# Model 3400 Toxic Air Sampler

## Operations and Maintenance Manual

**Version 1.40**

**June 17, 2007**

©2007 ATEC, 9727 Cotharin Road, Malibu, CA 90265-2112

**ATEC Model 3400 Toxic Air Sampler**
**Limited Warranty**

Atmospheric Technology (ATEC) warrants to the original purchaser of the Model 3400 Toxic Air Sampler that should it prove defective by reason of improper workmanship and/or material:

> Parts and Labor: For one year on all components from the date of original purchase, we will repair or replace, at our option, any defective part without charge for the part. Parts used for replacement are warranted for the remainder of the original warranty period.

To obtain warranty service, return the unit to ATEC. Shipping expenses are your responsibility. This WARRANTY DOES NOT COVER damage caused by: modification, alteration, repair or service of this unit by anyone other than ATEC; physical abuse to, or misuse of the unit; operation in a manner contrary to the instructions which accompany the unit; freight damage; or any damage caused by acts of God such as lightning or fluctuation in electrical power. This warranty also excludes all costs arising from installation, adjustment of user controls, initial technical adjustments (set-up) and user-required maintenance including filter changing.

Any express warranty not provided herein, and any remedy which, but for this provision, might arise by implication or operation of law, is hereby excluded and disclaimed. The implied warranties of fitness for any particular purpose are expressly limited to a term of one year.

Under no circumstances shall ATEC be liable to purchaser or any other person for any incidental, special, or consequential damages, whether arising out of breach of warranty, breach of contract, or otherwise.

Table of Contents


Introduction 1

Sampler Components 3

- Inlets 5
- Canister connections 5
- Cartridge Connections 5
- Canister filter 5
- Cartridge filter 5
- Ozone scrubber 5
- Solenoid valves 6
- Mass flow controllers 6
- Pressure Transducers 7
- Vacuum Pump 7
- Power supply 7

Sampler Setup 8

- Display and Function Tabs 9
- Date and Time 10
- Site Identification 10
- Canister, Cartridge, and Cr6 Filter Sampling Information 10
- Ozone Scrubber Temperature 11
- Purge Flow Rate 11
- Abort 11
- Function Tabs 12

Programming the Model 3400 13

- Time/Date 13

**Setup** **13**
Canister Parameters 14
Canister and Cartridge Parameter 15
Cartridge Parameters 15

**Schedules** **17**

**Data** **19**

**Leak Check** **22**

**SOP** **23**

**Manual Mode** **24**

**Advanced** **24**

**Maintenance** **27**

**Vacuum Pump** **27**

**Cartridge Filter** **28**

**Canister filter** **29**

**Ozone Scrubber** **29**

**Mass Flow Controller Calibration** **30**
Procedure for Calibrating the Canister Mass Flow Controller 30
Procedure for Calibrating the Cartridge Mass Flow Controller 32

**Pressure Transducer Calibration** **33**

**Model 3400 Parts List** **34**

**Appendix A – Procedure for Pressure Transducer and Flowmeter Calibration** **36**

**Appendix B – Schematics** **38**

**Appendix C – Manual for Mass Flow Controller** **49**

## Introduction

This manual covers the installation, operation and routine maintenance of the ATEC Model 3400 Toxic Air Sampler. This instrument is a microcomputer controlled sampler that can be programmed to draw ambient air into canisters, cartridges, and filters for subsequent analysis for VOC's, carbonyls, and Hexavelent Chromium (Cr6) according to EPA Methods. The Model 3400 has been specifically designed to simultaneously collect a canister, carbonyl cartridge, and two Cr6 samples using one easy-to-use instrument. The Model 3400-2F is designed to only sample Cr6 filters. The Model 3400 uses independent mass flow controllers in each channel to accurately monitor and control the flow rate to the canisters, cartridges, and filters.

The Model 3400 has the following features:

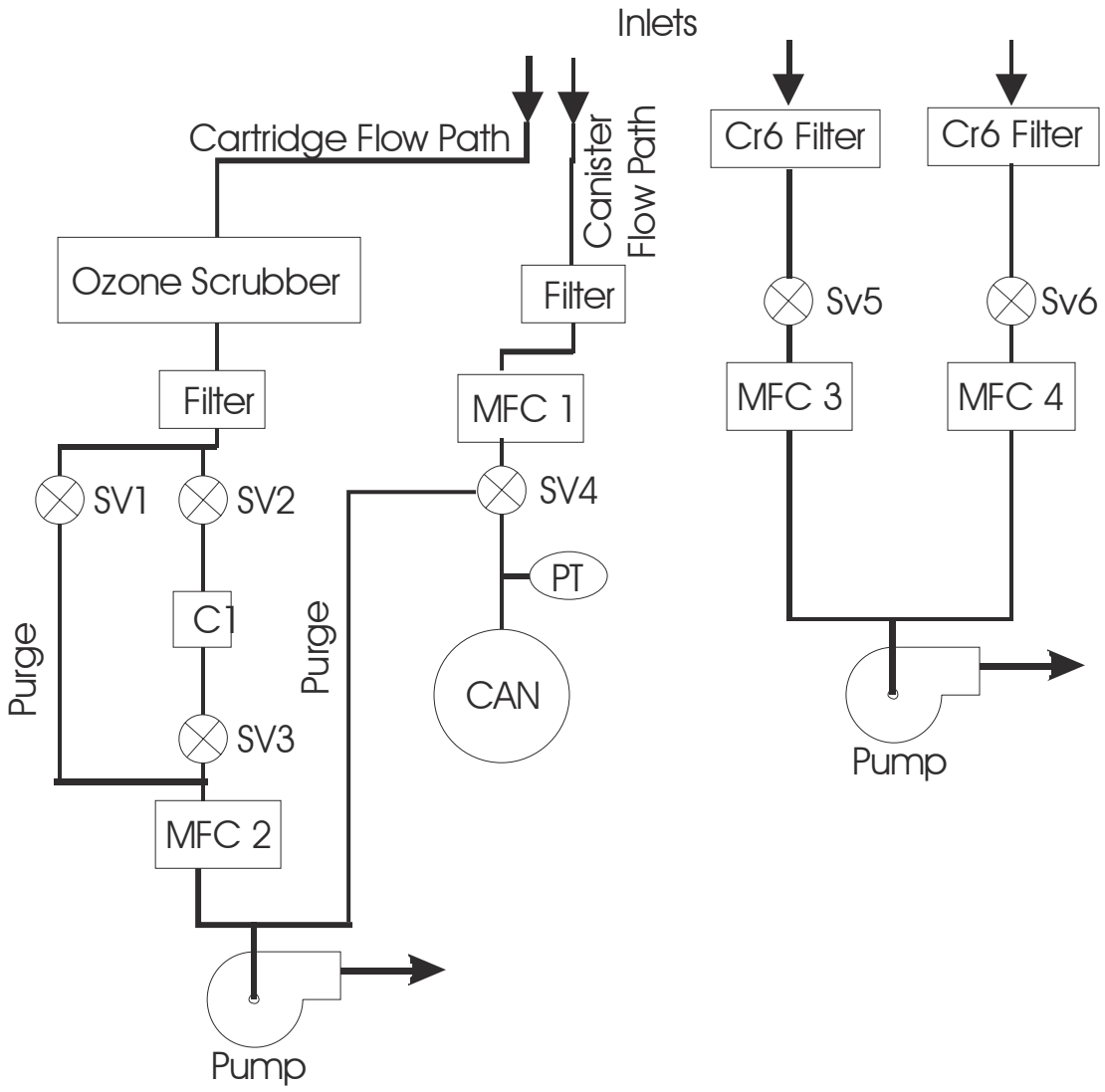
- Cr6 filter flow rate and volume logged during sampling
- Cr6 flow rate monitored for out of tolerance conditions
- Auto zero of mass flow controllers
- Software calibration of mass flow controllers
- On screen Standard Operating Procedures provide step-by-step guidance for operators during instrument setup and post sample data retrieval
- Duplicate sampling with independent mass flow controllers (maximum of four independent channels)
- ¼SVGA color touch-screen with Intel XScale microprocessor
- Optional label printer to provide QA labels for Cr6 filters and optional cartridges and canisters
- Data download to jump drive
- Idle channels can be programmed while sampling
- Manual mode operation to activate all components

