Model 8640
SUREFLOW ®

Face Velocity Controller

User's Guide

August 2000
P/N 1980149 Rev. B

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Service Policy

Knowing that inoperative or defective instruments are as detrimental to TSI as they are to our customers, our service policy is designed to give prompt attention to any problems. If any malfunction is discovered, please contact your nearest sales office or representative, or call TSI's Customer Service department at (651) 490-2711.

TABLE OF CONTENTS

INTRODUCTION

The Model 8640 User's Guide describes how to operate, calibrate, maintain and troubleshoot the Model 8640 Fume Hood Face Velocity Controller. Please read this guide thoroughly before using the Model 8640.

This guide assumes that Model 8640 has been properly installed. Refer to the Installation and Checkout Instructions if there is any question as to whether it has been installed properly.

The User's Guide has been divided into the following chapters to simplify its use.

Chapter 1 describes how to operate the Model 8640.

Chapter 2 describes how to calibrate the Model 8640.

Chapter 3 describes how to maintain the Model 8640.

Chapter 4 describes how to troubleshoot the Model 8640.

Appendix A lists the Model 8640 specifications.

Appendix B describes the Model 8640 theory of operation.

Appendix C describes how the Model 8640 is wired.

Appendix D describes how to measure face velocity.

References to the Model 8640 front panel are highlighted in this guide as follows:

Example: The ALARM light is red.

A black four-pointed star F is used throughout this guide to call attention to important notes or comments.

HELP!

Technical assistance:
Contact the TSI Industrial Test Instruments Group at (651) 490-2888.

Repair parts and service:
Contact the TSI Customer service department at (651) 483-4711.

CHAPTER ONE

OPERATION

The Model 8640 Fume Hood Face Velocity Controller is easy to use. Its operation is simple and straightforward. All the information you need to know about the face velocity is displayed on the velocity controller's front panel. The system is also easily calibrated via calibration adjustment screws accessed through holes in the front panel.

From an operations standpoint, the Model 8640 functions on two levels:

1. The controller's front panel provides indication of the face velocity via an analog meter, indication of the selected set point with a six-position selector switch and indication of low face velocity with an ALARM light.

2. The six-position selector switch on the controller's front panel also permits the the operator to select the face velocity control set point.

Specific details about the Model 8640 front panel display and controls are described on the following page.

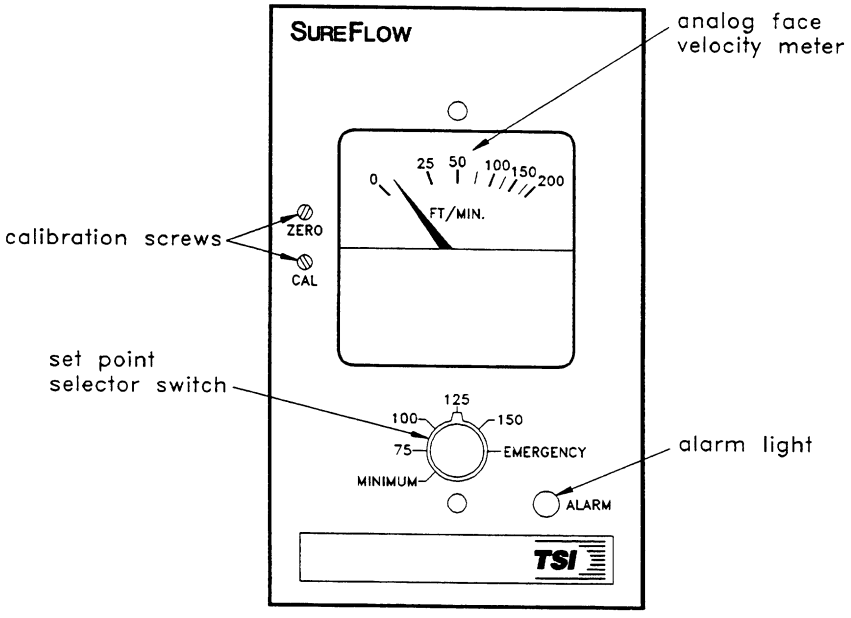

Figure 1. Model 8640 Front Panel Display and Controls

Front Panel Display *Analog Meter*

An analog meter indicates the face velocity. The meter has a range of 0 to 200 ft/min (0 to 1.0 m/s).

Set Point Indication

The six-position face velocity set point selector switch indicates the face velocity set point selected.

ALARM *Light*

The red ALARM light indicates low face velocity. The ALARM light turns on when the face velocity falls approximately 25 ft/min (0.125 m/s) or more below the selected set point. The alarm is activated after approximately a 10 second delay. When the face velocity increases to within 25 ft/min (0.125 m/s) of the selected set point, the ALARM light turns off after a delay of several seconds. The ALARM light also turns on whenever the set point selector switch is set to the EMERGENCY position.

