

Instructions for building a 14 plot irrigation controller using an Arduino Mega

Step 1: Connecting a 16 relay module to the Arduino Mega

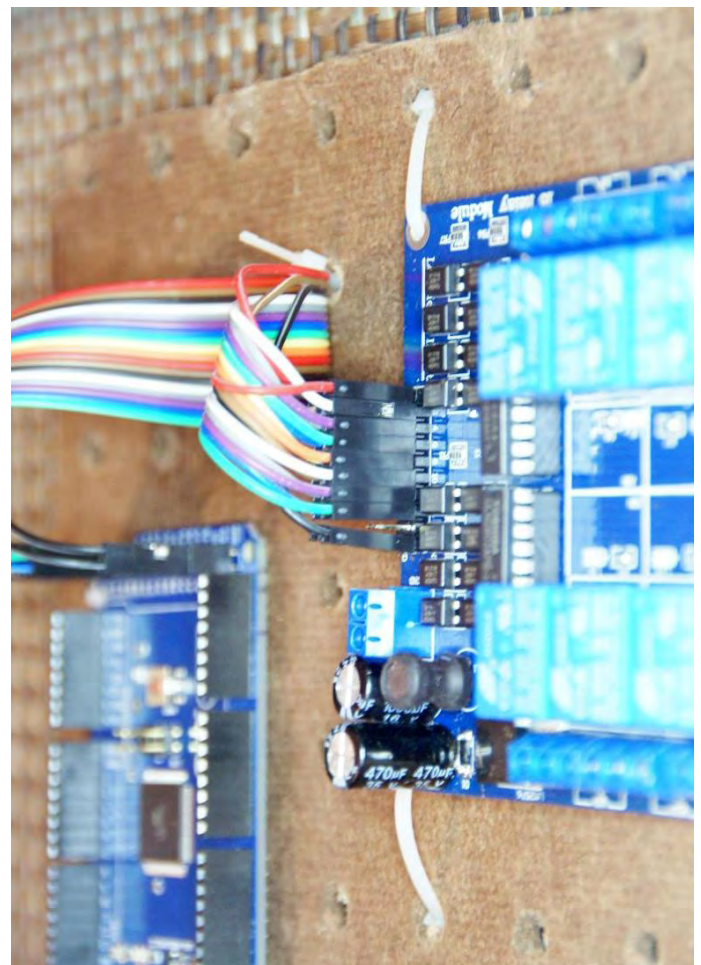
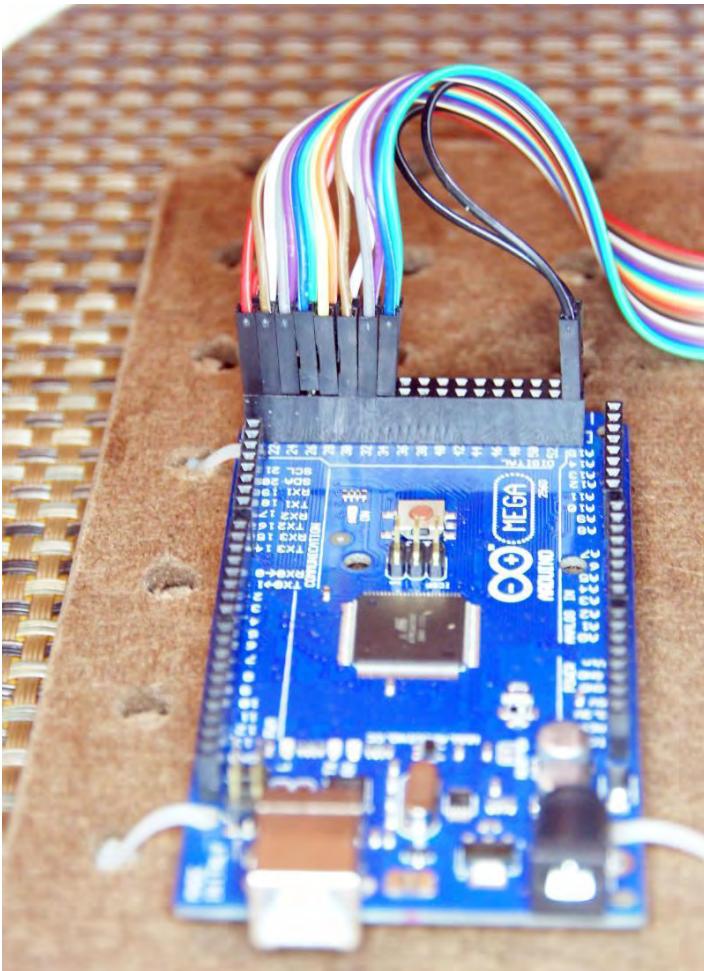
Note: the module has 16 relays, in this example we use only relay 1 - 14

