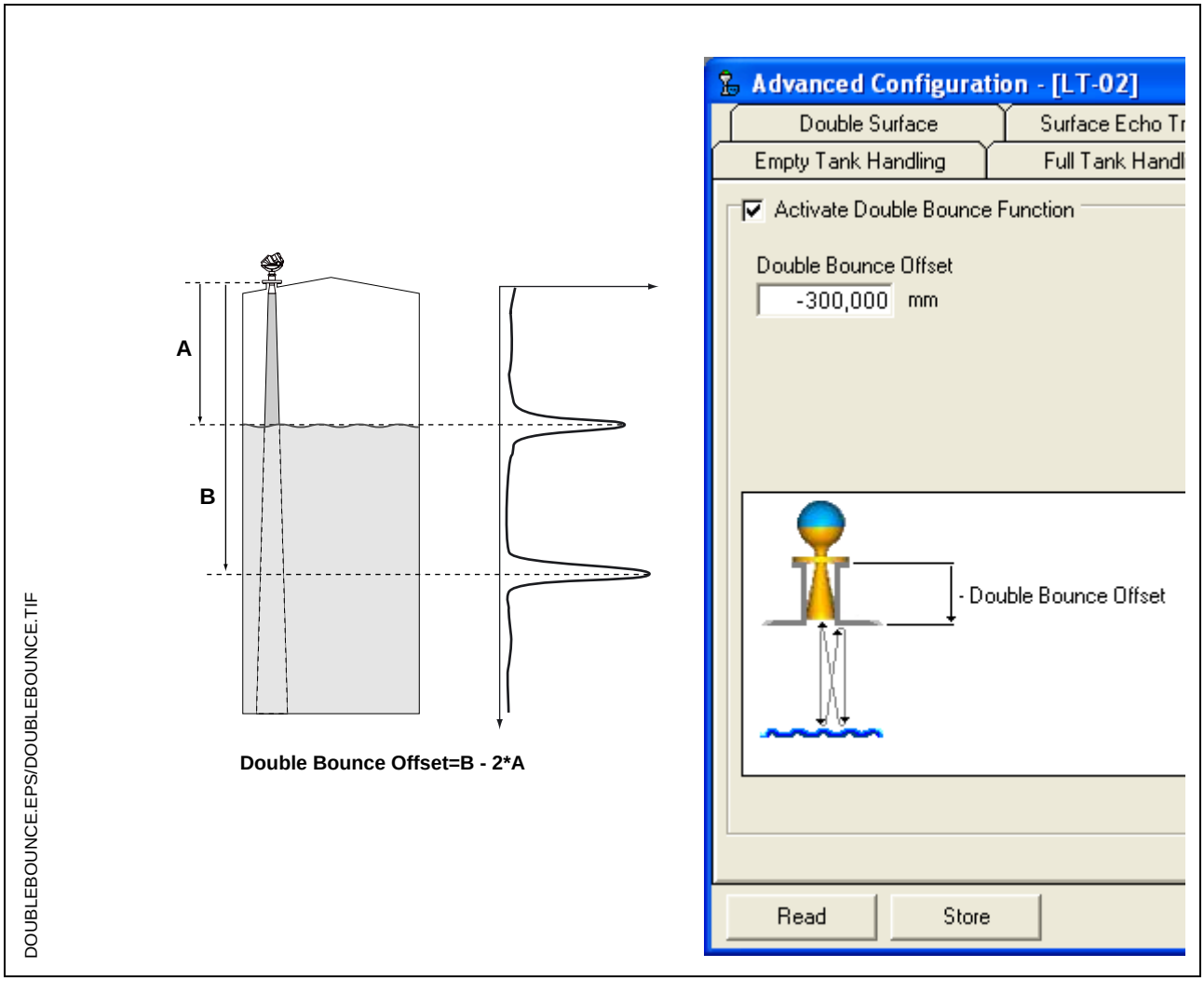
Double bounces are most commonly present in spherical or horizontal cylinder tanks. The tank roof in this case can sometimes amplify the double bounce echo amplitude. Normally double bounce echoes appear when the tank is about 60-70% filled. In these cases the double bounce echo can cause the transmitter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

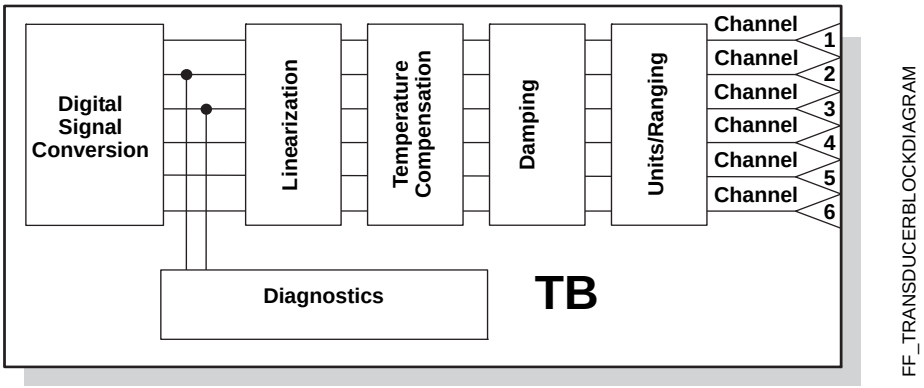


Appendix D Level Transducer Block

OVERVIEW

This section contains information on the 5400 Transducer Block (TB). Descriptions of all Transducer Block parameters, errors, and diagnostics are listed.

Figure D-1. Transducer Block Diagram



Definition

The transducer block contains the actual measurement data, including a level and distance reading. Channels 1–6 are assigned to these measurements (see Figure D-1). The transducer block includes information about sensor type, engineering units, and all parameters needed to configure the radar gauge.

Channel Definitions

Each input has an assigned channel wich can be linked to the AI block. The channels for the Rosemount 5400 Series are the following:

Table D-1. Channel Assignments

Channel Name	Channel Number	Process variable
Level	1	CHANNEL_RADAR_LEVEL
Ullage	2	CHANNEL_RADAR_ULLAGE
Level Rate	3	CHANNEL_RADAR_LEVELRATE
Signal Strength	4	CHANNEL_RADAR_SIGNAL_STRENGTH
Volume	5	CHANNEL_RADAR_VOLUME
Internal Temperature	6	CHANNEL_RADAR_INTERNAL_TEMPERATURE

PARAMETERS AND DESCRIPTIONS

Table D-2. Level Transducer Block Parameters and Descriptions.

Parameter	Index Number	Description
ST_REV	1	The revision level of the static data associated with the function block. The revision value increments each time a static parameter value in the block is changed.
TAG_DESC	2	The user description of the intended application of the block.
STRATEGY	3	The strategy field can be used to identify grouping of blocks. This data is not checked or processed by the block.
ALERT_KEY	4	The identification number of the plant unit. This information may be used in the host for sorting alarms, etc.
MODE_BLK	5	The actual, target, permitted, and normal modes of the block. Target: The mode to “go to” Actual: The mode the “block is currently in” Permitted: Allowed modes that target may take on Normal: Most common mode for target
BLOCK_ERR	6	This parameter reflects the error status associated with the hardware or software components associated with a block. It is a bit string, so that multiple errors may be shown.
UPDATE_EVT	7	This alert is generated by any change to the static data.
BLOCK_ALM	8	The block alarm is used for all configuration, hardware, connection failure or system problems in the block. The cause of the alert is entered in the subcode field. The first alert to become active will set the Active status in the Status parameter. As soon as the Unreported status is cleared by the alert reporting task, another block alert may be reported without clearing the Active status, if the subcode has changed.
TRANSDUCER_DIRECTORY	9	Directory that specifies the number and starting indices of the transducers in the transducer block.
TRANSDUCER_TYPE	10	Identifies the transducer.
XD_ERROR	11	A transducer block alarm subcode.
COLLECTION_DIRECTORY	12	A directory that specifies the number, starting indices, and DD Item ID’s of the data collections in each transducer within a transducer block.

