

User's Manual

ROTAMASS Total Insight Coriolis Mass Flow and Density Meter Safety Manual



IM 01U10D00-00EN-R

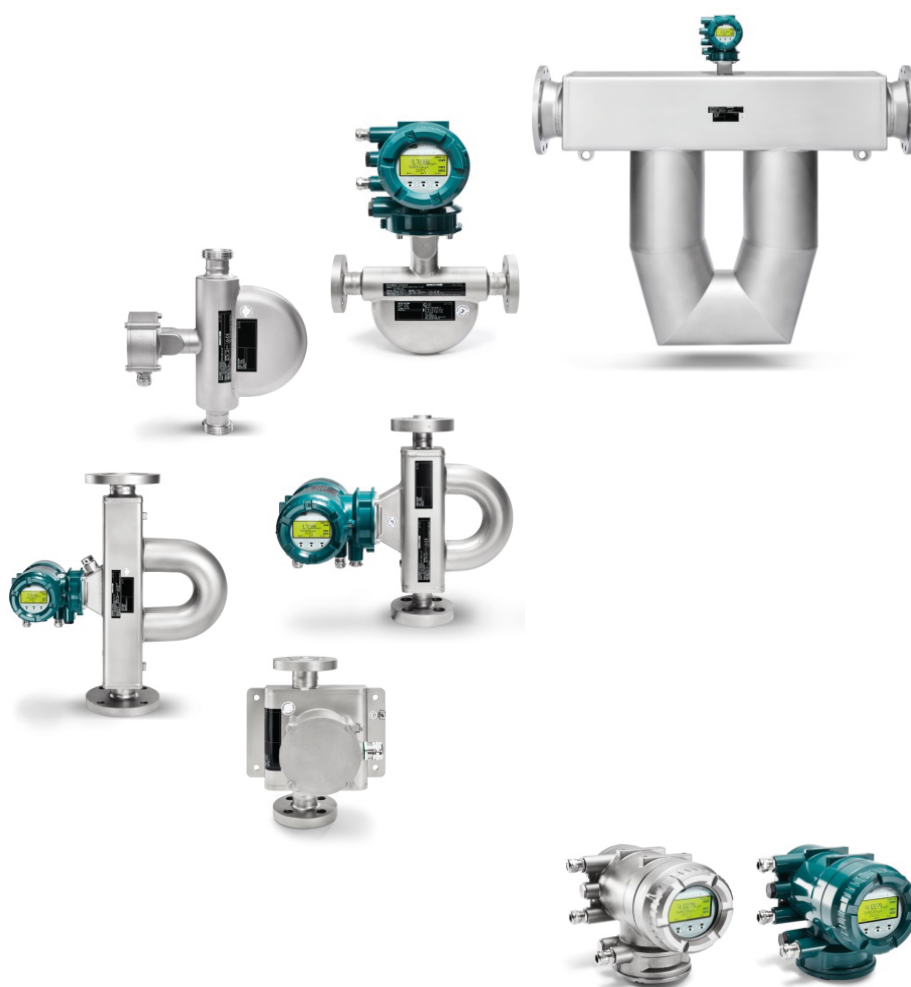


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1 Revision List

The following version combinations are certified as IEC 61508 products:

Hardware Revision	Software Revision		
	Main	Sensor	Indicator
S1.01	R1.01.02	R1.01.03	R1.01.01
	R2.01.01		R2.01.01
			R2.01.02
	R3.01.01	R1.01.04	R3.01.02
	R4.01.01		R4.01.01
			R4.01.02
S2.01	R4.01.01	R1.01.04	R4.01.02
S2.01	R4.01.02	R1.01.04	R4.01.02

2 Scope and purpose of the document



When using the Rotamass Total Insight Coriolis flow meter for the Safety Instrumented Systems (SIS) application, the instructions and procedures in this section must be strictly followed in order to preserve the transmitter for that safety level.

