5. 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 2, Installation for ESD details.

Quick Check

Verify the serial numbers of the flow element and electronics match.
Verify all cables are seated firmly.
Verify all customer connections are correct.
Verify the wiring is per the wiring diagram in Chapter 2.
Verify the installation is correct as shown in Chapter 2.
Check customer fuses and power switches.
Press [P] to reconfigure the FC88 to the proper 2 line display.
Press [N] to reset the software.

General Function Check

Once the flow meter has been installed and turned on, the instrument can be checked for proper operation by performing the NAMUR functional checks. The following tools will be required for this check.

Tools Needed - General Function Check -

FC88 Communicator or Computer with Interface Kit - Contact a Field Representative or Customer Service to purchase an FC88 or computer interface kit.
Digital Multimeter (DMM)
Allen Wrench 1/16 Inch (for aluminum, circular enclosure)
Medium size flat blade Screwdriver (for steel, square enclosure)

NAMUR Fault Indication

NAMUR NE43 is a German fault detection standard that lets the user know if there is a fault within the instrument. The fault indicator can be turned on or off with the **X** menu function as described in Chapter 3 - Operation.

When the indicator is on and a fault is detected the 4-20 mA output will be driven to less than or equal to 3.5 mA, or 22 mA or greater, depending upon what the user chooses. If a voltage output was selected, the output will be driven from 0 to 1 volt every 7 seconds. The voltage fault indicator is not part of the NAMUR NE43 standard.

When the NAMUR Fault indication is turned on (Menu **X**), the faults will be displayed when the instrument is in the normal operation mode (Menu **T**).

In a few cases there may be two error indications when there is only one fault. A single fault can cause multiple problems with the instrument, therefore there are more than one fault indications. The fault indications shown in the **T** mode are prioritized in the order of where the problem will most likely be found.

Example: Error codes are: "Sensor Error" "Overtemp Head"
There is most likely a sensor element wiring problem that is creating an over temperature fault situation.

Procedure

Open the enclosure to expose the customer connection board.

Connect the FC88 or computer to the RS-232 Jack (P1).

Set the FC88 communicator or computer to display the **T** mode.

Turn on the NAMUR fault flag (menu **X**).

Compare the fault indication from the **T** mode with Table 5-1. Follow the instructions provided in the table.

Table 5-1. NAMUR Fault Listing

Indicated Faults	Possible Causes
Nothing displayed on the FC88 or the optional display. No display on the FC88 no display on the optional display.	Power is not applied to the instrument. Power is not correctly applied to the customer connection board. There is a green LED that lights when AC power is applied. It is on the back side of the customer circuit board behind P1 (it is hard to see). If it is blinking remove power and contact customer service.
No display on the FC88. There is a display on the optional LCD display.	Press [P] [ENTER] on the FC88 to reset it. If there is no response connect it to another ST98 (if present) to verify operation. Replace the cable between the ST98 and the FC88 if there is no operation. If no operation contact customer service.
No fault indicated. Output mA or Vout operates correctly.	Verify the NAMUR option is activated [X] [ENTER]. If there is no fault indicated, verify the heater is on [H] [ENTER]. If there is no fault indicated, proceed to the installation and Application Verification procedure.
No fault indicated but the 4-20 mA (or Voltage) output is not transmitting.	Go to the Instrument Output Check procedure.
Sensor Error.	Wiring to the sensing element may be incorrect. One or more of the sense or excitation wires may be disconnected or shorted. The active or reference RTD is either open or shorted. Check the wiring (see Appendix A) and the sensor resistance as shown later in this chapter.
OverTemp Head!!	The process temperature has exceeded the maximum temperature rating of the flow element (350°F). Verify the temperature of the process. If the temperature is over 350°F, remove the flow element from the process. Damage to the flow element will occur. Contact customer service.
UnderTemp Head!!	The process temperature has exceeded the minimum temperature rating of the flow element (-50°F). Verify the temperature of the process. If the temperature is under -50°F, remove the flow element from the process. Damage to the flow element will occur. Contact customer service.
Open Heater!!	The flow element's heater has exceeded the maximum resistance allowed (approximately 170 ohms) or is disconnected. This limit also includes the cable resistance in remote installations. The heater fault flag will come on in cases when the heater is turned off (using the menu key [H] [ENTER]). Check the wiring and the sensor resistance.
Shorted Heater!!	The flow element's heater has exceeded the minimum resistance allowed (approximately 90 ohms) or it is shorted. This limit also includes the cable resistance on remote installation. The heater fault flag will come on in cases when the heater is turned off (using the menu key [H] [ENTER]). Check the wiring and the sensor resistance.

