

# Greg's temperature-controlled fridge

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This page describes the methods I used to use to keep the temperature constant when brewing beer. It's the second attempt; the [first attempt](#) was seriously suboptimal and worked quite badly under some circumstances. For blow-by-blow details of the problems and issues I had setting up this control system, see my [brewing log](#).

## Overview

The control system uses a computer to monitor a number of temperatures inside a fridge and turn on either the fridge motor to cool the surroundings, or a light bulb to warm them:



The equipment I used is:

- An old computer, of course. The size of the one I chose is simple: that's what I had left over. It's an Intel 486-DX2/66 with 16 MB of RAM, something you can probably pick up for free if you know where to look. It's running [FreeBSD](#), of course.
- A [temperature logger kit](#) available from from [Ozitrionics kits](#). By chance, I had seen this at [Linux.conf.au](#) in January 2004, though I already knew about it before. It connects to the system via the serial port.
- A [relay board](#) also available from from [Ozitrionics kits](#). It connects to the parallel port and controls up to 8 relays with up to 250 VAC and 10 A, though they recommend additional wiring for currents of over 5 A. A fridge typically uses a maximum of 3A, so this is of academic interest only.

The real fun in getting this working wasn't the hardware, which is easy enough to get. It's also not really the software, which I wrote myself, and which I'm still tweaking. The real problem were the little details and connectors and things. I spent a lot of time—see the [brewing log](#)—trying to decide how to connect things. Finally I discovered an old computer lying around without a mother board, so all the front panel connectors were hanging loose. That's exactly what I was looking for to mount the temperature sensors:



Other issues in the mounting included the fact that the kits are designed for external mounting (and the relay board needs a 12V power supply). I wanted to mount both inside, which had the added advantage that I could use the computer power supply to power the relay board. The problem was a certain amount of external cabling:





This one shows the temperature probe assembly. There are no mounting holes on the probe board, so I had to mount it by its 9 pin serial connector. I had already connected to probe cables to a 25 pin connector. I wanted it inside the case, so I had to connect the flat cable to the serial port on the outside of the case (the grey cable going out through another cutout just below the probe board). I need to find some kind of plate that I can use to mount it inside the case.



This shows the 12V connection to the relay board. I mounted it from the top of the cabinet, and the 12V input is from the computer power supply.



This one shows the other side of the relay board with the mains power connections.



A view of the back of the computer. This shows a number of things:

- The lower cable goes from the parallel port back inside to the relays. It would be nice to have internal cabling, but I don't know of any parallel ports that connect to a header on the board. They're all connected directly to an external connector.
- Above that is the temperature probe cable, as shown before.
- Higher and to the right, the flat band cable mentioned previously.
- At the top are the relay power outputs (white) and the computer power cable (black). The power supply is in at an angle because it was originally designed for a smaller case, and the internal cables are too short to allow normal mounting. Some time I must buy a proper power supply.

## Installation

The next step was installation in the laundry:



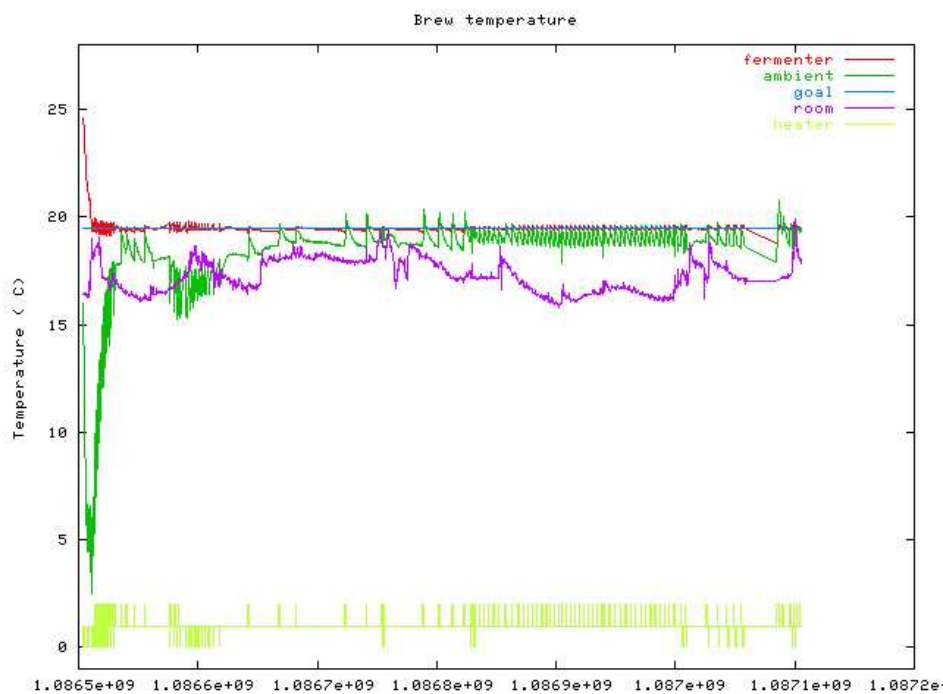


Note the position of the temperature sensors:

- The external (“room”) sensor is on the side of the fridge, not an ideal place, especially when I replace the power supply, when it’ll be in the exhaust area. To be relocated.
- The internal (“ambient”) temperature sensor is barely visible in front of the 25 pin connector. It’s fastened to one of the bars of the grille.
- The wort temperature sensor is taped to the outside of the fermenter. It’s covered with some bubble foil to minimize the effects of the ambient air.
- The fourth sensor is intended for a second fermenter. It’s hanging down in front of the light.

## The first brew

I used the first brew after installing the system to debug the software. As a result, the curves are not ideal, but they’re so much better than anything I would have had before:



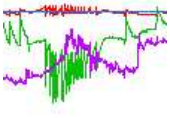
This shows a complete brew. Ignore the mess at the bottom; I’ll get the dates and times sorted out later. Look at the bottom (bright green) line: it shows the cooler (bottom state), idle (middle state) and heater (top state). The red line shows the wort temperature, the blue line the goal temperature (19.5°), and the dark green line shows the ambient temperature inside the fridge to maintain the wort temperature.

There are a number of phases to this fermentation:

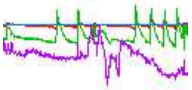




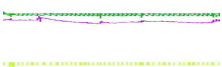
This shows the initial cooling of the wort. Some parameters weren't optimal, and so although it needed to cool things down, it did some heating in between.

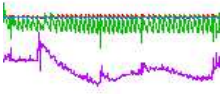


This section shows the period of the main fermentation. Note the difference in temperature between the ambience and the wort; it's about 3° at the peak. This is the part that normal fridge thermostats can't handle.



Here the main fermentation is dying down, and the ambient temperature rises towards the wort temperature. The control is relatively jagged.





Here I have done some tuning to heat for less time and more frequently, resulting in an even better temperature control. Finally we don't have any overshoot: it's only warming, not alternately cooling.



More, not entirely successful tuning.



This is the result of a power failure. The computer came back to life, but since I was still testing, I had started the program manually. My intention is to start it automatically when it's finished. As a result, both ambient and wort temperatures drop at about the same rate until caught.

# Current status

I'm still working on tuning the application. After that, I need to write some documentation, and then I'll put it up for free download. If you're in a real hurry, please contact me by mail to find out what today's status is like.

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[Greg's main brewing page](#) [Greg's diary](#)

[Greg's photos](#)



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