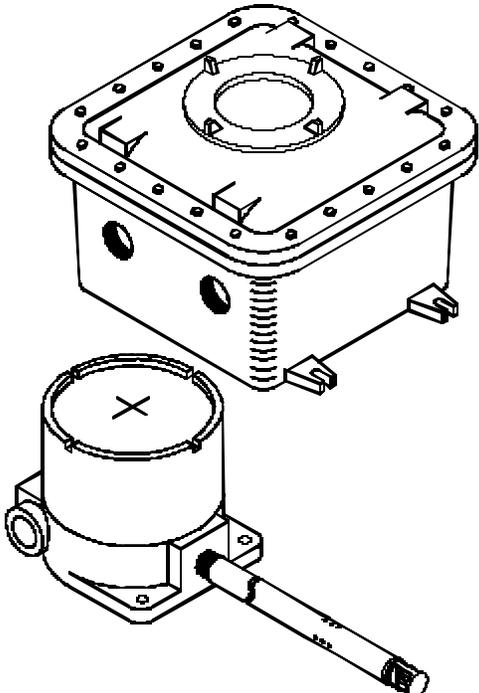


Installation, Operation and Maintenance
GF03 Flowmeter Series



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1. General Information

Description

This document describes the procedures required to install, operate, maintain, and troubleshoot the Model GF03 Flowmeter. There are a wide range of possible configurations and information related to the optional features. The flowmeter is composed of a remote thermal dispersion sensing transducer (flow element) connected to a microprocessor-based electronics control and display package (flow transmitter). The flow element is attached to the flow transmitter thru a cable of up to 1000 feet or 300 meters (remote instrument).

The instrument is designed to operate in gaseous flow metering environments. The flowmeter is factory calibrated to handle a range of flows.

Theory of Operation

The primary flow element consists of two thermowells of the same size, shape and mass. One thermowell contains a platinum RTD and a heater element. The other contains one RTD. The RTD located with the heater element is called the active RTD. The other RTD is referred to as the reference RTD. Since the active RTD is embedded in the heater, the temperature of the active thermowell is always above the temperature of the process media. The temperature at the reference RTD is the temperature of the process media. When the process media is flowing past the active RTD a quantity of heat is carried off into the flow stream. The amount of heat taken from the active RTD is a function of the process media mass flow rate. A ΔT (temperature) exists between the two thermowells and a proportional ΔR (ohms resistance) exists between the active and the reference RTDs. The ΔR is measured by the flow transmitter. The relationship of ΔR to the calibrated flow rate is calculated by the flow transmitter and is converted into both analog and digital outputs.

The Gas Compensation element provides a ΔR value similar to the primary flow element. This value is a no-flow ΔR based on the thermo physical properties of the gas mixture minus any flow component. This value is used to correct gas composition changes in the Transmitter microprocessor.

Sensing Element

The standard sensing element is an all welded 316L stainless steel insertion probe. The element consists of the primary flow element located on the end of the probe and the compensator element located in the insertion pipe. The optional Veri-Cal inlet tube runs the length of the insertion pipe exiting into the base of the primary flow element. This tube allows the Veri-Cal system to distribute a repeatable flow rate on the primary flow element for calibration verification purposes.

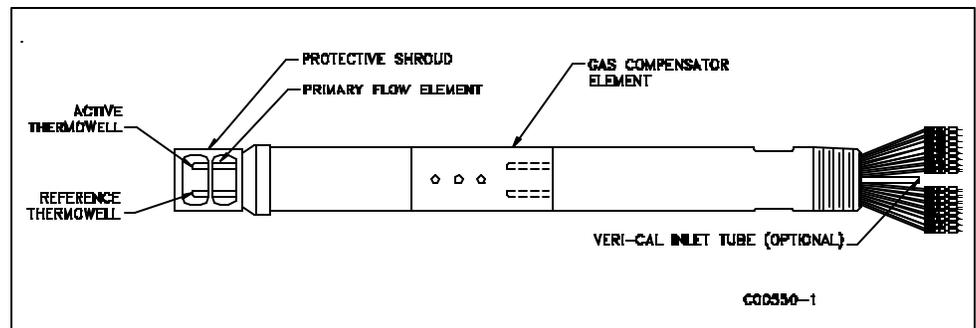


Figure 1 - Flow Element

Flow Transmitter

The other component of the flowmeter is the flow transmitter. The basic functions of the flow transmitter are to provide power to the flow element, measure the Differential Temperature (ΔT) between the two RTDs as a function of resistance, amplify and linearize the Differential Resistance (ΔR) measurement of the flow element and provide a proportional output signal.

This output signal is calibrated to the flow rate as a function of standard velocity or volume. To perform these functions, microprocessor-based electronic circuitry is employed to acquire the analog voltage signals from the RTDs, digitize and interpret the information.

The microprocessor-based electronics provides maximum flexibility and ease of operations with a menu-driven selection of control, monitoring, display and driver options.

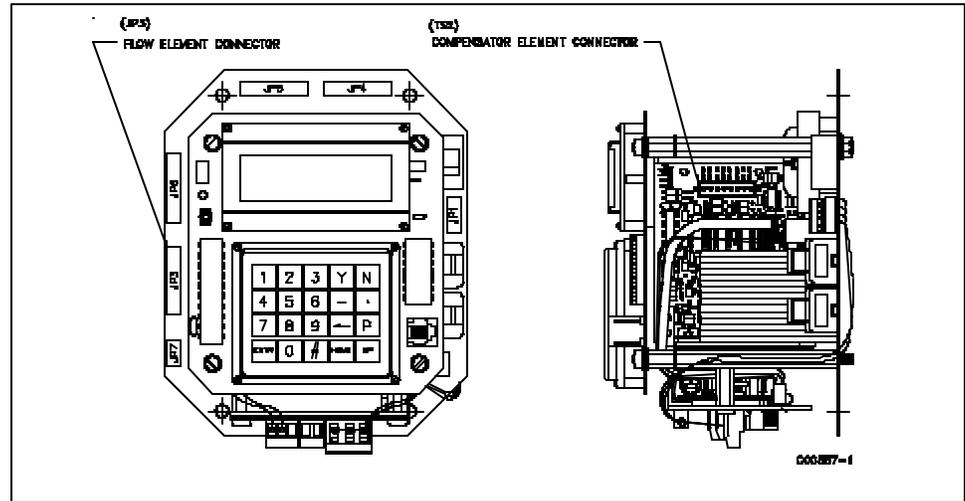


Figure 2 - Flow Transmitter

Technical Specifications

INSTRUMENT

Flow Range:

Insertion Flow Element: 0.5 to 275 SFPS [0.20 to 84 NMPS]
 — Air at standard conditions; 70°F [21.1°C] and 14.7 psia [1.01325 bar (a)].

Media: All gases that are compatible with the flow element material.

Accuracy:

Flow: $\pm 2\%$ to 5% of reading above 1 SFPS in open stack environments.
 Temperature: $\pm 2^\circ\text{F}$ (display only, flow rate must be greater than 5 AFPS)

Repeatability:

Flow: $\pm 0.5\%$ reading
 Temperature: $\pm 1^\circ\text{F}$ (flow rate must be greater than 5 AFPS)

Turndown Ratio:

Standard: Factory set and field adjustable from 2:1 to 600:1 within calibrated flow range.

Temperature Compensation:

Standard: $\pm 30^\circ\text{F}$ [$\pm 1^\circ\text{C}$] Optional: $\pm 100^\circ\text{F}$ [$\pm 38^\circ\text{C}$]

Agency Approvals (Pending):

FM, CSA, CE MARK, (EMC Directive 89/336/EEC), ATEX, CCE, CRN.

Calibration: Performed on NIST traceable equipment.

FLOW ELEMENTS

Material of Construction: All-welded 316L stainless steel. Elements with pressure transducer have braze and 300 series SST.

Operating Pressure: 0 to 250 psig [0 to 17 bar (g)]

Operating Temperature: Process temperature -40°F to 350°F [-40°C to 177°C];

Process Connection: 1" male NPT, Flange (ANSI), Packing Gland 1-1/4" NPT or Flanged.

FLOW TRANSMITTER**Operating Temperature:** 0 to 140°F [-18 to 60°C]**Input Power:** 115 Vac \pm 15 V; 230 Vac \pm 30 V; 22 to 30 Vdc; 23 Watts Max.**Output Signal****Analog:****Two independent, AC power isolated, which can be set as follows:**

4-20 mA, 600 ohm maximum load

0-10 Vdc, 5000 ohm minimum load

0-5 Vdc, 2500 ohm minimum load

1-5 Vdc, 2500 ohm minimum load

One optional pressure output:

4-20 mA, 600 ohm maximum load

One gas compensator output:

4-20 mA, 600 ohm maximum load.

Two programmable 10 amp (115 Vac or 24 Vdc) relay switch points.**Communication Port:** EIA-232 [RS-232C]**Display:** 4 line/20 character per LCD line, indicating flow rate and process temperature and/or totalized flow.**Communicator**(optional): Hand held plug-in interface (model FC88).**Remote Enclosure****Standard:** NEMA/CSA Type 4X (equivalent to IP66) Fiberglass**Option:** Aluminum rated for hazardous location use Class I and II, Division 1 and 2, Group B, C, D, E, F, G (previously referred to as NEMA 7 and EEx d IIB) resists the effects of weather and corrosion.

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2. Installation

Receiving / Inspection

- ◆ Unpack carefully, observe Electro-Static Discharge (ESD) precautions if handling the flow transmitter.
- ◆ Inspect for damage to the flow element and the flow transmitter.
- ◆ Verify that all items in the packing list were received and are correct.
- ◆ Verify the Delta R Data Sheet and the Instrument Information Sheet are present.

If the above items are satisfactory then proceed with installation. If not, then stop and contact the FCI customer service representative for instructions.

Packing / Shipping and Returns

These issues are addressed in Appendix C - Customer Service.

Factory Calibration Note

The flowmeter is factory calibrated to the flow range specified in the order. There is no need to perform any verification or calibration steps prior to installing and placing the flowmeter in service.

Pre-Installation Procedure



Caution: The flow transmitter contains electrostatic discharge (ESD) sensitive devices. Use standard ESD precautions when handling the flow transmitter. See below for ESD details.

The GF Series Flowmeter is not designed for weld-in-place applications. Never weld into the installation or to a structural support.

Use Standard ESD Precautions

Use standard ESD precautions when opening an instrument enclosure or handling the flow transmitter. FCI recommends the use of the following precautions: Use a wrist band or heel strap with a 1 megohm resistor connected to ground. If the instrument is in a shop setting there should be static conductive mats on the work table and floor with a 1 megohm resistor connected to ground. Connect the instrument to ground. Apply antistatic agents to hand tools to be used on the instrument. Keep high static producing items away from the instrument such as non-ESD approved plastic, tape and packing foam.

Prepare or Verify Flow Element Location

Prepare the media process pipe for installation or inspect the already prepared location to ensure the instrument will fit into system. Prepare the necessary sealants or gaskets to provide a leak proof installation.

The U-length should be double checked when installing the flow element into the process media. The U-length is determined at the factory order time and is the distance that places the flow element head center line in the center line of process media. See Figure 3. The greatest accuracy is achieved when the flow element is mounted at least 20 diameters downstream and 10 diameters upstream from any bends or interference in the process pipe or duct.

Verify Serial Numbers

Verify the flow element and flow transmitter have the same serial number, as they are to be installed as a matched set.

Verify Dimensions

Verify the flow element and flow transmitter dimensions as shown in Appendix A.

Verify Flow Direction for Flow Element Orientation and Placement



Note: Correct flow element placement in the measurement stream is vital for obtaining accurate flow readings. Before mounting the flow element, check the options ordered for correct orientation and insertion length at the planned site of installation.

The flow element thermowells must be positioned in the same orientation to the process flow as they were during calibration (refer to the Instrument Information Sheet). Failing to install the flow element correctly may reduce the accuracy of the flowmeter. Be sure the flow arrow points in the direction of flow.

The flow element thermowells are to be placed as shown in Figure 3, with the end of the shroud 0.6 inches past center line.

There is a flat area machined perpendicular to the thermowell plane. Adjust the flow element during installation so the flat area is parallel, with in $\pm 2^\circ$, to the direction of process media flow.

Adjustable / Retractable Flow Element Assembly



Caution: Do not over-tighten the flow element. The RTD's can be damaged if the flow element is forced into the far wall of the pipe or vessel.

Select one of the following installation procedures which is applicable to the unit being installed.

NPT and flange packing gland mounts are available. The valve assembly with appropriate connections are typically customer supplied. Follow the pipe or flange mounting procedure below.