Application Verification

After verifying that the flow meter is functioning, review the application parameters as shown below to verify the calibration matches the process media.

Equipment Needed

Flow Instrument Calibration Data
Process Parameters and Limits

Check Serial Numbers

Verify that the serial number of the flow element and the flow transmitter electronics are the same. The flow element and the flow transmitter are a matched set and cannot be operated independently of each other.

Check the Instrument Installation

Review the information in Chapter 2 - Installation, to verify correct mechanical and electrical installation.

Verify that the flow element is mounted at least 20 diameters downstream and 10 diameters upstream from any bends or interference in the process pipe or duct.

Check for Moisture

Check for moisture on the flow transmitter. Moisture on the flow transmitter may cause intermittent operation.

Check for moisture on the flow element. If a component of the process media is near its saturation temperature it may condense on the flow element. Place the flow element where the process media is well above the saturation temperature of any of the process gases.

Check Application Design Requirements

Application design problems may occur with first time application instruments, although the design should also be checked on instruments that have been in operation for some time. If the application design does not match field conditions, errors occur.

1. Review the application design with plant operation personnel and plant engineers.
2. Ensure that plant equipment such as pressure and temperature instruments conform to the actual conditions.
3. Verify operating temperature, operating pressure, line size, and gas medium.

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 flow meters, 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 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, 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:

$$Q_S = Q_A \times \frac{P_A}{T_A} \times \frac{T_S}{P_S}$$

(Metric: Where bar(a) and °K are used for pressure and temperature.)

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

PSIA and °R are used for pressure and temperature units.

Example: (Metric: P_S = 1.01325 bar(a)

Q_A = 1212.7 ACFM Q_S = 1485 SCFM T_S = 21.1°C (294.1K))
P_A = 19.7 PSIA T_A = 120°F (580°R)
P_S = 14.7 PSIA T_S = 70°F (530°R)

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

Verify the Calibration Parameters

The instrument uses a set of predetermined calibration parameters to process flow signals. Most of these parameters should not change. A data package located at the rear of this manual contains the "ST98 Delta R Data Sheet". This contains the calibration ST98 parameters stored in the flow transmitter at the factory. To verify that these parameters have not changed, complete the following:

1. Identify the appropriate Delta R Data sheets by serial number of the instrument.
2. Press [D] [ENTER] to examine each of the parameters. The [ENTER] key allows scrolling one message at a time. Use Table 5-2 to verify parameters with the Delta R Data sheet ST98 Parameters.

Table 5-2. Diagnostic Test Sequence on Display

Serial No.		eu:	
Cust. No.		curvefit:	
scale:		outmode:	
*c1:		*maxflow:	
*c2:		*minflow:	
*c3:		*Max A/D:	
*c4:		tot:	
*c5:		tflow:	
*c6:		*Min A/D:	
*c7:		*Density:	
*c8:		K-Factor:	
*c9:		zero:	
*c10		*sensor:	
*caltemp:		*tslp:	
*balance:		*tcslp0:	
*outz:		*tcslp:	
*outf:		*tcslp2:	
*heater i:		line size0	
*toff:		line size1:	
factor:		F.S.:	

If parameters that have an asterisk (*) have changed, this may indicate a problem. Customer Service should be contacted. If the parameters have not changed, continue with the next section.

Check the Hardware

Equipment Required

FC88 Communicator or Computer with Interface Kit - Contact a Field Representative or Customer Service to purchase an FC88 or computer interface kit.
Digital Multimeter (DMM)
Allen Wrench 1/16 Inch (for aluminum, circular enclosure)
Flat blade Screwdriver (for steel, square enclosure)

Troubleshooting the Flow Element

Use Table 5-3 to determine if the flow element is wired correctly or has failed. Table 5-3 is for resistances at a process temperature of about 70 degrees. To determine the exact resistance at another process temperature use the temperature versus resistance table in Appendix A.

Turn off the input power to the instrument. Unplug TS2 from the circuit board assembly and measure the resistances as shown in Table 5-3.

