

# 3. Operation

## Introduction

The flowmeter has been configured and calibrated to custom specifications. Each flowmeter contains distinct operating limits and units of measurement. This chapter will show how to determine and manipulate the configuration of the flowmeter.



**Caution:** The flow transmitter contains electrostatic discharge (ESD) sensitive devices. Use standard ESD precautions when handling the flow transmitter. See Chapter 2, Installation, for ESD details.

## Start Up Procedure

1. After the wiring has been verified, apply power to the flowmeter. (No special instructions for instrument shutdown; turn operating power off.)
2. Then wait 10 minutes for warm-up. During this period the flowmeter may indicate high flow.
3. After power up the instrument automatically enters the flow metering mode and the display sets to normal operation.

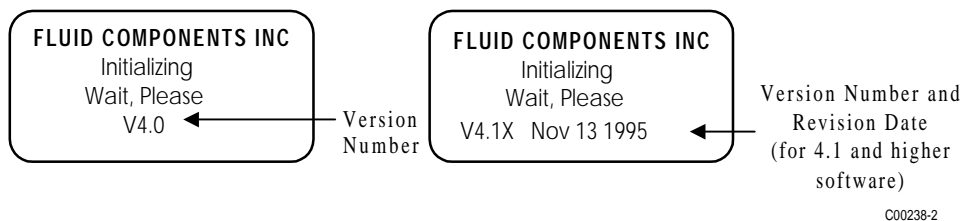
## Operation

### Display

The flowmeter contains a 4 x 20 character LCD display. Flow rate, temperature, and system status are all accessible through the display.

### Initialization Window

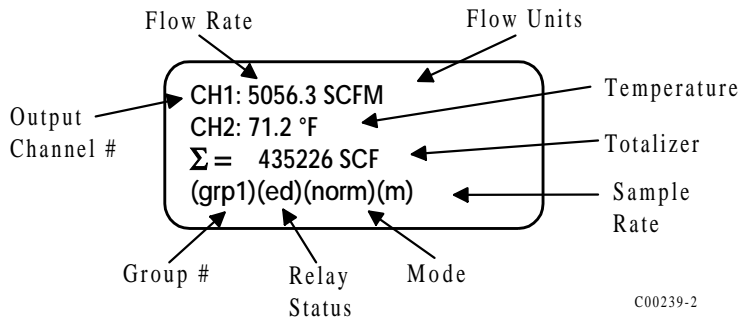
When power is applied to the flowmeter the display will briefly show the initialization window. See Figure 3-1.



**Figure 3-1. Initialization Window**

### Normal Mode Window

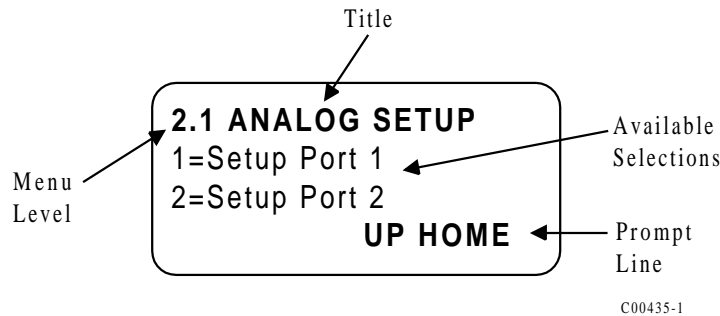
The flowmeter upon power up defaults to the normal mode of operation and begins to display the flow rate, the temperature, the total flow (if enabled) and the current system status. The Normal Operation display is shown in Figure 3-2.



**Figure 3-2. Normal Operation Display**

**Menu Window**

The menu is made up of 4 components. They are the menu level, title, selections, and prompt line. These components are illustrated in Figure 3-3. The top line displays a menu code and title. Lines 2 and 3 are used to scroll through the available selections. The prompt line indicates which menu commands are appropriate.



**Figure 3-3. Menu Window**

The menu code is a numeric reference that identifies each window of the menu structure. The menu code in Figure 3-3 indicates that the user is two levels deep (Level 2, sublevel 1). The menu structure will be explained further in Menu Organization.

The title gives the user a better idea of where the system is within the menu structure. Some titles are informative enough to completely describe the menu function, while other titles are ambiguous unless there is knowledge of the parent menus. The menu code is helpful in deciphering ambiguous titles.

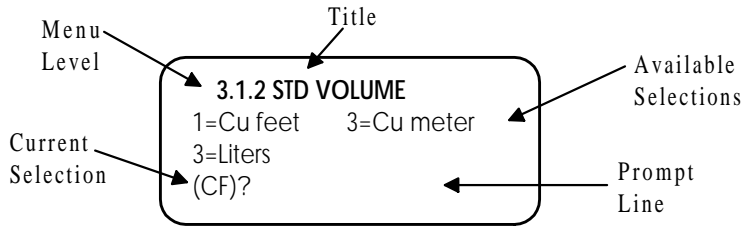
The middle two lines display the available selection. The number of choices is often more than the two displayed. Pressing the N (next) or P (previous) keys on the keypad will scroll the selections up or down. To choose a function from the available selections press the corresponding number on the keypad.

The prompt line displays appropriate menu control key strokes for that menu level. Pressing N, the (N)ext key, will scroll the display down two selections. Pressing P, the (P)rv or Previous key, will scroll the display up. Pressing the UP key shifts the current menu level up one. Pressing the HOME key goes straight to the 0.0 MAIN MENU.

### Other Window Types

Another common window encountered is shown in Figure 3-4. The window is similar to the Menu Window except that it does not scroll and all choices are contained within the window. The current selection (if there is one) is also contained in the parenthesis to the left of the question mark.

Press the corresponding number in the Available Sections for the choice of display.



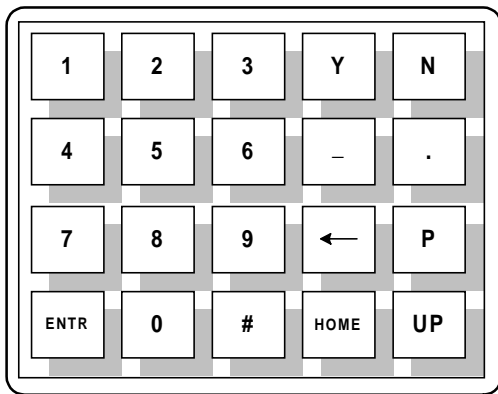
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**Figure 3-4. Non-Scrolling Menu Window**

### Menu Control

The prompt line displays appropriate key strokes for that menu level. If a key is pressed that is not valid for that menu, Invalid Response will flash briefly across the prompt line. The key pad layout is shown in Figure 3-5.

**Table 3-1. Key Assignments for the GF Series Key Pad**



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**Figure 3-5. Key Pad**

Key	Key Name	Action
0 - 9	Numeric	Selects options and enters numbers
Y	Yes	Enter a yes response
N	No or (N)ext	Enter a no response or scrolls to the next screen
-	Minus	Enter a minus sign
.	Decimal Point	Enter a decimal point
↵	Back Space	Moves cursor back one space
P	(P)rv or Previous	Scrolls to the previous screen
ENTR	Enter	Enters a numeric value or response
HOME	Home	Returns to the Main Menu or escapes from routines
UP	Up	Move current menu up one level

See Table 3-1 for key pad assignments. At any time, the HOME key can be pressed and the main menu will display. HOME can be used to escape from most routines, restart a progression into the menu structure, or quickly change from one area of the menu to another.

When (N)ext is displayed on the prompt line, more than two menu selections are available. Press N to scroll through all the selections.

The UP key, will back-out of a menu level. The menu moves back one level each time the UP key is pressed. The UP key only functions when UP is displayed on the prompt line.

To make a selection, press the numeric key associated with the desired menu selection. The selection does not have to be displayed, but it must be one of the available selections.

Every path through the menu will eventually cause control to pass from the menu structure to a routine that performs a task such as change a parameter value, initiate a test, or calibrate the system hardware. When the system is operating outside the menu structure, there are subtle differences in the user interface. For example, the UP key may have no affect or the prompt line won't appear.

## Menu Organization

The menu structure is divided into 8 major groups. The first menu option places the flow transmitter's display into the Normal Display mode. When the system is in this mode, flow and temperature measurements are displayed. While in the Normal Display mode, pressing any key will cause the main menu to display. Figure 3-6 shows the entire menu structure.

Menu selections two through eight allow the configuration of the flowmeter to be checked and manipulated. Table 3-2 summarizes the functions contained in each menu group.

**Table 3-2. Menu Functions**

Group Name	Function
Port Setup	Sets analog outputs, set relay switch points and configure the auxiliary input.
Display Setup	Sets the units of measure for the displayed flow rate, temperature and total flow. Sets the sample rate.
Miscellaneous	Sets the current calibration group. Configures the Corrector. Sets the user Password.
Verify	Displays system variables to the screen.
Diagnostics	Factory use only.
Calibration	Displays Delta R in ohms.
Normalize Board	Factory use only.

The Port Setup, Display Setup and Miscellaneous groups is where most activity is concentrated. The Verify, Diagnostics, Calibration and Normalize Board groups are used primarily for diagnostics and factory calibration.

