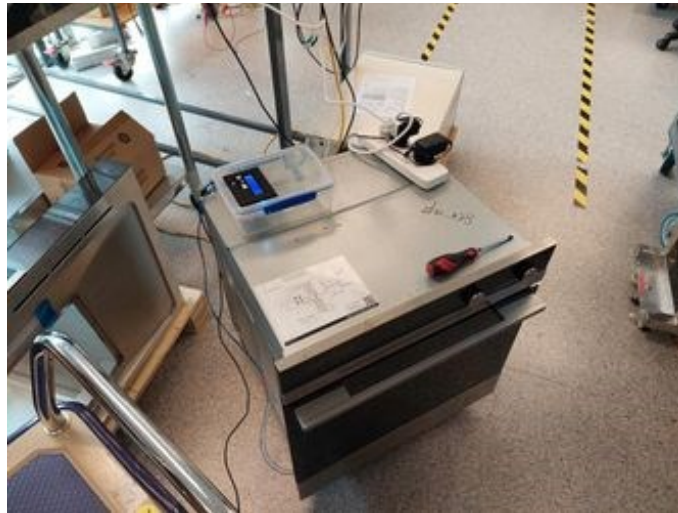


# Oven to Thermal Chamber Conversion

Author: Caleb Jackson



## Specifications

Temperature Range:	40C - 100C, temperatures above 100C are not tested and are likely unstable.
Overshoot on Warm Up:	< 10C
Max error when stable:	< 2.5C
Stabilization Time:	approx. 40mins
Temperature Sensor Error:	<0.5C

## Quick Start

Note: If you have bulky cables to feed into the oven, use the cable port described under the next heading.



1. Place the componentry on the MDF rack, thermocouples and other small wires can be fed through the oven door.
2. Check the cable port is closed if not in use.

3. **ENSURE THE TEMPERATURE SENSOR IS IN THE OVEN**
4. Plug the power board into the wall using an RCD. Then turn on the power board switches.
5. Using the right arrow button, navigate to the Set Temperature screen.
6. Use the up/down buttons to increase/decrease the temperature. Once the desired temperature is on the screen, press the tick button to set it.
7. Wait approx. 40mins for the oven temperature to stabilize.

## Cable Port

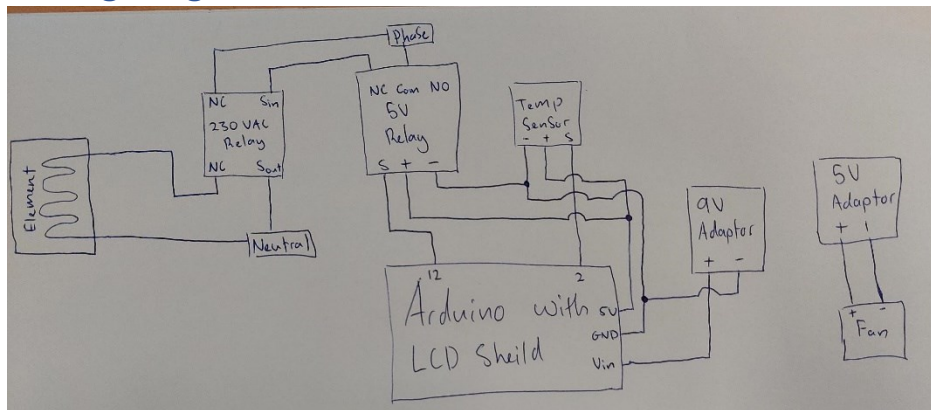


The cable port is useful if you have bulky cables that can't be fed through the oven door. To use the cable port you will need a spanner to take off the first plate. Once the first plate is off the nuts will need to be put on again to secure it. When the cables have been fed through the tunnel, seal off the tunnel with a bit of foam.

## Bill of Materials

- Arduino Uno
- Arduino LCD controller shield - <https://www.jaycar.co.nz/arduino-compatible-2-x-16-lcd-controller-module/p/XC4454>
- Arduino 5V Relay - <https://www.jaycar.co.nz/arduino-compatible-5v-relay-board/p/XC4419>
- Arduino Digital Temperature Sensor Module- <https://www.jaycar.co.nz/digital-temperature-sensor-module/p/XC3700>
- 4.7k Pull Up Resistor
- 230VAC Triggered Relay
- Oven
- 9V Adaptor with Barrell Jack
- 5V Adaptor
- 12V PC Fan
- Assorted Connectors and Wires

## Wiring Diagram



## Safety Considerations

### Case 1: Oven Control Becomes Unstable

In the code there is an if statement which stops everything if it detects that the oven temperature is greater than the set temperature by 30C.

### Case 2: Controller Powers Off

If the controller powers off then there will be no trigger to the 5V relay, and thus the element will not get any power.

### Case 3: Temperature Sensor not in Oven

The oven temperature will keep increasing until something bad happens.

### Case 4: Temperature Sensor not Connected

Whenever the temperature sensor gives a bad reading (negative number) the power delivered to the element will be set to 0%.

## Delivering Power to the Element

### Varying the Power

The power delivered to the element is done with PWM with a period of 25s. Having a long period reduces the wear on the relay contacts. The Arduino triggers the 5V relay. The 5V relay triggers the 230VAC relay which provides mains to the element. The 230VAC relay is more grunty and will cope with the high loads needed for driving the element.

## Control Logic

The controller is an Arduino Uno. The Arduino goes through 4 control states called IDLE, BEANS, COAST and PROP.

1. In the IDLE state the Arduino is waiting for the user to set a temperature. Once the temperature has been set it will go into BEANS if it is far below the desired the set temperature or PROP if it is close or above the set temperature.
2. In the BEANS state the Arduino gives the element 100% power until the temperature is 17C below the set temperature. When that happens it switches to the COAST state.
3. In the COAST state the power delivered to the element is 0%. The Arduino remains in the COAST state until temperature has reached its peak and starts dropping. When it starts dropping the state changes to PROP.
4. In the PROP state the power delivered to the element is proportional to the temperature below the set temperature. If the temperature is above the set temperature a little bit of power is fed to the element to slow the fall in temperature. Slowing the fall reduces the oscillations and improves the accuracy. The slow fall power is proportional to the temperature above the set temperature.

## Code and CAD

The code and CAD can be found on GitHub at <https://github.com/calebjnz/Oven-Controller>

## Serial Port

The controller prints out the current temperature, the control state and the relay power in a csv format, which looks as follows: currentTemperature, controlState, relayPower

This is printed every second. The baud rate of the serial port is 9600.

## Trouble Shooting

Problem	Solution
The oven temperature falls too slow	Increase the fallGradient in the code.
The oven overshoots	Decrease maxRelayPower or decrease kP.
Temperature reads -255	The temperature sensor wire is disconnected
No relay click sound for 30s when the relay is supposed be delivering power.	Relay disconnected or broken.