AutoClimate Controller

Ideal for environment control in fan-ventilated greenhouses and grow chambers

FOR INTELLIGENT CONTROL OF:-

- Exhaust fans (2 stages)
- Lighting control (2 stages)
- CO_2 injection
- Temperature & Humidity control
- Fogging
- Dehumidifying
- Optional air conditioner control
- Advances control rules
- PC computer interface

Contents

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1. Overview

In brief:-

Outputs
Six 24V AC outputs

1. Fan 1
2. Fan 2 (OR air-con)
3. Heater
4. CO_2 inject
5. Fogger
6. Lights 1
7. Lights 2
8. Dehumidifyer

Inputs

- Senses temperature and humidity using the Autogrow aspirated enviro sensor with option light sensor.
- Senses CO_2 from the (optional) self calibrating Autogrow CO_2 sensor

The above are used intelligently to keep the growing environment in optimal balance without excessive wastage of CO_2 or energy

The function of the AutoClimate controller is to measure and control the growing environment to provide optimal growing conditions. Research has shown that CO2 enrichment together with optimal temperature and humidity can significantly increase both yield and quality. By integrating the injection of CO2 with the other processes the wastage of CO2 is eliminated.

Both cooling and dehumidification make use of the exhaust fans and so it is necessary to combine these effects into one "calculated set point" for cooling and another "calculated set point" for heating. In effect the controller modifies the user entered temperature set-points to cause either an increase in venting (to reduce humidity) or a decrease (to raise humidity).

Cooling is achieved by a number of optional methods starting with extraction fan(s). When the measured temperature exceeds the calculated cooling set point, fan 1 will come on. If this is not sufficient to reduce the temperature then fan 2 will also come on to increase the ventilation. Optionally, an air con unit may be used in place of fan 2 in which case fan 1 will stop when the air con is on.

If the temperature falls below the calculated heating set point then the heater will come on. Normally the heating set point will be set a few degrees below the cooling set point to ensure there is never any overlap between them.

If lighting is installed then CO2 will only be injected when the lights are on and the plants can photosynthesise and use the CO2. CO2 is inhibited when the temperature approaches the venting temperature. CO2 injection is also inhibited when purging to reduce humidity but is not inhibited when air-con is active.

If lighting is not controlled by the AutoClimate then it is essential to install a light sensor and to set the controller so that CO2 injection will only be enabled when there is sufficient light.

Fogging to reduce temperature will only occur if the humidity is not too high. The user selects the temperature at which fogging can commence and also the maximum value of relative humidity at which fogging is permitted. If both of these conditions are met then fogging will commence. Fogging may be implemented by using either high or low pressure fogging controlled by either a pump or solenoid valve from the town water supply. High pressure fogging generates the smallest droplet size and so produces the "driest" fog. Fogging can drop the temperature by a number of degrees with the biggest falls possible when the humidity is low. It also raises the humidity which is normally desirable during hot weather. Remember that plants thrive better if the humidity is high when hot and lower when cool.

Fogging can also be used when the humidity is too low even when not excessively hot. A second set of settings allow this feature to be implemented

Lighting control is by simple time of day settings for the on time and off time.

In the event of very high humidity during cool weather, the controller will start purging by (1) raising the heating temperature (to dry the air) and (2) cycling the fan on and off. Both the humidity level and on/off durations are set by the user.

The controller has a built-in **battery backed** clock calendar to provide the timing functions and also to time and date stamp all logged data.

CO2 option – Safety Note

If you have the CO2 option then it is important that you realise that very high levels of CO2 (eg 5000ppm or more) can be dangerous to human life. For this reason we strongly recommend a totally independent CO2 alarm system that will warn if CO2 levels ever get dangerously high. In addition, the injection system should never be oversized so that even if the CO2 injection system should fail in the ON state, the CO2 will not become excessive. This means setting the regulator to a very low injection rate (see table in appendices) and also ensuring that the grow room is not completely sealed. You can run a test to check that with fans off and the CO2 on, that the CO2 level never becomes

dangerously high. Even with all of these safety features you should still practice safe work methods.

1) ALWAYS FORCE ON BOTH FANS (from the controller front panel) AND PHYSICALLY TURN OFF THE CO2 VALVE BEFORE ENTERING THE GROW ROOM AND KEEP THE DOOR OPEN WHILST INSIDE. (When the fans are forced on the CO2 injection will automatically stop but even if it didn't due to a fault the high exhaust rate should keep the CO2 levels down to safe levels.

2) ALWAYS HAVE A BUDDY OUTSIDE THE GROW ROOM THAT CAN RAISE THE ALARM IN THE EVENT THAT YOU WERE OVERCOME BY THE CO2 GAS

CO2 option – the basics

Many people think that the main source of plant food comes from the fertiliser mix taken in by the roots whereas, in reality, it is the CO2 taken in by the leaves during photosynthesis.

The ambient (normal free air) value of CO2 is approximately 380 to 400ppm and if a grow room is sealed you will find that CO2 levels will plummet below these levels during periods of adequate light when the plants photosynthesise. If artificial lights are used then the heat generated by these will normally mean that ventilation is required so that soon after lights are switched on, the ventilation will start and CO2 levels will rise back toward ambient levels. During winter, night time or if air conditioning is used for cooling, the ventilation may stay off and CO2 levels would stay low, starving the plants of their main source of food.

If the CO2 levels are elevated to between 800ppm and 1200ppm during light but cool periods then growth rates can be significantly increased. Plants such as tomatoes and roses seem to particularly benefit from CO2 enrichment.

CO2 is heavier than air and will tend to sink to form a layer on the ground. For this reason the best way of introducing it is from pipes run just above each row of plants. Use a large diameter pipe (1/2 inch for a typical grow room) with small holes drilled in its sides.

