FRC-200

Flow Rate Controller
Service and Operations Manual

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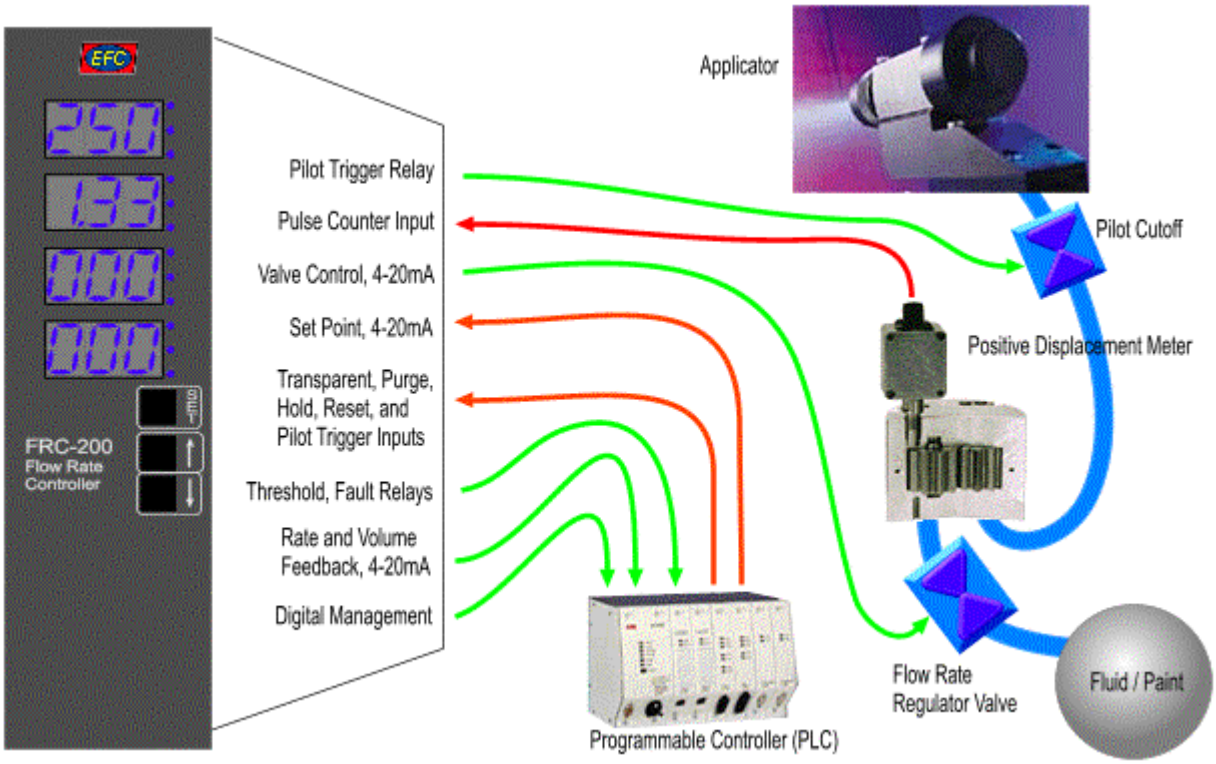
1 Description

The FRC-200 is a two-channel intelligent fluid flow rate controller. Its purpose is to provide accurate closed loop control and monitoring of the flow rate of 1 or 2 fluids. The dual controllers can be operated independently, or coordinated to maintain two flow rates at a preset ratio. The FRC-200 is compatible with a variety of positive displacement flow sensors. It can be operated standalone, or can be integrated into existing analog and discrete logic control systems (PLCs), as well as digital systems via its serial interface.



The FRC-200 is one of a family of EFC Systems products that can be integrated to create a state-of-the-art rotary atomizing finishing system. It can be installed into the EFC 4X4 Rack along with other EFC products. For more detail, refer to the EFC 4X4 Rack Installation Manual.

1.1 Features Summary

Dual Fluid Flow Rate Controllers

- Accurate Proportional, Integral, Derivative (PID) closed-loop control
  - Auto-learning, Fully tunable
  - Supports positive displacement flow meters with k-factors up to 30000 pulses/Liter.
- Supports binary (2-part) fluid management
  - Programmable A:B mix ratio

- Monitoring Features
    - Flow sensor presence, and signal noise/jitter
    - Flow rate within/outside of tolerance
    - Flow rate A:B ratio within/outside tolerance
    - Job volume crossed minimum/maximum thresholds
    - Job volume within/outside of thresholds

32 Fluid Profiles

- Profiles tailor the FRC-200 to the unique characteristics of each fluid.
- Each fluid profile has a calibration table to compensate for viscosity and lubricity characteristics that are unique to each fluid.
- Each fluid profile has volume and rate thresholds.
- Each fluid profile has a selectable A:B mix ratio.

For each Fluid Controller

- 4-20mA output for:
    - proportional valve/transducer control
    - flow rate feedback to a controller
    - volume feedback to a controller
- 24V+ supply for external transducers and sensors
- 4-20mA input for flow rate set point from a controller
- 4-20mA and 0-5V inputs for fluid profile selection
- Four multi-purpose SPDT relays, can be used for:
    - Any fault or ready indication
    - Any threshold crossing

Management Features

- Large bright LED readout of flow rate and job volume. Units can be:
    - cc per minute (ccpm)
    - Liters per minute (Lpm)
    - Gallons per minute (Gpm)
- Windows (98/NT/2K/XP) Graphical User Interface
- Time-stamped event log
- Installation/Diagnostic Tests
    - Relay on/off tests
    - Manual analog output current
    - Input displays
    - Analog input/output current readings
- PID parameter and gain adjustments
- Discrete input assignments
- Threshold settings
- Fault/event action assignments
- Save/recover all settings and calibration

2 Installation

The FRC-200 fits into a standard 6U – 19" rack that is installed and wired into the painting system before installing the FRC-200. The rack provides a set of connectors (DIN 41612) for the FRC-200 to plug into. Each slot can be wired differently; take care to verify that the slot is correctly wired for the FRC-200 before installation. Please see Sections 7.1 and 7.3 for the correct pin outs.

When placing the FRC-200 into the rack, check that the connectors mate before pushing the unit completely into the slot. When theFRC-200 is completely seated, lock the unit in place with the four quick turn latches. The latches look like normal screws, but require only a ¼ turn to secure the unit in its slot. Install filler panels into unused slots.

When first powered on, the FRC-200 should flash its indicators and finally result in all four numeric displays showing zeros. If nothing happens, recheck the power wiring on connector B and verify that the rack itself has power.

