ELITE® Model RFT9739 Field-Mount Transmitter

Instruction Manual

Version 2 Transmitters

January 1996

Micro Motion

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ELITE® Model RFT9739 Field-Mount Transmitter

Instruction Manual

Version 2 Transmitters

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- In the U.S.A., phone 1-800-522-6277, 24 hours
- Outside the U.S.A., phone 303-530-8400, 24 hours
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Conventions

Throughout this manual, the term *transmitter* refers to the Model RFT9739 transmitter. The term *sensor* refers to an ELITE® CMF, BASIS™ F, or Model D, DL, or DT sensor only. The term *flowmeter* refers to the sensor and RFT9739 transmitter installed as a flow metering system. Installation and operation of Micro Motion sensors are addressed in the sensor instruction manuals.

Shown in this manual are the signal words *NOTE*, *CAUTION* and *WARNING*, as described in the examples below:

NOTE

Notes are separated from the general text to bring the user's attention to important information.

⚠CAUTION

Caution statements signal the user about hazards or unsafe practices which **could** result in minor personal injury or product or property damage.

⚠WARNING

Warning statements signal the user about hazards or unsafe practices which could result in severe personal injury or death.

1 Before You Begin

1.1 About this manual

This instruction manual explains how to install the Micro Motion® ELITE® Model RFT9739 field-mount transmitter for use with Micro Motion Coriolis flow sensors. For more information about the sensor, see the appropriate sensor instruction manual.

⚠CAUTION

Improper installation could cause measurement error or transmitter failure.

For personal and system safety, follow all instructions to ensure transmitter will operate correctly.

NOTE

Instructions in this manual pertain to Version 2 transmitters. Do not use this manual for transmitters shipped before May 1993.

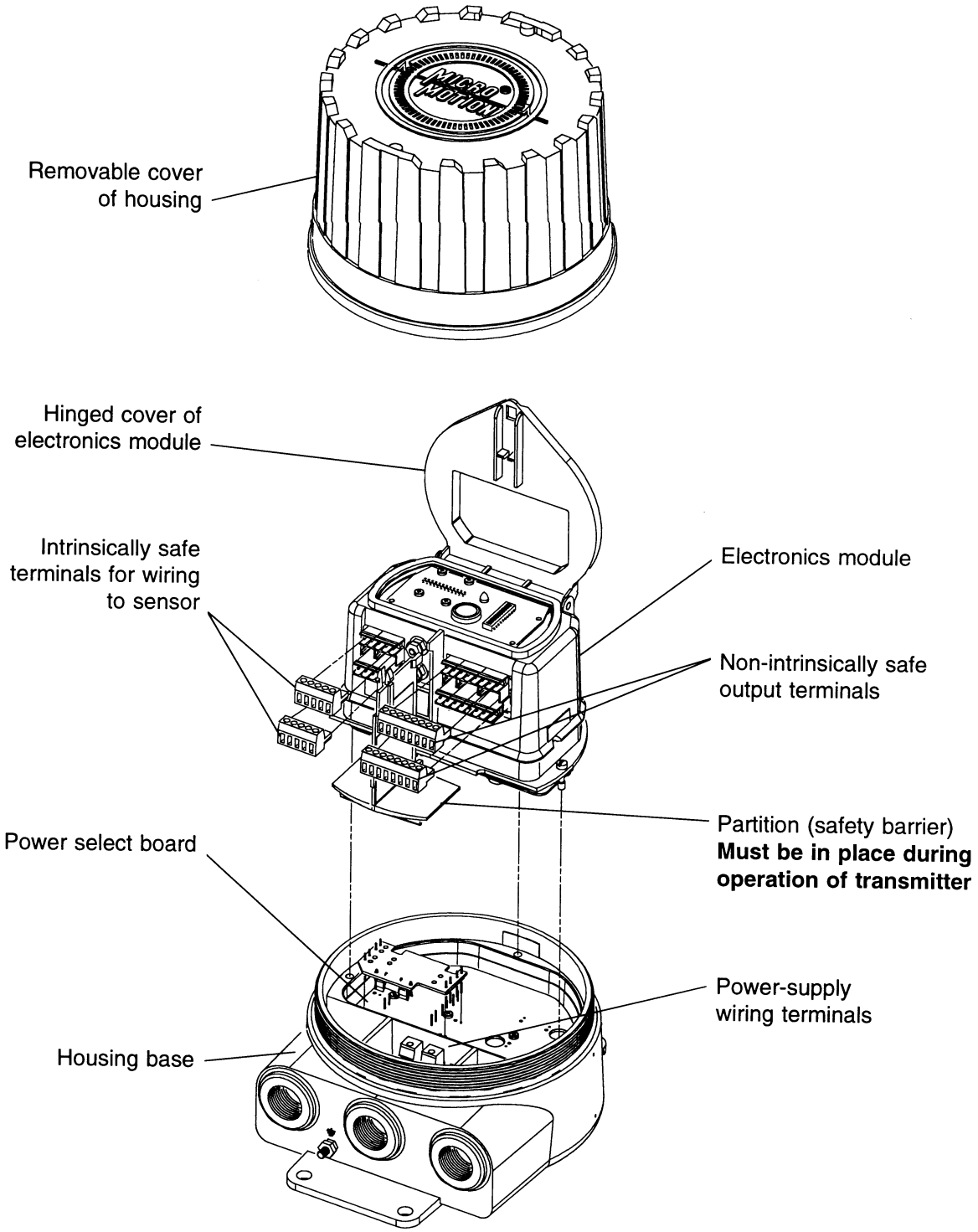
To identify the transmitter version, see **Appendix H**.

1.2 About the transmitter

The Micro Motion ELITE Model RFT9739 transmitter is a microprocessor-based transmitter for fluid process measurement. The transmitter works with Micro Motion sensors to measure mass or volume flow, density, and temperature.

Components of the transmitter are shown in **Figure 1-1**.

Figure 1-1 RFT9739 exploded view



2 Getting Started

2.1 Hazardous area installations

When properly installed with an approved sensor, the RFT9739 field-mount transmitter can be installed in the following hazardous areas:

UL and CSA
Class I, Div. 1, Groups C and D, Class II, Groups E, F, and G explosion-proof when installed with approved conduit seals; otherwise, Class I, Div. 2, Groups A, B, C, and D

CENELEC
EExd [ib] IIC T6 flameproof when installed with approved cable glands; otherwise, [EEx ib] IIC

SAA
Exd [ib] IIC T6

⚠WARNING

Failure to comply with requirements for intrinsic safety in a hazardous area could result in an explosion.

- Install the transmitter in an environment that is compatible with the hazardous area specified on the approvals tag.
- For intrinsically safe installations, use this document with Micro Motion UL, CSA, or SAA installation instructions.

- To comply with requirements for explosion-proof installations approved by UL or CSA, install approved explosion-proof conduit seals **on all three conduit openings**.
- To comply with requirements for flameproof installations approved by CENELEC, install approved flameproof cable glands and gland plugs **on all three conduit openings**.

2.2 Characterization and calibration

Transmitters and sensors can be replaced separately, because each sensor is characterized for flow and density sensitivity at the factory, and labeled with the appropriate flow and density calibration factors.

After the transmitter is installed, a Rosemount® SMART FAMILY® Interface 268, a HART® Communicator Model 275, or Micro Motion ProLink® software can be used for entering calibration factors for the attached sensor. Communication with the transmitter is possible using HART or Modbus® communication protocol. See Micro Motion HART Communicator or ProLink instruction manuals for more information. In addition:

- A basic software tree for the Model 268 is shown in **Appendix D**.
- A basic software tree for the Model 275 is shown in **Appendix E**.

2.3 Switch settings

NOTE

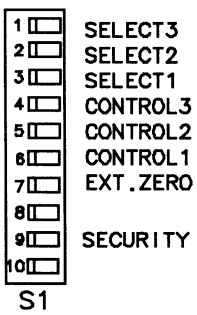
Instructions in this section pertain only to Version 2 transmitters. Do not use these instructions to set switches for transmitters shipped before May 1993.

To identify the transmitter version, see **Appendix H**.

Switches on the electronics module (see **Figure 1-1**) control the following transmitter functions:

- Baud rate
- Stop bits and parity
- Data bits, communication protocol, and physical layer
- mA outputs
- Zeroing method
- Write-protection of transmitter configuration

Switches are shown in **Figure 2-1**, and described in the following sections.



Switches at left are shown in the OFF position.

Figure 2-1. Switches

Hardware switches

Switches 7 and 9 are hardware switches. Hardware switches may be set at any time, and do not require turning the transmitter on and off.

External zero

Set hardware switch 7 (EXT. ZERO) to the ON position to enable use of a remote device, such as a keyed switch, for transmitter zeroing.

- **Section 5.7** explains how to connect an external switch for transmitter zeroing.
- **Section 6.3** explains how to zero the transmitter.

Security

Set hardware switch 9 (SECURITY) to the ON position to prevent use of HART or Modbus protocol for changing the transmitter configuration.

With the security switch in the ON position:

- Flowmeter zeroing is not possible.
- Batch totalizers can be reset only under zero flow conditions.
- Modbus and HART communications are read-only. Model 268 and 275 communicators, and the ProLink program, produce an error message if the user attempts to enter configuration changes into the transmitter.

Software switches

Switches 1 through 6 are software switches. Set software switches as desired, as instructed in **Table 2-1**. Switch settings are described below.

NOTE

When setting software switches, power to the transmitter must be turned on and off, or "cycled."

If possible, connect power supply to the transmitter at a workbench and set switches before the transmitter is installed.

Baud rate

Switch settings enable baud rates of 1200 baud to 38.4 kilobaud for RS-485. Bell 202 automatically uses 1200 baud, independent of the baud rate configured by the user. Model 268 and Model 275 communicators require the Bell 202 physical layer.

Stop bits and parity

For RS-485, switch settings enable one or two stop bits with odd parity, even parity, or no parity. Bell 202 automatically uses 1 stop bit with odd parity, independent of the stop bit and parity configured by the user for RS-485. Model 268 and Model 275 communicators require the Bell 202 physical layer.

Table 2-1. Software switch settings

Instructions

The transmitter reads the switch settings when the power supply is turned ON. For **each** setting:

1. Shut OFF power to the transmitter.
2. Set switches as desired.
3. Turn transmitter power supply ON.
4. Wait until the diagnostic LED on the electronics module blinks ON once per second.
5. Set SELECT 3, SELECT 2, SELECT 1, CONTROL 3, CONTROL 2, and CONTROL 1 to the OFF position.
6. Shut OFF power to the transmitter.
7. Turn transmitter power supply ON.

Baud rate	SELECT 3	SELECT 2	SELECT 1	CONTROL 3	CONTROL 2	CONTROL 1
1200 baud		ON				ON
2400 baud		ON	ON			ON
4800 baud	ON					ON
9600 baud	ON		ON			ON
19.2 kilobaud	ON	ON				ON
38.4 kilobaud	ON	ON	ON			ON

Stop bits and parity	SELECT 3	SELECT 2	SELECT 1	CONTROL 3	CONTROL 2	CONTROL 1
1 stop bit, no parity					ON	
1 stop bit, odd parity		ON			ON	
1 stop bit, even parity	ON	ON			ON	
2 stop bits, no parity			ON		ON	
2 stop bits, odd parity		ON	ON		ON	
2 stop bits, even parity	ON	ON	ON		ON	

Data bits, protocol, physical layer	SELECT 3	SELECT 2	SELECT 1	CONTROL 3	CONTROL 2	CONTROL 1
HART over Bell 202[1]	ON				ON	ON
HART over RS-485					ON	ON
Modbus RTU mode (8 bits) over RS-485			ON		ON	ON
Modbus ASCII mode (7 bits) over RS-485		ON	ON		ON	ON
Modbus RTU mode (8 bits) over RS-485 and HART over Bell 202[2]	ON		ON		ON	ON
Modbus ASCII mode (7 bits) over RS-485 and HART over Bell 202[2]	ON	ON	ON		ON	ON

mA outputs[3]	SELECT 3	SELECT 2	SELECT 1	CONTROL 3	CONTROL 2	CONTROL 1
4-20 mA primary and secondary outputs				ON		
0-20 mA primary and secondary outputs		ON	ON	ON		
0-20 mA primary output 4-20 mA secondary output			ON	ON		
4-20 mA primary output 0-20 mA secondary output		ON		ON		

[1]Setting required by Model 268 and Model 275 communicators.
[2]Setting enables HART over Bell 202 (required for Model 268 and Model 275 communicators) and Modbus over RS-485.
[3]Model 268 and Model 275 communicators require primary output to be set to 4-20 mA.

Data bits, protocol, and physical layer
Switch settings enable the following communication alternatives:

- HART protocol under the Bell 202 standard
- HART protocol under the RS-485 standard
- Modbus protocol in RTU (8-bit) mode under the RS-485 standard
- Modbus protocol in ASCII (7-bit) mode under the RS-485 standard
- HART protocol under the Bell 202 standard and Modbus protocol in RTU mode under the RS-485 standard
- HART protocol under the Bell 202 standard and Modbus protocol in ASCII mode under the RS-485 standard

Model 268 and Model 275 communicators, which use the Bell 202 physical layer, require HART protocol under the Bell 202 standard. Communication under Modbus protocol requires the RS-485 standard.

mA outputs
Switch settings enable primary and secondary mA outputs to produce a 0-20 mA or a 4-20 mA current. Model 268 and Model 275 communicators require a primary mA output that produces a 4-20 mA current.

3 Transmitter Mounting

3.1 General guidelines

Follow these guidelines when installing the field-mount RFT9739 transmitter:

- Locate the transmitter where it is accessible for service and calibration.
- In hazardous areas, install the transmitter in a location that is specified in **Section 2.1**.
- Total length of cable from the sensor to the transmitter must not exceed 1000 feet (300 meters).
- Locate the transmitter where the ambient temperature remains between –22 and 131°F (–30 and 55°C).
- Mount the transmitter to a stable, flat surface or instrument pole.

NOTE

The cover of the transmitter housing requires 11½ inches (292 mm) clearance for removal.

The base of the transmitter has three ¾-inch NPT female conduit openings (see **Figure 3-1**), which must remain sealed to keep the transmitter watertight.

⚠CAUTION

Failure to seal transmitter housing could cause a short circuit, which would result in measurement error or flowmeter failure.

To avoid risk of condensation or excessive moisture entering the transmitter housing, fully seal all conduit openings when installing the transmitter.

- Install conduit that allows a complete seal with the conduit openings.
- If possible, orient the transmitter with its conduit openings pointed downward. If this is not possible, seal the conduit to prevent condensation and other moisture from entering the housing.

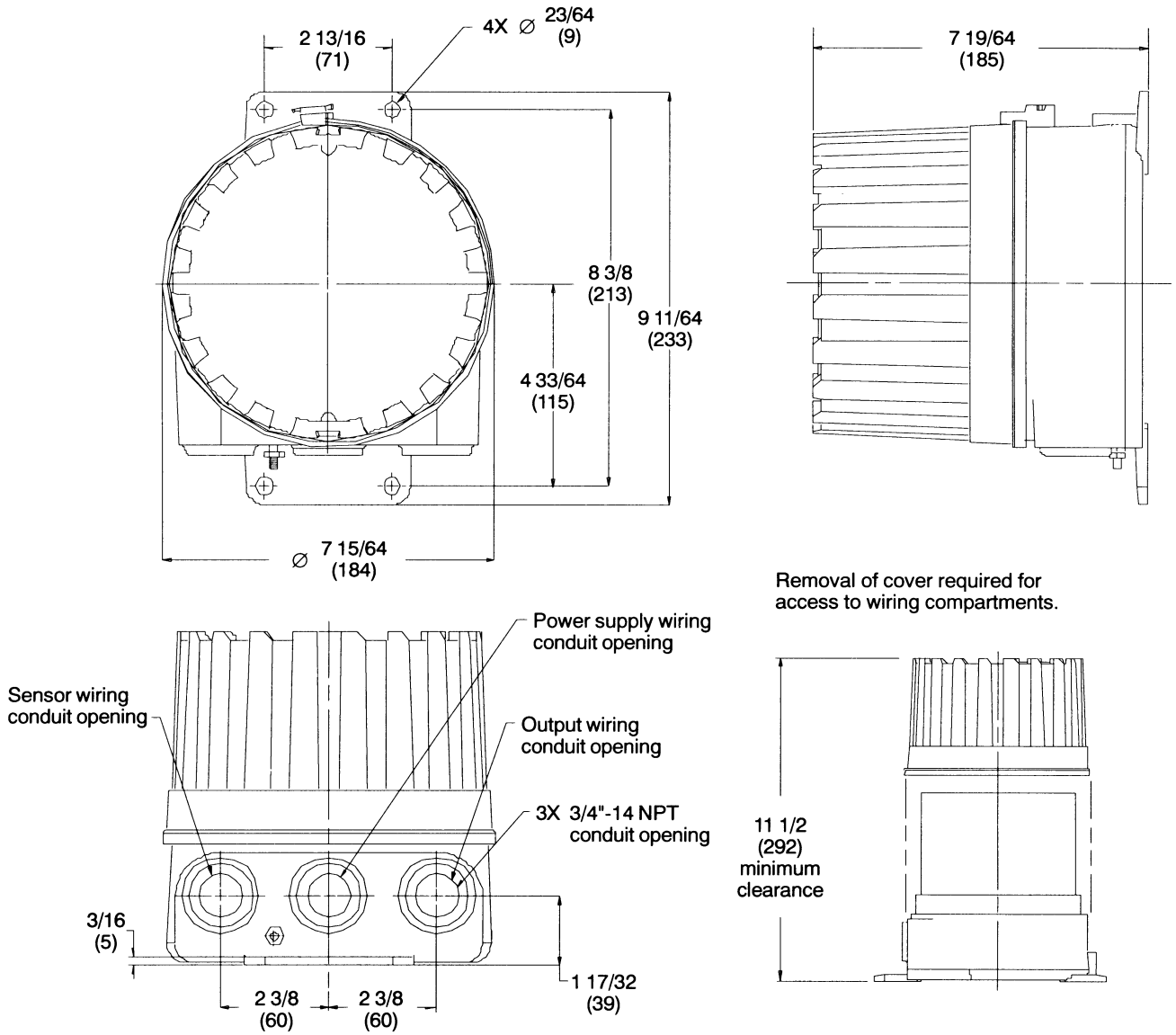
3.2 Mounting to a wall

Follow these guidelines and refer to **Figure 3-1** to mount the transmitter to a wall or other flat, rigid surface.

- Use four 5/16-inch diameter (or M8) bolts and nuts to mount the transmitter to a wall or other flat, rigid surface. Use bolts and nuts that can withstand the process environment. Micro Motion does not supply bolts or nuts.
- To minimize stress on the housing, secure all four mounting bolts to the same structure, which should be flat and should not vibrate or move excessively. Do not secure bolts to separate girders, beams, or wall studs, which can move independently.

