OpenSprinkler Pi (OSPi) v1.4x/v1.5 User Manual

(*Updated June 1, 2020*)

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OpenSprinkler

Introduction

OpenSprinkler Pi (OSPi) is an open-source sprinkler / irrigation extension board for the Raspberry Pi. It's an easy and low-cost solution to transform your Raspberry Pi into a capable sprinkler controller with unlimited number of stations, for lawn and plant watering, farm irrigation and other similar applications.

The OSPi v1.4x/v1.5 kit includes a set of laser cut acrylic **enclosure**, one assembled and tested **OSPi circuit board** and **terminal blocks**. The built-in components include 24VAC to 5VDC switching regulator, solenoid drivers, PCF8591T 8-bit ADC converter (4 input and 1 output), per-station transient voltage protector. **NOTE**: from version 1.44 onward, the real-time clock (RTC) and battery in previous versions have been removed, as the firmware never uses these components.

To get started, you will also need the following, which are NOT included by default and need to be purchased separately.
- a Raspberry Pi (any version)
- a nano-size USB WiFi dongle (optional, if your RPi does not have built-in WiFi)
- a 4GB or above microSD card
- 24V AC sprinkler transformer (output voltage 24V AC -- note that it's AC, not DC!)
  - Note: if you plan to use RPi 3 or 4: due to the rather high power consumption of these RPis, you may need an additional USB adapter to power RPi directly through its microUSB port.
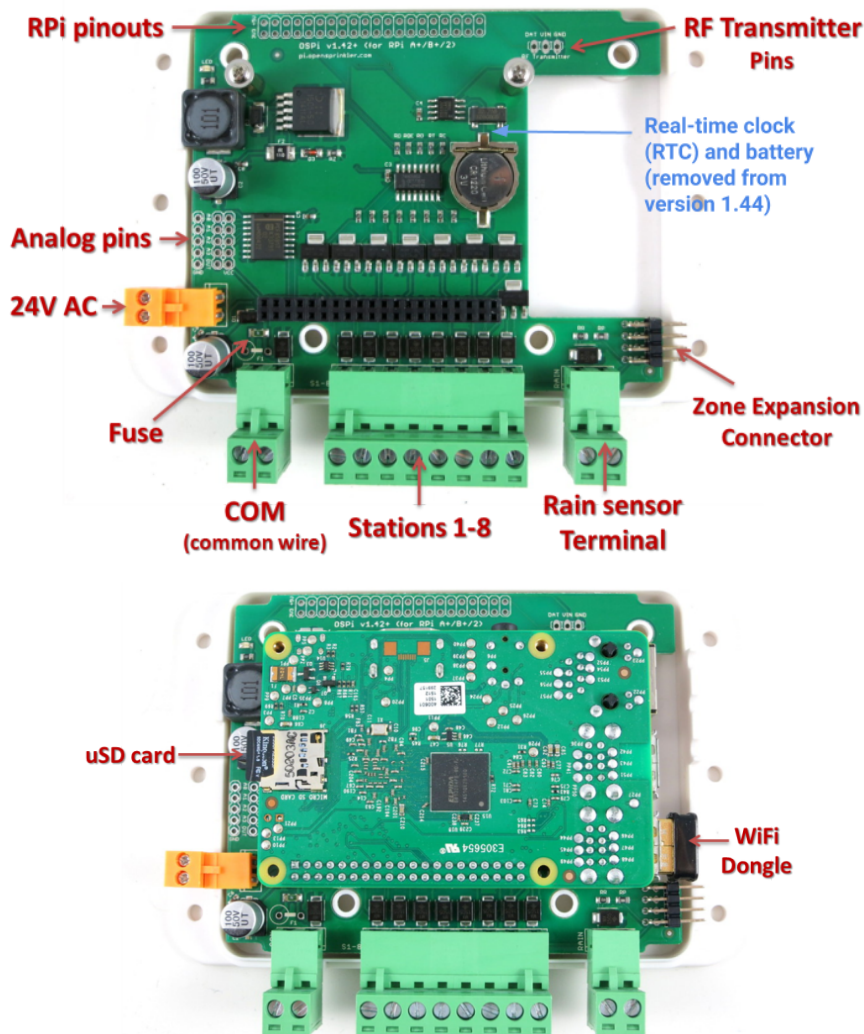- 24V AC sprinkler valves (note that it's 24V AC valve, not DC or latching solenoid valve!)
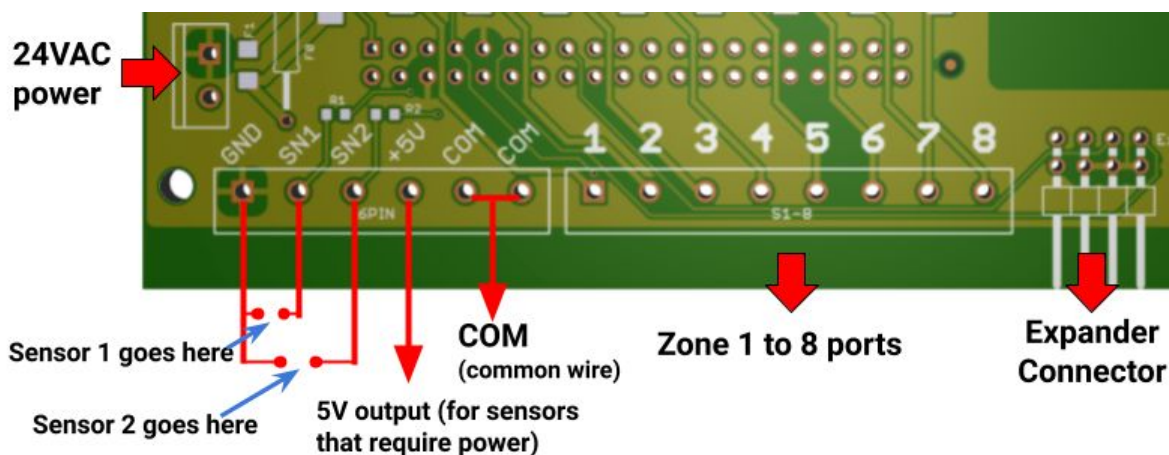
(Sold separately)

