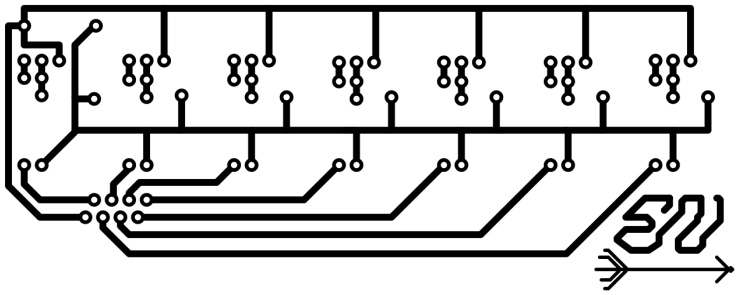
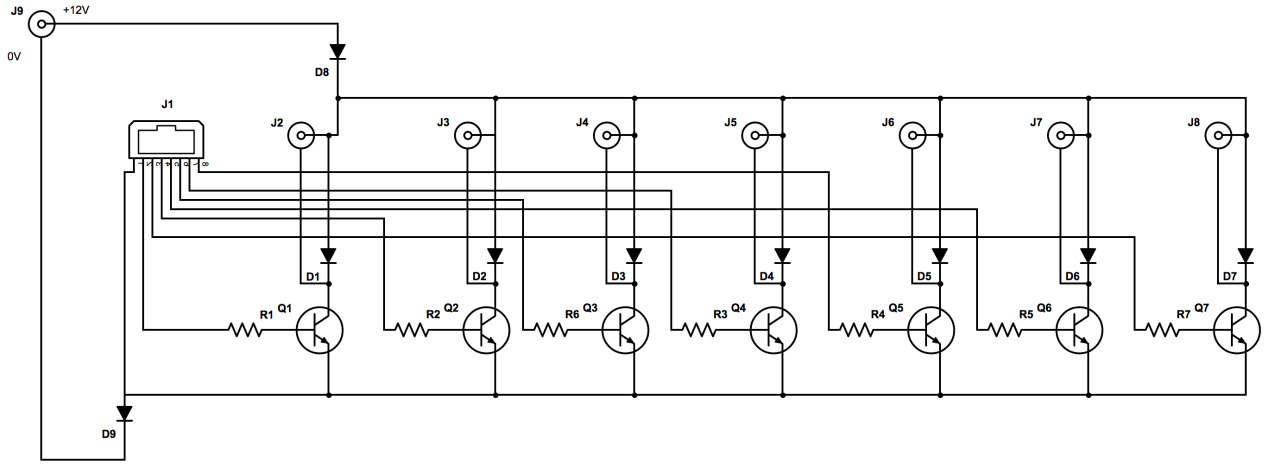




Bill of materials

1	RJ45 CONNECTOR (ground pin is the furthest left side pin)
9	1N4004 DIODE (orientation: stripe towards the RJ45 connector
7	26,4 Ohm Resistor
7	IRFZ46NL N-Channel Mosfet (orientation: text towards RJ45 connector)
8	DC connectors
1	a small box to house the circuit

Arduino sends a 5V control voltage to the gate of the Mosfet. A 12V powersupply connected to the power inputs of the circuit makes a 12V voltage always present at the Drain of the Mosfet. When the control voltage reaches the gate, the drain – source path connects in the Mosfet closing the circuit -> giving 12V to the motor, thus turning the motor on. Using a variable voltage from the Arduino's PWM ports, you can control how much of the 12V goes in the motor -> control the speed of a motor.

The IRFZ46NL N-Channel Mosfet uses voltages below 4 Volts to open the Drain / Source pat. The 26,4 Ohm resistor drops the 5V voltage from the arduino so that the whole range of the Arduinos PWM output can be used. The Diode blocks any current flowing back into the Arduino and is needed to protect the precious microcontroller. Depending on the motors you are using, they coils can create iduction currents that could otherwise flow back and damage the Arduino.

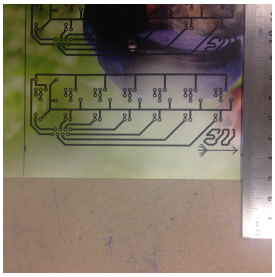
You will probably want to enclose the circuit in a box of some sort. You will also need connectors for the powersupply and the outputs.

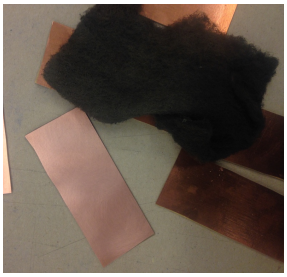
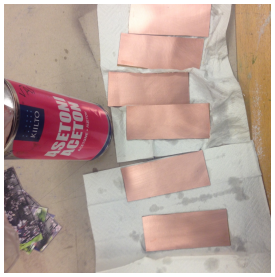
PCB build instructions:

For the PCB you will need:

- a black copper plated pcb (one side plated only)
- sodium persulfate
- plastic container
- rubber gloves
- protective glasses
- a wooden sticks
- glossy magazine paper
- iron (for ironing clothes)
- toiletpaper or any other soft paper
- acetone
- steelwool or very very fine sandpaper
- ink printer
- drill press, or a normal powerdrill
- 0,8mm drill bit or small nails + metal file to make your own drillbits
- metal saw

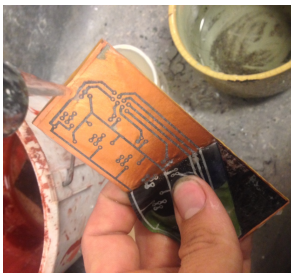
While making the PCB you are dealing with toxic chemicals so you need to make sure that you protect yourself and others while working. Also make sure you don't spill any of the chemicals to your surroundings. BE VERY SURE TO GET RID OF THE CHEMICALS IN AN ENVIROMENTALLY RIGHT WAY, BY TAKING THEM TO THE PROBLEM WASTE RECYCLING IN A CONTAINER THAT CANT BE BROKEN EASILY.



