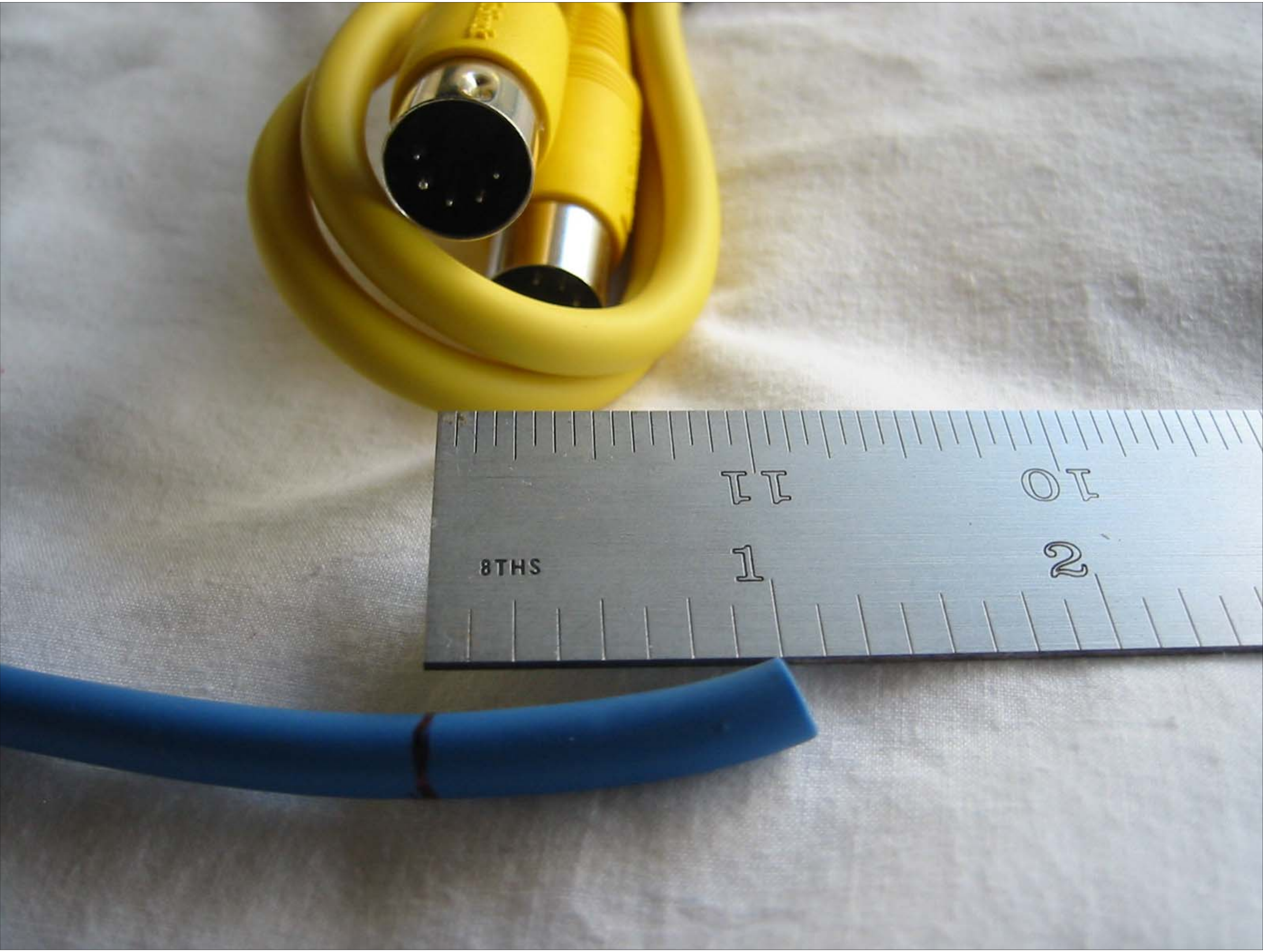
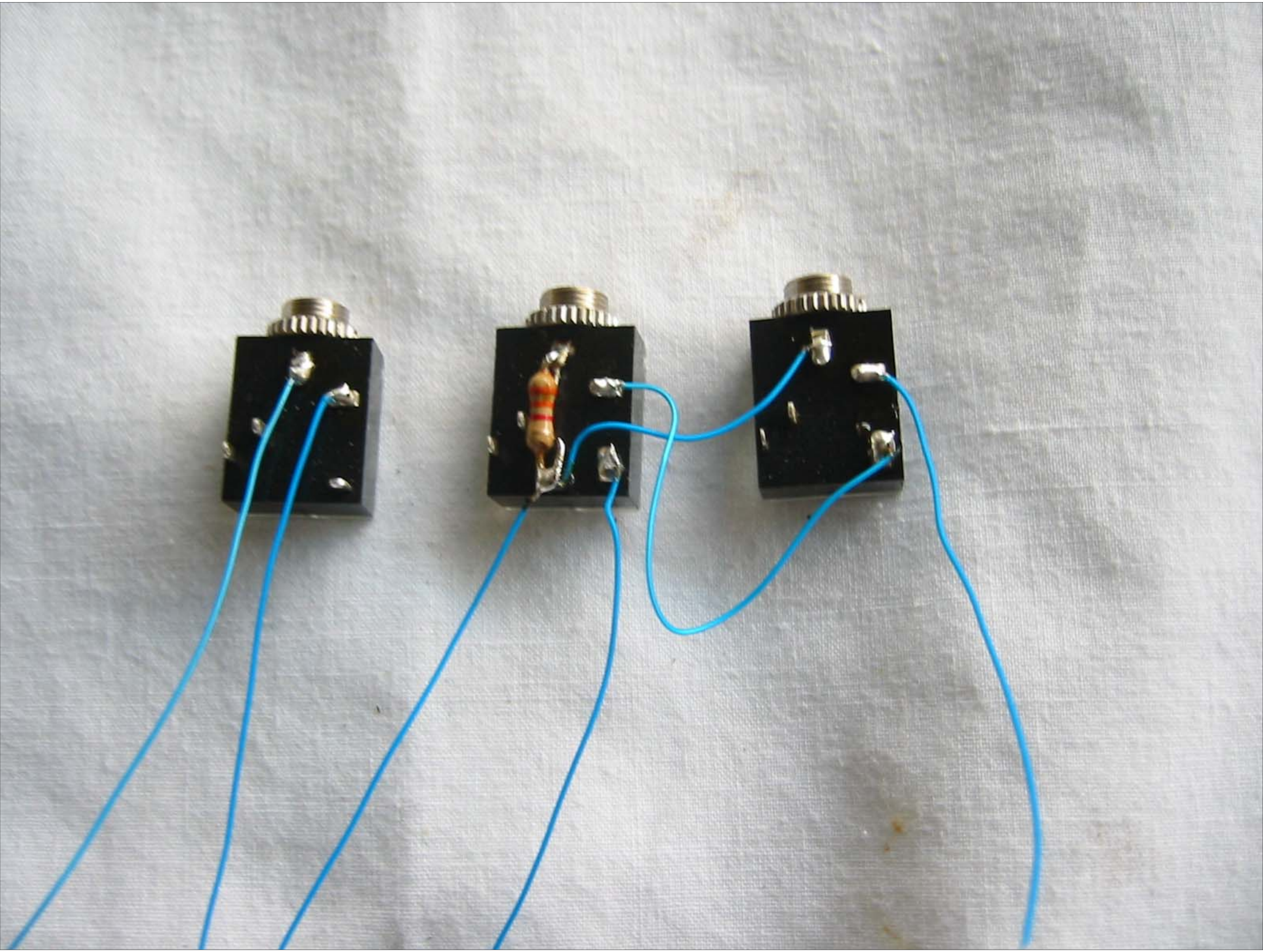