Figure 3-1. RFT9739 dimensions

Dimensions in inches (mm)

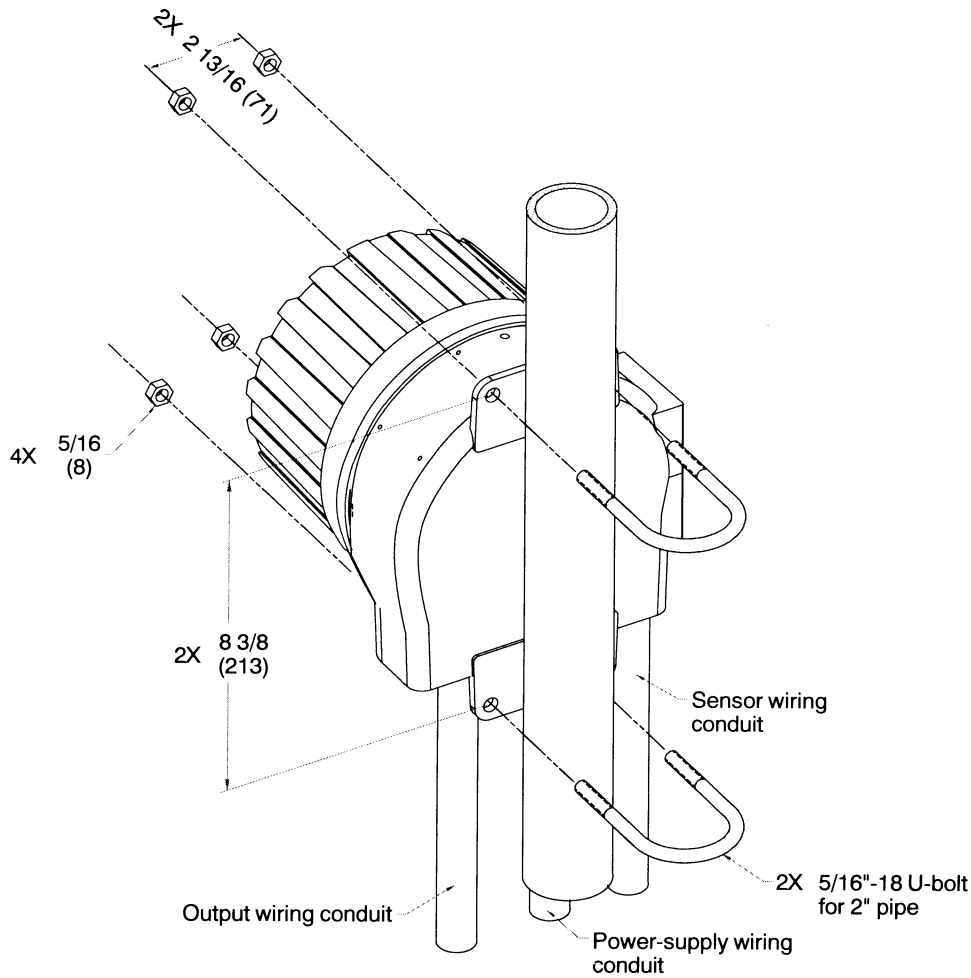


3.3 Mounting to an instrument pole

Follow these guidelines and refer to **Figure 3-2** to mount the transmitter to an instrument pole:

- Use two 5/16-inch U-bolts for 2-inch pipe, and four matching nuts, to mount the transmitter to a rigid instrument pole. Use U-bolts and nuts that can withstand the process environment. Micro Motion does not supply U-bolts or nuts.
- The instrument pole should extend at least 12 inches (305 mm) from a rigid base, and be no more than 2 inches (50.8 mm) in diameter.

Figure 3-2. Instrument-pole mounting



4 Power-Supply and Sensor Wiring

4.1 General guidelines

⚠WARNING

Failure to comply with requirements for intrinsic safety in a hazardous area could result in an explosion.

Sensor wiring is intrinscially safe.

- Keep intrinsically safe sensor wiring separated from power-supply wiring and output wiring.
- For intrinsically safe sensor installations, use this document with Micro Motion UL, CSA, or SAA installation instructions.
- Make sure the safety barrier partition is in place before operating the transmitter.

⚠CAUTION

Failure to seal transmitter housing and sensor junction box could cause a short circuit, which would result in measurement error or flowmeter failure.

To avoid risk of condensation or excessive moisture in the junction box or transmitter housing:

- Seal all conduit openings.
- Install drip legs in cable or conduit.
- Fully tighten transmitter housing cover and sensor junction box cover.

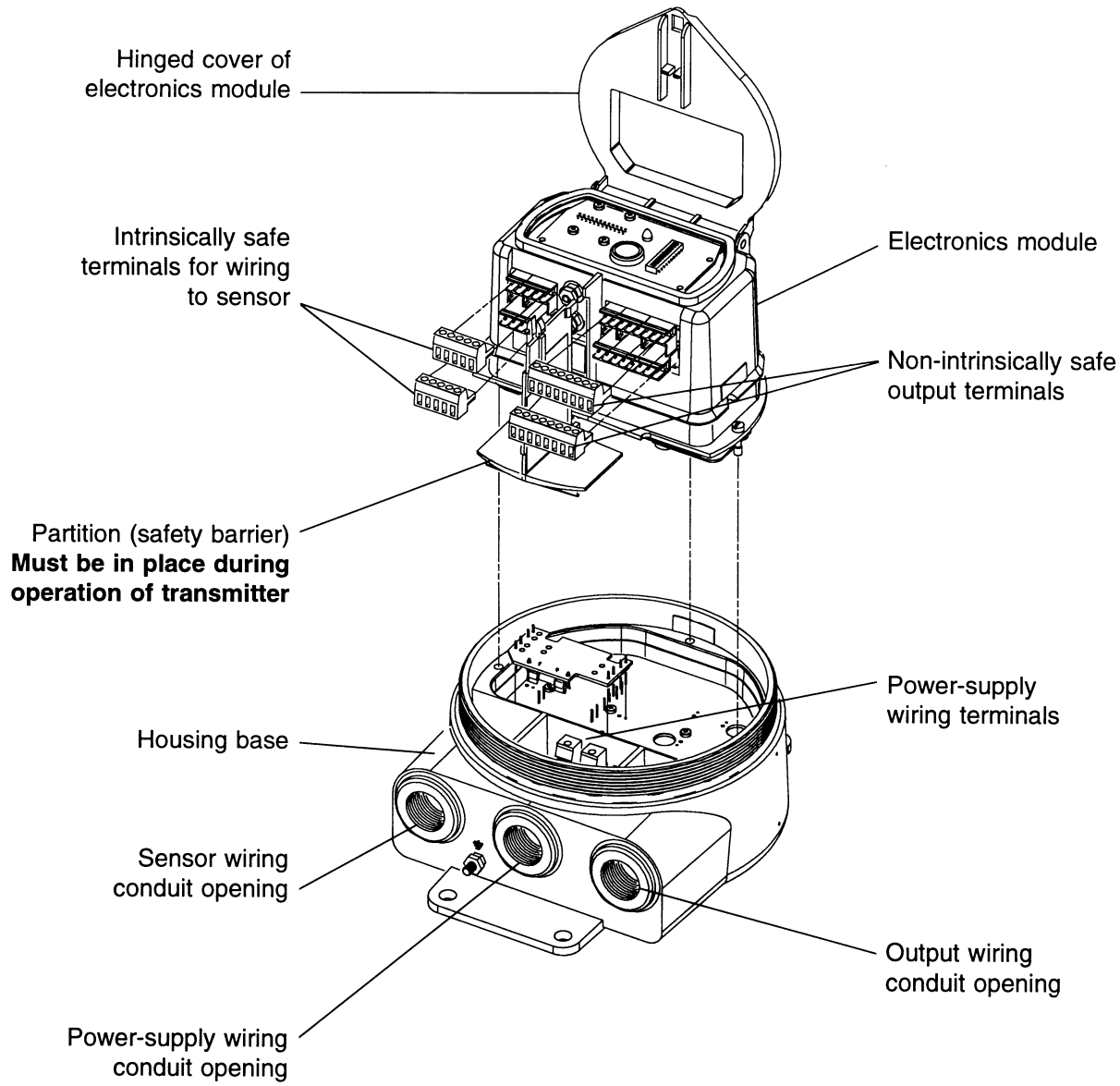
A removable partition on the electronics module keeps intrinsically safe wiring to the sensor separated from non-intrinsically safe output wiring. The module has a hinged cover of clear plastic. To access power-supply wiring, unlatch the cover of the module, then remove the partition.

- **Figure 4-1** shows the locations of the terminals for wiring to the sensor, output wiring terminals, and power-supply wiring terminals.
- Terminal blocks may be unplugged from the module for easier installation of wiring.
- Access the power-supply terminals by removing the partition that separates intrinsically safe terminals from non-intrinsically safe terminals.
- Install cable and wiring to meet local code requirements.
- Do not install power cable in the same conduit or cable tray as sensor cable or output wires.

The base of the transmitter has three ¾-inch NPT female conduit openings, shown in **Figure 4-1**, which must remain sealed to keep the transmitter watertight.

- Use conduit that allows a complete seal with the conduit openings.
- If possible, orient the transmitter with its conduit openings pointed downward. Seal conduit openings to prevent condensation and other moisture from entering the housing.
- To comply with requirements for explosion-proof installations approved by UL or CSA, install approved explosion-proof conduit seals **on all three conduit openings**.
- To comply with requirements for flameproof installations approved by CENELEC, install approved flameproof cable glands and gland plugs **on all three conduit openings**.

Figure 4-1. RFT9739 exploded view



4.2 Power-supply connections

⚠CAUTION

Incorrect voltage, or installation with power supply on, will cause transmitter damage or failure.

- Match power-supply voltage with voltage indicated in transmitter power terminals compartment.
- Turn off power before installing transmitter.

The AC transmitter accepts either a 100/115 VAC, or a 220/230 VAC power supply. The DC transmitter accepts a 12 to 30 VDC power supply.

- A label inside the power-supply wiring compartment indicates the correct power-supply voltage.
- **Figure 4-2** shows the location of power-supply wiring terminals in the base of the transmitter housing.

To install power-supply wiring, follow these steps:

1. To access power-supply wiring, unlatch the hinged cover of the module, then remove the partition that separates intrinsically safe sensor wiring from non-intrinsically safe output wiring.
2. Make input power connections at the two labeled terminals. As indicated in **Figure 4-2**. The power-supply terminals are labeled as follows:
   - If the terminals are labeled "L" and "N", install a 110/115 VAC power supply.
   - If the terminals are labeled "L1" and "L2", install a 220/230 VAC power supply.
   - If the terminals are labeled "+" and "–", install a 12 to 30 VDC power supply.

⚠WARNING

Failure to comply with requirements for intrinsic safety in a hazardous area could result in an explosion.

The transmitter must be properly grounded.

Follow the instructions in Step 3 to ground the transmitter.

3. Properly ground the transmitter.
   - For installations in which the sensor is in a UL, CSA, or SAA hazardous area, refer to Micro Motion UL, CSA, or SAA installation instructions for appropriate transmitter grounding procedures.
   - For installations in which the sensor is in a **non-hazardous** area, install grounding wires as illustrated in **Figure 4-3**.
   - For European installations in which the sensor is in a hazardous area, install grounding wires as illustrated in **Figure 4-4**.

Figure 4-2.
Power-supply wiring

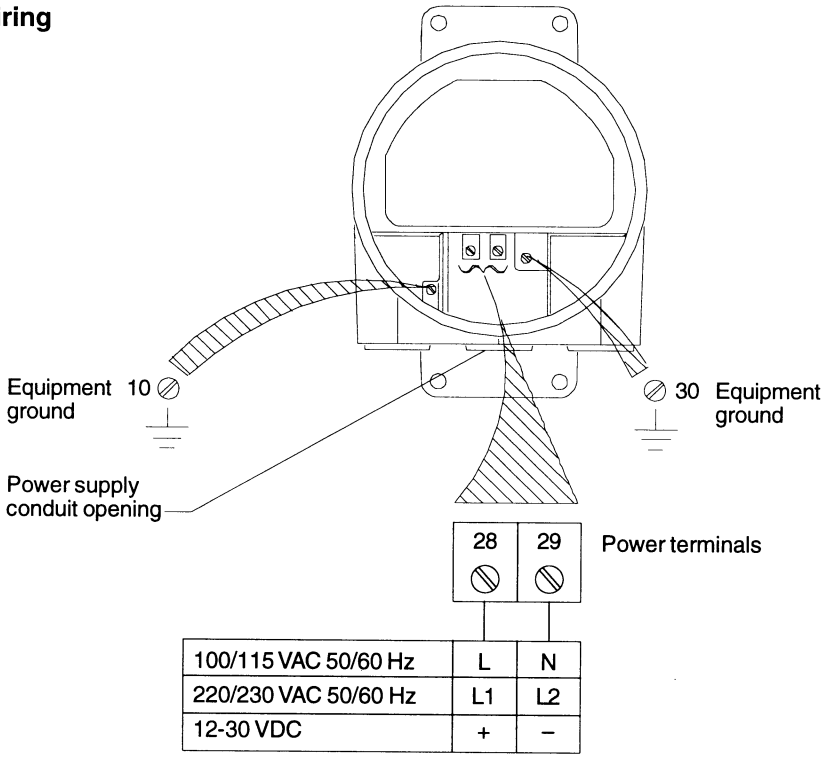
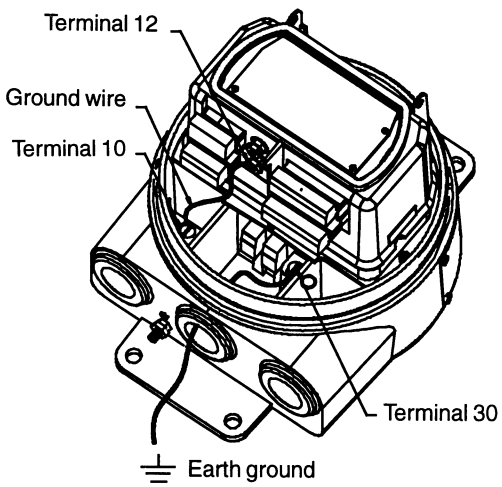


Figure 4-3.
Grounding detail: Non-hazardous sensor installations

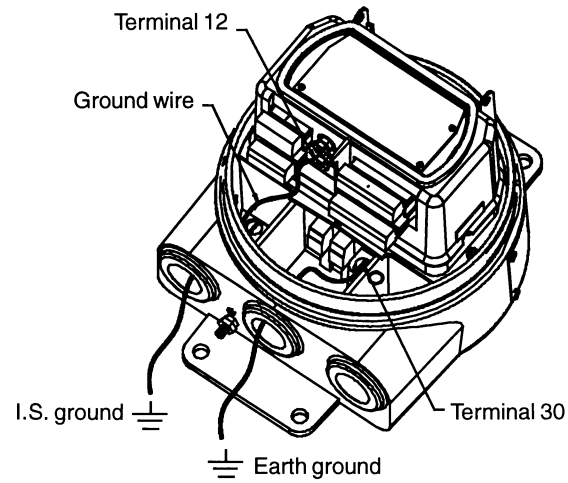


Notes for Figure 4-3.

If national standards are not in effect, adhere to this standard:

- Use copper wire, 14 AWG (2.5 mm²) or larger wire size, for grounding.
- Keep all ground leads as short as possible, <1 ohm impedance.
- Connect power-supply ground, terminal 30, directly to earth.
- Connect intrinsically safe ground, terminal 12, directly to equipment ground, terminal 10.

Figure 4-4. Grounding detail: Intrinsically safe sensor installations in Europe



Notes for Figure 4-4.

Because CENELEC standards do not cover grounding/bonding for intrinsically safe (I.S.) installations, national standards must be followed. If national standards are not in effect, adhere to this standard:

- Use copper wire, 14 AWG (2.5 mm^2) or larger wire size, for grounding.
- Keep all ground leads as short as possible, <1 ohm impedance.
- Connect power-supply ground, terminal 30, directly to earth.
- Connect I.S. ground from terminal 12 to high-integrity ground.
- I.S. ground wire must not be routed with other wires.
- Connect power-supply ground wire to either transmitter terminal 30 **or** (external) equipment ground screw 13. Do not use equipment ground screw 10.

4.3 Sensor wiring

These instructions explain how to prepare factory-supplied cable and cable glands for a Micro Motion Coriolis flowmeter. The sensor can be a Model D, DL, DT, ELITE, or BASIS sensor.

⚠CAUTION

Improper installation of cable, cable gland, or conduit could cause inaccurate measurements or flowmeter failure.

- Carefully prepare cables to avoid grounding the drain wires or shields to the transmitter housing, sensor enclosure, conduits, or other parts.
- Install factory-supplied cable glands to the sensor wiring conduit opening in the transmitter housing and the conduit opening in the sensor junction box.
- Keep cable away from devices such as transformers, motors, and power lines, which produce large magnetic fields.

- Use Micro Motion color-coded cable. Micro Motion supplies 10 feet (3 meters) of PVC-jacketed cable with each sensor. Longer cable lengths and Teflon® FEP-jacketed cable are available from Micro Motion.
- Total length of cable from the sensor to the transmitter must not exceed 1000 feet (300 meters).

- To ensure proper sealing of cable, install conduit or factory-supplied cable glands in the sensor wiring conduit opening in the transmitter and the conduit opening in the sensor junction box.
- If conduit is not used, make sure the cable jacket material is compatible with the application environment. To select the appropriate cable jacket material, refer to **Table 4-1**.
- Keep sensor cable away from power lines and devices such as transformers and motors, which produce large magnetic fields.

Table 4-1. Temperature ranges for cable jacket material

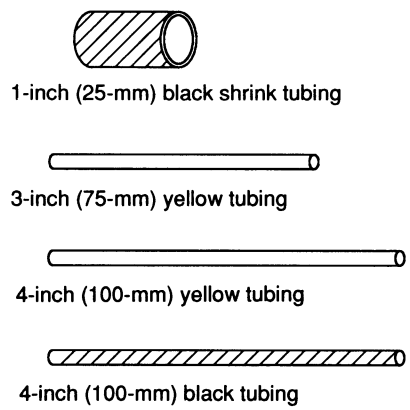
Cable jacket material	Low operating temperature limit	High operating temperature limit
PVC	23°F (–5°C)	140°F (60°C)
Teflon® FEP	–58°F (–50°C)	302°F (150°C)

Cable preparation

The cable preparation package includes the parts listed below and illustrated in **Figure 4-5**.

- Two pieces 1-inch (25-mm) black heat-shrink tubing
- One piece 3-inch (75-mm) yellow tubing
- One piece 4-inch (100-mm) yellow tubing
- One piece 4-inch (100-mm) black tubing

Figure 4-5. Cable preparation package

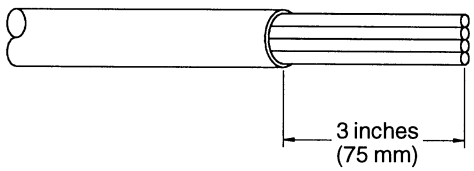


Cable preparation, sensor (junction box) end

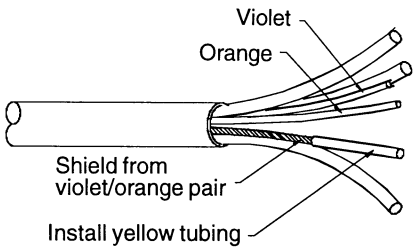
To prepare the cable end connecting to an ELITE CMF sensor, a BASIS™ F sensor, a Model D or DL sensor, or to the user-supplied junction box for a Model DT sensor, follow these steps:

1. Remove a 3-inch (75-mm) length of sheathing from the cable, and remove the fibrous material between the wires. Do not separate the twisted pairs of shielded wires yet.
2. Remove the foil wrapping around the **violet/orange** pair of wires, separate them and separate the shield from this pair.
3. Slip the 3-inch (75-mm) piece of yellow tubing over the shield of the **violet/orange** pair of wires. Leave as little distance as possible between the yellow tubing and the cable sheathing to reduce the amount of exposed wire.
4. Remove the foil wrapping around the other three pairs of shielded wires and separate them. Clip each shield off as close as possible to the cable sheathing.
5. Slip one piece of the 1-inch (25-mm) black heat-shrink tubing over all the wires and cable sheathing. The black tubing should completely cover all portions of the **violet/orange** wire shield remaining exposed next to the cable sheathing.
6. Without burning the cable, use a heat gun to shrink the tubing.
7. After the cable has cooled, strip ¼ inch (6 mm) of insulation from the individual wires. If less than ¼ inch (6 mm) of shielded wire extends from the yellow tubing, trim the tubing.
8. It these steps have been correctly followed, the sensor end should have nine wires.