Measurements:-

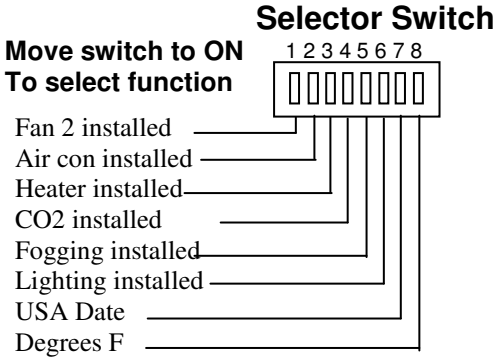
The Autogrow aspirated sensor box (or the mini aspirated sensor) is used to measure temperature and humidity (and optionally light) which is fed to the controller by means of a single cable.

2. Settings

Switch settings

Inside the controller will be found a row of 8 small slide switches (dip switches). These are used to configure the controller so that it knows what functions and sensors are installed.

Move each switch to the ON position
to select the named function



Key pad settings

The controller is set by pressing the mode button to get the required main menu item, then pressing the UP arrow to enter the required sub menu and then continue pressing the mode button again to move down through the sub-menu to the required screen. The only exception to this is that the up and down arrow keys are used to move up and down through the three "readings" screens A, B and C.

When the required screen has been reached, the up or down buttons can be pressed to change the setting, and finally, the save button is pressed to store the changed setting in permanent memory.

MAIN MENU	**press up and dn keys to move up and down thru A, B, C**
A. Temp, RH, CO2	measured readings
B. Calc: Cool Heat	calculated set points
C. F1 F2 H CO Fg Lt	status of outputs tick = ON, X=OFF, -- = disabled
D. Light, Integrated light	measured light level and light integrated today

M1 OVERRIDES
M2 SETTINGS 1
M3 SETTINGS 2
M4 CALIBRATIONS
M5 TIME/DATE
M6 ALARMS
M7 SYSTEM

Press **MODE** button to move down through the main menu then press **UP** to enter the sub-menu for that item

OVERRIDES AND ENABLES SUB-MENU

M10 Fan1	force on, force off or automatic
M11 Fan2/AC	"
M12 Heating	"
M13 CO2 inject	" (Co2 cannot be forced ON for safety)
M14 Fogging	"
M15 Lights	"
M16 Purging	"

Normally, set all of the above (if installed) to AUTO.

SETTINGS 1 SUB-MENU

M20 Cool Setpnt	(25C) Temperature that you want the venting to maintain
M21 Heat Setpnt	(18C) Temperature that you want the heating to maintain
M22 RH Setpoint	(70%) The ideal relative humidity for your crop
M23 CO2 Setpnt	(800ppm) The enriched CO2 level that you desire
M24 Min light	(400umol) The minimum light level for CO2 injection
M25 Lights ON	(8pm) Light ON time
M26 Lights OFF	(10am) Light OFF time
M27 High RH- INC	(2C) The amount that the controller is permitted to increase the heating setpoint by when RH is high in order to dry the air
M28 High RH- DEC	(2C) The amount that the controller is permitted to decrease the cooling setpoint by when RH is high in order exhaust the damp air
M29 Low RH - INC	(2C) The amount that the controller is permitted to increase the cooling setpoint by when RH is low in order to retain the humidity from the transpiring crop

SETTINGS 2 SUB-MENU

M30 Purge RH SP	(90%) The humidity level above which purging will occur
M31 Purge FanON	(10 secs) The purging ON time for the fan
M32 Purge FanOFF	(2 min) The purging OFF time for the fan
M33 Purge - INC	(4C) The increase in heating set point when purging
M34 Fog if Temp	(3C) Fog if temperature is above the CALCULATED SP
M35 Only fog if	(85%) but only if humidity is below this setting
M36 Fog if RH	(50%) Fog if humidity is too low …..
M37 Only Fog if	(18C) but only if temperature is above this setting
M38 Fog ON time	(3sec)Set fog times to get nice puffs of cooling fog
M39 Fog OFF time	(2min)without wetting the crop

CALIBRATIONS SUB-MENU

M40 Calibrate RH	These allow you to adjust the measured values;

M41 Calib Temperature
M42 Calib Light — the RAW values show the unadjusted value
M43 Calib CO2

TIME AND DATE SUB-MENU

M50 Date - Time	View the time and date
M51 Clock Set minutes	Set the clock calendar
M52 Clock Set Hour	
M53 Clock Set Day	
M54 Clock Set Month	
M55 Clock Set Year	

ALARM SUB-MENU

M60 Alarm ON/OFF	Enable/disable the alarm
M61 Alarm Temp max	(35 C)
M62 Alarm Temp min	(5 C)
M63 Alarm RH max	(95%)
M64 Alarm RH min	(40%)
M65 Alarm CO2 max	(1500ppm)
M66 Alarm CO2 min	(200ppm)
M67 Alarm Detent	Time lag before alarm sounds to avoid nuisance alarms

