Rosemount 5300 Series
Safety Instrumented Systems (4-20 mA only)

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This document is a supplement to the Rosemount 5300 Series Reference Manual (Document No. 00809-0100-4530).

1 Safety messages

Procedures and instructions in this section may require special precautions to ensure safety of 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 certifications.

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

Electrical shock could cause death or serious injury.

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

⚠ WARNING

Any substitution of non-authorized parts or repair, other than exchanging the complete transmitter head or probe 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 Equipment ratings and certifications are no longer valid on any products that have been damaged or modified without the prior written permission of Emerson Process Management.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.

2 Terms and definitions

FMEDA: Failure Modes, Effects and Diagnostic Analysis

HART: Highway Addressable Remote Transducer

HFT: Hardware Fault Tolerance

PFD_{AVG}: Average Probability of Failure on Demand

Safety Response Time: The delay between a change in the measured process and the indication of that change at the safety-rated output.

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).

SFF: Safe Failure Fraction

Type B device: Complex device (using microcontrollers or programmable logic)

3 Safety Instrumented System (SIS) Certification

This section applies to the 4-20 mA Rosemount 5300 Series safety-certified transmitter used in Safety Instrumented Systems (SIS) applications. The Rosemount 5300 Series safety-certified transmitter is certified to:

- Low and high demand: Type B element
- SIL 2 for random integrity @ HFT=0
- SIL 3 for random integrity @ HFT=1
- SIL 3 for systematic capability

NOTE:
Refer to the 5300 FMEDA(1) report for failure rate data, assessment details, and assumptions regarding failure rate analysis.

(1) The 5300 FMEDA report is accessible at www.emersonprocess.com/rosemount/safety.

4 Safety-certified identification

All Rosemount 5300 Series transmitters must be identified as safety-certified before installing into SIS systems. Table 1 lists the versions of the Rosemount 5300 Series transmitter that have been considered for the hardware assessment, to which this section applies.

- Models with the QS option code are supplied with a manufacturer's prior use certificate of FMEDA data.
- Models with the QT option code are IEC 61508 certified by an accredited 3rd party agency for use in safety instrumented systems up to SIL 3.
  (For single use (1oo1) capable up to SIL 2 and for redundant use (1oo2 or 2oo3) capable up to SIL 3.)

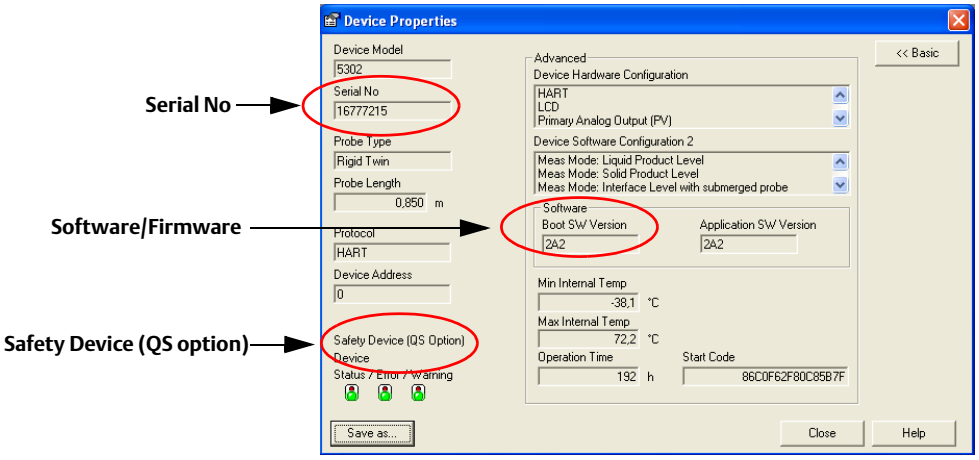
Table 1. Rosemount 5300 Series safety-certified option model codes

5300 4-20 mA HART Guided Wave Radar Level and Interface Transmitter	
Hardware	Model 5301Hxxxxxxxxxxxxxxx**QS** or 5301Hxxxxxxxxxxxxxxx**QT** Model 5302Hxxxxxxxxxxxxxxx**QS** or 5302Hxxxxxxxxxxxxxxx**QT** Model 5303Hxxxxxxxxxxxxxxx**QS** or 5303Hxxxxxxxxxxxxxxx**QT** **NOTE:** Transmitters will be marked with "QS" or "QT" in the model code on the label.
Software/Firmware	2.A1 - 2.J0

To identify a Rosemount 5300 Series safety-certified transmitter:

- Verify the option code QS or QT in the model code, on the label affixed to the outside of the transmitter head
- Check if a yellow label is affixed to the transmitter head for option code QT
- Before doing any configuration, write down the serial number from the label, and make sure you are connected to the correct transmitter by verifying the same serial number in your communication device

NOTE:
In Rosemount Radar Master, this information can be found in the Device Properties window. Select **Device** > **Properties**.



