Using the HART® Communicator with Micro Motion 9700 Series Transmitters

February 1994

Micro Motion
FISHER-ROEMOUNT® Managing The Process Better
Temperature Coefficients for Flow and Density

Please read this important notice if the sensor/transmitter/peripheral combination has not been factory-calibrated by Micro Motion.

To further improve the performance of our products, Micro Motion has changed the way sensor tube temperature is measured. A new RTD and mounting method have resulted in improved overall performance through:

- Improved response time to changes in fluid temperature
- Improved immunity to changes in ambient temperature
- Improved temperature input to the processor

As a result of the RTD change, the temperature coefficients for flow and density that are stated in this manual might be different from the values on the sensor serial number tag. The serial number tag carries the latest and correct values for the sensor. Failure to use the correct temperature coefficients may result in performance outside specifications.

Because the correct temperature coefficient will give you the best flowmeter performance, Micro Motion recommends using the values listed on the sensor serial number tag when reconfiguring the transmitter and peripheral device. If the sensor, transmitter, and peripheral were ordered together as a flowmeter, they are factory-calibrated with the correct coefficients, and no reconfiguration is required.
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Introduction to the Model 275 HART® Communicator

1. About this instruction manual

This manual explains how to use the Rosemount® hand-held Model 275 HART® Communicator with Micro Motion® 9700 Series flow transmitters. This manual is a companion publication to the Rosemount Product Manual for the HART Communicator.

This manual explains how to use the HART Communicator to perform online functions with Micro Motion 9700 Series transmitters.

Chapter 2 explains how to set up a Micro Motion transmitter to operate with the HART Communicator. Chapter 3 explains how to use the communicator’s keypads and displays. Chapters 4 through 16 are arranged in the order of the options in the online (main) menu with the HART Communicator connected to a Micro Motion transmitter. In this communication mode, the user can perform the following tasks:

- Viewing process variables;
- Controlling the transmitter’s internal totalizer(s);
- Testing, calibrating, and troubleshooting the flowmeter;
- Trimming transmitter outputs;
- Performing basic or detailed setup of the flowmeter for optimal performance in specific applications;
- Reviewing all parameters in the flowmeter configuration.

The HART Communicator also can perform offline tasks, communicate with any HART-compatible device, and poll devices in a HART-compatible network. For more information about using the communicator, refer to the Rosemount Product Manual for the HART Communicator, which is shipped with the communicator and with all Micro Motion 9700 Series transmitters. The Rosemount Product Manual for the HART Communicator includes the following sections:

- Liquid crystal display,
- Action keys,
- Software-defined function keys,
- Alphanumeric and shift keys,
- Hot key menu,
- HART Communicator connections,
- Getting to know the HART Communicator,
- Main (online) menu,
- Servicing the HART Communicator,
- Functional specifications,
- Performance specifications,
- Physical specifications,
- Ordering information,
- Index.
1.2 Introduction to 9700 Series transmitters

Micro Motion 9700 Series transmitters include RFT9712, RFT9729, and ELITE® RFT9739 microprocessor-based transmitters for fluid process measurement and control. All 9700 Series transmitters can function as part of a Bell 202 or RS-485 multidrop network.

The RFT9739 has an explosion-proof housing for field installation, or a rack-mount 19” European-standard 1/3 cassette housing for control room installation.

- The RFT9739 works with any ELITE sensor or with any Model D, DL, or DT sensor.
- The RFT9739 can use the Bell 202 or RS-485 standard under HART® protocol, or the RS-485 standard under Modbus® protocol.
- A 2.0 or higher-revision RR-9739 can simultaneously use HART and Modbus protocols.

The RFT9739 can simultaneously indicate mass and volume flow rates and totals.

The RFT97912 has a NEMA 4-rated housing for field installation. The RFT9729 provides the same performance as the RFT9712, but has a rack-mount 19” European-standard ½ cassette housing for control room installation.

- The RFT9712 or RFT9729 works with any Model D, DL, or DT sensor.
- The RFT9712 or RFT9729 can use the Bell 202 or RS-485 standard under HART protocol.

When operating with a sensor, a 9700 Series transmitter can measure flow, total (inventory), density, and temperature.

- The RFT9739 can simultaneously indicate mass and volume flow rates and totals.
- The RFT9712 or RFT9729 can indicate the mass or volume flow rate and total.

If a differential pressure transmitter (DP cell) measures pressure drop across the sensor, the RFT9739 can use differential pressure values to calculate viscosity for certain liquids.

1.2.1 Flowmeter operation

The transmitter and sensor function together as a Coriolis mass flowmeter. The transmitter produces a drive voltage to vibrate the sensor flow tubes at the structure’s natural frequency. The flow of fluid through the vibrating tubes twists the tubes at an angle directly proportional to the mass of the fluid.

Micro Motion mass flow sensors also provide an accurate density measurement, because the density of the fluid is inversely proportional to the square of the flow tube frequency.

The transmitter uses the time shift between velocity signals from pickoffs mounted on the flow tubes to calculate mass flow, and the frequency of the signal from one pickoff to calculate density.
The transmitter also measures the flow tube temperature from a platinum resistance temperature detector (RTD) mounted on one flow tube. Measuring the temperature of the flow tubes is necessary because changes in temperature affect the rigidity around the twisting axis and the elasticity around the bending axis. Changes in rigidity affect the twist angle, which indicates mass flow, while changes in elasticity affect the tube frequency, which indicates fluid density. In calculating mass flow and density, the transmitter uses temperature changes to account for proportional changes in the rigidity and elasticity of the flow tubes.

1.2.2 Transmitter outputs

The RFT9739 has two milliamp outputs, a frequency/pulse output, and a control output.

- Primary and secondary milliamp outputs can produce a 0-20 or 4-20 mA current. Milliamp outputs can independently indicate mass flow, volume flow, density, temperature, differential pressure, viscosity, event 1 status or event 2 status.
- The 0-10,000 Hz frequency/pulse output can indicate the mass flow rate, mass total, volume flow rate, or volume total.
- The 0/15 V control output can indicate faults; forward, reverse, or bi-directional flow; transmitter zeroing in progress; event 1 status or event 2 status.

The RFT9712 or RFT9729 has a 4-20 mA output, a frequency/pulse output, and a flow direction output.

- The milliamp output can indicate mass flow, volume flow, density, or temperature.
- The 0-10,000 Hz frequency/pulse output can indicate the mass flow rate or volume flow rate.
- The 0/15 V output indicates forward or reverse flow.

The primary milliamp output on the RFT9739 or the 4-20 mA output on the RFT9712 or RFT9729 can produce HART-compatible signals for Bell 202 communication. All 9700 Series transmitters have connections for RS-485 wiring.

- Up to 10 transmitters, each with a unique polling address of 1 to 15 or a unique tag, can participate with other devices in a Bell 202 multidrop network.
- Up to 15 transmitters, each with a unique polling address of 1 to 15, can participate in an RS-485 multidrop network.
2.1 Connection to a Micro Motion transmitter

**WARNING:** Before connecting the HART Communicator in an explosive atmosphere, make sure instruments in the loop are installed in accordance with intrinsically safe or nonincendive field wiring practices. Explosions can cause serious injury or death.

To connect an RFT9739 to the communicator, use the primary milliamp output. To connect the RFT9712 or RFT9729 to the communicator, use the 4-20 milliamp output.

Alternatively, the communicator can connect to the wire loops located near the transmitter’s output wiring terminals.

**CAUTION:** For the HART Communicator to function properly, a minimum of 250 ohms resistance must be present in the loop. The communicator does not directly measure loop current.

### 2.1.1 Connection to milliamp output wiring terminals

Table 2-1 lists the output wiring terminals used for connecting the transmitter to the HART Communicator.

<table>
<thead>
<tr>
<th>Transmitter model</th>
<th>Output wiring terminals</th>
</tr>
</thead>
<tbody>
<tr>
<td>RFT9739 field-mount</td>
<td>17</td>
</tr>
<tr>
<td>RFT9739 rack-mount</td>
<td>D30</td>
</tr>
<tr>
<td>RFT9712</td>
<td>17</td>
</tr>
<tr>
<td>RFT9729</td>
<td>16b</td>
</tr>
</tbody>
</table>

### 2.1.2 Connection to wire loops

The transmitter has a pair of wire loops for connection to the HART Communicator. The wire loops are located near the output wiring terminals. Table 2-2 lists the location of the wire loops in each Micro Motion transmitter.
### Table 2-2  Location of wire loops for connecting a Micro Motion® transmitter to the HART® Communicator

<table>
<thead>
<tr>
<th>Transmitter model:</th>
<th>Location of wire loops</th>
</tr>
</thead>
<tbody>
<tr>
<td>RFT9739 field-mount</td>
<td>To right of output wiring terminals on electronics module</td>
</tr>
<tr>
<td>RFT9739 rack-mount</td>
<td>To right of output wiring terminals on back of cassette</td>
</tr>
<tr>
<td>RFT9712</td>
<td>Below input/output wiring panel inside transmitter’s lower compartment</td>
</tr>
<tr>
<td>RFT9729</td>
<td>To right of output wiring terminals on back of cassette</td>
</tr>
</tbody>
</table>

### 2.2  Setting transmitter switches or jumpers

The user must set switches or jumpers to enable communication between the transmitter and the HART Communicator.

- For the RFT9739, set switches as instructed in Subsection 2.2.1.
- For the RFT9712 or RFT9729, set the jumper labeled 485/268 as instructed in Subsection 2.2.2.

#### 2.2.1  Switch settings for RFT9739

Use the switches on the electronics module of the RFT9739 to enable communication with the HART Communicator.

**CAUTION:**

Older RFT9739 transmitters have a hardware switch labeled BELL 202. To set switches on an older RFT9739, refer to the installation manual shipped with the transmitter.

Figure 2-1 illustrates the switches on the electronics module of a 2.0 or higher-revision RFT9739.

- Software switches, which require turning the transmitter power supply OFF and ON, are labeled SELECT 3, SELECT 2, SELECT 1, CONTROL 3, CONTROL 2, and CONTROL 1.
- Hardware switches, which function without turning the transmitter supply OFF and ON, are labeled EXT. ZERO and SECURITY.

1. If practical, set the switches before installing the transmitter.
2. Access the switches:
   - To access switches on the field-mount RFT9739, unscrew the cover from the base of the transmitter, then unlatch the hinged cover of the module.
   - To access switches on the rack-mount RFT9739, remove the bottom of the cassette.
3. Set software switches as desired, shutting power ON and OFF as indicated in Table 2-3.
4. After setting switches, securely close the transmitter to maintain its environmental seal.
A switch is ON when its toggle is toward the label and OFF when its toggle is away from the label. Figure 2-1 shows switches in the OFF position.

Table 2-3  RFT9739 switch settings for use with HART® Communicator

<table>
<thead>
<tr>
<th>Setting 1: stop bits and parity</th>
<th>SELECT 3</th>
<th>SELECT 2</th>
<th>SELECT 1</th>
<th>CONTROL 3</th>
<th>CONTROL 2</th>
<th>CONTROL 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 stop bit, odd parity</td>
<td></td>
<td></td>
<td></td>
<td>ON</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Setting 2: data bits, protocol, and physical layer</th>
<th>SELECT 3</th>
<th>SELECT 2</th>
<th>SELECT 1</th>
<th>CONTROL 3</th>
<th>CONTROL 2</th>
<th>CONTROL 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>HART over Bell 202</td>
<td>ON</td>
<td></td>
<td></td>
<td>ON</td>
<td>ON</td>
<td></td>
</tr>
<tr>
<td>Modbus RTU mode (8 bits) over RS-485 and HART over Bell 202</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td></td>
</tr>
<tr>
<td>Modbus ASCII mode (7 bits) over RS-485 and HART over Bell 202</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td></td>
<td>ON</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Setting 3: milliamp outputs</th>
<th>SELECT 3</th>
<th>SELECT 2</th>
<th>SELECT 1</th>
<th>CONTROL 3</th>
<th>CONTROL 2</th>
<th>CONTROL 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-20 mA primary output</td>
<td></td>
<td></td>
<td></td>
<td>ON</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4-20 mA secondary output</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ON</td>
<td></td>
</tr>
<tr>
<td>O-20 mA secondary output</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ON</td>
<td></td>
</tr>
</tbody>
</table>

NOTES:
1. The transmitter reads the switch settings when the power supply is turned ON. At each setting, shut OFF power to the transmitter, then:
   a. Set switches as desired.
   b. Turn transmitter power supply ON.
   c. Wait until the diagnostic LED on the electronics module blinks ON once per second.
   d. Set all switches to OFF.
2. The primary milliamp output must be configured to produce a 4-20 mA current to enable communication between the HART Communicator and the transmitter.
2.2.2 Jumper setting for RFT9712/ RFT9729

Use the jumpers inside the RFT9712 or RFT9729 to enable communication with the HART Communicator.

WARNING:

Shut OFF the power supply to the transmitter before setting jumpers. Explosions can cause serious injury or death.

Jumpers are located on the processor board. Figure 2-2 illustrates the jumpers on the processor board, and shows their orientation.

1. Access the jumpers:
   - To access jumpers on the RFT9712, open the upper compartment cover.
   - To access jumpers on the RFT9729, remove the sliding top cover of the cassette.

2. Set the jumper labeled 268/485 in the 268 position.
Figure 2-2  Location and orientation of jumpers on processor board of RFT9712/RFT9729
Getting Started with the Model 275 HART® Communicator

3.1 Introduction

The HART Communicator provides a common communication link to all HART-compatible, microprocessor-based instruments.

The HART Communicator uses the Bell 202 frequency shift keying (FSK) technique. This technique superimposes high-frequency digital communication signals on the 4-20 mA output from the transmitter. Because the net energy added to the loop is zero, communication does not disturb the 4-20 mA signal.

3.2 Liquid crystal display

The liquid crystal display (LCD) has eight 21-character lines. When the HART Communicator is connected to a HART-compatible device, the top line of each online menu shows the type of device and its tag, as illustrated at left. The bottom line of each menu shows a label for software-defined function keys F1, F2, F3, and F4, located directly below the display.

The labels indicate available functions. For example, the label HELP appears above the F1 key when access to on-line help is available. For more information about software-defined function keys, see Section 3.4.

3.3 Action keys

Six action keys are located above the alphanumeric keys.

On/off key: Press the on/off key to turn the communicator ON and OFF. When the communicator is on, it searches for a HART-compatible device on the 4-20 mA loop. If a device is not found, the display reads, "No Device Found. Press OK". Press F4 to display the offline menu.

For information about using the offline menu, see the Rosemount Product Manual for the HART Communicator.
If the communicator is connected to a HART-compatible device, the communicator displays the online menu. See Chapters 4 through 16 to use the online menu for a Micro Motion transmitter.

The message “Off key disabled” indicates the HART Communicator cannot be shut OFF while a device is fixed or before configuration data has been sent from the communicator to the device.

Up arrow and down arrow: Use the up arrow (↑) and down arrow (↓) to scroll through options in a menu or submenu.

Left arrow/previous menu key: Use the left arrow (←) key to move the cursor to the left or to back out of a menu.

Right arrow/select key: Use the right arrow (→) key to move the cursor to the right or to scroll through a menu.

Hot key: Use the hot key to access user-defined options. When the HART Communicator is connected to a HART-compatible device, pressing the hot key turns the communicator ON and brings up the hot key menu.

For more information about using the hot key menu, see Section 3.8.

3.4 Software-defined function keys

Use the four software-defined function keys, F1 through F4, located below the LCD to perform the software functions that are indicated by the labels. At any given menu, the label above a function key indicates its function for the menu. Various functions become available as the user moves from menu to menu. For example, if the menu has on-line help, the label HELP appears above the F1 key. In menus providing access to the online menu, the label HOME appears above the F3 key.
Table 3-1 describes the labels that appear above each function key as the user moves through the menus.

### Table 3-1  Labels for function keys

<table>
<thead>
<tr>
<th>Function key</th>
<th>F1</th>
<th>F2</th>
<th>F3</th>
<th>F4</th>
</tr>
</thead>
<tbody>
<tr>
<td>HELP</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ON/OFF</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RETRY</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EXIT</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>YES</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ALL</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BACK</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EDIT</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ADD</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SAVE</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SEND</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**3.5 Alphanumeric and shift keys**

Alphanumeric keys enable data entry and fast selection of menu options.

**3.6 Fast select**

To use fast select, on the alphanumeric keypad, press the number that corresponds to the desired option in the menu. From within any menu, select available options by using the up and down arrows and the right arrow (→), or by using fast select feature.
3.7 Data entry

Some configuration parameters require data entry. Use the alphanumeric and shift keys to enter alphanumeric data.

- To enter a number, press the appropriate alphanumeric key.

- To enter an alphabetical character, press the bottom-row shift key that indicates the position (\ or \ or \) of the desired character on the alphanumeric key, then press the alphanumeric key. The keystrokes shown at left would enter the character "A". Do not simultaneously press a shift key and an alphanumeric key.

Pressing a bottom-row key shifts from numbers to alphabetical characters, and causes a right arrow, left arrow, or center arrow to appear in the upper right corner of the display. To de-activate the shift function without entering an alphabetical character, press the active bottom-row key.

3.8 Hot key

The hot key enables quick access to frequently performed tasks. The user can add options to or delete options from the hot key menu.

- To perform a task in the hot key menu, press the hot key.
- To exit the hot key menu at any time, press the left arrow (\). The hot key menu for the RFT9739 includes the following permanent configuration options:

- View status
- Analog output 1 (primary variable) range values
- Analog output 2 (secondary variable) range values
- Frequency output (tertiary variable) scaling.
The hot key menu for the RFT9712/RFT9729 includes the following permanent configuration options:
- View status
- Analog output (primary variable) range values
- Frequency output (tertiary variable) scaling.

3.8.1 Adding options to the hot key menu

To add an option to the hot key menu:

1. Press the ON/OFF button with the HART Communicator connected to the transmitter.

2. The online menu then appears. Enter the branch of the software where the desired menu option can be configured. In this example, the desired menu option is in the basic setup branch.

   - The desired menu option can be an individual parameter, or an option that provides access to a submenu.
   - In this example, the user will add the device tag from the basic setup menu (see Chapter 9).

3. After choosing the option to be added to the hot key menu, press any shift key (or t or r), then press the hot key.
4. The hot key configuration menu appears. It displays the option to be added and lists the existing options in the hot key menu.
   a. Press F3 (add) to add the option to the hot key menu.
   b. Press F4 (exit) to exit the hot key menu and return to the previous menu.

5. The display then asks whether the option will be added to the hot key menu for all device types stored in the HART Communicator, or will be added to the hot key menu for the connected device.
   a. Press F1 (all) to add the option to the hot key menu for all devices stored in the communicator.
   b. Press F4 (one) to add the option to the hot key menu for the connected device.

6. If the display reads "Mark as read only variable on hotkey menu?", the user can make the option read-only in the hot key menu.
   a. If the display at left does not appear, the option cannot be read-only in the hot key menu. Skip to Step 7.
   b. If the option can be marked as read only:
      a. Press F1 (yes) to make the option read-only. Choosing yes means the variable can be viewed, but not changed, in the hot key menu.
      b. Press F4 (no) to make the option configurable. Choosing no means the variable can be changed in the hot key menu.

7. If the hot key configuration menu reappears, the option added to the hot key menu provides access to a submenu. Press F4 (exit), then skip to Step 9.

8. Some hot key options, such as the HART tag, can be displayed with the value of the configuration variable.
If the user chooses to display the value of the option, the value appears beside the option in the menu display, as shown in the display at left.

- If the value of the option cannot be displayed in the hot key menu, a display such as the one at left does not appear. Skip to Step 9.
- If the value can be displayed in the hot key menu:
  a. Press F1 (yes) to display the value of the option.
  b. Press F3 (no) to display the option without its value.

9. The hot key configuration menu then displays the new option. Press F4 (exit) to return to the configuration menu containing the new option.

3.8.2 Deleting an option from the hot key menu

To delete an option from the hot key menu:

1. Go to the menu containing the option to be deleted. In this example, the HART tag option will be deleted from the hot key menu. The tag can be configured in the basic setup menu (see Chapter 9). Use the up arrow (↑) or down arrow (↓) to highlight the option to be deleted.

2. Press any shift key (\ or t or \), release it, then press the hot key.
3. The hot key configuration menu appears
   a. Use the up arrow (↑) or down arrow (↓) to highlight the option to be deleted from the hot key menu, then press F2 (delete).
   b. The next option will then appear highlighted. If desired, again press F2 to delete the next highlighted option.
   c. After deleting the desired option(s), press F4 (exit) to exit the hot key configuration menu and return to the menu containing the original deleted option.
4 Process Variables

4.1 View field device variables

To view the values of process variables measured by the transmitter:

1. At the online menu, choose 1 (process variables).

2. At the process variables menu, choose 1 (view field device variables).

When connected to an RFT9739, the HART Communicator can display:
- Mass flow rate
- Temperature
- Mass total
- Density
- Mass inventory
- Volume flow rate
- Volume total
- Volume inventory
- Viscosity
- Pressure

Indication of viscosity and pressure require characterization for viscosity or pressure compensation. For more information about characterization, see Chapter 10.

When connected to an RFT9712 or RFT9729, the HART Communicator can display:
- Mass flow rate or volume flow rate
- Temperature
- Mass total (inventory) or volume total (inventory)
- Density

CAUTION: If the variable is too long to fit in the display, the value will not appear until the user presses the right arrow (→).
4.2 View output variables

To view the values of output variables indicated by the transmitter:

1. At the online menu, choose 1 (process variables).

2. At the process variables menu, choose 2 (view output variables).
   - For more information about output variables for the RFT9739, see Subsection 4.2.1.
   - For more information about output variables for the RFT9712 or RFT9729, see Subsection 4.2.2.

4.2.1 Output variables for RFT9739

When connected to an RFT9739, the HART Communicator can display:

- PV, or the primary variable, indicated by milliamp output 1; the percentage of the range that is being represented by the output; and the 0-20 or 4-20 mA current level.
- SV, or the secondary variable, indicated by milliamp output 2; the percentage of the range that is being represented by the output; and the 0-20 or 4-20 mA current level.
- TV, or the tertiary variable, indicated by the frequency/pulse output, and the 0-10,000 Hz frequency.
- QV, or the quaternary variable, which is not assigned to an output.
- Event 1 or event 2; the low or high alarm type; the setpoint; and the ON/OFF status of the event, which can be tied to milliamp outputs or to the O/I 5 V control output.

Table 4-1 lists variable assignments for the RFT9739.

Table 4-1 Variable assignments for RFT9739

<table>
<thead>
<tr>
<th>HART Communicator label</th>
<th>Variable</th>
<th>output</th>
<th>RFT9739 field-mount</th>
<th>RFT9739 rack-mount</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PV</td>
<td>Primary variable</td>
<td>Output</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Primary milliamp</td>
<td></td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>s v</td>
<td>Secondary variable</td>
<td>Secondary milliamp</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Secondary milliamp</td>
<td></td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>TV</td>
<td>Tertiary variable</td>
<td>Frequency/pulse</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Frequency/pulse</td>
<td></td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>QV</td>
<td>Quaternary variable</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

To assign primary, secondary, and tertiary variables to the RFT9739, see Chapter 13. To assign a quaternary variable to the RFT9739:
1. At the process variables menu, choose 1 (process variables).

2. At the process variables menu, choose 2 (view output variables).

3. At the view output variables menu, choose 4 (view QV).

4. At the view QV menu, choose 1 (QV is).

5. Use the down arrow (↓) or up arrow (↑) to select the desired quaternary variable, then press F4 (enter).

4.2.2 Output variables for RFT9712/RFT9729

When connected to an RFT9712 or RFT9729, the HART Communicator can display:
PV, or the primary variable, indicated by the 4-20 mA output; the percentage of the range that is being represented by the output; and the 4-20 mA current level.

SV, or the secondary variable, which is not assigned to an output. The transmitter assigns the flow rate, density, or temperature as the secondary variable, depending on the variable the user assigns to the 4-20 mA output.

TV, or the tertiary variable, which is always the mass or volume flow rate indicated by the frequency/pulse output, and the 0-10,000 Hz frequency.

QV, or the quaternary variable, which is not assigned to an output. The transmitter assigns the flow rate, density, or temperature as the quaternary variable, depending on the primary variable, which the user assigns to the 4-20 mA output.

For the RFT9712 or RFT9729, the user can assign the primary variable to the 4-20 mA output.

- When the user assigns a primary variable, the transmitter automatically assigns secondary and quaternary variables.
- The tertiary variable is always the mass or volume flow rate represented by the frequency/pulse output.
- The HART Communicator can always display the flow rate, temperature, flow total, and density, regardless of the primary variable chosen by the user.

To assign a primary variable to the RFT9712 or RFT9729, see Chapter 13.

Table 4-2 lists variable assignments for the RFT9712 or RFT9729.

<table>
<thead>
<tr>
<th>If user-assigned primary variable (PV) is:</th>
<th>Secondary variable (SV), tertiary variable (TV), and quaternary variable (QV) are:</th>
<th>Variable is assigned to terminals:</th>
</tr>
</thead>
<tbody>
<tr>
<td>PV = Flow rate</td>
<td>sV = Temperature, TV = Mass or volume total, QV = Density</td>
<td>RFT9712</td>
</tr>
<tr>
<td></td>
<td></td>
<td>+</td>
</tr>
<tr>
<td></td>
<td></td>
<td>17</td>
</tr>
<tr>
<td></td>
<td></td>
<td>16</td>
</tr>
<tr>
<td></td>
<td></td>
<td>16b</td>
</tr>
<tr>
<td></td>
<td></td>
<td>14b</td>
</tr>
<tr>
<td></td>
<td></td>
<td>None</td>
</tr>
<tr>
<td></td>
<td></td>
<td>None</td>
</tr>
<tr>
<td></td>
<td></td>
<td>None</td>
</tr>
<tr>
<td></td>
<td></td>
<td>None</td>
</tr>
<tr>
<td></td>
<td></td>
<td>RFT9729</td>
</tr>
<tr>
<td></td>
<td></td>
<td>+</td>
</tr>
<tr>
<td></td>
<td></td>
<td>17</td>
</tr>
<tr>
<td></td>
<td></td>
<td>16</td>
</tr>
<tr>
<td></td>
<td></td>
<td>16b</td>
</tr>
<tr>
<td></td>
<td></td>
<td>14b</td>
</tr>
<tr>
<td></td>
<td></td>
<td>None</td>
</tr>
<tr>
<td></td>
<td></td>
<td>None</td>
</tr>
<tr>
<td></td>
<td></td>
<td>None</td>
</tr>
<tr>
<td></td>
<td></td>
<td>None</td>
</tr>
</tbody>
</table>

PV = Temperature

| PV = Temperature                          | sV = Flow rate, TV = Mass or volume total, QV = Density                      | RFT9712                          |
|                                          |                                                                                 | +                                |
|                                          |                                                                                 | 17                               |
|                                          |                                                                                 | 16                               |
|                                          |                                                                                 | 16b                              |
|                                          |                                                                                 | 146                              |
|                                          |                                                                                 | None                             |
|                                          |                                                                                 | None                             |
|                                          |                                                                                 | None                             |
|                                          |                                                                                 | None                             |
|                                          |                                                                                 | RFT9729                          |
|                                          |                                                                                 | +                                |
|                                          |                                                                                 | 17                               |
|                                          |                                                                                 | 16                               |
|                                          |                                                                                 | 16b                              |
|                                          |                                                                                 | 146                              |
|                                          |                                                                                 | None                             |
|                                          |                                                                                 | None                             |
|                                          |                                                                                 | None                             |
|                                          |                                                                                 | None                             |

PV = Density

| PV = Density                              | sV = Temperature, TV = Mass or volume total, QV = Flow rate                  | RFT9712                          |
|                                          |                                                                                 | +                                |
|                                          |                                                                                 | 17                               |
|                                          |                                                                                 | 16                               |
|                                          |                                                                                 | 16b                              |
|                                          |                                                                                 | 14b                              |
|                                          |                                                                                 | None                             |
|                                          |                                                                                 | None                             |
|                                          |                                                                                 | None                             |
|                                          |                                                                                 | None                             |
|                                          |                                                                                 | RFT9729                          |
|                                          |                                                                                 | +                                |
|                                          |                                                                                 | 17                               |
|                                          |                                                                                 | 16                               |
|                                          |                                                                                 | 16b                              |
|                                          |                                                                                 | 14b                              |
|                                          |                                                                                 | None                             |
|                                          |                                                                                 | None                             |
|                                          |                                                                                 | None                             |
|                                          |                                                                                 | None                             |
View status

Status messages facilitate flowmeter characterization, calibration, testing, and troubleshooting.

