Re: Liquid level indicator

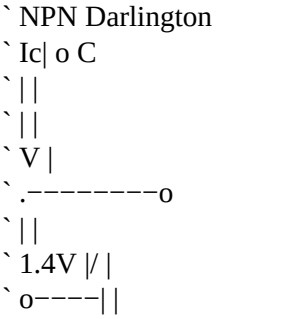
Source: http://sci.tech−archive.net/Archive/sci.electronics.basics/2005−06/msg00239.html

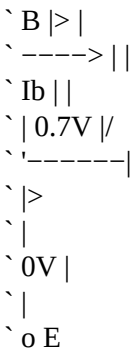
- *From*: "Chris" <cfoley1064@xxxxxxxxx>
- *Date*: 7 Jun 2005 17:06:08 −0700

MarkMc wrote:
> Hi Chris
>
> I did once get the .pdf from Maplin that you refer to. It's just a
> scan of the instructions which come with the module − assuming you have
> the same file. Perhaps I'm learning some of this electronics lark as I
> too came to the conclusion that I wouldn't be able to drive my relay
> from the tiny current available from the module.
>
> I assumed that a Darlington pair would help me out here. Is there any
> reason why you suggest the NPN−PNP cct in particular?
>
> The temperature control is definitely a luxury thing, and by the look
> of things is best left until version 2 of this setup which is already
> tring to achieve a lot.
>
> The heating side of things I can see getting used in two ways −
> 1.) To perform stepped mashes − only for a tiny proportion of brews
> (luxury)
> 2.) To keep the wort at a set temperature when recirculating − losses
> may occur at the pump and in the pipework.
>
> I have heard about homebrew systems existing called RIMS (RecIrculating
> Mash System) and HERMS (HEated Recirculating Mash System), and they
> rely recirculating the wort and for HERMS, heating it at the same time,
> so it must be possible.
>
> The pump will be pumping the liquid at all times when the heater is on,
> so the liquid shouldn't be in contact with the heater element for any
> length of time, so the liquid temperature level should be rising very
> slowly and steadily with any luck, but perhaps you're right, manual
> control and a normal glass thermometer may well be a better solution.
> But it's not very geeky, is it! :)
>
> There's two things which need to happen heat wise;
> 1). The heat of the liquid in the container must *never* go over 70−75C
> (well, not for long) as enzymes in the wort, which are performing the

> starch conversion of the grain, can de−nature and become useless for
> the mash and render the brew unfermentable − not desirable! This limit
> may be even lower (say 60C) at some stages for stepped mashing.
> 2). Heating and pumping/recirculating must stop when the temperature in
> the mash tun (not the underback where we'll be heating the wort and
> pumping from) is at the desired step temperature, say 66C
>
> So thinking about it, an even more custom solution is required with not
> one, but two temperature probes.
>
> I was wondering − I have PIC microcontrollers 16F628A at home, with
> necessary programming hardware and software development tools.
>
> I could make something to perform a controlled level out to the heating
> element, using the reference voltage generator of the 16F628A rather
> than simply turning the heater on and off. Of course the problem here
> is that I don't know how to scale up a 0−5v variable range to what's
> required for the heater element running on mains voltage. i.e. do I
> need to vary the current/resistance or the voltage peak−to−peak of the
> heater element, I'm not sure how to achieve either.
>
> Hmmm, maybe on/off is ok for the <= 70C part, but that still leaves me
> wondering how to physically measure the temperature. I don't mind
> making my own sensor out of stainless steel rod (somehow?) and
> performing the calibration etc, and using a cct/PIC microcontroller to
> act on the levels and perhaps drive an LCD display for the underback
> and the mash tun.
>
> >From reading the FE33L manual, they suggest any probe will work as long
> as it has a resistance < 30 ohms and that the shorter the wire, the
> more accurate it will be. Any suggestions on making a probe form
> stainless steel rod?
>
> I take it a GFCI is different to an RCD? I was always planning on
> using an RCD in the 240v cct.
>
> Thanks once again,
> Mark

