

Microphone

Purpose:

To build a microphone by soldering discrete items such as ECM (electret condenser microphone) device, resistors and capacitors, an operational amplifier IC, a TRS jack and a battery case.

Backgrounds

1. Sound and microphone

In the human body, a sound comes in ears and makes a vibration of ear drums. This vibration transferred to cochlea, that is an organ which stimulates nerve cells which sends the electric signal to the brain. In the world of technology, the item corresponding to the ear in such an auditory sensing system is a microphone. It is an device or apparatus that has a membrane or a surface which vibrates by sound and creates the electric signal, which is referred to as an audio signal.

The audio signal created by the microphone is an oscillation of voltage in very fast rate, usually more than one hundred times oscillation in a second. The signal to make sounds at loudspeakers is so-called analog signal, which changes continuously in time. However, in the audio and visual system today the audio signal is always changed into a digital signal in order to record and save for replaying. The digital signal has an advantage of removing noise and keeping quality of the original sound.

The digital signal is handled as an file in tools such as computers. The files of the audio signal have several types (formats) classified by codecs (types of decompression) and containers (types of description) with filename extensions *.wav, *.wma, *.mp3, *.aac and so on. Recently it is easy to find softwares in order to replay, analyze, transform, display and edit the audio files in PC.

2. External microphone and its connection

Before analyzing or saving a sound, you need to get an audio signal which is created by an acoustic sensor, i.e., a microphone. Sometimes you may get an audio file by use of some tools, such as a voice recorder, a notebook-type PC or a smartphone which has the built-in microphone in addition to the amplifier, the storage or the memory. The built-in microphone is designed to use for specific purposes, for example, of sensing voice around the tools. If you try to catch another sounds from some sound source, you will connect an external microphone to the tool. Usually a small external microphone, a so-called “condenser microphone” is used.

On a notebook PC, a voice recorder, or a stereo component system, you will find a terminal “MIC” of a 3.5 mm-diameter jack where the external microphone can be connected. There are the same shape even for the different purposes of terminals, i.e., for a loudspeaker, a line-out or a line-in, or for a head-set that is a unified device equipped with left-and-right output channels for a headphone in addition to an input channel of a monaural external microphone. The notebook PC and the voice

recorder can have a built-in internal microphone that will be automatically disconnected just after connecting the plug of the external microphone to the jack. You should note that even if a plug fits to a jack, it does not mean that the plug is connectable to the jack. Not only because of purposes of the terminals, as shown above, but also there are two types of standards for the external microphone terminals: for a condenser microphone its power supply is required through the terminal, but for a dynamic microphone it isn't.

The standard internal wirings for the MIC and head-set terminals are shown in the Figure 1.

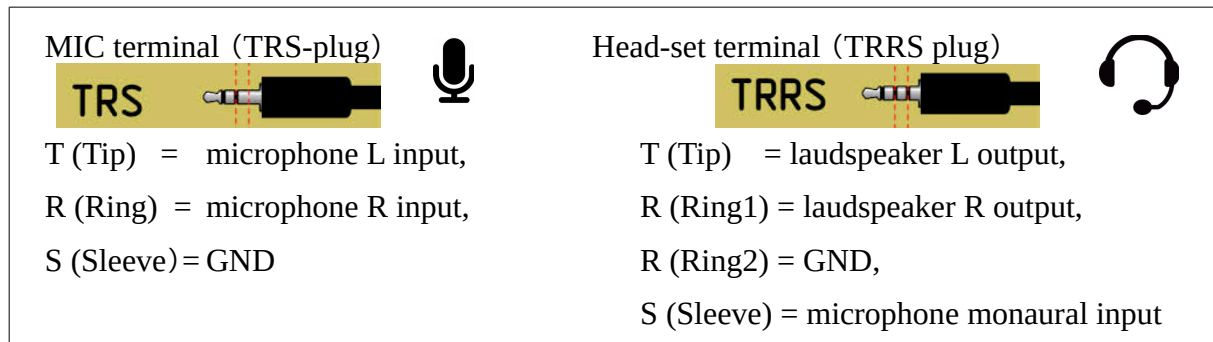


Figure 1. The internal wirings of MIC and head-set terminals

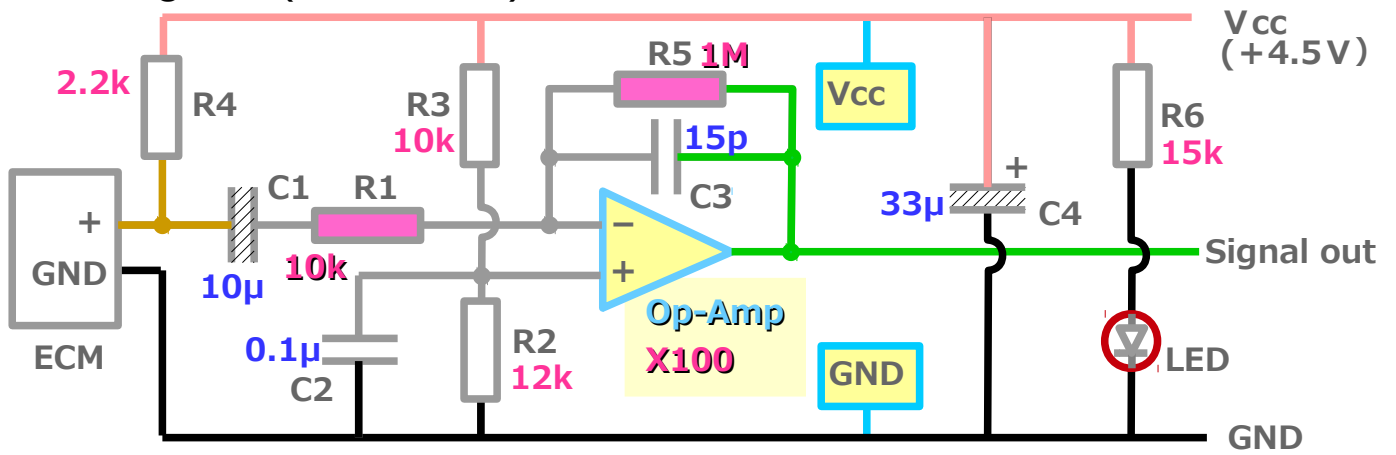
A traditional notebook PC has the TRS jacks with colored indication, as shown in Figure 2; pink for MIC, green for Line-out or headphone, and blue for Line-in. The MIC jack supplies the power (around +2.5 V) for the condenser-microphone from the inner circuit of the PC, though the Line-in jack doesn't. If you prepare an external power, the Line-in jack can be used for the microphone input.



