# Fume Hood Controller

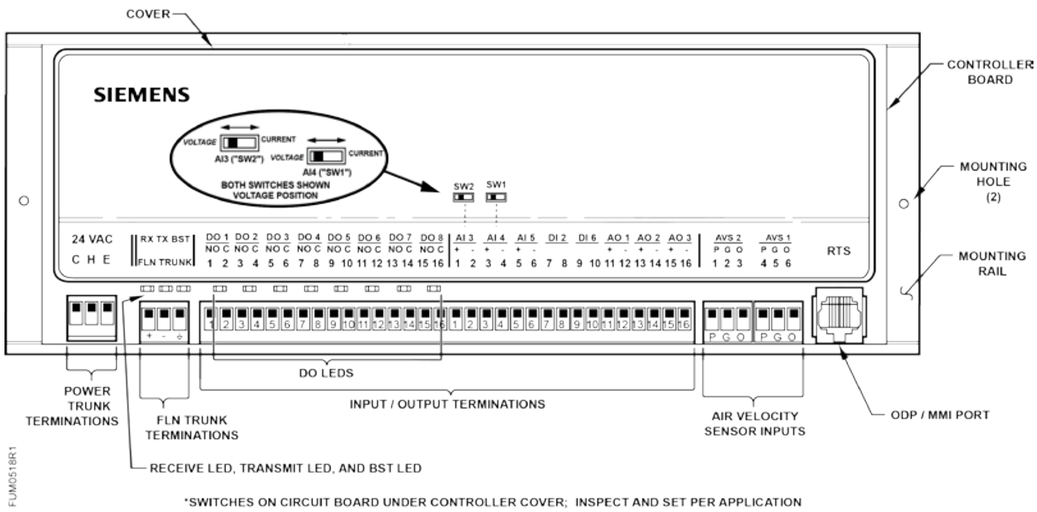
# 2-Position Constant Volume with Damper

## Start-up Procedures

# Table of Contents

# Before You Begin

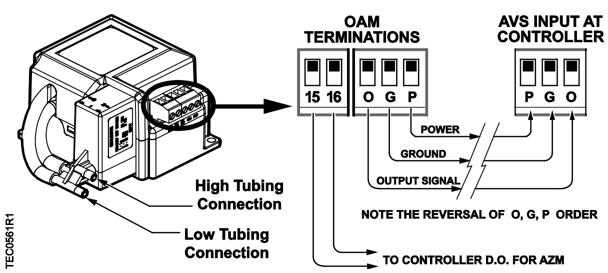
| | |
|---|---|
| | ⚠ WARNING |
| | **A fume hood is a safety device.**<br>Anyone attempting to start up a Fume Hood Controller and its related equipment should have completed Operations Training. |




*Generic Controller I/O Layout. See Wiring Diagram for application specific details.*

At the job site, locate the major control system and the mechanical and electrical drawings. These components include valves, motors, and any other components working in conjunction with the Fume Hood Controller (FHC).

Verify that the FHC input/output (I/O) points are wired per the installation instructions.




*Offboard Air Module Wiring.*

**CAUTION**

**The FHC-OAVS has two terminal blocks with terminations numbered identically (terminations 1 through 16). DO NOT mix these up with each other.**

If the FHC-OAVS is not connected as shown, it is not resistant to electrical surges. It is also susceptible to interference from other equipment.

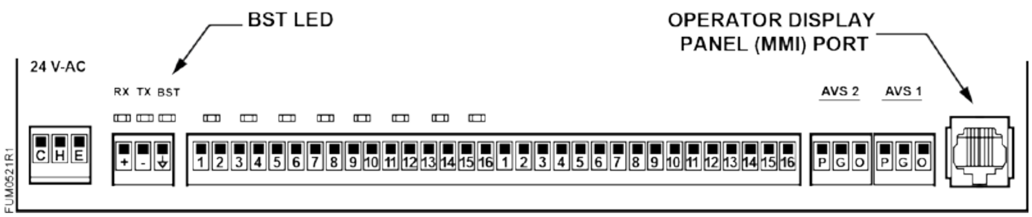
**CAUTION**

**A separate power supply is required if a 4-20 mA sensor is used.**

Failure to follow wiring precautions will result in equipment damage.

# Verifying Power

1. Verify that the controller has 24 Vac power and that the fuse has been inserted into the trunk or that power to the transformer is ON.
2. Verify that the Basic Sanity Test (BST) LED on the controller flashes once per second.