To view flowmeter status messages:

1. At the online menu, choose 1 (process variables).

2. At the process variables menu, choose 3 (view status).

Status messages can also be read by accessing the diagnostics/service branch of the HART Communicator software as instructed in Section 5.1. For more information about using status messages, see Chapter 5. Transmitter status messages also appear in the HART Communicator display at startup.

Totalizer control

The Totalizer Control menu enables the user to view values stored by the transmitter’s mass and/or volume totalizer(s), and to reset, start, or stop the totalizer(s).

To control the totalizer(s):

1. At the online menu, choose 1 (process variables).

2. At the process variables menu, choose 4 (totalizer control).
The RFT9739 has a mass totalizer and a volume totalizer.
- Choose 1 (mass total) to view the mass total.
- Choose 2 (volume total) to view the volume total.
- Choose 3 (start totalizer) to start the totalizers.
- Choose 4 (stop totalizer) to stop the totalizers. *
- Choose 5 (reset totalizer) to reset mass and volume totals to 0.00.

The RFT9712 or RFT9729 has a mass totalizer or a volume totalizer, depending on the measurement units selected for the flow total.
- Choose 1 (mass total) to view the mass or volume total.
- Choose 2 (start totalizer) to start the totalizer.
- Choose 3 (stop totalizer) to stop the totalizer."
- Choose 4 (reset totalizer) to reset the total to 0.00.

*CAUTION: Stopping the totalizer(s) disables the frequency/pulse output. The output remains disabled until the user starts the totalizer(s).
5

Diagnostics and Service: Test/Status

5.1 Status messages

Status messages indicate the operating condition of the flowmeter. Status messages facilitate flowmeter characterization, calibration, testing, and troubleshooting.

To view status messages:

1. At the online menu, choose 2 (diagnostics/service).

2. At the diagnostics/service menu, choose 1 (test/status).

3. At the test/status menu, choose 1 (view status).

Status messages can also be read by accessing the process variables branch of the HART Communicator software as instructed in Section 4.3. Transmitter status messages also appear in the HART Communicator display at startup.

5.2 Transmitter diagnostic tools

In some situations, proper diagnosis and troubleshooting requires use of the transmitter's diagnostic tools, which include the diagnostic LED and fault output levels. The transmitter's diagnostic tools supplement the status messages produced by the HART Communicator.
5.2.1  Fault indicators

All 9700 Series transmitters have downscale or upscale fault indicators.
- Downscale: Milliamp outputs go to 0 mA if they produce a 0-20 mA current, or to 2 mA if they produce a 4-20 mA current; the frequency/pulse output goes to 0 Hz.
- Upscale: Milliamp outputs go to 22 mA; the frequency/pulse output for the RFT9739 goes to 15,000 Hz; the frequency/pulse output for the RFT9712 or RFT9729 goes to 11,520 Hz.

The RFT9739 also has last measured value or internal zero fault indicators.
- Last measured value: RFT9739 outputs hold the values measured immediately before the fault condition occurred.
- Internal zero: RFT9739 outputs indicate a value of zero for the represented process variable.

To set a fault indicator for the RFT9739, see Chapter 13. To set downscale or upscale fault indicators for the RFT9712 or RFT9729, refer to the instruction manual shipped with the transmitter.

5.2.2  Diagnostic LED

While reading status messages, also read the transmitter’s diagnostic LED to derive more specific information about the operating condition of the flowmeter. Table 5-1 summarizes the operating conditions indicated by the diagnostic LED.

Table 5-1  Conditions indicated by diagnostic LED

<table>
<thead>
<tr>
<th>Diagnostic LED does this:</th>
<th>Condition indicated by LED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blinks ON once per second (OFF 75% of the time, ON 25% of the time)</td>
<td>Normal operation</td>
</tr>
<tr>
<td>Remains ON continuously</td>
<td>Startup and initialization, zero in progress</td>
</tr>
<tr>
<td>Blinks OFF once per second (ON 76% of the time, OFF 25% of the time)</td>
<td>Slug flow (density is outside user-defined limit)</td>
</tr>
<tr>
<td>Blinks ON 4 times per second</td>
<td>Fault condition</td>
</tr>
</tbody>
</table>

5.3  Over range and sensor failure messages

If a sensor failure occurs, if the flowmeter cable is faulty, or if flow, temperature, or density goes outside the sensor limits, at least one of the following messages appears in the HART Communicator display:
- Sensor failure
- Drive over range
- Input over range
- Temperature out of range
- Density outside limits
To interpret over range and/or sensor failure messages, use the following diagnostic tools:
1. Transmitter fault indicators.
2. The transmitter's LED.
3. A DVM or other reference device.

If an over range and/or sensor failure message appears, and the transmitter is producing fault indicators as described in Subsection 5.2.1, isolate the transmitter from devices that use transmitter outputs to control the flow loop, then follow these steps:
1. Shut off the transmitter's power supply.
2. Use a DVM or other reference device to check resistance values at the sensor junction box and at the transmitter wiring terminals, then refer to Table 5-2 and Table 5-3 to diagnose the problem.
   - Table 5-2 lists resistance values for Micro Motion sensors.
   - Table 5-3 summarizes how to use over range and sensor failure messages.

For detailed information about flowmeter troubleshooting, see the troubleshooting chapter in the instruction manual shipped with the sensor or the transmitter.

3. If troubleshooting procedures fail to reveal why over range and/or sensor failure messages have appeared, phone Micro Motion Customer Service, toll free, 1-800-522-MASS (1-800-522-6277). From outside the U.S.A., phone 1-303-530-8400.

Table 5-2 Nominal resistance values for Micro Motion sensors

- Nominal resistance values will vary by 40% per 100°C. However, confirming an open coil or shorted coil may be more important when troubleshooting than any slight deviation from the resistance values presented below.
- Resistance of right and left pickoffs should be within 10 ohms of each other.
- Resistance values depend on the sensor model and date of manufacture.

<table>
<thead>
<tr>
<th>Sensor model</th>
<th>Drive coil Ω at ambient temperature</th>
<th>Resistance value</th>
<th>Platinum RTD Ω at 0°C*</th>
</tr>
</thead>
<tbody>
<tr>
<td>D6, D12, D25, D40, D100, D150, D300, DL65, DL100, DL200</td>
<td>42 to 2660</td>
<td>130 to 300</td>
<td>100</td>
</tr>
<tr>
<td>D600</td>
<td>8 to 16</td>
<td>140</td>
<td>100</td>
</tr>
<tr>
<td>D65, DT65, DT100, DT150</td>
<td>42 to 617</td>
<td>6 to 15.6</td>
<td>100</td>
</tr>
<tr>
<td>CMF25, CMF50</td>
<td>42 to 2650</td>
<td>130 to 300</td>
<td>100</td>
</tr>
<tr>
<td>CMF100, CMF200, CMF300</td>
<td>84 to 146</td>
<td>15.9 to 25.5</td>
<td>100</td>
</tr>
</tbody>
</table>

- RTD resistance value increases .38Ω per °C increase in temperature.
<table>
<thead>
<tr>
<th>Message</th>
<th>Diagnostic LED and DVM</th>
<th>Cause(s)</th>
<th>Corrective action(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensor failure Drive over range input over range</td>
<td>• LED blinks ON 4 times per second&lt;br&gt;• Transmitter produces fault outputs&lt;br&gt;• Open or short from red to brown at transmitter terminals&lt;br&gt;• Open or short from red to brown at sensor j-box&lt;br&gt;• LED blinks ON 4 times per second&lt;br&gt;• Transmitter produces fault outputs&lt;br&gt;• Open or short from green to white at transmitter terminals&lt;br&gt;• Open or short from green to white at sensor j-box</td>
<td>• Flow rate outside sensor limit&lt;br&gt;• Faulty cable&lt;br&gt;• Open or short drive coil in sensor&lt;br&gt;• Flow rate outside sensor limit&lt;br&gt;• Faulty cable&lt;br&gt;• Open or short left pickoff in sensor</td>
<td>• Bring flow rate within sensor limit&lt;br&gt;• Monitor flow rate&lt;br&gt;• If open or short at transmitter, reconnect wiring or repair cable&lt;br&gt;• If open or short at sensor, return sensor to Micro Motion</td>
</tr>
<tr>
<td>Sensor failure</td>
<td>• LED blinks ON 4 times per second&lt;br&gt;• Transmitter produces fault outputs&lt;br&gt;• Open or short from blue to gray at transmitter terminals&lt;br&gt;• Open or short from blue to gray at sensor j-box</td>
<td>• Faulty cable&lt;br&gt;• Open or short right pickoff in sensor&lt;br&gt;• Moisture in sensor case</td>
<td>• If open or short at transmitter, reconnect wiring or repair cable&lt;br&gt;• If open or short at sensor, return sensor to Micro Motion&lt;br&gt;• Replace conduit and/or conduit seals&lt;br&gt;• Repair cable&lt;br&gt;• Return sensor to Micro Motion</td>
</tr>
<tr>
<td>Sensor failure Drive over range Density outside limits</td>
<td>• LED blinks ON 4 times per second&lt;br&gt;• Transmitter produces fault outputs</td>
<td>• Inappropriate density factors&lt;br&gt;• Process density &lt; 0.0000 g/cc&lt;br&gt;• Process density &gt; 6.0000 g/cc&lt;br&gt;• Severely erratic or complete cessation of flow tube vibration due to gas slugs or solids in process fluid&lt;br&gt;• Plugged flow tube</td>
<td>• Recalibrate for density&lt;br&gt;• Characterize density values for sensor&lt;br&gt;• Monitor density&lt;br&gt;• Bring density within sensor limit&lt;br&gt;• Purge flow tubes with steam, water, or purging chemical</td>
</tr>
<tr>
<td>Sensor failure Temperature out of range</td>
<td>• LED blinks ON 4 times per second&lt;br&gt;• Transmitter produces fault outputs&lt;br&gt;• Open or short from yellow to orange at transmitter terminals&lt;br&gt;• Open or short from yellow to orange at sensor j-box&lt;br&gt;• LED blinks ON 4 times per second&lt;br&gt;• Transmitter produces fault outputs&lt;br&gt;• Open or short from violet to yellow at transmitter terminals&lt;br&gt;• Open or short from violet to yellow at sensor j-box</td>
<td>• Temperature outside sensor limit&lt;br&gt;• Faulty cable&lt;br&gt;• Open or short lead length compensator&lt;br&gt;• Faulty cable&lt;br&gt;• Open or short RTD in sensor</td>
<td>• Bring temperature within sensor limit&lt;br&gt;• Monitor temperature&lt;br&gt;• If open or short at transmitter, reconnect wiring or repair cable&lt;br&gt;• If open or short at sensor, return sensor to Micro Motion</td>
</tr>
</tbody>
</table>
5.4 Transmitter failure messages

If a transmitter failure occurs, at least one of the following messages appears in the HART Communicator display:

- EEPROM checksum error
- RAM read/write error
- Real time interrupt failure
- Electronics failure

Table 54 summarizes possible transmitter failures.

CAUTION: The transmitter does NOT have any user-serviceable parts. If a transmitter failure message appears in the HART Communicator display, phone Micro Motion Customer Service, toll free, 1-800-522-MASS (1-800-522-6277). From outside the U.S.A., phone 1-303-530-8400.

<table>
<thead>
<tr>
<th>Message</th>
<th>Condition</th>
<th>Corrective action(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EEPROM checksum error</td>
<td>(E)EPROM checksum failed</td>
<td>Phone Micro Motion Customer Service, toll free, 1-800-522-MASS (1-800-522-6277). From outside the U.S.A., phone 1-303-530-8400</td>
</tr>
<tr>
<td>RAM read/write error</td>
<td>RAM diagnostic failed</td>
<td></td>
</tr>
<tr>
<td>Real time interrupt failure</td>
<td>Real-time interrupt failed</td>
<td></td>
</tr>
<tr>
<td>Electronics failure</td>
<td>Transmitter electronics failed</td>
<td></td>
</tr>
</tbody>
</table>

5.5 Field device not characterized

If a master reset is performed on the transmitter, “Field device not characterized” appears in the HART Communicator display. A master reset returns all transmitter options to their default factory values, and requires complete characterization and reconfiguration of the flowmeter.

To characterize the flowmeter, choose the options from the characterize sensor menu in the detailed setup branch of the HART Communicator software. For more information about characterization, see Chapter 10.

5.6 Calibration failed

“Calibration failed” indicates that the transmitter cannot properly calculate settings during a calibration procedure. The cause of the failure depends on the type of calibration being performed.
5.7  Slug flow

Programmed slug flow limits enable transmitter outputs, the diagnostic LED, and the HART Communicator to indicate conditions such as slug flow (gas slugs in a liquid flow stream). Such conditions adversely affect sensor performance by causing erratic vibration of the flow tubes, which in turn causes the transmitter to produce inaccurate flow signals.

To program slug flow limits, see Chapter 12. If the user programs slug flow limits, a slug flow condition causes the following to occur:
1. “Slug flow” appears in the HART Communicator display.
2. The frequency/pulse output goes to 0 Hz.
3. Milliamp outputs indicating the flow rate go to the level that represents zero flow.
4. The diagnostic LED blinks OFF once per second (ON 75% of the time, OFF 25% of the time).

The flowmeter resumes normal operation when liquid fills the flow tubes (when density stabilizes within the programmed slug flow limits).

The user can also program a slug duration into the configuration of an RFT9739. If process density goes outside a slug flow limit, flow outputs hold their last measured value for the period of time established as the slug duration. To program a slug duration for the RFT9739, see Chapter 13.

5.8  Outputs saturated

If an output variable exceeds its upper range limit, “Frequency over range”, “Analog output 1 saturated”, or “Analog output 2 saturated” appears in the HART Communicator display. The message can mean that the output variable has exceeded appropriate limits for the process, or that the user needs to change measurement units.

If “Frequency over range” appears, determine whether the flow rate is outside control limits. If the flow rate is outside control limits, use a control device to decrease the flow rate. If the flow rate is within control limits, isolate the transmitter from devices that use transmitter outputs to control the flow loop, then follow one of these procedures:
1. Rescale the frequency/pulse output. To rescale the output, see Chapter 9.
2. Change measurement units for mass or volume flow. To change flow units, see Chapter 11.
Example:

An RFT9739 indicates the flow rate in pounds per minute (lb/min). The frequency/pulse output has been scaled so 100 Hz = 1 lb/min. Although the process sometimes exceeds 100 lb/min, the frequency/pulse output goes out of range at 10 kHz, where the flow rate achieves 100 lb/min.

Increase the span of the frequency/pulse output in any of these ways:

- Rescale the frequency/pulse output so 10 kHz represents a flow rate above 100 lb/min. With the frequency set at 100 Hz and the rate set at 1 lb/min, decreasing the frequency to 50 Hz or increasing the rate to 2 lb/min would rescale the output so 10 kHz = 200 lb/min.

- Change lb/min to a flow rate unit with a longer-duration time base, such as pounds per hour (lb/hr). With the frequency set at 100 Hz and the rate set at 1 lb/hr, 10 kHz = 6000 lb/hr.

- Change lb/min to a flow rate unit with a larger mass base, such as kilograms per minute (kg/min). With the frequency set at 100 Hz and the rate set at 1 kg/min, 10 kHz = 100 kg/min or 220.5 lb/min.

If “Analog output 1 saturated” or “Analog output 2 saturated” appears, determine whether the process variable indicated by the output is outside control limits. If the output variable is outside control limits, use a control device to decrease the flow rate, density, temperature, pressure, or viscosity of the fluid. If the output variable is within control limits, isolate the transmitter from devices that use transmitter outputs to control the flow loop, then follow one of these procedures:

1. Increase the range values for the milliamp output variable. To change the range values, see Chapter 9.

2. If the milliamp output represents a flow rate or total, change measurement units for mass or volume flow. To change flow units, see Chapter 11.

Example:

An RFT9739 measures temperature in degrees Celsius (°C). In this application the process fluid sometimes achieves a temperature above 80°C, but milliamp output 2 indicates 80°C at 20 mA.

- If the process requires the temperature to remain lower than 80°C, use a control device to decrease the process temperature.

- If a process temperature above 80°C is acceptable, change the upper range value (URV) for milliamp output 2. In this example, the URV could be changed to 100°C.
Table 5-5 summarizes conditions indicated by outputs saturated messages.

### Table 5-5  Using outputs saturated messages

<table>
<thead>
<tr>
<th>Message</th>
<th>Condition</th>
<th>Corrective action(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency over range</td>
<td>• Flow rate driving RFT9739 frequency/pulse output to 15 kHz</td>
<td>• Change flow measurement units</td>
</tr>
<tr>
<td></td>
<td>• Flow rate driving RFT9712 or RFT9729 frequency/pulse output to 11,520 Hz</td>
<td>• Rescale frequency/pulse output</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Reduce flow rate</td>
</tr>
<tr>
<td>Analog output 1 saturated</td>
<td>RFT9739 primary milliamp output = 22 mA</td>
<td>• Change value of variable at 20 mA</td>
</tr>
<tr>
<td>Analog output 2 saturated</td>
<td>RFT9739 secondary milliamp output = 22 mA</td>
<td>• Monitor process variable</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Alter fluid process</td>
</tr>
</tbody>
</table>

5.9  Informational messages

“Field device warming up” indicates transmitter self-calibration in progress at startup or after power cycling.

“Calibration in progress” appears during flowmeter calibration and output testing.
- For more information about flowmeter calibration, see Chapter 7.
- For more information about output testing, see Chapter 6.

“Auto zero failure” appears if the transmitter cannot properly calculate the offset of the flow signal during transmitter zeroing. The failure can occur due to mechanical noise or flow of fluid through the sensor during zeroing. For more information about transmitter zeroing, see Section 7.2.

“Process too noisy to perform automatic zero” appears if mechanical noise has prevented the transmitter from setting an accurate zero flow offset during transmitter zeroing. For more information about transmitter zeroing, see Section 7.2.

“Excess calibration correction, zero too low” or “Excess calibration correction, zero too high” appears if flow is not completely shut off during sensor zeroing, thereby causing the transmitter to calculate a zero flow offset that is too low or too high to allow accurate flow measurement. For more information about transmitter zeroing, see Section 7.2.

“Analog output and its digital representation are in fixed mode, and not responsive to input changes” appears if the RFT9712 or RFT9729 has a polling address other than 0 for multidrop network communication. The output remains fixed at 4 mA until the user assigns a polling address of 0 to the transmitter. To assign a polling address to the transmitter, see Chapter 13.
"Analog output 1 fixed" or "Analog output 2 fixed" indicates one of several conditions:

- "Analog output 1 fixed" or "Analog output 2 fixed" can indicate the user has aborted a milliamp output trim or test. The output remains fixed at the assigned level until the user completes the output trim or test procedure. For more information about trimming milliamp outputs, see Chapter 8; for more information about testing milliamp outputs, see Chapter 6.

- "Analog output 1 fixed" can indicate that the RFT9739 has a polling address other than 0 for multidrop network communication. The output remains fixed at 4 mA until the user assigns a polling address of 0 to the transmitter. To assign a polling address to the transmitter, see Chapter 13.

- "Burst mode enabled" indicates the transmitter is configured to send data in burst mode while operating under HART protocol. In burst mode, the transmitter bursts data at regular intervals. To toggle burst mode ON or OFF, see Chapter 13.

- "Event 1 triggered" or "Event 2 triggered" appears if an event tied to an RFT9739 output switches the output ON.
  - With mass or volume total assigned to event 1 or event 2, the event switches ON and OFF according to the low or high configuration of the alarm. With a LOW alarm, the event switches ON when the user resets the totalizer. With a HIGH alarm, the event switches OFF when the user resets the totalizer.
  - With flow, density, temperature, pressure, or viscosity assigned to event 1 or event 2, the event switches OFF or ON whenever the process variable crosses the setpoint.
  - For more information about configuring events for the RFT9739, see Chapter 15.

- "Error cleared" indicates successful diagnosis and elimination of problems that caused the HART Communicator to produce status messages.

- "Power reset occurred" appears after a power failure, brownout, or power cycle has interrupted operation of the transmitter. The transmitter has a nonvolatile memory, which remains intact despite power interruptions.

- "Milliamp input error" indicates faulty wiring between an RFT9739 and a pressure transmitter connected to terminals S (MA SIG IN) and P (MA PWR OUT), or that the pressure input requires characterization. For more information about characterizing the pressure input to an RFT9739, see Chapter 10.

Table 5-6 summarizes conditions indicated by informational messages.
### Table 5-6  Using informational messages

<table>
<thead>
<tr>
<th>Message</th>
<th>Condition</th>
<th>Corrective action(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field device warming up</td>
<td>Transmitter startup/self-calibration in progress</td>
<td>If message remains ON, check flowmeter cable</td>
</tr>
<tr>
<td>Calibration in progress</td>
<td>Digital trim in progress, Auto zero in progress, Output trim in progress</td>
<td>• Eliminate noise, then retrim</td>
</tr>
<tr>
<td>Auto zero failure</td>
<td>Transmitter cannot calculate offset of flow signal</td>
<td>• Completely shut off flow, then rezero</td>
</tr>
<tr>
<td>Excess calibration correction, zero too high</td>
<td>Flow not completely shut off during auto zero</td>
<td>Complete shut off flow, then rezero</td>
</tr>
<tr>
<td>Process too noisy to perform automatic zero</td>
<td>Mechanical noise prevented accurate zero flow setting during auto zero</td>
<td>Eliminate mechanical noise, if possible, then rezero</td>
</tr>
<tr>
<td>Analog output 1 fixed</td>
<td>Polling address of 1 to 15 assigned to transmitter</td>
<td>Change polling address to 0</td>
</tr>
<tr>
<td>Analog output and its digital representation are in fixed mode, and not responsive to input changes</td>
<td>Transmitter configured to send data in burst mode under HART protocol</td>
<td>Configure burst mode to be OFF</td>
</tr>
<tr>
<td>Burst mode enabled</td>
<td>Transmitter configured to send data in burst mode under HART protocol</td>
<td></td>
</tr>
<tr>
<td>Event 1 triggered</td>
<td>Event 1 is ON</td>
<td>• If totalizer assigned:</td>
</tr>
<tr>
<td>Event 2 triggered</td>
<td>Event 2 is ON</td>
<td>- Low alarm switches event ON at totalizer reset</td>
</tr>
<tr>
<td>Milliamp input error</td>
<td>Pressure input to RFT9739 terminals P (MA PWR OUT) and S (MA SIG IN) &lt; 4 mA or &gt; 20 mA</td>
<td>• Characterize range limits for mA pressure input</td>
</tr>
<tr>
<td>Power reset occurred</td>
<td>Power failure, Brownout, Power cycling</td>
<td>• Check for faulty wiring to or from pressure transmitter</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Alter fluid process</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Check accuracy of totalizers</td>
</tr>
</tbody>
</table>
5.10  HART Communicator self -test

Testing the HART Communicator ensures its proper operation.

To test the HART Communicator:

1. At the online menu, choose 2 (diagnostics/service).

2. At the diagnostics/service menu, choose 1 (test/status).

3. At the test/status menu, choose 2 (self test).

4. When the self-test is completed, press F4 (OK).

5. If an error message appears, press F3 (abort) to return to the test/status menu, then perform the test again.

If the HART Communicator fails the self-test, phone the toll-free Rosemount National Response Center, 24 hours per day, 1-800-654-RSMT (1-800-654-7768).
Loop Test

6.1 Loop test overview

**WARNING:** Before performing calibration procedures, set process control devices for manual operation.

Whenever the display at left appears, isolate the transmitter from digital computers, Micro Motion peripherals, valves, or other devices that use transmitter outputs to control the flow loop, then press F4 (OK).

Milliamp output testing involves commanding the RFT9739 to produce a current at a specified 0 to 22 mA level, or commanding the RFT9712 or RFT9729 to produce a current at a specified 2 to 22 mA level. Milliamp output testing requires a digital voltmeter (DVM) or other reference device. To read output voltage, place a 250-1000 ohm resistor across the output wiring loop.

Frequency/pulse output testing involves commanding the RFT9739 to produce a frequency at a specified 0.1 to 10,000 Hz level, or commanding the RFT9712 or RFT9729 to produce a frequency at a specified 1 to 10,000 Hz level. Frequency/pulse output testing requires a reference frequency counter.

Output testing can be conducted in the diagnostics/service branch or detailed setup branch of the HART Communicator software.

6.2 Milliamp output testing

Milliamp outputs from an RFT9739 can be tested at their low current level (0 or 4 mA), at their high current level (20 mA), or at any specified current level from 0 to 22 mA if they produce a 0-22 mA current, or from 2 to 22 mA if they produce a 4-20 mA current.

The 4-20 mA output from an RFT9712 or RFT9729 can be tested at its low current level (4 mA), at its high current level (20 mA), or at any specified current level from 2 to 22 mA.

To read output voltage, place a 250-1000 ohm resistor across the output wiring terminals. If such a resistor is not already in place, install one before testing the milliamp output. Connect a reference device such as a DVM to the resistor. Table 6-1 lists the terminals to which the resistor and reference device should be connected on each Micro Motion transmitter.
Table 6-1  Milliamp output terminal connections for Micro Motion® transmitters

<table>
<thead>
<tr>
<th>Milliamp output</th>
<th>Transmitter model</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RFT9712</td>
</tr>
<tr>
<td>Primary +</td>
<td>17</td>
</tr>
<tr>
<td>Primary -</td>
<td>16</td>
</tr>
<tr>
<td>Secondary +</td>
<td></td>
</tr>
<tr>
<td>Secondary -</td>
<td></td>
</tr>
</tbody>
</table>

For more information about output wiring, see the instruction manual shipped with the transmitter.

6.2.1 Milliamp output test in diagnostics/service branch

To perform a milliamp output test in the diagnostics/service branch:

1. At the online menu, choose 2 (diagnostics/service).

2. At the diagnostics/service menu, choose 2 (loop test).

3. At the loop test menu, choose the output that will be tested:
   a. To test the milliamp output from an RFT9712 or RFT9729, choose 1 (fix analog output);
b. To test the primary milliamp output from an RFT9739, choose 1 (fix analog out 1);

c. To test the secondary milliamp output from an RFT9739, choose 2 (fix analog out 2).

4. When the HART Communicator display reads “WARN-Loop should be removed from automatic control”, isolate the transmitter from devices that use transmitter outputs to control the flow loop, then press F4 (OK).

5. Choose the current level at which the output will be tested:

   a. To test the output at its low level, choose 1 (4 mA or 0 mA), then skip to Step 6;

   b. To test the output at its high level, choose 2 (20 mA), then skip to Step 6; or
6.2.2 Milliamp output test in the detailed setup branch

A milliamp output test can also be conducted in the detailed setup branch of the HART Communicator software.

To conduct a milliamp output test in the detailed setup branch:

1. At the online menu, choose 4 (detailed setup).

6. The HART Communicator then indicates that the output has been fixed at the current level that was chosen for the test. Check the readout from the reference device. It should indicate the same amount of current as the amount displayed by the HART Communicator. Press F4 (OK).

d. Enter the desired current level in milliamps. Press F4 (enter).

c. To test the output at any current level from 0 to 22 mA if the produces a 0-22 mA current, or from 2 to 22 mA if the produces a 4-20 mA current, choose 3 (other). Press F4 (enter), then

7. To complete the milliamp output test, choose 4 (end), then press F4 (enter).
2. At the detailed setup menu, choose 3 (configure outputs).

3. At the configure outputs menu, the choice depends on the transmitter to which the HART Communicator is connected:
   a. To test the 4-20 mA output from an RFT9712 or RFT9729, choose 1 (analog output).
   b. To test the primary milliamp output from an RFT9739, choose 1 (analog output 1).
   c. To test the secondary milliamp output from an RFT9739, choose 2 (analog output 2).

4. At the analog output, analog output 1, or analog output 2 menu, the choice again depends on the transmitter to which the HART Communicator is connected:
   a. To test the 4-20 mA output from an RFT9712 or RFT9729, choose 4 (fix analog output).
b. To test the primary milliamp output from an RFT9739, choose 5 (fix analog output 1).

c. To test the secondary milliamp output from an RFT9739, choose 5 (fix analog output 2).

5. When the HART Communicator display reads, “WARN-Loop should be removed from automatic control”, isolate the transmitter from devices that use transmitter outputs to control the flow loop, then press F4 (OK). To conduct the test, follow Steps 5 through 7 of the procedure described in Subsection 62.1.

6.3 Frequency/pulse output testing

The frequency/pulse output from an RFT9739 can be tested at any frequency from 0.1 Hz to 10 kHz. The frequency/pulse output from an RFT9712 or RFT9729 can be tested at any frequency from 1 Hz to 10 kHz.

Frequency/pulse output testing requires a frequency counter. Connect the frequency counter to the transmitter terminals for the frequency/pulse output. Table 6-2 lists terminals to which the frequency counter should be connected on each Micro Motion transmitter.

<table>
<thead>
<tr>
<th>Frequency/pulse output</th>
<th>Transmitter model</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RFT9712</td>
</tr>
<tr>
<td>+</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>18</td>
</tr>
</tbody>
</table>

For more information about output wiring, see the instruction manual shipped with the transmitter.
To perform a frequency/pulse output test in the diagnostics/service branch of the HART Communicator software:

1. At the online menu, choose 2 (diagnostics/service).

2. At the diagnostics/service menu, choose 2 (loop test).

3. At the loop test menu, choose the output that will be tested:
   a. To test the frequency/pulse output from an RFT9712 or RFT9729, choose 2 (fix frequency out);
   b. To test the frequency/pulse output from an RFT9739, choose 3 (fix frequency out).

4. When the HART Communicator display reads "WARN-Loop should be removed from automatic control", isolate the transmitter from devices that use transmitter outputs to control the flow loop, then press F4 (OK).
5. Choose the frequency at which the output will be tested:

a. To test the output at 10 kHz, choose 1 (10 kHz). Press F4 (enter), then skip to Step 6; or

b. To test the output from an RFT9739 at any frequency from 0.1 Hz to 10 kHz, or to test the output from an RFT9712 or RFT9729 at any frequency from 1 Hz to 10 kHz, choose 2 (other). Press F4 (enter), then

c. Enter the desired frequency in Hertz. Press F4 (enter).

6. The HART Communicator then indicates that the output has been fixed at the frequency that was chosen for the test. Check the readout from the reference frequency counter. It should indicate the same frequency as the frequency displayed by the HART Communicator. Press F4 (enter).

7. Choose 3 (end) to complete the frequency/pulse output test.

A frequency/pulse output test can also be conducted in the detailed setup branch of the HART Communicator software.

To conduct a frequency/pulse output test in the detailed setup branch:
1. At the online menu, choose 4 (detailed setup).

2. At the detailed setup menu, choose 3 (configure outputs).

3. At the configure outputs menu, the choice depends on the transmitter to which the HART Communicator is connected:
   a. Choose 2 (frequency output) to test the frequency/pulse output from an RFT9712 or RFT9729.
   b. Choose 3 (frequency output) to test the frequency/pulse output from an RFT9739.

4. At the frequency output menu, the choice again depends on the transmitter to which the HART Communicator is connected:
   a. With the HART Communicator connected to an RFT9712 or RFT9729, choose 3 (fix frequency output).
b. With the HART Communicator connected to an RFT9739, choose 5 (fix frequency output).

5. When the HART Communicator display reads, "WARN-Loop should be removed from automatic control", isolate the transmitter from devices that use transmitter outputs to control the flow loop, then press F4 (OK). To conduct the test, follow Steps 5 through 7 of the procedure described in Subsection 6.3.1.

6.3.3 Ending the output test

After the milliamp or frequency/pulse output test has been completed, the HART Communicator reminds the user to return the flow loop to automatic control.

After returning the flow loop to automatic control, press F4 (OK).
7 Diagnostics and Service: Calibration

7.1 Calibration overview

WARNING: Before performing calibration procedures, set process control devices for manual operation.

Whenever the display at left appears, isolate the transmitter from digital computers, Micro Motion peripherals, valves, or other devices that use transmitter outputs to control the flow loop, then press F4 (OK).

Calibration accounts for performance variations in individual sensors, transmitters, and peripheral devices. When a transmitter and a sensor are ordered together as a Coriolis mass flowmeter, they are factory calibrated to produce highly accurate measurements of mass flow, fluid density, and flow tube temperature. The HART Communicator supports field calibration of the flowmeter if sensors and transmitters need to be interchanged.

Auto zero optimizes flow measurement accuracy by setting the offset of the flow signal under zero flow conditions. To zero the flowmeter, see Section 7.2.

Density calibration adjusts factors used by the transmitter to calculate density. To perform density calibrations, see Section 7.4.
- Two-point density calibration involves commanding the transmitter to measure the tube period when the sensor contains a low-density fluid (usually air) and when the sensor contains a high-density fluid (usually water).
- Third-point density calibration of the RFT9739, performed at or near full-scale flow conditions, adjusts for the effect of flow velocity on the flow tubes at high flow rates. Most applications do not require a third density calibration point for the RFT9739, but it is desirable if the process often approaches the full-scale flow rate for the sensor.

RFT9739 viscosity calibration, performed while process fluid flows through the sensor at line conditions, adjusts the equation used for calculating viscosity. To perform a viscosity calibration, see Section 7.5.
For Newtonian fluids that exhibit laminar flow, a 1.4 or higher-revision RFT9739 supports single-point viscosity calibration, which adjusts the slope of the equation.

For non-Newtonian fluids, a 1.5 or higher-revision RFT9739 supports 2-point viscosity calibration, which adjusts the slope and offset of the equation.

CAUTION: While performing calibration procedures, write down calibration values in the appropriate Flowmeter Calibration Record (Appendix II).

7.2 Auto zero

Auto zero sets the offset of the flow signal at zero flow.

7.2.1 Performing the auto zero

To zero the transmitter:
1. Make sure the sensor is installed according to the appropriate sensor instruction manual.
2. Fill the sensor completely with fluid.
3. Close the shutoff valve downstream from the sensor. Flow through the sensor must be completely stopped to enable accurate zeroing. Inaccurate zero settings sometimes result from leakage of fluid through valves.
4. If possible, shut off mechanical noise sources such as motors, pumps, and valves. Crosstalk, which is transfer of a resonant frequency through sensors operating in series or in parallel (in the same pipeline), can result in an inaccurate zero calibration.
5. At the online menu, choose 2 (diagnostics/service).
6. At the diagnostics/service menu, choose 3 (calibration).
7. At the calibration menu, choose 1 (auto zero).

8. At the auto zero menu, choose 1 (perform auto zero).

9. When the HART Communicator display reads “Flow must be zero”, make sure flow through the sensor is completely stopped, then press F4 (OK).

   a. The HART Communicator display reads “Calibration in progress” to indicate transmitter zeroing in progress.
   b. The transmitter LED remains ON during transmitter zeroing.
   c. To end the zero operation before its completion, press F3 (abort).

When transmitter zeroing is completed, the diagnostic LED blinks ON once per second to indicate normal operation, and the HART Communicator display reads “Auto Zero complete”. Press F4 (OK).
7.2.2 Diagnosing zeroing failure

If zeroing fails, the HART Communicator display produces an error message.
- To abort the zeroing procedure, press F3 (abort).
- To re-zero, make sure flow is completely shut off and the sensor tubes are completely filled with fluid, then press F4 (OK).

These are the most common sources of zeroing failure:
- Flow of fluid through sensor during zeroing.
- Flow tubes not completely filled with fluid during zeroing.
- Mechanical noise from equipment such as motors, pumps, or valves.
- Inappropriate zero time or convergence limit for the auto zero performed on an RFT9739.

7.3 Programming auto zero for the RFT9739

If the HART Communicator indicates an auto zero failure, and the zeroing procedure was performed on an RFT9739, the auto zero parameters can be reprogrammed.

During the zeroing process, the RFT9739 measures the time shift (the time between signals from the sensor's left and right pickoffs) for each measurement cycle, computes the average time shift per cycle, then derives the standard deviation of the average time shift over the zero time.
- Zero time is the number of measurement cycles required for transmitter zeroing, where one measurement cycle equals two tube periods. A longer zero time might improve the accuracy of the zeroing procedure by increasing the number of measurement cycles. The default zero time is 2048 cycles (approximately 40 seconds at a tube frequency of 100 Hz). See Subsection 7.3.1.
- If zeroing is too noisy, the user can program a convergence limit to account for mechanical noise, such as vibrating pumps or other equipment. Mechanical noise can cause zero failure by interfering with signals from the sensor. See Subsection 7.3.2.

7.3.1 Zero time

Programming the zero time enables a shorter or longer zeroing time than the default time (2048 measurement cycles).

To program the zero time:

1. At the online menu, choose 2 (diagnostics/service).
2. At the diagnostics/service menu, choose 3 (calibration).

3. At the calibration menu, choose 1 (auto zero).

4. Choose 3 (zero time).

5. Enter the desired number of measurement cycles, from 100 to 65,535.

If the zero time is not changed, the transmitter will sample the time shift over 2048 measurement cycles (approximately 40 seconds at a flow tube frequency of 100 Hz).

7.3.2 Convergence limit

Programming the convergence limit causes the RFT9739 to zero in one of the following ways:

- When the standard deviation of the average time shift converges to a value that is less than the programmed convergence limit, the RFT9739 will quit zeroing.
- If the standard deviation of the average time shift exceeds but is not more than 10 times the convergence limit, the RFT9739 will successfully zero, but will continue sampling throughout the entire zero time.
- If the standard deviation of the average time shift is more than 10 times the programmed convergence limit, the RFT9739 indicates zero failure and retains the previous zero calibration. This condition indicates a fault.
To program a convergence limit:

1. At the online menu, choose 2 (diagnostics/service).

2. At the diagnostics/service menu, choose 3 (calibration).

3. At the calibration menu, choose 1 (auto zero).


5. Enter the desired value.
7.4 Density calibration

The HART Communicator supports two types of density calibration:

- Two-point density calibration, preferably performed under zero flow conditions, establishes an individual sensor's tube periods at two reference densities, which the transmitter uses to calculate the density of the process fluid at low flow rates.
- Third-point density calibration for an RFT9739, performed at or near the full-scale flow rate of the sensor, adds a third density calibration point, which accounts for the minimal effects of mass flow on the tube period at high flow rates. Most applications do not require a third density calibration point for the RFT9739, but is desirable if the process often approaches the full-scale flow rate for the sensor.

7.4.1 Density measurement theory

Fluid density is inversely proportional to the square of the frequency of the sensor flow tubes. Density calibration adjusts the slope and offset of the factors used by the transmitter to calculate density.

During two-point density calibration, the user commands the transmitter to measure the tube period when the flow tubes contain a fluid (usually air) with a reference low density and when the flow tubes contain a fluid (usually water) with a reference high density. The transmitter then calculates the density of the process fluid from the following equation:

\[
D = \frac{\tau^2 - \tau_1^2}{\tau_2^2 - \tau_1^2} \times (D_2 - D_1) + D
\]

Where:
- \(D\) = Calculated density at measured temperature \(t\)
- \(D_1\) = Reference density of low-density calibration fluid at calibration temperature \(t_2\)
- \(D_2\) = Reference density of high-density calibration fluid at calibration temperature \(t_2\)
- \(\tau^2\) = Measured tube period squared at measured temperature \(t\), corrected to 0°C
- \(\tau_1^2\) = Tube period squared at \(D_1\), corrected to 0°C
- \(\tau_2^2\) = Tube period squared at \(D_2\), corrected to 0°C

During third-point density calibration of the RFT9739, an extra calibration point is set based on the measured density of a process fluid at zero flow and on a tube period measured while the sensor operates at or near its full-scale flow rate. Third-point calibration changes the density equation used by the RFT9739 to account for the angular momentum of the flow tubes when the process fluid flows at or above the full-scale flow rate.

CAUTION: Density calibration requires reading and entering density values in grams per cubic centimeter (g/cc). To configure grams per cubic centimeter as the density measurement unit, see Chapter 11.
The HART Communicator can be used for performing a two-point density calibration in the field. The procedure includes a low-density calibration and a high-density calibration.

To perform the low-density calibration:
1. Fill the sensor with a low-density fluid such as air.
2. If possible, shut off the flow. Otherwise, pump the fluid through the sensor at the lowest flow rate allowed by the process.
3. Use any established method to derive an accurate density, in grams per cubic centimeter, for the fluid at line conditions. (If air is the low-density calibration fluid, a value in Table 7-1 can be used for the density.)

4. At the online menu, choose 2 (diagnostics/service).

5. At the diagnostics/service menu, choose 3 (calibration),

6. At the calibration menu, choose 2 (density calibration).

7. At the density calibration menu, choose 1 (air).
8. Choose 1 (perform calibration).

9. Enter the line-condition density in grams per cubic centimeter.

10. When the HART Communicator display reads “Perform calibration?”, press F4 (OK). The transmitter measures the tube period, corrects it to 0°C, and stores it. The HART Communicator display reads “Calibration in progress” to indicate density calibration in progress.

When the low-density calibration is completed, the HART Communicator display reads “Density Calibration Complete”. Press F4 (OK).
### Table 7-1  Density of air

<table>
<thead>
<tr>
<th>Pressure in millibar (in-Hg)</th>
<th>Temperature in °C and °F</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10°C 50°F</td>
</tr>
<tr>
<td>850 (25.14)</td>
<td>.0010</td>
</tr>
<tr>
<td>950 (28.10)</td>
<td>.0012</td>
</tr>
<tr>
<td>1000 (29.67)</td>
<td>.0012</td>
</tr>
<tr>
<td>1050 (31.06)</td>
<td>.0013</td>
</tr>
</tbody>
</table>

To perform the high-density calibration:
1. Fill the sensor with a high-density fluid such as water.
2. If possible, shut off the flow. Otherwise, pump the fluid through the sensor at the lowest flow rate allowed by the process. To ensure stable density, make sure the fluid in the flow tubes remains completely free of gas bubbles during the calibration.
3. Use any established method to derive an accurate density, in grams per cubic centimeter, for the fluid at line conditions. (If water is the high-density calibration fluid, a value in Table 7-2 can be used for the density.)
4. At the online menu, choose 2 (diagnostics/service).
5. At the diagnostics/service menu, choose 3 (calibration).
6. At the calibration menu, choose 2 (density calibration).

7. At the density calibration menu, choose 2 (water).

8. Choose 1 (perform calibration).

9. Enter the line-condition density in grams per cubic centimeter.

10. When the HART Communicator display reads “Perform calibration?”, press F4 (OK). The transmitter measures the tube period, corrects it to 0°C and stores it. The HART Communicator display reads “Calibration in progress” to indicate density calibration in progress.
When the high-density calibration is completed, the HART Communicator display reads “Density Calibration Complete”. Press F4 (OK).

### Table 7-2  Density of water

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Density in g/cc</th>
<th>Temperature</th>
<th>Density in g/cc</th>
</tr>
</thead>
<tbody>
<tr>
<td>°F</td>
<td>°C</td>
<td>32</td>
<td>0.0</td>
</tr>
<tr>
<td>33</td>
<td>0.6</td>
<td>0.9998</td>
<td>69</td>
</tr>
<tr>
<td>34</td>
<td>1.1</td>
<td>0.9999</td>
<td>70</td>
</tr>
<tr>
<td>36</td>
<td>1.7</td>
<td>0.9999</td>
<td>71</td>
</tr>
<tr>
<td>36</td>
<td>2.2</td>
<td>0.9999</td>
<td>72</td>
</tr>
<tr>
<td>37</td>
<td>2.8</td>
<td>0.9999</td>
<td>73</td>
</tr>
<tr>
<td>38</td>
<td>3.3</td>
<td>0.9999</td>
<td>74</td>
</tr>
<tr>
<td>39</td>
<td>3.9</td>
<td>1.0000</td>
<td>75</td>
</tr>
<tr>
<td>40</td>
<td>4.4</td>
<td>1.0000</td>
<td>76</td>
</tr>
<tr>
<td>41</td>
<td>6.0</td>
<td>0.9999</td>
<td>77</td>
</tr>
<tr>
<td>42</td>
<td>6.6</td>
<td>0.9999</td>
<td>78</td>
</tr>
<tr>
<td>43</td>
<td>6.1</td>
<td>0.9999</td>
<td>79</td>
</tr>
<tr>
<td>44</td>
<td>6.7</td>
<td>0.9999</td>
<td>80</td>
</tr>
<tr>
<td>46</td>
<td>7.2</td>
<td>0.9999</td>
<td>81</td>
</tr>
<tr>
<td>46</td>
<td>7.8</td>
<td>0.9999</td>
<td>82</td>
</tr>
<tr>
<td>47</td>
<td>8.3</td>
<td>0.9998</td>
<td>83</td>
</tr>
<tr>
<td>48</td>
<td>8.9</td>
<td>0.9998</td>
<td>84</td>
</tr>
<tr>
<td>49</td>
<td>9.4</td>
<td>0.9998</td>
<td>86</td>
</tr>
<tr>
<td>50</td>
<td>10.0</td>
<td>0.9997</td>
<td>86</td>
</tr>
<tr>
<td>61</td>
<td>10.6</td>
<td>0.9996</td>
<td>95</td>
</tr>
<tr>
<td>62</td>
<td>11.1</td>
<td>0.9996</td>
<td>100</td>
</tr>
<tr>
<td>53</td>
<td>11.7</td>
<td>0.9995</td>
<td>104</td>
</tr>
<tr>
<td>64</td>
<td>12.2</td>
<td>0.9995</td>
<td>113</td>
</tr>
<tr>
<td>55</td>
<td>12.8</td>
<td>0.9994</td>
<td>122</td>
</tr>
<tr>
<td>66</td>
<td>13.3</td>
<td>0.9994</td>
<td>131</td>
</tr>
<tr>
<td>67</td>
<td>13.9</td>
<td>0.9992</td>
<td>140</td>
</tr>
<tr>
<td>68</td>
<td>14.4</td>
<td>0.9992</td>
<td>149</td>
</tr>
<tr>
<td>59</td>
<td>15.0</td>
<td>0.9991</td>
<td>158</td>
</tr>
<tr>
<td>60</td>
<td>15.6</td>
<td>0.9991</td>
<td>167</td>
</tr>
<tr>
<td>61</td>
<td>16.1</td>
<td>0.9989</td>
<td>176</td>
</tr>
<tr>
<td>62</td>
<td>16.7</td>
<td>0.9989</td>
<td>185</td>
</tr>
<tr>
<td>63</td>
<td>17.2</td>
<td>0.9988</td>
<td>194</td>
</tr>
<tr>
<td>64</td>
<td>17.8</td>
<td>0.9987</td>
<td>203</td>
</tr>
<tr>
<td>66</td>
<td>18.3</td>
<td>0.9986</td>
<td>212</td>
</tr>
<tr>
<td>67</td>
<td>18.9</td>
<td>0.9984</td>
<td>221</td>
</tr>
<tr>
<td>68</td>
<td>19.4</td>
<td>0.9983</td>
<td>230</td>
</tr>
</tbody>
</table>
The HART Communicator can be used for performing a two-point density calibration in the field. The procedure includes a low-density calibration and a high-density calibration.

To perform the low-density calibration:
1. Fill the sensor with air.
2. If possible, shut off the flow. Otherwise, pump the air through the sensor at the lowest flow rate allowed by the process.
3. At the online menu, choose 2 (diagnostics/service).
4. At the diagnostics/service menu, choose 3 (calibration).
5. At the calibration menu, choose 2 (air).
6. Choose 1 (perform calibration).
7. When the HART Communicator display reads “Perform calibration?”, press F4 (OK). The transmitter measures the tube period, corrects it to 0°C, and stores it. The HART Communicator display reads “Calibration in progress” to indicate density calibration in progress.
When the low-density calibration is completed, the HART Communicator display reads “Density Calibration Complete”. Press F4 (OK).

To perform the high-density calibration:
1. Fill the sensor with water.
2. If possible, shut off the flow. Otherwise, pump the water through the sensor at the lowest flow rate allowed by the process. To ensure stable density, make sure the water in the flow tubes remains completely free of gas bubbles during the calibration.
3. At the online menu, choose 2 (diagnostics/service).
4. At the diagnostics/service menu, choose 3 (calibration).
5. At the calibration menu, choose 3 (water).
6. Choose 1 (perform calibration).
7. When the HART Communicator display reads “Perform calibration?”, press F4 (OK). The transmitter measures the tube period, corrects it to 0°C, and stores it. The HART Communicator display reads “Calibration in progress” to indicate density calibration in progress.

When the high-density calibration is completed, the HART Communicator display reads “Density Calibration Complete”. Press F4 (OK).

7.4.4 Third-point density calibration for RFT9739

As the flow rate approaches or reaches the full-scale flow rate of the sensor, the angular momentum of the fluid can alter the tube period, which causes an increase in the density value measured by the sensor. An increase in the flow rate causes a proportional increase in the angular momentum of the fluid. For the RFT9739, the third calibration point accounts for the effect of flow on the tube period at high flow rates. Third-point density calibration for the RFT9739 is desirable if the process often approaches the full-scale flow rate for the sensor.

CAUTION:

During third-point density calibration, the transmitter uses memory locations that are also used during a two-point density calibration. To avoid overwriting two-point calibration settings during a third-point density calibration, pump the fluid through the sensor at no less than the maximum full-scale flow rate for the sensor.

If the process remains below the maximum full-scale flow rate for the sensor, calibrating a third density point is unnecessary, since angular momentum of the fluid will have a minimal effect on the flow tube frequency. To find out whether third-point density calibration is desirable, see Table 7-3.
### Table 7-3  Full-scale flow rates for Micro Motion® sensors

<table>
<thead>
<tr>
<th>Sensor model</th>
<th>Full-scale flow rate</th>
<th>Sensor model</th>
<th>Full-scale flow rate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>lb/min</td>
<td>kg/hr</td>
<td></td>
</tr>
<tr>
<td>D6</td>
<td>2</td>
<td>56</td>
<td>CMF025</td>
</tr>
<tr>
<td>D12</td>
<td>11</td>
<td>300</td>
<td>CMF050</td>
</tr>
<tr>
<td>D12 Hastelloy</td>
<td>13</td>
<td>360</td>
<td>CMF100</td>
</tr>
<tr>
<td>D25</td>
<td>46</td>
<td>1200</td>
<td>CMF200</td>
</tr>
<tr>
<td>D40</td>
<td>90</td>
<td>2400</td>
<td>CMF300</td>
</tr>
<tr>
<td>D40 Hastelloy</td>
<td>120</td>
<td>3300</td>
<td></td>
</tr>
<tr>
<td>D65</td>
<td>300</td>
<td>8160</td>
<td>DL65</td>
</tr>
<tr>
<td>D100</td>
<td>1000</td>
<td>27,300</td>
<td>DL100</td>
</tr>
<tr>
<td>D160</td>
<td>2800</td>
<td>76,200</td>
<td>DL200</td>
</tr>
<tr>
<td>D150 Hastelloy</td>
<td>3000</td>
<td>81,600</td>
<td></td>
</tr>
<tr>
<td>0300</td>
<td>7000</td>
<td>190,800</td>
<td>DT65</td>
</tr>
<tr>
<td>0300 Hastelloy</td>
<td>7200</td>
<td>195,900</td>
<td>D1-100</td>
</tr>
<tr>
<td>D600</td>
<td>25,000</td>
<td>680,400</td>
<td>DT150</td>
</tr>
</tbody>
</table>

To perform a third-point density calibration, make sure the 2-point density calibration has been established, then follow these steps:

1. Fill the sensor with a process fluid that has a stable density.
2. If possible, shut off the flow. Otherwise, pump the fluid through the sensor at the lowest flow rate allowed by the process. To ensure stable density, make sure the fluid in the flow tubes remains completely free of gas bubbles during the calibration.
3. Read and record the density of the process fluid:
   
   a. At the online menu, choose 1 (process variables).
b. At the process variables menu, choose 1 (view field device variables).

c. At the view field device variables menu, choose 4 (density).

d. Write down the indicated density value, then press F4 (exit).

4. Pump the fluid through the sensor at the highest flow rate allowed by the process. To ensure stable density, make sure the fluid in the flow tubes remains completely free of gas bubbles during the calibration.

5. At the online menu, choose 2 (diagnostics/service).

6. At the diagnostics/service menu, choose 3 (calibration).
7. At the calibration menu, choose 2 (density calibration).

8. At the density calibration menu, choose 3 (flow).


10. Enter the density, in grams per cubic centimeter, that was read in Step 3.

11. When the HART Communicator display reads “Perform calibration?”, make sure the flow rate is greater than the minimum flow rate indicated in the display, then press F4 (OK). The transmitter measures the tube period, corrects it to 0°C, and stores it as the third density calibration constant. The HART Communicator display reads “Calibration in progress” to indicate density calibration in progress.
When the third-point density calibration is completed, the HART Communicator display reads “Density Calibration Complete”. Press F4 (OK).

7.5 Viscosity calibration for RFT9739

Viscosity calibration adjusts viscosity as measured by the RFT9739 under conditions of flow. Single-point and two-point viscosity calibration of the RFT9739 requires accurate determination of the viscosity of fluids used during calibration.

7.5.1 Single-point viscosity calibration

Single-point viscosity calibration adjusts the slope of the straight line representing the ratio of pressure drop to the mass flow rate, which is used by the RFT9739 to calculate the viscosity of Newtonian fluids in laminar flow. Any RFT9739 supports single-point viscosity calibration.

To perform a single-point viscosity calibration:
1. Fill the system with the fluid that has the highest viscosity measured during the process. Use any established method to derive an accurate viscosity for the fluid at line conditions.
2. To optimize the accuracy of the differential pressure measurement, pump the fluid through the sensor at a high flow rate.
3. At the online menu, choose 2 (diagnostics/service).
4. At the diagnostics/service menu, choose 3 (calibration).
5. At the calibration menu, choose 3 (viscosity calibration).

6. At the viscosity calibration menu, choose 1 (viscosity slope calibration).

7. Choose 1 (perform calibration).

8. Enter the line-condition viscosity in centipoise or centistokes.

9. When the HART Communicator display reads “Perform calibration?”, press F4 (OK). The transmitter calculates the slope of the linear representation of viscosity and enters this factor into the microprocessor.
When the viscosity slope calibration is completed, the HART Communicator display reads “Viscosity Calibration Complete”. Press F4 (OK).

7.5.2 2-point viscosity calibration for version 1.5 and higher

Two-point viscosity calibration adjusts the slope and offset of the equation used by the RFT9739 to calculate the viscosity of non-Newtonian fluids. The linear output represents the best straight-line fit to a portion of the curve that describes the viscosity of the non-Newtonian fluid. A 1.5 or higher-revision RFT9739 supports two-point viscosity calibration.

To perform the low-point viscosity calibration:
1. Fill the system with the fluid that has the lowest stable viscosity measured during the process. Use any established method to derive an accurate viscosity for the fluid at line conditions.
2. To optimize the accuracy of the differential pressure measurement, pump the fluid through the sensor at a high flow rate.
3. At the online menu, choose 2 (diagnostics/service).
4. At the diagnostics/service menu, choose 3 (calibration).
5. At the calibration menu, choose 3 (viscosity calibration).
6. At the viscosity calibration menu, choose 1 (viscosity slope calibration).

7. Choose 1 (perform calibration).

8. Enter the line-condition viscosity in centipoise or centistokes.

9. When the HART Communicator display reads "Perform calibration?", press F4 (OK). The transmitter calculates the slope of the linear representation of viscosity and enters this factor into the microprocessor.

