Safety Manual
00809-0500-4130, Rev AL
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Rosemount™ 2130 Level Switch

Vibrating Fork

ROSEMOUNT™

EMERSON™

Safety messages

NOTICE

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

For technical assistance, contacts are listed below:

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

North American Response Center

Equipment service needs.

- 1-800-654-7768 (24 hours a day — includes Canada)
- Outside of these areas, contact your local Emerson representative.

⚠ WARNING

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

Ensure the level switch is installed by qualified personnel and in accordance with applicable code of practice.

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

The weight of a level switch with a heavy flange and extended fork length may exceed 37 lb. (18 kg). A risk assessment is required before carrying, lifting, and installing the level switch.

⚠ WARNING

Explosions could result in death or serious injury.

Verify the operating atmosphere of the level switch is consistent with the appropriate hazardous locations certifications.

Before connecting a handheld communicator in an explosive atmosphere, ensure that the instruments are installed in accordance with intrinsically safe or non-incendive field wiring practices.

In explosion-proof/flameproof and non-incendive installations, do not remove the housing cover when power is applied to the level switch.

The housing cover must be fully engaged to meet flameproof/explosion-proof requirements.

⚠ WARNING

Electrical shock could cause death or serious injury.

Avoid contact with the leads and terminals. High voltage that may be present on leads can cause electrical shock.

Ensure the power to the level switch is off, and the lines to any other external power source are disconnected or not powered while wiring the level switch.

Ensure the wiring is suitable for the electrical current and the insulation is suitable for the voltage, temperature, and environment.

⚠ WARNING

Process leaks could result in death or serious injury.

Ensure the level switch is handled carefully. If the process seal is damaged, gas might escape from the vessel (tank) or pipe.

⚠ WARNING

Physical access

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

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

⚠ 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 Emerson nuclear-qualified products, contact your local Emerson Sales Representative.

⚠ CAUTION

Hot surfaces

The flange and process seal may be hot at high process temperatures. Allow to cool before servicing.

Contents

1 Before you begin

1.1 About this document

This document provides information about how to install, commission, and proof test a Rosemount 2130 Level Switch to comply with Safety Instrumented Systems (SIS) requirements.

Note
The following conditions must apply:

- The level switch has been installed correctly and completely according to the instructions in the Reference Manual and Quick Start Guide.
- The installation complies with all applicable safety requirements.
- The operator is trained in local and corporate safety standards.

1.2 About this product

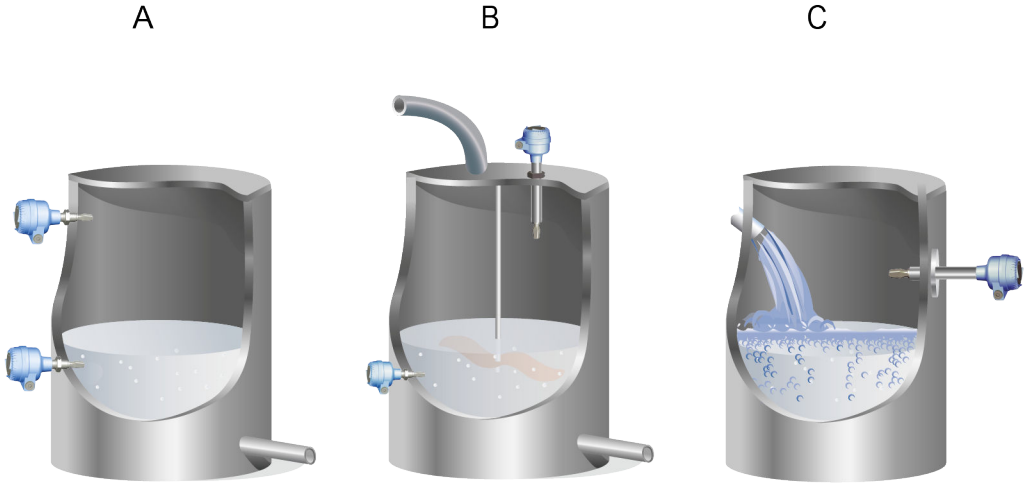
The Rosemount 2130 Level Switch consists of a tuned fork with a driver and receiver element, and integral interface electronics. The level detector is based on the principle that the resonant frequency of a tuned fork changes when it is immersed in a liquid. The frequency change is detected and used to switch an electrical output.

A range of output options are available to suit different applications.

1.2.1 Application examples

The level switch indicates, by means of an electronic output, whether the level of a process liquid is above, or below, a certain point (the switching point).