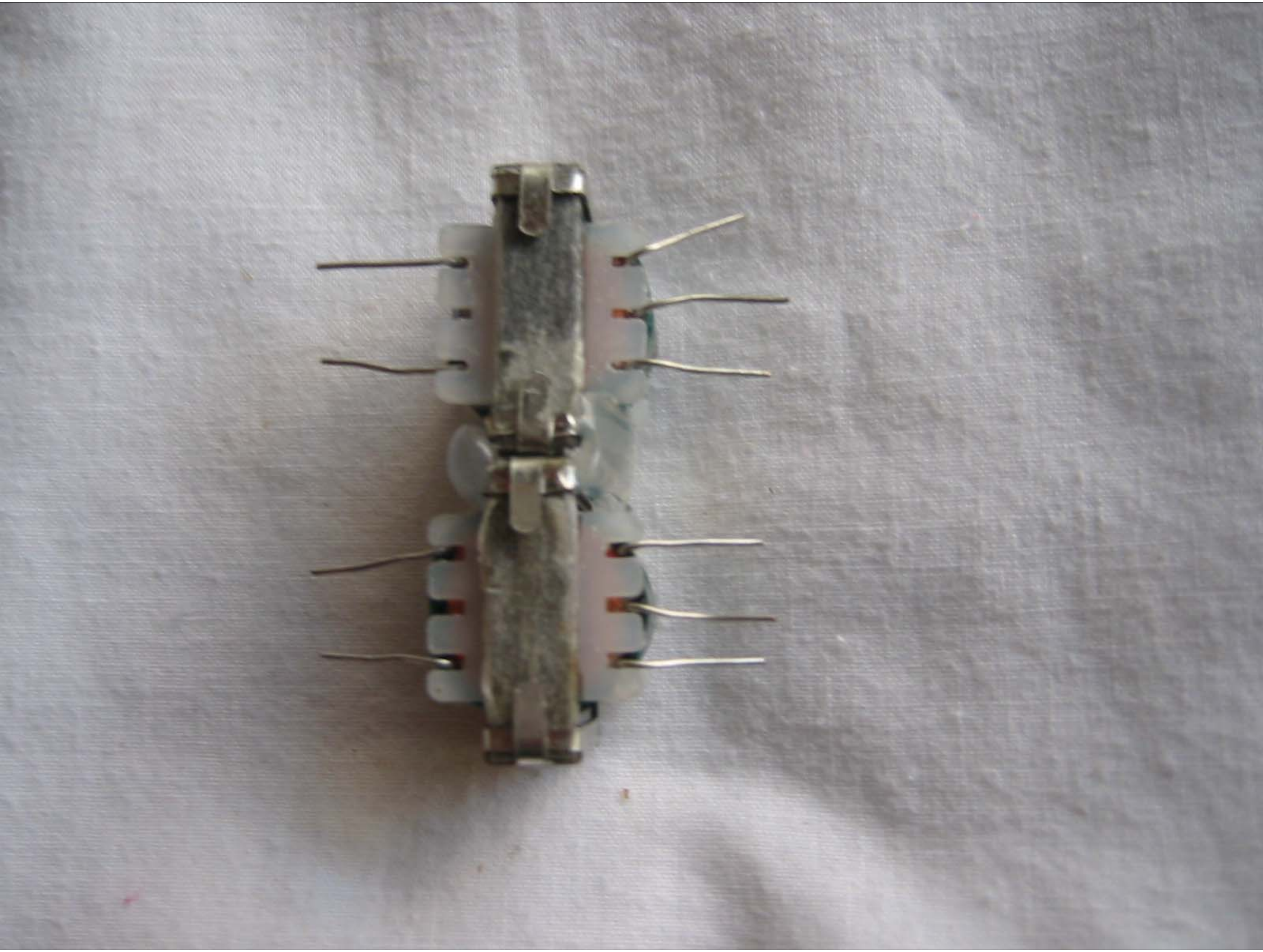
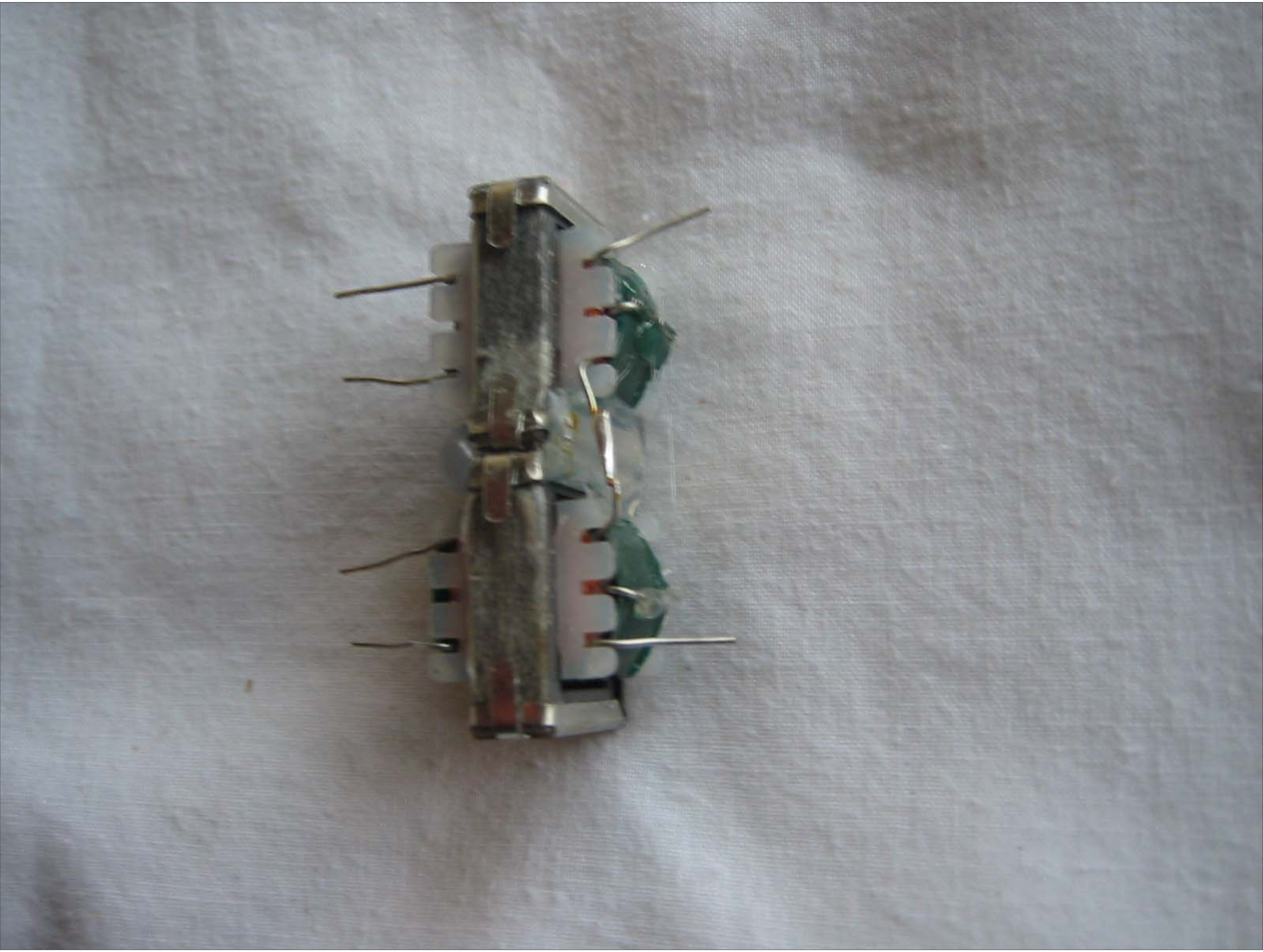

