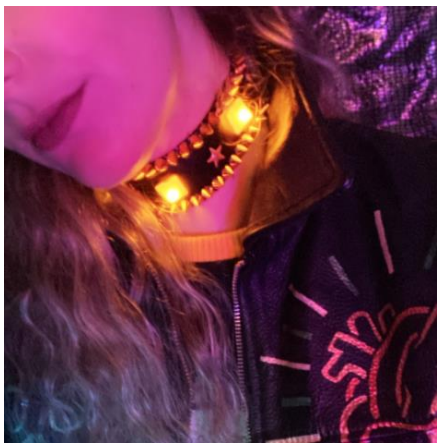
Soft Circuits: What You Need to Know

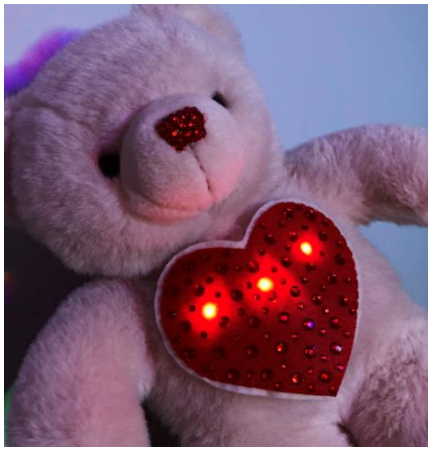
What are *Soft Circuits/Wearable Electronics?*

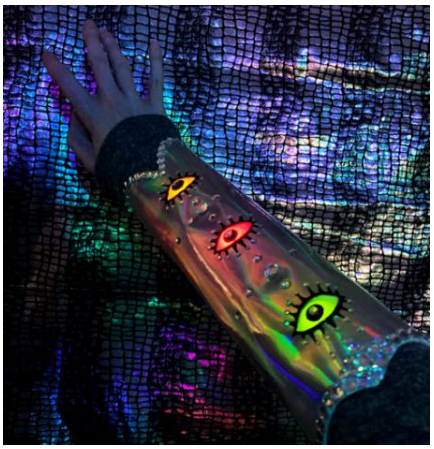
In electronics, a **circuit** is a closed pathway for electricity to flow. It can be used to make LED's light up, play sound - amongst many other options.

The structure of a circuit is built by connecting components with a conductive material. Commonly circuits are made with wires, but it can also be done with *conductive thread* or *conductive fabrics*. Because materials like conductive thread can be sewn directly to other fabrics, it is more flexible and thus is commonly referred to being a **soft circuit**.

Wearable electronics refers to the combination of electronics and clothing, whether it be through fashion, accessories, jewellery or other means. The same techniques used in wearable electronics can also be used for other soft projects, such as toys or bags.







What are *Wearable Components?*

Electronic components are parts of a *circuit* which help it function. They are the building blocks which are powered through an *electric current*, which is carried by the circuit.

Wearable/Sewable components are very similar to regular components used in electronics. However they are specifically designed with **sewable pins**, which have a metallic plate/coating that is conductive. Conductive thread can be wound around these pins which will carry an electric current from one component to another in order to complete the circuit.

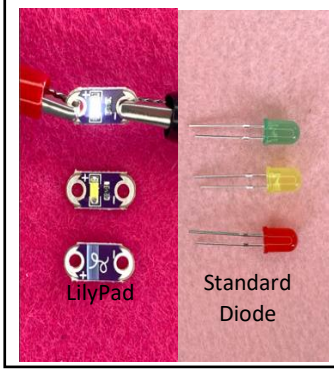
Components Suitable for Beginner Projects:

LilyPad Coin Cell Battery Holder

Power Supply

This component supplies electric power through the circuit. Most commonly these are designed for 3V (V = Volts) coin batteries, they are small and flat which is less bulky and is easier to conceal.

Microcontrollers and soft circuit components typically require between 2.7 and 5.5 volts to function. As the voltage required is so low, it is safe to work on your projects while the power is turned on.



