



by Mesa Labs

PQ 200 Air Sampler User Manual

U.S. EPA FRM Designated Sampler

PM_{2.5} RFPS-0498-116

PM₁₀ RFPS-1298-125



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MK101-05 Rev B

NOTICE

This manual pertains to the Revision U(C8445) version of the PQ200. Refer to the table of contents for information on previous versions of the sampler.

Customer Support and Technical Assistance

For technical assistance or to request repairs or replacement parts, contact Mesa Labs at (973) 492-8400, or by e-mail at csbutler@mesalabs.com.

Table of Contents

Section	Page
1.0	Introduction.....5
2.0	Instrument Description..... 6
3.0	Specifications.....10
4.0	Safety.....10
5.0	Setup
5.1.	Initial Setup Instructions.....10
5.2	Initially Powering the PQ200.....15
5.3	Setting the Date and Time.....15
5.4	Entering Site and Filter Information.....15
5.5	Initial Performance Checks.....15
6.0	Operation
6.1	Run the Sampler from Midnight to Midnight.....17
6.2	Run the Sampler with User-Defined Start/Stop Times.....18
6.3	While the PQ200 is Running.....18
6.4	Temporary Halt Then Continue Sampling.....19
6.5	Ending a Run.....20
6.6	Data Download Instructions.....20
6.6.1	Data Download Using USB On-The-Go (OTG) Flash Drive.....20
6.6.2	PQ200 Job Controller Software for Windows.....20
6.6.3	Data Download Using the PQ200 Menu.....21
6.6.4	Data Download Using Serial Communication Commands.....21
7.0	Calibration
7.1	Flow Rate
7.1.1	Flow Rate Calibration.....23
7.1.2	Verifying Flow Rate.....24
7.1.3	Changing Flow Rate.....24
7.2	Temperature Probe
7.2.1	Verifying Temperature.....25
7.2.2	Calibrating Temperature.....25
7.3	Barometric Pressure
7.3.1	Pressure Calibration and Verification.....26
7.4	Leak Tests
7.4.1	External Leak Test.....26
7.4.2	Internal Leak Test.....27
8.0	Maintenance
8.1	Cleaning the Inlet, VSCC, and Downtube.....27
8.2	Rebuilding the Pump.....27
8.3	Updating Firmware.....28
9.0	Troubleshooting.....29
10.0	Warranty.....31
Appendix A	Parts List and Blow-Out Figures.....32
Appendix B	PQ200 Sampler Menu Tree.....47
Appendix C	Filters and Weighing Procedure.....49
Appendix D	Dip Switch Functions.....51
Appendix E	Use of the PQ200 as a PM ₁₀ Designated Reference Sampler.....54
Appendix F	Solar Panel Power Supply.....55
Appendix G	Accessories.....62
Appendix H	PQ200 Job Controller Software.....64
Appendix I	Terminal Program Interface.....67
Appendix J	Very Sharp Cut Cyclone – VSCC – Instructions for Use and Maintenance.....68

Appendix K	Updating Main Controller Board to "Rev U".....	71
Appendix L	Instructions for PM _{coarse} Sampling.....	77
Appendix M	Leak Test Procedure for S'Ns 906 through 1016.....	79
Appendix N	Rev "D" PCBs Calibration and Parts.....	81
Appendix O	WINS Installation.....	85
Appendix P	Pump Rebuild Instructions.....	87
Appendix Q	Revision T Manual.....	97

Figure List

Name		Page
Figure 1.	Schematic View of System.....	9
Figure 2.	Exploded View of Components Installed in Back of Instrument.....	14
Figure A1.	Filter Holder with PM ₁₀ Adapter Installed.....	33
Figure A2.	PQ200 Pump Exploded Drawing.....	34
Figure A3.	Instrument Panel Exploded Drawing.....	35
Figure A4.	Components Behind Door.....	36
Figure A5.	PM ₁₀ Size Selective Inlet.....	37
Figure A6.	Current Model Cables.....	38
Figure A7.	Current Model Cables.....	39
Figure A8.	Current Model Cables.....	40
Figure A9.	Location of Cable Connections.....	41
Figure A10.	Location of Cable Connections on Rev T PCB.....	42
Figure D1.	Location of Dip Switches.....	51
Figure D2.	PQ200 Dip Switch.....	53
Figure E1.	PM ₁₀ Adapter and Filter Holder, Open.....	54
Figure F1.	Setup of Solar Panel.....	58
Figure F2.	Orientation of Solar Panel.....	59
Figure F3.	Setting the Tilt Angle.....	60
Figure F4.	Wiring Connections.....	61
Figure G1.	Cassette Opener (CO1).....	62
Figure G2.	Cassette Transport Carrier (F214).....	62
Figure J1.	Flow Path in VSCC Cyclone.....	68
Figure J2.	Exploded Diagram of VSCC.....	70
Figure K1.	Exploded View of Obsolete Instrument Panel Configuration.....	74
Figure K2.	Exploded View of Instrument Panel.....	75
Figure K3.	Location of Low Voltage and Ambient Cables on Inside Panel.....	76
Figure K4.	Location of Pressure Hoses.....	76
Figure N1.	Obsolete Cables from Rev D PCB.....	83
Figure N2.	Obsolete Cables from Rev D PCB.....	84
Figure P1.	PQ200 Pump Exploded Drawing.....	95
Figure P2.	Orientation of Valve Plates.....	96
Figure Q1.	Location of temperature probe trimpots on Rev T PCB.....	22

1.0 Introduction

The purpose of this manual is to provide complete operation, calibration, and maintenance details for the BGI PQ200 air sampler. This instrument has been specifically designed to meet or exceed the operational requirements of a Reference Method sampling device under 40 CFR Part 50, Appendices J and L. For additional guidance on sampler operation, recommended maintenance, and procedures for filter handling and weighing, refer to the EPA Quality Assurance Handbook Volume II¹.

The PQ200 is a microprocessor-controlled air sampling instrument capable of sampling TSP, PM₁₀, and PM_{2.5} over user-defined volumetric flow rate and sampling period. The PQ200 includes an internal battery, which allows the investigator to perform their work in areas where no line power is available. DC power operation can be further augmented with a power supply/charger, or external batteries and solar power. Further details about solar power operation are available in Appendix F. Recovered data may be handled with provided Windows software. The instrument is manufactured entirely in the U.S. in an ISO 9001-certified facility in Butler, New Jersey.

Current Models

Part Number	Description
PQVSCC	<u>PQ200 PM_{2.5} Sampler</u> - The PQ200 configured for PM _{2.5} sampling includes a BGI Very Sharp Cut Cyclone (VSCC™) and PM ₁₀ louvered inlet head. This instrument was designated as a PM _{2.5} sampler under Federal Reference designation number RFPS-0498-116.
PQ200PM10	<u>PQ200 PM₁₀ Sampler</u> - The PQ200 configured for PM ₁₀ sampling includes a PM ₁₀ louvered inlet head and a straight passage replacing the VSCC™ or WINS. This instrument was designated as a PM ₁₀ sampler under Federal Reference designation number RFPS-1298-125.
PQVSCC and PQ200PM10	<u>The PQ200 PM_{Coarse} Samplers</u> - The PQ200 may also be configured for sampling the PM Coarse (PM _{Coarse}). PM _{Coarse} is defined by the U.S. EPA as the size fraction between PM ₁₀ and PM _{2.5} . This measurement requires two PQ200 samplers, one for PM ₁₀ and one for PM _{2.5} . Specific instructions for operating instruments to perform these measurements are described in Appendix K.

Legacy Model

The PQ200A PM_{2.5} Audit Sampler - PQ200A is a legacy version of the PQ200 sampler including transport cases and limited enclosure modifications. The PQ200A model is covered under the original designation as amended August 1998.

1 U.S. EPA Quality Assurance Handbook for Air Pollution Measurement Systems:
<http://www.epa.gov/ttnamti1/files/ambient/pm25/qa/QA-Handbook-Vol-II.pdf>

2.0 Instrument Description

Your PQ200 comes with the following:

- PQ200 sampler
- Downtube
- PM₁₀ inlet with water jar
- VSCC or PM₁₀ adapter installed in filter assembly (model dependent)
- 12V battery
- Filter cassette
- AC power adapter
- Legs (3)
- Ambient temperature sensor with radiation shield
- Leak test kit (flow audit adapter and filter cassette plus rubber discs)
- Download cable

The components and basic instrument operation are as follows:

- | | |
|---------------------------------|--|
| Inlet | The louvered size-selective inlet is manufactured according to design drawings and specifications in 40 CFR 50 Appendix L. It is designed to operate independently of wind direction and wind speed, with a throughput of 16.7 LPM. The louvered design and wind deflector hinders rain intrusion. An enlarged water exit hole in the impactor plate is used to promote water flow to the water collection jar. |
| Downtube | The downtube, also specified by design drawings in 40 CFR 50 Appendix L, transports the aerosol from the inlet to the filter assembly. |
| VSCC | The Very Sharp Cut Cyclone (VSCC™) was designed by BGI as a replacement to the WINS PM _{2.5} separation impactor. Per 40 CFR 50 Appendix L, the VSCC may be used in any FRM device as a PM _{2.5} particle size selector. The VSCC™-B model is designed to fit the filter assembly of the PQ200. When sampling PM ₁₀ , the PM ₁₀ adapter should be used in place of the VSCC™. All PQ200 with a PM _{2.5} configuration will come standard with a VSCC. |
| PM _{2.5} WINS Impactor | The WINS (Well Impactor Ninety-Six) PM _{2.5} impactor is described by drawings and specifications in 40 CFR 50 Appendix L. The well impactor, when properly operated with a 37 mm glass fiber filter and 1 mL of Dow 704 diffusion oil in the well, is designed to operate for approximately one week, depending on the ambient concentrations, without overloading or alteration of the cutpoint or collection efficiency curve. Most modern PM _{2.5} samplers use the VSCC over the WINS. The WINS is no longer produced by Mesa Labs. |
| PM ₁₀ Adapter | For PM ₁₀ sampling, the PQ200 uses an adapter to provide a straight passage to the filter. This adapter is a direct replacement for the VSCC-B and is approved for PM ₁₀ sampling by the U.S. EPA under Federal Reference designation number RFPS-1298-125. |
| Filter Holder | The filter holder and filter cassette are manufactured per the drawings in 40 CFR 50 Appendix L. The upper filter holder housing is designed into the same piece as the VSCC-B. The lower section houses the filter temperature probe and the air hose connection, which leads to the pump system. O-rings on the upper and |

lower housings ensure a tight seal around the filter cassette. The filter cassette itself is made of Delrin® and has upper and lower sections which snap together. These two halves sandwich a single 47 mm filter and a stainless-steel screen which serves as a backing/support plate for the filter. To ensure a tight seal, the filter cassette was designed with an interference fit which can initially make opening and closing the cassette difficult. Practice is recommended so that the cassette may be opened without damaging or dropping the filter.

Flow System

The flow system of the instrument is schematically illustrated in Figure 1. The configuration from the size selective inlet to the filter holder is mandated for Reference Methods under 40 CFR Part 50 Appendix L. From the filter holder, air flows through an interception water separator. The separator is fitted with a clear elastomeric tube located in the right, rear of the instrument case behind the filter holder. The bottom of this tube is fitted with a push valve on the bottom/outside of the case to permit the draining of water collected in the clear tube. The flow of air is directed through the mass flow sensor and then to a pulsation dampening volume. Prior to the pump, the air passes through the solenoid valve. The sole purpose of this valve is to provide a means of sealing the far end of the system when the automatic leak check function is activated. The pump is a Mesa-manufactured, double diaphragm unit designed especially for this instrument.

A microprocessor controls the flow system. The mass flow sensor detects the mass flow rate through the unit, from which the microprocessor then computes the volumetric flow rate utilizing the current barometric pressure and ambient temperature.

The algorithm used for this process is:

$$Q_{vol} = Q_{cal} * \frac{T_{cal}}{T_{vol}} * \frac{P_{vol}}{P_{cal}}$$

Where:

Q_{vol} is the current volumetric flow rate in liters per minute

Q_{cal} is the calibrated volumetric flow rate in liters per minute
(calibrate at 16.67 LPM for EPA sampling)

T_{vol} is the current ambient temperature (K)

T_{cal} is the calibration ambient temperature (K)

P_{vol} is the current ambient barometric pressure in mmHg

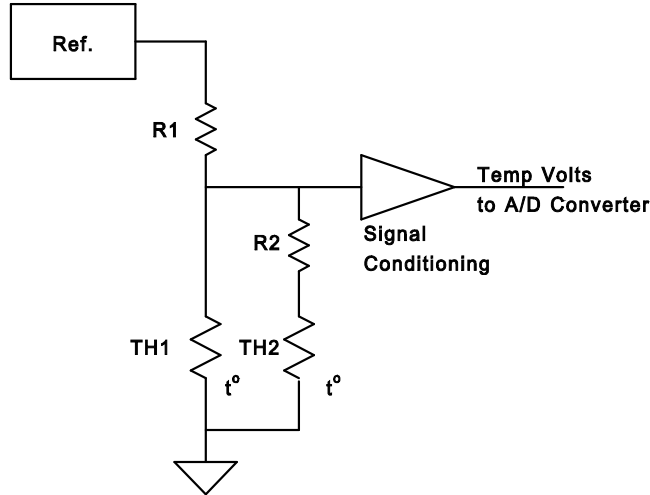
P_{cal} is the calibration barometric pressure in mmHg

While the sensor is detecting the mass of air flowing, the calibration device utilized is volumetric. The microprocessor is logging a mass flow rate along with barometric pressure and temperature at the time of calibration. The firmware in the microprocessor calculates a volumetric flow rate based on current actual conditions. This calculation and control adjustment is updated every 200 milliseconds.

Temperature Sensors

Temperature measurement is accomplished with a linearized thermistor circuit. A shunt resistor (R1) in series with a precision thermistor with a negative temperature coefficient (TH1) decreases the rate of resistance change as

temperature decreases. When used as a voltage divider, this circuit will produce a linear output voltage proportional to temperature. Resistor R2 and thermistor TH2 provide compensation for the typically narrow range of this simple approach providing a total accurate range of -30° to +50° C with a linearity deviation of +/- 0.16° C.



Pressure Measurement Ambient barometric pressure is measured using a precision temperature-compensated absolute pressure transducer. Its amplified output is signal-conditioned to obtain a voltage that is compatible with the PQ200 A/D converter and maximizes resolution by spanning the desired range across the A/D converter's input range. The inlet port of the barometric sensor is vented to outside the PQ200 case to eliminate errors due to case pressurization.

Unit Controls

Complete control of the sampler is achieved through only six buttons.



The buttons have these functions:

- ON/OFF:** powers the PQ200 on and off
- UP/DOWN ARROWS:** navigate through menu items
- SELECT:** chooses the current selection
- EXIT:** when available, it serves as the "back" or "exit" button
- LIGHT:** lights the screen when operating on battery power

Power

The PQ200 was designed to operate from a nominal 12 Volt DC source. Alternate power and battery charge is supplied via a standard, UL listed, class VI power supply. Auxiliary power can also be supplied via an external battery and/or solar panel to provide operation in remote areas.

When Operating from Batteries

The display will show Bty xx% (where xx = 00 to 99) and indicates approximate capacity. When the

Charger/External power supply is plugged in, the screen will display [DC In] or toggle between [DC In] and [Charged] depending on the internal battery status. While running from external batteries, the display will show EXT xx% indicating the approximate capacity of the external battery. A switching circuit within the PQ200 will automatically detect how the unit is powered and will display appropriately. When using an external battery, the PQ200 will drain the external battery first until cut-out occurs at approximately 10.5VDC to prevent deep discharge. At this point, the internal battery will then be switched into use. If the external battery is being charged by a solar panel, the unit will automatically switch to being powered by the external battery once it attains a charge of approximately 50%.

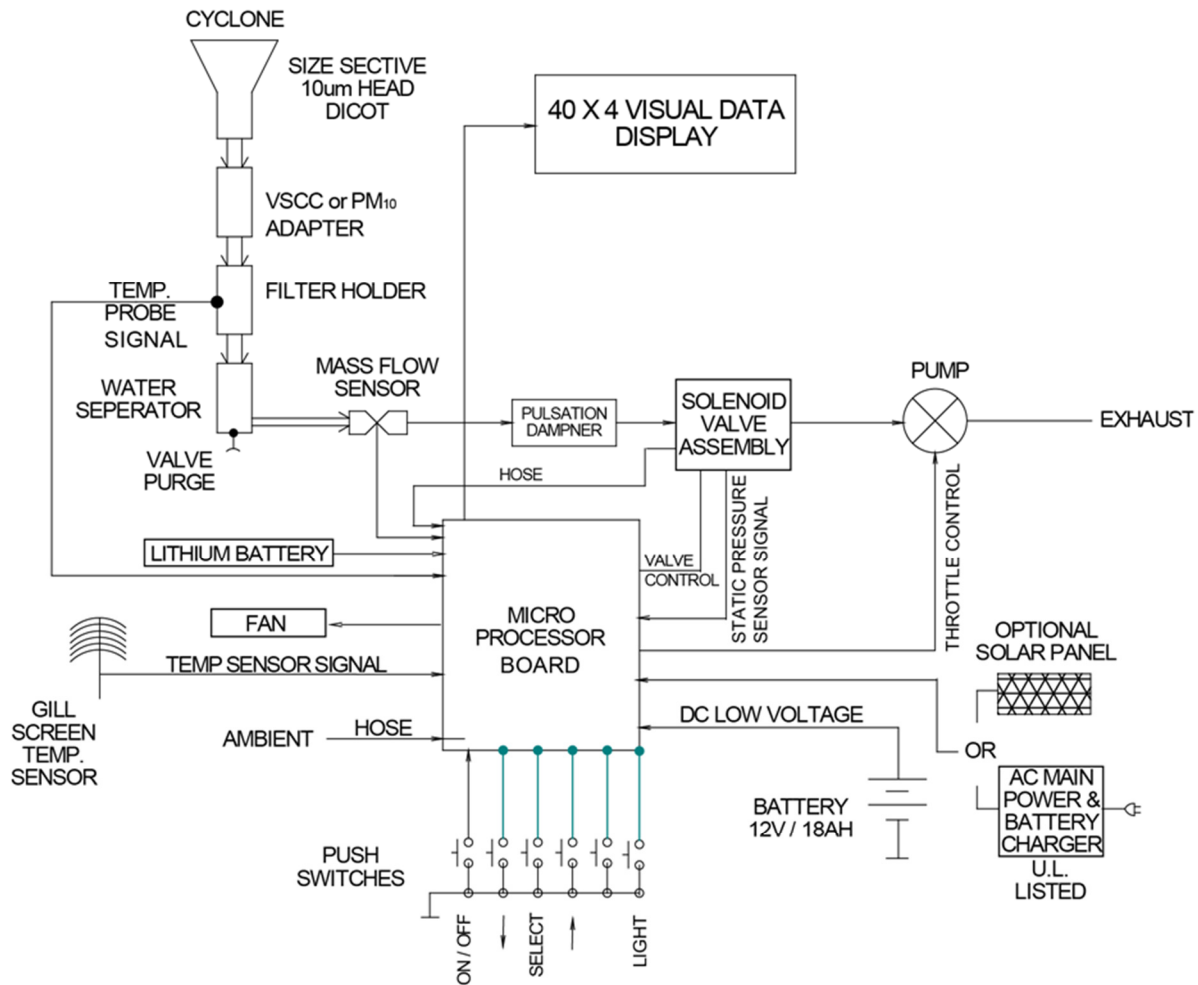


Figure 1. Schematic View of System

3.0 SPECIFICATIONS

PQ200 sampler weight:	48 lbs (21.8 kg)
Inlet and downtube weight:	5.5 lbs (3.4 kg)
Legs weight:	8 lbs (3.6 kg)
Complete system weight:	61.5 lbs (27.9 kg)
Enclosure Dimensions:	16 x 19 x 18 inches (41.1 x 48 x 47 cm)
Height of inlet above ground:	6.56 ft (2 m)
Display:	LCD screen
Data Port:	RS-232

4.0 SAFETY

The PQ200 should only be operated as described and for its intended use. Because the PQ200 runs primarily from battery power, all the typical hazards associated with high voltages and internal AC wiring have been reduced or eliminated. Personal injury, damage to the instrument, or fire can occur if the following electrical precautions are not observed:

- Caution should always be given when attaching the AC mains power connection. Do not attempt to connect main power if the plug or wire are cracked or frayed.
- Do not attempt to connect main power if the power cord, leads, or outlet are wet. Do not immerse power cords in water or other liquids.
- Place power cords away from traffic and do not allow anything to rest on them during operation.
- Do not overload AC outlets.
- Do not attach improperly-wired external batteries, solar panels, or power sources.
- Allow a few inches for ventilation at the rear of the instrument. Do not allow the fan opening to become clogged or blocked.
- Do not open the control panel or handle any other of the electrical parts while power is applied to the PQ200. Always disconnect the power supply first.
- Always operate the PQ200 in a normal, upright position. The legs should be bolted down to prevent tipping in conditions of high winds.
- Do not operate the PQ200 if any of the parts are defective, damaged, or missing.

5.0 Setup

5.1 Initial Setup Instructions

When you first receive your PQ200, unpack all of the components to ensure that you received all of the correct parts and nothing was damaged during shipment. It is recommended that each PQ200 sampler be assembled initially in a laboratory or other environment to check operation prior to installation in the field.

Follow these steps to set up your PQ200 sampler:

Step 1. Attach the legs to the unit at the three hard points on the underside of the sampler. The legs are identical and interchangeable. Make sure the connectors are seated properly and that the legs are securely attached.



Step 2. Attach the AC power supply to the rear of the unit underneath the fan cowling. Use the plate on the AC power supply to hook it to the rear of the instrument. Run the female, three-pin connector underneath the sampler to the hole in the sampler case near the front on the right side. Open the main door on the PQ200 and feed the connector through the hole and attach it securely to the upper of the two connectors.



Alternatively, the unit may be operated from the battery backup system or a solar power system. When fully charged, battery power is sufficient to operate the PQ200 for 24 hours in all but the most extreme conditions. Note that when operating from battery power, the control screen dims and it may be necessary to press the LIGHT button to view the screen. If using the solar power attachment, the connector attaches to the PQ200 in the same fashion as the AC power supply.



Step 3. Attach the external temperature gauge to the rear of the unit. The attachment points are on the fan cowling itself. Position the temperature gauge assembly so that it sits above the top of the sampler case. Screw the connectors firmly into the attachment points. Run the cord with the three-pin connector underneath the sampler case and through the hole, just as with the power connector, and attach it to the lower of the two connectors.



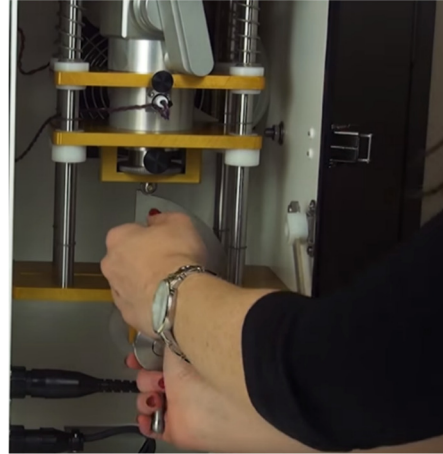
Step 4. Confirm the presence of two O-rings on the bottom end of the downtube that mates with the open tube on the top of the sampler case. Ensure the interior of the tube is clean and clear of any debris. Install downtube on sampler.



Step 5. Confirm the presence of two O-rings on the bottom side of the size selective inlet that mates with the downtube. Install on top of downtube. The water collection hardware is packed separately to avoid shipping damage. Locate and attach to the side of the size selective inlet.

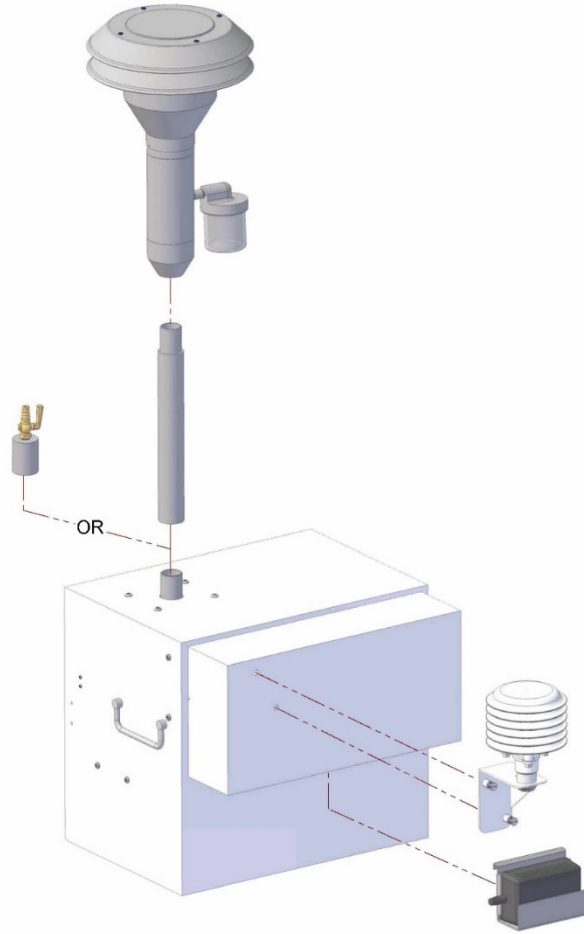


Step 6. The VSCC assembly is installed prior to shipment with model PQVSCC. Open the VSCC and filter assembly inside the PQ200 sampler case by carefully rotating the handle counterclockwise using both hands. Inspect the VSCC for obvious missing pieces or damage. Ensure the interior of the VSCC is clean and clear of any debris.



Step 7. The filter holder assembly and filter cassette is installed prior to shipment. Inspect the filter housing and filter cassette for obvious missing pieces or damage. Confirm the presence of O-rings inside the upper and lower filter housings where they contact the filter cassette. Ensure the housing interior is clean and free of debris.

Step 8. If you are going to immediately run the PQ200, place a filter inside of the filter cassette. Firmly pull the white rings apart and place a clean filter on top of the filter screen. New filter cassettes can be difficult to open the first few uses. Never twist the filter cassette rings to open with a filter installed as this will damage the filter. Reinstall the filter cassette in the filter housing.



1790

Figure 2. Exploded View of Components Installed in the Back of the Instrument

5.2 Initially Powering the PQ200

Press the ON/OFF button on the PQ200. The screen should light with the message:

```
PQ200 Air Sampling System
(c) Copyright 1998 BGI Incorporated
All Rights Reserved
Serial Number: XXXX          Version: X.XX
```

After a few seconds, the main screen will appear. The main screen always displays the ambient barometric pressure, ambient and filter temperatures, date, time, power source, and any flags that may have occurred. Any error or status messages will also appear on the screen. For example:

```
READY FOR NEW RUN!          [DC IN]
                              2016
                              04jul
746mmHg A 28.0°C F27.5°C    (MENU) 14:53
```

Confirm that the date and time displayed are accurate. If necessary, follow the steps in Section 5.3 below to set the proper date and time.

Press **SELECT** on the control panel to enter the main menu.

5.3 Setting the Date and Time

- From the home screen, press **SELECT** to access the main menu.
- From the main menu, scroll down by pressing the down arrow button and select **Set Date and Time** by pressing **SELECT**.
- The **Set the current DATE & TIME** message will be displayed. The current date and time will be flashing.
- The unit that is flashing can be edited by pressing the **Up** or **Down** arrows. Use these arrows to increase or decrease the selected value.
- After you have selected the desired value, press **SELECT** to move to the next value you wish to edit.
- Continue to press the **SELECT** and **Up** and **Down** arrow buttons in this fashion to enter the desired date and time. When done, press the **EXIT** button to return to the main menu.
- Press the **EXIT** button again to return to the home screen.

