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**Water Plus VPD Misting
and Irrigation Control**

The WATER PLUS is a “state of the art” VPD misting and irrigation control system. Each station may be individually programmed for either misting, or irrigation. The Water Plus has many on board features that you can also use to customize it for your particular needs.

VPD SENSOR

Using VPD (Vapor Pressure Deficit) for precise misting and irrigation within the greenhouse environment is an exacting and precise manner to deliver exactly the amount of water that your crops will require in response to the environmental conditions in which they are growing. The VPD sensor consists of three components. They are: 1) a highly accurate humidity sensor; 2) a precision ambient temperature sensor; 3) a second precision temperature sensor to simulate the radiated plant leaf temperature.

UNDERSTANDING VAPOR PRESSURE DEFICIT (VPD)

WATER PLUS

There has been a significant amount of study by a number of environmental and watering experts concerning this basic principle of using VPD to determine when plants need water.

Unlike other methods used to determine watering, using VPD looks at the **entire** environmental conditions surrounding the plant. The VPD Sensor that we use measures Temperature of the Air, Humidity of the Air, and the Temperature of the Leaf of the plant. With these instantaneous sensor values we can determine the VPD of the plants in the greenhouse at regular intervals (every 10 seconds). As the environmental conditions change so does the VPD. By adding the VPD's together we work our way toward a target where we know the plant must have water. After we water the plant the process starts all over again.

Just what is Vapor Pressure Deficit (VPD) and how does it relate to plants? Not really a difficult question to answer. To understand VPD we must understand the following:

1. How water moves through a plant.
2. A plant's structure.
3. How environmental factors effect plant water use.

Plant Water Movement

The amount of water a plant needs is controlled by what takes place in the leaf, not in the soil. When plants are watered, the roots take up water which moves through the stem to the leaf. There it evaporates into the air. A process known as “transpiration”. As water evaporates from the leaf, leaf tissues start to dry, which results in the leaf pulling more water in through the stem from the roots. This water vapor movement out of the leaf is critical because the faster the water evaporates from the leaf, the more water is taken from the soil and pulled through the plant to satisfy the plants needs. It's what takes place in the leaf, not the soil that will determine your plants watering requirements. Water evaporates from cells to the air inside the leaf. This air is always saturated at 100 percent relative humidity. Vapor Pressure Deficit is a measure of the difference in the amount of water in the air inside the leaf and the amount in the air around the leaf. The greater this difference, the faster the plant's lose water.

Plants and the Environment

The best example to understand the basics of VPD is as follows. Let's take a basin of water and a dry sponge. If you bring the basin of water and the dry sponge together, they'll try to neutralize each other out. The basin of water will loose water and the dry sponge will gain water. This neutralizing principle happens with plants. If you take a plant and put it into a dry (low humidity) environment the plant will transpire a certain amount. As the Humidity in the air increases, provided the Air & leaf Temperatures remain constant The VPD decreases and the plant transpires less. If the Leaf Temperature increases and the Humidity and the air Temperature remain constant the VPD increase and the plant transpires more. As you can see, all the environmental factors (Air Temperature, Leaf Temperature, and Humidity) play a part in the water lost by plants through transpiration. If the Air Temperature and the Leaf temperature are the same and the Humidity of the Air is 100%, there would be no VPD.

HOW TO DETERMINE CORRECT WATERING TARGETS

WATER PLUS

FIXED TARGET:

If you are establishing Fixed Targets for Mist or Irrigation, you'll use the Manual Mode, Set System Mode and the Set Station Mode exclusively. The Set Station Mode is where you enter the target.

Manual Mode is where you trigger the station to zero out the VPD accumulate VPD and approach the target you entered in the Set Station Mode. When you feel that a station (zone) needs watered you will read the accumulated VPD in Set Systems for that station and that will be your correct watering target. After doing this a couple of times, you'll establish the perfect fixed target for the station. If you can't, do the following:

- a. Setup a station with a High Fixed Target (5,000 for irrigation).
- b. When the time clock, or whatever waters the subject plants, go into the Manual Mode and Trigger the station you've set the high fixed target to. Leave the **ON/OFF/AUTO** Switch for this station in the OFF position. The station will zero-out the current VPD Accumulation and start accumulating toward the High Target.
- c. The next time clock that waters the plants check the current VPD Accumulation for the station. This is your target! You can divide this target by the number of minutes between watering.