Parameter	Index Number	Description
RADAR_LEVEL_TYPE	13	Not used
RADAR_LEVEL	14	Level
RADAR_LEVEL_RANGE	15	See Table H-4
RADAR_ULLAGE	16	Distance (Ullage)
RADAR_LEVELRATE	17	Level Rate
RADAR_LEVELRATE_RANGE	18	See Table H-5
RADAR_LEVEL_SIGNAL_STRENGTH	19	Signal strength
RADAR_LEVEL_SIGNAL_STRENGTH_RANGE	20	See Table H-7
RADAR_VOLUME	21	Volume
RADAR_VOLUME_RANGE	22	See Table H-8
RADAR_INTERNAL_TEMPERATURE	23	Internal Temperature
RADAR_INTERNAL_TEMPERATURE_ RANGE	24	Range, unit and number of decimals
ANTENNA_TYPE	25	Antenna Type
ANTENNA_TCL	26	TCL (Tank connection Length)
ANTENNA_PIPE_DIAM	27	Pipe Inner Diameter
DAMP_VALUE	28	Damping value
SIGN_PROC_CONFIG	29	Enable pipe inner diameter
ANTENNA_EXTENSION	30	Extended antenna
LCD_PARAMETERS	31	Parameters to show
LCD_LANGUAGE	32	Language on display
LCD_LENGTH_UNIT	33	Length unit on display
LCD_VOLUME_UNIT	34	Volume unit on display
LCD_TEMPERATURE_UNIT	35	Temperature unit on display
LCD_VELOCITY_UNIT	36	Velocity unit on display
GEOM_DIST_OFFSET	37	Distance Offset
GEOM_TANK_HEIGHT	38	Tank Height (R)
GEOM_MIN_LEVEL_OFFSET	39	Minimum distance offset (C)
GEOM_HOLD_OFF	40	Hold off distance
GEOM_CAL_DISTANCE	41	Calibration Distance
GEOM_TANK_TYPE	42	Tank type
GEOM_TANK_BOTTOM_TYPE	43	Tank bottom type
ENV_ENVIRONMENT	44	Process Condition
ENV_PRESENTATION	45	Tank Presentation
ENV_DEVICE_MODE	46	Service mode
ENV_DIELECTR_CONST	47	Dielectric constant
ENV_WRITE_PROTECT	48	Write protect
DIAGN_DEVICE_ALERT	49	Errors, Warnings, Status, Plant web alerts
DIAGN_VERSION	50	Gauge SW version
DIAGN_REVISION	51	P1451 revision
DIAGN_DEVICE_ID	52	Device ID for the gauge.
DIAGN_DEVICE_MODEL	53	Type of 5400. LF or HF
DIAGN_COMPL_TANK	54	The degree of complexity in the tank
STATS_ATTEMPTS	55	
STATS_FAILURES	56	
STATS_TIMEOUTS	57	

Table D-3. Antenna Type

VALUE	ANTENNA_TYPE
0	User defined
1	Cone 2
2	Cone 3
3	Cone 4
4	Cone 6
5	Cone 8
10	Process Seal 2”
11	Process Seal 3”
12	Process Seal 4”
13	Antenna A0
14	Antenna A1
15	Antenna A2
16	Antenna A3
20	Rod 100
21	Rod 250
22	Antenna B3
23	Antenna B4
24	Antenna B5
30	Cone 3” Exotic
31	Cone 4” Exotic
32	Antenna C3

Table D-4. Device Mode

VALUE	ENV_DEVICE_MODE
0	Normal operation
1	Spare
2	Restart device
3	Set to factory default database

Table D-5. Environment

Bit Number	Value of ENV_ENVIRONMENT	Description
0	0x00000001	Rapid Changes
1	0x00000002	Reserved
2	0x00000004	Turbulent Surface
3	0x00000008	Foam
4	0x000000010	Solid Product

Table D-6. Presentation

Bit Number	Value of ENV_PRESENTATION	Description
0	0x00000001	Level above min distance possible
1	0x00000002	Predicting_Allowed
2	0x00000004	Bottom echo always visible if tank is empty
3	0x00000008	Tank contains double bounces
4	0x000000010	Slow Search
5	0x00000020	Enable double surface
6	0x00000040	Select_Lower_Surface
7	0x00000080	Not used
8	0x00000100	Show negative levels as zero
9	0x00000200	Monotone level ullage Presentation
10	0x00000400	Bottom Projection
11	0x00000800	Rhs Handler
12	0x00001000	Invalid level is NOT set if tank is empty or full
13	0x00002000	Don't set invalid level when empty
14	0x00004000	Don't set invalid level when full
15	0x00008000	Not used
16	0x00010000	Use LS Filter
17	0x00020000	Use Adaptive Filter
18	0x00040000	Use jump filter
19	0x00080000	Not used
20	0x00100000	Use Extra echo detection
21	0x00200000	Always Track First Echo

Table D-7. LCD Parameters

Bit Number	Value of ENV_PRESENTATION	Description
0	0x00000001	Level
1	0x00000002	Distance
2	0x00000004	Level Rate
3	0x00000008	Signal Strength
4	0x000000010	Volume
5	0x000000020	Internal Temperature

Table D-8. Tank Type

VALUE	GEOM_TANK_TYPE
0	Unknown
1	Vertical Cylinder
2	Horisontal Cylinder
3	Spherical
4	Cubical

Table D-9. Tank Bottom Type

VALUE	GEOM_TANK_BOTTOM_TYPE
0	Unknown
1	Flat
2	Dome
3	Cone
4	Flat Inclined

Table D-10. Dielectrical Constant

VALUE	ENV_DIELECTR_CONST
0	Unknown
1	Range (1.9-2.5)
2	Range (2.5-4)
3	Range (4-10)
4	Range (>10)

SUPPORTED UNITS

Unit Codes

Table D-11. Length

Value	Display	Description
1010	m	meter
1012	cm	centimeter
1013	mm	millimeter
1018	ft	feet
1019	in	inch

Table D-12. Level Rate

Value	Display	Description
1061	m/s	meter per second
1063	m/h	meter per hour
1067	ft/s	feet per second
1069	in/m	inch per minute

Table D-13. Temperature

Value	Display	Description
1001	°C	Degree Celsius
1002	°F	Degree Fahrenheit

Table D-14. Signal Strength

Value	Display	Description
1243	mV	millivolt

Table D-15. Volume

Value	Display	Description
1034	m^3	Cubic meter
1038	L	Liter
1042	in^3	Cubic inch
1043	ft^3	Cubic feet
1044	Yd^3	Cubic yard
1048	Gallon	US gallon
1049	ImpGall	Imperial gallon
1051	Bbl	Barrel

DIAGNOSTICS DEVICE ERRORS

In addition to the BLOCK_ERR and XD_ERROR parameters, more detailed information on the measurement status can be obtained via DIAGN_DEV_ALERT. Table D-16 on page D-8 lists the potential errors and the possible corrective actions for the given values. The corrective actions are in order of increasing system level compromises. The first step should always be to reset the gauge and then if the error persists, try the steps in Table D-16. Start with the first corrective action and then try the second.

Table D-16. Device Errors Diagnostics

Bit Number	Value of DIAGN_DEV_ALERT	Description	Corrective action
0	0	No alarm active	See Section 4.
1	0x00000001	Reserved	See Section 4
2	0x00000002	FF card to gauge comm fault	See Section 4
3	0x00000004	Level Measurement Failure	See Section 4
4	0x00000008	Temperature Measurement Failure	See Section 4
5	0x00000010	Volume Measurement Failure	See Section 4
6	0x00000020	Database Error	See Section 4
7	0x00000040	HW Error	See Section 4
8	0x00000080	Microwave Unit Error	See Section 4
9	0x00000100	Configuration Error	See Section 4
10	0x00000200	SW Error	See Section 4
11	0x00000400	Invalid Strap Table	See Section 4
12	0x00000800	Internal Temp Warning	See Section 4
13	0x00001000	Database Warning	See Section 4
14	0x00002000	HW Warning	See Section 4
15	0x00004000	Microwave Unit Warning	See Section 4
16	0x00008000	Configuration Warning	See Section 4
17	0x00010000	SW Warning	See Section 4
18	0x00020000	Simulation Mode	See Section 4
19	0x00040000	Volume Range Warning	See Section 4
20	0x00080000	Software Write Protected	See Section 4
21	0x00100000	Full Tank	See Section 4
22	0x00200000	Empty Tank	See Section 4
23	0x00400000	Dirty Antenna	See Section 4
24	0x00800000	Reference Puls Invalid	See Section 4
25	0x01000000	Sweep lin Warning	See Section 4
26	0x02000000	Tank Signal Clip Warning	See Section 4
27	0x04000000	No Surface Echo	See Section 4
28	0x08000000	Predicted Level	See Section 4
29	0x10000000	Sampling Failed	See Section 4

Appendix E Register Transducer Block

OVERVIEW

The Register Transducer Block allows access to Database registers and Input registers of the Rosemount 5400 transmitter. This makes it possible to read a selected set of register directly by accessing the memory location.