## Operating Specifications

| | |
|---|---|
| Canister Flow Rate: | Nominal 10 cc/min (Optional ranges available). Accuracy ±2%FS |
| Cartridge Flow Rate: | Nominal 1 liter/min (Optional ranges available). Accuracy ±2% FS |
| Cr6 Filter Flow rate: | 15 lpm (other ranges optional). Accuracy ± 2% FS |
| Power: | 115VAC.<br>Maximum 8 Amp |
| Inlet: | ¼" OD tubing connector |
| Construction Materials: | Sample air exposed to stainless steel, Viton, polyethylene, brass, and PFA Teflon. |

**Sampler Components**

This section describes the general operation and major components of the ATEC Model 3400. Figure 1 is a schematic diagram of the sampler for canister carbonyl, and Cr6 sampling.




Model 3400 Flow Schematic

Figure 1.

The Model 3400 contains two filter/inlet assemblies to collect Cr6 samples. In addition, there are separate ambient air inlets to provide flow to the canister and cartridge sections when supplied with these options. A vacuum pump is mounted in an external module for the Cr6 filter samples. An internal vacuum pump is used to draw air into separate inlets for optional canister and carbonyl sampling. This internal vacuum pump also draws air through the cartridge flow path using a by-pass solenoid valve (SV1) that is opened prior to sampling to purge the sampling line. During sampling, the vacuum in the canisters provides the differential pressure for air to flow through the canister section (sub-ambient sampling). A separate internal filter is mounted in the canister and cartridge sample paths to remove ambient particulates. The cartridge flow path also contains a heated KI coated copper tube denuder to remove ozone. The flow rate to the canister, cartridge, and Cr6 filters is measured and controlled with a separate mass flow controller (MFC1 through MFC4).

Stainless steel solenoid valves with Viton seals (SV1 through SV6) are used to isolate the canisters, cartridges, and Cr6 filters from the flow path and open only during the scheduled sampling period. The solenoid valves are special low wattage valves that operate at much lower temperatures than standard valves, thereby minimizing out-gassing of volatile organic compounds from Viton surfaces. A three-way solenoid valve (SV4) is used with the canister so that the mass flow controller and inlet sampling line can be conditioned with ambient air prior to sampling. The canister line contains an accurate pressure transducer (PT) to measure the pressure within the canister. The pressure is periodically recorded during sampling to document the filling rate of the canister.

An internal microcomputer provides control for the automated sampling. A touch screen display allows operator input and shows sampling schedules and data.

Inlets

External sampling lines (one for canister sampling, one for cartridge sampling and 2 for Cr6 filters) are attached to the rear of the sampler using the ¼ " Swaglok bulkhead fittings.

Canister connections

Canisters are connected to the sampler using the 1/8" Swaglok fittings mounted on the rear panel. For a duplicate canister sample, attach a Swaglok tee fitting to the Canister 1 connection and attach separate lines from the tee to each canister.

Cartridge Connections

Cartridges are mounted using the Luer-lok fittings on the front panel

Canister filter

A 2 micron sintered stainless steel filter is located between the inlet and canister mass flow controllers to remove particulates from the air stream

Cartridge filter

A medium porosity (5-10 micron) 47mm diameter Teflon filter is mounted in a Teflon PFA filter holder located downstream of the ozone denuder to remove particles from the sample path.

Ozone scrubber

An ozone scrubber consisting of a ¼" OD copper tube, 36" long, which has been internally coated with potassium iodide (KI), is located downstream of the sampling inlet. The scrubber is mounted in an insulated heater, which is maintained at a temperature of 50±0.5°C. The temperature is controlled and monitored by the internal computer.

Solenoid valves

Two normally closed 2-way solenoid valves are used for the cartridge channel. The valves are located upstream and downstream of the cartridge. During normal sampling, both solenoid valves are opened. A leak check is performed during the first 20 seconds of each sampling interval. During leak check, the upstream solenoid valve is closed and the entire sampling line, downstream solenoid valve, cartridge, and flow controller are evacuated by the vacuum pump. If a small leak exists, the flow meter will detect the flow. During automatic operation, the microcomputer will set an error status if the flow exceeds a preset tolerance. A by-pass solenoid valve is located in parallel with the sampling valves to provide a purge flow to condition the sample lines prior to sampling. The purge flow is controlled using the cartridge Channel 1 mass flow controller.

A three-way solenoid valve is used to isolate each canister and corresponding pressure transducer from the flow path. When the valve is not activated, the sample path is connected to the vacuum pump, which pulls air through the inlet, filter, mass flow controllers and three-way solenoid valves to purge the entire sample path. When the solenoid valve is activated, the sample path is connected directly to the canister.

Two way solenoid valves are used to close the sample path for the two Cr6 filters.

Mass flow controllers

A separate mass flow controller is used to measure and control the flow rate to the canister, carbonyl and Cr6 filters. Various ranges of flow controllers can be installed depending on the required sampling flow rate. The control set point and output are interfaced to the internal computer. The mass flow controllers are zeroed prior to sampling to increase measurement accuracy.

Pressure Transducers

A precision pressure transducer is used to monitor the absolute pressure in the canister. The pressure transducers has a full-scale range of 0-30 psia. The output of the pressure transducer is interfaced to the internal computer.

Vacuum Pump

An internal diaphragm vacuum pump is used to draw air through the Model 3400 for purging and sampling. The pump is rated for continuous duty and can maintain a maximum vacuum level of 24 in Hg. The pump provides sufficient vacuum to sample a DNPH cartridges at a flow rate of 1 lpm. Maximum flow rate depends on the flow resistance of the cartridges.