221-1328
Pkg. of 5
RadioShack
3.3k-Ohm
Resistors
¼ watt • 5% tolerance
Resistor

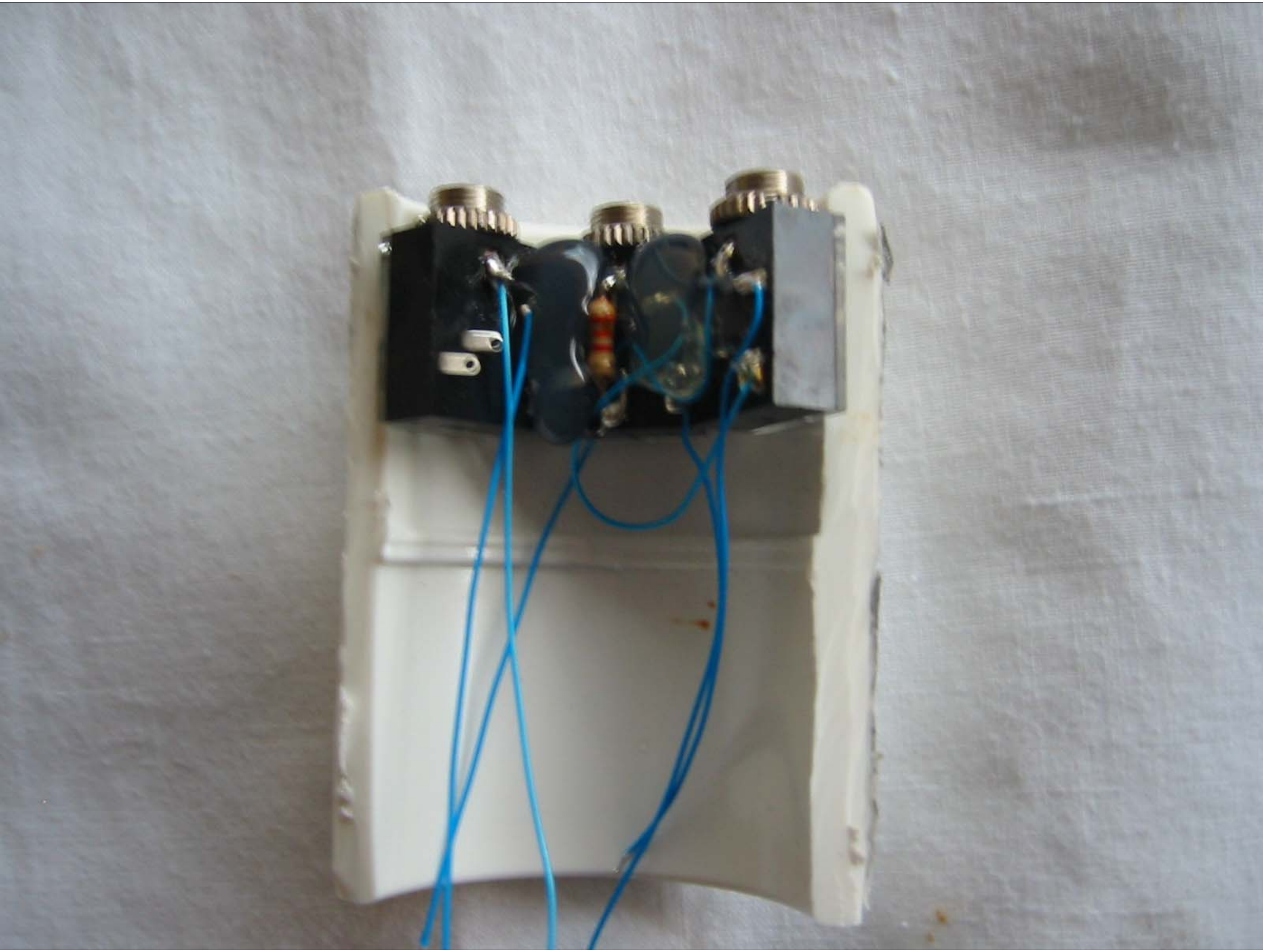

8THS
1
2

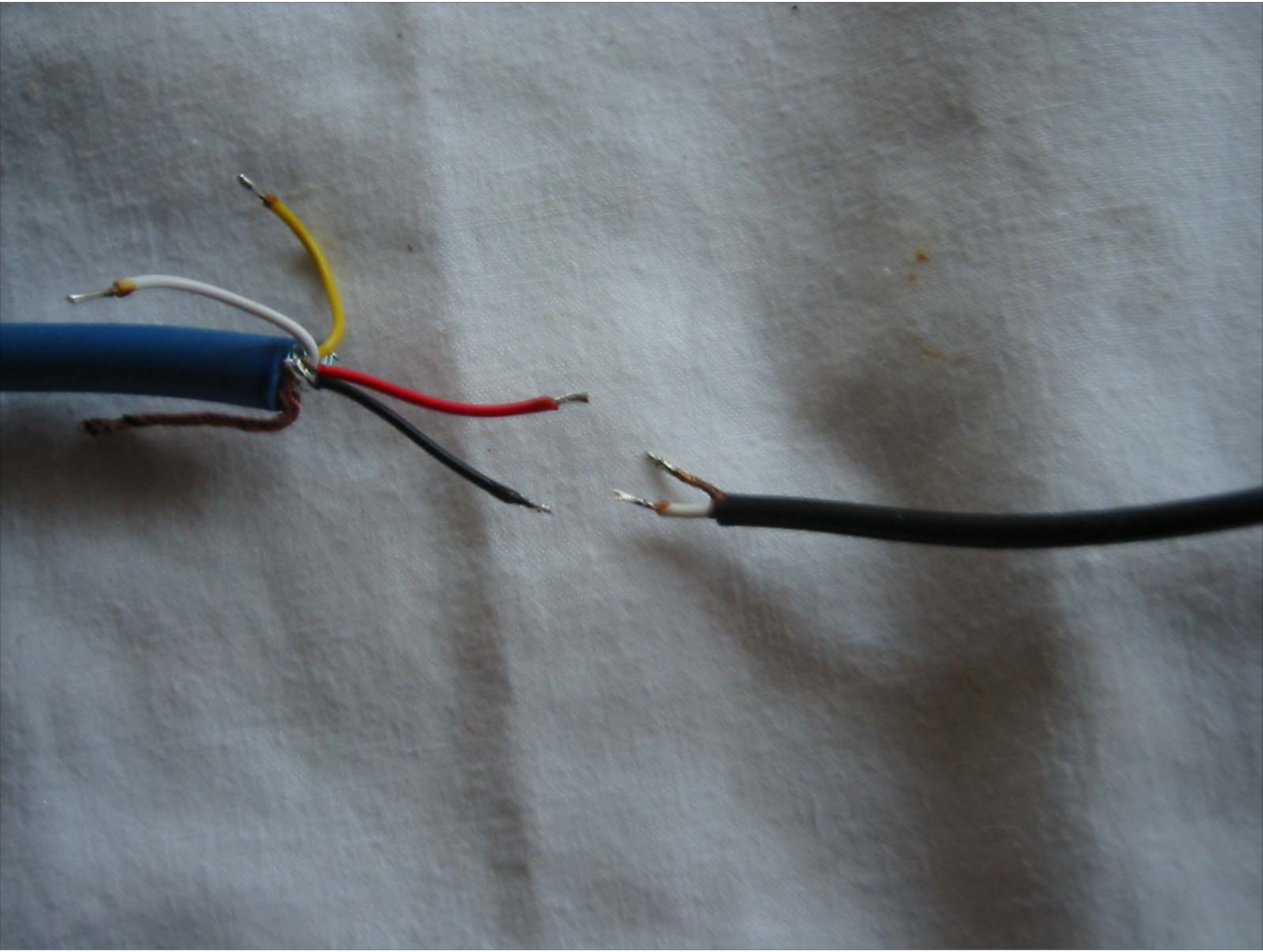

No. 64-021
Radio Shack®
Rosin Soldering
Paste Flux
applications
Net. Wt.