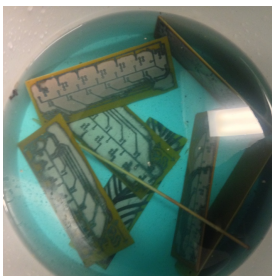



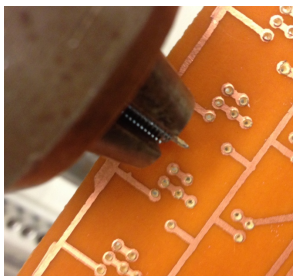
Print the PCB provided onto a glossy paper with an ink printer. You can dig up some glossy paper for free from a recycling bin or buy it if you want. Cut the copper boards to the correct size and use the steel wool to make the copper clean. Finally clean with acetone, and don't touch the copper anymore with your greasy fingers.






Next iron the paper to the copper plate. Don't mess around, the paper might tear if you scratch it with the edge accidentally. Try to iron as evenly as possible. After ironing, let the whole thing soak for a while in cold water so the paper comes off easier and you don't burn your fingers. The paper should peal off easy once fully soaked. If you need to rip it, its not ready yet…



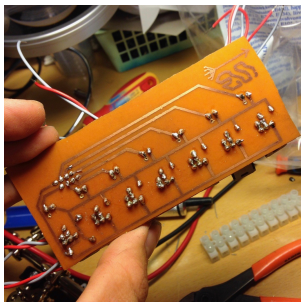



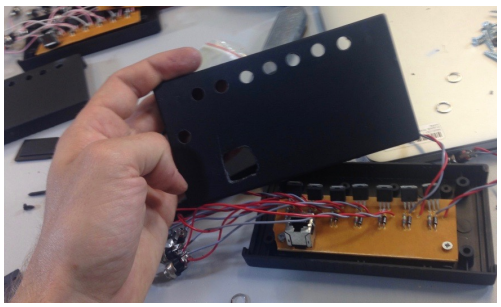
Next step is the dangerous part. You have to get sodium persulfate from an electronic store. This stuff is hazardous for the environment and your health so protect yourself! Use the rubber gloves, because it will burn your skin slowly if spilled. Also if this comes in contact with your favourite t-shirt, it will slowly burn holes to the fabric even if you try to wash it away. The stuff I had was supposed to be used in 1/5 ratio: 1 part chemical and 5 parts water. I did not measure this with a scale, just made an approximation. I had about 0,5 liters of water and and a 100g of the chemical and did the mix into a plastic container. Don't use a metal container. I dumped all the PCB's and some art work I did on a scrap piece of a copper board into the solution. I placed some wooden sticks in there as well to keep them from lying completely on the bottom. It will take about 30 minutes for the solution to do its thing, but you can speed this process by agitating the mix, giving it more oxygen which it likes. You need to do this in a well ventilated place and if you agitate, use a wooden stick, don't put any metals in there. Also probably not a good idea to inhale the nice smell it gives. If you leave the mixture unattended be 1000% sure that nobody will go an hurt themselves with it. After you see all the copper has vanished, carefully place the PCB's on some paper that will absorb any drops of the liquid.

NOW DON'T LEAVE THE LIQUID ANYWHERE JUST LYING AROUND. ITS A CHEMICAL WASTE AND NEEDS TO BE DEALT WITH ACCORDINGLY. PUT IT INTO AN EMPTY PLASTIC BOTTLE OR SOMETHING THAT YOU CAN CLOSE TIGHTLY. WRITE ON THE BOTTLE WITH A PERMANENT MARKER: SODIUM PERSULFATE SO THAT THE PEOPLE WHO ARE GOING TO DEAL WITH IT LATER WILL KNOW WHAT THE BLUE STUFF IS!

Next step is to use some acetone to wipe off the printer ink. You should see some beautiful copper traces revealing underneath. Examine all the PCB's for errors, you can fix them easily by soldering. Next drill the holes with a drill press. You need a 0.8mm drill bit, which are hard to find. I used an old screw and filed it to be a sharp needle. It did not last very long, but then I just made another one from a nail. Be careful to not mess up the copper ring around the spot where you are drilling.

After you have finished the PCB's, congratulations! Next step is the easy part. This circuit is not difficult to solder. The RJ45 connector pins are quite close to each other, but other than that, this is easy. Its still a good idea to take a break now and have some lunch or go sleep.





Next you have to solder all the parts to the PCB. Also think about what kind of enclosure you will use. I spent some money on some black plastic cases at the electronic store (2 euros each). Better anyway to build something durable because these things should last quite long, there's not really much to mechanically break.

The red cables are +12V and the grey cables are ground. The top left corner of the PCB has the power supply inputs. When you solder the DC connectors, be sure to solder them all identically, so one isn't inverted. I soldered all the DC plugs so that the center is +12V and the collar is ground. Depending also on the power supply you use, the plug can be reversible, so the polarity of the center and the collar might be inverted. Check this out carefully. I was not very clever, and forgot to put protective diodes to the power supply inputs. Its easy to add the two extra 1N4004 diodes shown in the schematic, so that the +12V cable coming into the board has the diodes ring towards the PCB, and the ground of the circuit has the ring of the diode pointing away from the board. This mod is not in these images, but shown in the schematic. Sorry for confusion… The image below will anyway guide you how to place all other components: