

*Installation, Operation and Maintenance*  
*GF90 and GF92*



Model GF90 Insertion



Model GF92 In-Line

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# 1. General Information

## Description

This document describes the procedures required to install, operate, maintain, and troubleshoot the Model GF90 and GF92 Flowmeters. 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 device (flow element) interconnected to a microprocessor-based electronics control and display package (flow transmitter). The flow element can be attached directly to the flow transmitter (local instrument) or it can be connected to the flow transmitter with a cable of up to 1000 feet or 300 meters (remote instrument).

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

## Flow Element

The flow element consists of 4 thermowells. The thermowells are hollow metal tubes that are braised together to make 2 pairs of thermowells. One thermowell pair contains the active Resistance Temperature Detector (RTD) and a heater. The other thermowell pair contains the reference RTD and an empty thermowell for thermal mass equalization. Figure 1 shows the flow element.

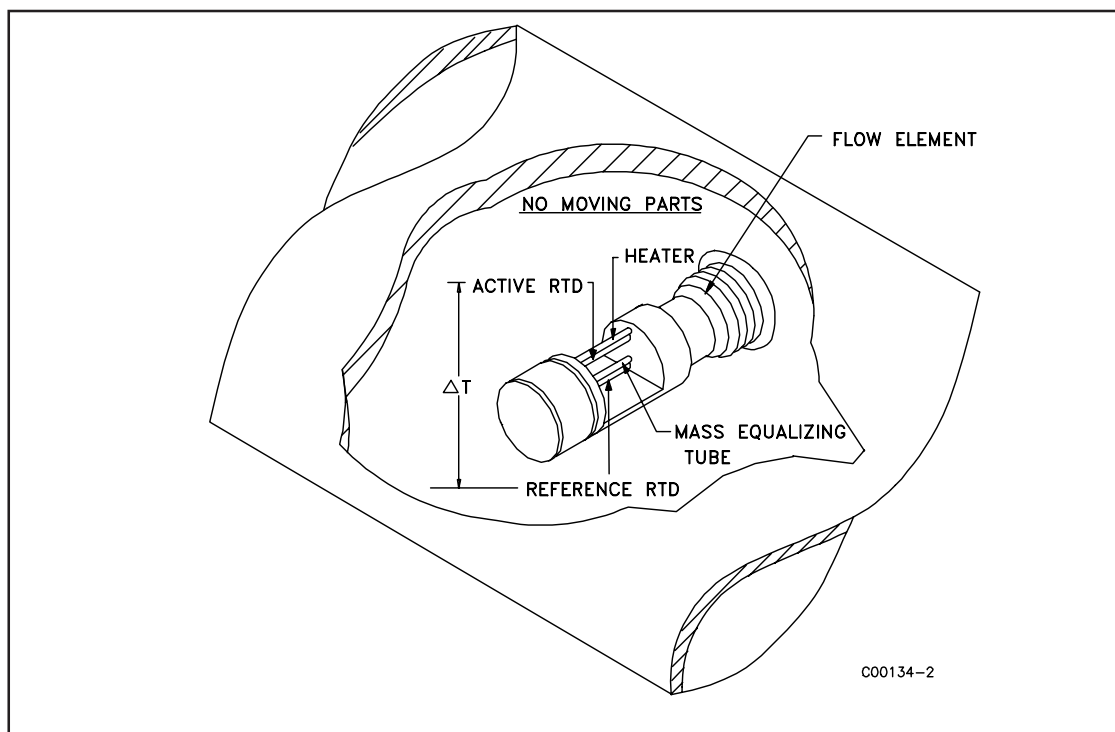


Figure 1. Cut-Away View of the Flow Element

## 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 ( $\Delta T$ ) between the two RTDs as a function of resistance, amplify and linearize the Differential Resistance ( $\Delta R$ ) measurement of the flow element input signal and to provide an output signal.

This output signal is calibrated to the flow rate as a function of velocity, standard volume or mass flow. 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 operation with a menu-driven selection of control, monitoring, display and driver options.

The flow element consists of two pairs of thermowells of the same size, shape and mass. One pair contains a platinum RTD and a heater element. The other pair contains one RTD. The RTD located next to the heater element is called the active RTD. The other RTD is referred to as the reference RTD. Since the active RTD is adjacent to the heater, the temperature at the walls of the thermowell are 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  $\Delta T$  exists between the two pairs of thermowells and a proportional  $\Delta R$  exists between the active and the reference RTDs. The  $\Delta R$  is measured by the flow transmitter. The relationship of  $\Delta T$  to the mass flow rate is calculated by the flow transmitter and is converted into a signal or is sent to the flow transmitter's display.

## Technical Specifications

### Gas Mass Flow Measurement:

**GF90:** In ducts or pipes sizes with a minimum 2.0 inch (5.1 cm) nominal inside diameter.

**GF92:** In pipe lines or tubing sizes from 0.125 to 3 inches (0.3175 to 7.62 centimeters).

### Flow Elements

#### Process Connection:

**GF90:** 1 inch male NPT standard. Flange connections and field retractable packing gland assemblies available.

**GF92:** 3/4 inch female NPT standard. 1.0, 1.5, 2.0 and 3.0 inch male or female NPT, flange connections available.

**Insertion Length — GF90:** Variable length. Specify insertion “U” length (dimension from the process connection to the tip of the flow element) to extend the tip of the flow element 1 inch (2.5cm) past the centerline of the process pipe.

**Body Length — GF92:** 7.25 inches (18.4cm) for 1 inch flow tubes; 12.0 inches (30.5 cm) for 1.5 to 3 inch (3.81 to 7.62 cm) pipe spool pieces. Variable A-lengths available.

**Flow Element Material:** All wetted surfaces are 316 stainless steel with nickel braze. Corrosion-resistant alloys are available with factory specified all welded construction or compatible brazes.

#### Flow Element Range:

**GF90:** 0.25 to 1600 SFPS for most gases (ft<sup>3</sup>/sec at a standard temperature of 70° F and pressure of 14.7 psia) or 0.08 to 487.7 NMPS [m<sup>3</sup>/sec at a normal temperature of 21.1°C and pressure of 1.013 bar (absolute)].

**GF92:** 0.006 to 2000 SCFM for most gases (ft<sup>3</sup>/min at a standard temperature of 70°F and pressure of 14.7 psia) or 0.01 to 3398 Nm<sup>3</sup>/h [m<sup>3</sup>/ hr at a normal temperature of 21.1°C and pressure of 1.013 bar (absolute)].

*Actual velocity for both the GF90 and GF92 must be limited to a maximum of 200 feet per second (60.96 meters per second).*

**Temperature Range:** -50° F to +350° F (-45° C to +176.7°C) with the standard temperature flow element. The GF90 is available in a High Temperature Flow Element configuration for service in process temperatures from -100° F to +850° F (-73.3° C to +454.4°C).

**Operation Pressure:** Up to 1000 psig [68.9 bar (gauge)].

### Transmitter

#### Signal Output:

**Analog:** Two independent signal outputs available that may be field set from the following listed selection:

4-20 mA, 600 ohms maximum load

0-10 Vdc, 5000 ohms minimum load

0-5 Vdc, 2500 ohms minimum load

1-5 Vdc, 2500 ohms minimum load

**Digital:** RS-232C (EIA-232) serial port.

**Switch Points (Dual Alarms):** The switch points may be field set by programming the GF90 or GF92 to alarm at high, low or windowed flow or at high, low or windowed process temperature.

## Technical Specifications (Cont'd)

**Relays:** Two Relays independently adjustable: 2 amps bifurcated gold plated DPDT contacts, 0-2.0 amps at 28 Vdc or 115 Vac resistive, 0.1 volts at 230 Vac resistive. 0 amps (or Dry) rating is good if load is kept below 30mA.

**Slave Relay Energization Terminals:** Customer provided relay may be energized at programmable values connecting to points on the output terminal strip.

**+Ext Relay:** 20 Vdc, sourcing up to 100 mA total both relay outputs.

**-Ext Relay:** Open/Ground (switching).

**Power Input:** 115 Vac,  $\pm 15$  Vac, 16 watts maximum or 230 Vac,  $\pm 30$  Vac, 50/60Hz, 16 watts maximum; or 24 Vdc, -2 and +6 Vdc, 16 watts maximum as selected by the power input switch and terminal selection.

**Indicator Display & Built-In Keypad:** 4 lines by 20 character liquid crystal display that may be programmed to indicate flow rate, total flow, temperature, and switch point status in customer determined English or Metric (SI) values. Keypad permits easy touch programming to change zero, span, switch points, and units of measurement and for instrument verification, trouble shooting and other critical instrument functions.

### Electrical Enclosures

Fiberglass NEMA/CSA Type 4X is standard. All aluminum and stainless steel enclosures are rated for hazardous location use (Class I and II, Division 1 and 2, Groups B, C, D, E, F and G; and EEx d IIC) and resists the effect of weather and corrosion (NEMA/CSA Type 4X and equivalent to IP66).

**Electrical Connection:** 1 inch female NPT.

**Temperature Range:** 0°F to +150°F (-18°C to +65.6°C).

### Flow

**Accuracy:**  $\pm 1\%$  reading + 0.5% full scale.

**Repeatability:**  $\pm 0.5\%$  reading or better.

**Turndown Ratio:** Field set to within specified flow range from 2:1 to 1000:1. Turndown ratios up to 1000:1 are possible in some applications. Signal output may be field set to be zero or non-zero based. Up to three independent calibrations may be stored in the GF Series transmitter and selected via the built-in keypad, RS-232C Serial Port or Auxiliary Input Terminal (4-20 mA).

**Calibration Adjustment:** Up to three independent calibration groups are available. Each group is precisely calibrated at the factory in accordance with the submitted Application Data Sheet to turndown ratios as high as 1000:1. Most calibrations are performed in the actual process fluid and process conditions described by the customer's specification. Adjustment to zero and span are made easily in the field by using the keypad to input revised flow or temperature range information.

### Temperature

**Accuracy:**  $\pm 2^\circ\text{F}$  ( $\pm 1.1^\circ\text{C}$ ). Valid only above minimum flowing conditions of 5 SFPS (1.5 NMPS).

**Repeatability:**  $\pm 1^\circ\text{F}$  ( $\pm 0.55^\circ\text{C}$ ).

### System Approvals

Factory Mutual Research (FM), CSA, CE Mark, CENELEC, CRN and ATEX.

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# 2. Quick Start Guide

## Pre-Installation

To get the best results from the instrument, the sensor should be located 20 pipe diameters down stream from any flow disturbance (valve, pipe elbow, etc.) and 10 pipe diameters upstream from any disturbance.

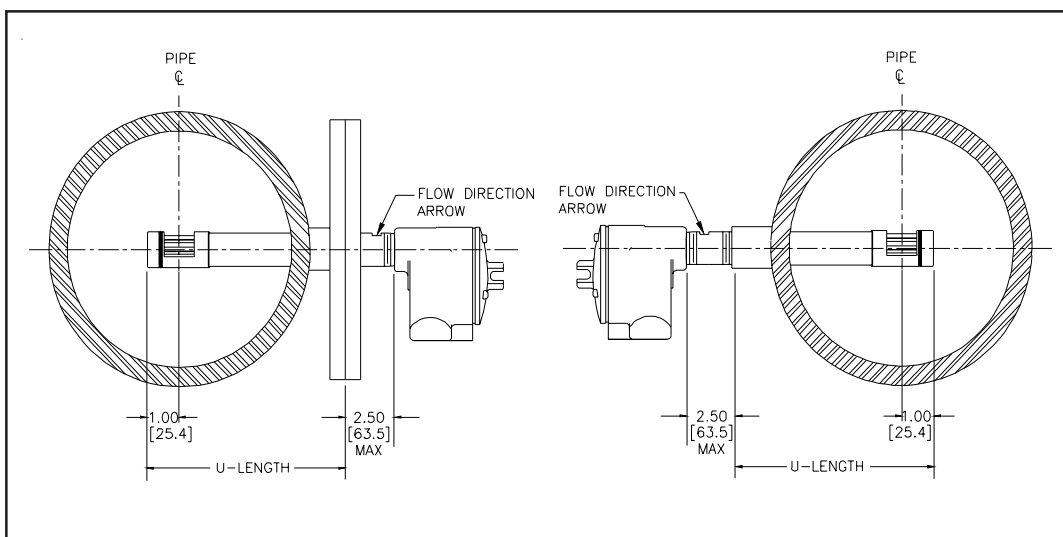
The outside of the instrument has tags which show the model number, tag number (if noted on the customer’s order) and serial number along with other important safety information. Compare this information with the appropriate pipe installation drawings and calibration sheets to verify the instrument is the correct configuration.

Verify that the serial numbers on the enclosure(s) tag(s), flow element and electronics match. The instrument may not work if the serial numbers are miss-matched.

The recommended installation/troubleshooting tools are:

- 1 ea. Open-ended wrench to fit the NPT connection
- 1 ea. Open-ended wrench to fit the flanged fitting nuts and bolts
- 1 ea. Small flat blade screw driver for manipulating potentiometers
- 1 ea. Medium flat blade screwdriver for tightening connections
- 1 ea. Medium phillips head screwdriver for tightening connections
- 1 ea. 3 mm Allen wrench
- 1 ea. Measuring tape for proper flow element placement
- 1 ea. DVM for Ohm/Voltage measurements

## Flow Element Installation



Example of GF90 Flow Meter (See Appendix A for Specific Diagrams)

Install the flow element, with the flow arrow pointing in the direction of media flow. The element should be in the center line of the process pipe or rectangular duct as shown above.

If the NPT option is used, see Page 13 for installation instructions.

If the flanged option is used, see Page 13 for installation instructions.

If the GF92 in-line option is used, see Page 14 for installation instructions.

**NOTE:** ST98 type flow element only inserts 0.50 inches past centerline. See VeriCal System Diagram on page 54.



## Wiring Preparation



**CAUTION:** Only qualified personnel are to wire or test this instrument. The operator assumes all responsibilities for safe practices while wiring or troubleshooting.

**ALERT:** The instrument contains electrostatic discharge (ESD) sensitive devices. Use standard ESD precautions when handling the flow transmitter.

Before the instrument is opened to install the wiring, FCI recommends that ESD precautions be observed. See Page 11 for ESD instructions.

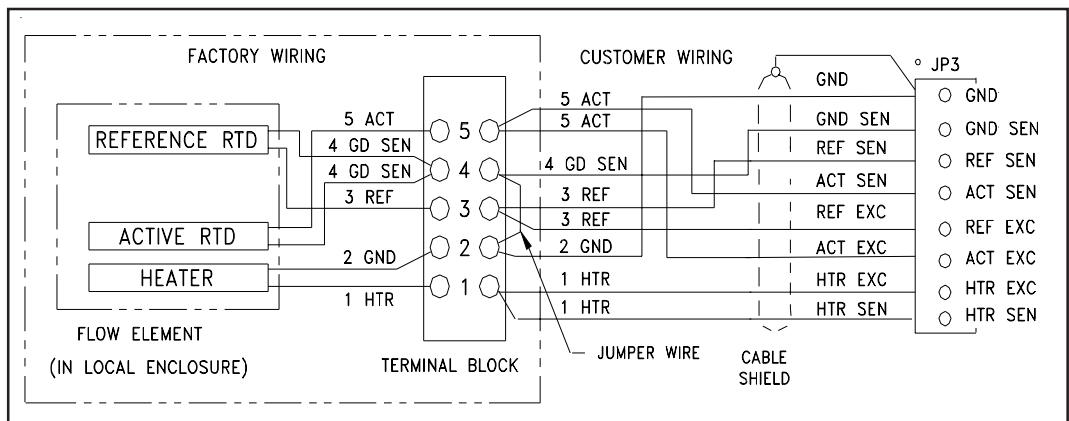
## Wiring the Instrument

This section wires the transmitter inputs, outputs and interconnection cabling for the instrument. Route the output wiring through the opposite port from the power wiring. The maximum gauge of wire to use is 16 AWG. See Table 1 on Page 16 and Table 2 on Page 17 for the maximum distance that wires can be run.

### Wiring the Flow Element

Connect a shielded, 8 wire cable between the transmitter and the local enclosure terminal strip as shown below. Be sure the shield (ground wire) is connected to JP3 GND along with the wire from terminal block terminal 2. Do not connect the shield to the local enclosure (leave it floating).

Alternate 8 wire, ST98 Type Flow Element wiring shown in VeriCal and 2 point Averaging System sections, see Operations Section 4.0.

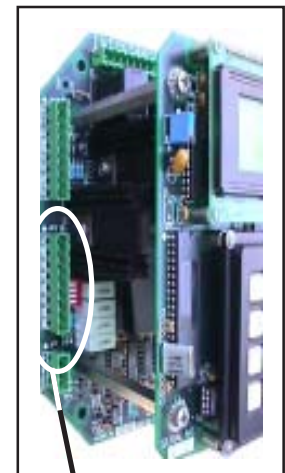


Local Enclosure Wiring Diagram



Flow Element Terminal Block	Transmitter JP3 (Terminal No.)
Terminal 5 (ACT)	ACT SEN (4)
Terminal 5 (ACT)	ACT EXC (6)
Terminal 4 (GND SEN)	GND SEN (2)
Terminal 3 (REF)	REF SEN (3)
Terminal 3 (REF)	REF EXC (5)
Terminal 2 (GND)	GND (1)
Terminal 1 (HTR)	HTR EXC (7)
Terminal 1 (HTR)	HTR SEN (8)

Flow Element Wiring Table



Connector JP3

Flow Element Terminal Block  
(Be sure the jumper is in place Terminal 2 to terminal 4.)





### Wiring the Input Power:

**Caution:** FCI recommends placing an ON/OFF switch in line with the power source. When JP1 is connected to the power source the instrument is ON.

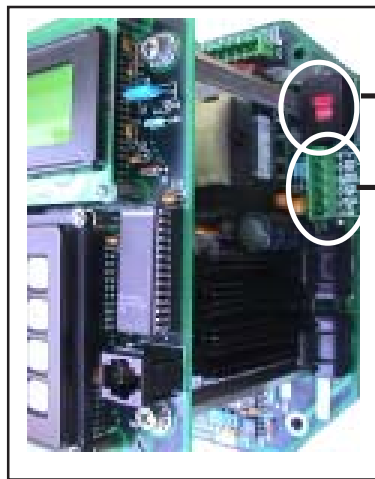
AC or DC power can be used to operate this instrument. For best results route the output signal wiring through the left port of the instrument enclosure and the power input wiring thorough the right port. See the wiring table on Page 16 to determine the minimum size of wiring to be used versus the length of the wire run to the power source.

#### 115 or 230 VAC Power Option

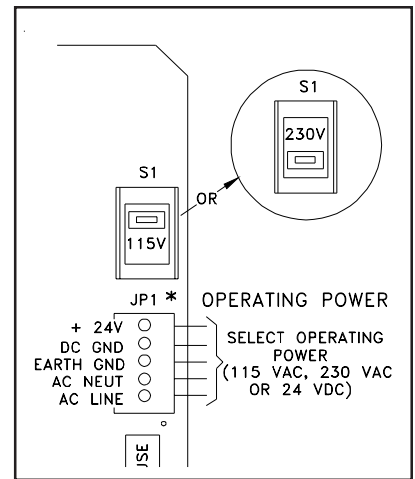
The input power can be switched from 115 Vac to 230 Vac by moving switch S1 to the correct setting. (The instrument requires only AC or DC to be connected, not both.) Connect the hot side of the AC Line to AC LINE, the neutral side to AC NEUT, and ground to EARTH GND. (Do not connect the local enclosure shield wire to the EARTH GND on this plug.)

#### 24 VDC Power Option

If DC power is used, the AC Input and switch S1 are not pertinent. Wire the positive 24 volt input to +24V. Connect the negative wire to DC GND.



Input Power Location

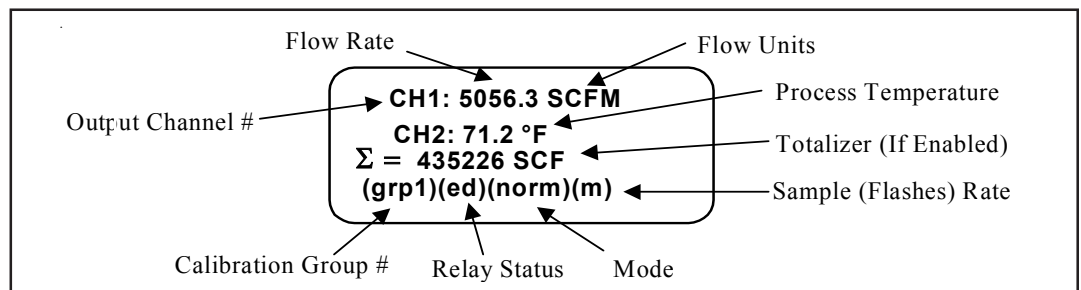


Input Power Wiring Diagram

### Instrument Operation

The instrument has been configured and calibrated to custom specifications. In-depth programming of the instrument in the field should not be necessary.

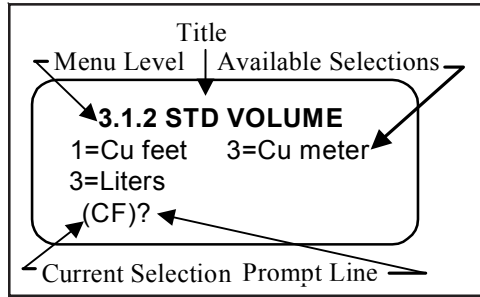
Apply power to the instrument. Wait 10 minutes for the instrument to stabilize. During this period the instrument may indicate a high flow condition. When the instrument is powered up, the instrument will display an initialization sequence. Then the instrument will display the normal operation information. Shown below is the normal operation window.



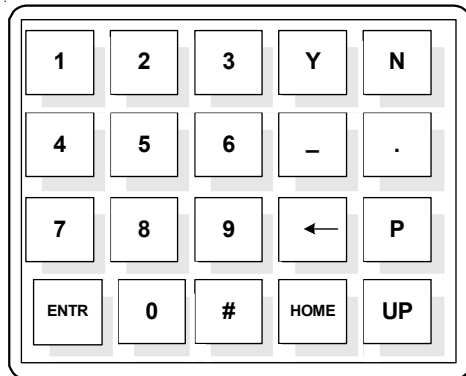
Normal Operation Window

### Menu Control

The prompt line displays appropriate key strokes for the required 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 and key assignments are shown below:



Display Characteristics



Key Pad

KEY	KEY NAME	ACTION
0-9	Numeric	Selects options and enters numbers.
Y	Yes	Enter a yes response
N	No or (N)ext	Enter a no response or scroll to next screen
-	Minus	Enter a minus sign
.	Decimal Point	Enter a decimal point
←	Back Space	Moves cursor back one space
P	(P)revious	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 on level

Key Assignments

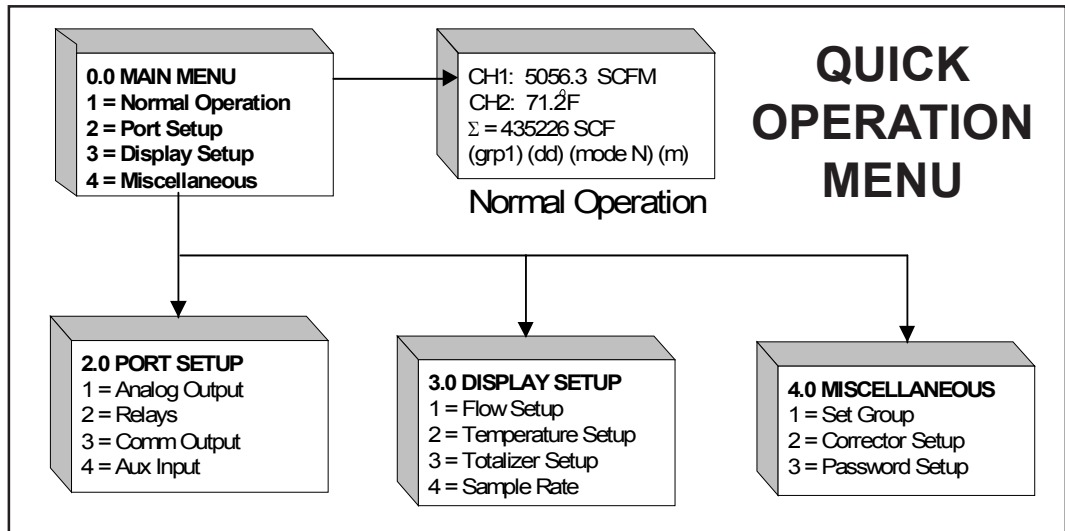
At any time, the HOME key can be pressed and the main menu will display. HOME can be used to escape from most routines, or restart a progression into the menu structure.

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.

The quick operation menu is shown below:



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## 3. Installation

### Receiving/ Inspection

- Unpack carefully.
- Verify that all items in the packing list are received and are correct.
- Inspect all instruments for damage or contaminants prior to installation.

If the above three items are satisfactory, proceed with the installation. If not, then stop and contact a customer service representative.

### Packing/ Shipping/ Returns

These issues are addressed in Appendix D - Customer Service.

### Factory Calibration Note

The instrument 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 instrument in service.

### Pre-Installation Procedure



**CAUTION:** Only qualified personnel should install this instrument. Install and follow safety procedures in accordance with the current National Electrical Code. Ensure that power is off during installation. Any instances where power is 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.



**ALERT:** The instrument is not designed for weld-in-place applications. Never weld to process connection or a structural support.

Damage resulting from moisture penetration of the enclosure(s) is not covered by product warranty.

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

#### Use Standard ESD Precautions

When opening an instrument enclosure or handling the flow transmitter use standard ESD precautions. 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.

The above precautions are minimum requirements to be used. The complete use of ESD precautions can be found in the U.S. Department of Defense Handbook 263.

#### Prepare or Verify the Flow Element Location

Prepare the process pipe for installation or inspect the already prepared location to ensure that the instrument will fit into the system.

Mount the flow element at least 20 diameters downstream and 10 diameters upstream from any bends or interference in the process pipe or duct to achieve the greatest accuracy.

**Verify Dimensions**

The GF90 Insertion Models have an adjustable insertion length ferrule until it is locked into position. Verify all dimensions before locking the fitting in place. See the appropriate figures in Appendix A.



**NOTE:** Two types of ferrules are available. One type of ferrule is made from Teflon. This can be tightened and loosened repeatedly at different places on the flow element. The other type of ferrule is made from Stainless Steel. This ferrule can only be tightened in one place on the flow element. The Stainless Steel Ferrule makes an indentation into the flow element for a more firm fit.

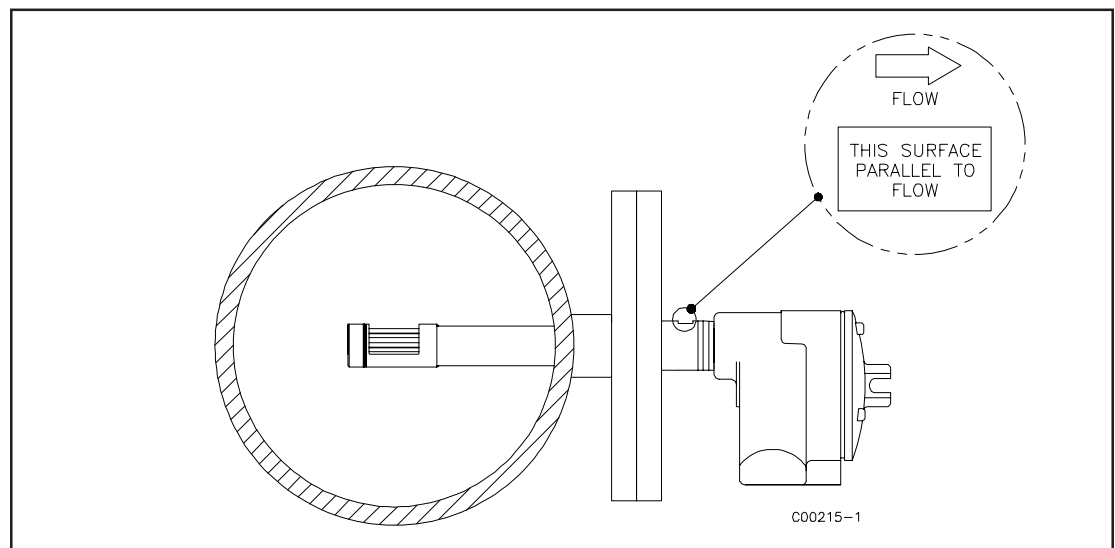
The GF92 In-Line Model's flow element has a tube or pipe length and diameter that is specified at the time of order. This dimension should be double checked with the process line.

**Verify Flow Direction**

Verify the flow direction and orientation of the flow element before placing it into the flow media. The GF90's flow element has flat areas machined on the flow element near the enclosure end of the flow element. Etched on the flow element is a flow arrow indicating the direction of flow. See Figure 2. Align the GF90's flow element during installation so the flat areas are parallel to the direction of the process media flow, and the flow arrow points in the direction of process media flow. A flow direction arrow is etched on the in-line GF92's tube or pipe and should be pointing in the direction of flow. Failing to install the flow element correctly will reduce the accuracy of the flow meter.

**Verify Serial Numbers**

Verify the serial number of the flow element and electronics. The instrument's flow element has a serial number near the flat machined area or flow arrow. The same number is on the main electronics circuit board, and on the tag of the electronics enclosure. These numbers have to match because the flow element and the electronics are a matched set. Failure to observe serial numbers will cause inaccurate readings.



**Figure 2. Model GF90 Insertion Flanged Flow Element Showing Orientation**



**Install Flow Element**



**ALERT:** Do not overtighten the flow element. The RTD's can be damaged if the flow element is forced into the far wall of the pipe or vessel.