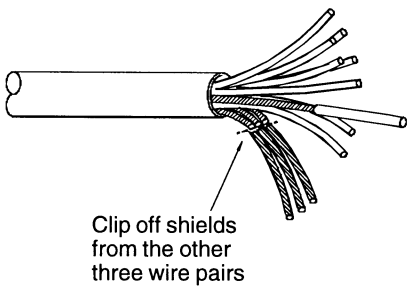
Step 1



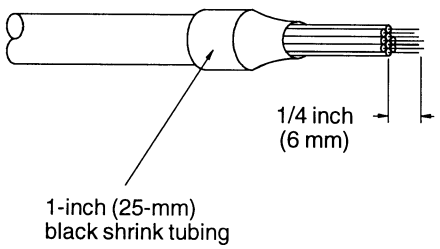
Steps 2 and 3



Step 4

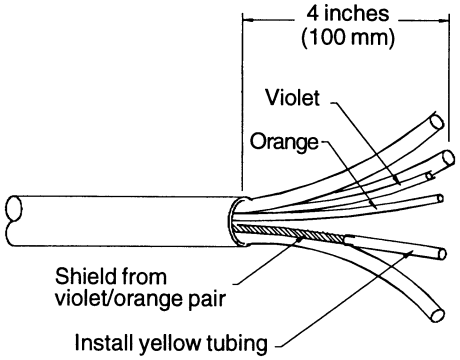


Steps 5, 6, and 7

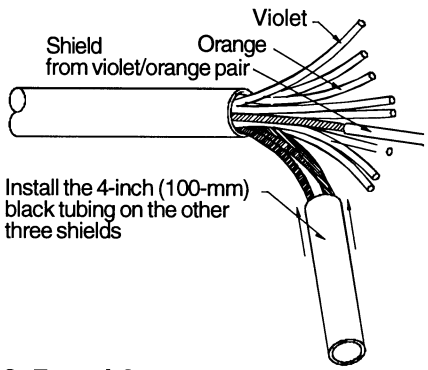


Cable preparation, transmitter end

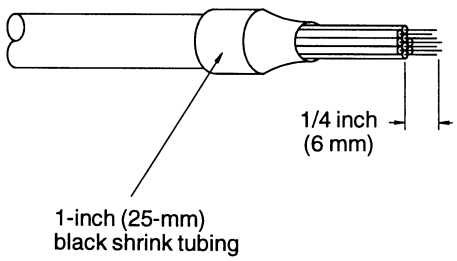
Steps 2, 3, and 4



Step 5



Steps 6, 7, and 8



If preparing the transmitter end is necessary, follow these steps:

1. If conduit is installed, run the unprepared end of the cable through the conduit from the sensor site.
2. Remove a 4-inch (100-mm) length of sheathing from the cable, and remove the fibrous material between the wires. Do not separate the twisted pairs of shielded wires yet.
3. Remove the foil wrapping around the **violet/ orange** pair of wires and separate them.
4. Slip the 4-inch (100-mm) piece of yellow tubing over the shield of the **violet/orange** pair of wires. Leave as little distance as possible between the yellow tubing and the cable sheathing to reduce the amount of exposed shield.
5. Remove the foil wrapping around the other three pairs of shielded wires and separate them. Twist the three remaining shields together. Slip the 4-inch (100-mm) piece of black tubing over these three shields and push the tubing as close as possible to the cable sheathing.
6. Slip one piece of the 1-inch (25-mm) black heat-shrink tubing over the wires and cable sheathing. The tubing should completely cover all exposed portions of the shields.
7. Without burning the cable, use a heat gun to shrink the tubing.
8. After the cable has cooled, strip ¼ inch (6 mm) of insulation from the individual wires. If less than ¼ inch (6 mm) of shielded wire extends from the yellow or black tubing, trim the tubing.
9. It these steps have been correctly followed, the transmitter end should have ten wires.

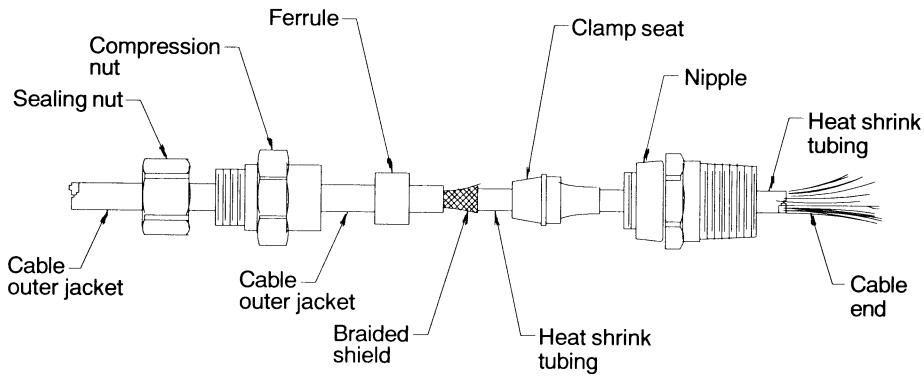
Cable gland assembly

The gland includes these parts:
- Sealing nut
- Compression nut
- Ferrule
- Clamp seat (integral to nipple on some glands)
- Nipple

NOTE
Gland assembly is the same for sensor and transmitter ends of the cable.

To assemble a cable gland for either end of the cable, refer to **Figure 4-6** and follow these steps:
1. Thread the nipple into the conduit opening. Tighten the nipple one to two turns past hand-tight to ensure good electrical contact.
2. Slide the sealing nut, compression nut, and ferrule onto the cable. Make sure to orient the ferrule so it will secure the shield.
3. Flare the exposed shield.
4. Slide the clamp seat under the shield.
5. Insert the cable end through the nipple.
6. Slide the ferrule over the shield.
7. Thread the compression nut onto the nipple. Torque the compression nut to 20-25 ft-lb (30 Newton-meters).
8. Thread the sealing nut onto the compression nut. Torque the sealing nut to 20-25 ft-lb (30 Newton-meters).

Figure 4-6. Cable gland assembly



Connections to sensor and transmitter

⚠WARNING

Operating the transmitter without covers in place exposes electrical hazards that can cause property damage, injury, or death.

For personal and system safety, make sure the safety barrier partition, electronics module cover, and housing cover are securely in place before operating the transmitter.

⚠CAUTION

Operating the sensor above 300°F (150°C) could cause oxidation at terminals, resulting in measurement error or flowmeter failure.

If the sensor continuously operates above 300°F (150°C), apply an inhibitor such as zinc chromate, to prevent oxidation of contacts.

⚠CAUTION

Failure to seal sensor junction box and transmitter housing could cause a short circuit, which would result in measurement error or flowmeter failure.

To avoid risk of condensation or excessive moisture in the junction box or transmitter housing:
- Seal all conduit openings.
- Install drip legs in conduit or cable.
- Fully tighten junction box cover.

The wiring procedure is the same for the sensor and transmitter. Refer to the wiring diagrams on pages 23 and 24, and follow these steps:

1. Insert the stripped ends of the individual wires into the terminal blocks. No bare wires should remain exposed.
   - At the sensor, connect wiring inside the sensor junction box.
   - At the transmitter, connect wiring to the transmitter's intrinsically safe terminals for sensor wiring, as numbered in **Table 4-2**. Transmitter terminal blocks can be unplugged for easier connection of wiring.
2. Locate the wires by color as indicated in **Table 4-2**.
3. Tighten the screws to hold the wires in place.
4. Tightly close the sensor junction-box cover or transmitter housing. On an ELITE sensor junction box, tighten all four cover screws.

Table 4-2.
Terminal designations

Wire color	Sensor terminal	Transmitter terminal	Function
Black*	no connection	0	Drain wires*
Brown	1	1	Drive +
Red	2	2	Drive –
Orange	3	3	Temperature –
Yellow	4	4	Temperature return
Green	5	5	Left pickoff +
Blue	6	6	Right pickoff +
Violet	7	7	Temperature +
Gray	8	8	Right pickoff –
White	9	9	Left pickoff –

*Combined drain wires from brown/red, green/white, and gray/blue pairs, and yellow/orange/violet triplet.

Figure 4-7. Wiring diagram: ELITE® sensors to RFT9739 transmitters

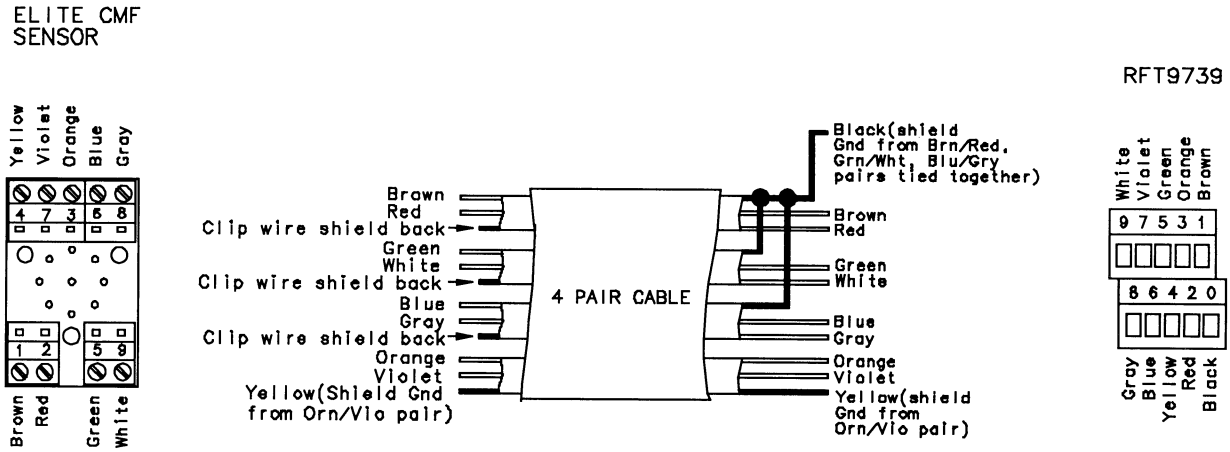


Figure 4-8. Wiring diagram: BASIS™, D, and DL sensors to RFT9739 transmitters

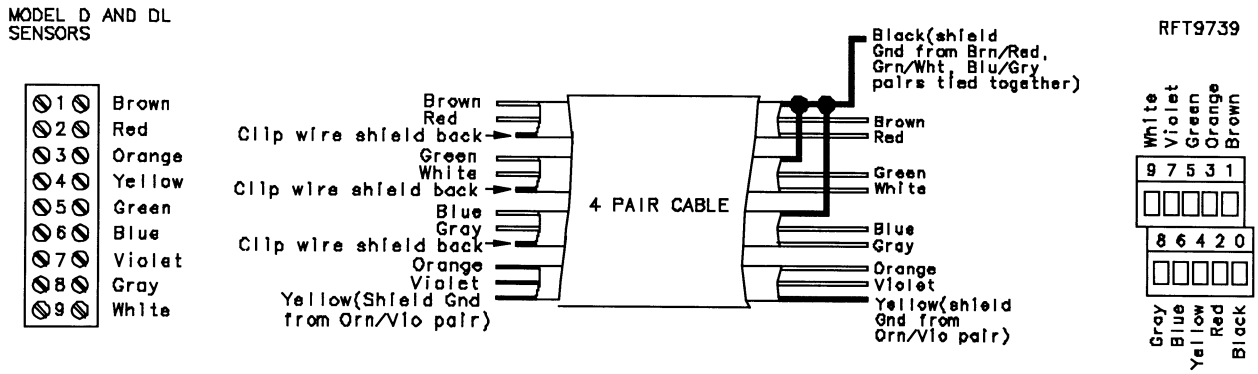
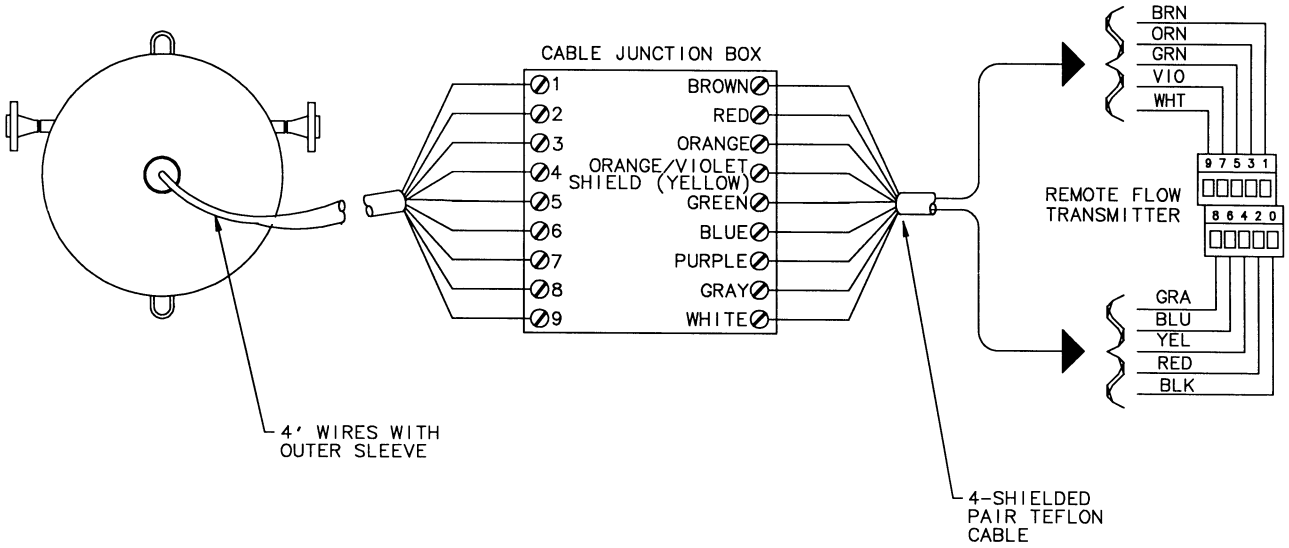


Figure 4-9. Wiring diagram: DT sensors to RFT9739 transmitters



5 Output Wiring

NOTE

Instructions in this chapter pertain only to Version 2 transmitters. Do not use these instructions to wire transmitters shipped before May 1993.

To identify the transmitters version, see **Appendix H.**

5.1 General guidelines

⚠WARNING

Failure to comply with requirements for intrinsic safety in a hazardous area could result in an explosion.

Output wiring is not intrinsically safe.

- Keep output wiring separated from power-supply wiring and intrinsically safe sensor wiring.
- Follow all output wiring instructions to ensure the transmitter and any connected devices will operate correctly.
- Make sure the safety barrier partition is in place before operating the transmitter.

A removable partition on the electronics module keeps intrinsically safe wiring to the sensor separated from non-intrinsically safe output wiring. Use the upper and lower blocks on the right side of the partition for output wiring connections. **Figure 5-1** and **Table 5-1** describe terminal designations for the output terminals. Terminal blocks can be unplugged from the module for easier installation of wiring.

- The transmitter has separate conduit openings for power-supply wiring and output wiring.
- To avoid possible electrical interference, do not install output wiring in the same conduit or cable tray as sensor cable or power-supply wiring.
- Use individually shielded pairs of 22 AWG (0.3 mm^2) or larger wires for connections between the transmitter and any peripheral device.
- Shields and/or drain wires must be terminated outside the transmitter housing, or left floating, as required by the installation. Do not allow shield or drain wires to enter the transmitter housing.
- Maximum wire length between the transmitter and any peripheral device is 500 feet for 22 AWG wire (150 meters for 0.3 mm^2 wire), 50 feet for 28 AWG wire (15 meters for 0.1 mm^2 wire).

Figure 5-1.
Output terminals

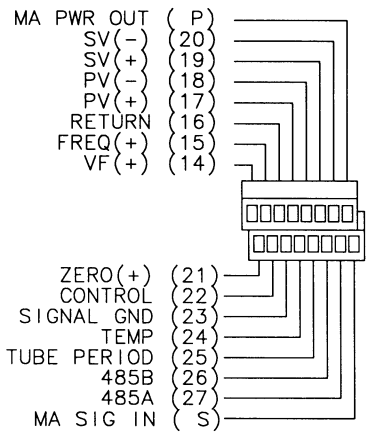


Table 5-1. Output terminal designations

Terminal number	Function	Terminal number	Function
14	DC voltage frequency output	23	Signal ground
15 and 16	Frequency/pulse output	24 and 23	Temperature output
17 and 18	Primary mA output	25 and 23	Tube period output
19 and 20	Secondary mA output	27 and 26	RS-485 I/O
21 and 16	Remote zero input	P	DC power to pressure transmitter
22 and 16	Control output	S	mA input from pressure transmitter

5.2 Primary and secondary mA outputs

The primary and secondary output signals can be independently configured, and can represent flow, density, temperature, event 1 or event 2. With a pressure or differential pressure transmitter, the primary and secondary output signals can also represent pressure, differential pressure or viscosity. For information on configuring the control output for events, see any of the following manuals:

- *Using the HART Communicator with Micro Motion Transmitters*
- *Using Modbus Protocol with the Micro Motion ELITE Model RFT9739 Transmitter*
- *Using ProLink Software with Micro Motion Transmitters*

The mA outputs can produce a user-selected 0-20 or 4-20 mA current. When configured as 4-20 mA outputs, they can supply loop-powered process indicators such as the Micro Motion PI 4-20.

Use transmitter terminals 17 and 18 for the primary mA output. Terminal 17 (PV+) is the signal line, and terminal 18 (PV–) is the return. Use terminals 19 and 20 for the secondary mA output. Terminal 19 (SV+) is the signal line, and terminal 20 (SV–) is the return.

NOTE

The negative signals can be grounded or left floating. If the output communicates via HART protocol, the negative signal should be grounded for optimal performance.

- The maximum allowable length for mA signal wiring is determined by measuring resistance over the signal wires and through the receiver device. Total loop resistance must not exceed 1000 ohms.
- The primary mA output must be set to the 4-20 mA mode for the Bell 202 physical layer. The Bell 202 layer will not work with the primary mA output configured as a 0-20 mA output.
- SMART FAMILY devices require a minimum loop resistance of 250 ohms. Loop resistance must not exceed 1000 ohms, regardless of the communication setup. The 250 ohm resistance must be between the SMART FAMILY device and the loop power supply.

5.3 Frequency/pulse output

The frequency/pulse output represents the flow rate or flow total (inventory), independent of the primary and secondary mA outputs. The frequency/pulse output connects to all Micro Motion peripheral devices except the DMS Density Monitoring System and the PI 4-20 Process Indicator, which do not have frequency inputs.

Use transmitter terminals 15 and 16 for the frequency/pulse output. Terminal 15 (FREQ+) is the signal line and terminal 16 (RETURN) is the return. The frequency/pulse output, control output, and external zero input share terminal 16 as a common return.

- The output circuit is rated to 30 VDC, with 0.1 ampere maximum sinking capability, when used in open collector mode.
- Transmitter output is a nominal 15-volt logic-level square wave, unloaded. Any load will decrease the peak voltage level.
- Output impedance is 2.2 kohm at the 15-volt logic level.
- For use with receivers other than Micro Motion peripheral devices, check the instruction manual for the receiver to make sure its input-voltage and electrical-current ratings match the output-voltage and electrical-current ratings of the transmitter.

5.4 Control output

The control output can indicate flow direction, transmitter zeroing in progress, faults, event 1 or event 2. For information on configuring the control output for events, see any of the following manuals:

- *Using the HART Communicator with Micro Motion Transmitters*
- *Using Modbus Protocol with the Micro Motion ELITE Model RFT9739 Transmitter*
- *Using ProLink Software with Micro Motion Transmitters*

Use transmitter terminals 22 and 16 for the control output. Terminal 22 (+) is the signal line and terminal 16 (–) is the return. The frequency/pulse output, control output, and external zero input share terminal 16 as a common return.

- When configured to indicate flow direction, the output is high (+15 V) when indicating forward flow, and low (0 V) when indicating reverse flow.
- When configured to indicate transmitter zeroing in progress, the output is low (0 V) when zeroing is in progress and high (+15 V) at all other times.
- When configured to indicate faults, the output is low (0 V) when a fault condition exists and high (+15 V) during normal operation.
- When configured to indicate event 1 or event 2, the output switches ON (0 V) or OFF (+15 V) when the flow rate, flow total, density, temperature, pressure, or viscosity of the process fluid achieves a programmed setpoint.
- The output circuit is rated to 30 VDC, with 0.1 ampere maximum sinking capability.
- Transmitter output is nominal 0 or +15 V, unloaded.
- Output impedance is 2.2 kohm.

5.5 Peripheral device wiring

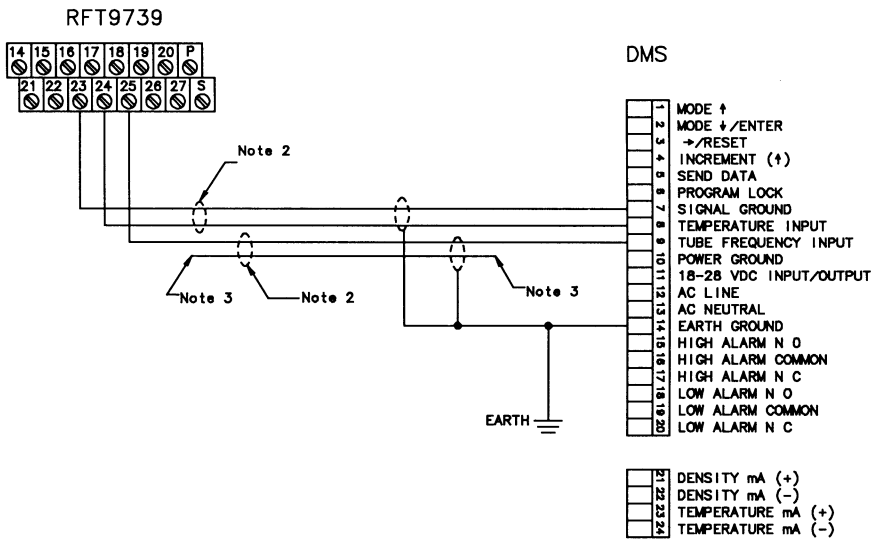
The wiring diagrams below and on the following pages illustrate wiring connections from the transmitter to Micro Motion peripheral devices.

