DIY Solar Measured Irrigation Training Manual for Smallholders

more crop per drop

Using a control dripper to adjust water usage

Dr Bernie Omodei
Measured Irrigation
5/50 Harvey Street East, Woodville Park SA 5011
Mobile 0403 935277
Email bomodei@measuredirrigation.com.au
Website www.measuredirrigation.com.au

August 2019

For unpowered measured irrigation, see the
Unpowered Measured irrigation Training Manual for Smallholders

CONTENTS

Introduction

This Manual is for smallholders using gravity feed drip irrigation on a garden or a small plot of land. You can automate your drip irrigation system so that water is pumped automatically from your farm pond (or from a rainwater tank, lake or river) to the header tank. All your plants are irrigated automatically so you can leave your plot unattended for weeks on end. This will allow you to become involved in other activities away from the plot; for example, travelling to the market to sell your produce.

I recommend that you watch the YouTube video with the title DIY Solar Drip Irrigation Kit.

The DIY Solar Drip Irrigation Kit can be purchased online from the Measured Irrigation website: www.measuredirrigation.com.au. All the other parts required may be purchased locally (for example, a solar panel and a battery).

It is assumed that the depth of the farm pond is no more than 4 metres. The water supply pressure from the header tank should be at least 10 kPa (1 metre head).

Farm pond in Kenya for gravity feed drip irrigation

How large can the plot be?

This Manual assumes that the smallholder has already established a gravity feed drip irrigation system. Provided that the drip irrigation system is already working effectively, you can use the DIY Solar Drip Irrigation Kit and the MI Six Zone Adaptor to automate the irrigation system. Additional solenoid valves connected in parallel may be needed to provide adequate flow for your irrigation application. For irrigation systems that require a larger flow rate, the solenoid valve can be replaced by a solenoid valve with a higher flow rate. For example, check out this solenoid valve with a flow rate of 4500 lph at 20 kPa, and 10000 lph at 100 kPa:

https://www.aliexpress.com/item/1-NPT-12v-Solenoid-Water-Valve-2-Way-2-Position-Electric-Solenoid-Valve-Water-Air-Gas/579769104.html

This solenoid valve is also available from the Measured Irrigation website.

Depending of the duration of the irrigation event and the power requirements of the pump and the solenoid valves, you may need to upgrade the battery to a larger battery, and you may need to upgrade the solar panel to a larger solar panel. As the plot becomes larger (400 m^2, for example) you may need more than one DIY Solar Drip Irrigation Kit.

No-pump DIY Solar Drip Irrigation Kit

For some applications the water supply is higher than land to be irrigated, and so the land can be irrigated directly from the water supply. For such applications, a header tank and a pump are not needed. The kit contains only one float switch, and the irrigation controller is quite different to the one used for the kit with the pump.

The No-pump DIY Solar Drip Irrigation Kit can be purchased online from the Measured Irrigation website: www.measuredirrigation.com.au.

The No-pump DIY Solar Drip Irrigation Kit can also be used to upgrade pressurised irrigation systems to fully automated measured irrigation.

Chapter 1. DIY Solar Drip Irrigation Kit

1.1 Contents of the DIY Solar Drip Irrigation Kit

As well as the User Manual, the kit includes the following components:

waterproof irrigation controller

light sensor

two float switches

solenoid valve with fittings to connect to19 mm poly pipe, and 2.5 metres of waterproof electrical cable

double pump (two pumps connected in series) with an inlet filter, fittings to connect to 19 mm poly pipe, and 9 metres of waterproof electrical cable

16 waterproof connectors for electrical wire

adjustable dripper

The kit does not include:

evaporator
battery
solar panel
extra 2-strand electrical cable.

1.2 Instructions for installing DIY Solar Drip Irrigation Kit

Step 1. Connect the pump.

Remove the header tank inlet pipe from the farm pond and connect it to the outlet from the pump (note that the outlet from the pump is perpendicular to the shaft of the pump.