Or the easier way

We have found that one point of VPD accumulates every 15 seconds during a hot summer afternoon. Take what you normally set for minutes off during the hottest part of the day and divide by 4. This will give you a good starting point. Check back after an hour. If cuttings are too dry, reduce the VPD target number. If cuttings are too wet, raise the target number.

INSTALLATION PROCEDURES

PANEL MOUNTING

Mount the control panel in an accessible location. Make sure that the location is free of vibration and in close proximity to the devices being controlled. Always consider voltage drop of electrical current when locating the control panel. Securely mount the panel.

TRANSFORMER – wire to the two AC screws, the ground screw is not used. Be careful not to cross the wires of the power cord or energized solenoid wires. The resulting short will blow the transformer.

The control panel will be powered by a 24 VAC transformer. The transformer must be heavy-duty type that will be able to handle the load of all of the connected solenoid valves, in addition to the control power requirements. In any case, do not use less than a 40 VA transformer. It is highly recommended that a "Machine Tool" variety be used. A Machine Tool Transformer is a heavy duty variety that will allow for high inrush currents that are associated with the use of valves, load contactors and relays.

ELECTRICAL CIRCUIT

The electrical circuit that feeds the machine tool transformer must have no other loads connected to it. This will prevent damaging surges from other related electrical devices. Follow all local and national codes in the connection of all of the greenhouse equipment. Always allow for voltage drop conditions. Always consider that the greenhouse is a wet environment. Plug the transformer into a surge protector. * **We would highly recommend using a surge protector when operating your misting controller so that it will stop voltage spikes and surges that could damage your controller, such damage is not covered by your warranty.**

WIRING METHODS

Always use stranded wire when connecting cables or conductors to the actual circuit board of the control panel. This will allow flexibility. Use no smaller than #18 gauge stranded wire for all outputs. Use no smaller than the recommended wire size of stranded cable for inputs, generally #22 gauge.

SENSOR CONDUCTORS

Route sensor conductors separately from control conductors. This is very important so as to reduce electrical interference. Never route sensor conductors in conduits used for other voltages. This is in violation of the electrical code and will cause dangerous interference to the control system. Always locate the actual sensor in the center of the range that is being controlled for accurate readings. Do not allow the sensor to come in contact with any greenhouse structure member such as a post that would give off any radiated heat and cause a false temperature reading. Do not locate the sensor where a particular piece of equipment would cause false readings, such as a heater blowing directly on the sensor. Mount all wind/rain sensor in a clear area, free of any wind obstructions.

CONTROL CONDUCTORS

Route all valve wiring conductors separately from sensor conductors. This is very important so as to reduce electrical interference.

VALVE SELECTION

You may use a standard 24 VAC watering or misting valve. Be sure to not exceed a total of three valves on any one station. If you will require more than three valves on a station, contact Micro Grow for information on how to do this. Always make sure that your transformer is sized correctly for the number of valves that you will be using.

PROGRAMMING LIGHTS

RUN-Indicates that the system is in the running mode.

MANUAL-Use this mode to manually energize a station.

VPD STATUS-This mode will indicate the individual station's VPD status. This will show the set VPD target that has been entered for that particular station, and also the current accumulation towards that target.

SET TARGETS-Set the desired VPD target levels here for each station.

SET UP STATIONS-This is where each station set is defined as to be used as misting or irrigation, the actual run times of the station, and whether the station will operate in the night mode.

SET CLOCK-Set the time clock here. This mode is also used to calibrate the VPD sensors.

DAY MODE-Set the criteria for the day mode here. You may choose the internal 24 hour clock, or use the automatic photocell.

