Link4
CORPORATION

HYDROROOT CONTROLLER

MANUAL

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1. Introduction

Figure 1

Welcome to HydroRoot, Link4's Intelligent Irrigation Controller. The HydroRoot 16 (**PIRR-A0-16T1**) represents the latest in automated irrigation management for greenhouses. It enables precise control and integration of multiple irrigation zones, giving growers flexibility to manage watering by schedule, misting cycles, or Vapor Pressure Deficit (VPD) mode.

Key Features:

- ☐ 16 outputs - triac driven, up to 2A max
- ☐ Schedule mode - 6 start times with a day calendar
- ☐ Cycle mode - watering window, watering shots to seconds
- ☐ VPDi mode - On-demand watering based on temperature and humidity
- ☐ Fuse-protected outputs
- ☐ Cloud enabled with remote access
- ☐ Data collection and analysis
- ☐ Custom user-controlled watering logic

At Link4, you are supported by the same engineers who designed the HydroRoot. It was our purpose to design a controller specifically for the demands and cost concerns for small to midsize growers, and HydroRoot delivers the best feature-to-price ratio in its class. Your irrigation system should improve the quality and efficiency of your operation; HydroRoot offers quick installation and flexible programming for easier and more accurate irrigation management so you can focus more on plant health and profitability.

What sets us apart is the Link4 Promise: our passion is to make growing easier. We understand that precision irrigation is critical to your success. That's why we commit to building outstanding controllers and delivering excellent support, giving you the confidence that HydroRoot is the right system for your operation.

2. Terms and Conditions

2.1 Warranty

Link4 warrants that the goods sold under this contract will be free from defects in material and workmanship **for a period of 12 months after the date of purchase**. This warranty will be limited to the repair and replacement of parts and the necessary labor and services required to repair the goods. IT IS EXPRESSLY AGREED THAT THIS WARRANTY WILL BE IN LIEU OF ALL WARRANTIES OF FITNESS AND IN LIEU OF THE WARRANTY OF MERCHANTABILITY. Moreover, any description of the goods contained in this contract is for the sole purpose of identifying them, is not part of the basis of the bargain, and does not constitute a *warranty* that the goods will conform to that description. The use of any sample or model in connection with this contract is for illustrative purposes only, is not part of the basis of the bargain, and is not to be construed as a *warranty* that the goods will conform to the sample or model. No affirmation of fact or promise made by Link4, whether or not in this contract, will constitute a *warranty* that the goods will conform to the affirmation or promise.

Link4 shall not be responsible for replacement(s) or repair(s) that become defective from user negligence, modification, abuse, and/or any type of improper usage. Nonconformance to any of the specifications in the product manual will void the warranty. Furthermore, our liability to the goods sold, whether on warranty, contract, or negligence, will be released upon the expiration of the warranty period when all such liability shall terminate. Link4 shall not be responsible for any loss or claims due to consequential damages afforded by the Buyer. Link4 also reserves the right to make any necessary changes to features and specifications, to condition or warranty.

2.2 Returns

Merchandise cannot be returned without a Return Merchandise Authorization (RMA) number from Link4. Requests for permission to return defective items must be made within (14) fourteen days after receipt of shipment. A Link4 RMA # for approved returns must appear on both the customer's shipping carton and the related receipt memo. Parts under warranty will be repaired at no charge. Other returned items will be subjected to the following restocking charges: 20% for no-value-added items, 50% for value-added items, and 100% for custom-designed or built-to-specification items.

2.3 Repairs

A repair order must also have a Link4 Return Merchandise Authorization (RMA) number. Repairs that are not covered by the warranty will be billed on a material and labor basis. Items returned for repair must be sent to Link4 with prepaid return transportation. Link4 will not be responsible for damage(s) due to improper packaging or shipping and delivery of items returned for repair.

2.4 Additional Costs

It is expressly agreed that Buyer will reimburse Link4 for any additional costs attributable to changes in the specifications, directions, or design of the items furnished, which are requested or approved by Buyer at Link4’s listed retail prices in effect at the time such changes are ordered.

2.5 Governing Law

The validity of this contract and of any of its terms or provisions, as well as the rights and duties of the parties under this contract, shall be construed pursuant to and in accordance with the law of California. The parties specifically agree to submit to the jurisdiction of the courts of California.

3. Before You Begin

3.1 Irrigation Strategy

Before installing and programming the HydroRoot, it is essential to establish a clear strategy for managing the watering strategies. The HydroRoot is a highly flexible and powerful controller, so careful planning is necessary to achieve the desired results and optimize plant quality while minimizing resource consumption.

To assist with this process, Link4 has included several worksheets in the following pages. These worksheets are intended for users with a foundational understanding of irrigation modes; if additional review is needed, please refer to the relevant sections of this manual. We recommend duplicating the worksheets for future use, as irrigation control requirements may evolve.

3.2 Schedule Worksheet for Irrigation

Station	Zone Name	Description	Watering Time (hh:mm:ss)	Start Time (hh:mm:ss)						Scheduled Irrigation Days													
				1	2	3	4	5	6	Su	M	T	W	Th	F	Sa	Su	M	T	W	Th	F	Sa
1																							
2																							
3																							
4																							
5																							
6																							
7																							
8																							
9																							
10																							
11																							
12																							
13																							
14																							
15																							
16																							

3.3 Cycle Worksheet for Irrigation

Station	Zone Name	Description	Watering Time (hh:mm:ss)	Watering Period (hh:mm)	Watering Window	
					Start	End
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						

3.4 VPD Worksheet for Irrigation

Station	Zone Name	Description	Watering Time (hh:mm:ss)	VPDi Threshold (kPa-Hr)	Watering Window	
					Start	End
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						

4. Installation

4.1 Content Inspection

- ☐ HydroRoot 16 Irrigation Controller with Weather-Resistant Enclosure
- ☐ 24VAC transformer (purchased separately) for power and valve activation
- ☐ Temperature and humidity sensor (purchased separately) for Vapor Pressure Deficit (VPD) mode
- ☐ Internet availability for remote cloud access (not operationally required)
- ☐ Wiring diagram (also available from www.link4controls.com)

The User Manual can also be downloaded from the Link4 Support Portal.

