VFC+
Operator's Manual

Version 6 Firmware

Table of Contents

VFC+ NOTATION

Notations and Measurements: The Table below describes the measurement notion used by the VFC+ and units used to report those measurements.

Notation	Units of Measurement	Description
Qsys	CFM	System Flow Rate
Qstd	CFM	Flow Rate at Standard Conditions *Reported at 760 mmHg and 25°C*
Qamb	CFM	Flow Rate at Ambient Conditions
Tamb	°C	Ambient Temperature
Tcjc	°C	Cold Junction Compensation Temperature (compensates Ambient Temp)
Pamb	mmHg	Ambient Pressure (Uncorrected Barometric Pressure)
Pdif	inH_2O	Differential Pressure (Orifice Pressure)

FLOW LIMITATIONS

One thing that is sometimes overlooked during sampling or during the design of an SOP is that there are limitations to what the sampler as a whole is capable of. The sampler can control the flow over a wide range of flow rates. However, it may not be capable of doing this with all filter media. For example, filter media with a high pressure drop will require more vacuum capacity from the motor. There is a tradeoff between vacuum capacity and flow rate. As the required pressure drop across the filter media increases, the maximum sustainable flow rate will decrease. It is very important to test the filter media, capacity of the system, and expected loading of the filter media when designing an SOP. This is true for all samplers regardless of manufacturer.

If the end user observes that the sampler is consistently falling to meet the requirements of the SOP and has verified the operation of the unit without the sample media installed, they should contact the SOP writer for further instructions.

VFC+ CONNECTIONS

The descriptions of the various connections to the VFC+ control unit are described below.

"Motor"

The "Motor" power connection supplies power to the motor being controlled by the VFC V+. Both Brush-Type and Brushless-Type motor are supported, but only one may be used at a time. The VFC+ will come configured to match the motor type ordered. ***THE MOTOR USED WITH THE VFC+ MUST MATCH THE AC POWER BEING SUPPLIED TO THE VFC+. THE VFC+ CONTROLS CAN NOT CHANGE THE OPERATING VOLTAGE OR THE FREQUENCY OF THE INCOMING POWER THAT IS SUPPLIED TO THE MOTOR.***

"Power"

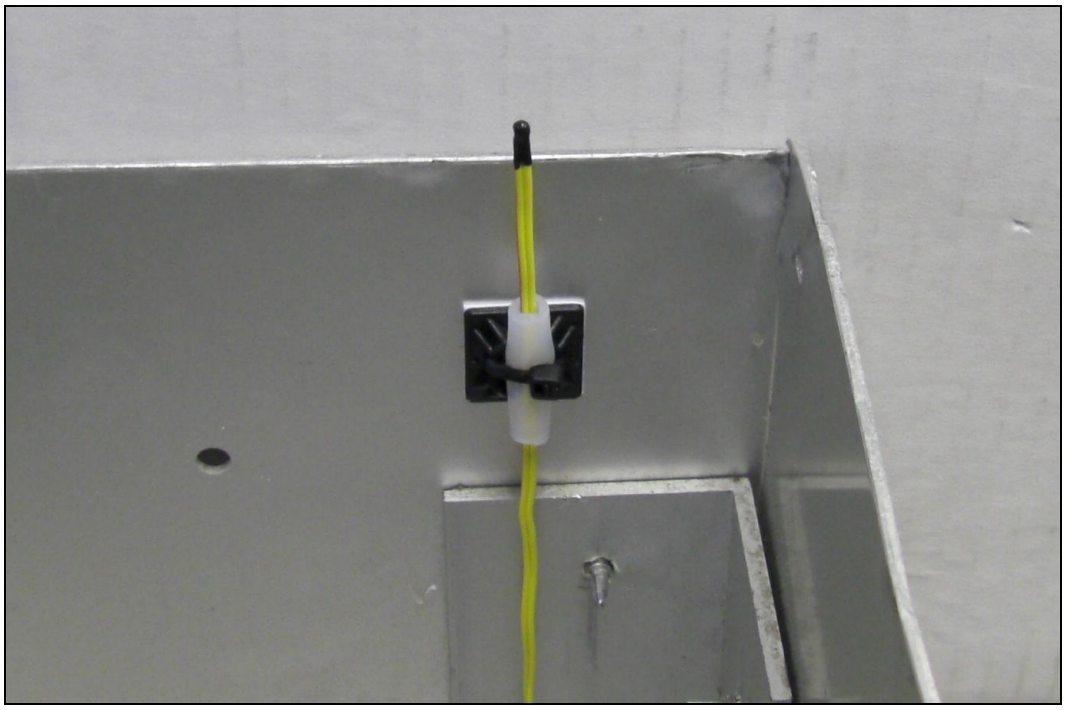
The "Power" connection supplies power to the VFC+. It should be connected to the AC power line. Operation at both 120 Volts AC and 240 Volts AC are supported. The system is designed to operate at either 50 or 60 Hz without the need to change the configuration of the unit. However, a jumper inside the VFC+ determines the voltage on which the unit operates. ***DO NOT APPLY 240-VOLT POWER TO THE VFC+ WHILE THE UNIT IS CONFIGURED FOR 120-VOLT OPERATION. THIS WILL DAMAGE THE UNIT. APPLYING 120-VOLT POWER TO THE VFC+ WHILE THE UNITS IS CONFIGURED FOR 240-VOLT OPERATION SHOULD NOT DAMAGE THE UNIT, BUT IS NOT RECOMMENDED OR SUPPORTED***.

"Ambient" Pressure

The "Ambient" pressure port is used to make the Pamb measurement. It should be left open to atmosphere so that it properly senses the ambient pressure.

"Ambient" Temperature

The Ambient Temperature thermocouple port is used to make the Tamb measurement. A Type K thermocouple must be used. The sensing tip of the thermocouple should be located so that it receives air flow while the unit is sampling and is always shield from the sun. By locating the sensor in this manner it can be used to monitor two items of importance. Most importantly, this will allow for the accurate measurement of the ambient temperature while the unit is sampling. In addition, when the unit is not sampling this allows the temperature of the filter to be approximated. This can be of importance when sampling for compounds that may changes phases (i.e. from solid to gas) due to changes in temperature. Below, is a picture showing a suitable location for the thermocouple. Note the thermocouple tip should be located so that it does not come into direct contact with any surface.



USER INTERFACE

The user interface of the VFC+ consists of the display, keypad, power status light, alert status light, and the buzzer.

User Interface: The Display

The Display is used to inform the user of the status and the configuration of the unit. When used with the Keypad, the user can configure the VFC+ operation.

User Interface: The Keypad

The Keypad is used by the user to input data into the VFC+ in order to configure the various operating parameters of the unit.

User Interface: Power Status Light

The Power Status Light indicates when power had been applied to the unit. A solid green light indicates that unit is running and receiving power. A flashing green light indicates that the motor is on.

User Interface: Alert Status Light

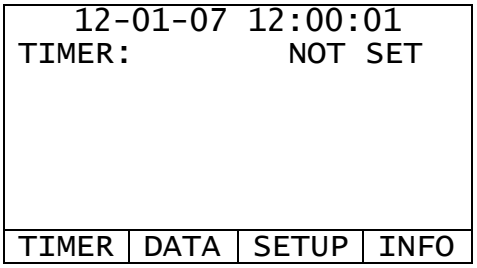
The Alert Status Light indicates the alert state of the unit. The unit monitors several operating parameters and alerts the user to take action when these parameters fall out of the expected range. A flashing red light indicates that a non-fatal alert has occurred. The unit will continue to operate, but may not be functioning optimally. A solid red light indicates a fatal alert has occurred. The unit will not continue to operate. To determine the source of the alert, use the INFO key on the main status screen. See INFO section of this manual for more details.

User Interface: Buzzer

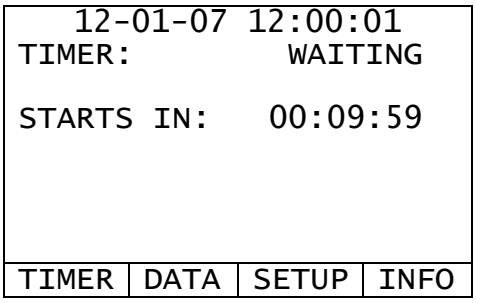
The Buzzer is primarily used to provide auditory feedback when a key is pressed. In addition, the buzzer provides auditory feedback for the boot loader program used to upgrade the operating firmware of the unit. More details of this function will be provided with the release of new firmware.

MAIN STATUS SCREEN

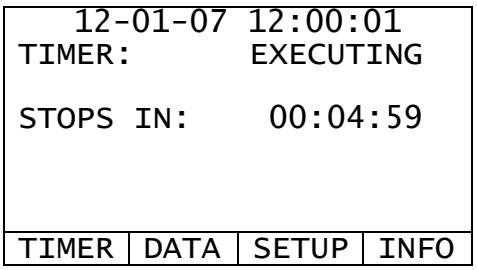
The main display of the VFC+ shows the operating status of the unit. If the timer is programmed to start at some time in the future, a countdown timer is shown. If the timer is currently running, a status screen is displayed with various operating parameters of the system. If the timer is not executing or set to start at some future time, a status screen is displayed describing the situation.