SYSTEM SUB-MENU

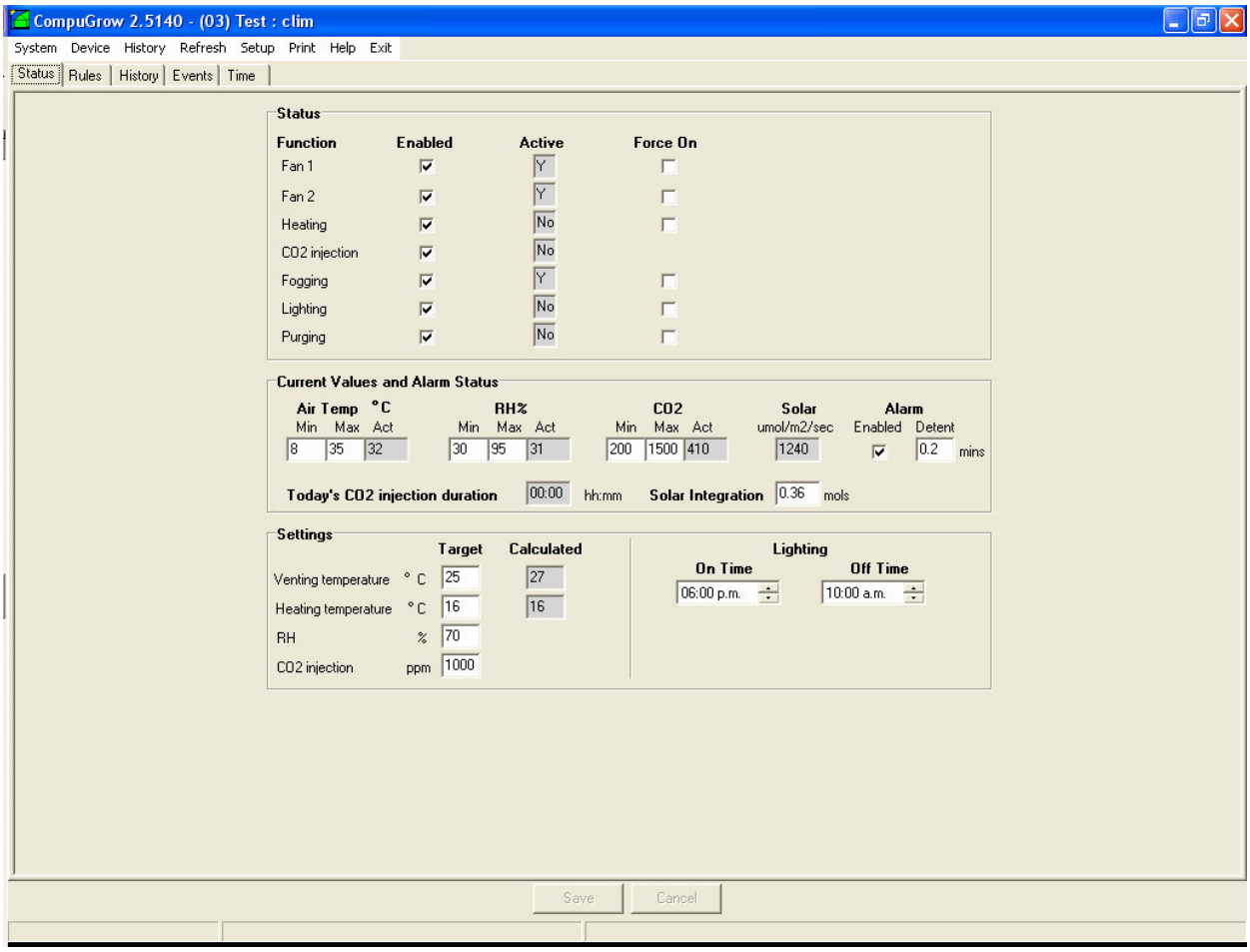
M70 Address	Address for PC communications. Every controller in the system must be set to a different number – start at address 34 and work up. Set the same address on the PC under "setup/configure"

FACTORY DEFAULT SETTINGS

To return the controller to the factory default values do the following:-

Switch off the power and wait 30 seconds. Hold the MODE, SAVE and DN buttons pressed while switching on. The values loaded give a good starting position for most systems.