4.2 Pre-Installation Requirements

- ☐ A clean 120VAC source is available to power the 24VAC transformer.

- ☐ Adequate mounting surface to hold enclosure (14” x 8” x 5”)
  - ☐ While the enclosure is equipped with gasket seals to help protect against moisture, it’s still important to install it in a dry area, away from any sprayed liquids.
  - ☐ Position the enclosure so that the display is at eye level for optimal visibility and ease of use.
  - ☐ Space to mount the 24VAC transformer
  - ☐ Ensure there is sufficient space at the bottom for irrigation wires and Ethernet cables to exit comfortably.
  - ☐ Use provided screws to mount the enclosure to a suitable surface (e.g., plywood wall) - 4 screws.
  - ☐ The front door must be removed to mount the panel.

- ☐ Ensure that the Internet is available through one of the following options below.
  - ☐ Direct hardwire to an Ethernet router or modem
  - ☐ Direct hardwire to a cellular modem
  - ☐ Direct hardwire to an Ethernet to WiFi adapter

- ☐ If a temperature and humidity sensor is used, make sure:
  - ☐ It is mounted in a well-ventilated area
  - ☐ It is not exposed to direct sunlight or any excessive heat sources (e.g., motors, heaters, heated walls, etc.)
  - ☐ It is not exposed to excessive moisture or direct water sprays.

4.3 Installing and wiring the HydroRoot 16

- [ ] Use the provided 4 wood screws, and mount the enclosure onto a suitable surface.
  - [ ] Remove the enclosure door first.
  - [ ] Run the required wiring (see instructions below and provided wiring diagram).
  - [ ] Once you complete setting up, remount the door.

Caution: Make sure the gasket on the door fits properly against the lip of the enclosure.

- [ ] Use a clean 120VAC source available to power the 24VAC transformer.
  - [ ] Hardwiring with conduit is preferred.

Caution: Do not drill from the top of the enclosure, as condensation, moisture, and other liquids can flow into the enclosure.

- [ ] If any additional openings are drilled, be careful not to damage the internal electronics or wiring.
- [ ] If any conduits are entering the enclosure from the sides, angle them slightly downward to draw condensation away from the enclosure.
- [ ] If a wall-mount transformer is used, make sure the outlet is a GFCI (Ground Fault Circuit Interrupter) version and is protected from moisture.
- [ ] The provided external terminal block for the 24VAC can be removed to directly land the 24VAC wires to the internal board.

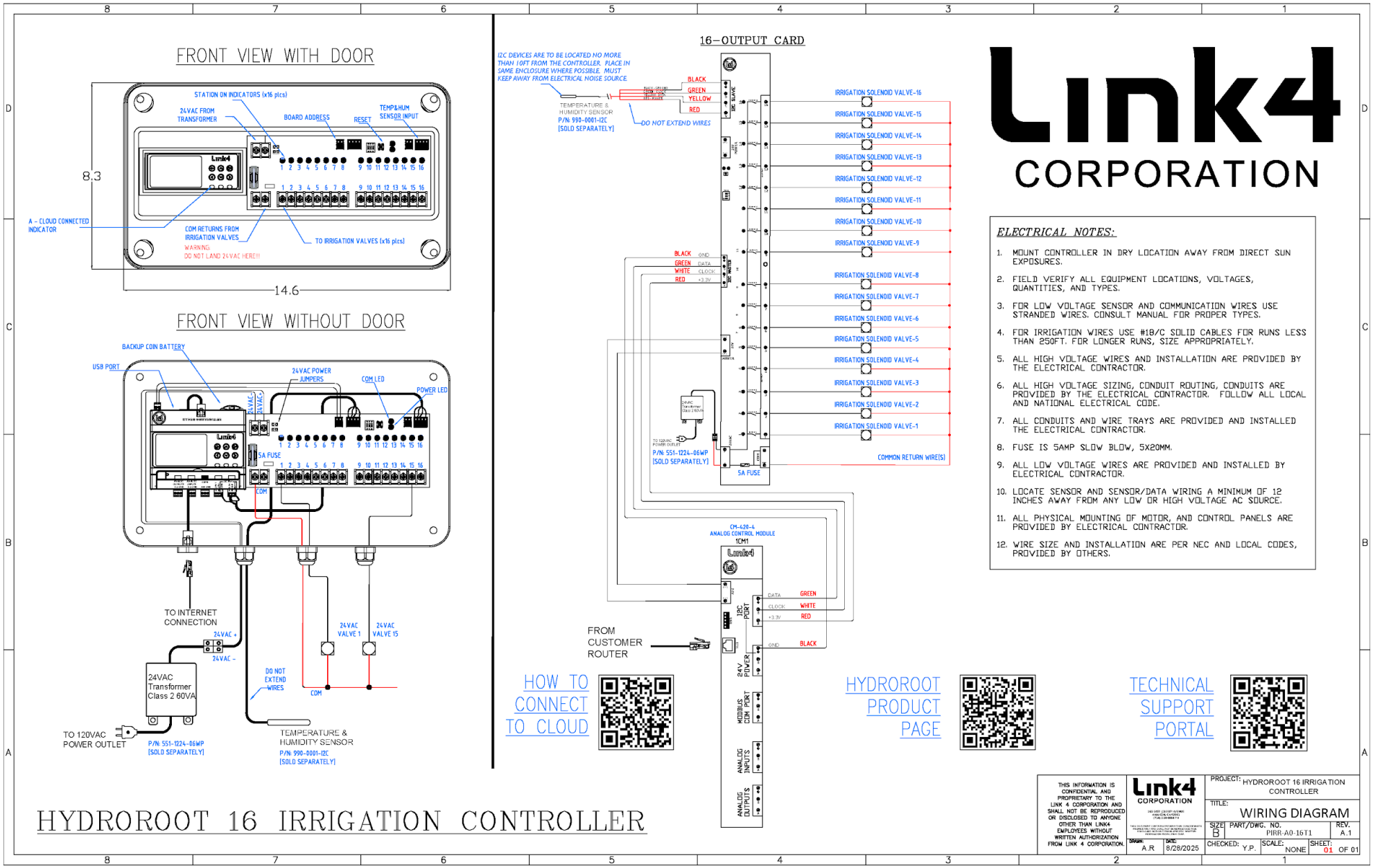
BE CAREFUL NOT TO LAND THE 24VAC WIRES TO THE COM RETURN TERMINALS!