This document provides an overview of the user responsibilities for installation and operation of the Rotamass Total Insight Coriolis flow meter in order to maintain the designed safety level.

Items that will be addressed are proof testing, repair and replacement of the flow meter, reliability data, lifetime, environmental and application limits, and parameter settings.

3 Using Rotamass Total Insight for a SIS application

For more detail information, refer to FMEDA report No. YEC 20-02-160 R002 V2R5.

The documents can be downloaded from the website of Yokogawa or purchased from the Yokogawa representatives.

Website address: <https://www.yokogawa.com/library/>

3.1 Safety function

The Rotamass Total Insight Coriolis flow meter for HART communication is intended for use as a mass flow, fluid density and fluid temperature measurement component in a Safety Instrumented System. It has one or two 4 – 20 mA analog outputs and other I/Os.

The flow meter must be used with one of the two or both 4 – 20 mA outputs to feed signals to a logic solver that is part of the safety instrumented function (SIF) as shown in the following figure. The fault annunciation mechanism is an out of-range analog current. In order to take advantage of the automatic diagnostics in the flow meter, this annunciation mechanism must be connected.

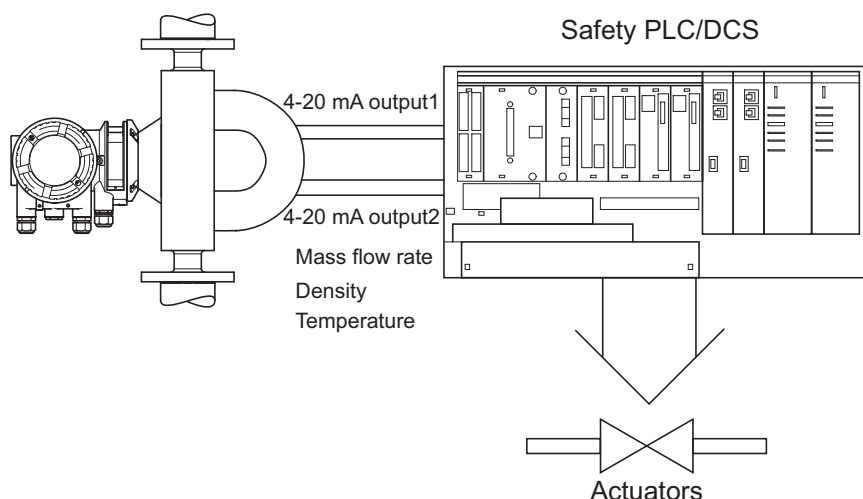


Fig. 1: Example Safety Instrumented Function

3.2 Safety accuracy

The Rotamass Total Insight Coriolis flow meter has a specified safety accuracy of 2 %. This means that internal component failures are listed in the device failure rate if they will cause an error of 2 % or greater.

3.3 Diagnostic response time

The Rotamass Total Insight Coriolis flow meter will report an internal failure within 3 minutes of fault occurrence for amplitude errors and within 7 seconds of fault occurrence for all other errors (e. g. frequency error, signal fault).

3.4 Setup

During installation the flow meter must be set up with engineering unit parameters. This is typically done with a field communicator or Display. These parameters must be verified during the installation to insure that the correct parameters are in the flow meter. Engineering range parameters can be verified by reading these parameters from the optional local display or by checking actual calibration of the flow meter.

Proof-Testing of the flow meter must be done after parameter setting.

3.5 Proof testing

The objective of proof testing is to detect failures within the flow meter that are not detected by the diagnostics of the flow meter. Of main concern are undetected failures that prevent the safety instrumented function from performing its intended function. The frequency of the proof tests (or the proof test interval) is to be determined in the reliability calculations for the safety instrumented functions for which the flow meter is applied. The actual proof tests must be performed more frequently, or as frequently as specified in the calculation in order to maintain the required safety integrity of the safety instrumented function.

The following tests need to be specifically executed when a proof test is performed. The results of the proof test need to be documented and this documentation should be part of a plant safety management system. Failures that are detected should be reported to Yokogawa.