See Figure 5-1 for component placement and Figure 5-2 for a view of the plug. If the instrument is set up in a remote configuration (flow element enclosure separate from the control circuit enclosure), and the ohm readings are incorrect disconnect the flow element cable at the local (flow element) enclosure. Measure the resistance as shown in Table 5-3. Figure 5-3 shows the terminal block configuration.
If the resistance is correct then the cable between the enclosures is probably bad or not connected properly (loose, corroded, or connected to the wrong terminal).

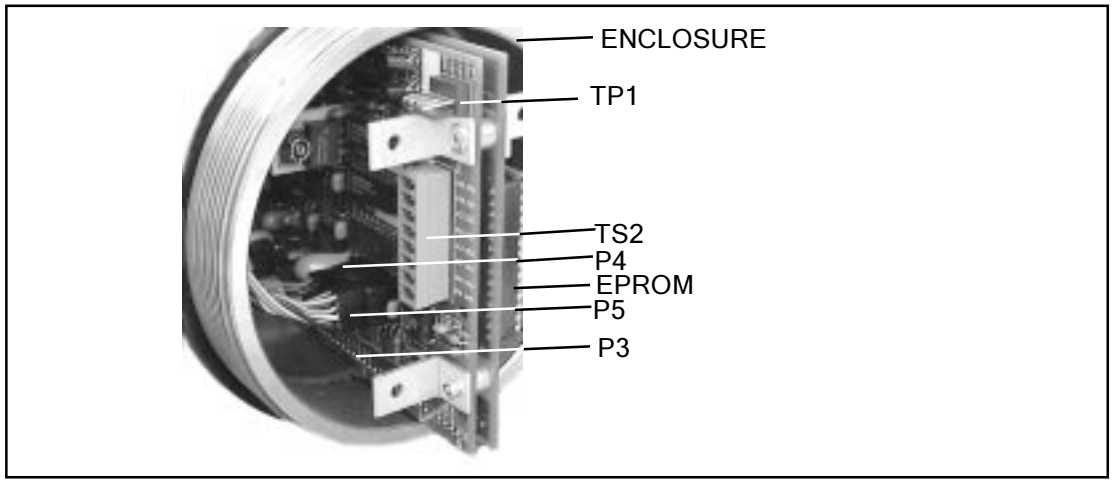

Figure 5-1. Component Identification

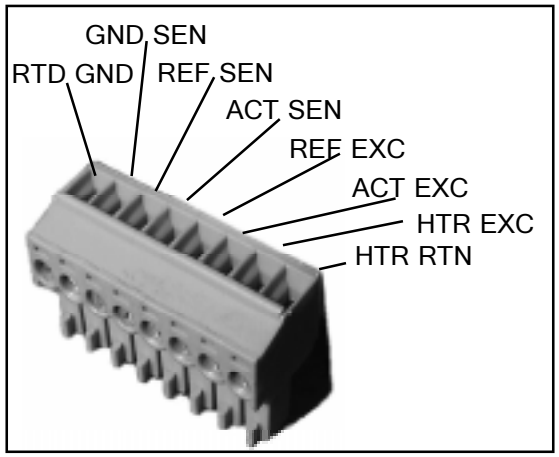

Figure 5-2. TS2 Connector Plug

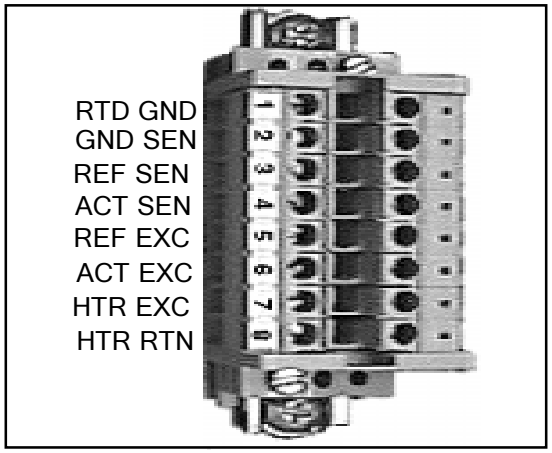

Figure 5-3. Terminal Block In Local Enclosure

Table 5-3. Flow Element Resistance at TS2 or Local Terminal Block

LUG OR PIN NUMBER	RESISTANCE
(7) HTR EXC TO (8) HTR RTN	110 - 118 OHMS
(4) ACT SEN TO (2) GND SEN	1.1K OHM
(3) REF SEN TO (2) GND SEN	1.1K OHM
(3) REF SEN TO (4) ACT SEN	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
SHIELD TO HTR RTN (8) (REMOTE INSTALLATIONS)	

The resistance of the Active and Reference sensor will depend on the temperature of the sensing element. Refer to the "Temperature Versus Resistance" Table in Appendix A.

