Safety Manual
MMI-20029788, Rev AC
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Coriolis Flowmeter with Micro Motion® Model 5700 Transmitters

Safety Manual for Safety Instrumented Systems (SIS)

MICRO MOTION™

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Safety messages

Safety messages are provided throughout this manual to protect personnel and equipment. Read each safety message carefully before proceeding to the next step.

Other information

Full product specifications can be found in the product data sheet. Troubleshooting information can be found in the configuration manual. Product data sheets and manuals are available from the Micro Motion web site at www.emerson.com.

Return policy

Follow Micro Motion procedures when returning equipment. These procedures ensure legal compliance with government transportation agencies and help provide a safe working environment for Micro Motion employees. Micro Motion will not accept your returned equipment if you fail to follow Micro Motion procedures.

Return procedures and forms are available on our web support site at www.emerson.com, or by phoning the Micro Motion Customer Service department.

Emerson Flow customer service

Email:

- Worldwide: flow.support@emerson.com
- Asia-Pacific: APflow.support@emerson.com

Telephone:

North and South America		Europe and Middle East		Asia Pacific	
United States	800-522-6277	U.K.	0870 240 1978	Australia	800 158 727
Canada	+1 303-527-5200	The Netherlands	+31 (0) 704 136 666	New Zealand	099 128 804
Mexico	+41 (0) 41 7686 111	France	0800 917 901	India	800 440 1468
Argentina	+54 11 4837 7000	Germany	0800 182 5347	Pakistan	888 550 2682
Brazil	+55 15 3413 8000	Italy	8008 77334	China	+86 21 2892 9000
		Central & Eastern	+41 (0) 41 7686 111	Japan	+81 3 5769 6803
		Russia/CIS	+7 495 981 9811	South Korea	+82 2 3438 4600
		Egypt	0800 000 0015	Singapore	+65 6 777 8211
		Oman	800 70101	Thailand	001 800 441 6426
		Qatar	431 0044	Malaysia	800 814 008
		Kuwait	663 299 01		
		South Africa	800 991 390		
		Saudi Arabia	800 844 9564		
		UAE	800 0444 0684		

Contents

1 Before you begin

1.1 About this document

This document provides information about how to install, commission, and proof test a Coriolis flowmeter with a Model 5700 transmitter to comply with Safety Instrumented Systems (SIS) requirements.

Important
This manual assumes that the following conditions apply:

- The transmitter has been installed correctly and completely according to the instructions in the transmitter installation manual
- The installation complies with all applicable safety requirements
- The user is trained in local and corporate safety standards

1.2 Related documents

You can find all product documentation on the product documentation DVD shipped with the product or at www.emerson.com.

For more information, see any of the following documents:

- *Micro Motion Model 5700 Product Data Sheet*
- *Micro Motion Model 5700 Transmitters with Configurable Outputs: Configuration and Use Manual*
- *Micro Motion Model 5700 Transmitters with Intrinsically Safe Outputs: Configuration and Use Manual*
- *Micro Motion Model 5700 Transmitters with Configurable Outputs: Installation Manual*
- *Micro Motion Model 5700 Transmitters with Intrinsically Safe Outputs: Installation Manual*
- Emerson sensor installation manual
- Emerson sensor product data sheets
- Report No. MiMo 18-01-016 R001 V2R2 FMEDA 5700, prepared for Emerson by exida.com LLC

2 Installation and commissioning

Use this section to install and commission a Coriolis flowmeter with a Model 5700 transmitter with SIS features.

IEC 61508 relevant requirements

The Coriolis flowmeter with a Model 5700 transmitter is certified per the relevant requirements of IEC 61508.