- Use **Figure 5-2** for a DMS Density Monitoring System
- Use **Figure 5-3a** for an LED-model DRT Digital Rate Totalizer
- Use **Figure 5-3b** for an LCD-model DRT Digital Rate Totalizer
- Use **Figure 5-4a** for an LED-model FMS-3 Flow Monitoring System
- Use **Figure 5-4b** for an LCD-model FMS-3 Flow Monitoring System
- Use **Figure 5-5** for an NFC Net Flow Computer
- Use **Figure 5-6a** for an AC-powered NOC Net Oil Computer
- Use **Figure 5-6b** for a DC-powered NOC Net Oil Computer

Connect wiring as illustrated, and follow these guidelines:

- Use individually shielded pairs of wires for connections between the transmitter and the peripheral device.
- Install 22 AWG (0.3 mm²) or larger wire.
- Maximum wire length between the transmitter and the peripheral device is 500 feet for 22 AWG wire (150 meters for 0.3 mm² wire), 50 feet for 28 AWG wire (15 meters for 0.1 mm² wire).

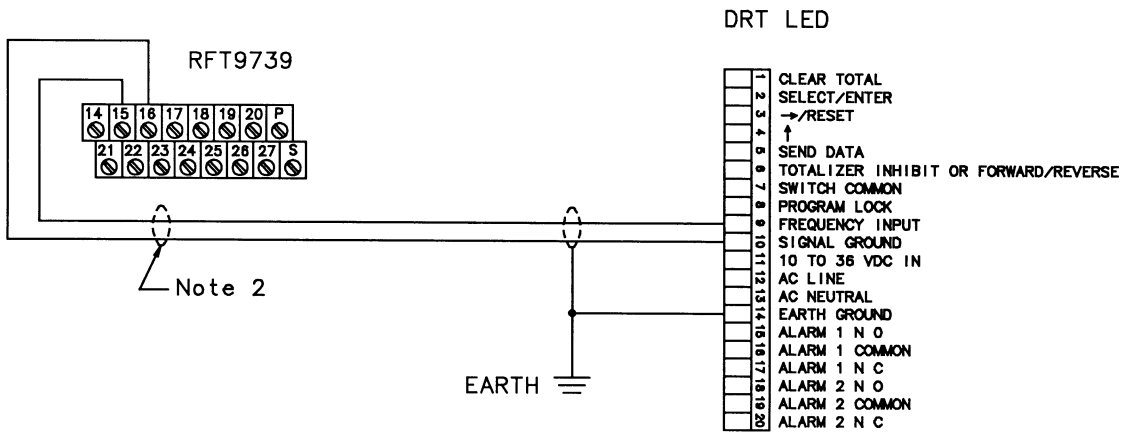
Figure 5-2. Wiring connections: RFT9739 to DMS



Notes for Figure 5-2.

1. Paired cables with shield. 50 ft. max. length for 28 AWG wire (15 meter max. for 0.1 mm² wire), 500 ft. for 22 AWG wire (150 meter for 0.3 mm² wire).
2. Clip shields at this end.
3. This wire not terminated.

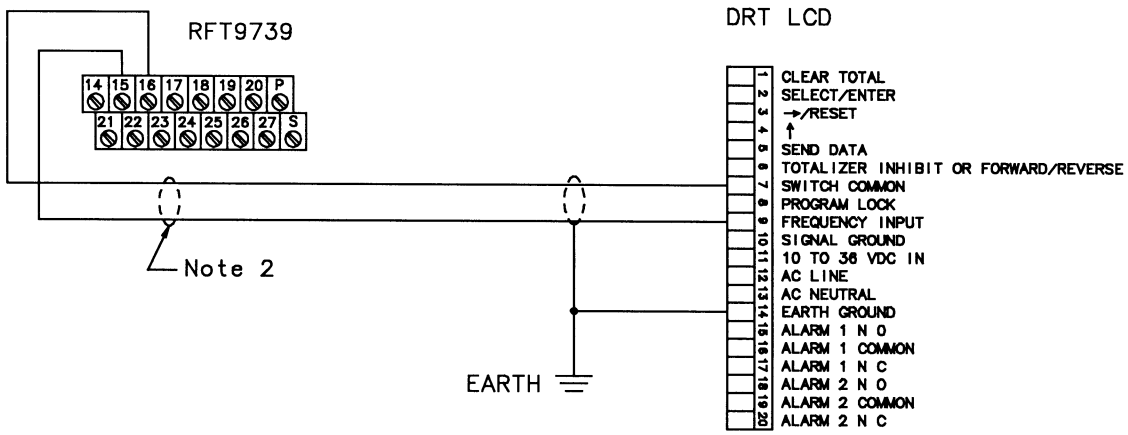
Figure 5-3a. Wiring connections: RFT9739 to DRT with LED



Notes for Figure 5-3a.

1. Paired cables with shield. 50 ft. max. length for 28 AWG wire (15 meter max. for 0.1 mm² wire), 500 ft. for 22 AWG wire (150 meter for 0.3 mm² wire).
2. Clip shields at this end.

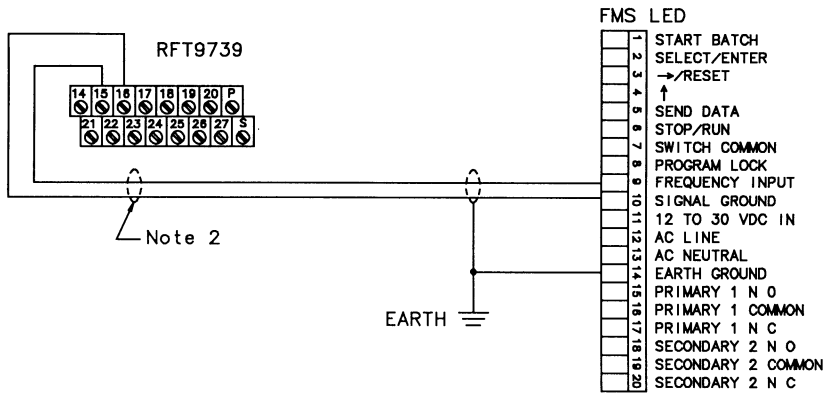
Figure 5-3b. Wiring connections: RFT9739 to DRT with LCD



Notes for Figure 5-3b.

1. Paired cables with shield. 50 ft. max. length for 28 AWG wire (15 meter max. for 0.1 mm² wire), 500 ft. for 22 AWG wire (150 meter for 0.3 mm² wire).
2. Clip shields at this end.

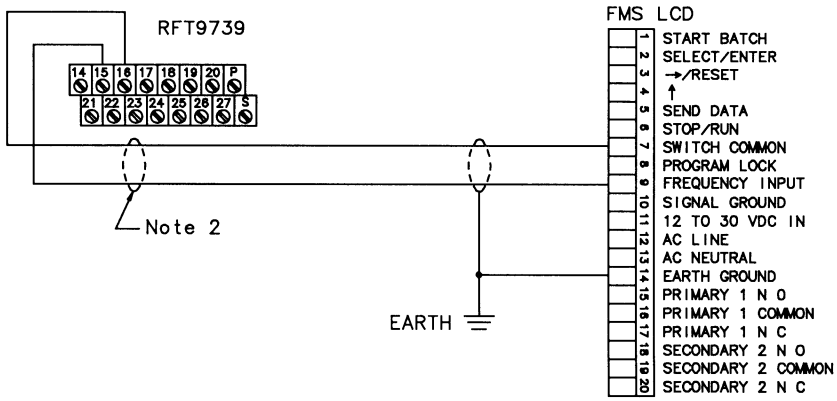
Figure 5-4a. Wiring connections: RFT9739 to FMS-3 with LED



Notes for Figure 5-4a.

1. Paired cables with shield. 50 ft. max. length for 28 AWG wire (15 meter max. for 0.1 mm^2 wire), 500 ft. for 22 AWG wire (150 meter for 0.3 mm^2 wire).
2. Clip shields at this end.

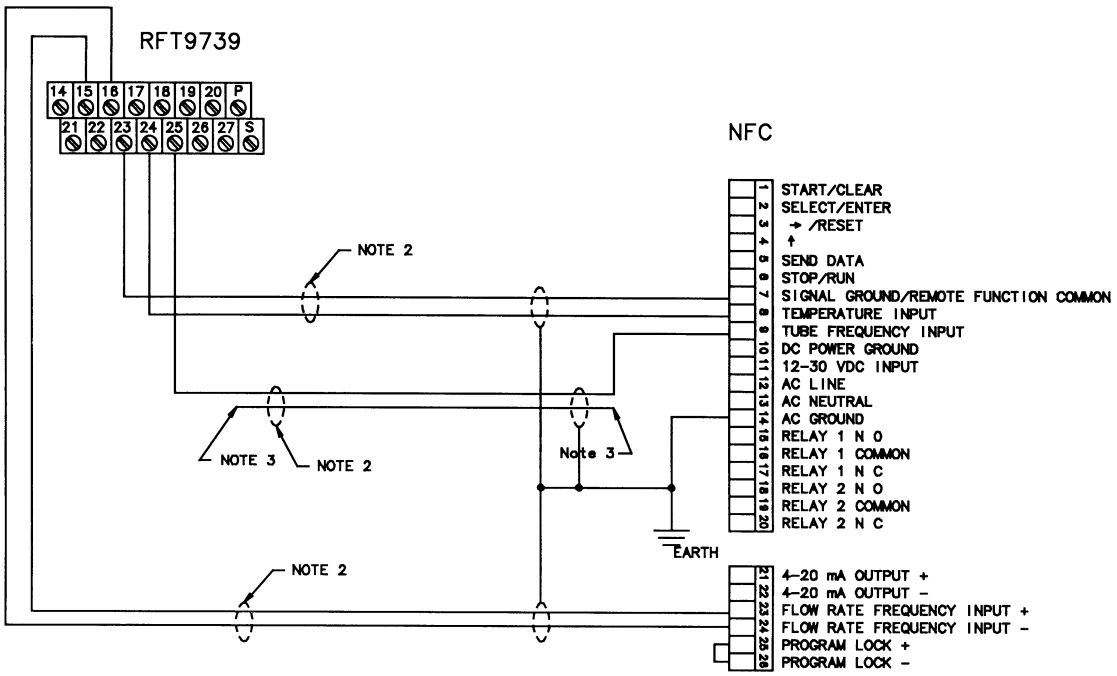
Figure 5-4b. Wiring connections: RFT9739 to FMS-3 with LCD



Notes for Figure 5-4b.

1. Paired cables with shield. 50 ft. max. length for 28 AWG wire (15 meter max. for 0.1 mm^2 wire), 500 ft. for 22 AWG wire (150 meter for 0.3 mm^2 wire).
2. Clip shields at this end.

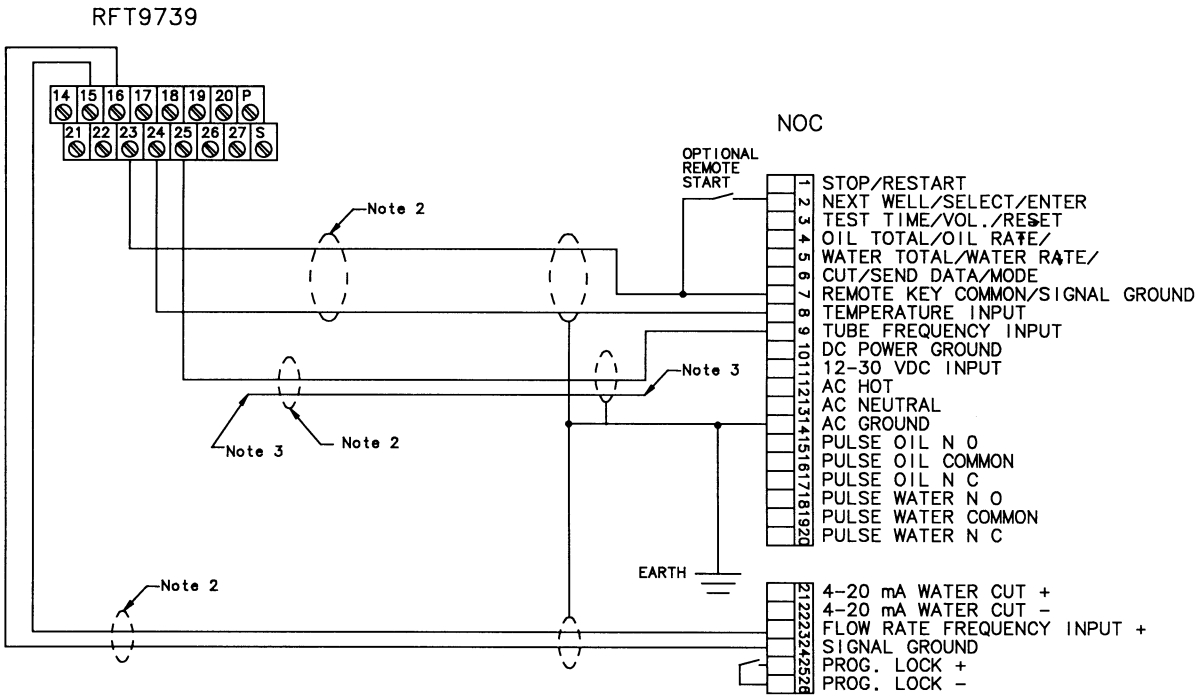
Figure 5-5. Wiring connections: RFT9739 to NFC



Notes for Figure 5-5.

1. Paired cables with shield. 50 ft. max. length for 28 AWG wire (15 meter max. for 0.1 mm^2 wire), 500 ft. for 22 AWG wire (150 meter for 0.3 mm^2 wire).
2. Clip shields at this end.
3. This wire not terminated.

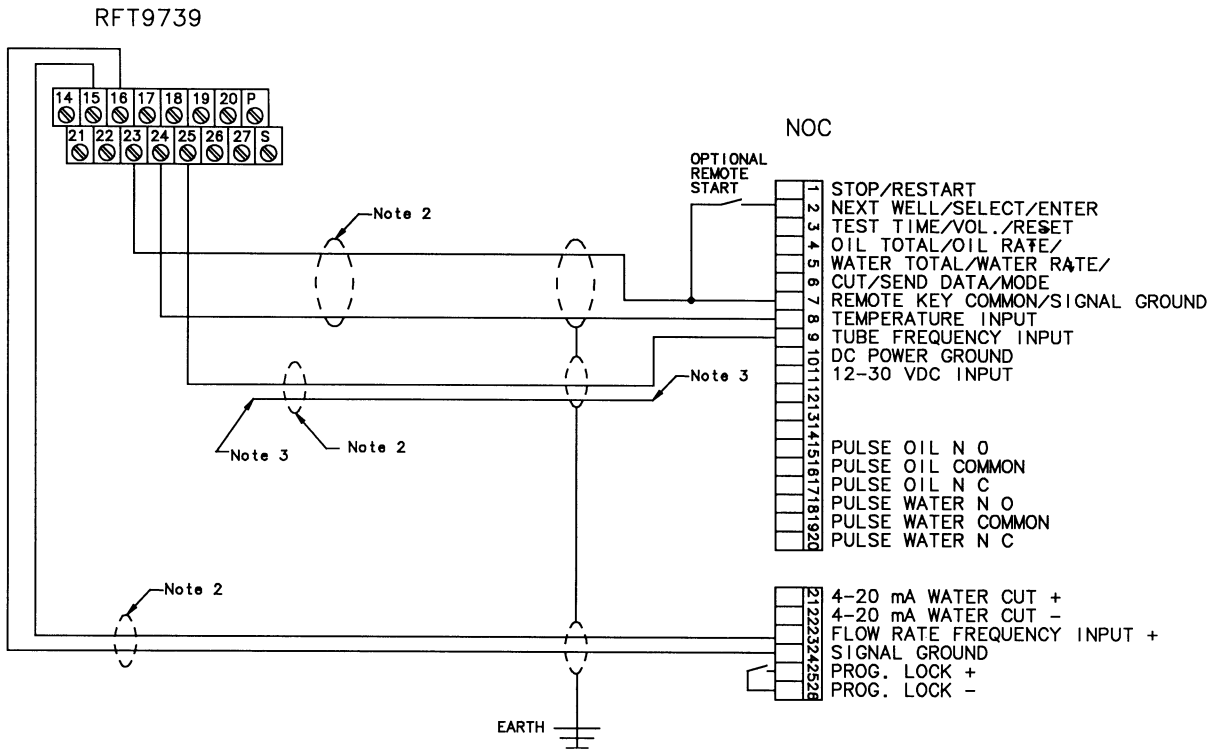
Figure 5-6a. Wiring connections: RFT9739 to AC-powered NOC



Notes for Figure 5-6a.

1. Paired cables with shield. 50 ft. max. length for 28 AWG wire (15 meter max. for 0.1 mm^2 wire), 500 ft. for 22 AWG wire (150 meter for 0.3 mm^2 wire).
2. Clip shields at this end.
3. This wire not terminated.

Figure 5-6b. Wiring connections: RFT9739 to DC-powered NOC



Notes for Figure 5-6b.

1. Paired cables with shield. 50 ft. max. length for 28 AWG wire (15 meter max. for 0.1 mm^2 wire), 500 ft. for 22 AWG wire (150 meter for 0.3 mm^2 wire).
2. Clip shields at this end.
3. This wire not terminated.

5.6 Pressure transmitter wiring

⚠WARNING

Failure to comply with requirements for intrinsic safety in a hazardous area could result in an explosion.

Pressure transmitter wiring is not intrinsically safe.

- Keep pressure transmitter wiring separated from power-supply wiring, intrinsically safe sensor wiring, and any other intrinsically safe wiring.
- Make sure the safety barrier partition is in place before operating the transmitter.

The pressure transmitter must produce a 4-20 mA current, which represents differential pressure or gauge pressure. If the input represents differential pressure, the RFT9739 uses flow and density inputs from the sensor, and the 4-20 mA signal from the pressure transmitter, to calculate viscosity. If the input indicates gauge pressure, the RFT9739 uses the 4-20 mA signal from the pressure transmitter to compensate for the effects of pressure on ELITE CMF100, CMF200 and CMF300 sensors, and Model DL100, DL200, D300 and D600 sensors. Most applications do not require pressure compensation.

- If the pressure transmitter requires a power supply no greater than 11.75 V, the RFT9739 can power the pressure transmitter. The output circuit is rated to 15 VDC. Use terminal P (MA PWR OUT) as the power output to the pressure transmitter, and terminal S (MA SIG IN) as the signal input to the RFT9739, as shown in **Figure 5-7a**.
- If the pressure transmitter requires a power supply greater than 11.75 V, or if other loop devices are required, an external source can power the pressure transmitter. Use terminal S (MA SIG IN) as the signal input to the RFT9739, and terminal 23 (SIGNAL GND) as the return, as shown in **Figure 5-7b**.
- If digital communication between the pressure transmitter and the RFT9739 is required, use primary variable terminals 17 (PV+) and 18 (PV–), as shown in **Figure 5-7c**. For detailed instructions on using digital communications for viscosity measurement, contact the Micro Motion Customer Service department:
  - In the U.S.A., phone 1-800-522-6277, 24 hours
  - Outside the U.S.A., phone 303-530-8400, 24 hours
  - In Europe, phone (0)318 549 431

5.7 External zero switch wiring

The transmitter can be configured to allow transmitter zeroing from an external switch. **Section 6.3** explains the external-switch method and two other methods for zeroing the transmitter.

To connect an external switch for zeroing the transmitter, use terminal 21 (+) as the signal line and terminal 16 (–) as the return. The external zero input, control output, and frequency/pulse output share terminal 16 as a common return.

- The switch must be a momentary-type contact, normally open, and must carry 1 mA of current in the closed position. The open circuit voltage is 5 VDC.
- Before using an external switch for transmitter zeroing, set the hardware switch labeled EXT. ZERO on the transmitter's electronics module to ON.