When measuring the resistance of the flow element through a long remote cable, the cable resistance must be subtracted from the measurement. The residual resistance of the DVM and its leads should also be considered. See Table 5-4 to calculate the resistance for copper wire. Each wire gauge size number increase represents a factor of 1.26 resistance increase over the previous size. Moving three gauge sizes higher doubles the resistance. To convert the table values to ohms per meter, multiply the value by 0.0394.

Table 5-4. Resistance Versus Wire Size (AWG)

AWG Size	Ohms Per 1000 Feet
14	2.52
15	3.18
16	4.02
17	5.05
18	6.39
19	8.05
20	10.1
21	12.8
22	16.2
23	20.3
24	25.7

Check the Flow Element Voltages

Use the following voltage measurements if power cannot be easily removed from the instrument or if resistance measurement fail to resolve the problem. Be sure the sensor heater current is set to 75 mA LO by pressing [O] on the FC88 and selecting the heater current. Be sure to set the heater current back to where it was before beginning this procedure. Make the voltage measurements found in Table 5-5 at terminal strip TS2 on the flow transmitter, or on the Local Terminal Block.

Table 5-5. Approximate Flow Element Voltages AT 70° F

LUG OR PIN NUMBER	VOLTAGE*
(7) HTR EXC TO (8) HTR RTN	Approximately 6.79 VDC
(4) ACT SEN TO (6) ACT EXC	Approximately 0.00 VDC
(3) REF SEN TO (5) REF EXC	Approximately 0.00 VDC
(5) REF EXC TO (1) RTD GND	Approximately 2.20 VDC
(6) ACT EXC TO (1) RTD GND	Approximately 2.21 - 2.82 VDC**
(4) ACT SEN TO (3) REF SEN	Approximately 0.24 VDC**

Cable resistance of the remote flow element will affect the TS2 voltage readings at the electronics enclosure.

*Voltages varies with Temperature and Flow and the Sensor Heater Current Selection.

**Voltage will vary with the process flow rate.

Verification Of The Electronics

Check the Flow Transmitter Voltages

Check the voltages in Table 5-6 being sure the volt meter is in the volt mode. Using the DVM in the current mode will damage the flow transmitter.

Table 5-6. Instrument Voltages

PIN NUMBER	VOLTAGE
P3-1 TO P3-5	-9 TO -5 VDC
P3-1 TO P3-6	+5 ± 0.2 VDC
P3-1 TO P3-11	+2 ± 0.01 VDC
TP1 +15 TO TP1 GND	+15 ± 0.5 VDC
TP1 +20 TO TP1 GND	+20 ± 0.5 VDC
TP1 +10 TO TP1 GND	+10 ± 0.01 VDC

If the voltage checks correspond to Table 5-6, the electronics are functioning properly.

Transmitter Circuit Calibration Check (Delta R Verification)

Equipment Needed

FC88 Communicator or equivalent
DVM
Original Delta R Data Sheet - Match By Serial Numbers
2 Precision Decade Resistance Boxes, 0.1% (Largest Steps: 1K Ohm, Smallest Steps 0.01 Ohms)
10 feet of wire, 22 to 18 AWG
Small Flat Blade Screwdrivers, 3/32 and 1/8 inches wide blades.
Small Wire Cutters
Small Wire Strippers

Procedure

1. Turn power off.
2. Mark all wires connected to terminal strip TS2 (or the terminal block for remote instruments) so they may be reconnected to the proper terminals. Disconnect the wires.
3. Connect the resistance decade boxes to terminal strip TS2 (or the terminal block for remote instruments) as shown in Figure 5-4. Check the Delta R Data sheet for the nominal resistance value. Set the decade boxes for the nominal resistance value ±0.01%.
4. Turn the power on and allow the instrument 5 minutes to stabilize.
5. Press [T] [ENTER] to view the normal operating mode. Adjust the active and reference decade boxes. Verify the parameters on the FC88 change.

