

Bill of Materials

For the sensors:

- [Felt](#)
- [Velostat](#)
- [Conductive thread](#)
- Regular thread
- [Sewing needle](#)

For the breadboard:

- [Teensy LC](#)
- [Breadboard or Protoboard](#)
- [Ribbon cables](#)
- [Connector pins](#)
- [Jumper cables](#)
- [10K Resistors](#)
- [Headers](#)

Useful tools:

- [Hot glue gun](#)
- [Soldering iron](#)
- [Solder wire](#)
- [Soldering iron tip cleaner](#)
- [Solder sucker](#)
- [Wire cutters](#)
- [Pliers](#)

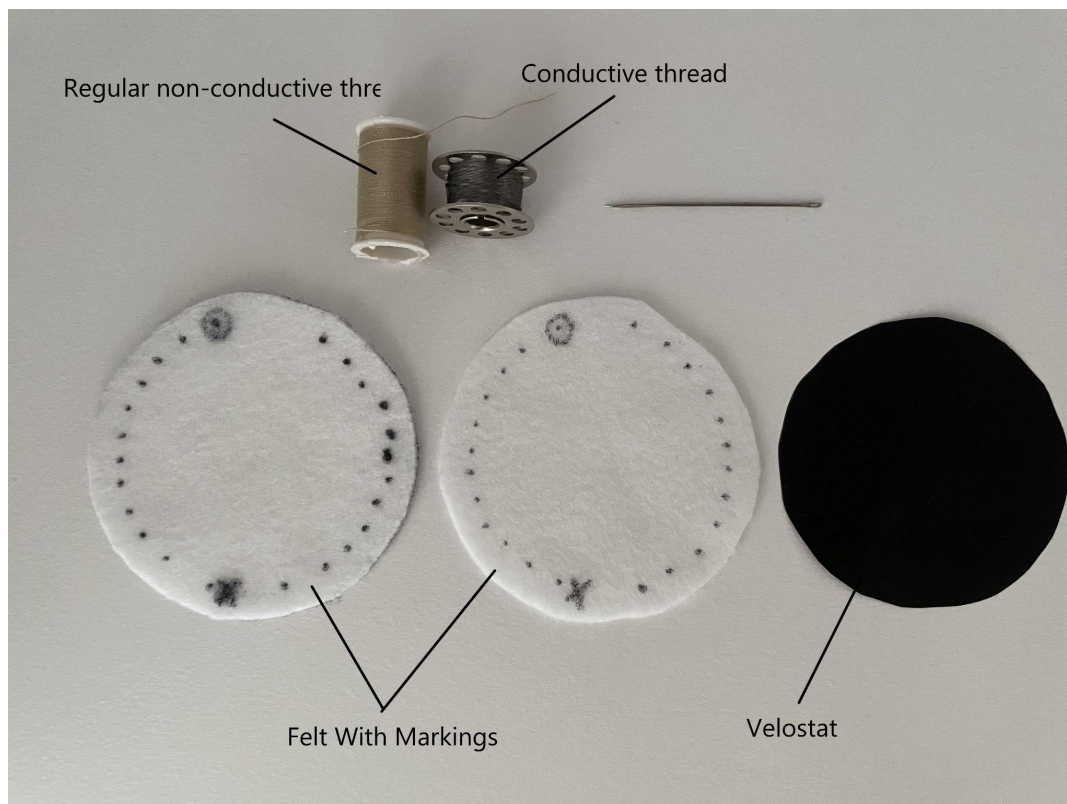
Templates:

- Small circle sensor template
- Large circle sensor template

Squishy Toy Construction Instructions

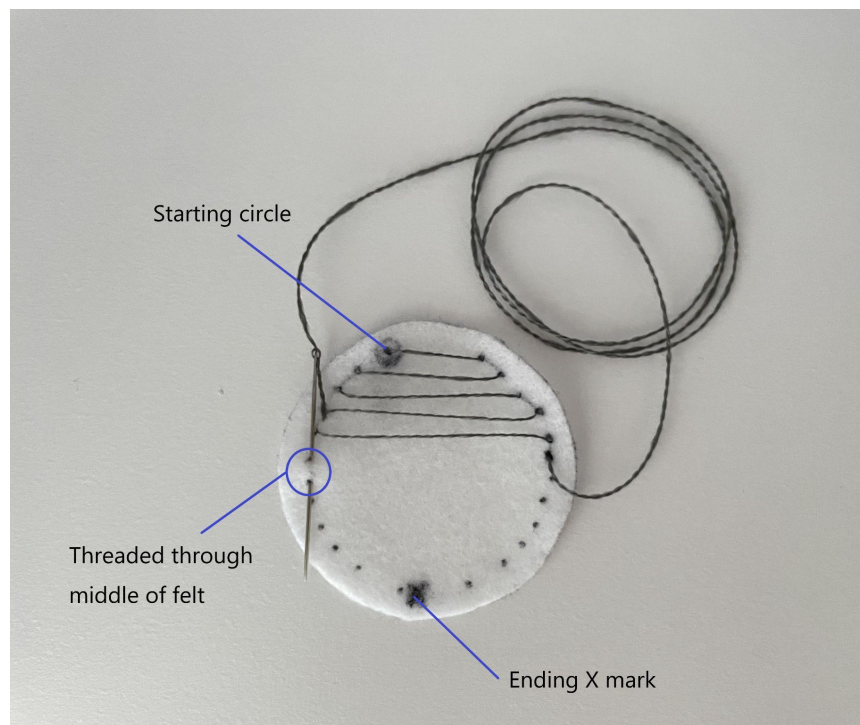
Gather your sensor materials. To start, you need to use the sensor template to cut out two pieces of felt for each sensor you want to make. Use the larger circle in the provided template for this. Next, you should use the edges of the lines on the smaller circle template to mark off where your threads will go with a dark colored pen. You then need to cut out one piece of your Velostat, again using the outer edge of the smaller circle template as a guide.