A separate vacuum pump is mounted in an external enclosure to provide flow to the two Cr6 filters. The pump is capable of providing a flow of 15 lpm through each Cr6 filter. The pump is connected to the sampler with ½" polyethylene tubing. A power cable connects the pump enclosure to the rear of the sampler.

Power supply

The Model 3400 is powered by 115VAC and activated with the on/off switch located on the rear panel (indoor model). The 115VAC power is used to run the vacuum pump(s), ozone scrubber heater, and electronics power supply. The internal electronic components are powered using a ±15 VDC power supply. This supply provides DC power for the mass flow controllers, interface electronics, pressure transducers, internal single board computer power supply, and cooling fan.

## Sampler Setup

Upon arrival, check all shipping containers for damage and notify the shipper if damage has occurred. Carefully unpack the instrument and either bench mount or rack mount using the optional rack mount kit. If the sampler was ordered with the optional outdoor enclosure, refer the installation instructions for the outdoor enclosure.

Verify that the power switch on the rear panel (on the front for the outdoor enclosure) is in the “off” position. Plug the main power cord into an 115VAC outlet. Move the power switch to the “on” position and verify that the front display becomes illuminated after approximately the first 30 seconds of operation.

The Model 3400 uses a ¼ SVGA LCD color touch screen display to show current operating status and to enter information into the computer. The computer is accessed using tabs and buttons which are displayed on the screen and can be activated by finger touch or stylus. A pencil eraser also works well. Avoid using a ball point pen tip because this can damage the screen. The touch level of the screen can be calibrated by selecting the Touchscreen button under the **Setup** tab. Follow the directions on the screen to set the touch sensitivity. Once this is set, the buttons can be pressed using a finger or stylus.

Quarter-inch sample lines are connected to the fittings labeled “Canister Inlet” and/or “Cartridge Inlet” on the rear of the sampler. Canister connections are made to the 1/8” fittings labeled “Canister Ch.1” and “Canister Ch.2” on the rear panel. Cartridges are installed in positions labeled “Channel 1” and Channel 2” on the front of the Model 3400 using the Luer fittings. The tubing length can be adjusted for various cartridge sizes by pushing the Teflon tubing through the hole in the panel. A “Blank” location is provided to mount a field blank. For the

optional outdoor enclosure, the canister is connected at the bottom of the enclosure.

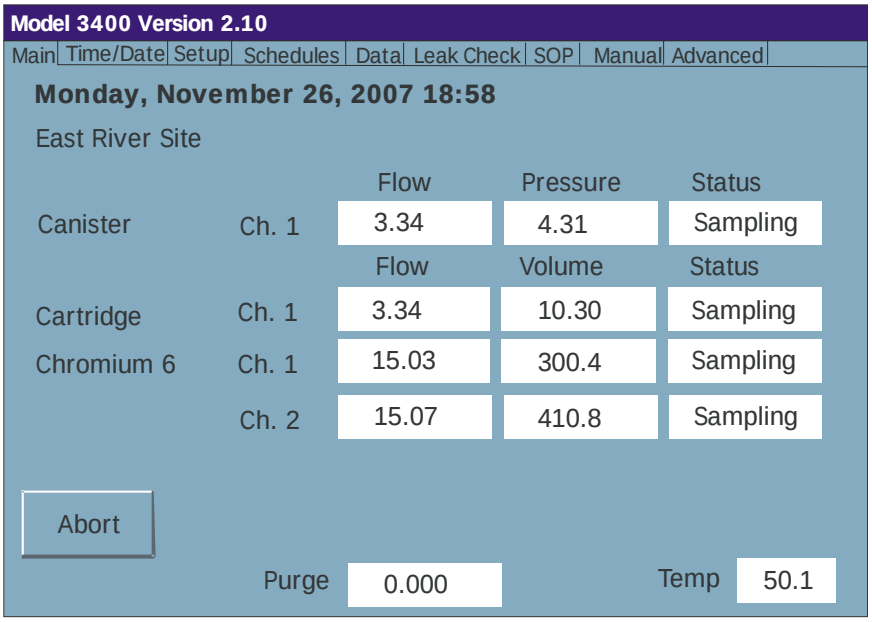
The Cr6 filters are connected with polyethylene tubing to the rear (bottom for outdoor enclosure) of the sampler at the ¼ Swaglok fittings labeled Filter 1 and Filter2.

A 9-pin connector is mounted on the rear panel to transmit data to a optional label printer. Below the touchscreen on the front panel are four USB connectors for retrieving data using a jump drive or updating the system software.

**All components, tubing, and fittings have been cleaned prior to assembly. The completed sampler has been purged with clean humidified air prior to shipment. After unpacking the instrument and after verifying operation, the Model 3400 should be purged with humidified zero air for a minimum of 24 hours before sampling.**

Display and Function Tabs

Normally the display will show the default main screen as illustrated here for the Moldel 3400 with one canister, carbonyl cartridge, and two Cr6 filter samples. This screen displays current sampling information and provides function tabs for the operator to enter operating parameters and retrieve data. The main screen displays the following:




## Date and Time

The current date, time, and day of the week is displayed at the top of the screen.

## Site Identification

A site identification label can be displayed below the time and date to identify the sampler. For example “East River Site” could be shown to identify this sampler from others used in a sampling network. This label is also displayed in the data that can be downloaded to a PC or laptop.

## Canister, Cartridge, and Cr6 Filter Sampling Information

The canister flow rate (cc/min) and pressure (psia),the cartridge flow rate (liters/min) and total volume (liters), and Cr6 filter flow rate and total volume are displayed. These values are continuously updated every 10 seconds. One of the following status indicators will also be shown in each status box, depending upon the sampling conditions:

*Sampling*—The channel is sampling

*Waiting*—The channel has been programmed to sample

*Purging*—The channel is purging prior to sampling

*Idle*—The channel has not been programmed to sample

*Aborted*—Operator terminated sampling

*Finished*—A successful sample has been collected without errors

*Used Can*—Canister starting pressure exceeded used can limit—no sampling occurred

*Leak Err*—Cartridge failed the leak check on start-up

*Post Leak Err*—Cartridge failed auto leak check at the end of sampling

*Temp Tol*—Ozone scrubber temperature exceeded ±5°C

*Press Tol*—Canister pressure tolerance exceeded

*Flow Tol*—Cartridge flow rate tolerance exceeded

*Zero Tol*—Cartridge MFC required excess zero compensation

*Errors*---Multiple errors, power outage, or sample aborted

Ozone Scrubber Temperature

The temperature of the ozone scrubber is displayed in the lower right hand corner of the screen. A red dot will appear next to the temperature when the heater is on.

