SBC-FHC
USER MANUAL

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SBC-FHC User Manual

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This manual describes the installation and operation of the SBC-FHC and FHC-SD. This document is divided into the following sections, each beginning with a table of contents for the section:

. One: Product Overview, describing the features of the SBC-FHC and FHC-SD products, and presenting the specifications for the controller.
. Two: Wiring & Installation, detailing the wiring and installation procedures.
. Three: Application Configuration, providing a step-by-step sequence for configuring the SBC-FHC.
. Four: Objects and Properties, listing all objects and properties within the device.
. Five: Using the FHC-SD, provides an overview of the operator interface for the FHC-SD.
. Appendix A: Channels & Attributes, enumerating the attributes in every channel along with their datatype, access, storage and default values.

This document contains certain style and formatting conventions for conveying information in a clear and concise manner:

. Attribute names are shown in **bold**. For example: **CV**.
. Menu commands appear with a ">" symbol between levels. For example: File>Open.
. *Italics* indicate a section of this manual or another publication.
. The following formats are used to highlight important information:

NOTE
Notes indicate noteworthy information and appear in boxes with this format separated from the running text.

CAUTION
Cautions indicate information that may prevent serious system or user problems and appear in boxes with this format separated from the running text.

WARNING
Warnings indicate inforamtion that prevent personal injury or equipment damage and appear in boxes with this format separated from the running text.

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SECTION 1: PRODUCT OVERVIEW

This section describes the FHC *and FHC-SD and provides operating specifications for the controller.*

IN THIS SECTION

1.1 PRODUCT OVERVIEW

The SBC-GPC^{FHC} (referred to as the FHC) is an application specific fume hood controller that offers unprecedented technology combined with flexibility of control found nowhere else in the industry today. Through utilizing technology made famous in traditional Auto-Flow technology, fume hoods are controlled using actual Face Velocity readings from any fume hood equipped with Auto-Flow components.

The FHC offers a dedicated sensor bus input for the FHC-SD, a color touch screen local user interface. The FHC-SD provides total user feedback information regarding the current status of the fume hood, including alarm notification, setpoint control and monitoring, as well as many other unique features.

1.1.1 FEATURES OF THE FHC

. Standalone or networked operation
. Optimized PID control, executed every 50ms, for exhaust damper output
. Configurable setpoints
. Intuitive Cascade Flow Network capabilities for multi-fume hood installations
. Easy configuration and firmware updates via software tools such as *Solo*Pro
. RS-485 communications rate up to 115.2k
. Battery-backed real time clock and memory
. Self-diagnostic circuits and LED indicators for power, I/O, network activity, processor and programs.

1.1.2 FEATURES OF THE FHC-SD

. Full color, 12-bit, 480 X272 pixel TFT-based touch screen display
. Easy to use button driven navigation
. Provides access to control setpoints, alarm limits and other configuration features of the FHC
. Full operator password protection
. High-speed network communications to the FHC via STATbus protocol

1.2 PRODUCT SPECIFICATIONS - SBC-GPC^{FHC}

1.2.1 NETWORKING
. **line signaling:** RS-485
. **wiring:** shielded, twisted pair
. **network protection:** dual tranzorbs, PTC
. **communications speed:** 9.6kbps, 19.2kbps, 38.4kbps, 57.6kbps, 76.8kbps, *115.2kbps
. **network configuration:** multidrop bus, per RS-485 specification and practice
. **communications protocol:** American Auto-Matrix PUP

1.2.2 PRODUCT SETUP AND CONFIGURATION
. **Software**: SoloPro v2.7.1

1.2.3 TERMINATIONS
. Pluggable terminal blocks for inputs, outputs, power, network, and STATbus connections.

1.2.4 POWER REQUIREMENTS
. NEC Class 2 transformer
. 22-29 VAC, 50/60 Hz, 4.16 A max
. PTC protection

1.2.5 OPERATING ENVIRONMENT
. **temperature range:** 32-122°F (0-50°C)
. **humidity range:** 0-80% RH, non-condensing
. **altitude:** up to 2000m

1.2.6 BATTERY BACKUP
. Only Sanyo CR-1/3N or Duracell CL-1/3N battery rated 3.0 VDC is to be used. (Not user replaceable).

1.2.7 DIMENSIONS
. **size:** 8.407 x 6.5 x 1.25 in. (20.83x16.51x3.18 cm)
. **shipping weight:** 3 lb. (1.36 kg)

1.2.8 AGENCY APPROVALS
. UL Listed Management Equipment, Energy (PAZX) UL standard 916
. UL Recognized Temperature-Indicating and Regulating Equipment – Component (XAPX2) UL standard 873
. Complies with FCC Part 15, subpart B, for Class B Computing Device
. Complies with CE Directive and Standards

1.3   PRODUCT SPECIFICATIONS - FHC-SD

1.3.1   NETWORKING
.   **Line signaling:** EIA-485
.   **Data isolation:** GMR Data Isolated
.   **Protocol:** STATbus

1.3.2   HARDWARE
.   **Processor:** ARM7-TDMI, 86Mhz
.   **Memory:** 8MB-flash
.   **Expansion slot:** SD card socket for applying firmware updates; future expansion
.   **LCD:** 4.3 in, 480x720 - 16:9 color TFT with white LED backlight
.   **Touch screen:** 4-wire analog resistive with protective flex window
.   **Beeper:** 4Khz On/Off

1.3.3   POWER REQUIREMENTS
.   **Power source:** 24 VAC/VDC, 50/60Hz
.   **Consumption:** 2.5W, 4W maximum
.   **Line protection:** 0.5A PTC, self-resetting fuse

1.3.4   OPERATING CONDITIONS
.   **Temperature:** 41-122º F (5 - 50º C) ambient
.   **Humidity:** 0-90%, non-condensing
.   **Altitude:** -2000 to + 10,000 ft. (-650 to + 3500m)

1.3.5   DIMENSIONS
.   **Size:** 3.400 in. (8.65cm) x 6.000 in. (15.24cm) x 1.019 in. (2.59cm)

1.3.6   AGENCY APPROVALS
.   CE Approved
.   FCC, Class A Computing Device
.   UL listed 916, Management Equipment, Energy (PAZX)
.   UL Listed 873, Component Temperature-Indicating and Regulating Equipment (XAPX2)
.   UL Listed, Component Temperature-Indicating and Regulation Equipment for Canada (XAPX8)

SECTION 2: WIRING AND INSTALLATION

This section describes how to make the necessary connections for power and network communications to the SBC-FHC. Connection of input and output devices, as well as the use of remote I/O on the STATbus is covered as well.

IN THIS SECTION

2.1 FHC INSTALLATION

This section will explain the steps necessary to mount the FHC, supply power to the controller, connect the controller to the communications network and connect and configure the controller's inputs and outputs

WARNING
This product should only be used in a manner specified by American Auto-Matrix. No operator replaceable parts exist on this product. Only trained personnel should service equipment.

There are three main steps to installing the FHC. First the FHC controller must be physically mounted. Second, the controller must be connected to a suitable power supply. Third, the controller must be connected to the RS-485 communications network.

NOTE
All equipment must be installed by a licensed electrician in accordance with the NEC/CEC and local codes.

2.1.1 MOUNTING THE FHC

The FHC product consists of the main unitary controller mounted inside of a rugged metal enclosure. Because of the application specific functionality of fume hood controllers, a fume hood controller is usually installed on top of the fume hood. The mounting area should be flat and unobstructed by other equipment or machinery, free of moisture, and located away from potential leakage. The product should be mounted to a site which provides access to a stable 24 VAC power transformer from which the controller will draw its power. The temperature of the mounting location must be between 32º F and 122º F (0º C to 50º C) with a relative humidity of 0-80% non-condensing.

The mounting dimensions for the FHC are shown in Figure 2-1.
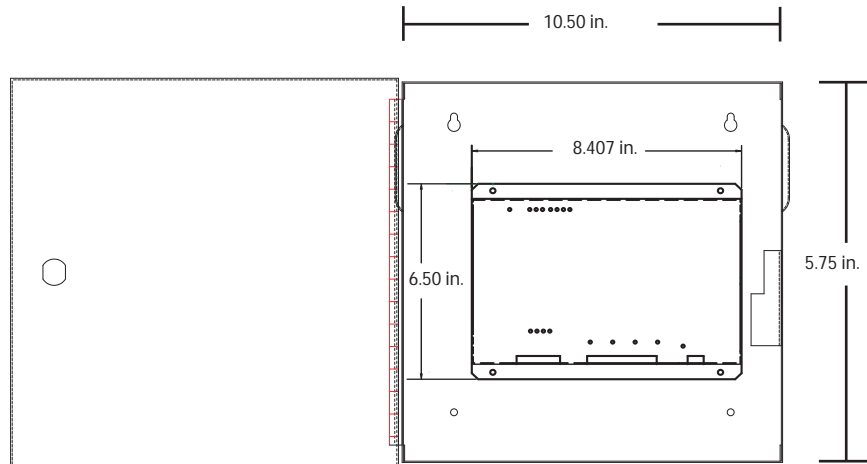
Figure 2-1: Mounting Dimensions for the FHC (all dimensions in inches)

NOTE

When installing the FHC, make sure that there is sufficient room to allow easy insertion and removal of terminal block plugs.

2.1.2 POWERING THE SBC-FHC

The FHC can be used in a variety of configurations. Because of this, the power requirements of the controller can vary greatly and are very much application specific. There are three main parts of the FHC which require power: the on-board I/O, the 24 VAC courtesy power output, and the power outputs on the STATbus ports.

The FHC requires a 22-29 VAC, 50/60 Hz NEC Class 2 transformer capable of providing a minimum of 1.85 A. The transformer is connected to the FHC at pins 43 and 44 on terminal block TB12 as shown in Figure 2-2.
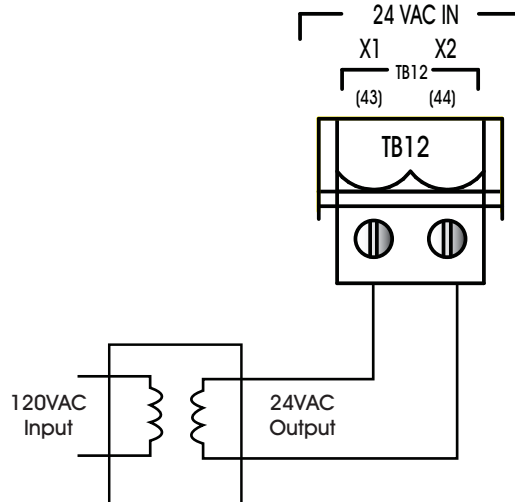
Figure 2-2: Connecting Power to the FHC

Once power is connected to the FHC, the Main Power light, located to the left of TB12 as shown in Figure 2-3, should be lit.
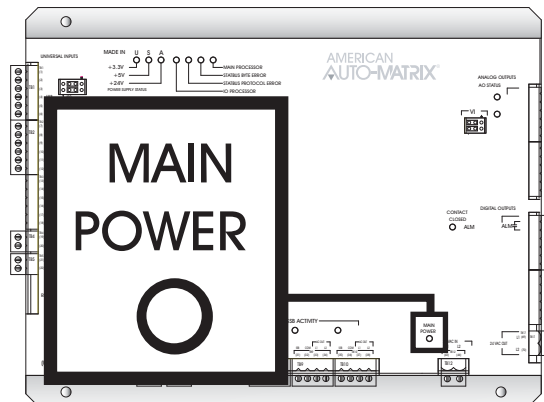
Figure 2-3: Location of the Main Power indicator

The Power Supply Status lights, shown in Figure 2-4, indicate that the 3.3 V, 5 V, and 24 V on-board power supplies are functioning properly. The Main Processor light will begin to blink. When the processor is functioning normally, this light will cycle on and off approximately every half second.
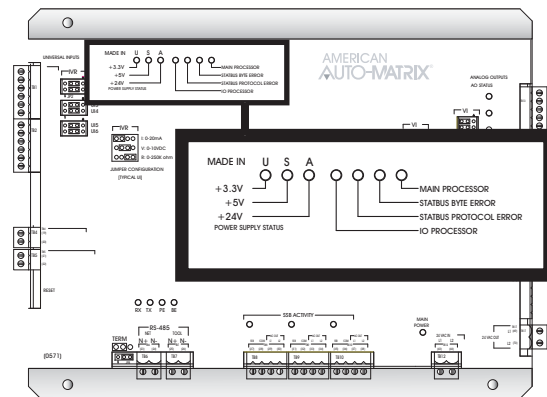
Figure 2-4: Location of the Power Supply Status Indicators and the Main Processor Indicator

2.1.3   CONNECTING THE RS-485 (PUP) NETWORK

The FHC communicates via RS-485 PUP protocol. As shown in Figure 2-5, the FHC has two network connections at terminal blocks TB6 and TB7.   The PUP network is connected to terminal block TB6 using 14-22 AWG, shielded, twisted pair wiring making sure to maintain polarity between devices.

The shield wire run to the first controller in the network should be connected to a reliable earth ground. At each connection along the network, the shield wires should be connected together and taped back.   At the last controller, the shield wire should simply be taped back.
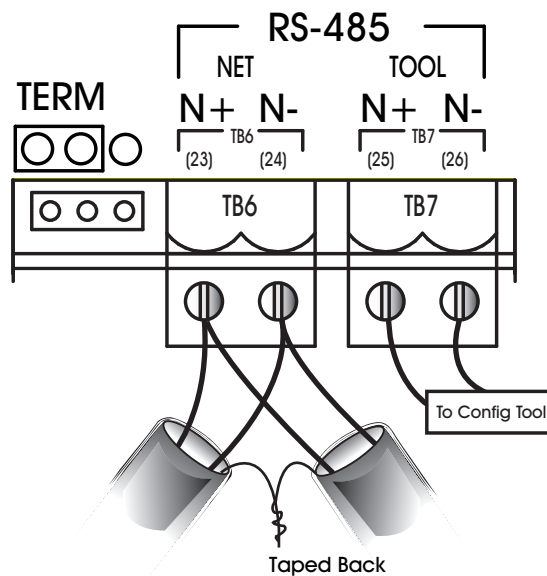
Figure 2-5: Proper Connection of the FHC to an RS-485 Network

The second network port on the FHC, terminal block TB7, is intended for the temporary connection of a configuration device. Do not use this terminal block to establish a regular connection between devices.

this terminal block The connection at TB7 is NOT intended for connection of devices that are part of the building RS-485 network.

2.1.3.1 RS-485 SHIELD GROUNDING
Proper shielding of the RS-485 cabling can help reduce the risk of communication problems and damage to equipment because of transient voltage spikes (e.g. lightning). The following guidelines should be followed at all times when grounding RS-485 cable shields:

.   Each PUP network segment should have a single point of shield ground.
.   Do not ground the RS-485 network shield using a controller terminal.
.   Never ground both ens of a shield because differences in potential between the grounds may include a current on the shield, causing network interference.
.   At ungrounded, exposed shield points (end of a segment between devices), tape back the shield to the wire jacket.

2.1.3.2 RS-485 NETWORK TERMINATION
For FHC units that are electrically the last device on the network, it may be necessary to connect a termination resistor across the N+ and N- terminals to minimize unwanted communications line effects, such as signal reflection. Only the end units on the multi-drop network should be terminated. The FHC provides the option of connecting an internal, jumper-selectable, 249 Ω termination resistor across the N+ and N- terminals. To connect the termination resistor, the TERM jumper, located to the left of TB6, should be moved to the left two pins as shown in Figure 2-6a. To disconnect the internal termination resistor, move the TERM jumper to the right two pins as shown in Figure 2-6b. If necessary, additional and termination resistance can be added by connecting a resistor between the N+ and N- pins. Network termination should also be applied at the opposite end of the network at the first device.
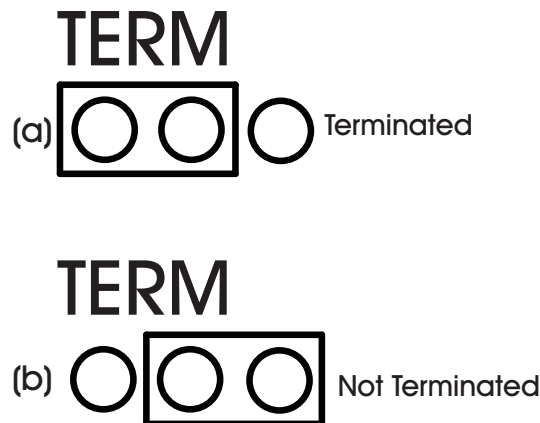
Figure 2-6: Configuring the TERM Jumper for RS-485 Communications Termination

CAUTION

Do not mis-match terminating resistors on the RS-485 network. Ensure that both resistors on a segment are rated for the same value.

Once power is supplied to the FHC and the unit is connected to the RS-485 network, the RX and TX lights, located just above terminal blocks TB6 and TB7, shown in Figure 2-7, should blink rapidly, indicating that the controller is communicating over the network.
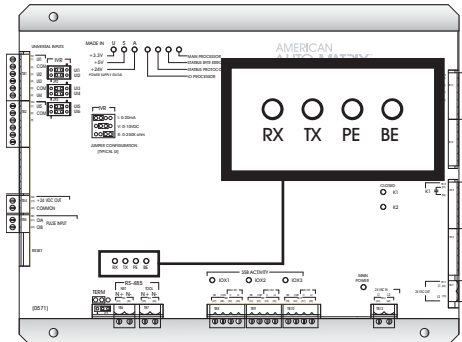
Figure 2-7: Network Status Indicator Lights

The BE light indicates that a Byte Error has occurred. This type of error occurs when information is being transferred over the network and data is lost. A Byte Error occurs if a problem is detected in the start, stop, or data bit timings. This type of error would also be generated if communication baud rates do not match. In this case, the FHC detects that the error has occurred, lights the BE light and sends a request over the network for the information to be resent.

A packet of data is a number of bytes of data that are transmitted over the network together. Each packet of data includes a checksum value used to validate the data. A Packet Error occurs when FHC detects a mismatch between the calculated checksum and the value received with the packet. Packet errors can also be caused by faulty transmission or reception of a data packet. When this happens, the PE light will be lit, indicating that such an error has occurred. A request will then be sent for the data to be retransmitted.

2.2   UNIVERSAL INPUTS

The FHC provides on-board universal inputs (UIs) for monitoring end devices in an effort to carry out control sequences. Each universal input is dedicated to a specific function for fume hood control. Dependent on the application profile that the FHC is configured for, some inputs may or may not be used. Devices are connected to the on-board universal input points on the FHC via terminal blocks TB1, and TB2. There are fewer common terminals than universal input points, so adjacent points must share common terminals. For example, UI1 and UI2, located at terminal 1 and 3 respectively, would both be connected using the common ground on terminal 2.
I

Table 2-1 Universal Input Function Assignments

UI Location	Function
1	Face Velocity Sensor Monitoring
2	Exhaust Flow Sensor Monitoring
3	Generic Universal Input
4	Emergency Input Monitoring
5	Sash Position Monitoring
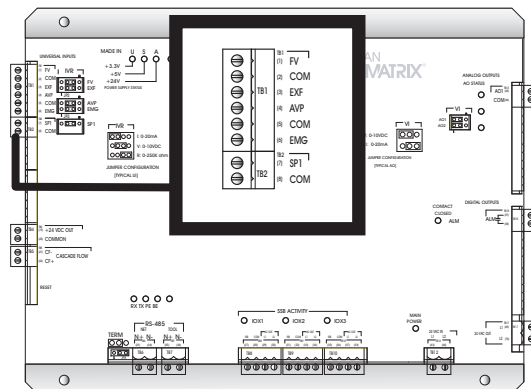
Figure 2-8: Location of the Universal Inputs on the FHC

Each universal input may operate as either a digital or analog input. Each input may be configured individually to read any of the following:

. digital (on/off)
. linear inputs (0-5 V, 0-10 V, 0-20 mA, 4-20 mA, etc.) scaled between a programmable minimum and maximum value
. non-linear inputs with response provided via two programmable piecewise curves
. thermistor (Precon type III 77° @ 10kΩ)

2.2.1   IVR JUMPERS FOR UNIVERSAL INPUTS

The IVR jumpers are located next to terminal block TB2 as shown in Figure 2-9.
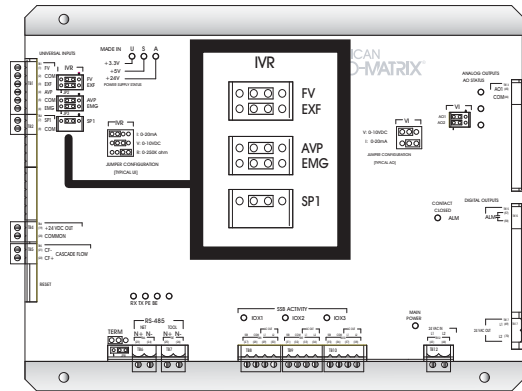
Figure 2-9: Location of the IVR Jumpers for Universal Inputs

The IVR jumpers are used to configure the FHC for the different types of signals that can be connected to the associated universal input point. By moving the jumper to different positions the associated point can be selected as either a current, voltage, or resistance input. The possible positions for the IVR jumper are show in Figure 2-10.
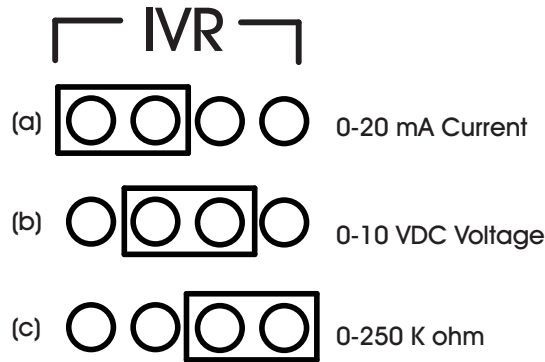
Figure 2-10: IVR Jumper Positions

Table 2-2 Jumper Positions Configuration Table

Jumper Configuration (corresponds to Figure 2-10)	Input Configuration
"I" Position - Figure 2-10 item-a	0-20mA current sensors
"V" Position - Figure 2-10 item-b	0-10V voltage sensor
"R" Position - Figure 2-10 item-c	Resistive sensor (status and thermistor sensors)

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2.2.2 LOOP POWERED UNIVERSAL INPUTS

For inputs that require power, the FHC provides a 24 VDC power connection capable of providing up to 150 mA via terminals 19 and 20 on terminal block TB4. This is enough current to power a few devices. An example of a loop powered input connected to the FHC is shown in Figure 2-11.
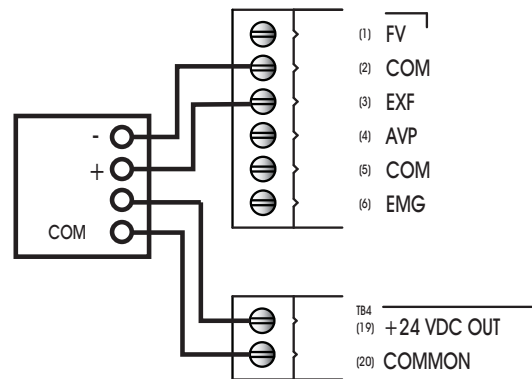
Figure 2-11: Using Loop Powered Universal Inputs

2.2.3 CURRENT INPUTS

Any sensor which generates a signal in the form of a current is classified as a current sensor. Ranges of 0-20 mA and 4-20 mA are common in sensors. The current produced by these sensors is directly proportional to the value being measured. For example, if a pressure sensor measured 0 to 5 inches of water gauge and had an output range of 0 to 20 mA, then a reading of 10 mA would correspond to a pressure of 2.5 inches of water gauge.

The first thing that needs to be done so that a universal input can be used as a current input is to make sure that the IVR jumper is in the correct position (See "IVR Jumpers for Universal Inputs", Section 2.2.1). In this case, you would make sure that the IVR jumper for the input was set to the "I" position.

Once the jumper has been set, you need to use SoloPro to configure the input object. Configuration entails specifying what type of sensor is connected to an input and then specifying the range of values over which that sensors operates.

To specify the sensor type, access the Universal Input object corresponding to the input you are configuring. Set the **ST** attribute to a value of 3, for 4-20 mA inputs, or 8, for 0-20 mA inputs.

You also need to specify the range over which the sensor operates. This is necessary so that the FHC can calculate the measured value from the input signal. The **MN** attribute should be set to the lowest value that your sensor can measure. The **MX** attribute should be set to the maximum scaled value for your input.

2.2.4 VOLTAGE INPUTS

Any sensor which puts out a voltage in response to a measured value is classified as a voltage sensor. Voltage sensors behave in very much the same way as current sensors. The primary differences have to do with the internal circuitry of the FHC and how the signal is read.

The first thing that needs to be done so that a universal input can be used as a voltage input is to make sure that the IVR jumper is in the correct position. In this case, you would make sure that the IVR jumper for the input was set to the "V" position.

Once the jumper has been set, you need to use *NB*-Pro to configure the input object. Configuration entails specifying what type of sensor is connected to an input and then specifying the range of values over which that sensors operates.

To specify the sensor type, access the Universal Input object corresponding to the input you are configuring. Set the **ST** attribute to a value of 2, for 0-5 V inputs, or 6, for 0-10 V inputs.

You also need to specify the range over which the sensor operates. This is necessary so that the FHC can calculate the measured value from the input signal. The **MN** property should be set to the lowest value that your sensor can measure. This would correspond to the reading at zero volts. The **MX** property should be set to the maximum scaled value for your input. For example, if a 0-10 V carbon dioxide sensor measuring from 0-5000 PM would have **MN** would be set to 0 and **MX** would be set to 5000.

2.2.5 THERMISTOR INPUTS

The thermistor is one of the most common types of resistive sensors for temperature measurement. The thermistor's combination of high accuracy over a wide range coupled with its low cost makes it one of the most popular temperature sensors used. Because of the thermistor's popularity, the FHC has a pre-programmed response curve for a **Precon Type III**.

The first thing that needs to be done to configure a universal input to be used as a thermistor input is to make sure that the IVR jumper is in the correct position. In this example, you would make sure that the IVR jumper to the "R" position.

Once the jumper has been set, you need to use *NB*-Pro to configure the input object. Configuration entails specifying what type of sensor is connected to an input and then specifying the range of values over which that sensors operates. Access the Universal Input object and set the **ST** property equal to a value of 7, which corresponds to Thermistor. The FHC will then automatically set the **MN** to -30.0 and the **MX** to 230.0, the minimum and maximum values that can be read by this type of sensor. The temperature will now be displayed in the **CV** property of this object.

2.2.6 NON-LINEAR INPUTS

The thermistors discussed previously are just one example of a sensor who's output characteristics are well defined. Because Precon type III thermistors are so prevalent, the output response curve is included with the controller. However, there are a number of other common sensors who's response is non-linear. For these types of inputs, the FHC provides the option of using one of the two Piecewise Curve objects to specify the response of the input device.

The Piecewise Curves can be used with current, voltage, or resistive inputs. Before configuring the Piecewise Curve, make sure that the IVR jumper is in the correct position for the type of sensor being used.

To use an input with a non-linear response, you must define the Piecewise Curve and then set the input to use the curve you have defined to scale its readings. The response data necessary to construct the curve will usually be available in the catalog from which the sensor was ordered or on the data sheet accompanying the sensor.

To set the input to use the Piecewise Curve, set the **ST** property for the input equal to 4 or 5. This tells the FHC to use Piecewise Curve 1 or 2 respectively. The next step is to set the minimum and maximum scaled values using the **MN** and **MX** properties. The **MN**, should be set to the lowest scaled value from your piecewise curve. For most application this will correspond to the value of **Y1** in the Piecewise Curve

object. Similarly, **MX** should be set to the maximum scaled value for the input. This will most likely be the value of **YB** in the Piecewise Curve object.

2.3   ANALOG OUTPUTS

2.3.1   CONNECTING ANALOG OUTPUTS

The FHC has two (2) Analog Output. Analog Output 1 is used to control the Auto-Flow AF-ACT Exhaust Damper actuator. Analog Output 2 is used exclusively for Cascade Flow network applications, explained later in this section.

NOTE

Analog Output 2 is designed exclusively for Cascade Flow netwrk applications and cannot be used to control equipment or end-devices associated with laboratory and fume hood control.

Outputs are connected to the on-board analog output points on the FHC via terminal blocks TB13. Each output also has a common terminal associated with it. The common terminal provides a ground connection for the output.

Before the output is physically connected, the VI jumper should be set to determine how the output is to function. Output devices are connected to an analog output point by connecting the positive wire to an odd numbered terminal and the negative to the associated even numbered common terminal, labeled COM, directly below it. By default, these jumpers are factory pre-set for each output usage designation.

2.3.2   VI JUMPER FOR ANALOG OUTPUTS

Analog Outputs may be configured via a jumper to operate either as a 0-10 V voltage output or a 0-20 mA current output. Each analog output has a VI jumper associated with it which is used to select the output as either a voltage or current output.
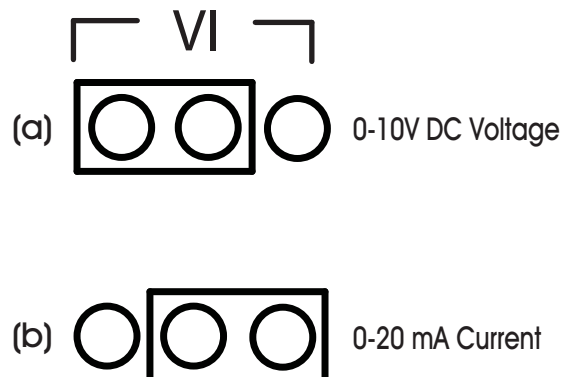
Figure 2-12: VI Jumpers for Analog Outputs

This jumper selects whether the output will operate as a 0-10 V voltage output or as a 0-20 mA current output. For a voltage output, you would move the jumper to the left, to the "V" position. For a current output, you would move the jumper to the Right, to the "I" position. For example, if you want to configure AO5 to operate as a current output, you would move the corresponding VI jumper to the right-most position. This is shown in Figure 2-12.

Each analog output point has an AO Status light associated with it. This light indicates when the output is powered and the approximate output level. It will light green if the associated output is between 0% and

33% of full scale, orange between 34% and 66% of full scale, and red between 67% and 100% of full scale.

2.3.3   WIRING THE AUTO-FLOW (AF-ACT) ACTUATOR

The AF-ACT Actuator is a high-speed response actuator designed exclusively for Auto-Flow fume hood control applications. The actuator connects to Analog Output 1, used by the FHC to perform PID Control of the Exhaust Damper of a fume hood. Power for the actuator can be found by using the courtesy 24VAC output located on the bottom right side of the FHC unitary controller.
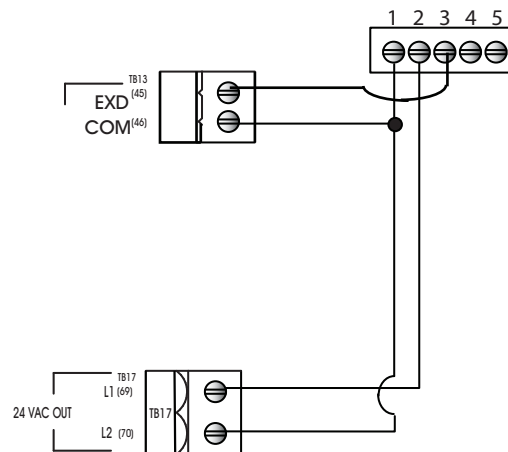
Figure 2-13 AF-ACT Example Wiring Diagram

Power for the AF-ACT actuator can be suppled using an external power transformer, separate from that which is supplying main power to the FHC controller.

