Small Terracotta Valve User Manual

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1. Introduction

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

The Small Terracotta Valve is an unpowered irrigation valve suitable for automatic sprinkler irrigation or drip irrigation. The valve operates in the pressure range 10 kPa to 800 kPa. The Small Terracotta Valve does not require an irrigation controller. Each valve is self-controlled whereby variations in the irrigation frequency are automatically controlled by the on-site prevailing weather conditions (namely, evaporation and rainfall).

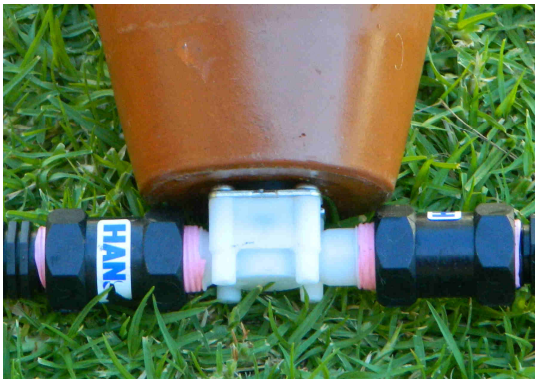
Terracotta is porous and so the water level in the pot falls as water evaporates from the outside surface of the pot. A float inside the pot floats on the water. When the water level reaches the low level, a magnet inside the float activates the valve so that the valve opens and the irrigation starts. 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.

Small Terracotta Valve showing float and water level

Float showing the ring magnet at the bottom of the float

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

The Small Terracotta Valve has a 15mm inlet and outlet, and so it is not suitable for large irrigation applications that require a bigger valve.



Small Terracotta Valve showing 15mm inlet and 15mm outlet

2. Assembly instructions

1. Connect the pipe with the cap and the pipe with the 20mm x 15mm adaptor (bush) to the 15mm tee.
2. Connect the control dripper assembly to the valve outlet.
3. Carefully slide the terracotta pot over the valve shaft and push down.
4. Adjust the terracotta pot so that it is vertical.
5. Slide the float over the clear plastic tube with the magnet at the bottom of the float.
6. Place the terracotta saucer on the terracotta pot.
7. Position the adjustable control dripper so that it will drip water into the saucer. Use the cable tie provided to secure the control dripper to the terracotta saucer.

3. How to use the Small Terracotta Valve

Position the Small Terracotta 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 the control dripper is on the outlet side of the valve).

Connect the water supply to the valve inlet

Connect the irrigation application to the valve outlet

Turn on the water supply and the irrigation will start immediately. The control dripper drips water into the terracotta pot during the irrigation. The irrigation stops automatically after control volume of water have dripped into the pot. The **control volume** is the volume of water required to raise the water level in the pot from the low level to the high level.

The control dripper drips water into the terracotta pot and the irrigation stops after 250 ml have dripped into the pot.

The irrigation starts again automatically after the control volume of water has evaporated from the outside surface of the porous terracotta pot. The cycle continues indefinitely and so you can leave your garden unattended for months on end. A terracotta saucer sits on top of the pot so that the water in the pot is protected from algae, mosquitoes and thirsty animals. There are 6 small drain holes in the saucer.

The irrigation starts again automatically after 250 ml of water have evaporated from the outside surface of the porous terracotta pot.

When using a conventional irrigation controller, you need to set the start time and the end time for each irrigation event. However, with the self-controlled terracotta valve you don't need a timer. The duration of the irrigation event is simply the time it takes for the control volume of water to drip into the pot.

It is important to note here that the control dripper is adjustable. If you reduce the flow rate of the control dripper, then it will take a lot longer for the control volume to drip into the pot and so the duration of the irrigation event increases and your plants will get more water. On the other hand, if you increase the flow rate of the control dripper, the control volume will drip into the pot more quickly and so the duration of the irrigation event decreases and your plants will 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 interval between irrigation events if the time it takes for the control volume of water to evaporate from the outside surface of the porous terracotta pot. The important thing to realise here is that the time it takes for the control volume to evaporate is determined by the prevailing weather conditions. When it is hot and dry, the water will evaporate more quickly and so the interval between irrigation events will be shorter. When it is cool and overcast, the water will evaporate more slowly and so the interval between irrigation events will be longer.

