INSTALLATION AND OPERATING MANUAL

VS8500 Intelligent Viable Air Sampler

ASL, Pharmagraph Division

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REVISION HISTORY

Date	Revision	Updated by	Detail
11 Apr 2018	1.00	T. McCollin	Created.
12 Nov 2018	2.00	T. McCollin	Up issued to reflect design changes
06 Mar 2020	3.00	T. McCollin	Added information pertaining to the Petri dish height adjustment and centralisation
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01 Oct 2020	4.01	T. McCollin	Added information on Flow Fault - Low Fan Current alarm and Sieve Head Correction Factors
30 Jul 2021	5.00	T. McCollin	Updated to reflect changes made in F/W Version 3.01 and to incorporate Biological and Physical Efficiency Results

1 INTRODUCTION

This document constitutes the Installation and Operating Manual for the VS8500 Intelligent Viable Air Sampler. It should be read in conjunction with the enVigil software manual that describes the configuration and operation of the monitoring software.

The VS8500 Intelligent Viable Air Sampler is a compact microbiological air sampler with integral flow measurement for use in all grades of clean room environment. The VS8500 provides outstanding functionality in a single integrated module:

- Easy fit aspirating head for a 90 mm Petri dish
- Height-adjustable plate supports for a 90mm Petri dish
- Aspirating fans for user selectable air flow at either 100 l/min or 50 l/min
- Monitoring and control of the fan to ensure a constant flow rate
- Configurable run time methods: Single Sample, Intermittent Sampling and Gassing
- Industry standard protocol for communications with Facility Monitoring Systems (FMS)
- Available in both Tri-Clover and free-standing (pedestal) base variants

To facilitate in-head air flow measurement and provide diagnostic information, the following parameters are measured internally:

- Differential pressure across the iVAS
- Air temperature
- Barometric pressure
- Fan current
- Fan speed
- Fan motor run hours

The Petri dish is supported within the unit on three crank shaped stands. These stands can be adjusted to vary the height of the Petri dish to ensure that the distance from the top of the agar to the bottom of the aspirating head matches the distance that was used during Biological Efficiency testing. The crank handles can also be positioned to centralise the Petri dish.

The control and monitoring of the fan along with the communications link is provided by a single PCB, housed within a fully sealed compartment of the module to prevent VHP from affecting the PCB.

The internal control PCB powers the fan motor and monitors the speed of the fan and the pressure across a controlled orifice. The pressure sensor reading is converted to an air flow rate using an algorithm. A Pulse Width Modulated (PWM) drive signal controls the fan to maintain the air flow through the air sampler to either 100 l/min or 50 l/min.

During calibration, setpoints are recorded for both 100 l/min and 50 l/min flow rates. When the correct flow has been established by varying the fan speed, the settings for the pressure across the orifice, fan speed, and drive current are written to non-volatile memory within the unit. Allowable limits are also written to the unit so that fault conditions can be detected. The flow rate for each sample can be defined at run-time via the communications link prior to starting a sample.

The VS8500 communicates with the FMS using Modbus RTU over RS485.

2 SPECIFICATION

- VS8501 module dimensions (with free-standing pedestal base)
  Max. diameter 104 mm
  Depth 122 mm
  Weight 2 kg
- VS8502 module dimensions (with Tri-Clover base)
  Max. diameter 104 mm
  Depth 144 mm
  Weight 2 kg
- VS8503 aspirating head calculated D50 values
  At 100 l/min: 1.1 µm
  At 50 l/min: 1.6 µm
- Air flow control error: ± 4 % of l/min value
- Power supply
  24VDC ±10%
  100 l/min: 650mA (1.2A on start-up)
  50 l/min: 200mA (400mA on start-up)
- Interfaces
  RS485 to host
  Protocol: Modbus RTU
  Baud rate: Fixed at 19k2 baud
  Max. distance: 1.2km (dependent on cable, since power is carried via spare cores)
- Environmental
  Operating temperature 0 to 50°C
  Storage temperature -20 to 60°C

2.1 Physical and Biological Efficiency

The results of the Physical and Biological Efficiency testing performed on the iVAS at Public Health England, Porton Down can be seen in Figure 1 and Figure 2. More information about the testing completed can be found in the associated White Paper (PHA-10-21) which is available on request.