NOTE

Careful consideration should be taken if you use the courtesy 24VAC output to power the AF-ACT actuator and a binary output source for external alarm. Please check required power ratings of the binary output device you are connecting to the FHC if you intend to power both simultaneously. If you are unsure, please contact AAM Technical Services for additional assistance.

2.4 DIGITAL OUTPUTS

The FHC has one digital output object intended for use with an external alarm signal. The digital output is energized when an emergency condition occurs through either a received network broadcast or user intervention.

2.4.1 CONNECTING THE DIGITAL OUTPUT

Outputs are connected to the on-board digital output points on the FHC via terminal blocks TB15 and TB16. Whenever a digital output is energized, the associated red Contact Closed light will be lit. This light will stay lit until the output is turned off.

The FHC can be used to power digital outputs using the courtesy 24 VAC voltage output connection located at terminals 69 and 70 on terminal block TB17. This power output is capable of providing 24 VAC at up to 1 A. Figure 2-14 shows how this output could be used to power a digital output.
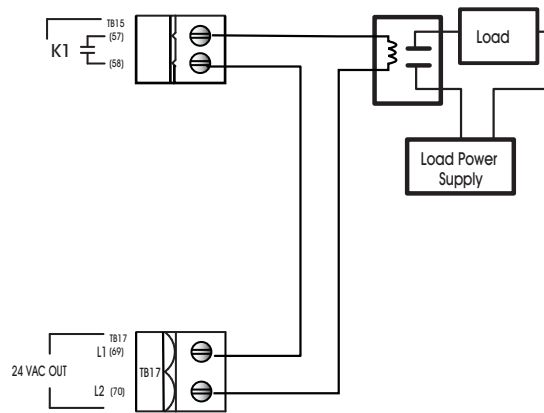
Figure 2-14: Digital Output Using the Power Output

2.4.2 OPTIONAL LIGHTING OUTPUT

The FHC's second digital output can be used as an optional lighting output utilizing an SSB-DO1 module. When present, the FHC will automatically enumerate the DO1 module and the output will then be available for control. There is a Show Lighting Output Button on Display (LB) property which will expose the feature on the display and allow the output to be commanded On/Off. Additionally, the output can be controlled automatically by the FHC through the use of the Auto Stuff property.

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2.5 CASCADE FLOW SETUP

The FHC provides terminal connections for cascade flow networking. Cascade Flow networking is a pulse-width modulated network designed to send high speed updates of reported exhaust flow readings among multiple FHC controllers. The receiving unit reads signal, adding its own exhaust flow (read from the face velocity transmitter), then transmitting onto the next successive FHC controller. The final flow can be sent to an FHC or approved laboratory fume hood controller. This specialized polarity insensitive system is independent of the standard EIA-485 communications network, and is intended to provide critical accumulated total exhaust flow information much more rapidly than typical EIA-485 network communications. If the accumulated total exhaust flow information from multiple FHC controllers is not request, then use of this function is optional.

On each FHC, the second Analog Output, designated with the termination labels of CFO and COM, is used to transmit Cascade Flow. In turn, each FHC contains an optically isolated digital Input, marked CF- and CF+, is used to receive the totalized cascade flow from other FHC networked in series. An example network displayed below provides a clear visual representation of how Cascade Flow is networked between FHC controllers.


```
CFO   to   CF-
COM   to   CF+
```
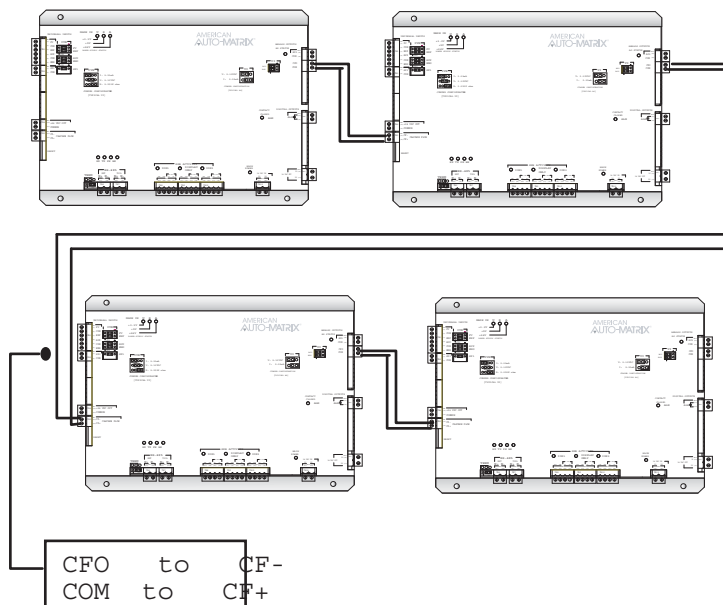
Figure 2-15 Cascade Flow Network Example

Table 1-3 Cascade Flow Setup

Step	Action	Procedure Details
1	Configure Analog Output 2 *Analog Outputs>2 (FD02)* Cascade Flow Transmitter	1. Verify that the jumper configuration for the Cascade Flow transmitter located on Analog Output 2 is configured for voltage mode (0-10VDC). 2. Configure **MN** and **MX** for the anticipated minimum and maximum totalized flow readings for your laboratory environment. The total flow value is scaled between the configured **MN** and **MX** parameters. **MN** can be as low a zero (0). **MX** can be as high as 32,767. 3. Verify **AM** = Automatic (value of 1) Analog Output 2 will always transmit total exhaust flow, and display the current reading in its **CV** attribute. The value transmitted will be the sum of flow measured on Universal Input 2 and the totalized cascade flow received on Digital Input 1.
2	Configure Digital Input 1 *Digital Inputs>1 (FD31)* Cascade Flow Receiver	1. Verify **OI** = No (value of 0). 2. Set **MD** = Cascade Flow (value of 3). Careful consideration must be taken to ensure that the first FHC electrically networked in the Cascade Flow network not have it's Digital Input configured to receive a totalized flow reading. This ensures that the SBC-FHC is not expecting to receive a cascade flow transmission from another SBC-FHC controller. The total flow value received at Digital Input 1 will be stored in **SV**.

2.6 FHC-SD TOUCH SCREEN DISPLAY

The installation of the FHC-SD involves mounting the product, supplying power, and connecting to the communications network. All wiring connections to the FHC-SD are made with the use of plug (female) & socket (male) terminal blocks (TB). The plug consists of terminal ports and adjustment screws.The socket consists of a row of pins and is permanently mounted to the printed circuit board (PCB).

When connecting/disconnecting the two parts of the terminal block, align the holes on the plug with the pins on the socket and avoid twisting, thus damaging the assembly. Such damage will void the product warranty.

	WARNING
	The sockets of the terminal block plugs are permanently attached to the PCB. Twisting or applying torque during connection revolutions may result in damage, voiding product warranty.
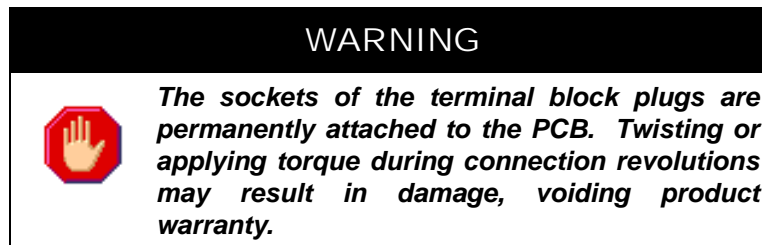
2.6.1 TOOLS REQUIRED

The following tools and supplied may be requires for installation of the FHC-SD:
.   Torx screw driver: used to disassemble T-10 Torx screws from the FHC-SD housing
.   Small flat-blade screw driver: used for EIA-485 and Power connections
.   A 2 inch hole saw: to run wires to unit through wall
.   Wire strippers: for wiring purposes
.   A meter: for verifying power connections

2.6.2 MOUNTING THE FHC-SD

The FHC-SD can be installed near the equipment it is monitoring. The installation site must provide 24VAC supply power. The temperature range for operation must be between 32 F and 104 F (0 C and 40 C). In addition, the mounting area should be free from moisture and/or leakage, and should be unobstructed by equipment or machinery. Before mounting the product, be sure to determine exactly where you wish to install the product. Figure 2-16 provides full dimension details of the unit.

The housing back-plate of the FHC-SD provides pre-drilled areas for different methods of mounting the product. Using the mounting plate, the FHC-SD can be mounted simply on a wall, on top of a US standard 2x4 junction box, or UK standard junction box. The middle of the back-plate provides clearance for the network and power jacks for the FHC-SD.

The middle of the back plate contains an open area to accommodate the EIA-485 networking port and power port for the FHC-SD. If you are going to mount the FHC-SD onto a wall surface, be sure to have the appropriate tools in order to do so (such as a 2.5 inch hole saw).
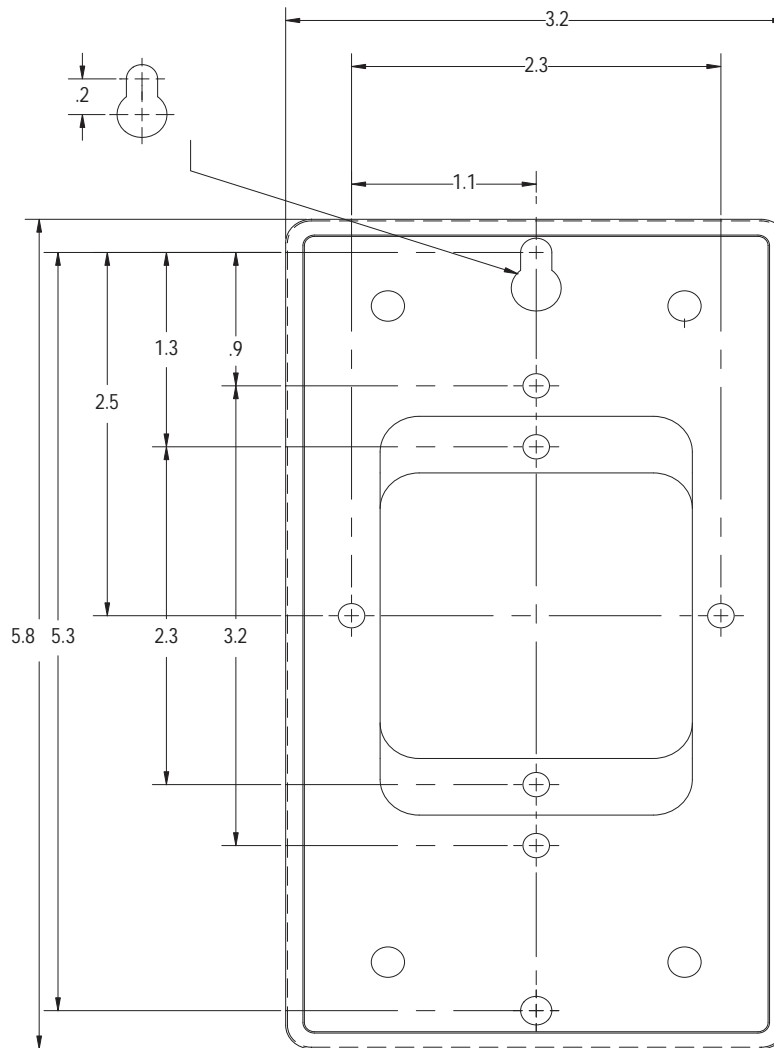
Figure 2-16 Mounting Dimensions of the FHC-SD

2.6.3 DISASSEMBLE THE **FHC-SD**

Prior to mounting, you will need to disassemble the FHC-SD. To do this, you will need a Torx screw driver that accommodates size T-10 screws. To disassemble the FHC-SD, perform the following steps:

1. Carefully loosen the four (4) T-10 Torx Drive screws located at the front of the FHC-SD and remove the cover.

WARNING

The printed circuit board and touch-screen hardware is assembed in a unconnected ("floating") manner. Use care during assembly cycles.

---

2. Remove PCB component set of the FHC-SD from housing (if still installed). Older units may require screw posts to be removed from the top of the PCB in order to achieve this. Screw posts can be loosened using an appropriate tool.
3. Retain all screws and housing components for later reassembly.

2.6.4 MOUNTING THE BACKPLATE

The backplate of the FHC-SD's housing can accommodate direct wall mounting, or mounting applications on electrical junction boxes. The backplate includes pre-formed screw holes that will align with drill holes located on the junction box. These screw holes are located near the middle of the backplate, near the cut out areas for power and network wiring.

For junction box mounting, use included screws from the junction box to mount the backplate.

For direct wall mounting, a keyhole-style screw hole is located on the outer left side of the backplate. The outer right side of the backplate contains a standard screw hole. The middle of the backplate contains an open area that accommodates network and power connections. To mount the backplate onto a wall, you may draw trace lines of the backplate prior to drilling.

2.6.5 CONNECTING THE FHC-SD TO THE SBC-FHC

Connecting the FHC-SD to the FHC requires a cable run between the two devices. The cable specification requires 4-wire, 18-20 ga., twisted pair. The connection will carry both power and communications from the FHC to the FHC-SD.
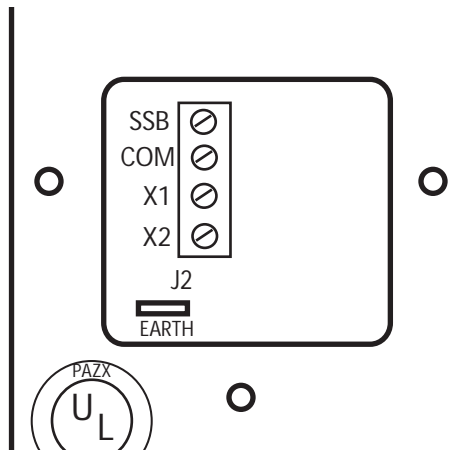
Figure 2-17 STATbus Network connection of FHC-SD

SECTION 3: CONFIGURATION

This section describes the setup for each application type that the SBC-FHC supports, as well as extended features of the SBC-FHC controller. Detailed programming notes are provided in this section for each application type.

IN THIS SECTION

3.1 CONTROL MODE OVERVIEW

There are two major control sequences in the FHC, Auto-Flow method and Sash Position Control method.

The Auto-Flow method is based off measuring the actual face velocity across the plane of a sash using a pitot tube sensor, then controlling the exhaust output damper to regulate airflow for the fume hood. The Auto-Flow method has four different variations for control:
.   Auto-Flow with PID/Fuzzy Control
.   Auto-Flow with PID/Fuzzy Control and Exhaust Flow Feedback
.   Auto-Flow with Feed Forward Control
.   Auto-Flow with Feed Forward Control and Exhaust Flow Feedback

The Sash Position Method differs from Auto-Flow, as control of the exhaust output damper is achieved through measuring the position of sash opening. This method also has three different variations for control:
.   Sash Position Open Loop
.   Sash Position with Shaft Position Feedback
.   Sash Position with Exhaust Flow Feedback
.
.

<table>
<tr><td>NOTE</td></tr>
<tr><td>When downloading a capture file to the SBC-FHC controller, ensure that the device is configured for the same control mode as the captured unit.</td></tr>
</table>

.

<table>
<tr><td>NOTE</td></tr>
<tr><td>After changing control modes, the unit must be removed from the locator list and re-added for the configuration changes to be applied.</td></tr>
</table>

3.2   CONTROL SEQUENCE CONFIGURATION

This section details the differences between the 7 different control modes in the FHC. These modes each differ slightly in their method of control as well as the objects and properties that they support. The FHC can be switched between control modes quickly and easily but many modes require different I/O hardware so care should be taken to select a mode that is supported by the hardware at hand.

3.2.1   CONTROL METHOD OVERVIEW

Various control methods are available for any given hood, based on the hardware compliment that is physically attached. Most control methods are closed loop, meaning that they actively sense the face velocity and make changes based on changes in the system. Several control methods require a calibrated venture valve and allow for open loop control if that is what is requested.

Deciding on a control method can be made easier by looking at the following chart. Once the method has been chosen and the hardware has been attached, the FHC can be set up to make use of that particular I/O compliment in a matter of minutes.

Name	Mode #	AutoFlow Sensor (FVR 1A or FVR 1B)	Sash String Pot.	Damper	Flow Switch (AVP)	Hood Presence Input (STATbus)	Exhaust Pitot Input
AutoFlow With PID/Fuzzy Control	20	Yes	No	Any	Any	No	No
AutoFlow With PID/Fuzzy Control & Exhaust Flow Feedback	21	Yes	No	Any	Any	No	Yes
AutoFlow With Feed Forward Control	22	Yes	Yes	Any	Any	No	No
AutoFlow With Feed Forward Control & Exhaust Flow Feedback.	23	Yes	Yes	Any	Any	No	Yes
Sash Position (Open Loop)	30	No	Yes	Venturi Valve	Yes	No	No
Sash Position with Shaft Pot Feedback	31	No	Yes	Venturi Valve -w- Shaft Pot Feedback	Yes	No	No
Sash Position with Exhaust Flow Feedback	32	No	Yes	Any	Any	No	Yes

3.3   CONTROL MODE 20: AUTO-FLOW WITH PID/FUZZY CONTROL

The standard Auto-Flow control methodology is designed to operate using traditional closed PID loop control, measured by the actual face velocity. The following table provides setup parameter information for configuring your unit for the Auto-Flow application profile.

Auto Flow Sensor:	Yes
String Pot (Sash):	No
Damper:	Any
Flow Switch (AVP):	Any
Hood Presence Input:	No
Exhaust Pitot Input:	No

3.3.1   SETUP HARDWARE

Attach the AutoFlow Sensor to 24Vdc (TB4-19) and attach the return line to input #1, (TB1-1). Set the IVR jumper to I for current.

Attach Actuator to EXD output and set the jumper appropriately. (Voltage most likely).

3.3.2   SETUP FIRMWARE

Default the controller into mode 20 using the settings listed above. This requires setting the "Modify Hardware Configuration" variable to "Allow Changes Below." Then once the appropriate hardware compliment has been set the variable needs to be modified once more to "Commit To Changes." This will save the information to the FHC, default its values in the new mode and cause it and the FHC-SD to reboot.

Channel Path: Setup -> Hardware Configuration

Once the Unit has been rebooted, make sure to re-discover the channels associated with the controller as a different set of channels may be specified for the new mode. This can be accomplished by closing out the SoloPro window to return to the Locator tab. Then highlight and delete the FHC in question and force SoloPro to find it once again using the "Find One Unit" button at the bottom of the page. Failure to rediscover the unit in SoloPro will result in channels being invisible to SoloPro.

Type in the appropriate occupied setpoint and unoccupied setpoint information in the Setpoint channel. Defaults are 100 and 40 meaning that when occupied the hood will target 100 feet per minute and when unoccupied it will target 40 feet per minute.

Channel Path: Setpoint

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In the Face Velocity Sensor Curve Object choose FVR-1A, FVR-1B or HWA-1 in the "(AC) Automatic Stuffing" property to fill in the curve. If a different sensor is being used its curve can be manually entered into the X & Y points.

Channel Path: Face Velocity -> Piecewise Curve 1

The Exhaust Damper is set up to use a linear output configuration. In the event that you need to limit the damper or if you choose to change its output characteristics, the scaling type can be changed from linear to "Curve 3." Once this has been set, the non-linear data can be entered into curve 3 for the damper actuator.

Channel Path: Damper Output -> EXD AND Damper Output -> Piecewise Curve 3

By default the PID loop is turned on and stuffed with some generic values. To turn the FHC on for the first time, enable the output damper by setting the damper's "Control Mode" attribute to Automatic.

Channel Path: Damper Output ->EXD

3.3.3 TUNING & CALIBRATION

Follow standard PID or Fuzzy logic tuning procedures to get the hood operating as desired.

Follow standard Face Velocity Calibration techniques to measure the face velocity and type the coefficient into AV-5, Sensor Coefficient.

The optional digital input (AVP) can be mapped in to disable/enable control or to set the occupancy for the unit. It is important to note that both of these functions can be set to receive broadcasts from other FHC's in order to share inputs. If this unit is one with a sensor attached to the AVP input terminal, the meaning of this switch can be mapped to either purpose. If you want the hood to be disabled when this switch is occupied, you can map it into the "Enable/Disable Hood Control Input" via the attribute "TI." If instead you choose to use this switch to determine occupancy, map the switch into the "Hood Presence Occupied/ Setback" via the "TI" attribute found there.

Channel Path: Occupancy -> Disable Control OR Occupancy -> Hood Presence

Face Velocity alarms can be configured following the procedures indicated in the Alarming section of this manual.

3.4 CONTROL MODE 21: AUTOFLOW WITH PID/FUZZY CONTROL & EXHAUST FLOW FEEDBACK

This mode uses active sensor measurements to determine the hood's face velocity. The exhaust damper is modulated based on the target face velocity using either a PID loop or a Fuzzy-PID algorithm. Exhaust Flow Data is also collected which can be used for alarming purposes and room pressurization purposes.

Auto Flow Sensor:	Yes
String Pot (Sash):	No
Damper:	Any
Flow Switch (AVP):	Any
Hood Presence Input:	No
Exhaust Pitot Input:	Yes

3.4.1 SETUP HARDWARE

Attach the AutoFlow sensor to 24Vdc (TB4-19) and attach the return line to the FV input, (TB1-1). Set the IVR jumper to I for current.

Attach Actuator to EXD output and set the jumper appropriately. (Voltage most likely).

Attach the exhaust flow sensor to 24Vdc (TB4-19) and attach the return line to the EXF input, (TB1-3). Set the IVR jumper to I for current.

3.4.2 SETUP FIRMWARE

Default the controller into mode 21 using the settings listed above. This requires setting the "Modify Hardware Configuration" variable to "Allow Changes Below." Then once the appropriate hardware compliment has been set the variable needs to be modified once more to "Commit To Changes." This will save the information to the FHC, default its values in the new mode and cause it and the FHC-SD to reboot.

Channel Path: Setup -> Hardware Configuration

Once the Unit has been rebooted, make sure to re-discover the channels associated with the controller as a different set of channels may be specified for the new mode. This can be accomplished by closing out the SoloPro window to return to the Locator tab. Then highlight and delete the FHC in question and force SoloPro to find it once again using the "Find One Unit" button at the bottom of the page. Failure to rediscover the unit in SoloPro will result in channels being invisible to SoloPro.

Type in the appropriate occupied setpoint and unoccupied setpoint information in the Setpoint Object. Defaults are 100 and 40 meaning that when occupied the hood will target 100 feet per minute and when unoccupied it will target 40 feet per minute.

Channel Path: Setpoint

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In the Face Velocity Sensor Curve Object choose FVR-1A, FVR-1B or HWA-1 in the "(AC) Automatic Stuffing" property to fill in the curve. If a different sensor is being used its curve can be manually entered into the X & Y points.

Channel Path: Face Velocity -> Piecewise Curve 1

The Exhaust Flow sensor curve needs to be set up for the size and type of sensor you have selected. If using a cross pitot with a differential pressure transmitter there are a number of automatic configuration options in the "(AC) Automatic Stuffing" property's drop down box. If a different sensor is being used its curve can be manually entered into the X & Y points.

Channel Path: Exhaust -> Piecewise Curve 2

The Exhaust Damper is set up to use a linear output configuration. In the event that you need to limit the damper or if you choose to change its output characteristics, the scaling type can be changed from linear to "Curve 3." Once this has been set, the non-linear data can be entered into curve 3 for the damper actuator.

Channel Path: Damper Output -> EXD AND Damper Output -> Piecewise Curve 3

By default the PID loop is turned on and stuffed with some generic values. To turn the FHC on for the first time, enable the output damper by setting the damper's "Control Mode" attribute to Automatic.

Channel Path: Damper Output -> EXD

Tuning & Calibration:

Follow standard PID or Fuzzy logic tuning procedures to get the hood operating as desired.

Follow standard Face Velocity Calibration techniques to measure the face velocity and type the coefficient into AV-5, Sensor Coefficient.

The optional digital input (AVP) is automatically mapped in when present to disable/enable control or to set the occupancy for the unit. It is important to note that both of these functions can be set to receive broadcasts from other FHC's in order to share inputs. If this unit is one with a sensor attached to the AVP input terminal, the meaning of this switch can be mapped to either purpose. If you want the hood to be disabled when this switch is occupied, you can map it into the "Enable/Disable Hood Control" input via the attribute "TI." If instead you choose to use this switch to determine occupancy, map the switch into the "Hood Presence Occupied/Setback" via the "TI" attribute found there.

Channel Path: Occupancy -> Disable Control OR Occupancy -> Hood Presence

Face Velocity alarms can be configured following the procedures indicated in the Alarming section of this manual.

3.5   CONTROL MODE 22: AUTOFLOW WITH FEED FORWARD CONTROL

This mode uses active sensor measurements to determine the hood's face velocity. The exhaust damper is modulated based on the target face velocity using a PID control loop. In addition, a potentiometer is attached to the hood's sash allowing the control algorithm to use sash area data to speed up the response of the PID loop.

Auto Flow Sensor:	Yes
String Pot (Sash):	Yes
Damper:	Any
Flow Switch (AVP):	Any
Hood Presence Input:	No
Exhaust Pitot Input:	No

3.5.1   SETUP HARDWARE:

Attach the AutoFlow Sensor to 24Vdc (TB4-19) and attach the return line to input #1, (TB1-1). Set the IVR jumper to I for current.

Attach Actuator to EXD output and set the jumper appropriately. (Voltage most likely).

Attach the sash position potentiometer between input SP1 and common, (TB1-7 & TB1-8). Set the IVR jumper to R for resistance.

3.5.2   SETUP FIRMWARE

Default the controller into mode 22 using the settings listed above. This requires setting the "Modify Hardware Configuration" variable to "Allow Changes Below." Then once the appropriate hardware compliment has been set the variable needs to be modified once more to "Commit To Changes." This will save the information to the FHC, default its values in the new mode and cause it and the FHC-SD to reboot.

Channel Path: Setup -> Hardware Configuration

Once the Unit has been rebooted, make sure to re-discover the channels associated with the controller as a different set of channels may be specified for the new mode. This can be accomplished by closing out the SoloPro window to return to the Locator tab. Then highlight and delete the FHC in question and force SoloPro to find it once again using the "Find One Unit" button at the bottom of the page. Failure to rediscover the unit in SoloPro will result in channels being invisible to SoloPro.

Type in the appropriate occupied setpoint and unoccupied setpoint information in the Setpoint Channel. Defaults are 100 and 40 meaning that when occupied the hood will target 100 feet per minute and when unoccupied it will target 40 feet per minute.

Channel Path: Control -> Setpoint

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In the Face Velocity Sensor Curve Object choose FVR-1A, FVR-1B or HWA-1 in the "(AC) Automatic Stuffing" property to fill in the curve. If a different sensor is being used its curve can be manually entered into the X & Y points.

Channel Path-> Face Velocity -> Piecewise Curve 1

The Exhaust Damper is set up to use a linear output configuration. In the event that you need to limit the damper or if you choose to change its output characteristics, the scaling type can be changed from linear to "Curve 3." Once this has been set, the non-linear data can be entered into curve 3 for the damper actuator.

Channel Path: Damper Output -> EXD AND Damper Output -> Piecewise Curve 3

Set up the Sash Geometry Object, either via the FHC-SD display or via the PUP network.

Channel Path -> Sash Geometry

By default the PID loop is turned on and stuffed with some generic values. To turn the FHC on for the first time, enable the output damper by setting the damper's "Control Mode" attribute to Automatic.

Channel Path: Damper Output -> EXD

Tuning & Calibration:
The feed forward portion of the control is disabled until a variable is written to the PID loop's "Feed-Forward Gain" property. This value is calculated using data from Sash Geometry and Exhaust Valve Output objects. Specifically, the hood needs to be at steady state at two points (likely with the sash fully closed and again with it fully open). The Feed Forward Gain is calculated using the following equation: FF = ((Percent Damper Output @ Max Open - Percent Damper Output @ Min Open) / (Sash Area in Sq Feet/ Meters @ Max Open – Sash Area in Sq Feet/Meters @ Min Open)). Once this variable has been set, the PID loop will use the feed-forward control when it is in Either PID or Fuzzy Logic mode.

Follow standard PID or Fuzzy logic tuning procedures to get the hood operating as desired.

Follow standard Face Velocity Calibration techniques to measure the face velocity and type the coefficient into AV-5, Sensor Coefficient.

The optional digital input (AVP) is automatically mapped in when present to disable/enable control or to set the occupancy for the unit. It is important to note that both of these functions can be set to receive broadcasts from other FHC's in order to share inputs. If this unit is one with a sensor attached to the AVP input terminal, the meaning of this switch can be mapped to either purpose. If you want the hood to be disabled when this switch is occupied, you can map it into the "Disable Control" channel via the attribute "TI." If instead you choose to use this switch to determine occupancy, map the switch into the "Hood Presence Detector" via the "TI" attribute found there.

Channel Path: Occupancy-> Disable Control OR Occupancy-> Hood Presence Detector

Face Velocity alarms can be configured following the procedures indicated in the Alarming section of this manual.

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3.6   CONTROL MODE 23: AUTOFLOW WITH FEED FORWARD CONTROL & EXHAUST FLOW FEEDBACK

This mode uses active sensor measurements to determine the hood's face velocity. The exhaust damper is modulated based on the target face velocity using a PID control loop. In addition, a potentiometer is attached to the hood's sash allowing the control algorithm to use sash area data to speed up the response of the PID loop. Exhaust Flow Data is also collected which can be used for alarming purposes and room pressurization purposes.

Auto Flow Sensor:	Yes
String Pot (Sash):	Yes
Damper:	Any
Flow Switch (AVP):	Any
Hood Presence Input:	No
Exhaust Pitot Input:	Yes

3.6.1   SETUP HARDWARE

Attach the AutoFlow Sensor to 24Vdc (TB4-19) and attach the return line to input #1, (TB1-1). Set the IVR jumper to I for current.

Attach Actuator to EXD output and set the jumper appropriately. (Voltage most likely).

Attach the sash position potentiometer between input SP1 and common, (TB1-7 & TB1-8). Set the IVR jumper to R for resistance.

Attach the exhaust flow sensor to 24Vdc (TB4-19) and attach the return line to the EXF input, (TB1-3). Set the IVR jumper to I for current.

3.6.2   SETUP FIRMWARE

Default the controller into mode 23 using the settings listed above. This requires setting the "Modify Hardware Configuration" variable to "Allow Changes Below." Then once the appropriate hardware compliment has been set the variable needs to be modified once more to "Commit To Changes." This will save the information to the FHC, default its values in the new mode and cause it and the FHC-SD to reboot.

