



CIRRIG Automation

Real-time implementation of CIRRIG requires automation to control irrigation valves in the field. Currently, there are two approaches for interfacing output from CIRRIG with an irrigation control system.

1. Non-UF computer-controlled irrigation system

A software program is available that enables the user to automatically download at a selected time a *.csv file from CIRRIG that contains a user-defined reference valve number and an associated irrigation run time. Some technical representative of the computer-controlled irrigation system would have to do additional programming to transfer the values in the *.csv file into the computer-controlled irrigation system's own data base. This approach is currently being successfully used by a nursery in Virginia.

2. UF computer-controlled irrigation system

UF has developed an automated irrigation control system that integrates the output of CIRRIG with programmable logic controller (PLC) technology. Currently the system **works only with pressurized irrigation systems** – the UF system does not control irrigation pumps, just solenoid valves.

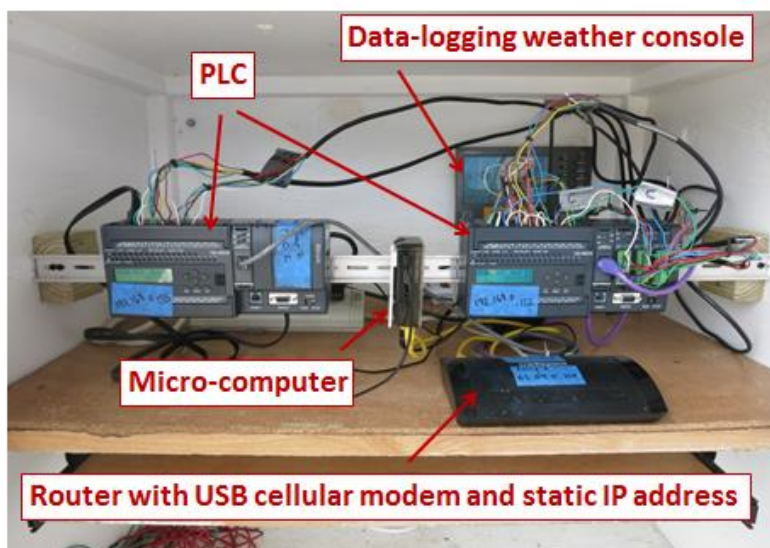


Fig. 1. A PLC system automatically irrigating 44 valves at one pump station at Hibernia Nursery in Webster, FL.

A description of the hardware and software required to run the system:

List of Hardware

1. PLC (D0-06DA, Automation Direct \$270) - controls 16 valves
 - a) communication module (ECOM-100, Automation Direct, \$200) – networking
 - b) 8-outlet module (DO-08TR, Automation Direct, \$64) – add 8 more valves*
2. Microcomputer (Raspberry Pi 3; Adafruit Industries, \$50) – Runs software controlling/monitoring one or more PLCs on the local network. It also runs software that interfaces with CIRRIG including weather data from a local weather station.
3. 24-VAC transformer (\$20) – energizes solenoid valves
4. Router and USB cellular modem with a static IP address (free with \$50/month service plan)

** 3 slots available for total of 40 valves total (16 + 3x8). 16 outlet modules are available but require additional powered relay boards. With 16-out modules a total of 64 valves can be controlled with one PLC. Other options are available but the above have worked well at several locations.*

Software **GUI** A UF-designed graphical user interface (GUI) allows the user to remotely control and monitor the PLC irrigation system. Each local network with a static IP address will have a designated GUI that can control one or more PLC on the same network. When initially set up, the user logs in under an account and adds one or more PLCs using the 'Add Irrigator' box and choosing the 'CirrigPLC' irrigator type. Other information needed is the IP address of the PLC on the local network and the number of outlets (valves) it will control.

