

Coriolis Flow Meter with Micro Motion[™] 4700 Intrinsically Safe Inputs and Outputs Transmitter

Safety Manual for Safety Instrumented Systems (SIS)



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.

Safety and approval information

This Micro Motion product complies with all applicable European directives when properly installed in accordance with the instructions in this manual. Refer to the EU Declaration of Conformity for directives that apply to this product. The following are available: the EU Declaration of Conformity, with all applicable European directives, and the complete ATEX installation drawings and instructions. In addition, the IECEx installation instructions for installations outside of the European Union and the CSA installation instructions for installations in North America are available at Emerson.com/global or through your local Micro Motion support center.

Other information

Troubleshooting information can be found in the appropriate Configuration and Use Manual. Product Data Sheets and Manuals are available from the Micro Motion website at Emerson.com/global.

Return policy

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

Return procedures and forms are available on our web support site at Emerson.com/global, or by calling the Micro Motion Customer Service department.

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1 Before you begin

1.1 About this document

This document provides information about how to install, commission, and proof test a 4700 transmitter to comply with Safety Instrumented Systems (SIS) requirements.

Important

This manual assumes that:

- The transmitter has been installed correctly and completely according to the instructions in the transmitter installation manual.
 - Users understand basic transmitter and sensor installation, configuration, and maintenance concepts and procedures.
-

1.2 Hazard messages

This document uses the following criteria for hazard messages based on ANSI standards Z535.6-2011 (R2017).



DANGER

Serious injury or death will occur if a hazardous situation is not avoided.



WARNING

Serious injury or death could occur if a hazardous situation is not avoided.



CAUTION

Minor or moderate injury will or could occur if a hazardous situation is not avoided.

NOTICE

Data loss, property damage, hardware damage, or software damage can occur if a situation is not avoided. There is no credible risk of physical injury.

Physical access



WARNING

Unauthorized personnel can potentially cause significant damage and/or misconfiguration of end users' equipment. Protect against all intentional or unintentional unauthorized use.

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

1.3 Related documentation

See the approval documentation shipped with the transmitter, or download the appropriate documentation from the Micro Motion web site ([Emerson.com/flowmeasurement](https://www.emerson.com/flowmeasurement)):

- [Micro Motion 4700 Configurable Inputs and Outputs Transmitter Product Data Sheet](#)
- [Micro Motion 4700 Transmitters with Configurable Inputs and Outputs Configuration and Use Manual](#)
- [ProLink III with ProcessViz Software User Manual](#)
- *Micro Motion 4700 Transmitters with Intrinsically Safe Outputs Installation Manual*
- Sensor installation manual, shipped with the sensor
- FMEDA report for Coriolis Flow Meter with 4700 Transmitter, prepared for Emerson by exida.com LLC
- Micro Motion 4700 ISIO Software FMEA Report

2 Installation and commissioning

Note

Smart Meter Verification is the only add on option that is compatible with the SIL license.

Use this section to install and commission a Coriolis flow meter with a 4700 transmitter with SIS features.

IEC 61508 relevant requirements

The Coriolis flow meter with a 4700 transmitter is certified per the relevant requirements of IEC 61508.

Systematic capability	Safety Integrity Level (SIL) 3 capable
Random capability	<ul style="list-style-type: none"> 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 4700 with Intrinsicly Safe Outputs

4700 ISIO	λ_{SD}	λ_{SU}^{15}	λ_{DD}	λ_{DU}
4700I Integral mount transmitter and 4700C 9-wire remote mount transmitter with an integrated core processor	51	56	3132	180
4700R 4-wire remote mount transmitter connected to a sensor with a standard core processor	652	170	3723	178
4700R 4-wire remote mount transmitter connected to a sensor with an enhanced core processor	939	231	4040	238

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**.

Table 2-2: SIS-certified Versions for a 4700 with Intrinsicly Safe Outputs

Device	Display tag	Version
4700 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
4700 hardware	Transmitter hardware	0 and later

(1) FIT = 1 failure / 10⁹ hours

- On SIS applications for a 4700 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 4700 Coriolis flow meter, 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 4700

Use this section to make sure the 4700 is installed and configured for SIS applications.