Channel Path: Setup -> Hardware Configuration

Once the Unit has been rebooted, make sure to re-discover the channels associated with the controller as a different set of channels may be specified for the new mode. This can be accomplished by closing out the SoloPro window to return to the Locator tab. Then highlight and delete the FHC in question and force SoloPro to find it once again using the "Find One Unit" button at the bottom of the page. Failure to rediscover the unit in SoloPro will result in channels being invisible to SoloPro.

Type in the appropriate occupied setpoint and unoccupied setpoint information in the Setpoint Object. Defaults are 100 and 40 meaning that when occupied the hood will target 100 feet per minute and when unoccupied it will target 40 feet per minute.

Channel Path: Setpoint

In the Face Velocity Sensor Curve Object choose FVR-1A, FVR-1B or HWA-1 in the "(AC) Automatic Stuffing" property to fill in the curve. If a different sensor is being used its curve can be manually entered into the X & Y points.

Channel Path: Face Velocity-> Piecewise Curve 1

The Exhaust Flow sensor curve needs to be set up for the size and type of sensor you have selected. If using a cross pitot with a differential pressure transmitter there are a number of automatic configuration options in the "(AC) Automatic Stuffing" property's drop down box. If a different sensor is being used its curve can be manually entered into the X & Y points.

Channel Path: Exhaust -> Piecewise Curve 2

The Exhaust Damper is set up to use a linear output configuration. In the event that you need to limit the damper or if you choose to change its output characteristics, the scaling type can be changed from linear to "Curve 3." Once this has been set, the non-linear data can be entered into curve 3 for the damper actuator.

Channel Paths: Damper Output -> EXD AND damper Output -> Piecewise Curve 3

Set up the Sash Geometry Object, either via the FHC-SD display or via the PUP network.

Object Path: Sash Geometry

By default the PID loop is turned on and stuffed with some generic values. To turn the FHC on for the first time, enable the output damper by setting the damper's "Control Mode" attribute to Automatic.

Channel Path: Damper Output -> EXD

3.6.3 TUNING & CALIBRATION

The feed forward portion of the control is disabled until a variable is written to the PID loop's "Feed-Forward Gain" property. This value is calculated using data from Sash Geometry and Exhaust Valve Output objects. Specifically, the hood needs to be at steady state at two points (likely with the sash fully closed and again with it fully open). The Feed Forward Gain is calculated using the following equation: FF = ((Percent Damper Output @ Max Open - Percent Damper Output @ Min Open) / (Sash Area in Sq Feet/ Meters @ Max Open – Sash Area in Sq Feet/Meters @ Min Open)). Once this variable has been set, the PID loop will use the feed-forward control when it is in Either PID or Fuzzy Logic mode.

Follow standard PID or Fuzzy logic tuning procedures to get the hood operating as desired.

Follow standard Face Velocity Calibration techniques to measure the face velocity and type the coefficient into AV-5, Sensor Coefficient.

The optional digital input (AVP) is automatically mapped in when present to disable/enable control or to set the occupancy for the unit. It is important to note that both of these functions can be set to receive broadcasts from other FHC's in order to share inputs. If this unit is one with a sensor attached to the AVP input terminal, the meaning of this switch can be mapped to either purpose. If you want the hood to be disabled when this switch is occupied, you can map it into the "Disable Control (On/Off)" channel via the attribute "TI." If instead you choose to use this switch to determine occupancy, map the switch into the "Hood Presence (Occupied/Setback)" channel via the "TI" attribute found there.

Channel Path: Occupancy-> Disable Control OR Occupancy -> Hood Presence

Face Velocity alarms can be configured following the procedures indicated in the Alarming section of this manual.

3.7   CONTROL MODE 30: SASH POSITION (OPEN LOOP)

This mode uses sash position to calculate the open area of the hood. This information is used to determine the appropriate target exhaust flow which is then sent to the calibrated Venturi valve. The AVP input is used to ensure that the exhaust flow is great enough to support the Venturi valve's operation. When the AVP flow switch indicates low or no flow, the hood disables its control.

Auto Flow Sensor: No
String Pot (Sash):   Yes
Damper: Venturi valve
Flow Switch (AVP):   Yes
Hood Presence Input: No
Exhaust Pitot Input: No

3.7.1   SETUP HARDWARE

Attach the sash position potentiometer between input SP1 and common, (TB1-7 & TB1-8). Set the IVR jumper to R for resistance.

Attach Actuator to EXD output and set the jumper appropriately. (Voltage most likely).

Attach the flow proving switch to the AVP input (TB1-4 & TB1-5) and set the IVR jumper to R for resistance.

3.7.2   SETUP FIRMWARE

Default the controller into mode 30 using the settings listed above. This requires setting the "Modify Hardware Configuration" variable to "Allow Changes Below." Then once the appropriate hardware compliment has been set the variable needs to be modified once more to "Commit To Changes." This will save the information to the FHC, default its values in the new mode and cause it and the FHC-SD to reboot.

Object Path: Setup -> Hardware Configuration

Once the Unit has been rebooted, make sure to re-discover the channels associated with the controller as a different set of channels may be specified for the new mode. This can be accomplished by closing out the SoloPro window to return to the Locator tab. Then highlight and delete the FHC in question and force SoloPro to find it once again using the "Find One Unit" button at the bottom of the page. Failure to rediscover the unit in SoloPro will result in channels being invisible to SoloPro.

Type in the appropriate occupied setpoint and unoccupied setpoint information in the Setpoint Channel. Defaults are 100 and 40 meaning that when occupied the hood will target 100 feet per minute and when unoccupied it will target 40 feet per minute.

Channel Path: Setpoint

The Exhaust Damper is set up by default to use curve 3. For this required curve, one must put the CFM of the actuator as the engineering units and the % of actuator travel for the full scale output. In this way, a

linear damper calibrated from 500 to 1500 CFM would have 0 to 100 in the X values and 500 to 1500 spread out evenly for the Y values. Non-linear actuators can also be set up in the very same way.

Channel Path: Damper Output -> Piecewise Curve 3

Set up the Sash Geometry Object, either via the FHC-SD display or via the PUP network.

Channel Path: Sash Geometry

By default the PID loop is turned on and stuffed with some generic values. To turn the FHC on for the first time, enable the output damper by setting the damper's "Control Mode" attribute to Automatic.

Channel Path: Damper Output -> EXD

3.7.3   TUNING & CALIBRATION

Follow standard Face Velocity Calibration techniques to measure the face velocity and type the coefficient into AV-5, Sensor Coefficient.

In order for the hood to be turned off when the lab is not in use, the "disable control" input can be set up to track a broadcast from another FHC, it can be manually controlled via PUP or it can track the AVP input. The drop-down options in the property "TI" will allow each hood to select how this is controlled. Please note that in this control mode, the actual face velocity is not being measured so the AVP input must be used to signal that there is enough pressure across the valve for it to operate properly.

Channel Path: Occupancy -> Disable Control

3.8 CONTROL MODE 31: SASH POSITION WITH SHAFT POT FEEDBACK

This mode uses sash position to calculate the open area of the hood. This information is used to determine the appropriate exhaust flow which is then sent to the calibrated Venturi valve. Feedback from the valve's shaft position is used to determine the current exhaust flow. The AVP input is used to ensure that the exhaust flow is great enough to support the Venturi valve's operation. When the AVP flow switch indicates low or no flow, the hood disables its control.

Auto Flow Sensor:	No
String Pot (Sash):	Yes
Damper:	Venturi valve -w- Shaft Pot Feedback
Flow Switch (AVP):	Yes
Hood Presence Input:	No
Exhaust Pitot Input:	No

3.8.1 SETUP HARDWARE

Attach the sash position potentiometer between input SP1 and common, (TB1-7 & TB1-8). Set the IVR jumper to R for resistance.

Attach the Damper's Shaft Pot to the EXF input (TB1-2 & TB1-3) and set the IVR jumper to R for resistance.

Attach Actuator to EXD output and set the jumper appropriately. (Voltage most likely).

Attach the flow proving switch to the AVP input (TB1-4 & TB1-5) and set the IVR jumper to R for resistance.

3.8.2 SETUP FIRMWARE

Default the controller into mode 31 using the settings listed above. This requires setting the "Modify Hardware Configuration" variable to "Allow Changes Below." Then once the appropriate hardware compliment has been set the variable needs to be modified once more to "Commit To Changes." This will save the information to the FHC, default its values in the new mode and cause it and the FHC-SD to reboot.

Channel Path: Setup -> Hardware Configuration

Once the Unit has been rebooted, make sure to re-discover the channels associated with the controller as a different set of channels may be specified for the new mode. This can be accomplished by closing out the SoloPro window to return to the Locator tab. Then highlight and delete the FHC in question and force SoloPro to find it once again using the "Find One Unit" button at the bottom of the page. Failure to rediscover the unit in SoloPro will result in channels being invisible to SoloPro.

Type in the appropriate occupied setpoint and unoccupied setpoint information in the Setpoint Channel. Defaults are 100 and 40 meaning that when occupied the hood will target 100 feet per minute and when unoccupied it target 40 feet per minute.

Channel Path: Setpoint

The Exhaust Flow is determined by the feedback from the shaft potentiometer. This uses Piecewise Curve 2, "Exhaust Valve Shaft Pot Curve" to determine the exhaust flow. This curve should be set up to indicate the flow vs. resistance for the shaft pot on hand.

The "Exhaust Valve Shaft Pot Curve" needs to be filled in with data specifying the relationship between the shaft pot resistance and the associated exhaust flow. The actual data entered is the percent of full scale resistance and the corresponding exhaust flow in CFM. Calculating the "full scale resistance value is accomplished via the following equation:

$$\% \text{ Full Scale Resistance} = 25 * ((\text{Resistance } (\Omega)) / (\text{Resistance } (\Omega) + 20000))$$

As an example, if a resistance of 67,600 Ω corresponded to 465 CFM, the "Engineering Units" entry would be 465 and the "% Full Scale" value would be 19.292 which is the result of placing the value 67,600 into the equation above.

Channel Path: Exhaust -> Piecewise Curve 2

Set up the Sash Geometry Object, either via the FHC-SD display or via the PUP network.

Channel Path: Sash Geometry

By default the PID loop is turned on and stuffed with some generic values. To turn the FHC on for the first time, enable the output damper by setting the damper's "Control Mode" attribute to Automatic.

Channel Path: Damper Output -> EXD

Tuning & Calibration:

Follow standard PID or Fuzzy logic tuning procedures to get the hood operating as desired.

Follow Standard Calibration techniques to measure the face velocity and type the coefficient into AV-5, Sensor Coefficient.

In order for the hood to be turned off when the lab is not in use, the "Disable Control" input can be set up to track a broadcast from another FHC, it can be manually controlled via PUP or it can track the AVP input. The drop-down options in the attribute"TI" will allow each hood to select how this is controlled. Please note that in this control mode, the actual face velocity is not being measured so the AVP input must be used to signal that there is enough pressure across the valve for it to operate properly.

Channel Path: Occupancy -> Disable Control

3.9   CONTROL MODE 32: SASH POSITION WITH EXHAUST FLOW FEEDBACK

This mode uses sash position to calculate the open area of the hood. This information is used to determine the appropriate exhaust flow which is then sent to the exhaust damper. Feedback from the measured exhaust flow is used to close the control loop.

Auto Flow Sensor:	No
String Pot (Sash):	Yes
Damper:	Any
Flow Switch (AVP):	Any
Hood Presence Input:	No
Exhaust Pitot Input:	Yes

3.9.1   SETUP HARDWARE:

Attach the sash position potentiometer between input SP1 and common, (TB1-7 & TB1-8). Set the IVR jumper to R for resistance.

Attach the exhaust flow sensor to 24Vdc (TB4-19) and attach the return line to the EXF input, (TB1-3). Set the IVR jumper to I for current.

Attach Actuator to EXD output and set the jumper appropriately. (Voltage most likely).

3.9.2   SETUP FIRMWARE

Default the controller into mode 32 using the settings listed above. This requires setting the "Modify Hardware Configuration" variable to "Allow Changes Below." Then once the appropriate hardware compliment has been set the variable needs to be modified once more to "Commit To Changes." This will save the information to the FHC, default its values in the new mode and cause it and the FHC-SD to reboot.

Channel Path: Setup -> Hardware Configuration

Once the Unit has been rebooted, make sure to re-discover the channels associated with the controller as a different set of channels may be specified for the new mode. This can be accomplished by closing out the SoloPro window to return to the Locator tab. Then highlight and delete the FHC in question and force SoloPro to find it once again using the "Find One Unit" button at the bottom of the page. Failure to rediscover the unit in SoloPro will result in channels being invisible to SoloPro.

Type in the appropriate occupied setpoint and unoccupied setpoint information in the Setpoint Channel. Defaults are 100 and 40 meaning that when occupied the hood will target 100 feet per minute and when unoccupied it will target 40 feet per minute.

Channel Path: Setpoint

The Exhaust Flow sensor curve needs to be set up for the size and type of sensor you have selected. If using a cross pitot with a differential pressure transmitter there are a number of automatic configuration

options in the "(AC) Automatic Stuffing" property's drop down box. If a different sensor is being used its curve can be manually entered into the X & Y points.

Channel Path: Exhaust -> Piecewise Curve 2

Set up the Sash Geometry Object, either via the FHC-SD display or via the PUP network.

Channel Path: Sash Geometry

By default the PID loop is turned on and stuffed with some generic values. To turn the FHC on for the first time, enable the output damper by setting the damper's "Control Mode" attribute to Automatic.

Channel Path: Damper Output -> EXD

3.9.3 TUNING & CALIBRATION

Follow standard PID or Fuzzy logic tuning procedures to get the hood operating as desired.

Follow Standard Face Velocity Calibration techniques to measure the face velocity and type the coefficient into the Setpoint Channel's "Sensor Coefficient" attribute.

3.10   ADVANCED CONTROL CONFIGURATION

This section describes in detail many of the configuration parameters found in the FHC. This section should be used to supplement the previous section, "Application Configuration" by providing more detail on how to get the most out of the FHC.

3.10.1   DISABLE CONTROL FUNCTIONALITY

There may be a time when the Fume Hood needs to be disabled. This is generally something that would be desired when there was no flow in the exhaust ducts or the lab was otherwise turned completely off. In either case, if the hood was to be operating as normal, it would be unable to maintain the target face velocity and could then trigger alarms needlessly. In order to account for this, the "Disable Control" function comes into play.

Channel Path: Occupancy -> Disable Control

When the control is disabled in the FHC, the damper will swing closed, the target velocity will read 0 fpm and the home screen of the display will show an icon saying that the control has been disabled.   The actual position that the damper chooses when control is disabled is 0.0% by default but it can be set to any value in the attribute "DP" or Disabled Position.

It is common to either use a flow proving switch in the exhaust damper, or to have a dry or wet contact provided by the lab controller to indicate when this mode should be enabled.   The AVP input is specially set up for just this sort of binary input and it is most commonly used although broadcast channels or a STATbus device mapped into the "Hood Presence Input" could also be used.

The "Disable Control" channel is where this feature is configured. There is an attribute called "TI" for Tracking Input. This can be set to manually force the control to be enabled or disabled, or to track the AVP input, the hood presence (STATbus) input, or track the broadcast channel.

There are some cases where a logical 1 might mean disable control and others where a logical 0 might indicate a command to disable control. When using either of the physical inputs, (AVP or Hood Presence), the polarity of the input can be set in the input channel itself to account for this possibility.

Channel Path: Occupancy -> Digital Input (AVP) OR Occupancy -> Hood Presence Optional Input

3.10.2   HOOD PRESENCE (OCCUPANCY)

There may be a time when the Fume Hood is operating but not currently being used. In this event there is a method to tell the hood to drop to a lower target face velocity setpoint. This should typically be used when a hood is operating but when there is no one in front of it and there is a desire to exhaust less air. Telling the hood that it is "unoccupied" allows the FHC to accomplish just this.

Channel Path: Occupancy -> Hood Presence (Occupied / Setback)

When the hood is unoccupied the face velocity drops to a lower target setpoint. By default the setback is 40fpm meaning that if the initial face velocity setpoint is 100fpm, the new target will be 60fpm when the hood is unoccupied. Unlike "Disable Control" mode, when the hood is merely unoccupied the face velocity alarming setpoints are also adjusted downwards by the same amount as the setback but they remain active and vigilant.

The "Hood Presence" channel is where this feature is configured. There is an attribute called "TI" for Tracking Input. This can be set to manually force the hood to be occupied or unoccupied, or to track the AVP input, the hood presence (STATbus) input, or track the broadcast channel.

There are delays set in the hood presence detector that keep the FHC from bouncing in and out of occupancy. The first of these, "PD" or Hood Presence Delay, is used to specify the amount of time that the input has to specify occupancy before the mode changes. This value defaults to 5 seconds meaning that the occupancy sensor needs to be active for 5 full seconds before the FHC will become occupied.

The other delay is "PT" or Hood Presence Duration. This timer is defaulted to 5 minutes meaning that if the hood is occupied, the hood presence input needs to declare it unoccupied for 5 straight minutes before the hood sets back to unoccupied mode. This is important if the occupancy sensor is a motion sensor or a mat sensor so that the hood doesn't go unoccupied as soon as the technician steps away from the hood.

There are some cases where a logical 1 might indicate occupied and others where a logical 0 might indicate a command to disable control. When using either of the physical inputs, (AVP or Hood Presence), the polarity of the input can be set in the input channel itself to account for this possibility.

If one occupancy sensor is being used for a number of hoods, the time delays mentioned above should be set in the hood with the sensor physically attached. All other hoods receiving the occupancy broadcast from that hood should set their delays to 0 so that they follow only the delays specified in the master hood.

3.10.3 SHARING I/O POINTS BETWEEN FHC'S

There are four Broadcast channels in the FHC, each one is a transport method to share information between FHC's in a lab. The four points that can be shared are: Alarms, Occupancy, Emergency Mode and Disable Hood Control. Each FHC can be set up to either send or receive these points, or in the case of Emergency Mode they can be set up to do both.

3.10.3.1 OCCUPANCY

If, for example there are a number of hoods in a lab that need to share occupancy data, one hood can be configured to have an occupancy sensor and the remaining hoods would receive that data from the hood with the sensor attached to it.

To configure this, the first hood would need to configure its hood presence detector channel to track a local physical input. Then in the "Broadcast Occupancy" channel, the hood would be configured to send its occupancy data by setting the attribute, "BE" Enable Transmit, to a logical 1 and attribute, "RB" Enable Receive, to a logical 0. This will tell the unit to send out occupancy data based on its sensor.

Channel Path: Broadcasts -> Occupancy

Each of the other units would then need to be set to receive occupancy broadcasts in their respective "Broadcast Occupancy" channels. In each of these units the attribute, "BE" Enable Transmit, to a logical 0 and attribute, "RB" Enable Receive, to a logical 1.

Channel Path: Broadcasts -> Occupancy

Finally, in the Hood Presence Detector channel, the tracking attribute, "TI" should be set to 4, "Track Broadcast Channel." Now the second hood will follow the first hood's occupancy sensor.

NOTE
The "Hood Presence Delay" and "Hood Presence Duration" should be set to 0 in the receiving unit since the initial sending unit will have already take sensor delays into account. Failure to set receiving units' timers to 0 can result in staggered occupancy situations between hoods.

Channel Path: Occupancy -> Hood Presence

3.10.3.2 DISABLE HOOD CONTROL

If there are a number of hoods in a lab that need to be disabled/enabled based on one switch or sensor, one hood can be configured to have a physical sensor and the other remaining hoods would receive that data from that hood.

To configure this, the first hood would need to configure its "Disable Control" channel to track a local physical input. Then in the "Disable Hood Control" broadcast channel, the hood would be configured to send its data by setting the attribute, "BE" Enable Transmit, to a logical 1 and attribute, "RB" Enable Receive, to a logical 0. This will tell the unit to send out Control Enable data based on its sensor.

Channel Path: Broadcasts -> Disable Hood Control

Each of the other units would then need to be set to receive Disable Control broadcasts in their respective "Disable Hood Control" broadcast channels. In each of these units the attribute, "BE" Enable Transmit, to a logical 0 and attribute, "RB" Enable Receive, to a logical 1.

Channel Path: Broadcasts -> Disable Hood Control

3.10.3.3 EMERGENCY MODE

Emergency Mode can be entered via the physical binary input on the hood, via the touchscreen interface, or via a broadcast. If it is desired to link all of the hoods in a lab so that they all go into and out of emergency mode together, then the broadcast channel in each hood needs to be set up to enable both receiving and sending emergency mode status.

Broadcasting emergency mode allows any unit to command all of the units in the lab to open their dampers to 100% as well as send out alarms, flash warning signs & sounds on their displays and energize their optional alarm outputs.

To configure this, the first hood would need to configure its "Disable Control" channel to track a local physical input. Then in the "Disable Hood Control" broadcast channel, the hood would be configured to send its data by setting the attribute, "BE" Enable Transmit, to a logical 1 and attribute, "RB" Enable Receive, to a logical 1. This will tell the unit to share Emergency Mode data with all of the other units in the lab.

Channel Path: Broadcasts-> Emergency

As always, clearing emergency mode can only be accomplished if the initial problem has been cleared. In the case of the Emergency Input, "EMG," if the input is still indicating an emergency condition, it will not be able to be cleared. If the emergency command was from a momentary switch or from the touchscreen then emergency mode can be unlatched from any FHC in the lab (assuming they are all sharing emergency mode data).

3.10.3.4 ALARMS

When alarming is configured, the FHC can be setup to broadcast the alarms. To configure this, Broadcast Alarms needs to be set to a 1. There is also a configurable "Delay for Alarms After Going Occupied" which specifies the amount of time in minutes to wait before generating alarms. For additional alarming detail please see the next section "Alarming"

3.10.4 ALARMING

Alarms can be set up to monitor the face velocity and, depending on the control mode, the exhaust flow. Each alarmable point has two Analog Values Objects associated with it. Each of these objects is either a "Yellow Alarm" or a "Red Alarm" which can be independently set for different thresholds.

Yellow Alarms are warning alarms. They are meant to be set closer to the setpoints and are meant to indicate that the flow is beginning to stray from what is acceptable. The Red Alarms are meant to be set farther from the setpoints and are meant to signify dangerous conditions that should be taken seriously by the operator.

As a typical example, imagine that the face velocity target is 100 fpm. The Yellow alarms could be set at +-10 fpm and the red alarms could be set at +- 20 fpm. In addition the alarm delays could be set at 5 seconds for the yellow and 10 seconds for the red alarm. In this example if the face velocity moved above 110 or below 90 fpm for more than 5 seconds, the yellow alarm would engage, and the display would make an intermittent audible noise.

If the face velocity continued to diverge from the setpoint and exceeded 120 fpm or dropped below 80 fpm for more than 8 seconds, the red alarm would also engage. Once the red alarm had engaged the display would flash red, and it would emanate a continuous audible noise alerting the technicians that the fume hood was at an unsafe condition.

It is important to realize that the location of the damper, the speed of the damper actuator, the fine-tuning of the PID or fuzzy logic loop and the type and location of sensors used all have a bearing on the speed of the fume hood's response to changes in the system. It is possible to set the alarms to be configured too close to the setpoint just as it is possible to set the time delays too small. The effect of setting the alarms too tightly is quite simple, there will be unnecessary, spurious alarms causing the end users to distrust the alarm signals when they are meaningful- much like the boy who cried wolf.

By default, the "Yellow" alarms are set to send out event notifications, whereas the "Red" alarms are set to send out alarm notifications. This differentiation will help the front end determine the difference between a passing event and an actual situation requiring closer monitoring or intervention.

NOTE

Alarms are automatically temporarily disabled when the unit is in "Disable Control" mode to eliminate nuisance alarms.

3.10.4.1 FACE VELOCITY ALARMS

The Red and Yellow face velocity alarms are both disabled by default when the FHC is first commissioned.

Channel Path: Face Velocity -> Measured Value

The high and low limits need to be set for face velocity alarms. They are specified as offsets from the target face velocity. As an example, if the variable "high-limit" is set for +15 and the variable "low-limit" is set for -15, this will encapsulate the face velocity with a 30 fpm window. If the face velocity setpoint was 100 fpm, the alarm would trigger above 115 and below 85 fpm. If that same unit went unoccupied and the target face velocity dropped to 60 fpm, the alarms would automatically adjust themselves to alarm above 75 and below 45 fpm.

In order to enable alarming, the "Alarm Enable" attribute will need to be set. You can choose to set single state or dual stage alarming. When single stage alarming is selected, only the red alarms will come on. When dual stage alarming is set, both yellow and red alarms can be triggered. Once this variable has been set, alarming is considered active.

NOTE

Face Velocity Alarms are not meaningful in control modes without feedback. For this reason, they will not be available in control mode 30.

3.10.4.2 EXHAUST FLOW ALARMS

The Red and Yellow exhaust flow alarms are both disabled by default when the FHC is first commissioned.

Channel Path: Exhaust -> Exhaust Flow

The high and low limits need to be set for exhaust flow alarms. Unlike face velocity alarms, these are specified as absolute values and are not subject to change due to occupancy.   It is assumed that these will be set sufficiently far apart such that they will not be triggered simply by fully opening or fully closing the sash.

In order to enable alarming, the "Alarm Enable" attribute will need to be set. You can choose to set single state or dual stage alarming. Once this variable has been set, alarming is considered active.

3.10.4.3 ALARM ROUTING

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Like all PUP devices, alarms can either be sent out over the network as a broadcast when they occur or then can be polled for via the front end. Please note that if alarms are meant to be broadcast (and not polled) then the unit can be set up to be either a master or a slave but either way it will require the use of the token.

The Alarms channel is where this differentiation is specified. The attribute "Broadcast Alarms" is set to true by default but it can be turned off if a front end is going to actively poll the FHC for its alarm status.

Channel Path: Broadcasts -> Alarms

3.10.5 EMERGENCY MODE

Emergency mode is an alarm condition, but it is different from the Face Velocity or Exhaust Flow alarms. Emergency Mode is evoked by a human operator pressing an emergency switch. This switch can be attached to an FHC on the dedicated Emergency Input or it can be the soft switch on the home screen of the display. Regardless of the cause of going into Emergency Mode, the results will be the same- the damper will swing fully open, the audible alarm will sound and the display screen will flash red.

Once the underlying issue has been fixed and it is safe to exit Emergency Mode, the condition can be cleared either via the touchscreen display or via the network. It is important to note that if the emergency condition still exists, it will not be possible to exit emergency mode. This can occur if the emergency input is still active due to a latched or locked switch wired to the Emergency Input.

To clear the emergency via the network, the attribute, "Reset Emergency", will need to be sent a logical 1. This attribute can be found in the Display Channel.

Channel Path: Display (FHC-SD)

To clear the emergency via the display, someone needs to log in at a level 1 or above. Once logged in the cancel emergency button can be found in the following path:

Button Path: Main Menu -> Alarms -> Cancel Emergency

It is important to note that if the hoods are in a high traffic area where unwanted emergency alarms are frequently engaged (in a high school chemistry lab for example) the "Press For Emergency" button on the display can be turned off. When this is the case it is strongly recommended that there still be a hard emergency button wired into the system so that emergencies can still be declared. Turning off this button can be accomplished in the Touchscreen channel in the FHC under the attribute, "Show Press For Emergency Button On Display."

Channel Path: Display (FHC-SD)

3.11   CALIBRATING THE FACE VELOCITY READING

When the hood is commissioned, a balancer may need to verify that the measured face velocity is exactly what the display reads. The Sensor Coefficient is used to calibrate the face velocity sensor during professional air balancing of the fume hood.   Depending on the selected control mode and the sensors used, this may or may not be an important step but it is always wise to perform this calibration if possible.

It is important to reset the coefficient to a value of 1.00 prior to taking the measurements. Once the coefficient has been set to 1.00, the balancer should manually measure the face velocity while the hood is actively maintaining the target velocity. The new coefficient is equal to the measured face velocity divided by the displayed face velocity. Typing the new value into the coefficient either via the display or the network will immediately change the face velocity reading. A subsequent measurement should confirm that the displayed and measured values for the face velocity now agree.

Channel Path: Setpoint

The simplest way to calibrate the velocity is by setting the face velocity target to 100 fpm. When this is the case, the coefficient is easy to calculate because it is the measured value divided by (in this case) 100. As an example, if the manual measurement reads 96 fpm and the display reads 100fpm, the sensor coefficient should be set at 0.960.

3.12   TUNING THE CONTROL LOOP (PID OR FUZZY)

There are two different control methods used in closed loop controls on the FHC- PID and Fuzzy Logic. The PID loop is probably the best understood control algorithm in use today whereas the fuzzy logic loop is a bit less well known and understood.   This section will discuss both control methods as well as mentioning how to set up feed-forward control which can be used in conjunction with either control methodology.

Tuning the PID loops can only be successfully accomplished if you turn off smoothing on the display. This feature is set to average a set number of samples on the screen which is nice for the end user. This feature can really cause problems when you are relying on the readout on the screen to tune the loop. When it is set to a value of 1, the number of samples it is averaging together is 1, meaning that it is putting real data on the screen. This attribute can be set as high as 15 if the users are complaining about the face velocity appearing to move more than they would like.

This variable is called the "Face Velocity Averaging Index" and it can be found in the Display channel. Remember to set it to a value of 1 before tuning the loop and then return it to a suitable value when you have finished.

<div align="center">Channel Path: Display (FHC-SD)</div>

3.12.1   FEED FORWARD CONTROL

Feed-Forward control is an option if your FHC is equipped with a string pot to measure the position of the sash. Because the FHC continuously calculates the open area of the sash, the controller can react to changes in sash position very quickly by temporarily controlling the damper output whenever the sash is moved. This allows for very tight control for several reasons.

The first reason feed-forward control is so nice is that it is able to make adjustments to the damper before the change in air flow is even detected. The second reason is that the PID (or Fuzzy) loop can be tuned for relatively steady-state operation because it will not need to take into account large changes to the system that occur when the sash is thrown open or closed. In this way the Proportional gain in the control loops can be significantly smaller making for much finer tuning around the setpoint.

Feed-Forward control is enabled any time the Feed-Forward coefficient is set to a non-zero value.   This coefficient can be found in the attribute, "F1" Feed Forward Gain, in the Loop channel.

<div align="center">Channel Path: PID Control Loop</div>

Calculating this gain must be completed after the "Sash Geometry" channel has been filled out, since the calculated open area of the sash needs to be used in the calculation.   The coefficient is derived using the following equation:

$$\text{Feed-Forward Gain} = \frac{((\%\ \text{Damper Output @ Max Open}) - (\%\ \text{Damper Output @ Min Open}))}{((\text{Sash Area @ Max Open}) - (\text{Sash Area @ Min Open}))}$$

Figure 19: Calculating the Feed Forward Gain Variable

The Sash Area value can be found in the Sash Geometry channel and the percent damper output can be found in the EXD Damper Output channel. Please make sure that the loop is active and the face velocity is targeting (and maintaining) the same value during both readings.