- [ ] Irrigation wires
  - [ ] Each output is wired directly to its respective irrigation valves.
  - [ ] Return wires are daisy-chained and brought back to the controller and landed on the COM terminals.
  - [ ] Use 18/9 direct burial irrigation wires. For longer runs, use heavier gauge cables.
  - [ ] Use one cable per cable gland on the bottom. Three have been provided.
  - [ ] Tighten the cable glands once the wiring installation is completed to tighten the internal gaskets
  - [ ] Provide additional mechanical stress relief protections and moisture protection.

- [ ] Irrigation loads
  - [ ] Use only AC actuators or valves.
  - [ ] Make sure the valve voltage matches the transformer voltage (e.g., for a 24VAC transformer, use 24VAC valves)

- [ ] Internet connection
  - [ ] Utilize high-quality CAT6A Ethernet cable for runs up to 200 feet. In environments with potential electrical interference, shielded Ethernet cable (STP or FTP) is recommended to ensure signal integrity.
  - [ ] For optimal installation, bypass the convenient Ethernet jack located at the bottom of the enclosure and route the cable directly into the controller.
  - [ ] Maintain a minimum separation of 12 inches between Ethernet cables and any high-voltage wiring.
  - [ ] Try to keep cables and equipment away from motors, light ballasts, or other devices that can generate electromagnetic interference.

- [ ] Sensor and communication wiring
  - [ ] Use the same high voltage separation as above.
  - [ ] For I2C sensors and devices, use only the original cable length provided by Link4 without extending it.
  - [ ] For communication wiring, use low-capacitance RS-485 communication cable (22AWG, stranded, shielded, twisted pairs).



HYDROROOT 16 IRRIGATION CONTROLLER WIRING DIAGRAM

5. HydroRoot Overview

Now that the HydroRoot has been mounted, look over the front panel. The HydroRoot has many features to help give you the growing advantage. The images below offer an overview of the main components of the HydroRoot. Pay careful attention to the provided drawing in Section 4.3.

The HydroRoot 16 is a system designed for precise irrigation management for agricultural light irrigation applications. It supports up to 16 irrigation zones, with flexible irrigation modes (Schedule, Cycle, VPD) to ensure reliable watering strategies. Built with simplicity and robustness in mind, the HydroRoot 16 focuses on irrigation-only functionality.

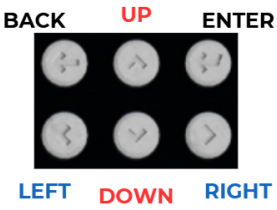
5.1 Hardware Descriptions

The controller is housed in a plastic weather-resistant enclosure.

- ☐ There is a transparent, convenient-access window for easy viewing and quick local programming.
  - ☐ Open the door by pressing down and pulling on BOTH bottom latches at the same time.
  - ☐ The gasket on the door protects against water intrusion. The door must be firmly closed when not in use.

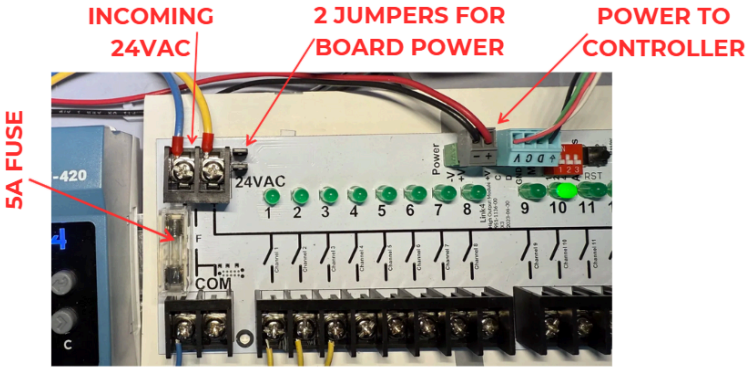
- ☐ Along the bottom are:
  - ☐ An Ethernet jack (located at the far left side) provides a quick cloud connection. Bypass this with a direct router or modem connection.
  - ☐ Three cable glands, located along the bottom and sealed tightly to protect from moisture, are used for sensor and irrigation wiring.