Figure 1-1: Example Application Overfill Protection



A. High and low alarm
B. Pump control
C. Overfill protection

1.3 Related documents

You can find all product documentation at Emerson.com/Rosemount.

For more information, see the following documents:

Table 1-1: Related Documentation

Document	Document type
00809-0100-4130	Reference Manual
00813-0100-4130	Product Data Sheet
00825-0100-4130	Quick Start Guide
00825-0200-4130	Product Certifications

2 Installation and commissioning

2.1 Safety Instrumented System (SIS) certification

For safety instrumented systems usage, the electrical output is used as the primary safety variable. It is configured to activate the alarm function if an error occurs. The Rosemount 2130 may be used in high level or low level safety related applications.

The measurement signal used by the logic solver must be the discrete levels set at the instrument output used to indicate the sensor condition. A change in liquid level through the switch point of the level switch results in the user configured state being set at the output by the instrument.

For Model Codes **P**, **L**, **N**, **M**, and **D**- Dry or Wet, the Rosemount 2130 is IEC 61508 certified to:

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

2.2 Safety-certified identification

All Rosemount 2130 Level Switches must be identified as safety-certified before installing into SIS systems. Table 2-1 lists the versions of the Rosemount 2130 Level Switches that have been considered for the hardware assessment, to which this section applies.

- 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.)
- Models with the QS option code are supplied with a manufacturer's prior use certificate of FMEDA data.

Table 2-1: Rosemount 2130 Series Safety-Certified Option Model Codes

Rosemount 2130 Level Switch	
Hardware	Model 2130 Z ZZ **L** Z ZZ Z ZZZZ **QT**. Dry=On, Wet=On Model 2130 Z ZZ **P** Z ZZ Z ZZZZ **QT**. Dry=On, Wet=On Model 2130 Z ZZ **D** Z ZZ Z ZZZZ **QT**. Dry=On, Wet=On Model 2130 Z ZZ **D** Z ZZ Z ZZZZ **QT** R2264. Dry=On, Wet=On (with Fault Relay) Model 2130 Z ZZ **N** Z ZZ Z ZZZZ **QT**. Dry=On, Wet=On Model 2130 Z ZZ **M** Z ZZ Z ZZZZ **QT**. Dry=On, Wet=On **Note** Switches will be marked with “QS” or “QT” at the end of the model number Z - different options, see Product Data Sheet. L - Direct load switching P - PNP/PLC D - Relay (DPCO) D - Fault Alarm Relay (R2264) N - NAMUR M - 8/16 mA
Software/Firmware	D: 1.0.0 or higher N: 2.10.0 or higher P: 2.10.0 or higher L: 2.10.0 or higher M: 2.10.0 or higher

2.2.1 Identify a safety-certified transmitter

To identify a Rosemount 2130 Level Switch safety-certified transmitter:

Procedure

1. Verify the model code is suffixed with the QT or QS option code.
2. Verify a yellow tag is affixed to the outside of the level switch for option code QT.

2.3 Installation

The Rosemount 2130 Level Switch must be installed as described in the installation section of the product Reference Manual.

Environmental conditions must not exceed the ratings in the specification section of the Reference Manual. The level switch must be accessible for physical inspection.

2.4 Configuration

2.4.1 Self-check setting

The Rosemount 2130 Level Switch must be user-configured to operate in the Self-check mode. This mode enables the internal diagnostic routines.

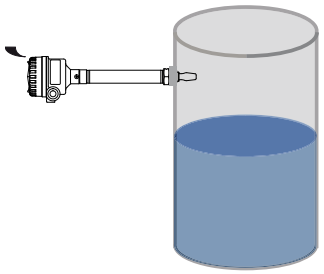
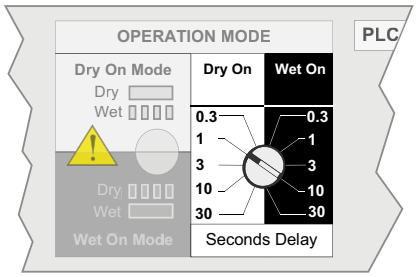
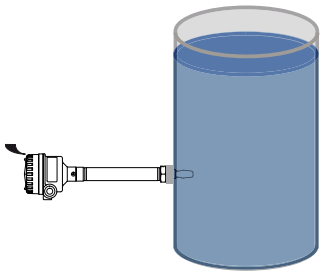
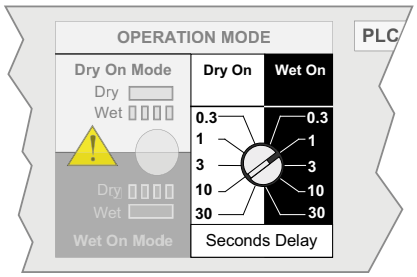
Self-check mode is indicated by the amber color of the LED on the electronics cassette. SIS-certified 2130 Level Switches (dependent on model code) are shipped with this mode pre-configured, but must be checked before first use, and periodically thereafter, as part of the proof-test routine.