Front Panel Controls

A six-position selector switch is provided for operator selection of the following face velocity control set points:

Setting*	Description
MINIMUM	Controls at 60 ft/min (0.300 m/s)
75 (0.375)	Controls at 75 ft/min (0.375 m/s).
100 (0.500)	Controls at 100 ft/min (0.500 m/s).
125 (0.625)	Controls at 125 ft/min (0.625 m/s).
150 (0.750)	Controls at 150 ft/min (0.750 m/s).
EMERGENCY	Maximum exhaust.

*English units are in feet per minute (ft/min), and metric units are in meters per second (m/s). The values for metric controllers are listed in parenthesis.

CHAPTER TWO

CALIBRATION

The Model 8640 Fume Hood Face Velocity Control System must be calibrated in order to accurately indicate and maintain face velocity. The calibration is a simple, two step procedure:

¶ Set the velocity calibration at zero flow.

· Set the velocity calibration span.

The following items are also needed to calibrate the Model 8640:

Masking Tape
Jeweller's straight-slot screwdriver
Portable Air Velocity Meter such as the TSI VELOCICALC® or VELOCICHECK®.

This chapter contains all the information needed to calibrate the Model 8640.

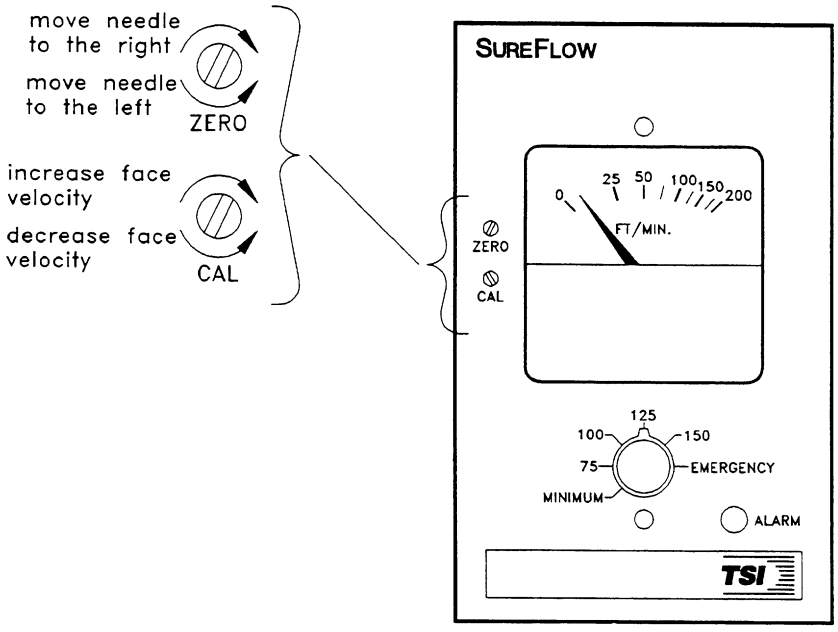

Figure 2. Model 8640 Calibration Adjustment Screw Locations

Calibration Procedure *Set the velocity calibration zero*

Place a piece of tape over the velocity sensor opening to seal off the air flow through the sensor. The tape must block all air flow from passing through the sensor.

NOTE:
The velocity sensor should be mounted on the inner sidewall of the hood four inches into the fume hood and four inches below the sash when the sash is full open.

·Wait two minutes for sensor to stabilize.
Set the velocity calibration zero by turning the ZERO adjustment screw clockwise or counter-clockwise until the indicator needle on the analog meter is aligned with the 0 ft/min (0 m/s) line. (Turn the ZERO adjustment screw clockwise to move the needle to the right and counter clockwise to move the needle to the left.)

Remove the tape from the sensor.

Set the velocity calibration span

¶ Set the set point selector switch to the velocity that the hood will normally control at (100 ft/min is typical). Set the baffles to the normal operating position.

·Wait 30 seconds for the sensor to stabilize.

_ Open the sash to the normal operating height or 60 percent of the full open position.

_ Use a portable air velocity meter to measure the average face velocity passing into the hood through the sash opening. See Appendix D for the proper method of measuring average face velocity.

º Compare the face velocity indicated on the Model 8640 to the face velocity measured by the portable air velocity meter.

» Set the velocity calibration span by turning the CAL adjustment screw clockwise or counter clockwise until the face velocity measured by the portable air velocity meter is the same as the face velocity indicated by the needle on the analog meter. Turn the CAL adjustment screw clockwise to increase the face velocity or counter clockwise to decrease the face velocity.

Allow several seconds for the control system to respond to changes and stabilize when making CAL adjustments. Each full turn of the CAL adjustment screw will increase or decrease the face velocity by approximately five ft/min.

The face velocity indicated on the analog display is not the same as the actual average face velocity unless the controller has been calibrated.

For example:

If the set point selector switch is set to 100 ft/min the needle on the analog display will indicate 100 ft/min +/-10 percent, while the actual average face velocity may be only 70 ft/min. In this case one would turn the CAL adjustment screw clockwise to increase the actual average face velocity to 100 ft/min.

¼ Verify that the Model 8640 controller maintains a constant face velocity by changing the sash position and then comparing the measured face velocity(portable air velocity meter) to the indicated face velocity (8640).