Once a PLC irrigator is added, a home ("options") page appears. On this page the user selects the maximum number of valves to run at one time, designates the name of the .txt output file, and selects whether multiple groups can run at the same time. With this page, the user can create zone groups and once created, can assign outlets to each group. In the figure below, the zone group 'UF 7-gal Vib od' with 18 valves has already been created. On the home page to the right, there is an irrigator outlet power display that allows the user to manually turn on and off each valve. It also allows the user to monitor outlet status as the "Off" will turn to "On". Other functions at the bottom include:

Apply Must be used to apply and save any changes made on the screen

Abort Cancels any on-going PLC activity

Clear Removes any irrigation runs from the queue

Init Reinitializes the network connection

Delete Irrigator removes the PLC irrigator

Change IP change IP address of the PLC irrigator

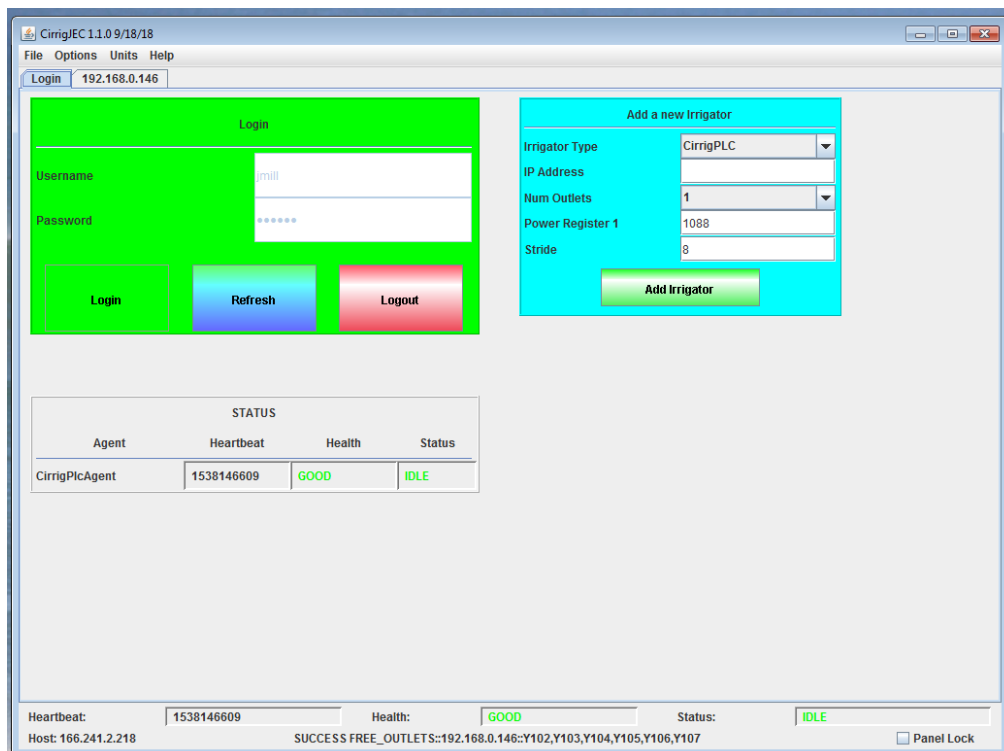


Fig. 2. Login page of GUI controlling one or more PLCs on a given network.