Figure 5-7a. Wiring connections: RFT9739 to pressure transmitter, analog input

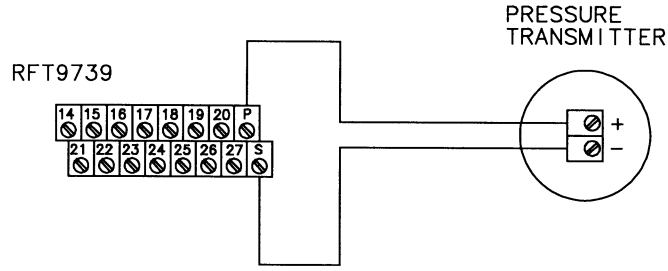
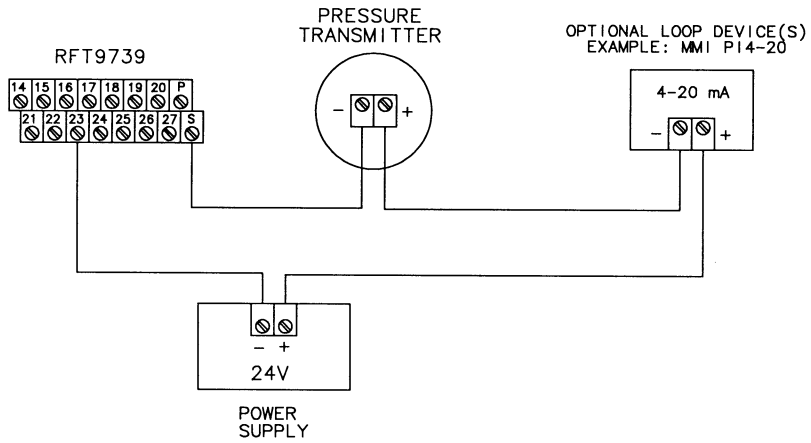


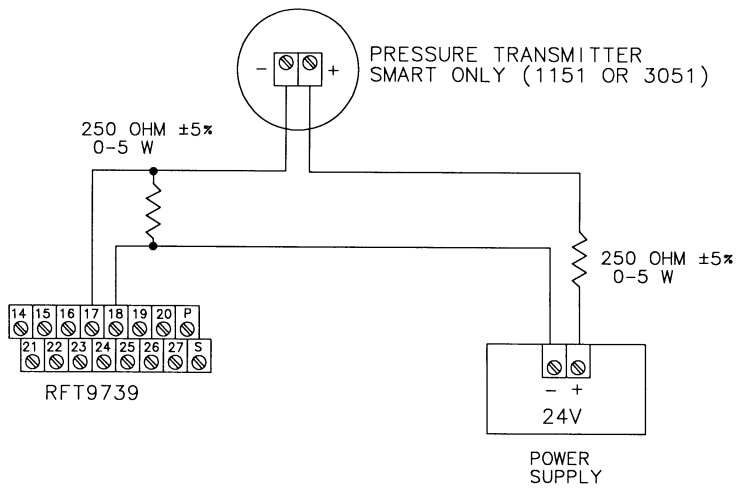
Figure 5-7b. Wiring connections: RFT9739 to pressure transmitter, external power, analog input



Note for Figure 5-7b.

Terminal 23 must be connected directly to the negative (–) terminal of the external power supply.

Figure 5-7c. Wiring connections: RFT9739 to pressure transmitter, digital communications



Note for Figure 5-7c.

The HART Communicator should be connected to the communicator hookup loops on the RFT9739 or the pressure transmitter. The location of the communicator hookup loops on the RFT9739 is illustrated in **Figure 7-1**.

5.8 RS-485 multidrop network

Multiple transmitters can participate in an RS-485 multidrop network that uses HART or Modbus protocol.

- Under HART protocol, up to 32 transmitters can participate in the network. Each transmitter must have a unique tag name. If polling addresses are used, up to 16 transmitters can have unique polling addresses from 0 to 15.
- Under Modbus protocol, up to 15 transmitters can participate in the network. Each transmitter must have a unique polling address from 1 to 15.

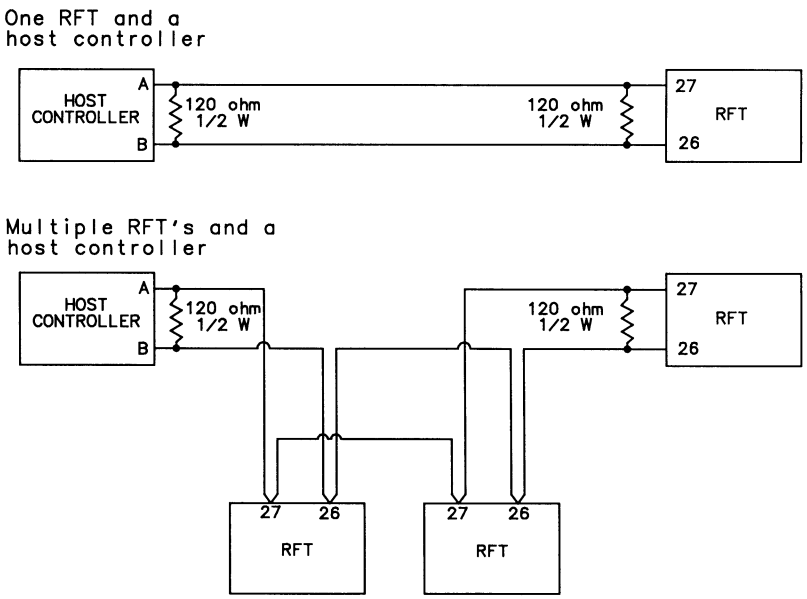
Figure 5-8 shows how to connect one transmitter or multiple transmitters to a host controller for RS-485 serial communication. Use transmitter terminals 27 and 26. Terminal 27 is the "A" line and terminal 26 is the "B" line.

- Install twisted-pair, shielded cable, consisting of 24 AWG (0.3 mm²) or larger wire, between the transmitter and an RS-485 communication device. Maximum cable length is 4000 feet (1200 meters).
- Some installations require a 120-ohm, ½-watt resistor at both ends of the network cable to reduce electrical reflections.
- Software switches on the electronics module of the transmitter allow the choice of Bell 202, RS-485, or simultaneous Bell 202 (HART protocol) and RS-485 (Modbus protocol) physical layers. Make sure switches are set as instructed in **Chapter 2** before attempting to use the transmitter in a multidrop network.

For information on communication protocol requirements for implementing an RS-485 network, phone the Micro Motion Customer Service Department:

- In the U.S.A., phone 1-800-522-6277, 24 hours
- Outside the U.S.A., phone 303-530-8400, 24 hours
- In Europe, phone (0)318 549 431

Figure 5-8. RS-485 wiring



Note for Figure 5-8.

For long-distance communication, or if noise from an external source interferes with the signal, install 120-ohm ½-watt resistors across terminals of both end devices.

5.9 Bell 202 multidrop network

Up to 10 transmitters can be connected into a Bell 202 multidrop network that uses HART protocol. Other Rosemount SMART FAMILY transmitters can also participate in a HART-compatible network. A Model 268, Model 275, or other HART-compatible control system can communicate with any device in the network over the same 2-wire pair.

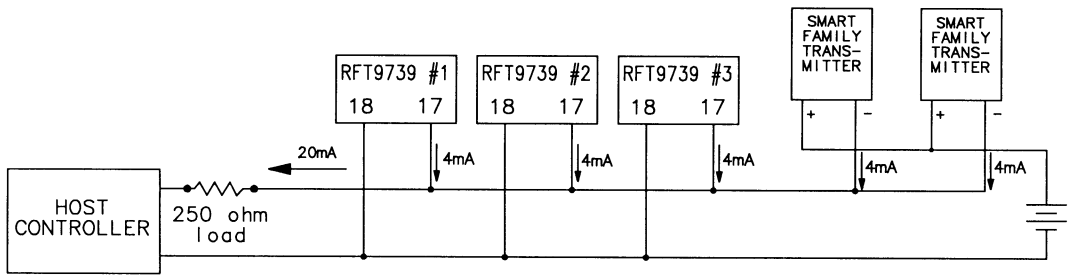
Using multiple transmitters in a HART-compatible network requires assigning a unique address from 1 to 15 to each transmitter.

- Assigning an address of 1 to 15 to the transmitter causes the primary mA output to remain at a constant 4 mA level.
- The primary mA output must produce a 4-20 mA current for the Bell 202 physical layer. The Bell 202 layer will not work with the primary mA output configured as 0-20 mA output.

Figure 5-9 shows how to connect wiring for a HART-compatible network. Use transmitter terminals 17 and 18. Terminal 17 (PV+) is the signal line, and terminal 18 (PV–) is the return.

- SMART FAMILY devices require a minimum loop resistance of 250 ohms. Loop resistance must not exceed 1000 ohms.
- Connect the mA outputs from each transmitter together so they terminate at a common load resistor, with at least 250 ohms impedance, installed in series.
- Software switches on the electronics module of the transmitter allow the choice of Bell 202, RS-485, or simultaneous Bell 202 (HART protocol) and RS-485 (Modbus protocol) physical layers. Make sure switches are set as instructed in **Chapter 2** before attempting to use the transmitter in a multidrop network.

Figure 5-9. HART® network wiring



Note for Figure 5-9.

For optimum HART communication, ensure that the output loop is grounded properly.

6 Startup

6.1 Initialization

After wiring has been connected, power can be supplied to the transmitter. During initialization, the light emitting diode (LED) on the electronics module remains on continuously, while the transmitter performs a self-diagnostic test. After initialization is completed, the LED blinks ON once per second to indicate proper operation of the transmitter.

NOTE

For DC-powered transmitters, at startup, the transmitter power source must provide a minimum of 2 amps of short-term current at a minimum of 12 volts at the transmitter's power input terminals.

If the startup voltage is pulled below 12 VDC, the transmitter could remain in the startup loop indefinitely.

6.2 Using the diagnostic LED

The diagnostic LED indicates the operating condition of the transmitter. **Figure 6-1** shows the location of the LED on the transmitter electronics module. For information about using the diagnostic LED for troubleshooting the flowmeter, see **Chapter 7**.

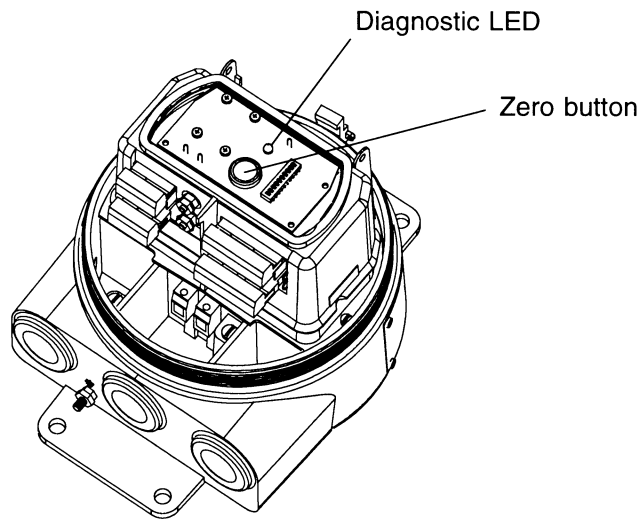


Figure 6-1. Diagnostic LED and zero button

6.3 Flowmeter zeroing

⚠ CAUTION

Failure to zero the flowmeter at initial startup could cause the transmitter to produce inaccurate signals.

To ensure accurate measurements, zero the flowmeter before putting the flowmeter in operation.

Flowmeter zeroing establishes flowmeter response to zero flow and sets a baseline for flow measurement.

Zeroing procedure

NOTE

Before performing zeroing procedure:
- Apply power to the transmitter, and allow the transmitter to warm up for at least 30 minutes.
- Run the process fluid to be measured through the sensor until the sensor temperature reading approximates the normal process operating temperature.

Follow these steps to zero the transmitter:
1. Install the sensor according to the sensor instruction manual.
2. Fill the sensor **completely** with the process fluid under normal process conditions of temperature, density, pressure, etc., and ensure zero flow through the sensor.
3. Close the shutoff valve downstream from the sensor.

⚠ CAUTION

Flow through the sensor during flowmeter zeroing will result in an inaccurate zero setting.

Make sure fluid flow through the sensor is **completely** stopped during flowmeter zeroing.

4. Zero the transmitter in any of three ways:
   - Press and hold the ZERO button for at least five seconds. **Figure 6-1** shows the location of the button on the electronics module.
   - With switch 7 (EXT. ZERO) in the ON position (see **Section 2.3**), an external contact closure can be used for transmitter zeroing. (Refer to **Section 5.7** for wiring instructions.) Close the contact for at least five seconds.
   - Issue an auto zero command using a Model 268 or 275 communicator, a HART-compatible or Modbus-compatible master controller, or the Micro Motion ProLink software program.

The LED remains on continuously during transmitter zeroing. After the zeroing procedure has been completed, the LED again blinks ON once per second to indicate normal operation. The default zero time is approximately 40 seconds at a tube frequency of 100 Hz.

Diagnosing zero failure

If zeroing fails, the LED blinks ON four times per second to indicate an error condition. An error condition could indicate:

- Flow of fluid during transmitter zeroing
- Partially empty flow tubes
- An improperly mounted sensor

To clear a zeroing error, re-zero the flowmeter after correcting the problem, or abort the procedure by cycling power to the transmitter.

Additional information about flowmeter zeroing

The transmitter has a programmable zeroing time (number of measurement cycles), and enables the user to set the standard deviation limits.

NOTE

Improved zeroing and low-flow accuracy can be achieved by increasing the zeroing time by a factor of 2 or more.

The default zero time is 2048 cycles (approximately 40 seconds at a tube frequency of 100 Hz). To increase the default zeroing time by a factor of 2, to 4096 cycles, use a Model 268 or 275 communicator, Modbus-compatible controller, or the ProLink software program to reconfigure the zero time.

For more information about flowmeter zeroing, see the following instruction manuals:

- *Using the SMART FAMILY Interface 268 with the Micro Motion ELITE Model RFT9739 Transmitter*
- *Using the HART Communicator with Micro Motion Transmitters*
- *Using Modbus Protocol with the Micro Motion ELITE Model RFT9739 Transmitter*
- *Using ProLink Software with Micro Motion Transmitters*

6.4 Process measurement

⚠WARNING

Operating the transmitter without covers in place exposes electrical hazards that can cause property damage, injury, or death.

For personal and system safety, make sure the safety barrier partition, electronics module cover, and housing cover are securely in place before operating the transmitter.

After flowmeter zeroing has been completed as described in **Section 6.3**, the flowmeter is ready for process measurement.

7 Troubleshooting

7.1 General guidelines

Troubleshooting a Micro Motion flowmeter is performed in two parts:
1. Tests of wiring circuit integrity
2. Observation of the transmitter's diagnostic tools, which include the diagnostic LED, diagnostic messages, and fault output levels

⚠ CAUTION

During troubleshooting, the transmitter could produce inaccurate flow signals.

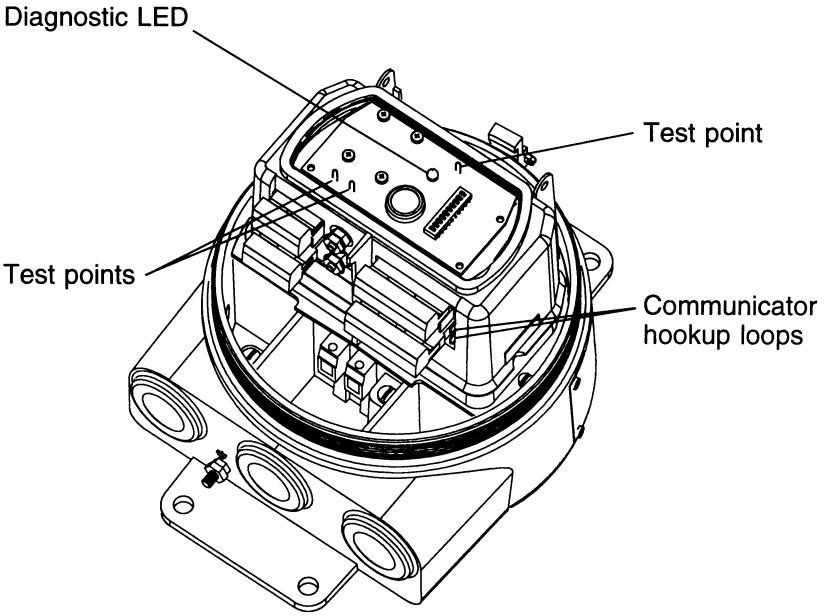
For personal and system safety, set control devices for manual operation while troubleshooting the flowmeter.

Follow these general guidelines when troubleshooting a Micro Motion flowmeter:
- Before beginning the diagnostic process, become familiar with this instruction manual and with the instruction manual for the sensor.
- While troubleshooting a problem, leave the sensor in place, if possible. Problems often result from the specific environment in which the sensor operates.
- Check all signals under both flow and no-flow conditions. This procedure will minimize the possibility of overlooking some causes or symptoms.

7.2 Transmitter diagnostic tools

In some situations, troubleshooting requires use of the transmitter's diagnostic tools, which include the diagnostic LED, diagnostic messages, and fault output levels. The diagnostic LED, test points, and communicator hookup loops are shown in **Figure 7-1**.

Figure 7-1. Transmitter diagnostic tools



Diagnostic LED

The diagnostic LED indicates the operating condition of the transmitter. **Table 7-1** explains the operating conditions indicated by the diagnostic LED.

Table 7-1. Conditions indicated by diagnostic LED

Diagnostic LED does this:	Condition
Blinks ON once per second (25% ON, 75% OFF)	Normal operation
Remains ON continuously	Startup and initialization, zero in progress
Blinks OFF once per second (75% ON, 25% OFF)	Slug flow (density below or above user-defined limits)
Blinks ON 4 times per second	Fault condition

Fault outputs

The RFT9739 has downscale, upscale, last measured value, or internal zero fault levels.

- Downscale: mA 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: mA outputs go to 22 mA; the frequency/pulse output goes to 15,000 Hz.
- Last measured value: Outputs hold the values measured immediately before the fault condition occurred.
- Internal zero: Outputs indicate a value of zero for the represented process variable.

Diagnostic messages

The transmitter provides a large number of diagnostic messages, which can be viewed on the displays of a Model 268 or 275 communicator, or in the Status window of the ProLink software program. Messages are described in the following instruction manuals:

- *Using the SMART FAMILY Interface 268 with the Micro Motion ELITE Model RFT9739 Transmitter*
- *Using the HART Communicator with Micro Motion 9700 Series Transmitters*
- *Using ProLink Software with Micro Motion 9700 Series Transmitters*

Connect a Model 268 or Model 275 communicator, or Bell 202-compatible cable included with the ProLink program, to the communicator hookup loops indicated in **Figure 7-1**.

The primary mA output loop must have a resistance of 250 to 1000 ohms to enable use of a Model 268 or 275 communicator, or the ProLink program.

Fault detection indicates an interruption in the functional integrity of the sensor and the electronics, including the sensor pickoff coils, drive coil, and RTD. Faults, such as a short or an open circuit, are detected by a Model 268 and 275 communicators and the ProLink program.

The transmitter runs continuous self-diagnostics. If these diagnostics reveal a failure, the communicator or ProLink program displays an error message. Self-testing allows the transmitter to check its own circuitry.

The transmitter works with a Micro Motion flow sensor to provide flow information. Therefore, many of the troubleshooting checks pertain only to the sensor. However, Model 268 and 275 communicators and the ProLink program enable the user to perform other tests:

- **mA output test** forces the transmitter to produce a user-specified current output of 0 to 22 mA.
- **Frequency/pulse output test** forces the transmitter to produce a user-specified frequency output between 0.1 and 15,000 Hz.
- **mA output trim** allows adjustment of the primary and secondary mA outputs against a highly accurate external standard such as a digital multimeter (DMM) or receiving device.

7.3 Power supply

Check for specified power at the transmitter power-supply terminals. Labels on the terminals identify the power-supply voltage that must be installed.

- If the labels read "L" and "N", install 110/115 VAC power supply.
- If the labels read "L1" and "L2", install 220/230 VAC power supply.
- If the labels read "+" and "–", install 12-30 VDC power supply.

7.4 Wiring

For detailed transmitter wiring instructions, refer to **Chapters 4 and 5**.