Hardware Interface

The images below show the OSPi hardware interface, including the connectors and terminal pins, and the whole assembly with RPi plugged in. Note that the terminal pins on version 1.5 have changed, including an added sensor 2 (SN2) port.

Version 1.4x:

Version 1.5:

0. Preparation

OSPi 1.4x/v1.5 comes with a laser-cut acrylic enclosure. **Enclosure assembly instructions can be found in this Youtube Video**. You can do so either before or after the following setup steps.

- From version 1.44, the real-time clock (RTC) and battery have been removed.
- If terminal blocks are pre-installed, you need to **first remove all terminal blocks before assembling the acrylic enclosure**.
- In some kits, the acrylic pieces may be replaced by 3D printed versions (*this is due to shortage of acrylic supply that occurred during the COVID-19 pandemic).

1. Test Power Supply First

Make sure the sprinkler transformer is unplugged to begin with. Insert the sprinkler transformer wires into the **orange** terminal block, tighten the terminal block screws. Then plug the orange terminal into the matching terminal on OSPi. The green LED should light up, indicating power is on. See pictures below.
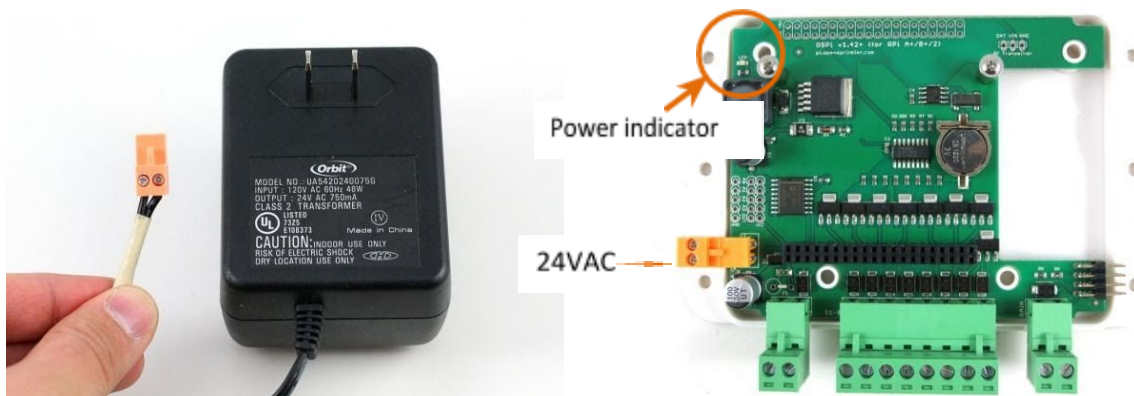
Warning: if the LED doesn't light up, please unplug the power immediately. If you can't figure out the problem, contact the support at support.opensprinkler.com

2. Attach RPi to OSPi

OSPi has two support pillars (positions marked in the left image below) that match the screw holes on RPi (except RPi 0 which doesn't have these screw holes). **First, install the support pillars to the OSPi board** (note: in some kits these support pillars are replaced by **3D printed version**, in which case just plug those in firmly into the OSPi board, no screws needed); then, plug RPi into OSPi through the 2x20 pin headers, with SD card slot facing the left, and USB and Ethernet jack facing the right. **Double check the orientation and make sure all pins are aligned**. **Any misalignment may result in damage to RPi!** The two screw holes should also match the positions of the two support pillars. Insert RPi all the way to the end. The USB and Ethernet connector should go through the cutouts on the PCB.
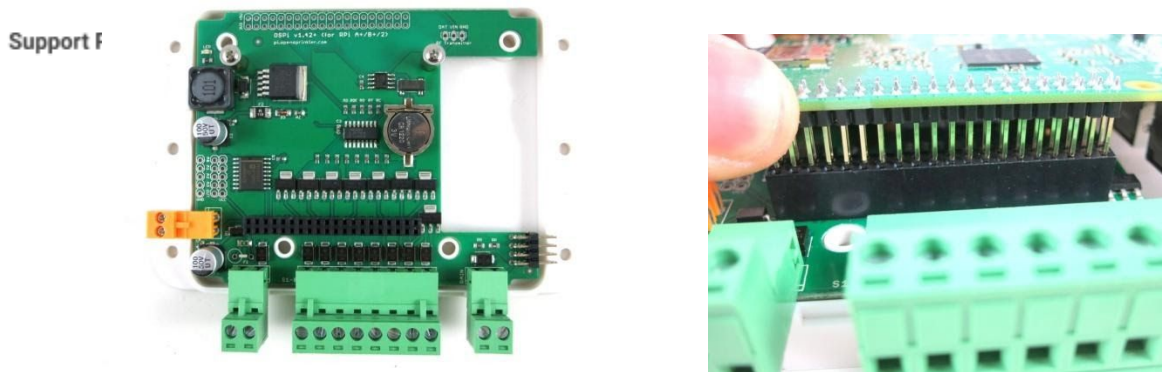
3. Web Connectivity

OSPi fits a nano-size USB WiFi dongle. You can insert the dongle into any of the available RPi USB ports. If you prefer wired connection, there is no special cutout for the Ethernet cable, you can take out one side panel of the laser-cut acrylic enclosure, or alternatively use a Dremel to make a cutout yourself, in order to allow Ethernet cable to pass through.

If you use RPi 3 or 4 and notice dropped performance of built-in WiFi, you probably need to use a separate USB power adapter to power it directly from its microUSB port. You can take out one of the side panels to allow the microUSB cable to pass through.

