ROSEMOUNT®

Calibration Verification Practices
Rosemount 8700 Magnetic Flowmeters

Prepared by:

Ron Pozarski
Product Manager
Rosemount Flow Division
Emerson Process Management
Eden Prairie, MN, USA

Updated: February 2003

EMERSON™
Process Management

PlantWeb®

Calibration Verification Practices
Rosemount 8700 Magnetic Flowmeters

TABLE of CONTENTS

1. Introduction

This document is intended for users of Rosemount series 8700 magnetic flow meter transmitters and flow tubes to use as a guideline for plant calibration and verification procedures and is focused on calibration and verification practice only. The user is responsible for the implementation of these guidelines in the plant, and should consider process criticality, product, plant and personnel safety, and legal and regulatory requirements when establishing the plant specific procedures. This document provides the standard practice calibration for Rosemount transmitter models 8712 and 8732, and flow tube models 8705, 8707, 8711 and 8721. It does not include calibration procedures associated with the model 8742 transmitter utilizing the Foundation Fieldbus communication protocol.

1.1. Guideline for Calibration/Verification

- The criticality of the loop has little impact on the technical requirements for calibration or verification of the flow meter. For standard loops, minimum calibration/verification should be required. However, in the case of critical loops that can directly impact plant or personnel safety, product safety, or are regulated by law or agency, the user should consider adjusting verification steps and/or frequency according to the risk in the case where the measurement fails.
- **Standard:** Section 2 through section 3 should be completed as required. If these criteria are met, there will be no significant change in meter performance from the time of calibration.
- **Critical:** Section 2 through section 3 should be completed as required. There will be no significant change in flowmeter performance from time of calibration for at least 5 years. If a new calibration is required, the meter can be sent back to Rosemount Inc., Eden Prairie, MN USA to be calibrated.

1.2. Documentation

This documentation is unique for each flow meter, and should be retained as a baseline.

- Factory Calibration Report (this data is shipped with the flow tube and should be filed as a baseline reference.)
- Rosemount 8700 Magnetic Flowmeter System Configuration Data Sheet, P/N 00813-0100-4727
  - Download at http://www.rosemount.com/document/configdatasheets.html#Flow

This documentation is common across the product model(s) indicated.

- Applicable Instrument Specifications (optional)
- 8712 Magnetic Flowmeter Transmitter Documentation:
  - Quick Installation Guide, P/N 00825-0100-4661 (shipped with product)
  - Download at http://www.rosemount.com/document/qigmfm.html
  - Magnetic Flowmeter Transmitter Manual, P/N 00809-0100-4661 (optional)
  - Download available at http://www.rosemount.com/document/manuals.html
- 8732 Magnetic Flowmeter Transmitter Documentation:
  - Quick Installation Guide, P/N 00825-0100-4725 (shipped with product)

  - Download at http://www.rosemount.com/document/qigmfm.html
  - Magnetic Flowmeter Transmitter Manual, P/N 00809-0100-4725 (optional)
  - Download available at http://www.rosemount.com/document/manuals.html
- 375 Field Communicator
  - Field Communicator Manual, P/N 00375-0047-0001 (optional)
  - Download available at http://www.fieldcommunicator.com/suppmanu.htm
- 8714D Flowtube Simulator Quick Installation Guide (shipped with product)
  - Download available at http://www.rosemount.com/document/qigmfm.html

If there are any questions, or more information is required, please contact Rosemount technical support at 1-800-999-9307 or via e-mail at http://www.rosemount.com/support/index.html

1.3. Hardware and Tools

All hardware and tools are required unless noted.

- Power supply: 90-250 V ac, 50 – 60 Hz; 12-42 V dc (8712) or 15-30 V dc (8732)
- Multi-meter: 4-1/2 digits (within NIST traceable calibration compliance time period)
  - Example: Fluke 25, 27, 83, 85, 87, or 8060A or equivalent
- LCR meter (optional)
  - Example: B&K Model 878 or equivalent
- 8714D Flowtube Simulator
- 375 Field Communicator (optional)
  - Precision Load Resistor: 250 ohms +/- 0.01% 2 watt or 500 ohms +/- 0.01% 2 watt

    Note: 250 ohm resistor plug assembly is included with HART 375 communicator

Note: All equipment used in calibration/verification should be calibrated on a regular schedule per plant metrology procedures.