If it rains, rainwater will collect in the saucer and drain into the pot. This means that the start of the next irrigation event will be delayed. In addition to the control volume that needs to evaporate, the rainwater that has entered the pot will also need to evaporate.

If it rains, rainwater will collect in the saucer and drain into the pot.

The Small 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 Small Terracotta Valve can be used for both gravity feed and pressurised irrigation. It can be used with pressure compensating drippers and non pressure compensating drippers. It can also be used with weeper hose or 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 at the bottom of the Small Terracotta Valve.

How to adjust the water usage:

Position an empty measuring container under one of the drippers

If you are using drippers, position an empty measuring container under one of the drippers so that water drips into the container during the irrigation event. At the end of the irrigation event check the amount of water in the measuring container. You should also check the moisture in the soil.

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 does not affect the irrigation frequency.

How to adjust the irrigation frequency:

To adjust the irrigation frequency, adjust the gap between the upper and lower discs

You can adjust the irrigation frequency by adjusting the gap between the upper and lower discs on the float. Note that the irrigation frequency is controlled by the net evaporation from the outside surface of the terracotta bowl between irrigation events. To adjust the gap by 4 mm rotate the upper disc by two and a quarter turns.

Adjusting the irrigation frequency does not change the water usage. For example, if you decrease the irrigation frequency by increasing the gap between the upper and lower discs, the amount of water used during the irrigation event will automatically increase to ensure that the water usage (litres per week for example) remains the same.

The following table shows the control volume (net evaporation from the outside surface of the terracotta pot between irrigation events) for various values of the gap between the upper and lower discs.

Gap between the upper and lower discs	Net evaporation from the outside surface of the terracotta pot between irrigation events (control volume)
zero gap	90 ml
4 mm	122 ml
8 mm	154 ml
12 mm	186 ml
16 mm	218 ml
20 mm	250 ml
23 mm	275 ml

For a more detailed discussion of irrigation scheduling, see the Appendix 1: Root zone scheduling.

If you prefer the control volume to be larger, it is recommended that you use the Large Terracotta Valve: https://www.measuredirrigation.com/product-page/large-terracotta-valve

4. When is water usage independent of pressure?

Ideally, the amount of water used to irrigate your garden should be independent of the water supply pressure. Provided that all of the drippers are identical and at approximately the same level, the Small Terracotta Valve can be used to ensure that the dripper discharge is independent of the water supply pressure. Conventional drip irrigation systems control the volume of water discharged by a dripper by using PC (pressure compensating) drippers to control the flow rate of the dripper 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.

Provided that identical drippers are at approximately the same level and the variations in pressure within a zone due to head loss are negligible, the volume of water discharged by each dripper during the irrigation event will be approximately the same. All the drippers may be NPC or PC. For domestic gardens, the irrigation system can usually be designed so that variations in pressure within the zone are negligible.

To ensure that approximately the same volume of water delivered by each dripper during the irrigation event **regardless of the water supply pressure**, the adjustable control dripper can be replaced by an irrigation dripper. For example, if the irrigation drippers are Antelco 2 L/H NPC drippers, then the control dripper must also be an Antelco 2 L/H NPC dripper. Then the volume of water discharged by each dripper will be the same as the volume of water discharged by the control dripper during the irrigation event, namely the control volume, regardless of the water supply pressure.

The adjustable control dripper has been replaced by an irrigation dripper.

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

By replacing the adjustable control dripper by an irrigation dripper, each irrigation dripper will discharge the control volume of water during the irrigation event. We now need to address the problem that control volume will often be too much or too little water for your plants at their current stage of growth. If the control volume is too much, then you can use more than one dripper as the control dripper. For example, if the control dripper consists of 2 drippers, then the volume of water discharged by each of the irrigation drippers will be half the control volume.