Wiring problems are often incorrectly diagnosed as a faulty sensor. At initial startup of the transmitter, always check the following:

1. Proper cable, and use of shielded pairs
2. Proper wire termination
   a. Wires on correct terminals
   b. Wires making good connections at transmitter terminals
   c. Wires making good connections at the sensor terminals
   d. Wires properly connected at any intermediate terminal junction, such as the user-supplied junction box between a Model DT sensor and transmitter

If a fault condition is indicated, follow these instructions:

1. Disconnect the transmitter's power supply.
2. Unplug the terminal blocks from the electronics module.
3. Use a digital multimeter (DMM) to measure ohms of resistance between wire pairs at the transmitter terminals:
   - Drive coil, check terminals 1 and 2
   - Left pickoff coil, check terminals 5 and 9
   - Right pickoff coil, check terminals 6 and 8
   - RTD, check RFT9739 terminals 3 and 7
4. If the measured resistance is outside the range listed in **Table 7-2**, repeat the measurements at the sensor terminals.
5. Reinsert the terminal blocks and restore power to the transmitter.
6. Use the DMM to check voltage across the test points on the transmitter electronics module (see **Figure 7-1**):
   - Drive gain, measure across TP1 and TP3
   - Integrated and amplified signals from pickoff coils, measure across TP2 and TP3
7. Use the guidelines listed in **Table 7-3** to troubleshoot the flowmeter. Conditions in the table are listed in order, from most likely to least likely cause.

Table 7-2. Nominal resistance values for sensors

Notes

- RTD resistance value increases 0.38675 ohms per °C increase in temperature.
- Nominal coil resistance values will vary by 40% per 100°C. However, confirming an open coil or shorted coil is more important than any slight deviation from the resistance values presented below.
- Resistance of right and left pickoff coils should be within 10% of each other.
- Resistance values depend on the sensor model and date of manufacture.

Sensor model	Drive coil Ω at ambient temperature	Pickoff coils Ω at ambient temperature	Platinum RTD Ω at 0°C
D6, D12, D25, DH38, D40, D100 D150, D300, DL65, DL100, DL200	42 to 2650	130 to 300	100
D600	8 to 16	130 to 150	100
D65, DT65, DT100, DT150	42 to 517	6 to 15.5	100
CMF025, CMF050	42 to 2650	130 to 300	100
CMF100, CMF200, CMF300	84 to 146	15.9 to 25.5	100
F025, F050, F100	308 to 1034	15.9 to 300	100

Table 7-3. Troubleshooting guides

Failure conditions	Cause	Corrective actions
1. At the transmitter, DMM indicates open circuit from terminal 6 to terminal 8 2. At the sensor, DMM indicates open circuit from blue wire to gray wire 3. DMM connected to TP1 and TP3 reads 0.6 to 9.0 VDC 4. DMM connected to TP2 and TP3 reads 3.7 VAC	Open right pickoff coil	• If open at the sensor junction box, return sensor to Micro Motion for repair or replacement • If open at the transmitter terminals, reconnect wiring, or repair or replace sensor cable
1. At the transmitter, DMM indicates open circuit from terminal 5 to terminal 9 2. At the sensor, DMM indicates open circuit from green wire to white wire 3. DMM connected to TP1 and TP3 reads ≥ 13 VDC 4. DMM connected to TP2 and TP3 reads 0 VAC	Open left pickoff coil	
1. At the transmitter, DMM indicates open circuit from terminal 1 to terminal 2 2. At the sensor, DMM indicates open circuit from red wire to brown wire 3. DMM connected to TP1 and TP3 reads ≥ 13 VDC 4. DMM connected to TP2 and TP3 reads 0 VAC	Open drive coil	
1. At the transmitter, DMM indicates open circuit from terminal 7 to terminal 4 2. At the sensor, DMM indicates open circuit from violet wire to yellow wire 3. DMM connected to TP1 and TP3 reads 0.6 to 9.0 VDC 4. DMM connected to TP2 and TP3 reads 3.7 VAC	Open RTD	
1. At the transmitter, DMM indicates open circuit from terminal 3 to terminal 4 2. At the sensor, DMM indicates open circuit from yellow wire to orange wire 3. DMM connected to TP1 and TP3 reads 0.6 to 9.0 VDC 4. DMM connected to TP2 and TP3 reads 3.7 VAC	Open RTD lead length compensator	
1. DMM connected to TP1 and TP3 reads ≥ 13 VDC 2. DMM connected to TP2 and TP3 reads 0 VAC	Moisture in sensor case	• Repair or replace conduit and/or conduit seals • Repair or replace cable • Return sensor to Micro Motion for repair or replacement
1. DMM connected to TP1 and TP3 intermittently reads ≥ 13 VDC 2. DMM connected to TP2 and TP3 intermittently reads 0 VAC	Flow tube stopped vibrating due to slugs of air in process fluid	• Check process • Use a Model 268 or 275, or the ProLink program, to monitor density • Change density limits
1. DMM connected to TP1 and TP3 reads ≥ 13 VDC 2. DMM connected to TP2 and TP3 reads 0 VAC	Plugged or partially plugged flow tube	• Purge flow tubes with steam, water, or purging chemical • Use a Model 268 or 275, or the ProLink program, communicator to monitor density

7.5 Master reset

Use the software switches on the transmitter electronics module to perform a master reset. A master reset causes communication options to default to the setup used by Model 268 and 275 communicators, causes all other configuration options to return to their default values, and **requires complete characterization and reconfiguration of the transmitter**.

Table 7-4 lists master reset defaults for characterization and configuration variables.

To perform a master reset:
1. Shut off power to the transmitter.
2. Set SELECT 1, SELECT 2, and SELECT 3 to OFF.
3. Set CONTROL 3, CONTROL 2, and CONTROL 1 to ON.
4. Restore power. Wait until the diagnostic LED blinks ON once per second (25% ON, 75% OFF).
5. Set all six switches, SELECT 3, SELECT 2, and SELECT 1, CONTROL 3, CONTROL 2, and CONTROL 1 to OFF.
6. Shut off power to the transmitter. Wait 30 seconds.
7. Restore power.

NOTE

If switches are not adjusted after a master reset, another master reset will occur the next time power to the transmitter is shut off and then restored.

After performing a master reset, return switches 1 through 6 to the OFF position.

After the user performs a master reset, the diagnostic LED on the electronics module blinks ON four times per second until the user characterizes the sensor. Use a Model 268 or Model 275 communicator, or the ProLink program, to characterize the sensor. After characterization is completed, the LED blinks ON once per second to indicate normal operation.

7.6 Additional information about troubleshooting

For more information about troubleshooting the RFT9739 transmitter, see the following instruction manuals:
- *Using the SMART FAMILY Interface 268 with the Micro Motion ELITE Model RFT9739 Transmitter*
- *Using the HART Communicator with Micro Motion Transmitters*
- *Using Modbus Protocol with the Micro Motion ELITE Model RFT9739 Transmitter*
- *Using ProLink Software with Micro Motion Transmitters*

7.7 Customer service

For technical assistance, phone the Micro Motion Customer Service Department:
- In the U.S.A., phone 1-800-522-6277, 24 hours
- From outside the U.S.A., phone 303-530-8400, 24 hours
- In Europe, phone (0)318 549 431

Table 7-4. Default values after a master reset

Characterization variables

	Default		Default
Flow calibration factor	1.00005.13	Viscosity calibration factor	1.000000.00000
Density		Pressure	
Density A	0.0000 g/cc	Pressure polling	No
K1 density constant	5000.00	Field device tag	DP CELL!
Density B	1.0000 g/cc	Pressure input at 4 mA	0.00 psi
K2 density constant	50000.00	Pressure input at 20 mA	1000.00 psi
Density temperature coefficient	4.44% per 100°C	Pressure correction for flow	0.00% per psi
K3 density constant	0.000	Pressure correction for density	0.00 g/cc per psi
Temperature calibration factor	1.00000T0000.0	Flow calibration pressure	0.00 psi

Measurement units

	Default		Default
Mass flow unit	g/sec	Temperature unit	°C
Volume flow unit	l/sec	Viscosity unit	centipoise
Density unit	g/cc	Pressure unit	psi

Field device variables

	Default		Default
Mass flow cutoff	0.00 g/sec	Low slug flow limit	0.0000 g/cc
Volume flow cutoff	0.0000 l/sec	High slug flow limit	5.0000 g/cc
Flow direction	Forward only	Internal damping on density	2.00 sec
Internal damping on flow	0.80 sec	Internal damping on temperature	4.00 sec

Transmitter output variables

	Default		Default
Primary mA output variable	Mass flow	Frequency/pulse output variable	Mass flow
Upper range value	160.00 g/sec	Frequency	10000.00 Hz
Lower range value	–160.00 g/sec	Rate	15000.00 g/sec
Added damping	0.00 sec	Maximum pulse width	0.50 sec
Secondary mA output variable	Temperature	Control output	Flow direction
Upper range value	450.00°C	Fault indicator	Downscale
Lower range value	–240.00°C	Slug duration	1.00 sec
Added damping	0.00 sec	Polling address	0
		Burst mode	Off

Device information

	Default		Default
Transmitter tag name	M. RESET	Sensor model	Unknown
Description	CONFIGURE XMTR	Sensor flow tube material	Unknown
Message	MASTER RESET - ALL DATA DESTROYED	Sensor flange type	Unknown
		Sensor flow tube liner material	None
Date	01/JAN/92		

Appendix A Transmitter Specifications

Performance specifications

Sensor model	Flow accuracy[1,2]
ELITE CMF	± 0.10% ± [(zero stability/flow rate) x 100]% of rate
D, DL, DT	± 0.15% ± [(zero stability/flow rate) x 100]% of rate
BASIS F	± 0.30% ± [(zero stability/flow rate) x 100]% of rate

Sensor model	Flow repeatability[1,2]
ELITE CMF	± 0.05% ± [½(zero stability/flow rate) x 100]% of rate
D, DL, DT	± 0.05% ± [½(zero stability/flow rate) x 100]% of rate
BASIS F	± 0.10% ± [½(zero stability/flow rate) x 100]% of rate

Sensor model	Density accuracy[1]
ELITE CMF	± 0.0005 g/cc
DL100, DL200, D300, D600	± 0.0005 g/cc
D65, DL65, DT65, D100, DT100, D150, DT150, DH300	± 0.001 g/cc
D6, D12, D25, D40, DH100, DH150	± 0.002 g/cc
DH6, DH12, DH25, DH38, DH40	± 0.004 g/cc
BASIS F	± 0.004 g/cc

Sensor model	Density repeatability[1]
ELITE CMF	± 0.0002 g/cc
DL100, DL200, D300, D600	± 0.0002 g/cc
D65, DL65, DT65, D100, DT100, D150, DT150, DH300	± 0.0005 g/cc
D6, D12, D25, D40, DH100, DH150	± 0.001 g/cc
DH6, DH12, DH25, DH38, DH40	± 0.002 g/cc
BASIS F	± 0.002 g/cc

Sensor model	Temperature accuracy[1]
All models	± 1°C ± 0.5% of reading in °C

Sensor model	Temperature repeatability[1]
All models	± 0.2°C

[1] Accuracy includes the combined effects of repeatability, linearity, and hysteresis. All specifications are based on reference conditions of water at 68 to 77°F (20 to 25°C) and 15 to 30 psig (1 to 2 bar) unless otherwise noted.
[2] For values of zero stability, refer to product specifications for each sensor.

Functional specifications

Output signals

Analog
Two independently configured analog outputs, designated as primary and secondary, can represent mass or volumetric flow rate, density, temperature, event 1 or event 2. With a pressure transmitter, can also provide indication for pressure or viscosity. Internally powered, can be selected as 4-20 mA or 0-20 mA current outputs. Galvanically isolated to ± 50 VDC, 1000 ohm load limit. Out-of-range capability: 0-22 mA on 0-20 mA output; 2-22 mA on 4-20 mA output.

Milliamp (mA) output rangeability

- Flow
  - Maximum span determined by sensor specifications.
  - Range limit determined by sensor maximum rate.
  - Minimum recommended span:
    - ELITE CMF sensors — 2.5% of nominal flow range
    - D, DL, DT, BASIS F sensors — 10% of nominal flow range
    - D300, D600 sensors — 5% of nominal flow range
- Density — 0.0 to 5.0 g/cc range limit; 0.1 g/cc minimum span
- Temperature — –400 to 842°F (–240 to 450°C) range limit; 36°F (20°C) minimum span

Frequency
One frequency/pulse output can be configured to indicate mass flow, volume flow, mass total (inventory), or volume total (inventory), independent of analog outputs. Internally powered, 0-15 V square wave, unloaded; 2.2 kohm impedance at 15 V, galvanically isolated to ± 50 VDC. Sinking capability, 0.1 amps in "on" condition (0 volt level), 30 VDC compliance in "off" condition. Can be configured as an isolated open collector. Signal can be scaled up to 10,000 Hz. Out-of-range capability to 15,000 Hz. Programmable pulse width for low frequencies.

Control
One control output can represent flow direction, fault alarm, zero in progress, event 1 or event 2. Internally powered, digital level, 0 or 15 V, 2.2 kohm pull-up, galvanically isolated to ± 50 VDC. Sinking capability, 0.1 amps in "on" condition (0 volt level), 30 VDC compliance in "off" condition. Can be configured as an isolated open collector.

Communication
Switch allows selection of Bell 202 and/or RS-485 serial standard. SMART FAMILY Interface 268 requires HART 6.2 or higher revision software.

Bell 202 signal is superimposed on primary variable mA, and available for host system interface. Frequency 1.2 and 2.2 kHz, amplitude 0.8 V peak-to-peak, baud rate 1200 baud. Requires 250 to 1000 ohms load resistance.

RS-485 signal is a ± 5 V square wave referenced to transmitter ground. Baud rates between 1200 baud and 38.4 kilobaud can be selected.

Additional outputs

Sensor frequency
8 V peak-to-peak at sensor natural frequency, referenced to sensor ground, 10 kohm output impedance.

Sensor temperature
5 mV/°C, referenced to sensor ground, 10 kohm output impedance.

API gravity
API gravity references to 60°F (15°C). Uses correlation based on API equation 2540 for Generalized Petroleum Products.

Accuracy of corrected density calculation relative to API-2540 from 0 to 300°F:

Diesel, heater, and fuel oils	±0.0005 g/cc (±0.2°API)
Jet fuels, kerosenes, and solvents	±0.002 g/cc (±0.5°API)
Crude oils and JP4	±0.004 g/cc (±1.0°API)
Lube oils	±0.01 g/cc (±2.0°API)
Gasoline and naphthenes	±0.02 g/cc (±5.0°API)

Minimum 4-20 mA span: 10°API

Requires Model 275 HART communicator or ProLink software version 2.1 or higher for reconfiguration.

Standard volume
Outputs standard volume at 60°F or 15°C for Generalized Petroleum Products when °API is selected as density unit of measure. Accuracy of standard volume measurements depends on accuracies of mass flow rate, density, temperature and temperature-corrected °API calculation, and can be estimated using the root mean square method. Standard volume accuracy of ±0.5% of rate is typically attainable for Generalized Petroleum Products such as fuel oils, jet fuels, and kerosenes.

Requires Model 275 HART communicator or ProLink software version 2.1 or higher for reconfiguration.

Input/output signal for pressure
One analog input/output can be configured to represent pressure for pressure compensation of flow and density, or to represent differential pressure for viscosity calculation. Range, 0-25 mA. Can be used to power independent pressure or differential pressure transmitter. Voltage sourcing capability, 15 V. Input impedance, 100 ohms.

Requires Model 275 HART communicator or ProLink software, version 2.1 or higher, for reconfiguration.

Low-flow cutoff

Each output configured for flow can be assigned a low-flow cutoff. Flow values below cutoff cause outputs to default to zero level (4 mA, 0 mA, or 0 Hz).

Slug-flow inhibit

Transmitter senses density outside user-selected limits. Flow output holds at last measured value prior to slug condition, for a programmed time of 0-60 seconds, before defaulting to the level that represents zero flow.

Damping

Wide range of programmed filter time constants for damping on flow, density, and temperature.

Fault indication

Faults can be indicated by user-selected downscale (0 mA or 2 mA, 0 Hz), upscale (22 mA, 15,000 Hz), internal zero, or last measured value output levels. The control output can also be configured to indicate a fault condition at 0 V.

Output testing

Current source
Transmitter can produce a user-specified current between 0 and 22 mA on a 0-20 mA output, or between 2 and 22 mA on a 4-20 mA output.

Frequency source
Transmitter can produce a user-specified frequency between 0.1 and 15,000 Hz.

Power supply options

110/115 VAC ± 25%, 48 to 62 Hz, 10 watts typical, 15 watts maximum, fused at 250 V/250 mA

220/230 VAC ± 25%, 48 to 62 Hz, 10 watts typical, 15 watts maximum, fused at 250 V/250 mA

12 to 30 VDC, 7 watts typical, 14 watts maximum, fused at 125 V/ 2 amp. At startup, transmitter power source must provide a minimum of 2 amps of short-term current at a minimum of 12 volts at the transmitter's power input terminals

Environmental limits

Ambient temperature limits
Operating: –22 to 131°F (–30 to 55°C)
Storage: –40 to 176°F (–40 to 80°C)

Humidity limits
Meets SAMA PMC 31.1-1980

Vibration limits
Meets SAMA PMC 31.1-1980, Condition 2

Environmental effects

RFI effect on sensor and transmitter

Level 1	± 0.25% of span at 1 V/m per IEC 801.3 - 1984
Level 2	± 1.00% of span at 3 V/m per IEC 801.3 - 1984
Class 3, A, B, C	± 0.25% of span at 1 V/m per SAMA PMC 33.1
Class 1, A, B, C	± 1.00% of span at 3 V/m per SAMA PMC 33.1

Conductive conduit for sensor cable, earth grounded at both ends, is required for RFI protection within this specification.

Ambient temperature effect on transmitter

On mA outputs:	± 0.005% of rate/°C
On temperature output:	±0.01°C/°C
On mA input:	±0.01% of span/°C

Hazardous area approvals

When properly installed with an approved sensor, the RFT9739 field-mount transmitter can be installed in the following hazardous areas:

U and CSA

Class I, Div. 1, Groups C and D, Class II, Groups E, F, and G explosion proof when installed with approved conduit seals; otherwise, Class I, Div. 2, Groups A, B, C, and D

CENELEC

EExd [ib] IIC T6 flameproof when installed with approved cable glands; otherwise, EEx [ib] IIC

SAA

Exd [ib] IIC T6

Shipping weight

12.5 lb (5.7 kg)

Appendix B How to Specify an RFT9739 Transmitter

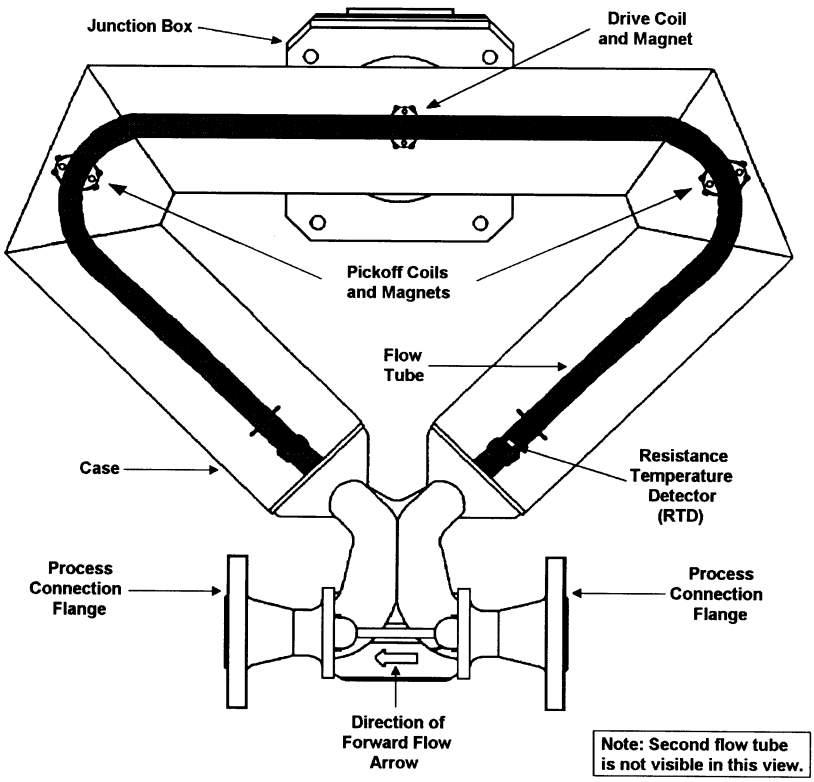
Model code	Power code	Config code	Approvals code	Glands code	Description
RFT9739E					RFT9739 field-mount transmitter
	1				110/115 VAC
	2				220/230 VAC
	3				12-30 VDC
		S			Standard
			M		Micro Motion standard (no approvals)
			U		U
			C		CSA
			B		CENELEC - intrinsically safe sensor
			F		CENELEC - intrinsically safe sensor/flameproof transmitter
			S*		SAA
				Available with approvals codes M, C, or S	
				A	No fittings or glands
				Available with approvals code U	
				J	1 x explosion-proof seal fitting (any cable)
				K	3 x explosion-proof seal fitting (any cable)
				Available with approvals code B (non-EExd)	
				For MMI shielded cable, type CBPS	
				B	1 x gland, nickel-plated brass (7-12.5mm)
				C	3 x gland, nickel-plated brass (7-12.5mm)
				Available with approvals code F (flameproof EExd)	
				For MMI armoured cable, type CBPA	
				D	1 x gland, nickel-plated brass (8-12 mm/10.5-16mm)
				E	1 x gland, SS (8-12mm/10.5-16mm)
				F	2 x gland, nickel-plated brass (8-12mm) and 1 x gland, nickel-plated brass (8-12mm/10.5-16mm)
				G	2 x gland, SS (8-12mm) and 1 x gland, SS (8-12mm/10.5-16mm)
				For MMI shielded cable, type CBPS	
				H	1 x gland, nickel-plated brass
				I	1 x gland, SS

*Not valid with Model DS065S, DL065S, DS600S, or DT sensors

Appendix C Theory of Operation

The flow tubes of the Coriolis mass flow sensor are driven to vibrate at their natural frequency by a magnet and drive coil attached to the apex of the bent tubes (see **Figure C-1**). An AC drive control amplifier circuit in the transmitter reinforces the signal from the sensor's left velocity pickoff coil to generate the drive coil voltage. The amplitude of this drive coil voltage is continuously adjusted by the circuit to maintain a constant, low amplitude of flow tube displacement, thereby minimizing stress to the tube assembly.