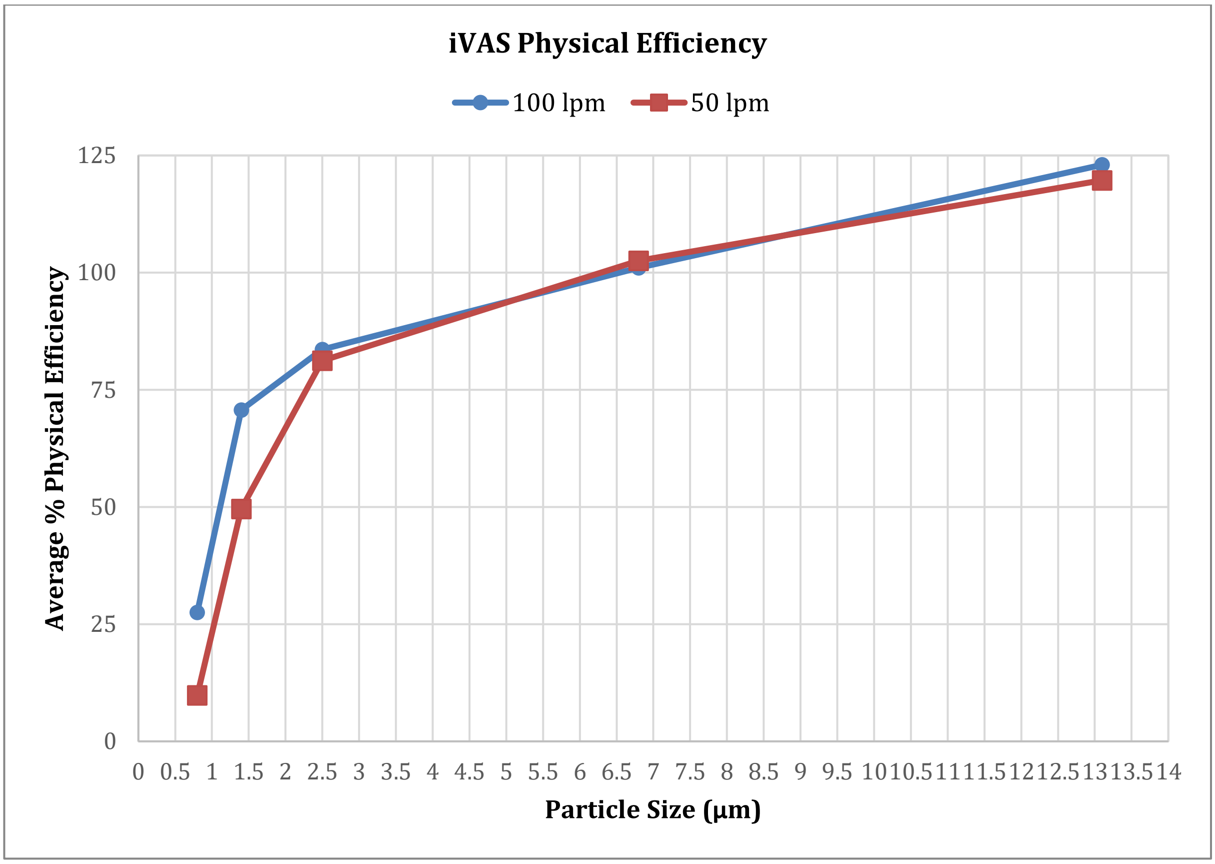


Figure 1 – iVAS Physical Efficiency

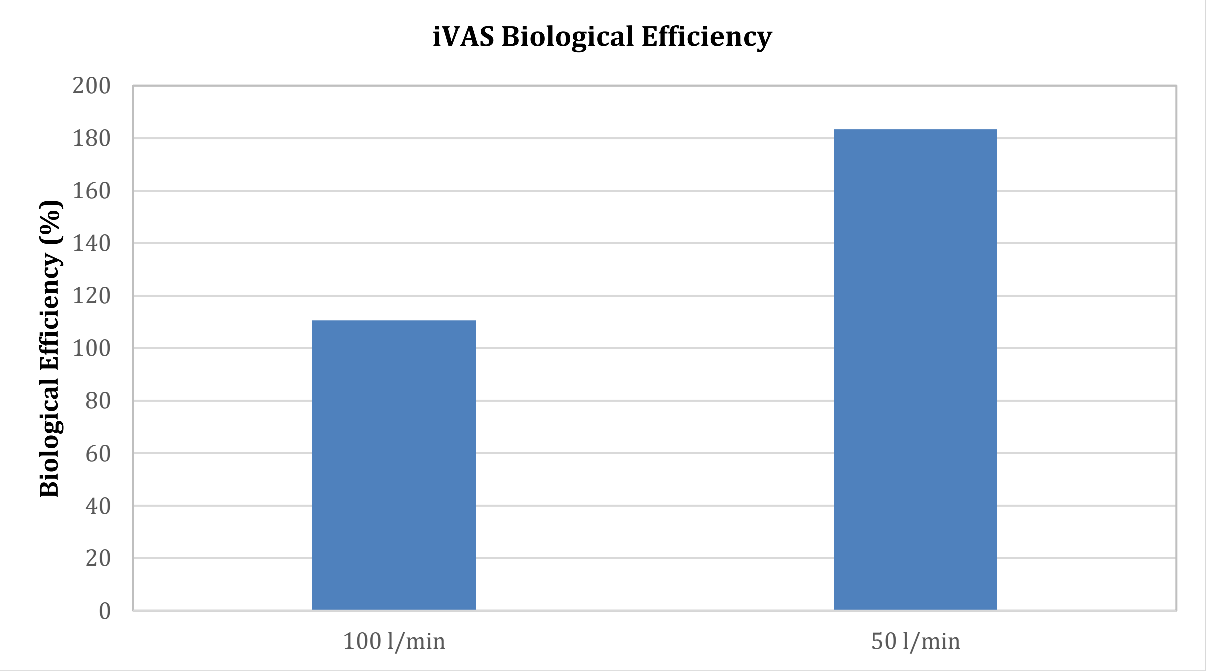


Figure 2- iVAS Biological Efficiency

3 AN OVERVIEW OF THE VS8500

The recommended general arrangement of a system using VS8500 modules with a VE8206 enclosure housing an MX6001 controller module is shown in Figure 3 below.

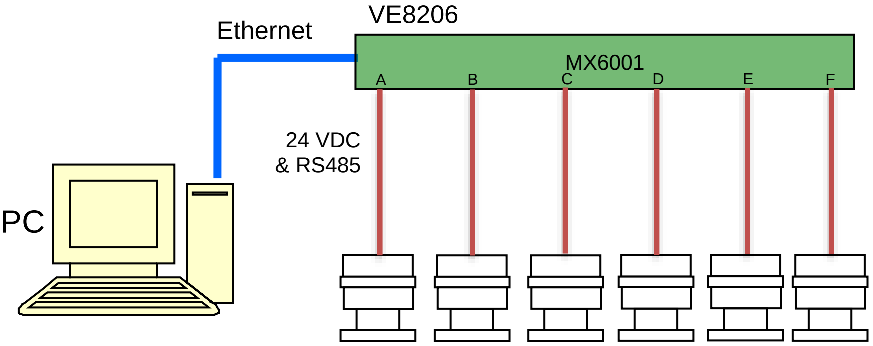


Figure 3 – Recommended System Arrangement

3.1 Power Supply

If the VS8500 is used in the recommended system arrangement shown in Figure 3 then the VE8206 will supply each VS8500 with a suitable 24Vdc supply.

If the VS8500 is connected directly to an RS485 port on a PC/PLC, then a suitable 24 VDC supply must be supplied to each VS8500.

3.2 Communications Interfaces

When the VS8500 is used in the arrangement shown in Figure 3 then the MX6001 will communicate with each VS8500 via a bus biased RS485 link.

If VS8500 is connected directly to a PC/PLC, then *each* VS8500 must be connected to a unique RS485 port on the PC/PLC. Further information on how to connect the VS8500 to a PC/PLC can be found in Section 4.

In both cases the VS8500 behaves as a Modbus RTU Server. Further information on the behaviour of the Modbus RTU link can be found in Section 5.

3.3 Operation

The VS8500 has been designed to draw air from the surrounding area through a series of identical circular holes towards a 90 mm Petri dish. The number and size of the holes has been selected to ensure a high quality D50 value while keeping the impact velocity of the particles down.

The VS8500 contains a pair of counter rotating fans that draw air through the Intelligent Air Sampler (IAS). The fans are controlled by a PCB within the unit which provides a Pulse Width Modulated signal to control the flow to either 100 or 50 l/min.

The VS8500 unit measures the flow by measuring the pressure drop across a controlled orifice and uses this to calculate the *mass flow* rate of air through the unit. The VS8500 then uses its on-board barometric pressure and air temperature sensors to calculate the *volumetric flow* rate.

The VS8500 provides a constant flow rate throughout the sample by performing a PID control loop of the calculated volumetric flow rate vs. volumetric flow rate setpoint for the current sample (set to either 100 or 50 l/min). Within 30 seconds of the start of an Intermittent or Continuous sample if the VS8500 does not achieve a flow rate within ±10 % of the setpoint, then the VS8500 will raise an alarm and abort the sample.

To accommodate a variety of plate designs and fill depths, the 90 mm Petri dish supports on the VS8500 have been designed to be raised and lowered. See section 6 for more details. The VS8500 centralises the Petri dish using 3 pins which are integral to the plate height adjusters.

While the fan is running, the VS8500 monitors the fan speed of both inlet and outlet fans along with the pressure across the controlled orifice. If the VS8500 detects that either the inlet or outlet fan fails to start, then it will raise an alert.

The VS8500 also monitors the current drawn by both the inlet and outlet fans and provides the sum of these values for diagnostic purposes and alarm (see Section 3.4).

The VS8500 has three fully configurable run time methods for Single Sample, Intermittent Sampling and Gassing. In Single Sample and Intermittent run time modes the VS8500 will run the fan at the desired flow rate for long enough to draw a target volume of air across the Petri dish. In Gassing mode, the VS8500 continuously runs the fan at a set speed until the Gassing mode demand is removed. All three run time methods are discussed in more detail in the following subsections.

3.3.1 Single Sample Mode

In Single Sample Mode the VS8500 runs the fan at the desired flow rate setpoint until it has been run for long enough to have sampled the target volume.

The target volume and desired flow rate must be defined prior to the sending the Single Sample Mode demand to the unit. The VS8500 stores the target volume and the desired flow rate in volatile memory so they need to be written to the VS8500 each time it is power cycled.

During each Single Sample, the VS8500 integrates the measured flow rate to determine the volume of air that has been sampled in the current run time as shown in Figure 2. When the VS8500 determines that volume sampled is greater than the target volume it stops the fan and completes the Single Sample.

