

USER MANUAL

LVS -100

Low Volume Air Sampler

Version 1.6



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Met One Instruments is now part of the Acoem Group. The Met One range of gas analyzers was originally developed by Acoem under the brand name Ecotech MicroVol 1100.

For the purposes of expediting the availability of Met One gas analyzers to Met One customers around the world; Met One Instruments have chosen to use the original Ecotech MicroVol 1100 operating manual.

Although the name of the Met One instrument is different, the analyzer itself has remained unchanged and meets the strictest quality and performance requirements expected of Met One equipment. All the information presented in this manual is current, including analyzer specifications and operating principles.

Met One will update this manual to reflect the new branding convention in due course.

Manufacturers statement

Thank you for selecting the MicroVol-1100 Low flow-rate Air Sampler. The MicroVol-1100 is designed primarily as a stand alone portable particulate sampler and should give many years of trouble free service if installed, used and maintained correctly. By following the guidelines contained in this manual and with the implementation of a good quality-assurance program, the user can obtain accurate and reliable particulate concentration data. Please ensure that you read the safety and warranty details as they contain important information for the user. If, after reading this manual you have any questions or you are still unsure or unclear on any part of the NUT-1000 then please do not hesitate to contact Ecotech.

Ecotech also welcomes any improvements that you feel would make this a more useable and helpful product then please send your suggestions to us here at Ecotech.



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WARNING

Safety requirements

- To reduce the risk of personal injury caused by electrical shock, follow all safety notices and warnings in this documentation.
- If the equipment is used for purposes not specified by Ecotech, the protection provided by this equipment may be impaired.
- Replacement of any part should only be carried out by qualified personnel, only using parts specified by Ecotech. Always disconnect power source before removing or replacing any components.

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1. your name, telephone number and Facsimile number
2. Your company name
3. The model number or a description of each item
4. The serial number of each item, if applicable
5. A description of the problem or the reason you are returning the equipment (eg, sales return, warranty return, etc)

If you are required to return the equipment an accompanying document with:

1. Your name, number and Facsimile number
2. Your company name with return shipment
3. The model number or a description of each item
4. The serial number of each item, if applicable

A description of the problem/reason you are returning the equipment

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2. The following documents are necessary to support claims:
 - a. Original freight bill and bill lading
 - b. Original invoice or photocopy of original invoice
 - c. Copy of packing list
 - d. Photographs of damaged equipment and container

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Shipping Discrepancies

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Manual Revision History

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1 Introduction

1.1 Description

The MicroVol-1100 Particulate Sampler provides a flexible platform for sampling of PM₁₀, PM_{2.5} or TSP particulate and for monitoring basic meteorological parameters. Incorporating a pump, filter holder and flow control circuit, the sampler is microprocessor based and features internal data logging of flow and meteorological parameters.

The MicroVol-1100 constantly monitors the 'mass flow rate' of air passing through the filter and pump. This mass flow is computed with the ambient pressure and temperature sensor measurements to calculate the volumetric flow rate (e.g. 3L/min). variation in pump vacuum is The pump is a linear diaphragm pump and the correct flow rate is maintained by varying the amplitude of diaphragm movement, this changes the vacuum created by the pump, more vacuum for more filter loading.

The MicroVol-1100 incorporates Active Volumetric flow control which mediates pump speed and air velocity to guarantee a constant sampling flow-rate no matter the filter loading of restrictions in place.

The MicroVol-1100 is designed to operate from a 12 VDC power supply. It can be powered from a variety of different sources, including the AC mains power adaptor, an optional battery pack, or solar panel and battery combination.

The MicroVol-1100 incorporates ambient temperature, pressure and humidity sensors, which are used to automatically maintain a constant volumetric flow-rate of typically 3 litres per minute (l/min) through a 47mm-diameter circular filter.

The MicroVol-1100 includes the facility to monitor wind speed and direction, using an optional external wind sensor. Wind speed and direction data are averaged and stored in internal memory, and may be used as triggers for conditional sampling.

The MicroVol-1100 also incorporates a time clock and programmable timer enabling multiple time based sampling programs to be configured.

The MicroVol-1100 internal data logger stores time based data averages at user selectable intervals. The data includes date and time stamp, flow-rate, total sample volume, average temperature, barometric pressure, and either wind speed and wind direction or rain-fall information. Data values stored in the MicroVol may be downloaded via the RS-232C Serial port.

The MicroVol-1100 is extremely quiet allowing it to be used at indoor sampling locations to assess human exposure to particulate matter (PM), and is housed in a weatherproof enclosure for outdoor sampling in a range of environments.

Some typical sampling applications include:

- Sample collection at surface mines
- Fence line sampling
- Saturation sampling to determine gradients in PM concentration
- Indoor air quality studies for health and safety
- Locations where mains power is unavailable

Sampler features

- Active volumetric flow control
- Internal data logging
- Sampler setup via four-line LCD display and keypad
- Sampling procedure can be programmed through specific time periods from the hour, the day and the day of week, as well as the calendar dates it will run between
- Conditional sampling based on wind speed and direction
- Ultra-efficient, long life pump designed for flow rates of 1 to 4.5 l/min¹
- Low power consumption
- Optional solar panel and battery operation.
- Auto pump shut-down when voltage is low to protect battery
- Light-weight rugged weather-proof construction and low noise operation suits indoor and outdoor operation
- Precision flow controller ensures flow-rate control within 1% of set-point
- PM₁₀ & TSP Sampling inlet (standard), PM_{2.5} inlet adaptor (optional extra), includes rain cap and insect mesh for outdoor use
- Optional dual-stage filter pack can collect particulate matter and gaseous compounds on separate filters:

Example: First stage collects fine particulate, inorganic anion concentrates or acidic particulate; Second stage collects non-reactive gases.

¹ The PM₁₀ Inlet must operate at flow rate of 3.0 l/min to achieve the specified cut-point

1.2 Specifications

1.2.1 Flow Control

Volumetric flow-rate range ¹ :	1 – 4.5 l/min
Flow accuracy:	2% of reading
Flow repeatability:	0.5% of reading

1.2.2 Inlet Assembly

Inlet Assembly material:	Anodised aluminium
Size Selective Inlets:	PM ₁₀ (standard), TSP (pending)
PM _{2.5} adaptor (option)	
Cut-point:	50% cut-point at 3 l/min volumetric flow-rate
Filter holder material:	Polycarbonate
Filter element:	Ø47mm Polypropylene-ringed circular filter (various materials and pore sizes available)

1.2.3 Operating environment

Ambient temperature range:	0 to +45°C
Temperature accuracy:	±1°C
Barometric pressure range:	600-900 mm Hg (Torr) (800-1200 hPa)
Barometric Pressure accuracy:	±4 mm Hg (Torr)

Note: Avoid corrosive, salty, or excessively humid environments where possible.

1.2.4 Construction and Dimensions

Housing:	PVC plastic, with rubber feet and weatherproof cap
Case dimensions:	300 mm (height) x 170 mm (diameter)
Sample tube length:	500mm (1000mm option or other lengths available)
Inlet height (approx.):	600mm (standard)
Weight:	3.75 kg with mains power adaptor 8.15kg with battery pack option

1.2.5 Power

Operating Voltage:	11-15 VDC (12VDC nominal)
Power consumption (typ.):	2.5 – 3 watts (210 mA @ 12 VDC) Using clean Teflon filter with support ring, 2µm pore size, 3l/min
Power consumption (max.):	6 watts (500 mA @ 12 VDC)
Power consumption (standby):	0.6W (50 mA @ 12 VDC)
Power connector:	2.5mm DC connector Centre (+), outside (-)
Power sources:	Mains power adaptor (standard) Battery pack (optional) Solar panel battery charger (optional)
Low voltage cut out:	At 11VDC, auto reset @ 12VDC (adjustable)

1.2.6 Accessories

Standard:	PM ₁₀ Size Selective inlet Single filter holder 100-240VAC to 12 VDC power pack
Optional:	Double filter holders Battery pack for 24 hour sampling Solar Panel & regulator PM _{2,5} Inlet Adaptors

1.2.7 Battery Pack option

Nominal Voltage:	12VDC
Nominal capacity:	12Ah at 20hr discharge rate of 600mA
Operation capacity:	At least 24 hours, up to 48 hours depending on filter loading, filter material and flow-rate (using a fully charged battery)
Fuse:	3.15A, M205 type (20x5mm)
Charge retention (shelf life) at 20°C:	
1 month	97%
3 months	91%
6 months	85%

Life expectancy vs depth of discharge (d.o.d.):	
100% d.o.d.	250 cycles (approx.)
50% d.o.d.	550 cycles (approx.)
30% d.o.d.	1500 cycles (approx.)
Battery charger type:	12V sealed lead-acid battery charger
Charging voltage:	14.4 – 15.0 VDC
Max. charge current:	2.5A
Charger connection:	Waterproof connector with cover, dotted pin (+)
Features:	Clips to underside of MicroVol Weather-proof construction
Dimensions:	185mm (height) x 170mm (diameter)

1.3 Nomenclature

SSI: Size Selective Inlet, used to sample particulates of a given Equivalent Aerodynamic Diameter (PM_{10} , $PM_{2.5}$).

TSP: The TSP (Total Suspended Particulate) includes all suspended particulate matter.

PM_{10} : The PM_{10} includes all particulates of an Equivalent Aerodynamic Diameter (EAD) of 10 microns or less.

$PM_{2.5}$: The $PM_{2.5}$ includes all particulates of an Equivalent Aerodynamic Diameter (EAD) of 2.5 microns or less.

PPM: Parts Per Million

1.4 Background/ Theory

1.4.1 Particulate Sampling

The MicroVol is designed primarily as a particulate sampler. The MicroVol pump and flow controller draws a sample of air through a specially prepared filter. The filter collects the airborne particles for analysis. The MicroVol controls the flow-rate and records the volume of air that has been sampled.

The airborne suspended particles are collected on a pre-weighed filter over a pre-determined period. After the sampling period is complete, the filter is removed and re-weighed to determine the concentration and/or composition of suspended particulate. Concentration results are typically expressed in micrograms per cubic metre ($\mu\text{g}/\text{m}^3$) of air sampled at standard temperature and pressure conditions.

Acceptable levels have been established to govern the amount of airborne particulate of a particular size and composition that may pose a health hazard to humans.

The MicroVol-1100 utilises a size-selective inlet to restrict the sampled particulate to being that of a designated size or smaller.

- A PM_{10} sample inlet restricts the collected particulate to that with an aerodynamic equivalent diameter (AED) of 10 microns or less.
- A $\text{PM}_{2.5}$ sample inlet similarly restricts the collected particulate to that with an aerodynamic equivalent diameter (AED) of 2.5 microns or less.
- A TSP (Total Suspended Particulate) sample inlet, ideally, samples all suspended particulate matter. However, it should prevent unusually large particles and insects from being collected on the filter element.