WARNING: The inlet and outlet of the pump are fragile, so be careful not to apply force to the inlet or outlet at any time.

Step 2. Install a float switch on the header tank.

Drill a 13 mm (half inch) hole in the side of the header tank so that the hole is about 1 cm lower than the inlet to the header tank. Install one of the float switches on the inside of the header tank so that the float shaft points down.

Float switch on the header tank is lower that the inlet

Float switch on the inside of the header tank with the float shaft pointing down

Step 3. Choose a suitable evaporator.

The **evaporator** is any container with vertical sides, with a surface area of at least 0.05 m^2, and a depth of at least 0.1 m. To adjust the water usage with higher precision (see Section 1.4) it is recommended that you use an evaporator with a large surface area.

Evaporator

Step 4. Install the other float switch on the evaporator.

Drill a half inch (13 mm) hole in the side of the evaporator so that the centre of the hole is 3.5 cm lower than the overflow level for the evaporator. Install the other float switch so that the float shaft points up.

Drill a hole in the side of the evaporator

Float switch installed on evaporator with float shaft pointing up

Step 5. Install the solenoid valve.

Connect the solenoid valve at ground level to 19 mm poly pipe at both ends. Check the arrow on the bottom of the solenoid valve to ensure that the flow is in the correct direction. Position the solenoid valve so that the cover protects the solenoid from the weather.

Solenoid valve installed at ground level

Step 6. Purchase and install a solar panel (not in kit).

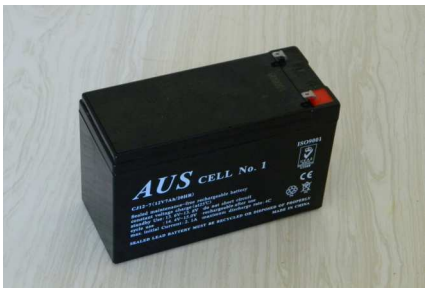
A 12 volt 20 watt solar panel should provide all the power required. You may purchase the solar panel either locally or online. You need to find a low cost method of mounting the solar panel. In the southern hemisphere the solar panel should face the sun when the sun is in the north. In the northern hemisphere the solar panel should face the sun when the sun is in the south. The ideal angle of the solar panel changes throughout the year. It is easy to adjust the orientation of the solar panel if it is mounted on a pole as shown.

Solar panel mounted on a pole

Step 7. Purchase a battery (not in kit).

A rechargeable 12 volt lead acid battery is required. You may be able to find a used car battery in good condition. If you buy a new battery then I recommend a sealed lead acid battery with a capacity of at least 7 amp hours and a standby voltage of at least 13.5 volts.

Note that the solar panel and the battery may be replaced by a 12V 5A power adaptor.



7 amp hour battery

Step 8. Connect the adjustable dripper.

Connect the adjustable dripper to the irrigation system and position the evaporator so that the adjustable dripper drips water into the evaporator during irrigation. The adjustable dripper should be at the same level as the irrigation drippers. The adjustable dripper is called the **control dripper**.

The adjustable dripper can be connected to a drip line using a Tee

Cut the drip line so that you can connect the Tee

Connect the Tee

The adjustable drip drips water into the evaporator during irrigation

Step 9. Measuring container

Place a measuring container under one of the irrigation drippers.

Measuring container under one of the irrigation drippers

Step 10. Adjust the control dripper.

Adjust the control dripper so that flow rate is about the same as the flow rate of the irrigation drippers. Make sure that there is no air in the tube connected to the control dripper.

Adjust the control dripper so that flow rate is about the same as the flow rate of the irrigation drippers

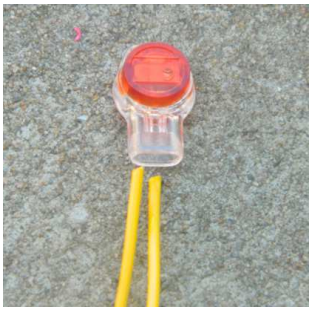
Step 11. You may wish to protect the evaporator to prevent animals drinking the water, but make sure that you do not impede the evaporation (chicken wire is ideal).