Step	Action
1.	▶ Bypass the safety function and take appropriate action to avoid a false trip.
2.	▶ Verify plausibility of current with flow tube filled and zero flow rate within stated accuracy.
3.	▶ Verify plausibility of current with flow tube filled at two different flow rates able to be independently estimated to approximately 10 % accuracy.
4.	▶ Use digital communications to retrieve process fluid temperature measurement and verify against independent measurement.
5.	▶ Use digital communications to retrieve any diagnostics and take appropriate action.
6.	▶ Send a digital command to the transmitter to go to the high and low alarm level output state current and verify that the analog current reaches these values. ¹⁾
7.	▶ Cycle power to transmitter so RAM soft errors are cleared.
8.	▶ Remove the bypass and otherwise restore normal operation.

¹⁾ This tests for possible quiescent current, low loop voltage and high loop impedance related failures.

For details, refer to FMEDA report No. YEC 20-02-160 R002 V2R5.

In case of non-IS 4 – 20 mA output, the proof test will detect 93.3 % of possible DU failures.

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The following tools need to be available to perform proof testing:

- Flow meter display or alternatively for digital communication: HART field communicator, PRM or FieldMate.
- Measurement instrument to verify output current.
- Reference temperature measurement as close as possible to the flow meter under test.

The person(s) performing the proof test of the Rotamass Total Insight Coriolis flow meter should be trained in SIS operations including bypass procedures, flow meter maintenance and company management of change procedures.

3.6 Repair and replacement

If repair is to be performed with the process online the Rotamass Total Insight Coriolis flow meter will need to be bypassed during the repair. The user should set up appropriate bypass procedures for that. Contact the Yokogawa sales office if this instrument requires repair. The person(s) performing the repair and / or replacement of the Rotamass Total Insight Coriolis flow meter should have a sufficient skill level.

3.7 Startup time

The Rotamass Total Insight Coriolis flow meter will generate a valid signal within 20 seconds of power-on startup.

3.8 Firmware update

In case firmware updates are required, they will be performed at factory. The replacement responsibilities are then in place. The user will not be required to perform any firmware updates.

3.9 Reliability data

A detailed Failure Mode, Effects, and Diagnostics Analysis (FMEDA) report is available from Yokogawa with all failure rates and failure modes. The Rotamass Total Insight Coriolis flow meter is intended for use in a Low Demand Mode. Low Demand Mode means the average interval between dangerous conditions occurs infrequently.

The Rotamass Total Insight Coriolis flow meter is certified up to SIL2 for use in a simplex (1oo1) configuration, depending on the PFDavg calculation of the entire Safety Instrumented Function. The development process of the Rotamass Total Insight Coriolis flow meter is certified up to SIL3, allowing redundant use, with hardware fault tolerance of 1, of the flow meter up to this Safety Integrity Level, depending the PFDavg calculation of the entire Safety Instrumented Function.

When using the Rotamass Total Insight Coriolis flow meter in a redundant configuration, the use of a common cause factor (β -factor) of 2 % is suggested.

For details, refer to FMEDA report No. YEC 20-02-160 R002 V2R5.

3.10 Lifetime limits

The expected lifetime of the Rotamass Total Insight Coriolis flow meter is 10 years. The reliability data listed in chapter Reliability data is only valid for this period. The failure rates of the Rotamass Total Insight Coriolis flow meter may increase sometime after this period. Reliability calculations based on the data listed in chapter Reliability data for Rotamass Total Insight Coriolis flow meter lifetimes beyond 10 years may yield results that are too optimistic, i.e. the calculated Safety Integrity Level will not be achieved.

For details, refer to FMEDA report No. YEC 20-02-160 R002 V2R5.

3.11 Required parameter settings

The following parameters need to be set in order to maintain the designed safety integrity.