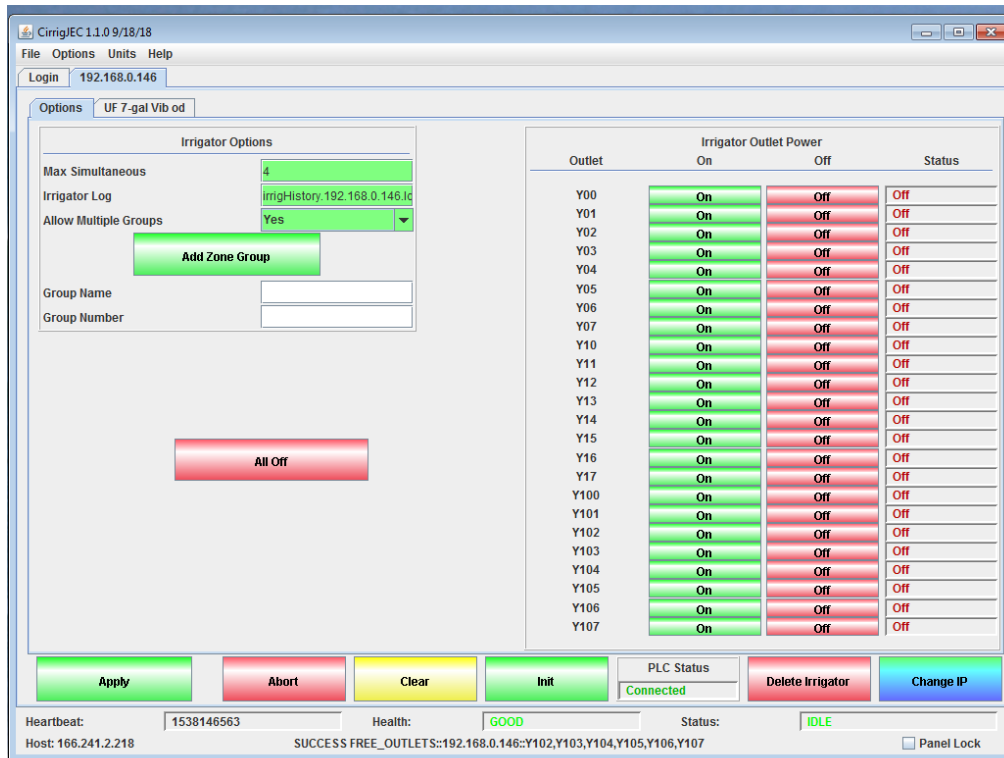


Fig. 3. Home page of a PLC at UF that has a 192.168.0.146 local IP address.



Fig. 4. Example zone group page “Micro Area”. A drop-down menu is shown that allows the user to assign a CIRRIG zone to the Y00 outlet.

After creating a zone group, the user assigns CIRRIG zones to each outlet (Fig. 4). A list of all **CIRRIG zones** in the user’s account will appear in the drop down menu. Other options beside CIRRIG zones include ‘None’ or ‘Fixed Manual Default’. If ‘None’ is selected, the outlet will not run. If ‘Fixed Manual Default’ is selected, a fixed value designated in the ‘Manual Def’ box will be run. Each outlet has a manual on/pause/resume/stop panel. For a manual timed run, the timer value entered can be started by clicking the ‘Start’ button. Other values input for each outlet include:

Rate Irrigation application rate (should match CIRRIG rate)

Default determines how irrigation amount will be decided if CIRRIG output cannot be acquired

Other features for each zone group include:

Max simultaneous The maximum number of outlets that can run at one time. This value cannot exceed the maximum value designated on the PLC irrigator home page. If the number of zones exceeds the max number then zones will be placed in a queue such that as soon as one zone stops, the next zone in the queue will start. If multiple zone groups allowed, the queue may include zones from the next zone group scheduled to start.

Free outlets Displays any free outlets that can be added

N cycles Select the number of irrigation cycles to run each day and start times can be selected for each cycle.

Cycle mode Select 'Continuous' which calculates run times just prior to the irrigation start time (the other option 'daily' is a little-used mode that calculates run times only once at the beginning of the day).

Mode Select 'Remote' so that run time output will come from CIRRIG server calculations but default to local (Raspberry Pi microprocessor) calculations if internet connection is lost. Select 'Local' if internet connection is not available.

System Check All zones in the zone group will run for the specified number of minutes following the queue rules described above under "Max simultaneous" feature. This feature is designed to allow staff to check the irrigation system. It could also be used for scheduling a custom irrigation event.

Rename Zone Group renames a zone group

Delete Zone Group removes a zone group

GUI output

There are three different outputs that can be used to review activity of each PLC.