Step 12. Connect the irrigation controller.

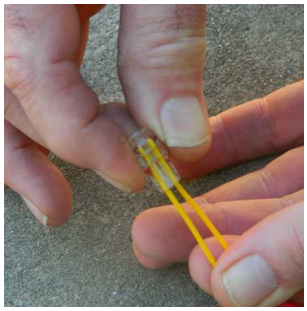
The irrigation controller has 10 colour-coded wires which need to be connected to the various components as follows:

Connect the **red** wire to the positive terminal on the battery.
Connect the **black** wire to the negative terminal on the battery.
Connect the **dark blue** wire to the positive wire form the solar panel.
Connect the **dark green** wire to the negative wire form the solar panel.
Connect the **purple** wire to one of the wires from the float switch on the evaporator.
Connect the **pink** wire to the other wire from the float switch on the evaporator.
Connect the **grey** wire to one of the wires from the float switch on the header tank.
Connect the **brown** wire to the other wire from the float switch on the header tank.
Connect the **orange** wire to the yellow wire from the pump.
Connect the **light pink** wire to the white wire from the pump.

16 waterproof connectors for electrical wire are provided. There is no need to strip the wires before inserting them into the connector. The connection is made by using a pair of pliers (for example) to push down the red cap so that the gel is squeezed out of the connector.

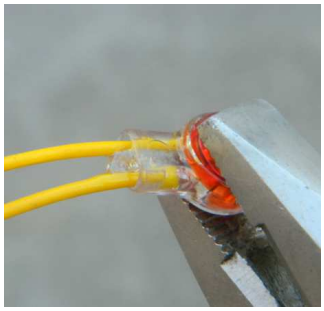


Wires are not stripped before insertion



Insert wires (2 or 3) into connector

Use pliers to push down the red cap



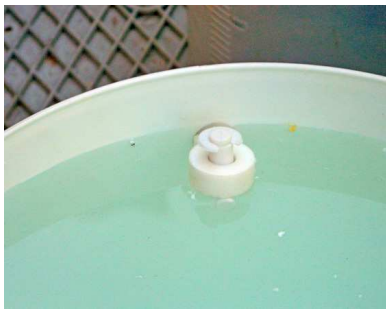
Gel is squeezed out of connector

If you are using a power adaptor instead of a battery, connect the **red** wire to the positive wire from the power adaptor, and connect the **black** wire to the negative wire from the power adaptor. It is recommended that you disconnect the red, black, light yellow, and light green wires from the solar charge controller inside the irrigation controller. Then connect the red wire to the light yellow wire, and the black wire to the light green wire.

Step 13. Fill the evaporator.

Fill the evaporator with water until the water level is just below the float switch. (Replace the water and clean the evaporator regularly to remove algae and other contaminants).

Fill the evaporator with water until the water level is just below the float switch



Water level just below the float switch

Step 14. Submerge the pump in the farm pond

The pump inlet should be at least 15cm above the bottom of the pond to avoid pumping sediment from the bottom of the pond and clogging the inlet filter. If clogging of the filter becomes a problem, you may wish to install a larger filter.

The inlet/outlet manifold on each pump may break if too much force is applied to the pump. If you break the inlet/outlet manifold, a replacement manifold (or a replacement pump) can be purchased online from the Solar Project UK: www.solarproject.co.uk.

The pump is also available from the Measured Irrigation website: www.measuredirrigation.com.au.

The two pumps provided in the kit are connected in series. If the water level in the header tank is less than 3.25 metres higher than the water level in the farm pond, rainwater tank, lake or river, then the two pumps should be connected in parallel rather than in series.

1.3 How to use the DIY Solar Drip Irrigation Kit

The switch on the irrigation controller is a three position switch with UP (ON), CENTRE (OFF), and DOWN (ON night only).

