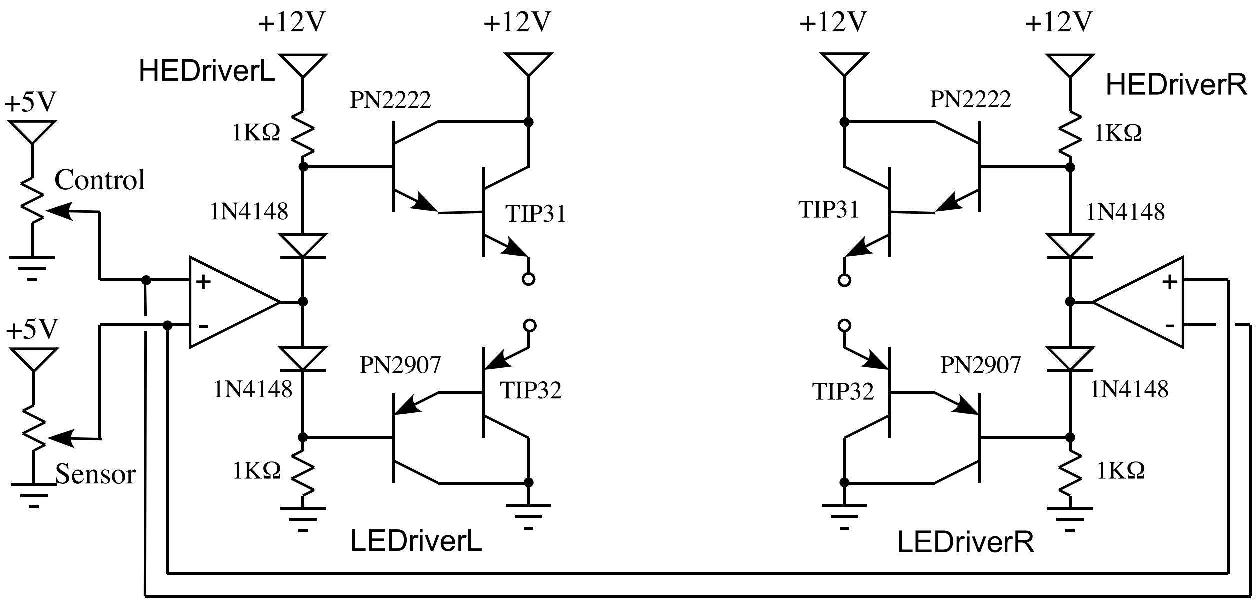
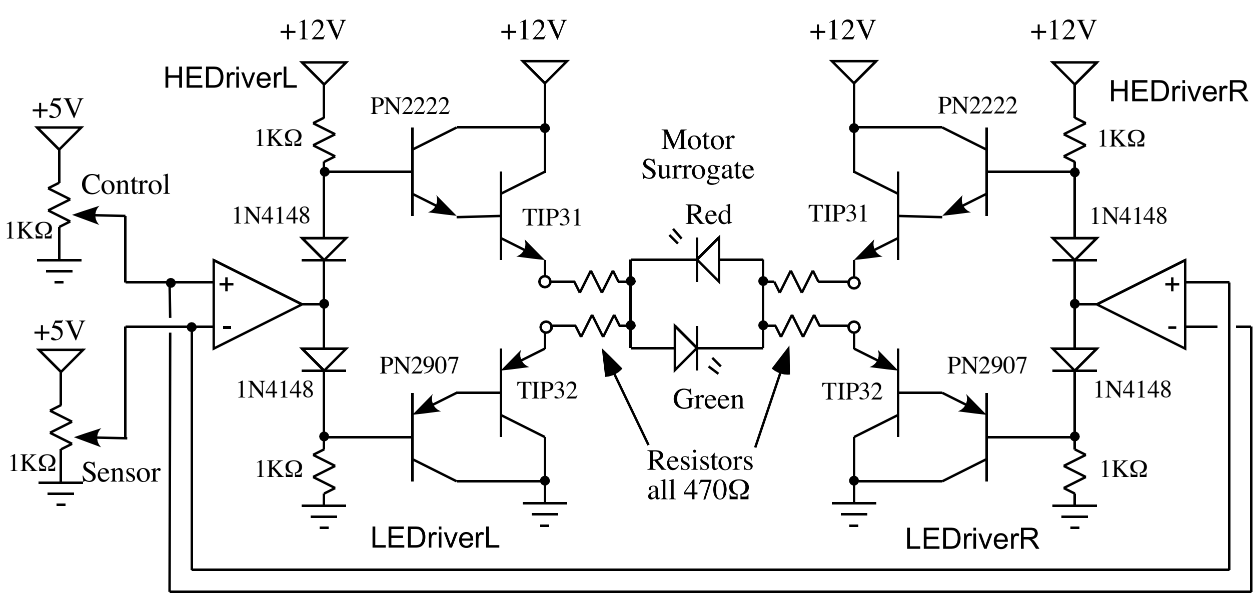
EGR222 Lab 8-9 Testing the H bridge