NIGHT MODE-Set the criteria for the night mode here. You may choose the internal 24 hour clock, or use the automatic photocell.

PROGRAMMING SWITCHES

There are three main programming switches located on the Water Plus front panel. These are:

RUN-SET SWITCH

RUN-Puts the control in the RUN mode.

SET-Puts the control in the SET mode in order to set all functions as outlined on the programming lights.

PRIOR-NEXT SWITCH

PRIOR-Advances to the prior item in the menu.

NEXT-Advances to the next item in the menu.

VALUE UP-VALUE DOWN SWITCH

VALUE UP-Increases the value in the display.

VALUE DOWN-Decreases the value in the display.

(The VALUE switch is also used to toggle between)

SYSTEM RUN MODE

While the Water Plus is running, the following information will be displayed on the screen:

1. The current ambient air temperature.
2. The current radiated simulated leaf temperature.
3. The current relative humidity.
4. The current VPD level.
5. The time of day.

In addition, if the Water Plus is in the **NIGHT MODE**, the indicator will be flashing.

TO MANUALLY OPERATE A STATION

1. Depress the **RUN-SET** switch until the **MANUAL** indicator is lighted.
2. Use the **PRIOR-NEXT** switch to select the desired station.
3. Once the desired station is displayed, depress and release the far right **VALUE** switch to manually energize that station. The station will run for the time period that has been set in the **SET UP STATIONS** mode. The station will then turn off automatically.

When finished, return to the **RUN** mode by holding up the **RUN-SET** switch.

TO CHECK A STATION'S STATUS

1. Depress the **RUN-SET** switch until the **VPD STATUS** indicator is lighted.
2. Using the far right **VALUE** switch, select the station number to check. The value shown next to the station number is the accumulative VPD value that has been reached for that particular station. Depressing the **PRIOR-NEXT** switch again will show the set target for that station. Depressing the **PRIOR-NEXT** switch a third time will show if that station is set up as a propagation mist station, or is an irrigation station.
3. To advance to another station's status, use the **VALUE** switch.

When finished, return to the **RUN** mode by holding up the **RUN-SET** switch.

TO SET A STATION'S VPD TARGET

1. Depress the **RUN-SET** switch until the **SET TARGETS** indicator is lighted.
2. Using the far right **VALUE** switch, select the station number to set.
3. When the correct station is displayed, depress the **PRIOR-NEXT** switch. This will flash the first digit to set. Use the **VALUE** switch to set the first digit. If you desire a number less than 100, enter 0 here.
4. To set the second and third digits. Use the **PRIOR-NEXT** switch, and the **VALUE** switch as above.
4. Using the **VALUE** switch, select if this station will be propagation misting, or irrigation.

When finished, return to the **RUN** mode by holding up the **RUN-SET** switch.

TO SET UP A STATION

1. Depress the **RUN-SET** switch until the **SET UP STATIONS** indicator is lighted.
2. Using the far right **VALUE** switch, select the station number to set up.
3. When the correct station is displayed, depress the **PRIOR-NEXT** switch.
4. Using the **VALUE** switch, select if this station will be propagation misting, or irrigation.
5. Depress the **PRIOR-NEXT** switch again to display the run time of that station. Use the **VALUE** switch to set the run time. If propagation mist was selected, the run time will be in seconds. If irrigation was selected, the run time will be in minutes. You may select from 1-99.
6. Depress the **PRIOR-NEXT** switch again to display the **NIGHT MODE** status. Use the **VALUE** switch to select if that particular station should run while the control is in the night mode (on) or not (off).
7. Depress the **PRIOR-NEXT** switch again to advance to the next station to be programmed. Repeat steps 1 through 6 above.

When finished, return to the **RUN** mode by holding up the **RUN-SET** switch.