CHAPTER THREE

MAINTENANCE and REPAIR

The Model 8640 Fume Hood Face Velocity Controller is almost maintenance free. Periodic inspection of system components and calibration as well as an occasional velocity sensor cleaning are all that are needed to insure that the Model 8640 is operating at optimum performance.

System Component Inspection

Periodically inspect the various system components for proper performance and signs of excessive wear.

Calibration

The Model 8640 should be calibrated annually. Refer to Chapter Two for calibration instructions

Velocity Sensor Cleaning

Significant build-up of contaminants including dust and dirt on the velocity sensor can degrade its performance and throw it out of calibration. It is recommended that the velocity sensor be periodically inspected for accumulation of contaminants. The frequency of these inspections is dependent upon the quality of the room air being drawn across the sensor. Quite simply, if the air in the room is dirty, the sensor will require more frequent inspection and cleaning.

CAUTION:
Turn off power to the Model 8640 prior to cleaning the velocity sensor.

CAUTION:
Do not use compressed air to clean the velocity sensor.

Visually inspect the velocity sensor. The air flow orifice should be free of obstructions. The small, cylindrical, ceramic sensor protruding from the orifice wall should be white and free of accumulated debris.

Accumulations of dust or dirt can be removed with a soft-bristled brush(such as an artist's brush), or by blowing the orifice clean with canned compressed air. Water, alcohol, acetone, or trichlorethane may be used as a solvent to remove other contaminants if required.

WARNING:
Do not attempt to scrape contaminants from the velocity sensor. The velocity sensor is quite durable, however, scraping may cause

mechanical damage and possibly break the sensor. Mechanical damage due to scraping voids the velocity sensor warranty.

WARNING:
Use extreme care when cleaning the velocity sensor. The ceramic sensor may break if excessive pressure is applied or if the cleaning apparatus abruptly impacts the sensor.

CAUTION:
If a solvent is used to clean the velocity sensor insure that it is completely dry before performing calibration.

Replacement Parts

All components of the Model 8640 are field replaceable. Contact TSI Industrial Test Instruments Group at (651) 490-2888 or your nearest TSI Field Representative for replacement part pricing and delivery.

Part Number	Description
800335	Face Velocity Controller - Damper Version
800329	Face Velocity Controller - Motor Version
800118	Electric Actuator
800199	Controller Output Cable
800119	Electric to Pneumatice Interface
800116	Pneumatic Actuator
800320	Velocity Sensor
800325	Sensor Cable
800414	Transformer Cable
800420	Transformer

CHAPTER FOUR

TROUBLESHOOTING

The fume hood exhaust system must be operating properly before troubleshooting the Model 8640. A properly operating exhaust system will typically provide enough static pressure to draw at least 100 ft/min (0.050 m/s) through the face with the sash fully open and the control damper fully open.

If the velocity sensor or actuator is suspected to be defective, follow the tests given at the end of this chapter.

Symptom	**What to Check**
Model 8640 is not controlling face velocity and the analog meter indicates 0 ft/min. Move the sash to determine if the Model 8640 is controlling. The face velocity should remain constant as the sash position is changed	Check for 24VAC between pins 1 and 2 on the 10 pin connector. Is the 10 pin connector plugged into back of controller? Is the 10 pin connector plugged into controller backwards? (This connector is keyed and very difficult to plug in backwards Is the internal controller fuse tripped? (Remove power from controller, wait 20 seconds for fuse to cool and automatically reset, and restore power. If unit still doesn't work, repeat the procedure. If it doesn't work the second time, send controller to TSI for repair.)
Model 8640 is not controlling	Is the controller wired to face velocity and the analogthe actuator or motor speed meter indicates face velocity controller correctly? (See diagrams in Appendix C for correct wiring. Does the damper move when the sash is moved? (Actuators may be defective. Use procedure at end of this chapter to test actuators.)
Model 8640 forces the hood to maximum face velocity and the analog meter indicates a low face velocity.	Is the velocity sensor cable plugged in backwards? (This connector is keyed and very difficult to plug in backwards)

Symptom	What to Check
Model 8640 forces the hood to maximum face velocity and the analog meter indicates a low face velocity	Check velocity sensor cable for opens or shorts.
Model 8640 forces damper fully open or blower fully on and the analog meter indicates a high face velocity	Is wiring between controller and actuator or motor speed controller correct? See wiring diagrams in Appendix C for correct wiring Is actuator jumper wire in correct position? Is damper stuck in full open position? Is damper 90 degrees out of phase so that when controller thinks it is closing the damper, it is actually opening it?
Model 8640 forces the damper fully closed or blower fully off and the analog meter indicates a high face velocity.	Is velocity sensor cable connected? Check velocity sensor cable for opens or shorts.
Model 8640 forces the hood to minimum velocity and the analog meter indicates a low face velocity	Is wiring between controller and actuator or motor speed controller correct? Is actuator jumper wire in correct position? Is damper stuck in full closed position? Is damper 90 degrees out of phase so that when controller thinks it is closing the damper, it is actually opening it? Is damper a normally closed type (pneumatic only)? Is the set point selector switch halfway between two positions?

To test velocity sensor:

Disconnect the velocity sensor from the sensor cable. Depress the latching piece on the connector to pull it out. Use an ohm meter to measure the resistance between the sensor pins indicated in figure 3. The resistance between pins 3 and 4 should be between 10 and 12.5 ohms. The resistance between pins 2 and 4 should be between 120 and 140 ohms.

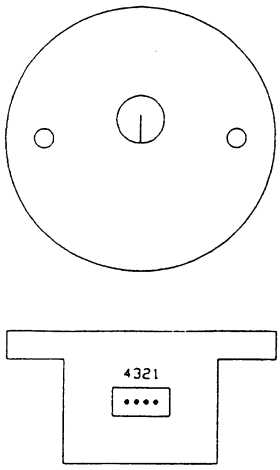

Figure 3. Model 8640 Velocity Sensor Pinouts

To test the electric actuator (p/n = 800118):

Move the fume hood sash to a 50-percent open position. Turn the velocity controller to the minimum position. The damper should be closed somewhat. Measure face velocity through the sash. Turn the velocity controller to emergency. Measure velocity through sash. It should go up. If velocity goes down, check jumper wire installation.

If actuator has no movement, remove screws to separate the controller from the fume hood. Turn the setpoint selector switch so that it is between two positions (any two positions). The voltage across pins 5 and 6 should slowly change from approximately 10 volts to approximately -0.4 volts. Turn the velocity setpoint switch to

emergency. The voltage across pins 5 and 6 should be approximately 10 volts. If these voltages are correct, check actuator/damper for proper mounting.

To test the electric to pneumatic interface (e/p) (p/n = 800119):

Move the fume hood sash to a 50-percent open position. Turn the velocity controller to the minimum position. The damper should be closed somewhat. Measure face velocity through the sash. Turn the velocity controller to emergency. Measure velocity through sash. It should go up. If velocity goes down, check jumper wire installation.

If actuator has no movement, remove screws to separate the controller from the fume hood. Turn the setpoint selector switch so that it is between two positions (any two positions). The voltage across pins 5 and 6 should slowly change from approximately 10 volts to approximately -0.4 volts. Turn the velocity setpoint switch to emergency. The voltage across pins 5 and 6 should be approximately 10 volts. If these voltages are correct, check actuator/damper for proper mounting.

n

APPENDIX A

SPECIFICATIONS

System Performance Specifications

Response Time ..... 5 seconds nominal for 50 ft/min step change

Temperature Compensated Range ..... 55 to 95° F

Model 8640 SUREFLOW Components

Face Velocity Controller

Face Velocity Display Range ..... 0 to 200 ft/min

Outputs

Voltage Output ..... 24 VAC, 4 watts max

Alarm Contacts ..... SPST (N.C.) 0.5 amps at 10 watts max, 24 VAC max. Contacts close in alarm conditions and loss of power.

Operating Temperature ..... 40 to 120° F

Input Power ..... 24 VAC, 5 watts max

Dimensions ..... 5" x 3.125" x 1.5"

Weight ..... 0.7 lb

Velocity Sensor

Dimensions (DxH) ..... 2.75 in. x 1.25 in.

Weight ..... 0.2 lb

Power Dissipation ..... 0.09 watts at 0 ft/min., 0.14 watts at 100 ft/min.

Cable Specifications ..... 4-conductor, 22 AWG, 4-pin polarized at both ends with a standard length of 5 ft, a maximum length of 10 ft.

Transformer

Primary	120 VAC	
Secondary	24 VAC	
Rating	20 VA	
Dimensions (HWD)	2.0 in. x 2.25 in. x 1.5 in. (mounts to 4 in. x 4 in. duplex box)	
Weight	1.3 lb.	
UL/CSA Approved	Yes	
Cable Specifications	2-conductor, 18 AWG with standard length of 25 ft, maximum length of 100 ft.	

Damper/Actuator

Standard Materials	16-gauge galvanized, Type 304 SS or Type 316 SS	
Optional Coating	Plasite No. 7122 finish	
Types of Actuators	Electric or pneumatic	
Input Power*	Electric:	24 vac, 7.5 watts max
	Pneumatic:	24 VAC, 3 watts max
Time for 90° Rotation	5 sec.	

*Actuator power only. No controller.

APPENDIX B

THEORY OF OPERATION

Introduction to the Model 8640 Fume Hood Face Velocity Controller

The Model 8640 Face Velocity Controller maintains a constant hood face velocity regardless of sash position. This improves operator safety by insuring there is always adequate face velocity into the hood. Controlling the face velocity also reduces the quantity of conditioned air exhausted.

The Model 8640 controls a fume hood by measuring the face velocity and modulating the exhaust volume in order to maintain a constant face velocity. The face velocity is measured by a sensor mounted in the hood's inner sidewall.

How it Works

The exhaust system in an operating fume hood produces a low static pressure which causes air to be drawn through the hood.

