Universal Measured Irrigation Controller User Manual

Universal Measured Irrigation Controller

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Chapter 1. Introduction to Measured Irrigation (MI)

Definition of measured irrigation

Measured irrigation is an irrigation scheduling method that satisfies the following two conditions:

1. *Variations in the water usage throughout the year are controlled by the prevailing net evaporation rate (evaporation minus rainfall).*
2. *The volume of water discharged by each emitter during an irrigation event is controlled directly without the need to control the flow rate or the duration of the irrigation event.*

Research on measured irrigation conducted at the Bureau of Meteorology weather station at Adelaide Airport demonstrated a correlation greater than 90% between the dripper discharge volumes and the prevailing ET (evapotranspiration) minus rainfall. When it rains the start of the next irrigation event is delayed, and when there is a heat wave the Universal Measured Irrigation Controller responds appropriately. If fact the water usage (litres per week for example) is directly proportional to the prevailing net evaporation rate. The research report *Evapotranspiration and Measured Irrigation - Report for Smart Approved Watermark* can be downloaded from the Measured Irrigation website: https://www.measuredirrigation.com.

Chapter 2. Universal Measured Irrigation Controller

2.1 Introduction to Universal Measured Irrigation Controller

The Universal Measured Irrigation Controller can upgrade your programmable irrigation controller or tap timer so that the water usage (litres per week for example) is significantly reduced without affecting the yield or the health of your plants. The Universal Measured Irrigation Controller can also be used a stand-alone irrigation controller.

The Universal MI Controller is an automatic smart irrigation controller with universal application. The Universal MI Controller can be used for any size irrigation system regardless of the size of the solenoid valve.

It can be used for gravity feed or pressurized systems, sprinkler or drip irrigation, pressure compensating drippers or non pressure compensating drippers.

For programmable irrigation controllers, one of the disadvantages of non pressure compensating drippers is that the water usage is affected by variations in the water supply pressure. With the Universal MI Controller the water usage is independent of the water supply pressure. If fact the water pressure can change significantly during the irrigation event without affecting the dripper discharge volumes. **This is a unique feature of measured irrigation.**

The water usage for the Universal Measured Irrigation Controller is directly proportional to the prevailing net evaporation experienced by your plants. **This is a unique feature of measured irrigation.**

The Universal MI Controller has 2 yellow wires attached to the white float switch mounted on the side of the blue evaporator, and 2 black wires attached to a second float switch mounted inside the vertical black tube. If you require the net evaporation between irrigation events to be 10 mm or less, you should use the white float switch by connecting the yellow wires. If you require the net evaporation between irrigation events to be greater than 10 mm, you should use the adjustable float by connecting the black wires.

Use the float switch for sandy soils or for plants with a shallow root zone. Use the adjustable float for clay soils or plants with a deep root zone. If you are using the Universal MI Controller as a stand-alone irrigation controller, you should use the adjustable float by connecting the black wires.

If you are using a programmable irrigation controller or a tap timer, you should set the start time and the end time to provide a time window within which the Universal MI Controller can operate. The start time should beset to the earliest time of day that irrigation may start (for example, at 6:00 pm to avoid irrigating during the heat of the day). The end time should be set to the latest time of day that irrigation may finish (for example, at 6:00 am to avoid irrigating during the heat of the day).

The Universal Measured Irrigation Controller can be purchased from the Online Shop at the Measured Irrigation website https://www.measuredirrigation.com/shop-1.

Universal Measured Irrigation Controller connected to a tap timer

2.2 Instructions for installing the Universal Measured Irrigation Controller

Step 1. Position the Universal Measured Irrigation Controller in a suitable location so that the evaporation matches the evaporation in your garden. Position the float shaft so that it points vertically up. Be very careful when adjusting the float shaft to avoid placing any stress on the fragile plastic float shaft.

Connect the water supply

Step 2. Connect a water supply to the inlet of the Universal Measured Irrigation Controller. The water supply pressure should be between 20 kPa and 800 kPa. The irrigation zone is connected to the water supply via a solenoid valve. The solenoid valve may be connected to a programmable irrigation controller, or there may be a tap timer between the solenoid valve and the water supply.