5 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. If a measured value goes beyond the measurement range, the transmitter enters saturation mode (limit alarm is disabled) or alarm mode, depending on the current configuration. The minimum time for the alarm condition is 200 ms.

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.

6 Installation in SIS applications

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 the standard installation practices outlined in this manual.

Environmental and operational limits are available in Appendix A: Reference data in the 5300 Series Reference Manual (Document No. 00809-0100-4530).

The loop must be designed so that the terminal voltage does not drop below the minimum input voltage when the transmitter output is 22.5 mA. See values in Table 2.

Table 2. Minimum input terminal voltage (U_i) at different currents

Hazardous approval	Current			
	3.60 mA	3.75 mA	21.75 mA	22.50 mA
	Minimum input voltage (U_I)			
Non-Hazardous Installations and Intrinsically Safe Installations	16 Vdc	16 Vdc	11 Vdc	11 Vdc
Explosion-proof / Flameproof Installations	20 Vdc	20 Vdc	15.5 Vdc	15.5 Vdc

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 5300 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.

7 Configuring in SIS applications

Use a HART-compliant master, such as Rosemount Radar Master or a Field Communicator, to communicate with and verify configuration of the Rosemount 5300 Series. A full review of configuration methods is available in Section 5: Configuration in the 5300 Series Reference Manual (Document No. 00809-0100-4530).

These instructions are applicable to the Rosemount 5300 Series safety-certified options with any differences noted.

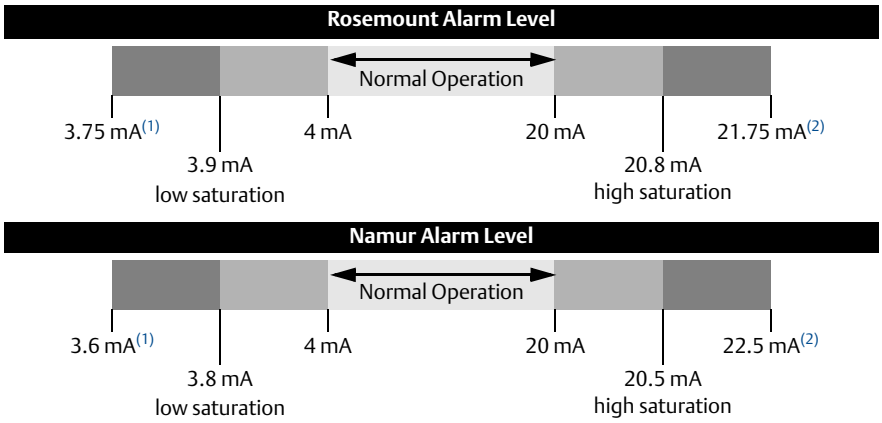
Damping

User adjusted damping will affect the transmitter's ability to respond to process changes. Therefore, the *damping values + response time* should not exceed the loop requirements. For further information on damping, see section "Echo tracking" in the 5300 Series Reference Manual (Document No. 00809-0100-4530).

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. Figure 1 identifies the alarm levels available and their operation values(1).

Figure 1. Alarm levels and operation values



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

It is assumed that the current output signal is fed to a SIL 2-compliant analog input board of a safety logic solver. For instructions on alarm level settings see section "Analog output (HART)" in the 5300 Series Reference Manual (Document No. 00809-0100-4530).

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

(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.

Write protection

A Rosemount 5300 Series safety-certified transmitter should always be protected from unintentional configuration changes by a password protected function. It is recommended to use write protection described in section "Write protecting a transmitter" in 5300 Series Reference Manual (Document No. 00809-0100-4530).

Site acceptance

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

8 SIS operation and maintenance

Proof test

The following proof test is recommended. If an error is found in the safety function, 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.

NOTE:
For a valid result, always perform the proof test on the product that will be stored in the tank while the device is in operation.

NOTE:
Before every test, make sure you are connected to the correct transmitter by verifying QT/QS in the model code on the label and your software version. Also verify that the serial number on the label matches the one in your configuration tool.

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

Required Tools: HART host/communicator and mA meter.

Note that prior to these tests, inspect the echo curve to ensure that no disturbing echoes affecting the measurement performance are present.

Rosemount Radar Master:

- Go to **Setup** > **Echo Curve**.

AMS Device Manager and Field Communicator:

- Go to **Service Tools** > **Echo Tuning** > **Echo Curve**.

8.1 Suggested comprehensive proof test

The suggested proof test described below will detect approximately **80%** of possible DU failures in the Rosemount 5300 Series transmitters.

1. Bypass the safety function and take appropriate action to avoid a false trip.

2. Disable write protection in device (if enabled).

   Rosemount Radar Master:

   a. In the **Tools** menu, select **Lock/Unlock Configuration Area**.

   b. Enter **Password** to unlock.

