



## Build a Web Enabled High Temperature Kiln Controller



by botheredbybees

Turns a Raspberry Pi into a cheap, universal & web-enabled kiln Controller.

I used this to add a firing schedule control to a little pottery kiln I picked up second hand. The kiln is 10A/240V rated to 1000 degrees C. It has a door switch and a basic thermostat which allows for 25%, 50%, 75% or 100% power but no timer, which means

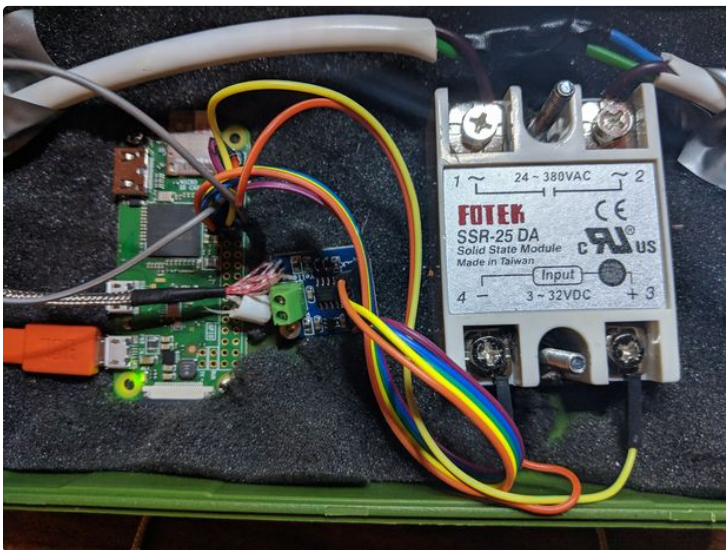
constant monitoring if you want to ramp the temperature up slowly or soak the wares at any point. With the kilnController I can now set it up for a bisque or low temperature glaze firing and leave it to its own devices, checking progress every now and then on my mobile phone or PC.



## Step 1: Hardware

1. Raspberry Pi Zero W running Raspbian. Any pi will do but the zeros are the cheapest at about \$15 here in Australia
2. MAX 31855 Cold-Junction K-Type Thermocouple (about \$6 on eBay)
3. K-Type Thermocouple Sensor -100°C to 1250°C (\$3 on eBay)
4. Solid State Relay Module SSR-25DA 25A /250V 3-32V DC Input 24-380VAC Output (again, about \$6 on eBay)
5. Half a dozen bits of wire
6. A tupperware box to house it all

To put it all together you'll need a soldering iron, screw drivers and some wire cutters



## Step 2: Wiring Up the Thermocouple

### MAX31855 to Raspberry Pi

Vin not connected

3Vo to Pin 1 (3.3v DC)

GND to Pin 9 (Ground)

DO to Pin 11 (GPIO 17)

CS to Pin 13 (GPIO 27)

CLK to Pin 15 (GPIO 22)

DO (data out) is an output from the MAX31855 (input to the microcontroller) which carries each bit of data

CS (chip select) is an input to the MAX31855 (output from the microcontroller) which tells the chip when its time to read the thermocouple data.

CLK (clock) is an input to the MAX31855 (output from microcontroller) which indicates when to present another bit of data

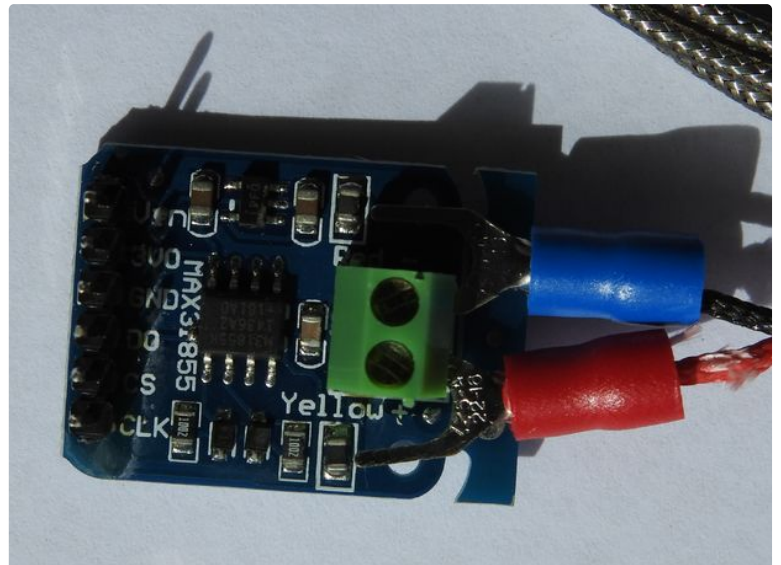
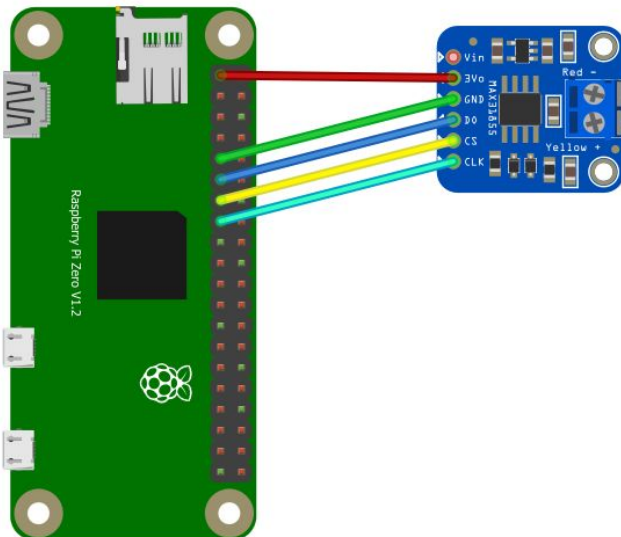
For this project I've used the MAX31855 python library from <https://github.com/Tuckie/max31855>.