Purge Flow Rate

When the sampler is purging prior to sampling, the purge flow rate will appear in the lower left hand side of the main screen. Normal purge flow rate is 1.0 lpm.

Abort

The **Abort** button is used to terminate sampling after purging has started. Once the **Abort** button is pressed, the channels that are sampling will be put through shut down which may take a minute or two. Also, pressing the **Abort** button will require the operator to enter a new sampling sequence to resume sampling.

Function Tabs

Several function buttons are located along the tap of the screen to enable the operator to interact with the sampler, to set the date and time, enter operating parameters, input a sampling schedule, retrieve data, leak check canisters and cartridges, or set-up the sampler using the Standard Operating Procedure (SOP) option. The operation of each tab is described in the programming section.

## Programming the Model 3400

The Model 3400 uses nine tab function to allow the operator to enter or retrieve information from the sampler**: Main, Time/date, Setup, Schedules, Data, Leak Check**, **SOP, Manual,** and **Advanced**. **Time/date** is used to enter the current time and date. **Setup** is used to configure the sampler and store sampling parameters. Sampling schedules are entered through the **Schedules** tab. Data can be displayed, sent to an optional label printer or downloaded to a jump drive using the **Data** tab. Canisters and cartridges are manually leak checked with the **Leak Check** option. The **SOP** tab uses a standard operating procedure to install and leak check canisters and cartridges and program sampling schedules. The **Manual** tab allows operational check out of the sampler hardware and the **Advanced** tab allows configuration of critical hardware parameters.

### Time/Date

The time and date that is stored in the Model 3400 can be changed using the **Time/Date** tab. When this tab is selected, a operating system screen will appear which will allow the user to change time, date, time zone, etc. Once this window is closed, the main screen should show the changed day of the week, date, and time.

### Setup

The **Setup** tab is used to input canister and cartridge operating parameters. This section is designed to allow field operators to change common operating parameters. When the **Setup** tab is selected, a screen appears which shows the following canister and/or cartridge operating parameters depending on the sampler configuration. This screen also enables recalibration of the touchscreen and the installation of software updates.

*Canister Parameters*

Pressure Tolerance

The Model 3400 continuously monitors the canister pressure during sampling and will produce an error flag if the pressure falls outside the pressure tolerance limit specified here. This tolerance is the difference between the expected pressure and the actual canister pressure. The sampler calculates the expected pressure based on the starting pressure, end pressure, and sampling duration.

End Pressure

The final end pressure is the desired canister pressure at the end of sampling. This value is an absolute pressure that should be determined from the atmospheric pressure at the sampling site. The end pressure must be at least 2 psia below this value to insure proper operation of the mass flow controllers (sub-ambient canister sampling only). The Model 3400 can be used to measure the site pressure by monitoring the canister pressure on the main screen without a canister attached.

The sampler uses the specified end pressure to calculate the necessary flow rate to fill the canister to this pressure. It must be noted that the mass flow controllers are factory calibrated to a volumetric flow rate at 760 mm Hg at 0°C (273°K). If the canister is sampled at a different temperature other than 0°C, the canister mass flow controller calibration slope must be adjusted. The filling rate and the resulting end pressure must be corrected using the ratio of sampling temperature to canister mass flow controller calibration temperature. For example, if the canister is filled at 273°K (0°C), the standard mass flow controller calibration (slope = 1.0) will provide the correct end pressure. However, if the canister is normally filled at 298°K (25°C), the canister mass flow controller calibration slope specified in Setup should be changed to 1.092 (298°K/273°K) in order to fill the canister to the specified pressure. As an alternative to changing the canister mass flow controller calibration slope, the

end pressure can be specified at a lower value to compensate for temperature. In the above example, the end pressure should be entered at 0.92 (273°K/298°K) times the desired end pressure.

Leak Rate Limit

The leak rate limit is the increase in pressure that is allowed to pass a canister during the manual leak check. This value is normally set to 0.1 psia/min.

Used Can Limit

The Model 3400 checks the pressure of each canister prior to sampling. The pressure specified in the used can limit is used to determine if a used or leaking canister has been installed. If the starting pressure is above this value, a used can error status code will be set and sampling will be stopped.

*Canister and Cartridge Parameter*

Purge Time

Purge time specifies the purging time before sampling either canisters or cartridges.

*Cartridge Parameters*

Ch.1 MFC Set Point

The sampling flow rate for the Channel 1 cartridge is specified in this box.

Ch.2 MFC Set Point

The sampling flow rate for the Channel 2 cartridge is specified in this box

Flow Leak Limit

The flow leak limit is the maximum flow rate that is allowed for a cartridge to pass either manual or automatic leak check.

Flow Tolerance

The cartridge flow rate is continuously monitored during sampling. If the measured flow rate deviates from the flow rate specified in Ch.1 MFC or Ch.2 MFC Set Point by this amount or more, an error status for flow tolerance will be generated.

Data Write Interval

The Data Write Interval specifies the time interval for recording canister pressure and cartridge flow rate data. The minimum time interval is 5 minutes.

Site Label

Touching the site label box brings up an alphanumeric keypad that can be used to input a site specific label (e.g. East River Site No. 2) that appears on the main screen. This label will also appear in the data downloaded to a PC or laptop.

*Cr6 Sampling Parameters*

Cr6 Filter Channel 1 Set Point

The sampling rate for the Cr6 Channel 1 filter is specified in this box

Cr6 Filter Channel 2 Set Point

The sampling rate for the Cr6 Channel 2 filter is specified in this box

Cr6 Flow Tolerance

The flow rate through each Cr6 filter is continuously monitored during sampling. If the flow rate falls above or below this tolerance, an error status for flow tolerance is displayed.

Set

Pressing the **Set** button saves the data that was entered in the Set-up screens and returns the program to the main screen.

*Update*

If the **Update** is pressed, the sampler searches for the presence of a jump drive in the USB connector below the screen. If the jump drive is present and has the proper updating files, the sampler software will be updated. If the update is successful, a message will appear on the screen stating that the update was successful and that the system will reboot in 15 seconds. If the jump drive cannot be recognized or it does not have the proper update files, a message will be display warning of an incomplete update and not software changes will be made.

Schedules

The **Schedules** tab is used to enter sampling schedules for the canisters or cartridges. Canister or cartridge channels can run independently or together (co-located sampling or duplicate sampling). When the **Schedules** tab is pressed, a screen appears which shows the start date, start time, and sample duration for Canister Ch.1. The values in each box can be changed by touching the text box and using the keypad or calendar to enter the appropriate values. All times are in military time format with midnight being 00:00. A 24-hour sample starting at midnight would be entered with a start time of 00:00 and a duration of 24:00 hours for the date entered in the “date” box. An identification label (e.g. Can 13420, Cart A6672) can also be entered for each canister and cartridge. This label will appear with the data to identify each sample. If a duplicate canister sample is to be taken (i.e. the Canister 1 connection on the rear of the sampler is connected to two canisters), the “with Duplicate Can” box

should be checked. If only Canister Ch. 1 is to be sampled, the **Done** button is pressed and the sampler will return to the main screen.