## Normal Operation

The flowmeter upon power up defaults to this mode. During normal operation the flow rate and the temperature is displayed. The total flow is displayed if it is enabled and few system configuration parameters are shown. Figure 3-2 is the Normal Operation display.

The first and second lines contain the current flow rate and temperature. The total flow is displayed on the third line only if it is enabled. The last line contains the current Group number (see the Multiple Groups section in Advanced Features), the relay status, the mode of operation and the sample rate.

The relays status shows either e (energized) or d (de-energized). The letters correspond to the first and second relays, respectively. The mode of operation is norm for normal, auto for Auto-Select or link for Link Groups. (See Advanced Features for explanation of these modes). The sample rate is slow (s), medium (m) or fast (f).

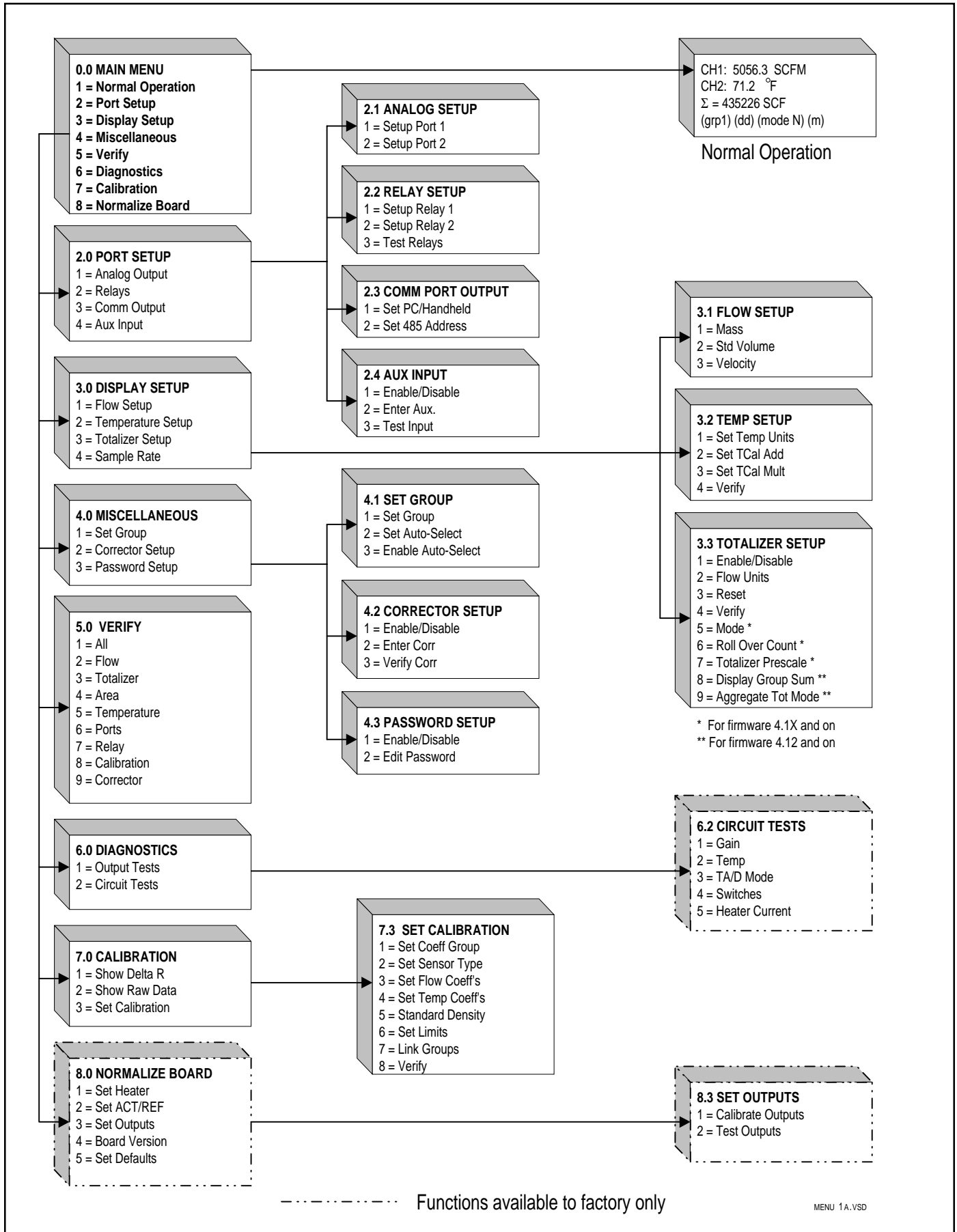


Figure 3-6. Menu Structure

## Quick Operation Procedure

Input power is the only thing needed to operate the instrument. If a modification to the factory setup is needed then continue with this section.

In order to use Table 3-3, an assumption has been made that the password is enabled (this is the factory preset condition).

For proper operation of the flowmeter all the information in the Analog Output category needs to be entered as a group, also all of the information in the Flow Rate Units category needs to be entered (do not skip steps).

If mistakes in data entry are made, press the back arrow key to correct the mistake.

**Table 3-3. Quick Operation Procedure**

Function Desired*	Keys to Press**	Comments
Main Menu	Press any key	To get from the normal display to the main menu.
Main Menu	Press HOME Then 1	To get from other menus to the main menu in most cases. In some cases (when shown) press ENTR, Then Home.
(1) NORMAL OPERATION	Press HOME Then 1	To get the normal display.
SET PASSWORD (1) Enable/Disable	Press HOME, 4, 3, 1, Then enter user password, Then press ENTR, HOME	The factory recommends that the password be disabled before any information is entered to speed up the process.
<b>ANALOG OUTPUTS</b>		
PORT 1: MODE (1) 4-20mA (2) 0-5V (3) 1-10V (4) 1-5V	Press HOME, 2, 1, 1, 1, Then 1 or 2 or 3 or 4 or ENTR, Then 5, Y or N, HOME	Press the key which best matches the analog input to the peripherals from Jack JP6 of the Flow Transmitter. Press ENTR only if previous values are correct.
PORT 1: UNIT (1) FLOW (2) TEMP	Press HOME, 2, 1, 1, 2, Then 1 or 2, Then 5, Y or N, HOME	Press the key which matches the condition to be measured.
PORT 1: F.S.	Press HOME, 2, 1, 1, 3, Then press in a numeric value, Then press ENTR, 5, Y or N, HOME	Enter the numeric full scale value which is expected to occur. The value needs to be between the two values shown on the second and third lines of the display. Press ENTR without inputting a numeric value only if previous values are correct.
PORT 1: ZERO	Press HOME, 2, 1, 1, 4, Then press in a numeric value, Then press ENTR, 5, Y or N, HOME	Enter the numeric zero scale value which is expected to occur. The value needs to be between the values displayed on the second and third lines of the display. Press ENTR without inputting a numeric value only if previous values are correct.
PORT 2: MODE (1) 4-20 mA (2) 0-5V (3) 1-10V (4) 1-5V	Press HOME, 2, 1, 2, 1, Then 1 or 2 or 3 or 4 or ENTR, Then 5, Y or N, HOME	Press the key which best matches the analog input to the peripherals from Jack JP6 of the flow transmitter. Press ENTR only if previous values are correct.
PORT 2: UNIT (1) FLOW (2) TEMP	Press HOME, 2, 1, 2, 2, Then 1 or 2, Then 5, Y or N, HOME	Press the key which matches the condition to be measured.

**Table 3-3. Quick Operation Procedure (Continued)**

<b>Function Desired*</b>	<b>Keys to Press**</b>	<b>Comments</b>
PORT 2: F.S.	Press Home, 2, 1, 2, 3, Then press in a numeric value, Then press ENTR, 5, Y or N, HOME	Enter the numeric full scale value which is expected to occur. The value needs to be between the two values shown on the second and third lines of the display. Press ENTR without inputting a numeric value only if previous values are correct.
PORT 2: ZERO	Press HOME, 2, 1, 2, 4, Then press in a numeric value, Then press ENTR, 5, Y or N, HOME	Enter the numeric zero scale value which is expected to occur. The value needs to be between the values displayed on the second and third lines of the display. Press ENTR without inputting a numeric value only if previous values are correct.
<b>FLOW RATE UNITS</b>		
MASS UNITS (1) LB (2) KG (3) TNS	Press HOME, 3, 1, 1, Then 1 or 2 or 3, then in the TIME UNITS menu press 1 or 2 or 3 or 4, Then in the AREA menu press 1 or 2, Then 1 or 2 or 3 or 4, Then enter a numeric value, then ENTR, any key, any key, Y or N, HOME	Enter the flow rate, using the necessary mass units needed along with the units per time and the pipe diameter or area. ENTR can be used if the values are already correct.
Std Volume (1) Cu feet (2) Cu meter (3) Liters	Press HOME, 3, 1, 2, Then 1 or 2 or 3, Then in the TIME UNITS menu press 1 or 2 or 3 or 4, Then in the AREA menu press 1 or 2, Then 1 or 2 or 3 or 4, Then enter a numeric value, Then ENTR, any key, any key, Y or N, HOME	Enter the standard volume in Cubic feet, Cubic meters, or Liters, along with the units per time and the pipe diameter or area. ENTR can be used if the values are already correct.
Std Velocity	Press HOME, 3, 1, 3, Then in the LENGTH UNITS menu press 1 or 2, Then in the TIME UNITS menu press 1 or 2 or 3 or 4, Then any key, Y or N, HOME	Enter the standard velocity in feet or meters per unit time.
SET PASSWORD (1) Enable/Disable	Press HOME, 4, 3, 1, Then HOME	The factory recommends the password be enabled with this step after the above information has been completed.
*NUMBERS IN PARENTHESIS ARE KEYS TO BE PRESSED		
**Y or N REFERS TO Y SAVE PERMANENTLY OR N DO NOT SAVE		

## Configuring the Flowmeter

There are several parameters that can be modified to customize the system. This section describes how the flowmeter can be customized to best fit requirements.