Use a serial cable to connect a Windows PC to the DB-9 Local Data Port on the front panel of the FRC-200. Run the FlowManagerSetup.exe to install the software and then run FlowManager.exe. You should see the Flow Manager `About` screen:

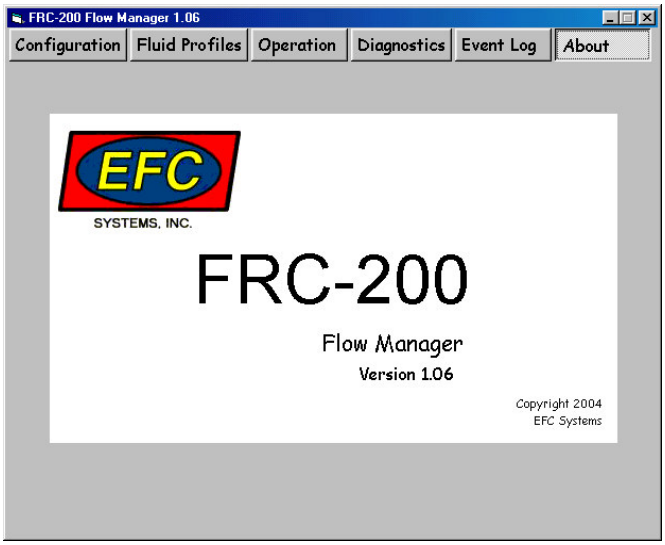


Figure 1 – About FlowManager

A handy way to tell if the PC is communicating with the FRC-200 is to click on the tab labeled `Event Log`. Within a second or two of entering this screen you should see some updates made to the log. Some of the log entries get a little esoteric – but they're sometimes useful.

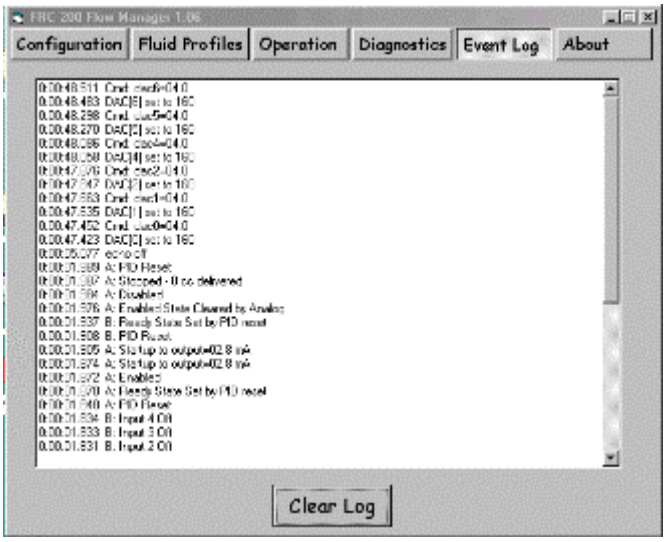


Figure 2 – FlowManager Event Log

If you don't see activity, verify that the RS232 setup is 9600 bps, 8-bits, 1-stop, No parity. The cable being used should be straight through and flow control settings should be disabled. See sections 7.4 and 7.5 for more information on the Local Data Port RS232 connector.

The Diagnostics tab is useful for initial system checkout. On this screen can be viewed the state of all discrete and analog inputs. Buttons are provided to wiggle the relays. Analog outputs can be tested by entering output values in milliamps (4.0 to 20.0).

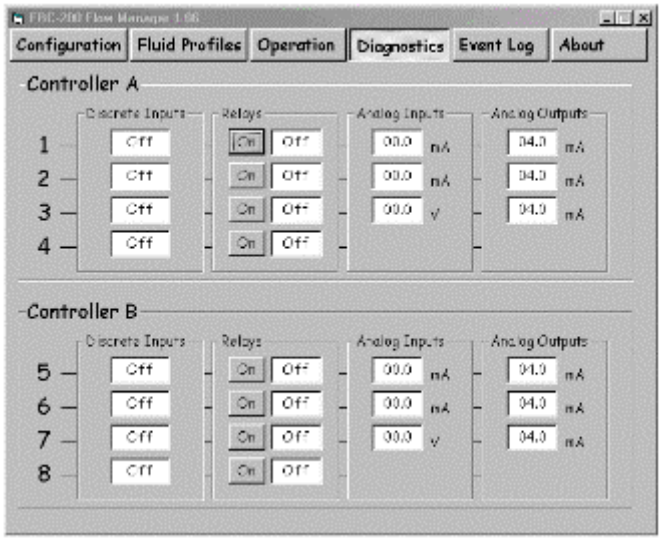


Figure 3 - FlowManager Diagnostics

Note: Verify that closed loop flow control is disabled (setpoint is zero) before attempting to enter values into Analog Output #1 – as if it is running, the control loop will overwrite whatever is entered! Take care using diagnostics if the system is loaded with fluid.

3 Front Panel

3.1 Description

The FRC-200 provides for (very) basic operation and monitoring via the front panel.

3.1.1 Digital Flow and Volume Meters

The FRC-200 front panel features a digital flow and volume meters for each of the two flow rate controllers. Next to each meter, a LED indicates the units being displayed.

3.1.2 Power On/Off Switch

The main power switch on the front panel controls the incoming AC power. When in the off position, all power to the FRC-200 is turned off and all relays are open.

3.1.3 Local Data Port

This is the front panel interface to a terminal or PC running the Flow Manager program. The interface is asynchronous RS232, 9600bps, 8 Bits, No Parity, 1 Stop Bit, Xon/Xoff flow control. For details of its operation, refer to Section 4. This port gives access to FRC-200 information and control via a PC or laptop computer.

3.1.4 Front Panel Operation

The front panel is a little tricky to operate, but with a few seconds of practice can be used to turn fluid flow on/off and reset the job volume.

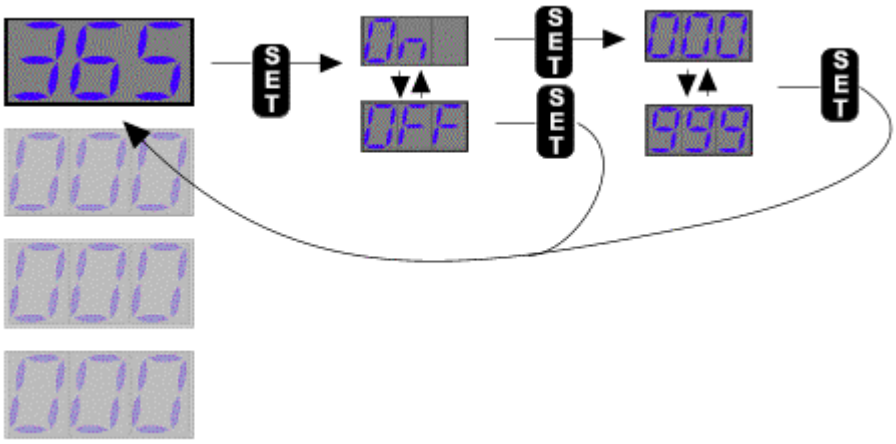


Figure 4 – Front Panel Setpoint Control

Start by using ↑and ↓to select which value to change. Notice that one of the front panel meters will blink twice after either arrow key is pressed. The one that blinks will be affected by a press of the SET key.