LilyPad

Standard Diode

LED (Light-Emitting-Diode)

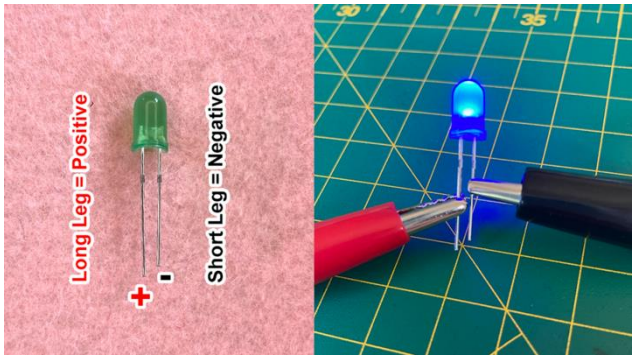
LED's function as a light source. When an electric current runs through it, the LED with light up in various colours. As LED's require only a small amount of power to turn on, multiple LED's can be strung on the same circuit at once.

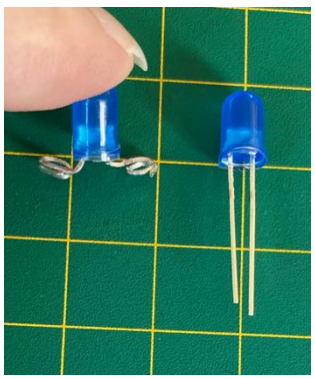
There are LED's designed specifically for soft circuits which are mounted on a board. These are made with sewable pins that are large enough for a sewing needle to pass through and are marked with visible positive (+) and negative (-) symbols.

Differences in LED's

Some LED's (designed for soft circuits/wearable electronics) are designed with visible + and – symbols to make the sewing process easier.

However standard LED's do not have these and are easier to identify by leg length. Using a marker pen, you can draw on one leg to keep track of which is which.





Standard LED's will also need to have their legs bent into loops with pliers to create their own sewable pins. This will make it easier to wind the conductive thread around and ensure a strong connection.

Please note the voltage required for these LED's must align with the same voltage of the power source. Depending on the colour, some require a higher voltage than others.

Materials:

Choosing the Right Fabrics:

The fabric you will be sewing onto is just as important as the circuit itself. The fabric needs to be stable enough to hold the weight of the components, but not heavy enough to be difficult to sew through.

While learning how to sew circuits, the best fabric to use is **felt**. It does not fray when cut and is easy to handle and sew through. After some practise, other fabrics that may be suitable are twill/drill fabrics, lightweight denim, calico and faux leather (plastic leather). It all depends on the project you are making it for.

About Conductive Thread:

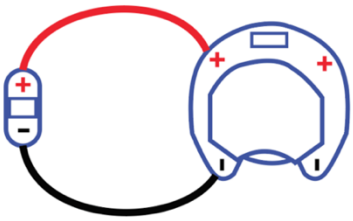
Conductive thread looks and works similar to conventional sewing thread, however it is coated with a conductive material which works to carry electrical current when used in a circuit.

It can be sewn by hand with a needle. By winding it around the conductive pins of each component in the circuit, it will carry the electrical current from one component to another.

However one key limitation for conductive thread is that it is not encased in a rubber coating to protect it (like wires are). As the thread is exposed, the circuit cannot overlap when sewn or it will interrupt the flow of current and stop the circuit from working.

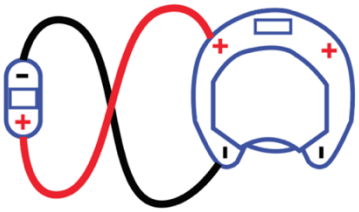
Yes!

The threads for the positive thread (red) is separate from the negative thread (black). This circuit will work correctly.



No!

The threads for the positive thread (red) is crossing over the negative thread (black). This circuit will not work as it interrupts the flow of electric current.



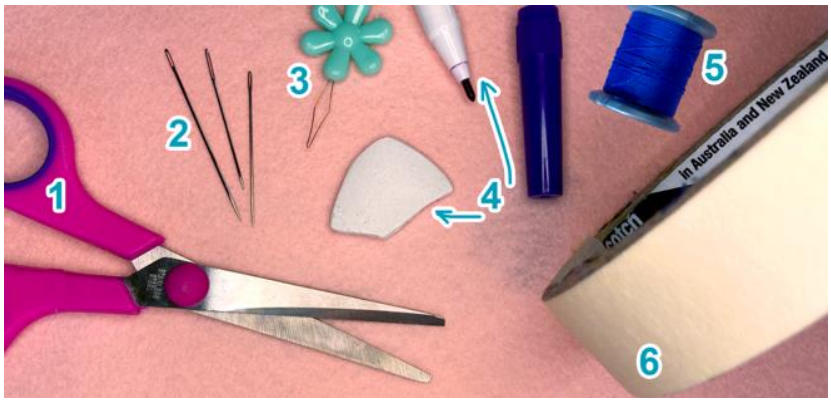
Additional Materials (Recommended):

Clear Nail Polish:

Clear nail polish works well to secure knots on the wrong side of the fabric. As conductive thread is coarser, it is more difficult to make a tight knot. Using nail polish or a similar adhesive ensures it will stay in place long term.

