Re: stepper motor power issues...

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- *From*: "Bob Monsen" <rcmonsen@xxxxxxxxx>
- *Date*: Fri, 01 Feb 2008 15:44:26 GMT

"vwkafer" <LKranker@xxxxxxxxx> wrote in message news:34721e44−4207−4bab−ace9−cd2bc1d31bf6@xxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

> I have taken several of your suggestions and definitely appreciate the help. My situation is much improved. I bought a 350 Watt PC power supply and am now using the +5V to power the motors and the +12V (regulated to +5V) to power the microcontroller. I also added more ULN2003A (paralleled), so I am using four channels for each lead of the motor (500mA x4 = 2A). When I used an ammeter on the motor I measured 1.9A, so I think this should be correct. When I turn everything on the motors work beautifully, my joystick (controlling the motors) works beautifully. But...the ULN2003A's start to overheat. I turned everything off before they got too hot (could still touch), but they are getting hot within the first few minutes.
>
> I have a few possible problems:
> 1) Right now, I have two motors sharing one of the chips (separate channels of course). Is that a problem?
>
> 2) I am using no protection diodes whatsoever. On the ULN2003A datasheet (http://www.ortodoxism.ro/datasheets/ SGSThomsonMicroelectronics/mXtyyvx.pdf). It looks like there are diodes. I thought this might be sufficient. Could someone please explain where the diodes would go?
>
> 3) Jamie mentioned, "make sure you are leaving a little gap between phase chances
> from the uC code." I am not sure what this means. In my current microcontroller code, I am sending a command to switch one lead to high, one to low simultaneously, but then I am forcing it to wait 500ms before doing anything else. I don't need the motors to rotate quickly for my application but I do need to have at least one lead high on each motor at all times to maintain torque.
>
> 4) On the ULN2003As, I have pin 8 grounded and pin 9 connected to the same +5V as the motor leads (different than the regulated +5V going to the PIC, clock, etc).
>
> Thanks again for the huge help. Any additional feedback is greatly

appreciated.

I just looked at the datasheet here:

http://focus.ti.com/lit/ds/symlink/uln2003a.pdf

There are several numbers that are interesting. Look in the "absolute maximum ratings" section. The peak collector current for each output is 500mA. That is OK in your setup.

Now, move down to "electrical characteristics". At 350mA, the device has a typical Vf of 1.7V. That means that it'll be dissipating .35 * 1.7 = 595mW here. If it does not have a heat sink, you can calculate how hot it'll get using the 'package thermal impedance' back up in the 'absolute maximum ratings' section by multiplying the power dissipated by the thermal impedance. If you are using an N package, you can compute this to be

67 C/W * .595W = 40 C

That is temperature above room temp.

The maximum junction temp is 150C, so that isn't so bad, for their example. It can run in an environment up to 110 C, which is hotter than I want to be.

Now, try it with 2A:

67 C/W * (2A * 1.7V) = 228 C

That is well beyond the 150C, so you'd have to be operating at room temp of −80C to fall within the limits.

So, while they say you can run each channel at 500mA, they don't really mean it. There is a maximum power dissipation, which is limited by how much heat the device can shed. That in turn is governed by the thermal impedance. Also, the devices are spec'd at 25C, so if you get them hotter, they may not perform the same as in the spec.

Sometimes, devices have nice charts showing the 'safe operating area'. This datasheet doesn't seem to have one.

You CAN heat sink a pdip package. Combined with a fan, you may be able to get it to work. However, it may be more workable if you split up the current between 4 devices. Using discrete darlingtons, and driving them yourself is another option, of course.

They also point out that 'Operating at the absolute maximum TJ of 150°C can affect reliability.' in note 4 of the maximums section, so if you continue using the chip like this, you may cause it to fail.

If you decide to go the discrete component route, use diodes to prevent the 'flyback emf' from destroying the devices. The problem is that motors are big inductors, and if you suddenly cut current, the voltage can spike. Assuming you are driving the motor winding from the collector of the device, you need a diode from the collector to the V+ input of the motor, which does not conduct in the normal case. However, when you shut off the current, and the voltage spikes, the diode will conduct, causing the current to loop through the motor. This can cause the motor to be slightly less responsive (since the current does not drop off as quickly) but it is better for the transistor switch.

Regards,
Bob Monsen

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