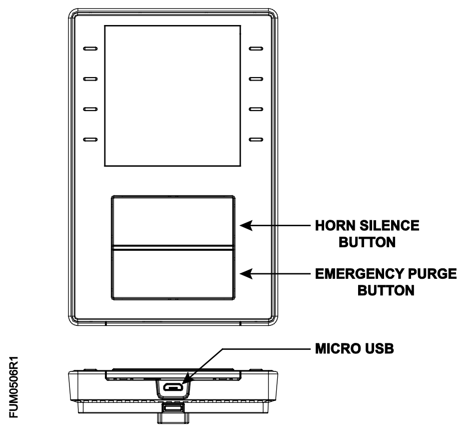


# Verifying Slave Mode Application Number

1. Plug the cable into the micro USB port.

   NOTE:
   Drivers for the ODP II port must be loaded to your computer prior to being able to communicate with the ODP II. Drivers can be found on the Technical Support Website.

2. Verify that Application 2900 (Slave Mode) is running at the controller.




# Setting Controller Address

1. In WCIS, select **View > Edit/View Reports**.
2. Select a report from the list and click **Apply**.
3. Set the controller address by setting CTLR ADDRESS to the appropriate number. (Addresses 00 through 98 are valid; 00 through 31 are typically used.)

**NOTE:**
Update each controller at the field panel immediately after you complete the controller start-up procedures and have made all other changes to the controller's point database (including balancing, tuning, and so on.)

# Setting the Application

1. Add the controller to your job database and select the desired application.

- 2900 Slave Mode
- 2940 2-Position Constant Volume Fume Hood with Damper

At the start of the calibration cycle, the controller automatically sets CAL AIR to YES. When the cycle is complete, CAL AIR returns to NO.

The air velocity sensor calibration cycle begins within three minutes of an application start-up or initialization, depending on the controller's address.

# Setting Display Units

Set ENG UNITS to English or System International (SI) units (default is English units) depending upon which unit (fpm or m/sec) you want displayed at the Operator Display Panel.

**NOTE:**
All measurements entered during the start-up sequences may be entered as either English or SI values (listed in parentheses after the English unit), depending upon which unit has been selected using the Metric/English Units button on the appropriate tool.

# Testing the Operator Display Panel

Test the Operator Display Panel (ODP) as follows:

1. Set LAMP TEST to **ON**.
2. Verify that all visual display functions of the ODP appear and that the audible alarm sounds continuously.
3. Set LAMP TEST to **OFF**.

# Setting Duct Area

If provided, enter the duct area (sq ft or sq m) into DUCT AREA.

If you do not know the duct area, use the appropriate tool to calculate it, or use one of the following equations to calculate it manually:

| Area = | Round Duct | Rectangular Duct |
|---|---|---|
| Area in Sq. Ft.<br>(Dimensions in inches) | $\pi \times R^2/144$<br>(where R = radius of duct) | Width x Height/144 |
| Area in Sq. M<br>(Dimensions in centimeters) | $\pi \times R^2/10{,}000$<br>(where R = radius of duct) | Width x Height/10,000 |

**NOTE:**
When entering the controller definition for a controller at the field panel, do not enter a duct area. (Choose **N** for none when prompted for the duct shape.) This controller does not send the value of air volume to the field panel in velocity (fpm). Instead, it uses volume (cfm) so a conversion is not necessary.

# Setting Airflow Sensing Input

The controller allows the exhaust volume to be measured in several different methods.

- Differential pressure on AVS-1 (default)
- Differential pressure signal on AI3
- Linear flow signal on AI3

When not using the default method, refer to the *Setting Airflow Input Type* section.

# Setting Flow Coefficients

**CAUTION**

**It is extremely important that the flow readings are accurate.**
Inaccurate flow readings will cause control problems.

**NOTE:**
The *Laboratory Room Exhaust Air Terminal Technical Specification Sheet* (149-320), has a full listing of the latest coefficients for multiple setups. Those coefficient values are initial values only. Actual values must be verified by the balancer.

**NOTE:**
Make sure the airflow sensors are calibrated before determining flow coefficients. This is done by setting CAL AIR to **YES** and waiting for it to switch back to NO on its own.

1. Set FLO COEF to initial values that match your hardware configuration.
2. Work with a balancer to obtain the exact value(s) for FLO COEF using the following formula to fine-tune the flow coefficient:

**New Flow Coefficient = (Actual Volume ÷ Controller Volume) × Old Flow Coefficient**

The actual volume is the value obtained from the balancer’s measurements. The controller volume is the value obtained from EXH VOL. If the controller volume is not within 5% of the actual volume, repeat the procedure until it is. Loose or kinked flow sensor tubes, tubing connected backwards, and improper actuator and/or Damper operation can cause inaccurate readings.