4. Wiring Sprinkler Valves

To connect one sprinkler valve, insert one wire to the **COM** (common) terminal, and the other wire to any of the station terminals (1-8). The COM terminal has two ports – they are internally connected so either port is fine. To connect multiple valves, one wire from each valve should come together and go to the **COM** terminal; and the other wire from each valve goes to an individual station terminal. See the diagram below.
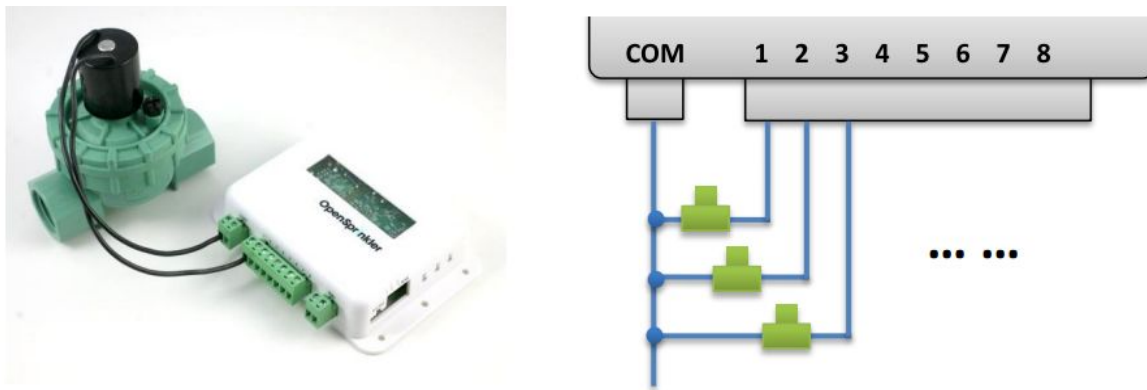
5. Zone Expansion Board

To connect a zone expansion board, use the extension cable you received to link the OSPi's *OUT* port to the expansion board's *IN* port. The connector on the cable is polarized (with a bump on the top), so there is only one way to plug it. If you have multiple expansion boards, you can daisy chain them in the same way, by following the OUT -> IN links.

When using zone expansion boards, the sprinkler valves are wired the same way as before: one wire from each valve should come together and go to the **COM** terminal on the OSPi; and the other wire from each valve goes to an individual station terminal. Refer to the diagram below:
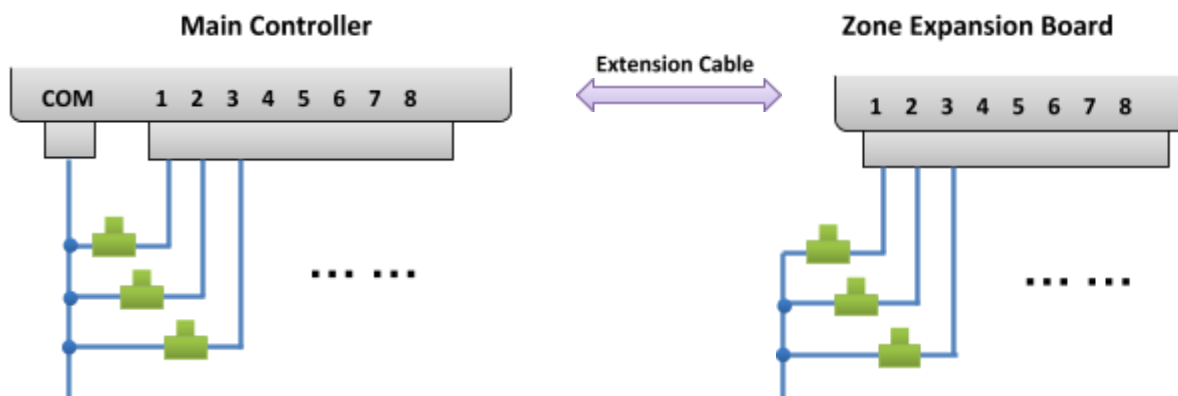
6. Rain Sensor / Flow Sensor / Program Switch

If you have a rain sensor, you can connect it to OSPi via the rain sensor terminal. The rain sensor has two wires and is essentially a rain-activated switch. The OSPi software can decide what to do when rain is detected, such as turn off stations or ignore rain. The latest OpenSprinkler also supports using the sensor terminal to connect a flow sensor, or program switch. Please refer to the **OpenSprinkler User Manual** Sensors Section for details.