If the control volume is too little, then you will need to use a control dripper that delivers a fraction of the volume of water discharged by an irrigation dripper during the irrigation event. For example, if the control dripper delivers one quarter of the water discharged by an irrigation dripper, then the volume of water discharged by each of the irrigation drippers will be 4 times the control volume regardless of the water supply pressure.

Appendix 2 describes a DIY method for making a **fractional dripper** for use as a control dripper. Appendix 3 explains how to use a fractional dripper.

Suppose that you are using automated drip irrigation on level ground from a rainwater tank by gravity feed without using a pump. If you are not using a terracotta valve, you will be faced with the problem that dripper discharge will decrease as the water level in the tank falls. By using the Small Terracotta Valve with the appropriate control dripper, you can irrigate directly from the rainwater tank by gravity feed without using a pump. Furthermore, the volume of water discharged by each dripper will be independent of the water level in the tank. The Small Terracotta Valve is a game-changer for automated gravity feed irrigation on level ground from a rainwater tank without using a pump.

The Small Terracotta Valve is a game-changer for automated gravity feed irrigation from a rainwater tank without using a pump.

5. NPC drippers and water usage independent of pressure

NPC (non pressure compensating) drippers are usually available with flow rates of 2 L/H, 4 L/H and 8 L/H (at a pressure of 100 kPa). Suppose that a combination of these drippers is used for the irrigation drippers. Provided that the control dripper is also an NPC dripper, the following table tells you the approximate volume of water discharged by the various irrigation drippers during the irrigation event when the control dripper is 2 L/H or 4 L/H. Provided that all the drippers have the same emitter discharge exponent, the volume of water discharged by an irrigation dripper during the irrigation event remains approximately constant across a large range of operational pressures.

Gap between the upper and lower discs	Control dripper	Irrigation dripper	Approximate volume of water discharged by the irrigation dripper during the irrigation event
zero gap	4 L/H	2 L/H	45 ml
4 mm	4 L/H	2 L/H	61 ml
8 mm	4 L/H	2 L/H	77 ml
zero gap	2 L/H	2 L/H	90 ml
zero gap	4 L/H	4 L/H	90 ml
12 mm	4 L/H	2 L/H	93 ml
16 mm	4 L/H	2 L/H	109 ml
4 mm	4 L/H	4 L/H	122 ml
4 mm	2 L/H	2 L/H	122 ml
20 mm	4 L/H	2 L/H	125 ml
zero gap	2 L/H	4 L/H	180 ml
23 mm	4 L/H	2 L/H	137 ml
8 mm	2 L/H	2 L/H	154 ml
8 mm	4 L/H	4 L/H	154 ml
zero gap	4 L/H	8 L/H	180 ml
12 mm	2 L/H	2 L/H	186 ml
12 mm	4 L/H	4 L/H	186 ml
16 mm	2 L/H	2 L/H	218 ml
16 mm	4 L/H	4 L/H	218 ml
4 mm	2 L/H	4 L/H	244 ml
4 mm	4 L/H	8 L/H	244 ml
20 mm	2 L/H	2 L/H	250 ml
20 mm	4 L/H	4 L/H	250 ml
23 mm	2 L/H	2 L/H	275 ml
23 mm	4 L/H	4 L/H	275 ml
8 mm	2 L/H	4 L/H	308 ml
8 mm	4 L/H	8 L/H	308 ml
zero gap	2 L/H	8 L/H	360 ml
12 mm	2 L/H	4 L/H	372 ml
12 mm	4 L/H	8 L/H	372 ml