Cable Glands and Conduit Fittings

All cable glands and conduit fittings, including conduit plugs, must meet or exceed the area approval where unit is being installed.



**NOTE:** The instrument accuracy will be reduced if the media flow is reversed from the flow direction of the flow arrow machined on the flow element or if the flats are not parallel, within  $\pm 1^\circ$  of the flow direction.

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

**GF90 Flange Mount**

The flange mount flow element is shown in Figure 2. 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.

**GF90 NPT Pipe Thread Mount**

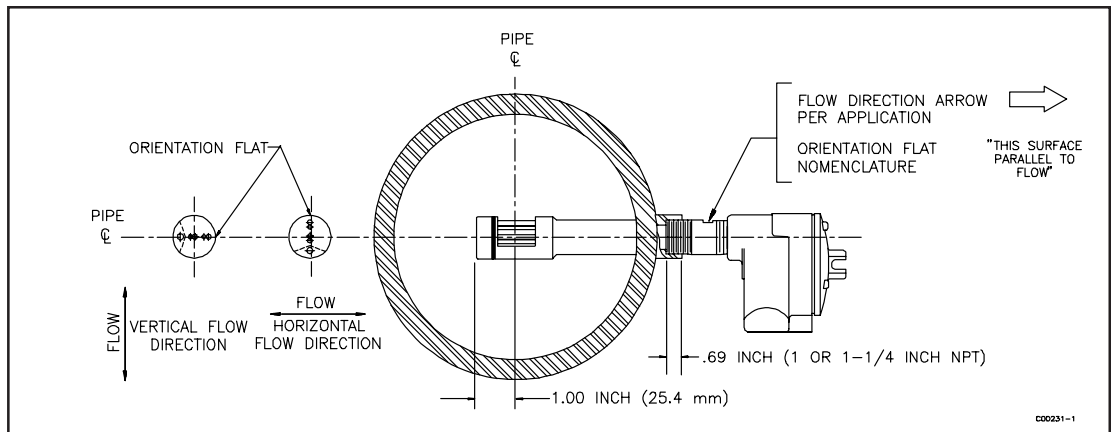


**ALERT:** DO NOT change the orientation of the flow element in the enclosure as the interconnecting RTD and heater wiring could be stressed and damaged. DO NOT apply any torque to the flow element enclosure - only apply to NPT pipe surface itself.



**NOTE:** When mounting the flow element to the process pipe, it is important that a lubricant/sealant is applied to the male threads of all connections. A lubricant/sealant compatible with the process environment should be used. All connections should be tightened firmly. To avoid leaks do not overtighten or cross-thread connections.

The pipe thread configuration is shown in Figure 3. 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 and continue to turn until flat is horizontal to process flow.



**Figure 3. Model GF90 Insertion NPT Flow Element**

### GF90 Adjustable / Retractable Flow Element Assembly

Applications involving the use of a packing gland (low, medium or high pressure) should refer to the drawings located in Appendix A for additional detail.

- NPT and flange packing gland mounts are available. The valve assembly with appropriate connections are customer supplied. Follow the pipe thread procedure or the flange procedure as shown on the previous page.
- Then 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.

### GF90 2 Inch (50 mm) Pipe Mount (Inside Diameter)

Use a tee-pipe configuration for applications where the inside diameter of the process pipe is 2 inches (50 mm). See Figure 4 for an illustration. The flow element active area is approximately 1 inch (25.4 mm) long, (the inactive area is also approximately 1 inch long), so it is impractical to place the flow element in a line of less than 2 inches (50 mm) inside diameter without loss of accuracy and reliability. Install the flow element per connection procedure for pipe thread, flange, or packing gland assembly as applicable.

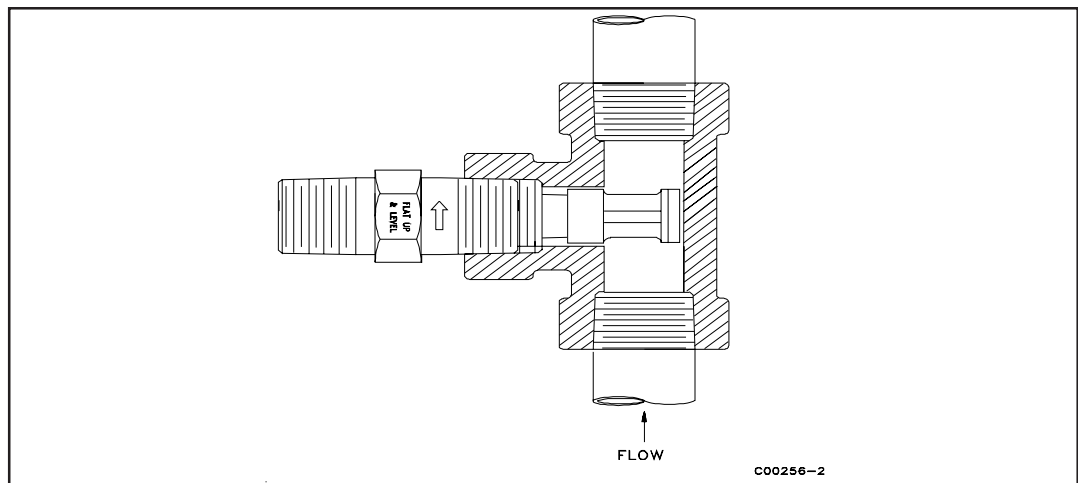


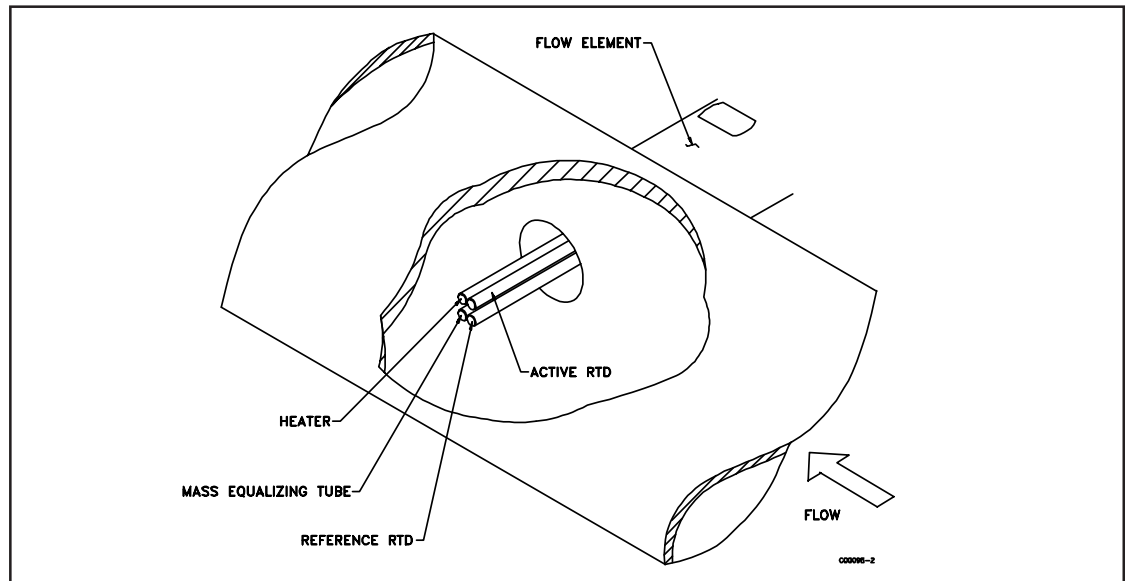
Figure 4. 2 Inch (51 mm) Pipe Mount

### GF90/GF92 Pigtail

Insert the instrument into the process and connect the flow element per the wiring diagram in Figure 50. Be sure to the correct diagram for either the cable or wire configuration.

**GF92 In-line Body Length Verification**

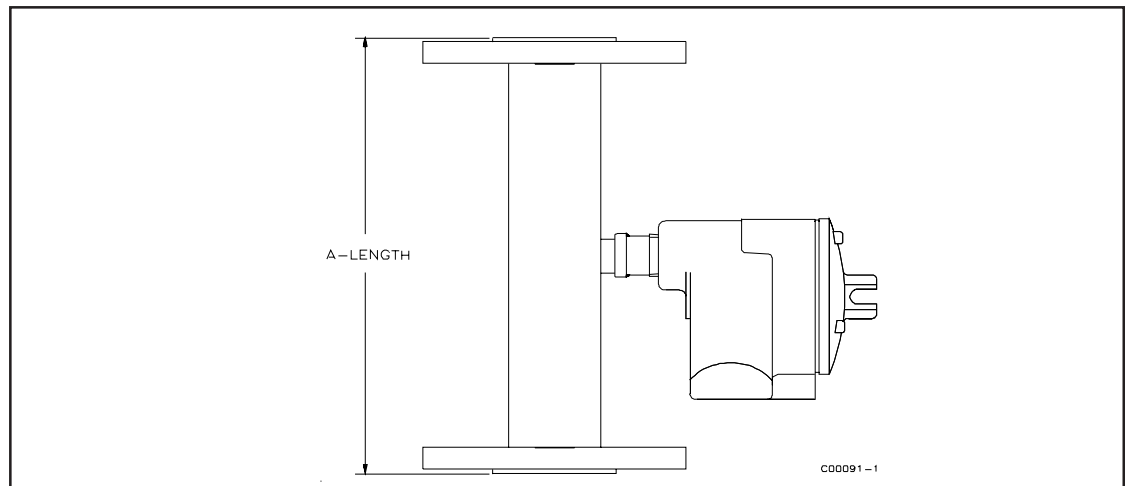
The GF92 flow element's mounting shape is a cylindrical pipe, with a customer specified "A" length (see Figures 5 and 6) with process connections as ordered. The minimum recommended clearance length in the process media pipe is 7.25 inches (184 mm).



**Figure 5. Correct Orientation**

**GF92 Flange Mount**

For flange mount flow element, attach the process mating flange with care. The correct orientation of the flow element must be maintained to ensure the calibrated accuracy.



**Figure 6. Flange Connections**

**GF92 Butt Weld**

When welding the butt weld option into the process line, be sure the flow arrow with the machined flat is facing up and the arrow is in the direction of flow. Also, be sure the wires to the remote enclosure are disconnected from the integral enclosure. Ground the flow element before welding. Do not weld anything to either the remote or local enclosures.

**GF92 NPT Connection (Threaded Male or Female)**

Apply sealant to male threads. Carefully place in the process media line with the machined flat facing up, flat and level within  $\pm 2^\circ$  for best results. The instruments threads are right-handed, tighten the process connections.

**Remote Hardware Location (GF90 and GF92)**

The outline dimensions shown in Appendix A show the physical dimensions for the proper mounting of the flow element and transmitter electronics enclosure. Select a location for the flow transmitter within 1000 feet (310 M) of the flow element. Pigtail flow elements can not be located more than 10 feet (3 M) from the flow transmitter. This location should be easily accessible with enough room to unscrew the enclosure top at any time. Secure the enclosure to a surface capable of providing support. Use appropriate hardware to secure the enclosure.

**Install Flow Transmitter**



**CAUTION:** Ensure that all power is off before wiring any circuit.



**ALERT:** 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.

Cable Glands and Conduit Fittings

All cable glands and conduit fittings, including conduit plugs, must meet or exceed the area approval where unit is being installed.



**NOTE:** FCI recommends installing an input power disconnect switch and fuse near the flow transmitter to interrupt power during installation, maintenance, calibration, and troubleshooting procedures.

Make all electrical connections through the 3/4 inch NPT ports in the enclosure. Run all electrical cables through appropriate conduit or protective sheathing.

**Minimum Wire Size**

If the instrument is used in a remote configuration, a shielded, 8 conductor cable is to be used between the local and remote enclosures. Table 1 shows the smallest (maximum AWG number) copper wire that should be used in the cable and in other wiring. Use a lower gauge of wire (larger diameter) for less of a voltage drop. Contact FCI concerning greater distances than those listed in the table. The sensing element cable for the remote option must be shielded. The maximum wire size of the non-power connectors in the instrument is 16 AWG (1.47 mm). The maximum wire size of the power connectors in the instrument is 12 AWG (2.36 mm). Table 2 shows the AWG to millimeter conversions.

**Table 1. Maximum AWG Number**

Connection	Maximum Distance for AWG					
	10 FT. (3M)	50 FT. (15 M)	100 FT. (31 M)	250 FT. (76 M)	500 FT. (152 M)	1000 FT. (305 M)
Power	22	22	22	20	18	16
Relay (2A at 220 VAC)	24	22	20	16	12	N/R
Relay (10A at 120 VAC or 24 VDC)	22	16	12	Not Recommended		
Flow Element Wires*	24	24	24	22	22	18

\* Requires a an 8 conductor shielded cable. 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).

**Table 2. Wire Conversion**

WIRE GAGE CONVERSION TABLE				
Gage	Stranding Strands/Gage	Nominal O.D. of Strand (in)	Minimum O.D. of Wire	
			Inches	mm
24	10/34	0.0063	0.024	0.584
22	7/30	0.010	0.030	0.762
20	10/30	0.010	0.037	0.890
18	16/30	0.100	0.047	1.20
16	19/29	0.113	0.058	1.47
14	19/27	0.0142	0.071	1.85

**Input Power**



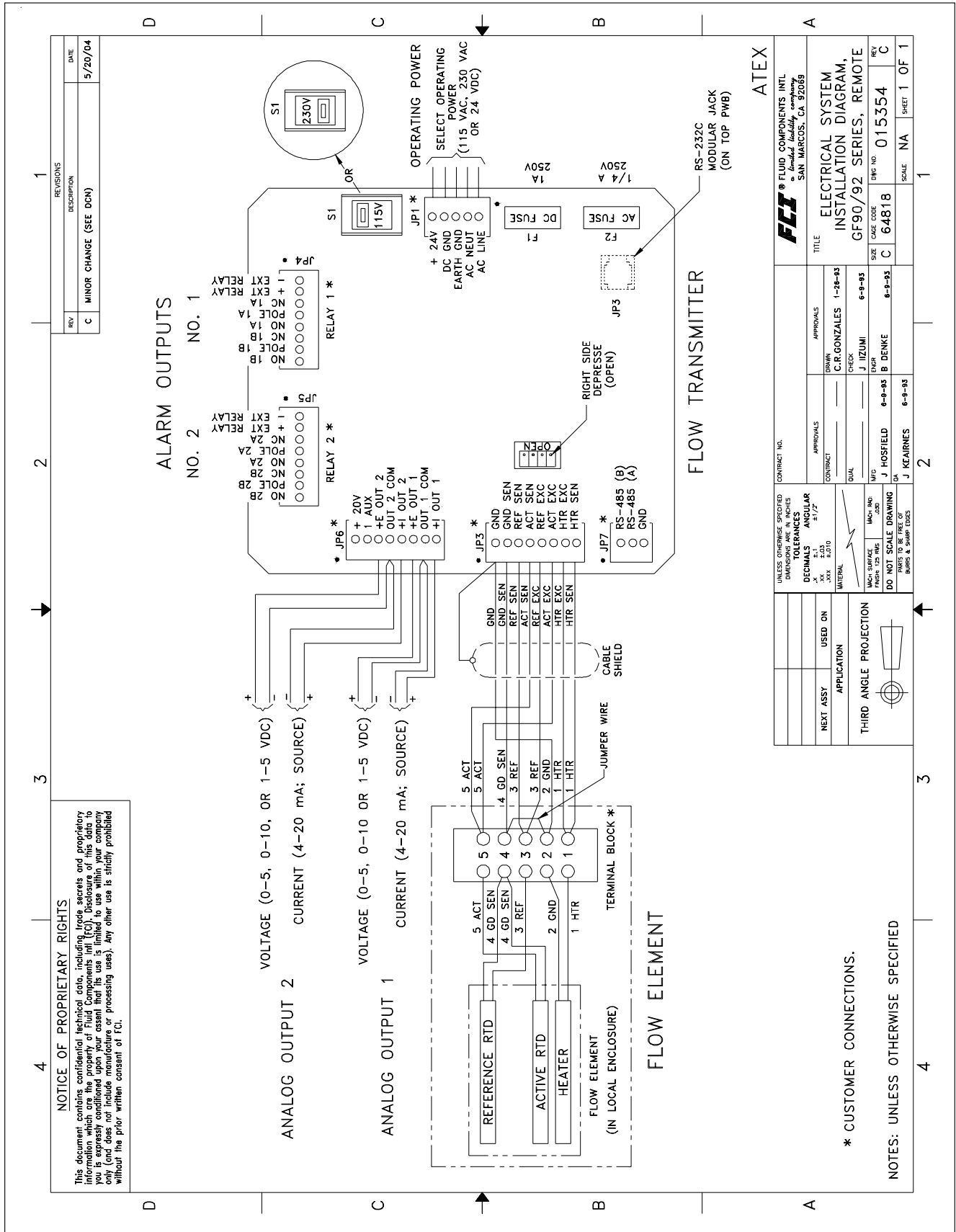
**CAUTION:** If 24 VDC is used as a power source, the terminals are not power isolated.

The flow transmitter is powered by 115 VAC, 230 VAC or 24 VDC (only one power source is needed). If 115 VAC is used, wire it directly to JP1 and position switch S1 to be in the 115 V position. See Figure 8 for details. If 230 VAC is used, position switch S1 to be in the 230 V position and then wire the power directly to JP1. See Figure 8 for details. If 24 VDC is used, it is wired directly to JP1 as shown in Figure 8.

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**

Feed the flow element cable and the two voltage/current output cables through the left access port in the remote enclosure. Similarly, feed the AC power line and the two relay cables through the right port. This separates the I/O signal and low voltage DC lines from the high voltage AC and relay lines. See wiring diagram, Figure 8 for the flow element wiring to JP3. Customer connections needing to be made are to JP4 and JP5 (relay logic), and also to JP6 (current or voltage).



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REV	DESCRIPTION	DATE
C	MINOR CHANGE (SEE DCN)	5/20/04

UNLESS OTHERWISE SPECIFIED		CONTRACT NO.	
DIMENSIONS ARE IN INCHES		FLUID COMPONENTS INTL	
TOLERANCES		SAN MARCOS, CA 92069	
DECIMALS	FRACTIONS	TITLE	
XX	XX	ELECTRICAL SYSTEM	
XX	XX	INSTALLATION DIAGRAM,	
XX	XX	GF90/92 SERIES, REMOTE	
MATERIAL		APPROVALS	APPROVALS
MACH SURFACE FINISH 125 RMS		DESIGN	CHECK
MACH. RAD. 0.008		J. IZUMI	J. IZUMI
DO NOT SCALE DRAWING		DATE	DATE
BASED TO BE REF. OF 2000 & 2002 EDITIONS		6-9-93	6-9-93
DRAWN BY		SCALE	SCALE
J. HOSFIELD		NA	NA
CHECKED BY		SHEET 1 OF 1	
B. DENKE		REV C	
DATE		Dwg No 015354	
6-9-93		64818	

\* CUSTOMER CONNECTIONS.

NOTES: UNLESS OTHERWISE SPECIFIED

Figure 8. GF90 or GF92 Wiring Diagram

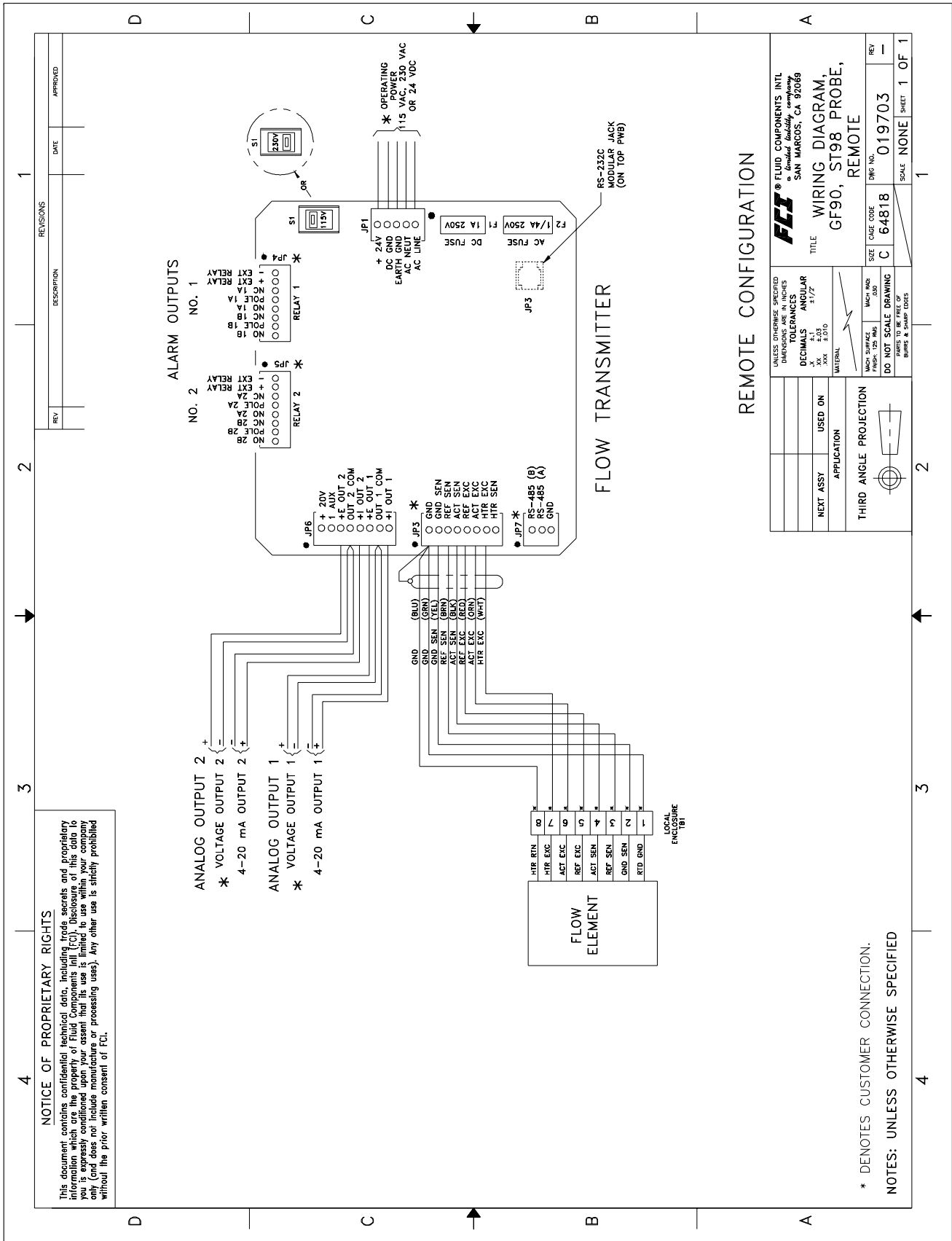


Figure 52. ST98 or ST98L Remote Wiring Diagram

**Customer Wiring**

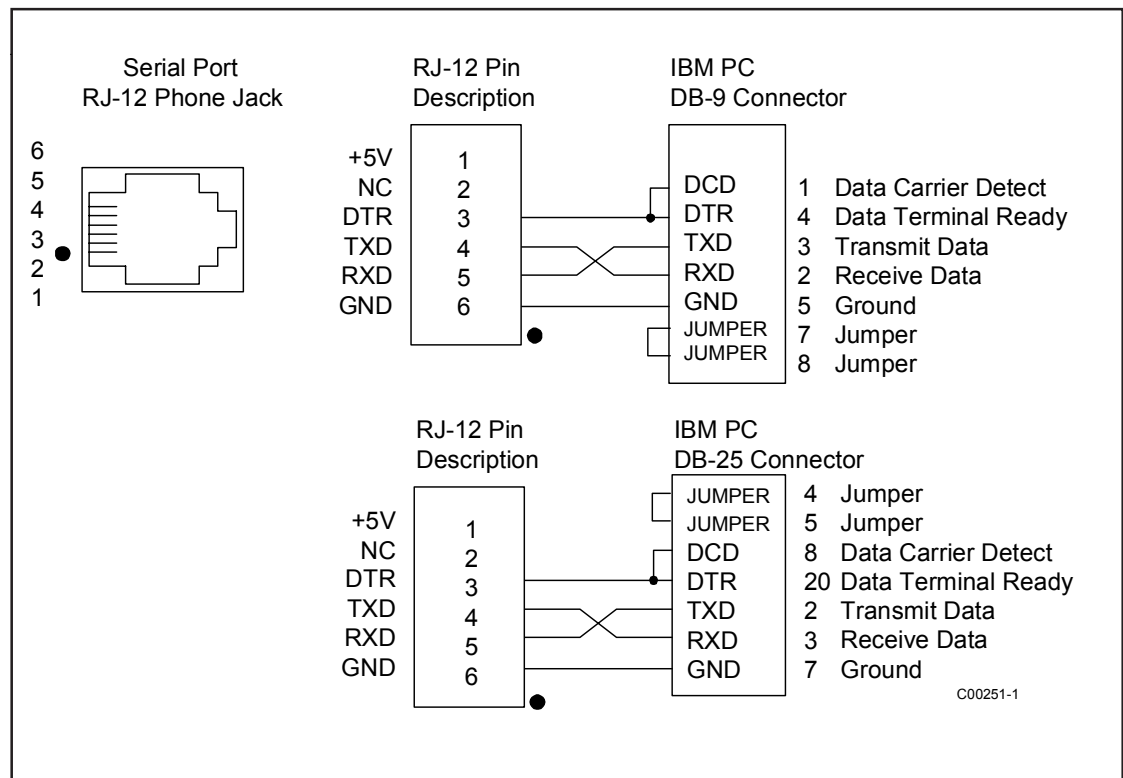
Jacks JP3 (top circuit board), JP4, JP5, JP6 and JP7 are for customer use and are described in Table 3.

**Table 3. Customer Wiring**

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 4 for more details.
JP4 Relay Output 1 and JP5 Relay Output 2	Factory pre-programmable relay contacts. Two normally open and 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 18 Vdc, 0.
JP6 Analog Output	There are two factory pre-programmable signals which are voltage and/or current. The 1AUX and +20 V pin is a customer option for the use as a dynamic correction factor. See Chapter 4 for more information
JP7 RS485 (EIA-485) Serial Port	Used in conjunction with equipment compatible with an RS 485 (EIA-485) serial port.

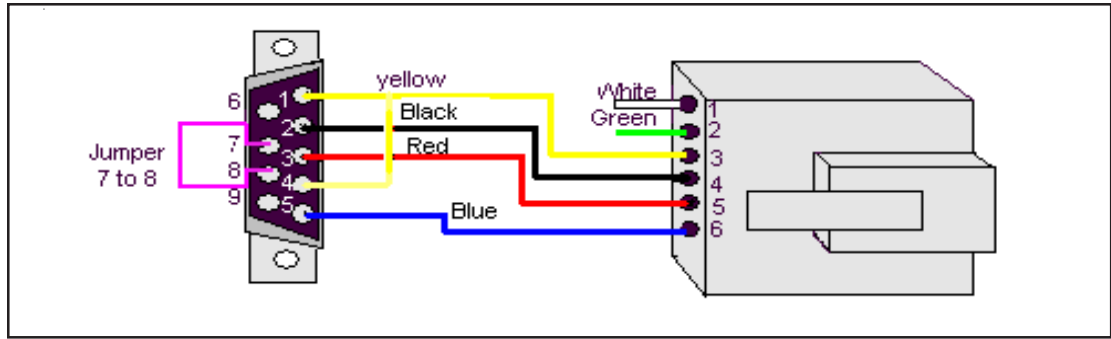
**Serial Communication Option (Hyper Terminal Hook Up)**

The RJ-12 (P3) connector on the top circuit board ( near the right side of the key pad) provides RS-232 communication with the user. An FC88 Communicator can be plugged in for periodic re-configuration and/or diagnostics, or personal computer can be plugged in instead of the FC88 Communicator. This connection is a RJ-12 communication (phone) jack. Figure 7 shows the connection between the serial port and a host device. Figure 56 shows the wiring of the DB-9 connector.



**Figure 7. Wiring Diagram, DB-9 and DB-25 PC Connectors**





**Figure 56. Wiring of DB-9 Connector**

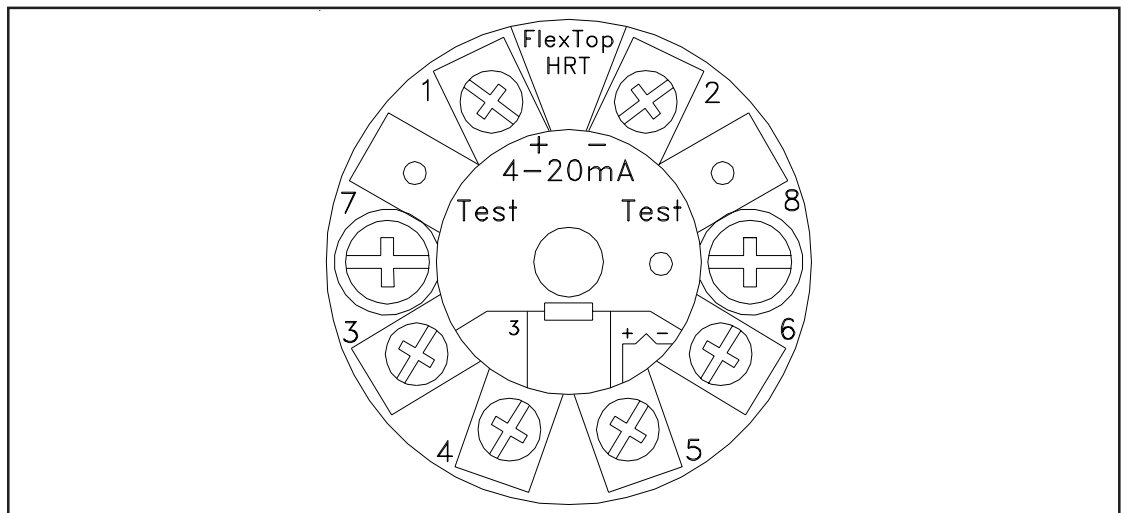
FCI recommends using the PC Interface Kit P/N: 014108-02 to connect the flow transmitter to a personal computer. The kit includes operation instructions and an adaptor for the RJ-12 to serial connection. Connect one end of the interface kit to the RJ-12 port and the other end to a DB pin connector. Plug the connector into the COM1 or COM2 port in the back of the computer terminal.

