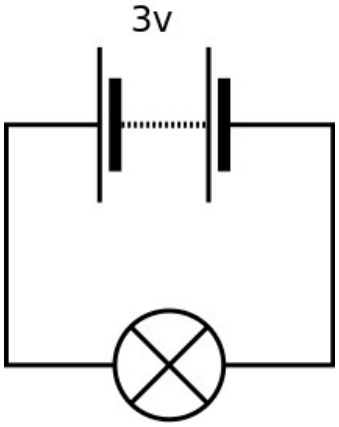
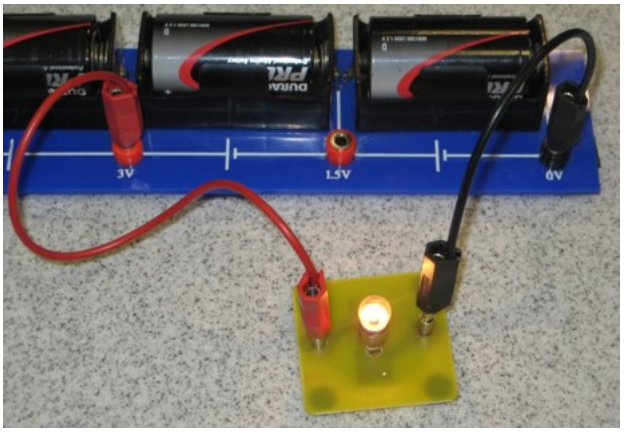
Circuit building

Building Simple Circuits

The art of electronics starts with being able to build the most basic circuits reliably and, most importantly, neatly. As circuits become more complex, good circuit building habits will be essential in tracing faults or following circuit diagrams.

Starting with the most basic battery and bulb circuit, always try to build the circuit in a similar layout to the circuit diagram - even to the point of laying out the components first. Use a sensible colour code for wires so that the circuit is easy to follow. It is most often the case that RED is used for positive and BLACK for negative - also called 0 V or Ground.

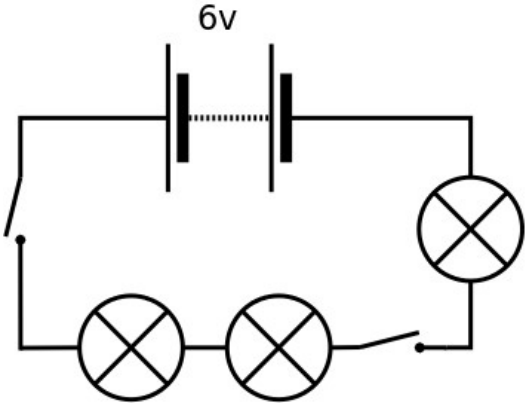


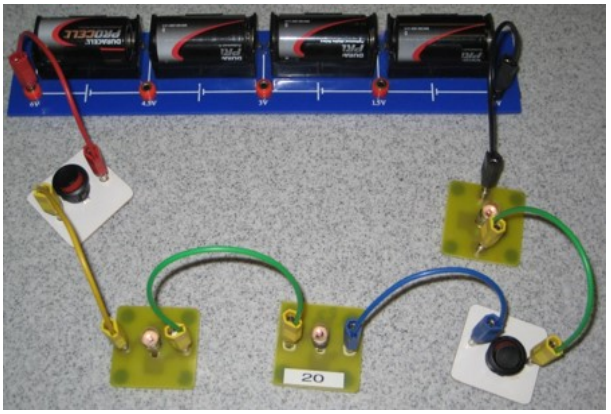


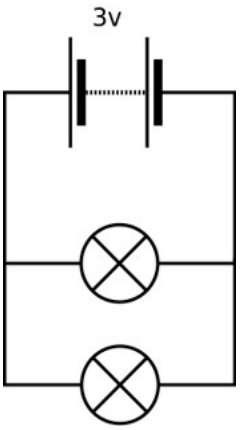
Circuit Building

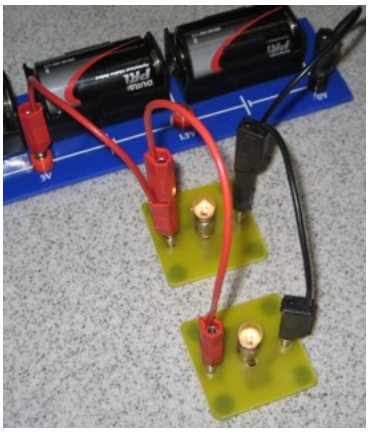
Adding more components in series simply involves extending the loop of wires but ensuring there is just one continuous path from the battery positive and leading back to the 0 V of the battery. The order does not actually matter but it is good practice to copy the circuit diagram.

