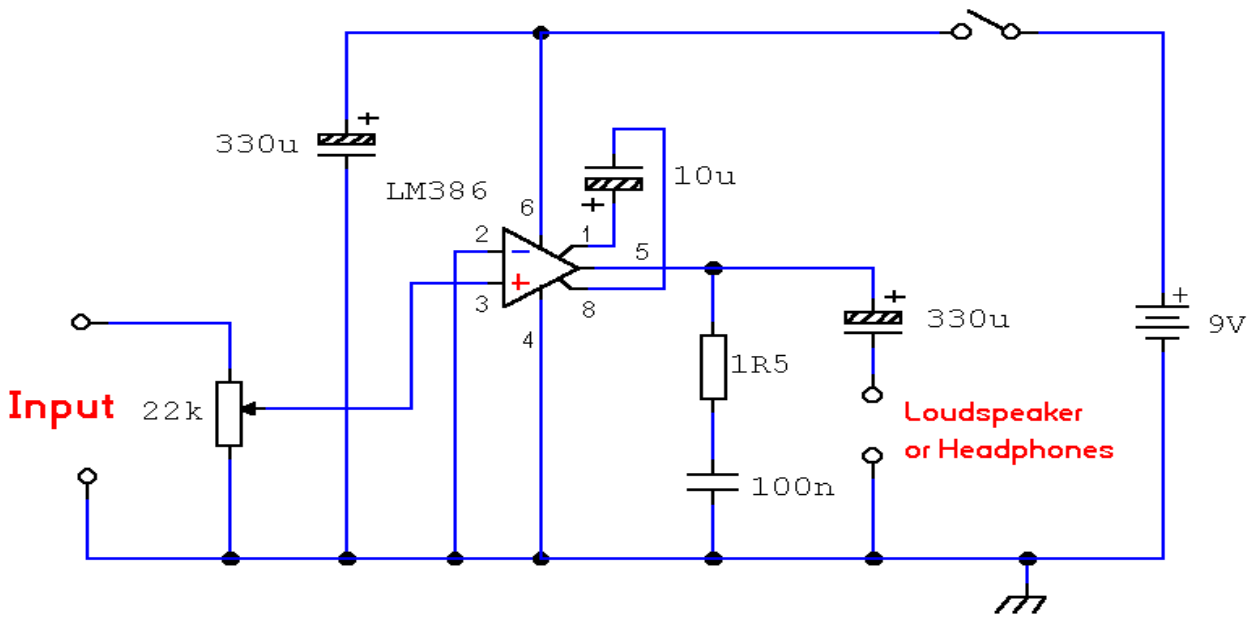
FROM SCHEMATIC TO VEROBOARD

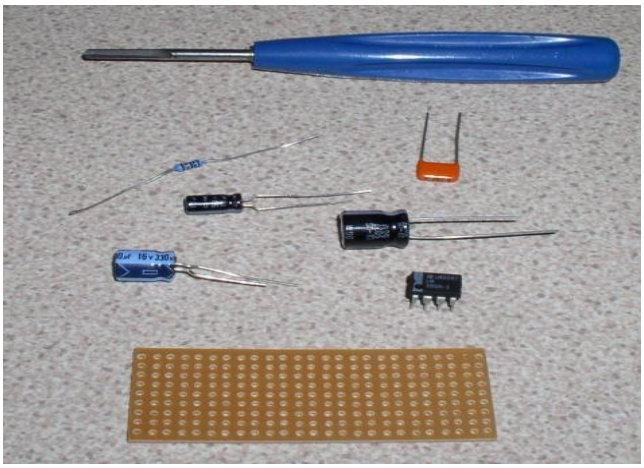
The circuit of a bench **amplifier** utilising a LM386 linear (integrated circuit) IC and a few other components is used for this tutorial. The schematic is shown below:



First a parts list is created.

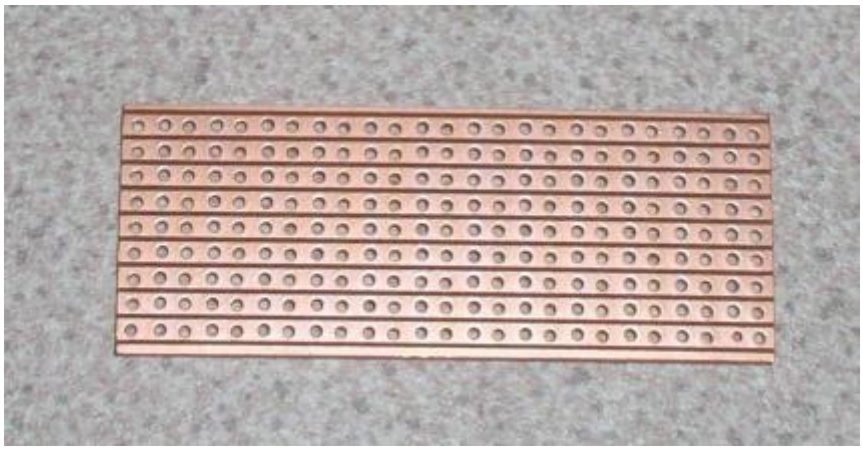
These are the parts for the above circuit:
- 1 x 22k potentiometer (log); or 25,000 Ohm variable resistor.
- 1 x 1R5 ohm 1/4W(att) resistor 5% tolerance; this is a 1.5 ohm resistor.
- 1 x 10uF 25V electrolytic capacitor
- 2 x 330uF 25V electrolytic capacitors
- 1 x 100nF ceramic capacitor 100V (these small capacitors are usually rated 100 or 2220 or 400V)
- 1 x LM386 linear integrated circuit
- 1 x 8 Pin DIL socket (optional)

First the components are collected and laid out. The blue item is a veroboard track cutter, but a 1/8 inch drill bit can be used to break the tracks.