See instructions on how to use the serial communications in the next chapter.

**HART  
Option  
Installation**

Use the following steps to install the Hart Option for GF90/GF92:

1. All the FCI transmitters that incorporate the HART protocol are set at the factory to polling address “0”. Users should reset the polling address to match the needs of their network.
2. At polling address “0”, the GF90/GF92 outputs a current of 4-20 mA; at any other polling address, the GF90/GF92 outputs a fixed 4 mA current; in compliance with the HART standard. A digital signal is provided with all polling addresses.
3. If the GF90/GF92 is going to be used as a HART network transmitter, the polling address needs to be changed to other than “0”.
4. When the GF90/GF92 is connected in a HART Network, the instrument is configured for an external current source. The polling address must be changed to other than “0”. The power supply feeding the network must provide sufficient current to support the instruments in the network.



**Figure 9. Hart Module**

**Wiring the Hart Instrument**

**INPUT POWER** - Follow the GF90/GF92 manual to connect power.

**OUTPUT SIGNAL** - The GF90/GF92 analog outputs are factory connected to the hart modules. The two diagrams below shows recommended methods of connecting the HART modules to the customer’s system.

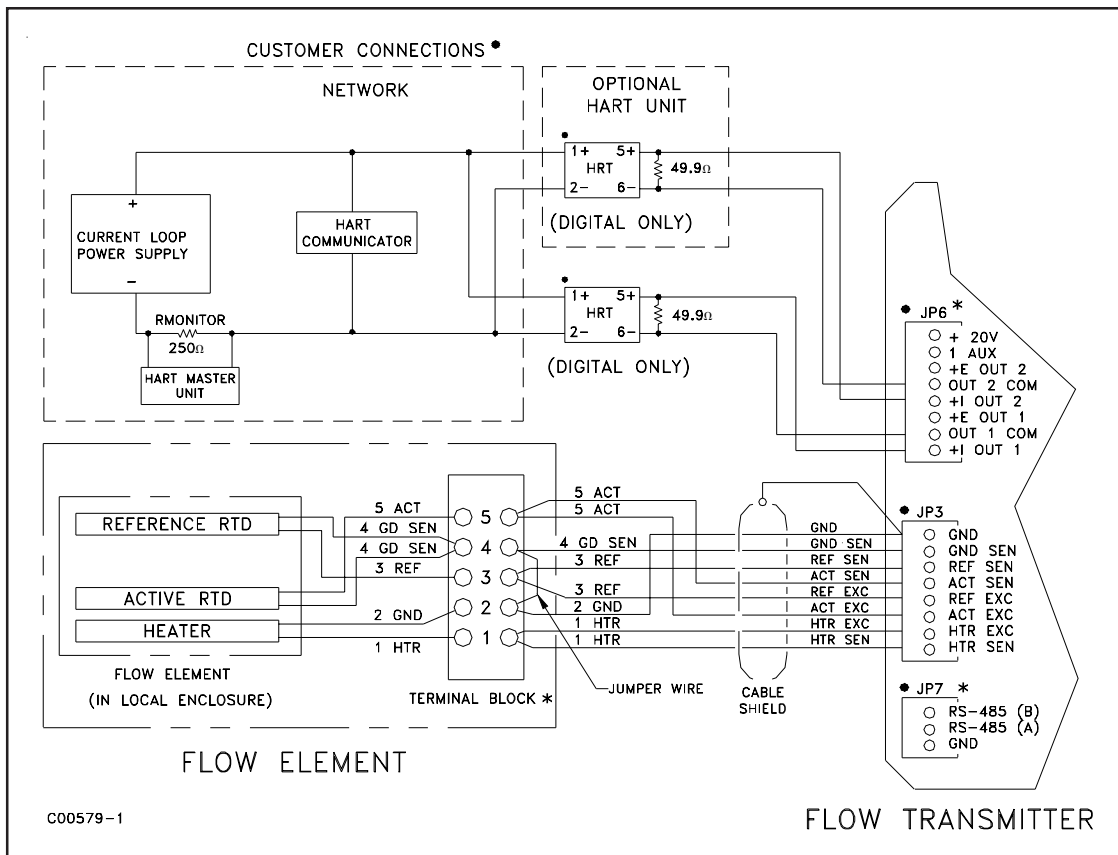


Figure 10. Hart Module Wiring Option 1

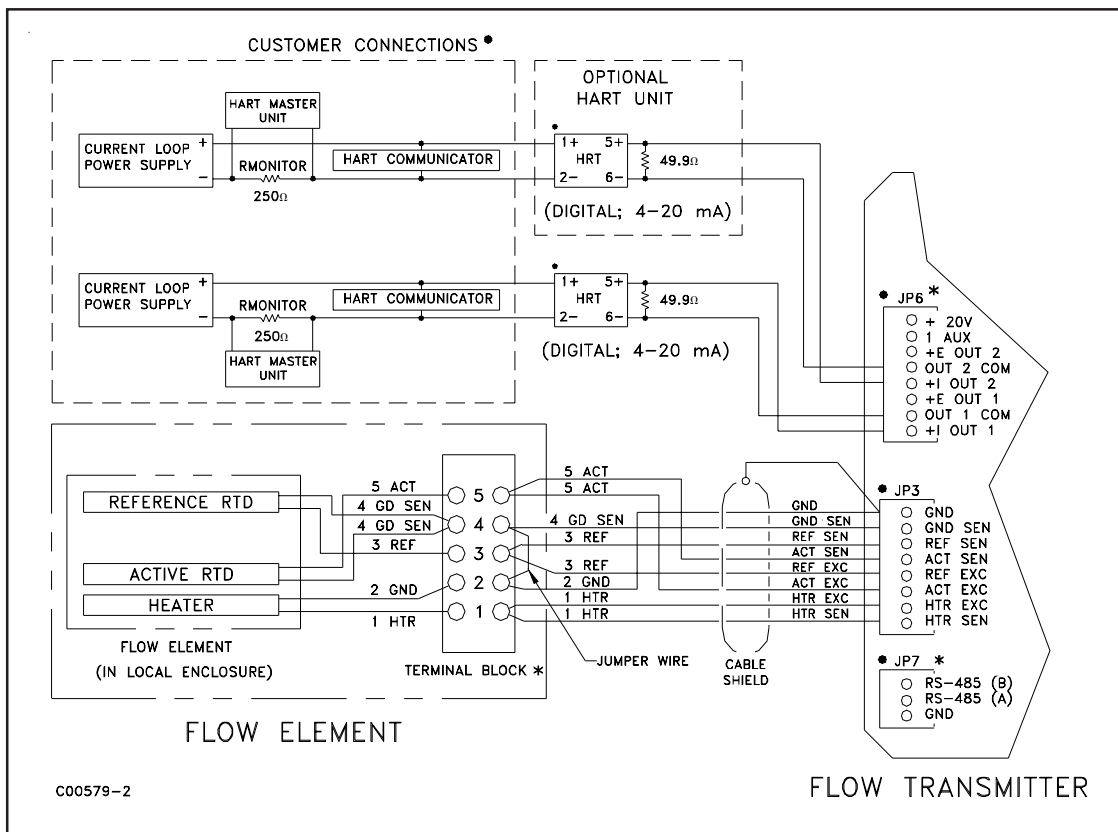


Figure 11. Hart Module Wiring Option 2

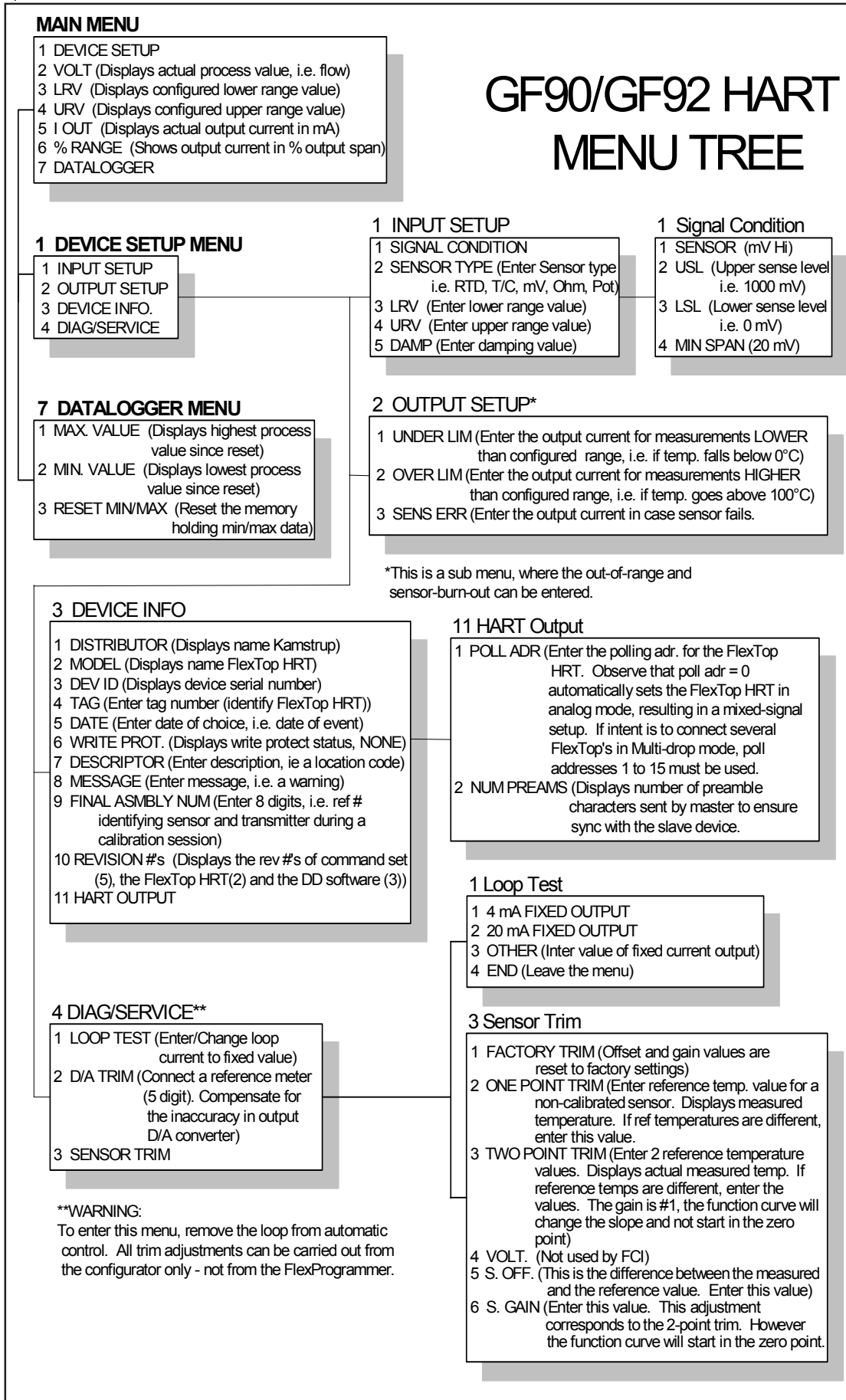


Figure 12. HART Module Menu Tree

## Foundation Field Bus

Foundation Fieldbus access to the GF90/GF92 signals is accomplished through the SMAR IF302 Current to Fieldbus Converter. Two GF90/GF92 parameters are available through the IF302; Process Flow in Channel 1 and Process Temperature in Channel 2.

The SMAR IF302 contains 18 functional blocks, and the GF90/GF92 flow and temperature signals are presented at the output of the corresponding “Analog Input” blocks in mA.

For complete details on the IF302 please go to the SMAR web site at [www.smar.com](http://www.smar.com) and register to receive the “Operation and Maintenance Instruction Manual”.

### Installation GF90/GF92 and IF302

Connect the GF90/GF92 Flow current output to the Channel 1 input of the IF302, and then connect the GF90/GF92 Temperature current output to Channel 2 of the IF302.

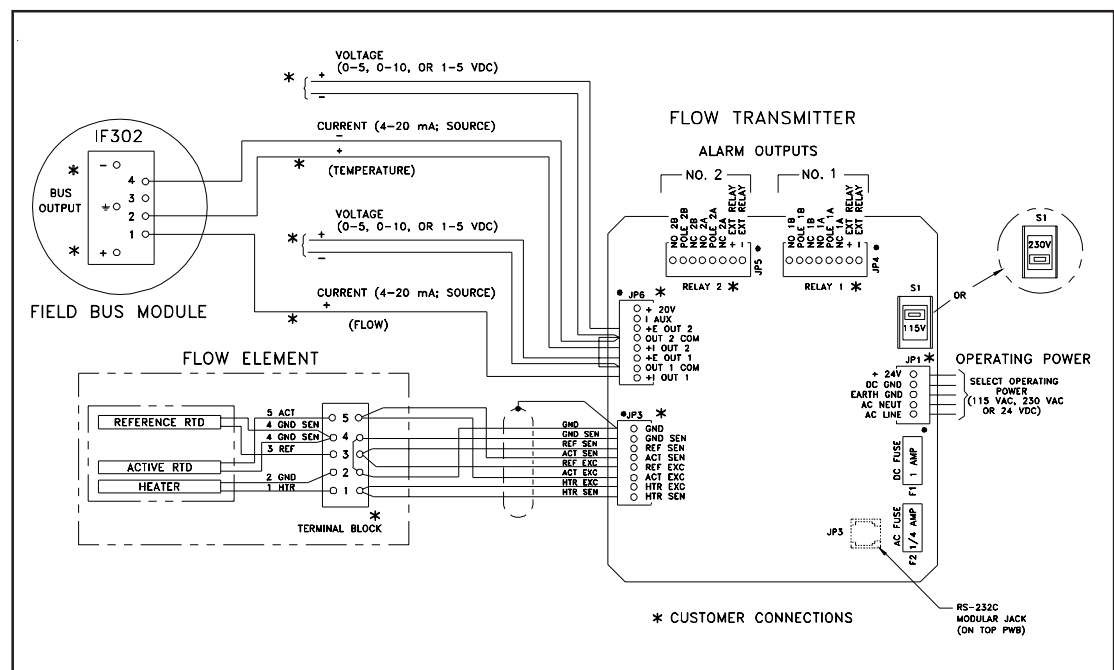
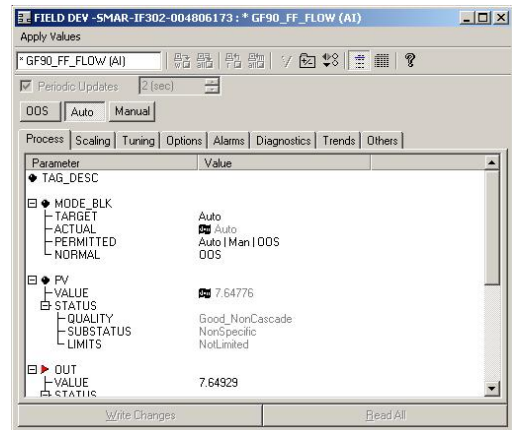
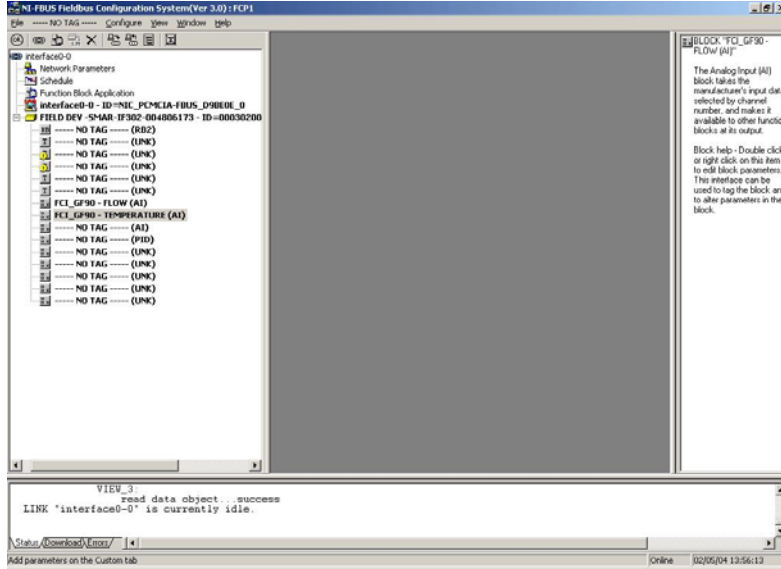


Figure 13. Foundation Field Bus Module Wiring Diagram

### Factory Setup of IF302

FCI sets the tags on the AI blocks that contain the signal connection to the Flow channel and the Temperature channel identifying them as shown below.

Other configuration and tag definitions are left to the system integrator.



### Isolated Output Option and 4-20 mA Adjustment

An isolated 4 to 20 milliamper (mA) output is an available option. The isolated output is available by connecting a loop powered isolator module to the transmitter output. The modules have their own set of output terminals which provide an isolated 4 to 20 mA output equal to the non-isolated instrument output. This one-to-one current isolation is used to prevent instrumentation ground loops. See Figure 14 for the wiring diagram to install the isolated output module.

Use of the isolator module will add a small signal conversion error to the instrument output and limit the output load to 350 ohms.

### LT81 Series Upgrade Information



**NOTE:** Follow the wiring diagrams in Appendix A to reconnect the existing flow element to the replacement GF series flow transmitter, and to install a jumper on the flow element terminal board if applicable.

The LT analog series flowmeters can be fully upgraded to the GF series flowmeters by replacing the LT series transmitter with a properly calibrated GF series transmitter. The flow elements are the same except for wiring differences at the flow element. The analog outputs also change locations. Jumper wire is added from terminal 2 to terminal 4 of the flow element head terminal block. New connectors will need to be installed on the transmitter for power, relays, flow element and analog output.

### Apply Power

The input power should not be turned on until the installation has been completed with all connections verified, power and signal connection board assembly screwed down and the instrument ready to operate. Be sure any external circuit breakers are on.

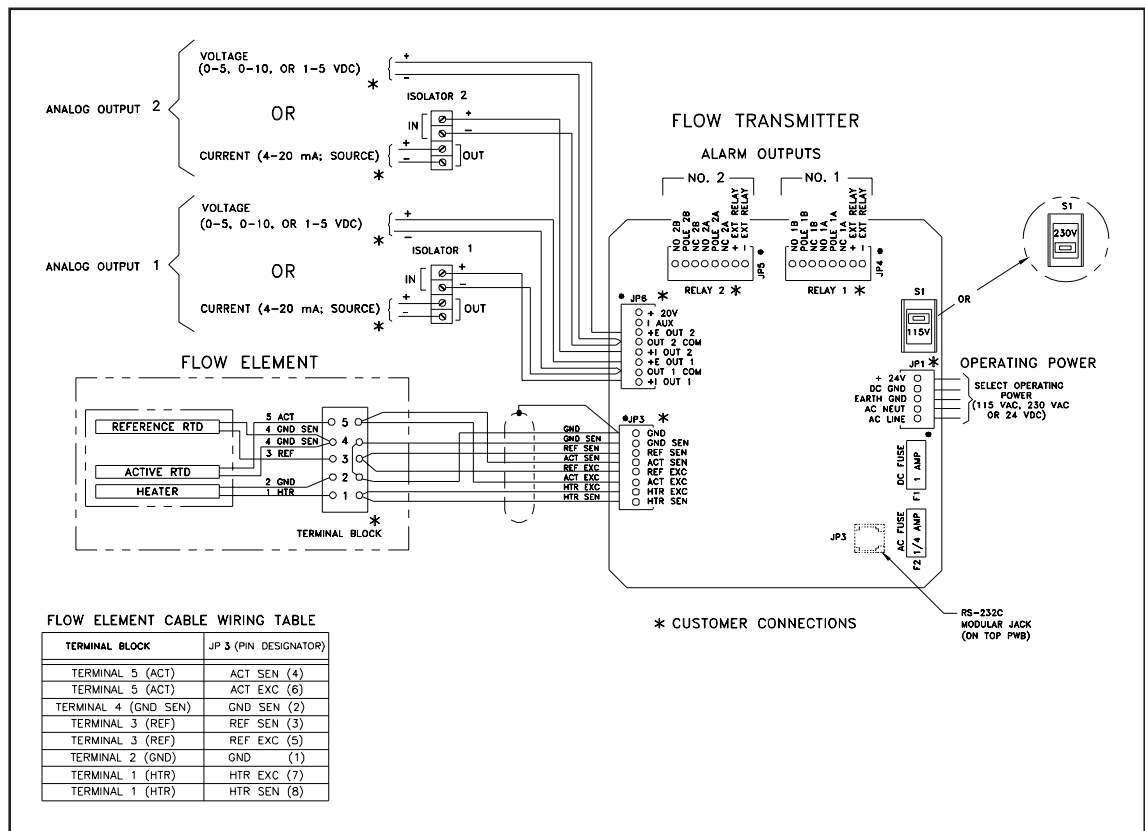


Figure 14. Isolated Output Option Wiring Diagram

# 4. Operation

## Introduction

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



**ALERT:** The flow transmitter contains electrostatic discharge (ESD) sensitive devices. Use standard ESD precautions when handling the flow transmitter. See Chapter 3, Installation for ESD details.

## Start Up Procedure

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

## Operation

### Display

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

### Initialization Window

When power is applied to the flowmeter the display will briefly show the initialization window. See Figure 15.

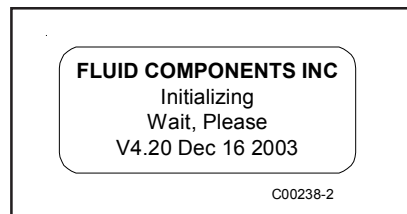


Figure 15. Initialization Window

### 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 16.

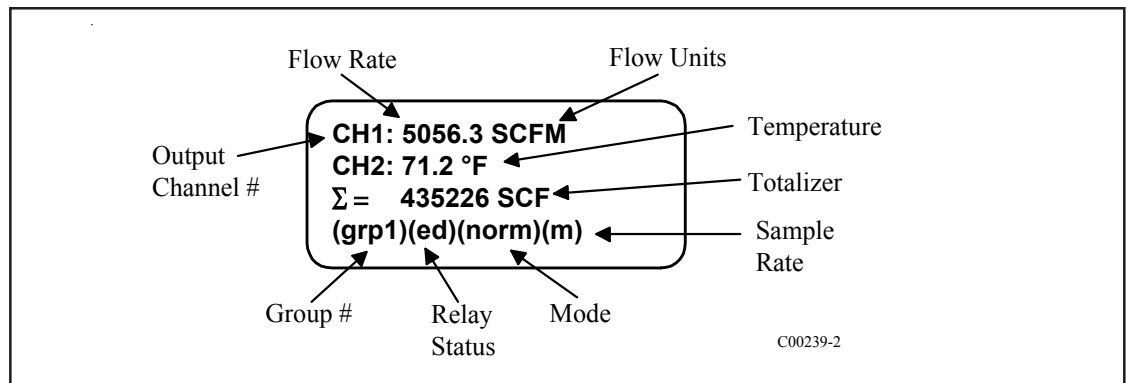
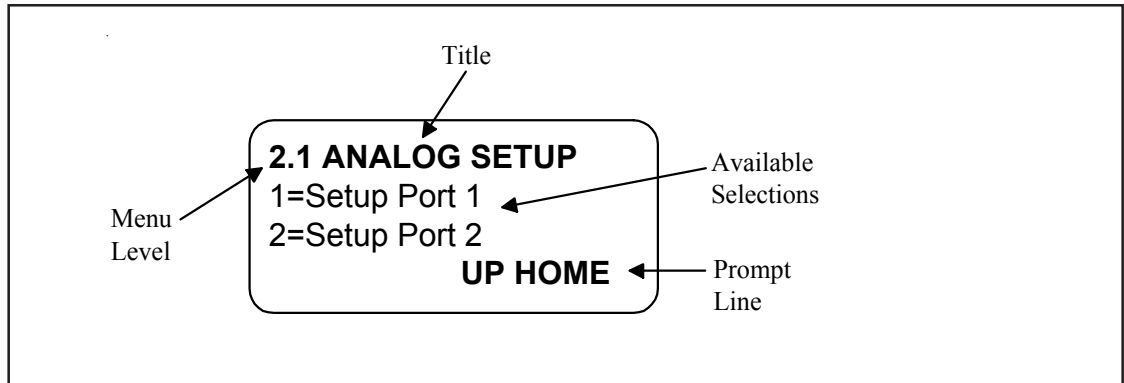


Figure 16. Normal Operation Display

**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 17. 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 17. Menu Window**

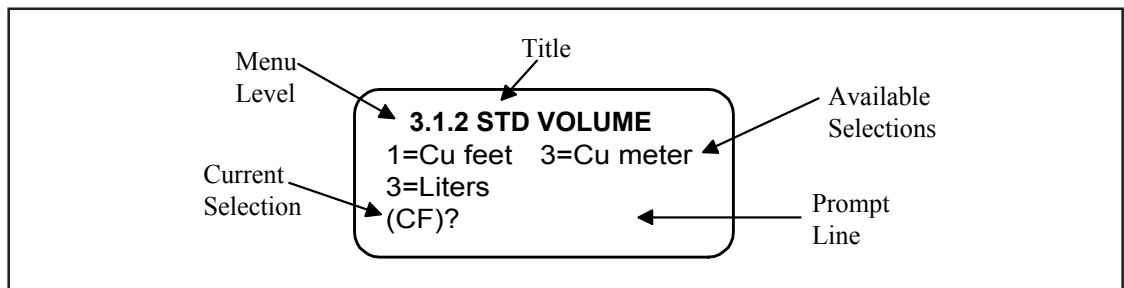
The menu code is a numeric reference that identifies each window of the menu structure. The menu code in Figure 17 indicates that the user is two levels deep (Level 2, sublevel 1). The menu structure will be explained further in Menu Organization.

The title gives the user a better idea of where the system is within the menu structure. Some titles are informative enough to completely describe the menu function, while other titles are ambiguous unless there is knowledge of the parent menus. The menu code is helpful in deciphering ambiguous titles. The middle two lines display the available selection. The number of choices is often more than the two displayed. Pressing the N (next) or P (previous) keys on the keypad will scroll the selections up or down. To choose a function from the available selections press the corresponding number on the keypad.

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

**Other Window Types**

Another common window encountered is shown in Figure 18. 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.

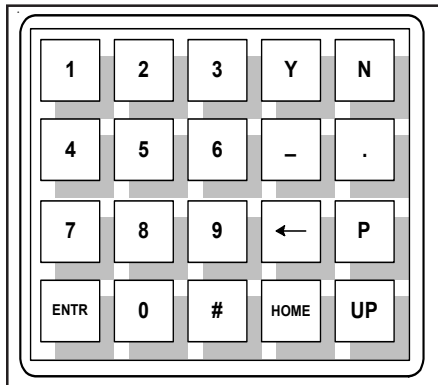


**Figure 18. Non-Scrolling Menu Window**



**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 19.



**Figure 19. Key Pad**

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

**Table 4. Key Assignments for the Key Pad**

See Table 4 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 20 shows the entire menu structure.

Menu selections two through eight allow the configuration of the flowmeter to be checked and manipulated. Table 5 summarizes the functions contained in each menu group.

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

**Table 5. 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 16 is the Normal Operation display.

The first and second lines contain the current flow rate and temperature. The total flow is displayed on the third line only if it is enabled. The last line contains the current Group number (see the Multiple Groups section in Advanced Features), the relay status, the mode of operation and the sample rate. The relays status shows either e (energized) or d (de-energized). The letters correspond to the first and second relays, respectively. The mode of operation is norm for normal, auto for Auto-Select or link for Link Groups. (See Advanced Features for explanation of these modes). The sample rate is slow (s), medium (m) or fast (f).

