Section 1 - General Description

1.1 OVERVIEW OF INSTALLATION AND OPERATION

Step 1. Select an appropriate site for the unit and mount it (Section 2).

Step 2. Configure the hardware according to your requirements:

- Verify switch settings and jumper connections (Section 3.1 and Appendix B)
- Make power connections (Section 3.2)
- Make signal connections (Section 3.3)
- Make communication connections if a host computer or printer is used (Section 3.4)

Step 3. Power-up your unit (Section 4.2).

Step 4. Familiarize yourself with the basic operation (Section 4).

Step 5. Program the unit according to your specific application requirements (Section 5). This may also be done using a host computer (Section 7).

Step 6. Monitor the flow as desired:

- Via the keypad and display (Section 6).
- Via a host computer (Section 7).
- Via a periodic printed report (Section 8).

1.2 FP-100 FEATURES

The FP-100 is a microprocessor-based flow processor, data logger, and remote terminal unit (RTU) that is fully programmable for a wide variety of flow applications and capable of monitoring a variety of flows and flow-related variables. As a programmable device, it can satisfy the requirements of nearly any flow application.

Enclosure

The FP-100 comes in an enclosure that meets or exceeds the National Electrical Manufacturer's Association (NEMA) requirements for a class 4 equipment enclosure. With its NEMA 4 rating, the FP-100 is protected from harsh environments where dust and steam could interfere with its operation.

Fluid Types

The FP-100 is capable of monitoring the flow of nearly any gas or liquid. Specific applications include: saturated or superheated steam, mass or heat flow of non-compressible liquids, ideal gas, and natural gas.

Inputs

A variety of different electrical inputs can be used with the FP-100. These inputs, with their corresponding functions, are summarized in the table below. A combination of these inputs may be selected to fit your specific flowmetering requirements.

Application	Input Type	Description
Flow Rate (Velocity)	Frequency	Square wave, sine wave, or pulse. 0 to 60 kHz, 2.5 to 40 V peak, 10 µsec minimum pulse width, 10 kΩ minimum impedence
	Analog	4 to 20 mA, 50 Ω nominal resistance
Flow Direction	Digital	Contact closure. Forward = 5 to 30 VDC or open; Reverse = 0 VDC or ground
Pressure	Analog	See above.
Temperature	Analog	See above.
	RTD	2 or 3 wire platinum, 1000 Ω nominal at 0 °C

Table 2-1. Input Application Guide

Outputs

The standard FP-100 has two digital outputs. Three analog outputs and eight relay outputs are available as an option. Refer to the model codes

Based upon inputs received from the transducers and data programmed into the unit, the FP-100 can calculate and display any of the following output variables and also show their associated engineering units in either English or metric equivalents:

- Temperature (cold, hot, and differential temperature)
- Line pressure (gauge and absolute)
- Fluid velocity
- Volumetric flow rate
- Mass flow rate
- Gas flow rate
- Heat flow rate
- Steam quality
- Fluid density
- Fluid enthalpy

In addition to the output variables listed, the FP-100 may be configured to accumulate (totalize) flow in the forward and reverse directions, and will also provide average, minimum, and maximum values for five of the output variables. Two optional mechanical totalizers can be used to accumulate any flow in a variety of user-selectable units, and three analog outputs producing 4-20 mA signals are also available. The analog outputs can be assigned and independently scaled to any of the output variables.

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Communication
A communication port built into the unit allows a host computer or other device to program and monitor the FP-100 from a central location. This port may be configured as either RS-422 or RS-423 (RS-232) with user-selectable baud rate and data format.

Printer
A separate communication port may be used to link the FP-100 with any RS-232 compatible serial printer. Data logging features support virtually unlimited report formats and intervals. This port provides user-selectable baud rate and data format.

System Security
Through the use of a lockable cabinet and a security password, the FP-100 is designed to prevent unauthorized manipulation of the programmed data. Furthermore, non-volatile memory is provided with a least six months of internal battery backup in the event of a power failure.

1.3 DEFINITION OF TERMS
The following terms appear frequently with the text of this manual. It is important that the user fully understand the meaning of each.

Programming vs. Display Mode
Programming mode refers to the operational state of the FP-100 during which various system parameters may be defined or altered. Display mode refers to the state during which normal monitoring of data and system status takes place. Typically, the FP-100 will remain in display mode except when the user is initially programming the unit to fit his specific requirements.

Mode ID
A mode ID refers to a two-digit hexadecimal number that identifies one of the parameters of the FP-100 system. Generally, each mode ID corresponds to a single internal value, which may act as either an input or an output to the flow processor. Inputs, like the fluid type selection mode ID, control how the system will behave under various circumstances, whereas outputs, such as the flow rates and steam quality, report on the operation of the unit.

Transducer
A transducer is a device capable of making an instantaneous measurement of a physical phenomenon, such as fluid velocity or temperature, and then generating an electrical signal proportional to that measurement. As an example, a typical temperature transducer will measure the temperature of an object and convert this to a 4-20 mA signal. Transducer inputs to the FP-100 provide the necessary information for determining flow rates, fluid densities, etc.

Fault
A fault on the FP-100 indicates when something is or has been amiss with the operation of the system. When programmed correctly, these faults can lend a sort of built-in intelligence to the FP-100, signaling when and where the system needs attention. Faults may arise from a number of situations, typically when an input or output falls out of a specified range or when a hardware problem occurs.

1.4 FP-100 ORIENTATION

This section is included to familiarize the user with the physical layout of the FP-100 Flow Processor. When a procedure in this manual calls for access to a specific component, refer back to this section to see where with component is located and how it can be accessed. The figures on the following pages depict important parts of the FP-100 that are described in the text.

Caution: Any time a PC board is removed, wiring is disconnected, or any electrical component is service, make sure that power to the unit is turned off. Also be sure to note the correct location and orientation of the part in order to properly reposition it.

Before describing where the various components on the FP-100 are and how to access them, it is necessary to understand some of the basic orientation conventions. Directions pertaining to the front, top, bottom, etc., of the unit assume that it is positioned in a typical wall or panel mount fashion. Hence, front is the side with the keypad and display, bottom is the side with four round portholes (NEMA version only), etc.

The FP-100 cabinet or NEMA enclosure surrounds the unit and contains the four cutout holes on the bottom, which are used as I/O portholes for feeding electrical cables into the main housing. Four metal clamps, one each on the top and bottom and two on the right side, are used to secure the hinged front door and maintain the NEMA rating. To open the front door, loosen the screws holding these clamps, and use the key to unlock the cabinet if necessary. Swing the door out of the way to expose the front panel and associated components.

The keypad is used to manually interact with the FP-100, which the display provides an eight-character readout of the mode ID number and corresponding data. If your unit is equipped with optional mechanical totalizers, they will be installed directly below the display. The remaining components may be exposed by loosening the thumbscrew to the right of the keypad and swinging the entire front panel to the left. The card cage holds the printed circuit board, which are: the CPU Board, the Interface Board, and Output Board. The Output Board is optional and will be present only if analog or relay outputs were specified when the unit was ordered. Each of these boards may be removed by carefully dislodging it from it connector at the back of the card cage. Once removed, the board's switches, jumpers, and electrical connections may be accessed easily.

The location of the power supply module depends on whether 24 VDC or 115/230 VAC is used to power the unit. With the 24-volt supply, it is attached to the top of the card cage, whereas the 115/230 VAC version is mounted on the inside back plane of the unit. In either case, the power input terminal, on/off switch, and fuse are positioned for easy access on the power supply module.

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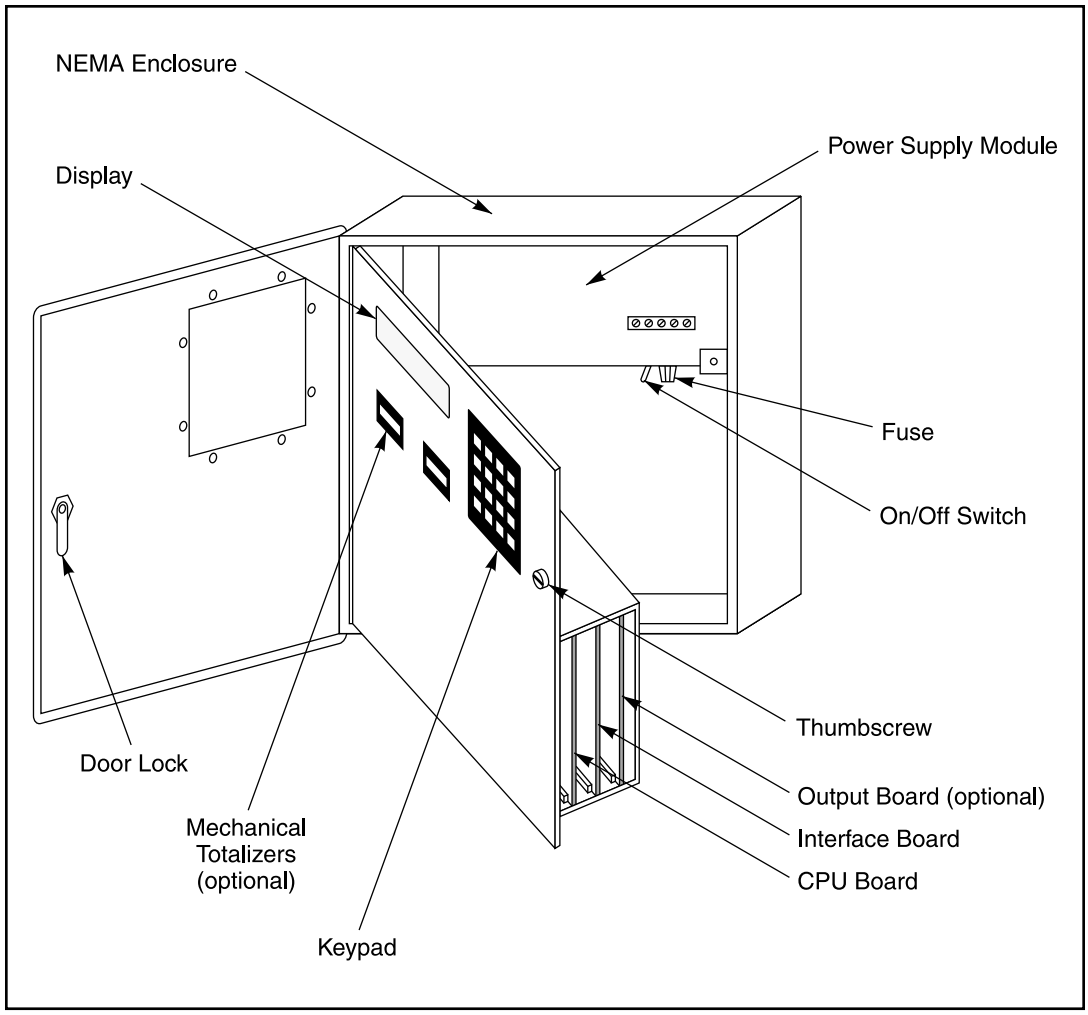

Figure 1-1. FP-100 Component Locations

Section 2 - Installation

2.1 GENERAL

The physical installation of the FP-100 is a straightforward process, which consists of selecting a suitable location and then mounting the unit. Carefully unpack the FP-100 and inspect it for possible shipping damage. If you detect any problems, immediately report them to the freight carrier and your EMCO representative. Make sure that your shipment contains all the necessary components as per your order.

2.2 SELECTING A SITE

Location of the FP-100 is not normally dependent upon environmental or electrical constraints. EMCO flowmeters, transducers, and densitometers may be several thousand feet from the unit, and the NEMA 4 enclosure allows placement either indoors or outdoors. In selecting a site, however, the user should keep in mind the following considerations:

- Make sure that the mounting structure is capable of supporting the unit's substantial weight (20 lb.). Use studs or beams to eliminate vibration.
- Select a location which provides adequate room for front door clearance and access to internal components. Remember to provide room for electrical wiring either through the four I/O portholes (NEMA version) or on back of the panel mount unit.
- Keep cable lengths as short as possible in order to minimize signal noise and electrical interference. See Section 3 for further wiring considerations.
- Take account of local traffic, operator convenience, and the need for periodic maintenance or repair.
- When installing the FP-100 outdoors, remember that the display can be difficult to read under direct sunlight. Position the unit to effectively shade the front panel.

2.3 MOUNTING

The FP-100's NEMA enclosure is designed to be wall mounted, although other placements are possible. Secure the unit with 1/4" diameter bolts using the four mounting holes located above and below the unit's main housing. Mounting dimensions for both the NEMA and panel mount versions are shown on the following page.

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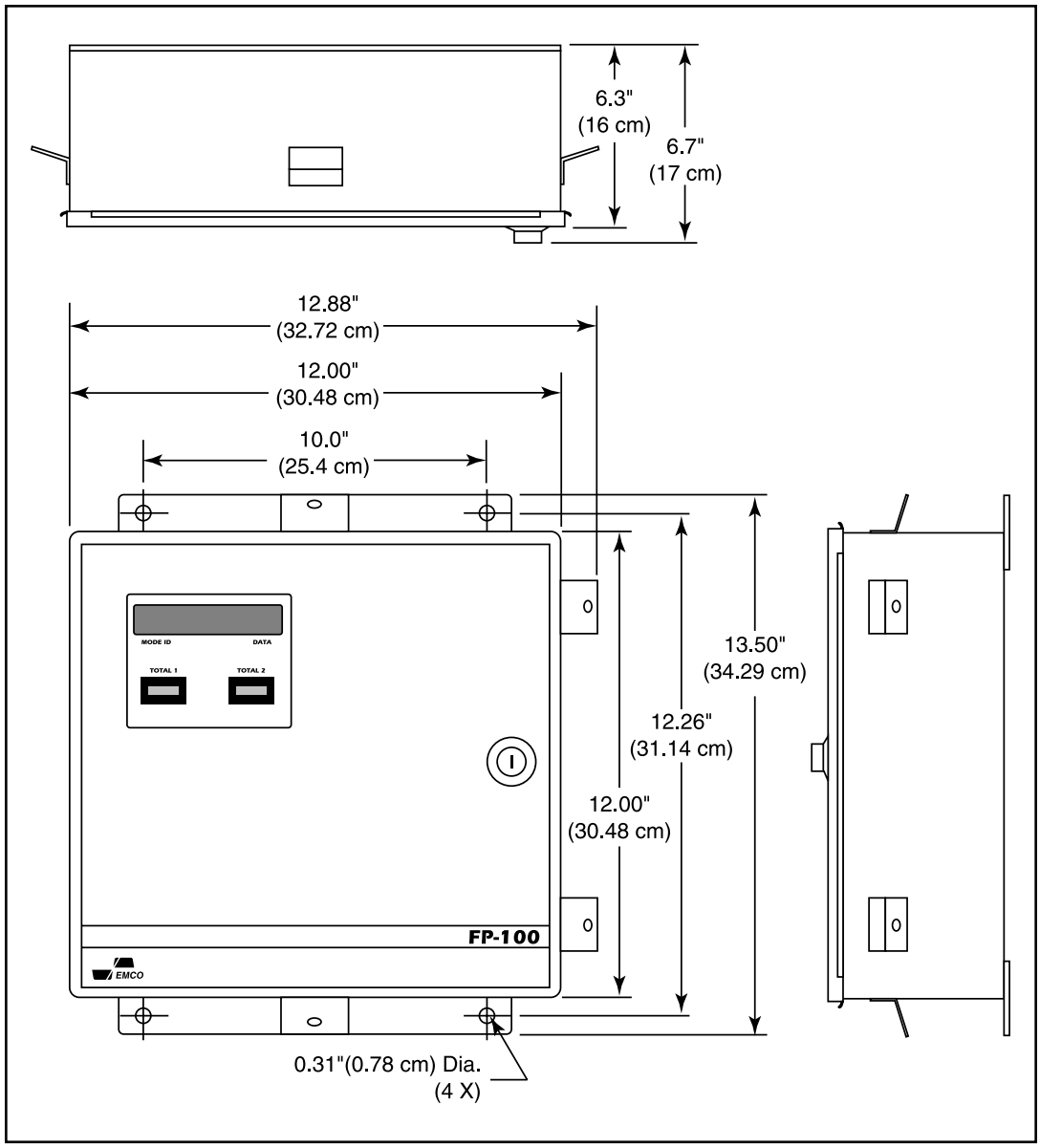

Figure 2-1. FP-100 Dimensional Outline

Section 3 - Hardware Configuration

3.1 SWITCHES AND JUMPERS

On each of the FP-100's printed circuit boards are a number of jumpers which must be installed correctly in order to configure the unit for your application. These jumpers are installed at the factory and should not normally require changing. On the CPU Board is a set of rotary switches used to set the flow processor's unit number. In order to check or change any jumper or switch settings, the corresponding board must be removed from the card cage.

Caution: Before removing any of the circuit boards, make sure that the power switch on the FP-100 is turned off.

FP-100 Unit Number

The unit number is used to identify each FP-100 as a unique device and may be set to any whole number between 0 and 9999. This number is used primarily for communications purposes and may be checked by examining mode ID C0. See Section 4.3 for how to examine mode IDs.

If the unit number must be changed, remove the CPU Board and locate the four rotary switches (refer to Appendix B if necessary). Use a thin-bladed screwdriver to set the switches to the desired value. The switches are labeled with multipliers 1000, 100, 10, and 1 from left to right. The following figure depicts the switch settings for a unit number of 3752.

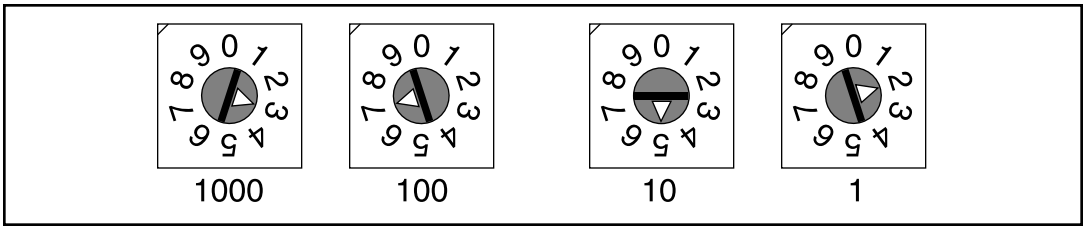

Figure 3-1. Switch Settings

Caution: It is important that the hardware jumpers are positioned correctly. Incorrect jumpers will affect your system performance and may damage the PC boards or transducers.

CPU Board Jumpers

There are three jumper blocks on the FP-100 CPU Board which affect the host computer communications, printer, and digital outputs. Refer to Appendix B if you need to change any of the jumper settings. There are two jumpers that may be installed to ground the negative side of the digital outputs. These jumpers must be installed in order for the electro-mechanical totalizers to function.

The CPU Board jumpers apply only to the printer version of the CPU Board (assembly #010732). If you have an earlier version of the CPU Board, and need to change the configuration, please contact your EMCO representative for information.

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Interface Board Jumpers

There is one jumper block on the Interface Board (J3), which will be jumpered at the factory for your application. The jumpers on this board are used to determine the hardware configuration for the various inputs to the system. The location of this jumper block and the various positions for the jumpers are given in Appendix B. These jumpers are listed for reference only, and should not require changing unless the application is changed.

Output Board Jumper

The optional Output Board may be configured for three analog outputs and/or eight relay outputs. All outputs are normally isolated from each other and from the remaining circuitry, unless jumpers are installed on the board. The use of these jumpers simplifies wiring and installation if you want to connect any of the outputs to common power supplies or grounds. The relative locations of the jumper blocks and the various jumper positions are shown in Appendix B.

The analog outputs may be connected to the power supply or to ground by jumper block J2. There are three possible configurations for each output: isolated, current source, or current sink. See Appendix B for typical analog output wiring diagrams.

Isolated Output. This configuration is used to drive a current loop, which includes an instrument, which does not have an isolated input. For an isolated output, no jumpers should be installed.

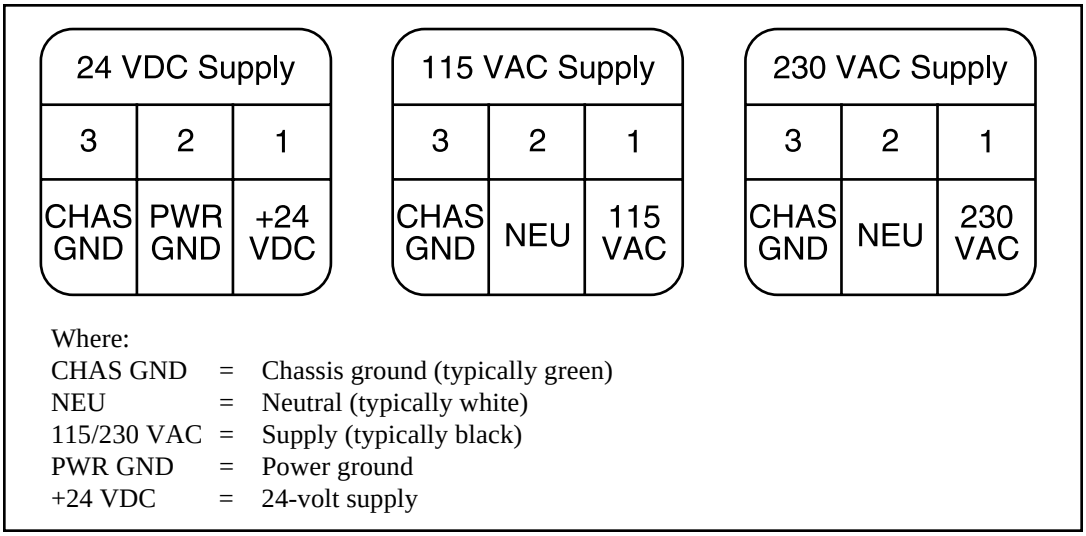
Current Source. An analog output may be used as a 4-20 mA current source (referenced to the FP-100 power supply ground) by con≈%cting the positive side of the output (+) to the DC supply voltage. In this case, the output current will flow from the negative analog output (-) terminal, through the current loop, to the FP-100 power supply ground. If this option is used, the negative side of the last device in the loop must be connected to the FP-100 power supply ground.

Current Sink. To use an analog output as a current sink, the negative side of the analog output (-) is connected to the power supply ground. The current will flow from the 24-volt supply, through the loop, and back to the positive analog output (+) terminal. This configuration will rarely be used.

The relay outputs are isolated from each other and from the supply unless connected by jumpers to a common circuit on the board called the relay bus. The relay bus may be isolated (so that several relays may be connected to an external circuit with a single wire), or may be connected to either the 24-volt supply or the power supply ground. The relay outputs are connected to the relay bus via jumper block J3.

3.2 POWER CONNECTIONS

The FP-100 is designed to operate on either a 24 VDC or an optional 115/230 VAC supply. For the 24-volt supply, connections are made on top of the card cage, while the 115 and 230 VAC options include a separate power supply module to which power connections are made. In either case, the wiring is straightforward and made according to the label on the unit. These labels are illustrated below, giving the symbol definitions and industry standard wiring colors.



Where:

CHAS GND	=	Chassis ground (typically green)
NEU	=	Neutral (typically white)
115/230 VAC	=	Supply (typically black)
PWR GND	=	Power ground
+24 VDC	=	24-volt supply

Figure 3-2. Wiring Labels

Caution: Before making any power connections, make sure that the power switch on the FP-100 is off and that no voltage is present on the incoming power leads.

3.3 SIGNAL CONNECTIONS

All signal connections to the FP-100 are made by means of screw terminal blocks on the PC boards. These terminal blocks consist or 4 or 6 position sections which may be removed from the board to simplify both initial wiring and board removal and replacement. In order to connect wire to the terminal block, it will be necessary to remove the board from the card cage. The terminal blocks are capable of accepting either solid or stranded wire between 14 and 24 AWG. Approximately 0.25" of insulation should be stripped off of the wires before inserting in the terminal block. Always use high quality, shielded cable to minimize hum and noise, and provide as clean a signal as possible.

Caution: Before removing any of the circuit boards, or connecting any leads to the terminal blocks, make sure that the power switch on the FP-100 is turned off.

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Input Wiring

Refer to Appendix B for a detailed drawing of the input and output wiring connections. There are four general categories of signals, which may be connected as input devices to the FP-100:

- Digital inputs (flow direction)
- 4-20 mA analog inputs (flow rate, temperature, pressure, specific gravity)
- RTD input(s) (temperature)
- Frequency input(s) (flow rate)

The two digital inputs available are connected to the CPU Board. Only one of these inputs is used with the present software - a flow direction input from a bi-directional flowmeter. If this input is left open, or held at a voltage greater than 3 volts, the flow directions is assumed to be forward. If connected to ground, or if the voltage is less than 2 volts, then reverse flow is implied.

Connections for the other input signals are made to the Interface Board according to the terminal designations in Appendix B. Some terminals have more than one designation, depending on the jumper configuration. External transducers requiring 24 VDC may be powered from the FP-100.

Caution: The Interface Board must be configured properly by means of jumpers before any devices are connected (see Section 3.1).