NPT Pipe Mounting

- ◆ Apply sealant compatible with the process media to male threads. Carefully insert into process mount. Threads are right-handed. Tighten with an open-end wrench on the hexagonal surface provided. Rotate until snug.

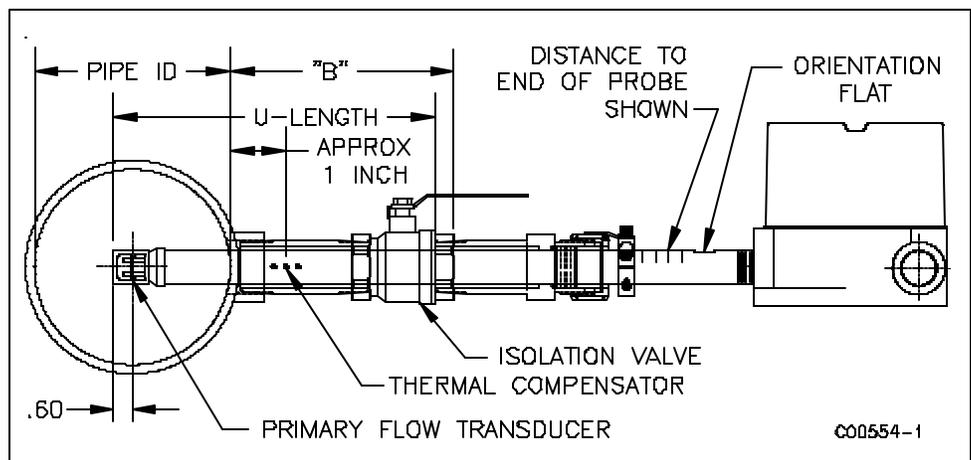


Figure 3 - NPT Pipe Mount

Flange Mounting

- ◆ Attach the process mating flange with care. The correct orientation of the flow element must be maintained to ensure the calibrated accuracy.
- ◆ Verify that the process media flow is in the same direction as the arrow on the FLAT.
- ◆ Apply the appropriate gasket and/or sealant to flange mount as required.
- ◆ Mate flow element flange to process mount keeping flat oriented properly.
- ◆ Attach with bolt, two flat washers, lock washer and nut for each bolt hole, apply lubricant/sealant to male threads and torque. Refer to ANISI B16.5 specifications.

General Mounting

- ◆ Tighten packing nut until internal packing is tight enough so that the friction fit on the shaft is adequate to prevent leakage but not prevent the shaft from sliding. Position the flat horizontal with arrow in direction of process flow.
- ◆ Proceed to insert the flow element into process media line. For the medium pressure packing gland use the adjusting nuts on the all-thread to pull the flow element into proper predetermined depth position.
- ◆ Tighten the opposing lock nuts on the all-threads. Tighten the packing nut another 1/2 to 1 turn until tight (approximately 65 to 85 ft-lbs torque).
- ◆ Rotate split ring locking collar to line up with connecting strap welded to packing nut. Tighten the two 1/4-28 hex socket cap screws on the split ring locking collar. Open valve - check for process media leakage.
- ◆ Reverse these steps for removal.

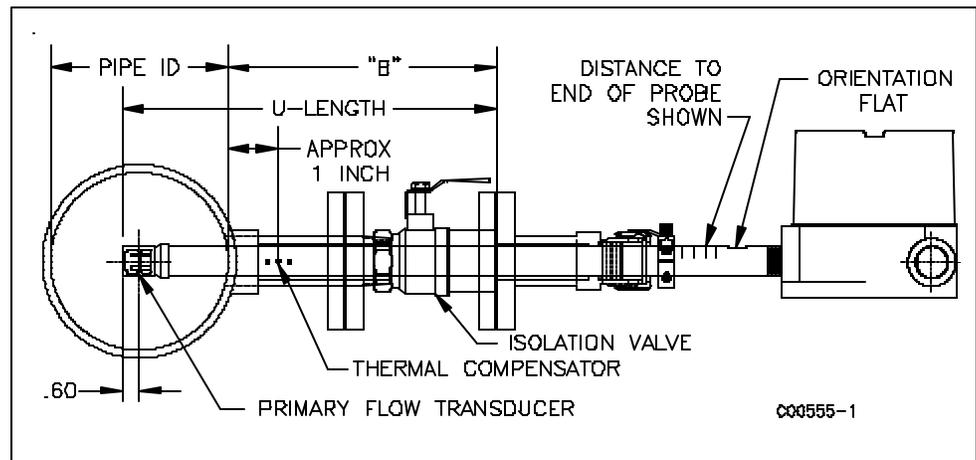


Figure 4 - Flange Mount

Install Transmitter



Warning: Installation of an FCI instrument should only be performed by properly trained personnel in accordance with the current edition of the National Electrical Code. Ensure that all power is off. Any instances where power should be applied to the instrument will be noted in this manual. Where the instructions call for the use of electrical current, the operator assumes all responsibility for conformance to safety standards and practices.



Caution: In applications where the flow element is located in an explosive environment, isolate the conduit before it leaves the environment. A potting "Y" may be used to provide the isolation.

Remote Hardware

See Appendix A for the remote enclosure along with the physical dimensions so the flow transmitter can be properly mounted.



Note: The factory recommends removal of the transmitter while pulling the necessary cables; this will prevent damaging the circuit boards or their components. To remove the transmitter unbolt the four outermost screws on the transmitter mounting plate.

Power Connection Information

Conduit Routing

All electrical connections are to be made through the female NPT openings in the flow transmitter's enclosure. FCI strongly recommends that all electrical cables be run through an appropriate conduit for the protection of the instrument and personnel. Refer to the appropriate wiring diagram.

Protection of the electronics from moisture is an important consideration. Keep the entry of the conduit into the enclosures in the downward direction so condensed moisture that collects in the conduit will not drain into the enclosure. In addition, FCI recommends sealing off the conduit with a potting Y or other sealing method to prevent moisture from entering the enclosure.

Minimum Wire Size

Table 1 shows the smallest (maximum AWG number) copper wire which should be used in the electrical cables. Use a lower gauge of wire for less of a voltage drop. Contact FCI concerning greater distances than those listed in the chart.

Connection	Maximum Distance for AWG					
	10 ft. (3 m)	50 ft. (15 m)	100 ft. (31 m)	250 ft. (76 m)	500 ft. (152 m)	1000 ft. (305 m)
AC Power	22	22	22	20	18	16
Relay (2A at 220 VAC)	24	22	20	16	12	Not Recommended
Relay (10A at 120VAC or 24 VDC)	22	16	12	Not Recommended		
Flow Element Wires for Remote Option *	24	24	24	22	22	18
Pressure Transducer	24	24	24	22	22	18

Table 1 - Interconnecting Wire Size

* Requires two 8 conductor shielded cables. The shield is connected to the GND pin of JP3 of the flow transmitter. The other end of the shield is left floating (no connection to the terminal block).

Input Power

The flow transmitter is powered by 115 VAC, 230 VAC or 24VDC (only one power source is needed). If 115 VAC is used, wire it directly to JP8 and position switch S1 to be in the 115V position. If 230 VAC is used, position switch S1 to be in the 230V position and then wire the power directly to JP8. If 24 VDC is used, it is wired directly to JP8 as shown on the wiring diagram.

The installation of an AC line disconnect switch (and possibly a fuse) between the power source and the flowmeter is strongly recommended. This facilitates easy power disconnection during calibration and maintenance procedures as well as an added safety feature.

Remote Transmitter

Route all interconnecting wiring into the remote transmitter enclosure. Ensure wires are long enough with sufficient service loops to eliminate excessive strain on the terminal connections. Connect Flow and Analyzer element cables as shown on wiring diagram. The display orientation varies for different transmitter configurations, but the termination block for the element connection remains the same. If the Veri-Cal option was ordered, wire the pressure transducer as shown on the wiring diagram.

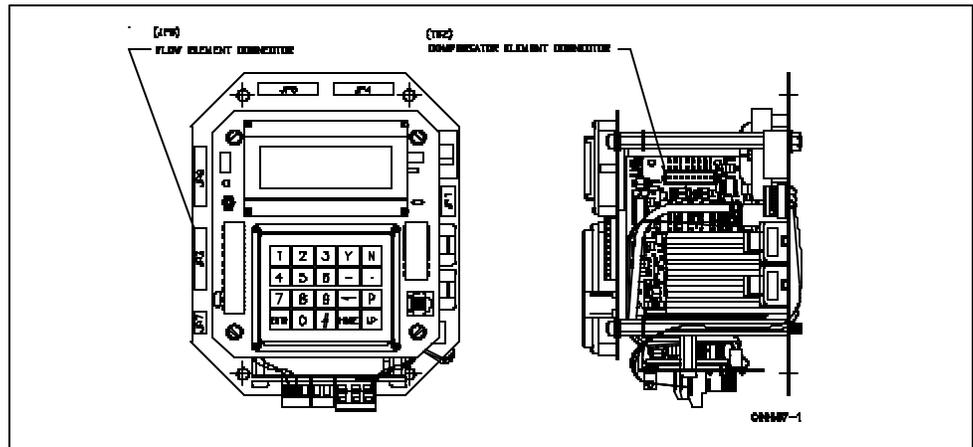


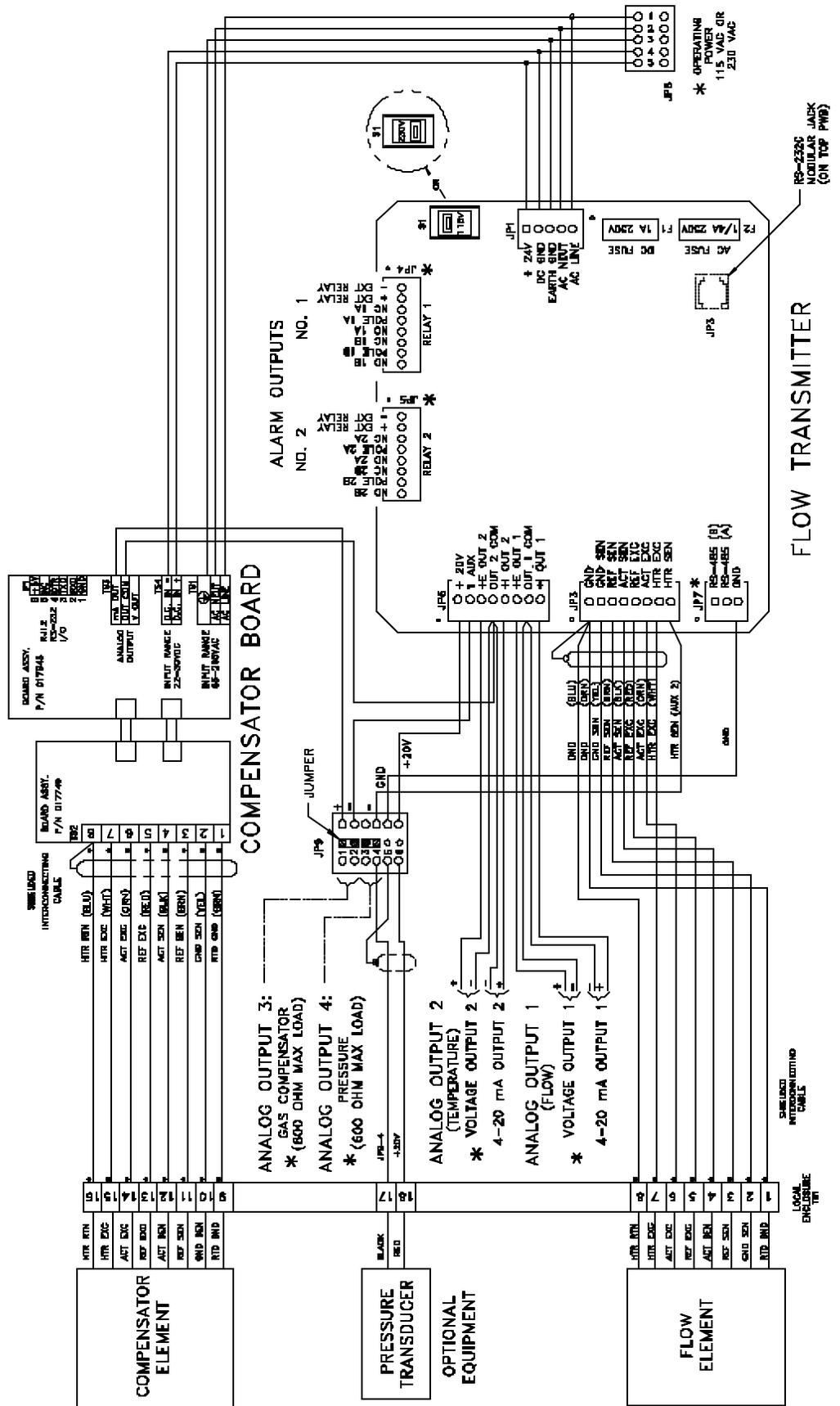
Figure 5 - Electronics Assembly

Customer Wiring

Jacks JP3 (top circuit board), JP4, JP5, JP6 and JP7 are for customer use and are described in Table 2.

