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Instructions for the ECI MK1.2 EvapoMisting Controller and associated ES4pt100 EvapoSensor

EVAPOSENSOR MISTING CONTROL
INSTALLATION AND OPERATION

The Evaposensor consists of two temperature sensing ‘leaves’ each with a temperature sensitive element formed by wet and dry platinum resistance Pt100 temperature sensors. One leaf remains wet via a wick immersed in a reservoir of distilled water, the other ‘dry’ leaf gets wetted periodically by bursts of mist or fog. Unlike conventional wet and dry hygrometers housed in an aspirated screen for measuring humidity, the Evaposensor is placed in the misting environment just above cutting height where it will be influenced by solar radiation, air temperature, humidity and air movement – i.e. the drivers affecting the rate of transpiration loss from the cuttings.
Evaporative cooling from the wick normally keeps the wet leaf cooler than the dry leaf during the day, except when the dry leaf is wetted by mist or fog The difference in temperature between these artificial leaves is called Wet Leaf Depression or WLD. The higher the WLD the greater the rate of evapotranspiration. Periodic misting or fogging will wet the dry leaf which is subject to evaporative cooling causing the WLD to rapidly drop, rising again as the wet leaf dries.
The Evaposensor accurately controls mist or fog in propagation, as it senses WLD in an analogous way to the transpiration stress experienced by cuttings or a plant and is approximately proportional to the evaporative demand on the real leaves of plants or cuttings. Misting frequency will be automatically adjusted to changes in the weather to accurately reflect changes in evaporative demand.
The Evaposensor is more reliable and accurate than the electronic leaf.
The Evaposensor is also better than controlling mist by light integration as it factors in air temperature, movement and humidity

The difference in temperature between these artificial leaves is approximately proportional to the evaporative demand on the real leaves of plants or cuttings.
The Evaposensor can act as stand alone misting controller, a fog control system (‘wet’ or ‘dry’ fog) or as an evaporative meter that can be integrated with an E&TS irrigation controller to automatically adjust watering requirements.
A digital meter continuously displays the current ‘wet leaf depression’ a measure of evaporative demand and thus of stress on unrooted cuttings.
The wet and dry sensors are connected to a differential amplifier, which cancels any common bridge error signals.

EVAPOSENSOR CONTROL

Any small difference in bridge resistance and connecting cable is cancelled by the adjustment of the ZERO control. This is normally set only when a new sensor has been connected. However it can be checked at regular intervals if so desired.

For mist or fog control the SET POINT can be adjusted from1ºC or less to maintain a very wet regime for soft and stress sensitive cuttings, right through to 10ºC for cuttings that need very dry conditions e.g. succulents.

The Evaposensor has three different types of output:

1) Relay with Change over contacts, voltage free.

2) 24Vac for switching mist valves etc When wet leaf depression (WLD) exceeds set point a 24Vac signal switches on the misting valve for the time set in seconds by the ON SECONDS control (adjustable from 0 – 10 seconds). This output switches off for a period set by the OFF MINUTES control (adjustable from 0 minutes to 30 minutes).This process is repeated until the sensor is 'satisfied', i.e. WLD falls below the set point.

3) 0 – 20 mA non isolated linear current output. This can be connected to existing controllers e.g. E&TS 16 station irrigation controller and other common misting, fogging and irrigation control systems that are capable of integrating the signal and adjusting the watering times accordingly. It can also be used for remote display, data logging etc.

The DEMAND LED is on when WLD is above set point, i.e. when there is a demand for mist. Relay contacts closed

The OUTPUT LED is on when the 24Vac output is on. If the DEMAND LED is on but the OUPUT LED is off it will normally mean that the system is timing the interval between mist bursts (set by the OFF time control).

When the DEMAND led is illuminated a mist burst can be activated manually by pushing MANUAL START, when the OFF interval has timed out.

Endorsed by years of successful use for propagation of difficult subjects in a research environment at East Malling

Successfully field tested with excellent results on six commercial nurseries in HDC funded research (HNS 159).