2.4.2 Output mode setting

The Rosemount 2130 Level Switch must be user-configured for an application so that the output is **ON** in the **Safe** or **Normal** condition.

The response time (seconds delay) may be set to a convenient value to prevent trips that are spurious i.e. not due to a real condition. Note that the Safety Response Time is the greater of 10 seconds and the selected seconds delay using the switch setting.

Table 2-2: Output Mode Setting

Application	Switch setting (Normal or Safe condition)
High Level Alarm	**Dry=On**
	
Low Level Alarm	**Wet=On**
	

3 Proof tests

3.1 Overview

The Rosemount 2130 must be tested at regular intervals to reveal faults which are undetected by automatic diagnostics. It is the user's responsibility to choose the type of testing and the frequency of these tests.

Results from periodic proof tests shall be recorded and periodically reviewed. If an error is found in the safety functionality, the device shall be put out of operation and the process shall be kept in a safe state by other measures.

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.

3.1.1 Suggested proof tests

The following proof tests are suggested:

- (A) Comprehensive proof test
- (B) Partial proof test

Table 3-1 can be used as a guidance for selecting the appropriate proof test for **Dry=On**:

Table 3-1: Suggested Proof Tests - Dry=On

Proof test #	Output Type and Model Code Option		Proof test coverage (%) of DU	Remaining dangerous, undetected failures	Test coverage			Can be performed remotely
					Output circuitry	Measurement electronics	Sensor	
A	2-wire/ Direct-Load	L	78	11 FIT	Yes	Yes	Yes	No
	8 and 16 mA	M	51	12 FIT				
	NAMUR	N	93	2 FIT				
	PNP/PLC	P	89	5 FIT				
	Relay	D	96	3 FIT				
	Fault Relay	D(1)	97	3 FIT				
B	2-wire/ Direct-Load	L	77	11 FIT	Yes	Yes	No	No
	8 and 16 mA	M	50	12 FIT				
	NAMUR	N	89	2 FIT				
	PNP/PLC	P	85	7 FIT				
	Relay	D	96	4 FIT				
	Fault Relay	D(1)	96	4 FIT				

(1) Add R2264 at the end of Model Code

Table 3-2 can be used as a guidance for selecting the appropriate proof test for **Wet=On**:

Table 3-2: Suggested Proof Tests - Wet=On

Proof test #	Output Type and Model Code Option		Proof test coverage (%) of DU	Remaining dangerous, undetected failures	Test coverage			Can be performed remotely
					Output circuitry	Measurement electronics	Sensor	
A	2-wire/ Direct-Load	L	81	13 FIT	Yes	Yes	Yes	No
	8 and 16 mA	M	95	3 FIT				
	NAMUR	N	95	2 FIT				
	PNP/PLC	P	86	7 FIT				
	Relay	D	97	3 FIT				
	Fault Relay	D(1)	98	3 FIT				
B	2-wire/ Direct-Load	L	77	13 FIT	Yes	Yes	Yes	No
	8 and 16 mA	M	93	3 FIT				
	NAMUR	N	92	3 FIT				
	PNP/PLC	P	81	10 FIT				
	Relay	D	97	4 FIT				
	Fault Relay	D(1)	97	4 FIT				

(1) Add R2264 at the end of Model Code

Related information

Comprehensive proof testing
Partial proof-testing

3.1.2 Proof test interval

The time intervals for proof testing are defined by the SIL verification calculation (subject to the PFD_{AVG}). The SIL verification calculation is an analytical method to calculate an appropriate proof test interval for the specific safety function based on equipment's reliability and required risk reduction for the specific SIF.

The proof tests must be performed more frequently than or as frequently as specified in the SIL verification calculation, in order to maintain the required safety integrity of the overall SIF.

3.1.3 Tools required

- Voltage or current meter, depending on output type
- Power supply
- Safety logic solver

3.2 Comprehensive proof testing

The comprehensive proof-test performs a complete test of the system elements. The sensor, measuring electronics and output stage are all checked by virtue of changing of the sensor condition and observation of the output.

According to the standard IEC 61508-2, proof-tests shall be undertaken to reveal dangerous faults which are undetected by diagnostic tests. This means that it is necessary to specify how dangerous undetected faults which have been noted during the Failure Modes, Effects, and Diagnostic Analysis can be detected during proof-testing.