JACK / NOMENCLATURE	DESCRIPTION
JP3 (top circuit board) RS-232 (EIA-232) Serial Port	Used in conjunction with equipment compatible with an RS-232 (EIA-232) serial port. See Chapter 3 for more details.
JP4 Relay Output 1 and JP5 Relay Output 2	Factory pre-programmable relay contacts. Two normally closed contacts are available (double pole, single throw relay) per jack. External relays can be connected to the +EXT and -EXT pins in each jack. Recommended relays are 18Vdc, 0.1A. max at 180 or more ohms pull in current.
JP6 Analog Output	There are two factory pre-programmable signals which are voltage and/or current. The 1 AUX and +20V pin is a customer option for the use as a dynamic correction factor. See Chapter 3 for more information.

Table 2 - Customer Wiring



C00553-1
01B1B7

Figure 6 - Wiring Diagram, Remote with Veri-Cal

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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.

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 8.

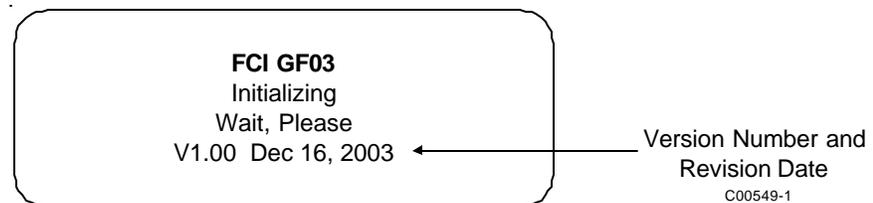


Figure 8 - Initialization Window

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 9.

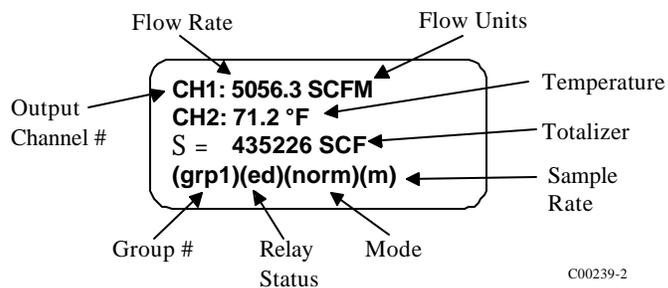


Figure 9 - Normal Operation Display

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 10. 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.

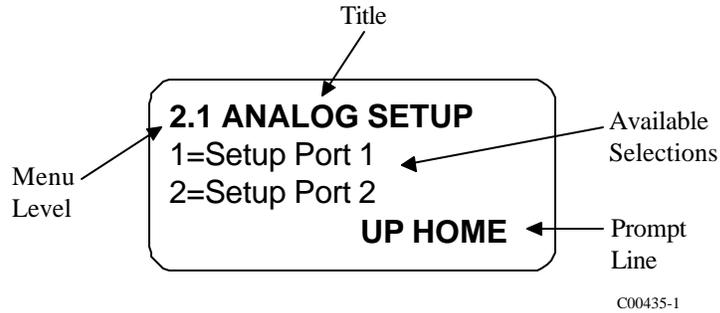


Figure 10 - Menu Window

The menu code is a numeric reference that identifies each window of the menu structure. The menu code in Figure 10 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 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. 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 11. 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.

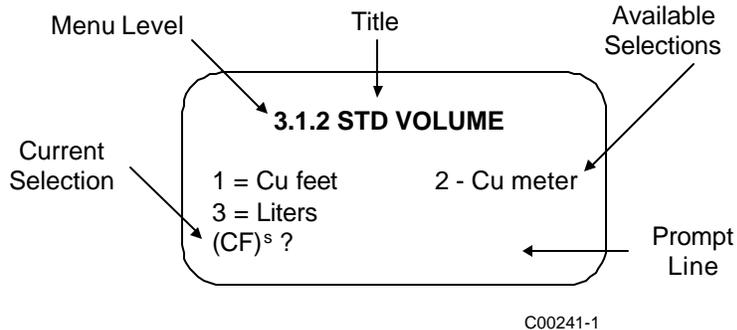


Figure 11 - Non-Scrolling Menu Window

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 12.

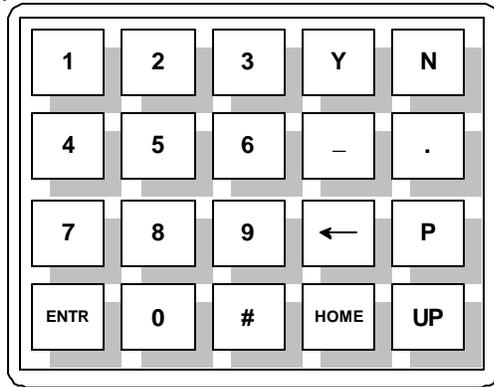


Figure 12 - Key Pad

C00220-1

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

Table 3 - Key Assignments for the GF Series Key Pad

See Table 3 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 13 shows the entire menu structure.

Menu selections two through eight allow the configuration of the flowmeter to be checked and manipulated. Table 4 summarizes the functions contained in each menu group.

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

Table 4 - Menu Functions

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 9 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).

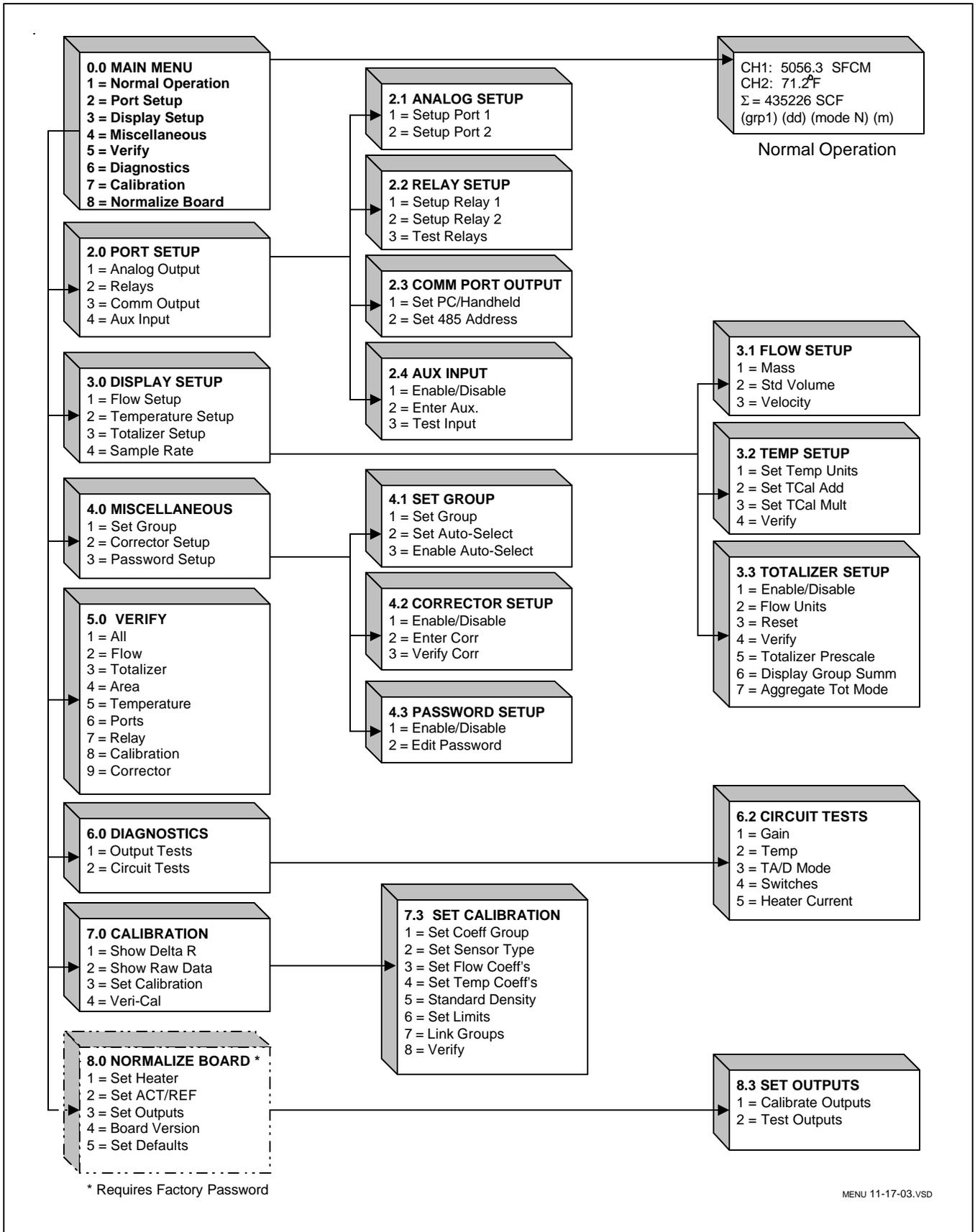


Figure13 - Menu Structure

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 5, 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 5 - 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 OME 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. (Default password: 123)
ANALOG OUTPUTS		
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 that 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 that 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 that is expected to occur. The value needs to be between the 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 that is expected to occur. The value needs to be between the 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: MODE (1) 4-20mA (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 that best matches the analog 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 that matches the condition to be measured.

Table 5 - Quick Operation Procedure

Function Desired *	Keys to Press **	Comments
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 that is expected to occur. The value needs to be between the 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 that is expected to occur. The value needs to be between the values shown on the second and third lines of the display. Press ENTR without inputting a numeric value only if previous values are correct.
FLOW RATE UNITS		
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. Press 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. Press 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. 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 = 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 gained. 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

The flowmeter measures the 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.

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.

♦ **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 6 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 6. 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 6 - 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 6 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 Totalizer Prescaler 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 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.

In this mode the totalizer will be displayed with a fixed decimal place.

- ◆ **To choose Display Group Sum 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 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:**

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, 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 the four 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 7.

The signal range varies linearly with change in flow rate as shown in Figure 14. Minimum

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

Table 7 - Typical Signal Output Configuration

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.

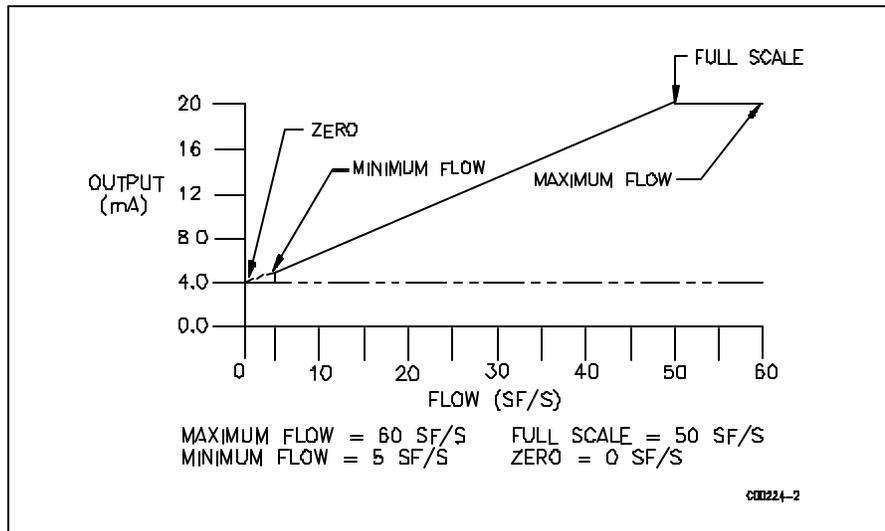


Figure 14 - Signal Output versus Flow Rate



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.

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 15 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.