7. Analog-Digital Converter (Advanced Topic)

OSPi has a built-in PCF8591T A/D D/A converter, which provides four 8-bit analog inputs, and one analog output. The analog inputs can be used to read analog sensors, such as light, temperature, soil humidity. Details on how to use this converter can be found in this blog post.

8. Radio Frequency (RF) Transmitter (Advanced Topic)

The current OSPi has a 3-pin header that fits a 433MHz or 315MHz radio frequency (RF) transmitter. This allows you to use OSPi to communicate with RF wireless power sockets. Please refer to the **OpenSprinkler User Manual** RF Transmitter Section for details.

Software Setup

1. Install OpenSprinkler Unified Firmware

The recommended way to install OpenSprinkler Firmware is to start from a standard Raspbian image, make sure you can boot RPi correctly, then follow the OSPi firmware installation instructions below to install the firmware yourself:

- **OSPi Firmware Installation Instructions**

NOTE: some Raspbian systems installed by NOOBs will take over GPIO 4 for 1-wire interface, but that OSPi needs GPIO 4 to send control signals to the solenoid valves. If you found that the firmware runs correctly but OSPi does not turn on valves correctly, one solution is to sudo open `/etc/modules`, and comment out the line containing `w1-gpio`, then reboot. Another solution is to reinstall Raspbian OS from scratch without using NOOBs.

The previous OSPi pre-configured SD card image is retired -- we no longer provide pre-configured SD card image because it's relatively easy to install a fresh Raspbian and follow the instructions above to install the OpenSprinkler firmware.

2. Using OSPi Firmware

The default firmware set to run on start-up is the OpenSprinkler Unified Firmware. It's available at **port 8080**. Open a browser, and type in ***http://ospi_ip:8080/*** to start using the firmware, where ospi_ip is your OSPi's local IP address. Details about the OpenSprinkler Unified Firmware can be found in the OpenSprinkler Firmware User Manual:

- **OpenSprinkler User Manual**

The two alternative firmwares are the Python Interval Program (written by Dan Kimberling) and the sprinklers_pi program (written by Rich Zimmerman). Please refer to their specific Github repositories for installation and usage instructions.

If you want to write your own firmware, use the provided firmwares as starting point. In addition, in the OSPi Github folder, there are a few demo programs that shows basic solenoid control in various programming languages.

