DIY Unpowered Irrigation Controller

User Manual

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1. Introduction

An irrigation control can save water by responding to the prevailing on-site weather conditions. The two most important weather conditions affecting the water requirements of your plants are rainfall and evaporation.

Conventional smart irrigation controllers respond to rainfall but they do respond the evaporation rate. The DIY Unpowered Irrigation Controller responds to both the onsite rainfall and the onsite evaporation rate.

It is recommended that you watch the YouTube video Unpowered Irrigation Controller: https://www.youtube.com/watch?v=A90f5aAxvHA

The DIY Unpowered Irrigation Controller is suitable for automatic sprinkler irrigation or drip irrigation. The valve operates with water supply pressure in the range 10 kPa to 800 kPa. The interval between irrigation events responds automatically to the on-site prevailing weather conditions (namely, evaporation and rainfall).

Terracotta is porous and so the water level in the pot falls as water seeps through the pot. A float inside the pot floats on the water. When the water level reaches the low level, a magnet inside the float activates the valve so that the valve opens and the irrigation starts. During the irrigation event a control dripper drips water into the pot and the water level rises. When the water level reaches the high level, the magnet inside the float disengages from the valve so that the valve closes and the irrigation stops.

Unpowered Irrigation Controller showing the float and the water level

Float showing the ring magnet at the bottom of the float

This remarkable low-cost invention may enable poor smallholders in remote locations to grow higher-valued crops cost-effectively.

If the flow rate through the valve is inadequate, you may wish to subdivide the irrigation application into a number of zones with a DIY Unpowered Irrigation Controller for each zone.

An irrigation control can save water by responding to the prevailing on-site weather conditions. The two most important weather conditions affecting the water requirements of your plants are rainfall and evaporation.

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2. Components of the DIY Unpowered Irrigation Controller

Description	Supplier	Link
two ferrite ring magnets 27x13x5mm (an alternative supplier may be used)	AMF Magnetics Code13080	https://magnet.com.au/search?q=13080
	Sekao Engineering	https://magnetsales.com.au/product/ferrite-ring-magnet-od-27r
plastic solenoid valve DC 12V 1/2" N/C (an alternative supplier may be used)	AliExpress	https://www.aliexpress.com/item/4000325042438.html
adjustable end line dripper Claber Model 91214 (this adjustable dripper is recommended, however any adjustable dripper may be used)	Amazon	https://www.amazon.com.au/Claber-91214-Underground-Drip-

threaded elbow (or tee) 15mm F x 19mm barb (tapered thread, BSP or NPT)

bush 15mm F x 20mm M (tapered thread, BSP or NPT)

all thread poly riser 15mm x 70mm

threaded joiner 15mm

terracotta pot 12cm, 6mm thick, 15mm drain hole (75mm minimum outer diameter at bottom, 110mm minimum height)

terracotta saucer 15cm

polypipe 4mm x 250mm

barbed joiner 4mm

Components of the DIY Unpowered Irrigation Controller

3. Assembling the DIY Unpowered Irrigation Controller

1. Remove the screws from the solenoid valve and carefully renove the solenoid from the valve.
2. Remove the metal base plate form the solenoid and reattach the metal base plate to the valve using stainless steel screws. Alternatively, to make the Unpowered Irrigation Controller waterproof, replace the metal base plate by a piece of 3mm thick acrylic plastic (the metal base plate may be used as a guide to drill the appropriate holes in the plastic)
3. Connect the bush to the valve inlet (use Teflon tape).
4. Connect the eblow (or tee) to the valve outlet (use Teflon tape).
5. Connect a piece of 19mm polypipe to the barb on the elbow.
6. Increase the inner diameter of the acrylic tube so that the acrylic tube can slide over the white plastic shaft.
7. From the inside, insert the grommet into the drain hole.
8. Insert the acrylic tube into the grommet so that it is flush with the bottom of the pot.
9. Using a sharp knife, cut off the grommet so that it is flush with the bottom of the pot.
10. Slide the acrylic tube over th white plastic shaft.
11. Using a pool noodle and a sharp knife, cut a 36mm lower float and a 20mm upper float.
12. Cut the threaded joiner to make a 23mm piece and a 17mm piece.
13. Insert the magnets into one end of the lower float so that the magnets are flush with the bottom of the float.
14. Using Teflon tape screw the all thread poly riser into the 23mm piece.
15. Insert the 23mm piece into the open end of the lower float.
16. Insert the 17mm piece into the upper float.
17. Gently screw the upper float onto the all thread poly riser and adust the gap between the upper and lower floats.
18. Use a masonry dill bit to drill six equi-spaced drain holes in the terracotta saucer. Drill an extra hole near one of the drain holes so that the cable tie can be attached to the saucer.
19. Attach the 4mm polypipe to the adjustable dripper and the other end to the takeoff adaptor.
20. Punch a hole in the 19mm polypipe and insert the takeoff adaptor.
21.. Use the cable tie to secure the adjustable dripper.
22. Position the valve in a suitable location in your garden so that the evaporation matches the evaporation at your plants.
23. Connect the water supply to the valve inlet and connect the irrigation application to the valve outlet.

