

# Unpowered Wicking Irrigation Controller User Manual

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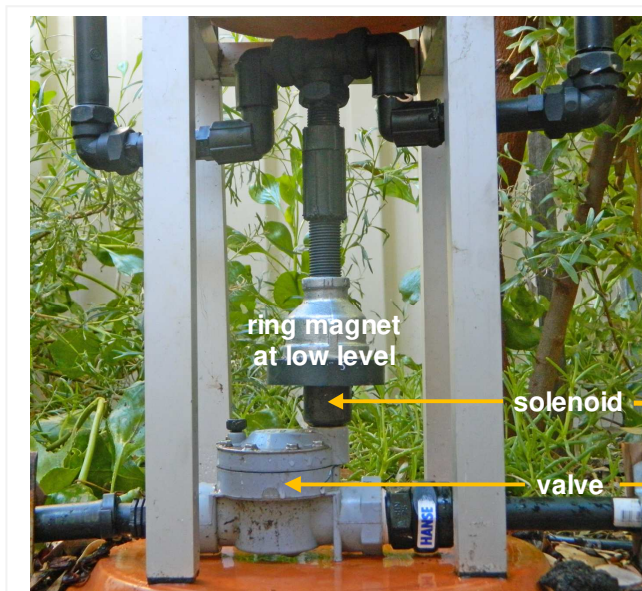
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## 1. Introduction

The Unpowered Wicking Irrigation Controller (UWIC) uses evaporation as a gauge to control irrigation rather than the static timer intervals in conventional devices. It works with ordinary irrigation solenoid valves of any size, one solenoid per controller, sprinkler or dripper systems.

After irrigation and as water evaporates from the soil, water also evaporates from the controller's container. The water in the container eventually reaches a low level corresponding to the soil drying out. The controller opens the solenoid and irrigation begins. A dripper attached to the outflow pipe slowly refills the container while the irrigation system 'refills' the soil. When the water in the container reaches a high level corresponding to the required watering of the soil, the controller shuts the water off and the cycle restarts.



Ring magnet and float at the low level at the start of the irrigation event



Ring magnet and float at the high level at the end of the irrigation event

Once correctly calibrated, the UWIC only sends water when plants need it and does not overwater. It responds to the same local weather conditions as the soil. Deep or shallow watering, frequent or delayed watering – all can be accommodated. You don't have to 'turn it off' over winter as rain and cooler temperatures keep the container from drying out. You can leave your irrigation system unattended for months on end.

A polyester cloth wicks water from inside the container to outside the container to evaporate and so the cloth is always wet.

An irrigation system with a conventional irrigation controller can be upgraded to an unpowered system where each solenoid valve is controlled by a UWIC. The conventional irrigation controller and the associated wiring become redundant.



A polyester cloth wicks water from inside the container to outside the container to evaporate



## 2. Installing the Unpowered Wicking Irrigation Controller

Step 1. The ring magnet has an outer diameter of 72 mm and an inner diameter of 32 mm. Check that the ring magnet can activate the solenoid by sliding the magnet over the solenoid. You should hear a click as you lower the magnet on to the solenoid. Irritrol, Orbit, and Toro (Pope) solenoid valves all work with one ring magnet.

If the ring magnet does not activate the solenoid, two ring magnets joined together should be strong enough to activate the solenoid. For example, Hunter solenoids valves require two ring magnets to activate the solenoid.



Check that the ring magnet can activate the solenoid



Hunter solenoids require two ring magnets

It is assumed that the solenoid is non-latching.

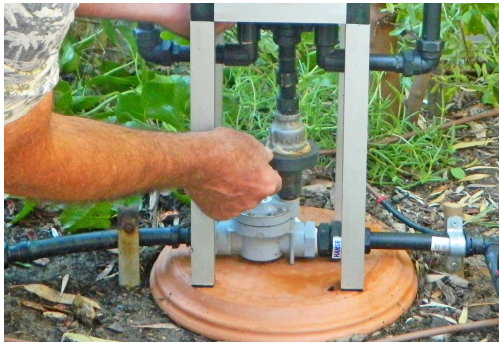
Step 2. As power is no longer required to operate the solenoid, you may wish to cut off the two wires connected to the solenoid. It is preferable that the solenoid valve is in a location where the evaporation at the valve matches the evaporation from the soil. For example, if the garden is in full sun, then the valve should also be in full sun.



Solenoid valve with wires removed in a location where the evaporation at the valve matches the evaporation from the soil

Step 3. The water supply should be connected to the valve inlet and the irrigation application to the valve outlet. Turn on the water supply.

Step 4. Choose the appropriate shaft extension and position the UWIC so that the ring magnet fits over the solenoid without starting the irrigation. Rotate the magnet to progressively lower the magnet over the solenoid until the magnet activates the solenoid and the irrigation starts. An additional full rotation of the magnet is recommended.



Position the UWIC so that the ring magnet fits over the solenoid without starting the irrigation



Rotate the magnet to progressively lower the magnet over the solenoid until the magnet activates the solenoid and the irrigation starts

Step 5. Connect the adjustable control dripper to the irrigation system and use the cable tie to position the control dripper so that it drips water onto the lid of the container. There are six small holes in the lid so that the water can drain into the container.