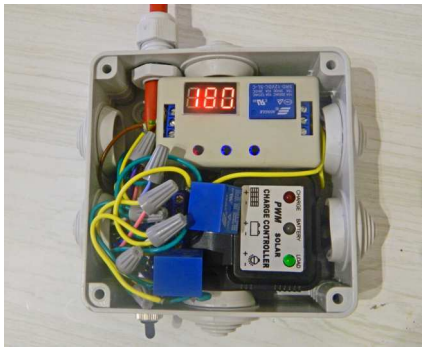
The switch on the irrigation controller has 3 positions: ON, OFF, ON night only

Turn the switch to the ON position (switch up) and the irrigation will start provided that the water level in the evaporator is below the float switch. The irrigation stops automatically when the water level raises the float on the float switch. With the switch in the ON position, the irrigation will start automatically as soon as the water level in the evaporator has fallen below the float switch.

With the switch in the ON night only position (switch down), the irrigation is restricted to dark hours only. If you do not wish to irrigate during the heat of the day, turn the switch to the ON night only position (switch down) so that the irrigation starts automatically at sunset (provided that the water level has fallen below the float switch).

To stop the irrigation at any time, turn the switch to the OFF position.

When the water level in the header tank falls below the float switch, the float switch activates a delay timer inside the irrigation controller and 3 minutes later the pump starts working. When the water level reaches the float switch the pump stops automatically.



The delay timer has a 3 digit display for the time delay in seconds

The operation of the pump is independent of the position of the switch on the irrigation controller.

The delay timer is inside the irrigation controller. You can access the delay timer by removing the four screws and removing the cover. The time delay can be adjusted by pressing the buttons on the delay timer. The delay timer has a 3 digit display for the time delay in seconds (preset to 180 seconds).

To change the time delay, press the middle button to select the digit you wish to change. The digit will flash to indicate that it is ready to be changed. Then press the right hand button to change the digit. When the time delay has been reset press the middle button until no digits are flashing.

Do not press the left hand button.

A solar charge controller is located inside the irrigation controller. One of the functions of the solar charge controller is to protect the battery from over-discharge. When the battery voltage is less than 10.8 volts, the solar charge controller isolates the battery so that the pump and solenoid valve stop operating. The over-discharge recovery voltage needs to be greater than 12.8 volts to allow the system to start working again.

1.4 How to use the control dripper to adjust water usage

1. Empty the measuring container before irrigation commences at sunset.

2. Position the measuring container under one of the irrigation drippers so that water drips into the container during the irrigation.

3. After sunrise the following morning, check the amount of water in the measuring container. You may also wish to check the moisture in the soil (see Irrigation scheduling for the DIY Solar Drip Irrigation Kit).

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

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

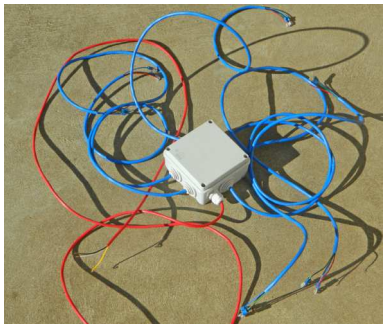
An alternative way to adjust the water usage is to change the surface area of the evaporator.

Garden beds being irrigated by the DIY Solar Drip Irrigation Kit

Chapter 2. Additional Irrigation Zones

In some applications you may wish to use more than one irrigation zone. For example, different crops may require separate zones. On sloping ground it is preferable to have a number of irrigation zones where each zone is at a different level. For each additional zone you will need an evaporator and an adjustable control dripper.

If you are using a DIY Solar Drip Irrigation Kit you will need to purchase a **MI Six Zone Adaptor**. You will also need a solenoid valve, a float switch and an adjustable dripper for each additional zone.



