Reference Manual
00809-0100-4026, Rev HA
November 2014

Rosemount 5400 Series

Superior Performance Two-Wire Non-Contacting Radar Level Transmitter

ROSEMOUNT

EMERSON
Process Management

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, Emerson Process Management has two toll-free assistance numbers.

Customer Central:
Technical support, quoting, and order-related questions.

United States - 1-800-999-9307 (7:00 am to 7:00 pm CST)

Asia Pacific- 65 777 8211

Europe / Middle East / Africa - 49 (8153) 9390

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 Emerson Process Management 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 Emerson Process Management Sales Representative.

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

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

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Section 1 Introduction

1.1 Manual overview

The sections in this manual provide installation, configuration, and maintenance information for the Rosemount 5400 Series Radar Level Transmitter. The sections are organized as follows:

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- Describes the process of performing proof test

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- Describes the operation and parameters of the Level Transducer Block

Appendix F: Register Transducer Block

- Describes the operation and parameters of the Register Transducer Block

Appendix G: Advanced Configuration Transducer Block

- Describes the operation and parameters of the Advanced Configurations Transducer Block

Appendix H: Resource Block

- Describes the operation and parameters of the Resource Block

Appendix I: Analog-Input Block

- Describes the operation and parameters of the Analog-Input function block

1.2 Service support

To expedite the return process outside of the United States, contact the nearest Emerson Process Management representative.

Within the United States, call the Emerson Process Management Instrument and Valves 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.

⚠ CAUTION

Individuals who handle products exposed to a 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.

Emerson Process Management Instrument and Valves Response Center representatives will explain the additional information and procedures necessary to return goods exposed to hazardous substances.

1.3 Product recycling/ disposal

Recycling of equipment and packaging should be taken into consideration and disposed of in accordance with local and national legislation/regulations.

1.4 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 safe installation and service 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 services other than those contained in this manual unless you are qualified.
- Any substitution of non-authorized parts or repair, other than exchanging the complete transmitter head or antenna assembly, may jeopardize safety and is prohibited.
- Unauthorized changes to the product are strictly prohibited as they may unintentionally and unpredictably alter performance and jeopardize safety. Unauthorized changes that interfere with the integrity of the welds or flanges, such as making additional perforations, compromise product integrity and safety. Equipment ratings and certifications are no longer valid on any products that have been damaged or modified without the prior written permission of Emerson Process Management. Any continued use of product that has been damaged or modified without prior written authorization is at the customer's sole risk and expense.

Explosions could result in death or serious injury.

- Verify that the operating environment of the transmitter is consistent with the appropriate hazardous locations specifications. See "Product Certifications" on page 217 in this manual.
- To prevent ignition of flammable or combustible atmospheres, disconnect power before servicing.
- In an Explosion-proof/Flameproof installation, do not remove the transmitter cover when power is applied to the unit.
- Before connecting a HART®, FOUNDATION™ fieldbus, or Modbus® based communicator in an explosive atmosphere, make sure the instruments in the loop are installed in accordance with intrinsically safe or non-incendive field wiring practices.
- To avoid process leaks, only use O-rings designed to seal with the corresponding flange adapter.

Electrical shock can result in death or serious injury.

- Avoid contact with the leads and terminals. High voltage that may be present on leads can cause electrical shock.
- Make sure the main power to the Rosemount 5400 Series transmitter is off and the lines to any other external power source are disconnected or not powered while wiring the transmitter.

Antennas with non-conducting surfaces.

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

Section 2 Transmitter Overview

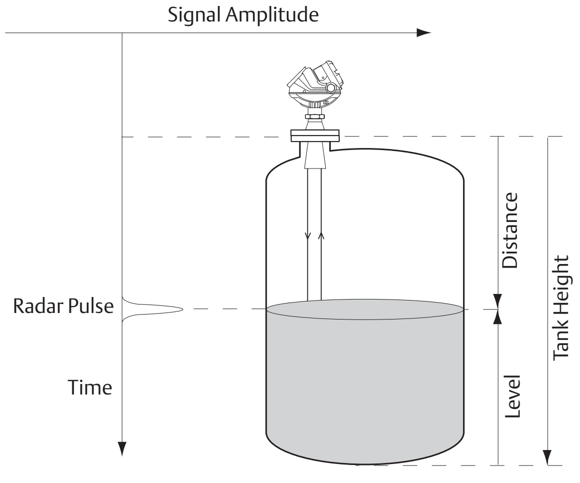
2.1 Theory of operation

The Rosemount 5400 Series Radar Transmitter is a smart, two-wire continuous level transmitter. A 5400 transmitter is installed at the top of the tank and emits short microwave pulses towards the product surface in the tank. When a pulse reaches the surface, 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, which calculates the level.

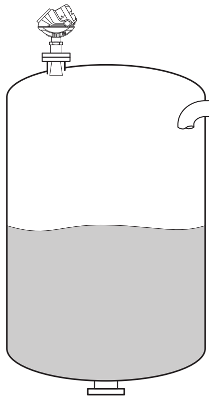
The product level is related to the tank height and the measured distance by the following expression:

Level = Tank Height - Distance

Figure 2-1. Measurement Principle for the Rosemount 5400 Series



2.2 Application examples



Tanks, vessels, and containers with calm surfaces

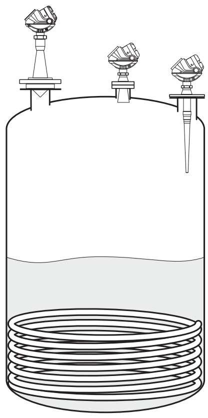
Non-contacting radar can be used in less challenging applications, such as storage and buffer tanks:

- It is easy to mount, maintenance-free, and highly accurate
- Gives precise monitoring and control of the process

Overfill and underfill detection

The Rosemount 5400 Series can be advantageous in risk reduction systems:

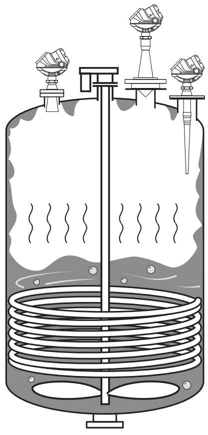
- Continuous measurement may reduce or simplify proof-tests
- Multiple 5400s can be used in the same tank



Corrosives

Radar measurement is ideal for most corrosive products, such as caustics, acids, solvents, and many other chemicals:

- Does not contact the process product
- Wide material offering such as PTFE, Alloy C-276 and Alloy 400
- Works well in non-metallic tanks also



Sticky, viscous, and crystallizing products

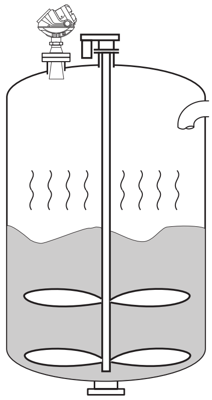
The best-in-class Rosemount 5400 Series provides an accurate and reliable level reading with difficult products, such as resins and adhesives:

- Non-contacting is best practice
- Almost unaffected by coating and build-up because of the uniquely designed condensation resistant antennas

Sludges and slurries

Applications like mud, pulp-stock, and lime slurries are ideal for non-contacting measurement:

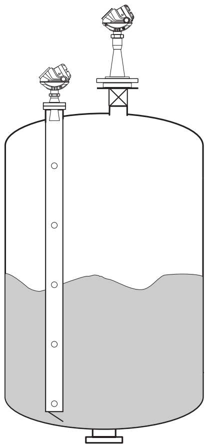
- Immune to splashing and solids content
- Unaffected by density changes
- No re-calibration, no or little maintenance



Reactor vessels

The innovative design of the Rosemount 5400 Series makes it an excellent choice for the most difficult applications, such as reactor vessels:

- Unique circular polarization provides greater mounting flexibility – no tank wall clearance distance is needed
- Direct measurement – independent of most variations in process conditions, such as density, dielectric, vapor, temperature, and pressure
- Can handle turbulent conditions created by agitation, top-filling, or process reaction

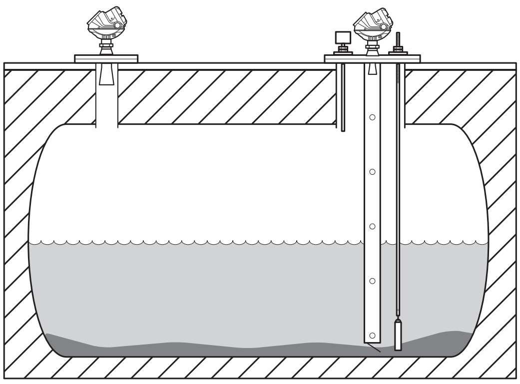


Mounting flexibility

The versatile Rosemount 5400 Series can be used in mounting configurations other than standard nozzles:

- Fits most existing pipes: 2-8 in. (50-200 mm)
- Easy to isolate from the process – use a ball-valve

Still-pipes reduce the influence of foam, turbulence, and tank obstructions. Ball-valves can be used on both still-pipes and nozzles.



Underground tanks

The mounting flexibility of the Rosemount 5400 Series makes it an excellent choice for many underground tanks:

- Easy top-mounting
- Can handle long narrow nozzles up to 6 ft (2 m) as long as they are clean and smooth, and pipes
- Unaffected by dirty products with solids content

2.3 System architecture

The Rosemount 5400 Series Radar Transmitter is loop-powered, and uses the same two wires for power supply and output signal. The output is a 4-20 mA analog signal superimposed with a digital HART®, FOUNDATION™ fieldbus or Modbus® signal.

By using the optional HART Tri-Loop™, the HART signal can be converted up to three additional 4-20 mA analog signals.

With the HART protocol, multidrop configuration is possible. In this case, communication is restricted to digital, since current is fixed to the 4 mA minimum value.

The transmitter can be connected to a Rosemount 751 Field Signal Indicator, or it can be equipped with an integral display.

The transmitter can easily be configured using a Field Communicator or a PC with the Rosemount Radar Master (RRM) software. Rosemount 5400 Series transmitters can also be configured with the AMS® Suite and DeltaV™ software, and other tools that support Electronic Device Description Language (EDDL) functionality.

For HART communication, a minimum load resistance of 250 Ω within the loop is required.

Figure 2-2. HART System Architecture

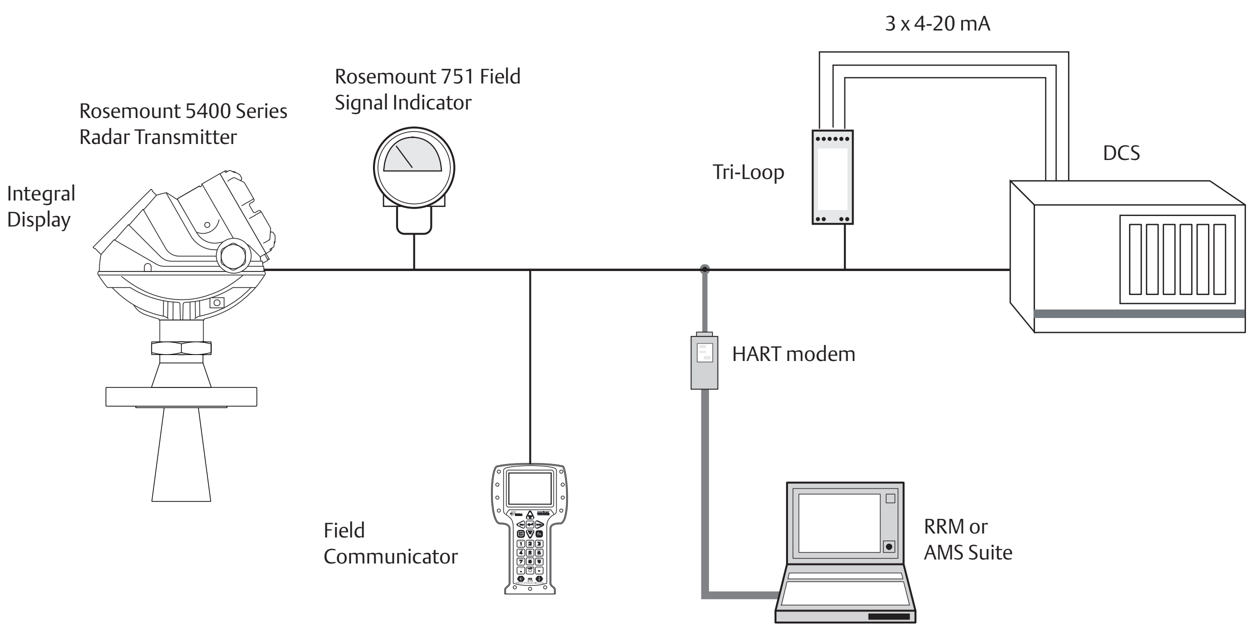
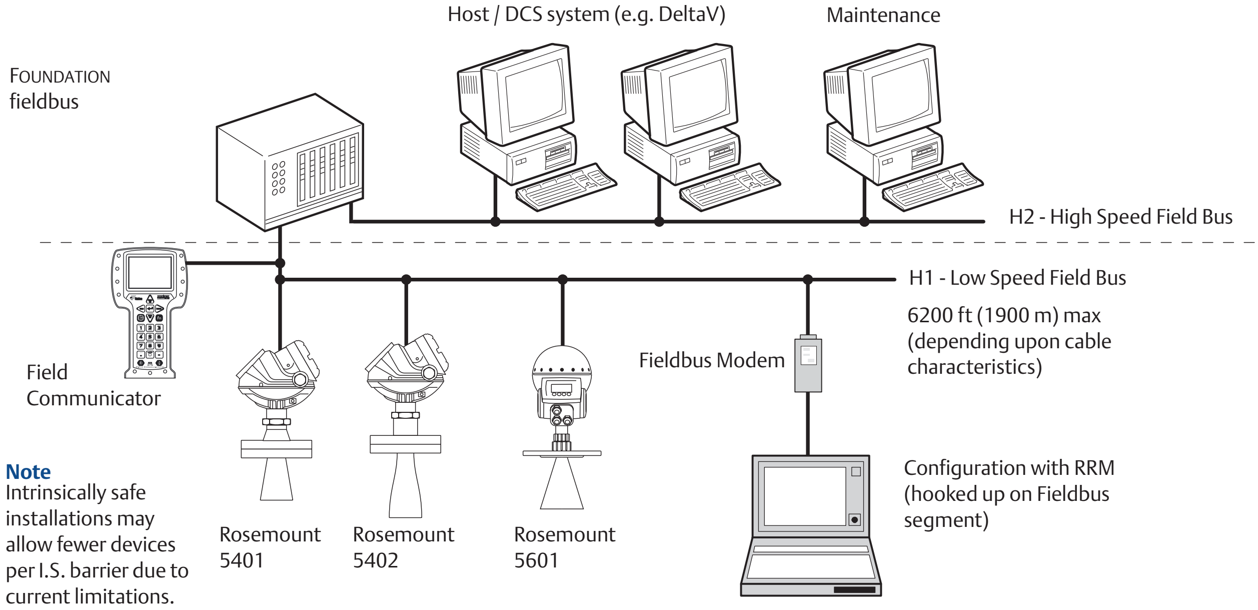


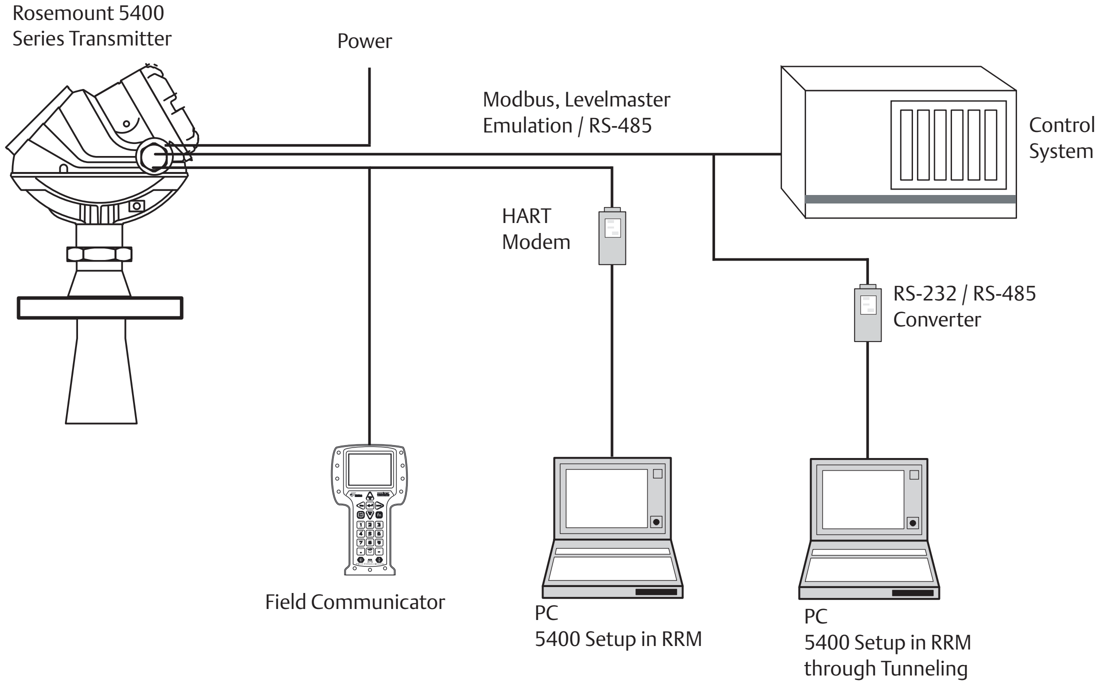
Figure 2-3. FOUNDATION fieldbus System Architecture



The RS-485 Modbus version communicates by Modbus RTU, Modbus ASCII, and Level Master Protocols.

HART communication is used for configuration via HART terminals, or tunneling via the RS-485.

Figure 2-4. RS-485 with Modbus Communication



2.4 Process characteristics

Dielectric constant

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

Foam

Rosemount 5400 Series Radar Transmitter measurement in foamy applications depends on the foam properties; light and airy or dense and heavy, high or low dielectrics, etc. If the foam is conductive and creamy, the transmitter may measure the surface of the foam. If the foam is less conductive, the microwaves may 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 depends on the frequency, the antenna size, the dielectric of the material, and the degree of turbulence. Consult Tables 2-2 and 2-3 on page 16 for the expected maximum range with the variables listed.

Temperature/pressure/density and vapor

Temperature, pressure, product density, and vapor generally have no impact on measurements.

Condensation

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

Tank characteristics

The conditions inside the tank have a significant impact on measurement performance. For more information see “Vessel characteristics” on page 35.

Solid surface

The surface of solid materials is rarely flat or horizontal. The angle of repose, or surface inclination, will change as the vessel fills and empties. There is often a lot of dust during the fill cycle. The dielectric value of many solids is fairly low. See Table 2-1 on page 2-13 for common solids characteristics.

For solids applications, the high frequency version Rosemount 5402 with 4 inch cone antenna is available.

Table 2-1. Sample Solids Applications[1]

Applications	Common characteristics				
	Particle size			Vapor space	
	Dust or Powder	Small (<1 in.)	Larger (>1 in.)	Dust	Steam or Condensation
Wood chip bins	Yes	Yes	Yes	Yes	Possible
Grain silo - small kernel grains	Yes	Yes	No	Yes	No
Grain silo - large kernel grains	No	Yes	No	No	No
Lime stone silo	No	Yes	Yes	Possible	No
Cement - raw mill silo	Yes	Yes	No	Yes	No
Cement - finished product silo	Yes	Yes	No	Yes	No
Coal bin	Yes	Yes	Yes	Yes	Yes
Saw dust	Yes	Yes	No	Yes	No
High consistency - pulp stock	No	No	No	No	Yes
Alumina	Yes	Yes	No	Yes	No
Salt	No	Yes	Yes	No	No

(1) *Air purging might be needed in dusty environments.*

2.5 Components of the transmitter

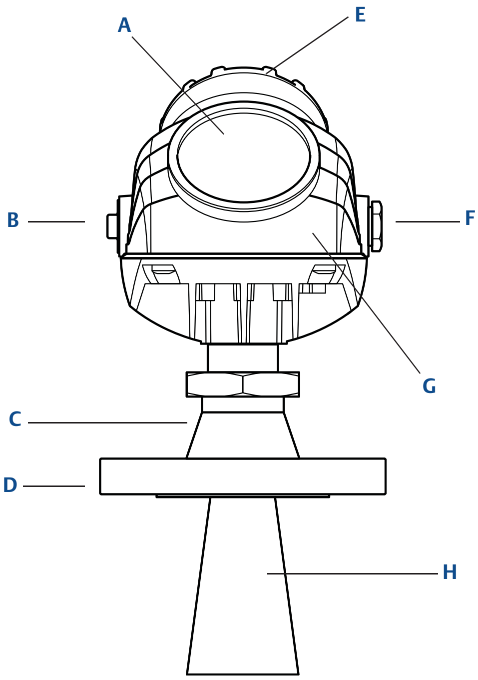
The Rosemount 5400 Series Radar Transmitter is available with a die-cast aluminum or stainless steel (SST) housing containing advanced electronics for signal processing.

The radar electronics produces an 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, and 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 2-5. Transmitter Components



A. Display Panel
B. Cable Entry: ½" NPT.
Optional adapters: M20
C. Tank Seal
D. Flange
E. Terminal side
F. Cable Entry: ½" NPT.
Optional adapters: M20
G. Transmitter head with Radar electronics
H. Antenna

2.6 Antenna selection guide/measuring range

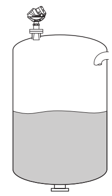
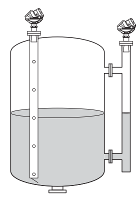
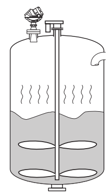
The measuring range depends on the microwave frequency, antenna size, the dielectric constant (ε_r) of the liquid, and process conditions. A higher dielectric constant value produces a stronger reflection. The figures in the tables below are guidelines for optimum performance. Larger measuring ranges may be possible. For more information, contact your local Emerson Process Management representative.

A. Oil, gasoline or other hydrocarbons, and petrochemicals (ε_r = 1.9-4.0). In pipes or with ideal surface conditions, for some liquefied gases (ε_r = 1.4-4.0).

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

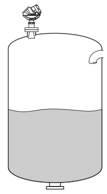
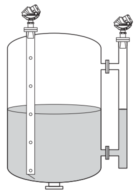
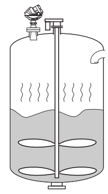
C. Conductive liquids, e.g. water based solutions, dilute acids, and alkalis (ε_r > 10.0).

Table 2-2. Rosemount 5402, Maximum Recommended Measuring Range, ft (m)

High frequency antennas									
	Dielectric constant[1]								
	A	B	C	A	B	C	A	B	C
2-in. Cone/ Process seal	33 (10)	49 (15)	66 (20)	82 (25)	115 (35)	115 (35)	9.8 (3)	20 (6)	33 (10)
3-in. Cone/ Process seal	49 (15)	66 (20)	98 (30)	82 (25)	115 (35)	115 (35)	13 (4)	30 (9)	39 (12)
4-in. Cone/ Process seal	66 (20)	82 (25)	115 (35)	82 (25)	115 (35)	115 (35)	23 (7)	39 (12)	49 (15)

(1) A. Oil, gasoline or other hydrocarbons, and petrochemicals (ε_r = 1.9-4.0)
In pipes or with ideal surface conditions, for some liquefied gases (ε_r = 1.4-4.0)
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 2-3. Rosemount 5401, Maximum Recommended Measuring Range, ft (m)

Low Frequency Antennas									
	Dielectric Constant[1]								
	a	b	c	a	b	c	a	b	c
3-in. Cone[2]	NA	NA	NA	82 (25)	115 (35)	115 (35)	NA	NA	NA
4-in. Cone / Rod[3]	23 (7)	39 (12)	49 (15)	82 (25)	115 (35)	115 (35)	13 (4)	26 (8)	39 (12)
6-in. Cone	43 (13)	66 (20)	82 (25)	82 (25)	115 (35)	115 (35)	20 (6)	33 (10)	46 (14)
8-in. Cone	66 (20)	82 (25)	115 (35)	82 (25)	115 (35)	115 (35)	26 (8)	39 (12)	52 (16)

(1) a. Oil, gasoline or other hydrocarbons, and petrochemicals (ε_r = 1.9-4.0)
In pipes or with ideal surface conditions, for some liquefied gases (ε_r = 1.4-4.0)
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)
(2) Pipe installations only. NA = Not Applicable.
(3) Pipe installations are not allowed with rod antennas.

Table 2-4. Model and Antenna Guide

Model and antenna guide	5402		5401	
This table gives guidelines on which model and antenna to select, depending on application. **G = Good** **AD = Application Dependent** (consult your local Emerson Process Management representative) **NR = Not Recommended**	**Cone (preferred)** 	**Process seal** 	**Cone (preferred)** 	**Rod** 
	Best choice for a broad range of applications, free propagation and pipe installations.	Ideal for small tanks and corrosive applications. Also good for heavy antenna condensation/build-up.	Suitable for some extreme process conditions.	Suitable for small process connections, and corrosive environment.
Tank considerations				
Installation close to smooth tank wall	G	G	G	G
Multiple units on the same tank	G	G	G	G
Internal obstructions, directly in path(1)	NR	NR	AD	AD
Internal obstructions, avoidance(1)	G	G	NR	NR
Beam angle	2" 19° 3" 14° 4" 9°	2" 19° 3" 14° 4" 9°	4" 37° 6" 23° 8" 17°	37°
Antenna extends below nozzle	G	G	G	G
Antenna recessed in smooth nozzle up to 6 ft (2 m)	G	G	NR(2)	NR(3)
Antenna recessed in nozzle with irregularities, such as bad welds	AD(4)	AD	AD(4)	NR(3)
Stilling well mounting	G 2"- 4" pipe	G 2"- 4" pipe	G 3"- 8" pipe	NR
Valves	G	G	NR	NR
Long ranges (>115' / 35 m)	NR	NR	NR	NR
Cleanability of antenna	AD	G	AD	G
Process medium characteristics				
Vapor (light, medium)	G	G	G	G
Vapor (heavy)	NR	AD	G	G
Condensing vapor/product build-up(5)	AD	G	G	AD
Boiling/Turbulent surface (low/medium)	G	G	G	G
Boiling/Turbulent surface (heavy)	AD	AD	G(6)	NR
Boiling/Turbulent surface (still-pipe)	G	G	G	NR
Foam(7)	NR	NR	AD	AD
Foam (still-pipe)(7)	G	G	G	NR
Corrosive products (options available)	G(8)	G(8)	G(8)	G
Materials with very low dielectric	G	G	G	AD
Changing density/dielectric/pH/ pressure/temperature	G	G	G	G
Coating/viscous/crystallizing liquids	G	G	G	G
Solids, granules, powders	G	NR	NR	NR

(1) *The obstruction should not be within the radar beam. Preferred choices due to more narrow radar beam: Model 5402, and cone antenna.*
(2) *If tall nozzle, use extended antenna.*
(3) *The active part must protrude beneath the nozzle.*
(4) *An extended cone antenna must be used.*
(5) *Build-up can often be avoided or reduced by using heat-tracing or cleaning arrangements.*
(6) *Use a 6 or 8 in. (150-200 mm) cone antenna.*
(7) *Foam can either reflect, be invisible, or absorb the radar signal. Pipe mounting is advantageous since it reduces the foaming tendency.*
(8) *Other wetted material options include Alloy C-276 and Alloy 400. See the Rosemount 5400 Series Product Data Sheet (Document No. 00813-0100-4026) for details.*

Section 3 Mechanical Installation

3.1 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 following safety messages before performing an operation preceded by this symbol.

⚠ WARNING

Failure to follow safe installation and service guidelines could result in death or serious injury.

- Make sure only qualified personnel perform installation or service.
- Use the equipment only as specified in this manual. Failure to do so may impair the protection provided by the equipment.
- Any substitution of non-recognized spare parts may jeopardize safety. Repair, e.g. substitution of components etc. may also jeopardize safety and is under no circumstances allowed.

Process leaks could result in death or serious injury.

- Make sure that the transmitter is handled carefully. If the Process Seal is damaged, gas might escape from the tank if the transmitter head is removed from the antenna.

Explosions could result in death or serious injury.

- Verify that the operating environment of the transmitter is consistent with the appropriate hazardous locations specifications.
- In an Explosion-proof/Flameproof installation, do not remove the transmitter cover when power is applied to the unit.
- Before connecting a HART®-based communicator in an explosive atmosphere, make sure the instruments in the loop are installed in accordance with intrinsically safe or non-incendive field wiring practices.

Electrical shock can result in death or serious injury.

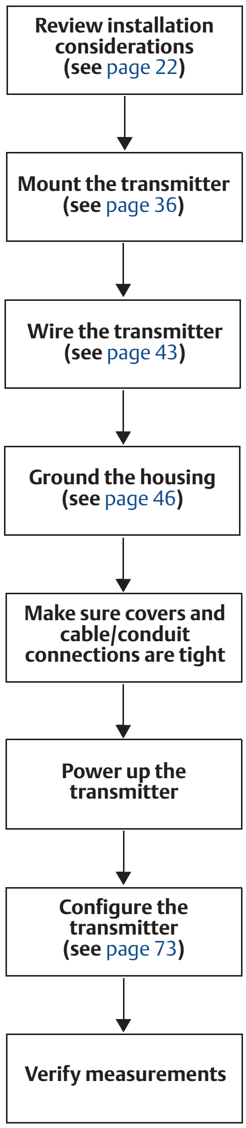
- Avoid contact with the leads and terminals. High voltage that may be present on leads can cause electrical shock.
- Make sure the main power to the Rosemount 5400 Series transmitter is off and the lines to any other external power source are disconnected or not powered while wiring the transmitter.

Antennas with non-conducting surfaces.

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

3.2 Installation procedure

Follow these steps for proper installation:



3.3 Mounting considerations

Before installing a Rosemount 5400 Series transmitter, consider specific mounting requirements, vessel, and process characteristics.

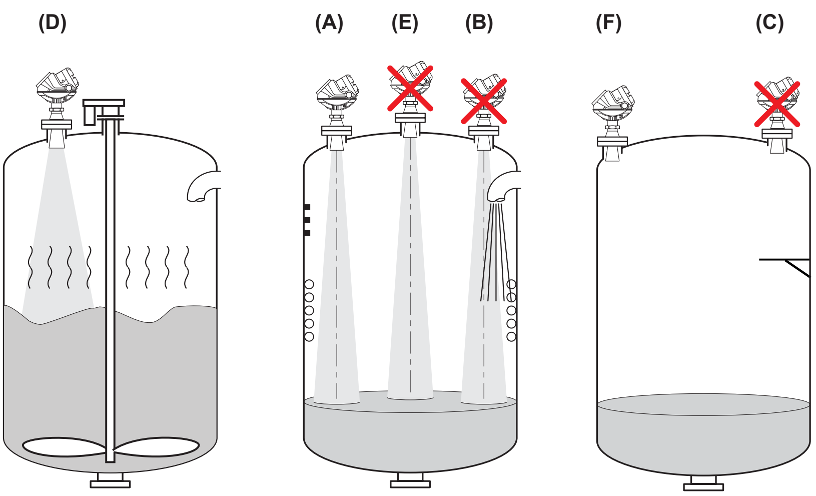
3.3.1 Mounting location

For optimal performance, the transmitter should be installed in locations with a clear and unobstructed view of the level surface (A):

- Filling inlets creating turbulence (B), and stationary metallic objects with horizontal surfaces (C) should be kept outside the signal beam – see page 33 for beamwidth information
- Agitators with large horizontal blades may reduce the performance of the transmitter, so install the transmitter in a location where this effect is minimized. Vertical or slanted blades are often invisible to radar, but create turbulence (D)
- Do not install the transmitter in the center of the tank (E)
- Because of circular polarization, there is no clearance distance requirement from the tank wall if it is flat and free of obstructions such as heating coils and ladders (F). Usually, the optimal location is 1/4 of the diameter from the tank wall

Note
Proper mounting position is important to consider.

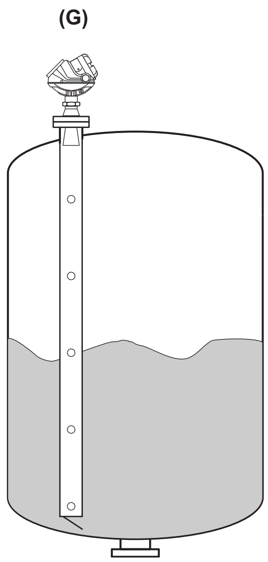
Figure 3-1. Proper Mounting Position



- The antenna is normally aligned vertically

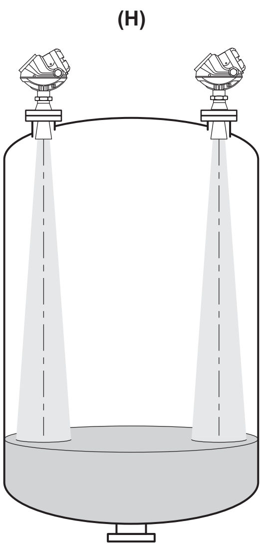
- A metal still-pipe can be used to avoid disturbing objects, turbulence, and foam (G)

Figure 3-2. Mounting in Still-Pipe



- The walls in non-metallic tanks are invisible to the radar signal, so nearby objects outside of the tank may be detected
- Choose the largest possible antenna diameter for installation. A larger antenna concentrates the radar beam, will be less susceptible to obstruction interference, and assures maximum antenna gain
- Multiple Rosemount 5400 Series transmitters can be used in the same tank without interfering with each other (H)

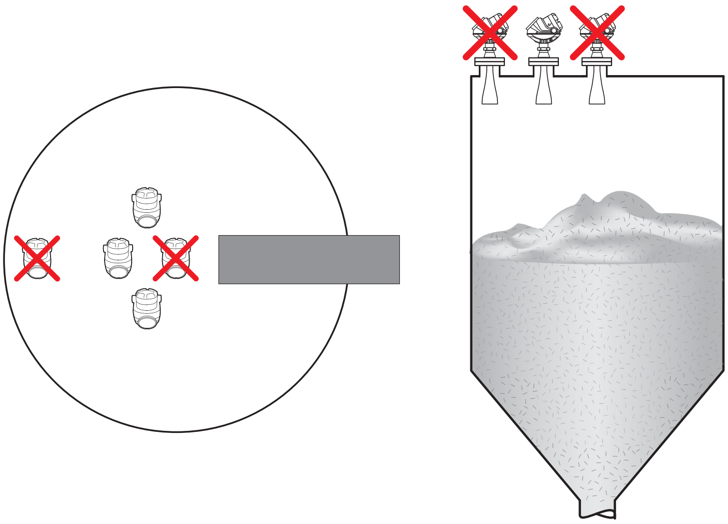
Figure 3-3. Multiple Rosemount 5400 Series Transmitters in the Same Tank



3.3.2 Special considerations in solids applications

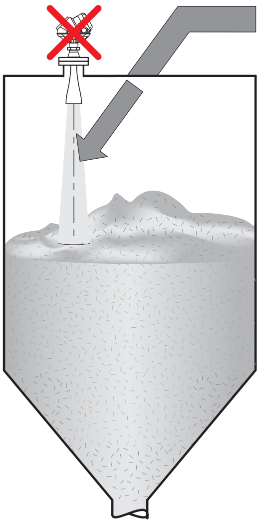
- The transmitter should be mounted as close to the center of the tank as possible, but not in the center of the tank. A general practice is to mount the transmitter at $^2/_3$ tank radius from the tank wall, see Figure 3-4.

Figure 3-4. Transmitter Location in Solids Applications



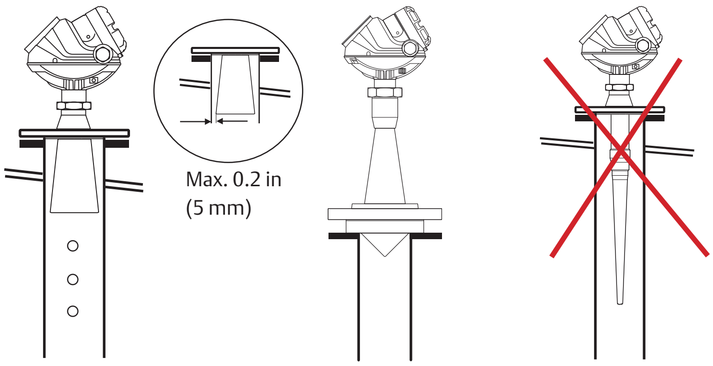
- The radar signal must never be shaded by the inlet nor the injected product, see Figure 3-5.

Figure 3-5. Install the Transmitter with a Clear and Unobstructed View



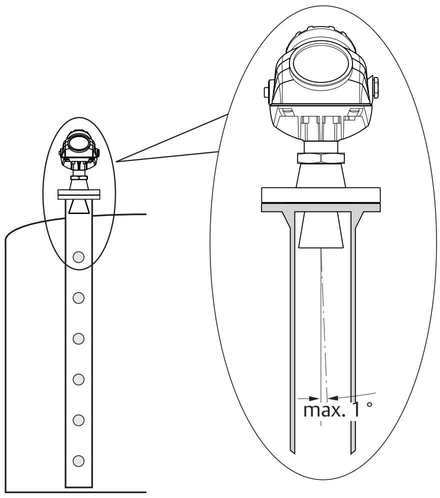
3.3.3 Mounting in pipes

Still-pipe mounting is recommended for tanks with extremely turbulent surface conditions. All cone antenna sizes for the Rosemount 5400 Series of transmitters can be used for Still-pipe installations. The 3 in. (75 mm) antenna for the 5401 is designed for use in Still-pipes only. Rod antennas are not recommended for Still-pipes.



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

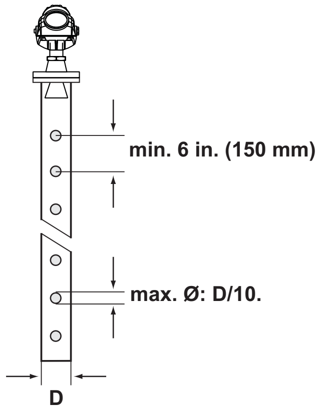
Figure 3-6. Mount the Transmitter Vertically



Recommendations for pipe installations

- The pipe interior must be smooth
- Not suitable for adhesive products
- At least one hole is above the product surface
- The hole diameter Ø should not exceed 10 % of the pipe diameter **D**
- Holes should only be drilled on one side

Figure 3-7. Recommended Hole Size for Pipe Installations



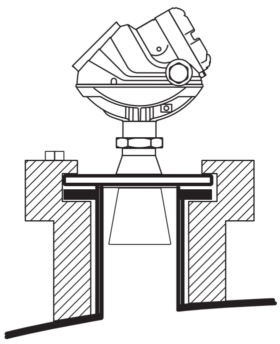
3.3.4 Installation considerations

Generally, the radar signal is unaffected by condensation and low pressure steam. If affected, the lower microwave frequencies are less affected. The critical point is the tank penetration, which acts as a cold spot, where the condensation will form. The radar antenna is located at this cold spot.

If droplets of water build up on the antenna parts, the microwave signal may get partially or even entirely blocked if the antenna is not designed for easy drip-off. Therefore, here it is beneficial to use as large opening for the microwaves as possible, which is the main reason for the oversized PTFE seal in the Rosemount 5400 Series Cone Antennas. An even better solution is to use a Process Seal Antenna if the process pressure permits that.

To reduce the cold spot within the nozzle, it is always recommended to insulate the nozzle. By doing so, the temperature in the nozzle will be the same as in the rest of the vessel and condensation will thus be reduced. If the temperature in the tank is much higher than the ambient temperature (i.e. tank is heated and located in a cold area), it might be necessary to heat trace the nozzle in addition to the insulation.

Figure 3-8. Insulate Nozzle to Avoid Condensation



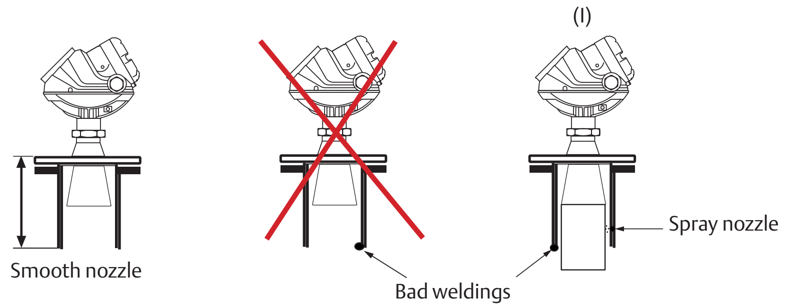
3.3.5 Nozzle considerations

Special considerations may have to be taken because of the nozzle, depending on the selection of transmitter model and antenna.

5402 with cone antenna

The antenna can be recessed in smooth nozzles up to 6 ft (2 m). If the inside of the nozzle contains disturbing objects, use the extended cone (I).

Figure 3-9. Nozzle Considerations for 5402 with Cone Antenna

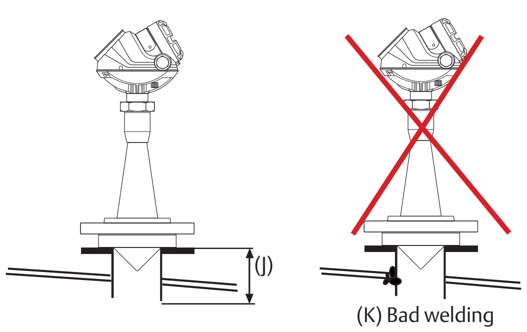


5402 with process seal antenna

The antenna can be used on nozzles up to 6 ft (2 m), (J). Disturbing objects inside the nozzle (K) may impact the measurement, and should therefore be avoided.

The flange on the tank should have a flat or raised face. Other tank flanges may be possible, please consult your local Emerson Process Management representative for advice.

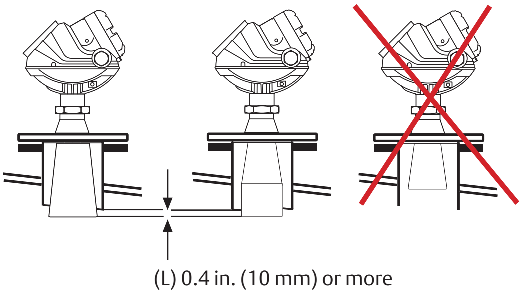
Figure 3-10. Nozzle Considerations for 5402 with Process Seal Antenna



5401 with cone antenna

The antenna should extend 0.4 in. (10 mm), or more, below the nozzle (L). If required, use the extended cone solution.

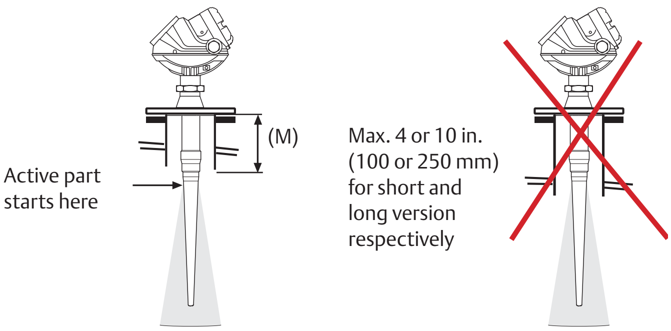
Figure 3-11. Nozzle Considerations for 5401 with Cone Antenna



5401 with rod antenna

The active part of the rod antenna should protrude below the nozzle (M).

Figure 3-12. Nozzle Considerations for 5401 with Rod Antenna



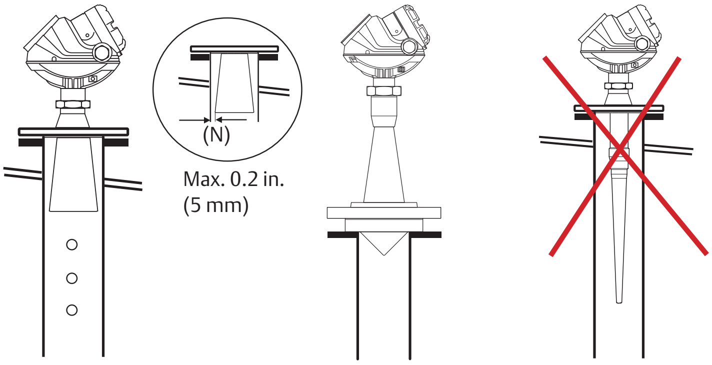
Still-pipes in metallic materials

If used correctly, pipe measurement can be advantageous in many applications:

- The 5402 is the preferred choice for smaller pipe diameters
- Use the 5401 for larger pipe diameters (6-8 in./150-200 mm), pipes with larger holes or slots, or for dirty/sticky media
- Use cone or process seal antennas - not the rod antenna
- The gap between the cone antenna and the still-pipe is limited to 0.2 in. (5 mm). If required, order an oversized antenna and cut on location (N). Only applicable to 5401 cone antennas and cone antennas with wetted flange plate (i.e. straight antennas).
- The inside of the chamber must be of a constant diameter

Note
Match antenna size to the stilling well diameter.

Figure 3-13. Nozzle Considerations for Still-Pipes in Metallic Materials



Ball-valve installation

The Rosemount 5400 Series transmitter can be isolated from the process by using a valve:

- The 5402 is the preferred choice for long nozzle measurement
- Use the largest possible antenna
- Use a full-port ball valve
- Ensure there is no edge between the ball valve and the nozzle or stilling well, the inside should be smooth
- Valves can be combined with stilling wells

3.3.6 Nozzle recommendations and requirements

The Rosemount 5400 Series is mounted on a nozzle by using appropriate flanges. For best performance, it is recommended that the nozzle meets the following recommendations for height (L) and diameter:

Figure 3-14. Mounting of the Rosemount 5400 Series Transmitter

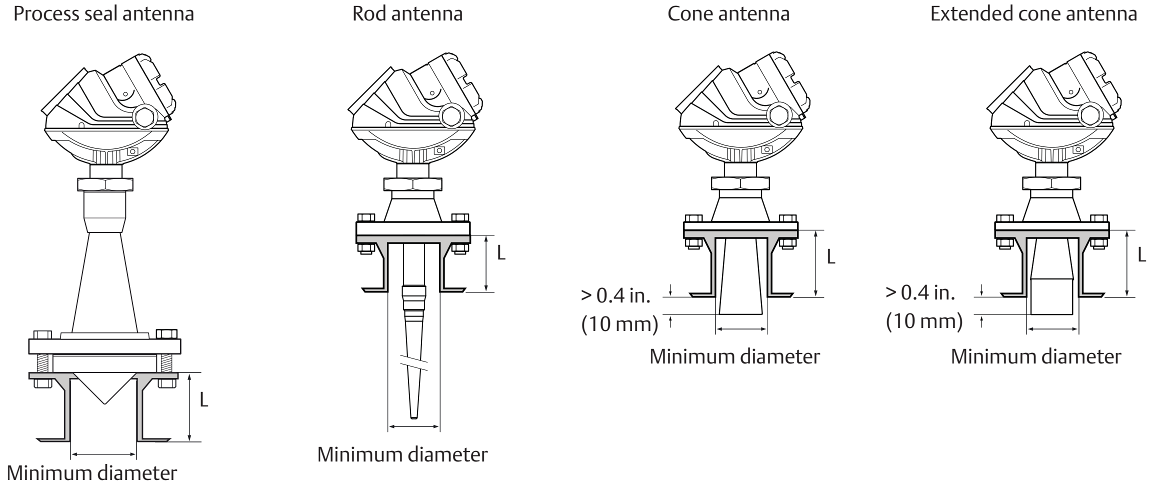


Table 3-1. Minimum Nozzle Diameter and Recommended Maximum Nozzle Height for Cone Antennas

Model	Antenna / material	L_{max} in. (mm)	Min. diameter in. (mm)
5402[1]	Cone 2 in. (50 mm) SST	6.1 (155)	2.2 (55)
	Cone 3 in. (75 mm) SST	5.5 (140)	2.8 (72)
	Cone 4 in. (100 mm) SST	8.5 (215)	3.8 (97)
	Cone 2 in. (50 mm) Alloy C-276, Alloy 400	5.5 (140)	2.2 (55)
	Cone 3 in. (75 mm) Alloy C-276, Alloy 400	6.5 (165)	2.8 (72)
	Cone 4 in. (100 mm) Alloy C-276, Alloy 400	9.6 (240)	3.8 (97)
5401	Cone 3 in. (75 mm) SST	Pipe installations only	
	Cone 4 in. (100 mm) SST	5.5 (140)	3.8 (97)
	Cone 6 in. (150 mm) SST	6.9 (175)	5.7 (145)
	Cone 8 in. (200 mm) SST	10.2 (260)	7.6 (193)
	Cone 3 in. (75 mm) Alloy C-276, Alloy 400	Pipe installations only	
	Cone 4 in. (100 mm) Alloy C-276, Alloy 400	5.5 (140)	3.8 (97)
	Cone 6 in. (150 mm) Alloy C-276, Alloy 400	6.9 (175)	5.7 (145)
	Cone 8 in. (200 mm) Alloy C-276, Alloy 400	10.2 (260)	7.6 (193)

(1) *For Rosemount 5402, the values for maximum nozzle height are recommendations. Note that the Rosemount 5402 with cone antenna can be recessed in smooth nozzles up to 6 ft (2m).*

Table 3-2. Minimum Nozzle Diameter and Maximum Nozzle Height for Rod Antennas

Model	Antenna	L_{max} in. (mm)	Min. diameter in. (mm)
5401[(1)]	Rod (short)	4.0 (100)	1.5 (38)
	Rod (long)	10 (250)	1.5 (38)

(1) *For Rosemount 5401, the values for minimum nozzle diameter and maximum nozzle height are requirements.*

Table 3-3. Minimum Nozzle Diameter and Recommended Maximum Nozzle Height for Process Seal Antennas

Model	Antenna	L_{max} in. (mm)	Min. diameter in. (mm)
5402[(1)]	Process Seal 2 in. (50 mm)	19.7 (500)	2.0 (51)
	Process Seal 3 in. (75 mm)	19.7 (500)	3.0 (77)
	Process Seal 4 in. (100 mm)	19.7 (500)	4.0 (102)

(1) *For Rosemount 5402, the values for maximum nozzle height are recommendations. Note that the Rosemount 5402 with process seal antenna can be recessed in smooth nozzles up to 6 ft (2m).*

Table 3-4. Minimum Nozzle Diameter and Maximum Nozzle Height for Extended Cone Antennas

Model	Antenna	L_{max} in. (mm)	Min. diameter in. (mm)
5402[(1)]	Extended Cone Antenna, S3[(2)]	20 in. (500 mm)	See Table 3-1
5401	Extended Cone Antenna, S3[(2)]	20 in. (500 mm)	See Table 3-1

(1) *For Rosemount 5402, the values for maximum nozzle height are recommendations.*
(2) *The extended cone antennas are available in 5 in. (125 mm) step increments from 10 to 50 in. (250-1250 mm). Consult your local Emerson Process Management representative for more information. Expect long lead times for sizes other than the 20 in. (500 mm) version.*

Install the transmitter as follows:

- Align the antenna vertically.
- Choose the largest antenna diameter possible. A larger receiving area concentrates the radar beam and ensures maximum antenna gain. Increased antenna gain permits greater margin for weak surface echoes. A larger antenna also results in smaller beam angle and thereby, less interference from any internal structures in the tank.
- For best measurement performance, the antenna should extend below the nozzle 0.4 in. (10 mm) or more.

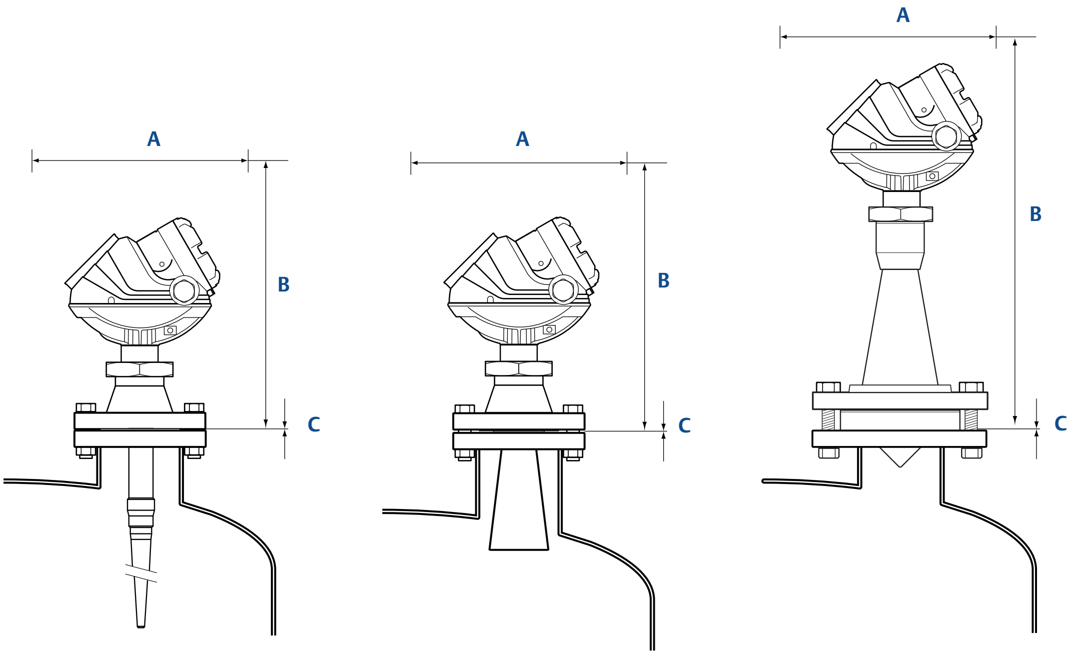
For more information, see "Nozzle considerations" on page 27.

3.3.7 Service space

For easy access to the transmitter, mount it with sufficient service space.

There is no requirement on clearance distance from the tank wall, provided it is flat and free of obstructions such as heating coils and ladders. The optimal location is often 1/4 of the tank diameter.

Figure 3-15. Service Space Recommendations



Rod antenna

Cone antenna

Process seal antenna

Service space	Antenna type	Distance in. (mm)
A	Cone, rod, process seal	20 (500)
B	Cone, rod	24 (600)
	Process seal	33 (850)
Inclination	**Antenna type**	**Maximum angle**
C	Cone, rod, process seal	3°

3.3.8 Beamwidth

The following recommendations should be considered when mounting the transmitter:

- The transmitter should be mounted with as few internal structures as possible within the beam angle
- The flat tank wall can be located within the antenna beam angle if there is a minimum distance from the transmitter to the tank wall (see Figure 3-15 for preferred installation)

Figure 3-16. Beamwidth at Various Distances from the Flange

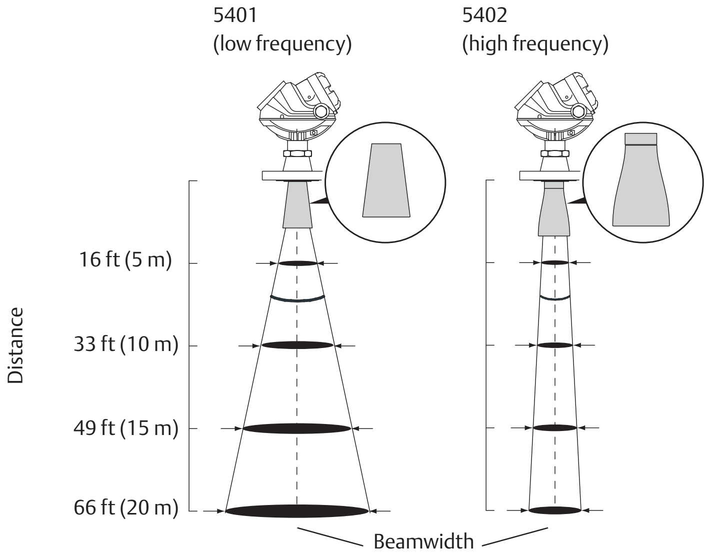


Table 3-5. Beamwidth for the Rosemount 5402 Model (in ft [m])

Distance	Antenna		
	2 in. (DN 50) cone/ process seal	3 in. (DN 80) cone/ process seal	4 in. (DN 100) cone/ process seal
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)

Table 3-6. Beamwidth for the Rosemount 5401 Model (in ft [m])

Distance	Antenna		
	4 in. (DN 100) cone /rod	6 in. (DN 150) cone	8 in. (DN 200) cone
16 ft (5 m)	9.8 (3..0)	6.6 (2.0)	4.9 (1.5)
33 ft (10 m)	21.3 (6.5)	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)	41 (12.5)	26.2 (8.0)	19.7 (6.0)

Figure 3-17. Beam Angle

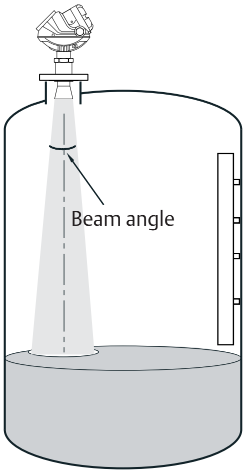


Table 3-7. Beam Angle for the Rosemount 5402

Antenna	Beam angle
2 in. (50 mm) cone / process seal	19°
3 in. (75 mm) cone / process seal	14°
4 in. (100 mm) cone / process seal, rod	9°

Table 3-8. Beam Angle for the Rosemount 5401

Antenna	Beam angle
3 in. (75 mm) cone	Pipe installations only
4 in. (100 mm) cone / rod	37°
6 in. (150 mm) cone	23°
8 in. (200 mm) cone	17°

3.3.9 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 76).

3.3.10 Disturbing objects

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

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

3.3.11 Valves

The Rosemount 5400 Series transmitter can be isolated from the process by using a valve:

- Use a full-port ball valve.
- The 5402 is the required and the Process Seal Antenna is the preferred choice, since it does not require a spool piece. The cone antenna can also be used.
- Ensure there is no edge between the ball valve and the nozzle/pipe, the inside should be smooth.

Valves can be combined with stilling wells.

3.4 Mounting

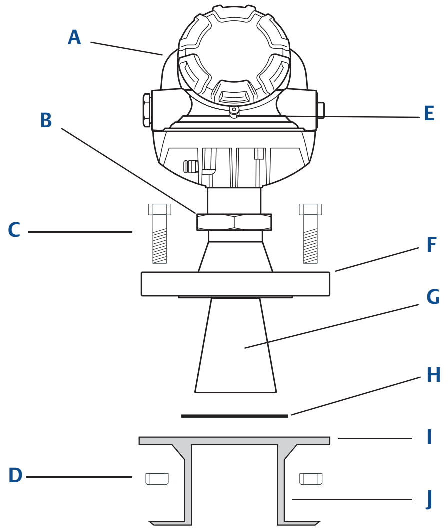
Mount the transmitter on a nozzle on top of the tank making sure only qualified personnel perform the installation.

⚠ The transmitter housing must not be opened.

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

3.4.1 Cone antenna flange connection

Figure 3-18. Mounting the Rosemount 5400 with Cone Antenna and Flange

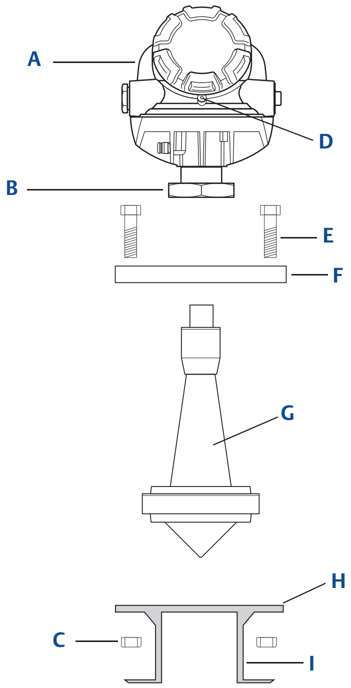


A. Transmitter housing
B. Nut, 40 Nm (30 Lbft)
C. Bolt
D. Nut
E. Locking screw
F. Flange
G. Cone antenna
H. Gasket
I. Tank flange
J. Nozzle

1. Place a gasket 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 for the flange and gasket choice.

3.4.2 Process seal antenna[1]

Figure 3-19. Mounting the Rosemount 5400 with Process Seal and Flange



A. Transmitter housing
B. Nut, 40 Nm (30 Lbft)
C. Nut
D. Locking screw (ATEX)
E. Bolt
F. Flange
G. Process Seal antenna
H. Tank flange
I. Nozzle

1. Place the antenna on top of the nozzle.
2. Mount the flange and tighten the bolts cross-wise. For torque information, see Table 3-9.
3. Mount the transmitter head and tighten the nut to 40 Nm (30 Lbft).
4. ⚠ Re-tighten the flange bolts after 24 hours.

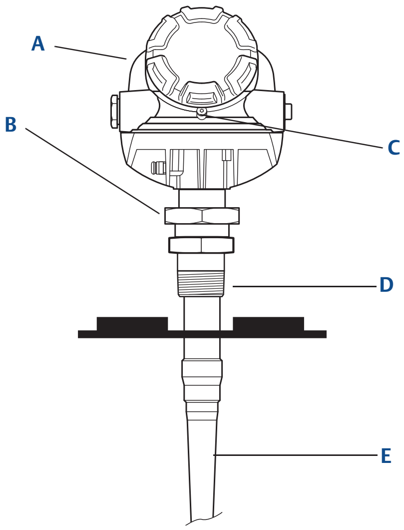
(1) *The mounting information applies to the updated Process Seal antenna design, released in February 2012. Antennas manufactured before this date have wetted O-rings and require a different installation procedure. For detailed information on the updated Process Seal antenna, see the Rosemount 5400 Series Reference Manual - Supplementary Information for Process Seal Antennas Manual Supplement (Document No. 00809-0700-4026).*

Table 3-9. Tightening Torque for Process Seal Flanges

Flange	Torque (Nm)	Torque (Lbft)
2 in. (50 mm), 150 lb.	40	30
2 in. (50 mm), 300 lb.	40	30
3 in. (75 mm), 150 lb.	60	44
3 in. (75 mm), 300 lb.	60	44
4 in. (100 mm), 150 lb.	50	37
4 in. (100 mm), 300 lb.	50	37
DN 50 PN 40	40	30
DN 80 PN 40	60	44
DN 100 PN 16	50	37
DN 100 PN 40	50	37
50A 10K	40	30
80A 10K	60	44
100A 10K	50	37
150A 10K	50	37

3.4.3 Rod antenna threaded connection

Figure 3-20. Mounting the Rosemount 5400 with Rod Antenna and Threaded Tank Connection



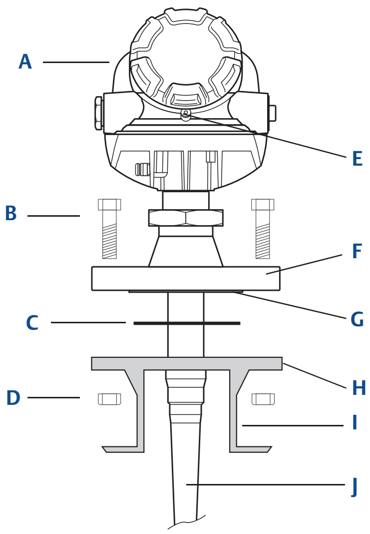
A. Transmitter housing
B. Nut, 60 Nm (44 Lbft)
C. Locking screw (ATEX)
D. Sealant threads
E. Rod antenna

1. Lower the transmitter and antenna into the tank.
2. Turn the transmitter until it is properly secured in the process connection.
3. Make sure the cable entries and display face the right direction.

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

3.4.4 Rod antenna flanged connection

Figure 3-21. Mounting the Rosemount 5400 with Rod Antenna and Flange



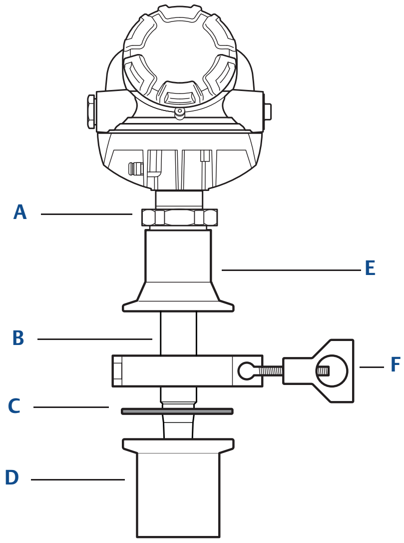
A. Transmitter housing
B. Bolt
C. Gasket (optional for the All PFA version)
D.Nut
E. Locking screw (ATEX)
F. Flange
G. PFA plate (only All PFA version, 1R, 2R)
H. Tank flange
I. Nozzle
J. Rod antenna

1. Place a gasket on top of the tank flange [(1)]. The gasket thickness and material must be suitable for the process.
2. Lower the transmitter with antenna and flange into the tank nozzle.
3. Tighten the bolts and nuts with sufficient torque for the flange and gasket choice.

(1) Gasket is optional for the All-PFA version of the rod antenna.

3.4.5 Tri-Clamp™ tank connection

Figure 3-22. Mounting the Rosemount 5400 using a Tri-Clamp

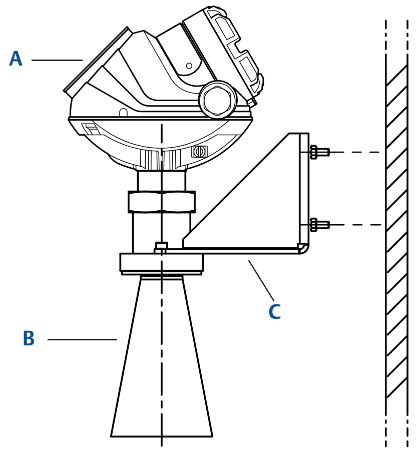


A. Nut
B. Rod antenna
C. Gasket
D. Tank connection
E. Tri-Clamp
F. Clamp

1. Place a gasket on top of the tank flange.
2. Lower the transmitter and antenna into the tank.
3. Fasten the Tri-Clamp to the tank with a clamp.
4. To rotate the transmitter housing, loosen the nut.
5. Rotate the transmitter housing so the cable entries / display face the desired direction.
6. Tighten the nut.