Channel Paths: Sash Geometry AND Damper Output -> EXD

3.12.2 PID TUNING

PID, "Proportional Integral Derivative," loops are perhaps the best understood control loops currently in use. There are many methods of tuning these loops and this manual will not go into great detail specifying one approach over another. It is important to note that the three variables for the PID loop are labeled "Proportional Gain," "Integral Gain," and "Derivative Gain," and all are found in the PID loop channel.

If feed-forward gain is desired, it should be set up prior to tuning the PID loop. This is due to the fact that a far smaller Proportional gain is required in feed-forward mode since large changes to the system due to sash movement can be taken out of the equation entirely.

Channel Path: PID Control Loop

3.12.3 FUZZY LOGIC TUNING

The Fuzzy Logic routine in the FHC is slightly different from a PID loop, but it still requires three variables to be properly tuned. Even when the Fuzzy loop is not tuned it is still less likely to be unstable than an untuned PID loop, making this a great default control mode and once tuned it offers very precise control.

To turn on the Fuzzy Logic routine (and thus turn off the PID control) the following attribute, "(UF) Use Fuzzy Logic?" needs to be turned set to True. Once this has been enabled the Fuzzy routines will take control of the FHC.

Channel Path: Control -> PID Control 1

The three tuning parameters are as follows:

1. Transient Gain- Determines how hard the loop will drive the damper when the error is large.
2. Rate Sensitivity- Specifies how important the rate of change is to the calculation.
3. Steady State Gain- Specifies how hard to drive the damper near the setpoint.

The Transient Gain is the first one to set. This can vary from a value of 10 to 100. The higher the gain, the harder the actuator will drive when there is a disturbance in the face velocity. If the face velocity takes too long to react to a setpoint change or a sash change (assuming feed forward is not engaged) this number is

probably too low. If on the other hand the damper is oscillating wildly, it is probably set too high, causing the damper to drive way too hard.

The Rate Sensitivity specifies quite literally how sensitive the algorithm is to the change in air flow. If the sensitivity is set too high, the damper will be seen backing off before the setpoint is met, (again, after a change to the system, like moving the sash or changing the setpoint). If this is the case, you will see the face velocity driving towards the setpoint, then moving slightly away, then moving closer, then slightly away, all before hitting or crossing the setpoint.

If the Rate sensitivity is too low the opposite will be true, the face velocity will overshoot the target setpoint from both directions with smaller and smaller oscillations. It is easiest to set this variable by moving it higher and higher until you see that it is too large and then back off one point from there. Again, this will be evident because you will see the actuator back off prior to crossing the setpoint because it thinks that the rate of change is too high.

The Steady State Gain variable is the simplest to set. This simply dictates how large a control action to take when the system is close to the setpoint and the unit is at steady state. If you see that the face velocity is constantly hunting 4 or 5 fpm above and below the setpoint, this value is probably set too high. Likewise if the face velocity constantly hovers a few fpm above or below the setpoint, this value is too low.

3.13 PIECEWISE CURVES

The FHC can accommodate non-linear sensors and actuators by using built-in tables to define the response characteristics of the I/O point. Each table requires 11 points to define 10 linear segments. The controller will perform a linear interpolation to 'look up' values that lie between any two points on the curve.

Each of the Curve channels contains properties that define the operation and display its results. These properties are X1 through XB, and Y1 through YB. The X values are the percentage of full scale of the I/O point and the Y values are the corresponding engineering units.

When a voltage I/O point is being used via a Curve channel, the full scale is 0 to 10 VDC. Let's use an example of an exhaust flow sensor that goes from 2 to 8 volts DC. If the corresponding exhaust flow could vary from 10 cfm to 960 cfm, the end points of the curve would be set up as follows:

$$X1 = 20 \ \ (\% \text{ full scale})$$
$$Y1 = 10 \ \ (\text{CFM})$$
$$\ldots..$$
$$XB = 80 \ (\% \text{ full scale})$$
$$YB = 960 \ (\text{CFM})$$

The lowest and highest X values were chosen because the full range of the sensor was 2 to 8 volts which corresponds to 20 to 80 percent of full scale since the input can read anything from 0 to 10 volts. The Y values are simply the CFM readings that correspond to each voltage level. The variables in between would be set according to the chart, or divided ratio metrically if the sensor was mostly linear.

Current I/O points are scaled from 0 to 20 ma, and they are calculated and stored in exactly the same manner as voltage points. Resistance points differ from voltage and current in that they have an added step required to determine the X values for a PWC. To determine the percentage of full scale for a resistance input the following equation must be used:

$$\% \text{ Full Scale} \ = \ 25 \ X \ \frac{\text{Resistance } (\Omega)}{\text{Resistance } (\Omega) + 20{,}000}$$

Figure 20: Calculating Resistance as a % of Full Scale

Some of the PWC's have several built in standard curve settings to simplify their configuration. In curves that support this feature an attribute can be found at the bottom of the curve called "AC, Automatic Curve Stuffing Options."   This variable is a drop down box that offers a selection between many different curves that may be of some use in that particular application.

SECTION 4: CHANNEL & ATTRIBUTE DESCRIPTIONS

This section describes the channels and attributes in the SBC-FHC and explains how to they are used.

IN THIS SECTION

4.1 SYSTEM, FF00

The System channel is used to control and configure a number of general controller features of the SBC-FHC. The System channel is divided into a number of sub-channels in SoloPro. These sub-channels are About, Power-Up, Network Configuration, and Setup. The System channel contains the following attributes: **ON**, **EM**, **SN**, **CT**, **VE**, **FT**, **FC**, **SR**, **CM**, **FA**, **OS**, **PD**, **PS**, **DE**, **RS**, **ID**, **ZN**, **CP**, **CF**, **TP**, **ER**, **U1**, **U2**, **U3**, **U4**, **TM**, **DT**, **DA**, **DS**, **RD**, **RM**, **ND**, **NM**, **ST**, **ET**, **TF**, **BA**, **BF**, **BS**, **BT**, and **CR**.

4.1.1 ABOUT

The About sub-channel contains information about the SBC-FHC. This is the place where the controller manufacturer (**CM**), controller type (**CT**), and serial number (**SN**) can be found. It is also where the firmware version (**VE**) and type (**FT**) along with the flash release code (**SR**) and the flash update count (**FC**) will be found.

Attribute **ON** is a user definable string that can be used to help identify the channel or, in the case of the System Channel, the controller itself or its location. This can be helpful if multiple controllers are on the same network. In this case, **ON** can be used to quickly identify each one.

Attribute **EM** is used to specify the engineering units to be used by the controller. Using this attribute the SBC-FHC can be set to operate using either english or metric units.

Attribute **SN** stores the controller's serial number. This number is set at the factory and cannot be changed.

Attribute **CT** attribute identifies the factory-set controller type number for the controller. **CT** for the SBC-FHC is 105.

The firmware version attribute, **VE**, identifies the firmware that is currently installed on the SBC-FHC. This number is checked when flashing updates to determine if updates are available.

The version of the kernel, **OS**, running within the controller is also displayed in the system channel.

The System channel also keeps a record of the firmware type installed in the controller. This information is stored in attribute **FT**. For the SBC-FHC, **FT** will be equal to 20.

When the firmware is updated by flashing the controller, the flash update count attribute, **FC**, is incremented. This keeps track of the total number of times the controller has been flashed. Also, when the controller is flashed, it stores the release code for the firmware in attribute **SR**. **FC** and **SR** are used primarily as diagnostic and troubleshooting tools.

Attribute **CM** identifies the factory-set manufacturer number for the controller. **CM** for American Auto-Matrix controllers is always 255.

Any faults that are detected are displayed in attribute **FA**. **FA** is the Faults Detected attribute. When a fault is detected, a check mark will appear next to the corresponding fault. If no fault is detected, no check marks will be displayed. If a fault is detected, the controller can be configured to broadcast that information to other units on the network. The faults displayed in **FA** are fire, emergency, and communication failure.

Attribute **OS**, shows the current version of the kernel.

4.1.2 POWER-UP

Attribute **PD** specifies the control and alarm power-on delay. This is the time delay (in seconds) that must elapse after the controller is reset before it begins control and alarming functions.

Attribute **PS** defines the power-up state of the SBC-FHC. This is the schedule state that the controller will operate in when it is first powered up or after power is restored following a power failure. The possible states in which the controller can start up are unoccupied, warmup, occupied, or night setback.

The default enable attribute, **DE**, is used if you wish to return the SBC-FHC to the factory default values for all attributes. Setting **DE**=197 will immediately clear all attributes and return them to their default values. Setting **DE**=197 also clears all the programs loaded into the SBC-FHC.

If you wish to reset the SBC-FHC, the reset attribute, **RS**, must be set to "Yes". When the controller is reset, the processor is reset, clearing the memory and stopping any programs that are running. **RS** then returns to a value of "No".

4.1.3 NETWORK CONFIGURATION

The **ID** attribute is the unit ID number. This is a number that uniquely identifies the controller on the network. Each controller must have a unique **ID** or communications problems will occur. The value of **ID** defaults to the last four digits of the unit's serial number.

Broadcasts sent from the SBC-FHC can be set to either broadcast globally or to a specific zone. This is specified in the appropriate Broadcast channel. If zone broadcast is enabled then the broadcasts will be sent to all of the units with the same zone number (**ZN**) as the SBC-FHC. The zone number attribute, **ZN**, is a number (from 0 to 65,535) used to group controllers so that they may be controlled together and can communicate exclusively with each other, if that is desired.

A number of the SBC-FHC's communications parameters are defined in the System channel.   The communication rate is define by attribute **CP**. The communication baud rates available in the SBC-FHC are 9600, 38.4k, 19.2k, 57.6k and 115.2k.

Along with a baud rate, a communications time-out must be specified. This is the amount of time that the controller will wait to be polled before entering a communication fault state. The communications failure time-out, given in seconds, is specified by attribute **CF**. If the communications time-out is exceeded, a communication fault will be generated and **FA** will be set to "Comm Failure".   This only needs to be set if a host or peer controller has an SPL program controlling the SBC-FHC's outputs.

Once the communication parameters have been defined, the SBC-FHC can be configured to operate on the network. First the token passing type should be set using attribute **TP**. The SBC-FHC can operate as either as an irresponsible peer or as a full administrator. As a full administrator, the controller will administer the token between itself and up to four peer units who's ID numbers are specified in attributes **U1** through **U4**. When the SBC-FHC is set to full administrator, it should also be configured to enable token error recovery using the **ER** attribute. When error recovery is enabled, the controller will detect when the token has been lost and will re-initiate communications by sending a new token onto the network.   If the SBC-FHC is configured as an irresponsible peer, then error recovery is not used and can be disabled.

4.1.4 SETUP

The System channel has registers for a number of system attributes such as the current time (**TM**), the current date (**DT**) and the current day of the week (**DA**). The current time is displayed in the **TM** attribute and takes the format HH:MM. The current dates is stored in **DT** and has the from MM/DD/YYYY. The day of the week attribute, **DA**, indicates the day of the week.

The SBC-FHC can be adjusted for daylight savings time. To configure daylight savings, you must specify when daylight savings time begins and ends. The starting day is specified in the **(RD) Daylight Saving Start Day** attribute. The options for **RD** are given in Table 4-1.

Table 4-1 : Daylight Savings Start Day

RD	Day of the Week
0	None
1	First Sunday
2	First Friday
3	Second Saturday
4	Third Sunday
5	Third Saturday
6	Last Sunday
7	Last Thursday
8	Last Friday

Once the starting day has been set, you must specify the month in which daylight savings time begins. The month is chosen using the **(RM) Daylight Saving Start Month** attribute. The option for **RM** are given in Table 4-2.

Table 4-2 : Daylight Savings Start Month

RM	Month
0	None
1	January
2	February
3	March
4	April
5	May
6	June
7	July
8	August
9	September
10	October
11	November
12	December

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The end of daylight savings time is specified in a very similar manner. The day on which daylight savings time ends is specified in the **(ND) Daylight Saving End Day** attribute. The options for **ND** are given in Table 4-3.

Table 4-3 : Daylight Savings End Day

ND	Day of the Week
0	None
1	First Sunday
2	First Friday
3	Second Saturday
4	Third Sunday
5	Third Saturday
6	Last Sunday
7	Last Thursday
8	Last Friday

The month is which daylight saving time ends is specified in the **(NM) Daylight Saving End Month** attribute. The options for **NM** are given in Table 4-4.

Table 4-4 : Daylight Savings End Month

NM	Month
0	None
1	January
2	February
3	March
4	April
5	May
6	June
7	July
8	August
9	September
10	October
11	November
12	December

The time at which daylight savings time begins is specified in the **(ST) Daylight Saving Start Time** attribute.

The time at which daylight savings time ends is specified in the **(ET) Daylight Saving End Time** attribute.

When the current date (**DT**) is after the daylight savings start time (**ST**) on the daylight saving start day (**RD**) and is before the daylight savings end time (**ET**) on the daylight saving end day (**ND**) then the **(DS) Daylight Saving Status** attribute will be set to "Yes" (**DS**=1).

The SBC-FHC has a number of broadcast capabilities that are controlled by the System channel. Some of these are triggered by faults detected by the SBC-FHC. By setting the appropriate attributes, the SBC-FHC can broadcast alarms (**BA**), change to fire mode commands (**BF**) or time synchronization signals (**BS**). The frequency with which these broadcasts are repeated can be controlled by the broadcast time interval attribute (**BT**).

If the broadcast alarms attribute is enabled (**BA**=1), then the SBC-FHC will broadcast to the network that an alarm has been generated within the controller. This broadcast can be received by other controllers and can lead to further control actions.

NOTE
If SBC-FHC is configured to broadcast alarms, then no other devices on the network should be configured to poll for alarms. You may either broadcast alarms or poll for alarms, but not both.

If a fire condition is detected, either by the SBC-FHC itself or as a result of a fire broadcast from another controller on the network, the controller will switch into a fire mode (**FA**, bit #0=1). It will stay in fire mode for an amount of time specified in attribute **TF**. The SBC-FHC can broadcast the fact that it has entered a fire mode to other units on the network. If the broadcast fire attribute is enabled (**BF**=1) then a broadcast will be sent when the SBC-FHC when a fire condition is detected (**FA**, bit #1=1).

The SBC-FHC also has the ability to synchronize the time of other units on the network. This is accomplished by enabling the broadcast time sync attribute (**BS**=1). The time between each broadcast, in minutes, is specified in **BT**.   When time synchronization is selected, the current time (**TM**) will be broadcast once every **BT** minutes when the SBC-FHC has the token.

Attribute **CR** defines how remote I/O devices on STATbus channels are configured. The possible values of **CR** are listed in Table 4-5
.

Table 4-5 : Remote I/O Configuration Options

CR	Option
0	Normal
1	FHC to Bus
2	Edit I/O GIDs
3	FHC from Bus

When remote I/O configuration is set to Normal mode (**CR**=0), editing I/O configuration attributes (**ST**, **RE**, **HL**, etc.) will update the configuration information in the remote I/O device.

When **CR**=1, The SBC-FHC writes all of the channel I/O configuration data to the STATbus devices in one atomic (unstoppable) write. The controller then reverts to Normal mode upon completion. This would be used if you wanted to configure the SBC-FHC offline. All of the assignments and configurations could be made before the SBC-FHC was installed and then **CR** could be set to 1 to write all of the configuration information to the STATbus devices which had already been installed.

If **CR**=2, the SBC-FHC will operate in GID Edit mode. In this mode, there is no reading, writing or configuration of I/O done by the controller. This mode is used to designate STATbus devices for use as inputs and outputs. None of the changes made while in edit mode are sent to the STATbus remote I/O devices until the "FHC to Bus" option is selected.

CR=3 is very similar to **CR**=1, except that the SBC-FHC reads all of the channel I/O configuration data from the STATbus devices in one atomic (unstoppable) read. The controller reverts to Normal mode upon completion. This would be used if all of the STATbus devices were already configured but the SBC-FHC did not have that information. This would occur, for example, if a SBC-FHC in the field were replaced by a different unit or if the controller had all of its attributes reset to their default values.

System, FF00

Attribute	Description
About	
ON	**Controller Name** specifies a user definable string that is used to help identify the channel or its function.
DN	**Description** specifies a user definable string that is used to help identify the channel or its function.
EM	**Engineering Units** specifies the units to be used when returning values 0=English 1=Metric
SN	**Serial Number** the factory-set serial number.
CT	**Controller Type** factory-set controller type number for the controller. **CT** for the SBC-FHC is 105.
VE	**Firmware Version** contains the version of the controller's firmware.
FT	**Firmware Type** indicates which firmware is installed on the controller. 20 indicates FHC.
FC	**Flash update count** indicates the number of times the controller has been flashed.
CM	**Manufacturer** indicates the factory-set manufacturer number for the controller. (**CM** for American Auto-Matrix controllers is always 255)
OS	**Kernel Version** indicates the version number of the kernel.
SR	**Flash Release Code** the release code of the firmware currently flashed on the controller, used primarily for technical support purposes.
FA	**Faults Detected** a bitmap indicating the current fault conditions. bit 0=Fire bit 1=Emergency bit 5=Communications failure
Power-up	
PD	**Power-Up Delay** time delay (in seconds) that must elapse after the controller is reset before it begins control and alarming functions. 5-255=# of seconds Default value is 15.

Attribute	Description
PS	**Power-up state** schedule state that the controller will operate in when it is first powered up or after power is restored following a power failure. 0=unoccupied 1=warmup 2=occupied 3=night setback
DE	**Default Enable** used to return all attributes in the controller to their default values. 0=Normal operation 197=set attributes to their default values.
RS	**Reset the Controller?** used to reset the controller. Setting **RS** to 1 resets the controller. 0=No 1=Yes
Network Configuration	
ID	**Unit Number (ID)** specifies the controller's identification number. The value of ID defaults to the last four digits of the unit's serial number.
ZN	**Zone Number** a number (from 0 to 65,535) used to group controllers so that they may be controlled together.
CP	**Communication Speed** the rate at which the controller communicates. 0=9600 6=38400 7=19200 8=115.2k 9=57.6k
CF	**Communication Failure Timeout** specifies the amount of time, in seconds, that the controller will wait to be polled before entering a communication fault state.
TP	**Token Passing Type** defines the mode for token passing. 0=Irresponsible Peer 1=Full Administrator
ER	**Token Recovery?** If Token Error Recovery is enabled and a token is lost, Full Administer will detect the condition and initiate a new token. 0=Disabled 1=Enabled
U1	**Peer Unit Number** specifies the unit number (**ID**) for the first peer unit on the network. **ID** is set to 65,535 if there is no peer.
U2	**Peer Unit Number** specifies the unit number (**ID**) for the second peer unit on the network. **ID** is set to 65,535 if there is no peer.

Attribute	Description
U3	**Peer Unit Number** specifies the unit number (**ID**) for the third peer unit on the network. **ID** is set to 65,535 if there is no peer.
U4	**Peer Unit Number** specifies the unit number (**ID**) for the fourth peer unit on the network. **ID** is set to 65,535 if there is no peer.
U5	**Peer Unit Number** specifies the unit number (**ID**) for the fourth peer unit on the network. **ID** is set to 65,535 if there is no peer.
U6	**Peer Unit Number** specifies the unit number (**ID**) for the fourth peer unit on the network. **ID** is set to 65,535 if there is no peer.
U7	**Peer Unit Number** specifies the unit number (**ID**) for the fourth peer unit on the network. **ID** is set to 65,535 if there is no peer.
U8	**Peer Unit Number** specifies the unit number (**ID**) for the fourth peer unit on the network. **ID** is set to 65,535 if there is no peer.
Setup	
TM	**Current Time** indicates the current time in the form HH:MM.
DT	**Current Date** the current date displayed as MM/DD/YYYY
DA	**Day of Week** the current day of the week 0=Monday 1=Tueday 2=Wednesday 3=Thursday 4=Friday 5=Saturday 6=Sunday
TF	**Time to Remain in Fire Mode** The time (in minutes) that the controller will remain in fire mode.
RD	**Daylight Savings Start Day** specifies the day on which daylight saving time begins 0 = None 1 = First Sunday 2 = First Friday 3 = Second Saturday 4 = Third Sunday 5 = Third Saturday 6 = Last Sunday 7 = Last Thursday 8 = Last Friday

Attribute	Description
RM	**Daylight Savings Start Month** specifies the month in which daylight savings time begins 0 = None 1 = January 2 = February 3 = March, 4 = April 5 = May 6 = June 7 = July 8 = August 9 = September 10 = October 11 = November 12 = December
ND	**Daylight Saving End Day** specifies the day on which daylight savings time ends 0 = None 1 = First Sunday 2 = First Friday 3 = Second Saturday 4 = Third Sunday 5 = Third Saturday 6 = Last Sunday 7 = Last Thursday 8 = Last Friday
NM	**Daylight Saving End Month** specifies the month in which daylight savings tim ends 0 = None 1 = January 2 = February 3 = March, 4 = April 5 = May 6 = June 7 = July 8 = August 9 = September 10 = October 11 = November 12 = December
ST	**Daylight Saving Start Time** specifies the time at which daylight savings time begins.
ET	**Daylight Saving End Time** specifies the time at which daylight saving time ends.
BA	**Broadcast Alarms?** specifies whether alarms are to be broadcast over the network 0=No 1=Yes
BF	**Broadcast Fire?** specifies whether the "change to fire mode" command should be broadcast 0=No 1=Yes

Attribute	Description
BS	**Broadcast Sync Time?** specifies whether to broadcast time synchronization information 0=No 1=Yes
BT	**Broadcast Time Interval** specifies the time (in minutes) between network broadcasts
CR	**Configure Remote I/O** specifies options for the configuration of remote I/O device located on the STATbus. 0=Normal 1=FHC to bus 2=Edit I/O GIDs 3=FHC from bus

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4.2   STATBUS 1 & 3, FF01 & FF04

The SBC-FHC is capable of using up to a total of thirteen STATbus devices connected to each of its three STATbus ports. Each of these ports has an associated STATbus channel. These channels are used to monitor the status of the STATbus network and the devices connected to it. Each STATbus channel has the following attributes: **ON**, **DN, G1**, **CD**, **CF**, **BS**, and **SM**.

Attribute **ON** stores the name of the channel. This is a user definable string that can be used to help identify the channel.

Attributes **G1** stores the global identification number of a device attached to the STATbus network. After the SBC-FHC has enumerated the connected STATbus device attached to the associated STATbus port, the device's global identification number will be assigned to an internal routing table and then displayed in **G1**. These values are read only.

Attribute **CD** is used with **CF** to help in field configuration of STATbus devices. The device you wish to configure is selected by entering its GID number into **CD**. **CF** can then be used to locate a specific STATbus device in the field by causing an LED on the device to blink (**CF**="1").

The overall status of the STATbus can be monitored using the bus status attribute **BS**. If the STATbus channel is functioning properly, is configured and is not experiencing an error, **BS** will equal 0. When **BS**=1, it indicates that the network needs to be configured. This means that a remote I/O device has been physically added and recognized by the SBC-FHC, but has not yet been assigned to a channel. If the SBC-FHC encounters an error on the STATbus, **BS** will take a value of 2.

The **(SM)** Status Map attribute is a bitmap which displays information about the current status of the STATbus. Bit 0 of **SM** is not used.

Bit 1 will be 1 if there is an unconfigured device on the network.

Bit 3 will take a value of 1 if there are duplicate configurations on the network. This could occur, for example, if two devices are assigned to the same input.

Bit 7 indicates that the power level on the STATbus is low. It is used to determine if the bus is shorted, or loaded down to the point that it will function. When a STATbus network is heavily loaded, the power drawn by the devices may be so great as to disrupt communications. This can lead to devices not enumerating correctly or dropping communications across STATbus ports.

Bit 15 indicates that a re-enumeration process has occurred.

STATbus 1, and 3, FF01, FF03

Attribute	Description
ON	**Statbus Name** specifies a user definable string that is used to help identify the channel or its function.
DN	**Description** specifies a user definable string that is used to help describe the channel or its function.
G1	**GID Device 1** indicates the global identification number of device 1.
CD	**Configure Device (GID)** used to specify a specific STATbus device that will be used with **CF**.
CF	**Configure Function** 0=Disabled 1=Blink LED
BS	**Bus Status** indicates the status of the SMARTStat Bus. 0=Ok 1=Needs configured
SM	**Status Map** bit #1=Unconfigured device on network bit #3=Duplicate configuration on network bit #7=Low power bit #15=Re-enumeration occurred

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4.3 DISPLAY, FF10

The Display Channel provides software configuration of the FHC-SD touch-screen display when connected to the *SBC*-FHC. Most general aspects of the FHC-SD can be configured from this object. This channel contains the following attributes: **ON**, **CA**, **O1**, **P1**, **O2**, **P2**, **O3**, **P3**, **O4**, **P4**, **AL**, **AS**, **HS**, **HT**, **ST**, **SN**, **CT**, **FT**, **VE**, **SR**, **CF**, and **EE**.

Attributes **ON** stores the name of the channel. These are definable strings that can be used to help identify the channel or, for example, the type of sensor connected to the input or the sensor's location

Attribute **CA** indicates the network status of a connected FHC-SD, allowing remote users to monitor whether or not an FHC-SD is online or offline.

Attributes **O1**, **O2**, **O3**, and **O4** specify the four available operator passwords used to access various menu levels of the FHC-SD. The operator passwords can be set for any 5 digit value ranging from 00000-99999. For each operator attribute, a corresponding privilege level attribute (**P1**, **P2**, **P3**, and **P4**) permitting access to specific menus of the FHC-SD, as well as limiting read/write access to alarm limits, setpoints, etc.

Attributes **AL** and **AS** define alarm silencing functionality for the FHC-SD. **AL**

Attributes **HS** and **HT** control the appearance of the Home Screen of the FHC-SD. At boot-time or by pressing the Home icon, the Home Screen displays the current Face Velocity as measured by Universal Input 1. By default, only the Face Velocity will be displayed. Through **HS**, users can select one of three pre-defined Home Screen modes which may be displayed. When **HS**=1, Face Velocity and the current control setpoint will be displayed on the Home Screen. When **HS**=2 or **HS**=3, the Face Velocity, along with descriptive text can be displayed on the home screen. The descriptive text displayed on the Home Screen can be defined by the user through the **HT** attribute.

Attribute **ST** controls the session time in which operators may remained logged into the FHC-SD touch-screen display interface. Once the time defined in **ST** elapses, the operator will be logged out. **ST** is a running timer, thus not based on idle or inactivity time.

Attributes **SN**, **CT**, **FT**, **VE**, and **SR** define factory and firmware revision information regarding the FHC-SD connected to the Display port of the SBC-FHC. **SN** indicates the serial number of the FHC-SD unit. **CT** indicates to the controller type identifier of the FHC-SD. **FT** indicates the firmware type identifier for the FHC-SD. **VE** indicates the firmware revision loaded on the FHC-SD.

Attribute **CF** contains a set of bits which defined current control events that are presently occurring at the FHC-SD. Each bit corresponds to a unique event, where bit #0 indicates if the Emergency Soft Button displayed on the FHC-SD has been pressed, bit #1 indicates if an alarm has been silenced, and bit #2 indicates if Emergency Mode has been reset through the FHC-SD.

Attribute **EE** specifies whether or not the Press for Emergency soft button is displayed on a connected FHC-SD unit. This attribute is intended for use in situations where the emergency button may be disabled during unoccupied periods or during certain custom situations. A value of 1 indicates that the soft button will be displayed.

Display, FF10

Attribute	Description
ON	**Display Name** specifies a user definable string that is used to help identify the channel or its function.
CA	**Display Status** Indicates whether the connected FHC-SD is online or offline.
O1	**Operator 1 Password** indicates a configurable operator password
P1	**Operator 1 Privileges** indicates the privilege level corresponding the Operator 1.
O2	**Operator 2 Password** indicates a configurable operator password
P2	**Operator 2 Privileges** indicates the privilege level corresponding the Operator 2.
O3	**Operator 3 Password** indicates a configurable operator password
P3	**Operator 3 Privileges** indicates the privilege level corresponding the Operator 3.
O4	**Operator 4 Password** indicates a configurable operator password
P4	**Operator 4 Privileges** indicates the privilege level corresponding the Operator 4.
AL	**Silence Time** Specifies the time in which an annunciated alarm at the FHC-SD will remain silent for when commanded to do so by a user.
AS	**Alarm Silence** Specifies whether an alarm has been silenced by a user.
HS	**Home Screen Layout** controls the home screen display method used. 0=Face Velocity Only 1=Face Velocity with Setpoint 2=Face Velocity with Small Custom Text 3=Face Velocity with Large Custom Text
HT	**Home Screen Test** defines the custom text displayed on the home screen when **HS**=2 or **HS**=3.
ST	**Session Timer** defines the time allotted for each operator session.
SN	**Small Display Serial Number** defines the serial number of the connected FHC-SD.

Attribute	Description
CT	**Small Display Controller Type** defines the controller type number for the connected FHC-SD.
FT	**Small Display Firmware Type** defines the firmware type number for the connected FHC-SD.
VE	**Small Display Firmware Version** defines the current firmware revision loaded in the connected FHC-SD.
SR	**Small Display Flash Release Code** defines the flash release code for firmware loaded in the connected FHC-SD.
CF	**Small Display Control Flags** bit #0=Emergency Soft Button Press bit #1=Alarm Silence bit #2=Reset Emergency Mode
EE	**Show "Press for Emergency" Button?** defines whether or not to display the Press For Emergency button on the connected FHC-SD. 0 = No 1 = Yes

4.4 UNIVERSAL INPUT SUMMARY, FE00

The Universal Input Summary channel is a convenient way to monitor the states and many of the options for the universal inputs on the SBC-FHC. From this channel, you can check the current values (**V1**-**V5**) as well as the channel reliabilities (**RE**) for each universal input. This channel will also display any inputs that are currently overridden (**OI**), or polarities (**IP**) switch. The Universal Input Summary channel has the following attributes: **ON**, **V1**, **V2**, **V3**, **V4**, **V5**, **RE**, **IP**, **OI**, and **AT**.

Attribute **ON** stores the name of the channel. This is a user definable string that can be used to help identify the channel or its function.

Attributes **V1** through **V5** display the current measured of inputs 1 through 5, respectively. Each value is displayed separately.

Each channel's reliability is displayed in attribute **RE**. This bitmap indicates which inputs have readings that are considered reliable. Inputs considered to be reliable inputs will have the corresponding bit in **RE**=0 while unreliable ones will have the corresponding bit in **RE**=1.

Attribute **IP** displays the input polarities. Each bit of **IP** specifies how the controller internally represents the corresponding input when it is configured as a digital input. When an input is set to normal polarity (**IP**=0), low voltage is displayed as **CV**=0 and high voltage is displayed as **CV**=1. If, however, the polarity is set to reverse polarity (**IP**=1), then low voltage will be displayed as **CV**=1 and high voltage as **CV**=0.

Similarly, attribute **OI** displays which attributes are currently overridden. If an input is overridden, the corresponding bit in **OI** will be set equal to 1. If the input is reading normally, the corresponding bit in **OI** will be set to 0.