Setting the Relays

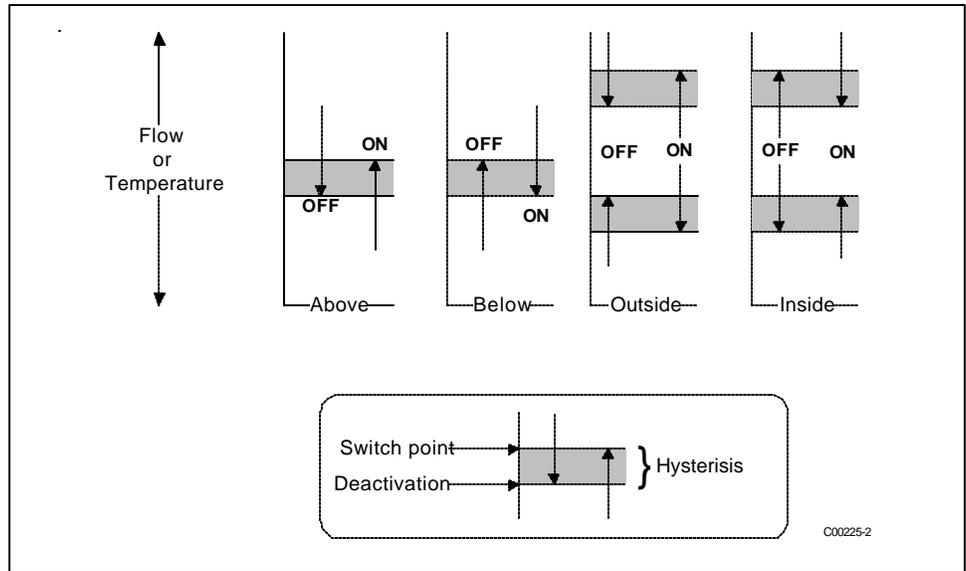


Figure 15 - Relay Switch Point Schemes

- ◆ **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 13). 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 13). 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 14. 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 14 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.)

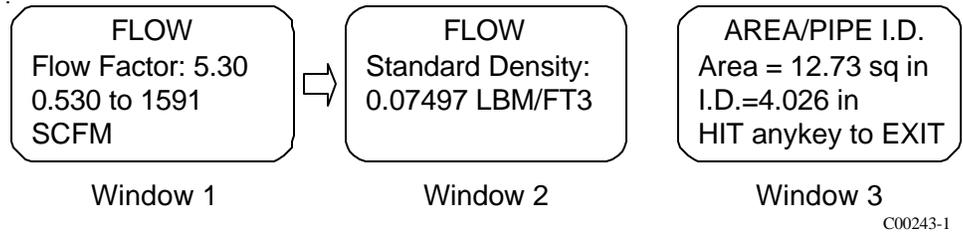


Figure 16 - Flow and Area Verification



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 17.

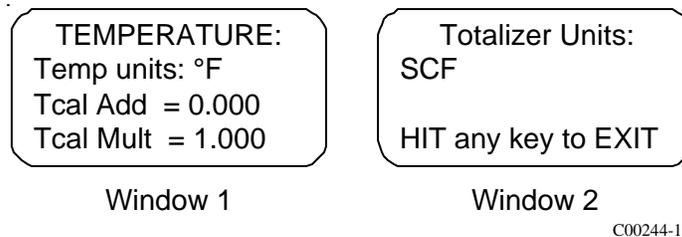


Figure 17 - Temperature, Totalizer Verification Display

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 18 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.

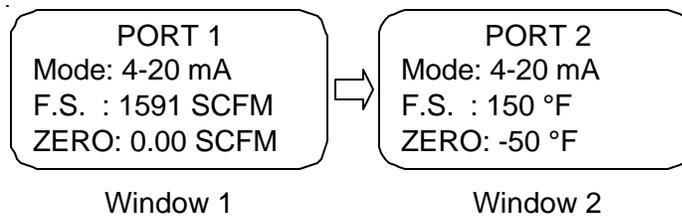


Figure 18 - Analog Output Verification

♦ **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 19 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.

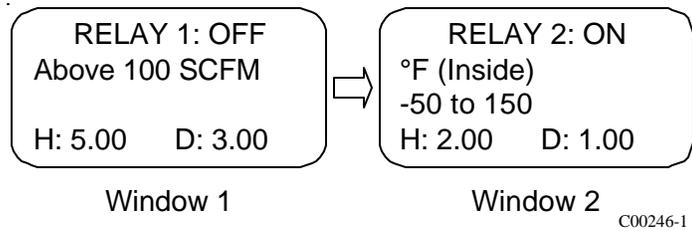


Figure 19 - Relay Status Verification Display

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 20 describes how the correction equation is applied.

The correction equation for the flowmeter is shown below.

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

where m_o = Measured Flow Rate

F_i = Correction Equation Coefficients (i = 1 through 4)

m_{new} = Corrected Flow Rate

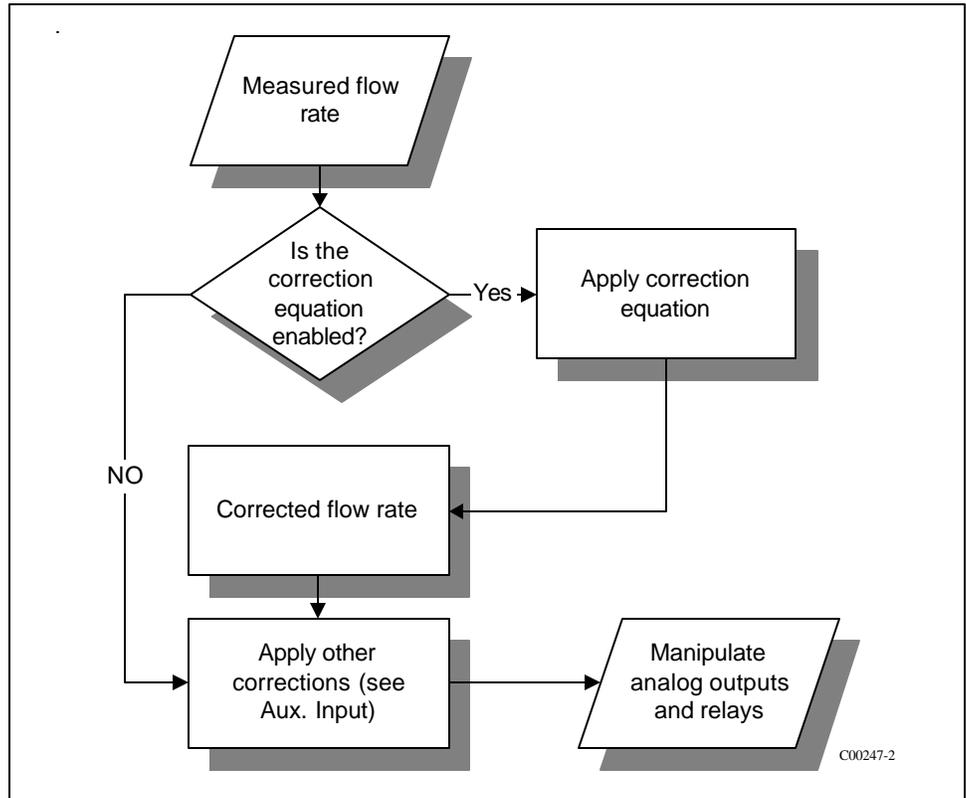


Figure 20 - Correction Factor

Application to 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 21 shows the variation of desired flow rate versus the measured flow rate.

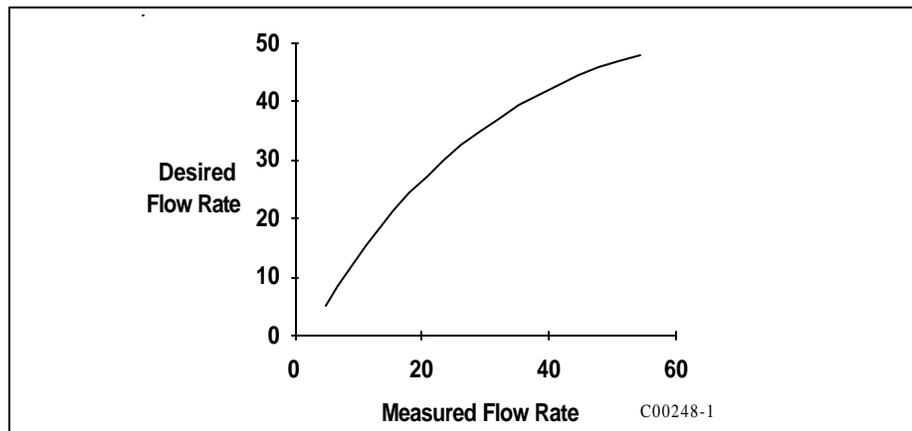


Figure 21 - Desired Flow Rate versus Measured Flow Rate

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

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

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

- ♦ **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 22 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 4-20mA.

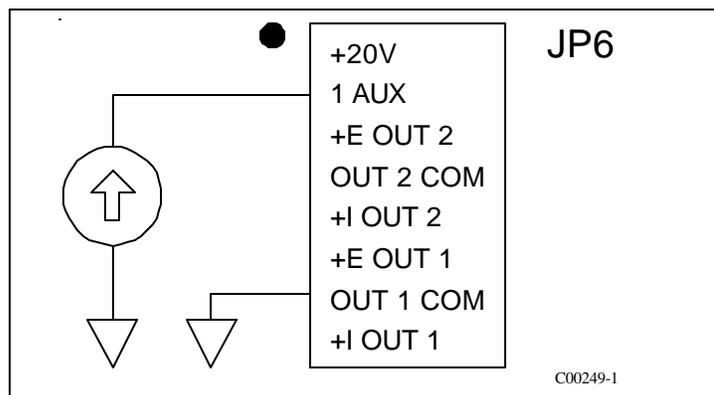


Figure 22 - Auxiliary Input Wiring Diagram

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 23 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.

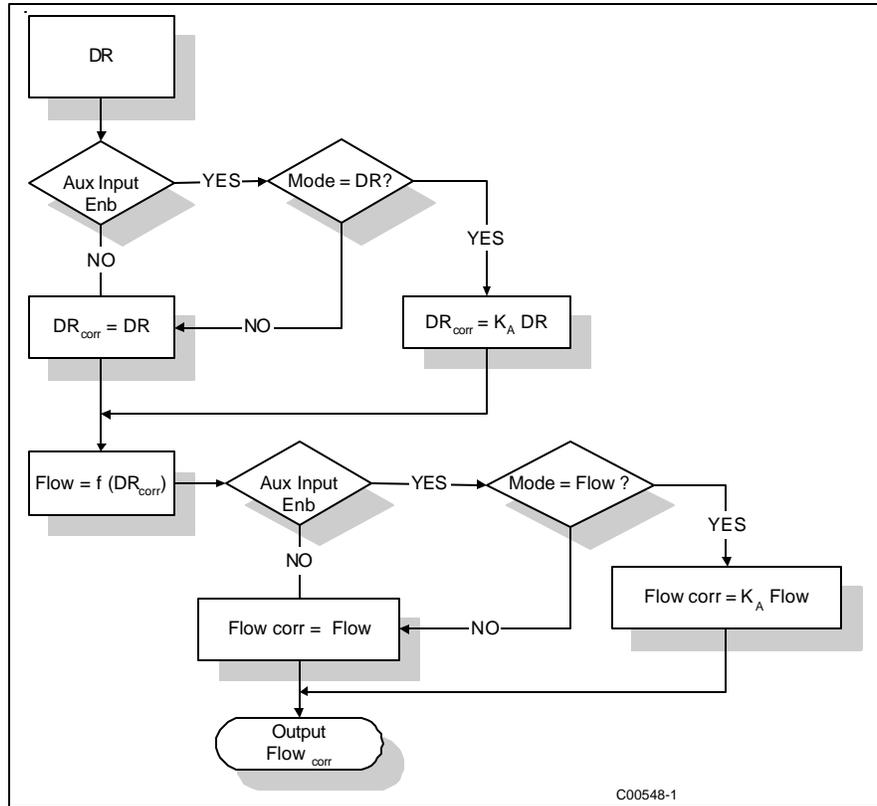


Figure 23 - Auxiliary Input Process

♦ To view the digital representation of the current input:

1. Apply a current to the auxiliary input as shown in Figure 22.
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 = Digital Value

A_i = Correction Factor Coefficients (i = 1 through 4)

K_A = 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 24 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.