### Password Protection

Before the flowmeter configuration is customized, access to the system parameters must be had. Two levels of password protection affect access to these parameters.

- Factory Level

The highest level of protection requires a system password for access. This password prevents the user from inadvertently changing variables associated with the system calibration or other parameters that require factory resources to properly set.

- User Level

The second level of protection requires a user password for access. This password provides the user with the ability to limit access to parameters that affect the way the system operates. The default user password is 123 and can be changed to any combination of up to 12 characters in length.

Both levels of password protection can be enabled or disabled. When the system leaves the factory, the factory level and user passwords are enabled. No password is required to enable a level of protection, but the appropriate password is required to disable protection.



**Note:** The user password is set to 123 when the system is shipped.

- **To edit the user password:**

1. From the Main Menu press 4. The 4.0 MISCELLANEOUS menu title will appear.
2. Press 3, Password Setup.
3. Press 2, Edit Password.
4. If password protection is enabled enter the current password.
5. Enter the new password of up to 12 characters.
6. When prompted to Save Permanently enter Y for yes.

- **To enable and disable the password protection:**

1. From the Main Menu press 4. The 4.0 MISCELLANEOUS menu title will appear.
2. Press 3, Password Setup.
3. Press 1, Enable/Disable Password.
4. Enter the user password if prompted to do so.
5. The password protection will be toggled on or off depending on its previous state.

### Selecting Units of Measure



**Note:** By answering the prompt, Save permanently?, with a N or by pressing the HOME key, the flowmeter will revert to the previously saved units of measure when the power is cycled.

The flowmeter measures the mass flow rate and stream temperature of the process media. The display can be set to present the flow rate and temperature in a variety of units. The factory will set the units of measure to those specified at order entry time. There are other units of measure that can be chosen. Two units that will appear are m and mm. The letter m stands for 1000 and mm stands for 10,000. Menu level 3.1 provides the options for changing the output units of measure. The units of measure can be selected for temperature at menu level 3.2. The units of measure for the totalizer are available at menu level 3.3.

- **To choose a new unit of measure for flow rate:**

1. From the Main menu press 3. The 3.0 DISPLAY SETUP menu title will appear.
2. Press 1, the Flow Setup option.
3. At this point there are three choices, Mass, Std Volume and Std Velocity. Table 3-4 summarizes the choices contained in Mass, Std Volume and Std Velocity.
4. By pressing 1, 2, or 3, the display will prompt the user to enter the user password (if it is enabled) and then the respective mass, volume or length units from Table 3-4. Enter the desired measurement type. For example, pressing 1 will show the following display: 1=LB, 2=KG or 3=TNS.
5. Enter the desired time units, seconds, minutes, hours or days.
6. If Mass or Std Volumetric units have been selected, enter the pipe cross-sectional area. There is the option of entering the area directly or, for circular pipes, entering the inside diameter.
7. Enter the desired area units.
8. Enter the pipe area or the pipe inside diameter. Press any key twice.
9. When prompted to Save permanently enter Y for yes.



**Note:** The term Std refers to standard or standard conditions. Standard volume refers to the space a gas occupies at a defined pressure and temperature. The factory uses 14.7 psia and 70°F as its standard conditions. Std Velocity is defined as the standard volumetric flow rate divided by the pipe cross-sectional area.

**Table 3-4. Flow Rate Units of Measure**

Selection	Units	Description
Mass	LB/Time	Pounds per Unit time. Time units are seconds, minutes, hours or days.
	KG/Time	Kilograms per unit time.
	TNS/Time	Metric Tonnes (1000 Kilograms) per unit time.
Std Volume	SCF/Time	Standard Cubic Feet per unit time.
	NCM/Time	Normal Cubic meters per unit time. (Normal is the metric equivalent of Standard.)
	NL/Time	Normal liters per unit time.
Std Velocity	SF/Time	Standard feet per unit time.
	NM/Time	Normal meters per unit time.

- **To choose a new unit of measure for temperature:**

1. From the Main menu press 3. The 3.0 DISPLAY SETUP menu title will appear.
2. Press 2, the Temperature Setup option.
3. Press 1 to change the units for temperature.
4. After entering the user password (if it is enabled) there will be 4 choices: (°F) degrees Fahrenheit, (°C) degrees Celsius, (K) Kelvin and (R) Rankine. Press the appropriate number corresponding to the desired temperature units.
5. When prompted to Save permanently enter Y for yes.

- **To choose a new unit of measure for total flow:**

1. From the Main menu press 3. The 3.0 DISPLAY SETUP menu title will appear.
2. Press 3, the Totalizer Setup option.
3. Press 2, Flow Units, to change the units for total flow.
4. There is the option of standard volumetric units or mass units. See Table 3-4 for a description of the available choices. Press 1 or 2.
5. After entering the user password (if it is enabled) the user will be prompted with standard volumetric or mass units. Enter the desired total flow units.
6. The user will be prompted to enter the pipe cross-sectional area. The user has the option of entering the area directly or, for circular pipes, entering the inside diameter. Enter the method desired.
7. Enter the desired area units.
8. Enter the value of the pipe area or the pipe inside diameter. Press any key twice.
9. When prompted to Save permanently enter Y for yes.

- **To choose a new totalizer mode for total flow (for 4.10 firmware and above):**



**Note:** Changing from float to fixed or from fixed to float mode will reset the totalizer.

1. From the Main menu press 3. The 3.0 DISPLAY SETUP menu title will appear.
2. Press 3, the Totalizer Setup option.
3. Press 5, Mode, to change the mode of the totalizer between float and fixed.

The fixed mode shows the totalized flow with a fixed decimal point and a fixed amount of digits. The float mode does not have a fixed decimal or digits. As the numbers get larger the display will show an exponential value.

4. The current mode is displayed. If a change is required press Y or N.
5. If Y is pressed, press 0 for float mode or 1 for fixed mode in the next display.

- **To view or reset the Roll Over Count for total flow (for 4.10 firmware and above):**

1. The fixed mode (see above) must be chosen. From the Main Menu press 3. The 3.0 DISPLAY SETUP menu title will appear.
2. Press 3, the Totalizer Setup option.
3. Press 6, Roll Over Count, to view the number of times the fixed counter has rolled over the zero mark. Press Y to reset the roll over counter, or N to return to the previous menu.

- **To choose Totalizer Prescaler for total flow (for 4.10 firmware and above):**

1. From the Main menu press 3. The 3.0 DISPLAY SETUP menu title will appear.
2. Press 3, the Totalizer Setup option.
3. Press 7, Totalizer Prescaler, to change between prescale values of 0, .001 or 1000.
4. Press 0 for no prescale, or press 1 for a prescale value of .001, or press 2 for a prescale value of 1000.

- **To choose Display Group Sum for total flow (for 4.12 firmware and above):**

1. From the Main menu press 3. The 3.0 DISPLAY SETUP menu title will appear.
2. Press 3, the Totalizer Setup option.
3. Press 8, the Display Group Sum.

The totalized flow for the first group will be displayed. Pressing any key will display the totalized flow for the second group if the second group is enabled. Pressing any key will display the totalized flow for the third group if the third group is enabled.

The group totals will be displayed regardless if they have been initialized. These values can be reset by switching to each group and individually resetting each one or doing a reset all from menu 3.3.3.

- **To choose Aggregate Tot Mode for total flow (for 4.12 firmware and above):**

1. From the Main menu press 3. The 3.0 DISPLAY SETUP menu title will appear.
2. Press 3, the Totalizer Setup option.
3. Press 9, Aggregate Tot Mode, to turn on or off the aggregate total mode.

This setting is saved in EEPROM and recalled when the system is reset. When the aggregate mode is enabled, the following parameters must be the same for all the groups that are linked; totalizer prescale, totalizer mode (fixed or float) and the totalizer units. If all the parameters do not match, the totalizer display will show "AGGREGATE TOT ERROR".