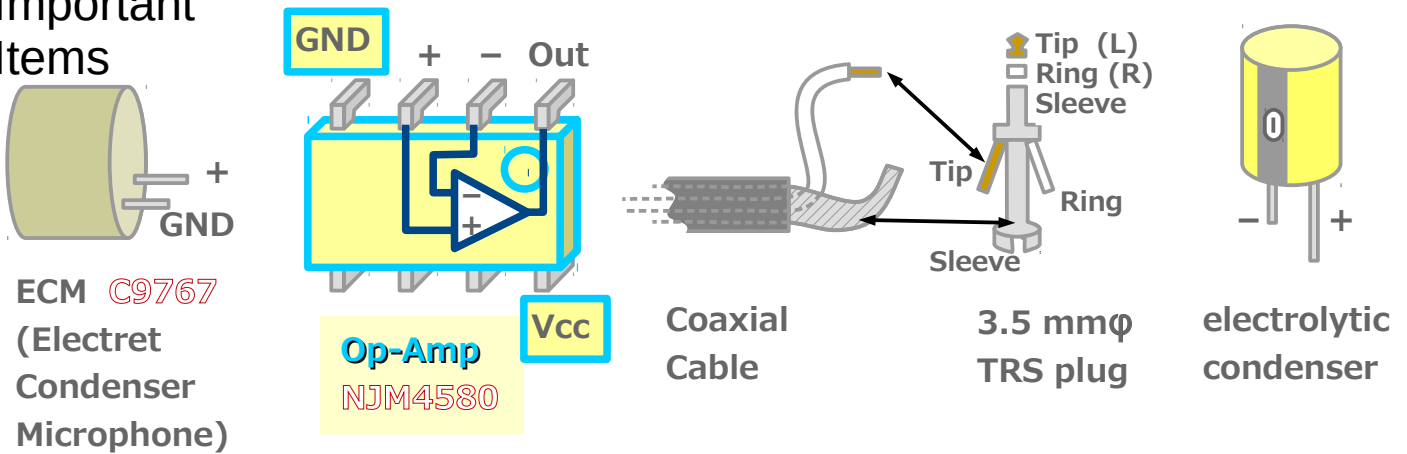
Figure 2. Three TRS jacks for the MIC, Line-in and Line-out terminals

Lastly, the 3.5 mm-diameter TRRS terminals are also used for the audio and visual cables for video systems. The video cable can be separated into three lines with the red, white, and yellow terminals. The Tip and Ring1 terminals are connected to Left (Red) and Right (White) audio signals, respectively. The Ring2 and Sleeve are possibly connected to the GND and Video (Yellow) signals, but sometimes they are connected oppositely.

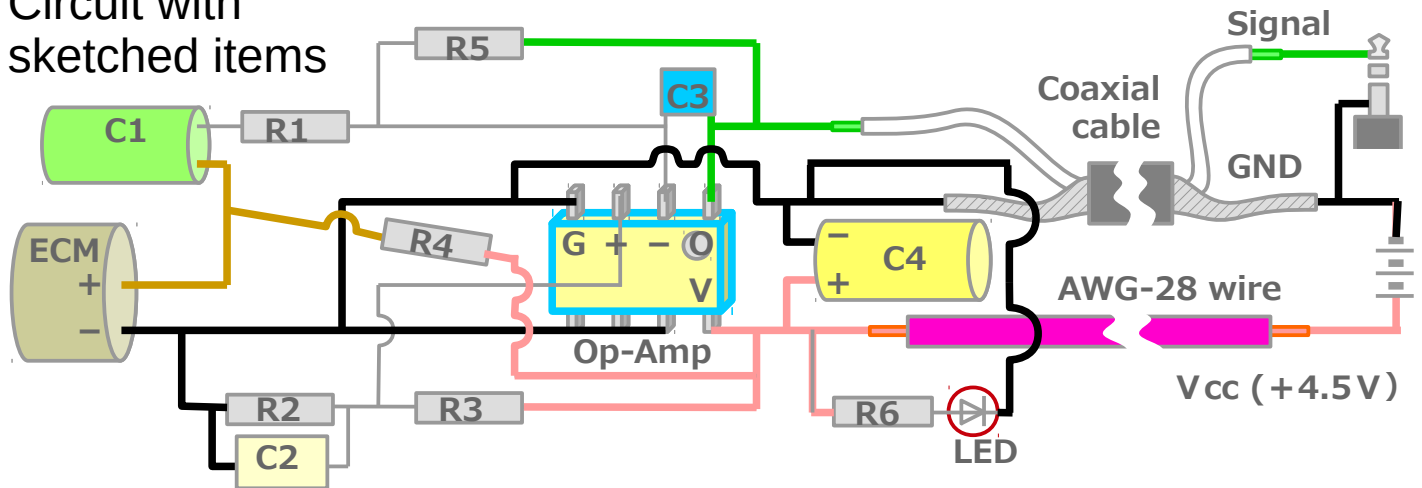
Circuit diagram (schematic)