- [ ] Main control unit (refer to diagram in Section 4.3)

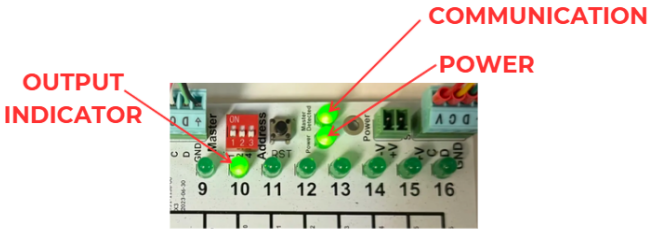


  - [ ] Large, sunlight-readable display for system status and readings
  - [ ] Six mechanical navigation push buttons
  - [ ] Green A light - indicates active connection to the Link4 Cloud
  - [ ] Behind the front door (accessible only when opened) (Wiring diagram Section 4.3)
    - [ ] Backup coin battery maintains an accurate clock during power outages or no internet
    - [ ] USB port for local configuration backup/restore or firmware updates when the internet is unavailable

- [ ] 16-Output Expansion Board (refer to diagram in Section 4.3)



  - [ ] Incoming 24VAC connects to upper left 2-pin terminals (NOT THE BOTTOM TWO). Refer to the illustration above.
  - [ ] Two jumpers provide power to the expansion board.
  - [ ] A 2-wire cable supplies power from the expansion board to the controller module.
  - [ ] 5A fuse connects the return COM wires from the solenoids back to the transformer.



- [ ] Indicators:
  - [ ] Output light: ON = output energized; OFF = inactive
  - [ ] Power light: ON = board powered
  - [ ] Communication light: blinks when communicating with the controller

- [ ] If a temperature and humidity sensor is used, connect it to the upper right 4-pin connector.

6. Programming the Controller

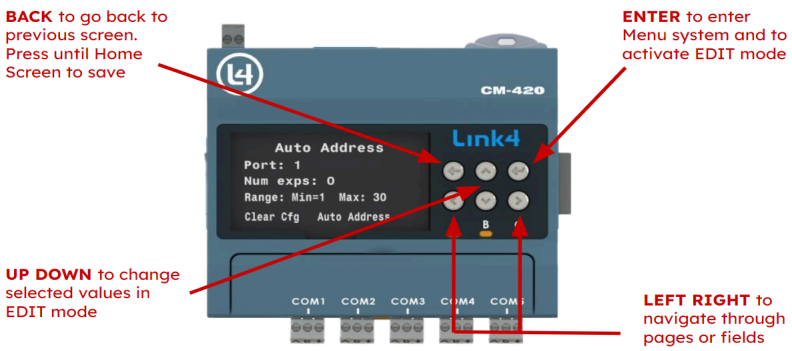
6.1 Overview

In the HydroRoot system, each irrigation area is referred to as a **Zone**. A single HydroRoot controller can manage up to **16 irrigation zones** through its built-in irrigation board. Each zone can be programmed with its own watering schedule, cycle/mist program, or VPD-based irrigation strategy.

All irrigation control is managed directly from one controller, keeping the system simple and cost-effective.

- **Zones:** Each of the 16 outputs can be assigned as a zone, allowing you to control different irrigation areas independently. For example, you may assign Zone 1 for drip irrigation in one crop section, Zone 2 for misting propagation trays, and Zone 3 for overhead sprinklers.
- **Custom Water Modes:** Each zone can be set to run in one of three irrigation modes (Schedule, Cycle/Mist, or VPD), or even combined with overrides for one-time watering needs.
- **Cloud Features:** With Link4 Cloud, add AUX controls and IF-THEN logic for advanced automation.
- **Master Pump/Valve Control:** Supports master pump or valve management for active zones.

6.2 Navigation and Screens



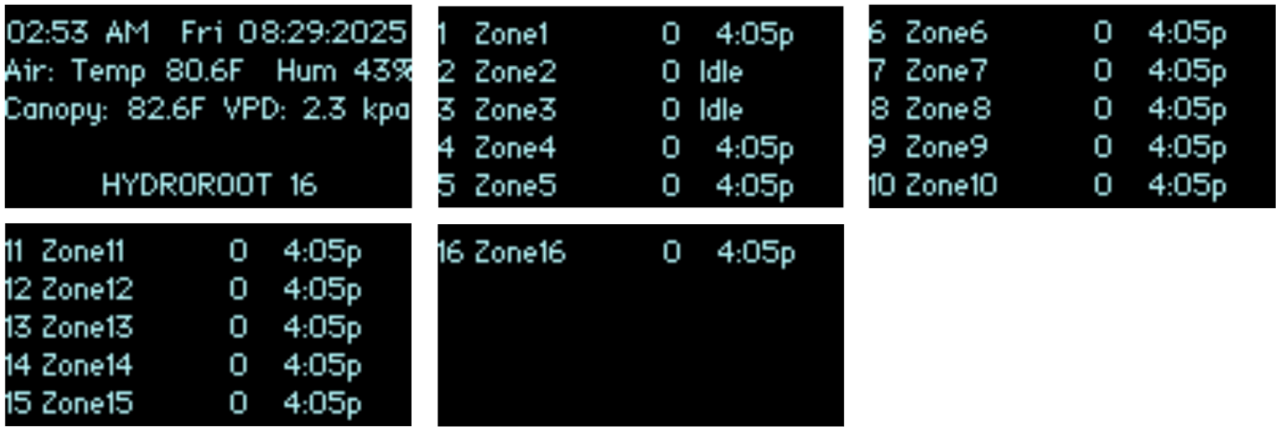
The HydroRoot controller has two operating modes:

Browsing: This mode lets you quickly navigate through the screens. Up, Down, Left, and Right buttons are used to move through the available screens. In this mode, there is no “cursor” visible. If you are in the Editing mode, press BACK to return to Browsing mode.