The Register Transducer Block is only available with advanced service.

⚠CAUTION

Since this Register Transducer Block allows access to most registers in the transmitter, which includes the registers set by the Methods and Configuration screens, in the Level Transducer Block (see Appendix D: Level Transducer Block) it should be handled with care and ONLY to be changed by trained and certified service personnel, or as guided by Emerson Process Management, Rosemount Division support personnel.

Register Access Transducer Block Parameters

Table E-1. Register Access Transducer Block Parameters

Parameter	Index Number	Description
ST_REV	1	The revision level of the static data associated with the function block. The revision value increments each time a static parameter value in the block is changed.
TAG_DESC	2	The user description of the intended application of the block.
STRATEGY	3	The strategy field can be used to identify grouping of blocks. This data is not checked or processed by the block.
ALERT_KEY	4	The identification number of the plant unit. This information may be used in the host for sorting alarms, etc.
MODE_BLK	5	The actual, target, permitted, and normal modes of the block. Target: The mode to “go to” Actual: The mode the “block is currently in” Permitted: Allowed modes that target may take on Normal: Most common mode for target
BLOCK_ERR	6	This parameter reflects the error status associated with the hardware or software components associated with a block. It is a bit string, so that multiple errors may be shown.
XD_ERROR	7	A transducer block alarm subcode.
INP_SEARCH_START_NBR	8	Search start number for input registers
DB_SEARCH_START_NBR	9	Search start number for holding registers
INP_REG_1_TYPE	10	Register type
INP_REG_1_FLOAT	11	If the register contains a float value it shall be displayed here
INP_REG_1_INT_DEC	12	If the register contains a DWORD value and *dec* is chosen, it shall be displayed here
INP_REG_2_TYPE	13	Register type
INP_REG_2_FLOAT	14	If the register contains a float value it shall be displayed here

Parameter	Index Number	Description
INP_REG_2_INT_DEC	15	If the register contains a DWORD value and *dec* is chosen, it shall be displayed here
INP_REG_3_TYPE	16	Register type
INP_REG_3_FLOAT	17	If the register contains a float value it shall be displayed here
INP_REG_3_INT_DEC	18	If the register contains a DWORD value and *dec* is chosen, it shall be displayed here
INP_REG_4_TYPE	19	Register type
INP_REG_4_FLOAT	20	If the register contains a float value it shall be displayed here
INP_REG_4_INT_DEC	21	If the register contains a DWORD value and *dec* is chosen, it shall be displayed here
INP_REG_5_TYPE	22	Register type
INP_REG_5_FLOAT	23	If the register contains a float value it shall be displayed here
INP_REG_5_INT_DEC	24	If the register contains a DWORD value and *dec* is chosen, it shall be displayed here
INP_REG_6_TYPE	25	Register type
INP_REG_6_FLOAT	26	If the register contains a float value it shall be displayed here
INP_REG_6_INT_DEC	27	If the register contains a DWORD value and *dec* is chosen, it shall be displayed here
INP_REG_7_TYPE	28	Register type
INP_REG_7_FLOAT	29	If the register contains a float value it shall be displayed here
INP_REG_7_INT_DEC	30	If the register contains a DWORD value and *dec* is chosen, it shall be displayed here
INP_REG_8_TYPE	31	Register type
INP_REG_8_FLOAT	32	If the register contains a float value it shall be displayed here
INP_REG_8_INT_DEC	33	If the register contains a DWORD value and *dec* is chosen, it shall be displayed here
INP_REG_9_TYPE	34	Register type
INP_REG_9_FLOAT	35	If the register contains a float value it shall be displayed here
INP_REG_9_INT_DEC	36	If the register contains a DWORD value and *dec* is chosen, it shall be displayed here
INP_REG_10_TYPE	37	Register type
INP_REG_10_FLOAT	38	If the register contains a float value it shall be displayed here
INP_REG_10_INT_DEC	39	If the register contains a DWORD value and *dec* is chosen, it shall be displayed here
DB_REG_1_TYPE	40	Register type
DB_REG_1_FLOAT	41	If the register contains a float value it shall be displayed here
DB_REG_1_INT_DEC	42	If the register contains a DWORD value and *dec* is chosen, it shall be displayed here
DB_REG_2_TYPE	43	Register type
DB_REG_2_FLOAT	44	If the register contains a float value it shall be displayed here
DB_REG_2_INT_DEC	45	If the register contains a DWORD value and *dec* is chosen, it shall be displayed here
DB_REG_3_TYPE	46	Register type
DB_REG_3_FLOAT	47	If the register contains a float value it shall be displayed here
DB_REG_3_INT_DEC	48	If the register contains a DWORD value and *dec* is chosen, it shall be displayed here
DB_REG_4_TYPE	49	Register type
DB_REG_4_FLOAT	50	If the register contains a float value it shall be displayed here
DB_REG_4_INT_DEC	51	If the register contains a DWORD value and *dec* is chosen, it shall be displayed here

Parameter	Index Number	Description
DB_REG_5_TYPE	52	Register type
DB_REG_5_FLOAT	53	If the register contains a float value it shall be displayed here
DB_REG_5_INT_DEC	54	If the register contains a DWORD value and *dec* is chosen, it shall be displayed here
DB_REG_6_TYPE	55	Register type
DB_REG_6_FLOAT	56	If the register contains a float value it shall be displayed here
DB_REG_6_INT_DEC	57	If the register contains a DWORD value and *dec* is chosen, it shall be displayed here
DB_REG_7_TYPE	58	Register type
DB_REG_7_FLOAT	59	If the register contains a float value it shall be displayed here
DB_REG_7_INT_DEC	60	If the register contains a DWORD value and *dec* is chosen, it shall be displayed here
DB_REG_8_TYPE	61	Register type
DB_REG_8_FLOAT	62	If the register contains a float value it shall be displayed here
DB_REG_8_INT_DEC	63	If the register contains a DWORD value and *dec* is chosen, it shall be displayed here
DB_REG_9_TYPE	64	Register type
DB_REG_9_FLOAT	65	If the register contains a float value it shall be displayed here
DB_REG_9_INT_DEC	66	If the register contains a DWORD value and *dec* is chosen, it shall be displayed here
DB_REG_10_TYPE	67	Register type
DB_REG_10_FLOAT	68	If the register contains a float value it shall be displayed here
DB_REG_10_INT_DEC	69	If the register contains a DWORD value and *dec* is chosen, it shall be displayed here
RM_COMMAND	70	Used to set what will be read or write from a secondary master.
RM_DATA	71	Data read/write from secondary master.
RM_STATUS	72	Status read by a secondary master.

Appendix F Advanced Configuration Transducer Block

OVERVIEW

The Advanced Configuration Transducer Block contains functions for advanced configuration of the Rosemount 5400 transmitter. It includes functions such as amplitude threshold settings for filtering of disturbing echoes and noise, simulation of measurement values, Empty Tank Handling for optimizing measurements close to the tank bottom and strapping table for volume measurements.