If additional channels are to be sampled, The **Next** button must be pressed to display the schedule for Canister Ch. 2. The start date, start time, and duration can be entered for Canister Ch. 2. However, if Canister Ch. 2 is to run as a co-located sample (i.e. same sampling time as Canister Ch. 1), the box marked "Sample with Ch. 1" should be checked and the same schedule for canister Ch. 1 will be entered for Canister Ch. 2. A label for Canister Ch. 2 can also be entered in the "Run Label" box. If no cartridges are to be sampled, the **Done** button can be used to return to the main screen. If a change must be made to the Canister Ch. 1 schedule, the **Prev** button will show the previous screen.

Pressing the **Next** button will show the schedule screen for Cartridge Ch. 1. The start date, start time, duration and label must be entered for this channel. However, if Cartridge Ch. 1 is to run at the same time as canister Ch. 1, the box labeled "Sample with Can" should be checked and the sampling schedule for Canister Ch. 1 will be automatically entered for cartridge Ch. 1. If desired, an identification label for this cartridge can be entered in the "Run Label" Box.

If a second cartridge is to be sampled, pressing the **Next** button will show the schedule for Cartridge Ch. 2. The schedule information can be entered or the "Collocated Cartridge" box could be pressed to enter the same schedule as Cartridge Ch. 1. The **Prev, Next** and **Done** buttons can be used to return to the previous screen, scroll around to the first screen, or move to the main screen.

If the Cr6 filters are to be sampled, the information is entered in the Cr6 scheduling screens.

Data

The **Data** tab is used to display or download data. After sampling has been completed, the **Data** tab is touched and the "Canister Ch. 1 Data" screen is displayed. The stored data includes: canister start time and starting pressure; canister stop time and ending pressure; average, minimum, and maximum flow rate; error status, and elapsed time.

If the label printer option has been installed, a label can be printed for each channel by pressing the **Label** button. On each label the following information will be printed: start date/time, end date/time, start and end pressure or total sampled volume, average flow rate, and error flag. The error flag is the sum valve of all errors that occurred during the sample period. The error values are:

| | |
|---|---|
| 0 | No Errors |
| 1 | Used Can Pressure Limit Exceeded |
| 2 | Leak Check Flow Limit Exceeded |
| 4 | Temperature Tolerance Exceeded |
| 8 | Pressure Tolerance Exceeded |
| 16 | Flow Rate Tolerance Exceeded |
| 32 | Flow Rate Zero Exceeded |
| 64 | Power Failure |
| 128 | Aborted |
| 256 | Post Run Leak Check Flow Limit Exceeded |
| 512 | Inlet Purge Line Flow Limit |

The entire data set can be downloaded to a jump drive inserted into one of the USB connectors below the screen. It takes approximately 20 seconds for the operating the system to recognize the jump drive. Pressing the ***Store*** button will cause all available data to be transferred. If data has already been transferred to the jump drive, it must be deleted from the jump drive before the drive can be used again to store data. Once all the files have been received, a message will appear confirming completion of the transfer.

An example of transferred canister data file is shown below.

```
East River Site
Canister 13249
Ch. 1 Canister Started at 11/20/00 9:00:06 PM
        Starting Pressure 0.11 psia
      Flow Rate Set Point 3.29 cc/min
                Stopped at 11/21/00 9:00:05 PM
             End Pressure 11.68 psia
        Average Flow Rate 3.29 cc/min
        Minimum Flow Rate 0.94 cc/min
        Maximum Flow Rate 3.47 cc/min
             Error Status Pressure Tolerance Exceeded

     Time          Can Pressure

11/20/00 9:00:17 PM      0.26
11/20/00 9:05:26 PM      0.16
11/20/00 9:10:36 PM      0.24
      •           •
      •           •
      •           •
11/21/00 8:45:25 PM      11.61
11/21/00 8:50:25 PM      11.63
11/21/00 9:00:05 PM      11.68
```

The **Next** button on the 3400 Data screen will advance to the next canister, cartridge, or Cr6 filter data or **Exit** can be used to return to the main screen.

The cartridge data screens follow the canister data screens. The stored cartridge data includes: start time; stop time; average, minimum, and maximum flow rate; error status; total volume sampled, and elapsed time.

An example of a cartridge data file is shown below.

```
Southern County Site
Cartridge A312
Ch. 1 Cartridge Started at 11/25/01 8:15:06 PM
       Flow Rate Set Point 1.000 lpm
                 Stopped at 11/26/01 8:15:36 PM
              Total Volume 1428.05 liters
         Average Flow Rate 0.996 lpm
         Minimum Flow Rate 0.984 lpm
         Maximum Flow Rate 1.017 lpm
              Error Status Temperature Tolerance Exceeded

     Time           Flow Rate          Volume

11/25/01 8:15:28 PM      1.902              0.35
11/25/01 8:20:36 PM      0.997              5.47
11/25/01 8:25:36 PM      0.996              10.45
11/25/01 8:30:46 PM      0.995              15.59
11/25/01 8:35:46 PM      0.995              20.57
11/25/01 8:40:56 PM      0.996              25.72
11/25/01 8:45:56 PM      0.996              30.70
11/25/01 8:51:06 PM      0.995              35.84
      •                  •
      •                  •
      •                  •
11/26/01 7:35:15 PM      0.997              1388.21
11/26/01 7:40:25 PM      0.996              1393.35
11/26/01 7:45:35 PM      0.995              1398.50
11/26/01 7:50:35 PM      0.998              1403.48
11/26/01 7:55:45 PM      0.994              1408.62
11/26/01 8:00:45 PM      0.995              1413.60
11/26/01 8:05:55 PM      0.996              1418.75
11/26/01 8:11:05 PM      0.994              1423.90
```

If a power failure occurs during sampling, the sampler will resume sampling based on the programmed sampling schedule. The sampling schedule and data will not be lost during a power failure. The actual sampling time will be shorter than programmed because of the power loss. Both canister, cartridge, and Cr6 filter data will show a power loss error, and the pressure/time and volume/time data will show the missing sampling interval during the power outage.

NOTE: The power failure error will also be reported if the system goes through a reboot during sampling. A hardware timer is monitoring system activity and if there is no activity for 30 seconds, the system will automatically reboot. The software sees this as a power outage and will record the power failure error. Sampling will resume with a minor loss of sampling data.

Leak Check

The **Leak Check** button is used to verify the canister and cartridge connections prior to sampling. The first screen is identified as “Can Ch. 1 Leak Check” and is used to leak check the Ch. 1 canister. Before starting the check, the operator must install an evacuated can on the Canister Ch. 1 port on the rear of the sampler. After the connections have been tightened, the canister valve is opened and then closed to evacuate the connecting line, internal sample tubing, and pressure transducer up to the isolation solenoid valve. Since the tubing has a small volume, small leaks will cause a rise in the measured pressure. The automated leak check routine will sample the pressure and determine if a leak is present. Even though pressure measurements fluctuate, the program will uses a least square data analysis routine to determine an accurate leak rate.