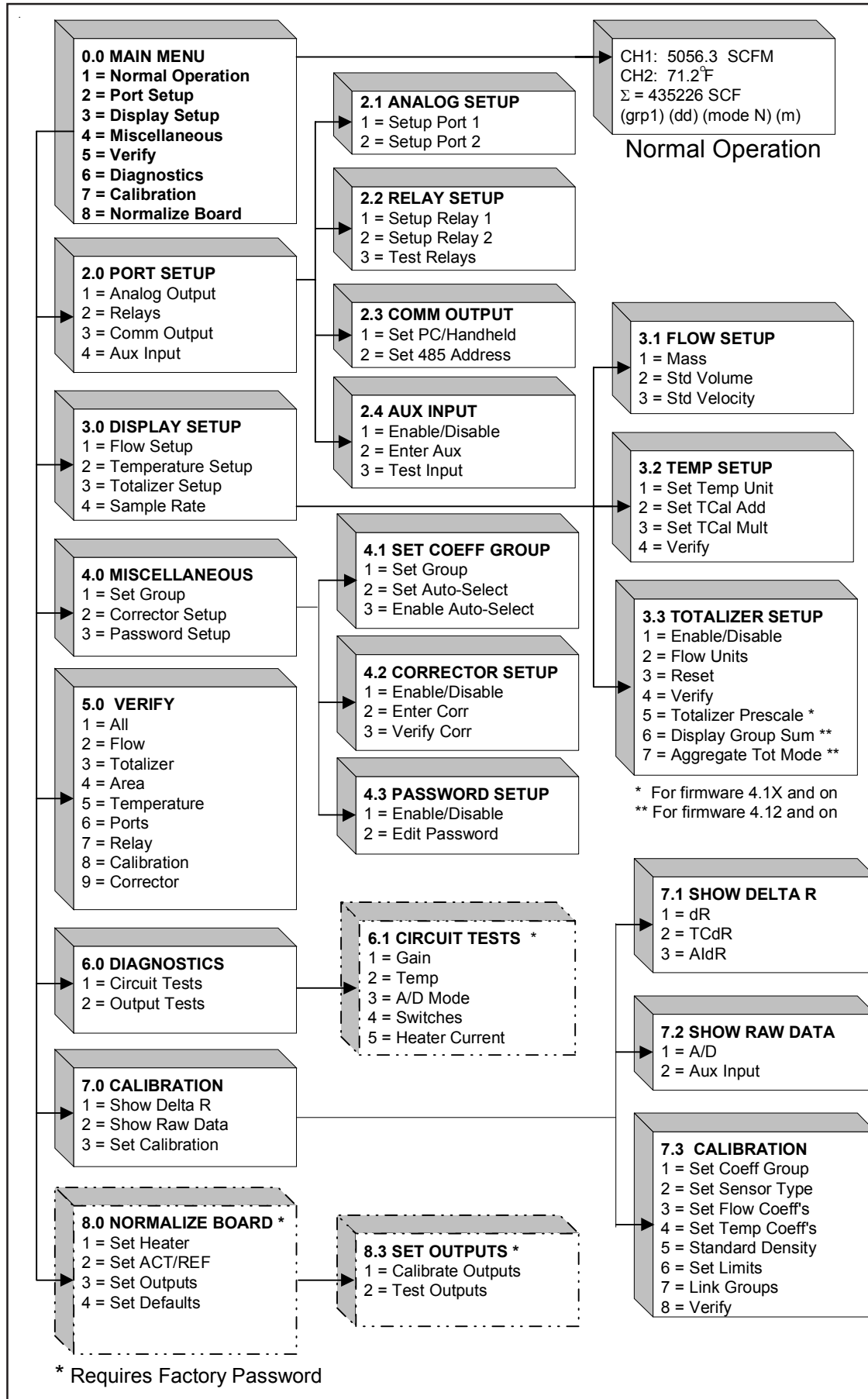


Figure 20. Menu Structure

### Quick Operation Procedure

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

To use Table 6, an assumption is, 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 6. Quick Operation Procedure**

FUNCTION DESIRED*	KEYS TO PRESS**	COMMENTS
Main Menu	Press any key	To get from the normal display to the main menu.
Main Menu	Press HOME then press 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 press 1	To get to the normal display.
Set Password (1) Enable/Disable	Press HOME, 4, 3, 1, enter the user password, then press ENTR, HOME	The factory recommends the password be disabled before any information is entered to speed up the process.
<b>ANALOG OUTPUTS</b>		
Port 1: Mode (1) 4-20 mA (2) 0-5 V (3) 0-10 V (4) 1-5 V	Press HOME, 2, 1, 1, 1, press 1,2, 3, 4, or ENTR, then press 5, Y or N, HOME	Press key which best matches the analog input to the peripherals from Jack JP6 of the Flow Transmitter. Press ENTR only if previous values are correct.
Port 1: Unit (1) Flow (2) Temp	Press HOME, 2, 1, 1, 2, then 1 or 2, then 5, Y or N, HOME	Press the key which matches the condition to be measured.
Port 1 : F.S.	Press HOME, 2, 1, 1, 3, then enter a numeric value. Then press ENTR, 5, Y or N, HOME	Enter the numeric full scale value which is expected to occur. 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 enter a numeric value. Then press ENTR, 5, Y or N, HOME	Enter the numeric zero scale value which is expected to occur. 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) 4-20 mA (2) 0-5 V (3) 0-10 V (4) 1-5 V	Press HOME, 2, 1, 2, 1, press 1,2, 3, 4, or ENTR, then press 5, Y or N, HOME	Press key which best matches the analog input to the peripherals from Jack JP6 of the Flow Transmitter. Press ENTR only if previous values are correct.
Port 2: Unit (1) Flow (2) Temp	Press HOME, 2, 1, 2, 2, then 1 or 2, then 5, Y or N, HOME	Press the key which matches the condition to be measured.

**Table 6. Quick Operation Procedure (continued)**

<b>FUNCTION DESIRED*</b>	<b>KEYS TO PRESS**</b>	<b>COMMENTS</b>
Port 1 : F.S.	Press HOME, 2, 1, 2, 3, then enter a numeric value. Then press ENTR, 5, Y or N, HOME	Enter the numeric full scale value which is expected to occur. 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, 2, 4, then enter a numeric value. Then press ENTR, 5, Y or N, HOME	Enter the numeric zero scale value which is expected to occur. 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.
<b>FLOW RATE UNITS</b>		
Mass Units (1) LB           (2) KG (3) TNS	Press HOME, 3, 1, 1, then 1, 2, or 3, then in the TIME UNITS Menu, press 1, 2, 3 or 4. In the AREA Menu press 1 or 2, then 1, 2, 3 or 4. Enter a numeric value, then ENTR, any key, any key, Y or N, HOME	Enter the flow rate, using the necessary mass units needed along with the units per time and the pipe diameter or area. ENTR can be used if the values are already correct.
Std Volume (1) Cu Feet (2) Cu Meter (3) Liter	Press HOME, 3, 1, 2, then 1, 2, or 3, then in the TIME UNITS Menu, press 1, 2, 3 or 4. In the AREA Menu press 1 or 2, then 1, 2, 3 or 4. Enter a numeric value, then ENTR, any key, any key, Y or N, HOME	Enter the standard volume in Cubic Feet, Cubic Meters, or Liters, along with the units per time and the pipe diameter or area. ENTR can be used if the values are already correct.
Std Velocity	Press HOME, 3, 1, 3, then 1, 2, or 3, then in the LENGTH UNITS Menu, press 1, or 2. In the TIME UNITS Menu press 1, 2, 3 or 4. Press 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.
<b>*NUMBERS IN PARENTHESIS ARE KEYS TO BE PRESSED</b>		
<b>**Y OR N REFERES TO Y SAVE PERMANENTLY OR N DO NOT SAVE</b>		

### Configuring the Flowmeter

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

### Password Protection

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


- **Factory Level**

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

- **User Level**

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

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



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


- **To edit the user password:**

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

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

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

### Selecting Units of Measure



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

The flowmeter measures the mass flow rate and stream temperature of the process media. The display can be set to present the flow rate and temperature in a variety of units. The factory will set the units of measure to those specified at order entry time. There are other units of measure that can be chosen. Two units that will appear are m and mm. The letter m stands for 1000 and mm stands for 1,000,000. Menu level 3.1 provides the options for changing the output units of measure. The units of measure can be selected for temperature at menu level 3.2. The units of measure for the totalizer are available at menu level 3.3.

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

1. From the Main menu press 3. The 3.0 DISPLAY SETUP menu title will appear.
2. Press 1, the Flow Setup option.
3. At this point there are three choices, Mass, Std Volume and Std Velocity. Table 7 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 7. 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 7. Flow Rate Units of Measure**

SELECTION	UNITS	DESCRIPTION
Mass	LB/Time	Pounds per unit time. Time units are seconds, minutes, hours or days
	KG/Time	Kilograms per unit time
	TNS/Time	Metric Tonnes (1000 Kilograms) per unit time
Std Volume	SCF/Time	Standard Cubic Feet per unit time
	NCM/Time	Normal Cubic Meters per unit time (Normal is the metric equivalent of Standard)
	NL/Time	Normal Liters per unit time
Std Velocity	SF/Time	Standard Feet per unit time
	NM/Time	Normal meters per unit time

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

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

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

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

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

1. From the Main menu press 3. The 3.0 DISPLAY SETUP menu title will appear.
2. Press 3, the Totalizer Setup option.
3. Press 5, Totalizer Prescaler, to change between prescale values of 0, .001 or 1000.
4. Press 0 for no prescale, or press 1 for a prescale value of .001, or press 2 for a prescale value of 1000.

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

1. From the Main menu press 3. The 3.0 DISPLAY SETUP menu title will appear.
2. Press 3, the Totalizer Setup option.
3. Press 6, the Display Group Sum.

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

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

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

1. From the Main menu press 3. The 3.0 DISPLAY SETUP menu title will appear.
2. Press 3, the Totalizer Setup option.
3. Press 7, Aggregate Tot Mode, to turn on or off the aggregate total mode.

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



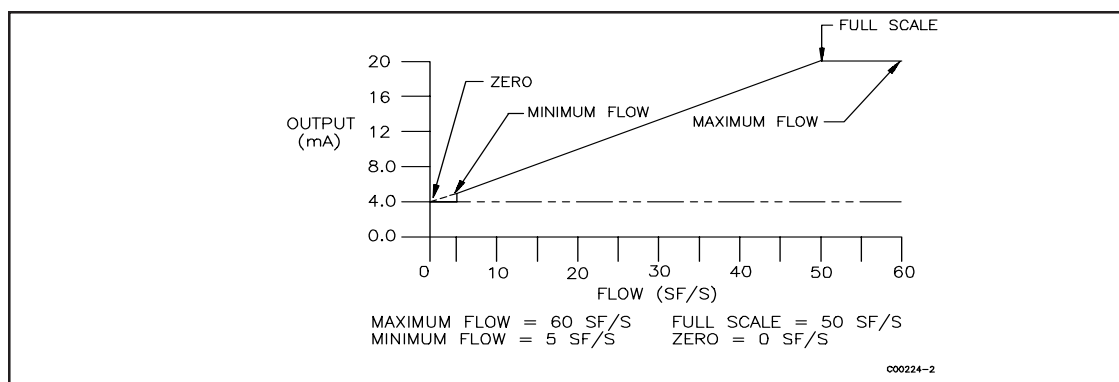
## Setting Analog Outputs

The flowmeter has two, independent analog signal outputs. The outputs can be set to represent flow rate or temperature. The flowmeter signal outputs have been configured according to the application information supplied to the factory at the time of order. However, the outputs can be re-scaled anywhere within the calibrated flow range. The outputs can be independently set to one of four signal ranges: 4 to 20 mA, 0 to 5 V, 0 to 10 V or 1 to 5 V. A typical configuration is presented in Table 8.

**Table 8. Typical Signal Output Configuration**

PORT NO.	MODE	TYPE	ZERO	FULL SCALE (F.S.)
1	4 TO 20 mA	Flow	0 SF/S	150 SF/S
2	4 TO 20 mA	Temp	-50° F	150° F

The signal range varies linearly with change in flow rate as shown in Figure 21. Minimum signal output can be set to indicate a flow of zero. This is often referred to as a zero-based signal output. A minimum signal that represents a value greater than zero is referred to as non-zero based.



**Figure 21. 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

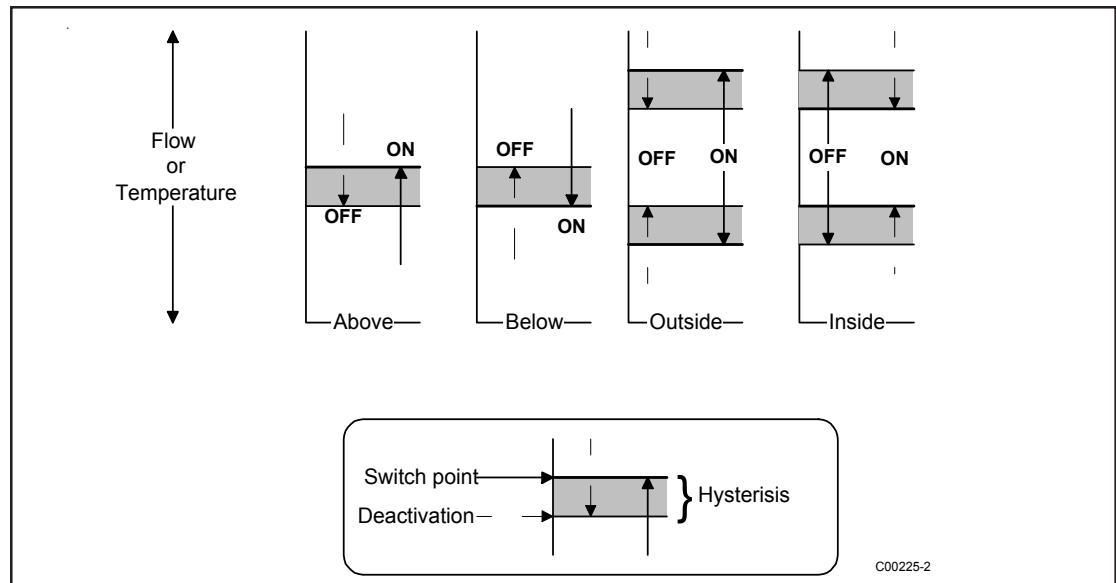


## Setting the Relays

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

There are four types of switching schemes to choose from. These are referred to as Above, Below, Outside, and Inside. Each switch point can be set to have hysteresis and a time delay. Figure 22 illustrates the four switch point schemes with arbitrary hysteresis assigned.

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



**Figure 22. 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 22). 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 22). 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 6 Troubleshooting.

- **To test the relays:**

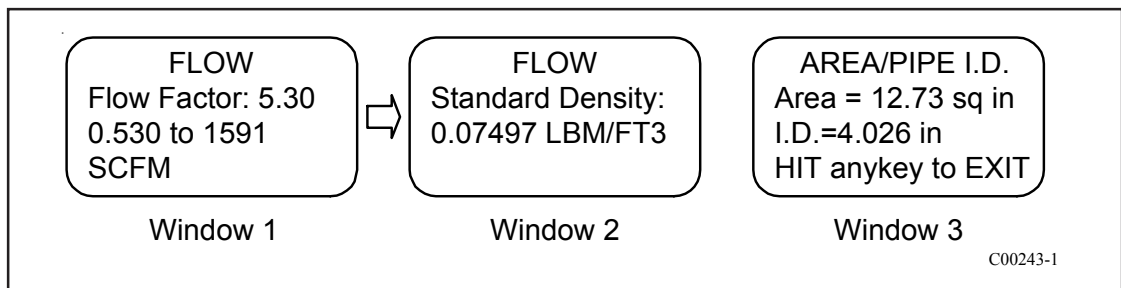
1. From the Main menu press 2. The 2.0 PORT SETUP menu title will appear.
2. Press 2, the Relay Setup option.
3. Press 3, for the Test Relays option.
4. Pressing 1 or 2 will toggle the states of the respective relays. The present state of the relays are displayed in parenthesis.

## 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 23. 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 23 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.)



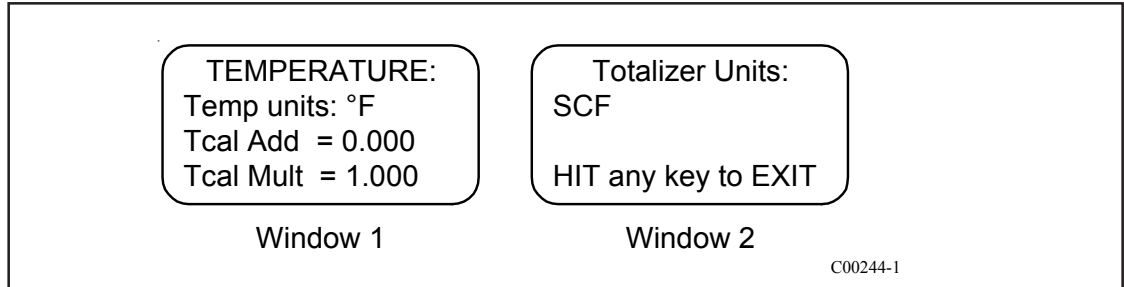
**Figure 23. Flow and Area Verification Display**



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

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

1. From the Main menu press 5. The 5.0 VERIFY menu title will appear.
2. Press 5 to view the current units for temperature. Press 3 to view the current units for the total flow. (If the totalizer is disabled the display will only show No Totalizer.) The information will be displayed to the screen as shown in Figure 24.

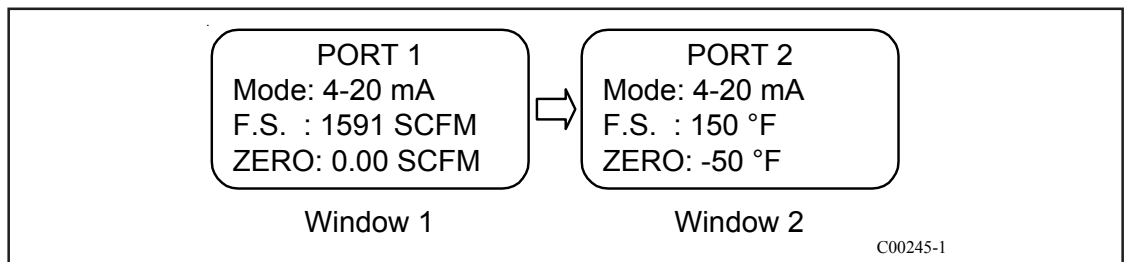


**Figure 24. Temperature, Totalizer Verification Display**

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:**

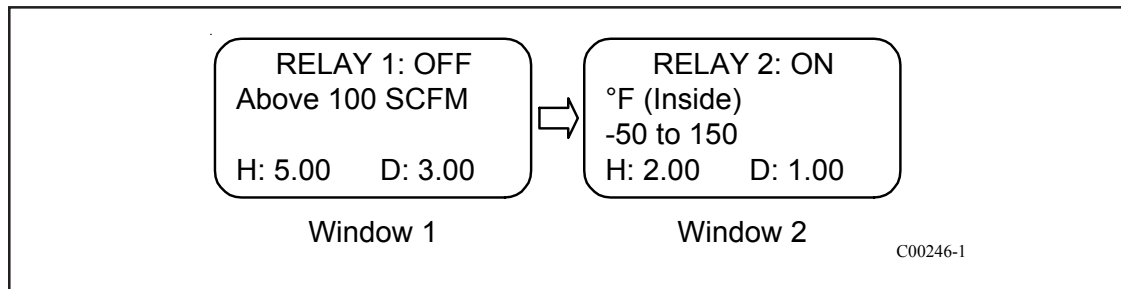
1. From the Main menu press 5. The 5.0 VERIFY menu title will appear.
2. Press 6, the Ports option. The two screens in Figure 25 are identical except for the port number. Line 2 is the current signal output mode. Line 3 shows the full scale flow rate or temperature value and the appropriate units. Line 4 is the zero value. Press any key for screen 2.



**Figure 25. 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 26 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 26. 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.

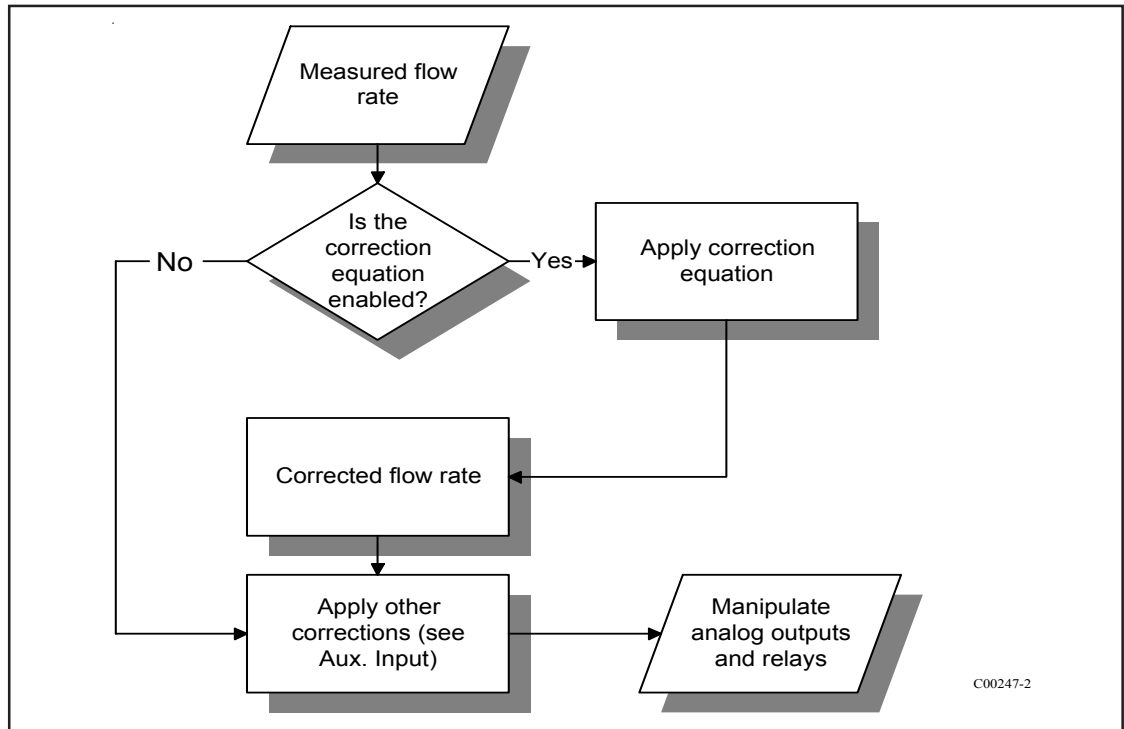
### Flow Rate Correction Equation

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 27 describes how the correction equation is applied.

The correction equation for the flowmeter is shown below.

$$m_{new} = F1 + (F2 \times m_o) + (F3 \times m_o^2) + (F4 \times m_o^3)$$

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



**Figure 27. Correction Factor**

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

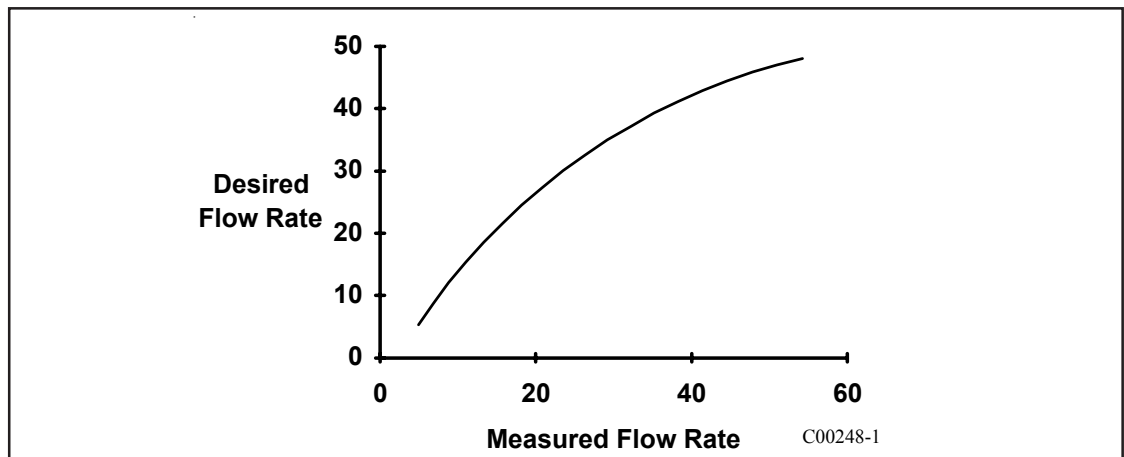
The correction equation takes the following form:

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

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

- Where
- F1 = 0
  - F2 = 1.056
  - F3 = 0
  - F4 = 0

A more complicated situation would be where the multiplication factor varies with flow rate. Figure 28 shows the variation of desired flow rate versus the measured flow rate.



**Figure 28. 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:

$$\begin{aligned} F1 &= -7.5672 & F2 &= 2.09253 \\ F3 &= -0.037082 & F4 &= 0.0003505 \end{aligned}$$

- **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.)

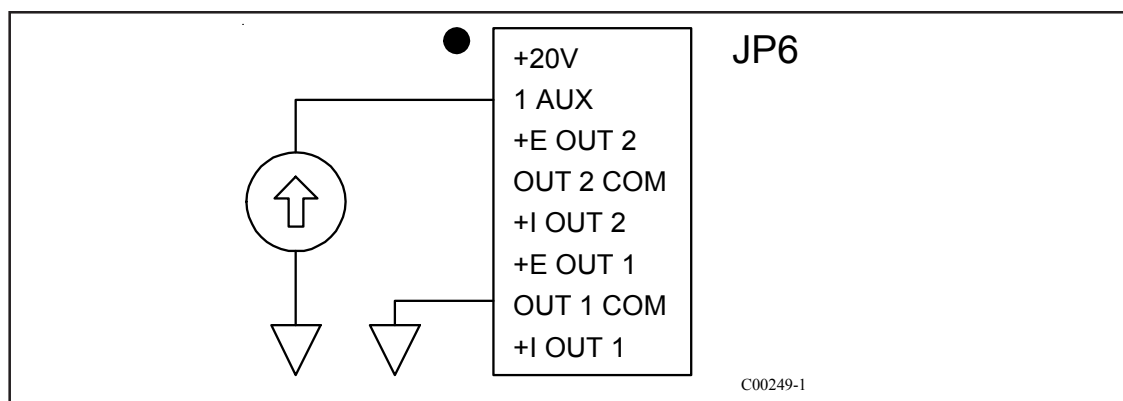
### The Auxiliary Input

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 6, 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.

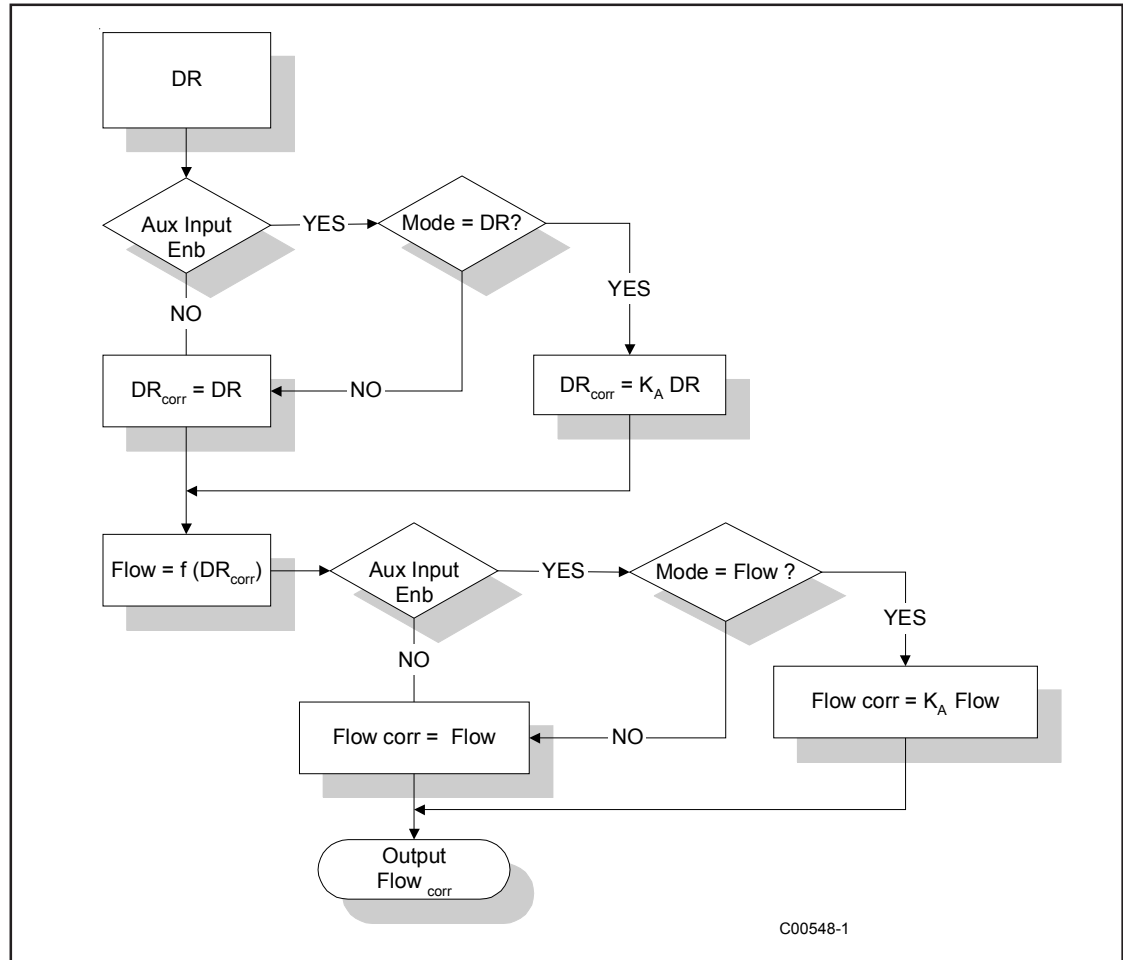
The auxiliary input is accessed at terminal JP6 located on the lower circuit board. Figure 29 illustrates the auxiliary input connected to a current source. If OUT 1 COM is not easily accessible then use JP6 OUT 2 COM, JP7 GND, JP1 DC GND or JP3 GND. They are electrically the same signal ground point. The range of this source is most likely 4-20 mA.