Step 3. Connect a control dripper to the irrigation system so that it will drip water into the evaporator during the irrigation event. For gravity feed applications you may need to adjust the height of the evaporator so that the NPC (non pressure compensating) control dripper is at the same level as the irrigation drippers. If your irrigation drippers are PC (pressure compensating), the control dripper should also be PC.

Connect the control dripper

Control dripper

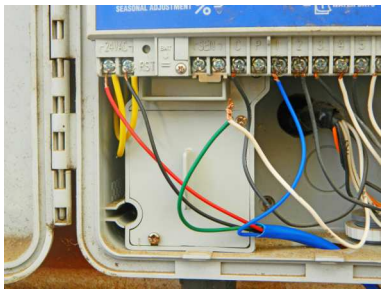
Step 4. The waterproof control box has a blue cable with 4 wires, and a red cable with 2 wires. The colour-coded wires need to be connected to the various components as follows:

Waterproof control box

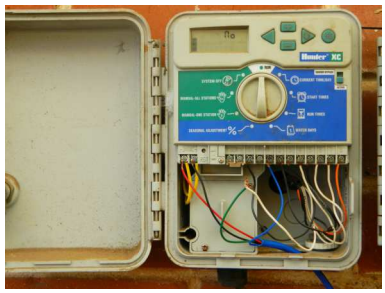
Connect the **white** wire (inside the red cable) to one of the wires (yellow or black) from the Universal Measured Irrigation Controller.
Connect the **yellow** wire (inside the red cable) to the other wire (yellow or black) from the Universal Measured Irrigation Controller.

Connect the white and yellow wires to the Universal Measured Irrigation Controller

If you are upgrading your **irrigation controller**, feed the blue lead into controller and connect the **red** wire to the active terminal of the 24V AC power supply and connect the **black** wire to the neutral terminal of the power supply. For the zone you are upgrading, disconnect the zone wire from the zone terminal and connect the **blue** wire to the zone terminal. Connect the **green** wire to the previously disconnected zone wire.



Connect the red, black, blue and green wires as described



Feed the blue lead into controller

If you are upgrading your **tap timer**, connect a 12V DC solenoid valve to the tap timer and then connect the **blue** wire to one of the solenoid wires and connect the **green** wire to the other solenoid wire. Connect the **red** wire to the positive terminal of a 12V DC power supply, and connect the **black** wire to the negative terminal of the power supply.

Connect the blue and green wires to the solenoid valve

If you are using the Universal Measured Irrigation Controller as a **stand-alone irrigation controller**, connect a 12V DC solenoid valve to your water supply and then connect the **blue** wire to one of the solenoid wires and connect the **green** wire to the other solenoid wire. Connect the **red** wire to the positive terminal of a 12V DC power supply, and connect the **black** wire to the negative terminal of the power supply.

Step 5. Turn on the water supply to the Universal Measured Irrigation Controller and open the small valves so that water trickles from the valves.


Turn on the water supply


Open the small valves

Step 6. Fill the evaporator with water until the water stops flowing from the small valves.


Fill the evaporator

Step 7 (using the adjustable float). The float falls as water slowly evaporates from the evaporator. When the float has fallen below the low level, the irrigation starts automatically (If you are using a tap timer or a programmable irrigation controller, the irrigation cannot start until the start time). The float rises as the control dripper drips water into the evaporator. When the float reaches the high level the irrigation stops automatically. The cycle continues indefinitely.


The control dripper drips water into the evaporator


When the float reaches the high level the irrigation stops

To avoid evaporative losses, the start time should be after sunset. The end time should be set so that the difference between the end time and the start time is much greater than the expected duration of the irrigation event. For example, setting the end time two hours after the start time will ensure that the irrigation stops automatically well before the end time.

Adjust the float to control the irrigation frequency (see Section 2.3).