You can use ProLink™ III, the 4700 display, or a field communicator to verify, or if needed, configure these settings. For more information, see the [Micro Motion 4700 Transmitters with Configurable Inputs and 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 4700 with Intrinsically Safe outputs

Procedure

1. Use the *Micro Motion 4700 Transmitters with Intrinsically Safe Outputs Installation Manual (MS-00825-0400-5710)* to install the 4700, except for the wiring instructions for Channel A. Instead, wire Channel A using the following power option:

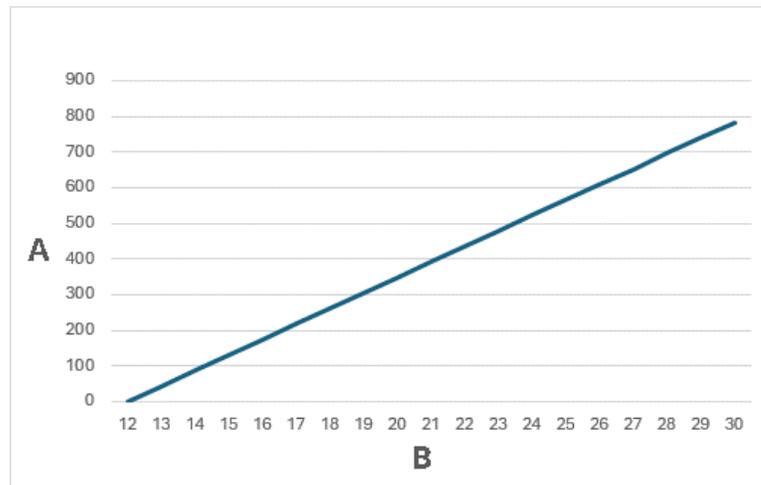
Channel A passive (external) power

Figure 2-1: Channel A Passive (Externally-powered) mA/HART® Output Wiring



- A. Channel A mA output
 - B. Terminal
 - C. 250–600 Ω resistance (see [Figure 2-2](#) for maximum loop resistance)
 - D. HART device
-

Figure 2-2: Externally-powered mA/HART Output: Maximum Loop Resistance



- A. External pull-up resistance (Ω)
- B. Supply voltage (V)

2. Verify that the following features are licensed: SIL, and ChA.

Note

If SIL is not licensed, see [Install the SIL license key](#).

3. 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 4700 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 mA01 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.

2.2.2 Enable or disable software write protection

When enabled, write protection prevents changes to the transmitter configuration. You can perform all other functions, and you can view the transmitter configuration parameters.

Write protection is enabled by toggling the physical write protect (dip) switch (identified by a lock icon) located behind the display module.

Figure 2-3: Write Protect (Dip) Switch behind the Display Module

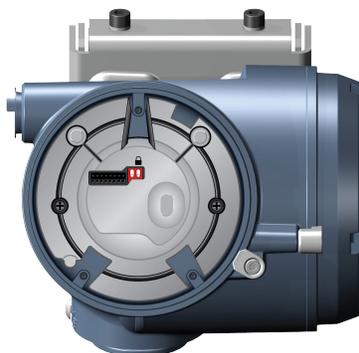


Figure 2-4: Write Protect on the Display (Upper Right Corner)



You cannot change write protection from any host configuration tool.

Note

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

2.3 Upgrade the transmitter firmware

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

2.3.1 Using a USB drive with the display

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

Prerequisites

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.

 **WARNING**

If the transmitter is in a hazardous area, do not remove the housing cover while the transmitter is powered up. Failure to follow these instructions can cause an explosion, resulting in serious injury or death.

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.

2.3.2 Using the USB A service port and ProLink™ III

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

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

 **WARNING**

If the transmitter is in a hazardous area, do not remove the housing cover while the transmitter is powered up. Failure to follow these instructions can cause an explosion resulting in injury or death.

Prerequisites

You must have the firmware upgrade files provided by Emerson.

Procedure

1. In ProLink III, choose **Device Tools** → **Transmitter Software Update**.
2. Navigate to the folder containing the firmware upgrade files.
3. Select **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.