Systematic capability	Safety Integrity Level (SIL) 3 capable
Random capability	• Type B element • SIL 2 capable @ HFT=0 (single meter) • SIL 3 capable @ HFT=1 (multiple meters)

Failure rates according to IEC 61508 in FIT (1)

Table 2-1: Failure rates for a Model 5700 with configurable outputs

Model 5700 CIO	λ_{SD}	λ_{SU}	λ_{DD}	λ_{DU}
Model 5700I Integral mount transmitter and Model 5700C 9-wire remote mount transmitter with an integrated core processor	0	72	2941	107
Model 5700R 4-wire remote mount transmitter connected to a sensor with a standard core processor	0	71	2522	78
Model 5700R 4-wire remote mount transmitter connected to a sensor with an enhanced core processor	0	132	3124	138

Table 2-2: Failure rates for a Model 5700 with intrinsically safe outputs

Model 5700 IS	λ_{SD}	λ_{SU}	λ_{DD}	λ_{DU}
Model 5700I Integral mount transmitter and Model 5700C 9-wire remote mount transmitter with an integrated core processor	0	78	3030	114
Model 5700R 4-wire remote mount transmitter connected to a sensor with a standard core processor	0	77	2615	84
Model 5700R 4-wire remote mount transmitter connected to a sensor with an enhanced core processor	0	138	3214	145

SIS-certified versions

Emerson maintains an SIS-compliant modification process. Changes made after initial release do not affect overall SIS certification.

Version information is available from the display at **About** > **Versions**.

(1) FIT = 1 failure / 10^9 hours

Table 2-3: SIS-certified versions for a Model 5700 with configurable outputs

Device	Display tag	Version
Model 5700 firmware	Transmitter	1.20 and later
Integrated Core Processor firmware	Core processor	4.14 and later
Enhanced Core Processor firmware	Core processor	4.14 and later
Standard Core Processor firmware	Core processor	3.42 and later
Model 5700 hardware	Transmitter hardware	0 and later

Table 2-4: SIS-certified versions for a Model 5700 with intrinsically safe outputs

Device	Display tag	Version
Model 5700 firmware	Transmitter	1.0 and later
Integrated Core Processor firmware	Core processor	4.60 and later
Enhanced Core Processor firmware	Core processor	4.60 and later
Standard Core Processor firmware	Core processor	3.42 and later
Model 5700 hardware	Transmitter hardware	0 and later

- On SIS applications for a Model 5700 with configurable outputs, the Channel A mA output, wired in series with the Channel D mA input in loopback mode, is used for the safety critical variable (mass flow, volume flow, or density). The SIS features are enabled via licensing. While other output channels may be licensed, they are outside the scope of SIS usage.
- On SIS applications for a Model 5700 with intrinsically safe outputs, the Channel A mA Output is used for the safety critical variable (mass flow, volume flow, or density). The SIS features are enabled through licensing. While other output channels can be licensed, they are outside the scope of SIS usage.

Safety precautions

Prior to making any changes to the Model 5700 Coriolis flowmeter, such as changing the configuration, upgrading the firmware, replacing the transmitter hardware or sensor:

- Take appropriate action to avoid a false trip by electronically bypassing the safety Programmable Logic Controller (PLC).

  Important
  Ensure alternate means are in place to maintain the process in a safe state.

- Prior to placing the meter online and removing the bypass from the safety PLC, verify the transmitter configuration and all safety parameters.

2.1 Set up the Model 5700

Use this section to make sure the Model 5700 is installed and configured for SIS applications.

About this task

You can use ProLink III, the Model 5700 display, or the field communicator to verify, or if needed, configure these settings. For more information, see the *Micro Motion Model 5700 Transmitters with Configurable Outputs: Configuration and Use Manual* or the *Micro Motion Model 5700 Transmitters with Intrinsically Safe Outputs: Configuration and Use Manual*.