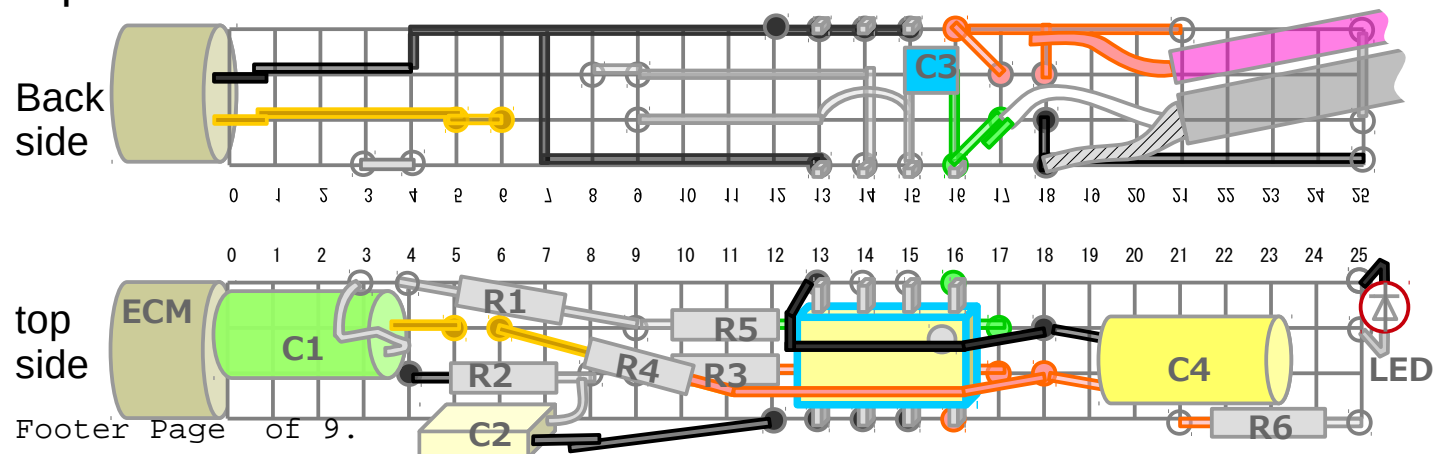
Important Items

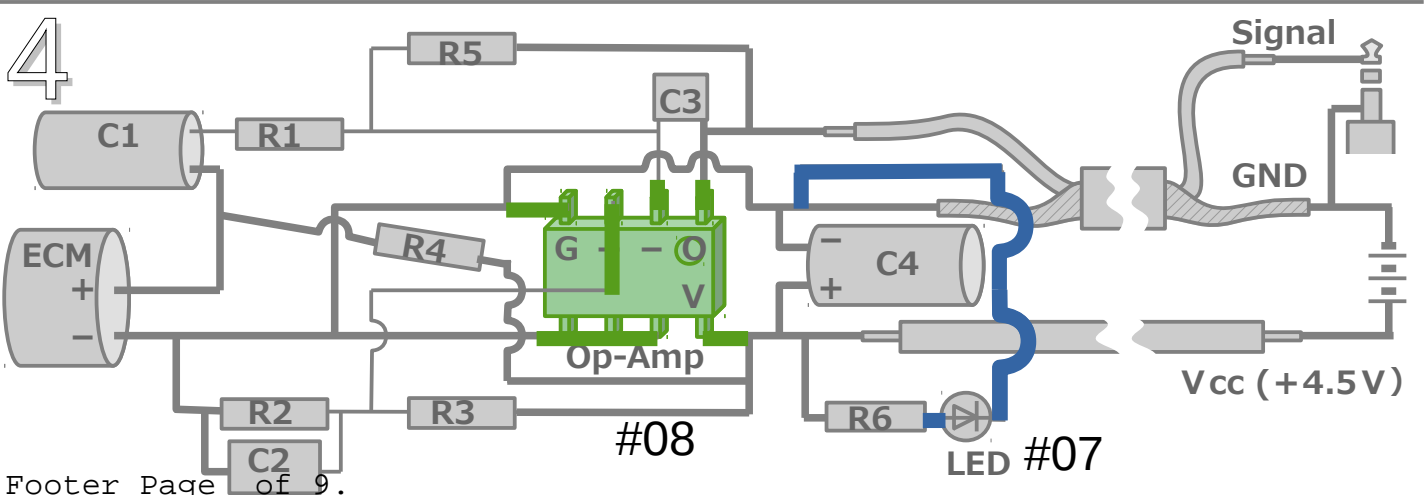