Output Wiring

Refer to Appendix B for a detailed drawing of the input and output wiring connections. There are three general categories of signals, which may be connected as output devices to the FP-100:

- Digital outputs
- Relay outputs
- Analog outputs

The isolated digital outputs are wired to the CPU Board, and may be used for either electro-mechanical totalizers, alarms, or communications control. If your FP-100 has factory installed totalizers, then the digital outputs are committed for this purpose. Otherwise, these outputs may be used to drive any DC load, which meets the specifications in Appendix A. The digital output circuit is shown in the following figure.

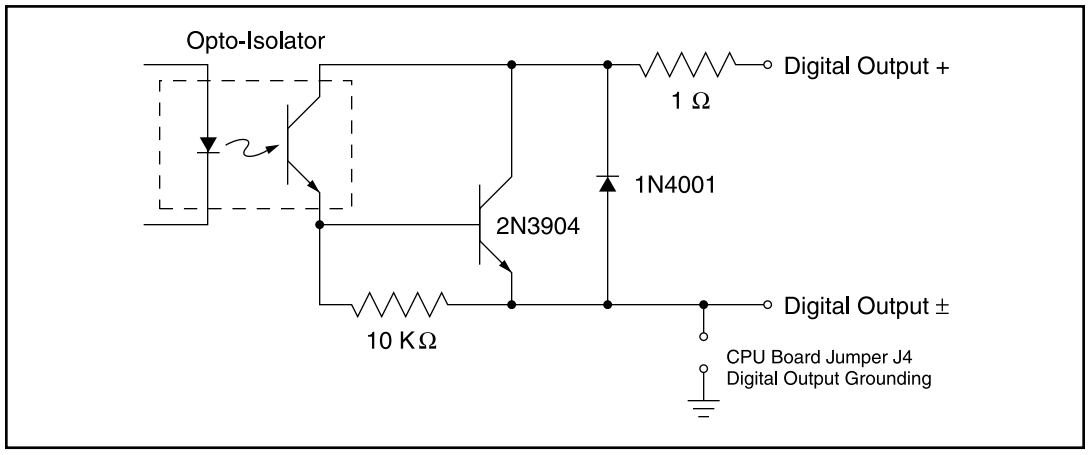

Figure 3-3. Digital Output Circuit

The optional relay and analog outputs are wired to the Output Board according to the terminal designations shown in Appendix B. The 4-20 mA analog outputs may be isolated or non-isolated (current source) depending upon the jumper configuration. A typical wiring diagram for both the isolated and non-isolated versions is shown in Appendix B.

The eight possible relay outputs operate in conjunction with the two digital outputs - relay #1 through #4 mimic digital output #1, and relays #5 through #8 mimic digital output #2. The relays may each be isolated or non-isolated (connected to a common bus) depending upon the jumper configuration.

3.4 COMMUNICATION AND PRINTER CONNECTIONS

Appendix B shows the signal connections for the host computer communications and the printer. These connections are made to the designated terminal blocks on the CPU Board.

The host communications interface may be configured (see jumper connections in Appendix B) for either RS-422 with transmit and receive data lines only, or as an RS-432 interface with additional handshaking lines. The RS-423 signal levels are compatible with those of PS-232C. Typical wiring diagrams for connecting a host computer or modem to an FP-100 are shown in Appendix B. Consult your computer or modem manual for further information on the communication requirement.

Only three wires are required to connect the printer to the FP-100: transmit data to the printer (terminal 19 on the CPU Board connector), a handshaking line (23), and ground (20, 21, or 24). The handshaking line may not be required if the printer can print continuously at the selected baud rate. Only hardware handshaking is supported in this release of the firmware; the data input signal at pin 22 of the connector is not used. Most printers are configured, according to the EIA RS-232C "standard," as Data Terminal Equipment, with a DB-25 connector. Data input in on pin 3 and pin 7 is ground. Since the RS-232C standard was not defined for printer interfaces, there is not a standard pin for handshaking purposes. Most of the printers using the RS-232 interface provide a handshaking signal on pin 20 (Data Terminal Ready); others may use pin 4, 8, 11, 13, 14, or 19. Some printers also require an active input, either at pin 5 (Request to Send), pin 6 (Data Set Ready), or at pin 8 (Data Carrier Detect). In this case, it may be necessary to install a jumper from 4 to 5, 4 to 6, or 4 to 8, in order to make the printer function. Appendix B shows a cable wiring diagram that should work with the majority of printers sold today with an RS-232C interface. Consult your printer manual for further information on interfacing requirements.

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Section 4 - Basic Operation

4.1 CONVENTIONS USED IN THIS MANUAL

Throughout this manual, user interaction via the keypad and display is presented in a standard format. The basic assumption is that after a key (or sequence of keys) is pressed, the FP-100 will respond with appropriate data or information. The format used in this manual will show keys to be pressed using boldface type, such as **D** or **7**, followed by the resulting display, such as FP-100. Display characters that are flashing are represented by an underlined character, such as the 1 in 2. 13000. A comment describing what happened or why will usually be included for further clarification. All examples using this format will assume that the FP-100 is initially in display mode rather than programming mode.

EXAMPLE: If the keys **#**, **C**, and **0** are pressed in succession, the display will appear as shown (see following note).

Keystrokes	Display		Comment
# C 0	C0	0	Examine the unit number, mode ID C0.

Note: All data values given in this manual under the "Display" heading are for illustrative purposes only - the data you see will likely be different. In the example above, C0 will always appear as shown, whereas 0 in the display may vary from unit to unit.

4.2 POWER-UP

Assuming that the desired electrical connections and configurations have been made, the next step is to apply power to the FP-100. The power switch is located on the card cage for a 24-volt supply, on the power supply module for 110/220 VAC units, and on the front panel for panel mount units.

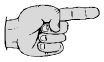
Power-Up First Time

To properly power-up the unit for the first time, simultaneously press and hold the front panel D-key while turning the power switch on. Continue to press the D-key until the display reads FP-100 D. During this initial period, the FP-100 performs a series of diagnostic tests and initialization procedures which clears the entire contents of memory and then loads the mode IDs with default values. This process assures a clean environment for programming the unit. If the D-key is not used on the first power-up, memory may contain meaningless information, which could prevent the unit from operating properly.

Power-Up Thereafter

Once the FP-100 has been initialized, or programmed with meaningful data, the power may be turned off for brief periods without affecting the memory or programmed data. The effect is identical to a power-fail situation in which the unit makes use of its battery backup to maintain memory while power is off. When power is reapplied, do not press the D-key, and the unit will regain the same operating state, which existed before the power went down. Note that the display during this power-up will show FP-100 without the D in the rightmost position, and also the power failure flag of mode ID D2 will be set after resuming operation. Using this memory retention facility, an operator may perform minor hardware modifications or maintenance without having to reprogram the unit.

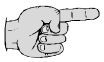
Following power-up the FP-100 automatically enters "display mode" and presents the normally displayed mode ID for the selected fluid type and application (see Section 6.1). At this point any of the existing mode IDs may be chosen for display on the front panel (Section 4.3), or the user may attempt to alter the value of a mode ID (Section 4.4).



Note: You may notice that the mode ID portion of the display periodically flashes **. This is an indication of faults in the unit, and may be ignored until the unit is completely programmed.

4.3 EXAMINING DATA

Examining data on the FP-100 is a simple process. For the most commonly accessed parameters such as flow rate or totalizer value, only one keystroke is needed. These parameters are labeled on the keypad directly above the key to be pressed. For other data, the #-key is used to signal the unit that you want to examine a mode ID. The unit will respond by asking MODE7, whereupon you will enter two digits which correspond to the mode ID's unique identification number (see Appendix C for a complete list of mode IDs). After the second digit is keyed in, the unit will display the mode ID number in the first two display positions followed by the data for that mode ID. If a requested mode ID does not exist, then the FP-100 will display data for the first valid mode ID that numerically precedes the ID requested.



Note: Mode IDs with the letter "E" or "F" do not have keys labels as such. Instead use the #-key for "E" and the *-key for "F".

EXAMPLE: What is the value for the first totalizer? Examine mode ID 10 to find out.

Keystrokes	Display		Comment
#	MODE7		Use #-key to request a mode ID to be examined.
1	MODE7	1	Enter the first digit of the mode ID.
0	10	0	After the second digit is entered, display shows the mode ID number and corresponding data.

From here on, successive keystrokes may be shown on a single line like this:

Keystrokes	Display		Comment
# 1 0	10	0	Examine mode ID 10.

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EXAMPLE: For mode IDs with an “E” or “F” in their number, use # and *, respectively.

Keystrokes	Display	Comment
# 2 *	2F 0.000	Examine mode ID 2F. Use * to enter “F”.

EXAMPLE: If the mode ID requested does not exist, then the next lower valid mode ID is displayed.

Keystrokes	Display	Comment
# 9 9	97 10000	Attempt to examine mode ID 99. Since the mode ID doesn’t exist, data for mode ID 97 is displayed instead.

Another convenient way to examine mode IDs is to use the A- and B-keys. The A-key finds and displays the *next* valid mode ID while the B-key finds and display the *previous* one. These keys can be used to step through the mode IDs without having to enter the mode ID number each time. In addition, both of these keys are auto-repeating and can scan rapidly through the mode IDs if continuously held down.

EXAMPLE: Step through the four totalizer values using the A-key. Remember, all data given is symbolic.

Keystrokes	Display		Comment
# 1 0	10	0	Examine the forward totalizer #1.
A	11	0	Examine the reverse totalizer #1.
A	12	0	Examine the forward totalizer #2.
A	13	0	Examine the reverse totalizer #2.
B	12	0	Examine the reverse totalizer #1.

Displaying Engineering Units

Many of the mode IDs on the FP-100 have associated engineering units. To display these units, simply press and hold the C-key, which is also labelled “UNITS.” As long as this key is pressed, the engineering units will be displayed. If no units exist, then the display will remain unchanged.

Keystrokes	Display	Comment
3 C	DEG F	The corresponding temperature units are displayed.

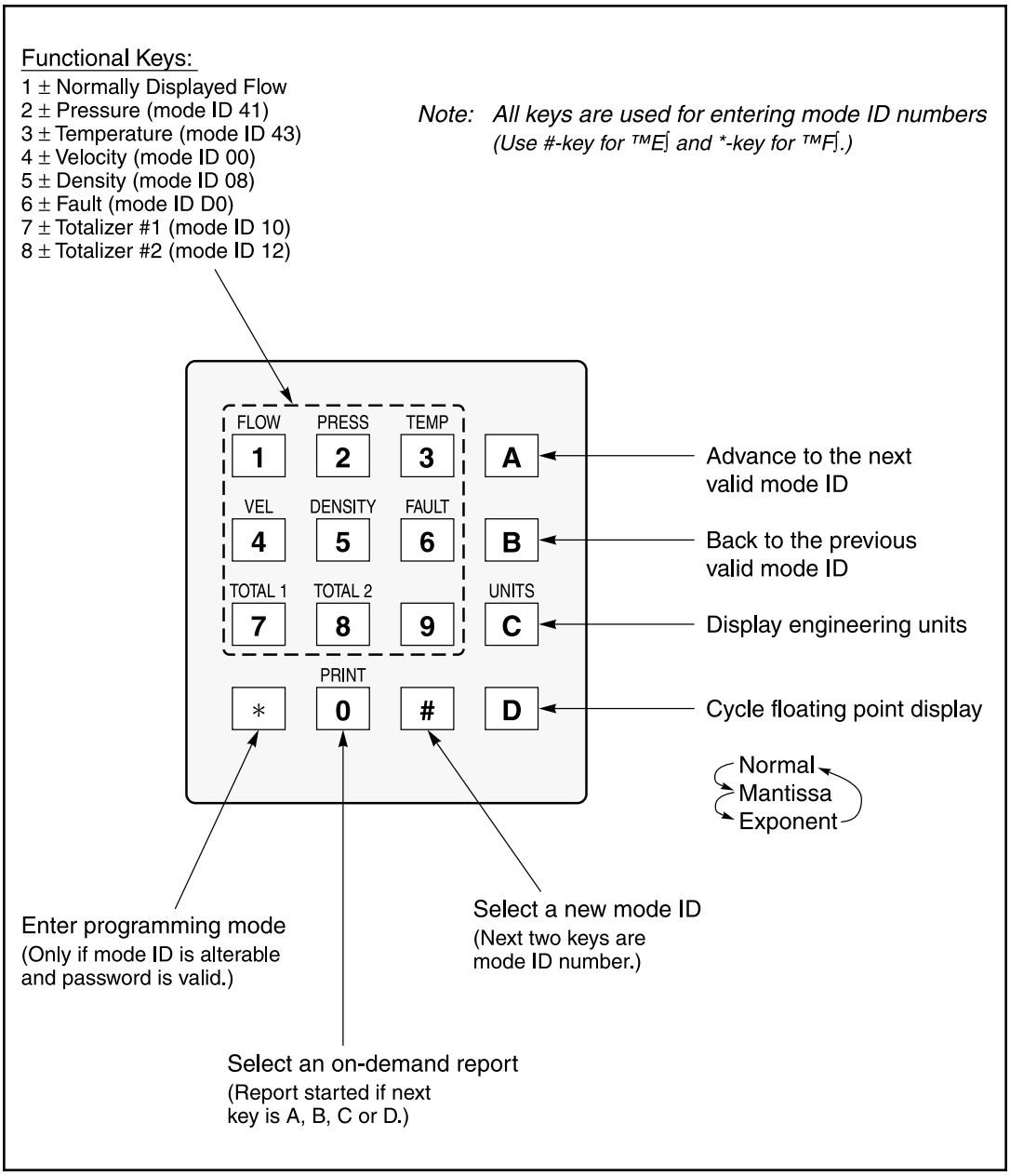

Figure 4-1. Display Mode Key Summary

4.4 ALTERING DATA

Before a mode ID can be altered it must first be examined using the procedure outlined in Section 4.3. Once the mode ID is displayed, pressing the *-key will attempt to put the FP-100 in programming mode. The attempt will be successful, allowing you to alter data, only if: 1) the mode ID is alterable, and 2) the password is valid. If the mode ID is not alterable, then the unit won't allow access to the programming mode. IF the ID is alterable, but the password is not valid, then the unit will first request a password to be entered. If the ID is alterable and the password is valid, then the unit will enter programming mode, indicated by a blinking character in the display.

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Password Entry

When the FP-100 asks for the security password (by displaying PASSWORD), the user has ten second in which to key in the correct five-digit number. For each key pressed, a "*" will replace the next "–" in the display from left to right. Additionally, a 10-second countdown timer appearing in the rightmost display position will show the amount of time remaining for password entry. If the password is incorrectly entered or the time runs out, the unit will revert to display mode without validating the password. Otherwise, the password becomes valid and the FP-100 will be in the programming mode. Refer to the FP-100 Setup Data Sheet for the password to your unit.

EXAMPLE: Assuming that password is not already valid, the following example shows how to enter it. Remember, the password used here, 12345, is not your password, but merely an example.

Keystrokes	Display	Comment
# 5 0	50 00	Examine the fluid type, mode ID 50.
*****	PASSWORD	The FP-100 indicates that the password must be entered.
1	*– – – – 8	Each key pressed echoes a "*",
2	**– – – 6	while the timer counts down from
3	***– – 4	10 seconds.
4	****– 2	
5	50 00	When the last digit is entered, the unit will be in programming mode. If the timer reaches zero, the unit reverts to display.

Note: The password countdown timer is started when the *-key is pressed, not when the first password digit is entered.

If the password was entered correctly, the cursor position in the display will blink. In the example above, this will be the rightmost display position. Once the password has been correctly entered, the user may modify any alterable mode IDs without having the re-enter the password. It will remain valid until there is no key pressed for five minutes. Hence, as long as the user continues to interact with the FP-100 by pressing keys, the password will remain valid.

Data Entry

If the password is already valid, the user may gain access to programming mode simply by pressing the *-key. The FP-100 will respond (if the mode ID is alterable) by continuously blinking the cursor position in the display. At this point data may be entered according to the programming mode key functions defined by the figure on the next page. Only the **0** through **9** keys are used to enter actual data; the other keys have special functions.

When altering a floating point mantissa or binary data, the digits are entered from left to right. Once the rightmost digit has been entered the unit won't accept any more data unless the B-key is used to clear the display. If the B-key is pressed at any time during data entry, the entire data field is zeroed, and the data entry process is begun anew starting from the left. This key can be used to correct mistakes made while in programming mode.

Floating point exponent and integer data differs in that the data "scrolls" to the left when a digit is entered. The cursor is always positioned at the rightmost digit in the display. Upon entering the first digit, the left digit is automatically zeroed. Subsequent digit entry will cause the previous digits to rotate to the left. The B-key zeroes the data just as it does with floating point mantissa or binary data.

The C- and D-keys are meaningful only when altering floating point data. The D-key toggles the display between the mantissa and exponent, allowing either part of the floating point number to be modified. The C-key changes the numeric sign of the displayed mantissa or exponent, alternating between a blank character for positive, and a minus sign (–) for negative.

Once the data has been modified to your satisfaction (both the mantissa and exponent if floating point), the next step is to deposit the data into the FP-100's memory. This can be done in one of three ways: 1) The 8-key deposits the data and exits programming mode, while the display remains on the mode ID just altered. 2) The #-key deposits the data, exits programming mode, and then prompts the user for a new mode ID to be examined. 3) The A-key deposits the data, exits programming mode, and then advances to the display to the next *alterable* mode ID.

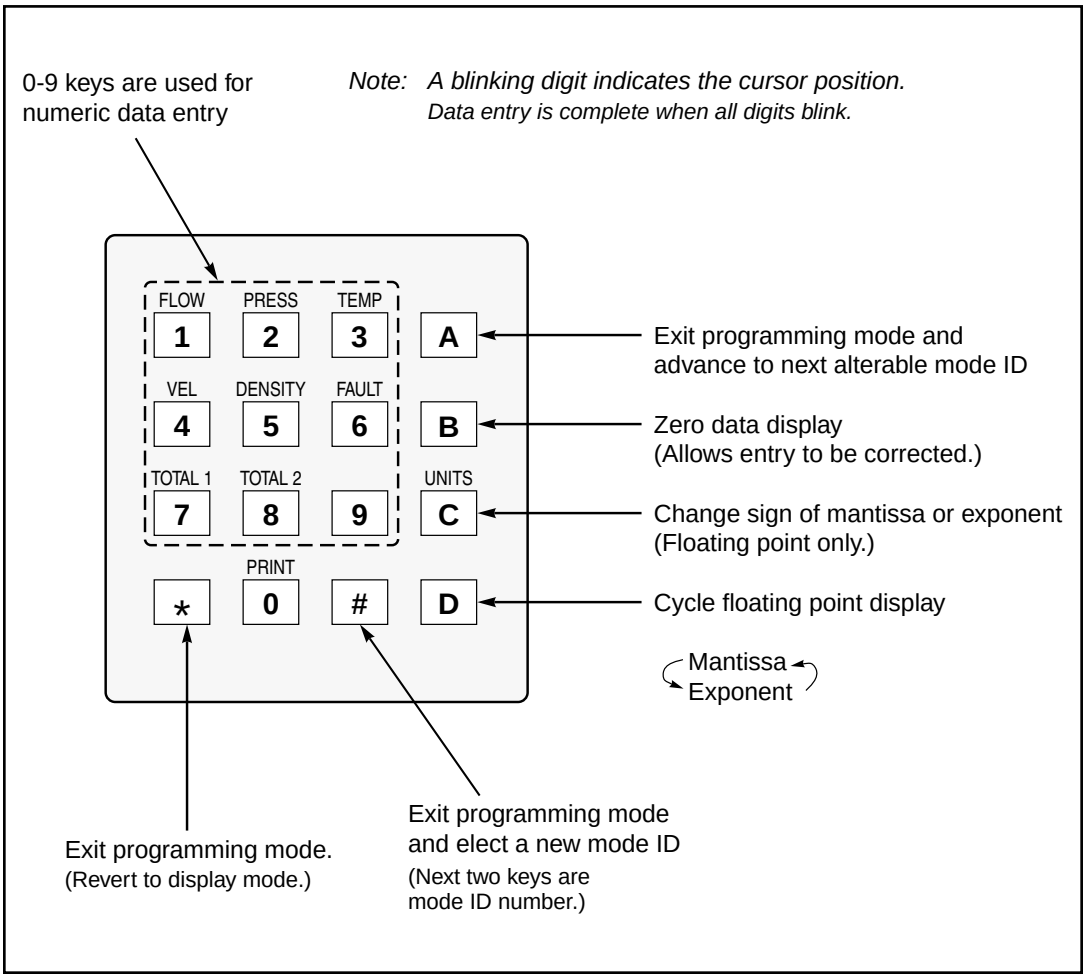

Figure 4-2. Programming Mode Key Summary

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Programming Examples

Now, here are a few examples to further clarify the data entry procedure. In each one it is assumed that the password is already valid.

EXAMPLE: Altering binary data. Change the Substitute Value Flags in mode ID B0 from its present value to 111101.

Keystrokes	Display	Comment
# B 0	B0 0 0 0 0 0 0	Examine mode ID B0.
*****	B0 0 0 0 0 0 0	Enter programming mode. Leftmost data digit in display flashes, indicating the present cursor position.
1	B0 1 0 0 0 0 0	The leftmost digit is changed to 1. The next digit flashes the cursor position.
1	B0 1 1 0 0 0 0	Digits are entered from left to right.
1101	B0 1 1 1 1 0 1	The remaining digits are entered, and the entire display flashes to indicate end of data entry.
A	B1 114. 7	Exit programming mode and advance to the next alterable mode ID, which is B1, the substitute pressure value.

EXAMPLE: Altering floating point data. The display is already on the substitute pressure value (mode ID B1) from the last example. Change it from its current value to 85 psi.

Keystrokes	Display	Comment
*****	1. 14730	Enter programming mode. Displays mantissa, with first digit of display flashing to indicate cursor position.
8	8. 00000	When the first digit is entered, the rest of the data is zeroed.
5	8. 50000	The leftmost digit is changed to 1. The next digit flashes the cursor position.
D	B1E 02	Toggle display to show exponent.
1	B1E 01	Change exponent to 1 ($8.5 \times 10^1 = 85$).
*****	B1E 85.00	Exit programming mode.

EXAMPLE: Change the pipe diameter constant (mode ID A1) to 11.938 inches. This example shows how to use the B-key in case a mistake is made during data entry.

Keystrokes	Display	Comment
*** A 1**	A1 2.880	Examine the pipe diameter constant.
*****	2.88000	Enter programming mode.
1 1 8	1.18000	Oops! Wanted 1.19 not 1.18.
B	0.00000	Press **B** to clear display.
1 1 9 3 8	1.19380	Enter correct data.
D	A1E 00	Display the exponent.
1	A1E 01	Enter the new exponent.
*****	A1 11.93	Exit programming mode.

EXAMPLE: Altering integer data. Each new digit is entered in the rightmost display position, and the previous digit is scrolled to the left. You may keep entering digits until the display shows the desired data.

Keystrokes	Display	Comment
# 9 0	90 53	Mode ID 90, an integer, is the totalizer assignment.
*****	90 53	Enter programming mode. Rightmost digit in display flashes to indicate cursor position.
2	90 02	Enter first digit at cursor position. Other digit is zeroed.
3	90 23	Enter next digit. Previous digit is scrolled to the left.
*****	90 23	Exit programming mode.

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4.5 MODE ID ORGANIZATION

Model IDs on the FP-100 are organized into functionally related groups. The three main groups are process variables, user-entered constants, and system parameters. Process variables are mode IDs whose values are calculated by the FP-100 from various inputs and other mode IDs. They include important data such as flow rates and totalizer values. User-entered constants must be programmed by the user in order to define the application and select appropriate inputs, outputs, scaling factors, etc. The pipe diameter constant, substitution flag, and totalizer assignments are all examples of user-entered constants. System parameters such as the unit number, communications format, and fault flags administer the human-interface side of the FP-100. The table below further subdivides these three basic groups and indicated a section of the manual where more detailed reference can be found.

Description	Mode IDs	Refer to:
Process variables		
Flow related mode IDs	00-0E, 17-19	Section 6.1
Totalizers	10-13	Section 6.1
Current outputs	14-16	Section 6.1
Avg., min., max. values	20-2F	Section 6.1
Transducer inputs	30-49	Section 6.1
User-entered constants		
Application definition	50-52	Section 5.3
Flow inputs	53, 60-63	Section 5.3
Flow calibration factors	54-5F, 64-6F	Section 5.3
Other analog inputs	70-78	Section 5.3
RTD inputs	7A-7F	Section 5.3
Current outputs	80-88	Section 5.5
Totalizers	90-93	Section 5.5
Alarms	91, 94-97	Section 5.5
Calculation constants	AO-AD	Section 5.4
Substitution inputs	B0-B6	Section 5.3
System Parameters		
General	C0-C2, CC-CF	Section 6.2
Communication	C3-C5	Section 7.1
Printer	C6-CB	Section 8.1
Faults	D0-D8	Section 6.3

4.6 DATA TYPES

FP-100 mode IDs are lumped into two general categories-those which are alterable and those which aren't. The latter are termed "examine only" and can't be modified by the user, whereas alterable mode IDs may have their values changed. To determine if a mode ID is alterable, first examine that ID and then press the *-key. If the mode ID is alterable, the cursor position in the display will blink or the display will read PASSWORD. If the mode ID is not alterable, the display will remain unchanged. Referring to the organization of mode IDs in Section 4.5, process variables are examine only, user-entered constants are alterable, and system parameters consist of both types.