1.4.2 Principle of operation of size selective inlets

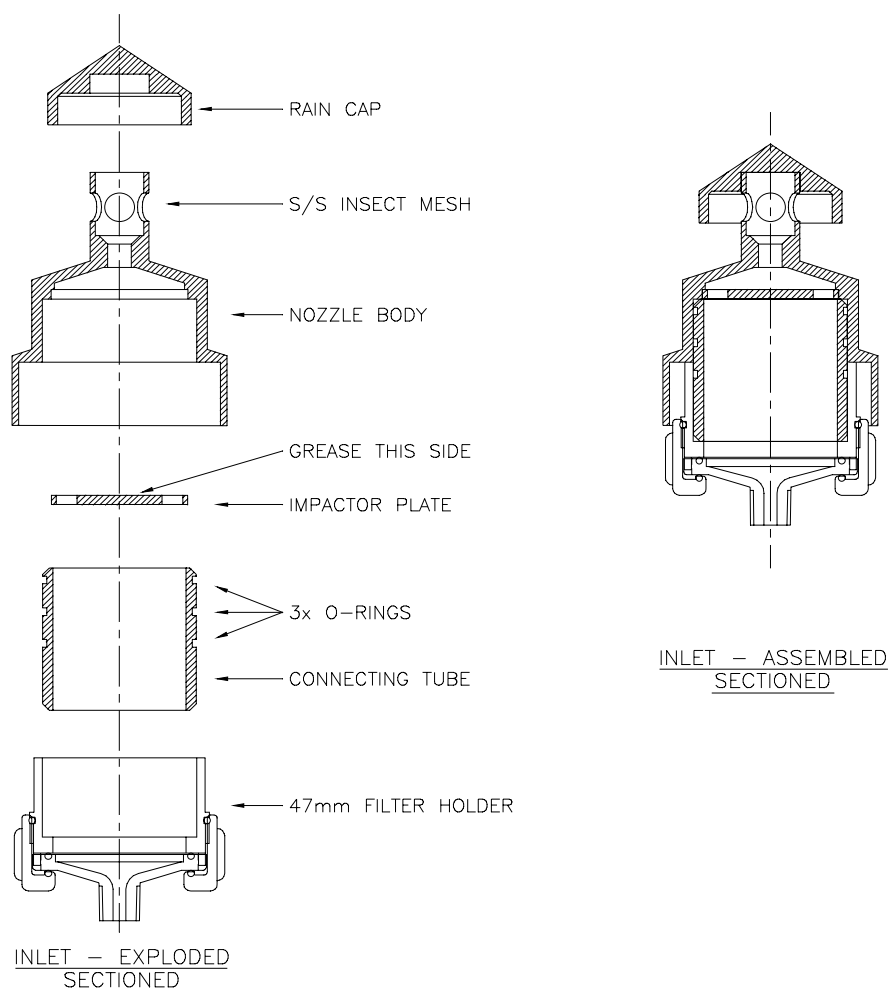


Figure 1 MicroVol-1100 Inlet Assembly

The MicroVol-1100 inlet has been developed, tested and calibrated by the Australian CSIRO Division of Atmospheric Research.

The size-selective inlet is of the impaction type. Ambient air enters the Inlet Assembly via a rain cap and Stainless Steel insect mesh screen that prevent contamination of the sample by precipitation and large debris. The air is funnelled through an acceleration nozzle where it is directed towards a flat impaction plate that sharply diverts the airstream. Particles larger than the size cut-point tend to be heavier and hit the impaction plate where they are trapped. Smaller particles remain airborne and continue into the sampler. The size cut-point is affected by airstream velocity / flow-rate, acceleration nozzle diameter, and particle density, composition and shape.

Ambient air is drawn into the size-selective inlet at a constant flow-rate in order to maintain the size cut-point. To achieve this, the MicroVol-1100 uses a volumetric flow-rate controller. The flow rate must be set to 3.0 l/min to achieve the correct particle size cut-point. This flow rate is the same for PM₁₀ and PM_{2.5} measurements.

The standard inlet consists of a PM₁₀ nozzle body, impactor plate, rain cap and connecting tube with o-ring seals. The PM₁₀ nozzle body incorporates a filter holder shroud and insect screen. An optional nozzle insert is available for PM_{2.5}

measurements. The impactor plate can be removed to closely approximate TSP sampling.

1.5 Instrument description

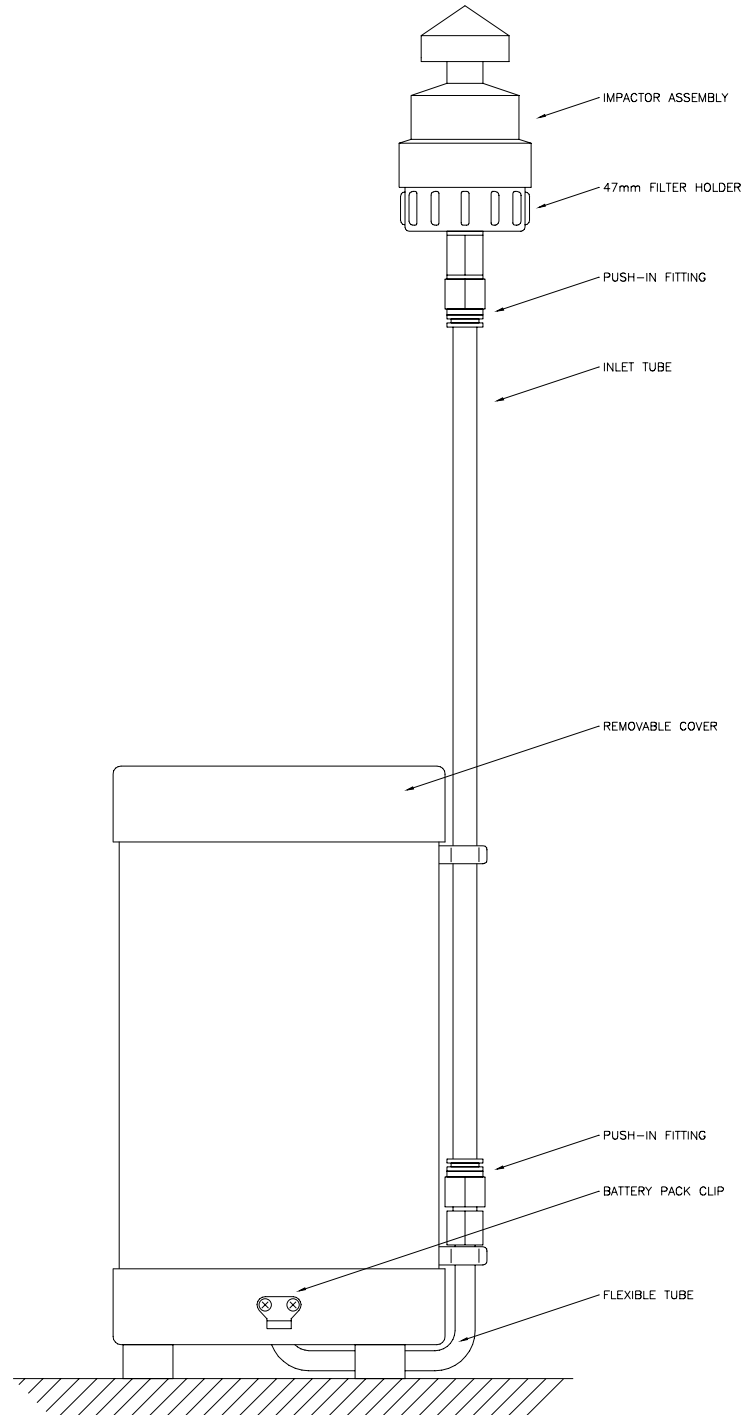


Figure 2 MicroVol-1100 components layout

Note: All parts, especially the impactor assembly, filter holder and inlet tube, must be clean and completely dry before assembly.

Note: The impactor must be greased prior to use – see Section 6.3.2 for details.

1.5.1 Inlet tube

The inlet tube is removed during transportation. Remove the seal caps from the inlet tube. Put the seal caps in a safe place for future transport. Check that the insides of the inlet components (aluminium inlet tube, filter holder and impactor assembly) are free of packing foam. Make sure the tube is clean and dry internally before fitting it to the sampler.

Insert one end of the tube into the orange push-in fitting near the base of the MicroVol-1100. Once initial resistance is felt, push the inlet tube into the fitting a further 5-10mm to make a gas-tight seal. Then clip the tube to the side of the MicroVol-1100. Put one of the seal caps on the top of the tube until the filter holder / impactor assembly is ready to be attached. Keep the caps for future transportation.

1.5.2 Filter holder/impactor assembly

Detach the blue filter holder from the metal impactor assembly. Disassemble the filter holder; install a filter in the filter holder, then re-assemble the filter holder and impactor assembly. The filter holder and impactor assembly fit together as shown in Figure 1. Make sure that the parts are pushed together and sealed correctly.

Remove the cap from the upper inlet tube and install the filter holder/impactor assembly on top of the tube. Once initial resistance is felt, push the assembly down another 5-10mm to make a gas-tight seal on the sample tube.

2 Installation

Important:

- A clean 47mm filter should always be installed in the filter holder before applying power.
- Always operate the MicroVol-1100 with the rain cap installed on top of the Inlet Assembly – refer to Figure 1.
- Do not expose the MicroVol-1100 to excessive amounts of water splashing or spray. Avoid excessively humid environments if possible.
- Keep the MicroVol-1100 away from corrosive environments including salt water.

2.1 Connecting Equipment to the Wind Speed and Direction Input Plug

The Wind Speed and Direction Input Plug is a 6-pin connector located on the underside of the MicroVol.

One of the following external devices may be connected to the Input Plug Note: It is not possible to connect more than one of the following at any one time. The MicroVol is easily configured to accept these inputs.

- Wind speed/direction sensor
- Remote external Trigger
- Rain gauge

2.1.1 Connecting a Wind sensor or Rain-gauge

The wind speed and direction sensor and tipping bucket rain gauge are optional accessories. The cables may be ordered separately, and can be manufactured to any length specified. Either cable connects to the socket on the underside of the MicroVol. A weatherproof cover is fitted to the socket to exclude dirt and moisture. This cover should be removed only when a cable is connected to the socket.

Mounting hardware is included. The wind sensor includes a 1.2m cross arm and rotating adaptor for aligning the sensor to true North. The rain gauge includes a bracket, which may be mounted to a 25-50mm pole (either vertical or horizontal).

The MicroVol is factory configured for the wind sensor input (default configuration). If a rain gauge is used, the configuration should be changed. Refer to the Hidden Menu section for details of how to set up the MicroVol for rain gauge or wind sensor input.

2.1.2 Connecting an External Trigger for remote activation

Refer to section 3.3.2.3 for details on how to setup the Trigger menu for remote activation.

The external trigger voltage must be between 0 and 5v. If using a contact closure to trigger the MicroVol then the signal must be pulled up to +5v with a 4.7kOhm resistor. +5V Pullup, ground and Trigger input are available on the external trigger cable.

Ensure the Trigger Signal to Trigger Ground voltage does not exceed 5V. To prevent damage to the MicroVol, opto-isolated or relay contacts are recommended to connect the triggering device to the MicroVol.

Refer to the cable diagram for further details.

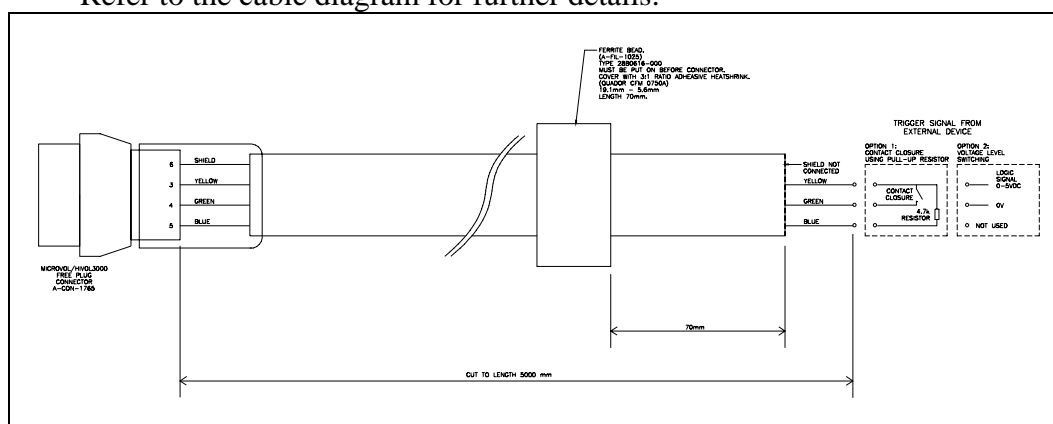


Figure 3 External Trigger Output

2.2 Installing the MicroVol-1100 for indoor sampling

Attach the MicroVol-1100 to a power-outlet that will not be needed for other purposes, so that the power supply to the Micro-Vol 1100 will not be disturbed.

The sampler should be located in a position that will allow it to collect a sample representative of the area of interest, without being influenced by any non-typical factors. The MicroVol-1100 may be placed on a table away from any source of particulate accumulation such as a wall, corner of room, or near an exhaust or inlet. It may be advisable to remove or switch the MicroVol off while vacuum cleaning is taking place, as unusually high dust levels will be present. Consult the relevant local standards for further information on siting air samplers.

2.3 Installing the MicroVol-1100 for outside sampling

Attach the MicroVol main tubular housing securely to a post, preferably elevated so that rain can not splash up underneath the sampler. An outdoor mounting bracket kit is available. The rechargeable battery pack (option) is recommended for use outdoors. Note: The standard mains power adaptor, and the mains powered battery charger are not weatherproof and are not suitable for use outdoors.