Note: Most portable equipment does not meet ANSI Z540 accuracy requirements. Therefore, field calibration is not desirable.

Note: Most ammeters only display two decimal points. Therefore, Rosemount standard calibration practice utilizes a precision 500-ohm load resistor. The output of the transmitter is measured across the load resistor giving 2.000 Volts at 4.00 mA and 10.000 Volts at 20.00 mA. This procedure increases the resolution of the output signal measurement.

2. Transmitter Configuration Verification

This section identifies the steps required to confirm the hardware and software configuration of the flow meter transmitter. Verifying the configuration insures that the flow meter is configured as intended for this application. A more comprehensive explanation of installation steps including wiring, basic configuration, handling, mounting and grounding is presented in the 8712 or 8732 Quick Installation Guides and Magnetic Flowmeter Transmitter Manuals. Refer to these documents for more detailed information.

2.1. Hardware Configuration Verification

The 8712 and transmitter electronics board is equipped with three user-selectable hardware switches. These switches set the Failure Alarm Mode, Internal/External Analog Power, and Transmitter Security. The standard configuration for these switches when shipped from the factory is as follows:

Failure Alarm Mode:	HIGH
Internal/External Analog Power:	INTERNAL
Transmitter Security:	OFF

In most cases, it is not necessary to change the setting of the hardware switches. If you need to change the switch settings and need to understand the functions of the switches, complete the steps outlined in the manual.

2.1.1. Failure Alarm Mode

If the transmitter experiences a catastrophic failure in the electronics, the current output can be set to be driven outside the normal 4-20 ma range, either HIGH (23.25 ma) or LOW (3.75 ma).

2.1.2. Internal/External Analog Power

The transmitter's 4 – 20 mA loop may be powered internally or by an external power supply. The Internal/External Analog Power jumper or switch determines the source of the 4 – 20 mA loop power. The external power option is required for multidrop communications.

2.1.3. Transmitter Security

The Transmitter Security switch allows the user to lock out any configuration changes attempted on the transmitter. No changes to the configuration are allowed when the switch is in the ON position. The display and totalizer function remain active.

2.2. Software Configuration Verification

A minimum of five parameters are required to commission the device: Flow Rate Units, URV (Upper Range Value), LRV (Lower Range Value), Line Size, and Calibration Number. This section provides a quick reference to verify the basic configuration of the transmitter. These parameters may be verified via a 375 Field Communicator, an optional local operator interface (LOI) or Asset Management software (AMS.) The following examples use the HART commands of the 375 Field Communicator. A complete listing of the HART commands, keys and menu tree can be found in the Quick Installation Guide and in the Magnetic Flowmeter Transmitter Manual.

2.2.1. Verify Tag

HART Fast Keys	1, 3, 1
LOI Key	XMTR INFO

Tag is the quickest and shortest way of identifying and distinguishing between transmitters. Transmitters can be tagged according to the requirements of your applications. The tag may be up to eight characters.

2.2.2. Verify Flow Rate Units

HART Fast Keys	1, 3, 2, 1
LOI Key	Units

The flow rate unit variable specifies the format in which the flow rate will be displayed. Units should be selected to meet your particular metering needs. The maximum flow rate on the second line of the display is for informational purposes and can not be changed by the user.

2.2.3. Verify URV (Upper Range Value)

HART Fast Keys	1, 3, 3
LOI Key	Analog Output Range

The upper range value (URV), or analog output range, is preset to 30 ft/s at the factory. The units that appear will be the same as those selected under the Units parameter.