When the viscosity slope calibration is completed, the HART Communicator display reads "Viscosity Calibration Complete". Press F4 (OK).

To perform the high-point viscosity calibration:
1. Fill the system with the fluid that has the highest stable viscosity measured during the process. Use any established method to derive an accurate viscosity for the fluid at line conditions.
2. To optimize the accuracy of the differential pressure measurement, pump the fluid through the sensor at a high flow rate.
3. At the online menu, choose 2 (diagnostics/service).

4. At the diagnostics/service menu, choose 3 (calibration).

5. At the calibration menu, choose 3 (viscosity calibration).

6. At the viscosity calibration menu, choose 2 (viscosity offset calibration).

7. Choose 1 (perform calibration).
8. Enter the line-condition viscosity in centipoise or centistokes.

9. When the HART Communicator display reads “Perform calibration?”, press F4 (OK). The transmitter calculates the offset of the linear representation of viscosity and enters this factor into the microprocessor.

When the viscosity slope calibration is completed, the HART Communicator display reads “Viscosity Calibration Complete”. Press F4 (OK).

7.6 Temperature calibration

Temperature calibration adjusts the slope and offset of the linear output indicating temperature.

CAUTION: Temperature calibration of the RFT9739 is not recommended. Temperature calibration affects flow and density calculations performed by the RFT9739.
Milliamp Output Trim

8.1 Preparing for output trim

WARNING: Before performing a milliamp output trim, set process control devices for manual operation.

Whenever the display at left appears, isolate the transmitter from digital computers, Micro Motion peripherals, valves, or other devices that use transmitter outputs to control the flow loop, then press F4 (OK).

Milliamp output trim adjusts the transmitter’s digital-to-analog converter to match primary and secondary milliamp outputs with a specific reference standard, receiver, or readout device.

For trimming, milliamp outputs require a 250-1 000 ohm resistor across the output wiring terminals. If such a resistor is not already in place, install one before trimming the output. Connect a reference device such as a DVM to the resistor. Table 8-1 lists the terminals to which the resistor and reference device should be connected on each Micro Motion transmitter. For more information about milliamp output wiring, see the instruction manual shipped with the transmitter.

Output testing can be conducted in the diagnostics/service branch or detailed setup branch of the HART Communicator software.

<table>
<thead>
<tr>
<th>Milliamp output</th>
<th>RFT9712</th>
<th>RFT9729</th>
<th>RFT9739 field-mount</th>
<th>RFT9739 rack-mount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary +</td>
<td>17</td>
<td>168</td>
<td>17</td>
<td>Z30</td>
</tr>
<tr>
<td>Primary -</td>
<td>16</td>
<td>14B</td>
<td>18</td>
<td>D30</td>
</tr>
<tr>
<td>Secondary +</td>
<td></td>
<td></td>
<td>19</td>
<td>Z28</td>
</tr>
<tr>
<td>Secondary –</td>
<td></td>
<td></td>
<td>20</td>
<td>D28</td>
</tr>
</tbody>
</table>

Table 8-1 Milliamp output terminal connections for Micro Motion® transmitters
8.2 Milliamp output trim in diagnostics/service branch

To trim a milliamp output in the diagnostics/service branch:

1. At the online menu, choose 2 (diagnostics/service).

2. At the diagnostics/service menu, choose the output that will be trimmed:
   a. To trim the milliamp output from an RFT9712 or RFT9729, choose 4 (trim analog output);
   b. To trim the primary milliamp output from an RFT9739, choose 4 (trim analog output 1);
   c. To trim the secondary milliamp output from an RFT9739, choose 5 (trim analog output 2).

3. When the HART Communicator display reads, “WARN-Loop should be removed from automatic control”, isolate the transmitter from devices that use transmitter outputs to control the flow loop, then press F4 (OK).
4. When the HART Communicator display reads, "Connect reference meter", connect the DVM or other reference device to the resistor on the appropriate wiring terminals, as listed in Table 8-1, then press F4 (OK).

5. The HART Communicator then indicates the output will be set at the 4.00 mA level. Press F4 (OK).

6. When the HART Communicator display reads, "Enter meter value", enter the amount of current indicated by the reference device. Press F4 (enter).

7. When the HART Communicator display reads, "Is field dev 4.00 mA output equal to reference meter?", choose 1 (yes) if the reference device indicates approximately 4 mA. If the reference device indicates a current level that is not acceptably close to 4 mA, choose 2 (no), then go back to Step 5.

8. When Yes is chosen in Step 7, the HART Communicator indicates the output will be set at the 20.00 mA level. Press F4 (OK).
9. When the HART Communicator display reads, “Enter meter value”, enter the amount of current indicated by the reference device. Press F4 (enter).

10. When the HART Communicator display reads, “Is field dev 20.00 mA output equal to reference meter?”, choose 1 (yes) if the reference device indicates approximately 20 mA. If the reference device indicates an output that is not acceptably close to 20 mA, choose 2 (no), then go back to Step 8.

When Yes is chosen in Step 10, the HART Communicator indicates the flow loop can be returned to automatic control.

8.3 Milliamp output trim in detailed setup branch

A milliamp output can also be trimmed in the detailed setup branch.

To trim a milliamp output in the detailed setup branch:

1. At the online menu, choose 4 (detailed setup).

2. At the detailed setup menu, choose 3 (configure outputs).
3. At the configure outputs menu, the choice depends on the transmitter to which the HART Communicator is connected:

a. To trim the 4-20 mA output from an RFT9712 or RFT9729, choose 1 (analog output).

b. To trim the primary milliamp output from an RFT9739, choose 1 (analog output 1).

c. To trim the secondary milliamp output from an RFT9739, choose 2 (analog output 2).

4. At the analog output, analog output 1, or analog output 2 menu, the choice again depends on the transmitter to which the HART Communicator is connected:

a. To trim the 4-20 mA output from an RFT9712 or RFT9729, choose 5 (trim analog output).

b. To trim the primary milliamp output from an RFT9739, choose 6 (trim analog output 1).
c. To trim the secondary milliamp output from an RFT9739, choose 6 (trim analog output 2).

5. When the HART Communicator display reads, "WARN-Loop should be removed from automatic control", isolate the transmitter from devices that use transmitter outputs to control the flow loop, then press F4 (OK). To trim the output, follow Steps 4 through 10 of the procedure described in Section 8.2.
Basic Setup

9.1 Basic setup overview

WARNING: Before using the basic setup menu, set process control devices for manual operation.

Whenever the display at left appears, isolate the transmitter from digital computers, Micro Motion peripherals, valves, or other devices that use transmitter outputs to control the flow loop, then press F4 (OK).

Use the basic setup menu to perform the following tasks:
- Assigning a HART tag name to the transmitter.
- Changing measurement units for process variables assigned to the milliamp output(s).
- Setting range values for the milliamp output(s).
- Scaling the frequency/pulse output.

The RFT9739 has two milliamp outputs and a frequency/pulse output:
- Primary and secondary milliamp outputs can produce a 0-20 or 4-20 mA current. Milliamp outputs can independently indicate mass flow, volume flow, density, temperature, differential pressure, or viscosity.
- The 0-1,000 Hz frequency/pulse output can indicate the mass flow rate, mass total, volume flow rate, or volume total.

The RFT9712 or RFT9729 has a 4-20 mA output and a frequency output:
- The milliamp output can indicate flow, density, or temperature.
- The 0-1,000 Hz frequency/pulse output can indicate the mass flow rate or volume flow rate.

9.2 HART tag

The HART tag name consists of up to eight characters that identify the transmitter when it communicates with other devices in a HART-compatible multidrop network.

To assign a HART tag name to a transmitter:
1. At the online menu, choose 3 (basic setup).

2. At the basic setup menu, choose 1 (tag).

3. Enter the desired tag name of up to eight characters, then press F4 (enter). The tag name can include spaces and periods.

9.3 Milliamp outputs

The RFT9739 has primary and secondary milliamp outputs that independently produce a 0-20 or 4-20 mA current. The RFT9712 or RFT9729 has a 4-20 mA output. Milliamp outputs go to controllers, PLCs, or recording devices.

9.3.1 Measurement units for milliamp outputs

To select a measurement unit for a process variable that is assigned to a milliamp output:

1. At the online menu, choose 3 (basic setup).
2. At the basic setup menu, the choice depends on the transmitter to which the HART Communicator is connected.

a. To assign a measurement unit to the primary variable, which is assigned to the primary milliamp output from an RFT9739 or to the 4-20 mA output from an RFT9712 or RFT9729, choose 2 (PV unit), or

b. To assign a measurement unit to the secondary variable, which is assigned to the secondary milliamp output from an RFT9739, choose 4 (SV unit).

3. Use the down arrow (↓) or up arrow (↑) to select the desired measurement unit, then press F4 (enter).

9.3.2 Range values for milliamp outputs

Use the basic setup menu to program range values for a process variable that is assigned to a milliamp output. Range values represent limits for the variable at 4 mA and 20 mA if the output produces a 4-20 mA current, or at 0 mA and 20 mA if the output produces a 0-20 mA current.

To set range values:

1. At the online menu, choose 3 (basic setup).
2. At the basic setup menu, the choice depends on the transmitter to which the HART Communicator is connected.

a. To set limits for the primary milliamp output from an RFT9739 or the 4-20 mA output from an RFT9712 or RFT9729, choose 3 (analog 1 range values or analog range values), or

b. To set limits for the secondary milliamp output from an RFT9739, choose 5 (analog 2 range values).

3. Choose the upper or lower range value for setting.

a. To set the upper range value, which represents the limit for the assigned process variable at 20 mA, choose 1 (URV), or

b. To set the lower range value, which represents the limit for the assigned process variable at 4 mA if the output produces a 4-20 mA current, or at 0 mA if the output produces a 0-20 mA current, choose 2 (LRV).

4. Enter the desired range value, then press F4 (enter).
9.4 Frequency/pulse output scaling

The frequency/pulse output goes to any Micro Motion peripheral or to another frequency-based totalizer or flow computer.

- If the output indicates the mass flow rate or volume flow rate, scaling requires entry of frequency and flow rate setpoints.
- If the output indicates the mass total or volume total, scaling requires entry of pulses and an equivalent total.

The frequency or number of pulses per unit time is always proportional to the flow rate, regardless of the process variable assigned to the frequency/pulse output.

The frequency/pulse output from an RFT9739 can indicate mass flow, mass total, volume flow, or volume total.

- If the output represents a flow rate, the output produces a frequency proportional to the flow rate.
- If the output represents a total, the output produces a given number of pulses per unit flow.

The frequency/pulse output from an RFT9712 or RFT9729 can indicate mass flow or volume flow.

To scale the frequency/pulse output:

1. At the online menu, choose 3 (basic setup).

2. At the basic setup menu, the choice depends on the transmitter to which the HART communicator is connected.

   a. To set the frequency for the output from an RFT9712 or RFT9729, choose 4 (frequency factor), or

   b. To set the proportional frequency or pulse rate for the output from an RFT9739, choose 6 (TV frequency factor).
3. Enter a setpoint for the frequency if the output represents a flow rate, or enter a number of pulses if the output represents a flow total, then press F4 (enter).

4. When the HART Communicator display returns to the basic setup menu, set the rate. The number corresponding to this menu item depends on the transmitter to which the HART communicator is connected.

   a. To set the rate for the output from an RFT9712 or RFT9729, choose 5 (rate factor), or

   b. To set the rate or total for the output from an RFT9739, choose 7 (TV rate factor).

5. Enter the desired flow rate or total, then press F4 (enter).
10 Detailed Setup: Characterize

10.1 Characterization overview

WARNINGS:

1. Values entered during sensor characterization override existing flow, density, temperature, and viscosity factors, and change the flowmeter calibration.
2. After a master reset has been performed, characterize the sensor to prevent inaccurate measurement of process variables.

Whenever the display at left appears, isolate the transmitter from digital computers, Micro Motion peripherals, valves, or other devices that use transmitter outputs to control the flow loop, then press F4 (OK).

In the detailed setup branch of the HART Communicator software, the characterize sensor menu enables the user to characterize the flowmeter. Characterization requires entry of factors describing the sensor’s sensitivity to flow and density. With an RFT9739, characterization also includes entry of factors used for calculating viscosity.

CAUTION: While characterizing the sensor, record factors in the appropriate Transmitter Configuration Worksheet (Appendix I).

10.2 Flow characterization

To recalibrate the flowmetering system for flow measurement, simply enter the 8-digit flow calibration factor from the sensor’s serial number tag. Although recalibration for flow is normally not required, the user can perform a flow calibration as instructed in Subsection 10.2.2.
10.2.1 Flow calibration factor

To enter the flow calibration factor:

1. At the online menu, choose 4 (detailed setup).

2. At the detailed setup menu, choose 1 (characterize sensor).

3. At the characterize sensor menu, choose 1 (flow cal factor).

4. Enter the flow calibration factor from the sensor serial number tag. The value includes eight digits and two decimal points. Press F4 (enter).

The following is the default flow calibration factor for a 9700 Series transmitter:

1.00005.13

The first five digits and first decimal point are the flow rate, in grams per second, required to produce one microsecond of time shift between velocity signals transmitted by the sensor's pickoffs. In the default factor, the first five digits indicate that, for every detected microsecond of time shift, 1.0000 grams of fluid per second flow through the sensor.

The last three digits and second decimal point represent the temperature coefficient of the rigidity modulus for the sensor. The temperature coefficient represents the percent change in the rigidity of the flow tubes around the twisting axis per 100°C. Table 1 O-I lists the correct temperature coefficient for flow according to each sensor type.
Table 10-1. Flow temperature coefficients for Micro Motion® sensors

<table>
<thead>
<tr>
<th>Sensor description</th>
<th>Flow temperature coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>ELITE sensor with 316L stainless steel flow tubes</td>
<td>4.75%</td>
</tr>
<tr>
<td>Model D or DL sensor with 316L stainless steel flow tubes</td>
<td>5.13%</td>
</tr>
<tr>
<td>ELITE sensor with Hastelloy C-22 flow tubes</td>
<td>2.90%</td>
</tr>
<tr>
<td>Model D or DT sensor with Hastelloy C-22 flow tubes</td>
<td>3.15%</td>
</tr>
</tbody>
</table>

10.2.2 Field calibration for flow measurement

CAUTION: Before calibrating the transmitter for flow:
1. Set process control devices for manual operation.
2. Zero the transmitter as instructed in Subsection 7.2.1.

Flow calibration involves adjusting the flow calibration factor so it accurately represents the sensitivity of the sensor to flow. This is done by running a batch of fluid through the sensor, then comparing the weighed amount of fluid in the batch with the amount of fluid indicated by the HART Communicator display.

CAUTION: During flow calibration, write down weighed and indicated batch totals in the appropriate Flowmeter Calibration Record (Appendix II).

To calculate the first five digits of the flow calibration factor and enter them into the transmitter memory:
1. At the online menu, choose 1 (process variables).
2. At the process variables menu, choose 4 (totalizer control). Become familiar with the operation of the transmitter’s internal totalizer(s), which will be used during the flow calibration procedure.

   a. The RFT9739 has a mass totalizer and a volume totalizer.
      - Choose 1 (mass total) to view the mass total.
      - Choose 2 (volume total) to view the volume total.
      - Choose 3 (start totalizer) to start the totalizers.
      - Choose 4 (stop totalizer) to stop the totalizers.
      - Choose 5 (reset totalizer) to reset mass and volume totals to 0.00.

   b. The RFT9712 or RFT9729 has a mass totalizer or a volume totalizer, depending on the measurement units selected for the flow total.
      - Choose 1 (mass total) to view the mass or volume total.
      - Choose 2 (start totalizer) to start the totalizer.
      - Choose 3 (stop totalizer) to stop the totalizer.
      - Choose 4 (reset totalizer) to reset the total to 0.00.

3. Reset the totalizer(s) to 0.00, then run a batch of fluid at the highest flow rate that occurs during the application. Weigh the batch, and record the weight.

4. Record the mass or volume total indicated by the HART Communicator display.

5. Repeat Steps 3 and 4 twice.

6. After running three batches, compute an average amount per batch as weighed and an average amount per batch as indicated by the HART Communicator display.

7. Using the average amounts as totals, calculate the first five digits of the flow calibration factor according to the following formula:

\[
\text{Flow cal factor}_{\text{new}} = \text{Flow cal factor}_{\text{old}} \times \frac{\text{Total}_{\text{weighed}}}{\text{Total}_{\text{displayed}}}
\]

Where:
- \(\text{Flow cal factor}_{\text{old}}\) = First five digits of flow calibration factor presently stored in transmitter memory (usually the same as factor from the sensor serial number tag)
- \(\text{Total}_{\text{weighed}}\) = Average amount of fluid per batch as indicated by weighing
- \(\text{Total}_{\text{displayed}}\) = Average amount of fluid per batch as indicated by HART Communicator display
Example: An ELITE CMF100 sensor has a serial number tag showing 49.0234.75 as the flow calibration factor. Weighing indicates an average of 1000.05 pounds of fluid per batch, whereas the HART Communicator indicates an average of 1000.00 pounds of fluid per batch.

\[
\text{Flow cal factor,} = 49.023 \times \frac{1000.05 \text{ pounds}}{1000.00 \text{ pounds}} = 49.025
\]

8. Enter the new flow calibration factor:

   a. At the online menu, choose 4 (detailed setup).

   b. At the detailed setup menu, choose 1 (characterize sensor).

   c. At the characterize sensor menu, choose 1 (flow cal factor).

   d. Enter the value that was calculated in Step 7 as the first five digits in the flow calibration factor. Referring to Table 10-1, enter the appropriate temperature coefficient for the sensor as the last three digits in the flow calibration factor.

9. To verify the accuracy of the new flow calibration factor, repeat Steps 3 and 4. The amount of fluid indicated by the HART Communicator should equal the weighed amount of fluid in the batch.
Density characterization resets the third density calibration factor for the RFT9739. If the sensor operates at or near the full-scale flow rate, characterize the sensor for density, then perform a third-point density calibration as instructed in Subsection 7.4.4.

To characterize density for the RFT9739:

1. At the online menu, choose 4 (detailed setup).

2. At the detailed setup menu, choose 1 (characterize sensor).

3. At the characterize sensor menu, choose 2 (density).

The RFT9739 uses five separate factors to calculate density.

Dens A is the density, in grams per cubic centimeter at line conditions, of the low-density material (usually air) used during a two-point density calibration. Enter one of these values for Dens A:

- The Dens 1 (D1) value on an ELITE sensor serial number tag,
- A value of 0.0000 grams per cubic centimeter for a Model D, DL, or DT sensor with a 13-digit density calibration factor, or
- The measured density of the low-density fluid used during a two-point density calibration.
K1 is the tube period, in microseconds and adjusted to 0°C, when the flow tubes contain the low-density calibration fluid at line conditions. Enter one of these values for K1:

- The K1 value on an ELITE sensor serial number tag,
- The first five digits of the 13-digit density calibration factor on a Model D, DL, or DT sensor serial number tag, or
- The K1 value generated by the transmitter during a low-density calibration. This value appears in the HART Communicator display during calibration for density point 1 (air).

Dens B is the density, in grams per cubic centimeter at line conditions, of the high-density fluid (usually water) used during a two-point density calibration. Enter one of these values for Dens B:

- The Dens 2 (D2) value on an ELITE sensor serial number tag,
- A value of 1.0000 grams per cubic centimeter for a Model D, DL, or DT sensor with a 13-digit density calibration factor, or
- The measured density of the high-density fluid used during a two-point calibration.

K2 is the tube period, in microseconds and adjusted to 0°C, when the flow tubes contain the high-density calibration fluid at line conditions. Enter one of these values for K2:

- The K2 value from an ELITE sensor’s serial number tag,
- The second five digits of the 13-digit density calibration factor on a Model D, DL, or DT sensor’s serial number tag, or
- The K2 value generated by the transmitter during a high-density calibration. This value appears in the HART Communicator display during calibration for density point 2 (water).

The density temperature coefficient represents the percent change in the elasticity of the flow tubes around the bending axis per 100°C. Table 10-2 lists the correct temperature coefficient for density according to each sensor type.

### Table 10-2 Density temperature coefficients for Micro Motion® sensors connected to RFT9739

<table>
<thead>
<tr>
<th>Sensor description</th>
<th>Density temperature coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>ELITE sensor with 316L stainless steel flow tubes</td>
<td>4.44%</td>
</tr>
<tr>
<td>Model D or DL sensor with 316L stainless steel flow tubes</td>
<td></td>
</tr>
<tr>
<td>Model D or DT sensor with Hastelloy C-22 flow tubes</td>
<td>2.75%</td>
</tr>
<tr>
<td>ELITE Model CMF025 sensor with Hastelloy C-22 flow tubes</td>
<td>3.10%</td>
</tr>
<tr>
<td>ELITE Model CMF100 sensor with Hastelloy C-22 flow tubes</td>
<td>3.00%</td>
</tr>
<tr>
<td>ELITE Model CMF300 sensor with Hastelloy C-22 flow tubes</td>
<td>2.90%</td>
</tr>
</tbody>
</table>
To characterize density for the RFT9712 or RFT9729:

1. At the online menu, choose 4 (detailed setup).

2. At the detailed setup menu, choose 1 (characterize sensor).

3. At the characterize sensor menu, choose 2 (density cat factor).

The RFT9712 or RFT9729 uses a 13-digit density calibration factor to calculate density. The following is the default density calibration factor:

\[0500500004.44\]

- The first five digits represent the natural vibration period, in microseconds, when the flow tubes contain air that has a density of 0.0000 g/cc at 0°C.
- The second five digits represent the natural vibration period, in microseconds, when the flow tubes contain water that has a density of 1.0000 g/cc at 0°C.
- The last three digits are the density temperature coefficient, which represents the percent change in the elasticity of the flow tubes around the bending axis per 100°C. Table 10-3 lists the correct temperature coefficient for density according to each type of sensor that can operate with an RFT9712 or RFT9729.
Table 10-3 Density temperature coefficients for sensors connected to RFT9712 or RFT9729

<table>
<thead>
<tr>
<th>Sensor description</th>
<th>Density temperature coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model D or DL sensor with 316L stainless steel flow tubes</td>
<td>4.44%</td>
</tr>
<tr>
<td>Model D or DT sensor with Hastelloy C-22 flow tubes</td>
<td>2.75%</td>
</tr>
</tbody>
</table>

Enter the 13-digit density calibration factor from the serial number tag of a Model D, DL, or DT sensor.

10.5 Temperature factor for WI-9739

For an RFT9739, the temperature calibration factor describes the slope and offset of the equation used for calculating the output level that represents the temperature of the sensor’s flow tubes. In a Micro Motion Coriolis flow sensor, a platinum resistance temperature detector (RTD) with a resistance of 100 ohms at 0°C measures the flow tube temperature. The specified temperature accuracy is ±1°C ±0.5% of the reading in °C.

CAUTION: Temperature calibration of the RFT9739 is not recommended. Changing the temperature calibration factor affects flow and density calculations, and might require recalibrating the flowmeter for flow and density measurement.

10.6 Viscosity characterization for RFT9739

The RFT9739 can use flow, density, and differential pressure signals to calculate viscosity. Measurement of viscosity can be implemented in one of several ways.

If a DP cell connected to a host controller measures pressure drop across the sensor or across any two points in the process line, any RFT9739 transmitter can use flow and density signals from the sensor and differential pressure signals from the host controller to calculate viscosity.

- In a HART-compatible network, the transmitter functions as a primary or secondary master while polling the host controller.
- In a Modbus-compatible network, the host controller downloads differential pressure values to register 40007 or register pair 20257-20258.

A 2.0 or higher-revision RFT9739 has terminals P (MA PWR OUT) and S (MA SIG IN), which connect to an analog pressure transmitter. The RFT9739 or an external source can power the pressure transmitter.
- To connect the pressure transmitter to the RFT9739, see ELITE Model RF79 739 Field-Mount Transmitter instruction Manual.
- If a flowmeter is ordered for an application requiring viscosity measurement, the pressure input is configured at the factory.
Viscosity characterization involves using the HART Communicator to determine how the RFT9739 will receive differential pressure values (by polling a HART-compatible master, by receiving values downloaded from a Modbus-compatible host, or by receiving them from a pressure transmitter connected to the input terminals).

- If the RFT9739 will poll a HART-compatible master for differential pressure values, the user must enter the HART tag name for the device that sends pressure signals to the master, as instructed in Subsection 10.6.3.

- If the RFT9739 will receive differential pressure values from a pressure transmitter connected to the input terminals, the user must set the values represented by the input at 4 mA and 20 mA, as instructed in Subsection 10.6.4.

Viscosity characterization also enables the user to change the viscosity calibration factor, which determines the slope of the linear output that represents the viscosity of a Newtonian fluid or the slope and offset of the linear output that represents the viscosity of a non-Newtonian fluid.

10.6.1 Pressure polling for viscosity

The choices in the pressure polling menu determine how viscosity measurement will be implemented. To implement viscosity measurement:

1. At the online menu, choose 4 (detailed setup).

2. At the detailed setup menu, choose 1 (characterize sensor).

3. At the characterize sensor menu, choose 4 (viscosity).
4. At the viscosity menu, choose 1 (pressure polling), then choose the appropriate option.

The pressure polling menu for a version 1.4 to 1.7 RFT9739 has the following options:

- Do not poll. The RFT9739 does not receive differential pressure signals and does not calculate viscosity.
- Poll as primary host. The RFT9739 functions as a primary master while polling the host controller in a HART-compatible network. If this option is chosen, the user must enter the HART tag name for the device that will send pressure signals to the host controller, as instructed in Subsection 10.6.3.
- Poll as secondary host. The RFT9739 functions as a secondary master while polling the host controller in a HART-compatible network. Because the HART Communicator also serves as a secondary master, selecting this option can cause communication conflicts between the RFT9739 and the HART Communicator. If this option is chosen, the user must enter the HART tag name for the device that will send pressure signals to the host controller, as instructed in Subsection 10.6.3.

The pressure polling menu for a 2.0 or higher-revision RFT9739 has the following options:
- Do not poll. The RFT9739 does not receive differential pressure signals and does not calculate viscosity.
- Visc: Poll as primary. The RFT9739 functions as a primary master while polling the host controller in a HART-compatible network. If this option is chosen, the user must enter the HART tag name for the device that will send pressure signals to the host controller, as instructed in Subsection 10.6.3.
- Visc: Poll as secondary. The RFT9739 functions as a secondary master while polling the host controller in a HART-compatible network. Because the HART Communicator also serves as a secondary master, selecting this option can cause communication conflicts between the RFT9739 and the HART Communicator. If this option is chosen, the user must enter the HART tag name for the device that will send pressure signals to the host controller, as instructed in Subsection 10.6.3.
- Visc: Use analog input. The RFT9739 receives analog signals from a pressure transmitter connected to terminals P (MA PWR OUT) and S (MA SIG IN). If this option is chosen, the input must represent pressure, with values of 4 mA and 20 mA, as instructed in Subsection 10.6.4.
- Visc: Modbus download. The Modbus-compatible host controller downloads differential pressure values to the transmitter. If this option is chosen, the user must enable downloading by writing an integer that represents differential pressure to input register 40007, or by writing an IEEE 754 floating point value that represents differential pressure to register pair 20257-20258.
CAUTION: The pressure polling menu for a 2.0 or higher-revision RFT9739 also includes options that enable the RFT9739 to compensate for the pressure effect on the sensor. The RFT9739 cannot simultaneously perform viscosity and pressure compensation calculations. To enable viscosity measurement, make sure to choose a viscosity option.

1. **0.6.2 Viscosity calibration factor**

   1. At the online menu, choose 4 (detailed setup).
   2. At the detailed setup menu, choose 1 (characterize sensor).
   3. At the **characterize sensor** menu, choose 4 (viscosity).
   4. At the viscosity menu, choose 2 (viscosity calibration factor), then enter the desired value.

   The viscosity calibration factor defines the slope and offset of the linear output representing viscosity. The following character string is the default calibration factor for viscosity:

   

   1.ooooo.oooooo

   The string represents a straight-line correction of the linear representation of the viscosity of a non-Newtonian fluid.