Advanced Configuration Transducer Block Parameters

Table F-1. Advanced Configuration Transducer Block Parameters

Parameter	Index Number	Description
ST_REV	1	The revision level of the static data associated with the function block. The revision value increments each time a static parameter value in the block is changed.
TAG_DESC	2	The user description of the intended application of the block.
STRATEGY0	3	The strategy field can be used to identify grouping of blocks. This data is not checked or processed by the block.
ALERT_KEY	4	The identification number of the plant unit. This information may be used in the host for sorting alarms, etc.
MODE_BLK	5	The actual, target, permitted, and normal modes of the block. Target: The mode to “go to” Actual: The mode the “block is currently in” Permitted: Allowed modes that target may take on Normal: Most common mode for target
BLOCK_ERR	6	This parameter reflects the error status associated with the hardware or software components associated with a block. It is a bit string, so that multiple errors may be shown.
TRANSDUCER_TYPE	7	Identifies the transducer. 100 = Standard pressure with calibration
XD_ERROR	8	A transducer block alarm subcode.
AMPLITUDE_THRESHOLD_CURVE	9	ATC: filters out weak disturbance echoes and noise.
SIMULATION_MODE	10	Simulation of measurement values.
SURFACE_SEARCH	11	If the device has locked on a false echo you can use this function to force the device to search for the product surface echo within the whole tank.
SET_EMPTY_TANK	12	Set Empty Tank; The Empty Tank Handling functions opmize measurements when the surface echo is close to the tank bottom.
SET_CONSTANT_THRESHOLD	13	A constant amplitude threshold can be used to filter out noise.
ECHO_REG	14	Read Echo distance, amplitude and class from gauge.
ECHO_WRITE	15	Echo Found/False Record.

Parameter	Index Number	Description
VOL_VOLUME_CALC_METHOD	16	Tank geometry
VOL_IDEAL_DIAMETER	17	Tank diameter
VOL_IDEAL_LENGTH	18	Tank length
VOL_VOLUME_OFFSET	19	Volume offset
VOL_STRAP_TABLE_LENGTH	20	Number of strap points
VOL_STRAP_LEV_1	21	Strap value level
VOL_STRAP_VOL_1	22	Strap value volume
VOL_STRAP_LEV_2	23	Strap value level
VOL_STRAP_VOL_2	24	Strap value volume
VOL_STRAP_LEV_3	25	Strap value level
VOL_STRAP_VOL_3	26	Strap value volume
VOL_STRAP_LEV_4	27	Strap value level
VOL_STRAP_VOL_4	28	Strap value volume
VOL_STRAP_LEV_5	29	Strap value level
VOL_STRAP_VOL_5	30	Strap value volume
VOL_STRAP_LEV_6	31	Strap value level
VOL_STRAP_VOL_6	32	Strap value volume
VOL_STRAP_LEV_7	33	Strap value level
VOL_STRAP_VOL_7	34	Strap value volume
VOL_STRAP_LEV_8	35	Strap value level
VOL_STRAP_VOL_8	36	Strap value volume
VOL_STRAP_LEV_9	37	Strap value level
VOL_STRAP_VOL_9	38	Strap value volume
VOL_STRAP_LEV_10	39	Strap value level
VOL_STRAP_VOL_10	40	Strap value volume
VOL_STRAP_LEV_11	41	Strap value level
VOL_STRAP_VOL_11	42	Strap value volume
VOL_STRAP_LEV_12	43	Strap value level
VOL_STRAP_VOL_12	44	Strap value volume
VOL_STRAP_LEV_13	45	Strap value level
VOL_STRAP_VOL_13	46	Strap value volume
VOL_STRAP_LEV_14	47	Strap value level
VOL_STRAP_VOL_14	48	Strap value volume
VOL_STRAP_LEV_15	49	Strap value level
VOL_STRAP_VOL_15	50	Strap value volume
VOL_STRAP_LEV_16	51	Strap value level
VOL_STRAP_VOL_16	52	Strap value volume
VOL_STRAP_LEV_17	53	Strap value level
VOL_STRAP_VOL_17	54	Strap value volume
VOL_STRAP_LEV_18	55	Strap value level
VOL_STRAP_VOL_18	56	Strap value volume
VOL_STRAP_LEV_19	57	Strap value level
VOL_STRAP_VOL_19	58	Strap value volume
VOL_STRAP_LEV_20	59	Strap value level
VOL_STRAP_VOL_20	60	Strap value volume

Appendix G Resource Transducer Block

OVERVIEW

This section contains information on the Rosemount 5400 Series Radar Level Transmitter Resource Block. Descriptions of all Resource Block Parameters, errors, and diagnostics are included. Also the modes, alarm detection, status handling, and troubleshooting are discussed.

Definition

The resource block defines the physical resources of the device. The resource block also handles functionality that is common across multiple blocks. The block has no linkable inputs or outputs.

PARAMETERS AND DESCRIPTIONS

The table below lists all of the configurable parameters of the Resource Block, including the descriptions and index numbers for each.

Parameter	Index Number	Description
ACK_OPTION	38	Selection of whether alarms associated with the function block will be automatically acknowledged.
ADVISE_ACTIVE	82	Enumerated list of advisory conditions within a device.
ADVISE_ALM	83	Alarm indicating advisory alarms. These conditions do not have a direct impact on the process or device integrity.
ADVISE_ENABLE	80	Enabled ADVISE_ALM alarm conditions. Corresponds bit for bit to the ADVISE_ACTIVE. A bit on means that the corresponding alarm condition is enabled and will be detected. A bit off means the corresponding alarm condition is disabled and will not be detected.
ADVISE_MASK	81	Mask of ADVISE_ALM. Corresponds bit of bit to ADVISE_ACTIVE. A bit on means that the condition is masked out from alarming.
ADVISE_PRI	79	Designates the alarming priority of the ADVISE_ALM
ALARM_SUM	37	The current alert status, unacknowledged states, unreported states, and disabled states of the alarms associated with the function block.
ALERT_KEY	04	The identification number of the plant unit.
BLOCK_ALM	36	The block alarm is used for all configuration, hardware, connection failure or system problems in the block. The cause of the alert is entered in the subcode field. The first alert to become active will set the Active status in the Status parameter. As soon as the Unreported status is cleared by the alert reporting task, another block alert may be reported without clearing the Active status, if the subcode has changed.
BLOCK_ERR	06	This parameter reflects the error status associated with the hardware or software components associated with a block. It is a bit string, so that multiple errors may be shown.
CLR_FSTATE	30	Writing a Clear to this parameter will clear the device FAIL_SAFE if the field condition has cleared.
CONFIRM_TIME	33	The time the resource will wait for confirmation of receipt of a report before trying again. Retry will not happen when CONFIRM_TIME=0.
CYCLE_SEL	20	Used to select the block execution method for this resource. The Rosemount 5600 supports the following: Scheduled: Blocks are only executed based on the function block schedule. Block Execution: A block may be executed by linking to another blocks completion.

Parameter	Index Number	Description
CYCLE_TYPE	19	Identifies the block execution methods available for this resource.
DD_RESOURCE	09	String identifying the tag of the resource which contains the Device Description for this resource.
DD_REV	13	Revision of the DD associated with the resource - used by an interface device to locate the DD file for the resource.
DEFINE_WRITE_LOCK	60	Allows the operator to select how WRITE_LOCK behaves. The initial value is “lock everything”. If the value is set to “lock only physical device” then the resource and transducer blocks of the device will be locked but changes to function blocks will be allowed.
DETAILED_STATUS	55	Indicates the state of the transmitter. See Resource Block detailed status codes.
DEV_REV	12	Manufacturer revision number associated with the resource - used by an interface device to locate the DD file for the resource.
DEV_STRING	43	This is used to load new licensing into the device. The value can be written but will always read back with a value of 0.
DEV_TYPE	11	Manufacturer’s model number associated with the resource - used by interface devices to locate the DD file for the resource.
DIAG_OPTION	46	Indicates which diagnostics licensing options are enabled.
DISTRIBUTOR	42	Reserved for use as distributor ID. No Foundation enumerations defined at this time.
DOWNLOAD_MODE	67	Gives access to the boot block code for over-the-wire downloads. 0 = Uninitialized 1 = Run mode 2 = Download mode
FAULT_STATE	28	Condition set by loss of communication to an output block, fault promoted to an output block or physical contact. When FAIL_SAFE condition is set, then output function blocks will perform their FAIL_SAFE actions.
FAILED_ACTIVE	72	Enumerated list of failure conditions within a device.
FAILED_ALM	73	Alarm indicating a failure within a device which makes the device non-operational.
FAILED_ENABLE	70	Enabled FAILED_ALM alarm conditions. Corresponds bit for bit to the FAILED_ACTIVE. A bit on means that the corresponding alarm condition is enabled and will be detected. A bit off means the corresponding alarm condition is disabled and will not be detected.
FAILED_MASK	71	Mask of FAILED_ALM. Corresponds bit of bit to FAILED_ACTIVE. A bit on means that the condition is masked out from alarming.
FAILED_PRI	69	Designates the alarming priority of the FAILED_ALM.
FB_OPTION	45	Indicates which function block licensing options are enabled.
FEATURES	17	Used to show supported resource block options. See Error! Reference source not found. The supported features are: SOFT_WRITE_LOCK_SUPPORT, HARD_WRITE_LOCK_SUPPORT, REPORTS, and UNICODE
FEATURES_SEL	18	Used to select resource block options.
FINAL_ASSY_NUM	54	The same final assembly number placed on the neck label.
FREE_SPACE	24	Percent of memory available for further configuration. Zero in a preconfigured device.
FREE_TIME	25	Percent of the block processing time that is free to process additional blocks.
GRANT_DENY	14	Options for controlling access of host computers and local control panels to operating, tuning, and alarm parameters of the block. Not used by device.
HARD_TYPES	15	The types of hardware available as channel numbers.
HARDWARE_REV	52	Hardware revision of the hardware that has the resource block in it.
HEALTH_INDEX	84	Parameter representing the overall health of the device, 100 being perfect and 1 being non-functioning. The value is based on the active PWA alarms.
ITK_VER	41	Major revision number of the inter operability test case used in certifying this device as interoperable. The format and range are controlled by the Fieldbus Foundation.
LIM_NOTIFY	32	Maximum number of unconfirmed alert notify messages allowed.
MAINT_ACTIVE	77	Enumerated list of maintenance conditions within a device.