Setting the controller from the PC

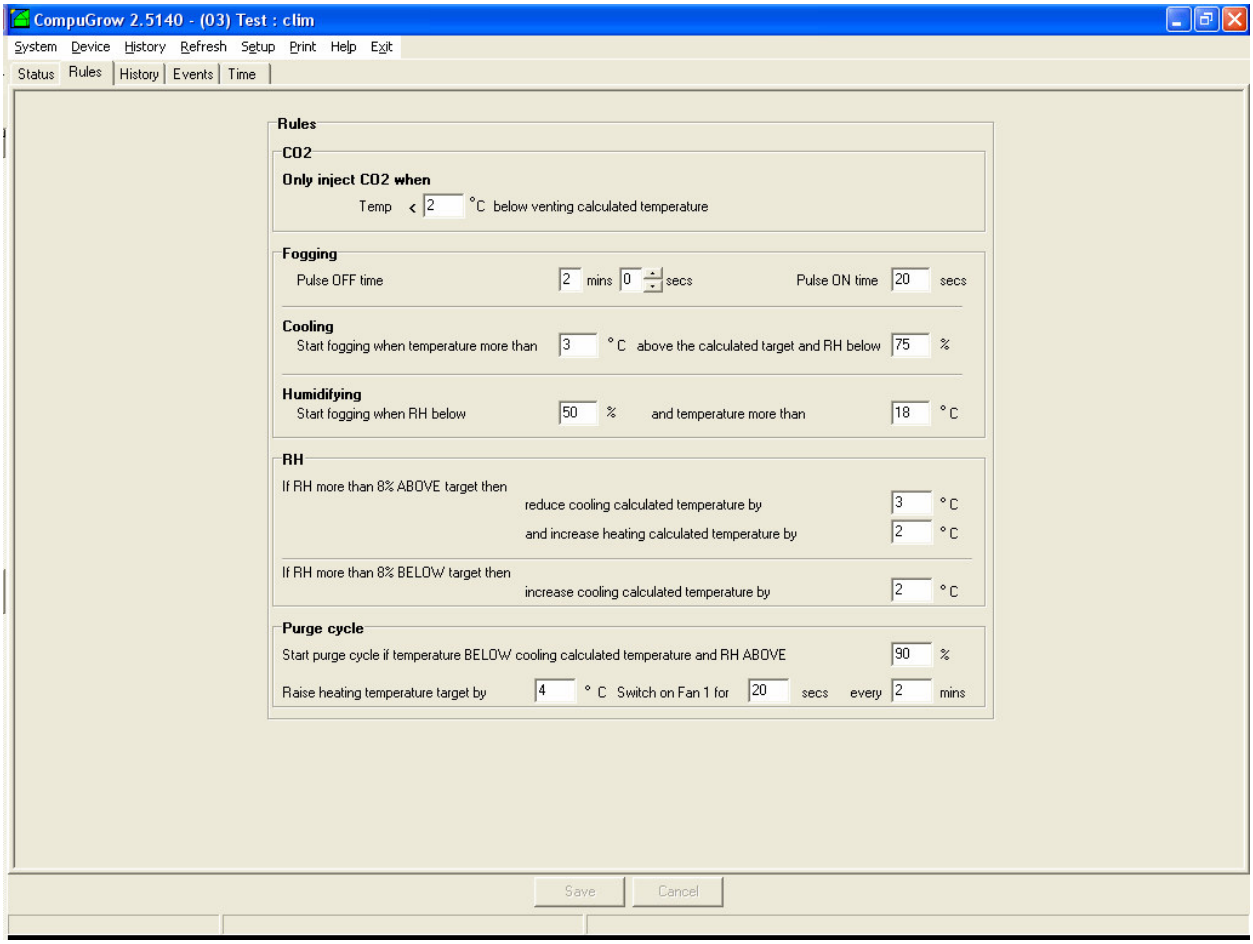


Most readings and settings are found on the status tab shown above. Here each output can be enabled by putting a tick in the enable boxes and most can also be forced ON. These functions are similar to those found in the OVERRIDE menu on the controller. Remember to send the setting to the controller by clicking on the save button at the bottom of the screen.

In the centre of the screen are the readings of temperature, RH, CO2 and light (if a light sensor is fitted). These are shown together with their min. and max. alarm settings. At the end of the row is the alarm enable and the alarm detent setting. The enable allows you to switch the alarm on or off whilst the detent allows you to enter a delay time before the alarm sounds after a trigger point has been reached. This is useful for avoiding nuisance alarms caused by brief transient overshoots etc.

Just below the readings can be found two integrators. The fist totals up the time that CO2 has been injected today so-far whilst the second integrates light level and gives a reading in mols of PAR photons received today. Both of these counters are zeroed at midnight.

At the bottom are found the main settings or set points. These are relatively self explanatory and typical values are shown in the image above. The lighting times can be set so that the lights are on during the day or the night although it is more common to set them to come on during the cooler nights.
Note that the calculated set-points cannot be changed by the user but are calculated from the user settings by applying the rules shown below.

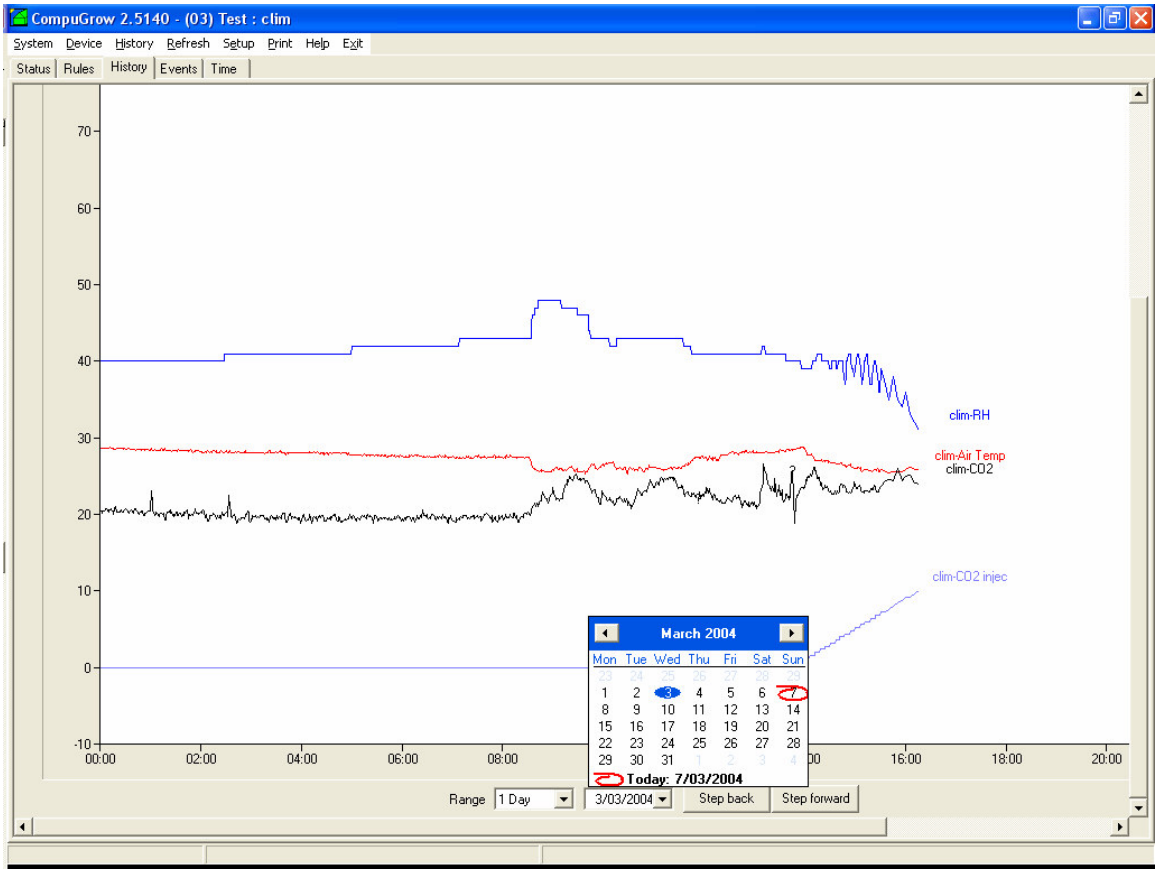


The first rule on the rules tab is to avoid wasting CO2. As the temperature rises from a low level toward the venting set point, the CO2 injection will be stopped at the degrees entered here and so there will be some while before the venting starts. This aloows some time for the present CO2 to be used by the crop.