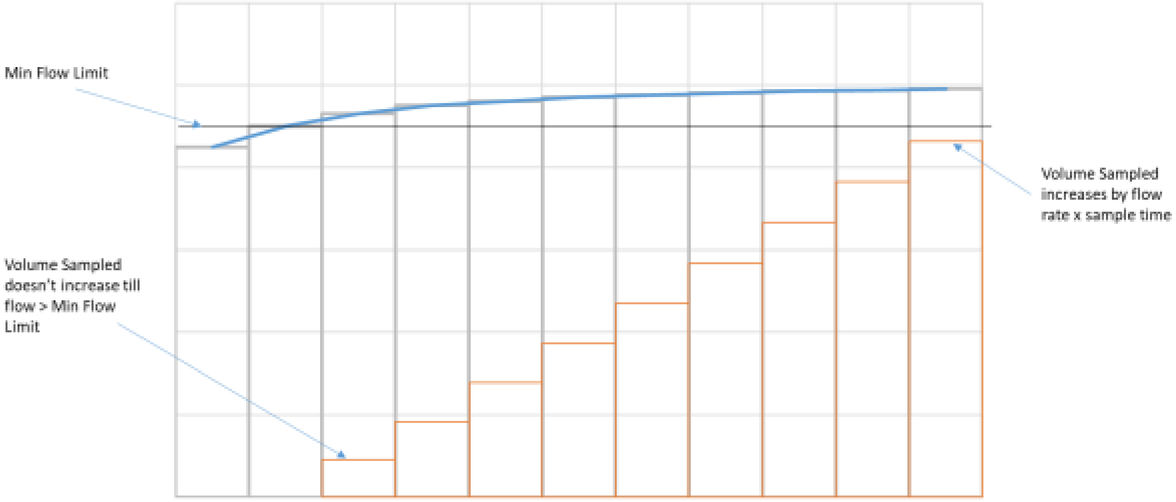


Figure 4 – Volume Integration

While in the Single Sample Mode the VS8500 provides the operator with the following parameters:

- Percentage complete
- Time left to complete sample in seconds
- Total time required to complete the sample in seconds
- Current time the head has been run for in this sample in seconds
- Estimated volume of air that has been drawn across the petri dish (m^3)

Upon starting a Single Sample Mode run, the VS8500 drives the fan according to parameters captured during the unit's calibration for the currently selected flow rate. It allows the fan to get to speed then begins to monitor the flow rate. Once the measured flow rate is within ±10 % of the flow rate setpoint, then the VS8500 controls the fan speed and starts to calculate the volume sampled as shown in Figure 4.

If the measured flow rate does not settle to within ±10 % of the flow rate setpoint within 30 seconds of sample start, the VS8500 will raise the "Failed to Achieve Flow" alarm and abort the sample. The "Failed to Achieve Flow" alarm will be held high until the next sample is demanded.

3.3.2 Intermittent Mode

In Intermittent Sampling mode the VS8500 splits the run time required to achieve the target volume at the desired flow rate into a series of intermittent shorter samples. The number of shorter samples used, along with the interval between the start of each shorter sample, can be defined prior to starting the sample.

An example of how the VS8500 can configured in Intermittent mode can be seen below:

- Desired flow rate: 100 l/min head
- Total target sample volume: 1 m^3
- Number of sampling periods: 4 separate periods
- Time between the start of each period 20 minutes apart

In this case an operator would set the parameters on VS8500 as follows:

- Target volume: 1 m^3
- Interval: 1200 sec (20 min)
- No. runs: 4

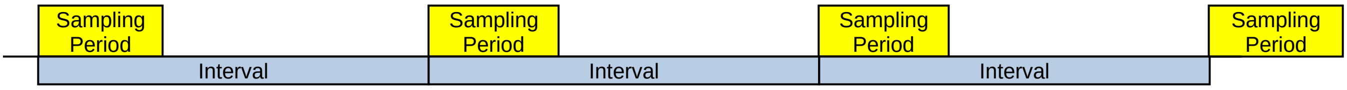
The VS8500 would then calculate the volume that needs to be sampled in each sampling period using the following formula:

$$Sampling\ Period\ Volume\ (m^3) = \frac{Target\ Volume\ (m^3)}{No\ Sampling\ Periods}$$

For this example, the VS8500 would set the Sampling Period Volume = 0.25 m^3.

During each sampling period, the VS8500 integrates the measured flow rate (as described in Section 3.3.1) to determine the volume of air that has been sampled. When the VS8500 determines that volume sampled in this period is greater than the Sampling Period Volume, it stops the fan and awaits the start of the next Sampling Period.

A representation of the above example can be seen below:



Note in this example the head will perform 4 run time periods but only 3 whole intervals such that the overall time is 62.5 mins, i.e. 3 x Interval + 1 x Run Time.

While in Intermittent Sample Mode the VS8500 provides the operator with the following parameters:

- Percent of run time complete
- An estimate of the time left to complete whole sample in seconds
- An estimate of the overall time it will take to complete the sample in seconds
- The overall time the head has been run for in this sample in seconds
- The time the head has been run for in the current run time period in seconds
- Overall volume of air that has been drawn across the petri dish (m^3) during all the Sampling Periods so far.

Upon commencing each sampling period, the VS8500 drives the fan using the PWM demand captured for the current flow rate during the unit’s calibration to allow the fan to get to speed. It also starts to monitor the flow rate. Once the measured flow rate is within ±10 % of the flow rate setpoint then the VS8500 will perform the PID control of the Fan speed and start to calculate the volume sampled as shown in Figure 4.

If the measured flow rate does not settle to within ±10 % of the flow rate setpoint within 30 seconds of the sample being started, then the VS8500 will raise the “Failed to Achieve Flow” alarm and abort the sample. The “Failed to Achieve Flow” alarm will be held high until the next sample is demanded.

While the VS8500 is in the period between the end of one runtime period and the start of the next the fan parameter alarms will be disabled to prevent spurious alarms. During the initial 5 second period of each period, the alarm checking logic is also disabled to prevent spurious alarms while the device is getting up to speed.

If the operator specifies parameters such that the interval period is shorter than the theoretical amount of time required for each Sampling Period Volume, the VS8500 will automatically set the interval period equal to double the theoretical time required. For example, if an operator initially sets up the device as follows:

- Target Volume = 1 m^3, Flow Rate = 100 l/min
- No. runs = 10
- If the interval was set to 0 it would be modified to 120 sec

If the operator decides instead to have only 2 runtime samples then the VS8500 will automatically update the parameters as follows:

- Target Volume = 1 m^3
- No. runs = 2
- Interval = 600 sec

3.3.3 Gassing Mode

When the VS8500 receives a Gassing Mode demand it runs the fan continuously at a speed setpoint until the Gassing Mode demand is removed.

During Gassing, the VS8500 provides the operator with the duration of time in seconds that the fan has been running.

During Gassing mode, the VS8500 runs the fans at the speed set during calibration and does not control the Flow Rate. All Alarms and Warnings are inhibited to prevent spurious alerts.

3.4 Fan/Motor Alarm Checking

While running, the VS8500 performs an alarm limit check on the inlet and outlet fan speeds and the combined Fan Current.

If the VS8500 detects that either of the two fans fail to start (their speed is still measured as 0 Hz) then it will raise the “Fan Failed to Start Alarm” for the fan in question.