# Automatic Calibration Option

This only functions when using the OAVS. To set CAL SETUP, select the automatic calibration option that best meets the job’s requirements from the following table. It is highly recommended that Option 4, the factory default mode, be used.

At the start of the calibration cycle, the controller automatically sets CAL AIR to **YES**. When the cycle is complete, it sets CAL AIR to **NO**.

**NOTE:**
The air velocity sensor should be calibrated at least once every 24 hours. Make sure that the sensor has been calibrated before balancing takes place, as this will affect the balancer's results.

| CAL SETUP Options. | |
|---|---|
| **CAL SETUP Option Values** | **Description** |
| 0 | Calibration occurs ONLY when CAL AIR is set to YES. |
| 1 | Calibration occurs with an occupied to unoccupied mode changeover. |
| 4 (factory default mode) | Calibration occurs on the time interval set in CAL TIMER.<br>**Example:** If CAL TIMER = 12, then the calibration period is 12 hours. In this option, actual calibration is subject to a time delay of up to 10 minutes to prevent it from interfering with a response to fume hood flow change(s). This is the recommended option when using a controller with an Autozero Module. |

# Setting Blank Display

Set BLANK DSPLY to NO in order to display airflow readings at the ODP.

**NOTE:**
If BLANK DSPLY is set to YES, alarms will still display at the ODP.

# Setting Display Weight

Set DISPLAY WT to a value of 0 through 100% (default is 100%). The suggested value is 30%.

**NOTE:**
If DISPLAY WT is set to 100%, the exhaust volume displayed at the ODP may fluctuate rapidly. This rapid fluctuation is due to the constant adjustments of the FHC. When DISPLAY WT is set to a value less than 100%, the exhaust volume displayed at the ODP is a weighted calculated value. This value is used to stabilize the ODP displayed value only; it has no effect on the control sequence.

If you set DISPLAY WT to zero, the Operator Display Panel will "freeze" at the last read value. Setting DISPLAY WT to a value other than zero (suggested value is 30%) allows the Operator Display Panel to update the displayed exhaust volume.

# Setting Display Resolution

Set DISPLAY RES to a value of 0 through 255 cfm (0 to 120 lps). The default is 20 cfm (9.4 lps). This value is used as a COV limit for face velocity readings displayed at the ODP only; it has no affect on the control sequence and has no effect on values going across the network.

**NOTE:**
If you set DISPLAY RES to zero, the Operator Display Panel will “freeze” at the exhaust volume setpoint EXH VOL STPT. Setting DISPLAY RES to a value other than zero allows the Operator Display Panel to update the displayed exhaust volume.

# Setting High Flow Setpoint

Set EXH HI STPT to the desired air volume. Values are in CFM (LPS). The valid range of values will depend on the size of the exhaust duct.

# Setting Low Flow Setpoint

Set EXH LO STPT to the desired air volume. Values are in CFM (LPS). The valid range of values will depend on the size of the exhaust duct.

# Setting ODP Display

Set ODP DISPLAY to the desired value. Values are CFM or MODE. In CFM, the ODP displays the exhausted CFM. Use the table below to set the value. The default value is MODE.

| ODP Display | Flow Setpoint | Actual display on the ODP |
|---|---|---|
| Cfm | HI | Cfm |
| | Low | Cfm |
| | | |
| Mode | HI |  |
| | Low |  |

# Setting Hi and Low Warn Limits

Skip this step unless there is a special requirement on the job; the default will be used.

1. Change report to **STARTUP**.
2. Set HI WARN LMT and LOW WARN LMT.
   These limits are defined as a percentage of the controlled setpoint, meaning that the alarm limits will be closer as the EXH STPT decreases. The default values are 135% and 85% respectively. These points may be adjusted to meet customer requirements.

# Setting Hi and Low Alarm Limits

Skip this step unless there is a special requirement on the job; the default will be used.

1. Change report to **STARTUP**.
2. Set HI ALM LMT and LOW ALM LMT.
   These limits are defined as a percentage of the controlled setpoint, meaning that the alarm limits will be closer as EXH STPT decreases.

   The default values are 150% and 70% respectively. These points may be adjusted to meet customer requirements.