1) PLC log text output - provides time-line detailed information

```
Sep 01 09:00:42 LT: Irrigation turned DISCONNECTED. Error - Could not read camera for outlet 0 (name=Y00, zone=Zone 1: W1 - NRS - Oakleaf H) to 1.167056 cm; timer = 365.33926 sec
Sep 01 09:00:46 LT: Setting irrigation outlet 0 (name=Y00, zone=Zone 1: W1 - NRS - Oakleaf H) to 1.167056 cm; timer = 365.33926 sec
Sep 01 09:00:47 LT: Irrigation outlet 0 (name=Y00, zone=Zone 1: W1 - NRS - Oakleaf H) turned ON
Sep 01 09:00:47 LT: Setting irrigation outlet 1 (name=Y01, zone=Zone 2: W2 - Burford Holly) to 0.583528 cm; timer = 182.66963 sec
Sep 01 09:00:49 LT: Irrigation outlet 1 (name=Y01, zone=Zone 2: W2 - Burford Holly) turned ON
Sep 01 09:00:49 LT: Setting irrigation outlet 2 (name=Y02, zone=Zone 3: W3 - Burford Holly) to 0.583528 cm; timer = 182.66963 sec
Sep 01 09:00:51 LT: Irrigation outlet 2 (name=Y02, zone=Zone 3: W3 - Burford Holly) turned ON
Sep 01 09:00:51 LT: Setting irrigation outlet 3 (name=Y03, zone=Zone 4: W4 - Burford Holly) to 1.0698013 cm; timer = 334.89432 sec
Sep 01 09:00:53 LT: Irrigation outlet 3 (name=Y03, zone=Zone 4: W4 - Burford Holly) turned ON
Sep 01 09:03:52 LT: Irrigation outlet 1 (name=Y01, zone=Zone 2: W2 - Burford Holly) turned OFF
Sep 01 09:03:52 LT: Total irrigation time outlet 1 (name=Y01, zone=Zone 2: W2 - Burford Holly) = 3 minutes and 3 seconds.
Sep 01 09:03:54 LT: Setting irrigation outlet 5 (name=Y05, zone=Zone 17: Y 1/2/3 - NRS) to 1.9510808 cm; timer = 206.40292 sec
Sep 01 09:03:54 LT: Irrigation outlet 2 (name=Y02, zone=Zone 3: W3 - Burford Holly) turned OFF
Sep 01 09:03:54 LT: Total irrigation time outlet 2 (name=Y02, zone=Zone 3: W3 - Burford Holly) = 3 minutes and 3 seconds.
Sep 01 09:03:54 LT: Irrigation outlet 5 (name=Y05, zone=Zone 17: Y 1/2/3 - NRS) turned ON
Sep 01 09:03:56 LT: Setting irrigation outlet 6 (name=Y06, zone=Zone 18: Y4/5 - Wax Myrtle) to 3.785679 cm; timer = 412.733 sec
Sep 01 09:03:57 LT: Irrigation outlet 6 (name=Y06, zone=Zone 18: Y4/5 - Wax Myrtle) turned ON
Sep 01 09:06:28 LT: Irrigation outlet 3 (name=Y03, zone=Zone 4: W4 - Burford Holly) turned OFF
Sep 01 09:06:28 LT: Total irrigation time outlet 3 (name=Y03, zone=Zone 4: W4 - Burford Holly) = 5 minutes and 35 seconds.
Sep 01 09:06:30 LT: Setting irrigation outlet 7 (name=Y07, zone=Zone 19: Y 6/7 - NRS) to 4.1933675 cm; timer = 371.45972 sec
Sep 01 09:06:31 LT: Irrigation outlet 7 (name=Y07, zone=Zone 19: Y 6/7 - NRS) turned ON
Sep 01 09:06:52 LT: Irrigation outlet 0 (name=Y00, zone=Zone 1: W1 - NRS - Oakleaf H) turned OFF
Sep 01 09:06:52 LT: Total irrigation time outlet 0 (name=Y00, zone=Zone 1: W1 - NRS - Oakleaf H) = 6 minutes and 5 seconds.
Sep 01 09:06:54 LT: Setting irrigation outlet 8 (name=Y10, zone=Zone 21: Y 8/9 W - Green Giant Thuja) to 3.9371061 cm; timer = 412.74265 sec
Sep 01 09:06:55 LT: Irrigation outlet 8 (name=Y10, zone=Zone 21: Y 8/9 W - Green Giant Thuja) turned ON
Sep 01 09:07:21 LT: Irrigation outlet 5 (name=Y05, zone=Zone 17: Y 1/2/3 - NRS) turned OFF
Sep 01 09:07:21 LT: Total irrigation time outlet 5 (name=Y05, zone=Zone 17: Y 1/2/3 - NRS) = 3 minutes and 27 seconds.
Sep 01 09:07:22 LT: Setting irrigation outlet 9 (name=Y11, zone=Zone 20: Y 8/9 E - Leyland Cypress) to 0.81130016 cm; timer = 82.55174 sec
Sep 01 09:07:23 LT: Irrigation outlet 9 (name=Y11, zone=Zone 20: Y 8/9 E - Leyland Cypress) turned ON
Sep 01 09:08:46 LT: Irrigation outlet 9 (name=Y11, zone=Zone 20: Y 8/9 E - Leyland Cypress) turned OFF
Sep 01 09:08:46 LT: Total irrigation time outlet 9 (name=Y11, zone=Zone 20: Y 8/9 E - Leyland Cypress) = 1 minutes and 23 seconds.
Sep 01 09:08:48 LT: Setting irrigation outlet 10 (name=Y12, zone=Zone 23: Y 10/11 W - Easton Holly) to 2.10521 cm; timer = 246.62402 sec
```