   AMS Device Manager and Field Communicator:

   a. Go to **Configure** > **Manual Setup** > **Device Setup** > **Security**.

   For HART Device Revision 3: Go to **Device Diagnostics** > **Tools** > **General**.

   b. Click **Write Protect** and follow the instructions.

3. Retrieve any diagnostics and take appropriate action.

   Rosemount Radar Master:

   - Go to **Tools** > **Diagnostics**. See section "Diagnostics Messages" in the 5300 Series Reference Manual (Document No. 00809-0100-4530) for recommended actions.

   AMS Device Manager and Field Communicator:

   - Go to **Service Tools** > **Alerts**. See section "Diagnostics Messages" in the 5300 Series Reference Manual (Document No. 00809-0100-4530) for recommended actions.

   For HART Device Revision 3: Go to **Device Diagnostics** > **Diagnostics**.

4. Using Loop Test, enter current value (mA) representing high alarm current. Verify that analog output current and terminal voltage are correct using reference meters.

   This step tests for voltage compliance problems, such as low power supply voltage or increased wiring resistance.

   Rosemount Radar Master:

   a. Go to **Setup** > **Output** > **Analog Out 1** and click **Loop test**.

   b. Enter current value representing high alarm current.

   c. Click **Start** to output current.

   d. Verify that analog output current is correct.

   e. Verify that terminal voltage is correct. See values in Table 2.

   f. Click **Stop** to end loop test.

   AMS Device Manager and Field Communicator:

   a. Go to **Configure** > **Manual Setup** > **Device Setup** > **Output**.

   For HART Device Revision 3: Go to **Configure/Setup** > **Analog Output** > **Analog Out**.

   b. Click **Loop Test** and select **Other**.

   c. Enter current value representing high alarm current.

   d. Verify that analog output current is correct.

   e. Verify that terminal voltage is correct. See values in Table 2.

   f. Click **Abort** to end loop test.

5. Using Loop Test, enter current value (mA) representing low alarm current. Verify that analog output current and terminal voltage are correct using reference meters.

   This step tests for possible quiescent current related failures.

   Rosemount Radar Master:

   a. Go to **Setup** > **Output** > **Analog Out 1** and click **Loop test**.

   b. Enter current value representing low alarm current.

   c. Click **Start** to output current.

   d. Verify that analog output current is correct.

   e. Verify that terminal voltage is correct. See values in Table 2.

   f. Click **Stop** to end loop test.

   AMS Device Manager and Field Communicator:

   a. Go to **Configure** > **Manual Setup** > **Device Setup** > **Output**.

      For HART Device Revision 3: Go to **Configure/Setup** > **Analog Output** > **Analog Out**.

   b. Click **Loop Test** and select **Other**.

   c. Enter current value representing low alarm current.

   d. Verify that analog output current is correct.

   e. Verify that terminal voltage is correct. See values in Table 2.

   f. Click **Abort** to end loop test.

6. Enable write protection.

   Rosemount Radar Master:

   a. In the **Tools** menu, select **Lock/Unlock Configuration Area**.

   b. Enter **Password** to lock.

   AMS Device Manager and Field Communicator:

   a. Go to **Configure** > **Manual Setup** > **Device Setup** > **Security**.

      For HART Device Revision 3: Go to **Device Diagnostics** > **Tools** > **General**.

   b. Click **Write Protect** and follow the instructions.

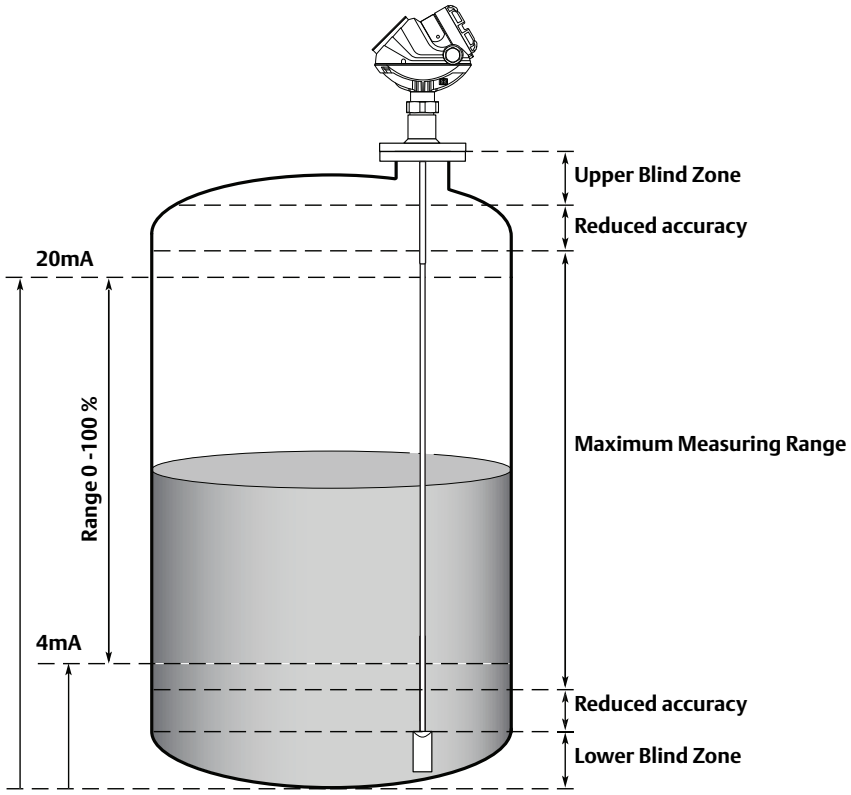
7. Inspect the transmitter for any leaks, visible damage, or contamination.