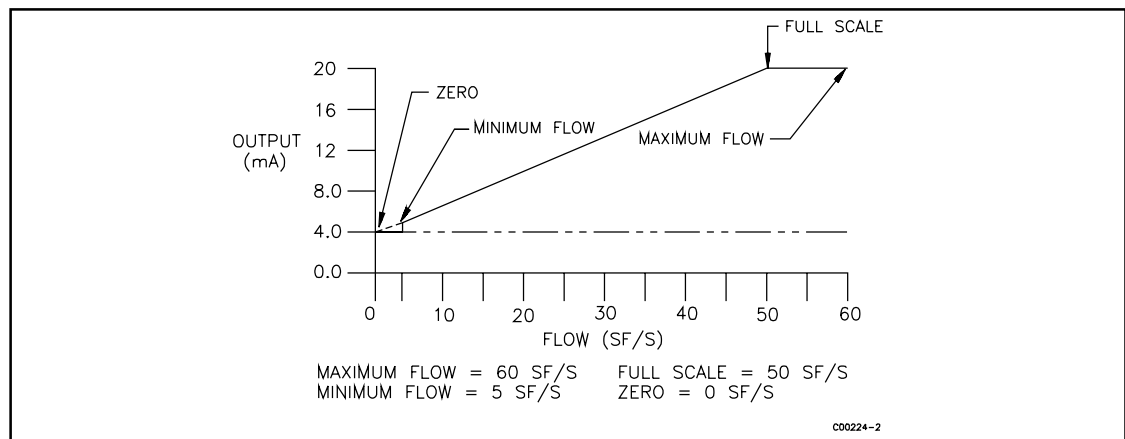
## Setting Analog Outputs

The flowmeter has two, independent analog signal outputs. The outputs can be set to represent flow rate or temperature. The flowmeter signal outputs have been configured according to the application information supplied to the factory at the time of order. However, the outputs can be re-scaled anywhere within the calibrated flow range. The outputs can be independently set to one of four signal ranges: 4 to 20 mA, 0 to 5 V, 0 to 10 V or 1 to 5 V. A typical configuration is presented in Table 3-5.

**Table 3-5. Typical Signal Output Configuration**

Port No.	Mode	Type	Zero	Full-Scale (F.S.)
1	4 to 20mA	Flow	0 SF/S	150 SF/S
2	4 to 20mA	Temp	-50°F	150°F

The signal range varies linearly with change in flow rate as shown in Figure 3-7. Minimum signal output can be set to indicate a flow of zero. This is often referred to as a zero-based signal output. A minimum signal that represents a value greater than zero is referred to as non-zero based.



**Figure 3-7. Signal Output Versus Flow Rate**



**Note:** The flowmeter inherently has a minimum, non-zero flow rate that it is able to detect. Therefore, setting the minimum signal output (referred to as Zero in Menu 2.1.1) to zero will create a step in the output. This step corresponds to the flow where the flowmeter begins accurate measurement. Turndown ratios (turndown is defined as the maximum flow rate divided by the minimum flow rate) smaller than 10:1 will have a large step change thus reducing the usable signal range.

- **To re-scale the signal outputs:**

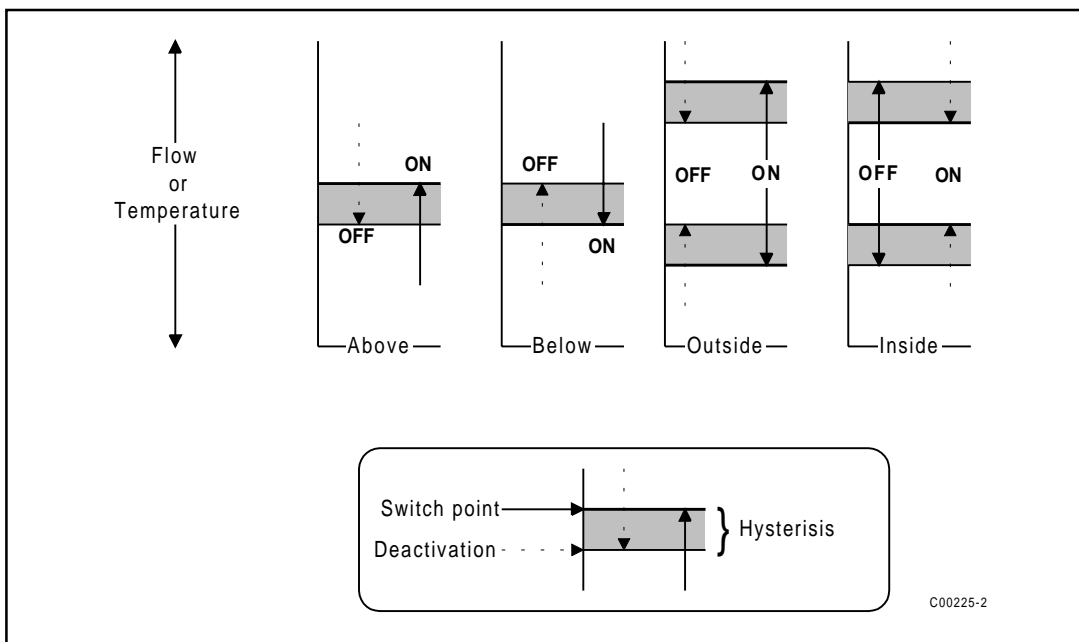
1. From the Main menu press 2. The 2.0 PORT SETUP menu title will appear.
2. Press 1, the Analog Output option.
3. Press 1 or 2, corresponding to the analog port to be re-scaled.
4. After entering the user password (if it is enabled), press 1 to change the analog output mode. Select the signal mode. (The current selection is shown in parenthesis to the left of the question mark.)
5. Press 2 to change the analog output type. Press 1 for an output signal based on flow. Press 2 for an output signal based on temperature.
6. Press 3 to change the maximum or Full Scale (F.S.) flow rate. Enter a maximum flow rate value within the specified range.
7. Press 4 to change the zero flow rate. Enter a minimum flow rate value within the specified range. A value of zero is valid.
8. Press 5 to save and exit to the previous menu level. Press Y when asked to save permanently.

### Setting the Relays

There are two double pole, double throw relays on the flowmeter. They can be set to respond to changing flow rates or changing temperatures.

There are four types of switching schemes to choose from. These are referred to as Above, Below, Outside, and Inside. Each switch point can be set to have hysteresis and a time delay. Figure 3-8 illustrates the four switch point schemes with arbitrary hysteresis assigned.

Switching schemes, Above and Below change relay states when the flow or temperature crosses the switch point value. The outside and inside schemes contain a range wherein the relay changes states.



**Figure 3-8. Relay Switch Point Schemes**

- **To set the relays:**

1. From the Main menu press 2. The 2.0 PORT SETUP menu title will appear.
2. Press 2, the Relay Setup option.
3. Press 1 or 2, corresponding to the relay to be set.
4. After entering the user password (if it is enabled), press 1, Unit, to select the switching parameter. Press 1 to switch on flow rate or press 2 to switch on temperature. (The current selection is shown in parenthesis to the left of the question mark.)
5. Press 2, Activate On, to select the switching scheme desired (See Figure 3-8). Press 1 for an Above, press 2 for Below, press 3 for Inside or press 4 for Outside. Depending on the choice made, enter 1 or 2 switch point values. For example, if Inside has been chosen, the user will then be prompted to enter a low range switch point and a high range switch point. The values entered must be within the displayed allowable range.
6. Press 3 to change the switch delay. Delay pauses the change in relay state when a switch point is crossed. The value entered is approximately equal to seconds.
7. Press 4 to change the dead band or hysteresis of the switch point (See Figure 3-8). The dead band or hysteresis has a value of flow rate or temperature depending on whether switch on changes in flow rate or temperature have been chosen.
8. Press 5 to save and exit to the previous menu level. Press Y when asked to save permanently.

### Testing the Relays

From the keypad, the relay state can be switched. This can be used to test the interface with relays. This is also described in Chapter 5 Troubleshooting.

- **To test the relays:**

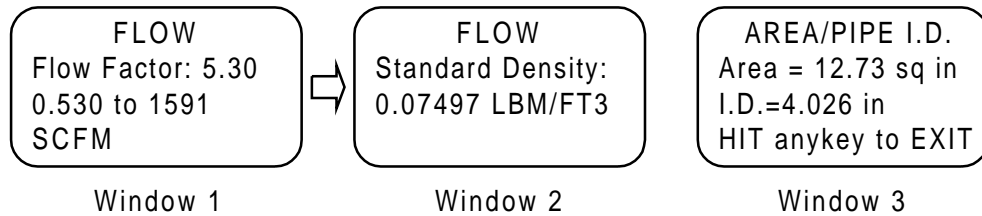
1. From the Main menu press 2. The 2.0 PORT SETUP menu title will appear.
2. Press 2, the Relay Setup option.
3. Press 3, for the Test Relays option.
4. Pressing 1 or 2 will toggle the states of the respective relays. The present state of the relays are displayed in parenthesis.

### Checking the Current Setup

The functions within menu level 5.0 provides a quick means of displaying the current system parameters for the flowmeter. The flow rate and temperature units of measure, the state of the analog outputs and relays or other critical information can be viewed from this menu.

- **To view the flow range, the flow rate units of measure and the area:**

1. From the Main menu press 5. The 5.0 VERIFY menu title will appear.
2. Press 2, the Flow option. The sequence of information will be displayed to the screen as shown in Figure 3-9. Press Enter twice to proceed. The first line of screen 1 is the window title. Line 2, the Flow Factor is the conversion factor from the internal units of measure (SF/S) to the desired units. Lines 3 and 4 show the flow range and the current flow units. Screen 2 shows the standard density of the flow stream.
3. Press 4, the Area option. Screen 3, shown in Figure 3.9 will appear. The second line shows the pipe area and units. The third line is the inside diameter of the pipe. (The third line will appear only if the pipe I.D. is entered. If Std Velocity flow units are used the Area option is not available.)