Example of the Main Display with the Timer not configured



Example of the Main Display with the Timer configured to start in the future



Example of the Main Display with the Timer Operating

The Soft-Menu Function Keys

From the main display, there are four keys used to access the various information and configuration screens of the unit. The four keys are F1, F2, F3, and F4. They are called soft-menu function keys, because there functions change throughout the system. When used, the function assigned to each key is described by the bottom line of the display. While on the Main Display the functions are described by the following table:

KEY	Display Description	Extended Description
F1	TIMER	Pressing this key accesses the "TIMER" menu. The "TIMER" menu is used to setup the timer or abort the timer if it is currently running. More details on these functions are described in the "TIMER" menu section of this manual.
F2	DATA	Pressing this key accesses the "DATA" menu. The "DATA" menu is used to work with data collected by system. Data can be reviewed on the display, transfer to a memory card, or erased. More details on these functions are described in the "DATA" menu section of this manual.
F3	SETUP	Pressing this key accesses the "SETUP" menu. The "SETUP" menu is used to configure, calibrate, and diagnose the unit. More details on these functions are described in the "SETUP" menu section of this manual.
F4	INFO	Pressing this key accesses the "INFO" display. The "INFO" display show various status and operating parameters for the unit. More details on these functions are described in the "INFO" section of this manual.

STEP BY STEP GUIDE

This section of the manual serves as a quick guide providing step by step instructions to some of the most important features of the VFC+. For additional details, refer to the relevant section of this manual.

Step by Step: Installing the Gable Roof Assembly

The Gable Roof is shipped uninstalled to prevent damage that could occur in shipping and must be installed by the user when first setting up the unit.

A bag of parts is shipped tapped to the inside of the lid and contains the following:

- 5 pcs 10-24 x 1/2 pan head screws
- 5 pcs 10-24 stop nuts
- 1 pc 6-32 x 3/8 pan head screw
- 1 pc 6-32 hex nut
- 1 pc 20" chain with" S" hook
- 1 pc TE-5001-10-9 roof back catch
- 1 pc TE-5001-10-10 front catch
- 1 pc TE-5001-10-11 rear lid hasp

Installation:

1. Secure TE-500l-10-10 front catch to the shelter using (2) 10-24 pan head screws with stop nuts.
2. Secure TE-5001-10-9 roof back catch to the back of shelter using 10-24 pan head screw with stop nut.
3. Secure TE-5001-10-11 rear lid hasp inside the lid with the slotted end angled up using (2) 10-24 pan head screws with stop nuts.

   Note: These three items may need adjustment after the shelter lid is installed.

4. Remove (4) -10-24 x 1/2 pan head screws from the nutserts in back of shelter.
5. Attach the lid to the shelter by placing the lid hinge plates on the "OUTSIDE" of the shelter top and tighten the (4) 10-24 x 1/2 pan head screws into the nutserts.
6. Adjust the front catch to be sure that the lid slot lowers over it when closing the lid. The rear lid hasp should align with the roof back catch when the lid is open.
7. Attach the chain and "S" hook assembly to the side of the shelter with a 6-32 pan head screw and nut.
8. The lid can now be secured in an open or closed position with the "S" hook.

Step by Step: Attaching the Filter Holder to the Motor

The following steps provide instructions for assembling the filter holder to the motor and inserting it into the system shelter.

1. Set the TE-5070 blower motor assembly on a flat surface
2. Place the TE-5005-9 black filter holder casket on top of the TE-10557 Volumetric flow controller.
3. Set the stainless steel filter holder on top of the volumetric flow controller ensuring that the gasket remains in place.
4. Tighten the black king on the filter holder ensuring that it is tightly sealed, do not over tighten.
5. After you have attached the filter holder to the motor, lower the entire assembly into the shelter through the square hole on the top side of the shelter. Be careful not to damage the stagnation pressure port on the side of the filter holder as you lower the assembly into place.

Step by Step: Connecting the Tubing

The VFC+ system includes three pieces of 1/8" clear vinyl tubing and a three way barbed T-fitting.

1. One Piece of tubing will be attached to the bulkhead fitting on the inside of the aluminum shelter; the other end of this piece of tubing will be attached to the T-fitting.
2. The second piece of clear tubing will be attached to the bottom of the VFC+ controller, the other wend will be attached to the T-fitting
3. The Third piece of tubing will be connected to the T-fitting, the other end of this piece of tubing will get connected to the stagnation port on the side of the Stainless Steel filter holder funnel.

Note: This tubing must all be connected during the sample, the VFC+ collects the pressure drop from the stagnation port to calculate the ambient flow. The tubing attached to the bulk head fitting on the side of the aluminum shelter is used for calibration(see flow calibration instructions for more information).

Step by Step: Setting the Date and Time

The following steps provide instructions for setting the date and time.

1. From the Main Status Screen, press "F3" key to enter the SETUP menu.
2. Scroll using the arrow keys and select the CONFIGURE menu item and press the "ENT" key.

3. Select "SET DATE" and press the "ENT" key. If adjusting date and time, the date should always be set first. If only setting the time, proceed to Step 5.
4. Using the numeric keypad enter the starting date for the timer and press the "ENT" key. The date should be entered with leading zero. For example, January 02, 2007 would be entered as 010207.
5. Select "SET TIME" and press the "ENT" key.
6. Using the numeric keypad enter the starting time for the timer and press the "ENT" key. The time should be entered with leading zeros and in 24-hour format. For example, 1:00 PM would be entered as 1300 while 1:00 AM would be entered as 0100.
7. Press the "ESC" key to return to the previous menu. To return to the main status screen, continue pressing the "ESC" key.

Step by Step: Setting the Timer

The following instructions provide step by step instructions for settings the timer.

1. Starting from the Main Screen, press the F1 key for "TIMER".
2. Select "DATE" and press the "ENT" key.
3. Using the numeric keypad enter the starting date for the timer and press the "ENT" key. The date should be entered with leading zero. For example, January 02, 2007 would be entered as 010207.
4. Select "TIME" and press the "ENT" key.
5. Using the numeric keypad enter the starting time for the timer and press the "ENT" key. The time should be entered with leading zeros and in 24-hour format. For example, 1:00 PM would be entered as 1300 while 1:00 AM would be entered as 0100.
6. Select "DURATION" and press the "ENT" key.
7. Using the numeric keypad enter the duration timer should run and press the "ENT" key. The duration should be entered in HHMM format with leading zeros. For example:
   0024 = 24 minutes
   2400 = 24 hours
   0240 = 2 hours 4 minutes
8. Select "REPEAT" and press the "ENT" key. Select the desired repeat frequency and press the "ENT" key. Select "NONE" if this event is not to reoccur. The most common choices are included (1 IN 1 for everyday sample, 1 IN 3 for every 3rd day sample, 1 IN 6 for six day sample, and 1 IN 7 for seven day sampling). The CUSTOM option can be used to enter a non-standard duration in accordance with specific sampling protocols.
9. Select "SAVE and EXIT" and press the "ENT" key. This will save the setting and activate the timer. The main screen will appear and the "TIMER" should now show waiting. A second line labeled "STARTS IN" will appear showing a countdown to the timer starting a sample.

Step by Step: Viewing Data on the Display

The following instructions provide step by step instruction for viewing data for a timer event.

1. Starting from the Main Screen, press the "F2" key to access the "DATA" menu.
2. Select "VIEW PAST SAMPLE" and press the "ENT" key.
3. A list showing the timer start dates and times will be displayed. Select the desired date and time and press the "ENT" key.
4. The first page of the sample data for this timer event will be displayed. The arrow keys can be used to switch to the different pages. Press the "ESC" key to exit and return to the list of available dates and times. Continue press the "ESC" key to return to the Main Screen.

Step by Step: Saving Data to the USB Memory Drive

The following instructions provide step by step instruction for saving data to the USB memory card.

Do not remove the memory stick while the unit is saving data.
This could cause corruption of the data and usb drive.

1. Insert the USB memory stick into the USB port above the "POWER" status light.
2. Starting from the Main Screen, press the "F2" key to access the "DATA" menu.
3. Select the "SAVE" menu item and press the "ENT" key. This will save the data to the USB stick using the comma separated values file format (CSV) which can be viewed using Microsoft Excel or other spreadsheet programs. The format data files created by the unit are described in the DATA FORMATS section of this manual.
4. Press the "ESC" key to return to the Main Screen.

Step by Step: Flow Calibration entering the G factor

Flow calibration is determined by the geometry of the specific VFC orifice. Each VFC orifice is calibrated at the factory when it is manufactured. The calibration process determines a single value that characterizes the flow properties of the orifice. This value is called the G Factor (the G factor is printed on the serial number tag on the VFC device and is also printed on the VFC device look up table). The VFC+ requires this G Factor in order to calculate the flow rate. This value is entered using the following procedure:

1. Press the 'F3' to enter the SETUP menu.
2. Press the 'ENT' key to acknowledge the warning message concerning SETUP.

3. Select the CALIBRATE menu item and press 'ENT'.
4. Select the Qamb menu item and press 'ENT'.
5. Press 'F1' to enter the G Factor.
6. The unit will prompt "ENTER G FACTOR". Enter the G Factor using the numeric keypad and press the 'ENT' key to accept the new value.
7. Press 'F4' to exit the Calibration screen.
8. Select "YES" and press 'ENTER' when the "SAVE CALIBRATION" prompt appears.
9. Press "ESC" to return to the SETUP menu.
10. Press "ESC" to exit the SETUP menu and return to the Main Status display.
11. The VFC+ will now use the entered G Factor to calculate the flow rate.

TIMER

The VFC+ controller contains a microprocessor based timer that allows for a variety of timing options including:

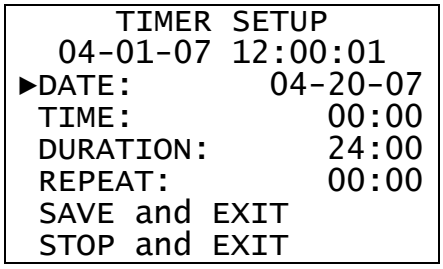
- Single Occurrence Timed Event
- Repeating Timed Event (ideal for 1 in X day sample operating protocols)
- Flexible Remotely Triggered Timed Event (requires optional remote trigger cable)

This section documents the possible configurations that can be used with the timer. To access the timer setup menu, press the "F1" soft-menu function key while the main status display screen is displayed. If the timer is not currently executing, the Timer Setup menu will be displayed. If the timer is currently executing, the option to the "Abort Timer" menu will be displayed.