Pressing SET for a job volume meter will reset the meter's value back to 000.

Pressing SET for a flow rate meter is more interesting – for the number disappears and in its place is displayed either OFF or On.

On means that flow is enabled. It can be turned off by pressing either arrow key (so that the window shows OFF) and then pressing SET.

OFF means that flow is disabled. It can be enabled by pressing either arrow button (so that the window says On) and then pressing SET.

Here's how to set the flow rate. If the window says On, pressing SET will cause the window to briefly flash FLO before displaying a number. At this point, use the ↑and ↓to increase or decrease the set point flow rate. Note that you can press and hold either arrow. Once your favorite setpoint number is reached, press SET to engage the new setpoint.

4 FlowManager Software

The FRC-200 configuration, calibration and diagnostics are accessed using FlowManager software. To use it: power on the FRC-200, connect your PC's COM1 to the FRC-200's Local Data Port using a handy straight-through serial cable, and run the FlowManager software. Your PC's COM1 not available? No problem, the FlowManager will search for the COM port that is plugged into the FRC.

A rear-panel port is available for installations that are more permanent. The rear panel is RS422 (for longer range), so you'll need an adapter to connect it to a PC.

4.1 Configuration

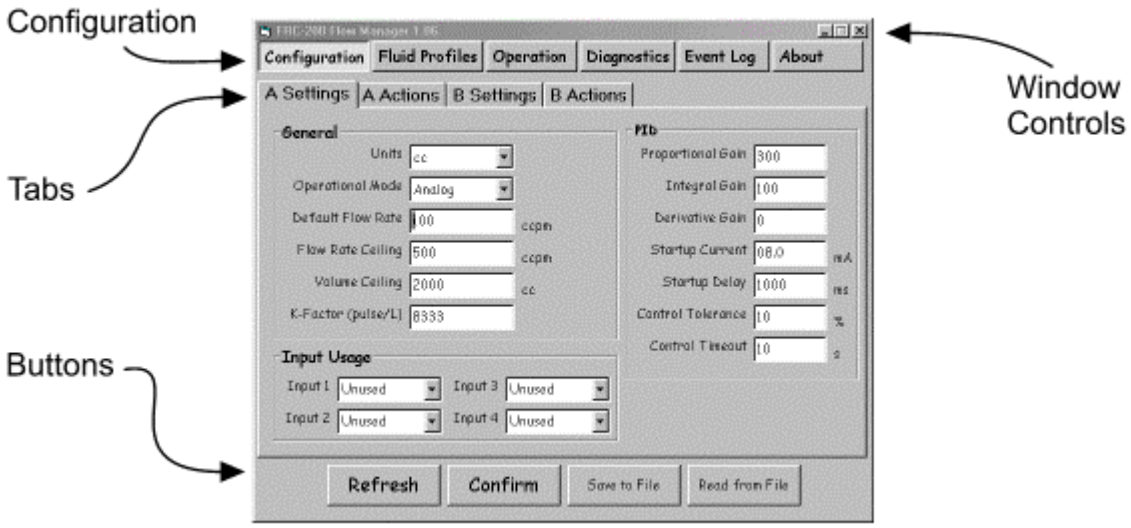


Figure 5 - FlowManager Configuration

The Configuration form is used to tailor the FRC-200 to its environment. It is likely that you will have to adjust each and every one of these parameters, so kick back and give this section a good read.

First, note the Tabs. Each fluid controller (creatively named A and B) has a tab for `Settings` and `Actions`. Details follow.

After changing any parameters, press the `Confirm` button to send the new data to the FRC-200. If you don't do this, nothing will be changed. The `Refresh` button reads back the latest FRC-200 configuration.

The `Save to File` button allows saving of the configuration (both Settings and Actions for both A and B controllers) into a text file on the PC. The `Read from File` is used to recover the saved configuration into the form and send it to the FRC-200.

You can use the Window Controls to hide the FlowManager window on the task bar, or to close the FlowManager program.

4.1.1 General Settings

4.1.1.1 Units

The default is to display volume in milliliters (cc) and flow rate in cc/minute (ccpm). You can change this to Liters and Lpm or Gallons and Gpm.

4.1.1.2 Operational Mode

This parameter establishes how the desired fluid flow rate, or Setpoint, is determined.

Option	Description
Analog	Setpoint is determined by 4-20mA current received on the analog input. A current of 4mA turns off flow and 20mA selects the maximum flow rate (see Flow Rate Ceiling 4.1.1.4).
Transparent	In this mode, the 4-20mA on the analog input is passed *transparently* through to the proportional valve that controls the fluid flow. This mode bypasses the FRC-200 and allows an external device to directly control fluid flow. This mode is useful for maintenance and for diagnosing some control system problems.
Constant	In this mode, the Setpoint is the Default Flow Rate (see 4.1.1.3) and the system can be controlled in an off/on manner using on of the Discrete Inputs as an Enable signal. When the Discrete Input is On, the Default Flow Rate is selected. When the Discrete Input is Off, the flow will cease.
Passive	In this mode, the FRC-200 is acting as a fluid flow monitor. Like Transparent mode, the analog input is passed transparently to the fluid flow control valve. However, in Passive Mode, the FRC-200 continues to monitor flow rate and volume, and can close a relay if any tolerances are exceeded or thresholds are crossed.
Digital	In this mode, the state of the analog input is ignored.

Table 1 - Operational Mode Options

4.1.1.3 Default Flow Rate

This is the flow rate setpoint when operating the Operational Mode is set to *Constant*. Otherwise, this parameter is unused.

4.1.1.4 Flow Rate Ceiling

The Flow Rate Ceiling specifies the maximum flow rate that the system can be expected to run. This value should be set slightly above the maximum flow rate value that will be conceivably used in the system.

The Flow Rate Ceiling affects these elements of the system:

- When the Operational Mode is *Analog*, a 20mA input (maximum) will select the Flow Rate Ceiling as the setpoint.
- The Operation screen adjusts its “analog” scales so that the maximum reading is the Flow Rate Ceiling.

- Analog feedback current will be 20mA when the measured flow rate reaches the Flow Rate Ceiling.