Jumper cables: Ribbon wire (male – female) with 18 individual jumper wires. Color does not matter, but in these instructions, we use red wires for any power connections (+5 VDC) and black or green wire for ground connections.

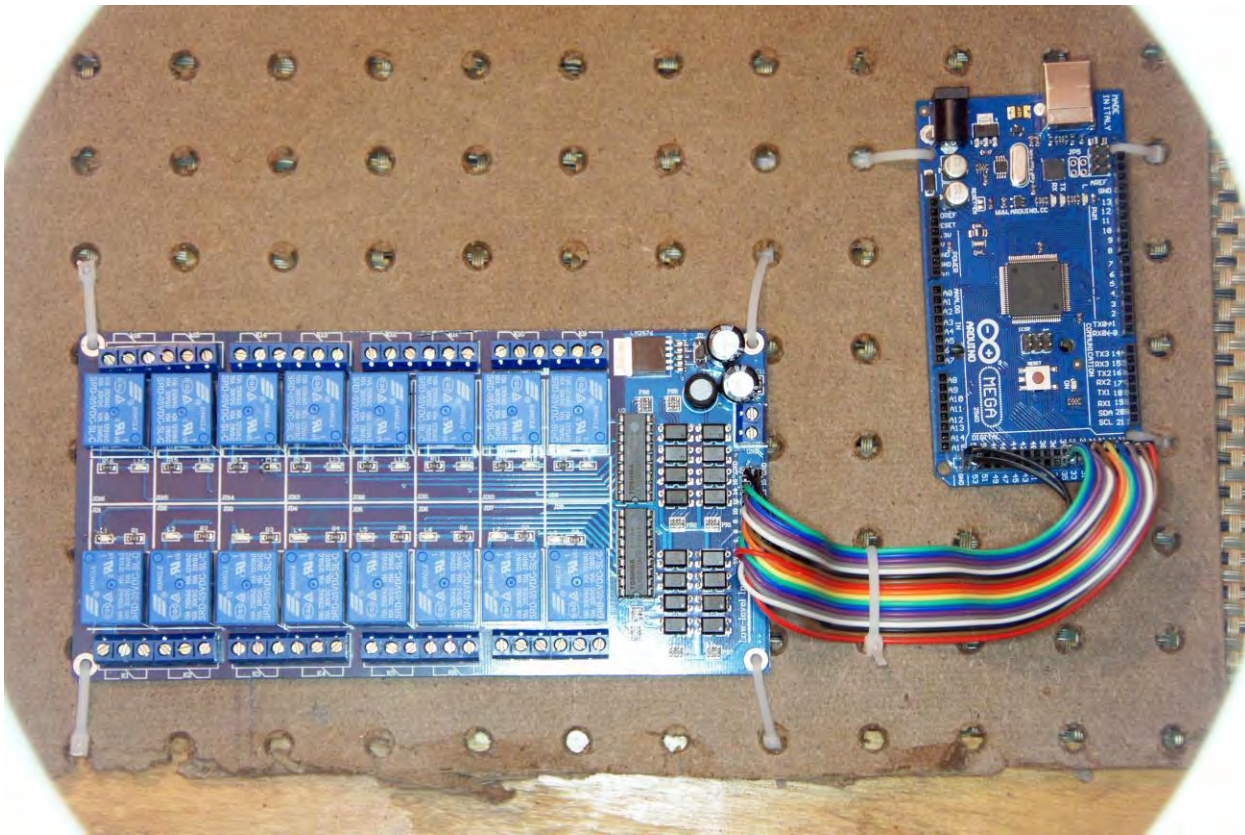
At the end of the Arduino Mega opposite from the USB and power input, you will find two ground pins (bottom left in picture below), two 5V pins (bottom right in picture) and digital pins D22 - D53 (note: pins 23, 25, 27, and 29 are not numbered on the board because of a lack of space).