In this circuit RED is used for positive but then other coloured wires are used for the intermediate connections before ending with BLACK for negative - the colours used should not be random, they should make the circuit easier to follow.





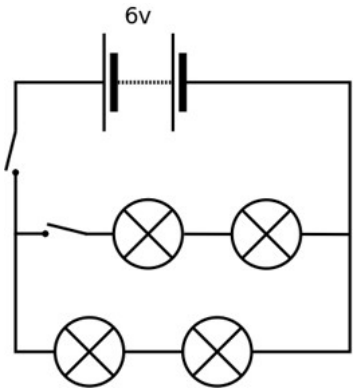


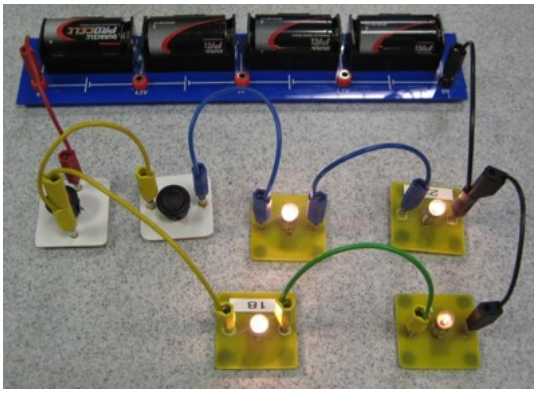


Adding components in parallel simply involves connecting each end of the two components together so that the circuit splits and the current can go down one branch of the circuit or another. Again, keep the layout as close to the circuit diagram as possible and ensure the colour code is consistent. Wires that join should be the same colour therefore only RED and BLACK are used in this circuit.

When circuits contain both series and parallel circuits all mixed up together it is a good idea to build the basic circuit first and then add the remaining components one at a time rather than just building the whole circuit in one go and hoping for the best.

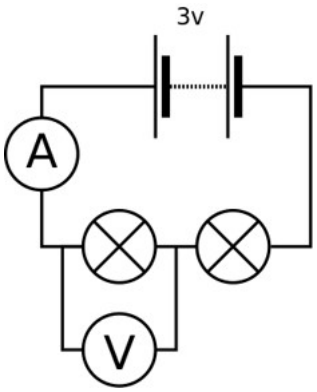
Again, try and use a sensible colour code - even if it just getting the RED and BLACK wires consistent - and lay the circuit out like the circuit diagram.

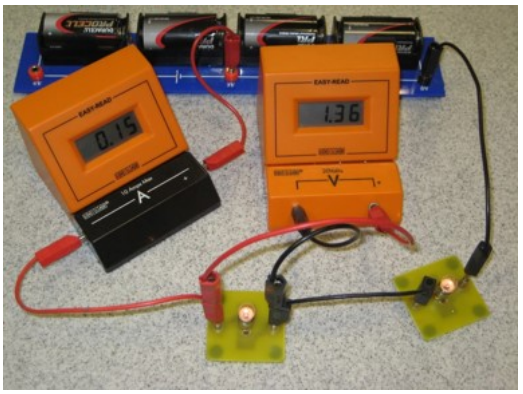




Ammeters and voltmeters are always added to the circuit after it has been built and tested - these are measuring instruments and should not actually affect the working of the circuit.

The circuit should work without the ammeters and voltmeters. Ammeters are added in series and voltmeters are connected in parallel.



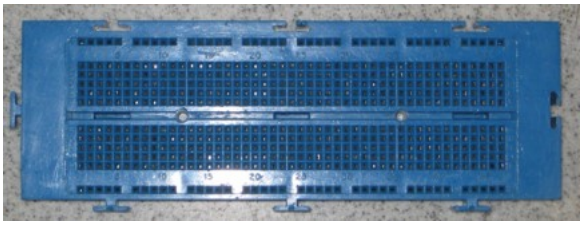


Building circuits on protoboard (breadboard)

Protoboard, sometimes refered to as breadboard, is a tool for quickly building and prototyping circuits.