2) PLC html output each cycle - time-line output for each irrigation cycle

Day	Date	Group	Time Finished	PLC	Outlet	Zone	Name	Plant	RT	Water
Fri	Sep 28	1	12:32:59	Y116	30	41	Z 11/12 E	Ligustrum Wax	9m 3s	0.995 gal
Fri	Sep 28	1	12:32:27	Y120	32	43	Z 13/14 E	Ligustrum Recurves	6m 47s	0.791 gal
Fri	Sep 28	1	12:29:22	Y117	31	44	Z 13/14 W	Ligustrum Wax	5m 17s	0.528 gal
Fri	Sep 28	1	12:28:27	Y113	27	40	Z 9/10 W 7gal	Ligustrum Wax	8m 34s	0.856 gal
Fri	Sep 28	1	12:25:36	Y115	29	42	Z 11/12 W	Burford Holly	4m 4s	0.406 gal
Fri	Sep 28	1	12:24:02	Y114	28	39	Z 9/10 E - 7gal	Ligustrum Jack Frost	3m 19s	0.331 gal
Fri	Sep 28	1	12:23:52	Y112	26	38	Z 7/8	Burford Holly	4m 5s	0.469 gal

3) html output daily summary – total daily output (sums output for multiple cycles)

Day	Date	Group	Zone	Name	Plant	Tot RT	Water
Thu	Sep 27	1	43	Z 13/14 E	Ligustrum Recurves	21m 33s	2.514 gal
Thu	Sep 27	1	41	Z 11/12 E	Ligustrum Wax	28m 46s	3.164 gal
Thu	Sep 27	1	40	Z 9/10 W 7gal	Ligustrum Wax	27m 18s	2.73 gal
Thu	Sep 27	1	44	Z 13/14 W	Ligustrum Wax	16m 46s	1.676 gal
Thu	Sep 27	1	42	Z 11/12 W	Burford Holly	12m 57s	1.295 gal
Thu	Sep 27	1	38	Z 7/8	Burford Holly	12m 57s	1.489 gal
Thu	Sep 27	1	39	Z 9/10 E - 7gal	Ligustrum Jack Frost	6m 4s	0.606 gal
Thu	Sep 27	1	36	Z 2/3/4	#7 Ligustrum	18m 43s	1.678 gal
Thu	Sep 27	1	37	Z 5/6	Ligustrum Recurves	12m 57s	1.510 gal

For more detailed information about automation contact:

The GUI also sends output to CIRRIg which can be viewed for each zone in ‘My Zones’.

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