Gap between the upper and lower discs	Control dripper	Irrigation dripper	Approximate volume of water discharged by the irrigation dripper during the irrigation event
16 mm	2 L/H	4 L/H	436 ml
16mm	4 L/H	8 L/H	436 ml
4 mm	2 L/H	8 L/H	488 ml
20 mm	2 L/H	4 L/H	500 ml
20 mm	4 L/H	8 L/H	500 ml
23 mm	2 L/H	4 L/H	550 ml
23 mm	4 L/H	8 L/H	550 ml
8 mm	2 L/H	8 L/H	616 ml
12 mm	2 L/H	8 L/H	744 ml
16 mm	2 L/H	8 L/H	872 ml
20 mm	2 L/H	8 L/H	1000 ml
23 mm	2 L/H	8 L/H	1100 ml

8. Key features of the Small Terracotta Valve

1. Completely automatic
2. No electricity required (no batteries, no solar panels, no electronics, no computers, and no WiFi)
3. No timer required
4. Smart irrigation – the irrigation is controlled by the prevailing weather conditions
5. Valve operates in the pressure range 10 kPa to 800 kPa
6. Use for gravity feed or pressurised irrigation
7. Use with PC (pressure compensating) drippers or NPC (non pressure compensating) drippers
8. Use for sprinkler irrigation, drip irrigation, or porous hose irrigation
9. Adjust the water usage by adjusting the control dripper
10. Adjust the irrigation frequency by adjusting the float to change the volume of water discharged by the control dripper during the irrigation event (between 90 ml and 275 ml)
11. Adjusting the water usage does not affect the irrigation frequency, and adjusting the irrigation frequency does not affect the water usage
12. The water usage and irrigation frequency are directly proportional to the net evaporation rate (evaporation minus rainfall)
13. Responds appropriately when there is an unexpected heat wave
14. When it rains, water enters the terracotta pot and delays the start of the next irrigation
15. If you are using the same drippers throughout the irrigation application including the control dripper, the water usage is independent of the pressure
16. You can irrigate directly from a rainwater tank without using a pump
17. Uses less water without affecting the yield
18. Water in the terracotta pot is protected from algae, mosquitoes and thirsty animals
19. Simple, unpowered, and low tech, and therefore fewer things can go wrong
20. Provided you have a continuous water supply, you can leave your irrigation application unattended for months on end

9. Conclusion

The Small 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 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. Because the pressure range is not restricted by pressure compensation, the Small Terracotta Valve can be used with any pressure in the range 10 kPa to 800 kPa.

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

The Small Terracotta Valve is a game-changer for automated irrigation on level ground from a rainwater tank. If you are using pressurised irrigation with pressure compensating drippers, the following items are required.

- Pump for the rainwater tank
- Additional solenoid valves (one needed for each additional zone)
- Conventional irrigation controller
- Hose clamps

These items are not required if you use a Small Terracotta Valve, and so the cost of installing and running the irrigation systems can be reduced dramatically.

Appendix 1 Root zone scheduling

For plants with deep roots or for plants in clay soils, it is preferable to irrigate with more water less frequently to enable the water to reach the bottom of the root zone. Between irrigation events the soil near the surface is allowed to dry out, but there should still be moisture in the root zone. If you decide that your plants need irrigating less frequently than daily (for example, once a week), then **root zone scheduling** is recommended. Root zone scheduling takes account of evapotranspiration, the soil type and the depth of the root zone

The following steps can be applied to any irrigation zone, regardless of the size of the zone.

Step 1. How much water is needed

Allow the soil to dry out over several days until the soil is dry between the surface and the bottom of the root zone.

Adjust the float so that the gap between the upper and lower floats is set to the maximum value. Slowly remove water from the terracotta pot until the float drops down and the irrigation starts. Stop irrigating by raising the float when the position of the wetting front is near the bottom of the root zone (or when the wetting front has reached an appropriate depth). Slowly transfer water from the terracotta pot to a measuring container until the float drops down and the irrigation starts. The volume of water in the measuring container is the **irrigation control volume** which is the control volume required for the irrigation event to moisten the soil from the surface to the bottom of the root zone.