The **Start** button is pressed to begin the leak check. The leak rate box will show “testing” during the measurement period. The canister pressure measurement is shown in the lower right hand side of the screen along with the elapsed time. Testing can be stopped at any time by pressing the **Stop** button. After sampling for one minute, the calculated leak rate is shown in the leak rate box. If the test passed, the value is shown and “Passed” is displayed below the leak rate box. If the test failed, the value is shown and “Failed” is displayed below the box. When a canister fails, the test should be repeated to verify the first test. After repeated failures, the connections should be tightened again or replaced and

the leak check repeated. The **Next** button is used to advance to Canister Ch. 2. if a collocated can is to be tested.

A similar procedure is used to leak check the cartridges. After the Ch. 2 canister is tested, the **Next** button will display the cartridge "Ch. 1 Leak Check" screen. Cartridges are leak checked by turning on the vacuum pump and closing the upstream isolation solenoid valve. The downstream solenoid valve remains open to evacuate the cartridge, mass flow controller and tubing to the pump. If a leak is present, the flow controller will show a small flow. A leak is identified if the flow rate exceeds the flow rate tolerance set in the setup section.

The cartridge leak check procedure is similar to the one used for canisters. After a cartridge has been installed, the operator must press the **Start** button to begin the test. The cartridge leak check runs for 20 seconds. During this time, the vacuum pump is started and the flow rate is monitored. If the flow rate is above the leak limit at the end of the test, a "Failed" message is displayed and the leak flow rate is displayed. If a cartridge fails, the test should be repeated to verify the first test. After repeated failures, the fittings should be checked and the cartridge re-tested or replaced. The test can be repeated by pressing the **Start** button, or the next button can be used to advance to Ch. 2 cartridge testing.

SOP

The **SOP** tab provides a Standard Operating Procedure for installing, leak checking, and scheduling the Model 3400. The SOP software guides the user through the required procedures and enables inexperienced operators to successfully program the sampler.

Pressing the **SOP** tab initializes the program. The **Back**, **Next,** and **Exit** buttons are used to advance through the procedure or return to the main screen.

Initially, the program brings up a screen that requires the user to check the number of cans or cartridges to be sampled. Several screens follow which lead the operator through an automated leak check procedure. Each canister or cartridge must pass leak check or the program will not continue. After all of the cartridges and canisters have been installed and leak checked, the SOP leads the user through a scheduling procedure to program the sampling times. When scheduling has been completed, the **Next** button returns the program to the main screen. After sampling has been finished, the operator uses the **Data** tab to retrieve the collected data.

Manual Mode

A **Manual** tab is provided to allow the operator to activate any solenoid valve or pump. This mode is useful in troubleshooting and testing individual components. In addition, the flow set point of each mass flow controller can be individually set. Upon leaving the manual mode screen, all settings revert to the values used in automatic mode. The flow rate and pressure values shown in this mode are ***not adjusted*** by the calibration constants (slope and intercept) entered in Setup.

Advanced

Additional settings can be modified in the Advanced tab section that is accessed through the **Advanced** tab. Portions of this screen can only be accessed with a password and should only be used by individuals familiar with the operation and calibration of components used in the Model 3400. Changing the values in the Advanced Setup will alter the accuracy of the instrument.

Mass Flow Controller Calibration

The calibration of the mass flow controllers can be changed by entering the appropriate slope and intercept for each mass flow controller. See Appendix A.

Pressure Transducer Calibration

The calibration of each pressure transducer can be changed by entering the appropriate slope and intercept for each pressure transducer. See Appendix A.

Mass Flow Meter Range

If the full scale range of a mass flow controller is changed, the corresponding full-scale range must be entered in the MFC Range box. This item is hardware dependent and can is password controlled.

Heater Set Point

The set point of the ozone scrubber heater may be changed by replacing the value in the box marked Heater Set Point. The normal set point is 50 °C. This item is hardware dependent and can is password controlled.

Purge Flow Rate

The purge flow rate can be changed by selecting a new value in the Purge Flow Rate box. The purge flow is regulated by MFC 3 and can not be greater than the full scale range of this mass flow controller.

Pressure Transducer Range

The range of each pressure transducer must be entered in the Press 1 and Press 2 Cal boxes. This item is hardware dependent and can is password controlled.

Pressure Transducer Offset

Some pressure transducers have a zero offset. The value for the offset must be entered in the Press 1 and Press 2 Off boxes. This item is hardware dependent and can is password controlled.

control the enclosure temperature.

Temp High Limit

If the sampler is in an outdoor enclosure, the cooling fan will be turned on when the enclosure temperature exceeds this limit. The fan is also activated any time the pump is on. This item is hardware dependent and can is password controlled.

Temp Low Limit

If the sampler is in an outdoor enclosure, a heater will be activated if the enclosure temperature should fall below this value. This item is hardware dependent and can is password controlled.

Inlet Purge Flow Limit

If the sampler has an optional inlet purge mass flow meter, an error flag will be set if the inlet purge flow rate falls below this setting. This item is hardware dependent and can is password controlled.

## Maintenance

This section describes routine maintenance procedures for the Model 3400 Toxic Air Sampler. All other repair work should be performed by trained personnel.

Vacuum Pump

To remove the vacuum pump from the sampler, remove the top and side covers. Remove the inlet tube and disconnect the electrical connector. Remove the four screws attaching the pump mounting bracket to the side of the sampler and remove the pump.

Inspect the pump but DO NOT at any time lubricate any of the parts with oil, grease, or petroleum products nor clean with acids, caustics or chlorinated solvents. Be very careful to keep the diaphragm from contacting any petroleum product or hydrocarbons. It can affect the service life of the pump.

**WARNING**: To prevent explosive hazard, do NOT pump combustible liquids or vapors with these units. Personal injury and or property damage would result.

To clean or replace the filters and/or rubber gasket, remove the five screws in the top of the unit. The filters and gasket are located beneath this top plate. Remove the filters and wash them in a solvent and/or blow off with air and replace. The gasket may be cleaned with water. Replace the filters in proper position and replace the gasket. Note that the gasket and top plate will fit in one position only.

To replace the diaphragm, remove the socket cap screws from the head of the pump. The diaphragm is held in place by two Phillips head screws. Remove screws, retainer plate, and the diaphragm. The diaphragm will fit in any position on the connecting rod. Replace the plate and the two Phillips head screws. Torque to 17- inch-pounds.

**CAUTION**: Do not raise any burrs or nicks on the heads of these screws. These burrs could cause damage to the inlet valve.