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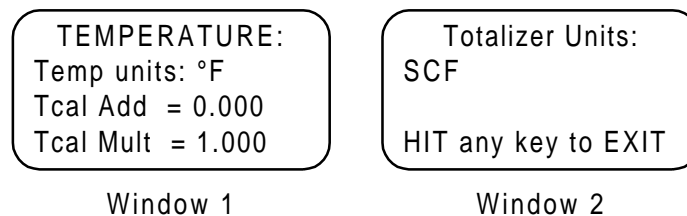
**Figure 3-9. Flow and Area Verification Display**



**Note:** The flowmeter does not measure standard density. This number is entered through menu level 7.3.5. The standard density displayed in menu 5.2 must be equivalent to the standard density of the process media. The factory has entered the process standard density supplied at the time of order. The standard density factor is only used when calculation mass flow units.

• **To view the temperature and totalizer units of measure:**

1. From the Main menu press 5. The 5.0 VERIFY menu title will appear.
2. Press 5 to view the current units for temperature. Press 3 to view the current units for the total flow. (If the totalizer is disabled the display will only show No Totalizer.) The information will be displayed to the screen as shown in Figure 3 -10.



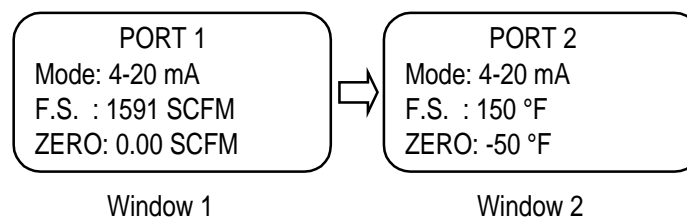
C00244-1

**Figure 3-10. Temperature, Totalizer Verification Display**

Line 2 of screen 1 shows the current units for temperature. Lines 3 and 4 display the offset and multiplier to the measured temperature. See Advanced Features for a detailed explanation. Screen 2 shows the total flow units.

• **To view the analog output parameters:**

1. From the Main menu press 5. The 5.0 VERIFY menu title will appear.
2. Press 6, the Ports option. The two screens in Figure 3-11 are identical except for the port number. Line 2 is the current signal output mode. Line 3 shows the full scale flow rate or temperature value and the appropriate units. Line 4 is the zero value. Press any key for screen 2.

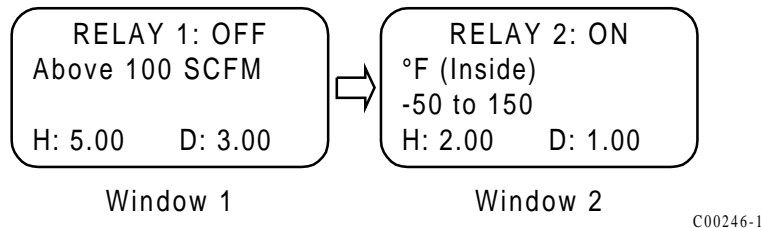


C00245-1

**Figure 3-11. Analog Output Verification**

- **To view the relay switching parameters:**

1. From the Main menu press 5. The 5.0 VERIFY menu title will appear.
2. Press 7, the Relay option. The two screens in Figure 3-12 describe how the two relays will react to changes in flow rate or temperature. Screen 1, line 1 is the current status of relay 1. Line 2 shows that the relay will change states when the flow rate exceeds 100 SCFM. The last line displays a hysteresis (H) of 5 SCFM and a delay of about 3 seconds. Screen 2, line 1 is the current status of relay 2. Line 2 and 3 shows that the relay will switch states on changes in temperature (°F). The state of the relay will change when the temperature is inside the temperature range of -50 to 150 °F. The last line displays a hysteresis (H) of 2 °F and a delay of about 1 second.



**Figure 3-12. Relay Status Verification Display**

## Advanced Features

The remainder of this chapter contains topics that may not be applicable to every user of the flowmeter. In most cases the flowmeter will be ready for use straight out of the box. However, there may be an application where the advanced features of the flowmeter may be needed. This section discusses how to correct for bias errors due to non-ideal installations, how to communicate with the flowmeter through the serial port, and how to use the multiple calibration options.

### Flow Rate Correction Equation

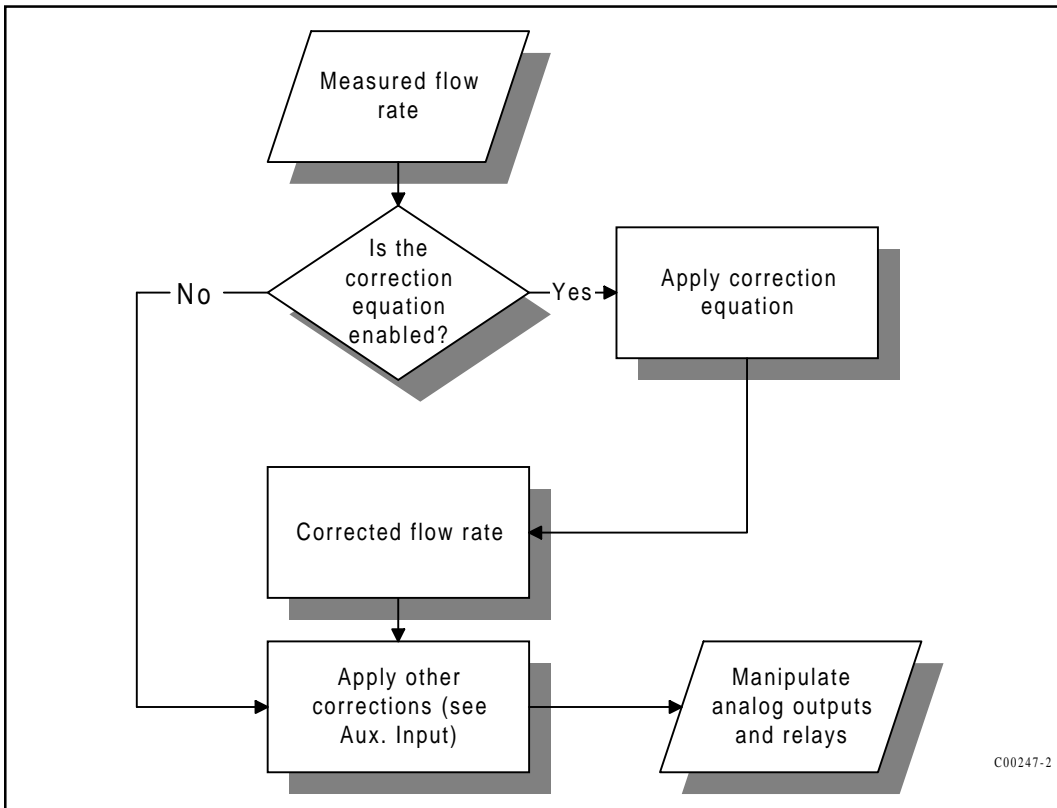
The flow rate correction equation or corrector is used to bias the flow rate output. The correction equation contained in the flowmeter allows the user to correct for bias errors due to non-ideal installation effects. The correction equation is applied to the measured flow rate and then this corrected flow rate is used to drive the analog outputs and manipulate the relays. The flow rate shown on the display is also the corrected value. Figure 3-13 describes how the correction equation is applied.

The correction equation for the flowmeter is shown below.

$$m_{\text{new}} = F_1 + (F_2 \times m_o) + (F_3 \times m_o^2) + (F_4 \times m_o^3)$$

where

- $m_o$  = Measured Flow Rate
- $F_i$  = Correction Equation Coefficients (  $i = 1$  through 4 )
- $m_{\text{new}}$  = Corrected Flow Rate



**Figure 3-13. Correction Factor**

Application of the correction equation will be illustrated in the following example. Through analysis of the process flow stream it is determined that the flow rate must be multiplied by 1.056 to output the desired value. The correction equation takes the following form:

$$m_{new} = 0 + (1.056 \times m_o) + (0 \times m_o^2) + (0 \times m_o^3)$$

Therefore  $m_{new} = 1.056 \times m_o$

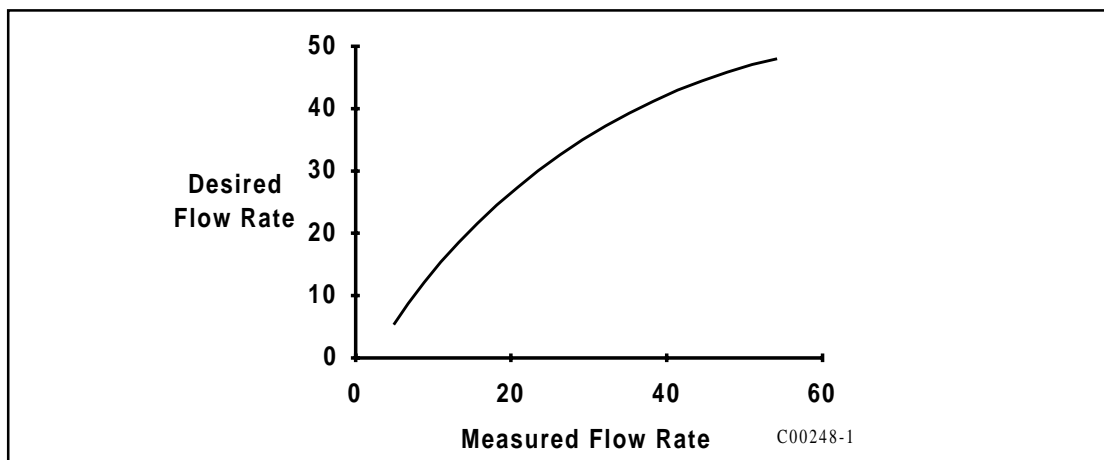
Where  $F_1 = 0$

$F_2 = 1.056$

$F_3 = 0$

$F_4 = 0$

A more complicated situation would be where the multiplication factor varies with flow rate. Figure 3-14 shows the variation of desired flow rate versus the measured flow rate.