Related information

Suggested proof tests

3.2.1 Impact on SIF and process

In order to achieve the product safe state, the sensor must be either removed from or immersed in the process medium, depending on the operating mode. The process cannot be allowed to operate whilst the proof test is being performed.

3.2.2 Perform comprehensive proof test Low Level Alarm

Procedure

1. Inspect the accessible parts of the level detector for any leaks or damage.
2. Bypass the safety function and take appropriate action to avoid a false trip.
3. Verify the **Mode Switch** is set to the required mode of operation.
4. Disable any filling mechanism and drain the vessel to force the switch to the fail-safe state and confirm that the Safe State was achieved and within the correct time as indicated by the setting of the Mode Switch.

   ⚠ CAUTION

   Independent precautions must be taken to ensure that no hazard can result from this operation.

5. Reinstate the filling mechanism so that the vessel refills and confirm that the normal operating state of the switch was achieved.
6. Remove the safety function bypass and otherwise restore normal operation.

3.2.3 Perform comprehensive proof test High Level Alarm

Procedure

1. Inspect the accessible parts of the level detector for any leaks or damage.
2. Bypass the safety function and take appropriate action to avoid a false trip.
3. Verify the **Mode Switch** is set to the required mode of operation.
4. Disable any drain mechanism and fill the vessel to force the switch to the fail-safe state and confirm that the Safe State was achieved and within the correct time as indicated by the setting of the Mode Switch.

⚠ CAUTION

Independent precautions must be taken to ensure that no hazard can result from this operation.

5. Reinstate the drain mechanism so that the vessel refills and confirm that the normal operating state of the switch was achieved.
6. Remove the safety function bypass and otherwise restore normal operation.

3.2.4 Duration of comprehensive proof-test

The comprehensive proof-test takes several hours to perform with all safety measures being followed.

3.3 Partial proof-testing

The level switch has the ability of performing a partial proof-test. This test has reduced diagnostic coverage compared with the comprehensive proof-test, in that it is limited to exercising the output and measurement electronics only.

The partial proof-test presents the following benefits:

- Provides a percentage of the comprehensive proof-test coverage, enabling the unit to be tested and its effective PFD to be reduced by this percentage at the time of the test.
- Test can be performed “in-process” and takes less than one minute to complete.
- Provides capability to prolong comprehensive testing to align with standard plant maintenance schedules.
- May give the user the flexibility to schedule the comprehensive proof-testing Interval to fit with a site's scheduled plan.

The suggested partial proof-test for the Rosemount™ 2130 Level Switch exercises the signal processing and output, but does not test the sensor.

Related information

Suggested proof tests

3.3.1 Impact on SIF and process

The process cannot be allowed to operate whilst the proof-test is being performed.

3.3.2 Perform partial proof test

Procedure

1. Inspect the accessible parts of the level detector for any leaks or damage.
2. Bypass the safety function and take appropriate action to avoid a false trip.
3. Verify the **Mode Switch** is set to the required mode of operation.
4. Apply a bar magnet to the Magnetic Test Point to force the switch to the fail-safe state and confirm that the Safe State was achieved within two seconds.

   ⚠ CAUTION

   Independent precautions must be taken to ensure that no hazard can result from this operation.

5. Remove the bar magnet from the Magnetic Test Point and confirm that after 1s the normal operating state of the switch was achieved.
6. Remove the safety function bypass and otherwise restore normal operation.

3.3.3 Duration of partial proof-test

The partial proof-test takes less than an hour to perform with all safety measures being followed.

4 Operating constraints

4.1 Specifications

The Rosemount 2130 must be operated according to the functional and performance specifications provided in the Rosemount 2130 Product Data Sheet.

4.1.1 Failure rate data

The FMEDA report includes failure rate data, assessment details, and assumptions regarding failure rate analysis.

4.1.2 Transmitter response time

The Rosemount 2130 Level Switch worst case response time shall be considered to be the larger of 10 seconds plus the switch setting for response mode of operation.