If the VS8500 detects that the combined Fan Current has fallen below a tuneable tolerance of the combined Current setpoint for the flow rate in question, then it will raise the “Flow Fault - Low Fan Current” alarm and the Fault Output. When the “Flow Fault - Low Fan Current” alarm is raised the VS8500 will abort the current sample. The “Flow Fault - Low Fan Current” alarm could be caused by a blockage to the sieve head that has not been picked up by the Flow Rate fault checking. If the “Flow Fault - Low Fan Current” is raised and there is no apparent blockage to the unit then the tuneable tolerance should be adjusted, this can be done via one of the VS8500’s Modbus Registers (see Section 5.2). The tuneable tolerance is a percentage and the Low Fan Current Alarm level is calculated as follows:

$$Alarm\ Level = \left(1 - \frac{Tunable\ Tolerance}{100}\right) * Current\ Setpoint$$

The current setpoint for each flow rate is captured during calibration as the average current drawn by the fan across 10 seconds of running at the flow rate in question. The Current Setpoint is stored in Flash Memory within the VS8500.

NOTE: the operating Fan Current for a given Volumetric Flow rate is dependent on the Ambient Air Conditions (Air Temperature and Barometric Pressure) therefore the Current Setpoint should be captured once the iVAS has been installed within the Facility. See Section 7 for more information on how to perform this operation.

3.5 Environmental Monitoring

The VS8500 control PCB has on-board barometric pressure and air temperature sensors. These values are updated once every 10 minutes and are used by the VS8500 to convert the standard volumetric flow rate, calculated from the differential pressure measured across the controlled orifice, into volumetric flow rate.

The VS8500 also outputs the values of the barometric pressure and air temperature sensor as Modbus registers, along with a calculated air density value obtained from these two measurements.

If the VS8500 fails to communicate with either of these on-board sensors, then it will raise a “Sensor Failed” alert. When it detects a “Sensor Failure”, the VS8500 will force the value of that sensor to a fixed value.

3.6 Fan Cumulative Runtime

The VS8500 calculates a cumulative hours and minutes run time counter for the fan assembly. This time is incremented while the fans are running in any of the three run time methods discussed in Section 3.3. As the fans are supplied as a single package, the cumulative run time is the same for both the inlet and outlet fans.

The cumulative run time is stored within non-volatile memory within the VS8500 to the nearest 10 minutes.

If the fan assembly is replaced by a suitably qualified and experienced service engineer, they will reset the fan run time in accordance with the procedure.

4 CONNECTING THE VS8500

Since the VS8500 uses two wire RS485 communication, you must ensure that the RS485 interface has Tx+ connected to Rx+, and Tx- connected to Rx-. Some RS485 interfaces allow this to be setup via jumpers or switches on the PCB. If this facility is not available, then you must make this links within the RS485 plug attached to the interface board.

Make sure to connect A and B correctly and that the port is set for RS485 half-duplex auto-gating mode in the computer setup panel.

4.1 Free-Standing (Pedestal) Base

The free-standing base variant of the VS8500 supplied with a 5-way female Camden Boss connector. The pin-out of the connector is outlined in the table below:

Mating Connector Type: Camden Boss CCA1P1/A05

Pin No.	Description
1 (below the keyway)	+24Vdc
2	0V
3	RS485 A
4	RS485 B
5	RS485 Screen

4.2 Tri-Clover Base

The Tri-Clover base variant of the VS8500 supplied with a 4-way circular connector. The pin out of the connector is outlined in the table below:

Mating Connector Type Binder 99-0410-00-04

Pin No.	Description
1	+24Vdc
2	0V
3	RS485 A
4	RS485 B

5 MODBUS OPERATION

VS8500 modules communicate with the host Facility Monitoring System (FMS) using Modbus RTU protocol over an RS485 link. The protocol is compliant with MODBUS Application Protocol Specification V1.1b3 and should allow the unit to be connected to and be controlled by local operator panels or PLCs.

The VS8500 RS485 port has the following fixed settings:

- 19200 baud
- 8 data bits
- 1 stop bit
- no parity
- fixed bus address of 01

The VS8500 will respond only to the Modbus function codes shown in Table 1.

Function Code	Description	Expected Use
0x03	Read Holding Registers	Reading parameter values from the VS8500
0x04	Read Input Registers	Reading parameter values from the VS8500
0x06	Write Single Register	Setting a single signed integer control parameter value on the VS8500
0x10	Write Multiple Registers	Setting multiple signed integer or single/multiple floating-point control parameter values on the VS8500

Table 1 – Supported Modbus Function Codes

VS8500 supports both Function Code 0x3, Read Holding Registers and Function Code 0x4, Read Input Registers, and on receiving either of these, the VS8500 will behave in an identical manner.

The VS8500 can perform the read/write register commands in either Signed Integer or Floating-Point format depending on the register requested.

In signed integer mode, the unit returns the value of the parameter scaled by the number of decimal places multiplied by 10. For instance, a signal that is measured to 1 decimal place will be scaled by a factor of 10, whereas a signal that is measured to 2 decimal places will be scaled by a factor of 100.

In floating point mode, the unit returns the value as a 32-bit IEEE 754 Floating Point format. Since a single Modbus register is only 16-bits this means that each value must be transmitted as two registers. The values are sent in Big Endian format (i.e. with the most significant byte sent first).

The tables in the following sub-sections define the signed integer and floating-point register map and indicate which registers can be modified by the user. The number of decimal places each parameter is scaled by is also defined in the Tables.

5.1 Control Signals

Signed Int Register (Base 1)	Floating Point Register (Base 1)	Read/ Write	Description	Units	Decimals
1	501	R/W	Intermittent Mode run command		0
2	503	R/W	Gassing Mode run command		0
3	505	R/W	Continuous Mode run command		0
6	511	R	Motor running status		0
7	513	R	Fault detected status		0

5.2 Program registers

Signed Int Register (Base 1)	Floating Point Register (Base 1)	Read/ Write	Description	Units	Decimals
12	523	R/W	Interval	sec	0
13	525	R/W	No. runs		0
14	527	R	Control Mode (0 = Speed, 1 = Volumetric Flow)		0
17	533	R/W	Flow rate (0 = 100 l/min, 1 = 50 l/min)		0
18	535	R/W	Target volume	m^3	3
19	537	R/W	Target volume (l)	l	0

5.3 Error reporting registers

Signed Int Register (Base 1)	Floating Point Register (Base 1)	Read/ Write	Description	Units	Decimals
21	541	R	Inlet fan failed to start	-	0
22	543	R	Outlet fan failed to start	-	0
23	545	R	Failed to achieve flow rate alarm	-	0
24	547	R	Flow Fault - Low Fan Current	-	0
25	549	R	Air temperature sensor failed	-	0
26	551	R	Barometric pressure sensor failed	-	0

5.4 Fan/Motor Run Time Registers

Signed Int Register (Base 1)	Floating Point Register (Base 1)	Read/ Write	Description	Units	Decimals
27	553	R	Time since last service (hours)	Hours	0
28	555	R	Time since last service (mins)	Min	0

5.5 Runtime registers

Signed Int Register (Base 1)	Floating Point Register (Base 1)	Read/ Write	Description	Units	Decimals
30	559	R	Percent of sample time complete	%	0
31	561	R	Percent of volume sampled	%	0
32	563	R	Time left to sample complete	sec	0
33	565	R	Total sample duration	sec	0
34	567	R	Total head run time	sec	0
35	569	R	Current run time	sec	0
36	571	R	Inlet fan frequency	Hz	0
37	573	R	Outlet fan frequency	Hz	0
38	575	R	Current volumetric flow rate	lpm	0
39	577	R	Estimated total volume sampled	m^3	3
40	579	R	Estimated total volume sampled (litres)	l	0
71	641	R	Inlet fan current	mA	0
72	643	R	Outlet fan current	mA	0
73	645	R	Total fan current	mA	0
75	649	R	Pressure across controlled orifice	Pa	0
76	651	R	Current standard volumetric flow rate	slpm	0
77	653	R	Barometric pressure	mBar	0
78	655	R	Air temperature	^oC	1
79	657	R	Air density	kg/m^3	3