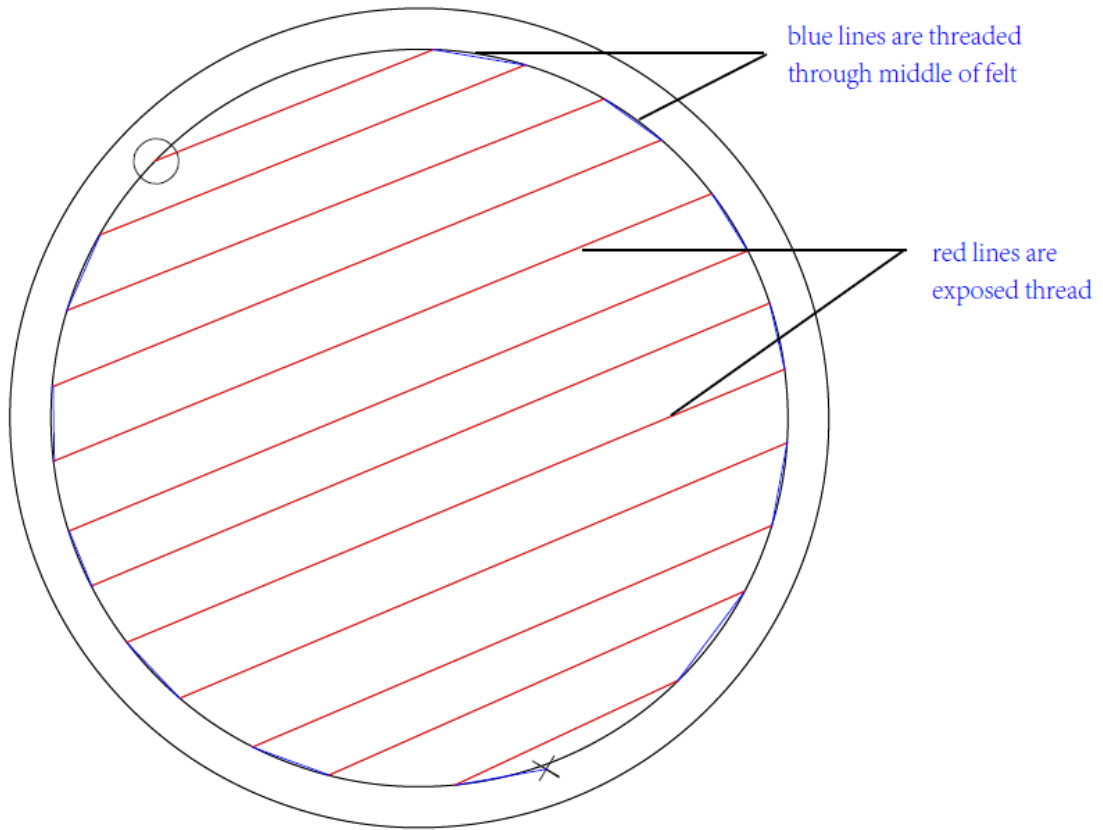
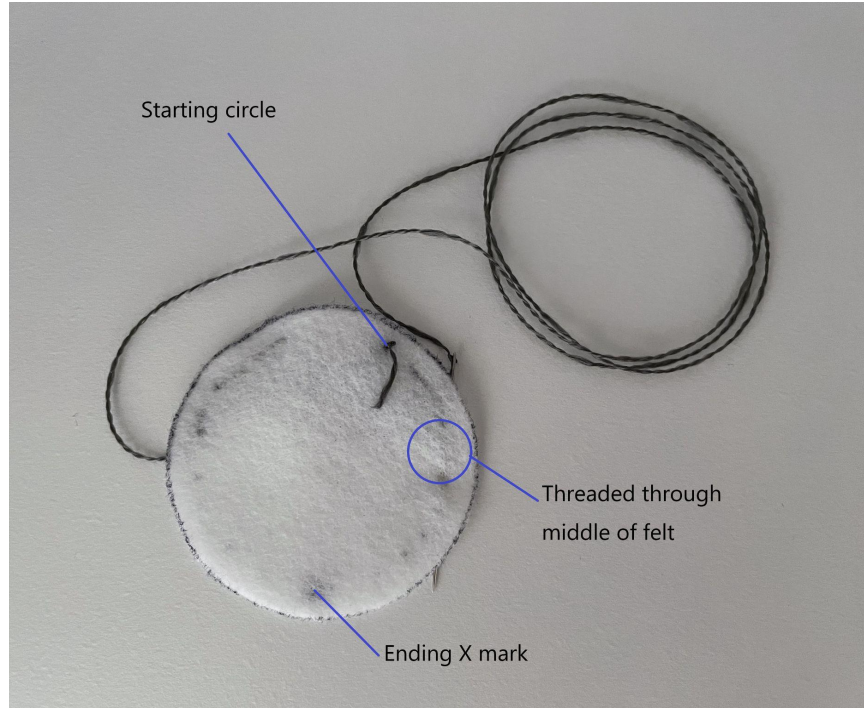
Then, you need to prepare your conductive thread for sewing the sensor. You will need roughly 1.5 feet of conductive thread for each half of the small circular sensor and 2 feet for each half of the large circular sensor.



Thread your needle with conductive thread and tie a knot at the end of the thread. Run the needle through the felt starting at the circled marking (see above diagram).