5.4 Entering Site and Filter Information (optional)

1. From the home screen, press **SELECT** to access the main menu.
2. From the main menu, scroll down by pressing the down arrow button and select **Site & Filter Information**.
3. The first character (**T**) of the second line has a flashing cursor on it.
4. Using the **Up** and **Down** arrow buttons, cycle through the possible characters. To select the flashing character and move to the next character, press the **SELECT** button. When all information has been entered, press the **EXIT** button to return to main menu.

5. Press the **EXIT** button again to return to the home screen.

NOTE: The site and filter information may also be entered using the PQ200 Job Controller software (Appendix H), through OTG Flash Drive (section 6.2), or through the computer using a terminal program (Appendix I).

5.5 Initial Performance Checks

We recommend the operator perform a series of performance checks after installation and before operating the instrument for the first time. These checks include an external and internal leak check and temperature, pressure, and flow verifications.

CAUTION! Do not operate the system without a filter installed.

Leak Check

Leak checks should be performed at regular intervals. The U.S. EPA recommends an external and internal leak check every 5 sampling events¹. To perform a leak check on the PQ200, follow the detailed instructions in Section 7.4 of this manual.

Temperature and Pressure Verification

Check the readings of the ambient temperature and barometric pressure gauges against NIST-traceable devices (see Sections 7.2 and 7.3 of this manual) each time the sampler is operated. Refer to 40 CFR 50 Appendix L for acceptable tolerances. If recalibration is necessary, follow the procedures in Sections 7.2.2 and 7.3.1 of this manual.

Flow Rate Verification

A verification of the sampler flow rate should be performed on a regular schedule; refer to Section 2.12 of EPA's QA Handbook for the suggested frequency and acceptable tolerances. Section 7.1.2 of this manual provides instructions on how to verify the PQ200's flow rate.

¹ Quality Assurance Guidance Document 2.12, U.S. EPA, November 1998, <http://www.epa.gov/ttn/amtic/files/ambient/pm25/qa/m212covid.pdf>

6.0 Operation

6.1 Run the Sampler from Midnight to Midnight

For most applications, this is the appropriate method of operation. It complies with the EPA's requirement for 24-hour sampling. The run will commence at the next occurrence of midnight (00:00) and will stop sampling at midnight of the following day. To run the sampler with user defined start/stop times, follow instructions in section 6.2. *Data from a previous run should already have been downloaded prior to use of this function.* However, the instrument will alert the operator if the data has not been downloaded.

- From the Main menu, select * **Run Sampler from Midnight to Midnight.**
- If the user has already downloaded the previous run data, the following message will be displayed:

**Run is Scheduled
PQ200 Shutting Down**

The PQ200 is then programmed to power itself on and begin sampling at midnight. If you turn on the PQ200 back on before the run is scheduled to begin, the main screen will read **WAITING RUN TIME EVENT!**

If you wish to cancel your scheduled run, turn on the PQ200 and enter the main menu. Scroll down using the **Down** arrow button and select ***Reset Run Data & Scheduled Run.**

6.2 Run the Sampler with User-Defined Start/Stop Times

6.2.1 Setting User-Defined Start/Stop Times Using PQ200 Menu

If operation other than midnight to midnight sampling is desired, start and stop times can be programmed. As above, data from a previous run should be downloaded prior to setting up a sample run. However, the instrument will alert the operator if the data has not been downloaded.

- From the home screen, press **SELECT** to access the main menu.
- From the main menu, scroll down by pressing the down arrow button and select **Run with User Defined Start & Stop**
- **Set Sample START DATE & TIME** and **Set Sample STOP DATE & TIME** will be displayed. The current selection will be flashing on the second line.
- Use the **Up** and **Down** arrow buttons to increase or decrease the selected value. When done, press **SELECT**.
- Continue to press the **SELECT** and **Up** and **Down** arrow buttons to enter the desired date and time.
- When you are finished setting the start date and time, press the **EXIT** button to continue.
- If you have not entered a valid date and time, the following message will be displayed:

Please, Enter Valid Date & Time

Press UP, DOWN, or SELECT to Continue

Setup Procedure for the PQ200 using a flash drive

To adjust settings in your PQ200 using a USB, you will need a USB On-The-Go (OTG) flash drive. This

procedure will not work if another type of USB is utilized. To adjust PQ200 settings, follow the steps below:

1. Open Notepad on your computer.
2. The document MUST start with <begin> and end with <end>.
3. Write values that you would like to customize. The options are listed below:
 - a. language: language of operation, English or Spanish
 - b. filter: filter information, 32 symbols
 - c. site: site information, 32 symbols
 - d. logger: logger interval, 30sec or from 01min to 99min
 - e. flow: flow rate, from 5.0 to 20.0
 - f. date: current date in dd/mm/yyyy format
 - g. time: current time in hh:mm:ss format
 - h. startdate: run start date in dd/mm/yyyy format
 - i. starttime: run start time in hh:mm:ss format
 - j. stopdate: run stop date in dd/mm/yyyy format
 - k. runstoptime: run stop time in hh:mm:ss format
 - l. runscheduled: run is scheduled? 1=yes, 0=no
 - m. reset: clears previous run data. 1=yes, 0=no
4. Once the setup data is complete and to your liking, save the file to your USB OTG flash drive under this specific name and file format(case sensitive):
 - a. pq200settings.cfg
5. Eject the flash drive from the computer.
6. Turn the PQ200 sampler on. Take the thumb screws out of the front panel assembly and gently pull the panel forward to expose the circuit board (see figure A3).
7. Connect the USB OTG flash drive to the USB type A jack in the PQ200 circuit board.
8. Shortly after the flash drive is connected, the instrument will beep and the screen will display "Downloading!", and the PQ200 will start to load the settings file automatically. If the load is successful, one of two things will happen:
 - a. If you scheduled a run, the PQ200 will power off.
 - b. If you did not schedule a run, the PQ200 will return to the home screen.
9. If the download was not successful, the changes will not be seen on the unit. Indicators that the download was not successful are incorrect dates and/or times, no scheduled runs, or any settings that you wrote in Notepad not being reflected by the PQ200.

```

<begin>
language=English
filter=User filter information
site=User site information
logger=5min
flow=16.7
date=dd/mm/yyyy
time=hh:mm:ss
startdate=dd/mm/yyyy
starttime=00:00:00
stopdate=dd/mm/yyyy
stoptime=00:00:00
runscheduled=1
reset=1
<end>
  
```

Note: you do not need to include all of the fields. If you need to adjust the date and time in your PQ200 but do not need to schedule a run, you can just utilize the date and time fields (bracketed by <begin> and <end>). An example of a pq200settings.cfg file used for adjusting the PQ200 settings can be seen below:

6.3 While the PQ200 is Running

While the PQ200 air sampler is running, the display will look similar to this:

ET000:05 TV:000.08M3	[DC In]	
Start:04jul15:00 Stop:05jul15:00		2017
Q(Vlpm):16.70 AVG:16.71 CV 0.16		04jul
749mmHg A28.6°C F27.8°C SP025cm		15:05

Pressing the select button will display a second screen:

Tmax:28.5 Tmin:28.2 Tavg:28.4	
BPmax:750 BPmin:749 BPavg:749	2017
Q(Vlpm):16.70 AVG:16.71 CV 0.16	04jul
749mmHg A28.6°C F27.8°C SP025cm	15:05

Where:

ET: elapsed time since the current run started
TV: total volume sampled during the current run
[DC In]: current power source from which the sampler is operating
Start: the time and date the current sample started
Stop: the time and date the current sample stopped (or is set to stop)
Q(Vlpm): the instantaneous flow rate in liters per minute
AVG: average flow rate, liters per minute
CV: coefficient of variation of flow rate
mmHg: instantaneous ambient barometric pressure, millimeters of mercury
A ° C: instantaneous ambient temperature in degrees Celsius
F ° C: instantaneous filter temperature in degrees Celsius
SP cm: pressure drop across the filter, in cm H₂O
Tmax: the maximum ambient temperature measured during the run
Tmin: the minimum ambient temperature measured during the run
Tavg: the average ambient temperature
BPmax: the maximum barometric pressure measured during the run
BPmin: the minimum barometric pressure measured during the run
BPavg: the average barometric pressure

Flags which may appear in the upper right corner of the screen. The following flags are possible:

P indicates that a power failure has occurred
Q indicates that flow has varied more than +/- 5 percent
F indicates that a 5 degree filter overheat lasting more than 30 minutes has occurred
T indicates that the sample ran less than 23 hours 50 minutes
M indicates memory overflow (max run time with 5 minute logger interval)

During operation, the **SELECT** button provides alternate displays of minimum, maximum, and average ambient temperatures and barometric pressures or other run time data while the **ON/OFF** button will temporarily suspend the run. The run is not considered complete until the Sample Stop Date and Time have been attained.

6.4 Temporary Halt Then Continue Sampling

Per the U.S. regulations for PM_{2.5} sampling, samples must be taken from at least 23 but not more than 25 hours. In the event that it becomes necessary to temporarily halt a sample in progress, simply press the **ON/OFF** button. The unit will return to the main menu and display:

Halted by Operator!

To continue with the current sample run,

- From the home screen, press **SELECT** to access the main menu.
- From the main menu, scroll down by pressing the down arrow button and select * **Continue Current Run**

The sampler will then resume the run. However, observe that the elapsed time did not change while the unit was halted. At the end of the 24-hour sample period, if elapsed time is less than 23 hours 50 minutes, the **T** flag will be displayed. However, per the U.S. regulations, samples between 23 and 25 hours are valid.

6.5 Ending a Run

When the PQ200 has completed its run, the display will show:

<p>SAMPLE RUN COMPLETED!</p> <p>751mmHg A28.1°C F27.4°C</p>	<p>2015</p> <p>05jul</p> <p>(MENU) 15:02</p>
---	---

The filter may now be removed.

6.6 Data Download Instructions

When the sampler has completed its run, the data may be downloaded from the PQ200. Be sure to download the most recent run before setting the sampler to start another run. For user convenience, the PQ200 allows for several different methods to perform this task.

6.6.1 Data Download Using USB On-The-Go (OTG) Flash Drive

To download with a USB OTG, follow the steps below:

1. To access the USB jack, unscrew the top button screws on the instrument panel assembly (part 85 in Figure A3).
2. After the screws are removed, gently pull the panel forward, exposing the circuit board. Be sure not to pull on any wire connections, and not to expose the circuit board to rain or moisture.
3. Plug the USB OTG flash drive into the USB type A jack.
4. After a beep, the downloading will start automatically, and the screen will show **Downloading!**.
5. When complete, the display will return to the home screen or turn off if you have scheduled a run.
6. After you have downloaded the data on your USB, the file name will have the serial number and run date as the file name (i.e., 00001_18jan01.job, where 00001 is the serial number and 18jan01 is the date of the sampling run in yymmmdd format).

6.6.2 PQ200 Job Controller Software for Windows

To extract the run data, a computer with the PQ200 Downloader software loaded and a female-female serial cable are required. Section 4.0 also contains greater detail about the other features of the PQ200 Job Controller software.

- Using a serial (9-pin) cable (female-female DL02), or a USB cable (accessory P/N: USB A/B), connect the PQ200 sampler to a computer with the PQ200 Job Controller Program. The USB port is located on the edge of the circuit board. To access it, unscrew the two thumb screws at the top of the front panel and gently pull the panel forward to expose the circuit board, taking care not to pull on any of the wire connections.
- Open the PQ200 Job Controller Program.
- Click on the "File" menu in the top menu bar, select new, and "New". The new job screen will open. Enter the appropriate information as needed and click "Save".
- A "Save As" screen will open with a default file name of today's date. This file name may be changed by operator if needed.
- Click "Save" and a download screen will open.
- Go to the top menu bar and click on "Download". A new window will open. Click on "Begin".
- When data stops scrolling, the download is complete. Click on "Return"
- Data will now appear on the download sheet. At this point all data has been saved.

6.6.3 Data Download Using the PQ200 Menu

After the sampler has completed its run, the data is available for download. To download the data using the menu on the updated PQ200, follow the steps below:

1. Connect a RS-232 or USB type B cable between the PC and PQ200.
2. Open a TeraTerm terminal (a free software available online) and set up the following serial communication settings:
 - a. Click on the "Setup" drop down menu and select the serial port.
 - b. Set the required settings:
 - i. Baud rate: 9600
 - ii. Data: 8 bit
 - iii. Parity: none
 - iv. Stop: 1 bit
 - v. Flow control: none
 - vi. Transmit delay: 0 msec/char and 70 msec/line
 - vii. Turn off echo characters locally
 - c. Click "OK"
3. Turn the PQ200 on
4. Press **SELECT** to enter the main menu
5. Use the **UP/DOWN** buttons to navigate to the "**Download Now**" menu and press **SELECT**
6. Using the **UP/DOWN** buttons, navigate to the desired communication interface (RS-232 or USB-B)
7. Initiate the data transfer to the terminal by pressing **SELECT**. While the data transfers, the LCD display will show "Downloading!"

6.6.4 Data Download Using Serial Communication Commands

After the sampler has completed its run, the data is available for download. To download the data using serial communication commands, follow the steps below:

1. Connect an RS-232 or USB type B cable between the PC and PQ200
2. Open a window Using HyperTerminal or similar program (TeraTerm is a free software available online) and set up the following serial communication settings:
 - a. Click on the "Setup" drop down menu and select the serial port
 - b. Set the required settings:
 - i. Baud rate: 9600
 - ii. Data: 8 bit
 - iii. Parity: none
 - iv. Stop: 1 bit
 - v. Flow control: none
 - vi. Transmit delay: 0 msec/char and 70 msec/line
 - vii. Turn off echo characters locally
 - c. Click "OK"
3. Turn the PQ200 on
4. Send the following serial communication command to the PQ200 using the terminal program:
 - ?S - download summary data
 - ?L - download logger data

For further information on communication packages like HyperTerminal, contact us at csbutler@mesalabs.com.

7.0 Calibration

The EPA has published recommended intervals for calibration and verification of flow rate, temperature, and barometric pressure in table 6-1 of the Quality Assurance Guidance Document 2.12: Monitoring PM2.5 in Ambient Air Using Designated Reference of Class I Equivalent Methods. They are:

Table 6-1. Calibration and Verification Check Intervals¹⁷

Parameter	Recommended minimum interval
Flow rate calibration (multi-point)	Upon failure of flow rate verification; also, on installation and then annually or when out of specifications
Flow rate verification (single-point)	Every 30 days \pm 3 days and 12/year
Temperature calibration (multi-point; both ambient air inlet and filter temperature sensors)	Upon failure of multi-point verification
Temperature multi-point verification	On installation, then annually or when out of specifications
Temperature verification (single-point; ambient air inlet sensor, filter temperature sensor if convenient to do so)	Every 30 days \pm 3 days and 12/year
Pressure calibration	On installation, then annually or when out of specifications
Pressure verification (single-point)	Every 30 days \pm 3 days and 12/year

7.1 Flow Rate

7.1.1 Manual Flow Rate Calibration

To calibrate the flow rate of your PQ200, follow the steps outlined below:

1. Remove the size selective inlet from the top of the downtube, leaving the downtube in place.
2. Turn on your calibration device and install on downtube. A BGI deltaCal is preferable for PQ200 calibration.
3. From the home screen on the PQ200, press **SELECT** to access the main menu.
4. From the main menu, scroll down by pressing the down arrow button and select ***Calibrate/Verify Flow Rate**, then select ***Manual Calibration**
5. The next screen will display **Target Q: 16.7 LPM**. The numeric value will be flashing. The second and third lines display the current ambient temperature and barometric pressure, and the ambient temperature and barometric pressure for the current calibration.
6. Press **SELECT**. The value preceding the decimal place will stop flashing, indicating it can be edited.
7. Use the arrow buttons to increase or decrease the selected value. When finished, press **SELECT**.
8. Repeat until you have selected the flow rate you wish to calibrate and press **SELECT**. The calibration screen will then be displayed.
9. Press the **EXIT** button to advance to the next screen.
10. Press the **ON/OFF (PUMP)** button to turn on the pump. The **Corrected Q:** message will then be displayed. The Corrected Q that is shown is for reference only.
11. Use the arrow keys to adjust the pump speed to obtain the required flow rate on the calibration device. The arrow keys will fine adjust the speed. To coarse adjust, hold the **SELECT** key and the up or down arrow key simultaneously.
12. When satisfied that the flow rate is sufficient and stable, press the **EXIT** button to lock the calibration into memory.

NOTE: Calibrations must be performed at 3 (15.0, 18.4 & 16.7 LPM) separate flow rate measurements, evenly spaced within the range of +/- 10 percent of the operational flow rate of 16.7

LPM. The calibration for 16.7 LPM should be performed last.

7.1.2 Automatic Flow Rate Calibration

To use the automatic calibration feature on your PQ200, you must use a deltaCal and accessory cable (70066). To calibrate, follow the steps outlined below:

1. Remove the size selective inlet from the top of the downtube, leaving the downtube in place.
2. Turn on your deltaCal and install on downtube.
3. From the home screen on the PQ200, press **SELECT** to access the main menu.
4. From the main menu, scroll down by pressing the down arrow button and select ***Calibrate/Verify Flow Rate**, then select ***Automatic Calibration**
5. If you have not connected your deltaCal to the RS-232 port in the PQ200, the next screen will display **Please, Connect DeltaCal via RS232 and Press SELECT to Start**. Connect the devices accordingly to continue.
6. Once your deltaCal is connected, the next screen will display **Calibration is in Progress... Please wait a few minutes**.
7. If the calibration is successful, the screen will display: **Calibration Successful!!!**
8. If the calibration is not successful, the following flags may appear:
 - o **Flow Restricted!**
 - o **Maximum Load Exceeded!**
9. Once the unit has successfully been calibrated, remove the deltaCal from the RS-232 port and from the downtube, and replace the louvered inlet.

7.1.2 Verifying flow rate

- Install the calibration device on your PQ200 as described above.
- From the main menu, scroll down by pressing the down arrow button and select ***Calibrate/Verify Flow Rate**, then select ***Verify**
- Selecting ***Verify** will start running the pump automatically, and will display a screen with a Target Q, Actual Q, Ambient Temp, BP, SP, and Calibrated @ values.
- Once you have allowed the pump to run and verified the flow rate, you can exit this function by pressing the **EXIT** button.
- If offset greater than 4% is observed, your instrument should be recalibrated using the steps in section 7.1.1 above.

7.1.3 Changing flow rate

- From the home screen, press **SELECT** to access the main menu.
- From the main menu, scroll down by pressing the down arrow button and select * **Select Flow Rate**.
- The numeric value will be flashing. The second line displays the current ambient temperature and barometric pressure. The third line displays the ambient temperature and barometric pressure for the current calibration.
- Use the arrow **UP** and **DOWN** buttons to increase or decrease the selected value. When finished, press **SELECT**. The value preceding the decimal place will stop flashing, indicating that it can be edited.
- Press the **EXIT** button to return to the Main menu.
- Return to Section 7.1.1 to repeat the procedure for additional flowrates.

7.2 Temperature Probe

**Note: See Appendix Q for earlier rev "T" PCBs
See Appendix N for earlier rev "D" PCBs**

7.2.1 Verifying Temperature

You will need a NIST-traceable thermometer, such as that included with the BGI deltaCal calibrator, for both the verification and calibration of the PQ200 temperature probes.

To verify the ambient temperature sensor, allow the temperature probe to reach equilibrium with the ambient air. The ambient temperature is displayed on the main screen of the PQ200. Insert the calibration probe into the radiation screen. If the sampler temperature is more than 2% off from the calibrator temperature. From main menu select **Calibrate Temperature & Pressure** press **SELECT** to choose Ambient Temperature. The **UP** and **DOWN** buttons will change the value to match your traceable thermometer.

To verify the filter temperature sensor, open the filter assembly and remove the filter cassette if present. Put the traceable thermometer as close as possible to the filter temperature probe without touching the two sensors. Refer to EPA 40 CFR 50 Appendix L for acceptable tolerances. If recalibration is necessary Adjust if any offset greater than 2% exists. From main menu select **Calibrate Temperature & Pressure** press **SELECT** to choose Filter Temperature. The **UP** and **DOWN** buttons will change the value to match your traceable thermometer.

7.2.2 Calibrating Temperature

The U.S. EPA recommends an annual multi-point temperature calibration. We recommend that you perform this calibration in the lab rather than the field. The same procedure should be followed for both the ambient and filter temperature sensors.

Remove the temperature probes from their housings but keep connected to the sampler. Prepare three containers for an ambient, cold, and hot temperature baths. For the ambient bath, fill a container with tap water and let equilibrate at room temperature for several hours. For the cold bath, use crushed ice in water. Note, during the cold test, do not let the probe tip hit a piece of ice because it will give an inaccurate reading. For the hot bath, use a temperature that is appropriate for the ambient temperature range in your area.

For each test, insert the probe into the baths along with a partial immersion thermometer. You should always perform an ambient test between the cold and hot to allow the probe to re-equilibrate easier.

Perform any adjustments as needed to match the NIST-traceable probe to the PQ200 probe.

7.3 Barometric Pressure

**Note: See Appendix Q for earlier rev "T" PCBs
See Appendix N for earlier rev "D" PCBs**

7.3.1 Pressure Calibration and Verification

You will need a NIST-traceable barometer, like that included with the BGI deltaCal calibrator. Compare the ambient pressure reading on the PQ200 main screen with the pressure reading on the traceable barometer. If pressure differs by more than 10 mmHg, adjust the PQ200 pressure reading. From main menu select **Calibrate Temperature & Pressure** press **SELECT** to choose Barometric Pressure. The **UP** and **DOWN** buttons will change the value to match your barometer.

7.4 Leak Tests

Note: Serial Numbers 906 thru 1016 see Appendix M

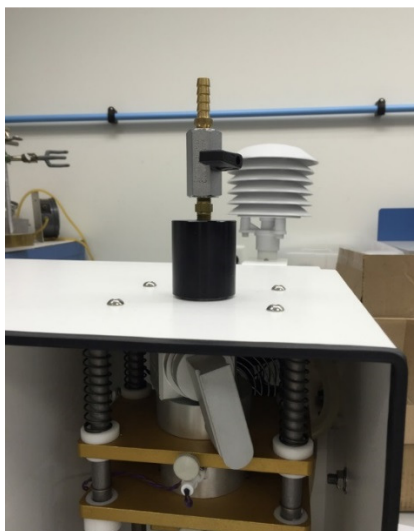
The PQ200 can perform an external and internal leak test. The external leak test uses a flow adapter with a valve to seal off air flow into the instrument at the downtube. The internal leak test uses an impermeable barrier in the filter cassette to seal off air flow at the filter level. The external leak test should be performed first. The internal test should only be performed if the external leak test failed.

7.4.1 External Leak Test

The U.S. EPA mandates that a sampler passes a leak test if it experiences less than 5 cm of H₂O of pressure drop over two minutes. Prior to 2000, the U.S. EPA allowed a pressure drop of 10 cm of H₂O over 10 minutes. PQ200 units with firmware earlier than 1.91 will perform the ten minute test. Newer units will all perform the two minute test.

To perform a leak test, use the following steps:

1. Insert an unused filter into the filter holder.
2. Remove the inlet from the downtube and place the flow audit adapter on the top of the downtube. Close the valve on the adapter to prevent air flow.



3. From the main menu, scroll down by pressing the down arrow button and select ***Leak Test**.

4. The **PQ200 LEAK TEST: In Progress! Plug the Inlet Now! Press <Select> Key to Continue!** screen will be displayed. Ensure that the valve is closed on the flow audit adapter and press **SELECT** to begin evacuating the system.
5. After pressing **SELECT**, the **PQ200 LEAK TEST: In Progress! Creating the Initial Vacuum....** Will be displayed.
6. The PQ200 will automatically evaluate the performance of the system and report whether the system has passed or failed the leak test. This is a 2-minute test. The initial pressure is displayed on the left side of the screen. This will be a number more than 75 cm of water column. To pass the test, the actively displayed pressure shown on the right side of the screen must not drop by more than 5 cm of water column during the 2-minute timing interval.
7. If the leak test is passed, the sampler is operating properly. If the leak test is failed, investigate and correct any malfunction in the following:
 - audit adapter is securely seated on the downtube and that the valve is completely closed
 - VSCC and Filter Assembly is securely closed
 - filter cassette was securely closed and placed in the filter housing during the leak test
 - inspect tubing for cracks or loose connections
 - check O-rings in the flow audit adapter, VSCC, and filter holder for cracks, deformation, or improper seating

If these items appear normal and the sampler continues to fail the leak check, perform an internal leak test to test whether there could be a leak in the filter cassette, internal tubing, or malfunction in the solenoid valve.

7.4.2 Internal Leak Test

The purpose of the internal leak test is to determine if there is a leak from the filter cassette to the pump assembly. This test is performed exactly as above with two changes. The flow audit adapter is NOT installed on the end of the down tube and an impermeable membrane is placed in the filter cassette below the filter. Use part KT006, cassette fitted with membrane, or part RD006, pack of six membranes.

8.0 Maintenance

8.1. Cleaning the Inlet, VSCC, and Downtube

Cleaning of the inlet, VSCC, and downtube should be performed in the field at least once per month. Parts to be cleaned should be removed from the PQ200 sampler prior to cleaning to prevent the introduction of foreign materials or cleaning compounds into the sampler filter assembly and pump. Parts should be clean and dry before they are reinstalled.

8.2. Rebuilding the Pump

The pump should be rebuilt after 8,000 hours of use. This rebuild interval may be shortened in areas with high particulate concentrations and high altitude, both of which increase pump component wear. For a detailed description on how to fully rebuild the pump, refer to Appendix P.

To determine the cumulative hours of operation on the pump use the PQ200 software to obtain a

download from the PQ200 sampler. Pump cumulative time is shown when either printing or screen viewing a download. When this time exceeds 8,000 hours the pump should be rebuilt. The rebuild is a relatively easy task and requires the replacement of diaphragms, valves, and bearings. Depending on which components need replacing, we offer three rebuild kit levels.

X014 – Basic Pump Rebuild Kit

- 2 Valves
- 2 Diaphragms
- 8 Buna 010 O-rings

X015 – Advanced Pump Rebuild Kit

- 2 Valves
- 2 Diaphragms
- 8 Buna 010 O-rings
- 1 Eccentric
- 1 Bearing Eccentric

X016 – Total Pump Rebuild Kit

- 2 Valves
- 2 Diaphragms
- 8 Buna 010 O-rings
- 1 Eccentric
- 1 Bearing Eccentric
- 1 Pump Motor
- 1 Set Screw

8.3 Updating Firmware

Starting with Revision U of the main PCB, the firmware may be updated by the end user. Please contact Mesa Labs customer service for new releases.

8.3.1 Updating Firmware Using OTG Flash Drive

Be sure to download any run data before updating the firmware, the data will not be available after the new firmware has been installed. In order to update the firmware on the PQ200 using the flash drive, remove all other files from the drive. Installing the firmware supersedes all other functions. Rename firmware file to pq200_fw.hex (case sensitive) and put it in the main directory of the flash drive. Power on the PQ200 and insert the OTG Flash Drive. The PQ200 will display:

```
FIRMWARE LOADING...  
WHEN DONE REMOVE FLASH DRIVE AND  
PRESS ON/OFF TO CONTINUE
```

Once complete, the screen will clear. Remove Flash Drive and push the ON/OFF button to restart the PQ200.