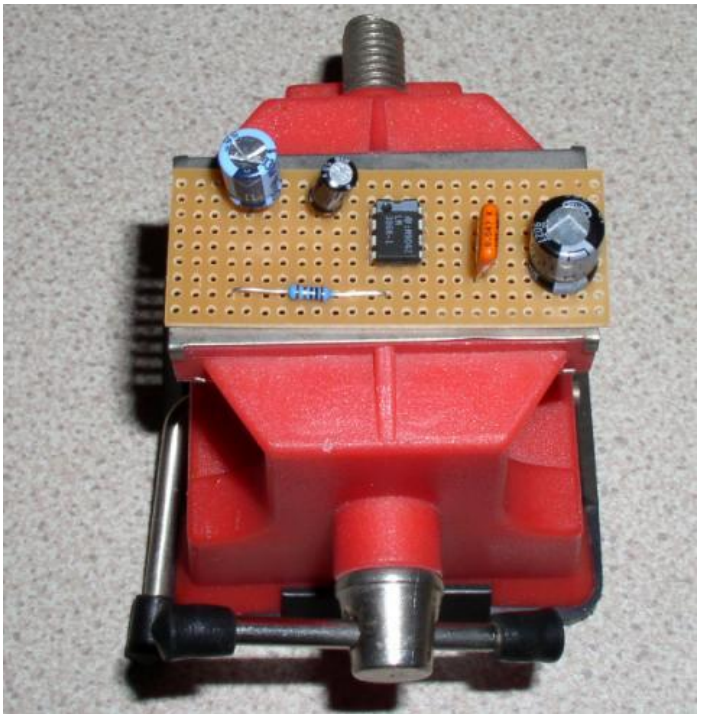
A suitable piece of veroboard is used.

This must be large enough to hold all the components of the circuit. They are available in standard sizes, the piece below is 9 holes wide by 25 holes long and approximate dimensions 1 by 2.5 inches. Each of the horizontal 9 strips is known as a "track". A track is the same as a single wire running from opposite ends of the board.

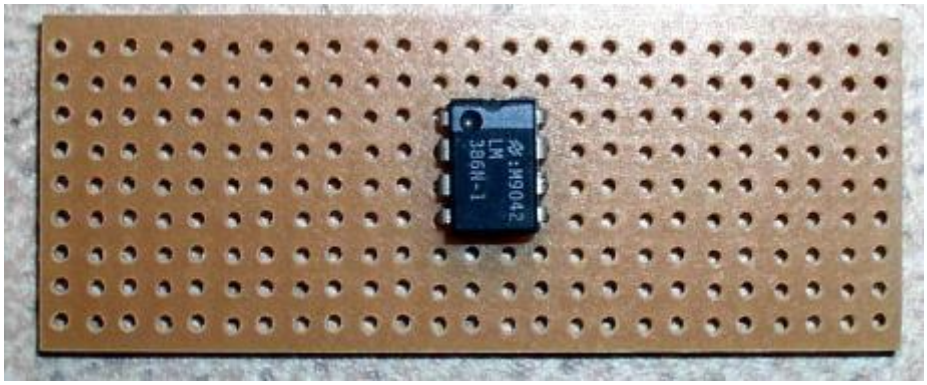


If a track is broken, with a drill bit or veroboard cutter, then you have two non-connected wires on the same horizontal strip. Note that NO continuity exists across adjacent tracks. If this should happen, i.e. when cutting a track and a piece of copper "swarf" should accidentally bridge two tracks, then the design would be compromised and probably not work at all. Therefore take care when breaking tracks and examine the board after making each break.

Check that the veroboard is large enough. Loosely push all components through the holes (in any order). Leave at least a space of 2 holes between components. This will allow room for wiring and track breaks. A small vice may be helpful to assemble your circuit.



Work begins ! You do need to know how to read a schematic. The lines represent wires, the symbols are the components.



Look at the schematic. The triangle represents the LM386 Integrated Circuit component. As 7 connections are used it makes sense to place the IC somewhere central, (see above picture), as tracks above and below the IC will act as the wires for the power supply.

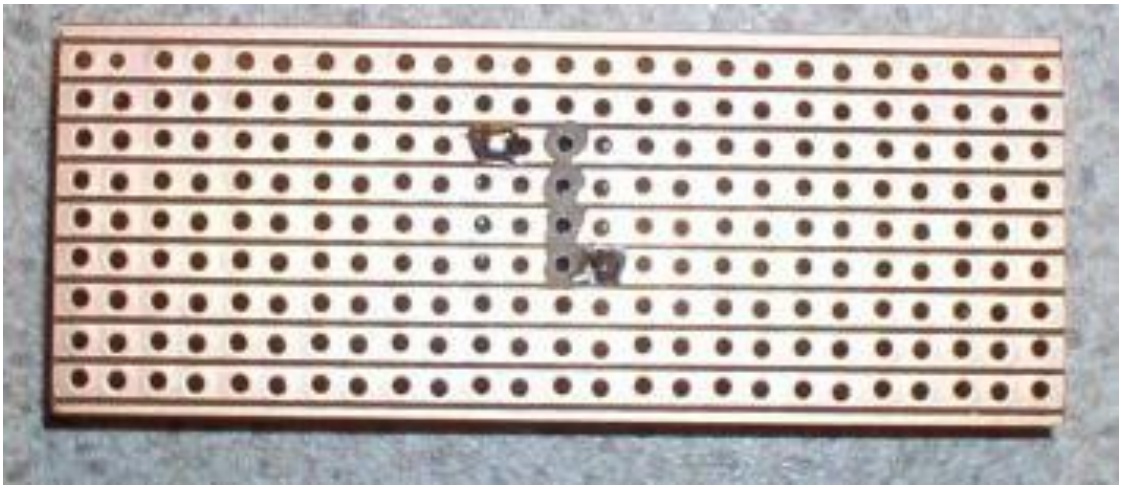
Turn the board over, all component pins should poke through the shiny copper side of the board. All soldering and track cutting is also done on this side.

You need a little soldering experience to begin with. If you are not used to soldering, then it is advisable to use a plastic IC socket.

There are other advantages to using a socket, mainly if the IC should fail, it can be simply unplugged from the socket and replaced, no need to de-solder and resolder.