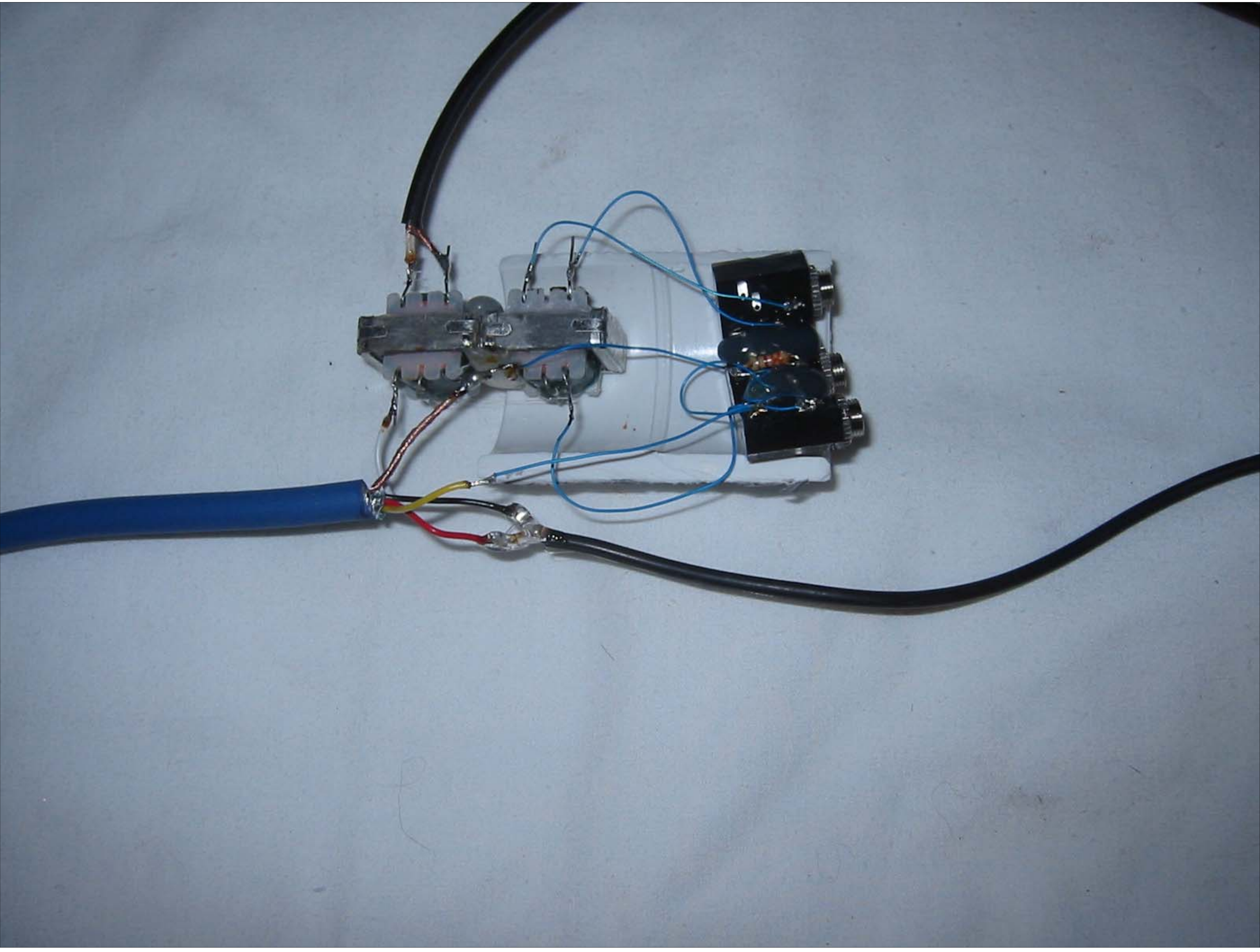


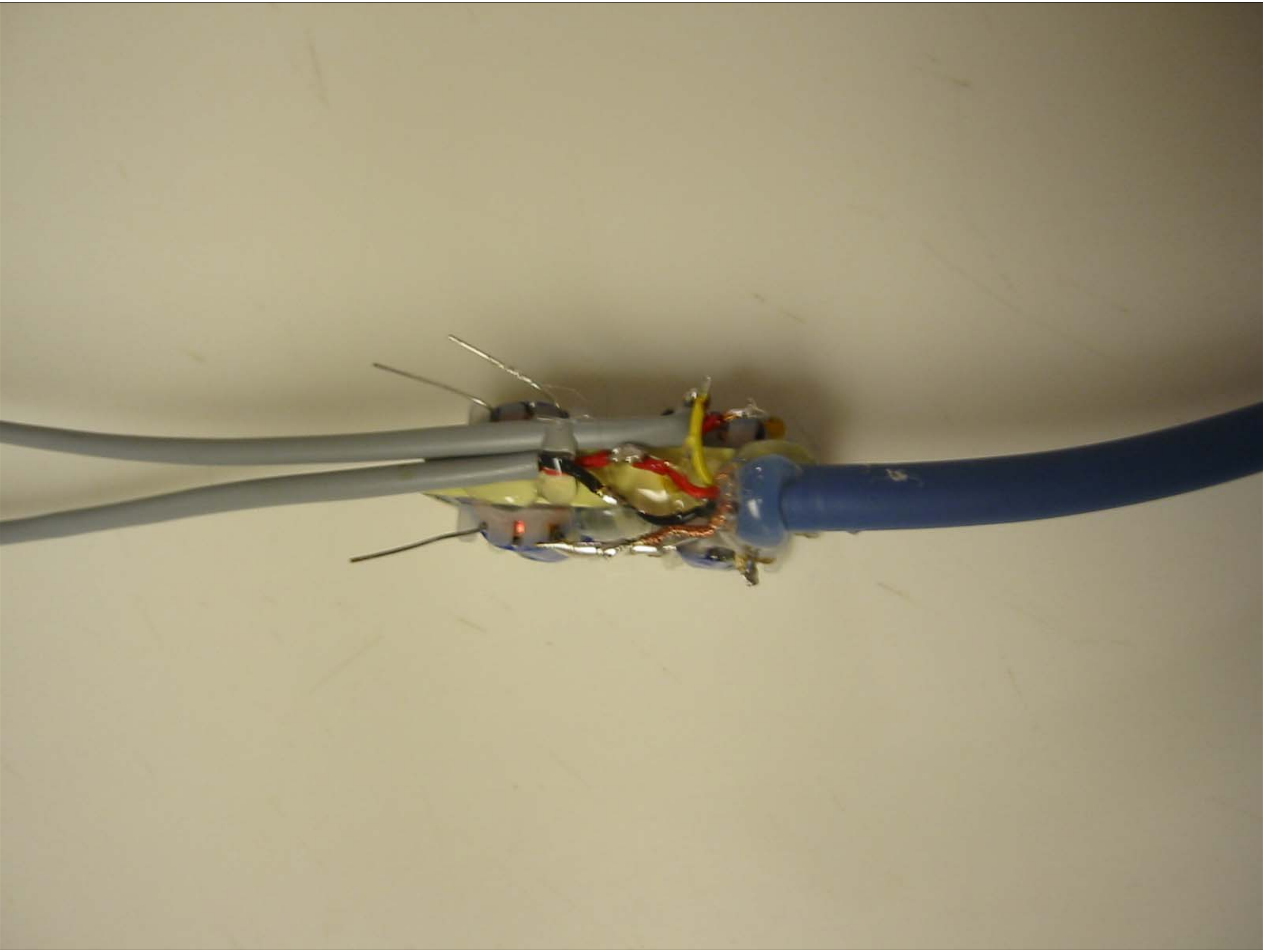


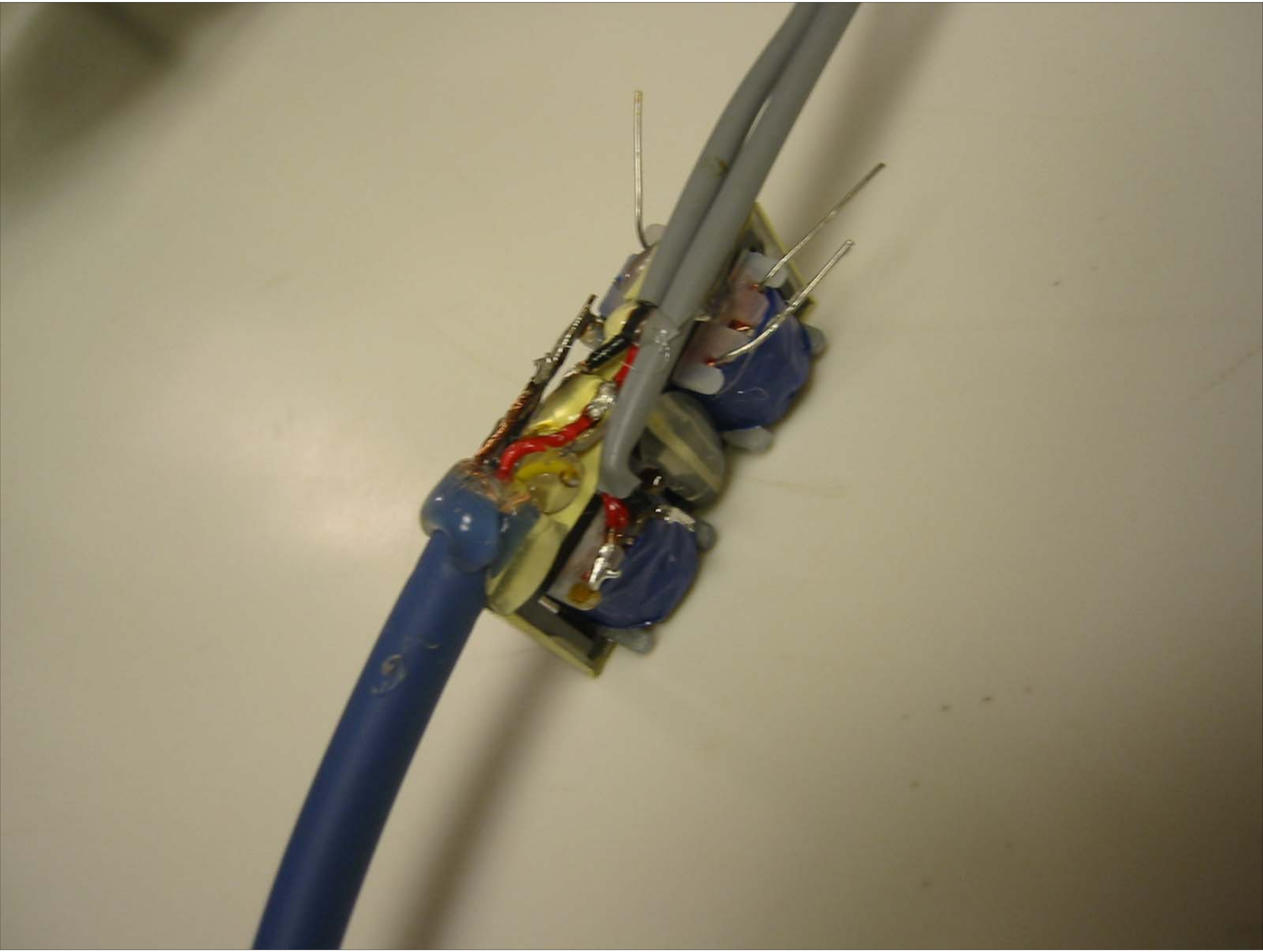


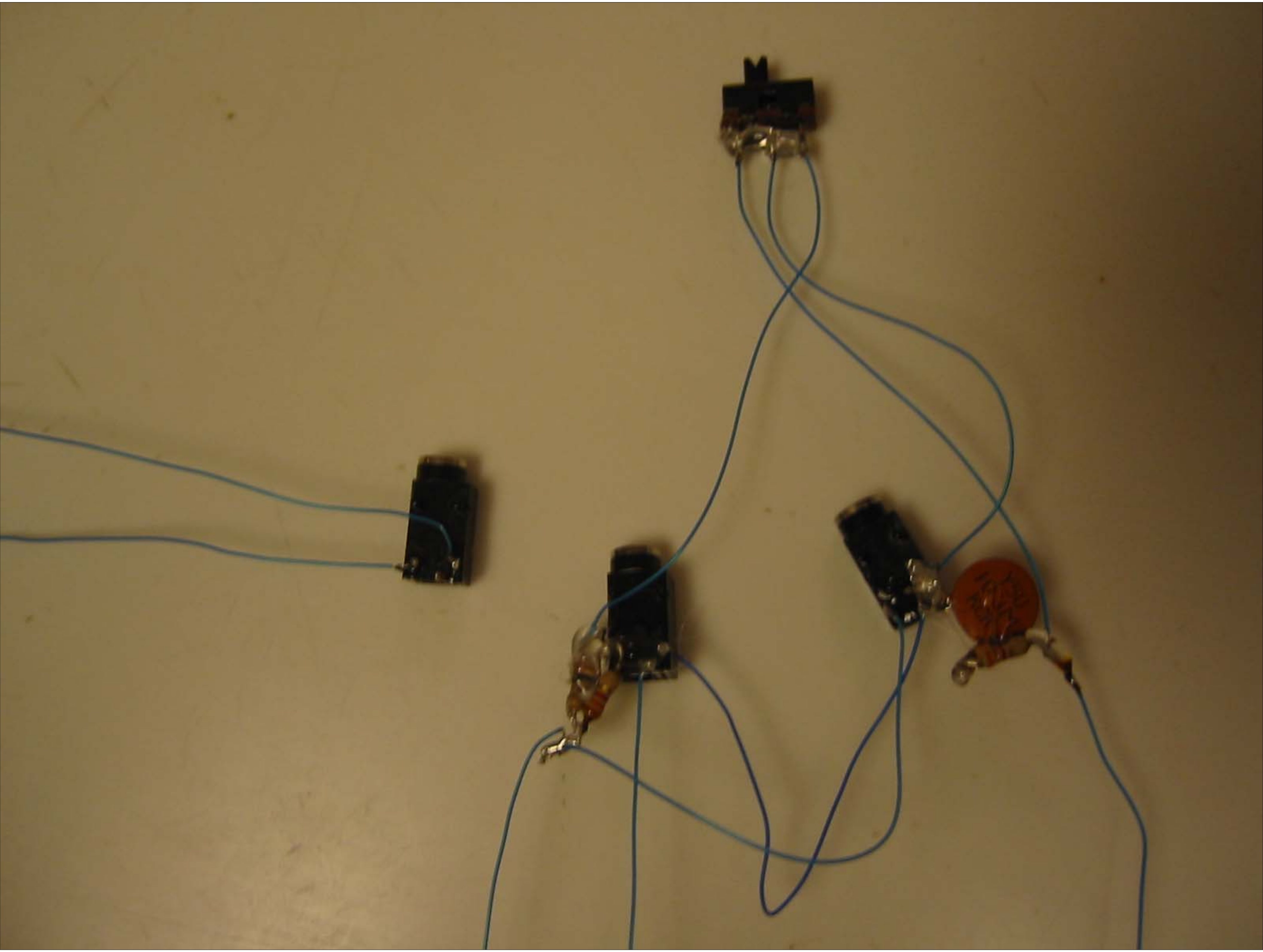


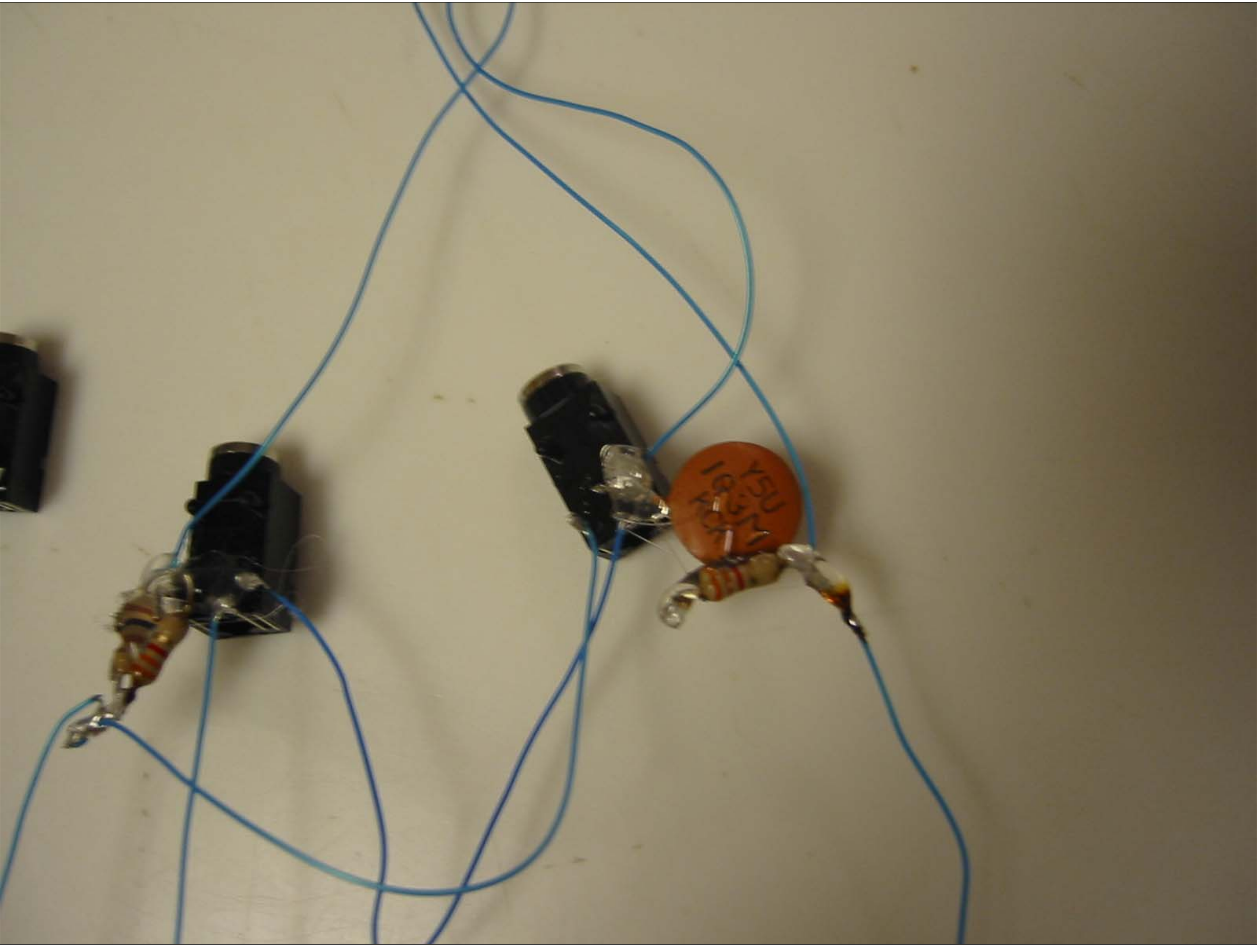


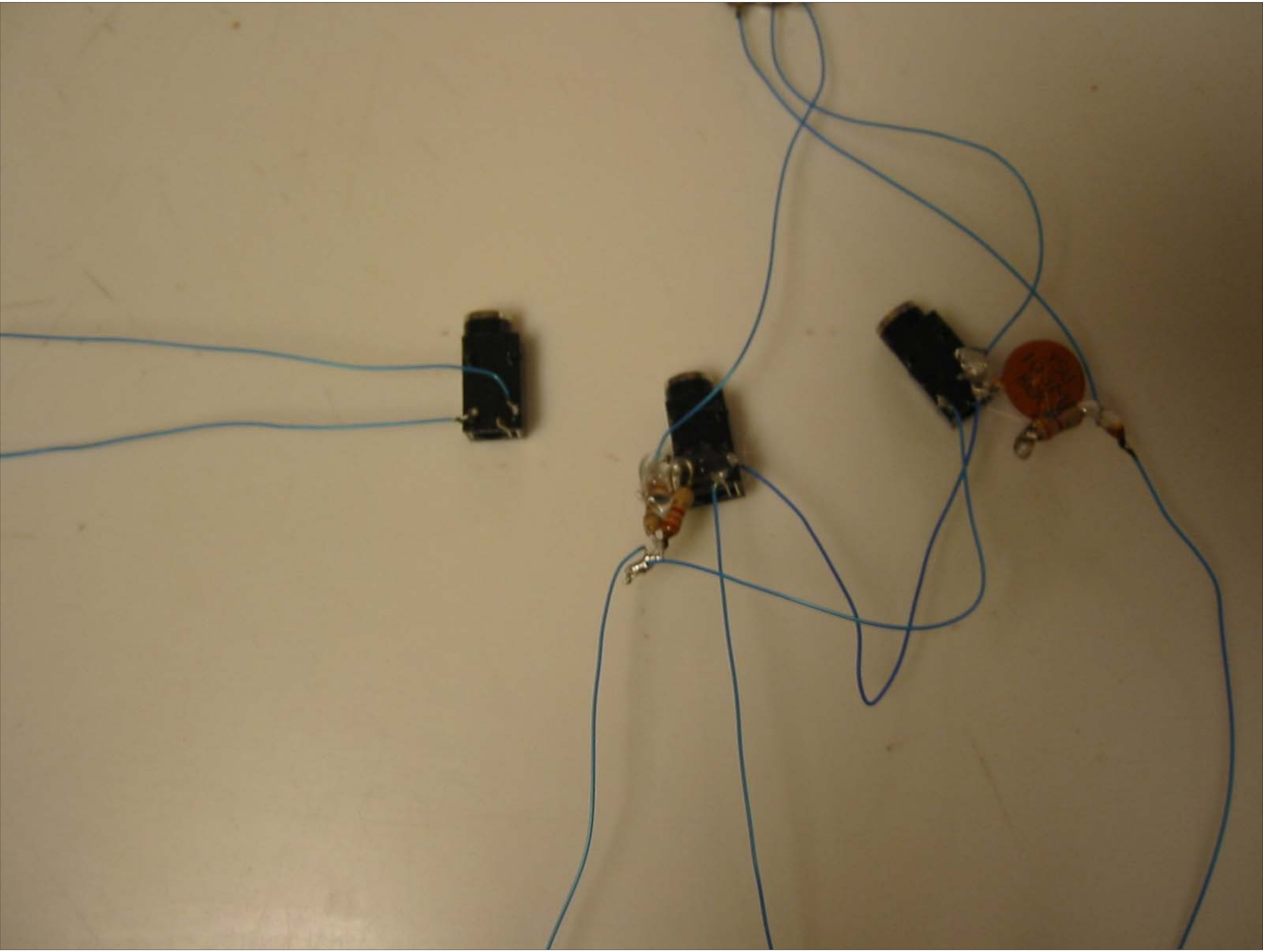












Line level signal to microphone input adapter

Sometimes there is need to convert line level signals to such signal that it can be connected to microphone input. Because the line level signals are typically in range of 0.5..2V and the microphone signals are in millivolt range, quite much attenuation is needed to match the signal levels. This means that typically you will need 40-50 dB of attenuation.

40 dB PAD

Consumer audio line (-10dBu) level to microphone matching can be done using a "40 dB L-pad attenuator". This circuit is indeed quite simple:

```
+Line level input -----R1----+-- +Mic level output
                             |
                  +----R2----+
                  |
Ground (input)----+--------------- Ground (output)

R1 = 10 kohm
R2 = 100 ohm
```

Circuit technical data:

- Attenuation: 40 dB
- Input impedance: 10 kohm
- Output impedance: 100 ohm
- Input signal: Unbalanced line level input
- Output: Unbalanced microphone output

50 dB PAD