The URV (20-mA point) can be set for forward and reverse flow rate. Flow in the forward direction is represented by positive values and flow in the reverse direction is represented by negative values. The letter R will also be displayed in the corner of the local display if the flow is in the reverse direction. The URV can be any value from –30 ft/s to 30 ft/s, as long as it is at least 1 ft/s from the lower range value (4-mA point). The URV can also be set to a value less than the lower range value which would cause the transmitter analog output to operate in reverse with the electrical current increasing for lower (or negative) flow rates.

2.2.4. Verify LRV (Lower Range Value)

HART Fast Keys	1, 3, 4
LOI Key	Aux. Function

Reset the lower range values (LRV), or analog output zero, to change the size of the range (or span) between the URV and LRV. Under most circumstances, the LRV should be set to a value near the minimum expected flow rate to maximize resolution. The LRV must be between –30 ft/s and 30 ft/s.

The LRV can be set to a value greater than the URV, which would cause the analog output to operate in reverse. In this mode, the analog output will increase with lower (more negative) flow rates.

2.2.5. Verify Line Size

HART Fast Keys	1, 3, 5
LOI Key	Tube Size

The line size (flowtube size) must be set to match the actual flowtube connected to the transmitter. The size is specified in inches. The second line on the LOI screen, MAX FLOW, is for informational purposes only. The MAX FLOW value is defined as the URV on the Model 375 and most control systems.

2.2.6. Verify Calibration Number

HART Fast Keys	1, 3, 6
LOI Key	Tube Cal. No.

The tube calibration number is a 16-digit number used to identify flowtubes calibrated at the Rosemount factory. The number provides detailed calibration information to the transmitter. The calibration number is also printed inside the flowtube terminal block. To function properly within accuracy specifications, the number displayed on the transmitter must match the calibration number exactly.

3. Transmitter and Flowtube Testing and Verification

This section identifies the steps to verify proper operation of the flow meter.

3.1. Transmitter Output Verification and Self-Test

The three following tests verify the basic operation of the transmitter and are accessible through the LOI or the Model 375 HART communicator. The functions listed appear in the DIAGNOSTICS AND SERVICE section of the menu tree or under the AUXILIARY function key on the Model 8712 LOI.

3.1.1. Analog Output Test

HART Fast Keys	1, 2, 2
LOI Key	Aux. Function

The analog output test (referred to as Loop Test on 8732) allows the user to drive the transmitter output terminals to a desired electrical current output. This capability allows the user to check the entire 4 – 20 mA current loop. The test will end after five minutes if the transmitter is not returned to normal operation manually.

3.1.2. Pulse Output Test

HART Fast Keys	1, 2, 3
LOI Key	Aux. Function

The pulse output test allows the user to drive the frequency output terminals to a desired value. This capability allows the user to check auxiliary output. The test will end after five minutes if the transmitter is not returned to normal operation manually.

3.1.3. Self Test

HART Fast Keys	1, 2, 1, 2
LOI Key	Aux. Function

The Self Test (referred to as Transmitter Test on the 8732) initiates a series of diagnostic tests that are not performed continuously during normal operation. It performs diagnostic tests of the transmitter display, RAM and PROM. During the test, all outputs of the 8712 respond to flow signal. The test requires approximately 10 seconds to complete.

(CAUTION: During the Transmitter Test on the 8732 transmitter, the outputs DO NOT respond to flow signal. All outputs are driven to full-scale (20 mA and 1,000 Hz) for the duration of the test.)

3.2. Transmitter Electronics Verification

A Rosemount 8714 Calibration Standard can be used to verify that the transmitter is working correctly. The 8714 Calibration Standard simulates a functioning flowtube operating at user selectable, pre-set flow rates. The following steps will verify that the transmitter is functioning correctly and within specification.

1. Power down the transmitter.
2. Remove covers to access main transmitter board. (In the case of the 8732 transmitter with LOI, you will need to remove the LOI temporarily to complete step 3 and 4.)
3. Disconnect the cables connecting the flowtube to the transmitter.
4. Connect the transmitter to a Model 8714D flowtube simulator using cables provided with the 8714D.
5. Power up the transmitter.
6. Change the calibration number in the transmitter to match the calibration number of the 8714D.
7. Set the flow rate of the 8714D to 30 ft/sec.