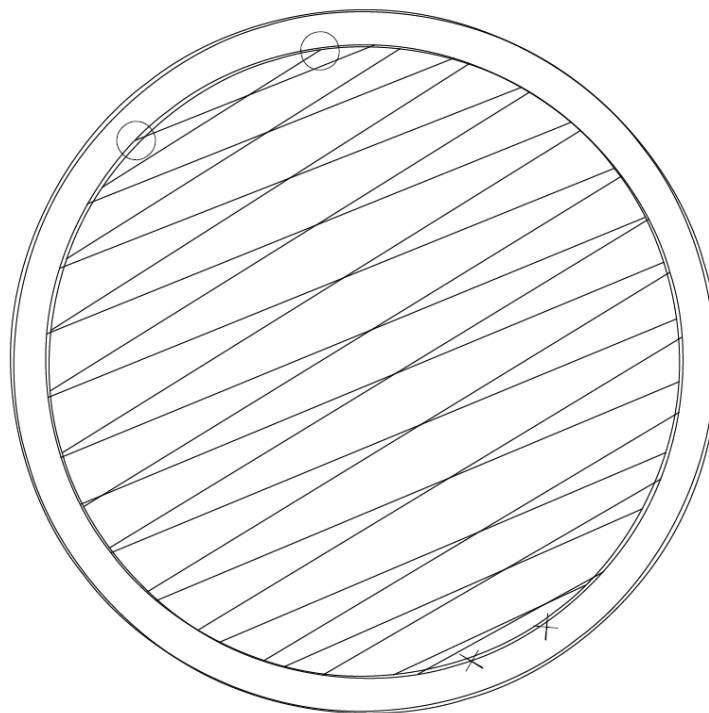
Thread the needle through the middle layer of the felt between the two dot markings on the opposite side of the circled dot. Follow the pattern of exposed conductive thread and middle layer unexposed conductive thread according to the diagram below. Note - don't sew the conductive thread too closely to the edge of the felt. The velostat needs to easily cover all of the conductive thread.





Once you reach the last normal dot, thread through the middle of the felt and thread out the backside of the X. There should be a long conductive thread hanging out of the side without the exposed conductive thread.

After threading both pieces of felt with conductive thread, arrange the two felt pieces such that the X marks are close but not on top of each other. You should notice that the exposed conductive thread crosses the exposed thread on the other felt and does not completely lie on top of one another. The outside of the two pieces should not have exposed conductive thread except for the long hanging strands. It should form a cross pattern similar to the one below.



Slide a piece of velostat between the two pieces of felt, and make sure the three circular pieces are aligned. The velostat should be a bit smaller than the felt circles, but should **completely cover** all the conductive thread. This is important to prevent short circuits.

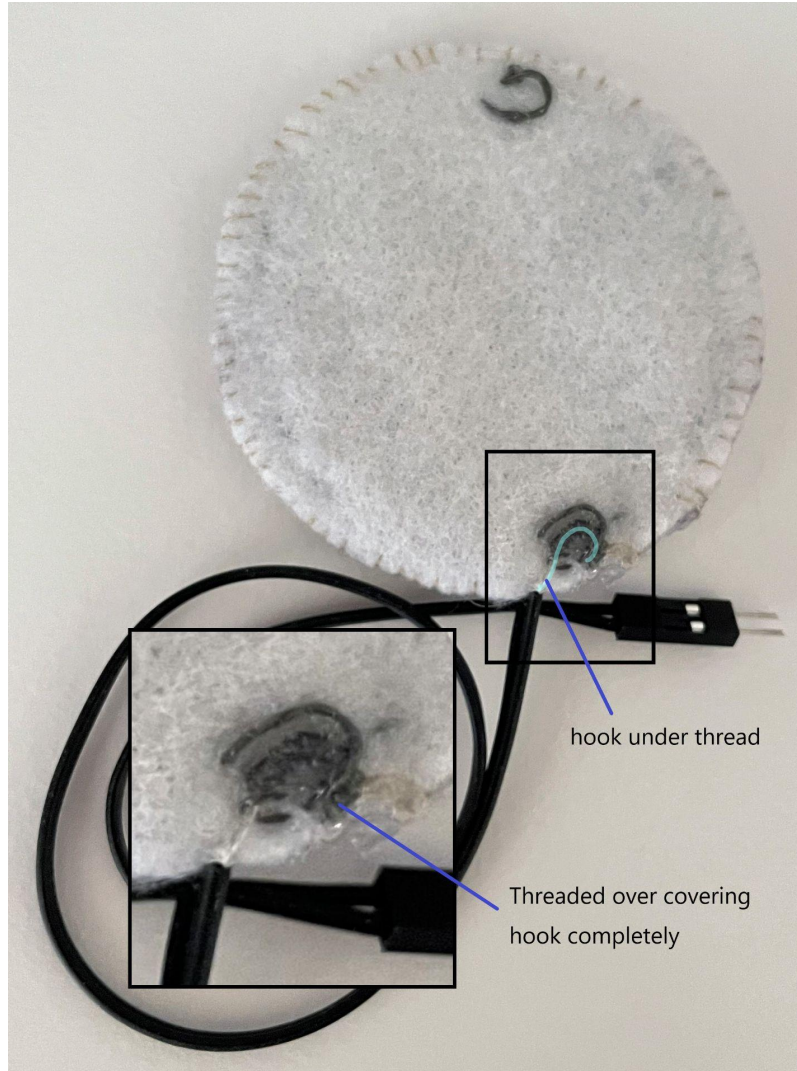
Cut regular non-conductive thread a bit larger than twice the circumference of the sensor. Thread and knot the regular thread onto a needle. Starting slightly outside of the two conductive threads are hanging out, sew together the two felt flaps using the whipstitch.