The Model 8640 measures the velocity of this airflow with a thermal anemometer sensor mounted in the sidewall of the hood. Since they are driven by the same differential pressure, the velocity across the face of the hood (face velocity) is the same as that across the velocity sensor. The controller compares the measured velocity to the selected set point and varies the control output to maintain that set point. The controller modulates either an electrically-actuated damper, a pneumatically-actuated damper or the exhaust fan speed via an AC-adjustable frequency drive.

Technical Description *Velocity Sensor*

The Model 8640 Fume Hood Face Velocity Controller uses a thermal anemometer sensor to measure the face velocity. The sidewall mounted velocity sensor assembly actually consists of two sensors: an air velocity sensor and a temperature compensation sensor. The velocity sensor is heated to 35° Celsius above the ambient air temperature by the controller electronics. The temperature compensation sensor corrects for changes in the ambient air temperature and forces the velocity sensor to remain at a constant temperature above the ambient air temperature (constant overheat).

The velocity sensor and temperature sensor form two legs of a Wheatstone bridge as shown in figure 4. The bridge circuit forces the voltages at points A and B to be equal. Air flowing past the velocity sensor cools the sensor, reducing its electrical resistance, which causes the voltage at point A to decrease. An operational amplifier instantly responds to this change by increasing the power at the top of the bridge until the voltage at point A increases and is equal to the voltage at point B. As more air flows past the sensor, more power is required to maintain a balanced bridge. Thus, the voltage required at the top of the bridge to maintain a constant overheat is directly related to the velocity of the air flowing past the sensor. This is the principal of operation of all constant-temperature thermal anemometers.

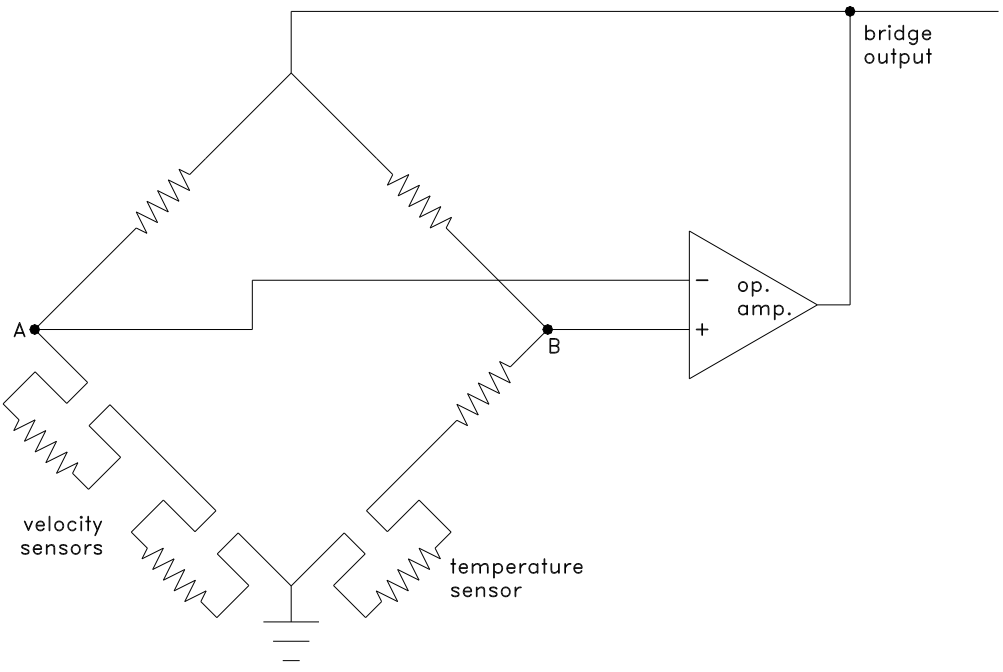

Figure 4. Model 8640 Bridge Circuit

Velocity Controller

The velocity controller reads the voltage at the top of the bridge circuit and compares this value to the selected set point value. If the face velocity is outside of the control deadband the velocity controller outputs a control signal to the final control element(damper or AC-adjustable frequency drive) to bring the face velocity back to set point.

