vinduino

Vinduino User Manual

Draft version July 30,2016
Updated August 4, 2016

vinduino

Table of contents

vinduino

Introduction

Vinduino remote sensor platform for optimizing agricultural irrigation

The Vinduino R3 sensor station contains all the electronics needed for a solar powered remote sensor platform. It is designed for optimizing agricultural irrigation, aimed at saving 25% irrigation water. This board represents the 3rd generation design of our remote sensor platform, and has gone through extensive vineyard field trials.

Features:

- Arduino based, easy to customize programming
- 4 electrically separated inputs for soil moisture sensors
- Supports Wifi (ESP8266, not included) or Globalsat LM-210 LoRa module for long range
- Irrigation valve control output
- Several options for temperature/humidity sensors
- Solar battery charger
- Real time clock for sleep mode power saving and precise irrigation timing
- Load switch for actuators or sensors that require electric power

Supported sensors:

- Vinduino soil moisture sensor
- Watermark SS200 soil moisture sensor
- DHT11, DHT22
- DS18b20

The Vinduino board is designed for continuous unattended operation. It can be powered by a small solar panel, and the battery charger maintains a Li-ion battery fully charged, to keep the system working during the night and during periods with dense cloud cover. The battery voltage can be monitored remotely to check battery health.

The LM-210 module requires a compatible gateway, and is designed for LoRa LAN.

Scope

This user manual covers use and installation of the Vinduino R3 remote sensor station and the Vinduino Gateway

Disclaimer

Always use multiple data sources, appearance of your crop, and common sense when making irrigation decisions. Vinduino LLC is not responsible for crop yield results.

Sensors

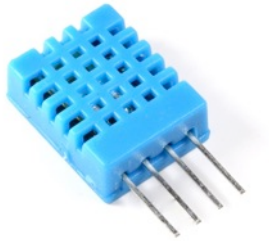
The Vinduino R3 is designed to support up to 4 resistive soil moisture sensors. These can be gypsum sensors, like the Vinduino sensor shown below, or commercial sensors like the Watermark SS200 granular matrix sensor.

The Vinduino design uses short alternating electrical pulses to measure the resistance of the sensor, which is a measure of the water content of the soil. A low resistance indicates high moisture, whereas a high resistance value indicates low water availability. The resistance is expressed in Ohm, and can be used in combination with a calibration chart to determine water content.

Vinduino calibration chart to be inserted here at next document update

For Watermark SS200 sensors, calibration is well documented (Shock et all) and available on-line:
http://www.kimberly.uidaho.edu/water/swm/Calibration_Watermark2.htm

The Vinduino remote sensor station has the option to support other types of sensors. Here is a list of sensors that have been tested to work with the Vinduino:



DHT11 air temperature and humidity sensor,
temperature accuracy 2%, RH accuracy 5%

DHT22 air temperature and relative air humidity sensor
temperature accuracy 0.5%, RH accuracy 2%

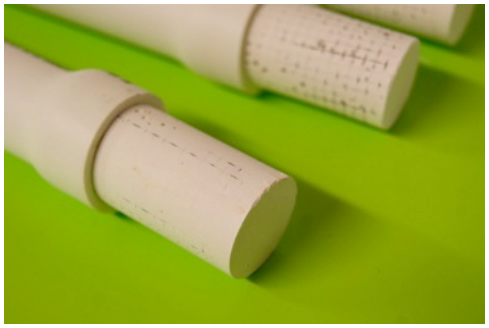
DS18b20 waterproof 0.5% accurate digital temperature sensor
3 wire interface (Red =Vcc, Black =ground, Yellow=data out)

The choice of sensors needs to be agreed when ordering, as the Vinduino R3 programming and Internet interface needs to be configured to support the selected sensors. Sensors can be added later, and the supporting software can be upgraded in the field.

Sensor installation

The installation of sensors needs preferably be done at least two weeks before the anticipated activation of the remote sensor station.
The Vinduino project uses 4 soil moisture sensors at different depths per location to determine the percolation of irrigation water in the soil.
For wine grapes, the recommended installation depths are 1 foot, 2 feet, 4 feet, and 5 feet.
The sensor at 5 feet is to be considered below the active root zone, and should show low moisture levels as drainage of irrigation water below 4 feet is out of reach of the grapes.