Figure C-1.
Coriolis mass flow sensor



Mass flow measurement

The vibrating motion of the flow tube, combined with the momentum of the fluid flowing through the tubes, induces a Coriolis force that causes each flow tube to twist in proportion to the rate of mass flow through the tube during each vibrational cycle. Since one leg of the flow tube lags behind the other leg during this twisting motion, the signals from sensors on the two tube legs can be compared electronically to determine the amount of twist. The transmitter measures the time delay between the left and right pickoff signals using precision circuitry and a high frequency crystal controlled clock. This "delta time" value is digitally filtered to reduce noise and improve the measurement resolution.

Delta time is multiplied by the flow calibration factor to determine the mass flow rate. Since temperature affects flow tube stiffness, the amount of twist produced by the Coriolis force will be affected by the flow tube temperature. The measured flow rate is continuously adjusted by the transmitter, which monitors the output of a platinum element resistance temperature detector (RTD) attached to the outside surface of the flow tube. The transmitter measures the sensor temperature using a three-wire RTD bridge amplifier circuit. The voltage out of the amplifier is converted to a frequency and is digitized by a counter read by the microprocessor.

Density measurement

The Coriolis mass flow sensor also functions as a vibrating tube densimeter. The natural frequency of the tube assembly is a function of tube stiffness, geometry, and the mass of the fluid the tube contains. Therefore, fluid density can be derived from a measurement of tube frequency.

The transmitter measures the time period of each vibrational cycle using a high frequency clock. This measurement is digitally filtered, and density is calculated using the density calibration factors for the sensor after compensating the sensed natural frequency for known changes in the tube stiffness due to operating temperature. The transmitter calculates volumetric flow by dividing the measured mass flow by the measured density.

API gravity

If °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:

$$\rho_o = \rho_s * \exp[-\alpha\Delta T(1 + 0.8\alpha\Delta T)]$$

Where

ρ_o = operating density
ρ_s = standard density
ΔT = temperature difference from base (standard) temperature (60°F or 15°C)
α = $[K_0/(\rho_s)^2 + K_1/\rho_s]$ 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 °API by the following expression:

$$\text{Degrees API} = (141.5/\text{standard specific gravity}) - 131.5$$

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 RFT9739 is valid for Generalized Petroleum Products from 2-95°API 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.

API standard volume

If °API is selected as the density unit, the RFT9739 automatically calculates standard volume at 60°F or at 15°C based on the following expression:

$$\text{Standard volume} = \text{mass flow/standard density}$$

If a density unit other than °API is the selected, the transmitter calculates gross volume at line conditions. Any of the standard engineering units available 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. RFT9739 correlation to API tables

The accuracy of each factor varies based on the process operating conditions and fluid that is being measured. For 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 RFT9739 standard volume output can be used only for Generalized Petroleum Products or materials that exhibit the same thermal expansion characteristics as Generalized Petroleum Products.

Pressure compensation and viscosity

If the RFT9739 has version 2.0 or higher-revision software, a pressure transmitter can be connected to the RFT9739 for pressure compensation or viscosity measurement. The RFT9739 or an external source can supply power to the pressure transmitter.

If the input is configured to indicate differential pressure, the transmitter uses the pressure input and the flow and density inputs from the sensor to calculate viscosity. The transmitter calculates viscosity by dividing the pressure drop across the flow line by the mass or volume rate.

If the input is configured to indicate gauge pressure, the transmitter uses the pressure input to account for effects of pressure on the flow tubes of ELITE CMF100, CMF200 and CMF300 sensors, and Model DL100, DL200, D300, and D600 sensors. In this mode, the pressure effect is calculated as the percent change in the flow rate per psi change in pressure and/or the amount of change in density, in g/cc, per psi change in pressure.

Output variables

Measured variables can be output in a variety of ways from the transmitter. Mass or volume flow rate can be output as an isolated 4-20 or 0-20 mA signal over either of two sets of output terminals. Alternatively, either mA output can be configured to indicate temperature, density, viscosity, pressure, event 1 or event 2.

Mass or volume flow pulses from the isolated frequency output terminals can be scaled to 10,000 Hz for compatibility with PLCs, batch controllers, and totalizers.

All measured variables, including totalizers for batch and inventory, can be accessed digitally. The transmitter can use the Bell 202 physical layer at 1200 baud superimposed on the primary mA signal and/or the RS-485 physical layer at 1200 baud to 38.4 kilobaud. The transmitter can use HART protocol over the Bell 202 or RS-485 physical layer, Modbus protocol over the RS-485 physical layer, or HART over the Bell 202 layer and Modbus over the RS-485 layer.

A logic output can be programmed to indicate the flow direction, a fault alarm, or a zero in progress condition. The transmitter operational status is also indicated by a coded LED indicator (visible with the transmitter lid removed on the field mount transmitter). The measured sensor temperature and natural frequency are brought out as analog signals for interface to Micro Motion density measurement peripherals (DMS, NOC, and NFC).

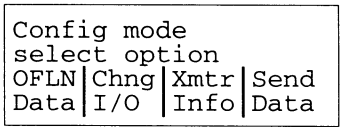
Appendix D Model 268 Software Trees for RFT9739 Transmitters

Format branch

```
Format Xmtr-Initial
setup & maintenance
Othr | Char | Dgtl | Exit
Fcns | ize  | Trim |
```

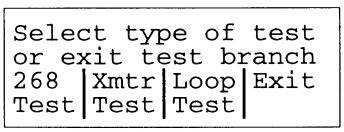
- **F1:** Othr Fcns
  - Burst mode
- **F2:** Charize
  - Flow cal factor
  - Temp cal factor
  - Dens 1
  - K1
  - Dens 2
  - K2
  - Dens temp coef
  - Viscosity (yes)
    - Visc fact
    - DP tag
  - Xmtr S/N
- **F3:** Dgtl Trim
  - Density Trim
    - Dens 1
      - Ref dens A
      - Perform calibration
    - Dens 2
      - Ref dens B
      - Perform calibration
  - Viscosity Trim
    - Ref visc
    - Perform calibration
  - Output Trim
    - Current oput 1)
      - Std Scal
      - Othr Scal
    - Current oput 2)
      - Std Scal
      - Othr Scal
  - Auto Zero
    - Chng Time
    - Chng Dev
    - Auto Zero
    - End
- **F4:** Exit

Configuration branch



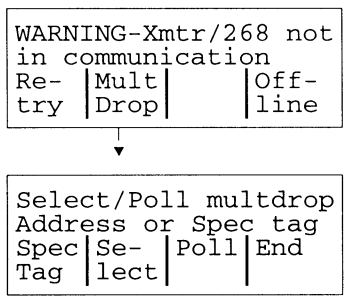
- **F1:** OFLN Data
- **F2:** Chng I/O
  - Current oput 1)
    - 1) LRV 1)URV
    - 1) PV is
    - 1) Cutoff
    - 1) Added damp
  - Current oput 2)
    - 2) LRV 2)URV
    - 2) SV is
    - 2) Cutoff
    - 2) Added damp
  - Freq oput
    - 3) TV is
    - 3) Freq
    - 3) Rate
    - 3) Freq pulse width
  - Control Oput
    - Fwd/Rev
    - Zero in progress
    - Fault
  - Xmtr Variable
    - Mass flow unit
    - Configure special mass unit
    - Mass flow cutoff
    - Vol flow unit
    - Configure special vol unit
    - Vol flow cutoff
    - Flow dir
    - Flow damp
    - Dens unit
    - Dens lo
    - Dens hi
    - Dens damp
    - Temp unit
    - Temp damp
    - DP unit
    - Visc unit
  - Fault Oput
    - Fault limit
    - Fault duratn
- **F3:** Xmtr Info
  - Tag
  - Snsr S/N
  - Snsr typ
  - Snsr matl
  - Flnge typ
  - Liner matl
  - Des
  - DD/MMM/YY
  - Msg
- **F4:** Send Data

Test Branch



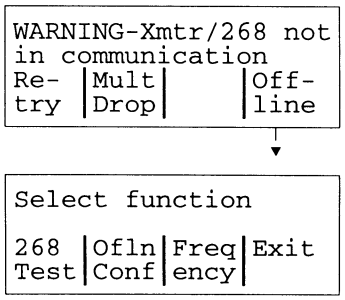
- **F1:** 268 Test
  - Test 268
  - Xmtr Revs
  - End
- **F2:** Xmtr Test
- **F3:** Loop Test
  - Current oput 1)
    - Lo Oput
    - Hi Oput
    - Othr
    - End
  - Current oput 2)
    - Lo Oput
    - Hi Oput
    - Othr
    - End
  - Freq oput
    - 10 kHz
    - Othr
    - End
- **F4:** Exit

Multidrop Functions



- **F1:** Retry
- **F2:** Mult Drop
  - **F1:** Spec Tag
  - **F2:** Select
  - **F3:** Poll
  - **F4:** End

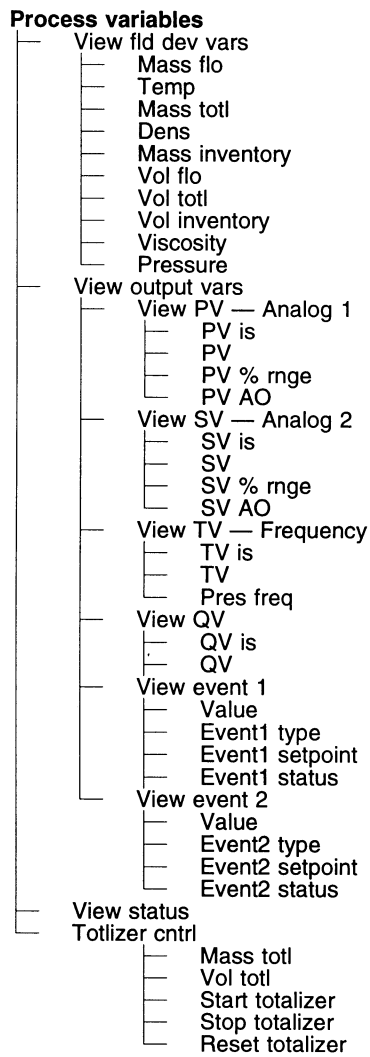
Offline Branch



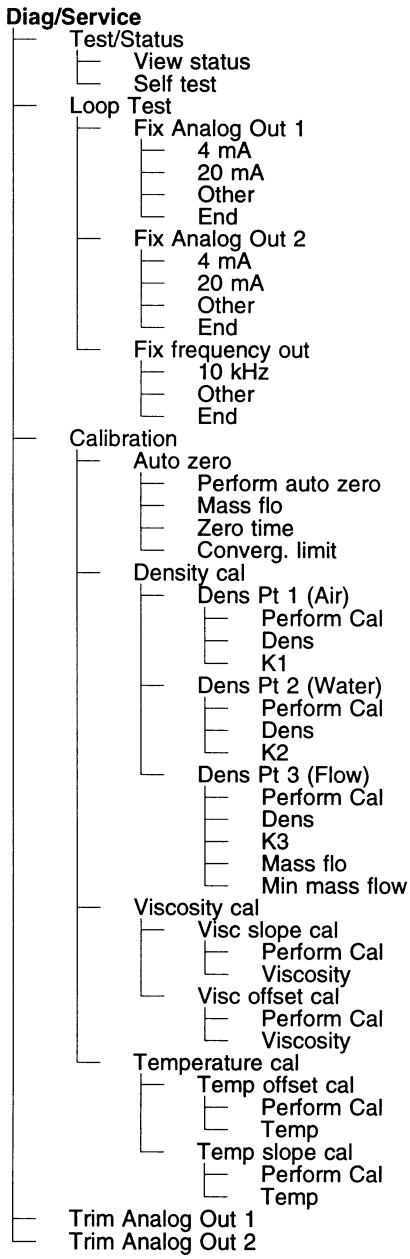
- **F4:** Offline
  - **F1:** 268 Test
    - Test 268
    - Xmtr Revs
    - End
  - **F2:** Ofln Conf
    - Model
    - 1)Range Unit
    - 2)Range Unit
    - Rate unit
    - Mass flow unit
    - Vol flow unit
    - Dens unit
    - Temp unit
    - Visc unit
    - DP unit
    - 1)Cutoff
    - 1)Added damp
    - 2)Cutoff
    - 2)Added damp
    - Flow dir
    - Spcl mass flow unit
    - Base mass unit
    - Mass conversn no.
    - Mass time base unit
    - Spcl mass flow rate unit
    - Mass flow cutoff
    - Spcl vol flow unit
    - Base vol unit
    - Vol conversn no.
    - Vol time base unit
    - Spcl vol flow rate unit
    - Vol flow cutoff
    - 1)LRV
    - 1)URV
    - 2)LRV
    - 2)URV
    - 3)Freq
    - 3)Rate
    - 3)Freq pulse width
    - Dens lo
    - Dens hi
    - Flow damp
    - Dens damp
    - Temp damp
    - Fault limit
    - Fault duratn
    - Control output
    - PV is
    - SV is
    - TV is
    - Tag
    - Snsr S/N
    - Snsr typ
    - Snsr matl
    - Flnge typ
    - Liner matl
    - Des
    - DD/MMM/YY
    - Msg
    - Data saved in OFLN Mem for downloading
  - **F4:** Exit

Appendix E Model 275 Software Trees for RFT9739 Transmitters

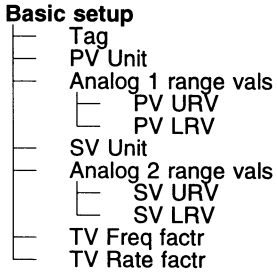
Process variables branch



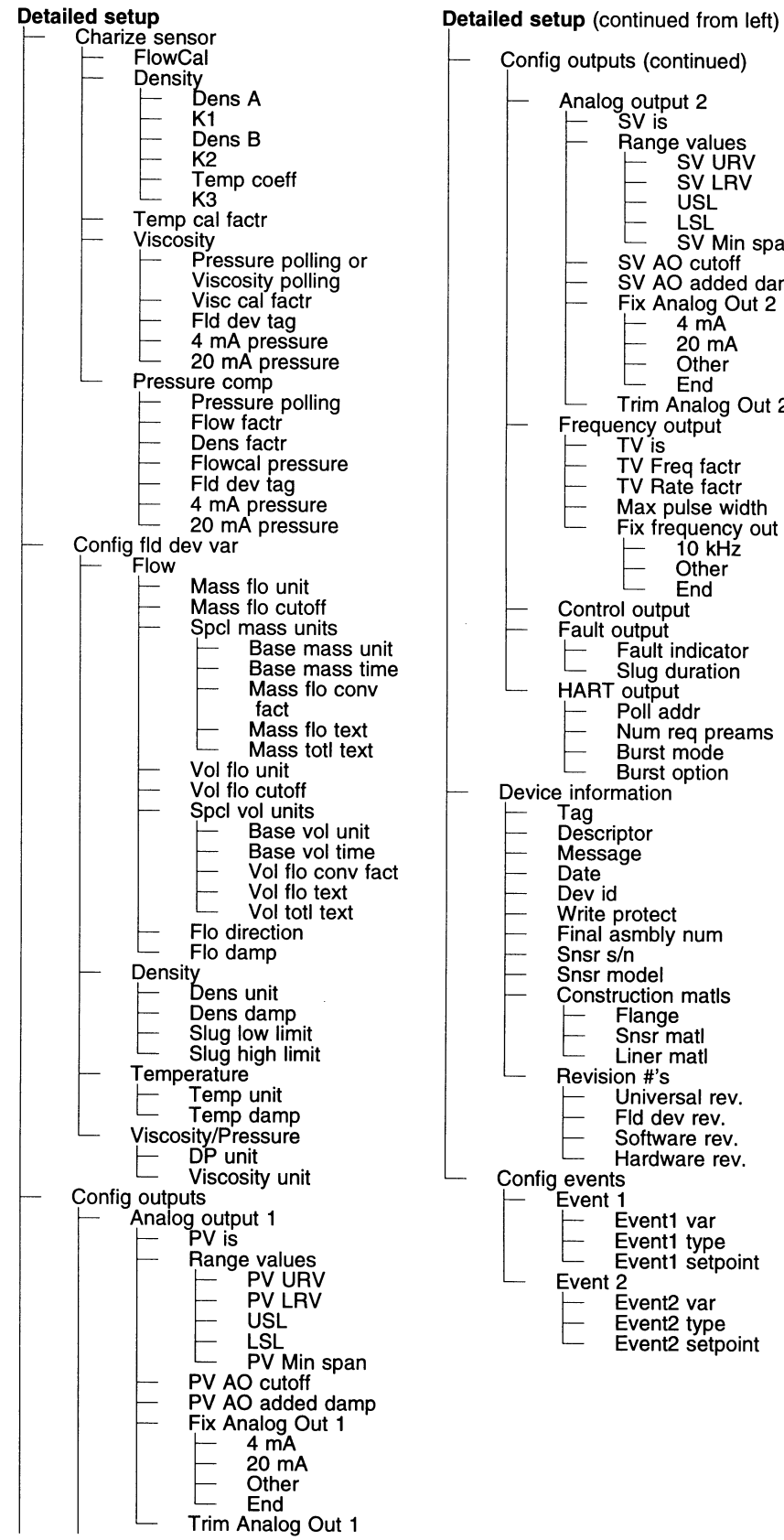
Diagnostics/service branch



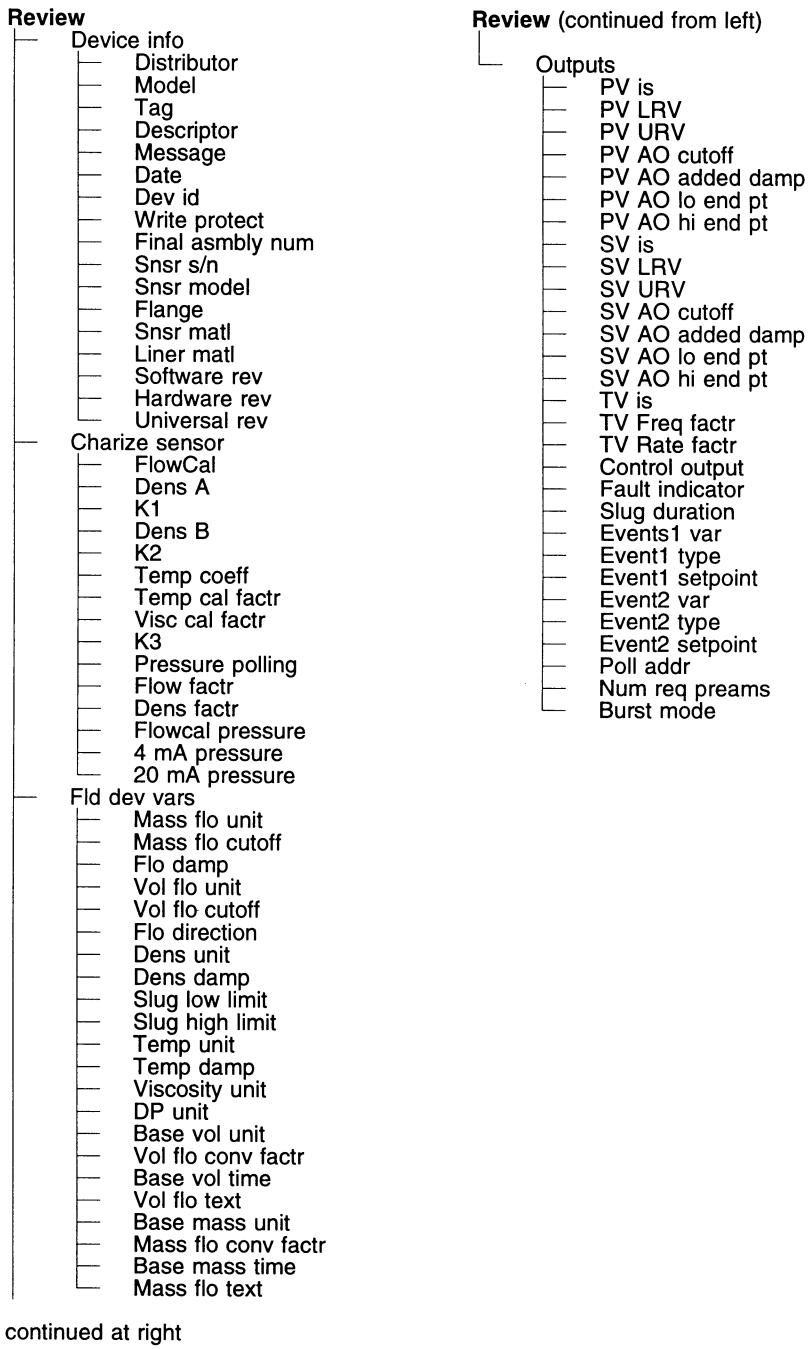
Basic setup branch



Detailed setup branch



Review branch



Appendix F Replacing an Older Transmitter with an RFT9739 Transmitter

Step 1 Disconnecting the old transmitter

⚠CAUTION

Process control will stop when the transmitter is disconnected.