EXAMPLE: Mode ID B2 is alterable, ID D0 is not. This example assumes that the password is already valid.

Keystrokes	Display	Comment
# B 2	B2 338. 0	Examine mode ID B2.
*****	3. 38000	Cursor position of display will blink indicating that the FP-100 is in programming mode.
*****	B2 338. 0	Exit programming mode without altering data.
# D 0	D0 000000	Examine mode ID D0.
*****	D0 000000	Attempt to alter fails. Display remains the same.

In addition to being alterable or not, each mode ID on the FP-100 has a specific data type which dictates the properties of the ID. The various data types are displayed differently and require slightly different techniques for altering their values. The following subsections describe characteristics and display formats peculiar to each data type.

Floating Point

Floating point mode IDs on the FP-100 are stored and displayed in scientific notation. Each one has a signed, 6-digit mantissa and a signed, 2-digit exponent, giving exceptional accuracy and range. When a floating point number is displayed, the D-key will cycle between the normal, mantissa, and exponent display, changing once each time the key is pressed. In programming mode only, the mantissa and exponent will be cycled. In either case a positive sign is indicated by a blank, while a negative sign will show a "–".

EXAMPLE: Line velocity, mode ID 00, is a floating point variable.

Keystrokes	Display	Comment
# 0 0	00 17. 32	Examine mode ID 00.
D	1. 73264	Display the mantissa.
D	00E 01	Display the exponent.
D	00 17. 32	Return to normal display.

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Normal, mantissa, and exponent displays are described as follows:

Normal. This format is an attempt to display floating point numbers in a manner convenient to the user. Numbers with absolute values between 0.0001 and 100,000 will be displayed as four or five significant digits with a floating decimal point and no exponent. Numbers outside of this range will show one significant digit of the mantissa in addition to a two-digit exponent. In either case, the mode ID number will be displayed in the first two display positions and the number displayed is truncated, rather than rounded. The following gives examples of normally display floating point numbers:

01 .0012 02-338. 0 03 7E 05

Mantissa. The mantissa display consists of a sign (blank if positive) followed by six significant digits of data and a decimal point. The number shown in the display is rounded to six significant digits. The value of the mantissa will always range between - 1.0 and - 10.0 or 1.0 and 10.0. Typical mantissa displays are:

1.27453 –3. 38000 7. 14629

Exponent. The exponent display consists of the two-digit mode ID followed by an E and the value of the exponent. Due to internal limitations, the exponent can only range between -78 and 77. Typical exponent displays are:

01E –03 03E 02 05E 05

Percentage

This data type is similar to floating point in that it is internally stored in scientific notation. However, percentages can only have values between 0.0 and 100.00 (never negative) and always show a percent symbol (%) in the rightmost display position when normally displayed. As with floating point data, the D-key will cycle through normal, mantissa, and exponent displays. Examples of this data type include steam quality (mode ID 07) and analog outputs (mode IDs 14-16).

Integer

The display of integer mode IDs on the FP-100 consists of a two-digit mode identifier followed by one to six digits. The D-key has no effect on this display. Example integers include totalizers (mode IDs 10-13, up to six digits each) and the flow rate time base (mode ID 52, two digits).

Hexadecimal

Hexadecimal and integer data types are very similar except that hex digits have a greater range (0...9 or A...F). As with integers, the mode ID number is shown in the first two display positions and the D-key has no effect on the display. Mode ID D7, the RAM write/read error address, is of hexadecimal type.

Binary

Binary data is typically used to control or select various inputs and outputs on the FP-100. Each binary digit or bit can be thought of as an on/off indicator since it can have only one of two values, 0 or 1. The display of binary data consists of a two-digit mode identifier followed by one to six bits of data. When altering mode IDs of this type only the 0- and 1-keys can be used to enter data. The flow input select flag (mode ID 53) and all of the fault flags (mode IDs D0-D3) are of binary data type.

Special

A few of the FP-100's mode IDs don't conform to any of the above data types and, consequently, are termed "special." These are IDs that display times, dates, or flash messages. The fault clearing mode ID, D8, is an example of this data type, and when examined the display alternately flashes FAULTS and CLEARED.

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Section 5 - Programming

5.1 GENERAL

Programming the FP-100 is an important process that will determine how the unit will handle the various inputs and outputs available to the system. There are several groups of parameters that must be programmed sequentially in order for the unit to properly calculate flow rates. In several cases, the value of one mode ID will affect subsequent mode IDs so it is important to follow the sequence below when programming your FP-100. Each step is described in detail in the remainder of this section.

1. Defining the Application - select a fluid type and the desired engineering units (IDs 50-52).

2. Programming Inputs - select, scale, and calibrate one or more of the following inputs:
   a. Flow input, frequency or analog 4-20 mA (IDs 53-6F)
   b. Pressure input, analog 4-20 mA (IDs 70-72)
   c. Temperature input, RTD, or analog 4-20 mA (IDs 70, 73-76, 7A-7F)
   d. Specific gravity input, analog 4-20 mA (IDs 70, 77-78)
   e. Select substitute inputs as desired (IDs B0-B6)

3. Calculation Constants - program pipe diameter, viscosity, etc. (IDs A0-AD)

4. Programming Outputs - assign and scale one or more of the following outputs:
   a. Analog 4-20 mA, up to three (IDs 80-88)
   b. Totalizers, two forward and two reverse (IDs 90, 92-93)
   c. Digital outputs (solid state and relay), up to two (ID 91)
   d. Alarms, up to two (IDs 94-97)
5. System Parameters - configure the system clock (IDs CC and CD)

Please refer to Section 4 for information on how to access and alter data within the FP-100 before attempting to program the unit. Appendix C contains a complete listing of mode IDs for reference. If a Setup Data Sheet was shipped with your unit, then use the data provided there to program your FP-100.

Note: Not all mode IDs listed in Appendix C may exist. Only those IDs that pertain to the application as it is defined may be accessed on the FP-100.

5.2 DEFINING THE APPLICATION

The FP-100 may be configured to measure flow for a variety of fluids, including saturated and superheated steam, ideal gas, natural gas, water, or any other liquid that exhibits a linear density with respect to temperature. In addition, the engineering units (English or metric) and flow rate time base (seconds, minutes, hours, or days) may be selected. These choices are made via mode IDs 50-52, and since they will affect the presence or absence of subsequent mode IDs should be programmed first.

EXAMPLE: Program mode IDs 50-52 for a natural gas application with metric units and flow rates displayed in units per minute.

Keystrokes	Display		Comment
# 5 0	50	00	Select mode ID 50.
*	50	00	Enter programming mode. This assumes that the password is valid.
2	50	02	Change fluid type to 02 (Natural gas).
A	5 1	00	Deposit data, advance to mode ID 51, the units selection flag.
*	5 1	00	Enter programming mode.
1	5 1	0 1	Change to metric units.
A	52	03	Deposit data, advance to mode ID 52, the flow rate time units. Unit is set to display flow rates per hour.
*	52	03	Enter programming mode.
2	52	02	Change time units to display flow rates per minute, instad of per hour.
*	52	02	Deposit data and exit programming mode.

5.3 PROGRAMMING INPUTS

The FP-100 is capable of accepting inputs from a variety of transducers for flow rate, pressure, temperature, and specific gravity. The type of signal used for these inputs and also the scaling and calibration factors are programmed into mode IDs 53-7F.

Flow Input Selection

The FP-100 supports input from a variety of different flowmeter types. Either frequency or analog (4-20 mA) devices may be used, and unidirectional, bidirectional, or dual frequency applications are supported. Mode ID 53 selects several attributes of the flowmeter and should be programmed before the other flow input mode IDs. Program mode ID 53 according to your specific application as follows:

Flow Signal Type	Applications	Mode ID 53
Frequency Input	Unidirectional flow	0xyy00
	Bidirectional flow	1xyy00
	Dual frequency inputs	1xyy10
Analog Input	Linear characteristic	0xyy01
	Square-law characteristic	0x0011

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The digit identified as “x” above is used only with liquid heat flow (fluid type 04 or 06) applications; otherwise, this digit should be 0. The digits identified as “yy” select the EMCO rotor type used. If an EMCO turbine meter is not used, set these digits to 00. See Appendix C, mode ID 53 for further information.

Frequency Flow Input

There are several mode IDs which need to be programmed before the FP-100 can accurately translate a raw frequency input into a flow rate. The frequency input sample interval (mode ID 60) can be used to filter or smooth the flow signal. Programmed in seconds from 1 to 60, this parameter determines how often the FP-100 will sample the input frequency. Typically, this mode ID is set to 1, although a larger value will smooth out rapid fluctuations of the frequency signal.

Mode ID 62, the frequency alarm setpoint, determines the frequency at which a fault condition will arise. If either of the two frequency inputs to the FP-100 exceeds this value, then a fault condition will be indicated.

Multiple-Point Calibration (Mode IDs 54-5F). If your flowmeter is provided with multiple-point calibration data, then set mode ID 61 to 00 and enter the calibration data in mode IDs 54-5F. These mode IDs are “frequency/velocity pairs,” and each pair represents a point on the meter’s calibration curve. When combined, the points produce a “segmented” curve that better fits the actual response of the flowmeter. Up to six pints may be entered on the FP-100, and they must be entered in order of increasing frequency. (The point 0,0 is implied and need not be entered.) If fewer than six points are given, then enter the available data into the higher numbered mode IDs, and all remaining mode IDs (starting with 54) should be programmed with zero. The Setup Data Sheet will supply the calibration data for all EMCO flowmeters. The figure below graphically depicts the difference between multiple-point and K-factor calibration.

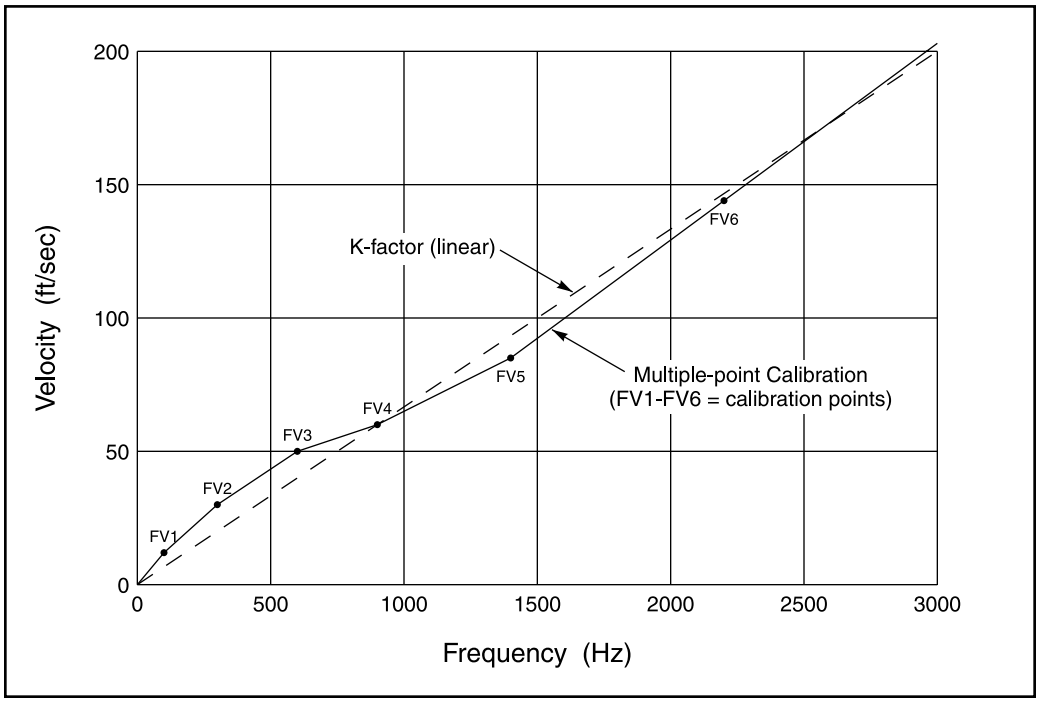


Figure 5-1. Multiple-Point Calibration v. K-factor

K-Factor Calibration (Mode ID 54). If your flowmeter is provided with a K-factor for calibration, then program mode ID 61 for the proper K-factor units. Note that the units selection allows for frequency to be proportional to either velocity or volume flow. The actual K-factor value is entered into mode ID 54, and mode IDs 55-5F will be inaccessible.

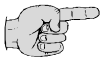
EXAMPLE: If a particular flowmeter has a specified K-factor of 7.58 pulses per cubic foot, then program mode ID 54 with 7.58 and mode ID 61 with 21.

Bidirectional Flow. For applications of bidirectional flow the FP-100 includes mode IDs for frequency-velocity calibration of the reverse direction. The calibration data, if available, is entered into mode IDs 64-6F similarly to the multiple-point calibration procedure discussed above. If no data is available, then use the same values for both forward and reverse calibration. If a K-factor calibration is used, then ignore mode IDs 64-6F. Bidirectional flow with an analog flow input is not supported by the FP-100.

Data Frequency Input. The dual frequency feature of the FP-100 provides a means to verify the integrity of the flow signal. The two velocities derived from the input frequencies are compared, and if they are both within a specified tolerance, are averaged to obtain the final line velocity. If not within the tolerance, the higher velocity is used in flow calculations and a velocity deviation fault is indicated. The tolerance is specified as a percent in mode ID 63. Both frequency inputs may be calibrated using the multiple-point calibration procedure discussed above.

Analog Flow Input

When an analog (4-20 mA) input is used for flow, the calibration data (mode IDs 54-5F) is used to correct for deviation from perfect linear or perfect square-law response of the transducer. The Fp-100 interpolates between the data points entered, producing a "segmented" curve that better fits the actual response of the flowmeter. For more information on this calibration, see EMCO Technote #43.



Note: If no calibration data is available for your analog flow transducer, set mode IDs 54-5F as follows: 54 = 0.0, 55-5F = 1.0.

The 4-20 mA flow signal is scaled by means of a value programmed into mode ID 62. This scaling factor is determined by one of the following equations depending on whether the transducer signal is linearly (directly) proportional or proportional to the square of the flow:

square law input: $$C_0 = 3600 \bullet v_{fs} \bullet \rho_{fs} = 60 \bullet \frac{q_{fs} \bullet \sqrt{\rho_{fs}}}{A} = \frac{m_{fs}}{A \bullet \sqrt{\rho_{fs}}}$$

linear input: $$C_0 = v_{fs} = \frac{q_{fs} \bullet \sqrt{\rho_{fs}}}{60 \bullet A} = \frac{m_{fs}}{3600 \bullet A \bullet \sqrt{\rho_{fs}}}$$

Where:

C_0 = flow rate scaling factor (mode ID 62)
v_{fs} = full scale velocity (ft/sec)
q_{fs} = full scale actual volumetric flow rate (ft^3/min. ACFM)
m_{fs} = full scale mass flow rate (lbs/hr, PPH)
ρ_{fs} = fluid density at full scale flow (lbs/ft^3)
A = pipe inside area (ft^2), $A = \pi d^2/576$, d = pipe inside diameter in inches

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EXAMPLE: An orifice plate with differential pressure transducer (square-law) is rated at 10,000 pounds per hour of saturated steam at 150 psia in a 6" schedule 40 pipe (d = 6.065"). From the ASME Steam Tables, the density for 150 psia saturated steam is 0.3318 lb/ft^3.

$$C_0 = \frac{m_{fs}}{A \bullet \sqrt{\rho_{fs}}} = \frac{10{,}000}{\pi \bullet (6.065)^2 / 576 \bullet \sqrt{0.3318}} = 86{,}529.8$$

Pressure, Temperature, and Specific Gravity

Mode ID 70 selects the remaining inputs to be used by the FP-100 and in some cases the signal type. Note that the pressure input can be selected for either gauge or absolute pressure transducers. After this ID has been programmed, the analog inputs can be scaled for the desired input range.

Mode IDs specifying "zero scale" for pressure, temperature, and specific gravity inputs are used to set the lower limit (value at 4 mA) for that parameter. "Full scale," likewise, indicates the upper limit (value at 20 mA). Both the zero and full scale values (mode IDs 71-78) are specified in the units shown in Appendix C.

Note: Jumpers on the Interface Board must be positioned correctly in order that the desired inputs will function properly. Refer to Appendix B to verify the jumper positions.

EXAMPLE: A typical superheated steam application used 4-20 mA inputs for pressure and temperature. If the pressure range is 0-250 psig, and the temperature range is 212-400 °F, the following values would be programmed into mode IDs 70-7F:

Mode ID	Description	Value
70	Analog input select flag	001100
71	Zero scale pressure input	0.0
72	Full scale pressure input	250.0
73	Zero scale temperature input	212.0
74	Full scale temperature input	400.00
75-7F	If programmed correctly and mode ID 50 = 00 (steam), then these IDs will not exist.	—

If resistance temperature device (RTD) inputs are used for temperature, then the resistance to temperature equation constants must be programmed. The Setup Data Sheet will specify values for these constants for all RTDs supplied by EMCO. Otherwise, the constants may be calculated from the following equation:

$AT^2 + BT + 1 = R/R_0$

Where:
A, B = constants to be determined
T = temperature (°C)
R = resistance at temperature T (Ω)
R_0 = resistance at 0 °C (Ω)

The previous quadratic equation must be solved for A and B. Hence, the resistance value (R) must be given at two different calibration temperatures. However, for all 1000 ohm platinum RTDs, the value of A can be taken to be -6.01883×10^{-7} without a loss of accuracy, thus requiring one less calibration point. The constants A, B, and R_0 are entered as mode ID values.

Substitute Inputs

Under normal conditions, the FP-100 will use actual "live" inputs for flow, temperature, pressure, density, and flow direction. It may be desirable, however, to substitute operator entered values in place of the actual values. Mode ID B0 is a binary value consisting of several flags that turn the substitute inputs on or off.

EXAMPLE: Program the FP-100 to use a substititute temperature value of 140 °F (assuming English units are selected).

Keystrokes	Display	Comment
# B 0	B0 0 0 0 0 0 0	Examine mode ID B0.
*** 0 0 0 0 1 0**	B0 0 0 0 0 1 0	Set temperature substitution flag to 1. (No other substitute inputs).
# B 2	B2 338. 0	Select mode ID B2, substitute temperature.
*** 1 4 D 2**	B2 140. 0	Change substitute temperature value to 140.0.

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5.4 CALCULATION CONSTANTS

Calculation constants include important parameters, such as pipe diameter, barometric pressure, etc. Several of these parameters can be calculated internally by the FP-100 or entered as constants by the user. Some of the mode IDs may not exist depending on the fluid type selected.

Mode IDs A0 and A2-A4 are designed for use with EMCO's insertion turbine meters (TMP). Mode ID A0 consists of three flags, which determine whether the viscosity, profile factor, and obscuration factor are calculated or entered, and this ID should be programmed before the other calculation constants. Fluid viscosity (mode ID A2) is used in the calculation of the profile factor. If a constant profile factor is used, then disregard the viscosity. The obscuration and profile factors (mode IDs A3 and A4) compensate for variations in the placement of the meter within the pipe. Explicitly, the profile factor adjusts for the fact that the velocity measured at the flowmeter sensor (rotor) is not the same as the average velocity over the whole pipe cross-section. Obscuration factor is a correction for the area inside the pipe which is obstructed by the physical presence of the flowmeter. Although these two parameters apply strictly to EMCO insertion turbine meters, they may be used as correction factors for other meters. The equation below shows how these factors are used in the computation of average line velocity:

Note: For flowmeters other EMCO's TMP series, set mode ID A0 so that the obscuration and profile factors are entered as constants (A0 = 000). Then set both of these factors to a value of one (A3 = A4 = 1.0).

Mode IDs A1 and A6 must be entered for all applications. A1 is the pipe diameter and should be entered as the inside diameter of the pipe (e.g., 6", schedule 40 = 6.065"). A6 must be set to the approximate atmospheric pressure of the meter site (sea level = 14.73 psi).

The remaining mode IDs (A7-AD) are applicable only for specific fluid types. The two mole fraction IDs (AC and AD) apply only to natural gas and must be entered as fractions instead of percents. (e.g. Enter "0.012" for natural gas consisting of 1.2% CO2.) If either of the mole fractions are nonzero, then the supercompressibility (mode ID AB) will be automatically calculated by the FP-100; if both are zero, then the supercompresibility will be a user-entered constant.

5.5 PROGRAMMING OUTPUTS

Analog Outputs

Of your FP-100 is equipped with analog outputs on the optional Output Board, you may assign these outputs to virtually any variable within the FP-100. The assignment and scaling of these outputs is accomplished by programming mode IDs 80 through 88. There are three mode IDs associated with each analog output: assignment, zero scale value, and full scale value. The assignment is an integer value which tells the FP-100 which variable will be represented by the analog output (see Appendix C for a description of the assignments). The zero scale value is set such that when the assigned variable has this value an output of 4 mA will be generated. The full scale value corresponds to that value which should produce a 20 mA output. The output is determined from the following equation:

$$I_{out} = 4 + 16 \bullet \frac{x - x_{zero}}{x_{full} - x_{zero}}$$

Where:

I_{out} = output current in mA
x = value of variable assigned to analog output
x_{zero} = analog output zero scale value
x_{full} = analog output full scale value

EXAMPLE: Program analog output #1 to represent the absolute pressure where 100 psia = 4 mA and 550 psia = 20 mA.

Keystrokes	Display	Comment
# 8 3	83 00	Select mode ID 83, the assignment for analog output #2.
*** 4 A**	84 0.000	Enter programming mode. Change assignment to 04 for absolute pressure. Advance to next mode ID, zero scale value.
*** 1 D 2 A**	85 100.0	Enter programming mode. Change value to 100.0. Advance to next mode ID, full scale value.
*** 5 5 D 2**	85 550.0	Enter programming mode, change value to 550.0. Exit programming mode.

Totalizers

The FP-100 has four internal totalizers which may be accessed through mode IDs 10-13. The totalizers are referred to by number-totalizer #1 (mode IDs 10 and 11), and totalizer #2 (mode IDs 12 and 13)-and by forward or reverse designations. The reverse flow totalizers (mode IDs 11 and 13) are only used if the FP-100 is programmed for bidirectional flow. Like the analog outputs, the totalizers may be independently assigned to a variable within the FP-100. They are used to maintain a running total of any of the flow rates represented by mode IDs 01 through 06, and are not resettable.

The flow rates assigned to both totalizer #1 and totalizer #2 are selected by mode ID 90. The right digit of this mode ID represents the assignment for totalizer #1, while the left digit represents the assignment for totalizer #2.

Mode IDs 92 and 93 are the totalizer scale factors for totalizer #1 and totalizer #2, respectively. These scale factors are simply the number of units of flow represented by one count of the totalizer. For example, if a totalizer is assigned to mass flow in pounds per hour, and its associated scale factor is set to 100.0, then each increment of the totalizer represents 100 pounds-mass.

EXAMPLE: Program totalizer #1 to accumulate actual volume flow with each increment of the totalizer representing 100 cubic feet, and totalizer #2 representing mass flow in increments of 50 pounds. This example assumes English units are used.

Keystrokes	Display	Comment
# 9 0	90 53	Select mode ID 90, totalizer assignments.
*** 3 1**	90 3 1	Enter programming mode. Set totalizer #2 assignmnet to 3 (mass flow), and totalizer #1 assignment to 1 (actual volume flow).
*** 9 2**	92 1000.	Deposit data, then select mode ID 92, totalizer #1 scale factor.
*** 1 D 2 ***	92 100.0	Enter programming mode, change scale factor to 100.0, exit programming mode.
A * 5 D 1 *	93 50.00	Advance to mode ID 93, enter programming mode, change scale factor to 50.0, exit programming mode.

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Digital Outputs

The two digital output on the CPU Board may be independently assigned to one of the four totalizers, to one of the two alarms, or to control an external communications device. The assignments are made through mode 91 (see Appendix C for a description of the assignments). If your FP-100 is equipped with electromechanical totizers, the digital outputs are factory wired to drive the totalizers, and the digital outputs must be assigned to internal totalizers in order that they may work properly. If a digital output is assigned to an internal totalizer, the digital output will turn on for 50 milliseconds each time the internal totalizer is incremented. The maximum output pulse rate is ten pulses per second. If this rate is exceeded, a totalizer fault will occur and the totalizer count will be incorrect.