Note: That timer event will not be started while the Timer Setup menu is displayed. For this reason it is important to always use the SAVE and EXIT menu item after the timer has been configured.

TIMER SETUP MENU: Basic Timer with Optional Repeat

The TIMER SETUP menu allows the user to configure the operation of the timer as desired to meet sampling protocols. The details of the timer setup parameters are described below.



The figure above displays an example of the Timer Setup menu. For convenience, the current time and data are displayed on the second line. The details of each menu item are described below.

DATE Menu Item

The DATE menu item is used to specify the start date of the timer. The date must be entered in the MMDDYY format. Leading zeros are required (For example, to sample on January 1, 2007, enter 010107).

TIME Menu Item

The TIME menu item is used to specify the start time of the timer. The time must be entered in the HHMM format. Leading zeros are required (For example, to sample at 09:30 AM, enter 0930).

DURATION Menu Item

The DURATION menu item is used to specify the length of time the unit should sample. The duration must be entered in the HHMM format. Leading zeros are required (For example, to sample for 1 hour, enter 0100). This is the intended length of the sample. Power failures or other interruptions will not extend the sample time. For example, if the timer is set to turn on at 12:00 and run for 24 hours, but the power fails for 2 hours. The timer will stop at 12:00 the following day.

REPEAT Menu Item

The REPEAT menu item is used to specify the interval of time between sample start times. If set to zero (NONE), the repeat feature is disabled and the timer will only execute once. Several standard repeat intervals are selectable. For example, the "1 IN 3" selection will set the repeat interval for sampling every third day (a new sample would start every 72 hours). The CUSTOM selection allows for non-standard repeat intervals to be entered. When entering non-standard repeat intervals, the HHMM format must be used. Leading zeros are required (For example, to sample for 1 hour, enter 0100).

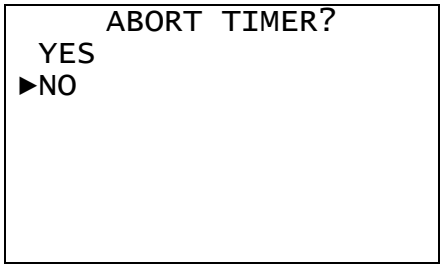
SAVE and EXIT Menu Item

The SAVE and EXIT menu item saves the current setup and returns to the Main Status Display.

STOP and EXIT Menu Item

The STOP and EXIT menu item configures the timer so that it will not operate until it is reprogrammed with valid parameters and returns to the Main Status Display.

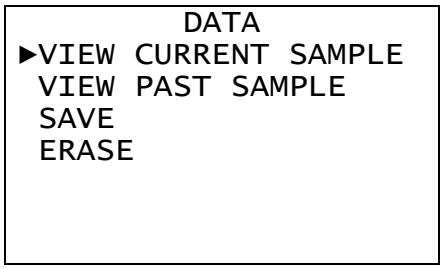
Aborting Timer Operation



The ABORT TIMER menu (shown above) is displayed when the "F1" soft-menu function key is pressed from the main status display and the timer is currently executing. This allows the user to stop a currently executing timer event and re-configure the timer to the desired settings. Once a timer event is aborted, the timer will not execute until it has been re-programmed with a valid start time and duration. To stop a timer that has not started use the STOP and EXIT option in the TIMER SETUP menu.

DATA

The DATA menu allows the data collected by the unit to be viewed, saved to a USB memory stick, or erased.



"VIEW CURRENT SAMPLE"

The "VIEW CURRENT SAMPLE" menu item will display a summary of a currently executing timer sample. More details are provided in the Reviewing Sample Data section.

"VIEW PAST SAMPLE"

The "VIEW PAST SAMPLE" menu item will display a list of start dates and times for past timer runs. Selecting a date and time will display the summary information collected during the execution of the timer for that start date and time. More details are provided in the Reviewing Sample Data section.

"SAVE"

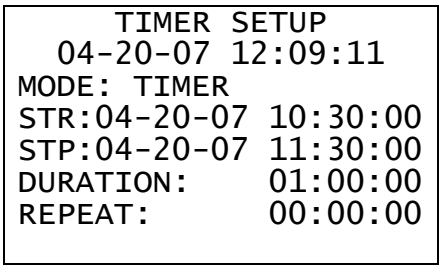
The "SAVE" menu item will save all data to a file on an inserted USB memory stick. This data may then be viewed on a PC. The file format is comma separated values with can easily be read by spreadsheet and database programs.

"ERASE"

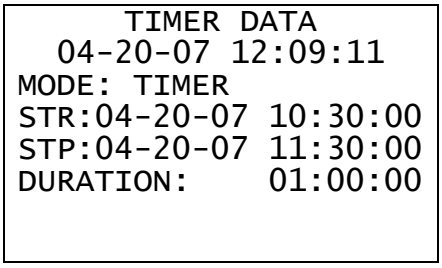
The "ERASE" menu item will allows for the individual logs to be erased. Because the unit automatically writes over the oldest collected data, there is normally no use of this feature. It is provided to allow the system's memory to be periodically erased to eliminate old data from being viewed or saved.

Reviewing Data

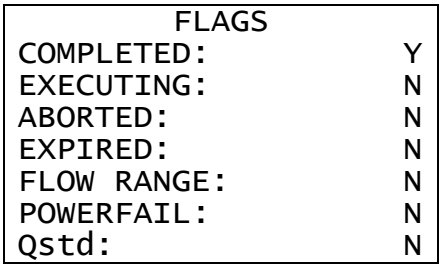
When using either the VIEW CURRENT SAMPLE or VIEW PAST SAMPLE menu items, a series of screens will be displayed that contain data collected during the timer event. Switch between screens us the UP and DOWN ARROW keys. Use the ESC key to return to the DATA menu.



The first screen (shown above) displays the timer setup data. This includes the timer mode (either TIMER or REMOTE), the set start date, the set stop date, the set duration of the timed event, and the repeat interval.

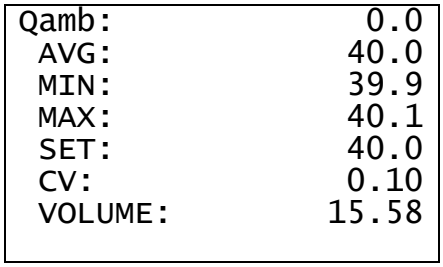


The second screen (shown above) displays the timer actual data. This includes the actual start date, the actual stop date and the actual duration. Please note that if a power failure occurs, then it is possible that the values will not match the data from the TIMER SETUP screen.

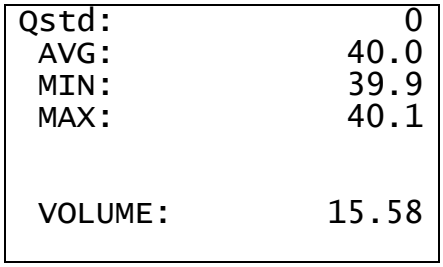


The third screen (shown above) displays flags associated with the timer event. The flags are described below.

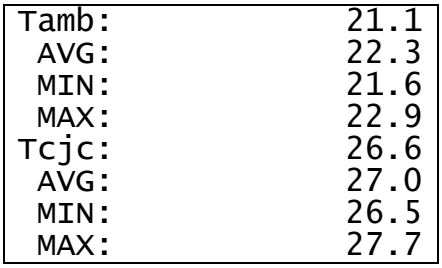
FLAG	Description
COMPLETED	Indicates that the Timer Event has been completed
EXECUTING	Indicates that the Timer Event is currently executing
ABORTED	Indicates that the Timer Event was aborted by the user
EXPIRED	Indicates that the Timer Event expired before it could be started. This can happen if the unit is without power during the entire timer event.
FLOW RANGE	Indicates that the sampling flow rates exceeded +/- 10 percent of the set flow rate for a period exceeding 2 minutes. This indicates that the system was not able to control the flow at the desired set point and the sample event was stopped for this reason. Examine the system for disconnected tubing, clogged orifices, proper sensor operation, calibration errors, and filter media requirements to determine the source of the problem.
POWERFAIL	Indicates that a power failure occurred during the Timer Event.
Qstd	Indicated that the Timer Event is using Qstd for flow control.



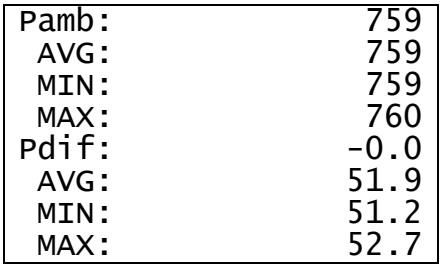
The fourth screen (shown above) displays the Qamb (ambient conditions) data including the current flow rate, average flow rate, minimum flow rate, and maximum flow rate, set flow rate, coefficient of variation, and the total volume ambient conditions volume. The coefficient of variation is a measure of stability of the flow rate during the test. The SET and CV values are only shown if the unit is set to control the flow at ambient conditions.



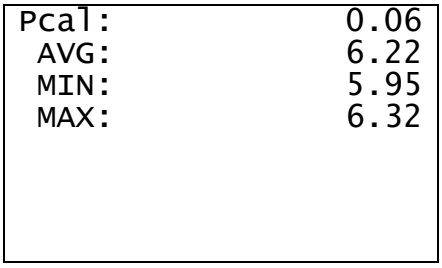
The fifth screen (shown above) displays the Qstd (standard conditions) data including the current flow rate, average flow rate, minimum flow rate, and maximum flow rate, set flow rate, coefficient of variation, and the total volume ambient conditions volume. The coefficient of variation is a measure of stability of the flow rate during the test. The SET and CV values are only shown if the unit is set to control the flow at ambient conditions.