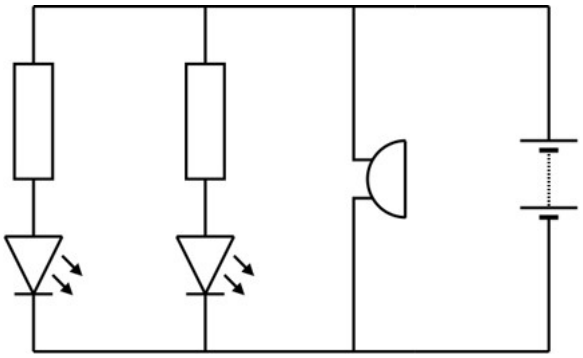
Components can be easily inserted into the protoboard without soldering and the internal connectors inside the protoboard connect the components together. These internal connectors are called tracks or rails - tracks are quite short, and rails tend to be longer.

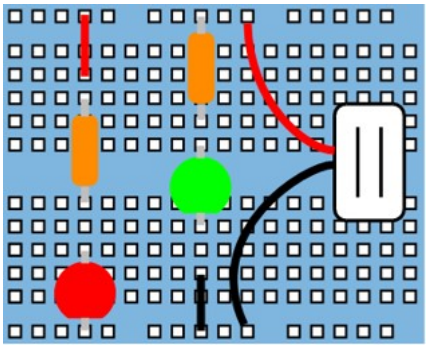
A basic protoboard is shown below and the connectors are revealed to show which sockets are connected together and which are separate. The two rails running horizontally along the length of the protoboard top and bottom are for the power supply connections and the short vertical tracks are used to connect different components together.



The top and bottom rails are connected along the length of the protoboard - these are used for power supply connections for all components in the circuit.

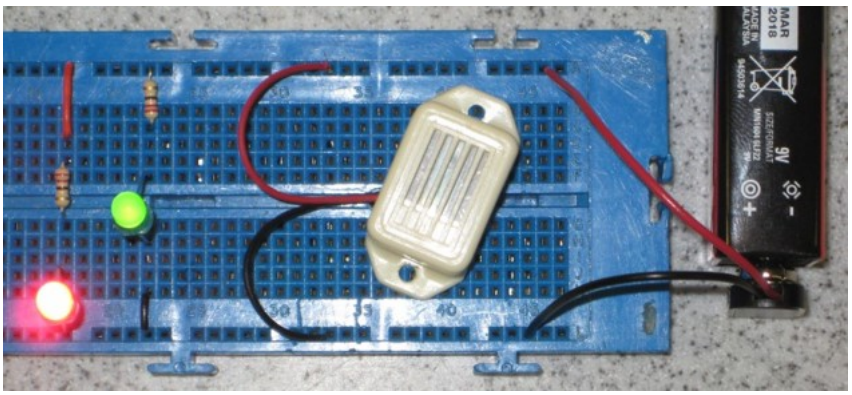
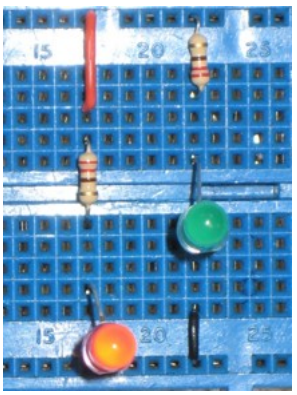
The circuit below shows the battery connected to the power supply rails. Components must link from one track to another - components should never have both legs plugged into the same track or there will be a short circuit.





The RED LED and resistor in the circuit are connected using the vertical tracks. Notice how each component crosses a gap between one track and the next and a wire link is needed to make the connection from the positive rail to the resistor.

The GREEN LED is also correctly connected. In this case the resistor is directly connected to the positive rail and this connects to the LED, a wire link is needed down to the zero volt rail. Finally, the buzzer is simply connected to the power supply rails.