If a digital output is assigned to an alarm (see below), it is turned on whenever the alarm condition is met. A digital output assigned to communications control will be turned on before a message is transmitted by the FP-100, and turned off at the end of the message. The timing for the output control is the same as that for the RTS output, as discussed in Section 7.

EXAMPLE: Assign digital output #1 to alarm #1, and digital output #2 to forward totalizer #1.

Keystrokes	Display		Comment
# 9 1 *	91	64	Select mode ID 91 and enter programming mode.
6 2 *	91	62	Assign digital output #1 to 2 (alarm #1), and digital output #2 to 6 (forward totalizer #1).

Alarms

The two alarms on the FP-100 may be assigned to either low or high setpoint values, or to an internal fault condition. These alarms have no effect unless assigned to a digital output (see above). Assignment of the alarms is accomplished via mode ID 94 for alarm #1 and 96 for alarm #2. The setpoint value, either high or low, is programmed into mode ID 95 for alarm #1 and 97 for alarm #2.

EXAMPLE: Program the FP-100 so that alarm #1 will be set if a temperature input fault occurs, and alarm #2 will be set if the pressure drops below 50 psia. Furthermore, assign alarm #1 to digital output #1, and alarm #2 to digital output #2.

Keystrokes	Display		Comment
# 9 4 * 8 2 *	94	82	Set alarm #1 assignment to 82 (temperature input out of range). Note that mode ID 93, alarm #1 limit, does not apply since this is a fault alarm.
# 9 6 * 0 3 *	96	03	Set alarm #2 assignment to 03 (low pressure).
A * 5 D 1 *	97	50.00	Set alarm #2 limit to 50.00.
# 9 1 * 3 2 *	91	32	Assign digital output #1 to alarm #1, and digital output #2 to alarm #2.

5.6 SYSTEM PARAMETERS

Only two alterable system parameters will be discussed here: the time and date (mode IDs CC and CD, respectively). Communication parameters (IDs C3-C5) are covered in Section 7, and printer mode IDs (C6-CB) are covered in Section 8. The system time is always displayed and programmed in 24-hour format (HH.MM: $00 \le HH \le 23$, $00 \le MM \le 59$). In display mode, the system date will show the month and day (MM/DD: $01 \le MM \le 12$, $01 \le DD \le 31$). In programming mode, the display also shows the current year (YY/MM/DD: $00 \le YY \le 99$). The FP-100 will correct for leap years, but not for leap centuries. Be sure to mark your calender to correct for this on March 1, 2100.

EXAMPLE: Program the current time to 4:57 p.m., and the current date to November 19, 1988. This example assumes that the password is still valid.

Keystrokes	Display	Comment
# C C	CC 00. 27	Select mode ID CC, enter programming mode.
1 6 5 7 *	CC 16. 57	Set the time to 4:57 p.m. (=16.57).
A	CD 09 / 01	Advance to mode ID CD.
*****	88 / 09 / 01	Enter programming mode–display shows year/month/day.
8 8 1 1 1 9 *	CD 11 / 19	Change date to 11/19/87–display shows month/day.

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Section 6 - Monitoring Data

6.1 PROCESS VARIABLES

Process variables are those values which are calculated by the FP-100 as opposed to user-entered constants which are programmed by the user. Included in these variables are such items as volumetric, mass and energy flow rates, pressure, temperature, analog output values, and totalizers. These variables may be examined at any time by accessing the associated mode ID, or in some cases, by simply pressing the key functionally labeled as such.

Flow Related Data

Mode IDs 01 through 06 contain current values of the valid flow rates for the selected application. The flow rates valid for each fluid type are listed below. Those mode IDs marked by "*" are the "normally displayed" mode IDs which will be first displayed after the power is applied, and which will be displayed if the 1-key (FLOW) is pressed when in display mode.

		Valid for Fluid Type						
Mode ID	Description	00	01	02	03	04	05	06
01	Actual volume flow	●	●	●	●	●	●	●
02	Liquid volume flow				✪	●	✪	●
03	Mass flow	✪	●	●	●	●	●	●
04	Standard or normal volume flow		✪	✪				
05	Heat flow (Btu or kJ)	●			●	✪	●	✪
06	Heat flow (refrigeration tons or kw)	●			●	●	●	●

In addition to the flow rates, line velocity may be examined by accessing mode ID 00 or pressing the 4-key (VEL). The current values of density, enthalpy, and specific volume of the fluid are accessible through mode IDs 08 through 0E.

Totalizers

Mode IDs 10-13 contain the forward and reverse totalizers, which continuously accumulate the flow in the pipe according to the totalizer assignments and scale factors. For example, if a totalizer is assigned to mass flow, with a scaling factor or 1000.0, and if the totalizer reads 347, then the total mass flow (since startup) in the pipe is 347,000 pounds mass (assuming English units). The totalizers are not manually resettable, and will count up to 999,999 before rolling over to zero. The reverse totalizers only apply if bidirectional flow is selected with a frequency input for flow.

Analog Outputs

If your FP-100 is equipped with the optional Output Board, then up to three analog outputs may be assigned to variables within the unit. The assignment of the analog outputs and the zero and full scale values for each output is discussed in Section 5.5. The analog output values represented in mode IDs 14-16 are displayed as a percent of full scale, with 0% representing an analog output current of 4.0 mA and 100% indicating 20.0 mA output current. The range of these mode IDs is restricted to 0.0 to 100.0%. If the variable assigned to an analog output drops below the zero scale value or exceeds the full scale value then a fault condition is set and is indicated by a "1" in mode ID D1. In this case, the value displayed will be 0.0 or 100.0, and the output current will not drop below 4.0 mA, nor exceed 20.0 mA. If an analog output is not assigned, the corresponding mode ID will read 0.0%, and the output will be set to 4.0 mA.

Average, Minimum, and Maximum Values

Mode IDs 21-2F indicate average, minimum, and maximum values of selected variables. See Appendix C for information about variables which are assigned to these mode IDs. These values are effective for the time that the FP-100 is initialized using the D-key powerup, or from the time that the values are cleared. The total time in minutes since the calues were last cleared is shown in mode ID 20.

Accessing mode ID D9 will cause the FP-100 to clear the average, minimum, and maximum values in mode IDs 21-2F. The average and maximum frequencies in mode IDs 31 and 34-36 are also cleared. The password must be valid in order to access this mode ID. When accessed, the display will alternately show VALUES and CLEARED until another mode ID is selected.

Input Values

Mode IDs 30-36 are used to display data related to the flow frequency input (s). The maximum pulse rate and average frequency values in mode IDs 31 and 34-36 are cleared along with the average, minimum, and maximum values discussed in the previous section by accessing mode ID D9.

Analog flow, temperature, and pressure values from transducers are displayed in mode IDs 40-44. If two temperature probes are used in a liquid heat flow application, then differential temperature is displayed in mode ID 45. Mode IDs 46-49 are used to display the resistance of RTD(s) and their leads, if these are used in place of 4-20 mA analog inputs for temperature.

6.2 SYSTEM PARAMETERS

Mode ID C0 displays the unit number selected by setting switches on the CPU Board. This number is used for identification of the unit during commication (Section 7) and report generation (Section 8). Mode ID C0 provides a convenient means for checking the unit number and verifying that the switches have been set correctly.

Mode IDs C1 and C2 contain a program code and version number. If you have any questions regarding the operation of the FP-100, please make note of these numbers for reference when talking to your EMCO representative. The current time and date may be displayed by examining mode IDs CC and CD, respectively. These parameters are used mainly for timing of the periodic reports. Mode ID CF shows the calculation cycle time, or the amount of time taken to complete the last calculation cycle. This mode ID is for diagnostics only, and should be of no concern during normal operation.

Communications mode IDs C3-C5 are discussed in Section 7, and printer mode IDs C6-CB are discussed in Section 8.

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6.3 FAULTS

When a fault occurs on the FP-100, the "MODE ID" portion of the display (leftmost two digits) will periodically flash two asterisks "**". The type of fault which occurred will be indicated by the presence of a "1" in one of the fault mode IDs (D0-D3). In addition, several types of faults will trigger a timer that logs the duration in minutes of the fault condition. Refer to Appendix C, mode IDs D0-D6 for a complete description of the fault mode IDs and timers.

Note: The existence of communications fault(s) in mode ID D3 will not affect the periodic "**" fault indication.

Input Faults, mode ID D0

These faults are caused be a problem with one or more of the input signals to the FP-100. Associated with the input faults are timers in mode IDs D4 and D5, which display accumulated fault time in minutes for the flow and analog inputs, respectively.

Computation faults, mode ID D1

These faults typically indicate incorrect programming of the FP-100. A floating point overrange usually indicates an attempt to divide by zero. A totalizer fault results from a scale factor which is too small, causing the totalizer to increment faster than 10 counts per second. The analog output faults indicate that the selected variable either fell below the zero scale value or exceeded the full scale value. Any of the analog output faults will trigger a fault timer in mode ID D6.

Hardware faults, mode ID D2

These faults indicate a problem with the electronics of the FP-100 or a power failure to the unit. If one of these faults occurs, first clear it by examining mode ID D8 (see below). If the fault was not caused by a power failure, then cycle power to the unit, and if the fault reappears, contact your EMCO representative for assistance. If a power failure has occurred, make sure that the unit is still operating normally.

Communication faults, mode ID D3

These faults are normally associated with a noisy communications channel or with improper baud rate or data format. See Section 7 for communications information.

6.4 CLEARING FAULTS

To clear faults, simply examine mode ID D8, entering the password if necessary. The display will alternate "FAULTS" and "CLEARED," and all of the fault flags and timers (mode IDs D0-D6) will be cleared and reset to zero. If after being cleared, the unit again indicates faults, further trouble-shooting will be necessary to find the source of the fault.

EXAMPLE: The mode ID portion of the display is periodically flashing "******." Find out which fault or faults occurred and for how long, and then clear the fault condition.

Keystrokes	Display	Comment
6	D0 000001 0	Examine the input faults. The "1" in this position indicates a temperature input out of range.
A	D1 00000	Advance to the computation faults. All zeros indicate none have occurred.
A	D2 00000	Advance to the hardware faults.
A	D3 000	Advance to the communications faults.
# D 4	D4 293	The temperature fault timer shows that the fault occured for 293 minutes.

At this point, you know that a temperature fault has existed for nearly five hours. If the condition that caused this fault still exists, then appropriate action should be taken to fix it. When the condition no longer exists, access mode ID D8 to clear the fault indication.

# D 8	PASSWORD	Examine mode ID D8 to clear the faults.
(password)	FAULTS CLEARED	Correctly entering the password (if needed) will result in clearing the faults and timers.
# D 0	D1 000000	Examine the faults again to make sure the fault is gone.

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Section 7 - Communication

7.1 GENERAL

The FP-100 Flow Processor has provisions for communicating with an intelligent device such as a host computer. In fact, any operation that can be performed from the front panel can also be done via a hose computer and typically much faster. The communication port of the FP-100 may be used with any serial interface device that meets the following requirements:

Interface:	EIA RS-422 or RS-423 (RS-232) compatible
Baud rates:	300, 600, 1200, 2400, 4800, or 9600
Data format:	7 or 8 data bits Even, odd, or no parity bit 1 or 2 stop bits
Handshaking:	Hardware handshaking, using the CTS input to the FP-100 (RS-423/232 only): READY > 3.0 volts, NOT READY < -3.0 volts
Character set:	ASCII

7.2 COMMUNICATION CONFIGURATION

The data format and baud rate of both FP-100 and the host computer must match before any communication can occur. Examine mode IDs C3-C5 to check the FP-100's configuration.

Data Format

The communication port data format (data bits, parity, and stop bits) is set by mode ID C3. Refer to Appendix C, mode ID C3 for settings of this mode ID. The default value is 04, which results in a data format of 8 data bits, no parity, and 2 stop bits. This format should work with the default setting of many computers and modems sold today.

Baud Rate

The communication port baud rate is selected by installing a jumper at J6 on the CPU Board, as shown in Appendix B. The baud rate of the FP-100 port must match that of the host computer. After the baud rate is set, it may be verified by accessing mode ID C4, which will show the actual baud rate in bits per second.

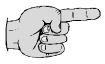
Message Delay

Some host computers may require an additional delay at the start of an incoming message. The FP-100 may be programmed (via mode ID C5) to adjust for this by sending up to 99 null characters (ASCII 00) before transmitting each message. At 1200 baud, this results in a delay of about 0.8 seconds. Normally, however, one null character is sufficient, and mode ID C5 should be set to 1.

7.3 GETTING DATA TO AND FROM THE FP-100

Communication Protocol

A strict communication protocol must be observed in order for the FP-100 to respond to a host's request. With this protocol, mode IDs may be examined or altered, a process which allows the user to completely program a unit from scratch. The general procedure is for a host to send a message and then wait for the FP-100 to respond. All messages are transmitted and received using the ASCII character set which is summarized in a table at the end of this section. The FP-100's response will be started within 0.5 seconds after receiving the final character of the host's message.



Note: Communication with an FP-100 must be under half-duplex conditions. The FP-100 will not respond to messages coming in while it is transmitting.

To examine mode ID data, the host computer sends:

`:unit#MM<CR>`

To alter mode ID data, host sends:

`:unit#MM*data,SS<cr>`

In either case, if the message received by the FP-100 is correct, the FP-100 responds:

`:unit#MMXdata,SS<CR><LF><NUL>` (No faults)

or `:unit#MMXdata!SS<CR><LF><NUL>` (Faults present)

If there is an error in the message received by the FP-100, the FP-100 responds:

`:unit*n,SS<CR><LF><NUL>` (No faults)

or `:unit*n!SS<CR><LF><NUL>` (Faults present)

Note: When faults are present (i.e., if any bits are set in the fault flags, mode IDs D0-D3), an exclamation mark (!) will precede the checksum field instead of a comma (,) in the response.

Definitions for all of the symbols used in the above messages may be found in the following table on the following page.

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7.4 COMMUNICATION PROTOCOL DEFINITIONS

(Hexadecimal ASCII values are preceded by a $)

`:` Colon ($3A)-indicates start of message. All messages to or from the FP-100 start with this character.

`unit` FP-100 unit number as set by the rotary switches (0...9999). Leading zeros in the unit number are optional (i.e., “0001” is the same as “1”).

`#` Pound sign ($23)-separator after the unit number, always precedes the mode ID number.

`MM` Hexadecimal 2-digit mode ID number. Each mode ID digit must be in the range 0...9 or A...F.

`*` Asterisk ($2A)-separator after the mode ID, always precedes the data field. Used when altering data and also in the return message if an error is detected in the incoming message.

`X` Character identifying the data type of the mode ID in messages from the FP-100. See the following table on communication data format for definitions of the data types.

`,` Comma ($2C)-separator preceding the checksum character if there are no faults present.

`!` Exclamation mark ($21)-separator preceding the checksum characters if one or more of the fault flag bits (mode IDs D0-D3) are set.

`SS` Hexadecimal 2-digit checksum. When used, this is the sum (modulo 256) of the ordinal values of all characters in the message from the colon to the comma (or exclamation mark), inclusive.

`<CR>` Carriage return ($0D)-terminator for messages sent to the FP-100. All characters received after the <CR> will be ignored, until a colon is received.

`<LF>` Line feed ($0A)-terminator for messages sent from the FP-100.

`<NUL>` Null character ($00)-Message to and from the FP-100 may contain nulls before or after the message to synchronize the communication devices or delay the message from the FP-100.

`n` Error number sent by FP-100, as follows:

0 - ACIA receiver error (framing, overrun, or parity)

1 - Syntax error (invalid character of format of message)

2 - Non-existent mode ID (see Appendix C for valid mode IDs)

3 - Examine only error (mode ID is not alterable)

4 - Data error (see following table on communication data for correct format)

5 - Checksum error

`data` See following page on communication data format.

7.5 COMMUNICATION DATA FORMAT

Data Type	X*	Data Format
Floating point	a	sD.dddddEsdD
Percentage	b	sD.dddddEsdD
Integer, 2-digit	c	DD
Integer, 5-digit	d	DDDDD
Integer, 6-digit	e	DDDDDD
Integer, 3-digit	f	DDD
Hexadecimal, 4-digit	h	HHHH
Binary flags, 1-bit	i	zzzzzB
Binary flags, 2-bit	j	zzzzBB
Binary flags, 3-bit	k	zzzBBB
Binary flags, 4-bit	l	zzBBBB
Binary flags, 5-bit	m	zBBBBB
Binary flags, 6-bit	n	BBBBBB
Special, mode IDs CA, CB, & CC	p	DD.DD
Special mode ID CD	p	DD.DD.DD
Special, mode ID C6	p	HH-HH-HH...(up to 20)
Special, mode ID D8†	x	FAULTS
Special, mode ID D9†	x	VALUES

* The data type character, X, is not sent in messages to the FP-100. In messages from the FP-100, this character will be upper case for alterable mode IDs and lower case for examine only mode IDs.

† These data types are not alterable. An attempt to modify one of these types will result in an input error 3.

7.6 DEFINITIONS

s Sign of mantissa or exponent. In messages to the FP-100, the sign is optional; in messages from the FP-100 the sign will always be included. A negative sign must be a dash, "-" ($2D); a positive sign may be any character except a dash, but will always be a space ($20) in messages from the FP-100.

D Decimal digit in the range 0...9 ($30...$39).

d Optional decimal digit in the range 0...9 ($30...$39). In messages to the FP-100, these digits are optional; in message from the FP-100, these digits will always be included.

H Hexadecimal digit in the range 0...9 or A...F ($30...$39 or $41...$46).

B Binary digit in the range 0...1 ($30...$31).

z A filler in binary data. In messages to the FP-100, these are ignored and may be any character; in messages from the FP-100, these will always be spaces ($20). All binary data contains 6 characters.

All other characters must appear as shown (".", "E", etc.).

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7.5 SPECIAL COMMUNICATION FUNCTIONS

Mode IDs F0-F4, F9, and FF are reserved for special communication purposes, and are not accessible from the FP-100's front panel. These mode IDs are not alterable and need only be examined by a host to perform their special function. Mode ID F0 will result in a normal reset of the FP-100 simulating a power-up reset with no key pressed, while mode ID FF will cause a reset to default values, as is done when the D-key is pressed at power on. Mode IDs F1-F4 and F9 are defined as report mode IDs, and are convenient for obtaining long streams of data without having to send a new message for each mode ID. Examining mode ID F9 results in a report of all data without having to send a new message for each mode ID. Examining mode ID F9 results in a report of all data specified by mode ID C6. Hence, this is a programmable report, returning up to 20 mode ID values. See Section 8.2 for information on how to program mode ID C6. Refer to the table of communication protocol definitions for meaning of the symbols used below.

To examine report mode ID data, host sends:

`:unit#MM<CR>`

If the message received by the FP-100 is correct, the FP-100 responds:

`:unit#MMXdata#MMXdata. . . . #MMXdata,SS<CR><LF>` (no faults)

`:unit#MMXdata#MMXdata. . . . #MMXdata!SS<CR><LF>` (faults present)

Mode ID	Mode IDs transmitted in report
F1	07,03,05,10,12,42,43,B0
F2	20,21,22,23,24,25,26,27,28,29,2A,2B,2C,2D,2E,2F
F3	D0,D1,D2,D3
F4	03,05,42,07
F9	(List of IDs programmed into mode ID C6.)

7.6 FURTHER DETAILS ON PROTOCOL AND CONFIGURATION

After the FP-100 receives a message and the unit number is verified, the RTS output (if wired for RS-423) is turned on. If a digital output is assigned to communication control, it will be turned on and off with the RTS output. A delay of 150 milliseconds will always precede the return message from the FP-100. If configured for RS-423 and the CTS input to the FP-100 is used, the CTS input must be held high or left disconnected in order for the data to be transmitted.

If the FP-100 is configured for RS-423, the RTS output is normally high when transmitting data. To change the state of the RTS output, so that it is low when transmitting, remove the jumper from J4 13-14, and install it at J4 11-13 on the CPU Board.

Immediately after the end of the transmitted message (following <LF><NUL>), RTS (and the digital output, if assigned) is turned off. At this time, the host may send another message.

7.7 COMMUNICATION EXAMPLES

All of the examples shown in this section assume that the FP-100 is configured with a unit number of zero. The checksums given will be incorrect if a different unit number is used, or if the data is not exactly as shown. Note that leading zeros need not be included-"0","00","000", and "0000) are all equivalent. Note also that the message transmitted to the Fp-100 must be terminated with a carriage return, and that all response messages may be preceded by the number of nulls programmed into mode ID C5, and are terminated with a carriage return, line feed, and a single null character. The first example demonstrates the use of these control characters in communicating with the FP-100. For clarity, the control characters are not shown in subsequent examples.

EXAMPLE: Examine the data in mode ID 00. This example assumes that the number of nulls in the response message is 2 (Mode ID C5).

Transmit message `:0#00<CR>`

FP-100 response `<NUL><NUL>:0#00a4.69982E 01,D4<CR><LF><NUL>`

EXAMPLE: Examine the data in mode ID 50:

Transmit message :0#50

FP-100 response `:0#50C00,C1`

EXAMPLE: Request report mode ID F3, which returns data for the fault mode IDs D0-D3:

Transmit message `:0#F3`

FP-100 response `:0#D0n000000#D1m 00000#D2n000000#D3k 000,EC`

EXAMPLE: Change the data in mode ID 50 to 02:

Transmit message `:0#50*02,AA`

FP-100 response `:0#50C02,C3`

EXAMPLE: Clear the faults by accessing mode ID D8:

Transmit message `:0#D8`

FP-100 response `:0#D8xFAULTS,7C`

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EXAMPLE: Change the floating point data represented by mode ID 82. Several examples are shown to illustrate the versatility in the floating point data format.

Transmit message	`:000#82*1.2E3,B6`
FP-100 response	`:000#82A 1.20000E 03,FD`
Transmit message	`:000#82*2.E4,86`
FP-100 response	`:000#82A 2.00000E 04,FD`
Transmit message	`:000#82*-1.E2,B0`
FP-100 response	`:000#82A-1.00000E 02,07`
Transmit message	`:000#82*1.E-2,B0`
FP-100 response	`:000#82A 1.00000E-02,07`
Transmit message	`:000#82*1E03,86`
FP-100 response	`:000#82A 1.00000E 03,FB`

Note that the mantissa may consist of 1 to 6 digits, with an optional sign, and must range between 1.00000 and 9.99999. If the mantissa is a single digit, the decimal point is optional. The exponent may contain 1 or 2 digits also with an optional sign. The letter E must separate the mantissa and exponent.

EXAMPLE: Demonstrate input error #1, syntax error:

Transmit message	`:000#AR`
FP-100 response	`:000*1,51`

Mode ID characters must be in the range 0-9 or A-F.

EXAMPLE: Demonstrate input error #4, incorrect data format:

Transmit message	`:000#82*1,DE`
FP-100 response	`:000*4,54`

EXAMPLE: Demonstrate input error #5, checksum error:

Transmit message	`:000#50*01,08` (correct checksum is 09)
FP-100 response	`:000*5,55`

7.8 ASCII CHARACTER SET

Value Hex	Value Decimal	Character	Value Hex	Value Decimal	Character	Value Hex	Value Decimal	Character	Value Hex	Value Decimal	Character
00	**0**	**NUL**	**20**	**32**	**Space**	40	64	@	60	96	`
01	1	SOH	**21**	**33**	**!**	**41**	**65**	**A**	**61**	**97**	**a**
02	2	STX	22	34	“	**42**	**66**	**B**	**62**	**98**	**b**
03	3	ETX	**23**	**35**	**#**	**43**	**67**	**C**	**63**	**99**	**c**
04	4	EOT	24	36	$	**44**	**68**	**D**	**64**	**100**	**d**
05	5	ENQ	25	37	%	**45**	**69**	**E**	**65**	**101**	**e**
06	6	ACK	26	38	&	**46**	**70**	**F**	**66**	**102**	**f**
07	7	BEL	27	39	‘	**47**	**71**	**G**	**67**	**103**	**g**
08	8	BS	28	40	(	**48**	**72**	**H**	**68**	**104**	**h**
09	9	HT	29	41	)	**49**	**73**	**I**	**69**	**105**	**i**
0A	**10**	**LF**	**2A**	**42**	*****	**4A**	**74**	**J**	**6A**	**106**	**j**
0B	11	VT	**2B**	**43**	**+**	**4B**	**75**	**K**	**6B**	**107**	**k**
0C	12	FF	**2C**	**44**	**,**	**4C**	**76**	**L**	**6C**	**108**	**l**
0D	**13**	**CR**	**2D**	**45**	**-**	**4D**	**77**	**M**	**6D**	**109**	**m**
0E	14	SO	**2E**	**46**	**.**	**4E**	**78**	**N**	**6E**	**110**	**n**
0F	15	SI	2F	47	/	**4F**	**79**	**O**	**6F**	**111**	**o**
10	16	DLE	**30**	**48**	**0**	**50**	**80**	**P**	**70**	**112**	**p**
11	17	DC1	**31**	**49**	**1**	**51**	**81**	**Q**	**71**	**113**	**q**
12	18	DC2	**32**	**50**	**2**	**52**	**82**	**R**	**72**	**114**	**r**
13	19	DC3	**33**	**51**	**3**	**53**	**83**	**S**	**73**	**115**	**s**
14	20	DC4	**34**	**52**	**4**	**54**	**84**	**T**	**74**	**116**	**t**
15	21	NAK	**35**	**53**	**5**	**55**	**85**	**U**	**75**	**117**	**u**
16	22	SYN	**36**	**54**	**6**	**56**	**85**	**V**	**76**	**118**	**v**
17	23	ETB	**37**	**55**	**7**	**57**	**87**	**W**	**77**	**119**	**w**
18	24	CAN	**38**	**56**	**8**	**58**	**88**	**X**	**78**	**720**	**x**
19	25	EM	**39**	**57**	**9**	**59**	**89**	**Y**	**79**	**121**	**y**
1A	26	SUB	**3A**	**58**	**:**	**5A**	**90**	**Z**	**7A**	**122**	**z**
1B	27	ESC	3B	59	;	5B	91	[	7B	123	{
1C	28	FS	3C	60	<	5C	92	\	7C	124	|
1D	29	GS	3D	61	=	5D	93	]	7D	125	}
1E	30	RS	3E	62	>	5E	94	^	7E	126	~
1F	31	US	3F	63	?	5F	95	_	7F	127	DEL

Note: Characters which are used in messages to or from the FP-100 are shown in boldface.