Although the MicroVol-1100 is housed in a weatherproof enclosure, it should be protected from moisture as much as possible. Water must not be allowed to enter the inlet, filter holder, or inlet tube. Inlet components must be dried before removing them (ie. when changing filters). Do not change the filter in wet conditions or if there is

moisture visible on the inlet components. Always cover the inlet tube when the impactor assembly and filter holder are removed outdoors.

The sampler should be located in a position that will allow it to collect a sample representative of the area of interest, without being influenced by any non-typical factors. For outdoor use, keep the sampler away from obstacles such as trees, exhaust and inlet ducts, edges of buildings, etc. Consult the relevant local standards for further information on siting air samplers.

2.4 Connecting power

2.4.1 Mains power adaptor

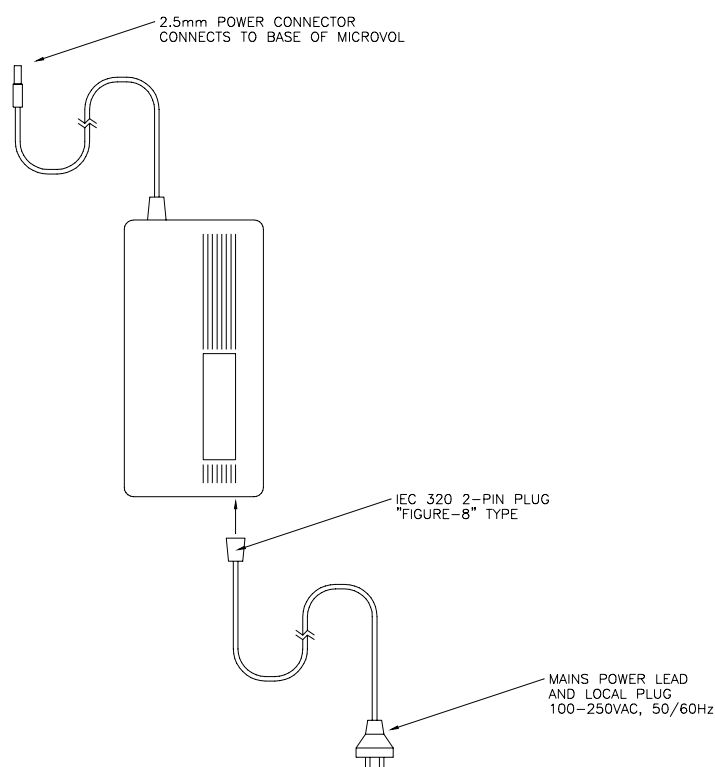


Figure 4 Mains power adaptor

Attach the power connector to the underside of the MicroVol-1100. Switch on the power to the mains adaptor at the wall-socket.

The Mains power adaptor has an IEC 320 2-pin connector. It may be necessary to purchase an input lead to suit the local power point outlet configuration.

The Mains power adaptor operates on most AC power supplies, from 100-240V, and either 50 or 60 Hz.

2.4.2 Connecting power – Battery pack option

If the battery pack is being used, first connect the power lead to the underside of the MicroVol-1100. Then centre the MicroVol-1100 on top of the battery pack. The latch tension may be adjusted if necessary by turning the threaded part of the latch. Do not

over-tighten the latches. The latch tension should be approximately equal on both sides. Check this with the latches released. The latches should both project downwards at about 45°. Fasten the latches to secure the battery pack to the MicroVol 1100.

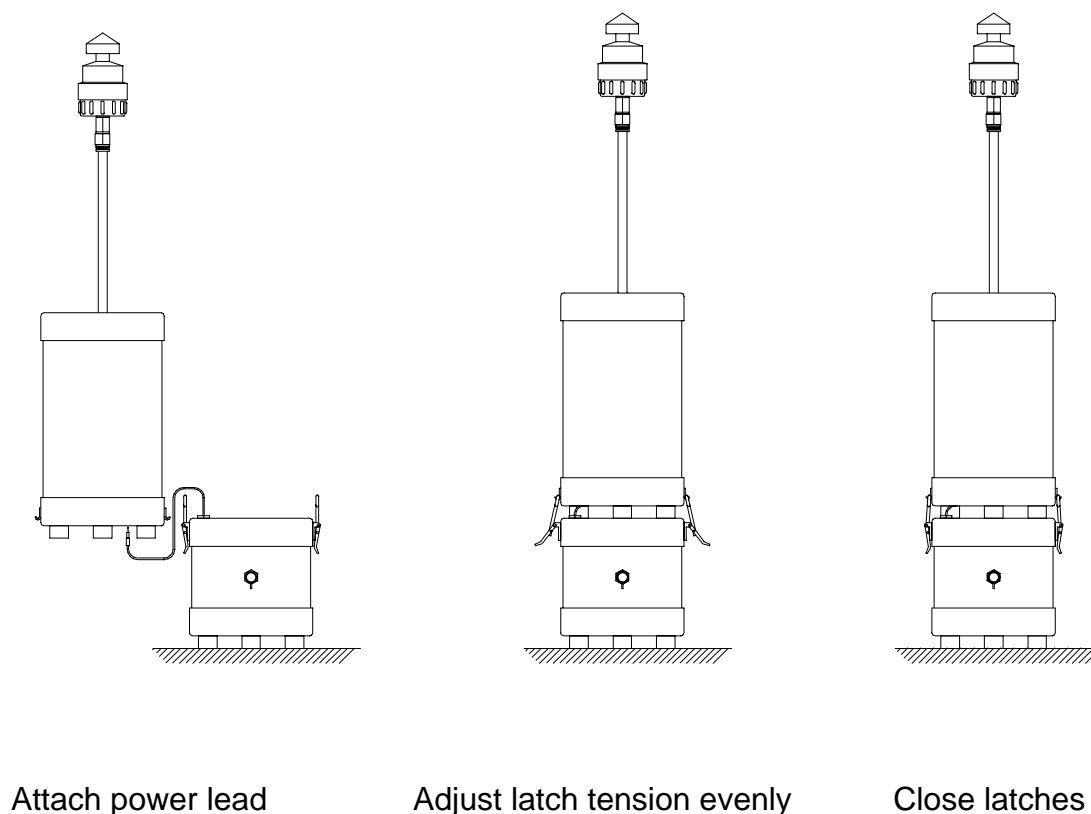


Figure 5 Battery pack connection sequence

2.5 Transporting/Storage

When transporting the sampler, the inlet assembly should be removed and stored in a clean container or zip-lock plastic bag. The inlet tube should also be removed and capped. The MicroVol-1100 can then be packed in the original container.

2.6 Filter preparation and handling

Exchanging filters is a simple task, the sampler being fitted with a quick-connect push-in fitting on a 47mm filter holder. The entire filter holder and impactor assembly may be removed quickly and simply, taken away and the filter element replaced under laboratory conditions.

A large variety of filter media is currently available, with various pore sizes, and many are suitable for air sampling. Some of these include:

- Stretched Teflon filters
- Quartz glass-fibre filters
- Fluoropore filters
- Membra-fil filters

Select the type of filter that is most suitable for the particles that you are interested in sampling, but do not use filters that are, or become, too restrictive, or the sampler will be unable to maintain constant flow-rates. Filters with a sealing-ring around the outer edge are recommended.

The filters should only be handled with clean, non-serrated tweezers, never with fingers, and only at the edge.

Inspect each filter for defects such as pinholes, loose material, discolouration and non-uniformity. Discard any filters that are defective in any way.

2.6.1 Pre-collection equilibration

Place filters on a Petri dish, and label each dish with a filter number. The filters need to equilibrate for at least 24 hours under precisely controlled temperature and relative humidity conditions:

Relative humidity should be maintained at a constant level of $50\% \pm 10\%$ with a variability of less than 5% (Australian Standards 3580.9.6-1990)

Temperature should be maintained at a constant level of $20-25^{\circ}\text{C}$ (Australian Standards 3580.9.6-1990).

A 6-place microbalance with a resolution of better than 0.01mg is required. Before initial weighing of the filters, turn the microbalance on for 1 hour to allow them to stabilise.

Weigh each filter at least twice and record the average initial mass of each filter, W_i . Always check the zero reading of the microbalance between each reading.

Immediately after weighing, place each filter into either a filter holder, and assemble the filter holder, or into a Petri dish with a lid. The sample travels down through the filter holder, so ensure that the filter is installed with the sample side up.

Record the relative humidity, temperature, date and time of the initial weighing.

2.6.2 Filter exchange

Filter element exchange should ideally occur under laboratory conditions. Two or more filter holders can be used on a rotating basis. Extra filter holders are available as spare parts. Transport the filter holder (filter element installed) in a press-seal anti-static plastic bag to the sampling site.

Whenever a filter is replaced, record the time, date, sampling times and dates. This may be a good time to record the sample volume and corrected sample volume, or download the data from the MicroVol. (See section 5)

A log-book sample page can be found at the back of this manual.

2.6.3 Post Collection Equilibration

Carefully remove the filter elements from their holders and check them for defects that may have occurred during sampling. The sample should be reasonably even across the element. Localised dark spots could indicate pinhole leaks. Filter holder support screens will produce a pattern on the filter. If this is unacceptable due to the type of analysis being performed requiring a steady filter loading, an optional woven wire screen support is available.

Place the filter element on its numbered Petri dish and cover the top of the dish with a paper towel.

Record the relative humidity, temperature, date and time of the post collection equilibration. The equilibration temperature and relative humidity should be as close as possible to the initial equilibration conditions. Once again, each filter should be allowed to equilibrate for at least 24 hours.

2.6.4 Final weighing

Use the same microbalance that was used in the initial weighing. Before weighing the filters, turn the microbalance on for 1 hour to allow them to stabilise.

Weigh each filter at least twice and record the average final mass of each filter, W_f . Always check the zero reading of the microbalance between each reading.

Immediately after weighing, place each filter into a Petri dish with lid, sample side up, and record the time and dates that the sample was taken.

Record the relative humidity, temperature, date and time of the final weighing.

Refer to the Calculation section for method of determining mass concentrations.

3 Operation

Remove the cover from the top of the MicroVol-1100 and connect the power supply.

The MicroVol flow, temperature and barometric pressure sensors have been factory calibrated. The flow-rate is set in the Setup menu and should normally be set to 3. The size selective inlet particle cut-point will be most accurate when the flow-rate is set to 3.0 l/min. The size selective inlet was designed to operate at 3.0 l/min to ensure that the MicroVol-1100 takes a sample of sufficient quantity while allowing sufficient pump capacity for when the filter becomes loaded.