Before you get to trying out your H bridge with the motor, you want to do some "low stakes" testing. Break up your H bridge into four separate driver circuits as shown below:



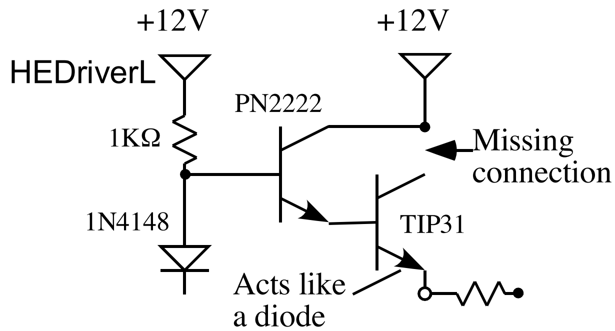
The idea is to test as safely as possible, avoiding high currents that might destroy a transistor. (It is heat that kills. Voltage times a large current produces heat. Those little TO-92 package transistors shouldn't have to dissipate more than .25 W, and even that is stressing.

It is safe to test all the drivers together under a "safe" load. That is illustrated below, with resistors and LED's as the load. This will tell you whether your drivers are all working well enough to handle a light load. The LED's and resistors serve as a "surrogate load" in place of the motor. If Vcontrol > Vsensor, the green LED should light. Otherwise, the Red LED.

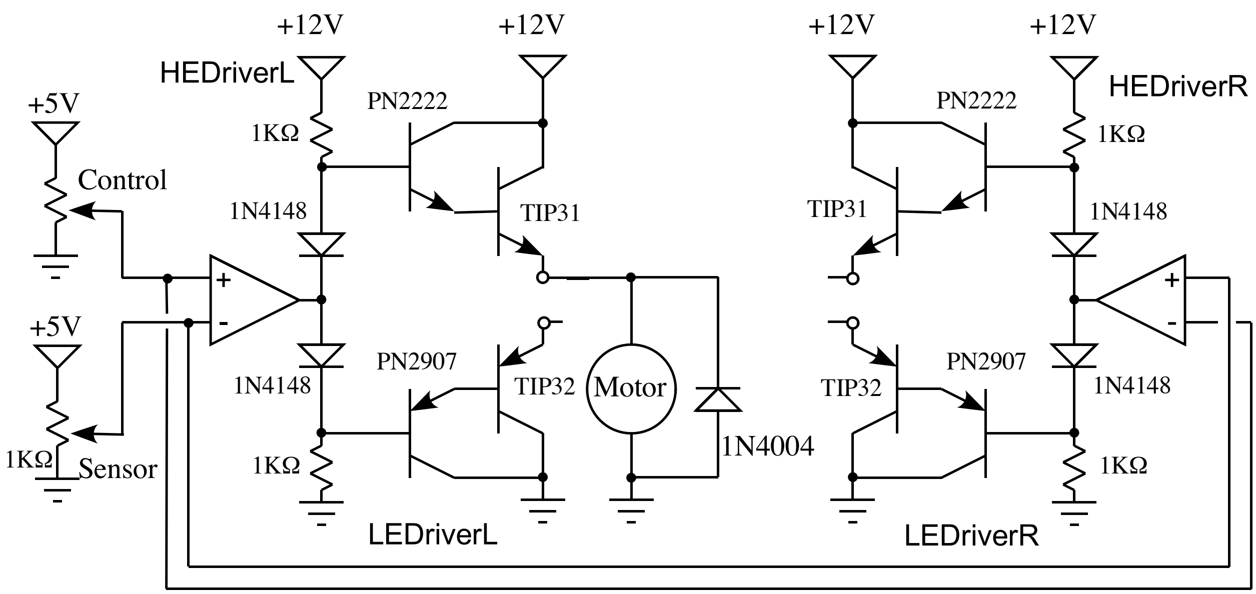


If this circuit does not work, then check each of the drivers carefully. Suppose the red LED lights when it should, but the green one does not. Then either the high end left driver is bad, or the low end right driver. Which? Use a Voltmeter. Check the Voltages. (It is also possible that one of the other two drivers is on when it shouldn't be! Check the Voltage at each output (at the emitters of the power resistors). If a driver is "off" there should be no Voltage across the 470 Ohm resistor at its output. If it is "on" there should be.