Fogging is applied in short pulses or “puffs” of fog and the grower needs to specify the pulse ON and OFF times such that adequate fogging is achieved without wetting the foliage. When fogging for the purpose of cooling the temperature needs to be set as well as the maximum RH at which fogging is allowed. Similarly, when fogging to raise humidity, a minimum temperature may be set.

The rules for RH modification apply when the temperature is moderate and allow the temperature at which venting and heating commence to be varied a little to try to correct humidity as well as temperature.

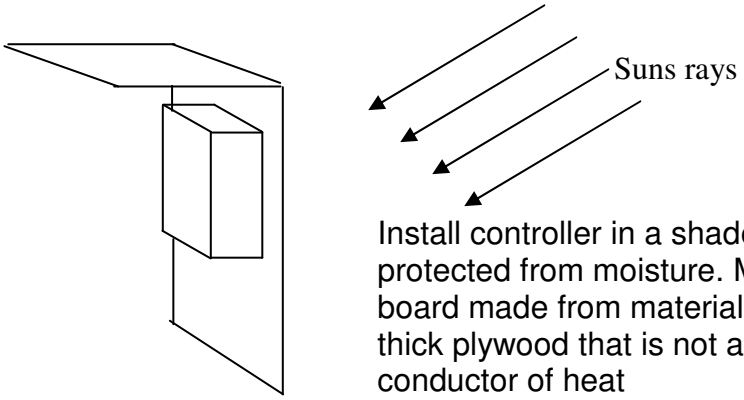
When humidity becomes very excessive, purging may be used to economically keep it in check. Purging tries to reduce humidity by raising the heating temperature to try to dry the air and then cycling the fan on occasionally. If this cycling is still unsuccessful the fan 1 will stay on until the RH drops.



The “history” tab allows you to look back to see what conditions were like on any day of the year. Simply click on the arrow next to the date box and a calendar pops up allowing you to easily select the required period. Displayed periods may be changed from 5mins to 1 week with 1 day being the default duration. Double clicking anywhere on the screen shifts that point back in time to the lie on the start of the graph. This enables you to zoom in to view any area of the graph in great detail.

3. Installation

Install (and store) the controller in a cool, dry well ventilated, shaded position. Normally this means that a shade cover must be provided in the greenhouse or control room to protect it from the suns rays. This is important as the surface temperatures of items in a greenhouse or other closed area, in full sun, may easily exceed 60 deg C (140 deg F). **If this is allowed to happen the warranty is voided**. The shade cover will also prevent condensation drips falling onto the controller.



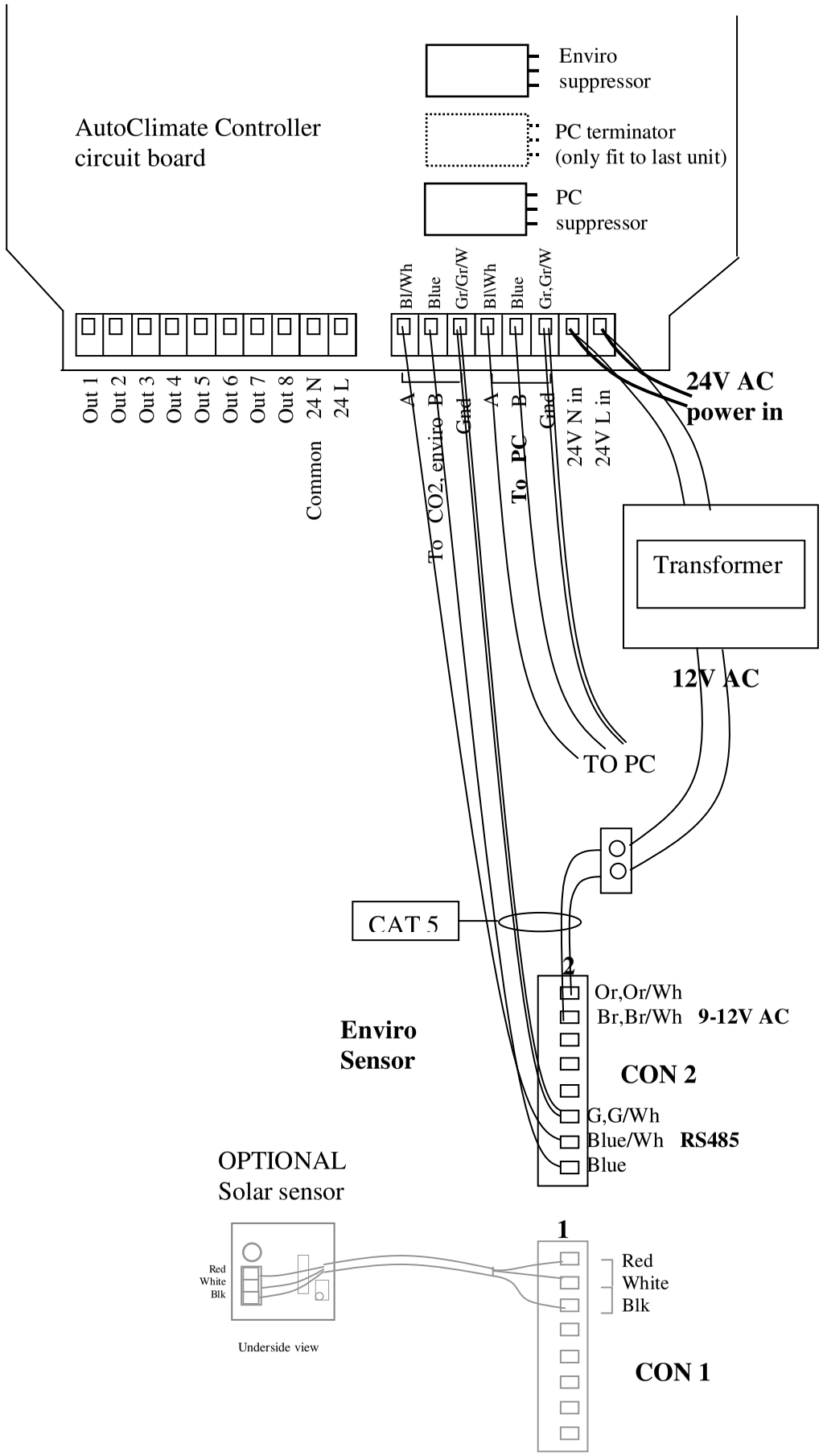
Install controller in a shaded position protected from moisture. Mount on a board made from material such as thick plywood that is not a good conductor of heat

