

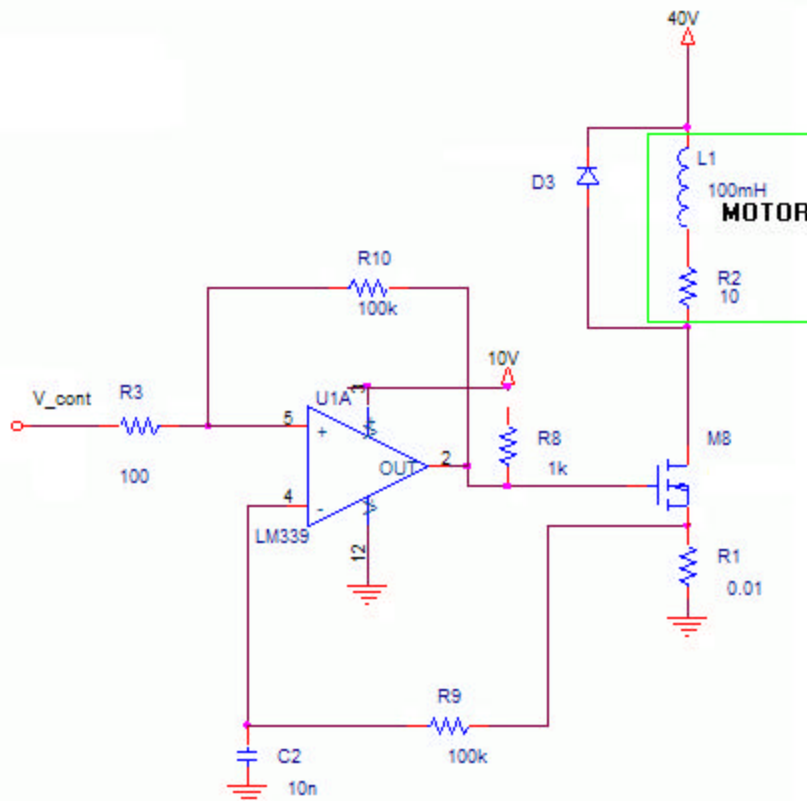
Message 16813 From: "Stefan Trethan" Date: Mon Apr 18, 2005  
Subject: Re: [Electronics\_101] my driver circuit (Re: Unipolar, chopper, microstep  
(there is discussion on the list in addition to this post)

Hi,

[http://groups.yahoo.com/group/Electronics\\_101/files/Stefan\\_Trethan/stepper2.gif](http://groups.yahoo.com/group/Electronics_101/files/Stefan_Trethan/stepper2.gif)

Note that there was the mistake with the pullup, and also there was another problem. The freewheeling current was not going through the current sense resistor, so it didn't work nicely.

There is no way to put the sense resistor in the freewheeling loop, so it can not be used. (reason is I don't want high-side sensing and some steppers have a common return so one side of the coil must be common.) I got around the problem by adding a R and a C, it damages much of the simplicity of the circuit, but it works.



Ok, circuit description as promised:

Let's start at the output, R1 is a sense resistor, it converts current to a voltage, which we can process. M8 is the FET (don't ask why M8), it could also be a npn. R2 and L1 form the stepper coil. Note that R2 is the internal resistance I used for simulation, it is inside the motor. I measured the 100mH on a stepper I have here. D3 is the freewheeling diode (conducts the current when M8 is switched off, in a coil the current must rise/fall slowly.)

Ok, so far, if we apply a positive voltage to the gate of the FET it will switch on. the current in the stepper will start to rise. if we don't switch it off soon it will be too much current after some time and the motor will burn. If switch off the gate voltage the current in the motor will switch over to the diode, and in this loop it will circulate and reduce to zero over time.

Now to the other part. U1 is a comparator. It works like that: if the voltage on + is higher than on - the output will be a open transistor, meaning that R8 will pull the output up to +10V. If the input voltage on - is higher than on + the output transistor is switched on, pulling the output down to almost zero. As you see it compares the input voltages and sets the output accordingly.

For now let's ignore C2 and R9 is a short. We see the current sense voltage is connected to -. this means if it gets too high the output goes low, switching the FET off, which is what we want. the + input is connected over R3 to the control voltage. The control voltage should be set to the current sense voltage we "would like to have". That means, set it to 0 and the current is 0. set it to 0.02V and the current will be 2A(roughly). R10 causes something called positive feedback or hysteresis. This means the switching thresholds of the comparator are pulled apart. It is like your fridge thermostat, it switches off at a colder temperature than it switches on, otherwise the pump would be started and stopped all the time. Hysteresis cools it more than required, allowing it to warm up to the higher threshold before the pump is switched on again. We want the same effect in our circuit, the FET should not be switched on/off too fast, or it will heat too much. The temperature/current needs not stay rock-steady, it can vary a tiny amount.

Ok, so far if we switch the whole thing on:

FET is on, the current in the coil rises until the upper threshold is reached, then the FET is switched off again. Now the current in the sense resistor is zero, the voltage on it falls, the voltage on the comparator input falls below the lower threshold and it switches on again almost instantly, and off again, and.

To solve this problem we have R9/C2. C2 is charged/discharged through R9, causing the input to the comparator to fall (and also rise) slowly. It takes some time to move from one threshold to the other, switching the FET no faster than a certain frequency.

Now what happens:

We power on, the comparator sees the output current is way too low. It switches the FET on until the upper threshold is reached. Then the FET is switched off and stays off until the voltage on C2 drops below the lower threshold. Then the FET is switched on again to reach the upper threshold, and so on.

Note that when the coil is first energized the FET will stay on for a relatively long time, the current rising fast from zero to the set current. Then it will switch on/off at much shorter intervals because the current only varies by small amounts around its set value.

Oh well, best make a simulation. ;-)

ST