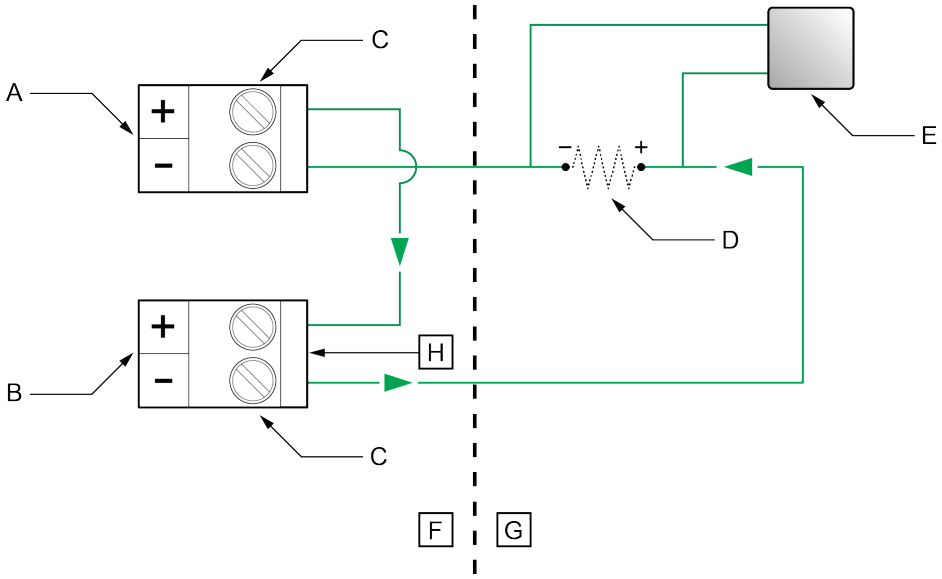
The sensor does not require special installation in addition to the standard installation procedures in the sensor installation manual.

2.1.1 Set up a Model 5700 with configurable outputs

Procedure

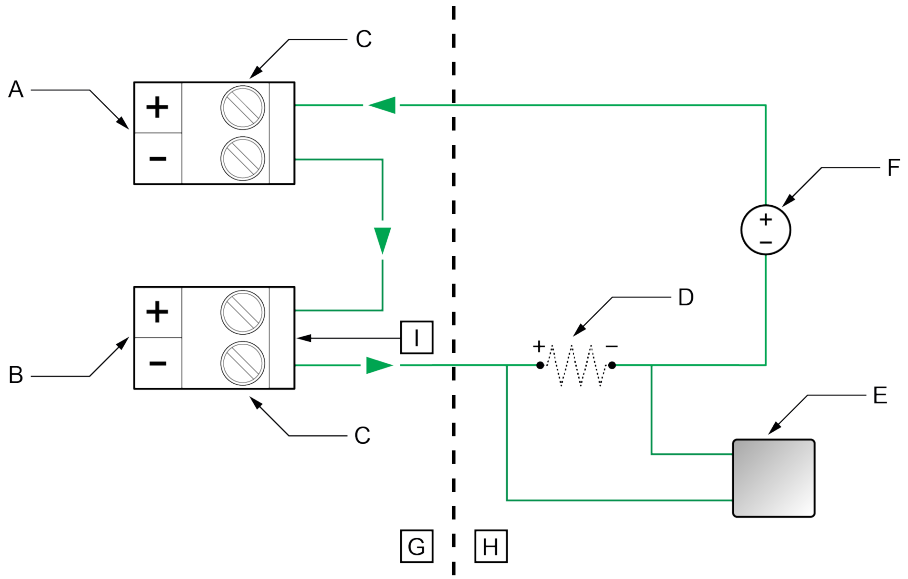
1. Use the *Micro Motion Model 5700 Transmitters with Configurable Outputs: Installation Manual* to install the Model 5700, except for the wiring instructions for Channels A and D. Instead, wire Channels A and D using one of the following power options:
   - Channel A active (internal) power and Channel D passive (external) power
   - Channel A passive (external) power and Channel D passive (external) power