8.3.2 Uploading Firmware Using Serial Interface

The firmware can also be uploaded using serial interface and a computer terminal program (Hyperterminal, or similar). This can be accomplished using either the DB9 RS232 port on the front of the PQ200, or using the USB type B port on the main PCB. Configure computer terminal program using settings from section 6.6.3. Choose send text file, and select the firmware file to be sent to the PQ200. The terminal window will update after each successful

memory address has been written. Once complete, the terminal program will display Completed. Resetting. Disconnect serial cable and press the ON/OFF button on the PQ200 to restart.

9.0. TROUBLESHOOTING

- Problem:** Selecting **Run the Sampler from Midnight to Midnight** or **Run Sampler w/ User Defined Start/Stop** causes the unit to shut down.
- Solution:** This indicates that the PQ200 is now powered off and ready to begin a sample run at the designated Start Date and Time. To reset the scheduled run, press **SELECT** from the home screen, and use the **DOWN** arrow button to navigate to **Reset Run Data & Scheduled Run**.
- Problem:** The flow rate does not seem to hold when additional pressure is added to the load (usually tested using a pinch clamp).
- Solution:** This is usually caused by a leak somewhere between the inlet and the calibration measuring device. Make sure that the hose adapter is firmly tightened in the inlet, check the inlet mechanism and filter holder. You can usually isolate the suspect device by starting at the inlet and working your way out. Replace any O-rings that show signs of wear.
- Problem:** The instrument shuts down shortly after the start up screen indicates max. load exceeded.
- Solution:** Check that your inlet and VSCC have been recently cleaned. Check for any debris in the internal tubing in the instrument. If plugging is found, clear it and return to normal operation.
- Problem:** The ambient temperature sensor is abnormally high or low.
- Solution:** The plug from the external temperature sensor has not been reconnected.
- Problem:** The backlighting on the display screen is inactive.
- Solution:** When running on battery power, the backlight function automatically deactivates to conserve power. It can be temporarily restored by pressing the **LIGHT** button.
- Problem:** The instrument is "locked up" or the screen looks wrong. Pressing buttons has no effect.
- Solution:** Open the front panel and disconnect the battery and power cables from the main board. The terminals are labeled JP3 and JP4. Reconnect and the instrument will reboot.
- Problem:** Ambient or filter temperatures displayed are obviously incorrect by 10-30° C.
- Solution:** This is indicative of a loose connection. Unplug and reconnect at the sensor and main board.
- Problem:** The parts of the filter assembly which slide on the four stainless steel rods have become "sticky".
- Solution:** Although the nylon bushings are self-lubricating, with long use, the rods can become dirty. To clean, wet a cotton rag with a light lubricating oil and use it to wipe the four stainless steel rods clean of all deposits. Then, with a clean cloth, wipe off as much of

the oil as possible. Under no circumstances should any spray lubricants be utilized.

Problem: The pump is running rough or will not maintain a stable flow rate.
Solution: Disassemble the pump and clean out any debris. Inspect the motor and replace components that show signs of wear. If this does not solve the issue, try replacing the pump cable or installing the pump in a separate instrument, if available.

Problem: Pump stops during run.
Solution: Check integrity of AC power supply cable and battery cable. Clean battery connectors and replace if necessary.

Problem: Date changes without prompting or shows nonsensical characters.
Solution: Ensure the connection on the clock battery is secure. If the connection appears secure and the problem persists, replace the battery.

Error Flag Meanings:

- P** Power: indicates that an A/C power failure has occurred
- Q** Flow Rate: indicates that flow has varied more than +/- 5%
- F** Filter Temperature Overheat: indicates that a 5-degree filter overheat lasting more than 30 minutes has occurred
- T** Time: indicates that a 24-hour sample ran less than 23 hours and 50 minutes
- M** Memory: indicates memory overflow (max run time with 5-minute logger interval)

10.0. Warranty

Mesa Labs warrants equipment of its manufacture and bearing its nameplate to be free from defects in workmanship and material. We make no warranty, express or implied, except as set forth herein. Mesa's liability under this warranty extends for a period of one (1) year from the date of product's shipment. Mesa Labs warrants service performed on equipment at our factory for a period of ninety (90) days and spare parts for a period of sixty (60) days. During these periods, the warranty is expressly limited to repairing or replacing any device or part returned to the factory and proven defective upon evaluation. These warranty periods will not be extended under any circumstances.

Mesa assumes no liability for consequential damages of any kind. The purchaser, by acceptance of this equipment, shall assume all liability for consequences of its misuse by the purchaser, its employees, or others. Purchaser is responsible for all damages resulting from field repairs and installation of equipment and parts. This warranty will be void if the equipment is not handled, transported, installed, or operated in accordance with our instructions. If damage occurs during transportation to the purchaser, Mesa must be notified immediately upon arrival of the equipment.

A defective part in the meaning of this warranty shall not, when such part is capable of being repaired or replaced, constitute a reason for considering the complete equipment defective. Acknowledgment and approval must be received from Mesa prior to returning parts or equipment for credit. To obtain a Return Material Authorization (RMA), contact csbutler@mesalabs.com with details of the warranty or service claim. Purchaser is responsible for return shipment of equipment to the factory for warranty and non-warranty repairs. Mesa Labs will provide ground shipment to the purchaser for warranty repairs. All shipments from Mesa Labs will be handled by FedEx, unless otherwise requested. If the purchaser elects to use a third-party freight forwarder or another shipping carrier, the purchaser is thereby responsible for the shipment.

Mesa Labs periodically makes engineering changes and improvements on instruments of its manufacture. We are under no obligation to retrofit these improvements and/or changes into instruments which have already been purchased.

For refund of new products, equipment must be in a new and unused condition. A restocking fee of 30% of the product's value will be charged for returns after thirty (30) days. Mesa Labs will not accept any returns after ninety (90) days.

No representative of ours has the authority to change or modify this warranty in any respect.

Appendix A

Parts List and Exploded Drawing Figures

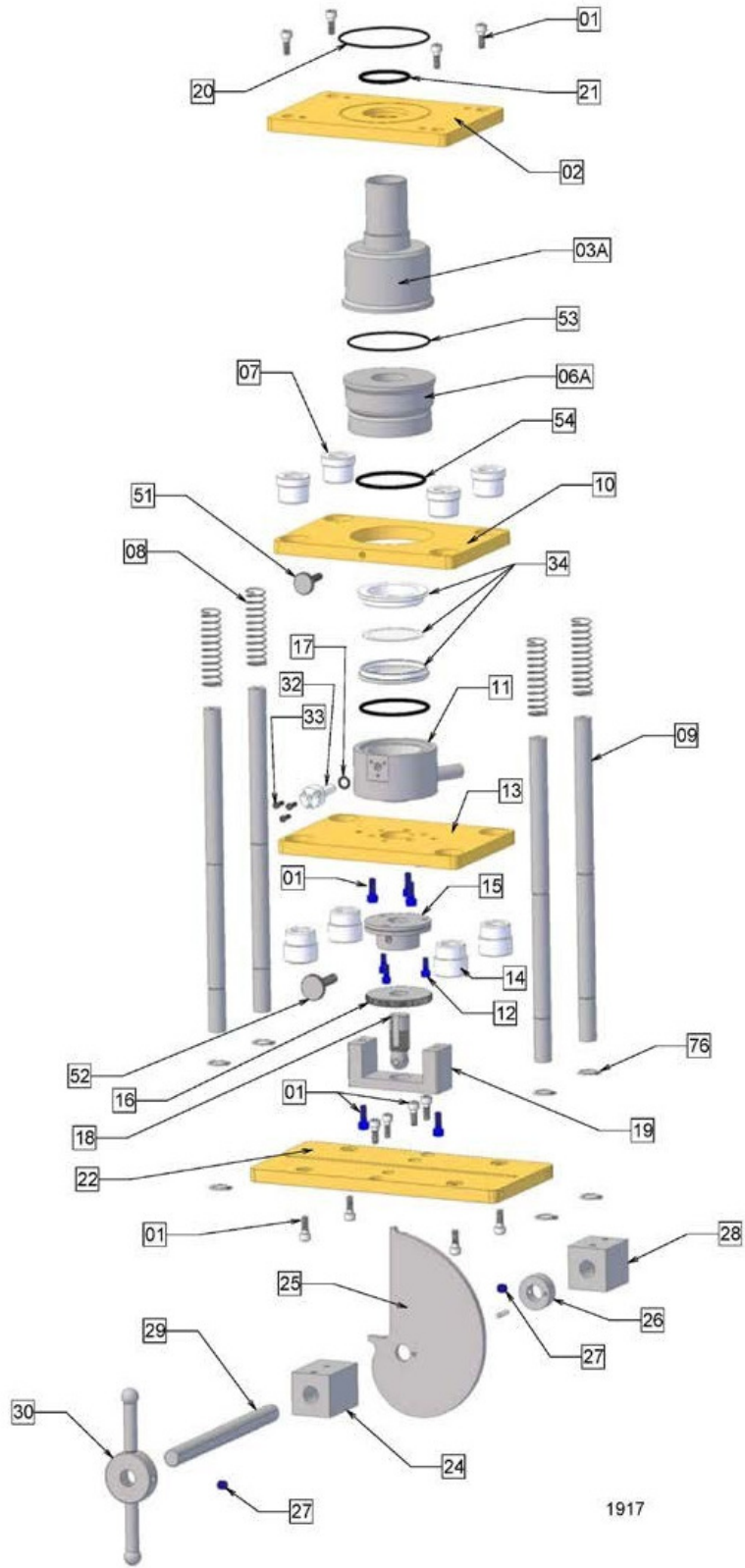


Figure A1. Filter Holder with PM₁₀ Adapter Installed

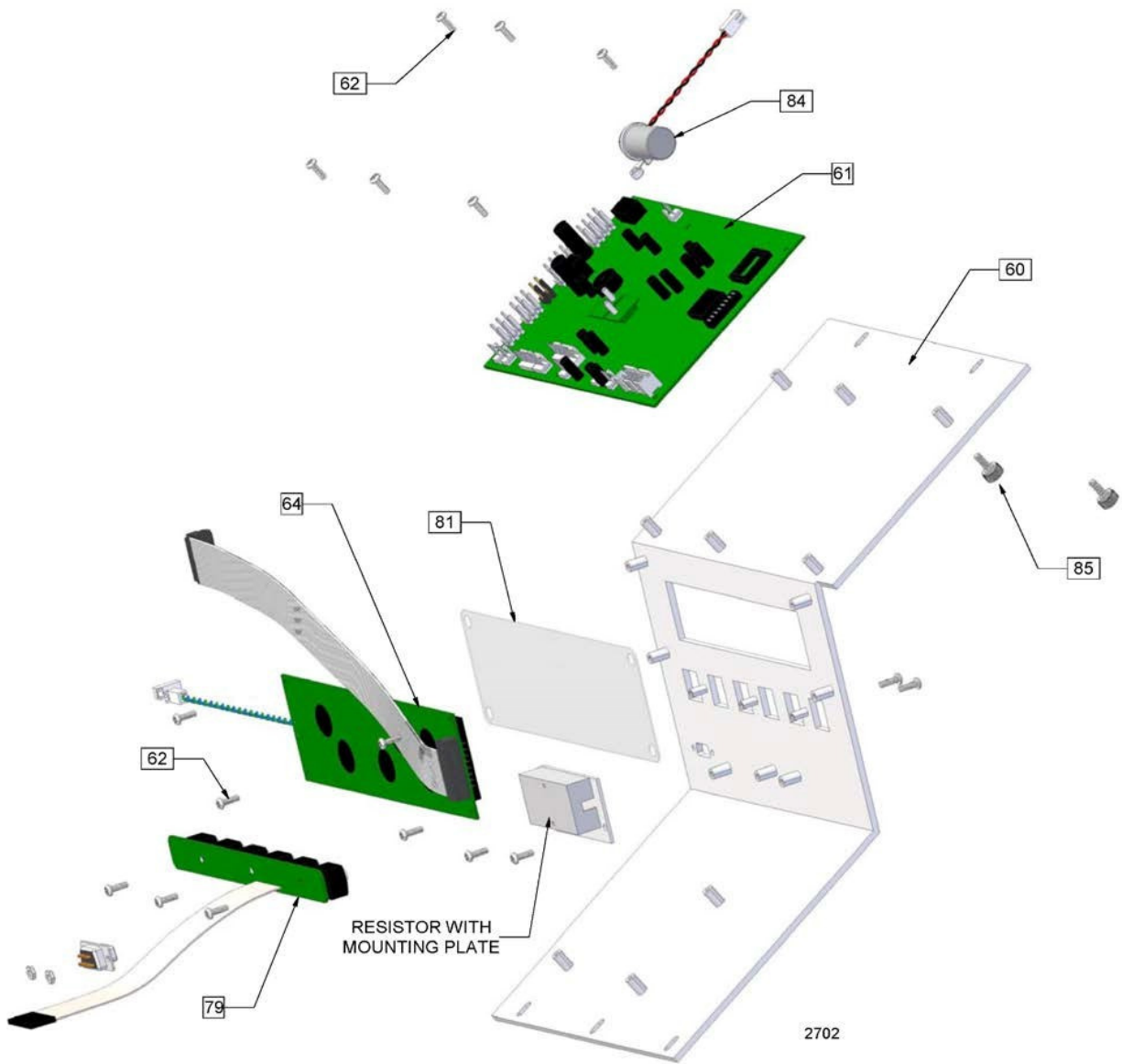


Figure A3. Instrument Panel Exploded Drawing

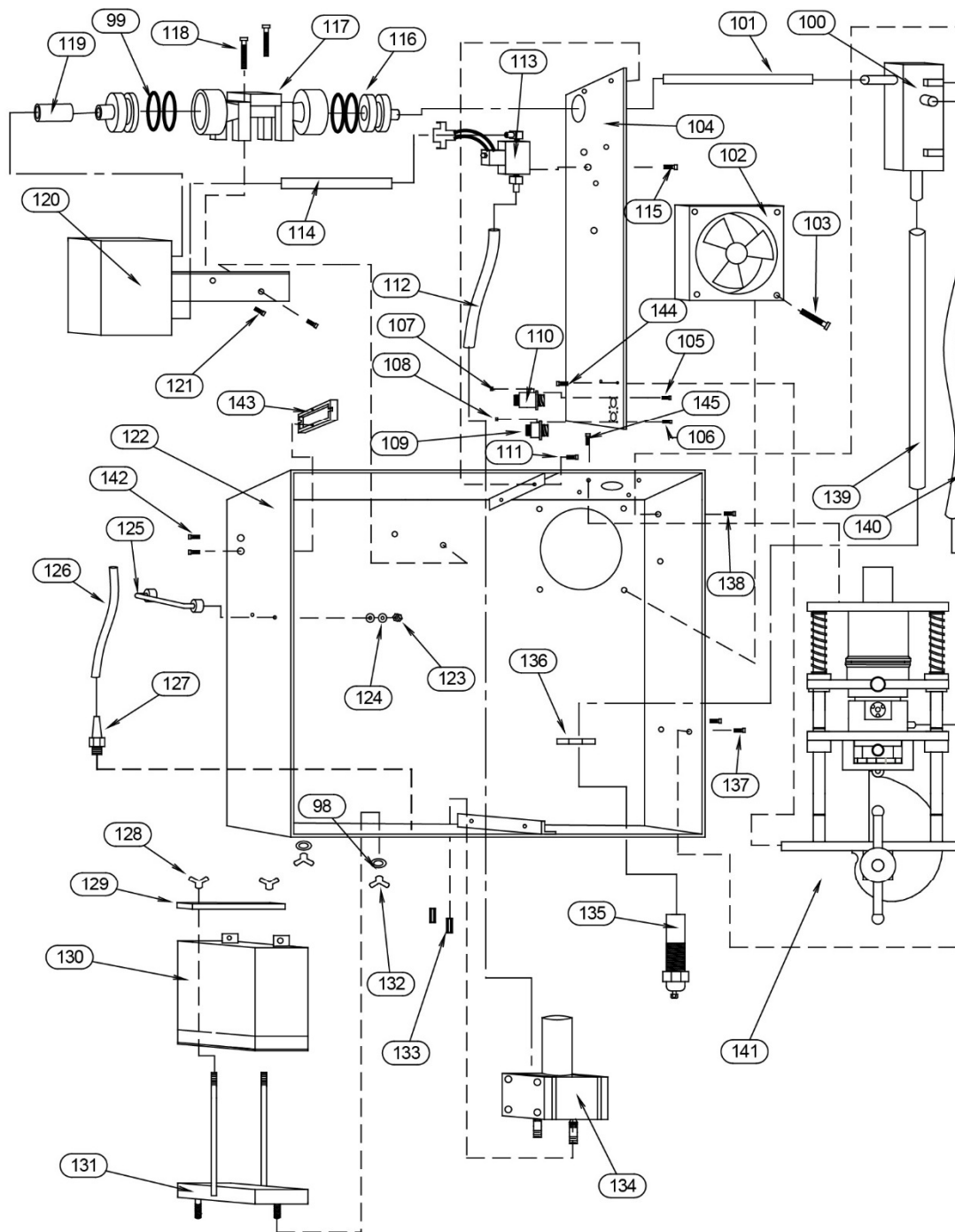
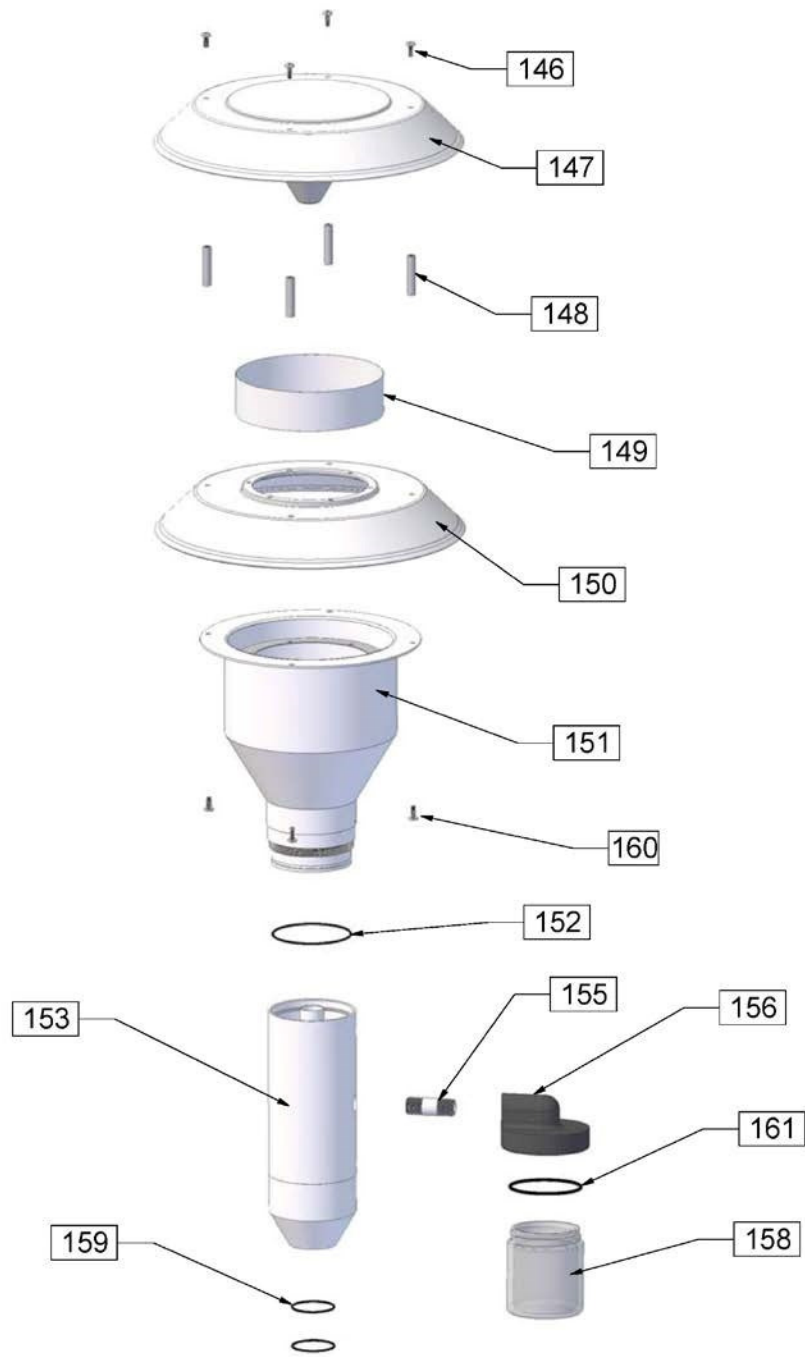
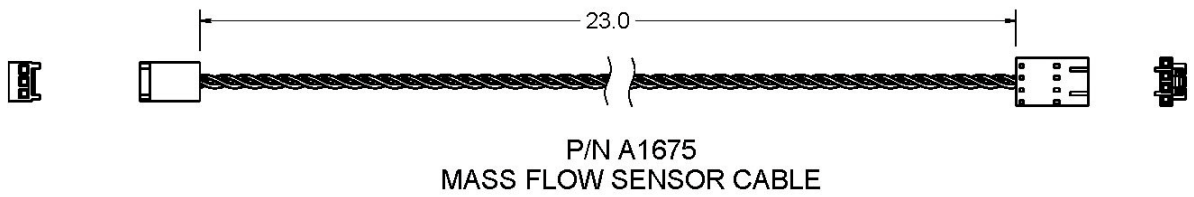
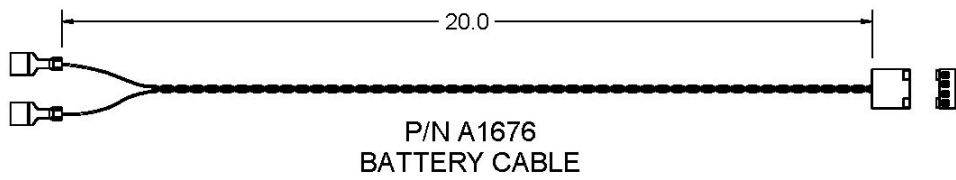
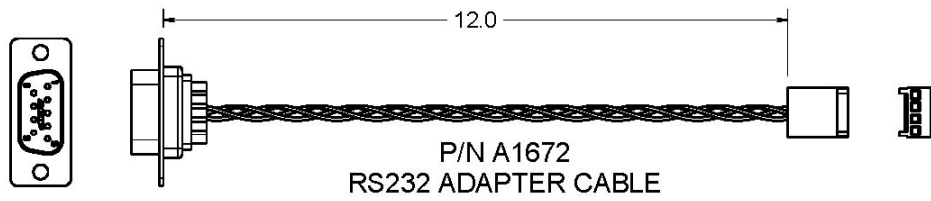


Figure A4. Components behind door



1791

Figure A5. PM₁₀ Size Selective Inlet

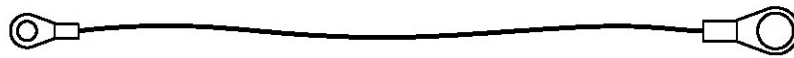


1695a

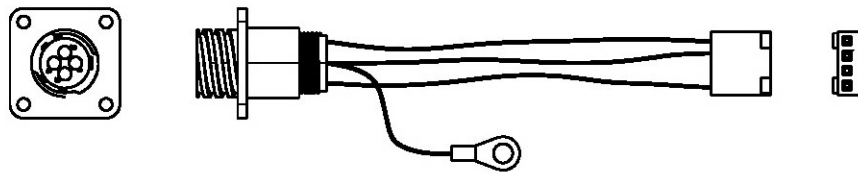
Figure A6. Current Model Cables



P/N A1795
PUMP CABLE



P/N A2090
GROUND WIRE



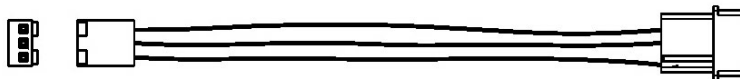
P/N A2335
LOW VOLTAGE INPUT CABLE

1695d

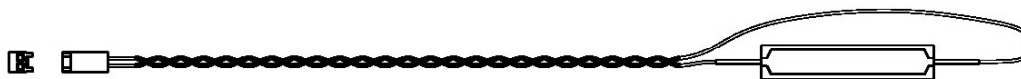
Figure A7. Current Model Cables



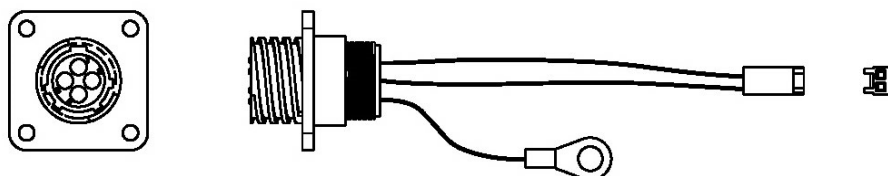
P/N A2336
BACKLIGHT TO SWITCHBOARD
(REV "T" BOARD)



P/N A2340
DRIVER BOARD CABLE
(REV "T" BOARD)



P/N 2366
RESISTOR CABLE
(REV "T" BOARD)



P/N 2338
AMBIENT ADAPTER CABLE
(REV "T" BOARD)