**Figure 29. 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 30 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 30. Auxiliary Input Process**

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

1. Apply a current to the auxiliary input as shown in Figure 29.
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 or the TCdR value. This digital value is used to calculate a factor that is multiplied by the measured flow rate or TCdR. The factor is calculated using the relationship:

$$K_A = A_1 + (A_2 \times s) + (A_3 \times s^2) + (A_4 \times s^3)$$

where  $s = \text{Digital Value}$

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

$K_A = \text{Correction Factor}$



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

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

### Serial Communications

Make the electrical connections using the information from the last chapter. The wiring diagram is Figure 8. 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, JP3 located on the lower right corner of the upper circuit board. 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 31A 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 DO        ' Exit the loop if the user
                        ' PRESSED alt+q.
    END IF

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

```

Figure 31A - 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 31A - Series Serial Communication Code Example Cont'd.**

The connection is a RJ-12 phone jack. Figure 31B 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-12 serial port and the host device. The order number for the Connector kit is 014108-01.

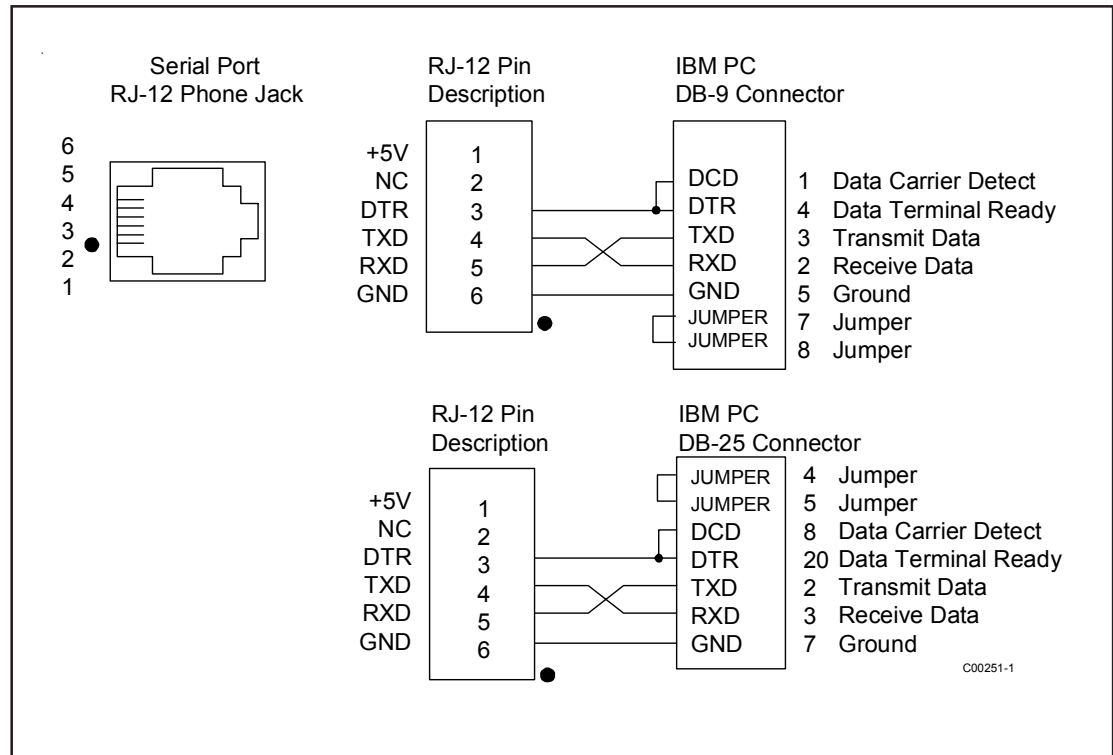


Figure 31B - Wiring Diagram, DB-9 and DB-25 PC Connectors

**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 16) 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.
3. Press 1 again, the Set Group option. Enter the user password (if it is enabled).
4. Press 2, to change the current group to Group 2.
5. 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.
6. Change the current group in Set Group back to group 1.

### **Switching Groups Through the Keypad**

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

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

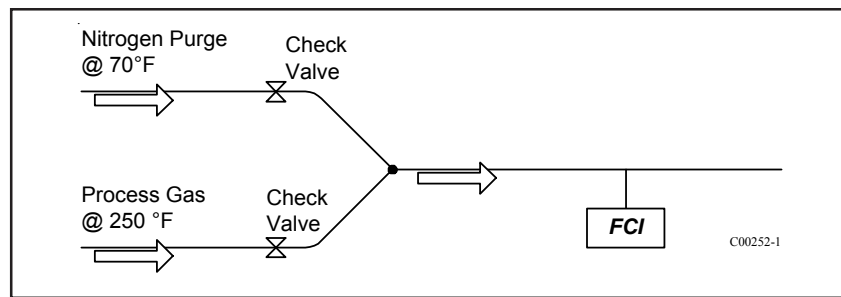
1. Press 4, the Set Group option.
2. Press 1, the Set Group option. Enter the user password (if it is enabled).
3. Enter the desired group number, 1, 2 or 3. The flowmeter is now set to use that group of calibration information.

### **Switching Groups Through the Serial Port**

The current calibration group can be changed remotely through the serial port. The sequence of commands sent through the serial port is equivalent to the sequence taken at the keypad. The command string should include sufficient time delays to allow the flowmeter to respond. One possible command string is "H H 4 1 1" + (desired group number) + "H 1". The command string sends to HOME (H) characters, sets the menu level to 4.1.1, enters the desired group number and returns the flowmeter to normal operation. Remember to insert a time delay after sending each character. (See Figure 31A 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 32.



**Figure 32. 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.
3. Press 2, the Set Auto-Select option.
4. Press 2, the By Temperature option. Enter the user password (if it is enabled).
5. Enter the number groups involved in the Auto-Selecting. (Zero to disable.)
6. Enter the switch point temperature(s).



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

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

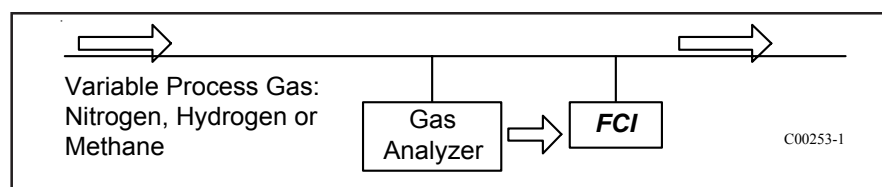
1. Press 4, the Miscellaneous option.
2. Press 1, the Set Group option.
3. Press 3, the Enable Auto-Select option. Auto-Select will toggle on or off depending on its previous state. Enter the user password (if it is enabled).



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

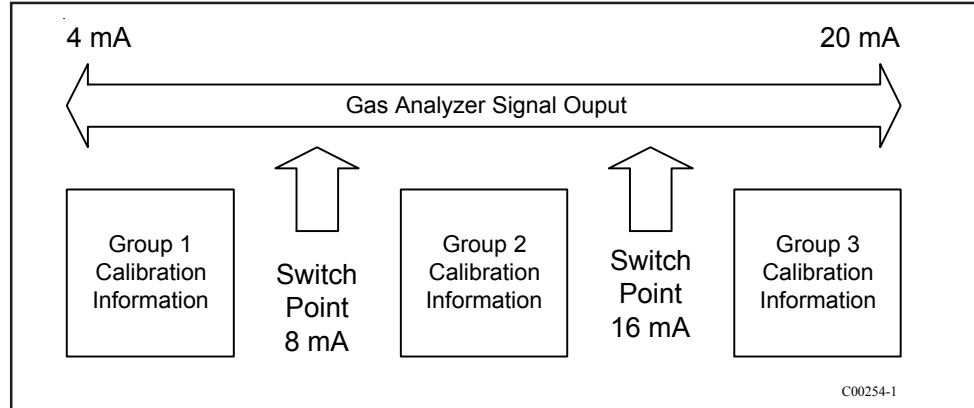
**Switching Groups by the Auxiliary Input - Auto-Selecting**

Group switching can also be initiated by a change in signal measured through the Auxiliary Input. (See the section Auxiliary Input and Figure 29 for instructions on connecting the flowmeter to an external signal source.) Switch points are based on external signal levels. A typical application that would benefit from using auto-selecting by an external signal is described in Figure 33.



**Figure 33. Auto-Select, External Signal Application**

In the example above, the pipe line could contain nitrogen, hydrogen or methane. The gas analyzer's 4-20 mA output is connected to the flowmeter's Auxiliary port. The gas analyzer outputs 4 mA when it detects nitrogen, 12 mA when it detects hydrogen and 20 mA when it detects methane. The flowmeter is set to switch groups when it detects the signal crossing 8 mA or 16 mA. Figure 34 illustrates this graphically.



**Figure 34. Auto-Select, Switch Point Scheme**

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

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

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

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

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

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

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

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

Contact factory to change system parameters in link mode.



**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 6, Troubleshooting.

- **To view RTD resistance values:**

1. Press 7, the Calibration option.
2. Press 1, the Show Delta R option.
3. Press 1, for raw dR, 2 for TCdR or 3 for AIdR

### **Forced Output Setup (EPROM Version 4.20 and later)**

#### **Purpose**

To force the analog output of the unit.

#### **Password**

The user password is required to perform this procedure.

#### **Procedure**

Go to the 'Set Output' menu by pressing 8, 3, 2. Select the output port you wish to test, either 1 or 2. Select the percentage of full scale for the output, 0% = 4mA and 100% = 20mA.

To change the forced output, press N for 'New Value' or to Exit, press Home.



## External Input Auto-Select Procedure

### Set 'AUX INPUT'

Pass code 942

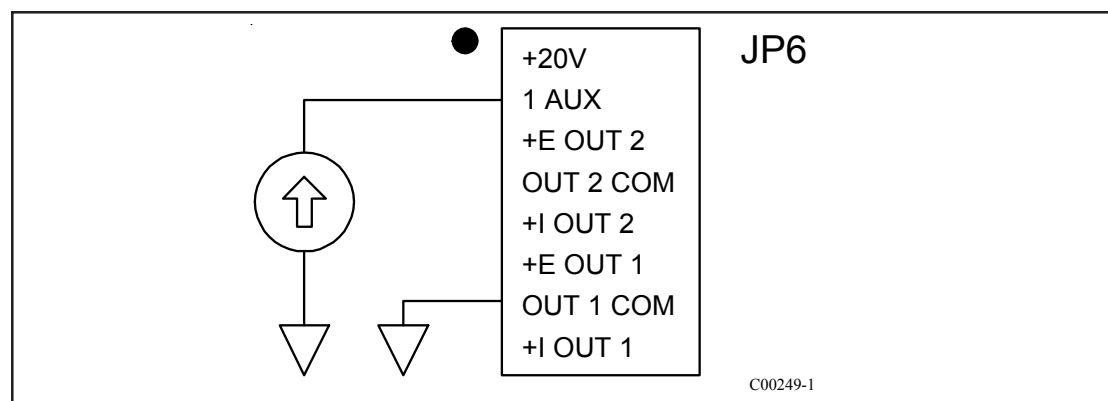
1. Power the meter on if it is not already; wait for the electronics to complete its initialization before continuing.
2. Access the "0.0 Main Menu" by pressing the Home key.
3. Enable the "AUX INPUT" by typing "2", "4" and "1". Type '942' and Enter
4. Access Section "4.1.2 AUTO SELECT" by typing "4", "1" and "2".
5. Press the Home Key to return to the "0.0 Main Menu"
6. Input the appropriate MA signal into the GF90 flow meter to switch calibration groups (Group # 1 to Group #2)
7. Access the "0.0 Main Menu" by pressing the Home key.
8. Access Section "AUX INPUT, TEST Input" by typing "2", "4" and "3".
9. Note the Digital Value displayed to the corresponding inputted mA source.
  - a) Repeat steps 5.1.5 thru. 5.1.9 should it be required for a 3 group Auto-Select function (Group # 1 to Group #2 to Group # 3).
10. Press the Home Key to return to the "0.0 Main Menu"

### Set 'AUTOSELECT'

Pass code 942

1. From the Main Menu, access section "4.1.2 AUTO SELECT by typing "4", "1" and "2"
2. Choose '1 BY AUX INPUT' by typing "1". Type '942' and Enter.
3. Choose the appropriate number of calibration groups to be active as prompt on the meters display ( 0= No Groups ACTIVATED, 2= 2 Groups ACTIVATED, 3= 3 Groups ACTIVATED) and Enter.
4. Enter the "LOWER SWITCH POINT VALUE" (digital number) that represented the input mA value taken in step 5.1.9. Press Enter to confirm the 'SWITCH POINT'
  - a) For a 3 Group Activation, enter the "UPPER SWITCH POINT VALUE" (digital number) that represented the input mA value taken in step 5.1.9. a)). Press Enter to confirm the 'SWITCH POINT'
5. Press '3 and Enter PASSWORD of 942' to access menu 4.1.3. "ENABLE THE AUTO-SELECT"
6. Return to the "Main Menu" by pressing the "Home" key on the keypad.
7. Press 1 for the Normal Operating Mode

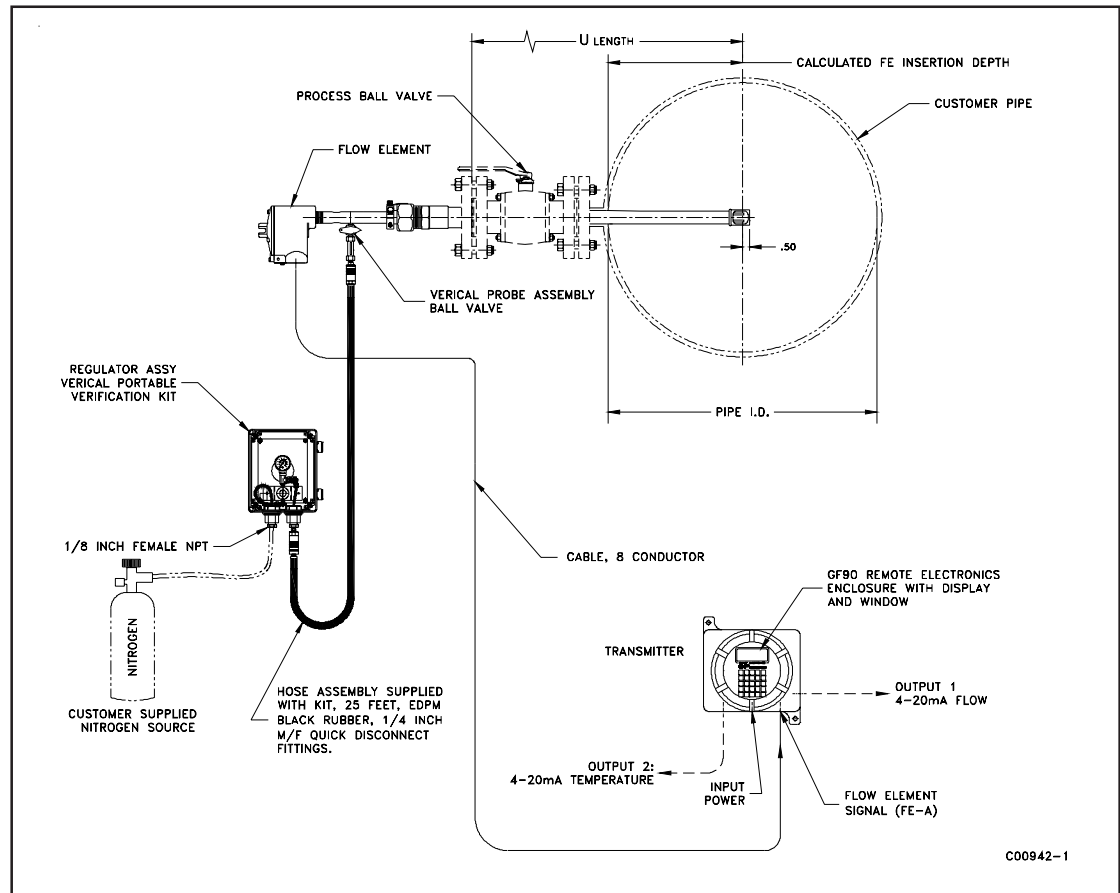
The meter should now be set up to change calibration groups using external mA Source.



Auxiliary Input Wiring Diagram

## Optional VeriCal In-Situ Calibration Verification

The GF90 has an optional VeriCal 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 VeriCal system.



### VeriCal System

The basic system consists of the Transmitter assembly, flow element with internal VeriCal flow system, the VeriCal regulator assembly and interconnecting hose. An optional pressure transducer is available. The pressure transducer is mounted in the regulator assembly housing.

The VeriCal 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 may be used.

The VeriCal system uses a sonic nozzle to consistently control the amount of calibration gas injected on to the thermal flow transducer located on the end of the probe assembly. The operating principle of the sonic nozzle requires the total or absolute pressure on the high side of the nozzle to be repeatable  $\pm .20$  psia. The pressure difference between the high side of the sonic nozzle and the process pressure (low-pressure side of the nozzle) must be greater than 2X. When these two requirements are met, a repeatable flow is injected on to the thermal flow transducer.

### Validation Check Procedure

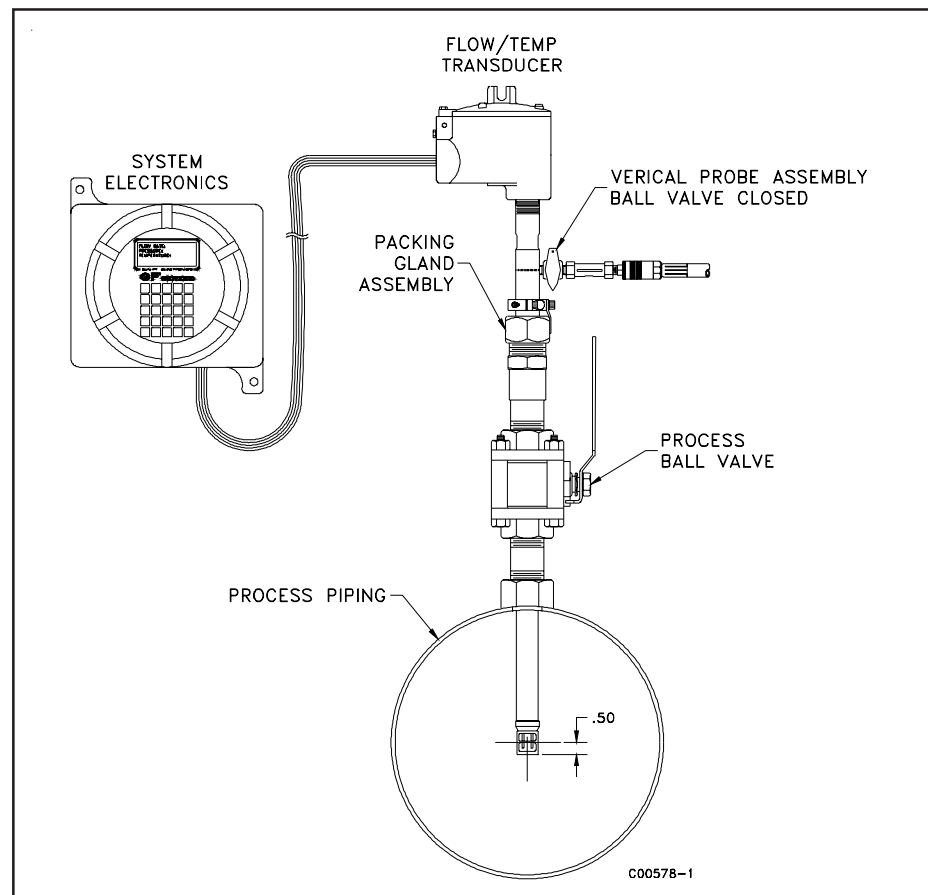
This procedure systematically guides the user of the VeriCal instrumentation through an initial gathering of in-situ baseline data. This baseline line data will then be compared to data gathered during similar future verification processes to determine if the system is operating with-in factory specifications

### Recommended Procedure without Pressure Transducer

FCI recommends that this procedure be run during the commissioning process of the instrument to determine an initial installed baseline calibration and to document any installed offset from the factory Verical baseline.

Frequency: Every 18 months minimum. The instrument owner has a better understanding for the required maintenance of their particular process. After the process has been performed several times the customer should determine the required verification frequency of the process.

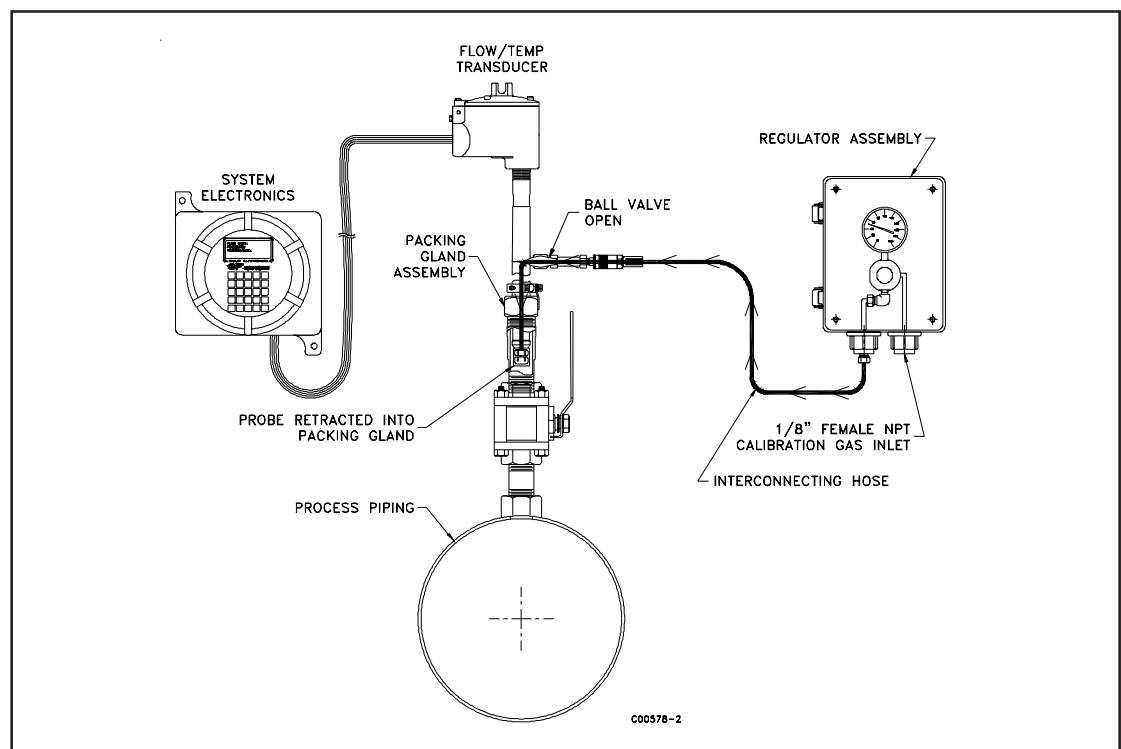
This procedure makes the assumption that the instrument has been installed and is completely functional in the normal operating condition and orientation. The customer should also have access to the factory VeriCal calibration certificate and the local atmospheric pressure.



**Normal Operation Configuration**

All standard safety procedures must be followed during the verification process. The verification process should be performed at normal operation conditions.

1. Loosen the packing nut on the packing gland assembly until the internal packing is loose enough to allow the probe assembly to be retracted out of the process and is recessed completely into packing gland assembly. Retracted the probe assembly completely. The process ball valve remains in the open position throughout the entire process.
2. Level the orientation flat on the probe assembly using a standard bubble level and tighten the packing nut to secure the assembly. To optimize the repeatability of the verification process, the position and orientation of the probe assembly should be identical every time the process is performed.
3. Attach the regulator assembly with the interconnecting hose to the VeriCal ball valve, in the closed position, on the probe assembly if it is not permanently installed.
4. Attach the calibration gas source, typically nitrogen, to the inlet side of the regulator assembly.
5. Determine VeriCal calibration group from the VeriCal calibration sheet. If the VeriCal calibration group is different than the normal operation group, change to the VeriCal calibration group through Menu 4.1.1, pass code 942.
6. The instrument is now in the calibration verification configuration.
7. Slowly apply 125 psig to the verification setup and check that the system is leak free using a liquid leak detection fluid on all junction points. Turn off Nitrogen source gas.
8. Open the VeriCal ball valve on the probe assembly, turn on Nitrogen source, adjust the pressure regulator until the pressure gauge indicates 100.00 psig  $\pm$  0.20 psig. The Regulator Assembly will bleed about 2 psig of the source gas in to the assembly enclosure.
9. Allow the instrument to stabilize by sustaining the pressure for a minimum of 5 minutes. Observing the flow and temperature reading stability on the electronic display will indicate when the instrument has come to equilibrium.
10. Record the Indicated pressure, from the pressure gauge, and flow and temperature readings from the electronic display.



**Calibration Verification Configuration**

11. Repeat steps 8 through 10 for 75 psig, 50 psig and 25 psig. The recorded values for flow temperature and pressure are the instruments in-situ baseline calibration readings. All future verification readings will be compared to these baseline values and should be within 2 % of these indicated readings.
12. The initial baseline calibration readings can be compared to the factory Verical calibration readings. If the local atmospheric pressure is within 0.50 psi of atmospheric pressure during the factory Verical calibration (located on the factory calibration sheet). The readings should be within 5 %.
13. Return the instrument electronics to the normal operation mode by pressing the “Home” key twice and then pressing the no. “1” key. Place probe assembly back into the correct location in the center of the process piping as indicated in the installation section of the operation manual. Return to normal operation group if VeriCal group differs from normal operation group.

**Recommended Procedure with Pressure Transducer**

The pressure transducer is located in the VeriCal Regulator Assembly box. The transducer is wired to the electronics assembly as shown in page 58.

The pressure transducer option provides a flow, temperature and pressure indication on the GF electronics display. These parameters are accessed through the 7.4 menu.