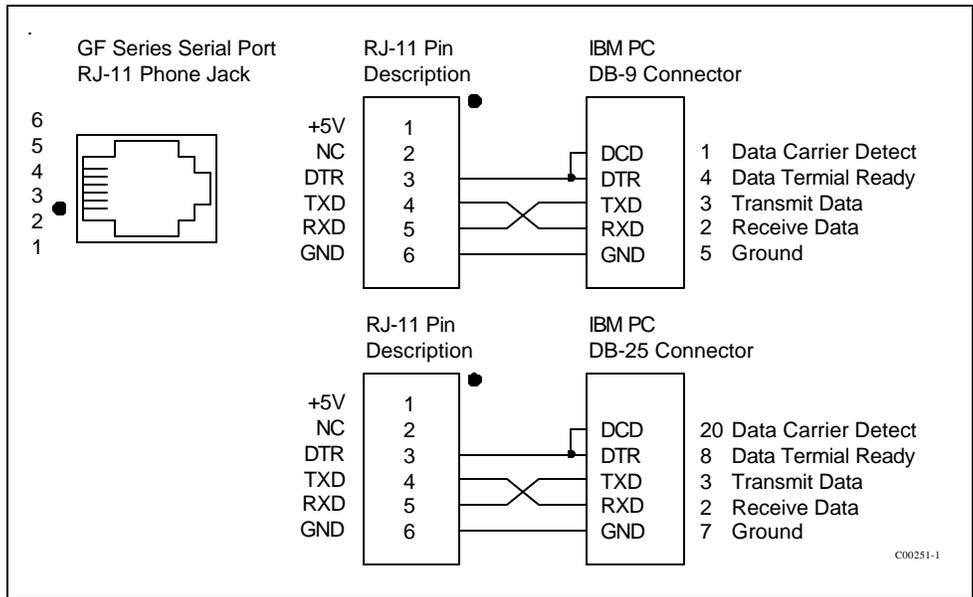


Figure 24 - Wiring Diagram, DB-9 and DB-25 PC Connectors

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 25 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 25 - 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 25 - 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 9) 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 "HH 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 25 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 26.

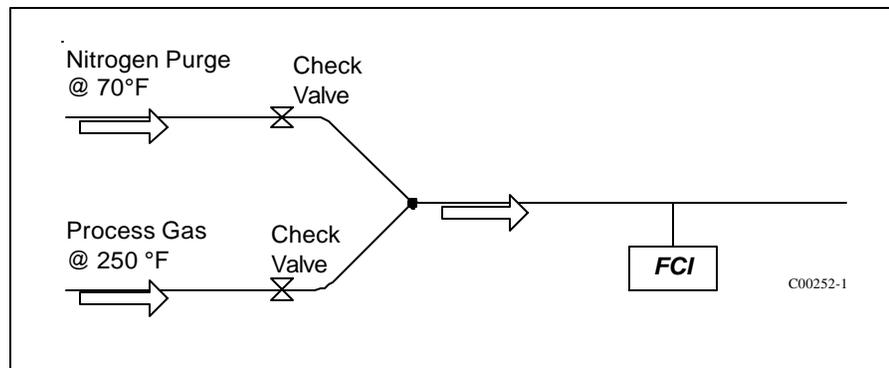


Figure 26 - Auto Select by Temperature Application

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.

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. Links 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.

Veri-Cal In-Situ Calibration Verification

The GF03 has an optional Veri-Cal system that allows the user to check, or verify, the instruments calibration without removing the flow element from the process installation. The diagram below shows the Veri-Cal system.

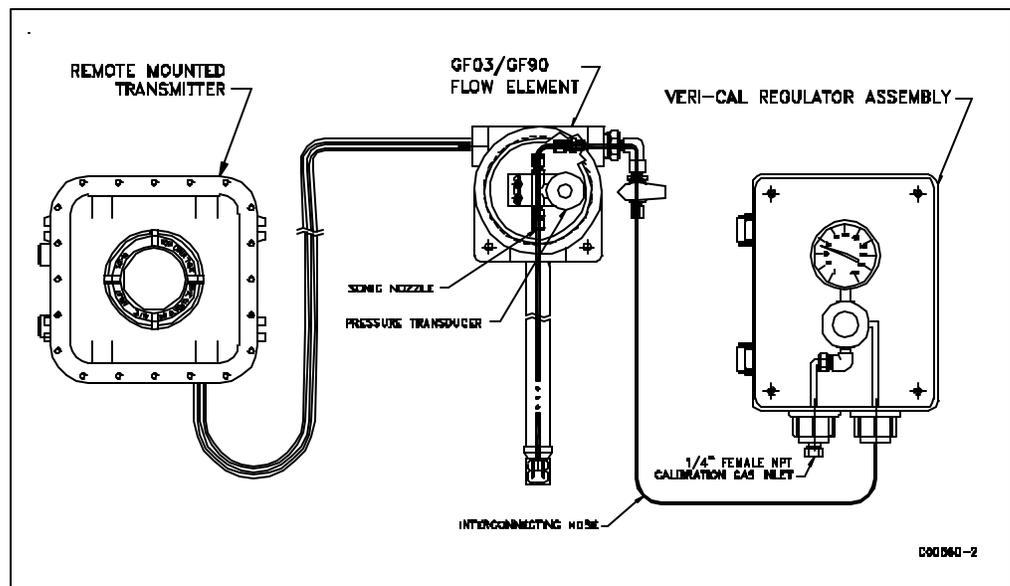


Figure 28 - Veri-Cal System

The system consists of the Transmitter assembly, GF03 flow element with internal Veri-Cal flow system, the Veri-Cal regulator assembly and interconnecting hose.

The Veri-cal flow system delivers a repeatable flow through a nozzle across the primary flow element thermowells. This is done while the flow element is retracted out of the process flow stream into the insertion packing gland assembly. The flow element orientation is leveled. An inert gas controlled through a precision regulator on the inlet side of a sonic nozzle is then injected across the thermowells. The factory calibration gas is typically Nitrogen, but other gases maybe used.

Validation Check Procedure:

FCI recommends that this procedure be run at the Instruments commissioning to determine an initial installed baseline verification calibration, and to record any installed offset from the factory Veri-cal Baseline.

1. Loosen the packing nut assembly until the internal packing is loose enough to allow the probe assembly to be retracted completely back into the insertion pipe assembly.
2. Level orientation flat and tighten packing nut so probe assembly is secure.

3. Verify that the ball valve on the probe assembly is closed. Remove the end cap and attach the interconnecting hose and regulator assembly.
4. Attach the calibration gas source to the inlet side of the regulator assembly.
5. Slowly open the gas source regulator until the analog gauge in the Veri-cal regulator assembly reads 125 psig, no gas should be flowing through the instrument at this time.
6. Verify that the system is leak free.
7. Obtain local atmospheric pressure. Look at the GF03 Veri-Cal calibration sheet and calculate the pressure offset from the local atmospheric pressure and calibrated atmospheric pressure.

Calibrated atm press – Local atm press = pressure offset

Add this offset to the Veri-Cal Baseline indicated pressure values in column 1 on the calibration sheet to determine verification indicated pressure check values.

For example, if the calculated pressure offset is 1.40 psi and the first baseline indicated pressure is 100 psig. The first verification check value of 101.40 should be dialed into the Pressure displayed on the Transmitter display.

8. Enter the Veri-cal menu on the Transmitter assembly (menu 7.4) Flow, Temperature and Pressure will be displayed.
9. Open the ball valve on the probe assembly and adjust the regulator so that the Pressure display on the Transmitter display equals the first verification check value (101.40 in the example).
10. Sustain this flow rate for 5 minutes to allow the instrument to come to thermal equilibrium.
11. Record the Indicated Flow, Temperature and Pressure.
12. Repeat this procedure for the remaining 3 indicated pressure check values. A consistent flow across the thermowell should be held for a minimum of 5 minutes before values are recorded.
13. Record all values on the Veri-cal calibration sheet for reference and comparison during the next in-situ verification check. An example of the calibration sheet is shown below.

Fluid		Temp			Test Tech	L. Sales
Nitrogen		AMBIENT				
Indicated Pressure, psig	Atmospheric pressure, psia	Total pressure, psia	Indicated (SFPS) Veri-Cal Flow	Indicated Temp	VDC, Output	Pressure
100	14.64	114.64	27.64	70.59	5.00	
75	14.64	89.64	21.54	70.73	4.00	
50.02	14.64	64.66	14.95	74.03	3.00	
24.97	14.64	39.61	8.62	74.35	2.00	

Field Check 1		Date:	Indicated (SFPS) Veri-Cal Flow	Indicated Temp.	VDC Pressure Output	"Raw"
Indicated Pressure, psig	Atmospheric pressure, psia	Total pressure, psia				

Table 13 - Example of GF03 Calibration Sheet

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4. Maintenance



Warning: To avoid hazards to personnel, ensure that all environmental isolation seals are properly maintained.

Introduction

The flowmeter needs very little maintenance. There are no moving parts or mechanical parts subject to wear in the flowmeter. The flow element that is exposed to the process media is all stainless steel construction with nickel braze. The flow element is only subject to chemical attack based on the corrosion relationship between the flow element sensing point material and process media.

Maintenance

No specific maintenance steps are made for inspecting, cleaning, or testing procedures without detailed knowledge of the process media components. However, shown below are some general guidelines for maintenance. Use operating experience to set the frequency for each type of maintenance.

Calibration - Every 18 months as a minimum, verify the calibration of the flowmeter and recalibrate if necessary (contact the factory).

Electrical Connections - Periodically inspect the cable connections, the terminal strips and the terminal blocks for good connections. Verify that terminal connections are tight and physically sound with no sign of corrosion.

Enclosures - Verify that the moisture barriers and seals that protect the local and remote enclosures are in tact.

Electrical Cables - Periodically inspect the power cable, flow element cable(s) and output cable. Check for deterioration of the cable's insulation.

Flow Element Mounting Connections - Verify that all seals are performing properly and that there is no leakage of the process media. Check for deterioration of the gaskets and environmental seals used.

Flow Element Assembly - Periodically remove the flow element for inspection based on historical evidence of debris, foreign matter, or scale build-up. Also the flow element can be removed at appropriate plant shutdown schedules. Check for corrosion, stress cracking, and/or build-up of oxides, salts, or foreign substances. The thermowells must be free of excessive contaminants and be physically intact. Any build-up could cause faulty readings. Clean the flow element as needed with a soft brush and available solvents (compatible with stainless steel).

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5. Troubleshooting



Warning: Only qualified personnel should attempt to test this instrument. The operator assumes all responsibilities for safe practices while troubleshooting.



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.

Introduction

In new or re-calibrated instruments, operating problems are most often caused by an improper installation. Review the information on instrument installation in Chapter 2 to verify correct mechanical and electrical installation.

Troubleshooting is more effective if the operation of the equipment is understood before trying to solve the equipment problems. Be familiar with the way the instrument operates (Chapter 3) before troubleshooting an instrument that does not function properly.

Replacement parts must be of the same part type and number. Therefore, contact the FCI Customer Service Department for the correct replacement parts.

Damage to the equipment due to negligence or lack of technician skill is not covered by the warranty, or is damage to flow transmitter caused by part replacement in the field. When parts are replaced, the verification and calibration procedures should be performed by a qualified technician to ensure the accuracy and calibration of the instrument.

Troubleshooting Equipment

Digital Multi-Meter (DMM) (at least 4 1/2 digits resolution recommended) capable of measuring ohms, milliamperes, and volts AC and DC.

Precision decade resistance boxes (two needed, however they are optional).

Quick Check Troubleshooting

At this point simply observe the system setup to verify operation. Use Table 8 as a quick check of problems and solutions. More in-depth discussions follow this table.

Problem	Solution
No Display	1) Check the fuses. 2) Verify that S1 is switched to the correct input voltage 3) Verify correct power is applied. 4) Verify the ribbon cable between the upper and lower circuit boards is solidly connected and the red stripe is at pin 1.
No Display or Dim Display	Adjust potentiometer R1 on the top circuit card. If there is no change in the display return the potentiometer to the original setting.
Display is Locked Up Readings Seem Incorrect	Press HOME and then 1 to return to normal operation. Reset the flowmeter by cycling the power. Verify the serial number of the flow element and the flow transmitter are the same number. Verify the flat on the flow element is parallel to the pipe and the flow arrow is pointed in the direction of the flow stream. S2 switches should all be closed for an integral (local) instrument and all open for a remote instrument. Verify all jacks and plugs are firmly seated and the wiring to them is secure.
If the above solutions do not correct the problem, continue to use the rest of this chapter to troubleshoot.	

Table 8 - Quick Check Troubleshooting

**In-Depth
Troubleshooting
The Flow Element**



Check Serial Numbers

Verify that the serial number of the flow element and the flow transmitter are the same. The flow element and the flow transmitter are a matched set and cannot be operated independently of each other. The only exception is when the flow transmitter has been specifically configured to be a replacement.

Check the Resistance of the Flow Element

Use Tables 9 and 10 to determine if the flow element is wired incorrectly or has failed. Turn off the input power to the transmitter. Unplug the flow element at JP3 located on the lower board and measure resistances described below by touching the DMM test leads to the JP3 terminal screws. (Remember to reconnect JP3 back to the flow transmitter when finished.) Repeat resistance check on TS2.