# Setting Alarm Timer

Skip this step unless there is a special requirement on the job; the default will be used.

- Set ALARM TIME to a value of 1 through 255 seconds.
  This is the time the flow must be in an alarm or warn condition before the alarm will sound. The alarm clears immediately upon returning to normal operation. The default for ALARM TIME is 5 seconds.

# Setting Emergency Setpoint

Skip this step unless there is a special requirement on the job, the default will be used.

- Set EMER STPT to a value of 0 through 255%; default value is 150%.
  This percentage, multiplied by the normal EXH STPT, is used to set the fume hood to a safe operating level during the second phase of the emergency purge sequence.
  **NOTE:** If EMER STPT is set to a value less than 100%, the exhaust flow will be reduced during the emergency purge sequence.

# Setting Emergency Timer

Skip this step unless there is a special requirement on the job, the default will be used.

- Set EMER TIMER to a value of 0 through 32,767 seconds; default is 300 seconds.
  This is the time the fume hood will be at full exhaust during the first phase of the emergency purge sequence.
  **NOTE:** If EMER TIMER is set to zero, the FHC immediately sets the exhaust flow to EMER STPT when the emergency purge button is pushed.

# Setting Damper Control

Skip this step if you are using high speed actuators from Siemens Industry, Inc.

The application has the option of not inverting DO2 operation. An inverted RETC DO2 means that to hold a position, the RETC DO2 must remain on.

- Set INVERT DO2 by selecting one of the following:
  – **YES** to invert RETC DO2 (default).
  – **NO** for non-inverted operation.

# Checkout of Damper

1. Set DMPR CMD to **100.0**. The damper moves to the fully opened position.
2. Set DMPR CMD to **-100.0**. The damper moves to the fully closed position.
3. If the damper moves opposite of the way it should, reverse the wires on EXTN DO1 and RETC DO2 on the FHC terminal block.
4. Release DMPR CMD. Verify the point has been released.

# (Optional) Setting Airflow Input Type

If you are using a Siemens terminal box/Venturi valve with an OAVS sensor, you can skip this section.

Otherwise, if the job uses differential pressure sensors, Vortex shedders or another linear device made by others, perform the steps in this section.

**NOTE:** When using AI-3 to input the airflow, the input can't be used as an input for External Face Area.

## Setting Transmitter Range

1. Set TRANS RANGE to the value printed on the differential pressure transmitter, typically: 0.1 in. WC (25.3 Pa), 0.25 in. WC (62.275 Pa), 0.5 in. WC (124.55 Pa), or 1.0 in. WC (249.1 Pa). Any value from 0.0 to 2.55 in. WC is acceptable. The default value is 0 in. WC.
2. Zero the transmitter by doing one of the following:
   – If an Autozero module is not present, proceed to *Calibrating the DP Transmitter without an Autozero Module*.
   – If an Autozero module is present, proceed to *Calibrating with an Autozero Module*.

**NOTE:**
If the milliamp reading from the transmitter is less than 3.7 mA or more than 4.3 mA with the high and low ports disconnected, you must zero the DP transmitter using the zero screw on the DP transmitter.

### Linear Flow Input Signal

This section is used if the job has Vortex shedders or another linear device made by others. CAL SETUP does not function in this mode.

1. Set TRANS RANGE to = **0** (default value).
   ⇨ TRANS RANGE must be 0 for the linear input function to work.
2. Enter the velocity range of the linear device into LINEAR FL RG.
3. Set FLOW COEF to **1.**

Proceed to *Flow Accuracy Verification*.

## (Optional) Calibrating the DP Transmitter without an Autozero Module

This section applies for fume hoods with an external pressure sensor and without an Autozero module. If the DP Transmitter is slightly out of adjustment, you can compensate for that within the controller.

1. Set REPORT to **AIRFLOW IN**.
2. Remove the tubing connected at the HI and LO ports of the DP transmitter (the tubing can be disconnected at the flow sensor if desired). Both ports must be disconnected to calibrate the transmitter.
3. Set CAL AIR to **YES**. The calibration will take approximately 3 seconds. When calibration is completed, this point will automatically change back to NO.
4. When **CAL AIR** changes back to NO, reconnect the HI and the LO tubing to the transmitter (or to the flow sensor if you disconnected it there).

## (Optional) Calibrating with an Autozero Module

This section is for fume hoods with an external pressure sensor and an Autozero module. If the DP Transmitter is slightly out of adjustment, you can compensate for that within the controller.