Parameter	Index Number	Description
MAINT_ALM	78	Alarm indicating the device needs maintenance soon. If the condition is ignored, the device will eventually fail.
MAINT_ENABLE	75	Enabled MAINT_ALM alarm conditions. Corresponds bit for bit to the MAINT_ACTIVE. A bit on means that the corresponding alarm condition is enabled and will be detected. A bit off means the corresponding alarm condition is disabled and will not be detected.
MAINT_MASK	76	Mask of MAINT_ALM. Corresponds bit of bit to MAINT_ACTIVE. A bit on means that the condition is masked out from alarming.
MAINT_PRI	74	Designates the alarming priority of the MAINT_ALM
MANUFAC_ID	10	Manufacturer identification number – used by an interface device to locate the DD file for the resource.
MAX_NOTIFY	31	Maximum number of unconfirmed notify messages possible.
MEMORY_SIZE	22	Available configuration memory in the empty resource. To be checked before attempting a download.
MESSAGE_DATE	57	Date associated with the MESSAGE_TEXT parameter.
MESSAGE_TEXT	58	Used to indicate changes made by the user to the device's installation, configuration, or calibration.
MIN_CYCLE_T	21	Time duration of the shortest cycle interval of which the resource is capable.
MISC_OPTION	47	Indicates which miscellaneous licensing options are enabled.
MODE_BLK	05	The actual, target, permitted, and normal modes of the block: Target: The mode to “go to” Actual: The mode the “block is currently in” Permitted: Allowed modes that target may take on Normal: Most common mode for actual
NV_CYCLE_T	23	Minimum time interval specified by the manufacturer for writing copies of NV parameters to non-volatile memory. Zero means it will never be automatically copied. At the end of NV_CYCLE_T, only those parameters which have changed need to be updated in NVRAM.
OUTPUT_BOARD_SN	53	Output board serial number.
PWA_SIMULATE	85	Parameter allowing simulation of PWA alarms.
RB_SFTWR_REV_ALL	51	The string will contains the following fields: Major rev: 1-3 characters, decimal number 0-255 Minor rev: 1-3 characters, decimal number 0-255 Build rev: 1-5 characters, decimal number 0-255 Time of build: 8 characters, xx:xx:xx, military time Day of week of build: 3 characters, Sun, Mon,... Month of build: 3 characters, Jan, Feb. Day of month of build: 1-2 characters, decimal number 1-31 Year of build: 4 characters, decimal Builder: 7 characters, login name of builder
RB_SFTWR_REV_BUILD	50	Build of software that the resource block was created with.
RB_SFTWR_REV_MAJOR	48	Major revision of software that the resource block was created with.
RB_SFTWR_REV_MINOR	49	Minor revision of software that the resource block was created with.
RECOMMENDED_ACTION	68	Enumerated list of recommended actions displayed with a device alert.
RESTART	16	Allows a manual restart to be initiated. Several degrees of restart are possible. They are the following: 1 Run – nominal state when not restarting 2 Restart resource – not used 3 Restart with defaults – set parameters to default values. See START_WITH_DEFAULTS below for which parameters are set. 4 Restart processor – does a warm start of CPU.
RS_STATE	07	State of the function block application state machine.
SAVE_CONFIG_BLOCKS	62	Number of EEPROM blocks that have been modified since last burn. This value will count down to zero when the configuration is saved.

Parameter	Index Number	Description
SAVE_CONFIG_NOW	61	Allows the user to optionally save all non-volatile information immediately.
SECURITY_IO	65	Status of security switch.
SELF_TEST	59	Instructs resource block to perform self-test. Tests are device specific.
SET_FSTATE	29	Allows the FAIL_SAFE condition to be manually initiated by selecting Set.
SHED_RCAS	26	Time duration at which to give up on computer writes to function block RCas locations. Shed from RCas shall never happen when SHED_ROUT = 0
SHED_ROUT	27	Time duration at which to give up on computer writes to function block ROut locations. Shed from ROut shall never happen when SHED_ROUT = 0
SIMULATE_IO	64	Status of simulate switch.
SIMULATE_STATE	66	The state of the simulate switch: 0 = Uninitialized 1 = Switch off, simulation not allowed 2 = Switch on, simulation not allowed (need to cycle jumper/switch) 3 = Switch on, simulation allowed
ST_REV	01	The revision level of the static data associated with the function block.
START_WITH_DEFAULTS	63	0 = Uninitialized 1 = do not power-up with NV defaults 2 = power-up with default node address 3 = power-up with default pd_tag and node address 4 = power-up with default data for the entire communications stack (no application data)
STRATEGY	03	The strategy field can be used to identify grouping of blocks.
SUMMARY_STATUS	56	An enumerated value of repair analysis.
TAG_DESC	02	The user description of the intended application of the block.
TEST_RW	08	Read/write test parameter - used only for conformance testing.
UPDATE_EVT	35	This alert is generated by any change to the static data.
WRITE_ALM	40	This alert is generated if the write lock parameter is cleared.
WRITE_LOCK	34	If set, no writes from anywhere are allowed, except to clear WRITE_LOCK. Block inputs will continue to be updated.
WRITE_PRI	39	Priority of the alarm generated by clearing the write lock.
XD_OPTION	44	Indicates which transducer block licensing options are enabled.

PlantWeb™ Alerts

The Resource Block will act as a coordinator for PlantWeb alerts. There will be three alarm parameters (FAILED_ALARM, MAINT_ALARM, and ADVISE_ALARM) which will contain information regarding some of the device errors which are detected by the transmitter software. There will be a RECOMMENDED_ACTION parameter which will be used to display the recommended action text for the highest priority alarm and a HEALTH_INDEX parameters (0 - 100) indicating the overall health of the transmitter. FAILED_ALARM will have the highest priority followed by MAINT_ALARM and ADVISE_ALARM will be the lowest priority.

FAILED_ALARMS
A failure alarm indicates a failure within a device that will make the device or some part of the device non-operational. This implies that the device is in need of repair and must be fixed immediately. There are five parameters associated with FAILED_ALARMS specifically, they are described below.

FAILED_ENABLED
This parameter contains a list of failures in the device which makes the device non-operational that will cause an alert to be sent. Below is a list of the failures with the highest priority first.

1. Microwave Unit
2. Electronics
3. Configuration
4. Invalid Strapping Table
5. NV Memory
6. IO
7. Hardware Electronics
8. Level Measurement
9. Volume Measurement

FAILED_MASK
This parameter will mask any of the failed conditions listed in FAILED_ENABLED. A bit on means that the condition is masked out from alarming and will not be reported.

FAILED_PRI
Designates the alerting priority of the FAILED_ALM, see Alarm Priority on page G-7. The default is 0 and the recommended values are between 8 and 15.