The verification procedure is the same as the steps outline in the previous section (without pressure transducer) steps 1 - 13. The only difference is that flow, temperature and pressure reading are all available on the GF electronics display. The analog gauge mounted in the Regulator Assembly box can be used as a caparison to the pressure transducer output as indicated on the GF electronics display.

**Calibration Verification (example)**

Customer Order:	C024057	Equip. No.:	Cal. Due Date
Customer:		EL-029	9-12-09
Date:	02-19-09	EL-383	7-28-09
Serial No.:	244110		

**VeriCal**

Indicated Pressure, psig	Pressure Transducer mA Output	Indicated Flow (SFPS)	Indicated Temperature Deg. °F
100		29.96	72.4
75.00		34.25	74.2
50.00		22.15	74.7
25.00		10.55	75.3
0.000		0.000	78.3

FCI Certificate

<b>Field Baseline</b>	<b>Date:</b>	
<b>Indicated Pressure, psig</b>	<b>Indicated Flow (SFPS)</b>	<b>Indicated Temp.</b>

For Customer Input Records

<b>Field Check 1</b>	<b>Date:</b>	
<b>Indicated Pressure, psig</b>	<b>Indicated Flow (SFPS)</b>	<b>Indicated Temp.</b>



## Optional Purge System

The GF90 has an optional purge system. This system allows the user to inject a purge gas or liquid onto the sensor element. The process is typically used to remove contaminants from the surface of the sensor element thermowells.

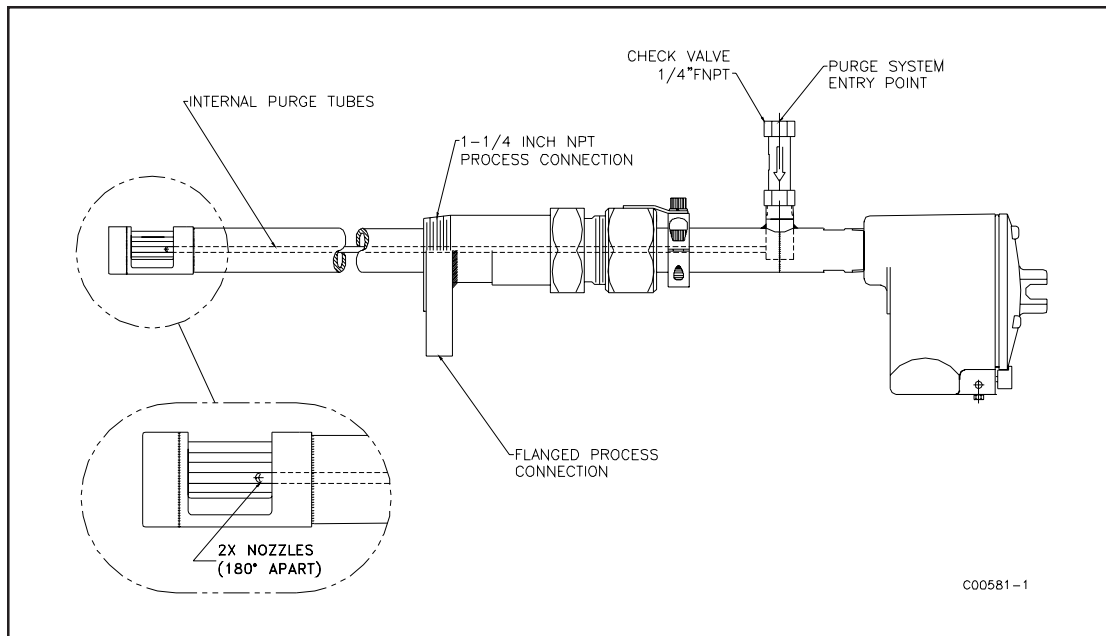
The purge system entry point is mounted on the side of the insertion pipe and is capped with a check valve (1/4" female NPT connection). The purge media is fed into the system at this point and exits through two nozzles directed at the thermowells inside the process.

### Check valve specifications

Temperature range: -4 to 360 degrees F

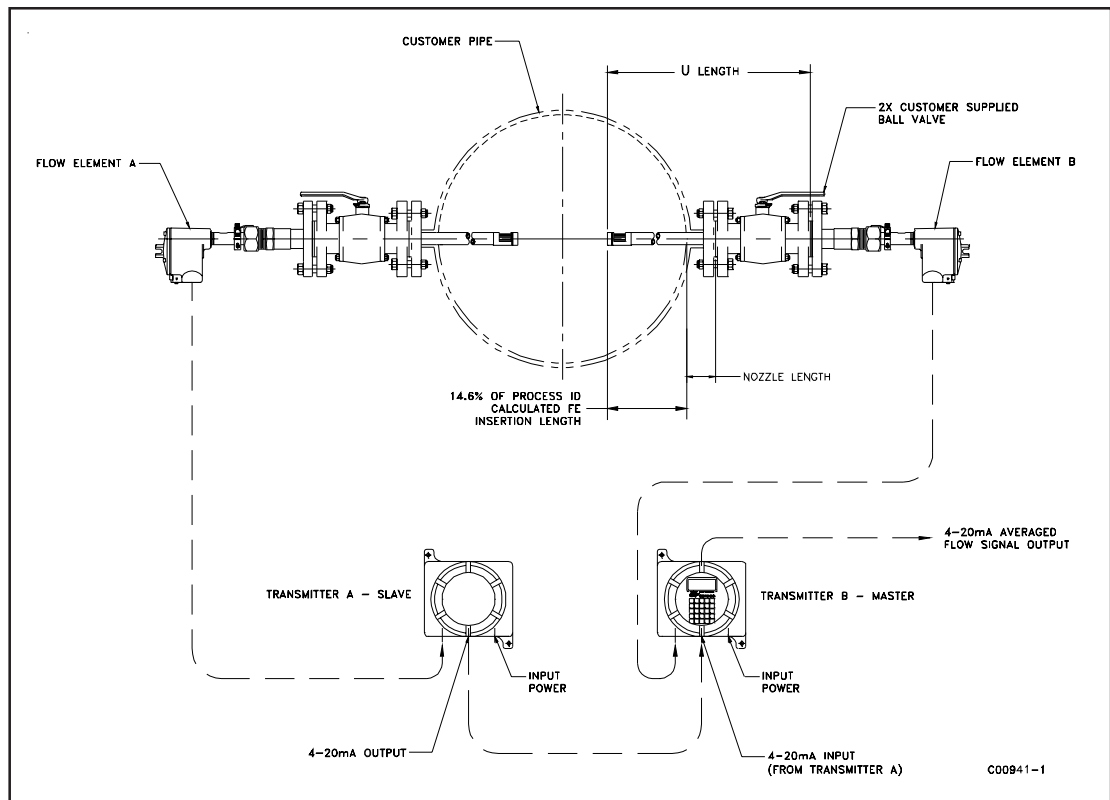
Cracking pressure: 3.6 psi

System operating pressure: 250 psi



## Two Point Averaging System Option

A two point averaging system is illustrated in figure 54. This system will have two flow elements and associated remote transmitter electronics. One of the transmitters will be designated as the “Master”. This master will display and output the average (4-20mA) flow rate of the system. The slave unit will operate as a stand alone meter with the output signal provided to the Master for averaging. The Master and Slave transmitters do not share the same firmware and are not interchangeable.



**Figure 54. 2 Point Averaging Flow Measurement System Diagram**

### Verify Averaging Mode

With the averaging system installed and correctly wired (see wiring diagrams located at the end of this section), the following sequence will verify the system is set up in the averaging mode.

- Press the “Home” key to return to the Main Menu.
- Press “2” to enter *Port setup* menu
- Press “4” to enter *Aux Input* menu
- Press “2” to enter *Enter Aux* menu
- Enter “942” for User PW (Password) and Press “Enter”
- Press “6” to enter the Verify set up menu

Page one of the menu is shown below”

- Aux’s
- Aux1 = -8.307499885
- Aux2 = 0.040643348
- Aux3 = 0.000000000
- Press “Enter” to view page 2



Aux's  
 Aux4=0.000000000  
 Enabled  
 Mode = Average Flow  
 Values for Aux1, Aux2, Enabled and Mode = Average Flow, indicates that the instrument is correctly set up for averaging flow. Each instrument will have different values for Aux1 and Aux2 depending on the specific instrument set up.

To return to Main Menu:

Press "Enter"  
 Press "Home"

**Decade Box Verification (example)**

The averaging system can be verified using the Delta R calibration sheets and decade boxes to simulate the delta R signal from the flow elements. The following example begins with the instrument wired for input power, the Slave flow output is connected the Master Aux 1 input and both instruments are set up using the same flow units.

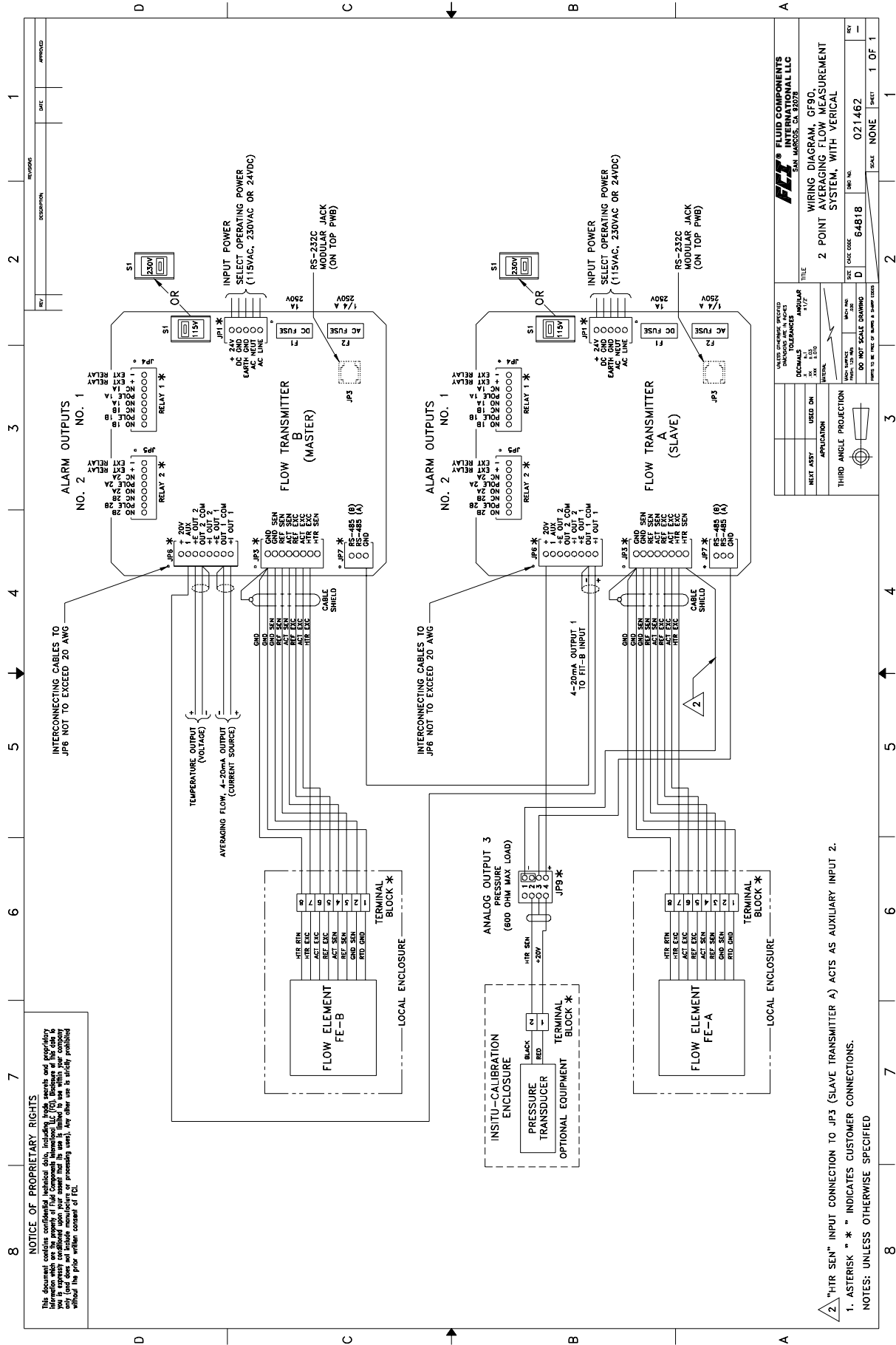
The master unit can be switched between the **Average Flow** on and normal **Flow** modes to view the results of the averaging function. This switching is done in the 2.4.2. Menu under the **Mode** selection.

Master Serial no. 272222

Ref = 1000 ohms Delta R	Master Display SCFM Averaging function <b>off</b>	Master Display SCFM Averaging function <b>on</b>
219.03	0	0
146.16	5	7.775
119.07	25	25.36
95.76	65	57.83
81.38	110	105.2
66.13	190	195.4
54.34	290	295.6
47.66	375	383.1
46.01	400	400.9

Slave Serial no. 272223

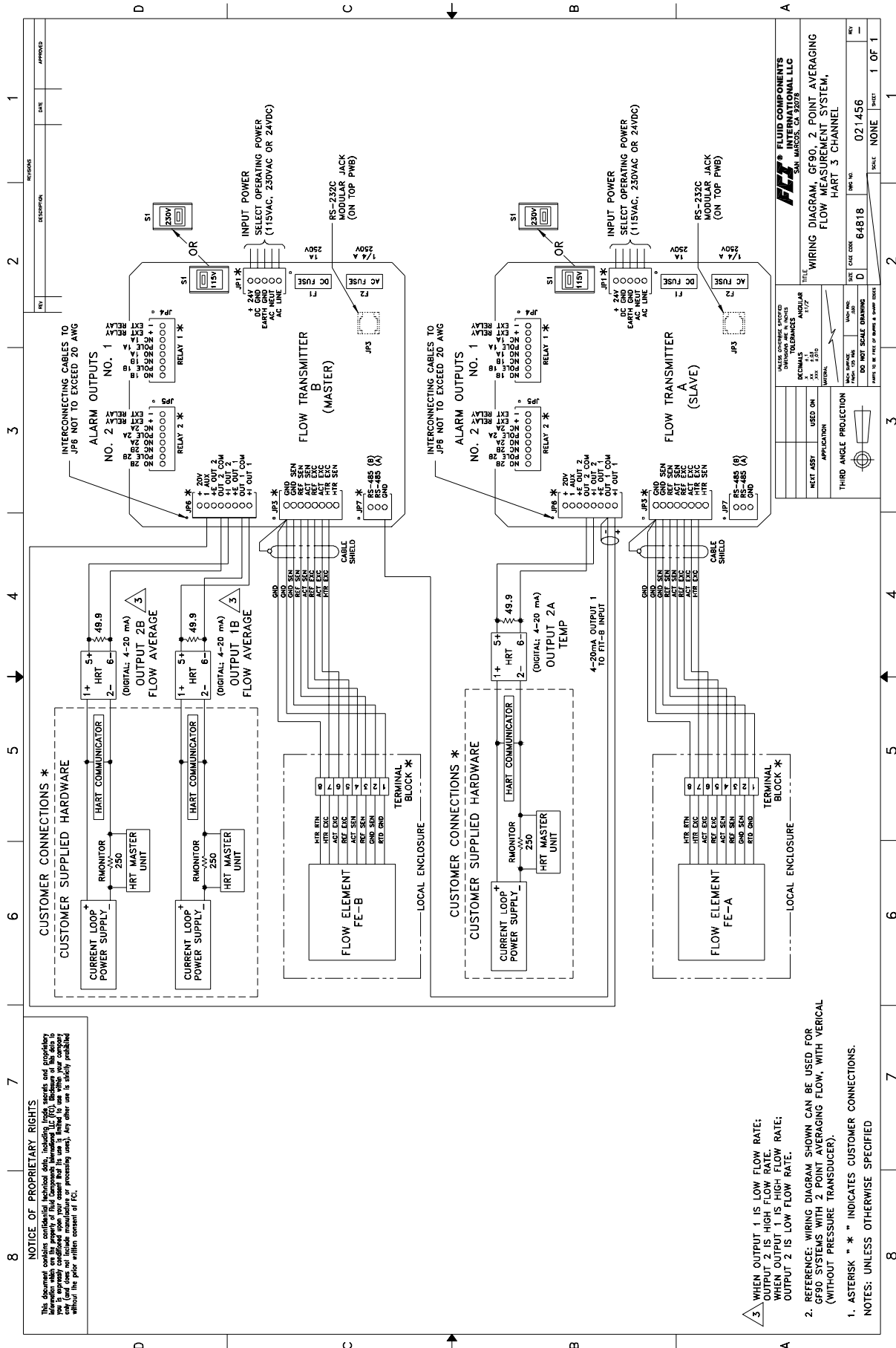
Ref = 1000 ohms Delta R	Slave Display SCFM
229.46	0
147.87	10
129.46	25
111.35	50
90.6	100
68.9	200
56.54	300
48.98	390
45.97	400



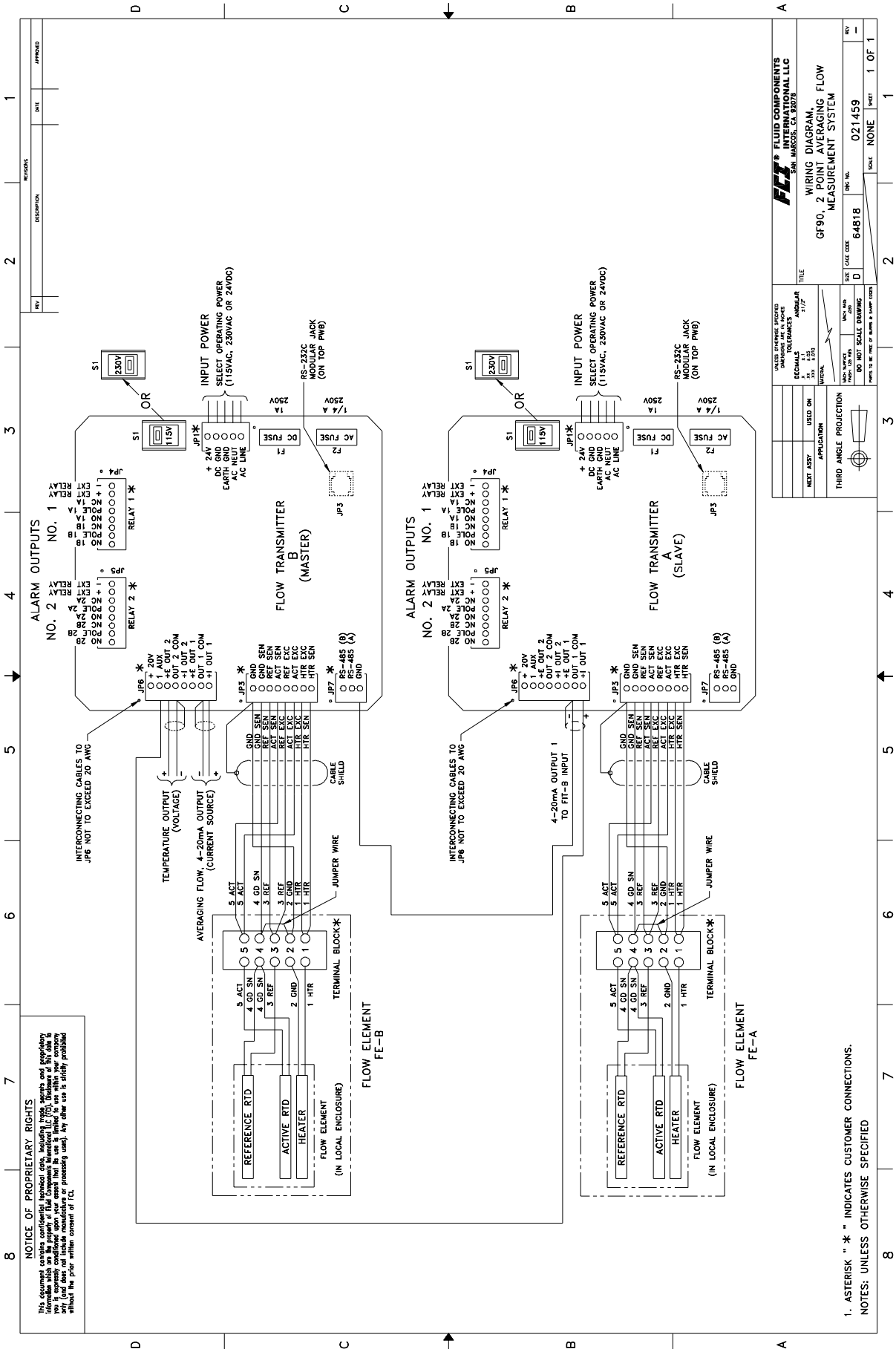
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REV		DESCRIPTION	DATE	APPROVED
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES		DECIMALS: UNLESS OTHERWISE SPECIFIED FRACTIONS: 1/8, 1/16, 1/32, 1/64		
NEXT ASSY APPLICATION	USED ON	TITLE <b>WIRING DIAGRAM, GF90,                  2 POINT AVERAGING FLOW MEASUREMENT                  SYSTEM, WITH VERTICAL                  SYSTEM, WITH VERTICAL</b>		
THIRD ANGLE PROJECTION	DRAWING NO. <b>64818</b>	REV. NO. <b>021462</b>	SCALE NONE	SHEET 1 OF 1

**8 Wire Flow Element**



8 Wire VeriCal Flow Element with or without Pressure Transducer, with HART



5 Wire VeriCal Flow Element

## 5. Maintenance



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

**ALERT:** The flow transmitter contains electrostatic discharge (ESD) sensitive devices. Use standard ESD precautions when handling the flow transmitter. See Chapter 3 Installation for ESD details.

### Maintenance

The FCI instrument requires little maintenance. There are no moving parts or mechanical parts subject to wear in the instrument. The sensor assembly which is exposed to the process media is all stainless steel construction.

Without detailed knowledge of the environmental parameters of the application surroundings and process media, FCI cannot make specific recommendations for periodic inspection, cleaning, or testing procedures. However, some suggested general guidelines for maintenance steps are offered below. Use operating experience to establish the frequency of each type of maintenance.

#### Calibration

Periodically verify the calibration of the output and recalibrate if necessary. See Chapter 6 - Troubleshooting. FCI recommends every 18 months at a minimum.

#### Electrical Connections

Periodically inspect cable connections on terminal strips and terminal blocks. Verify that terminal connections are tight and physically sound with no sign of corrosion.

#### Remote Enclosure

Verify that the moisture barriers and seals protecting the electronics in the local and remote enclosures are adequate and that no moisture is entering those enclosures.

#### Electrical Wiring

FCI recommends occasional inspection of the system's interconnecting cable, power wiring and flow element wiring on a "common sense" basis related to the application environment. Periodically the conductors should be inspected for corrosion and the cable insulation checked for signs of deterioration.

#### Flow Element 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 and appropriate plant shutdown schedules and procedures. 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 debris or residue build-up could cause inaccurate switching. Clean the flow element, as necessary, with a soft brush and available solvents (compatible with Stainless Steel).

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## 6. Troubleshooting



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



**ALERT:** The electronics contains electrostatic discharge (ESD) sensitive devices. Use standard ESD precautions when handling the electronics. See Chapter 3, 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 3 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 4) 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 Troubleshooting

At this point simply observe the system setup to verify operation. Use Table 9 as a quick check of problems and solutions. More in-depth discussions follow this table.

**Table 9. Quick Check Troubleshooting**

PROBLEM	SOLUTION
No Display	Check the fuses. Verify S1 is switched to the correct input voltage. Verify correct power is applied.
No Display or Dim Display	Adjust potentiometer R1 on the top circuit board. If there is a change in the display, return the potentiometer to the original setting.
Display is Locked Up	Press HOME and then 1 to return to normal operation. Reset the flowmeter by cycling power.
Reading Seems Incorrect	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 flow. 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.	

**In-Depth Troubleshooting**

**Standard GF90/GF92 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 Table 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. Plug JP3 is shown in Figure 35. The numbers in Figure 35 have been added to the wire designations for discussion purposes and are not found on the JP3 terminal plug or wires. (Remember to reconnect JP3 back to the flow transmitter when finished.)



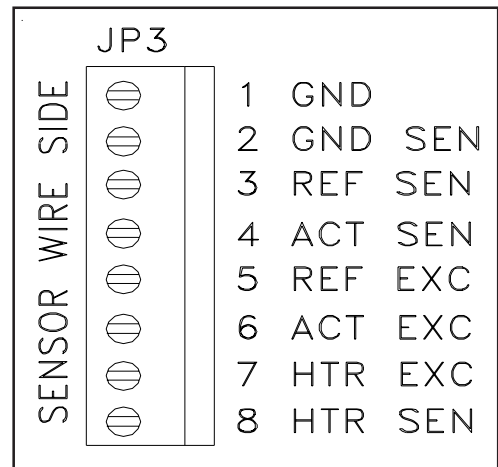
**NOTE:** If the system does not allow the disconnection of the flowmeter power, or unplugging the flow element, then proceed to the section, "In-Depth Troubleshooting - The Flow Transmitter".

Be sure that pins 2 and 4 are jumpered on the terminal block located in the flow element (local enclosure (see Figure 36). All resistances in Table 10 are based on a temperature of 32°F (0 °C). Resistances across the ACT and the REF RTDs for a GF90/92 are approximately 1080 ohms\* and for a GF90 high temperature are approximately 110 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.

**Table 10.  
Resistance at JP3  
Terminal Plug (GF90/GF92)**

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	220 Ohms
2 to 8	220 Ohms

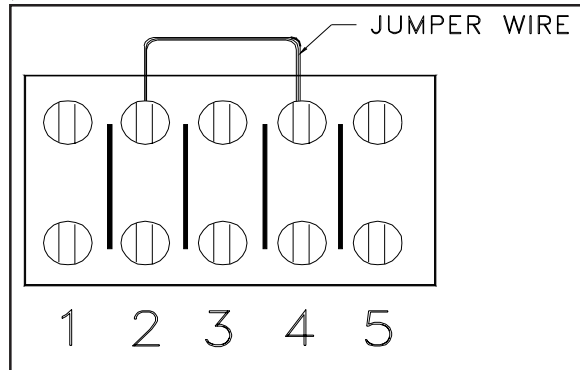
\*For the GF90 high temperature flow element divide by 10.



**Figure 35. JP3 Terminal Plug**



If the measured resistances correspond to Table 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 10 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 11.



**Figure 36.**  
**Flow Element Enclosure Terminal Block**

**Table 11.**  
**Resistance at Flow Element Enclosure Terminal Block**

TERMINAL NUMBER	APPROXIMATE RESISTANCE
1 to 4	220 Ohms
2 to 4	0 Ohms
3 to 4	1000 Ohms*
5 to 4	1000 Ohms*

\*For GF90HT divide by 10.

If the measured resistances correspond to Table 11 then the cable or wiring is defective. If the measured values do not correspond to Table 11 then the Flow Element is defective. Contact customer service for details on how to obtain another cable or flow element.

**In-Depth Troubleshooting**

**GF90 with VeriCal 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 Table 13 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. Plug JP3 is shown in Figure 55. The numbers in Figure 55 have been added to the wire designations for discussion purposes and are not found on the JP3 terminal plug or wires. (Remember to reconnect JP3 back to the flow transmitter when finished.)

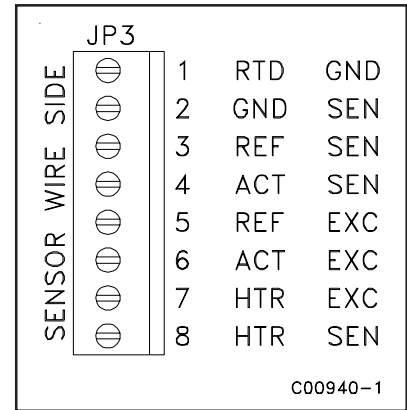


**NOTE:** If the system does not allow the disconnection of the flowmeter power, or unplugging the flow element, then proceed to the section, "In-Depth Troubleshooting - The Flow Transmitter".

All resistances in Table 13 are based on a temperature of 32°F (0 °C). Resistances across the ACT and the REF RTDs for a GF90/92 are approximately 1080 ohms\* and for a GF90 high temperature are approximately 110 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.

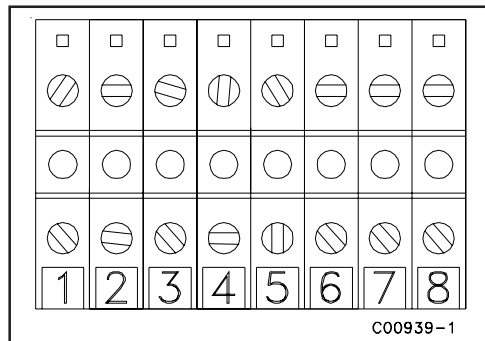
**Table 13.**  
**Resistance at JP-3 terminals after cable has**  
**been disconnected for 15 minutes.**  
**(This test will also verify cable continuity)**

LUG OR PIN NUMBER	RESISTANCE
(1) GND TO (7) HTR EXC	110 – 118 OHMS
(4) ACT SEN TO (2) GND SEN	1.1K OHMS
(3) REF SEN TO (2) GND SEN	1.1K OHMS
(3) REF SEN TO (4) ACT SWEN	2.2K OHMS
(1) RTD GND TO (2) GND SEN	0 OHMS
(4) ACT SEN TO (6) ACT EXC	0 OHMS
(3) REF SEN TO (5) REF EXC	0 OHMS
<b>NOTE: SHIELD TO GND AT TRANSMITTER BOARD ONLY</b>	



**Figure 55. JP3 Terminal Plug**

If the measured resistances correspond to Table 13 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 13 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 14.



**Figure 53.**  
**VeriCal Flow Element**  
**Enclosure Terminal Block**

**Table 14.**  
**Resistance at probe terminals after cable has**  
**been disconnected for 15 minutes**

LUG OR PIN NUMBER	RESISTANCE
(7) HTR EXC TO (8) HTR RTN	110 – 118 OHMS
(4) ACT SEN TO (2) GND SEN	1.1K OHMS
(3) REF SEN TO (2) GND SEN	1.1K OHMS
(3) REF SEN TO (4) ACT SWEN	2.2K OHMS
(1) RTD GND TO (2) GND SEN	0 OHMS
(4) ACT SEN TO (6) ACT EXC	0 OHMS
(3) REF SEN TO (5) REF EXC	0 OHMS
<b>NOTE: SHIELD TO GND AT TRANSMITTER BOARD ONLY</b>	

If the measured resistances correspond to Table 14 then the cable or wiring is defective. If the measured values do not correspond to Table 14 then the Flow Element 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. Refer to Figure 35 for pin numbers on the standard GF90/GF92 and Figure 55 for pin numbers on the GF90 with VeriCal.

**Table 12. Voltage Readings in Volts DC at JP3**

PIN NUMBER	APPROXIMATE VOLTAGE GF90	APPROXIMATE VOLTAGE GF90 HIGH TEMPERATURE	APPROXIMATE VOLTAGE GF92
1 to 2	0	0	0
2 to 3	1.1	0.25	1.1
2 to 4	1.2	0.27	1.2
2 to 5	1.1	0.25	1.1
2 to 6	1.2	0.27	1.2

All GF90 and GF92 Units

2 to 7	16.5	16.5	11.4
2 to 8	16.5	16.5	11.4

All Standard GF90 and GF92 Units with 220ohm heaters

1 to 7	8.25 - 9.0		
--------	------------	--	--

All GF90 Units with 110ohm heaters (Veri-Cal flow element)

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 data page entitled "GF Series Delta R Data Sheet" is located in the back of this manual. 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 3 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 3 for instructions on proper installation.

**In-Depth Troubleshooting The Process**

**Verify Standard versus Actual Process Conditions**

The flowmeter measures the mass flow rate. 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)

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



**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 4 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.

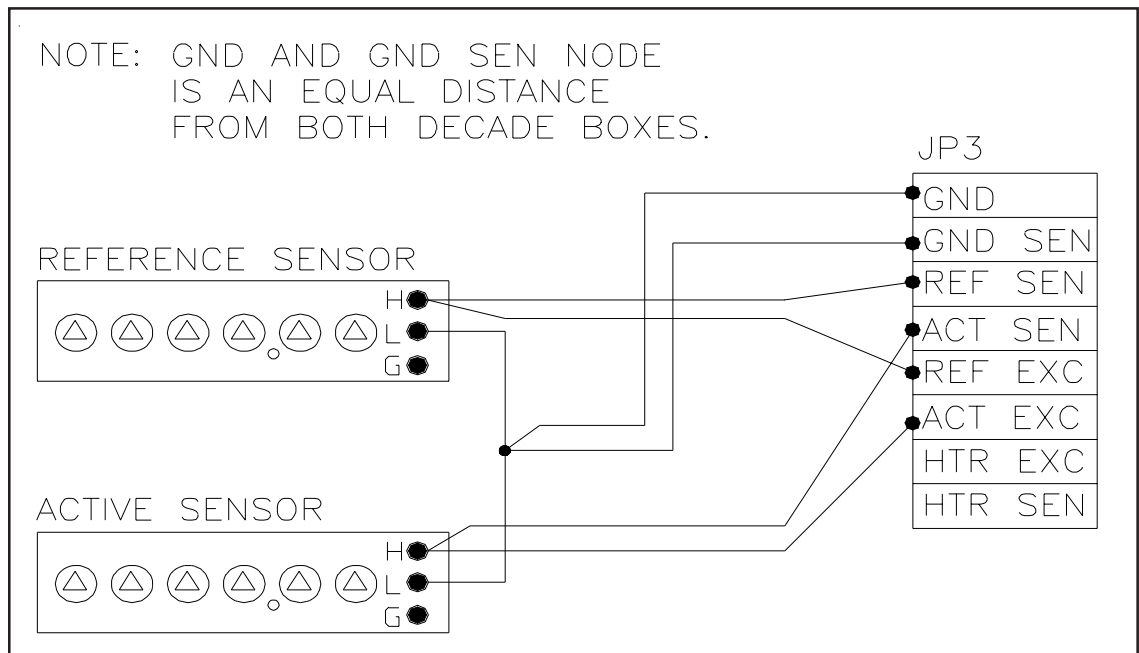
## Verifying Delta R's



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