MI Six Zone Adaptor

The MI Six Zone Adaptor allows you to irrigate up to six additional zones. The MI Six Zone Adaptor, additional solenoids valves, additional float switches and additional adjustable drippers are available from the Measured Irrigation website. www.measuredirrigation.com.au

The MI Six Zone Adaptor has 3 colour-coded wires (inside the red cable) which need to be connected to the irrigation controller as follows:

Connect the **yellow** wire to the purple wire from the irrigation controller.
Connect the **white** wire to the white wire from the irrigation controller.
Connect the **black** wire to the grey wire from the irrigation controller.

MI Six Zone Adaptor close-up

For each additional zone, the MI Six Zone Adaptor has 4 colour-coded wires (inside a blue cable) which need to be connected to the various components as follows:

Connect the **blue** wire with the spade connection to one of the terminals on the solenoid valve for the zone.
Connect the **green** wire with the spade connection to the other terminal on the solenoid valve for the zone.
Connect the **red** wire to one of the wires from the float switch for the zone.
Connect the **black** wire to one of the other wire from the float switch for the zone.

For each additional zone, you will need to adjust the control dripper for the zone to adjust water usage for the zone (see Section 1.4 How to use the control dripper to adjust water usage).

If you are using the MI Six Zone Adaptor, an extra solar panel or an extra battery may be required.

Evaporator, float switch and control dripper for zone 1

Evaporator, float switch and control dripper for zone 2

Two solenoids valves, one for each zone

Garden beds in zone 2 being irrigated by the MI Six Zone Adaptor in conjunction with the DIY Solar Drip Irrigation Kit

Chapter 3. Soil moisture and 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 heavy 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 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 online from the Measured Irrigation website www.measuredirrigation.com.au

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. A control dripper may be used to adjust the water usage.

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 Irrigation scheduling for the DIY Solar Drip Irrigation Kit

When you use a DIY Solar Drip Irrigation Kit the irrigation starts at sunset provided that the water level has fallen below the float switch. This method or irrigation scheduling is called **sunset 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 me 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.

Step by step instructions for root zone scheduling

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.

Place a measuring container under one of the drippers to collect the water and start irrigating just before sunset.

While irrigating, check the moisture level in the soil by hammering the steel pipe into the soil near a dripper. Stop irrigating when the position of the wetting front is near the bottom of the root zone.

The volume of water in the measuring container is the amount of water that each dripper should deliver during the irrigation event. It is called the **dripper control volume** and it is the volume of water required 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

Step 2. How much evaporation is required between irrigation events?

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

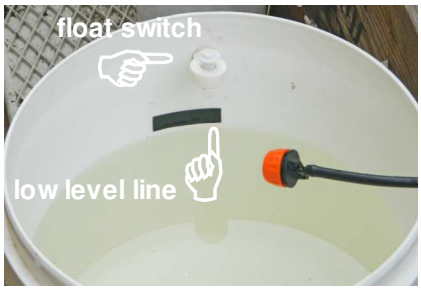
Turn the switch on the irrigation controller to the ON position (switch up) and the irrigation will start. Fill the evaporator with water until the water level raises the float on the float switch and the irrigation stops. Turn the switch on the irrigation controller to the OFF position

At sunset each day, check the moisture in the soil until the soil is dry between the surface and the middle of the root zone. If you wish to water your plants less frequently, you could wait until the soil is dry between the surface and the bottom of the root zone. The number of mm that has evaporated is called the **root zone evaporation** and it is the evaporation required to dry out the soil from the surface to the middle of the root zone.

Mark a line on the inside of the evaporator corresponding to the water level. This line is called the **low level line**. The gap between the float switch and the low level line corresponds to the root zone evaporation.

While the soil is drying, the water level is the evaporator is falling due to evaporation

Mark the low level line



Low level line and float switch

Step 3. Run the irrigation

Empty the measuring container and place it below one of the irrigation drippers.
When the water level in the evaporator has fallen below the low level line, turn the switch on the irrigation controller to the ON night only position (switch down) so that the irrigation starts automatically at sunset and stops when the water level reaches the float switch. Turn the switch to the OFF position after the irrigation has stopped.