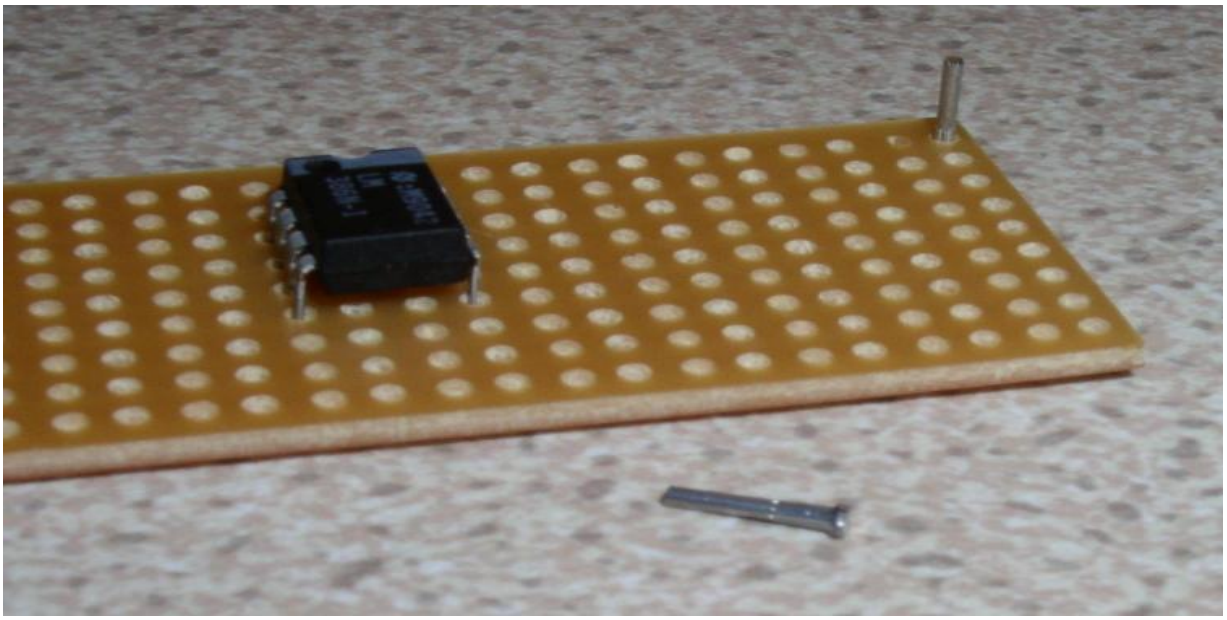
Remember that as the board is now upside down that the top and bottom tracks are reversed. If you turn it upside down and through 180 degrees then left and right are also interchanged. This must be born in mind throughout construction.

If in doubt, turn the board back and forth and keep an eye on a reference point, say pin 1 of the IC, marked with a dimple or round spot.



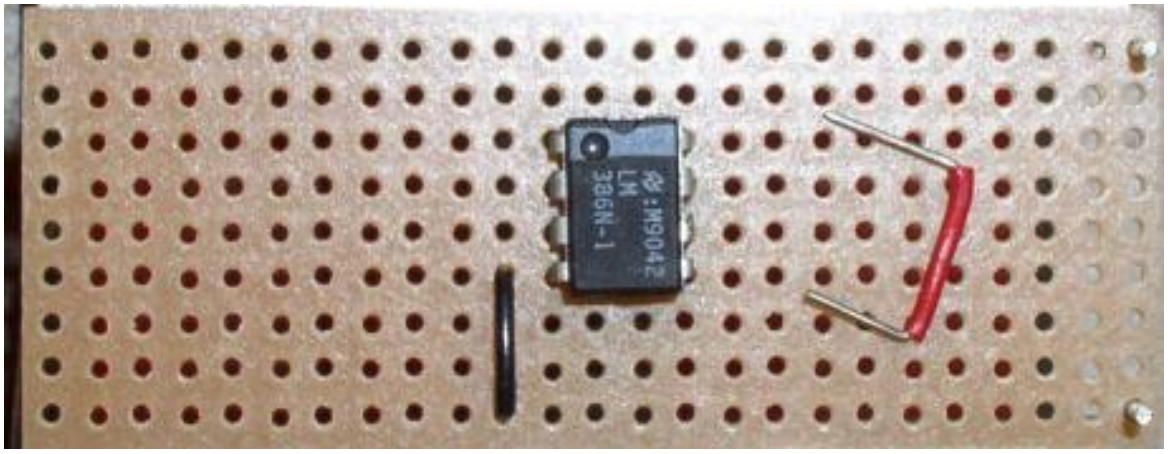
Diagonally opposite legs are first soldered. This makes sure the IC is held firmly. Next the veroboard track cutter is used to break 4 holes in the centre of the IC (or IC socket). Without this pins 1and 8, 2 and 7, 3 and 6, 4 and 5 would be short-circuited. After breaking the tracks, solder the remaining pins on the IC or IC socket.

Turn the board over and use two veropins for the power connectors. A veropin is a short piece of metal which makes contact with the copper side of the veroboard. It is rigid and allows a wire to be connected on the component side of the board. Veropins also make convenient test points as well.

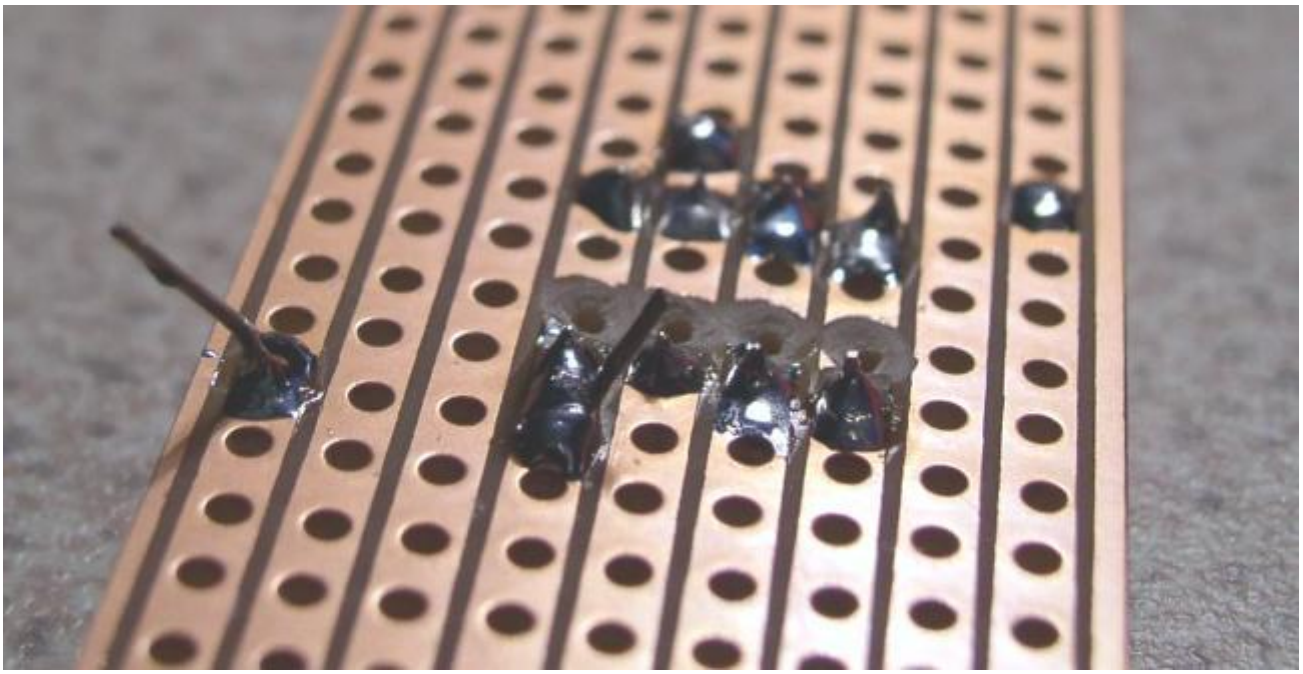


A veropin is shown above (centre bottom). Push two veropins through the copper side at the right hand side on track extremities. It is a good idea to separate power supply rails by at least one vero track.