TO SET THE SYSTEM CLOCK AND CALIBRATE THE SENSORS

CLOCK SETTING

1. Depress the **RUN-SET** switch until the **SET CLOCK** indicator is lighted.
2. Change the first digit of the displayed time by using the **VALUE** switch.
3. Depress the **PRIOR-NEXT** switch to change to the minute setting. Use the **VALUE** switch to set the correct minutes.
4. Depress the **PRIOR-NEXT** switch to change to the AM/PM status. Hold the **VALUE** switch to change the AM/PM status.

When finished, return to the **RUN** mode by holding up the **RUN-SET** switch.

CALIBRATION

Directly after the clock settings, comes the sensor calibrations. Before attempting any calibrations, make sure that you are using some very reliable test thermometers for the temperature readings, and an accurate method to determine the humidity readings. It is best to calibrate the temperatures in the very early morning, or evening hours when the radiated affect is nil.

1. Depress the **RUN-SET** switch until the **SET CLOCK** indicator is lighted.
2. Continue to depress the **PRIOR-NEXT** switch until the air temperature is displayed.
3. Use the **VALUE** switch to change the temperature reading.
4. To calibrate the simulated leaf temperature, depress the **PRIOR-NEXT** switch until that setting is displayed. Use the **VALUE** switch to change the display.
5. To calibrate the humidity reading, follow step 4 above.

When finished, return to the **RUN** mode by holding up the **RUN-SET** switch.

SETTING THE DAY AND NIGHT MODES

TO SET THE DAY MODE TIME

1. Depress the **RUN-SET** switch until the **DAY MODE** indicator is lighted.
2. Use the **VALUE** switch to select either the internal photocell (PHO), or a specific hour in the day to switch to the day mode of operation.
3. If a specific hour is selected, after selection, use the **PRIOR-NEXT** switch to advance to the minute selection. Set the minutes using the **VALUE** switch.
4. Finally, set the AM/PM mode by depressing the **PRIOR-NEXT** switch again, and by using the **VALUE** switch.

When finished, return to the **RUN** mode by holding up the **RUN-SET** switch.

TO SET THE NIGHT MODE TIME

1. Depress the **RUN-SET** switch until the **NIGHT MODE** indicator is lighted.
2. Use the **VALUE** switch to select either the internal photocell (PHO), or a specific hour in the day to switch to the night mode of operation.
3. If a specific hour is selected, after selection, use the **PRIOR-NEXT** switch to advance to the minute selection. Set the minutes using the **VALUE** switch.
4. Finally, set the AM/PM mode by depressing the **PRIOR-NEXT** switch again, and by using the **VALUE** switch.

When finished, return to the **RUN** mode by holding up the **RUN-SET** switch.

SYSTEM FEATURES

ON/OFF/AUTO SWITCHES WITH LIGHTED OUTPUT INDICATORS

Each station may be selectively switched using the front panel toggles. The station may be manually energized by using the on position, left completely off, or put in automatic operation. In addition, each station has a bright, LED indicator that will show if it is in manual or automatic operation.

PRIORITY OPERATIONS

If the Water Plus is operating an extended time irrigation station, and at the same time a misting station should become due to operate, the Water Plus will disable the irrigation station if it will exceed the maximum allowable stations in operation at any time (see DIP switch settings next), in order to operate the propagation mist station. After the propagation mist station has operated, the irrigation station will continue.

CUSTOM DIP SWITCH SETTINGS

By using the custom dip switch inside the Water Plus, it is possible to customize the control for your particular needs. The connection drawing features a detail of the DIP switch settings. The possible customization changes are:

DISPLAY MODE

Select either Fahrenheit or Centigrade temperature readings.

IRRIGATION REPETITIONS AND WAIT TIMES

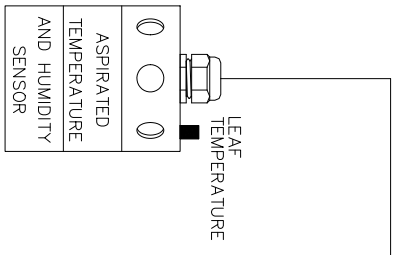
It is at times advantageous to have an irrigation station water and then repeat in order to allow for saturation. The Water Plus will allow the grower to set this information on the control DIP switches.