APPENDIX C

WIRING DIAGRAMS

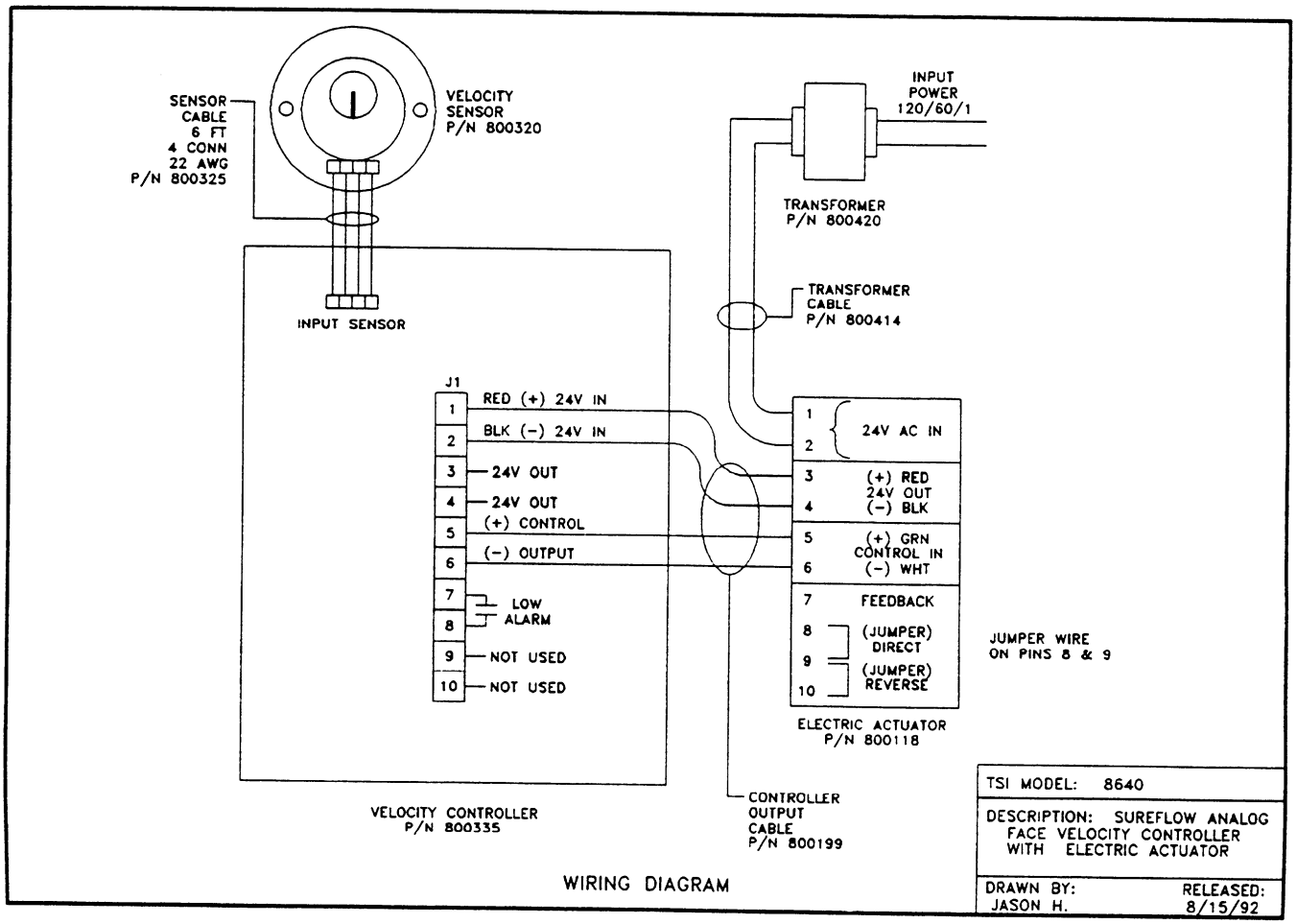

Figure 5. Model 8640 Electric Actuator Wiring Diagram

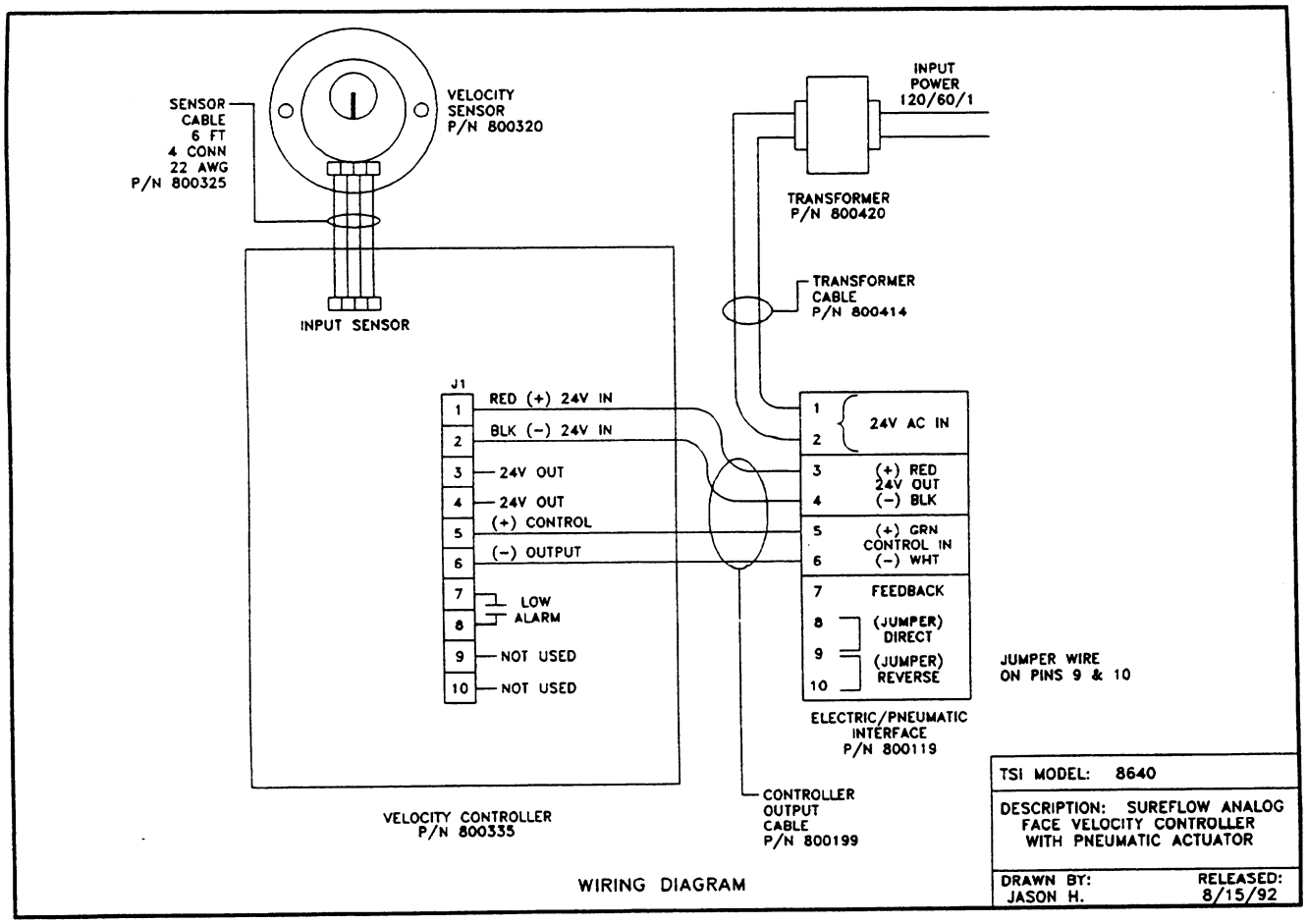

Figure 6. Model 8640 Pneumatic Actuator Wiring Diagram

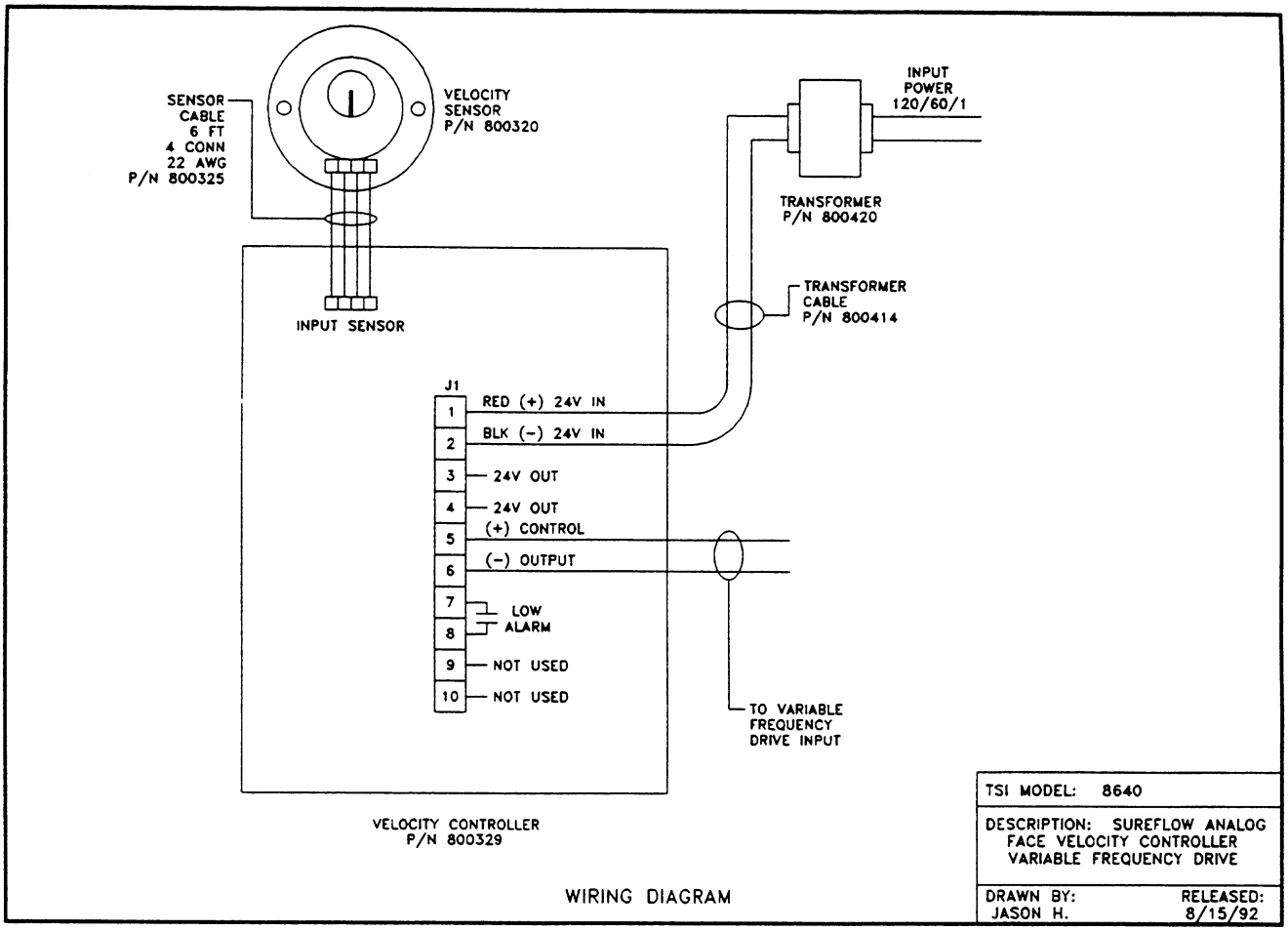

Figure 7. Model 8640 Variable Frequency Drive Wiring Diagram

APPENDIX D

FACE VELOCITY MEASUREMENTS

Prior to calibrating a fume hood face velocity fume hood controller, the average face velocity of the fume hood needs to be established. "ASHRAE standard 110-1985, Method of Testing Performance of Laboratory Fume Hoods, section 6.3 Face Velocity Measurements", describes how to establish an average face velocity. The following procedure to establish average face velocity complies with the requirements of ASHRAE 110-1985.

TSI fume hood face velocity controllers should be calibrated with the fume hood sash open 18 inches. The average face velocity should also be established at this position, so that the two correlate.