Reports available from HDC

Based on sound theoretical concept (Harrison Murray), 1991.

Reference:

HARRISON – MURRAY, R.S. (1991). An electrical sensor for potential transpiration: principle and prototype.
Journal of Horticultural science, 66, 141 – 149

SPEEDY SET UP OUT OF THE BOX

1) Mount rear enclosure by observing the mounting cut outs on P. 8
2) Connect 110/240Vac mains supply to the terminal block labelled TB2
3) EvapoSensor is pre wired. DO NOT SHORTEN or LENGTHEN
4) Connect 0-20mA from TB4 to the integrator board of the PC. Ignore this step if you do not wish to schedule irrigation
5) Connect the 24Vac misting solenoid to terminal block TB3
6) Connect front enclosure to rear connection. Do not force the IDC connectors they can only be fitted one way
7) Immerse EvapoSensor with or without wick into a bucket of water
8) Apply mains power. Agitate the water for a few seconds to allow the WLD reading to stabilise. The reading will be near zero. If slightly off adjust using the ZERO CONTROL until 00:00 is displayed. This is quite a fiddly procedure but it is do able with patience
9) Remove the EvapoSensor from the bucket of water and replace the wick if removed, remembering to insert the end into the 10mm hole. Fill the reservoir with distilled water.
10) Place the EvapoSensor at leaf height of the cuttings
11) Set the rocker switch to the TIMER position and until experience gained, for tender cuttings set the WLD to 1 for established cuttings set to 1+.
    Set the ON SECONDS to 5 and the OFF MINUTES to 5.
    With the headers (page 4) set at factory default, when the measured WLD exceeds the set WLD relay will close and misting will be applied for 5 seconds (red led illuminated) followed by an off period of 5 minutes. Misting will not occur until after 5 minutes has passed even if the DEMAND (green led) is illuminated.

    With the rocker switch in CONTINUOUS position misting is applied and remains applied continuously.

There are seven control modes configured by header selection HDR2, HDR3, HDR4 and HDR5
HDR2 labelled **SENSOR**. HDR3 labelled **CYCLIC**. HDR4 labelled **DEMAND**. HDR5 labelled **OUTPUT**.
These headers are located on the inner main board

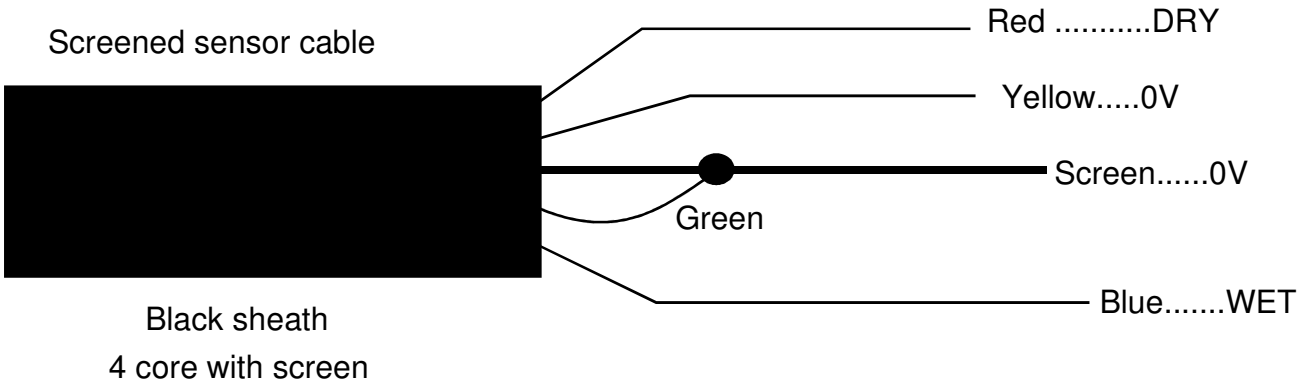
1) Factory setting HDR2 + HDR4.
   Control by sensor, when the measured WLD exceeds the set WLD, relay turns on and the solenoid valve mists for the time set in seconds by adjusting the ON SECONDS control. During the misting period the sensor will become wet, WLD falls below WLD set point and the relay will turn off. The solenoid valve will mist as per the setting on the ON SECONDS control.
2) HDR2 only. Control by sensor, when the measured WLD exceeds the set WLD solenoid valve mists for the time set on the ON SECONDS control. When WLD falls below WLD set point the solenoid will mist as per the setting on the ON SECONDS control. **NO RELAY OPERATION**
3) HDR3 only, control by cyclic timing. Solenoid valve mists for the time set on the ON TIMER followed by an off period set by the OFF MINUTES control adjustable from 0 to 30 minutes. **NO RELAY OPERATION**
4) HDR4 only, control by sensor, when the measured WLD exceeds the set WLD, relay turns on. When the WLD falls below the set WLD the relay turns off. **NO SOLENOID.**
5) HDR2 and HDR5, Control by sensor, when the measured WLD exceeds the set WLD, relay turns on and the solenoid valve mists for the time set in seconds by adjusting the ON SECONDS control. During the misting period the sensor will become wet, WLD falls below WLD set point, the relay and solenoid valve runs for the time set on the ON SECONDS control.
6) HDR3 and HDR5, control by cyclic timing. Solenoid valve mists and relay turns on for the time set on the ON TIMER, followed by an off period set by the OFF MINUTES control adjustable from 0 to 30 minutes.
7) HDR3 and HDR4, relay action controlled by sensor (WLD), misting action by cyclic timing. When the measured WLD exceeds the set WLD relay is turned on. When the WLD falls below the set WLD relay turns off. Misting dwell period is controlled by the time set on the OFF MINUTES control and is not synchronised with the relay action. Misting time is controlled by the time set on the ON TIMER.

HDR2 + HDR4 control by sensor. Relay by **DEMAND** misting by SENSOR.
HDR2 control by sensor Misting by **SENSOR**
HDR3 cyclic control. Misting by **CYCLIC**
HDR4 control by sensor relay by **DEMAND**
HDR2 + HDR5 control by sensor. Relay plus misting common time. Misting by SENSOR, relay by **OUTPUT**
HDR3 + HDR4 control by sensor. Relay by **DEMAND**, misting by CYCLIC

DISALLOWED, NO HARM JUST CONFUSION:
HDR2 + HDR3 DEFAULTS TO CYCLING MODE
HDR4 + HDR5 DEFAULTS TO MIST CONTROL MODE

ES4 Evaporation sensor

Fitted with two Pt100 temperature sensors



MAINTENANCE

Fill the reservoir with distilled water . Under no circumstances use tap water, otherwise the wick could rapidly clog up with lime deposit. Check on the level weekly and fill with a tubed plastic bottle.
The wick should be occasionally cleaned of excessive algae using an old toothbrush or similar.
New replacement wicks are available from E&TS Ltd.
Chipped paint on leaf sensors can be touched up with matt black board paint available from good D.I.Y. Stores.

POSITIONING OF THE EVAPOSENSOR
It is important to position the Evaposensor in the optimum position to get the best Results.

Ideally the sensor should be placed just above the height of the cuttings, this may involve placing the sensor unit on an inverted flower pot or other suitable object o that the wet and dry sensors are not shaded or sheltered from mist.

The sensor needs to be placed in a representative area so that it experiences the same mist conditions as the cuttings.

The sensor must not be covered or shaded. Position to the South side of any structures such as risers, pipes or stanchions to reduce the likelihood of sensor shading.

CONNECTIONS:

INPUTS
Please refer to diagram 1

SUPPLY
Connect a mains 240V ac supply to terminal block TB2
Brown to LIVE
Neutral to BLUE
Green/yellow to Earth.