NOTE: If the system does not allow the disconnection of the flowmeter power, or unplugging the flow element, then proceed to the section, "In-Depth Troubleshooting - The Flow Transmitter".

All resistances in Tables 9 and 10 are based on a temperature of 32°F (0 °C). Resistances across the ACT and the REF RTD's are approximately 1080 ohms* at 70 °F (21 °C). The resistances will continue to increase for higher temperatures at the flow element. Check resistance from each pin in the local/remote enclosure to case ground. There should be an infinite resistance.

Pin Number	Approximate Resistance
1 to 2	0 Ohms
2 to 3	1000 Ohms
2 to 4	1000 Ohms
2 to 5	1000 Ohms
2 to 6	1000 Ohms
2 to 7	115 Ohms

Table 9 - Resistance at JP3 Terminal Plug Primary Flow Element

Pin Number	Approximate Resistance
1 to 2	0 Ohms
2 to 3	1000 Ohms
2 to 4	1000 Ohms
3 to 4	2000 Ohms
4 to 6 , 3 to 5	0 Ohms
7 to 8	110 – 118 Ohms

Table 10 - Resistance at TS2 Compensator Element

If the measured resistances do not correspond to Tables 9 and 10 then the flow element is functioning properly. The problem lies elsewhere. Skip the rest of this section and proceed with the section, In-Depth Troubleshooting - The flow transmitter. If the measured values do not correspond to Table 5-2 then a problem exists in the flow element. For remote instruments, with a cable between the flow element and the flow transmitter, the cable could be shorted or open. To isolate a problem with the cable, check the flow element resistances at the terminal block located within the flow element (local) enclosure. Disconnect the wires from the terminal block and measure resistances described below by touching the DMM test leads to the terminal block screws. The measured resistances should correspond approximately to the values in Table 5-3.

If the measured resistances correspond to Table 5-3 then the cable or wiring is defective. Contact customer service for details on how to obtain another cable or flow element.

In-Depth Troubleshooting The Flow Transmitter

Check the Voltages Across the RTD Leads

This is done without disconnecting any flow element wires. Voltage measurements can be made at JP3 located on the lower circuit board. Measure voltages described below by touching the DMM test leads to the terminal screws. The expected voltages are given in Table 12.

Table 12
Voltage Readings in Volts DC at JP3

Pin Number	Approximate Voltage
1 to 2	0
2 to 3	1.1
2 to 4	1.2
2 to 5	1.1
2 to 6	1.2
2 to 7	16.5

If the measured voltages correspond to Table 12 then the power supplied to and the signals returning from the flow element are correct. The problem is most likely a corrupted calibration parameter. Continue troubleshooting at the next section. If the measured values do not correspond to Table 12 and the flow element was proven to function correctly (see previous section), then the flow transmitter is defective. If the previous section checks were not possible and the above values did not correspond, then the problem could be in the flow element or the flow transmitter. Contact Customer Service for details on how to obtain replacements.

Verify the Calibration Parameters

The flowmeter uses a set of predetermined calibration parameters. Most of these parameters cannot change. A "Delta R Data Sheet" is located in the data package. It contains the calibration parameters set in the flow transmitter at the factory. (See the Appendix for a description of these parameters.) Verify that these parameters have not changed using the steps describe below.

1. Identify the appropriate "Delta R" data sheet by serial number. Determine the current group number the flow transmitter by viewing the "Normal Operation" display window. Make sure the current group number corresponds to the group number on the data sheet.
2. Press Home, 5, 1 to enter the "Verify All" function. Verify all calibration parameters listed in the first two columns on the data sheet. Note any differences in values.
3. Press Home, 5, 8 to enter the "Verify Calibration" function. Verify all calibration parameters listed in the second two columns on the data sheet. Note any differences in values.

If any of the parameters have changed, please contact Customer Service. If the parameters have not changed the problem lies elsewhere. Continue with the next section.

**In-Depth
Troubleshooting
The Installation**

Verify Proper Orientation

The flow element must be oriented as described on the "Instrument Information Sheet" located in the back of this manual. Verify that the flat on the flow element is parallel to the pipe and the flow arrow is pointed in the direction of the flow stream. Improper orientation will cause an indeterminate amount of error in the flow measurement. See Chapter 2 for instructions on proper installation.

Verify Proper Insertion Depth

The flow element's thermowells must be located at the center line of the pipe unless the factory specifies otherwise. Improper insertion depth will cause an indeterminate amount of error in the flow measurement. See Chapter 2 for instructions on proper installation.

**In-Depth
Troubleshooting
The Process**

Verify Standard versus Actual Process Conditions

The flowmeter can measure the mass flow rate if mass units of flow are selected. The mass flow rate is the mass of the gas flowing through a pipe per time. Other flowmeters, such as an orifice plate or a pitot tube, measure the volumetric flow rate. The volumetric flow rate is the volume of gas per time. If the readings displayed by the GF series flowmeters do not agree with another instrument, some calculations may be necessary before comparing them. To calculate the mass flow rate, the volumetric flow rate, and the pressure and temperature at the point of measurement must be known. Use the following equation to calculate the mass flow rate (standard volumetric flow rate) for the other instrument.

Equation:

$$Q_s = Q_A \times \frac{P_A}{T_A} \times \frac{T_s}{P_s}$$

Where:

- | | |
|---------------------------|----------------------------------|
| Q_A = Volumetric Flow | Q_s = Standard Volumetric Flow |
| P_A = Actual Pressure | T_A = Actual Temperature |
| P_s = Standard Pressure | T_s = Standard Temperature |

Pressure and Temperature are in absolute units.

Example:

- | | |
|---------------------|-----------------------|
| Q_A = 1212.7 ACFM | Q_s = 1485 SCFM |
| P_A = 19.7 PSIA | T_A = 120°F (580°R) |
| P_s = 14.7 PSIA | T_s = 70°F (530°R) |

$$\left(\frac{1212.7 \text{ ACFM}}{1} \right) \left(\frac{19.7 \text{ PSIA}}{580 \text{ }^\circ\text{R}} \right) \left(\frac{530 \text{ }^\circ\text{R}}{14.7 \text{ PSIA}} \right) = 1485 \text{ SCFM}$$



NOTE: The rated outputs of fans, blowers or compressors cannot be accurately compared to the flow rate output of the GF series flowmeter.

Swirling Flow and the Length of the Meter Section

The GF series flowmeter is calibrated in a non-rotating flow stream with the streamline parallel to the pipe walls. Rotation of the flow stream or a flow stream that is not parallel to the pipe walls may cause flow measurement errors. A straight pipe run of 20 pipe diameters upstream and 10 pipe diameters downstream generally produces a desirable flow stream. Elbows, valves, and other obstructions, located close to the GF Series Flowmeter may cause an indeterminate error in the flow rate measurement. If a shorter pipe run distance is needed, a flow conditioner can be installed with the flow element. Contact an FCI representative for more information.

Condensation, Pulsing Flow or Transient Flow

If a component of the process media is near its saturation temperature it is probably condensing on the flow element. Liquid on the flow element will drive the flow measurement higher than actual. The flow element must be placed somewhere else in the process where the flow stream temperature is well above the saturation temperature and below the saturation pressure of any of the process gases.

Pulsing or transient flows will cause the flowmeter measurement to be higher than actual. Compressors, fans, blowers, etc. commonly induce pulsation within the flow stream. The flow element should be located at least 20 diameters downstream and 10 diameters upstream of any compressor, fan or blower.

Transient flow (quick increases or decrease flow rate) may cause an indeterminate amount of error in the flow measurement. The flow rate measurements made during quick changes in flow rate should be discarded.

Natural Convection in Vertical Pipes and Ducts

A long, vertical stand of pipe that has no induced flow may have a circulation of gas caused by free convection. If the flowmeter was calibrated to measure small flow rates the convection current may cause a flow reading. If this is undesirable, move the flow element to another location.

Other Troubleshooting

The Relays

See Chapter 3 for instructions on setting the relays. From the keypad, the relay state can be switched. This can be used to test the interface with the GF series relays.

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.

The relays toggle between energized and de-energized and the state should be reported in the status line of the "Normal Operation" window. Changing states also cause an audible click.

Verifying Delta R's



NOTE: Be sure to use the ΔR table supplied with this flowmeter. Use two decade resistance boxes, and or fixed resistors.

A ΔR table is supplied with each flowmeter. The table can be used to verify correct operation of the transmitter independent of the flow element by simulating the RTDs' input with precision resistance decade boxes. In order to verify that the flow transmitter is functioning properly, the inputs from the RTDs may be disconnected and precision resistance of known value substituted. Then measure the flow transmitter output (voltage, current, or relay logic switch points) and compare to the Delta R table. Perform the following steps to verify operation.

1. Verify that the serial number of the flowmeter and the serial number of the Delta R Data Sheet are the same before proceeding. If the serial numbers do not match, the Delta R Data Sheet is not applicable. Each flowmeter has a unique Delta R Data Sheet.
2. Verify the Delta R Data Sheet has the appropriate group number.
3. Disconnect JP3 and connect the decade boxes as shown in Figure 27.

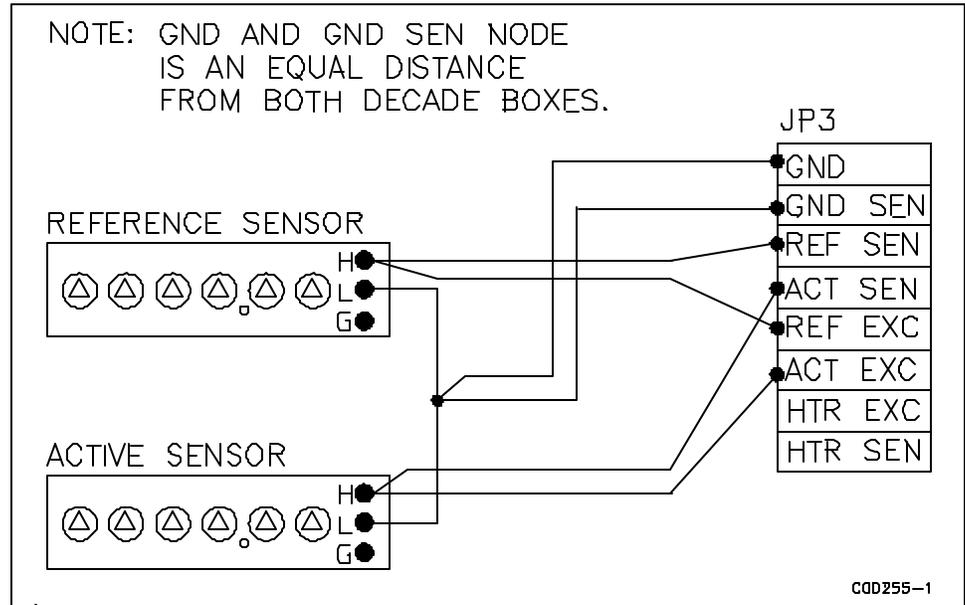


Figure 27 - Decade Box Connections

4. Set the reference decade box to 1000 ohms, depending on type of nominal flow element resistance.
5. Set the active decade to the same reading as step 3, plus the Δ R value from the Δ R table (i.e. 1000 ohms + 25 ohms = 1025 ohms).
6. For current loop outputs, connect the milliamp meter between the +I OUT (positive lead) and OUT COM (negative lead) on connector terminal JP6 and select a range appropriate for your output current. For the voltage output signals, connect a DMM across the +E OUT and OUT COM on connector terminal JP6.
7. Turn power ON and allow the instrument 10 minutes to stabilize.
8. Be sure the flow transmitter is in the correct group.
9. Increase the decade resistance connected to the active terminal by the value shown in the Δ R column for the low-limit signal. Set the active decade for a resistance of 1000 ohm + the Δ R value. The meter reading should equal the recorded value within ±1% of the full signal range.

Example: 4-20 milliampere Output Signal = 1% of 16 milliampere = 0.16 milliampere = Tolerance.

10. Repeat step 7 for the other flow rates in the Delta R Table for this flowmeter.
11. Compare results of the verification measurements with the output signal values recorded on the Delta R Data Sheet to determine if the transmitter is functioning properly. Also verify the display reading matches.
12. Turn power OFF and disconnect the decade resistors. Connect the proper wires from the flow element to terminal block.
13. Disconnect the milliamp meter. Connect the output load to the appropriate OUT+ and OUT COM terminals on the lower (I/O/P) board.
14. Close the enclosure, making sure that none of the wires are caught. Ensure that all seals and gaskets are properly installed. If a custom enclosure exists, be sure it is placed back into safe operating condition.