A portable air velocity meter is required to make the face velocity measurements. TSI recommends the Model 8350 VELOCICALC air velocity meter due to it's ability to measure low velocities accurately, and for the averaging capabilities which greatly simplifies the calculation of average face velocity.

Figure 8 below shows a typical 5 foot fume hood that needs to have the average face velocity established. The first step is to move the sash so there is 18 inches between the bottom of the sash and the top of the air foil.

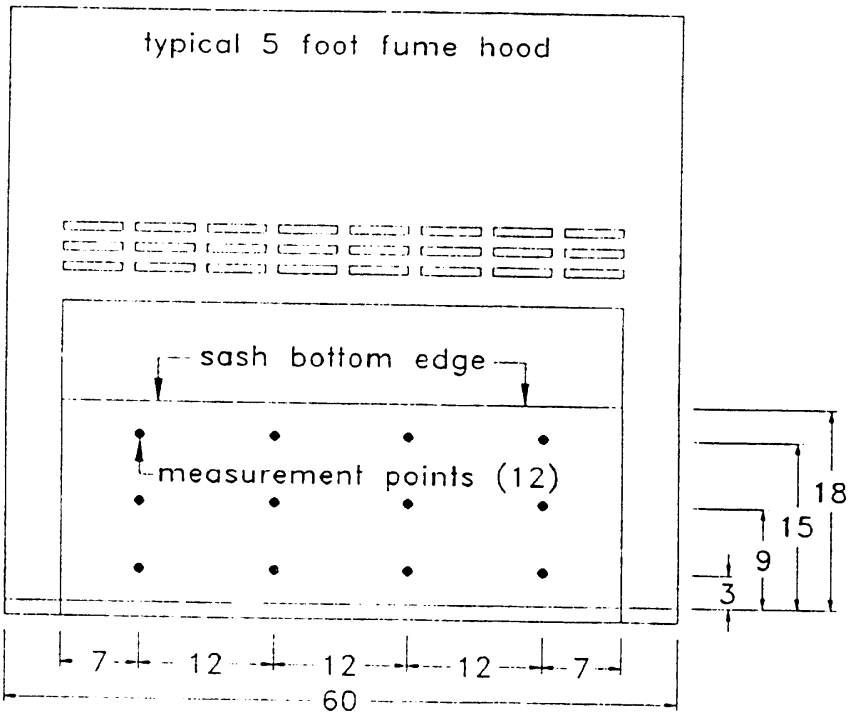

Figure 8. Face Velocity Measurement Locations

The second step is to establish several locations where the air velocity will be measured. The dots in figure 8 shows the position of each measurement in a typical 5 foot hood. If your fume hood is larger or smaller add or delete measurements in 12 inch increments. No change is required in the 3, 9, or 15 inch positions.

It is important that air velocity measurements are made in the same plane in which the sash travels. An air velocity meter positioned away from this plane will not measure the true face velocity.

Start the air velocity measurements in the upper left corner and traverse the width of the hood left to right. Record each air velocity measurement until all 3 rows of measurements are complete. If you are using the TSI VELOCICALC "store" each reading into the instruments memory. The average face is then automatically computed by pressing the "average" key. If your air velocity meter does not store and average, the equation below can be used to calculate the average face velocity.

$$\text{Average face velocity (ft/min)} = \frac{\text{Reading 1 + Reading 2+ ...+ Reading (n)}}{\text{Total number of readings (n)}}$$

Example: Five foot fume hood requires 12 readings.

The face velocities (ft/min) were as follows;

98	99	99	100
95	92	95	96
98	97	96	99

$$\text{Average face velocity} = \frac{98+99+99+100+95+92+95+96+98+97+96+99}{12} = \frac{1164}{12} = 97 \text{ ft/min}$$

The average face velocity is now the value used when calibrating a fume hood face velocity controller.