

Unpowered Terracotta Valve

User Manual

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1. Introduction

It is recommended that you watch the YouTube video Unpowered Terracotta Valve:
<https://www.youtube.com/watch?v=A90f5aAxvHA>

The Unpowered Terracotta Valve has a half inch inlet and outlet. The valve 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 Terracotta Valve 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.

The valve has a half inch inlet and outlet, and so it is not suitable for large irrigation applications that require a bigger valve. If the flow rate through the valve is inadequate, you may wish to subdivide the irrigation application into zones with an Unpowered Terracotta Valve for each zone.

A clear acrylic tube is connected to the valve is quite fragile, so be very careful not to break it.

The **control volume** is the volume of water that drips into the pot during the irrigation event. By adjusting the float, the control may be set to any value between 110 ml and 385 ml.

A Control Volume Boost Container may be connected to the terracotta pot so that the control volume may be set to any value between 1000 ml and 1825 ml.

Conventional drip irrigation systems 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. 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.

With identical NPC drippers (including the control dripper) at approximately the same level and negligible variations in the pressure within the zone due to frictional head loss, the Terracotta Irrigation Controller ensures that the volume of water discharged by each dripper during the irrigation event is approximately the same regardless of the pressure. 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 within the zone due to frictional head loss are negligible.

By using the Terracotta Irrigation Controller in this way, many zones with PC drippers can be combined into a single zone with NPC drippers and a single Terracotta Irrigation Controller, and so the cost of the irrigation system can be reduced dramatically.

2. Installation of the Unpowered Terracotta Valve

Position the valve in a suitable location in your garden so that the evaporation matches the evaporation at your plants.

Connect the water supply to the valve inlet and connect the irrigation application to the valve outlet (note that an arrow under the valve indicates the direction of flow).

Connect the control dripper to the irrigation application. Place the terracotta saucer on the terracotta pot so that the control dripper drips water into the pot. The control dripper should be lower than most of the irrigation drippers in your application.

To prevent water draining out of the irrigation system via the control dripper after the irrigation has stopped, you may wish to install swing check valve between the control dripper and the irrigation system.



Connect the water supply to the valve inlet



Connect the irrigation application to the valve outlet



Place the terracotta saucer on the terracotta pot so that the control dripper drips water into the pot

4. How to use the Unpowered Terracotta Valve

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 and evaporated. 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 Terracotta Valve 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 low 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 Terracotta Valve 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 valve 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	110 ml
4 mm	144 ml
8 mm	179 ml
12 mm	213 ml
16 mm	247 ml
20 mm	282 ml
24 mm	316 ml
28 mm	350 ml
32 mm	385 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.

A small drain valve at the bottom of the terracotta pot allows you to drain water from the pot.

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 to position an empty measuring container under one of the drippers so that water drips into the container during the irrigation event.

5. Control Volume Boost Container

The Control Volume Boost Container can be connected to the drain valve on the terracotta pot so that the water level in the container is the same as the water level in the terracotta pot. By using the Control Volume Boost Container, the control volume can be set to any value between 1000 ml and 1825 ml (see Table 2). The Control Volume Boost Container can be purchased online at the Measured Irrigation website. A polyester cloth is provided to wick water from inside the container to outside the container to evaporate. Make sure that the polyester cloth is wet at all times. The interval between irrigation events is determined by how quickly water evaporates from the container via the polyester cloth. In addition to adjusting the float, the interval between irrigation events can also be adjusted by exposing more or less of the polyester cloth outside the container. The lid on the container protects the water in the container from debris, algae, mosquitoes and thirsty animals.



Control Volume Boost Container



Control Volume Boost Container connected to the drain valve on the terracotta pot



Adjust the interval between irrigation events by adjusting the exposed surface area of polyester cloth

gap between the upper and lower floats	control volume using the Control Volume Boost Container
zero gap	1000 ml
4 mm	1103 ml
8 mm	1206 ml
12 mm	1309 ml
16 mm	1412 ml
20 mm	1515 ml
24 mm	1618 ml
28 mm	1721 ml
32 mm	1825 ml

Table 2. Control volume using the Control Volume Boost Container for various gaps between the upper and lower floats

If the adjustable control dripper is replaced by one of the irrigation drippers, then each dripper in the irrigation application will deliver the control volume during the irrigation event (assuming that frictional head loss is negligible). A major advantage of using an irrigation dripper as the control dripper is that the dripper discharge can be set to any value between 1000 and 1825 ml and the dripper discharge is independent of pressure (this is not the case for the adjustable control dripper). For example, if the water source is a header tank and the gap between the upper and lower floats is set to 16 mm, then each dripper will discharge 1412 mls during the irrigation event, regardless of the water level in the tank. The interval between irrigation events can be decreased by exposed more of the polyester cloth.

Table 3 shows the volume of water discharged by each irrigation dripper for various choices for the control dripper and various choices for the gap between the upper and lower floats. It is assumed that the same dripper is used throughout the irrigation application, that all drippers are at the same level, and that frictional head loss is negligible.

gap between the upper and lower floats	dripper discharge when the control dripper is one irrigation dripper	dripper discharge when the control dripper is two irrigation drippers	dripper discharge when the control dripper is three irrigation drippers	dripper discharge when the control dripper is four irrigation drippers
zero gap	1000 ml	500 ml	333 ml	250 ml
4 mm	1103 ml	551 ml	368 ml	276 ml
8 mm	1206 ml	603 ml	402 ml	301 ml
12 mm	1309 ml	654 ml	436 ml	327 ml
16 mm	1412 ml	706 ml	471 ml	353 ml
20 mm	1515 ml	757 ml	505 ml	379 ml
24 mm	1618 ml	809 ml	539 ml	404 ml
28 mm	1721 ml	860 ml	574 ml	430 ml
32 mm	1825 ml	912 ml	608 ml	456 ml

Table 3. Volume of water discharged by each irrigation dripper for various choices for the control dripper and various choices for the gap between the upper and lower floats

6. Key features of the Unpowered Terracotta Valve

1. Unpowered (no batteries, no solar panels, no electronics, no computers, and no WiFi)
2. Water supply pressure 10 kPa to 800 kPa
3. Half inch inlet and outlet
4. Use for sprinkler irrigation or drip irrigation
5. Use for gravity feed or pressurised irrigation
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. The Control Volume Boost Container allows the control volume to be set to any value between 1000 and 1825 mls
12. If the adjustable control dripper is replaced by one of the irrigation drippers, then each dripper in the irrigation application will deliver the control volume during the irrigation event
13. If the adjustable control dripper is replaced by two of the irrigation drippers, then each dripper in the irrigation application will deliver half the control volume during the irrigation event
14. The Control Volume Boost Container allows the interval between irrigation events to be adjusted by adjusting the exposed surface area of the polyester cloth
15. Irrigate directly from a rainwater tank without using a pump
16. Water in the terracotta pot is protected from debris, algae, mosquitoes and thirsty animals
17. Simple, unpowered, and low tech, and therefore fewer things can go wrong
18. Leave your irrigation application unattended for months on end

7. Conclusion

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