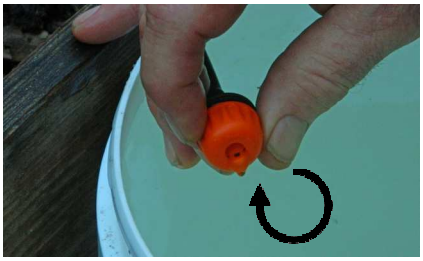
Irrigation starts at sunset

Irrigation stops when the water level reaches the float switch,

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 moisture below a dripper 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 moisture below a dripper may extend beyond 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.

Check the volume of water in the measuring container.



If volume in the measuring container is less than the dripper control volume, turn the control dripper clockwise to reduce the flow rate of the control dripper.

If the volume in the measuring container is more than the dripper control volume, turn the control dripper anticlockwise to increase the flow rate of the control dripper.

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 in a period when there is no rain.

After a few adjustments to the control dripper, the water usage should stabilise at an appropriate level for the plants at their current stage of growth and no further adjustments of the control dripper are required. The volume of water in the measuring container after each irrigation event should be approximately the same as the dripper control volume recorded in Step 2. It is preferable that the above steps are done in a period when there is no rain.

As your crop grows and the water requirement of the crop changes, you may wish to repeat the above steps for root zone scheduling

.

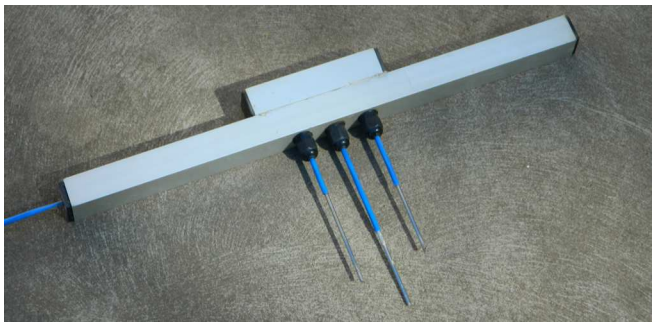
Root zone scheduling for the DIY Solar Drip Irrigation Kit is not completely automatic. However, root zone scheduling can be made completely automatic by replacing the float switch with a three probe level sensor that allows you to set both a high level and a low level. The MI Upgrade Kit with Level Sensor is discussed in another section of this document.

Chapter 4. MI Upgrade Kit with Level Sensor

4.1 Contents of the MI Upgrade Kit with Level Sensor

The MI Upgrade Kit with Level Sensor may be purchased from the Measured Irrigation website: www.measuredirrigation.com.au

As well as this User Manual, the kit consists of the following components:

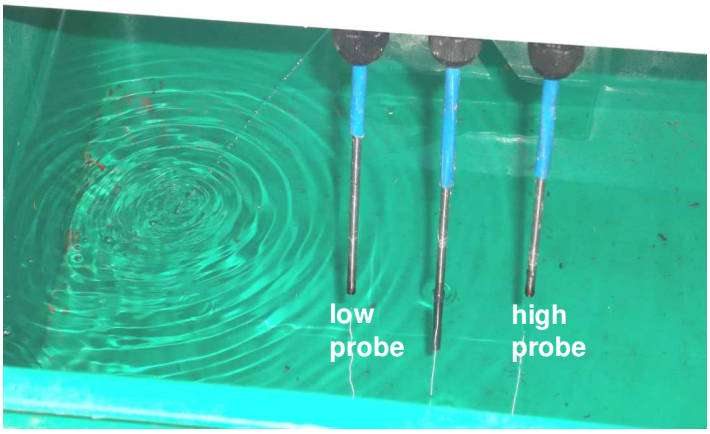


level sensor with 3 probes

9 metres of 3-strand waterproof electrical irrigation cable

MI upgrade kit adaptor

The level sensor has three probes as shown. During the irrigation event the water level rises as water slowly drips into the evaporator from the control dripper. When the water level reaches the high probe on the right the solenoid valve closes and the irrigation stops. The water level then falls due to evaporation until the water level is below the low probe on the left at which point the solenoid valve opens and the irrigation recommences. The middle probe is a reference probe. This cycle continues indefinitely.



level sensor with 3 probes

The volume of water required to raise the water level from the low probe level to the high probe level is called the **control volume**. It is also the volume of water that must evaporate between irrigation events. The control volume is determined by the surface area of evaporation and the gap between the high probe and the low probe. The length of the low probe and high probe are adjustable.