3.1 General operational information

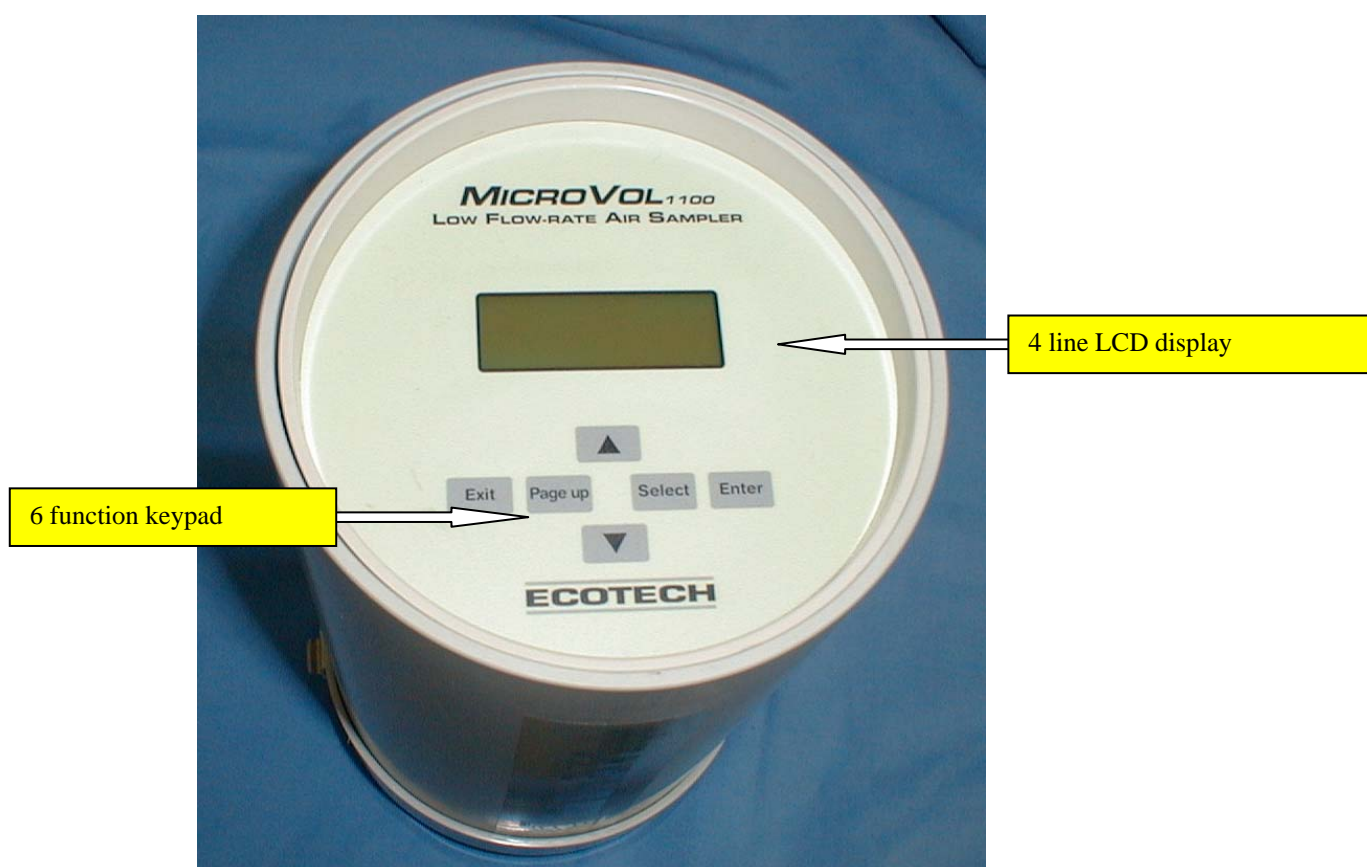


Figure 6 MicroVol-1100 control panel (cover removed)

The MicroVol-1100 is microprocessor based and features internal data logging of flow and meteorological parameters.

The internal data logger stores time based records at user-selectable intervals. The data includes Date and Time, flow-rate (volumetric), sample volume (uncorrected and corrected to Standard Temperature and Pressure conditions), average temperature, pressure, wind speed and wind direction or rainfall information. Values stored in the sampler may be downloaded via the RS-232C Serial port.

The MicroVol-1100 includes an input connector for wind speed and direction. These inputs are averaged and stored in the unit, and may be used as triggers for conditional sampling (eg. sampling when the wind direction is within a specified range). The MicroVol also incorporates a time clock and programmable timer enabling multiple time based sampling programs to be configured.

3.1.1 MicroVol Sampling Protocol

The MicroVol uses a number of logical (conditional) parameters to decide when it should switch the sample pump on.

The pump will be energised when all conditional parameters are satisfied. The conditional parameters can be summarised as follows:

- Is the current date after the specified Start Date and Time?
 - Is the current date before the specified End Date and Time?
 - Is the current time within one of the programmed Daily sampling times? (Between any of the 6 programmable On Time / Off Time periods)
 - Is the current Day Of Week a specified sampling day?
 - Is the wind speed and direction sensor data within the programmed range?
 - Is the power supply voltage above the lower limit (typically 11V)?
- If all of the conditional parameters are satisfied (All 'YES' values displayed in the Status Menu), then the MicroVol sample pump will operate, and a sample will be collected on the filter paper.

In order to make the MicroVol pump operate continuously, it is possible to set the MicroVol with parameter values that ensure all conditions are satisfied for long periods of time. The only exception is that of the Power supply voltage, which should always be maintained at above 11VDC. To set the MicroVol-1100 to run continuously, enter the Setup menu:

Select Setup menu, then Times menu:

- Select Start Date: Enter a date that is before the current date.

Example: Set the Start Date as yesterdays date or earlier.

- Select End Date: Enter a date in the distant future.

Example: Set the End Date as tomorrows date or later.
--

- Select Daily: Set On Time 1 to 00:00, Set Off Time 1 to 24:00.
- Select Weekly: Set all days to YES.
- Set Days/cycle to 1

Select Setup menu, then Wind menu

- Set CCW W.Dir to 0
- Set CW W.Dir to 360
- Set LO W. Speed to 0
- Set HI W. Speed to 100

The MicroVol's data logger collects data even when the pump is not running. The data is collected at regular intervals, called the averaging period. The averaging period is set in the Logger Setup menu. The data that is logged is the average data value during the averaging period, with the data being written to memory at the end of that period.

Data from up to 150 averaging periods may be stored in the MicroVol. Once the data logger memory is full, the MicroVol stops collecting data. The MicroVol begins collecting data when the logger accumulator is cleared. When setting the averaging period, keep this in mind. If you want to collect one day worth of data, it will be necessary to set the Logger setup averaging period to at least 10 minutes. If the averaging period is set to one hour, 150 hourly averages of data will be collected. This equates to over 6 days worth of data.

Note: Data is also collected when the MicroVol is in Manual mode.
--

3.1.2 Menu operation

The MicroVol is equipped with a six-function keypad.

The keys are:

Exit

Page up

Select

Enter

Up arrow

Down arrow

To enter the menu system press Select or Enter.

To move the cursor to a different menu item press the Up arrow or Down arrow. If the current menu is larger than four items then the screen will scroll up or down when necessary.

To select the menu item under the cursor press the Select or Enter key.

To exit to the previous menu press Page up.

To exit from the menu system press *Exit*.

3.1.3 Changing Menu Settings

Each menu comprises a number of menu items. The menu item contains a description on the left and an operand on the right. The operand types are:

Type:	Operand Text:
Floating-point (FP) number	6 characters max.
Long floating-point number	8 characters max.
Integer	3
Long integer	8
Text	6 characters max.
Time	hh:mm:ss (24-hour format)
Date	dd/mm/yyyy (day/month/year) mm/dd/yyyy (optional format) yyyy/mm/dd (optional format)
Day	SUN, MON, TUE...
YesNo	YES, NO
Submenu	→

When an editable menu operand is selected, the following functions are available.

To move the cursor left or right, use:

← *Page up* or *Select* →

To change the character under the cursor press *Up arrow* or *Down arrow*.

Note: Some characters are fixed and can not be changed.
--

The order in which the characters appear is:

FP first character	-.0123456789
FP other characters	.0123456789
Integer	0123456789
Time/Date	0123456789
Text	!"#\$%&'()*+,-./0123456789:;<=>? @ABCDEFGHIJKLMN OPQRSTUVWXYZ[\]^_ 'abcdefghijklmnopqrstuvwxyz
Day	SUN MON TUE WED THU FRI SAT
YesNo	YES, NO

To accept the edited value press *Enter*

To discard the edited value press *Exit*

3.2 Main screen

The main screen will constantly show parameter such as date and time, and other depending whether the pump is on or off (see Figure 7 and Figure 8). If the user wishes to change the MicroVol's settings pressing Enter or select will then open the main menu as shown in Figure 9.

Pump On

Auto/Manual	20/09/05	Displays current operating mode & date
Sampling	11:53:23	Displays current time
Flow	l/min 3.000	Displays current flow-rate
Temp.	C 22.90	Displays current temperature
Press	mmHg 763.4	Displays current barometric pressure

Figure 7 Main screen pump on

OR Pump Off

Ecotech	20/09/2005	Displays current date
MicroVol	11:53:23	Displays current time
(A one-line status message is displayed)		Displays status message stating why pump is off.

Figure 8 Main screen pump off

To enter the menu system press *Select* or *Enter*.

Status	→	To Status Screen
Setup	→	To Setup Menu
Manual	→	To Manual Menu
S/W version	V2.08x	Displays software version information

Figure 9 Main menu

3.3 Menus and screens

The MicroVol-1100 uses a menu system to organise the operating parameters and settings. The layout of the menu system is straightforward and easy to learn.

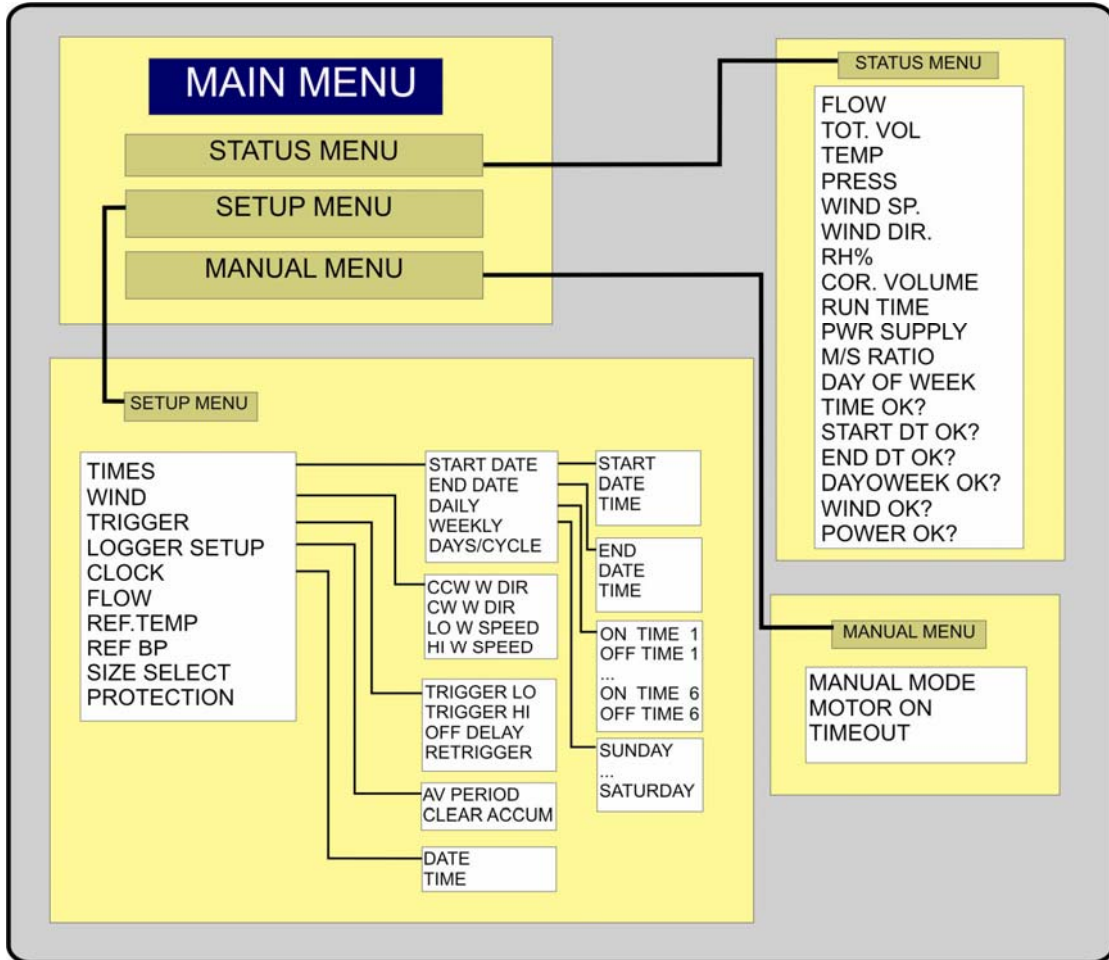


Figure 10 Menu structure summary

3.3.1 Status Screen

The Status Screen displays current MicroVol status information. The data can not be changed from this screen. Sample volume and Corrected sample volume data is updated every minute, all other data updates instantly. Corrected sample volume is used to calculate particulate concentration and has been corrected to standard Reference conditions.

Note: All YES/NO conditions must be met before sampling takes place in Automatic sampling mode.