3.4.6 Bracket mounting on wall

Figure 3-23. Bracket Mounting the Rosemount 5400, on Wall

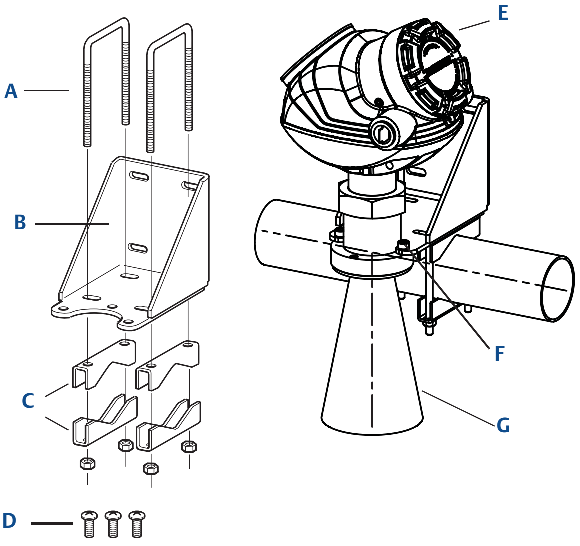


A. Transmitter housing
B. Antenna
C. Bracket

1. Mount the bracket directly to the wall with screws suitable for the purpose.
2. Mount the transmitter with antenna to the bracket, then secure the installation with the three supplied screws.

3.4.7 Bracket mounting on pipe

Figure 3-24. Bracket Mounting the Rosemount 5400, on Pipe



A. U-bolts
B. Bracket
C. Clamping bracket
D. Screws
E. Transmitter housing
F. Screw
G. Antenna

1. Put the two U-bolts through the holes of the bracket. Holes are available for both vertical and horizontal pipe mounting.
2. Put the clamping brackets on the U-bolts and around the pipe.
3. Fasten the bracket to the pipe with the four supplied nuts.
4. Mount the transmitter with antenna to the bracket, and secure with the three supplied screws.

Section 4 Electrical Installation

4.1 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 following safety messages before performing an operation preceded by this symbol.

⚠ WARNING

Failure to follow safe installation and service guidelines could result in death or serious injury.

- Make sure only qualified personnel perform installation or service.
- Use the equipment only as specified in this manual. Failure to do so may impair the protection provided by the equipment.
- Any substitution of non-recognized spare parts may jeopardize safety. Repair, e.g. substitution of components etc. may also jeopardize safety and is under no circumstances allowed.
- Do not perform any service other than those contained in this manual unless you are qualified.

Process leaks could result in death or serious injury.

- Make sure that the transmitter is handled carefully. If the process seal is damaged, gas might escape from the tank if the transmitter head is removed from the antenna.

Explosions could result in death or serious injury.

- Verify that the operating environment of the transmitter is consistent with the appropriate hazardous locations specifications.
- In an Explosion-proof/Flameproof installation, do not remove the transmitter cover when power is applied to the unit.
- Before connecting a HART®-based communicator in an explosive atmosphere, make sure the instruments in the loop are installed in accordance with intrinsically safe or non-incendive field wiring practices.

Electrical shock can result in death or serious injury.

- Avoid contact with the leads and terminals. High voltage that may be present on leads can cause electrical shock.
- Make sure the main power to the Rosemount 5400 Series transmitter is off and the lines to any other external power source are disconnected or not powered while wiring the transmitter.

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 Rosemount 5400 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.

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

Additional warnings or restrictions may apply depending on type of Hazardous approval. See Appendix B: Product Certifications for details.

4.2 Wiring and power supply requirements

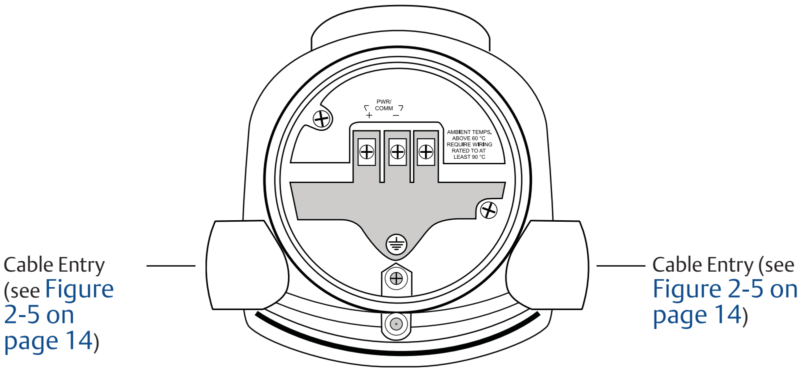
Wiring and power supply requirements can be dependent upon the approval certification. As with all FOUNDATION™ fieldbus requirements, a conditioned power supply and terminating resistors are required for proper operation.

4.3 Cable/conduit entries

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

Properly seal unused ports to prevent moisture or other contamination from entering the terminal compartment of the electronics housing. Install wiring with a drip loop with the bottom of the loop lower than the cable/conduit entry.

Figure 4-1. Cable Entries



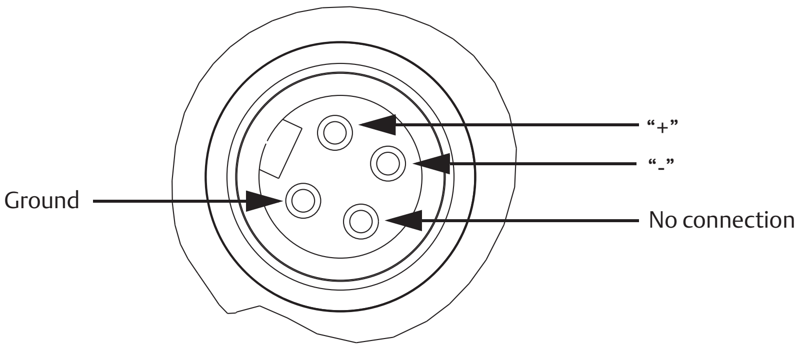
Remove the orange protective plastic plugs, used for transportation.
Seal any unused port with the enclosed metal plug.

Note
Use the enclosed metal plug to seal the unused port. The temporary orange plastic plugs used at delivery are not sufficient seals! Failure to use the metal plug to seal the unused port invalidates product certification.

4.3.1 Conduit electrical connector wiring (using minifast®)

For wiring details, refer to pin-out drawing and the cordset manufacturer's installation instructions.

Figure 4-2. Quick Connect Housing Pin-Out



For Rosemount 5400 Series transmitters with conduit electrical connector M, refer to the cordset manufacturer's installation instructions for wiring details.

4.4 Grounding

When wiring the transmitters, the grounding should be completed such that:

- The loop is grounded at the power supply.
- When transmitters are installed on metal tanks, ensure there is a metal-to-metal connection between the device and the tank.
- If the tank is non-metallic, the housing must be grounded to an earth ground that is separate from the power supply. The external ground terminal may be used for this purpose.
- If the tank is cathodically protected, the housing must be grounded to an earth ground that is outside of the cathodic protection system ground. Use the external terminal for this purpose.

When transient protection terminal block is used, the ground wire should be separate from the signal wire. Use the external ground terminal.

Make sure grounding is done (including IS ground inside Terminal compartment) according to Hazardous Locations Certifications, national and local electrical codes.

The most effective transmitter housing grounding method is a direct connection to earth ground with minimal (< 1 Ω) impedance.

Note
Grounding the transmitter housing using the threaded conduit connection may not provide a sufficient ground. The transient protection terminal block will not provide transient protection unless the transmitter housing is properly grounded. Use the above guidelines to ground the transmitter housing. Do not run transient protection ground wire with signal wiring; the ground wire may carry excessive current if a lightning strike occurs.

Note
After installation and commissioning, make sure that no ground currents exist from high ground potential differences in the installation.

4.5 Cable selection

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

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

For Modbus® units (RS-485 bus), the following rules apply:

- 2 cables are used for communication: 24 AWG shielded twisted pair wiring is recommended to get an impedance of 120 Ω
- 2 cables are used for power: AWG 16-18 cables must be used

Note
Avoid running instrument cable next to power cables in cable trays or near heavy electrical equipment.

It is important that the instrument cable shield be:
- trimmed close and insulated from touching the transmitter housing
- continuously connected throughout the segment
- connected to a good earth ground at the power supply end

4.6 Hazardous areas

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

4.7 External circuit breaker

For compliance with Low Voltage Directive 2006/95/EC, an external circuit breaker should be installed.

4.7.1 Connecting the transmitter

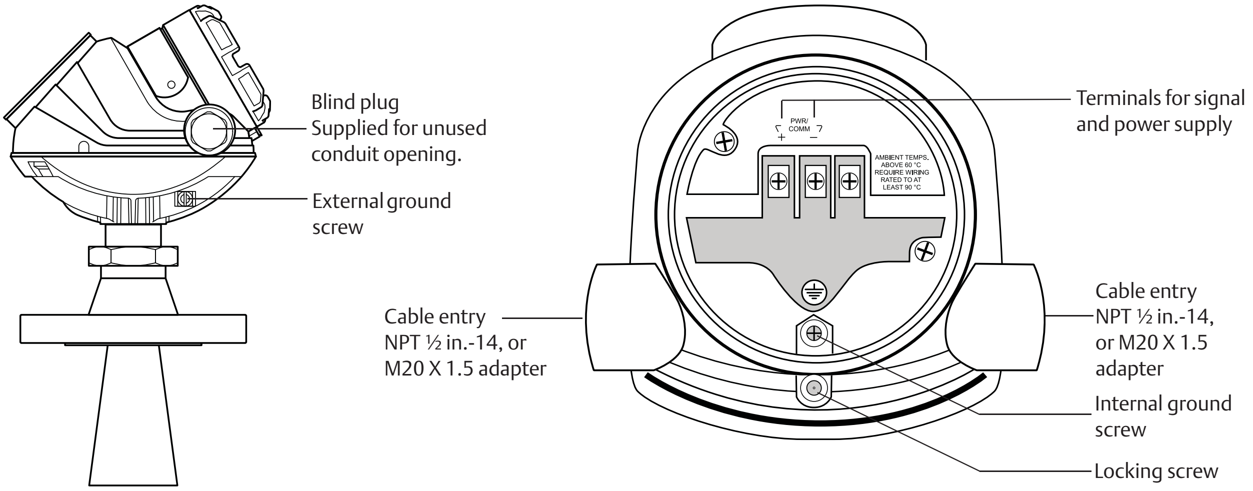
The Rosemount 5400 Series accepts power supplies ranging from 16 Vdc to 42.4 Vdc. It uses 4-20 mA power superimposed with a HART signal.

To connect the transmitter:

1. Verify that the power supply is disconnected.
2. Remove the terminal block cover (see Figure 4-3).
3. Pull the cable through the cable gland/conduit. For explosion-proof/ flameproof installations, only use cable glands or conduit entry devices certified explosion-proof or flameproof. Install the wiring with a drip loop where the bottom of the loop must be lower than the cable/conduit entry.
4. To connect the wires, see the illustrations on the following pages.
5. Remove the orange protective plastic plugs used for transportation. Seal any unused port with the enclosed metal plug.
6. ⚠ Mount the cover and make sure it is fully engaged to meet explosion-proof requirements (adapters are required if M20 glands are used).
   For ATEX, IECEx, NEPSI, INMETRO, and TIIS installations, lock the cover with the locking screw.
7. Connect the power supply.

Note
Use PTFE tape or other sealant at the NPT threads in the cable entries.

Figure 4-3. Terminal Compartment and External Ground Screw



Note

Remove the orange, protective, plastic plugs, used for transportation. Seal any unused port with the enclosed metal plug.

4.8 HART

4.8.1 Power requirements

The Rosemount 5400 Series transmitter operates with a power supply ranging from 16 - 42.4 Vdc (16 - 30 Vdc in IS applications, 20 - 42.4 Vdc in explosion-proof / flameproof applications and in non-sparking / energy-limited applications).

All configuration tools for HART communication, such as the Field Communicator and Rosemount Radar Master, require a minimum load resistance (R_L) of 250 Ω within the loop in order to function properly.

Terminals in the transmitter housing provide connections for signal wiring. The Rosemount 5400 Series operates with the following power supplies:

Table 4-1. Minimum Input Voltage (U_I) at Different Currents

Hazardous approval	Current	
	3.75 mA	21.75 mA
	Minimum input voltage (U_I)	
Non-Hazardous Installations and Intrinsically Safe Installations	16 Vdc	11 Vdc
Explosion-proof / Flameproof Installations	20 Vdc	15.5 Vdc

4.8.2 Load limitations

Maximum load resistance (R) is determined by the voltage level of the external power supply (U_E), as described by:

Figure 4-4. Non-Hazardous Installations, and Non-Sparking / Energy-Limited Power Supply

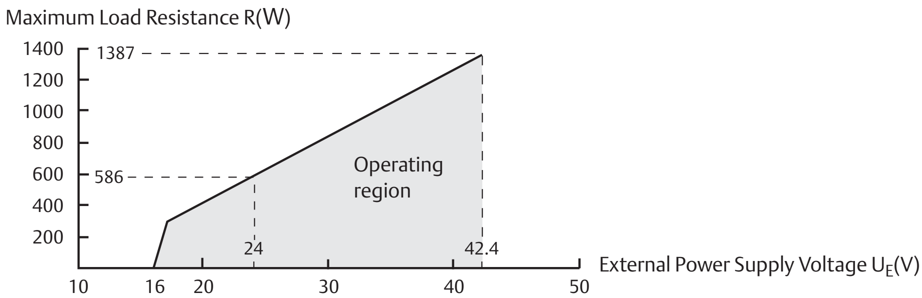


Figure 4-5. Intrinsically Safe Installations

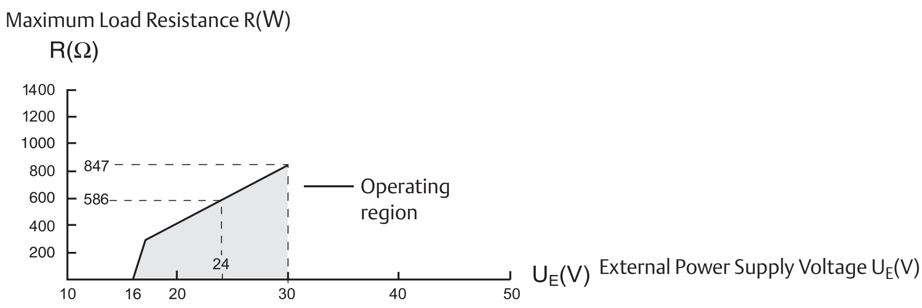
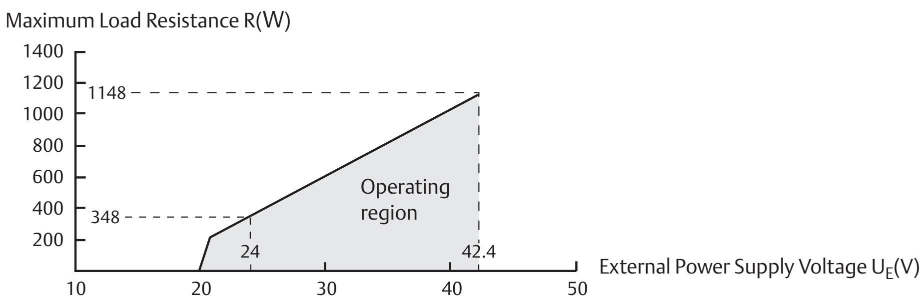


Figure 4-6. Explosion-Proof / Flameproof Installations



Note

For flameproof/explosion-proof installations, the diagram is only valid if the HART load resistance is at the + side and if the - side is grounded. Otherwise, the load resistance value is limited to 435 Ω.

Note

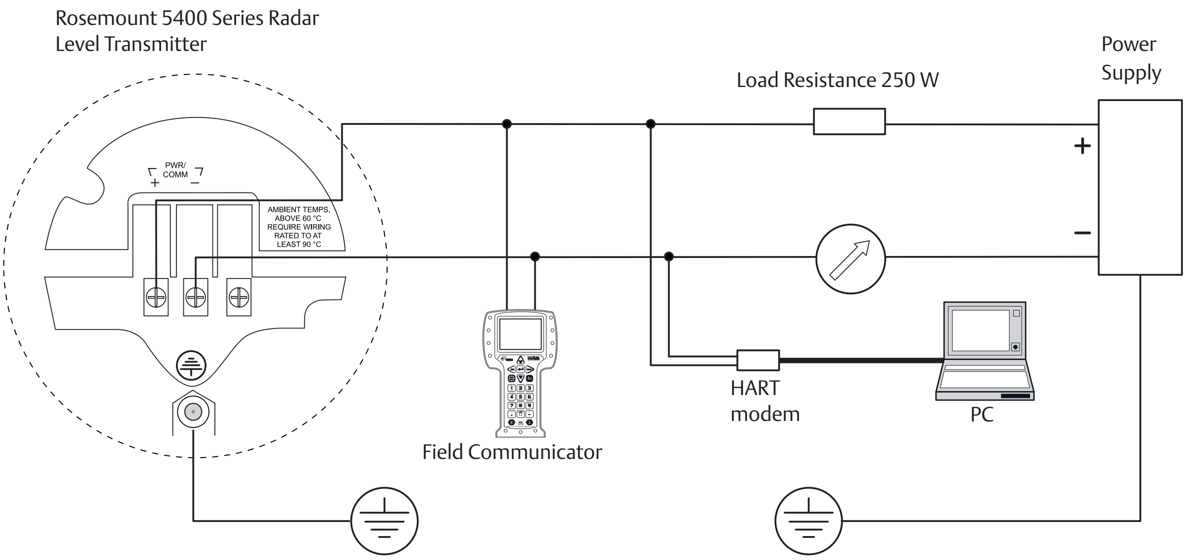
Rosemount 5400 Series Transmitters with flameproof/explosion-proof output have a built-in barrier; no external barrier needed.

4.8.3 Non-intrinsically safe power supply

With a non-intrinsically safe power supply in non-hazardous installations or explosion-proof/flameproof installations, wire the transmitter as shown in Figure 4-7.

Note
Make sure the power supply is off when connecting the transmitter.

Figure 4-7. Wiring for Non-Intrinsically Safe Power Supply (HART)



The Field Communicator and the HART modem require a minimum load resistance of 250 Ω within the loop to function properly.

Note
The diagram is valid only if the HART load resistance is at the + side and if the - side is grounded, otherwise the load resistance value is limited to 435 Ω.

Note
For explosion-proof/flameproof installations make sure the transmitter is grounded to the I.S. ground terminal inside the terminal compartment in accordance with national and local electrical codes.

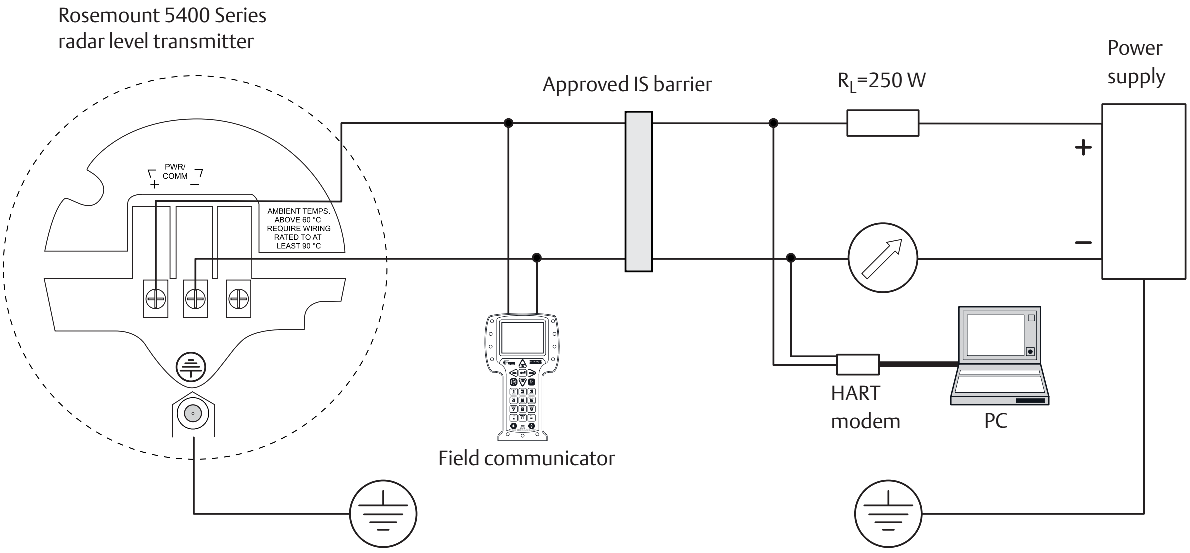
4.8.4 Intrinsically safe power supply

With an intrinsically safe power supply, wire the transmitter as shown in Figure 4-8.

Note
Make sure the instruments in the loop are installed according to intrinsically safe field wiring practices.

Installation also needs to comply with the applicable installation/control drawing. See "Approval drawings" on page 230.

Figure 4-8. Wiring Diagram for Intrinsically Safe Power Supply (HART)



For IS parameters, see Appendix B: Product Certifications.

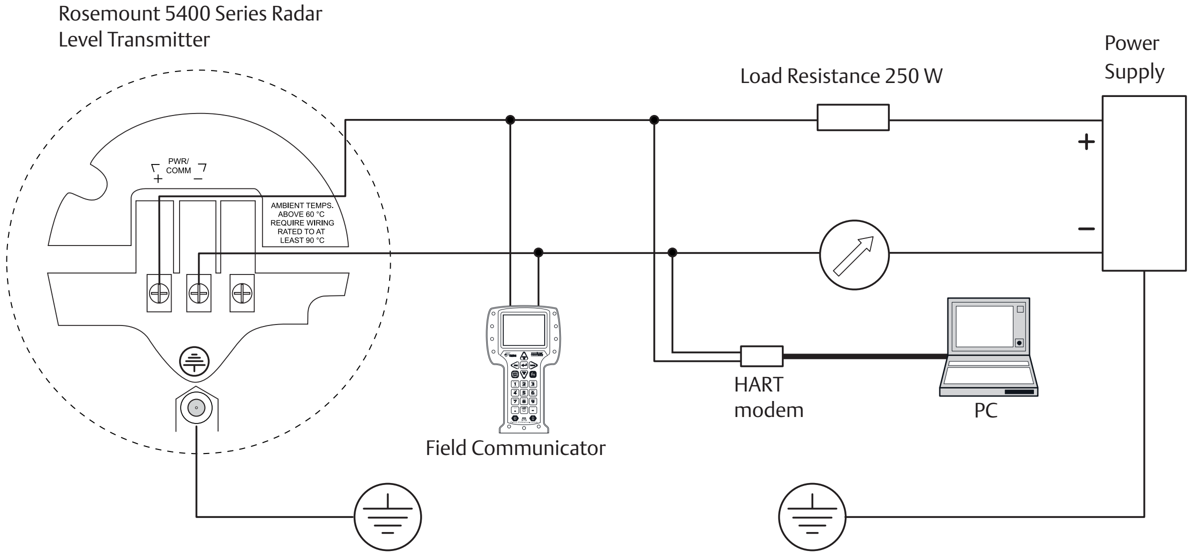
The Field Communicator and the HART modem require a minimum load resistance within the loop of 250 Ω to function properly. For maximum load resistance see Figure 4-5.

For Safety Instrumented Systems information, see Section 8: Safety Instrumented Systems (4-20 mA Only).

4.8.5 Type N approvals: non-sparking / energy-limited power supply

With a non-sparking / energy- limited power supply, wire the transmitter as shown in Figure 4-9.

Figure 4-9. Wiring Diagram for Non-Sparking / Energy-Limited Power Supply (HART)

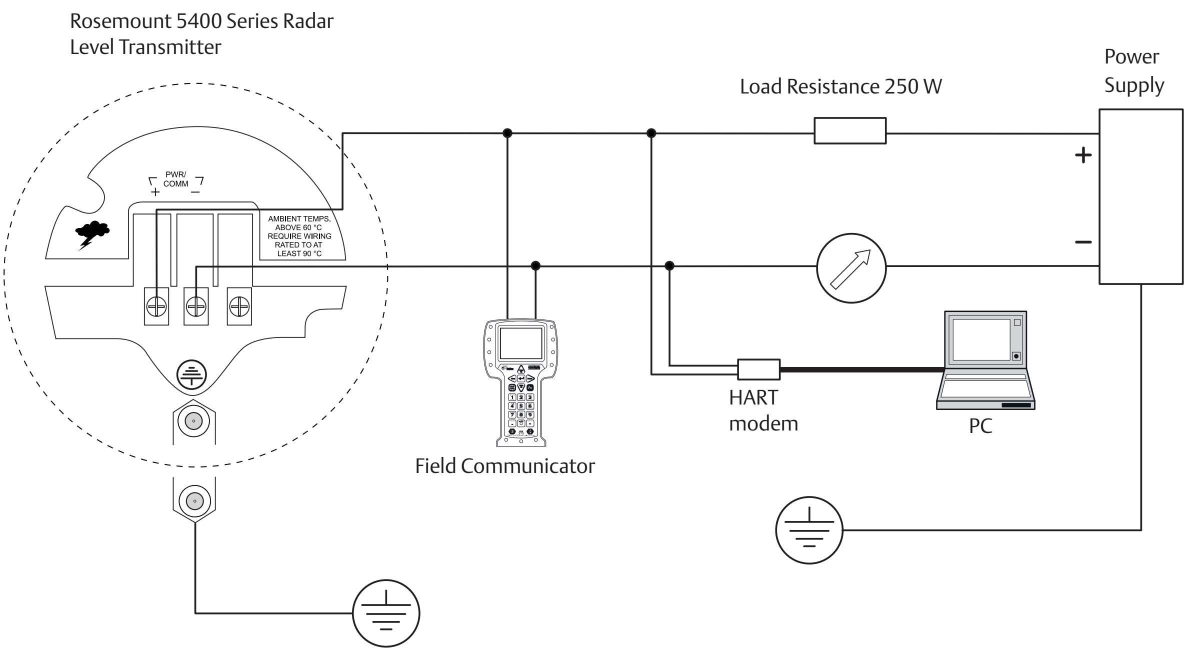


HART: U_n=42.4 V

4.8.6 Transient protection terminal block

For a terminal block with transient protection, wire the transmitter as shown in Figure 4-10.

Figure 4-10. Wiring Diagram for Transient Protection Terminal Block (HART)



4.9 FOUNDATION fieldbus

4.9.1 Power requirements

Terminals in the transmitter housing provide connections for signal wiring.

The Rosemount 5400 transmitter is powered over FOUNDATION fieldbus with standard fieldbus power supplies.

The transmitter operates with the following power supplies:

Approval type	Power supply (Vdc)
IS	9 - 30
Explosion-proof/flameproof	16 - 32
None	9 - 32

The Rosemount 5400 Series with FOUNDATION fieldbus operates using a power supply ranging from 9-32 Vdc (9-30 Vdc in IS applications, 16-32 Vdc in explosion-proof / flameproof applications, and 9-17.5 Vdc in FISCO, IS applications).

Grounding

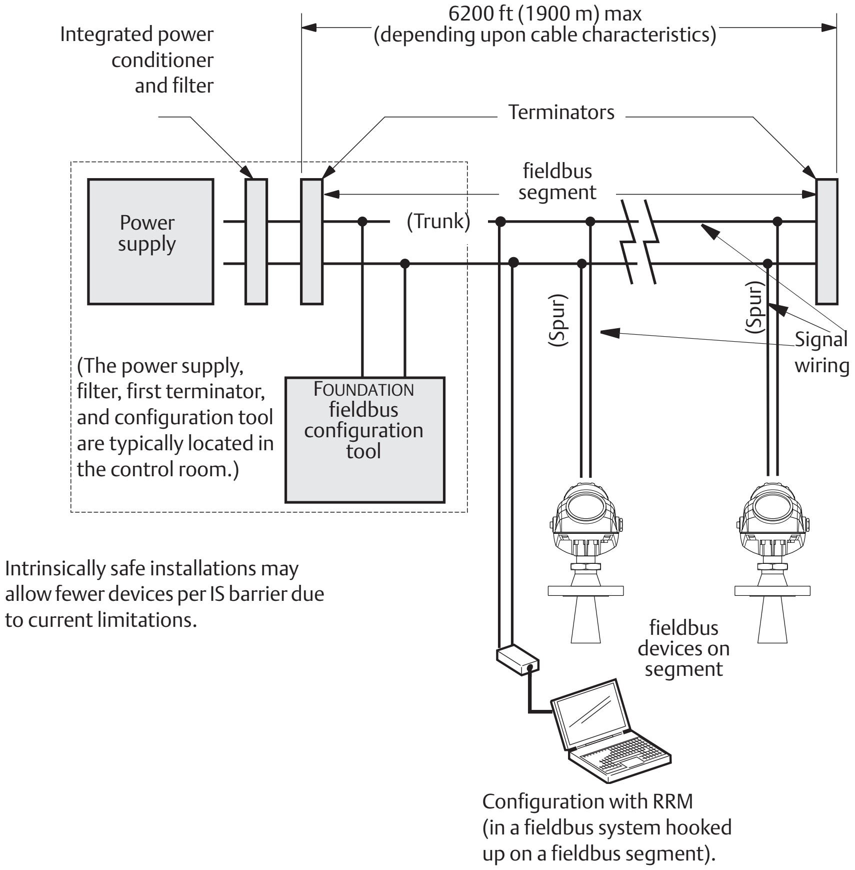
Signal wiring of the fieldbus segment cannot be grounded. Grounding out one of the signal wires will shut down the entire fieldbus segment.

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 4-11. Rosemount 5400 Series Radar Transmitter Field Wiring



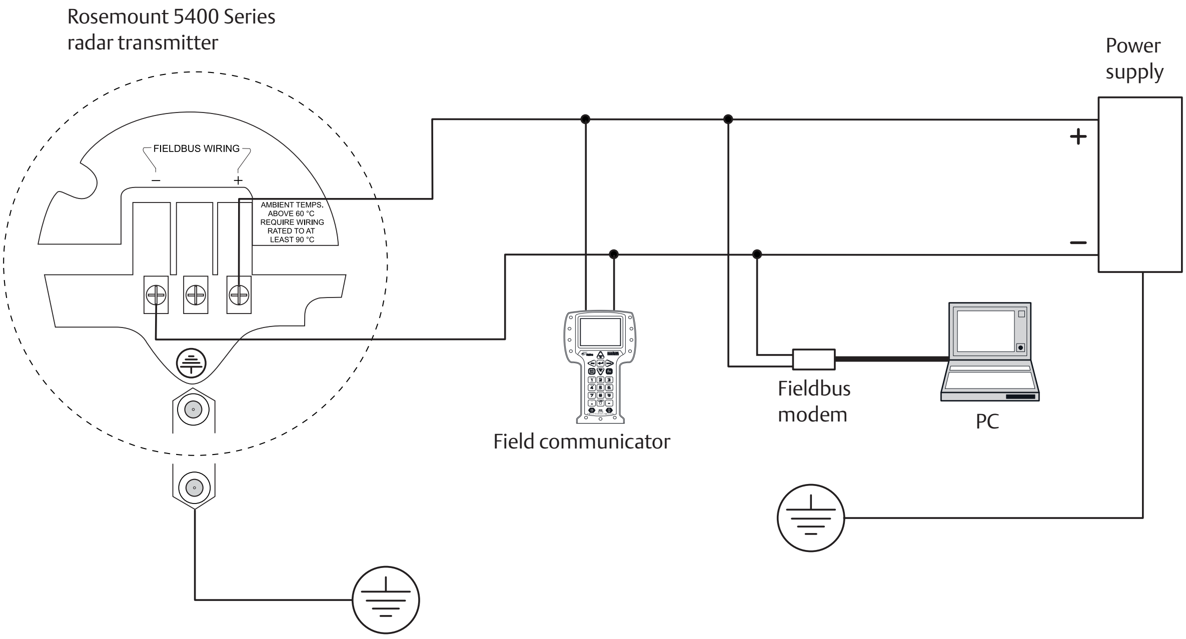
4.9.2 Non-intrinsically safe power supply

With non-intrinsically safe power supply in Non-hazardous installations or Explosion-proof/Flameproof installations, wire the transmitter as shown in Figure 4-12.

Rosemount 5400 Series Transmitters with Explosion-proof/Flameproof Output have a built-in barrier; no external barrier needed.

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

Figure 4-12. Wiring for Non-Intrinsically Safe Power Supply (FOUNDATION fieldbus)



Note
For explosion-proof/flameproof installations make sure that the transmitter is grounded to the IS ground terminal inside the terminal compartment in accordance with national and local electrical codes.

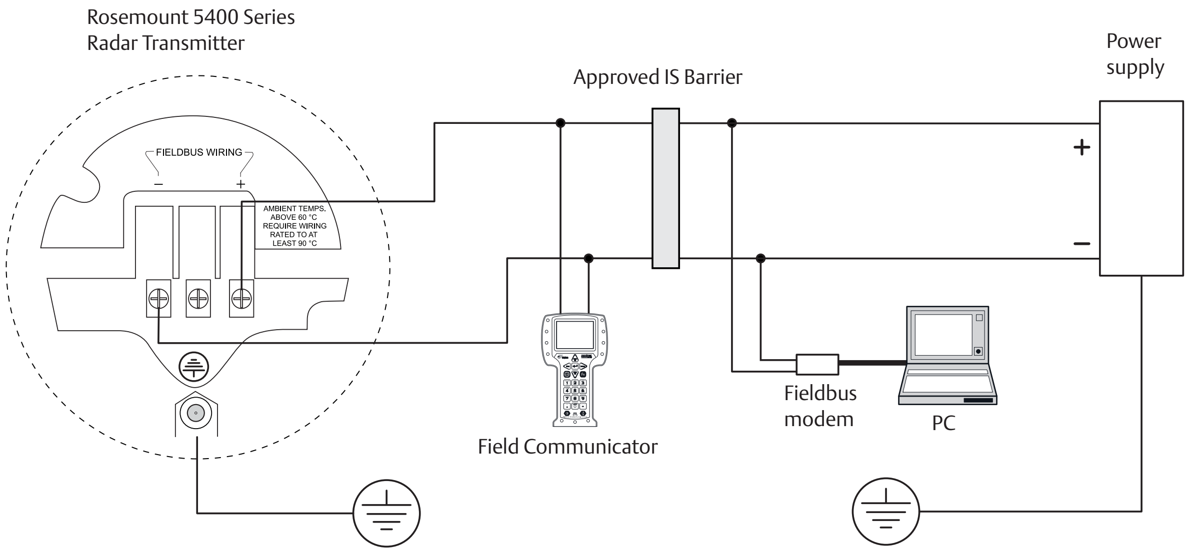
4.9.3 Intrinsically safe power supply

When your power supply is intrinsically safe, wire the transmitter as shown in Figure 4-13.

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

Installation also needs to comply with the applicable installation/control drawing. See "Approval drawings" on page 230.

Figure 4-13. Wiring Diagram for Intrinsically Safe Power Supply (FOUNDATION fieldbus)

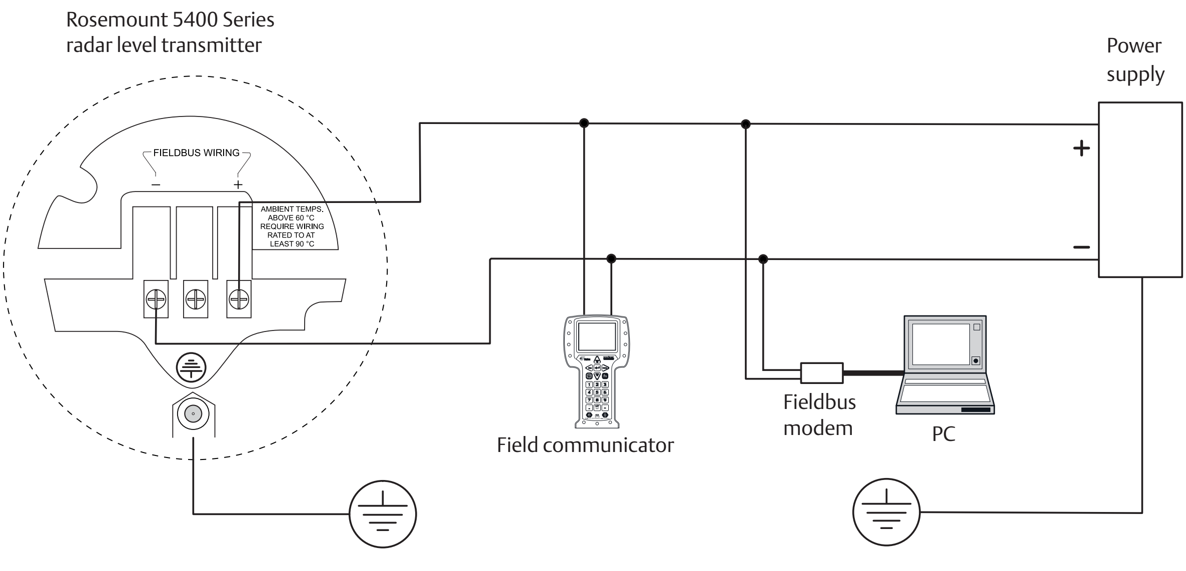


For IS Parameters, see Appendix B: Product Certifications.

4.9.4 Type N approvals: non-sparking / energy-limited power supply

With a non-sparking / energy-limited power supply, wire the transmitter as shown in Figure 4-14.

Figure 4-14. Wiring Diagram for Non-Sparking / Energy-Limited Power Supply (FOUNDATION fieldbus)



FOUNDATION fieldbus: U_n = 32 V

4.10 HART to Modbus Converter (HMC)

The Rosemount 5400 Series RS-485 with Modbus communication transmitter version operates using a power supply ranging from 8-30 Vdc (max. rating). See the Rosemount 5300/5400 Series with HART to Modbus Converter Manual Supplement (Document No. 00809-0500-4530) for details.

Power consumption:

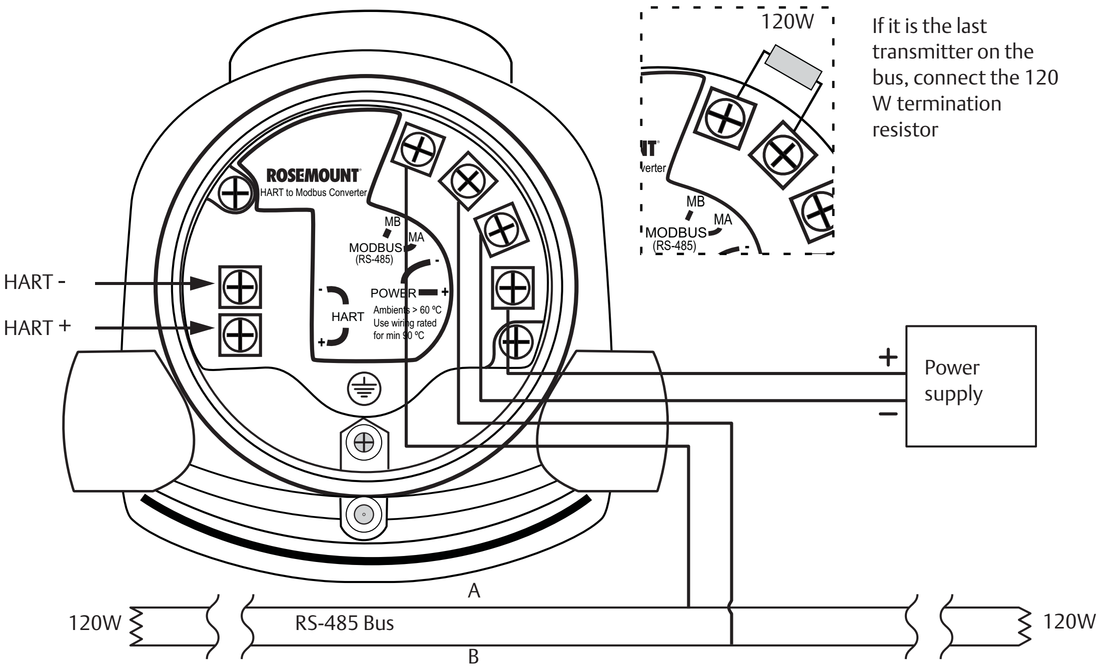
< 0.5 W (with HART address = 1)
< 1.2 W (incl. four HART slaves)

4.10.1 Connecting the transmitter

1. Disconnect/shut off the electrical power to transmitter head and then open the instrument cover. Do not remove the cover in an explosive atmosphere with a live circuit.
2. Pull the cable through the cable gland/conduit. For the RS-485 bus, use shielded twisted pair wiring, preferably with an impedance of 120 Ω (typically 24 AWG) in order to comply with the EIA-485 standard and EMC regulations. The maximum cable length is 4000 ft (1200 m).
3. Make sure that the transmitter housing is grounded, then connect wires according to Figure 4-15 and Table 4-2. Connect the lead that originates from the "A" line from the RS-485 bus to the terminal marked MB, and the lead that originates from the "B" line to the terminal marked MA.
4. If it is the last transmitter on the bus, connect the 120 Ω termination resistor.
5. Connect the leads from the positive side of the power supply to the terminal marked POWER +, and the leads from the negative side of the power supply to the terminal marked POWER -. The power supply cables must be suitable for the supply voltage and ambient temperature, and approved for use in hazardous areas, where applicable.
6. Attach and tighten the housing cover. Tighten the cable gland, then plug and seal any unused terminals, and connect the power supply.

Note
Rosemount 5400 Series transmitters with flameproof/explosion-proof output have a built-in barrier; no external barrier needed.

Figure 4-15. Field Wiring Connections



4.10.2 Connection terminals

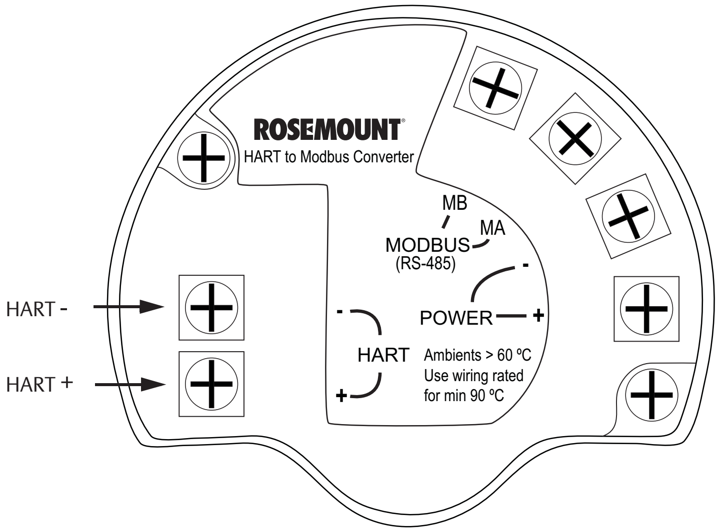
The connection terminals are described in Table 4-2 below:

Table 4-2. Connection Terminals

Connector label	Description	Comment
HART +	Positive HART connector	Connect to PC with RRM software, Field Communicator, or other HART configurators.
HART -	Negative HART connector	
MA	Modbus RS-485 **B** connection (RX/TX+)(1)	Connect to Remote Terminal Unit (RTU)
MB	Modbus RS-485 **A** connection (RX/TX-)(1)	
POWER +	Positive Power input terminal	Apply +8 Vdc to +30 Vdc (max. rating)
POWER -	Negative Power input terminal	

(1) *The designation of the connectors does not follow the EIA-485 standard, which states that RX/TX- should be referred to as 'A' and RX/TX+ as 'B'.*

Figure 4-16. Connection Terminals for Rosemount 5400 with HART to Modbus Converter



4.10.3 RS-485 bus

- The Rosemount 5400 transmitter does not provide electrical isolation between the RS-485 bus and the transmitter power supply
- Maintain a bus topology and minimize stub length
- Figure 4-17 identifies multidrop wiring topology, where up to 32 devices may be wired on one RS-485 bus
- The RS-485 bus needs to be terminated once at each end, but should not be terminated elsewhere on the bus

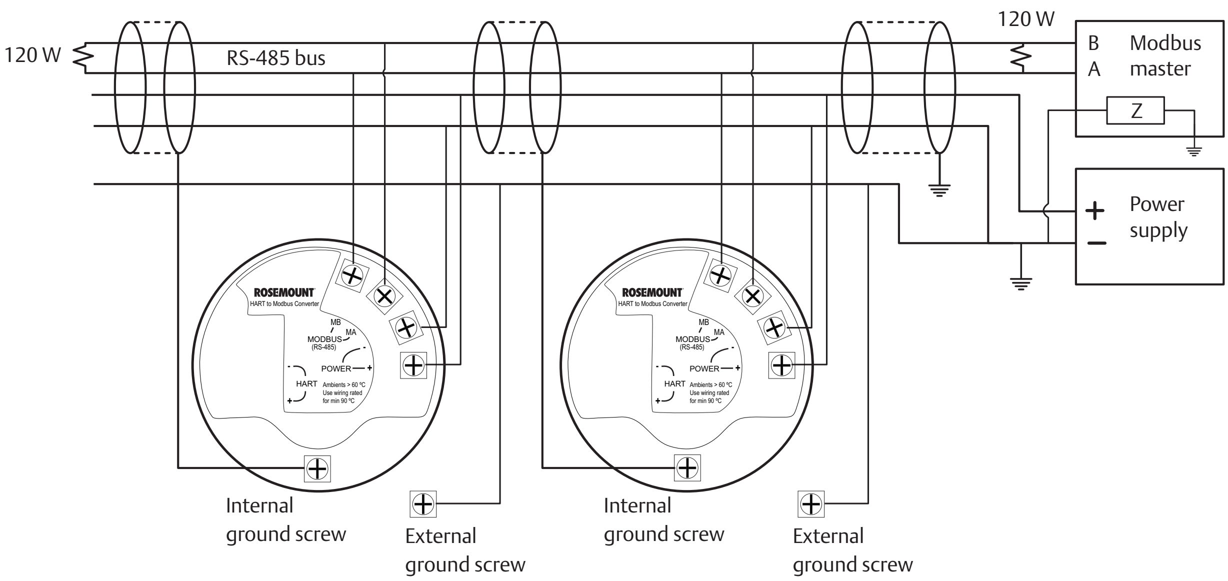
4.10.4 Installation cases

Install the Rosemount 5400 Series Transmitter as shown in Figure 4-17.

- Use common ground for Modbus Master and Power Supply
- The Power cables and RS-485 Bus are in the same cable installation
- A ground cable is installed and shall be used (cable size ≥ 4 mm according to IEC60079-14, or size according to applicable national regulations and standards). A properly installed threaded conduit connection may provide sufficient ground.
- The cable shielding is grounded at master site (optional)

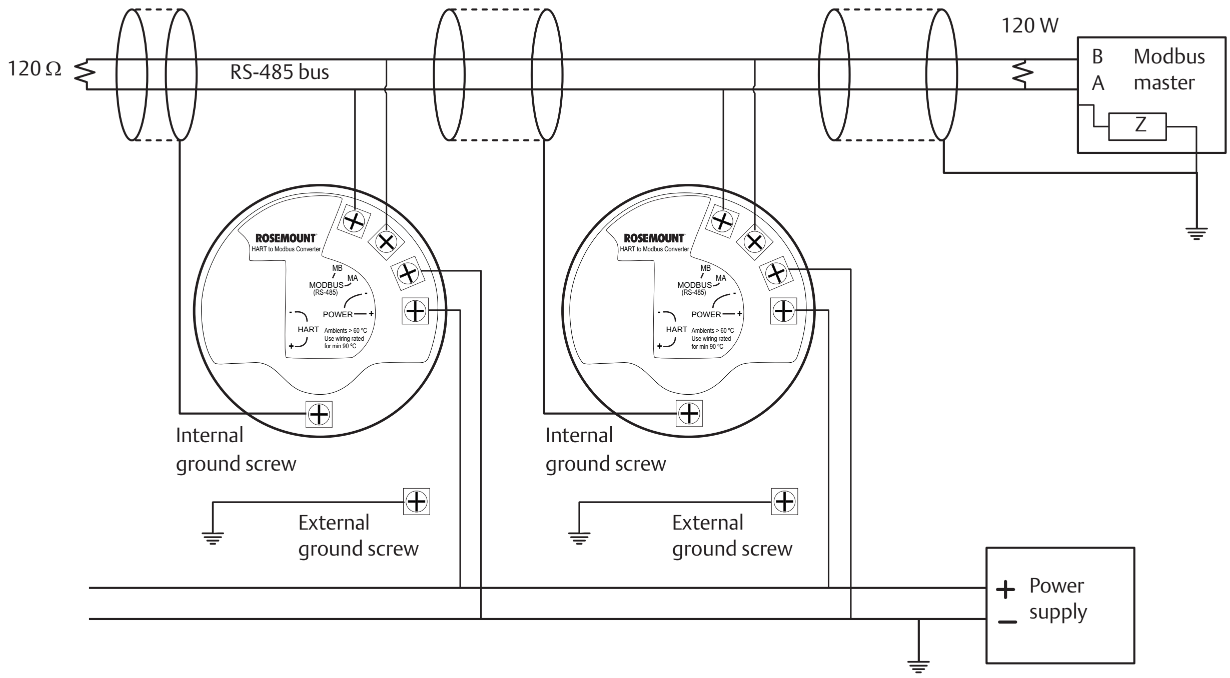
Note
The HMC equipped transmitter contains intrinsically safe circuits that require the housing to be grounded in accordance with national and local electrical codes. Failure to do so may impair the protection provided by the equipment.

Figure 4-17. Multidrop Connection of Rosemount 5400 Series Transmitters



Alternatively, the Rosemount 5400 Series Transmitter can be installed as shown in Figure 4-18. If this wiring layout is used, there is an increased risk for communication disturbances due to differences in potential between grounding points. By using the same grounding point for Modbus Master and Power Supply, this risk is reduced.

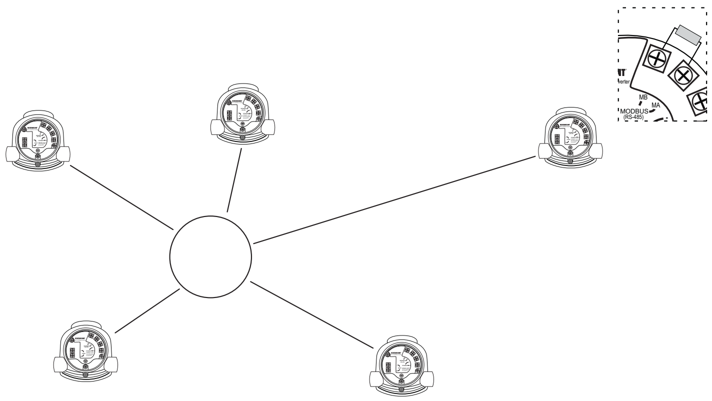
Figure 4-18. Alternative Multidrop Connection of Rosemount 5400 Series Transmitters



Star topology

For a star topology connection of the Rosemount 5400 Series transmitters, the transmitter with the longest cable run needs to be fitted with a 120 Ω termination resistor.

Figure 4-19. Star Topology Connection of Rosemount 5400 Series Transmitters



4.10.5 External HART devices (slaves)

The HMC supports up to four external HART devices. The external devices are separated by using the HART address. The address must be different between the external devices and only addresses 1 to 5 are allowed for multiple slaves. Connect the devices one at a time and change the short address prior to connecting the next device by using a HART Configuration Tool such as RRM, or a Field Communicator.

Note

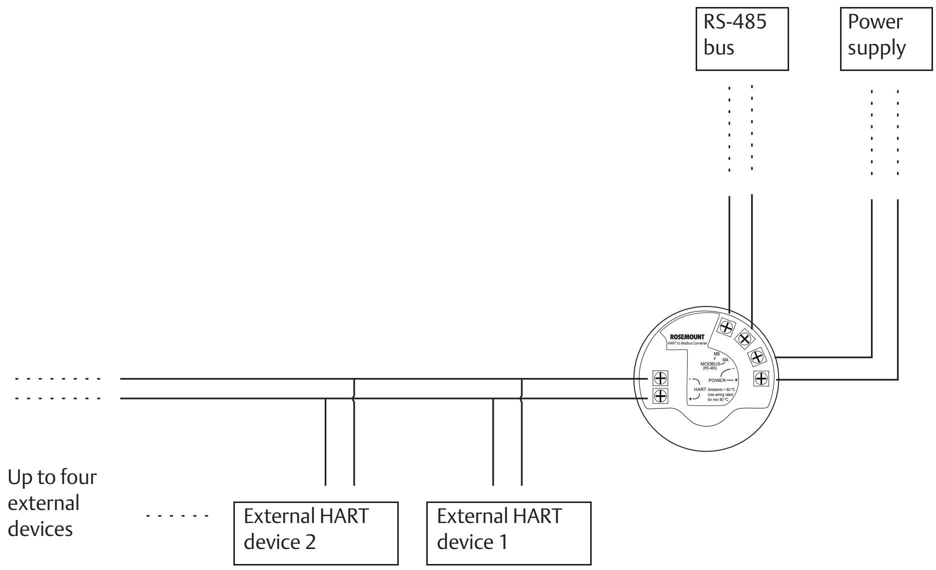
The power supply from the HMC to external HART devices is not intrinsically safe. In a hazardous environment, any external HART device connected to the HMC must have Flameproof/Explosion-proof certification.

The HMC cyclically polls the HART devices for measurement values. The update rate depends on the number of connected devices and is shown in Table 4-3.

Table 4-3. Approximate Update Rates for Measurement Values

No. of devices (slaves)	Approx. update rate
1	2 seconds
2	3 seconds
3	4 seconds
4	5 seconds
5	5 seconds

Figure 4-20. The HMC Module Supports up to Four External Devices (slaves)



4.11 Establish HART communication

The Rosemount 5400 Series can be configured using the RRM PC software or a Field Communicator. Configuration is done by sending HART commands through the HMC to the Rosemount 5400 transmitter electronics. To establish HART communication, connect to the MA/MB terminals, or to the HART terminals. Both alternatives are described below.

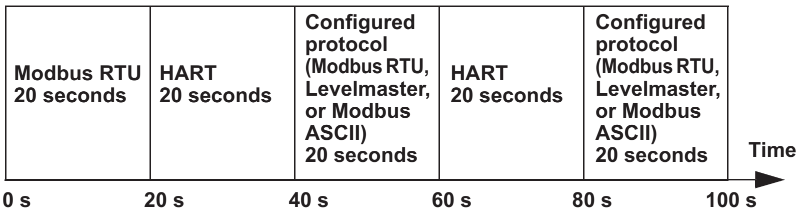
4.11.1 Connect to the MA/MB terminals

The Rosemount 5400 level transmitter can be configured with RRM using the MA, MB terminals.

An RS-485 Converter is required to connect to the transmitter.

The transmitter will try to establish communication using different protocols during 20 second timeslots from time of startup.

Figure 4-21. RS-485 Communication after Startup

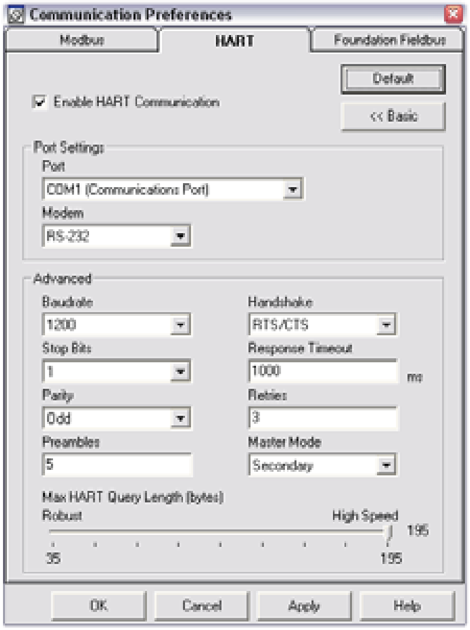


The transmitter will continue to use a communication protocol once communication has been established.

To configure the Rosemount 5400 level transmitter using RRM and the MA, MB terminals, do the following:

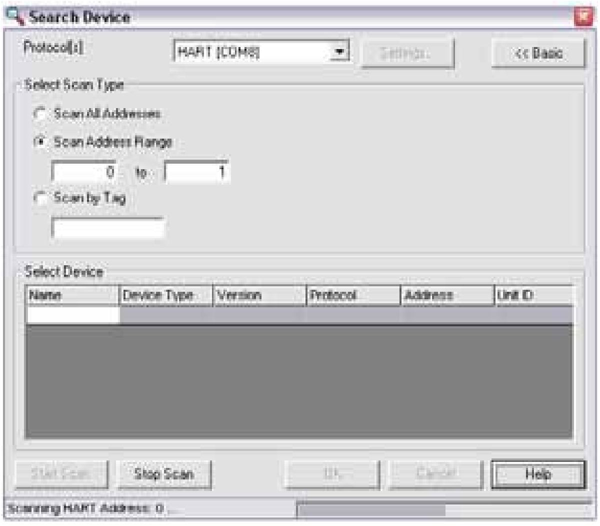
1. Connect the RS-485 Converter to the MA, MB connectors.
2. Start RRM and open Communication Preferences.

3. Enable HART communication and make sure the port for the RS-485 Converter is selected. Use the following settings:



4. Connect the power wires (or cycle power) to the transmitter.

5. Wait 20 seconds and then open the Search Device window in RRM (also see Note on page 68). Make sure HART address 1 is being scanned.



6. Connect to the transmitter and perform the necessary configuration.

7. After completing the configuration, disconnect the RS-485 Converter, connect the Modbus communication wires and cycle power to the transmitter

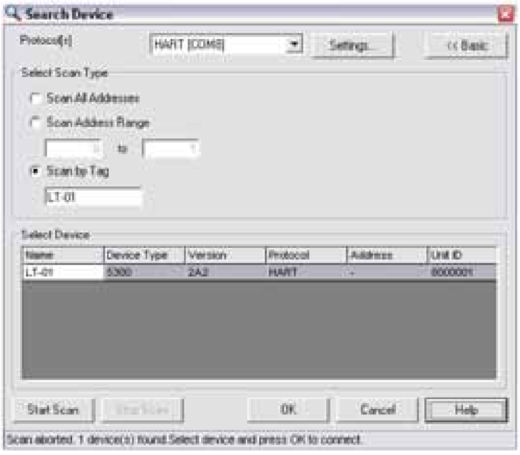
8. Verify that communication between the transmitter and the RTU is established (can take up to 60 seconds from startup).

Note

Take the following into consideration if there are multiple Rosemount 5400 Modbus units on the bus:

By default, the transmitters have HART address 1. It will not be possible to establish communication on HART address 1 if several transmitters have the same address. In this case, there are alternative solutions to establish communication:

1. Select the Scan by Tag option in the Search Device window in RRM and enter the HART Device Tag of the transmitter. Communication can now be established with an individual transmitter even if several devices have the same HART address.



2. Make sure the Rosemount 5400 transmitter is alone on bus. Disconnect or turn off power from any other dcevies.

4.11.2 Connect to the HART terminals

To configure the Rosemount 5400 transmitter, connect the communicator or PC to the HART terminals using a HART modem, see Figure 4-16 on page 62. Both the configuration tool and the RS-485 bus can be connected simultaneously. Configuration data is sent with HART commands through the HMC to the Rosemount 5400 transmitter electronics.

Note that the power supply must be connected during configuration, see also “Connecting the transmitter” on page 47.

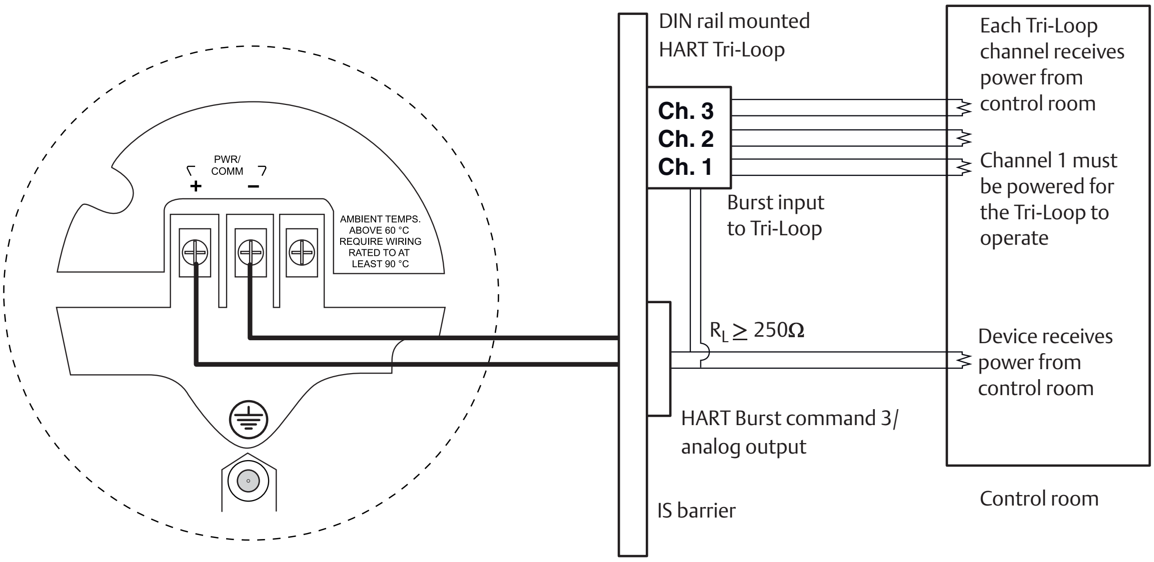
Note
Measurement data is not updated to the Modbus Master when a configuration tool is connected.

4.12 Optional devices

4.12.1 Tri-Loop™ HART to analog converter

The Rosemount 5400 Series transmitter outputs a HART signal with four process variables. The Model 333 HART Tri-Loop provides up to three additional analog 4-20 mA outputs.

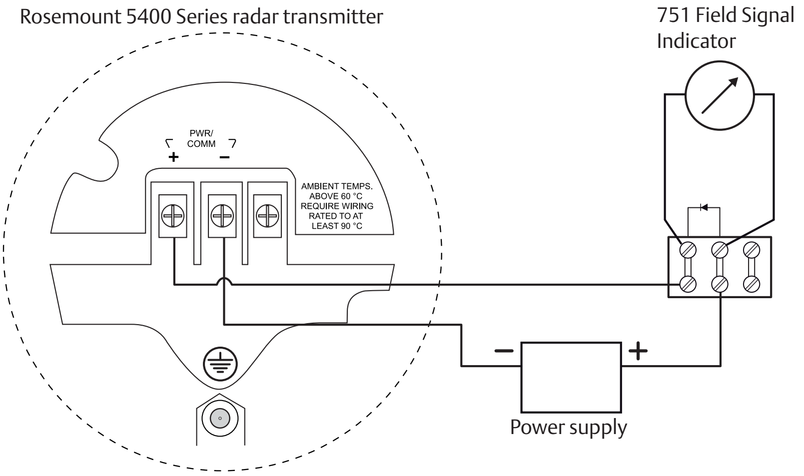
Figure 4-22. Wiring Diagram for HART Tri-Loop



Configure Channels 1, 2, and 3 to reflect the units in addition to Upper Range Values and Lower Range Values for secondary, tertiary, and fourth variables (variable assignment is configured in the Rosemount 5400 Series). It is also possible to enable or disable a channel from this menu.

4.12.2 751 Field Signal Indicator

Figure 4-23. Wiring Diagram for a Rosemount 5400 Series Transmitter with a 751 Field Signal Indicator

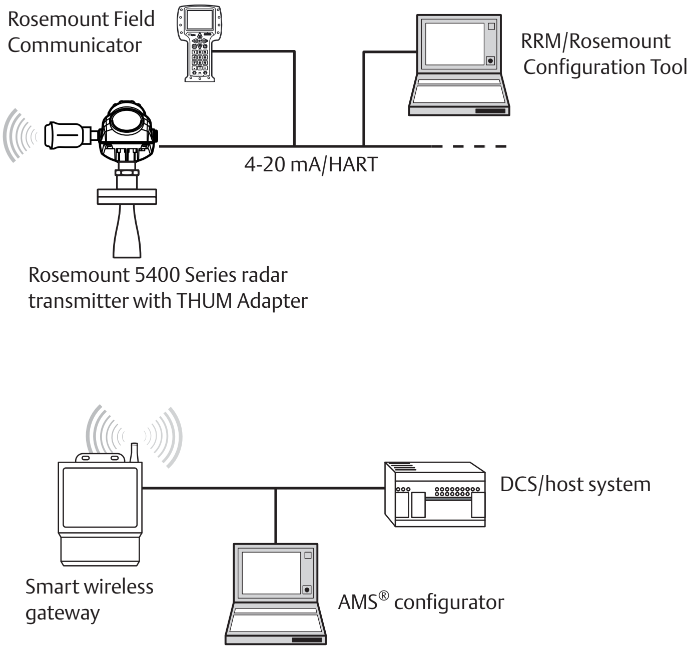


4.12.3 Smart Wireless THUM™ Adapter

The Rosemount 5400 Series can be combined with the Smart Wireless THUM Adapter.

For more information, see the Smart Wireless THUM™ Adapter for Rosemount Process Level Transmitter Applications Technical Note (Document No. 00840-0100-4026) and the Smart Wireless THUM™ Adapter Reference Manual (Document No. 00809-0100-4075).

Figure 4-24. Wiring Diagram for a Rosemount 5400 Series with the Smart Wireless THUM Adapter



Section 5 Basic Configuration/Start-up

5.1 Safety messages

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

⚠ WARNING

Explosions could result in death or serious injury.

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

Before connecting a HART®-based communicator in an explosive atmosphere, make sure the instruments in the loop are installed in accordance with intrinsically safe or non-incendive field wiring practices.

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

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

⚠ WARNING

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

Make sure only qualified personnel perform the installation.

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

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

5.2 Overview

The configuration of a Rosemount 5400 Series transmitter is normally a simple and straightforward task. If the transmitter is pre-configured at the factory according to ordering specifications in the Configuration Data Sheet, no further basic configuration is required, unless tank conditions have changed.

The Rosemount 5400 Series supports a set of advanced configuration options that can be used to handle special tank conditions and applications. For further information on advanced configuration options, see Appendix C: Advanced Configuration.