Step 2. How much evaporation is required between irrigation events

You need to estimate the evaporation from the outside surface of the terracotta pot before the soil is dry between the surface and the bottom of the root zone.

Slowly add water to the terracotta pot until the float jumps up. At sunset each day, check the moisture in the soil until the soil is dry between the surface and the bottom of the root zone. If you wish to water your plants more frequently, you could wait until the soil is dry between the surface and the middle of the root zone. Fill a measuring container with water, weigh it and record the weight. Slowly transfer water from the measuring container to the terracotta pot until the float jumps up. Reweigh the container to determine the volume of water that has evaporated. This is called the **evaporation control volume** which is the evaporation required to dry out the soil from the surface to the bottom of the root zone.

Adjust the float so that the net evaporation between irrigation events corresponds to the irrigation control volume (see page 5).

Step 3. Run the irrigation

The irrigation starts automatically when the water level reaches the low level. The irrigation stops automatically when the water level reaches the high level. To calculate the control volume, slowly transfer water from the terracotta pot to a measuring container until the float drops down and the irrigation starts. The volume of water in the measuring container is the control volume.

Step 4 Adjust the control dripper

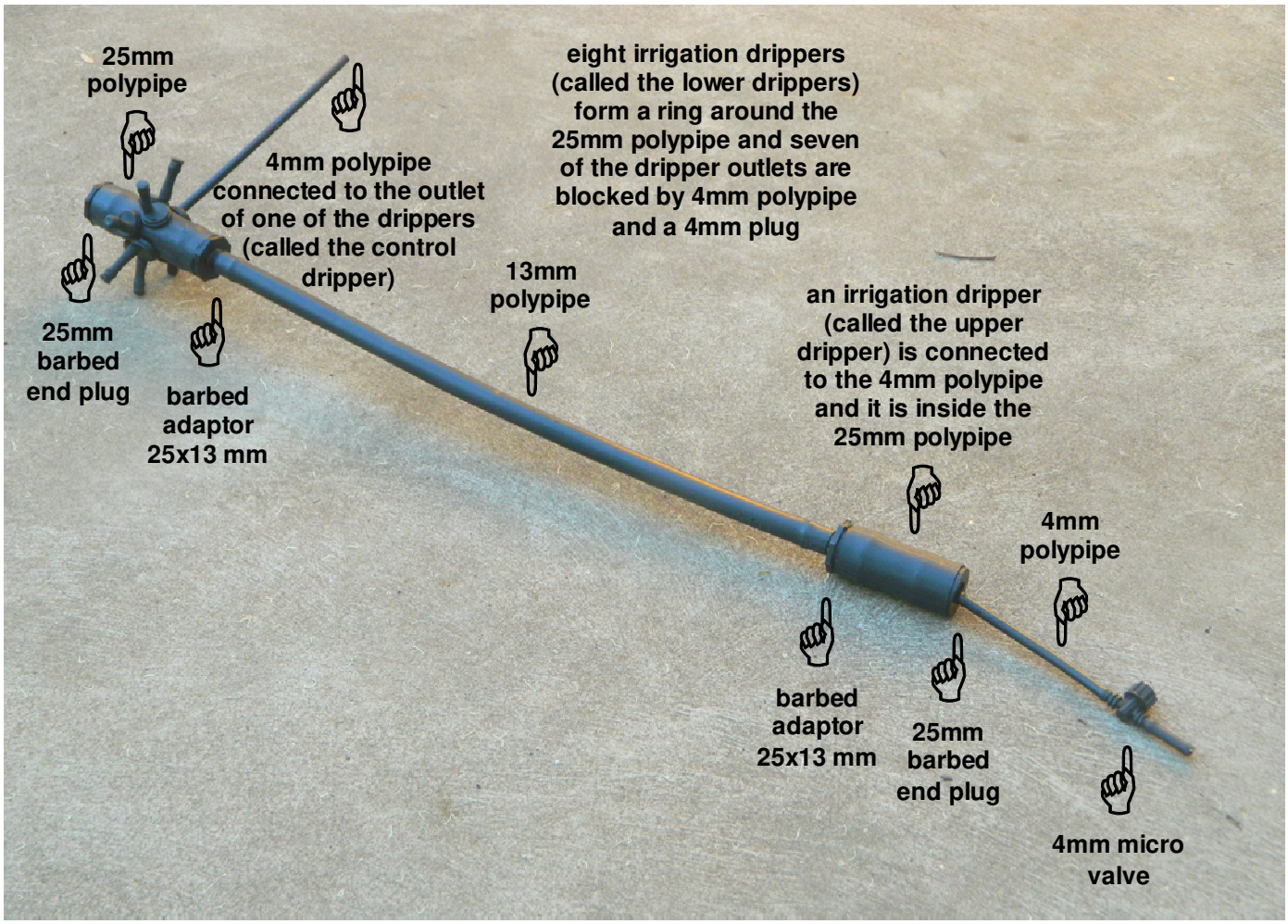
If the control volume is less than the irrigation control volume, then the wetting front is unlikely to have reached the bottom of the root zone. So reduce the flow rate of the control dripper (to increase the duration of the irrigation event) in preparation for the next irrigation. If the control volume is more than the irrigation control volume, then the wetting front is probably below the bottom of the root zone. So increase the flow rate of the control dripper (to decrease the duration of the irrigation event) in preparation for the next irrigation.