Now the IC and power rails are ascertained, it is time to start wiring. Pin 4 is the ground connection, so a piece of wire is used to connect from the adjacent track next to pin 4 of the LM386 to the ground track (bottom track) with veropin. Any colour wire may be used, many people use black for ground connections, and red wires for power. It's up to you. Just remember what the colours of each wire signify.

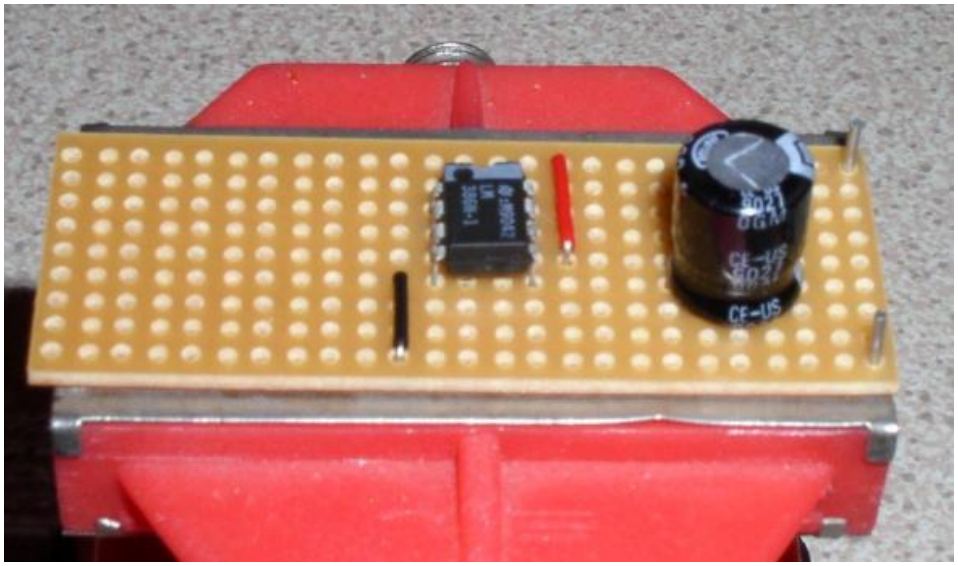


The wire (also called a "jumper") because it bridges are spans several tracks is soldered on the copper side. After soldering the end wires are cut close to the board. The red jumper connects pin 6 of the IC to the top power rail and can be seen in the photo below already soldered.



Components can be added in any order. Some people prefer to use the larger parts first, so that they are aware of the physical space left on the board. It is however good practice to solder veropins, jumpers first, then passive components, resistors, capacitors, inductors, followed by active components such as diodes and transistors next.

Finally IC's are added last, the reason for this order is that repeated soldering and excessive overheating of the board can destroy the sensitive components. If however, you are a competent at soldering, any order of assembly can take place.

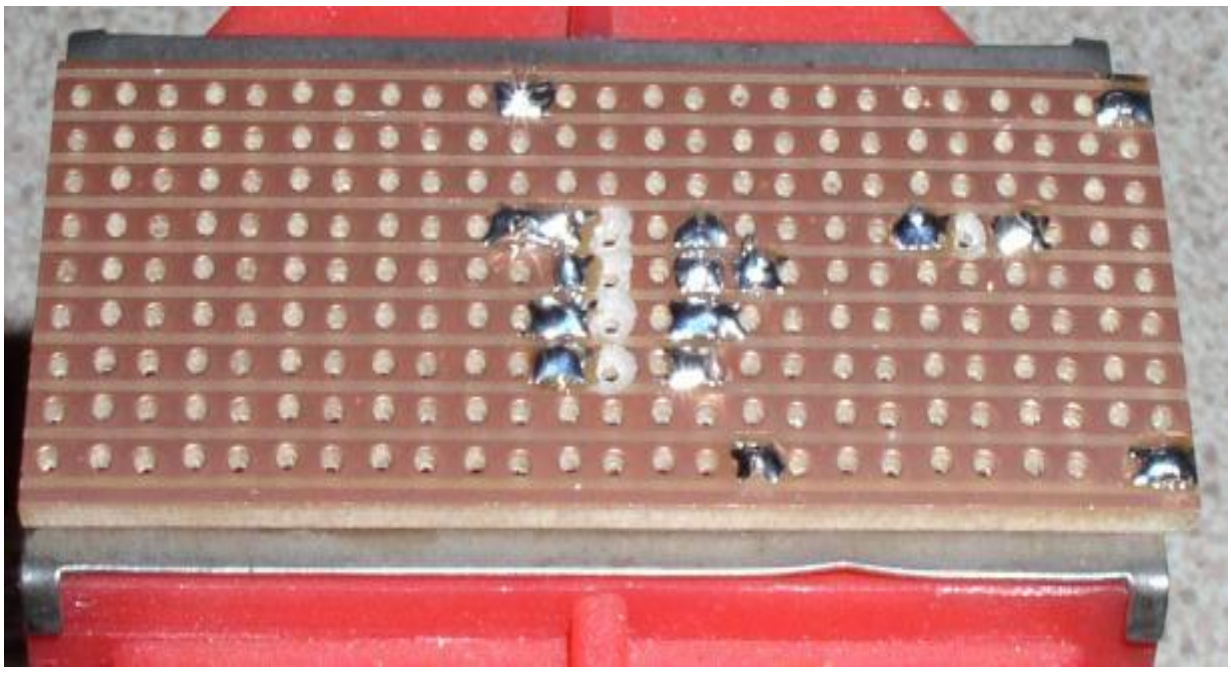


The board is turned over and the 330uF output capacitor put in place. From the schematic the "+" plate needs to connect to pin 5 of the IC. Place the