### Thermocouple sensor to MAX31855

The MAX31855's terminals are marked 'Yellow +' and 'Red -', but my thermocouple sensor came with red and black wires, each with a little tab on the end. If you have the same sort of sensor, you'll need to put the red wire into the 'Yellow +' terminal, and the black one into the 'Red -' terminal.

While you can cut the terminations off the ends of each wire, I don't recommend it, as the insulation will unravel, leading to possible short circuits. Connect the tabs as shown in the picture above and everything should be sweet.

For now we've done enough wiring up to be able to start testing. But first, we'll need to install the web interface on the Pi...





### Step 3: Installing the Web Interface Software on the Raspberry Pi

I built my controller on a 16GB SD card with [raspbian](#) installed but all the software would fit on an 8GB card if that's what you've got (df -h is showing less than 5GB of files).

After getting raspbian installed and connecting to your wireless network, run the following commands in a terminal on the pi:

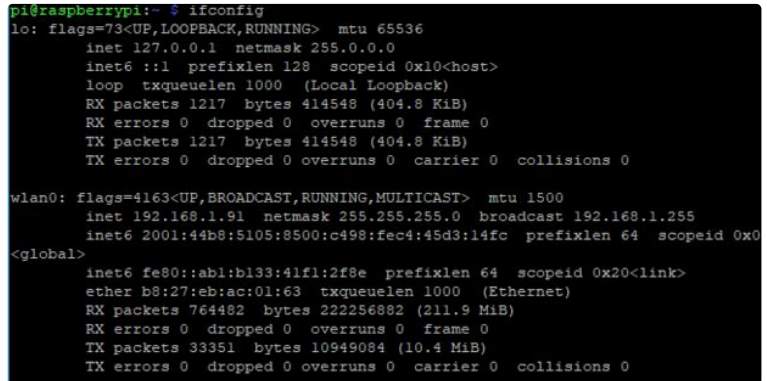
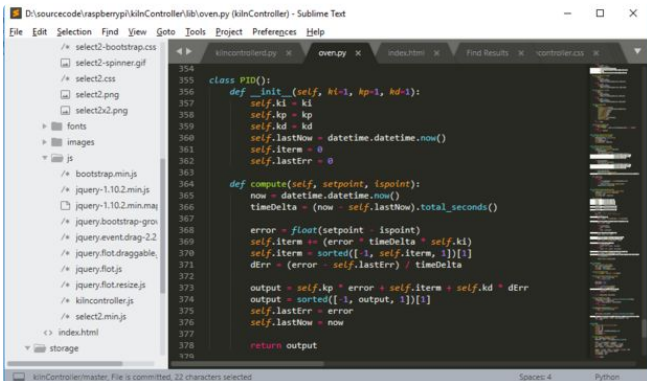
```
sudo apt-get install python-pip python-dev libevent-dev git
sudo pip install ez-setup
sudo pip install greenlet bottle gevent gevent-websocket
git clone https://github.com/botheredbybees/kilnController
```

Just about ready to start, but first get the IP address of your Pi by typing the following command in your terminal session:

```
ifconfig
```

Write down the IP address for your wlan0 connection. It should look something like: 192.168.1.91 (the last couple of numbers might be different)

Note: [kilnController](#) is a forked and then modified version of the reflow oven project: [picoReflow](#) which I found out about through a blog post on [succulent ceramics](#). Because the original project was for a solder reflow oven, it had quite a bit of cod for driving cooling fans and monitoring a door switch. I didn't need these for my project, but the code's still there (commented out) if you feel the need for a cooling fan. I added more code so that it would display nicely on my mobile phone.