   A calibration factor containing two decimal points is derived from a 2-point viscosity calibration for non-Newtonian fluids, performed as instructed in Subsection 7.5.2.
The first six digits and first decimal point represent the slope.
The second six digits and second decimal point represent the offset.

A 1.5 or higher-revision RFT9739 supports a 2-point viscosity calibration factor.

The following character string is a viscosity calibration factor for a Newtonian fluid:

1 .00000000000

The string represents the slope of the linear output. A calibration factor containing one decimal point is derived from a single-point viscosity for Newtonian fluids, performed as instructed in Subsection 7.51. Any Model RFT9739 field-mount transmitter supports a single-point viscosity calibration factor.

10.6.3 Field device tag

If the RFT9739 will function as a primary or secondary master while polling for differential pressure values from a HART-compatible field device, the user must identify the field device by HART tag name. To enter the HART tag name for the pressure input device:

1. At the online menu, choose 4 (detailed setup).

2. At the detailed setup menu, choose 1 (characterize sensor).

3. At the characterize sensor menu, choose 4 (viscosity).
4. At the viscosity menu, choose 3 (field device tag).

5. Enter the desired HART tag name. The tag name refers to the device that will send pressure signals to the host controller. Press F4 (enter).

10.6.4 Pressure input range

If the RFT9739 will receive pressure signals from a pressure transmitter connected to terminals P (MA PWR OUT) and S (MA SIG IN), the user must specify the range of differential pressure values represented by the input. To enter the pressure input range for the RFT9739:

1. At the online menu, choose 4 (detailed setup).

2. At the detailed setup menu, choose 1 (characterize sensor).

3. At the characterize sensor menu, choose 4 (viscosity).
4. At the viscosity menu, the choice depends on whether the user wishes to set the lowest or highest pressure value represented by the input.

   a. Choose 4 (4 mA pressure) to enter the differential pressure value represented by the input at 4 mA.

   b. Choose 5 (20 mA pressure) to enter the differential pressure value represented by the input at 20 mA.

5. Enter the desired differential pressure value in psid, then press F4 (enter).

A 2.0 or higher-revision RFT9739 can use pressure signals to compensate for the pressure effect on the flow tubes of a Model D300, D600, DL100, DL200, CMF200, or CMF300 sensor. Pressure compensation can be implemented in one of several ways.

If a pressure transmitter connected to a host controller measures gauge pressure drop at the sensor input, any RFT9739 transmitter can use flow and density signals from the sensor and pressure signals from the host controller to compensate for the pressure effect on the sensor.

- In a HART-compatible network, the transmitter functions as a primary or secondary master while polling the host controller.
- In a Modbus-compatible network, the host controller downloads pressure values to register 40007 or register pair 20257-20258.

A 2.0 or higher-revision RFT9739 has terminals P (MA PWR OUT) and S (MA SIG IN), which connect to an analog pressure transmitter. The RFT9739 or an external source can power the pressure transmitter.

- To connect the pressure transmitter to the RFT9739, see ELITE Model RFT9739 Field-Mount Transmitter Instruction Manual.
- If a flowmeter is ordered for an application requiring pressure compensation, the pressure input is configured at the factory.
Characterization for pressure compensation involves using the HART Communicator to determine how the RFT9739 will receive pressure values (by polling a HART-compatible master, by receiving values downloaded from a Modbus-compatible host, or by receiving them from a pressure transmitter connected to the input terminals).

- If the RFT9739 will poll a HART-compatible master for pressure values, the user must enter the HART tag name for the device that sends pressure signals to the master, as instructed in Subsection 10.7.4.
- If the RFT9739 will receive pressure values from a pressure transmitter connected to the input terminals, the user must set the values represented by the input at 4 mA and 20 mA, as instructed in Subsection 10.7.5.

Characterization for pressure compensation also enables the user to change the pressure correction factors for flow and density.

10.7.1 Pressure polling for pressure compensation

For a 2.0 or higher-revision RFT9739, choices in the pressure polling menu determine how pressure compensation will be implemented. To implement pressure compensation:

1. At the online menu, choose 4 (detailed setup).

2. At the detailed setup menu, choose 1 (characterize sensor).

3. At the characterize sensor menu, choose 5 (pressure compensation).
4. At the pressure compensation menu, choose 1 (pressure polling), then choose the appropriate option:

- Do not poll. The RFT9739 does not receive pressure signals and does not compensate for the pressure effect on the sensor.
- Comp: Poll as primary. The RFT9739 functions as a primary master while polling the host controller in a HART-compatible network. If this option is chosen, the user must enter the HART tag name for the device that will send pressure signals to the host controller, as instructed in Subsection 10.7.4.
- Comp: Poll as secondary. The RFT9739 functions as a secondary master while polling the host controller in a HART-compatible network. Because the HART Communicator also serves as a secondary master, selecting this option can cause communication conflicts between the RFT9739 and the HART Communicator. If this option is chosen, the user must enter the HART tag name for the device that will send pressure signals to the host controller, as instructed in Subsection 10.7.4.
- Comp: Use analog input. The RFT9739 receives analog signals from a pressure transmitter connected to terminals P (MA PWR OUT) and S (MA SIG IN). If this option is chosen, the user must set values represented by the input at 4 mA and 20 mA, as instructed in Subsection 10.7.5.
- Comp: Modbus download. The Modbus-compatible host controller downloads pressure values to the transmitter. If this option is chosen, the user must enable downloading by writing an integer that represents pressure to input register 40007, or by writing an IEEE 754 floating point value that represents pressure to register pair 20257-20258.

**CAUTION:** The pressure polling menu for a 2.0 or higher-revision RFT9739 also includes options that enable the RFT9739 to calculate viscosity. The RFT9739 cannot simultaneously perform viscosity and pressure compensation calculations. To enable pressure compensation, make sure to choose a compensation option.

### 10.7.2 Pressure correction factors for flow and density

If the RFT9739 will compensate for the pressure effect on the flow tubes of a Model 0300, D600, DL100, DL200, CMF200, or CMF300 sensor, the transmitter uses pressure correction factors for flow and density. Micro Motion has determined appropriate values of pressure correction factors for each sensor model.

The pressure correction factor for flow is the percent change in the flow rate per psi. To enter the pressure correction factor for flow:
1. At the online menu, choose 4 (detailed setup).

2. At the detailed setup menu, choose 1 (characterize sensor).

3. At the characterize sensor menu, choose 5 (pressure compensation).

4. At the pressure compensation menu, choose 2 (flow factor).

5. Enter the appropriate value in % per psi:
   - For the D300 or DL200, the value is 0.009% of rate per psi.
   - For the 0600 or DL100, the value is 0.005% of rate per psi.
   - For the CMF200, the value is 0.0008% of rate per psi.
   - For the CMF300, the value is 0.0006% of rate per psi.

The pressure correction factor for density is the change in fluid density in grams per cubic centimeter per psi. To enter the pressure correction factor for density:
1. At the online menu, choose 4 (detailed setup).

2. At the detailed setup menu, choose 1 (characterize sensor).

3. At the characterize sensor menu, choose 5 (pressure compensation).

4. At the pressure compensation menu, choose 3 (density factor).

5. Enter the appropriate value in g/cc per psi:
   - For the D300 or DL200, the value is 0.000011 g/cc per psi.
   - For the D600 or DL100, the value is 0.000004 g/cc per psi.
   - For the CMF200, the value is -0.000001 g/cc per psi.
   - For the CMF300, the value is -0.0000002 g/cc per psi.

10.7.3 Flow calibration pressure

At the factory, Micro Motion flowmeters are calibrated for flow at 20 psig. If the flowmeter is later recalibrated for flow and the transmitter will use a pressure input for pressure compensation, the user should enter the calibration pressure. To enter the flow calibration pressure:
1. At the online menu, choose 4 (detailed setup).

2. At the detailed setup menu, choose 1 (characterize sensor).

3. At the characterize sensor menu, choose 5 (pressure compensation).

4. At the pressure compensation menu, choose 4 (flow calibration pressure).

5. Enter the pressure in psig at which the flowmeter was calibrated for flow.

10.7.4 Field device tag

If the RFT9739 will function as a primary or secondary master while polling for pressure values from a HART-compatible field device, the user must identify the field device by HART tag name. To enter the HART tag name for the pressure input device:
1. At the online menu, choose 4 (detailed setup).

2. At the detailed setup menu, choose 1 (characterize sensor).

3. At the characterize sensor menu, choose 5 (pressure compensation).

4. At the pressure compensation menu, choose 5 (field device tag).

5. Enter the desired HART tag name. The tag name refers to the device that will send pressure signals to the host controller. Press F4 (enter).

10.7.5 Pressure input range

If the RFT9739 will receive pressure signals from a pressure transmitter connected to terminals P (MA PWR OUT) and S (MA SIG IN), the user must specify the range of pressure values represented by the input. To enter the pressure input range for the RFT9739:
1. At the online menu, choose 4 (detailed setup).

2. At the detailed setup menu, choose 1 (characterize sensor).

3. At the characterize sensor menu, choose 5 (pressure compensation).

4. At the pressure compensation menu, the choice depends on whether the user wishes to set the lowest or highest pressure value represented by the input.
   a. Choose 6 (4 mA pressure) to enter the lowest pressure value represented by the input.

   b. Choose 7 (20 mA pressure) to enter the highest pressure value represented by the input.
5. Enter the desired pressure value in psig, then press F4 (enter).
11 Detailed Setup: Measurement Units

11.1 Measurement units overview

WARNING: Before configuring measurement units, set process control devices for manual operation.

Whenever the display at left appears, isolate the transmitter from digital computers, Micro Motion peripherals, valves, or other devices that use transmitter outputs to control the flow loop, then press F4 (OK).

Field device variables include measurement units for all process variables.
- The RFT9712 or RFT9729 supports standard engineering units for density and temperature, and standard engineering units or special units for mass or volume.
- The RFT9739 supports standard engineering units for density, temperature, pressure, and viscosity, and standard engineering units or special units for mass and volume.

CAUTION: While configuring measurement units, record them in the appropriate Transmitter Configuration Worksheet (Appendix I).

11.2 Flow and totalizer units

Units of mass and volume can be standard engineering units, listed in Table 11-1, or special units.
- The RFT9739 can use one mass unit flow and one volume flow unit simultaneously.
- The RFT9712 or RFT9729 can use only one mass flow unit or one volume flow unit at a time.
- The transmitter automatically totalizes in the base unit of mass or volume chosen for the flow rate.

Use of a special unit of mass or volume requires converting the base unit of mass or volume to another unit (such as converting pounds to ounces or converting gallons to pints).

To select a measurement unit for flow:
1. At the online menu, choose 4 (detailed setup).

2. At the detailed setup menu, choose 2 (configure field device variables).

3. At the configure field device variables menu, choose 1 (flow).

4. At the flow menu, the choice depends on the transmitter to which the HART Communicator is connected and on whether the user wishes to configure units of mass or units of volume.
   
   a. With the HART Communicator connected to an RFT9712 or RFT9729, choose 1 (flow unit) to select the unit of mass flow or volume flow.
   
   b. With the HART Communicator connected to an RFT9739, choose 1 (mass flow unit) to select the mass flow unit.
c. With the HART Communicator connected to an RFT9739, choose 4 (volume flow unit) to select the volume flow unit.

5. Use the down arrow (↓) or up arrow (↑) to scroll to the desired flow unit, then press F4 (enter).

After establishing flow units, continue using them to configure outputs and process limits.
## Table 1 I-I  Measurement units for process variables

<table>
<thead>
<tr>
<th>Process variable</th>
<th>Measurement units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass flow rate</td>
<td>grams/second</td>
</tr>
<tr>
<td></td>
<td>grams/minute</td>
</tr>
<tr>
<td></td>
<td>grams/hour</td>
</tr>
<tr>
<td></td>
<td>kilograms/second</td>
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<td></td>
<td>kilograms/minute</td>
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<td></td>
<td>kilograms/hour</td>
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<td></td>
<td>kilograms/day</td>
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<td></td>
<td>metric tons/hour</td>
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<td></td>
<td>metric tons/day</td>
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<td>pounds/second</td>
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<td></td>
<td>pounds/minute</td>
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<td></td>
<td>pounds/hour</td>
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<td></td>
<td>pounds/day</td>
</tr>
<tr>
<td></td>
<td>short tons (2000 pounds)/minute</td>
</tr>
<tr>
<td></td>
<td>short tons (2000 pounds)/hour</td>
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<tr>
<td></td>
<td>short tons (2000 pounds)/day</td>
</tr>
<tr>
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<tr>
<td>Density</td>
<td>specific gravity unit</td>
</tr>
<tr>
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<td>grams/cubic centimeter</td>
</tr>
<tr>
<td></td>
<td>kilograms/cubic meter</td>
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<td></td>
<td>pounds/gallon</td>
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<td></td>
<td>pounds/cubic foot</td>
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<td></td>
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<tr>
<td></td>
<td>degrees Kelvin</td>
</tr>
<tr>
<td></td>
<td>degrees Rankine*</td>
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<tr>
<td></td>
<td>imperial gallons/minute</td>
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<tr>
<td></td>
<td>cubic meters/hour</td>
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<td>barrels/second*</td>
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<tr>
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<td>barrels/day*</td>
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<td></td>
<td>centipoise*</td>
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<td>Differential pressure</td>
<td>inches of water at 68°F*</td>
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<td></td>
<td>inches of mercury at 0°C*</td>
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<td>feet of water at 68°F'</td>
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<tr>
<td></td>
<td>millimeters of water at 68°F*</td>
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<tr>
<td></td>
<td>millimeters of mercury at 0°C&quot;</td>
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<tr>
<td></td>
<td>pounds/square inch</td>
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<tr>
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<td>bar*</td>
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<td>milibar*</td>
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<td>kilograms/square centimeter</td>
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<td></td>
<td>pascals*</td>
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<td></td>
<td>kilopascals*</td>
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<tr>
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<td>pounds</td>
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<td>short tons (2000 pounds)</td>
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<tr>
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</tr>
<tr>
<td>Mass inventory</td>
<td>gallons/minute</td>
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<tr>
<td></td>
<td>liters</td>
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<tr>
<td></td>
<td>imperial gallons</td>
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<tr>
<td></td>
<td>cubic meters</td>
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<tr>
<td>Volume total</td>
<td>gallons</td>
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<tr>
<td></td>
<td>liters</td>
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<td>cubic meters</td>
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<tr>
<td></td>
<td>barrels*</td>
</tr>
<tr>
<td></td>
<td>cubic feet*</td>
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<tr>
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</tr>
<tr>
<td>Volume inventory</td>
<td>gallons/minute</td>
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<td>cubic meters/second</td>
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<td>imperial gallons/hour</td>
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<td>barrels/hour</td>
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<td>barrels/day</td>
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<tr>
<td></td>
<td>SPECIAL</td>
</tr>
</tbody>
</table>

*Units available with RFT9739 only.
If "spcl" (special) is selected as the flow unit, the HART Communicator allows the user to configure a special unit for mass or volume flow rates and totals.

To establish a special unit:

1. At the online menu, choose 4 (detailed setup).

2. At the detailed setup menu, choose 2 (configure field device variables).

3. At the configure field device variables menu, choose 1 (flow).

4. At the flow menu, the choice depends on the transmitter to which the HART Communicator is connected and on whether the user wishes to configure units of mass or units of volume.

   a. With the HART Communicator connected to an RFT9712 or RFT9729, choose 1 (flow unit) to select the unit of mass flow or volume flow.
b. With the HART Communicator connected to an RFT9739, choose 1 (mass flow unit) to select the mass flow unit.

c. With the HART Communicator connected to an RFT9739, choose 4 (volume flow unit) to select the volume flow unit.

5. Use the down arrow (↓) or up arrow (↑) to scroll to “spcl”, then press F4 (enter).

6. When the HART Communicator display returns to the flow menu, the choice depends on the transmitter to which the HART Communicator is connected:

   a. With the HART Communicator connected to an RFT9712 or RFT9729, choose 3 (configure special units) to configure a special unit of mass or volume.

   b. With the HART Communicator connected to an RFT9739, choose 3 (special mass units) to configure a special unit of mass.
c. With the HART Communicator connected to an RFT9739, choose 6 (special volume units) to configure a special unit of volume.

7. Since the flow rate is mass or volume per unit time, special units require a base unit of mass or volume, a time base, and a conversion factor.
   - The RFT9739 can use one special unit of mass and one special unit of volume to calculate mass and volume flow rates and totals.
   - The RFT9712 or RFT9729 can use one special unit of mass or one special unit of volume to calculate a flow rate and total.

   a. Choose 1 (base unit) to select the base unit of mass or volume.

   b. Choose 2 (base time) to select the time base.

   c. Choose 3 (conversion factor) to enter a conversion factor. The conversion factor determines the value of the special unit in terms of the base unit of mass or volume. Find the conversion factor by performing either of the following calculations:

   \[
   \text{Special mass flow} = \frac{\text{Mass conversion factor} \times \text{Base mass unit}}{\text{Base time unit}}
   \]

   \[
   \text{Special volume flow} = \frac{\text{Volume conversion factor} \times \text{Base volume unit}}{\text{Base time unit}}
   \]
8. If desired, names can be assigned to special units.

a. Choose 4 (flow text) to assign a name to the special flow unit. Enter up to four characters, such as "s/hr" (slugs per hour), for the special flow unit. The name can include spaces and/or slashes (/).

b. Choose 5 (total text) to assign a name to the special totalizer unit. Enter up to four characters, such as "slug", for the special totalizer unit. The name can include spaces and/or slashes (/).

Example:
Configure pints per hour as the special volume flow rate unit for the RFT9739. At the flow menu, choose 4 (volume flow unit), then select "spcl".

When the HART Communicator returns to the flow menu, choose 6 (special volume units).

Choose 1 (base volume unit) to select a base unit of volume. Since pints easily convert to gallons, select gallons.

Choose 2 (base volume time), then select h (hours).

Choose 3 (volume flow conversion factor), then calculate the conversion factor:

\[
\text{Pint} = \frac{1/8 \times 1 \text{ Gallon}}{\text{Hr}}
\]

Since eight pints equals one gallon, \( \text{Pint} = 1/8 \times 1 \text{ Gallon} \), the conversion factor is 1/8, or 0.125.

If desired, choose 4 (volume flow text), then enter a name of up to four characters, such as "p/hr" (pints per hour), for the flow unit.

If desired, choose 5 (volume total text), then enter a name of up to four characters, such as "pint", for the totalizer unit.

11.4 Density units
The transmitter can measure and indicate density in any of standard engineering units listed in Table 1-1.

To select a density unit:
1. At the online menu, choose 4 (detailed setup).

2. At the detailed setup menu, choose 2 (configure field device variables).

3. At the configure field device variables menu, choose 2 (density).

4. At the density menu, choose 1 (density unit).

5. Use the down arrow (↓) or up arrow (↑) to scroll to the desired density unit, then press F4 (enter).

After establishing a standard density unit, continue using the chosen density unit to configure density outputs, but use grams per cubic centimeter (g/cc) to configure density limits, calibration factors, and characterization factors.

11.4.1 API gravity

If degrees API is selected as the density unit, scale the density output(s) to represent the range of densities for the Generalized Petroleum Product(s) measured during the application. To range outputs, see Chapter 9.
If degrees API is selected as the density unit, the transmitter calculates standard volume for Generalized Petroleum Products according to API-2540. The transmitter calculates volume flow and volume total at 60°F or 15°C, depending on the temperature unit:
- If degrees Fahrenheit or degrees Rankine is selected as the temperature unit, the transmitter calculates volume at 60°F.
- If degrees Celsius or degrees Kelvin is selected as the temperature unit, the transmitter calculates volume at 15°C.

From the operating density (fluid density at line conditions) and operating temperature of a given petroleum fluid, the standard density (density at 60°F or 15°C) can be determined directly from API thermal expansion tables or by using API equation API-2540:

\[ r_0 = r_s \cdot \exp[-aD_T(1 + 0.8aD_T)] \]

*Where:*  
- \( r_0 \) = operating density  
- \( r_s \) = standard density  
- \( D_T \) = temperature difference from base (standard) temperature (60°F or 15°C)  
- \( a = \frac{K_0}{r_s^2} + \frac{K_1}{r_s} \) where \( K_0 \) and \( K_1 \) are constants

The equation is iterative, and requires significant calculation time to generate one reading. The RFT9739 contains a simplification of this correlation to maximize sampling frequency of the measurement. Accuracy of the Micro Motion correlation is ±0.0005 g/cc relative to the API-2540 equation. After temperature correction to 60°F or 15°C, the density is converted to degrees API by the following expression:

Degrees API = (141.5/Standard specific gravity) - 131.5

The \( K_0 \) and \( K_1 \) in the API-2540 equation are constants characteristic of different types of Generalized Petroleum Products. Separate API tables exist for crude oils, distillates, gasolines, lube oils, and other products. The correlation in the RFT9739 is based on the API constants for Generalized Petroleum Products.

The API equation used by the transmitter is valid for Generalized Petroleum Products from 2-95ºAPI over an operating temperature range of 0-300°F. As fluid density or operating temperature extends beyond these values, the RFT9739 correlation error will increase. Density calibration must be performed in units of g/cc for the API correlation to be correct.
11.4.2 API standard volume

If degrees API is selected as the density unit, the transmitter automatically calculates standard volume at 60°F or at 15°C based on the following expression:

\[
\text{Standard volume} = \frac{\text{Mass flow}}{\text{Standard density}}
\]

If a density unit other than degrees API is the selected, the transmitter calculates gross volume at line conditions. Any of standard engineering units for gross volume can be selected for standard volume.

Accuracy of standard volume measurement is based on the accuracies of the following factors:
1. Mass rate measurement;
2. Operating density measurement;
3. Temperature measurement;
4. Transmitter correlation to API tables.

The accuracy of each factor varies based on the process operating conditions and fluid that is being measured. For most Generalized Petroleum Products, standard volume will be accurate within ±0.5% of the flow rate. Because the temperature correction correlations for density are based on API equations, the standard volume output applies only to Generalized Petroleum Products or materials that exhibit the same thermal expansion characteristics as Generalized Petroleum Products.

11.5 Temperature units

The transmitter can measure and indicate temperature in any of standard engineering units listed in Table 11-1.

To select a temperature unit:

1. At the online menu, choose 4 (detailed setup).
2. At the detailed setup menu, choose 2 (configure field device variables).

3. At the configure field device variables menu, choose 3 (temperature).

4. At the temperature menu, choose 1 (temperature unit).

5. Use the down arrow (↓) or up arrow (↑) to scroll to the desired temperature unit, then press F4 (enter).

After establishing a unit of temperature, continue using the same unit to configure outputs and process limits, but use degrees Celsius (°C) for setting temperature calibration and characterization factors.

11.6 Viscosity and pressure units for RFT9739

The RFT9739 can measure and indicate viscosity and pressure in any of standard engineering units listed in Table 11-1.

11.6.1 Choosing units of viscosity or pressure

To select a unit of pressure or viscosity:
1. At the online menu, choose 4 (detailed setup).

2. At the detailed setup menu, choose 2 (configure field device variables).

3. At the configure field device variables menu, choose 4 (viscosity/pressure).

4. At the viscosity/pressure menu, the choice depends on the process variable for which a measurement unit will be selected:
   a. Choose 1 (DP unit) to select a unit of pressure, or
   b. Choose 2 (viscosity unit) to select a unit of viscosity.
11.6.2 Special considerations for units of viscosity and pressure

After establishing pressure or viscosity unit, continue using the same unit to configure outputs and process limits. If a 2.0 or higher-revision RFT9739 receives input signals from a pressure transmitter connected to terminals P (MA PWR OUT) and S (MA SIG IN), use pounds per square inch (psi) to characterize the pressure input.

The RFT9739 calculates viscosity in centistokes while measuring the mass flow rate, or in centipoise while measuring the volume flow rate.

- If the mass flow rate is being measured, select centistokes as the viscosity unit.
- If the volume flow rate is being measured, select centipoise as the viscosity unit.

11.7 Sending measurement units to the transmitter

Measurement units affect other field device variables, and must be sent to the transmitter before other variables can be configured.

To send the measurement unit to the transmitter, press F2 (send).
12 Detailed Setup: Configure Field Device Variables

12.1 Field device variables overview

**WARNING:** Before configuring field device variables, set process control devices for manual operation.

Whenever the display at left appears, isolate the transmitter from digital computers, Micro Motion peripherals, valves, or other devices that use transmitter outputs to control the flow loop, then press F4 (OK).

Field device variables include measurement units for all process variables, and limits on outputs indicating mass or volume flow, temperature, and density. Such limits include:

- Mass flow or volume flow cutoffs for internal totalizers and the frequency/pulse output;
- Forward flow, reverse flow, or bidirectional flow;
- Internal damping on flow, temperature, and density;
- Slug flow limits on flow outputs.

**CAUTION:** While configuring field device variables, record them in the appropriate Transmitter Configuration Worksheet (Appendix I).

12.2 Flow cutoffs

In some sensor installations, velocity signals from the pickoffs can carry noise caused by a mechanical source, such as a valve or motor. Flow cutoffs allow the user to filter out noise by defining the measured value below which the transmitter’s frequency/pulse and digital outputs indicate zero flow.

A flow cutoff is the lowest flow rate at which the transmitter produces a nonzero digital flow reading and frequency/pulse output. If the flow signal drops below the flow cutoff, all the following occur:

- The frequency/pulse output goes to 0 Hz;
- The internal totalizers stop counting; and
- The transmitter indicates zero flow during polling from a host controller.

Default flow cutoffs have a value of 0.
Milliamp outputs have their own flow cutoffs, which remain unaffected by the flow cutoffs established for the frequency/pulse output and internal totalizers. Subsection 13.2.4 explains how to set flow cutoffs for milliamp outputs.

To set a flow cutoff for internal totalizers and the frequency/pulse output:

1. At the online menu, choose 4 (detailed setup).

2. At the detailed setup menu, choose 2 (configure field device variables).

3. At the configure field device variables menu, choose 1 (flow).

4. At the flow menu, the choice depends on the transmitter to which the HART Communicator is connected:
   a. With the HART Communicator connected to an RFT9712 or RFT9729, choose 2 (flow cutoff) to set the mass or volume flow cutoff.
b. With the HART Communicator connected to an RFT9739, choose 2 (mass flow cutoff) to set the mass flow cutoff.

c. With the HART Communicator connected to an RFT9739, choose 5 (volume flow cutoff) to set the volume flow cutoff.

5. Enter the flow rate at which the frequency/pulse and digital outputs will indicate zero flow, then press F4 (enter).
   - In most applications, the flow cutoff should equal 0.05% of the maximum full-scale flow rate for the sensor. See Subsection 12.2.1.
   - If the transmitter calculates viscosity, the flow cutoff should be greater than the flow rate at which the process achieves the maximum turndown pressure drop specified for the DP cell. See Subsection 12.2.2.

12.2.1 Flow cutoffs for most applications

In most applications, the flow cutoff should equal 0.05% of the maximum full-scale flow rate for the sensor. If a cutoff equal to 0.05% of the sensor full-scale flow rate proves impractical, the user can enter a higher or lower flow cutoff. Table 12-1 lists full-scale flow rates for all Micro Motion sensors.
Table 12-1  Full-scale flow rates for Micro Motion® sensors

<table>
<thead>
<tr>
<th>Sensor model</th>
<th>Full-scale flow rate</th>
<th>Sensor model</th>
<th>Full-scale flow rate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>lb/min</td>
<td>kg/hr</td>
<td></td>
</tr>
<tr>
<td>D6</td>
<td>2</td>
<td>55</td>
<td>CMF025</td>
</tr>
<tr>
<td>D12</td>
<td>11</td>
<td>300</td>
<td>CMF050</td>
</tr>
<tr>
<td>D12 Hastelloy</td>
<td>13</td>
<td>360</td>
<td>CMF100</td>
</tr>
<tr>
<td>D25</td>
<td>45</td>
<td>1200</td>
<td>CMF200</td>
</tr>
<tr>
<td>D40</td>
<td>90</td>
<td>2400</td>
<td>CMF300</td>
</tr>
<tr>
<td>D40 Hastelloy</td>
<td>120</td>
<td>3300</td>
<td></td>
</tr>
<tr>
<td>D65</td>
<td>300</td>
<td>6100</td>
<td>DL65</td>
</tr>
<tr>
<td>D100</td>
<td>1000</td>
<td>27,300</td>
<td>DL100</td>
</tr>
<tr>
<td>D150</td>
<td>2800</td>
<td>76,200</td>
<td>DL200</td>
</tr>
<tr>
<td>D150 Hastelloy</td>
<td>3000</td>
<td>81,500</td>
<td></td>
</tr>
<tr>
<td>D300</td>
<td>1000</td>
<td>180,800</td>
<td>DT65</td>
</tr>
<tr>
<td>D300 Hastelloy</td>
<td>7200</td>
<td>165,900</td>
<td>DT100</td>
</tr>
<tr>
<td>D600</td>
<td>25,000</td>
<td>680,400</td>
<td>DT150</td>
</tr>
</tbody>
</table>

Example:
A Model CMF025 sensor has a maximum full-scale flow rate of 80 pounds per minute (lb/min). Internal totalizers should stop counting when the mass flow rate drops below 0.05% of the maximum full-scale flow rate.