Attribute **AT** is the alarm limit setup/setback time delay. **AT** specifies the time, in minutes (0-255), that must elapse after an input following a schedule makes a transition to occupied mode before alarm limits are no longer setup/setback. If a universal input has alarming enabled (FE0x;**AE**>0), has an alarm limit setup/setback offset specified (FE0x;**SU**>0.0), and the fume hood senses occupancy, then the input's alarm limits will remain setup/setback for **AT** minutes after the schedule indicates a changeover from unoccupied to occupied mode. If **AT**=0 minutes, the input's alarm limits will be returned to their normal occupied values as soon as the schedule indicates the change from unoccupied to occupied mode.

Universal Input Summary, FE00

Attribute	Description
ON	**Universal Inputs Summary Name** specifies a user definable string that is used to help identify the channel or its function.
DN	**Description** specifies a user definable string that is used to help describe the channel or its function.
V1	**Current Measured Input 1 Value** indicates the current measured value of input 1.
V2	**Current Measured Input 2 Value** indicates the current measured value of input 2.
V3	**Current Measured Input 3 Value** indicates the current measured value of input 3.
V4	**Current Measured Input 4 Value** indicates the current measured value of input 4.
V5	**Current Measured Input 5 Value** indicates the current measured value of input 5.
RE	**Inputs with Unreliable Channels** indicates whether the reading from the corresponding input is considered reliable. 0=Reliable 1=Unreliable **RE** is a bitmap with bit 0 corresponding to UI1, bit 1=UI2, etc. up to bit 4=UI5.
IP	**Input Polarities** specifies how the controller represents the input internally. 0=Normal polarity. Low Voltage is displayed as **CV**=0 and High Voltage is displayed as **CV**=1. 1=Reverse polarity. Low Voltage is displayed as **CV**=1 and High Voltage is displayed as **CV**=0. **IP** is a bitmap with bit 0 corresponding to UI1, bit 1=UI2, etc. up to bit 4=UI5.
OI	**Overridden Inputs** allows the current value of the corresponding input, V1 through VO, to be overridden. 0=Normal 1=Override **OI** is a bitmap with bit 0 corresponding to UI1, bit 1=UI2, etc. up to bit 4=UI5.
AT	**Alarm Limit setup/setback time delay** the time (in minutes) that must elapse after transitions from occupied to unoccupied or from unoccupied to occupied before alarm limits return to their previous (pre-setup/setback) values.

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4.5 UNIVERSAL INPUTS 1-5, FE01-FE5

The Universal Input channels specify the configuration and scaling information for each of the universal inputs on the *SBC*-FHC. The attributes in each Universal Input channel are identical. Each Universal Input channel has the following attributes: **ON**, **DN**, **CV**, **OI**, **RE**, **ST**, **DT**, **MN**, **MX**, **HL**, **LL**, **LX**, **HS**, **AS**, **AE**, **AD**, **SU**, **IF**, **IP**, **OF**, **SU**, **SW**, **SH**, **SZ**, **SP**, **RD**, **SA**, and **GI**

Attributes **ON** and **DN** stores the name and description of the channel. These are definable strings that can be used to help identify the channel or, for example, the type of sensor connected to the input or the sensor's location.

Attribute **CV** displays the current measured input value of the associated universal input. **CV** will have a datatype specified in **DT**.

Attribute **OI** allows you to override the value of the channel's input **CV**. If **OI** is set to 0, overriding is disabled, and you will read the value of the wired input. If you set **OI** to 1, you can manually change the value of the input with a user interface device. To override an input value, you must set **OI**=1 and then change **CV** to the desired override value.

Attribute **RE** displays the channel reliability. **RE** indicates whether an input is questionable. An input is considered questionable if it is outside of its range. A good example of this would be a 4-20 mA sensor. Sensor readings from 0-4 mA would be considered questionable because the sensor should normally never have a reading in that range. In this case, the controller would clamp the readings below 4 mA at 4 mA and set the corresponding reliability attribute to questionable (**RE**=1). In the case of a digital input, the reliability can still be questionable. **RE** will be set equal to 1 while the input filter delay (**IF**) elapses or in the event of a communications failure when a host is controlling the state of the output.

Attribute **ST** specifies the type of sensor connected to the input. **ST** lets you define the type of sensor as well as the type of scaling to be used when displaying the current value (**CV**) for that sensor. The available types of sensors that can be used with the *SBC*-FHC are listed in Table 4-6.

Table 4-6 : Sensor Types

ST	Sensor Type
0	Digital
2	MN.MX 0 to 5V
3	MN.MX 4 to 20mA
4	Curve 1
5	Curve 2
6	MN.MX 0 to 10V
7	Thermistor -30.0 to 230.0
8	MN.MX 0 to 20mA
11	Resistance

When the input is configured as a digital input (**ST**=0), the value of **CV** (either 0 or 1) is determined by the value of the input voltage with respect to a voltage threshold and input polarity **IP**.   An input filter delay (**IF**) is included to minimize the bouncing that may occur with digital inputs.

For linear, analog input devices that operate in the range 0-5 V (**ST**=2), 4-20 mA (**ST**=3), 0-10 V (**ST**=6), or 0-20 mA (**ST**=8) the minimum and maximum values are scaled to **MN** and **MX** respectively. For example, if you wanted a 0-10 V input to be displayed as a percentage, you would set **MN**=0 and **MX**=100. The controller would then scale the raw counts (0-16,777,215) to the range 0-100. Here zero counts would correspond to a value of **CV**=0 and 16,777,215 counts would correspond to a **CV**=100.

NOTE
By making the value of **MN** greater than **MX**, you can configure the input for reverse scaling.

The *SBC*-FHC is also capable of handling nonlinear sensor types. The most common type of non-linear sensor is a precon-type 3 thermistor. When the input is configured as a thermistor input (**ST**=7), it is assumed to be a precon-type 3 thermistor with a range of -30º to 230º F. The scaling for this type of input is performed using a built in table that is automatically referenced when this sensor type is selected.

If a different type of non-linear sensor is needed, it is possible to use one of the Piecewise Curve channels to scale the input (**ST**=4 or **ST**=5). This option works much like the thermistor input, but instead of referencing a built-in table, the table that correlates input counts to an output value is defined in the Piecewise Curve channel.

Attribute **DT** determines how certain attributes will display their values. Datatype codes determine the number of decimal places in the value, and whether it is signed (positive or negative) or unsigned. **DT** affects the display of **CV**, **MN**, **MX**, **LL, LX**, **HL, HX**, **HS** and **SU**. The default value for **DT** is 254 (unsigned 10 digit).

Attributes **MN** and **MX** define the minimum and maximum scaled values, in Engineering Units, for the associated input configured to operate as a linear analog input (**ST**=2,3,6, 8 or 11).

Attributes **LL, LX**, **HL, HX**, **HS**, **AS**, **AE** and **SU** provide the controller with alarming capability for the associated input.

Attributes **LL**, **LX**, **HL**, and **HX** are the low- and high-alarm limits.   They define the high and low limits for alarming on the analog input. The datatype for both of these attributes is determined by **DT**. If the value of the analog input (**CV**) rises above the high alarm or high extreme limit (**HL**) then a high limit or high extreme alarm will be generated. Similarly, if the value of the analog input (**CV**) falls below the low alarm limit (**LL**) or Low Extreme Limit then a low limit or low extreme alarm will be generated.

Attribute **HS** defines an alarm limit hysteresis. This value determines when the controller returns from a high- or low-alarm limit alarm condition. If the controller is currently in a high limit alarm, then the current value, **CV**, must drop below **HL** or **HX** by an amount **HS** before a limit return is generated. Similarly if the controller is in a low limit alarm, then the current value, **CV**, must rise above **LL** or **LX** by an amount **HS** before controller function returns to normal. The effects of **LL**, **HL**, and **HS** are shown in Figure 4-1. The SBC-FHC provides the option to setup or setback the alarm limits during unoccupied periods when control can be less stringent.
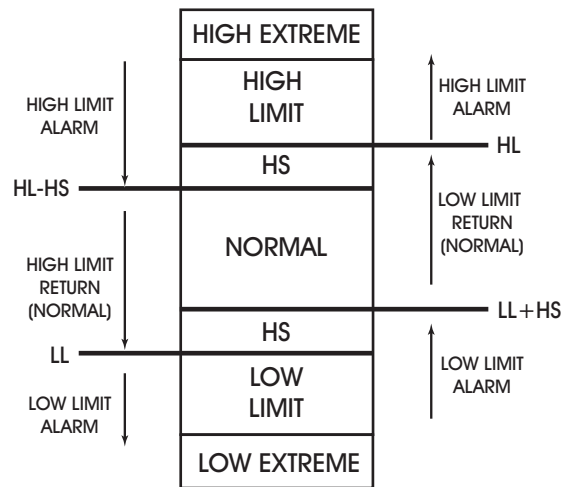
Figure 4-1: Alarm States and Thresholds for Alarming

The alarm status attribute, **AS**, displays the current alarm state for the input corresponding to each universal input channel. The possible values for **AS** are Normal, Contact 0 > 1, Contact 1 > 0, Change of State, Low Limit, High Limit, Low and High Limit, Multi Level, and Fire.

In the normal condition (**AS**=0), there are no alarms for the associated input.

AS="Contact 1 > 0" indicates that the input is in an alarm condition because **AE**=1 and a transition from 0 to 1 has been detected on the input.

Similarly, **AS**="Contact 0 > 1", indicates that the input is in an alarm condition because **AE**=2 and a transition from 1 to 0 has been detected.

If **AS**="Change of State", it indicates that a transition has occurred on the input. When **AE** is set to "Change of State", the **CV** of the input is taken as the normal state. When the state of the input changes to the opposite state, an alarm will be generated and, when the value returns to the normal state for that input, an alarm return will be generated.

AS=5 indicates that the input is in a low limit alarm state. This will occur when **CV** drops below **LL** and **AE**=4 or **AE**=7.

Similarly, when **AS**=6, a high limit alarm is indicated. This is a result of **CV** exceeding **HL** while **AE**=5 or **AE**=6.

A fire condition is indicated when **AS**=8. This will occur when the corresponding input, configured as a digital input and set for fire detection, indicates a value of 1 and **AE**=8.

If **AS**=10, it indicates a run-limit alarm. This is the case when the run hours (**RH**) exceeds the run limit (**RL**).

Finally, if **AS**=11 through **AS**=22, the input is in a supervisory alarm state. This indicates that the controller has changed the state for the digital output that this input is supervising but the input has not detected a changed state after an amount of time specified by **AD**.

Attribute **AE** is the alarm function attribute. **AE** enables the various types of alarming for the associated input. This attribute can specify one of 20 alarming types to be used. The alarming options are Disabled, Contact 0 > 1, Contact 1 > 0, Change of State, Low Limit, High Limit, Low & High Limit, Fire, and Supervise DO1 through DO12.

If **AE**="Disabled", then alarming has been disabled for the corresponding input channel and no alarms will be generated.

When **AE**="Contact 0 > 1", an input configured as a digital input will generate an alarm when its value transitions from 0 to 1. Similarly **AE**="Contact 1 > 0" will generate an alarm for a digital input that transitions from 1 to 0.

For **AE**="Change of State", the **CV** of the input when the option is set is taken as the normal state. When the **CV** of the input changes to the opposite state, an alarm will be generated. When the value returns to the normal state, an alarm return will be generated. For example, if an input is configured for change of state alarming and it has a **CV** of 0, then that state will be normal for the input. If **CV** changes to a value of 1, then a change of state alarm will be generated. When **CV** returns to 0, an alarm return would be generated. If **CV** had been 1 when **AE** was set, then the alarm would be generated on the transition to a 0 and a return would be sent when it returned to a 1.

> **WARNING**
>
> When power is cycled to the controller, the normal state for an input configured for Change of State alarming will be set to the **CV** of the input.

Low limit alarming (**AE**="Low Limit") will generate an alarm when the **CV** of the analog input drops below the low alarm limit (**LL**). Similarly, high limit alarming (**AE**="High Limit") will generate an alarm if the current value of the analog input exceeds the high alarm limit (**HL**). If **AE**="Low & High Limit", an alarm will be generated if **CV** drops below the low alarm limit (**LL**) or exceeds the high alarm limit (**HL**).

When configured for fire alarming (**AE**="Fire"), an alarm will be generated if a digital input configured for fire detection indicates a value of 1. By adjusting the input polarity (**IP**), the fire alarming can be configured to operate so that the fire alarm state (**CV**=1) will occur either when the signal is open (**IP**=0) or closed (**IP**=1). This is to accommodate different kinds of fire sensors.

For **AE**="Supervise DO1" through **AE**="Supervise DO12", the SBC-FHC will supervise DO1 through DO12 respectively. When supervising an output, the controller will wait an amount of time specified in **AD** and then compare the supervisory input state to that of the output. If they do no match, a supervisory alarm will be generated.

For all types of alarming on analog inputs, there is an alarm delay attribute (**AD**).

Attribute **AD** specifies an alarm delay which can be used when monitoring the effects of the corresponding digital outputs. A supervisory alarm is generated when a digital input fails to make a transition when the corresponding outputs makes a transition. **AD** specifies a delay time in seconds (0-6000) that must elapse

after the output changes state before the corresponding digital input is checked for supervision.

Attribute **SU** specifies the amount to setup/setback the alarm setpoints. **SU** is a value (0.0 to 25.5) which is added to **HL** and subtracted from **LL** during scheduled unoccupied periods.

Attribute **IF** specifies an input filter delay. **IF** is the debounce time (in seconds) during which a digital input must remain stable to avoid the signal being read as a digital bounce. In the case of a bounce, the channel reliability, **RE**, is set to 1. For analog inputs, **IF** specifies a weighted gain used to smooth the values from a fluctuating input.

Attribute **IP** is the input polarity bitmap for digital inputs on the SBC-FHC. Setting the bits of IP specifies how the controller represents the input internally. A value of **IP**=0 indicates normal polarity. In this case low voltage is displayed as **CV**=0 and high voltage is displayed as **CV**=1. If **IP**=1, the input is configured to operate using reverse polarity. Here, low voltage is displayed as **CV**=1 and high voltage is displayed as **CV**=0.

Attribute **OF** specifies the offset for calibrating an analog input sensor type. This attribute is commonly used for sensor types using **MN** and **MX** for scaling, as well as thermistor sensor types.

Attribute **SW** specifies the total sash width, in inches. This attribute is only applicable to Universal Input 5, which is used for Sash Position sensing.

Attribute **SH** specifies the total sash height, in includes. This attribute is only applicable to Universal Input 5, which is used for Sash Position sensing.

Attribute **SZ** specifies the point of resistance which is measured for reading the minimum sash door position. When the sash door is completely closed, the **RD** attribute will indicate the raw resistance data. With the sash door completely closed, the value of **RD** should be written to **SZ**. This attribute is only applicable to Universal Input 5, which is used for Sash Position sensing.

Attribute **SP** specifies the point of resistance which is measured for reading the maximum sash span.When the sash door is fully open, the **RD** attribute will indicate the raw resistance data. With the sash door completely open, the value of **RD** should be written to **SP**. This attribute is only applicable to Universal Input 5, which is used for Sash Position sensing.

Attribute **RD** specifies raw resistance read from the universal input, and is used for configuring the points of Sash Zero (**SZ**) and Sash Span (**SP**).

Attribute **SA** is the calculated sash area. This attribute displays the calculated sash area once the sash zero and sash span attributes have been configured and entered.

Attribute **GI** indicates the global identification number of the STATbus device associated with the universal input. **GI** is used to assign a remote I/O device to the channel when the GP is set to edit more (FF00;**CR**=2). If the inputs does not have a STATbus device mapped to it, **GI** will be zero.

Universal Inputs 1-12, FE01-FE0C

Attribute	Description
ON	**Universal Input Name** specifies a user definable string that is used to help identify the channel or its function.
DN	**Description** specifies a user definable string that is used to help describe the channel or its function.
CV	**Current Measured Input Value** displays the scaled value of the associated universal input.
OI	**Override Input?** allows the current value of the input, CV, to be overridden. 0=No 1=Yes
RE	**Data Reliability** indicates whether the reading from the input is considered reliable. 0=Reliable 1=Unreliable
ST	**Sensor Type** specifies the type of sensor connected to the input. 0=Digital 2=MN..MX 0 to 5V 3=MN..MX 4 to 20mA 4=Curve 1 5=Curve 2 6=MN..MX 0 to 10V 7=Thermistor -30.0 to 230.0 8=MN..MX 0 to 20mA 9=SMARTStat Temperature 10=SMARTStat Humidity
DT	**PUP Datatype for Input** specifies the PUP datatype for the input.
MN	**Minimum Scaled Value** specifies the minimum scaled value in engineering units.
MX	**Maximum Scaled Value** specifies the maximum scaled value in engineering units.
HX	**High Extreme Alarm Limit** if alarming is enabled and the current value, **CV**, rises above HX, then a high extreme limit alarm will be generated.
HL	**High Alarm Limit** if alarming is enabled and the current value, **CV**, rises above **HL**, then a high limit alarm will be generated.
LL	**Low Alarm Limit** if alarming is enabled and the current value, **CV**, drops below **LL**, then a low limit alarm will be generated.

Attribute	Description
LX	**Low Extreme Alarm Limit** if alarming is enabled and the current value, **CV**, drops below LL, then a low extreme limit alarm will be generated.
HS	**Alarm Limit Hysteresis** specifies a value that determines when the controller returns from a high- or low-alarm limit. The current value, **CV**, must be **HS** below **HL** or **HS** above **LL** before a limit return is generated.
AS	**Alarm Status** indicates the alarm state for the input. 0=Normal 1=Contact 0>1 2=Contact 1>0 3=Change of State 4=Low Extreme Limit 5=Low Limit 6=High Limit 7=High Extreme Limit 8=Fire
AE	**Alarm Enable** specifies the type of alarming to be used by the input. 0=Disabled 1=Contact 0>1 2=Contact 1>0 3=Change of State 4=Low Extreme Limit 5=Low Limit 6=Low & Hi Limit 7=Multi-Level Limit 8=Fire
AD	**Alarm Delay** specifies the amount of time that the input must exceed a limit before an alarm condition is generated. 0=Disable 1-6000 Seconds
SU	**Amount to Setup/Setback Alarm Limit** specifies a value (0.0 to 25.5) which is added to **HL** and subtracted from **LL** during scheduled unoccupied periods.
IF	**Input Filter Delay or Weighted Gain** the debounce time (in seconds) during which the input must remain stable to avoid the signal being read as a digital bounce. In the case of a bounce, the channel reliability, **RE**, is set to 1. For analog inputs, **IF** specifies a weighted gain used to smooth the values from a fluctuating input.
IP	**Input Polarity** specifies how the controller represents the input internally. 0=Normal Polarity. Low Voltage is displayed as **CV**=0 and High Voltage is displayed as **CV**=1. 1=Reverse Polarity. Low Voltage is displayed as **CV**=1 and High Voltage is displayed as **CV**=0.
OF	**Input Offset** specifies an offset amount to be added to the current value.

Attribute	Description
SW	**Sash Width** specifies the total sash width, in inches.
SH	**Sash Height** specifies the total sash width, in inches.
SZ	**Sash Zero** specifies the resistance data value sensed by the input when the sash door is completely closed.
SP	**Sash Span** specifies the resistance data value sensed by the input when the sash door is completely opened.
RD	**Raw Resistance Data** indicates the raw resistance sensed by the input and is used to configure **SZ** and **SP.**
SA	**Calculated Sash Area** indicates the calculated sash area after configuring **SZ** and **SP**.
GI	**GID of I/O Device** indicated the global identification number of the STATbus device associated with the analog output. Analog outputs 1-6 will have a value of **GI** set equal to the serial number of the FHC. If Digital inputs 7-12 do not have a STATbus device mapped to them, **GI** for that input will be 0.

4.6 DIGITAL INPUT SUMMARY, FE30

The Digital Input Summary channel is a convenient way to monitor the states and many of the options for the digital inputs on the *SBC*-FHC. From this channel, you can check the current values (**CV**) as well as the channel reliabilities (**RE**) for each digital input. This channel will also display any inputs that are currently overridden (**OI**). The input polarities (**IP**) as well as the interlock polarities (**LP**) for each channel will also be displayed. The Digital Input Summary channel has the following attributes: **ON**, **CV**, **OI**, **RE**, **LP**, and **IP**.

Attributes **ON** and **DN** stores the name and description of the channel. These are definable strings that can be used to help identify the channel or, for example, the type of sensor connected to the input or the sensor's location.

Attribute **CV** indicates the current value of the associated Digital input. **CV** is a bitmap with bit #0 corresponding to FE31, and bit #1=FE32.

Attribute **OI** allows you to override the value of the channel's input **CV**. **OI** is a bitmap with bit #0 corresponding to FE31, and bit #1=FE32. If **OI** is set to 0, overriding is disabled, and you will read the value of the wired input. If you set **OI** to 1, you can manually change the value of the input with a user interface device. To override an input value, you must set **OI**=1 and then change **CV** to the desired override value.

Attribute **RE** displays the channel reliability. **RE** indicates whether a an input is questionable. In the case of a digital input, the reliability will be 1 during the time when the input filter delay (**IF**) elapses. **RE** is a bitmap with bit #0 corresponding to FE31, and bit #1=FE32. A value of 0 indicates that the input is reliable while a value of 1 means that the input associated with that bit is unreliable.

Attribute **LP** displays the interlock polarities. Each bit of **LP** indicates the individual interlock polarity states for the corresponding digital input. For normal operation (**LP**=0), the corresponding input is considered to be normal when **CV**=0. When the corresponding bit is configured for reverse operation (**LP**=1), then the input will be considered normal when **CV**=1.

Attribute **IP** displays the input polarities. Each bit of **IP** specifies how the controller internally represents the corresponding digital input.   When an input is set to normal polarity (**IP**=0), low voltage is displayed as **CV**=0 and high voltage is displayed as **CV**=1. If, however, the polarity is set to reverse polarity (**IP**=1), then low voltage will be displayed as **CV**=1 and high voltage as **CV**=0.

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Digital Input Summary, FE30

Attribute	Description
ON	**Digital Inputs Summary Name** specifies a user definable string that is used to help identify the channel or its function.
CV	**Current Digital Input Value** indicates the current state of the associated digital input. bit #0=FE31 bit #1=FE32
OI	**Overridden Inputs** indicates any inputs which have been overridden. bit #0=FE31 bit #1=FE32
RE	**Inputs with Unreliable Values** indicates whether the reading from the corresponding digital input is considered reliable. 0=Reliable 1=Unreliable bit #0=FE31 bit #1=FE32
IP	**Input Polarities** specifies how the controller represents the input internally. 0=Normal polarity. Low Voltage is displayed as **present_value**=0 and High Voltage is displayed as **present_value**=1. 1=Reverse polarity. Low Voltage is displayed as **present_value**=1 and High Voltage is displayed as **present_value**=0. bit #0=FE31 bit #1=FE32
LP	**Interlock Polarities** indicates the individual interlock polarity states for each Digital Input. 0=Normal 1=Reverse bit #0=FE31 bit #1=FE32

4.7 DIGITAL INPUT, FE31-FE32

Digital inputs are special inputs that operate at a higher frequency than a Universal Input configured to read a digital signal. Digital Input 1 can be used to either as a pulse monitor input, or used as part of a cascade flow network with other fume hood controllers. Digital Input 2 is used exclusively for Hood Presence applications with an applicable STATbus end-device. The Digital Input channels may consist of the following attributes: **ON**, **CV**, **DT**, **RE**, **AS**, **AE**, **AD**, **IF**, **IP**, **RH**, **RL**, **OI**, **NP**, **MD**, **SF**, **SV**, and **GI.**

Attributes **ON** and **DN** stores the name and description of the channel. These are definable strings that can be used to help identify the channel or, for example, the type of sensor connected to the input or the sensor's location.

Attribute **CV** indicates the current value of the associated digital input.

Attribute **DT** determines how certain attributes will display their values. The default value for **DT** is 254 (unsigned 10 digit).

Attribute **RE** displays the channel reliability. **RE** indicates whether an input is questionable. In the case of a digital input, the reliability will be 1 during the time when the input filter delay (**IF**) elapses.

Attributes **AS**, **AE**, and **AD**, are used to configure the alarming options for the digital input.

The alarm status attribute, **AS**, defines the current alarm state for the corresponding input. The possible values for **AS** are Normal, Contact 0 > 1, Contact 1 > 0, Change of State, Fire, Runtime, and Supervisory.

In the normal condition, **AS**="Normal", there are no alarms for the associated input.

If **AS**="Contact 0 > 1", it indicates that the input is in an alarm condition. This will occur if **AE**="Contact 0 > 1" and a transition from 0 to 1 has been detected.

Similarly, **AS**="Contact 1 > 0", indicates that the input is in an alarm condition. This will occur if **AE**="Contact 1 > 0" and a transition from 1 to 0 has been detected.

Attribute **AE** is the alarm function attribute. **AE** enables the various types of alarming for the associated input. The alarming options are Disabled, Contact 0 > 1, Contact 1 > 0.

If **AE**="Disabled", then alarming has been disabled for the corresponding input channel.

When **AE**="Contact 0 > 1", the digital input will generate an alarm when its value transitions from 0 to 1. Similarly **AE**="Contact 1 > 0" will generate an alarm for a digital input that transitions from 1 to 0.

WARNING
When power is cycled to the controller, the normal state for an input configured for Change of State alarming will be set to the **CV** of the input.

For all types of alarming, there is an alarm delay attribute (**AD**) which specifies the amount of time, in seconds, that the input must stay in an alarm state before an alarm condition is actually generated. This delay can be any value between 1 and 6000 seconds. Setting **AD**=0 will disable the alarm delay. **AD** is used to compensate for noisy signal that may fluctuate in and out of a state that would cause an alarm to be generated.

Attribute **IF** specifies an input filter delay. **IF** is the debounce time (in seconds) during which a digital input must remain stable to avoid the signal being read as a digital bounce. In the case of a bounce, the channel reliability, **RE**, is set to 1.

Attribute **IP** displays the input polarity of the associated digital input. **IP** specifies how the controller internally represents the input.   When an input is set to normal polarity (**IP**=0), low voltage is displayed as **CV**=0 and high voltage is displayed as **CV**=1. If, however, the polarity is set to reverse polarity (**IP**=1), then low voltage will be displayed as **CV**=1 and high voltage as **CV**=0.

Attribute **RH** is used for runtime monitoring. **RH** indicates the number of hours **CV**=1 for the associated digital input.

Attribute **OI** allows you to override the value of the channel's input **CV**. If **OI** is set to 0, overriding is disabled, and you will read the value of the wired input. If you set **OI** to 1, you can manually change the value of the input with a user interface device. To override an input value, you must set **OI**=1 and then change **CV** to the desired override value.

Attributes **NP**, **MD**, **SF**, and **SV** are used when the digital input is enabled for pulse counting for Digital Input 1.

Attribute **NP** stores the raw number of pulses that have been detected by the controller. This value may be converted to a scaled pulse count (**SV**) by multiplying the value of **NP** by a pulse multiplier (**SF**).

Attribute **MD** is the pulse counter mode and defines how the *SBC*-FHC will detect a pulse. There are two ways that a pulse can be detected, by sensing the rising edge of the pulse (**MD**="Rising Edge"), by sensing the falling edge of the pulse (**MD**="Falling Edge"), or both (**MD**="Both"). The differences between the rising edge and falling edge of the pulse are shown in Figure 4-2.
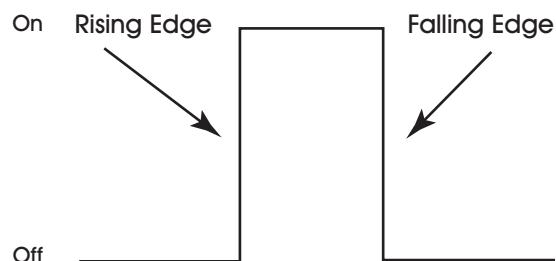

Figure 4-2: Rising and Falling Edges of a Pulse

Setting **MD**="Disabled" will disable the pulse counting features for the digital input.

Attribute **SF** specifies a scaling factor that is multiplied by **NP** to obtain a scaled count (**SV**). The final scaled pulse count, **SV,** is found using the formula **SV = NP** x **SF**. Both **SF** and **SV** are single-precision, floating point values.

Attribute **GI** is the GID of a STATbus device with a digital input associated with it. When a STATbus device is used as an digital input, the global identification number of that device will be set using in **GI**. If no STATbus device is being used, **GI** will display a value of zero.

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Digital Inputs 1-4, FE31-FE32

Attribute	Description
ON	**Digital Input Name** specifies a user definable string that is used to help identify the channel or its function.
DN	**Description** specifies a user definable string that is used to help describe the channel or its function.
CV	**Current Input Value** indicates the current state of the associated digital input.
OI	**Override Input?** allows the current value of the input, CV, to be overridden. 0=No 1=Yes
RE	**Data Reliability** indicates whether the reading from the corresponding digital input is considered reliable. 0=Reliable 1=Unreliable
DT	**PUP Datatype** determines how certain attributes will display their values. The default value for **DT** is 254 (unsigned 10 digit).
AS	**Alarm Status** indicates the alarm state for the input. 0=Normal 1=Contact 0>1 2=Contact 1>0
AE	**Alarm Enable** specifies the type of alarming to be used by the input. 0=Disabled 1=Contact 0>1 2=Contact 1>0
AD	**Alarm Delay** specifies the amount of time that the input must exceed a limit before an alarm condition is generated. 0=Disable 1-6000 seconds
IF	**Input Filter Delay** the debounce time (in seconds) during which the input must remain stable to avoid the signal being read as a digital bounce. In the case of a bounce, the channel reliability, **RE**, is set to 1.
IP	**Input Polarity** specifies how the controller represents the input internally. 0=Normal polarity. Low Voltage is displayed as **CV**=0 and High Voltage is displayed as **CV**=1. 1=Reverse polarity. Low Voltage is displayed as **CV**=1 and High Voltage is displayed as **CV**=0.

Attribute	Description
RH	**Run Hours** indicates the number of hours **CV**=1 for the input.
NP	**Number of Pulses Accumulated** displays the current number of pulses detected on the digital input.
MD	**Pulse Counter Mode** defines how the FHC detects a pulse. 0=Rising edge 1=Falling edge 2=Both 3=Receive Cascade Flow
SF	**Pulse Multiplier** specifies a scaling factor that is multiplied by **NP** to obtain a scaled count.
SV	**Scaled Pulse Count** displays a scaled version of NP using the formula **SV = NP** x **SF.** If the Digital Input is configured to receive Cascade Flow, then the total cascade flow received from the network will be displayed in this attribute.
GI	**GID of I/O Device** indicated the global identification number of the STATbus device associated with the digital input. Digital Inputs 1 will have a value of **GI** set equal to a GID for the on-board IO processor of FHC. If Digital inputs 2-8 do not have a STATbus device mapped to them, **GI** for that input will be 0.