Technical Details

RPi Pin Uses

OSPi uses the following GPIO pins on the RPi (shaded in red, blue, and yellow colors below). The other pins are free. The power pins as well as SDA/SCL pins can be shared with other devices. All 40 pins from RPi are mapped out in the pinout area at the upper left corner of the OSPi circuit board. The layout of the mapped out pins match the RPi GPIO pins.
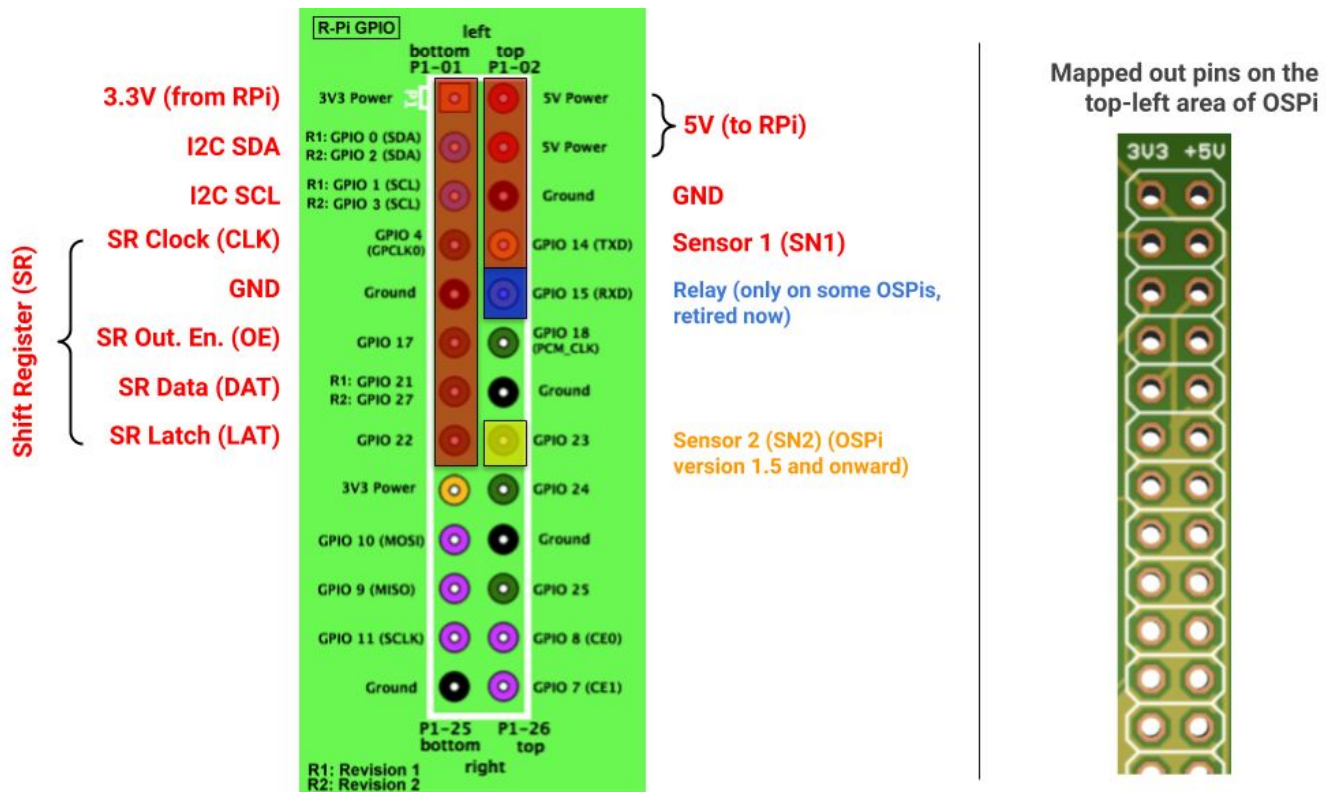
Specifications

- **Input Voltage:**   22V AC to 30V AC.
- **DC Output Current:**   500mA @ 5V (to power RPi).
- **Number of Zones:**   8 on the OSPi, expandable by linking zone expansion boards.
- **AC Output Current:**   800mA continues @ 24V AC per zone / station, 8A impulse / inrush.
- **Over-voltage Protection:** 48V bi-directional TVS on each zone, AC input, and rain sensor terminal.
- **Size:**   135mm x 100mm x 32mm (5.3" x 4" x 1.26")
- **Weight:**   150g (5.3oz) w/o RPi

Terms and Conditions

OpenSprinkler Pi (OSPi) is an open-source project. The hardware design and software code are made publicly available under the [Creative Commons Attribution-ShareAlike (CC BY--SA) 3.0](#) license. The product is open-source for educational purpose and to promote innovations. The hardware and software are provided as is. We (OpenSprinkler) are not responsible for any damage or accident that may occur due to hardware or software error, or during the assembly, use, and modification of OSPi.

Open-Source Links

- [OSPi Github Repository](#)
- [OpenSprinkler Firmware Github Repository](#)
- [OSPi homepage](#)