FAILED_ACTIVE
This parameter displays which of the alarms is active. Only the alarm with the highest priority will be displayed. This priority is not the same as the FAILED_PRI parameter described above. This priority is hard coded within the device and is not user configurable.

FAILED_ALM
Alarm indicating a failure within a device which makes the device non-operational.

MAINT_ALARMS
A maintenance alarm indicates the device or some part of the device needs maintenance soon. If the condition is ignored, the device will eventually fail. There are five parameters associated with MAINT_ALARMS, they are described below.

MAINT_ENABLED
The MAINT_ENABLED parameter contains a list of conditions indicating the device or some part of the device needs maintenance soon.

Below is a list of the conditions with the highest priority first.

1. Antenna Contamination
2. Hardware Warning
3. Configuration Warning
4. Temperature/Volume Warning

MAINT_MASK
The MAINT_MASK parameter will mask any of the failed conditions listed in MAINT_ENABLED. A bit on means that the condition is masked out from alarming and will not be reported.

MAINT_PRI
MAINT_PRI designates the alarming priority of the MAINT_ALM, see Process Alarms on page G-7. The default is 0 and the recommended values is 3 to 7.

MAINT_ACTIVE
The MAINT_ACTIVE parameter displays which of the alarms is active. Only the condition with the highest priority will be displayed. This priority is not the same as the MAINT_PRI parameter described above. This priority is hard coded within the device and is not user configurable.

MAINT_ALM
An alarm indicating the device needs maintenance soon. If the condition is ignored, the device will eventually fail.

Advisory Alarms
An advisory alarm indicates informative conditions that do not have a direct impact on the device's primary functions There are five parameters associated with ADVISE_ALARMS, they are described below.

ADVISE_ENABLED
The ADVISE_ENABLED parameter contains a list of informative conditions that do not have a direct impact on the device's primary functions. Below is a list of the advisories with the highest priority first.

1. Gauge Simulation Active
2. NV Writes Deferred
3. PWA Simulate Active

ADVISE_MASK
The ADVISE_MASK parameter will mask any of the failed conditions listed in ADVISE_ENABLED. A bit on means the condition is masked out from alarming and will not be reported.

ADVISE_PRI
ADVISE_PRI designates the alarming priority of the ADVISE_ALM, see Process Alarms on page G-7. The default is 0 and the recommended values are 1 or 2.

ADVISE_ACTIVE
The ADVISE_ACTIVE parameter displays which of the advisories is active. Only the advisory with the highest priority will be displayed. This priority is not the same as the ADVISE_PRI parameter described above. This priority is hard coded within the device and is not user configurable.

ADVISE_ALM
ADVISE_ALM is an alarm indicating advisory alarms. These conditions do not have a direct impact on the process or device integrity.

Alarm Priority

Alarms are grouped into five levels of priority:

Priority Number	Priority Description
0	The alarm condition is not used.
1	An alarm condition with a priority of 1 is recognized by the system, but is not reported to the operator.
2	An alarm condition with a priority of 2 is reported to the operator.
3-7	Alarm conditions of priority 3 to 7 are advisory alarms of increasing priority.
8-15	Alarm conditions of priority 8 to 15 are critical alarms of increasing priority.

Process Alarms

Process Alarm detection is based on the OUT value. Configure the alarm limits of the following standard alarms:

- High (HI_LIM)
- High high (HI_HI_LIM)
- Low (LO_LIM)
- Low low (LO_LO_LIM)

In order to avoid alarm chattering when the variable is oscillating around the alarm limit, an alarm hysteresis in percent of the PV span can be set using the ALARM_HYS parameter. The priority of each alarm is set in the following parameters:

- HI_PRI
- HI_HI_PRI
- LO_PRI
- LO_LO_PRI

Recommended Actions for PlantWeb Alerts

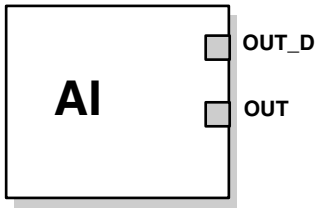
RECOMMENDED_ACTION
The RECOMMENDED_ACTION parameter displays a text string that will give a recommended course of action to take based on which type and which specific event of the PlantWeb alerts are active.

Table G-1. RB.RECOMMENDED_ACTION

	Alarm Type	Failed/Maint/Advise Active Event	Recommended Action Text String
PlantWeb Alerts	None	None	No action required
	Advisory	NV Writes Deferred	Non-volatile writes have been deferred, leave the device powered until the advisory goes away.
		Gauge Simulation Active	Use Simulation Method under advanced configuration tool to get the device out of Simulation Mode.
		PWA Simulation Active	Disable simulation to return to process monitoring and control.
	Maintenance	Hardware Warning	Replace the device.
		Antenna Contamination	Clean the antenna.
		Configuration Warning	Load default database and configure the device.
		Temperature/Volume Warning	1. Check ambient temperature at installation site 2. Verify Strapping Table.
	Failed	Electronics Failure	Replace the Fieldbus Electronics Board.
		NV Memory Failure	Reset the device then download the Device Configuration.
		IO Failure	Replace the device.
		Microwave Unit Error	Replace the device.
		Configuration Error	Load default database and reconfigure the device.
		Invalid Strapping Table	Check that the strapping table values are input in ascending order.
		Hardware Electronics Failure	Replace the device.
		Level Measurment Failure	Check the device configuration.
		Volume Measurment Failure	Check the volume configuration.

Appendix H Analog-Input Block

Figure H-1. Analog-Input Block



FIELDBUS-FBUS_31A

OUT=The block output value and status
OUT_D=Discrete output that signals a selected alarm condition

The Analog Input (AI) function block processes field device measurements and makes them available to other function blocks. The output value from the AI block is in engineering units and contains a status indicating the quality of the measurement. The measuring device may have several measurements or derived values available in different channels. Use the channel number to define the variable that the AI block processes.

The AI block supports alarming, signal scaling, signal filtering, signal status calculation, mode control, and simulation. In Automatic mode, the block's output parameter (OUT) reflects the process variable (PV) value and status. In Manual mode, OUT may be set manually. The Manual mode is reflected on the output status. A discrete output (OUT_D) is provided to indicate whether a selected alarm condition is active. Alarm detection is based on the OUT value and user specified alarm limits. Figure H-2 on page H-4 illustrates the internal components of the AI function block, and Table H-1 lists the AI block parameters and their units of measure, descriptions, and index numbers.

Table H-1. Definitions of Analog Input Function Block System Parameters

Parameter	Index Number	Units	Description
ACK_OPTION	23	None	Used to set auto acknowledgment of alarms.
ALARM_HYS	24	Percent	The amount the alarm value must return within the alarm limit before the associated active alarm condition clears.