**Figure 3-14. Desired Flow Rate Versus Measured Flow Rate**

The relationship between the measured and the desired flow rates was determined through a least squares analysis. The coefficients for the above relation are:

$$F_1 = -7.5672 \qquad F_2 = 2.09253$$

$$F_3 = -0.037082 \qquad F_4 = 0.0003505$$

- **To enter the correction equation coefficients and to enable it:**

1. From the Main menu press 4. The 4.0 MISCELLANEOUS menu title will appear.
2. Press 2, the Corrector Setup option.
3. Press 2, the Enter Corr option, to enter the Correction Equation coefficients
4. Enter the user password (if it is enabled). Press 1 to enter the coefficient F1. Press 2 for F2 and so on to F4. Press 5 to verify the entries.
5. Press 6 to exit.
6. Press 1 to enable to Corrector. (To disable the Corrector press 1 again.)

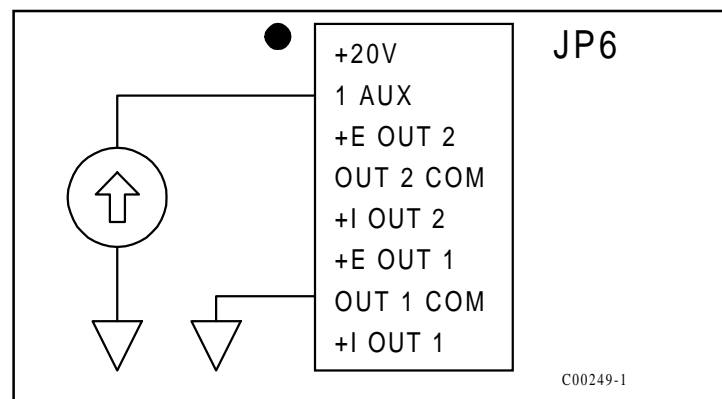
### The Auxiliary Input

The flowmeter has one analog signal input port that can be used to directly manipulate the flow rate output. This signal input port is called the auxiliary input. The signal measured by the flowmeter allows for the correction of errors that may be caused by changes such as process composition. The factory has determined from the application data supplied at the time of order whether the flowmeter would benefit from using the auxiliary input. If the auxiliary input is not used in the flowmeter the following section can be skipped. If the auxiliary input is used, all the internal settings necessary have been entered into the flowmeter. The following is a description of the internal and external workings of the auxiliary input.

- **To determine if the flowmeter is set to use the auxiliary input:**

1. From the Main menu press 2. The 2.0 PORT SETUP menu title will appear.
2. Press 4, the Aux Input option.
3. Press 2, the Enter Aux option. Enter the user password (if it is enabled).
4. Press 5, the Verify option. The variables AUX 1, 2 and 3 will appear.
5. Press ENTR and DISABLED or ENABLED will be on the third line. If ENABLED is displayed then the flowmeter has been configured to use the auxiliary input.

The auxiliary input is accessed at terminal JP6 located on the lower circuit board. Figure 3-15 illustrates the auxiliary input connected to a current source. If OUT 1 COM is not easily accessible then use JP6 OUT 2 COM, JP7 GND, JP1 DC GND or JP3 GND. They are electrically the same signal ground point. The range of this source is most likely 4-20 mA.



**Figure 3-15. Auxiliary Input Wiring Diagram**

The flowmeter measures the applied current input, converts it to a digital value and makes a correction to the measured flow rate. The corrected flow rate is used to drive the analog outputs and manipulate the relays. The flow rate shown on the display is also the corrected value. Figure 3-16 charts the process.

The auxiliary input port monitors the signal input level and converts it to a digital value. This digital value can be displayed from menu level 2.4.3, the Auxiliary Test Input function.

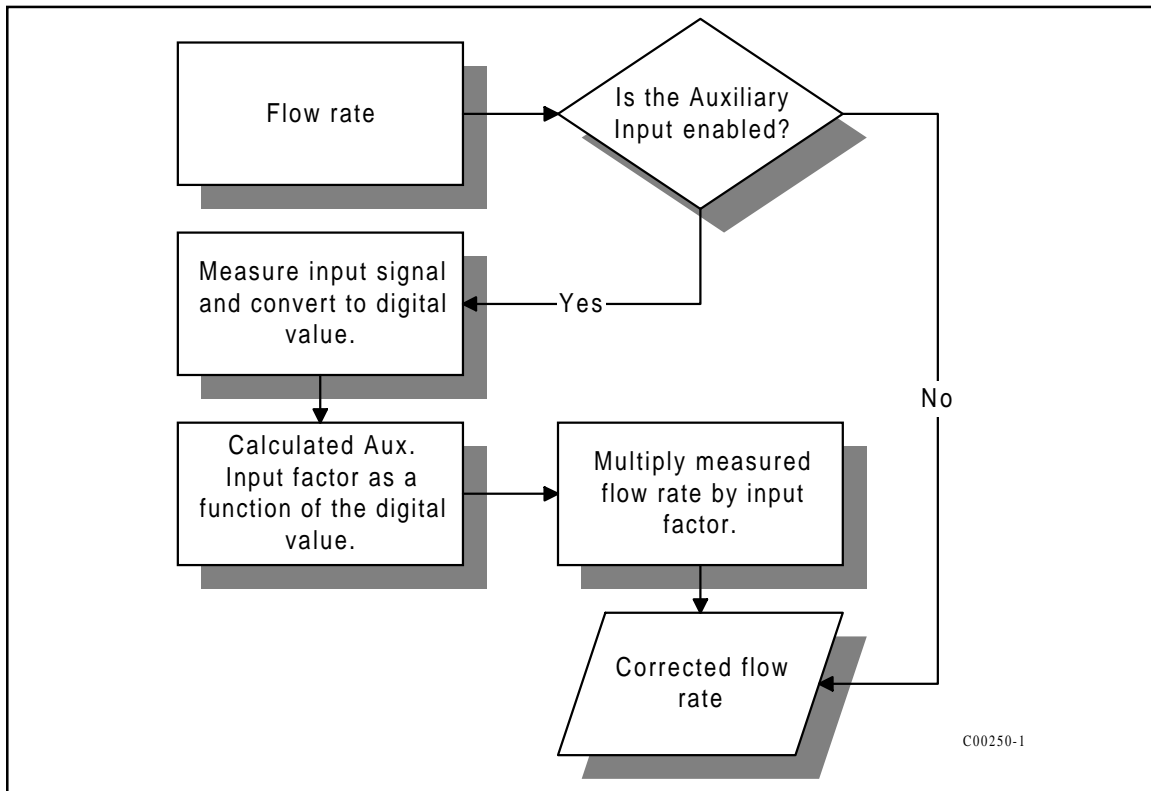


Figure 3-16. Auxiliary Input Process

- **To view the digital representation of the current input:**

1. Apply a current to the auxiliary input as shown in Figure 3-15.
2. From the Main menu press 2. The 2.0 PORT SETUP menu title will appear.
3. Press 4, the Aux Input option.
4. Press 3, the Test Input option. The digital representation of the current input is displayed on the second line.

The approximate relationship between current input and the digital value displayed in menu level 2.4.3 is:

$$\text{Digital Value} = \text{Current Input} \times 51.1$$

The digital value is used to manipulate the measured flow rate. This digital value is used to calculate a factor that is multiplied by the measured flow rate. The factor is calculated using the following relationship:

$$K_A = A_1 + (A_2 \times s) + (A_3 \times s^2) + (A_4 \times s)$$

where  $s = \text{Digital Value}$

$A_i = \text{Correction Factor Coefficients } (i = 1 \text{ through } 4)$

$K_A = \text{Correction Factor}$



**Note:**  $A_i$  is used for clarity in the manual. The flowmeter uses  $F_j$  as the Correction Factor Coefficient.

The Auxiliary Input Equation coefficients are determined by the factory from the data supplied at the time of order entry.