Professional audio audio line level (+4dBu) to microphone matching can be done using a "50 dB L-pad attenuator". This circuit is indeed quite simple:

```
+Line level input -----R1----+-- +Mic level output
                             |
                  +----R2----+
                  |
Ground (input)----+--------------- Ground (output)

R1 = 33 kohm
R2 = 100 ohm
```

Circuit technical data:

- Attenuation: 50 dB
- Input impedance: 33 kohm
- Output impedance: 100 ohm
- Input signal: Unbalanced line level input

- Output: Unbalanced microphone output

Other attenuation values

```
+Line level input -----R1----+-- +Mic level output
                             |
                  +----R2----+
                  |
Ground (input)----+--------------- Ground (output)
```

The attenuation of the circuit is determined by equation:

attenuation (in dB) = 20 * log10 ((R1 + R2) / R2)

This equation is quite accurate when the impedance of the mic input where this circuit is connected has much higher impedance than the resistance of R2. Typical microphone inputs in equipments have input impedance of 1.5 kohm or higher (which is much higher than 100 ohms).

Component selection tips:

- R2 should prefeerably be something between 10 ohms and one kilo-ohms
- R1 should be from few kilo-ohms to few hindred kilo-ohms..

Those value ranges generally works bets for audio applications.

Constructing the circuit

The circuit itself can be built to a small metal box or even can be fitted inside an audio connector. The resistors in this circuit do not need more than 1/4W power rating (even lower ratings will do). I would recommend using metal film resistors in this circuit, because they are less noisy than cheap carbon film resistors.

I don't recommend building the circuit to a plastic box because we are playing with low level microphone signals, so the interference from nearby equipments or cellular phones can be a signnificant if you build this circuit to a plastic box or without any box. If you plan to use the circuit in any serious audio system do yourself a favor and build a circuit to a good metal box.

What to do if I get humming noise when I connect this to my system ?

Unbalanced microphone inputs of audio equipments are very sentitive to all noise in the system, especially when you connect something else than a flowating microphone to them. Usually at short distances there are no problems in usign the adapter. If you get any 50/60 Hz noise problems, put an audio isolation transformer to teihter input or output side of my circuit.

Balanced version