5.2.1 Basic configuration parameters

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

- Measurement Units
- Tank Configuration
  - Tank Geometry
  - Environment
  - Volume
- Analog Output
- Echo Tuning: see page 83 for more information on the Amplitude Threshold Curve (ATC), and "Echo tuning" on page 83 for more information on False Echo Registration

5.2.2 Configuration tools

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

- RRM. Note that RRM is required for advanced configuration features.
  See "Basic configuration using RRM" on page 84 for information on using RRM to configure the Rosemount 5400 Series.
- Rosemount Field Communicator.
  See "Configuration using a Field Communicator" on page 101 for the Field Communicator Menu Tree.
- DTM (compliant with version 1.2 of the FDT®/DTM™ specification) is also available supporting configuration in, for instance, Yokogawa Fieldmate/PRM, E+H™ FieldCare, and PACT*ware*™
- AMS® Suite software (for HART).
  See "Basic configuration using AMS Suite" on page 105 for information on configuring AMS Suite.
- DeltaV™ (only for FOUNDATION™ fieldbus).
  See "Configuration using DeltaV" on page 106 for information on configuring the Rosemount 5400 Series transmitter using DeltaV.
- Other tools that support EDDL functionality.

RRM is a user-friendly, Windows™ based software package that includes waveform plots, offline/online configuration Wizard, logging, and extensive online help.

To communicate with the transmitter using RRM, a HART modem (part number 03300-7004-0001 or 03300-7004-0002) or a FOUNDATION fieldbus modem (part number 03095-5108-0001 for PCMCIA) is required. For FOUNDATION fieldbus communication you will also need the *National Instruments Communication Manager* software (see "Installing the RRM software for FOUNDATION fieldbus" on page 88).

5.3 Basic configuration parameters

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

Different configuration tools are described at the end of this section.

5.3.1 Measurement units

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

5.3.2 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 5-2 for further information on Upper Reference Points for various tank connections). The transmitter measures the distance to the product surface and subtracts this value from the Tank Height to determine the product level.

Figure 5-1. Tank Geometry

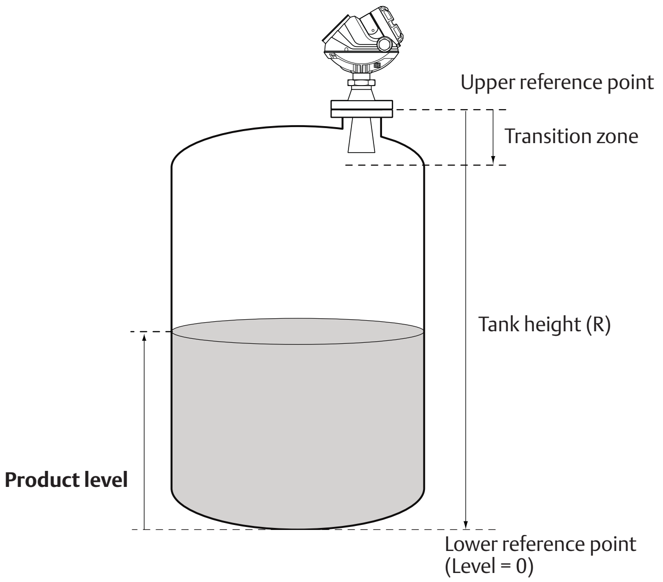
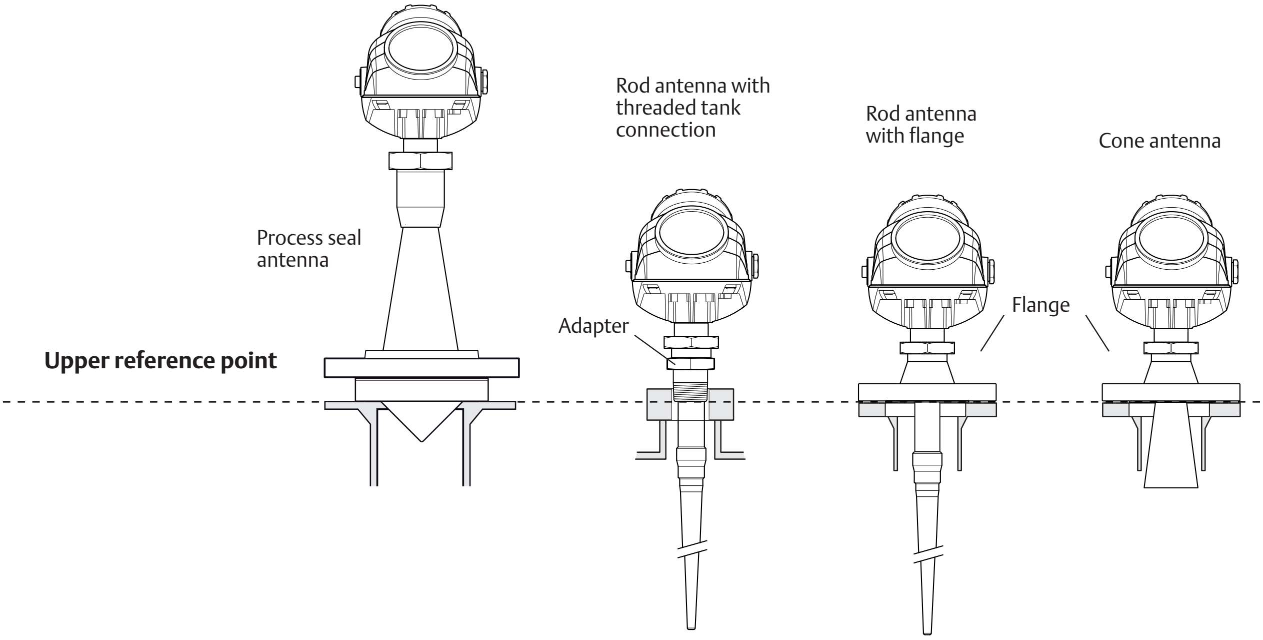


Figure 5-2. Upper Reference Point



Tank type and tank bottom type

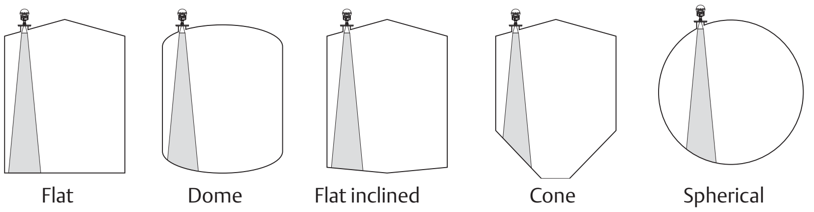
The Rosemount 5400 Series transmitter is optimized according to the *Tank Type* and *Tank Bottom Type* configuration by automatically setting some parameters to predefined default values.

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

Table 5-1. Tank Type and Tank Bottom Type

Tank type	Tank bottom type
Vertical cylinder	Flat, dome, cone, flat inclined/obstructed
Horizontal cylinder	*Not used*
Spherical	*Not used*
Cubical	Flat, dome, cone, flat inclined/obstructed

Figure 5-3. Transmitter Optimization 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 gives a scale factor error. If locally supplied still-pipes are used, make sure the inner diameter is noted before the pipe is installed.

Transition zone

The measurement accuracy is reduced within the transition zone region 6 in. (150 mm) from the lower end of the antenna. It is recommended that the Upper Range Value (20 mA) be set outside the transition zone.

5.3.3 Process conditions

Describe the conditions of the tank according to the tank environment parameters for process conditions listed below. For best performance, choose only if applicable, **and no more than two options**.

Rapid level changes

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

Turbulent surface

This parameter should be used if the tank has 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 improve 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 foam’s upper surface.

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 properly, even if the actual Dielectric Constant differs from the configured value.

Solid product

Setting this parameter optimizes the device for solid products, for example concrete or grains. For instance, this parameter can be used when the application is a silo with product pile-up. The transmitter will be optimized for weak echoes and a sloping surface which is typical when measuring at solid materials. This option shall only be used for a Rosemount 5402 with a 4” cone antenna.

5.3.4 Volume configuration

For volume calculations, choose one of the standard tank shapes or the strapping option. Select None if volume calculation is not used. For the standard tanks, a Volume Offset parameter can be specified which can be used for a non-zero volume that corresponds to the zero level. This may be useful, for example, if the user wants to include the product volume below the zero level.

Volume calculation is performed by using a predefined tank shape or a strapping table. One of the following standard tank shapes can be chosen:

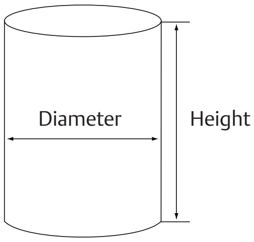
- Sphere
- Vertical cylinder
- Horizontal cylinder
- Vertical bullet
- Horizontal bullet

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

- Tank diameter
- Tank height (not for spherical tanks)
- Volume offset

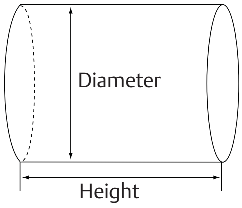
Standard tank shapes

Figure 5-4. Standard Tank Shapes



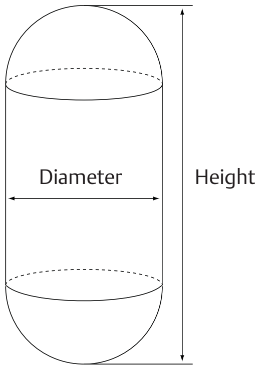
Vertical cylinder

Vertical cylinder tanks are specified by diameter, height, and volume offset.



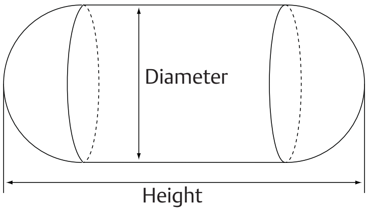
Horizontal cylinder

Horizontal cylinder tanks are specified by diameter, height, and volume offset.



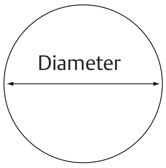
Vertical bullet

Vertical bullet tanks are specified by diameter, height, and volume offset. The volume calculation model for this tank shape estimates that the radius of the bullet end is equal to the diameter/2.



Horizontal bullet

Horizontal bullet tanks are specified by diameter, height, and volume offset. The volume calculation model for this tank shape estimates that the radius of the bullet end is equal to the diameter/2.



Sphere

Spherical tanks are specified by diameter and volume offset.

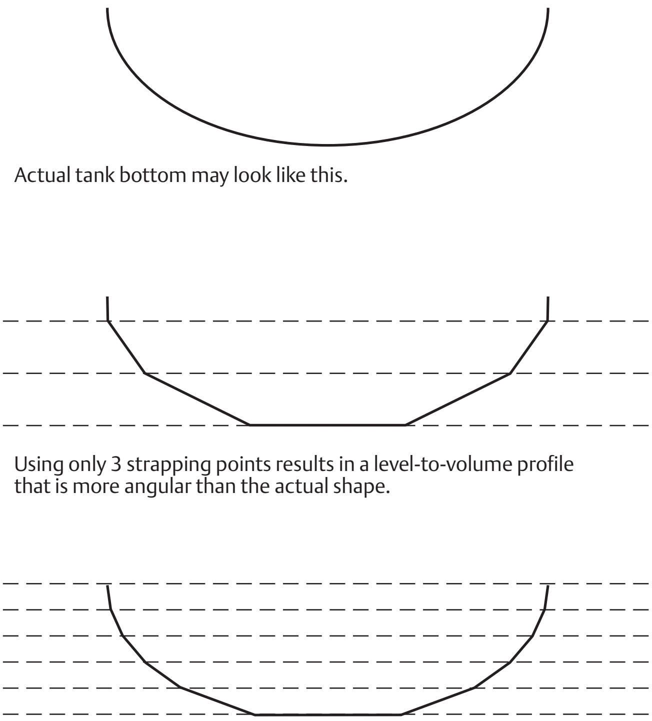
Strapping table

The Strapping Table option is 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 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.

Figure 5-5. Strapping Points



Actual tank bottom may look like this.

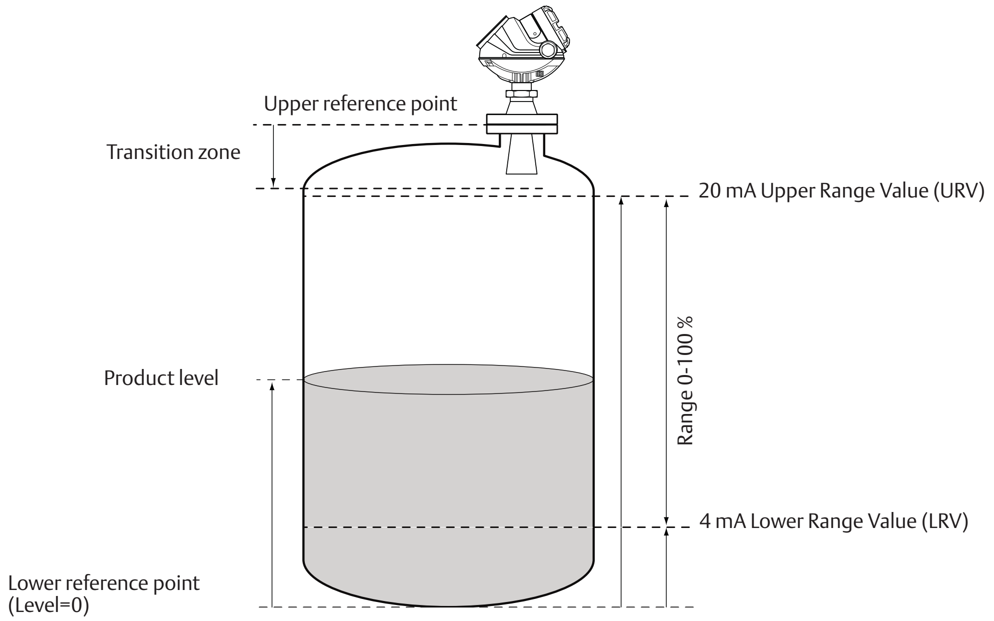
Using only 3 strapping points results in a level-to-volume profile that is more angular than the actual shape.

Using 10-15 of the points at the bottom of the tank yields a level-to-volume profile that is similar to the actual tank bottom.

5.3.5 Analog output (HART)

For the analog output, the output source (primary value), range values, and alarm mode are specified.

Figure 5-6. Standard Range Value Settings



Output source/primary variable

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

Upper/lower range value

Enter the range values that correspond to the analog output values 4 and 20 mA. The 20 mA point should be set below the Transition Zone, since the measurement accuracy is reduced in this region. For information on the Transition Zone, see "Performance specifications" on page 189.

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

Alarm mode

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

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

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

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

Default settings for alarm mode:

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

Table 5-2. Analog Output: Standard Alarm Value vs. Saturation Value

Level	4–20 mA saturation value	4–20 mA alarm value
Low	3.9 mA	3.75 mA
High	20.8 mA	21.75 mA

In saturation mode, if the primary variable is not in low alarm mode, the minimum output is 3.9 mA. If the primary variable is not in high alarm mode, the maximum output is 20.8 mA.

Table 5-3. Analog Output: NAMUR-compliant Alarm Value vs. Saturation Value

Level	4–20 mA saturation value	4–20 mA alarm value
High	20.5 mA	22.5 mA

5.3.6 Level and distance calibration

Level and distance calibration may be necessary when using a nozzle or pipe or if there are disturbances in the near zone caused by a physical object.

Non-metallic (e.g. plastic) vessels and installation geometry may introduce an offset for the zero reference point. This offset may be up to ± 25 mm. The offset can be compensated for using Distance Calibration.

When calibrating the transmitter, it is important that the product surface is calm and that the tank is not being filled or emptied.

A complete calibration is performed in two steps:

1. Calibrate the distance measurement by adjusting the Calibration Offset parameter.
2. Calibrate the level measurement by adjusting the Tank Height.

Distance calibration

1. Measure the actual distance between the Upper Reference Point and the product surface.

2. Adjust the Calibration Distance so that the Distance measured by the transmitter corresponds to the actual distance.
   The Calibration Distance parameter is available via
   HART command [2, 3, 2, 4, 1],
   or
   RRM:

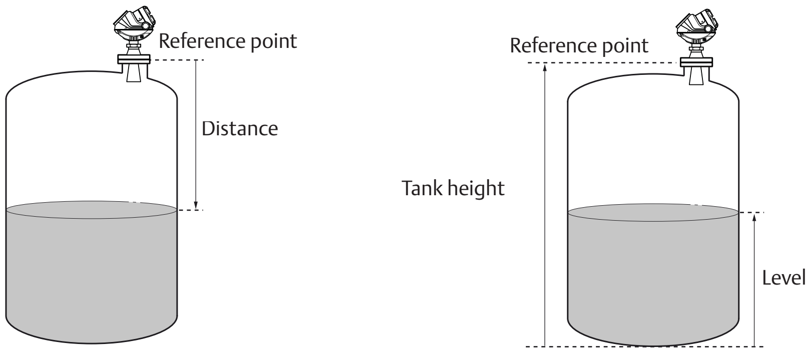
   a. Select the **Tank** icon under *Device Config/Setup* in the RRM workspace.
   b. In the *Tank* window, select the **Geometry** tab.
   c. Select the **Advanced** button.
   d. Enter the desired value in the *Calibration Distance* field and select the **Store** button.

Level calibration

1. Measure the actual Product Level.

2. Adjust the **Tank Height** so the product level measured by the transmitter corresponds to the actual product level.

Figure 5-7. Distance and Level Calibration



5.3.7 Echo tuning

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

- ATC
- False echo registration, see "Registration of false echoes" on page 135

The *Guided Setup* in the RRM configuration program includes a *Measure and Learn* function which automatically registers false echoes and creates an ATC (see "Guided setup" on page 92).

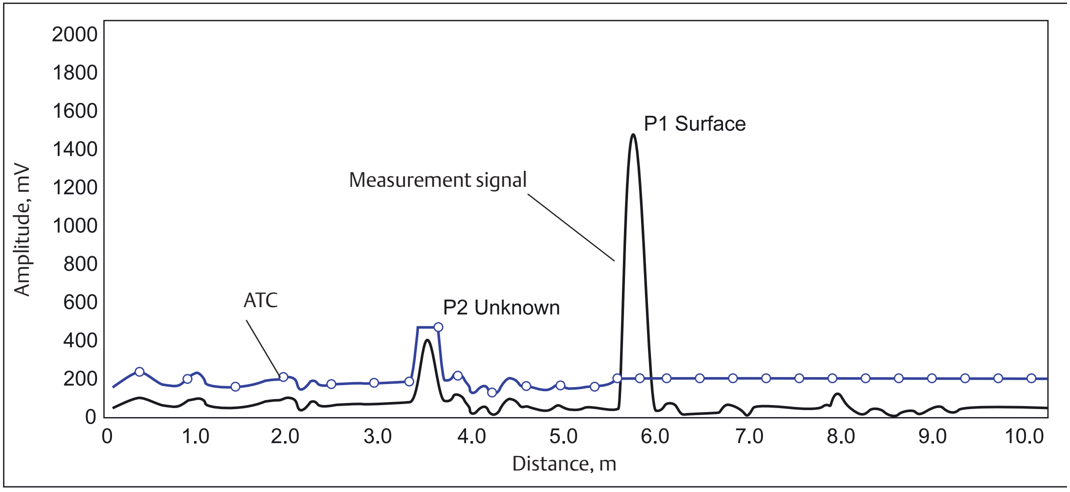
The created ATC is based on the present tank spectra and process condition settings. Disturbances below the product surface might not be handled by the *Measure and Learn* function.

5.3.8 ATC

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

The ATC is designed as a number of individually adjustable amplitude threshold points.

Figure 5-8. Weak Disturbing Echoes can be Filtered Out by Creating an Amplitude Threshold



To create an ATC, the Measure and Learn function is available in the RRM program.

5.4 Basic configuration using RRM

The RRM is a user-friendly software tool that allows configuration of the Rosemount 5400 transmitter. Choose either of the following methods to configure a Rosemount 5400 transmitter with RRM:

- Guided Setup, if you are unfamiliar with the Rosemount 5400 Series transmitter (see page 92)
- Setup functions, if you are already familiar with the configuration process, or for changes to the current settings (see page 100)

5.4.1 System requirements

Hardware

COM Port: 1 serial COM port or 1 USB port

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

Hard drive space: 100 MB

Software

Operating Systems supported:

- Windows XP
- Windows 7

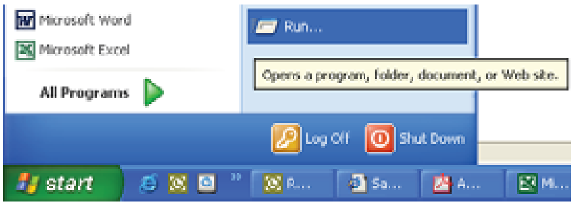
5.4.2 Help in RRM

From the Help menu, select the Contents option to access help information. Help is also available from a Help button in most windows.

5.4.3 Installing the RRM software for HART communication

To install the RRM:

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



3. Enter D:\RRM\Setup.exe where D is the CD-ROM drive.
4. Follow the instructions on the screen.
5. Make sure that HART is chosen as default protocol.
6. Set COM Port Buffers to 1, see page 88.

Getting started

1. From the *Start* menu, select **Programs** > **Rosemount** > **Rosemount Radar Master** or select the **RRM** icon in the Windows workspace.

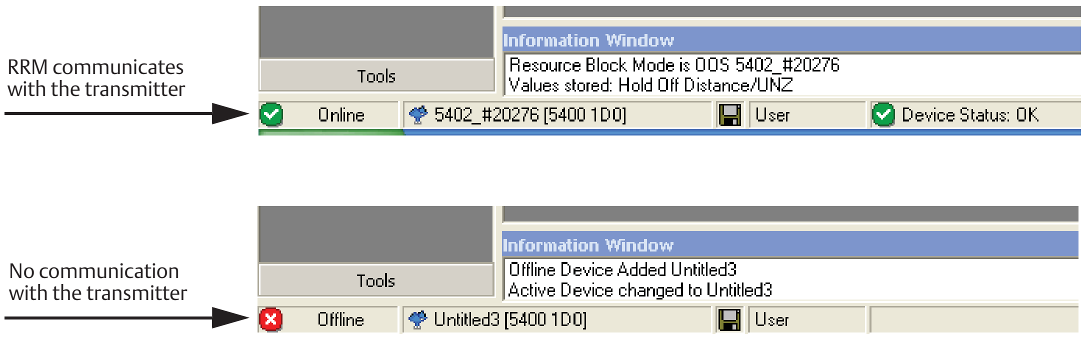
2. If the *Search Device* window did not appear automatically, select menu option *Device* > *Search*.

3. In the *Search Device* window, select communication protocol HART and select the **Start Scan** button (select the **Advanced** button to specify start and stop address).
Now RRM searches for the transmitter.

4. The *Search Device* window presents a list of found transmitters.

5. Select the desired transmitter and press **OK** to connect. If communication does not work, check that the correct COM port is configured correctly and is connected to the computer. See "Specifying the COM port" on page 87. Verify from the Communication Preferences window that HART communication is enabled.

6. The RRM Status Bar can be used to verify that RRM is communicating with the transmitter:

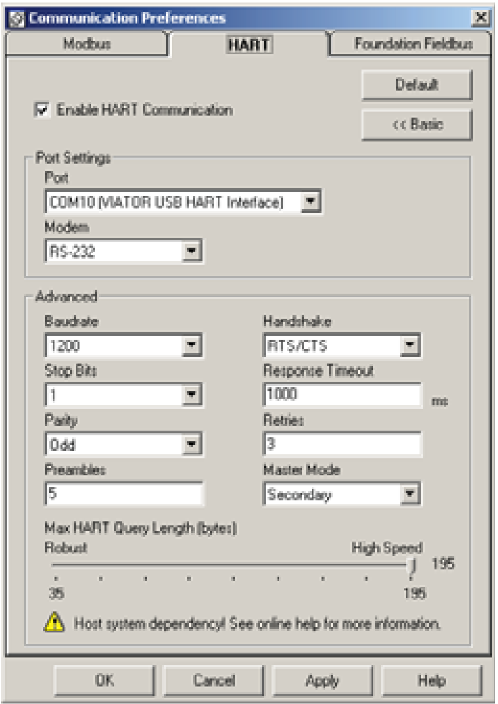


5.4.4 Specifying the COM port

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

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

Figure 5-9. Communication Settings



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

5.4.5 To set the COM port buffers

The COM port Receive Buffer and Transmit Buffer need to be set to 1 by doing the following:

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

5.4.6 Specifying measurement units

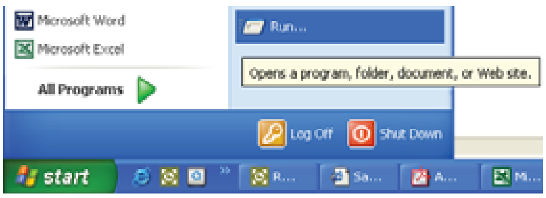
Measurement units for data presentation in RRM can be specified when the RRM program is installed. Units can also be changed as follows:

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

5.4.7 Installing the RRM software for FOUNDATION fieldbus

To install the RRM for FOUNDATION fieldbus communication:

1. Start by installing 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, select **Run** from the Windows Start bar.



4. Type D:\RRM**Setup.exe** where D is the CD-ROM drive.
5. Follow the instructions on the screen.
6. Make sure that FOUNDATION fieldbus is selected as default protocol.

Getting started

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

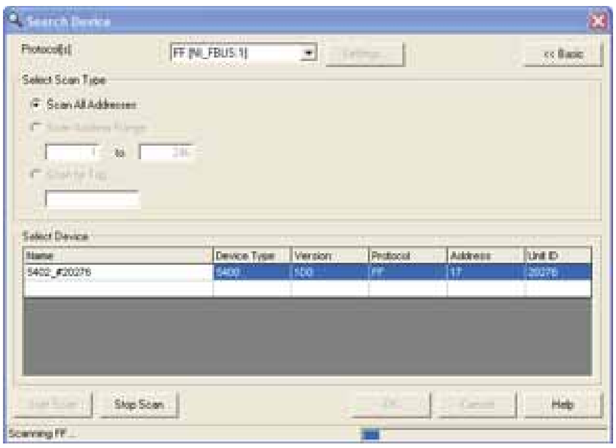
   Use the following settings:
   Device address = Visitor
   Device Type = Link Master Device
   Usage = NI-FBUS

2. Start RRM: from the *Start* menu click **Programs** > **Rosemount** > **Rosemount RadarMaster** or click the **RRM** icon in the Microsoft Windows workspace.

3. If the *National Instruments Communication Manager* server is not running, click **Yes** when RRM displays a request for starting the server.

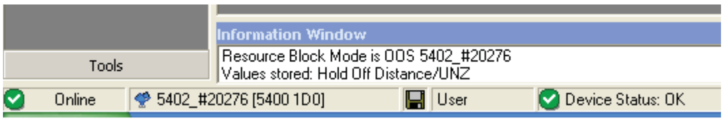
4. If the *Search Device* window did not appear automatically, select menu option **Device** > **Search**.

5. In the *Search Device* window, select communication protocol **FOUNDATION fieldbus** (if not already selected) and click the **Start Scan** button (click the **Advanced** button if you want to specify start and stop dress).
   Now RRM searches for the transmitter. After a while, RRM shows the transmitters found on the bus:

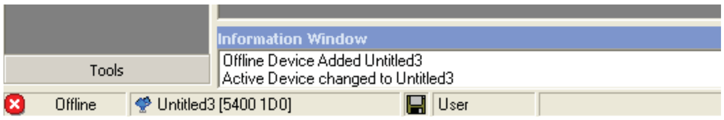


6. Select the desired transmitter and click **OK** to connect.
   In the RRM Status Bar, verify that RRM communicates with the transmitter:

RRM communicates with the transmitter



No communication with the transmitter



5.4.8 Specifying measurement units

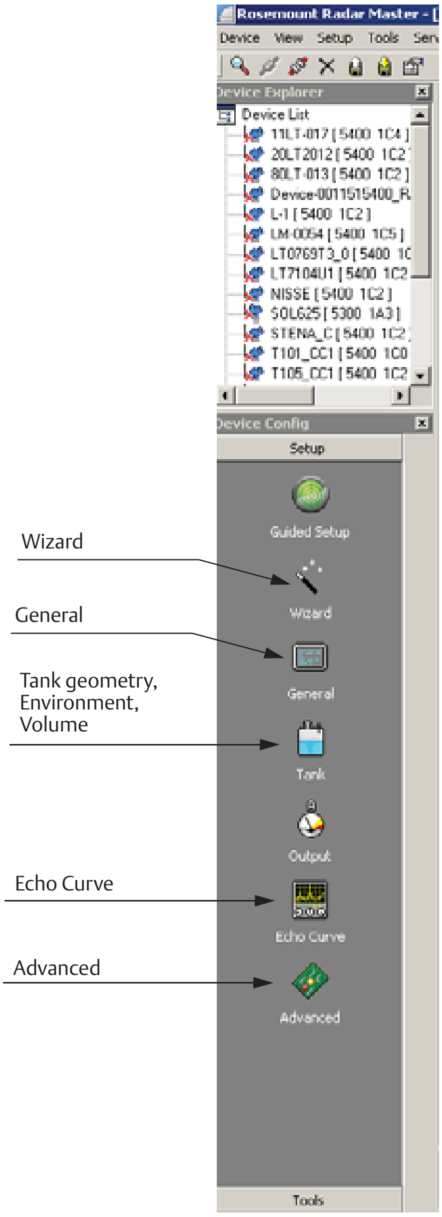
Measurement units for data presentation in RRM can be specified when the RRM program is installed. Units can also be changed as follows:

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

5.4.9 Using the Setup functions

Use the **Setup** function if you are already familiar with the configuration process for the Rosemount 5400 Series transmitter or for changes to the current settings:

Figure 5-10. Setup Functions in RRM



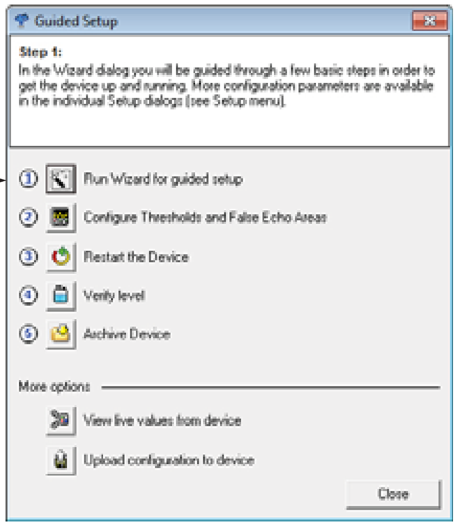
1. Start the RRM software.
2. In the RRM workspace, select the appropriate icon for the configuration of transmitter parameters:
   - **Wizard**: the Wizard is a tool that guides you through the basic configuration procedure of a Rosemount 5400 Series transmitter
   - **General**: configuration of general 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 Curve**: disturbance echo handling
   - **Advanced**: advanced configuration

5.4.10 Guided setup

The following description tells how to use the RRM Guided Setup. The corresponding HART commands (Field Communicator Fast Key Sequence) are also shown. The Guided Setup is useful for those unfamiliar with the Rosemount 5400 Series transmitter.

Guided Setup and Configuration Wizard

Run Wizard

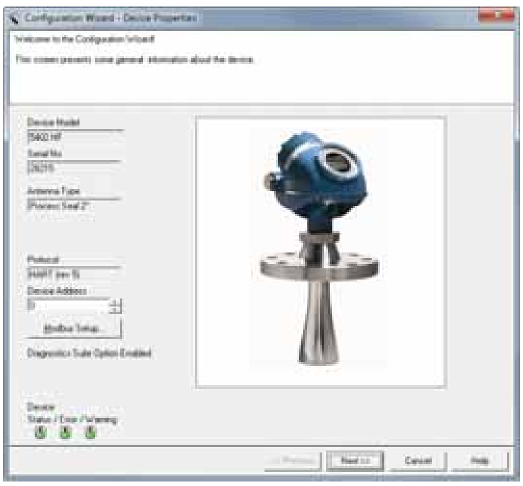


1. Start the RRM program. RRM automatically presents a list of available transmitters. Select the desired transmitter. The transmitter is now connected and the *Guided Setup* window appears.

2. In the *Guided Setup* window, select the **Run Wizard...** button and follow the instructions through a short transmitter installation procedure.

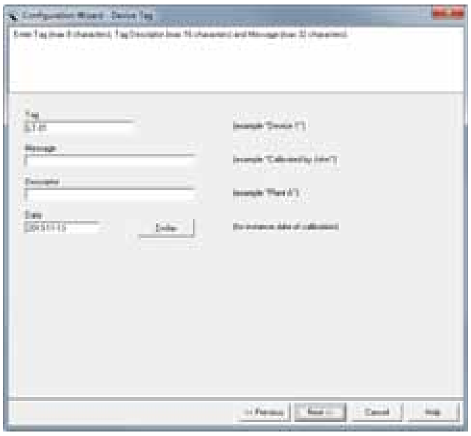
Note
The *Guided Setup* is an extended installation guide including more than just the configuration Wizard. It can be disabled by de-selecting the O**pen Guided Setup dialog after Connect** check-box in the *Application Preferences* window (menu option **View > Application Preferences**).

Device Properties



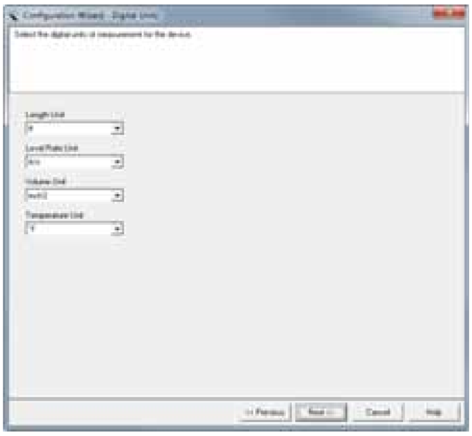
3. The first window in the Configuration Wizard presents general information that is stored in the transmitter database, such as device model, serial number, antenna type, communication protocol, and device address.
Verify that the information matches the ordering information.

Device Information



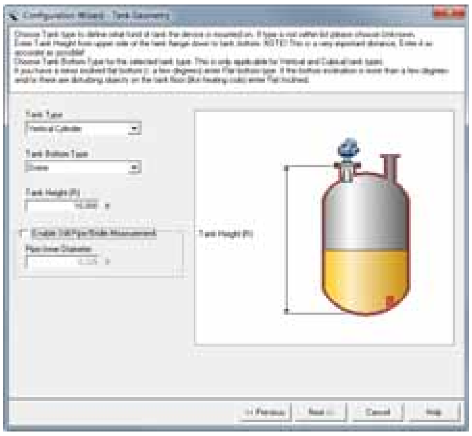
4. The *Tag, Message, Descriptor*, and *Date* information is entered in this window. This information is not required for the operation of the transmitter and may be left out, if desired. HART command: [2, 2, 1].

Digital Units

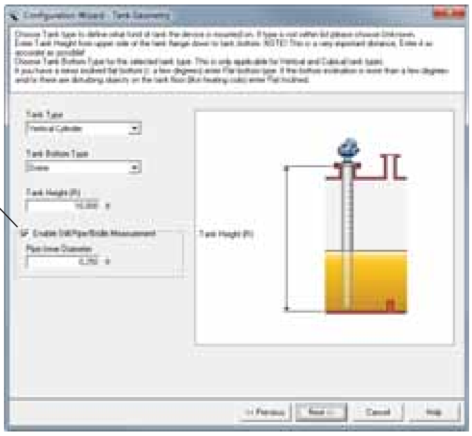


5. The *Length Unit, Level Rate Unit, Volume Unit*, and *Temperature Unit* information is entered in this window.

Tank Geometry



Enable Still Pipe/Bridle Measurement



6. Select the Tank Type corresponding to the actual tank. If none of the available options matches the tank, select Unknown.
   HART command: [2, 1, 2, 1].
   FOUNDATION fieldbus parameter:
   TRANSDUCER_1100 > GEOM_TANK_TYPE.

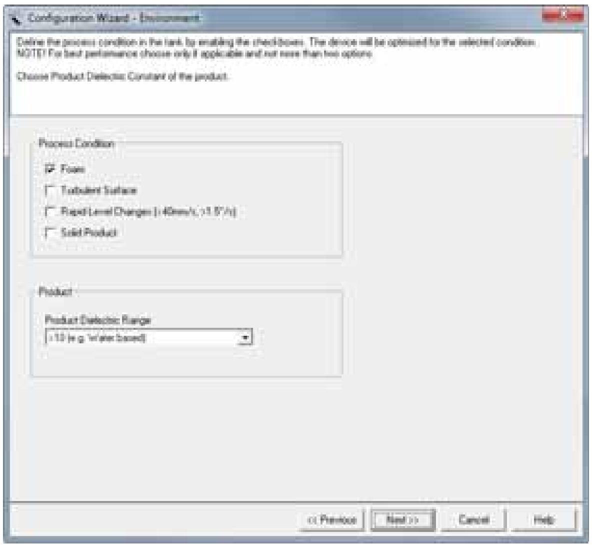
   Tank Bottom Type is important for the measurement performance close to the tank bottom.
   HART command: [2, 1, 2, 2].
   FOUNDATION fieldbus parameter:
   TRANSDUCER_1100 >
   GEOM_TANK_BOTTOM_TYPE.

   Tank Height is the distance from the Upper Reference Point to the Lower Reference Point (see “Tank geometry” on page 75). This number needs to be as accurate as possible.
   HART command: [2, 1, 2, 3].
   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 on a Still-Pipe.
   HART command: [2, 1, 2, 4] / [2, 1, 2, 5].
   FOUNDATION fieldbus parameter:
   TRANSDUCER_1100>
   SIGNAL_PROC_CONFIG (Enable),
   ANTENNA_PIPE_DIAM.

   For more information, see “Tank geometry” on page 75.

Tank Environment

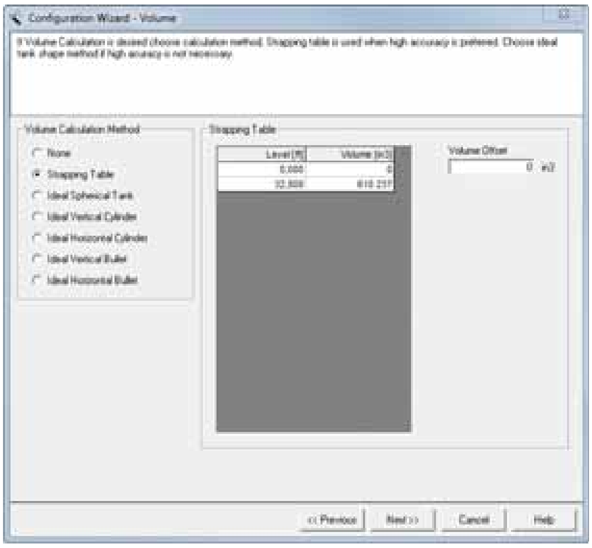


7. In the *Process Condition* box, select the check-boxes that correspond to the conditions of the tank. Select as few options as possible and no more than two. See "Process conditions" on page 77 for more information.
   FOUNDATION fieldbus parameter:
   TRANSDUCER_1100 > ENV_ENVIRONMENT.

   The Dielectric Chart lists the dielectric constants of a large number of products and can be opened by selecting **View > Dielectric Constant Chart** menu option.

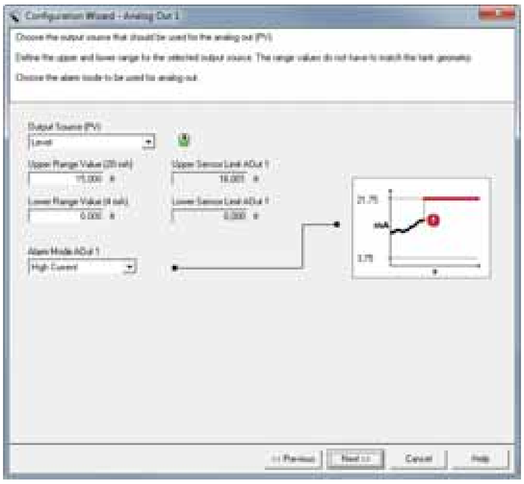
   Select the Product Dielectric Range that corresponds to the current product. If the correct range value for this parameter is unknown, or the contents in the tank are continually changing, choose *Unknown*.
   HART command: [2, 1, 3, 2].
   FOUNDATION fieldbus parameter:
   TRANSDUCER_1100 > ENV_DIELECTR_CONST.

Volume



8. For volume calculation, select a pre-defined calculation method based on a tank shape that corresponds to the actual tank. Select *None* if volume calculation is not needed.
   The Strapping Table option is used if the actual tank does not match any of the available options for pre-defined tanks or if higher calculation accuracy is desired.
   HART command: [2, 1, 4, 1].
   FOUNDATION fieldbus parameters:
   ADV_CONFIG_TB_1300 >
   VOL_VOLUME_CALC_METHOD/
   VOL_IDEAL_DIAMETER/
   VOL_IDEAL_LENGTH/
   VOL_VOLUME_OFFSET.

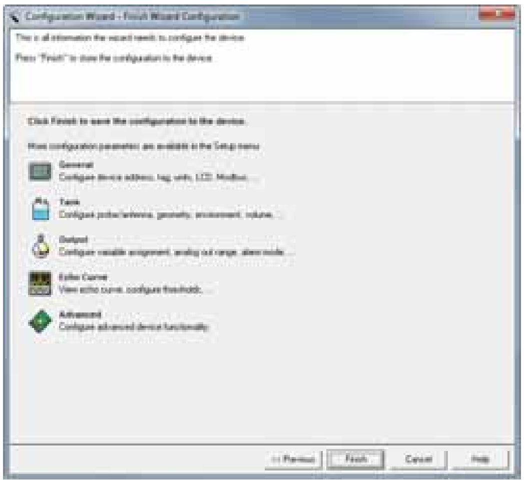
   For more information, see "Volume configuration" on page 78.



Analog output

9. Typically, the **Primary Variable** (PV) is configured to be Product Level or Volume.
   Set the analog output range by inputting the **Lower Range Value** (4 mA) and the **Upper Range Value** (20 mA) to the desired values.
   The **Alarm Mode** specifies the output state when a measurement error occurs.
   HART command: [2, 1, 5].

   See "Analog output (HART)" on page 81 for more information on Analog Output configuration and Alarm Mode settings.

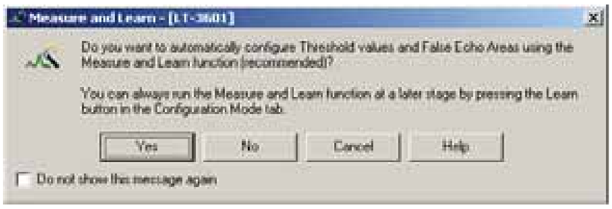


Finish Configuration Wizard

10. This is the last window in the Configuration Wizard. The configuration can be changed at any time by using the Setup windows (General, Tank, Output etc., see "Using the Setup functions" on page 100), which contain further options not available in the configuration wizard.
    Select the **Finish** button and continue with the next step in the Guided Setup.

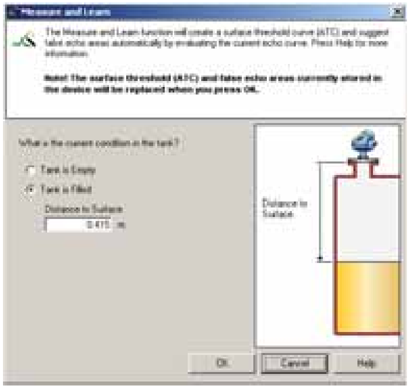
Echo tuning

11. Step 2 in the Guided Setup allows automatic configuration of the ATC and registration of false echoes by running the *Measure and Learn* function. See "Echo tuning" on page 83 for more information on amplitude thresholds and false echoes.
    Click button **2** to start the *Measure and Learn* function.
    (If Echo Tuning is not needed, or is done at a later stage, go on to step 3 in the *Guided Setup*).



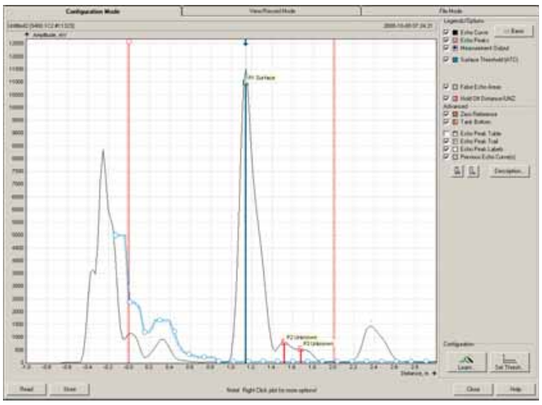
Measure and Learn function

12. Select the **Yes** button to run the *Measure and Learn* function. If **No** is selected, this function can be run at a later stage using the Spectrum Analyzer in RRM.
    Make sure there is no filling or emptying occurring when the *Measure and Learn* function is used.



Tank precondition settings

13. The Measure and Learn function creates an ATC automatically and suggests False Echo Areas. See “Echo tuning” on page 83.
    (By selecting the **Advanced** button, one or both of the options can be selected in the corresponding check-box).
    Verify the Tank Precondition settings. Verify that the *Distance to Surface* value is correct. If not, it may be due to a disturbing object in the tank).
    Select *Empty Tank* if the tank is empty.



Spectrum plot

14. The automatically created 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 found interfering echoes to be blocked out. False Echo Areas can be moved or removed before storing to the transmitter database. Verify that each False Echo Area is identified as an object in the tank that gives rise to a disturbing echo. See “Echo tuning” on page 83 for more information.
    Select the **Store** button to save the ATC and the registered disturbance echoes.

Restart the transmitter

15. Restart the transmitter to activate all of the configuration changes. It may take up to 60 seconds after the restart button is pressed before measurement values are updated.

Verify Level

16. Run the Verify Level tool to match the product level reported by the device to a reference measurement (measured by using for example hand gauging). In any difference, the Calibration Distance parameter will be adjusted.

    A minor adjustment using Calibration Distance is normal. There may, for example be a deviation between the actual tank height and the configured value.

Configuration backup

17. When configuration is complete, the configuration should be saved to a backup file. This information is useful for:
    - installing another Rosemount 5400 Series transmitter in a similar tank, since the file can be directly uploaded to a new device.
    - restoring the configuration, if configuration data is lost or accidentally modified, making the device inoperable.
      Use *Archive Device* to create a backup file and save additional information, such as an echo curve movie, for future reference to a .zip file.

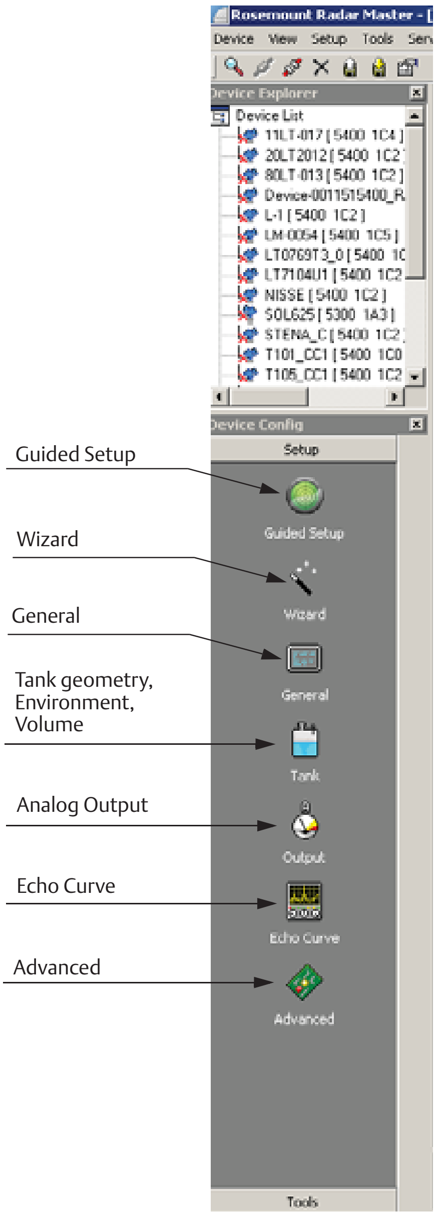
Guided Setup complete

18. The Guided Setup is now complete. To exit the Guided Setup, select the **Close** button.

5.4.11 Using the Setup functions

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

Figure 5-11. Setup Functions in RRM



1. Start the RRM software.
2. In the RRM workspace, choose the appropriate icon for configuring transmitter parameters:
   - **Guided Setup:** this dialog guides you through the most important steps to perform a successful configuration of the device. The guide consists of a few steps.
   - **Wizard:** guides the user through the basic configuration procedure of the Rosemount 5400 transmitter
   - **General:** configures general settings, such as measurement units and communication parameters, and which LCD variables to display
   - **Tank:** configures tank geometry, tank environment, and volume
   - **Output:** configures Analog Output
   - **Echo Curve:** disturbance echo handling
   - **Advanced:** advanced configuration

5.5 Configuration using a Field Communicator

This section describes the configuration of a Rosemount 5400 Series transmitter with a Field Communicator.

The menu tree with the various configuration parameters is shown in Figure 5-14 on page 103.

Section "Basic configuration parameters" on page 75 describes the basic configuration parameters. See sections "Echo tuning" on page 83 and Appendix C: Advanced Configuration for information on disturbance echo handling and advanced configuration.

For information on all capabilities, refer to the Field Communicator Product Manual (Document No. 00809-0100-4276).

Figure 5-12. 375 Field Communicator

A. Navigation keys
B. Tab key
C. On/Off key
D. Enter key
E. Function key
F. Alpha numeric keypad
G. Backlight adjustment key

Figure 5-13. 475 Field Communicator

A. Power key
B. Navigation key
C. Tab key
D. Backlight key
E. Enter key
F. Function key
G. Alphanumeric keypad

To make a basic setup of the transmitter, do the following:

1. Check that the desired Measurement Units are selected. HART command: [2, 1, 1, 5].
2. Enter configuration parameters for the following:
   - Device info. HART command: [2, 2, 1]
   - Geometry. HART command: [2, 1, 2]
   - Environment. HART command: [2, 1, 3]
   - Volume. HART command: [2, 1, 4]
   - Analog Out. HART command: [2, 1, 5]
3. Run *Measure and Learn*. HART command: [2, 1, 6, 2]. This function creates an ATC.
4. Restart the transmitter. HART command: [2, 1, 6, 4].

To view the Echo Curve and adjust threshold settings, see "Using the Echo Curve Analyzer" on page 137.

Figure 5-14. Field Communicator Menu Tree Corresponding to Device Revision 3

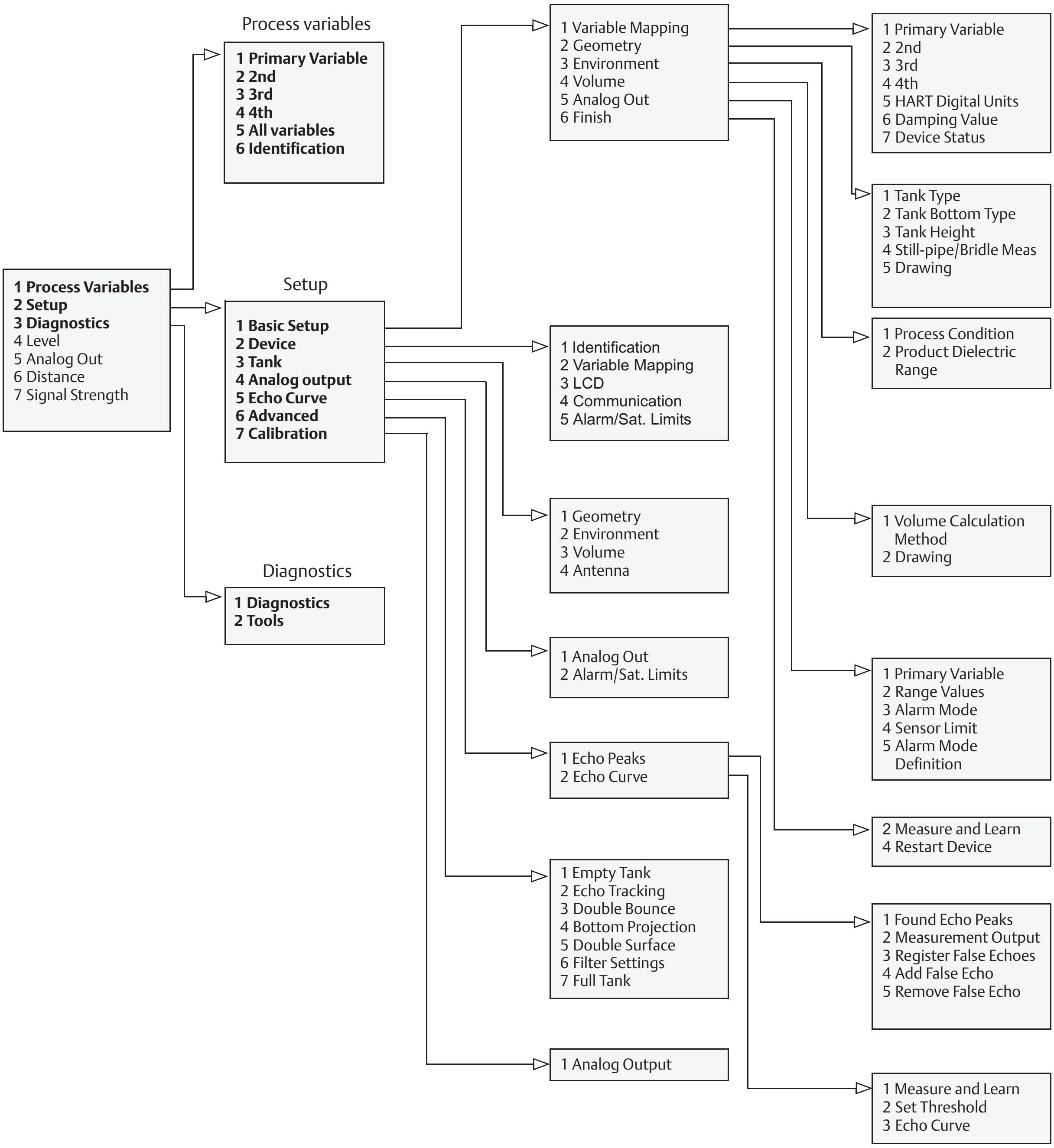
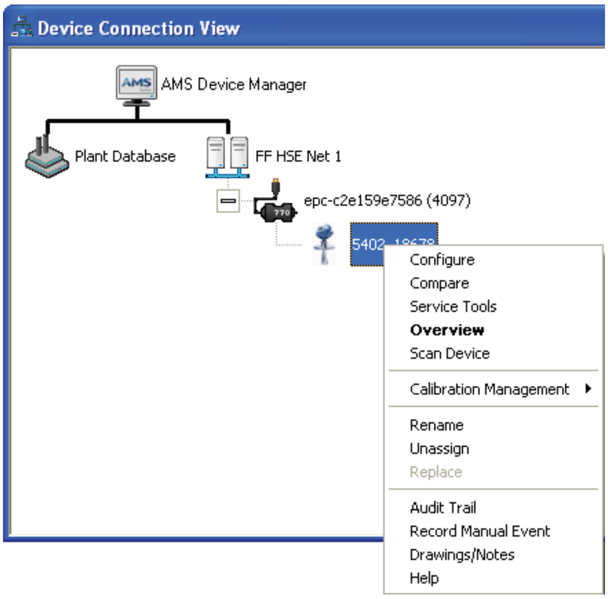


Table 5-4. HART Fast Key Sequences

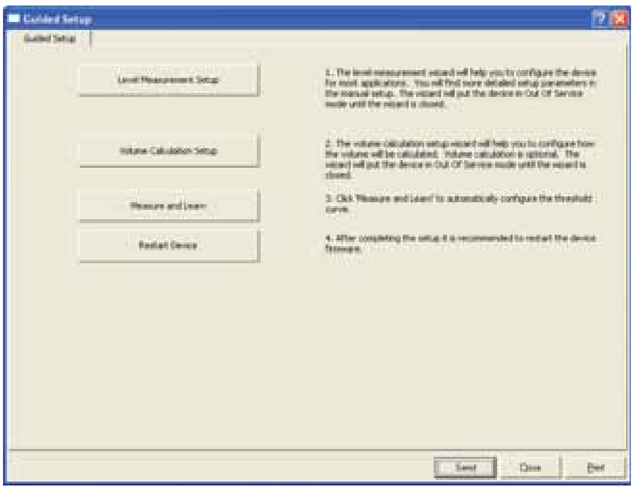
Function	HART Fast Key
Alarm mode	2, 1, 5, 3
Antenna type	2, 3, 4
Device information	2, 2, 1
LCD language	2, 2, 3
LCD variables	2, 2, 3
Length unit	2, 1, 1, 5
Lower Range Value (LRV) (4 mA)	2, 1, 5, 2
Pipe diameter	2, 1, 2, 4
Primary variable	2, 1, 1, 1
Product dielectric constant	2, 1, 3, 2
Range Values (LRV/URV)	2, 1, 5, 2
Tag	2, 2, 1
Tank bottom type	2, 1, 2, 2
Tank height	2, 1, 2, 3
Tank type	2, 1, 2, 1
Temperature unit	2, 1, 1, 5
Hold off distance/upper null zone	2, 3, 4
Upper Range Value (URV) (20 mA)	2, 1, 5, 2
Volume configuration	2, 1, 4, 1
Volume unit	2, 1, 1, 5

5.7 Basic configuration using AMS Suite

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



1. Start the *AMS Device Manager* making sure the transmitter is connected. The transmitter is displayed in the *Device Connection View* window (pictures correspond to AMS version 9.0).
2. In the *Device Connection View*, right click the transmitter icon.
3. Select the Configure option.

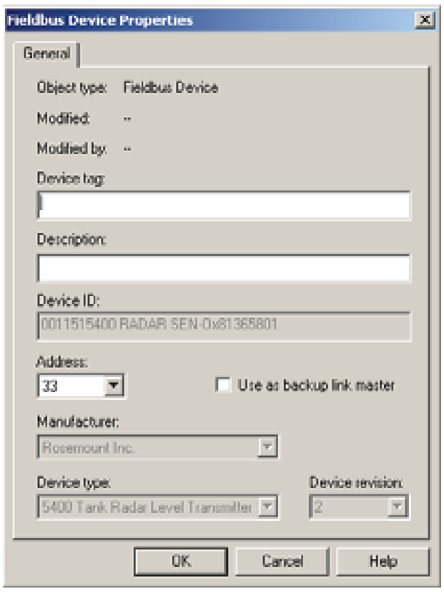


4. Select the Guided Setup option.
5. Configure the transmitter by selecting the appropriate buttons. For information on the various configuration parameters, see "Basic configuration parameters" on page 75 .

5.8 Configuration using DeltaV

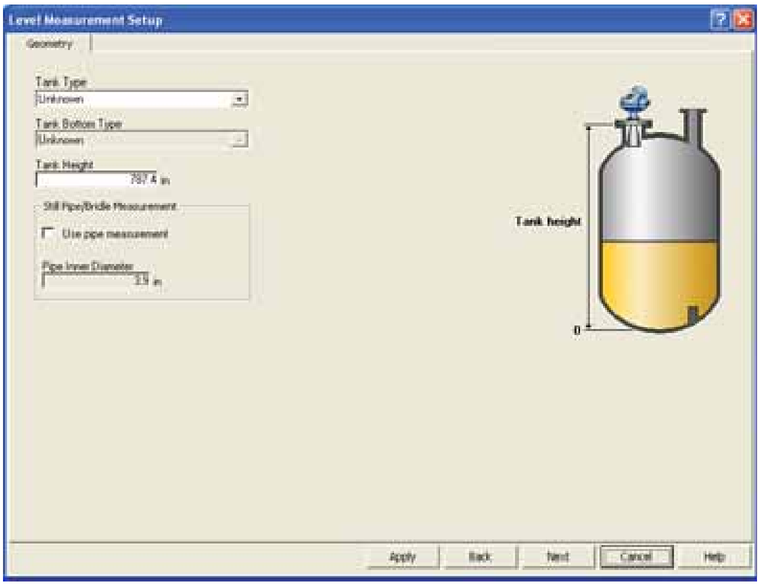
The following description shows how to configure a Rosemount 5400 Series transmitter using DeltaV with the AMS application. The corresponding FOUNDATION fieldbus parameters are also shown. The Rosemount 5400 Series supports DD Methods for DeltaV in order to facilitate transmitter configuration.

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



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: 0011515400-EPM-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 **Level Measurement** setup button.



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 75). Make sure that this number is as accurate as possible.

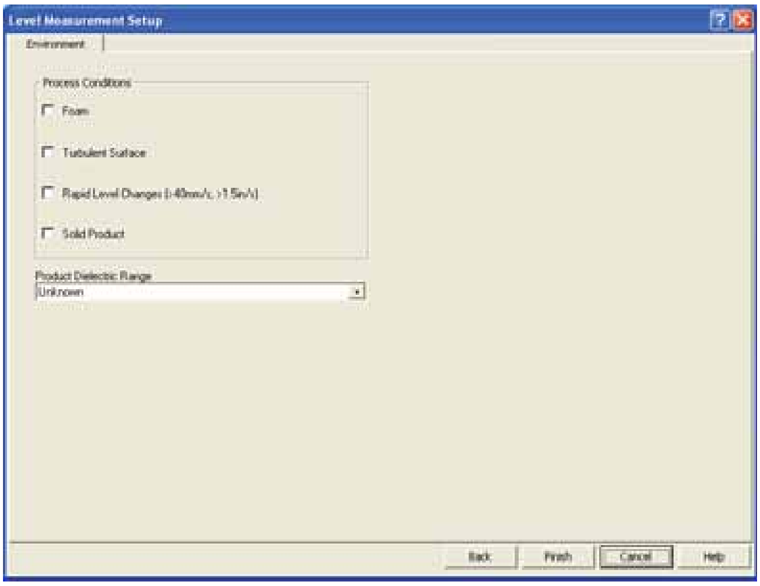
   FOUNDATION fieldbus parameter:
   TRANSDUCER_1100 > GEOM_TANK_HEIGHT.

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 75 for more information.

10. Select the **Environment** tab.

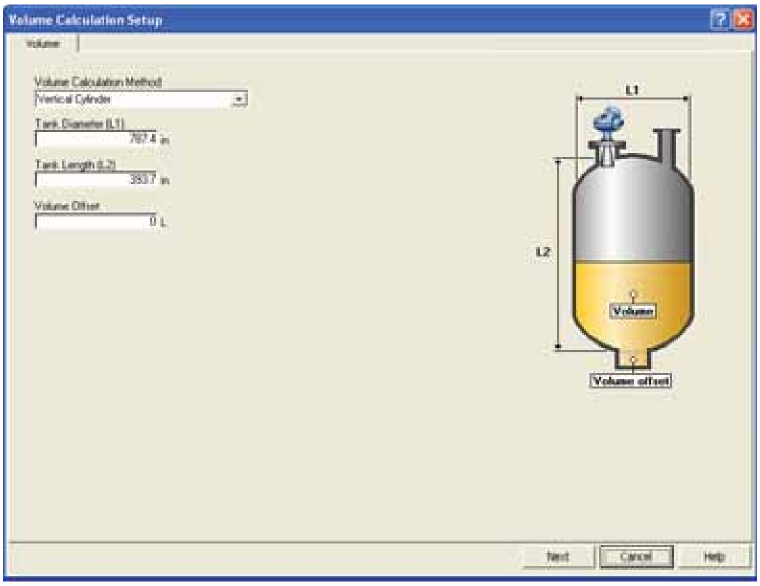


11. In the Process Conditions box select the check-boxes that correspond to the conditions in your tank. You should select as few options as possible and not more than two. See "Process conditions" on page 77 for more information.
    FOUNDATION fieldbus parameter:
    TRANSDUCER_1100 > ENV_ENVIRONMENT.

    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 content 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 ADV_CONFIG_TB_1300 block and choose the Volume tab.

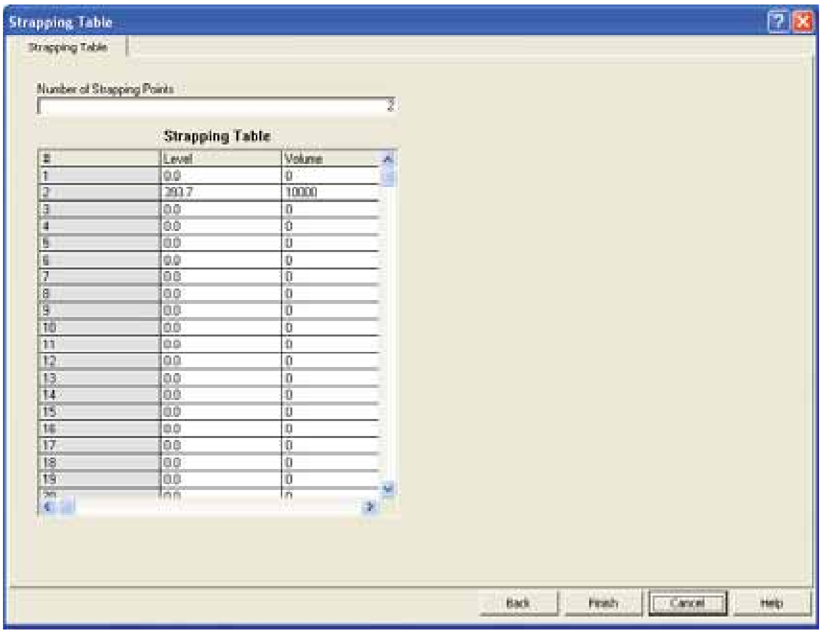


13. Choose a pre-defined calculation method based on a tank shape that corresponds to the actual tank.

    A. Choose None if volume calculation is not desired.

    B. 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:
    ADV_CONFIG_TB_1300 > VOL_VOLUME_CALC_METHOD.

    Diameter:
    FOUNDATION fieldbus parameter:
    ADV_CONFIG_TB_1300 > VOL_IDEAL_DIAMETER.

    Tank Length:
    FOUNDATION fieldbus parameter:
    ADV_CONFIG_TB_1300 > VOL_IDEAL_LENGTH.

    Volume Offset:
    FOUNDATION fieldbus parameter:
    ADV_CONFIG_TB_1300 > VOL_VOLUME_OFFSET.

    See "Volume configuration" on page 78 for more information.