Alligator Clips

These are especially useful for trialling circuits before committing to sewing them down.

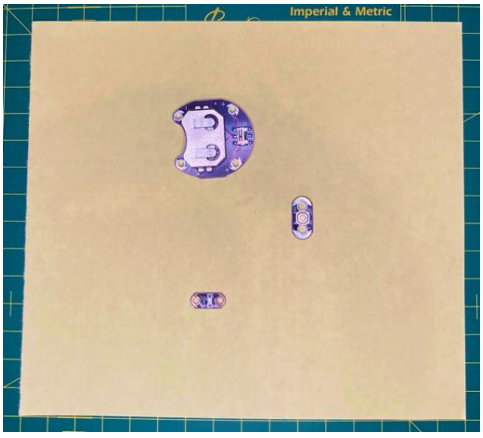


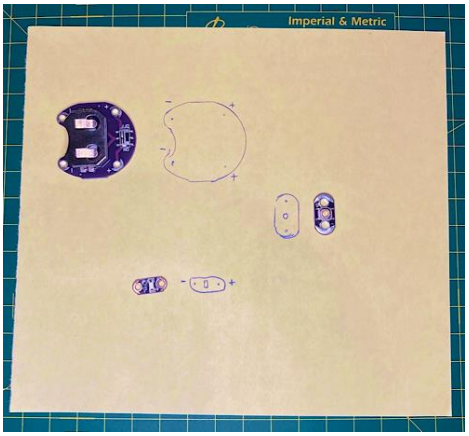
Sewing Equipment

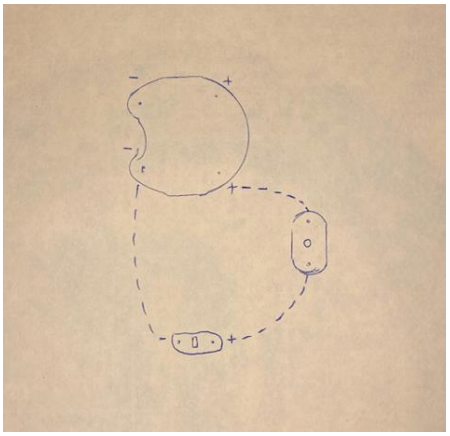
1. **Scissors.** Craft scissors are recommended instead of sewing shears as conductive thread can be more difficult to cut than standard sewing materials.
2. **Hand Sewing Needle.** As conductive thread tends to be thicker than standard sewing thread, using a sewing needle with a wide eye will make the threading process much easier.
3. **Needle Threader**. Depending on the thickness of the conductive thread you are using, a needle threader can also be particularly useful.
4. **Options for Marking Your Circuit**. Before sewing your circuit, it helps to draw out the sewing lines beforehand to ensure a straight stitching line. This can be done with *chalk, tailors wax* or an *evaporating fabric pen.*
5. **Standard Sewing Thread.** After completing the circuit, there may be some pins leftover on the components that need to be secured to the fabric. Using standard sewing thread helps as it is non-conductive and therefore will not affect the circuit.
6. **Masking Tape (and/or Hot Glue).** To stop any components from wiggling around while sewing, they can be secured with little pieces of tape or a small dot of hot glue on the wrong side of the component. It doesn't need to be stuck down much, just enough to keep it in place temporarily.

Tips Before Starting a New Project:

Plan your circuit on a piece of paper that is the same size/shape as the fabric you are sewing onto. Lay the components out where you would like them, trace around each one and draw the circuit lines to connect them. By doing this you can check the positive (+) and negative (-) pins are all joined correctly, have enough room, and are not crossing-over anywhere.







Always test your circuit before sewing!

This is where the alligator clips come in handy, clip each end of the components so they touch the metal pins on both the power source and components you are using. Alligator clips are excellent for checking your circuit plan is correct before sewing them in place. This will help iron out any problems that may have been easy to miss otherwise.