1. Set REPORT to **AIRFLOW IN**.
2. Set CAL AIR to **YES.**
   **When calibration is completed, this point will automatically change back to NO.**

# AVS FAILMODE

AVS FAILMODE is a point that describes how the Venturi Air Valve will respond if the Air Velocity Sensor (AVS1) fails.

Set AVS FAILMODE to the desired value.

| AVS1 failure and AVS FAILMODE values. | |
|---|---|
| | AVS FAILMODE |
| OPEN<br>(default) | Exhaust fails Open |
| HOLD | Exhaust Holds current Position |

# Setting AO2 Range

1. Set REPORT to **AIRFLOW IN**.
2. Do one of the following:
   – For a single Fume Hood wired to an LRC:
   Set AO2 RANGE to the maximum expected flow for the fume hood, plus approximately 10%. For example, if the maximum flow is 900, set it to 1000.
   – For two to six Fume Hoods wired to an LRC using a Fume Hood Averaging Module:
   Set AO2 RANGE to the maximum expected flow for the largest fume hood, plus approximately 10%.
   The AO2 RANGE point must be set to the same value for all fume hoods connected to the Fume Hood Averaging Module.
   ⇨ AO2 is now active and a proportional 1 to 10V signal can be read on AO2.
3. Set AO2 DEADBAND to the desired value.

**NOTE:**
AO2 DEADBAND can be set from 0 to 102% in 0.4% increments. 0% will give the actual flow all the time. This signal may be too bouncy to give a stable output and will cause short-term room instability during fume hood sash movements. A 10% deadband is equal to ±5% of the flow. Any value over 100% will turn the feature off and revert to standard control.

For stable pressure reading, lower the AO2 DEADBAND. For unstable pressure readings, raise the AO2 DEADBAND until the output signal stabilizes.

# Setting AO2 Voltage Minimum

This section can be skipped, if the FHC is connected to a room controller or field panel from Siemens Industry, Inc.

This function allows the minimum voltage to be set to a value other than 1 (default). The minimum voltage is output when the flow is equal to 0 cfm.

- Set AO2 V MIN to the desired value.

# Start-up/Decommission Mode

The Fume Hood Controller contains different modes controlled by STARTUP MODE (default is 3). These modes of operation allow the controller to be started up without the sound of nuisance alarms at the hood. These modes are useful at different stages of construction and after decommissioning.

The FHC also contains decommission modes and allow some or all of the functionality of the controller to be turned off.

The modes are described as an enumerated point:

| STARTUP MODE | Mode | Description |
|---|---|---|
| 0 | Normal | The controller is fully functional. |
| 2 | Non-functional Decommission, closed | The controller is fully functional, except the flow setpoint is set to 0, alarming is limited and the ODP displays “Out of service” and “OFF”. If the sash is opened, nothing changes. |
| 3 (default) | Non-functional Startup | The controller is fully functional, except alarming does not work and the ODP displays “Controller – Startup” and “OFF”. |

The digital output DO6 can be used for local indication that the sash was opened after the hood entered Out of Service mode. The output will remain ON until STARTUP MODE is changed.

# Loop Tuning Procedures

Set REPORT to TUNING.

## General Information

The FHC uses one Proportional, Integral, and Derivative (PID) loop. It is similar to the LOOP in a PPCL statement except gains are smaller by a factor of 1000. The process variable (PV) is EXH VOL. The setpoint is EXH STPT. The control variable (CV) is DMPR CMD.

You can evaluate loop performance and do loop tuning by observing the display at the Operator’s Display Panel. The displayed face velocity is related to the exhaust flow, which is directly controlled by the loop.

However, the most reliable way to evaluate loop performance is to collect trend data on the exhaust volume and the exhaust setpoint.

When using the Operator Display Panel for loop evaluation or tuning, set DISPLAY WT to 100%.

## Loop Time

Commanding LOOP TIME controls the speed of the loop calculations. The value of LOOP TIME controls how often the loop calculations are performed. The default value is 0.1 seconds and can be increased to slow the response of the system.

## Steady State Performance

Steady state performance is the ability of the loop to maintain its setpoint. Variation of the EXH VOL from setpoint (with the sash position fixed) can be a sign of poor loop tuning. However, if the exhaust flow measurement is very noisy, even with a perfectly tuned loop, the exhaust volume display may still fluctuate.

To distinguish measurement noise from control loop hunting, set the DMPR CMD output to a fixed value (0%). This locks the actuator; any remaining variation is probably measurement noise.

Remember to release DMPR CMD when you are done.