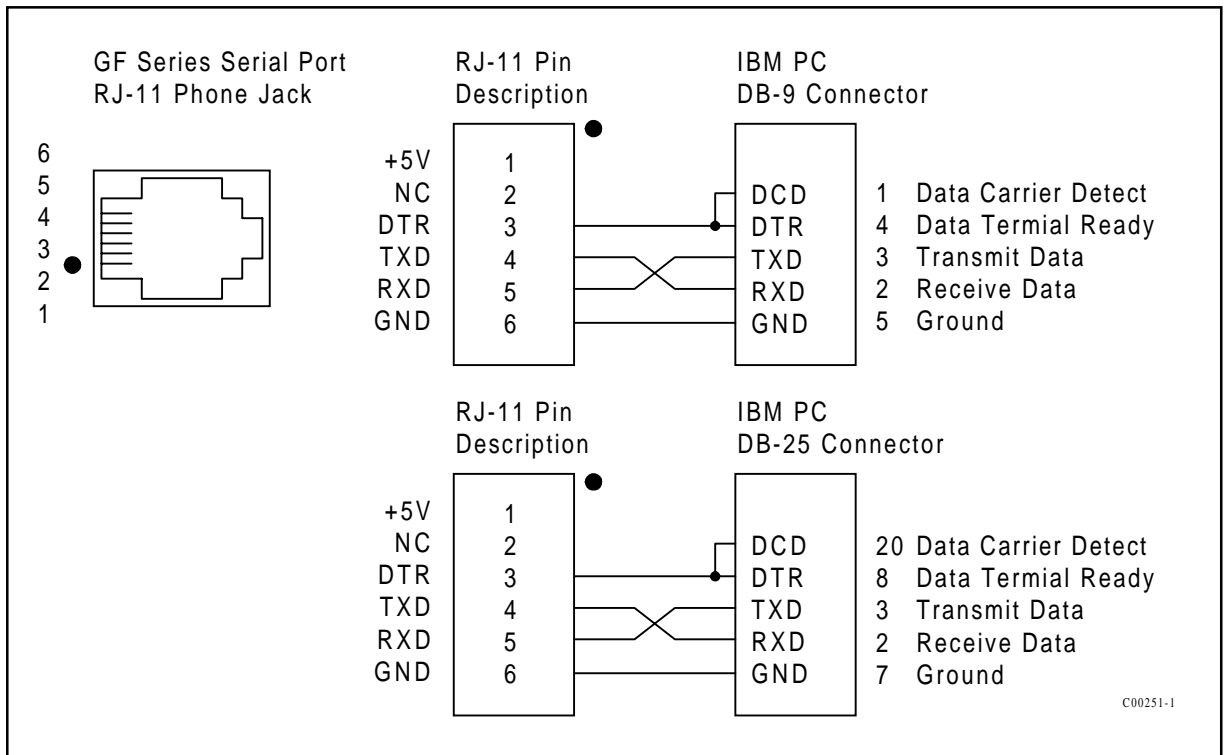
### Serial Communications

The flowmeter has one RS-232 port. The data stream is sent at a rate of 9600 baud with no parity, 8 bit characters and 1 stop bit. The baud rate is fixed and cannot be changed. All operations accessible through the keypad are also available through the serial port. The serial port, designated as JP3, is located on the lower right corner of the upper circuit board. The connection is a RJ-11 phone jack. Figure 3-17 represents the connection between the serial port and the host device.

A serial communications kit containing adapter plugs are available from FCI for both the DB-9 and DB-25 connectors which allow the use of standard 6 wire phone line cord between the RJ-11 serial port and the host device. The order number for the DB-9 Connector kit is 014108-01. Serial communication software is provided with each connector.



**Note:** The standard phone line used must be a reversing type and not a straight-through type of cable.



**Figure 3-17. Wiring Diagram, DB-9 and DB25 PC Connectors**

The serial port input/output stream duplicates the actions of the keypad and the LCD display. Commands sent through the serial port to manipulate the flowmeter are exactly equivalent to the keypad sequences. Data coming out of the serial port is equivalent to the data sent to the display. Remote communication with the flowmeter consists of character sequences that duplicate actions taken at the keypad. For example, the string H 2 4 2 5 produces the same results as pressing HOME, 2, 4, 2, 5 from the keypad. Figure 3-18 is an example of code written in Quick Basic that extracts the flow rate and the temperature through the serial port.

A common communication problem is over writing flowmeter serial buffer. If the buffer is overwritten the last characters sent are lost. If the flowmeter does not respond as expected to a command, slow down the data flow from the user PC or control device.

```

' Serial Communication example
' Fluid Components Intl

' This program places the flowmeter into normal
' operation and displays the current flow rate and
' temperature.

DEFINT A-Z
ON ERROR GOTO error.trap

COLOR 7, 1                                ' Set screen color.

CLS

Quit$ = CHR$(0) + CHR$(16)                ' Value returned by INKEY$
                                           ' when ALT+q is pressed.

' Set up screen and turn cursor off.

LOCATE 24, 1, 0
PRINT STRING$(80, "_");
LOCATE 25, 1
PRINT TAB(30); "Press ALT+q to quit";

VIEW PRINT 1 TO 23                        ' Print between lines 1 & 23.

' Open communications (9600 baud, no parity, 8-bit data,
' 1 stop bit, 256-byte input buffer):

OPEN "COM1:9600,N,8,1,RS,CS,DS,CD,OP10000,RB2000" FOR RANDOM AS #1 LEN =512

PRINT#1, "H";                             ' Send a HOME command. (Send
                                           ' another also.)

x! = TIMER                                ' Wait for response. (A long
DO UNTIL TIMER - x! < 3                   ' wait is not necessary after
LOOP                                       ' most commands.)

PRINT #1, "H";                             ' Send another HOME command

x! = TIMER                                ' Wait again
DO UNTIL TIMER - x! < 3

LOOP

PRINT #1, "1";                             ' Normal Operation

DO                                         ' Main communications loop.

    KeyInput$ = INKEY$                    ' Check the keyboard.
    IF KeyInput$ = Quit$ THEN              ' Exit the loop if the user
        EXIT DO                             ' PRESSED alt+q.
    END IF

    GFINPUT$ = ""                          ' Empty the two working
    moreGFInput$ = ""                      ' strings

```

**Figure 3-18. Series Serial Communication Code Example**

```

IF NOT EOF(1) THEN
  ' LOC(1) gives the number of characters waiting.
  GFInput$ = GFInput$ + INPUT$ (LOC(1), #1)

  ' Gather at least one full display of information
  IF INSTR(GFInput$, "CH1:") THEN

    DO UNTIL INSTR(more GFInput$, "CH:")
      moreGFInput$ = moreGFInput$ + INPUT$(LOC(1), #1)
    LOOP

    GFInput$ = GFInput$ + moreGFInput$

    ' Parse and print the flow rate and temperature
    n% = INSTR(GFInput$, "CH:")
    FlowRate! = VAL(MID$(GFInput$, n% + 5))
    n% = INSTR(GFInput$, "CH2:")
    Temperature! = Val(MID$(GFInput$, n% + 5))

    PRINT FlowRate!, Temperature!

  END IF

END IF

LOOP

CLOSE                                     ' End communications.

END

error.trap:
RESUME NEXT

```

**Figure 3-18. Series Serial Communication Code Example Cont'd.**

### Multiple Groups

The flowmeter is calibrated at the factory in a test stand that duplicates or models the customer application. The calibration process produces the information needed to relate RTD signal to an actual mass flow rate. That calibration information is entered into the flowmeter. Information about the customer's process such as pipe inside diameter and the process standard density is also entered. Situations exist where a pipe or duct may have two or more distinct process flow streams or the flowmeter needs to be used in more than one installation. The flowmeter can accommodate three sets of calibration information, therefore it can be used to monitor multiple flow streams or used in multiple installations. Each set of calibration information is called a Group. The factory has determined from the application data supplied at the time of order whether the flowmeter would benefit from using multiple Groups. If multiple Groups are not used in the flowmeter the following section can be skipped. If multiple Groups are used, all the information necessary has been entered into the flowmeter. However, the method and conditions that determine the current Group can be altered.

- **To determine if the flowmeter is set to use the Multiple Groups:**

From the Main menu press 1. The flowmeter will enter the normal mode of operation. If the mode on the last line of the window (see Figure 3-2) is Auto, or Link then the flowmeter contains multiple calibration groups.

If the mode is normal or Norm is displayed in the normal operation window, the flowmeter may still contain multiple calibration groups.

- **To determine if the flowmeter is set to use the Multiple Groups in Normal mode:**

1. Press 4, the Miscellaneous option.
2. Press 1, the Set Group option.
2. Press 1 again, the Set Group option. Enter the user password (if it is enabled).
3. Press 2, to change the current group to Group 2.
4. Press HOME, 7, 3 and 8. Scroll the display to show C1 to C5. If the coefficients C1 through C5 are non-zero values, the Flowmeter has been set to use multiple groups.
5. Change the current group in Set Group back to group 1.

### Switching Groups Through the Keypad

The current calibration group that the flowmeter uses can be changed from the keypad. This may be the most desirable method of changing groups for a flowmeter that has been configured for multiple installations.