Use the cable tie to position the control dripper so that it drips water into the container via the lid of the container

Step 6. Make sure that the polyester cloth is wet.

Step 7. You may wish to protect the UWIC with a cage or a tree guard, but make sure that the evaporation is not impeded.

### 3. Calibrating the Unpowered Wicking Irrigation Controller

The UWIC controls the irrigation in 2 ways:

- The volume of water applied during each watering, and
- The length of time between waterings

Both these factors are determined by the water level in the UWIC container. Water evaporates from the container and when the water level reaches the low level, irrigation starts and the control dripper then delivers water into the container. Eventually the rising water level lifts the float and magnet away from the solenoid below and irrigation stops. The amount of water that the control dripper delivers to the container is called the **control volume**. The control volume is also the amount of water that evaporates between irrigation events.

The following two steps work together to calibrate the controller:

First, you set how much water is discharged from each emitter during the irrigation event by adjusting how long it takes for the control dripper to deliver the control volume to the container. So while the container is filling, the plants are being watered. The time it takes to fill the container is adjusted by changing the flow rate of the control dripper (by turning the orange part). If you set the control dripper to a fast flow rate, the container fills more quickly; thus there will be less time for watering and the plants receive less water. If you set the control dripper to a slow flow rate, the container fills more slowly and the plants receive more water.



Adjusting the control dripper

Next, you set the frequency of watering by adjusting how quickly water evaporates from the container. This is done by exposing more or less of the polyester cloth outside the container. To make this adjustment you may need to remove the float from the container (see Appendix). The time interval between irrigation events can be from half a day to a week or longer.



Large area of polyester cloth exposed



Small area of polyester cloth exposed

The control volume depends on the particular solenoid being used. The following table shows the control volume of a number of solenoids from different manufacturers.

Manufacturer	Approximate control volume
Irritrol	470 ml
Hunter	270 ml
Orbit	650 ml

It is important to realize that the control dripper is simply replacing water that has evaporated from the container. This means that an irrigation event may be started or stopped manually at any time without affecting the water usage rate (litres per week for example). An irrigation event can be started manually by pushing the float and magnet down. An irrigation event can be stopped manually by lifting the float and magnet up.

The volume of water applied during an irrigation event (and the water usage rate) can be increased by temporarily removing the control dripper.

#### **4. Weather-based irrigation control**

The time it takes for the control volume of water to evaporate depends on the prevailing on-site weather conditions. When it is hot and dry, the water evaporates more quickly and so the interval between irrigation events is shorter. When it is cool and overcast, the water evaporates more slowly and so the interval between irrigation events is longer.

When it rains, water enters the container, and so the start of the next irrigation event is delayed. Any rainwater that has entered the container between irrigation events needs to evaporate before the next irrigation event can start.

To avoid irrigating during the heat of the day, you can turn off the water supply. Alternatively, a tap timer can be used so that water is only available between sunset and sunrise.

The UWIC uses on-site weather data (namely, evaporation and rainfall). Most smart irrigation controllers do not use on-site weather data. Instead they use weather data from the nearest weather station of the Bureau of Meteorology.



## 5. Pressure independent dripper discharge

Conventional drip irrigation systems control the dripper discharge by using PC (pressure compensating) drippers to control the flow rate and an irrigation controller to control the time. In a domestic garden with mains water supply, many zones are usually required to ensure that the pressure in each zone does not fall below the lower limit for pressure compensation. The irrigation controller is programmed so that each zone is irrigated at a different time.

If you use the Unpowered Wicking Irrigation Controller and the following three conditions are satisfied, the dripper discharge is approximately the same for all drippers and is independent of pressure:

- Identical drippers are used including the control dripper
- All drippers are at approximately the same level
- Frictional head loss is negligible.

When the three conditions are satisfied, the pressure independent dripper discharge is the same as the control volume. Note that the pressure independent dripper discharge is also independent of the flow rate of the irrigation drippers. For example, 4 L/H (at 100 kPa) NPC (non pressure compensating) drippers will deliver the same pressure independent dripper discharge as 2 L/H (at 100 kPa) NPC drippers. For this example the duration of the irrigation event for the 2 L/H drippers will be twice as long as the duration of the irrigation event for the 4 L/H drippers.

If the water supply pressure decreases, the flow rate of the NPC drippers also decreases. However, the duration of the irrigation event increases automatically to ensure that the control volume of water is discharged by each dripper. For domestic gardens on level ground, the irrigation system can usually be designed so that variations in pressure due to frictional head loss are negligible.



The adjustable control dripper is replaced by one of the dripline irrigation drippers

By using the UWIC with pressure independent dripper discharge, many zones with PC drippers can be combined into a single zone with NPC drippers and a single UWIC and solenoid valve, and so the cost of the irrigation system can be reduced significantly.