Table 4-1: Transmitter response time

Output Type and Model Code Option		Supply voltage	Safety alarm levels (leakage currents)(1)	Transmitter response time(2)	Switch point (water)(3)	Switch point (other liquid)(4)
2-wire/Direct-Load	L	20 to 60 Vdc 20 to 264 Vac	6 mA	10 s minimum	11 to 15 mm	0 to 30 mm
8 and 16 mA	M	11 to 36 Vdc	< 3.7 mA			
NAMUR	N	7 to 9 Vdc	< 1.0 mA			
PNP/PLC	P	20 to 60Vdc	< 100 µA			
Relay	D	20 to 60 Vdc 20 to 264 Vac	N/A			
Fault Relay	D(5)	20 to 60 Vdc 20 to 264 Vac	N/A			

(1) Logic solver trip levels should be set higher than these values in order to ensure reliable trips.
(2) The Rosemount 2130 Level Switch worst case response time shall be considered to be the larger of 10 seconds plus the switch setting for response mode of operation
(3) Operating (switching) point measured from lowest point of fork when liquid is water.
(4) Operating (switching) point measured from lowest point of fork when liquid is not water.
(5) Add R2264 at the end of Model Code

4.1.3 Diagnostic test interval

All diagnostic checks complete to entirety within one hour (< 60 min).

4.1.4 Useful lifetime

10 years

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

4.2 Product repair

Repair procedures in the Rosemount 2130 Level Switch Reference Manual must be followed.

In case of malfunction of the system or SIF, the Rosemount 2130 Level Switch shall be put out of operation and the process shall be kept in a safe state by other measures.

Emerson must be informed when the Rosemount 2130 is required to be replaced due to failure. The occurred failure shall be documented and reported to Emerson using the contact details on the back page of this functional safety manual. This is an important part of the Emerson SIS management process.

The Rosemount 2130 is repairable by major component replacement. All failures detected by the device diagnostics or by the proof test must be reported. Feedback can be submitted electronically at Go.EmersonAutomation.com/Contact-Us (Contact Us).

A Terms and definitions

λ_{DU}	Dangerous Undetected failure rate
λ_{DD}	Dangerous Detected failure rate
λ_{SU}	Safe Undetected failure rate
λ_{SD}	Safe Detected failure rate
Diagnostic test interval	The time from when a dangerous failure/condition occurs until the device has set the safety related output in a safe state (total time required for fault detection and fault reaction).
Element	Term defined by IEC 61508 as “part of a subsystem comprising a single component or any group of components that performs one or more element safety functions”
FIT	Failure In Time per billion hours
FMEDA	Failure Modes, Effects and Diagnostic Analysis
HART® protocol	Highway Addressable Remote Transducer
HFT	Hardware Fault Tolerance
High demand mode	The safety function is only performed on demand, in order to transfer the EUC (Equipment Under Control) into a specified safe state, and where the frequency of demands is greater than one per year (IEC 61508-4).
Low demand mode	The safety function is only performed on demand, in order to transfer the EUC into a specified safe state, and where the frequency of demands is no greater than one per year (IEC 61508-4).
PFD_{AVG}	Average Probability of Failure on Demand
PFH	Probability of dangerous Failure per Hour: the term "probability" is misleading, as IEC 61508 defines a rate.
Proof test coverage factor	The effectiveness of a proof test is described using the coverage factor which specifies the share of detected dangerous undetected failures (λ_{DU}). The coverage factor is an indication of a proof test’s effectiveness to detect dangerous undetected faults.
Safety deviation	The maximum allowed deflection of the safety output due to a failure within the device (expressed as a percentage of span). Any failure causing the device output to change less than the Safety Deviation is considered as a "No Effect" failure. All failures causing the device output to change more than the Safety Deviation and with the device output still within the active range (non-alarm state) are considered dangerous failures. **Note** The Safety Deviation is independent of the normal performance specification or any additional application specific measurement error.
SIF	Safety Instrumented Function
SIL	Safety Integrity Level – a discrete level (one out of four) for specifying the safety integrity requirements of the safety instrumented functions

	to be allocated to the safety instrumented systems. SIL 4 has the highest level of safety integrity, and SIL 1 has the lowest level.
SIS	Safety Instrumented System – an instrumented system used to implement one or more safety instrumented functions. An SIS is composed of any combination of sensors, logic solvers, and final elements.
Systematic capability	A measure (expressed on a scale of SC 1 to SC 4) of the confidence that the systematic safety integrity of an element meets the requirements of the specified SIL, in respect of the specified element safety function, when the element is applied in accordance with the instructions specified in the compliant item safety manual for the element.
Transmitter response time	The time from a step change in the process until transmitter output reaches 90% of its final steady state value (step response time as per IEC 61298-2).
Type B device	Complex device using controllers or programmable logic, as defined by the standard IEC 61508.
Useful lifetime	Reliability engineering term that describes the operational time interval where the failure rate of a device is relatively constant. It is not a term which covers product obsolescence, warranty, or other commercial issues. The useful lifetime is highly dependent on the element itself and its operating conditions (IEC 61508-2).

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For more information: **Emerson.com/global**

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