Flow	l/min	3.000	Displays current volumetric flow-rate
Tot. Vol.	l	708.02	Displays sample volume
Temp.	C	22.90	Displays current ambient temperature
Press.	mmHg	763.4	Displays current barometric pressure
Wind Sp.	m/s	12.980	Displays current wind speed
Wind Dir.	deg	128.34	Displays current wind direction*
RH%		50	Displays Relative Humidity
Cor. Volume	l	650.33	Displays sample volume corrected to STP**
RunTime	min	890.00	Displays sampling duration (pump running)
Pwr Supply	V	11.921	Displays current power supply voltage
M/S Ratio		0.5543	Displays pump load (0.000-2.000)
Day of Week		WED	Displays current day of the week
Time OK?		YES	Is current time/date combination active?
Start Dt OK?		YES	Is current date after timer start date?
End Dt OK?		YES	Is current date before timer end date?
DayOWeek OK?		YES	Is this an active sampling day?
Wind OK?		YES	Is wind condition (sector/speed) active?
Power OK?		YES	Is power supply voltage in range?

Figure 11 Status Screen

* - if no sensor is installed, wind direction displays random data

** - Standard Temperature and Pressure, set in the Setup menu.

Note: Some parameters may be reset to zero by Clearing Accumulated data in the Setup → Logger Setup Menu.

3.3.2 Setup Menu

The Setup Menu contains a number of sub-menu items and some direct entry parameters, where the user can program various parameters.

Times	→	To Times Menu
Wind	→	To Wind Menu
Trigger	→	To Trigger Setup Menu
Logger Setup	→	To Logger Setup Menu
Clock	→	To Clock Menu
Flow	l/min 3.0	Set sampler flow-rate, litres/minute
Ref.Temp.	C 0	Set STP standard temperature, °C
Ref. BP	mmHg 760	Set STP standard pressure, mmHg
Size Select	YES	Sets SSI flow rate limits active
Protection	NO	Set protection mode YES/NO

Figure 12 Setup Menu

Notes:

Flow:
Flow-rate should be set at 3.0 l/min when using size selective inlets. The size selective inlet particle cut-point will be most accurate when the flow-rate is set 3.0 l/min. Do not set the flow rate below 1.0 or above 4.5 l/min.

Ref. Temp. and Ref BP:
Ensure these are set to Standard Temperature and Pressure Conditions (varies between different countries.)

Size Select function:
This function determines what happens when the filter blocks up and the flow rate can no longer be maintained at the set value. Setting this parameter to "YES" activates low flow-rate limits. As the filter loading increases the MicroVol will use active volumetric control to stabilise flow and continue sampling. In extreme cases where the flow rate drops below the set flow rate for more than about 45 seconds, the FILTER BLOCKED screen is displayed and the motor stops. This feature means that the sample need not be discarded if a blocked filter causes the flow-rate to drop below the required value for the Size Selective Inlet. The RunTime, Total Volume and Corrected Volume will stop accumulating at this point.

If Size selection is not required, it can be de-activated by setting Size Select parameter to NO. For example, TSP sampling can usually tolerate some decrease in the flow-rate without invalidating the sample.

If this parameter is set to NO, the Filter Blocked screen will not appear until the flow-rate drops to half of the set flow rate.

<p>FILTER BLOCKED. Replace filter before Restart</p>	<p>Filter blocked screen Press Exit or PageUp to resume normal operation after replacing the filter.</p>
---	--

Figure 13 Filter Blocked

3.3.2.1 Times Menu

The Times Menu contains programmable timer settings. Note that times should be entered in 24-hour format. Days/Cycle is normally set to 1.

Start Date	→	To Start Date Menu
End Date	→	To End Date Menu
Daily	→	To Daily Menu
Weekly	→	To Weekly Menu
Days/Cycle	1	For regular sequence set this parameter to 1. To set a timed sequence of a different number of days, see below.

Figure 14 Main screen pump off

It is possible to program a timer sequence that repeats after a fixed number of days. An example is to program a 6-day sequence for EPA sampling by setting the Days/Cycle parameter to 6. In this way, it is possible to program the MicroVol-1100 to collect a sample on Friday, then the following Thursday, then the following Wednesday, etc. which commences at the programmed Start Date and will continue until the End Date is reached. All conditions must be met for the sampling to commence, so make sure that the Start Date, End Date, Daily and Weekly parameters have the parameters set correctly. It is possible to program a six-day sequence, which never samples on Sundays for example, by setting the Sunday parameter to NO in the Weekly Menu.

Important Note: For an n-Days/Cycle sequence where n is 2 or more, it is important to set the Start Date later than today's date. An internal counter is reset to zero when the Start Date is reached.

3.3.2.1.1 Start Date Menu

Start Date	20/09/2000	Set the start date for the timer program Set the start time for the timer program
Time	11.34.00	

Figure 15 Start Date Menu

3.3.2.1.2 End Date Menu

End Date	27/09/2000	Set the end date for the timer program Set the end time for the timer program (Must be later than the Start Date/time)
Time	11.34.00	

Figure 16 End Date Menu

3.3.2.1.3 Daily Menu

Up to six on and off periods can be programmed into the timer. If the current time is within any of the six programmed periods, then the Time condition will be satisfied. Note that times should be entered in 24-hour format.

On Time 1	09:00
Off Time 1	17:00
On Time 2	00:00
Off Time 2	00:00
On Time 3	00:00
Off Time 3	00:00
On Time 4	00:00
Off Time 4	00:00
On Time 5	00:00
Off Time 5	00:00
On Time 6	00:00
Off Time 6	00:00

Example shows 9am to 5pm program

Set On and off times the same for all unused time periods.

Figure 17 Daily Menu

3.3.2.1.4 Weekly Menu

Sunday	NO
Monday	YES
Tuesday	YES
Wednesday	YES
Thursday	YES
Friday	YES
Saturday	NO

Set the sampling days

Example shows Monday to Friday program, with no sampling on Saturday or Sunday.

Figure 18 Weekly Menu

3.3.2.2 Wind Menu

Note: It is necessary to disable the Trigger function if using the wind sensor to control the MicroVol. This is achieved by setting the Trigger Lo and Hi parameters to the same value, normally set them both to zero.

The Wind Menu contains wind sector and speed conditional sampling parameters. When the wind direction angle has been greater than the counter-clockwise wind direction, but less than the clockwise wind direction, and has been greater than the Low wind speed limit but less than the High wind speed limit, for between 60 and 80 seconds, the Wind condition is satisfied. If all other conditions are satisfied (eg. programmable

timer settings), then the MicroVol pump will operate and sampling will take place. Once this condition is satisfied, the MicroVol will sample for at least 40 seconds. This time delay prevents rapid on/off cycling if the wind condition is borderline. To over-ride wind conditional sampling, or if there is no wind sensor connected, set the parameter values as shown so that the wind conditions are always satisfied.

See section 2.1.1 for more information on wind sector set-up.

CCW W Dir	0	Set Counter-clockwise wind direction (°)
CW W Dir	360	Set Clock-wise wind direction (°)
LO W Speed	0	Set Low wind speed limit (m/s)
HI W Speed	100	Set High wind speed limit (m/s)

Figure 19 Wind Menu

3.3.2.3 Trigger Setup Menu

The Trigger menu appears as follows:

Trigger Lo	0	Set trigger voltage range lower limit (V)
Trigger Hi	2.	Set trigger voltage range upper limit (V)
OFF Delay	01:00	Set sampling period in hours:minutes
ReTrigger	NO?	Set retrigger mode YES/NO

Figure 20 Trigger Setup Menu

The trigger works in conjunction with other conditional parameters. Check other Setup menu parameters to ensure they don't interfere with the Trigger program (for example Times and Wind settings.) Likewise, if external triggering is not required, set the trigger parameters so that they do not interfere with other programs. The external trigger can be disabled by setting Trigger Lo and Trigger Hi to the same value (typically zero.) Setting OFF Delay to 00:00 will behave as if it were set to 00:01 - it does not disable the trigger function, and if triggered, the sampler will run for 1 minute. The RunTime parameter will also increase by 1 minute in this situation.

Note: It is necessary to disable the Wind function if using the Trigger function to control the MicroVol. This is achieved by setting the wind direction range from 0 to 360 and wind speed from 0 to 100 as described in section 3.3.2.2.

The Trigger Menu contains parameters for specifying an external trigger to start the MicroVol sampling period.

Example: a separate gas analyser might be used to trigger the MicroVol to start sampling when the gas concentration reaches a certain alarm level. You could also use a contact closure (switch or relay) to start and stop the MicroVol.

The data logging features and parameters in the Status menu continue to function as normal. The triggering device must have either a contact closure or logic output signal (0-5VDC). A cable will be required to connect the triggering device to the MicroVol. For details of the electrical connections refer to section 2.1.2.

- External triggering uses the wind direction input connector and internal circuitry to monitor the external trigger, so wind control and external trigger cannot be used together.
- The Trigger Lo and Trigger Hi parameters specify the voltages that the external trigger voltage must be between to trigger the MicroVol. If these voltages are the same then external triggering is disabled.
- If the external trigger is a contact closure then Trigger Lo should be 0.5v and Trigger Hi should be 6v.
- To trigger above a set voltage, set Trigger Lo to that switching voltage and Trigger Hi to 6.
- To trigger below a set voltage, set Trigger Lo to -1 and Trigger Hi to that switching voltage.
- The OFF Delay specifies the time in hours and minutes that the Microvol continues to sample after triggering.
- Unlike the wind sensor menu, the status of the trigger device is checked 'on the minute' (when the seconds of the MicroVol clock reach "00" seconds.)
- The MicroVol switches on when a valid trigger is received. The MicroVol will then sample for a set time duration, called the "OFF Delay". Trigger function uses a Trigger Time counter to count up to the OFF Delay value.
- A parameter called ReTrigger controls how the MicroVol deals with repeated trigger signals during the active sampling period.
- If the ReTrigger parameter is set to YES, then each time the MicroVol clock reaches :00 seconds, the Trigger Time counter resets to zero if the trigger condition is met, ie. The trigger operates from the end of the last valid trigger signal.
- If the ReTrigger parameter is set to NO then the OFF Delay operates from the start of the trigger signal. The Trigger Time counter will reset only if the trigger goes off for a :00 crossing (MicroVol clock reads hh:mm:00), and then retriggers at a later :00 crossing. This means that if the initial trigger is still active at the end of the OFF Delay period, then the MicroVol will stop sampling until the trigger goes off and then on.

3.3.2.4 Logger Setup Menu

AvPeriod	min	60	Set data averaging/storage period
Clear Accum		→	Clears all stored data after confirming

Figure 21 Logger setup Menu

Note: After changing the Logger Setup Menu Averaging period, disconnect the power from the base of the MicroVol and then re-connect it. This will initialise the MicroVol using the new averaging period settings.

3.3.2.5 Clock Menu

The Clock Menu sets the MicroVol clock. Note that times should be entered in 24-hour format.

Date	20/09/2000	Set current date
Time	17:34:00	Set current time

Figure 22 Clock Menu

Note: After changing the Clock Menu Time and Date parameters, disconnect the power from the base of the MicroVol and then re-connect it. This will initialise the MicroVol using the new clock settings.

3.3.3 Manual Menu

Manual mode is useful for checking the flow-rate and verifying pump operation. The Manual Menu allows the MicroVol to be switched on or off independent of other conditions such as programmable timer settings, wind speed and direction parameters. It is not intended for long-term sampling as it returns to Automatic mode after the time-out period. The time-out reverts to Automatic mode after a preset number of minutes, which can be set between 1 and 227 minutes.

Manual Mode	YES	Set YES for Manual mode operation
Motor On	NO	Once in Manual mode, set YES to turn pump motor on, or NO to turn it off.
Timeout	min 1	Timeout period in minutes, reverts to Automatic mode after this time.

Figure 23 Manual Mode

3.4 Wind Sensor

The wind sensor may be used for conditional sampling. The data logger automatically collects wind speed and direction data at programmable averaging periods.

Note: Wind direction data should be ignored if the wind sensor is not installed.

The wind sensor must be aligned to true north. This is usually done using a hand-held compass and adjusting for the magnetic declination from true north. Align the mark on the wind sensor to the specified direction.

Set the wind direction conditional sampling parameters in the Wind menu:

- Set CCW W.Dir - This is the compass direction of the counter-clockwise (CCW) end of the ACTIVE sector.
- Set CW W.Dir - This is the compass direction of the clock-wise (CW) end of the ACTIVE sector.
- Also set the Low and High wind speed limits for sampling.