2.4 Replace equipment

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

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

Procedure

1. Replace the hardware.
Use the appropriate sensor installation document or the appropriate 4700 installation manual.
2. Verify the transmitter configuration and all safety parameters.
3. Enable write protection.

2.5 Install the SIL license key

Use this procedure if the license key was purchased after shipment.

Important

If you added a SIL license key to a meter that was originally installed for a different function, note that the expected meter lifetime starts at the time of the original installation and commissioning. Meter lifetime and all SIS calculations should include total meter operational time.

Always perform [Proof tests](#) before placing the meter online.

Note

Smart Meter Verification is the only add on option that is compatible with the SIL license.

Prerequisites

Obtain the SIL license key from your local service office by requesting the model code: LICKEY4700SI.

Note

After you obtain the license key, manually enter the license key using the display, ProLink™ III, or a field communicator.

Procedure

1. To install a license using the display:
 - a) Choose **Menu** → **Service Tools** → **License Manager**.
Depending on the type of license key provided, choose either **Enter Permanent License** or **Enter Trial License**.
 - b) Use the arrow keys to enter the license key.
2. To install a license using ProLink III:
 - a) Open the license file.
 - b) Choose **Device Tools** → **Configuration** → **Feature License**.
 - c) Copy the license from the file to the appropriate **License Key** field.
 - d) Select **Apply**.
3. To install a license using a field communicator:
 - a) Choose **Overview** → **Device Information** → **Licenses** → **Upload License**.
 - b) Select the license feature to upload, Permanent Feature or Temporary Feature.
 - c) Write the license key.
4. Use the following menu structures to verify that the license has been installed.

Display	Menu → Service Tools → License Manager
ProLink III	Device Tools → Configuration → Feature License
Field communicator	Device Settings → Device Information → Licenses

The features supported by the new license are displayed.

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 flow meter with a 4700 transmitter has three proof tests you can use to detect failures.

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

Table 3-1: Proof Test Options

Device	Proof test	Description	DU failure detection
4700R with standard core processor	1	<ul style="list-style-type: none"> mA Output min-to-max test Checking for alarms Checking configuration 	50%
	1 and 3	<ul style="list-style-type: none"> mA Output min-to-max test Checking for alarms Checking configuration Calibration against primary standard 	99%
<ul style="list-style-type: none"> 4700I 4700C 4700R with enhanced core processor 	1	<ul style="list-style-type: none"> mA Output min-to-max test Checking for alarms Checking configuration 	50%
	1 and 3	<ul style="list-style-type: none"> mA Output min-to-max test Checking for alarms Checking configuration Calibration against primary standard 	99%
	2	<ul style="list-style-type: none"> mA Output min-to-max test Checking for alarms Checking configuration Smart 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	<ul style="list-style-type: none"> • mA Output min-to-max test • Checking for alarms • Checking configuration • Smart 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 4700 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 4700 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.

Example

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 (22 mA).
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
3.2 mA	Default for a 4700 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 4700 with the integrated core processor (4700I / 4700C) or the enhanced core processor (4700R).

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 4700 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.

Example

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 (22 mA).

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
3.2 mA	Default for a 4700 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 flow meter to return to normal operation.
7. Run a Smart 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 4700 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 4700 transmitter:

- Has a specified safety deviation of 2 percent. Internal component failures are listed in the device failure rate if they will cause an error of 2 percent 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 4700 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 flow meter and transmitter, as the reliability calculations are valid only for the lifetime of the equipment; useful flow meter lifetime is 10 years — see the FMEDA report for details

Obtain a FMEDA report from [Emerson.com](https://www.emerson.com).

Environmental and application limits

See the sensor and [Micro Motion 4700 Configurable Inputs and Outputs Transmitter Product Data Sheet](#) product data sheets for environmental and application limits.

Using the 4700 transmitter outside environmental or application limits invalidates the reliability data in the FMEDA report.

4.2 Report failures

If you have detected any failures that compromise safety, contact our Customer Service team either through e-mail (flowsupport@emerson.com) or by phone: 1-800-522-6277. Customer service is available 24 hours a day, seven days a week.



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