Repeat Steps 3 and 4 until the control volume matches the irrigation control volume. It is preferable that the above steps are done in a period when there is no rain.

Appendix 2. How to make a fractional dripper

To ensure that each irrigation dripper discharges the appropriate volume of water during the irrigation event (regardless of the water supply pressure) you will need to make a control dripper that delivers a fraction of the volume of water discharged by an irrigation dripper. This can be done for either PC (pressure compensating) drippers or NPC (non pressure compensating) drippers. If you are using PC drippers, then the pressure at PC drippers does not need to be within the pressure range specified by the manufacturer for pressure compensation.

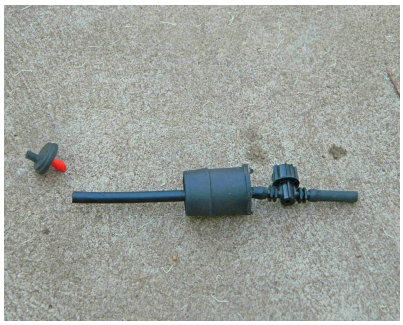
The component parts of the fractional dripper are labelled in the picture below.



The component parts of the fractional dripper are labelled in the above picture

The following pictures provide step by step instructions for making the fractional dripper.

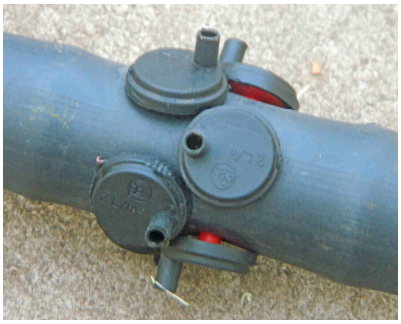
Step 1. Connect 4mm polypipe to the 4mm micro valve. Drill a 13mm hole in the 25mm end plug.



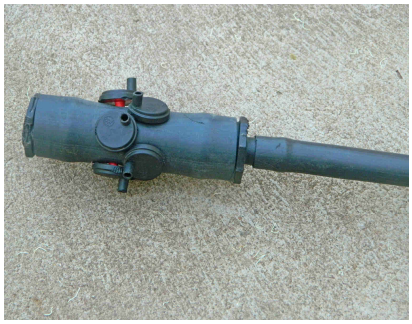
Step 2. Insert the 4mm polypipe through the hole in the end plug.

Step 3. Connect the irrigation dripper to the 4mm polypipe.