## Dynamic Performance

Dynamic performance is the speed and the overshoot involved in the response of the face velocity to a movement of the sash. The face velocity display should return to within 10% of the setpoint in three seconds or less with minimal overshoot.

## Setting P-Gain

The loop should work well with P-only control. For any steady-state flow, the loop output settles at 0% to maintain the actuator at a fixed position.

## Trial and Error Method

If the loop responds too slowly to sash movement, double the EXH P GAIN and reevaluate it.

If the face velocity overshoots a lot or swings back and forth after a sash movement, decrease the EXH P GAIN and reevaluate it again.

## Exhaust Flow Accuracy Verification

This section presents the steps for verifying the exhaust flow accuracy.

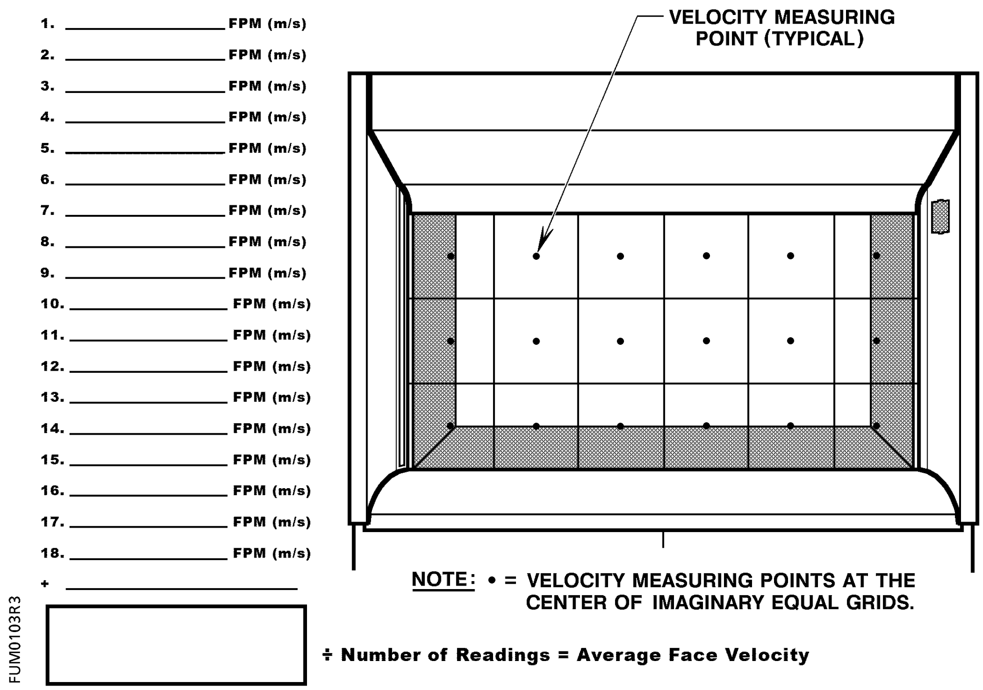
**NOTE:**
It is recommended that this procedure be performed with the balancer so that the flow coefficient is coordinated with the measured exhaust flow.

Verify the exhaust flow as follows:

1. Move the sash to an open position. Using a hand-held air velocity meter, perform a grid measurement of the face velocity. (Divide the face of the fume hood into 1’ × 1’ squares.) Calculate the average face velocity as shown in Figure *Grid Measurement of Face Velocity*.

2. Take the average measured face velocity and face area to determine the volume of air exiting the hood. Use the calculation shown below:
CFM = ((Average measured face velocity) x (Open area of the hood))

Start-up is now complete. Set **STARTUP MODE** to **0**, to enable the FHCs full functionality.




*Calculating Average Face Velocity*

# Flashing Controller Firmware

**NOTE:**
When re-loading/flashing firmware, existing PPCL may no longer function correctly.

## FLT Procedure

Use the Firmware Loading Tool (FLT) for this procedure.

1. Connect to the RTS port of the TEC.
2. Set Communications to **38400 baud**.
3. Click the **Identify** button.
4. Browse to the folder where the new firmware is saved.
5. Double-click the firmware file and then click **Load**.

## WCIS Procedure

1. Connect to the RTS port of the TEC.
2. From the **Device** menu, select **Load TEC Firmware**.
   ⇨ The **Load TEC Firmware** dialog box displays.
3. Click the **Browse** button.
4. Browse to the folder where the new firmware is saved.
5. Double-click the firmware file and then click **Load**.

Issued by
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