4.8   HOOD PRESENCE, FC01

The Hood Presence Detector channel defines the application settings for user occupancy of a fume hood controlled by the *SBC*-FHC. From this channel, users can associate which input they are using to determine presence, as well as time durations of occupancy with the hood. The Occupancy Detector channel has the following attributes: **ON**, **DN**, **PT**, **PD**, **PR**, **HP**, and **TI**.

Attributes **ON** and **DN** stores the name of the channel and its description. These attributes are user definable strings that can be used to help identify the channel.

Attribute **PT** indicates the time window, in minutes, allotted for hood presence.

Attribute **PD** specifies the amount of time, in minutes, that hood presence will be verified.

Attribute **PR** indicates the amount of time, in minutes, remaining for Hood Presence.

Attribute **HP** indicates the current status of Hood Presence, as defined in attribute **TI**.

Attribute **TI** specifies the method used to determine Hood Presence. Within the controller's available applications, Hood Presence can be determined by a software trigger to enable/disable hood presence, an available universal input (UI3), an available Digital Input via STATbus (DI2), or received through one of the applicable broadcast channels (F005) from another fume hood controller or lab controller.

Hood Presence, FC01

Attribute	Description
ON	**Hood Presence Name** specifies a user definable string that is used to help identify the channel or its function.
DN	**Description** specifies a user definable string that is used to help describe the channel or its function.
PT	**Hood Presence Duration** indicates the time window, in minutes, allotted for hood presence.
PD	**Hood Presence Delay** defines the amount of time, in minutes, that hood presence will be verified.
PR	**Hood Presence Remaining** indicates the amount of time, in minutes, remaining for Hood Presence.
HP	**Hood Presence Status** indicates the current status of Hood Presence.
TI	**Enable/Disable Hood Presence Input** specifies the method used to determine hood presence (occupancy mode). 0 = Disable 1 = Enable 2 = Track DI2 3 = Track UI3 4 = Track Broadcast Channel

4.9   ANALOG OUTPUT SUMMARY, FD00

The Analog Output Summary channel is a convenient way to monitor the states and many of the options for the analog outputs on the *SBC*-FHC. From this channel, you can check the current values (**V1**-**V2**) for each output. This channel also allows you to set whether the output will be controlled automatically or manually (**AM**). The Analog Output summary channel has the following attributes: **ON**, **DN**, **V1, V2**, **RE**, and **AM**.

Attributes **ON** and **DN** stores the name of the channel and its description. These attributes are user definable strings that can be used to help identify the channel.

Attribute **V1** through **V2** display the current values for analog outputs 1 through 12 respectively.

Attribute **RE** indicates channel reliability for the analog outputs. A value of zero indicates that the output is reliable.

Attribute **AM** determines which outputs will operate in automatic mode. **AM** is a bitmap with bit 0 corresponding to FD01, and bit 1=FD02. If the corresponding bit in **AM** is set equal to 1, then the corresponding output is being controller automatically by the *SBC*-FHC. If a bit in **AM** is set equal to 0, then the corresponding output is being controlled manually, either by a host controller or an SPL program.

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Analog Output Summary, FD00

Attribute	Description
ON	**Analog Output Summary Name** specifies a user definable string that is used to help identify the channel or its function.
DN	**Description** specifies a user definable string that is used to help describe the channel or its function.
V1	**Current Value for Output 1** indicates the current value of output 1.
V2	**Current Value for Output 2** indicates the current value of output 2.
RE	**Outputs with Unreliable States** indicates whether the reading from the corresponding analog output is considered reliable. 0=Reliable 1=Unreliable bit #0=FD01 bit #1=FD02
AM	**Outputs in Automatic Mode** specifies how the analog output is controlled. 0=Manual 1=Automatic bit #0=FD01 bit #1=FD02

4.10 ANALOG OUTPUTS 1 AND 2, FD01-FD02

The Analog Output objects on the *SBC*-FHC are used to control the Exhaust Damper Position (Analog Output 1) and send Cascade Exhaust Flow (Analog Output 2) to another *SBC*-FHC controller connected in series. The user can set minimum and maximum values, both in engineering units (**MN** and **MX**) as well as scaled values **(LS** and **HS**). The user can also set up various alarming options for the analog output. Each Analog Output channel has the following attributes: **ON**, **DN**, **CV**, **RE**, **OU**, **ST**, **MN**, **MX**, **LS**, **HS**, **EP**, **UT**, and **AM**.

Attributes **ON** and **DN** stores the name of the channel and its description. These attributes are user definable strings that can be used to help identify the channel.

Attribute **CV** indicates the current value of the associated analog output. The current value of the output can be manually controlled by a user manually writing a value to **CV**, controlled by a host controller writing a value to **CV**, or controlled automatically.

Attribute **RE** indicates channel reliability for the analog outputs. A value of zero indicates that the output is reliable.

Attribute **OU** displays the actual state of each of the outputs. **OU** can differ from **CV** because it is possible for the actual output state to differ from the current value because of various delays.

Attribute **ST** indicates the scaling type mode applied to the Analog Output. A value of zero (0) indicates that scaling is achieved through use of the **MN** and **MX** attributes, whereas a value of 1 indicates scaling is accomplished through Piecewise Curve 3, channel *F703*.

Attributes **MN** and **MX** are the minimum and maximum engineering units attributes. These attributes define the range of **CV** that is displayed by the SBC-FHC. The output's value may be scaled to units that are more meaningful in the control application being used (e.g., percent, psi, voltage, current, etc.). The minimum and maximum values of the range can be set in attributes **MN** and **MX**. Reverse scaling can be accomplished by setting **MN** > **MX**. **MN** and **MX** default to 0.0 and 100.0, respectively.

Attributes **LS** and **HS** are the low and high scaled voltage attributes. These attributes specify a range of the total output signal that is then scaled across **MN** and **MX**. Reverse scaling can be accomplished by setting **LS** > **HS**. **LS** and **HS** default to 0.0% and 100.0%, respectively.

For example, if the analog output value (**CV**) is to be displayed as a percentage (0-100) of a 10 VDC output range, set **MN** to 0 and **MX** to 100 (a 0.0%-100.0% display range). Set **LS**=0.0% and **HS**=100.0% (the full range of the output signal), because **CV**=0 represents 0.0% of the output range and **CV**=100 represents 100.0% of the output range.

Attribute **EP** is the emergency position attribute. In the event of an emergency condition, the Analog Output reverts to the emergency position (**EP**) defined.

Attribute **UT** specifies an update threshold for the current value. This is a threshold value by which **CV** must change before the output is updated.

Attribute **AM** determines whether the associated output will operate in automatic or manual mode. If **AM** is set equal to 1, then the output is being controller automatically by the SBC-FHC. If **AM** is set equal to 0, then the output is being controlled manually, either by a host controller or a custom SPL program.

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Analog Outputs 1 and 2, FD01-FD02

Attribute	Description
ON	**Analog Output Name** specifies a user definable string that is used to help identify the channel or its function.
DN	**Description** specifies a user definable string that is used to help describe the channel or its function.
CV	**Current Output Value** indicates the current value of the associated analog output.
RE	**Data Reliability** indicates whether the reading from the corresponding analog output is considered reliable. 0=Reliable 1=Unreliable
OU	**Actual Output Value** indicates the actual output value of the analog output.
ST	**Scaling Type** indicates the scaling for the Analog Output during automatic control 0 = Linear 1 = Curve 3
MN	**Minimum Scaled Value** specifies the minimum value for a scaled reading of **CV**, in Engineering Units.
MX	**Maximum Scaled Value** specifies the maximum value for a scaled reading of **CV**, in Engineering Units.
LS	**Minimum Scaled Voltage** specifies the percentage of the total output for **CV=MN**.
HS	**Maximum Scaled Voltage** specifies the percentage of the total output for **CV=MX**.
EP	**Emergency Position** specifies the failure position (0-100%) for the output to be used when the controller enters emergency mode.
UT	**Update Threshold** specifies a threshold value by which **CV** must change before the output is updated.
AM	**Control Mode** specifies how the analog output is controlled. 0=Manual 1=Automatic

4.11 EMERGENCY OUTPUT, FB01

The Digital Output location on the *SBC*-FHC provides an emergency alarm output, intended to drive a horn, annunciator input, etc. This output is turned on and off accordingly when the fume hood in placed in to Emergency Mode. The Emergency Output contains the following attributes: **ON**, **DN**, **CV**, **RE**, **OU**, **NT**, **FT**, **IP**, **RH**, and **AM**.

Attributes **ON** and **DN** stores the name of the channel and its description. These attributes are user definable strings that can be used to help identify the channel.

Attribute **CV** is the *requested state* (0 or 1), rather than the *actual state* of the output (see attribute **OU**). In automatic mode (**AM**=1), **CV** is set through emergency mode control. **CV** can be also set manually or via remote host program when the output is set for manual mode (**AM**=0). The requested state and actual state may also be flipped in logic by manipulating the **IP** attribute.

Attribute **RE** indicates the channel reliability for the digital output, as monitored by the on-board IO processor of the *SBC*-FHC.

Attribute **OU** is a read only attribute that displays the *actual* digital output value. **OU** differs from **CV** in that **CV** reflects the *requested* state of the output. **OU** can differ from **CV** because when the actual output state differs from the current value because of various staging delays.

Attributes **NT** and **FT** specify a minimum ON and OFF time for the digital input. **NT** defines the minimum time, in seconds, that must elapse after the output is energized before it may be turned off. **FT** specifies the minimum time, in second, that must elapse after the output is turned off before it may be re-energized.

Attribute **RH** is used for runtime monitoring. **RH** indicates the number of hours **CV**=1 for the associated digital output.

Attribute **AM** is the automatic/manual mode selection attribute. **AM** determines whether the output value (**CV**) is set: manually or automatically. If **AM**=0 (manual mode), you must manually set **CV** by changing the value through a user interface device (e.g., a host) or a custom SPL program.

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Emergency Output, FB01

Attribute	Description
ON	**Digital Output Name** specifies a user definable string that is used to help identify the channel or its function.
DN	**Description** specifies a user definable string that is used to help describe the channel or its function.
CV	**Requested Output Value** specifies the current state of output. Because of various delays, this value may differ from **OU**. 0=Off 1=On
RE	**Data Reliability** indicates whether the reading from the corresponding digital output is considered reliable. 0=Reliable 1=Unreliable
OU	**Actual Output Value** specifies the actual state of the output. 0=Off 1=On
NT	**Minimum On Time** specifies the minimum time in seconds that must elapse after the output is energized before it may be turned off.
FT	**Minimum Off Time** specifies the minimum time in second that must elapse after the output is turned off before it may be re-energized.
IP	**I/O Polarity** specifies the logical manner in which the requested value corresponds to the actual output value.
RH	**Run Hours** indicates the number of hours **CV**=1 for the input.
AM	**Control Mode** specifies how the digital output is controlled. 0=Manual 1=Automatic

4.12   CONTROL SUMMARY, FA00

The Control Summary channel is a convenient way to monitor and modify specific control parameters of the *SBC*-FHC. From this channel, you can check the current values for each input, tune the sensor coefficient (**SC**), enable and disable emergency modes, and other items. This channel includes the following attributes: **ON**, **DN**, **FV**, **EF**, **SP**, **SB**, **SC**, **EE**, **DC**, **DP** and **CS**.

Attributes **ON** and **DN** stores the name of the channel and its description. These attributes are user definable strings that can be used to help identify the channel.

Attribute **FV** indicates a reflection of the Face Velocity input value, sensed by FE01;**CV**.

Attribute **EF** indicates a reflection of the Exhaust Flow input value, sensed by FE02;**CV**.

Attribute **SP** indicates a reflection of the PID Loop Setpoint, as stored in the FA01;**SP**.

Attribute **SB** specifies the unoccupied setback. During unoccupied modes, the PID Control setpoint will be adjusted (added or subtracted) as configured through the action setting of the PID Control loop (**SG**).

Attribute **SC** specifies the sensor coefficient. When the face velocity sensor is calibrated during balancing, the face velocity is measured with a calibrated air velocity meter, generating a proportional constant. THe sensor coefficient will take the value of face velocity sensed by the meter and dividing it by the face velocity measured in Auto-Flow.

Attribute **EE** specifies whether or not Emergency Mode functionality is enabled on the *SBC*-FHC.   To enable Emergency Mode functionality, set **EE** to a value of 1.

Attributes **DC** and **DP** specify how control is disabled manually within the *SBC*-FHC**.** Through the use of the **DC** attribute, control can be disabled for service or maintenance of the fume hood or its sub-components. To disable run-time control, set **DC** to a value of 1. In turn, the Exhaust Damper output will be commanded to the value specified in **DP**. Therefore, **DP** should be set accordingly to the configuration of the Analog Output (FD01).

Attribute **CS** provides a status of which Control Sequence, or application, the *SBC*-FHC is currently operating under. Table 4-7 provides a list of the applications and their corresponding enumerations.

Table 4-7 Control Mode Applications

Value of **CS**	Current Application Mode
0	Auto-Flow
1	Auto-Flow + Fuzzy Logic Tuning
2	Auto-Flow + Feed Forward Control
3	Sash Position
4	Sash Position with Shaft Position Feedback
5	Sash Position with Exhaust Flow Feedback

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Control Summary, FA00

Attribute	Description
ON	**Control Summary Name** specifies a user definable string that is used to help identify the channel or its function.
DN	**Description** specifies a user definable string that is used to help describe the channel or its function.
FV	**Face Velocity** indicates a reflection of the Face Velocity input value, sensed by FE01;**CV**
EF	**Exhaust Flow** indicates a reflection of the Exhaust Flow input value, sensed by FE02;**CV**.
SP	**PID Setpoint** indicates a reflection of the PID Loop Setpoint, as stored in the FA01;**SP**.
SB	**Unoccupied Setback** specifies the unoccupied setback. During unoccupied modes, the PID Control setpoint will be adjusted (added or subtracted) as configured through the action setting of the PID Control loop (**SG**).
SC	**Sensor Coefficient** specifies the sensor coefficient. When the face velocity sensor is calibrated during balancing, the face velocity is measured with a calibrated air velocity meter, generating a proportional constant. THe sensor coefficient will take the value of face velocity sensed by the meter and dividing it by the face velocity measured in Auto-Flow.
EE	**Enable Emergency** specifies whether or not Emergency Mode functionality is enabled on the *SBC*-FHC. To enable Emergency Mode functionality, set **EE** to a value of 1.
DC	**Disable Control** provides a software point to disable run-time control of the SBC-FHC 0 = Control Enabled 1 = Control Disabled
DP	**Disable Position** specifies the position of the Analog Output when **DC**=1
CS	**Control Sequence** provides a status of which Control Sequence, or application, the *SBC*-FHC is currently operating under. 0 = Auto-Flow 1 = Auto-Flow + Fuzzy Logic Tuning 2 = Auto-Flow + Feed Forward Control 3 = Sash Position 4 = Sash Position with Shaft Position Feedback 5 = Sash Position with Exhaust Flow Feedback

4.13   ANALOG PID, FA01

Proportional + Integral + Derivative (PID) represents a method of control that controls equipment according to a setpoint in proportion to the value of a measured variable. It accounts for the amount of error (difference between the measured variable and the setpoint) and the continued presence of error. Each PID Control channel has the following attributes: **ON**, **SP**, **TS**, **CS**, **DL**, **AO**, **PO**, **IC**, **IA**, **OL**, **OH**, **SR**, **MR**, **RC**, **RA**, **RS**, **RL**, **DB**, **PB**, **RP**, **RT**, **SU**, **SM**, **CE**, **FR**, **FF**, and **FG.**

You can use PID control in the analog output loop by enabling the Control Enable attribute (**CE** = 1). Setting **CE** = 0 disables PID control.

Attributes **ON** and **DN** stores the name of the channel and its description. These attributes are user definable strings that can be used to help identify the channel.

Attribute **SP** is Loop Setpoint. It specifies the desired loop setpoint. In PID control, the setpoint is defined in **SP**. The measured input variable is the analog sensor referenced by the universal input specified in **IC** and **IA**. The setpoint is expressed in the same kind of measurement units (engineering units) that the measured variable uses (e.g., degrees, cfm, inches of WC, etc.). The data type of **SP** is the same as the data type of the selected measured variable. This value is used with the unoccupied setup/setback and the reset to calculate **CS**.

Attribute **TS** indicates any setpoint adjustments read in from a SmartSTAT. This value is used in calculating the final control setpoint.

Attribute **CS** is Calculated Control Setpoint. It shows the actual loop control setpoint. This read-only point reflects the unoccupied setup/setback as well as any reset and/or SmartSTAT setpoint adjustment. This point is expressed in the same kind of measurement units (engineering units) that the measured variable uses (e.g., degrees, cfm, inches of WC, etc.). The data type of **CS** is the same as the data type of the selected measured variable.

Attribute **DL** indicates the demand load for the control loop. This is the amount by which **CS** differs from the loop measured variable specified in **IC** and **IA**.

Attribute **AO** is Analog Output Value. It shows the scaled output value used by the analog output and is a reflection of the Analog Output attribute **CV**. This point is the **PO** value scaled to **MN** and **MX** of the corresponding analog output **AO**. You can write to attribute **AO** when the Analog Output attribute **AM** = 0.

Attribute **PO** is Percent Output Value. This attribute shows the output value in hundredths of a percent (e.g., 75.00%). The value is calculated based on the error, change in error and past error for the control loop. The point is then scaled to the selected engineering units of the analog output and is stuffed into the **AO** attribute as well as into **CV** of the analog output. This point can be set manually if the control loop is disabled (**CE** = 0).

Attributes **IC** and **IA** specify the channel and attribute to be used as the Loop Measured Variable. It specifies the input to be used for the control loop's measured variable.

NOTE

To clear **IC** and remove the association with its target channel, you must write a value of 0000 (four zeroes) to **IC**.

Attribute **OL** and **OH** define the minimum and maximum limits of the output range for the control loop. The value of **PO** will be scaled between **OL** and **OH** before being sent to the analog output.

Attribute **SR** specifies the soft start ramp.   **SR** is the maximum percentage change per minute for the associated output under he following conditions: when the controller is initially powered up or reset; upon transitions from unoccupied to occupied mode, upon cancellation of an interlock failure or fire condition, or when a control loop is initially enabled. These situations can cause the control loop to peg to 100% which can cause the output to spike and, in turn, could lead to equipment damage. To prevent this, the output will be limited to changing **SR** percent per minute. The effects of **SR** are seen in **AO**, but do not effect **PO**.

Attribute **MR** is Maximum Amount to Reset Setpoint. It specifies the maximum amount needed to reset the loop setpoint (**SP**) based on when reset is being used. Attribute **CS** takes into account the use of the maximum reset specified in **MR**.

NOTE

The data type of **MR** is the same as the data type of the referenced input variable specified by **IC** and **IA**.

Attributes **RC** and **RA** specify the channel and attribute to be used as the Reset Variable. It specifies the input to be used for calculating the reset used by the control loop.

Attribute **RS** is the Reset Setpoint. This attribute specifies the value at which the reset action begins. When the value of the reset variable exceeds **RS**, reset action will be used in determining the calculated setpoint. Just as **SP** is the proportional control setpoint for the measured variable, **RS** is the reset control setpoint for the value of the reset variable selected by **RC** and **RA**. The data type of **RS** is the same as the data type of the reset variable specified by **RC** and **RA**.

Attribute **RL** is Limit for Maximum Reset. It specifies the value at which maximum reset is used. When the value of the reset variable is equal to **RL**, the maximum reset (**MR**) is used in determining the calculated setpoint (**CS**).

The relationship between **RL** and **RS**, as well as the sign (+ or −) of **MR**, determines how changes in the reset variable specified by **RC** and **RA** affect the setpoint of the loop **SP**. Refer to Figure 4-3.
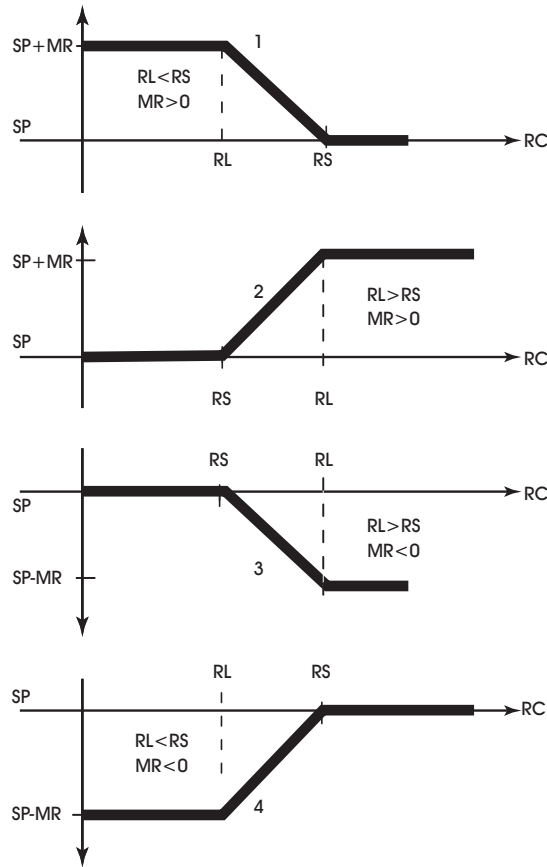
Figure 4-3: Four Forms of Reset Action

NOTE

The data types returned for attributes **RS** and **RL** are determined by the data type of the referenced reset variable specified by **RC** and **RA**.

NOTE

It may not be possible to use a negative value for **MR** if the data type of the control loop's input, specified by **IC** and **IA** uses an unsigned data type.

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Attribute **DB** is Dead Band. It specifies the dead band within the proportional control band in which the output remains constant at a point midway between maximum output and minimum output. By specifying a **DB** that is greater than or equal to the resolution of the sensor specified in **IC** and **IA**, you eliminate the possibility of cycling around the setpoint. The value of **DB** should never exceed the proportional band **PB**. If **DB** is greater than **PB**, then the control loop will not have proportional control.

Attribute **DB** is used to specify an input variable range within the proportional band **PB**. The size of **DB** should be based on the type of sensor input selected for the input specified in **IC** and **IA**. When the value of the measured variable is within this dead band, the output signal remains constant at the midpoint of the minimum/maximum range.

The point **DB** is centered on the setpoint **SP** to create the actual control dead band. When the value of the control variable (specified by **IC**) is within ±**DB**/2 of the setpoint **SP**, the SBC-FHC assumes that it has reached the setpoint. Refer to Figure 4-4.
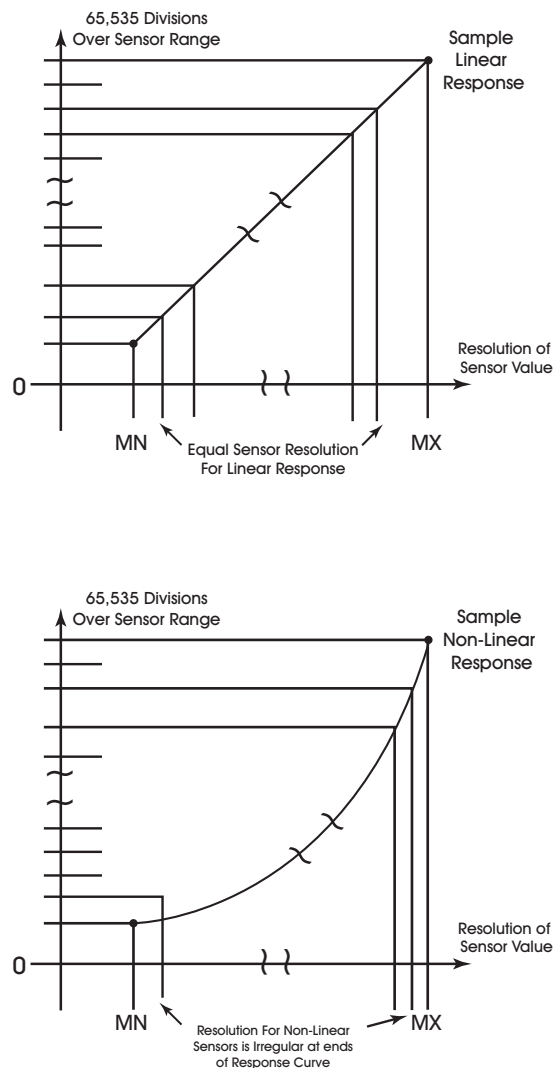
Figure 4-4: Normal Acting, Proportional Control Output Response Showing a Dead Band Centered Around the Setpoint (SP)

By entering a value in **DB** that is greater than the resolution of the measured variable sensor, you create a deadband that allows the SBC-FHC to effectively reach setpoint.

Be sure that the **DB** selected does not exceed the size of the proportional band (**PB**). The attribute **DB** is expressed in the same kind of measurement units (engineering units) that the measured variable uses (e.g., degrees, cfm, inches of WC, etc.). The data type of **DB** is the same as the data type of the selected measured variable. The point **DB** defaults to 0.

NOTE

The data types returned for attributes **DB** and **PB** are determined by the data type of the referenced measured variable specified by **IC** and **IA**.

CAUTION

*Never change **DB** to a value greater than half of the proportional band **PB**. Doing so will eliminate the effects of PID control, resulting in on/off control.*

At this point, the SBC-FHC will provide simple closed loop feedback proportional control. This means that the actual measured performance of the control (from the measured variable input) is fed back to the controller and is compared with the effective setpoint for the loop. Any difference between the actual value of the measured variable (let's call this MV) and effective setpoint values is called error (MV − **CS**).

An analogy is helpful in explaining the effects of error. Figure 4-5 shows a simple lever and fulcrum. A change in the lever position on the error side produces a proportional change in the lever on the output side. Depending on the position of the fulcrum, a change on the error side will have a greater or lesser effect on the output side. The fulcrum position changes the ratio of error to output.
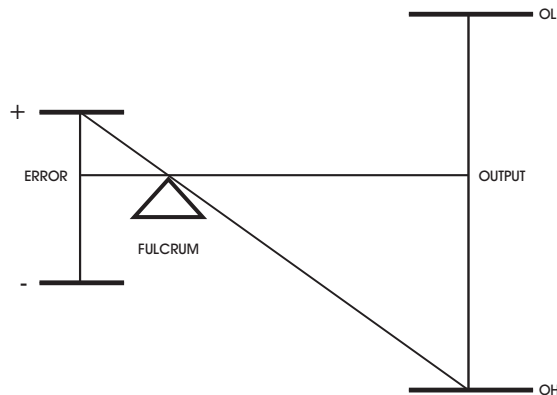
Figure 4-5: Input/Output Ratio

One problem with proportional only control is the changes in loop performance that occur when the condition being measured by the input sensor changes (e.g., the measured temperature changes when a door is opened and the room or space is flooded with cold air). As the loop environment changes, the proportional only control loop begins to cycle around an offset from the setpoint. Figure 4-6 illustrates the performance of a typical loop under proportional only control.
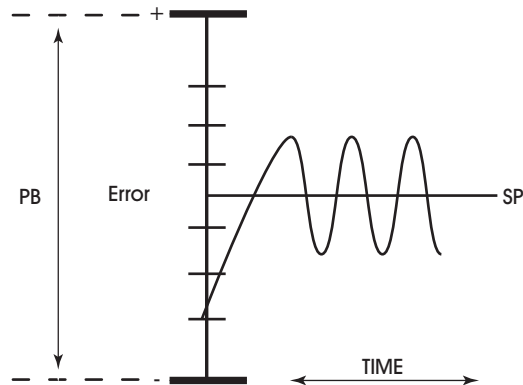
Figure 4-6: Proportional Only Control

Attribute **PB** is Proportional Band. It specifies the input variable range over which the output value is proportional to the error value (i.e., changes in the measured variable result in proportional changes in the output signal). The proportional band is centered around setpoint for the loop. This point is expressed in the same kind of measurement units (engineering units) that the measured variable uses—for example: degrees, cfm, inches of WC. The data type of **PB** is the same as the data type of the selected measured variable

.

<div style="border:1px solid black">

NOTE

The data type of **PB** is the same as the data type of the referenced input variable specified by **IC** and **IA**.

</div>

To determine **PB**, first decide how closely the SBC-FHC must control the output to the setpoint. For instance, if the setpoint is 72°F, then an acceptable control range might be within two degrees of the setpoint. This control range can be expressed as a band centered on the setpoint: from 70° to 74°, or 4 degrees—the *proportional band* (**PB**). Refer to Figure 4-7 and Figure 4-8.

For normal acting control loops (see Figure 4-7), **PO** is set to maximum output when the input variable equals the setpoint plus half of the proportional band (**CS** + **PB**/2). The point **PO** is set to minimum output when the input variable equals the setpoint minus half of the proportional band (**CS** - **PB**/2). These associations are reversed for reverse acting control loops. See Figure 4-8. **PO** will be midway between minimum and maximum output when MV=**CS**.
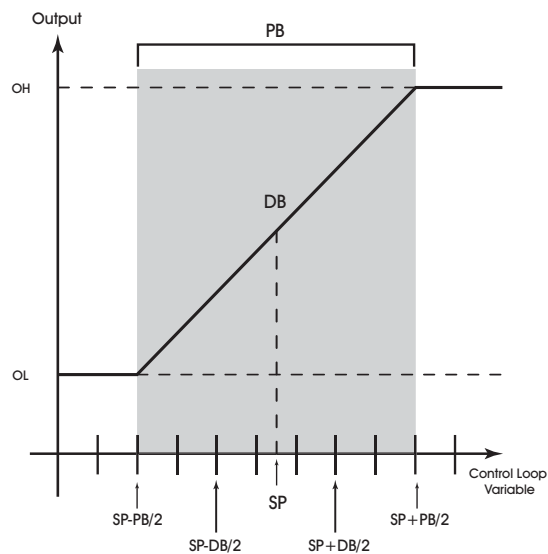
Figure 4-7: Proportional Band Control

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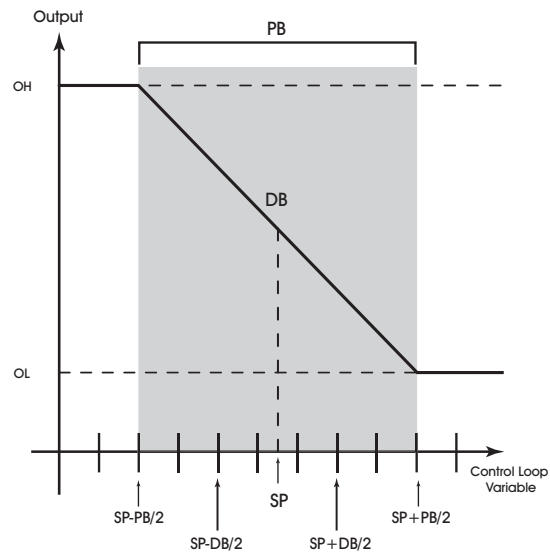
*Figure 4-8: Proportional Band for Reverse Acting Control (**SG** = 1)*

Attribute **RP** is Reset Period. This attribute specifies the reset period (in seconds) over which the error history is accumulated. If **RP =** 10 seconds with a constant error of 2.0, then the error history would increase by 0.2 every second. In five seconds, the error history would be 1.0. At the end of ten seconds, the error history would be 2.0. Setting **RP** to 0 disables integral action making the loop proportional only. The longer **RP** is, the less effect it has on the control response. Figure 4-9 shows the response of a typical control loop when integral action is used in addition to proportional action (PI control). A value of 0 disables the reset period.
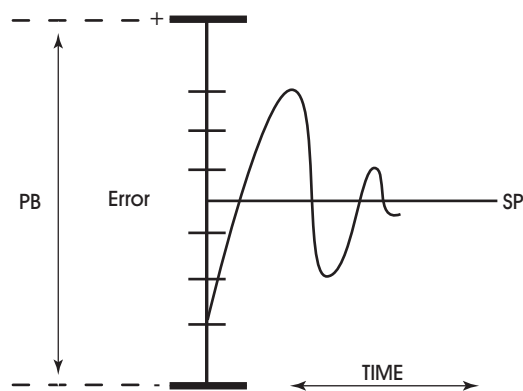
Figure 4-9: Proportional + Integral (PI) Control

At the start-up of the loop or following a change in setpoint (see Figure 4-9), the error is fairly large. Proportional action causes the loop output to accelerate toward the setpoint. However by the time the loop response reaches the setpoint value, it has gained inertia from the preceding proportional action. This causes the loop to overshoot the setpoint. As the loop exceeds the setpoint moving toward its first peak,

the error sum is accumulating. This slows down the acceleration, eventually causing the downturn in response.