Since 0.05% of the maximum full-scale flow rate equals 0.04 lb/min, (80 lb/min * 0.0005 = 0.04), set the mass flow cutoff at 0.04 lb/min.

12.2.2 Flow cutoffs for viscosity measurement

If the transmitter calculates viscosity, the flow cutoff should be greater than the flow rate at which the process achieves the maximum turndown pressure drop specified for the DP cell (the minimum pressure drop that the DP cell can accurately measure). For maximum turndown ratings of individual DP cells, refer to the specifications supplied by the manufacturer.

- If the viscosity unit is centistokes, set a mass flow cutoff in the measurement unit established for mass flow as a process variable.
- If the viscosity unit is centipoise, set a volume flow cutoff in the measurement unit established for volume flow as a process variable.
CAUTION: When the flow rate drops below the flow cutoff, the transmitter assumes zero flow, and quits calculating viscosity until the flow rate again exceeds the flow cutoff.

12.3 Flow direction

Milliamp outputs, the frequency/pulse output, and internal totalizers can indicate forward, reverse, or bidirectional flow.

If the control output from an RFT9739 indicates forward and reverse flow, the output will always be +15 VDC during forward flow and 0 VDC during reverse flow. The flow direction output from an RFT9712 will also be +15 VDC during forward flow and 0 VDC during reverse flow. Configuration of flow direction does not affect the RFT9739 control output or the RFT9712 flow direction output.

CAUTION: If possible, install the sensor so the arrow on the manifold indicates forward flow.

To set the flow direction option:

1. At the online menu, choose 4 (detailed setup).

2. At the detailed setup menu, choose 2 (configure field device variables).

3. At the configure field device variables menu, choose 1 (flow).
4. At the flow menu, the choice depends on the transmitter to which the HART Communicator is connected.

   a. With the HART Communicator connected to an RFT9712 or RFT9729, choose 4 (flow direction).

   b. With the HART Communicator connected to an RFT9739, choose 7 (flow direction).

5. Choose the desired flow direction option, then choose F4 (Enter).

If forward only is chosen:

- When fluid flows in the forward direction, milliamp and frequency/pulse outputs increase as flow rate increases.
- When fluid flows in the reverse direction, milliamp outputs configured to produce a 4-20 mA current decrease to a lower limit of 2 mA, milliamp outputs configured to produce a 0-20 mA current decrease to a lower limit of 0 mA; the frequency/pulse output remains at 0 Hz.
- Flow totals indicated by internal totalizers increase with forward flow and remain constant with reverse flow.
- If the RFT9739 control output indicates flow direction, the output is +15 VDC with forward flow or 0 VDC with reverse flow.
- The RFT9712 flow direction output is +15 VDC with forward flow or 0 VDC with reverse flow.

If reverse only is chosen:

- When fluid flows in the reverse direction, milliamp and frequency/pulse outputs increase as flow rate increases.
- When fluid flows in the forward direction, milliamp outputs configured to produce a 4-20 mA current decrease to a lower limit of 2 mA, milliamp outputs configured to produce a 0-20 mA current decrease to a lower limit of 0 mA; the frequency/pulse output stays at 0 Hz.
- Flow totals indicated by internal totalizers increase with reverse flow and remain constant with forward flow.
- If the RFT9739 control output indicates flow direction, the output is +15 VDC with forward flow or 0 VDC with reverse flow.
- The RFT9712 flow direction output is +15 VDC with forward flow or 0 VDC with reverse flow.
If bidirectional flow is chosen:

- Milliamp and frequency/pulse outputs increase as the flow rate increases, regardless of flow direction.
- Milliamp outputs configured to produce a 4-20 mA current remain at or above 4 mA, regardless of flow direction.
- Flow totals indicated by internal totalizers increase with forward flow and decrease with reverse flow.
- If the RFT9739 control output indicates flow direction, the output is +15 VDC with forward flow or 0 VDC with reverse flow.
- The RFT9712 flow direction output is +15 VDC with forward flow or 0 VDC with reverse flow.

### 12.4 Internal damping

Internal damping filters out noise or the effects of rapid changes in the flow rate without affecting measurement accuracy.

The damping value is the filter coefficient, which approximates the time required for the output to achieve 63% of its new value in response to a step change at the input. The actual time for internal damping on the flow rate depends on many factors, including sensor type and the density of the fluid. The transmitter rounds down the chosen damping value to the nearest available programmed time constant.

- The RFT9739 software implements a selective digital filter on flow, density, and temperature outputs.
- The RFT9712 implements damping by emulating the effect of a low-pass resistance-capacitance (RC) filter on flow outputs.

### 12.4.1 Internal damping on flow outputs

To put internal damping on flow outputs:

1. At the online menu, choose 4 (detailed setup).
2. At the detailed setup menu, choose 2 (configure field device variables).
3. At the configure field device variables menu, choose 1 (flow).

4. At the flow menu, the choice depends on the transmitter to which the HART Communicator is connected and on whether the user wishes to damp the volume flow output or mass flow output.

   a. With the HART Communicator connected to an RFT9712 or RFT9729, choose 5 (flow damping).

   b. With the HART Communicator connected to an RFT9739, choose 8 (flow damping).

5. Enter the desired filter coefficient from Table 12-2, then press F4 (enter).

   Table 12-2  Time constants for internal damping on flow outputs

<table>
<thead>
<tr>
<th>Filter coefficients in seconds</th>
</tr>
</thead>
<tbody>
<tr>
<td>RFT9739</td>
</tr>
<tr>
<td>--------</td>
</tr>
<tr>
<td>0</td>
</tr>
<tr>
<td>0.1</td>
</tr>
<tr>
<td>0.2</td>
</tr>
<tr>
<td>0.4</td>
</tr>
<tr>
<td>0.8</td>
</tr>
<tr>
<td>1.6</td>
</tr>
<tr>
<td>3.2</td>
</tr>
<tr>
<td>6.4</td>
</tr>
<tr>
<td>0.05</td>
</tr>
<tr>
<td>0.1</td>
</tr>
<tr>
<td>0.4</td>
</tr>
<tr>
<td>0.8</td>
</tr>
<tr>
<td>1.6</td>
</tr>
<tr>
<td>3.2</td>
</tr>
<tr>
<td>6.4</td>
</tr>
<tr>
<td>12.8</td>
</tr>
</tbody>
</table>

   For the RFT9739, the user can put added damping on milliamp outputs configured to indicate flow. For more information about added damping, see Subsection 13.2.5.
12.4.2 Damping on density outputs from RFT9739

To put internal damping on density outputs:

1. At the online menu, choose 4 (detailed setup).

2. At the detailed setup menu, choose 2 (configure field device variables).

3. At the configure field device variables menu, choose 2 (density).

4. At the density menu, choose 2 (density damping).

5. Enter the desired filter coefficient from Table 12-3.

### Table 12-3 Time constants for internal damping on density outputs from RFT9739

<table>
<thead>
<tr>
<th>Filter coefficients in seconds</th>
</tr>
</thead>
<tbody>
<tr>
<td>RFT9739</td>
</tr>
<tr>
<td>---------</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>
For the RFT9739, the user can put added damping on milliamp outputs configured to indicate density. For more information about added damping, see Subsection 13.2.5.

12.4.3 internal damping on temperature outputs from RFT9739

To put internal damping on temperature outputs:

1. At the online menu, choose 4 (detailed setup).

2. At the detailed setup menu, choose 2 (configure field device variables).

3. At the configure field device variables menu, choose 3 (temperature).

4. At the temperature menu, choose 2 (temperature damping).
Slug flow limits enable detection of conditions such as slug flow (gas slugs in a liquid flow stream).

If fluid density goes outside a slug flow limit, all the following occur:
- “Slug flow” appears in the HART Communicator display.
- The frequency/pulse output goes to 0 Hz.
- Milliamp outputs indicating the flow rate go to the level that represents zero flow.
- The diagnostic LED blinks OFF once per second.

To set slug flow limits:

1. At the online menu, choose 4 (detailed setup).
2. At the detailed setup menu, choose 2 (configure field device variables).

5. Enter the desired filter coefficient from Table 12-4.

### Table 124 Time constants for internal damping on temperature outputs from RFT9739

<table>
<thead>
<tr>
<th>Filter coefficients in seconds</th>
</tr>
</thead>
<tbody>
<tr>
<td>RFT9739</td>
</tr>
<tr>
<td>0</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>8</td>
</tr>
</tbody>
</table>

For the RFT9739, the user can put added damping on milliamp outputs configured to indicate temperature. For more information about added damping, see Subsection 13.2.5.
3. At the configure field device variables menu, choose 2 (density).

4. At the density menu, the choice depends on the transmitter to which the HART Communicator is connected and on whether the user wishes to set the low or high slug flow limit.
   
   a. With the HART Communicator connected to an RFT9712 or RFT9729, choose 2 (slug low limit), or choose 3 (slug high limit),
   
   b. With the HART Communicator connected to an RFT9739, choose 3 (slug low limit), or choose 4 (slug high limit).

5. Enter the desired slug flow limit in grams per cubic centimeter, regardless of the density units established for density as a transmitter variable.

Example:

Vaporization of the process liquid sometimes causes slug flow in a liquid flow stream in which the density of the liquid should remain above 0.9000 grams per cubic centimeter (g/cc).

To prevent density from decreasing below the specified density of the process liquid due to vaporization, set the low slug flow limit at a density above 0.9000 g/cc. Such a setting will cause the transmitter to indicate slug flow before the process density goes below the specified limit for the liquid.
13 Detailed Setup: Configure outputs

13.1 Transmitter outputs

WARNING: Before configuring output variables, set process control devices for manual operation.

Whenever the display at left appears, isolate the transmitter from digital computers, Micro Motion peripherals, valves, or other devices that use transmitter outputs to control the flow loop, then press F4 (OK).

The RFT9739 has two milliamp outputs, a frequency/pulse output, a control output, two digital outputs, fault indicators, and a slug duration.

The RFT9712 has a 4-20 mA output, a frequency/pulse output, a flow direction output, and a digital output.

CAUTION: While configuring output variables, record them in the appropriate Transmitter Configuration Worksheet (Appendix I).

13.2 Milliamp outputs

The RFT9739 has primary and secondary milliamp outputs that independently produce a 0-20 or 4-20 mA current. The RFT9712 or RFT9729 has a 4-20 mA output. Milliamp outputs go to controllers, PLCs, or recording devices.

13.2.1 Milliamp output variables

Use the analog output, analog output 1, or analog output 2 menu to assign a variable to milliamp outputs:

- The 0-20 or 4-20 mA outputs from the RFT9739 can independently indicate mass flow, volume flow, density, temperature, differential pressure, viscosity, event 1 status or event 2 status.
- The 4-20 mA output from the RFT9712 can indicate mass flow, volume flow, density, or temperature.

To assign a variable to a milliamp output:
1. At the online menu, choose 4 (detailed setup).

2. At the detailed setup menu, choose 3 (configure outputs).

3. At the configure outputs menu, the choice depends on the transmitter to which the HART Communicator is connected:
   a. Choose 1 (analog output) to assign a variable to the 4-20 mA output from an RFT9712 or RFT9729.
   b. Choose 1 (analog output 1) to assign a variable to the primary milliamp output from an RFT9739, or
   c. Choose 2 (analog output 2) to assign a variable to the secondary milliamp output from an RFT9739.
4. Choose 1 (PV is or SV is).

5. Use the down arrow (↓) or up arrow (↑) to scroll to the process variable to be represented by the output, then press F4 (enter).

13.2.2 Range values for milliamp outputs

The range represents values of the variable at 4 mA and 20 mA if the output produces a 4-20 mA current, or at 0 mA and 20 mA if the output produces a 0-20 mA current.

To configure the 0-20 mA or 4-20 mA span of milliamp outputs from the RFT9739, see the instruction manual shipped with the transmitter.

To set range values:

1. At the online menu, choose 4 (detailed setup).

2. At the detailed setup menu, choose 3 (configure outputs).
3. At the configure outputs menu, the choice depends on the transmitter to which the HART Communicator is connected:

a. Choose 1 (analog output) to set range values for the 4-20 mA output from an RFT9712 or RFT9729.

b. Choose 1 (analog output 1) to set range values for the primary milliamp output from an RFT9739, or

c. Choose 2 (analog output 2) to set range values for the secondary milliamp output from an RFT9739.

4. Choose 2 (range values).

5. Choose the upper or lower range value for setting.

a. Choose 1 (URV) to set the upper range value, which represents the limit for the assigned process variable at 20 mA, or
b. Choose 2 (LRV) to set the lower range value, which represents the limit for the assigned process variable at 4 mA if the output produces a 4-20 mA current, or at 0 mA if the output produces a 0-20 mA current.

6. Enter the desired range value, then press F4 (enter).

13.2.3 Read-only sensor range limits and minimum span

Sensor range limits are the lowest and highest possible range values that a milliamp output can represent. The minimum span is the smallest range that can be represented by the milliamp output.

To read sensor range limits or the minimum span:

1. At the online menu, choose 4 (detailed setup).

2. At the detailed setup menu, choose 3 (configure outputs).
3. At the configure outputs menu, the choice depends on the transmitter to which the HART Communicator is connected:

   a. Choose 1 (analog output) to read sensor limits or the minimum span for the RFT9712 or RFT9729.

   b. Choose 1 (analog output 1) to read sensor limits or the minimum span for the primary milliamp output from an RFT9739, or

   c. Choose 2 (analog output 2) to read sensor limits or the minimum span for the secondary milliamp output from an RFT9739.

4. Choose 2 (range values).

5. Choose the value that will be read.

   a. Choose 3 (USL) to read the upper sensor limit, which is the highest value that can be represented by the output at 20 mA.
b. Choose 4 (LSL) to read the lower sensor limit, which is the lowest value that can be represented by the output at 4 mA if the output produces a 4-20 mA current, or at 0 mA if the output produces a 0-20 mA current.

c. Choose 5 (minimum span) to read the minimum span, which is the smallest range of values that can be represented by the milliamp output.

6. After reading the desired value, press F4 (exit).

13.2.4 Flow cutoffs for milliamp outputs

Flow cutoffs enable the user to filter out noise by defining the level below which milliamp outputs will indicate zero flow.

If a milliamp output indicates mass flow or volume flow, the user can define a flow cutoff for the output. A flow cutoff is the lowest flow rate at which the milliamp output indicates nonzero flow. If the flow signal drops below the flow cutoff, the output goes to the current level that indicates zero flow.

Flow cutoffs for milliamp outputs remain unaffected by the flow cutoff for the transmitter's frequency/pulse output and internal totalizers.

To set a flow cutoff for a milliamp output:

1. At the online menu, choose 4 (detailed setup).
2. At the detailed setup menu, choose 3 (configure outputs).

3. At the configure outputs menu, the choice depends on the transmitter to which the HART Communicator is connected:
   a. Choose 1 (analog output) to set the flow cutoff for the 4-20 mA output from an RFT9712 or RFT9729.
   b. Choose 1 (analog output 1) to set the flow cutoff for the primary milliamp output from an RFT9739, or
   c. Choose 2 (analog output 2) to set the flow cutoff for the secondary milliamp output from an RFT9739.

4. Choose 3 (PV AO cutoff or SV AO cutoff).
5. Enter the desired flow cutoff, then press F4 (enter).

Example: The primary milliamp output from an RFT9739 indicates mass flow, and has programmed limits of zero flow at 4 mA and 100 grams per minute (g/min) at 20 mA. The output should go to 4 mA when the mass flow rate goes below 2.00 g/min.

Enter a flow cutoff of 2.00.

An output of 4.32 mA indicates a mass flow rate of 2.00 g/min. The primary milliamp output goes to 4 mA if the flow rate drops below 2.00 g/min.

13.2.5 Added damping on RFT9739 outputs

For the RFT9739, a secondary filter adds damping to internal damping on milliamp outputs indicating flow, temperature, and density. If two or three outputs indicate the same variable, added damping enables more than one damping value on the variable. Damping filters the effects of rapid changes in the variable.

The added damping value is the time coefficient of the secondary filter. The actual time depends on many factors, including sensor type, the density of the fluid, and the duration of the digital time constant.

To put added damping to the internal damping on a milliamp output:

1. At the online menu, choose 4 (detailed setup).

2. At the detailed setup menu, choose 3 (configure outputs).
3. At the configure outputs menu, the choice depends on the milliamp output to which damping will be added:

   a. Choose 1 (analog output 1) to put added damping on the primary milliamp output, or

   b. Choose 2 (analog output 2) to put added damping on the secondary milliamp output.


5. Enter the desired time coefficient, then press F4 (enter).

The transmitter rounds down the entered value to the nearest available programmed filter coefficient. Table 13-1 lists programmed filter coefficients in seconds of added damping on flow, density, and temperature as indicated by the milliamp outputs.

Table 13-1  Filter coefficients for added damping on milliamp outputs from RFT9739

<table>
<thead>
<tr>
<th>Mass or volume flow</th>
<th>Temperature</th>
<th>Density</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0 266</td>
<td>0.6 128</td>
</tr>
<tr>
<td>0.1</td>
<td>2 612</td>
<td>1 266</td>
</tr>
<tr>
<td>0.2</td>
<td>4 1024</td>
<td>2 612</td>
</tr>
<tr>
<td>0.4</td>
<td>8 2048</td>
<td>4 1024</td>
</tr>
<tr>
<td>0.8</td>
<td>16 4096</td>
<td>8 2048</td>
</tr>
<tr>
<td>1.6</td>
<td>32 8192</td>
<td>16 4096</td>
</tr>
<tr>
<td>3.2</td>
<td>64 16384</td>
<td>32 8192</td>
</tr>
<tr>
<td>6.4</td>
<td>128 32768</td>
<td>64</td>
</tr>
</tbody>
</table>
13.2.6 Milliamp output testing

A milliamp output can be tested in the detailed setup or diagnostics/service branch of the HART Communicator software. To test a milliamp output, see Chapter 6.

13.2.7 Milliamp output trim

A milliamp output can be trimmed in the detailed setup or diagnostics/service branch of the HART Communicator software. To trim a milliamp output, see Chapter 8.

13.3 Frequency/pulse output

The frequency/pulse output goes to any Micro Motion peripheral or to another frequency-based totalizer or flow computer.

- For the RFT9712 or RFT9729 the frequency always represents the flow rate.
- For the RFT9739, the frequency/pulse output can represent mass flow, volume flow, mass total, or volume total.
- The output requires frequency/flow rate scaling when indicating the flow rate, or pulses per flow total when indicating the flow total. Regardless of the scaling, the frequency is always proportional to the flow rate.
- For the RFT9739, the pulse width is programmable for low frequencies.

13.3.1 Frequency/pulse output variable from RFT9739

The frequency/pulse output from an RFT9739 can indicate mass flow, mass total, volume flow, or volume total.

- If mass flow is chosen, the output produces a frequency proportional to the mass flow rate.
- If mass total is chosen, the output produces a given number of pulses per unit mass flow.
- If volume flow is chosen, the output produces a frequency proportional to the volume flow rate.
- If volume total is chosen, the output produces a given number of pulses per unit volume flow.

The frequency or number of pulses per unit time is always proportional to a flow rate, regardless of the process variable assigned to the output.

To assign a variable to the frequency/pulse output:

1. At the online menu, choose 4 (detailed setup).
2. At the detailed setup menu, choose 3 (configure outputs),

3. At the configure outputs menu, choose 3 (frequency output).

4. At the frequency output menu, choose 1 (TV is).

5. Use the down arrow (↓) or up arrow (↑) to select a process variable to be represented by the output, then press F4 (enter).

13.3.2 Frequency/pulse output scaling

Use the frequency output menu to scale the frequency/pulse output:

- If the output indicates the mass flow rate or volume flow rate, scaling requires entry of frequency and flow rate setpoints.
- If the output indicates the mass total or volume total, scaling requires entry of pulses and an equivalent total.

The frequency represents a mass or volume flow rate, so the frequency varies proportionally to the flow rate.

To scale the frequency/pulse output:
1. At the online menu, choose 4 (detailed setup).

2. At the detailed setup menu, choose 3 (configure outputs).

3. At the configure outputs menu, the choice depends on the transmitter to which the HART Communicator is connected:
   a. To scale the frequency/pulse output from an RFT9712 or RFT9729, choose 2 (frequency output).
   b. To scale the frequency/pulse output from an RFT9739, choose 3 (frequency output).

4. At the frequency output menu, the choice depends on the transmitter to which the HART communicator is connected.
   a. To set the frequency for the output from an RFT9712 or RFT9729, choose 1 (frequency factor).
b. To set the proportional frequency or pulse rate for the output from an RFT9739, choose 2 (TV frequency factor).

5. Enter a setpoint for the frequency if the output represents a flow rate, or enter a number of pulses if the output represents a flow total, then press F4 (enter).

6. When the HART Communicator display returns to the frequency output menu, set the rate factor. The number corresponding to this menu item depends on the transmitter to which the HART communicator is connected.

a. To set the rate for the output from an RFT9712 or RFT9729, choose 2 (rate factor).

b. To set the rate or total for the output from an RFT9739, choose 3 (TV rate factor).

7. Enter the desired flow rate or total, then press F4 (enter).
Example: The frequency/pulse output represents mass flow. Scale the frequency output so 4 kHz represents a mass flow rate of 400 grams per minute (g/min).

Since $\frac{4000}{400} = 10$, the frequency is 10 times as large as the proportional flow rate.

- Enter a value of 10.00 for the frequency.
- Enter a value of 1.00 for the rate.

One Hz represents a mass flow rate of 0.10 g/min. The maximum frequency of 10 kHz represents a flow rate of 1,000 g/min or 1 kg/min.

Example: The frequency/pulse output represents volume total. Scale the pulse output so 10,000 pulses represent an accumulated volume of 200,000 cubic meters.

Since $100 \text{ pulses} \times 2000 \text{ cubic meters} = 200,000$, and $\frac{2000}{100} = 20$, each pulse represents 20 cubic meters. The frequency of the pulses will vary with the volume flow rate.

- Enter a value of 100 for the frequency.
- Enter a value of 2000 for the rate.

**13.3.3 Frequency pulse width for RFT9739**

The frequency/pulse output from the RFT9739 operates in different modes at high and low frequencies.

At high frequencies, the output produces a square wave with an approximate 50% duty cycle. (The ON and OFF states are of approximately equal duration). High-frequency counters such as frequency-to-voltage converters, frequency-to-current converters, and Micro Motion peripherals usually require such an input.

At low frequencies, the output can revert to a constant pulse width in the ON state, with an OFF state that varies in relationship to the actual frequency. Electromechanical counters and PLCs that have low-scan cycle rates generally use an input with a constant ON state and a varying OFF state. Most low frequency counters have a specified requirement for the maximum pulse width.

The user can program the frequency/pulse output by setting the ON state at a specified pulse width between 0.012 and 0.500 seconds to accommodate the requirements of a particular counting device. The programmed pulse width defines a crossover frequency:

$$\text{crossover frequency} = \frac{1}{2 \cdot \text{pulse width}}$$
Above the crossover frequency, the output has a 50% duty cycle. Below the crossover frequency, the output has a constant ON state (0V) duration.

- The lowest available crossover frequency is one Hz, when the pulse width is 0.500 seconds.
- The highest available crossover frequency is 41.67 Hz, when the pulse width is 0.012 seconds.

To set the pulse width:

1. At the online menu, choose 4 (detailed setup).

2. At the detailed setup menu, choose 3 (configure outputs).

3. At the configure outputs menu, choose 3 (frequency output).

4. At the frequency output menu, choose 4 (maximum pulse width).

5. Enter the desired pulse width, then choose F4 (Enter).
13.4 Frequency/pulse output testing

The frequency/pulse output can be tested in the detailed setup or diagnostics/service branch of the HART Communicator software. To test the frequency/pulse output, see Chapter 6.

13.5 Control output from RFT9739

The RFT9739 control output produces a digital signal level, which has a 15 V OFF state and a 0 V ON state. The output can indicate flow direction, transmitter zeroing in progress, faults, event 1 or event 2.

**CAUTION:** Assigning event 1 or event 2 to the control output changes its function, and changes the output configuration procedure. To assign an event to the control output, see Chapter 15.

If the control output indicates flow direction, the output is high (+15 V) when indicating forward flow, and low (0 V) when indicating reverse flow. Near zero flow, the output goes high or low, depending on the flow direction before the flow rate approached zero.

Configure the control output to indicate flow direction if the transmitter connects to a Micro Motion peripheral device.

If the control output indicates zero in progress, the output is low (0 V) when zeroing is in progress, and high (+15 V) at all other times. Whether or not the control output is configured to indicate transmitter zeroing in progress, the diagnostic LED on the transmitter’s electronics module remains ON during transmitter zeroing.

If the control output indicates faults, the output is high (+15 V) when indicating normal operation, and low (0 V) when indicating a fault condition. Whether or not the control output is set to indicate faults, the diagnostic LED on the transmitter’s electronics module blinks ON 4 times per second to indicate a fault condition.

To configure the control output:

1. At the online menu, choose 4 (detailed setup).
2. At the detailed setup menu, choose 3 (configure outputs).

3. At the configure outputs menu, choose 4 (control output).

4. Use the down arrow (↓) or up arrow (↑) to scroll to the desired option, then press F4 (enter).

13.6 Fault outputs for RFT9739

The RFT9739 has programmable fault indicators and a slug duration.
- Outputs can produce upscale, downscale, internal zero, or last measured value fault indicators.
- If density goes outside a low or high slug limit, the slug duration is the amount of time flow outputs hold their last measured value before indicating slug flow.

13.6.1 Fault indicators for RFT9739

Fault indicators control milliamp outputs and the frequency/pulse output when the RFT9739 cannot accurately measure process variables.
- Downscale. A milliamp output goes to 0 mA if it produces a 0-20 mA current, or to 2 mA if it produces a 4-20 mA current; the frequency/pulse output goes to 0 Hz.
- Upscale. Milliamp outputs go to 22 mA; the frequency/pulse output goes to 15 kHz.
- Internal zero. Milliamp outputs go to the current level that indicates a value of zero for the represented process variable; the frequency/pulse output goes to 0 Hz.
- Last measured value. Milliamp outputs and the frequency/pulse output hold the values measured immediately before the fault condition occurred.

Regardless of the fault indicator that is chosen, the diagnostic LED on the transmitter's electronics module blinks ON 4 times per second indicate a fault condition.
To set fault indicators:

1. At the online menu, choose 4 (detailed setup).

2. At the detailed setup menu, choose 3 (configure outputs).

3. At the configure outputs menu, choose 5 (fault output).

4. At the fault output menu, choose 1 (fault indicator).

5. Select the desired fault indicator option, then choose F4 (Enter).

13.6.2 Slug duration for RFT9739

In some applications, slug flow typically occurs for short periods of time. If the slug flow condition ceases in less than one minute, the RFT9739 can continue holding the last accurately measured flow value until process density stabilizes within the programmed slug flow limits. The slug duration specifies the amount of time the transmitter indicates the last measured flow value before indicating zero flow.
To set the slug duration:

1. At the online menu, choose 4 (detailed setup).

2. At the detailed setup menu, choose 3 (configure outputs).

3. At the configure outputs menu, choose 5 (fault output).

4. At the fault output menu, choose 2 (slug duration).

5. Enter a slug duration of 0.00 to 60.00 seconds, then choose F4 (Enter).

All Micro Motion 9700 Series transmitters can produce a digital output compatible with HART protocol. Configuring the HART output requires assigning a polling address to the transmitter, determining whether the output will operate in burst mode, and selecting data that will be transmitted if the output operates in burst mode.
13.7.1 Polling address

The polling address identifies the transmitter when it communicates with the HART Communicator or with devices on a multidrop network via the Bell 202 or RS-485 serial standard.