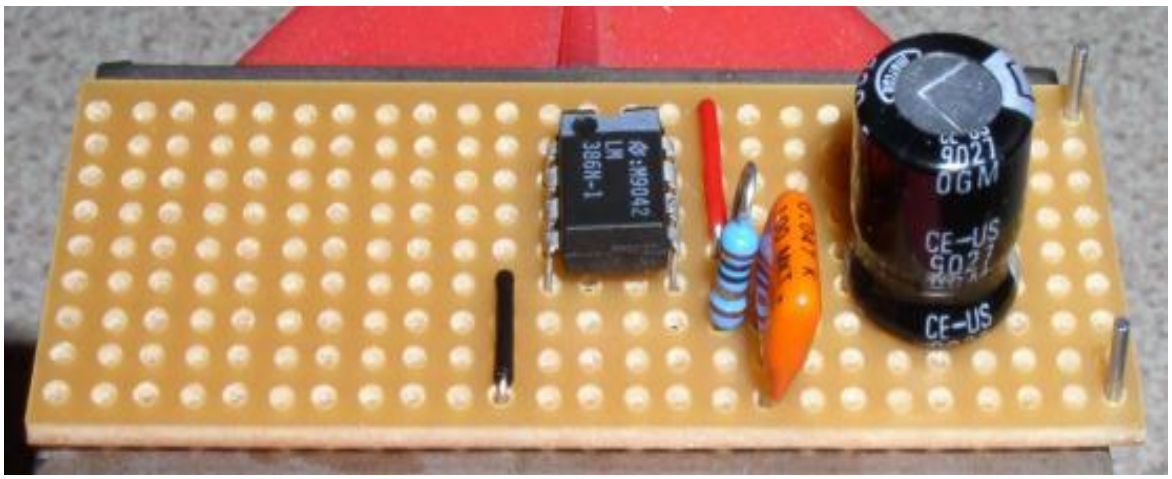
component a few holes away on the same track as pin 5 of the IC in the same direction.

As can be seen below, the 330uF capacitor is now soldered a few holes away from pin 5 of the IC. Also note that the centre track of the capacitor is broken. If you forget to do this then the component is short circuited by the vero track itself.

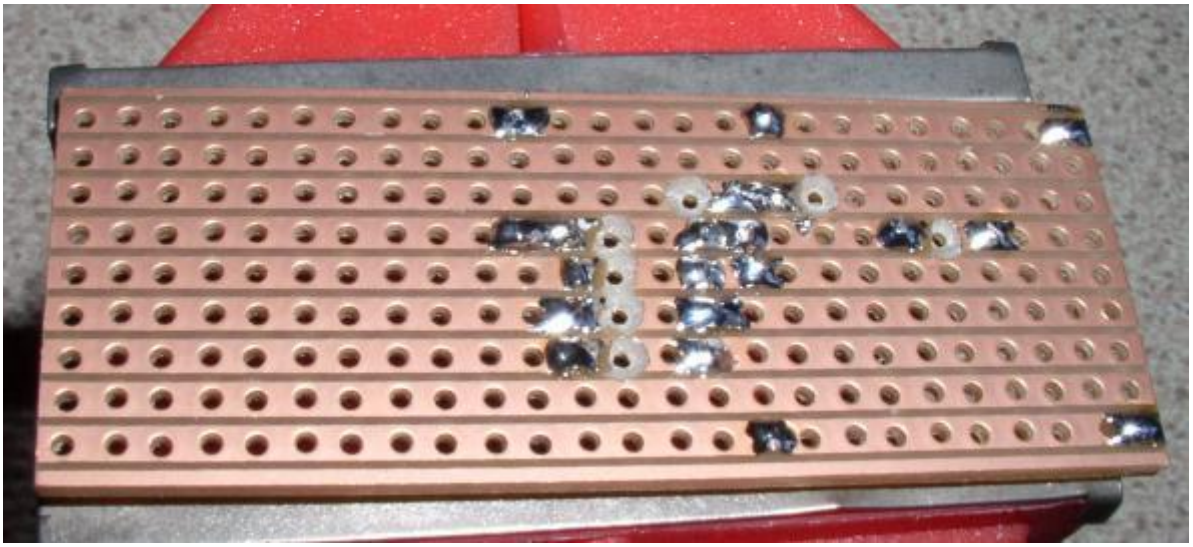
Components may be placed in line with the tracks, at right angles, or diagonally, there are no rules. However, if components are in line with a track, then the track must be broken, otherwise the component is short circuited. The output from the amplifier (see schematic) is the negative side of this capacitor. A veropin can also be used to make the external connection to a loudspeaker easier.



As the output capacitor has been soldered, the zobel network comprising of the 1R5 resistor and 100nF capacitor are wired up. Referring to the schematic, one end of the resistor is also connected to pin 5, one end of the capacitor goes to ground, and the free ends of these two components are wired together.



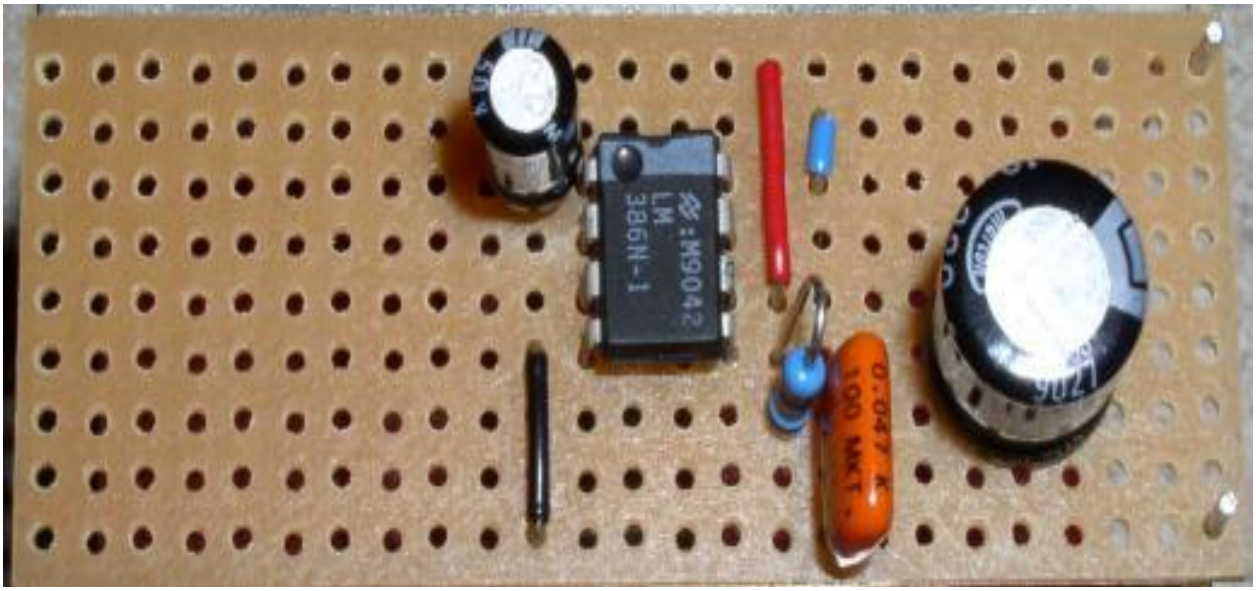
This is the underside of the 1R5 resistor and 100nF capacitor. The resistor is wired adjacent to pin 5 of the IC and to the track immediately below the IC. The 100nF capacitor is wired adjacent to the resistor and to ground.