Parameter	Index Number	Units	Description
ALARM_SEL	38	None	Used to select the process alarm conditions that will cause the OUT_D parameter to be set.
ALARM_SUM	22	None	The summary alarm is used for all process alarms in the block. The cause of the alert is entered in the subcode field. The first alert to become active will set the Active status in the Status parameter. As soon as the Unreported status is cleared by the alert reporting task, another block alert may be reported without clearing the Active status, if the subcode has changed.
ALERT_KEY	04	None	The identification number of the plant unit. This information may be used in the host for sorting alarms, etc.
BLOCK_ALM	21	None	The block alarm is used for all configuration, hardware, connection failure or system problems in the block. The cause of the alert is entered in the subcode field. The first alert to become active will set the Active status in the Status parameter. As soon as the Unreported status is cleared by the alert reporting task, another block alert may be reported without clearing the Active status, if the subcode has changed.
BLOCK_ERR	06	None	This parameter reflects the error status associated with the hardware or software components associated with a block. It is a bit string, so that multiple errors may be shown.
CHANNEL	15	None	The CHANNEL value is used to select the measurement value. Refer to the appropriate device manual for information about the specific channels available in each device. You must configure the CHANNEL parameter before you can configure the XD_SCALE parameter.
FIELD_VAL	19	Percent	The value and status from the transducer block or from the simulated input when simulation is enabled.
GRANT_DENY	12	None	Options for controlling access of host computers and local control panels to operating, tuning, and alarm parameters of the block. Not used by device.
HI_ALM	34	None	The HI alarm data, which includes a value of the alarm, a timestamp of occurrence and the state of the alarm.
HI_HI_ALM	33	None	The HI HI alarm data, which includes a value of the alarm, a timestamp of occurrence and the state of the alarm.
HI_HI_LIM	26	EU of PV_SCALE	The setting for the alarm limit used to detect the HI HI alarm condition.
HI_HI_PRI	25	None	The priority of the HI HI alarm.
HI_LIM	28	EU of PV_SCALE	The setting for the alarm limit used to detect the HI alarm condition.
HI_PRI	27	None	The priority of the HI alarm.
IO_OPTS	13	None	Allows the selection of input/output options used to alter the PV. Low cutoff enabled is the only selectable option.
L_TYPE	16	None	Linearization type. Determines whether the field value is used directly (Direct) or is converted linearly (Indirect).
LO_ALM	35	None	The LO alarm data, which includes a value of the alarm, a timestamp of occurrence and the state of the alarm.
LO_LIM	30	EU of PV_SCALE	The setting for the alarm limit used to detect the LO alarm condition.
LO_LO_ALM	36	None	The LO LO alarm data, which includes a value of the alarm, a timestamp of occurrence and the state of the alarm.
LO_LO_LIM	32	EU of PV_SCALE	The setting for the alarm limit used to detect the LO LO alarm condition.
LO_LO_PRI	31	None	The priority of the LO LO alarm.
LO_PRI	29	None	The priority of the LO alarm.
LOW_CUT	17	%	If percentage value of transducer input fails below this, PV = 0.
MODE_BLK	05	None	The actual, target, permitted, and normal modes of the block. Target: The mode to “go to” Actual: The mode the “block is currently in” Permitted: Allowed modes that target may take on Normal: Most common mode for target

Parameter	Index Number	Units	Description
OUT	08	EU of OUT_SCALE	The block output value and status.
OUT_D	37	None	Discrete output to indicate a selected alarm condition.
OUT_SCALE	11	None	The high and low scale values, engineering units code, and number of digits to the right of the decimal point associated with OUT.
PV	07	EU of XD_SCALE	The process variable used in block execution.
PV_FTIME	18	Seconds	The time constant of the first-order PV filter. It is the time required for a 63% change in the IN value.
SIMULATE	09	None	A group of data that contains the current transducer value and status, the simulated transducer value and status, and the enable/disable bit.
STRATEGY	03	None	The strategy field can be used to identify grouping of blocks. This data is not checked or processed by the block.
ST_REV	01	None	The revision level of the static data associated with the function block. The revision value will be incremented each time a static parameter value in the block is changed.
TAG_DESC	02	None	The user description of the intended application of the block.
UPDATE_EVT	20	None	This alert is generated by any change to the static data.
VAR_INDEX	39	% of OUT Range	The average absolute error between the PV and its previous mean value over that evaluation time defined by VAR_SCAN.
VAR_SCAN	40	Seconds	The time over which the VAR_INDEX is evaluated.
XD_SCALE	10	None	The high and low scale values, engineering units code, and number of digits to the right of the decimal point associated with the channel input value.

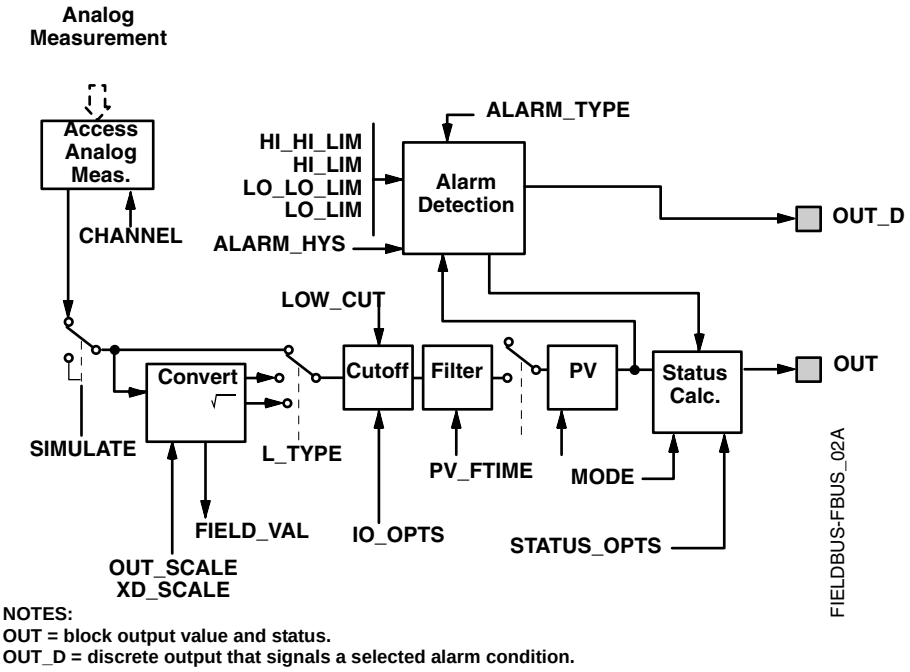
SIMULATION

To support testing, you can either change the mode of the block to manual and adjust the output value, or you can enable simulation through the configuration tool and manually enter a value for the measurement value and its status. In both cases, you must first set the ENABLE jumper on the field device.

NOTE
All fieldbus instruments have a simulation jumper. As a safety measure, the jumper has to be reset every time there is a power interruption. This measure is to prevent devices that went through simulation in the staging process from being installed with simulation enabled.

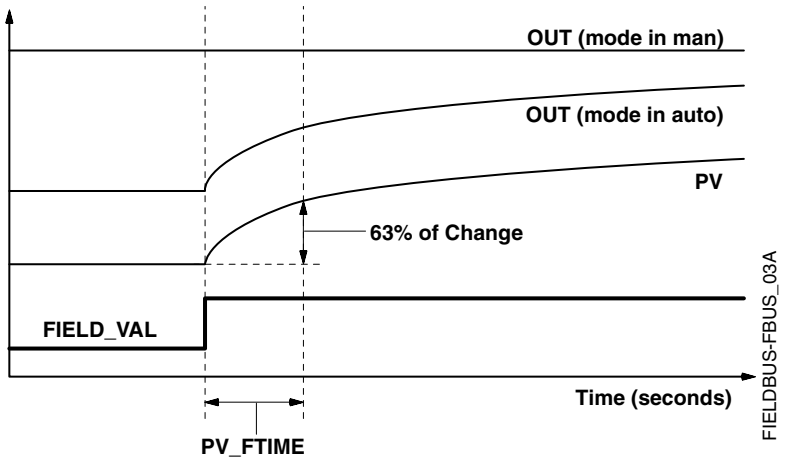
With simulation enabled, the actual measurement value has no impact on the OUT value or the status.

Figure H-2. Analog Input Function Block Schematic



NOTES:
OUT = block output value and status.
OUT_D = discrete output that signals a selected alarm condition.

Figure H-3. Analog Input Function Block Timing Diagram



DAMPING

The filtering feature changes the response time of the device to smooth variations in output readings caused by rapid changes in input. You can adjust the filter time constant (in seconds) using the PV_FTIME parameter. Set the filter time constant to zero to disable the filter feature.

SIGNAL CONVERSION

You can set the signal conversion type with the Linearization Type (L_TYPE) parameter. You can view the converted signal (in percent of XD_SCALE) through the FIELD_VAL parameter.

$$\text{FIELD\_VAL} = \frac{100 \times (\text{Channel Value} - \text{EU*@0\%})}{(\text{EU*@100\%} - \text{EU*@0\%})}$$

*** XD_SCALE values**

You can choose from direct or indirect signal conversion with the L_TYPE parameter.