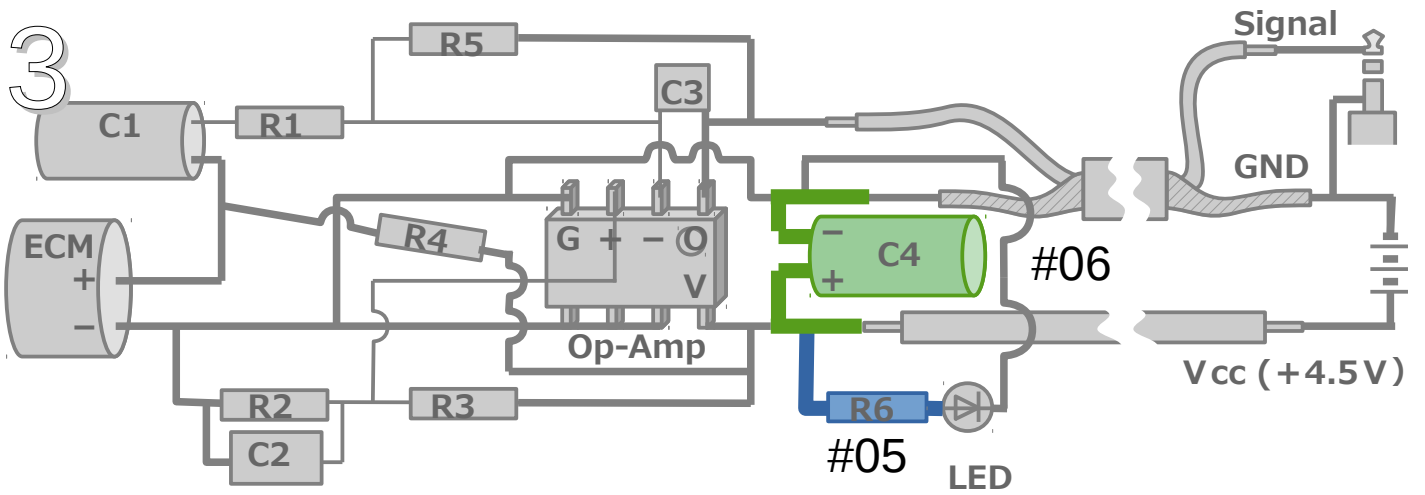
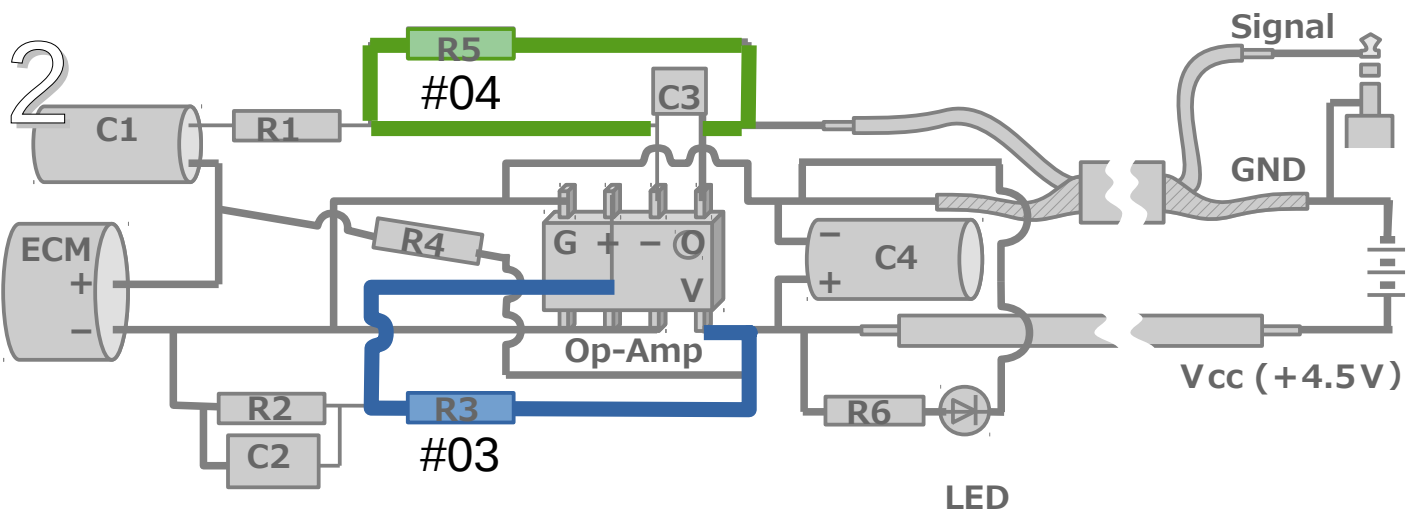
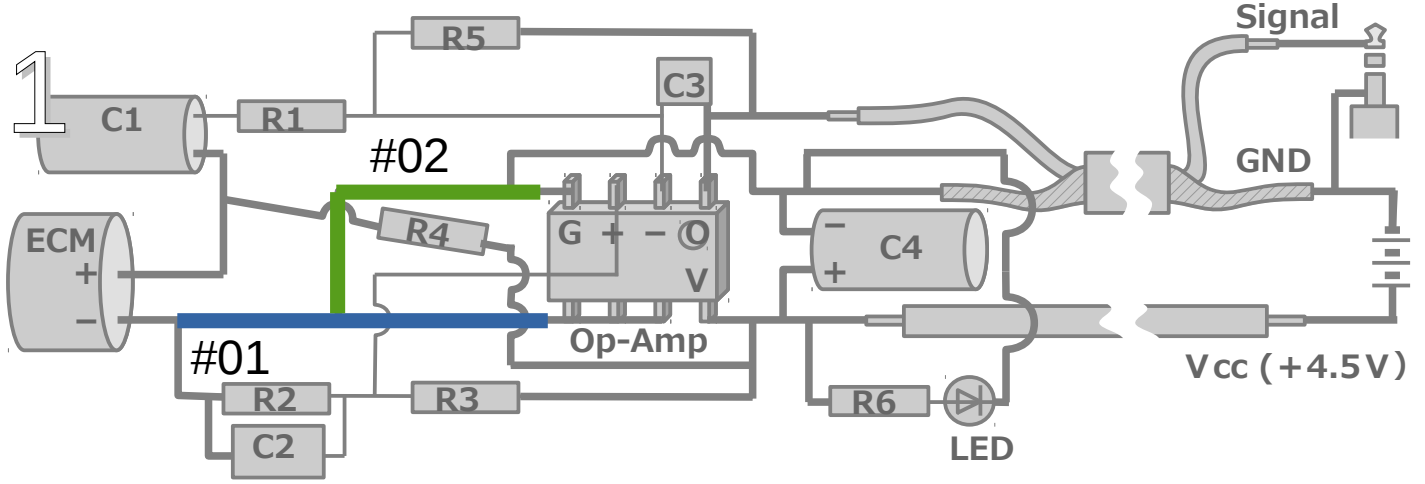