As the error falls and then drops below the setpoint, the error sum will be reduced because now the error is in the opposite direction. The cycle continues in diminishing peaks until it finally converges at the setpoint as shown in Figure 4-9.

The proportional control action of the loop has a major effect on integral action. Increasing **PB** results in a smaller integral effect for a given value of **RP**. In general, decreasing the proportional band, **PB,** will increase the magnitude of the changes in **PO**.

Several important factors may not be obvious to inexperienced users of these DDC techniques.

First, whenever the error falls outside of the proportional band—that is, ±**PB**/2 from the setpoint, two important things happen: the controller's output is fully pegged in the appropriate direction, and the error sum stops accumulating. The control produces its maximum output because it must bring the error within the proportional band again. The error sum is accumulating so that it does not "wind up" a massive error sum that would take many control cycles to dissipate. This feature is called antireset windup.

Antireset windup also makes the loop recover quickly when it reenters the proportional band. Another feature of antireset windup is that the error history is limited to **PB**/2 because that is all that required to produce maximum output. Additional error accumulation would only slow down loop recovery.

To quicken loop response while eliminating overshoot, derivative action must be taken. Derivative action takes into account the rate of change in error and allows the SBC-FHC to counter the effects of the error's rate of change on the control output. To find the change in error, subtract the current error (read every second by the PID loop) from the previous second's error. A percentage of this change (specified by **RT**) becomes the derivative contribution to the PID output.

Attribute **RT** is Derivative Rate. It specifies a percentage of change in error that is to be used in calculating **PO**. The value is specified in percent per second. The point **RT** can have any value from 0.0 to 25.5%/second. The effect of adding derivative action to the output response appears in Figure 4-10.
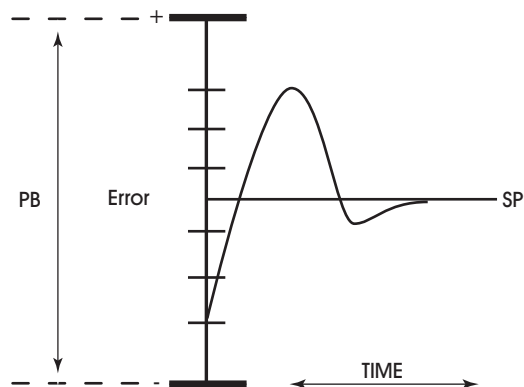

Figure 4-10: Proportional + Integral + Derivative (PID) Control

Proportional only control produces cycling, and its performance changes when the measured environment changes. The way to eliminate cycling and to compensate for load changes is to use *integral* action, the *I* part for PID control.

Rather than responding exclusively to the loop error from moment to moment as is the case with proportional action, integral action is based on a summation of the error that has occurred over some period. This error sum is used to reset, or modify, the response of the control loop (output) based on a running average of the error. The amount of time over which the error averaging is accumulated is called the *reset period*.

Attribute **SU** is Unoccupied SetUp/Setback. This point specifies the amount to add (if **SG** = 0) or subtract (if **SG** = 1) from the setpoint during an unoccupied period. The adjusted setpoint will be displayed in **CS**.

Attribute **CE** is Enable Control Loop. It enables the PID loop. When **CE** = 0, **PO** is not updated but may be set manually. When **CE** = 1, PO is updated by the PID control loop and if the analog output is set to automatic control, the **AO** value will be set accordingly.

Attribute **FR** is the Fuzzy Logic Rate Sensitivity. It specifies the level of rate used by the PID Control Loop to initially maintain setpoint during control startup. This value defaults to 5. Lower values will help slow response to maintain setpoint whereas higher values will increase response to maintain setpoint.

Attribute **FF** is the Fuzzy Logic Steady State Gain. It specifies the steady state gain used by the PID Control Loop to constantly maintain setpoint during runtime. This value defaults to 5. Lower values will help slow initial response to maintain setpoint whereas higher values will increase initial response.

Attribute **FG** is the Fuzzy Logic Transient Gain. It specifies the level of gain used by the PID Control Loop to continually maintain setpoint when large changes in flow occur. This value defaults to 50. Lower values will slow the response of the loop whereas higher values will speed up response.

Analog PID, FA01

Attribute	Description
ON	**Control Loop Name** specifies a user definable string that is used to help identify the channel or its function.
DN	**Description** specifies a user definable string that is used to help describe the channel or its function.
SP	**Loop Setpoint** specifies the desired value of the variable selected in **IC** and **IA**.
CS	**Calculated Control Setpoint** specifies the effective (calculated) setpoint accounting for setup/setback, manual setpoint adjustments, etc.
DL	**Demand Load** indicates the demand load for the control loop. This is the amount by which **CS** differs from the loop measured variable specified in **IC** and **IA**.
AO	**Analog Output Value** displays the output of the PID loop.
PO	**Percent Output Value** displays the calculated output of the PID control loop. **PO** ranges from **OL** to **OH**.
DB	**Desired Control Deadband** specifies the deadband that is used to control cycling around the setpoint. If the current value of the input channel is between **SP**-(**DB**/2) and **SP**+(**DB**/2), the measured variable is considered to be at its setpoint.
PG	**Proportional Gain** specifies a range, centered around the loop setpoint **SP**, where the output signal is proportional.
IG	**Integral Gain** specifies a time, in seconds over which the output of the control loop should be adjusted (reset) using integral action.
DG	**Derivative Gain** specifies a a percentage of the amount of derivative error that is contributed each second to the PID output of the control loop.
BS	**Bias** defines the amount of bias to use against the proportional control of the loop.
F1	**Feed Forward Gain 1** specifies the calculation value for FeedForward Gain 1 for Sash Position Applications.
F2	**Feed Forward Gain 2** specifies the calculation value for FeedForward Gain 2 for Sash Position Applications.
FB	**Feed Forward Bias** specifies the amount of biasing used between the two gain calculations for sash positioning.

Attribute	Description
SU	**Unoccupied Setup/Setback** specifies a value (0.0 to 25.5) which is added to (if **SG**=1) or subtracted from (if **SG**=0) the control loop setpoint during scheduled unoccupied periods.
ER	**Error** specifies the current control error sensed by the PID Control Loop during runtime control.
CE	**Enable Control Loop?** enables/disables PID control. 0=No 1=Yes
FR	**Fuzzy Logic Rate Sensitivity** specifies the level of rate used by the PID Control Loop to initially maintain setpoint during control startup. This value defaults to 5. Lower values will help slow response to maintain setpoint whereas higher values will increase response to maintain setpoint.
FF	**Fuzzy Logic Steady State Gain** specifies the steady state gain used by the PID Control Loop to constantly maintain setpoint during runtime. This value defaults to 5. Lower values will help slow initial response to maintain setpoint whereas higher values will increase initial response.
FG	**Fuzzy Logic Transient Gain** specifies the level of gain used by the PID Control Loop to continually maintain setpoint when large changes in flow occur. This value defaults to 50. Lower values will slow the response of the loop whereas higher values will speed up response.

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4.14 SASH AREA, F721

The Sash Area channel of the *SBC*-FHC is used to setup and configure the sash type used with the target fume hood. The channel contains the following properties: **ON**, **DN**, **CV**, **CF**, **CE**, **BA**, **ST**, **FA**, **HL**, **BH**, and **TW**.

Attributes **ON** and **DN** stores the name of the channel and its description. These attributes are user definable strings that can be used to help identify the channel.

Attribute **CV** indicates the current value of the open sash area as measured by the sash input. This is a mirrored reference of the Sash Position input with calculations applied.

Attribute **CF** indicates the current control setpoint used to control face velocity within the fume hood, based on the sash area.

Attribute **CE** indicates the current control setpoint used to control the exhaust flow of the fume hood, based on the sash area.

Attribute **BA** indicates the calculated area for the bypass damper control of the fume hood, as indicated by the *SBC*-FHC.

Attribute **ST** indicates the type of sash closure installed on the fume hood itself. The sash type can be configured for one of the following types listed in Table 4-8.

Table 4-8 Sash Types

ST value	Description of Value
0	Disabled
1	Single Vertical
2	Vertical + 2 Track / 4 Pane
3	Vertical + 3 Track/ 6 Pane
4	Vertical + 3 Track/ 3 Pane

Attribute **FA** is the user-defined area of the sash as calibrated during commissioning and start-up.

Attribute **HL** stores the current measured airflow leakage, as measured during balancing and commissioning of the fume hood itself.

Attribute **BH** stores the measured height of the bypass duct used in conjunction with the fume hood.

Attribute **TW** stores the total sash width of the sash door installed onto the fume hood.

Sash Area, F721

Attribute	Description
ON	**Sash Area Name** a user definable string that can be used to help identify the channel or, for example, to identify what the scaling is to be used for.
DN	**Description** specifies a user definable string that is used to help describe the channel or its function.
CV	**Current Value** indicates the current value of the open sash area as measured by the sash input.
CF	**Calculated Face Velocity Setpoint** indicates the current control setpoint used to control face velocity within the fume hood, based on the sash area.
CE	**Calculated Exhaust Flow Setpoint** indicates the current control setpoint used to control the exhaust flow of the fume hood, based on the sash area.
BA	**Calculated Bypass Area** indicates the calculated area for the bypass damper control of the fume hood, as indicated by the *SBC*-FHC.
DT	**Datatype** indicates the PUP datatype used to convey sash area calculations based on raw resistance.
ST	**Sash Type** indicates the type of sash closure used with on the fume hood.
FA	**Fixed Area** user-defined area of the sash as calibrated during commissioning and start-up.
HL	**Hood Airflow Leakage** stores the current measured airflow leakage, as measured during balancing and commissioning of the fume hood itself.
BH	**Bypass Height** stores the current measured airflow leakage, as measured during balancing and commissioning of the fume hood itself.
TW	**Total Width** stores the total sash width of the sash door installed onto the fume hood.

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4.15 PIECEWISE CURVES 1-4, F701-F703

The SBC-FHC can accommodate non-linear sensors by using built-in tables to define the response characteristics of the sensor. Each tables requires 11 points to define 10 linear segments. These 10 segments approximate the response of the sensor. The controller will perform a linear interpolation to 'look up' values that lie along an individual segment. Each of the Piecewise Curve channels contain attributes that define the operation and display its results. These attributes are **ON**, **DT**, **X1**, **X2**, **X3**, **X4**, **X5**, **X6**, **X7**, **X8**, **X9**, **XA**, **XB**, **Y1**, **Y2**, **Y3**, **Y4**, **Y5**, **Y6**, **Y7**, **Y8**, **Y9**, **YA** and **YB.**

Attributes **ON** and **DN** stores the name of the channel and its description. These attributes are user definable strings that can be used to help identify the channel.

Attribute **DT** indicates the datatype for the coordinates used to define the piecewise curve.

Attributes **X1** through **XB** represent the sensor readings for eleven chosen points on a sensor curve. These values must be in the same range as the chosen sensor type. So, for a 0-10 V input, **X1** through **XB** could take any value from 0 through 10.   The values of **X1** through **XB** must be in increasing order (**X1** < **X2** < **X3** etc.).

Attributes **Y1** through **YB** are the Engineering Unit values (e.g., 70 degrees, 72 degrees, etc.), corresponding to the sensor readings entered into **X1** through **XB**. These values, coupled with the corresponding sensor readings, define the line segments which make up the piecewise curve

To program a piecewise curve for a nonlinear sensor, you need to know the response characteristics of the sensor. These response characteristics are usually supplied by the manufacturer and may be in the form of a graph or table.   Figure 4-11 shows an example of what a curve for a temperature sensor may look like. Once you have the response data, in either graph or table form, you must choose the points which define the line segments that approximate the response curve. When choosing the points to use, you can use fewer points in areas of the curve that are mostly linear and concentrate the points more to better approximate the more non-linear portions of the response.
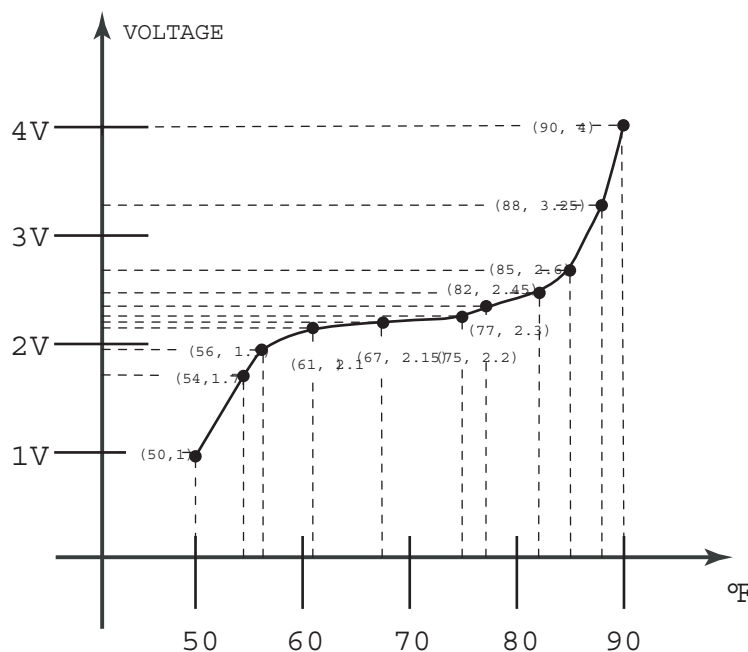
Figure 4-11: An Example of a Sensor Response Curve

From the graph, we can read the following values:

Table 4-9 : Sensor Response Points

Voltage	Temperature (°F)
1.00	50
1.70	54
1.90	56
2.10	61
2.15	67
2.20	75
2.30	77
2.45	82
2.60	85
3.25	88
4.00	90

To construct the piecewise curve, you would enter the values for the voltage into attributes **X1** Through **XB**. Similarly, the temperature values would be entered into **Y1** through **YB**. This gives the following assignments:

Table 4-10 : Assigning Sensor Response Points to the Piecewise Curve

		Voltage	Temperature (°F)		
X1	⇦	1.00	50	⇨	**Y1**
X2	⇦	1.70	54	⇨	**Y2**
X3	⇦	1.90	56	⇨	**Y3**
X4	⇦	2.10	61	⇨	**Y4**
X5	⇦	2.15	67	⇨	**Y5**
X6	⇦	2.20	75	⇨	**Y6**
X7	⇦	2.30	77	⇨	**Y7**
X8	⇦	2.45	82	⇨	**Y8**
X9	⇦	2.60	85	⇨	**Y9**
XA	⇦	3.25	88	⇨	**YA**
XB	⇦	4.00	90	⇨	**YB**

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Piecewise Curves 1-4, F701-F703

Attribute	Description
ON	**Piecewise Curves Name** specifies a user definable string that is used to help identify the channel or its function.
DN	**Description** specifies a user definable string that is used to help describe the channel or its function.
DT	**PUP Datatype** specifies the PUP datatype for the piecewise curve.
X1	**Point 1's value in raw counts** specifies the x coordinate of point 1.
X2	**Point 2's value in raw counts** specifies the x coordinate of point 2.
X3	**Point 3's value in raw counts** specifies the x coordinate of point 3.
X4	**Point 4's value in raw counts** specifies the x coordinate of point 4.
X5	**Point 5's value in raw counts** specifies the x coordinate of point 5.
X6	**Point 6's value in raw counts** specifies the x coordinate of point 6.
X7	**Point 7's value in raw counts** specifies the x coordinate of point 7.
X8	**Point 8's value in raw counts** specifies the x coordinate of point 8.
X9	**Point 9's value in raw counts** specifies the x coordinate of point 9.
XA	**Point 10's value in raw counts** specifies the x coordinate of point 10.
XB	**Point 11's value in raw counts** specifies the x coordinate of point 11.
Y1	**Point 1's value in engineering units** specifies the y coordinate of point 1.
Y2	**Point 2's value in engineering units** specifies the y coordinate of point 2.
Y3	**Point 3's value in engineering units** specifies the y coordinate of point 3.
Y4	**Point 4's value in engineering units** specifies the y coordinate of point 4.
Y5	**Point 5's value in engineering units** specifies the y coordinate of point 5.
Y6	**Point 6's value in engineering units** specifies the y coordinate of point 6.

Attribute	Description
Y7	**Point 7's value in engineering units** specifies the y coordinate of point 7.
Y8	**Point 8's value in engineering units** specifies the y coordinate of point 8.
Y9	**Point 9's value in engineering units** specifies the y coordinate of point 9.
YA	**Point 10's value in engineering units** specifies the y coordinate of point 10.
YB	**Point 11's value in engineering units** specifies the y coordinate of point 11.

4.16   BROADCAST CHANNELS

The Broadcast channels allow the controller to send and receive Occupancy Status, Emergency Broadcasts, and Hood Control parameter over the network. Each Broadcast channels contain the following attributes: **ON**, **BE**, **BZ**, **CV**, **DT**, **IC**, **IA** and **RB**.

Attributes **ON** and **DN** stores the name of the channel and its description. These attributes are user definable strings that can be used to help identify the channel.

Attribute **BE** is the broadcast enable attribute. It specifies whether the controller should broadcast the value of **CV** over the network. If **BE**=1, the controller will broadcast the value of **CV**. If **BE**=0, no value will be broadcast.

Attribute **BZ** is the broadcast zone/global attribute. This attribute specifies whether the information broadcast will be sent to the entire network or just the units having the same zone number as the SBC-FHC. If **BZ**=1, the information will be broadcast globally. If **BZ**=0, the value of **CV** will only be sent to controllers having the same zone number a the SBC-FHC. In this case, only those controllers that are capable of receiving broadcasts on the same channel will be able to use the information.

Attribute **CV** indicates the current value of the channel and attribute specified on **IC** and **IA**. This is the value that will be broadcast by the associated channel.

Attribute **DT** is a value that represents the data type of **CV**. This will be the data type of the broadcast value.

Attributes **IC** and **IA** specify the channel and attribute respectively that is to be broadcast over the network. Because the unit is an application specific controller, many of the values defined by default in **IC** and **IA** cannot be modified.

Attribute **RB** is the receive broadcast attribute. It specifies whether the controller should accept the broadcasted values for **CV**. This attribute enables received values of **CV** to be directed to the channel and attribute specified in **IC** and **IA**. If **RB**=1, then the SBC-FHC will receive broadcast values for **CV**.

Broadcast Channels

Attribute	Description
ON	**Broadcast Name** specifies a user definable string that is used to help identify the channel or its function.
DN	**Description** specifies a user definable string that is used to help describe the channel or its function.
CV	**Current Value** indicates the current value of the referenced channel specified in **IC** and **IA**.
DT	**PUP Data Type for Values** specifies the PUP datatype for **CV**.
IC	**Input channel** specifies the input channel to be broadcast.
IA	**Input Attribute** specifies the attribute associated with the channel specified in **IC** to be broadcast.
BE	**Broadcast Enable** specifies whether the controller should broadcast the value of CV over the network. 0=No 1=Yes
BZ	**Broadcast Zone/Global** specifies whether the controller's broadcasts are sent to the zone or broadcast globally. 0=Zone broadcast 1=Global broadcast
RB	**Receive Broadcast?** specifies that the controller should accept broadcasted values for the channel and attribute specified in **IC** and **IA**.

SECTION 5: FHC-SD OPERATION

This section describes operation of the FHC-SD Touch-Screen Display, detailing usage information regarding the user interface and general instructions.

IN THIS SECTION

5.1 THE OPERATOR INTERFACE

The FHC-SD provides hood operators with status information regarding the operation of the SBC-FHC. The operator interface consists of dynamic fields referencing data or other areas of the system. Other aspects of the operator interface may appear with additional buttons that are used to configure the FHC-SD, enter pin-passwords, penetrate menus, change system variables, monitor and modify network attributes, scroll through attribute and alarm lists, perform tests, and signal emergency override conditions. Buttons displayed on the FHC-SD will perform different functions depending on the situation.

5.1.1 CONFIGURATION VIA PUP NETWORK INTERFACE

There is a channel in the Fume Hood Controller that pertains solely to the display. This channel is named "Touchscreen Display (Port 2)" and it is used to set up some of the parameters that govern the look, feel and access levels of the display.

5.1.2 (CA) FHC DISPLAY COMM STATUS

This read-only attribute describes the current communication status of the display. If the display is connected, powered up and communicating, this value will be set to "Online." If the display has not been attached or is not communicating with the hood, this variable will indicate "offline.

5.1.3 (ST) SESSION TIMER

This attribute indicates the time in minutes that a user can be logged into the display. Of course a user can also manually log out of the display at any time. Regardless of whether the user is still near the hood, after X minutes they will automatically be logged out. The default for this value is 10 minutes.

5.1.4 OPERATOR PASSWORD & PRIVILEGES

Some configuration parameters and display screens are meant to be viewed by all parties but some have been reserved for only a few selct people. As an example, you would not want an end user standing in front of a hood to be able to accidentally change the balancing data, the type of hood, or the sensor management data. On the other hand there is good reason to allow these users access to the I/O data.

You can assign up to 4 different passwords to the display, each of which can have a unique level of privileges. There are three privilege levels available; 0, 1 and 2. Level 2 access is the highest level and it allows access to all screens and abilities. Level 1 access has many but not all of the privileges of level 2 and a "privilege level" of 0 indicates that the user cannot log into the system.

By default, User 1's password is "11111" and this user has been granted level 2 access.

5.1.5 (AL) ALARM SILENCE TIMER

When the FHC is in an emergency or alarm condition, the alarm buzzer in the display will sound. When this buzzer is active a button will appear on the home screen that allows the user to temporarily silece the alarm.

The **(AL)** attribute indicates the time in minutes that the buzzer in the display can be temporarily silenced. By default this time is set to 15 minutes.

5.1.6 HOME SCREEN LAYOUT

There are 4 different layouts available for the Home Screen on the FHC-SD. The options include the following:

Displaying the Face Velocity
Displaying the Face Velocity and the current Face Velocity setpoint

Displaying the Face Velocity with small custom text above
Displaying the Face Velocity with large custom text above

The third and forth options require that you fill out the next variable, "Home Screen Text." By default it states "Add Text…" but it is generally assumed that it would indicate the number of the hood, the chemicals used in it, etc. Depending on how long a message you want to display you may find either the large or small text options to be best for your particular application.
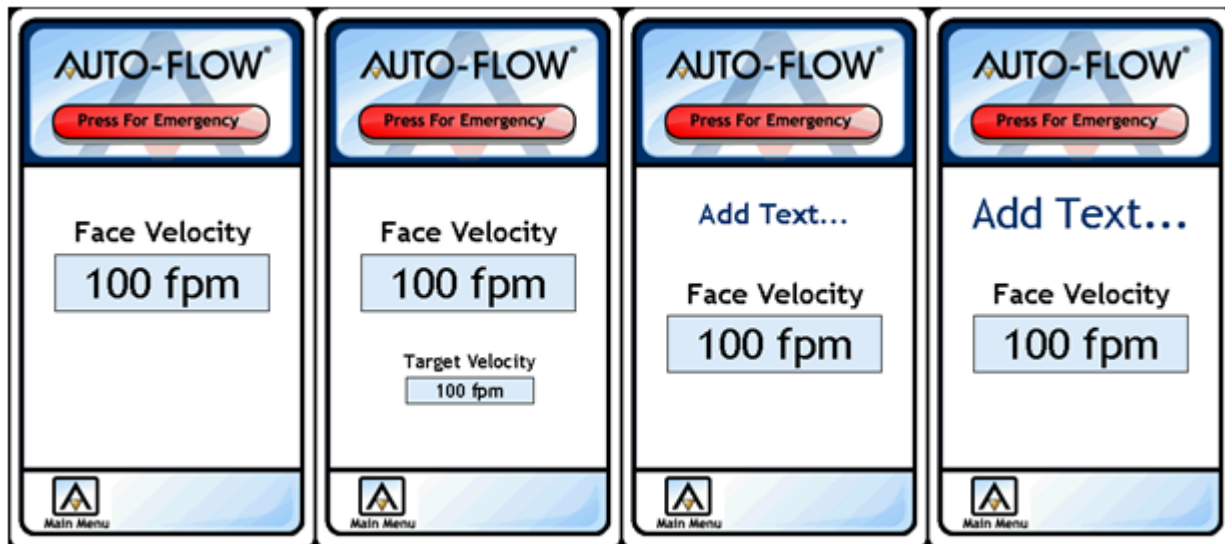

Figure 5-1 Possible Home Screen Configurations

5.1.7   (HT) Home Screen Text
If you choose to have custom text on your home screen you will need to configure the text in this variable. By default it says "Add Text" but it can be configured to display up to 16 characters.
\

NOTE

Some characters take up more space than others. If your message cannot fit across the screen with the large text option, selecting the small text option should allow the message to appear properly.

5.1.8   (HB) Home Screen Background Color
Upon start-up, the FHC-SD will display the Home Screen, which displays the current measured face velocity. The Home Screen can be configured to also display the current control setpoint, or custom text in small or large font size (consisting of about 12 to 15 characters, size dependent). When enabled, a software emergency push button can be made available to command a fume hood into emergency mode.

Figure 5-2 Background Colors

5.1.9   (AN) FACE VELOCITY AVERAGING NUMBER

Depending on the type of sensor used to determine the face velocity, the FHC-SD's display might jump around more than the end user cares to notice. As an example, using a hot wire anemometer the face velocity might jump from 98 to 102 feet per minute ten different times within a second. This fast a change in data is often counter productive except when tuning the PID loops. For this reason the averaging number has been made available for modification.

When this number is a 1, it sends the raw data to the screen as fast as it can gather it. This number can be set as high as 15. meaning that the display will show a face velocity that is a continuous average of the previous 15 samples. In this way the screen will react in a slower and more measured way.

NOTE

This averaging number only affects the display screen on the FHC-SD, the actual face velocity is still unused, un-averaged for all control, alarming and network functions.

5.1.10 (SN) FHC-SD DISPLAY'S SERIAL NUMBER

This read-only attribute is simply the serial number of the display currently attached to the fumehood controller.

5.1.11 (VE) FHC-SD DISPLAY'S FIRMWARE VERSION

This read-only attribute indicates the firmware version of the display currently attached to the fume hood controller. This firmware can be upgraded in the field via the SD slot in the display.

5.1.12 (SR) FHC-SD DISPLAY'S FIRMWARE TIME STAMP

This read-only attribute indicates the release code of the firmware in the display currently attached to the fume hood controller.

5.1.13 (RE) RESET EMERGENCY MODE

If the unit is in Emergency Mode, the cause of the emergency needs to be cleared and following that Emergency Mode needs to be exited. Among the many methods for clearing this mode, (via the touch screen, the network, or a broadcast from a different controller) this one is the easiest to control via the PUP network. Please keep in mind that if the emergency condition still exists, this will not be able to clear it as the unit would immediately return to emergency mode.

5.1.14 (EE) EMERGENCY ENABLE

This variable determines if the "Press for Emergency" button will be available on the home screen and main menu screens of the display. In critical environments where an emergency may need to be declared at the hood which would in turn trigger HVAC and perhaps evacuation responses, it is strongly suggested that this button be left intact.

In the case of a fume hood in a less strictly monitored environment you may wish to remove this button from the screen. As an example, in a high school chemistry lab this button might be pressed frequently without good cause. In this instance you may choose to remove the button from the screen.

Figure 5-3 Home and Menu Screens With & Without the Emergency Button

5.2   LOGGING IN TO THE DISPLAY

The "Login" button is located on the Main Menu screen. There are five digits available, offering 100000 different login codes. These codes are accessible and modifiable via the PUP network and can also be modified if the user is logged into the display with level 2 access.

Using the up and down arrow keys, each digit can be manipulated. Moving left and right between digits is achieved by pressing on the left and right arrows. To enter the password, press the green check key which indicates the enter key.

If you have successfully logged in, the login button on the Main Menu screen will be replaced with a "Logout" button. A single press on the logout button will end your session and return the display to its normal, logged out mode.

NOTE

Each FHC is shipped with a default pass code of 10000 which will provide level 2 access. This pass code will remain effective until such time as it is changed via the network or the display.

Figure 5-4 The Login Screen Data Viewing Screens

As mentioned above, there are three basic types of screens on the display, menu screens, data viewing screens and data entry screens. This section will describe the data viewing screens and the data that can be found therein.

Please note that there are a few screens that are either data viewing or data modifying screens, based on login level. These screens will show up in both this section and the next.

5.3   PRODUCT INFORMATION

This screen displays information about the display itself. The current firmware and serial number are always displayed here. In addition, (depending on login level), information about the fume hood itself and its hardware configuration can also be found on this screen by scrolling up and down through the menus.

Figure 5-5 Examples of the Product Information Screen

5.4   DISPLAY SCREENS

The following sections show different display screens and their functionality.

5.4.1   INPUTS

This screen displays information about the various inputs attached to the FHC. These are read-only and can't be overridden from the display. As always, more data is available on this screen depending on the login level and the hardware compliment.

Figure 5-6 Examples of the Inputs Screen

5.4.2   OUTPUTS

This screen displays information about the various outputs attached to the FHC. These are read-only and can't be overridden from the display.
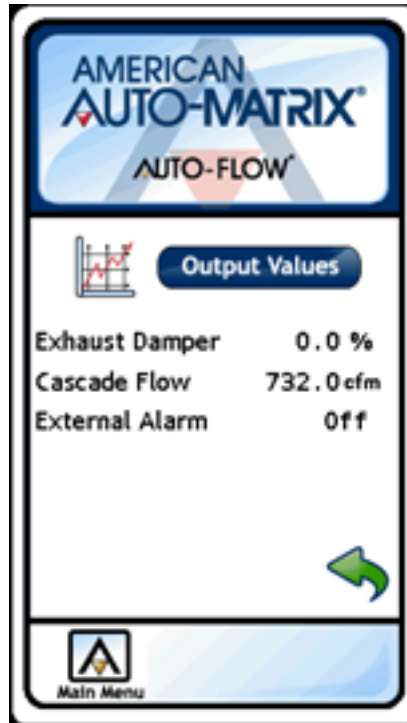
Figure 5-7 Example of the Outputs Screen

5.4.3 ALARM STATUS

This screen displays information about the various inputs and modes that can currently be in alarm. This screen is the first one to look to when trying to ascertain the cause of an alarm.