See section 3.3.2.2 for more information on wind menu set-up.

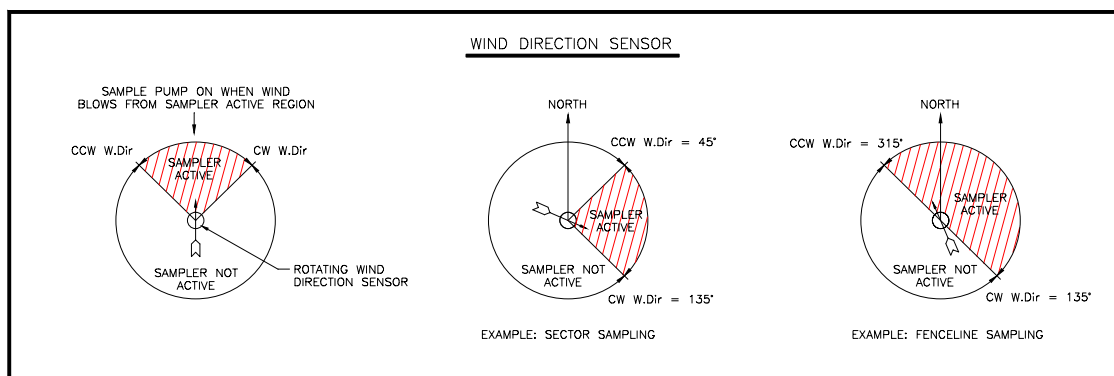


Figure 24 Conditional sampling, wind direction sensor setup.

3.5 Rain Gauge

The rain gauge can not be used for conditional sampling. The data logger automatically collects rainfall data in a counter that is reset by clearing the accumulator (Setup – Logger Setup menu.) The rainfall counter value is stored at the programmable averaging periods. By looking at when the rainfall data increases, the time that the rainfall occurred can be worked out.

The MicroVol data logger increments each time the rain-gauge bucket tips. The data value increases until the data logger is reset using the Setup - Logger setup - Clear Accumulator menu.

Note: Clearing the accumulator will clear all data in the MicroVol-1100 internal data logger.

The rainfall units are “tips”, which refers to the number of times the rain gauge bucket fills and empties. The units can not be changed. Multiply the data by the calibration factor to convert to millimetres or inches of rainfall.

4 Calibration

Check the calibration at least every six months or when the flow-rate, barometric pressure or temperature data is suspect.

Perform the calibration indoors, out of direct sunlight, especially when calibrating the temperature sensor.

Refer to the calibration sheet for factory-calibrated values – these are different to the default values.

To change any of the calibration coefficients, it will be necessary to access the Hidden Menu. Refer to the Hidden Menu section for further information regarding the calibration coefficients.

4.1 Temperature Sensor Calibration

1. Record the temperature displayed by the MicroVol.
2. Record the actual temperature with a certified precision thermometer. If these measurements are significantly different, continue with the calibration as follows:
3. Calculate
4. Then:

Assign...	...the value of...
Temp coeff 1	$(\text{Temp coeff 1}) \div x$
Temp coeff 0	Do not change

5. Repeat steps 1-4 (if necessary) until the MicroVol temperature is close to the actual temperature.

4.2 Barometric Pressure Sensor Calibration

1. Record the barometric pressure displayed by the MicroVol.
2. Record the actual barometric pressure with a certified pressure gauge or barometer. If these measurements are significantly different, continue with the calibration as follows:
3. Calculate the difference between the two values and adjust the barometric pressure coefficient 0 (Pres. coeff0) by this value. If the MicroVol is reading high, decrease the value of the coefficient 0, and vice versa. Do not adjust coefficient 1 (Pres. coeff1).
4. Re-check the MicroVol barometric pressure reading.

4.3 Flow Rate Calibration

The MicroVol-1100 flow-controller is factory calibrated. Care should be taken to keep moisture out of the inlet tube and the sampler should always be operated with a filter installed. If this is done, the MicroVol should maintain its calibration accuracy for extended periods (several years).

The flow-rate may be periodically checked using a bubble flow-meter. Do not use a piston type flow-meter as the piston inertia affects the flow-rate and flow-control system. An optional Flow-rate Checking kit is available for this purpose.

Take care when using the bubble flow-meter so that no liquid gets into the MicroVol. Place the MicroVol and flow-meter on the same level (eg. on a bench), and connect the flow-meter to the top of the inlet pipe using flexible tubing and push-in fittings. If the flow-meter and MicroVol report different flow-rate readings, first check that there are no leaks in the connecting tubes.

4.4 Procedure for re-calibrating the MicroVol-1100:

1. Set the MicroVol flow rate to a particular value and record this value.
2. Measure the actual flow-rate using a bubble flow-meter.
3. Repeat steps 1 and 2 with a different flow-rate. Flow-rates of 2.0 litres/min and 3.0 litres/min are recommended. Record the results in a table (see below). If the MicroVol and actual values are significantly different, continue with the calibration. The names in the table are those that will be used in the calculations that follow.

MicroVol flow-rate, l/min	Actual flow-rate, l/min (measured with bubble-meter)
SETFLOW1 = (eg. 2.0)	MEASUREFLOW1 =
SETFLOW2 = (eg. 3.0)	MEASUREFLOW2 =

4. Calculate (to four decimal places):

$$A = \frac{\text{MEASUREFLOW1} - \text{MEASUREFLOW2}}{\text{SETFLOW1} - \text{SETFLOW2}}$$

and

$$B = \text{MEASUREFLOW1} - A \times \text{SETFLOW1}$$

5. Then:

Assign...	...the value of...
Flow coeff 0 _{new}	(Flow coeff 0) _{existing} × A + B
Flow coeff 1 _{new}	(Flow coeff 1) _{existing} × A

Enter the new values for flow coefficients 0 & 1 at the hidden menu (refer to Hidden Menu section).

5 Downloading data

The serial port is a 9-way female D-connector on the underside of the MicroVol housing. A weatherproof cover is fitted to the connector to exclude dirt and moisture. This cover should be removed only when a cable is connected to the port.

The serial port operates at 9600 baud, eight data bits, one stop bit, no parity. This cannot be changed.

Data can be downloaded using the Windows-based Ecotech MicroVol Downloader program supplied on the Utilities CD, or with the Ecotech WinCollect program.

Note: If using WinCollect, the MicroVol uses the same command protocol as a 9400 Data Logger, and WinCollect should be setup to communicate with a 9400.

The Serial port (RS-232C) is used for downloading data from the MicroVol. The MicroVol port is a DB9 female connector on the underside of the sampler. This port should be covered, using the cap supplied, when not in use, to keep out dust and moisture. Connect a standard 9-pin serial cable to this port. Connect the other end of the cable to your computer. If your computer has a 25 pin male serial port, you may need to use a DB9 M / DB25 F adaptor or the appropriate 9-pin to 25-pin cable.

5.1 Using MicroVol Downloader software


The MicroVol Downloader software is supplied with the MicroVol on the Utilities CD. The software may be installed on any PC type computer running Microsoft Windows 95, Windows 98, or Windows 2000. It will not run under Windows 3.x.

A laptop computer is a practical way of downloading the data from a HiVol that is in service in the field. If your laptop does not contain a serial port then a U.S.B. – serial adaptor should be used. It is highly recommended that the easysync U.S.B. – serial adaptor be used for this function as it has been widely tested with all Ecotech products, works effectively and can be purchased from Ecotech.

To install the software:

- Close any programs that are running on the computer (visible in the Windows task-bar)
- Put CD in the computers CD rom drive
- A window will appear called Software Utilities.
- Click on the Install software button
- Within this new window select xVol Communicator
- Now follow the prompts and windows to install the program.
- The downloader program will open automatically ready for use.

To run the MicroVol Downloader program:

- Click on the “Start” button
- Select “Programs”, then click on “MicroVolDownloader”
- The program will run and a window will appear
- The program is simple to use.
- Enter the settings menu through the ‘properties’ under the Comm menu or by clicking the following icon 
- In the “Output file:” box, type the directory pathname and filename for the data file to be created

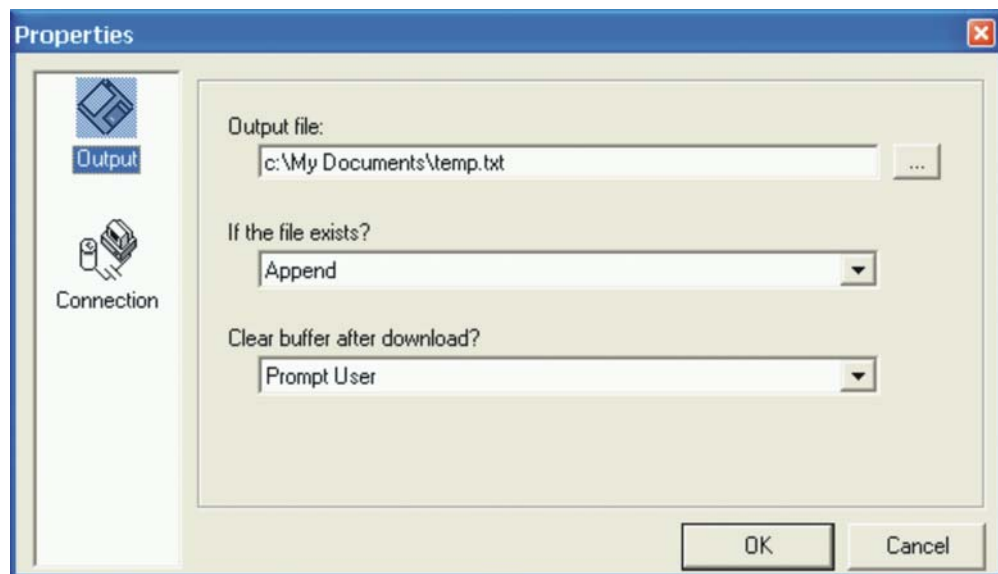



Figure 25 Properties screen

- Next click on the Connection icon show in the column on the left hand side in Figure 25. Select Com port from pulldown menu. Do not select a port that says “(In Use)”
- Click on “Collect Data” button  shown in Figure 26.

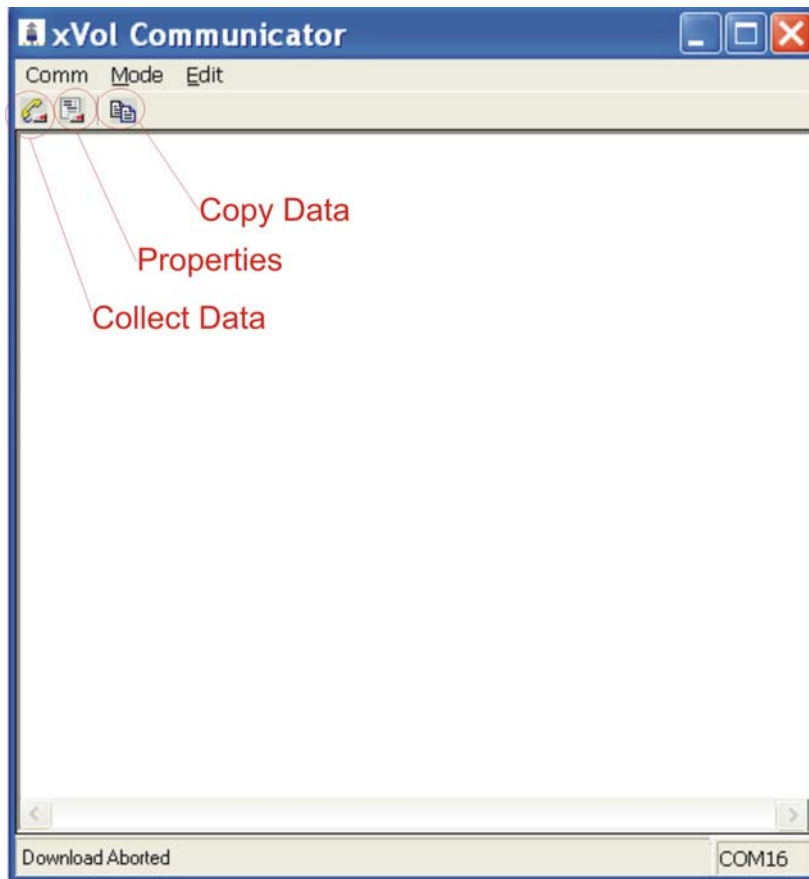


Figure 26 Output screen

- The data will be collected. After a few seconds, a box will appear asking whether you want to clear the data from the MicroVol memory. Select Yes or No.
 - The data will appear on the screen.
 - To close program, click on the box (top right corner of the window)
- The data will be stored in the directory and file specified. The data is separated by a comma (called a delimiter). The data file may be imported into another program, such as Microsoft Excel, by specifying that the data is delimited, using comma delimiters. Using this method, the data will be formatted into individual cells.