A darlington transistor requires two Vbe drops to turn on −− that would
be 1.4V, which is too close to the 1.5V logic level output:





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Following the NPN (80uA base drive) with a PNP (1.2 mA or so) allows current magnification that will lead to the second transistor being completely on when it's on. That's important to limit power dissipation (P = (Vc − Ve) * I) as well as other reliability issues. Also, most relays are guaranteed to turn on with 75% to 80% of nominal voltage. If there's too much voltage drop across the transistor, the relay might not turn on (especially if your power supply is somewhat low).

I'm kind of glad in a way that you're holding off on the temp control part of the circuit for a while −− possibly you can get what you have working, and go from there. It might also help as far as getting a few more bucks together for the effort, which might allow you a much better controller.

Most of the time, in controlling a heater load with a long thermal time constant, programmed pulse width modulation is used instead of phase control of the line or attempting some kind of linear controller.

Here's how PWM works. Let's say it takes 5 minutes of full−on line voltage for significant load heating to occur. The PIC programmer would choose a period of, say, 10 seconds. Out of that 10 seconds, if the heater is on for one second, that's the same equivalent heating as 10% of full line voltage power. If, every 10 seconds, the PIC turns the heater on for 5 seconds, that's the same as 50% power. If it's on for the full 10 seconds, that's 100% power, of course. Every 10 seconds the pulsed ON repeats. That's called PWM, and is easy to program with a computer.

The only problem is that the repeated ON/OFF cycling tends to wear out relay contacts. This type of thing is perfect for a Solid State Relay. All you do is drive an optoisolator LED with 3 to 20 mA (depending on the type of SSR), and the load turns on with triacs instead of relays. Instead of 10,000 to 1,000,000 operations like a relay, an SSR can operate virtually forever, if it's got a good heat sink to prevent thermal cycling.

Unfortunately, having a PIC will not really help you with accuracy of the temp controller. The error budget is mostly due to the kind of

simple method being used to read the thermistor resistance (this is a guess based on what's implied in the docs). Having the PIC read the serial output will just duplicate the action of the LOW output if you do a straight bang−bang ON/OFF controller. I would guess that, unless you've got a bit of experience in PICs as well as know a little control theory, you're going to get kind of frustrated with a proportioning controller program. However, there's quite a bit of help out there in the PIC support groups, and there might be something out there that will do the job.

The biggest problem with the PIC, though, is using it for a critical application without having an ICE (In−Circuit Emulator) or having experience in debugging real time control programs.

The thermistor is a variable resistor whose resistance is dependent on the temperature it's sensing. Normally, if there's a long wire length, the controller will have a 4−wire connection to the thermistor to remove the effect of the resistance of the wires. Your FE33L doesn't have that, so they say to keep the wires short. However, you'll still need a thermistor, which is a separate purchase part. The problem is, they make many different kinds (they're usually specified by room temperature resistance and temperature coefficient in ohms per degree). Maplin sells them with room temperature values from 4K7 to 150K. Gotta buy it, not make it, and you've got to know the temperature coefficient if you want it to work with your module. The FE33L is built to work with a specific thermistor probe. If you want to use something else, you'll have to figure out what the thermistor is. If you can figure out a way to make the FE34 work, you can use a switch setup like is shown in the appnote.

I'm not sure what an RCD is. I explained GFCI in the prior post, and I believe that's what it's called on your side of the pond, too.
Possibly you should check in at a do−it−yourself hardware shop and ask what they recommend to protect people from accidents with line voltage and water in the bathroom or kitchen.

Best of luck to you.
Chris

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- ***Follow−Ups***:
  - ♦ ***Re: Liquid level indicator***
    - ◊ *From:* MarkMc

- ***References***:
  - ♦ ***Re: Liquid level indicator***
    - ◊ *From:* MarkMc
  - ♦ ***Re: Liquid level indicator***