Step 4. Insert the 25mm end plug into one end of a 70mm length of 25mm polypipe. Insert a barbed adaptor into the other end of the 25mm polypipe. Insert the other end of the barbed adapter into a 500mm length of 13mm polypipe.



Step 5. Insert eight irrigation drippers in a circle around a 100mm length of 25mm polypipe so that the outlets of the drippers are in line.



Step 6. Insert a 25mm end plug into one end of the 100mm length of 25mm polypipe. Insert a barbed adaptor into the other end of the 25mm polypipe. Insert the other end of the barbed adaptor into the 13mm polypipe.

Fractional drippers for dripline

To make a fractional dripper for dripline you will need to cut dripline into short lengths with one dripper per length and with one end blocked.

Make the upper dripper by connecting a short length of dripline to the 4mm polypipe.

Attach eight 4mm micro valves in a circle around a 100mm length of 25mm polypipe so that they are at the same level. Make the lower drippers by attaching a short length of dripline to each micro valve.

Appendix 3. How to use the fractional dripper

Fractional dripper suspended above the Small Terracotta Valve

To install the fractional dripper, replace the adjustable control dripper by a length of 4mm polypipe connected to the fractional dripper so that the fractional dripper is suspended above the Small Terracotta Valve. A length of 4mm polypipe is connected to one of the lower drippers (called the control dripper) so that it drips water into the terracotta saucer during the irrigation event. The remaining seven lower drippers should be blocked using a short length of 4mm polypipe and a 4mm plug. The height of the upper dripper should be approximately the same as the height of the irrigation drippers, and the irrigation drippers should all be at approximately the same level

The control dripper drips water into the terracotta saucer and the remaining seven lower drippers should be blocked.

When the irrigation starts, the upper dripper fills the 13mm polypipe until water start to overflow from the 13mm hole in the 25mm barbed end plug, and the control dripper drips water into the saucer. Progressively unblock the lower drippers until water stops overflowing at the upper dripper. The unblocked drippers (excluding the control dripper) drip water outside the terracotta saucer. As the number of unblocked drippers increases, the flow rate of the control dripper decreases.

Water overflowing from the 13mm hole at the upper dripper

Progressively unblock the lower drippers until water stops overflowing at the upper dripper.

Adjust the fractional dripper by unblocking lower drippers until the irrigation delivers the appropriate amount of water during the irrigation event to your plants at their current stage of growth.

Adjust the fractional dripper by unblocking lower drippers until the irrigation delivers the appropriate amount of water to your plants.

When the water supply pressure is low (gravity feed for example), the difference in level between the upper dripper and the irrigation drippers may mean the difference in flow rate becomes significant. You may be able to adjust the length of the 13mm polypipe so that the upper dripper is at the same level as the irrigation drippers.

When you use the fractional dripper you must always ensure that water is not overflowing at the upper dripper. However, you may be able to stop the water overflowing by increasing the length of the 13mm polypipe.

The following table shows the volume of water discharged by each irrigation dripper during the irrigation event as the number of unblocked drippers increases. The volume of water discharged by each irrigation dripper during the irrigation event is independent of the water supply pressure.

Number of unblocked drippers	Fractional dripper fraction	Volume of water discharged by each irrigation dripper during the irrigation event
1	1	control volume
2	1/2	control volume x 2
3	1/3	control volume x 3
4	1/4	control volume x 4
5	1/5	control volume x 5
6	1/6	control volume x 6
7	1/7	control volume x 7
8	1/8	control volume x 8

Additional options can be obtained by using more than one lower dripper as the control dripper. For example, the following table shows that volume of water discharged by each irrigation dripper during the irrigation event when 2 lower drippers are used as the control dripper

Number of unblocked drippers	Fractional dripper fraction	Volume of water discharged by each irrigation dripper during the irrigation event
2	1	control volume
3	2/3	control volume x 1.5
4	1/2	control volume x 2
5	2/5	control volume x 2.5
6	1/3	control volume x 3
7	2/7	control volume x 3.5
8	1/4	control volume x 4