## Step 4: Running the Web Server and Testing the Thermocouple

Time to start the web server. Type the following into your terminal window:

```
cd kilnController
python kilncontrollerd.py
```

You should see a couple of lines saying something like:

```
2019-01-10 21:49:20,006 INFO kilncontrollerd: Starting kilncontrollerd
2019-01-10 21:49:20,024 INFO oven: import MAX31855
2019-01-10 21:49:20,036 INFO oven: init MAX31855
2019-01-10 21:49:20,074 INFO kilncontrollerd: listening on 0.0.0.0:8081
```

Now, go to a mobile phone or computer that's using the same wireless network as the pi. Open a web browser and enter the IP address you wrote down earlier, followed by a colon and the port number 8081. For example: 192.168.1.91:8081

After a short wait you should see the temperature displayed on the top left of the web page. Warm up the thermocouple sensor by holding it in your hand or putting it on a lamp or a soldering iron. You should see the temperature increasing at 1 second intervals.

```
pi@raspberrypi: ~/kilnController
Using username "pi".
pi@192.168.1.91's password:
Linux raspberrypi 4.14.50+ #1122 Tue Jun 19 12:21:21 BST 2018 armv6l

The programs included with the Debian GNU/Linux system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.

Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.
Last login: Wed Jan  9 14:03:35 2019 from 192.168.1.14
pi@raspberrypi:~$ cd kilnController/
pi@raspberrypi:~/kilnController$ python kilncontrollerd.py
2019-01-10 21:49:20,006 INFO kilncontrollerd: Starting kilncontrollerd
2019-01-10 21:49:20,024 INFO oven: import MAX31855
2019-01-10 21:49:20,036 INFO oven: init MAX31855
2019-01-10 21:49:20,074 INFO kilncontrollerd: listening on 0.0.0.0:8081
```



## Step 5: Wiring Up the Solid State Relay

So far no-one would be hurt if you got things wrong, but this step involves electricity at voltages and currents that could kill you if not handled properly, so please be careful. Make sure that nothing is plugged in while you work on the circuit and that there are no exposed wires or short circuits when you start using it on the kiln. I put my project inside a plastic box that I had sitting around (but I'm thinking that I might make a nice ceramic container now that I have the kiln running again :)

The solid state relay (SSR) turns the power to the kiln on and off. For my setup I wired in a short extension cord and plugged the kiln into that. I did this by carefully removing the outer insulator just behind the

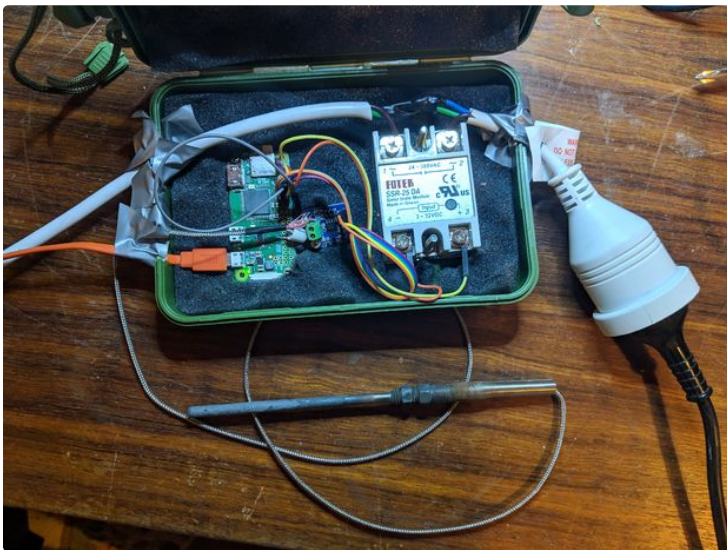
female socket on the power cord. Then I cut through the active wire and connected the ends to terminals 1 and 2 on the SSR. The Active wire (high potential) is coloured brown here in Australia (used to be red).

Connect pin 16 on the Pi (GPIO 23) to the '+' terminal on the SSR (terminal 3) and pin 6 on the Pi (Ground) to terminal 2 on the SSR.

Note: the SSR can get quite hot when in operation so you might want to put it on a heat sink. I sit my plastic box on a tin can when firing.

Danger image: public domain from [Max Pixel](#)





## Step 6: Final Test

One last test before we can use our kiln controller in anger.

Plug a desk lamp into the controller. Plug the other end into a wall socket. Watch for any obvious signs of problems (the smoke getting out of components, funny smells etc.), if all is going well turn on the lamp and rest the thermocouple sensor on the lamp's bulb. At this stage the lamp should not be illuminated.

If it's not already running, start up the kiln controller software on the pi. Select a profile and click on 'Start' on the top right and then on the 'Start the firing' button on the Firing Overview modal.

Now, the bisque profile I've set up has a start temperature of 30 degrees Celsius. I live in

Tasmania, where it's almost always cooler than that so the controller should immediately turn on the lamp to warm up the sensor. If you live in a warmer climate you might have to wait a while until the profile calls for something higher than your current ambient temperature. Either way, if everything's working to plan, you'll eventually see the light turn on and a 'kiln on' icon light up on the interface.

Leave it running for a while and you'll see the lamp turn on and off while the controller tracks the temperature profile.

Click on the 'Stop' button on the top left when you're done and go forth and fire up your kiln!