4.1.1.5 Volume Ceiling

The Volume Ceiling specifies the maximum volume of fluid that the system can be expected to measure. The measured volume is called the *Job Volume* – and is displayed on the front panel. The Volume Ceiling should be set slightly above the largest volume that will be conceivably measured during a job or batch.

The Volume Ceiling affects these elements of the system:

- The Operation screen adjusts its "analog" scales so that the maximum reading is the Volume Ceiling.
- Analog feedback current will be 20mA when the measured volume reaches the Flow Rate Ceiling.

4.1.1.6 K-Factor

Positive displacement sensors emit a pulse for each tiny volume of fluid that passes through them. A sensor with a large k-factor will have higher precision, but likely lower capacity than a sensor with a smaller k-factor. Sensor manufacturers all publish k-factor as pulses/unit, though they don't all agree on the units to use. Please convert your sensor's k-factor into pulses/Liter before entering this number.

The FRC-200 can use sensors with k-factors up to 30000 pulses/Liter.

4.1.2 Discrete Input Usage Settings

Each controller (A and B) has four digital discrete inputs that can be assigned to perform the functions in the following table.

Option	Description
Unused	The state of the discrete input is ignored.
Enable	When the discrete input is On, the FRC-200 will use the Default Flow Rate as the flow rate Setpoint. Use of an Enable signal allows implementation of a simple on/off fluid flow controller.
Transparent	When the discrete input is On, the FRC-200 operates as if configured for Transparent Mode operation. If will transparently pass the 4-20mA current received on its analog input directly to the fluid control valve. A useful feature for diagnostics and maintenance.
Hold	When the discrete input is On the FRC-200 goes open-loop and ceases making changes to the fluid flow valve. The FRC-200 expects that flow may stop due to the action of an external pilot valve. This is the reverse of Pilot.
Pause	While the discrete input is On, the FRC-200 will suspend the Job Volume counter. The pause feature is intended to used in maintenance situations to avoid counting volume of solvents or air during flushing operations.
Reset	Changing the state of the discrete input will reset the Job Volume counter. This is expected to happen between batches or jobs.

Option	Description
Pilot	When the discrete input is Off the FRC-200 goes open-loop and ceases making changes to the fluid flow valve. The FRC-200 expects that flow may stop due to the action of an external pilot valve. This is the reverse of Hold.
Purge	When the discrete input is On, the FRC-200 will pause the volume counter and apply 20mA to fully open the fluid flow control valve. This feature can be used to purge fluid lines.

4.1.3 PID Settings

PID stands for Proportional Integral Derivative – a time-honored method of providing feedback control of a system. The FRC is not purely a PID controller – it is also an intelligent controller, as it learns the fluid control valve positions that correspond to various flow rates. After a few fluid control runs, the system can establish stable flow rates very quickly. The PID becomes a mechanism for making fine adjustments to compensate for minor fluctuations in system characteristics.

4.1.3.1 Proportional Gain

The proportional gain is a unit-less factor that determines how strongly the FRC-200 will react to instantaneous flow rate errors. Each pulse from the fluid flow sensor updates the flow rate estimate that the FRC-200 uses to determine how close the actual flow rate is to the set point. The PID uses the difference between the actual and setpoint flow rate to compute a correction to the fluid control valve setting.

Normally, the FRC-200 uses “weak” PID gains, as it relies on “learned” flow rate data for speed. If you observe the system “hunting” around the setpoint flow rate, reducing the proportional gain may be necessary.

4.1.3.2 Integral Gain

The integral gain determines how strongly the FRC-200 will react to long-term flow rate errors. Using PID, the proportional action gets the flow rate close to the setpoint – but cannot get it all of the way. The integral component of PID converges the flow rate all the way to the setpoint.

Normally, the FRC-200 applies “weak” gains, as it relies on “learned” flow rate data for speed. If you observe the system “hunting” around the setpoint flow rate, reducing the integral gain may be necessary.

4.1.3.3 Derivative Gain

The derivative gain is used in cases where there is substantial hysteresis in the flow rate control system. It is used to prevent the PI corrections from increasing the flow rate too quickly. The derivative gain is not normally necessary in naturally damped fluid control systems, and is set to 0.

If you observe that the system is able to reach the setpoint quickly, but has a large amount of overshoot – then you may have a situation for employing derivative gain. Experiment!

4.1.3.4 Startup Current

To improve PID performance, the FRC-200 can be configured to start out with a constant fluid control valve setting. Sometimes, due to startup "stiction", it is best to apply a fixed valve setting to get fluid flowing, hoses pressurized, and sensors spinning before attempting to work in a closed loop mode. The flow control valve setting is controlled by a 4-20mA current. The default startup setting is intentionally conservative. After running for a while, make an observation of the output current near the startup setpoint and record this as the Startup Current.

4.1.3.5 Startup Delay

Selects how long (in milliseconds) that the Startup Current will be applied before shifting over to PID closed loop control. The default is 1000ms, which seems to be a good choice in most systems. The optimum Startup Delay is the minimum interval of time needed for the system to achieve a steady flow rate after applying the Startup Current. If your fluid flow system takes a few seconds to become stable, then you will get improved startup performance by increasing the Startup Delay.

4.1.3.6 Control Tolerance

The Control Tolerance is used for monitoring the capability of the system to control the flow rate. The control tolerance is specified as a percentage of full range. It is indicative of a system problem if the FRC-200 cannot maintain flow rate within tolerance. The FRC-200 can be configured to set a relay when the flow rate error is outside of this tolerance for too long.

4.1.3.7 Control Timeout

The Control Timeout establishes how long the measured flow rate must be outside of tolerance before declaring the flow rate as being out-of-tolerance. Set this parameter long enough to give the system time to establish control of the flow rate – but short enough that flow control problems can be detected before larger problems occur.

4.1.4 Controller Actions

The FRC-200 has four relays that can be used to signal events back to a controller or PLC. The FRC-200 can recognize 18 system states/events, and each of these can be ignored (the default), recorded in the event log, or cause any of the four relays to be set.

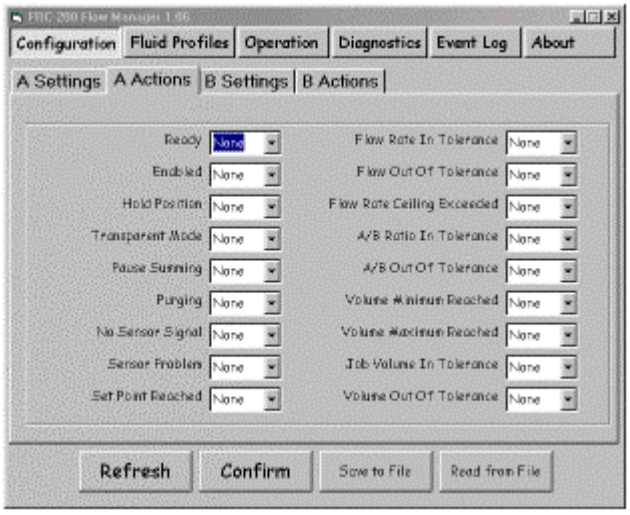


Figure 6 - Configuration Actions

This arrangement offers some flexibility. With a little planning, you should be able to get the events of interest communicated back to your controller or PLC.