As no more connections are at the union of the resistor and capacitor, the tracks are cut either side. The track either side of the break is now free to be used, if required.

The tiny piece of solder also on the same track as pin 5 of the IC is a solder splash. As long as the solder blob does not bridge adjacent tracks, it is nothing to worry about.

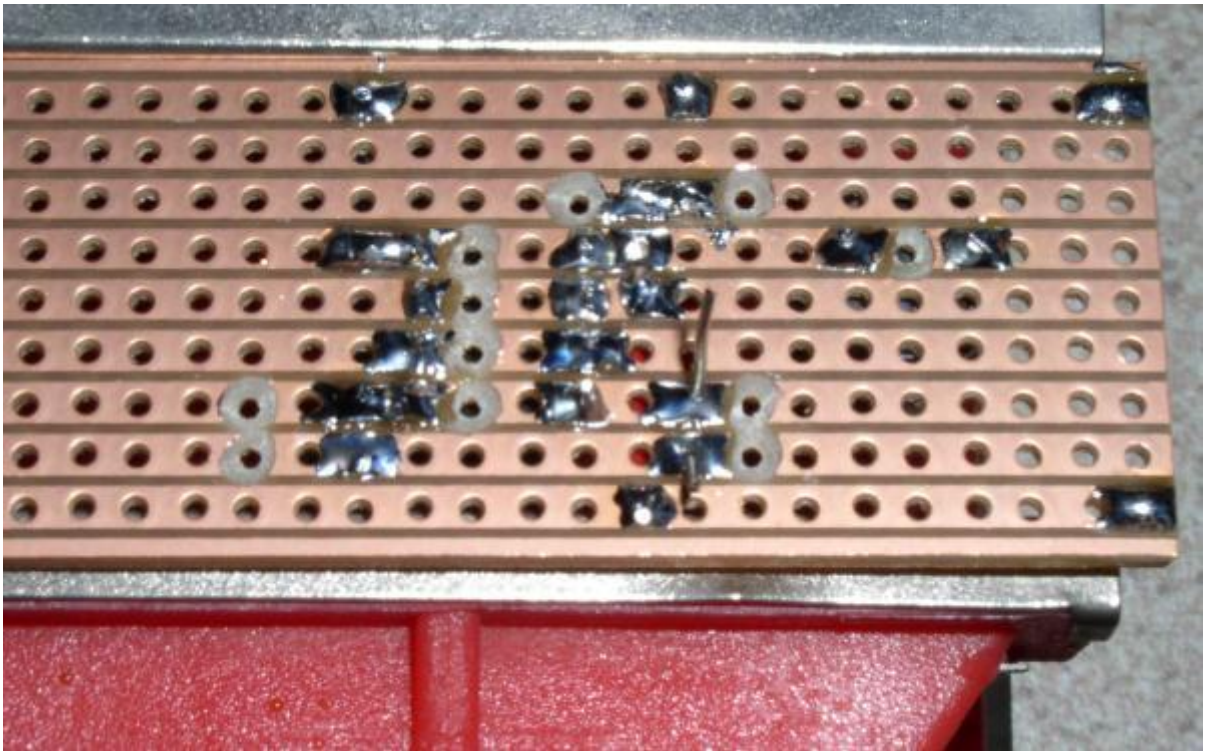
Referring to the schematic, the output side of the amplifier is almost complete, apart from a 10uF electrolytic capacitor connected to pins 1 and 8 of the IC. Note the polarity, the positive terminal connect at pin 1, so the capacitor is pushed through a veroboard hole adjacent to pin 1 of the LM386, at right angles to the copper tracks on the reverse side.



As pin 8 is connected to the negative plate of the capacitor, a blue jumper wire is pushed through a hole near the IC on pin 8, the other end of the jumper wire

is connected to the same track as the negative pin of the 10u capacitor. This is shown in the above picture.

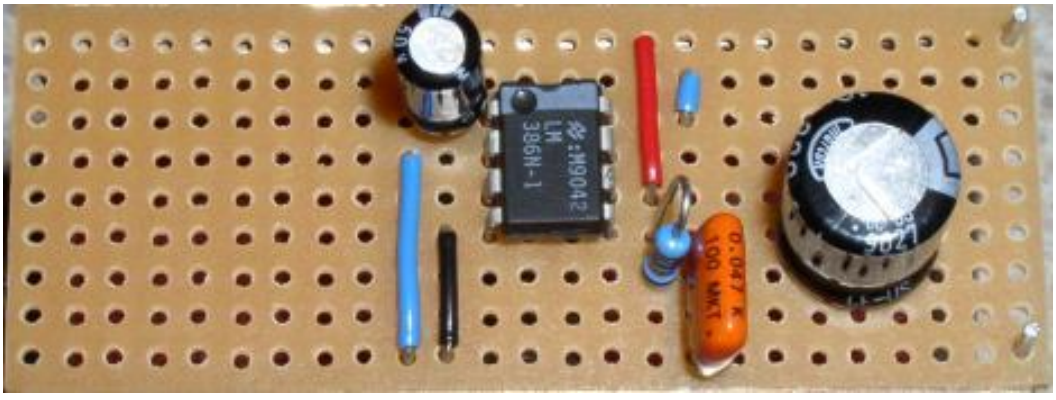
The underside of the veroboard is shown below. Note that the right hand side of the picture shows the power supply veropins (top and bottom tracks).



The blue jumper wire leads are shown (before being cut flush to the board). The 10uF capacitor is soldered and cut short. Note that the second track from the bottom is now connecting the negative side of the capacitor to the jumper wire which returns to the LM386 pin 8.

As before, the track is broken outside of each of these two soldered points. This is because no more connections are required at pin 1 or pin 8 and also frees the section of the verotrack which may be used again if required.