For replacing the inlet and outlet valve, remove the slotted machine screw that holds each valve in place. The stainless steel inlet and outlet valves are not interchangeable. Clean them with water. When replacing the outlet valve, place the new valve in location and note there is a retaining bar near the machine screw hole. This retaining bar holds the valve in position. When replacing the inlet valve, note that the valve holder is marked with an X in one corner. This X should be in the lower right hand corner toward the inlet of the air chamber. Replace the head and tighten the socket head screws. Torque to 30 inch-pounds.

**WARNING**: The motor may be thermally protected and can automatically restart when the overload resets. Always disconnect the power source before servicing. Personal Injury and/or property damage could result.

Do not attempt to replace the connecting rod or motor bearings. If after cleaning the unit and/or installing a new Service Kit, the unit still does not operate properly, contact your representative, the factory, or return the pump to an authorized Service Center.

Cartridge Filter

The operator should periodically replace the Teflon filter located in the cartridge sample path. The replacement frequency will depend on site conditions. The filters must be replaced when the flow rate through the cartridges cannot be maintained. However, it is recommended that the filter be replaced before this condition exists. The operator should periodically check the filter and determine when it needs to be replaced. To replace the filter, turn off the main power to the sampler, remove the four screws that fasten the top to the sampler, slide the top towards the rear of the instrument and remove. Loosen the tubing nuts on each end of the filter housing and remove the housing. Remove the filter by

removing the retaining ring on the filter using the hand wrenches supplied with the sampler. Replace the filter with a 5 to 10 micron Teflon filter and replace the filter housing in the sampler.

Canister filter

The operator should periodically replace the 2 micron sintered stainless steel filter in the canister flow path. The filter must be replaced when the canister flow rate cannot be maintained. Site conditions will determine the replacement frequency. Remove the Filter assembly in the sample line at the ¼" Swaglok "T" fitting on the canister side of the "T" (Refer to Figure 1). Using a wrench, disassemble the assembly to expose the pressed-in filter disk. Using a small punch or rod, push the filter disk out the end of the fitting and replace with a new disk. The new disk may need to be tapped into the fitting with a clean hammer.

Ozone Scrubber

The ozone scrubber should be replaced after approximately 100,000 ppb ozone hours of either sampling or purging at 1 lpm. This is generally every 6-12 months depending on the sampling frequency. The operating life in hours can be estimated by:

Life (hrs)= 100,000/Average Ozone concentration at site.

The ozone scrubber is replaced by removing the top cover on the sampler and removing the ¼" stainless steel sample line with fittings and the Teflon filter holder on each side of the scrubber. Remove the two retaining knobs on the heater cover and remove the cover, exposing the heater block and copper tube denuder. Remove the insulation surrounding the heater block and carefully remove the denuder. Install a new denuder and replace the insulation and heater cover. Replace the sample lines and Teflon filter. Leak check the sample path by using the procedure described in the Sampler Leak Check Procedure section.

Mass Flow Controller Calibration

Each mass flow controller should be calibrated on an annual schedule. The mass flow controllers can be calibrated either electronically or manually. Manual calibration consists of adjusting the zero (no flow) and span potentiometers using a reference flow standard. The potentiometers can be accessed on the side of the flow controller housing. Electronic calibration can be performed by inserting the appropriate calibration constants into the advanced portion of the setup screen. Appendix A provides a worksheet to calculate these constants using a calibrated flow reference standard. Note that the canister mass flow controller calibration should be based on the average ambient sampling temperature as specified in the section on End Pressure under Programming the Model 3400.

*Procedure for Calibrating the Canister Mass Flow Controller*

If frequent pressure tolerance errors occur, either the pressure tolerance value entered in the Set-Up screen is set too low or the mass flow controller needs to be re-calibrated. The MFC is re-calibrated as follows:

1. Remove the top cover of the sampler
2. Disconnect the 1/8” stainless steel tubing at the inlet to the mass flow controller
3. Connect a calibrated flow standard to the inlet to the mass flow controller

   IMPORTANT: Use a standard that will not contaminate the sampler components
4. Connect an evacuated canister to the canister fitting on the rear of the sampler
5. Enter the Set-Up Screen and advance to the Manual screen

6. Set the canister flow rate by touching FSet1 or FSet2 (the Model 3400-2 has two canister flow controllers) by using the keypad to enter the value normally used in sampling, usually 3.5 cc/min for a 24 hour sample.
7. Open the valve on the canister and activate the internal canister valve by checking Can1 or Can2 on the manual screen
8. Allow the flow to stabilize and record the flow rate shown in Flow1 or Flow2 on the manual screen along with the flow rate indicated by the flow standard. IMPORTANT: The flow rate shown on the manual screen is the raw value that is NOT corrected by the calibration constants entered in the Set-Up screen. The calibration factors are only applied to the flow rate shown on the main screen when the sampler is running.
9. Calculate the MFC calibration constants (slope and intercept) using the procedure contained in Appendix A.
10. Exit the manual screen and enter the Set-Up screen. Enter the canister MFC slope and intercept. Exit the Set-Up screen
11. Enter a schedule and observe the canister flow rate while the sampler is running. Compare this value to the flow standard to verify that the MFC is properly calibrated.
12. Remove the flow standard and re-connect the inlet tubing to the MFC and replace the top cover on the instrument.

*Procedure for Calibrating the Cartridge Mass Flow Controller*

The cartridge MFC is re-calibrated as follows:

1. Remove the Luer connector or cartridge on the channel to be calibrated
2. Connect a calibrated flow standard on the Luer fitting on the outlet tubing on the front panel of the sampler.
3. Enter the Set-Up Screen and advance to the Manual screen
4. Set the cartridge flow rate by touching FSet3 or FSet4 (the Model 3400-2 has two cartridge flow controllers) by using the keypad to enter the value normally used in sampling.
5. Activate the internal cartridge valve by checking Cart1 or Cart2 on the manual screen
6. Allow the flow to stabilize and record the flow rate shown in Flow3 or Flow4 on the manual screen along with the flow rate indicated by the flow standard. IMPORTANT: The flow rate shown on the manual screen is the raw value that is NOT corrected by the calibration constants entered in the Set-Up screen. The calibration factors are only applied to the flow rate shown on the main screen when the sampler is running.
7. Calculate the MFC calibration constants (slope and intercept) using the procedure contained in Appendix A.
8. Exit the manual screen and enter the Set-Up screen. Enter the cartridge MFC slope and intercept. Exit the Set-Up screen
9. Disconnect the flow standard and attach a Luer connecter between the inlet and outlet tubing on the front panel.
10. Enter a schedule and allow the sampler to start sampling.
11. Remove the Luer connector and reconnect the flow standard at the outlet Luer connector tubing on the channel that is being sampled.

12. Observe the cartridge flow rate while the sampler is running. Compare this value to the flow standard to verify that the MFC is properly calibrated.
13. Remove the flow standard.