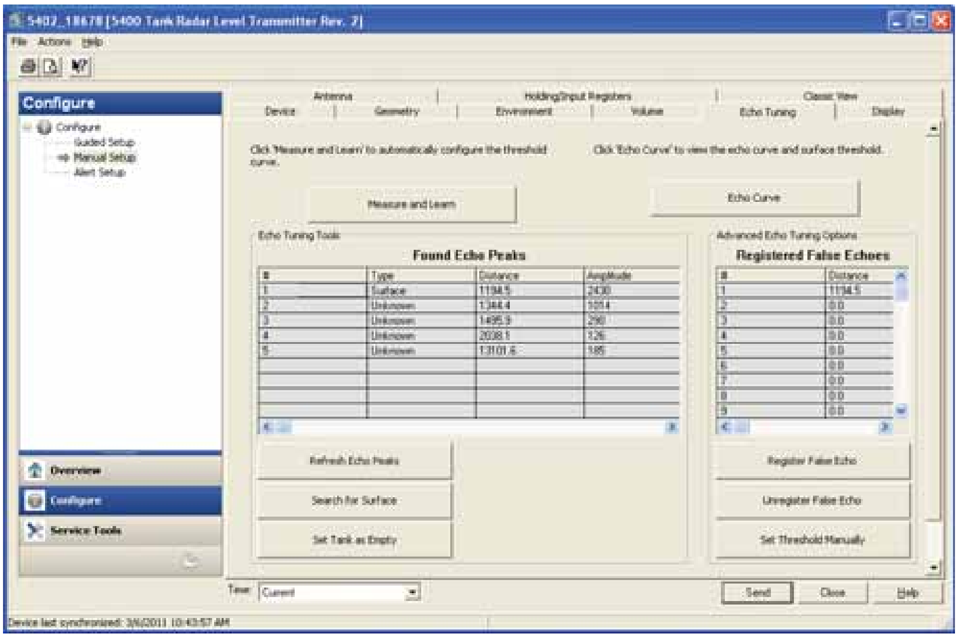
14. Choose Measure and Learn to configure the thresholds. For more information on the Measure and Learn function, see "Echo tuning" on page 83.

15. Restart the device.

5.8.1 Advanced configuration

False echo registration

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



2. Select **Manual Setup** and choose the **Echo Tuning** tab.

3. Click the **Register False Echo** button and follow the wizard to choose and register echoes which can be identified as disturbing objects in the tank. See "Registration of false echoes" on page 135 for more information.

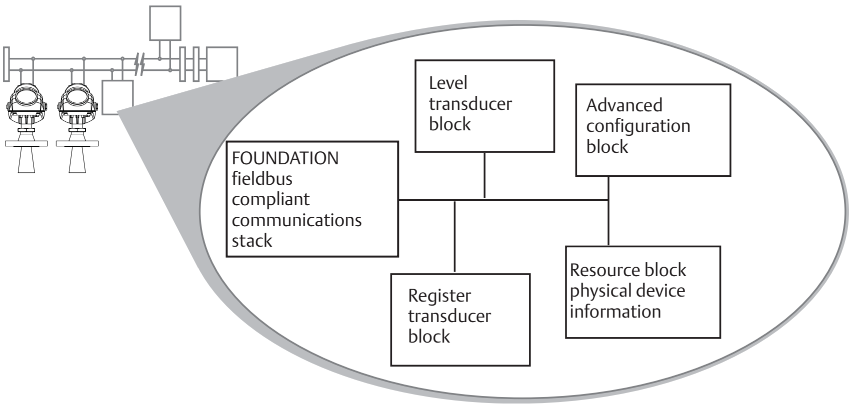
4. To unregister false echoes, click the **Unregister False Echo** button and follow the wizard.

5.9 FOUNDATION fieldbus overview

The configuration of a Rosemount 5400 Series transmitter is normally a simple and straightforward 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 Rosemount 5400 Series supports a set of advanced configuration options as well, which can be used to handle special tank conditions and applications.

Figure 5-15 illustrates how the signals are channeled through the gauge.

Figure 5-15. 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.

This section covers basic operation, software functionality, and basic configuration procedures for the Rosemount 5400 Series Level Transmitter with FOUNDATION fieldbus (Device Revision 3). For detailed information about FOUNDATION fieldbus technology and function blocks used in the Rosemount 5400 Series, refer to the FOUNDATION fieldbus Blocks Manual (Document No. 00809-0100-4783).

5.9.1 Assigning device tag and node address

A 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 a 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.

5.9.2 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/Integral/Derivative (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 configuration transducer block

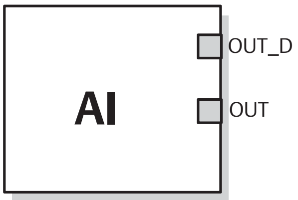
The advanced configuration transducer block contains functions such as amplitude threshold settings for filtering of disturbing echoes and noise, simulation of measurement values and strapping table for volume measurements.

Resource block

There are no linkable inputs or outputs to the Resource block.

Analog-Input Block

Figure 5-16. Analog-Input Block



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

The 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 C: Analog-Input Block.

For more information on the different function blocks refer to Appendix C: Level Transducer Block, Appendix C: Register Transducer Block, Appendix C: Advanced Configuration Transducer Block, Appendix C: Resource Block, and Appendix C: Analog-Input Block.

Function blocks

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

- Analog Input (AI)
- Proportional/Integral/Derivative (PID)
- Control Selector (CSEL)
- Output Splitter (OSPL)
- Signal Characterizer (CHAR)
- Integrator (INTEG)
- Arithmetic (ARITH)
- Input Selector (ISEL)

For detailed information about FOUNDATION fieldbus technology and function blocks used in the Rosemount 5400 Series, refer to the FOUNDATION fieldbus Blocks Manual (Document No. 00809-0100-4783).

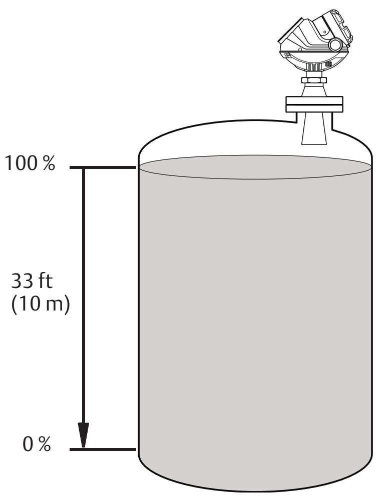
5.10 Application examples

5.10.1 Radar level transmitter - level value

Situation

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

Figure 5-17. Situation Diagram



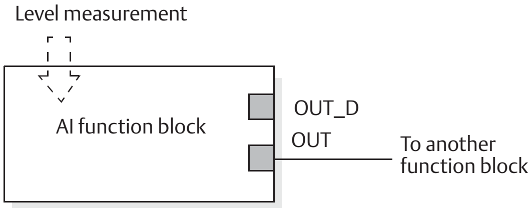
Solution

Table 5-5 lists the appropriate configuration settings, and Figure 5-18 illustrates the correct function block configuration.

Table 5-5. 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 5-18. Analog-Input Function Block Diagram for a Typical Level Transmitter

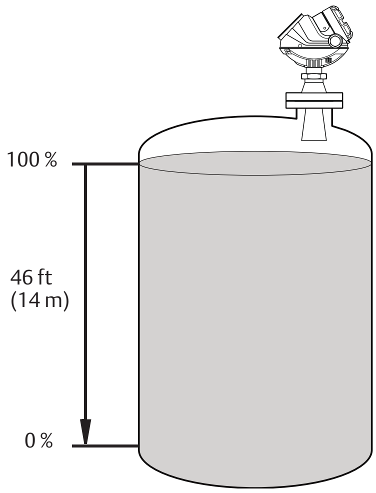


5.10.2 Radar level transmitter - level value in percent (%)

Situation

The level of a tank is to be measured using the Rosemount 5400 Series mounted on a nozzle on the top of the tank. The maximum level in the tank is 46 ft (14 m). The level value will be displayed in percentage of the full span (see Figure 5-19).

Figure 5-19. Situation Diagram



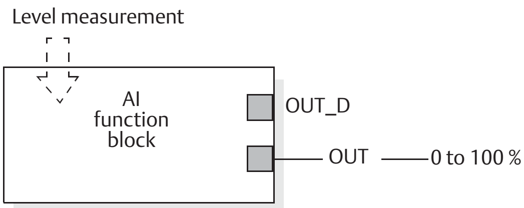
Solution

Table 5-6 lists the appropriate configuration settings, and Figure 5-20 illustrates the correct function block configuration.

Table 5-6. 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 5-20. Function Block Diagram for a Level Gauge where Level Output is Scaled between 0-100 %

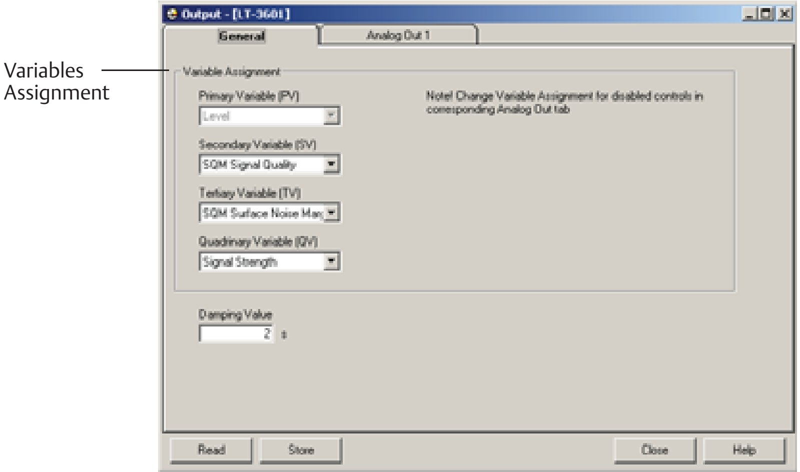


5.11 Tri-Loop™ HART to Analog Converter

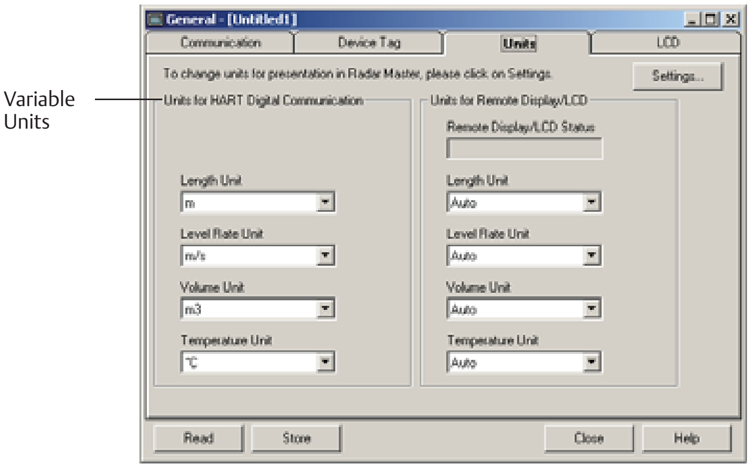
The Rosemount 333 HART Tri-Loop HART-to-Analog Signal Converter is capable of converting a digital HART burst signal into three additional
4-20 mA analog signals.

To set the Rosemount 5400 Series transmitter up for the HART Tri-Loop:

1. Make sure the Rosemount 5400 transmitter is properly configured.
2. Assign transmitter variables Primary Variable, Secondary Variable etc.
   HART command [2, 1, 1].
   RRM: Setup > Output/General.



3. Configure variable units: Length, Level Rate, Volume, and Temperature.
   HART command [2, 2, 2, 5].
   RRM: Setup > General/Units.



4. Set the Rosemount 5400 in Burst mode.
   HART command [2, 2, 4, 2].
   RRM: Setup > General/Communication.

5. Select Burst option 3 = Process variables and current (Process vars/crnt).
HART command [2, 2, 4, 2, 2].

6. Install the Tri-Loop. Connect Channel 1 wires, and optionally wires for Channel 2 and Channel 3.

7. Configure Tri-Loop Channel 1:
   a. Assign variable: Tri-Loop HART command [1, 2, 2, 1, 1].
   Make sure that the SV, TV, and QV match the configuration of the Rosemount 5400 Series transmitter.
   b. Assign units: Tri-Loop HART command [1, 2, 2, 1, 2]. Make sure that the same units are used as for the Rosemount 5400 Series transmitter.
   c. Set the Upper Range Value and the Lower Range Value: Tri-Loop HART command [1, 2, 2, 1, 3-4].
   d. Enable the channel. Tri-Loop HART command [1, 2, 2, 1, 5].

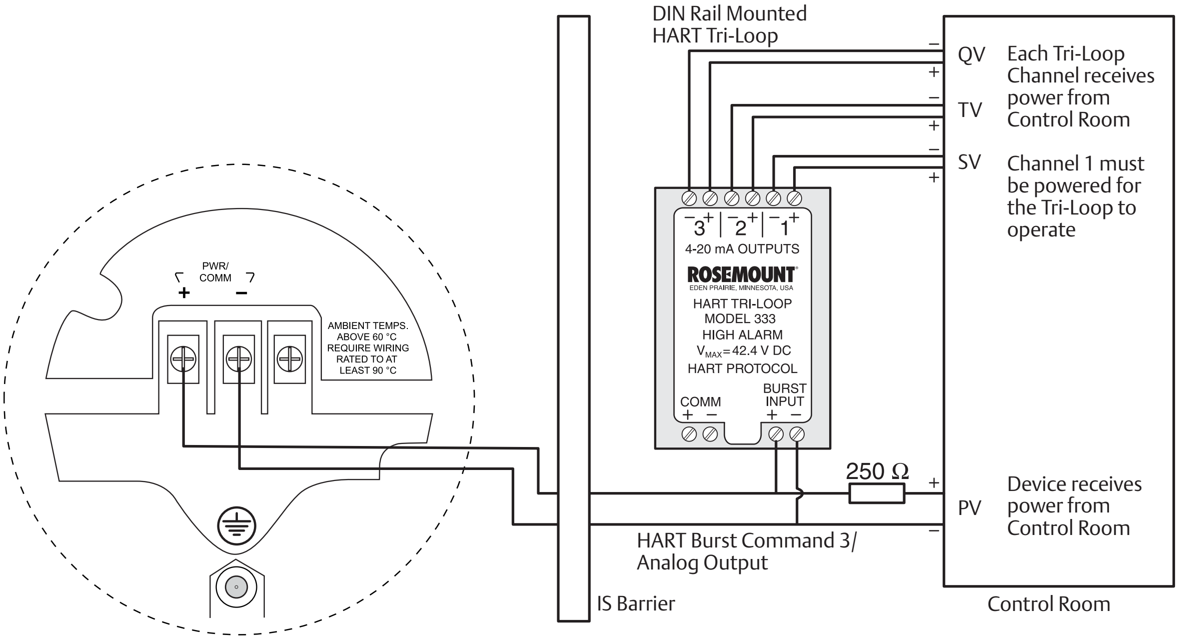
8. (Optional) Repeat steps a-d for Channels 2 and 3.

9. Connect wires to Tri-Loop Burst Input.

10. Enter the desired tag, descriptor, and message information:
Tri-Loop HART command [1,2,3].

11. (Optional) If necessary, perform an analog output trim for Channel 1 (and Channel 2 and 3 if they are used).
Tri-Loop HART command [1, 1, 4].

Figure 5-21. Tri-Loop Wiring



See the reference manual for the Rosemount 333 HART Tri-Loop HART-to-Analog Signal Converter (Document No. 00809-0100-4754) for further information on how to install and configure the Tri-Loop.

Section 6 Operation

6.1 Safety messages

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

⚠ WARNING

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

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

Explosions could result in death or serious injury.

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

Electrical shock could cause death or serious injury.

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

Antennas with non-conducting surfaces.

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

⚠ WARNING

Any substitution of non-authorized parts or repair, other than exchanging the complete transmitter head or antenna assembly, may jeopardize safety and is prohibited.

Unauthorized changes to the product are strictly prohibited as they may unintentionally and unpredictably alter performance and jeopardize safety. Unauthorized changes that interfere with the integrity of the welds or flanges, such as making additional perforations, compromise product integrity and safety. Equipment ratings and certifications are no longer valid on any products that have been damaged or modified without the prior written permission of Emerson Process Management. Any continued use of product that has been damaged or modified without prior written authorization is at the customer's sole risk and expense.

6.2 Viewing measurement data

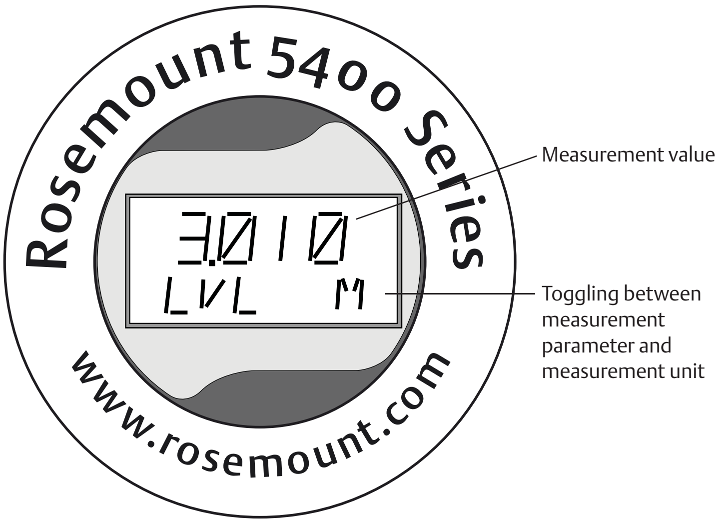
6.2.1 Using the display panel

The Rosemount 5400 Series transmitter uses an optional display panel to present 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 operating, 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 120).

The display has two rows, with the upper row showing the measured value and the bottom row showing the parameter name and measurement unit. The display toggles between the different variables every 2 seconds. Variables can be selected to be presented by using a Field Communicator, the AMS Suite, DeltaV, or the RRM software.

Figure 6-1. The Rosemount 5400 Series Display Panel



Error messages are listed in sections “LCD display error messages” on page 126 and “LED error messages” on page 127.

6.2.2 Specifying display panel variables

It is possible to specify the variables to be presented on the display panel (LCD display).

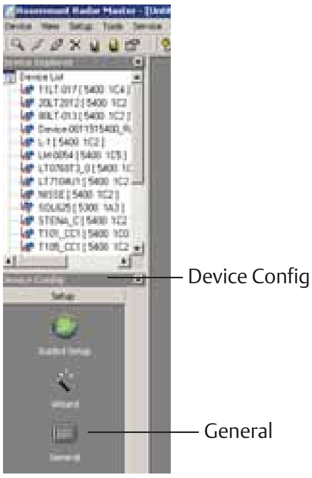
Using a Field Communicator

For a Field Communicator, the LCD display settings are available with
HART command [2, 2, 3].
FOUNDATION fieldbus parameters:
TRANSDUCER_1100 > LCD_PARAMETERS.

Using RRM

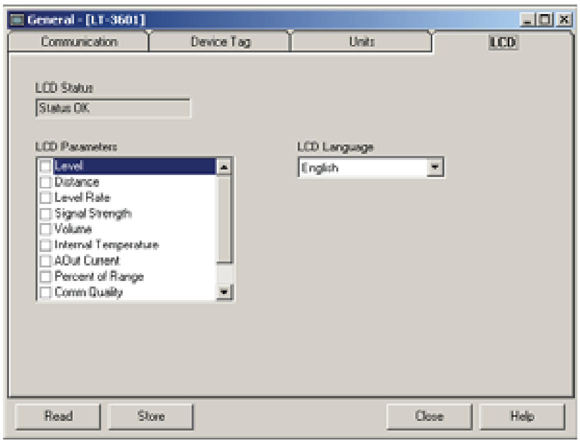
The **LCD** tab in the *General* window allows variables to be specified for view on the Display Panel screen:

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



2. Select the **LCD** tab.

Figure 6-2. RRM lets you Specify Variables for the Rosemount 5400 Series Display Panel



3. Select the variables to appear on the Display Panel. The LCD will alternate between the selected items.

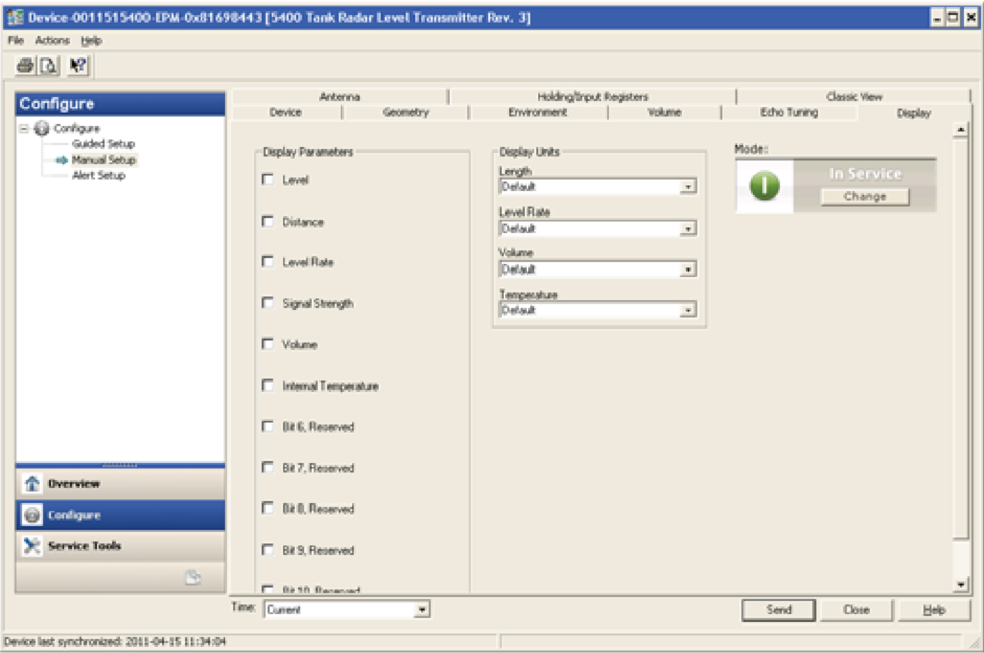
4. Click the **Store** button to save the LCD display settings in the transmitter database.

Using AMS and DeltaV

The **LCD** tab in the *Configure* window specifies which variables will be shown on the Display Panel screen:

1. Select the transmitter icon in the AMS and DeltaV explorer.
2. Click the right mouse button and choose the **Configure** option.
3. Select **Manual Setup** and choose the **Display** tab to set the desired LCD display parameters and LCD display measurement units. The available LCD display parameters are listed in Table 6-1 on page 6-123.
4. Click the **Send** button to save the configuration.
5. Close the window.

Figure 6-3. Configure Parameters to be Presented on the Display Panel



LCD display parameters

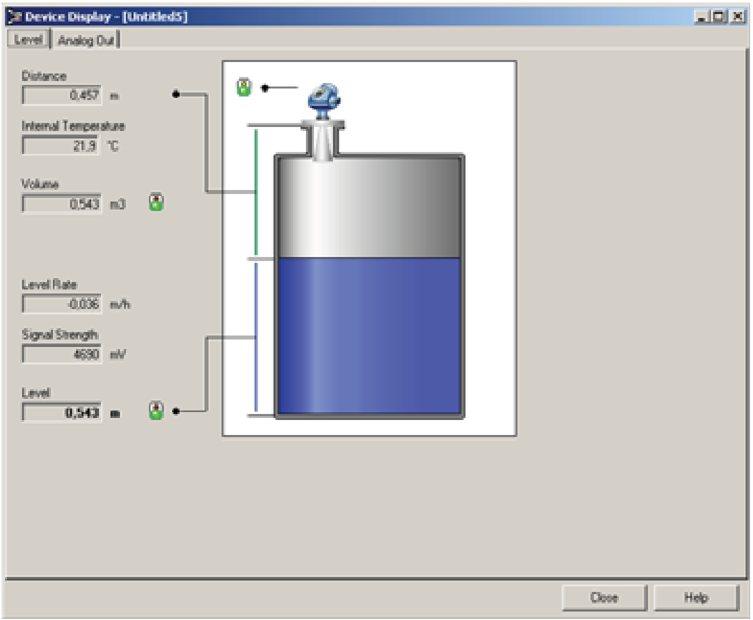
Table 6-1. LCD Display Parameters and Presentation on Display

Parameter	Presentation on display	Description
Level	LVL	Product level.
Distance	DST	Distance from the upper reference point to the product surface.
Level Rate	LR	The speed of level movement up or down.
Signal Strength	AMP	The signal amplitude of the surface echo.
Volume	Only measurement unit is shown.	Total product volume.
Internal Temperature	ITEMP	Temperature inside the transmitter housing.
AOut Current	ANOUT	Analog Output 4 -20 mA current.
Percent of Range	% RNG	Level value in percent of total measurement range.
Comm Quality	COM Q	Digital communication signal quality.

6.2.3 Viewing measurement data in RRM

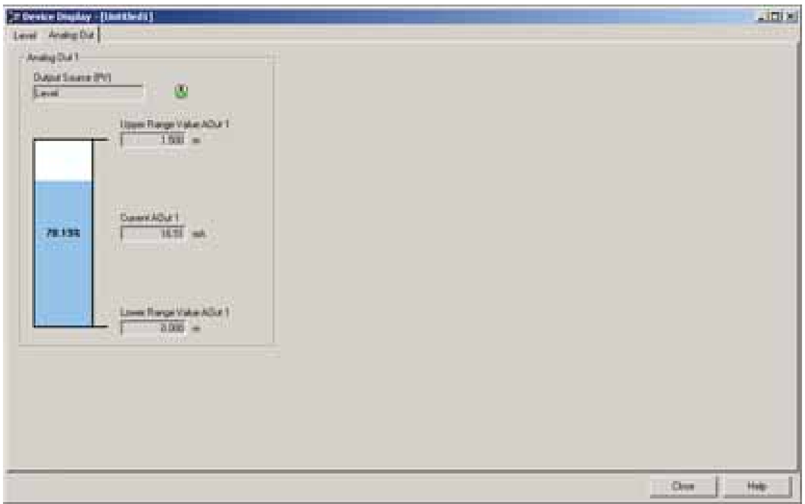
To view measurements, such as level, signal strength, etc. in RRM, choose the *Tools* > *Device Display* option and select the **Level** tab:

Figure 6-4. Presentation of Measurement Data in RRM



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

Figure 6-5. Presentation of Analog Output Value in RRM

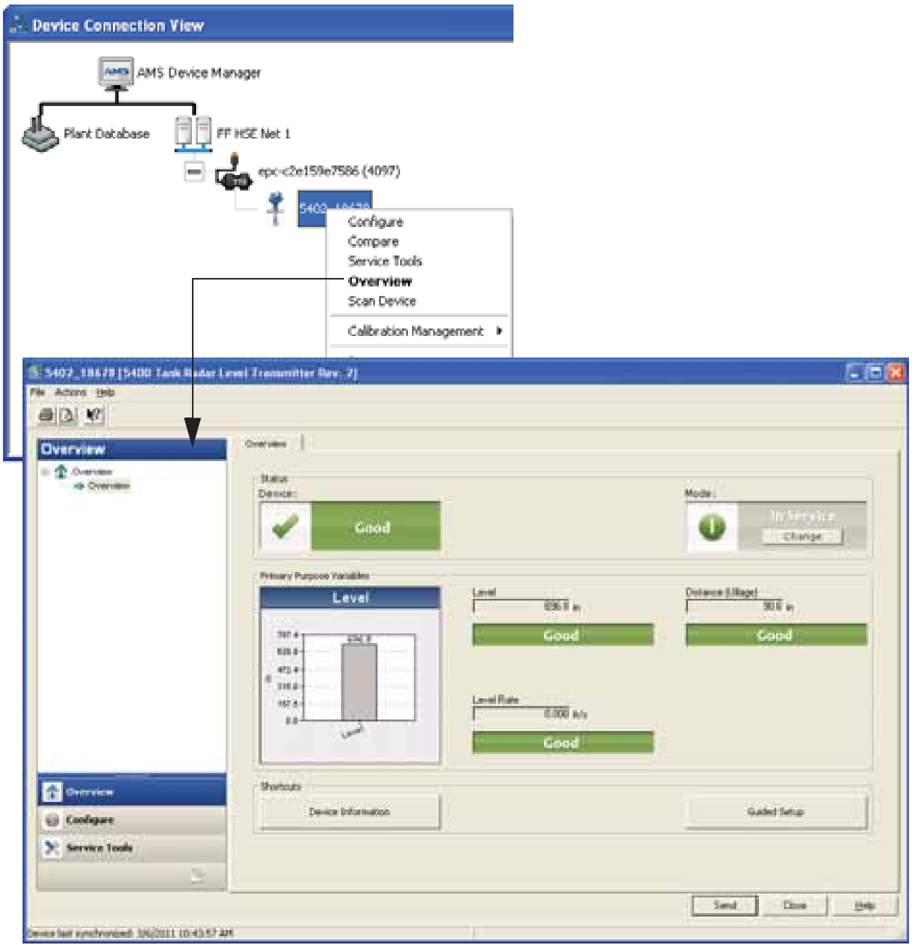


6.2.4 Viewing measurement data in AMS Suite and DeltaV

To view measurements, such as level, signal strength, etc. in the AMS Suite:

1. Select the transmitter icon in the AMS Suite **Device Connection View** window.
2. Click the right mouse button and choose the **Overview** option.

Figure 6-6. Presentation of Measurement Data in AMS Suite



6.3 LCD display error messages

Figure 6-7. The Rosemount 5400 Series Display Panel Displaying an Error Message

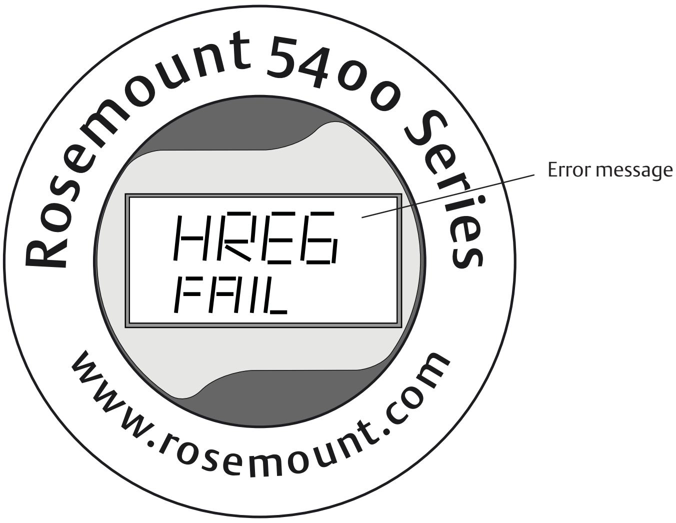


Table 6-2. Error Messages Displayed on the Rosemount 5400 Series Display Panel

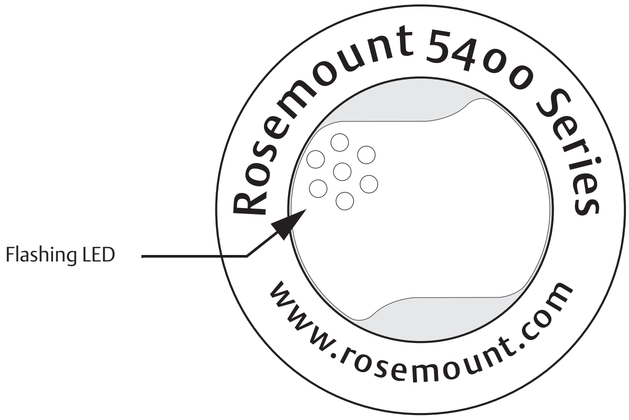
Error message	Description
RAM FAIL	An error in the gauge data memory (RAM) has been detected during the startup tests. NOTE: this resets the gauge automatically.
FPROM FAIL	An error in the gauge program memory (FPROM) has been detected during the startup tests. NOTE: this resets the gauge automatically.
HREG FAIL	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.
OMEM FAIL	Other memory failure.
MWM FAIL	An error in the microwave module.
DPLY FAIL	An error in the LCD display.
MODEM FAIL	Modem hardware failure.
AOUT FAIL	An error in the Analog Out Module.
OHW FAIL	An unspecified hardware error has been detected.
ITEMP FAIL	An error in the internal temperature measurement.
MEAS FAIL	A serious measurement error has been detected.
CONFIG FAIL	At least one configuration parameter is outside the allowed range. NOTE: the default values are used until the problem is solved.
SW FAIL	An error has been detected in the transmitter software.

For more information on errors, see “Error Messages” on page 154.

6.4 LED error messages

For Rosemount 5400 Series transmitters without a display, a flashing Light Emitting Diode (LED) is used to present error messages.

Figure 6-8. Rosemount 5400 Series Transmitters without Display use a LED for the Presentation of Error Messages



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

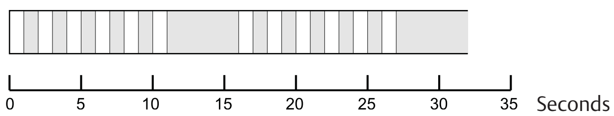
The following errors can be displayed:

Table 6-3. LED Error Codes

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

Example

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



Section 7 Service and Troubleshooting

7.1 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.

⚠ **Note**
The antenna seal assembly should under no circumstances be disassembled.

WARNING

Failure to follow safe installation and service guidelines could result in death or serious injury.

- Make sure only qualified personnel perform installation or service.
- Use the equipment only as specified in this manual. Failure to do so may impair the protection provided by the equipment.
- Any substitution of non-authorized parts or repair, other than exchanging the complete transmitter head or antenna assembly, may jeopardize safety and is prohibited.
- Unauthorized changes to the product are strictly prohibited as they may unintentionally and unpredictably alter performance and jeopardize safety. Unauthorized changes that interfere with the integrity of the welds or flanges, such as making additional perforations, compromise product integrity and safety. Equipment ratings and certifications are no longer valid on any products that have been damaged or modified without the prior written permission of Emerson Process Management. Any continued use of product that has been damaged or modified without prior written authorization is at the customer's sole risk and expense.

Explosions could result in death or serious injury.

- Verify that the operating environment of the transmitter is consistent with the appropriate hazardous locations specifications.
- In an Explosion-proof/Flameproof installation, do not remove the transmitter cover when power is applied to the unit.
- Before connecting a HART® based communicator in an explosive atmosphere, make sure the instruments in the loop are installed in accordance with intrinsically safe or non-incendive field wiring practices.

Electrical shock can result in death or serious injury.

- Avoid contact with the leads and terminals. High voltage that may be present on leads can cause electrical shock.
- Make sure the main power to the Rosemount 5400 Series transmitter is off and the lines to any other external power source are disconnected or not powered while wiring the transmitter.

Antennas with non-conducting surfaces.

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

7.2 Troubleshooting overview

Table 7-1 below gives information on the possible causes of system malfunctions. It also lists the symptoms and necessary actions to be taken.

Table 7-1. 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 • Check LED/Display
No HART communication	• COM Port configuration does not match the connected COM Port • Cables may be disconnected • Wrong HART address is used • Hardware failure • HART resistor	• Check that correct COM Port is selected in the HART server (see "Specifying the COM port" on page 87) • Check the COM port buffer, "Specifying the COM port" on page 87 • Check wiring diagram • Verify that the 250 Ω resistor is in the loop, see Figure 4-23 on page 70 • Check cables • Make sure that correct HART short address is used. Try address = 0 • Check the COM Port Buffer setting, see page 88 • Check Analog Output current value to verify that transmitter hardware works
Analog Out is set in Alarm	• Measurement failure or transmitter failure	• Open the Diagnostics window in RRM to check active errors and alarms, see "Diagnostics" on page 145 • See also "Analyzing the measurement signal" on page 132 and "Analog Output status" on page 158
Incorrect level reading	• Configuration error • Disturbing objects in the tank • See "Application errors" on page 159	• Check the Tank Height parameter; RRM>Setup>Tank • Check status information and diagnostics information, see "Diagnostics" on page 145 • Check that the transmitter has not locked on an interfering object • See "Analyzing the measurement signal" on page 132
Integral display does not work		• Check the display configuration in RRM (open menu Setup > General) • Diagnostics • Contact Emerson Process Management Service Department[(1)]
Temperature measurement failure		• Check ambient temperature[(2)] • Restart gauge • Contact Emerson Process Management Service Department
Level measurement failure		• Check Power Supply • Check the gauge configuration • Check that the mechanical installation is correct
Volume measurement failure		• Restart gauge • Check gauge configuration using PC Based configuration tool
No surface echo		• Check signal strength • Restart transmitter • See "Analyzing the measurement signal" on page 132

(1) A malfunctioning display panel may only be replaced by service personnel at the Emerson Process Management Service Department.
(2) If the Rosemount 5400 Series transmitter has been exposed to temperatures outside the specified limits, the device may stop its normal operation.

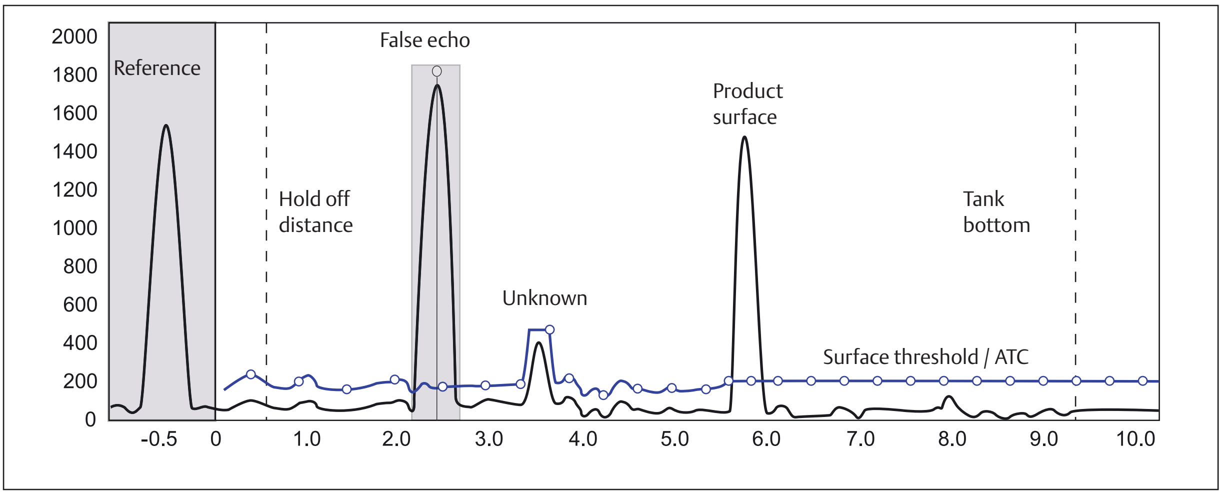
7.3 Service overview

The functions mentioned in this section are available in the RRM configuration program.

7.3.1 Analyzing the measurement signal

RRM, and other tools using enhanced EDDL, has powerful functions for advanced troubleshooting. By using the Echo Curve plot function, an instant view of the tank signal is displayed. Measurement problems can be resolved by studying the position and amplitude of the different pulses.

Figure 7-1. The Echo Curve Presents all Visible Echoes



In a typical measurement situation, the following pulses appear in the diagram:

Reference. This pulse is caused by the transition between transmitter head and antenna and it is used by the transmitter as a reference at level measurements.

A missing reference pulse might be a symptom of a malfunctioning transmitter. Contact your local Emerson Process Management representative for assistance.

Product surface. This pulse is caused by a reflection on the product surface.

Different amplitude thresholds are used to filter out unwanted signals and pick up different pulses. The transmitter uses certain criteria to decide which type of pulse that is detected.

Echoes found above the Surface Threshold might be considered the product surface.

Surface threshold. The amplitude threshold used for detecting the product level peak. The amplitude threshold is designed as a number of individually adjustable amplitude threshold points, the ATC. See “ATC” on page 84.

The ATC is set during the *Measure and Learn* function and can be adjusted manually. The ATC is used for filtering out disturbances with an amplitude smaller than the product surface echo.

The surface thresholds should be set to approximately 20 % of the measured signal amplitude of the product surface.

False echo area. False Echo Areas are set during the *Measure and Learn* function (see “Guided setup” on page 92), when the disturbing object is larger than the surface echo. The False Echo Area can be adjusted manually.

Hold off distance - upper null zone. Measurements are not performed within the hold off distance. By setting the hold off distance to zero, measurements can be performed close to the flange. Consider near zone accuracy. See “Near zone accuracy” on page 193.

Tank bottom. Measurements are not performed after the Tank Bottom limit.

7.3.2 Surface pulse not found

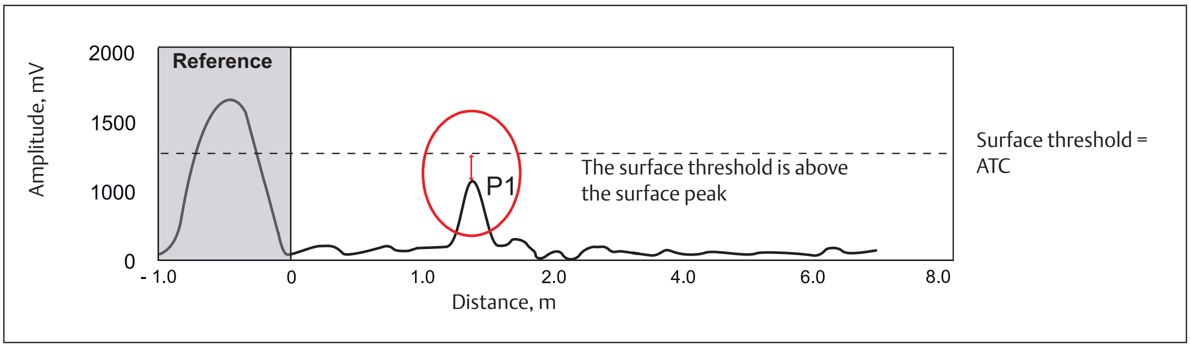
The amplitude thresholds are adjusted manually or during the *Measure and Learn* function to appropriate values to filter out noise and other non-valid measurements from the measurement signal.

The amplitude of the measurement signal, that is the amplitude of the signal reflected by the product surface, is related to the actual dielectric constant of the product.

RRM has a plot function that allows viewing of the reflections in the tank.

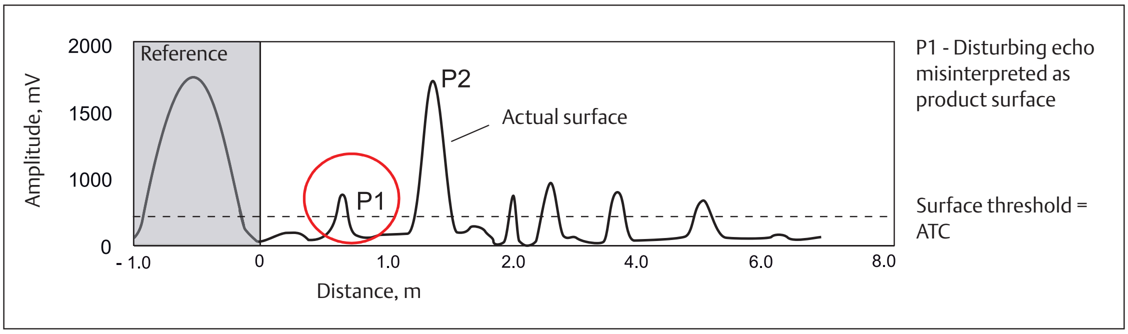
If the amplitude threshold is too high, the product level will not be detected, as illustrated in Figure 7-2. In a situation like this, the amplitude threshold is lowered so that the Surface peak is not filtered out.

Figure 7-2. Example 1: Surface Threshold is Too High



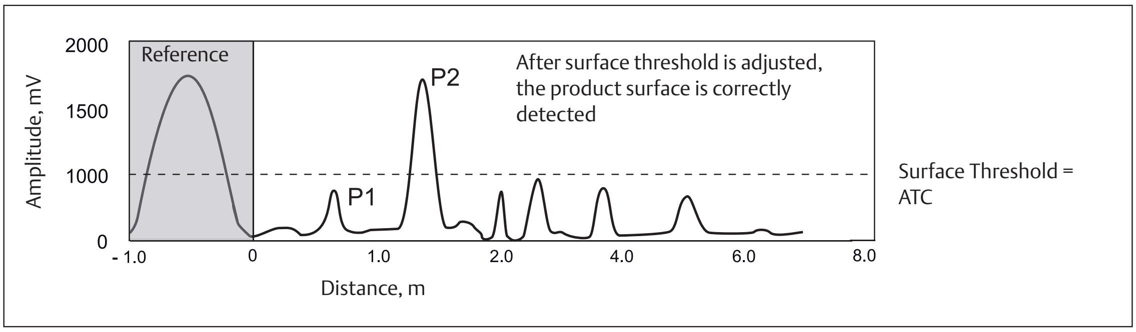
If there are disturbing objects in the tank, the threshold must be set carefully to avoid locking on the wrong amplitude peak. In Figure 7-3, the transmitter has locked on a peak above the actual product surface, that is a disturbance was interpreted as the product surface.

Figure 7-3. Example 2: Surface Threshold is Too Low



By adjusting the surface threshold, the product surface is properly detected, as illustrated in Figure 7-4:

Figure 7-4. Echo Curve after Surface Threshold was Adjusted



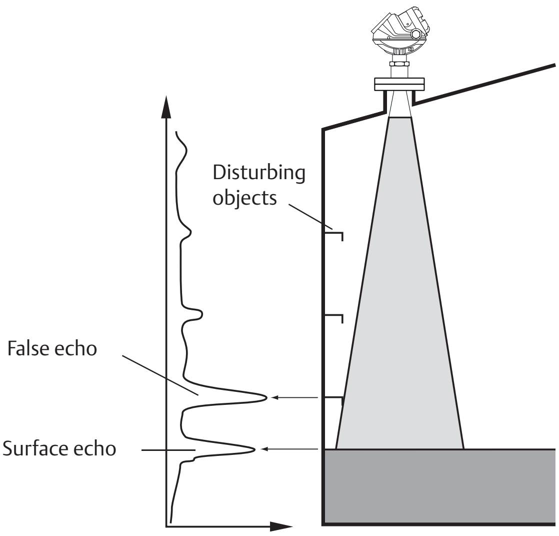
To adjust the amplitude thresholds, see "Using the Echo Curve Analyzer" on page 137.

In the *Echo Curve Analyzer* in RRM, the amplitude threshold points can easily be dragged to the desired values.

7.3.3 Registration of false echoes

The False Echo function improves the performance of the gauge when the surface is close to a horizontal surface of a static 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 may interfere and cause a decrease in performance.

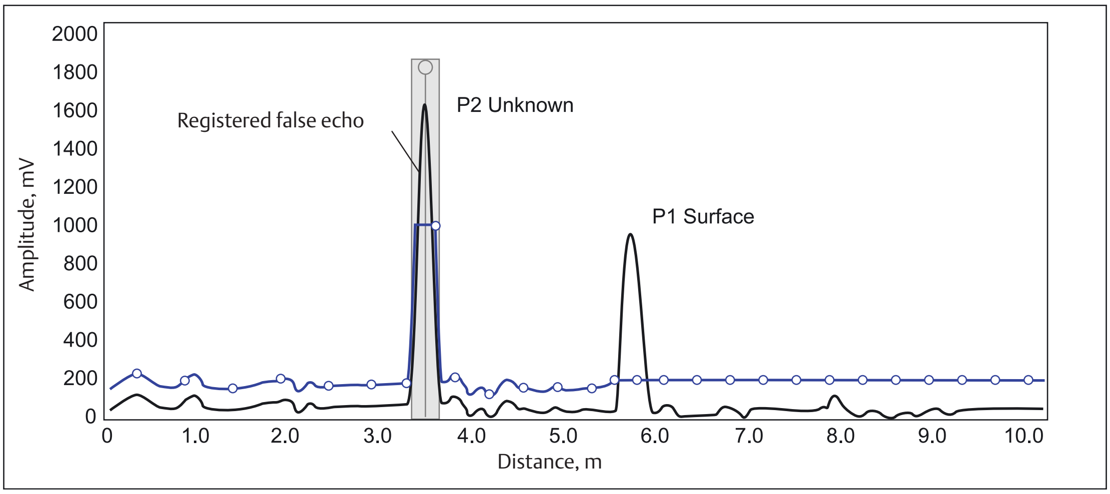
Figure 7-5. The Rosemount 5400 Series can Handle Disturbing Radar Echoes



The False Echo function allows registration of disturbing echoes caused by objects in the tank. When the surface is passing a disturbing object, the transmitter measures with higher reliability if 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. Follow these recommendations before registering new interfering echoes:

- Make sure a correct ATC is set before registering any disturbance echoes (see "ATC" on page 84).
- Compare the list of interfering echoes with the tank drawing or visual inspection of the tank. Note any objects like beams, heating coils, agitators, etc. which correspond to the found echoes. Only register echoes above the ATC 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 registering a disturbance echo. A fluctuating level may indicate a temporary disturbance that is not from an interfering object.
- Do not register False Echoes located below the product surface. It is recommended that registration be done when the tank is empty.

Figure 7-6. Disturbing Echoes can be Filtered Out by Registration as False Echoes



The False Echo Registration function is available in the RRM program, in the AMS Suite, as well as for the Field Communicator.

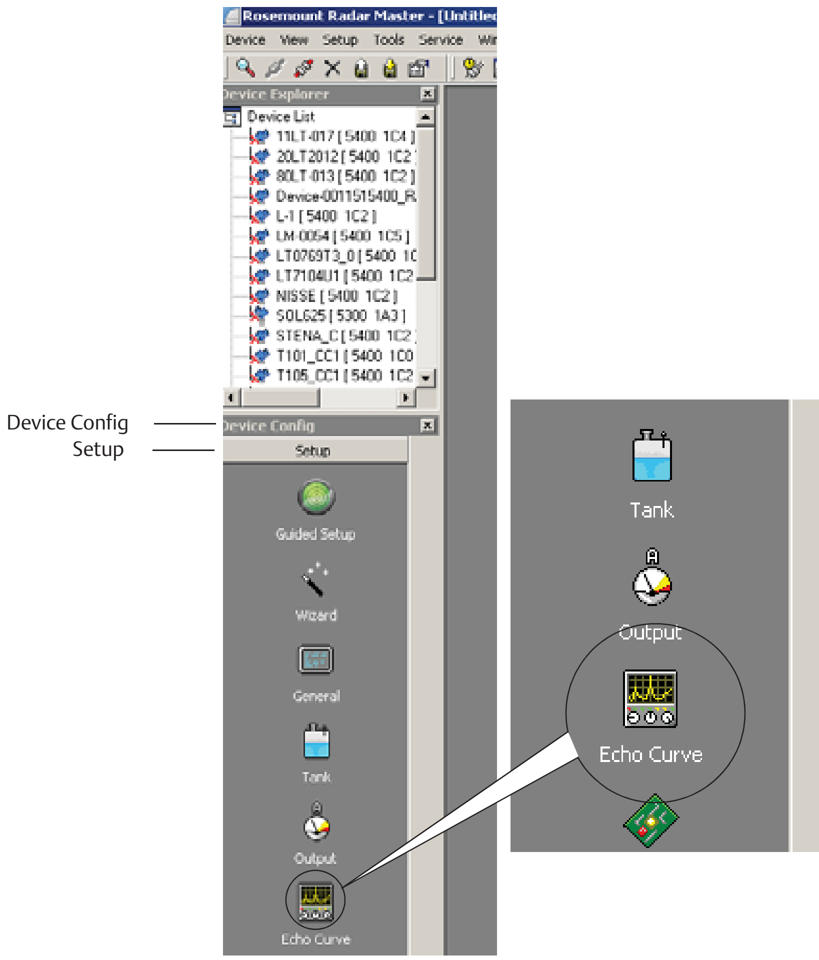
7.3.4 Using the Echo Curve Analyzer

The Echo Curve in RRM shows the measurement signal amplitude in the tank and includes the Echo Tuning functionality (see "Echo tuning" on page 83 for more information on false echo handling).

To plot the measurement signal:

1. Start the RRM program.
2. Open *Device Config/Tools* (or *Device Config/Setup*).
3. Click the **Echo Curve** icon (see Figure 7-7).

Figure 7-7. The Echo Curve Function is a Useful Tool for Signal Analysis

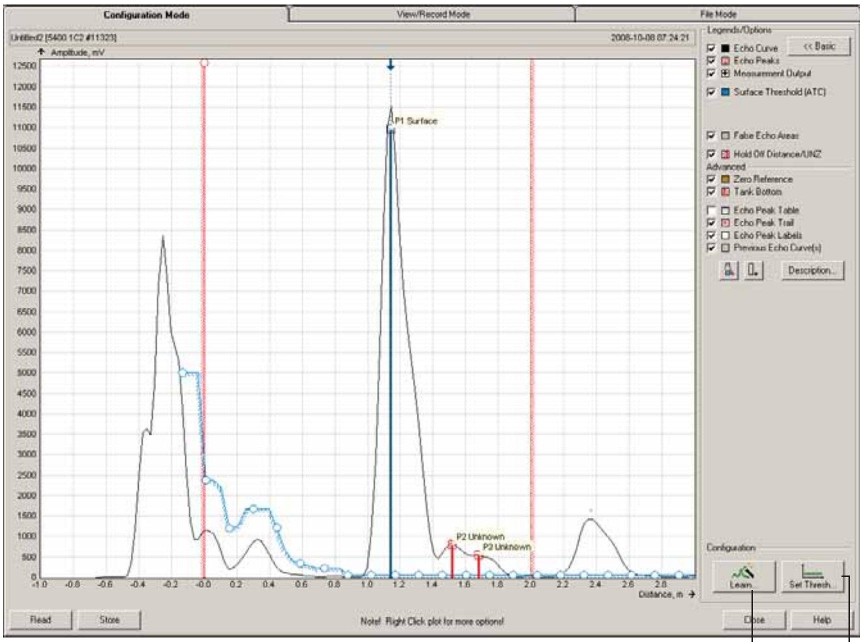


4. The *Echo Curve Analyzer* window appears with the *View/Record Mode* tab (or the *Configuration Mode* tab) selected.

The Configuration Mode tab

The *Configuration Mode* tab allows for adjustment of the different amplitude thresholds. When clicking the **Echo Curve** icon under *Device Config/Setup*, the *Echo Curve Analyzer* window appears with the *Configuration Mode* tab selected:

Figure 7-8. Echo Curve Analyzer Plot in Configuration Mode



The Measure and Learn function in RRM automatically creates an ATC used by the Rosemount 5400 Series transmitter to find the surface pulse. The ATC is adapted to the shape of the measurement signal as described in “Echo tuning” on page 83.

To create an ATC, click the **Learn** button in the *Echo Curve Analyzer/Configuration Mode* window. By clicking the **Learn** button, the Measure and Learn function is activated and creates an ATC that filters out all disturbing echoes. The ATC can also be edited manually if further fine tuning is needed.

The *Configuration Mode* window also allows the changing of the amplitude thresholds manually, simply by dragging the corresponding anchoring points in the plot to the desired positions.

Note

By changing the amplitude thresholds in the Echo Curve plot manually, the Automatic mode is disabled for the corresponding threshold.

The **Set Thresholds** button sets the ATC to a fixed value based on the configured Dielectric Constant of the product.

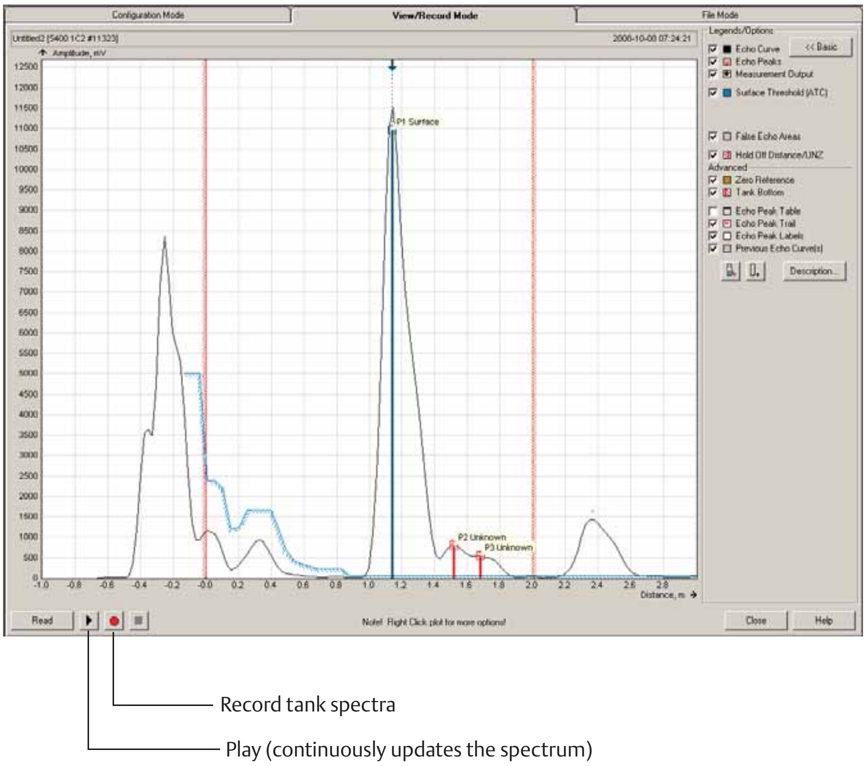
To register a false echo, right-click and select **Register as false echo**.

The View/Record Mode tab

The *View/Record Mode* tab presents a plot of the current tank conditions where each radar echo is displayed as a peak in the signal plot.

When clicking the **Echo Curve** icon under *Device Config/Tools*, the *Echo Curve Analyzer* window appears with the *View/Record Mode* tab selected:

Figure 7-9. A Echo Curve Plot in View/Record Mode



Advanced

The **Advanced** button opens a list below the Echo Curve plot with information on all echoes in the tank, such as signal amplitude and position in the tank.

Play

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

Record tank spectra

This function records tank spectra over time. This can be a useful function if, for example, studying the tank signal when filling or emptying the tank is desired.

File mode tab

The *File Mode* tab will open files with saved snapshots/movies to be presented in the spectrum plot. A movie file can be played to view the amplitude plot at the desired update rate.

7.3.5 Using the Echo Curve Analyzer with a Field Communicator

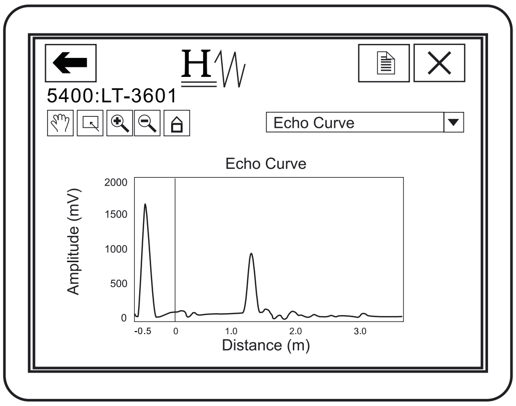
The Field Communicator supports the EDDL with enhancements that allows viewing of the Echo Curve, creating an ATC, and specifying amplitude thresholds, such as the Surface Threshold.

Viewing the Echo Curve

To view the Echo Curve:

1. Select HART command [2, 5, 2, 3].
   FOUNDATION fieldbus parameter:
   TRANSDUCER_1300 > AMPLITUDE_THRESHOLD_CURVE

   The Echo Curve appears on the display:

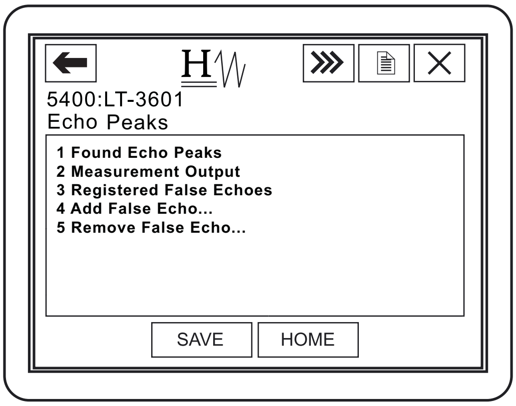
2. Use the Hand and Zoom tools to view specific parts of the Echo Curve. The drop down list allows for choosing items, such as the different amplitude thresholds to be displayed in the plot.

   The Echo Curve plot also shows an ATC if available. See “ATC” on page 84 for more information.

Register false echoes

To register false echoes:

1. Select HART command [2, 5, 1].



2. Select option 1 *Found Echo Peaks* to display found echoes.

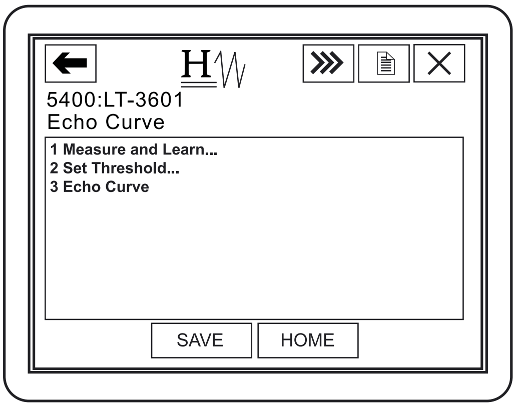
3. Select option 2 *Add False Echo...* to register false echoes based on distance.

Threshold settings

To adjust the amplitude thresholds:

1. Select HART command [2, 5, 2].

   The different echo curve options appear on the display:



2. Select option 1 *Measure and Learn* to create an ATC, see “ATC” on page 84 for more information.
   Select option 2 *Set Threshold* to specify a constant Surface Threshold.

3. Click the **SAVE** button to store the new settings in the transmitter database.

7.4 Analog Output calibration

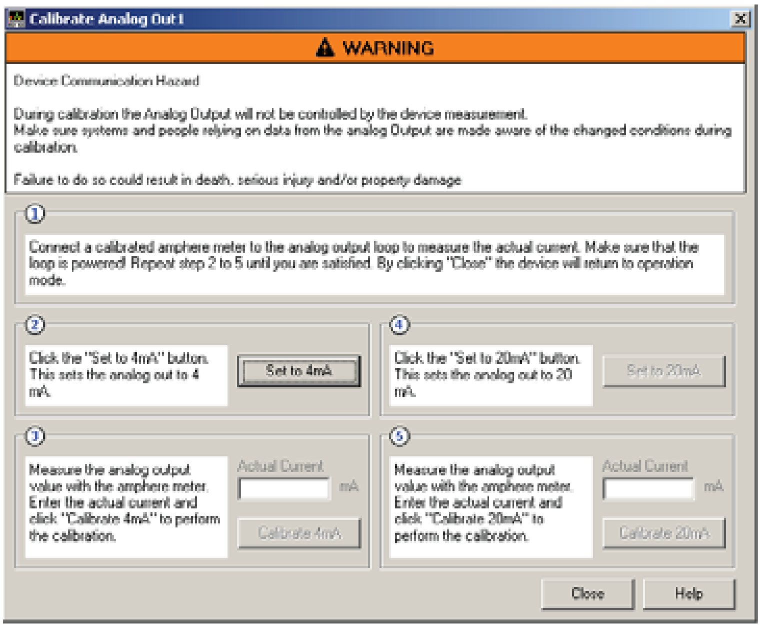
This function calibrates the Analog Output by comparing the actual output current with the nominal 4 mA and 20 mA currents. Calibration is done at the factory and normally the transmitter does not need to be recalibrated.

The Analog Output calibration function is available via the HART command [2, 7, 1].

In RRM, this function is available via *Setup* > *Output*.

To calibrate the Analog Output current:

1. Start RRM and make sure that the transmitter communicates with the PC.
2. Select the **Output** icon in the *Device Config/Setup* toolbar.
3. Select the **Analog Out** tab in the *Output* window.
4. Select the **Calibrate DAC** button.

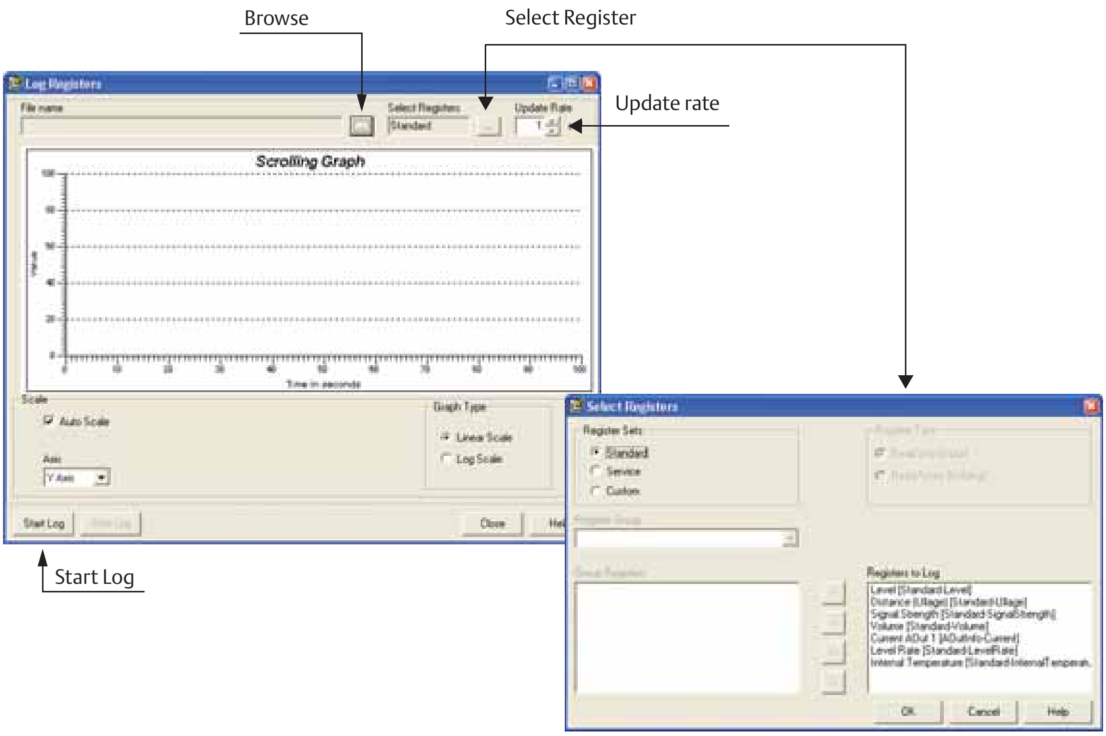


5. Follow the instructions to calibrate the 4 mA and the 20 mA outputs.

7.5 Logging measurement data

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

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



To begin logging:

1. Select the **Browse** button, select a directory to store the log file, and type a log file title.
2. Select the **Select Register** button and choose the register type to be logged.
3. Select the desired registers to be logged. There are three options available: *Standard*, *Service*, and *Custom*. Standard and Service refer to pre-defined sets of registers. The Custom option allows the user to choose the desired range of registers.
4. Enter the update rate. An update rate of 10 seconds means that the plot will update every 10 seconds.
5. Select the **Start Log** button. The logging will proceed until the **Stop Log** button is selected.