The following table lists the States/Events recognized by the FRC-200. Each of these states can cause a relay to be set.

State	Description
Ready	System is powered on and no fault condition is present.
Enabled	Enabled by discrete input, analog setpoint, or digital command and set point is non-zero.
Hold Position	Flow rate fixed – open loop
Transparent Mode	Operating transparently – open loop
Pause Summing	Job volume counter paused/suspended
Purging	Flow control valve fully open – purging
No Sensor Signal	No pulses received from the flow rate sensor
Sensor Problem	Excessive noise observed from flow rate sensor
Set Point Reached	Flow rate has reached the set point
Flow Rate In-Tolerance	Flow rate is within tolerance of set point
Flow Rate Out Of Tolerance	Flow rate is outside of tolerance
Flow Rate Ceiling Exceeded	Flow rate ceiling value exceeded
A/B Ratio In Tolerance	Ratio of flow rates is within tolerance
A/B Ratio Out Of Tolerance	Ratio of flow rates is outside of tolerance
Volume Minimum Reached	Job volume has reached minimum threshold
Volume Maximum Reached	Job volume has reached maximum threshold
Job Volume In Tolerance	Job volume is in tolerance, between minimum and maximum.
Volume Out Of Tolerance	Job volume is out of tolerance, either below minimum or above maximum.

Table 2 - State/Action Descriptions

4.2 Fluid Profiles

To cater for the situation where a number of different fluids are managed, the FRC-200 provides 32 fluid profiles. Each profile contains parameters and calibration that may be unique to each kind of fluid. The profile to use is selectable by analog input (either 4-20mA or 0-5V), digital command, or the FlowManager software.

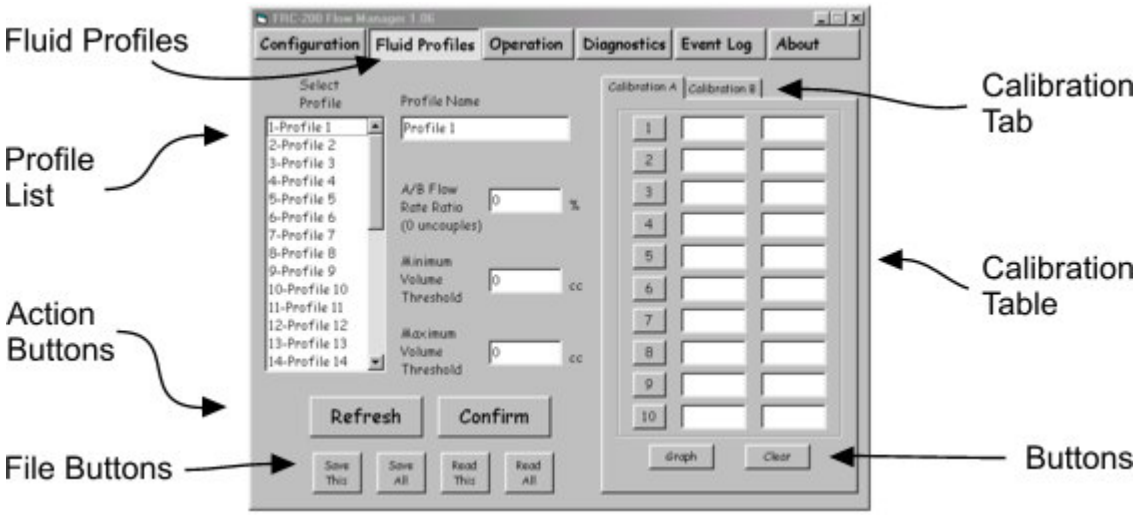


Figure 7 - Fluid Profiles

Use the `Select Profile` List to select which fluid profile to view or edit.

The `Refresh` and `Confirm` buttons work the same way as those on the Configuration page. After making any changes to a Profiles' parameters, you must press `Confirm` to make the changes permanent on the FRC-200. Pressing `Refresh` loads the Fluid Profiles form with the latest information saved on the FRC-200.

The file buttons are a little different. Here, you can press `Save All` to archive all 32 of the profiles into a single large text file, or `Save This` to archive a single profile. The advantage of saving a single profile is that you can more easily reuse it as the basis for other fluid profiles. If you press `Read All`, please be patient, it takes a minute to recover all of the profiles to the FRC-200.

On the right side of the page, the Calibration Tab selects which set of 10 calibration points to view. Yes, each profile has two calibration tables – one for each controller. You will probably find that most systems are linear, but the tables are here just in case some combination of fluid and sensor gives you problems. The table contains "sensor" and "actual" flow rate values. Use the `Graph` button to check the linearity of the data.

Pressing one of the buttons marked `1` to `10` will start a "wizard" that will walk you through the steps to collect the calibration data.

4.2.1 Profile Parameters

You can set up a profile for each fluid to be controlled. Each profile can be configured with its own Name, A/B Flow Rate Ratio, and Volume Thresholds. Each profile also has calibration tables.

4.2.1.1 Profile Name

The profiles are identified both by number (1..32) or by name. The Profile Name field allows you to enter a descriptive name for the profile.

4.2.1.2 A/B Flow Rate Ratio

Using this parameter, the FRC-200 can automatically govern the flow rate of controller B to track that of controller A. This feature is intended to make it simple to automatically manage the delivery of 2-part solutions. An external controller need only establish the setpoint for controller A and the flow rate of controller B will track it.

By default, the A/B ratio is 0, which de-couples the A and B controllers, allowing controller B to operate completely independently of the controller A. However, if the A/B ratio is non-zero then the flow rate of controller B will automatically track the flow rate of controller A.

The ratio is specified as a percentage. If you want A and B to deliver identical flow rates, set the A/B ratio to 100%. If you want controller A to deliver twice as much as B, then set the A/B ratio to 200%. If you want controller A to deliver 1/3 as much as B, then set the A/B ratio to 33%.