Step 7 (using the float switch). The water level falls as water slowly evaporates from the evaporator. The irrigation starts automatically at the start time provided that the water level is below the float switch. The water level rises as the control dripper drips water into the evaporator. When the water level reaches the float switch the irrigation stops automatically. The cycle continues indefinitely. To avoid evaporative losses, the start time should be after sunset. The end time should be set so that the difference between the end time and the start time is much greater than the expected duration of the irrigation event. For example, setting the end time two hours after the start time will ensure that the irrigation stops automatically well before the end time.

Step 8. Adjust the control dripper to suit the water requirements of your plants (see Section 2.4). If you are using pressure compensating dripper, adjust water usage by adjusting the surface area of evaporation.

Step 9. You may wish to protect the evaporator to prevent animals drinking the water, but make sure that you do not impede the evaporation (chicken wire is ideal).

Replace the water and clean the evaporator regularly to remove algae and other contaminants.

2.3 How to adjust irrigation frequency for the Universal Measured Irrigation Controller

Using the adjustable float

To increase the options for the irrigation frequency, the Universal Measured Irrigation Controller is provided with an adjustable float consisting of a 7 cm diameter cylindrical float and 6 float rings that can slide over the cylinder to increase the outside diameter of the float (the bottom of the float ring should align with the bottom of the cylindrical float).

Six float rings

Slide the float ring over the cylindrical float

The following table shows the irrigation frequency for various float rings. The irrigation frequency is determined by the net evaporation from the evaporator between irrigation events.

Table 1. Irrigation frequency for the Universal Measured Irrigation Controller

Outside diameter of float	Net evaporation between irrigation events
7 cm	34.9 mm
8 cm	28.6 mm
9 cm	21.3 mm
10 cm	17.4 mm
11 cm	14.9 mm
13 cm	12.3 mm
15 cm	10.9 mm

Besides the values of net evaporation in the table, additional values of the net evaporation between irrigation events can be achieved by sliding the float ring up the cylindrical float so that there is small gap between the bottom of the float ring and the bottom of the cylindrical float. For example, if the outside diameter of the float is 8 cm and the gap is 1.5 cm, then the net evaporation between irrigation events is 25.8 mm.

Whenever you adjust the gap between the bottom of the float ring and the bottom of the cylindrical float, you will need to recalculate the net evaporation between irrigation events. It is recommended that you use the following method: Slowly add water to the evaporator until the float jumps up and the irrigation stops. Measure the volume of water that needs to be removed from the evaporator before the irrigation starts again (this is called the control volume). Be careful not to disturb the water surface as you remove the water. Measure the surface area of evaporation (this is the internal area of the evaporator minus the cross-sectional area of the float). Then the net evaporation between irrigation events is the control volume divided by the surface area of evaporation

Provided that the water level in the evaporator is below the high level, you can start the irrigation manually at any time by pressing the float down.

For example, you may wish to irrigate at sunset each day assuming that the water level is below the high level at sunset. Simply push the float down at sunset to start irrigating.

Push the float down to start irrigating

You can delay the next irrigation or stop the irrigation at any time by removing the float. The irrigation cannot start again until the float is replaced.

Remove the float to stop irrigating

It is important to realise that when you adjust the irrigation frequency by adjusting the outside diameter of the float, the water usage (litres per week for example) does not change.

Using the float switch

Set the irrigation frequency on the programmable irrigation controller or tap timer. The irrigation will start automatically at the start time provided that the water level is below the float switch. Adjusting the irrigation frequency does not affect the water usage (litres per week for example).

For example, if you set the irrigation to run every 24 hours and you set the start time to 6:00 pm, then the irrigation will start at 6:00 pm each day provided that the water level is below the high level. Similarly, if you set the irrigation to run every 48 hours and you set the start time to 6:00 pm, then the irrigation will start at 6:00 pm every second day provided that the water level is below the high level.

Irrigation starts automatically at the start time provided that the water level is below the float switch

2.4 How to adjust water usage for the Universal Measured Irrigation Controller

Adjusting water usage by adjusting the control dripper

Position an empty measuring container under one of the irrigation 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 may also wish to check the moisture in the soil.