Circuit with sketched items



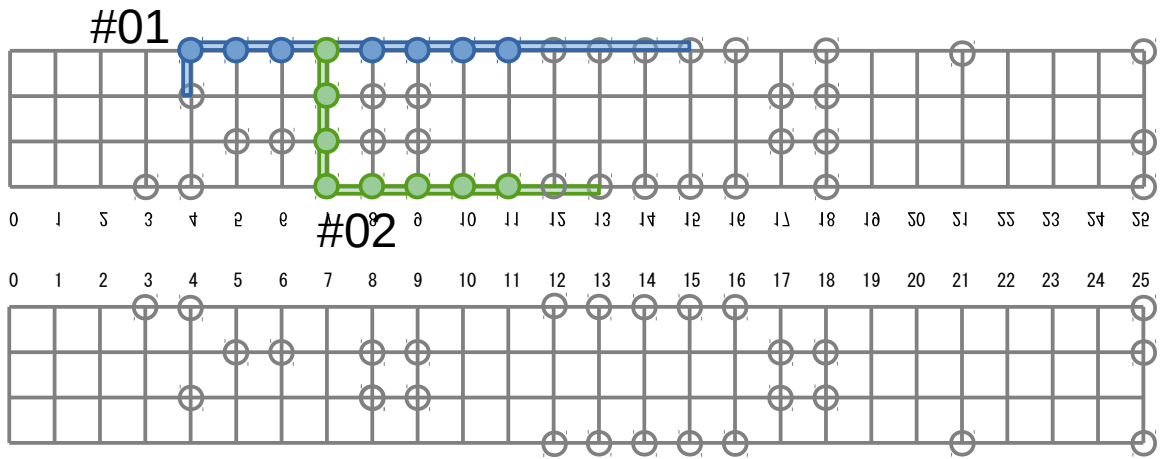
Implimentation





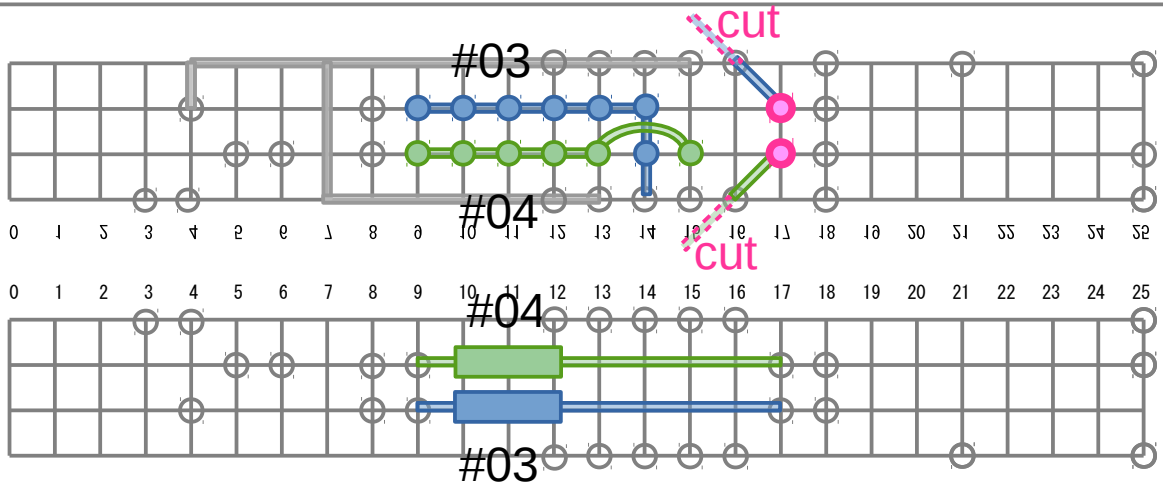
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