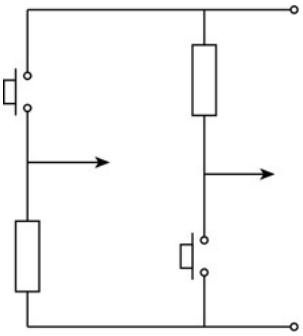
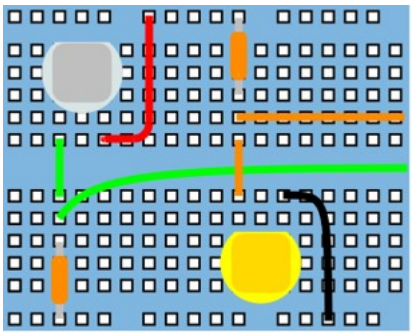
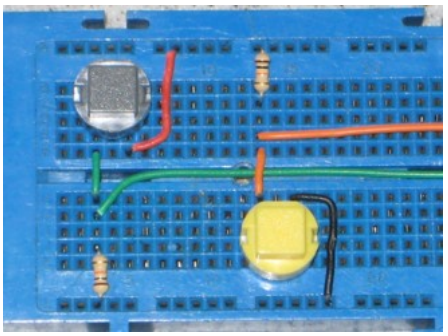



The close up shows the LED connections in detail. A RED wire links from the positive rail, crosses the gap and connects to a spare track. The connections in the protoboard mean the lower end of the RED wire is now connected to the upper end of the resistor. The resistor crosses the central gap and the lower end of the resistor is now connected to the upper end of the LED. The LED bridges the gap at the bottom of the protoboard and connects to the zero volt rail.

Specific components used in many circuits

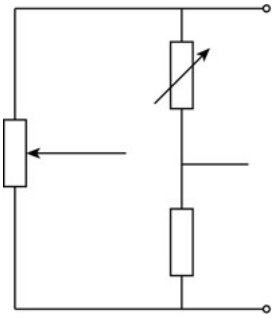
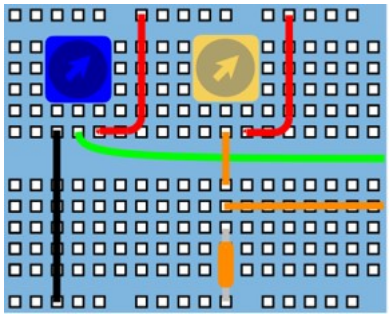
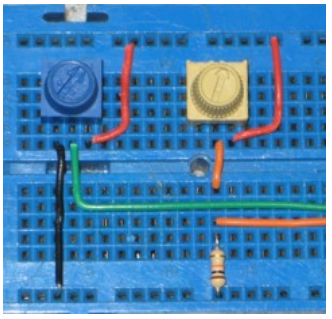
Push buttons

The wires for a push button must not stop the push button from functioning and so it is **not** a good idea to force the wires close to the push button. For the push button shown, bring both wires out from beneath the button so that there is plenty of space for the button to operate. The circuit shows the configuration for a pull down resistor and for a pull up resistor. There are other arrangements that would work equally well depending on the type of push button used.

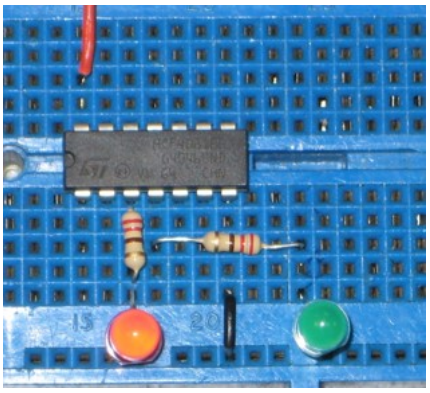




Potentiometer

The three wires for a potentiometer should all be taken from the same row on the protoboard so that the three wires are next to each other. This prevents the circuit being too crowded and also means it is easy to see the connections. In the circuits below, the blue potentiometer is being used as a three terminal potentiometer to provide a variable voltage. The cream potentiometer is actually connected as a variable resistor as one of the legs is not connected. The variable resistor then forms part of a potential divider.

LED and resistor



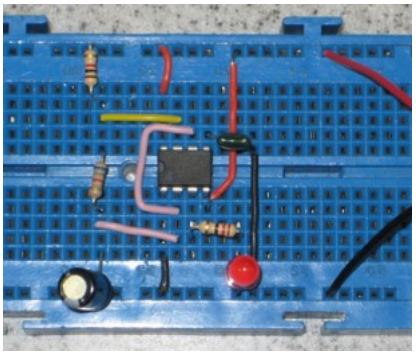
An LED almost always has a series resistor.

It doesn't matter in what order the resistor and LED are connected but it is usually more convenient to have the resistor followed by the LED.

It is a very common mistake to simply wire the resistor and LED in a straight line (as is shown on a circuit diagram) but this simply short circuits the resistor leaving the LED with no protection.