4.2.1.3 Minimum Volume Threshold

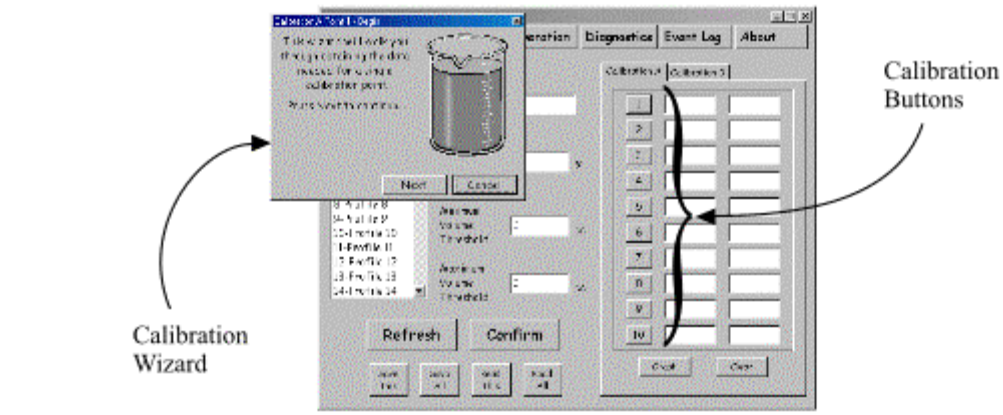
The FRC-200 can be configured to close a relay when the job volume meets or exceeds this value. The job volume is considered to be "in-tolerance" when it is between the minimum and maximum volume thresholds.

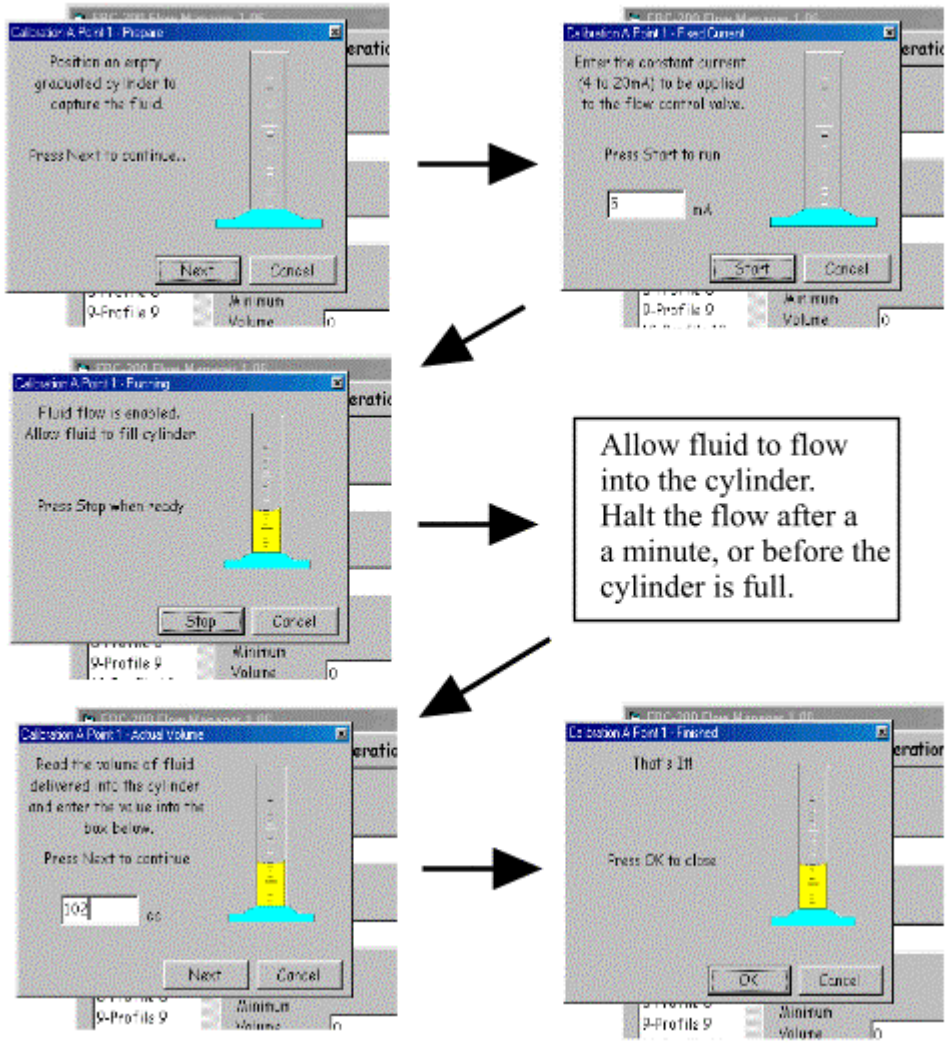
4.2.1.4 Maximum Volume Threshold

The FRC-200 can be configured to close a relay when the job volume meets or exceeds this value. The job volume is considered to be "in-tolerance" when it is between the minimum and maximum volume thresholds.

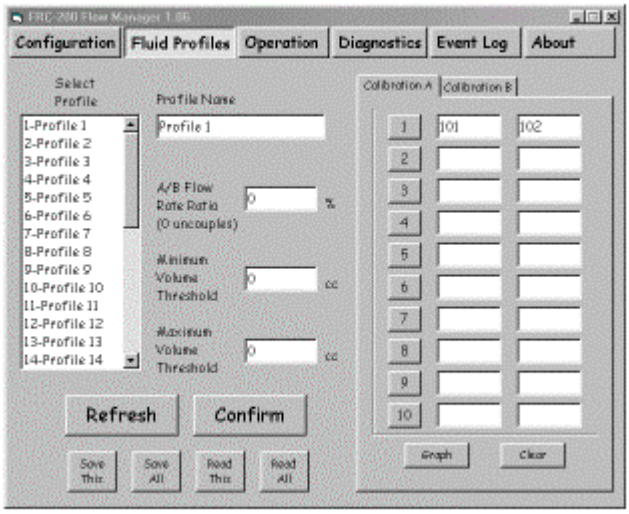
4.2.2 Fluid Calibration

Each fluid profile contains calibration tables for both controllers. The purpose of the calibration is to compensate for non-linearity of the sensor. Linear errors should be compensated for by correcting the k-factor. Press any of the buttons labeled 1-10 to start the calibration wizard.