- If the transmitter is configured to use the Bell 202 serial standard, a polling address of 1 to 15 fixes the milliamp output from an RFT9712 or RFT9729 or the primary milliamp output from an RFT9739 at 4 mA.
- A polling address of 0 enables the milliamp output from an RFT9712 or RFT9729 or the primary milliamp output from an RFT9739 to represent a process variable.

The transmitter has 0 as the default polling address. If the transmitter is assigned a polling address other than 0, communication with the transmitter requires use of the polling menu in the offline branch of the HART Communicator software.

To assign a polling address:

1. At the online menu, choose 4 (detailed setup).

2. At the detailed setup menu, choose 3 (configure outputs).

3. At the configure outputs menu, the choice depends on the transmitter to which the HART Communicator is connected:

   a. Choose 3 (HART output) to assign a polling address to an RFT9712 or RFT9729.
b. Choose 6 (HART output) to assign a polling address to an RFT9739.

4. At the HART output menu, choose 1 (polling address).

5. Enter any desired polling address, from 0 to 15, then press F4 (enter).

13.7.2 Required number of preambles

Messages framed for transmission under HART protocol require a given number of preambles. A preamble contains specific codes enabling network devices to acknowledge the message.

To read the number of preambles required for HART data transmission:

1. At the online menu, choose 4 (detailed setup).
2. At the detailed setup menu, choose 3 (configure outputs).

3. At the configure outputs menu, the choice depends on the transmitter to which the HART Communicator is connected:
   
a. Choose 3 (HART output) to read the required number of preambles for an RFT9712 or RFT9729.

b. Choose 6 (HART output) to read the required number of preambles for an RFT9739.

4. At the HART output menu, choose 2 (number of required preambles).

5. After reading the required number of preambles, press F4 (exit).

13.7.3 Burst mode

The digital output can operate in burst mode when using HART protocol. In burst mode, the transmitter bursts data at regular intervals. The interval varies according to the baud rate. The interval is 3.7 seconds at 1200 baud.
To configure the transmitter to operate in burst mode:

1. At the online menu, choose 4 (detailed setup).

2. At the detailed setup menu, choose 3 (configure outputs).

3. At the configure outputs menu, the choice depends on the transmitter to which the HART Communicator is connected:

   a. Choose 3 (HART output) to set the burst mode of data transmission for an RFT9712 or RFT9729.

   b. Choose 6 (HART output) to set the burst mode of data transmission for an RFT9739.

4. At the HART output menu, choose 3 (burst mode).
13.7.4 Data transmission options for burst mode

If the HART output will operate in burst mode, the user must select the data that will be transmitted in burst mode.

To select data for transmission in burst mode:

1. At the online menu, choose 4 (detailed setup).

2. At the detailed setup menu, choose 3 (configure outputs).

3. At the configure outputs menu, the choice depends on the transmitter to which the HART Communicator is connected:

   a. Choose 3 (HART output) to set the burst mode options for an RFT9712 or RFT9729.

4. Choose 1 (off) or 2 (on), then press F4 (enter),
b. Choose 6 (HART output) to set the burst mode options for an RFT9739.

4. At the HART output menu, choose 4 (burst option).

5. Use the down arrow (↓) or up arrow (↑) to select the appropriate option, then press F4 (enter).
   - If option 1 (PV) is chosen, the HART output bursts the measured value of the primary variable.
   - If option 2 (% range/current) is chosen, the HART output bursts the percentage of the range represented by the primary variable at its measured value, and the current level of the primary milliamp output from an RFT9739 or the 4-20 mA output from an RFT9712 or RFT9729.
   - If option 3 (process variables/current) is chosen, the HART output bursts measured values of the primary, secondary, tertiary, and quaternary variables, and the current level of the primary milliamp output from an RFT9739 or the 4-20 mA output from an RFT9712 or RFT9729.

Table 13-2 lists burst mode options and the corresponding data the HART output will transmit in burst mode.

### Table 13-2 Burst mode options for HART® digital output

<table>
<thead>
<tr>
<th>Burst mode option</th>
<th>Data transmitted when option is selected</th>
<th>Outputs represented by data</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>RFT97 12/RFT9729</td>
</tr>
<tr>
<td>1 PV</td>
<td>Primary variable</td>
<td>4-20 mA</td>
</tr>
<tr>
<td>2 % range/current</td>
<td>• Percent of range for primary variable</td>
<td>4-20 mA</td>
</tr>
<tr>
<td></td>
<td>• Current level of primary mA output or</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4-20 mA output</td>
<td></td>
</tr>
<tr>
<td>3 Process variables/current</td>
<td>• Primary variable</td>
<td>4-20 mA</td>
</tr>
<tr>
<td></td>
<td>• Secondary variable</td>
<td>Frequency/pulse</td>
</tr>
<tr>
<td></td>
<td>• Tertiary variable</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Quaternary variable</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Current level of primary mA output or</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4-20 mA output</td>
<td></td>
</tr>
</tbody>
</table>
14 Detailed Setup: Device Information

14.1 Device information overview

Device information enables the user to change the HART tag that identifies the transmitter for network communication, to find out whether the transmitter configuration is read/write or read-only, and to store and/or read configuration parameters that serve as references without affecting calibration factors, totalizers, or outputs.

The device information menu has nine main-menu options plus two submenus.
- The construction materials submenu stores the sensor flange type, flow-tube construction material, and flow-tube liner material.
- The revision numbers submenu enables the user to view read-only serial numbers and software-revision levels.

CAUTION: Record transmitter information in the appropriate Transmitter Configuration Worksheet (Appendix I).

14.2 Device information main menu

Use the device information option to configure communication options.

1. At the online menu, choose 4 (detailed setup).

2. At the detailed setup menu, choose 4 (device information).
Tag. Choose 1, then enter up to eight characters that identify the transmitter when it communicates with other devices in a HART-compatible network.

Descriptor. Choose 2, then enter any description or message from 1 to 16 characters.

Message. Choose 3, then enter any description or message from 1 to 32 characters.

Date. Choose 4, then enter a 2-digit code for the day, a 2-letter code for the month, and a 2-digit code for the year, separated by slashes (/). When shipped from the factory, the date is the day on which the flowmeter was calibrated in the Micro Motion Flow Calibration Lab.

Device ID. Choose 5, then read the number that identifies the electronics module for manufacturing purposes. This menu item is read-only.

Write protect. Choose 6, then use the HART Communicator display to find out whether the transmitter configuration is write-protected. This menu item is read-only. To write-protect the transmitter configuration, use the SECURITY switch on the electronics module of the RFT9739, or the ENABLE/DISABLE jumper on the processor board of the RFT9712 or RFT9729.

- If 1 (on) is highlighted, the configuration is write-protected.
- If 2 (off) is highlighted, the transmitter configuration can be changed.

For more information about write-protecting the transmitter configuration, see the installation manual shipped with the transmitter.

Final assembly number. Choose 7, then read the number that identifies the transmitter assembly for manufacturing purposes. It should match the serial number from the metal tag on the transmitter housing.

Sensor serial number. Choose 8, then enter the serial number from the metal tag on the sensor housing.

Sensor model. Choose 9, then enter up to eight characters that describe the sensor type (such as D006S for a Model D6 sensor with a 3 16L stainless steel flow tube).

Table 14-1 summarizes the information stored in the device information main menu.
Table 14-1  Configuration parameters in device information main menu

<table>
<thead>
<tr>
<th>Menu item</th>
<th>Type of information that can be entered and/or read</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tag</td>
<td>Name, initials, or message of 1 to 8 characters used as polling address in HART-compatible network</td>
</tr>
<tr>
<td>Descriptor</td>
<td>Description or message from 1 to 16 characters</td>
</tr>
<tr>
<td>Message</td>
<td>Message from 1 to 32 characters</td>
</tr>
<tr>
<td>Date</td>
<td>Configuration date (such as 01/07/92)</td>
</tr>
<tr>
<td>Device ID</td>
<td>Read-only number identifying electronics module for manufacturing purposes</td>
</tr>
<tr>
<td>Write protect</td>
<td>Read-only indicator of write-protection for transmitter configuration</td>
</tr>
<tr>
<td>Final assembly number</td>
<td>Serial number from metal tag on transmitter housing</td>
</tr>
<tr>
<td>Sensor serial number</td>
<td>Serial number from metal tag on sensor housing</td>
</tr>
<tr>
<td>Sensor model number</td>
<td>Up to 8 characters identifying sensor type (such as D006S)</td>
</tr>
</tbody>
</table>

14.3  Construction materials submenu

The construction materials submenu enables the user to store the flange type, flow-tube construction material, and flow-tube liner material. Options can be changed without affecting transmitter outputs or the flowmeter configuration.

To use the construction materials submenu:

1. At the online menu, choose 4 (detailed setup).

2. At the detailed setup menu, choose 4 (device information).

3. Use the down arrow (↓) or up arrow (↑) to scroll to construction materials, then press the right arrow (→).
After accessing the construction materials submenu, use it to read and/or change the following options:

Flange. Choose 1, then select the flange type for the sensor.

Sensor material. Choose 2, then select the construction material for the sensor flow tubes.

Liner material. Choose 3, then select the liner material for the sensor flow tubes.

Table 14-2 lists all the options available in the construction materials submenu.

Table 14-2 Sensor material, flange, and liner options

<table>
<thead>
<tr>
<th>Menu Item</th>
<th>Available options</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material</td>
<td>Unknown, 316 L, Hast-C, Monel, Tantalum, Special</td>
</tr>
<tr>
<td>Flange</td>
<td>Unknown, ANSI 150, ANSI 300, ANSI 600, ANSI 900, Union, Sanitary, PN 40, JIS 10 K, JIS 20 K, Special</td>
</tr>
<tr>
<td>Liner</td>
<td>None, Special, Unknown, PTFE, Halar</td>
</tr>
</tbody>
</table>

14.4 Read-only revision numbers submenu

The revision numbers submenu enables the user to check revision levels for the transmitter's software and hardware. Revision numbers are for reference only and cannot be changed by the user.

To use the revision numbers submenu:

1. At the online menu, choose 4 (detailed setup).

2. At the detailed setup menu, choose 4 (device information).
3. Use the down arrow (↓) or up arrow (↑) to scroll to revision numbers, then press the right arrow (→).

After accessing the revision numbers submenu, use it to select the following options:

Universal revision. Choose 1 to read the software revision number for universal HART commands used by the transmitter.

Field device revision. Choose 2 to read the software revision number for the HART device-specific commands used by the transmitter.

Software revision. Choose 3 to read the revision number for the software used by the electronics module.

Hardware revision. Choose 4 to read the revision number for the hardware in the electronics module.

Table 14-3 lists the read-only revision numbers that can be accessed via the revision numbers submenu:

<table>
<thead>
<tr>
<th>Menu item</th>
<th>Revision number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Universal</td>
<td>Revision number for HART universal commands</td>
</tr>
<tr>
<td>Field device</td>
<td>Revision number for HART device-specific commands</td>
</tr>
<tr>
<td>Software</td>
<td>Revision number for software used by transmitter electronics module</td>
</tr>
<tr>
<td>Hardware</td>
<td>Revision number for hardware in electronics module</td>
</tr>
</tbody>
</table>
15 Detailed Setup: Events for RFT9739

15.1 Events overview

**WARNING:** Before configuring events, set process control devices for manual operation.

Whenever the display at left appears, isolate the transmitter from digital computers, Micro Motion peripherals, valves, or other devices that use transmitter outputs to control the flow loop, then press F4 (OK).

Assigning event 1 or event 2 to an output from the RFT9739 changes the function of the output. If associated with an event, a milliamp output or the control output functions as an event indicator.

- As an event indicator, a milliamp output switches from one current level to another current level when the process reaches the setpoint.
- As an event indicator, the control output switches from 0 V to + 15 V or vice versa when the process reaches the setpoint.

15.2 Assigning an event to a milliamp output

To assign an event to a milliamp output:

1. At the online menu, choose 4 (detailed setup).

2. At the detailed setup menu, choose 3 (configure outputs).
3. At the configure outputs menu, select the output to which the event will be assigned.

   a. Choose 1 (analog output 10 to assign the event to the primary milliamp output.

   b. Choose 2 (analog output 2) to assign the event to the secondary milliamp output.

4. At the analog output 1 or analog output 2 menu, choose 1 (PV is or SV is).

5. Use the down arrow (↓) or up arrow (↑) key to select event 1 or event 2, then press F4 (enter).

15.3 Assigning an event to the control output

To assign an event to the control output:

1. At the online menu, choose 4 (detailed setup).
2. At the detailed setup menu, choose 3 (configure outputs).

3. At the configure outputs menu, choose 4 (control output).

4. Use the down arrow (↓) or up arrow (↑) to select event 1 or event 2, then press F4 (enter).

15.4 Configuring event 1 or event 2

Use the event 1 or event 2 menu to configure the following event parameters:

- Process variable. Any process variable can control the states of an event indicator.
- Low or high alarm. Event 1 or event 2 can serve as a low or high alarm.
- Setpoint. Any desired value of a process variable can serve as the setpoint.

15.4.1 Assigning variables to events

Any process variable, including a mass or volume total or inventory, can control the states of an event.

When outputs function as event indicators, the transmitter periodically compares the measured value of the assigned process variable against the setpoint. The process variable determines the rate of the comparison.

Table 15-1 summarizes rates of comparison between the measured value and the setpoint, based on the process variable assigned to the event.

To assign a process variable to an event:
1. At the online menu, choose 4 (detailed setup).

2. At the detailed setup menu, choose 5 (configure events).

3. At the configure events menu, the choice depends on the event to which a process variable will be assigned:
   a. Choose 1 (event 1) to assign a variable to event 1.
   b. Choose 2 (event 2) to assign a variable to event 2.

4. At the event 1 or event 2 menu, choose 1 (event 1 variable or event 2 variable).
5. Use the down arrow (↓) or up arrow (↑) to select the desired process variable, then press F4 (enter).

### Table 15-1
Rates of comparison between setpoints and process variables assigned to events

<table>
<thead>
<tr>
<th>Process variable assigned to event</th>
<th>Frequency of comparison between setpoint and measured value of variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass total (mass inventory)</td>
<td>100 comparisons per second</td>
</tr>
<tr>
<td>Volume total (volume inventory)</td>
<td></td>
</tr>
<tr>
<td>Mass flow or</td>
<td>One comparison every 2 tube cycles, or approximately 20 to 80 comparisons per second, depending on sensor size, flow tube construction material, and process fluid density</td>
</tr>
<tr>
<td>Volume flow</td>
<td></td>
</tr>
<tr>
<td>Density</td>
<td>10 comparisons per second</td>
</tr>
<tr>
<td>Temperature</td>
<td>1 comparison every 0.8 second, or 1.25 comparisons per second</td>
</tr>
<tr>
<td>Differential pressure or</td>
<td>1 comparison per second</td>
</tr>
<tr>
<td>Viscosity</td>
<td></td>
</tr>
</tbody>
</table>

### 15.4.2 Low or high alarm type

Event indicators can operate as low or high process alarms.

With any process variable except a total or inventory assigned to an event, the following conditions determine its state:

- A high alarm is ON if the measured value is equal to or greater than the setpoint. Otherwise, the alarm is OFF.
- A low alarm is ON if the measured value is equal to or less than the setpoint. Otherwise, the alarm is OFF.

**Example:**

Event 1 has been assigned to the control output, and temperature has been assigned to the event. The output controls a normally closed electronic valve. (The valve is ON when closed.) Configure the control output to switch ON and close the valve if the process temperature exceeds the setpoint.

With temperature assigned to the event 1, a high alarm switches ON when temperature goes above the setpoint.

In the event 1 menu, use the event 1 type submenu to configure event 1 as a high alarm.

The alarm will switch ON and produce 0 V output to close the valve when temperature exceeds the setpoint.
With a total or inventory assigned to the event, resetting the totalizer switches a high totalizer alarm OFF or switches a low totalizer alarm ON. The value of the setpoint determines when the alarm switches states.

- If the setpoint is positive, the alarm switches states when forward flow causes the total or inventory level to increase to the setpoint.
- If the setpoint is negative, the alarm switches states when reverse flow causes the total or inventory level to decrease to the setpoint.

The user then must reset the totalizer to switch the totalizer alarm ON or OFF. To stop, start, or reset mass or volume totalizers, at the online menu, choose 1 (process variables), then choose 4 (totalizer control).

**Example:**

Mass total has been assigned to event 1. Configure the totalizer alarm to switch OFF when 500 kilograms (kg) of fluid have been loaded.

With mass total assigned to the event, the low alarm will switch OFF when the mass total equals the setpoint, then will switch ON when the totalizer is reset.

In the event 1 menu, use the event 1 type submenu to configure event 1 as a low alarm.

Since the setpoint is positive (+500 kg), the low alarm will switch OFF when forward flow causes the mass total to exceed 500 kilograms. The totalizer alarm then will remain OFF until the user resets the mass totalizer.

1. At the online menu, choose 4 (detailed setup).

2. At the detailed setup menu, choose 5 (configure events).
3. At the configure events menu, the choice depends on the event to which an alarm type will be assigned:

   a. Choose 1 (event 1) to assign an alarm type to event 1.

   b. Choose 2 (event 2) to assign an alarm type to event 2.

4. At the event 1 or event 2 menu, choose 2 (event 1 type or event 2 type).

5. Use the down arrow (↓) or up arrow (↑) to select high alarm or low alarm, then press F4 (enter).

15.4.3 Event setpoint

Any value of the assigned process variable can serve as the setpoint at which the event switches states.

CAUTION:

Before establishing the setpoint for a total or inventory, configure internal totalizers to indicate forward, reverse, or bi-directional flow. To set indication of flow direction, see Section 12.3.
To establish the setpoint for an event:

1. At the online menu, choose 4 (detailed setup).

2. At the detailed setup menu, choose 5 (configure events).

3. At the configure events menu, the choice depends on the event for which a setpoint will be established:
   - a. Choose 1 (event 1) to establish a setpoint for event 1.
   - b. Choose 2 (event 2) to establish a setpoint for event 2.

4. At the event 1 or event 2 menu, choose 3 (event 1 setpoint or event 2 setpoint).
5. Enter the value at which the indicator will switch ON/OFF states, then press F4 (enter).
16 Review

16.1 Overview of review function

The review branch enables the user to read values of all parameters in the flowmeter configuration.

The review branch has the following menus:
- Device information
- Characterize sensor
- Field device variables
- Outputs

Each menu enables the reader to view values of parameters that can be configured by using a menu in the detailed setup branch of the HART Communicator software.

16.2 Review menus

Menus in the review branch correspond to configuration menus in the detailed setup branch of the HART Communicator software.

Table 16-1 lists the menus in the review branch, the corresponding menus in the detailed setup branch, and the chapters in this manual that explain how to configure flowmeter parameters. Event parameters are available only for the RFT9739.

Table 16-1 Cross-reference to information about configuring parameters visible in review branch

<table>
<thead>
<tr>
<th>Menu in review branch:</th>
<th>Menu in detailed setup branch:</th>
<th>&quot;X&quot; indicates parameter is available for transmitter model</th>
<th>To configure parameters, see:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device information</td>
<td>Device information</td>
<td>X</td>
<td>RFT9739</td>
</tr>
<tr>
<td>Characterize sensor</td>
<td>Characterize sensor</td>
<td>X</td>
<td>RFT9712/RFT9729</td>
</tr>
<tr>
<td>Field device variables</td>
<td>Field device variables</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>outputs</td>
<td>Configure outputs</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Events</td>
<td></td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>
16.2.1 Device information menu

At the online menu, choose 5 (review).

Choose 1 (device information) to read values of parameters that can be configured by using the device information menu in the detailed setup branch. Table 16-2 lists device information parameters.

Table 16-2 Read-only parameters in device information menu

<table>
<thead>
<tr>
<th>Device information parameter</th>
<th>&quot;X&quot; indicates parameter is available for transmitter model</th>
<th>To configure parameter, see:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RFT9739</td>
<td>RFT9712/RFT9729</td>
</tr>
<tr>
<td>Distributor</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Model</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Tag</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Descriptor</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Message</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Date</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Device ID</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Write protect</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Final assembly number</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Sensor serial number</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Sensor model</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Flange</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Sensor material</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Liner material</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Software revision</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Hardware revision</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Universal revision</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>
16.2.2 Characterize sensor menu

At the online menu, choose 5 (review).

Choose 2 (characterize sensor) to read values of parameters that can be configured by using the characterize sensor menu in the detailed setup branch. Table 16-3 lists characterization parameters.

Table 16-3 Read-only parameters in characterize sensor menu

<table>
<thead>
<tr>
<th>Characterize sensor parameter</th>
<th>&quot;X&quot; indicates parameter is available for transmitter model</th>
<th>To configure parameter, see:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RFT9739</td>
<td>RFT9712RFT9729</td>
</tr>
<tr>
<td>Flow calibration factor</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Dens A</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>K1</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Dens B</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>K2</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Density temperature coefficient</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Density calibration factor</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Temperature calibration factor</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Viscosity calibration factor</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>K3</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Pressure correction for flow</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Pressure correction for density</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Flow calibration pressure</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Input pressure at 4 mA</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Input pressure at 20 mA</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>
16.2.3 Field device variables

At the online menu, choose 5 (review).

Choose 3 (field device variables) to read values of parameters that can be configured by using the configure field device variables menu in the detailed setup branch.

- Table 16-4 lists field device variables available for the RFT9712 or RFT9729.
- Table 16-5 lists field device variables available for the RFT9739.

Table 16-4 Read-only parameters in field device variables menu for RFT9712/RFT9729

<table>
<thead>
<tr>
<th>Field device variable</th>
<th>To configure variable, see:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow and totalizer unit</td>
<td>Sections 11.2, 11.3</td>
</tr>
<tr>
<td>Flow cutoff</td>
<td>Section 12.2</td>
</tr>
<tr>
<td>Internal damping on flow outputs</td>
<td>Subsection 12.4.1</td>
</tr>
<tr>
<td>Flow direction</td>
<td>Section 12.3</td>
</tr>
<tr>
<td>Density unit</td>
<td>Section 11.4</td>
</tr>
<tr>
<td>Low slug flow limit</td>
<td>Section 12.6</td>
</tr>
<tr>
<td>High slug flow limit</td>
<td>Section 12.5</td>
</tr>
<tr>
<td>Temperature unit</td>
<td>Section 11.5</td>
</tr>
<tr>
<td>Base flow unit</td>
<td>Section 11.3</td>
</tr>
<tr>
<td>Flow conversion factor</td>
<td>Section 11.3</td>
</tr>
<tr>
<td>Base time unit</td>
<td>Section 11.3</td>
</tr>
<tr>
<td>Flow text</td>
<td>Section 11.3</td>
</tr>
<tr>
<td>Total text</td>
<td>Section 11.3</td>
</tr>
</tbody>
</table>
### Table 16-5  Read-only parameters in field device variables menu for RFT9739

<table>
<thead>
<tr>
<th>Field device variable</th>
<th>To configure variable, see:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass flow and totalizer unit</td>
<td>Sections 11.2, 11.3</td>
</tr>
<tr>
<td>Mass flow cutoff</td>
<td>Section 12.2</td>
</tr>
<tr>
<td>Internal damping on flow outputs</td>
<td>Subsection 12.4.1</td>
</tr>
<tr>
<td>Volume flow and totalizer unit</td>
<td>Sections 11.2, 11.3</td>
</tr>
<tr>
<td>Volume flow cutoff</td>
<td>Section 12.2</td>
</tr>
<tr>
<td>Flow direction</td>
<td>Section 12.3</td>
</tr>
<tr>
<td>Density unit</td>
<td>Section 11.4</td>
</tr>
<tr>
<td>Internal damping on density outputs</td>
<td>Subsection 12.4.2</td>
</tr>
<tr>
<td>Low slug flow limit</td>
<td>Section 12.6</td>
</tr>
<tr>
<td>High slug flow limit</td>
<td>Section 12.5</td>
</tr>
<tr>
<td>Temperature unit</td>
<td>Section 11.5</td>
</tr>
<tr>
<td>Internal damping on temperature outputs</td>
<td>Subsection 12.4.3</td>
</tr>
<tr>
<td>Viscosity unit</td>
<td>Section 11.6</td>
</tr>
<tr>
<td>Pressure unit</td>
<td>Section 11.6</td>
</tr>
<tr>
<td>Base volume unit</td>
<td>Section 11.3</td>
</tr>
<tr>
<td>Volume flow conversion factor</td>
<td>Section 11.3</td>
</tr>
<tr>
<td>Base volume time</td>
<td>Section 11.3</td>
</tr>
<tr>
<td>Volume flow text</td>
<td>Section 11.3</td>
</tr>
<tr>
<td>Base mass unit</td>
<td>Section 11.3</td>
</tr>
<tr>
<td>Mass flow conversion factor</td>
<td>Section 11.3</td>
</tr>
<tr>
<td>Base mass time</td>
<td>Section 11.3</td>
</tr>
<tr>
<td>Mass flow text</td>
<td>Section 11.3</td>
</tr>
</tbody>
</table>
6.2.4 Outputs menu

At the online menu, choose 5 (review).

Choose 4 (outputs) to read values of parameters that can be configured by using the configure outputs and configure events menus in the detailed setup branch.

- With the HART Communicator connected to an RFT9712 or RFT9729, use the outputs menu to read output parameters. The RFT9712 and RFT9729 do not indicate events. Table 16-6 lists output parameters for the RFT9712 and RFT9729.
- With the HART Communicator connected to an RFT9739, use the outputs menu to read output and event parameters. Table 16-7 lists output and event parameters for the RFT9739.

Table 16-6 and Table 16-7 refer to all sections and subsections in this manual that explain how to configure output and event parameters.