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Section 8 - Printer

8.1 GENERAL

The printer output of the FP-100 may be used with any serial interface printer that meets the following requirements:

Interface:	EIA RS-232C compatible
Baud rates:	300, 600, 1200, 2400, 4800, or 9600
Data format:	7 or 8 data bits Even, odd, or no parity bit 1 or 2 stop bits
Handshaking:	Hardware handshaking, using the CTS input to the FP-100; READY > 3.0 volts, NOT READY < -3.0 volts
Character set:	ASCII
Print columns:	40 to 200
Line terminator:	Carriage return ($0D) + line feed ($0A)
Page eject:	Form feed ($0C)
Lines per page:	66

8.1 PRINTER CONFIGURATION

The data format and baud rate of both the FP-100 and the printer must match before the printer output will function correctly. Examine mode IDs C7 and C8, respectively, to check the FP-100's configuration.

Data Format

The printer port data format (data bits, parity, and stop bits) is set by mode ID C7, which is identical to the communication port format in mode ID C3. Refer to Appendix C, mode ID C7 for settings of the mode ID. The default value is 04, which results in a data format of 8 data bits, no parity, and 2 stop bits. This format should work with the default setting of most printers sold today.

Baud Rate

The printer port baud rate is selected by installing a jumper at J6 on the CPU Board, as shown in Appendix B. The baud rate of the FP-100 printer port must match that of the printer. After the baud rate is set, it may be verified by accessing mode ID C8, which will show the actual baud rate in bits per second.

8.2 GETTING PRINTED REPORTS FROM THE FP-100

On Demand Reports

The FP-100 will print a report on demand with a very simple 2-keystroke sequence. The procedure is to press the 0-key (PRINT) followed by the A, B, C, or D-key. The length of the report will depend on which key was pressed. If a key other than A, B, C, or D is pressed, the print request will be cancelled. It is a good idea to print an A-report in order to see if your printer is working correctly.

Keystrokes	Display	Comment
0	PRINT 7	Select print report function.
A	PRINT A 03 0.000	Display momentarily shows which key was pressed then reverts to normal display mode.

At this point, if the printer is wired correctly and the FP-100 baud rate and data format match those of the printer, the printer should product a report similar to the following:

```
UNIT 0000                  FP-100 REPORT                    12:06 AM  11/16/87
  CC         01         03         00         41         43         10         12
 TIME     VOL FLOW  MASS FLO VELOCITY  PRESS, G    TEMP    TOTAL 1F TOTAL 2F
           CU FT/H    LBS/H     FT/S       PSI      DEG F
--------  --------  -------- --------  -------- --------  -------- --------
12:06 AM  0.00000   0.00000  0.00000   29.6240   272.908      0          0
```

If the printer didn't operate at all, or produced garbled output, then refer to Section 8.3 of this manual for troubleshooting. If it produced a report similar to the one above, then congratulations! The only thing remaining to verify is that the handshaking is working. If the handshaking is not working, then characters will likely be missing from a longer report. Let's try a longer report now.

Keystrokes	Display	Comment
0	PRINT 7	Select print report function.
A	03 0.000	D-report printed and display reverts to selected mode ID. The following report will be printed.

```
  UNIT 0000  FP-100          12:06 AM      11/16/87

ID          DESCRIPTION          DATA         UNITS
--         ------------       ---------    ----------
00           VELOCITY        0.00000e 00      FT/S
01           VOL FLOW        0.00000e 00    CU FT/H
03           MASS FLO        0.00000e 00     LBS/H
05           HEAT FLO        0.00000e 00     BTU/H
06           HEAT FLO        0.00000e 00      TONS
 •
 •       (Mode IDs between 06 and D0 deleted for brevity)
 •
D0            INPT FLT             000000
D1            COMP FLT              00000
D2            HARD FLT             001000
D3            COMM FLT                000
D4            INP FTIM                  0
D5            FLO FTIM                  0
D6            OUT FTIM                  0
D7             RAM ERR               0000
```


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Check the listing for missed characters or lines. All valid mode IDs should be printed. If there are any missing characters or lines, the handshaking is probably not working correctly. Refer to the troubleshooting section for further details.

You've now seen two of the four demand report formats: the A-key report, which is identical in appearance to the periodic report, and the D-key report, which is a complete listing of all the valid mode IDs in the FP-100. The other two reports, which, as you might guess, are the B-key and C-key reports, print subsets of the D-key report. The B-key report prints all of the valid mode IDs from 00 through 49, followed by the fault mode IDs D0 through D7. The C-key report prints all of the valid mode IDs from 50 through EE. Experiment with your unit to find out exactly which mode IDs are printed for each type of on-demand report and which one best suits your needs.

Note: Pressing any key other than A, B, C, or D after pressing the 0-key cancels the print request. If a report is currently being printed, the 0-key will be ignored until the report is completed.

Periodic Reports and Data Logging

The FP-100's periodic report generator is extremely versatile. Any of the mode IDs (up to 20 total) may be printed in each report and in any order. The starting time and interval between reports are both programmable. In addition, several features such as page headings, fault reporting, and clearing of average, minimum, and maximum values may be turned on or off.

Let's take a look at the periodic report format:

```
UNIT 0000                  FP-100 REPORT                    12:06 AM  11/16/87
   CC         01         03         00         41         43         10         12
  TIME     VOL FLOW   MASS FLO  VELOCITY   PRESS, G    TEMP    TOTAL 1F  TOTAL 2F
            CU FT/H     LBS/H      FT/S       PSI      DEG F
--------  ---------  ---------  ---------  ---------  ---------  --------  --------
12:06 AM   0.00000    0.00000    0.00000    29.6240    272.908       0         0
12:07 AM   0.00000    0.00000    0.00000    29.7932    275.086       0         0
12:08 AM   0.00000    0.00000    0.00000    29.5128    276.712       0         0
12:09 AM   0.00000    0.00000    0.00000    29.2924    273.956       0         0
12:10 AM   0.00000    0.00000    0.00000    28.9143    268.642       0         0

12:11 AM   0.00000    0.00000    0.00000    29.9130    266.013       0         0
12:12 AM   0.00000    0.00000    0.00000    29.0243    269.410       0         0
12:13 AM   0.00000    0.00000    0.00000    27.6257    277.305       0         0
```

The first six lines of this report comprise the page heading. Each page, if the page heading function is enabled, will start with a heading similar to this. The first line of the heading includes the unit number and the time and date that this page of the report was started. The third through fifth lines contain the report column headings, which includes the following information:

- Mode ID number
- Brief description of the mode ID data
- Units of the mode ID, if applicable

At each report interval, one line is printed, which includes current data for each of the mode IDs selected. Each line is terminated with an ASCII carriage return followed by a line feed. The mode IDs, which are printed, may be selected by programming mode ID C6. Up to 20 mode IDs may be selected, depending upon your printer's line length capability. Each mode ID printed in the report will require 10 characters. For example, if you have a 40-column printer, the maximum number of mode IDs that can be printed is 4. Any of the valid mode IDs may be selected for printing in the report, and they may be selected in any order.

8.3 MODE ID C6

This mode ID is used to select the data to be printed with each report. When examined, this mode ID will display something like: C6 01–CC, where 01 is the report column number, and CC is the mode ID that will be printed in this report column. There is no way of reviewing what is programmed into mode ID C6 from the keypad without reprogramming the mode ID. The easiest way to review the data in C6 is to print an A-key report and note each mode ID that is printed.

To program mode ID C6, perform the following steps:

1) Choose the mode IDs to be printed and the order in which they should be printed.

2) Access mode ID C6 and enter programming mode. Enter the password if necessary.

3) As each report column is displayed, enter the mode ID number to be printed at that position.

4) When done, press the *-key to exit programming mode.

EXAMPLE: Program the FP-100 to print, from left to right, the average, minimum, and maximum volume flow and temperature, followed by the report date. Mode IDs to be selected are 21, 22, 23, 2A, 2B, 2C, and CD. This example assumes the password is already valid.

Keystrokes	Display	Comment
# C 6	C6 01–CC	Select mode ID C6.
*****	C6 01–CC	Last character flashes, indicating programming mode.
2	C6 01–02	First digit is entered at right, other digit zeroed.
1	C6 01–21 C6 02–01	Second digit entered and display momentarily shows mode ID just entered before showing data for column 2 (01).
2 2	C6 02–22 C6 03–03	Enter data for column 2. Display holds momentarily before showing data for column 3 (previously mode ID 03).
2 3	C6 04–00	Continue entering the rest of the mode IDs.
2 A	C6 05–41	
2 B	C6 06–43	
2 C	C6 07– 10	
C D	C6 08– 12	
*****	C6 01–21	After last mode ID is entered, press * to exit.

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Press **0 A** to verify the configuration. The FP-100 should print a report similar to the following:

```
UNIT 0000                  FP-100 REPORT          08:24 AM  11/19/87
  21         22         23         2A         2B         2C         CD
AVE #1     MIN #1     MAX #1     AVE #4     MIN #4     MAX #4      DATE
CU FT/H    CU FT/H    CU FT/H    DEG F      DEG F      DEG F
--------  --------  --------  --------  --------  --------  --------
8170.26    0.00000   8190.74   272.873    266.013    277.305   11/19/87
```

Note: If an invalid mode ID is chosen for a periodic report, then a blank column (no data) will be printed. This can sometimes be useful for improving the legibility of the report.

8.4 MODE ID C9

This mode ID is used to select several attributes of the report generator. It is a 6-bit binary flag which controls the following characteristics of the report. See the mode ID listing for further information on programming this mode ID.

- The report interval may be programmed in increments of one minute or one second. This allows intervals from 1 second to 99 hours, 59 minutes to be selected.
- Average, minimum, and maximum values may be cleared after each report, if any of mode IDs 21 through 2F are printed. If this attribute is turned on, then the average, minimum, and maximum values printed are those since the last report; otherwise, the printed values are those accumulated since the last time the values were manually cleared by accessing mode ID D9.
- The printing of reports in groups of five may be enabled or disabled. If enabled, a blank like is printed after every fifth report line. This improves the readability of the reports.
- Printing page headings may be turned on or off. It may be desirable to turn the headings off when used with non-perforated paper, such as thermal paper in small data-logging printers.
- Select 12-hour (HH:MM AM or PM) or 24-hour (HH:MM:SS) time format. This format is used in fault reports, in the page heading and for printing the time mode ID CC.
- Fault reporting may be enabled or disabled. If enabled, the occurrence of a fault will cause a special fault report to be printed, which indicates the type of fault and the data and time when it occurred.

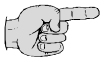
8.5 MODE ID CA

This mode ID controls when the periodic reports will be started. The format of this mode ID is HH.MM, ($00 \le HH \le 23$ and $00 \le MM \le 59$), which allows starting at any time of the day. Additionally, this mode ID may be programmed to start reporting immediately (on the next minute) or exactly on the next hour. To start immediately, program 99.99 into this mode ID; to start on the next hour, program 99.00.

8.6 MODE ID CB

This mode ID controls the time interval between successive periodic reports, and may be set to any value between 00.00 and 99.59. If set to 00.00, then periodic reporting is turned off. The interval units are selected by the report format flag, mode ID C9, as follows:

- If mode ID C9 bit 5 = 0, then the interval is in minutes and seconds (MM.SS)
- If mode ID C9 bit 5 = 1, then the interval is in hours and minutes (HH.MM)



Note: Periodic reporting will be started if and only if the starting time is reached and the interval is set to a non-zero value. If periodic reporting is turned off at any time (by setting the report interval to 00.00), then the report is stopped completely, and a form feed is sent to the printer.

EXAMPLE: Program the FP-100 to print a periodic report every hour, starting at 4:00 pm. This example assumes that the password is still valid.

Keystrokes	Display	Comment
# C A	CA 00.00	Select mode ID CA.
*****	CA 00.00	Left digit in display flashes, indicating programming mode.
1 6 0 0 *	CA 16.00	Enter starting time in 24-hour format (midnight = 0:00). Exit programming mode.
A *	CB 00.00	Advance to report interval (mode ID CB) and enter programming mode.
0 1 0 0 *	CB 01.00	Report interval = 1 hour, 0 minutes. This assumes that bit 5 of mode ID C9 is one. If it is 0, then mode ID CB should be set to 60.00 (60 minutes, 0 seconds).

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8.7 PRINTER TROUBLESHOOTING

The RS-232 interface has been described as more of a non-standard than a standard. When devised by the Electronic Industries Association in the 1960s, it was intended for connecting such obsure devices as data sets and data terminals. Nobody ever thought it would be used for data transfer from such devices as flow processors to printers. Several problems have arisen from this lack of standardization:

- In which category does a manufacturer place his equipment? There are two categories of equipment described in the RS-232 standard-Data Terminal Equipment (DTE) and Data Communication Equipment (DCE). From an interface standpoint, and for our purposes here, the only difference between DTE and DCE is that they are wired backwards from each other. Input pins to DCE are output pins from DTE, and input pins to DTE are outputs from DCE. If equipment configured as DTE is wired directly to equipment wired as DCE, then everything is theoretically just fine. As you might suspect, wiring DTE directly to DTE will not work.

- Which of the 25 signal lines should a printer use to stop the flow of data (handshaking line)? Very few printers can print continuously at 9600 baud (approximately 960 characters per second). Many printers do, however, have an input buffer which can accept anywhere from one line to several pages of text to be printed, and may run without handshaking. If not, then there must be a signal from the printer to let the flow processor know that the printer cannot accept data. This signal is know as the handshaking line. There is nothing in the RS-232 standard describing such a line. Most printer manufacturers today use pin 20, Data Terminal Ready, for handshaking. Only your printer manual, or the manufacturer of your printer, can tell you which pin to use.

- What polarity of the handshaking line indicates that the printer is READY? Most printer manufacturers use the pistive RS-232 level (≥ 3.0 volts DC) to indicate that the printer is ready and can accept data. However, there certainly are exceptions to this rule. If your printer cannot be made to output a positive when ready handshaking signal, it may not be used with handshaking with the FP-100. There is, however, a possibility that the printer may run at a slower-than-normal baud rate without handshaking, and not miss any characters.

Other than the hardware interface, the other problems that may be encountered in interfacing your printer to the FP-100 include incorrect baud rate or data format. The baud rate of the FP-100 must be set to that of the printer. The data format of the FP-100 will probably have to be set the same as that of the printer.

The following chart on the following page should help in identifying and solving interface problems. It is not intended to include all possible interface problems, but is a guide to some of the more common problems that may be encountered.

Problem	Possible Cause	Things to Try
No output.	Data input to printer not connected to FP-100 printer data output.	Check your printer manual to fing exactly which pin is the data input line. Wire this pin to terminal 19 on the FP-100 CPU Board.
	The CTS input at the FP-100 connector (pin 23) is not at the positive EIA RS-232 level (≥ 3.0 volts DC).	Try disconnectly the wire at in 23. If the printer starts working, then its handshaking line is not at the proper level.
	Incorrect baud rate.	Verify that the FP-100 is set for the same baud rate as your printer.
	Incorrect data format.	Verify that the FP-100 data format is the same as that of your printer.
Normal output, but missing characters or lines.	The handshaking output of the printer is not changing to th enegative EIA level (≤ - 3.0 volts DC) when the printer cannot accept data.	Check your printer manual to determine which line the printer uses for handshaking. Wire this pin to terminal 23 on the FP-100 CPU Board. If an oscilloscope or multimeter is available, verify that this signal is ≥ 3.0 volts DC when idling, and that it changes to ≤ - 3.0 volts DC during operation.
	Incorrect data format.	Verify that the FP-100 data format is the same as that of your printer.
Garbled output.	Incorrect baud rate or incorrect data format.	Verify that the FP-100 is set for the same baud rate and data format as that of your printer.
Double-spaced output.	Printer is set to advance the paper when a carriage return is received. The FP-100 outputs both carriage return and line feed characters, causing paper to advance two lines.	Change your printer configuration so that it advances the paper only when a line feed is received (not a carriage return). Check your printer manual for details.

Table 8-1. Printer Troubleshooting Guide

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Appendix A - Specifications

PHYSICAL

Size ..... 12.75" W x 13.5" H x 6.75" D (32.4 cm x 34.3 cm x 17.1 cm)
Weight ..... 20 lb (9 kg)

ENVIRONMENT

Operating Temperature ..... 32 to 120 °F (0 to 49 °C)
Storage Temperature ..... 0 to 140 °F (-17 to 60 °C)
Humidity ..... 0 to 95% RH non-condensing
Power
  Standard ..... AC Power
  ..... 115 VAC ± 15% @ 48-52/57-63 Hz
  ..... 230 VAC ± 15% @ 48-52/57-63 Hz
  Optional ..... DC Power
  ..... 24 VDC nominal (22-30 VDC), 0.8 Amps maximum draw
Battery-backed Memory ..... 3.0 VDC Lithium Cell (6 month minimum)

INPUTS

Analog (4 total) ..... 4.0 to 20.0 mA, 50 Ω
RTD (2 total) ..... 2 or 3-wire platinum, 1000 Ω nominal
Frequency (2 total) ..... 0 to 60 kHz, 2.5 to 25.0 V p-p, 10 kΩ minimum impedence, 10 µsec minimum pulse width
Digital (Flow Direcction)
  Forward = 5 to 30 VDC (or open)
  Reverse = 0 VDC (or ground)

OUTPUTS

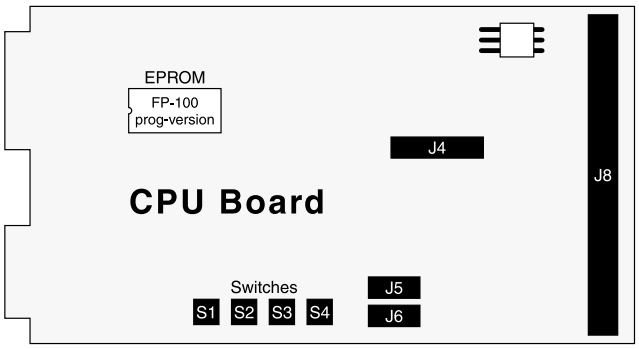
Power ..... 30 VDC ± 5%, short circuit protected, 200 mA maximum
Analog (3 total) ..... 4.0 to 20.0 mA ± 0.1% isolated output (requires voltage drop of 13 to 60 VDC)
Digital (2 total) ..... Isolated open collector transistor, 32 VDC, 50 mA

COMMUNICATION

Host Computer ..... RS-422 or RS-423 (RS-232 compatible), half duples, ASCII protocol, 7 or 8 bits, 1 or 2 stop bits, odd, even, or no parity, 300, 600, 1200, 2400, 4800, 9600 baud
Printer ..... RS-423 (RS-232 compatible), 40-200 columns, 66 lines per page, 7 or 8 data bits, 1 or 2 stop bits, odd, even, or no parity, 300, 600, 1200, 2400, 4800, 9600 baud

Appendix B - Hardware Reference

CPU BOARD JUMPERS

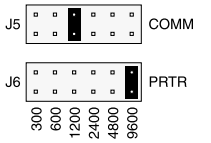


RS-422 without terminator

RS-422 with terminator

RS-423/RS-232C

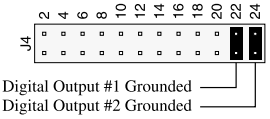
Communications and Printer Port Baud



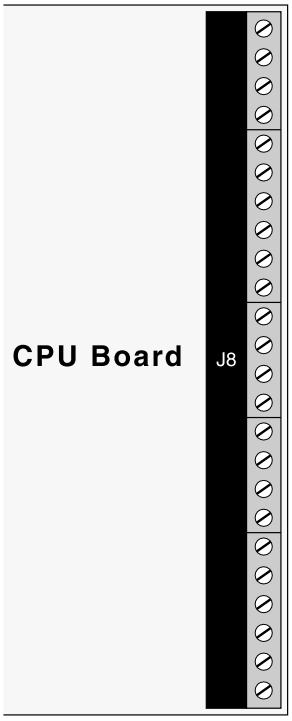
Communications port baud rate jumper (shown jumpered for 1200 baud)

Printer port baud rate jumper (shown jumpered for 9600 baud)

Digital Output Grounding



CPU BOARD TERMINALS



1	+24 volts DC		
2	Ground		
3	+24 volts DC		
4	Ground		
5	TxD–(RS-422)	TxD (RS-423/RS-232)	Communications
6	TxD+(RS-422)	RTS (RS-423/RS-232)	output signals.
7	Ground		
8	RxD–(RS-422)	RxD (RS-423/RS-232)	Communications
9	RxD+(RS-422)	CTS (RS-423/RS-232)	output signals.
10	Ground		
11	Digital output #2 +		Optical isolated
12	Digital output #2 –		digital outputs
13	Digital output #1 +		
14	Digital output #1 –		
15	Digital input #2 +		(unused)
16	Digital input #2 – (Ground)		
17	Digital input #1 +		Flow direction input
18	Digital input #1 – (Ground)		
19	TxD (RS-232 compatible)		Output data to printer
20	Ground		
21	Ground		
22	RxD (RS-232 compatible)		Input data from printer
23	CTS (RS-232 compatible)		Printer handshaking
24	Ground		

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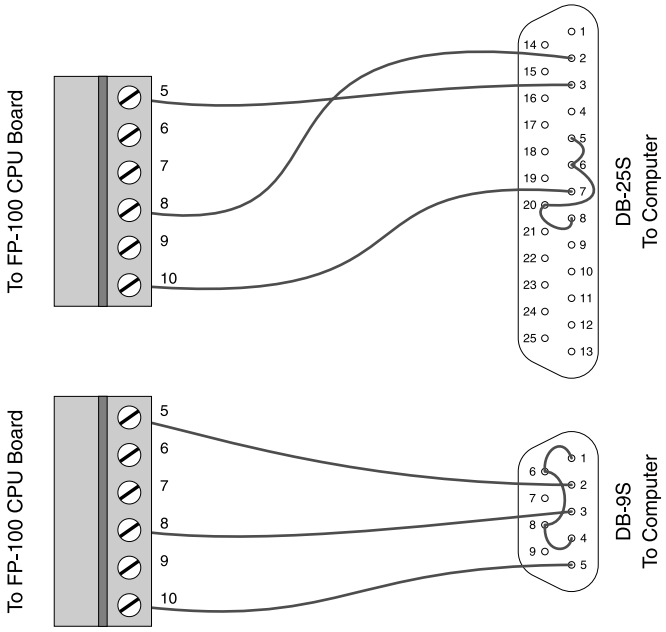
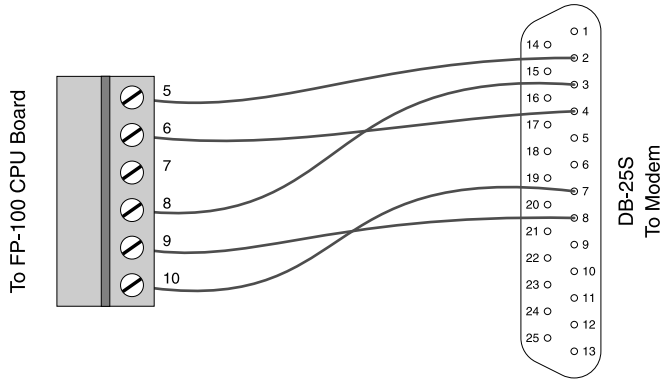
FP-100 TO COMPUTER OR TERMINAL

Typical connections from an FP-100 to a computer or terminal configured as Data Terminal Equipment (DTE) are shown at left. The diagrams show the use of either a female 25-pin connector (DB-25S) or a female 9-pin connector (DB-9S). No handshaking is used in either configuration. With the 25-pin connector, pins 5, 6, 8, and 20 may need to be connected together as shown in order for the computer or terminal to send or receive data. Likewise, pins 1, 4, 6, and 8 of the 9-pin connector may need to be connected together.