As well as being completely automatic, the irrigation frequency responds to the prevailing weather conditions. During very hot weather the evaporation rate will be much greater and so the irrigation frequency increases. On cool overcast days, the evaporation rate will be quite small and so the irrigation frequency decreases. The irrigation frequency can be changed by adjusting the gap between the low probe and the high probe. For root zone scheduling the gap between the low probe and the high probe should be the root zone evaporation.

4.2 Instructions for installing the MI Upgrade Kit with Level Sensor

Step 1. You may need to replace the evaporator if the level sensor does not rest on the evaporator with the probes clear of the bottom of the evaporator.

Step 2 The MI upgrade kit adaptor has 7 colour-coded wires which need to be connected as follows:

Connect the **red** wire to the grey wire from the irrigation controller.

Connect the **black** wire to the white wire from the irrigation controller.

Connect the **blue** wire to the purple wire from the irrigation controller (or to one of the red wire from the four-zone adaptor to upgrade a zone connected to the four-zone adaptor).

Connect the **green** wire to the pink wire from the irrigation controller (or to the corresponding black wire from the four-zone adaptor to upgrade a zone connected to the four-zone adaptor).

Connect the **white** wire to the white wire from the level sensor (reference probe).

Connect the **yellow** wire to the yellow wire from the level sensor (high probe).

Connect the **brown** wire to the black wire from the level sensor (low probe).

Step 3 Fill the evaporator with water until the water level is just below the low probe

Step 4. Start irrigating

Turn the switch the side if the irrigation controller to the ON position (switch up) and the irrigation will start. The irrigation stops automatically when the water level reaches the high probe. During the day the water level in the evaporator falls due to evaporation. The switch is a three position switch with UP (ON), CENTRE (OFF), DOWN (ON night only).

With the switch in the up position (ON), the irrigation will start automatically as soon as the water level in the evaporator has fallen below the low probe.

With the switch in the down position (ON night only), the irrigation is restricted to dark hours only. If you do not wish to irrigate during the heat of the day, turn the switch to the ON night only position (switch down) so that the irrigation starts automatically at sunset (provided that the water level is below the low probe).

The switch on the irrigation controller has 3 positions

To stop the irrigation at any time, turn the switch to the OFF position.

Chapter 5. Troubleshooting

Problem	Possible cause	Solution
Pump is not working	The time delay has not elapsed yet (time delay preset to 3 minutes)	Wait for the time delay to elapse or reset the time delay on the delay timer inside the irrigation controller.
	Low voltage on the battery (the solar charge controller protects the battery from over-discharge, see * below)	Recharge the battery with a battery charger or the solar panel. Use a multimeter to check the standby voltage on the fully charged battery. If the standby voltage is less than 13 volts replace the battery. Turn the switch on the irrigation controller to the OFF position before reconnecting the battery.
	Float switch on the header tank is mounted incorrectly	Make sure that the float shaft is pointing down.
	Float switch on the header tank is faulty	Replace the float switch on the header tank.
Pump has lost power	One of the pumps in the double pump has become faulty	Replace the faulty pump.
	The pump inlet filter has become clogged	Clean the pump filter or replace the filter with a larger filter.
Header tank is overflowing	Float switch on the header tank is mounted incorrectly	Make sure that the float shaft is pointing down.
	Float switch on the header tank is faulty	Replace the float switch on the header tank.
Irrigation not starting when the switch is ON (switch up)	Water level in the evaporator is above the float switch	Wait for water to evaporate or manually remove some water from the evaporator.
	Low voltage on the battery (the solar charge controller protects the battery from over-discharge, see * below)	Recharge the battery with a battery charger or the solar panel. Use a multimeter to check the standby voltage on the fully charged battery. If the standby voltage is less than 13 volts replace the battery. Turn the switch on the irrigation controller to the OFF position before reconnecting the battery.
	Float switch on the evaporator is not mounted correctly	Make sure that the float shaft is pointing up.
	Float switch on the evaporator is faulty	Replace the float switch on the evaporator.
	Solenoid valve is faulty	Replace the solenoid valve.