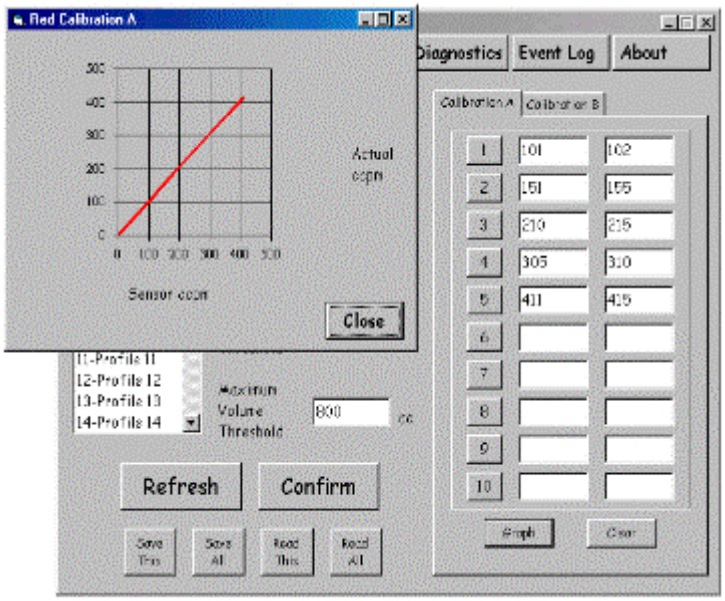




Some trial and error will be necessary to determine the best choices of output current that result in well spaced calibration points. You can use any means to turn the fluid flow on and off. The FRC-200 starts the test when fluid flow measurement starts and halts the measurement when flow stops.



After completion of the calibration wizard, a pair of flow rate calibration data is placed into the table. Repeat the process to install other calibration points. Use the Graph button to verify that the calibration data look reasonable and re-run any points that appear to be in error.



When all points are collected, press the `Confirm` button to update the FRC-200 with the new calibration data. Use the `Clear` button to erase the table.

4.3 Operation

This is the FRC-200 control panel.

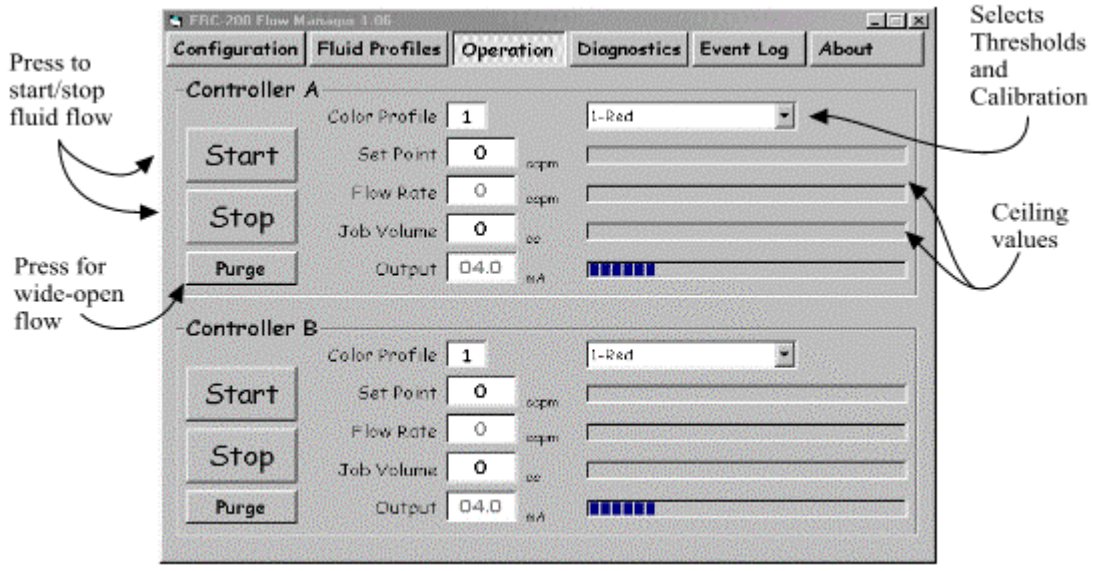


Figure 8 – Operation

Enter a setpoint value, then press `Start` and `Stop` to control the flow of the fluid.

The `Set Point` is green while fluid flow is enabled. Displayed units for flow rate and volume can be changed in the `Configuration` form (page 11).

`Flow Rate` and `Job Volume` will have a red background when Out-of-Tolerance, and a green background when In-Tolerance. The "analog" scales run from zero to the configured ceiling values (page 11).

The `Purge` button is a maintenance aid. When pressed, the FRC-200 applies 20mA to the flow control valve – to allow for purging of lines and system maintenance. Pressing `Purge` again will close the valve by returning the Output current to 4mA.

5 Troubleshooting

The FRC-200 is designed to provide as much information as possible in the case of non-operation or Fault conditions. The FRC-200 is engineered to be highly reliable; fault conditions are likely to be caused by external system issues.

Symptom	Action / Check
Front panel flow meters and LEDs are off	Indicates that the card has no power. • Check the front panel power switch. • Check AC power to rack and the card slot. • Check the main power fuse. • Look for bent power pins. • Verify that card is fully seated into the rack.
Front panel LEDs and flow meter displays flash on and off	Usually means that the microprocessor is malfunctioning. Return the FRC-200 for repair.
Flow meter displays show FLt and then the system resets.	**Software Fault** Indicates a software problem. Return the FRC-200 for repair.
Flow meter display shows nF	**No Flow** FRC-200 is enabled, and expects fluid flow, but it is not receiving pulses from the flow sensor. • Fluid flowing? • Verify sensor cabling and power • Check flow control valve
Flow meter display shows OOt	**Out of Tolerance** FRC-200 is unable to achieve and maintain the setpoint flow rate. This may also happen when the FRC-200 is first learning the system. • Use Diagnostic screen to set a constant output current – verify constant flow rate. • Try different flow rates to verify that flow control valve is not sticking. • Try reduced PID gain settings. Start by dividing both P and I gains by half.

6 Specifications

6.1 Electrical Specifications

Power Requirements	115/230 VAC +/- 10%, 50/60 Hz., Single Phase
Power Consumption	22VA Maximum AC
Main Power Fuse	2 AG 2 Ampere Slow Acting
Analog Control Input Voltage Current	0 to 5 VDC, Z=250 Ohms 0 VDC Input = Profile 1 5 VDC Input = Profile 32 0 to 20 mA, Z = 250 Ohms 0 or 4 mA = 00.0 20 mA = Flow Rate Ceiling
Relay Contacts	4A, 250VAC, Isolated

