

# Sherwood M501 User's Manual



## Sherwood Tornado M501 Fluid Bed Dryer



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## Sherwood Tornado M501 User Manual

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# Chapter 1

## Introduction

### Customer service

Thank you for purchasing the M501 Fluid Bed Dryer from Sherwood Scientific Ltd.

If you need spare parts or service please contact your local distributor in the first instance, or Sherwood Scientific Ltd office at the address below: -

Sherwood Scientific Ltd.  
1 The Paddocks  
Cherry Hinton Road  
CAMBRIDGE  
England  
CB1 8DH

*Tel* +44 (0)1223 24 34 44

*Fax* +44 (0)1223 24 33 00

*Email* enquiries@sherwood-scientific.com

If you require spare parts please have the following information ready: -

- \_ Serial number of the instrument.
- \_ Part numbers and /or exact descriptions of the items required.
- \_ Quantity required.
- \_ Date required and any special shipment request.
- \_ Delivery address.
- \_ Purchase request / order reference.

If you require technical assistance please have the following information ready: -

- \_ Serial number of the instrument.
- \_ Description of the problem.
- \_ Address and telephone number.
- \_ Contact name.

## Using this Manual

The information contained in this manual will assist you in getting the best from your M501 Fluid Bed Dryer. The text accurately describes the original build specification but the drawings and illustrations are intended for general reference only and are not necessarily accurate in every detail. Dimensions and characteristics are not to be considered binding and may be changed without prior notice.

The user is responsible for updating the manual with any bulletins from Sherwood Scientific Ltd and to reflect any changes or modifications made by the customer. Sherwood Scientific Ltd cannot be held responsible for the conditions of use and changes to the instrument that are beyond its control.

Please read the manual in conjunction with our conditions of sale, including those limiting warranties and remedies, which apply to all goods supplied by us. Neither the information given in this manual nor the instrument to which it refers is intended for any use that would violate or infringe the rights or statutory obligations to third parties.

Tornado M501 is a trademark of Sherwood Scientific Ltd. Copyright © Sherwood Scientific Ltd, 2006. All rights reserved.

No parts of this manual or any other documents supplied with this instrument may be reproduced or transmitted without the prior written consent of Sherwood Scientific Ltd.

## Safety Instructions

Throughout this manual the reader's attention is drawn to specific safety instructions as follows: -

### **WARNING!**

**A warning alerts the reader to a personnel hazard. Failure to act on the warning may result in death or injury.**

### **CAUTION!**

**A caution alerts the reader to a hazard. Failure to comply with the caution may result in damage to the instrument or product.**

### **NOTE:**

**A note provides additional information that should be given special attention.**

## Safe Use of Instrument

Sherwood Scientific Ltd makes every possible effort to ensure that the instruments it supplies are designed and constructed to be safe and without risk to health or property when used properly. In accordance with relevant EU Directives, they are marked with the CE symbol to indicate they comply with all relevant European safety and hygiene requirements. However, please note, that instruments can cause injury if you are careless and do not follow the operating instructions.

Ensure that you and all others working nearby know the location of the instrument controls and how to use them; especially the front panel Operations On/Off button and the Power On/Off switch located on the back of the instrument.

Ensure that you have read the relevant parts of this manual before attempting to use or work with the M501. For your own safety and those of others, please ensure the operator or personnel in charge of the location has received proper training.

## Setting Up the Instrument

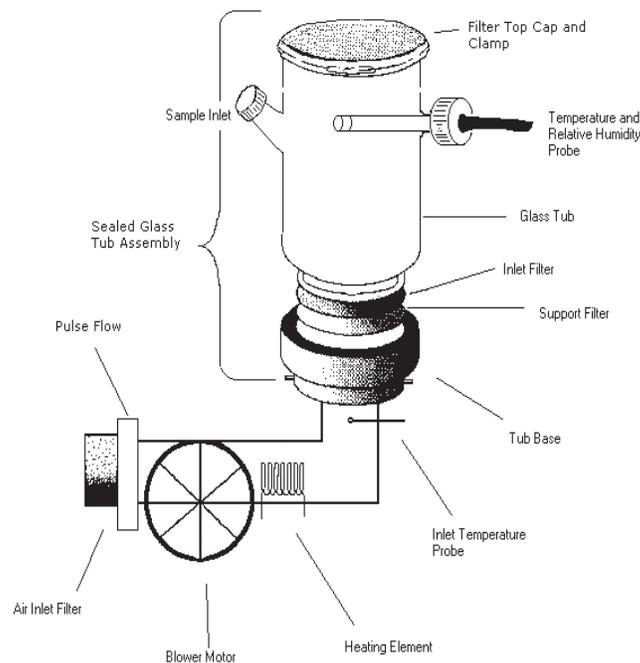
The instrument will arrive packed in a purpose designed box having a packing slip. Ensure that all the system components arrive safely. To form an operating system there are three components which are required. The instrument, the tub assembly, and a suitable filter for the tub assembly.

The location of the dryer should be chosen for the intended use. For use with samples where dust may be generated or for frequent use on samples with high moisture content, we suggest positioning the dryer in a fume hood. The rear panel of the instrument and the underside have air filters provided for supplying cooling air for the inside of the cabinet. The rear panel also has a stainless steel mesh filter provided for the inlet air used for drying the sample. Ensure there is enough space adjacent to these filters to allow air to enter the instrument.

## Instrument Description

The dryer is of simple, compact design, conveniently portable and easy to operate, the only requirement being a mains power supply. The source of power should be within the reach of the instrument lead so that no extension wires are required.

The instrument contains the air distribution system, heater element, thermostat, and electrical controls. It can be used as a stand alone unit or be operated under computer control and monitoring. There are many types of tub assemblies to choose from which can be used with the M501. (See our website [www.sherwood-scientific.com](http://www.sherwood-scientific.com)). Our top of the range Programmable Analytical Dryer, incorporating the full range of options is illustrated below. This dryer enables the operator to have complete control and compile a record of the drying process. The main components are shown below: -



Main Elements of the Analytical Dryer

Air is drawn in through a Stainless Steel Inlet filter in the back of the instrument and blown by the centrifugal fan over a 2kW electrical Heater and through a Stainless Steel Filter Gauze at the top of the dryer body. A Pulse Flow Unit (optional extra) is situated after the inlet filter, which can intermittently shut the inlet air on and off, which acts as an additional means of fluidising a difficult sample. A 5 litre sealed glass tub is shown having a tub base which attaches to the instrument by means of a bayonet fitting. There is an "O" ring seal between the tub assembly and the instrument. At the inlet of the tub assembly, there is a 60 mesh stainless steel support filter and a fine-mesh nylon filter. These filters retain the sample in the tub assembly while assuring a uniform distribution of air enters the assembly. A filter top cap is clamped on to the top of the tub by means of a clamp and seals on a silicon "O" ring which also keeps the sample particles from escaping the tub assembly. The wide range of tub assemblies which are available are designed to match the variety of sample types and drying applications.

To facilitate the addition of a sample a side port is provided having a sealing screw cap. In addition to an inlet temperature probe, which is part of the thermostat control, a temperature / humidity probe is also available for the outlet of the tub assembly.

The above dryer can be used as a stand alone unit, with full control of the flow rate, inlet temperature, and time of drying. The values of the inlet set temperature, actual inlet temperature, outlet temperature and humidity and time remaining in the drying cycle can be obtained by directly reading from the front panel.

The M501 dryer can also be operated along with a computer using a serial interface. A special application software, must be downloaded to your computer, allowing direct control of the M501. The software allows the user to write a program containing an indefinite number of steps. Within each step the time and inlet temperature can be defined. Each step is terminated either at the expiration of the pre-defined time interval or when a defined outlet temperature or humidity is obtained. The data can be gathered from the various sensors in the instrument during the running of a program or while running the instrument manually. The data can be presented graphically, in real time, and stored for later reference. This feature allows us to fully analyse the drying process of a sample.

Programs and Drying Data can be stored for future reference. A single 16 step program can be downloaded and stored in the M501 and can be subsequently recalled and operated without a computer.

**PLEASE NOTE: -**

WHEN OPERATING THE M501 AS A STAND-ALONE UNIT PLEASE DISCONNECT THE SERIAL INTERFACE LINK TO THE COMPUTER.

Not doing so may result in communication errors.

## DRYING TUBS and ACCESSORIES

The 5 Litre Sealed Glass Tub having a sample port and a sensor port is the standard tub assembly for the M501. It allows full utilisation of the analytical, data capture and storage, and programming control feature on the dryer. There are many other types of tub assemblies each having their own type of filter which can be used on the instrument.