By using the UWIC with pressure independent dripper discharge, solenoid valves with flow control can be adjusted to suit the pressure limitations of the irrigation system without affecting the dripper discharge. For example, if you prefer not to use hose clamps on barbed fittings, then you can use the flow control on the solenoid valve to reduce the pressure accordingly.

To determine the pressure independent dripper discharge (control volume), position an empty container under one of the drippers so that water drips into the container during the irrigation event. At the end of the irrigation event, the pressure independent dripper discharge is the volume of water in the container



Measuring the pressure independent dripper discharge

If the pressure independent dripper discharge is more than your plants require at their current stage of growth, the pressure independent dripper discharge can halved by using 2 irrigation drippers for the control dripper. On the other hand, if the pressure independent dripper discharge is less than your plants require at their current stage of growth, increase the number of irrigation drippers so that your plants get more water.

## 6. Key features

1. Unpowered (no batteries, no wires, no solar panels, no electronics, no computers, and no WiFi)
2. If you upgrade to the UWIC, the conventional irrigation controller and associated wiring become redundant
3. Use for any size irrigation application
4. Use for sprinkler irrigation or drip irrigation
5. Use with PC (pressure compensating) drippers or NPC (non pressure compensating) drippers
6. Adjust the dripper discharge by adjusting the control dripper
7. Adjust the interval between irrigation events by adjusting the exposed surface area of the polyester cloth
8. Adjusting the dripper discharge does not affect the interval between irrigation events, and adjusting the interval between irrigation events by adjusting the polyester cloth does not affect the dripper discharge
9. Responds automatically to on-site evaporation and rainfall
10. The irrigation frequency increases significantly during a heat wave
11. When it rains, water enters the container and delays the start of the next irrigation event
12. Provided the same drippers are used throughout the irrigation application (including the control dripper), the dripper discharge is independent of the water supply pressure
13. Water in the container is protected from debris, algae, mosquitoes and thirsty animals
14. UV resistant including the container and polyester cloth
15. Simple, unpowered, and low tech, and therefore fewer things can go wrong
16. Leave your irrigation application unattended for months on end



Unpowered Wicking Irrigation Controller prior to installation



## 7. Conclusion

The Unpowered Wicking Irrigation Controller uses measured irrigation, a radically different approach to irrigation scheduling (see the Measured Irrigation website for more information:

[www.measuredirrigation.com.au](http://www.measuredirrigation.com.au))

Conventional irrigation systems **indirectly** control the volume of water discharged by a dripper by using PC drippers to control the flow rate and an irrigation controller to control the time. However, measured irrigation **directly** controls the volume of water discharged by a dripper, rather than controlling the flow rate and the time. Because it is no longer necessary to control the flow rate, one can use NPC drippers as well as PC drippers.

The UWIC uses the prevailing on-site weather information rather than information from the Bureau of Meteorology, and so it is ideal for greenhouse applications.

Suppose your irrigation system has a conventional irrigation controller. When one of the solenoid valves for a particular zone fails to operate, you can take the opportunity to upgrade the zone to measured irrigation by installing a UWIC. Because the controller is unpowered, the valve can still operate even when the solenoid coil has failed. The performance of the UWIC can then be compared with the performance of the conventional irrigation controller for the other zones.

### Weather-based smart irrigation controllers

According to the Irrigation Association (USA), weather-based controllers use weather data to calculate evapotranspiration, the amount of water that evaporates from the soil surface or is used by the plant. Based on local weather conditions, smart controllers automatically adjust the irrigation schedule. Different controllers use different sources of weather data. These include on-site weather sensors or data from nearest weather station.

The cost of the on-site weather sensors required to calculate evapotranspiration is prohibitively expensive. Hence almost all weather-based irrigation controllers use data from the nearest weather station to approximate the on-site evapotranspiration. Weather-based irrigation controllers calculate evapotranspiration by multiplying the crop coefficient by the reference evapotranspiration. Reference evapotranspiration uses a formula based only on weather data that does not include the evaporation rate. Furthermore, the crop coefficient is a theoretical value that depends upon the stage of growth of the crop.

The UWIC responds to changes in the actual on-site evaporation. This approach to irrigation control is more appropriate than using a theoretical formula based on off-site weather data. Research done by the Bureau of Meteorology has demonstrated a strong correlation (about 90%) between pan evaporation and reference evapotranspiration:

<http://www.bom.gov.au/watl/eto/reference-evapotranspiration-report.pdf>

My own research has demonstrated a correlation greater than 90%. See *Evapotranspiration and Measured Irrigation: Report for Smart Approved Watermark* which can be downloaded from the Measured Irrigation website: <https://www.measuredirrigation.com/>

## Appendix. Installing the float and polyester cloth



Components of the Unpowered Wicking Irrigation Controller



Step1. Wet the polyester cloth and place it over the outer container so that the desired exposed surface area forms a skirt around the outside of the container



Step 2. Insert the inner container into the outer container



Step 3. Insert the float



Step 4. Place the container on the terracotta saucer on the stand



Step 5. Use the two sockets to connect the external frame of the float assembly to the upper tee of the float assembly



Step 6. Use a screw driver to tighten the clamps

To remove the float and the polyester cloth, do the steps in reverse order.