DEFAULT OPERATION TIME IF NO CHANGE IN VPD

This provides for backup operation of the propagation mist and/or irrigation stations in the event that the VPD sensor becomes disconnected or damaged in the field.

MAXIMUM NUMBER OF STATIONS ALLOWED ON AT ANY TIME

If water pressure is a problem, set the maximum allowable stations that can operate at any one time. The Water Plus will then “queue” those waiting stations in order to keep the water pressure up for the system.



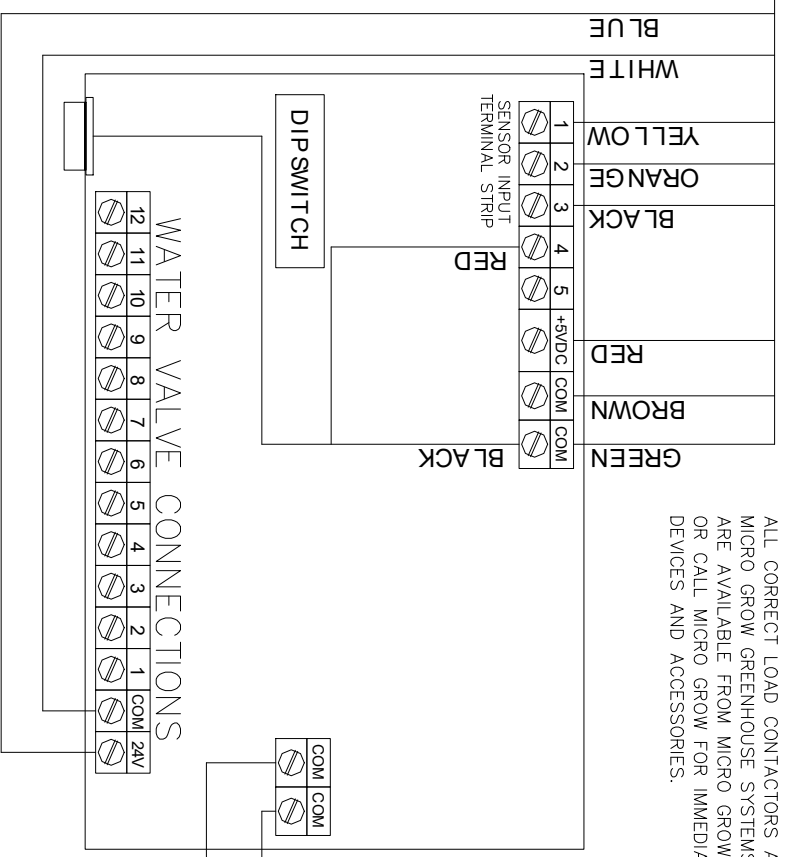
LOCATE IN THE CENTER OF CONTROLLED AREA AWAY FROM DIRECT CONTACT WITH GREENHOUSE METAL POSTS AND MEMBERS.

PHOTOCELL DETECTS SUNSET AND SUNRISE

TRANSFORMER NOTE:
USE A MACHINE TOOL VARIETY ONLY. 100 VA IS RECOMMENDED. IF A SMALLER SIZED TRANSFORMER IS USED, ADJUST THE FUSE PROTECTION ACCORDINGLY. (see fuse note)

OUTPUT NOTE:
THE CONTROL OUTPUTS ARE RATED AT 1 AMP EACH MAXIMUM. DO NOT EXCEED THIS OR DAMAGE MAY RESULT. DO NOT EXCEED 1 AMP FOR ANY SINGLE OUTPUT OR 4 AMPS TOTAL FOR ALL OUTPUTS. (2 AMPS TOTAL IF A VA TRANSFORMER IS IN USE)

FUSE NOTE:
IMPORTANT: DO NOT EXCEED 4 AMPS FOR THE FUSE RATING WHEN USING A 100 VA TRANSFORMER OR 2 AMPS WHEN USING A 50 VA TRANSFORMER. USE A SLOW BLOW VARIETY.