Figure 2-1: Channel A active (internal) and Channel D passive (external) power



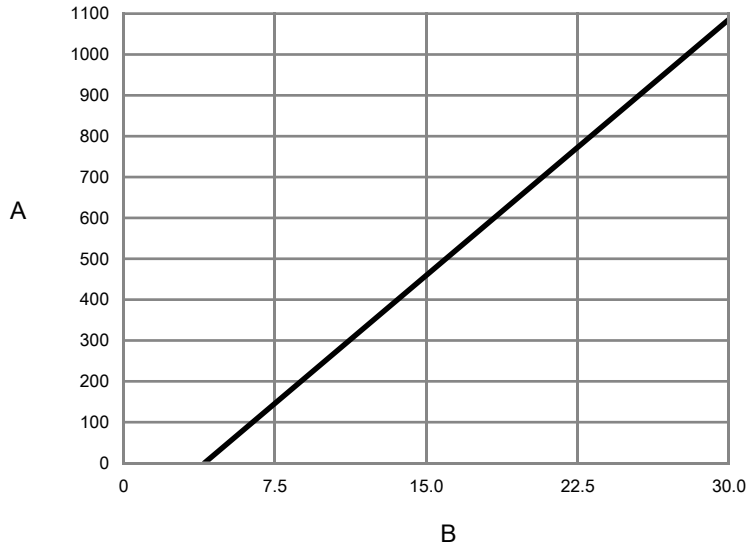
A. Channel A mA Output
B. Channel D mA Input
C. Terminals
D. 820 ohm maximum loop resistance including 100 ohms (H) for mA Input (250–600 ohm for HART communications)
E. Signal device
F. Terminal compartment
G. External to the Model 5700
H. 100 ohm input resistance

Figure 2-2: Channel A passive (external) and Channel D passive (external) power



A. Channel A mA Output
B. Channel D mA Input
C. Terminals
D. Maximum loop resistance including 100 ohms (I) for mA Input — see Figure 2-3.
E. Signal device
F. 5–30 VDC (maximum)
G. Terminal compartment
H. External to the Model 5700
I. 100 ohm input resistance

Figure 2-3: Externally-powered mA/HART output: maximum loop resistance



A. Maximum resistance (Ω)
B. External supply voltage (V)

Note
The calculation for loop resistance must include 100 ohms for the mA Input.

2. Verify that the following features are licensed: SIL, ChA, ChD.
3. Verify that Channel D is configured as follows:

Channel D setting	Option
Channel Type	mA Input
Power Source	External (Passive)
mA Input Assignment	Loop Current

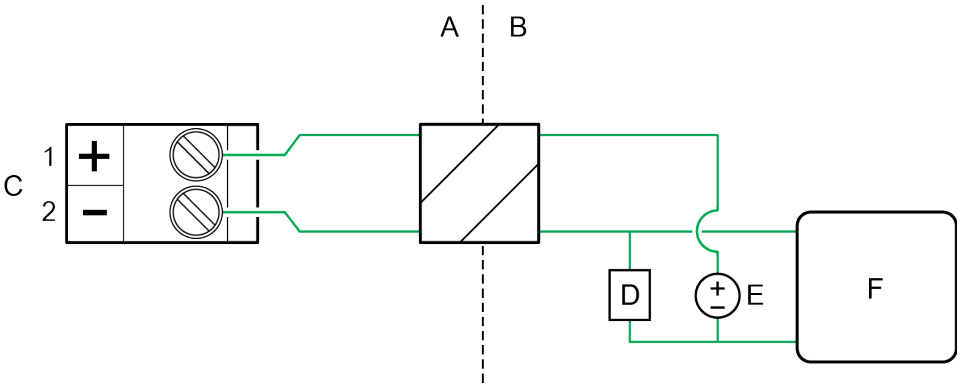
4. Verify all safety parameters:
   a) Verify that all appropriate flow and density calibration parameters are set (FCF, K1, K2, D1, D2, and DT).
   b) Verify that the Lower Range Value (LRV) and the Upper Range Value (URV) for Channel A mA Output 1 is configured.
   c) Verify that the appropriate measurement units are configured (mass flow, volume flow, density, and temperature).
   d) Verify that the HART Primary Variable (PV) is assigned to Channel A mA Output.
   e) Verify that the appropriate low flow cutoff parameter is configured.
   f) Verify that the appropriate damping values are configured - such as flow, density, temperature, and added damping.
   g) Verify that the **mA Output Fault Action** is set to Upscale or Downscale.