7.6 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. It is recommended to store the transmitter configuration in a backup file.

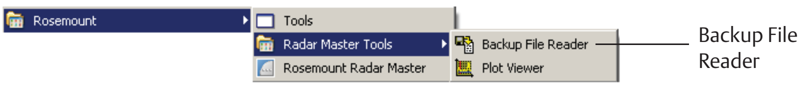
The backup function is available from the *Device* menu in RRM.

To make a backup copy of the configuration parameters:

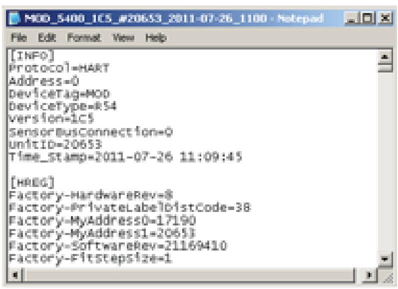
1. From the *Device* menu, choose the **Backup Config to File** option.

2. Browse to the desired directory.

3. Enter a name for the backup file and select the **Save** button, so the transmitter configuration is stored. The backup file can be used at a later stage to restore an accidentally changed configuration. The backup file can also be used to quickly configure transmitters 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 using the Backup File Reader installed with the RRM software:



4. The backup file can also be viewed as a text file in a word processing program such as Notepad:



See "Configuration report" on page 147 for further information on viewing backup files.

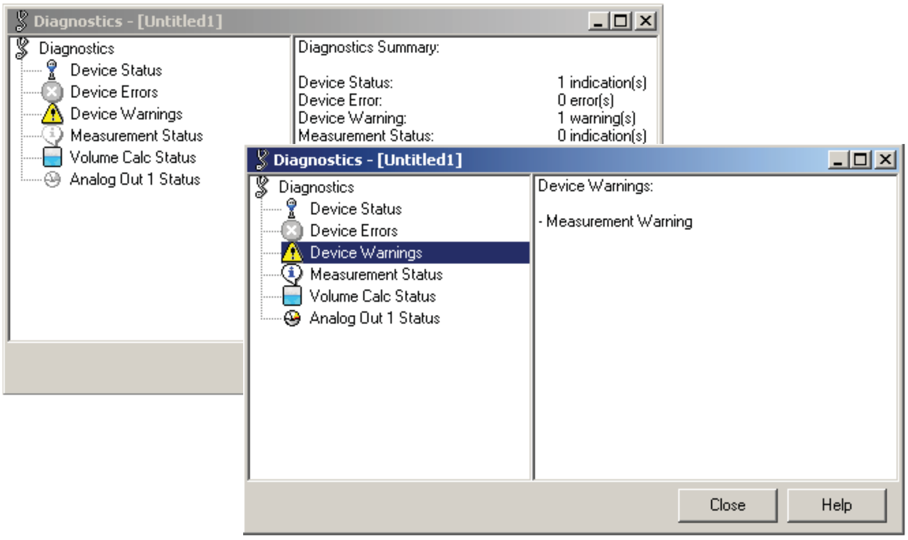
7.7 Diagnostics

The following information about the device can be retrieved:

- "Device status" on page 153
- "Errors" on page 154
- "Warnings" on page 155
- "Measurement status" on page 155
- "Volume calculation status" on page 157
- "Analog Output status" on page 158

RRM

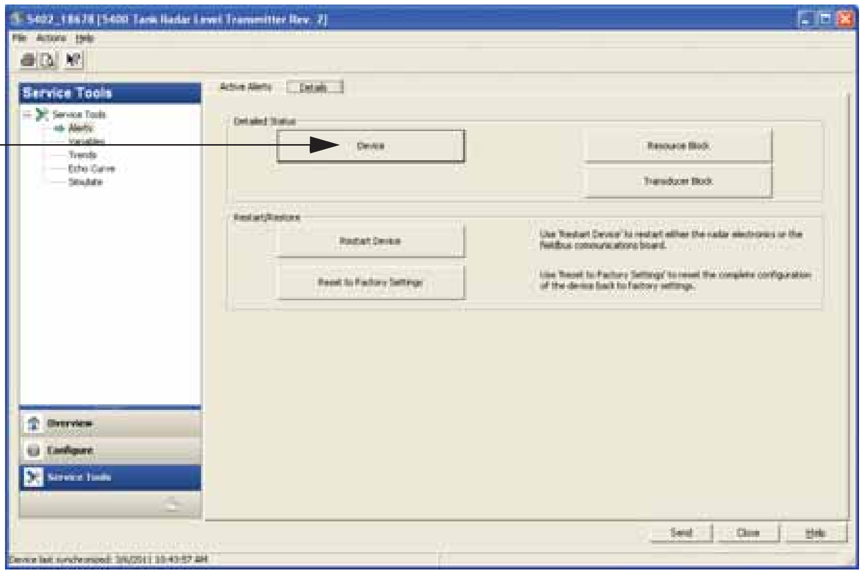
To open the *Diagnostics* window in RRM, choose the **Diagnostics** option from the *Tools* menu.



AMS and DeltaV

To view the *Diagnostics* window in AMS Suite, click the right mouse button on the desired transmitter and choose the **Configure** option. Select **Service Tools** and the tab **Active Alerts**. Detailed Status is found in *Details|Device*:

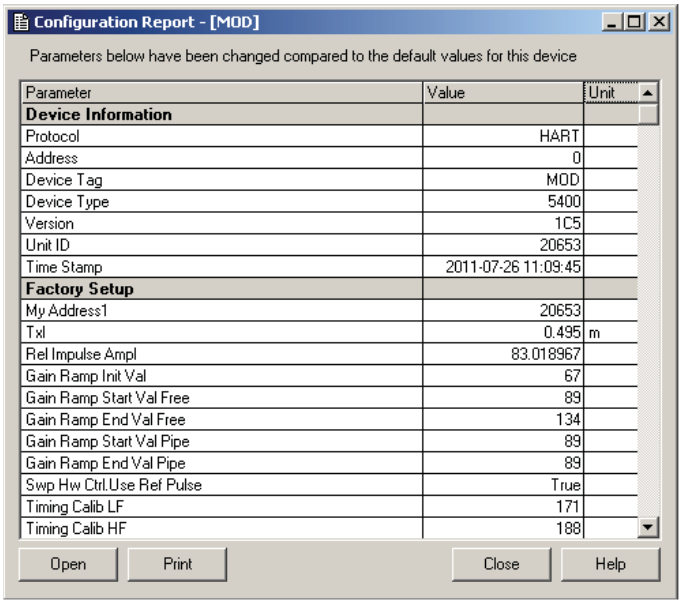
Device



7.8 Configuration report

This RRM function shows the configuration changes made to the transmitter compared to the factory configuration. The report compares a specified backup file with the default transmitter configuration.

To open the Configuration Report, choose the *Tools* > *Configuration Report* menu option:



Parameter	Value	Unit
Device Information		
Protocol	HART	
Address	0	
Device Tag	MOD	
Device Type	5400	
Version	1C5	
Unit ID	20653	
Time Stamp	2011-07-26 11:09:45	
Factory Setup		
My Address1	20653	
Txl	0.495	m
Rel Impulse Ampl	83.018967	
Gain Ramp Init Val	67	
Gain Ramp Start Val Free	89	
Gain Ramp End Val Free	134	
Gain Ramp Start Val Pipe	89	
Gain Ramp End Val Pipe	89	
Swp Hw Ctrl.Use Ref Pulse	True	
Timing Calib LF	171	
Timing Calib HF	188	

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

7.9 Viewing input and holding registers

Measured data is continuously stored in the Input Registers and by viewing the contents, advanced users can check if the transmitter is working properly.

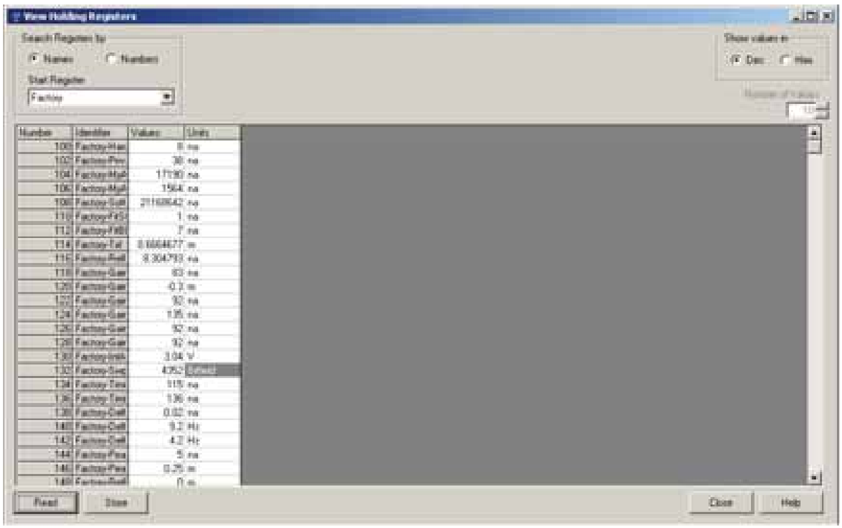
The Holding Registers store various transmitter parameters, such as configuration data, used to control the measurement performance.

By using the RRM program, most Holding Registers can be edited by typing a new value in the appropriate Value input field. Some Holding Registers can be edited in a separate window and the individual data bits can be changed.

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”).
3. The View Input / Holding Registers option is now available.
4. Choose the **View Input** / **Holding Registers** option from the *Service* menu.
5. Select the **Read** button. To change a Holding register value, enter a new value in the corresponding *Value* field. Select the **Store** button to save the new value.

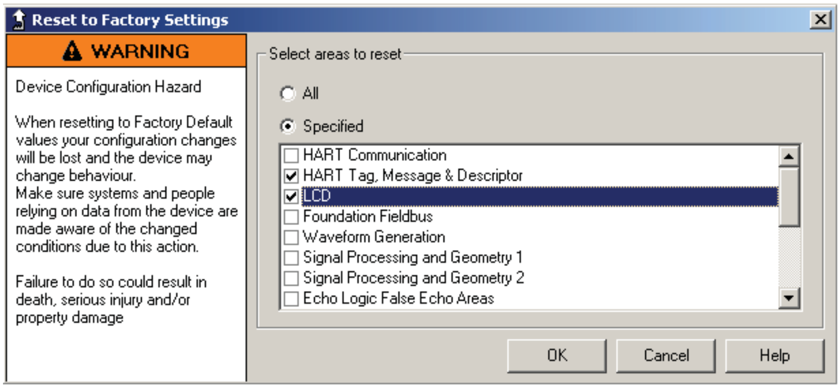
Figure 7-10. Holding and Input Registers



7.10 Reset to factory settings

This function resets all, or a specific part, of the holding registers to the factory settings. It is recommended that a backup of the configuration be made before resetting, so the old transmitter configuration can be loaded, if necessary.

RRM: choose menu option *Tools > Factory Settings*.

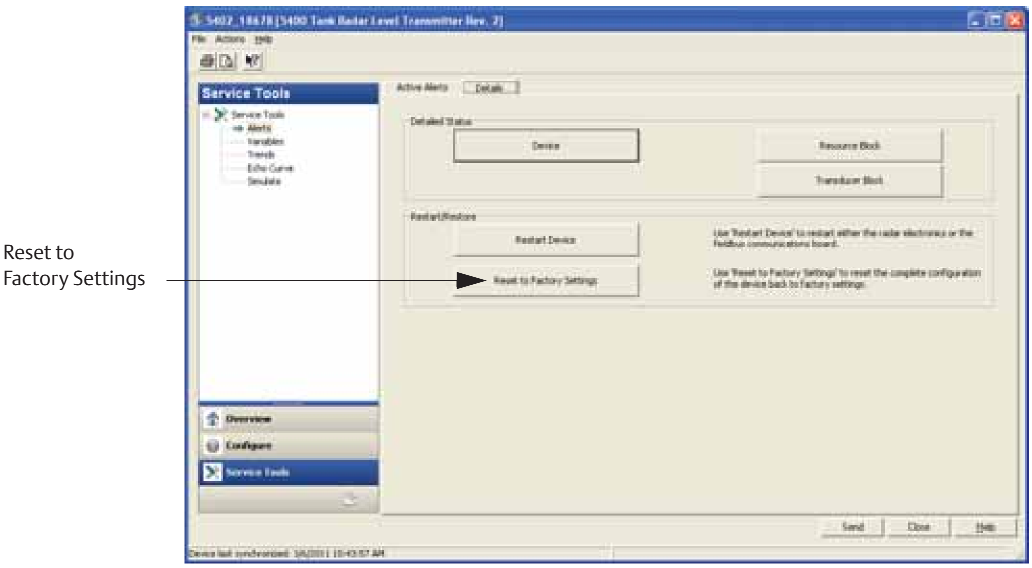


AMS Suite: *Tools / Service > Factory Settings*.

HART Command: [1, 2, 8].

AMS and DeltaV

1. In the AMS/DeltaV explorer, select **Configure**/**Service Tools**, and choose **Reset to Factory Settings**.



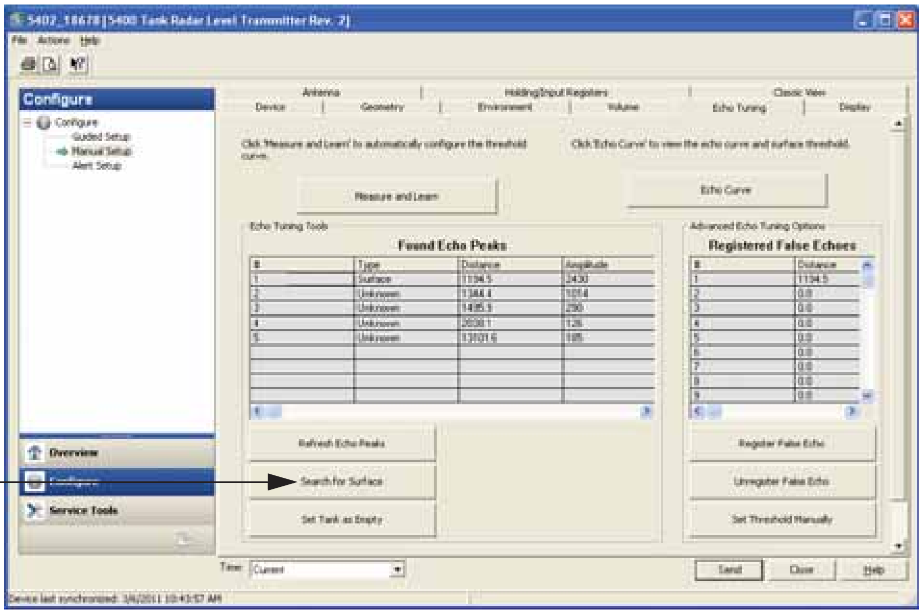
2. Choose the **Factory Settings** option.

7.11 Surface search

The *Surface Search* command triggers a search for the product surface and can be used, for example, if the measured level is locked onto a disturbing object in the tank (see “Configuration report” on page 147).

AMS and DeltaV

1. In the AMS and DeltaV explorer select **Configure/Manual setup**, choose the **Echo Tuning** tab, and select **Search for Surface**.

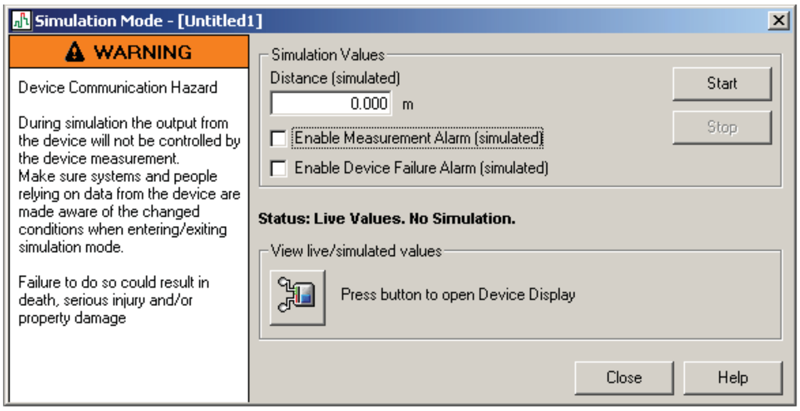


2. Choose the **Surface Search** option.

7.12 Using the Simulation Mode

This function can be used to simulate measurements and alarms.

RRM: choose menu option *Tools > Simulation Mode*:



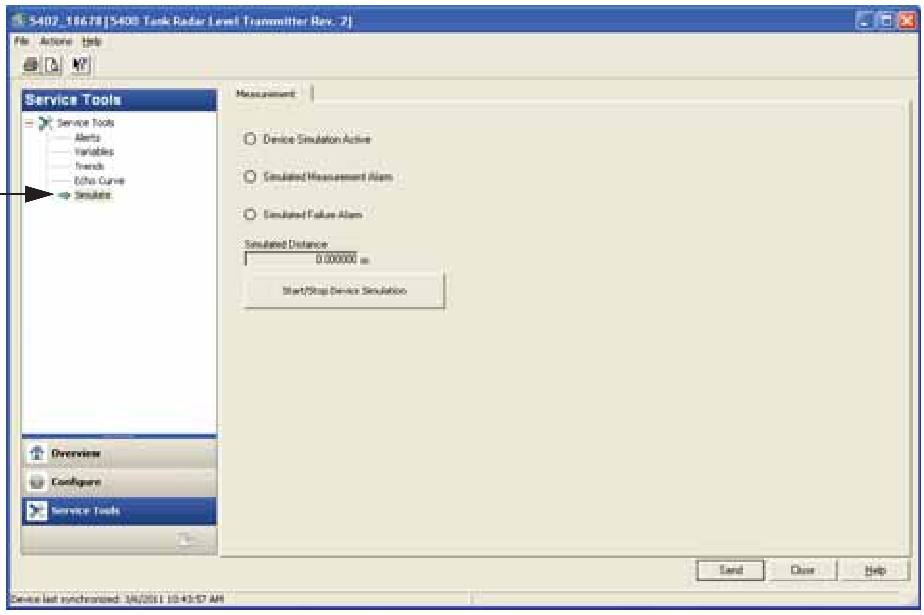
AMS Suite: *Tools > Service > Simulation Mode*.

HART Command: [3, 2, 1, 3].

AMS and DeltaV

1. In the AMS/DeltaV explorer select **Configure/Service Tools**, choose **Simulate** to setup simulation mode:

Simulate



7.13 Write protecting a transmitter

A Rosemount 5400 Series transmitter can be password protected from unintentional configuration changes. The default password is 12345 and it is recommended that this password not be changed to facilitate service and maintenance of the transmitter.

RRM: *Tools* > *Lock / Unlock Configuration Area*.

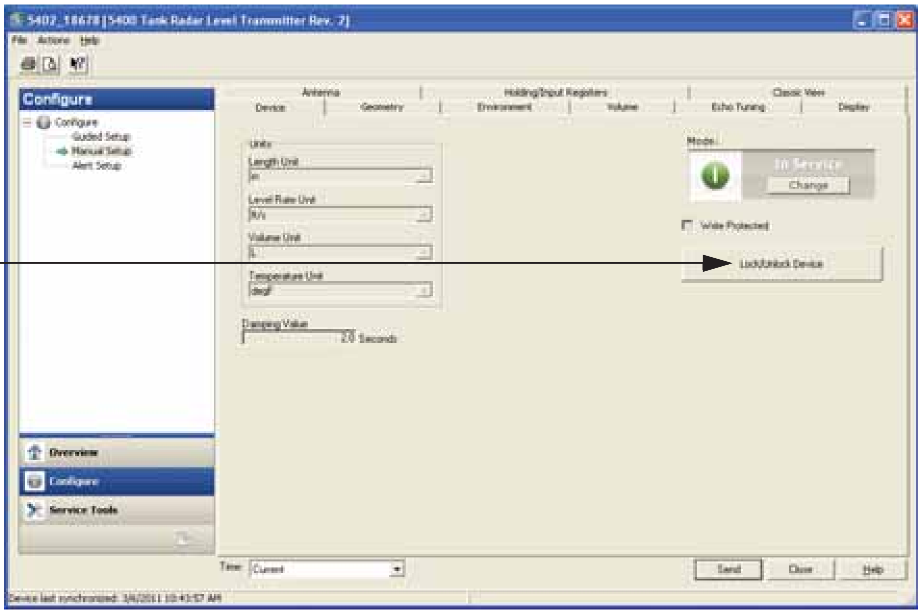
AMS Suite: *Tools* > *Service* > *Lock / Unlock Device*.

HART Command [3, 2, 1, 2].

AMS and DeltaV

1. In the AMS/DeltaV explorer select **Configure**/**Manual setup**, choose the **Device** tab and select **Lock/Unlock Device**.

Lock/Unlock Device



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

7.14 Diagnostic messages

7.14.1 Troubleshooting

If there is a malfunction, despite no diagnostic messages, see Table 7-1 on page 131 for information on possible causes.

Note
If the transmitter housing needs to be removed for service, make sure the antenna PTFE sealing is carefully protected against dust and water.

7.14.2 Device status

Device Status messages that may appear on the Integral Display, on the Field Communicator, or in the RRM program are shown in Table 7-2:

Table 7-2. Device Status

Message	Description	Action
Running Boot Software	The application software could not be started.	Contact Emerson Process Management Service Department.
Device Warning	A device warning is active.	See "Warning Messages" on page 155 for details.
Device Error	A device error is active.	See "Error Messages" on page 154 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 "Analog Output calibration" on page 142).
Invalid Measurement	The level measurement is invalid.	Check "Error Messages" on page 154, "Warning Messages" on page 155 and "Measurement Status" on page 155 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 152).
Hardware Write Protected	The Write Protection switch is enabled.	Set the Write Protection switch to Off. Contact Emerson Process Management Service Department for information.
Factory Settings Used	The factory default configuration is used.	The transmitter calibration is lost. Contact Emerson Process Management Service Department.
User Area Write Protected	The configuration area is write protected.	See "Write protecting a transmitter" on page 152 for details.

7.14.3 Errors

Error messages that may be displayed on the Integral Display, on a Field Communicator, in AMS, or in the RRM program, are shown in Table 7-3. Errors normally result in an Analog Output alarm.

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

Table 7-3. Error Messages

Message	Description	Action
RAM Error	An error in the gauge data memory (RAM) has been detected during the startup tests. NOTE: this resets the gauge automatically.	Contact Emerson Process Management Service Department.
FPROM Error	An error in the gauge program memory (FPROM) has been detected during the startup tests. NOTE: this resets the gauge automatically.	Contact Emerson Process Management 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 Emerson Process Management Service Department if the problem persists.
MWM Error	An error in the microwave module.	Contact Emerson Process Management Service Department.
Display Error	An error in the LCD.	Contact Emerson Process Management Service Department.
Modem Error	Modem hardware failure.	Contact Emerson Process Management Service Department.
Analog Out Error	An error in the Analog Out Module.	Contact Emerson Process Management Service Department.
Internal Temp Error	An error in internal temperature measurement.	Contact Emerson Process Management Service Department.
Other HW Error	An unspecified hardware error has been detected.	Contact Emerson Process Management Service Department.
Meas Error	A serious measurement error has been detected.	Contact Emerson Process Management Service Department.
Config Error	At least one configuration parameter is outside the 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 149) Configure the transmitter or upload a backup configuration file (see "Backing up the transmitter configuration" on page 144) Contact Emerson Process Management Service Department if the problem persists
SW Error	An error has been detected in the transmitter software.	Contact Emerson Process Management Service Department.

7.14.4 Warnings

Table 7-4 is a list of diagnostic messages that may be displayed on the Integral Display, on the Field Communicator, or in the RRM program. Warnings are less serious than errors, and in most cases, do not result in Analog Output alarms.

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

Table 7-4. Warning Messages

<table>
<tr><th>Message</th><th>Description</th><th>Action</th></tr>
<tr><td>RAM warning</td><td colspan="2" rowspan="12">See Diagnostics (RRM: Tools > Diagnostics) for further information on a warning message.
See also "Diagnostics" on page 145.</td></tr>
<tr><td>FPROM warning</td></tr>
<tr><td>Hreg warning</td></tr>
<tr><td>MWM warning</td></tr>
<tr><td>LCD warning</td></tr>
<tr><td>Modem warning</td></tr>
<tr><td>Analog out warning</td></tr>
<tr><td>Internal temperature warning</td></tr>
<tr><td>Other hardware warning</td></tr>
<tr><td>Measurement warning</td></tr>
<tr><td>Config warning</td></tr>
<tr><td>SW warning</td></tr>
</table>

7.14.5 Measurement status

Measurement Status messages that may appear on the Integral Display, on the Field Communicator, or in the RRM program are shown in Table 7-5.

Table 7-5. Measurement Status

Message	Description	Action
Full tank	The level measurement is in Full Tank state. The transmitter waits for the surface echo to be detected at the top of the tank.	The transmitter leaves the Full Tank state when the product surface gets below the Full Tank Detection Area, see "Full tank handling" on page 241 and "Full tank handling" on page 247.
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 239 and "Empty tank handling" on page 243.
Reference pulse invalid	An error in the reference pulse in the last sampled tank signal.	Check Warning messages. If MicroWave Module (MWM) Warning is active, this might indicate a transmitter error. Contact Emerson Process Management Service Department.
Sweep linearization warning	The sweep is not correctly linearized.	Check Warning messages. If MWM Warning is active, this might indicate a transmitter error. Contact Emerson Process Management Service Department.

Message	Description	Action
Tank signal clip warning	The last Tank Signal was clipped.	Check Warning Messages. If MWM Warning is active, this might indicate a transmitter error. Contact Emerson Process Management Service Department.
No surface echo	The Surface Echo Pulse cannot be detected.	Check if the configuration can be changed so that the surface echo can be tracked in this current region.
Predicted level	The presented level is predicted. The surface echo could not be detected.	See *No surface echo* above.
Sampling failed	The sampling of the last tank signal failed.	Check Warning Messages.
Invalid volume value	The given volume value is invalid.	Check Volume Status for details.
Simulation Mode	The simulation mode is active. The presented measurement values are simulated.	No action needed.
Advanced Simulation Mode	The advanced simulation mode is active. The given measurements are simulated.	To turn off the Advanced Simulation mode, set Holding Register 3600 = 0 (see "Analog Output calibration" on page 142).
Tracking Extra Echo	The transmitter is in the empty tank state tracking an extra echo.	See "Extra echo" on page 240 and page 245.
Bottom Projection	The bottom projection function is active.	See "Tank bottom projection" on page 240.
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 83).
Sudden level jump detected.	This may result from various measurement problems.	Check the tank to find out what causes problem tracking the surface.

7.14.6 Volume calculation status

Volume calculation status messages that may appear on the integral display, on the Field Communicator, or in the RRM program are shown in Table 7-6.

Table 7-6. Volume Status

Message	Description	Action
Level is below lowest strapping point.	The measured level is below the lowest point in the given strapping table.	For a correct volume calculation in this region, change the strapping table.
Level is above highest strapping point.	The measured level is above the highest point in the given strapping table.	For a correct volume calculation in this region, change the strapping table.
Level out of range.	The measured level is outside the given tank shape.	Check if the correct tank type is chosen, and check the configured Tank Height.
Strap table length not valid.	The configured strap table length is too small or too large.	Change the strapping table size to a valid number of strapping points. A maximum number of 20 strapping points can be entered.
Strap table not valid.	The strapping table is not correctly configured.	Check that both level and volume values in the strapping table are increasing with strapping table index.
Level not valid.	The measured level is not valid. No volume value can be calculated.	Check "Measurement Status" on page 155, "Warning Messages" on page 155, and "Error Messages" on page 154.
Volume configuration missing.	No volume calculation method is chosen.	Configure Volume.
Volume not valid.	The calculated volume is not valid.	Check the other volume status messages for the reason.

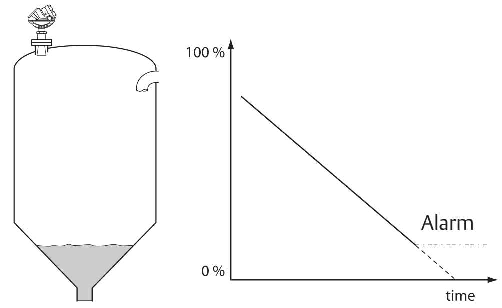
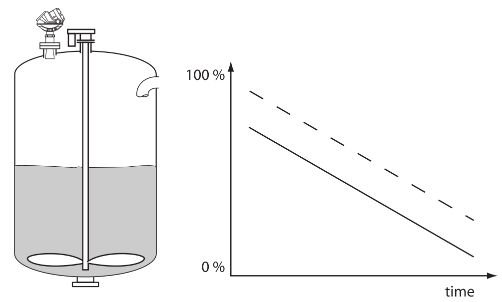
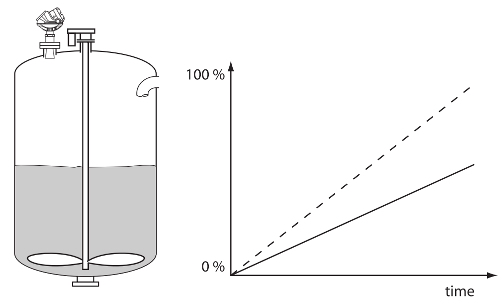
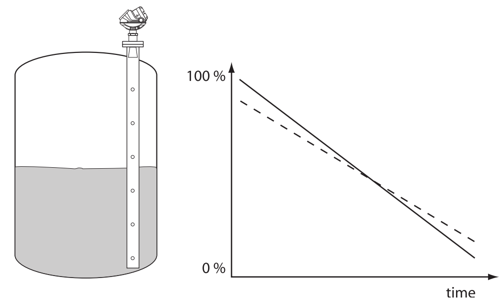
7.14.7 Analog Output status

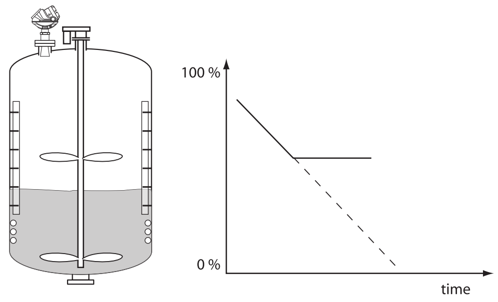
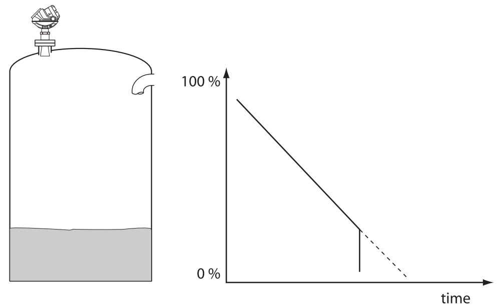
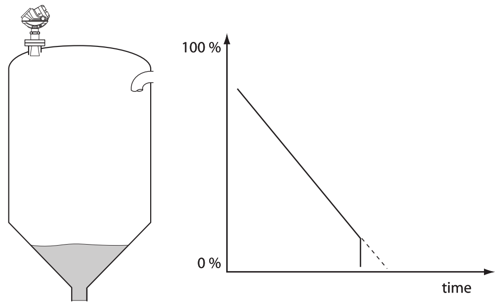
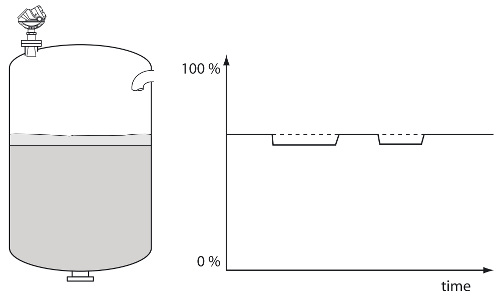
Analog Output status messages that may appear on the integral display, on the Field Communicator or in the RRM program are shown in Table 7-7.

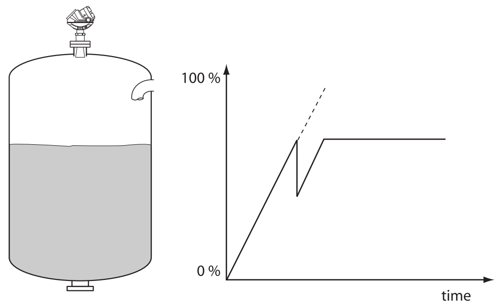
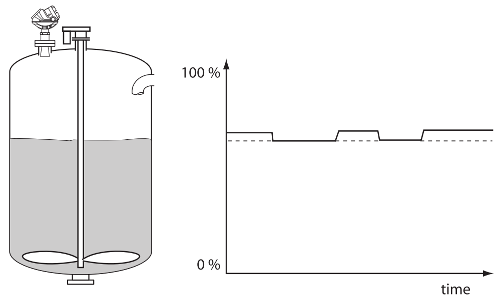
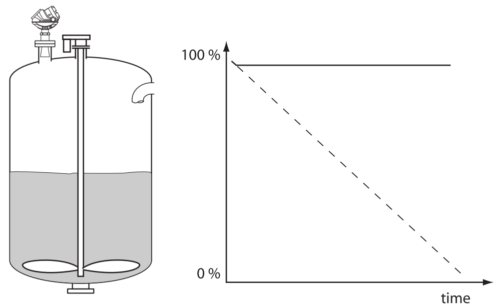
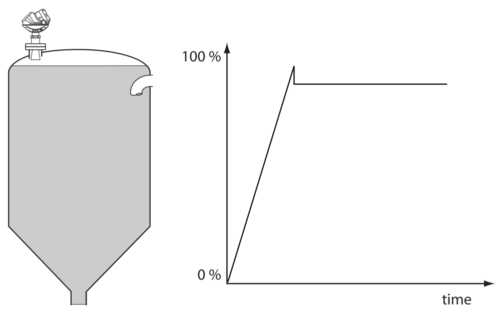
Table 7-7. Analog Output Status

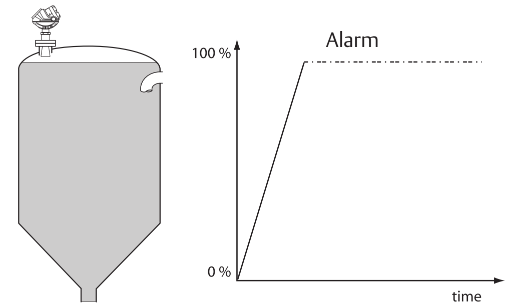
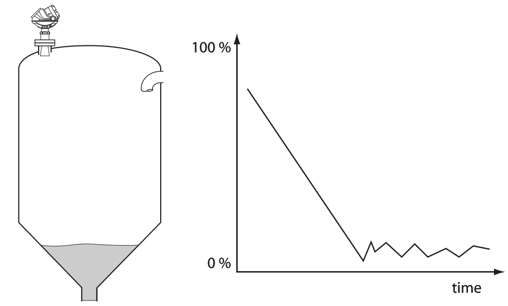
Message	Description	Action
Not connected	Analog output hardware is not connected.	Contact Emerson Process Management Service Department.
Alarm mode	The analog output is in Alarm Mode.	Check "Error Messages" on page 154 and "Warning Messages" on page 155 to find the reason for the Alarm.
Saturated	The analog output signal value is saturated, that is equal to the saturation value.	No action needed.
Multidrop	The transmitter is in Multidrop Mode. The analog output is fixed at 4 mA.	This is the normal setting when a device is used in Multidrop configuration.
Fixed current mode	The analog output is in fixed current mode.	This mode is used when calibrating the Analog Output channel.
Invalid limits	The given Upper and Lower Range Values are invalid.	Check that the difference between the Upper and Lower Range Value is greater than the Minimum Span.

7.14.8 Application errors

	When product surface is near the tank bottom, the transmitter enters alarm mode (see "Alarm mode" on page 81).	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 240 and 244 • Make sure that the *Bottom Echo Visible* parameter is not set, see "Bottom echo visible" on page 240 and 243
	Incorrect level.	Action: • Check Tank Height configuration • For rapid level changes, check the Damping Value. (See "Damping value" on page 243)
	Incorrect level.	May be caused by wrong Range Value settings. Action: • Check that the Upper Range Value matches the 100 % level in the tank
	Incorrect level when using a pipe.	May be caused by an incorrectly configured Pipe Inner Diameter. Action: • Check that the actual Pipe Inner Diameter matches the configured Inner Diameter

	Measured value is locked.	May be caused by a disturbing object in the tank Action: • Remove the disturbing object • Move the transmitter to another position • Use the Echo Tuning function in RRM to register the false echo causing the transmitter to lock at the wrong level, see “Echo tuning” on page 83 • Put an inclined metal plate on top of the disturbing object
	Measured value drops to zero level.	May be caused by strong echoes from the tank bottom when the product is slightly transparent. Action: • Check the Tank Height • Make sure that the *Bottom Echo Visible* parameter is enabled, see “Bottom echo visible” on page 240 and 243 • Try using the *Tank Bottom Projection* function if the following conditions are met: - The product is transparent - The tank bottom echo is visible
	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 240 and 244. Action: If possible, try another mounting position.
	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 242 RRM: *Setup > Advanced*

	Incorrect measurement level when the product surface is above the 50 % level.	May be caused by: • Radar echo bouncing from the product surface to the tank roof then back to the surface • Strong echoes from a very high reflectivity product Action: • Move the transmitter from the center of the tank roof • Enable the *Double Bounce* function, see "Double bounce" on page 241 and 248 RRM: *Setup > Advanced*
	Measured level jumps to a higher value.	May be caused by: • Foam on the product surface • Turbulent product surface Action: • Enable the Tank Environment *Foam* parameter RRM: Setup > Tank > Environment HART: [2, 3, 2] • Enable the Tank Environment *Turbulent Surface* parameter RRM: Setup > Tank > Environment HART: [2, 3, 2]
	Measured level gets locked near the top of the tank.	May be caused by: • Antenna tip ends inside the tank nozzle • Disturbing objects near the antenna • Product built up on the antenna Action: • Mount the transmitter on another nozzle, if possible • Increase the *Hold Off* distance RRM: *Setup > Advanced* HART: [2, 3, 4]
	The level value drops to a lower value when the product surface is close to the antenna.	May be caused by: • Product level within the Hold Off region, that is outside the approved measuring range, and the transmitter is picking up secondary signal reflections Action: • Avoid filling the tank to levels close to the antenna • Move the transmitter to increase the distance between maximum product level and antenna, if possible • Activate the Full Tank Handling function if measurements up to the antenna are required, see "Full tank handling" on page 241 and 247

	The transmitter displays “measurement error” and activates Measurement Alarm when the product level is close to the antenna.	May be caused by: • Product level within the Hold Off region, that is outside the approved measuring range Action: • Avoid filling the tank to levels very close to the antenna • Move the transmitter to increase the distance between maximum product level and antenna, if possible • Activate the Full Tank Handling function if measurements up to the antenna are required, see “Full tank handling” on page 241 and 247
	The measured level is unstable.	May be caused by: • An empty tank with the Amplitude Threshold too low • Product surface is close to a registered False Echo Action: • Create a new ATC, see “Echo tuning” on page 83

7.15 Troubleshooting

If there is a malfunction despite the absence of diagnostic messages, see Table 7-8 for information on the possible causes.

Note
If the transmitter housing must be removed for service, make sure that the PTFE seal is carefully protected against dust and water.

Table 7-8. 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 159	• Check the Tank Height parameter; RRM > Setup > Tank. • Check status information and diagnostics information, see “Diagnostics” on page 145. • Check that the transmitter has not locked on an interfering object.
Integral display does not work		• Check the display configuration; RRM > Setup > General. • Diagnostics. • Contact Emerson Process Management 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 to the device. If error persists, replace the transmitter head.
Level Measurement Failure		• Analyze the echo curve for possible reasons • Check device configuration • Check physical installation of device (for example, antenna contamination) • Load default database to the device • Reconfigure the device. If error persists, replace the transmitter head.
Internal Temperature Critical		• Replace the transmitter head
Volume Measurement Failure		• If Level Measurement Failure is active, clear that alert first • Check volume configuration • Load default database to the device • Reconfigure the device. If error persists, replace the transmitter head.
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 the Emerson Process Management Service Department. A display must not be replaced when the transmitter is in operation.*

7.15.1 Resource block

This section describes error conditions found in the Resource block. Read Table 7-9 through Table 7-11 to determine the appropriate corrective action.

Block errors

Table 7-9 lists conditions reported in the BLOCK_ERR parameter.

Table 7-9. 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 the 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 7-10. Resource Block SUMMARY_STATUS Messages

Condition name
Uninitialized
No repair needed
Repairable
Call Service Center

Table 7-11. 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

7.15.2 Transducer block

This section describes error conditions found in the sensor transducer block.

Table 7-12. Transducer Block BLOCK_ERR Messages

Condition name and description
Other
Out of Service: The actual mode is out of service

Table 7-13. 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.

7.15.3 Analog Input (AI) function block

This section describes error conditions that are supported by the AI Block. Read Table 7-15 to determine the appropriate corrective action.

Table 7-14. 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

Condition number	Condition name and description
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 7-15. 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 293). 2. Check L_TYPE parameter (see "L_TYPE" on page 293) 3. Check XD_SCALE engineering units. (see "XD_SCALE and OUT_SCALE" on page 294
	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 294)
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 294.
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 the 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.

Section 8 Safety Instrumented Systems (4-20 mA Only)

8.1 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 following safety messages before performing an operation preceded by this symbol.

⚠ WARNING

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

- 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 specifications.
- Before connecting a HART®-based communicator in an explosive atmosphere, make sure the instruments in the loop are installed in accordance with intrinsically safe or non-incendive field wiring practices.

Electrical shock can result in death or serious injury.

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

Antennas with non-conducting surfaces.

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

⚠ WARNING

Any substitution of non-authorized parts or repair, other than exchanging the complete transmitter head or antenna assembly, may jeopardize safety and is prohibited.

Unauthorized changes to the product are strictly prohibited as they may unintentionally and unpredictably alter performance and jeopardize safety. Unauthorized changes that interfere with the integrity of the welds or flanges, such as making additional perforations, compromise product integrity and safety. Equipment ratings and certifications are no longer valid on any products that have been damaged or modified without the prior written permission of Emerson Process Management. Any continued use of product that has been damaged or modified without the written authorization is at the customer's sole risk and expense.

8.2 Overview

The following section applies to the 4-20 mA Rosemount 5400 Series with QS Prior-Use Certificate of FMEDA data transmitter used in Safety Instrumented Systems (SIS) applications. The 5400 QS Prior Use option with analog output provides overfill and empty tank protection to improve the system safety. The transmitter is classified as a Type B device. It contains self-diagnostics and is programmed to send its output to either a high or low failure state upon internal detection of a failure.

An independent third party approval of the FMEDA (detailed performance assessment) was conducted by *SP (Technical Research Institute of Sweden)* according to IEC 61508:2010. The FMEDA is performed to determine failure rates, calculate the Safe Failure Fraction (SFF), and the average Probability of Failure on Demand (PFD_{AVG}). The hardware assessment is one of the steps taken to achieve functional safety per IEC 61508 / IEC 61511. It provides the failure rate data suitable for prior-use assessment.

Note
Refer to the Rosemount 5400 Series FMEDA[1] report for failure rate data, additional details, and assumptions regarding the failure rate analysis.

8.2.1 Applicable models

Table 8-1 lists the versions of the Rosemount 5400 Series transmitter that have been considered for the hardware assessment, to which this section applies.

Table 8-1. Rosemount 5400 Series QS Option Model Codes

QS option model codes	
1	Model 5401xHxxxxxxxxxxxxQS[1]
2	Model 5402xHxxxxxxxxxxxxQS[1]

(1) Not available with option code C4 or C8.

To identify a 5400 QS Prior Use transmitter, verify the option code QS in the model code, on the label affixed to the outside of the transmitter head.

(1) The Rosemount 5400 Series FMEDA report is accessible at www.emersonprocess.com/rosemount/safety/PriorUse.htm.

8.2.2 Skill level of personnel

It is assumed that the personnel installing, configuring, and operating the system have the knowledge equal or greater than that of a qualified Instrument Technician familiar with safety-related systems, process control applications, and general instrument use.

Note
The Rosemount 5400 Series transmitter is not safety-rated during maintenance work, configuration changes, multidrop, loop test, or other activity that affects the Safety Function. Alternative means should be used to ensure process safety during such activities.

8.3 Functional specifications

The Safety Function is based on the analog output 4-20 mA, used as the safety variable. It is configured to activate the alarm function if an error occurs or if the measured value goes beyond the measurement range set by the user.

In the case of the Rosemount 5400 Series, the definition of the Safe State Safety Function is:

- The distance measurement is performed as intended inside the safety accuracy limits, that is with a deviation of < ±2 % of the measuring range.
- The safety analog output signal is set outside the normal 4-20 mA range (Low or High Alarm). The Rosemount standard alarm setting is: $\leq$ 3.75 mA or $\geq$ 21.75 mA.

Only the 4-20 mA output can be used in the Safety Function. The HART protocol can only be used for setup, calibration, and diagnostic purposes, not for safety critical operation. The measurement signal used by the logic solver must be the analog 4-20 mA signal proportional to the level generated.

8.4 Installation

The device should be installed and configured as a level sensing device per manufacturer’s instructions. The materials must be compatible with process conditions and process fluids. No special installation is required in addition to what is described in this section, the standard installation practices outlined in Section 3: Mechanical Installation, and the Rosemount 5400 Series Quick Start Guide (Document No. 00825-0100-4026).

Environmental limits are available in Appendix A: Reference Data.

Note
False echoes within the radar beam from obstructions may lead to a situation where the Rosemount 5400 Series can no longer be used for safety related functions with the listed failure rates, SFF, and PFD_{AVG}. However, reduced proof test intervals can help to detect such unwanted causes.

The loop must be designed so the terminal voltage does not drop below the minimum input voltage, see values in Table 8-2, when the transmitter output is 21.75 mA. The input voltage U_i for HART is 16-42.4 Vdc (16-30 Vdc in IS applications, and 20-42.4 Vdc in Explosion-proof / Flameproof applications).

The HART loop must be referenced to ground in one point located between the power supply and the load resistor. Either the negative or the positive pole of the power supply can be ground referenced, depending on the placement of the load resistor. See Figure 8-1 as an example.

Figure 8-1. Reference Ground when the Load Resistor is Inserted in the Negative Line

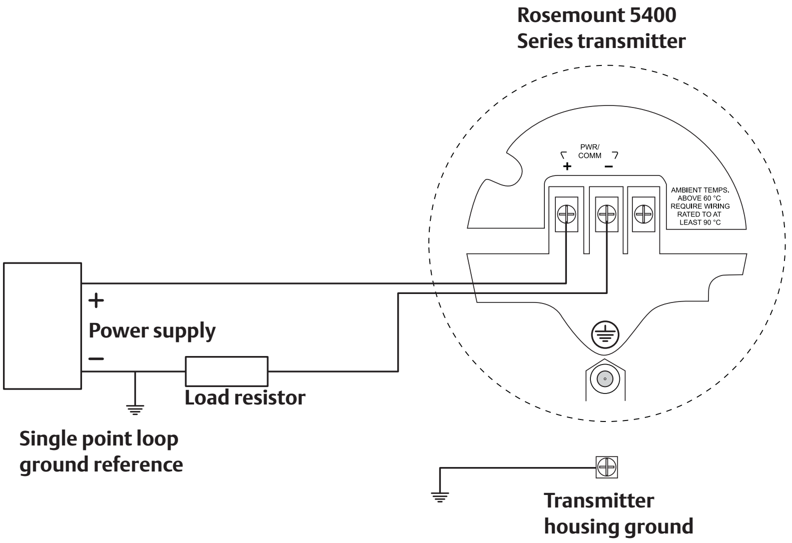


Table 8-2. Minimum Input Voltage (U_i) at Different Currents

Hazardous approval	Current	
	3.75 mA	21.75 mA
	Minimum input voltage (U_i)	
Non-hazardous Installations and intrinsically safe installations	16 Vdc	11 Vdc
Explosion-proof / flameproof installations	20 Vdc	15.5 Vdc

8.5 Configuration

Use a HART-compliant master, such as RRM or a Field Communicator, to communicate with and verify configuration of the Rosemount 5400 Series. A full review of configuration methods is available in Section 5: Basic Configuration/Start-up. These instructions are applicable to the 5400 QS option with any differences noted.

It is not recommended to use any advanced configuration that is described in Appendix C: Advanced Configuration. If advanced configuration is required, consult your local Emerson Process Management representative for guidance.

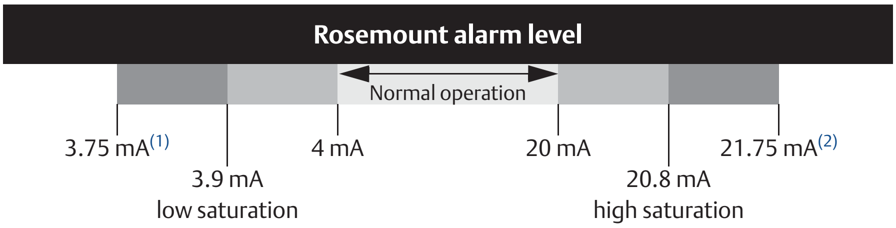
8.5.1 Damping

User adjusted damping will affect the transmitter's ability to respond to process changes. Therefore, the *damping values + response time* should not exceed the Safety loop requirements.

8.5.2 Alarm and saturation levels

DCS or safety logic solver should be configured to handle both High alarm and Low alarm. It is also required that the transmitter is configured for High or Low alarm. Table 8-3 identifies the alarm levels available and their operation values[(1)].

Table 8-3. Alarm Levels



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

For instructions on alarm level settings, see "Analog output (HART)" on page 81.

Note
Only the High or Low Alarm Mode can be used for the Safety Function. Do not choose Freeze Current as an error will not be announced in the current loop.

Note
Alarm Limits should be set with a sufficient margin to Near Zone and Hold Off, or both. See "Near zone distance" on page 193 and "Hold off setting" on page 250 for more information.

(1) In certain cases, the transmitter does not go into the user defined alarm state. For example, in case of a short circuit, the transmitter goes into High Alarm state even if Low Alarm has been configured.

8.5.3 Amplitude threshold

For amplitude thresholds, verify that:

- the Amplitude Threshold is at least 50 % greater than the amplitude of disturbances. For example, if the amplitude of disturbance is 1000 mV, the Amplitude Threshold should be at least 1500 mV.
- the Amplitude Threshold has an amplitude of at least 100 mV
- the Amplitude Threshold is set to 20-50 % of the signal amplitude of the product surface

Amplitude Thresholds should be verified with the measured product in the tank. It is not recommended to register any false echo areas. For more information on Amplitude Thresholds, see "Echo tuning" on page 83, "ATC" on page 84, and "Analyzing the measurement signal" on page 132.

8.5.4 Write protection

A Rosemount 5400 Series transmitter can be protected from unintentional configuration changes by a password protected function. It is recommended to use write protection described in "Write protecting a transmitter" on page 152.

8.5.5 Site acceptance

After the installation and configuration, proper operation of the transmitter should be verified. A site acceptance test is therefore recommended. The proof test outlined in this section can be used for this. Note that re-verification of the transmitter operation is recommended if the configuration is changed.

8.6 Operation and maintenance

8.6.1 General

The Rosemount 5400 Series QS option must be tested at regular intervals to confirm that the overfill and empty tank protection function result in the desired system response. The required proof test intervals are dependent on the configuration of the transmitter and the process environment. It is the responsibility of the operator/owner of the system to determine the sufficient time interval and verify it is followed. See the FMEDA(1) report for additional details or references.

If the overfill and empty tank protection function cannot be tested by a controlled filling to the response height, suitable simulation of the level must be used to make the level sensor respond.

The following proof test is recommended. If an error is found in the safety functionality, the measuring system must be switched out of service and the process held in a safe state by means of other measures. Proof test results and corrective actions taken must be documented at www.emersonprocess.com/rosemount/safety.

(1) The Rosemount 5400 Series FMEDA report is accessible at www.emersonprocess.com/rosemount/safety/PriorUse.htm.

Proof test

This test detects approximately 95 % of the possible Dangerous Undetected (DU) failures of the transmitter. Note that prior to conducting the test, the echo curve should be inspected to ensure that no disturbing echoes affecting the measurement performance are present in the tank.

Required Tools: HART host/communicator and mA meter.

1. Bypass the logic solver or take other appropriate actions to avoid false trip.
2. Disable write protection if the function is enabled.
3. Using Loop Test, enter the mA value representing a high alarm current output and verify that the analog current reaches that value using the mA meter.
   This step tests for compliance voltage problems, such as low loop power supply voltage or increased wiring resistance.
4. Using Loop Test, enter the mA value representing a low alarm current output and verify that the analog current reaches that value using the reference meter.
   This step tests for possible quiescent current related failures.
5. Perform a two-point calibration check of the transmitter by adjusting the product level in two points in the measuring range(1). Verify that the current output corresponds to the level input values using a known reference measurement.
   This step verifies that the analog output is correct in the operating range and that the Primary Variable is properly configured.
6. Enable write protection.
7. Restore the loop to full operation.
8. Remove the bypass from the safety logic solver or otherwise restore normal operation.
9. Document the test result for future reference.

For troubleshooting the transmitter, see Section 7: Service and Troubleshooting.

8.6.2 Inspection

Visual inspection

It is recommended to inspect the antenna for possible build up or clogging.

Special tools

Not required.

Product repair

The Rosemount 5400 Series is repairable by major component replacement. All failures detected by the transmitter diagnostics or by the proof test must be reported. Feedback can be submitted electronically at www.emersonprocess.com/rosemount/safety (**Contact Us**).

(1) *For best performance, use the 4-20 mA range points as calibration points.*

8.7 References

8.7.1 Specifications

The Rosemount 5400 Series must be operated in accordance with the functional and performance specifications provided in Appendix A: Reference Data.

8.7.2 Failure rate data

The FMEDA report includes failure rates and common cause Beta factor estimates. The full report is accessible at www.emersonprocess.com/rosemount/safety/PriorUse.htm.

8.7.3 Useful lifetime

The established failure rates of electrical components apply within the useful lifetime, which should be based on experience. According to IEC 61508-2, 7.4.7.4, note 3, the useful lifetime often lies within a range of 8 to 12 years for transmitters.

8.8 Spare parts

Additional spare parts are available in Appendix A: Reference Data.

8.9 Terms and definitions

FMEDA

Failure Modes, Effects and Diagnostic Analysis

HART

Highway Addressable Remote Transducer

PFD_{AVG}

Average Probability of Failure on Demand

SFF

Safe Failure Fraction

SIF

Safety Instrumented Function

SIL

Safety Integrity Level, discrete level (one out of a possible four) for specifying the safety integrity requirements of the safety functions to be allocated to the E/E/PE safety-related systems, where Safety Integrity Level 4 has the highest level of safety integrity, and Safety Integrity Level 1 has the lowest.

SIS

Safety Instrumented System – Implementation of one or more Safety Instrumented Functions. A SIS is composed of any combination of sensor(s), logic solver(s), and final element(s).

Type B device

Complex device (using microcontrollers or programmable logic)

Appendix A Reference Data

A.1 Functional specifications

A.1.1 General

Field of liquid application

Ideal for liquids and slurries in tanks, vessels, containers, reactor vessels, and underground tanks. Applications with sticky, viscous, corrosive, condensing, and crystallizing product.

- Model 5402, best choice for a broad range of applications and suitable for mounting in valves and bridles/stilling wells
- Model 5401, suitable for some extreme process conditions such as condensing vapors, product build-up, and heavy turbulence

Field of solids application

- Model 5402 with 4 inch cone antenna for a broad range of solids applications.

Measurement principle

Pulsed, free propagating radar. Low frequency (model 5401, 6 GHz) and high frequency (model 5402, 26 GHz). (see “Theory of operation” on page 7 for details)

Microwave output power

< 1 mW

Internal power consumption

< 50 mW in normal operation

Humidity

0 - 100% relative humidity, non-condensing

Start-up time

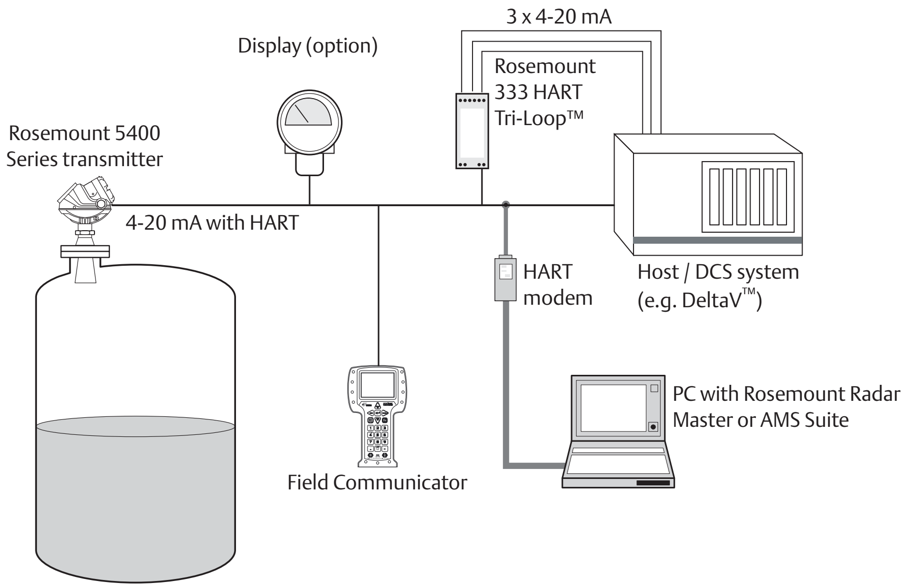
< 40 s

A.1.2 4-20 mA HART® (output option code H)

Output

Two-wire 4–20 mA, HART Revision 5. Digital process variable is superimposed on 4–20 mA signal, and available to any host that conforms to the HART protocol. The HART signal can be used in a multidrop mode.

Figure A-1. 4-20 mA HART



Signal wiring

Recommended output cabling is twisted shielded pairs, 18-12 AWG

HART Tri-Loop

By sending the digital HART signal to the optional HART Tri-Loop, it is possible to have up to three additional 4–20 mA analog signals. See the Rosemount 333 HART Tri-Loop Product Data Sheet (document number 00813-0100-4754) for additional information.

Figure A-2. Rosemount 333 HART Tri-Loop

Smart Wireless THUM™ Adapter

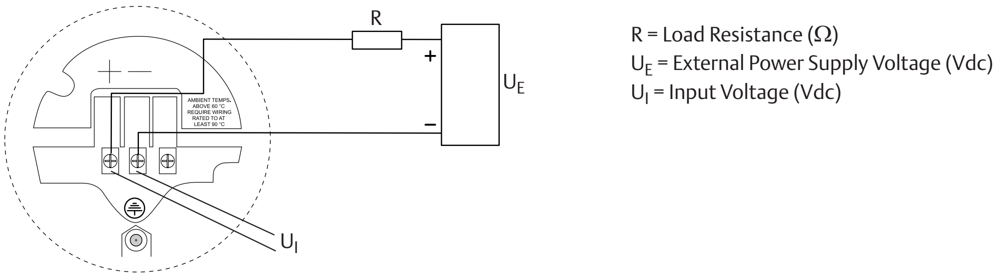
The optional Smart Wireless THUM adapter can be mounted directly on the transmitter or by using a remote mounting kit. IEC 62591 (*Wireless*HART®) enables access to multi-variable data and diagnostics, and adds wireless to almost any measurement point. See the Rosemount Smart Wireless THUM Adapter Product Data Sheet (document number 00813-0100-4075) and Smart Wireless THUM Adapter for Rosemount Process Level Transmitter Applications (document number 00840-0100-4026).

Figure A-3. Smart Wireless THUM Adapter

External power supply

The input voltage UI for HART is 16-42.4 Vdc (16-30 Vdc in IS applications, and 20-42.4 Vdc in Explosion-proof / flameproof applications).

Figure A-4. External Power Supply



IS Electrical parameters

See “Product Certifications” on page 217.

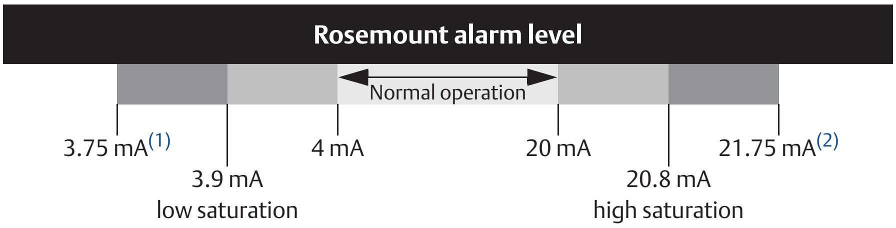
Signal on alarm (configurable)

- High = 21.75 mA (standard Rosemount setting)
- Low = 3.75 mA (option code C8)
- Namur NE43: High = 22.5 mA (option code C4)

Saturation levels

- Standard: Low=3.9 mA, High=20.8 mA
- Namur NE43: Low = 3.8 mA, High = 20.5 mA

Figure A-5. Alarm Levels



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

Load limitations

Maximum load resistance (R) is determined by the voltage level of the external power supply (U_E), as described by Figure A-6 to Figure A-8:

Figure A-6. Non-Hazardous Installations

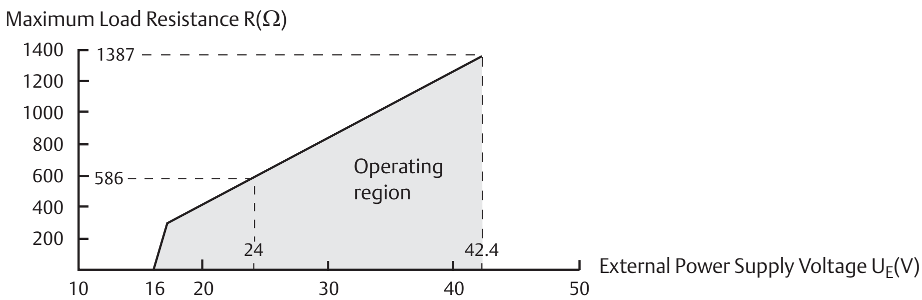


Figure A-7. Intrinsically Safe Installations

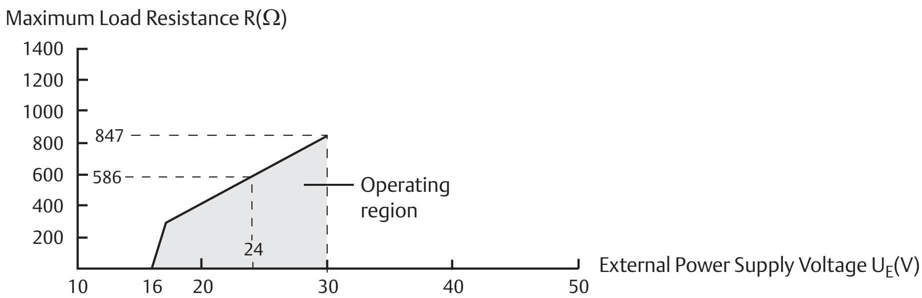
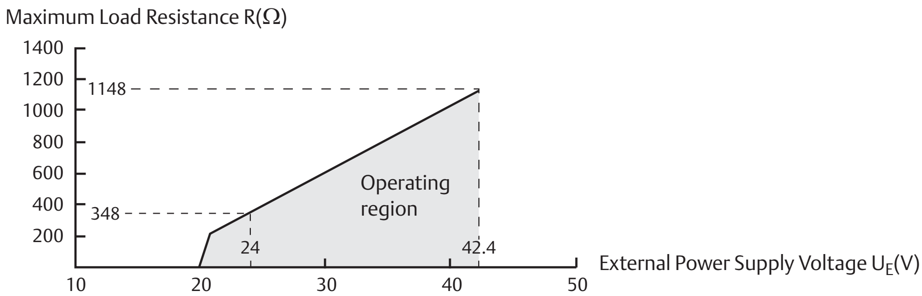


Figure A-8. Explosion-Proof/Flameproof Installations

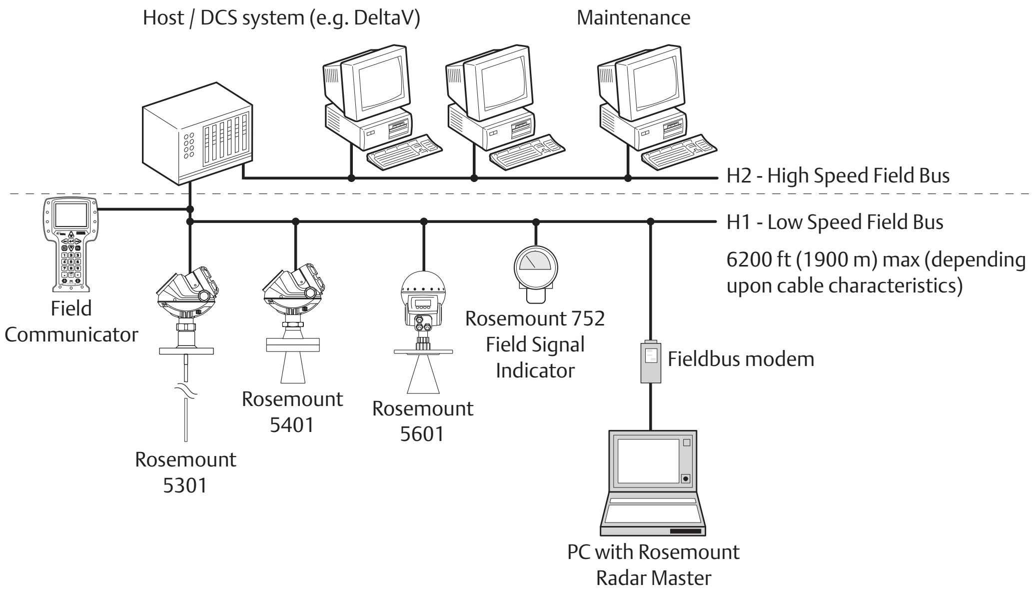


Note
The diagram is only valid if the HART load resistance is at the + side and if the - side is grounded, otherwise the load resistance value is limited to 435 Ω.