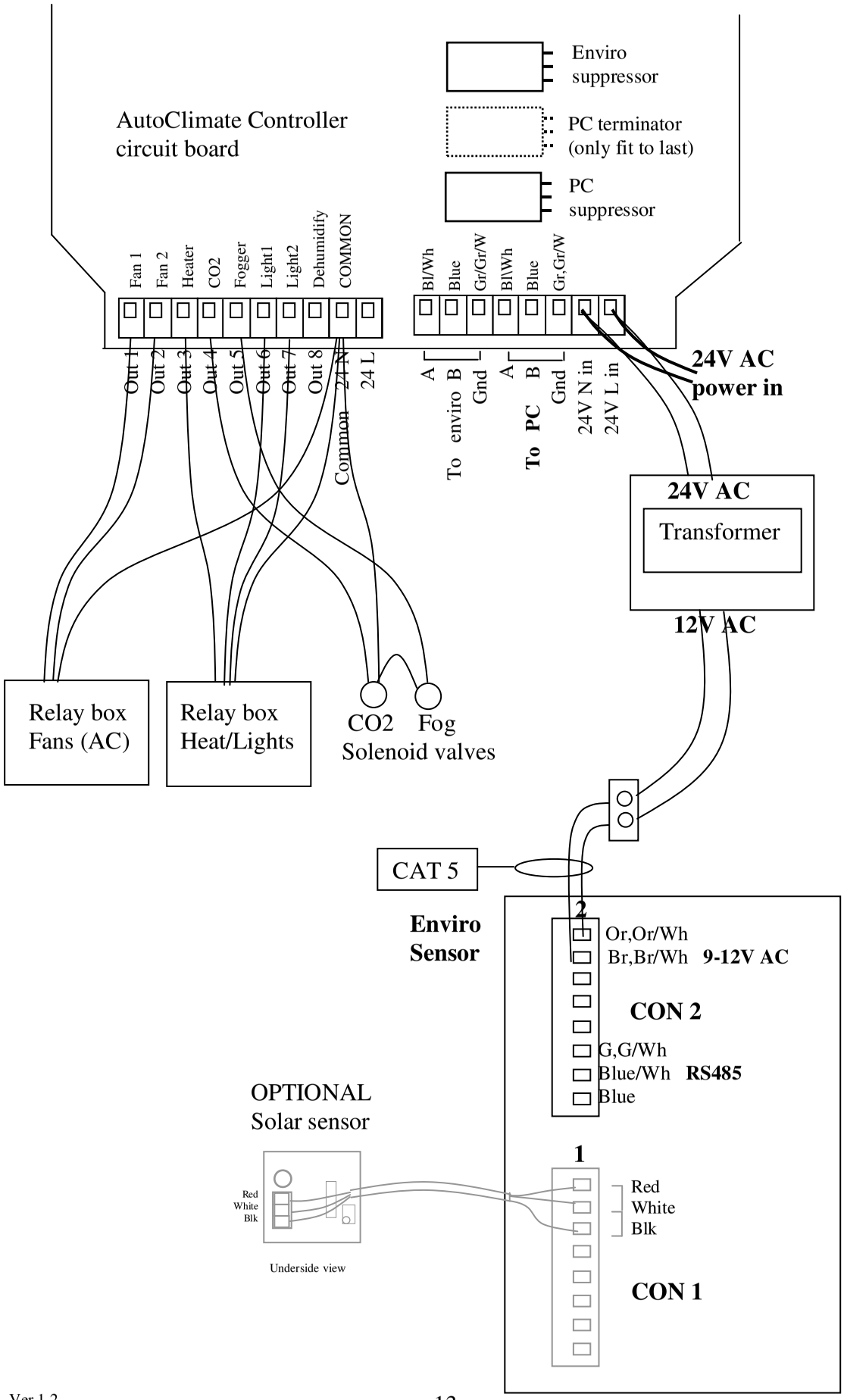
For the longest life the product should not be exposed to high temperatures or humidity for long periods of time.

Install the aspirated temperature and humidity sensor close to the growing canopy so the air that is sampled is representative of the air experienced by the crop.

Avoid spraying chemicals directly onto the enviro sensor box or the controller. If connected to a PC, then pause the fan for a suitable period before spaying. This can be done from the “setup” menu on the PC.

