



## 2 STRANDED CORE WIRE



### **SUPERPOWER**

Insulated // Low Resistance

#### ABOUT

- Fairly flexible when secured to fabric with a couching stitch (zig-zag) or passed through a sewn channel,
- Not much resistance in longer traces, so signal or voltage loss is negligible.
- The wire is insulated, so the user has some freedom in laying out the circuit without worrying about shorts.
- Heavier and less flexible than conductive tape or thread.
- It can be soldered, but soldered joints should be planned for areas with minimum flex.
- It can be connected to sewable elements by securing wire to fabric and wrapping conductive thread around exposed end.

#### KEYWORDS

flexible, low-resistance, solderable, insulated



## 6 CONDUCTIVE RIBBON



### **SUPERPOWER**

Separate Traces // Flexible

#### ABOUT

- Fabric ribbon cable is useful in applications that need multiple traces along the same path.
  - It has 3 or more separate traces that can be used to connect elements that require power, signal, and ground.
  - It is very strong, but its thickness makes it a little difficult to sew by hand.
  - Works great with a sewing machine.
  - Some ribbons can be soldered, others must be connected with conductive thread.
  - Some ribbons are insulated with a non-conductive fabric, an added benefit.
  - More expensive per yard than other materials.
- The 3-channel ribbon pictured above, from Sparkfun, has a low resistance but is not insulated.

#### KEYWORDS

Sewable, multiple traces, insulated options,



## 5 CONDUCTIVE FABRIC



### **SUPERPOWER**

Flexible Sensor // Fabric PCB

#### ABOUT

- Conductive fabric often comes in squares, but can be cut in zig-zag patterns to achieve longer traces.
- The square surface area allows circuit layouts similar to a PCB to be cut with a knife, laser, or cnc.
- It sews well, (though stretch varieties are trickier), and can be attached to iron-on adhesive sheets, usually before cutting.
- Most fabric cannot be soldered, conductive thread can be used for hook-up.
- It is especially useful in touch pads, capacitive sensors and soft buttons.
- It comes in many varieties, which may affect its resistivity and stretch.

#### KEYWORDS

sewable, non-solderable, touch pads, capacitive sensors, customizable



## 3 COPPER TAPE



### **SUPERPOWER**

Easy Application // Low Profile

#### ABOUT

- Copper tape is an option for users with less sewing experience.
- Most tapes have adhesive on the back, and can be more permanently attached using iron-on adhesive or interfacing.
- Low-cost and often found in hardware stores, it can be a good entry point into prototyping conductive materials.
- You can solder to this material directly, however, it is not the most durable and would require more reinforcement between connections for a permanent piece.
- Low-resistance, similar to wire in conductivity, but not insulated

#### KEYWORDS

iron-on adhesive, no-sew, prototype friendly, low cost, low durability, low-resistance



## 6 CONDUCTIVE RIBBON

**Hook-Up Method** Sewable coin cell battery holder and sewable vibration motor, attached with conductive thread.

**Test Length** 16 inches.

**Average Resistance ( $\Omega$ )** 1.2 ohms in trace (low)  
85 ohms in circuit (med)

**Notes** We sewed across the three separate lines for this test, because we only needed power and ground. This may have further reduced material resistance.

Ribbon attached to fabric with sewing machine using a straight stitch. Can also be sewn by hand.

eTextile Trading Card  <http://idmwearables.club>



## 2 STRANDED CORE WIRE

**Hook-up Methods** Standard vibration motor and battery holder, solder.

Sewable vibration motor and battery holder attached to removable conductive snaps. (pictured).

**Test Length** 16 inches.

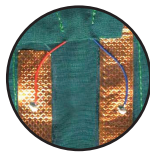
**Average Resistance ( $\Omega$ )** 0.5 ohms in trace (low)  
28 ohms in soldered circuit (low)  
75 ohms in snap circuit (med)

**Notes** Soldered connections are very reliable. Wrapping conductive thread around exposed wire is a viable alternative.

For removable snaps: too much solder can prevent them from closing. Snaps connected with thread are more durable. Snaps increased resistance to average 65 ohms, med-low

Wire was attached to fabric with sewing machine using a couching stitch. A sewn channel would also work well.

eTextile Trading Card  <http://idmwearables.club>



## 3 COPPER TAPE

**Hook-up Methods** Standard vibration motor and battery holder, solder.

**Test Length** 16 inches.

**Average Resistance ( $\Omega$ )** 0.6 ohms in trace (low)  
31 ohms in circuit (low)

**Notes** Copper tape has adhesive, but additional iron-on adhesive makes a more permanent connection to the fabric.

The soldered connection between components is not flexible. After repeated battery removal, connection to battery holder broke in this test.

Flexible fabric glue could be used to reinforce the connections.

eTextile Trading Card  <http://idmwearables.club>



## 5 CONDUCTIVE FABRIC

**Hook-up Methods** Sewable battery holder and standard vibration motor, attached with conductive thread.

**Test Length** 16 inches.

**Average Resistance ( $\Omega$ )** 49 ohms in trace (high)  
95 ohms in circuit (med-high)

**Notes** Because the swatch came in a square, we attached it to iron-on adhesive, then cut a zig-zag pattern to make a longer trace and ironed it onto fabric.

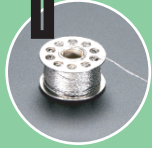
Because of the large, uninsulated conductive area, care must be taken to avoid shorts when attaching components, particularly the battery holder.

