Safety Manual
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Coriolis Flowmeter with Model 1700 or Model 2700 Transmitter

Safety Manual for SIS

Micro Motion®

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Process Management

Contents

1 Terms and Abbreviations

Safety Freedom from unacceptable risk of harm.

Functional Safety The ability of a system to carry out the actions necessary to achieve or 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.

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.

FMEDA Failure Modes, Effects and Diagnostic Analysis

HART Highway Addressable Remote Transducer

PFD_{AVG} Average Probability of Failure on Demand

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).

2 Reference Documents

Micro Motion Model 1700 and Model 2700 Transmitters: Installation Manual	Document generated by Micro Motion
Micro Motion Series 1000 and Series 2000 Transmitters: Configuration and Use Manual	Document generated by Micro Motion
Report No.: MiMo 04/06-22 R004 Version V3, Revision R2, April 25, 2014	FMEDA report for Coriolis Flowmeter with 1700/2700 Transmitter and Core Processor Prepared for Micro Motion by exida.com LLC
Report No.: MiMo 08/04-67 R001 Version V3, Revision R2, April 25, 2014	FMEDA report for Coriolis Flowmeter with 1700/2700 Transmitter and Enhanced Core Processor Prepared for Micro Motion by exida.com LLC
Micro Motion sensor installation manuals	Documents generated by Micro Motion
Micro Motion sensor product data sheets	Documents generated by Micro Motion

All documents are available on the Micro Motion web site: **www.micromotion.com**.

3 Using and Maintaining the Flowmeter

3.1 Communications Tools

The following communications tools can be used to commission the transmitter:

- The appropriate version of the ProLink® software package from Micro Motion
- The 375 Field Communicator (handheld) with the appropriate HART device description (DD)
- AMS Device Manager

The proof test instructions in this manual are designed for use with ProLink II v2.8 or the HART device rev 5, DD rev1. Adapt these instructions as required for use with earlier or later versions of ProLink, the HART DD, or AMS Device Manager.

Refer to *Micro Motion Series 1000 and Series 2000 Transmitters: Configuration and Use Manual* for information on connecting the handheld or ProLink II to the transmitter, and using the communications tool with the transmitter.

3.2 Installation and Commissioning

No special installation is required in addition to the standard installation practices outlined in *Micro Motion Model 1700 and Model 2700 Transmitters: Installation Manual* and the appropriate sensor installation manual.

During commissioning, the following safety-critical parameters must be verified or configured:

- Flowmeter characterization parameters (FCF, K1, K2, D1, D2, DT)
- mA output range (LRV and URV)
- Engineering units (measurement units)
- Primary variable (process variable assigned to the primary mA output)
- Low flow cutoff
- Damping values (flow damping, density damping, temperature damping, added damping)

During the proof test, these parameters must be verified.

3.3 Safety Integrity Parameter Settings

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

Parameter	Reason
mA Fault Action (set to Upscale or Downscale)	To specify if the mA output should go high (> 21 mA) or low (< 3.6 mA) upon detection of an internal failure
mA Fault Level	To specify the actual mA output signal in case of fault: • Upscale: range = 21–24 mA, default = 22 mA • Downscale: - I.S transmitters: range = 3.2–3.6 mA, default = 3.2 mA - All other transmitters: range = 1.0–3.6 mA, default = 2.0 mA
Password option or write-protection enabled	To prevent accidental changes to parameter settings

3.4 Proof Tests

The objective of proof testing is to detect failures within the Coriolis flowmeter with a Model 1700 or Model 2700 transmitter that are not detected by the diagnostics of the transmitter. Of main concern are undetected failures that prevent the Safety Instrumented Function from performing its intended function.

The frequency of proof testing, or the proof test interval, is to be determined in reliability calculations for the Safety Instrumented Functions for which the Coriolis flowmeter with a Model 1700 or Model 2700 transmitter is applied. The proof tests must be performed at least as frequently as specified in the calculation in order to maintain the required safety integrity of the Safety Instrumented Function.