1695e

Figure A8. Current Model Cables

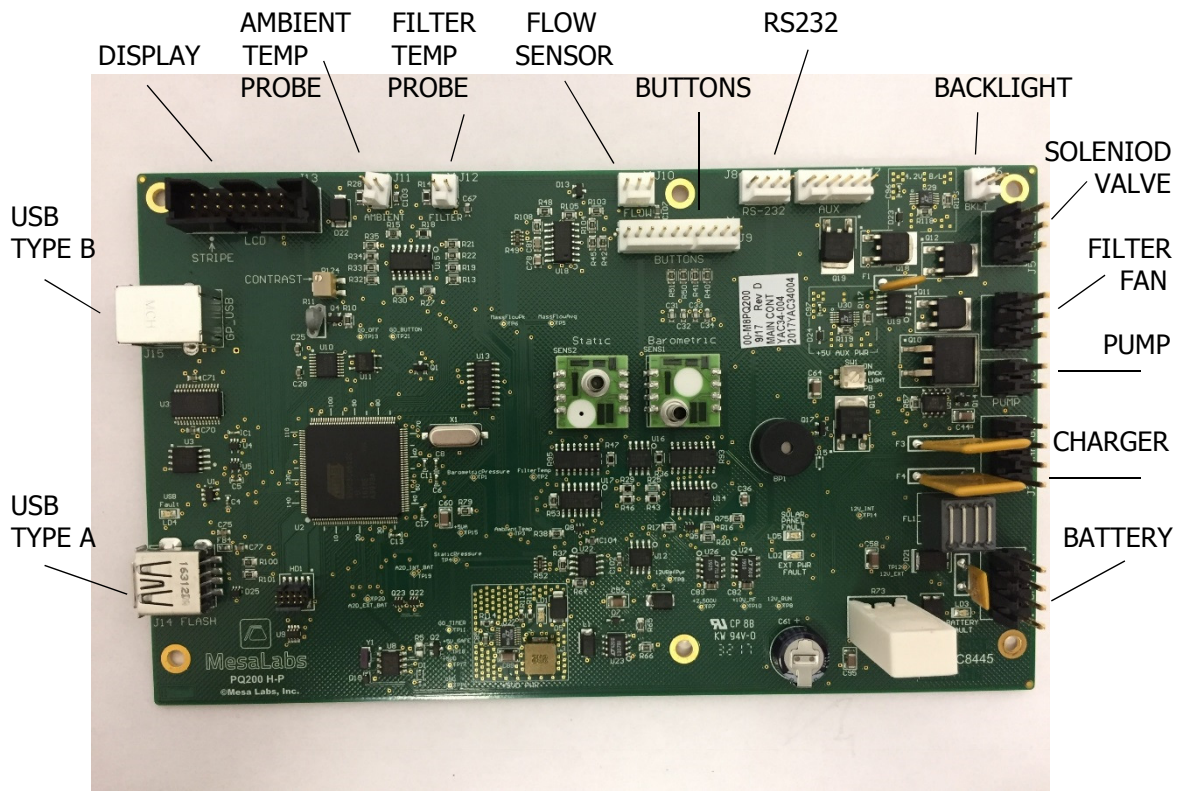


Figure A9. Location of cable connections on PCB

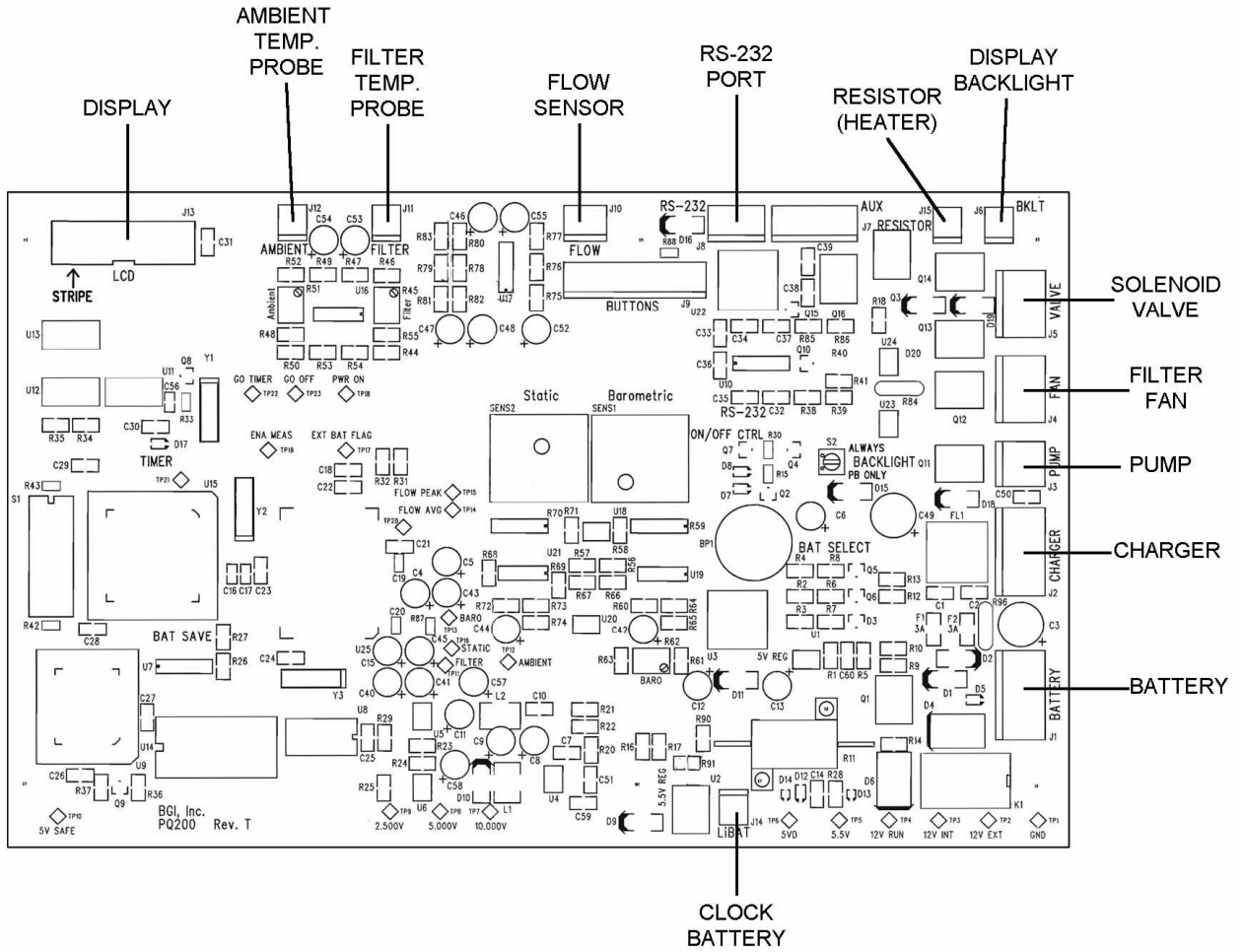


Figure A10. Location of cable connections on Rev T PCB (Obsolete)

DET. #	QTY	FIG.	PART #	DESCRIPTION
1	17	A1	SC1001	#10-32 X 1/2" Allen Cap Screws
2	1	A1	A1590	Filter Holder Top Plate
3	1	A1	A1754	PM10 Upper Impactor Housing
6	1	A1	B1755	PM10 Lower Impactor Housing
7	4	A1	A1609	Bushing (upper)
8	4	A1	SP1002	Spring
9	4	A1	A1625	Assembly Rod
10	1	A1	A1591	Filter Holder Upper Sliding Plate
11	1	A1	A1606	Lower Filter Holder
12	3	A1	SC1003	#8-32 X 3/8" Allen Cap Screw
13	1	A1	A1592	Filter Holder Lower Sliding Plate
14	4	A1	A1597	Bushing (lower)
15	1	A1	A1602	Cam Follower Mounting Plate
16	1	A1	A1603	Cam Follower Adjustment Nut
17	1	A1	010SILICONE	O-Ring
18	1	A1	A1611	Cam Follower Assembly
19	1	A1	M-A1604	Adjustment Nut Cover
20	1	A1	BUNA038	O-Ring
21	1	A1	BUNA126	O-Ring
22	1	A1	A1608	Filter Holder Bottom Plate
24	1	A1	A1598	Long Cam Shaft Block
25	1	A1	A1600	Cam
26	1	A1	A1596	Cam Hub
27	2	A1	SC1008	1/4-20 X 1/4" Allen Set Screw
28	1	A1	A1599	Short Cam Shaft Block
29	1	A1	A1595	Cam Shaft
30	1	A1	A1612,A1613	Handle Ring and Rods (assembled)
32	1	A1	A1610	Temperature Probe (filter)
33	3	A1	SC1010	#4-40 X 3/8" Allen Cap Screw
34	1	A1	F212	Filter Cassette
35	2	A2	B1292	Valve Upper Plate
36	2	A2	B1293	Valve Lower Plate
37	2	A2	A1288	Diaphragm Retainer
38	2	A2	M-A2187	Diaphragm
39	2	A2	A1289	Diaphragm Retainer Bushing
40	1	A2	B1283	Pump Housing
41	1	A2	A1287	Follower Yoke
42	1	A2	DDRI-6632	Bearing
43	1	A2	A1294	Eccentric
44	1	A2	SC0105	M4 X 5mm Set Screw
45	3	A2	SC0106	M2.5 x 8mm Cheese Head Screw
46	1	A2	A1290	Motor Mount
47	1	A2	PQMOTOR	Motor
48	8	A2	010BUNA	O-Rings
49	4	A2	A1402	Locating Pins
50	2	A2	B1408	Valves
51	1	A1	SC1011	#10-32 X 1" Cap Screw W/ Knob
52	1	A1	SC1012	1/4-20 X 11/4" Cap Screw W/ Knob

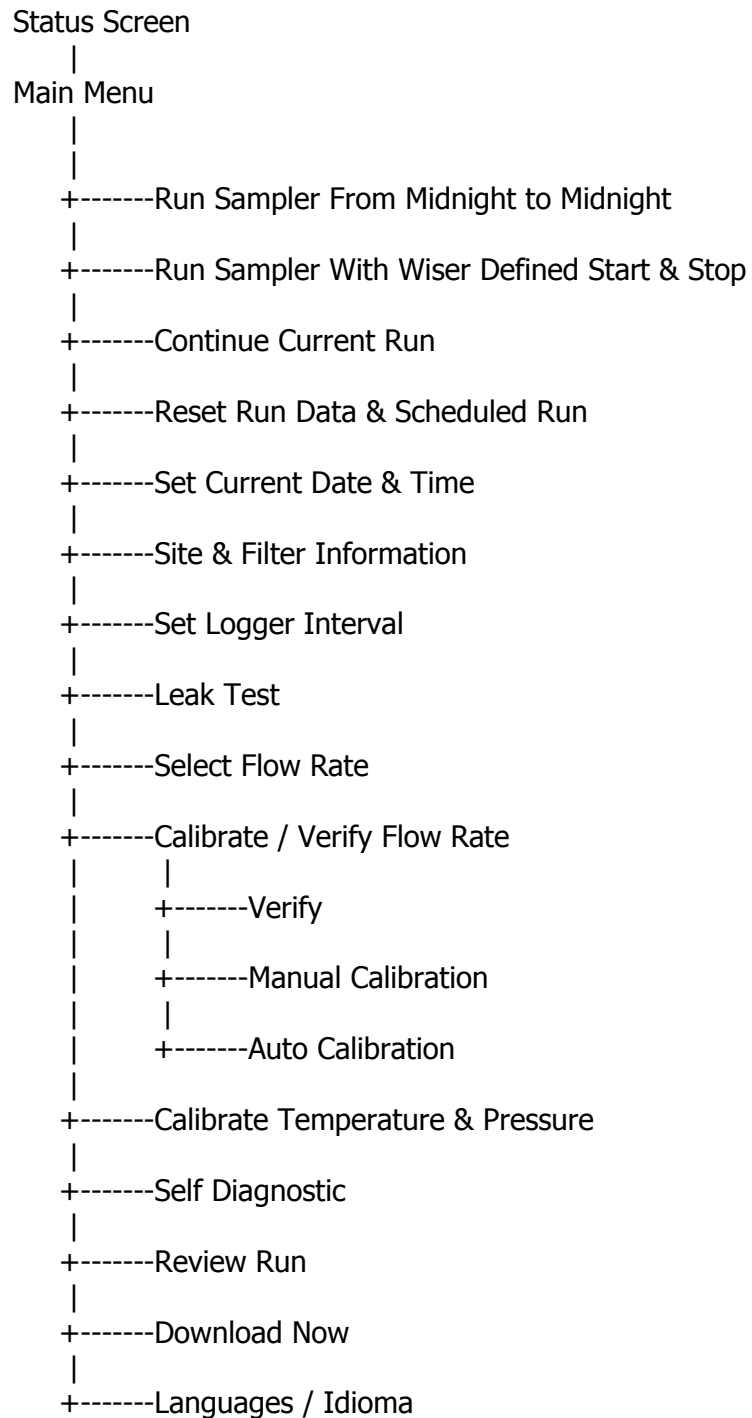
DET. #	QTY	FIG.	PART #	DESCRIPTION
53	2	A1	VITON036	O-RING
54	2	A1	BUNA135	O-RING
56	2	A2	SC1015	#8-32 X 1 1/4 Studs for Pump
59	1	A1	VITON030	O-RING
60	1	A3	A1644	Inside Panel
61	1	A3	C8445	Main Controller Board
62	18	A3	SC2001	#4-40 X 3/8 Phillips Pan Head Screw
63	1	A3	A1672	RS 232 Adapter Cable
64	1	A3	A2339	Display Screen (rev "T" Main PCB)
76	8	A1	RR002	1/2" Retaining Rings
79	1	A3	2546	Push Button Board
81	1	A3	A1684	Display Cover
84	1	A3	CB1	Clock Battery (rev "T" Main PCB & earlier)
85	2	A3		Panel Screw Assembly (SC3010, C003)
86	8	A2	SC1014	#8 X 1 Sheet Metal Screws
87	2	A2	A1403	Pump Tubes
88	2	A2	SC1013	#8 X 5/8 Sheet Metal Screws
97	2	A4	WA3021	#6 X .375 Flat Washer
98	2	A4	WA3020	5/16 Flat Washer
99	4	A4	BUNA113	O-RINGS
100	1	A4	A1661	Water Trap
101	1	A4	HO3001	7" Silicon Hose
102	1	A4	188098	Cooling Fan
103	4	A4	SC3003	#6-32 X 2" Phillips Head Screw
104	1	A4	A1640	Inside Panel
105	4	A4	SC3004	#4-40 X 3/8 Phillips Pan Head Screw
107	4	A4	NT3006	#440 Keps- Nut
109	1	A4	A1680	Ambient Temp. Probe Adaptor
110	1	A4	A1679	Low Voltage Input Cable Connector
111	4	A4	SC3010	#6-32 X 3/8 Phillips Pan Head Screw
112	1	A4	HO3011	7.5" Silicon Hose
113	1	A4	188065	Solenoid Valve
114	1	A4	HO3013	4.5" Silicon Hose
115	2	A4	SC3014	#8-32 X 1/2 Phillips Pan Head Screw
116	2	A4	A1416	Sensor Tube Adapter
117	1	A4	MFS1	Mass Flow Sensor
118	2	A4	SC3015	#4-40 X 1 1/8 Phillips Pan Head Scr
119	1	A4	HO3016	1 1/4" Silicon Hose
120	1	A4	188280	Pulsation Dampener
121	2	A4	SC3017	#6-32 X 1/4 Phillips Pan Head Screw
122	1	A4	D1639	Cabinet
123	4	A4	NT3018	5/16-24 Hex Nut
124	8	A4	WA3019	5/16 Flat Washer
125	2	A4	HA3032	Handle

DET. #	QTY	FIG.	PART #	DESCRIPTION
126	1	A4	HO3020	9" Tygon Hose
127	1	A4	CT3021	External Pressure Connector
128	2	A4	NT3022	1/4-20 Wing Nut
129	1	A4	A1624	Clamp
130	1	A4	BT3023	Battery
131	1	A4	A1621	Battery Holder
132	2	A4	NT3024	5/16-18 Wing Nut
133	2	A4	SC3025	8-32 x 3/4 Long Nut
134	1	A4	PM3026	Pump Assembly
135	1	A4	188229	Water Trap Drain
136	1	A4	NT3027	7/16-32 Hex Nut
137	4	A4	SC3028	#10-32 X 3/8 Slot Pan Head W/Seals
138	2	A4	SC3028	#10-32 X 3/8 Slot Pan Head W/Seals
139	1	A4	HO3030	7.5" Tygon Hose
140	1	A4	HO3031	11" Silicon Hose
141	1	A4	FH3022	Filter Holder Assembly
142	2	A4	SC4014	4-40 x 1/4 Screw W/ Seal
143	1	A4	A1635	Resister Clamp
144	2	A4	SC3032	10-32 x 3/8 Pan Head Screw
145	4	A4	SC3031	1/4-20 X 3/8 Button Head
146	4	A5	SC3030	#6-32 x 3/8" Philips Pan Screw w/ Seal
147	1	A5	1705-L5	10 micron inlet top
148	4	A5	1709-L9	Spacer
149	1	A5	1708-L8	Screen
150	1	A5	1711-L11	10 micron inlet sub top
151	1	A5	1712-L12	10 micron inlet body
152	1	A5	VITON 036	O-ring
153	1	A5	1704-L4	10 micron inlet tube
155	1	A5	NP3032	1/4 NPT nipple
156	1	A5	JC3033	Jar top
157	1	A5	SC3034	1/4 NPT plug
158	1	A5	JR3035	Glass jar
159	2	A5	BUNA 026	O-ring
160	4	A5	SC3010	#6-32 x 3/8" Philips Pan Head Screw
161	1	A5	BUNA 137	O-ring
	2	10	SC4014	4-40 X 2 Phillips Pan with Seals
	3		A1634	Leg
	3		PN4001	Leg Locking Pin
	2		LT4002	Door Latch
	4		SC4003	4-40 Pem Nut
	2		A1636	Door Hook
	4		SC4004	#4-40 Phillips Pan Head Screw
	2		DS4005	Door Stops
	8		SC4006	#6-32 X 1/4 Phillips Pan Head Screw
	8		NT4007	#6-32 Hex Nuts
	1		SL4008	Front Door Rubber Seal

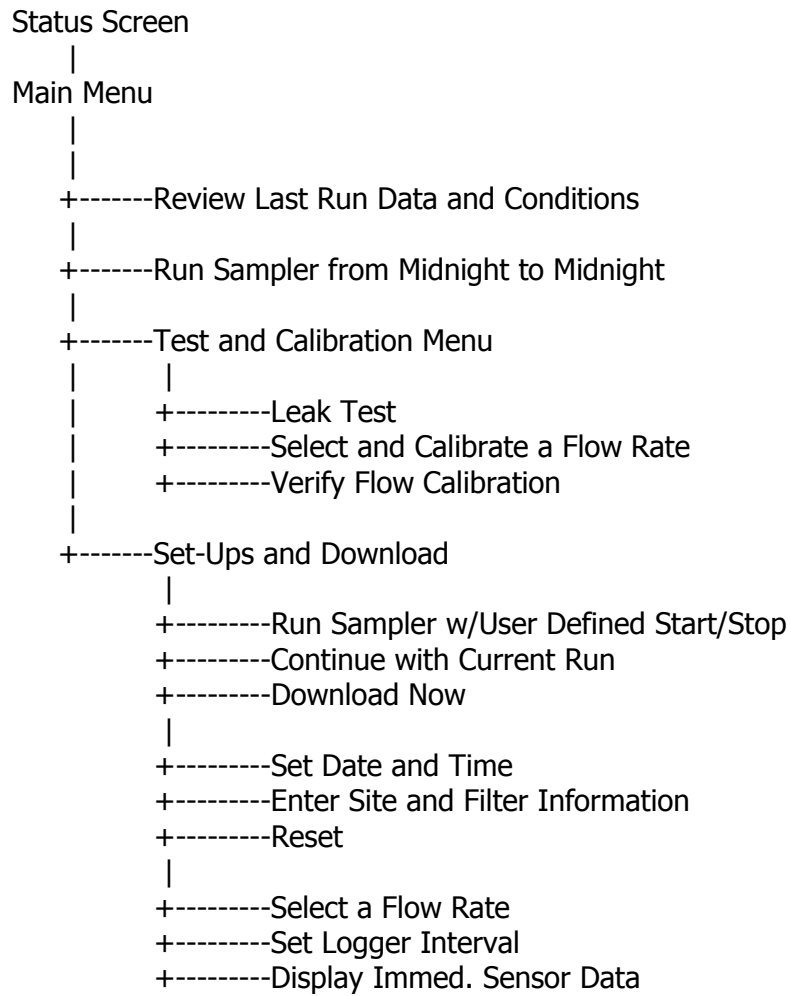
DET. #	QTY	FIG.	PART #	DESCRIPTION
	1		PS15V6A 90W	Power Supply
	1		188055	Power Supply with Bracket Assembly
	2		RP4009	Rubber Protectors for Cable Wires
	1		A1647	Leg Sub Base W/ Short Legs & Ring
	3		SC4010	3/8-16 X 1 Hex Head Bolt
	1		GS4012	Stud Mount (1660)
	1		B1659	Gill Screen Bracket
	1		A1667	Hex Nut
	1		A1666	Outside Temp. Probe Assembly
	2		A1686	Fan Guard
	1		A1687	Gill Screen with Probe (Assembly)
	1		188064	Dampener with Flow Sensor (Assembly)
	1		A1689	Fan Filter
	1		A1697	Filter Clamp
	4		SC4013	4-40 X 1/4 Phillips Pan Head Screw
	1		V1005	Fitting
	1		V1004	Fitting
	2		V1002	90E Brass Elbow
	4		SC4015	#8 X 2" Type A Tapping Screw
	2		LW4001	#8 Internal Lock Washer
	1		L30	Calibration Adaptor
	1		SSI2.5	PM ₁₀ Size Selective Inlet
	1		188056	10-Micron Down Tube
	1		EBC-1	External Battery Cable f/ Marine Battery
	1	A6	A1671	Filter Probe cable
	1	A6	A1672	RS232 Adapter Cable
	1	A6	A1676	Battery Cable
	1	A6	A1675	Mass Flow Sensor Cable
	1	A6	A1676	Battery Cable
	1	A7	A1795	Pump Cable
	1	A7	A2090	Ground Wire
	1	A7	A2335	Low Voltage Input Cable
	1	A8	A2336	Backlight to Switchboard Cable
	1	A8	A2340	Driver Board cable
	1	A8	A2366	Resistor Cable (Rev T board only)
	1	A8	A2338	Ambient Adapter Cable
	1		DL02	RS232 Download cable

Appendix B

PQ200 Sampler Menu Tree



PQ200 Sampler Revision T Menu Tree (Obsolete)



Appendix C

Filters and Weighing Procedure

For exact compliance with EPA PM_{2.5} procedures, refer to 40 CFR Part 50, Appendix L, and Section 2.12 of EPA's Quality Assurance Handbook.

Filters

The filter should have the following characteristics:

Size: Circular, 46.2 mm diameter \pm 0.25 mm.

Medium: Polytetrafluoroethylene (PTFE Teflon), with integral support ring.

Support ring: Polymethylpentene (PMP) or equivalent inert material, 0.38 \pm 0.04 mm thick, outer diameter 46.2 mm \pm 0.25 mm, and a width of 3.68 mm \pm 0.51mm

Pore size: 2 μ m as measured by ASTM F316.94.

Filter thickness: 30 to 50 μ m.

Maximum Pressure Drop (clean filter): 30 cm H₂O column @ 16.67 LPM air flow

Maximum moisture pickup: Not more than 10 μ g weight increase after 24-hour exposure to air of 40% relative humidity, relative to weight after 24-hour exposure to air of 35% relative humidity.

Collection efficiency: Greater than 99.7 percent, as measured by the DOP test (ASTM D 2986-91) with 0.3 μ m particles at the sampler's operating face velocity.

Alkalinity: Less than 25 microequivalents/gram of filter, as measured by the guidance given in reference 2 in Section 13.0 of 40 CFR Part 50 Appendix L

Filter Handling

For more complete recommendations on filter handling for PM_{2.5}, refer to Section 2.12 of the QA Handbook. In general, filters should be handled delicately using non-serrated forceps, never using fingers (even in laboratory gloves) to touch any part of the filter. When not in use, filters should be stored in protective cartons in conditions of moderated temperature and relative humidity. Filters should always be transported from the laboratory to the sampling location in the filter cassette, which should be protected within a metal canister. These canisters may be ordered directly from Mesa Labs.

Filter Cassette Handling

The filter cassettes provided for use with the PQ200 are as specified in 40 CFR 50 Appendix L, Figures L-27 through L-29. The upper and lower halves of the cassette have been designed with an interference fit to prevent the cassette from coming apart easily, therefore some care must be exercised when opening and closing the cassette, especially when a filter is inside. Always maintain the cassette in an upright position, especially after the filter has been used to collect particles. To open, place a clean, flat blade device (knife edge, screwdriver blade) against the outside edge of the cassette between the upper and lower halves and gently wedge them apart. **DO NOT TWIST THEM APART**, this could tear the filter. A specialized tool for opening the filter cassette may be purchased from Mesa Labs.

Set the upper half of the cassette aside. Handle the filter with non-serrated forceps only.

To close the cassette, place the upper and lower halves together and gently press them together, being careful not to twist them. When closed, the two halves should seat snugly together with the backing screen securely held in place between the two halves.

Filter Weighing

Because of the small amounts of material collected, an extremely high quality microbalance and carefully, temperature and humidity controlled filter weighing room are required.

The analytical balance used to weigh filters must be suitable for weighing the type and size of filters specified and have a readability of $\pm 1\mu\text{g}$. The balance should be calibrated as specified by the manufacturer at installation and should be recalibrated immediately prior to each weighing session.

Appendix D Rev T Dip Switch Functions (Obsolete)

There is an 8-pole dip switch located on the left side of the main control board of the PQ200, in Figure 9 of this manual. When standing in front of the PQ200, with the front panel swung forward for inspection, the dip switch will be found to the lower left, on the board.

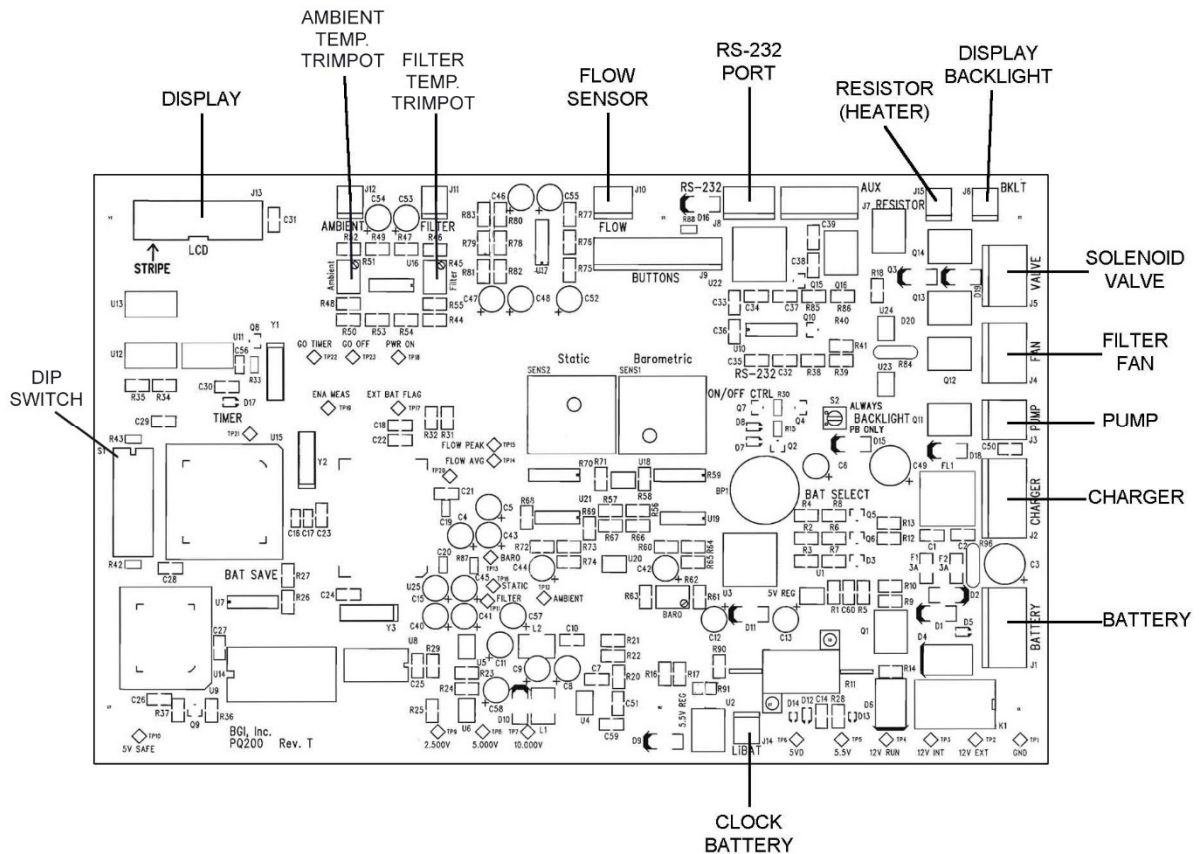


Figure D1. Location of Dip Switches

WARNING! DO NOT TURN ON SWITCHES LABELLED F.D. (Factory Diagnostic) IN FIGURE D2. FIRMWARE MAY BECOME CORRUPTED AND THE UNIT MAY NO LONGER OPERATE.

In general, these switches will seldom, if ever, be utilized by an operator of the PQ200. However, in the event that use is required, their application is explained.

To utilize a switch, first shut the instrument completely off. Then move the switch to the on position and turn the unit power on and the requisite function will then be performed. The switch may be returned to the off position with power on or off.