### TUB ASSEMBLIES AND FILTERS

Part Number	Description of Item
-------------	---------------------

#### LARGE TUB ASSEMBLIES

50035005	2 LITRE STAINLESS STEEL TUB & BASE
50035006	2 LITRE GLASS TUB & BASE
50035008	5 LITRE STAINLESS STEEL TUB & BASE
50035009	5 LITRE GLASS TUB & BASE

USE LARGE FILTER BAGS

AVAILABLE IN NYLON, TERYLENE,  
POLYPROPYLENE, AND NOMEX

50035014	5 LTR SEALED GLASS TUB & BASE
----------	-------------------------------

USE TOP CAP FILTERS

AVAILABLE IN SS (60, 250, 500 MESH), 3 MICRON  
POLYESTER

#### MINI TUB ASSEMBLIES

USE FOUR MINI TUBS WITH A MINI TUB ADAPTOR (50035011)

50035012	MINI SS TUB MINI GLASS TUB
----------	-------------------------------

USE MINI FILTER BAGS

AVAILABLE IN NYLON, TERYLENE,  
POLYPROPYLENE, AND NOMEX

500 350 33	MINI SEALED GLASS TUB
------------	-----------------------

USE MINI DISC FILTERS

AVAILABLE IN NYLON, SS (60, 250, AND 500 MESH),  
3 MICRON POLYESTER

## Special Notes on the Accessories

Only the 5 litre glass tub assemblies, both those using filter bags and the sealed variety, can have an inlet for the outlet humidity and temperature probe. Only these tubs can fully utilise all the features on the M501.

The glass tubs have an advantage in the operator being able to see the sample as it dries. The optimum flow rate is easy to select judging by the appearance of the fluidised sample. The operator is often able to estimate the state of dryness and guess the shape and size distribution of the particles simply by the appearance of the sample flowing in the tub. The main advantage of the stainless steel tubs is durability. High-grade stainless steel is used since the process requirements usually call for high product purity and good chemical and corrosion resistance at high temperature.

Other specialised tub assemblies which can be used on the M501 include a Particle Classifier (50035049) and a Sieve Dryer (50035045).

The mini tubs are 250ml in capacity and can be used effectively on samples weighing from 5 to 50 grams per tub. Four tubs can be dried simultaneously.

The decision to go to sealed tubs is based simply on particle size. Below 45 microns, we suggest you go to a sealed tub.

The 3 micron polyester filters can be used for the mini tubs as well as the 2 and 5 litre tubs. These filters are effective for 5 to 25 micron particles. Please note that these filters greatly reduce the flow rate of air through the sample. Drying times normally occurring between 10 to 30 minutes can take up to several hours using these small pore size filters. Furthermore, the use of these filters may even hinder the mixing of sample particles during drying. Many of the main advantages of fluid bed drying may be lost. If in doubt, Sherwood offers to do an initial study on your sample which will ensure proper accessories are chosen for the application.

A wet sample should occupy about 1/3 of the tub assembly volume. As it dries and the density drops, the apparent volume will increase to about 1/2 the volume. Tubs should be purchased that are 3 x the volume of the sample size.

## THE INSTRUMENT COMPONENTS

Like our other instruments in the fluid bed dryer range, the M501 incorporates an electrical heater, temperature controller, timer and a powerful air blower fan. There are, however, significant improvements over previous models.

All the controls on the front panel are on a printed membrane with pressure controlled contacts which prevent the ingress of fine powder. The cooling air, as well as the air for drying the sample are filtered. This eliminates possible faults related to powder getting inside the instruments and switches.

The air blower is controlled by a thyristor circuit to give a smooth variation over a wide range of motor speeds, as in previous models. On the M501, however, the blower motor speed is monitored and a feed back loop assures the blower motor speed is maintained regardless of surges in power supply or effects of a heater being switched on and off. This achieves a more controlled fluidisation and allows us to monitor the volume of air per time used in the drying process. A seal between the tub assembly and the instrument ensures all the air that is measured goes through the sample. Each instrument is calibrated for flow rate output during manufacturing.

<b>Blower Set Value</b>	<b>Cubic Metres per Min</b>	<b>Cubic Feet per Min</b>	<b>Metres per Second</b>	<b>Feet per Minute</b>	<b>Litres per Second</b>
<b>0</b>	<b>0.13</b>	<b>4.59</b>	<b>0.35</b>	<b>68.6</b>	<b>2.17</b>
<b>10</b>	<b>0.32</b>	<b>11.30</b>	<b>0.86</b>	<b>169</b>	<b>5.33</b>
<b>20</b>	<b>0.50</b>	<b>17.66</b>	<b>1.34</b>	<b>264</b>	<b>8.33</b>
<b>30</b>	<b>0.70</b>	<b>24.72</b>	<b>1.88</b>	<b>369</b>	<b>11.67</b>
<b>40</b>	<b>0.89</b>	<b>31.43</b>	<b>2.39</b>	<b>470</b>	<b>14.83</b>
<b>50</b>	<b>1.07</b>	<b>37.79</b>	<b>2.87</b>	<b>564</b>	<b>17.83</b>
<b>60</b>	<b>1.25</b>	<b>44.14</b>	<b>3.35</b>	<b>659</b>	<b>20.83</b>
<b>70</b>	<b>1.45</b>	<b>51.21</b>	<b>3.89</b>	<b>765</b>	<b>24.17</b>
<b>80</b>	<b>1.64</b>	<b>57.92</b>	<b>4.40</b>	<b>865</b>	<b>27.33</b>
<b>90</b>	<b>1.82</b>	<b>64.27</b>	<b>4.88</b>	<b>960</b>	<b>30.33</b>
<b>100</b>	<b>2.00</b>	<b>70.63</b>	<b>5.36</b>	<b>1055</b>	<b>33.33</b>
<b>110</b>	<b>2.20</b>	<b>77.69</b>	<b>5.90</b>	<b>1161</b>	<b>36.67</b>
<b>120</b>	<b>2.38</b>	<b>84.05</b>	<b>6.38</b>	<b>1256</b>	<b>39.67</b>
<b>127</b>	<b>2.50</b>	<b>88.29</b>	<b>6.70</b>	<b>1319</b>	<b>41.67</b>

The 2kW heater element is controlled by a thermostat system. The maximum achievable temperature is 200 degrees Centigrade, but this is determined and limited by the flow rate that and the power supply.

## Warning!

When Operating a Dryer above 65°C we recommend making a copy of the following warning sign so that it can be displayed next to the instrument and tub assembly.



Stick on thermal labels can be also provided for all 2 and 5 litre tub assemblies on request and should be positioned in the most visible location if the instrument will be used at elevated temperatures.

The use of microprocessors in the instrument allows us to control the temperature during heating and cooling the sample to within a few degrees.

### Note: -

**Good temperature control is only obtained when a tub assembly is in position on the instrument. Without a tub assembly, the air flows without resistance and a wide deviation may be observed between the set temperature and that actually achieved.**

The microprocessor in the M501 allows storage of a 16 step program that has been written and downloaded from a computer. The instrument is able to take the signals from the probe located in the tub assembly and convert them into humidity and temperature (°C).

A Pulse Flow device may be added to the unit as an optional extra. The M501 has a Pulser which is retrofitable and is positioned externally at the air inlet.

## Applications

The wide range of materials that can be dried includes fine powders, coarse particles, crystals, granules, slurries or pastes (after decanting, or pre-drying or by spraying into bed of initially dried material). Samples with moisture content up to 80% such as some polymers, dyestuffs and molecular sieves can also be dried with the provision that they remain solid in nature at these high moisture levels.

An operator can also dry heat sensitive materials, such as foodstuffs e.g. peas, wheat and lentils, since they may be dried at relatively low temperatures. If traces of volatile organic compounds or hazardous fumes are generated during the drying process, drying should be conducted in a fume cupboard.

### Warning:-

**The M501 is not an explosion proof instrument and therefore samples having volatile compounds that are flammable or able to reach their flash point should not be used with this dryer.**

Because of the high heat and mass transfer rates obtainable, drying times for the Laboratory Fluid Bed Dryer are much less than for the more traditional methods available in laboratories such as oven or vacuum drying. Many materials can be dried in less than 15 minutes.

## Optimal Bed Depth

The optimal bed depth which is related to the amount of wet sample which can be used is that at which the sample can be fluidised smoothly at the required temperature by a set air velocity. This normally is equal to the sample filling approximately 1/3 of the tub being used for drying. (The advantages of the fluid bed dryer can however be realised even if the sample lurches and mixing in a non-ideal manner).

As drying proceeds with most samples, the sample becomes less dense and less "sticky" and the bed becomes easier to fluidise. The apparent volume of the fluidised sample will change from 1/3 (75mm bed depth) to 1/2 (150mm bed depth) of the volume of the tub assembly. Normally, the air velocity will be progressively reduced as the sample dries. Using the M501, a program can be written to automatically drop the velocity of air as the sample dries.

Due to the complexities of the mixing and drying process, the optimal amount of sample to use is best determined by trial and error.

The pulse flow works most effectively on "stringy" samples that will not mix, particularly when they are wet. The short blasts of air from the pulse flow essentially mixes the sample with each pulse. This is usually only required until the sample loses its external moisture, after which we find most samples will fluidise more easily. Using a pulse flow may not show any improvement in drying more ideal, easier to mix samples.

## Basic Principles of Fluidised Beds

When a stream of gas is passed upwards through a bed of material at a certain velocity the bed will first expand, then become suspended and agitated by the gas stream to form a fluidised bed. This has the appearance of boiling liquid due to the formation of many small bubbles at the surface of the sample, the so-called “bubbling fluidisation”. Ideal fluidisation is achieved only with spherical particles of a narrow size distribution range and with the appropriate amount of sample with the optimal flow of gas. The optimum operating gas velocity for bubbling fluidisation lies above the minimum fluidising velocity but below the velocity of entrainment of the material. Needless to say, this ideal is not often achieved with real samples. With real samples and maximum amounts of material to dry, the other forms of drying are more generally obtained.