2.1.2 Set up a Model 5700 with intrinsically safe outputs

Procedure

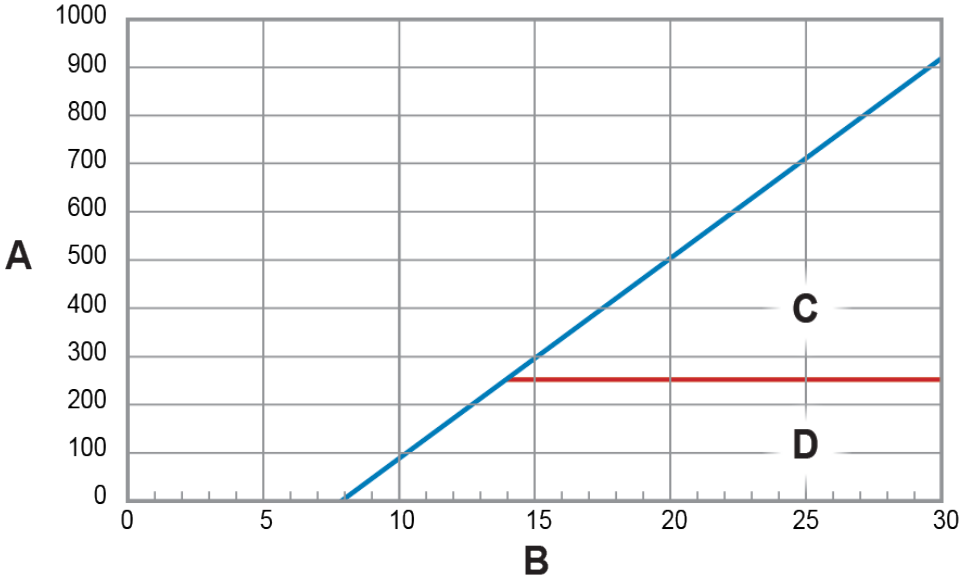
1. Use the *Micro Motion Model 5700 Transmitters with Intrinsically Safe Outputs: Installation Manual* to mount the transmitter and install the sensor wiring.
2. Wire the Channel A passive (external) power to the appropriate output terminal and pins.

Figure 2-4: Channel A mA/HART output wiring



A. Hazardous area
B. Non-hazardous area
C. mA/HART output
D. 250–600 Ω resistance
E. 24V nominal
F. HART device

Figure 2-5: Channel A mA/HART supply voltage and loop resistance



A. Total loop resistance R_{max} (including barrier)
B. Supply voltage VDC (volts)
C. Operating region with HART
D. Operating region without HART (includes the C range)

3. Verify that the following features are licensed: SIL and ChA.
4. Verify all safety parameters:
   a) Verify that all appropriate flow and density calibration parameters are set (FCF, K1, K2, D1, D2, and DT).
   b) Verify that the Lower Range Value (LRV) and the Upper Range Value (URV) for Channel A mA output 1 is configured.
   c) Verify that the appropriate measurement units are configured (mass flow, volume flow, density, and temperature).
   d) Verify that the HART Primary Variable (PV) is assigned to Channel A mA Output.
   e) Verify that the appropriate low flow cutoff parameter is configured.
   f) Verify that the appropriate damping values are configured - such as flow, density, temperature, and added damping.
   g) Verify that the mA Output Fault Action is set to Upscale or Downscale.

2.2 Diagnostics

2.2.1 Diagnostics for a Model 5700 with configurable outputs

The SIL license enables a mA Output to mA Input comparison diagnostic.

If the difference between the programmed mA Output and the actual mA Input exceeds 0.2 mA, an `Electronics Failed` alert becomes active and all analog outputs will be turned off (outputs all to zero) within 5 minutes. The alert shows up as:

On the display as:	`Verification of mAO1 Failed`
On ProLink III as:	`mAO Verification Failed`

After 5 minutes, the outputs are turned back on, and the mA Output to mA Input comparison check is performed again. If the alert was due to a transient condition, since cleared, the transmitter will resume normal operations. If the alert was due to a component failure, the alert will remain active and the outputs will turn off again.