8. Perform a two-point calibration check of the device by verifying level output for two points on the probe within 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 Upper and Lower Range values, otherwise the device enters alarm mode. If level is outside 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 2.

Figure 2. Range Values



9. Restore the loop to full operation.

10. Remove the bypass from the safety PLC or otherwise restore normal operation.

11. Document “as found” conditions and test results using a tool like SILStat™.

For troubleshooting the transmitter, see Section 7: Service and troubleshooting in the 5300 Series Reference Manual (Document No. 00809-0100-4530) for recommended actions.

8.2 Suggested simple proof test

The suggested proof test described below will detect approximately **50%** of possible DU failures in the Rosemount 5300 Series transmitters.

1. Bypass the safety function and take appropriate action to avoid a false trip.
2. Disable write protection if the function is enabled.
3. Retrieve any diagnostics and take appropriate action.
4. Using Loop Test, enter current value (mA) representing high alarm current. Verify that analog output current and terminal voltage are correct using reference meters.(1)
5. Using Loop Test, enter current value (mA) representing low alarm current. Verify that analog output current and terminal voltage are correct using reference meter.(2)
6. Enable write protection.
7. Inspect the transmitter for any leaks, visible damage or contamination.
8. Remove the bypass and otherwise restore normal operation.
9. Document “as found” conditions and test results using a tool like SILStat™.

For troubleshooting the transmitter, see Section 7: Service and troubleshooting in the 5300 Series Reference Manual (Document No. 00809-0100-4530) for recommended actions.

Calculations of average probability of failure on demand

PFD_{AVG} calculation can be found in the FMEDA report located at www.rosemount.com/safety.

9 Inspection

Visual inspection

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

Special tools

Not required.

Product repair

The Rosemount 5300 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) This step tests for compliance voltage problems, such as a low loop power supply voltage, or increased wiring resistance. This also tests for other possible failures.
(2) This step tests for possible quiescent current related failures.

Reset to factory settings

Transmitters with option code QS or QT are shipped with a special factory pre-configuration. If the device needs to be reset to factory settings, please contact your local Emerson Process Management representative to get the factory pre-configuration file to be uploaded to the device or use the backup file created upon receiving the transmitter. This will ensure the proper settings for your safety device are configured and your QS or QT certificate is still valid.

10 Specifications

For general specifications, see Appendix A: Reference data in the Rosemount 5300 Series Reference Manual (Document No. 00809-0100-4530) or refer to the Rosemount 5300 Series Product Data Sheet (Document No. 00813-0100-4530).

The Rosemount 5300 Series must be operated in accordance with the functional and performance specifications provided in Appendix A: Reference data in the Rosemount 5300 Series Reference Manual (Document No. 00809-0100-4530).

Reference conditions can be found in section "Specifications" in Appendix A: Reference data of the Rosemount 5300 Series Reference Manual (Document No. 00809-0100-4530).

SIS reference

Failure rate data

The FMEDA report includes failure rates. The full report is accessible at www.emersonprocess.com/rosemount/safety.

Failure values

- Safety accuracy: 2.0%(1)
- Safety response time: at least below 8 seconds for specific configurations

  Higher Safety Response Time is allowed for other user-selectable configurations, for example damping, level rate etc. See section "Set alarm limits" in the Rosemount 5300 Series Product Data Sheet (Document No. 00813-0100-4530) for more information.
- Self-diagnostics test interval: at least every 90 minute

Product life

50 years

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

Spare parts

Additional spare parts are available in section "Spare parts" in the Rosemount 5300 Series Product Data Sheet (Document No. 00813-0100-4530) for more information.

(1) The safety accuracy of the Rosemount 5300 Series safety-certified option is ±2% of full span (± 0.32 mA). See section "Specifications" in Appendix A: Reference data of the Rosemount 5300 Series Reference Manual (Document No. 00809-0100-4530) for additional application-specific measuring error.

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