5.6 Calibration and setup registers

Signed Int Register (Base 1)	Floating Point Register (Base 1)	Read/ Write	Description	Units	Decimals
42	581	R	Speed control setpoint	Hz	0
43	583	R	Flow rate setpoint	lpm	0
51	601	R	PCB serial number		0
52	603	R	Calibration date - day		0
53	605	R	Calibration date - month		0
54	607	R	Calibration date - year		0
55	609	R	Product code		0
56	611	R	F/W version		0
57	613	R	Batch code		0
58	615	R	Assembly serial number		0

6 SETTING THE PETRI DISH

As outlined in Section 1 the 90 mm Petri dish is supported within the unit on 3 crank shaped supports. These supports can be adjusted to vary the height of the Petri dish and to ensure that it is centralised once placed within the unit. To aid in this process, every VS8500 unit is supplied with a Petri dish Setting Tool shown in Figure 5.

Figure 5 – Petri dish Setting Tool

The setting tool is used for both setting the height of the medium and centralising the Petri dish. The diameter settings are stepped in and marked at diameters 83, 85, 87, 89 and 91 to the left of the upstand and for even diameters 84, 86, 88 and 90, to the right of the upstand. They can be used for rotating the crank handles to centralise the Petri dish. The top of the upstand is used to set the level for the Petri dish medium.

6.1 Setting the height of the medium

In order to set the crank supports to obtain the optimum distance between the top of the agar and the bottom of the aspirating head the following equipment will be required:

- The Petri dish setting tool
- A Petri dish of the type is intended to be used filled with the desired volume of agar solution.

Using the equipment listed above, the crank supports should be adjusted as follows:

- The setting tool should be laid between the cranks as shown in Figure 6

Figure 6 – Setting Tool Placement for height adjustment

- The Petri dish is now placed on the crank supports as shown in Figure 7

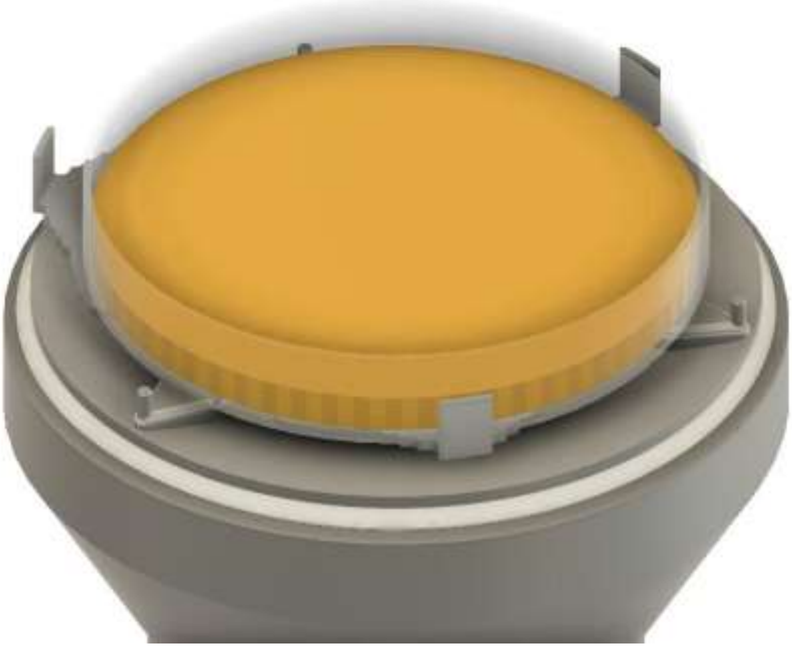


Figure 7 – Petri dish placed on crank supports

- Select any of the three setting tool upstands and slide it into contact with the side of the Petri dish to prevent parallax error when setting the medium level to the top of the upstand.
- Estimate the height adjustment required, the top of the agar solution needs to be level with the top of the plastic upstands.

- Remove the Petri dish and adjust the height of the crank supports adjacent to the plastic upstand by turning the cranks, clockwise to lower, anticlockwise to heighten, looking down onto the crank. Adjust the height, bearing in mind that one full rotation of the crank will give a height adjustment of 0.8mm.
- Should the crank's final position result in the pin being under the Petri dish, the crank can be pulled upward (approximately 2mm) to disengage it, rotated to be outboard of the Petri dish and pushed back down to engage. Re-engagement is possible every 60° of rotation. This will not alter the height setting.
- Reposition the Petri dish on the crank supports to check that top of the agar is now level with the top of the plastic upstand. Readjust the adjacent crank supports if necessary.
- Proceed, selecting the next setting tool upstand in a clockwise direction, repeating the above steps until the height of the medium has been set in all three positions.

6.2 Centralising the Petri dish

Ascertain the outside diameter of the base of the Petri dish - it will be an odd or even number of mm. The Setting Tool should be laid on the cranks as shown in Figure 8. In this example, an odd mm sized Petri dishes is to be used so the first crank pin is near the odd mm markings.

Figure 8 - Setting Tool placement for plate centralisation (odd diameters shown)

The setting tool should be centralised with the upstand edges in contact with the crank pins – left edges for odd sizes and right edges for even sizes. The cranks can then be adjusted as follows to provide plate centralisation:

- Rotate the Setting Tool away from the pins slightly to make some room then turn the first crank towards the upstand until the pin engages in the desired diameter step. You may need to rotate the tool again to achieve this.
- Now, **without moving the setting tool**, turn the remaining two cranks until they touch the relevant step in the setting tool.
- The setting tool can now be removed since the Petri dishes will now be automatically centralised at the correct height.

NOTE: The minor rotation of the cranks to achieve Petri dish centralisation will have negligible effect on the height setting.

7 FAN OPERATING POINT CAPTURE

This section outlines how to capture Fan Operating Points for the iVAS once it has been fully installed. This procedure needs to be performed on the site where the iVAS will be operated as the parameters captured are dependent on the Ambient Air Conditions. For this reason the procedure below should be incorporated into any Installation Acceptance Tests that are performed on iVAS units.