For personal and system safety, set control devices for manual operation before disconnecting the transmitter.

⚠WARNING

Hazardous voltage can cause severe injury or death.

Shut off power before disconnecting the transmitter.

Follow these steps to wire the RFT9739 in place of the old transmitter:

a. Shut off power to the transmitter.

b. Open the transmitter wiring compartment covers. **Do not disconnect wires from the transmitter yet.** Wires will need to be moved from the old transmitter terminals to the appropriate terminals on the RFT9739 transmitter. Make note of which terminals the wires are connected to **before removing them from the old transmitter.**
   - **Figure F-1** shows the location of terminals on a Model RE-01 transmitter.
   - **Figure F-2** shows the location of terminals on a Model RFT9712 transmitter.

c. Detach wires from the old transmitter, then remove the transmitter.

Step 2 Determining type of RTD in the sensor

Determine whether the sensor has a platinum or copper RTD (resistance temperature detector). The type of RTD determines how the transmitter and sensor must be wired and configured.

All sensors shipped after October 1986 have **platinum** RTDs. For older sensors, or if the date of manufacture is not known, follow these steps to determine the sensor's RTD type:

a. Identify the sensor serial number on the tag that is attached to the outside of the sensor case.
   - If the sensor serial number is higher than 87263, the sensor has a **platinum** RTD. Skip to Step 4 if the sensor serial number is higher than 87263.
   - If the serial number is 87263 or lower, check resistance values as described below.

b. If the sensor and transmitter were properly wired with Micro Motion color-coded cable, the orange and violet wires provide temperature detection. These wires were connected to RE-01 terminals 3 and 9, or RFT9712 terminals 3 and 7. The yellow or shield wire from the orange/violet pair, which was connected to RE-01 terminal 6 or RFT9712 terminal 4, provides temperature lead length compensation.

   Use a digital multimeter (DMM) to check resistance between the orange, violet, and yellow wires. Refer to **Table F-1** to determine the sensor's RTD type. Contact the Micro Motion Customer Service Department for further assistance.
   - In the U.S.A., phone 1-800-522-6277, 24 hours
   - Outside the U.S.A., phone 303-530-8400, 24 hours
   - In Europe, phone (0)318 549 431

Table F-1. Resistance values for determining RTD type

Wire colors	Resistance if RTD is platinum	Resistance if RTD is copper	Resistance if RTD is open
Violet to orange	110 Ω at ambient temperature (70°F)	open (infinite resistance)	open (infinite resistance)
Violet to yellow	110 Ω at ambient temperature (70°F)	110 Ω at ambient temperature (70°F)	open (infinite resistance)
Orange to yellow	0-10 Ω	open (infinite resistance)	—

Step 3 If the sensor has a copper RTD

If the sensor has a copper RTD, the RFT9739 transmitter must have version 2.4 or higher-revision software to operate correctly with the sensor. If the sensor has a platinum RTD, go to Step 4.

All RFT9739 transmitters shipped after April 1995 have software version 2.4 or higher. To confirm the transmitter's software version:

a. When shipped from the factory, a sticker affixed to the transmitter electronics module identifies its software version.
b. If the identification sticker has been removed, use a Model 268 or 275 HART communicator, or the ProLink software program, to determine the transmitter software version (see the appropriate instruction manual for instructions).
c. If the transmitter software version is lower than 2.4, contact the Micro Motion Customer Service Department to upgrade the transmitter electronics module.

Step 4 Installing the RFT9739 transmitter

⚠WARNING

Failure to maintain intrinsic safety could result in an explosion.

Connect power-supply wiring and ground wires to the transmitter as instructed in **Chapter 4**.

Follow these instructions to mount and wire the new RFT9739 transmitter:

a. Mount the RFT9739 transmitter in accordance with the instructions in **Chapter 3**.
b. Connect power-supply wiring and ground wires to the RFT9739 transmitter in accordance with the instructions in **Chapter 4**.
c. Connect the flowmeter and output wiring from the old transmitter to the appropriate terminals on the RFT9739 transmitter.
   - Refer to **Figure F-1** and **Table F-2** for a Model RE-01
   - Refer to **Figure F-2** and **Table F-3** for a Model RFT9712
   - **Figure F-3** shows the terminals on a Model RFT9739
d. If the sensor has a copper RTD, temperature lead length compensation is necessary for proper operation.
   - Connect the orange and yellow wires at the sensor end, to sensor terminal 4.
   - Alternatively, if the sensor is not easily accessible, and the cable that connects the sensor and transmitter is 50 feet (15 meters) or less, install a jumper between RFT9739 transmitter terminals 3 and 4.

Figure F-1. RE-01 Remote Electronics Unit terminals

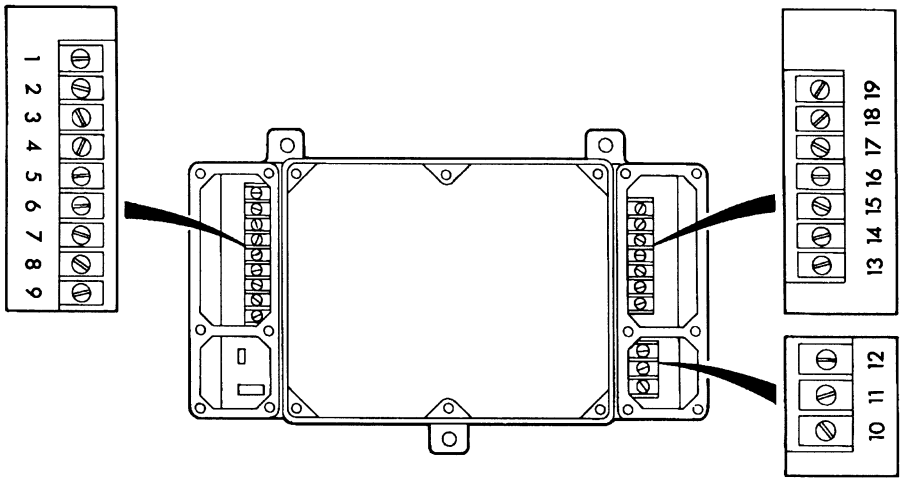


Table F-2. RE-01 to RFT9739 terminal conversions

Take the wire from RE-01 terminal number:	...and connect it to RFT9739 terminal number:	Wire color (Micro Motion color-coded cable)	Function
1	1	Brown	Drive +
2	2	Red	Drive –
3	3	Orange	Temperature –
4	no connection	—	—
5	no connection	—	—
6	4	Yellow*	Temperature lead length compensation
7	5	Green	Left pickoff +
8	6	Blue	Right pickoff +
9	7	Violet	Temperature +
10 11 12	see RFT9739 power-supply wiring and grounding instructions (Chapter 4)		
13	23	—	Signal ground
14	14	—	VF +
15	no connection	—	—
16	18	—	PV –
17	17	—	PV +
18	16	—	Return
19	15	—	Freq +

*Shield wire from orange/violet pair

Figure F-2. RFT9712 Remote Flow Transmitter terminals

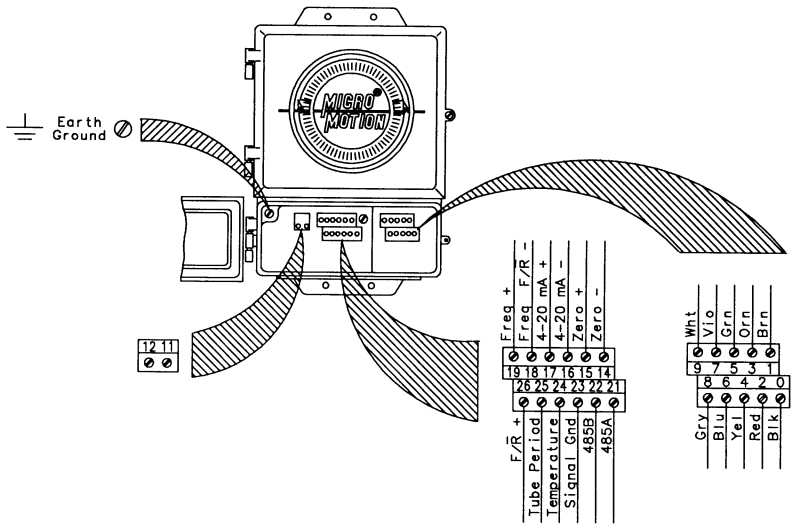
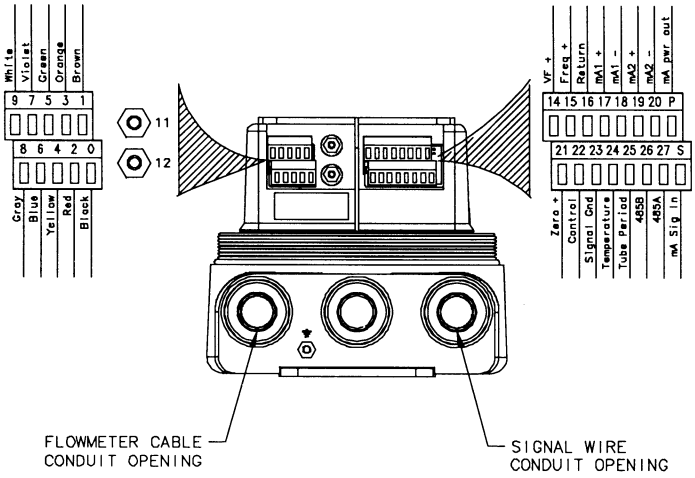


Table F-3. RFT9712 to RFT9739 terminal conversions

Take the wire from RFT9712 terminal number:	and connect it to RFT9739 terminal number:	Wire color (Micro Motion color-coded cable)	Function
0	0	Black[1]	Shields
1	1	Brown	Drive +
2	2	Red	Drive –
3	3	Orange	Temperature –
4	4	Yellow[2]	Shield (Temperature lead length compensation)
5	5	Green	Left pickoff +
6	6	Blue	Right pickoff +
7	7	Violet	Temperature +
8	8	Gray	Right pickoff –
9	9	White	Left pickoff –
10 11 12	see RFT9739 power-supply wiring and grounding instructions (Chapter 4)		
14	16	—	Return
15	21	—	Zero +
16	18	—	PV –
17	17	—	PV +
18	16	—	Return
19	15	—	Freq +
21	27	—	485A
22	26	—	485B
23	23	—	Signal ground
24	24	—	Temperature
25	25	—	Tube period
26	22	—	Control

[1]Combined shields from brown/red, green/white, and gray/blue pairs
[2]Shield wire from orange/violet pair

Figure F-3. RFT9739 terminals



Step 5 Characterizing sensors with copper RTDs

⚠ CAUTION

Failure to characterize a sensor with a copper RTD will cause measurement error.

If the sensor has a copper RTD, the flow calibration factor programmed into the transmitter must be modified to ensure accurate flow measurement.

This modification is simple: Replace the second decimal point in the flow calibration factor with the letter "c".

Example:

Calibration factor with platinum RTD	63.1905.13
Calibration factor with copper RTD	63.1905c13

Use the procedures in one of the following manuals to characterize the sensor for flow.

- *Using the SMART FAMILY Interface 268 with the Micro Motion ELITE Model RFT9739 Transmitter*
- *Using the HART Communicator with Micro Motion Transmitters*
- *Using Modbus Protocol with the Micro Motion ELITE Model RFT9739 Transmitter*
- *Using ProLink Software with Micro Motion Transmitters*

When entering the flow calibration factor, replace the second decimal point with the letter "c", if the sensor has a copper RTD, as shown in the example above. If the sensor has a platinum RTD, do not use a letter in place of the decimal point.

Appendix G Replacing the Power-Supply Board

⚠WARNING

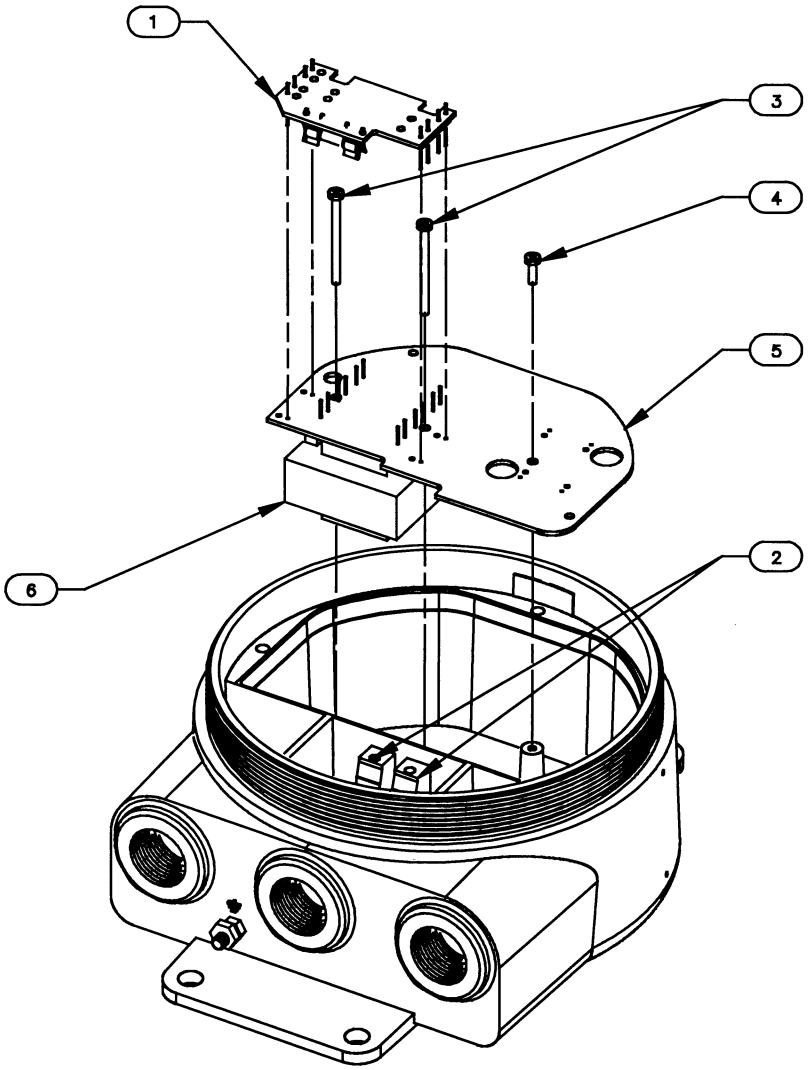
Hazardous voltage can cause severe injury or death.

Shut off power before removing the old power-supply board, or installing the new board.

While replacing the power-supply board on an RFT9739 field-mount transmitter, refer to **Figure G-1** on the following page.

1. Carefully unplug the voltage card (1) from the power-supply board. Exercise caution to avoid bending the pins.
2. Use a solder sucker and soldering iron to remove the solder from the terminal hooks (2). On the power-supply board, the solder is visible in the two holes located above the hooks. Removal of the terminals from the base of the transmitter is not necessary.
3. Carefully unscrew the two transformer screws (3). Loctite® adhesive has been applied to the screws. Use caution to avoid breaking them during removal.
4. Remove the short screw (4) from the plated hole in the power-supply board.
5. Carefully lift the power-supply board (5) out of the base of the transmitter housing.
6. Insert the new power-supply board into the base of the transmitter, making sure the transformer (6) faces downward and toward the conduit openings.
7. Apply Loctite 222 (red) adhesive to the two transformer screws (3), then insert them through the transformer.
8. Insert the short screw (4) into the plated hole in the power-supply board, then completely tighten the screw.
9. Completely tighten the two transformer screws (3).
10. **Use low-temperature solder** to solder the ends of the terminal hooks (2), which should be seated in the matching holes in the power-supply board.
11. Put the voltage card back into place on the board.

Figure G-1. Essential components for replacing power-supply board



Appendix H Transmitter Version Identification

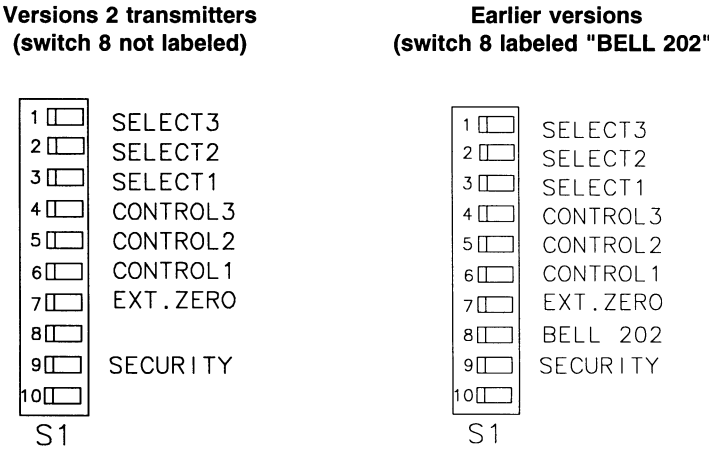
To identify a Version 2 RFT9739 field-mount transmitter:

1. Unscrew the cover from the base of the transmitter's explosion-proof housing.
2. Inside the transmitter is an electronics module, which has terminal blocks for intrinsically safe and non-intrinsically safe wiring connections. A Version 2 transmitter has an electronics module that is different than older versions. Earlier versions of the module have switch labeled *BELL 202*. A module for a Version 2 transmitter does not have a label that reads BELL 202. For comparison, refer to **Figure H-1**.

Although determining whether the RFT9739 is a Version 2 transmitter, it does not identify the software version. **To identify the transmitter's software version:**

1. When shipped from the factory, a sticker affixed to the module identifies the transmitter software version.
2. If the identification sticker has been removed, use a Model 268 or 275 HART communicator, or the ProLink software program to identify the software version. See one of the following communications manuals for instructions:
   - *Using the SMART FAMILY Interface 268 with the Micro Motion ELITE Model RFT9739 Transmitter*
   - *Using the HART Communicator with Micro motion 9700 Series Transmitters*
   - *Using ProLink Software with Micro Motion 9700 Series Transmitters*

Figure H-1. Switches on RFT9739 transmitters



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