A Delta R 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 Table 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 37.



**Figure 37. Decade Box Connections**

4. Set the reference decade box to 100 or 1000 ohms, depending on type of nominal flow element resistance.
5. Set the active decade to the same reading as step 3, plus the Delta R value from the Delta 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 the output current. Connect a DMM across the +E OUT and OUT COM on connector terminal JP6 for the voltage output signals.
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 Delta R column for the low-limit signal. Set the active decade for a resistance of 1000 ohm or 100 ohm + the Delta R value. The meter reading should equal the recorded value within  $\pm 1\%$  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 later in this manual) to determine the best course of action.

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## Defective Parts

Before returning any equipment to FCI, please obtain an RA number for authorization, tracking, and repair/replacement instructions. If a return is required, remove defective instrument, replace with spare, calibrate, then return defective instrument to FCI freight prepaid for disposition.

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## Customer Service

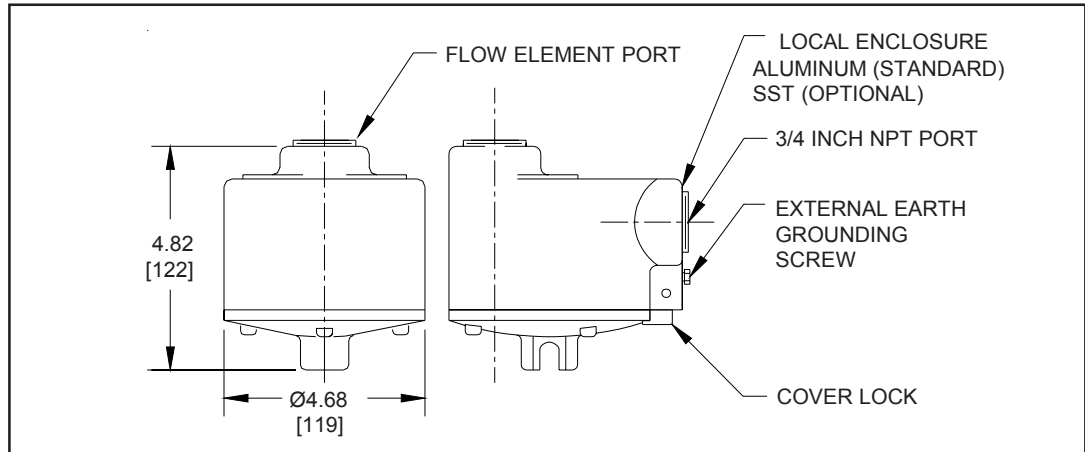
1. In the event of problems or inquiries regarding the flowmeter, please contact the regional or country authorized FCI Field Agent. There is an extensive list of these representatives at the front of this manual.
2. Before contacting the FCI representative, please be sure that all the applicable information is near so that a more effective, efficient and timely response may be provided.
3. Refer to Appendix D for specific Customer Service policy provisions.

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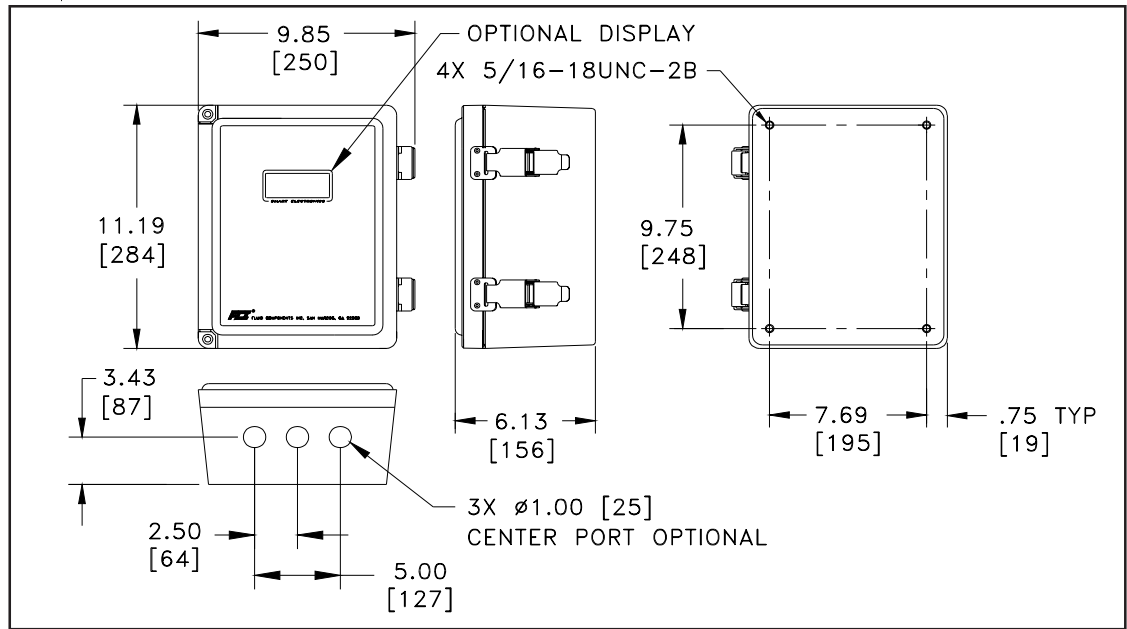


# Appendix A. Drawings

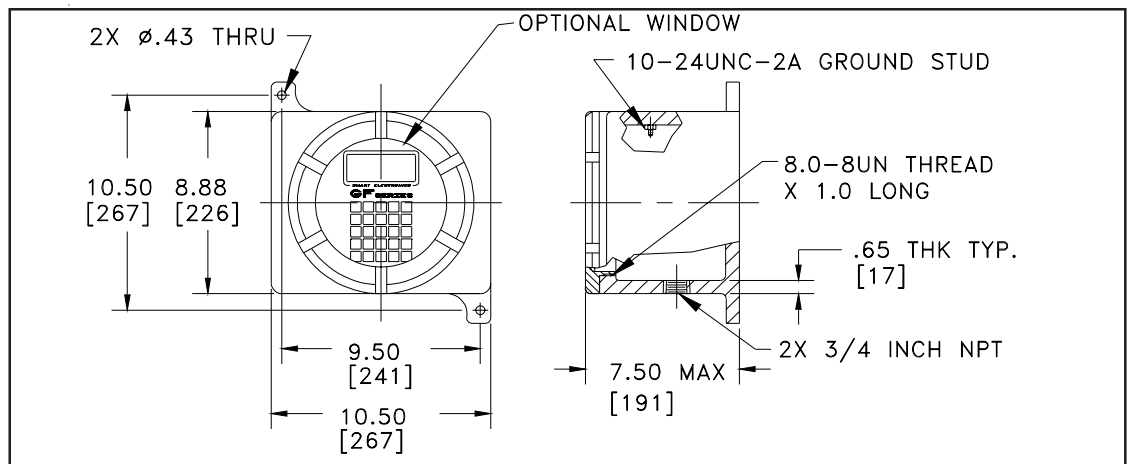
All dimensions are shown in inches. Brackets [ ] indicate dimensions in millimeters.



**Figure 38. Local Enclosure, NEMA Type 4X and Hazardous Location (Aluminum Enclosure Shown)**



**Figure 39. Remote Enclosure NEMA 4X (.827 inch - 21 mm Ports are Optional)**



**Figure 40. Remote Aluminum Enclosure NEMA 4X and Hazardous Location**

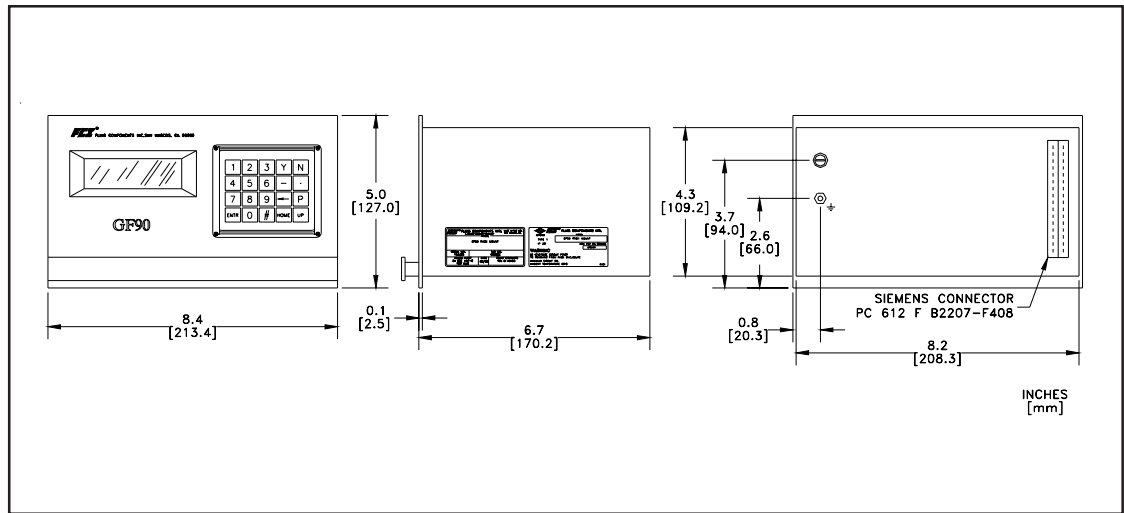


Figure 41. Rack Mount Installation Outline Drawing

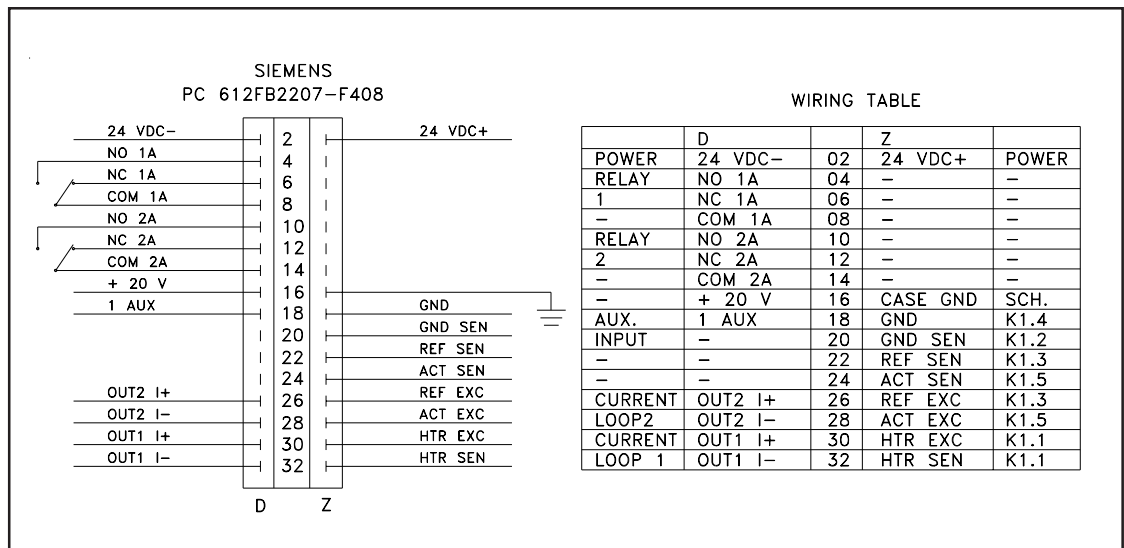
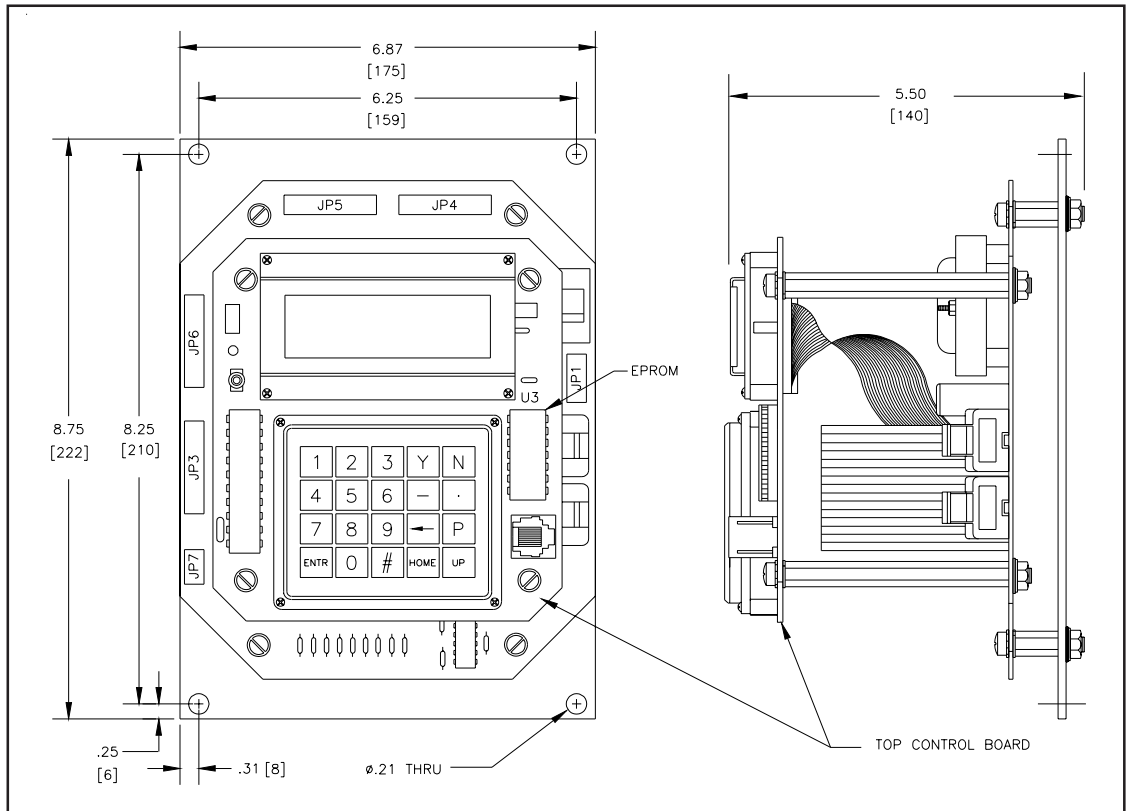
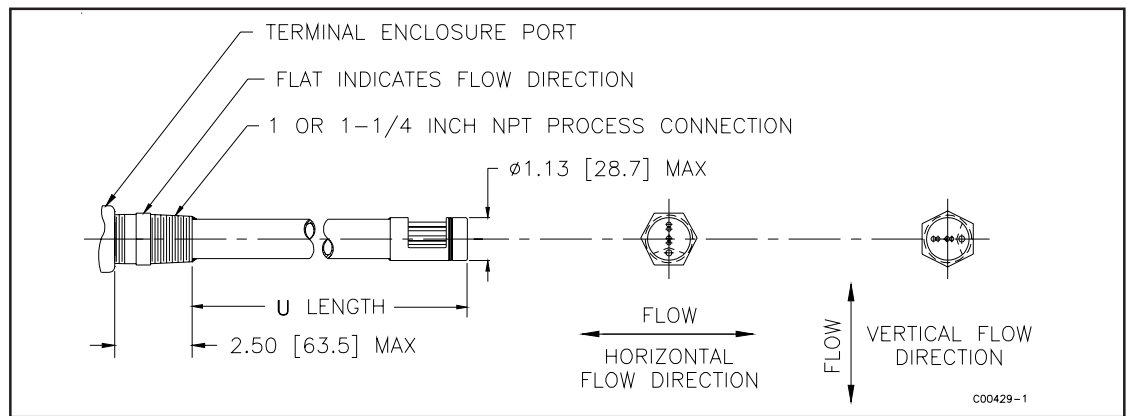


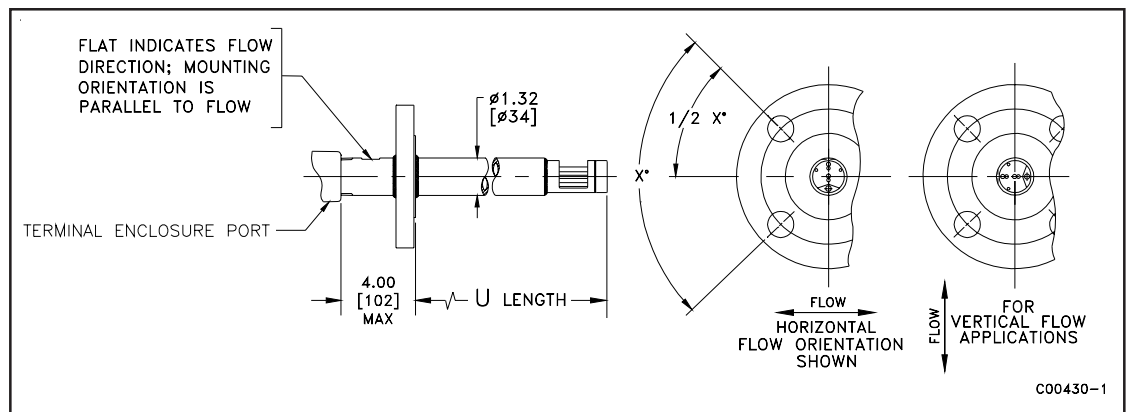
Figure 42. Rack Mount Wiring Diagram and Table



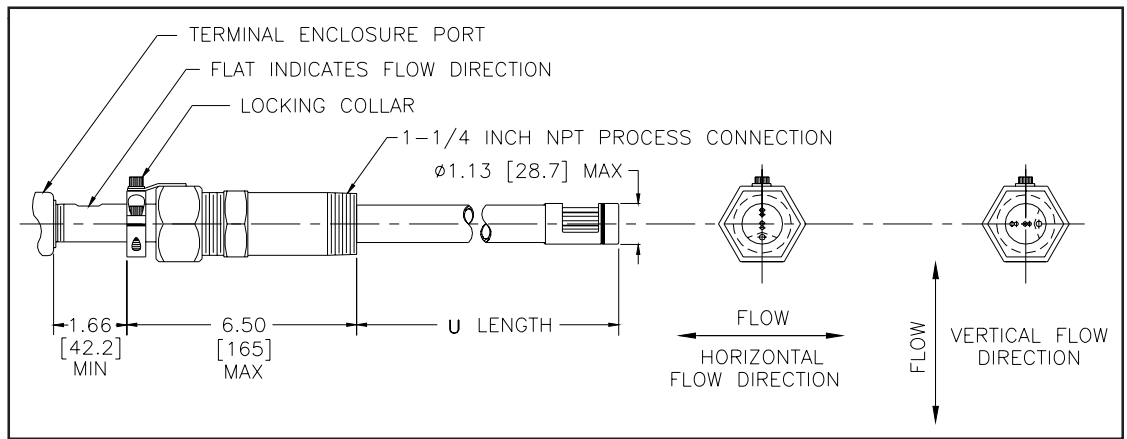
**Figure 43. Flow Transmitter Configuration With Panel Assembly**



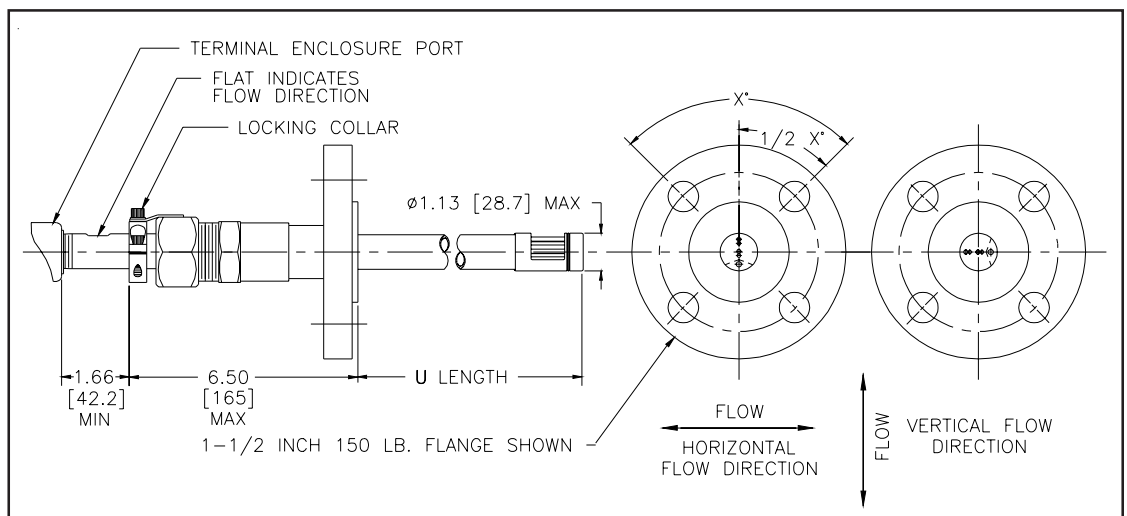
**Figure 44. NPT Process Connection**



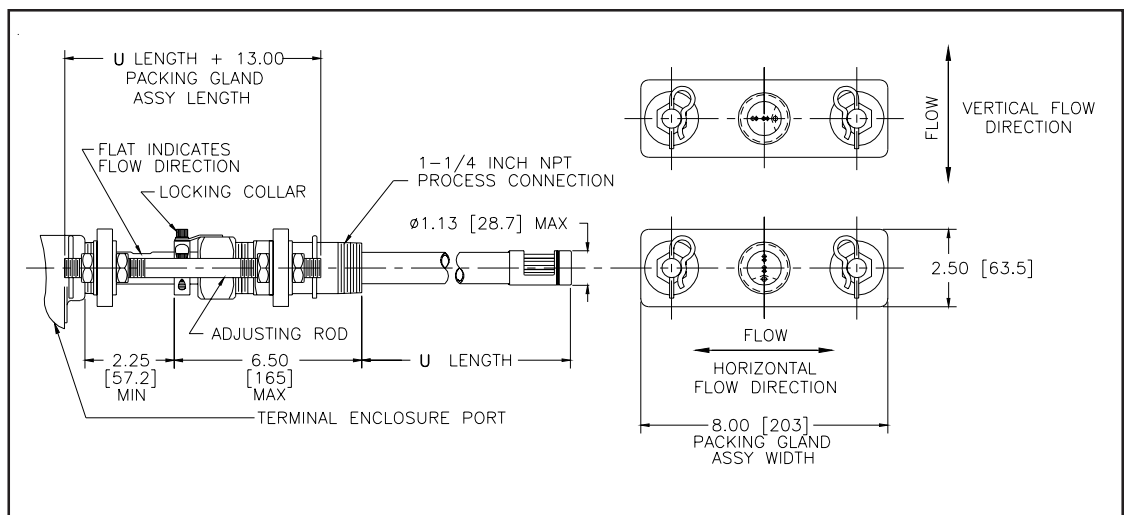
**Figure 45. Flanged Process Connection**



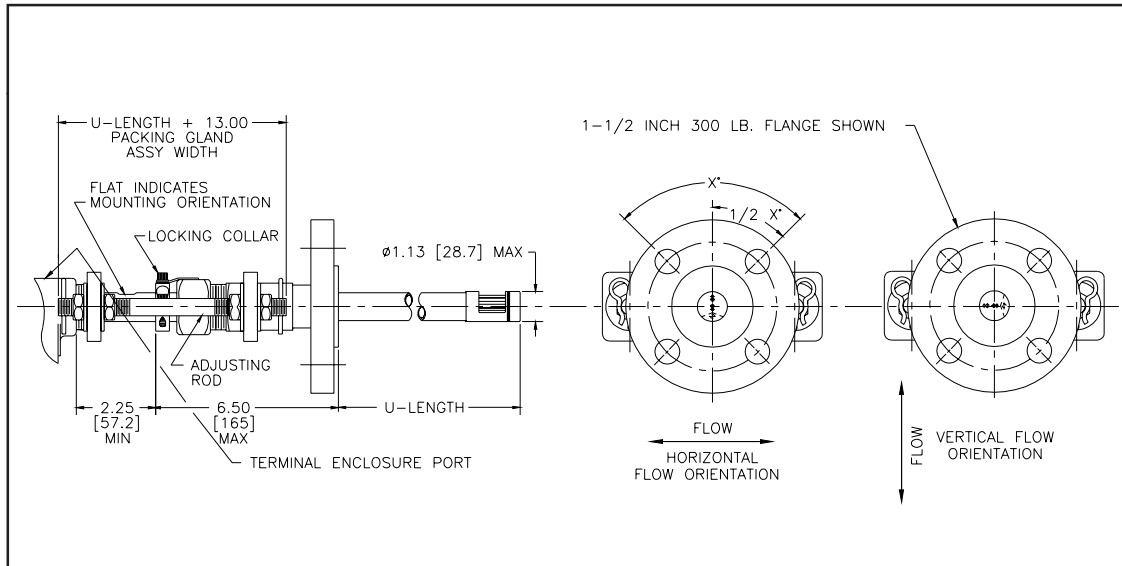
**Figure 46. 1-1/4 Inch NPT Low Pressure Gland (PGL) Flow Element**



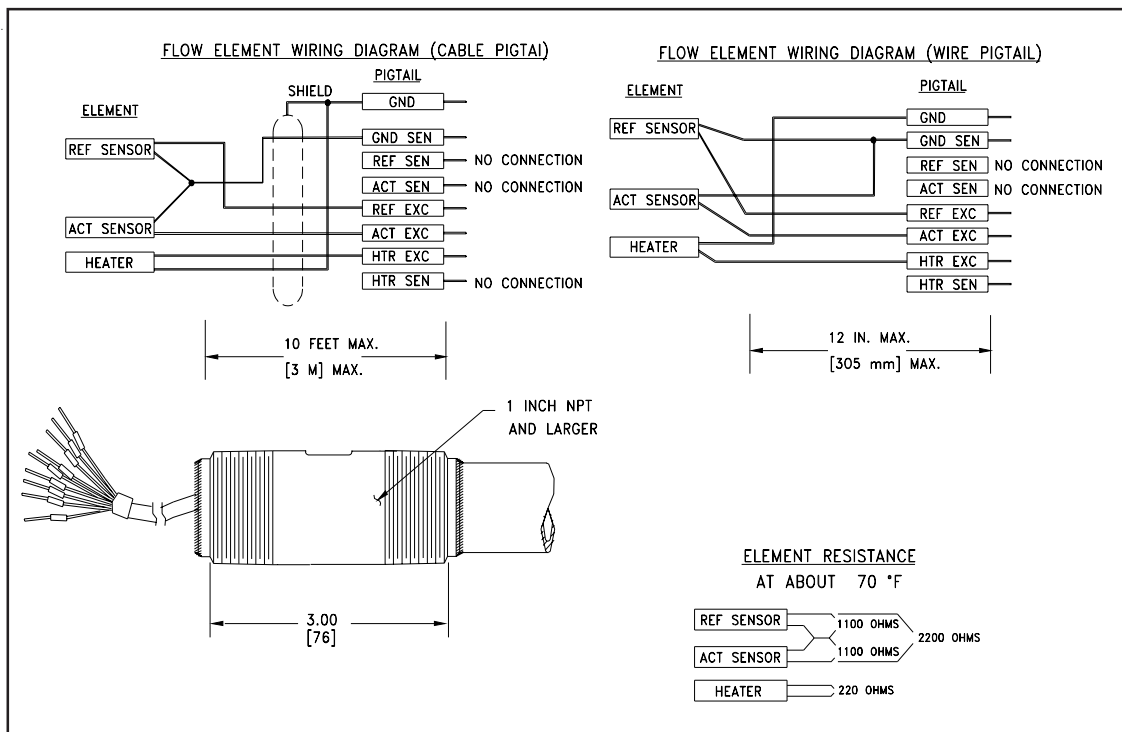
**Figure 47. Flanged Low Pressure Gland (PGL) Flow Element**



**Figure 48. NPT Medium Pressure Gland (PGM) Flow Element**



**Figure 49. Flanged Medium Pressure Gland (PGM) Flow Element**



**Figure 50. GF90/GF92 Pigtail Configuration**

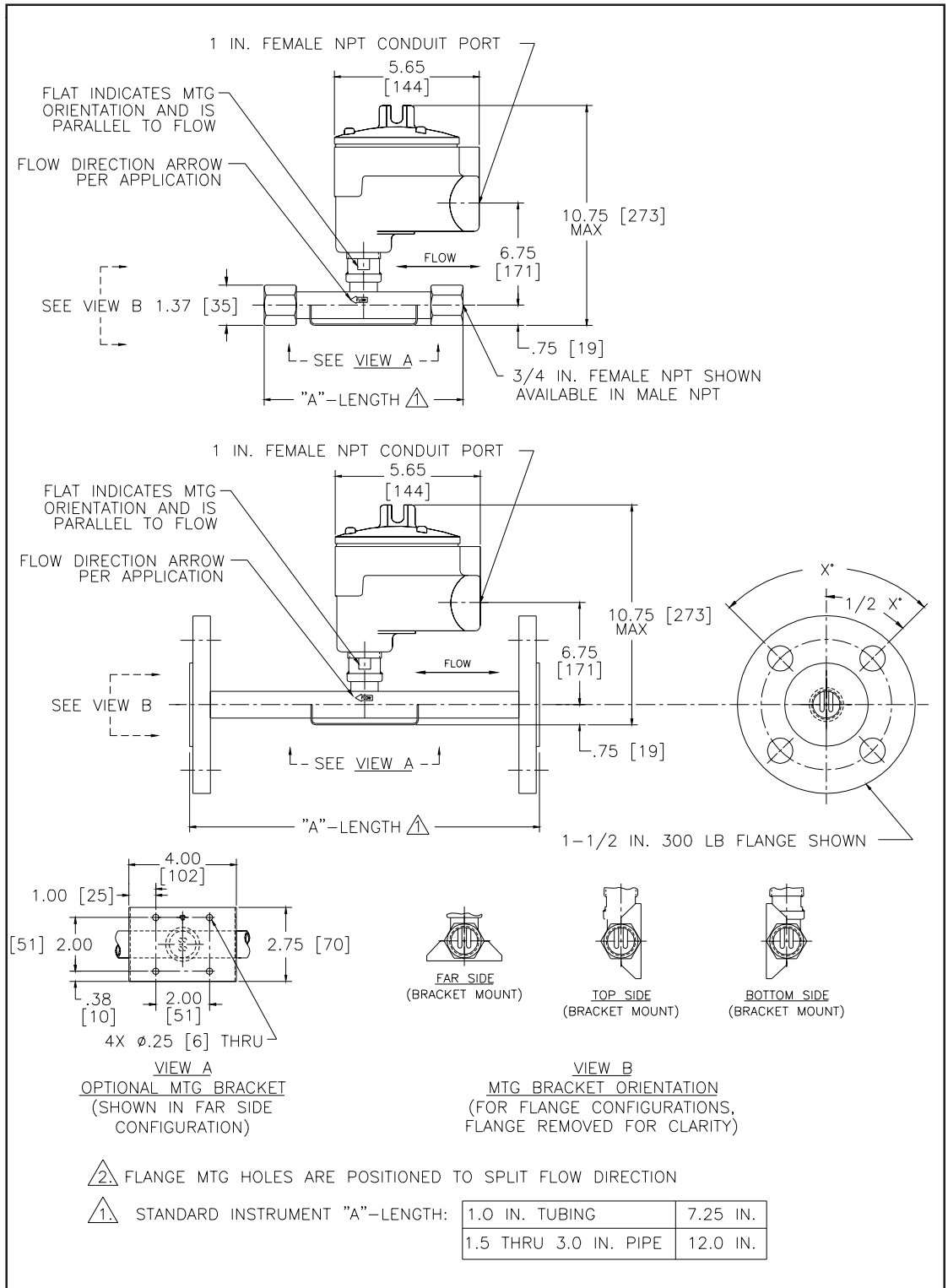


Figure 51. GF92 NPT and Flanged Flow Element Configurations

# Appendix B. Glossary of Terms

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

## Explanation of Terms

The following terms are used in the display menu aand Delta R Data Sheet. The terms are shown in the order they are displayed through out the display menu.

### Totalizer Setup 3.3 Menu Function

**m** Abbreviation for thousand

**mm** Abbreviation for million

### Verify 5.1 Menu Function

**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

**Std. Density** Density of media (customer's original request) at standard conditions

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



<b>Slope 2</b>	Slope for equation: $D/A\# = \text{current} \times \text{Slope 2} + \text{Off 2}$ . Corresponding to current or voltage output
<b>STD Density</b>	Density of media (customer's original request) at standard conditions usually at 14.7PSIA and 70 degrees F: used by firmware for conversion when a mass flow rate unit is chosen such as LB/HR etc.
<b>Tot. Unit</b>	Unit of Totalizer as NCM or SCF: Note that there is no time unit
<b>Prt B:</b>	Port B
<b>Prt C:</b>	Port C
<b>A/D Mode</b>	Analog to Digital Mode
<b>Boxcar</b>	A number between 1 - 64 that represents a signal filtering parameter. See Chapter 4, Sample Rate
<b>Link Mode</b>	Shows if link mode is enabled or disabled
<b>Flow Min</b>	Minimum calibrated Flow Rate in SFPS
<b>Flow Max</b>	Maximum calibrated Flow Rate in SFPS
<b>dR Min</b>	Delta R value low end cutoff. Should be set to approximately 5 ohms less than the lowest dR corresponding to Flow Max
<b>dR Max</b>	dR value high-end cut-off. Should be set to approximately 5 ohms greater than the dR corresponding to Flow Min
<b>C1 - C5</b>	Coefficients for Characteristic Equation; unique to each probe:
<b>CAL REF OHM</b>	Calibration Average Reference Resistance
<b>T0, T1</b>	Temperature Compensation coefficients
<b>T2</b>	Serial number of unit
<b>T3</b>	Customer Order number of unit

---

## Miscellaneous Terms

The following terms are miscellaneous terms to know:

<b>Full Scale</b>	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
<b>Power Isolated</b>	Input AC power terminals are electrically isolated from all other terminals
<b>Turndown</b>	This is Full Scale divided by the Min Flow

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# Appendix C. Approval Information

## CE Information



### EC DECLARATION OF CONFORMITY GF Series



We, *Fluid Components Intl.*, located at 1755 La Costa Meadows Drive, San Marcos, California 92078-5115 USA, declare under our sole responsibility that the **GF Series Mass Flow Meter**, models GF90/GF92, to which this declaration relates, are in conformity with the following standards and Directives.

#### Directive 94/9/EC ATEX

Certified by KEMA Quality B.V. (0344): Utrechtseweg 310, 6812 AR, Arnhem, The Netherlands.

EC-Type Examination Certificate: KEMA 03ATEX2152 satisfies EN 60079-0:2006, EN 60079-1:2004, EN 61241-0:2006, and EN 61241-1:2004.

Hazardous Areas Approval KEMA 03ATEX2152 for:  
 Category II 2 G for Gas protection Ex d IIC T6...T1  
 Category II 2 D for Dust protection Ex tD A21 IP66 T 85°C ...T 355°C

#### IECEx Scheme

Certified by CSA International: 178 Rexdale Blvd, Toronto Ontario M9W 1R3, Canada

IECEx Certificate: IEC CSA07.0011 satisfies IEC 60079-0:2004 and IEC 60079-1:2003.

Hazardous Areas Approval IEC CSA07.0011 for:  
 Category II 2 G for Gas protection Ex d IIC T2 or T4.

#### Directive 2004/108/EC EMC

Immunity specification: EN 61000-6-2:2005  
Emissions specification: EN 61000-6-4:2007

#### Directive 2006/95/EC Low Voltage

Safety Requirements For Electrical Equipment For Measurement, Control and Laboratory Use: EN 61010-1:2001, Cor 2002 and EN 61010-2-010:2003

#### Directive 97/23/EC Pressure Equipment

The GF90 Model does not have a pressure bearing housing and is therefore not considered as pressure equipment by itself according to article 1, section 2.1 of the **Pressure Equipment Directive 97/23/EC**. Model GF92 is in conformity with the sound engineering practices as defined in the **Pressure Equipment Directive 97/23/EC** article 3, paragraph 3, instruments with a line size greater than 25 mm are limited by the requirements of Annex II, table 6 as define in article 3 section 1.3.

*Issued at San Marcos, California USA  
 April 2009*

 Eric Wible  
 2009.04.13  
 10:49:42  
 -0700'

Eric Wible, Engineering Manager

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 Web: www.fluidcomponents.com ☎ Email: info@fluidcomponents.com  
 ISO9001:2000/AS9100 Certified

Doc No. 23EN000011F

## ATEX Information

### Safety Instructions for the use of the GF90/92 Flowmeter in Hazardous Areas Approval KEMA 03 ATEX 2152 for:

**Category II 2 G for Gas protection Ex d IIC T6...T1**

**Category II 2 D for Dust protection Ex tD A21 IP6x T85°C ...T355°C**

The GF90/92 series consist of a sensing element and remote mounted electronics mounted in a type "d" flameproof enclosure.

- 1) The cable entries are 1 inch Female NPT.
- 2) Cables must be terminated in either a safe area or within ATEX approved enclosures.
- 3) The temperature classes for both ambient and process temperature ranges are as follows:

Ambient temperature range (Ta):           T5/T100°C for :   -40°C <Ta< + 60°C  
T6/T85°C for :    -40°C <Ta< + 40°C

Process temperature range (Tp):           T4/T135°C for :   -40°C <Tp< + 40°C  
T3/T200°C for :   -40°C <Tp< + 130°C  
T2/300°C for :    -40°C <Tp< + 205°C  
T1/T355°C for :   -40°C <Tp< + 260°C

- 4) Electrical data:  
Power supply: 115/230 VAC, 50/60 Hz, 120/60mA or 24 VDC, 350 mAmp  
Contact rating: 115/230 VAC, 10/2A, 24 VDC, 10A

Dansk	Sikkerhedsforskrifter	Italiano	Normative di sicurezza
Deutsch	Sicherheitshinweise	Nederlands	Veiligheidsinstructies
English	Safety instructions	Português	Normas de segurança
Υπ	Υπ δει εις ασφαλειας	Español	Instrucciones de seguridad
Suomi	Turvallisuusohjeet	Svenska	Säkerhetsanvisningar
Français	Consignes de sécurité		

## DK Dansk- Sikkerhedsforskrifter

Disse sikkerhedsforskrifter gælder for Fluid Components, GF90/92 EF-typeafprøvningsattest-nr. KEMA 03 ATEX 2152 (attestens nummer på typeskiltet) er egnet til at blive benyttet i eksplosiv atmosfære kategori II 2 G/D.

- 1) Ex-anlæg skal principielt opstilles af specialiseret personale.
- 2) GF90/92 flowmeter skal jordforbindes.
- 3) Klemmerne og elektronikken er monteret i et hus, som er beskyttet af en eksplosionssikker kapsling med følgende noter:
  - Gevindspalten mellem huset og låget er på en sådan måde, at ild ikke kan brede sig inden i det.
  - Ex-"d" tilslutningshuset er forsynet med et 1" NPT og/eller 3/4" NPT gevind for montering af en Ex-"d" kabelindføring, der er attesteret iht. EN50018/EN60079-1
  - Det er vigtigt at sørge for, at forsyningsledningen er uden spænding eller eksplosiv atmosfære ikke er til stede, før låget åbnes og når låget er åbent på "d" huset (f.eks. ved tilslutning eller servicearbejde).
  - Låget på "d" huset skal være skruet helt ind, når apparatet er i brug. Det skal sikres ved at dreje en af låseskruerne på låget ud.

## D A Deutsch-Sicherheitshinweise

Diese Sicherheitshinweise gelten für die Fluid Components, GF90/92 flowmeter gemäß der EG-Baumusterprüfbescheinigung Nr. KEMA 03 ATEX 2152 (Bescheinigungsnummer auf dem Typschild) der Kategorie II 2 G/D.

- 1) Die Errichtung von Ex-Anlagen muss grundsätzlich durch Fachpersonal vorgenommen werden.
- 2) Der GF90/92 flowmeter muß geerdet werden.
- 3) Die Klemmen und Elektronik sind in einem Gehäuse in der Zündschutzart druckfeste Kapselung („d“) eingebaut.
  - Der Gewindespalt zwischen dem Gehäuse und dem Deckel ist ein zünddurchschlagsicherer Spalt.
  - Das Ex-"d" Anschlussgehäuse besitzt ein 3/4" und/oder 1" NPT Gewinde für den Einbau einer nach EN50018/EN60079-1 bescheinigten Ex-"d" Kabeleinführung.
  - Es ist sicherzustellen, dass vor dem Öffnen und bei geöffnetem Deckel des „d“ Gehäuses (z.B. bei Anschluss oder Service- Arbeiten) entweder die Versorgungsleitung spannungsfrei oder keine explosionsfähige Atmosphäre vorhanden ist.
  - Der Deckel des „d“ Gehäuses muss im Betrieb bis zum Anschlag hineingedreht sein. Er ist durch eine der Deckelarretierungsschrauben zu sichern.

## GB IRL English- Safety instructions

These safety instructions are valid for the Fluid Components, GF90/92 flowmeter to the EC type approval certificate no. KEMA 03 ATEX 2152 (certificate number on the type label) for use in potentially explosive atmospheres in Category II 2 G/D.

- 1) The installation of Ex-instruments must be made by trained personnel.
- 2) The GF90/92 flowmeter must be grounded.
- 3) The terminals and electronics are installed in a flame proof and pressure-tight housing with following notes:
  - The gap between the housing and cover is an ignition-proof gap.
  - The Ex-"d" housing connection has a 1" and/or 3/4 " NPT cable entry for mounting an Ex-d cable entry certified acc. to EN50018/EN60079-1.
  - Make sure that before opening the cover of the Ex"d" housing, the power supply is disconnected or there is no explosive atmosphere present (e.g. during connection or service work).

During normal operation: The cover of the "d" housing must be screwed in completely and locked by tightening one of the cover locking screws

## GR Υπ\_δεί\_εις ασφαλείας

Αυτές οι οδηγίες ασφαλείας ισχύουν για τα Ροόμετρα της Fluid Components τύπου GF90/92 που φέρουν Πιστοποιητικό Εγκρίσεως Ευρωπαϊκής Ένωσης, με αριθμό πιστοποίησης KEMA 03 ATEX 2152 (ο αριθμός πιστοποίησης βρίσκεται πάνω στην ετικέτα τύπου του οργάνου) για χρήση σε εκρηκτικές ατμόσφαιρες της κατηγορίας II 2 G/D.

- 1) Η εγκατάσταση των οργάνων με αντιαεκρηκτική προστασία πρέπει να γίνει από εξειδικευμένο προσωπικό.
- 2) Το όργανο τύπου GF90/92 flowmeter πρέπει να είναι γειωμένο.
- 3) Τα τερματικά ηλεκτρικών συνδέσεων (κλέμες) και τα ηλεκτρονικά κυκλώματα είναι εγκατεστημένα σε περιβλήμα αντιαεκρηκτικό και αεροστεγές σύμφωνα με τις ακόλουθες παρατηρήσεις:
  - Το κενό ανάμεσα στο περίβλημα και στο κάλυμμα είναι τέτοιο που αποτρέπει την διάδοση σπινθήρα.
  - Το "Ex-d" αντιαεκρηκτικό περίβλημα, έχει ανοίγματα εισόδου καλωδίου με διάμετρο ¾ ή/και 1 ίντσα NPT, κατάλληλα για τοποθέτηση υποδοχής αντιαεκρηκτικού καλωδίου πιστοποιημένης κατά EN50018/EN60079-1
  - Βεβαιωθείτε ότι πριν το άνοιγμα καλύμματος του του "Ex-d" αντιαεκρηκτικού περιβλήματος, η τάση τροφοδοσίας είναι αποσυνδεδεμένη ή ότι δεν υφίσταται στη περιοχή εκρηκτική ατμόσφαιρα (π.χ. κατά τη διάρκεια της σύνδεσης ή εργασίας συντήρησης)
  - Κατά τη διάρκεια ομαλής λειτουργίας: Το κάλυμα του "d" καλύμματος αντιαεκρηκτικού περιβλήματος πρέπει να είναι εντελώς βιδωμένο και ασφαλισμένο, σφίγγοντας μία από τις βίδες ασφαλείας του περιβλήματος.

## FIN Suomi - Turvallisuusohjeet

Nämä turvallisuusohjeet koskevat Fluid Components, GF90/92 EY-tyyppitarkastustodistuksen nro. KEMA 03 ATEX 2152 mukaisesti (todistuksen numero näkyy tyyppikilvestä) käytettäessä räjähdysvaarallisissa tiloissa luokassa II 2G/D.