Balanced Taper Pad: 50dB (for 600 ohm impedance, XLR connector)

```
   XLR in                XLR out

      1 ------------------ 1

      2  ---R1---+---R2--- 2
                 |
                 R3
                 |
      3  ---R1---+---R2--- 3
```

Component values:

```
R1 = 300 ohms
R2 = 300 ohms
R3 = 4 ohms
```

Equations to calculate different value attenuations

```
        ---R1---+---R2---
                |
   -> Z1        R3      Z2 ->
                |
        ---R1---+---R2---
```

```
R1 = ((Z1 + Z2)* 0.994 + (Z1 - Z2))/4

R2 = ((Z1 + Z2)* 0.994 - (Z1 - Z2))/4

R3 = (Z1 + Z2) / attenuation
```

Example: Z1=600 ohms Z2=600 ohms attenuation=317.3 (=50 dB)
Then R1=298 ohms, R2=298 ohms, R3=3.78 ohms

Tomi Engdahl <*Tomi.Engdahl@iki.fi*>

Audio Transformers

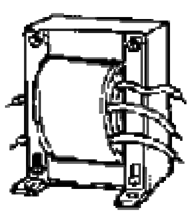
Audio transformers can:

1. Step up (increase) or step down (decrease) a signal voltage.
2. Increase or decrease the impedance of a circuit.
3. Convert a circuit from unbalanced to balanced and vice versa.
4. Block DC current in a circuit while allowing AC current to flow.
5. Electrically isolate one audio device from another.

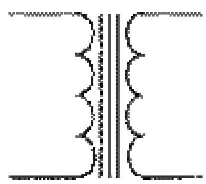
While transformers are useful in other applications, this paper deals only with audio usage.