Ideally, all sensors should be vertically aligned close to an irrigation dripper.
For easy maintenance and replacement, 1“ PVC pipe is recommended to mount and install the sensor at the desired depth. Keeping 1’ of pipe above ground helps avoid wildlife damage to the electrical wiring.



TIP:
For Vinduino sensors, PVC pipe can be widened after applying hot air with a heat gun. After inserting the sensor, re-heating with shrink the pipe to tightly fit around the sensor.

Gypsum sensors need a good soak before installation in the soil. To ensure good soil contact, put some soil slurry in the hole and make sure that the sensor is well settled into the slurry before filling up with soil.
Link to sensor installation guidelines:
http://mea.com.au/upload/new/product_brochures/b83_soil-moisture_sensor_installation_guide_web.pdf

Vinduino R3, remote sensor station

Solar power

The remote sensor station is designed for continuous unattended operation. It is powered by a small solar panel, and the battery charger keeps the battery fully charged to keep the system working during the night and during periods with dense cloud cover. A green LED on the electronics board indicates that the charger is operational.
The battery voltage is measured and sent together with the sensor data. A healthy battery should provide a voltage between 4.2V and 3.6V. Below 3.6V, the battery is close to empty.

The battery connector is also used to switch the system on or off. Disconnect the solar panel before disconnecting the battery to avoid the system continuing on solar power.

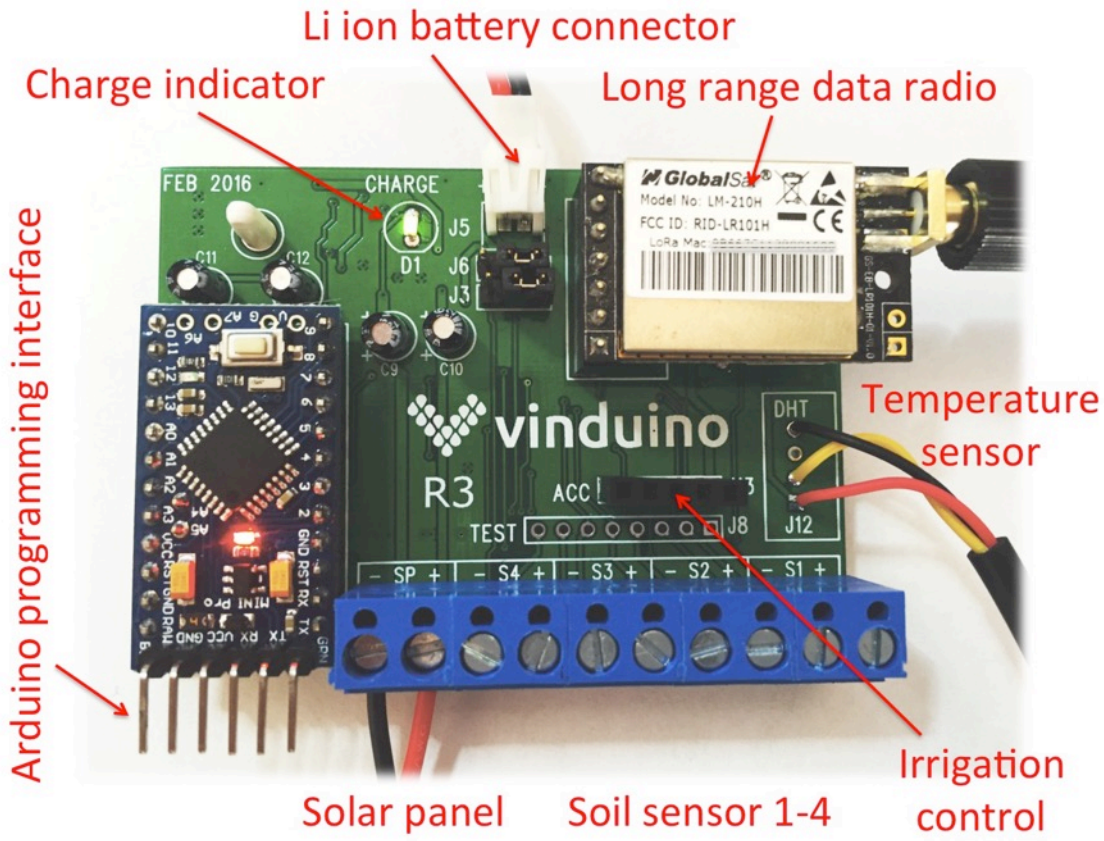
Important: the solar panel is connected to the wire terminal block. The red wire connects to the "+", and the black wire connects to the "-". Connecting the solar panel with the wires with reversed polarity will damage the battery charging chip.

Connecting sensors

The Vinduino R3 has inputs for 4 soil sensors. The soil sensor wires connect to the wire connection block. Sensor 1 wires are connected on the right side. The type of wiring is not critical for the accuracy or performance of the soil moisture measurement.

The printed circuit board is designed to support a DHT11 or DHT22 sensor (temperature and relative humidity). These sensors are not waterproof and can only be used for measuring inside the enclosure.
For temperature measurement outside the enclosure, soil or air temperature, a waterproof temperature sensor like the DS18b20 can be used.

Other sensors can be attached using the "Accessories" connector on the electronics board. This connector gives access to 2 digital pins, an analog input, and a switched 3.3V power supply pin that can be used for sensors that require electric power.
Future use of the accessories connector is to control an irrigation valve and water pressure sensor.



Timer

The Vinduino R3 has an integrated clock chip that is used to wake up the system from power saving sleep mode. After the Vinduino is done with making measurements and transmitted the measurement data, it goes back to sleep again.
During the active mode, a LED on the Arduino board lights up.
Typically, the timer is programmed for 15 minutes or one hour. When many remote sensor stations share one gateway, it is better to have longer interval times to avoid “crowding” of the radio frequency.

The timer can also be used (future) for precision irrigation timing, or keeping system time.

LM-210 radio module

The telemetry radio unit used in the Vinduino project follows the recent LoRa standard, which allows long range wireless networking. The unit is FCC approved in the USA for license-free use in the 915 MHz band.
Range is dependent on the conditions. With the supplied antennas typically 1-3 miles is possible. With line-of-sight and external antennas, considerable longer distances are possible.

The unit can be re-programmed for different output power levels and frequency. The default settings are 915 MHz and 100mW power. Frequency change is only needed in vase of strong local interference from other users of the frequency or in case of installation in Europe where 868MHz is used for LoRa.

The Vinduino sensor station is designed for supporting the LM-210. Before programming the Arduino microcontroller board with a USB adapter cable, the LM-210 module should be removed to avoid USB level voltages (5V) reaching the module.

Programming

In order to change the program code of the Vinduino, for instance to change the wake up time or change sensors, you will need a programming cable and Arduino PC software.
The USB programming cable is needed to connect to a PC
Please use the 3.3V version of the cable: http://amzn.com/B00DJBPIGI

The radio module needs to be removed before programming and connecting the programming cable.

Arduino programming software is available for free for most recent computer operating systems: https://www.arduino.cc/en/Main/Software

Vinduino programming code is available for download via Github:
https://github.com/ReiniervdL/Vinduino

Vinduino R3 installation and maintenance

The remote sensor station comes as a watertight NEMA enclosure. Sensor cables should enter the enclosure using a NEMA rated cable gland (supplied).
The unit can be mounted at an angle for the solar panel to get best exposure to the available sunlight. Best direction for the solar panel is facing South.

TIP: It is recommended to spray paint the transparent cover partially white to keep the temperature inside the enclosure lower. Leave the solar panel area clear.
This will improve the life of your battery.

Due to exposure to sunlight, the battery will be operating at high operating temperatures. It is therefore recommended to frequently check the battery for visible mechanical deformation, in which case replacement is needed. Annual replacement of the battery is recommended preventive maintenance for outdoors installations where the unit is in continuous operation.