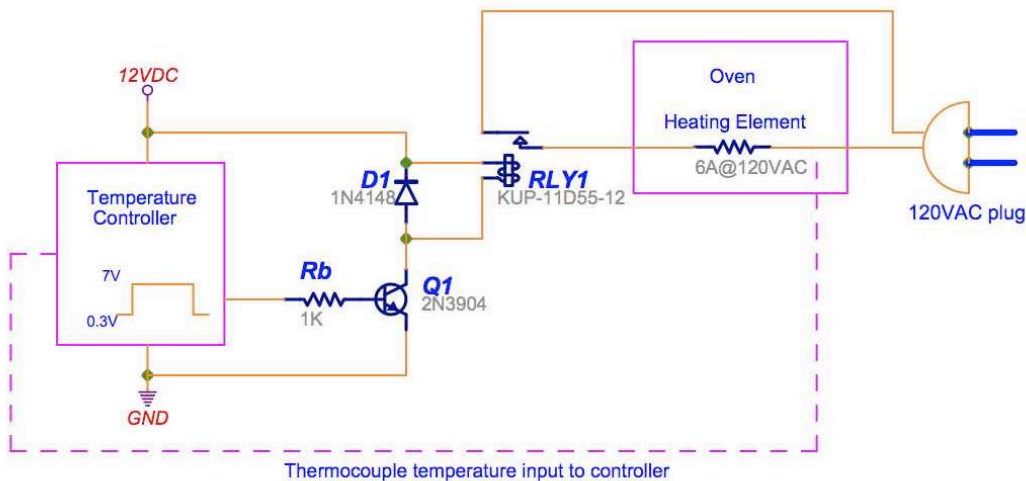


HWK #1 Solution (Transistor Relay Driver)

The plan is to have the temperature controller turn on and off a transistor, which turns on and off a relay, which turns on and off the heating element inside the oven keeping it at a fixed temperature.



Relay Requirements:

Since the load is a 20Ω resistive heater powered from the wall socket the max current will be: $120V/20\Omega = 6A$. You have available a 12VDC power supply (provided by the temperature controller) that can provide up to 200mA.

Relay contacts: $>6A, >120VAC$

Relay coil: $12VDC, <200mA$

You always want to have a safety margin so the pick a relay with contacts rated at $\geq 8A$ and a coil current $<150mA$. Searching digikey.com for power relays and narrowing the search to relays that are in stock with contacts rated between 8-10A with a 12VDC coil yielded 209 matches. Further narrowing the search to relays with quick connect terminals (termination style) left 27 choices. Note: You can choose any contact type. The relay I chose is a made by Tyco (**KUP-11D55-12**). **Relay specs: contacts 10A@240VAC, coil 12VDC@100mA.**

Transistor Requirements:

The transistor will be switching the coil on and off so it needs to handle 100mA at 12V (actually 12.7V when current is flowing through the flyback diode). Most transistors meet these requirements. I chose a **2N3904** made by Fairchild because we've been using it in class.

Transistor specs (worst case): $V_{ce0} = 40V, I_C = 200mA, h_{fe}@100mA = 30$.

Base Current and Resistor Calculation:

$$I_b = I_C/h_{fe} = 100mA/30 = 3.3mA$$

We'll use **6mA** to make sure the transistor saturates (i.e. is fully on and V_{ce} is about 0.2V). Note: The controller output can provide up to 20mA so 6mA is OK. The controller outputs 7V when high and the base emitter junction of the transistor drops about 0.7V when forward biased. Therefore:

$$R_b = (7V - 0.7V)/6mA = 1K\Omega$$

When the controller output is low no current will flow into the base because 0.3V is less than the 0.7V required to forward bias the base emitter junction.