A.1.3 FOUNDATION™ fieldbus (output option code F)

Output

Figure A-9. FOUNDATION fieldbus System Architecture



Signal wiring

Recommended output cabling is twisted shielded pairs, 18-12 AWG

External power supply

The input voltage UI for FOUNDATION fieldbus is 9-32 Vdc (9-30 Vdc in IS applications, 9-17.5 Vdc in FISCO applications, and 16-32 Vdc in Explosion-proof / flameproof applications).

Quiescent current draw

21 mA

FOUNDATION fieldbus blocks

Resource block, 3 transducer blocks, 6 Analog Input (AI) blocks, Proportional /Integral/Derivate (PID) block, Input Selector (ISEL) block, Signal Characterizer (SGCR) block, Arithmetic (ARTH) block, and Output Splitter (OS) block

FOUNDATION fieldbus class (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

Conforming FOUNDATION fieldbus

ITK 4.6.1

FOUNDATION fieldbus PlantWeb® Alert Support

Yes

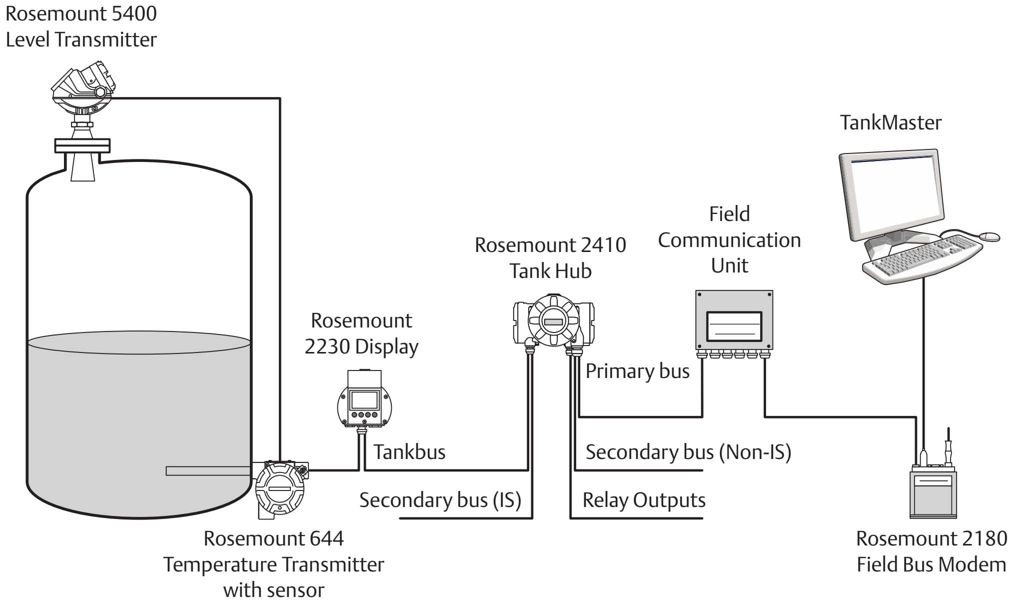
Rosemount 2410 Tank Hub connectivity (output option code U)

Output

The 5400 Level Transmitter communicates with the 2410 Tank Hub via a daisy-chain connection. The 2410 Tank Hub supports auto-configuration of the FOUNDATION fieldbus based Tankbus. The hub identifies and auto-addresses the different field devices in the network, manages communication, and supervises the status of all connected devices.

- Primary fieldbus: Rosemount 2410 communicates with a host or a field communication unit via TRL2 Modbus®, RS485 Modbus, Enraf or HART
- Secondary fieldbus: TRL2 Modbus, Enraf, IEC 62591 (*Wireless*HART)

Figure A-10. Rosemount 2410 Tank Hub Connectivity



Signal wiring

Recommended output cabling is twisted shielded pairs, 18-12 AWG (cable characteristics specified for FISCO according to IEC 60079-27).

Power supply

The 5400 Level Transmitter and other connected devices are powered by the 2410 Tank Hub.

A.1.4 RS-485 with Modbus communication (output option code M)

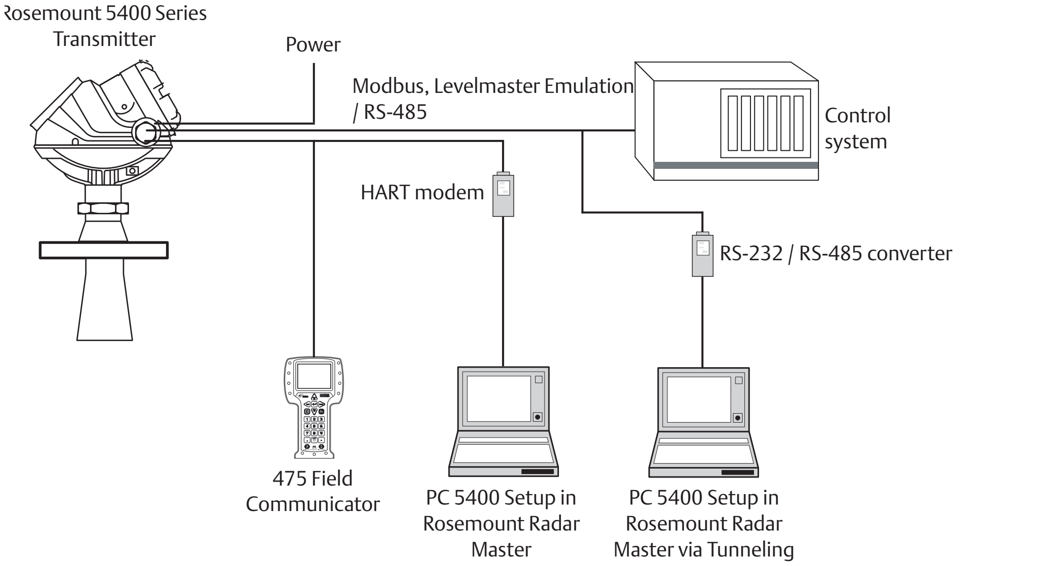
Output

The RS-485 Modbus version communicates by Modbus RTU, Modbus ASCII, and Level Master Protocols.

- Data Bits: 8 data bits, 1 start bit, 1 or 2 stop bits, and software configured parity
- Baud Rate: 1200, 2400, 4800, 9600 (default), and 19200 bits/s
- Address range: 1 to 255 (default device address is 246)

HART communication is used for configuration via HART terminals, or tunneling via the RS-485.

Figure A-11. RS-485 with Modbus Communication

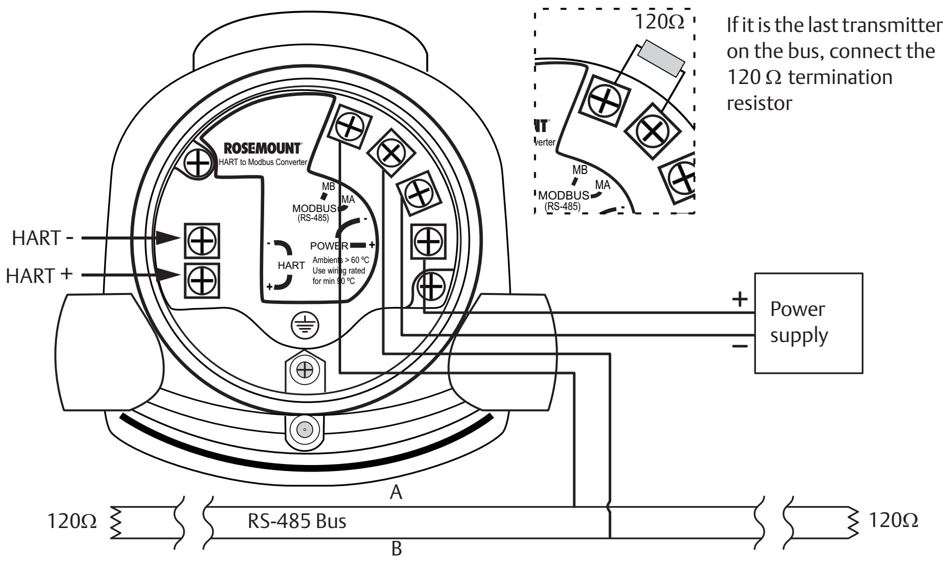


External power supply

The input voltage Ui for Modbus is 8-30 Vdc (max. rating).
Power consumption:

- < 0.5 W (with HART address = 1)
- < 1.2 W (incl. four HART slaves)

Figure A-12. Field Wiring Connections



Signal wiring

Two-wire half duplex RS-485 Modbus. Use shielded twisted pair wiring, preferably with an impedance of 120 Ω (typically 24 AWG), in order to comply with EIA-485 standard and EMC regulations.

Ground (common mode) voltage limit

± 7 V

Bus termination

Standard RS-485 bus termination per EIA-485

A.1.5 Display and configuration

Integral display (option code M1)

5-digit integral display. The process variables listed in "Output variables" on page 186 can be presented. If more than one variable is chosen, carousel toggling of data is used. The display also shows diagnostics and error information.

Remote display

Data can be read remotely by using the Rosemount 751 Field Signal Indicator (see Product Data Sheet, document number 00813-0100-4378) for 4-20 mA / HART, or Rosemount 752 Remote Indicator for FOUNDATION fieldbus (see Product Data Sheet, document number 00813-0100-4377).

Configuration tools

Emerson Field Communicator (e.g. 375/475 Field Communicator), Rosemount Radar Master (RRM) software package (included with delivery of transmitter), Emerson AMS® Device Manager or any other EDDL or enhanced-EDDL host, or DeltaV™ or any other DD (Device Description) compatible host systems. Certificates are available from all major host system vendors.

Note
DTM (compliant with version 1.2 of the FDT®/DTM™ specification) supporting configuration in for instance Yokogawa Fieldmate/PRM, E+H™ FieldCare, and PACT*ware*™.

Note
To communicate using RRM or AMS Device Manager, a HART modem is required. The HART modem is available as an RS232 or USB version (see Table A-12 on page 215).

Note
The transmitter can be pre-configured by selecting option code C1 (see page 209), and sending a complete Configuration Data Sheet (CDS). The CDS is available from www.rosemount.com.

Output units

- Level and distance: ft, in., m, cm, or mm
- Volume: ft^3, $in.^3$, US gals, Imp gals, barrels, yd^3, m^3, or liters
- Level rate: ft/s, m/s
- Temperature: °F, °C

Output variables

Level, distance, volume, level rate, signal strength, surface/noise margin, internal temperature, analog output current (not applicable for FOUNDATION fieldbus) and % of range (not applicable for FOUNDATION fieldbus)

Damping

0-60 s (2 s, default value)

A.1.6 Diagnostics

General

Invalid measurement alerts, configuration error alerts, advanced full/empty tank diagnostics, hardware/software failures, electronic temperature, online status report (advisory/warnings/errors), signal quality and signal strength monitoring

Diagnostics Suite (option code D01 or DA1)

Signal Quality Metrics - Diagnostics package that monitors the relations between surface, noise and threshold. The function can be used to detect abnormal conditions in the process such as antenna contamination or sudden loss of signal strength. Signal Quality Metrics parameters are available as Output Variables in Rosemount Radar Master, and can be sent to Distributed Control System (DCS) to trigger an alarm.

A.1.7 Temperature and pressure limits

Ambient temperature

Verify that the operating atmosphere of the transmitter is consistent with the appropriate hazardous locations certifications, see Table A-1.

Table A-1. Ambient Temperature

	Ambient temperature		
	IS/Ex ia	**XP/Ex d**	**Non-hazardous**
HART communication	-58 °F to 158 °F (-50 °C to 70 °C)	-40 °F to 158 °F (-40 °C to 70 °C)	-40 °F to 176 °F (-40 °C to 80 °C)
FOUNDATION fieldbus	-58 °F to 140 °F (-50 °C to 60 °C)	-40 °F to 140 °F (-40 °C to 60 °C)	-40 °F to 176 °F (-40 °C to 80 °C)
FISCO	-58 °F to 140 °F (-50 °C to 60 °C)	N/A	-40 °F to 176 °F (-40 °C to 80 °C)
Modbus communication	N/A	-40 °F to 158 °F (-40 °C to 70 °C)	-40 °F to 176 °F (-40 °C to 80 °C)

LCD display 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 display: -40 °F to 185 °F (-40 °C to 85 °C)

Process temperature and pressure

The final rating depends on the antenna, the tank seal, and O-rings (if applicable).
See Table A-2 on page 189.

Figure A-13. Rosemount 5402 and 5401 with SST Cone Antenna (Model Code: 2S-8S), Rosemount 5402 and 5401 with Protective Plate Cone Antenna (Model Code: 2H-8H, 2M-8M, and 2N-8N)

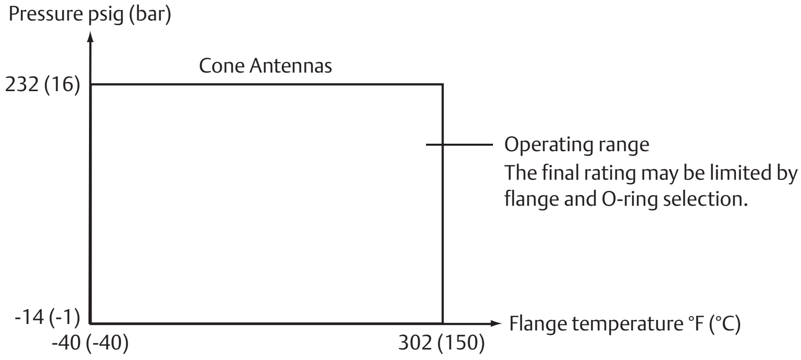


Figure A-14. Rosemount 5401 with Rod Antenna (Model Code: 1R-4R)

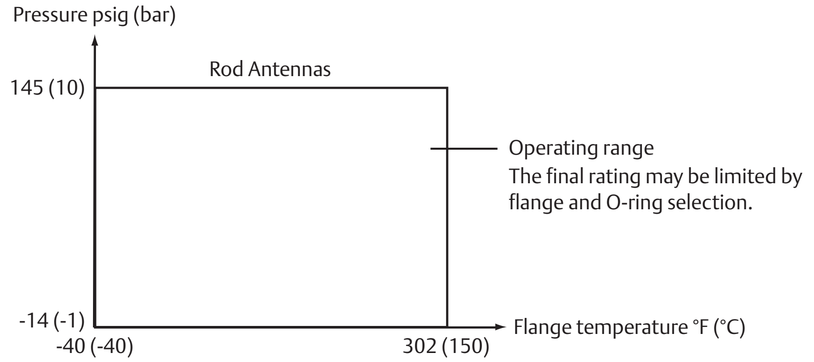
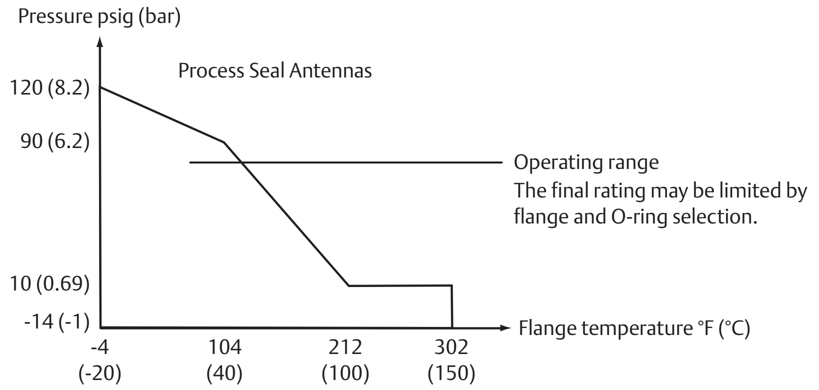


Figure A-15. Rosemount 5402 with Process Seal Antenna (Model Code: 2P-4P)



ASME/ANSI Flange rating

316L SST flanges according to ASME B16.5 Table 2-2.3

EN Flange rating

1.4404 according to EN 1092-1 material group 13E0

JIS Flange rating

316L SST according to JIS B2220 material group 2.3

Flange connection rating

See Table A-3 for the conditions used for flange strength calculations.

Table A-2. Temperature Restrictions due to O-ring Selection (Not Applicable for 1R-2R or 2P-4P Where no Process O-ring is Present)

Tank seal with different O-ring materials(1)	Min. temperature °F (°C) in air	Max. temperature °F (°C) in air
Viton® Fluoroelastomer	-4 (-20)	302 (150)
Ethylene Propylene (EPDM)	-40 (-40)	302 (150)
Kalrez® 6375 Perfluoroelastomer	5 (-15)	302 (150)
Nitrile Butadiene (NBR)	-40 (-40)	230 (110)

(1) *Always check the chemical compatibility of the O-ring material with your application.*

Table A-3. Conditions Used for Flange Strength Calculations

	Bolting material	Gasket	Flange material
ASME / ANSI	SST SA193 B8M Class 2	Soft (1a) with min. thickness 1.6 mm	SA/A182 316L
EN, JIS	EN 1515-1/-2 group 13E0, A4-70	Soft (EN 1514-1) with min. thickness 1.6 mm	EN 10222-5-1.4404

A.2 Performance specifications

A.2.1 General

Reference conditions

- Ideal metal plate with no disturbing objects.
- Temperature: + 68 °F (20 °C)
- Pressure: 14-15 psi (960-1060 mbar)
- Humidity: 25-75% RH

Instrument accuracy at reference conditions

- 5402: ± 0.1 in. (± 3 mm)
- 5401: ± 0.4 in. (± 10 mm

Repeatability

± 0.04 in. (± 1 mm) at 16.4 ft (5 m) distance

Resolution

0.04 in. (1 mm)

Ambient temperature effect

0.05%/10 K in temperature range -40 °F to 176 °F (-40 °C to 80 °C)

Update interval

1 second

A.2.2 Measuring range

Measuring range and minimum dielectric constant

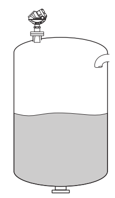
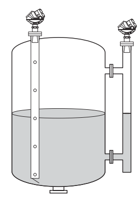
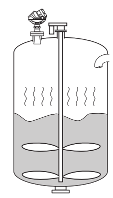
Maximum measuring range from flange: 115 ft (35 m)

The measuring range depends on:

- Microwave frequency
- Antenna size
- The dielectric constant (ε_r) of the liquid (min. ε_r=1.4)
- Process conditions

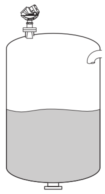
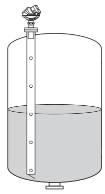
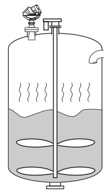
See Table A-4 and Table A-5 for measuring range and minimum dielectric constant. Due to the measuring range depending on the application and factors described below, the values are a guideline for clean liquids. For more information, ask your local Emerson Process Management representative.

Table A-4. Rosemount 5402, Maximum Recommended Measuring Range, ft (m)

									
High frequency antennas	**Dielectric constant**[(1)]								
	A	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**
2-in. Cone / Process Seal	33 (10)	49 (15)	66 (20)	82 (25)	115 (35)	115 (35)	9.8 (3)	20 (6)	33 (10)
3-in. Cone / Process Seal	49 (15)	66 (20)	98 (30)	82 (25)	115 (35)	115 (35)	13 (4)	30 (9)	39 (12)
4-in. Cone / Process Seal	66 (20)	82 (25)	115 (35)	82 (25)	115 (35)	115 (35)	23 (7)	39 (12)	49 (15)

(1) A. Oil, gasoline or other hydrocarbons, and petrochemicals (ε_r=1.9-4.0)
In pipes or with ideal surface conditions, for some liquefied gases (ε_r=1.4-4.0)
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)

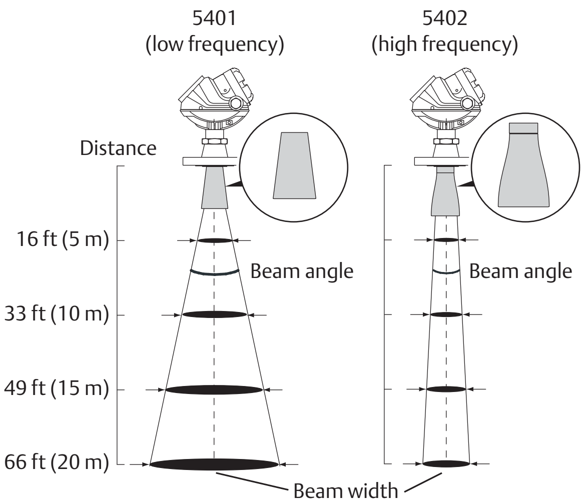
Table A-5. Rosemount 5401, Maximum Recommended Measuring Range, ft (m)

									
Low frequency antennas	**Dielectric constant(1)**								
	A	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**
3-in. Cone(2)	N/A	N/A	N/A	82 (25)	115 (35)	115 (35)	N/A	N/A	N/A
4-in. cone / rod(3)	23 (7)	39 (12)	49 (15)	82 (25)	115 (35)	115 (35)	13 (4)	26 (8)	39 (12)
6-in. Cone	43 (13)	66 (20)	82 (25)	82 (25)	115 (35)	115 (35)	20 (6)	33 (10)	46 (14)
8-in. Cone	66 (20)	82 (25)	115 (35)	82 (25)	115 (35)	115 (35)	26 (8)	39 (12)	52 (16)

(1) A. Oil, gasoline or other hydrocarbons, and petrochemicals (ε_r=1.9-4.0)
In pipes or with ideal surface conditions, for some liquefied gases (ε_r=1.4-4.0)
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)
(2) Pipe installations only. N/A=not applicable.
(3) Pipe installations are not allowed with rod antennas.

A.2.3 Beam angle and beam width

Figure A-16. Beam Angle and Beam Width



For a comparison between the beam angle and beam width for the Rosemount 5401 (~6 GHz) and 5402 (~26 GHz) transmitters with antennas of the same size and type, see Table A-6, Table A-7, and Table A-8.

Table A-6. Beam Angle for the Rosemount 5400 Series

Antenna size	Beam angle 5402	Beam angle 5401
2-in. Cone / Process Seal(1)	19°	N/A
3-in. Cone / Process Seal(1)	14°	(pipe only)
4-in. Cone / Process Seal(1), Rod(2)	9°	37°
6-in. Cone	N/A	23°
8-in. Cone	N/A	17°

(1) *Only with Rosemount 5402.*
(2) *Only with Rosemount 5401.*

Table A-7. Beam Width at Different Distances from Flange for 5402

Distance	Antenna		
	2-in. Cone/Process seal	3-in. Cone/Process seal	4-in. Cone/Process seal
16 ft (5 m)	4.9 ft (1.5 m)	3.3 ft (1.0 m)	3.3 ft (1.0 m)
33 ft (10 m)	9.8 ft (3.0 m)	6.6 ft (2.0 m)	4.9 ft (1.5 m)
49 ft (15 m)	14.8 ft (4.5 m)	9.8 ft (3.0 m)	8.2 ft (2.5 m)
66 ft (20 m)	19.7 ft (6.0 m)	13.1 ft (4.0 m)	9.8 ft (3.0 m)

Table A-8. Beam Width at Different Distances from Flange for 5401

Distance	Antenna		
	4-in. Cone/Rod	6-in. Cone	8-in. Cone
16 ft (5 m)	11.5 ft (3.5 m)	6.6 ft (2.0 m)	4.9 ft (1.5 m)
33 ft (10 m)	23.0 ft (7.0 m)	13.1 ft (4.0 m)	9.8 ft (3.0 m)
49 ft (15 m)	32.8 ft (10 m)	19.7 ft (6.0 m)	14.8 ft (4.5 m)
66 ft (20 m)	42.7 ft (13 m)	26.2 ft (8.0 m)	19.7 ft (6.0 m)

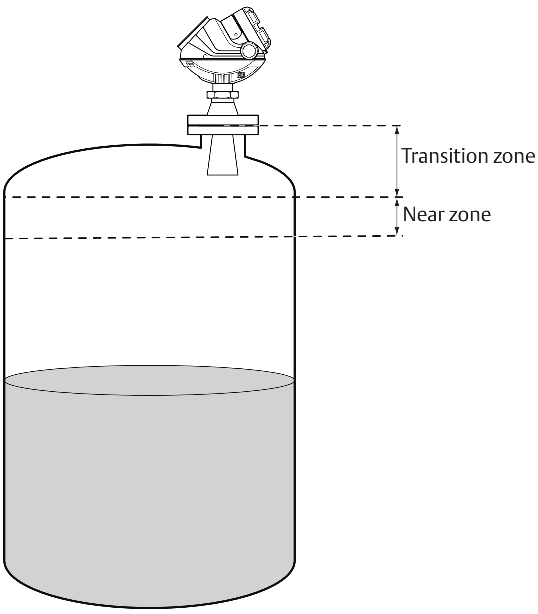
Max level rate

1.6 in./s (40 mm/s) as default, adjustable to 7.1 in./s (180 mm/s)

A.2.4 Transition zone and near zone

Transition zones are areas where measurements are not recommended. Near zones are areas where the accuracy is reduced.

Figure A-17. Transition Zone and Near Zone



Transition zone

6 in. (150 mm) from lower end of the antenna

Near zone distance

1.3 ft (0.4 m) from lower end of the antenna

Near zone accuracy

- 5402: ± 0.6 in. (± 15 mm)
- 5401: ± 1.2 in. (± 30 mm)

A.2.5 Environment

Vibration resistance[1]

- Aluminum housing: IEC 60770-1 Level 1
- SST housing: IACS E10

Electromagnetic compatibility[1]

Emission and immunity: EMC directive 204/108/EC. EN 61326-1:2006[2].
NAMUR recommendations NE21[2].

Transient / built-in lightning protection

- IEC 61000-4-5:2001
- T1 option: C62.41.2-2002 (IEEE), C37.90.1 (IEEE)

Pressure Equipment Directive (PED)

Complies with 97/23/EC article 3.3

Radio approvals[3][4]

FCC part 15C (1998)[5], R&TTE (EU directive 99/5/EC), and IC (RSS210-5)

(1) *The device may also comply with other standards. Consult your local Emerson Process Management representative.*
(2) *Additional deviations at strong electromagnetic fields (NAMUR NE21) at specific frequencies are less than ± 1.6 in. (40 mm).*
(3) *Only a limited selection is presented. Contact your local Emerson Process Management representative for more information.*
(4) *For Japan: "Install device on tanks or pipes made of metal".*
(5) *For 5402: "This device is authorized for use in tank-mounted applications, including metal tanks as well as concrete, plastic, glass, and other non-conductive tanks." No specific restrictions are stated for the 5401.*

A.3 Physical specifications

A.3.1 Material selection

Emerson provides a variety of Rosemount product with various product options and configurations including materials of construction that can be expected to perform well in a wide range of applications. The Rosemount product information presented is intended as a guide for the purchaser to make an appropriate selection for the application. It is the purchaser's sole responsibility to make a careful analysis of all process parameters (such as all chemical components, temperature, pressure, flow rate, abrasives, contaminants, etc.), when specifying product, materials, options and components for the particular application. Emerson Process Management is not in a position to evaluate or guarantee the compatibility of the process fluid or other process parameters with the product, options, configuration or materials of construction selected.

A.3.2 Housing and closure

Product

Rosemount 5400 Series, Non-Contacting Radar

Type

Dual compartment (terminal compartment and the electronics are completely separated). Two entries for conduit or cable connections. The transmitter housing can be rotated in any direction.

Electrical connection

½ - 14 NPT for cable glands or conduit entries. Optional: M20 x 1.5 conduit / cable adapter, M12 4-pin male eurofast® connector or A size Mini 4-pin male minifast® connector. Recommended output cabling is twisted shielded pairs, 18-12 AWG.

Housing material

Polyurethane-covered Aluminum, or Stainless Steel Grade CF8M (ASTM A743)

Ingress protection

Type 4X, IP66, IP67

Factory sealed

Yes

Weight

- Aluminum transmitter head: 4.4 lb (2 kg)
- Stainless steel transmitter head: 10.8 lb (4.9 kg)

A.3.3 Engineered solutions

When standard model codes are not sufficient to fulfill requirements, please consult the factory to explore possible Engineered Solutions. This is typically, but not exclusively, related to the choice of wetted materials or the design of a process connection. These Engineered Solutions are part of the expanded offerings and may be subject to additional delivery lead time. For ordering, factory will supply a special R-labeled numeric option code that should be added at the end of the standard model string. See example model string below.

Example Model String: 5402-A-H-1-E5-45-PV-CA-M1C1-**R1234**

A.3.4 Tank connection and antennas

Tank connection

The tank connection consists of a tank seal, a flange, Tri-Clamp™, or NPT thread.

Certain models of tank connections have a tank connection design with a protective plate of the same material as the antenna. This is to prevent the 316L / EN1.4404 stainless steel flange from being exposed to the tank atmosphere. See "Dimensional drawings and mechanical properties" on page 200.

Flange dimensions

Follows ASME B16.5, JIS B2220, and EN 1092-1 standards. For more information, see "Standard flanges" on page 205.

Antennas

Cone, Process Seal, and Rod Antenna. Cone antennas can be ordered in different materials. Extended cone antennas are available in SST 316L.

5402 Cone Antenna

- Suitable for stilling-well/bridle installation
- Can be recessed in smooth nozzles
- Cone extensions are available
- Suitable for solids applications (only 4 inch cone antenna)

5402 Process Seal Antenna

- Ideal for small tanks and corrosive applications
- Suitable for applications with heavy condensation/build-up

5401 Cone Antenna

- Suitable for applications with heavy condensation/build-up
- Cone extensions are available

5401 Rod Antenna

- Suitable for small process connections and corrosive environments
- Two versions: all PFA and PFA+SST

Antenna dimensions

- Cone antenna: See "Rosemount 5402 and 5401 with SST Cone Antenna (Model Code: 2S-8S)" on page 200 and "Rosemount 5402 and 5401 with Protective Plate Cone Antenna (Model Code: 2H-8H, 2M-8M, and 2N-8N)" on page 201.
- Rod antenna: See "Rosemount 5401 with Rod Antenna (Model Code: 1R-4R)" on page 202.
- Process Seal Antenna: See "Rosemount 5402 with Process Seal Antenna (Model Code: 2P-4P)" on page 203.

Material exposed to tank atmosphere

Cone Antenna

- 316 / 316 L SST (EN 1.4404) or Alloy 400 (UNS NO4400) or Alloy C-276 (UNS N10276). Alloy 400 and Alloy C-276 antennas have a protective plate design
- PTFE fluoropolymer
- O-ring material

Rod Antenna, two versions

- All-PFA[1] fluoropolymer
- PFA[1] fluoropolymer, 316 / 316 L SST (EN 1.4404) and O-ring material

Process Seal Antenna

- PTFE fluoropolymer

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

Weight

Antennas

- Cone Antenna (Model Code 2S-8S, 2H-8H, 2M-8M, 2N-8N): 2.2 lb (1.0 kg)
- Process Seal Antenna (Model Code 2P-4P): 4.4 lb (2.0 kg)
- Rod Antenna (Model Code 1R-4R): 2.2 lb (1.0 kg)

Process connections(1)

- ANSI Flange, 2 in. 150 lb SST (AA): 6.6 lb (3.0 kg)
- EN (DIN) Flange, DN50 PN40 SST (HB): 8.8 lb (4.0 kg)
- JIS Flange 50A 10K SST (UA): 6.6 lb (3.0 kg)
- Bracket mounting (BR): 4.4 lb (2.0 kg)
- Thread adapter (RA): 1.1 lb (0.5 kg)

Minimum clearance

No clearance distance needed.

(1) *Approximate weights for other 5400 Series process connection sizes than those in this table can be estimated: First of all, find out the weight of the SST blind flange (slip-on for Process Seal Antennas) that corresponds to the type and size shown in this table. Find out the weight for the SST blind flange that corresponds to the specific Rosemount 5400 Series flange size which is not represented in this table. The Rosemount 5400 Series flange weight can be estimated by adding the relative weight difference of these SST blind flanges.*

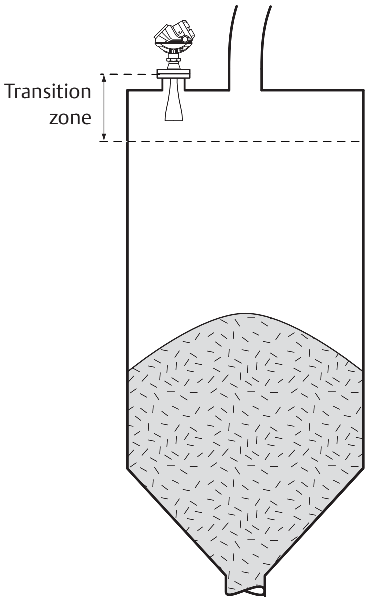
Solids applications

Rosemount 5402 Non Contacting Radar level transmitter provides industry leading measurement capabilities and reliability on solids.

Characteristics include:

- 4 inch cone antenna (4S, 4H, 4M or 4N)
- Measurement accuracy: Application dependent
- Measurement independent of dust (may need air purging[1])

Figure A-18. Transition Zone



Note
Transition zones are areas where measurements are not recommended. The transition zone for Rosemount 5402 in solids mode is 3 ft (1 m).

Table A-9. Measuring Range and Dielectric Constant[2]

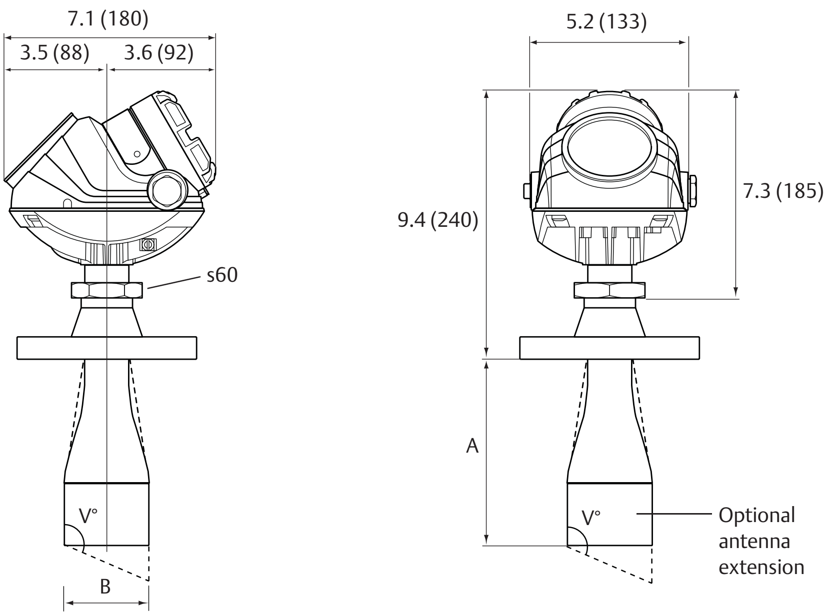
Minimum dielectric constant	Maximum measuring range	Transition zone
1.5	33 ft (10 m)	3 ft (1 m)
2.0	66 ft (20 m)	

(1) *An air purging connection can prevent clogging of the antenna in extremely dusty applications, consult factory if unclear.*
(2) *Measuring range may be reduced by steep inclining surfaces and a combination of dust and condensation. For low dielectric constants and /or long ranges consider the Rosemount 5303 guided wave radar or the Rosemount 5708 3D solids scanner.*

A.4 Dimensional drawings and mechanical properties

A.4.1 Rosemount 5402 and 5401 with SST Cone Antenna (Model Code: 2S-8S)

All dimensions are in inches (mm).



Process connection availability
● Available as standard
❍ Available as special, consult factory
– Not available

	Antenna code	
Process connection	**2S**	**3S, 4S, 6S, 8S**
2 in./DN 50/50A	●	❍
3 in./DN 80/80A	●	●
4 in./DN 100/100A	●	●
6 in./DN 150/150A	●	●
8 in./DN 200/200A	●	●
Threaded connection	-	-
Bracket mounting	●	●

5402 Standard SST Cone

Cone size (in.)	A	B	Antenna code
2	6.5 (165)	2.0 (50)	2S
3	5.9 (150)	2.6 (67)	3S
4	8.8 (225)	3.6 (92)	4S

5402 and 5401 Extended SST Cone(1)

Max. nozzle height	A	Option code
20 (500)	20.4 (518)	S3

(1) *The extended cone antennas are available in 5-inch step increments from 10 to 50 inches. Consult your local Emerson Process Management representative for more information. Expect long lead times for other sizes than the 20 in. (500 mm) version.*

5401 Standard SST Cone

Cone size (in.)	A	B	Antenna code
3	3.3 (84)	2.6 (67)	3S
4	5.9 (150)	3.6 (92)	4S
6	7.3 (185)	5.5 (140)	6S
8	10.6 (270)	7.4 (188)	8S

5402 Extended SST Cone

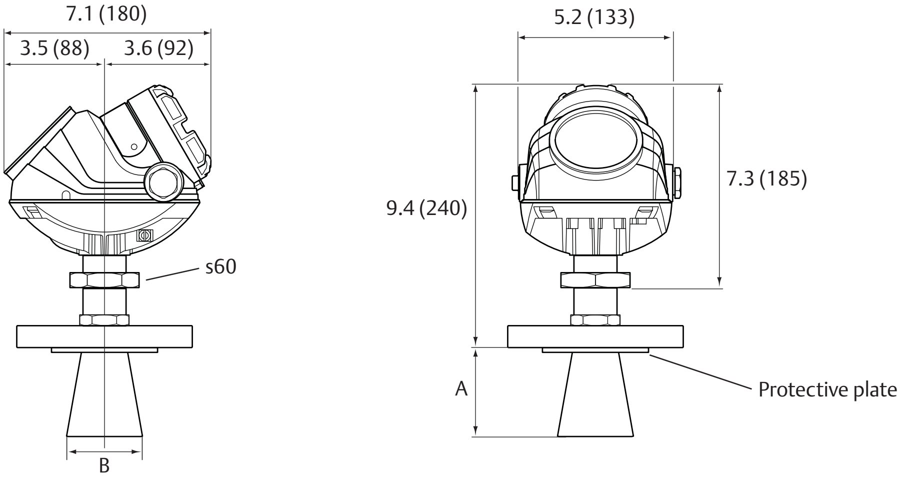
Cone size (inches)	V°
2	90°
3	90°
4	90°

5401 Extended SST Cone

Cone size (inches)	V°
3	90°
4	135°
6	135°
8	90°

A.4.2 Rosemount 5402 and 5401 with Protective Plate Cone Antenna (Model Code: 2H-8H, 2M-8M, and 2N-8N)

All dimensions are in inches (mm).



5402 Cone Antenna with Protective Plate

Cone size (in.)	A	B	Antenna code
2	5.9 (150)	2.0 (50)	2H, 2M, 2N
3	6.9 (175)	2.6 (67)	3H, 3M, 3N
4	9.8 (250)	3.6 (92)	4H, 4M, 4N

5401 Cone Antenna with Protective Plate

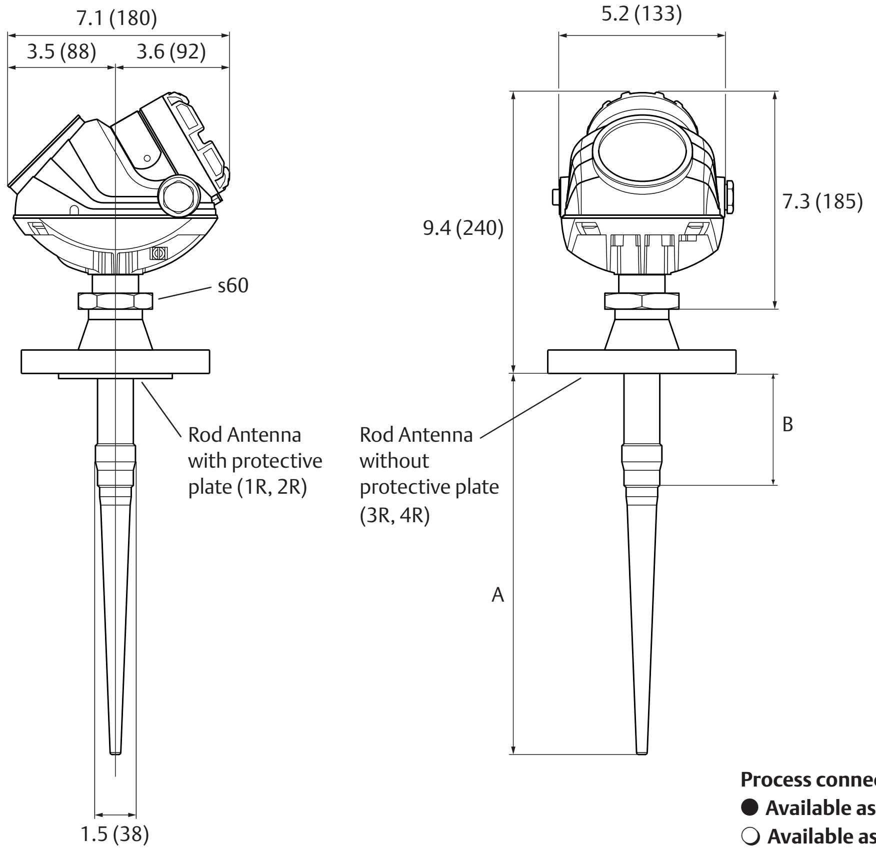
Cone size (in.)	A	B	Antenna code
3	3.3 (84)	2.6 (67)	3H, 3M, 3N
4	5.9 (150)	3.6 (92)	4H, 4M, 4N
6	7.3 (185)	5.5 (140)	6H, 6M, 6N
8	10.6 (270)	7.4 (188)	8H, 8M, 8N

Process connection availability
● Available as standard
❍ Available as special, consult factory
– Not available

	Antenna code				
Process connection	**2H, 2M, 2N**	**3H, 3M, 3N**	**4H, 4M, 4N**	**6H, 6M, 6N**	**8H, 8M, 8N**
2 in. / DN 50 / 50A	●	❍	❍	❍	❍
3 in. / DN 80 / 80A	❍	●	❍	❍	❍
4 in. / DN 100 / 100A	❍	❍	●	❍	❍
6 in. / DN 150 / 150A	❍	❍	❍	●	❍
8 in. / DN 200 / 200A	❍	❍	❍	❍	●
Threaded connection	-	-	-	-	-
Bracket Mounting	-	-	-	-	-

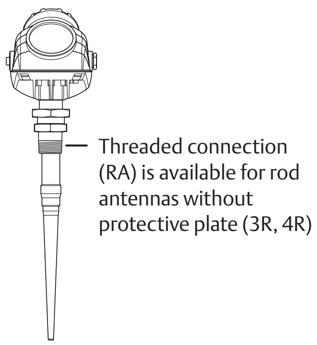
A.4.3 Rosemount 5401 with Rod Antenna (Model Code: 1R-4R)

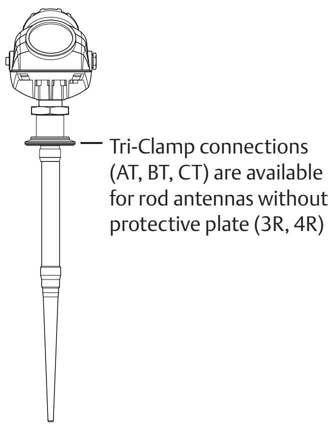
All dimensions are in inches (mm).



Rod	A	B(1)	Antenna code
Short	14.4 (365)	4 (100)	1R, 3R
Long	20.3 (515)	10 (250)	2R, 4R

(1) The active part of the antenna must protrude into the tank. B is the maximum nozzle height.



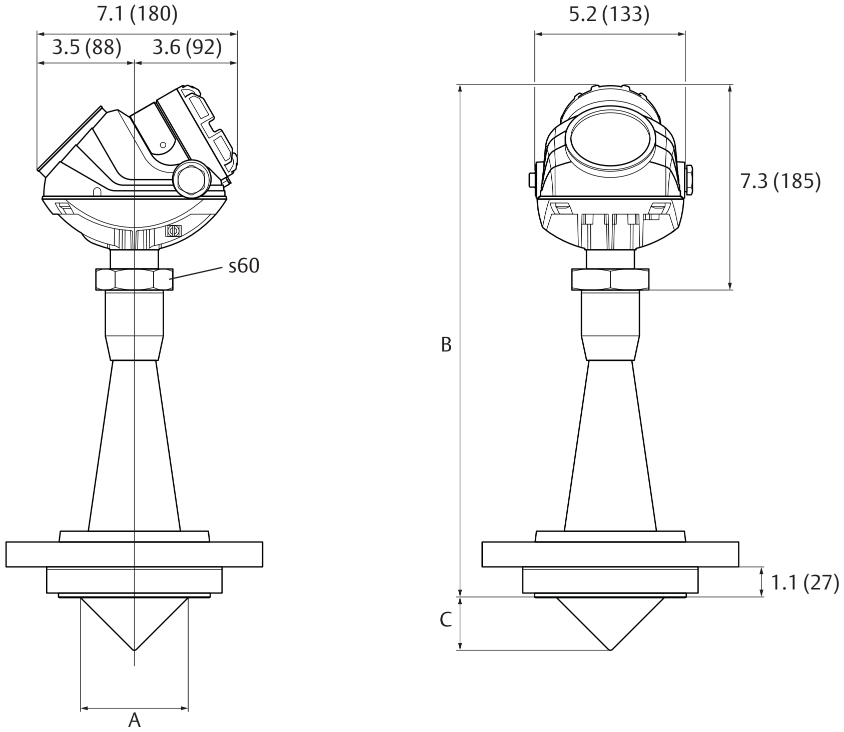


Process connection availability
● Available as standard
❍ Available as special, consult factory
– Not available

Process connection	Antenna code	
	1R, 2R	**3R, 4R**
2 in. / DN 50 / 50A	●	●
3 in. / DN 80 / 80A	●	●
4 in. / DN 100 / 100A	●	●
6 in. / DN 150 / 150A	❍	●
8 in. / DN 200 / 200A	❍	●
2 in. Tri-Clamp	❍	●
3 in. Tri-Clamp	❍	●
4 in. Tri-Clamp	❍	●
Threaded connection	-	●
Bracket mounting	-	●

A.4.4 Rosemount 5402 with Process Seal Antenna (Model Code: 2P-4P)

All dimensions are in inches (mm).



Process seal size (in.)	A	B	C	Antenna code
2	1.8 (46)	14.2 (360)	0.9 (22)	2P
3	2.8 (72)	17.3 (440)	1.4 (35)	3P
4	3.8 (97)	18.9 (480)	1.9 (48)	4P

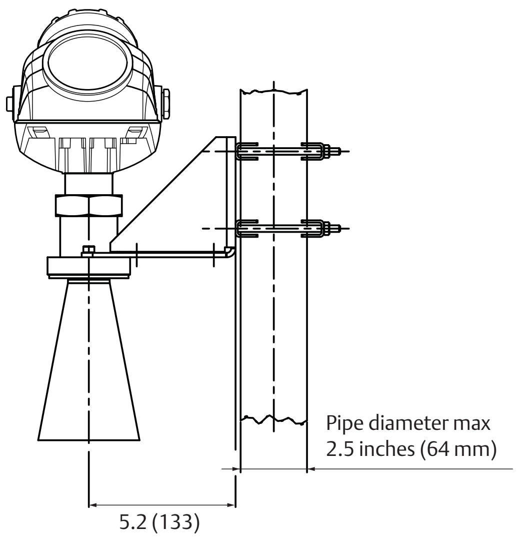
Process connection availability
● Available as standard
❍ Available as special, consult factory
– Not available

	Antenna code		
Process connection	**2P**	**3P**	**4P**
2 in. / DN 50 / 50A	●	-	-
3 in. / DN 80 / 80A	-	●	-
4 in. / DN 100 / 100A	-	-	●
6 in. / DN 150 / 150A	-	-	-
8 in. / DN 200 / 200A	-	-	-
Threaded connection	-	-	-
Bracket mounting	-	-	-

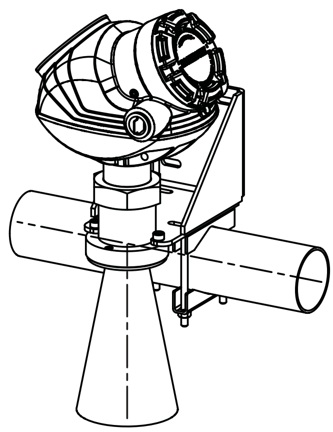
A.4.5 Bracket mounting (Model Code: BR)

Bracket mounting is available for the Rosemount 5401 and 5402 with SST Cone Antenna (2S-8S) and Rosemount 5401 with Rod Antenna (3R-4R).

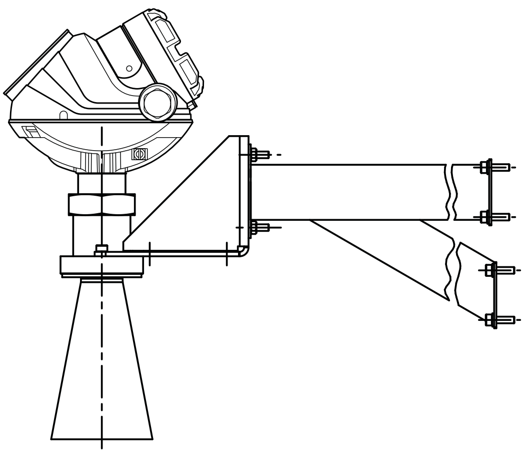
All dimensions are in inches (mm).



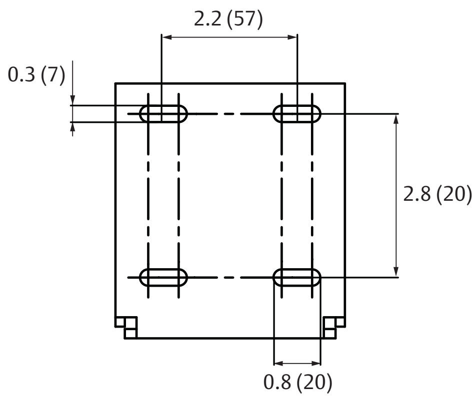
Pipe mounting
(vertical pipe)



Pipe mounting
(horizontal pipe)



Wall mounting

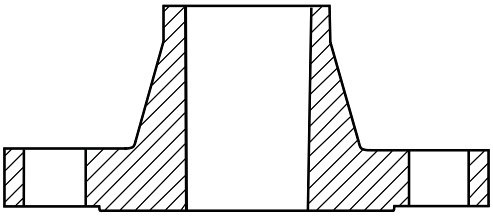


Hole pattern wall mounting

A.4.6 Process connections

Standard flanges

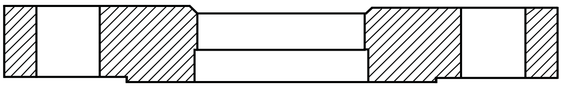
Figure A-19. Cone and Rod Antennas (Model Code: 2S-8S and 1R-4R)



Designation	Mating standard	Face style(1)	Face surface finish	Material
ANSI	ASME B16.5	0.06 in. raised face	R_a = 125-250ì in	316 / 316L
EN (DIN)	EN 1092-1	2 mm raised face (Type B1)	R_a = 3.2-12.5ì m	EN 1.4404
JIS	JIS B2220	2 mm raised face	R_a = 3.2-6.3ì m	EN 1.4404

(1) Face gasket surface is serrated per mating standard.

Figure A-20. Cone Antennas with Protective Plate (Model Code: 2H-8H, 2M-8M, and 2N-8N)



Designation	Mating standard	Face style(1)	Face surface finish	Material
ANSI	ASME B16.5	0.06 in. raised face	R_a = 125-250ì in	316 / 316L
EN (DIN)	EN 1092-1	Flat face (Type A)	R_a = 3.2-12.5ì m	EN 1.4404
JIS	JIS B2220	2 mm raised face	R_a = 3.2-6.3ì m	EN 1.4404

(1) Face gasket surface is serrated per mating standard.

Figure A-21. Process Seal Antennas

Designation	Standard	Style	Material
ANSI	ASME B16.5	Slip-on	316 / 316L
EN (DIN)	EN 1092-1	Slip-on (Type 01)	EN 1.4404
JIS	JIS B2220	Slip-on plate (SOP)	EN 1.4404

A.5 Ordering information

Specification and selection of product materials, options, or components must be made by the purchaser of the equipment. See page 195 for more information on Material Selection.

Table A-10. 5402 High Frequency Radar Level Transmitter Ordering Information

The starred options (★) represent the most common options and should be selected for best delivery. The non-starred offerings are subject to additional delivery lead time.

Model	Product description	
5402	High frequency version (~26 GHz)	★
Housing material		
A	Polyurethane-covered Aluminum	★
S	Stainless Steel (SST), Grade CF8M (ASTM A743)	
Signal output		
H	4-20 mA with HART communication (HART Revision 5, see page 178 for details)	★
F	FOUNDATION fieldbus (see page 181 for details)	★
M	RS-485 with Modbus communication (see page 183 for details)	★
U	Rosemount 2410 tank hub connectivity (consult factory for details)	
Conduit/cable threads		
1	½ in. - 14 NPT	★
2	M20 x 1.5 adapter	★
E(1)	M12, 4-pin, male connector (eurofast®)	★
M(1)	A size Mini, 4-pin, male connector (minifast®)	★
4	2 pcs M20 x 1.5 adapters (consult factory for details)	
G(2)(3)	2 pcs metal cable glands (½-14 NPT), (consult factory for details)	
Product certifications		
NA	No product certificates	★
E1(1)	ATEX Flameproof	★
I1	ATEX Intrinsic safety	★
IA(4)	ATEX FISCO Intrinsic safety	★
E5(1)	FM Explosion-proof	★
I5	FM Intrinsic safety and non-incendive	★
IE(4)	FM FISCO Intrinsic safety	★
E6(1)	CSA Explosion-proof	★
I6	CSA Intrinsic safety	★
IF(4)	CSA FISCO Intrinsic safety	★
E7(1)	IECEx Flameproof	★
I7	IECEx Intrinsic safety	★

Table A-10. 5402 High Frequency Radar Level Transmitter Ordering Information

The starred options (★) represent the most common options and should be selected for best delivery. The non-starred offerings are subject to additional delivery lead time.

IG(4)	IECEx FISCO Intrinsic safety	★
E2	INMETRO Flameproof	
EM	Technical Regulations Customs Union (EAC) Flameproof (consult factory for details)	
I2	INMETRO Intrinsic safety	
IB	INMETRO FISCO Intrinsic safety	
E3(1)	NEPSI Flameproof	
I3	NEPSI Intrinsic safety	
IC	NEPSI FISCO Intrinsic safety	
IM	Technical Regulations Customs Union (EAC) Intrinsic Safety (consult factory for details)	
E4(5)	TIIS Flameproof	
N1(1)	ATEX Type n (consult factory for details)	
N7(1)	IECEx Type n (consult factory for details)	
Antenna - size and material (for process connection availability, reference to "Dimensional drawings and mechanical properties" on page 200)		
Cone antennas		
2S	2 in. DN 50, 316L SST (EN 1.4404)	★
3S	3 in. DN 80, 316L SST (EN 1.4404)	★
4S	4 in. DN 100, 316L SST (EN 1.4404)	★
2H	2 in. DN 50, Alloy C-276 (UNS N10276) with protective plate	
3H	3 in. DN 80, Alloy C-276 (UNS N10276) with protective plate	
4H	4 in. DN 100, Alloy C-276 (UNS N10276) with protective plate	
2M	2 in. DN 50, Alloy 400 (UNS N04400) with protective plate	
3M	3 in. DN 80, Alloy 400 (UNS N04400) with protective plate	
4M	4 in. DN 100, Alloy 400 (UNS N04400) with protective plate	
2N	2 in. DN 50, 316L SST (EN 1.4404), with protective plate. Complies with guidelines in NACE® MR0175/ISO 15156 and NACE MR0103.	
3N	3 in. DN 80, 316L SST (EN 1.4404), with protective plate. Complies with guidelines in NACE MR0175/ISO 15156 and NACE MR0103.	
4N	4 in. DN 100, 316L SST (EN 1.4404), with protective plate. Complies with guidelines in NACE MR0175/ISO 15156 and NACE MR0103.	
Process seal antennas		
2P	2 in. (DN50), PTFE (requires tank sealing code NA)	
3P	3 in. (DN80), PTFE (requires tank sealing code NA)	
4P	4 in. (DN100), PTFE (requires tank sealing code NA)	
Other antennas		
XX	Customer specific	

Table A-10. 5402 High Frequency Radar Level Transmitter Ordering Information

The starred options (★) represent the most common options and should be selected for best delivery. The non-starred offerings are subject to additional delivery lead time.

Tank sealing, o-ring material		
PV	Viton Fluoroelastomer	★
PK	Kalrez 6375 Perfluoroelastomer	★
PE	Ethylene Propylene (EPDM)	★
PB	Nitrile Butadiene (NBR)	★
NA	None(6)	★
Process connection and material (for antenna availability, reference to "Dimensional drawings and mechanical properties" on page 200)		
ASME/ANSI flanges (316/316L SST)(7)		
AA	2 inch, 150 lb	★
AB	2 inch, 300 lb	★
BA	3 inch, 150 lb	★
BB	3 inch, 300 lb	★
CA	4 inch, 150 lb	★
CB	4 inch, 300 lb	★
DA	6 inch, 150 lb	★
EA	8 inch, 150 lb	★
EN (DIN) flanges (EN 1.4404 SST)(7)		
HB	DN 50 PN 40	★
IB	DN 80 PN 40	★
JA	DN 100 PN 16	★
JB	DN 100 PN 40	★
KA	DN 150 PN 16	★
LA	DN 200 PN 16	★
JIS flanges (EN 1.4404 SST)(7)		
UA	50A 10K	★
VA	80A 10K	★
XA	100A 10K	★
YA	150A 10K	★
ZA	200A 10K	★
Other		
BR(8)	Bracket mounting, 316L / EN 1.4404 SST	
XX	Customer specific	
Options		
M1	Integral digital display	★

Table A-10. 5402 High Frequency Radar Level Transmitter Ordering Information

The starred options (★) represent the most common options and should be selected for best delivery. The non-starred offerings are subject to additional delivery lead time.

GC	Transparent meter glass protection cover made of PTFE / FEP	★
T1	Transient protection terminal block (standard with FISCO options)	★
Factory configuration		
C1	Factory configuration (Configuration Data Sheet required with order, available at www.rosemount.com)	★
Alarm limit configuration		
C4	NAMUR alarm and saturation levels, high alarm	★
C8(9)	Low alarm (standard Rosemount alarm and saturation levels)	★
Overfill		
U1(10)	WHG Overfill approval	★
Special certifications		
Q4	Calibration Data Certificate	★
Q8(11)	Material Traceability Certification per EN 10204 3.1	★
N2(12)	Certificate of compliance with guidelines in NACE MR0175/ISO 15156 and NACE MR0103	
QG	GOST Primary Verification Certificate	
Safety certifications		
QS(10)	Prior use certificate of FMEDA data	
Shipboard approvals(13)		
SBS	American Bureau of Shipping Type Approval (consult factory for details)	
SDN	Det Norske Veritas (DNV) Type Approval (consult factory for details)	
SLL	Lloyd's Register Type Approval (consult factory for details)	
SBV	Bureau Veritas Type Approval (consult factory for details)	
SRS	Russian Maritime Register of Shipping Type Approval (consult factory for details)	
SGL	Germanischer Lloyd Type Approval (consult factory for details)	
Special procedures		
P1(8)	Hydrostatic testing	★
Antenna extension		
S3(14)	Cone Antenna extension in 316 / 316L / EN 1.4404 SST. To be used if there are irregularities in the nozzle. Fits nozzles up to 20 in. (500 mm).	
Diagnostics functionality (see page 186 for more information)		
D01	FOUNDATION fieldbus Diagnostics Suite (includes Signal Quality Metrics diagnostics) (consult factory for details)	
DA1	HART Diagnostics Suite (includes Signal Quality Metrics diagnostics) (consult factory for details)	

Table A-10. 5402 High Frequency Radar Level Transmitter Ordering Information

The starred options (★) represent the most common options and should be selected for best delivery. The non-starred offerings are subject to additional delivery lead time.

Solids applications		
SM1	Solids Measurement mode **(see page 199)**	★
Engineered solutions (see page 196)		
Rxxxx	Engineered Solutions beyond standard model codes (consult factory for details)	
Typical model number: 5402 A H 1 E5 4S PV CA - M1 C1		

(1) Options E (eurofast) and M (minifast) are not available with explosion-proof, flameproof, or type n approvals.
(2) Min temperature -20 °C (-4 °F).
(3) Not available with explosion-proof, flameproof, or type n approvals.
(4) Requires FOUNDATION fieldbus signal output (Ui parameter listed in "Product Certifications" on page 217).
(5) G ½ in. SST cable gland is included in delivery.
(6) Requires Process Seal Antenna (2P-4P). O-rings are not wetted.
(7) See "Process connections" on page 205 for Face style.
(8) Bracket mounting (BR) is not available with hydrostatic testing (P1).
(9) The standard alarm setting is high.
(10) Only available with 4-20 mA HART signal output.
(11) Certificate includes all pressure retaining wetted parts.
(12) Requires Protective Plate Cone Antennas (2H-4H, 2M-4M, 2N-4N) or Process Seal Antennas (2P-4P).
(13) Only for stainless steel housing material (code S). Not available with Modbus signal output (code M). Contact an Emerson Process Management representative for additional information.
(14) Requires a SST Cone Antenna (2S-4S).

Table A-11. 5401 Low Frequency Radar Level Transmitter Ordering Information

The starred options (★) represent the most common options and should be selected for best delivery. The non-starred offerings are subject to additional delivery lead time.

Model	Product description	
5401	Low frequency version (~6 GHz)	★
Housing material		
A	Polyurethane-covered Aluminum	★
S	Stainless Steel (SST), Grade CF8M (ASTM A743)	
Signal output		
H	4-20 mA with HART communication (HART Revision 5, see page 178 for details)	★
F	FOUNDATION fieldbus (see page 181 for details)	★
M	RS-485 with Modbus communication (see page 183 for details)	★
U	Rosemount 2410 tank hub connectivity (consult factory for details)	
Conduit/cable threads		
1	½ in. - 14 NPT	★
2	M20 x 1.5 adapter	★
E(1)	M12, 4-pin, male connector (eurofast)	
M(1)	A size Mini, 4-pin, male connector (minifast)	
Product certifications		
NA	No product certificates	★
E1(1)	ATEX Flameproof	★
I1	ATEX Intrinsic safety	★
IA(2)	ATEX FISCO Intrinsic safety	★
E5(1)	FM Explosion-proof	★
I5	FM Intrinsic safety and non-incendive	★
IE(2)	FM FISCO Intrinsic safety	★
E6(1)	CSA Explosion-proof	★
I6	CSA Intrinsic safety	★
IF(2)	CSA FISCO Intrinsic safety	★
E7(1)	IECEx Flameproof	★
I7	IECEx Intrinsic safety	★
IG(2)	IECEx FISCO Intrinsic safety	★
E2	INMETRO Flameproof	
I2	INMETRO Intrinsic safety	
IB	INMETRO FISCO Intrinsic safety	
E3(1)	NEPSI Flameproof	

Table A-11. 5401 Low Frequency Radar Level Transmitter Ordering Information

The starred options (★) represent the most common options and should be selected for best delivery. The non-starred offerings are subject to additional delivery lead time.

EM	Technical Regulations Customs Union (EAC) Flameproof (consult factory for details)	
I3	NEPSI Intrinsic safety	
IC	NEPSI FISCO Intrinsic safety	
IM	Technical Regulations Customs Union (EAC) Intrinsic Safety (consult factory for details)	
E4(3)	TIIS Flameproof	
N1(1)	ATEX Type n (consult factory for details)	
N7(1)	IECEx Type n (consult factory for details)	
Antenna - size and material (for process connection availability, reference to "Dimensional drawings and mechanical properties" on page 200)		
Cone antennas		
3S	3 in. DN 80, 316L SST (EN 1.4404)	★
4S	4 in. DN 100, 316L SST (EN 1.4404)	★
6S	6 in. DN 150, 316L SST (EN 1.4404)	★
8S	8 in. DN 200, 316L SST (EN 1.4404)	★
3H	3 in. DN 80, Alloy C-276 (UNS N10276) with protective plate, pipe installations only	
4H	4 in. DN 100, Alloy C-276 (UNS N10276) with protective plate	
6H	6 in. DN 150, Alloy C-276 (UNS N10276) with protective plate	
8H	8 in. DN 200, Alloy C-276 (UNS N10276) with protective plate	
3M	3 in. DN 80, Alloy 400 (UNS N04400) with protective plate, pipe installations only	
4M	4 in. DN 100, Alloy 400 (UNS N04400) with protective plate	
6M	6 in. DN 150, Alloy 400 (UNS N04400) with protective plate	
8M	8 in. DN 200, Alloy 400 (UNS N04400) with protective plate	
3N	3 in. DN 80, 316L SST (EN 1.4404), with protective plate, pipe installations only. Complies with guidelines in NACE MR0175/ISO 15156 and NACE MR0103.	
4N	4 in. DN 100, 316L SST (EN 1.4404), with protective plate. Complies with guidelines in NACE MR0175/ISO 15156 and NACE MR0103.	
6N	6 in. DN 150, 316L SST (EN 1.4404), with protective plate. Complies with guidelines in NACE MR0175/ISO 15156 and NACE MR0103.	
8N	8 in. DN 200, 316L SST (EN 1.4404), with protective plate. Complies with guidelines in NACE MR0175/ISO 15156 and NACE MR0103.	
Rod antennas		
1R(4)(5)	Short version, all-PFA, with protective plate, max. nozzle height 4 in. (100 mm), free propagation only	
2R(4)(5)	Long version, all-PFA, with protective plate, max. nozzle height 10 in. (250 mm), free propagation only	
3R(4)	Short version, SST+PFA, max. nozzle height 4 in. (100 mm), free propagation only	
4R(4)	Long version, SST+PFA, max. nozzle height 10 in. (250 mm), free propagation only	
Other antennas		
XX	Customer specific	

Table A-11. 5401 Low Frequency Radar Level Transmitter Ordering Information

The starred options (★) represent the most common options and should be selected for best delivery. The non-starred offerings are subject to additional delivery lead time.