The data is presented in the following format:

Report Date Time, Barometric Pressure (mmHg), Ambient Temperature (°C), Wind speed (m/s), Wind direction (°), Sigma Theta (standard deviation for wind direction), Rainfall (bucket tips), Flow-rate (l/min), Corrected accumulated sample volume (standard litres), Uncorrected accumulated sample volume (litres)

Note: Wind direction data should be ignored if the wind sensor is not installed.

Note: Wind direction average data will be zero if there has been no wind speed data for the entire averaging period.

If the data file already exists, any further downloading of data will be appended to the existing data in that file. If the data file does not exist, the MicroVol Downloader software automatically creates the file.

Note: The Windows regional settings for time and date format should be set the same on the computer used to download the data and the computer used to process the data (if different computers are used.) The settings are located in the Windows menu system under Start, Settings, Control Panel, Regional Settings, Time and Date

5.2 Communicating with the MicroVol (alternative method)

An alternative (more complicated) way of downloading data is to use a terminal emulator. Send ***EA command, then use terminal to download file using X-modem. Using this method the data will be in hexadecimal format and will need to be converted to ASCII format.

If required, it is possible to connect a modem to the MicroVol to collect data. It is also possible to use a terminal program to communicate with the MicroVol via the Serial port (RS-232C). This may be useful for remote interrogation or for connecting the MicroVol to an external data logger.

Contact Ecotech for details.

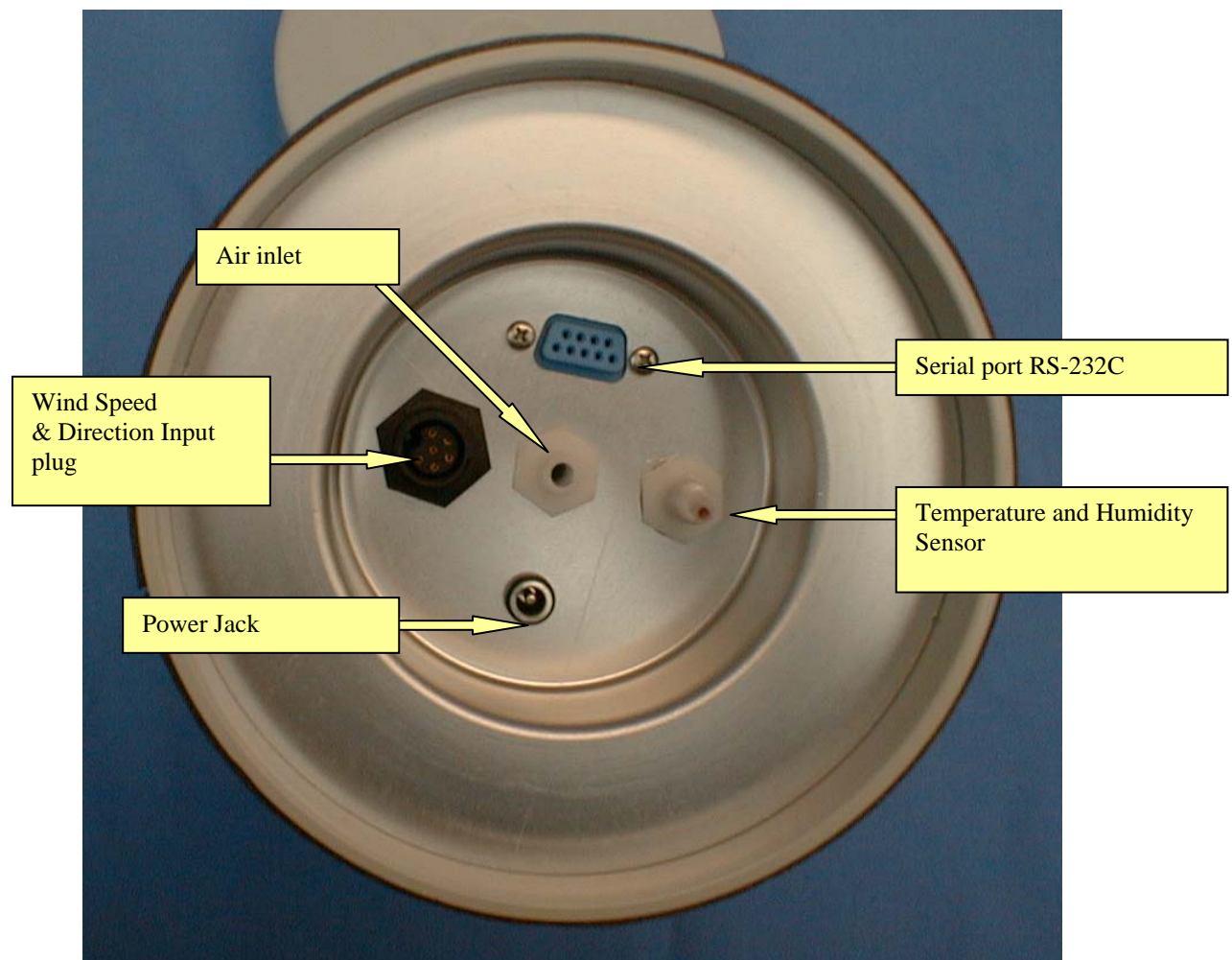


Figure 27 MicroVol-1100 Underside

5.3 Calculations

The MicroVol-1100 flow-controller regulates the volumetric flow-rate of air when the pump is operating. In-built temperature and barometric pressure sensors collect ambient data, which are stored in the internal data logger. The MicroVol-1100 uses the temperature and pressure data to determine the density of the gas.

All current data can be viewed in the Status menu. Historical data can be downloaded to a laptop computer via the serial port.

Note: Once the internal data logger memory is full, the MicroVol stops collecting data. If the sample pump is still operating when the memory is full, then use the current data in the Status menu to read the uncorrected sample volume in litres (Tot. Vol. l) or the Corrected sample volume in standard litres (Cor.Volume l).

Using the ambient and Reference temperature and pressure information, the sample volume is automatically corrected to Standard Temperature and Pressure (STP) conditions. The MicroVol's internal data logger stores both uncorrected and STP corrected sample volume data in the internal memory. The sample volume data is used to calculate the mass concentration. The mass concentration may either be reported at STP corrected conditions, or at actual ambient conditions by using the relevant sample volume data in the calculation. Refer to local reporting standards. The STP Reference conditions have been factory set, but may be changed via the Setup menu:

Mass concentration data is generally reported in $\mu\text{g}/\text{m}^3$ referenced to standard temperature and pressure (STP). There are, however, different accepted values of STP:

	Standard Temperature °C (K)	Standard Barometric Pressure mmHg
MicroVol Setup menu parameter	Ref. Temp	Ref. BP
Australia, Europe	0°C (273.18K)	760
USA	25°C (298.18K)	760
Japan	20°C (273.18K)	760

Note: 760mmHg = 760Torr = 101.325kPa = 1 standard atmosphere

5.3.1 Sample Volume

The sample volume is automatically calculated and stored/updated in the MicroVol. The sample volume is also automatically corrected to STP conditions and stored/updated in the MicroVol.

5.3.2 Mass concentration calculation

Mass concentration (MC) is calculated using the formula:

$$MC = \frac{W_f - W_i}{V}$$

where

W_f	=	Final mass of filter element
W_i	=	Initial mass of filter element
V	=	Sample volume, either corrected or uncorrected

If the corrected sample volume is used, the units for the concentration are standard $\mu\text{g}/\text{m}^3$ referenced to standard temperature and pressure conditions (STP). If the uncorrected sample volume is used, the units for the concentration are $\mu\text{g}/\text{m}^3$.

6 Maintenance

6.1 Maintenance tools

To perform general maintenance on the MicroVol-1100 the user will be required to carry the following equipment:

- Phillips screwdriver (to suit M4 and M3 screws)
- Side cutters or other cutting tool (for cable ties)
- Spare cable ties (for securing tubes)
- Flat terminal screwdriver (for removing cables from connectors)
- Small shifting spanner or pliers (for holding hex fittings on flow sensor).

6.2 Maintenance schedule

Interval (samples)*	Item	Procedure	Page
Weekly	Inlet components	Clean	42
Weekly	Impactor	Assembly	43
If necessary	Pump	Maintenance	44

* Suggested intervals for maintenance procedure may vary with sampling intensity and environmental conditions.

6.3 Maintenance procedures

6.3.1 Cleaning the inlet components

A regular routine should be devised to ensure that the sampler is functioning as it was designed to. This includes cleaning all surfaces that are exposed to the sample.

Note: The flow sensor can be damaged by moisture. Make sure that all water has been removed before reassembling the components. Always dry the components thoroughly with compressed air after cleaning.

The impactor assembly has a removable rain-cap and stainless-steel mesh insect screen, which are easily removed for cleaning.

The inlet tube should be removed and cleaned if contamination has occurred. Remove the tube from the sampler and clean and flush the tube with hot soapy water and a bottlebrush.

The filter holder should also be kept clean and thoroughly dried before installing a new filter. Transport the filter holder in a plastic zip-lock bag to prevent contamination.

6.3.2 Impactor assembly

The impactor assembly should be cleaned and re-greased at least every 10 sampling periods, and sooner if dirt is visible. Remove the impactor assembly from the filter holder. Remove the rain cap. Remove the connecting tube and impactor plate by pulling them apart. If necessary, the impactor plate and connecting tube may be pushed out by inserting a rod down the inlet jet, taking care not to scratch the jet, then pushing the impactor plate out of the impactor assembly.

Wipe any dirt off the top of the impaction plates using a lint-free cloth. Wipe the inside of the holes to remove all grease and dirt. All components should be wiped initially with a soft clean cloth to remove grease and dirt. They should then be cleaned using warm soapy water and rinsed a couple of times with fresh hot water. Use compressed air to dry the components. Inspect the o-rings for damage, and replace them if necessary. Always apply a trace of o-ring grease to the o-rings before assembly or they will be damaged.

The impaction plate should be greased lightly in the centre, masking the outer part of the disc so that the grease is only in the centre of the impaction plate – covering an area about 10mm in diameter. Light petroleum grease such as Vaseline can be used in many applications where particulate composition is not being analysed. Otherwise, silicone grease such as Dow Corning Slipicone release spray can be used. Dry the plate thoroughly with a clean lint-free cloth. If necessary, store in a clean zip-lock bag until ready for use.

The acceleration nozzle orifice should be cleaned after approximately 1000 hours of use, depending on loading. Do not use anything sharp to clean the passage - a soft brush or pipe cleaner and soap solution is sufficient.

Re-assembly

A light smear of silicone O-ring grease should be re-applied to the O-rings as needed to ease assembly and disassembly. When re-assembling sections with O-rings, take care to align the pieces well and to twist and slide them together smoothly to avoid displacing or damaging the O-rings.

The impactor plate locates in the nozzle body, grease side towards the nozzle. The inlet should be held upside-down during assembly. The adaptor tube retains the impactor plate. Apply gentle pressure to the adaptor tube to seat it against the impactor plate.

6.3.3 Pump maintenance

The MicroVol-1100 pump is available as a spare part, and takes only about 10 minutes to replace. This may be required after a period of several years, due to deterioration of the seals. Remove the sampler from the plastic tubular housing. Remove the tube from the port on the side of the pump (see Figure 28), noting which port the pipe is connected to, and turn the sampler on to check whether there is vacuum and pressure on the appropriate ports. If there appears to be a problem, disconnect the pump terminals from the circuit board, cut the ties that secure the pump and remove the pump from the sampler. Ease the pump out of the rubber mounts. The pump should be exchanged - contact Ecotech for spares details. Replace with a new pump and reassemble. Do not over-tighten the cable ties that secure the pump. The pump needs to be free to vibrate in the rubber mountings. The polarity of the pump wires is not important.