SENSOR
Connect the evaposensor to terminal block TB1
Dry sensor to the block labeled ‘dry’.
Wet sensor to the block labeled ‘wet’
Returns and cable screen to the block labeled 0V

1) Connect the evaposensor, wet leaf to Wet and 0v on TB1, dry leaf to Dry and 0v on TB1. Connect both screens to 0v
2) Power up
3) Remove sensor top and fill reservoir with distilled water.
4) Remove wick from Wet sensor, invert top and immerse both sensors into the reservoir. Leave for 10 minutes
5) Stir water (not with finger as the heat could affect the zero point). Carefully adjust the zero control until 0.00 is displayed on DPM. It is ‘fiddly’ but you can do it ±0.001 or ±0.002 is acceptable but 0.00 is preferable
6) Leave for a further 10 minutes and repeat condition 4.
7) Replace wick and fit sensor top.
   This procedure need only be carried out when new or at the beginning of the growing season.
8) If you gently warm the Dry sensor the reading displayed will be positive, if the reading displays a (-) negative reading, swap the sensor connections over and re do zero calibration.

Do not SHORTEN or LENGTHEN the sensor lead,by doing so you will void the warranty and introduce errors that will cause faulty operation.

OUTPUTS

24V ac misting valve connected to terminal block TB3 maximum power draw not to exceed 9 watts.
0 – 20mA connected to terminal block TB4, direction sensitive
Change over voltage free contact connected to TB5

CONTROL SELECTION, Refer to page 4.

SAFETY

F1 1 amp quick blow 20mm control fuse
F2 500mA slow blow 20mm mains fuse
F3 1 amp quick blow 20mm 24v ac output fuse