Tank sealing, o-ring material		
PV	Viton Fluoroelastomer	★
PK	Kalrez 6375 Perfluoroelastomer	★
PE	Ethylene Propylene (EPDM)	★
PB	Nitrile Butadiene (NBR)	★
PD[4]	All-PFA Rod Antennas (O-rings are not wetted)	★
Process connection and material (for antenna availability, reference to "Dimensional drawings and mechanical properties" on page 200)		
ASME/ANSI flanges (316/316L SST)[6]		
AA	2 in. 150 lb	★
AB	2 in. 300 lb	★
BA	3 in. 150 lb	★
BB	3 in. 300 lb	★
CA	4 in. 150 lb	★
CB	4 in. 300 lb	★
DA	6 in. 150 lb	★
EA	8 in. 150 lb	★
EN (DIN) flanges (EN 1.4404 SST)[6]		
HB	DN 50 PN 40	★
IB	DN 80 PN 40	★
JA	DN 100 PN 16	★
JB	DN 100 PN 40	★
KA	DN 150 PN 16	★
LA	DN 200 PN 16	★
JIS flanges (EN 1.4404 SST)[6]		
UA	50A 10K	★
VA	80A 10K	★
XA	100A 10K	★
YA	150A 10K	★
ZA	200A 10K	★
Tri-Clamp connection (316/316L)		
AT[7]	2 in. Tri-Clamp	
BT[7]	3 in. Tri-Clamp	
CT[7]	4 in. Tri-Clamp	
Threaded (316L / EN 1.4404 SST)		

Table A-11. 5401 Low Frequency Radar Level Transmitter Ordering Information

The starred options (★) represent the most common options and should be selected for best delivery. The non-starred offerings are subject to additional delivery lead time.

RA[8]	1.5-in. NPT	
Other		
BR[8]	Bracket mounting, 316L / EN 1.4404 SST	
XX	Customer specific	
Options		
M1	Integral digital display	★
T1	Transient protection terminal block (standard with FISCO options)	★
GC	Transparent meter glass protection cover made of PTFE/FEP	
Factory configuration		
C1	Factory configuration (Configuration Data Sheet required with order, available at www.rosemount.com)	★
Alarm limit configuration		
C4	NAMUR alarm and saturation levels, high alarm	★
C8[9]	Low alarm (standard Rosemount alarm and saturation levels)	★
Overfill		
U1[10]	WHG Overfill approval	★
Special certifications		
Q4	Calibration Data Certificate	★
Q8[10]	Material Traceability Certification per EN 10204 3.1	★
N2[11]	Certificate of compliance with guidelines in NACE MR0175/ISO 15156 and NACE MR0103	
QG	GOST Primary Verification Certificate	
Safety certifications		
QS[12]	Prior use certificate of FMEDA data	
Shipboard approvals[13]		
SBS	American Bureau of Shipping Type Approval (consult factory for details)	
SDN	Det Norske Veritas (DNV) Type Approval (consult factory for details)	
SLL	Lloyd's Register Type Approval (consult factory for details)	
SBV	Bureau Veritas Type Approval (consult factory for details)	
SRS	Russian Maritime Register of Shipping Type Approval (consult factory for details)	
SGL	Germanischer Lloyd Type Approval (consult factory for details)	
Special procedures		
P1[8]	Hydrostatic testing	★
Antenna extension		
S3[14]	Extended Cone Antenna in 316 / 316L / EN 1.4404 SST. Maximum recommended nozzle height is 20 in. (500 mm).	

Table A-11. 5401 Low Frequency Radar Level Transmitter Ordering Information

The starred options (★) represent the most common options and should be selected for best delivery. The non-starred offerings are subject to additional delivery lead time.

Diagnostics functionality (see page 186 for more information)		
D01	FOUNDATION fieldbus Diagnostics Suite (includes Signal Quality Metrics diagnostics) (consult factory for details)	
DA1	HART Diagnostics Suite (includes Signal Quality Metrics diagnostics) (consult factory for details)	
Engineered solutions (see page 196)		
Rxxxx	Engineered Solutions beyond standard model codes (consult factory for details)	
Typical model number: 5401 A H 1 NA 4S PV CA - M1 C1		

(1) Options E (eurofast) and M (minifast) are not available with explosion-proof, flameproof, or type n approvals.
(2) Requires FOUNDATION fieldbus signal output (Ui parameter listed in "Product Certifications" on page 217).
(3) G ½ in. SST cable gland is included in delivery.
(4) PFA is a fluoropolymer with properties similar to PTFE.
(5) All-PFA Rod Antennas (1R or 2R) require all-PFA tank seal (PD).
(6) See "Process connections" on page 205 for Face style.
(7) Only available with Rod Antenna (3R and 4R).
(8) Certain process connections are not available with hydrostatic testing (P1).
(9) The standard alarm setting is high.
(10) Certificate includes all pressure retaining wetted parts.
(11) Requires Protective Plate Cone Antennas (3H-8H, 3M-8M, 3N-8N) or Rod Antennas (1R-4R).
(12) Only available with 4-20 mA HART signal output.
(13) Only for stainless steel housing material (code S). Not available with Modbus signal output (code M). Contact an Emerson Process Management representative for additional information.
(14) Requires a SST Cone Antenna (4S-8S).

Table A-12. Accessories

The starred options (★) represent the most common options and should be selected for best delivery. The non-starred offerings are subject to additional delivery lead time.

HART modem and cables		
03300-7004-0001	MACTek Viator HART modem and cables (RS232 connection)	★
03300-7004-0002	MACTek Viator HART modem and cables (USB connection)	★

Appendix B Product Certifications

B.1 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 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 specifications.
- To prevent ignition of flammable or combustible atmospheres, disconnect power before servicing.
- Before connecting a HART®-, FOUNDATION™ fieldbus-, or Modbus®-based communicator in an explosive atmosphere, make sure the instruments in the loop are installed in accordance with intrinsically safe or non-incendive field wiring practices.
- To avoid process leaks, only use O-rings designed to seal with the corresponding flange adapter.

Electrical shock can result in death or serious injury.

- Avoid contact with the leads and terminals. High voltage that may be present on leads can cause electrical shock.
- Make sure the main power to the Rosemount 5400 Series transmitter is off and the lines to any other external power source are disconnected or not powered while wiring the transmitter.

Antennas with non-conducting surfaces.

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

⚠ WARNING

Failure to follow safe installation and service 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 services other than those contained in this manual unless you are qualified.

Any substitution of non-recognized spare parts may jeopardize safety.

Unauthorized changes to the product are strictly prohibited as they may unintentionally and unpredictably alter performance and jeopardize safety. Unauthorized changes that interfere with the integrity of the welds or flanges, such as making additional perforations, compromise product integrity and safety. Equipment ratings and certifications are no longer valid on any products that have been damaged or modified without the prior written permission of Emerson Process Management. Any continued use of product that has been damaged or modified without prior written authorization is at the customer's sole risk and expense.

B.2 European Directive information

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.

B.3 FCC and ICC

This device complies with Part 15 of the FCC Rules and with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) This device may not cause interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

⚠ CAUTION

Changes or modifications to this equipment not expressly approved by Rosemount Inc. may void the FCC authorization to operate this equipment.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

⚠ CAUTION

Les changements ou les modifications apportés à l'équipement qui n'est pas expressément approuvé par Rosemount Inc pourraient annuler l'autorité de l'utilisateur à utiliser cet équipement.

B.4 Safety Instrumented Systems (SIS)[1]

The Rosemount 5400 Series has been evaluated by a third party, the SP (Technical Research Institute of Sweden), against hardware requirements according to IEC 61508. With a FMEDA (Failure Modes, Effects and Diagnostics Analysis) report with a Safe Failure Fraction (SFF) above 80%, 5400 is suitable in SIS according to the Prior Use methodology. For more information, go to: http://www.rosemount.com/safety. To order the certificate of FMEDA data, use option code QS.

(1) *Not available for solids applications.*

B.5 Hazardous locations certifications

Other temperature restrictions may apply beside the ones mentioned in the following sections. For more information, see "Reference Data" on page 177.

B.5.1 North-American certifications

Factory Mutual (FM) approvals

The Rosemount 5400 Series Non-Contacting Radar Level Transmitter that has the following labels attached has been certified to comply with the requirements of the approval agencies noted.

Project ID: 3020497
Specific Conditions of Use:

1. WARNING – Potential Electrostatic Charging Hazard – The enclosure is constructed from a non-metallic material. To prevent the risk of electrostatic sparking the plastic surface should only be cleaned with a damp cloth.
2. WARNING – The apparatus enclosure contains aluminum and is considered to constitute a potential risk of ignition by impact or friction. Care must be taken into account during installation and use to prevent impact or friction.

E5 Explosion-proof for Class I, Div. 1, Groups B, C, and D;

Dust ignition proof for Class II/III, Div. 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.

Temp. Code T4

Ambient temperature limits: -50 °C to +70 °C(1).

Seal not required.

Approval valid for HART, FOUNDATION fieldbus, and Modbus options.

I5, IE Intrinsically Safe for Class I, II, III, Div. 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, II, Div.2, Groups A, B, C, D, E, F, and G suitable for Class II, III.

4-20 mA/HART model: U_i = 30 Vdc, I_i = 130 mA, P_i = 1.0 W, C_i = 7.26 nF, L_i = 0 µH

FOUNDATION fieldbus model: U_i = 30 Vdc, I_i = 300 mA, P_i = 1.3 W, C_i = 0 nF, L_i = 0 H

FISCO model: U_i = 17.5 Vdc, I_i = 380 mA, P_i = 5.32 W, C_i = L_i = 0

Temp. Code T4
Ambient temperature limits: -50 °C to +70 °C(1)
Approval valid for HART, FOUNDATION fieldbus, and FISCO options.

(1) *+60 °C with FOUNDATION fieldbus or FISCO option.*

B.5.2 Canadian Standards Association (CSA) Approvals

When bearing the “Dual Seal” marking, this product meets the Dual Seal Requirements of ANSI/ISA 12.27.01-2003.

Cert. No.: 1514653

E6 Explosion-proof with internal Intrinsically safe circuits [Exia] Class I, Div. 1, Groups B, C, and D;

Temp. Code T4.

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

Class III, Div. 1

Ambient temperature limits -50 °C to +70 °C(1).

Approval valid for HART, FOUNDATION fieldbus, and Modbus options.

I6, IF Intrinsically safe Exia.

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

Temp. Code T4.

4-20 mA/HART model: U_i = 30 Vdc, I_i = 130 mA, P_i = 1.0 W, C_i = 7.26 nF, L_i = 0 H.

FOUNDATION fieldbus model: U_i = 30 Vdc, I_i = 300 mA, P_i = 1.3 W, C_i = 0 nF, L_i = 0 H.

FISCO model: U_i = 17.5 Vdc, I_i = 380 mA, P_i = 5.32 W, C_i = L_i = 0.

Installation drawing: 9150079-906.

Ambient temperature limits: -50 °C to +70 °C(1).

Approval valid for HART, FOUNDATION fieldbus, and FISCO options.

(1) *+60 °C with FOUNDATION fieldbus or FISCO option.*

B.5.3 European certifications

ATEX Approvals CE 0575

Nemko 04ATEX1073X

Specific Conditions for Safe Use (X):

1. The intrinsically safe circuits do not withstand the 500V AC test as specified in EN 60079-11clause 6.4.13.
2. "Potential ignition hazards by impact or friction need to be considered according to EN 60079-0:2012 clause 8.3 (for EPL Ga and EPL Gb) and clause 8.4 (for EPL Da and EPL Db), when the transmitter enclosure and antennas exposed to the exterior atmosphere of the tank, is made with light metals containing aluminum or titanium, The end user shall determine the suitability with regard to avoid hazards from impact and friction."
3. The antennas for type 5400, are non-conducting and the area of the non-conducting part exceeds the maximum permissible areas for Group IIC and according to EN 60079-0:2012 clause 7.4: 20 cm^2 for EPL Gb and 4 cm^2 for EPL Ga. Therefore, when the antenna is used in a potentially explosive atmosphere, appropriate measures must be taken to prevent electrostatic discharge.
4. The Ex ia version of model 5400 may be supplied by an Ex ib certified safety barrier. The whole circuit shall then be regarded type Ex ib.
   The preferred type Ex ia or Ex ib shall be indicated on the marking label as specified in the instructions for the transmitter. The antenna part, located in the process vessel, is classified EPL Ga and electrically separated from the Ex ia or ib circuit.
5. ½" NPT threads need to be sealed for dust and water ingress protection, IP 66, IP 67 or 'Ex t', EPL Da or Db is required.

E1 Flameproof:

II 1/2 G Ex d ia IIC T4 Ga/Gb (-50 °C ≤ Ta ≤ +70 °C(1))

II 1D Ex ta IIIC T79°C(2) Da (-40 °C ≤ Ta ≤ +70 °C(1))

U_m = 250 V

Approval valid for HART, FOUNDATION fieldbus, and Modbus options.

I1, IA Intrinsically safe:

II 1 G Ex ia IIC T4 Ga or II 1/2 G Ex ib IIC T4 Ga/Gb (-40 °C ≤ Ta ≤ +70 °C(1))

II 1 D Ex ta IIIC T79°C(2) Da (-50 °C ≤ Ta ≤ +70 °C(1))

4-20 mA / HART model: U_i=30 Vdc, I_i=130 mA, P_i=1.0 W, C_i=7.26 nF, L_i=0 H.

FOUNDATION fieldbus model: U_i=30 Vdc, I_i=300 mA, P_i=1.5 W, C_i=4.95 nF, L_i=0 H.

FISCO model: U_i=17.5 Vdc, I_i=380 mA, P_i=5.32 W, C_i=4.95 nF, L_i<1 ì H.

Installation drawing: 9150079-907.

Approval valid for HART, FOUNDATION fieldbus, and FISCO options.

(1) +60 °C with FOUNDATION fieldbus or FISCO option.
(2) +69 °C with FOUNDATION fieldbus or FISCO option.

Nemko 10ATEX1072

N1 Type n:

II 3G Ex nA IIC T4 Gc (-50 °C ≤ Ta ≤ +70 °C[1])

II 3G Ex nL IIC T4 Gc (-50 °C ≤ Ta ≤ +70 °C[1])

HART 4-20 mA[2]

Maximum input voltage U_i: 42.4 V, Maximum input current I_i: 23 mA

Maximum input power P_i: 1.0 W, Maximum internal capacitance C_i: 7.25 nF

Maximum internal inductance L_i: 0 H

FOUNDATION fieldbus[2]

Maximum input voltage U_i: 32 V, Maximum input current I_i: 21 mA

Maximum input power P_i: 0.7 W, Maximum internal capacitance C_i: 4.95 nF

Maximum internal inductance L_i: 0 H

Approval valid for HART and FOUNDATION fieldbus options.

Installation drawing: 9240031-958

(1) +60 °C with FOUNDATION fieldbus or FISCO option.

(2) Valid for Ex nL.

B.5.4 IECEx Approval

IECEx NEM 06.0001X

Specific Conditions for Safe Use (X):

1. The intrinsically safe circuits do not withstand the 500V AC test as specified in IEC 60079-11 clause 6.4.13.
2. “Potential ignition hazards by impact or friction need to be considered according to IEC 60079-0:2011 clause 8.3 (for EPL Ga and EPL Gb) and clause 8.4 (for EPL Da and EPL Db), when the transmitter enclosure and antennas exposed to the exterior atmosphere of the tank, is made with light metals containing aluminum or titanium, The end user shall determine the suitability with regard to avoid hazards from impact and friction.”
3. The antennas for type 5400, are non-conducting and the area of the non-conducting part exceeds the maximum permissible areas for Group IIC and according to IEC 60079-0 .2011 clause 7.4: 20 cm2 for EPL Gb and 4 cm2 for EPL Ga. Therefore, when the antenna is used in a potentially explosive atmosphere, appropriate measures must be taken to prevent electrostatic discharge.
4. The Ex ia version of model 5400 may be supplied by an Ex ib certified safety barrier. The whole circuit shall then be regarded type Ex ib.
   The preferred type Ex ia or Ex ib shall be indicated on the marking label as specified in the instructions for the transmitter. The antenna part, located in the process vessel, is classified EPL Ga and electrically separated from the Ex ia or ib circuit.
5. ½” NPT threads need to be sealed for dust and water ingress protection, IP 66, IP 67 or ‘Ex t’, EPL Da or Db is required.

E7 Flameproof:
Ex d ia IIC T4 Ga/Gb (-40 °C ≤ Ta ≤ +70 °C(1))
Ex ta IIIC T79°C(2) Da (-40 °C ≤ Ta ≤ +70 °C(1))
U_m = 250 V
Approval valid for HART, FOUNDATION fieldbus, and Modbus options.

I7, IG Intrinsically safe:

Ex ia IIC T4 Ga or Ex ib IIC T4 Ga/Gb (-50 °C ≤ Ta ≤ +70 °C).

Ex ta IIIC T79°C(2) Da (-50 °C ≤ Ta ≤ +70 °C).

4-20 mA / HART model: U_i=30 Vdc, I_i=130 mA, P_i=1.0 W, C_i=7.26 nF, L_i=0 H.

FOUNDATION fieldbus model: U_i=30 Vdc, I_i=300 mA, P_i=1.5 W, C_i=4.95 nF, L_i=0 H.

FISCO model: U_i=17.5 Vdc, I_i=380 mA, P_i=5.32 W, C_i=4.95 nF, L_i<1 ì H.

Installation drawing: 9150079-907.

Approval valid for HART, FOUNDATION fieldbus, and FISCO options.

(1) +60 °C with FOUNDATION fieldbus or FISCO option.
(2) +69 °C with FOUNDATION fieldbus or FISCO option.

IECEx NEM 10.0005

N7 Type n:
Ex nA IIC T4 Gc (-50 °C ≤ Ta ≤ +70 °C[(1)])
Ex nL IIC T4 Gc (-50 °C ≤ Ta ≤ +70 °C [(1)])
HART® 4-20 mA[(2)]
Maximum input voltage U_i: 42.4 V, Maximum input current I_i: 23 mA
Maximum input power P_i: 1.0 W, Maximum internal capacitance C_i: 7.25 nF
Maximum internal inductance L_i: 0 H

FOUNDATION fieldbus[(2)]
Maximum input voltage U_i: 32 V, Maximum input current I_i: 21 mA
Maximum input power P_i: 0.7 W, Maximum internal capacitance C_i: 4.95 nF
Maximum internal inductance L_i: 0 H

Approval valid for HART and Foundation fieldbus options
installation drawing 9240031-958

B.5.5 EAC certifications

Technical Regulations Customs Union (EAC)

EM, IM: Contact an Emerson Process Management representative for additional information.

(1) +60 °C with FOUNDATION fieldbus or FISCO option.
(2) Valid for Ex nL.

B.5.6 Brazilian certifications

NCC/INMETRO Approvals

Special Condition for Safe Use (X):

Refer to Certificate NCC 14.2256X

Standards

ABNT NBR IEC 60079-0:2013, ABNT NBR IEC 60079-1:2009, ABNT NBR IEC 60079-11:2009; ABNT NBR IEC 60079-26:2008, ABNT NBR IEC 60079-27:2010, ABNT NBR IEC 60079-31:2011

E2 Flameproof:
Ex ia/db ia IIC T4 Ga/Gb(-40 °C ≤ Ta ≤ +70 °C[1])
Ex ta IIIC T79 °C[2]
IP66/67

I2, IB Intrinsically safe:
Ex ia IIC T4 Ga/Gb (-50 °C ≤ Ta ≤ +70 °C[1])
Ex ta IIIC T79 °C[2] (-50 °C ≤ Ta ≤ +70 °C[1])
IP66/67
4-20mA / HART model: U_i=30 Vdc, I_i=130 mA, P_i=1.0 W, C_i=7.26 nF, L_i=0 H.
FOUNDATION™ fieldbus model: U_i=30 Vdc, I_i=300 mA, P_i=1.5 W, C_i=4.95 nF, L_i=0 H.
FISCO model: U_i=17.5 Vdc, I_i=380 mA, P_i=5.32 W, C_i=4.95 nF, L_i<1 ì H.

B.5.7 Chinese certifications

National Supervision and Inspection Center for Explosion Protection and Safety of Instrumentation (NEPSI) approvals

Special Condition for Safe Use (X):

Refer to Certificate GYJ111229X

E3 Flameproof:
Ex d ia IIC T4 (-40 °C < Ta < +70 °C[1])
U_m=250 V

I3 Intrinsically safe:
Ex ia IIC T4 (-50 °C < Ta < +70 °C[1])
DIP A20 Ta 79°C[2] (-50 °C < Ta < +70 °C[1])

4-20 mA / HART model: U_i=30 Vdc, I_i=130 mA, P_i=1.0 W, C_i=7.26 nF, L_i=0 H.
FOUNDATION fieldbus model: U_i=30 Vdc, I_i=300 mA, P_i=1.5 W, C_i=4.95 nF, L_i=0 H.
FISCO model: U_i=17.5 Vdc, I_i=380 mA, P_i=5.32 W, C_i=4.95 nF, L_i<1 ì H.

(1) +60 °C with FOUNDATION fieldbus option or FISCO option.
(2) +69 °C with FOUNDATION fieldbus option or FISCO option.

B.5.8 Japanese certifications

Technology Institution of Industrial Safety (TIIS) Approval

Special Condition for Safe Use (X):

Refer to certificate TC20109-TC20111 (4-20 mA HART) and TC20244-TC20246 FOUNDATION fieldbus)

E4[1] Flameproof:
4-20 mA HART model:
Transmitter: Ex d [ia] IIC T4x
-20 ~ +60 °C
DC 20 - 42.4 V
U_m = 250 V
U_o = 22.2 V
I_o = 177 mA
P_o = 0.985 W
Antennas: Ex ia IIC T4X

FOUNDATION fieldbus model:
Transmitter: Ex d [ia] IIC T4x
-20 ~ +60 °C
DC 16 - 32 V
U_m = 250 V
U_o = 22.2 V
I_o = 177.5 mA
P_o = 0.985 W
Antennas: Ex ia IIC T4X
Installation drawing: 05400-00375.
Approval valid for HART and FOUNDATION fieldbus options.

(1) *Not available for solids applications.*

B.5.9 Other certifications

Overfill protection

Cert. No: Z-65.16-475

U1 TÜV-tested and approved by DIBt for overfill protection according to the German WHG regulations.
Approval valid for HART options.

Suitability for Intended Use

Compliant with NAMUR NE 95, version 07.07.2006 “Basic Principles of Homologation”.

Type Approval Certifications (Marine/shipboard approvals)

SBS[1] American Bureau of Shipping (ABS) Product Type Approval

Certificate Number: 10-LD530607-PDA

Intended Service: For monitoring, process-control and hi/lo-alarming in continuous or batch like operation for the marine applications on Oil, Product, Chemical and Gas tankers as well as on Offshore mobile units.

ABS Rules: 2010 Steel Vessels Rules 1-1-4/7.7, 4-8-4/27.5 and 4-9-7, 5C-1-7/21.15.1; 5C-8-13/2; 5C-9-13/1

Approval valid for HART and FOUNDATION fieldbus options.

SDN[1] Det Norske Veritas (DNV) Type Approval Certificate

Certificate Number: A-11731

Intended Service: The Rosemount 5400 is found to comply with Det Norske Veritas' Rules for Classification of Ships, High Speed & Light Craft and Det Norske Veritas' Offshore Standards.

Location classes	
Temperature	D
Humidity	B
Vibration	A
EMC	B
Enclosure	C

Approval valid for HART and FOUNDATION fieldbus options.

(1) *Not available for solids applications.*

SLL[1] Lloyd's Register Type Approval Certificate

Certificate Number: 09/00034

Application: For use in environmental categories ENV1, ENV2, ENV3 and ENV5 as defined in Lloyd's Register Test Specification No. 1: 2002.

Approval valid for HART and FOUNDATION fieldbus options.

SBV[1] Bureau Veritas Type Approval Certificate

Certificate Number: 22379/A0 BV

Requirements: BUREAU VERITAS Rules for the Classification of Steel Ships

Application: Approval valid for ships intended to be granted with the following additional class notations: AUT-UMS, AUT-CCS, AUT-PORT and AUT-IMS.

Approval valid for HART and FOUNDATION fieldbus options.

SRS[1] Russian Maritime Register of Shipping Type Approval Certificate

Certificate Number: 08.00159.120

Application and limitations: Rosemount 5400 Series Twin-Lead Radar Level Transmitter (models: 5401, 5402) are intended for using on sea-going ships, floating constructions and fixed offshore platforms.

Approval valid for HART and FOUNDATION fieldbus options.

SGL[1] Germanischer Lloyd Type Approval Certificate

Certificate Number: 86 883 - 10 HH

Approval valid for HART and FOUNDATION fieldbus options.

B.5.10 Canadian Registration Number (CRN)

Cert No: 0F06878.2

The product design has been accepted and registered for use in Canada.

(1) *Not available for solids applications.*

B.6 Approval drawings

This section contains a FM Approvals system control drawing and Canadian Standards Association and IECEx/ATEX/TIIS installation drawings. You must follow the installation guidelines presented in order to maintain certified ratings for installed transmitters.

This section contains the following drawings:

- Rosemount drawing 9150 079-905:
  System control drawing for hazardous location installation of intrinsically safe FM approved apparatus.
- Rosemount drawing 9150 079-906:
  System control drawing for hazardous location installation of CSA approved apparatus.
- Rosemount drawing 9150 079-907:
  Installation drawing for hazardous location installation of ATEX and IECEx approved apparatus.
- Rosemount drawing 9240031-958:
  Installation drawing Ex n Rosemount 5400 Series
- TIIS drawing TIIS-R-IS 05400-00375:
  Installation drawing for hazardous location installation of TIIS approved apparatus.

Figure B-1. System Control Drawing for Hazardous Location Installation of Intrinsically Safe FM Approved Apparatus

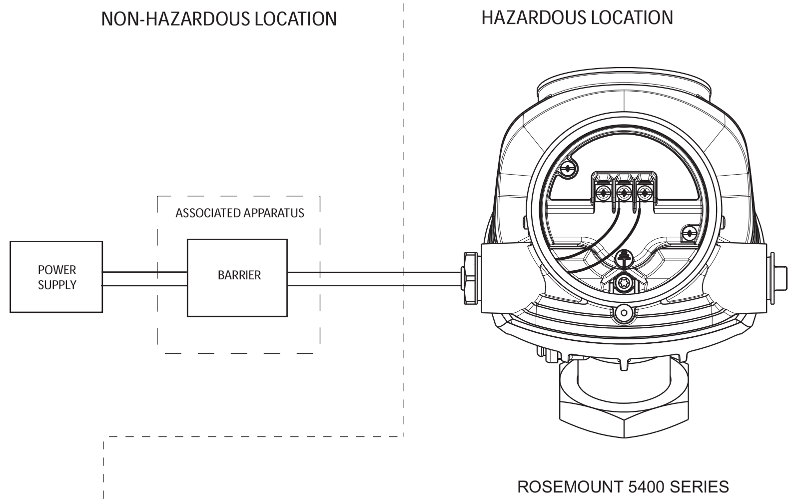
)3-21 Electronic Master - PRINTED COPIES ARE UNCONTROLLED - Rosemount Propriety

ORIGINAL SIZE A3

ISSUE	CH. ORDER No	WEEK	ISSUE	CH. ORDER No	WEEK	ISSUE	CH. ORDER No	WEEK	ISSUE	CH. ORDER No	WEEK
1	SME-3446	0346	2	SME-5134	0526	3	SME-5513	0644	4	SME-5879	0751
5	SME-7120	1144	6	SME-7473	1242	7	SME-7655	1409			

ENTITY CONCEPT APPROVAL

The Entity concept allows interconnection of intrinsically safe apparatus to associated apparatus not specifically examined in combination as a system. The approved values of max. open circuit voltage (Voc or Vt) and max. short circuit current (Isc or It) and max. power (Voc x Isc / 4) or (Vt x It / 4), for the associated apparatus must be less than or equal to the maximum safe input voltage (Vmax), maximum safe input current (Imax), and maximum safe input power (Pmax) of the intrinsically safe apparatus. In addition, the approved max. allowable connected capacitance (Ca or Co) of the associated apparatus must be greater than the sum of the interconnecting cable capacitance and the unprotected internal capacitance (Ci) of the intrinsically safe apparatus, and the the approved max. allowable connected inductance (La or Lo) of the associated apparatus must be greater than the sum of the interconnecting cable inductance and the unprotected internal inductance (Li) of the intrinsically safe apparatus.



Notes:

1. No revision to this drawing without prior Factory Mutual approval.
2. Associated apparatus manufacturer's installation drawing must be followed when installing this product.
3. Dust-Tight seal must be used when installed in Class II and Class III environments.
4. Control equipment connected to the barrier must not use or generate more than 250 Vrms or Vdc.
5. Resistance between Intrinsically Safe Ground and Earth Ground must be less than 1.0 ohm.
6. Installations should be in accordance with ANSI/ISA-RP12.6 "Installation of Intrinsically Safe Systems for Hazardous Locations" and the National Electric Code (ANSI/NFPA 70).
7. The associated apparatus must be Factory Mutual Approved.
8. Connect supply wires to the appropriate terminals as indicated on the terminal block and in the installation documents.

WARNING : To prevent ignition of flammable or combustible atmospheres, read , understand and adhere to the manufacturer's live maintenance procedures.

WARNING: Substitution of components may impair Intrinsic Safety.

WARNING: Potential Electrostatic Charging Hazard – The enclosure is a non-metallic construction. To prevent the risk of electrostatic sparking the plastic surface should only be cleaned with a damp cloth.

WARNING: The apparatus enclosure contains aluminum and is considered to constitute a potential risk of ignition by impact or friction. Care must be taken into account during installation and use to prevent impact or friction.

Intrinsically Safe Apparatus for use in Class I,II,III,
Division 1, Groups A,B,C,D,E,F,G,
Class I, Zone 0, AEx ia IIC T4, Temperature Class T4 :

Model	Entity Parameters	Ambient Temperature Limits
4-20 mA/HART IS Model	Vmax(Ui) <= 30V, Imax(Ii) <= 130 mA Pi <= 1W, Ci = 7.26 nF, Li = 0 uH	-50 <= Ta <= 70 deg C
Fieldbus IS Model	Vmax(Ui) <= 30V, Imax(Ii) <= 300 mA Pi <= 1.3W, Ci = 0, Li = 0 uH	-50 <= Ta <= 60 deg C
Fieldbus FISCO IS Model	Vmax(Ui) <= 17.5V, Imax(Ii) <= 380 mA Pi <= 5.32W, Ci = 0, Li = 0 uH	-50 <= Ta <= 60 deg C

FM Approved Product
No revisions to this drawing without prior Factory Mutual Approval.

9150 079-905

ISSUED BY GU-LN	WEEK 0346	PRODUCT CODE 5400	
APPROVED BY GU-PO	WEEK 0346	DOC. TYPE 6	FILE PDF
ALL DIMENSIONS ARE IN MILLIMETRES.		FINISH, UNLESS OTHERWISE STATED:	
ROSEMOUNT		1 ST ANGLE	SCALE 1:1

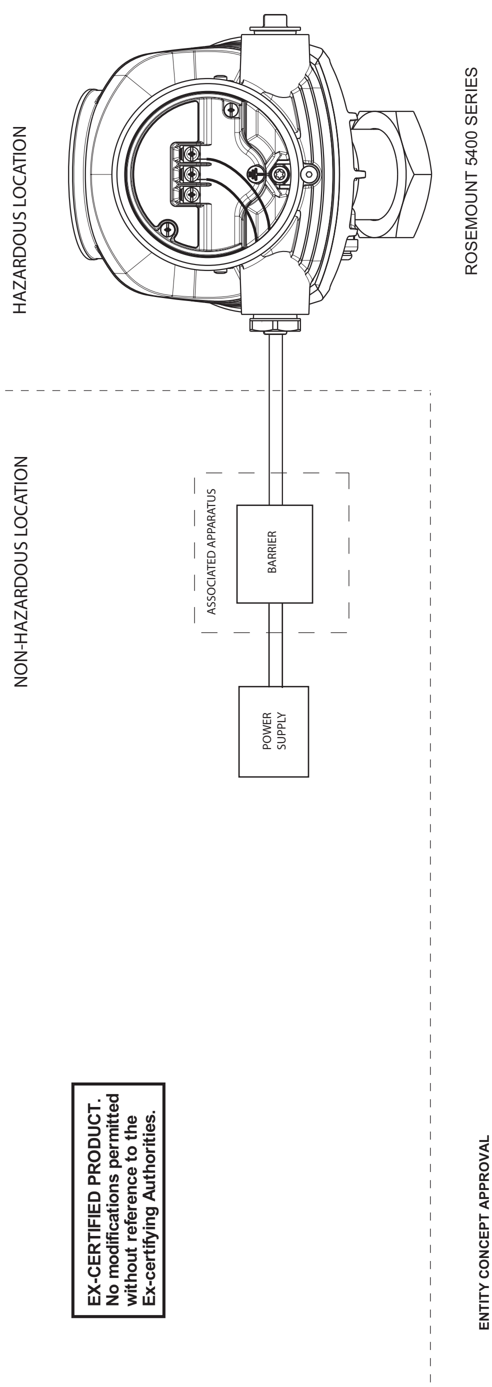
TITLE
SYSTEM CONTROL DRAWING
for hazardous location installation of Intrinsically Safe FM approved apparatus

DWG NO. 9150 079-905 | ISSUE 7 | SHEET 1 / 1

Figure B-2. System Control Drawing for Hazardous Location Installation of CSA Approved Apparatus

ORIGINAL SIZE A3

ISSUE	CH. ORDER No	WEEK	ISSUE	CH. ORDER No	WEEK	ISSUE	CH. ORDER No	WEEK	ISSUE	CH. ORDER No	WEEK
1	SME-3445	0346	2	SME-5134	0526	3	SME-5514	0644	4	SME-5880	0751
5	SME-6019	0840	6	SME-7063	1123						



ENTITY CONCEPT APPROVAL

The Entity concept allows interconnection of intrinsically safe apparatus to associated apparatus not specifically examined in combination as a system. The approved values of maximum open circuit voltage (Voc) and maximum short circuit current (Isc) and maximum output power (or Voc x Isc / 4), for the associated apparatus must be less than or equal to the maximum safe input voltage (Ui), maximum safe input current (Ii), and maximum safe input power (Pi) of the intrinsically safe apparatus. In addition, the approved maximum allowable connected capacitance (Ca) of the associated apparatus must be greater than the sum of the interconnecting cable capacitance and the unprotected internal capacitance (Ci) of the intrinsically safe apparatus, and the approved maximum allowable connected inductance (La) of the associated apparatus must be greater than the sum of the interconnecting cable inductance and the unprotected internal inductance (Li) of the intrinsically safe apparatus.

Intrinsically Safe Ex ia
Class I, Division 1, Groups A,B,C and D, Temperature Code T4 :

Model	Entity Parameters	Ambient Temperature Limits
4-20 mA/HART IS Model	Vmax <= 30V, Imax <= 130 mA Pi <= 1W, Ci = 7.3 nF , Li = 0 uH	-50 <= Ta <= 70 deg C
Fieldbus IS Model	Vmax <= 30V, Imax <= 300 mA Pi <= 1.3W, Ci = 0, Li = 0 uH	-50 <= Ta <= 60 deg C
Fieldbus FISCO IS Model	Vmax <= 17.5V, Imax <= 380 mA Pi <= 5.32W, Ci = 0, Li = 0 uH	-50 <= Ta <= 60 deg C

Notes :

1. Entity parameters listed (for HART/Fieldbus Model) apply only to associated apparatus with linear output.
2. Control equipment connected to the barrier must not use or generate more than 250 Vrms or Vdc.
3. Connect supply wires to the appropriate terminals as indicated on the terminal block and in the installation documents.
4. Installations should be in accordance with ANSI/ISA-RP12.6 "Installations of Intrinsically Safe Systems for Hazardous Locations" and the Canadian Electric Code.
5. Product options bearing the DUAL SEAL marking on the label meets the Dual Seal requirements of ANSI/ISA 12.27.01. No additional process sealing is required. For the in-service limits applicable to a specific model, see Process Pressure/Temperature range in Appendix A of the Reference manual.

9150 079-906

ISSUED BY	WEEK	PRODUCT CODE		TITLE
GU-LN	0346	5400		**INSTALLATION DRAWING** for hazardous location installation of CSA approved apparatus
APPROVED BY	WEEK	DOC. TYPE	FILE	
GU-PO	0346	6	PDF	

ALL DIMENSIONS ARE IN MILLIMETRES. FINISH, UNLESS OTHERWISE STATED:

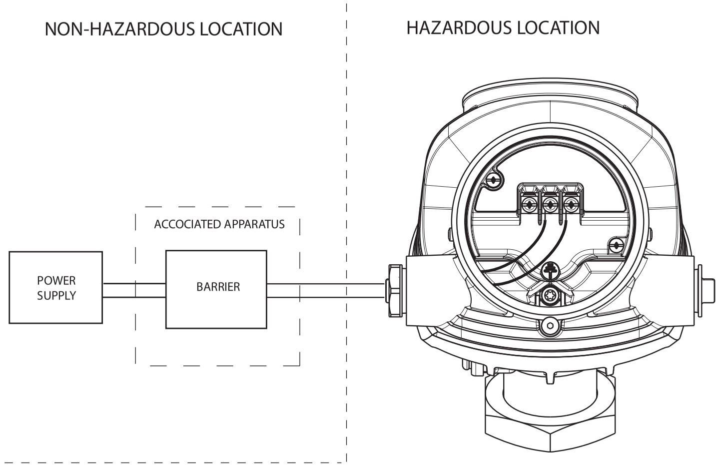
DWG NO. 9150 079-906 ISSUE 6 SHEET 1 / 1

ROSEMOUNT® 1 ST ANGLE SCALE 1:1

Figure B-3. Installation Drawing for Hazardous Location Installation of ATEX and IECEx Approved Apparatus

ORIGINAL SIZE A3

ISSUE	CH. ORDER No	WEEK	ISSUE	CH. ORDER No	WEEK	ISSUE	CH. ORDER No	WEEK	ISSUE	CH. ORDER No	WEEK
1	SME-3444	0346	2	SME-6440	0511	3	SME-5236	0548	4	SME-5515	0644
5	SME-6440	1048	6	SME-7230	1217	7	SME-7653	1409			



ROSEMOUNT 5400 SERIES

SPECIFIC CONDITIONS FOR SAFE USE (X) :

1. The intrinsically safe circuits do not withstand the 500V AC test as specified in IEC 60079-11 clause 6.4.13.

2. "Potential ignition hazards by impact or friction need to be considered according to IEC 60079-0:2011 clause 8.3 (for EPL Ga and EPL Gb) and clause 8.4 (for EPL Da and EPL Db) , when the transmitter enclosure and antennas exposed to the exterior atmosphere of the tank, is made with light metals containing aluminium or titanium. The end used shall determine the suitability with regard to avoid hazards from impact and friction."

3. The antennas for type 5400, are non-conducting and the area of the non-conducting part exceeds the maximum permissible areas for Group IIC and according to IEC 60079-0 .2011 clause 7.4: 20 cm2 for EPL Gb and 4 cm2 for EPL Ga. Therefore, when the antenna is used in a potentially explosive atmosphere, appropriate measures must be taken to prevent electrostatic discharge.

4. The Ex ia version of model 5400 may be supplied by an Ex ib certified safety barrier. The whole circuit shall then be regarded type Ex ib. The preferred type Ex ia or Ex ib shall be indicated on the marking label as specified in the instructions for the transmitter. The antenna part, located in the process vessel, is classified EPL Ga and electrically separated from the Ex ia or ib circuit.

5. ½" NPT threads need to be sealed for dust and water ingress protection, IP 66, IP 67 or 'Ex t', EPL Da or Db is required.

Intrinsic Safety Parameters :
□ II 1 G Ex ia IIC T4 Ga or □ II 1/2 G Ex ib IIC T4 Ga/Gb ; II 1D Ex ta IIIC Da

Model	Parameters	Ambient Temperature Limits
4-20 mA/HART IS Model	Ui <= 30V, Ii <= 130 mA Pi <= 1W, Ci = 7.26 nF, Li = 0	-50 <= Ta <= 70 deg C
Fieldbus IS Model	Ui <= 30V, Ii <= 300 mA Pi <= 1.5W, Ci = 4.95nF, Li = 0	-50 <= Ta <= 60 deg C
Fieldbus FISCO IS Model	Ui <= 17.5V, Ii <= 380 mA Pi <= 5.32W, Ci = 4.95nF, Li = 0	-50 <= Ta <= 60 deg C

INTRINSICALLY SAFE INSTALLATIONS

The approved values of maximum open circuit voltage (Uo) and maximum short circuit current (Io) and maximum output power (or Uo x Io / 4), for the associated apparatus must be less than or equal to the maximum safe input voltage (Ui), maximum safe input current (Ii), and maximum safe input power (Pi) of the intrinsically safe apparatus. In addition, the approved maximum allowable connected capacitance (Co) of the associated apparatus must be greater than the sum of the interconnecting cable capacitance and the unprotected internal capacitance (Ci) of the intrinsically safe apparatus, and the approved maximum allowable connected inductance (Lo) of the associated apparatus must be greater than the sum of the interconnecting cable inductance and the unprotected internal inductance (Li) of the intrinsically safe apparatus.

Notes :

1. Safety parameters listed (for HART/Fieldbus Model) apply only to associated apparatus with linear output.
2. Control equipment connected to the barrier must not use or generate more than 250 Vrms or Vdc.
3. Connect supply wires to the appropriate terminals as indicated on the terminal block table and in the installation documents.

EX-CERTIFIED PRODUCT.
No modifications permitted without reference to the Ex-certifying Authorities.

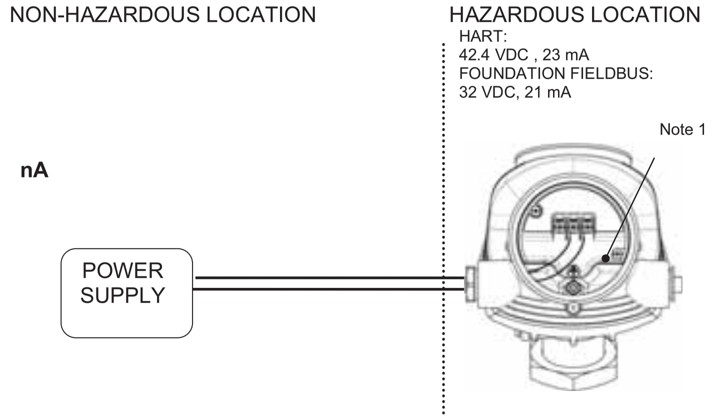
9150 079-907

ISSUED BY	WEEK	PRODUCT CODE		TITLE
GU-LN	0346	5400		**INSTALLATION DRAWING** for hazardous location installation of ATEX and IECEx approved apparatus
APPROVED BY: GU-PO	WEEK: 0346	DOC. TYPE: 6	FILE: PDF	DWG NO.: 9150 079-907 — ISSUE: 7 — SHEET: 1 / 1
ALL DIMENSIONS ARE IN MILLIMETRES.		FINISH, UNLESS OTHERWISE STATED:		
ROSEMOUNT		1 ST ANGLE	SCALE 1:1	The copyright/ownership of this document is and will remain ours. The document must not be used without our authorization or brought to the knowledge of a third party. Contravention will be prosecuted. *Rosemount Tank Radar AB, Sweden*

Figure B-4. Installation drawing Ex n Rosemount 5400 Series

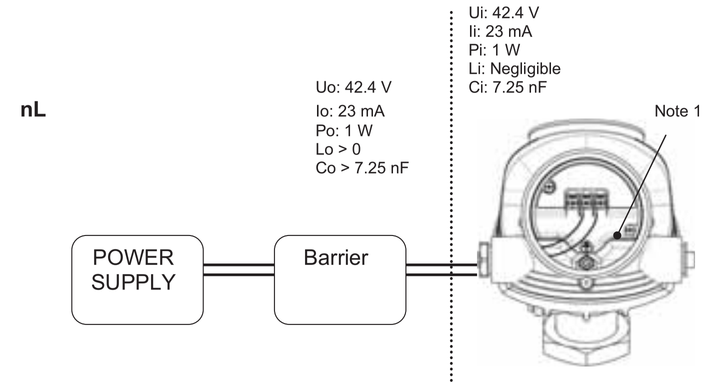
ORIGINAL SIZE A3

ISSUE	MODIF. ORDER NO.	WEEK	ISSUE	MODIF. ORDER NO.	WEEK	ISSUE	MODIF. ORDER NO.	WEEK
1	SME-5859	1041	2	SME-6864	1126			



Input parameters for Non-sparking

Model	Parameters	Ambient Temperature Limits
CURRENT LOOP / HART	42.4 VDC, 23 mA,	$-50 \le T_a \le 70$ °C
FOUNDATION FIELDBUS	32 VDC, 21 mA	$-50 \le T_a \le 60$ °C



Input parameters for Energy Limited

Model	Parameters	Ambient Temperature Limits
CURRENT LOOP / HART	U_i = 42.4 V, I_i = 23 mA, P_i = 1.0 W C_i = 7.25 nF, L_i: Negligible	$-50 \le T_a \le 70$ °C
FOUNDATION FIELDBUS	U_i = 32 V, I_i = 21 mA, P_i = 0.7 W C_i = 4.95 nF, L_i: Negligible	$-50 \le T_a \le 60$ °C

EX-CERTIFIED PRODUCT
No modifications permitted without reference to the Ex-certifying Authorities.

Notes:
1 Connect supply wires to the appropriate terminals as indicated on the terminal block label and in the installation documents.

ISSUED BY	WEEK	DOC. TYPE	PRODUCT CODE	TITLE
EE-VM	1041	6	5400	INSTALLATION DRAWING Exn ROSEMOUNT 5400 SERIES
APPROVED BY	WEEK	FILE		
EAP	1041	Word		

ROSEMOUNT

DOC NO.	ISSUE	PAGE
9240031-958	2	1/1

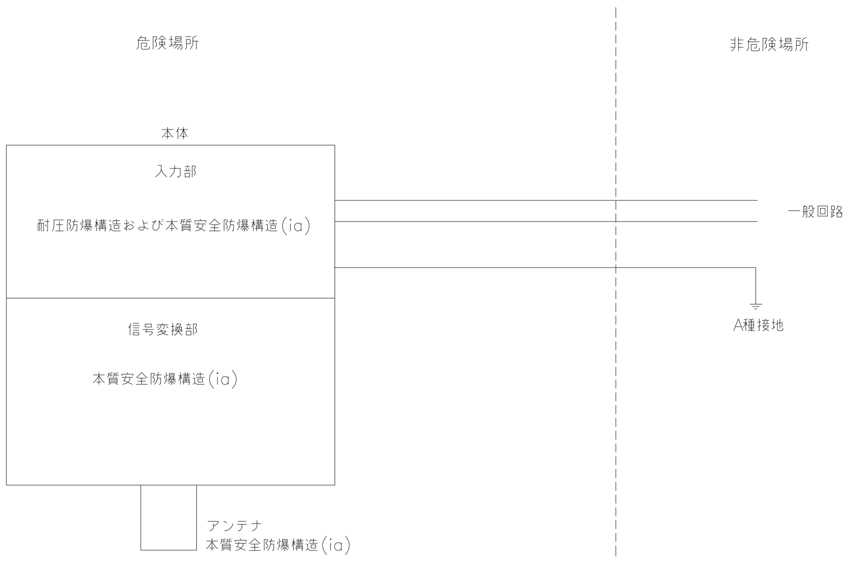
2011-06-28 14:34
9240031-958_I02_P01_A3.DOCX

Figure B-5. Installation Drawing for Hazardous Location Installation of TIIS Approved Apparatus

国内(TIIS)防爆仕様 1)

対象機器	＜5401/5402＞
防爆記号	入力部 Ex d [ia] IIC T4 X,　信号変換部及びアンテナ Ex ia IIC T4 X
定　　格	本安回路 Uo = 22.2V　Io = 177mA　Po = 0.985W
	非本安回路
	電源 DC 20~42.4V/4-20mA, DC 16~32V/ Fieldbus
	許容電圧 AC 250V 50/60Hz, DC250V
周囲温度	-20℃～60℃

システム構成図 2)



05400-00375B

1) 注：改造禁止。
静電気防止のためアンテナ部の乾拭き禁止。
発火防止のため金属部への衝撃または摩擦禁止。
接地端子は非危険場所において、単独で A 種接地工事に準じて接地すること。
爆発性ガスまたは蒸気が存在する場所ではカバー開放禁止。
外部導線は耐熱温度 70℃以上のケーブルを使用すること。

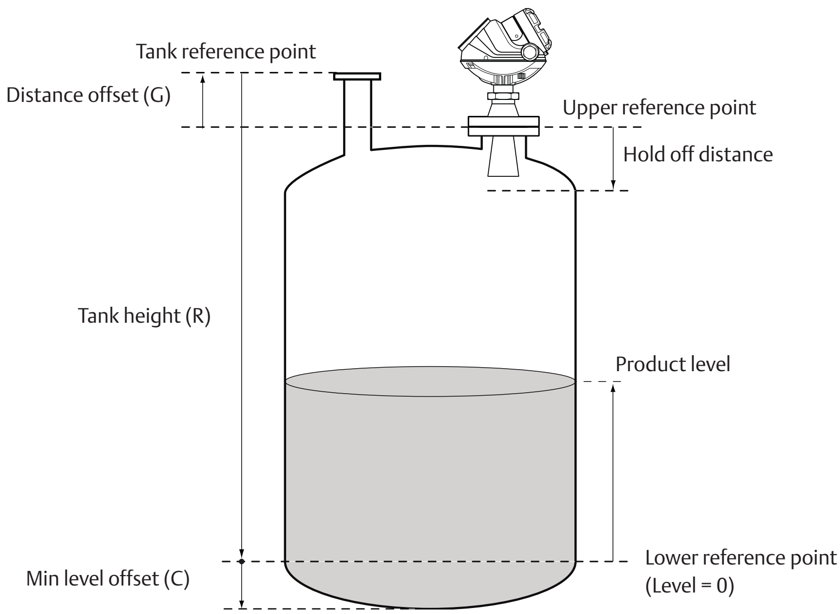
2) 一般回路(電源及び入出力)はその入力電源,機器内部の電圧等が正常状態および異常状態においても AC/DC250V 50/60Hz を超えないものとする。
本安用接地端子は非危険場所において単独で A 種接地する。

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.

C.1 Tank geometry

Figure C-1. Advanced Tank Geometry



C.1.1 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 the distance between the upper reference point and the flange. (The flange is referred to as the Transmitter's Reference Point). The Distance Offset can be used to specify a reference point at the top of the tank. Set the Distance Offset to zero to identify the lower side of the device flange as the upper reference point. The Distance Offset is defined as positive if an upper reference point above the Upper Reference Point is used.

C.1.2 Minimum level offset (C)

The Minimum Level Offset (C) defines a lower null zone which extends the measurement range beyond the Lower Reference Point to the tank bottom. The Minimum Level Offset is 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 to use the tank bottom as the Lower Reference Point. This case corresponds to the standard tank geometry configuration.

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

C.1.3 Hold off distance

This parameter should only be changed if there are disturbing objects close to the antenna. No valid measurements are possible above the Hold Off Distance. By increasing the Hold Off Distance, the measuring range is reduced. See “Hold off setting” on page 250 for more information.

C.1.4 Calibration distance

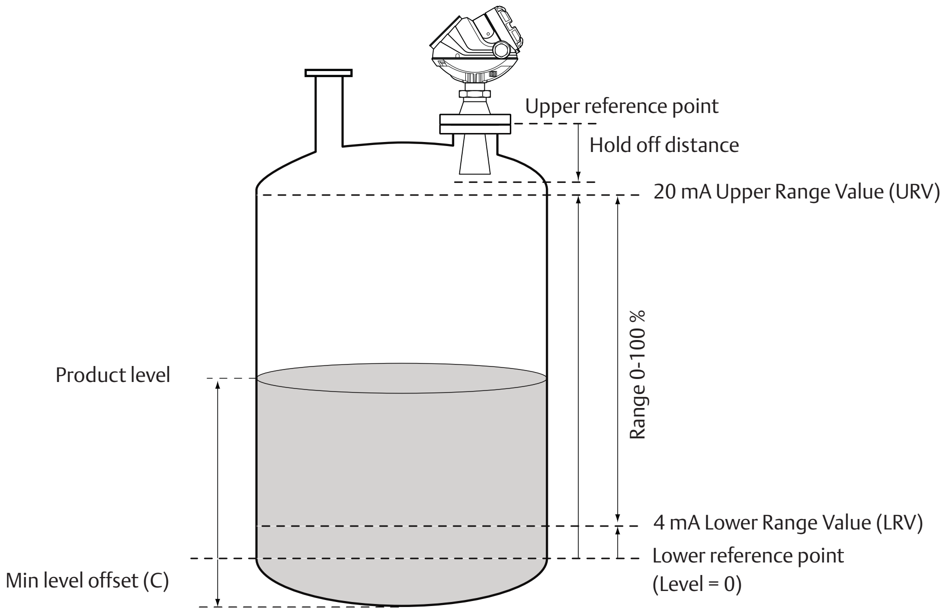
The Calibration Distance is defaulted to zero. It is used to adjust the transmitter so measured levels match hand-dipped or otherwise known product levels. Normally, a minor adjustment is necessary. There may, for example, be a deviation between the actual tank height and the value from tank drawings,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

Non-metallic (for example, plastic) vessels and installation geometry may introduce an offset for the zero reference point. This offset may be up to ± 10 mm. The offset can be compensated for using Calibration Distance.

C.2 Advanced analog output settings

The 20 mA Upper Range Value should be outside the Hold Off Distance (see “Hold off distance” on page 238) in order to utilize the full range of the analog output.

Figure C-2. Advanced Range Value Settings



C.3 Advanced transmitter settings

C.3.1 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.

C.3.2 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 has the transmitter present a zero-level measurement. An alarm is activated unless the alarm has been blocked.

Empty tank detection area

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

If the tank is empty, the transmitter searches double the 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, but if there are, they may need to be filtered out.

This function requires the Bottom Echo Visible function to be 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 244.

Bottom echo visible

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

Check that the gauge detects the tank bottom when the tank is empty before activating this function. See “Bottom echo visible” on page 243.

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 be significantly stronger than the measurement signal from the product surface, in some situations.

Extra echo

Extra Echo Detection is used for tanks with domed or conical bottom types and when there is no strong echo from the tank bottom when the tank is empty and an echo beneath the actual tank bottom can sometimes be seen. See “Extra echo function” on page 245.

Level alarm is not set when tank is empty

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

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

C.3.3 Full tank handling

Full tank detection area

This parameter defines a range where the surface echo can be lost. If the echo is lost in this range, the tank is considered full (the device enters Full Tank State) and the device presents maximum level indication.

When the tank is full, the device searches double the Full Tank Detection Area for the product surface. When a new echo is found in this range, it is identified as the product surface.

It is important to filter out any disturbances in this area.

Level above hold off distance possible

This function should be enabled if the level can rise above the Hold Off Distance/UNZ and it is necessary to display the tank as full in that case. Normally, the device will be able to track the surface and the product level will never rise to that height. If the function is not enabled and the surface is lost at the top of the tank, the device searches the whole tank for a surface echo.

Note
Measurements are not performed within the Hold Off Distance/UNZ region.

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.” This parameter should be set to suppress the “invalid” display.

Note
Setting this parameter disables the analog output so it does not enter alarm mode for invalid levels close to the antenna.

See “Full tank handling” on page 247 for more information.

C.3.4 Double bounce

Some radar waves are reflected at the surface and then reflected against the tank roof and back to the surface before being detected by the transmitter. Normally, these signals have a low amplitude and are ignored by the transmitter. For spherical and horizontal cylinder tanks however, the amplitude may be strong enough for the transmitter to interpret the double bounce as the surface echo. Setting the *Double Bounce Possible* parameter can solve this type of measurement situation. This function should only be used if double bounces cannot be corrected by changing the mechanical installation. See “Double bounce” on page 248 for more information.

C.3.5 Surface echo tracking

Slow search

This variable controls how to search for the surface when 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 search region until the surface is found. If this variable is not set, the transmitter searches the whole tank. This parameter is typically used for tanks with turbulent conditions.

Slow search speed

This parameter indicates the speed 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 partially transparent to the radar signal.

The *Select Lower Surface* parameter specifies the surface layer selected as the surface.

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 is identified as the product surface. If not, the upper surface is used.

Echo timeout

Echo Timeout defines the time, in seconds, after the echo has been lost, before the transmitter starts searching for a surface echo. 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 where new surface echo candidates can be selected. The size of the window is ±CloseDist. Echoes outside this window will not be considered surface echoes and the transmitter will jump to the strongest echo inside this window. If there are rapid level changes in the tank, the value of the Close Distance Window can be increased to prevent the transmitter from missing level changes. On the other hand, a large value may cause the transmitter to select an invalid echo as the surface echo.

C.3.6 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. A damping value of 10 indicates that in 10 seconds the output from the transmitter is approximately 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 track the surface. In noisy environments, with low level rates, it may be best to increase the damping value for a stable output signal.

Activate jump filter

The Jump Filter is typically used for turbulent surface applications where it smooths the echo tracking as the level passes, for example, an agitator. If the surface echo is lost and a new surface echo is found, the Jump Filter has the transmitter wait before jumping to the new echo so it can be validated. During that time the new echo has to be considered a valid echo.

C.4 Advanced functions in RRM

C.4.1 Empty tank handling

Bottom echo visible

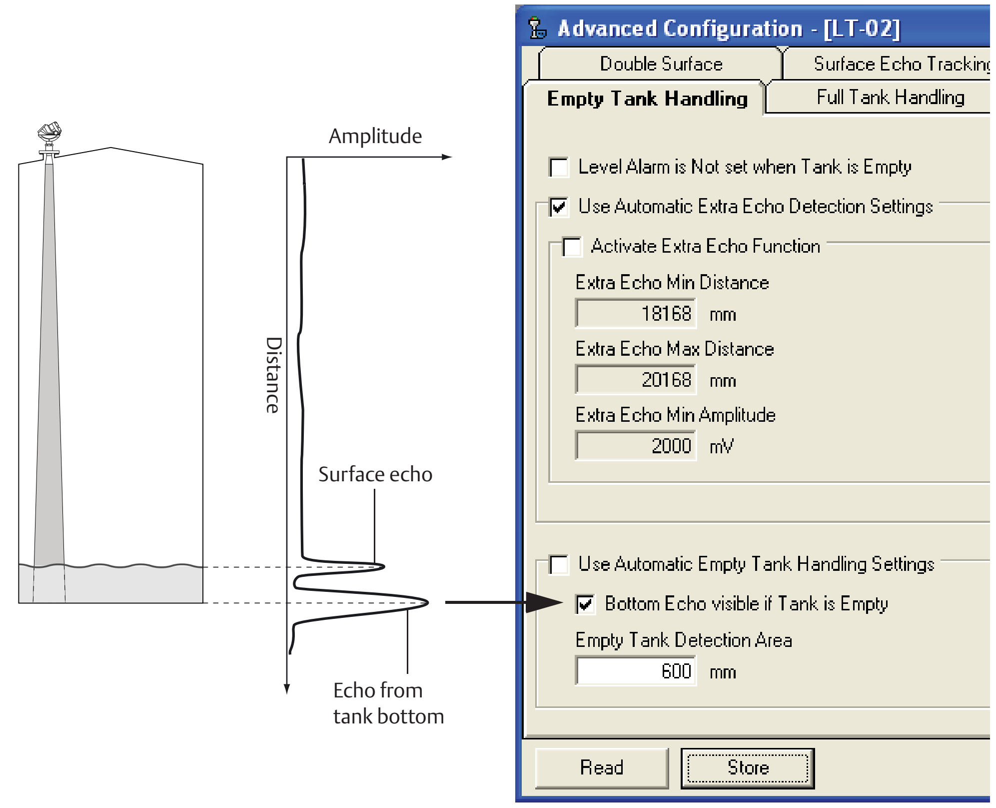
The *Bottom Echo Visible...* parameter allows the transmitter to separate the product surface from the tank bottom by identifying the bottom echo as a disturbance echo. This is useful for products relatively transparent for microwaves, such as oil. For non-transparent products, such as water, there is 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 a Flat bottom type where the radar echo from the tank bottom is clearly visible. If there is no distinct bottom echo, even if 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 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 in an empty tank.



Empty tank detection area

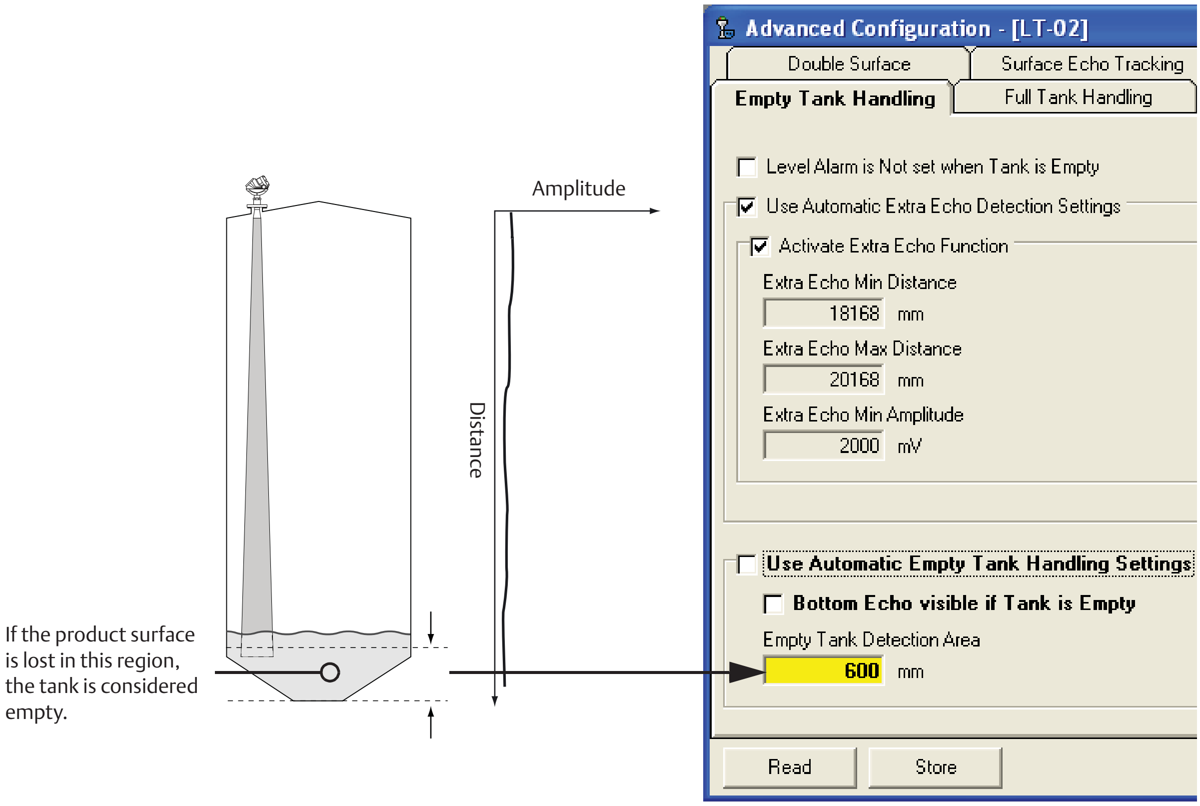
If the signal from the product surface is lost within the region given by the parameter *Empty Tank Detection Area*, the tank is considered empty and the product level is presented as zero.

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

The Empty Tank Detection Area can be increased 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.



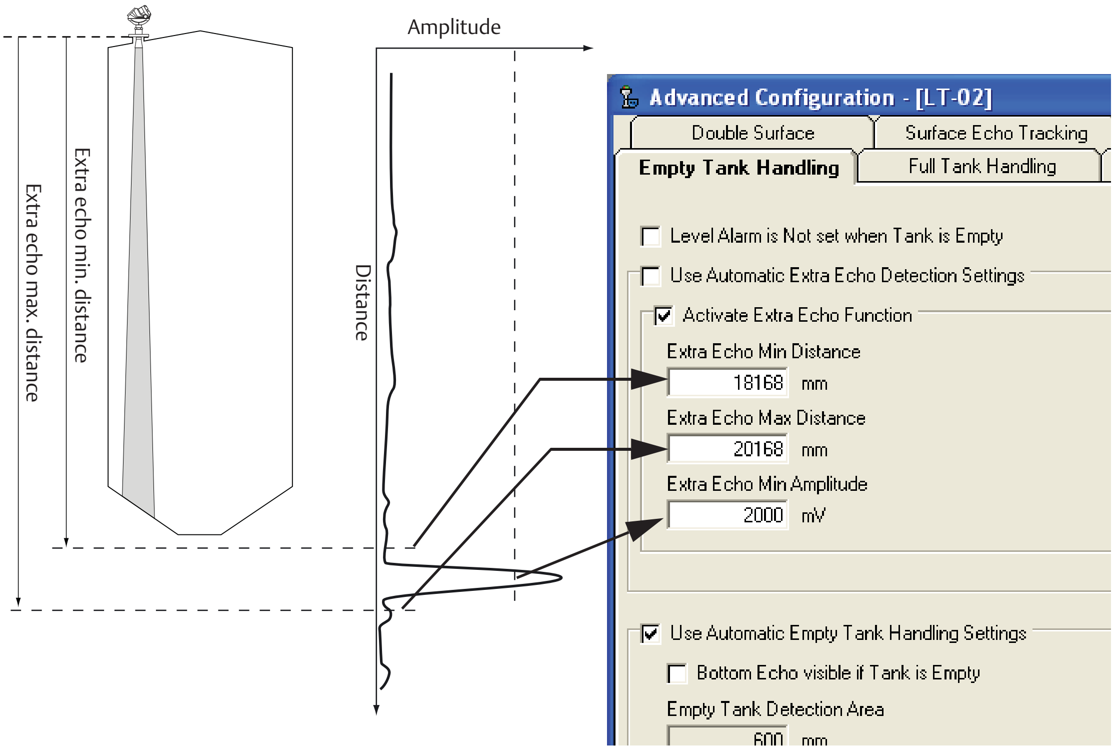
See "Empty tank detection area" on page 240 for further information.

Extra echo function

The Extra Echo Detection function makes for more robust measurements in the bottom region for conical or domed bottom shape tanks. 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 unable to detect the tank bottom, this function can ensure that the transmitter stays in Empty Tank state as long as an extra echo is present.