At higher gas velocities, larger bubbles and plugs of material are formed resulting in a more violent type of fluidisation called slugging or spouting. Particles that are needle shape (have a large aspect ratio) are more likely to give “spouting fluidisation” with the spout arising from the center of the sample and falling back down along the outer surface of the sample near the tub.

## The Drying Process

If water is added to a dry sample, it is absorbed by particles until the point at which the particles become saturated. The saturation point is known as the Critical Moisture Content. The CMC is characteristic of the sample material, and the initial water which is incorporated into the particle is held as internal moisture. If placed in a sealed container, a sample containing internal moisture will become homogeneous. The further addition of water past saturation will become external moisture. External moisture is heterogeneous by nature, being pools of water lying in between the saturated particles. The drying process reverses the procedure, as external moisture is first removed.

A bed of wet material fluidised by a heated air stream provides ideal conditions for drying. The very efficient contact between gas and solid particles due to the turbulence of the bed results in high heat transfer rates causing rapid evaporation (mass transfer) of moisture which is carried away with the exit air. This process has a high thermal efficiency because most of the heat input is used in vaporising the moisture and the exit air only rises in temperature as drying of external moisture nears completion. External moisture is the first to be removed, and it is removed at a rate controlled by the flow rate and temperature and is not influenced by the presence of the solid constituent in the sample. Following this, the internal moisture is removed. The rate of internal moisture removal is usually limited by the diffusion of water from within the particle, and less directly influenced by process parameters.

Continuous and thorough mixing of the sample while drying ensures that the temperature and moisture content are uniform throughout the sample and the drying process is reproducible and the end product is homogeneous.

The process can be conducted at relatively low temperatures and there is little abrasion, since the particles are separated by air bubbles. The drying process can be analysed to show the amount of internal and external moisture. When external moisture is removed, drying can be conducted quickly, since the temperature is kept low by the evaporation of water. When internal water is removed, drying should be conducted very slowly to give time for the water to diffuse out of the particles. The temperature control and understanding of the critical aspects of drying ensures that heat-sensitive materials can be treated with care.

The knowledge gained from lab scale fluid bed drying is directly applicable to industrial fluid bed dryers, since the same principles apply. Characterising a product in the laboratory provides useful information for continuous and batch scale dryers in the plant. Studies in the lab are useful for designing plant scale fluid bed dryers.

## Typical Applications

1. Drying of a material to a given moisture content using reproducible drying parameters.
2. Fluidising curves give the variation of pressure drop with air flow-rate.
3. Establishing the conditions required to achieve minimum and the more normal operating fluidisation velocity.
4. Determination of drying curves indicating Critical Moisture to assess Internal and External Moisture and show feasibility of fluidised bed drying of a material on an industrial scale. Also established best industrial scale dryer to use. (Drying curves are relevant to the mechanism of drying. They may be used as a basis for heat and mass balances, thermal efficiency of drying and dryer design.)
5. Calculation of heat transfer coefficients for different conditions relevant to dryer design and comparison of fluidised beds with other drying methods.

Other applications include: -

Drying small particulates, drying particulates with a wide particle size range, drying down to a particular moisture concentration, analysis of moisture, rapid drying, homogenising samples, separating particles based on density, coating samples, etc.

A most important application of fluid bed drying is determining a drying curve for a sample. A drying curve, i.e. a plot of moisture loss over time, shows the drying characteristics of the material. We can derive the drying rate, constant rate of moisture loss (external moisture) and falling rate periods (internal moisture), drying times, equilibrium moisture content and critical moisture content and heat transfer coefficients. All valuable information in characterising a sample and designing an industrial drying process.

The manual technique for obtaining a drying curve consists of repeatedly measuring the weight loss on drying a sample over two minute intervals until a steady weight is reached. The results are converted to per cent moisture in sample and plotted against time. This technique is cumbersome and has associated errors introduced since the drying process is interrupted in order to take the measurements.

Using the M501 it is now possible to construct a drying curve for a sample derived from the data collected during an uninterrupted drying procedure.

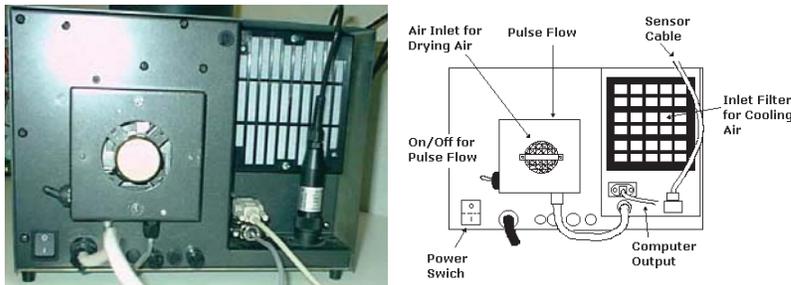
# Chapter 2

## Manual Operation

### Manual operation: - Overview

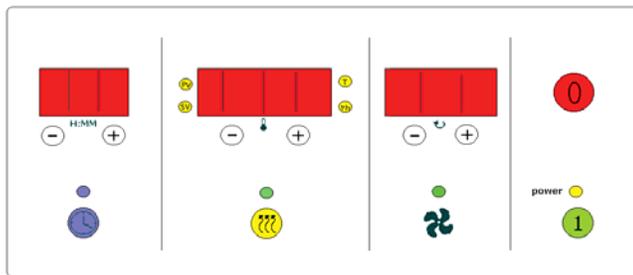
The M501 Fluid Bed Dryer has been designed to make reproducible drying easy.

The instrument should be connected to the power source and turned on from the mains switch on the back of the instrument.



When turning the mains power on, all the lights on the front panel flash on and off while the instrument initialises. Following this, the Version number of the Software held within the instrument is displayed momentarily (V1.05 at time of going to press). The instrument starts up in standby mode, displaying the last settings for the blower speed, timer and temperature.

The operator can set the functions and power the instrument on and off from the front panel.



There are four sections on the front panel namely to set the drying time, set the inlet temperature (SV), set the blower speed and turn the instrument on and off. Each will be discussed in turn.

## Setting the Conditions

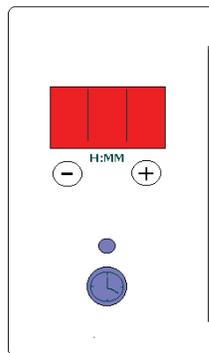
In standby mode, the variables of time, inlet temperature and blower speed can be set prior to running the instrument. There are symbols indicating the four sections. A blue clock face icon indicates the timer, the yellow radiation symbol icon indicates the heater, a fan blade icon indicates the blower and finally the power section having on/off symbols as buttons.

If the display for the timer or heater sections are not illuminated when the instrument is turned on, this simply indicates these functions were not used on the last occasion when the instrument was operated. They can be turned on by a short press of their icon buttons.

The set-up procedure for manual operation consists of the following: -

### Section 1 Setting the timer.

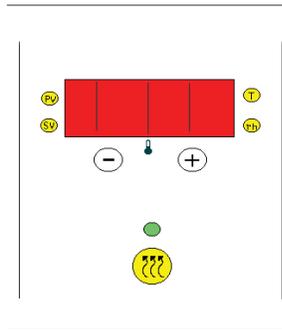
A blue flashing light above the timer icon indicates that the timer is ready to receive an input setting. Pressing the (+) or (-) positions adds or subtracts minutes to the timer. The display is hours and minutes, with a minimum setting of 1 minute and a maximum setting of 9 hours and 59 minutes. Pressing the blue clock face at any stage turns the timer off. The timer section is shown below.



**Section 1**

## Section 2 Setting the temperature.

A green flashing light above the “Heater Symbol” indicates that it is ready to receive a temperature value. The red light (SV) is illuminated in the lower left hand corner of the digital display shows that the “Set Value” of the temperature is being displayed.



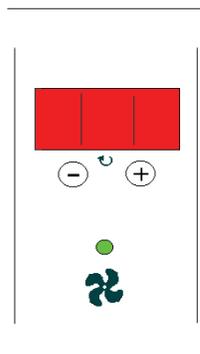
### Section 2

The (+) and (-) buttons allow the set value to be adjusted from 20.0 up to 199.9 deg Centigrade. Pressing the Heater Symbol at any stage in the operation of the instrument turns the temperature control off.

## Section 3 Setting the blower.

The blower function always turns on when the power is supplied to the instrument and the flashing green light above the blower icon flashes indicating an input adjustment to the blower speed can be made. The (+) and (-) switches allow adjustment between 2 and 127%, which is displayed.

(The blower setting above 100% is extra power only available in manual mode and not particularly well calibrated for flow rate, ask your Sherwood Scientific representative how to access this. The blower speed below 10% is also considered less accurate in its correlation to an absolute flow rate).