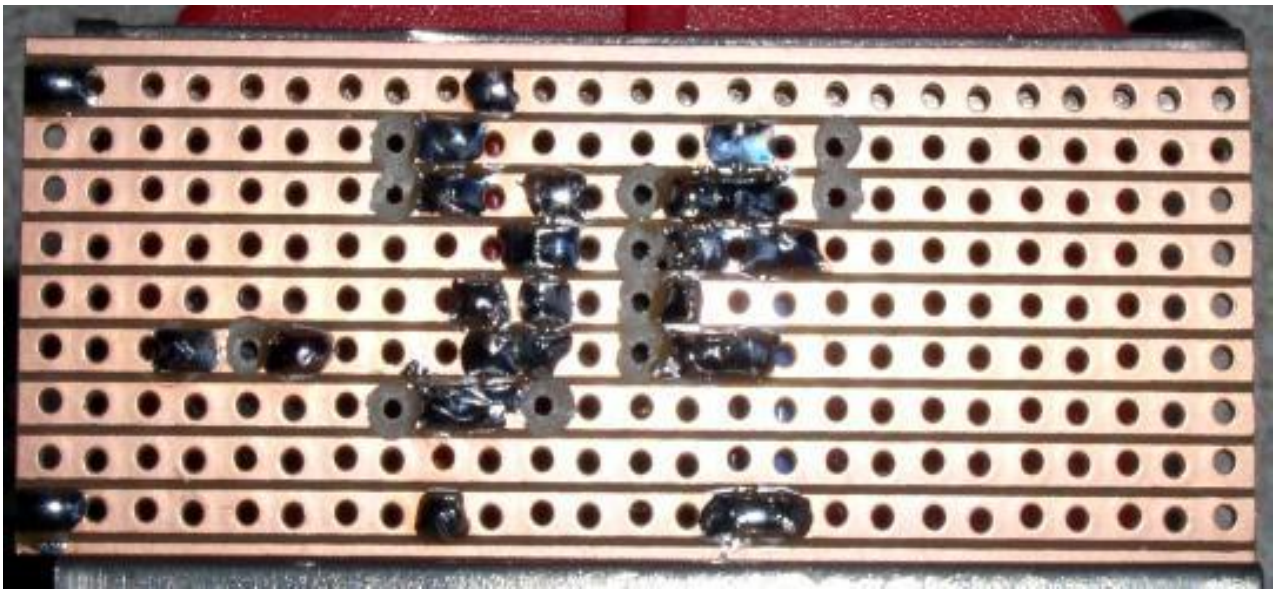
If you are new to constructing circuits you may find it helpful to print out the circuit and place a pencil tickmark at each point on the schematic where a connection has been made.



In the schematic so far, the right hand side of the circuit from the op-amp has now been connected.

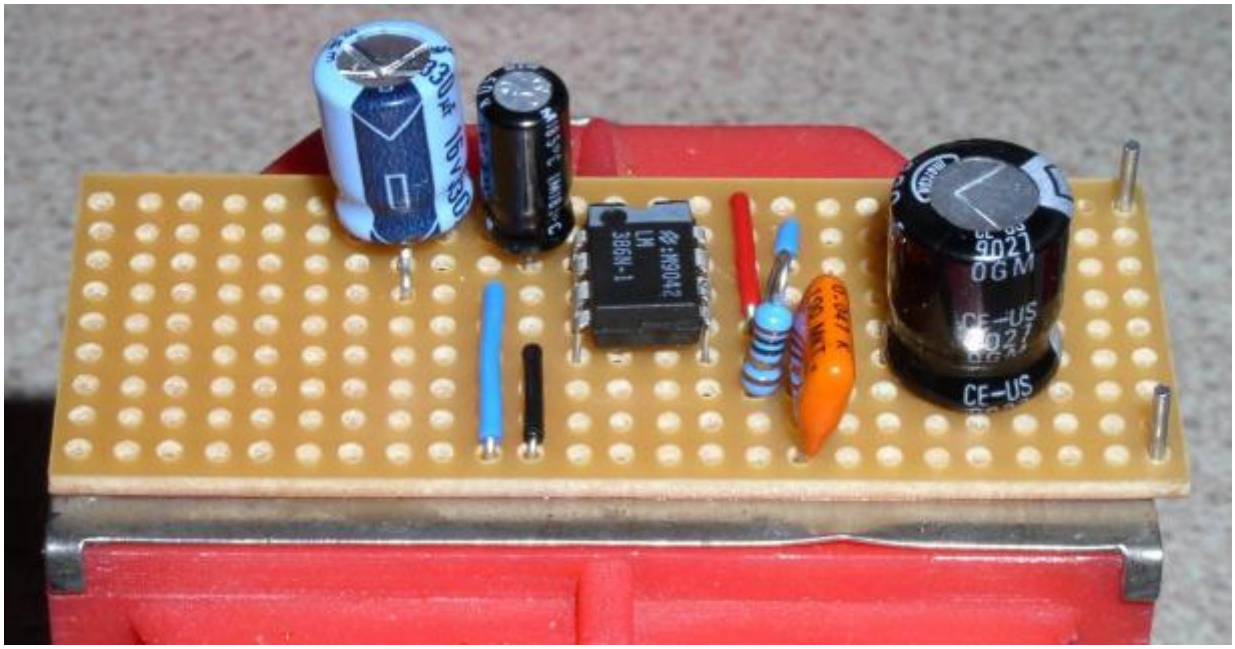
All that remains, is the inputs of the LM386 and the smoothing capacitor. A link is created from pin 2 to ground (shown in blue) above.

The link is soldered. Note that the board is now upside down and reversed in the picture below. Turn the veroboard back and forth a few times to help familiarise the position of components from each side. This will help you become familiar with making circuits on veroboard.



The blue link is now on the right side track 1 (bottom) and track 6.

The final 330uF electrolytic capacitor can be added. This is the leftmost capacitor in the schematic.