Direct

Direct signal conversion allows the signal to pass through the accessed channel input value (or the simulated value when simulation is enabled).

$$PV = \text{Channel Value}$$

Indirect

Indirect signal conversion converts the signal linearly to the accessed channel input value (or the simulated value when simulation is enabled) from its specified range (XD_SCALE) to the range and units of the PV and OUT parameters (OUT_SCALE).

$$PV = \left(\frac{\text{FIELD\_VAL}}{100}\right) \times (\text{EU**@100\%} - \text{EU**@0\%}) + \text{EU**@0\%}$$

**** OUT_SCALE values**

Indirect Square Root

Indirect Square Root signal conversion takes the square root of the value computed with the indirect signal conversion and scales it to the range and units of the PV and OUT parameters..

$$PV = \sqrt{\left(\frac{\text{FIELD\_VAL}}{100}\right)} \times (\text{EU**@100\%} - \text{EU**@0\%}) + \text{EU**@0\%}$$

**** OUT_SCALE values**

When the converted input value is below the limit specified by the LOW_CUT parameter, and the Low Cutoff I/O option (IO_OPTS) is enabled (True), a value of zero is used for the converted value (PV). This option is useful to eliminate false readings when the differential pressure measurement is close to zero, and it may also be useful with zero-based measurement devices such as flowmeters.

NOTE
Low Cutoff is the only I/O option supported by the AI block. You can set the I/O option in **Manual** or **Out of Service** mode only.

BLOCK ERRORS

Table H-2 lists conditions reported in the BLOCK_ERR parameter.

Table H-2. BLOCK_ERR Conditions

Condition Number	Condition Name and Description
0	Other
1	**Block Configuration Error:** the selected channel carries a measurement that is incompatible with the engineering units selected in XD_SCALE, the L_TYPE parameter is not configured, or CHANNEL = zero.
2	Link Configuration Error
3	**Simulate Active:** Simulation is enabled and the block is using a simulated value in its execution.
4	Local Override
5	Device Fault State Set
6	Device Needs Maintenance Soon
7	**Input Failure/Process Variable has Bad Status:** The hardware is bad, or a bad status is being simulated.
8	**Output Failure:** The output is bad based primarily upon a bad input.
9	Memory Failure
10	Lost Static Data
11	Lost NV Data
12	Readback Check Failed
13	Device Needs Maintenance Now
14	Power Up
15	**Out of Service:** The actual mode is out of service.

MODES

The AI Function Block supports three modes of operation as defined by the MODE_BLK parameter:

- **Manual (Man)** The block output (OUT) may be set manually
- **Automatic (Auto)** OUT reflects the analog input measurement or the simulated value when simulation is enabled.
- **Out of Service (O/S)** The block is not processed. FIELD_VAL and PV are not updated and the OUT status is set to Bad: Out of Service. The BLOCK_ERR parameter shows Out of Service. In this mode, you can make changes to all configurable parameters. The target mode of a block may be restricted to one or more of the supported modes.

ALARM DETECTION

A block alarm will be generated whenever the BLOCK_ERR has an error bit set. The types of block error for the AI block are defined above.

Process Alarm detection is based on the OUT value. You can configure the alarm limits of the following standard alarms:

- High (HI_LIM)
- High high (HI_HI_LIM)
- Low (LO_LIM)
- Low low (LO_LO_LIM)

In order to avoid alarm chattering when the variable is oscillating around the alarm limit, an alarm hysteresis in percent of the PV span can be set using the ALARM_HYS parameter. The priority of each alarm is set in the following parameters:

- HI_PRI
- HI_HI_PRI
- LO_PRI
- LO_LO_PRI

Alarms are grouped into five levels of priority:

Table H-3. Alarm level priority

Priority Number	Priority Description
0	The priority of an alarm condition changes to 0 after the condition that caused the alarm is corrected.
1	An alarm condition with a priority of 1 is recognized by the system, but is not reported to the operator.
2	An alarm condition with a priority of 2 is reported to the operator, but does not require operator attention (such as diagnostics and system alerts).
3-7	Alarm conditions of priority 3 to 7 are advisory alarms of increasing priority.
8-15	Alarm conditions of priority 8 to 15 are critical alarms of increasing priority.

Status Handling

Normally, the status of the PV reflects the status of the measurement value, the operating condition of the I/O card, and any active alarm condition. In Auto mode, OUT reflects the value and status quality of the PV. In Man mode, the OUT status constant limit is set to indicate that the value is a constant and the OUT status is *Good*.

The **Uncertain** - EU range violation status is always set, and the PV status is set high- or low-limited if the sensor limits for conversion are exceeded.

In the STATUS_OPTS parameter, you can select from the following options to control the status handling:

BAD if Limited – sets the OUT status quality to *Bad* when the value is higher or lower than the sensor limits.

Uncertain if Limited – sets the OUT status quality to *Uncertain* when the value is higher or lower than the sensor limits.

Uncertain if in Manual mode – The status of the Output is set to *Uncertain* when the mode is set to Manual.

NOTES
The instrument must be in **Manual** or **Out of Service** mode to set the status option.
The AI block only supports the **BAD if Limited** option. Unsupported options are not grayed out; they appear on the screen in the same manner as supported options.

ADVANCED FEATURES

The AI function block provided with Fisher-Rosemount fieldbus devices provides added capability through the addition of the following parameters:

ALARM_TYPE – Allows one or more of the process alarm conditions detected by the AI function block to be used in setting its OUT_D parameter.

OUT_D – Discrete output of the AI function block based on the detection of process alarm condition(s). This parameter may be linked to other function blocks that require a discrete input based on the detected alarm condition.

VAR_SCAN – Time period in seconds over which the variability index (VAR_INDEX) is computed.

VAR_INDEX – Process variability index measured as the integral of average absolute error between PV and its mean value over the previous evaluation period. This index is calculated as a percent of OUT span and is updated at the end of the time period defined by VAR_SCAN.

CONFIGURE THE AI BLOCK

⚠ A minimum of four parameters are required to configure the AI Block. The parameters are described below with example configurations shown at the end of this section.

CHANNEL

Select the channel that corresponds to the desired sensor measurement. The Rosemount 5600 measures Level (channel 1), Distance (channel 2), Level Rate (channel 3), Signal Strength (channel 4), Volume (channel 5), and Average Temperature (channel 6).

L_TYPE

The L_TYPE parameter defines the relationship of the transmitter measurement (Level, Distance, Level Rate, Signal Strength, Volume, and Average Temperature) to the desired output of the AI Block. The relationship can be direct or indirect root.

Direct
Select direct when the desired output will be the same as the transmitter measurement (Level, Distance, Level Rate, Signal Strength, Volume, and Average Temperature).

Indirect
Select indirect when the desired output is a calculated measurement based on the transmitter measurement (Level, Distance, Level Rate, Signal Strength, Volume, and Average Temperature). The relationship between the transmitter measurement and the calculated measurement will be linear.

Indirect Square Root
Select indirect square root when the desired output is an inferred measurement based on the transmitter measurement and the relationship between the sensor measurement and the inferred measurement is square root (e.g. level).

XD_SCALE and OUT_SCALE

The XD_SCALE and OUT_SCALE each include three parameters: 0%, 100%, and, engineering units. Set these based on the L_TYPE:

L_TYPE is Direct
When the desired output is the measured variable, set the XD_SCALE to represent the operating range of the process. Set OUT_SCALE to match XD_SCALE.

L_TYPE is Indirect
When an inferred measurement is made based on the sensor measurement, set the XD_SCALE to represent the operating range that the sensor will see in the process. Determine the inferred measurement values that correspond to the XD_SCALE 0 and 100% points and set these for the OUT_SCALE.

L_TYPE is Indirect Square Root
When an inferred measurement is made based on the transmitter measurement and the relationship between the inferred measurement and sensor measurement is square root, set the XD_SCALE to represent the operating range that the sensor will see in the process. Determine the inferred measurement values that correspond to the XD_SCALE 0 and 100% points and set these for the OUT_SCALE.

NOTE
To avoid configuration errors, only select Engineering Units for XD_SCALE and OUT_SCALE that are supported by the device. The supported units are:

Table H-4. Length

Display	Description
m	meter
cm	centimeter
mm	millimeter
ft	feet
in	inch

Table H-5. Level Rate

Display	Description
m/s	meter per second
m/h	meter per hour
ft/s	feet per second
in/m	inch/minute

Table H-6. Temperature

Display	Description
°C	Degree Celsius
°F	Degree Fahrenheit

Table H-7. Signal Strength

Display	Description
mV	millivolt

Table H-8. Volume

Display	Description
m^3	Cubic meter
L	Liter
in^3	Cubic inch
ft^3	Cubic feet
Yd^3	Cubic yard
Gallon	US gallon
ImpGall	Imperial gallon
bbl	barrel

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