If your plants are not getting enough water, turn the control dripper clockwise to reduce the flow rate of the control dripper.

If your plants are getting too much water, turn the control dripper anticlockwise to increase the flow rate of the control dripper.

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If the irrigation drippers are PC (pressure compensating), you can adjust the water usage by replacing the PC control dripper by a different combination of PC drippers.

Adjusting water usage by adjusting the surface area of evaporation

This technique is particularly useful when you are using pressure compensating drippers.

The water usage is directly proportional to the surface area of evaporation. You can increase the surface area of evaporation by choosing a supplementary evaporator with vertical sides. The total surface area of evaporation is the surface area of the supplementary evaporator plus the surface area of the original evaporator minus the surface area of the float. One way to connect the evaporators is to drill in hole in the side of each evaporator and to insert a rubber grommet into each hole. Insert a barbed connector or elbow into each grommet, and then use a length of flexible tube to connect the evaporators. The water level will be same in both evaporators.

You can decrease the surface area of evaporation by placing full bottles of water in the evaporator.

How to connect two evaporators

A supplementary evaporator increases the surface area of evaporation

A full bottle of water decreases the surface area of evaporation

2.5 Key features of the Universal Measured Irrigation Controller

1. Use with a tap timer or a programmable irrigation controller, or use as a stand-alone irrigation controller
2. Completely automatic
3. Smart irrigation controller – the irrigation is controlled by the prevailing weather conditions rather than a program
4. Use for both gravity feed and pressurised irrigation
5. Use for any size irrigation system regardless of the size of the solenoid valve
6. Use for sprinkler or drip irrigation
7. Use with pressure compensating drippers or non pressure compensating drippers.
8. You can adjust the water usage by adjusting the control dripper
9. You can adjust the irrigation frequency by adjusting the float
10. Adjusting the control dripper does not change the irrigation frequency
11. Adjusting the float does not change the water usage
12. The water usage is directly proportional to the net evaporation rate
    a unique feature of measured irrigation
13. Respond appropriately when there is an unexpected heat wave
14. When it rains, water enters the evaporator and delays the start of the next irrigation
15. The water usage is independent of the water supply pressure
    a unique feature of measured irrigation
16. Uses much less water without affecting the yield
17. Simple and low tech and so there are fewer things to go wrong

Chapter 3. Soil moisture and measured irrigation scheduling

3.1 Soil moisture probe

The amount of water that your plants need will depend on many factors in addition to the weather. For example, as the plants grow and become bigger they will need more water. Plants growing in sandy soil will need more water than plants growing in clay soil.

To take account of all these additional factors, you may need a soil moisture probe is to check the moisture level in the soil at various depths. A very simple but effective soil moisture probe is a length of steel pipe with a long slot. I suggest that the diameter of the pipe be between 30 and 40 mm. An angle grinder can be used to cut a long slot in the steel pipe to that you can inspect the soil inside the pipe. I suggest that the width of the slot be about 15 mm. You can also use the angle grinder to sharpen the edge of the end of the soil moisture probe.

A suitable soil moisture probe may be purchased from the Online Shop at the Measured Irrigation website: https://www.measuredirrigation.com/product-page/soil-moisture-probe.

By checking the moisture level in the soil through the slot in the steel pipe, you can decide whether your plants have been irrigated with too much or not enough water.

Hammer the steel pipe into the soil near a dripper so that the slot faces the dripper. Remove the steel pipe from the soil and use the slot to inspect the moisture level in the soil and the position of the wetting front. You may wish to use the slot to remove some soil from the pipe and to squeeze the soil sample between your fingers.

An angle grinder can be used to make a long slot in a length of steel pipe.

Hammer the steel pipe into the soil near a dripper so that the slot faces the dripper.

Remove the steel pipe from the soil and use the slot to inspect the moisture level in the soil and the position of the wetting front.

3.2 Introduction to measured irrigation scheduling

Measured irrigation scheduling can be applied to sprinkler irrigation as well as drip irrigation.

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

As your crop grows and the water requirement of the crop changes, you may wish to repeat the process of root zone scheduling.