What is a transformer?
A transformer is an electrical device that allows an AC input signal (like audio) to produce a related AC output signal without the input and output being physically connected together. This is accomplished by having two (or more) coils of insulated wire wound around a magnetic metal core. These wire coils are called windings. When an AC signal passes through the input winding (the *primary*), a related AC signal appears on the output winding (the *secondary*) via a phenomenon called inductive coupling. By changing the number of wire turns in each winding, transformers can be manufactured to have various impedance ratios. The ratio between the input and output impedances provides a gain or loss of signal level as the signal passes through the transformer. Transformers are bidirectional so that an input winding can become the output winding and an output can become an input. Because of a transformer's bidirectional nature, it can provide a gain in signal level when used in one direction or a loss when used in reverse.

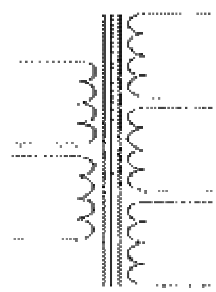
Transformers can be manufactured with multiple primary or secondary windings. A winding can also have multiple connections or "taps". Multiple taps offer different impedances along with different gains/losses.



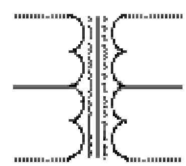
Picture of a Transformer



Electrical Diagram of a Transformer



Multiple Windings



Multiple Taps

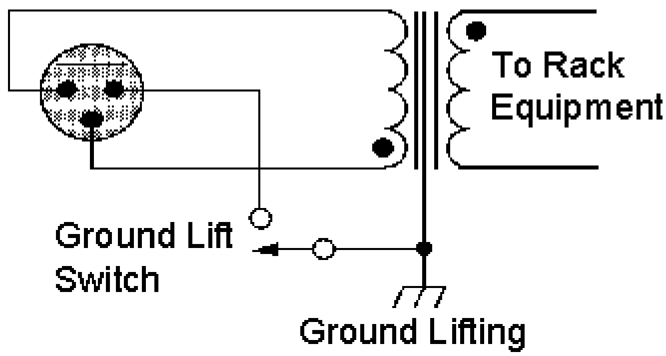
What types of audio transformers exist?
There are two basic types of audio transformers with each having multiple functions:

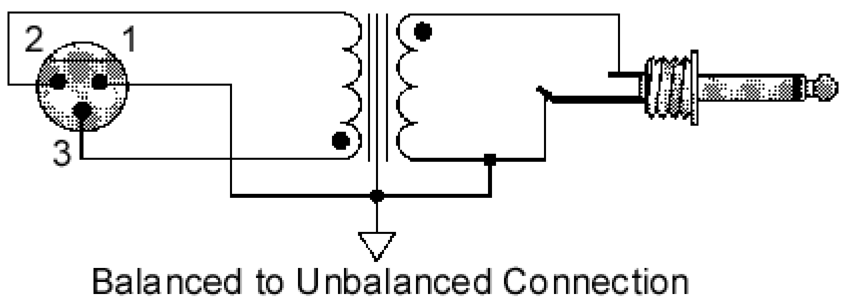
Step-up / Step-down transformers
- Signal level compatibility or matching
- Impedance compatibility or matching

Unity 1:1 transformers
- DC blocking
- Radio Frequency Interference (RFI) blocking
- Ground lift and device isolation

Step-up / Step-down transformer
In a step-up / step-down transformer, the primary and secondary have a different number of windings, thus they have different impedances. Different impedances cause the signal level to change as it goes through the transformer. If the secondary has a higher impedance (more windings) than the primary, the signal level at the secondary will be a higher voltage than at the primary. A transformer with multiple taps provides access to multiple impedances and to different signal gains or losses. Many microphones have step up transformers at their output. For example, inside of every SM57 and SM58 microphone is a transformer that steps up the signal level and impedance before it exits the microphone.

Unity 1:1 transformer
Often called an isolation transformer, it has the same number of windings on each coil. As the impedance is identical for the primary and secondary, the signal level does not change. A unity transformer allows an audio signal to pass unmodified from the primary to the secondary while blocking DC voltage and radio frequency interference (RFI). Also, since the primary and secondary are insulated from each other, a unity transformer will electrically isolate different pieces of equipment. This can solve hum problems by isolating ("lifting") the grounds of different devices. Other unity transformer applications include providing multiple outputs from a single mic input by using multiple secondary windings, and changing balanced signals to unbalanced signals or vice-versa.





What are the limitations of audio transformers?
The first limitation is frequency response. By design, audio transformers only pass audio signals. Therefore, an audio transformer will reduce or block signals that are below or above the audio range of 20 - 20,000 Hz. This can be a limitation or a benefit depending on the situation. A second limitation is that audio transformers have a maximum input level that cannot be exceeded without causing a distorted signal. When the maximum level is exceeded, the transformer is said to be "saturated", i.e. it cannot hold any more signal. A third limitation is that audio transformers cannot step up a signal by more than about 25 dB when used in typical audio circuits. Because of this limitation, an audio transformer normally cannot be substituted for a microphone preamp. If more than 25 dB of gain is required, an active preamplifier must be used instead of a transformer.

What is the difference between an expensive transformer and an inexpensive transformer?
Most of the differences involve the limitations stated above. For example, an expensive transformer will have a flatter and broader frequency response. Often, a hotter input signal can be put through an expensive transformer without saturating it. Expensive transformers are also shielded better. Shielding reduces pickup of hum and interference from outside sources such as power supplies. Not only does the shielding keep unwanted signals out of the transformer, it also keeps the desired signal within the transformer. Many inexpensive transformers have no shielding while expensive transformers may have multiple shields.

Do's and Don'ts of Audio Transformers

Do use a transformer to match impedances.

Do use a transformer to increase or decrease signal level by up to 25 dB.

Do use a 1:1 transformer to isolate problem components in an audio chain.

Do not use a transformer to increase signal level by more than 25 dB.

APPENDIX: Important Equations

The number of wire turns in each coil is related to the *Turns Ratio:*. The specified impedance of a transformer is the open circuit impedance, i.e. with nothing connected to either the primary or secondary of the transformer. When a microphone is connected to the transformer, the secondary will reflect the microphones impedance, modified by the square of the turns ratio.

$$\text{Turns Ratio} = \frac{\#\ \text{of secondary turns}}{\#\ \text{of primary turns}} = \sqrt{\frac{\text{secondary impedance}}{\text{primary impedance}}}$$

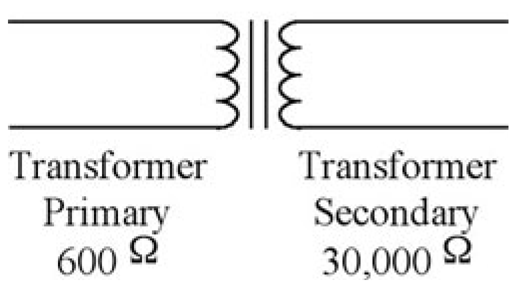
The *Turns Ratio:* is related to the voltage and current ratios:

$$\text{Turns Ratio} = \frac{\text{primary current}}{\text{secondary current}} = \frac{\text{secondary voltage}}{\text{primary voltage}}$$

The following equation is used to determine the gain or loss when using a transformer.

$$\text{Transformer Gain} = 20 * \log\sqrt{\frac{\text{impedance}_{\text{secondary}}}{\text{impedance}_{\text{primary}}}}$$

Here is an example:



$$20 * \log\sqrt{\frac{30000}{600}} = 16.9\ \text{dB}$$

The gain of the above transformer is 16.9 dB.