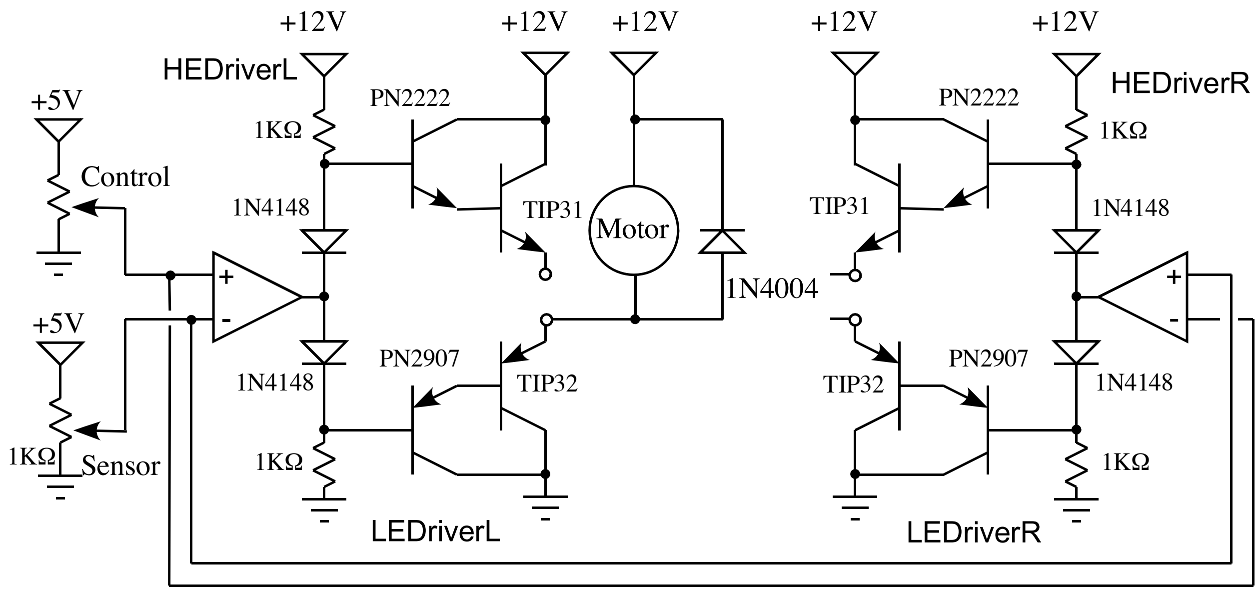
Just because this circuit works does not mean it will work with your motor. It could be, for example, that the hight end driver is working entirely off the small transistor because the power transistor collector is not connected! See the figure at right. This works fine with an LED. But if you put in a motor in place of the LED and resistor load, the small transistor dies.



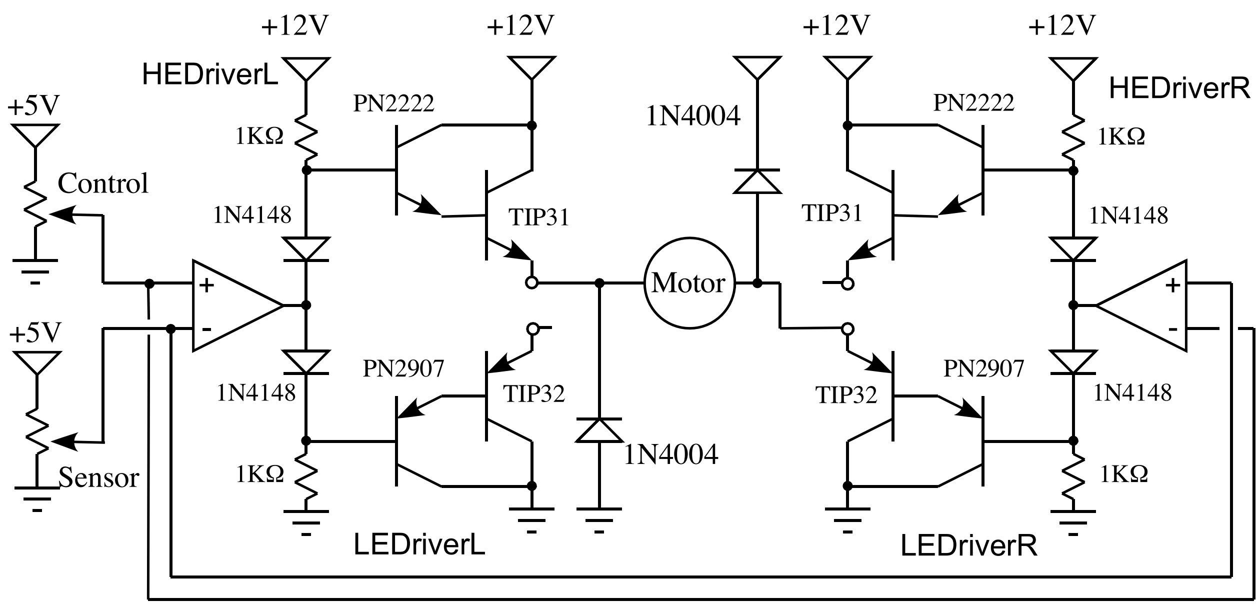
What you want to do is test the individual legs of the H bridge separately. For example, to test the Hight end Left driver, connect that one driver to the motor as shown below. When the control Voltage is higher than the sensor Voltage, the motor should come on. When the control Voltage is lower, it should go off. You can similarly test the high end driver on the right. It should go on when the control Voltage is less than the sensor Voltage. By the way, make sure you get the protection diode polarities correct. If opposite, they are shorts to ground or power, and something dies!