8. Read the flow rate on either the LOI or the HART communicator. The flow rate reading after warm-up should be between 29.97 and 30.03 ft/s.
9. If the reading is within the range, disconnect the 8714D and re-connect the flowtube cables, remembering to change the calibration number in the transmitter to match the flowtube calibration number.
10. If the reading is not within the range, the transmitter electronics should be replaced.

3.3. Flowtube Verification

There are no moving parts on a magnetic flowmeter that wear under normal operation, and it is very unusual that a magnetic flowmeter will require a new calibration for wear in normal applications. Magnetic flowmeters measure the voltage across the electrode, which is a function of the fixed magnetic coils and the distance between the electrodes. The Calibration Number is established during factory calibration and accounts for minute differences in coils and electrodes that do not change over time with normal use. While these physical properties cannot be adjusted in the field, the electrical integrity of the flowtube can be tested and verified.

> **Note:** Highly corrosive processes or processes with very abrasive solids content may cause wear, which over an extended period could have a small effect on the accuracy. Selecting the correct electrode material for the application can significantly reduce or eliminate corrosion or abrasive wear. If recalibration is required, the flow tube can be sent back to Rosemount for recalibration. Contact your sales or service representative for details.

3.3.1. Flowtube Electrical Test

Measuring the resistances in the flow tube will identify electrical failures in the flow tube including open or shorted coils, electrode failure and extraneous moisture related current paths. These test can be done to base line a new flowtube or to confirm the operational status of a flowtube. Detailed instructions can be found in the Magnetic Flowmeter Transmitter Manuals, Section 5, Maintenance and Troubleshooting.

The following chart can assist in verifying the performance of the flowtube. Before performing any of the flowtube tests, disconnect or turn off power to the transmitter, and disconnect the flowtube from the transmitter and any field wiring. To interpret the results, the product certification for the flowtube must be known. These codes are listed in the model number on the flowtube and are: N0, N1, N5, E5, CD, and KD. Always check the operation of test equipment before each test. A combination of tests, required equipment, expected values, and corrective actions are listed in Table 1. If possible, take all readings from inside the flowtube junction box. Readings taken at the terminals of remote-mount transmitters that are more than 100 feet of cable length away from the flowtube may provide incorrect or inconclusive information and should be avoided.

Test equipment is needed to conduct these tests. Some of these tests will require measuring conductance (nS, nanosiemens), the reciprocal of resistance. It is possible to test a LCR meter by selecting nS as the units and holding the leads apart. The value should be less than one, while touching the leads together should result in an overload value. The LCR meter may be used with process fluid in the flowtube.

Table 1

Test	Flowtube Location	Required Equipment	Measuring at Connections	Expected Value	Potential Cause	Corrective Action
Step 1: Flowtube Coil	Installed or Uninstalled	Multimeter	1 and 2	$2\Omega \leq R \leq 28\Omega$	Open or Shorted Coil	Replace Flowtube
Step 2: Shield to Case	Installed or Uninstalled	Multimeter	17 and Ω.	$\leq 0.2\ \Omega$	Moisture in terminal block	Clean terminal block
Step 3: Coil Shield to Coil	Installed or Uninstalled	Multimeter	1 and Grnd. 2 and Grnd.	$\infty\ \Omega$ $\infty\ \Omega$	Process behind liner Leaky electrode	Clean terminal block Confirm with Flowtube Coil Test
Step 4: Electrode shield to electrode	Installed with full flow tube	LCR (set to resistance and 120 Hz)	18 and 17 = R_1 19 and 17 = R_2	R_1 and R_2 should be stable N0:| $R_1 - R_2 \leq 300\Omega$ _____ N1, N5, E1, E5, CD, K1, K5, KD: $\|R_1 - R_2\| \leq 1500\Omega$	Unstable readings indicate coating Shorted electrode Empty pipe Low conductivity	Remove flowtube Use bulletnose electrodes Repeat measurement