Now make the following connections between the Arduino mega and the relay module:

- Two red jumper cables from 5V on the Arduino Mega to 5V on the relay module
- Two black jumper cables from Ground on the Arduino Mega to Ground on the relay module
- Fourteen jumper wires (various colors) from digital pin D22 - D35 on the Arduino Mega to pin 1 - 14 on the relay board. these wires must be in order: digital pin D22 to pin 1, digital pin D23 to pin 2, ... digital pin D35 to pin 14
- This will use all but pin 15 and 16 on the relay module.



This should now look like the picture below:



Step 2: Installing and connecting the Adafruit datalogging board

This board has two functions:

- It has an SD card holder and the SD card will be used to store all data collected by the system. Obviously, and SD card needs to be inserted for this to work
- The board has a 'real-time clock' (RTC) built in. This helps the system keep track of time. A small coin battery needs to be inserted into the battery holder. The system may malfunction without a battery, so it is best to never remove this battery. Keeping the battery inserted also assures that the RTC will be able to keep time even if the power to the system is disconnected. The RTC uses analog pins A4 and A5: these pins can thus NOT be used for anything else.

The datalogging board is designed to be plugged onto the Arduino Mega, which will make most (but not all) of the needed connections. Make sure to align all the pins correctly. For more information about this board see:

<http://learn.adafruit.com/adafruit-data-logger-shield/overview>.

Now we need to make four connections between the Arduino Mega and the datalogging board, using male-male jumper wires (again, colors do not matter, but are shown to clarify the connections in the picture).

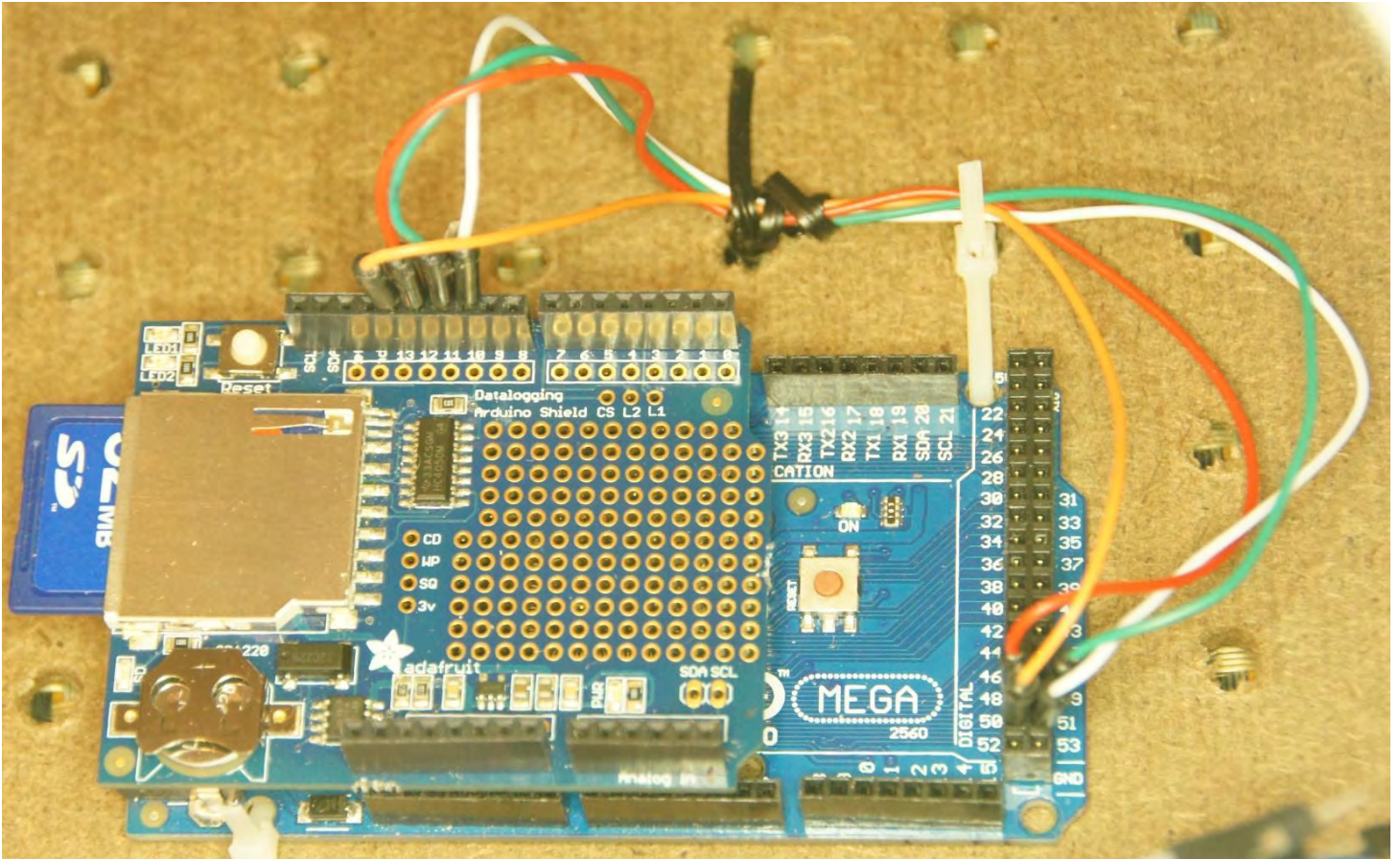
digital pin D51 on the Arduino to SD shield digital pin D11 (green)