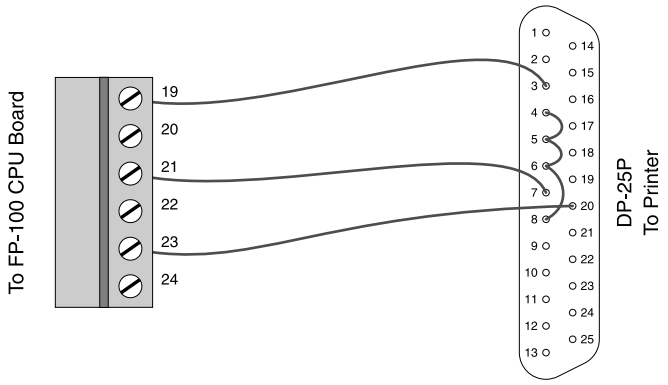
FP-100 TO MODEM

Typical connections from an FP-100 to a modem configured as Data Communications Equipment (DCE) are shown at left. The diagram shows the use of a female 25-pin connector (DB-25S). Full handshaking is shown, with the modem's Data Carrier Detect (DCD) output on pin 8 controlling the Clear to Send (CTS) input of the FP-100, and the FP-100's Request to Send (RTS) output controlling the CTS input to the modem.



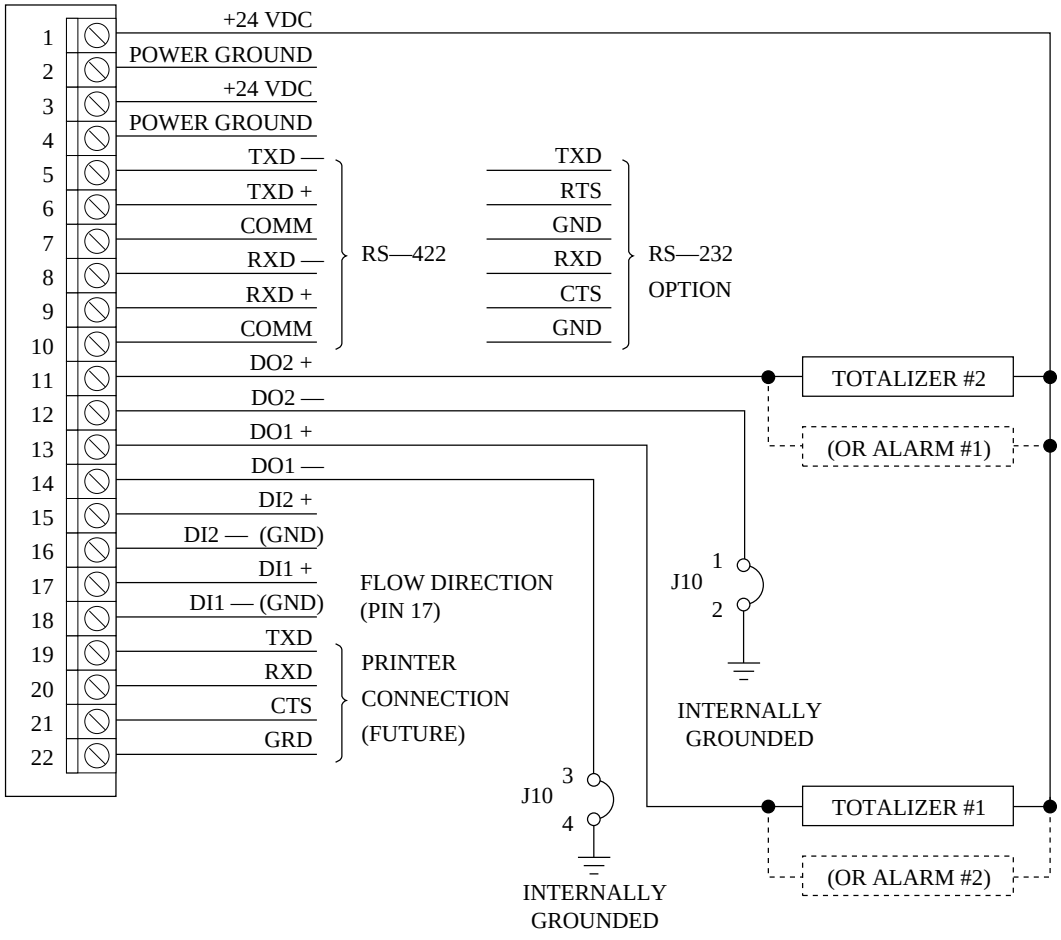
FP-100 TO PRINTER

Typical connections from an FP-100 to a printer configured as Data Terminal Equipment (DTE) are shown at left. The diagram shows the use of a male 25-pin connector (DB-25P). Printer handshaking from pin 20 (DTR) is shown, and pins 4, 5, 6, and 8 may need to be connected together as shown in order for the printer to receive and print data.



FP-100 SYSTEM CONTROLLER INSTALLATION

FP-100 CPU
(SYSTEM CONTROLLER)



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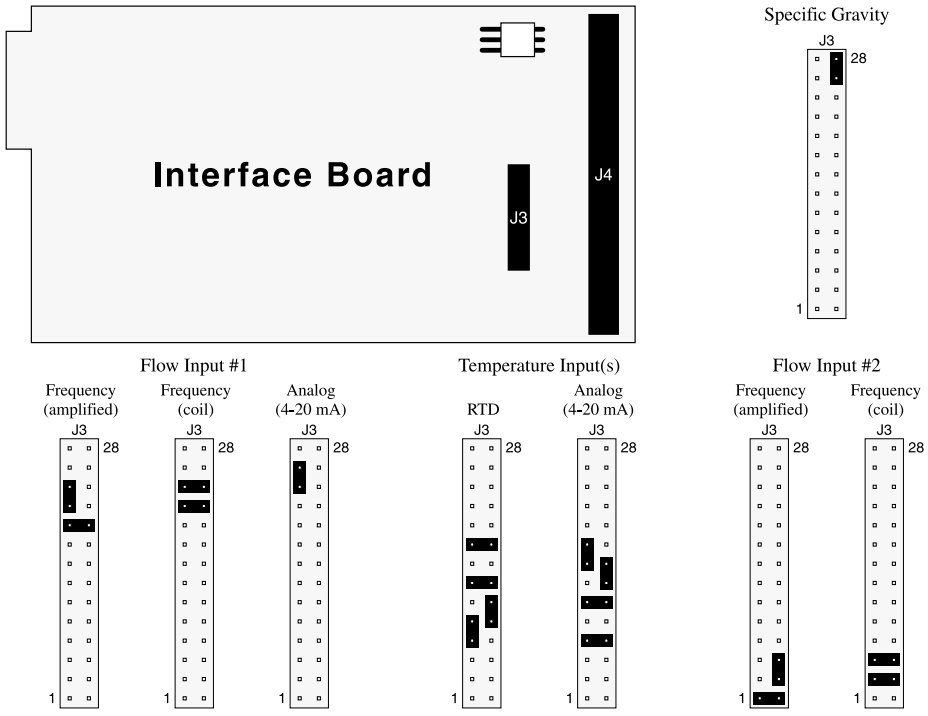
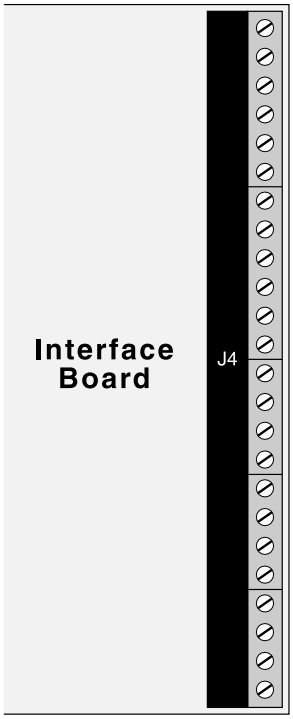
INTERFACE BOARD JUMPERS

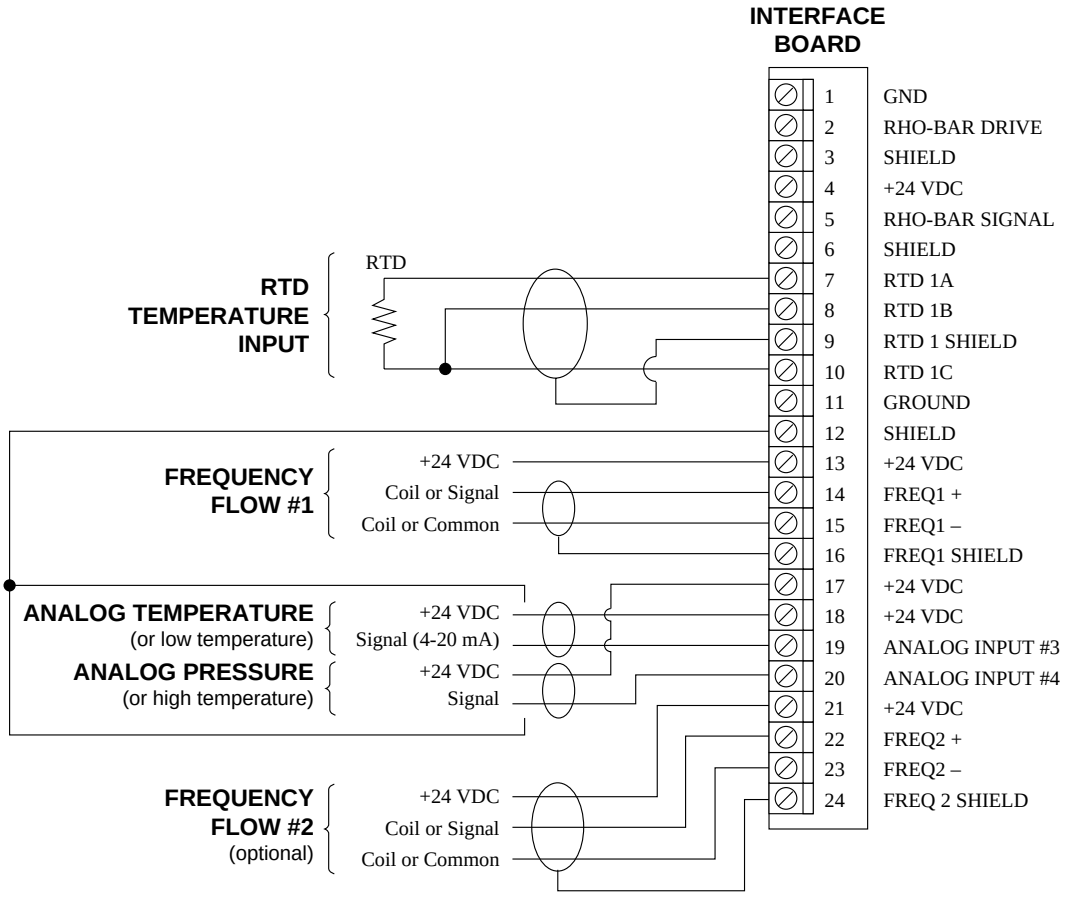


INTERFACE BOARD TERMINALS



1	Ground		
2	Rho-Bar/Q-Bar Drive		
3	Shield		
4	+24 volts DC		
5	Rho-Bar/Q-Bar Signal	or	Specific Gravity Analog Input
6	Shield		
7	RTD #1-A		
8	RTD #1-B		
9	RTD #1 Shield		
10	RTD #1-C		
11	Ground		
12	Shield		
13	+24 volts DC		
14	Frequency #1 Signal	or	Flow Analog Input
15	Frequency #1 Common		
16	Frequency #1 Shield		
17	RTD #2-A	or	+24 volts DC
18	RTD #2-B	or	+24 volts DC
19	RTD #2 Shield	or	Temperature #1 Analog Input
20	RTD #2-C	or	Pressure or Temperature #2 Analog Input
21	+24 volts DC		
22	Frequency #2 Signal		
23	Frequency #2 Common		
24	Frequency #2 Shield		

WIRING:
FREQUENCY FLOW INPUT
WITH RTD OR ANALOG TEMPERATURE INPUT
AND ANALOG PRESSURE INPUT



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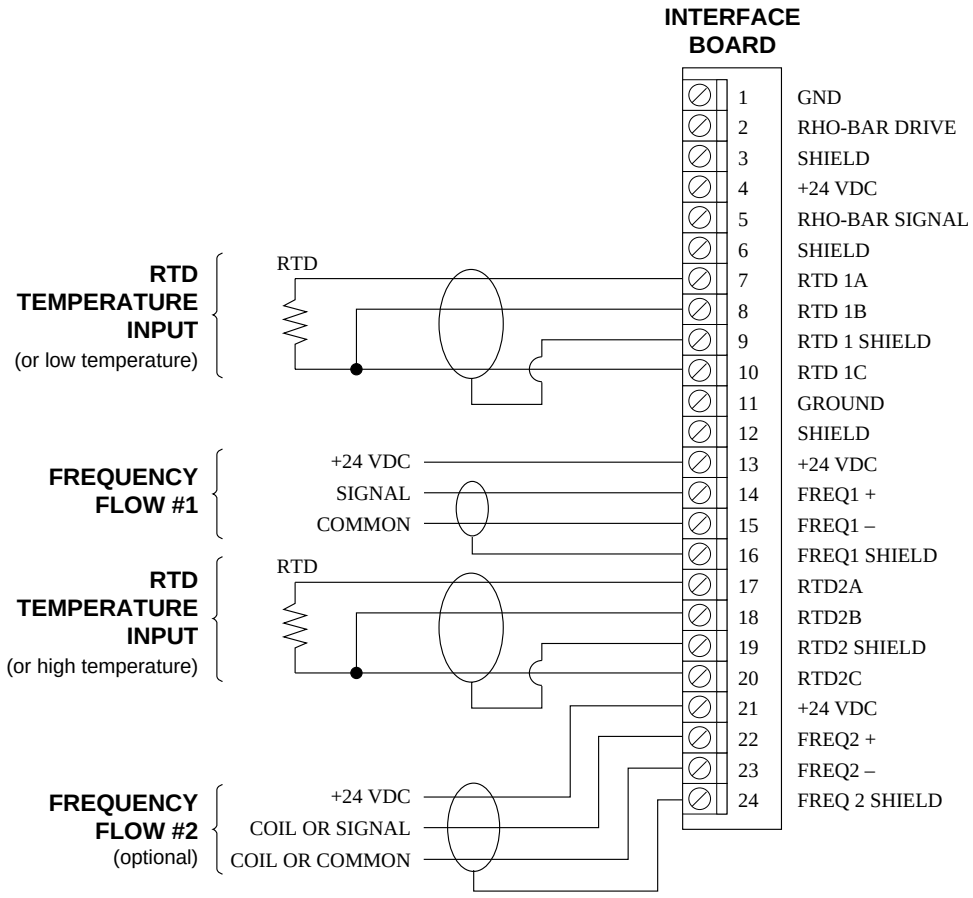
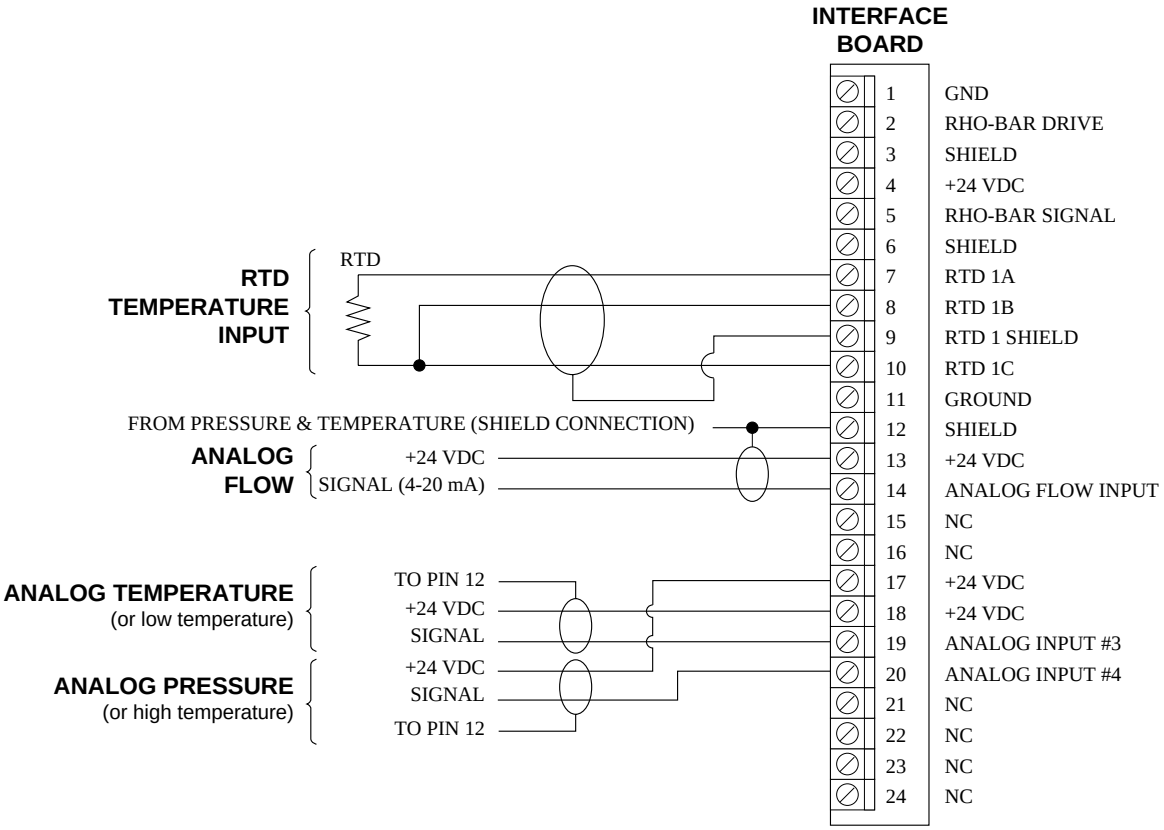
WIRING:

FREQUENCY FLOW INPUT

WITH TWO (2) RTD TEMPERATURE INPUTS



WIRING:
ANALOG FLOW INPUT
WITH RTD OR ANALOG TEMPERATURE INPUT
AND ANALOG PRESSURE INPUT



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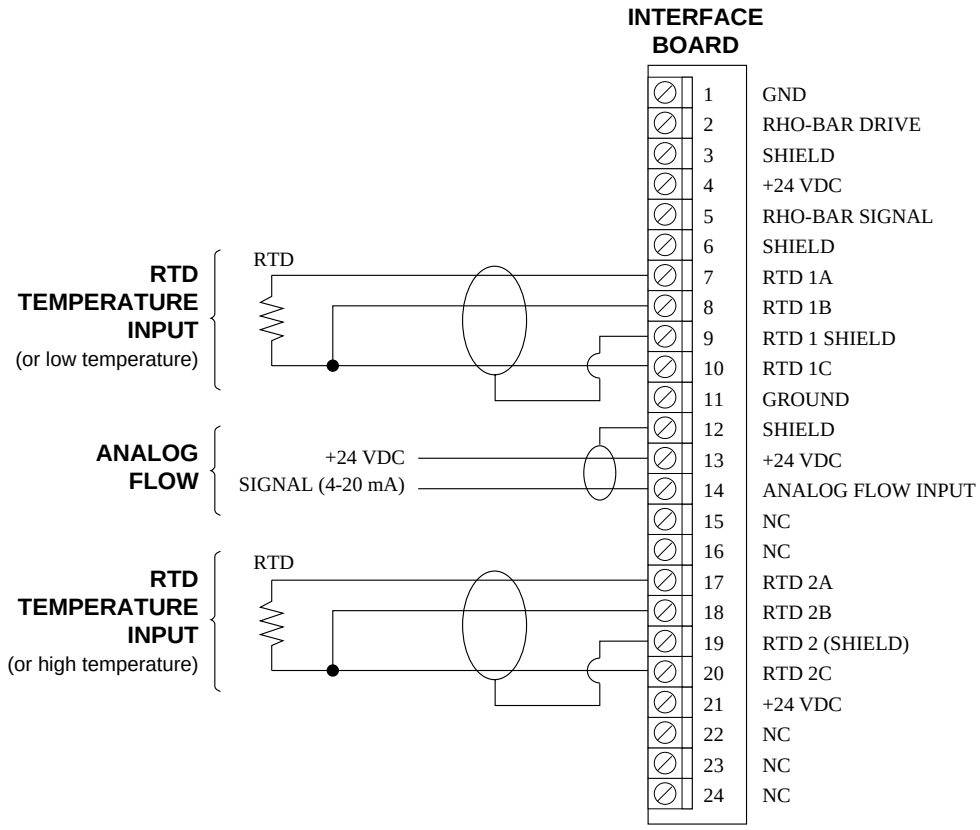
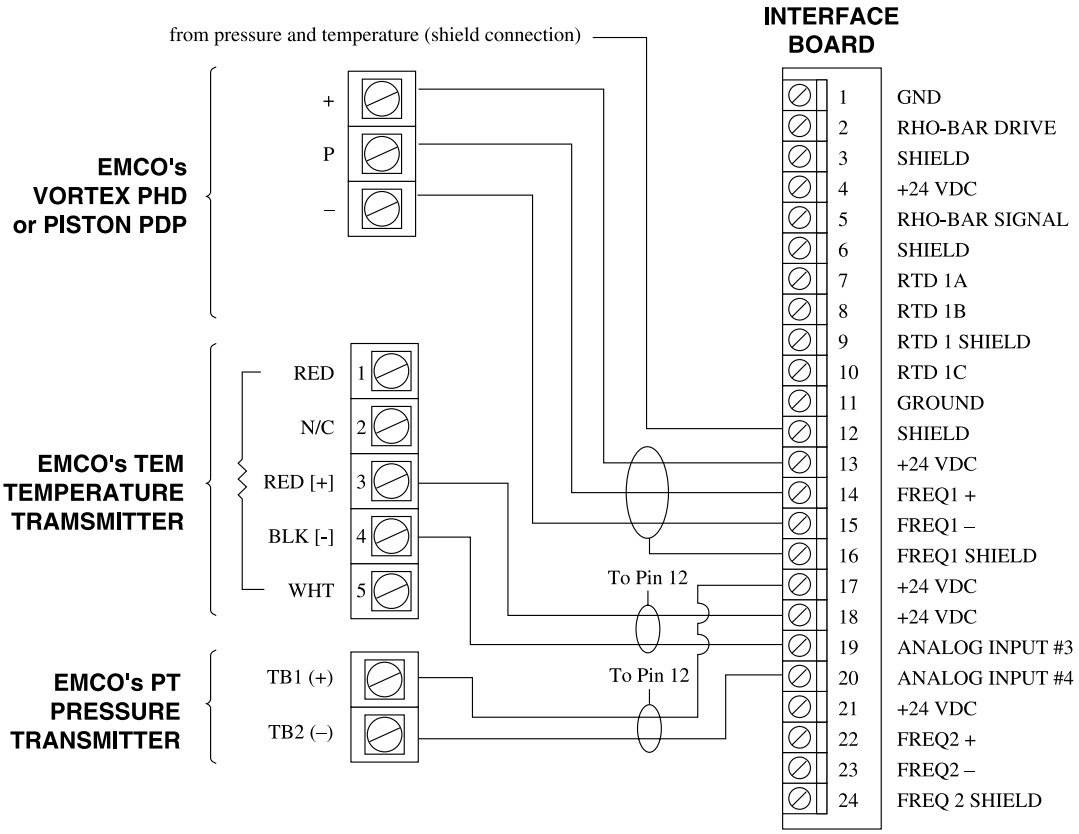
WIRING:

ANALOG FLOW INPUT

WITH TWO (2) RTD TEMPERATURE INPUTS



WIRING:
EMCO'S VORTEX PHD INLINE VORTEX FLOWMETER OR EMCO'S POSITIVE DISPLACEMENT PISTON FLOWMETER WITH RTD OR ANALOG TEMPERATURE INPUT AND ANALOG PRESSURE INPUT