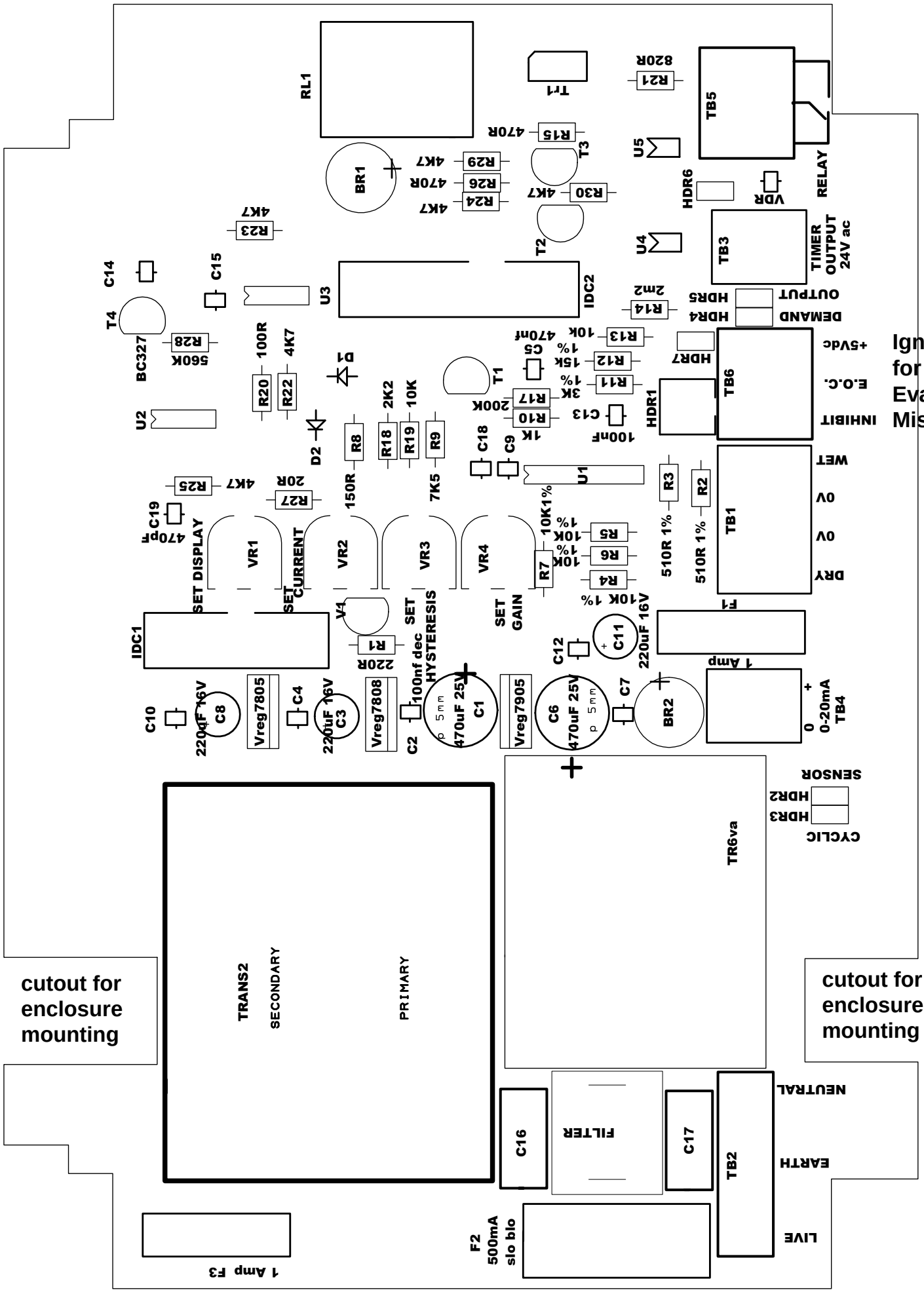
SPECIFICATIONS

Control range 0º to 10ºC
Displayed reading -16ºC to 20ºC
Switching differential 0.15ºC
Bridge temperature drift 15ppm 5ºC to 50ºC zero
Bridge zeroing ± 0.1ºC
Maximum bridge error resistance 2 ohm.
High specification bridge differential amplifier with high CMMR.
0 to 20mA non isolated linear current output proportional to the wet leaf depression. Capable of driving long distance into a maximum 350 ohm load. (250 ohm to convert to a 0 – 5V signal, plus max 100 ohm line resistance).

The gain and range have been factory set and must not be adjusted, **do not adjust** VR1, VR2 and VR4.
The hysteresis level has been set at ±0.5 WLD and has a range from 0.1 to 1 WLD. For minimum setting turn VR3 a.c.w.

0V connected to mains earth.
Optical isolators switch the relay and triac outputs.
Input voltage 240V ac European harmonized.
Relay output: voltage-free contacts, change-over.
24V ac 800mA via triac or manual switch operation.
Splash proof box size 175mm x 150mm x 80mm.
Meets all CE requirements.

EvapoMister and EvapoIrrigator artwork 29 06 2012



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Trouble shooting

1) No power, check for good 240Vac mains supply, refer to installation instructions for more detail.

2) If power present check all 3 board mounted fuses, F2 for mains incoming supply, F3 for solenoid and relay operation, F1 for logic supply.

3) Check all terminal block connections, paying extra attention to the sensor input. It is important that sensor cable connected to TB1 follows exactly the illustration on page 6 in the instruction manual. If the wet and dry connections are crossed, the output will display a negative value and there will be no control function.

4) Check that both jumpers are fitted, HDR2 (sensor) and HDR4 (demand).

5) Run the sensor cable clear of any 3 phase or heavy duty single phase cabling, close coupling could induce induce interference currents that would render the control inoperable.

6) Careful attention must be given to the control set up. Zero off period will cause continuous misting until the sensor is satisfied, which may cause over watering.

7) Don't leave the rocker switch in the continuous position, unless you want to thoroughly soak your cuttings, this is the manual position. For automatic control the switch has to set in the timed position.

8) Thoroughly read and digest the instruction manual.

9) If all else fails we can always fix it for you.

Troubleshooting for erroneous reading on EvapoMister controller. This test will prove whether the controller or the sensor is faulty.