If the readings are good, the flow transmitter is good and problem may involve the flow element. If readings are off, a flow element calibration may be required or the flow transmitter needs to be setup.

Repair



Note: Any unauthorized repair attempts will void the warranty.

At this time FCI does not consider there to be any field-repairable items with the exception of the replacement of fuses F1 and F2. Any repair at the component level for either the flow elements and enclosure or the flow transmitter and attached components is not advised or recommended by FCI.

Contact the authorized FCI field representative (see list of regional territories and the respective agents) or FCI (see telephone and FAX numbers in the front of this manual) to determine the best course of action.

Defective Parts

Before returning any equipment to FCI, obtain a return authorization number (see Appendix C) for authorization, tracking, and repair/replacement instructions. Remove the defective instrument, replace with a spare, calibrate, and return the defective instrument to FCI freight prepaid for disposition.

Spares

FCI typically recommends a flow element and a flow transmitter assembly, depending on how critical the monitoring process is.

Storage Information

Spare parts should be kept above grade and indoors. Keep the instrument dry. Add desiccant and enclose in plastic wrap for extended storage periods. There is no predetermined shelf life; reinspect at six month intervals.

Customer Service

If problems or questions exist regarding the flowmeter, please contact the regional or country authorized FCI Field Agent (manufacturer's representative). There is an extensive list of these representatives at the front of this manual. If additional technical assistance is required, contact the FCI Customer Service Department at 1 (800) 854-1993 toll free.

Refer to Appendix C for specific customer service policy and procedures.

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Appendix A. Drawings

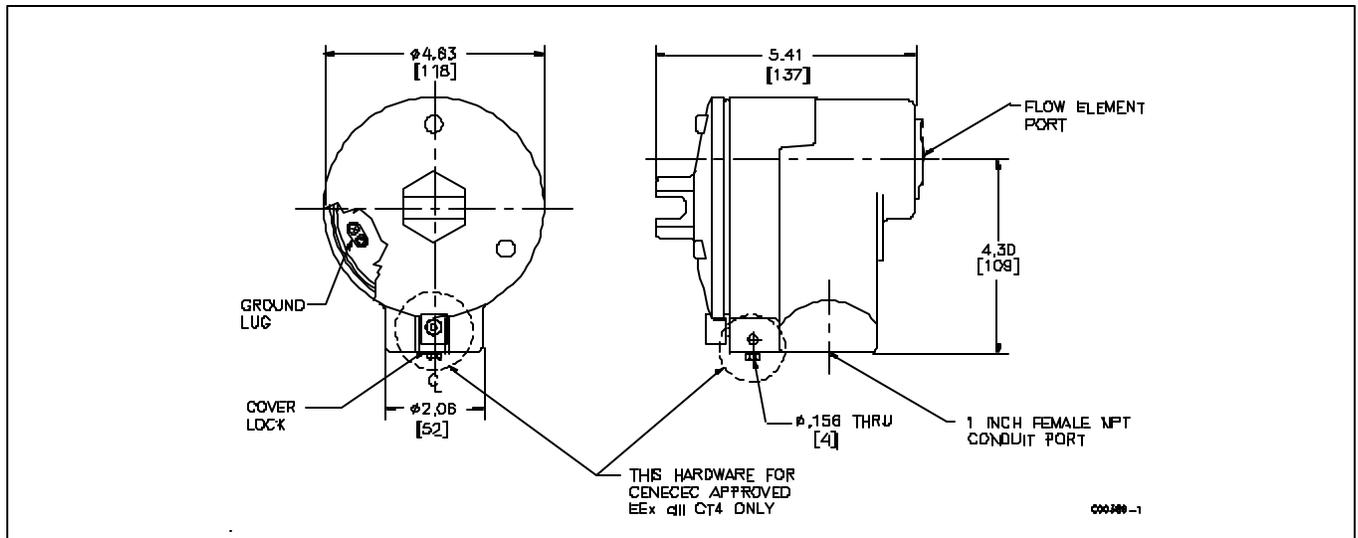


Figure 29. Local Enclosure NEMA Type 4X and 7 Hazardous Location (Aluminum and 300 series stainless steel enclosures shown. Feraloy enclosures are slightly smaller)

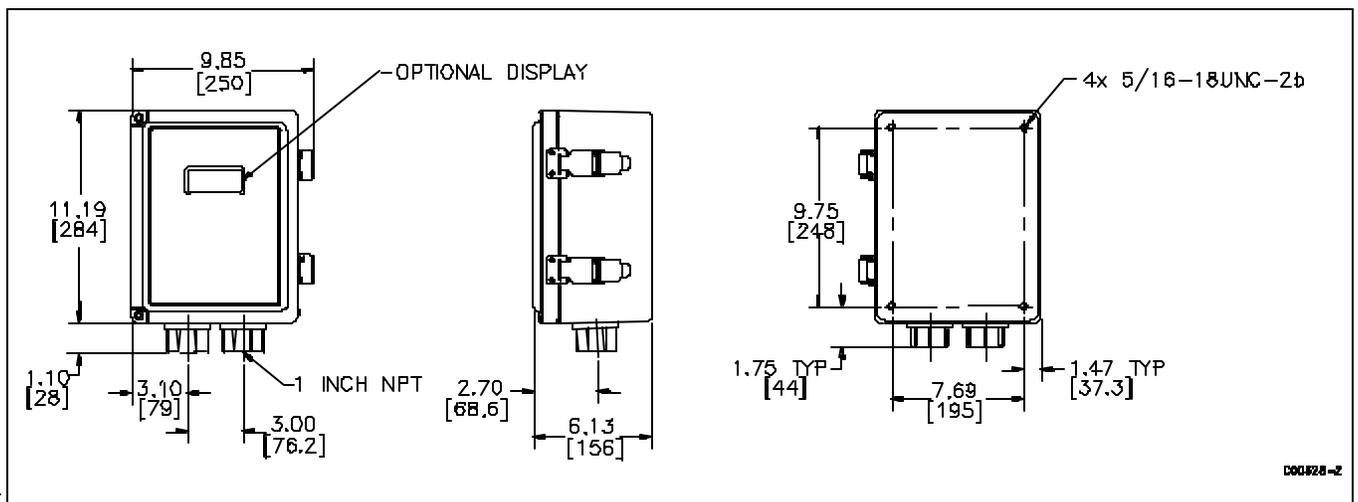


Figure 30. Remote Enclosure NEMA Type 4X (Fiberglass)

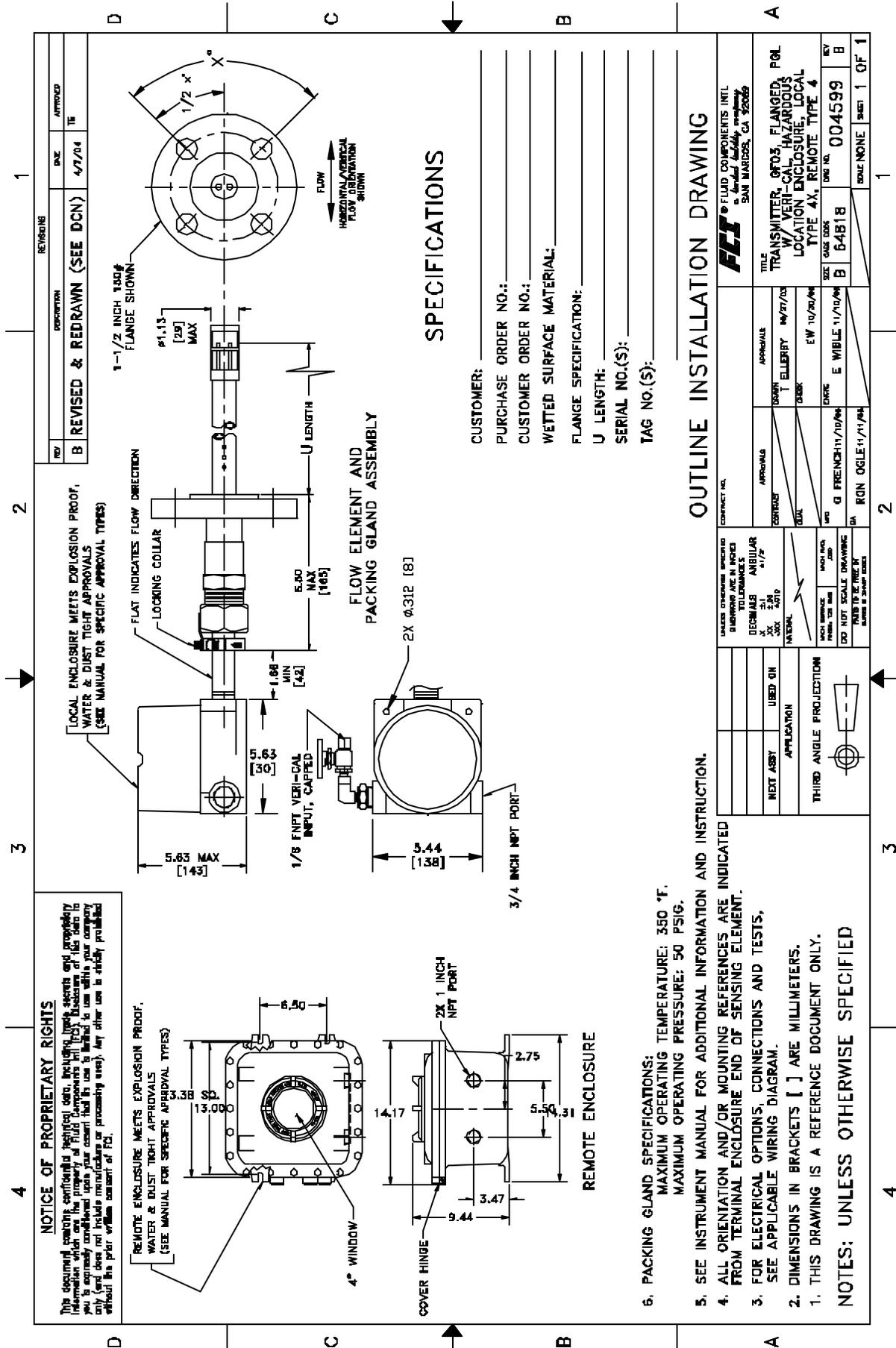


Figure 31 - Outline Dimensional

Appendix B. Glossary

Abbreviations

DMM	Digital Multi-Meter.
DR	The difference between two resistance values.
DT	The difference between two temperature values.
DV	The difference between two voltage values.
ESD	Electro-Static Discharge.
EXC	Excitation wire.
FCI	Fluid Components Intl
F.S.	Full Scale.
IOP	Input/Output/Power supply.
MSDS	Material Safety Data Sheet.
NC	Normally Closed.
NO	Normally Open.
RA	Return Authorization.
RTD	Resistance Temperature Detector. It operates on the principle of change in resistance as a function of temperature.
SEN	Sense wire.
STP	Standard Temperature and Pressure.

Explanation of Terms

DISPLAY MENU / DELTA R DATA SHEET

The terms are shown in the order they are displayed through out the display menu.