Switch No. 1 Factory diagnostic use ONLY

Switch No. 2 Reset century. The PQ200 will automatically change to the year 2000.

Switch No. 3 Half time running. Setting switch number 3 to "on" will cause the PQ200 to run for one minute and rest for one minute. The total elapsed hours will be correct and the accumulated volume will be one half of that expected over the elapsed time period. There are two potential reasons for utilizing this feature. When operating from battery power, it might be desirable to extend the running time for two days. When operating from battery or line power in an area of extremely heavy concentrations, it could be desirable to operate at half time to preclude premature filter loading and shut down. However, it should be noted that a sample gathered by this half-time technique may not be equivalent to the concentration discerned by full time operation.

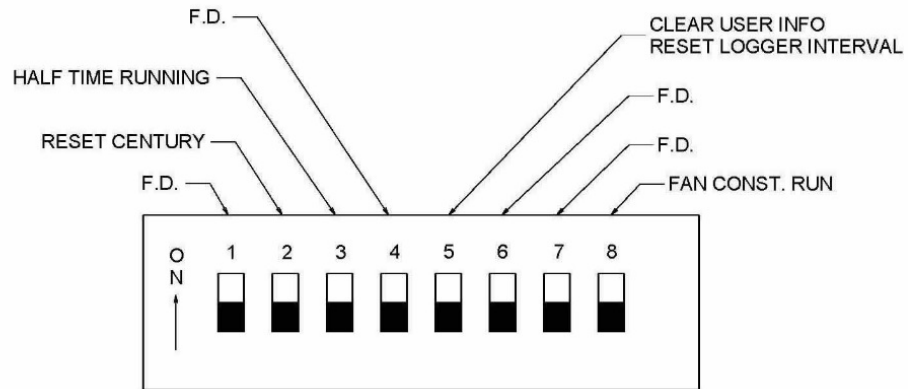
Switch No. 4 Factory diagnostic use ONLY

Switch No. 5 Clear user information and default logger interval to five minutes. This function is only utilized when a computer is not available for connection to the PQ200. When a computer is available, it is more convenient to bring up the remote-control function on the computer screen and re-set from there. If this procedure is followed, the switch need not be activated.

Switch No. 6 Factory diagnostic use ONLY

Switch No. 7 Factory diagnostic use ONLY.

Switch No. 8 Fan constant run. In the normal configuration, the filter cooling fan only runs when a developing overheat is detected. The fan switches off when cooling air is not required. This function conserves battery power and reduces the ingress of dust to the inside surfaces of the case. However, if it is desired, in areas where volatile particulates predominate, to maintain an absolute minimum overheat, full time fan operation should be considered.



SWITCHES ILLUSTRATED IN NORMAL - OFF POSITION

F.D. = FACTORY DIAGNOSTIC

Figure D2. PQ200 Dip Switch

Appendix E

Use of the PQ200 as a PM₁₀ Designated Reference Sampler

The PQ200 is an EPA designated reference sampler for PM₁₀ and PM_{2.5} sampling. To perform PM₁₀ sampling, the PM₁₀ adaptor should be used instead of the VSCC. The PM₁₀ adaptor is merely a continuation of the 12-inch long straight tube connecting the inlet to the instrument. The assembly is readily removed for cleaning, and can be installed without the use of tools. The PM₁₀ adaptor in the open position is depicted in Figure E1.

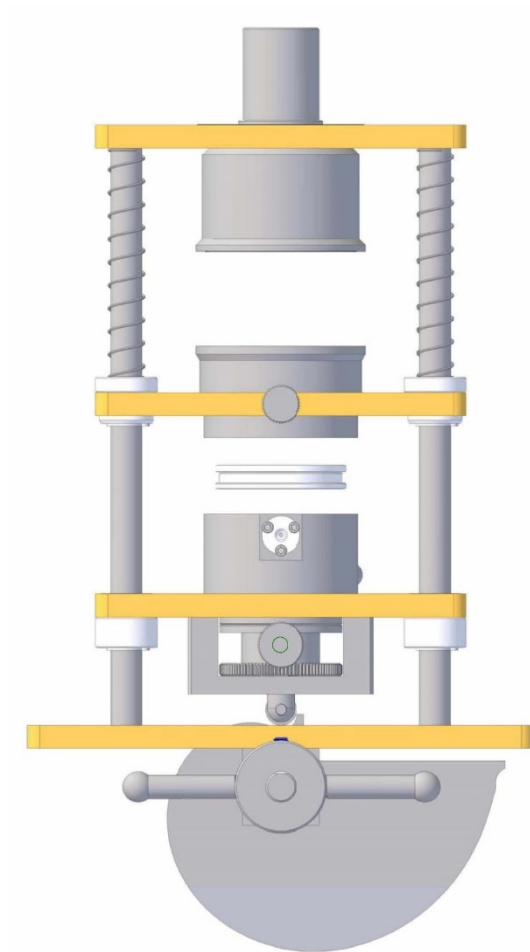


Figure E1. PM₁₀ Adaptor and Filter Holder, Open

Appendix F

Solar Panel Power Supply

Introduction

The 188095 solar panel kit is intended to permit the PQ200 to run for extended or indefinite periods of time depending on the available solar radiation at a given location. Because of the low current draw, The PQ200 is highly amenable to this technique. The solar panel may only be used as the sole source of power for a U.S. EPA-designated instrument if sampling is not being performed every day (i.e. continuously).

The basic components of the solar kit are:

1. 32-watt solar panel with mounting brackets
2. Built-in voltage regulator
3. 100+ amp hour (approx.) ballast battery (user supplied)

The purpose of the external high capacity battery is to provide backup power on days with little to no sunlight. The recommended battery capacity will provide 7-8 days run time with little or no sunlight. It will recharge, almost completely, after one days use during a day of full sunlight while the instrument is non-operational. Complete recharging of a fully depleted system would require 10 days.

This type of system should not be considered for latitudes higher than 45-50° or particularly overcast regions.

Operational Considerations

While the use of solar power is highly desirable from the standard of utilizing a renewable energy source and being freed from the need to locate a source of power in difficult situations, there are some preliminary considerations. The PQ200 is not operating directly from the received solar energy but rather from a battery, which has been charged by that energy. If a PQ200 were to be run continuously from the internal and recommended external battery, 7 to 8 days run time could be achieved. However, considering only EPA designated sampling conditions, i.e. sampling from midnight to midnight, then it would be possible to run on alternate days yielding one day to replenish the energy used. Given that this is accomplished in full sunlight while the instrument is running, the extra day recovery reduces the need for full sunlight by 50%. If the popular, one in 3 days, or one in 6 days schedule is utilized, the probability of complete replenishment is greatly increased.

Experience has shown that on cloudless days in the Boston area, 5 Kwh/M² insolation will replenish the energy used by a PQ200. To determine the suitability of the PQ200 solar system for a given location, Appendix A of the cited reference¹ gives the insolation index for 54 locations in the US and other places throughout the world. Given a one in 6-day sampling schedule; only Fairbanks Alaska is unsuitable for solar application in the months of November, December, and January. These are clear sky tables and seasonal overcast must be considered in individual locals. Table F1 comprises locations at various US latitudes and indicates operational months vs. sampling schedules.

There are other factors which will reduce the energy replenishment of the system and make accurate performance predictions difficult. Amongst these are:

1. Dirt on the solar panel
2. Extreme cold weather affecting battery performance
3. Extremely high particulate loadings causing high filter resistance and consequent high current drain
4. Old batteries -- more than two years' old

While all the preceding factors are to be considered in the deployment of a solar powered PQ200, they are not easy to quantitate. The effect of too little sunlight will be noticed on the "percent charge remaining" on the PQ200's main screen. Given perfect replenishment, it will always read 99%. If at any time it falls below 50%, consider replacing the large battery with a fully charged one. At a minimum, given winter gloom, a fully charged battery and an every other day sampling schedule, a one month operating period is achievable at any location below 45° latitude.

Setting up

After unpacking a new unit, the solar panel is attached to the rear leg of the PQ200 as shown in Figure F1. The board should be positioned as shown in the figure with the battery placed on top of it. This serves to anchor the lower end of the panel to prevent its lifting during high winds. Failure to do so could result in damage to the solar panel and the PQ200.

NOTE: In consideration of weight, shipping expense and ready, local availability, a battery is not furnished with the solar panel kit. However, the recommended battery is known as a "trolling motor" battery. This is a marine type battery used for low speed, electric outboard motors. They are equipped with handles and 5/16-inch binding posts with wing nuts. Because of their marine specifications, they are a "deep discharge" battery, which is also the type recommended for solar panel applications¹.

Direction

Position the solar panel with its long axis from the north to south, with the foot (low) end of the panel to the south. Since the cell will be attached to the rear leg of the PQ200, this means that the back of the PQ200 is pointing due south and the front or door side of the instrument is due north as illustrated in Figure F2.

Tilt Angle

The tilt angle is defined as the angle of inclination of a solar collector measured from the horizontal. The reason for tilt angle is because the sun's elevation will vary over a range of 47° from winter solstice to summer solstice¹.

For the greatest annual energy production, the tilt angle should equal the latitude at the location of deployment. For best energy production, the wintertime the angle should be the latitude plus 15°. The maximum summertime production is obtained at latitude minus 15. The tilt angle and one method of setting is shown in Figure F3. It may also be set with a user supplied protractor/bubble level.

Wiring Connections

On the back of the solar panel is a rectangular box from which two cables exit as shown in Figure F4. The cable with 5/16-inch ring terminals is intended to connect to the external battery described in Section F2. The white or red wire is positive (+). The black wire is negative (-) and the green wire, with the tinned end is ground. A 12-inch ground spike and terminal is provided.

The other wire emanating from the box is equipped with a CPC connector. This wire is installed through the hole in the bottom of the PQ200 enclosure normally used for the power supply cable. This wire is installed in place of the power supply cable when running on solar power.

Overall Operation and Troubleshooting

Prior to deploying a PQ200 with solar panel, it is prudent to ensure that the internal battery is fully charged. This is accomplished by plugging the PQ200's power supply into a source of line current for 16 hours. Full internal battery charge will be indicated on the main menu display as 99% or charged when the battery is full charged and the power supply is disconnected.

The external solar panel battery may be initially charged from any automotive battery charger. Alternatively, the PQ200 may simply set in a sunny location or the actual field sampling site and not run for 10 days. The solar panel will fully charge both batteries.

Troubleshooting

Battery is not maintaining at least 50% charge - caused by inclement weather or excessive current drain. Excessive current drain is caused by an extremely dirty filter or a worn-out pump. After installing a new filter, if problem persists, check for worn pump valves or diaphragm. If either battery is more than two years old - replace.

Reference

- (1) Stand-Alone Photovoltaic Systems, A Handbook of Recommended Design Practice. Sandia National Laboratories. Document No. SAND87-7023. https://www.wbdg.org/ccb/DOE/TECH/sand87_7023.pdf

TABLE F1. Clear Sky Insolation Data from Northernmost to Southernmost U.S. cities¹.

Months wherein full charge can be maintained.

City	N. Latitude	Continuous Sampling	Every other day Sampling	Third day Sampling	Sixth day Sampling
Caribou, ME	46E 52'	Mar-Aug	Jan-Oct	Jan-Dec	Jan-Dec
Boston, MA	41E 40'	May-Sept	Jan-Nov	Jan-Dec	Jan-Dec
Raleigh-Durham, NC	35E 52'	Apr-Aug	Jan-Dec	Jan-Dec	Jan-Dec
Miami, FL	25E 48'	Feb-Sep	Jan-Dec	Jan-Dec	Jan-Dec

NOTE: This approximation is based upon 5 Kwh/M² received, as being necessary to fully restore the PQ200 system whilst drawing 500 MA (typical).

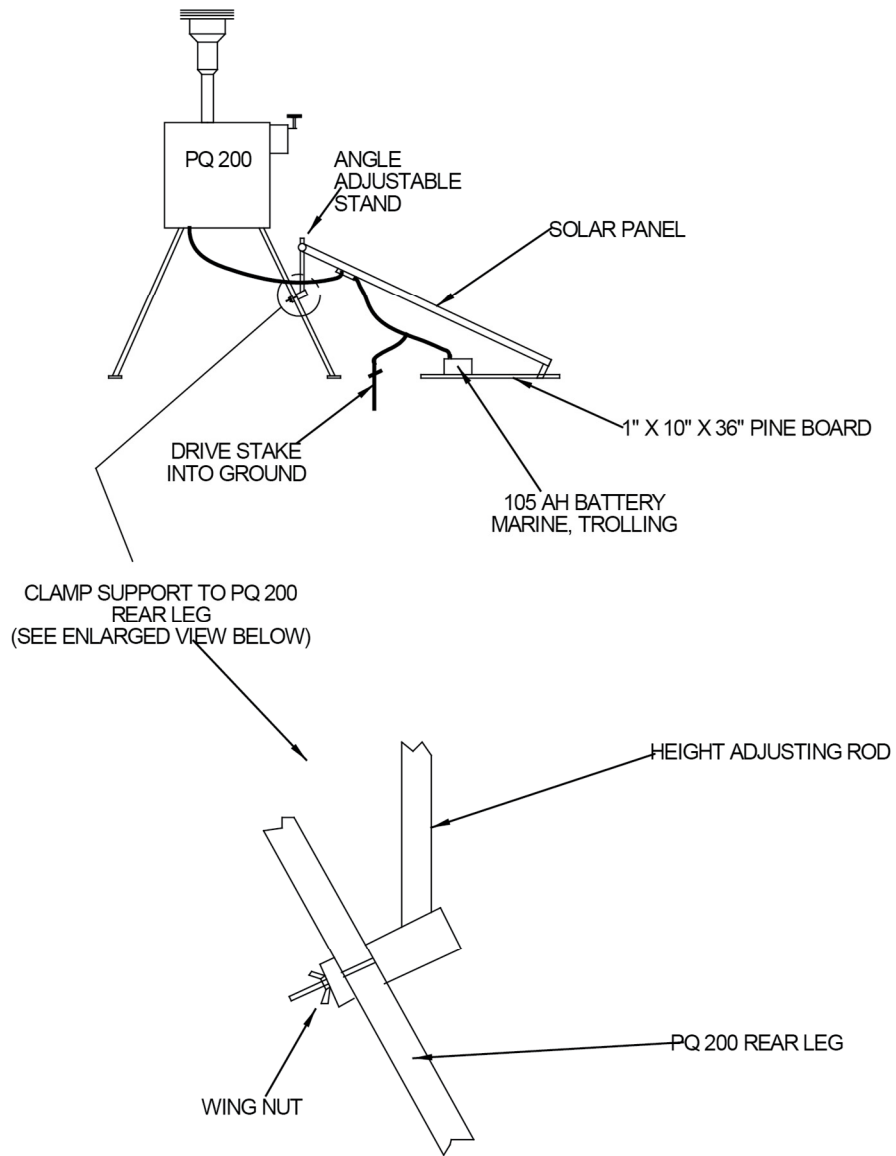


Figure F1. Setup of Solar Panel

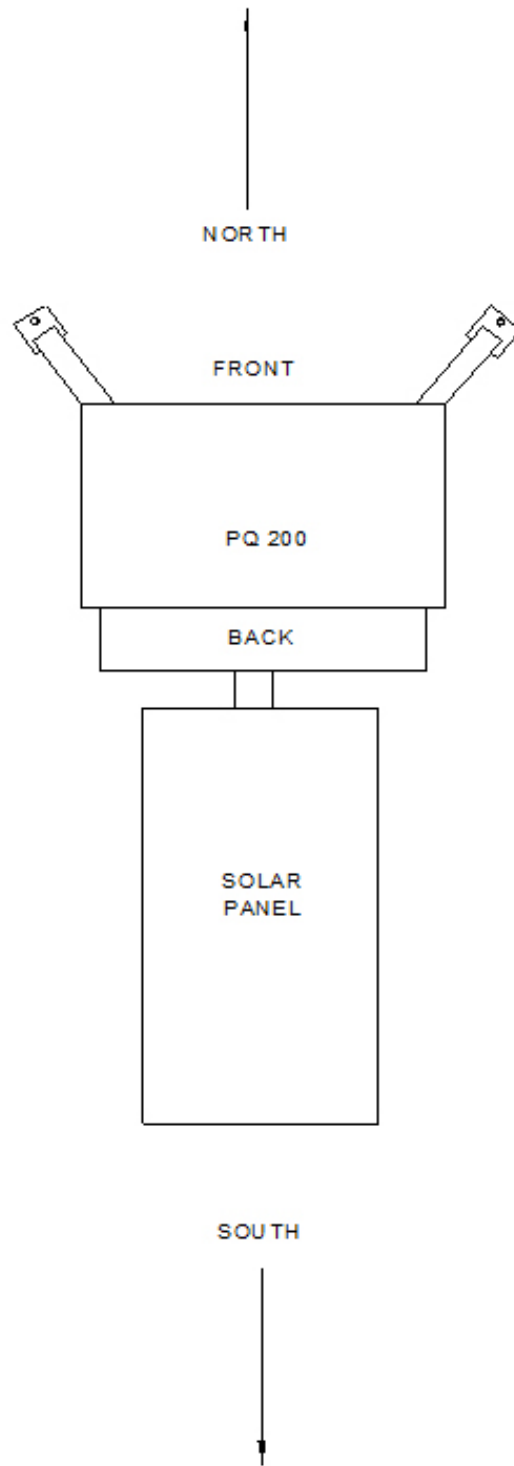
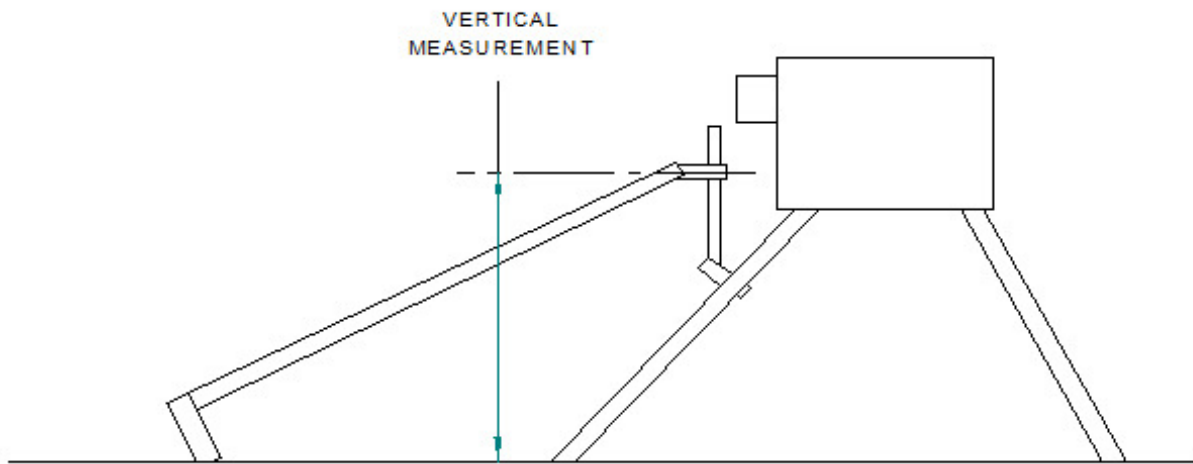


Figure F2. Orientation of Solar Panel



BEFORE USING THE CHART BELOW DETERMINE WHETHER YOU HAVE THE LONG STYLE (13" WIDE x 51" LONG) OR THE SHORT STYLE (21" WIDE x 25" LONG) SOLAR PANEL

VERTICAL MEASUREMENT				TILT ANGLE
SHORT STYLE (21"x25")		LONG STYLE (13"x51")		
INCHES	CM	INCHES	CM	DEGREES
12.2	30.0	18.7	47.5	15
16.1	40.9	27.5	69.8	25
19.8	50.3	35.2	89.4	35
22.3	56.6	42.2	107.2	45
24.5	62.2	48.0	121.9	55
25.5	64.8	51.8	131.6	65

Figure F3. Setting Tilt Angle

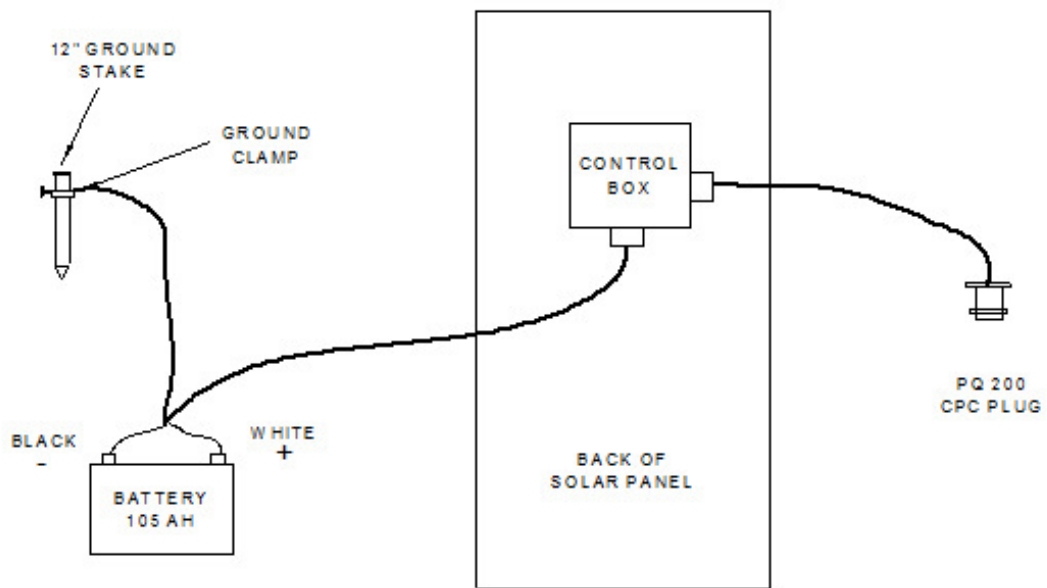


Figure F4. Wiring Connections

Appendix G. Accessories

Cassette Opener (CO1)

In order to prevent filter damage due to dropping or touching the filter during the cassette disassembly procedure a cassette opener has been developed to provide a gentle opening action while keeping all components on the bench top. In use the opener is laid flat on the bench top such that the base pad elevates the "forks" of the opener. Shown in Figure G1 The cassette (screen side towards the bench/filter side up) is slid between the fork legs and pushed forward with the thumb only. The top of the cassette will be gently levered upwards, free of the bottom. Remove the top of the cassette and carefully slide away the opener. The bottom of the cassette may now be lifted off the bench and the filter is freely available for removal with forceps. Usually the bottom of the fingers of one hand and a third finger of that hand is used to gently lift the screen so that the edge of the filter is presented to the forceps.

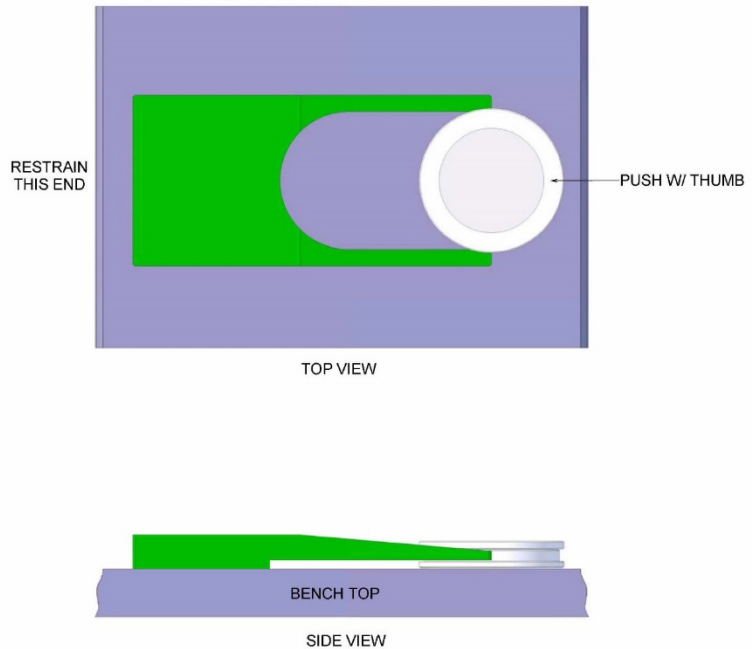


Figure G1. CO1 Cassette Opener

Cassette Transport Carrier (F214)

In further compliance with the FRM directives, a new all metal cassette container has been produced. Shown in Figure G2, the new container completely seals the cassette from the elements, holds it rigidly in place and when the cover is removed, permits easy access for removal. No additional bagging or containment is required.

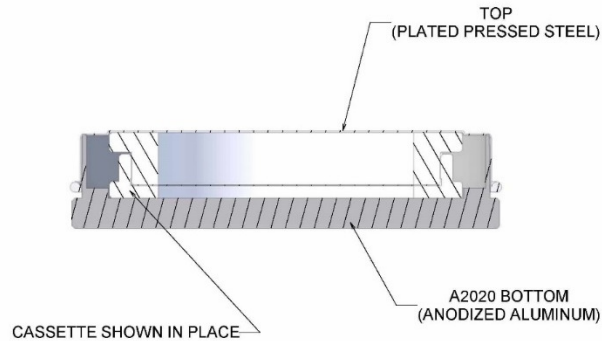


Figure G2. F214 Cassette Transport Carrier

USB Download Cable (USB A/B)

USB type A to USB type B cable to download data to a computer. The PQ200 uses an internal USB to RS232 converter. The first time a PQ200 is connected to a computer via the USB cable, it will need to install the drivers for the converter.

Automatic Calibration Interface Cable (70066)

The Automatic Calibration Interface Cable is used to connect the PQ200 to a deltaCal calibrator to perform automatic calibration. The cable is 2 meter, male to female, null modem cable. A standard RS232 cable can not be used.

Appendix H

PQ200 Job Controller Software

SUPPORTED HARDWARE

The PQ200 Job Controller software program installs into any IBM PC or compatible computer running 32-bit Windows or 64-bit Windows in compatibility mode. The computer must have:

- COM1 or COM2, RS232 serial port for downloading
- Hard drive with at least 5MB free disk space

DOWNLOAD and INSTALLATION

Download the PQ200 Job Controller Software from our website here: <http://bgi.mesalabs.com/software/>. Continue to follow the onscreen instructions for installing the PQ200v2.0 Job Controller software.

PROGRAM OVERVIEW

The PQ200 Job Controller software is a menu-driven program that utilizes the serial communications port of the PC to download sample data from the PQ200 air sampler and to provide data logging, data manipulation, concentration calculation, and sample validation capabilities. The data may then be appended with the measured filter weights for concentration calculation.

The Program has three folders in menu bar: **File, Options and Remote Control.**

- **F**ile
 - N**ew : creates a new job file.
 - O**pen : opens an existing job file.
 - U**ser Prefs : allows the user to preset the default information that the PQ200 Job Controller software uses when creating a new job file, alleviating tedious repetition
- **O**ptions : displays toolbar if desired.
- **R**emote Control : allows the user to program the PQ200 air sampler instead of using the six-button interface on the sampler itself.

USING THE SOFTWARE

To Start a Job File

- Choose File and New
- Enter Generic Job Information. **(Click save)** • You may now change the file if desired. **(Click save)**
- A blank summary sheet will be displayed.
- Go to the menu bar and click on **(DOWNLOAD)**, make sure the PQ200 sampler is on and connected to the computer at this time. **(Click Begin)**
- When download is complete. **(Click Return)**

Charts

- **Temp:** Displays temperature graph only.
- **Overheat:** Displays overheat graph only.
- **Static Pressure:** Displays static pressure graph only.
- **Update Spreadsheet:** Button applies the three changed graphs if you have changed them into the Summary spreadsheet.
- **Return to Spreadsheet:** returns user to summary sheet.