The sixth screen (shown above) displays the current, average, minimum, and maximum values for the ambient temperature (Tamb) and the cold-junction compensation temperature (Tcjc).



The seventh screen (shown above) displays the current, average, minimum, and maximum values for the ambient pressure (Pamb) and the differential pressure (Pdif).



The eighth screen (shown above) displays the current, average, minimum, and maximum values for the calibration pressure (Pcal).

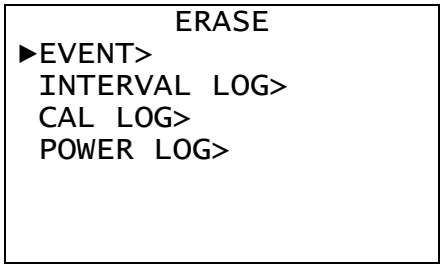
Saving Data

If the control unit is equipped with the optional data drive, then the data logs may be saved to the USB memory stick for later review using a PC. The data logs are stored in the CSV (comma separated values) format. In addition to saving the timer sample event logs, the units also saves a configuration log, interval log, calibration log, and power log. Further details on the data format are presented in the DATA LOG FORMATS section of this manual.

Notes on the usage of the USB data drive:

- All USB memory sticks are not created equal and some vary greatly in how well they adhere to the specifications. A USB memory stick from 64mb to 2gb is recommended.
- While it possible to save data to a memory stick used for other purpose (i.e. like a digital camera or portable drive), this is not recommended.
- Each unit records a single data file that is named with the serial number of the unit. It is therefore possible to use a single memory stick to save data from multiple units.
- If a memory stick already contains saved data from the same unit, it will be overwritten.
- If you experience errors when saving the data, it is possible that the memory stick is not compatible or has become corrupted. Memory sticks can become corrupted if they are used for purposes other than saving data from the unit or if the data saving process is interrupted. In most cases, this can be resolved by formatting the memory stick on a PC.

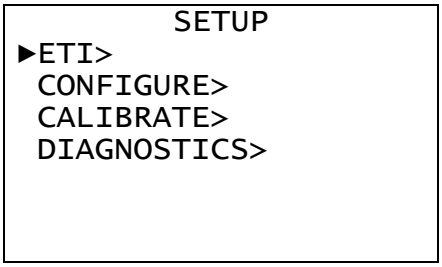
Erasing Data



The ERASE menu (shown above) provides ability to erase the different data logs that are collected by the system. The control unit automatically overwrites the oldest data in each of the logs, so this feature does not need to be used on a routine basis. It can be used in situation where the unit has changed locations and the user no longer wishes to review the data from the other site.

SETUP

The SETUP menu allows the various operating parameters of the unit to be configured and/or monitored. Some of these parameters include the ETIs, Sensor calibrations, and general diagnostics.



ETI Menu Item

The ETI menu item contains information and setting pertaining to the elapsed time indicator maintained by the system. For further details on the ETI's refer to the ETI section of this manual.

Configure Menu Item

The CONFIGURE menu item allows various operating parameters to be edited. This includes the setting the date and time, flow rate parameters, timer mode, and other items. For further details on the Configure menu refer to the CONFIGURATION section of this manual.

Calibrate Menu Item

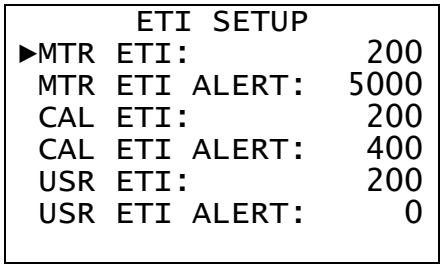
The CALIBRATE menu item provide calibration function for the various sensors in the system. For more details on the CALIBRATE menu refer to the CALIBRATION section of this manual.

Diagnostics Menu Item

The DIAGNOSTICS menu item provides item that are helpful in troubleshooting and diagnosing the operation of the unit. Refer to the DIAGNOSTICS section of this manual for additional details.

ETI

The ETI menu item displays the ETI menu. The ETI menu allows the operating parameters of the units 3 ETI's to be configured. There are two menu items for each ETI in the system. The first shows the current ETI value in hours. The second shows the point at which an alert will be triggered to notify the user of needed action. Both values are given in hours of motor operation.



The unit has 3 independent ETIs which can be used to track various maintenance procedures for the unit. Each ETI functions identically and is incremented any time the more is on.

ETI Designation	Use
MTR	This is the MOTOR ETI and is used to track motor lifetime and maintenance.
CAL	This is the CALIBRATION ETI and is used to track calibration schedules.
USR	This is the USER ETI and has no assigned purpose. It may be used to track other maintenance items that should be performed after some many hours of operation.

Clearing an ETI

To Clear an ETI, select the desired ETI and press the "CLEAR" key.

Setting an ETI Alert Point

To set the ETI Alert Point, select the desired ETI Alert and press enter. Then enter the ETI Alert point in hours of motor operation. To disable the ETI Alert, enter a value of 0. This will disable the ETI Alert, but the ETI will continue to increment with motor operation.

CONFIGURATION

The CONFIGURE menu (shown below) allows for various operating parameter of the unit to be configured. Details are provided below.

```
      CONFIGURE
►SET DATE:   04-20-07
 SET TIME:   12:11:18
 FLOW CONDITIONS: AMB
 FLOW RATE:        40
 LCD CONTRAST:     32
 LOG INTERVAL:      5
 TIMER MODE:    TIMER
```

Setting the Date and Time

The SET DATE and SET TIME menu items allow the battery backup real-time clock to be programmed. This clock provides the time base used for operation with the timer. The clock automatically adjusts for leap years, but does not automatically adjust for daylight savings time. If the date needs to be set, it should be set first. The date should be entered in the format MMDDYY with leading zeros. For example, January 3rd, 2007 would be entered as 010307. The time should be entered in the 24 hour format HHMM with leading zero. For example, 1:14 AM would be entered as 0114, while 1:14 PM would be entered as 13:14.

Setting the Flow Conditions

The FLOW CONDITIONS menu item selects whether the unit will operate in ambient (AMB) conditions or standard (STD) conditions flow. Standard conditions are defined to be 760 mmHg and 25°C

Setting the Flow Rate

The FLOW RATE menu item determines the operating flow rate for the system and is measured in CFM. For VFC+ systems changing the flow rate will not change the flow rate, the flow rate is determined by the VFC device not the VFC+ controller. This setting is only indented to be displayed on the data.csv file for reference only. CHANGING THIS WILL NOT CHANGE THE SYSTEMS FLOWRATE.

Setting the LCD Contrast

The LCD CONTRAST menu item controls the software contrast adjustment of the LCD. Press the ENT key with the LCD CONTRAST menu item selected to change the LCD

contrast setting. Use the "+" and "-" keys to change the contrast level. The contrast level can be set between 0 and 63. Press the "ESC" key when the contrast is at the desired level. The default contrast level is 32. The LCD contrast adjustment can also be accessed by pressing the "+" or "-" keys during the first 5 seconds the unit is turned on (while the startup screen is displayed).

Setting the Interval Log Period

The LOG INTERVAL menu item determines the time period in minutes over which the data is averaged before an entry is made in the interval data log. Setting the LOG INTERVAL to a value of 0 will disable the interval log. The default value is 5 minutes.

Setting the Timer Mode

The TIMER MODE menu item determines whether the timer operates as a normal timer or in remote trigger mode. The two choices for this menu item are "TIMER" and "REMOTE". When configured for "TIMER" operation, the unit will start sampling for a predetermined time for a set duration. When configured for "REMOTE" operation, the unit will sample when the appropriate signal is applied to the Remote input. For additional information refer to the TIMER section of this manual.

CALIBRATION

The CALIBRATE menu allow the user to calibrate the sensors used by the unit. The CALIBRATE menu (shown below) list the sensors in the system, the associated raw sensor values and the values using the current calibration. Pressing the ENT key will begin the calibration process for the selected sensor. The LOAD FACTORY CAL and LOAD DEFAULT CAL menu items will load the calibration values set at the factory or the default values from the firmware. These can be useful when tracking down calibration problems. The factory calibration values are preferred because they compensate for the normal manufacturing variations which the default firmware calibration values do not.

```
      CALIBRATE
 Qstd:(    0)     0.0
►Tamb:(39000)    21.2
 Tcjc:(21789)    26.9
 Pamb:( 3713)     759
 Pdif:(  552)    -0.0
 Pcal:(  332)    0.01
 LOAD FACTORY CAL>
 LOAD DEFAULT CAL>
```

Important Notes on Calibration

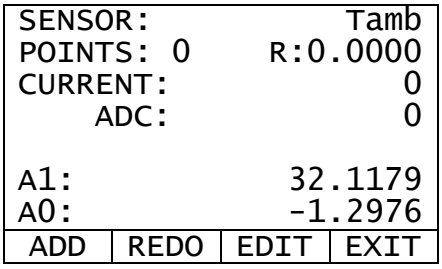
- Sensors may be calibrated using from 1 to 5 calibration points. There are two exceptions to this. The first is the Tcjc (cold junction compensation temperature). It requires only a single point calibration. The second is the Qsys (system flow rate) which requires 5 points per EPA guidelines.
- Single point calibrations while possible, are not recommended (except for Tcjc). Single point calibrations only adjust the offset (A0) of the sensor and do not compensate for any changes in the gain (A1). If single point calibrations are used, the user should verify the gain by checking additional points against a reference.
- The ambient temperature (Tamb) is dependent on the cold junction compensation temperature (Tcjc). The cold junction compensation temperature is used to correct the voltage error introduced at the "cold junction" of the thermocouple circuit. This sensor does not normally require calibration once it leaves the factory, but if you wish to calibrate the Tcjc sensor you must locate the reference temperature probe near the thermocouple connection on the electronics.
- Flow calibration (Qsys) is dependent on other sensors in the system. It is therefore critical that they be properly calibrated or verified before calibrating the flow.
- If the unit has been powered off longer than 15 minutes, please allow 30 to 60 minutes for the electronics to warm up prior to calibrating any sensor. This is to

minimize errors that can occur while the electronics are warming up. The error is typically small, but doing this will provide optimal calibration results.