digital pin D50 on the Arduino to SD shield digital pin D12 (red)

digital pin D52 on the Arduino to SD shield digital pin D13 (orange)

digital pin D53 on the Arduino to SD shield digital pin D10 (white)

These connections should look like the picture below (note: the relay module was disconnected for clarity, but should remain connected)



Step 3: Connecting the 10HS soil moisture sensors to the Arduino Mega

This is perhaps the hardest part, simply because there are so many wires that need to be connected. Things get very crowded here. It may be best to do this in the greenhouse, since portability of the setup with all sensors connected is not very good.

The 10HS sensors have three wires, red, white, and bare. The bare wires need to be connected to ground, the white wires provide power to the sensor, and the red wires provide a voltage output that will be measured by the Arduino. Number the sensors 1 - 14.

Connecting the red wires:

Attach jumper wires to the red wire from each sensor (using a 14 wire ribbon cable). Keep track of which wire is connected to which sensor. Connect the wires from sensor 5 - 14 to analog pin A6 - A15 on the Arduino Mega.

Accessing analog pin 6 on the Arduino Mega is difficult because of the design of the datalogging board. Unplug the

datalogging board, make the needed connections on the Arduino Mega and then plug the board back in. That may put some tension on the wire plugged into analog pin A6, but that should not be a problem.

Now connect the jumper wires from the red wires from sensor 1 - 4 to analog pins A0 - A3 on the Adafruit datalogging board.