When the display continuously reads + or -20 Degree C:

1) Turn power off, leave for a few seconds, turn power on if no difference:
2) **TO TEST THE SENSOR**: Remove blue EvapoSensor lead from terminal block. Display should read -20 degree C.
3) Replace blue lead, remove red EvapoSensor lead from terminal block. Display should read +20 degree C.
   A reading of -20 degree C indicates a faulty wet sensor.
   A reading of +20 degree C indicates a faulty dry sensor.

   FOR A WORKING CONTROLLER, with the sensor **disconnected**, adjust zero control to minimum, display should typically read -3V. Turn zero control to maximum, display should typically read -0.7V.
4) Connect a wire link between the dry and 0V terminals and do the same to the wet and 0V terminals. Display reading should be approximately 0.2V to 0.5V.
   If these results are confirmed, the controller is functional.

If all the above checks out, the controller is functional, the ES4 pt 100 EvapoSensor unit needs renewing.

GROWERS QUESTIONS

Over the years I have been asked by growers to relate the technical terms used in the manual to a practical growing situation.

Question: ‘what is the difference in adjusting the zero and the set point?’
Zero is setting the base line and has to be carried out at least once a year as per the instructions on pages 3 and 6 of the manual. The WLD range of measurement, which is displayed as degC WLD is from 0 to 10. The reading will go up to 20 but for practical control 10 is used. If the zero is say elevated to 0.5 degC WLD the range of measurement is now 0.5 to 10.5 degC WLD, which although small is an error of 0.5. Suffice to say ZEROING is important as it calibrates the controller but once set should not drift and the grower need not touch this on a regular basis.

Set point, is the value at which the relay closes and misting commences. So if the SET POINT has been set to 3, misting will not occur until the actual degC WLD exceeds 3, which on a hot, dry, low humid, windy day misting will be often as the controller is following the weather.

Question:’what is 1 degC and 10 degC. This relates to the actual level of evapotranspiration and is displayes as degC WLD. The hotter, drier the day the evapotranspiration will be greater and the cuttings will require misting more often. The display reflects the weather conditions, for a dull humid day the degC WLD will be low, typically 1 to 2 degC and misting will occur less. Conversely on a hot day the degC will be higher typically 6 degC and the misting will be more often. To get the optimum control actual degC WLD has to be used in conjunction with the SET POINT.

Question ‘I do not understand what OFF minutes is for.’ This is an important control as it regulates the frequency of misting and is used to harden cuttings by forcing root growth. Also it is wise to have a minimum setting of 3 minutes to allow the EvapoSensor to stabilise after misting.

Question ‘what is the function of the DEMAND and OUTPUT leds’
DEMAND led when illuminated indicates that actual WLD has exceeded SET POINT and misting will happen when the OFF TIME, times out, or by pushing the MANUAL START when DEMAND is illuminated misting will occur for the time set on the ON SECONDS adjustable control.

When the red led labelled OUTPUT is illuminated, misting is being applied. It can be used to indicate a faulty misting solenoid valve, foreign matter in the valve seat or poor wiring

GROWERS PROBLEM:

I am emailing you today to let you know of a few difficulties we are having with our leaf sensor/controller and see if you maybe able to give some suggestions on how to fix.
Our propagation house/ shed is approximately 35m x 15m shed, with cement floor. The roof is fiberglass with polycarbonate walls. It has a false roof inside to reduce radiation. We also have the option to put shadecloth over the top of the house to also reduce radiation as was discussed in your notes. It has a vent that runs the length of the roof of the shed which can be opened or closed according to weather conditons. Although not a poly house / tunnel house by its true definition, our "shed"/ house has been operating very successfully as a propagation facility for over 25 years and produces 75 % of our plant tubestock to supply our production nursery- which would be approximately 15 acres of under plant. Hence the reason for our desire to get our strike rates back up to where they used to be. Hopefully this helps.

We are finding that we are unable to set the 'Set Point' and leave it on that all day. I understand about re-zeroing when seasons change etc however, what I am referring to is within a season.