- It is very important to understand the calibration process and how it affects the operation of the unit. Improperly calibrating a unit can make the unit think it is working fine while in reality it is not. For example, if the ambient temperature was incorrectly calibrated during a flow calibration, then the flow calibration will have an error in it, even after the ambient temperature calibration is correct. This may mean that the system is controlling the flow at a value of say 40 CFM, but when measured by an independent reference is only running at 36 CFM. This does not mean the unit is broken, only that the calibration is incorrect. To resolve this situation, properly calibrate the unit.

Calibrating a Sensor

The procedure for calibrating a sensor is similar regardless of what sensor is being used. The exception to this is the flow calibration which is described in detail in the Flow Calibration section.



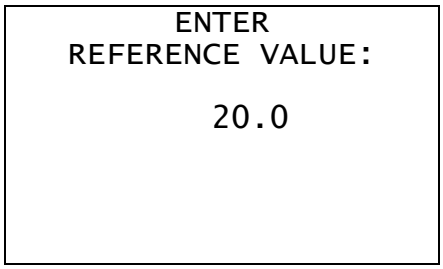
The main calibration display is shown above and is common to all sensors. The SENSOR line shows the name of the sensor being calibrated. The POINTS field shows the current number of calibration point being used to determine the A1 and A0 values. The R field is an indication of how closely the calculated calibration curve matches the raw data. The R field is only valid with 3 or more data points. The closer the R value is to 1, the better the agreement between the calculated and raw data. The CURRENT and ADC values show the calibration value using the current calibration values and the raw analog to digital converter values. The A1 and A0 fields show the current gain and offset values for the sensor.

Similar to the Main Status Display, the calibration display uses the soft-menu function keys F1, F2, F3, and F4 to navigate the calibration process. Each of the soft-menu function key is described below.

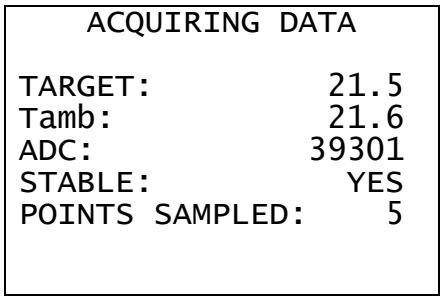
Adding a Calibration Point (F1)

Pressing the F1 key (ADD) will begin the process of adding a calibration point to the data used to calibrate the sensor. Adding a calibration point involves providing the unit with a reference signal on the sensor being calibrated and then telling the unit what the value of that signal is using a reference device. The following are screen shots from a adding a calibration point to the Tamb (ambient temperature) sensor.

After pressing the F1 key, the screen below is displayed. A default reference value is automatically selected. These are provided as guidelines so that the entire calibration range of the sensors is used for the calibration. If a different value is being applied to the sensor, simply enter the correct reference value. While maintaining a constant reference value to the sensor, press the ENT key to begin data collection.



Once the ENT key is pressed, the screen below will be displayed. This screen will automatically exit and return to the main calibration screen once the system has collected a stable reading from the applied signal. If the reference signal is not sufficiently stable, this screen may be displayed for a long period of time. In these situations, the user may press the "F1" key to force the unit to collect data even if it is not being detected as stable. This may not result in an optimal calibration, but may be required in cases where the reference in not stable.



Once back at the main calibration screen, the reference value should now match the calibrated sensor value more closely. This process can be repeated to add different calibration points across the range of operation of the sensor.

Redo a Calibration Point (F2)

Pressing the F2 key (REDO) will list the current calibration points used to calibrate the sensor. Selecting one of these points allows the calibration point to be performed again. This allows the user to recover to a bad calibration point without having to redo all of the calibration points. The procedure for redoing a calibration point is identical to adding a calibration point, once the desired calibration value is selected.

Edit Calibration Constants (F3)

Pressing the F3 key (EDIT) allows the A1 (gain) and A0 (offset) calibration constants for the sensor to be manually entered. This feature is useful in trouble shooting the unit or recovering from the incorrect calibrations. Past values for A1 and A0 for each sensor can be found in the calibration log.

Exit Calibration (F4)

Pressing the F4 key (EXIT) will exit the calibration process and prompt the user save the data the sensor was calibrated. If the user chooses not to save the calibration values, the original calibration values will be restored.

Flow Rate Calibration

Calibration Procedure

The following is a step by step process of the calibration of a VFC+ Volumetric Flow Controlled TSP Particulate Sampling System. Following these steps are example calculations determining the calibration flow rates for the sampler. The air flow through these types of sampling systems is controlled by a Volumetric Flow Controller (VFC) or dimensional venturi device.

This calibration differs from that of a mass flow controlled TSP sampler in that a slope and intercept does not have to be calculated to determine air flows. Also, the calibrator orifice Qactual slope and intercept from the orifice certification worksheet can be used here, unlike a mass flow controlled TSP where Qstandard slope and intercept are used. The flows are converted from actual to standard conditions when the particulate concentrations are calculated. With a Volumetric Flow Controlled (VFC) sampler, the calibration flow rates are provided in a Flow Look Up Table that accompanies each sampler.

The attached example calibration worksheet uses a TE-5028A Variable Orifice Calibrator which uses an adjustable or variable orifice, which we recommend when calibrating a VFC.

Proceed with the following steps to begin the calibration:

Step 1: Mount the calibrator orifice and top loading adapter plate to the sampler. A sampling filter is generally not used during this procedure. Tighten the top loading adapter hold down nuts securely for this procedure to assure that no air leaks are present.

Step 2: Turn on the sampler and allow it to warm up to its normal operating temperature.

Step 3: Conduct a leak test by covering the holes on top of the orifice and pressure tap on the orifice with your hands. Listen for a high-pitched squealing sound made by escaping air. If this sound is heard, a leak is present and the top loading adapter hold-down nuts need to be re-tightened.

Avoid running the sampler for longer than 30 seconds at a time with the orifice blocked. This will reduce the chance of the motor overheating. Also, never try this leak test procedure with a manometer connected to the pressure tap on the calibration orifice or the pressure tap on the side of the sampler. Liquid from either manometer could be drawn into the system and cause motor damage.

Step 4: Connect one side of a water manometer or other type of flow measurement device to the pressure tap on the side of the orifice with a rubber vacuum tube. Leave the opposite side of the manometer open to the atmosphere.

Step 5: Connect a water manometer to the quick disconnect located on the side of the aluminum outdoor shelter (this quick disconnect is connected to the pressure tap on the side of the filter holder).

Step 6: Make sure the TE-5028A orifice is all the way open (turn the black knob counter clock-wise). Record both manometer readings, the one from the orifice and the other from the side of the sampler. To read a manometer one side goes up and the other side goes down, you add both sides, this is your inches of water. Repeat this process for the other four points by adjusting the knob on the variable orifice (just a slight turn) to four different positions and taking four different readings. You should have five sets of numbers, ten numbers in all.

Step 7: Remove the variable orifice and the top loading adapter and install a clean filter. Set your timer.

Step 8: Record the ambient air temperature, the ambient barometric pressure, the sampler serial number, the orifice serial number, the orifice Qactual slope and intercept with date last certified, todays date, site location and the operators initials.

G-Factor Excel Spreadsheet Instructions

The TE-5170V calibration worksheet can be found on our website at www.tisch-env.com. If you have the G Factor that accompanies each VFC, go to "TE-5170V High Vol. TSP VFC with G-Factor".

Note: Calibration orifices should be sent back to Tisch Environmental for calibration on an annual basis per US EPA Compendium Method IO-2.1 Part 7.3.2 *Sampling of Ambient Air For Total Suspened Particulate Matter (SPM) and PM_{10} Using High Volume (HV) Sampler*

1. Enter the following information in the corresponding cells in the worksheet:

Site Information

Location	The location of the instrument
Date	Current Date
Tech	Technician performing the calibration
Serial #	Serial number of the instrument, Pxxxx
VFC G Factor	The g-factor of the VFC you are calibrating. This can be found on the lookup table documentation (first page of this doc) or the sticker located on the VFC.

Calibration Orifice Information

Make	The make of the orifice, typically Tisch Environmental
Model	The model number of the orifice, typically TE-5028A
Serial #	The Serial number of the calibration orifice you are using
Qa Slope (m)	The Qa slope of the calibration orifice you are using. This is found on the calibration documentation provided with the calibration orifice
Qa Int (b)	The Qa intercept of the calibration orifice you are using. This is found on the calibration documentation provided with the calibration orifice
Calibration Due Date	The date that the calibration of the orifice is due. Orifice should be calibrated on an annual basis. Call Tisch Environmental at 1-TSP-AND-PM10 to schedule a recalibration.