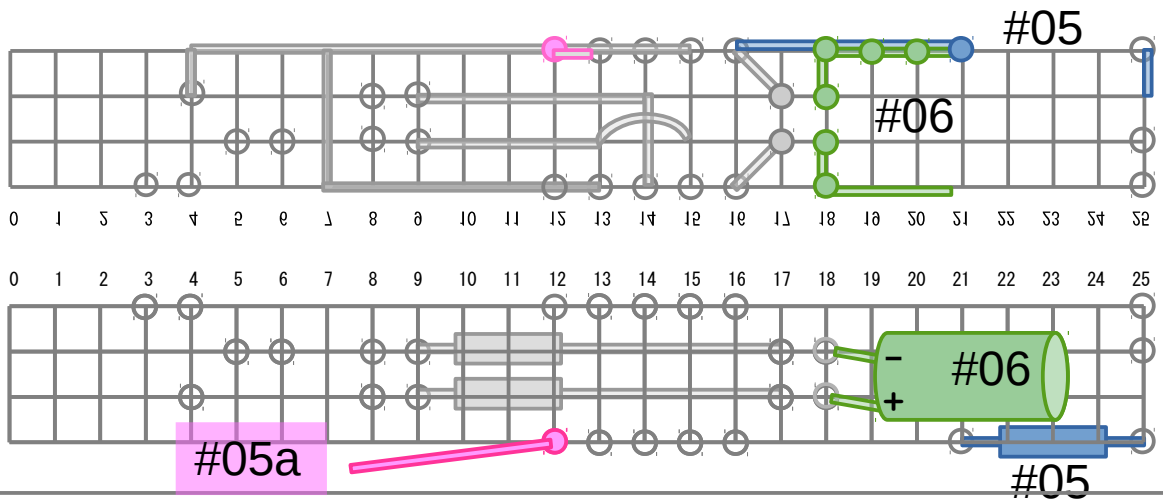
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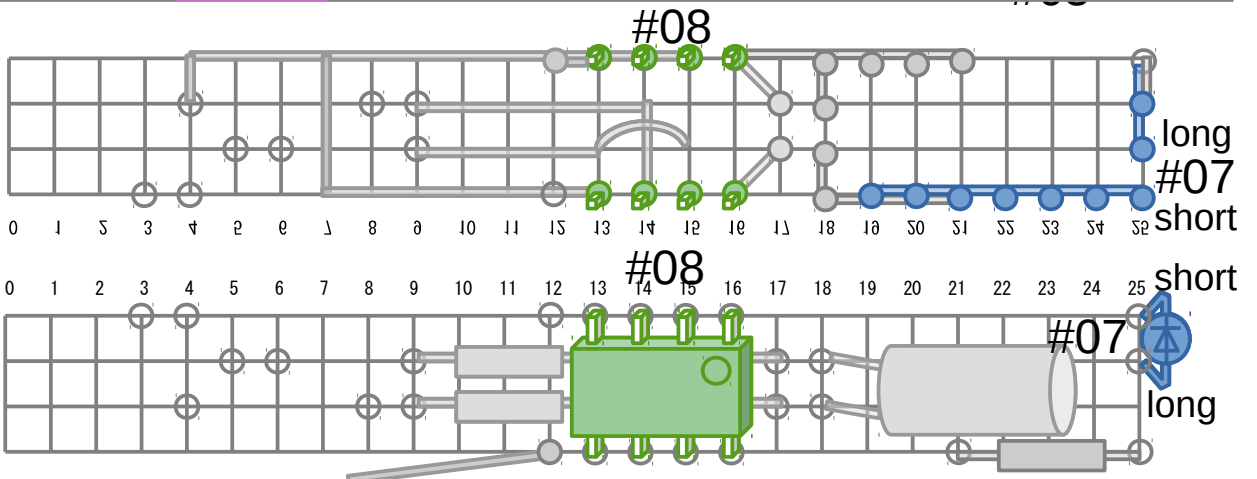
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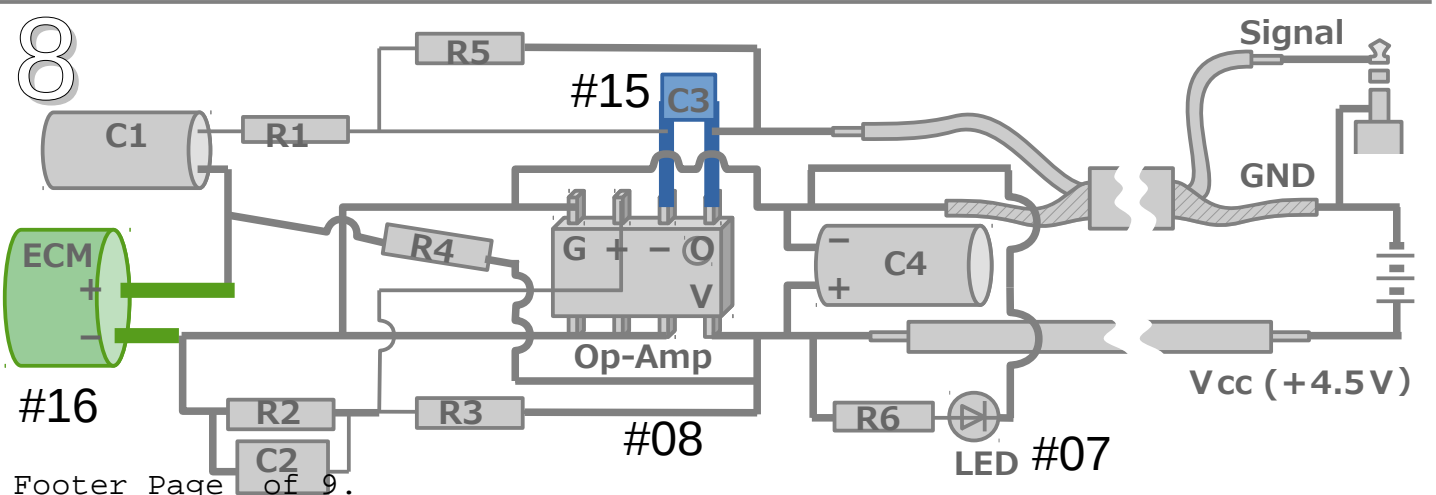