- 1) Ex-laitteet on aina asennettava ammattihenkilökunnan toimesta.
- 2) GF90/92 flowmeter on maadoitettava.
- 3) Syöttöjännitteen kytkemisessä tarvittavat liittimet ja elektroniikka on asennettu koteloon jonka rakenne kestää räjähdyspaineen seuraavien lisäksi :
  - Kotelon ja kannen välissä on räjähdyspurkausväli.
  - Ex-d liittämät kotelossa on 3/4" NPT ja/tai 1" NPT kierre EN50018/EN60079-1 mukaisen Ex-d kaapeliläpiviennin asennusta varten
  - Kun "d"-kotelon kansi avataan (esim. liitännän tai huollon yhteydessä), on varmistettava, että joko syöttöjohto on jännitteetön tai ympäristössä ei ole räjähtäviä aineita.
  - "d" -kotelon kansi on kierrettävä aivan kiinni käytön yhteydessä ja on varmistettava kiertämällä yksi kannen lukitusruuveista kiinni.

## F B L Consignes de sécurité

Ces consignes de sécurité sont valables pour le modèle GF90/92 flowmeter de la société Fluid Components (FCI) conforme au certificat d'épreuves de type KEMA 03 ATEX 2152 (numéro du certificat sur l'étiquette signalétique) conçu pour les applications dans lesquelles un matériel de la catégorie II2G/D est nécessaire.

- 1) Seul un personnel spécialisé et qualifié est autorisé à installer le matériel Ex.
- 2) Les GF90/92 flowmeter doivent être reliés à la terre.
- 3) Les bornes pour le branchement de la tension d'alimentation et l'électronique sont logées dans un boîtier à enveloppe antidéflagrante avec les notes suivantes :
  - Le volume entre le boîtier et le couvercle est protégé en cas d'amorçage.
  - Le boîtier de raccordement Ex-d dispose d'un filetage ¾" NPT et/ou 1" NPT pour le montage d'un presse-étoupe Ex-d certifié selon la EN50018/EN60079-1.
  - Avant d'ouvrir le couvercle du boîtier « d » et pendant toute la durée où il le restera (pour des travaux de raccordement, d'entretien ou de dépannage par exemple), il faut veiller à ce que la ligne d'alimentation soit hors tension ou à ce qu'il n'y ait pas d'atmosphère explosive.
  - Pendant le fonctionnement de l'appareil, le couvercle du boîtier « d » doit être vissé et serré jusqu'en butée. La bonne fixation du couvercle doit être assurée en serrant une des vis d'arrêt du couvercle.

## I Italiano - Normative di sicurezza

Queste normative di sicurezza si riferiscono ai Fluid Components, GF90/92 secondo il certificato CE di prova di omologazione n° KEMA 03 ATEX 2152 (numero del certificato sulla targhetta d'identificazione) sono idonei all'impiego in atmosfere esplosive applicazioni che richiedono apparecchiature elettriche della Categoria II 2 G/D.

- 1) L'installazione di sistemi Ex deve essere eseguita esclusivamente da personale specializzato.
- 2) I GF90/92 flowmeter devono essere collegati a terra.
- 3) I morsetti per il collegamento e l'elettronica sono incorporati in una custodia a prova di esplosione („d“) con le seguenti note:
  - La sicurezza si ottiene grazie ai cosidetti „interstizi sperimentali massimi“, attraverso i quali una eventuale accensione all'interno della custodia non può propagarsi all'esterno o raggiungere altre parti dell'impianto.
  - La scatola di collegamento Ex-d ha una filettatura 3/4" e/o 1" NPT per il montaggio di un passacavo omologato Ex-d secondo EN50018/EN60079-1.
  - Prima di aprire il coperchio della custodia „d“ (per es. durante operazioni di collegamento o di manutenzione) accertarsi che l'apparecchio sia disinserito o che non si trovi in presenza di atmosfere esplosive.
  - Avvitare il coperchio della custodia „d“ fino all'arresto. Per impedire lo svitamento del coperchio é possibile allentare una delle 2 viti esagonali poste sul corpo della custodia, incastrandola nella sagoma del coperchio.

## NL B Nederlands - Veiligheidsinstructies

Deze veiligheidsinstructies gelden voor de Fluid Components, GF90/92 overeenkomstig de EG-typeverklaring nr. KEMA 03 ATEX 2152 (nummer van de verklaring op het typeplaatje) voor gebruik in een explosieve atmosfeer volgens Categorie II 2G/D.

- 1) Installatie van Ex-instrumenten dient altijd te geschieden door geschoold personeel.
- 2) De GF90/92 flowmeter moet geaard worden.
- 3) De aansluitklemmen en de electronika zijn ingebouwd in een drukvaste behuizing met de volgende opmerkingen:
  - De schroefdraadspleet tussen de behuizing en de deksel is een ontstekingsdoorslagveilige spleet.
  - De Ex-d aansluitbehuizing heeft een 3/4" of een 1" NPT schroefdraad voor aansluiting van een volgens EN50018/EN60079-1 goedgekeurde Ex- 'd' kabelinvoer.
  - Er moet worden veilig gesteld dat vóór het openen bij een geopende deksel van de 'd' behuizing (bijv. bij aansluit- of servicewerkzaamheden) hetzij de voedingsleiding spanningsvrij is, hetzij geen explosieve atmosfeer aanwezig is.
  - De deksel van de 'd' behuizing moet tijdens bedrijf tot aan de aanslag erin geschroefd zijn. Hij moet door het eruit draaien van een van de dekselborgschroeven worden geborgd.

## P Português - Normas de segurança

Estas normas de segurança são válidas para os Fluid Components, GF90/92 conforme o certificado de teste de modelo N.º KEMA 03 ATEX 2152 (número do certificado na plaqueta com os dados do equipamento) são apropriados para utilização em atmosferas explosivas categoria II 2 G/D.

- 1) A instalação de equipamentos em zonas sujeitas a explosão deve, por princípio, ser executada por técnicos qualificados.
- 2) Os GF90/92 flowmeter precisam ser ligados à terra.
- 3) Os terminais e a electrónica para a conexão da tensão de alimentação estão instalados num envólucro com protecção contra ignição á prova de sobrepressão com as seguintes notas :
  - A fenda entre o envólucro e a tampa deve ser á prova de passagem de centelha.
  - O envólucro de conexão Ex-“d“ possui uma rosca 1" NPT e/ou 3/4" NPT para a entrada de cabos Ex-“d“ certificado conforme a norma EN50018/EN60079-1.
  - Deve-se assegurar que, antes de abrir a tampa do armário „d“ ( por exemplo, ao efectuar a conexão ou durante trabalhos de manutenção), o cabo de alimentação esteja sem tensão ou que a atmosfera não seja explosiva.
  - Durante a operação, a tampa do envólucro „d“ deve estar aparafusada até o encosto. A tampa deve ser bloqueada, por um dos parafusos de fixação.

## **E** Español - Instrucciones de seguridad

Estas indicaciones de seguridad son de aplicación para el modelo GF90/92 flowmeter de Fluid Components, según la certificación CE de modelo N° KEMA 03 ATEX 2152 para aplicaciones en atmósferas potencialmente explosivas según la categoría II 2 G/D (el número de certificación se indica sobre la placa informativa del equipo).

- 1) La instalación de equipos Ex tiene que ser realizada por personal especializado.
- 2) Los GF90/92 tienen que ser conectados a tierra.
- 3) Los bornes de conexión y la unidad electrónica están montados dentro de una caja con protección antideflagrante y resistente a presión, considerándose los siguientes puntos:
  - La holgura entre la rosca de la tapa y la propia de la caja está diseñada a prueba contra ignición.
  - La caja tiene conexiones eléctricas para entrada de cables con rosca 3/4" y/o 1" NPT, donde deberán conectarse prensaestopas certificados Exd según EN50018/EN60079-1.
  - Antes de la apertura de la tapa de la caja "Exd" (p. ej. durante los trabajos de conexión o de puesta en marcha) hay que asegurar que el equipo se halle sin tensión o que no exista presencia de atmósfera explosiva.
  - Durante el funcionamiento normal: la tapa de la caja antideflagrante tiene que estar cerrada, roscada hasta el tope, debiéndose asegurar apretando los tornillos de bloqueo.

## **S** Svenska - Säkerhetsanvisningar

Säkerhetsanvisningarna gäller för Fluid Components, Flödesmätare typ GF90/92 flowmeter enligt EG-typkontrollintyg nr KEMA 03 ATEX 2152 (intygsnumret återfinns på typskylten) är lämpad för användning i explosiv gasblandning i kategori II 2 G/D.

- 1) Installation av Ex- klassade instrument måste alltid utföras av fackpersonal.
- 2) GF90/92 måste jordas.
- 3) Anslutningsklämmorna och elektroniken är inbyggda i en explosions och trycktät kapsling med följande kommentar:
  - Spalten mellan kapslingen och lockets gänga är flamsäker.
  - Ex-d kapslingen har en 3/4" och / eller 1" NPT gänga för montering av en EN50018/EN60079-1 typkontrollerad Ex- „d“ kabel förskruvning
  - När Ex- „d“ -kapslingens lock är öppet (t.ex. vid inkoppling - eller servicearbeten) ska man se till att enheten är spänningslös eller att ingen explosiv gasblandning förekommer.
  - Under drift måste Ex - d“ -kapslingens lock vara iskruvad till anslaget. För att säkra locket skruvar man i en av lockets insex låsskruvar .

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# Appendix D. Customer Service

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## Customer Service/ 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](mailto: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](http://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**

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

Documents 1 and 2 follow this page.

**Hardware Return Procedure**

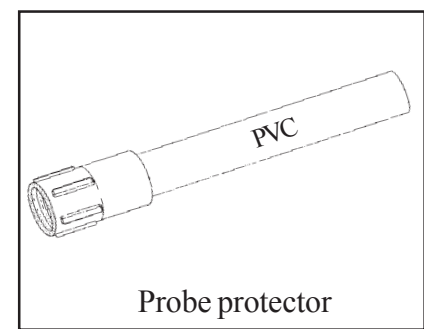
Complete a Return Authorization (RA) Request/Certificate of Non-Contamination form (Document 1). Mail or fax it to FCI Customer Service Department. After FCI issues an RA number, complete the following steps:

1. Thoroughly clean the hardware.
2. 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 (11.34 KG) each are to be covered with protective wrap, i.e. bubble wrap or surrounded with "popcorn". Instruments weighing greater than 60 pounds (27.7 KG) 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 as shown below.
  - c. Protect the electronics with an Anti-Static bag like the one shown below.
  - d. Do not pack more than four small instruments in each carton.
  - e. Packages weighing in excess of 70 pounds (31.8 KG) or with a combined length and girth of more than 138 inches (350 cm) cannot be shipped by United Parcel Service. Larger packages or crates should be shipped by carriers who specialize in the transport of industrialized instrumentation.
  - f. The RA number should be noted on the packing list and marked clearly on the outside of the box.
3. Prepay freight to the FCI receiving door.

**Shipping/Handling Charges**

All Shipping (Warranty/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. 92078-5115 USA  
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.

**Non-Warranty 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 Procedures**

Contact an 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.

**Field Service 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 FCI's 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.



1755 La Costa Meadows Drive, San Marcos, CA 92078-5115 USA  
 760-744-6950 / 800-854-1993 / Fax: 760-736-6250  
 Web Site: www.fluidcomponents.com  
 E-mail: techsupport@fluidcomponents.com

RA # \_\_\_\_\_

## Return Authorization Request

**1. Return Customer Information**

Returning Company's Name: \_\_\_\_\_ Fax # \_\_\_\_\_  
 Return Contact Name: \_\_\_\_\_ Phone # \_\_\_\_\_  
 Email Address: \_\_\_\_\_

**2. Return Address**

Bill To: \_\_\_\_\_ Ship To: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

**3. Mandatory End User Information**

Contact: \_\_\_\_\_ Company: \_\_\_\_\_ Country: \_\_\_\_\_

**4. Return Product Information**

Model No: \_\_\_\_\_ Serial No(s): \_\_\_\_\_  
 Failure Symptoms (Detailed Description Required): \_\_\_\_\_

What Trouble Shooting Was Done Via Phone or Field Visit by FCI: \_\_\_\_\_

FCI Factory Technical Service Contact: \_\_\_\_\_

- 5. Reason For Return**     Sensor Element     Electronics     As Found Testing     Credit  
 Recalibrate (Old Data)     Recalibrate (New Data)     Other

*(Note: A new Application Data Sheet (ADS) must be submitted for all recalibrations and re-certifications)*

- 6. Payment Via**     Faxed Purchase Order

*(Note: A priced quotation is provided for all Non-Warranty repairs after equipment has been evaluated. All Non-Warranty repairs are subject to a minimum evaluation charge)*

**Decontamination Information!      This Section Must Be Completed!**

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 or toxic materials or substances in which they may come in contact while handling returned products. Consequently, our employees must have access to data regarding the hazardous or toxic materials or substances which the equipment has been exposed to in your process(es). Accordingly, prior to returning your instrument for evaluation/repair, please read then sign the certification below and thoroughly comply with the applicable instructions. I certify that the returned item(s) has(have) been thoroughly and completely cleaned. If the returned item(s) has(have) been exposed to hazardous or toxic materials or substances, the undersigned attests that the attached Material Safety Data Sheet(s) (MSDS) which cover said materials or substances are complete and accompany the returned item(s). Furthermore, I understand that this Certificate, or providing a MSDS, shall not waive our responsibility to provide a neutralized, decontaminated, and clean product for evaluation/repair to FCI. Cleanliness of a returned item or the acceptability of the MSDS shall be at the sole discretion of FCI. Any item returned which does not comply with these instructions shall be returned to your location Freight Collect and at your risk.

Process Flow Media \_\_\_\_\_

Authorized Signature \_\_\_\_\_ Date \_\_\_\_\_

## Document 2. Warranties

### 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 one (1) year 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 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. 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. THIS WARRANTY IS EXPRESSLY IN LIEU OF ANY AND ALL OTHER EXPRESS OR IMPLIED WARRANTIES WITH RESPECT TO THE GOODS OR THEIR INSTALLATION, USE, OPERATION, REPLACEMENT OR REPAIR, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS OF PURPOSE; AND THE GOODS ARE BEING PURCHASED BY BUYER "AS IS". SELLER WILL NOT BE LIABLE BY VIRTUE OF THIS WARRANTY OR OTHERWISE FOR ANY SPECIAL, INCIDENTAL OR CONSEQUENTIAL LOSS OR DAMAGE RESULTING FROM THE USE OR LOSS OF USE OF THE GOODS.



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