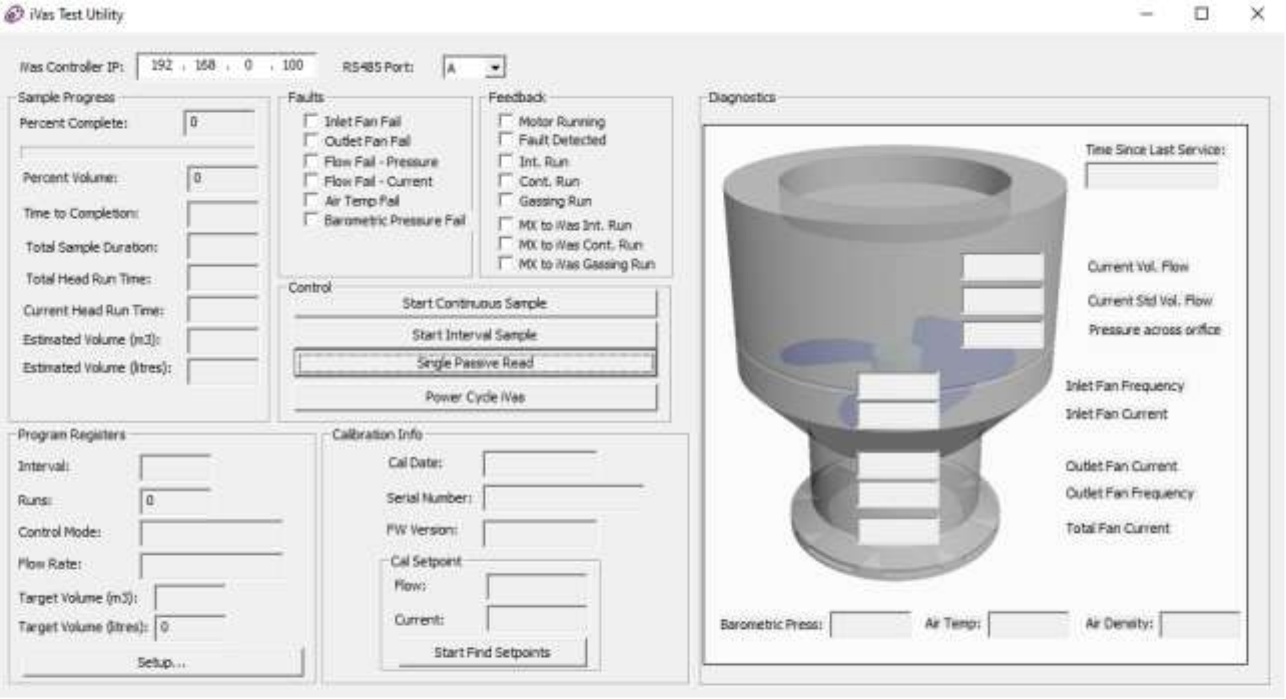
7.1 Pre-requisites

The procedure outlined below should be carried out with a Production standard Petri-Dish and once the iVAS Plate Setting procedure outlined in Section 6 has been successfully completed.

The latest version of the iVAS Test Utility will need to be installed onto a Computer that is connected via Ethernet to a VE8206 controller that is connected to the iVAS in question.

7.2 Procedure

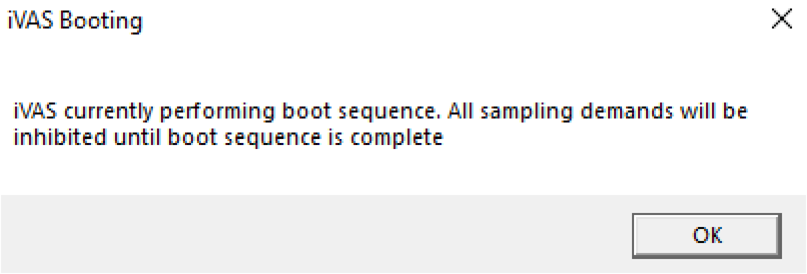
- Open the iVAS Test Utility on the Computer (the Dialog shown in Figure 9 should be displayed)



iVas Controller IP: 192 . 168 . 0 . 100
RS485 Port: A
Percent Complete: 0
Percent Volume: 0
Runs: 0
Target Volume (litres): 0

Figure 9 – iVAS Test Utility

- Enter the IP Address of the VE8206 Controller and select the Port of the iVAS to be configured
- Press “Single Passive Read” to test the communications with the iVAS if the iVAS is still booting then the message box shown in Figure 10 will be shown

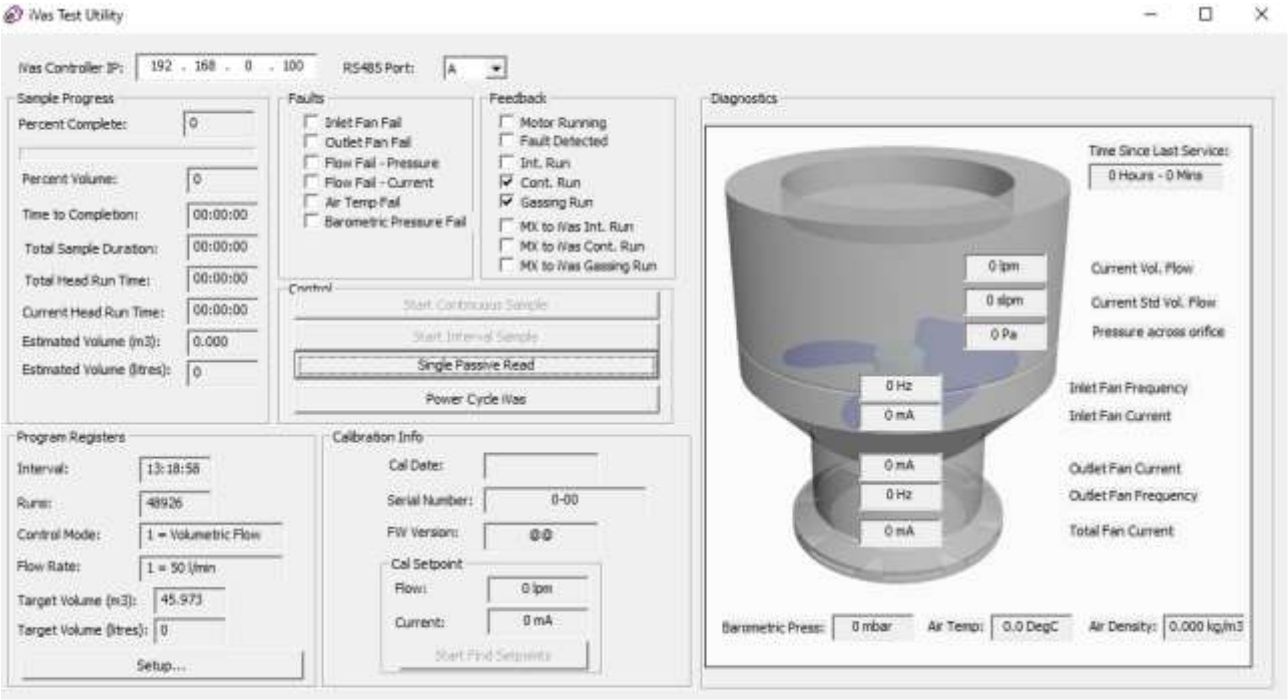


iVAS Booting

iVAS currently performing boot sequence. All sampling demands will be inhibited until boot sequence is complete

Figure 10 – iVAS Booting Message Box

- Whilst the iVAS is booting the iVAS Test Utility will disable all of the sample demand buttons as shown in Figure 11



iVas Controller IP: 192 . 168 . 0 . 100
RS485 Port: A

Percent Complete: 0
Percent Volume: 0
Time to Completion: 00:00:00
Total Sample Duration: 00:00:00
Total Head Run Time: 00:00:00
Current Head Run Time: 00:00:00
Estimated Volume (m3): 0.000
Estimated Volume (litres): 0

☐ Inlet Fan Fail
☐ Outlet Fan Fail
☐ Flow Fail - Pressure
☐ Flow Fail - Current
☐ Air Temp Fail
☐ Barometric Pressure Fail

☐ Motor Running
☐ Fault Detected
☐ Int. Run
☑ Cont. Run
☑ Gassing Run
☐ MX to iVas Int. Run
☐ MX to iVas Cont. Run
☐ MX to iVas Gassing Run