Totalizer Setup 3.3

m Abbreviation for thousand

mm Abbreviation for million

Verify 5.1

Flow Factor The multiplier that converts the internal flow rate to the user selected flow units

Units Customers Requested Flow Rate unit

Flow Range The minimum and maximum of the measurable flow

Area	Cross-sectional area of pipe or duct
Diameter	Inner diameter of pipe
Temp. Unit	Unit of temperature
Tcal Add	A value that is added to measured temperature (default is 0)
Tcal Mult	A value that is multiplied by the measured temperature (default is 1)
Relay 1	Current status of Relay 1, energized or de-energized
Above, Below, Inside or Outside	See Chapter 3 Relays, for the explanation
H:	Hysteresis value (in flow rate units such as 50 SCFM etc.)
D:	Delay in seconds
Relay 2	Current status of Relay 2, energized or de-energized
Port 1	Channel 1 output signal
Mode	Current (4 - 20 mA) or Volts (0 - 5, 0 - 10, etc.) output
F.S.	Full Scale: 100% of flow rate
Zero	0.00 for zero based and Min flow for non-zero based
Port 2	Channel 2 output signal
Corr1 through Corr4	Correction Factors: Default is Corr 2 = 1 and Corr1, 3, 4 = 0 $(\text{Flow}) = \text{Corr1} + \text{Corr2}(\text{Flow}) + \text{Corr3}(\text{Flow})^2 + \text{Corr4}(\text{Flow})^3$
<u>Menu 5.8</u>	
dR gain	Digital representation of A/D# for ΔR value - derived during front-end set-up: $\Delta R = \text{dR Gain} \times \text{A/D\#} + \text{dR Off}$
R gain	Digital representation of A/D# for REF RTD value - derived during front-end setup: $\text{REF R} = \text{R Gain} \times \text{A/D\#} + \text{R Off}$
dR Off	Offset value of equation: $\Delta R = \text{dR Gain} \times \text{A/D\#} + \text{dR Off}$
Ref off	Offset/constant value for REF RTD derived during front-end set-up: $\text{REF R} = \text{R Gain} \times \text{A/D\#} + \text{R Off}$
Offset 1	Offset for equation: $\text{REF R} = \text{R Gain} \times \text{A/D\#} + \text{R Off}$
Slope 1	Slope for equation: $\text{D/A\#} = \text{current} \times \text{Slope 1} + \text{Off 1}$. Corresponding to current or voltage output

Offset 2	Offset for equation: $REF R = R Gain \times A/D\# + R Off$
Slope 2	Slope for equation: $D/A\# = current \times Slope 2 + Off 2$. Corresponding to current or voltage output
Std. Density	Density of media (customer's original request) at standard conditions usually at 14.7 PSIA and 70 degrees F; used by firmware for conversion when a mass flow rate unit is chosen such as LB/HR etc.
Tot. Unit	Unit of Totalizer as NCM or SCF (Note that there is no time unit)
Prt B:	Port B
Prt C:	Port C
A/D Mode	Analog to Digital Mode
Boxcar	A number between 1 - 64 that represents a signal filtering parameter. See Chapter 3, Sample Rate
Link Mode	Shows if link mode is enabled or disabled
Flow Min	Minimum calibrated Flow Rate in SFPS
Flow Max	Maximum calibrated Flow Rate in SFPS
dR Min	dR value low end cutoff. Should be set to approximately 5 ohms less than the lowest dR corresponding to Flow Max
dR Max	dR value high-end cut-off. Should be set to approximately 5 ohms greater than the dR corresponding to Flow Min
C1 - C5	Coefficients for Characteristic Equation; unique to each probe
CAL REF W	Calibration Average Reference Resistance
T1	Temperature Compensation coefficients
T2	Serial number of unit
T3	Shop Order number of unit
T4	Engineering serial number - if any

Miscellaneous Terms

Full Scale	This is the value that the customer chooses to set the 20mA (or 10 VDC) output to. The Max Flow value, by comparison, is the highest flow, in SFPS, that the meter was calibrated to. This value is in the customers units
Power Isolated	Input AC power terminals are electrically isolated from all other terminals
Turndown	This is Full Scale divided by the Min Flow

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Appendix C. Customer Service

Customer Service and Technical Support

FCI provides full in-house technical support. Additional technical representation is also provided by FCI field representatives. Before contacting a field or in-house representative, please perform the troubleshooting techniques outlined in this document.

By Mail

Fluid Components International LLC
1755 La Costa Meadows Dr.
San Marcos, CA 92078-5115 USA
Attn: Customer Service Department

By Phone

Contact the area FCI regional representative. If a field representative is unable to be contacted or if a situation is unable to be resolved, contact the FCI Customer Service Department toll free at 1-800-854-1993.

By Fax

To describe problems in a graphical or pictorial manner, send a fax including a phone or fax number to the regional representative. Again, FCI is available by facsimile if all possibilities have been exhausted with the authorized factory representative. Our Fax number is 1-760-736-6250; it is available 7 days a week, 24 hours a day.

By E-Mail

FCI Customer Service can be contacted by e-mail at: techsupport@fluidcomponents.com. Describe the problem in detail making sure a telephone number and best time to be contacted is stated in the e-mail.

International Support

For product information or product support outside the contiguous United States, Alaska, or Hawaii, contact your country's FCI International Representative or the one nearest to you.

After Hours Support

For product information visit FCI's Worldwide Web at www.fluidcomponents.com. For product support call 1-800-854-1993 and follow the prerecorded instructions. A person from the Technical Support Staff will be paged and promptly return the call.

Point of Contact

The point of contact for service, or return of equipment to FCI is an authorized FCI service representative.

Reference Documents

Documents 1 and 2 are included in this appendix.

1. Return Authorization Request/Certificate of Non-Contamination (Document 1)
2. Warranties (Document 2)

Hardware Return Procedure

1. Complete a Return Authorization (RA) Request/Certificate of Non-Contamination form (Document 1) and mail or fax it to the FCI customer department. After FCI issues you an RA number, complete the following steps.
2. Thoroughly clean the hardware.
3. Package each instrument with protective packing material similar to the original FCI shipment cartons indicated below. **All damage occurring in transit is the customer's responsibility.**
 - a. Instruments weighing less than 25 pounds each are to be covered with protective wrap, i.e. bubble wrap or surrounded with "popcorn". Instruments weighing greater than 60 pounds or extending more than four feet should be secured in wooden crates by bolting the sensing element assembly in place.
 - b. Protect the sensing element with a cardboard tube or other sturdy wrapping.
 - c. Do not pack more than four small instruments in each carton.
 - d. Packages weighing in excess of 70 pounds or with a combined length and girth of more than 138 inches cannot be shipped by United Parcel Service. Larger packages or crates should be shipped by carriers who specialize in the transport of industrialized instrumentation.
 - e. The RA number should be noted on the packing list and marked clearly on the outside of the box.
4. Prepay freight to the FCI receiving door.

Shipping / Handling Charges

All Shipping (Warranty and Nonwarranty Repairs or Returns)

The customer prepays all shipping, freight, duty/entry and handling charges from the customer site to the FCI door. If the customer does not prepay, FCI will invoice the customer for the charges that appear on the freight bill. Address the return equipment to:

FLUID COMPONENTS INTERNATIONAL LLC
 1755 LA COSTA MEADOWS DRIVE
 SAN MARCOS, CA. 92078
 ATTN: REPAIR DEPT.
 RA NUMBER: _____

Warranty Repairs or Returns

FCI prepays ground transportation charges for return of freight to the customer's door. FCI reserves the right to return equipment by the carrier of our choice.

International freight, handling charges, duty/entry fees for return of equipment are paid by the customer.

Nonwarranty Repairs or Returns

FCI returns repaired equipment to the customer either collect or prepaid and adds freight charges to the customer invoice.

Return to Stock Equipment

The customer is responsible for all shipping and freight charges for equipment that is returned to FCI stock from the customer site. These items will not be credited to customer's account until either all freight charges are cleared or until the customer agrees to have any freight costs incurred by FCI deducted, along with applicable return to stock charges, from the credit invoice. (Exceptions are made for duplicate shipments made by FCI.)

If any repair or return equipment is received at FCI, freight collect, without prior factory consent, FCI bills the sender for these charges.

Field Service Procedure

Field Service Requests

Contact your FCI field representative to request field service.

A field service technician is dispatched to the site from either the FCI factory or one of the FCI representative offices. After the work is complete, the technician completes a preliminary field service report at the customer site and leaves a copy with the customer.

Following the service call, the technician completes a formal, detailed service report. The formal report is mailed to the customer within five days of the technician's return to the factory or office.

Rates

All field service calls are billed at the prevailing rates as listed in the FCI Price Book unless specifically excepted by the FCI Customer Service Manager. FCI reserves the right to bill for travel times at our discretion.

Customers are charged for shipping costs related to the transfer of equipment to and from the job site. They are also invoiced for field service work and travel expenses by FCI's Accounting Department.

Document 1.

FCI RETURN AUTHORIZATION REQUEST

Customer Information

Name of Company Returning Hardware _____

Contact Name: _____ Phone # _____ Fax # _____

Customer Bill to Address: _____ Ship to: _____

Purchase Agent Contact: _____ Phone # _____ Fax # _____

Product Information

Model Number(s) _____ Serial Number(s) _____

Sending: Electronics only Sensor only Complete unit Number of units _____

Failure Symptoms _____

Troubleshooting done in the field by FCI representative or by Customer : _____

Action to be taken by FCI _____

(Note: Re-calibration/Re-certification requires the completion of a new Application Data Sheet)

Process Flow Media: _____

Who is your FCI factory technical contact: _____

Note: FCI will charge a **\$100 minimum** handling fee on all non-warranty evaluations.

Have you contacted your local FCI representative for assistance? _____ yes _____ no

Decontamination Information

Exposure to hazardous materials is regulated by Federal, state (California), County and City laws and regulations. These laws provide FCI's employees with the right to know the hazardous materials with which they come in contact while handling our products. Consequently, our employees must have access to data regarding the hazardous materials which the equipment has been exposed to in your process(es). Accordingly, prior to returning your instrument for repair, please sign the certification below and thoroughly comply with the instructions, if applicable.

I certify that the item(s) has (have) been thoroughly and completely cleaned and if the item(s) has (have) been exposed to or contacted by a hazardous material, hazardous substance or toxic materials or substances that the undersigned can assure the returned item(s) has (have) been thoroughly and completely decontaminated and neutralized of such substances and contamination. I have also attached a Material Safety Data Sheet (MSDS) which covers all hazardous material, hazardous substance or toxic materials or substances exposed to or contacted by the instrument. Furthermore, I understand that this Certificate, or providing a MSDS, shall not waive our responsibility to provide a neutralized, decontaminated, and clean product for repair to FCI.

Authorized Signature _____ Date _____

Cleanliness of a returned item or the acceptability of the MSDS shall be at the sole discretion of FCI.

Any returned item which does not comply with these instructions shall be returned to you at your expense.

Warranties

Goods furnished by the Seller are to be within the limits and of the sizes published by the Seller and subject to the Seller's standard tolerances for variations. All items made by the Seller are inspected before shipment, and should any of said items prove defective due to faults in manufacture or performance under Seller approved applications, or fail to meet the written specifications accepted by the Seller, they will be replaced or repaired by Seller at no charge to Buyer provided return or notice of rejection of such material is made within a reasonable period but in no event longer than three (3) years for non-calibration defects and one (1) year for calibration defects from date of shipment to Buyer, and provided further, that an examination by Seller discloses to Seller's reasonable satisfaction that the defect is covered by this warranty and that the Buyer has not returned the equipment in a damaged condition due to Buyer's or Buyer's employees', agents', or representatives' negligence and Buyer has not tampered, modified, redesigned, misapplied, abused, or misused the goods as to cause the goods to fail. In addition, this warranty shall not cover damage caused by Buyer's exposure of the goods to corrosive or abrasive environments. Moreover, Seller shall in no event be responsible for (1) the cost or repair of any work done by Buyer on material furnished hereunder (unless specifically authorized in writing in each instance by Seller), (2) the cost or repair of any modifications added by a Distributor or a third party, (3) any consequential or incidental damages, losses, or expenses in connection with or by reason of the use of or inability to use goods purchased for any purpose, and Seller's liability shall be specifically limited to free replacement, or refund of the purchase price, at Seller's option, provided return or rejection of the goods is made consistent with this paragraph, and the Seller shall in no event be liable for transportation, installation, adjustment, loss of good will or profits, or other expenses which may arise in connection with such returned goods, or (4) the design of products or their suitability for the purpose for which they are intended or used. Should the Buyer receive defective goods as defined by this paragraph, the Buyer shall notify the Seller immediately, stating full particulars in support of his claim, and should the Seller agree to a return of the goods, the Buyer shall follow Seller's packaging and transportation directions explicitly. In no case are the goods to be returned without first obtaining a return authorization from the Seller. Any repair or replacement shall be at Seller's factory, unless otherwise directed, and shall be returned to Seller transportation prepaid by Buyer. If the returned goods shall prove defective under this clause they will be replaced or repaired by Seller at no charge to Buyer provided the return or rejection of such material is made within a reasonable period, but in no event longer than (1) year from the date of shipment of the returned goods or the unexpired terms of the original warranty period whichever is later. If the goods prove to be defective under this paragraph, the Buyer shall remove the goods immediately from the process and prepare the goods for shipment to Seller. Continued use or operation of defective goods is not warranted by Seller and damage occurring due to continued use or operation shall be for Buyer's account. Any description of the goods contained in this offer is for the sole purpose of identifying them, and any such description is not part of the basis of the bargain, and does not constitute a warranty that the goods will conform to that description. The use of any sample or model in connection with this offer is for illustrative purposes only, is not part of the basis of the bargain, and is not to be construed as a warranty that the goods will conform to the sample or model. No affirmation of that fact or promise made by the Seller, whether or not in this offer, will constitute a warranty that the goods will conform to the affirmation or promise.

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ISO 9001:2000 and AS9100 Certified

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