- **To change the current group from the keypad:**

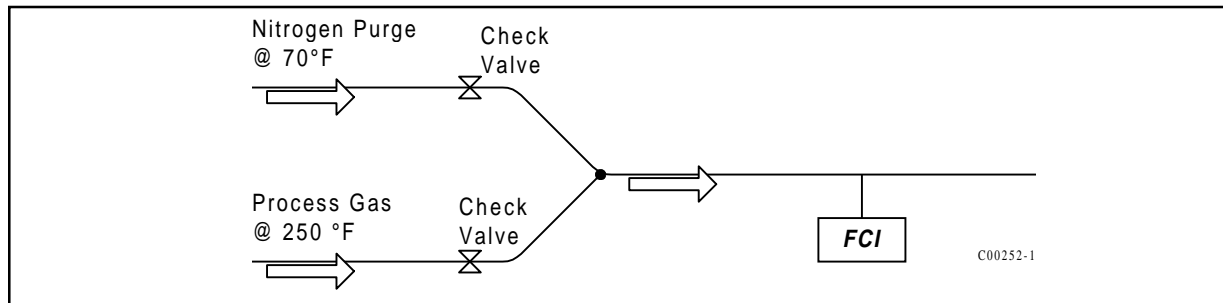
1. Press 4, the Set Group option.
2. Press 1, the Set Group option. Enter the user password (if it is enabled).
3. Enter the desired group number, 1, 2 or 3. The flowmeter is now set to use that group of calibration information.

### Switching Groups Through the Serial Port

The current calibration group can be changed remotely through the serial port. The sequence of commands sent through the serial port is equivalent to the sequence taken at the keypad. The command string should include sufficient time delays to allow the flowmeter to respond. One possible command string is "H H 4 1 1" + (desired group number) + "H 1". The command string sends to HOME (H) characters, sets the menu level to 4.1.1, enters the desired group number and returns the flowmeter to normal operation. Remember to insert a time delay after sending each character. (See Figure 3-18 for an serial communication example.)

### Switching Groups by Temperature - Auto-Selecting

The flowmeter has the ability to switch groups on changes in process temperature or changes in signal into the auxiliary port. To use the auto-select option, the flowmeter must be configured by the factory. Use the procedure described in the section Multiple Groups to determine if the flowmeter has been configured to use multiple groups. In Auto-Select mode the user can program the flowmeter to switch on temperature. One temperature switch point is used for switching between two groups and two switch points are used for three groups. The switch points have a 2.5% hysteresis and cannot be changed. A typical application that would benefit from using auto-selecting by temperature is described in Figure 3-19.



**Figure 3-19. Auto-Select by Temperature Application**

The flowmeter would be calibrated in both nitrogen and the process gas, then the information would be stored in Group 1 and 2. An auto-select temperature switch point of 150 °F would allow the flowmeter to toggle automatically between nitrogen and the process gas when the switch point is crossed. If requested, the factory, will configure the flowmeter for the Auto-Select mode from the application information supplied at the time of the order. Generally, there will be no need to change the settings, however, the switch point values can be adjusted if necessary.

- **To enter a new temperature switch point(s) for the Auto-Select mode:**

1. Press 4, the Miscellaneous option.
2. Press 1, the Set Group option.
2. Press 2, the Set Auto-Select option.
3. Press 2, the By Temperature option. Enter the user password (if it is enabled).
4. Enter the number groups involved in the Auto-Selecting. (Zero to disable.)
5. Enter the switch point temperature(s).



**Note:** The minimum and maximum temperatures for adjacent Groups must be separated by a least 20°F (11°C).

- **To enable or disable the Auto-Select mode:**

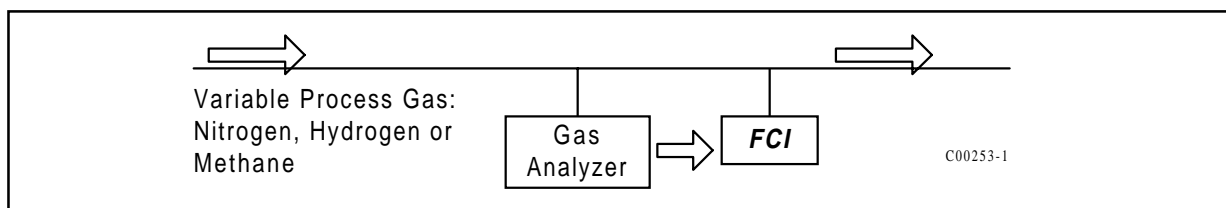
1. Press 4, the Miscellaneous option.
2. Press 1, the Set Group option.
3. Press 3, the Enable Auto-Select option. Auto-Select will toggle on or off depending on its previous state. Enter the user password (if it is enabled).



**Note:** When changing system parameters such as flow rate units the Auto-Select mode must be turned off.

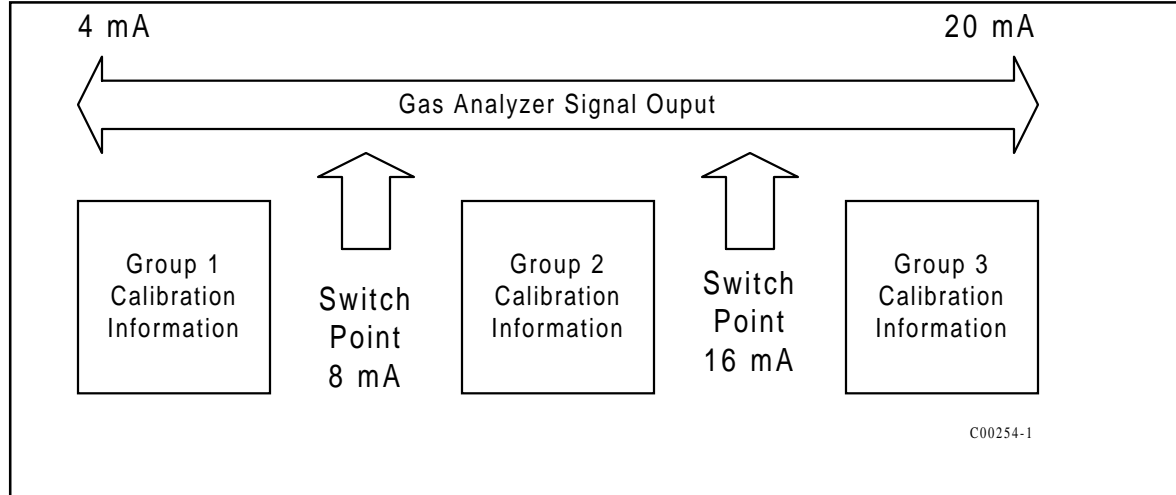
### Switching Groups by the Auxiliary Input - Auto-Selecting

Group switching can also be initiated by a change in signal measured through the Auxiliary Input. (See the section Auxiliary Input and Figure 3-15 for instructions on connecting the flowmeter to an external signal source.) Switch points are based on external signal levels. A typical application that would benefit from using auto-selecting by an external signal is described in Figure 3-20.



**Figure 3-20. Auto-Select, External Signal Application**

In the example above, the pipe line could contain nitrogen, hydrogen or methane. The gas analyzer's 4-20 mA output is connected to the flowmeter's Auxiliary port. The gas analyzer outputs 4 mA when it detects nitrogen, 12 mA when it detects hydrogen and 20 mA when it detects methane. The flowmeter is set to switch groups when it detects the signal crossing 8 mA or 16 mA. Figure 3-21 illustrates this graphically.



**Figure 3-21. Auto-Select, Switch Point Scheme**

- **To enter a new external signal switch point(s) for the Auto-Select mode:**
  1. Press 4, the Miscellaneous option.
  2. Press 1, the Set Group option.
  2. Press 2, the Set Auto-Select option.
  3. Press 1, the By Aux Input option. Enter the user password (if it is enabled).
  4. Enter the number groups involved in the Auto-Selecting. (Zero if there is only one Group of calibration information.)
  5. Enter the digital switch point value that represents the signal level.

### **Link Groups (Extended Range Emulation)**

The Link Groups option enables the flowmeter to measure flow ranges of greater than 100:1 to up to 1000:1. (Turndown is defined as the maximum flow rate divided by the minimum flow rate.) This function is similar to the LT Series Extended Range. Link Groups can only be set by the factory. The Link Groups mode operates transparently (as if the flowmeter were operating in normal mode), although, when changing system parameters there are a few extra steps that need to be taken.

- **To determine if the flowmeter is in Link Groups mode:**

Press 1, the Normal Operation option. The mode of operation is displayed on the last line. Link is displayed if the link groups option is enabled.

If the flowmeter's link groups option is enabled, then changes in system parameters must be made for each group. For instance, if the flow rate units are changed, the flow rate units for each linked group must be changed.

- **To change system parameters in Link Groups mode:**

1. Press 5, the Verify option.
2. Press 8. Scroll the display to the fourth window. The Link Groups mode is displayed on the third line.
3. Press Home, 7, 3 and 7, the Link Groups option. Enter 9 4 2 to enable the function.
4. Press 4 to disable the Link Groups option.
5. Make the parameter changes for all groups, switching between groups using the Set Group option, 4.1.1.
6. Re-Link Groups from menu level 7.3.7 by repeating step 3. Reset the link to the prior setting.



**Note:** The link groups (extended range) and auto-select modes cannot be used simultaneously.

### **Calibration Functions, Menu 7.0**

The calibration functions of the flowmeter are contained in menu level 7.0. These functions are not needed for general operation and setup of the flowmeter. With the exception of 7.1, Show Delta R, these functions should be used only after consultation with a factory service representative. Menu level 7.1 displays the RTD resistances and can be compared to calibration resistances. This is useful for troubleshooting problems and is addressed in Chapter 5, Troubleshooting.

- **To view RTD resistance values:**

1. Press 7, the Calibration option.
2. Press 1, the Show Delta R option.