NOTE: Just as with the spreadsheets, the graphs can be activated by double-clicking the open window. By activating a graph, virtually any feature of the graph can be manipulated: scale, color scheme, data labels, etc. However the graphs have been optimized by the software and should not require changes.

Remote Control Button

The remote control button allows a variety of data to be uploaded to the PQ200 from a notebook computer. From this window you may:

Set clock time	Set stop time
Set start time	Set flow rate
Set start date	Set stop date
Enter filter information	Set logger interval
Set date	Enter user information

This function is useful because this information can be set in the computer in a comfortable location prior to uploading. The PQ200 may also be controlled from this screen.

Bottom Button Bar

- Summary: Displays summary sheet.
- Hourly: Displays hourly logger sheet.
- Logger: Displays 5-minute logger (User selectable)

User ID

User 1 and User 2 fields are designated by the EPA to be controlled by the person in the field operating the PQ 200 instrument and are to be held in the memory by the instrument. The software can be used to edit this field, but changes are not saved when job file is saved.

Notes 1 & Notes 2

To provide the software user additional fields that can be edited and saved, the Field Notes 1 and Notes 2 have been added to version 2.0 of the PQ200 control software. These values can be edited and saved.

Summary Sheet

Once a job file has been created and data have been downloaded from a sampler, the **Summary** folder displays the basic information about the sample run as a convenience to the operator.

The "PQ200 Air Sampling System" box includes the sampler version number, the sampler serial number, and the total pump hours.

The "Timer Info" box displays the sample run start and stop time and the calculated elapsed time.

The "Filter Overheat, C" box displays the differential achieved between the filter temperature and the

ambient temperature in degrees Celsius, and also the time at which this maximum differential occurred, even if it occurred after the completion of the sampling period.

The "Flowrate Info in Lpm" box shows the target flow, the average flow achieved during the sample run, the coefficient of variation of the measured flow rates, and the total volume of air sampled in actual cubic meters.

The "Pressure Info, mmHg" box contains the minimum, maximum, and average barometric pressure recorded during the sample run.

The "Temperature Info, C" box contains the, minimum, maximum and average ambient temperature measured during the sample run. The "QCv" Box displays the Coefficient of Variance of the average flow rate. The "Flags" box displays any flags that may have been triggered during the sample run (i.e., power failure, flow rate variation beyond +/- 5 percent, filter overheat of more than 5 degrees C lasting more than 30 minutes, or that a 24 sample actually ran for less than 23 hours 50 minutes). A flag not triggered will read as **OK**.

The "Filter Info" box includes any filter information entered during the creation of the job file. This information may be changed in the text fields of this box. The weight gain is automatically computed if the initial and final weights are entered.

The "PM2.5 Concentration" box shows the concentration of PM2.5 in micrograms per actual cubic meter, computed as the weight gain in the "Filter Info" box divided by the total air volume sampled in the "Flowrate Info in Lpm" box.

The "Date downloaded" box gives information as to when the download of information was executed.

Appendix I

Terminal Program interface

The PQ200 can be communicated with directly if the PQ200 Job Controller is not used. Run data is available for download, and new run settings can be entered. To configure the PC to communicate with the PQ200, follow the steps below:

1. Connect an RS-232 or USB type B cable between the PC and PQ200
2. Open a window Using HyperTerminal or similar program (TeraTerm is a free software available online) and set up the following serial communication settings:
 - a. Click on the "Setup" drop down menu and select the serial port
 - b. Set the required settings:
 - i. Baud rate: 9600
 - ii. Data: 8 bit
 - iii. Parity: none
 - iv. Stop: 1 bit
 - v. Flow control: none
 - vi. Transmit delay: 0 msec/char and 70 msec/line
 - c. Click "OK"
3. Turn the PQ200 on
4. Send the following serial communication commands to the PQ200 using the terminal program:

*#Thhmmss	Set current time hh:mm:ss
*#Dddmmyyyy	Set current date dd-mm-yyyy
*#Wxxxxxxxx	Set user filter information, 32 characters max (If less than 32 characters are entered, additional characters will not be overwritten)
##Xyyyyyyyy	Set user site information, 32 characters max (If less than 32 characters are entered, additional characters will not be overwritten)
*#Fxxx	Set Flow rate to XX.X Liters Per Minute
*#Lxx	Set logger interval in minutes
*#Cddmm	Set user defined start date ddmm
*#Shhmm	Set user defined start time hhmm
*#Eddmm	Set user defined stop date ddmm
*#Rhhmm	Set user defined stop time hhmm
*!G	Shut down for programmed run
*!S	Stop
*!C	Continue
*!R	Reset
?S	Download summary data
?L	Download logger data

Appendix J

VERY SHARP CUT CYCLONE - VSCC®

Instructions for Use and Maintenance

Introduction

The BGI Very Sharp Cut Cyclone (VSCC®) is designed and manufactured only by Mesa Labs. The VSCC® intended use is as an equivalent fine particulate matter separator in place of the US EPA WINS Impactor for PM_{2.5} sampling in any commercial model of the U.S. EPA Federal Reference Method (FRM) Samplers. The VSCC® may be freely utilized as a PM_{2.5} separator on a FRM type sampler and used for particulate mass, metal collection and sulfate and nitrate particulate collection. The VSCC® can be utilized as a fine particle separator on continuous particulate monitors, including the TEOM, BAM, and other light scattering and beta ray attenuation samplers.

Mesa Labs manufactures two versions of the VSCC. They are the VSCCA, which is a direct replacement for any commercial FRM/FEM system, such as the Thermo Partisol or Met One BAM-1020. The VSCCB is intended for installation only in the BGI PQ200. Each VSCC is clearly identified on its side with a part number and individual serial number.

The flow path through a VSCC is shown below in a cut-away view. PM₁₀ aerosol enters tangentially after being pre-separated by the PM₁₀ FRM inlet. Particles greater than PM_{2.5} are removed to the grit pot on the side of the VSCC and the PM_{2.5} sample is ducted through the cyclone separator to the filter holder. Field and laboratory tests indicate the VSCC can operate up to a period of 90 days between cleaning frequencies, even in high urban loading sites.

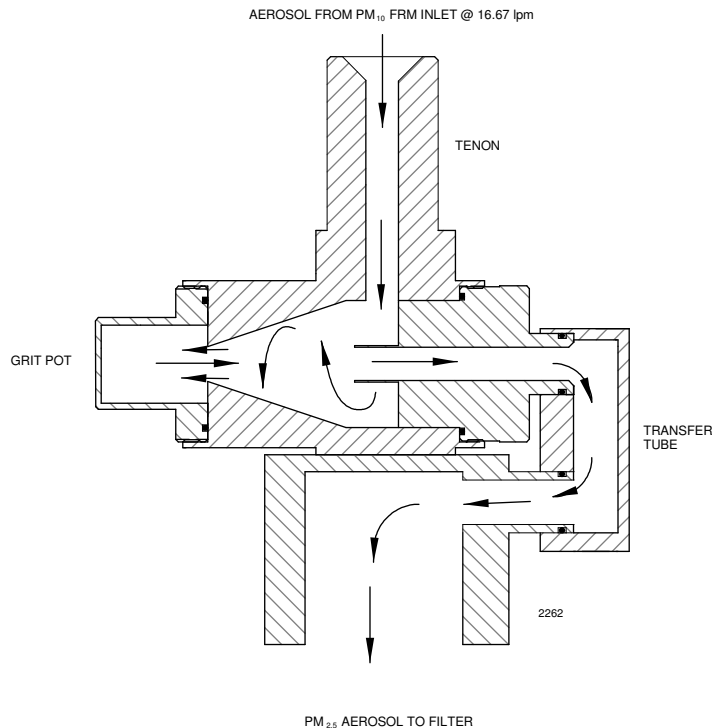


Figure J1. Flow path in VSCC cyclone

Operation

After installation of the VSCC[®], the instrument may be run in the normal manner at a flow rate of 16.67 LPM as described in the manufacturers operation manual and 40CFR Part 53 specification. It is important to note the performance and operation of the VSCC[®] is based on volumetric *actual* flow rate and not STP corrected flows.

Maintenance

The US EPA recommends that you clean the VSCC after every 30 days of 24-hour sampling. Testing by BGI under 40 CFR part 53.65 EPA requirements for designation has demonstrated a validated cleaning interval up to 90 days¹. For use of the VSCC on fine particulate "continuous monitors" i.e.: TEOM, Beta attenuation monitors or light scatter units, the operator can clean the device on a 90 day continuous operation basis.

Exploded views of the VSCC is shown below. Recommended cleaning materials are cleaning with use of mineral free water and lint free lab wipes. In cases, where stubborn deposits are observed, ultrasonic cleaning in soap and water is recommended.

To disassemble a BGI VSCC:

- Step 1. Remove the VSCC from its installed position in the instrument.
- Step 2. Pull off the side transfer tube. If it is too tight to remove by hand, pry it off with a rigid plastic lever. Care should be taken to not damage the two "O" ring seals.
- Step 3. Remove the top cap and grit pot by unscrewing.
- Step 4. Wet a lint free wipe with water and remove all visible deposits. These are most likely to be found at the bottom of the cone and inside the grit pot.
- Step 5. Inspect all "O" rings for shape and integrity. If at all suspect, replace. Lubricate all "O" rings with light grease. It is important to well lubricate the transfer tube to avoid difficult disassembly.
- Step 6. Assemble in reverse order and reinstall.
- Step 7. Perform a leak check according to manufacturer's operating manual specifications.

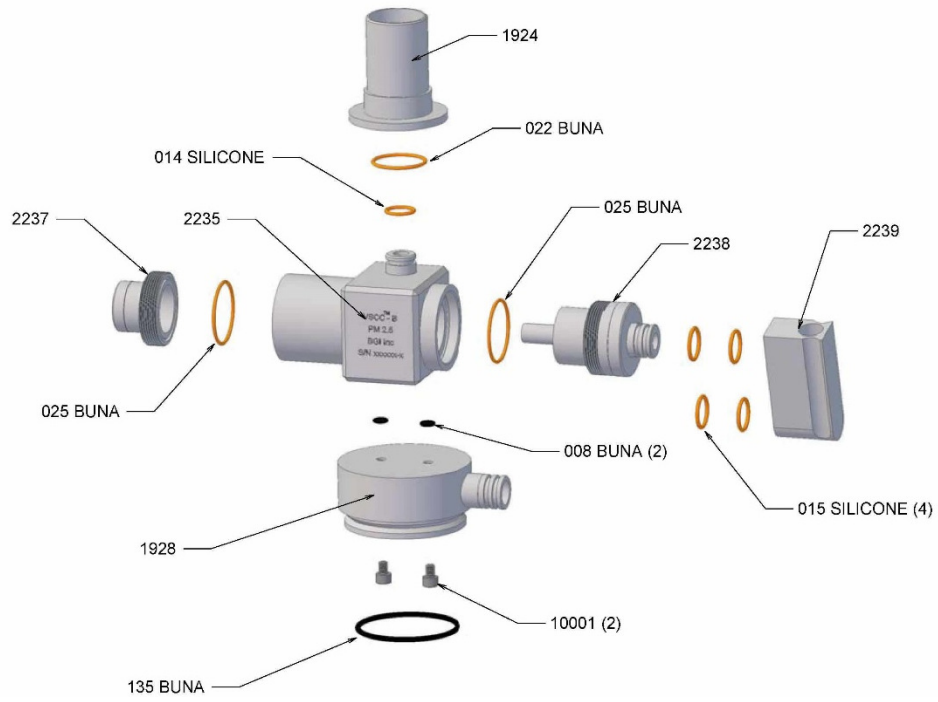


Figure J2. Exploded Diagram of VSCC

1. Thorpe A. et al (2001) Effects of Dust Loading on the Performance of the VSCC® Cyclone, Health & Safety Laboratory Report # IR/L/EXCON/O1/09

Appendix K

Updating Main Controller Board to Rev U(C8445)

Upgrading from a pre Revision T Board

PQ200 board Revision D and later can be updated to the current version. Boards prior to Revision T require the following hardware upgrade kit which includes the required main controller board:

MESA P/N 188281

PARTS INCLUDED

C8445	Revision U Controller Board
2546	Push Button PCB Board
A1676	Battery Cable
A2335	Low Voltage Input Cable
A2339	Display Screen
M-A2338	Ambient Adapter Cable
M-A2340	Driver Board Cable
HO3033	Tygon Hose
SC2001	Screw and Washer Set
70034	Label "EXIT"
M-A2358	Mounting Plate for Resistor (Obsolete: for upgrade to Revision T)
M-A2366	Resistor Cable (Obsolete: for upgrade to Revision T)

Upgrading from a Revision T Board

Upgrading from Revision T to current version requires the main controller board (C8445), and label "EXIT" (70034).

Recommended for all upgrades

Mesa Labs recommends the optional kit below for both of the above upgrades. It includes a new power supply and bracket, as well as a revised pulsation dampener. It includes a template for 2 additional mounting holes to be drilled into the PQ200 chassis.

MESA P/N 188278

PARTS INCLUDED

188280	Pulsation Dampener Assembly
70033	Power Supply Bracket
PS15V6A 90W	Power Supply
T1245	Drill Template

REPLACEMENT STEPS FOR PRE REVISION T BOARDS

- 1) Cut and remove all tie wraps.
- 2) Remove all cables to the Controller Board.
- 3) Remove 6 screws (62) holding Controller Board (61). Discard Controller Board and save screws, clock battery (84) and spacer. (See Figure K1)
- 4) Remove temperature boards (70 & 72), barometric board (68), static pressure board (78), button

board (79), display (64) and all cables from these boards. Discard boards and cables. Save screws. (See Figure K1)

- 5) Remove Ambient Sensor cable (A1680), External Power cable (A1679), Backlight Shunt cable with resistor (A1677), and Battery Cable (A1676). Discard all cables. Save the Resistor Clamp (143). Plug the two holes from the resistor clamp using existing screws and 2 nuts provided.
- 6) Install new Button Board (2546), Display (DS 2011B), Resistor Clamp (143) with Mounting Plate (2358) /Resistor Cable (2366) and Main Controller Board (2368) (See figure K3). Tighten all screws.
- 7) Install new Ambient Adapter cable (2338), Low Voltage Input cable (2335), Driver Board cable (2340) and Battery cable (1676). (Low Voltage cable is mounted above Ambient Adapter cable (See figure K2).
- 8) Cable Placement to Main Controller Board
 - a) Plug in the Display ribbon cable (gray) to the connector marked LCD.
 - b) Plug in the Ambient Adapter cable (orange and blue wires) to the AMBIENT connector.
 - c) Plug in the Filter cable (purple and brown) to the FILTER connector.
 - d) Plug in the Flow cable (purple, black and red wires) to the FLOW connector.
 - e) Plug in the RS232 cable (purple, brown and green wires) to the RS232 connector.
 - f) Plug in the Resistor cable (2366) (both orange) to the RESISTOR connector. (Upgrade to Rev T only)
 - g) Plug in the Backlight cable from the Display (green and blue wires) to the BKLT connector.
 - h) Plug in the Driver Board cable (red, black and green) to the VALVE connector.
 - i) Plug in the Fan cable (red and black wires) to the FAN connector.
 - j) Plug in the Pump cable (white and black wires) to the PUMP connector.
 - k) Plug in the Low Voltage cable (2335) (See figure K2) to the CHARGER connector.
 - l) Plug in the Battery cable (from the battery) to the BATTERY connector.
 - m) Install clock battery (84, Fig K2) and connect wire to LiBAT connector.
 - n) Remove old Small Solenoid Hose and replace with new Static Pressure Hose (HO3033). Attach one end to the solenoid and the other to the front sensor tube marked "Static" (See figure K3)
 - o) Take the old Solenoid Hose (126, Appendix A, Fig 4) and install one end where the old barometric hose was mounted in the bottom of unit on barb fitting. Take the other end and attach to the Sensor Tube marked "Barometric" on the Main Controller board (See figure K3). You may need to shorten the hose.
 - p) Tie wrap all wires in a neat form, same as was before replacing the new controller board.
 - q) Double check to make sure all cables are plugged in correctly.
- 9) Turn unit on, check to make sure of a proper boot up. The new controller will double click the Solenoid Value; this is normal. Check the display to make sure all temperature, barometric, and other readings are shown.
- 10) Apply "EXIT" label (70034) below the unmarked button on the instrument panel.
- 11) At this time you should
 - a) Set the correct time and date.

- b) Calibrate temperatures, barometric pressure and flow.
- c) Program a run for 15 minutes.

12) You are now ready to start sampling.

REPLACEMENT STEPS FOR REVISION T BOARDS

- 1) Remove all connectors and pressure sensor tubing from PC board. Be sure to identify each cable before removing it.
- 2) Remove 6 screws attaching board to PQ200.
- 3) Remove old PC board and replace with new.
- 4) Reinstall 6 mounting screws.
- 5) Reinstall cables and tubing. All connectors are in the same location and orientation as was the Rev T board.
- 6) The 2 pin connector (A2366) for heat resistor is not reused.
- 7) Apply "EXIT" label (70034) below the unmarked button on the instrument panel.
- 8) At this time you should
 - a) Set the correct time and date.
 - b) Calibrate temperatures, barometric pressure and flow.
 - c) Program a run for 15 minutes.

REPLACEMENT STEPS FOR RECOMMENDED UPDATE

- 1) Remove 2 screws holding dampener assembly to PQ200.
- 2) Remove tubing from dampener and flow meter and remove assembly.
- 3) The drill template (T1245) uses the existing dampener posts as location points to orient the template. Place the template over existing dampener screw posts from the back of the PQ200.
- 4) Using a 3/16" drill bit, drill through the PQ200 chassis at the 2 new locations.
- 5) Remove the template and expand the pilot holes to .281" (size K bit).
- 6) Transfer flow meter to new dampener assembly.
- 7) Reconnect tubing to flow meter and dampener.
- 8) Attach assembly to PQ200 chassis using 1/4-20 screws included in the kit.
- 9) Replace power supply with power supply included in kit.
- 10) Perform a leak check on the PQ200. (Section 7.4)

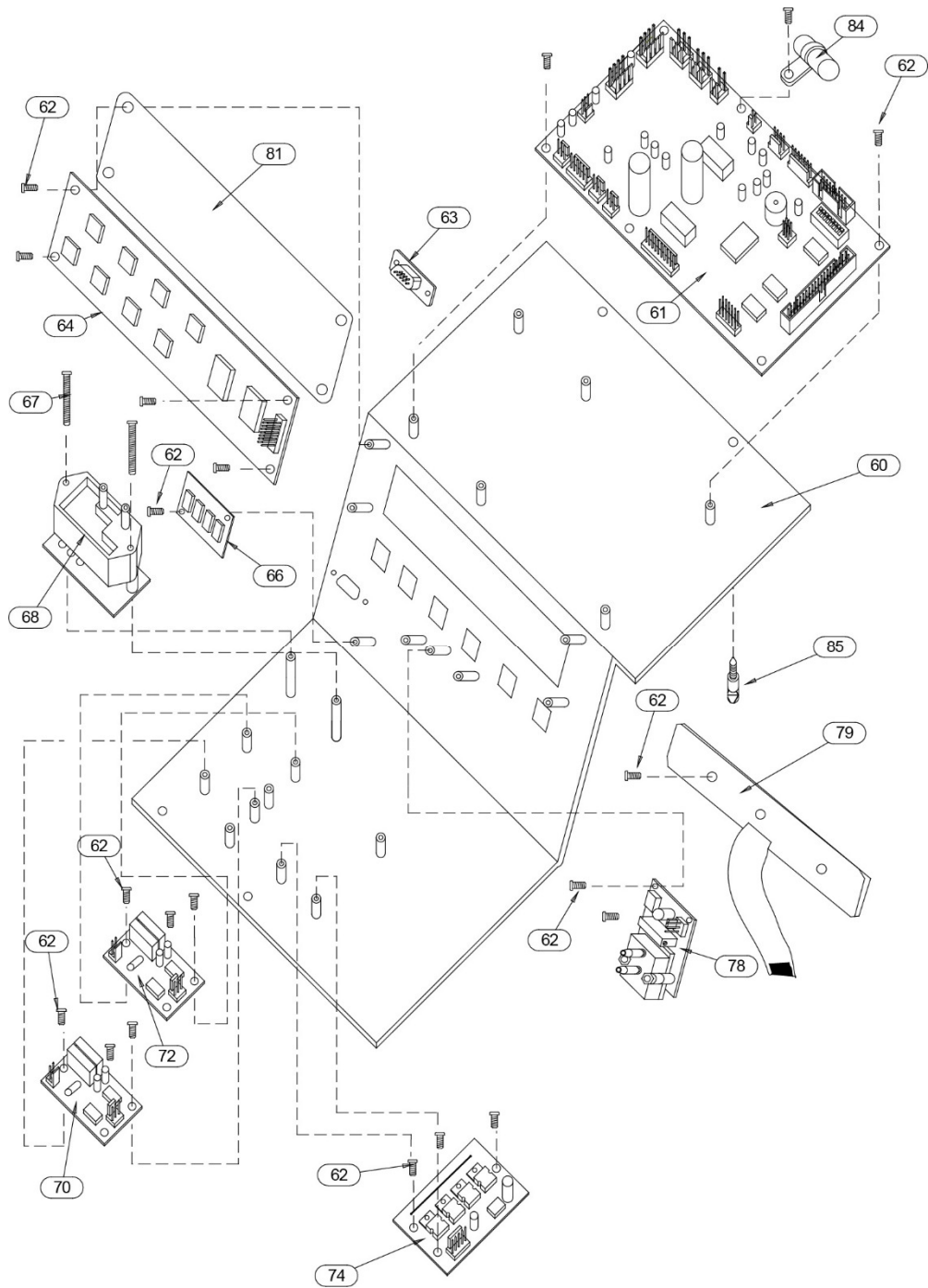


Figure K1. Exploded view of obsolete instrument panel configuration

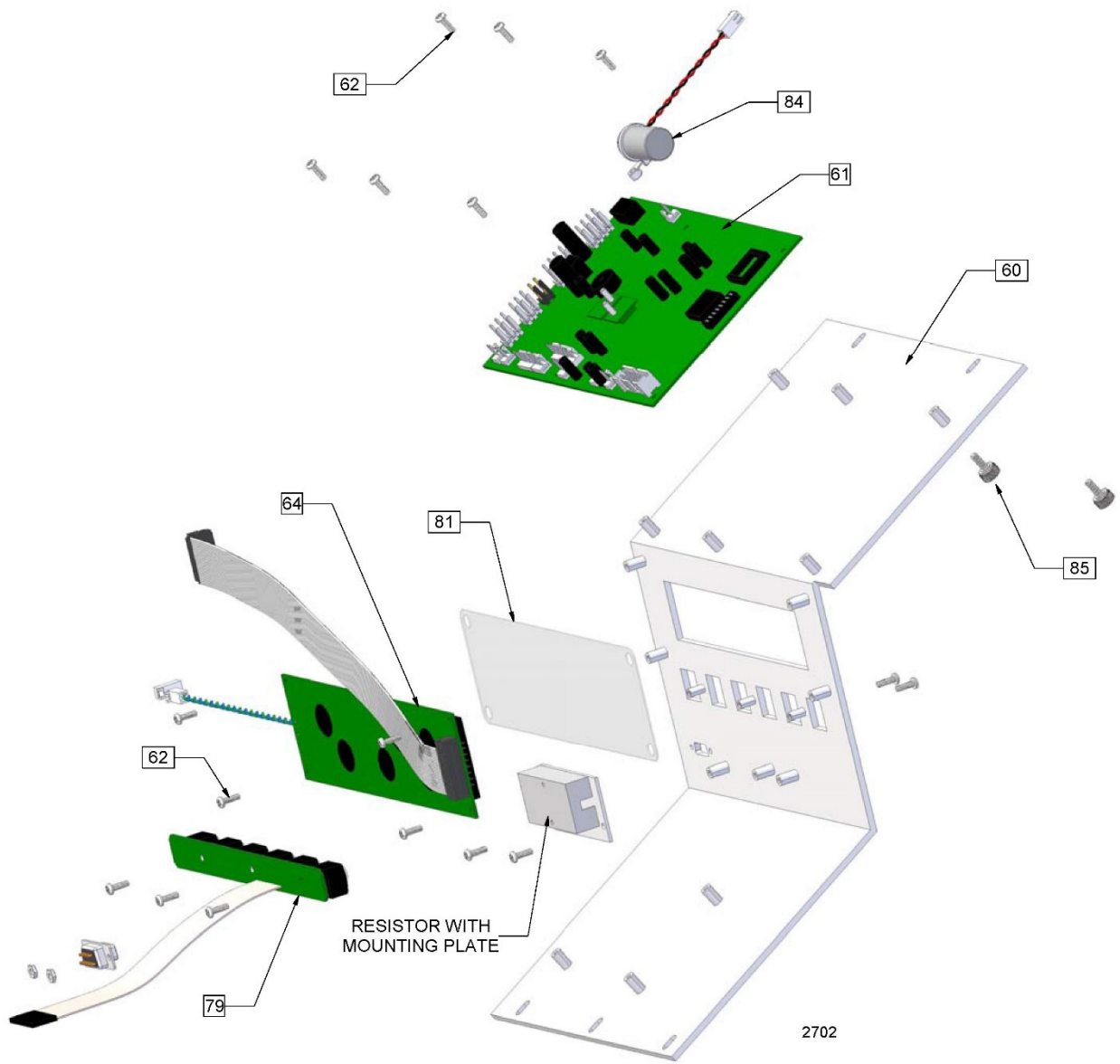


Figure K2. Exploded View of Instrument Panel

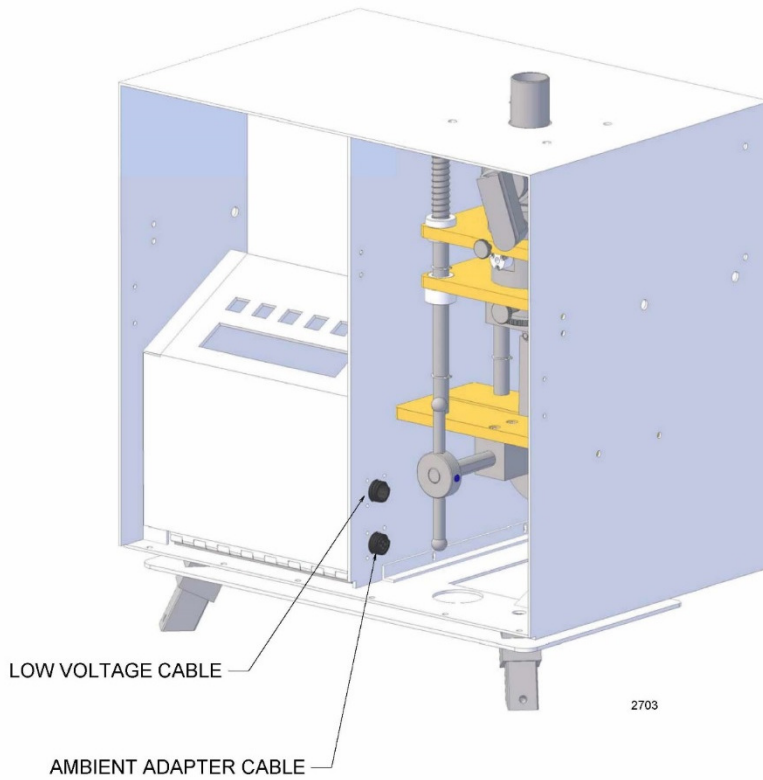


Figure K3. Location of Low Voltage and Ambient Cables on Inside Panel

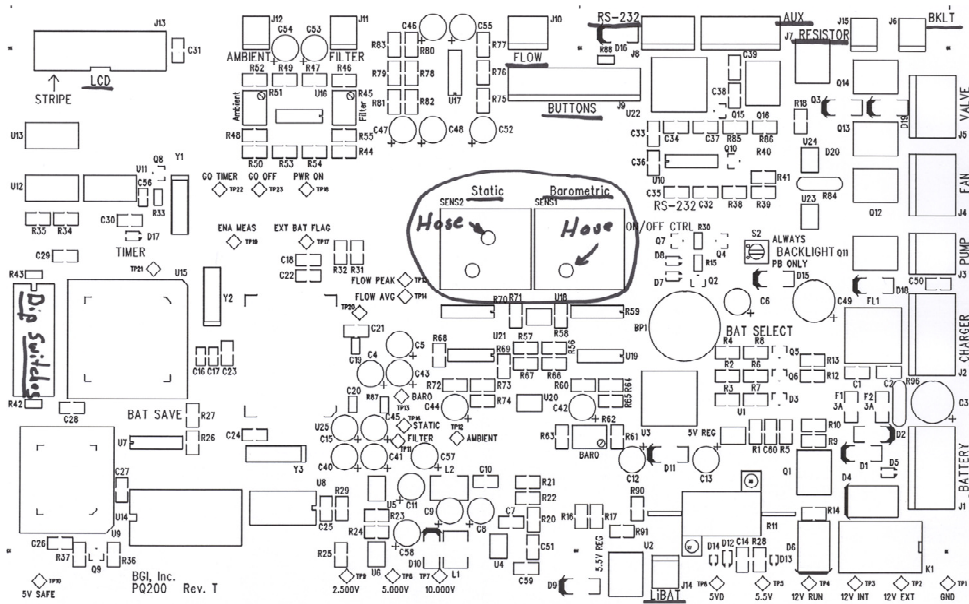


Figure K4. Location of pressure hoses.