Note
The mA Output to mA Input comparison diagnostic is disabled for the first 5 minutes after the transmitter is powered up. This allows time to verify correct wiring and operation of the ChA-ChD mA Output with mA Input loopback.

2.2.2 Diagnostics for a Model 5700 with intrinsically safe outputs

The SIL license enables a mA Output to internal mA Readback comparison diagnostic.

If the difference between the programmed mA Output and the actual internal mA Readback exceeds 0.2 mA, an `Electronics Failed` alert becomes active and all analog outputs will be turned off (outputs all to fault state) within 5 minutes. The alert shows up as:

On the display as:	`Verification of mAO1 Failed`
On ProLink III as:	`mAO Verification Failed`

After 5 minutes, the outputs are turned back on, and the mA Output to internal mA Readback comparison check is performed again. If the alert was due to a transient condition, since cleared, the transmitter will resume normal operations. If the alert was due to a component failure, the alert will remain active and the outputs will turn off again.

Note
The mA Output to mA Readback comparison diagnostic is disabled for the first 5 minutes after the transmitter is powered up. This allows time to verify correct wiring and operation of the ChA mA Output with internal mA Readback.

2.3 Enable or disable software write-protection

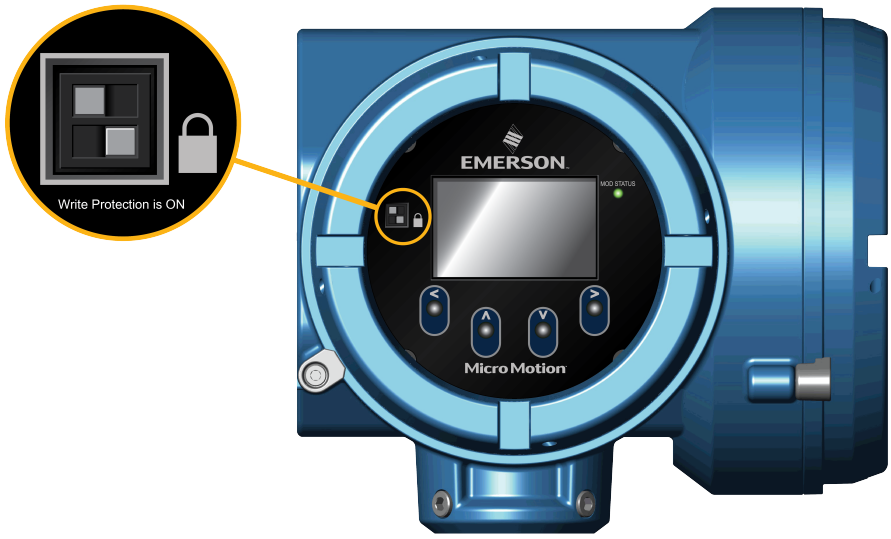
Display	Use a mechanical switch on the display.
ProLink III	**Device Tools** > **Configuration** > **Write-Protection**
Field Communicator	**Configure** > **Manual Setup** > **Security** > **Lock/Unlock Device**

When enabled, **Write-Protection** prevents changes to the transmitter configuration. You can perform all other functions, and you can view the transmitter configuration parameters.

About this task

Note

The write protection setting via software methods (such as ProLink III) is only available on transmitters without a display.
For transmitters with a display, write protection is only available using the lock switch on the display.



Write-protecting the transmitter primarily prevents accidental changes to configuration, not intentional changes. Any user who can make changes to the configuration can disable write protection.

2.4 Upgrade the transmitter firmware

You can upgrade the transmitter firmware to stay current with development and to take advantage of any new features.

2.4.1 Using a USB drive with the display

You can upgrade the transmitter firmware to stay current with development and to take advantage of any new features.

Prerequisites

You must have the firmware upgrade files provided by Micro Motion.

The service port must be enabled. It is enabled by default. However, if you need to enable it, choose **Menu** > **Configuration** > **Security** and set **Service Port** to On.