Pressure Transducer Calibration

Pressure transducers should be calibrated on an annual schedule. The pressure transducers can be calibrated either electronically or manually. Since manual calibration requires removal of the transducer from the sampler, it is recommended that the pressure transducers be calibrated electronically. Appendix A provides a worksheet to calculate these constants using a calibrated pressure reference standard.

**Model 3400 Parts List**

Components of the Model 3400 are shown in the following Parts List. This list does not include common parts such as fuses, fittings, or fasteners.

| | |
|---|---|
| Chassis | 3400-100-1 |
| Front Panel | 3400-100-2 |
| Rear Panel | 3400-100-3 |
| Mass Flow Controller (Specify Range) | 3400-200-1 |
| 3-Way Solenoid Valve | 3400-200-2 |
| Canister Tubing Set | 3400-200-3 |
| Cartridge Tubing Set | 3400-200-4 |
| Cartridge Filter Holder | 3400-200-5 |
| Cartridge Filter (47mm Teflon) | 3400-200-6 |
| Canister Filter Assembly | 3400-200-7 |
| Canister filter (2 micron) | 3400-200-8 |
| Pressure Transducer | 3400-200-9 |
| Ozone Scrubber Heater (Complete) | 3400-200-10 |
| Ozone scrubber (KI copper coil) | 3400-200-11 |
| Heater Relay | 3400-300-1 |
| Vacuum Pump | 3400-200-12 |
| Vacuum Pump Relay | 3400-300-2 |
| 2-Way Solenoid Valve | 3400-200-13 |
| *Canister Pressure Pump | 3400-200-14 |
| *Pressure Gauge | 3400-200-15 |
| *Pressure Adjusting Valve | 3400-200-16 |
| *Pulsation Damper | 3400-200-17 |
| Single Board Computer | 3400-400-1 |
| GPIO Board | 3400-400-2 |
| Interface Board | 3400-400-3 |

| | |
|---|---|
| Temperature Probe | 3400-400-4 |
| Power Supply | 3400-300-3 |
| Cooling Fan | 3400-300-4 |
| Power Switch | 3400-300-5 |
| Fuse Holder | 3400-300-6 |
| Pump Fan Guard | 3400-500-1 |
| Cooling Fan Guard | 3400-500-2 |
| Vacuum Line Tubing Set | 3400-200-16 |
| MFC Canister Ch.1 Cable | 3400-700-1 |
| MFC Canister Ch.2 Cable | 3400-700-2 |
| MFC Cartridge Ch.1 Cable | 3400-700-3 |
| MFC Cartridge Ch.2 Cable | 3400-700-4 |
| GPIO Cable Set | 3400-700-5 |
| Pressure Transducer Cable Set | 3400-700-6 |
| Rear Panel Output Cable Set | 3400-700-7 |
| Interface Board Ribbon Cable Set | 3400-700-8 |
| *Canister Pump Relay | 3400-300-7 |
| *Canister Pump Relay Cable | 3400-700-9 |
| Vacuum Pump  Relay Cable | 3400-700-10 |

*Pressurized Canister Option

## Appendix A – Procedure for Pressure Transducer and Flowmeter Calibration

Flowmeter Calibration Procedure

1. For the flowmeter to be calibrated, set the slope to ***1.0*** and the intercept to ***0.0*** on the Setup option.
2. Connect the output of the channel to be measured to a calibrated flow measuring unit.
3. Under Manual Mode, set the flowmeter set point to its full range value. Read the flowmeter value from the screen (X1). **X1:** ☐
4. Read the calibrated flow unit value (Y1). **Y1:** ☐
5. Set the flowmeter set point to zero or a very low value. Read the flowmeter value from the screen (X2). **X2:** ☐
6. Read the calibrated flow unit value (Y2). **Y2:** ☐
7. The slope is calculated by:

$$Slope = \frac{Y2 - Y1}{X2 - X1}$$ **Slope:** ☐

8. The intercept is calculated by:

$$Intercept = Y1 - slope \times X1$$ **Intercept:** ☐

9. In the Setup option, enter the new values for slope and intercept.

Pressure Transducer Calibration Procedure

1. For the pressure transducer to be calibrated, set the slope to ***1.0*** and the intercept to ***0.0*** on the FLOW SET option.
2. Connect the output of the channel to be measured to a calibrated pressure measuring unit.
3. Under Manual Mode, pressurize the line that the pressure transducer is measuring by turning on the pump and opening the appropriate valve. Read the pressure value from the screen (X1). **X1:** ☐
4. Read the calibrated pressure unit value (Y1). **Y1:** ☐
5. Attach a vacuum source to the line, close the Leak Check or Channel 2 valve and open the port valve to the vacuum source. Read the pressure value from the screen (X2). **X2:** ☐
6. Read the calibrated pressure unit value (Y2). **Y2:** ☐
7. The slope is calculated by:

$$Slope = \frac{Y2 - Y1}{X2 - X1}$$ **Slope:** ☐

8. The intercept is calculated by:

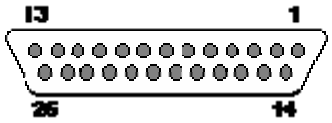
$$Intercept = Y1 - slope \times X1$$ **Intercept:** ☐

9. In the Setup option, enter the new values for slope and intercept.

## Appendix B – Schematics

## Appendix C – Manual for Mass Flow Controller

## Rear Panel Analog Outputs




| Pin Number | Signal | Calibration* |
|---|---|---|
| 1 | Scrubber Temperature[1] | 14.7°C/volt |
| 2 | Enclosure Temperature[2] | 14.7°C/volt |
| 3 | Flow Rate 1 | Range 1/5 volts |
| 4 | Flow Rate 2 | Range 2/5 volts |
| 5 | Flow Rate 3 | Range 3/5 volts |
| 6 | Flow Rate 4 | Range 4/5 volts |
| 7 | Pressure 1 | 6.05 psia/volt |
| 8 | Pressure 2 | 6.05 psia/volt |
| 9 | Flow Rate 5 | Range 5/5 volts |
| 10 | Flow Rate 6 | Range 6/5 volts |
| 11 | Pressure 3/Flow Rate 7[3] | Range 7/5 volts |
| 12 | Spare | |
| 13 | Open | |
| 14 | Ground | |
| 15 | Ground | |
| 16 | Ground | |
| 17 | Ground | |
| 18 | Ground | |
| 19 | Ground | |
| 20 | Ground | |
| 21 | Ground | |
| 22 | Ground | |
| 23 | Ground | |
| 24 | Ground | |
| 25 | Ground | |

*Calibration constants must by applied to measured voltages to adjust to calibrated standards.

[1]Scrubber temperature is present on sampler with carbonyl channels

[2]This temperature is present when sampler is configured in an outdoor enclosure.

[3]This signal is present in samplers configured with an inlet line flow meter which measures the inlet line pressure which is proportional to the inlet line flow rate.