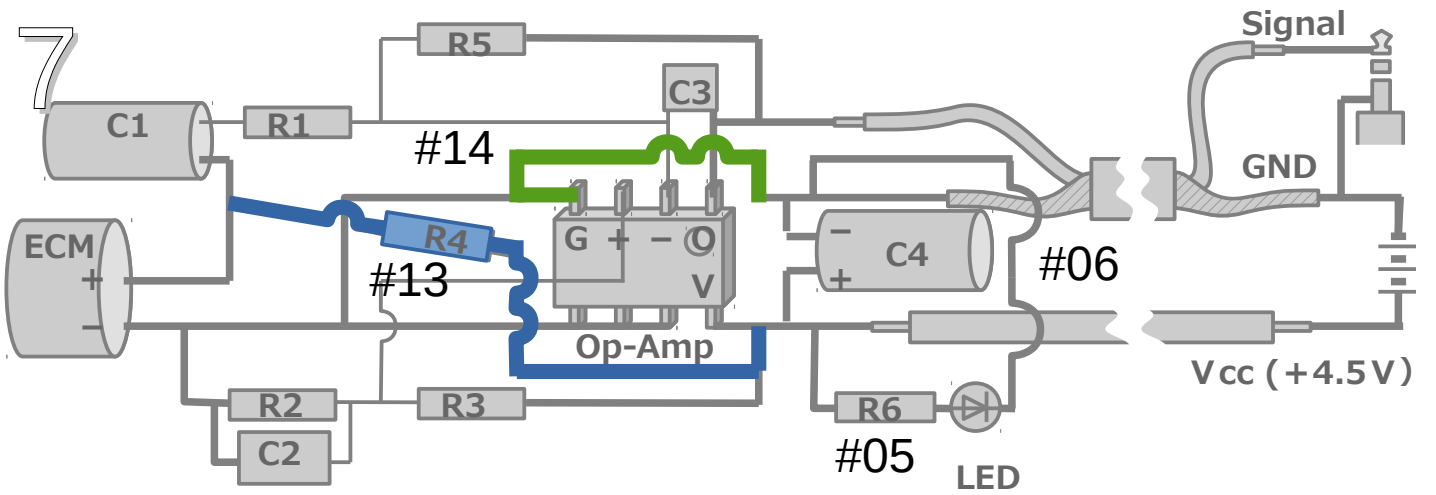
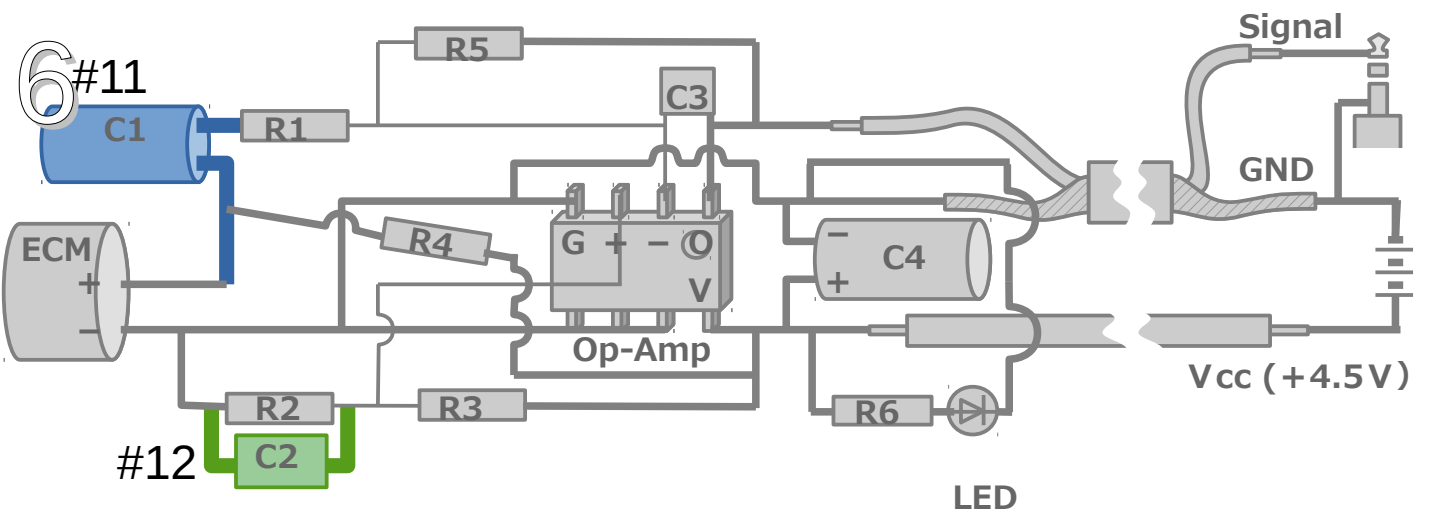
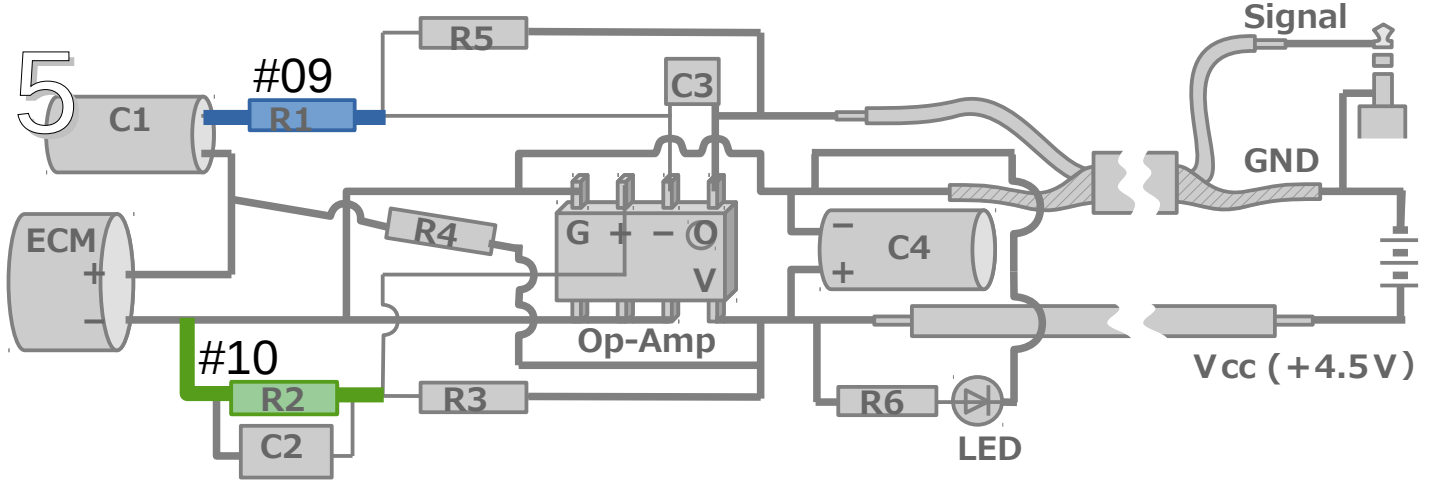
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