For example. During summer we find that we have to change our set point at least 3 times a day. If we don't it either stays too dry or too wet depending on the setting.

My understanding was that once set to a desired set point after doing a few trials …….we should be able to go through a season without having to change it?

We have been cleaning the sensor when start to build up some calcification……..could I double check with you on how you recommend that we clean it. Also with the wicks……..are we able to just take them off and rinse them when they get a bit of algae on them….. We have had a little algae build up but nothing major……..I am assuming we are doing everything ok in that regard.

Basically our leaf sensor isn't really operating as a leaf sensor but more like a timer. We are desperately hoping that you are able to help us out and point us in the right direction as to what we may be doing wrong.

SOLUTION author Dr Richard Harrison Murray:
I have given the problem described by the people at Ibrox Park Nursery a lot of thought and revisited many of the research reports. As usual it is hard to advise at a distance but I shall do my best. I list below concepts that may help them investigate the problem themselves to find ways to optimise their propagation environments:

1. The sharp rise in WLD when radiation rises to a high level during strong sunshine correctly reflects the rise in evaporative demand on plants. Most propagation facilities use shade to reduce the maximum evaporative demand. This ranges from shade paint applied to the glass, through shade cloth pulled over by hand, to two independent layers of automatically adjusted reflective shade cloth. Shade intensity (proportion of outside light reaching the cuttings) can be as low as 10% in a heavily shaded house or as high as 50% when there is little or no shading other that the glasshouse structure itself. Of course cuttings need light to photosynthesise so that too much shade can slow or prevent rooting. It is a balancing act and the optimum varies with species.

2. Misting reduces the amount of water loss from the cuttings but it does not prevent it, unless the species is one that is able to shut down transpiration by closing the stomata (i.e. pores in the leaf surface) in the undersurface of the leaf, combined with a waterproof cuticle over the rest of the leaf surface.

3. For stress sensitive species, the most effective reduction of stress is achieved by the combination of raising the relative humidity around the cuttings close to 100%, misting (or fogging) to wet the leaves and shading to reduce radiation. However, for most species, this is overkill and brings practical problems such as algal growth and discomfort for workers.

4. In my experience (mainly relating to UK) excessive misting during radiation peaks occurs mainly in lightly shaded glasshouses with generous ventilation. This perhaps corresponds closely to the facility at Ibrox Park Nursery.

5. Under heavy misting is mainly a problem where rooting trays or modules are placed directly on an impermeable surface (e.g. a concrete floor) so that the rooting medium becomes virtually saturated. A sand bed, or even capillary matting, can alleviate this problem by 'sucking' water out of the rooting medium during periods of heavy misting.

6. The OFF minutes setting can be used to limit the maximum rate of misting.

7. Raising the WLD set point will also reduce the amount of misting but is a more dangerous approach. Under conditions of low evaporative demand the WLD set point might not be reached for an indefinitely long period. For example, on a cool cloudy day with high humidity and little air movement there could be no misting at all. Cuttings would continue to transpire, albeit slowly, and would eventually suffer stress.

8. It would be an interesting development of the equipment if the WLD was also integrated over time, as in the Evapo-Irrigation Interface, to ensure that under conditions where the WLD set point was rarely if ever reached, mist would eventually be triggered by the integrated signal instead. This would ensure that some mist was applied even when the WLD set point had been set high, thereby avoiding the situation described in 7 above.

9. The Evapo-Irrigation approach can be used as the sole method of controlling mist but in that case it would be logical to locate the evaposensor above the mist, sensing the background evaporative demand, rather than under the mist as required to achieve a closed loop control with the EvapoMister.

10. Where a grower feels that the system is too responsive to radiation, a pragmatic way to reduce that sensitivity might be to change the colour of the evaposensor leaves to something lighter, to reflect some of the radiation. In the first instance, I would try switching one evaposensor to white cloth and white paint and doing a comparison of the WLD readings under a variety of weather conditions.