Table 16-6  Read-only parameters in outputs menu for RFT9712/RFT9729

<table>
<thead>
<tr>
<th>Output or event parameter</th>
<th>To configure parameter, see:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary variable</td>
<td>Subsection 13.2.1</td>
</tr>
<tr>
<td>mA output lower range value</td>
<td>Subsection 13.2.2</td>
</tr>
<tr>
<td>mA output upper range value</td>
<td>Subsection 13.2.2</td>
</tr>
<tr>
<td>Flow cutoff for mA output</td>
<td>Subsection 13.2.4</td>
</tr>
<tr>
<td>Frequency factor</td>
<td>Subsection 13.3.2</td>
</tr>
<tr>
<td>Rate factor</td>
<td>Subsection 13.3.2</td>
</tr>
<tr>
<td>Polling address</td>
<td>Subsection 13.7.1</td>
</tr>
<tr>
<td>Number of required preambles</td>
<td>Read-only</td>
</tr>
<tr>
<td>Burst mode</td>
<td>Subsection 13.7.3</td>
</tr>
<tr>
<td>Output or event parameter</td>
<td>To configure parameter, see:</td>
</tr>
<tr>
<td>------------------------------------------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>Primary variable</td>
<td>Subsection 13.2.1</td>
</tr>
<tr>
<td>Primary variable lower range value</td>
<td>Subsection 13.2.2</td>
</tr>
<tr>
<td>Primary variable upper range value</td>
<td>Subsection 13.2.2</td>
</tr>
<tr>
<td>Flow cutoff for primary mA output</td>
<td>Subsection 13.2.4</td>
</tr>
<tr>
<td>Added damping on primary mA output</td>
<td>Subsection 13.2.6</td>
</tr>
<tr>
<td>Primary mA output lower limit</td>
<td>Read-only</td>
</tr>
<tr>
<td>Primary mA output upper limit</td>
<td>Read-only</td>
</tr>
<tr>
<td>Secondary variable</td>
<td>Subsection 13.2.1</td>
</tr>
<tr>
<td>Secondary variable lower range value</td>
<td>Subsection 13.2.2</td>
</tr>
<tr>
<td>Secondary variable upper range value</td>
<td>Subsection 13.2.2</td>
</tr>
<tr>
<td>Flow cutoff for secondary mA output</td>
<td>Subsection 13.2.4</td>
</tr>
<tr>
<td>Added damping on secondary mA output</td>
<td>Subsection 13.2.5</td>
</tr>
<tr>
<td>Secondary mA output lower limit</td>
<td>Read-only</td>
</tr>
<tr>
<td>Secondary mA output upper limit</td>
<td>Read-only</td>
</tr>
<tr>
<td>Tertiary variable</td>
<td>Subsection 13.3.1</td>
</tr>
<tr>
<td>Frequency factor</td>
<td>Subsection 13.3.2</td>
</tr>
<tr>
<td>Rate factor</td>
<td>Subsection 13.3.2</td>
</tr>
<tr>
<td>Control output</td>
<td>Section 13.6</td>
</tr>
<tr>
<td>Fault indicators</td>
<td>Subsection 13.6.1</td>
</tr>
<tr>
<td>Slug duration</td>
<td>Subsection 13.6.2</td>
</tr>
<tr>
<td>Event 1 variable</td>
<td>Subsection 15.4.1</td>
</tr>
<tr>
<td>Event 1 type</td>
<td>Subsection 15.4.2</td>
</tr>
<tr>
<td>Event 1 setpoint</td>
<td>Subsection 16.4.3</td>
</tr>
<tr>
<td>Event 2 variable</td>
<td>Subsection 16.4.1</td>
</tr>
<tr>
<td>Event 2 type</td>
<td>Subsection 15.4.2</td>
</tr>
<tr>
<td>Event 2 setpoint</td>
<td>Subsection 15.4.3</td>
</tr>
<tr>
<td>Polling address</td>
<td>Subsection 13.7.1</td>
</tr>
<tr>
<td>Number of required preambles</td>
<td>Read-only</td>
</tr>
<tr>
<td>Burst mode</td>
<td>Subsection 13.7.3</td>
</tr>
</tbody>
</table>
## Model RFT9739 Configuration Worksheet

### Characterize (Chapter 10)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow calibration factor</td>
<td>-</td>
<td>Pressure polling</td>
</tr>
<tr>
<td>Dens A</td>
<td></td>
<td>Field device tag</td>
</tr>
<tr>
<td>K1</td>
<td></td>
<td>Pressure input at 4 mA</td>
</tr>
<tr>
<td>Dens B</td>
<td>-</td>
<td>Pressure input at 20 mA</td>
</tr>
<tr>
<td>K2</td>
<td></td>
<td>Pressure correction for flow</td>
</tr>
<tr>
<td>Density temperature coefficient</td>
<td></td>
<td>Pressure correction for density</td>
</tr>
<tr>
<td>Temperature calibration factor</td>
<td></td>
<td>Flow calibration pressure</td>
</tr>
<tr>
<td>Viscosity calibration factor</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Measurement units (Chapter 11)

<table>
<thead>
<tr>
<th>Unit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass flow unit</td>
<td>Volume flow unit</td>
</tr>
<tr>
<td>If mass flow unit is a special unit</td>
<td>If volume flow unit is a special unit:</td>
</tr>
<tr>
<td>Base mass unit</td>
<td>Base volume unit</td>
</tr>
<tr>
<td>Base time unit</td>
<td>Base volume unit</td>
</tr>
<tr>
<td>Conversion factor</td>
<td>Conversion factor</td>
</tr>
<tr>
<td>Flow text</td>
<td>Flow text</td>
</tr>
<tr>
<td>Total text</td>
<td>Total text</td>
</tr>
<tr>
<td>Density unit</td>
<td>Viscosity unit</td>
</tr>
<tr>
<td>Temperature unit</td>
<td>Pressure unit</td>
</tr>
</tbody>
</table>

### Field device variables (Chapter 12)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass flow cutoff</td>
<td>Internal damping on density</td>
</tr>
<tr>
<td>Volume flow cutoff</td>
<td>Internal damping on temperature</td>
</tr>
<tr>
<td>Flow direction</td>
<td>Slug flow low limit</td>
</tr>
<tr>
<td>Internal damping on flow</td>
<td>Slug flow high limit</td>
</tr>
</tbody>
</table>
### Transmitter outputs (Chapter 13)

<table>
<thead>
<tr>
<th>Analog 1 variable</th>
<th>Frequency/pulse variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower range value</td>
<td>Frequency</td>
</tr>
<tr>
<td>Upper range value</td>
<td>Rate</td>
</tr>
<tr>
<td>Flow cutoff</td>
<td>Maximum pulse width</td>
</tr>
<tr>
<td>Added damping</td>
<td>Control output</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Analog 2 variable</th>
<th>Fault indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower range value</td>
<td>Slug duration</td>
</tr>
<tr>
<td>Upper range value</td>
<td>Polling address</td>
</tr>
<tr>
<td>Flow cutoff</td>
<td>Burst mode</td>
</tr>
<tr>
<td>Added damping</td>
<td>Burst mode option</td>
</tr>
</tbody>
</table>

### Device information (Chapter 14)

<table>
<thead>
<tr>
<th>Tag</th>
<th>Final assembly number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Descriptor</td>
<td>Sensor serial number</td>
</tr>
<tr>
<td>Message</td>
<td>Sensor model</td>
</tr>
<tr>
<td>Date</td>
<td>Material</td>
</tr>
<tr>
<td>Device ID</td>
<td>Flange</td>
</tr>
<tr>
<td>Write protect</td>
<td>On Cl Off</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tag</th>
<th>Final assembly number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Descriptor</td>
<td>Sensor serial number</td>
</tr>
<tr>
<td>Message</td>
<td>Sensor model</td>
</tr>
<tr>
<td>Date</td>
<td>Material</td>
</tr>
<tr>
<td>Device ID</td>
<td>Flange</td>
</tr>
<tr>
<td>Write protect</td>
<td>On Cl Off</td>
</tr>
</tbody>
</table>

### Events (Chapter 15)

<table>
<thead>
<tr>
<th>Event 1</th>
<th>Event 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output assignment</td>
<td>Output assignment</td>
</tr>
<tr>
<td>Process variable</td>
<td>Process variable</td>
</tr>
<tr>
<td>Type</td>
<td>High Alarm Cl Low Alarm 0</td>
</tr>
<tr>
<td>Setpoint</td>
<td>High Alarm Cl Low Alarm 0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Event 1</th>
<th>Event 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output assignment</td>
<td>Output assignment</td>
</tr>
<tr>
<td>Process variable</td>
<td>Process variable</td>
</tr>
<tr>
<td>Type</td>
<td>High Alarm Cl Low Alarm 0</td>
</tr>
<tr>
<td>Setpoint</td>
<td>High Alarm Cl Low Alarm 0</td>
</tr>
</tbody>
</table>
Model RFT9712 or Model RFT9729 Configuration Worksheet

### Characterize (Chapter 10)

<table>
<thead>
<tr>
<th>Flow calibration factor</th>
<th>Density calibration factor</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Measurement units (Chapter 11)

**Flow unit**
- If flow unit is a special unit:
  - Base mass unit
  - Base time unit
  - Conversion factor
  - Flow text
  - Total text

<table>
<thead>
<tr>
<th>Density unit</th>
<th>Temperature unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Field device variables (Chapter 12)

<table>
<thead>
<tr>
<th>Flow cutoff</th>
<th>Slug flow low limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow direction</td>
<td>Slug flow high limit</td>
</tr>
<tr>
<td>Internal damping on flow</td>
<td></td>
</tr>
</tbody>
</table>

### Transmitter outputs (Chapter 13)

<table>
<thead>
<tr>
<th>Analog variable</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower range value</td>
<td>Rate</td>
</tr>
<tr>
<td>Upper range value</td>
<td>Polling address</td>
</tr>
<tr>
<td>Flow cutoff</td>
<td>Burst mode</td>
</tr>
<tr>
<td></td>
<td>Burst mode option</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CI On CI Off</th>
</tr>
</thead>
</table>

### Device information (Chapter 14)

<table>
<thead>
<tr>
<th>Tag</th>
<th>Final assembly number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Descriptor</td>
<td>Sensor serial number</td>
</tr>
<tr>
<td>Message</td>
<td>Sensor model</td>
</tr>
<tr>
<td>Date</td>
<td>Material</td>
</tr>
<tr>
<td>Device ID</td>
<td>Flange</td>
</tr>
<tr>
<td>Write protect</td>
<td>Liner</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CI On CI Off</th>
</tr>
</thead>
</table>
### Appendix II  Flowmeter Calibration Records

Model RFT9739 Calibration Record

#### Flow calibration (Subsection 10.2.2)

<table>
<thead>
<tr>
<th>Weighed amount of fluid</th>
<th>Amount of fluid per HART Communicator display</th>
</tr>
</thead>
<tbody>
<tr>
<td>Batch #1</td>
<td>Batch #1</td>
</tr>
<tr>
<td>Batch #2</td>
<td>Batch #2</td>
</tr>
<tr>
<td>Batch #3</td>
<td>Batch #3</td>
</tr>
<tr>
<td><strong>Total</strong> weighed</td>
<td><strong>Total</strong> displayed</td>
</tr>
</tbody>
</table>

Flow temperature coefficient

#### Auto zero (Subsection 7.2.1)

<table>
<thead>
<tr>
<th>Convergence limit</th>
<th>Zero time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### 2-point density calibration (Subsection 7.4.2)

<table>
<thead>
<tr>
<th>First point (air)</th>
<th>Second point (water)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Line-condition density</td>
<td>Line-condition density</td>
</tr>
<tr>
<td>g/cc</td>
<td>g/cc</td>
</tr>
</tbody>
</table>

#### Third-point density calibration (Subsection 7.4.4)

<table>
<thead>
<tr>
<th>Line-condition density at zero flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>g/cc</td>
</tr>
</tbody>
</table>
### Single-point viscosity calibration (Subsection 7.5.1)

| Line-condition viscosity |

### 2-point viscosity calibration (Subsection 7.5.2)

<table>
<thead>
<tr>
<th>Slope Calibration</th>
<th>Offset Calibration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Line-condition viscosity</td>
<td>Line-condition viscosity</td>
</tr>
</tbody>
</table>

### Milliamp output trim (Chapter 8)

<table>
<thead>
<tr>
<th>Milliamp output 1</th>
<th>Milliamp output 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference current at ±4 mA = ______ mA</td>
<td>Reference current at ±4 mA = ______ mA</td>
</tr>
<tr>
<td>Reference current at ±20 mA = ______ mA</td>
<td>Reference current at ±20 mA = ______ mA</td>
</tr>
</tbody>
</table>
## Model RFT9712 or Model RFT9729 Calibration Record

### Flow calibration (Subsection 10.2.2)

<table>
<thead>
<tr>
<th>Weighed amount of fluid</th>
<th>Amount of fluid per HART Communicator display</th>
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<tbody>
<tr>
<td>Batch #1</td>
<td>Batch #1</td>
</tr>
<tr>
<td>Batch #2</td>
<td>Batch #2</td>
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<tr>
<td>Batch #3</td>
<td>Batch #3</td>
</tr>
<tr>
<td>Total weighed</td>
<td>Total displayed</td>
</tr>
</tbody>
</table>

### Flow temperature coefficient

### Milliamp output trim (Chapter 8)

- Reference current at ± 4 mA = ______ mA
- Reference current at ± 20 mA = ______ mA
Appendix III  Pressure Correction for RFT9739 Flow Measurement

At the factory, Micro Motion flowmeters are calibrated for flow at 20 psig. Although not normally required, the user can also recalculate the flowmeter for flow measurement. In applications where a Model D300, D600, DL100, DL200, CMF200, or CMF300 sensor operates at a pressure that varies significantly from the pressure at which the flowmeter was calibrated for flow, the user can adjust the flow calibration factor or flow output(s) to account for the pressure effect on the flow tubes.

- If the process pressure remains relatively constant, the flow calibration factor can be adjusted.
- If the process pressure varies considerably, the flow output(s) can be adjusted.

**CAUTION:** In most applications, the flow calibration factor does not require pressure correction.

### Adjusting the flow calibration factor for stable operating pressures

If the Model D300, D600, DL100, DL200, CMF200, or CMF300 operates at a relatively constant pressure, the user can apply the following equation to the first five digits of the flow calibration factor:

\[
\text{Flow cal factor}_{\text{new}} = \text{Flow cal factor}_{\text{old}} [1 + K_p \cdot 0.01)(P_{\text{meas}} - P_{\text{cal}})]
\]

Where:
- \( K_p \) = pressure correction factor for flow:
  - 0.009% of rate per psi for D300 or DL200
  - 0.005% of rate per psi for D600 or DL100
  - 0.0008% of rate per psi for CMF200
  - 0.0006% of rate per psi for CMF300
- \( P_{\text{meas}} \) = measured pressure, in psig, at sensor inlet
- \( P_{\text{cal}} \) = pressure at which flowmeter was calibrated for flow (20 psig for a factory-calibrated flowmeter)

**Example:** A Model CMF300 sensor will operate at 100 psig. After being calibrated for flow at 20 psig, the sensor has a flow calibration factor of 697.624.75.

\[
\text{Flow cal factor}_{\text{new}} = 697.62 \cdot [1 + (0.0006)(0.01) \cdot (100 - 20)]
\]
\[
= 697.62 \cdot [1 + (0.000006 \cdot 80)]
\]
\[
= 697.62 \cdot (1.00048)
\]
\[
= 697.95
\]

The new flow calibration factor, including the 3-digit temperature coefficient, is 697.954.75.
Real-time pressure correction to flow outputs

**CAUTION:** In most applications, flow outputs do not require pressure correction.

If the Model D300, 0600, DL100 DL200, CMF200, or CMF300 operates at a pressure that varies considerably, the user can apply the following equation to the flow outputs:

\[
\text{Flow rate}_{\text{corrected}} = \text{Flow rate}_{\text{measured}} \left[ 1 + K_p (0.01)(P_{\text{meas}} - P_{\text{cal}}) \right]
\]

Where:
- \( K_p \) = pressure correction factor for flow:
  - 0.009% of rate per psi for D300 or DL200
  - 0.005% of rate per psi for D600 or DL100
  - 0.0008% of rate per psi for CMF200
  - 0.0006% of rate per psi for CMF300
- \( P_{\text{meas}} \) = measured pressure, in psig, at sensor inlet
- \( P_{\text{cal}} \) = pressure at which flowmeter was calibrated for flow (20 psig for a factory-calibrated flowmeter)

The pressure correction can be performed by the transmitter. Alternatively, if pressure at the sensor inlet is known, the pressure correction can be calculated by an external device such as a PLC, DCS (distributive control system), or personal computer.

Pressure input signals can originate from one of several sources:
- A 2.0 or higher-revision RFT9739 has terminals P (MA PWR OUT) and S (MA SIG IN), which connect to an analog pressure transmitter. The RFT9739 or an external source can power the pressure transmitter.
- The RFT9739 can be configured to poll a HART-compatible pressure transmitter for real-time pressure values.
- If a pressure cell connected to the host controller measures pressure at the sensor inlet, the host controller can be configured to download pressure signals to the RFT9739.

For more information about implementing pressure correction for flow, see Section 10.7.
Example: After being calibrated at the factory at 20 psi, a Model D300 sensor operating at 220 psig indicates a flow rate of 500 pounds per minute (lb/min). Determine the corrected flow rate after compensating for the pressure effect on the flow tubes.

Flow rate_{corrected} = 500 \times [1 + (0.009)(0.01) \times (220 - 20)]
= 500 \times [1 + (0.00009 \times 200)]
= 500 \times [1 + (0.018)]
= 500 \times (1.018)
= 509 \text{ lb/min}

The corrected flow rate is 509 lb/min.
Appendix IV  Pressure Correction for RFT9739 Density Measurement

At the factory, Micro Motion flowmeters are calibrated for density at 20 psig. Although not normally required, the user can also recalibrate the flowmeter for density measurement. In applications where a Model 0300, 0600, DL100, DL200, CMF200, or CMF300 sensor operates at a pressure that varies significantly from the pressure at which the flowmeter was calibrated for density, the user can adjust the high-density tube period or the density output(s) to account for the pressure effect on the flow tubes.

- If the process pressure remains relatively constant, density calibration settings can be adjusted.
- If the process pressure varies considerably, the density output(s) can be adjusted.

Pressure correction by adjusting density calibration settings

CAUTION: In most applications, density calibration settings do not require pressure correction.

If a Model D300, 0600, DL100, DL200, CMF200, or CMF300 sensor operates at a relatively constant pressure, the user can adjust the density calibration settings.

- For a Model CMF200 or CMF300 sensor, adjust the K2 density constant.
- For a Model D300, 0600, DL100, or DL200 sensor, adjust the second five digits of the density calibration factor.

The following series of examples illustrates the procedure.

Step 1. Use the following equation to find the density offset:

\[
\text{Density offset} = K_p (P_{\text{meas}} - P_{\text{cal}})
\]

Where:  
- \(K_p\) = pressure correction factor for density:  
  0.000011 g/cc per psi for D300 or DL200  
  0.000004 g/cc per psi for D600 or DL100  
  -0.000001 g/cc per psi for CMF200  
  -0.0000002 g/cc per psi for CMF300  
- \(P_{\text{meas}}\) = measured pressure, in psig, at sensor inlet  
- \(P_{\text{cal}}\) = pressure at which flowmeter was calibrated for density (20 psig for a factory-calibrated flowmeter)
Step 2. After finding the density offset, use the following equation to calculate the correct density:

\[
\text{Density}_{\text{corrected}} = \text{Density}_{\text{measured}} + \text{Density}_{\text{offset}}
\]

Example:

After being calibrated at the factory at 20 psi, a Model D300 sensor operating at 220 psig indicates a process density of 0.9958 grams per cubic centimeter (g/cc). Determine the density offset and the corrected density.

\[
\text{Density}_{\text{offset}} = 0.000011(200 - 20) = 0.000011(200) = 0.0022
\]

\[
\text{Density}_{\text{corrected}} = 0.9958 + 0.0022 = 0.9980 \text{ g/cc}
\]

---

Step 3. After calculating the corrected density, use the following equation to adjust the K2 density constant or the second five digits of the density calibration factor:

\[
K_{2\text{new}} = [(K_{2\text{old}} - K1) \cdot (\text{Density}_{\text{measured}} / \text{Density}_{\text{corrected}})] + K1
\]

or

\[
2nd \ 5 \ digits_{\text{new}} = [(2nd \ 5 \ digits_{\text{old}} \cdot 1st \ 5 \ digits) \cdot (\text{Density}_{\text{measured}} / \text{Density}_{\text{corrected}})] + 1st \ 5 \ digits
\]

Example:

An RFT9739 is connected to a Model D300 sensor with 316L stainless steel flow tubes. The flowmeter indicates a density of 0.9958 grams per cubic centimeter (g/cc), which has been corrected to 0.9980 g/cc. The first five digits of the density calibration factor are 09615, and the second five digits are 13333.

\[
2nd \ 5 \ digits_{\text{new}} = [(1 \ 3333 - 9615) \cdot (0.9958/0.9980)] + 9615
\]

\[
= (3718 \cdot 0.9977956) + 9615
\]

\[
= 3709.804 + 9615
\]

\[
= 13325
\]

The new 13-digit density calibration factor, including the density temperature coefficient, is 09615133254.44.
On-line pressure correction to density outputs

**CAUTION:** In most applications, density outputs do not require pressure correction.

If the Model D300, 0600, DL100, DL200, CMF200, or CMF300 operates at a pressure that varies considerably, the user can apply the following equation to the density outputs:

$$\text{Density}_{\text{corrected}} = \text{Density}_{\text{measured}} - [K_p \times (P_p - P_{\text{cal}})]$$

Where:
- $K_p$ = pressure correction factor for density:
  - 0.000011 g/cc per psi for D300 or DL200
  - 0.000004 g/cc per psi for D600 or DL100
  - -0.000001 g/cc per psi for CMF200
  - -0.0000002 g/cc per psi for CMF300
- $P_p$ = measured process pressure, in psig, at sensor inlet
- $P_{\text{cal}}$ = pressure at which flowmeter was calibrated for density (20 psig for a factory-calibrated flowmeter)

The pressure correction can be performed by the transmitter. Alternatively, if pressure at the sensor inlet is known, the pressure correction can be calculated by an external device such as a PLC, DCS (distributive control system), or personal computer.

Pressure input signals can originate from one of several sources:
- A 2.0 or higher-revision RFTS739 has terminals P (MA PWR OUT) and S (MA SIG IN), which connect to an analog pressure transmitter. The RFT9739 or an external source can power the pressure transmitter.
- The RFT9739 can be configured to poll a HART-compatible pressure transmitter for real-time pressure values.
- If a pressure cell connected to the host controller measures pressure at the sensor inlet, the host controller can be configured to download pressure signals to the RFT9739.

For more information about implementing pressure correction for density, see Subsection 10.7.

**Example:**
After being calibrated at the factory at 20 psig, a Model D300 sensor operating at 100 psig indicates a density of 0.9958 grams per cubic centimeter (g/cc). Determine the corrected density after compensating for the pressure effect on the flow tubes.

$$\text{Density}_{\text{corrected}} = 0.9958 + [0.000011 \times (100 - 20)]$$
$$= 0.9958 + (0.000011 \times 80)$$
$$= 0.9958 + 0.00088$$
$$= 0.9967 \text{ g/cc}$$
Appendix V  HART® Communicator software trees

Process variables branch
for RFT9739

Process variables
View fld dev vars
- Mass flo
- Temp
- Mass totl
- Dens
- Mass inventory
- Vol flo
- Vol totl
- Vol inventory
- Viscosity
- Pressure

View output vars
View PV — Analog 1
- PV is
- PV
- PV % range
- PV AO

View SV — Analog 2
- SV is
- SV
- SV % range
- SV AO

View TV — Frequency
- TV is
- TV
- Pres freq

View QV
- QV is
- QV

View event 1
- Value
- Event 1 type
- Event 1 setpoint
- Event 1 status

View event 2
- Value
- Event2 type
- Event2 setpoint
- Event2 status

View status
Totlizer cntrl
- Mass totl
- Vol totl
- Start totalizer
- Stop totalizer
- Reset totalizer
Diagnostics/service branch for RFT9739

**Diagnostics/service branch**

- **Test/Status**
  - View status
  - Self test
- **Loop Test**
  - Fix Analog Out 1
    - 4 mA
    - 20 mA
    - Other
    - End
  - Fix Analog Out 2
    - 4 mA
    - 20 mA
    - Other
    - End
  - Fix frequency out
    - 10 kHz
    - Other
    - End
- **Calibration**
  - Auto zero
    - Perform auto zero
    - Mass flow
    - Zero time
    - Converg. limit
  - Density cal
    - Dens Pt 1 (Air)
      - Perform Cal
      - Dens
    - K1
    - Dens Pt 2 (Water)
      - Perform Cal
      - Dens
    - K2
    - Dens Pt 3 (Flow)
      - Perform Cal
      - Dens
      - K3*
      - Mass flow
      - Min mass flow
  - Viscosity cal
    - Visc slope cal
      - Perform Cal
      - Viscosity
      - Visc offset cal
        - Perform Cal
        - Viscosity
  - Temperature cal
    - Temp offset cal
      - Perform Cal
      - Temp
      - Temp slope cal
        - Perform Cal
        - Temp
- **Trim Analog Out 1**
- **Trim Analog Out 2**

- 2.0 or higher-revision RFT9739

**Basic setup branch for RFT9739**

**Basic setup**

- **Tag**
  - PV Unit
  - Analog 1 range vals
    - PV URV
    - PV LRV
  - SV Unit
  - Analog 2 range vals
    - sv URV
    - sv LRV
  - TV Freq factr
  - TV Rate factr
Detailed setup (continued from left)

---

### Charize sensor
- FlowCal
- Density
  - Dens A
  - K1
  - Dens B
  - K2
  - Temp coeff
  - K3
- Temp cal factr
- Viscosity
  - Pressure polling or
  - ViscCal pressure
  - Fid dev tag
  - 4 mA pressure*
  - 20 mA pressure*
- Pressure comp
  - Pressure polling
  - Flow factr*
  - Dens factr*
  - FlowCal pressure
  - Fid dev tag*
  - 4 mA pressure*
  - 20 mA pressure*

---

### Config fld dev var
- Flow
  - Mass flo unit
  - Mass flo cutoff
  - Spcl mass units
    - Base mass unit
    - Base mass time
    - Mass flo conv fact
    - Mass flo text
    - Mass totl text
  - Vol flo unit
  - Vol flo cutoff
  - Spcl vol units
    - Base vol unit
    - Base vol time
    - Vol flo conv fact
    - Vol flo text
    - Vol totl text
  - Flo direction
  - Flo damp
- Density
  - Dens unit
  - Dens damp
  - Slug low limit
  - Slug high limit

---

### Temperature
- Temp unit
- Temp damp

### Viscosity/Pressure
- DP unit
- Viscosity unit

---

### Config outputs (continued)
- Analog output 1
  - PV is
    - Range values
      - PV URV
      - PV LRV
    - USL
    - LSL
    - PV Min span
    - PV AO cutoff
    - PV AO added damp
    - Fix Analog Out 1
      - 4 mA
      - 20 mA
      - Other
      - End
    - Trim Analog Out 1

---

### Device information
- Tag
- Descriptor
- Message
- Date
- Dev id
- Write protect
- Final assembly num
- Snsr s/n
- Snsr model
- Construction mats
  - Flange
  - Liner matl
- Revision #’s
  - Universal rev.
  - Flid dev rev.
  - Software rev.
  - Hardware rev.

---

### Config events
- Event 1
  - Event1 var
  - Event1 type
  - Event1 setpoint
- Event 2
  - Event2 var
  - Event2 type
  - Event2 setpoint

- 2.0 and higher-revision RFT9739
Review branch for RF19739

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<th>Review (continued from left)</th>
</tr>
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<td>- Model</td>
<td>- PV LRV</td>
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<td>- Tag</td>
<td>- PV U RV</td>
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<tr>
<td>- Descriptor</td>
<td>- PV AO cutoff</td>
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<tr>
<td>- Message</td>
<td>- PV AO lo end pt</td>
</tr>
<tr>
<td>- Date</td>
<td>- PV AO hi end pt</td>
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<tr>
<td>- Dev id</td>
<td>- SV is</td>
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<td>- Write protect</td>
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<td>- Final asmbly num</td>
<td>- sv U RV</td>
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<td>- Snsr s/n</td>
<td>- SV AO cutoff</td>
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<td>- Snsr model</td>
<td>- SV AO added damp</td>
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<td>- Flange</td>
<td>- SV AO lo end pt</td>
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<tr>
<td>- Snsr matl</td>
<td>- SV AO hi end pt</td>
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<tr>
<td>- Liner matl</td>
<td>- N Is</td>
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<td>- Software rev</td>
<td>- TV Freq factr</td>
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<td>- Hardware rev</td>
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<td>- Universal rev</td>
<td>- Control output</td>
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Process variables branch for
RFT9712 or RFT9729

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<td>PV % range</td>
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<td>PV AO</td>
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<td>Reset totalizer</td>
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Diagnostics/service branch for
RFT9712 or RFT9729

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<td>Trim Analog Output</td>
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Basic setup branch for
RFT9712 or RFT9729

Basic setup
| Tag                  |
| PV Unit              |
| Analog range vals    |
| U R V                |
| L R V                |
| Freq factor          |
| Rate factor          |
Detailed setup branch for RFT9712 or RFT9729

<table>
<thead>
<tr>
<th>Detailed setup branch</th>
<th>Charize sensor</th>
<th>FlowCal</th>
<th>Dens calib factr</th>
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<td>Flo cutoff</td>
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