The person(s) performing the proof test of the Coriolis flowmeter with a Model 1700 or Model 2700 transmitter should be trained in SIS operations, including bypass procedures, flowmeter maintenance and company Management of Change procedures. A handheld communicator or ProLink II is required. Refer to *Micro Motion Series 1000 and Series 2000 Transmitters: Configuration and Use Manual* for information on connecting the handheld device or ProLink II to the transmitter, and using the communications tool with the transmitter.

The results of the proof test need to be documented and this documentation should be part of a plant safety management system. Any failures that are detected and that compromise functional safety should be reported to the Product Safety Officer within Micro Motion (see Section 5).

Table 1-1 describes the proof test options and the associated DU (Dangerous Undetected) failure detection rate.

Table 1-1 Proof Test Options

Core Processor Type	Proof Test	Description	DU Failure Detection
Standard	1	• mA output min-to-max test • Checking for alarms • Checking configuration	56%
	1 and 3	As above, plus: • Calibration against primary standard	99%
Enhanced	1	• mA output min-to-max test • Checking for alarms • Checking configuration	56%
	2	• mA output min-to-max test • Checking for alarms • Checking configuration • Meter verification • Verification of onboard temperature measurement • Test for soft errors in RAM	91%
	2 and 3	As above, plus: • Calibration against primary standard	99%

Proof Test 1

The following proof test is recommended for all flowmeters.

Step	Action
1	Electronically bypass the safety PLC by using a maintenance override function or take other appropriate action to avoid a false trip, following Management of Change procedures.
2	Set each mA output to go to the Fault Level specified for Upscale, and verify that the mA current reaches that value. If the mA output Fault Action is not set for Upscale, use the default value (22 mA). • Using a handheld: **Diag/Service > Loop Test > Fix Analog Out** • Using ProLink II: **ProLink > Test > Fix mA Output** *This tests for compliance voltage problems such as a low loop power supply voltage or increased wiring resistance. This also tests for other possible failures.*
3	Set each mA output to go to the Fault Level specified for Downscale, and verify that the mA current reaches that value. If the mA output Fault Action is not set for Downscale, use the default value (I.S. transmitters: 3.2 mA, all other transmitters: 2.0 mA). • Using a handheld: **Diag/Service > Loop Test > Fix Analog Out** • Using ProLink II: **ProLink > Test > Fix mA Output** *This tests for possible failures related to quiescent current.*
4	Ensure that no alarms or warnings are present in the transmitter. • Using a handheld: **Diag/Service > View Status** • Using ProLink II: **ProLink > Status**
5	Verify all safety-critical configuration parameters. See Section 3.2.
6	Restore the loop to full operation.
7	Remove the bypass from the safety PLC or otherwise restore normal operation.

Proof Test 2

The following proof test is recommended for all flowmeters with an enhanced core processor.

Note: Proof Test 2 incorporates all the steps of Proof Test 1.

Step	Action
1	Electronically bypass the safety PLC by using a maintenance override function or take other appropriate action to avoid a false trip, following Management of Change procedures.
2	Set each mA output to go to the Fault Level specified for Upscale, and verify that the mA current reaches that value. If the mA output Fault Action is not set for Upscale, use the default value (22 mA). • Using a handheld: **Diag/Service > Loop Test > Fix Analog Out** • Using ProLink II: **ProLink > Test > Fix mA Output** *This tests for compliance voltage problems such as a low loop power supply voltage or increased wiring resistance. This also tests for other possible failures.*
3	Set each mA output to go to the Fault Level specified for Downscale, and verify that the mA current reaches that value. If the mA output Fault Action is not set for Downscale, use the default value (I.S. transmitters: 3.2 mA, all other transmitters: 2.0 mA). • Using a handheld: **Diag/Service > Loop Test > Fix Analog Out** • Using ProLink II: **ProLink > Test > Fix mA Output** *This tests for possible failures related to quiescent current.*
4	Read the temperature value from the sensor, compare it to process temperature, and verify that this is a reasonable reading. • Using a handheld: **Process Variables > View Fld Dev Vars > Temp** • Using ProLink II: **ProLink > Process Variables > Temp**
5	Power-cycle the transmitter, then wait approximately 40 seconds for the flowmeter to return to normal operation.