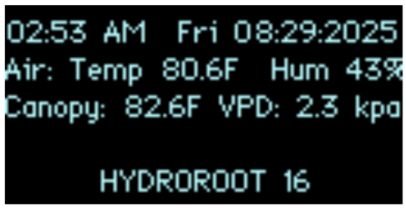
Editing: Once the desired screen has been located, this mode allows you to change the desired parameter. To activate Editing mode, press ENTER in Browsing mode on the desired screen. In this mode, the “cursor” (reversed highlighted texts) is visible. You can move this cursor around by using the LEFT and RIGHT buttons. Once the cursor highlights the parameter, you can edit it by either pressing the UP or DOWN buttons or the ENTER button again to activate the keypad.

To save your changes, press the BACK button repeatedly until you reach the HOME screen. Unsaved edits are lost if the system reverts automatically.

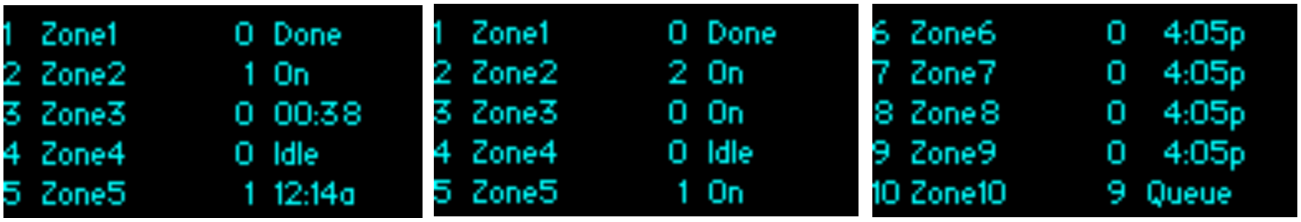
6.3 Status Screens



These top-level screens show the current state of the HydroRoot controller as well as the various states of the 16 outputs. Pressing LEFT and RIGHT will cycle through these top-level screens.



This is the main status screen. If the optional temperature and humidity sensor is installed, readings and calculated VPD levels are shown. Canopy temperature may be measured with an additional sensor or (by default) set as a fixed offset from the air temperature. This offset can be changed by navigating to the Menu section.



These screens show the state of the 16 irrigation outputs. The name of the output is as indicated along with the station number (1-16). The next field is the number of times this station has watered the zone for today. Today starts at midnight. For example, 2 means there have been 2 water cycles delivered to this zone since 12 AM this morning.

The last field has different meanings for each watering mode:

Done - No more irrigation for the day.
Idle - Outside watering window or no active schedule.
On - Zone is currently being irrigated.
Count down time - This zone is in a cyclic mode. Time remaining until next irrigation cycle.
Queue - Waiting for its turn in Sequential mode (only 1 valve can be turned on at a time). Multiple stations could be waiting in the queue.
Time - This zone is in a scheduled mode. This is the time for the next watering event. Once the last event ends for the day, the screen will display the Done message.

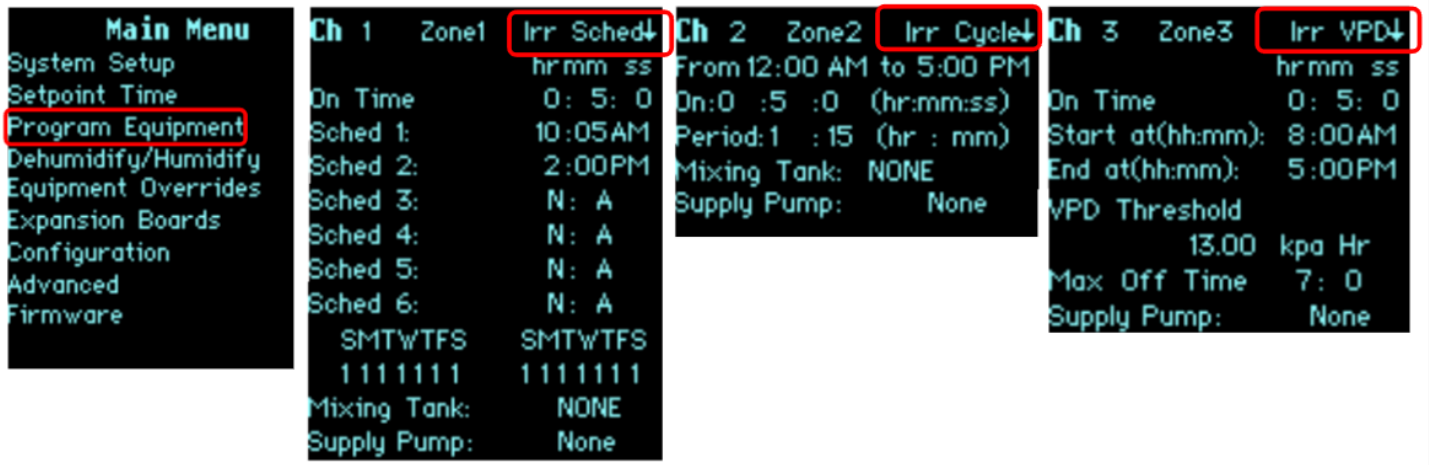
6.4 User Programming

The HydroRoot controller must be programmed according to your needs. This is easiest through the Link4 Cloud, but it could be done locally via the display and keypad.