Irrigation not starting when the switch is ON night only (switch down)	Too much light on the light sensor	Wait until it is dark or cover the light sensor to exclude light.
	Water level in the evaporator is above the float switch	Wait for water to evaporate or manually remove some water from the evaporator.
	Low voltage on the battery (the solar charge controller protects the battery from over-discharge, see * below)	Recharge the battery with a battery charger or the solar panel. Use a multimeter to check the standby voltage on the fully charged battery. If the standby voltage is less than 13 volts replace the battery. Turn the switch on the irrigation controller to the OFF position before reconnecting the battery.
	Light sensor is faulty	Replace the light sensor.
	Float switch on the evaporator is faulty	Replace the float switch on the evaporator.
	Solenoid valve is faulty	Replace the solenoid valve.
Irrigation not stopping when the water level reaches the float switch	Float switch on the evaporator is not mounted correctly	Make sure that the float shaft is pointing up.
	Float switch on the evaporator is faulty	Replace the float switch on the evaporator.
Irrigation stopping before the water level in the evaporator reaches the float switch	Low voltage on the battery (the solar charge controller protects the battery from over-discharge, see * below)	Recharge the battery with a battery charger or the solar panel. Use a multimeter to check the standby voltage on the fully charged battery. If the standby voltage is less than 13 volts replace the battery. Turn the switch on the irrigation controller to the OFF position before reconnecting the battery.
	Solar panel has not fully charged the battery between irrigation events	If this is a regular problem, you may need a bigger solar panel.
	A fully charged battery cannot meet the demands of your irrigation system	If this is a regular problem, you may need a bigger battery.
Insufficient flow from the solenoid valve	Air in the pipe connected to the inlet of the solenoid valve	Disconnect the pipe from the inlet of the solenoid valve and run water through the pipe to remove any air. Reconnect the solenoid valve while the water is running.
	Solenoid valve is not adequate for your irrigation application	Add an extra solenoid valve (or valves) in parallel with the existing solenoid valve. Alternatively, replace the solenoid valve with a solenoid valve with higher flow rate. A suitable hi-flow solenoid valve is available from the Measured Irrigation website.

Pump stopping before the water level in the header tank reaches the float switch	Low voltage on the battery (the solar charge controller protects the battery from over-discharge, see * below)	Recharge the battery with a battery charger or the solar panel. Use a multimeter to check the standby voltage on the fully charged battery. If the standby voltage is less than 13 volts replace the battery. Turn the switch on the irrigation controller to the OFF position before reconnecting the battery.
	Solar panel has not fully charged the battery between irrigation events	If this is a regular problem, you may need a bigger solar panel.
	A fully charged battery cannot meet the demands of your irrigation system	If this is a regular problem, you may need a bigger battery.
Problems with the control dripper	Air in the tube connected to the control dripper	Disconnect the control dripper and run water through the tube to remove any air. Reconnect the control dripper while the water is running.
Variable depth of the wetting front (root zone scheduling)	Non-uniform soil composition	Perform multiple trials with a soil moisture probe and choose the wetting front depth that is deep enough to ensure that almost all your plants get enough water

* One of the functions of the solar charge controller is to protect the battery from over-discharge. When the battery voltage is less than 10.8 volts, the solar charge controller isolates the battery so that the pump and solenoid valve stop operating. The over-discharge recovery voltage needs to be greater than 12.8 volts to allow the system to start working again.