Ambient Conditions

Temp (Deg F)	Enter the current ambient temperature at calibration, Ta in Degrees K and Ta in degrees C will be calculated by the spreadsheet
Barometric Pressure	Enter the ambient barometric pressure (Pa) inches of Hg at calibration, the Pa in mmHg will be calculated by the spreadsheet

2. Enter the calibration information by performing each calibration point and entering the following information into each corresponding row for each point:

Calibration Information

Orifice "H_20	The pressure measured at the orifice port using a manometer. The first point should be performed with the orifice knob turned counter-clockwise or wide open, then four consecutive points turning the orifice knob clockwise (not closed) Good idea to take a few extra points here.
Sampler "H_20	The pressure measured at the sampler side port using a manometer (clear tubing that is connect to bulk head fitting that is connected to side of filter holder)

The calibrator flow is calculated (Qa) using the formula:

$$Qa = \frac{1}{Slope} x \sqrt{"H20x\left(\frac{Ta}{Pa}\right)} - Intercept$$

The calculated flow in m^3/min will be calculated using the g-factor formula, this flow will correspond to the flow found in the lookup table supplied with the VFC.

The percent difference will be calculated using the formula:

$$\%\ Difference = \frac{Calculated\ Flow - (Qa)\ \ Calibrator\ Flow}{(Qa)\ \ Calibrator\ Flow}\ x\ 100$$

As per stated in the method IO-2.1, % Difference calculations should be less than +-4%

3. To calculate the total air volume during the sample enter the following information:

Calculate Total Air Volume Using G-Factor

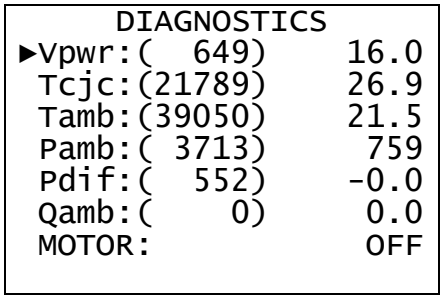
Average Temperature	Enter the average temperature of the sample throughout the sample period in Deg F. The temperature will then be calculated in Deg K
Barometric Pressure	Enter the average barometric pressure of the sample throughout the sample period in Inches of Hg. The barometric pressure in mmHg will then be calculated
Clean Filter "H_20	Enter the clean filter pressure in inches of water prior to sampling
Dirty Filter "H_20	Enter the dirty filter pressure in inches of water after sampling. The average sample pressure will then be calculated in mmHg
Runtime	Enter the total runtime in hours (xx.xx) of the sample

Using the g-factor formula, Po/Pa will be calculated and an average flow rate of the sample will be calculated in m^3/min. Using this information the total sample volume will be calculated.

The flow rate values calculated using this worksheet can be compared to the values calculated by the VFC+ controller for flow rate verification.

DIAGNOSTICS

The DIAGNOSTICS menu (shown below) provides information and troubleshooting functions to help diagnose any problems that may occur. Details on the various menu items are provided below.



Vpwr

The Vpwr menu item displays the internal DC voltage being seen by the system. The number in parentheses is the raw analog to digital converter value (range of 0 - 1024), while the number to the right represents the calibrated value. The calibration is approximate and cannot be adjusted by the user. Typical calibrated value is between 14 and 18 volts.

Tcjc

The Tcjc menu item displays the cold junction compensation temperature associated with the thermocouple measuring Tamb. The value in parentheses is the raw analog to digital converter (ADC) value (range of 0 - 65535), while the number to the right represents the calibrated value. An ADC value of 0 or 65535 indicates that the sensor is saturated. If this is observed, check all system connections. If the problem persist, contact technical support for further instruction.

Tamb

The Tamb menu item displays the temperature being measured by the ambient thermocouple. The value in parentheses is the raw analog to digital converter (ADC) value (range of 0 - 65535), while the number to the right represents the calibrated value. An ADC value of 0 or 65535 indicates that the sensor is saturated. If this is observed, check all system connections and examine the thermocouple for signs of damage. If the problem persist, contact technical support for further instruction.

Pamb

The Pamb menu item displays the ambient pressure (uncorrected barometric pressure) being measured by the system. The value in parentheses is the raw analog to digital converter (ADC) value (range of 0 - 4095), while the number to the right represents the calibrated value. An ADC value of 0 or 4095 indicates that the sensor is saturated. If this is observed, check all system connections. If the problem persist, contact technical support for further instruction.

Pdif

The Pdif menu item displays the pressure drop (across the filter) being measured by the system. **This sensor is not used in the flow control calculation on the VFC +.** The value in parentheses is the raw analog to digital converter (ADC) value (range of 0 - 4095), while the number to the right represents the calibrated value. An ADC value of 0 or 4095 indicates that the sensor is saturated. If this is observed, check all system connections looking for kinks or cuts in the tubing. If the problem persist, contact technical support for further instruction.

Qstd (or Qamb)

The Qstd (or Qamb) menu item displays the flow rate being measured by the system. The menu item label changes between Qstd and Qamb to indicate the current flow conditions as determined by the MTR CONTROL setting. This is where the Gfactor onteh VFC device will be entered.

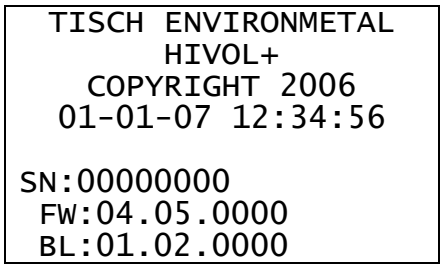
Motor

Use this function to manually toggle the motor on/off.

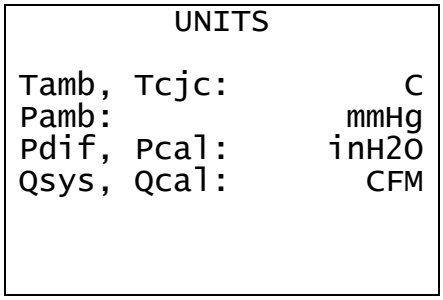
INFO DISPLAY

The INFO screens are accessed by pressing the F4 soft-menu function key while the main status screen is displayed. In addition to basic information about the system, these screens also contain the ALERT status screens. If an ALERT condition exists then system will automatically display that screen first. Use the UP and DOWN Arrow keys to switch between screens. Press the ESC key to exit the INFO screens display.

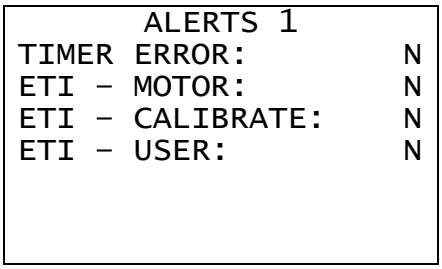
The screen above shows the manufacturer's name and the current date and time.



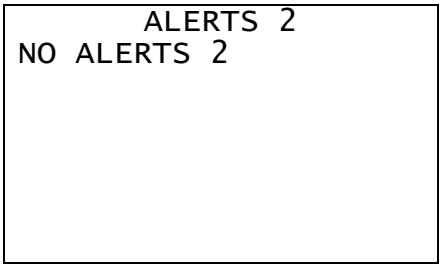
This screen shows the copyright notice, current date and time, unit serial number, firmware version number, and boot loader version number.



The UNITS screen shows the units of measurement associated for the values measured by the system.



The ALERTS 1 screen shows the status of the alerts. ALERTS are automatically cleared when the underlying cause is resolved. For example, if the ETI – MOTOR flag is set, then service the motor and resetting the ETI using the ETI menu will clear the flag.



The ALERTS 2 screen is reserved for future use and currently contains no alerts.

DATA FORMATS

The VFC+ creates to files containing data each time the SAVE function is used. Data on the memory stic is stored in the CSV (comma separated values) format readable by most spreadsheet programs. The files names are REPORT.CSV and DATA.CSV. They are stored in the following directory on the memory stick: \TISCH\DATA\SN\ (where SN is the serial number of the unit). The REPORT.CSV file contains summary data for each sample collected in an easily readable format. The DATA.CSV file contains all data collected by the unit. The individual logs described below are appended one after the other in the DATA.CSV file. The formats of the different logs are described below.

REPORT.CSV: Format

An Example of the report format is shown below. Description of the format is provided after the example.

```
HIVOL+ SN:00000000 REPORT
RETRIEVED ON 01-08-08 AT 15:38:22

--------
Start Time (Set),12-29-07 12:35:00
Start Time (Act),12-29-07 12:35:00
Duration,01:00:00
Conditions,Standard
Flow (Set),250
Flow (Avg),250
Flow CV,0.15
Sample Volume,14.98
Avg Amb Temperature,25.5
Avg Amb Pressure,757
Flags
--------
Start Time (Set),12-29-07 14:00:00
Start Time (Act),12-29-07 14:00:00
Duration,01:23:59
Conditions,Standard
Flow (Set),250
Flow (Avg),250
Flow CV,0.22
Sample Volume,20.97
Avg Amb Temperature,26.2
Avg Amb Pressure,757
Flags,ABORTED
```

The first line of the report identifies that this unit as a VFC+ with the given serial number and that this is the REPORT format.

The second line indicates when the REPORT.CSV file was retrieved from the unit.

The "--------" line indicates the beginning of a sample record.

The "Start Time (Set)" and "Start Time (Act)" lines indicate when the unit was set to start and when it actually started, respectively. These times could be different if there was a power failure at the beginning of the test and the unit started late.

The "Duration" line indicates the actual sampling duration in Hours : Minutes : Seconds.

The "Conditions" line indicates whether the test and data provided are being reported at Ambient or Standard Conditions.

The "Flow (Set)" and "Flow (Avg)" lines indicate the flow rate set point and average values respectively. The values are reported in L/min with conditions as indicated by the "Conditions" line.

The "Flow CV" line provides the value for the coefficient of variation of the flow rate during the test. This is a measure of stability of the flow during the test. The closer the number is to zero the more stable the flow. This value should usually be less than 2%. If it is greater, it could indicate a pending failure of the motor, odd sites conditions (i.e. extremely gusty wind conditions), or someone tampering with the unit during sampling.