This test used knit-jersey conductive fabric from Adafruit.

eTextile Trading Card  <http://idmwearables.club>

# 1

## CONDUCTIVE THREAD



### SUPERPOWER

Solder alternative // Flexible

#### ABOUT

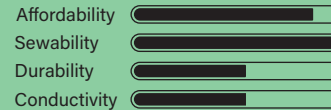
- Commonly composed of stainless steel or silver-coated nylon, it can vary greatly in resistance and price.
- Sewing multiple layers, double threading your needle, or using 2 ply thread can reduce resistance.
- Sews well through the bobbin of a sewing machine.
- In longer traces, the resistance is higher and can reduce the need for resistors.
- Aside from traces, it is a good alternative to solder, and can make connections between soft materials, like conductive fabric, and hard materials, like a PCB or wire.
- Most cannot be soldered.
- Though flexible, it is more coarse than normal thread and may require a needle with a large eye.

#### KEYWORDS

variable traces, alternative to solder, sewable, flexible

# 4

## CONDUCTIVE FABRIC TAPE



### SUPERPOWER

Low Profile Traces // Flexible

#### ABOUT

- Fabric tape is a good option for making a flexible trace with a low profile (completely flat).
- The adhesive on the tape makes it easy to apply and prototype with.
- For a more permanent connection, it can be attached to fabric with iron-on adhesive or seam tape, or sewn by hand or with a sewing machine.
- It is often easier to create long traces with this material than with conductive thread.
- The wide, flat surface area is good for creating folded connections, or conductive tabs.
- Most cannot be soldered, so prepare to make connections using conductive thread.

#### KEYWORDS

flexible, low-profile, folded connections, conductive tabs,

## ABOUT THE CARDS

These six eTextile trading cards are designed to help beginners interested in wearable technology compare the affordances of common conductive materials.

To develop the cards, we made 14 circuit swatches, each using the same circuit components (vibration motor, battery), and 16 inch (40 cm) pieces of fabric. Different conductive materials were tested as "traces," to run power and ground between components. Beyond the materials used for traces, hook-up methods (e.g. soldering, sewing, removable snaps), and component types can also impact resistance in the circuit.

#### USING THE CARDS

These cards are meant to be scannable. We suggest checking the Keywords section on the front of each card to narrow down connections and materials suited to your project or design and then reading the rest of the information.

All of the resistance data is measured in Ohms, and higher numbers indicate higher resistance.

#### NOTES ON SOURCING MATERIALS

Our eTextile trading cards were first developed between 2020 and 2021. We indicated where materials were obtained when relevant, but other sources and manufacturers may produce a different result. We recommend checking material datasheets to see if they provide resistance data, and over what distance, for example, "28 Ohms/Ft"

## KEYWORDS

#### BOBBIN

A circular spool of thread that sits in the bottom chamber of a sewing machine.

#### CAPACITIVE TOUCH SENSORS

A sensor that monitors changes in the electrical field either by touch or proximity.

#### COIN CELL BATTERY

A small circular battery commonly used in watches, calculators, car keys, remote controls, bank card readers, and electronic games.

#### COUCHING STITCH

A type of stitch where material is laid on a ground fabric and fastened in place with small stitches of thread or yarn on either side of the material, rather than through the material.

#### INSULATION

Non-conductive materials that will hold conductors into position, away from each other and from surrounding structures.

#### OHMS

The unit in which electrical resistance is measured.

#### PCB

Acronym for "printed circuit board" which can contain all the components of a circuit.



## 4 CONDUCTIVE TAPE

**Hook-up Methods** Sewable battery holder and vibration motor, attached with conductive thread.

**Test Length** 16 inches.

**Average Resistance ( $\Omega$ )** 1.5 ohms in trace (low)  
50 ohms in circuit (med-low)

**Notes** Because of the large, uninsulated conductive area, care must be taken to avoid shorts when attaching components.

The tape has adhesive but additional iron-on adhesive makes a more permanent connection to fabric.

Standard components (designed to be soldered), can also be used, but we found sewable components easier to hook-up.

eTextile Trading Card ⚡ <http://idmwearables.club>



## 1 CONDUCTIVE THREAD

**Hook-up Method** Sewable battery holder and vibe motor. Stainless steel thread sewn through bobbin once (pictured).

Sewable components. Stainless steel thread sewn through bobbin 4 times.

**Test Length** 16 inches.

**Average Resistance ( $\Omega$ )** Single thread:  
24 ohms in trace (med-high),  
105 ohms in circuit (med-high)

Four Thread:  
8 ohms in circuit (med-low);  
86 ohms in circuit (med)

**Notes** Sewing over the traces multiple times greatly increased the performance of the trace, the trace sewn 4 times had an average resistance of 75 ohms.

If unable to sew thread through bobbin, you may attach it with a couching stitch, layering multiple threads before attaching it will lower resistance.

eTextile Trading Card ⚡ <http://idmwearables.club>

## KEYWORDS (CONT)

### RESISTANCE

A measure of the opposition of current flow in a circuit. Sometimes resistance is necessary to protect components from overload, but too much resistance can also prevent a circuit from functioning properly. Variable resistance can be used to impact a circuit or to get feedback, by using potentiometers, for example.

### SOLDER

A method of joining materials together using a low-melting alloy typically made up of lead, tin, brass, or silver and an iron to join less fusible materials together to create a permanent connection.

### TRACE

Conductive material that connects components in a circuit and allows electric current to flow. On printed circuit boards, traces are usually copper.

## SHARE YOUR WORK

If these cards help you with your project we would love to see your work.

Visit **idmwearables.club** to contact us and tell us about your work.

Or use the hashtag **#eTextileTradingCards** on Instagram.

Notes and suggestions are also welcome.