When the tank is empty, use the spectrum function in RRM to verify if such an echo exists or not by entering a distance that exceeds the tank bottom. The suitable values for Extra Echo Min Distance, Extra Echo Max Distance and Extra Echo Min Amplitude can also be viewed in the spectrum. The tank is considered empty when an echo is within the minimum and maximum distance and the amplitude is above the specified limit.

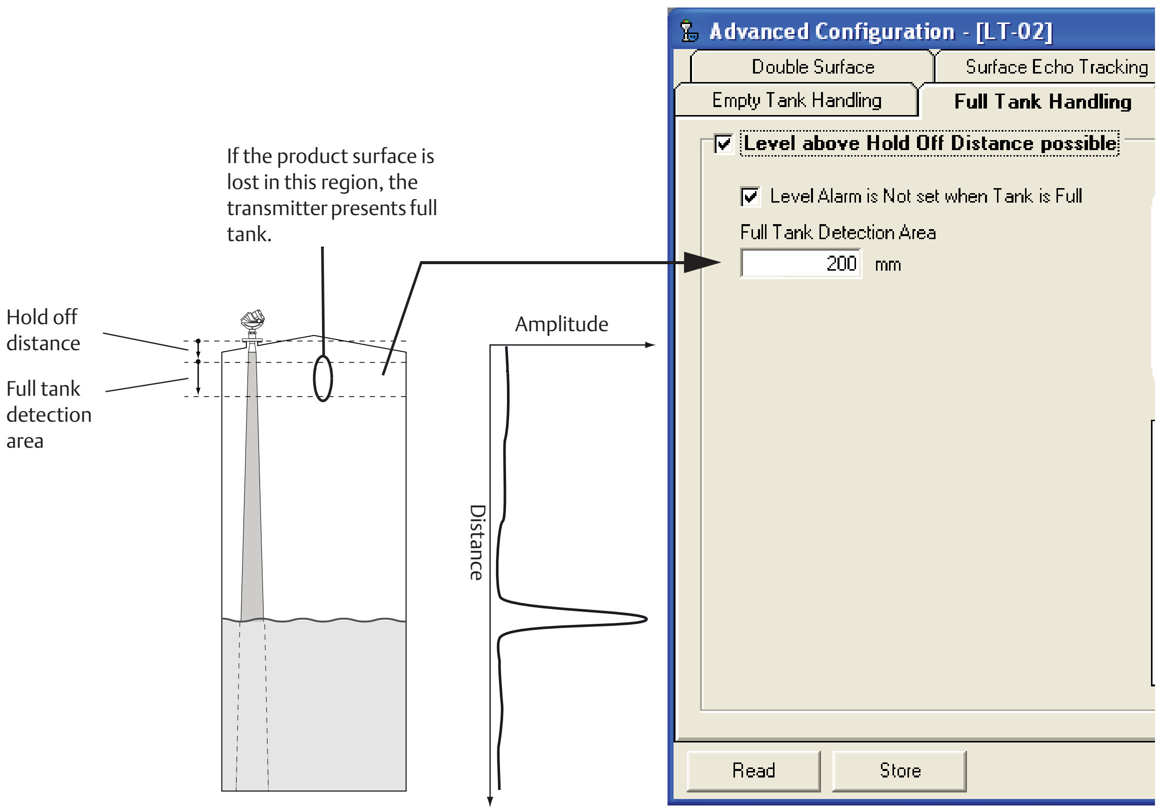

Extra echo max. distance
Extra echo min. distance
Amplitude
Distance
Advanced Configuration - [LT-02]
Double Surface
Surface Echo Tracking
Empty Tank Handling
Full Tank Handling
Level Alarm is Not set when Tank is Empty
Use Automatic Extra Echo Detection Settings
Activate Extra Echo Function
Extra Echo Min Distance
18168 mm
Extra Echo Max Distance
20168 mm
Extra Echo Min Amplitude
2000 mV
Use Automatic Empty Tank Handling Settings
Bottom Echo visible if Tank is Empty
Empty Tank Detection Area

C.4.2 Full tank handling

With the Full Tank Handling function product levels close to the antenna can be reported as a 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 where the tank is considered full is specified by the *Full Tank Detection Area*
- The level alarm for Full Tank is normally disabled



C.4.3 Double bounce

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

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

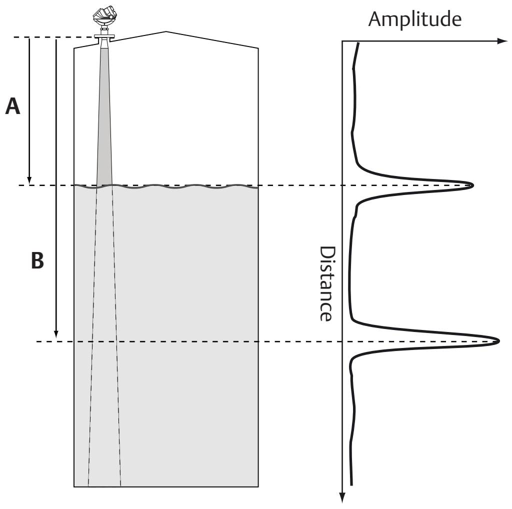
The Double Bounce function is used for managing problems with echoes appearing in the tank because of the tank shape stronger than the surface echo itself.

The Double Bounce Offset is given by the following formula:

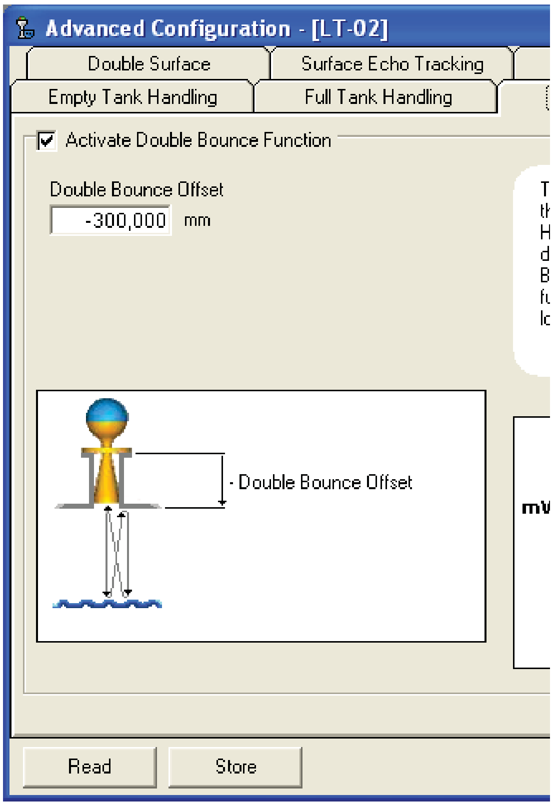
Double Bounce Offset = B - 2*A,

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

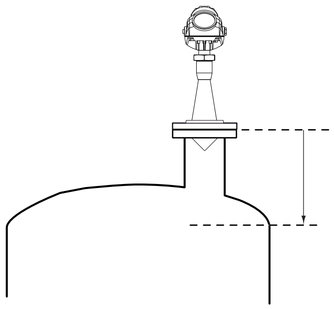
Note that the surface echo is required to suppress the double bounce. If the surface echo enters the hold off distance region, there is no product surface reference and the double bounce might be interpreted as the surface echo.



Double bounce offset=B - 2*A

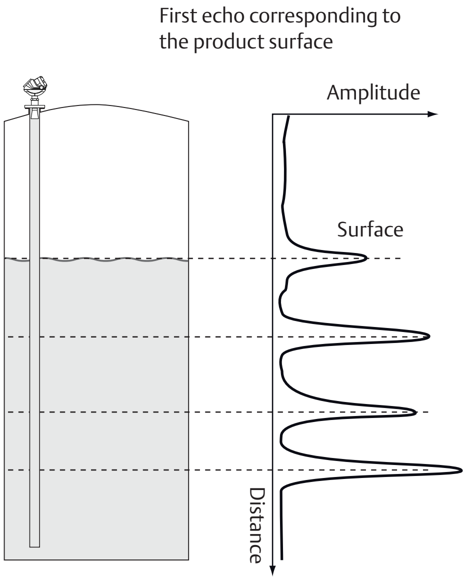


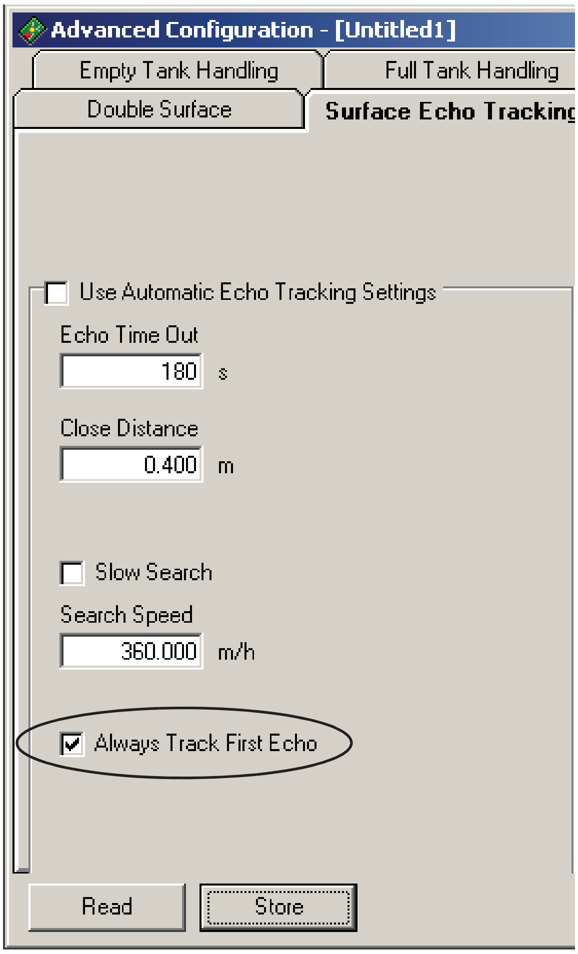
C.4.4 Surface echo tracking



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

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





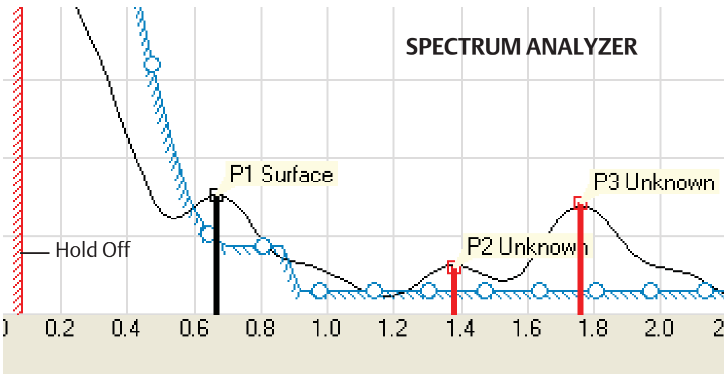
C.4.5 Hold off setting

The Hold Off parameter is set to a default value that rarely needs any adjustment (see “Hold off distance” on page 238 for definition of Hold Off distance). The Process Seal antenna is slightly more affected by disturbances in the nozzle than the cone and rod antennas. If necessary, a small Hold Off adjustment may be sufficient to solve the problem.

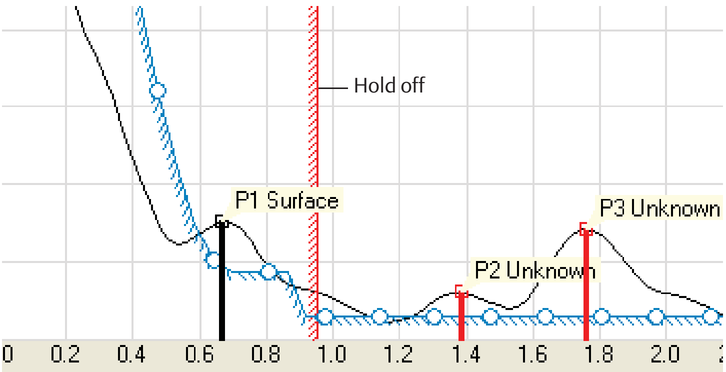
In a typical situation, a small object, such as a weld joint, may give rise to a disturbing echo. If this disturbance is strong enough, the transmitter may misinterpret this echo as the product surface. By setting the Hold Off large enough to avoid a measurement within and close to the nozzle, the problem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

The Spectrum Plot function in RRM allows for adjustment to the Hold Off distance:

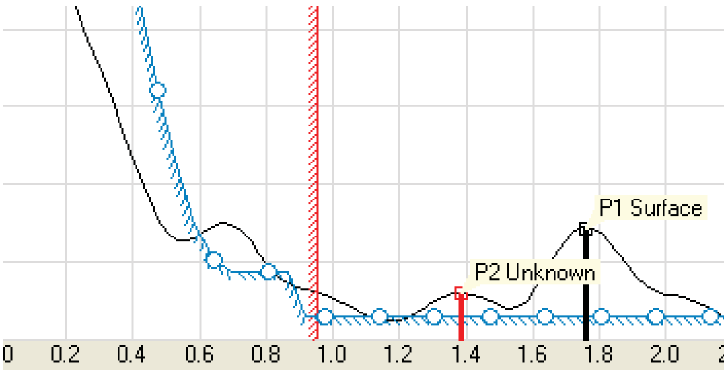
1. In RRM, click the **Spectrum Plot** icon to open the Spectrum Analyzer window.
2. Select the **Configuration Mode** tab.
3. Click the **Read** button and view the amplitude versus distance graph. If there is a disturbance caused by an object in the nozzle, the transmitter may misinterpret the position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



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



6. The transmitter will now disregard any disturbing echoes in the nozzle and find the product surface.



Appendix D Performing Proof Test

D.1 Performing proof test

This test detects approximately 95 % of the possible Dangerously Undetected (DU) failures of the transmitter including the sensor element. Here is a description of how to perform the test using a Field Communicator, RRM, or AMS® Suite. Note that the transmitter is not safety-rated during proof tests. Alternative means should be used to ensure process safety during such activities.

Required tools: HART® host/communicator and a mA meter.

D.2 Field communicator

Prior to this test, inspect the echo curve to ensure that no disturbing echoes affecting the measurement performance are present.

HART Sequence: [2, 6, 1]

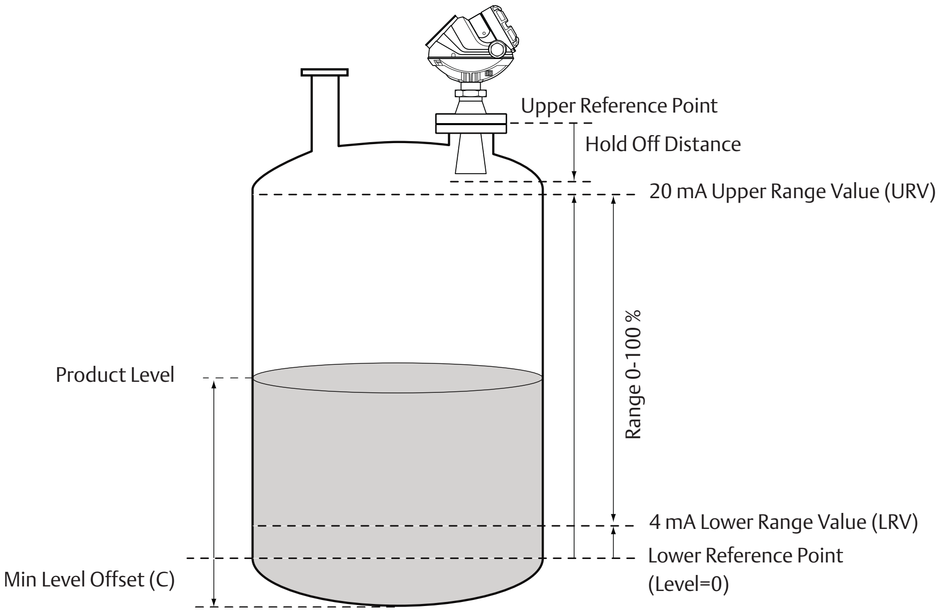
1. Bypass the safety PLC or take other appropriate actions to avoid false trip.
2. Disable write protection if the function is enabled.

   HART Sequence: [3, 2, 1, 2, 1]. Type the password.
3. Using loop test, enter the mA value representing the high alarm current. Verify that the analog output current is correct using the reference meter.
   This step tests for compliance voltage problems, such as low power supply voltage or increased wiring resistance.

   HART Sequence: [2, 4, 1, 7]. Select **3 Other**. Enter the analog output level representing the high alarm current. Press **Enter** and click **OK**.
   Verify that the analog output current is correct. Click **Abort** to end loop test.
4. Using loop test, enter the mA value representing the low alarm current. Verify that the analog output current is correct using the reference meter.
   This step tests for possible quiescent current related failures.

   HART Sequence: [2, 4, 1, 7]. Select **3 Other**. Enter the analog output level representing the low alarm current. Press **Enter** and click **OK**.
   Verify that the analog output current is correct. Click **Abort** to end loop test. Verify that the Current output is restored to the original mode.

Figure D-1. Range Values



5. Perform a two-point calibration check of the transmitter by applying level at two points within the measuring range. Verify that the current output corresponds to the level input values using a known reference measurement.
This step verifies that the analog output is correct in the operating range and that the Primary Variable is properly configured.

   Note that the applied level has to be between the Upper and Lower Range values, otherwise the transmitter enters alarm mode. If the applied level is outside the Maximum Measuring Range, the level reading accuracy may be reduced. For best performance, use the
4-20 mA range points as calibration points. See Figure 1.

6. Enable write protection.

   HART Sequence: [3, 2, 1, 2, 1].

7. Restore the loop to full operation.

8. Remove the bypass from the safety PLC or otherwise restore normal operation.

9. Document the test results for future reference.

D.3 RRM

Prior to this test, inspect the echo curve to ensure that no disturbing echoes affecting the measurement performance are present.

RRM: Tools / Echo Curve

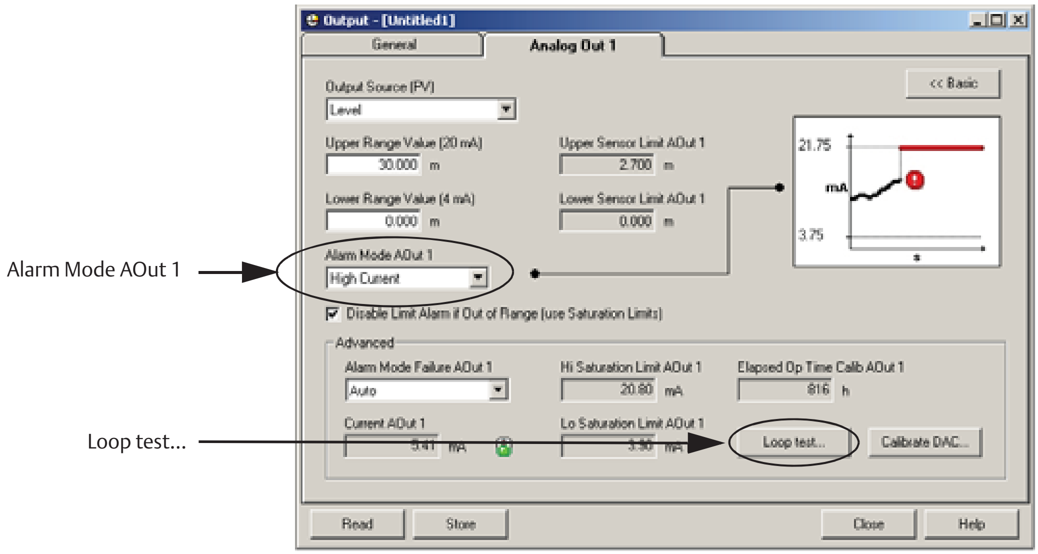
1. Bypass the safety PLC or take other appropriate actions to avoid false trip.

2. Disable write protection if the function is enabled.

   RRM: Select **Tools, Lock / Unlock Configuration Area** from the menu.
   Type the password being used for this device and click **OK**.

3. Set Alarm mode to High Current. Using loop test, enter the mA value representing the high alarm current. Verify that the analog output current is correct using the reference meter.
   This step tests for compliance voltage problems, such as low power supply voltage or increased wiring resistance.

   RRM: Select **Setup, Output** from the menu.



   Make sure **Alarm Mode AOut 1** is set to High Current. Click **Store** to save changes. Click **Loop test...** and enter the **Current AOut 1** value representing the high alarm current.
   Click **Start** and verify that the output current is correct.
   Click **Stop** to end loop test.

4. Set Alarm mode to Low Current. Using loop test, enter the mA value representing the low alarm current. Verify that the analog output current is correct using the reference meter.
   This step tests for possible quiescent current related failures.

   RRM: Set **Alarm Mode AOut 1** to Low Current. Click **Store** to save changes. Click **Loop test...** and enter the **Current AOut 1** value representing the low alarm current.
   Click **Start** and verify that the output current is correct.
   Click **Stop** to end loop test.

5. Restore the Alarm mode to the original mode used in the loop. Verify that the analog output current is correct.

   RRM: Set **Alarm Mode AOut 1** to original mode. Click **Store** to save changes.
   Verify that the output current is correct.

6. Perform a two-point calibration check of the transmitter by applying level at two points within the measuring range. Verify that the current output corresponds to the level input values using a known reference measurement.
   This step verifies that the analog output is correct in the operating range and that the Primary Variable is properly configured.

   Note that the applied level has to be between the Upper and Lower Range values, otherwise the transmitter enters alarm mode. If the applied level is outside the Maximum Measuring Range, the level reading accuracy may be reduced. For best performance, use the
   4-20 mA range points as calibration points. See Figure 1 on page 252.

7. Enable write protection.

   RRM: Select **Tools, Lock / Unlock Configuration Area** from the menu.

8. Restore the loop to full operation.

9. Remove the bypass from the safety PLC or otherwise restore normal operation.

10. Document the test results for future reference.

D.4 AMS Suite

Prior to this test, inspect the echo curve to ensure that no disturbing echoes affecting the measurement performance are present.

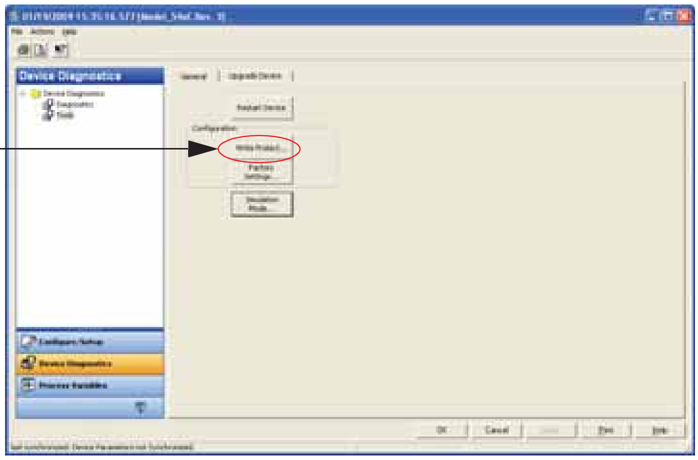
AMS: Click **Configure / Setup / Echo Curve**

1. Bypass the safety PLC or take other appropriate actions to avoid false trip.

2. Disable write protection if the function is enabled.

   AMS: Select **Device Diagnostics/ Tools** from the left menu, and choose the **General** tab.

   Write Protect...

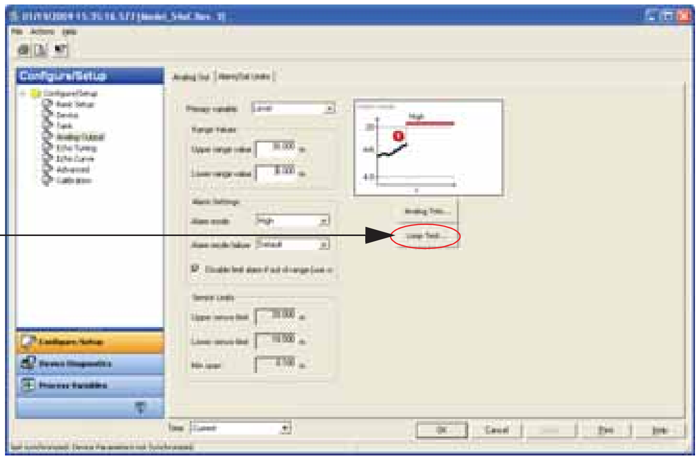
   

   Click **Write Protect...** and follow the instructions. (Note that the password cannot be written with letters.)

3. Using loop test, enter the mA value representing the high alarm current. Verify that the analog output current is correct using the reference meter.
   This step tests for compliance voltage problems, such as low power supply voltage or increased wiring resistance.

   AMS: Select **Configure / Setup, Analog Output** from the menu.

   Loop Test...

Click **Loop Test...** Select **Other** and enter the mA value representing the high **Analog Output Level** and follow the instructions. Verify that the output current is correct.

4. Using loop test, enter the mA value representing the low alarm mode. Verify that the analog output current is correct using the reference meter.
   This step tests for possible quiescent current related failures.

   AMS: Select **Configure / Setup, Analog Output** from the menu. Click **Loop Test...** Select **Other** and enter the mA value representing the low **Analog Output Level** and follow the instructions. Click **OK** to save changes. Verify that the output current is correct.
   Select **End** to stop loop test. Verify that the Current output is restored to the original mode.

5. Perform a two-point calibration check of the transmitter by applying level at two points within the measuring range. Verify that the current output corresponds to the level input values using a known reference measurement.
   This step verifies that the analog output is correct in the operating range and that the Primary Variable is properly configured.

   Note that the applied level has to be between the Upper and Lower Range values, otherwise the transmitter enters alarm mode. If the applied level is outside the Maximum Measuring Range, the level reading accuracy may be reduced. For best performance, use the 4-20 mA range points as calibration points. See Figure 1 on page 252.

6. Enable write protection.

   AMS: Select Configure / Manual Setup from the menu, choose the Device tab, check **Write Protected**, and follow the instructions. (Note that the password cannot be written with letters.)

7. Restore the loop to full operation.

8. Remove the bypass from the safety PLC or otherwise restore normal operation.

9. Document the test results for future reference.

Appendix E Level Transducer Block

E.1 Overview

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

E.1.1 Definition

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

E.1.2 Channel definitions

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

Table E-1. Channel Assignments

Channel name	Channel number	Process variable
Level	1	RADAR_LEVEL
Ullage	2	RADAR_ULLAGE
Level Rate	3	RADAR_LEVELRATE
Signal Strength	4	RADAR_LEVEL_SIGNAL_STRENGTH
Volume	5	RADAR_VOLUME
Internal Temperature	6	RADAR_INTERNAL_TEMPERATURE

E.2 Parameters and descriptions

Table E-2. Level Transducer Block Parameters and Descriptions

Parameter	Index number	Default value	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	0x08(Auto) 0x08(Auto) 0x88(Auto | OOS) 0x08(Auto)	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	0x0000(0x0000)	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	0	Directory that specifies the number and starting indices of the transducers in the transducer block.
TRANSDUCER_TYPE	10	0x8180(0x8180)	Identifies the transducer.
XD_ERROR	11	0x00(No error)	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.
TRANSDUCER_TYPE_VER	13	769	Transducer type version = 0x0301
RADAR_LEVEL	14		Level

Parameter	Index number	Default value	Description
RADAR_LEVEL_RANGE	15	100 0 0X03f2(m) 3	The following sub-elements are available: • EU_100 • EU_0 • UNITS_INDEX • DECIMAL
RADAR_ULLAGE	16	-	Distance (Ullage)
RADAR_LEVELRATE	17	-	Level Rate
RADAR_LEVELRATE_RANGE	18	100 0 0X0425(m/s) 3	The following sub-elements are available: • EU_100 • EU_0 • UNITS_INDEX • DECIMAL
RADAR_LEVEL_SIGNAL_STRENGTH	19	-	Signal strength
RADAR_LEVEL_SIGNAL_STRENGTH_RANGE	20	100 0 0x04db(mV) 3	The following sub-elements are available: • EU_100 • EU_0 • UNITS_INDEX • DECIMAL
RADAR_VOLUME	21		Volume
RADAR_VOLUME_RANGE	22	100 0 0x040a(m) 3	The following sub-elements are available: • EU_100 • EU_0 • UNITS_INDEX • DECIMAL
RADAR_INTERNAL_TEMPERATURE	23	-	Internal Temperature
RADAR_INTERNAL_TEMPERATURE_RANGE	24	100 0 0x03e9 3	The following sub-elements are available: • EU_100 • EU_0 • UNITS_INDEX • DECIMAL
ANTENNA_TYPE	25	0x00000000	Antenna Type
ANTENNA_TCL	26	0	TCL (Tank Connection Length)
ANTENNA_PIPE_DIAM	27	0.1	Pipe Inner Diameter
DAMP_VALUE	28	2	Damping value
SIGN_PROC_CONFIG	29	0x00010000	Enable pipe inner diameter
ANTENNA_EXTENSION	30	0x00000000(None)	Extended antenna
LCD_PARAMETERS	31	0x00000000(0x00000000)	Parameters to show
LCD_LANGUAGE	32	0x00000000(English)	Language on display
LCD_LENGTH_UNIT	33	0x00000000	Length unit on display
LCD_VOLUME_UNIT	34	0x00000000	Volume unit on display
LCD_TEMPERATURE_UNIT	35	0x00000000	Temperature unit on display
LCD_VELOCITY_UNIT	36	0x00000000	Velocity unit on display
GEOM_DIST_OFFSET	37	0	Distance Offset
GEOM_TANK_HEIGHT	38	20	Tank Height (R)
GEOM_MIN_LEVEL_OFFSET	39	0	Minimum distance offset (C)
GEOM_HOLD_OFF	40	0	Hold off distance
GEOM_CAL_DISTANCE	41	0	Calibration Distance
GEOM_TANK_TYPE	42	0x00000000(Unknown)	Tank type
GEOM_TANK_BOTTOM_TYPE	43	0x00000000(Unknown)	Tank bottom type

Parameter	Index number	Default value	Description
ENV_ENVIRONMENT	44	0x00000000(0x00000000)	Process Condition
ENV_PRESENTATION	45	0x0c431000(Tank contains double bounces | Slow Search | Show negative level as zero | Don't set invalid level when empty | Don't set invalid level when full | Use jump filter)	Tank Presentation
ENV_DEVICE_MODE	46	0x00000000(Normal operation)	Service mode
ENV_DIELECTR_CONST	47	0x00000000(Unknown)	Dielectric constant
ENV_WRITE_PROTECT	48	0	Write protect
DIAGN_DEV_ALERT	49		Errors, Warnings, Status
DIAGN_VERSION	50	1D0	Gauge SW version
DIAGN_REVISION	51	3	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		
SENSOR_DIAGNOSTICS	58		
P1451_SLAVE_STATS	59		
P1451_HOST_STATS	60		
FF_SUPPORT_INFO	61		
HEART_BEAT_COUNT	62		
RADAR_LEVEL_TYPE	63	0x0000006e(Level)	

Table E-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 4” / 100 mm
21	Rod 10” / 250 mm
22	Antenna B3
23	Antenna B4
24	Antenna B5
30	Cone 2” Exotic
31	Cone 3” Exotic
32	Cone 4” Exotic
33	Cone 6” Exotic
34	Cone 8” Exotic
40	Antenna D1
41	Antenna D2
42	Antenna D3
43	Antenna D4
44	Antenna D5

Table E-4. Device Mode

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

Table E-5. Tank Environment

Bit Number	Value of ENV_ENVIRONMENT	DESCRIPTION
0	0x00000001	Reserved
1	0x00000002	Rapid Level Changes (> 40 mm/s, > 1.5 in/s)
2	0x00000004	Reserved
3	0x00000008	Turbulent Surface
4	0x00000010	Foam
5	0x00000020	Solid Product

Table E-6. Presentation

Bit Number	Value of ENV_PRESENTATION	DESCRIPTION
0	0x00000001	Reserved
1	0x00000002	Level above min distance possible
2	0x00000004	Predicting_Allowed
3	0x00000008	Bottom echo always visible if tank is empty
4	0x00000010	Tank contains double bounces
5	0x00000020	Slow Search
6	0x00000040	Enable double surface
7	0x00000080	Select lower surface
8	0x00000100	Bit 7, Reserved
9	0x00000200	Show negative level as zero
10	0x00000400	Bit 9, Reserved
11	0x00000800	Bottom Projection
12	0x00001000	Bit 11, Reserved
13	0x00002000	Don't set invalid level in antenna zone
14	0x00004000	Don't set invalid level when full
15	0x00008000	Don't set invalid level when full
16	0x00010000	Bit 15, Reserved
17	0x00020000	Bit 16, Reserved
18	0x00040000	Bit 17, Reserved
19	0x00080000	Use jump filter
20	0x00100000	Bit 19, Reserved
21	0x00200000	Use Extra echo detection
22	0x00400000	Always track first echo
23	0x00800000	Bit 22, Reserved
24	0x01000000	Bit 23, Reserved
25	0x02000000	Calculate signal quality metrics
26	0x04000000	Infinite alarm delay
27	0x08000000	Bit 26, Reserved
28	0x10000000	Bit 27, Reserved
29	0x20000000	Bit 28, Reserved
30	0x40000000	Bit 29, Reserved
31	0x80000000	Bit 30, Reserved

Table E-7. LCD Parameters

Bit Number	Value of ENV_PRESENTATION	DESCRIPTION
0	0x00000001	Reserved
1	0x00000002	Level
2	0x00000004	Distance
3	0x00000008	Level Rate
4	0x000000010	Signal Strength
5	0x000000020	Volume
6	0x000000040	Internal Temperature
7	0x000000080	Bit 6, reserved
8	0x000000100	Bit 7, reserved

Bit Number	Value of ENV_PRESENTATION	DESCRIPTION
9	0x000000200	Bit 8, reserved
10	0x000000400	Bit 9, reserved
11	0x000000800	Bit 10, reserved

Table E-8. Tank Type

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

Table E-9. Tank Bottom Type

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

Table E-10. Dielectrical Constant

DEVICE VALUE	ENV_DIELECTR_CONST
0	Unknown
1	1.9 - 2.5 (e.g. oil based)
2	2.5 - 4.0 (e.g. oil based)
3	4.0 - 10 (e.g. alcohols, acids)
4	> 10 (e.g. water based)

E.3 Supported units

E.3.1 Unit codes

Table E-11. Length

Value	Display	Description
0(1)	Default	Unit for LCD is the same as set in the value window
1010	m	meter
1012	cm	centimeter
1013	mm	millimeter
1018	ft	feet
1019	in	inch

(1) Default only for parameter LCD_LENGTH_UNIT.

Table E-12. Level Rate

Value	Display	Description
0(1)	Default	Unit for LCD is the same as set in the value window
1061	M/s	Meter per second
1063	M/h	Meter per hour
1067	Ft/s	Feet per second
1069	In/m	Inch per minute

(1) Default only for parameter LCD_VELOCITY_UNIT.

Table E-13. Temperature

Value	Display	Description
0(1)	Default	Unit for LCD is the same as set in the value window
1001	°C	Degree Celsius
1002	°F	Degree Fahrenheit

(1) Default only for parameter LCD_TEMPERATURE_UNIT.

Table E-14. Signal Strength

Value	Display	Description
1243	mV	millivolt

Table E-15. Volume

Value	Display	Description
0(1)	Default	Unit for LCD is the same as set in the value window
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 (oil)

(1) Default only for parameter LCD_VOLUME_UNIT.

E.4 Diagnostics device errors

In addition to the BLOCK_ERR and XD_ERROR parameters, more detailed information on the measurement status can be obtained via SENSOR_DIAGNOSTICS. Table H-1 on page 282 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 H-1. Start with the first corrective action and then try the second.

Appendix F Register Transducer Block

F.1 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 registers 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 E: 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 Business Unit support personnel.

F.1.1 Register access transducer block parameters

Table F-1. Register Access Transducer Block Parameters

Parameter	Index number	Default value	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	0	The strategy field can be used to identify grouping of blocks. This data is not checked or processed by the block.
ALERT_KEY	4	0	The identification number of the plant unit. This information may be used in the host for sorting alarms, etc.
MODE_BLK	5	0x08(Auto) 0x08(Auto) 0x88(Auto | OOS) 0x08(Auto)	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.

Parameter	Index number	Default value	Description
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	0	Directory that specifies the number and starting indices of the transducers in the transducer block.
TRANSDUCER_TYPE	10	0x8080(0x8080)	Identifies the transducer.
XD_ERROR	11		A transducer block alarm subcode.
COLLECTION_DIRECTORY	12	0	A directory that specifies the number, starting indices, and DD Item IDs of the data collections in each transducer within a transducer block.
TRANSDUCER_TYPE_VER	13	769	Transducer type version = 0x0301
RB_PARAMETER	14	0	Reserved. RB parameter
INP_REG_1_TYPE	15		Register type
INP_REG_1_FLOAT	16		If the register contains a float value, it shall be displayed here
INP_REG_1_INT_DEC	17		If the register contains a DWORD value and *dec* is chosen, it shall be displayed here
INP_REG_2_TYPE	18		Register type
INP_REG_2_FLOAT	19		If the register contains a float value, it shall be displayed here
INP_REG_2_INT_DEC	20		If the register contains a DWORD value and *dec* is chosen, it shall be displayed here
INP_REG_3_TYPE	21		Register type
INP_REG_3_FLOAT	22		If the register contains a float value, it shall be displayed here
INP_REG_3_INT_DEC	23		If the register contains a DWORD value and *dec* is chosen, it shall be displayed here
INP_REG_4_TYPE	24		Register type
INP_REG_4_FLOAT	25		If the register contains a float value, it shall be displayed here
INP_REG_4_INT_DEC	26		If the register contains a DWORD value and *dec* is chosen, it shall be displayed here
INP_REG_5_TYPE	27		Register type
INP_REG_5_FLOAT	28		If the register contains a float value, it shall be displayed here
INP_REG_5_INT_DEC	29		If the register contains a DWORD value and *dec* is chosen, it shall be displayed here
INP_REG_6_TYPE	30		Register type
INP_REG_6_FLOAT	31		If the register contains a float value, it shall be displayed here
INP_REG_6_INT_DEC	32		If the register contains a DWORD value and *dec* is chosen, it shall be displayed here
INP_REG_7_TYPE	33		Register type
INP_REG_7_FLOAT	34		If the register contains a float value, it shall be displayed here

Parameter	Index number	Default value	Description
INP_REG_7_INT_DEC	35		If the register contains a DWORD value and *dec* is chosen, it shall be displayed here
INP_REG_8_TYPE	36		Register type
INP_REG_8_FLOAT	37		If the register contains a float value, it shall be displayed here
INP_REG_8_INT_DEC	38		If the register contains a DWORD value and *dec* is chosen, it shall be displayed here
INP_REG_9_TYPE	39		Register type
INP_REG_9_FLOAT	40		If the register contains a float value, it shall be displayed here
INP_REG_9_INT_DEC	41		If the register contains a DWORD value and *dec* is chosen, it shall be displayed here
INP_REG_10_TYPE	42		Register type
INP_REG_10_FLOAT	43		If the register contains a float value, it shall be displayed here
INP_REG_10_INT_DEC	44		If the register contains a DWORD value and *dec* is chosen, it shall be displayed here
DB_REG_1_TYPE	45		Register type
DB_REG_1_FLOAT	46		If the register contains a float value, it shall be displayed here
DB_REG_1_INT_DEC	47		If the register contains a DWORD value and *dec* is chosen, it shall be displayed here
DB_REG_2_TYPE	48		Register type
DB_REG_2_FLOAT	49		If the register contains a float value, it shall be displayed here
DB_REG_2_INT_DEC	50		If the register contains a DWORD value and *dec* is chosen, it shall be displayed here
DB_REG_3_TYPE	51		Register type
DB_REG_3_FLOAT	52		If the register contains a float value, it shall be displayed here
DB_REG_3_INT_DEC	53		If the register contains a DWORD value and *dec* is chosen, it shall be displayed here
DB_REG_4_TYPE	54		Register type
DB_REG_4_FLOAT	55		If the register contains a float value, it shall be displayed here
DB_REG_4_INT_DEC	56		If the register contains a DWORD value and *dec* is chosen, it shall be displayed here
DB_REG_5_TYPE	57		Register type
DB_REG_5_FLOAT	58		If the register contains a float value, it shall be displayed here
DB_REG_5_INT_DEC	59		If the register contains a DWORD value and *dec* is chosen, it shall be displayed here
DB_REG_6_TYPE	60		Register type
DB_REG_6_FLOAT	61		If the register contains a float value, it shall be displayed here
DB_REG_6_INT_DEC	62		If the register contains a DWORD value and *dec* is chosen, it shall be displayed here
DB_REG_7_TYPE	63		Register type
DB_REG_7_FLOAT	64		If the register contains a float value, it shall be displayed here

Parameter	Index number	Default value	Description
DB_REG_7_INT_DEC	65		If the register contains a DWORD value and *dec* is chosen, it shall be displayed here
DB_REG_8_TYPE	66		Register type
DB_REG_8_FLOAT	67		If the register contains a float value, it shall be displayed here
DB_REG_8_INT_DEC	68		If the register contains a DWORD value and *dec* is chosen, it shall be displayed here
DB_REG_9_TYPE	69		Register type
DB_REG_9_FLOAT	70		If the register contains a float value, it shall be displayed here
DB_REG_9_INT_DEC	71		If the register contains a DWORD value and *dec* is chosen, it shall be displayed here
DB_REG_10_TYPE	72		Register type
DB_REG_10_FLOAT	73		If the register contains a float value, it shall be displayed here
DB_REG_10_INT_DEC	74		If the register contains a DWORD value and *dec* is chosen, it shall be displayed here
RM_COMMAND	75		Used to set what will be read or write from a secondary master.
RM_DATA	76		Data read/write from secondary master.
RM_STATUS	77		Status read by a secondary master.
INP_SEARCH_START_NBR	78		Search start number for input registers.
DB_SEARCH_START_NBR	79		Search start number for holding registers.

Appendix G Advanced Configuration Transducer Block

G.1 Overview

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

G.1.1 Advanced configuration transducer block parameters

Table G-1. Advanced Configuration Transducer Block Parameters

Parameter	Index number	Default value	Description
ST_REV	1	N/A	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	N/A	The user description of the intended application of the block.
STRATEGY	3	0	The strategy field can be used to identify grouping of blocks. This data is not checked or processed by the block.
ALERT_KEY	4	0	The identification number of the plant unit. This information may be used in the host for sorting alarms, etc.
MODE_BLK	5	0x88(Auto | OOS) 0x08(Auto)	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	N/A	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	N/A	
BLOCK_ALM	8	N/A	
TRANSDUCER_DIRECTORY	9	0	
TRANSDUCER_TYPE	10	0x8121(0x8121)	Identifies the transducer.

Parameter	Index number	Default value	Description
XD_ERROR	11	N/A	A transducer block alarm subcode.
COLLECTION_DIRECTORY	12	0	
TRANSDUCER_TYPE_VER	13	769	
AMPLITUDE_THRESHOLD_CURVE	14	0x00000000(Undefined) 0	Command. The following sub-elements are available: • ACTION • VALUE
SIMULATION_MODE	15	0x00000000 (0x00000000) 0	Simulation of measurement values. The following sub-elements are available: • ACTION • VALUE
SURFACE_SEARCH	16	0	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	17	0x00000000(No Action)	Command.
SET_CONSTANT_THRESHOLD	18	0	A constant amplitude threshold can be used to filter out noise.
ECHO_UPDATE	19	0x00000000 (Uninitialized)	
ECHO_FOUND_DISTANCE	20	0	
ECHO_FOUND_AMPLITUDE	21	0	
ECHO_FOUND_CLASS	22	0x00(Unknown)	
ECHO_COMMAND	23	0x00000000 (Uninitialized)	The following sub-elements are available: • ACTION • VALUE
ECHO_FALSE	24	0	
VOL_VOLUME_CALC_METHOD	25	0x000000fb(None)	
VOL_IDEAL_DIAMETER	26	20	Tank diameter
VOL_IDEAL_LENGTH	27	20	Tank length
VOL_VOLUME_OFFSET	28	0	Volume offset
VOL_STRAP_TABLE_LENGTH	29	2	Number of strap points
VOL_STRAP_LEV_1	30	0	Strap value level
VOL_STRAP_VOL_1	31	0	Strap value volume
VOL_STRAP_LEV_2	32	10	Strap value level
VOL_STRAP_VOL_2	33	10	Strap value volume
VOL_STRAP_LEV_3	34	0	Strap value level
VOL_STRAP_VOL_3	35	0	Strap value volume
VOL_STRAP_LEV_4	36	0	Strap value level
VOL_STRAP_VOL_4	37	0	Strap value volume
VOL_STRAP_LEV_5	38	0	Strap value level
VOL_STRAP_VOL_5	39	0	Strap value volume
VOL_STRAP_LEV_6	40	0	Strap value level
VOL_STRAP_VOL_6	41	0	Strap value volume
VOL_STRAP_LEV_7	42	0	Strap value level
VOL_STRAP_VOL_7	43	0	Strap value volume
VOL_STRAP_LEV_8	44	0	Strap value level

Parameter	Index number	Default value	Description
VOL_STRAP_VOL_8	45	0	Strap value volume
VOL_STRAP_LEV_9	46	0	Strap value level
VOL_STRAP_VOL_9	47	0	Strap value volume
VOL_STRAP_LEV_10	48	0	Strap value level
VOL_STRAP_VOL_10	49	0	Strap value volume
VOL_STRAP_LEV_11	50	0	Strap value level
VOL_STRAP_VOL_11	51	0	Strap value volume
VOL_STRAP_LEV_12	52	0	Strap value level
VOL_STRAP_VOL_12	53	0	Strap value volume
VOL_STRAP_LEV_13	54	0	Strap value level
VOL_STRAP_VOL_13	55	0	Strap value volume
VOL_STRAP_LEV_14	56	0	Strap value level
VOL_STRAP_VOL_14	57	0	Strap value volume
VOL_STRAP_LEV_15	58	0	Strap value level
VOL_STRAP_VOL_15	59	0	Strap value volume
VOL_STRAP_LEV_16	60	0	Strap value level
VOL_STRAP_VOL_16	61	0	Strap value volume
VOL_STRAP_LEV_17	62	0	Strap value level
VOL_STRAP_VOL_17	63	0	Strap value volume
VOL_STRAP_LEV_18	64	0	Strap value level
VOL_STRAP_VOL_18	65	0	Strap value volume
VOL_STRAP_LEV_19	66	0	Strap value level
VOL_STRAP_VOL_19	67	0	Strap value volume
VOL_STRAP_LEV_20	68	0	Strap value level
VOL_STRAP_VOL_20	69	0	Strap value volume
LENGTH_UNIT	70	0x000003f2(m)	
VOLUME_UNIT	71	0x0000040a(m)	
SIGNAL_STRENGTH_UNIT	72	0x000004db(mV)	

Appendix H Resource Block

H.1 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.

H.2 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	Default value	Description
ST_REV	01	0	The revision level of the static data associated with the function block.
TAG_DESC	02		The user description of the intended application of the block.
STRATEGY	03	0	The strategy field can be used to identify grouping of blocks.
ALERT_KEY	04	0	The identification number of the plant unit.
MODE_BLK	05	0x08(Auto) 0x08(Auto) 0x88(Auto | OOS) 0x08(Auto)	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
BLOCK_ERR	06	0x0000(0x0000)	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.
RS_STATE	07	0x04(Online)	State of the function block application state machine.
TEST_RW	08		Read/write test parameter - used only for conformance testing.
DD_RESOURCE	09		String identifying the tag of the resource which contains the Device Description for this resource.

Parameter	Index number	Default value	Description
MANUFAC_ID	10	0x00001151	Manufacturer identification number – used by an interface device to locate the DD file for the resource.
DEV_TYPE	11	5400	Manufacturer's model number associated with the resource - used by interface devices to locate the DD file for the resource.
DEV_REV	12	3	Manufacturer revision number associated with the resource - used by an interface device to locate the DD file for the resource.
DD_REV	13	1	Revision of the DD associated with the resource - used by an interface device to locate the DD file for the resource.
GRANT_DENY	14	0x00(0x00)	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	0x0001(Scalar Input)	The types of hardware available as channel numbers.
RESTART	16	0x01(Run)	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.
FEATURES	17	0x0c1b(Unicode | Reports | Soft W Lock | Hard W Lock | Multi-bit Alarm (Bit-Alarm) Support | Restart/Relink after FB_Action)	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	0x0000(0x0000)	Used to select resource block options.
CYCLE_TYPE	19	0x0003(Scheduled | Block Execution)	Identifies the block execution methods available for this resource.
CYCLE_SEL	20	0x0000(0x0000)	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.
MIN_CYCLE_T	21	8000	Time duration of the shortest cycle interval of which the resource is capable.
MEMORY_SIZE	22	16	Available configuration memory in the empty resource. To be checked before attempting a download.
NV_CYCLE_T	23	960000	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.
FREE_SPACE	24	23.8095	Percent of memory available for further configuration. Zero in a preconfigured device.
FREE_TIME	25	0	Percent of the block processing time that is free to process additional blocks.
SHED_RCAS	26	640000	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

Parameter	Index number	Default value	Description
SHED_ROUT	27	640000	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
FAULT_STATE	28	0x01(Clear)	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.
SET_FSTATE	29	0x01(OFF)	Allows the FAIL_SAFE condition to be manually initiated by selecting Set.
CLR_FSTATE	30	0x01(Off)	Writing a Clear to this parameter will clear the device FAIL_SAFE if the field condition has cleared.
MAX_NOTIFY	31	3	Maximum number of unconfirmed notify messages possible.
LIM_NOTIFY	32	3	Maximum number of unconfirmed alert notify messages allowed.
CONFIRM_TIME	33	640000	The time the resource will wait for confirmation of receipt of a report before trying again. Retry will not happen when CONFIRM_TIME=0.
WRITE_LOCK	34	0x01(Not Locked)	If set, no writes from anywhere are allowed, except to clear WRITE_LOCK. Block inputs will continue to be updated.
UPDATE_EVT	35		This alert is generated by any change to the static data.
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.
ALARM_SUM	37		The current alert status, unacknowledged states, unreported states, and disabled states of the alarms associated with the function block.
ACK_OPTION	38	0x0000(0x0000)	Selection of whether alarms associated with the function block will be automatically acknowledged.
WRITE_PRI	39	0	Priority of the alarm generated by clearing the write lock.
WRITE_ALM	40	0X00(Uninitialized) 0x00(Uninitialized) 01/01/72 00:00:00 0x0000(Other) 0x00(State 0)	This alert is generated if the write lock parameter is cleared. Five sub-elements available: - UNACKNOWLEDGED - ALARM_STATE - TIME_STAMP - SUB_CODE - VALUE
ITK_VER	41	5	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.
distributor	42	0x00001151 (Rosemount)	Reserved for use as distributor ID. No FOUNDATION enumerations defined at this time.
DEV_STRING	43	0	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.
XD_OPTIONS	44	0x00000000 (0x00000000)	Indicates which transducer block licensing options are enabled.

Parameter	Index number	Default value	Description
FB_OPTIONS	45	0x00000000 (0x00000000)	Indicates which function block licensing options are enabled.
DIAG_OPTIONS	46	0x00000000 (0x00000000)	Indicates which diagnostics licensing options are enabled.
MISC_OPTIONS	47	0x00000000 (0x00000000)	Indicates which miscellaneous licensing options are enabled.
RB_SFTWR_REV_MAJOR	48	3	Major revision of software that the resource block was created with.
RB_SFTWR_REV_MINOR	49	0	Minor revision of software that the resource block was created with.
RB_SFTWR_REV_BUILD	50	33	Build of software that the resource block was created with.
RB_SFTWR_REV_ALL	51	3-00-033 - Mon Apr 18 16:47:05 2011 by chadwar	The string will contain 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
hardware_rev	52	6	Hardware revision of the hardware that has the resource block in it.
output_board_sn	53		Output board serial number.
FINAL_ASSY_NUM	54	0	The same final assembly number placed on the neck label.
detailed_status	55	0x00000000 (0x00000000)	Indicates the state of the transmitter. See Resource Block detailed status codes.
summary_status	56	0x01(No repair needed)	An enumerated value of repair analysis.
message_date	57	01/01/84 00:00:00	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.
SELF_TEST	59	0x01(No self test)	Instructs resource block to perform self-test. Tests are device specific.
define_write_lock	60	0x01(Everything locked)	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.
save_config_now	61	0x01(No save)	Allows the user to optionally save all non-volatile information immediately.
save_config_blocks	62	0	Number of EEPROM blocks that have been modified since last burn. This value will count down to zero when the configuration is saved.
start_with_defaults	63	0x01(No NV defaults)	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)
simulate_IO	64	0x01(Jumper off)	Status of simulate switch.
security_IO	65	0x01(Jumper off)	Status of security switch.

Parameter	Index number	Default value	Description
SIMULATE_STATE	66	0x01(Jumper off* no simulation)	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
download_mode	67	0x01(Run Mode)	Gives access to the boot block code for over-the-wire downloads. 0 = Uninitialized 1 = Run mode 2 = Download mode
RECOMMENDED_ACTION	68	0x0001 (No action required.)	Enumerated list of recommended actions displayed with a device alert.
FAILED_PRI	69	0	Designates the alarming priority of the FAILED_ALM.
FAILED_ENABLE	70	0x00007760 (Software Error | Sensor Database Error | Internal Temperature Critical | Electronics Failure - Main Board | Software Incompatibility Error | Memory Failure - Output Board | Internal Communication Failure | Electronics Failure - Output Board)	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	0x00000000 (0x00000000)	Mask of FAILED_ALM. Corresponds bit of bit to FAILED_ACTIVE. A bit on means that the condition is masked out from alarming.
FAILED_ACTIVE	72	0x00000000 (0x00000000)	Enumerated list of failure conditions within a device.
FAILED_ALM	73		Alarm indicating a failure within a device which makes the device non-operational.
MAINT_PRI	74	0	Designates the alarming priority of the MAINT_ALM
MAINT_ENABLE	75	0x08608000 (Device Simulation Active | Configuration Warning | Internal Temperature Out of Limits | Configuration Error	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	0x00000000 (0x00000000)	Mask of MAINT_ALM. Corresponds bit of bit to MAINT_ACTIVE. A bit on means that the condition is masked out from alarming.
MAINT_ACTIVE	77	0x00000000 (0x00000000)	Enumerated list of maintenance conditions within a device.
MAINT_ALM	78		Alarm indicating the device needs maintenance soon. If the condition is ignored, the device will eventually fail.
ADVISE_PRI	79	0	Designates the alarming priority of the ADVISE_ALM
ADVISE_ENABLE	80	0x10000000 (PlantWeb® Alerts Simulation Active)	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.

Parameter	Index number	Default value	Description
ADVISE_MASK	81	0x00000000 (0x00000000)	Mask of ADVISE_ALM. Corresponds bit of bit to ADVISE_ACTIVE. A bit on means that the condition is masked out from alarming.
ADVISE_ACTIVE	82	0x00000000 (0x00000000)	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.
HEALTH_INDEX	84	100	Parameter representing the overall health of the device, 100 being perfect and 10 being non-functioning. The value is based on the active PWA alarms.
PWA_SIMULATE	85	0x00(Simulation off)	Parameter allowing simulation of PWA alarms.

H.2.1 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:

- Electronics Failure - Output Board
- Internal Communication Failure
- Memory Failure - Output Board
- Software Incompatibility Error
- Electronics Failure - Main Board
- Internal Temperature Critical
- Sensor Database Error
- Software Error

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 281. 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:

- Configuration Error
- Level Measurement Failure
- Volume Measurement Failure
- Internal Temperature Out of Limits
- Configuration Warning
- Volume Measurement Warning
- Device Simulation Active

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 “Recommended actions for PlantWeb alerts” on page 282. 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. The following advisory alarm may be displayed:

- PlantWeb Alerts Simulation 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 "Recommended actions for PlantWeb alerts" on page 282. 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.

H.2.2 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.

H.2.3 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.

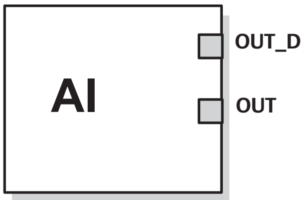
Table H-1. Recommended Actions

Alarm type	Failed/maint/advise/ active event	Description	Recommended action
Advisory	PlantWeb alerts simulation active	Alerts are currently being simulated. Real alerts active in the device are blocked (except for this alert).	Use the switch on the fieldbus electronics board to turn simulation on or off.
Maintenance	Device simulation active	The measurement output from the device is currently being simulated. Simulation disables normal measurement except for Internal Temperature. Variables are GOOD if the simulated level is GOOD and the device is in service.	Use "Start/Stop Device Simulation" to enable or disable simulation.
	Volume measurement warning	The level measurement is outside the configured volume range.	Check volume configuration.
	Configuration warning	The configuration of at least one parameter is outside specifications. Refer to the device manual for details. Disregard this alert if the device is working properly.	Check device configuration.
	Internal temperature out of limits	Internal temperature is outside its limits (-40 °F/-40 °C to 176 °F/+80 °C).	Check ambient temperature at installation site.
	Volume measurement failure	Reasons may be multiple: • Incorrect volume configuration • Level measurement invalid Volume status is set to BAD.	2. If Level Measurement Failure is active, clear that alert first. 3. Check volume configuration. 4. Load default database to the device and reconfigure it. 5. If the error persists, it might indicate a hardware error. Replace the transmitter head.
	Level measurement failure	No valid level reading. Reasons may be multiple: • No valid surface echo peak in the measuring range. • Incorrect transmitter configuration Level status is set to BAD.	1. Analyze echo curve for reason and check device configuration. 2. Check device physical installation (for instance, antenna contamination). 3. Load default database to the device and reconfigure it. 4. If the error persists, it might indicate a hardware error. Replace the transmitter head.
	Configuration error	At least one of the configuration parameters is outside its allowed minimum-maximum range. The default value for applicable parameters is being used.	Load default database to the device and reconfigure it.

Alarm type	Failed/maint/advise/ active event	Description	Recommended action
Failed	Software error	The device software has encountered an error. Reasons may be multiple, including too low supplied voltage, or an error being simulated. The status for all variables is BAD, and the device is out of service.	1. Make sure that enough voltage is supplied to the device. 2. Restart the device. 3. Turn off simulation of device failure. 4. If the alert persists, replace the transmitter head.
	Sensor database error	The device has found an error in the configuration database. Status for all variables is BAD. Device recovery is possible.	1. Load default database to the device to clear the error. 2. Reconfigure the device. 3. If the alert persists, replace the transmitter head.
	Internal temperature critical	The internal temperature of the device has reached critical levels and the integrity of the device electronics has been compromised. Ambient temperature should not exceed device specifications (-40 °F/-40 °C to 176 °F/+80 °C). The device is not in service (OOS) and status for all variables is BAD.	Replace the transmitter head.
	Electronics failure – main board	The device has detected a fault with an electrical component on the main board electronics module assembly. The status for all variables is BAD, and the device is out of service.	Replace the transmitter head.
	Software incompatibility error	Fieldbus software and main firmware versions are incompatible. The device is not in service (OOS).	Replace the transmitter head.
	Memory failure - output board	Configuration data has been corrupted or pending configuration changes has been lost due to loss of power before storage could complete. Default values are loaded into the faulty block. Potential errors in stored data may cause unwanted behavior. The device is not in service (OOS) and status for all variables is BAD. Device recovery is possible.	1. Load default database to the device to clear the error. 2. Download a device configuration. 3. If the error persists, it may indicate a faulty memory chip. Replace the transmitter head.
	Internal communication failure	The communication between the main transmitter board and the fieldbus electronics board has been lost. The device holds the last known measurement values with status BAD.	Replace the transmitter head.
	Electronics failure - output board	The device has detected a fault with an electrical component on the output board electronics module assembly. The device is not in service (OOS).	Replace the transmitter head.

Appendix I Analog-Input Block

Figure I-1. Analog-Input Block



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 2 on page 288 illustrates the internal components of the AI function block, and Table 1 lists the AI block parameters and their units of measure, descriptions, and index numbers.

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

Parameter	Index number	Units	Description
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.
STRATEGY	03	None	The strategy field can be used to identify grouping of blocks. This data is not checked or processed by the block.

Parameter	Index number	Units	Description
ALERT_KEY	04	None	The identification number of the plant unit. This information may be used in the host for sorting alarms, etc.
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
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.
PV	07	EU of XD_SCALE	The process variable used in block execution.
OUT	08	EU of OUT_SCALE	The block output value and status.
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.
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.
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.
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.
IO_OPTS	13	None	Allows the selection of input/output options used to alter the PV. Low cutoff enabled is the only selectable option.
CHANNEL	15	None	The CHANNEL value is used to select the measurement value. You must configure the CHANNEL parameter before you can configure the XD_SCALE parameter.
L_TYPE	16	None	Linearization type. Determines whether the field value is used directly (Direct) or is converted linearly (Indirect).
LOW_CUT	17	%	If percentage value of transducer input fails below this, PV = 0.
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.
FIELD_VAL	19	Percent	The value and status from the transducer block or from the simulated input when simulation is enabled.
UPDATE_EVT	20	None	This alert is generated by any change to the static data.
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.
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.
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.
HI_HI_PRI	25	None	The priority of the HI HI alarm.
HI_HI_LIM	26	EU of PV_SCALE	The setting for the alarm limit used to detect the HI HI alarm condition.
HI_PRI	27	None	The priority of the HI alarm.
HI_LIM	28	EU of PV_SCALE	The setting for the alarm limit used to detect the HI alarm condition.

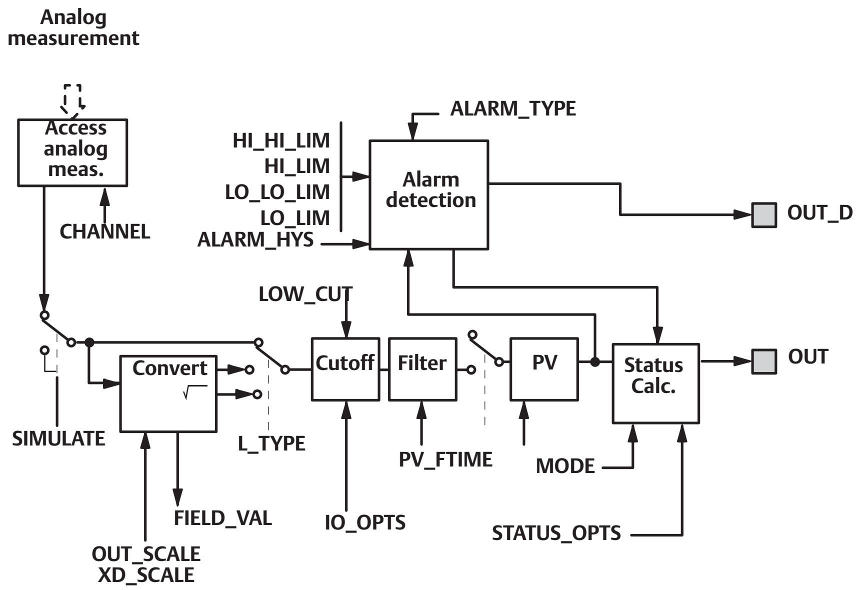
Parameter	Index number	Units	Description
LO_PRI	29	None	The priority of the LO alarm.
LO_LIM	30	EU of PV_SCALE	The setting for the alarm limit used to detect the LO alarm condition.
LO_LO_PRI	31	None	The priority of the LO LO alarm.
LO_LO_LIM	32	EU of PV_SCALE	The setting for the alarm limit used to detect the LO LO alarm condition.
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_ALM	34	None	The HI alarm data, which includes a value of the alarm, a timestamp of occurrence and the state of the alarm.
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_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.
OUT_D	37	None	Discrete output to indicate a selected alarm condition.
ALM_SEL	38	None	Used to select the process alarm conditions that will cause the OUT_D parameter to be set.
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.

I.1 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.

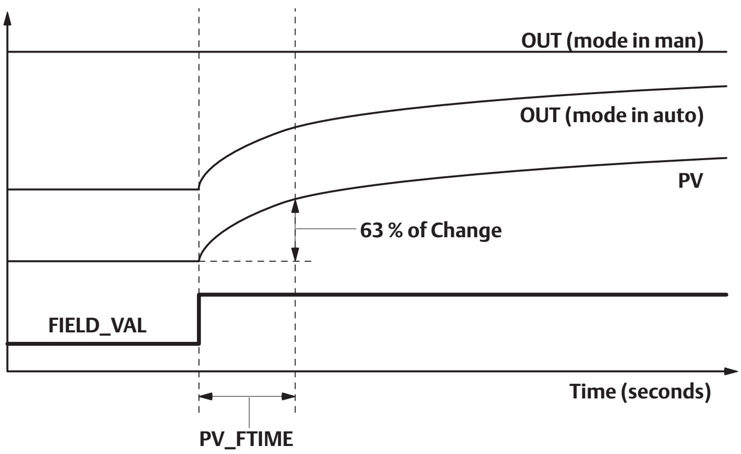
With simulation enabled, the actual measurement value has no impact on the OUT value or the status.

Figure I-2. Analog-Input Function Block Schematic



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

Figure I-3. Analog-Input Function Block Timing diagram



I.2 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.

I.3 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).

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

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).

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

** 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.

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

** 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).

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.

I.4 Block errors

Table 2 lists conditions reported in the BLOCK_ERR parameter.

Table I-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.

I.5 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.

I.6 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 I-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.

I.6.1 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.

Note
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.

I.7 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	RADAR_LEVEL
Distance	2	RADAR_ULLAGE
Level Rate	3	RADAR_LEVELRATE
Signal Strength	4	RADAR_LEVEL_SIGNAL_STRENGTH
Volume	5	RADAR_VOLUME
Internal Temperature	6	RADAR_INTERNAL_TEMPERATURE

L_TYPE

The L_TYPE parameter defines the relationship of the transmitter measurement (Level, Distance, Level Rate, Signal Strength, Volume, and Internal 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 Internal 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 Internal 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 (for example, 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 I-4. Length

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

Table I-5. 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 I-6. Temperature

Display	Description
°C	Degree Celsius
°F	Degree Fahrenheit

Table I-7. Signal Strength

Display	Description
mV	millivolt

Table I-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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