ALL CORRECT LOAD CONTACTORS AND CONTROL RELAYS ARE AVAILABLE FROM MICRO GROW GREENHOUSE SYSTEMS. 50 AND 10 VA MACHINE TOOL TRANSFORMERS ARE AVAILABLE FROM MICRO GROW GREENHOUSE SYSTEMS. SEE YOUR DISTRIBUTOR OR CALL MICRO GROW FOR IMMEDIATE SHIPMENT OF ALL REQUIRED CONNECTION DEVICES AND ACCESSORIES.

ALL CONNECTED 24 VAC LOAD RELAYS AND CONTACTORS MUST HAVE A SURGE PROTECTION DEVICE INSTALLED ACROSS THE COILS. SURGE SUPPRESSION DEVICES ARE SUPPLIED WITH EACH UNIT.

DIP SWITCH CONFIGURATION

MAXIMUM NUMBER OF STATIONS ALLOWED ON AT ONE TIME	IRRIGATION WAIT TIME BETWEEN REPETITIONS	IRRIGATION REPETITIONS	FAHRENHEIT CENTIGRADE
#1 OFF #2 OFF #3 OFF 4 STATIONS	#6 OFF #7 OFF 1 MINUTE	0 TIMES	
#1 ON #2 OFF #3 OFF 1 STATION	#6 OFF #7 ON 3 MINUTES	2 TIMES	
#1 OFF #2 ON #3 OFF 2 STATIONS	#6 ON #7 OFF 5 MINUTES	1 TIME	
#1 ON #2 ON #3 OFF 3 STATIONS	#6 ON #7 ON 10 MINUTES	4 TIMES	
#1 OFF #2 OFF #3 ON 3 STATIONS	REPETITIONS		
#1 ON #2 OFF #3 ON 5 STATIONS	#8 OFF		
#1 OFF #2 ON #3 ON 7 STATIONS	#8 ON		
#1 ON #2 ON #3 ON 8 STATIONS			

WATER PLUS

Project ASPIRATED WATER PLUS SYSTEM			
Drawn by SB	Date 04/29/04	Distributor N/A	Order ID N/A

LIMITED WARRANTY

Phytotronics Inc. warrants that all of the products Phytotronics Inc. manufactures are free from defects at the time of shipment by Phytotronics Inc. This warranty covers defects in workmanship and materials. No warranty is extended on any parts, materials, or components manufactured by others and purchased by Phytotronics Inc., and any warranty on these materials is limited to the warranty supplied by the original manufacturer or supplier of said products only. This warranty excludes any and all damages cause by power surges, lightning, installation by unqualified individuals, damage by misuse or neglect, shipment damage, alterations to original manufacturing, and improper installation or use for any reason than intended by manufacturer. This warranty may not be altered in any manner except with the written authorization of one the officers or owners of Phytotronics Inc. The only and sole liability of Phytotronics Inc. under this warranty is limited to repairing, replacing or the issuance of credit for any products returned to Phytotronics Inc., during the warranty period of twelve (12) months from date of shipment. This warranty is specifically conditioned upon Phytotronics Inc. being notified in writing promptly upon discovery of any product defects by the buyer or end user. The product must then be returned prepaid to Phytotronics Inc. within the twelve month warranty period for inspection by Phytotronics Inc. Upon inspection of said product, Phytotronics Inc. will notify buyer or end user of its findings. At Phytotronics Inc. sole discretion, the product will be replaced, repaired or a credit will be issued for the original sale price of the product, provided that damage has not occurred due to misuse, neglect, improper use or installation as outlined above, shipping damages or accident.

Phytotronics Inc. SHALL NOT BE LIABLE FOR ANY DAMAGES BEYOND THE ACTUAL ORIGINAL COST OF THEIR PRODUCT EITHER DIRECTLY OR INDIRECTLY ARISING FROM DEFECTIVE PRODUCTS OR WORKMANSHIP.