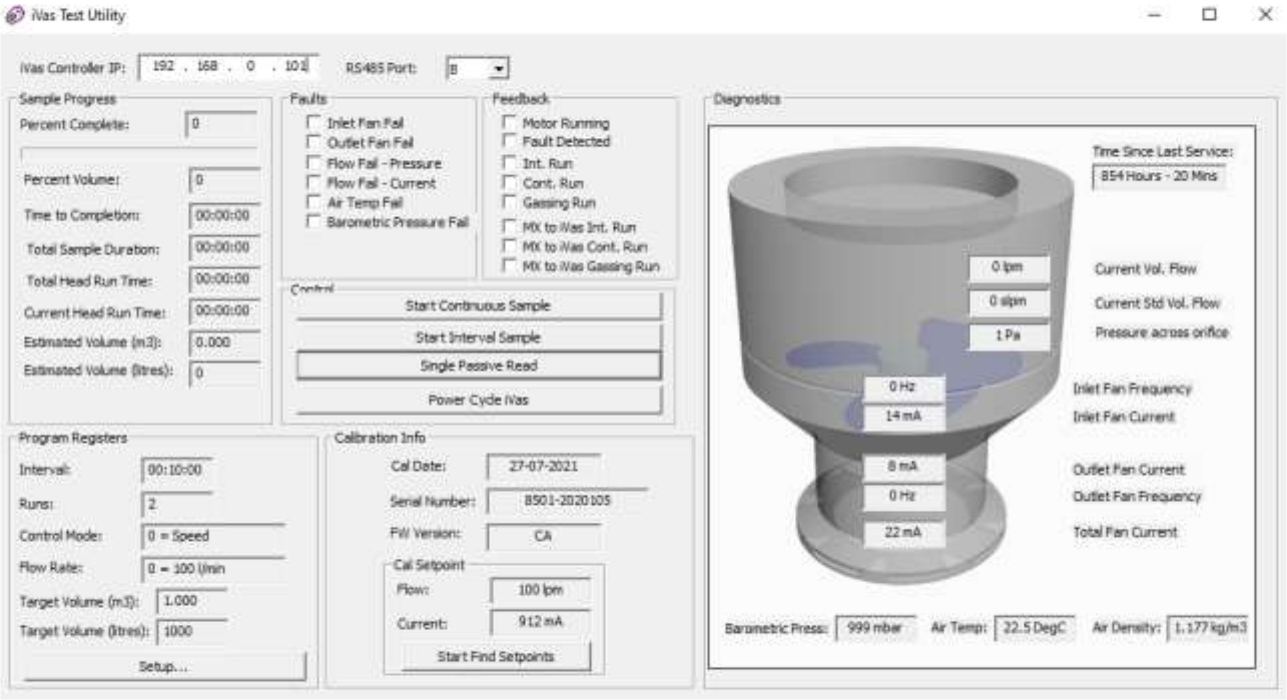
Interval: 13:18:58
Runs: 48926
Control Mode: 1 = Volumetric Flow
Flow Rate: 1 = 50 l/min
Target Volume (m3): 45.973
Target Volume (litres): 0

Cal Date:
Serial Number: 0-00
FW Version: @@
Flow: 0 lpm
Current: 0 mA

Time Since Last Service: 0 Hours - 0 Mins
Current Vol. Flow: 0 lpm
Current Std Vol. Flow: 0 slpm
Pressure across orifice: 0 Pa
Inlet Fan Frequency: 0 Hz
Inlet Fan Current: 0 mA
Outlet Fan Current: 0 mA
Outlet Fan Frequency: 0 Hz
Total Fan Current: 0 mA
Barometric Press: 0 mbar
Air Temp: 0.0 DegC
Air Density: 0.000 kg/m3

Figure 11 – iVAS Test Utility During Boot Sequence

- Once the iVAS has completed its boot sequence the iVAS Test Utility will re-enable the sample demand buttons and show the current values of the all the iVAS registers as shown in Figure 12



iVas Controller IP: 192 . 168 . 0 . 101
RS485 Port: B

Percent Complete: 0
Percent Volume: 0
Time to Completion: 00:00:00
Total Sample Duration: 00:00:00
Total Head Run Time: 00:00:00
Current Head Run Time: 00:00:00
Estimated Volume (m3): 0.000
Estimated Volume (litres): 0

☐ Inlet Fan Fail
☐ Outlet Fan Fail
☐ Flow Fail - Pressure
☐ Flow Fail - Current
☐ Air Temp Fail
☐ Barometric Pressure Fail

☐ Motor Running
☐ Fault Detected
☐ Int. Run
☐ Cont. Run
☐ Gassing Run
☐ MX to iVas Int. Run
☐ MX to iVas Cont. Run
☐ MX to iVas Gassing Run

Interval: 00:10:00
Runs: 2
Control Mode: 0 = Speed
Flow Rate: 0 = 100 l/min
Target Volume (m3): 1.000
Target Volume (litres): 1000

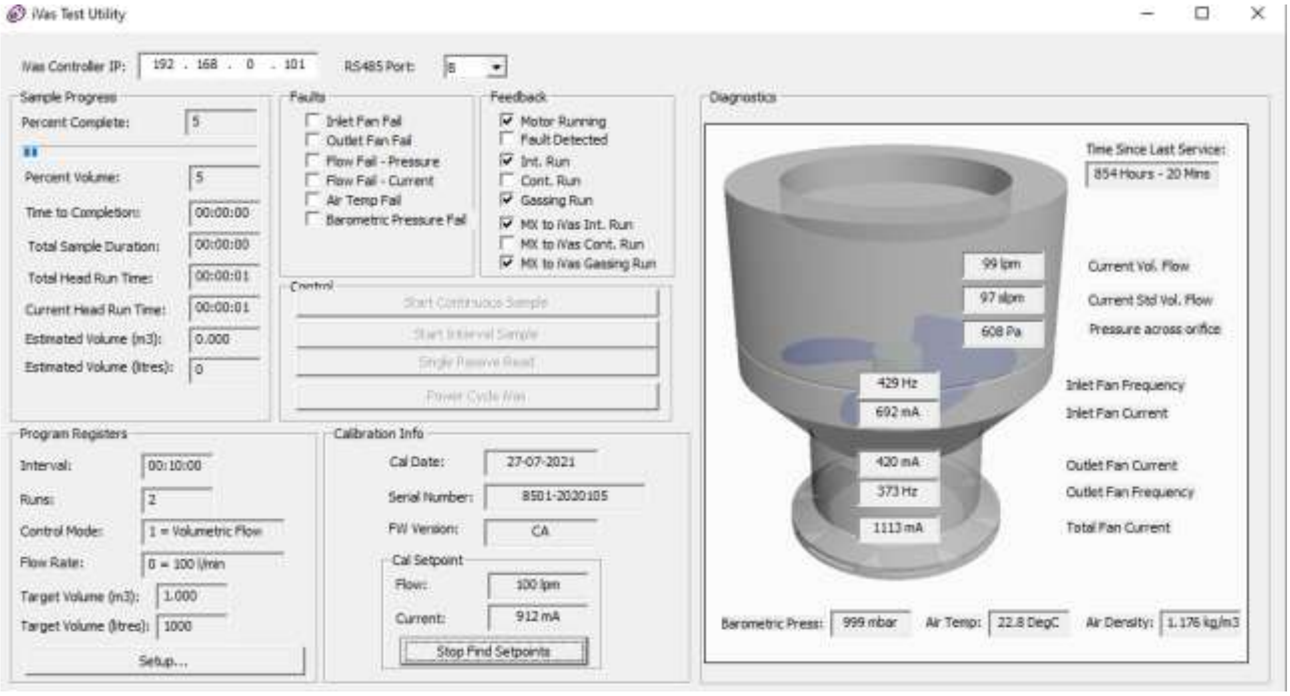
Cal Date: 27-07-2021
Serial Number: 8501-2020105
FW Version: CA
Flow: 100 lpm
Current: 912 mA