The pump part number is listed in the Spare Parts section.

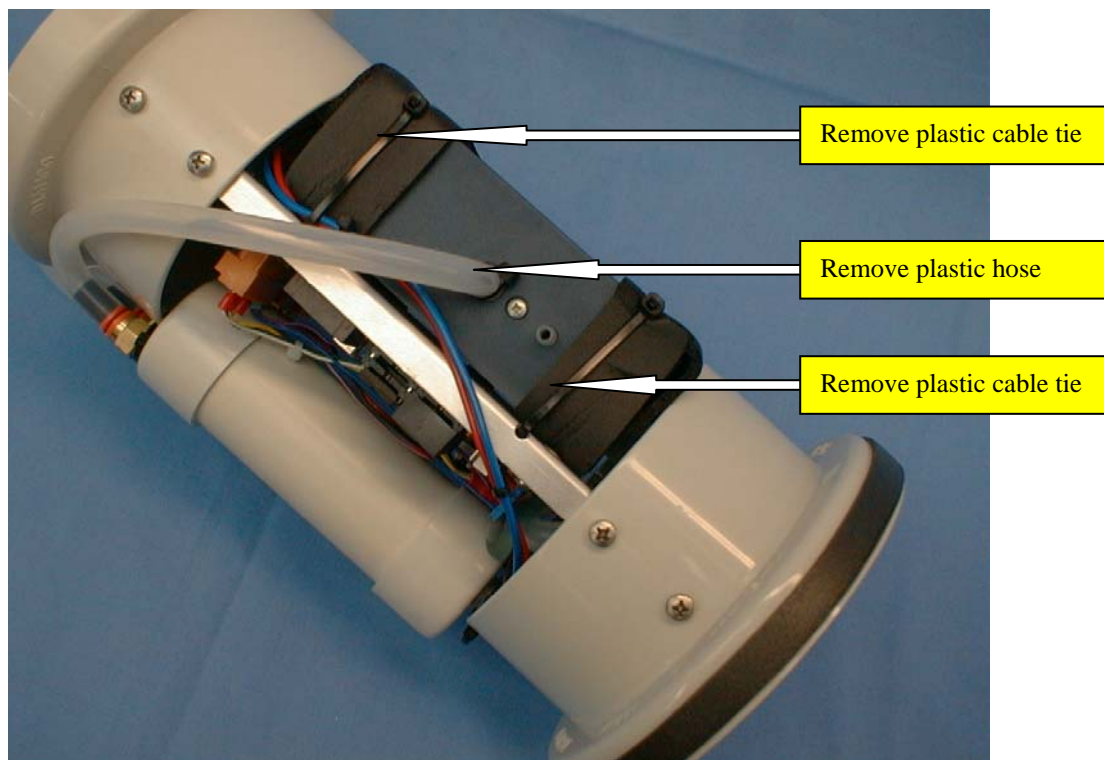


Figure 28 Replacing the pump

6.3.4 Hidden Menu

The Hidden Menu is used to set parameters at the factory. It is not usually necessary to access the Hidden Menu.

To access the Hidden Menu, hold down the secret key (the first letter C in the ECOTECH logo), then press the Select key at the same time.

Voltages	→	Diagnostics only
ID	0	Enter a MicroVol identification number
Motor Freq.	40.	Optimised at the factory – do not adjust!
Date Format	1	0=mm/dd/yyyy (USA)
		1=dd/mm/yyyy (common)
		2=yyyy/mm/dd (Japan)
		dd = day, mm = month, yyyy = year
Flow coeff0	-1.25	Flow calibration coefficient 0
Flow coeff1	1.25	Flow calibration coefficient 1
Temp coeff0	0.381	Temperature calibration coefficient 0
Temp coeff1	0.0192	Temperature calibration coefficient 1
Pres. coeff0	73.	Baro. pressure calibration coefficient 0
Pres. coeff1	168.7	Baro. pressure calibration coefficient 1
WS coeff0	0	Wind speed calibration coefficient 0
WS coeff1	0.7989	Wind speed calibration coefficient 1
WD coeff0	0	Wind direction calibration coefficient 0
WD coeff1	79.2	Wind direction calibration coefficient 1
Min 12V	12.	Power up voltage*
Default Prms	→	Resets all hidden menu parameters!
0=RG, 1=WS	1	Rain gauge or Wind sensor selection
Inst. Type	0	Factory setting – do not adjust!

Figure 29 Hidden Menu

* Power down voltage is 90% of power up voltage value.

7 Troubleshooting

The sampler is fitted with a number of features to protect it from internal damage. Some of these features will prevent the sampler from performing as would normally be expected.

Fuse:

A 2A fuse is soldered on the circuit board inside the MicroVol. Check the fuse continuity with a multi-meter.

Low Voltage Automatic Shut-off:

Shuts down the pump automatically when supply voltage drops below 11V (nominal). This feature protects the battery from damage. The MicroVol display and data collection continues to operate until the battery voltage drops to about 5V, when the microprocessor powers off.

Battery pack fuse:

A 3.15A (20x5mm) fuse is housed in a waterproof fuse holder on top of the optional battery pack. Check the fuse continuity with a multi-meter.

Status Menu:

Gives a description of the current status of various parameters. The main screen also has a single-line status description when the sampler pump is not running, which gives an indication of why the pump is not running.

8 Accessories and Options

8.1 Battery Pack

Caution:

- The battery pack contains sealed lead-acid batteries, which produce small quantities of flammable hydrogen gas.
- Do not short-circuit the battery connections.

This option allows the sampler to operate in areas where mains power supply is not available. The rechargeable battery pack will operate the MicroVol for 24-hours before recharging is required.

For details on attaching the battery pack to the MicroVol-1100, see Section 2.4.2, Assembling the MicroVol-1100.

Note: Always fully charge the battery pack after use. If the battery pack is not being used for an extended period of time, remove the fuse and re-charge the battery periodically (every 2 months recommended.)

The MicroVol turns the pump off automatically if the power supply (battery) voltage drops below 11V (factory setting). The MicroVol continues to operate until the battery discharges to about 5V, after a period of several days. Ideally, the battery should be recharged well before this, as the battery may be damaged.

8.1.1 Charging the battery pack

The battery pack must be charged in a ventilated area. Connect the 12V battery-charger to the Charging Port on the side of the battery pack, via the black weather-proof connector. Do not attempt to charge the battery via the Power Connector.

The optional battery charger should be used to charge the battery pack. If a different charger is used, it must be suitable for charging sealed-type 12-volt lead-acid batteries. The charging current should be no more than 2.5 Amps. The charging time will depend on the charging current. At 1 Amp charging current, the battery should be allowed to charge for 8-12 hours, depending on the depth of discharge.

Place the protective cap over the charging socket when the charger is not connected.

8.1.2 Disposing of old batteries

The battery pack contains lead-acid batteries. After several hundred uses, battery performance will decrease. Old batteries must be disposed of according to local regulations. Most areas require that lead-acid batteries be recycled and have a facility for battery disposal. Contact your local council for more information.

8.1.3 Battery charger with timer, 100-250V Model

The universal battery charger is designed to recharge the MicroVol battery pack via the charging connector. The battery charger automatically controls the charging cycle.

Features:

- 3-step charge controller
- Universal supply input: 100-250VAC
- Charge current is not affected by voltage fluctuations
- 3 stage charging cycle – coloured indicator shows status
- IEC 320 2-pin connector

The charging cycle occurs in three stages. The light on the charger indicates which stage is current.

Stage 1 Indicator red, battery charge state 0-80%

Initial boost mode, constant current charging at 2.3A until battery voltage reaches 14.7V

Stage 2 Indicator yellow, battery charge state 80-100%

Timer mode, 14.7V maintained for approximately 2 hours

Stage 3 Indicator green, float mode

Battery is charged, charger maintains battery at 13.8V.

The battery charger should be switched off at the mains outlet when connecting and disconnecting the battery.

The charging time will vary depending on the initial charge state of the battery. When the indicator lamp is green, the battery is fully charged. The universal charger may be connected continuously if required.

8.1.4 Battery Charger, basic 240V Model

The basic battery charger is designed to recharge the MicroVol battery pack via the charging connector. The battery charger has a battery voltage selector switch for 6V and 12V batteries. The MicroVol battery is a 12V battery, so the battery charger switch must be set to 12V. Do not connect the charger when the switch is in the 6V position or the battery and charger may be damaged. Switch the power off and unplug the charger before connecting or disconnecting the battery and charger.

The battery charger should be switched off at the mains outlet when connecting and disconnecting the battery.

The charging time will vary depending on the initial charge state of the battery. If the battery is completely flat, the battery should be charged for 12 hours. The charger may be left connected for up to 24 hours. Do not leave the charger permanently connected to the battery.

8.2 Dual-stage filter holder (option)

The upper filter holder has an open face for collecting particulate matter, while the lower filter holder is without open face, used only for collecting gaseous compounds. The filter holders are connected with a threaded coupling and can be separated easily. Before re-connecting the filter holders, wrap Teflon thread sealer tape around the threads in a clockwise direction (2 turns is sufficient.)



Figure 30 Dual stage filter holder

8.3 PM_{2.5} Nozzle Adaptor (option)

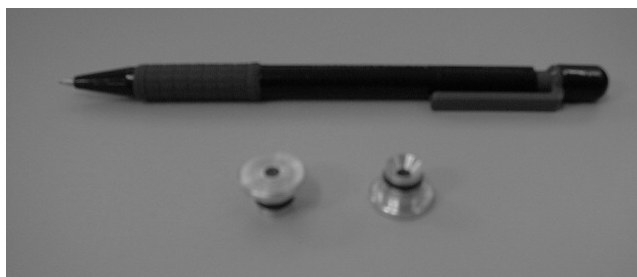


Figure 31 Views of the PM_{2.5} nozzle adaptor (pencil shows scale)

The PM_{2.5} nozzle adaptor is designed for sampling fine inhalable particulate matter with an aerodynamic diameter of 2.5 microns and smaller. The PM_{2.5} nozzle adaptor fits inside the impactor assembly, effectively reducing the nozzle diameter. An O-ring seals and retains the PM_{2.5} nozzle adaptor. The PM_{2.5} nozzle adaptor is precision machined to obtain the correct particle size cut-point. Extra care should be taken when handling the adaptor, in order to prevent damage.

To install or remove the adaptor, first separate the 47mm filter holder and impactor assembly from the inlet tube. Disassemble the impactor assembly. Refer to Figure 1 Section 1.4.2 for details of how the parts are re-assembled.

With the filter holder, connecting tube and impactor plate removed, carefully insert (or remove) the PM_{2.5} nozzle adaptor in the nozzle body.



Figure 32 PM_{2.5} Nozzle components and assembly

Carefully reassemble the impactor assembly by inserting the greased impactor plate (greased side towards nozzle), connecting tube, and filter holder with filter element installed. Finally, re-attach the assembly to the inlet tube.

Appendix A Spare Parts and Accessories List

<u>Parts</u>	<u>Part Number</u>
Standard 47mm Filter Holder – open face (Includes coupling and push in fitting)	P-ECO-MICRO10004-S
Second stage 47mm Filter Holder Two threaded ports (Includes female threaded coupling)	P-ECO-MICRO10005-S
Replacement Pump	P-ECO-MICRO10006-S
Replacement Flow sensor	P-ECO-MICRO10007-S
50x 47mm Filters 2.0um	P-ZRU-10-002322-0050
Battery pack	P-ECO-MICRO11001-O
Battery charger, 240V	P-ECO-MICRO10002-O
Battery charger with timer, 100-250V	P-ECO-MICRO11003
Solar panel 30W and accessories	P-ECO-MICRO10003-O
Long inlet tube	P-ECO-MICRO10007-O
Outdoor mounting bracket kit	P-ECO-MICRO10008-O
PM ₁₀ to PM _{2.5} Nozzle Adaptor	P-ECO-MICRO100025-O
Flow-rate checking kit	P-ECO-MICRO11010-O
Wind speed & direction sensor and mounting arm	
Cable to suit wind sensor, specify length	
Tipping bucket rain gauge and bracket	
Cable to suit rain gauge, specify length	
Trigger input cable, specify length	

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