Appendix L

Instructions for PM_{coarse} Sampling

PM_{coarse} is defined by the U.S. EPA as a regular PM₁₀ concentration measurement with a concurrent PM_{2.5} concentration measurement subtracted from it. Both concentration measurements are to be taken simultaneously and reported on a volumetric basis, i.e. under actual (ambient temperature & barometric pressure) rather than standardized conditions. Inasmuch as the PQ200's are designed for volumetric sampling, no changes to the equipment are required.

The keynote of effective PM_{coarse} sampling is careful attention to synchronizing both samplers; timed event, filter media and calibrated flow rate, temperature(s) and pressures.

1. Sampler Preparation.

Both samplers should be in prime operating condition with identical firmware versions. If brand new units are being used, this step will already be accomplished. For both units, follow the setup procedures found in Section 5.0 of this manual.

At this point, it is strongly recommended that each sampler be labeled to minimize confusion. A minimal recommendation is:

PM Coarse Pair	PM Coarse Pair
Sampler SN <u>XXXX</u>	Sampler SN <u>XXXX</u>
Measuring PM2.5	Measuring PM10

2. Sampler Operation & Site Set Up

The samplers are to be set up and run in exactly the same fashion as a pair of PM₁₀ or PM_{2.5} samplers, which are simply making collocated measurements. Special care is taken as to the relative location of the two samplers and the setting of date and time. US EPA site criteria is that the sampler inlet should be placed at a height of 2 to 15 meters above ground level. When collocating PM₁₀ and PM_{2.5} samplers, the spacing between sampler inlets must be >1 meter. The spacing between inlets must be no more than 4 meters apart for PM_{coarse} sampling. The heights of the two inlets should be within 1 meter as measured in the vertical direction.

3. Data Reporting.

Report concentrations to EPA as $\mu\text{g}/\text{m}^3$, at actual volume. Typically PM_{10} methods are reported in standard volume, however when sampling with two PQ200s for $\text{PM}_{\text{coarse}}$, both sample volumes are reported in actual volumes.

It is strongly recommended that you check to see the start and stop times of the PM_{10} and $\text{PM}_{2.5}$ collocated PQ200s are within 15 minutes of each other. This will insure accurate flow rate and concentration data.

Appendix M

Leak Test Procedure for S/Ns 906 through 1016

On September 01, 2010 BGI changed the PQ200 External Leak Check procedure for Serial Numbers greater than S/N906. The electronic Solenoid Valve was removed and replaced with a manual valve to perform the external leak check procedure. This change requires the operator to conduct the external leak check procedure as follows:

- a) Insert an unused filter into the filter holder. (Do not use this leak test filter for sampling, it is intended only for leak testing and flow rate calibration)
- b) Remove the PM10 Inlet from the Inlet Downtube and set aside. Place the L-30 Flow Audit Adapter (aluminum cap with brass valve) on top of the male Downtube. This valve can be in the open position with the valve handle at the 12 o'clock position or closed in the 9 or 3 o'clock position.



- c) Inside the cabinet the operator will see a manual Leak Check Valve located near the filter holder. The valve in the forward position, 9 o'clock is in the closed position and will not allow air flow. The Valve in the down 6 o'clock position is open and allows flow rate.



- d) From the Keypad and Display go to the MAIN MENU. Go to TEST MENU and press SELECT to enter the TEST MENU.
- e) From the TEST MENU, press the arrow key until LEAK TEST appears on the display and flashes. Press SELECT to enter LEAK TEST.
- f) The screen will ask that the operator CLOSE THE INLET CAP. The operator must now manually move the brass valve handle on the L-30 Flow Audit Adapter into the 9 or 3 o'clock position. This closes the valve to the atmosphere and the PQ200 is ready to leak test.
- g) When the Inlet Cap valve is closed press SELECT . The vacuum pump will slowly run and create a vacuum inside the PQ200 system.

NOTE: It is Important for the operator to watch the lower right corner of the display and see the SP numbers increase from 000 to 095 or higher.

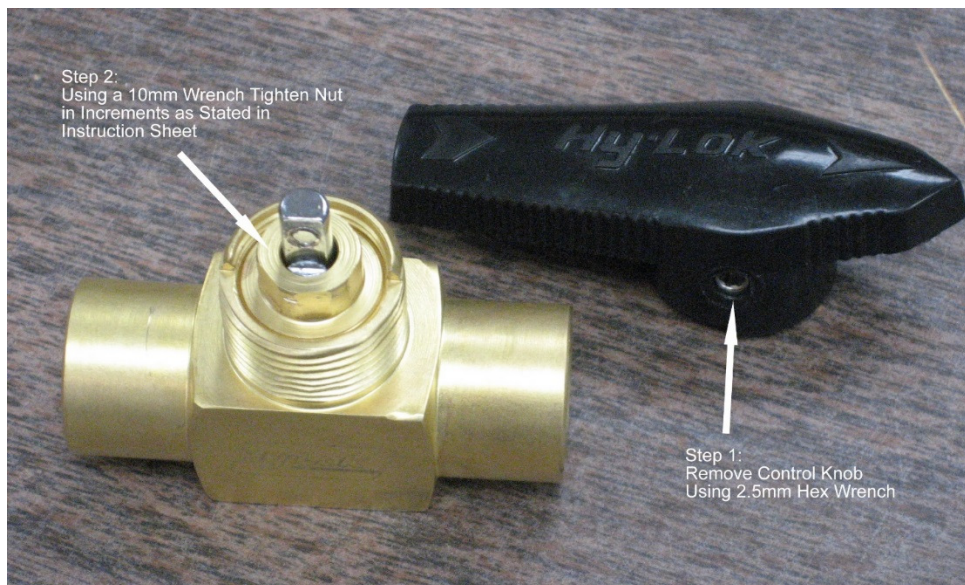
- h) After 10 to 15 seconds the SP will rise to approximately 95 cm. When the SP reading displays 95 cm, "immediately" close the Leak Test valve near the filter holder by rotating the handle forward to the 9 o'clock position.
- i) After two seconds the screen will display LEAK TEST IN PROGRESS and the SP display should remain constant at a SP number of 95 to 100 cm. An automatic timer will display on the screen starting at 0:00 minutes and count upward to 2:00. At the end of two minutes the sampler will end the Leak Test and display PASS or FAIL. A PASS indicates the sampler is ready for sampling. If FAIL is displayed the sampler is leaking air into the hardware and must be investigated to correct the problem.
- j) If PASS, it is important to remember to open the two valves, the valve on top of the sampler and the Leak Check Valve must be in the open positions for sampling.
- k) The PQ200 cannot leak more than 5cm of Water from the initial setting of 90 to 100 cm over two minutes. If the SP drops more than 5cm over two minutes the sampler is not ready for sampling and corrective steps must be taken to correct the leak.
 - 1) Make sure the audit adapter is securely set and closed onto the downtube
 - 2) Make sure the PM2.5 VSCC® cyclone or PM10 Bypass are sealed tightly. Use the thumbwheel to increase the sealing of the O-Rings in the filter and cyclone area.

NOTE: It is important to remember to reset the Leak Check Valve, near the filter holder into the OPEN position before normal sampler operation can start. BGI designed the valve so the handle will push against the cabinet door, to help the user remember to open the valve for sampling conditions. With the Leak Check Valve in the DOWN position the sampler is ready to operate.

Note: Valves are factory set for leak tests at 70° F (21° C). If you are experiencing a leak at the valve it may be necessary to adjust the packing of the valve.

Adjustment Instructions: (see photo also)

- 1) Remove the black plastic knob using a 2.5mm hex wrench.
- 2) Tighten the packing nut in small increments until a leak tight seal is achieved.
- 3) Reinstall black plastic knob.



Appendix N

Rev "D" PCBs Calibration and Parts

Temperature Probe Calibration

Equipment for rev "D" PCBs

The following apparatus is required to perform an accurate temperature calibration.

- 4½ digit, precision, calibrated, volt meter (recommend B&K Precision model #2945)
- Total immersion, precision, NIST traceable thermometer • Partial immersion, precision, NIST traceable thermometer
- A small slotted screwdriver.

Procedure for rev "D" PCBs

NOTE: The filter temperature sensor board is located on the front panel and the ambient sensor board is located on a bracket that is attached to the ambient sensor gauge connector. Temperature should be calibrated indoors where temperature variations will be minimal and not abrupt.

- Hang the total immersion thermometer somewhere close to the Gill screen (preferably at about the same height) where it can be read without handling (handling will cause abrupt false readings).
- Set the PQ200 up to run for about 3 or 4 hours to attain equilibration of the sensors and the thermometer.
- When confident that the devices are equilibrated and stable, and while the unit is still running, carefully open the front panel of the PQ200 and locate JP4 on the main P.C. board.
- Set up the DVM (digital volt meter) for a range that will allow a reading of +2.389 VDC.
- Attach the negative (black) lead of the meter to the black wire connection of JP4.
- Touch the positive (red) lead to the test point labeled TP1 on the TEMP SENSOR board to be calibrated. If the voltage reads somewhere between +2.388 and +2.390, the span will not have to be set. A higher or lower reading will have to be adjusted. Use a small slotted screwdriver to adjust the "SPN" trimmer pot on the sensor board.
- Compare the displayed readings to that of the total immersion thermometer. Adjust the "OFST" trimmer pot until the readings agree +/- 0.1° Celsius.

NOTE: This procedure applies to both TEMP SENSOR boards.

Barometric Pressure Calibration

Equipment for rev "D" PCBs

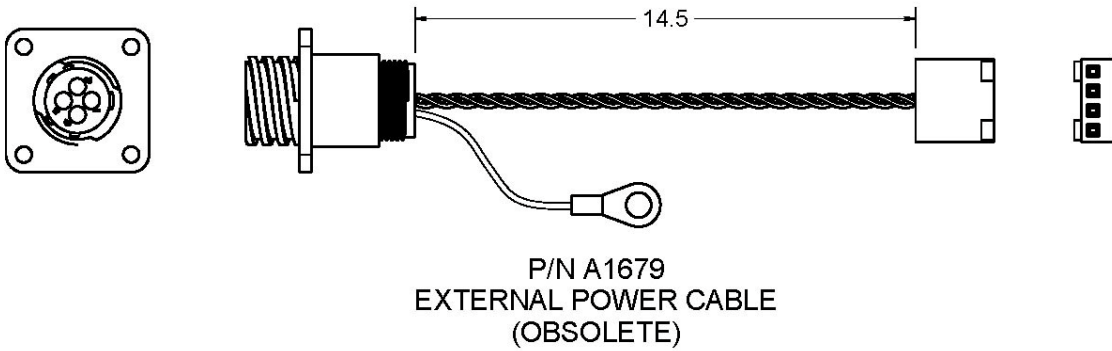
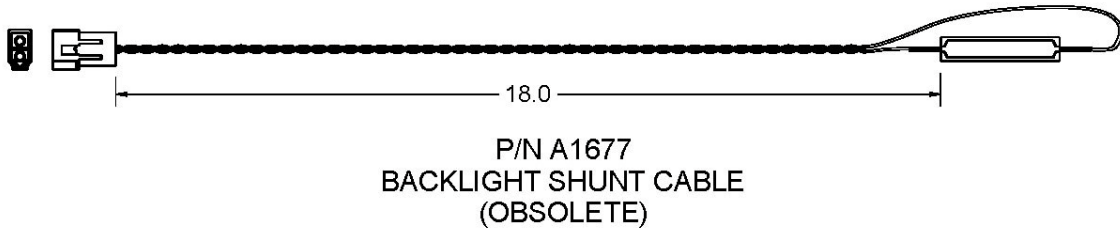
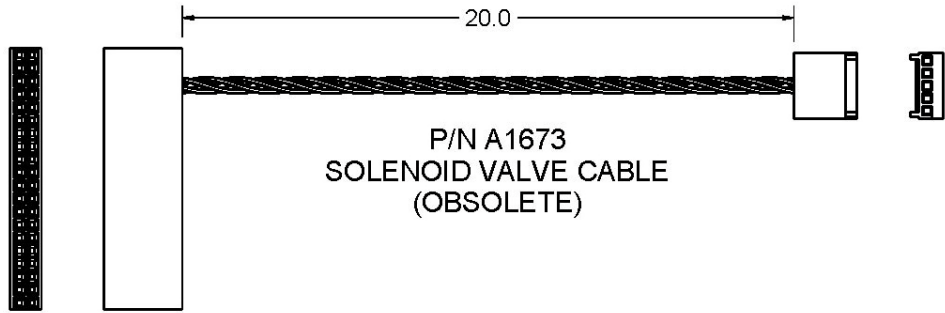
The following apparatus is required to perform an accurate barometric pressure calibration.

- An accurate, NIST traceable, barometer
- An accurate, mercury, manometer with a range of 100 millimeters of mercury
- A small slotted screwdriver
- Rubber hose (proper size to secure to connections and fittings)
- A "T" adapter for the hose

- A pair of hemostats

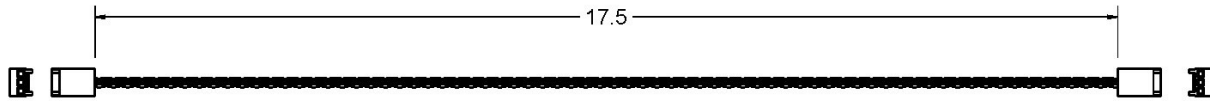
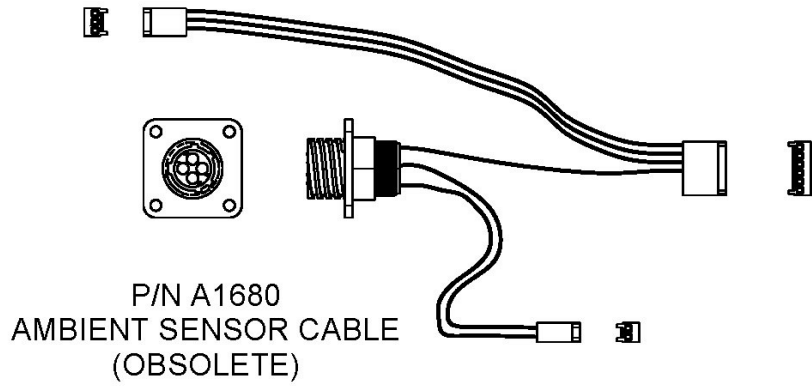
Procedure for rev "D" PCBs

- At the Main screen, compare the PQ200 barometric reading to that of the NIST traceable barometer (If the barometer reads in inches (typical US readings) multiply by 25.4 to obtain millimeters). Adjust the "OFFSET" until they do agree.
- Remove the tubing that is attached to the P1 port of the barometric pressure sensor and attach a piece of hose to this port. At the end of the hose attach a "T" adapter and attach pieces of hose to the other two ends.
- Attach one of the hoses to the manometer negative pressure fitting.
- Apply light suction to the last hose until the manometer reads 100 mmHg. Clamp off the hose with the hemostats to prevent leakage.
- Observe the displayed value. It should be 100 mmHg less than the current, ambient, barometric pressure. If not, adjust the "GAIN". (After making a gain adjustment, the "OFFSET" may require re-adjustment. Work back and forth a few times to obtain a 100mm span and an ambient reading that agrees with the NIST barometer.)

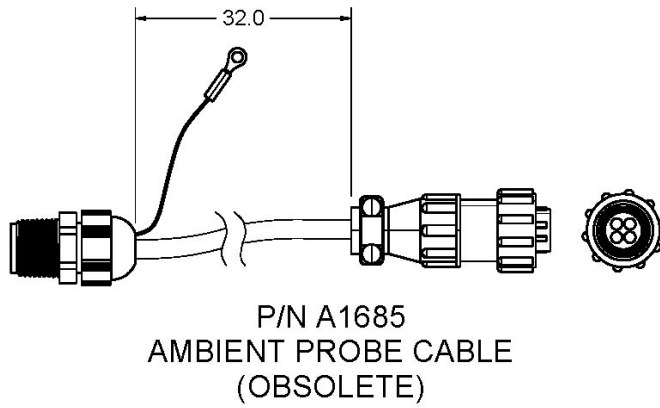


1695b

Figure N1. Obsolete Cables from Rev D PCB



P/N A1681 BAROMETRIC PRESSURE CABLE (OBSOLETE)
 P/N A1732 STATIC PRESSURE CABLE (OBSOLETE)
 P/N A1733 FILTER TEMPERATURE CABLE(OBSOLETE)



1695

Figure N2. Obsolete Cables from Rev D PCB

Appendix O

WINS Installation (Obsolete)

- To open the WINS (Well Impactor Ninety-Six) and filter assembly inside the PQ200 sampler case, carefully rotate the handle counterclockwise using both hands. (CAUTION! Once the assembly has started to open, the weight of the two plates will tend to force the whole assembly open even further.) This will expose the WINS impactor and the filter cassette (see Figure 4).
- The filter cassette and WINS impactor should now be visible. If not, gently pull the filter cassette or WINS impactor from its respective upper housing. Take special precaution not to damage the filter in the filter cassette.
- Inspect the filter cassette and WINS impactor for damage, dirt, or oil. Clean, repair, or replace as necessary.
- Inspect the upper and lower sections of both the WINS impactor housing and filter housing for damage, dirt, or oil. Clean as necessary.
- Inspect the o-rings in the upper and lower housing of both the WINS impactor and filter holder. If the o-rings are cracked or broken, replace them.
- Place a filter cassette with an unused, undamaged 47mm filter into the filter holder. The filter surface should be facing upwards. Take care that the filter is not touched by any foreign object (fingers, rain, etc.). (Remember that filters for EPA PM_{2.5} measurement must meet certain material and preparation specifications (see Appendix E).)
- If necessary, place a clean, properly prepared WINS impactor into the impactor housing. The well should be facing upwards.
- Close the assembly by slowly rotating the handle clockwise 3/4 of a turn. Watch the filter cassette and WINS impactor to ensure that they are seated properly and the assemblies close securely.
- If necessary, the compression between the upper and lower housings of the WINS assembly can be adjusted using the knurled ring.

NOTE: The PQ200 air sampling system should never be operated (or left unoperated for long periods) without a filter in the filter cassette. Operation without a filter in place allows particulate matter to enter the pump and mass flow sensor, which could reduce their operating life.

Adding Oil to the Impactor

For proper operation of sampler for collection of PM_{2.5}, 1 mL of Dow Corning 704 diffusion oil and a 37 mm glass fiber filter must be present in the impactor well. The diffusion oil allows the impactor well to continuously collect particulate material for several 24-hour periods. The filter is necessary to prevent migration of the diffusion oil due to the force of the impactor jet, which would reduce the well's effectiveness. This filter is not meant to be weighed.

Overloading of the impactor will alter its performance curve. Section 2.12 of EPA's Quality Assurance Handbook contains a recommended schedule for cleaning the impactor well by replacing the filter and diffusion oil. Follow these guidelines for impactor cleaning, including any recommendations for where these procedures should be performed. The new filter should lie evenly and flat against the bottom of the impactor well and the layer of oil should just cover the filter. Be careful not to splash the oil or leave air pockets under the filter. When reassembling the well, ensure that the o-ring between the upper ring and

impactor well is in good condition and maintains a tight fit. Replace if necessary. Wipe the exterior of the well with a clean Kimwipe. Transport the well to the sampler upright in a clean, protective container away from direct sunlight or extreme temperatures.

Appendix P

Pump Rebuild Instructions

1. 1.0 Introduction

The pump used in the BGI PQ100 and PQ200 air samplers is of Mesa design and manufacture. The only items not of Mesa manufacture are the motor and bearing for the eccentric. The basic design is a double diaphragm, steel reed valve, scotch yoke. This is a time-honored design.

2.0 When to Rebuild

There are two reasons for rebuilding and replacing components of the pump.

1. Rebuild the pump when it has ceased to function.
2. Rebuild when sufficient, in service hours have elapsed, to indicate that certain components are nearing the end of their effective service lifetime. Because of the variable use to which a pump is subjected, it is hard to quote a fixed number of hours for preventative maintenance. Experience has now shown, that when the pump is utilized for normal EPA type sampling, i.e. 16.7 LPM at 30-50cm of H₂O pressure drop, eight to nine thousand hours may be readily anticipated. This amounts to one year of continuous operation. Under idealized conditions, we have run the pump at 16.7 LPM against 50cm of H₂O for 18 months. The mode of failure was pump brush wear (brushes are non-replaceable). Bear in mind, given EPA sampling protocols 8-9000 hours is 2 years of every other day sampling, 3 years of every third day and 6 years of every sixth day!

The following chart is a guide to preventative maintenance for absolute reliability.

Replace Motor:	9000 Hours
Replace Diaphragms:	9000 Hours
Replace Eccentric and Bearing:	14000 Hours
Replace Valves:	14000 Hours

Using the equipment for non EPA designated sampling at high flow rates and/or pressure drops may significantly abbreviate the above figures and it would not be imprudent to perform a complete rebuild at 5000 hours.

2. 3.0 Disassembly and Inspection

All of the component parts of the pump are shown in Figure P1 and described in the parts list, Table 1. Four levels of repair/rebuild kit are made available. Other than the parts listed in the kits, it is not anticipated that any other components will be required except through physical damage or loss.

Rebuild Kits:

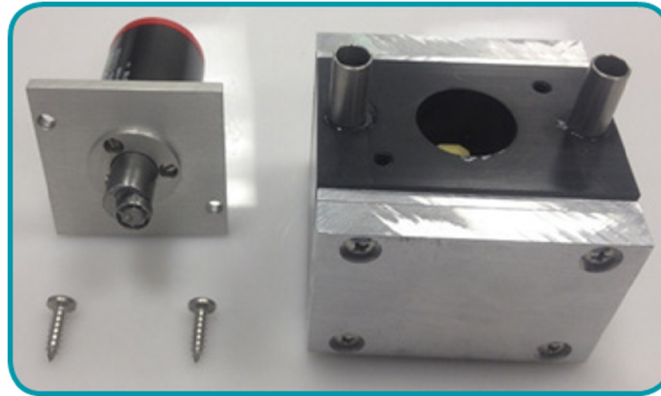
Catalog No.	Quantity	Description	Detail No.*	Part No.
X017	2	Diaphragms	38	M-A2187
X014	2	Diaphragms	38	M-A2187
	2	Valves	50	B1408
	8	"O" Rings	48	010BUNA
X015	2	Diaphragms	38	M-A2187
	2	Valves	50	B1408
	8	"O" Rings	48	010BUNA
	1	Mounted Bearing	42, 43	DDRI-6632, A1294
X016	2	Diaphragms	38	A2187
	2	Valves	50	B1408
	8	"O" Rings	48	010BUNA
	1	Mounted Bearing	42, 43	DDRI-6632, A1294
	1	Motor	47	PQ Motor

*detail numbers refer to Figure P1 and Table 1

3.1 Pump Rebuild Instructions



Step 1: To start rebuilding your pump, remove the two screws that secure the motor to the pump body. The motor assembly can now be pulled away from the pump body. Inspect the eccentric bearing for looseness on the shaft. Inspect the bearing for smooth rotation and absence of play. If these components are in good condition, then wipe the bearing clean with a fresh, lint free cloth and re-lubricate with light grease. Set aside for reassembling.



Step 2: If the bearing requires replacement, loosen the set screw on the eccentric shaft and remove the bearing or eccentric assembly. Replace with a new assembly, pushing it firmly on the shaft as far as it will go, before tightening the set screw.

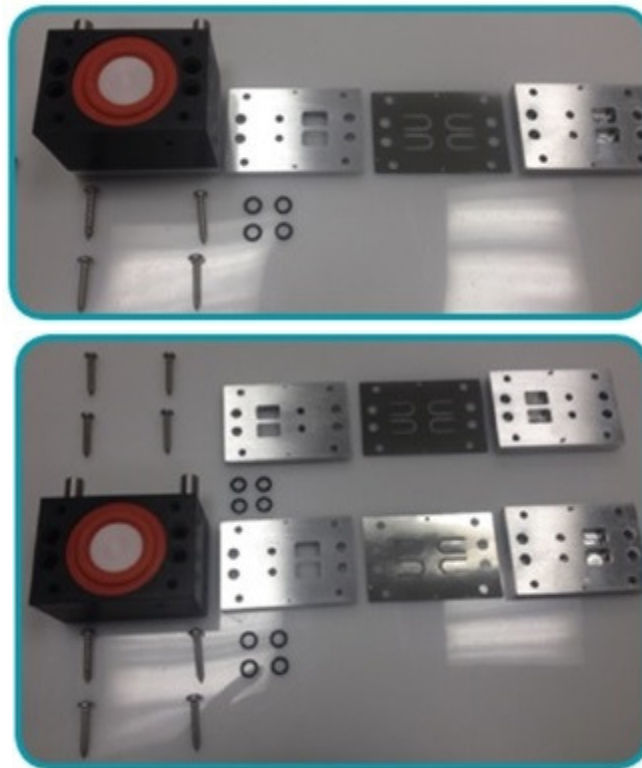


3.2 Valve Removal

Step 3: Before beginning valve disassembly, it is important to note that if improperly assembled, the pump will malfunction and little or no air will be pumped. Mesa suggests drawing a line, or witness mark, across the entire face of the pump body. Doing this will make it very difficult to commit a misalignment error if the marks are exactly aligned during re-assembly. Do not draw

lines on the face containing the motor or the mounting studs.
If the motor also requires replacement after removing the eccentric bearing assembly, also remove the three motor plate screws which secure the motor plate to the motor. The new motor is attached to the plate utilizing the three screws just removed.