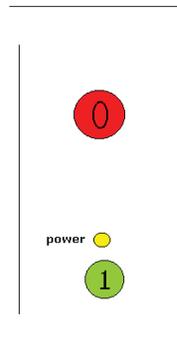


### Section 3

The blower can never be entirely turned off while the instrument is in operation which is a safety feature which prevents overheating. (The unit also has an over-temperature cut off switch as a further precaution against overheating).

## Section 4 Starting and Stopping the Dryer.

The dryer can be turned on, to operate according to its pre-set conditions, by pressing the green switch below the power light.



### Section 4

Pressing the red switch stops the dryer operation and displays the last set values. Pressing the start again refreshes the timer which begins counting down from the original set time. When the dryer reaches the end of a timed cycle, it automatically goes into standby mode.

The 'power' light changes from a yellow colour in standby to a red colour during operation.

All the (+) and (-) adjustments can be accelerated by holding down the switches.

# Operating Manually

## General

Several conditions can be modified during a drying procedure.

While operating the M501, the timer counts down from the set time. It cannot be altered by pressing the (+) and (-) buttons. The timer function can, however, be turned off by holding down the icon button. Once off, it can be turned on again by holding down the icon button yet again. It now starts in the standby mode and a blinking blue light above the icon indicates the settings can be altered by the (+) and (-) buttons. Once the correct time has been set, the timer can be starting by holding down the icon until the blue light stops blinking.

While operating the unit, the digital display of temperature shows the actual measured temperature, i.e. Process Value as opposed to the set temperature it displayed in the standby mode. This is indicated by the little light, indicating PV, near the upper left corner of the display. The PV indicator light flashes from green (off) to red (on) indicating the status of the heater.

The Set Value can be displayed by a short press of the ( $\pm$ ) or the temperature icon. The set temperature can be altered by holding down the ( $\pm$ ) button as indicated on the display. The heater can be shut off by pressing and holding the icon button. It can be turned on again, by pressing and holding the icon again, and wakes up in standby mode like the timer.

The blower rate can be readily altered at any time while operating the unit.

On stopping the unit, the settings of the timer, temperature, and blower will all default to the values last set in standby mode.

Since the unit does not have a cooling facility, the minimum temperature that can be achieved is usually around 30 to 35 degrees Centigrade, which is limited by the temperature of the intake air and the compression of the blower.

## Optional Extras

There are two instrument options, the first is the Humidity Temperature Probe and the second is a Pulse Flow Device. Both options are easily retrofitable and can be added on after purchasing the basic unit.

## Connecting the Humidity/Temperature Probe

Note: -

**The instrument should be turned off before connecting the H/T Probe.**

The h/t probe requires a five litre glass tub with a special port designed to hold the probe in position within the tub assembly. The probe connector fits into a special plug in on the back of the instrument (see photos on page 17). The probe is inserted through a retaining cap and a silicon washer is inserted into the port on the tub assembly, as illustrated on page 8. The instrument can be powered up and turned on immediately after the installation of the probe.

Note: -

**Connectors on the back of the instrument are shipped with plastic covers to prevent contamination. These covers should be used whenever a connection is not being used, particularly when the instrument is being used.**

## Manual Operation with the H/T Probe

The Digital Display for the Temperature, Section 2 of the front panel, also displays the additional information obtained when using the H/T probe. The probe measures the humidity and temperature at the outlet of the tub assembly while the instrument is running. By pressing the heater symbol switch for a short duration, the display changes from: -

PV	= Process Value of inlet temperature (°C).
SV	= Set Value of temperature (°C).
T	= Outlet temperature measures in tub assembly (°C) .
rH	= Relative Humidity at Outlet of tub assembly (%).

The new readings being displayed are indicated by lights appearing around the display. Outlet temperature lights are to the upper right of the display and Relative Humidity indicator lights are to the lower right.

During operation, the set value will be displayed for a few seconds and the display will automatically change back to reading the process value of temperature. The inlet and outlet temperatures as well as relative humidity will remain displayed during the operations. While in standby, only the set value of the inlet temperature will be displayed. This is the only option which can be displayed in section 2 that can actually be set during manual operation.

## Installing a Pulse Flow Device

The picture of the back of the instrument on page 17 shows a pulse flow device installed in the photograph with the stainless steel filter removed. The illustration indicates a stainless steel filter on a pulse flow device. To attach a Pulse Flow Device: -

- 1 Remove the four nuts from the four studs, two of which hold the bracket containing the stainless steel filter. Remove the SS Filter and bracket.
- 2 Place four wavy washers on the four studs; followed by the four spacers provided with the PFD. (The spacers are 3.5cm in length). The spacers should be made finger tight plus an additional  $\frac{1}{4}$  turn.
- 3 The PFD should be positioned on the spacers with the on/off switch in the lower left hand corner, facing the back of the instrument (see picture on page 17) and the power supply/signal line coming from the bottom of the unit. The PFD should be pushed tightly against the instrument.
- 4 The bracket and SS Filter should be placed horizontally across the two spacers. This may take a little bit of force if the bracket has been distorted at all. 4 wavy washers and 4 self locking nuts (M4 size) should be placed on the screw threads of the four spacers sequentially and tightened.
- 5 The cable coming from the bottom of the PFD should be connected to the 15-way D socket adjacent to it (see page 17).

The PFD is now installed.

## Manual Operation with the Pulse Flow Device

The PFD can be made to function by simply pressing the on/off switch on the device downward. The pulsing of the valve occurs in cycles of approximately 2.5 seconds closed and 2.5 seconds open.

## Running a Stored Program in Manual Mode

The M501 is able to store a program containing up to 16 steps, each having pre-set operational conditions. To load the stored program into the unit, the operator must locate a "hidden" button. This button is located on the front panel, halfway between the heating icon and the blower icon. The operator can find the button by feeling along a line between the two icons until he can hear the clicks.

To access the stored program, the instrument must be in standby mode.

By pressing the hidden key first and holding it down, followed by pressing the green On Button (I), the M501 enters a Program mode. This is indicated by the timer display showing "PRO" and the Heater display showing the number of the program that is stored. This is the equivalent of standby when in program mode. Pressing the on button will start the stored program.

As the program starts, the number of the step is shown momentarily in the timer section of the front panel as no. 1 etc. This display then switches to showing the time remaining in the step. The temperature section shows the process value of incoming temperature and blinks to indicate a program is running. The blower speed is shown in the third section.

The program proceeds through all its steps in a similar manner.

Pressing the red stop button (0) at any time will stop the program and return the instrument to standby in program mode. Pressing on (I) at this stage would restart the program from step 1.

Pressing and holding down the hidden button while pressing the power on (0) will bring the 501 back to its normal operating mode.

The hidden button is designed so that a single program could be set up by a supervisor which could not be easily altered by the operator.

For loading a new program into the M501 see page 34.

### **Note:**

**For manual operations it is best to leave the serial link to the computer unplugged to avoid communication errors.**

# Chapter 3

## Computer Control

### Introduction

To fully utilise the facilities available on the M501 requires the M501 Software (501 86 700) and Interface Cable (926 09 052) and a computer. With computer interface, the M501 Software will allow drying procedures to be written which will guide the Dryer through an unlimited number of drying stages. The following drying parameters can be set by the computer and controlled by the dryer.

- Timer
- Blower motor speed
- Inlet air temperature
- Pulse flow function

The actual blower speed and actual inlet temperature (as opposed to that which has been set) can be monitored in real time along with the additional information from the sensor probe, i.e. outlet temperature and relative humidity. (The installation of the H/T sensor has been described on page 22). The computer and M501 combination allows the user to monitor the drying process continuously, in real time and in detail. The data can be displayed in chart form and can be logged and stored for future reference and analysis.

### Computer Requirements

To Use the M501 Software, a Pentium processor having Window 98 or higher Operating System is required.

Plus 32 MB of RAM, more memory improves performance.

A typical installation requires 100 MB of available hard disc.

Serial Interface to M501 is required and a DVD /CDR drive for program installation.

A colored printer for printing graphs.

## Loading the Application Software

The M501 can be supplied with a CD containing the Application Software for driving the instrument. To install, place the CD in the disc drive of the computer and go to the START / RUN / Use the Browse button to locate the file Setup.exe on the CD. Then follow direction for the installation.

Following installation, locate the application "Fluid Bed Dryer Controller" in the program files and double click.

### **Note: -**

**You can configure your PC to automatically start the application on start up of the computer or create a shortcut on the desk top. Refer to your Windows help for instruction.**

## Connecting to a Computer

A Cable is supplied to connect the RS232 (9 pin) outlet from the back of the M501 to a 9 pin Serial Interface on the computer. (See the picture and illustration on the top of page 17).