There are 2 main steps:

1 - Program the individual stations with its desired operating modes: Schedule (default), Cycle, VPD, or Master Pump.
2 - Adjust system parameters for fine-tuning the controller to your needs.

6.5 Station programming



Access station programming by pressing ENTER to enter the controller Menu system and navigating to the Programming Equipment section.

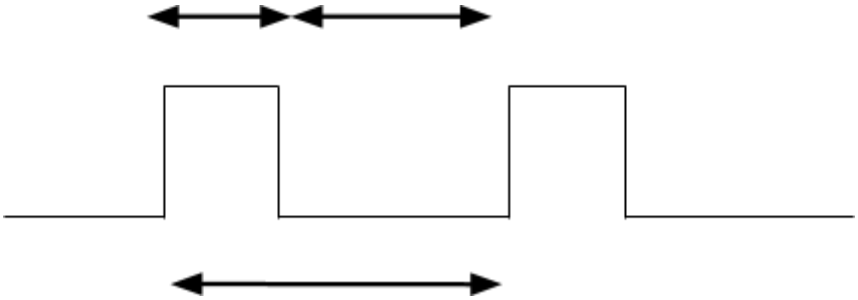
You could program each station with one of the following modes:

Schedule Mode:

- ☐ 1 to 6 watering event times in a given day (starting at midnight)
- ☐ Watering duration for every time a watering event is triggered by time
- ☐ 2-week calendar: “1” means it will be watered on that day of the week. “0” means skipped.
  - ☐ 2-week calendar: Allows for every-other-day watering

    e.g., S M T W T F S S M T W T F S
    0 1 0 1 0 1 0 1 0 1 0 1 0 1
- ☐ The Mixing Tank is not used
- ☐ Supply Pump: If you need a master pump, then add the Pump ID (from 1 to 8) for the Master Pump here.

Cycle Mode:



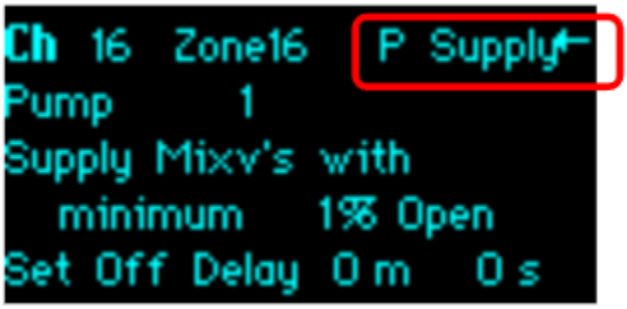
- ☐ Water only within defined time windows
  - ☐ If both are 12:00 AM, then watering will be disabled for this station.
- ☐ On: Watering time for each cycle.
- ☐ Period: Cycle time. This must be larger than the On time; otherwise, it will water constantly.
- ☐ The Mixing Tank is not used
- ☐ Supply Pump: If you need a master pump, then add the Pump ID (from 1 to 8) for the Master Pump here.
- ☐ Examples:
  - ☐ 8:00AM to 3:00PM, On = 5min, Period = 15min
    The station will water from 8:00 AM to 8:05 AM, then from 8:15 to 8:20, etc., until 3 PM.

VPD Mode:

- ☐ This is a watering-on-demand mode. It calculates the transpiration rate (water loss) by making a vapor pressure deficit calculation from the air temperature, air humidity, and canopy temperature.
- ☐ The canopy is assumed to be a fixed offset from the air temperature. An additional temperature sensor could be used to measure actual canopy temperature.
- ☐ The VPD calculation returns a pressure measurement expressed in kPa.
- ☐ The On time is the water duration once the watering threshold (see below) is reached.
- ☐ Watering will only happen within the provided cycle. The VPD accumulation will continue to happen regardless of the time window.
- ☐ VPD Threshold. This is NOT just the current VPD reading; it is the accumulated VPD over time. It is also referred to as VPDi (integrated VPD). It measures the amount of stress that the plants have been experiencing over time. The unit is kPa-Hr.
  - ☐ Example: 13 kPa-Hr could be an average VPD of 2 kPa over 6.5 hours or 2.5 kPa in 5.2 hours.
- ☐ Max Off Time is the maximum amount of time allowable between watering events. However, remember that the allowable watering window still applies. So, it is possible for the time in between watering cycles to exceed the Max Off Time limit because it can't water outside of the provided watering window.

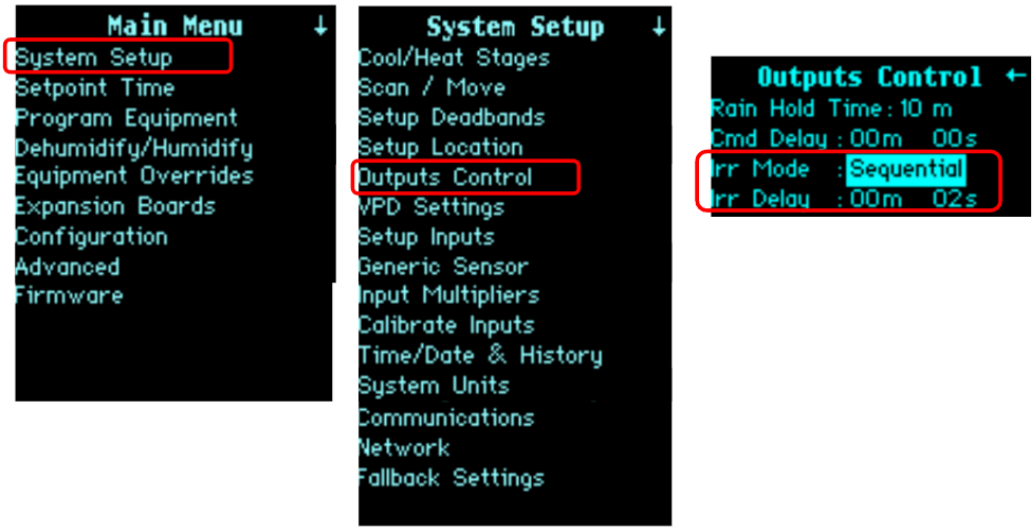
6.6 Pump programming

HydroRoot has support for applications where a master pump needs to be activated to pressurize the irrigation system. Any channel can be programmed to be a master pump. There can be up to 8 master pumps in a given system.