Step 4: Starting on either side of the pump, remove 4 screws from the valve upper plate, lift off, and set aside. The valve plate alignment pins are pressed into the plate. Do not attempt to remove them. Carefully remove the valve the valve, which may be lightly adhered to the upper or lower plate. Be extremely careful as this component is very thin. Set aside for inspection. Next, remove the valve lower plate. This component is usually a tight fit and a tool may be required to separate. Set aside, taking care to remove and retain the four O-rings. Repeat the same procedure on the other side of the pump.



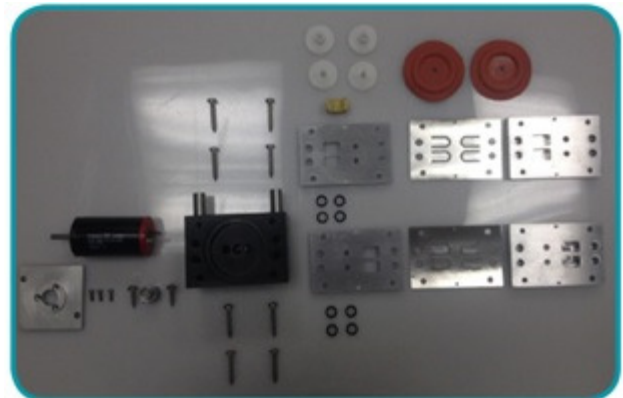
3.3 Valve Inspection

Step 5: All visible metal parts should be bright and clean, completely free of corrosion or dirt. The leaves of the valve should be nearly flat or only slightly curved, and should be free of chips or cracks. If the valves are not perfect, they should be replaced. If they are dirty, they should be carefully wiped clean with a fresh, lint free cloth.



3.4 Diaphragm Removal

Step 6: The diaphragms are removed by grasping the diaphragm retainer between the thumb and forefinger and rotating in a counter-clockwise direction when looking down at it. The other hand is used to grasp the same component on the opposite side. In this manner, one of the retainers may be removed. The remaining retainer is removed by inserting a finger through the bearing hole and forcing the yoke against an inside wall. Set these components aside for inspection. The diaphragms may now be pulled from their recesses.



3.5A Diaphragm Inspection

Step 7: To inspect the condition of a diaphragm, grasp it across its diameter and pull in opposite directions. If any cracks in the surface are observed, the diaphragm must be replaced.

4.0 Re-assembly

4.1 Diaphragm and Yoke Assembly

Step 8: To re-install a diaphragm, insert the retainer into the diaphragm and slide the retainer bushing over the diaphragm retainer shaft. Seize the follower yoke with a pair of long nose pliers and insert it through the drive hole in the pump housing. Align the threaded hole in the yoke, such that the diaphragm assembly may be inserted through its guide hole in the pump body and screwed to the yoke. Grasp the diaphragm retainer between the thumb and forefinger and rotate clockwise until tight. The diaphragm will be lying on top of the pump body. Leave it that way, for

the moment. Prepare the opposite diaphragm assembly and screw it into the yoke, holding each assembly between the thumb and forefinger of each hand. Each diaphragm may now be inserted into its respective recess. The edges of the disks are to be tucked into the recess in the pump body. Looking through the drive hole, align the yoke by eye so that you are looking into the bearing drive recess and align it such that it will receive the eccentric bearing and is parallel to the pump sides and square to the face. Now complete tightening the loose diaphragm retainers to the yoke and check alignment. Now, install the 8 O-rings into the body and set the assembly aside.

4.2 Valve Assembly

Step 9: Lay the valve upper plate outside face down on the work surface. Lay the valve upper plate onto the face using the guide pins for alignment. If it is a used valve and the leaves have curved, be certain that the curve is towards the round holes in the valve plate. Lay the flat surface of the valve lower plate on top of the valve using the guide pin holes for alignment. Check to see that the witness marks are aligned. If not, raise the lower valve plate and re-align. Place the valve assembly onto the pump body. Press it home into the diaphragm recess and align the witness marks on the valve plates with those on the body. Install the four securing screws but do not fully tighten yet. Assemble and install the other valve components to the body in the same manner. All 8 of the valve plate screws may now be tightened.

4.4 Motor Installation

Step 10: Place the motor assembly into the hole in the pump body and rotate it until the bearing engages the opening in the yoke. The motor plate will not lie flat to the body unless the bearing is engaged in the yoke. Once this is accomplished, align the two screw holes in the motor plate to the screw holes in the pump body. Re-install the two motor plate screws. Before fully tightening the screws, centralize the motor plate on the pump body.

5.0 Final Procedure

Re-install the pump in the instrument and set up a run. When the pump comes on, ensure that it is drawing air through the instrument. If not, then the intake and exhaust pipes have been reversed. Place the suction hose onto the suction side of the pump and proceed to verify proper operation.

If witness marks were not properly scribed onto the pump body prior to disassembly, or if several pumps have been disassembled or through malfortune, the valve plates have been improperly installed, refer to Figure P2. Following this figure, carefully, will permit the pump to be reassembled with the air flow paths in the proper direction.

It is highly recommended to run a 24 hour burn in of a rebuilt pump to allow the diaphragms to settle. Not following this procedure may lead to a tendency to draw 10 to 15% higher current during the first 24 hours.

When reinstalling a rebuilt pump for the first time, there may be a delay of up to 30 seconds

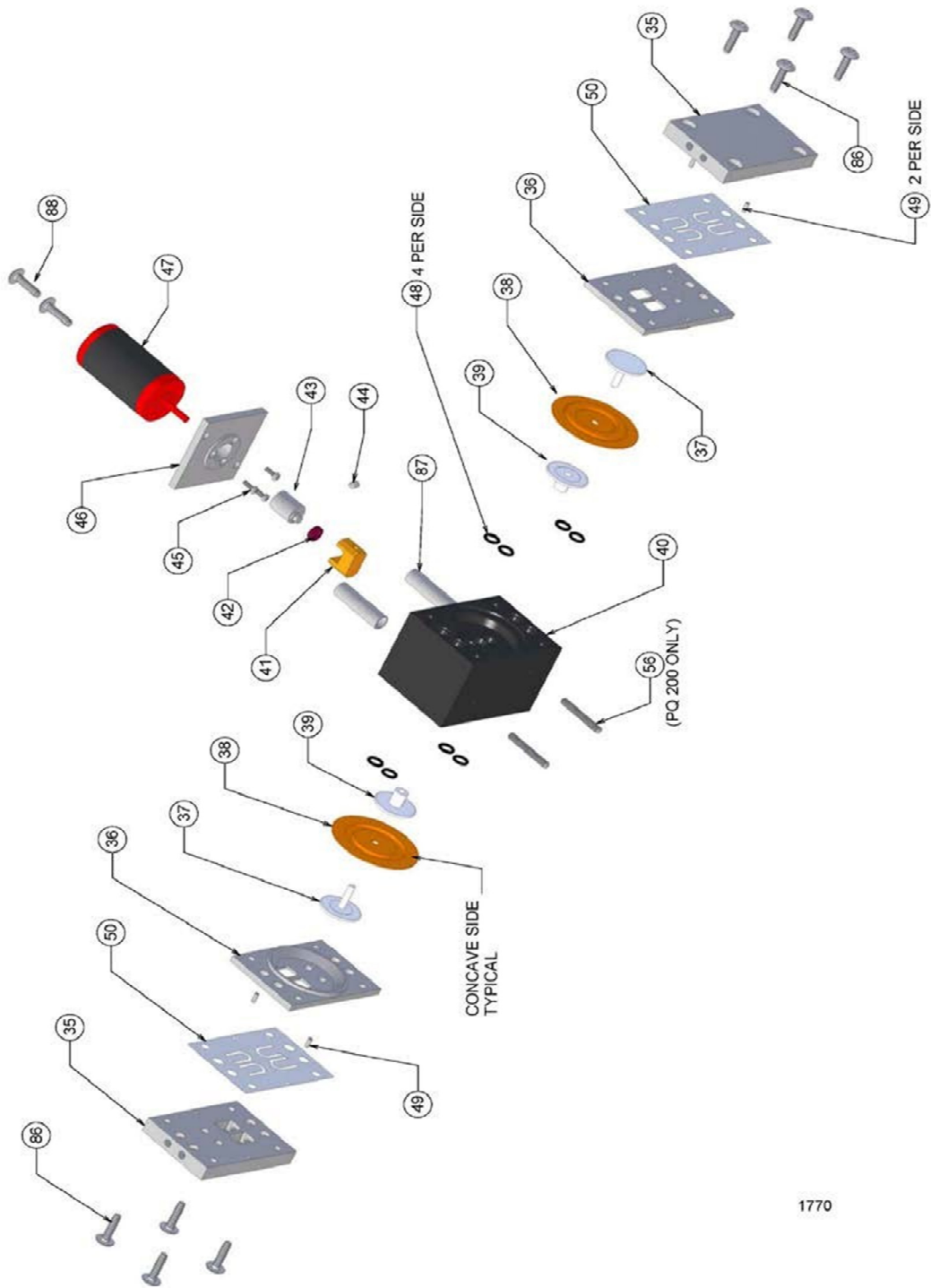
before the pump “turns over”. This is within normal limits but should only occur, if at all, during the first start up. If 30 seconds has been exceeded, shut down at once. The assembly procedures have not been correctly followed.

If the pump runs but there is little or no air flow, check to ensure that one of the valve assemblies has not been reversed. If this has occurred, one side of the pump will be drawing air whilst the other side is pushing. Essentially, the pump is fighting itself. Disassemble and refer to Figure P2.

Recalibration of a PQ100/200 is not required after the replacement/rebuilding of a pump. However, in following good practice it is always wise to verify flow calibration after replacing a major component.

Table 1 List of PQ 100/200 Pump Parts

<u>DET.#</u>	<u>QTY</u>	<u>FIG.</u>	<u>PART #</u>	<u>DESCRIPTION</u>
35	2	1	B1292	Valve Upper Plate
36	2	1	B1293	Valve Lower Plate
37	2	1	A1288	Diaphragm Retainer
38	2	1	A2187	Diaphragm
39	2	1	A1289	Diaphragm Retainer Bushing
40	1	1	B1283	Pump Housing
41	1	1	A1287	Follower Yoke
42	1	1	DDRI-6632	Bearing
43	1	1	A1294	Eccentric
44	1	1	SC0105	M4 X 4mm Set Screw
45	3	1	SC0106	M2.5 X 8mm Cheese Head Screw
46	1	1	A1290	Motor Mount
47	1	1	PQMOTOR	Motor
48	8	1	BUNA010	O-Rings
49	4	1	A1402	Locating Pins
50	2	1	B1408	Valves
86	8	1	SC1014	# 8 X 1 Sheet Metal Screws
87	2	1	A1403	Pump Tubes
88	2	1	SC1013	#8 X 5/8 Sheet Metal Screws



1770

Figure P1 – PQ200 Pump Exploded Drawing

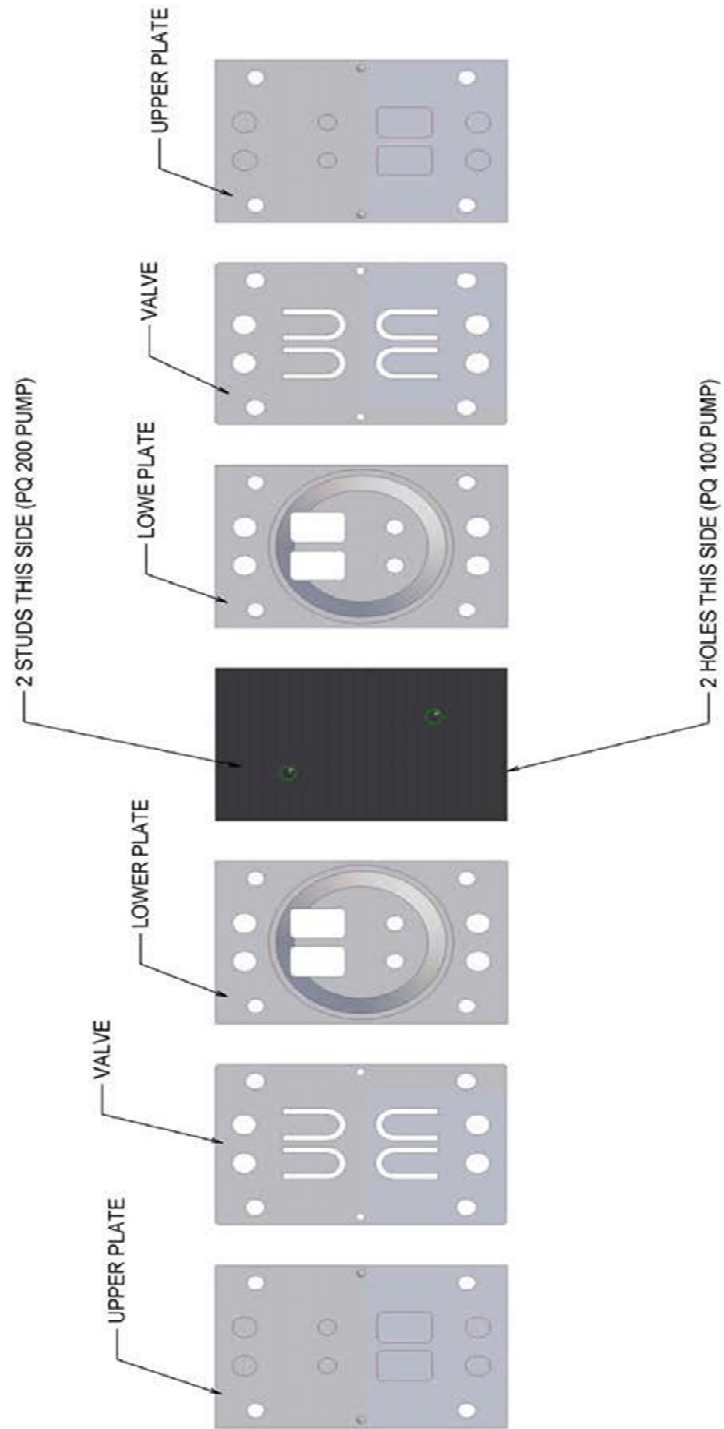


Figure P2 – Orientation of Valve Plates

Appendix Q

Revision T Manual (Obsolete)

For sections not included in this appendix see manual main sections.

2.0 Instrument Description

The PQ200 control panel and screen are menu driven for ease of operation. Complete control of the sampler is achieved through only six buttons:



The buttons have these typical functions:

- ON/OFF:** powers the PQ200 on and off
- (arrows):** moving from one menu item to the next, up or down; cycling through options
- SELECT:** chooses the current selection
- (blank):** optional; when available, its function is shown on the screen just above it
- LIGHT:** lights the screen (only necessary when the sampler is using battery power)

5.0 Setup

5.3 Setting Date and Time

1. From the Main menu, use the arrow keys until * **Set-Ups and Download** flashes. Press **SELECT** to enter the Set-ups and Download menu.
2. From the Set-Ups and Download menu, with * **More Selections** flashing, press the down arrow until * **Set Date and Time** flashes. Press **SELECT**.
3. The **Set the current DATE and TIME** message will be displayed. The current date and time will be flashing.
4. Press **SELECT (NEXT)**. The first value (date) will stop flashing (it can now be edited).
5. Use the arrow (**EDIT**) buttons to increase or decrease the selected value. When done press **SELECT (NEXT)**.
6. Continue to press the **SELECT (NEXT)** and arrow (**EDIT**) buttons in this fashion to enter the desired date and time. When done, press the blank (**EXIT**) button to return to the second Set-Ups and Download screen. Select * **More Selections**, then * **Return to Main Screen** or press the blank (**EXIT**) button.

5.4 Entering Site and Filter Information (optional)

1. From the Main menu, use the arrow keys until * **Set-Ups and Download** flashes. Press **SELECT** to enter the Set-ups and Download menu.
2. From the Set-Ups and Download menu, with * **More Selections** flashing, press **SELECT** to view the next screen of the menu.
3. From the next screen, use the arrow keys until * **Enter Site and Filter Information** flashes. Press **SELECT**.
4. The - **USER INFO** - message will be displayed. The data area of below this message is blank. The first character (**T**) of the second line has a flashing cursor on it.
5. Use the arrow (**EDIT**) buttons to cycle through the possible characters. To select the flashing character and move to the next character, press **SELECT (NEXT)**. When all information has been entered, press the blank (**EXIT**) button to return to the Set-Ups and Download menu.

NOTE: The site and filter information may also be entered using the PQ200 computer software program. Refer to Appendix H.

6.0 Operation

6.2 Run the Sampler with User Defined Start/Stop Times

If the procedure in Section 2.3.1 does not fit the intended sample cycle, the operator can program his/her own Start and Stop times as follows. As above, data from a previous run should be downloaded prior to use of this function. However, the instrument will alert the operator if the data has not been downloaded.

- From the Main menu, use the arrow keys until * **Setups and Download** flashes. Press **SELECT**.

From the Set-Ups and Download menu, use the arrow keys until * **Run w/ User Defined Start/Stop** flashes. Press **SELECT**.

- The **Set the sample Start Date and Time** message will be displayed. The current selection will be flashing on the second line.
- Press **SELECT (NEXT)**. The first value (Day of the Month) will stop flashing, indicating it can be edited.
- Use the arrow (**EDIT**) buttons to increase or decrease the selected value. When done press **SELECT (NEXT)**.
- Continue to press the **SELECT (NEXT)** and arrow (**EDIT**) buttons in this fashion to enter the desired date and time.
- When done setting the start date and time, press the blank (**EXIT**) button to continue. If the unit has been previously downloaded, the following message will be displayed;

Clearing Memory. Please Wait!

- The **Set the sample STOP DATE and TIME** message will be displayed. The current selection will be flashing on the second line.
- Use the same procedure to set the stop date and time. When done, press the blank (**EXIT**) button to return to the Set-Ups and Download screen. Select * **More Selections**, then * **Return to Main Screen**.

6.4 Temporary Halt Then Continue Sampling

According to EPA rules for PM_{2.5} sampling, a 24-hour sample may be temporarily halted for up to 10 minutes and still remain a legitimate sample. In the event that it may become necessary to temporarily halt a sample in progress, a feature has been incorporated into the PQ200 program that allows the sample run to be halted and later resumed.

To halt the sampler, simply press the **ON/OFF** button. The unit will jump to the Main menu and will display the message;

Halted by Operator!

To continue with the current sample run;

- From the Main menu, use the arrow keys until * **Setups and Download** flashes. Press **SELECT**.
- From the Set-Ups and Download menu, use the arrow keys until * **Continue with Current Run** flashes. Press **SELECT**.

The sampler will then resume the run. However, observe that the elapsed time did not change while the unit was halted. At the end of the 24 hour sample period, if elapsed time is less than 23 hours 50 minutes, the **T** flag will be displayed indicating that the run did not meet EPA requirements for run length.

6.6 Data Download Instructions

6.6.1 Data Download Using the PQ200 Menu

After the sampler has completed its run, the data is available for download. To download the data using the menu on the updated PQ200, follow the steps below:

8. Connect a RS-232 or USB type B cable between the PC and PQ200.
9. Open a TeraTerm terminal (a free software available online) and set up the following serial communication settings:
 - a. Click on the "Setup" drop down menu and select the serial port.
 - b. Set the required settings:
 - i. Baud rate: 9600
 - ii. Data: 8 bit
 - iii. Parity: none
 - iv. Stop: 1 bit
 - v. Flow control: none
 - vi. Transmit delay: 0 msec/char and 70 msec/line
 - c. Click "OK"
10. Turn the PQ200 on
11. Press **SELECT** to enter the main menu
12. Use the **UP/DOWN** buttons to navigate to the "**Download Now**" menu and press **SELECT**
13. Using the **UP/DOWN** buttons, navigate to the desire communication interface (RS-232 or USB-B)
14. Initiate the data transfer to the terminal by pressing **SELECT**. While the data transfers, the LCD display will show "Downloading!"

6.6.2 Data Download Using Serial Communication Commands

After the sampler has completed its run, the data is available for download. To download the data using serial communication commands, follow the steps below:

5. Connect an RS-232 cable between the PC and PQ200

6. Open a window Using HyperTerminal or similar program (TeraTerm is a free software available online) and set up the following serial communication settings:
 - a. Click on the "Setup" drop down menu and select the serial port
 - b. Set the required settings:
 - i. Baud rate: 9600
 - ii. Data: 8 bit
 - iii. Parity: none
 - iv. Stop: 1 bit
 - v. Flow control: none
 - vi. Transmit delay: 0 msec/char and 70 msec/line
 - c. Click "OK"
7. Turn the PQ200 on
8. Send the following serial communication command to the PQ200 using the terminal program:
 - ?L - dump logger data
 - ?S - dump summary log

6.6.3 Data Download Using USB On-The-Go (OTG) Flash Drive

Not Applicable

6.6.4 PQ200 Job Controller Software for Windows

When the sampler has completed its run, the data may be downloaded from the PQ200. Be sure to download the most recent run before setting the sampler to start another run.

To extract the run data, a computer with the PQ200 Downloader software loaded and a female-female serial cable are required. Section 4.0 also contains greater detail about the other features of the PQ200 Job Controller software.

- Using a serial (9-pin) cable (female-female), connect the PQ200 sampler to a computer with the PQ200 Job Controller Program.
- Open the PQ200 Job Controller Program.
- Click on the "File" menu in the top menu bar, select new, and "New". The new job screen will open. Enter the appropriate information as needed and click "Save".
- A "Save As" screen will open with a default file name of today's date. This file name may be changed by operator if needed.
- Click "Save" and a download screen will open.
- Go to the top menu bar and click on "Download". A new window will open. Click on "Begin".
- When data stops scrolling, the download is complete. Click on "Return"
- Data will now appear on the download sheet. At this point all data has been saved.

6.6.5 Download without the software tool

For those who wish to use standard communication software packages, like HyperTerminal, to retrieve data from the PQ200 sampler, the communication parameters are 9600 baud, 8 bit data word, no parity, 1 stop bit.

Open the communication software package and attach the 9-pin female-female serial cable to both the computer and the PQ200.

Select **Download Now** from the PQ200 Menu and the entire summary and logger download will be sent. To obtain just the summary data, use the software package to transmit the character string ?S to the PQ200 and the summary data will be downloaded to the computer. To obtain just the logger data, transmit the character string ?L.

For further information on communication packages like HyperTerminal, contact us at csbutler@mesalabs.com.

7.0 Calibration

7.2 Temperature Probe

7.2.1. Verifying Temperature

You will need a NIST-traceable thermometer, such as that included with the BGI deltaCal calibrator, for both the verification and calibration of the PQ200 temperature probes.

To verify the ambient temperature sensor, allow the temperature probe to reach equilibrium with the ambient air. The ambient temperature is displayed on the main screen of the PQ200. Insert the calibration probe into the radiation screen. Adjust the trimpot on the motherboard using a small slotted screwdriver until the PQ200 reading matches the traceable thermometer.

To verify the filter temperature sensor, open the filter assembly and remove the filter cassette if present. Put the traceable thermometer as close as possible to the filter temperature probe without touching the two sensors. Adjust the trimpot on the motherboard using a small slotted screwdriver until the PQ200 reading matches the traceable thermometer.

See the figure below for the location of the two trimpots on the electronic board.

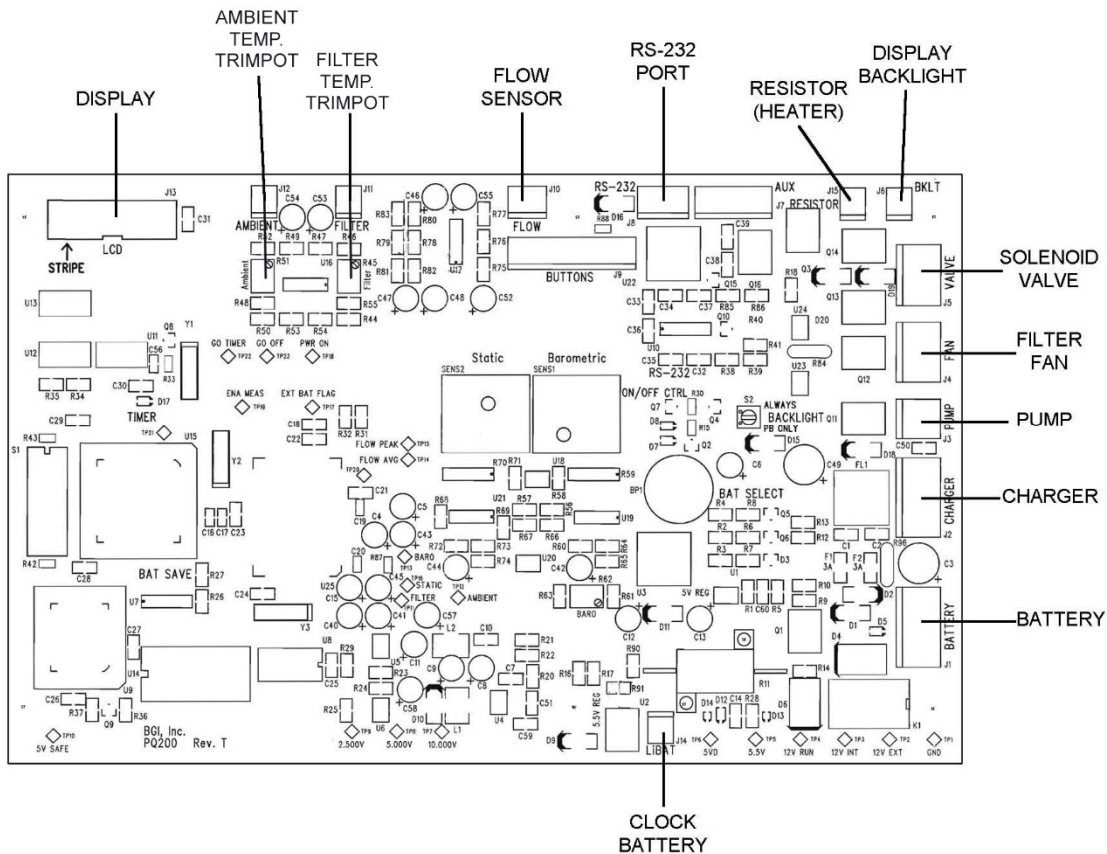


Figure Q1. Location of temperature probe trimpots on Rev T PCB

7.2.2 Calibrating Temperature

The U.S. EPA recommends an annual multi-point temperature calibration. We recommend that you perform this calibration in the lab rather than the field. The same procedure should be followed for both the ambient and filter temperature sensors.

Remove the temperature probes from their housings but keep connected to the sampler. Prepare three containers for an ambient, cold, and hot temperature baths. For the ambient bath, fill a container with tap water and let equilibrate at room temperature for several hours. For the cold bath, use crushed ice in water. Note, during the cold test, do not let the probe tip hit a piece of ice because it will give an inaccurate reading. For the hot bath, use a temperature that is appropriate for the ambient temperature range in your area.

For each test, insert the probe into the baths along with a partial immersion thermometer. You should always perform an ambient test between the cold and hot to allow the probe to re-equilibrate easier.

Perform any adjustments as needed using the trimpots as described above to match the NIST-traceable probe to the PQ200 probe.

7.3 Barometric Pressure

7.4.1 Pressure Calibration and Verification

You will need a NIST-traceable barometer, like that included with the BGI deltaCal calibrator. Compare the ambient pressure reading on the PQ200 main screen with the pressure reading on the traceable barometer. If pressure differs by more than 10 mmHg, adjust the PQ200 pressure reading. Use a small slotted screwdriver to adjust the screw on the barometric pressure trimpot (labelled in the drawing above).

When the BP on the display of the PQ 200 matches the barometer, stop and wait 15-30 seconds to make sure it has settled. Repeat last step if needed.