The "Sample Volume" is the total volume (reported at the value stated in the "Conditions" line) that passed through the sample media during the test. The value is reported in m^3. This value may be slightly larger than the value calculated by multiplying the duration by the average flow rate. This is because the volume is recorded from the very beginning of the test, while the average flow calculation starts after 1 minute to keep startup variation in the flow from affecting the average value. The difference is very very small and may not be noticeable on longer test.

The "Avg Amb Temperature" line reports the average ambient temperature during the sampling event. The value is reported in degrees C.

The "Avg Amb Pressure" line reports the average ambient pressure (aka true barometric pressure) and is reported in mmHg.

The "Flags" line reports any items that may be of importance in determining the validity of the data. The individual flags are separated by commas. The possible flags are POWER (which indicates a power failure or brown out occurred during the sampling), ABORTED (which indicates the sampling was aborted by user interaction with the timer), FLOW (which indicates the flow rate exceed the set flow rate by +/- 10 percent for a period greater that 2 minutes) and EXPIRED (which indicates the sampling never occurred, likely because the unit was without power for the entire test).

DATA.CSV: General Comments on the Data Record Entries

All log entries share some common entries that are best described separately. The log formats were designed so that they could be easily read in either an automated fashion or interrupted manually. In order to accomplish this, several fields that pertain to the format of each line were added at the beginning of each line.

All log entries share 3 fields in common that appear at the beginning of each line. The first field is a new record indicator that signifies that start of a new data record. This is signified by a "!". The second field is a log type identifier. This is a numeric value that indicates what type of log this record belongs to. The third field is a record type identifier. This is a numeric field that is used to indicate the format of the remaining record entry.

Each data record is terminated by a <CR><LF> (carriage return and linefeed).

DATA.CSV: Begin and End Records

Each log begins with a "Begin" record (record type 1) and end with an "End" record (record type 4). In addition, to marking the start and conclusion of each log, these records indicate the name of the log that was saved, the date and time the record was saved, the model of the unit, and the serial number of the unit.

DATA.CSV: Header Records

The second record entry of each log is a header entry (record type 2). This record entry identifies the field names for the main record entries (record type 3).

DATA.CSV: Main Records

The main data records (record type 3) for each log type follow the header record. Refer to the header record of each log type to identify what a given value represents.

DATA.CSV: System Log Example

The System Log contains information on how the system was configured at the time the log was saved. An example log is shown below.

!,0,1,"Begin","System Log",04-20-07 12:34:43,"HIVOL+","100-0004"
!,0,2,"Item","Value"
!,0,3,"BL VER",01.03.0000
!,0,3,"FW VER",03.03.0000
!,0,3,"MOTOR","BRUSH – 60Hz"

!,0,3,"LOG INTERVAL",1
!,0,3,"LCD CONTRAST",32
!,0,3,"MOTOR TYPE","BRUSHLESS"
!,0,3,"MTR ETI",1
!,0,3,"MTR ETI ALERT",0
!,0,3,"CAL ETI",1
!,0,3,"CAL ETI ALERT",0
!,0,3,"USR ETI",1
!,0,3,"USR ETI ALEART",0
!,0,4,"End","System Log",04-20-07 12:34:43,"HIVOL+","100-0004"

DATA.CSV: Event Log Example

The Event Log contains the data for each timer event. This is the same data that can be viewed using the VIEW CURRENT SAMPLE and VIEW PAST SAMPLE menu items in the DATA menu. The log entries here are shown wrapped due to space limitations. In the actual data file each record is a single line.

!,1,1,"Begin","Event Log",04-20-07 12:34:43,"HIVOL+","100-0004"
!,1,2,"Set Start","Set Stop","Set Duration","Act Start","Act Stop","Act Duration","Tamb Avg","Tamb Min","Tamb Max","Tcjc Avg","Tcjc Min","Tcjc Max","Pamb Avg","Pamb Min","Pamb Max","Pdif Avg","Pdif Min","Pdif Max","Pcal Avg","Pcal Min","Pcal Max","Qamb Avg","Qamb Min","Qamb Max","Qamb Vol","Qstd Avg","Qstd Min","Qstd Max","Qstd Vol","Q Set","Q CV","Flag: Power", "Flag: Flow Range", "Flag: Completed","Flag: Executing","Flag: Aborted","Flag: Expired","Flag: Qstd"
!,1,3,04-20-07 10:30:00,04-20-07 11:30:00,01:00:00,04-20-07 10:30:00,04-20-07 11:30:00,01:00:00,22.3,21.6,22.9,27.0,26.5,27.7,759,759,760,51.9,51.2,52.7,6.22,5.95,6.32,260,259,261,15.58,259,258,260,15.53,260,0.10,0,1,0,0,0,0,0
!,1,3,04-20-07 11:35:00,04-20-07 11:40:00,00:05:00,04-20-07 11:35:00,04-20-07 11:40:00,00:05:00,22.6,22.3,22.7,27.9,27.9,28.0,760,759,760,52.0,51.3,52.7,6.22,6.06,6.30,260,259,261,1.28,259,258,260,1.28,260,0.09,0,1,0,0,0,0,0
!,1,4,"End","Event Log",04-20-07 12:34:43,"HIVOL+","100-0004"

DATA.CSV: Interval Log Example

The Interval Log contains the period averages of the sensors as defined by the LOG INTERVAL parameter in the CONFIGURE menu. The interval log records data constantly (whether the timer is executing or not) and therefore serves as a type of site log for ambient temperature and pressure. They interval log maintains the last 4,608 entries. This equates to 16 days of data with the default 5 minute log interval.

!,2,1,"Begin","Interval Log",04-20-07 12:34:44,"HIVOL+","100-0004"
!,2,2,"Time","Tamb","Tcjc","Pamb","Pdif","Pcal","Qamb","Qstd","DAC"
!,2,3,04-20-07 10:27:00,21.6,26.5,759,-0.0,-0.01, 0, 0,0
!,2,3,04-20-07 10:28:00,21.5,26.5,759,-0.0,-0.01, 0, 0,0
!,2,3,04-20-07 10:29:00,21.4,26.6,760,-0.0,-0.01, 0, 0,0

```
!,2,3,04-20-07 10:30:00,21.4,26.6,760,-0.0,-0.01,  0,  0,0
!,2,3,04-20-07 10:31:00,21.5,26.6,760,48.8,5.87,245,244,0
!,2,3,04-20-07 10:32:00,21.6,26.6,760,51.8,6.22,260,259,0
!,2,3,04-20-07 10:33:00,21.6,26.6,760,51.8,6.24,260,259,0
!,2,3,04-20-07 10:34:00,21.7,26.6,760,51.8,6.22,260,259,0
!,2,3,04-20-07 10:35:00,21.7,26.6,760,51.8,6.23,260,259,0
!,2,4,"End","Interval Log",04-20-07 12:34:47,"HIVOL+","100-0004"
```

DATA.CSV: Power Log Example

The Power Log contains information on when the unit started and stopped. This is useful in identifying when power failures occurred and how long they lasted. The last 64 power failures are recorded. This can be important in determining whether a sample can be considered valid if a power failure occurred during the sampling period. The "Source" field is intended to help technical support track down any power related problems with the unit and does not contain any data relating to the actual sampling taken place.

```
!,3,1,"Begin","Power Log",04-20-07 12:34:47,"HIVOL+","100-0004"
!,3,2,"Off","On","Source"
!,3,3,04-20-07 10:19:35,04-20-07 10:19:38,130
!,3,3,04-20-07 11:48:50,04-20-07 12:02:50,16
!,3,4,"End","Power Log",04-20-07 12:34:47,"HIVOL+","100-0004"
```

DATA.CSV: Calibration Log Example

The "Calibration Log contains a list of the times, sensors, number of calibration points used in the calibration, the calibration gain (A1) and the calibration offset (A0) of each sensor. The last 64 calibrations are recorded. This information can be used to track how the calibration of the unit changes over time, help identify potential problem before they occur, and identify which users may need additional training in calibration a particular sensor.

```
!,4,1,"Begin","Calibration Log",04-20-07 12:34:47,"HIVOL+","100-0004"
!,4,2,"Time","Sensor","Pts","A1","A0"
!,4,3,03-02-07 20:39:29,"Tcjc",1,13.771930,0.000000
!,4,3,03-02-07 20:41:47,"Tamb",2,0.299843,-11935.423828
!,4,3,03-02-07 20:46:11,"Pamb",4,30.914890,-13626.343750
!,4,3,03-02-07 20:48:59,"Pdif",4,3.201837,-1770.477539
!,4,3,03-02-07 20:52:18,"Pcal",4,0.854666,-284.707397
!,4,3,03-02-07 20:55:23,"Pcal",5,0.857291,-287.563842
!,4,3,04-20-07 09:19:46,"Pcal",1,0.857291,-281.191467
!,4,3,04-20-07 11:48:15,"Qstd",5,32.117942,-1.297638
!,4,4,"End","Calibration Log",04-20-07 12:34:48,"HIVOL+","100-0004"
```

Motor Brush Replacement

(110 volt Brush part #TE-33392)
(220 volt Brush part #TE-33378)

The following steps are accompanied by pictures to aid your understanding of motor brush replacement procedures. **Please be aware that the pictures are standardized and may not exactly match the equipment that you are using.** Motor brush removal and replacement does not change based on motor or brush type, so do not be confused if your equipment differs from what is pictured.

CAUTION: Unplug the unit from any line voltage sources before any servicing of blower motor assembly.

1. Remove the VFC device by removing the eight bolts. This will expose the gasket and the TE-115923 motor.

2. Turn assembly on side, loosen the cord retainer and then push cord into housing and at the same time let motor slide out exposing the brushes.