The circuit shows LEDs connected as outputs from a pair of logic gates. The RED left hand LED is incorrect because the resistor simply connects from one pin of a track to a different pin of the same track and is short circuited. Resistors should always lead away from ICs horizontally.

Integrated Circuit e.g. 555

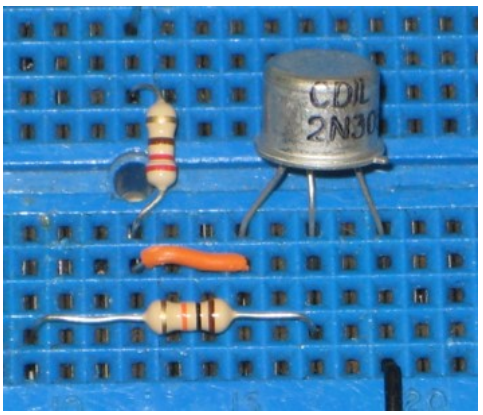


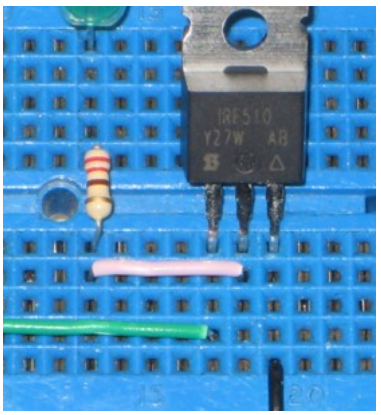
When wiring up an IC always start with the power supply wires so that you don't forget about them later on.

Work carefully around the IC so that each connection is neat and has enough space. Remember, you don't have to connect the wires right next to the IC, anywhere in the correct track will do. Do not loop wires over the top of the IC. It is a good idea to have the circuit board layout and the circuit diagram bear some resemblance to each other.

Transistors

To avoid confusion, always wire a transistor up with all three legs in a straight line - even if the legs are arranged in a triangle on the actual device. In keeping with the comments for the push buttons and the potentiometers, always make all three connections from the same side to make it easier to see the layout.





Reasons to build circuits neatly

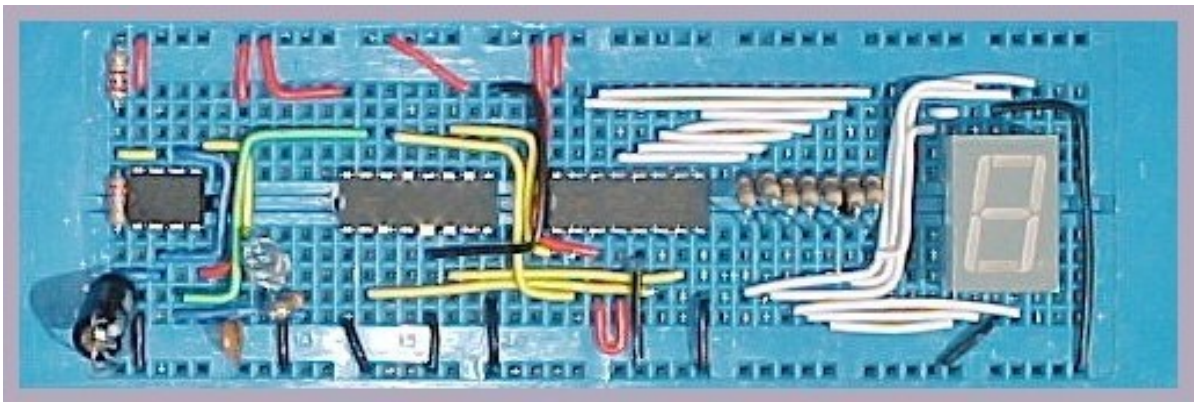
It is very important to build all protoboard circuits neatly and carefully! This is a skill that you should strive to develop whenever you are building protoboard circuits. Quickly built circuits that are messy rarely save time and effort in the long run.