Connect the units using STRANDED CAT5 cable as shown in the following diagrams.


AutoClimate Controller
circuit board
Enviro
suppressor
PC terminator
(only fit to last unit)
PC
suppressor
Bl/Wh
Blue
Gr/Gr/W
Bl\Wh
Blue
Gr,Gr/W
Out 1
Out 2
Out 3
Out 4
Out 5
Out 6
Out 7
Out 8
24 N
24 L
Common
A
B
Gnd
A
B
Gnd
24V N in
24V L in
24V AC
power in
To CO2, enviro
To PC
Transformer
12V AC
TO PC
CAT 5
2
Or,Or/Wh
Br,Br/Wh 9-12V AC
Enviro
Sensor
CON 2
G,G/Wh
Blue/Wh RS485
Blue
OPTIONAL
Solar sensor
1
Red
White
Blk
Underside view
Red
White
Blk
CON 1


AutoClimate Controller
circuit board
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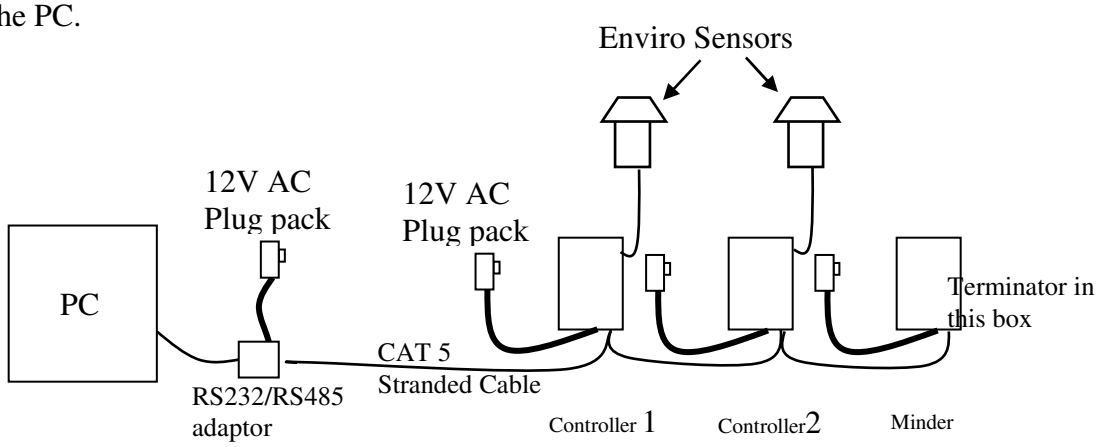
PC
suppressor
Fan 1
Fan 2
Heater
CO2
Fogger
Light1
Light2
Dehumidify
COMMON
Bl/Wh
Blue
Gr/Gr/W
Bl\Wh
Blue
Gr,Gr/W
Out 1
Out 2
Out 3
Out 4
Out 5
Out 6
Out 7
Out 8
24 N
24 L
A
B
Gnd
A
B
Gnd
24V N in
24V L in
24V AC
power in
To enviro
To PC
Common
24V AC
Transformer
12V AC
Relay box
Fans (AC)
Relay box
Heat/Lights
CO2
Fog
Solenoid valves
CAT 5
Enviro
Sensor
2
Or,Or/Wh
Br,Br/Wh
9-12V AC
CON 2
G,G/Wh
Blue/Wh
RS485
Blue
OPTIONAL
Solar sensor
Red
White
Blk
Underside view
1
Red
White
Blk
CON 1

4. PC Interface

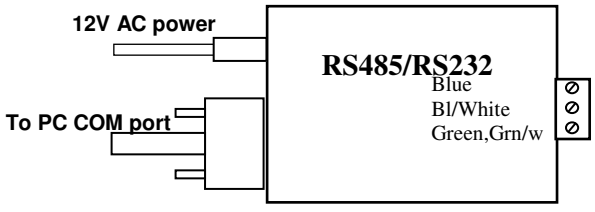
Controller addresses. When the PC requests data from a monitor or controller it first sends the address for that monitor. All monitors/controllers must have a different address and this is set pressing the "MODE" button to get to the "System" sub menu. The base address for these monitors is 34. Press the up or down arrows to change the address and when the required address is displayed, press save to store it in permanent memory. Set up the controllers in sequence starting with the first one at 34 and working upward from there. ie set the first controller to 34 the second to 35 the third to 36 etc. Make a note of the address of each controller and its type as you will need to enter this information on the PC.

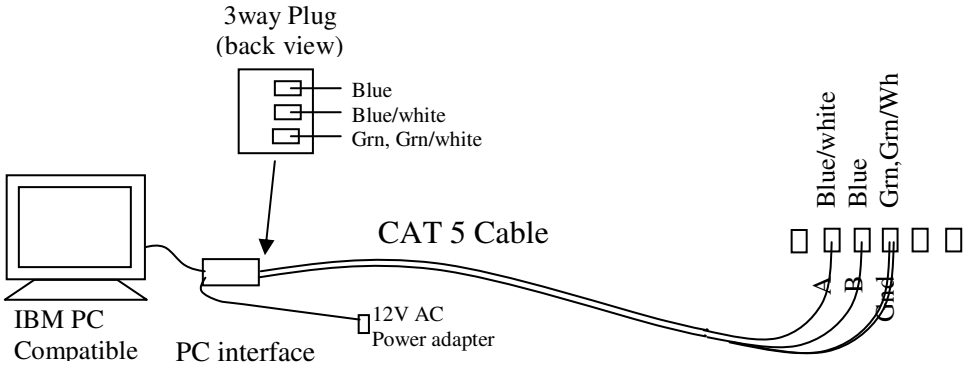


Terminator. If this is not the furthest monitor/controller from the PC then the terminator must be removed and the Data comms cable will be connected as shown and will then loop back out of the box and on to the next monitor/controller. Only the furthest monitor should have a terminator connected. See connection diagrams above.