3. Looking down at motor, there are 2 brushes, one on each side. Carefully pry the brass quick disconnect tabs (the tabs are pushed into end of brush) away from the expended brushes and toward the armature. Try to pry the tabs as far as you can without damaging the armature.

4. With a screwdriver loosen and remove brush holder clamps and release brushes. Carefully, pull quick disconnect tabs from expended brushes.

5. Carefully slide quick disconnect tabs into tab slot of new brush.

6. Push brush carbon against armature until brush housing falls into brush slot on motor.

7. Put brush holder clamps back onto brushes.

8. Make sure quick disconnect tabs are firmly seated into tab slot. Check field wires for good connections.

9. Assemble motor after brush replacement by replacing the motor cushion and metal motor ring(s), placing housing over and down on the motor (at same time pull power cord out of housing), being careful not to pinch any motor wires beneath the motor spacer ring.

10. Secure power cord with the cord retainer cap.

11. Replace VFC device on top of motor making sure to center gasket.

****IMPORTANT**** To enhance motor life:
1. Change brushes before brush shunt touches armature.

2. Seat new brushes by applying 50% voltage for 10 to 15 minutes, the TE-5075 brush break in device allows for the 50% voltage.

110v VFC Motor

110v VFC Motor Brush(orange)

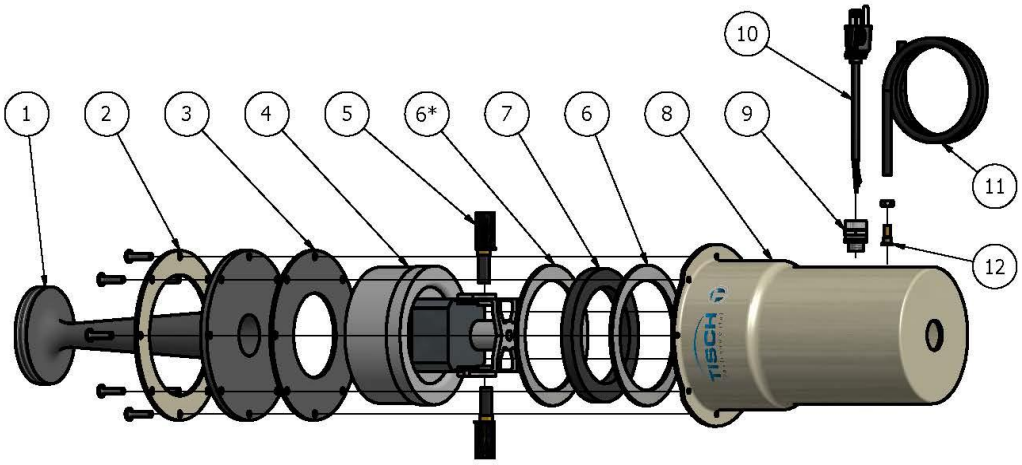
220v VFC Motor

220v VFC Motor Brush (brown)

Warranty

Instruments manufactured by Tisch Environmental, Inc. are guaranteed by warranty to be free of defects in materials and workmanship for one year after shipment from Tisch Environmental factories. The liability of Tisch Environmental, Inc. is limited to servicing or replacing any defective part of any instrument returned to the factory by the original purchaser. All service traceable to defects in original material or workmanship is considered warranty service and is performed free of charge. The expense of warranty shipping charges to and from our factory will be borne by Tisch Environmental. Service performed to rectify an instrument malfunction caused by abuse, acts of god or neglect, and service performed after the one-year warranty period will be charged to the customer at the current prices for labor, parts, and transportation. Brush-type and brushless motors will carry a warranty as far as the original manufacture will pass through its warranty to Tisch Environmental, Inc. The right is reserved to make changes in construction, design specifications, and prices without prior notice.

ASSEMBLY DRAWINGS



TE-5070 w/ TE-10557 Assembly			
ITEM	QTY	PART NUMBER	DESCRIPTION
1	1	TE-10557	Volumetric Flow Controller
2	1	TE-5070-3	Clamp Ring w/ 8 Hole Pattern for VFC Motor Housing
3	1	TE-5070-1	Gasket w/ 8 Holes VFC Flange Gasket
4	1	TE-115923 TE-116111	Motor for 110V VFC Blower Motor for 220V VFC Blower
5	2	TE-33392 TE-33378	Motor Brushes for 110V Motor VFC Motor Brushes for 220V Motor VFC
7	1	TE-5005-4	Motor Cushion
6	2	TE-5005-5	Motor Spacer Ring
8	1	TE-5070-2	VFC Aluminum Blower Motor Housing
9	1	TE-5005-7	Cord Retainer w/ Nut
10	1	TE-5010-4	Power Cord
11	1	TE-5005-6	Tubing 3 ft. Piece
12	1	TE-5005-8	Pressure Tap

*ONLY FOR 110V MOTOR TE-115923

Calibration Worksheet

TE-5170V Sampler Calibration Worksheet
(Using G-Factor)

Site and Calibration Information

Site		Calibration Orifice	
Location:	Cleves, OH	**Make:**	Tisch Environmental
Date:	Oct 31, 2014	**Model:**	TE-5028A
Tech.:	Jim Tisch	**Serial:**	1179
Sampler:	TE-5170V	**Qa Slope (m):**	0.92408
Serial #:	P8644 TSP	**Qa Int (b):**	-0.00383
VFC G-Factor:	0.0974264900	**Calibration due date:**	10/24/15

Ambient Conditions

Temp (deg F):	68.0		
Ta (deg K):	293	**Barometric Press (in Hg):**	29.50
Ta (deg C):	20.0	**Pa (mm Hg):**	749.3

Calibration Information

Run Number	Orifice "H2O	Qa m3/min	Sampler "H2O	Pf mm Hg	Po/Pa	Calculated m3/min	% of Diff
1	3.80	1.323	6.40	11.944	0.984	1.287	-2.72
2	3.80	1.323	6.80	12.691	0.983	1.286	-2.80
3	3.80	1.323	7.20	13.437	0.982	1.284	-2.95
4	3.75	1.315	9.25	17.263	0.977	1.277	-2.81
5	3.75	1.315	10.20	19.036	0.975	1.274	-3.04

Calculate Total Air Volume Using G-Factor

Enter Average Temperature During Sampling Duration (Deg F)	62.00
Average Temperature During Sampling Duration (Deg K)	289.67
Enter Average Barometric Pressure During Sampling Duration (In Hg)	29.40
Average Barometric Pressure During Sampling (mm Hg)	746.76
Enter Clean Filter Sampler Inches of Water	12.60
Enter Dirty Filter Sampler Inches of Water	16.00
Average Filter Sampler (mm Hg)	26.69
Enter Total Runtime in Hours (xx.xx)	23.90
Po/Pa :	0.964
Calculated Flow Rate (m3/min):	1.254
Total Flow (m3):	1797.57

Calculations

Calibrator Flow (Qa) = 1/Slope*(SQRT(H20*(Ta/Pa))-Intercept)
Pressure Ratio (Po/Pa) = 1-Pf/Pa
% Difference = (Look Up Flow-Calibrator Flow)/Calibrator Flow*100

NOTE: Ensure calibration orifice has been certified within 12 months of use

Tisch Environmental 145 South Miami Ave, Cleves OH 45002 • 877.263.7610 • sales@tisch-env.com • www.tisch-env.com

CALIBRATION CERTIFICATE

TISCH ENVIRONMENTAL, INC.
145 SOUTH MIAMI AVE
VILLAGE OF CLEVES, OH
45002
513.467.9000
877.263.7610 TOLL FREE
513.467.9009 FAX

ORIFICE TRANSFER STANDARD CERTIFICATION WORKSHEET TE-5028A

Date - Oct 24, 2014 Rootsmeter S/N 9833620 Ta (K) - 296
Operator Tisch Orifice I.D. - 2978 Pa (mm) - 755.65

PLATE OR VDC #	VOLUME START (m3)	VOLUME STOP (m3)	DIFF VOLUME (m3)	DIFF TIME (min)	METER DIFF Hg (mm)	ORFICE DIFF H2O (in.)
1	NA	NA	1.00	1.1880	4.5	1.50
2	NA	NA	1.00	0.9230	7.5	2.50
3	NA	NA	1.00	0.8380	9.0	3.00
4	NA	NA	1.00	0.7790	10.5	3.50
5	NA	NA	1.00	0.5860	18.0	6.00

DATA TABULATION

Vstd	(x axis) Qstd	(y axis)		Va	(x axis) Qa	(y axis)
0.9950	0.8375	1.2254		0.9940	0.8367	0.7665
0.9910	1.0737	1.5819		0.9901	1.0727	0.9896
0.9891	1.1803	1.7329		0.9881	1.1791	1.0840
0.9871	1.2671	1.8718		0.9861	1.2659	1.1709
0.9771	1.6674	2.4507		0.9761	1.6657	1.5331
Qstd slope (m) =		1.47574		Qa slope (m) =		0.92408
intercept (b) =		-0.00613		intercept (b) =		-0.00383
coefficient (r) =		0.99985		coefficient (r) =		0.99985
y axis = SQRT[H2O(Pa/760)(298/Ta)]				y axis = SQRT[H2O(Ta/Pa)]		

CALCULATIONS

Vstd = Diff. Vol[(Pa-Diff. Hg)/760](298/Ta)
Qstd = Vstd/Time

Va = Diff Vol [(Pa-Diff Hg)/Pa]
Qa = Va/Time

For subsequent flow rate calculations:

Qstd = 1/m{[SQRT(H2O(Pa/760)(298/Ta))]- b}
Qa = 1/m{[SQRT H2O(Ta/Pa)]- b}