Reasons to build circuits well:

- Carefully built circuits have a better chance of working
- Well laid out boards are easier to fix if they don't work
- Neat circuits can be understood by other people more easily - especially those people trying to help you fix it
- Colour coded circuits make it easy to follow wires links and see what is connected to what
- If you are doing an exam, the exam board expects beautiful circuits - projects are photographed
- Teachers tend to rip your circuit to bits and make you start again if you don't build it properly

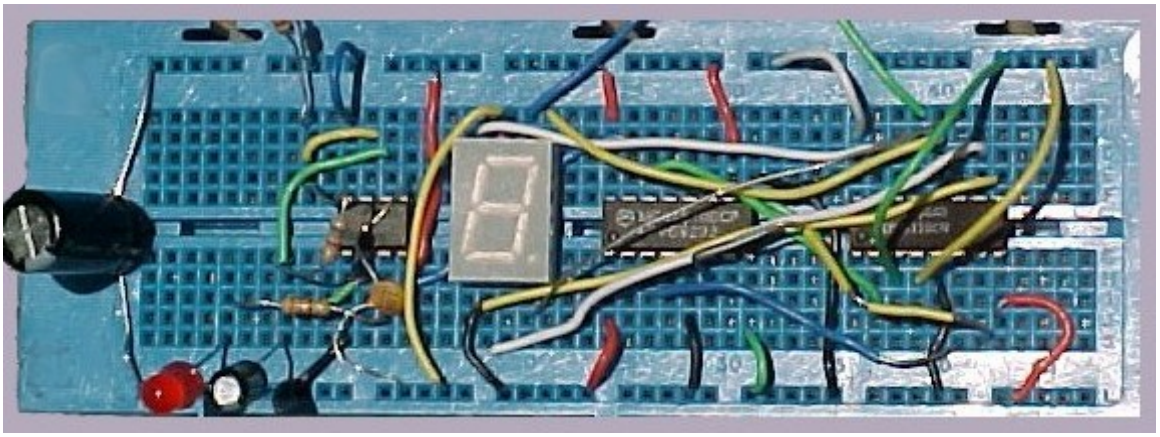
Do do these:

- Plan the layout BEFORE you begin
- Check the protoboard is in good condition before you begin
- Position Components Logically
- Use pliers to bend wires neatly
- Use RED wire for the positive power supply connections
- Use BLACK wire for the zero / negative power supply connections
- Use coloured wires to make the circuit easy to understand
- Connect polarised components correctly (diodes, capacitors, LEDs, Transistors etc)
- Insert ICs the correct way round with the right power supplies
- Include power supplies for all ICs
- Check component values carefully



Do NOT do these:

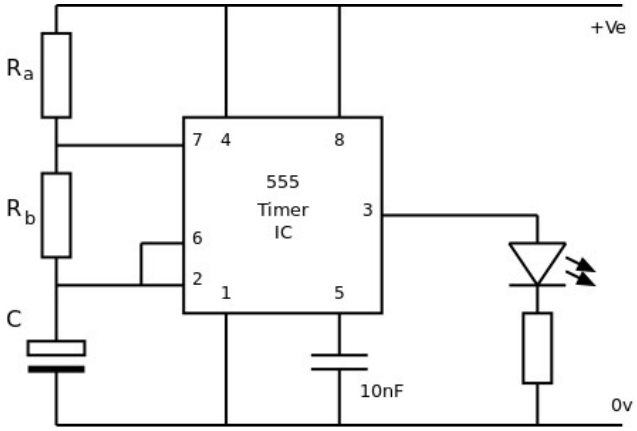
- Arrange components randomly or squash them all up at one end of the board
- Loop wires over components
- Use RED or BLACK wire for non power supply connections
- Use long loops of wire that get caught and pulled out
- Forget power supply wires for ICs
- Guess the pin layout for ICs - look them up

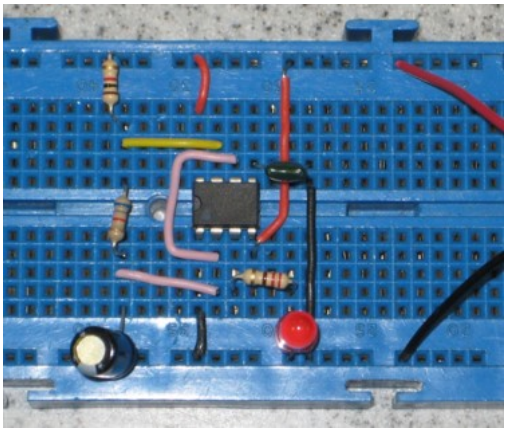


More Complex Circuits

More complex circuits are built in the same way as simple circuits with the following points to bear in mind:

- Try and copy the circuit diagram layout as far as possible
- Think about how much space large components need
- Don't loop wires over IC's or other components
- Spend time to make the wires the right length and route them carefully





Website

https://www.electronicsteaching.com/Electronics_Resources/DocumentIndex.html

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