4 – 20 mA output setting	One of the following values should be set: <ul style="list-style-type: none">▪ Mass flow▪ Density▪ Temperature
Write lock setting	The parameter “write lock” should be set to “All locked”.
High-Low (Burnout) switch	To specify if the output should go high (> 21.6 mA) or low (< 2.4 mA) upon detection of an internal failure.
Write Protect (Security)	The write function should be disabled.

The detail is described in the User’s Manual and the Software Instruction Manual of Rotamass Total Insight.

3.12 Environmental limits

The environmental limits of the Rotamass Total Insight Coriolis flow meter are specified in the applicable General Specifications (GS) of Rotamass Total Insight.

3.13 Application limits

The application limits of the Rotamass Total Insight Coriolis flow meter are specified in the applicable General Specifications (GS) of Rotamass Total Insight.

If the flow meter is used outside of the application limits the reliability data listed in chapter Reliability data becomes invalid.

4 Definitions and abbreviations

4.1 Definitions

Safety

Freedom from unacceptable risk of harm.

Functional safety

The ability of a system to carry out the actions necessary to maintain a defined safe state for the equipment / machinery / plant / apparatus under control of the system.

Basic safety

The equipment must be designed and manufactured such that it protects against risk of damage to persons by electrical shock and other hazards and against resulting fire and explosion. The protection must be effective under all conditions of the nominal operation and under single fault condition.

Verification

The demonstration for each phase of the life-cycle that the (output) deliverables of the phase meet the objectives and requirements specified by the inputs to the phase. The verification is usually executed by analysis and / or testing.

Validation

The demonstration that the safety-related system(s) or the combination of safety related system(s) and external risk reduction facilities meet, in all respects, the Safety Requirements Specification. The validation is usually executed by testing.

Safety assessment

The investigation to arrive at a judgment – based on evidence – of the safety achieved by safety-related systems.

Safety	Freedom from unacceptable risk of harm.
Functional safety	The ability of a system to carry out the actions necessary to maintain a defined safe state for the equipment / machinery / plant / apparatus under control of the system.
Basic safety	The equipment must be designed and manufactured such that it protects against risk of damage to persons by electrical shock and other hazards and against resulting fire and explosion. The protection must be effective under all conditions of the nominal operation and under single fault condition.
Verification	The demonstration for each phase of the life-cycle that the (output) deliverables of the phase meet the objectives and requirements specified by the inputs to the phase. The verification is usually executed by analysis and / or testing.
Validation	The demonstration that the safety-related system(s) or the combination of safety related system(s) and external risk reduction facilities meet, in all respects, the Safety Requirements Specification. The validation is usually executed by testing.
Safety assessment	The investigation to arrive at a judgment – based on evidence – of the safety achieved by safety-related systems.

Further definitions of terms used for safety techniques and measures and the description of safety-related systems are given in IEC 61508-4.

4.2 Abbreviations

Value	Name / Description
DU	Dangerous Undetected
FMEDA	Failure Mode, Effects and Diagnostic Analysis
IS	Intrinsically safe explosion-proof
non-IS	Non-intrinsically safe explosion-proof
PFDavg	Average Probability of Failure on Demand
PLC/DCS	Programmable Logic Controller / Distributed Control System
PRM	Plant Resource Manager
SIF	Safety Instrumented Function
SIL	Safety Integrity Level
SIS	Safety Instrumented System
SLC	Safety Lifecycle

TRADEMARKS

HART:	registered trademark of FieldComm Group, Inc., US
ROTAMASS:	registered trademark of Rota Yokogawa GmbH & Co. KG, DE
FieldMate:	registered trademark of YOKOGAWA ELECTRIC CORPORATION


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Manufacturer:

Rota Yokogawa GmbH & Co. KG
Rheinstr. 8
D-79664 Wehr
Germany

For the actual manufacturing location of your device refer to the model code and/or serial number.



QUALITY SYSTEM CERTIFICATION
DNV
ISO 14001
ISO 45001
ISO 9001
ISO/IEC 27001