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Hosetail connectors RS Stock146-3183

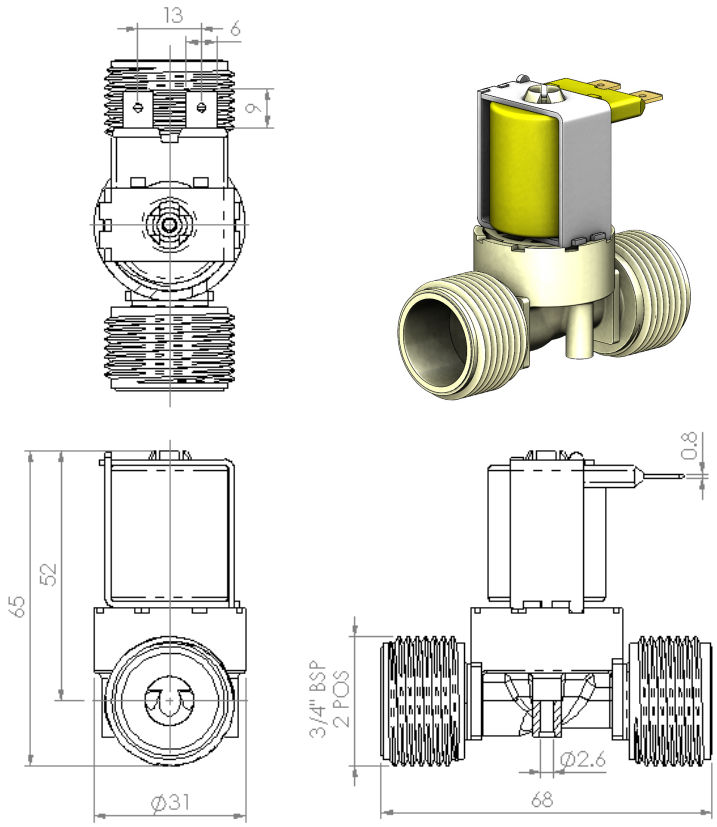
<-------- Direction of flow

ENGLISH

Datasheet

RS Pro Solenoid Valve
2 Port, NC, 24v AC/DC, ¾” BSP

RS Stock No: 1904137



SPECIFICATIONS:	
VOLTAGE:	24V
FREQUENCY:	AC/DC
POWER DRAW:	2.8w on 12Vdc. 9w on 24Vac
COIL INSULATION:	CLASS F (140°C OPERATING TEMPERATURE)
AMBIENT TEMPERATURE:	60°C Max
MEDIUM:	Potable water 90° Max
DUTY CYCLE 100%:	Tu 60°C, Tm 25°C
DUTY CYCLE:	3min ON / 5min Off - Tu 60°C, Tm 90°C
OPERATING PRESSURE:	0.2 - 10 Bar
EMC:	Fully Compliant
APPROVALS:	EN 60 730-2-8, WRAS, ACS.
TERMINALS:	6mm x 0.8mm Male tab terminals (x2)

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www.ets-controls.co.uk

email john@ets-controls.co.uk

DECLARATION OF CONFORMITY

Name of manufacturer or supplier:	E&TS Ltd
Full postal address including country of origin:	40 Acreville Rd, Bebington, Wirral, CH63 2HY U.K.

Description of product: Eii MK1.2 EvapoMisting controller
Conforms to the following product specifications:

Low Voltage Directive 2006/95/EC

Standard EN61558-1:2005

EMC and harmonised European and national standards

Standard	**2004/108/EC**
Emissions	EN6100-3-2/3/4
Immunity	EN61000-4-2/3/4/5/6/8/11/13/14 EN61000-6-2

Place of Issue: Bebington

Date: 08. 05. 2013

Name of authorised representative: John W Walker

Position of authorised representative: Managing Director

Declaration:
I declare that as the authorised representative, the above information in relation to the supply/manufacture of this product is in conformity with the stated standards and other related documents following the provisions of EEC Directives.

Signature of authorised representative:……..