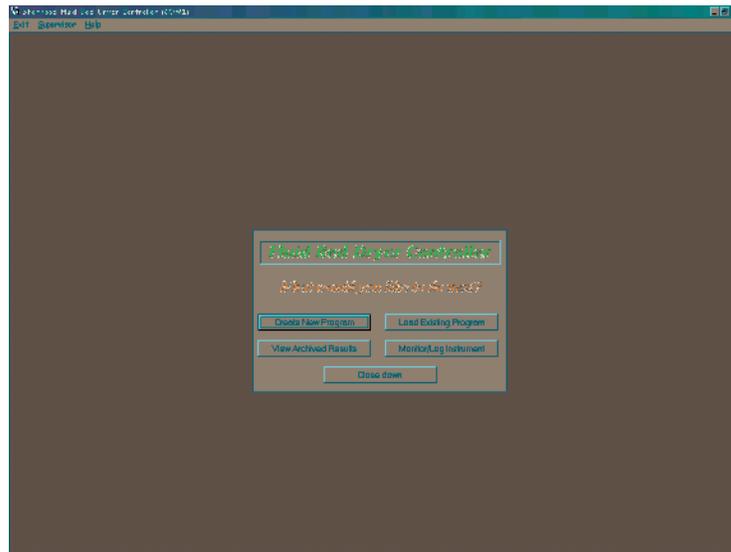
### **NOTE: -**

**When operating the M501 with a computer, please connect the serial interface link to the computer before starting the application software. Not doing so may result in communication errors.**

Communication errors are shown by an "Error 01" appearing on the temperature display. To remove the error the operator must correct the fault (usually by connecting a cable properly) and shut off and restart the instrument.

## Using the Program

Go to Start, Programs and select the “Fluid Bed Dryer Controller”.



The above screen opens offering the following options: -

On the top left of the screen, the operator can select **Exit**. Clicking the mouse on this option introduces a “Close Down” screen which allows the operator to leave the program.

Also on the top left of the screen, the operator can select **Supervisor** which provide a facility to set up the default options and prevent a program, once written, from being altered. It also provides a means of updating the control firmware in the M501 in the future. This option is password protected for security. The Supervisor facility is described in greater detail on page 39.

Also on the top left of the screen, the operator can select **Help**, which gives the details of the operator manual which should be used with your M501. The **About** selection with the **Help**, provides you with the version number of the Software Application.

Note: -

**To view the screens in detail, it is best to open the Program and look at the actual display on the computer monitor while reading this manual. The pictures presented in this chapter are merely pointers.**

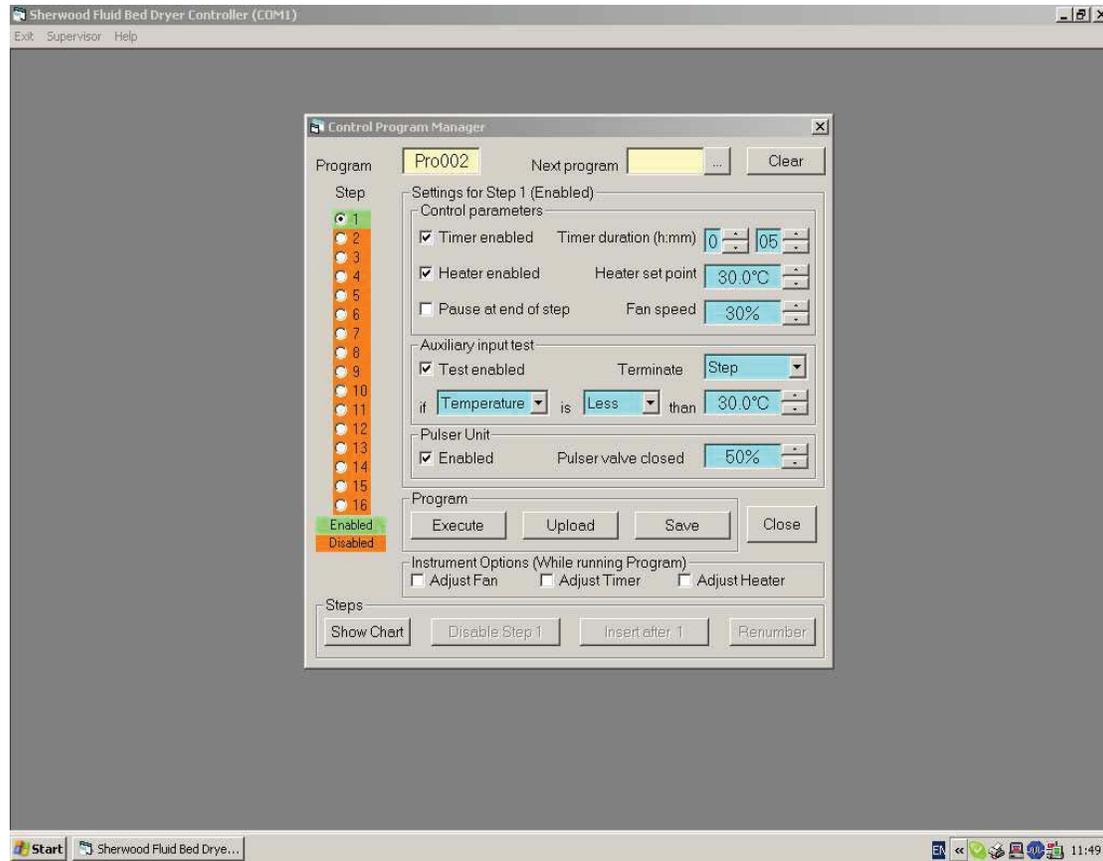
The five main options are shown on the centre of the screen:

CREATE NEW PROGRAM  
LOAD EXISTING PROGRAM  
VIEW ARCHIVED RESULTS  
MONITOR / LOG INSTRUMENT  
CLOSE DOWN

Each of the options can be selected by clicking the cursor on the appropriate button.

## Create a New Program

Choosing this option calls up a *menu screen* which allows the user to choose the conditions for each step of a multi-step drying procedure. The choice of the options and the number of steps are the basics to writing a Program. The *menu screen* is shown below.



## Program Number

A number is automatically assigned to a program that is being written as an identifier along with the date and time of entry. The number is sequential, taking into account the other stored programs. Should a program be deleted at some later time, its number will be re-assigned to the next written program, along with the latest date and time of entry.

### Note: -

**We advise that the Operator keep a Program Notebook which lists the Program Number, date and time of entry, and application description. They should also note when a Program is being deleted or replaced.**

## Next Program

A program has the option of continuing on to another program after completing its final step. By clicking on the button near to the Next Program window, existing programs are shown and the desired one can be selected and clicked. The follow-on program number should now appear in the Next Program window. To remove an entered program, the operator should press the Clear key next to the window.

## Program Steps

On the left of the Menu screen, 16 Program Steps are shown in a vertical column. The little circular window adjacent to each step is known as a “radio button” and can be “pushed” (selected) by locating the cursor on it and clicking the mouse once. Only one of the steps can be selected at a time. The selected step, the button last pressed, is indicated by a black dot appearing in the center of the circle. The operating conditions for the selected step are shown to the right of the vertical column of steps.

By clicking the mouse twice on a selected step, the background color of the program step changes from green to orange. The color green indicates that a particular step is enabled. Enabling a step means that the conditions of that step can be changed provided the radio button is pushed on that step. It also means that this step will be included in the running of a program when the program is executed. Conversely, an orange color indicates that the particular step is disabled and cannot have new conditions entered and will not be included in the running of the program.

The operator may call up a program and decide to omit or alter particular steps prior to executing the program. He may decide to save the altered program as a new program, or decide to replace the previously written program with the modified program. A program must have a minimum of one enabled step.

## Setting the Conditions of a Step

A step must be selected on the radio button and enabled, having a green background, prior to setting the conditions. The control parameters are set as follows:

### Timer enabled

Checking the box will enable the timer to run the step for the time set using the scroll keys to the right. The minimum time which can be set is 1 min while the maximum is 9 hours and 59 minutes.

Leaving the timer box unchecked will not introduce a maximum time limit for which the step can run.

### Heater enabled

Checking the heater box sets the temperature control for the step. The temperature can be set from 20 degrees to 199.0 degrees Centigrade. The temperature setting may not be reached if too short a time is set for the step. Similarly, temperatures over 150 deg C may be difficult to achieve at high air flow rates, particularly when the power source is at a low voltage. (In such cases, supplemental heating and addition heat insulation on the tub assembly is possible).

Leaving the heater box unchecked, means that the heater will not be turned on and temperature will not be controlled. Under these conditions the temperature will read ambient plus several degrees due to the blower.

### Pause at end of step

When this option is selected by a check, there is a pause that automatically is introduced when that step ends. This allows the operator to add more sample or an ingredient, take an aliquot of the sample, etc. While paused, the **Execute** button towards the bottom of the menu is changes to read **Resume**. Following the manual intervention, the operator can continue the program by activating the **Resume** button.

### Blower Speed

This is not an option in the sense that it can be turned off. The computer setting can be varied between 2 to 100 units. (See page 12 for the equivalent flow values).

### Auxiliary input test

This function can only be activated if the humidity / temperature sensor and tub assembly which accommodates it are being used. With the sensor attached to the instrument (as per the directions given on page 22) this option can be selected by a check in the box.

The settings in this box allow the operator to terminate the Step or the entire Program at an earlier time than the timer setting. The decision to terminate is based on either the **Temperature** or **Humidity** becoming **Less** than or **Greater** than a **selected value**. This option can be removed by the operator by unchecking the box.

(The Supervisor has the choice of permanently disabling this function as an option, e.g. if the sensors are not being used. See Supervisor functions on page 39).