Next, assuming you have high end drivers working, you want to test the low end drivers similarly. The figure following shows that. You would do the other low end driver similarly. The motor should go on and off for the opposite control and sensor conditions.



Now the next step would be to check pairs of drivers together. You'd connect the motor between high and low end drivers on opposite sides, so that the two drivers come on together to turn the motor in one direction, but leave it off in the other direction. You would check this out both ways.



Once both pairs work, hook all of them all up in the original circuit given in the lab manual. Now, the motor should turn one way or the other depending on the relative polarity of the two pots. Your H bridge works!

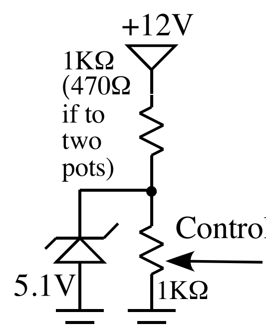
When you put it all together with the mechanical subsystem, the feedback should be negative. make sure that's the case. So, if the control and feedback pots are out of balance, the system should move the motor to bring them into balance. It's possible that it does that but the system is unstable. Even likely. That's when you add the resistors (as shown in Figure 9 of the lab manual lab exercise description) to reduce the gain of the op-amps to the point where you get stability.

You ARE using TIP-31's and TIP-32's for your output transistors, right? With heat sinks? Handling power matters. We are doing Analog control. The high end drivers are under the most stress because our power supply of 12V is used for both the electronics and the motor. That means that there will be a Voltage drop of at least a few Volts across the PNP power transistor when it is all the way on. If the motor current is large, the transistor dissipates power. If the sensor quickly matches up with the control, that is brief and the motor stops, drawing very little current. The “testing” circuits are more stressing than normal operation, because they turn the motor all the way on and you get the most current draw. So, when you are doing testing, don’t leave it on too long. Also, lightly touch the power transistors just to see if they are getting hot. If hot, give them a rest. If you see smoke, turn things off! Any semiconductor that smokes is probably dead. (Resistors are probably OK.)

Hopefully this testing guide will help you. You want to do this before you connect up to your mechanics, and before you substitute your actual sensor for the pot.

You should also check out your actual sensor with no motor activated. See if moving the object controlled back and forth reverses the op-amp outputs (with no motor in the circuit) just as for the pot above. Try it at different control Voltage settings. This should give you a good idea of the range of motion you can expect. You may need to adjust your sensor conditioning to get the range of operation closer to what you prefer.

If you need a 5V source for the control (and sensor) reference and you want to use your %V power supply elsewhere, a simple shunt regulator as show at right does the trick. (The 5V Zeners are glass, and look a bit like the 1N4148’s, but are thicker and have heavier leads.) The choice of dropping resistor depends on the load of the circuit being supplied. For a 1K pot, 1K is good. If you have both pots, use 470Ω. You should also probably pot a capacitor across the Zener, 10 uF or so should do it (not shown).



It is hoped that this outline of a testing procedure is helpful. Indeed, it is a good idea to build a little, then test as you go. That’s a very helpful principle to follow, especially in large complicated systems.