Figure 5-8 Examples of the Alarm Status Screen

5.4.4   BUZZER SILENCE TIME

This screen (when it is read-only) indicates the amount of time that a user can override the local piezo buzzer in the display. If an alarm or emergency condition is present the "Silence Alarm" button will appear on the home screens and the main menu screen. The amount of time the alarm can be silenced is displayed here.

Figure 5-9 The Buzzer Silence Time Screen

5.4.4.1   SILENCE TIME REMAINING

This read-only screen indicates the amount of time left in a silence buzzer override. Unless there is a current alarm that is being silenced, this shall display 0.

Figure 5-10 Buzzer Silence Time Remaining Screen

5.4.5   LOW AND HIGH ALARM SCREENS

These screens are for both Face Velocity alarming as well as Exhaust Flow alarming. In these screens you can see the values at which the alarms will trigger. The High and Low alarms indicate warning alarms are would be accompanied with a yellow flashing background screen. The Extreme alarms indicate a major alarm or emergency condition and would cause the background to flash yellow

NOTE
The Face Velocity alarms are set as relative values indicating a distance from the current target setpoint. The Exhaust Flow alarms are absolute and not used as offsets to any other variable.
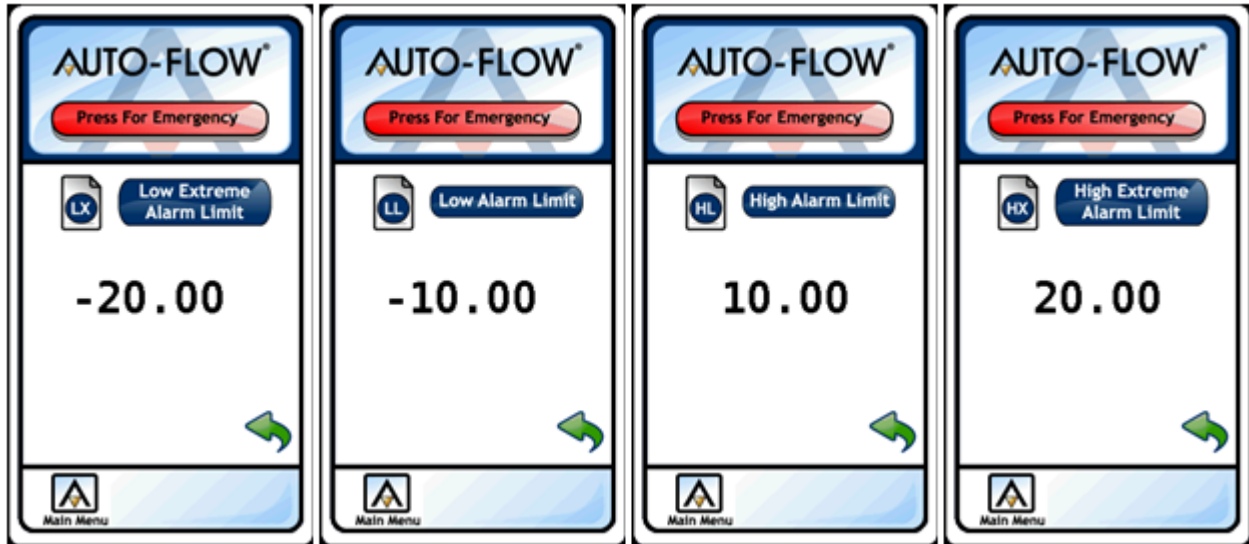
Figure 5-11 Examples of High & Low Alarm Screens (Read Only)

5.4.6   LOGIN TIME REMAINING

This read-only screen indicates the amount of time left before the user is logged out of the display. The user can always override this and log out immediately by pressing the "Logout" button which replaced the "Login" button once the used initially logged in.
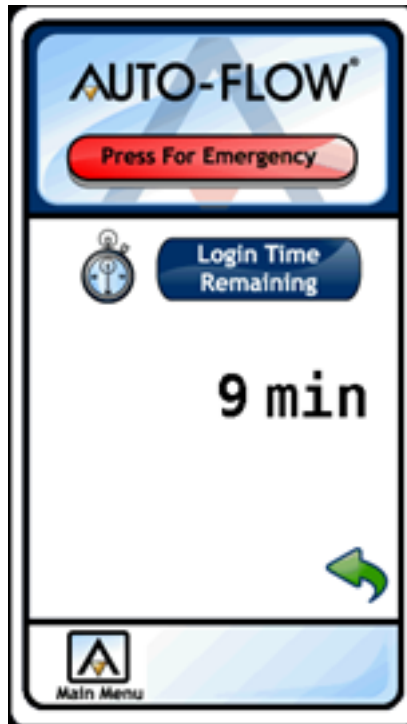
Figure 5-12 Login Time Remaining Screen

5.4.7 DIAGNOSTICS

The Diagnostics screen is meant to offer feedback as to the general health of the display.
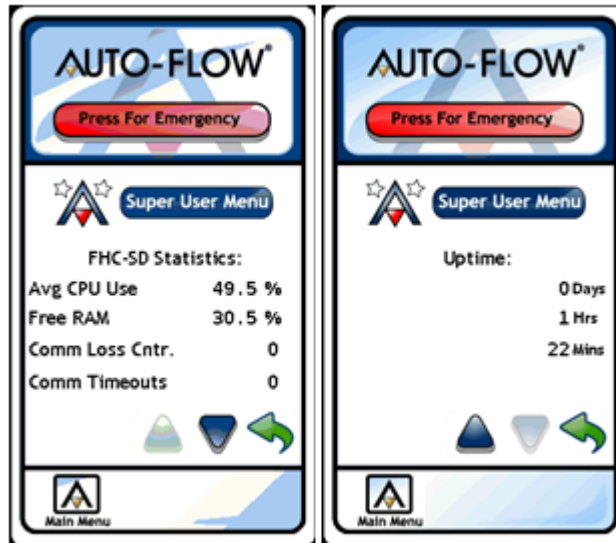
Figure 5-13 Diagnostics Screen

5.4.8 VIEW UNIT SETUP DATA

This screen displays the data specific to the hood configuration. It may contain data specific to the opening of the fume hood although that data is not required in all modes. The Occupied and Unoccupied setpoints are among the most useful data on this screen.
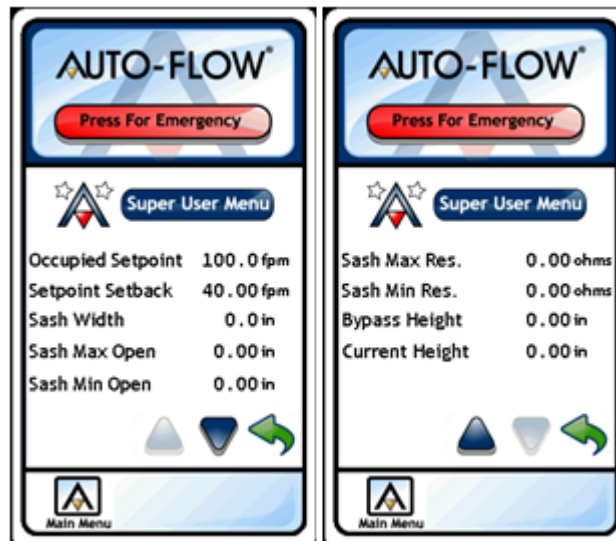
Figure 5-14 Unit Setup Data Screen

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5.5 DATA ENTRY SCREENS

As mentioned above, there are three basic types of screens on the display, menu screens, data viewing screens and data entry screens. This section will describe the data entry screens and the data that can be found therein.

Modifying values through the FHC-SD is accomplished through the use of the arrows on the data entry panel. The data entry panel provides up, down, left, and right buttons. Using these buttons, modifications to numeric values can occur by using the left and right arrows to navigate to the placeholder desired, followed by touching the up or down buttons to increment or decrement the value respectively. Holding any of these buttons longer than one second will result in faster, continuous increments or decrements of the desired value. No data is stored until the enter button, generally a green check mark, is pressed.

Some data entry screens contain one data point, whereas others are actually a sequence of related screens. If the data entry screen has only one data point, hitting the enter or cancel keys will return the user to the previous screen. If on the other hand it is a multiple data point screen (also considered a Wizard Screen sequence), the variables are modified one at a time but only after entering the last data point will the user be returned to the starting point.

Please note that there are a few screens that are either data viewing or data modifying screens, based on login level. These screens will show up in both this section and the previous one but might look slightly different in the corresponding images.

5.5.1 SCREEN CALIBRATION

The touchscreen calibration menu can be accessed by any user, regardless of login level. Once the calibration routine has been begun a target will appear on the screen and the user will be directed to press the target several times as it moves across the display. Instructions are provided on-screen.
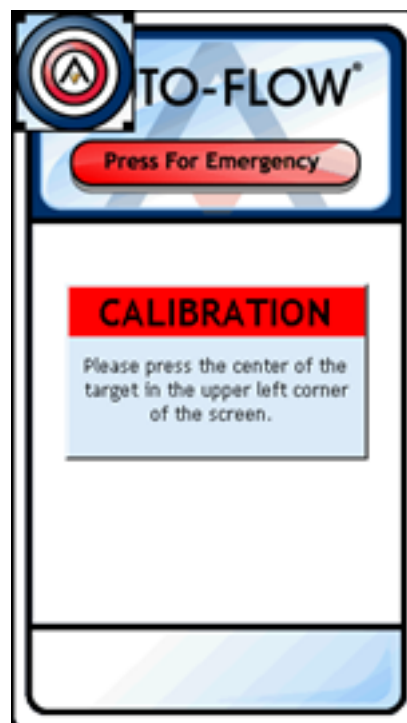

Figure 5-15 Screen Calibration

5.5.2 BUZZER SILENCE TIME

This screen indicates the amount of time that a user can override the local piezo buzzer in the display. If an alarm or emergency condition is present the "Silence Alarm" button will appear on the home screens and the main menu screen. The amount of time the alarm can be silenced is displayed here.
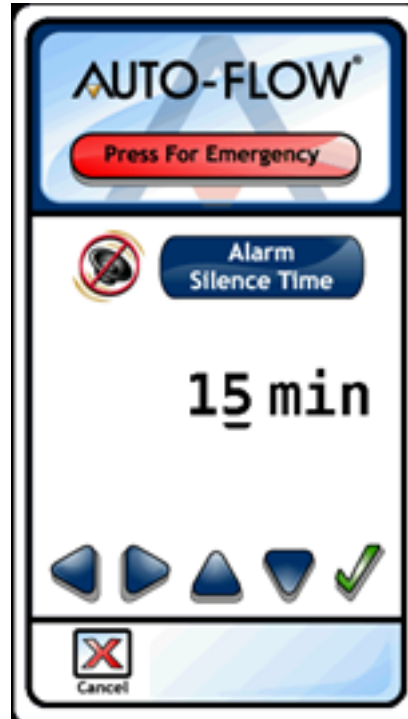

Figure 5-16 Modifiable Silence Timer Screen

5.5.3 CANCEL EMERGENCY

When the Fume Hood is in an emergency condition the cause of that condition needs to be cleared before all else. As an example, if the dedicated emergency input button was pressed, it needs to be reset prior to being able to clear the condition. Conversely, if the emergency condition was entered via the momentary switch on the display screen or via a network broadcast, the underlying condition might already be considered cleared.

To see the "Cancel Emergency button in the Alarms screen, the user must be logged in (either level 1 or level 2 permissions will suffice). Pressing the button will take the unit out of emergency mode and reset it to normal operation. If this does not eliminate the emergency condition, the button above it, "Alarm Status" will provide the user with the uncleared cause of the emergency or alarm.

Figure 5-17 Cancel Emergency Button

5.5.4 LOW & HIGH ALARM SCREENS

These screens are for both Face Velocity alarming as well as Exhaust Flow alarming. In these screens you can see and modify the values at which the alarms will trigger. The High and Low alarms indicate warning alarms are would be accompanied with a yellow flashing background screen. The Extreme alarms indicate a major alarm or emergency condition and would cause the background to flash yellow.
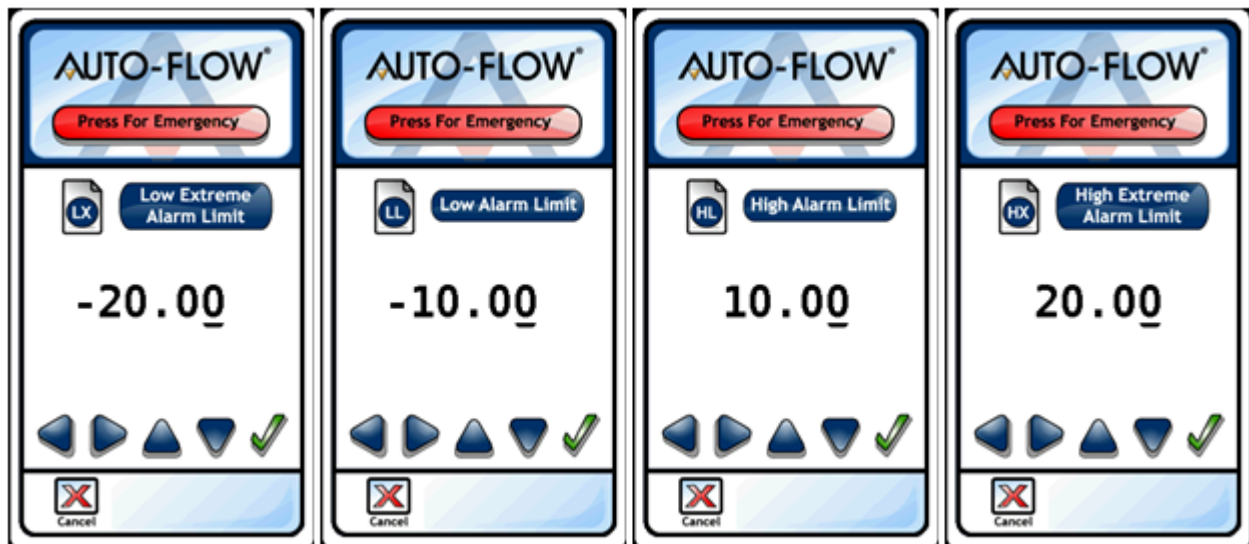

Figure 5-18 Examples of Modifying High & Low Alarm Screens

5.5.5 FACE VELOCITY SMOOTHING

Depending on the type of sensor used to determine the face velocity, the FHC-SD's display might jump around more than the end user cares to notice. As an example, using a hot wire anemometer the face velocity might jump from 98 to 102 feet per minute ten different times within a second. This fast a change in data is often counter productive except when tuning the PID loops. For this reason the averaging number has been made available for modification.

When this number is a 1, it sends the raw data to the screen as fast as it can gather it. This number can be set as high as 15. meaning that the display will show a face velocity that is a continuous average of the previous 15 samples. In this way the screen will react in a slower and more measured way.

Figure 5-19 Face Velocity Smoothing Variable

5.5.6 EXHAUST DAMPER AUTO-MANUAL

This variable turns on and off the automatic control of the exhaust damper. Under normal operating conditions this should always remain enabled. Should the user or balancer require that the damper remain in a fixed position, the auto/manual switch provides a simple method to accomplish this.
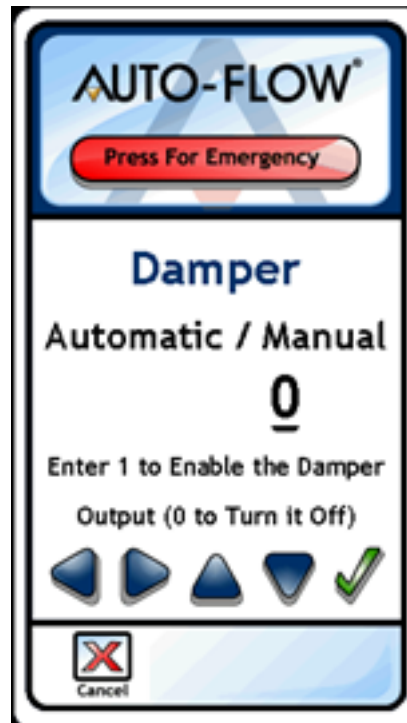
Figure 5-20 Exhaust Damper Auto/Manual Switch

5.5.7   FACE VELOCITY SETPOINTS

These screens are wizard screens, meaning that you are asked to provide several data points in succession prior to returning to the menu screens. The first point is the Occupied Face Velocity Setpoint, the target control point for the fume hood. The second point is the amount to offset that point when the hood is deemed unoccupied.

As an example, if the Occupied setpoint is 95 feet per minute and the Unoccupied offset is 50 feet per minute, the target will be either 95 or 45 feet per minute based on the fume hood's occupancy.
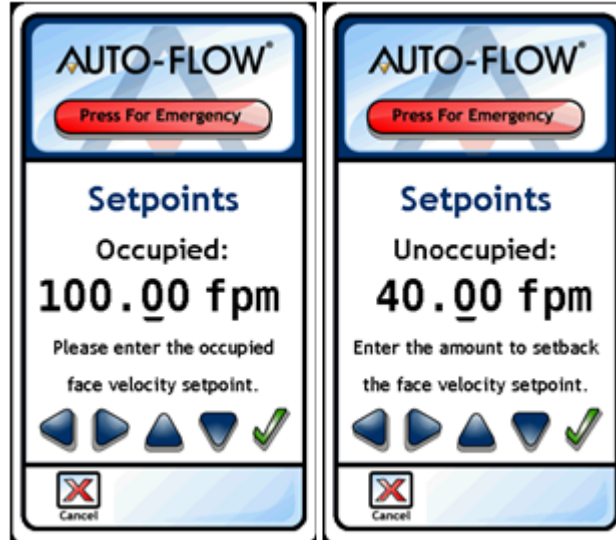
Figure 5-21 Face Velocity Setpoint Wizard Screens

5.5.8   PWC (PIECEWISE CURVE) SCREENS

The Piecewise Curves in the FHC are used to tailor non-standard non-linear I/O devices to allow them to be used with the fume hood. Curves are provided for the Face Velocity sensor, the exhaust flow sensor as well as the exhaust damper output.

By matching the percentage of full scale with the corresponding engineering units one can choose from an infinite number of I/O devices with the FHC.

NOTE
It should be noted that although these values can be viewed and modified via the display, the network interface of the SBC-FHC provides a simpler method for this task.

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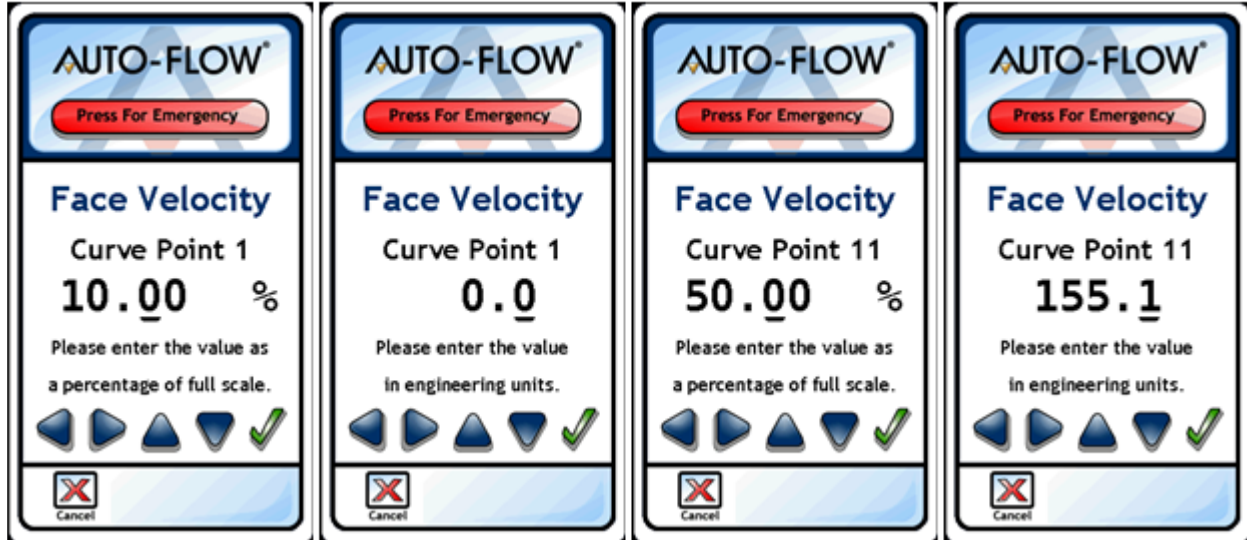
Figure 5-22 Examples of PWC Data Points

5.5.9 SENSOR COEFFICIENT (BALANCING THE HOOD)

This data point is the main calibration point for the fume hood. This is where the measured (perceived) face velocity can be offset by the balancer. The higher the number, the higher the Face Velocity will become and vice versa.

The sensor coefficient should be set to 1 prior to balancing and the exhaust damper should be locked into manual mode to reduce the control actions and steady the flow. Then after a number of face velocity measurements have been taken, the sensor coefficient should be set based on the following algorithm:

Sensor coefficient = Measured Velocity / Displayed Velocity

As an example, if the measured face velocity is 93fpm and the displayed face velocity is 101fpm, the sensor coefficient should be set to 0.921.
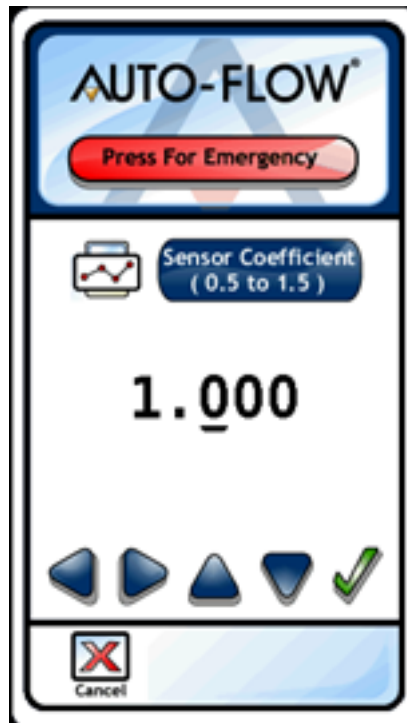
Figure 5-23 The Face Velocity Sensor Coefficient Screen

5.5.10 SASH GEOMETRY

These screens are wizard screens, meaning that you are asked to provide several data points in succession prior to returning to the menu screens. Following the instructions on the screen will allow the user to properly calibrate the string pot so that an accurate measurement of the open area of the fume hood can be maintained.

NOTE
This menu is only available if a sash sensor is present. If the hood is set up not to require such a sensor, these screens (and the link to them) will not appear on the display.

Figure 5-24 Sash Geometry Screens

5.5.11 PUP NETWORK SETTINGS

Many of the pertinent PUP network settings can be viewed and modified directly via the display. These include the unit's ID, the baud rate and all token passing and peer list parameters. Once any of these settings has been changed, the unit should be rebooted for them to fully take effect.

These PUP settings screens are set up as wizard screens and the last screen provides the ability to reboot the unit if desired. Note that peer-screens 2 through 7 do not appear below but they are in the display.

Figure 5-25 PUP Network Settings

5.5.12 PID/FUZZY SETPOINTS

The closed-loop control of the fume hood is based on either a PID routine, a fuzzy logic routine, or a PID routine with sash-based feed forward control. Final tweaking of all of these parameters can be made via the display in the PID wizard screens.
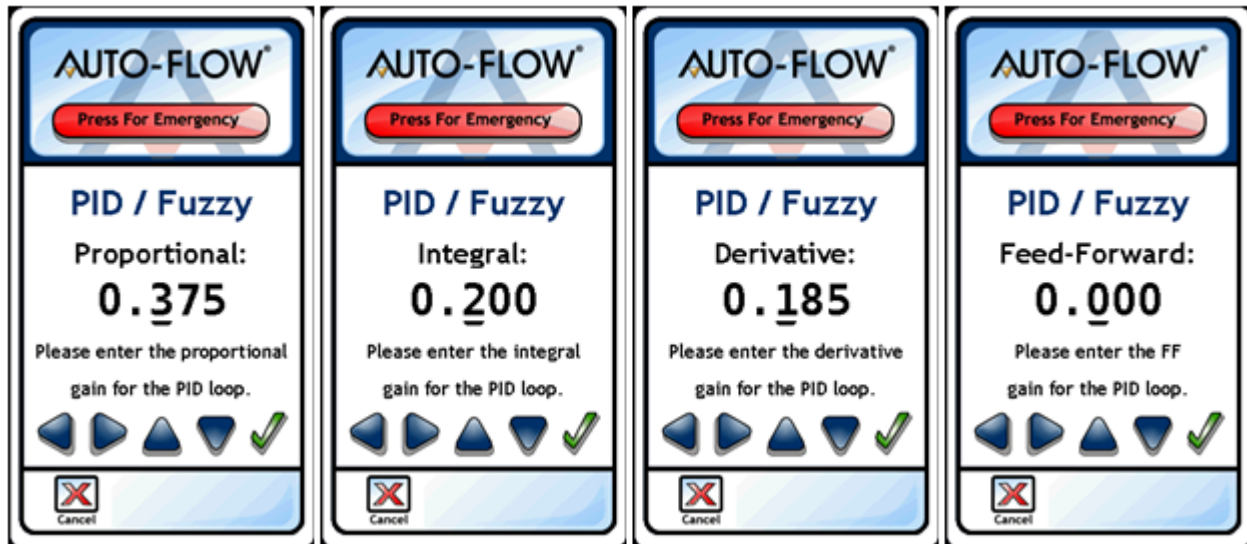
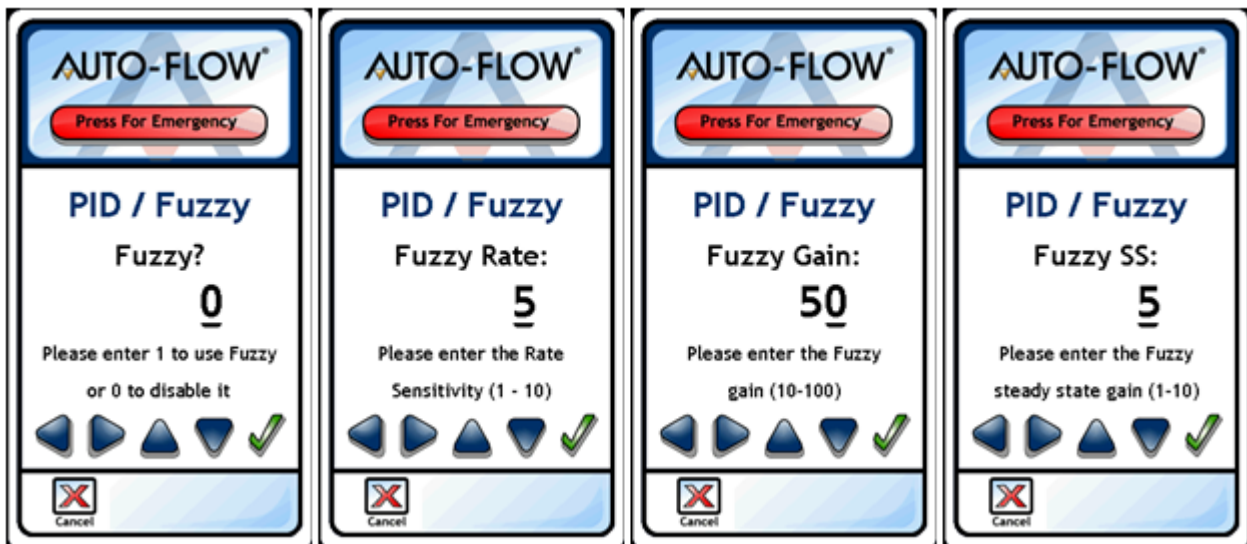*Figure 5-26 PID Wizard Screens (1 of 2)*

Figure 5-27 PID Wizard Screens (2 of 2)

5.5.13 Operator Permissions and Passwords

The Operators option provides access to setup and modify Operator Passwords and Privilege levels for the FHC-SD. Changes made through the FHC-SD to these parameters take effect immediately throughout the system. However, if you are modifying your own operator password and or privilege level, the change will not take effect until your login session has expired or manually logout.

The Privilege Levels for any user can vary from 0 to 2 where 0 indicates not logged in (or user not assigned/used), 1 indicates that this particular user has level 1 permissions and 2 indicates that they have full access to the display and all features therein.

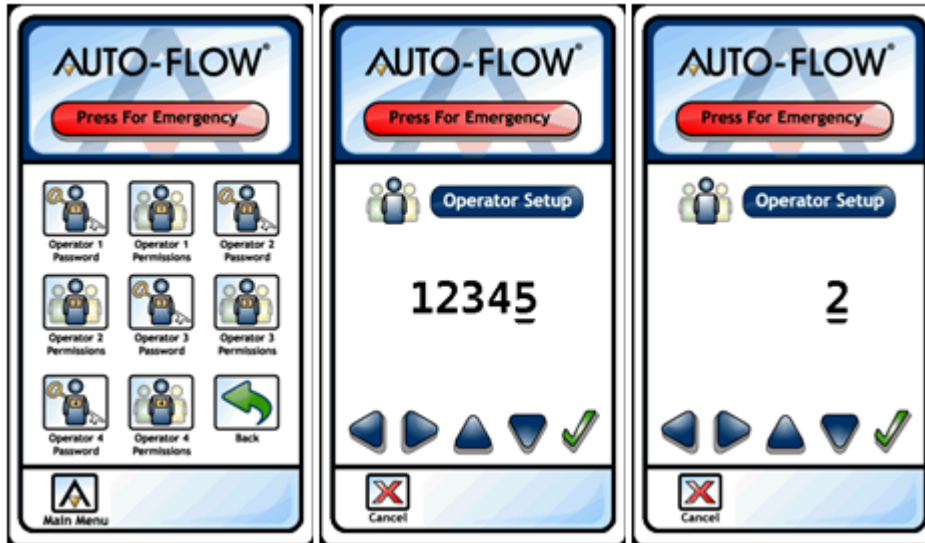The images below show an example of a user being set up with level 2 privileges and a password of 12345.

Figure 5-28 Operator Passwords and Permissions

5.6 UPDATE FIRMWARE

Updating the firmware on the display is very straightforward and simple. First, the new firmware needs to be copied to the root directory of an SD-Card. Note that the name of the firmware file can not be modified from the original, which is always "FHC_Disp.aff."

When navigating to the "Update Firmware" screen, the display will look for an SD card and will search out the FHC_Disp.aff file. If both are found and the file has been proven intact, the upgrade process will take over and automatically re-flash itself with the new firmware. This upgrade process is robust and there is no danger of "bricking" the display even in the event of a power outage during the upgrade process

Figure 5-29 Firmware Upgrade in Process