Procedure

1. Copy the folder containing the firmware upgrade files to a USB drive.
2. Open the wiring compartment and insert the USB drive into the service port.

   CAUTION
   If the transmitter is in a hazardous area, do not open the wiring compartment. Contact customer support.

3. Follow the prompts once the transmitter recognizes the USB drive.
4. Select **USB Drive --> Transmitter**.
5. Select **Update Device Software**.
6. Select the firmware upgrade folder and follow the prompts.

   Note
   If required, the transmitter upgrade procedure automatically includes an upgrade to the core processor software.

   If you chose to reboot the transmitter at a later date, you can reboot it from the menu, or you can power-cycle it.
7. Verify the transmitter configuration and all safety parameters.
8. Enable write-protection.

2.4.2 Using the USB service port and ProLink III

You can upgrade the transmitter firmware to stay current with development and to take advantage of any new features.

About this task

This procedure is not available over HART. You must use a service port.

CAUTION

If the transmitter is in a hazardous area, do not open the wiring compartment. Contact customer support.

Prerequisites

You must have the firmware upgrade files provided by Emerson.

Procedure

1. Choose **Device Tools** > **Transmitter Software Update**.
2. Navigate to the folder containing the firmware upgrade files.
3. Click **Update**.

   Note
   If required, the transmitter upgrade procedure automatically includes an upgrade to the core processor software.

   If you chose to reboot the transmitter at a later date, you can reboot it from the display, or you can power-cycle it.
4. Verify the transmitter configuration and all safety parameters.
5. Enable write-protection.

2.5 Replace equipment

If you need to replace hardware, purchase all spare parts from Emerson.

About this task

You cannot use user-supplied components on any Emerson printed circuit assemblies.

Procedure

1. Replace the hardware.
2. Verify the transmitter configuration and all safety parameters.
3. Enable write-protection.

3 Proof tests

Proof tests detect transmitter failures that are not detected by transmitter diagnostics — mainly undetected failures that prevent the Safety Instrumented Function from performing correctly.

The frequency of proof testing, or the proof test interval, is determined by reliability calculations for your transmitter model's Safety Instrumented Functions.

The proof tests must be performed at least as frequently as specified in the calculation to maintain the required Safety Instrumented Function integrity.

3.1 Proof test options

The Coriolis flowmeter with a Model 5700 transmitter has 3 proof tests you can use to detect failures.

Proof tests can be performed using the display, ProLink III, or the field communicator.

Table 3-1: Proof test options

Device	Proof test	Description	DU failure detection
5700R with standard core processor	1	• mA Output min-to-max test • Checking for alarms • Checking configuration	50%
	1 and 3	• mA Output min-to-max test • Checking for alarms • Checking configuration • Calibration against primary standard	99%
• 5700I • 5700C • 5700R with enhanced core processor	1	• mA Output min-to-max test • Checking for alarms • Checking configuration	50%
	1 and 3	• mA Output min-to-max test • Checking for alarms • Checking configuration • Calibration against primary standard	99%
	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%

Table 3-1: Proof test options *(continued)*

Device	Proof test	Description	DU failure detection
	2 and 3	• mA Output min-to-max test • Checking for alarms • Checking configuration • Meter verification • Verification of onboard temperature measurement • Test for soft errors in RAM • Calibration against primary standard	99%

3.2 Proof test 1

Proof test 1 is recommended for all SIL-approved 5700 models.

Prerequisites

This procedure assumes that you are familiar with plant procedures. For details on how to do any of the following steps, see the appropriate Model 5700 configuration and use manual.

Procedure

1. Take appropriate action to avoid a false trip by electronically bypassing the safety Programmable Logic Controller (PLC).

   Important
   Ensure alternate means are in place to maintain the process in a safe state.

   Use Management of Change procedures to override the safety PLC function.
2. Disable write-protection.
3. Using an external device such as a fluke meter, test the mA Output by setting each mA Output to the Fault Level specified for Upscale. Verify that the mA current reaches that value, or use the default value (22mA).