If the display changes, proceed to the next section. If the display is frozen the instrument is malfunctioning. Contact Customer Service.

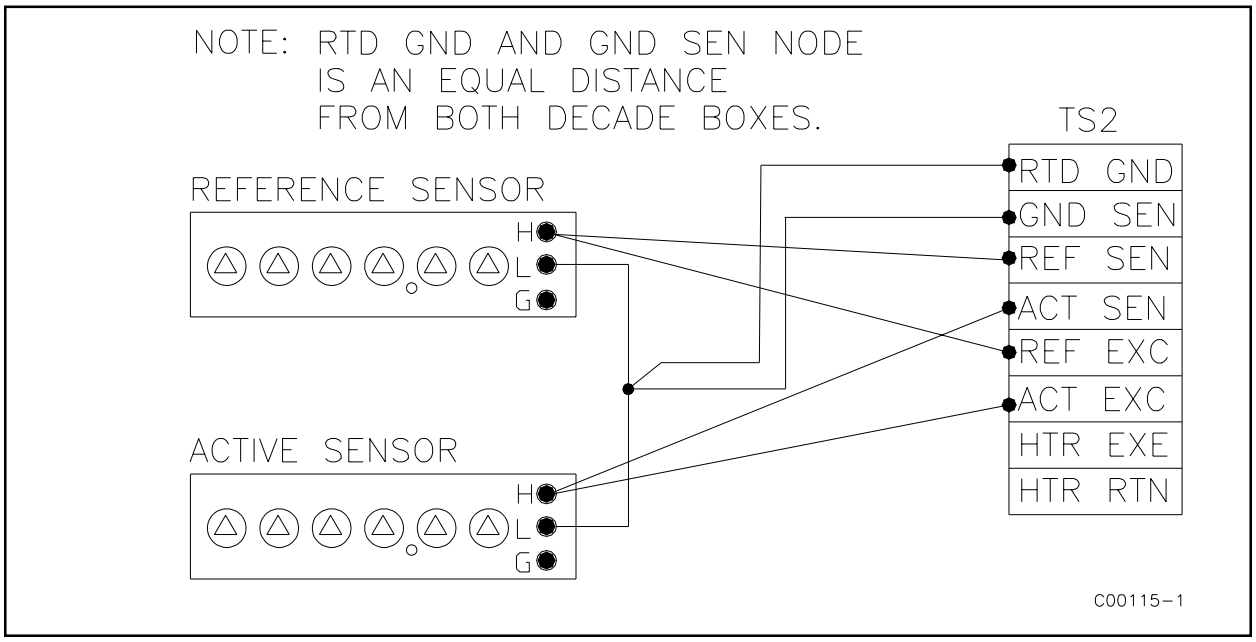

Figure 5-4. Decade Box Connections

Instrument Output Check

Alert: If the mA output is being used on the flow transmitter, the receiver must have a resistance range of 0 to 700 ohms, including the cable resistance.

To vary the output, follow the procedure below:

1. Press [I] then [ENTER] on the FC88. "Enter #(0 01000)" will be displayed on the FC88. Press [0] for minimum output or [500] for an output that is in the center of the range or [1000] for a maximum output.
2. Check the receiver and verify that it agrees with what is being sent.
3. When the above step is verified press [ENTER].

If the receiver is not responding to the signal being sent, remove the power from the instrument. Disconnect the output cable (TS3) and connect a current meter to "mA OUT". Apply power to the instrument and go through the [I] routine to check the output locally. If the mA output responds correctly then there is a problem with the cable or receiver. If there is no response form the mA output, there may be a configuration error or the output circuit is inoperative.

The voltage output option can also be checked with the [I] menu and can help solve problems with the 4-20 mA output

Alert: When finished with troubleshooting be sure that environmental seals are intact and properly installed when securing enclosure lids. Damage resulting from moisture penetration of the Local or Remote Enclosure is NOT covered by product warranty.

Spares

FCI recommends one of each of the following should be kept as a spare: One identically set up ST98 Flow meter. Contact FCI for specific recommendations.

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.

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 C for specific Customer Service policy provisions.