Continue sewing the sensors together along the outside border. Try not to sew onto the velostat - but it is fine if you have to puncture it a few times. Stop sewing once you hit the part where the conductive thread hangs out - just before where you started - and tie a knot to end the regular thread there.

Next we need to prepare the ribbon cables. Split your grouped cable in two - so you have two sets of two wires. Strip both ends of each of your cables - you should take off about $\frac{3}{8}$ ". On one end of the cable, affix male pin connectors to each wire, and set them into a housing to make a two-pronged connector. On the other end, twist and bend each open end into a loop or hook shape.

Rethread the hanging conductive thread through a needle and continuously loop around the hook through the middle of the felt to keep the hook in place and ensure a connection between the conductive thread and the ribbon cable.

After thoroughly looping around the hook such that it stays in place on the felt, knot the conductive thread and trim the extra thread. Repeat with the hook on the other side as well. Be careful not to let the two sides touch each other or overlap at all - this will result in a short circuit.



Warm up the hot glue gun. Glue will be applied to all places where there is exposed conductive thread on the outside of the felt. Make sure the hot glue covers all of the exposed thread. Try not to use too much hot glue or try to flatten the glue to make sure there are no huge lumps on the outside of the sensor.

You can find more great information on creating soft sensors like these on Hannah Perner-Wilson's [website](#).



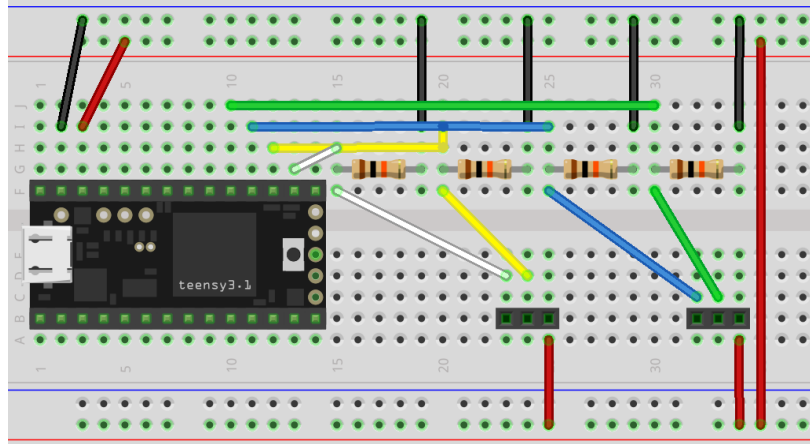
Hardware and Breadboard Instructions

Gather the protoboard, Teensy, headers, jumper wires, resistors, and all of your soldering equipment.

The first thing you need to do is solder male headers to the Teensy board. Cut the headers to the correct length, and set them in a breadboard with the Teensy to solder (doing this in a breadboard ensures that your headers will not come out crooked).

Next, you should attach female headers where shown in the breadboard diagram below - there should be two places for the sensor cables, and two for the Teensy. This is easily done by using masking tape to hold the headers in place while you solder.

Create the rest of the breadboard by following the diagram below. Note: the color of the jumper wires may be different. Make sure that the jumper wires are connected to the correct Teensy labels. Different Teensy's may have different ordering of pins. You can find diagrams of their different boards on their [website](#).



Take the two male headers from ribbon cable connecting to a sensor and place in the rightmost two holes of the open female headers on the board.

Now you are ready to test your teensy!