### Variable Adjustment while Running a Program

After setting the conditions of each individual step, the operator can further choose to make it possible to adjust the timer, heater temperature or the flow rate variables at any time during the operation of a program. This is done by designating this in the box next to each of these variables, following the programme steps.

To change the timer, which has been made adjustable, the operator should press on the timer clockface constantly until the numbers disappear. By pressing on the clockface for a short time, the numbers reappear and flash. While flashing, the minutes could be adjusted to the new setting. Pressing the clock-face for a third time will stop the flashing and start the new time countdown.

### Pulser Unit

This function can only be activated if the Pulser Unit is installed (see page 23) **and is turned on at the pulser** on the back of the instrument (see page 17). A complete pulser cycle is 2.5 seconds. The length of time that air flow is suppressed can be set by the operator, as a per cent of the total pulse cycle.

The Pulser function can be disabled for the step by unchecking the box.

(This option is used for samples that are difficult to mix. Settings have to be established empirically. Normally as the sample dries, it flows more easily, so the pulser function is most useful during the initial steps of drying).

(The Supervisor has the choice of disabling this function as an option if the pulser unit is not installed. See Supervisor functions on page 39).

### Writing a Complete Program

Following the setting of the conditions of the first step, the operator can select the next step by pushing the radio button and enabling the step, followed by setting the parameters for that step. The process can be repeated for up to 16 steps to form a program. If more steps are required, an additional program can be written as a continuation of the operation. (See the Next Program function described on pages 29 and 34).

### Running / Stopping a Program

All enabled steps of a displayed program can be run by activating the **Execute** button on the bottom of the menu. The **Execute** button changes to **Halt** during the operation of a program.

A program may be stopped by either pressing **Halt** button on the computer screen or by pressing **Stop power** on the M501 front panel.

A program may be restarted by pressing the Execute button.

A more drastic means of stopping the instrument operations is by shutting off the mains power inlet at the back of the instrument.

### Storing a Program

To store a program press the **Save** button. All saved programs will be displayed together with the file name for the current program.

The program will be saved under any name in the format "ProNNN" where NNN can be any number from 001 to 999.

## Editing a Program.

The program displayed can be edited by first enabling a step and then modifying its parameters.

Disabled steps can be eliminated by selecting the **Renumber** button located on the lower right of the menu screen.

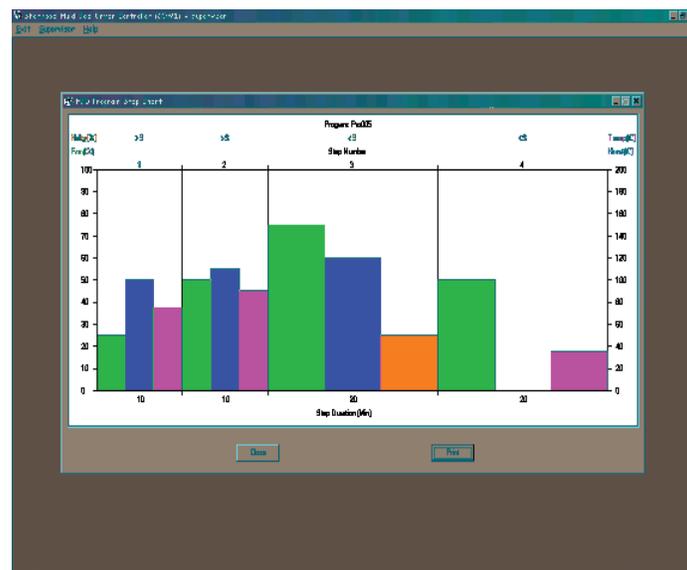
Steps can be inserted between existing *enabled* steps in a program by selecting the **Insert after** button.

The operator can execute a modified program. The data print out that follow will indicate that the program has been altered by an asterisk (\*) appearing as a superscript to the program number.

A modified program can be saved as a new program. To save a modified program as the same program number from which it originated requires supervisor access (see page 39).

## Displaying a Program

A program, with all its parameters, can be illustrated in chart form by pressing the **Show Chart** button in the lower left of the menu screen. Disabled steps are shown as blank sections on the chart.



The above chart shows a four step program for Program 005. The chart can be shown in real time simultaneously when writing a program.

A detailed explanation of the above Program Chart follows:

The Chart shows the Blower Fan speed (in green) and the tub sensor reading of relative Humidity (in orange). The scales for these parameters are read off the left side of the Y-axis and range from 0 to 100 %. On the right side of the Y-axis, the thermostated inlet temperature is shown as Heat(C) (in blue) and the outlet tub assembly temperature is shown as Temp(C) (in magenta). The X-axis shows time in minutes and is divided into sections corresponding to the number of steps of the program. The number of the step is written at the top of the chart above the section.

In the first step. The timer was set for a duration of 10 minutes, the heater for 100 deg C inlet temperature, and the blower flow rate at 25%. An auxiliary condition was set to terminate the step if the outlet temperature went beyond 75 degrees C. A further condition was set to Pause this step to allow the addition of an additive.

The chart indicates the above as follows: -

The duration of the first step is shown by the length of the first step along the X-axis. The heater is indicated by the height of the blue column as measured against the right side of the Y-axis. The height of the green column indicates the blower setting on the left side of the Y-axis.

The magenta column indicates that the auxiliary condition for outlet temperature is set and its height along the right side of the Y-axis indicates its value. To show that this condition was applied on an increasing temperature you have to look above the chart where >S indicates that the condition would be applied if the temperature went above the set value.

The Pause that ends the first step can be seen by observing the Program number, which is colored in red.

Step 2 can be interpreted in the same manner with different values.

Step 3 shows the changes in the operating conditions values and indicates the removal of the outlet Temperature condition. This is replaced with a Humidity condition. The condition of terminating the step is applied when Humidity falls below a set value.

Step 4 stops the heater and runs the blower until either 20 minutes is reached or the sample outlet temperature falls below 35 degrees C.

Although pulser use is not shown, one can call for a Print Out on the Chart display, which prints all the steps and their conditions along with a chart display.

**Note: -**

**For a more through understanding of the information on the Program Chart, the chart can be viewed while creating a program. We recommend altering the conditions of a program while observing the effects produced on the chart.**

## Load Existing Program

A program can be recalled from the start up screen, shown on page 27 as one of the options offered, i.e. LOAD EXISTING PROGRAM. By clicking the mouse on that option, a list of Programs appear in order of their Number. By highlighting the particular program, a date of last modification appears. A double click brings up the Program Menu Screen, which can be executed, modified, uploaded, or saved.

## Advanced Features of Programming

### Uploading a Program:

The M501 instrument can store one program containing up to 16 steps which can be recalled and used without the use of a computer. This program can be loaded onto the M501 by displaying it and pressing the **Upload** button next to the execute. The previous program will be erased and the new program entered.

### Writing a Circular or Linked Programs

A program has the option of continuing on to another program that already exists after completing its final step. The Next Program option (as explained on page 29) allows the user to choose the continuation program from a list of existing programs.

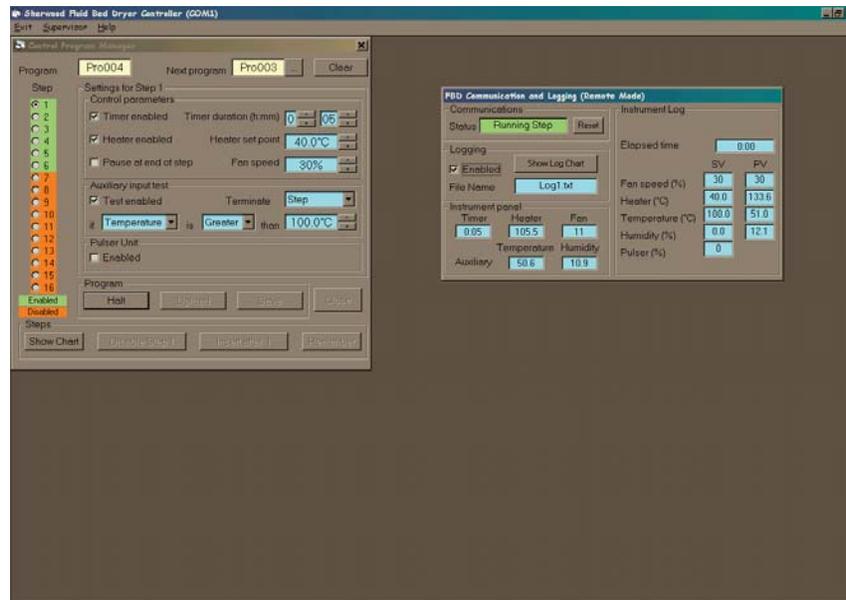
The operator may wish, however, to continue on to a program that hasn't yet been written or even create a Circular Program, which continues on to itself. This is possible to achieve by writing the program without defining the Next Program number to which it will continue and then saving it (noting its program number).

This program can be recalled at a future time, and it can now be altered by entering the details into the Next Program. At this stage, you can even enter its own program number, since it is in the saved file. The new altered program can be saved under a new number or even the same number (with supervisor access).

A circular program can be useful when trying to dry down to a certain humidity level without knowing the initial moisture content or size or nature of sample.

## Collecting and Storing Data

When a Program Menu is being displayed, having been just written or having been recalled from memory, the operator can **Execute** it to start a drying procedure. On doing so, a small Dialog Box appears, asking the operator “Do you wish to record a log of the program results?” If the answer is **No**, no data will be stored. If **Yes** is selected, the data will be stored and another Dialog Box appears allowing the operator to enter up to 40 characters identifying the procedure to follow, e.g. “Drying Sugar Sample No.104” A selection of **OK** will activate the program and open another Screen next to the Program Menu.



The new screen shows the current operating status of the instrument and can be referred to as the Annunciator Screen.

The **Status** window in the upper left of this screen indicates whether the instrument is connected or not, and if it is “Running Step” in a program. There is a **Reset** button next to the **Status** which should only be used to resolve a communication problem (like the wrong coms port selected).

### Please Note: -

**Using the Reset Button on the Annunciator Screen may disrupt any communication or corrupt data that is currently being collected.**

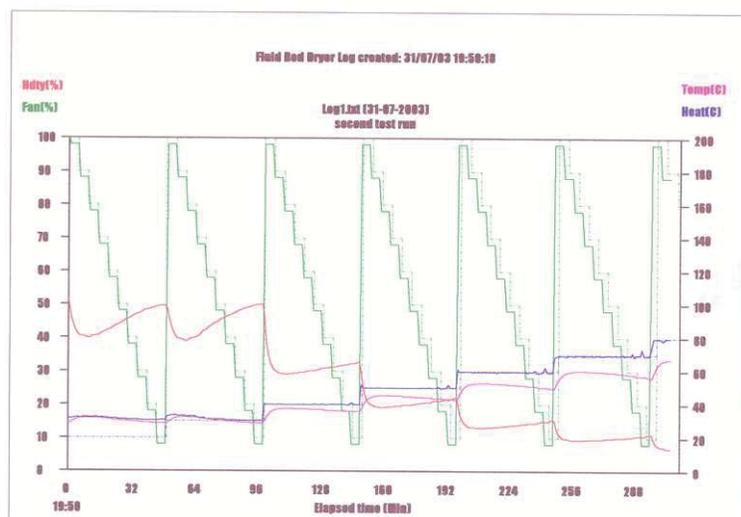
If Data Logging has been selected, the option is shown as “selected” and the Log Number of the data being stored as a text file (.txt) is shown. The data is automatically stored under this log number and the date of the run, without further prompting.

**Please Note: -**

**Log files should be recorded in a notebook, giving details of log files, date, time, and samples being run.**

The “Instrument Panel” section of the Annunciator screen simply shows the data which is available on the front panel of the instrument, although it is able to show inlet temperature, outlet temperature, and humidity simultaneously. The “Instrument Log” section of the annunciator on the right of its screen shows the data which is collected and stored, which is refreshed every minute.

The only active button on the Annunciator Screen is “**Show Log Chart**” which when pressed will show the data being collected in real time in the form of a chart. An example of such a chart is shown below.



To access the raw data used to form the chart, go to the Start key and then into Windows Explorer. Enter: -

*Start/Window Explorer/Programs/FBD/Logs/Date/ log numbers*

All Data available is recorded every minute of operation as a text file (.txt). While viewing the chart on the screen, the operator can choose option buttons to **Print** or **Close** the chart display. At the bottom of the Chart, the options to Close the chart or to print.

The form of the text file is shown below which has been captured on September 30<sup>th</sup>, 2002 at 11:04 AM.

**Data Capture: -**

30/09/02 11:04:12,Prog = 332  
30/09/02 11:04:12,Time = 2:00  
30/09/02 11:04:12,FanSV = 70%  
30/09/02 11:04:12,FanPV = 67%  
30/09/02 11:04:12,HeatSV = 100.0C  
30/09/02 11:04:12,HeatPV = 91.2C  
30/09/02 11:04:12,TempSV = 40.0C  
30/09/02 11:04:12,TempPV = 31.6C  
30/ 09/ 02 11:04: 12 ,Hdty SV = 0 %  
30/ 09/ 02 11:04: 12 ,Hdty PV = 58.6 %  
30/ 09 /02 11:04: 12 , Pulser = 0 %

**View Archived Results**

Archived Data may be recalled and be seen as a Chart from the Start Up screen by pressing the option button **View Archived Results**. The dates that have logged data are shown and when one is selected, it shows the logs recorded on that date. (To be able to find a particular drying operation quickly, it is important to keep a good log book).

When a particular log number is selected and double clicked, the operator is presented with a displayed Chart (whether or not the Chart was displayed at the time of gathering the data).

The displayed Chart offers option buttons on the bottom: -

PRINT  
CLOSE  
EXPORT

When printing the Chart, the operator is offered the normal printer options of number of pages and horizontal or vertical page format.

**Exporting Data**

Choosing the Export button, the operator is able to save the data in a CSV (comma separated value) format to a location of their choosing and also rename the log file number.

The option of exporting data in this manner is only offered when archived results are recalled. It is not an option when viewing a Chart being generated in real time.

(There is also the option of getting to the data via the Window Explorer route cited on page 35).

## Monitor/Log Instrument

The operator is able to run the M501 as if in manual mode, controlling the parameters from the instrument front panel, and still be able to monitor the drying process and store the data.

By leaving the computer interfaced to the dryer, the operator must go to the startup screen (page 27 and 28) and choose the option named **Monitor/Log Instrument**.

The Annunciator screen appears, without a Program menu present, and the dialog box invites the operator to enable the data logging function. If selected, the operator is invited to enter a descriptive of up to 40 characters and the data is given a log number as before.

The operator is offered the option of displaying the Chart being formed in real time. As before the data is automatically saved.

## Information on the Printed Chart

Whenever a Chart is shown, the operator is offered a print key, to make a hardcopy record of the results. The following items on the print out should be noted: -

At the top of the chart, there is the log number and date of the log and an entry showing the source of the program.

A stored program is indicated by its number and the comment "Stored Mode".

A program that has been called up but modified prior to running is indicated by an asterisk appearing after the Program number.

A program that has been written and not recalled from the archive is shown as "Execute Mode".

The time that the data has been logged is shown at the top center of the page and the time that the print out has occurred is shown bottom left of the page.

On the Charts indicating the Program, the Program number is shown top center and in the lower left of the print-out the following information can be found: -

Next program number is shown if there is a continuation program.

The date and time of the last update on the program.

The date and time of the print out.

## Supervisor Control

The Supervisor mode is accessible on the top left of the screen position between **Exit** and **Help**. It is provided as a security feature.

Trying to access it, you are requested to enter a code. The code that has been entered at the time of shipment is: -

### SHERWOOD

Entering these numbers will access Supervisor. You will be able to change to any 8 digit or letter combination. The supervisor accesses the following functions. -

<b>Password Change –</b>	As described.
<b>Com Port -</b>	changes the com port on your computer which is used for communications with the M501.
<b>Auxiliary Input Default –</b>	Removes this option from the program menu if you do not have a humidity / temperature tub assembly sensor.
<b>Pulser Unit Default –</b>	Removes this option from the program menu if you do not have a Pulser Unit.
<b>Add Log Comment –</b>	Removes the invitation to provide a descriptive to a data storage experiment.
<b>Suppress Welcome –</b>	Stops the welcome page.
<b>ISP –</b>	Provides a facility to load your M501 with a new program to be able to take advantage of new applications which may arise. It means "In System Programmable".

## ISP Uploads

The M501 has a microprocessor which holds a program controlling its operation and the way it interfaces with the sensors. It also holds the algorithms which control temperature and flow rate. It is now possible to introduce a new program in the future to your instrument directly from your computer.

With the normal serial link to your computer, the new program may come to you on a floppy disc, through e-mail, or on a CD. By entering as a supervisor you can go directly to the **ISP** option and you are invited to **Start ISP Upgrade**. You have to designate where the new program is being introduced, i.e. Disc Drive, or floppy etc, and activate. The new control programs are present as a \*hex" file. The upgrade is automatic and takes minutes.

# Chapter 4

## Maintenance

### General maintenance

#### WARNING!

Before starting any maintenance procedure on the Fluid Bed Dryer ensure that the instrument is switched off and disconnected from the electrical supply and read all the instructions thoroughly. This is for your safety and to prevent damage to the instrument.

### Air Filters

The M501 is designed to be very reliable and requires little routine maintenance apart from external cleaning. If used in a dusty environment we recommend that the air filters are cleaned regularly to ensure optimum performance.

There are three filters which are easily accessed on the outside of the instrument, namely: -

The **Air Inlet Filter** can be found on the back of the instrument and seen in the illustration on page 17. The photograph adjacent to it has the filter removed. There is a bracket holding the filter to the Pulse Flow Device (if one is provided) or to the back of the instrument (if there is no PFD being used). The screws holding the bracket should be loosened and the filter slid off the instrument. The filter can be washed in warm soapy water or put into a dish washer. It should be dried and replaced on the instrument.

To the right of the Air Inlet Filter (as you face the back panel of the instrument, is a **Cooling Air Inlet Filter** which allows air to enter the inner instrument for cooling purposes. It is a flat filter which can be easily removed and cleaned with a vacuum cleaner to remove dust or blown clean by a clean air supply in a well ventilated area.

Finally, there is a **Cooling Air Outlet Filter** which can be found and easily accessed on the underside of the instrument. This can be accomplished by placing a protective sheet on the table top next to the instrument and gently turning the instrument and resting it on its side. This filter can also be cleaned by a vacuum cleaner, or alternatively blown clean by a clean air supply in a well ventilated area.

## Replacement of Flange “O” Ring

There is a silicon “O” ring in the flange on the top of the instrument on to which the tub assemblies seal. Should the instrument develop an air leak coming from between the tub-assembly and the instrument, this ring will have to be replaced. It is easily removed from the flange by carefully prizing it out with a screwdriver or small pair of pliers.

The “O” ring is not really a ring but spongy silicon rubber which is supplied as a length of cord. The length of cord is 51cm, which appears to be several centimeters longer than it needs to be.

**Note: -**

**Do not shorten the length of the silicon cord, but compress the cord into the groove on the flange while inserting it back.**

The compression technique forms a more rigid structure and results in a better seal.

## Replacement of Outlet Filter on the Instrument

The mains power should be disconnected prior to following the procedure described below. The 60 mesh stainless steel filter can be removed by unscrewing the three hexagonal screws in the top flange. The filter is placed between the instrument housing and a fiber glass insulating washer on to which the flange is positioned.

Removing the filter allows access to the inside of the casting. It is possible to vacuum out any particulates which may have gotten into this area, but care should be taken not to move the thermocouple sensor positioned in the center of the casting housing.

## Power-on checks

**Note: -**

**Power-on checks should be made with the instrument in manual mode.**

The M501 needs a mains electricity supply. In the UK, the unit is supplied with a 13A earthed plug; in the US, the unit is supplied with a suitable plug for its power requirements.

When switching the power on to the unit from the back of the instrument all 8 LED lights and the 3 digital displays should flash on for five times. The version of the software used to drive the instrument, “firmware,” is then displayed for two seconds. (At the time of going to press, the version number is 76, displayed as V1.05). The instrument then proceeds to standby mode.

In standby mode, the display that is shown will depend on your last settings. Only those functions, such as time, temperature and flow rate that have been used on the last shut down will be shown giving their last value. If a function isn't displayed, it can be turned on by pressing the function button. The LED next to the activated function's symbol should be flashing to indicate that the operator can now alter the setting of that function.

In standby mode, the power button light is on and displayed in a yellow color. If the instrument is turned on by pressing the ON switch on the front panel (I), all the function lights stop flashing and the power button light becomes red.

**Note: -**

**While in operation, the functions of blower speed and temperature can be altered, but their values will not be remembered by the instrument at its next start-up.**

The timer and temperature function may be shut off during manual operation by holding down their respective symbol keys. The blower may be altered, but not turned off.

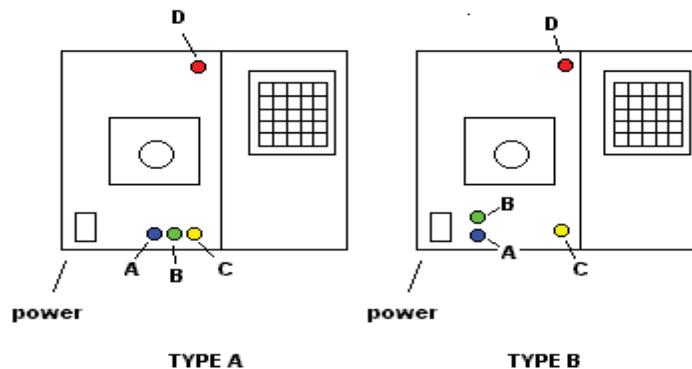
At any time during the operation of the unit, you can revert to standby mode by pressing the off button (O) on the front panel.

Should the instrument behave differently than described above, please notify your dealer or call Sherwood. Failure to pass the power on tests are indicative of either an indicator or the function itself not operating correctly.

## Fuses

The M501 has four fuses accessible on the back of the instrument. All the fuses used are Fast Fuses (Quick-Blow). There are two possible instrument configurations being used and the position of the fuses are different on each. Both configurations, Type A and Type B, are shown below.

Fuse Type	Color	Purpose	230V	110V
A	blue	general	15 A	25 A
B	green	blower	8 A	10 A
C	yellow	heater	10 A	20 A
D	red	pulse flow	2 A	2 A



View of the Back of M501

Fuse type A and C are finger-turn  
 Fuse type B and C are screwdriver

## Service Engineer

A service engineer maintenance manual will become available on request which includes details for the following procedures: -

### REPLACING COMPONENTS

- blower motor
- motor brushes
- heater element
- electrical diagrams

Contact Sherwood Scientific for further information regarding Service and Maintenance of your instrument.

Tel. +44 (0) 1223 – 243444

Fax. +44 (0) 1223 – 243300

e-mail [info@sherwood-scientific.com](mailto:info@sherwood-scientific.com)

# Warranty Statement

## SHERWOOD SCIENTIFIC LIMITED: - PRODUCT WARRANTY

Serial Number: - \_\_\_\_\_ Date Received: - \_\_\_\_\_

Company: \_\_\_\_\_

Address: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Contact Person: - \_\_\_\_\_

Warranty Term: - 12 Months

Sherwood Scientific warrants, subject to the conditions itemised within this document, through either Sherwood Scientific personnel or personnel of its authorised distributors, to repair or replace free of all charges, including labour, any part of this product which fails within the warranty time specified above, appertaining to this particular product. Such failure must have occurred because of a defect in material or workmanship and not have occurred as a result of operation of the product other than in accordance with procedures described in the instructions furnished with this product.

Conditions and specific exceptions that apply to the above statement are as follows:

1. End-user warranty time commences on the day the product is shipped from Sherwood or on the date of the delivery of product to end-user premises provided the end user informs Sherwood that he has received the product, by making a copy of this page appropriately completed and faxing it to Sherwood on +44 (0)1223 243300. In any case, the warranty period is not to exceed 18 months from the shipment date from Sherwood.
2. "Free of all charges" statement applies only in areas recognised by Sherwood as being instrument services which either are directly by its own personnel, or indirectly through personnel of an authorised distributor. Products purchased outside these areas requiring service during the warranty period will incur charges relative to the travel/transit costs involved. However, products purchased in such areas will be serviced during the warranty period free of all charges providing they are returned carriage paid, to either Sherwood or by pre-arrangement to an authorised Sherwood distributor.
3. All maintenance (other than operator maintenance as described in the instructions), repairs or modifications have been made by Sherwood or Sherwood authorised personnel.
4. This product has where applicable been operated using Sherwood specified supplies and reagents.
5. Sherwood reserves the right to make any changes in the design or construction of future products of this type at any time, without incurring any obligation to make any changes whatsoever to this particular product.
6. Reagents, supplies, consumables, accessories and user maintenance items are not included in this warranty.

**Warranty Statement**

continued

7. Repairs or replacement of any part failing due to abnormal conditions including the following, are excluded from this warranty:
  - a) Flood, lightning, earthquake, tornado, hurricane, or any other natural or man-made disaster.
  - b) Fire, bombing, armed conflict, malicious mischief or sprinkler damage.
  - c) Physical abuse, misuse, sabotage or electrical surge.
  - d) Damage incurred in moving the product to another location.
8. User agrees to permit Sherwood personnel or personnel of its authorised distributor to make changes in the product which do not affect results obtained, but do improve product reliability.

Representations and warranties purporting to be on behalf of Sherwood Scientific made by any person, including distributors and representatives of Sherwood, which are inconsistent or in conflict with the terms of this warranty (including but not limited to the limitations of the liability of Sherwood as set forth above), shall not be binding upon Sherwood unless reduced to writing and approved by an officer of Sherwood Scientific.

Except for the obligations specifically set forth in this warranty statement, in no event shall Sherwood Scientific Limited be liable for any direct, indirect, special, incidental, or consequential damages, whether based on contract, tort or any other legal theory and whether advised of the possibility of such damages.

Neither Sherwood nor any of its third party suppliers makes any other warranty of any kind, whether expressed or implied, with respect to Sherwood products.

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## REMOVING THE M501 Fluid Bed Dryer Cover

- 1) At the rear of the instrument, remove the plastic fan cover located in the recess on the right hand side. This will reveal two of the three screws on the right hand side, that must be removed to release the cover.
- 2) Remove the three screws on the left hand side of the rear of the instrument also.
- 3) Place a soft protective mat on the right hand side of the instrument, and roll the instrument on it's side.
- 4) Remove the four feet and the screws along the front edge and two sides only. (Do not remove any screws from the rear edge.)
- 5) Roll the instrument back on it's base, and unscrew the three screws holding the top ring in place.
- 6) Lift off the top ring and any mesh and gasket.
- 7) Carefully slide the cover toward the front, enough to reveal the earth post at the right hand rear of the base. Remove the earth leads linking the cover to the base. It will now be possible to lift the cover clear of the casting, and place it on it's side to the right of the instrument. It may be necessary to pull the sides outward slightly, to easily clear the casting. The wires should be long enough to place the cover close to the base.