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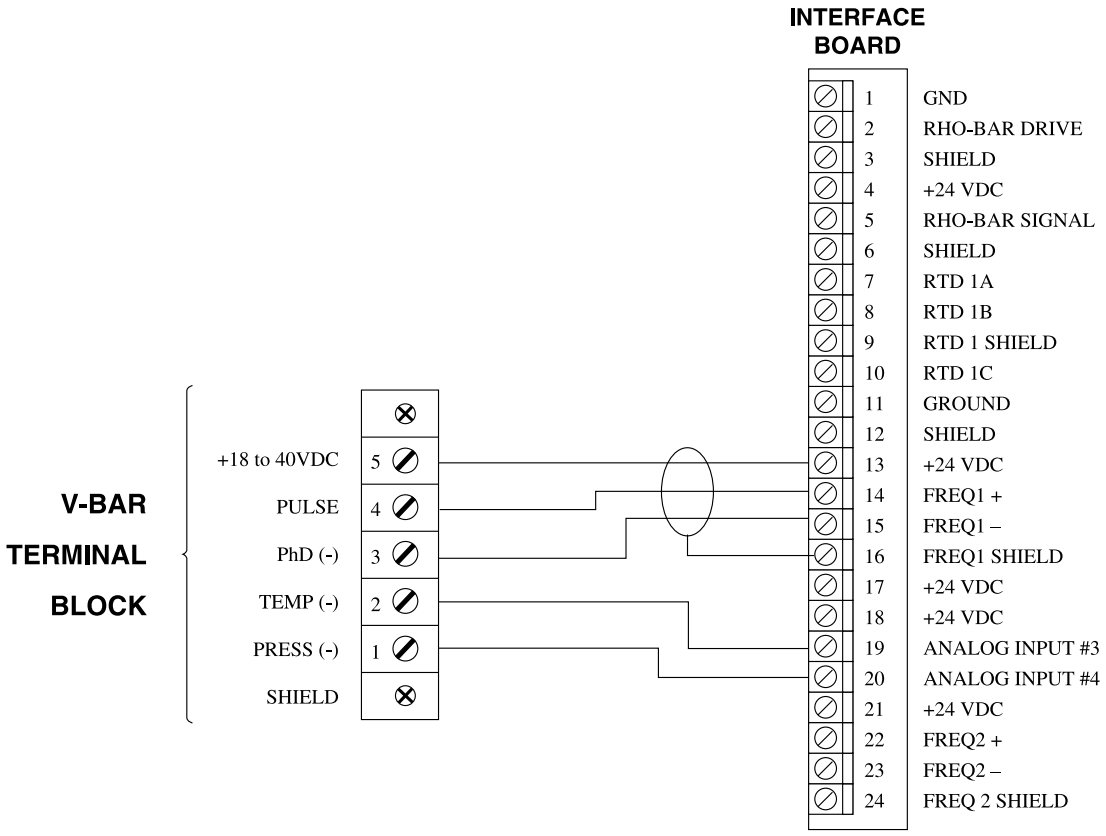
WIRING:

EMCO'S V-BAR INSERTION VORTEX FLOWMETER

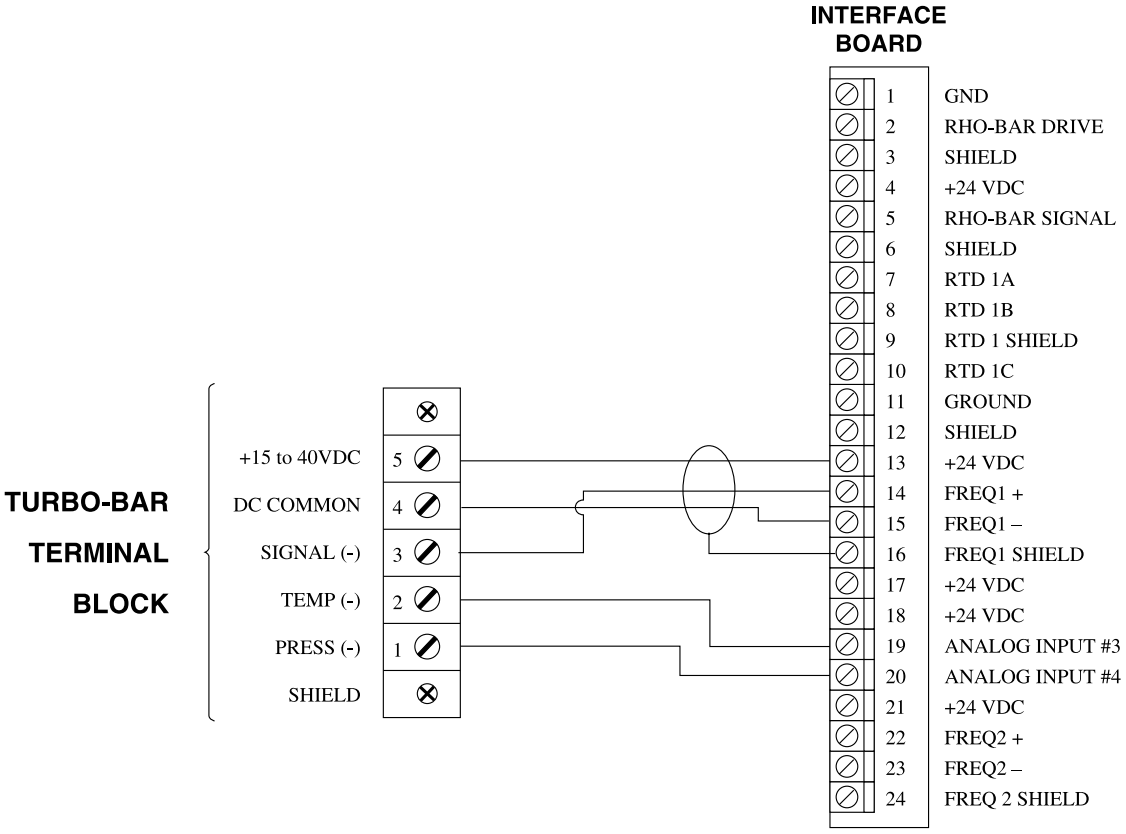
WITH RTD OR ANALOG TEMPERATURE INPUT

AND ANALOG PRESSURE INPUT



WIRING:

EMCO'S TURBO-BAR INSERTION TURBINE FLOWMETER WITH RTD OR ANALOG TEMPERATURE INPUT AND ANALOG PRESSURE INPUT



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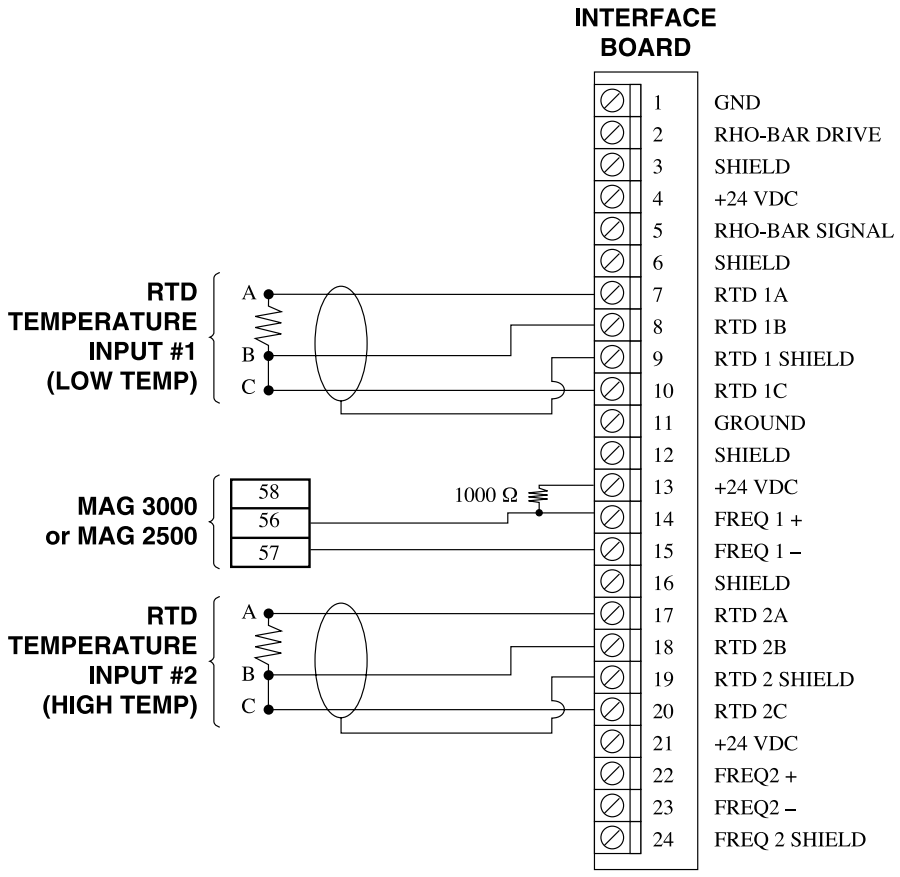
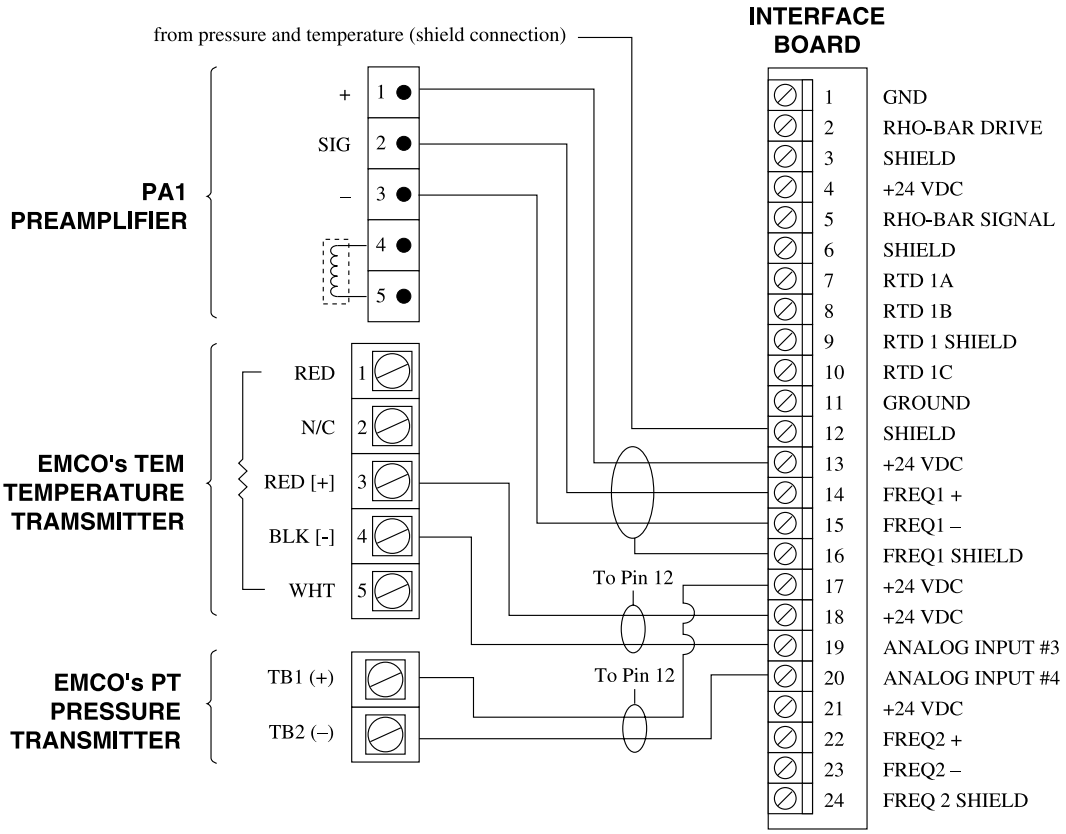
WIRING:

EMCO'S MAGFLO ELECTROMAGNETIC FLOWMETER

WITH TWO (2) RTD TEMPERATURE INPUTS



WIRING:
EMCO FLOWMETER WITH PA1 PREAMPLIFIER WITH RTD OR ANALOG TEMPERATURE INPUT AND ANALOG PRESSURE INPUT



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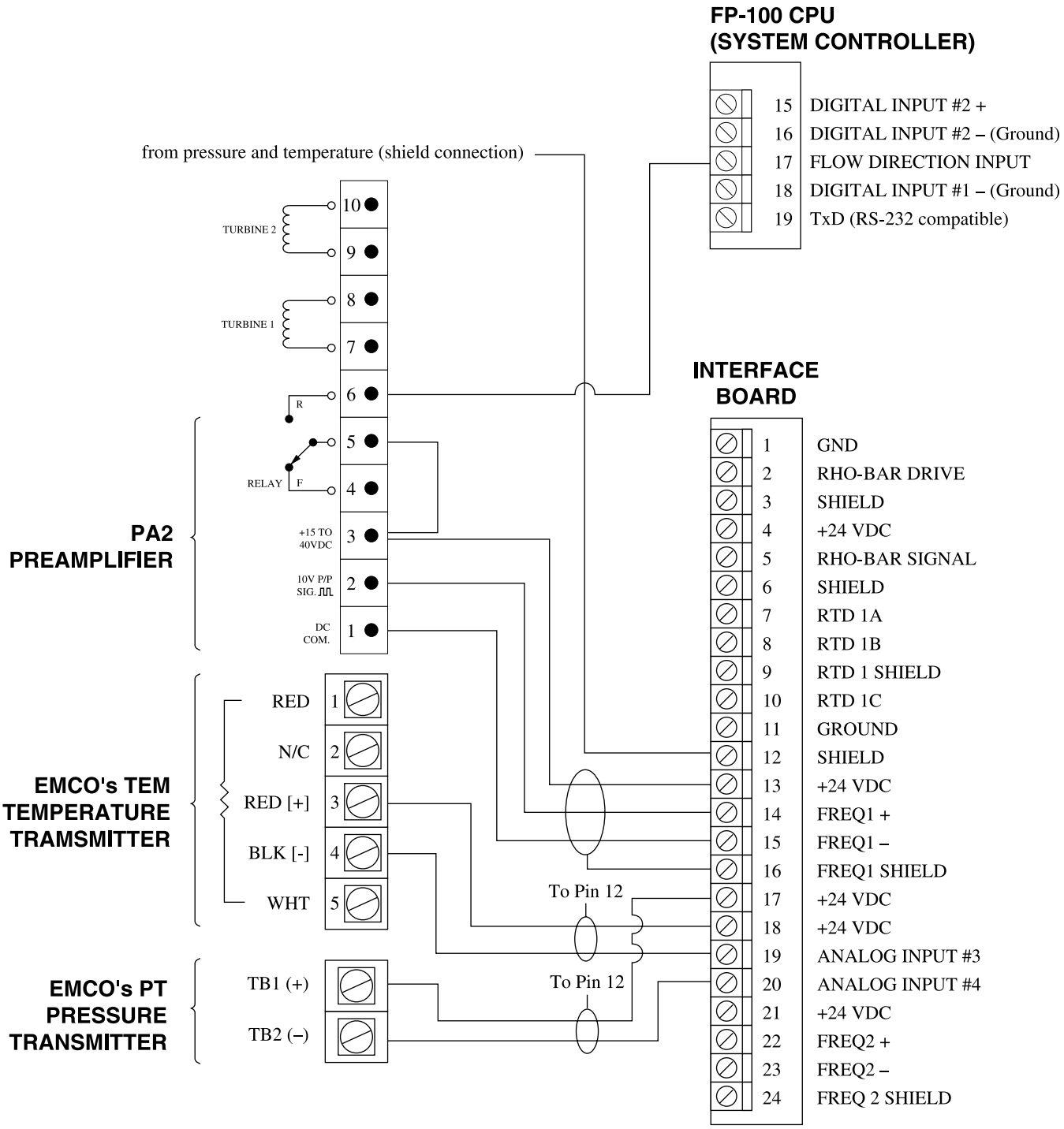
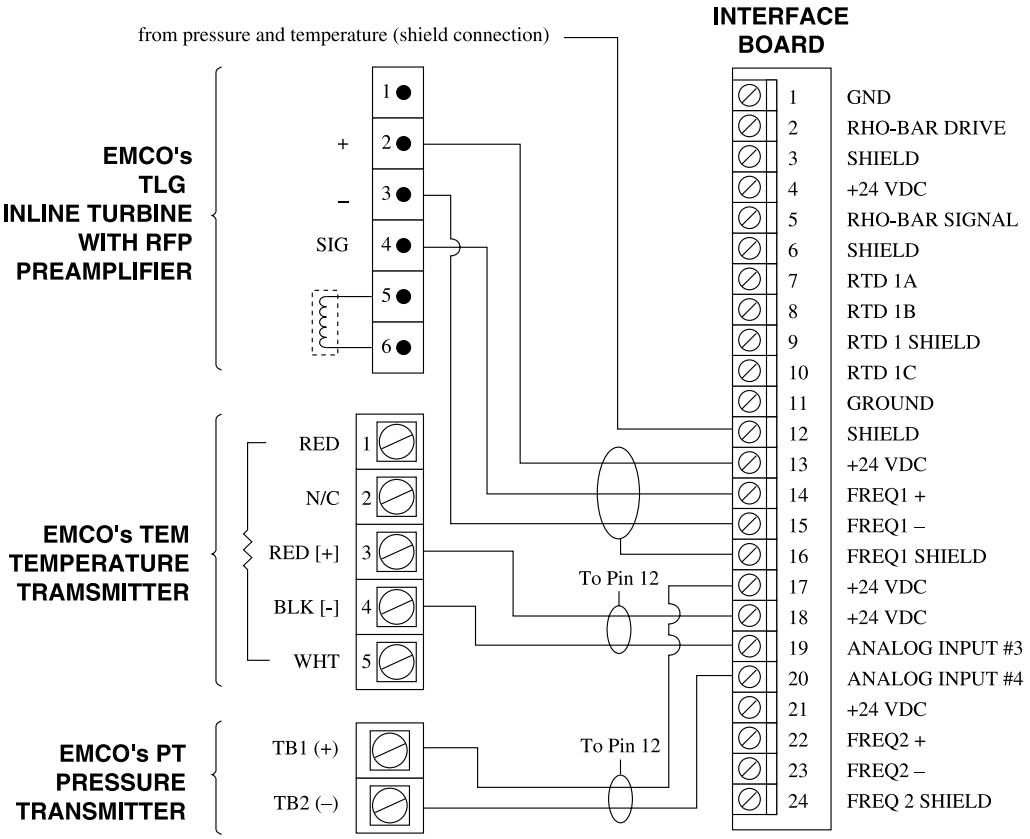
WIRING:

EMCO FLOWMETER WITH PA2 PREAMPLIFIER WITH RTD OR ANALOG TEMPERATURE INPUT AND ANALOG PRESSURE INPUT



WIRING:
EMCO TLG INLINE TURBINE FLOWMETER WITH RFP PREAMPLIFIER WITH RTD OR ANALOG TEMPERATURE INPUT AND ANALOG PRESSURE INPUT



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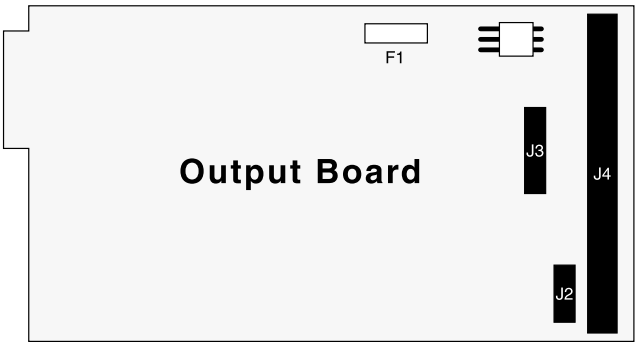
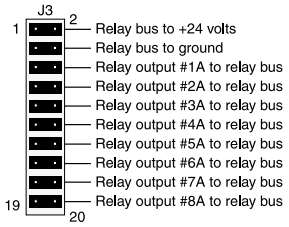
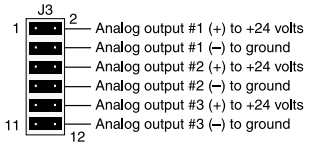
OUTPUT BOARD JUMPERS



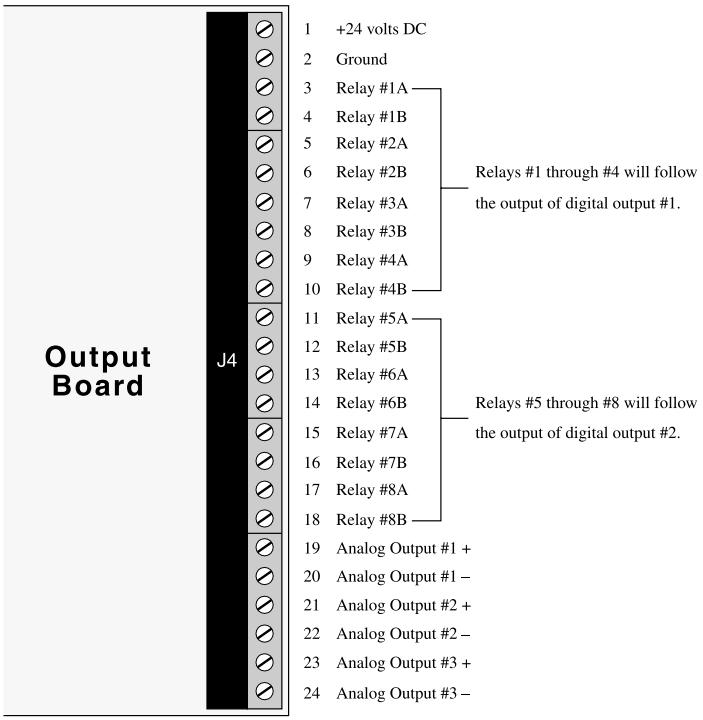
Relay Output Jumpers



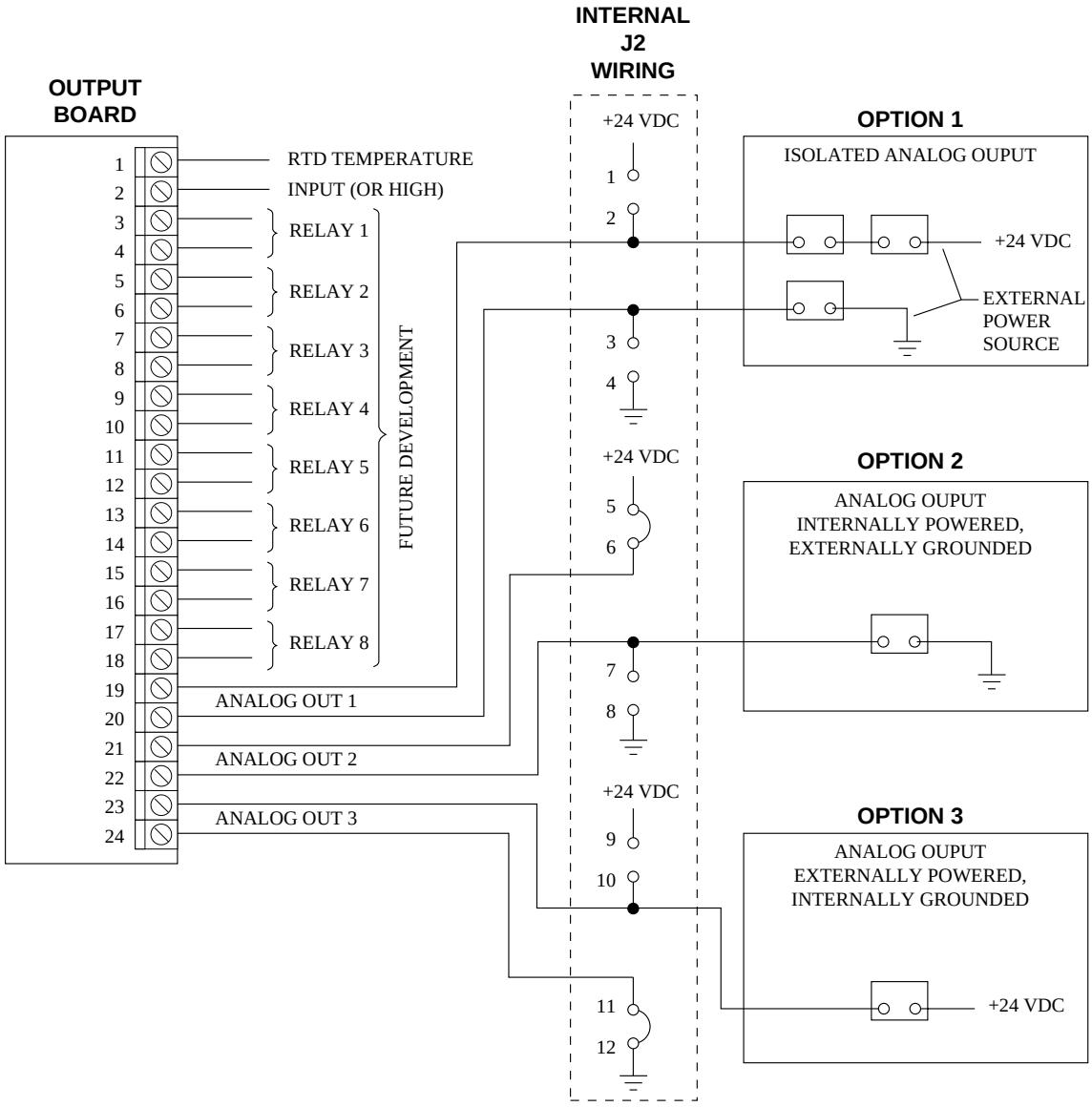
Analog Output Jumpers



OUTPUT BOARD TERMINALS



WIRING:
FP-100 ANALOG/RELAY OUTPUT INSTALLATION



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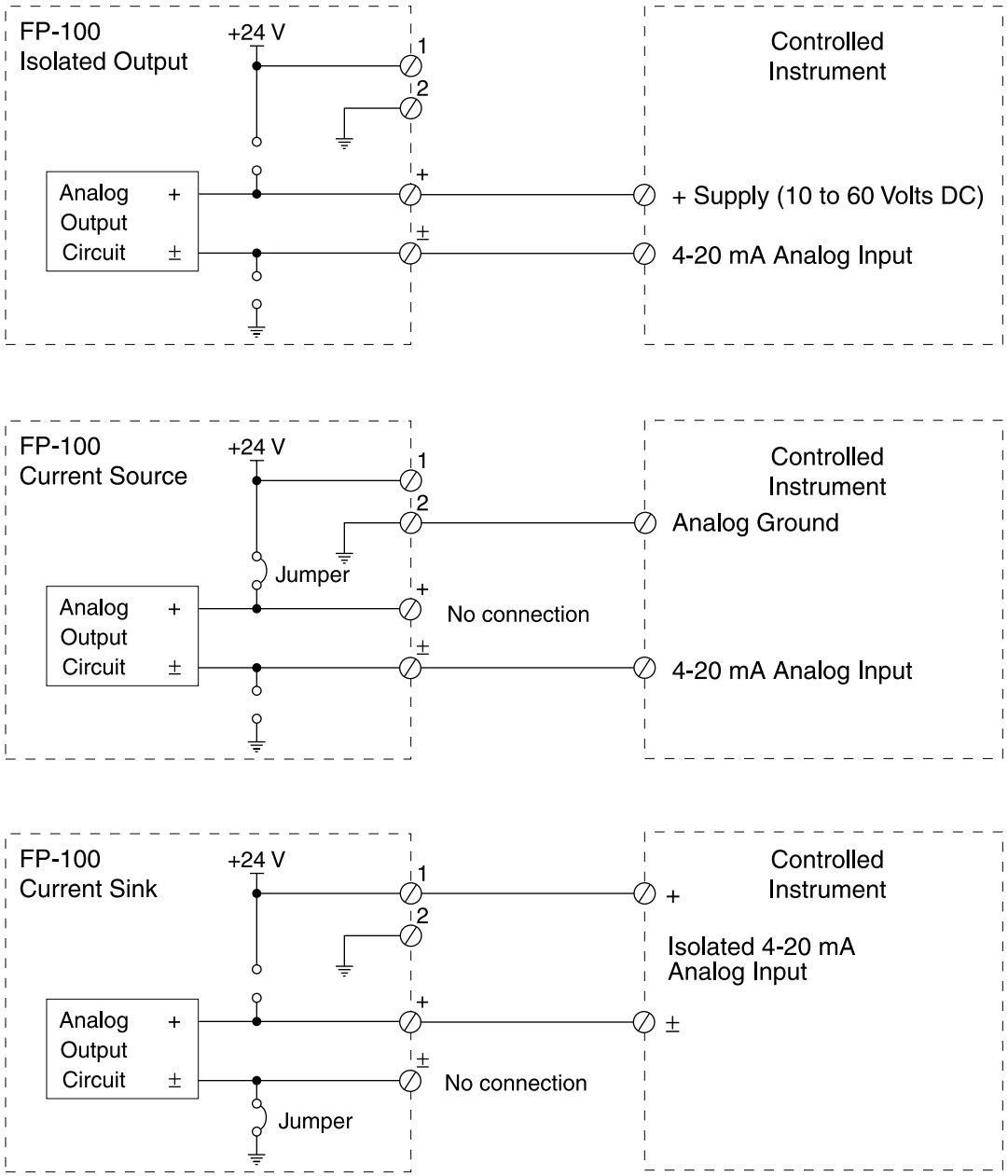
WIRING:

TYPICAL ANALOG OUTPUT



Appendix C - Mode ID Listing

GENERAL

The mode IDs listed in the following pages apply to Program 00, Version 9. If your FP-100 firmware is a different version (check mode ID C2 for the firmware version number) and you don't have documentation for the mode IDs, please contact your EMCO representative for an updated program PROM or documentation.

Each entry in the mode ID tables consists of four parts:

- The mode ID number (if the mode ID is alterable, the number appears in **bold type**)
- Description of data displayed by examining the mode ID
- English units, if applicable
- Metric units, if applicable

INFORMATION ON FP-100 FIRMWARE VERSIONS

The format of the version number is *nn.xy.* The *"nn"* designates major revisions of the firmware, which may include additional mode IDs and operational features. The *"x"* changes for minor revisions, while the *"y"* changes only for special releases. For example, version 8.10 was a standard release with minor revisions to version 8.00, and version 8.11 was a special release that was based on version 8.10.

The firmware version number may be read in mode ID C2 (the decimal point is not shown), and the program may be accessed in mode ID C1. If you have any problems with your FP-100, please note these numbers before contacting your representative or the factory.

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PROCESS VARIABLES (CALCULATED VALUES)

ID	Description	English Units	Metric Units
00	Line velocity	feet/second	meters/second
01	Actual volume flow rate	$feet^3$/time unit*	$meters^3$/time unit*
02	Liquid volume flow rate	gallons/time unit*	liters/time unit*
03	Mass flow rate	pounds/time unit*	kilograms/time unit*
04	Gas flow rate	scf/time unit*	ncm/time unit*
05	Heat flow rate	Btu/time unit*	kilojoules/time unit*
06	Heat flow rate	tons of refrigeration	kilowatts
07	Steam quality	percent	percent
08	Bulk density (calculated from T and P)	$pounds/foot^3$	$kilograms/meter^3$
09	Gas or vapor density (calculated from T and P)	$pounds/foot^3$	$kilograms/meter^3$
0A	Liquid density (calculated from temperature)	$pounds/foot^3$	$kilograms/meter^3$
0B	Bulk enthalpy (differential enthalpy if liquid heat flow)	Btu/pound	kilojoules/kilogram
0C	Vapor enthalpy (hot pipe enthalpy if liquid heat flow)	Btu/pound	kilojoules/kilogram
0D	Liquid enthalpy (cold pipe enthalpy if liquid heat flow)	Btu/pound	kilojoules/kilogram
0E	Specific volume (inverse of bulk density)	$feet^3$/pound	$meters^3$/kilogram

* Time units may be seconds, minutes, hours, or days and is selected by mode ID 52.

PROCESS VARIABLES (TOTALIZERS, ANALOG OUTPUTS, CALCULATED VALUES)

ID	Description	English Units	Metric Units
10	Totalizer #1 (forward)	Same as assigned	Same as assigned
11	Totalizer #1 (reverse)	Same as assigned	Same as assigned
12	Totalizer #2 (forward)	Same as assigned	Same as assigned
13	Totalizer #2 (reverse)	Same as assigned	Same as assigned
14	Analog output value #1	percent	percent
15	Analog output value #2	percent	percent
16	Analog output value #3	percent	percent
17	Raw velocity from frequency input #1	feet/second	meter/second
18	Raw velocity from frequency input #2	feet/second	meter/second
19	Velocity deviation	percent	percent

PROCESS VARIABLES (AVERAGES, MINIMUMS, AND MAXIMUMS)

ID	Description	English Units	Metric Units
20	Time since average, minimum, and maximum values were last cleared	minutes	minutes
21	Average	Volume flow (fluid types 00-02)	feet^3/time unit	meters^3/time unit
22	Minimum	Volume flow (fluid types 03-06)	gallons/time unit	liters/time unit
23	Maximum			
24	Average	Mass flow	pounds/time unit	kilograms/time unit
25	Minimum			
26	Maximum			
27	Average	Heat flow (fluid types 00, 03-06)	Btu/time unit	kilojoules/time unit
28	Minimum	Gas volume flow (fluid types 01-02)	scf/time unit	ncm/time unit
29	Maximum			
2A	Average	Temperature	°F	°C
2B	Minimum			
2C	Maximum			
2D	Average	Pressure (fluid types 00-03,05)	psia	bars absolute
2E	Minimum	Hot pipe temperature (fluid types 04,06)	°F	°C
2F	Maximum			

PROCESS VARIABLES (INPUTS)

ID	Description	English Units	Metric Units
30	Flow input #1 frequency	Hertz	Hertz
31	Maximum pulse rate #1 (historical)	Hertz	Hertz
32	Flow direction (1-forward, 0-reverse)	—	—
33	Flow input #2 frequency	Hertz	Hertz
34	Maximum pulse rate #2 (historical)	Hertz	Hertz
35	Average flow input #1 frequency	Hertz	Hertz
36	Average flow input #2 frequency	Hertz	Hertz
40	Analog flow input ratio (0.0 to 1.0)	—	—
41	Line pressure, gauge	psig	bars gauge
42	Line pressure, absolute	psia	bars absolute
43	Temperature (cold pipe temperature if liquid heat flow)	°F	°C
44	Hot pipe temperature (liquid heat flow only)	°F	°C
45	Differential temperature (liquid heat flow only)	°F	°C
46	Temperature RTD resistance (cold pipe)	Ω	Ω
47	Temperature RTD total lead resistance (cold pipe)	Ω	Ω
48	Temperature RTD resistance (hot pipe)	Ω	Ω
49	Temperature RTD total lead resistance (hot pipe)	Ω	Ω

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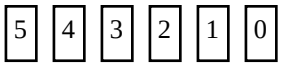
OPERATOR ENTERED CONSTANTS

ID	Description
50	Fluid type: 00-Steam 01-Ideal gas 02-Natural gas 03-Water (one temperature input) 04-Water energy (two temperature inputs) 05-Liquid (one temperature input) 06-Liquid energy (two temperature inputs)
51	Units selection flag: 00-English units 01-Metric units
52	Flow rate time units (mode IDs 01-05, 21-29): 01-second 02-minute 03-hour 04-day
53	Flow input select flags: Bit 5: 0—Single frequency flow input with unidirectional flow 1—Dual frequency flow input or bidirectional flow Bit 4: If liquid heat flow (Mode ID 50 = 04 or 06) 0—Flowmeter is located in hot pipe 1—Flowmeter is located in cold pipe Bit 3 & 2: 00—1/2” or 3/4” rotor 01—1” rotor (G6) 10—1-1/2” rotor (L1, G1, G2, G3, G4, G5) 11—1-3/4” rotor Bit 1: 0—linear analog input or bidirectional flow 1—square law analog input or dual frequency input Bit 0: 0—frequency input 1—analog input

BIT LAYOUT



OPERATOR ENTERED CONSTANTS (FLOW INPUTS)

ID	Description	English Units	Metric Units
Frequency input #1 calibration points			
54	K-factor (see mode ID 61 for units) Frequency or analog flow input #1	Pulses/length or vol. Hertz or none	Pulses/length or vol. Hertz or none
55	Velocity or linearity correction factor #1	feet/second or none	meters/second or none
56	Frequency or analog flow input #2	Hertz or none	Hertz or none
57	Velocity or linearity correction factor #2	feet/second or none	meters/second or none
58	Frequency or analog flow input #3	Hertz or none	Hertz or none
59	Velocity or linearity correction factor #3	feet/second or none	meters/second or none
5A	Frequency or analog flow input #4	Hertz or none	Hertz or none
5B	Velocity or linearity correction factor #4	feet/second or none	meters/second or none
5C	Frequency or analog flow input #5	Hertz or none	Hertz or none
5D	Velocity or linearity correction factor #5	feet/second or none	meters/second or none
5E	Frequency or analog flow input #6	Hertz or none	Hertz or none
5F	Velocity or linearity correction factor #6	feet/second or none	meters/second or none
60	Frequency input sample interval	seconds	seconds
61	Frequency/velocity or volumetric flow calculation flag:		
	00 Turbine meter frequency input with velocity in feet/second derived from frequency/ velocity pairs		
	1X Linear frequency input with velocity in feet per second proportional to frequency:		
	10 K = pulse per inch		
	11 K = pulses per foot		
	12 K = pulses per millimeter		
	13 K = pulses per centimeter		
	14 K = pulses per meter		
	2X Linear frequency input with volumetric flow in actual cubic feet/hour proportional to frequency:		
	20 K = pulses per cubic inch		
	21 K = pulses per cubic foot		
	22 K = pulses per fluid ounce		
	23 K = pulses per gallon		
	24 K = pulses per cubic centimeter		
	25 K = pulses per cubic meter		
	26 K = pulses per liter		

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OPERATOR ENTERED CONSTANTS (FLOW INPUTS)

ID	Description	English Units	Metric Units
62	If frequency input, frequency alarm setpoint If either frequency input exceeds this value, then the frequency fault bit is set.	Hertz	Hertz
	If analog flow input, analog flow to velocity or mass flow conversion factor	—	—
63	Maximum velocity deviation allowed. If the velocity derived from frequency input #2 deviates from the velocity derived from frequency input #1 by more than this factor, then the velocity deviation fault bit is set.	percent	percent
Frequency input #2 or reverse flow calibration points			
64	Frequency #1	Hertz	Hertz
65	Velocity #1	feet/second	meters/second
66	Frequency #2	Hertz	Hertz
67	Velocity #2	feet/second	meters/second
68	Frequency #3	Hertz	Hertz
69	Velocity #3	feet/second	meters/second
6A	Frequency #4	Hertz	Hertz
6B	Velocity #4	feet/second	meters/second
6C	Frequency #5	Hertz	Hertz
6D	Velocity #5	feet/second	meters/second
6E	Frequency #6	Hertz	Hertz
6F	Velocity #6	feet/second	meters/second

OPERATOR ENTERED CONSTANTS (ANALOG INPUTS)

BIT LAYOUT

5	4	3	2	1	0

ID	Description	English Units	Metric Units
70	Analog input flags: Bit 5: 0—No specific gravity input 1—4-20 specific gravity input Bits 4 & 3: 00—No pressure input 01—4-20 mA guage pressure input 10—4-20 mA absolute pressure input 11—4-20 mA gauge pressure input for display only Bits 2 & 1: 00—No temperature input(s) 01—RTD temperature input(s) 10—4-20 mA temperature input(s) Bit 0: 0—Bit 0 should always be 0		
71	Zero scale pressure input	psia or psig	bars absolute or gauge
72	Full scale pressure input	psia or psig	bars absolute or gauge
73	Zero scale temperature input #1 (normal or cold pipe)	°F	°C
74	Full scale temperature input #1	°F	°C
75	Zero scale temperature input #2 (hot pipe)	°F	°C
76	Full scale temperature input #2	°F	°C
77	Zero scale specific gravity input	—	—
78	Full scale specific gravity input	—	—
79	K	°F	°C
RTD #1 resistance to temperature equation constants			
7A	A	—	—
7B	B	—	—
7C	R_0	Ω	Ω
RTD #2 resistance to temperature equation constants			
7D	A	—	—
7E	B	—	—
7F	R_0	Ω	Ω

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OPERATOR ENTERED CONSTANTS (ANALOG OUTPUTS)

ID	Description	English Units	Metric Units
80	Analog output #1 assignment: 00—not assigned		
	01—temperature (or cold pipe temperature)	°F	°C
	02—hot pipe temperature	°F	°C
	03—differential temperature	°F	°C
	04—absolute pressure	psia	bars absolute
	05—gauge pressure	psig	bars gauge
	06—line velocity	feet/second	meters/second
	07—actual volume flow	$feet^3$/time unit	$meters^3$/time unit
	08—liquid volume flow	gallons/time unit	liters/time unit
	09—gas volume glow	scf/time unit	ncm/time unit
	10—mass flow	pounds/time unit	kilograms/time unit
	11—heat flow	Btu/time unit	kilojoules/time unit
	12—heat flow	tons of refrigeration	kilowatts
	13—vapor density	$pounds/foot^3$	$kilograms/meter^3$
	14—liquid density	$pounds/foot^3$	$kilograms/meter^3$
	15—bulk density	$pounds/foot^3$	$kilograms/meter^3$
	17—steam quality	percent	percent
81	Zero scale analog output #1	Same as assigned	Same as assigned
82	Full scale analog output #1	Same as assigned	Same as assigned
83	Analog output #2 assignment: See mode ID 80 for assignment list		
84	Zero scale analog output #2	Same as assigned	Same as assigned
85	Full scale analog output #2	Same as assigned	Same as assigned
86	Analog output #3 assignment: See mode ID 80 for assignment list		
87	Zero scale analog output #3	Same as assigned	Same as assigned
88	Full scale analog output #3	Same as assigned	Same as assigned

OPERATOR ENTERED CONSTANTS (TOTALIZERS AND DIGITAL OUTPUTS)

BIT LAYOUT

2	1

ID	Description	English Units	Metric Units
90	Totalizer assignments:		
	Totalizer #2 assignment (Bit 2): 0—totalizer not assigned		
	1—accumulates actual volume flow	feet3	meters3
	2—accumulates liquid volume flow	gallons	liters
	3—accumulates mass flow	pounds	kilograms
	4—accumulates gas volume flow	standard cubic feet	normal cubic meters
	5—accumulates heat flow	Btu	kilojoules
	6—accumulates heat flow	ton-hours	kilowatt-hours
	Totalizer #1 assignment (Bit 1): Same assignments as Totalizer #2		

BIT LAYOUT

2	1

91	Digital output assignment:		
	Digital output #2 assignment (Bit 2): 0—not assigned 1—communications control (on when transmitting) 2—alarm #1 3—alarm #2 4—forward totalizer #1 5—reverse totalizer #1 6—forward totalizer #2 7—reverse totalizer #2		
	Digital output #1 assignment (Bit 1): Same assignments as Digital output #2		
92	Totalizer #1 scale factor	Same as assigned	Same as assigned
93	Totalizer #2 scale factor	Same as assigned	Same as assigned

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OPERATOR ENTERED CONSTANTS (ALARM OUTPUTS)

94	Alarm #1 assignment:		
	00—not assigned		
	01—low temperature	°F	°C
	02—low hot pipe temperature	°F	°C
	03—low pressure	psia	bars absolute
	04—low line velocity	feet/second	meters/second
	05—low actual volumetric flow	$feet^3$/time unit	$meters^3$/time unit
	06—low liquid volumetric flow	gallons/time unit	liters/time unit
	07—low gas volumetric flow	scf/time unit	ncm/time unit
	08—low mass flow	pounds/time unit	kilograms/time unit
	09—low heat flow	Btu/time unit	kilojoules/time unit
	10—low bulk density	$pounds/foot^3$	$kilograms/meter^3$
	11—low steam quality	percent	percent
	41—high temperature	°F	°C
	42—high hot pipe temperature	°F	°C
	43—high pressure	psia	bars absolute
	44—high line velocity	feet/second	meters/second
	45—high actual volumetric flow	$feet^3$/time unit	$meters^3$/time unit
	46—high liquid volumetric flow	gallons/time unit	liters/time unit
	47—high standard volumetric flow	scf/time unit	ncm/time unit
	48—high mass flow	pounds/time unit	kilograms/time unit
	49—high heat flow	Btu/time unit	kilojoules/time unit
	50—high bulk density	$pounds/foot^3$	$kilograms/meter^3$
	51—high steam quality	percent	percent
	80—General fault (any bit of ID D0, D1, or D2)		
	81—Pressure input out of range (ID D0, bit 0)		
	82—Temperature input out of range (ID D0, bit 1)		
	83—Hot pipe temperature input out of range (ID D0, bit 2)		
	84—SGU input out of range (ID D0, bit 3)		
	85—Frequency overrange or analog flow input out of range (ID D0, bit 4)		
	86—Velocity deviation fault (ID D0, bit 5)		
	87—Analog output #1 out of range (ID D1, bit 2)		
	88—Analog output #2 out of range (ID D0, bit 3)		
	89—Analog output #3 out of range (ID D1, bit 4)		
95	Limit on variable assigned to alarm #1	Same as assigned	Same as assigned
96	Alarm #2 assignment See mode ID 94 for assignment list	-	-
97	Limit on variable assigned to alarm #2	Same as assigned	Same as assigned

OPERATOR ENTERED CONSTANTS (CALCULATION CONSTANTS)

BIT LAYOUT

2	1	0

ID	Description	English Units	Metric Units
A0	Viscosity, obscuration, and profile factor calculation flags: (1 = calculate factor, 0 = enter as a constant) Bit 2: Viscosity Bit 1: Obscuration factor Bit 0: Profile factor		
Flow calculation constants and variables			
A1	Pipe diameter constant	inches	millimeters
A2	Fluid viscosity constant or variable	centipoise	centipoise
A3	Obscuration factor constant or variable	—	—
A4	Profile factor constant or variable	—	—
A6	Barometric pressure constant	psi	bars
A7	Liquid specific heat constant	Btu/pound-°F	kilojoules/kilogram-°C
A8	Liquid density at 32 °F	pounds/foot3	kilgrams/meter3
A9	Liquid density at 100 °F	pounds/foot3	kilograms/meter3
AA	Specific gravity, gas	—	—
AB	Supercompressibility constant or variable, gas	—	—
AC	Mole fraction of CO2, natural gas	—	—
AD	Mole fraction of N2, natural gas	—	—

SUBSTITUTION INPUTS

BIT LAYOUT

5	4	3	2	1	0

ID	Description	English Units	Metric Units
B0	Substitution input flags: (0 = normal, 1 = substitute input) Bit 5: Bulk density Bit 4: Frequency or analog flow input Bit 3: Flow direction Bit 2: Hot pipe temperature Bit 1: Temperature Bit 0: Pressure		
B1	Substitute pressure value	psia or psig	bars absolute or gauge
B2	Substitute temperature value	°F	°C
B3	Substitute hot pipe temperature value (liquid heat flow only)	°F	°C
B4	Substitute flow direction 1—forward 0—reverse	—	—
B5	Substitute frequency or analog flow input	Hertz or none	Hertz or none
B6	Substitute bulk density	pounds/foot^3	kilograms/meter^3

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SYSTEM PARAMETERS

ID	Description

C0 Unit number as selected by rotary switches on CPU Board

C1 Program code number

C2 Program version number

C3 Communications port data format:

	Data bits	Parity	Stop bits
00	7	Even	2
01	7	Odd	2
02	7	Even	1
03	7	Odd	1
04	8	None	2
05	8	None	1
06	8	Even	1
07	8	Odd	1

C4 Communications port baud rate (300-9600) as selected by jumper on CPU Board

C5 Number of ASCII NULLs preceding transmit message (00...99)

C6 Report mode ID selection-used to select mode IDs to be printed in periodic report or transmitted when communications mode ID F9 is requested

C7 Printer port data format (see mode ID C3 for definition)

C8 Printer port baud rate (300-9600) as selected by jumper on CPU Board

C9 Printer report format:

BIT LAYOUT

5	4	3	2	1	0

Bit 5: Periodic interval select flag:
0—interval in MM.SS
1—interval in HH.MM

Bit 4: Clear values flag:
0—not cleared
1—avg/min/max values cleared with each report

Bit 3: Periodic report grouping by five lines:
0—no groups
1—group reports by 5 lines

Bit 2: Periodic report page headings:
0—no headings
1—print headings

Bit 1: Time format on printouts:
0—24-hour
1—12-hour

Bit 0: Fault reporting:
0—no fault reports
1—print fault report at time of fault

CA Periodic report starting time: HH.MM (00.00 (midnight) to 23.59, or 99.99 to start at next minute)

CB Periodic report interval: MM.SS if bit 5 of mode ID C9 = 0
HH.MM if bit 5 of mode ID C9 = 1

CC System time: HH.MM (24-hour format, 00.00 = midnight)

CD System date: MM/DD if in display mode
YY/MM/DD if in data entry mode

CF Time in seconds since last calculation was done

FAULT MODE IDS

BIT LAYOUT

5	4	3	2	1	0

BIT LAYOUT

4	3	2	1	0

BIT LAYOUT

5	4	3	2	1	0

BIT LAYOUT

2	1	0

ID	Description
D0	Input fault flags. (0 = no fault, 1 = fault): Bit 5: Velocity deviation fault Bit 4: Frequency input over range or analog flow input out of range Bit 3: Specific gravity input out of range Bit 2: Hot pipe temperature input out of range Bit 1: Temperature input out of range
D1	Computation fault flags. (0 = no fault, 1 = fault): Bit 4: Analog output #3 out of range Bit 3: Analog output #2 out of range Bit 2: Analog output #1 out of range Bit 1: Floating point overflow error Bit 0: Totalizer rate > counts/sec.
D2	Hardware fault flags. (0 = no fault, 1 = fault): Bit 5: A/D conversion fault Bit 4: 0—Bit 4 should always be 0 Bit 3: Power failure Bit 2: PROM checksum error Bit 1: RAM checksum error Bit 0: RAM W/R error
D3	Communications fault flags (ACIA): Bit 2: Parity error Bit 1: Receiver overrun error Bit 0: Framing error
D4	Temperature, pressure, or specific gravity input fault time, minutes
D5	Analog or frequency flow input fault time, minutes
D6	Analog output fault time, minutes
D7	Address of first RAM W/R error
D8	Clear faults. Faults and fault timers are cleared
D9	Clears average, minimum, and maximum values

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