Time Since Last Service: 854 Hours - 20 Mins
Current Vol. Flow: 0 lpm
Current Std Vol. Flow: 0 slpm
Pressure across orifice: 1 Pa
Inlet Fan Frequency: 0 Hz
Inlet Fan Current: 14 mA
Outlet Fan Current: 8 mA
Outlet Fan Frequency: 0 Hz
Total Fan Current: 22 mA
Barometric Press: 999 mbar
Air Temp: 22.5 DegC
Air Density: 1.177 kg/m3

Figure 12 – iVAS Test Utility Boot Sequence Complete

- In order to perform the Fan Operating Point procedure press the “Start Find Setpoints” button

- The iVAS should then start to run and will wait until the Current Volumetric Flow Rate is within ± 1 lpm Flow Rate setpoint. During this time the iVAS Test Utility will continue to update the live values of the iVAS registers
- Once the iVAS's Volumetric Flow rate is within ± 1 lpm of the Flow Rate setpoint the iVAS will monitor the Total Fan Current and calculate the average across 20 seconds. Whilst the iVAS is performing this averaging it will increment the Percent Complete register by 5 % every second (as shown in Figure 13)



iVas Controller IP: 192 . 168 . 0 . 101
RS485 Port: 6

Percent Complete: 5
Percent Volume: 5
Time to Completion: 00:00:00
Total Sample Duration: 00:00:00
Total Head Run Time: 00:00:01
Current Head Run Time: 00:00:01
Estimated Volume (m3): 0.000
Estimated Volume (litres): 0

Interval: 00:10:00
Runs: 2
Control Mode: 1 = Volumetric Flow
Flow Rate: 0 = 100 l/min
Target Volume (m3): 1.000
Target Volume (litres): 1000

Cal Date: 27-07-2021
Serial Number: 8501-2020105
FW Version: CA
Flow: 100 lpm
Current: 912 mA

Time Since Last Service: 854 Hours - 20 Mins
99 lpm Current Vol. Flow
97 slpm Current Std Vol. Flow
608 Pa Pressure across orifice
429 Hz Inlet Fan Frequency
692 mA Inlet Fan Current
420 mA Outlet Fan Current
373 Hz Outlet Fan Frequency
1113 mA Total Fan Current
Barometric Press: 999 mbar
Air Temp: 22.8 DegC
Air Density: 1.176 kg/m3

Figure 13 – iVAS Test Utility During Find Settle Point Operation

- Once the 20 second Fan Current averaging has completed the iVAS also captures the current Fan Drive setting
- The iVAS will then Stop the Fan and save the following parameters to its internal flash memory:
    - Average Fan Current – this will become the Fan Current setpoint used for all future samples to determine the value of the "Flow Fault – Low Current" alarm as described in Section 3.4
    - Fan Drive - this will be used to determine the initial demand that iVAS will send to the Fan on commencing a sample
    - Barometric Pressure – this will become the default Barometric Pressure that will be used in the event of a Barometric Pressure sensor failure
- Once the iVAS has completed the Find Setpoints operation the iVAS Test Utility will return to the view shown in Figure 12 but the Current setpoint directly above the "Start Find Setpoints" button should have been updated

8 SIEVE HEAD CORRECTION FACTORS

As the VS8500 is a static sieve type Viable Air Sampler once the sample has been taken and the petri-dish has been incubated, the number of colonies observed will need to be adjusted using the correction factors outlined in Table 2.

No Colonies Observed	Correction Factor	Estimated Viable Organisms	No Colonies Observed	Correction Factor	Estimated Viable Organisms
1	1.0131	1	37	1.1246	42
2	1.0158	2	38	1.1283	43
3	1.0185	3	39	1.1320	44
4	1.0212	4	40	1.1357	45
5	1.0239	5	41	1.1395	47
6	1.0266	6	42	1.1433	48
7	1.0294	7	43	1.1471	49
8	1.0322	8	44	1.1510	51
9	1.0350	9	45	1.1550	52
10	1.0378	10	46	1.1589	53
11	1.0407	11	47	1.1629	55
12	1.0435	13	48	1.1670	56
13	1.0464	14	49	1.1711	57
14	1.0494	15	50	1.1752	59
15	1.0523	16	51	1.1794	60
16	1.0553	17	52	1.1837	62
17	1.0583	18	53	1.1880	63
18	1.0614	19	54	1.1923	64
19	1.0644	20	55	1.1967	66
20	1.0675	21	56	1.2011	67
21	1.0706	22	57	1.2056	69
22	1.0738	24	58	1.2101	70
23	1.0769	25	59	1.2147	72
24	1.0801	26	60	1.2193	73
25	1.0834	27	61	1.2240	75
26	1.0866	28	62	1.2288	76
27	1.0899	29	63	1.2336	78
28	1.0932	31	64	1.2385	79
29	1.0966	32	65	1.2434	81
30	1.1000	33	66	1.2484	82
31	1.1034	34	67	1.2534	84
32	1.1069	35	68	1.2585	86
33	1.1103	37	69	1.2637	87
34	1.1139	38	70	1.2689	89
35	1.1174	39	71	1.2742	90
36	1.1210	40	72	1.2796	92

No Colonies Observed	Correction Factor	Estimated Viable Organisms	No Colonies Observed	Correction Factor	Estimated Viable Organisms
73	1.2851	94	116	1.6186	188
74	1.2906	96	117	1.6299	191
75	1.2962	97	118	1.6414	194
76	1.3018	99	119	1.6531	197
77	1.3076	101	120	1.6652	200
78	1.3134	102	121	1.6774	203
79	1.3193	104	122	1.6900	206
80	1.3253	106	123	1.7029	209
81	1.3314	108	124	1.7160	213
82	1.3375	110	125	1.7295	216
83	1.3438	112	126	1.7433	220
84	1.3501	113	127	1.7575	223
85	1.3565	115	128	1.7720	227
86	1.3631	117	129	1.7869	231
87	1.3697	119	130	1.8022	234
88	1.3764	121	131	1.8179	238
89	1.3832	123	132	1.8340	242
90	1.3901	125	133	1.8506	246
91	1.3972	127	134	1.8676	250
92	1.4043	129	135	1.8852	254
93	1.4116	131	136	1.9032	259
94	1.4190	133	137	1.9218	263
95	1.4264	136	138	1.9409	268
96	1.4341	138	139	1.9607	273
97	1.4418	140	140	1.9811	277
98	1.4497	142	141	2.0021	282
99	1.4577	144	142	2.0239	287
100	1.4658	147	143	2.0464	293
101	1.4741	149	144	2.0696	298
102	1.4825	151	145	2.0938	304
103	1.4911	154	146	2.1187	309
104	1.4999	156	147	2.1447	315
105	1.5087	158	148	2.1716	321
106	1.5178	161	149	2.1996	328
107	1.5270	163	150	2.2288	334
108	1.5364	166	151	2.2591	341
109	1.5460	169	152	2.2908	348
110	1.5558	171	153	2.3238	356
111	1.5657	174	154	2.3584	363
112	1.5759	176	155	2.3946	371
113	1.5862	179	156	2.4326	379
114	1.5968	182	157	2.4725	388
115	1.6076	185	158	2.5144	397

No Colonies Observed	Correction Factor	Estimated Viable Organisms	No Colonies Observed	Correction Factor	Estimated Viable Organisms
159	2.5587	407	165	2.8859	476
160	2.6054	417	166	2.9540	490
161	2.6548	427	167	3.0274	506
162	2.7072	439	168	3.1066	522
163	2.7630	450	169	3.1925	540
164	2.8224	463	170	3.2862	559

Table 2 – VS8503 Correction Factors