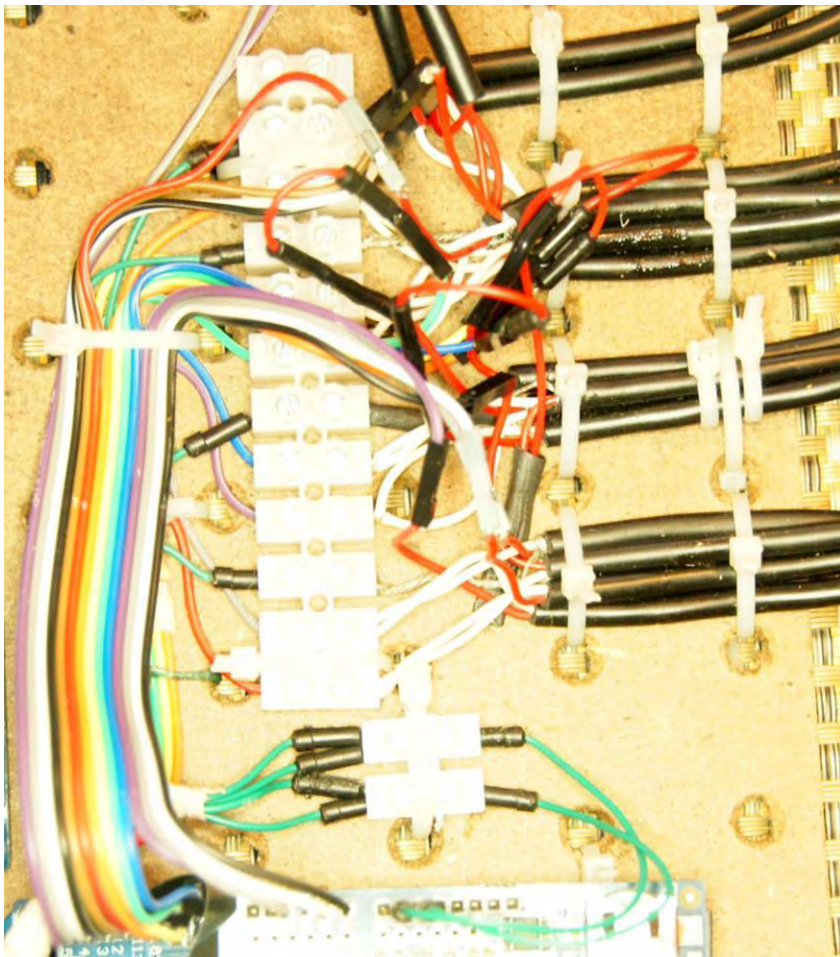
White wires from the sensors:

Connect the white wires from sensor 1 and 2 together (I used "euro-style" terminal blocks to do this) and connect a jumper from the two white wires to digital pin D43 on the Arduino Mega.

Likewise, connect the white wires from sensor 3 and 4 to digital pin D44, sensors 5 and 6 to digital pin D45, sensors 7 and 8 to digital pin D46, sensors 9 and 10 to digital pin D47, sensors 11 and 12 to digital pin D48, and sensors 13 and 14 to digital pin D49.

Bare (ground wires):

All bare wires from the sensors need to be connected to a GND and the Arduino Mega (or datalogging shield) by connecting the bare wires from sensor 1 - 4 together and connecting those to a green jumper wire. Likewise with the bare wires from sensor 5 - 8, 9 - 12, and 13 and 14. So now there are for green wires that need to be connected to ground. Connect two of these four wires to another green jumper and the same for the other two wires (using a 'euro-style' connector). That now results in two green wires that can be plugged into two grounds on the Adafruit datalogging shield.

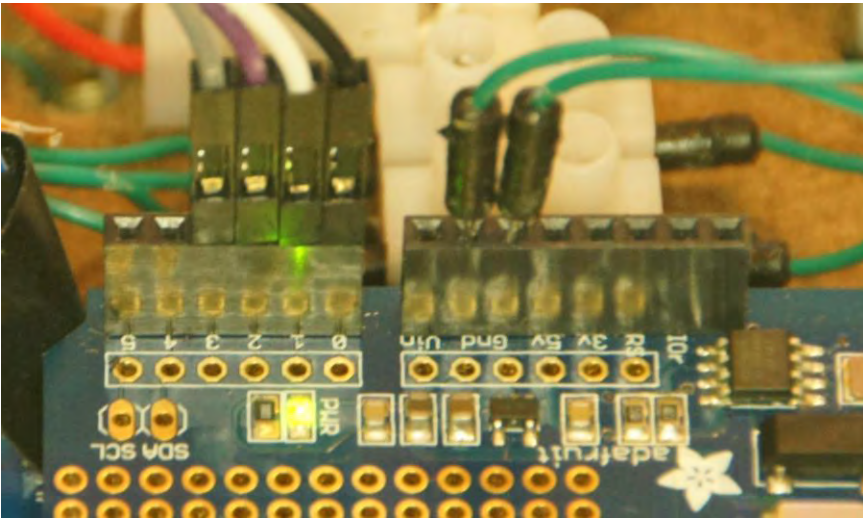


Sensor connections: hard to see everything, because of the number of wires.