Most weather-based irrigation controllers use data from a weather station to control the irrigation scheduling. Root zone scheduling responds to the prevailing weather conditions in your garden rather than the weather at a weather station. For example, it responds to the actual evapotranspiration of your plants, rather than the theoretical evapotranspiration at a weather station. This is particularly important if you are using a greenhouse.

There are two ways to implement root zone scheduling. The first way is to use an adjustable dripper as the control dripper (see Section 3.3). The second way is to use one or more irrigation drippers as the control dripper and to select an evaporator with an appropriate surface area (see Section 3.4).

3.3 Root zone scheduling using an adjustable dripper

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 (use the soil moisture probe).

Place a measuring container under one of the drippers to collect the water and start irrigating just before sunset (for sprinkler irrigation, place a measuring container under a non pressure compensating dripper that has been added to the irrigation zone).

While irrigating, check the moisture level in the soil by hammering the soil moisture probe into the soil near a dripper. Stop irrigating 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).

The volume of water in the measuring container is the **dripper control volume** and it is the amount of water that each dripper should deliver during the irrigation event to moisten the soil from the surface to the bottom of the root zone.

Place a measuring container under one of the irrigation drippers

Dripper control volume for root zone scheduling

By following this procedure the volume of water that each dripper discharges during the irrigation event can be adjusted to match the dripper control volume.. Alternatively, your knowledge of your plants requirements at their current stage of growth can be used to adjust the volume the volume of water that each dripper discharges during the irrigation event.

Step 2. How much evaporation is required between irrigation events

You need to estimate the evaporation in mm before the soil is dry between the surface and the bottom of the root zone.

Position any container with vertical sides at a suitable location so that the evaporation from the container matches the evaporation near your plants. Fill the container with water and weigh it at sunset.

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. For deficit irrigation, you may wait until the soil is dry between the surface and below the root zone.

Reweigh the container to determine the volume of water that has evaporated.
The number of mm that has evaporated is the volume of water divided by the surface area of the container. This is called the **root zone evaporation** and it is the evaporation required to dry out the soil from the surface to the bottom of the root zone.

Make adjustments to the float so that the net evaporation between irrigation events corresponds to the root zone evaporation.

Step 3. Run the irrigation

Adjust the control dripper so that the flow rate is roughly the same as the flow rate of the dripper used in Step 1. Empty the measuring container and place it below the same dripper used in Step 1. Slowly remove water from the evaporator until the irrigation starts.

Step 4 Adjusting the control dripper

Check the volume of water in the measuring container at the end of the irrigation event. If the volume in the measuring container is less than the dripper 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 volume in the measuring container is more than the dripper 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 volume of water in the measuring container matches the dripper control volume. It is preferable that the above steps are done during a period when there is no rain.

3.4 Root zone scheduling using an evaporator with an appropriate surface area

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

Step 1. How much water is needed (see Step 1 in Section 3.3)

Step 2. How much evaporation is required between irrigation events (see Step 2 in Section 3.3)

Step 3. How to choose a supplementary evaporator

You need to increase the surface area of evaporation so that the dripper control volume is delivered during the irrigation event. Calculate the **reference surface area** by dividing the dripper control volume by the root zone evaporation. Then choose a supplementary evaporator with vertical sides so that the total surface area of evaporation is an integral multiple ***m*** of the reference surface area. The value of **m** should be as small as possible (typically, 1 or 2). The total surface area of evaporation is the surface area of the supplementary evaporator plus the surface area of the original evaporator minus the surface area of the float. Connect the two evaporators together. One way to connect the evaporators is to drill in hole in the side of each evaporator and to insert a rubber grommet into each hole. Insert a barbed connector into each grommet, and then use a length of flexible tube to connect the evaporators. The water level will be same in both evaporators.

Step 4. How to set-up the evaporator

Position the evaporator at a suitable location so that the evaporation matches the evaporation near your plants. Position ***m*** drippers so that they will drip water into the evaporator during the irrigation event. The drippers should be identical to the dripper used in Step 1.