Step	Action
6	Perform the meter verification procedure as described in *Micro Motion Series 1000 and Series 2000 Transmitters: Configuration and Use Manual*.
7	Ensure that no alarms or warnings are present in the transmitter. • Using a handheld: **Diag/Service > View Status** • Using ProLink II: **ProLink > Status**
8	Verify all safety-critical configuration parameters. See Section 3.2.
9	Restore the loop to full operation.
10	Remove the bypass from the safety PLC or otherwise restore normal operation.

Proof Test 3

The following proof test is recommended for all flowmeters.

Perform a full calibration against a primary standard.

Note: The meter verification procedure and the onboard temperature verification test are incorporated into a full calibration.

3.5 Repair and Replacement

There are no user-replaceable components on printed circuit assemblies, and all other spare components for the Model 1700 or Model 2700 transmitter must be purchased from Micro Motion. Any failures that are detected and that compromise functional safety should be reported to the Product Safety Officer within Micro Motion (see Section 5). When replacing the Coriolis sensor or the Model 1700 or Model 2700 transmitter, the procedures in the applicable installation manual should be followed. The user is responsible for maintaining adequate risk reduction for the Safety Instrumented Function during repair and replacement.

3.6 Firmware Update

In case firmware updates are required, they will be performed at the factory or by a Micro Motion certified service technician. The user will not be required to perform any firmware updates.

4 Operating Constraints

4.1 Safety Accuracy

The Coriolis flowmeter with a Model 1700 or Model 2700 transmitter 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.

4.2 Diagnostic Response Time

The Coriolis flowmeter with a Model 1700 or Model 2700 transmitter will report an internal failure within 5 minutes of fault occurrence (worst case).

4.3 Startup Time

The Model 1700 or Model 2700 transmitter will generate a valid signal within 16 seconds of power-on startup.

4.4 Reliability Data and Lifetime Limit

A detailed Failure Mode, Effects, and Diagnostics Analysis (FMEDA) report is available from Micro Motion. This report details all failure rates and failure modes, common cause factors for applications with redundant devices and the expected lifetime of the Coriolis flowmeter with a Model 1700 or Model 2700 transmitter.

The Coriolis flowmeter with a Model 1700 or Model 2700 transmitter is certified for applications up to SIL2 for use in a simplex (1oo1) configuration, depending on the PFD_{AVG} calculation of the entire Safety Instrumented Function.

The development process of the Coriolis flowmeter with a Model 1700 or Model 2700 transmitter is certified up to SIL3, allowing redundant use of the transmitter up to this Safety Integrity Level, depending on the PFD_{AVG} calculation of the entire Safety Instrumented Function.

When using the Coriolis flowmeter with a Model 1700 or Model 2700 transmitter in a redundant configuration, a common cause factor should be included in reliability calculations. For details, see the FMEDA report.

The reliability data listed in the FMEDA report is valid only for the useful lifetime of the Coriolis flowmeter with a Model 1700 or Model 2700 transmitter. The failure rates of the Coriolis flowmeter with a Model 1700 or Model 2700 transmitter may increase sometime after this period. Reliability calculations based on the data listed in the FMEDA report for mission times beyond the lifetime may yield results that are too optimistic, i.e., the calculated Safety Integrity Level will not be achieved.

4.5 Environmental Limits

The environmental limits of the Model 1700 or Model 2700 transmitter are specified in *Micro Motion Model 1700 and Model 2700 Transmitters: Installation Manual*.

The environmental limits of the sensor are specified in the sensor's product data sheet.

4.6 Application Limits

The application limits of the Model 1700 or Model 2700 transmitter are specified in *Micro Motion Model 1700 and Model 2700 Transmitters: Installation Manual*. If the transmitter is used outside of the application limits, the reliability data referenced in Section 4.4 becomes invalid.

The application limits of the sensor are specified in the sensor's product data sheet.

5 Product Safety Officer

Any failures that are detected and that compromise functional safety should be reported to the Product Safety Officer within Micro Motion. Please contact Micro Motion or Emerson Process Management customer service. Customer service is available 24 hours a day, seven days a week. Contact information is provided on the back cover of this manual.

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