4. How to use the Unpowered Irrigation Controller

Turn on the water supply and the irrigation starts immediately. The control dripper drips water into the terracotta pot during the irrigation. The **control volume** is the volume of water that drips into the pot during the irrigation event. It is also the volume of water that seeps through the terracotta pot between irrigation events.

The irrigation stops automatically when the control volume of water has dripped into the pot. The irrigation starts again automatically after the control volume of water has seeped through the pot. The cycle continues indefinitely and so you can leave your garden unattended for months on end. A saucer sits on top of the pot so that the water in the pot is protected from algae, mosquitoes and thirsty animals. There are small drain holes in the saucer.

When using a conventional irrigation controller, you need to set the start time and the end time for each irrigation event. However, with the Unpowered Irrigation Controller you don't need a timer. The duration of the irrigation event is the time it takes for the control volume of water to drip into the pot, and the interval between irrigation events is the time it takes for the control volume of water to seep through the pot.

It is important to note that the control dripper is adjustable. If you reduce the flow rate of the control dripper, it takes a lot longer for the control volume of water to drip into the pot and so the duration of the irrigation event increases and your plants get more water. On the other hand, if you increase the flow rate of the control dripper, the control volume of water drips into the pot more quickly and so the duration of the irrigation event decreases and your plants get less water. Adjust the control dripper so that the irrigation delivers the appropriate amount of water to your plants at their current stage of growth.

The control dripper is adjustable.

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

If it rains, rainwater collects in the saucer and drains into the pot. This means that the start of the next irrigation event is delayed. In addition to the control volume of water that needs to seep through the pot between irrigation events, any rainwater that has entered the pot between irrigation events also needs to seep through the pot.

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 Unpowered Irrigation Controller 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 Bureau of Meteorology.

The Unpowered Irrigation Controller can be used for both gravity feed and pressurised irrigation. It can be used with sprinklers, drippers, weeper hose and soaker hose.

You can irrigate directly from a rainwater tank by gravity feed without using a pump provided that the water level in the tank is at least 1 metre higher than the valve.

It is recommended that you adjust the interval between irrigation events before adjusting the water usage rate. You may need to readjust the interval between irrigation events and the water usage rate as the plants grow and their water requirements change.

Note that the term **water usage rate** refers to the number of litres per week used by the irrigation system.

How to adjust the interval between irrigation events

You can adjust the interval between irrigation events by adjusting the gap between the upper and lower floats. The interval between irrigation events is the time it takes for the control volume of water to seep through the porous terracotta pot. To adjust the gap by 4 mm, rotate the upper float by two and a quarter turns.

Adjusting the interval between irrigation events does not change the water usage rate. For example, if you increase the interval between irrigation events by increasing the gap between the upper and lower floats, the amount of water used during the irrigation event increases automatically to ensure that the water usage rate remains the same.

To adjust the interval between irrigation events, adjust the gap between the upper and lower floats

gap between the upper and lower floats	control volume
zero gap	95 ml
4 mm	128 ml
8 mm	161 ml
12 mm	194 ml
16 mm	227 ml
20 mm	261 ml
24 mm	294 ml
28 mm	327 ml
32 mm	360 ml

Table 1. Control volume for various gaps between the upper and lower floats

The gap between the upper and lower floats should be chosen so that the next irrigation event starts when there is no further soil moisture available to the plants. Soil moisture sensors or probes may be used to determine the soil moisture profile.

You can start the irrigation at any time by pushing the float down. You can stop the irrigation at any time by lifting the float up.

How to adjust the water usage rate

If your plants are not getting enough water, reduce the flow rate of the control dripper. Reducing the flow rate of the control dripper increases the duration of the irrigation event and so your plants get more water. If your plants are getting too much water, increase the flow rate of the control dripper.

Adjusting the water usage rate does not affect the interval between irrigation events.

You may wish measure the amount of water discharged by a dripper during the irrigation event. Position an empty measuring container under one of the drippers so that water drips into the container during the irrigation event.

7. Key features of the Unpowered Irrigation Controller

1. Unpowered (no batteries, no solar panels, no electronics, no computers, and no WiFi)
2. Water supply pressure 10 kPa to 800 kPa
3. Use for sprinkler irrigation or drip irrigation
4. Use for gravity feed or pressurised irrigation
5. Can deliver water to at least 400 2 L/H drippers
6. Adjust the water usage rate by adjusting the control dripper
7. Adjust the interval between irrigation events by adjusting the float
8. Adjusting the water usage rate does not affect the interval between irrigation events, and adjusting the interval between irrigation events does not affect the water usage rate
9. Responds automatically to on-site evaporation and rainfall
10. The irrigation frequency increases significantly during a heat wave
11. Irrigate directly from a rainwater tank without using a pump
12. Water in the terracotta pot is protected from debris, algae, mosquitoes and thirsty animals
13. Simple, unpowered, and low tech, and therefore fewer things can go wrong
14. Leave your irrigation application unattended for months on end

8. Conclusion

The Unpowered Irrigation Controller uses a radically different approach to irrigation scheduling called Measured Irrigation. See the Measured Irrigation website for more information: www.measuredirrigation.com.au

Conventional irrigation systems **indirectly** control the volume of water discharged by a dripper by using PC (pressure compensating) 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. It is recommended that NPC (non pressure compensating) drippers be used for measured irrigation.

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