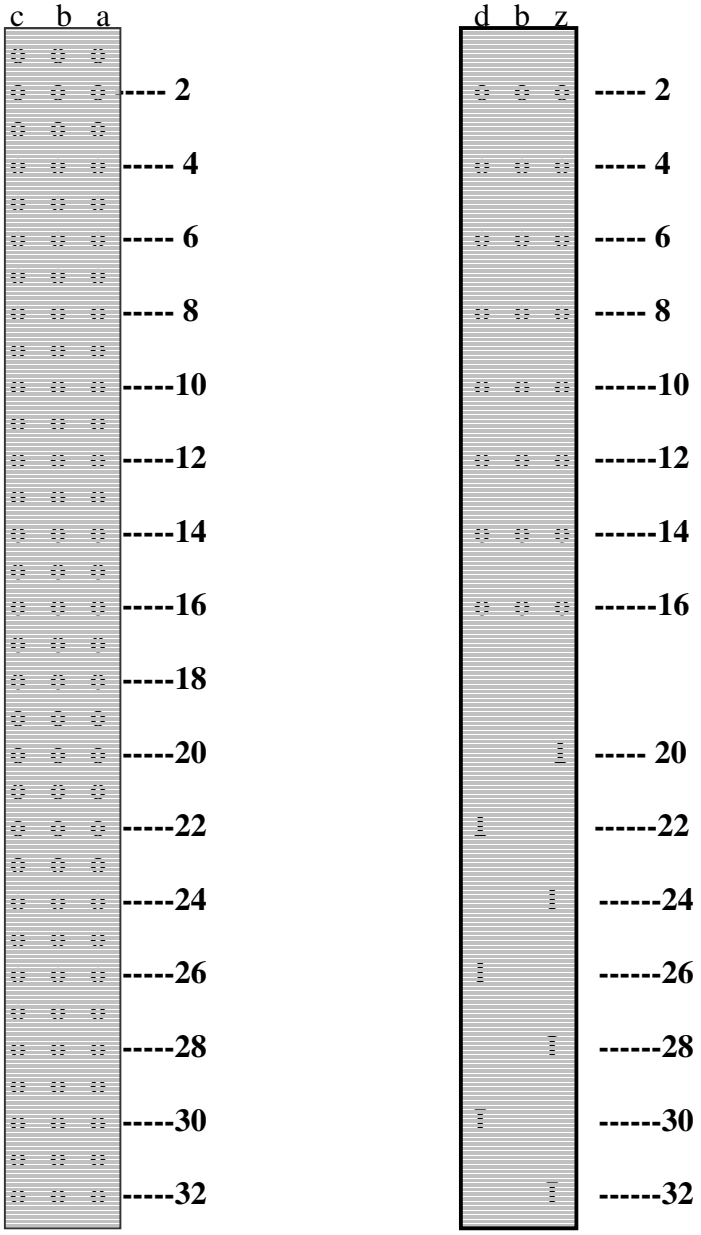
6.2 Mechanical Specifications

Height	10.3in., 266.70mm, 6U
Width	2.79in., 70.86mm, 14HP
Depth	7.7in., 172.50mm
Weight	4.5lb, 2.0kg
Connectors Rear Front	 A - AMP-650473-5 B - EPT-117-40064-2 DB9-S - AMP 745781-4

7 Connectors and Pin-Outs

7.1 Back Plane Connectors

The rear panel consists of two connectors. These are referred to as A and B. Connector A is above connector B when the FRC-200 is installed. The following sections outline the pin-out of these connectors.



Connector A (Top)
Rear View
Type C

Connector B (Bottom)
Rear View
Mate: EFC 60-1A70

7.2 Connector A Pin out

This connector interfaces the FRC-200 to the rest of the painting system.

Connector A				
	Row	C	B	A
CONTROLLER A	1	Relay 1 NC (normally closed)	Relay 1 COM (common)	Relay 1 NO (normally open)
	2	Analog Input 1 + 4-20mA, set point	Analog Output 2 + 4-20mA flow rate feedback	Analog Output 1 + 4-20mA flow control valve
	3	Analog Input 1 –	Analog Output 2 –	4-20mA Output 1 –
	4	Counter Input –	Counter Input + Flow rate sensor	+24V Supply
	5	Relay 2 NC	Relay 2 COM	Relay 2 NO
	6	Discrete Input 1 & 2 Common Ground	Discrete Input 2	Discrete Input 1
	7	Analog Input 2 + 4-20mA, profile selection	RS422 RX + Digital IO	+24V Supply
	8	Analog Input 2 –	RS422 RX -	Ground
	9	Relay 3 NC	Relay 3 COM	Relay 3 NO
	10	Analog Input 3 + 0-5V, profile selection	Analog Output 4 + Unused	Analog Output 3 + 4-20mA volume feedback
	11	Analog Input 3 –	Analog Output 4 –	Analog Output 3 –
	12	Counter Input –	Counter Input +	+24V Supply
	13	Relay 4 NC	Relay 4 COM	Relay 4 NO
	14	Discrete Input 3 & 4 Common Ground	Discrete Input 4	Discrete Input 3
	15	Analog Input 4 +	RS422 RX +	+24V Supply
	16	Analog Input 4 –	RS422 RX –	Ground
CONTROLLER B	17	Relay 1 NC (normally closed)	Relay 1 COM (common)	Relay 1 NO (normally open)
	18	Analog Input 1 + 4-20mA, set point	Analog Output 2 + 4-20mA flow rate feedback	Analog Output 1 + 4-20mA flow control valve
	19	Analog Input 1 –	Analog Output 2 –	4-20mA Output 1 –
	20	Counter Input –	Counter Input + Flow rate sensor	+24V Supply
	21	Relay 2 NC	Relay 2 COM	Relay 2 NO
	22	Discrete Input 1 & 2 Common Ground	Discrete Input 2	Discrete Input 1
	23	Analog Input 2 + 4-20mA, profile selection	RS422 RX + Digital IO	+24V Supply
	24	Analog Input 2 –	RS422 RX -	Ground
	25	Relay 3 NC	Relay 3 COM	Relay 3 NO
	26	Analog Input 3 + 0-5V, profile selection	Analog Output 4 + Unused	Analog Output 3 + 4-20mA volume feedback
	27	Analog Input 3 –	Analog Output 4 –	Analog Output 3 –
	28	Counter Input –	Counter Input +	+24V Supply
	29	Relay 4 NC	Relay 4 COM	Relay 4 NO
	30	Discrete Input 3 & 4 Common Ground	Discrete Input 4	Discrete Input 3
	31	Analog Input 4 +	RS422 RX +	+24V Supply
	32	Analog Input 4 –	RS422 RX –	Ground

7.3 Connector B Pin out

This connector is used exclusively for AC power.

Connector B			
Row	**D**	**B**	**Z**
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
20			AC1
21			
22			
23			
24			
25			
26	AC2		
27			
28			
29			
30			
31			
32			Ground

7.4 Communications Cable

Local Data Port (Front Panel)

To PC DB9-S		FRC-200 DB9-P
1		1
2	----------	2
3	----------	3
4		4
5	----------	5
6		6
7		7
8		8
9		9

7.5 RS232 Communication Parameters

Emulation:	VT100 or ANSI
Speed:	9600
Stop Bits:	1
Data Bits:	8
Parity:	None
Flow Control:	Xon, Xoff