The red wires from the sensors are connected to the 14 wire ribbon cable clearly visible in the left side of the picture. These jumper wires are connected to analog pin A0 - A3 and A6 - A15.

The white wires from sensor 1 and 2 are tied together and then connected to a red jumper wire going to digital pin D43. White wires from sensor 3 and 4 are connected to a grey wire going to pin D44 etc.

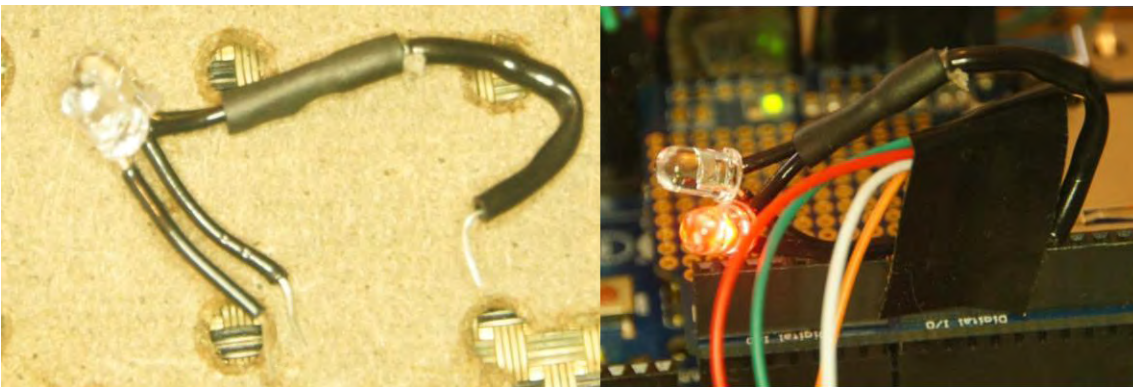
The bare wires from sensors 1 - 4 are all connected together and then connected to a green jumper wire. Same for bare wires from sensor 5-8, 9-12, and 13 and 14, resulting in four green ground jumper wires). Near the bottom of the picture, you can see how those four green jumper wires are connected (using a terminal block) to two green jumper wires, which are plugged into the two ground pins on the Adafruit datalogging shield.



Close up of the two green wires (connected to the ground wires from all 14 sensors) to the grounds on the Adafruit datalogging shield

Step 4: Connecting the LEDs

Although not needed for the system to work, connecting two LEDs to the setup is useful for error checking. Use a green LED that comes on when the sensors are measured and will stay on if all sensors give a 'normal' reading. The red LED will come on if any of the sensors give a volumetric water content reading outside the normal range (less than 0 or more than $0.8 \text{ m}^3 \text{ m}^{-3}$). The two shorter wires (negative) of the red and green LEDs are connected together and then connected to a 4,600 Ohm resistor. The exact resistance does not matter anything from 500 to 10,000 Ohm should work fine. All exposed wire is then covered with heat shrink tubing.



The bare wire on the right comes from the resistor and gets inserted into a GND on the datalogging shield (not clearly labeled, but right next to digital pin D13). The long wire from the red LED is connected to digital pin D9, the long wire from the green LED to digital pin D8 (directly inserting the LED wires into digital pins D8 and D9, without using any additional wire).

After making all connections and making sure the connections are correct, use electrical tape to secure the wires to the boards. You may want to do this after testing the entire setup.

Step 5: Connecting the solenoid valves

Solenoid valves are triggered by relays 1 - 14, which are controlled by digital pins D22 - D35. We are showing just one valve because all valves need to be connected the exact same way. Pin K1 on the relay board controls relay 1 and needs to be connected to Arduino Mega digital pin D22. One wire from the 24VAC power supply has to be divided in 14 wires and be

connected to one of the wires of all 14 valves. It does not matter which valve wire you connect this to. The other wire from the 24VAC power supply also has to be split in 14 wires and these wires are connected to the COM terminal of relays 1 - 14 at COM. We are showing just a few valves for clarity.