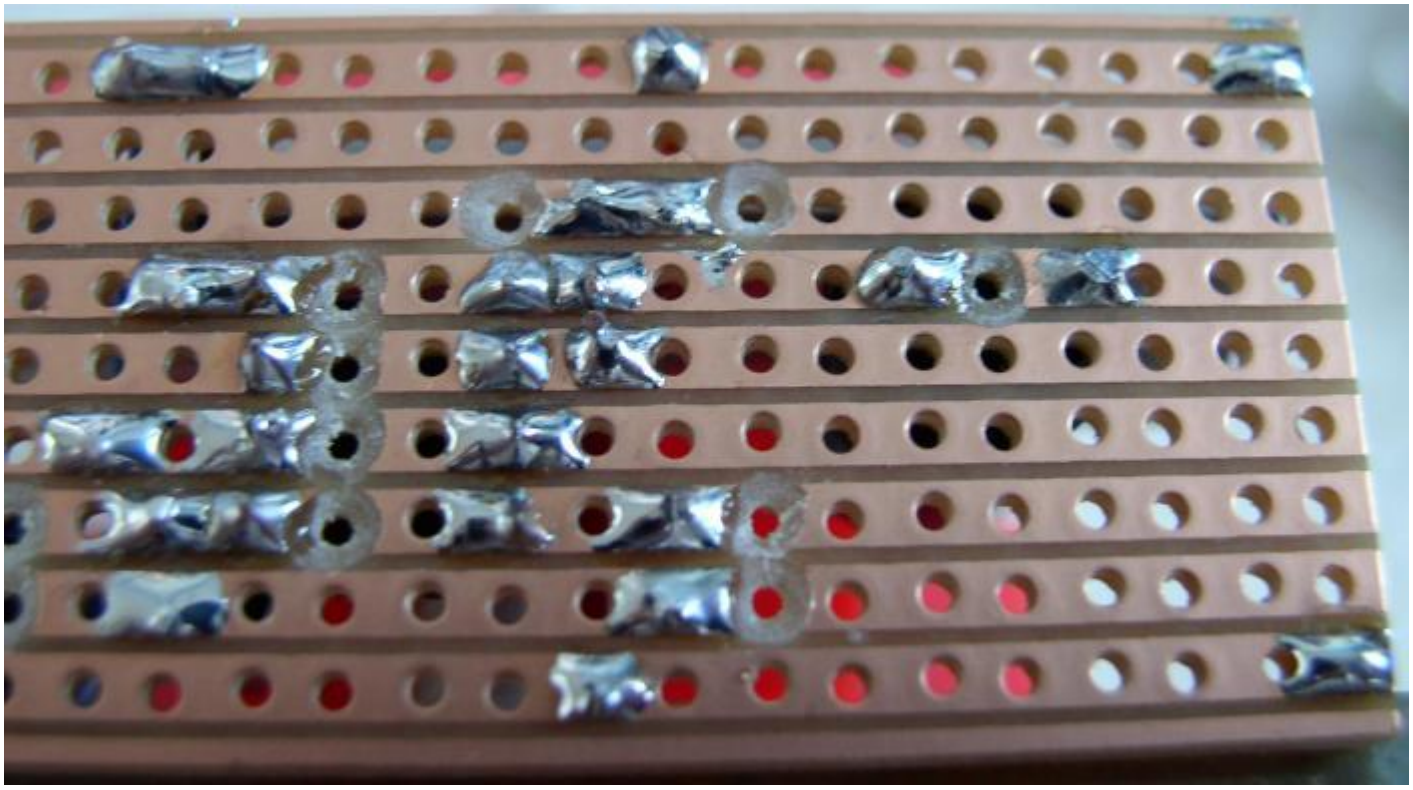


This capacitor is inserted so that the positive plate is on the positive power track and the negative plate reached to the same track as pin 2 of the LM386

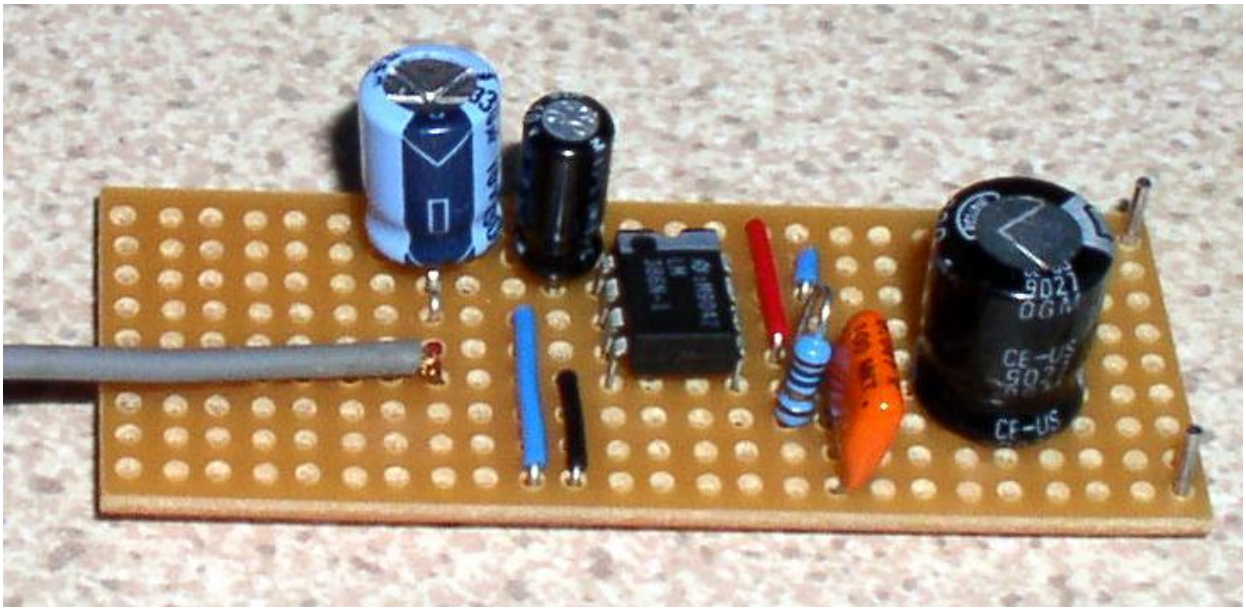
which is also at ground potential. The final component is the volume control. As this is external all that remains is to solder a length of screened cable between the LM386 at pin 3 and ground.

Job complete.

A final close-up inspection of the board is recommended. Pay particular attention to all areas where the tracks have been cut and also where there are any solder splashes. All soldered joints should appear shiny as in the picture below.



The final completed amplifier circuit with a short length of screened cable (grey) leading off to the volume control.



Going Further:

If you have followed this article, then it’s only a short step from wiring up a more complex circuit. Working with digital circuits or logic circuits can prove challenging. The pinouts of IC's need to be studied, but usually, by careful placement of the IC, veroboard tracks can be utilised, minimising the number of wire links to be made on a digital circuit.

When working with a multiple gate IC, you may find it useful to first complete all pins on that IC, making sure any unused inputs connect to ground, and that the IC has correct terminations for power.

Good luck with your next project!!