The PC Interface.

The RS484/RS232 optically isolated interface box should be installed adjacent to the PC computer. It requires a 12V AC supply. A lead is supplied to connect this to a free DB9 COM port on the back of the PC. The CAT 5 cable should be connected as shown below.





Connection of PC interface to the TRS2000

Software installation

The CompuGrow software is suitable for PC compatible computer running Windows 95/98/Me/2000/XP. The computer must have a free serial COM port and should be a Pentium or better. If no serial port is available a USB port with a USB to serial converter may be used.

To install the software on your PC, insert the disk in drive A and execute the CompuGrow install program. This will self-install the software onto your hard drive. You will be prompted during installation to select a folder. The default folder is C:\Program Files\ Compugro\ . When the program is executed it will create some sub-folders under the main folder. Each system (greenhouse group) installed will have its own sub-folder where the files for each of its monitors is stored. Each file will save the data for the whole current month.

Setting up the PC software. When the Compugrow software is first executed the first task is to select the serial COM port that the RS232/RS485 adaptor is connected to. (Note that the adaptor must be one supplied by Autogrow as it performs some special functions as well as converting the signal levels.)

Next, go into Main/setup/add system and add the systems or group names for your monitors. For example if you have say two greenhouses (maybe one growing tomatoes and the other lettuce) and the lettuce greenhouse is divided into two growing systems, say lettuce-main and lettuce-nursery then you might add three systems:- Tomatoes, Lettuce1 and Lettuce2. Once you have allocated names to your systems the next job is to allocate the monitors to each system. To do this, go into Main/setup/configure and select the first system. Now add a short name for each monitor and alongside enter its address number and select the type of monitor that it is. EPT = EC/pH/Temperature, EPR = EC/pH/RunOff, TRS = Temp/RH/Solar

When you save this information the PC will try to communicate with these monitors on the selected port.

If it fails to communicate this could be due to a number of factors:-

1) Wrong COM port on PC selected or COM port not installed
2) No power to monitors
3) No power to the PC adaptor

4) More than one monitor with the same address
5) Address set on PC different to address set on monitor
6) Wires crossed between monitors and PC adaptor
7) No terminator fitted at furthest monitor in the chain
8) Terminators left inside the boxes of the intermediate monitors or two terminators fitted at the end monitor (one inside the box and the other outside)

Finally set the logging frequency to be either every minute or every 5 minutes. The software creates one file for each monitor for each month..

3. Fault-Finding

RH reading incorrect – check calibration and replace the plug-in sensor.

No temperature or RH reading – check power supply to the enviro-sensor – check cable to enviro-sensor.

Graph missing on PC but readings are visible. Check date and time on both the PC and the controller are correct.

No communications to PC – check cable between PC and controller. Check power supply to PC interface. One of the PC interface lights should blink as the power to the interface is switched off/on. Click on "refresh" and ensure that one light on the PC interface blinks. If one light blinks but not the other then check that the controller address matches that set on the PC. If neither blink then check that the correct PC comm. Port is selected and that the PC is functioning correctly. The last thing to try is to remove the suppressor diodes from all of the controllers and the PC interface. If this clears the fault then reinstall them one at a time until the faulty suppressor is found. (Suppressors are supplied to protect the equipment from induced surges (eg due to lightning) and in doing so may themselves be destroyed.)

Other operational functions can be checked by adjusting set-points to force the suspect operation to activate. Remember to allow sufficient time for a response when doing this.

It is often useful to return the controller to its factory default settings as described below.

FACTORY DEFAULT SETTINGS
To return the controller to the factory default values do the following:-

Switch off the power and wait 30 seconds. Hold the MODE, SAVE and DN buttons pressed while switching on. The values loaded give a good starting position for most systems.

4. Maintenance

Periodically, brush away any dust and fluff from the underside grill of the enviro-sensor. If badly contaminated then it is advisable to also clean inside the case. Switch off power to the Enviro-sensor and open the case by removing the front plate then withdraw the plastic box and fan assembly. Carefully, brush any dust from the fan and observe the condition of the little slot(s) on the side of the RH sensor. If clogged then replace the sensor (simply pull out the old one and insert a new one).

Ensure the fan turns freely and is clear of obstructions. Switch on the power and check that the fan rotates quietly. If noisy, replace the fan.

After replacing the RH sensor it is advisable to check its calibration against an accurate humidity meter.

5. Warranty

The warranty on the controller and temperature sensor is limited to 2 years – return to factory. Before returning the unit for service you must call Autogrow Systems Ltd for a return authorization .
RH sensors and fans carry only a 6 month warranty from their respective manufacturers.
This warranty specifically excludes any parts that have been broken or damaged by water, chemical attack or excessive temperature. In particular, the controller and PC interface must be stored and used in a dry, shaded and well ventilated situation. At no time must the case temperature be allowed to exceed 60 deg C (140 deg F).
This warranty specifically excludes liability for consequential damages or for charges for labour or other expense in making repairs or adjustments, or loss of time or inconvenience.

6. Appendix 1. CO2 regulator settings

Adjust the CO2 regulator according to the following table. To use the table, measure the grow room (in meters) and calculate its volume in cu. Metres (Length x Width x Breadth)

Grow room volume	Regulator setting (Ltr per min)
5 cu m	1
10 cu m	1
20 cu m	1
30 cu m	2
40 cu m	2
50 cu m	5
75 cu m	8
100 cu m	10
150 cu m	15
200 cu m	20