- ☐ Each pump is assigned a Pump ID (1 - 8).
- ☐ Stations can be linked to a Pump ID; when the station is activated, the pump will activate too.
- ☐ *Off Delay* is the amount of time it will keep the master pump running briefly after all linked stations shut off.

6.7 Output Control



By default, HydroRoot operates in **Sequential** mode, which means only one irrigation station can be on at a time (Master pumps are not irrigation stations). The other mode is **Concurrent**, which will allow multiple outputs to be on at the same time.

In sequential mode, if an output is set to turn on but another output is already on, said channel will queue up in the irrigation Queue. The queue is a FIFO (First In, First Out) queue. Exercise caution and use the provided table to plan your irrigation schedule. Ensure that there is enough watering time available for all channels to exit the queue.

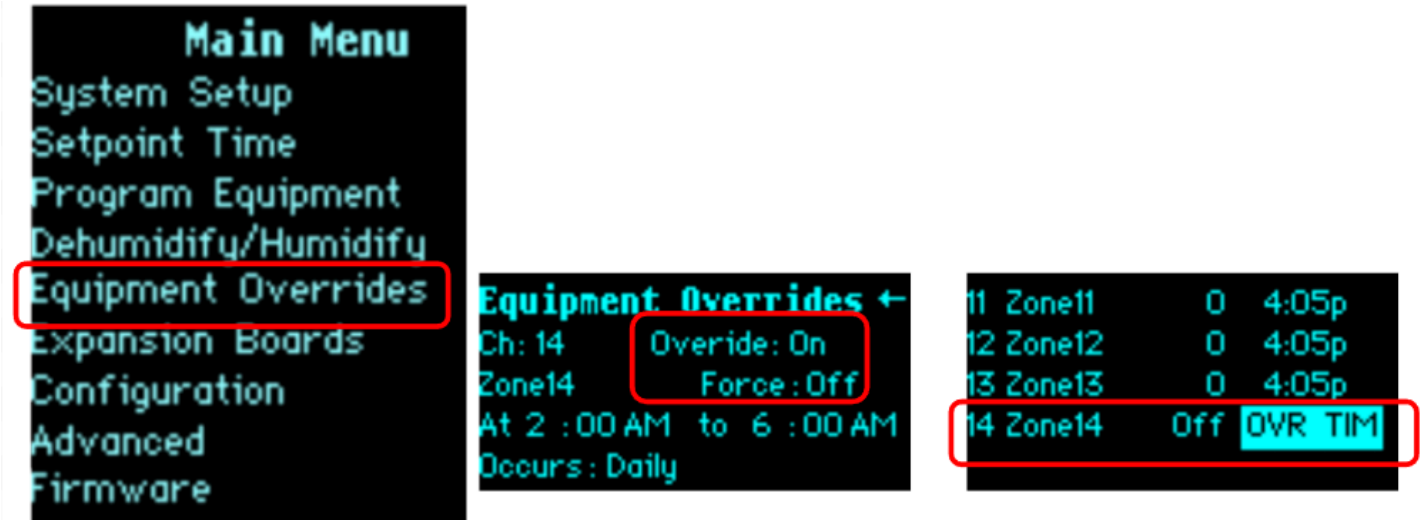
The irrigation delay is the adjustable delay time between one station turning off and the next one in the queue turning on. This time might be useful for the system to repressurize itself properly.

6.8 VPD Settings

From this screen, you can change the plant's canopy sensor as a fixed offset from the air temperature. A typical workflow is using a non-contact temperature sensor to measure the average canopy temperature of the plants. Record the offset against the current air temperature and enter it here.

For higher accuracy, use an extra non-contact sensor to measure canopy temperature.

6.9 Equipment Overrides



This programming feature allows you to manually force a station to either Off or On for a specified time window. This can be applied daily or as a one-time override.

If a station is being overridden, its status will be shown as OVR TIM (for Time Override).

6.10 Configuration

HydroRoot configuration can be saved and restored in multiple ways:

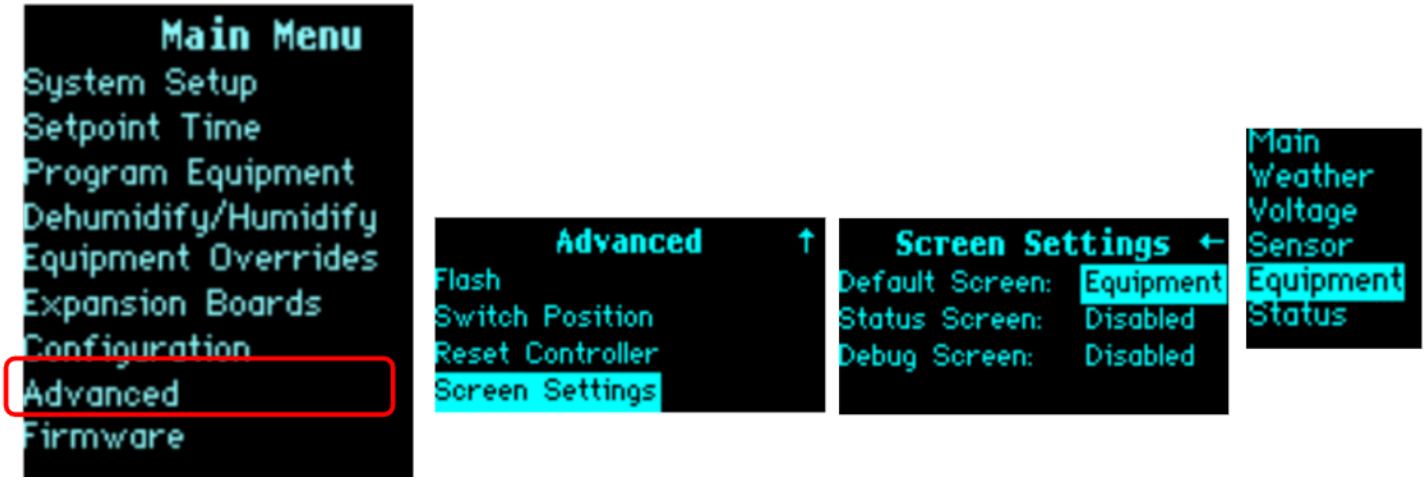
The first two options, “Configuration,” are Backup and Restore to and from an external USB stick. Remove the door to get to the USB port, located at the back of the controller. You can have multiple files to store all your configurations.

The next two options, “Config Flash,” are Backup and Restore to and from the controller itself. There can only be one configuration stored directly in the controller. No external devices are necessary.

** You can also save and restore multiple configurations via the Link4 Cloud.

6.11 Advanced

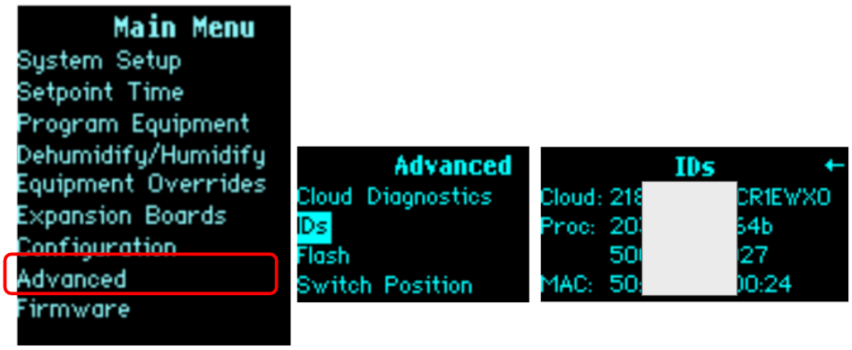
6.11.1 Main Home Screen



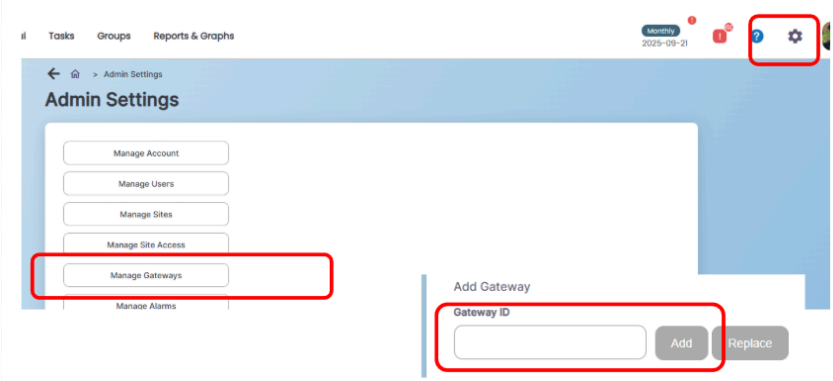
If you press BACK repeatedly, or, if the system has been idle for too long, it will revert to its HOME screen. The default HOME screen for the HydroRoot is the Equipment screen. However, this can be changed here.

6.11.2 System IDs

This section lists the Cloud ID, the Controller ID, and the Controller's MAC (Media Access Control) address.

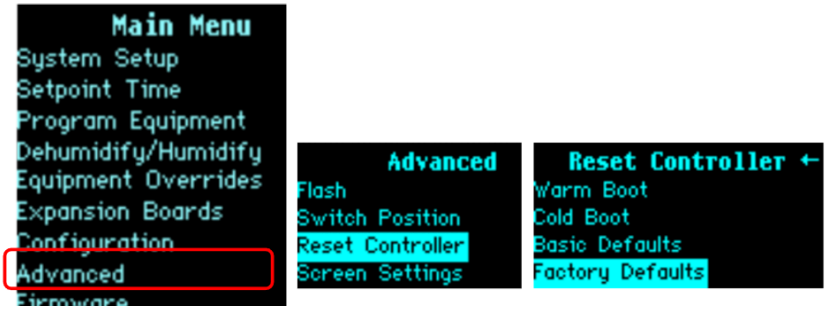


You need this information to connect the controller to the Link4 Cloud.



Enter the Cloud ID on the controller from the Advanced > IDs menu as the Gateway ID on the cloud.

6.11.3 Reset Controller



The HydroRoot can be reset to its Factory Default settings if necessary. All settings will be lost if this option is used. Before attempting this, always perform a configuration backup first, either locally (on a USB) or through the cloud.