   This step tests for compliance voltage problems, such as low voltage on the loop power supply, or increased wiring resistance.
4. Using an external device such as a fluke meter, test the mA Output by setting each mA Output to the Fault Level specified for Downscale. Verify that the mA current reaches that value, or use the default value.

Option	Description
2.0 mA	Default for a Model 5700 with configurable outputs
3.2 mA	Default for a Model 5700 with intrinsically safe outputs

   This step tests for possible failures related to quiescent current.
5. Verify that the transmitter does not display alarms or warnings.

6. Verify all safety-critical configuration parameters.
7. Restore the loop to full operation.
8. Enable write-protection.
9. Remove the bypass from the safety PLC, or otherwise restore normal operation.
10. Document the results of this proof test as part of your plant safety management procedures.

3.3 Proof test 2

Proof test 2 is recommended for an SIL-approved Model 5700 with the integrated core processor (5700I / 5700C) or the enhanced core processor (5700R).

Prerequisites

This procedure assumes that you are familiar with plant procedures. For details on how to do any of the following steps, see the appropriate Model 5700 configuration and use manual.

Procedure

1. Take appropriate action to avoid a false trip by electronically bypassing the safety Programmable Logic Controller (PLC).

   Important
   Ensure alternate means are in place to maintain the process in a safe state.

   Use Management of Change procedures to override the safety PLC function.
2. Disable write-protection.
3. Using an external device such as a fluke meter, test the mA Output by setting each mA Output to the Fault Level specified for Upscale. Verify that the mA current reaches that value, or use the default value (22mA).

   This step tests for compliance voltage problems, such as low voltage on the loop power supply, or increased wiring resistance.
4. Using an external device such as a fluke meter, test the mA Output by setting each mA Output to the Fault Level specified for Downscale. Verify that the mA current reaches that value, or use the default value.

Option	Description
2.0 mA	Default for a Model 5700 with configurable outputs
3.2 mA	Default for a Model 5700 with intrinsically safe outputs

   This step tests for possible failures related to quiescent current.
5. Read the sensor temperature value. Compare it to the process temperature, and verify that this is a reasonable reading.
6. Power cycle the transmitter. Wait approximately 30 seconds for the flowmeter to return to normal operation.
7. Run a meter verification test.

8. Verify that the transmitter does not display alarms or warnings.
9. Verify all safety-critical configuration parameters.
10. Restore the loop to full operation.
11. Enable write-protection.
12. Remove the bypass from the safety PLC, or otherwise restore normal operation.
13. Document the results of this proof test as part of your plant safety management procedures.

3.4 Proof test 3

Proof test 3 is recommended for all SIL-approved 5700 models.

Procedure

Perform a full calibration against a primary standard.

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

4 Operating constraints

4.1 Reliability data

The Coriolis flowmeter with a Model 5700 transmitter:

- Has a specified safety deviation of 2%. Internal component failures are listed in the device failure rate if they will cause an error of 2% or greater.
- Reports an internal failure within 5 minutes of fault occurrence – worst case scenario.
- Generates a valid signal within 30 seconds of a power-on startup.

FMEDA report

The Failure Mode, Effects, and Diagnostics Analysis (FMEDA) report is used to calculate the failure rate. A FMEDA report for a Coriolis flowmeter with a Model 5700 transmitter contains:

- All failure rates and failure modes
- Common cause factors for applications with redundant devices that should be included in reliability calculations
- The expected lifetime of your flowmeter and transmitter, as the reliability calculations are valid only for the lifetime of the equipment

Obtain a FMEDA report from www.emerson.com.

Environmental and application limits

See the sensor and the Model 5700 product data sheets for environmental and application limits.

Using the flowmeter or transmitter outside environmental or application limits invalidates the reliability data in the FMEDA report.

4.2 Report failures

Procedure

If you have detected any failures that compromise safety, contact the Emerson Product Safety Officer.

Contact the Product Safety Officer through customer service. Customer service is available 24 hours a day, seven days a week. Contact information is located at the front of this manual.

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