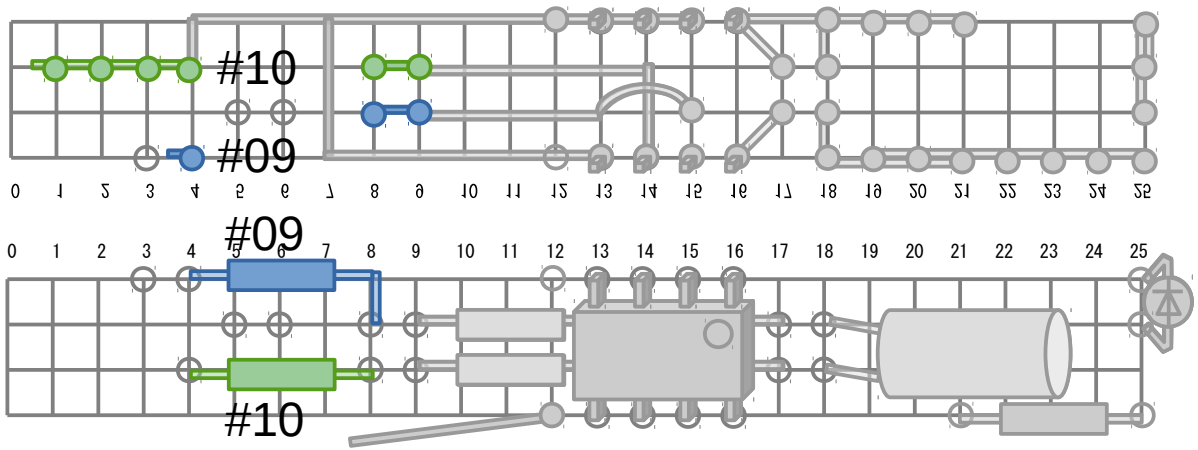
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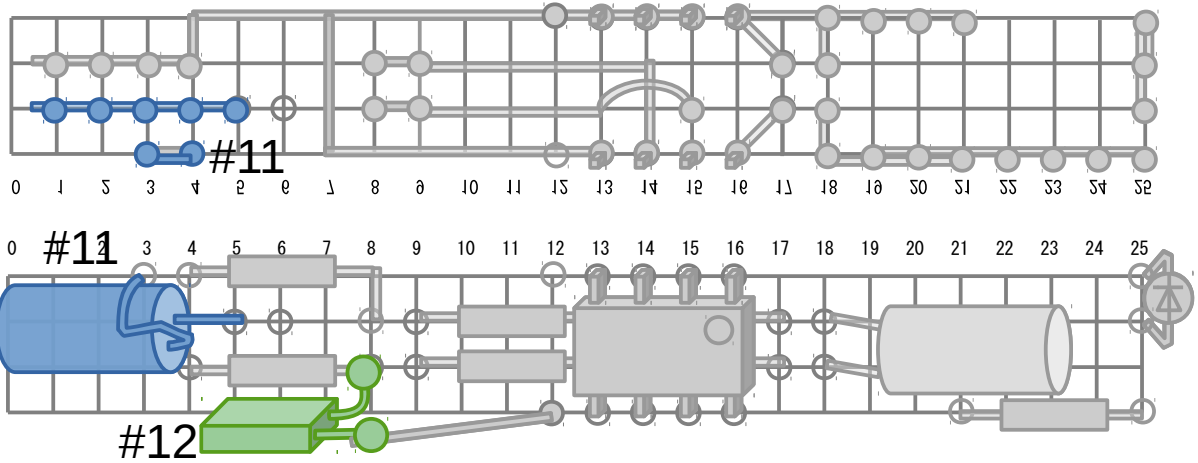
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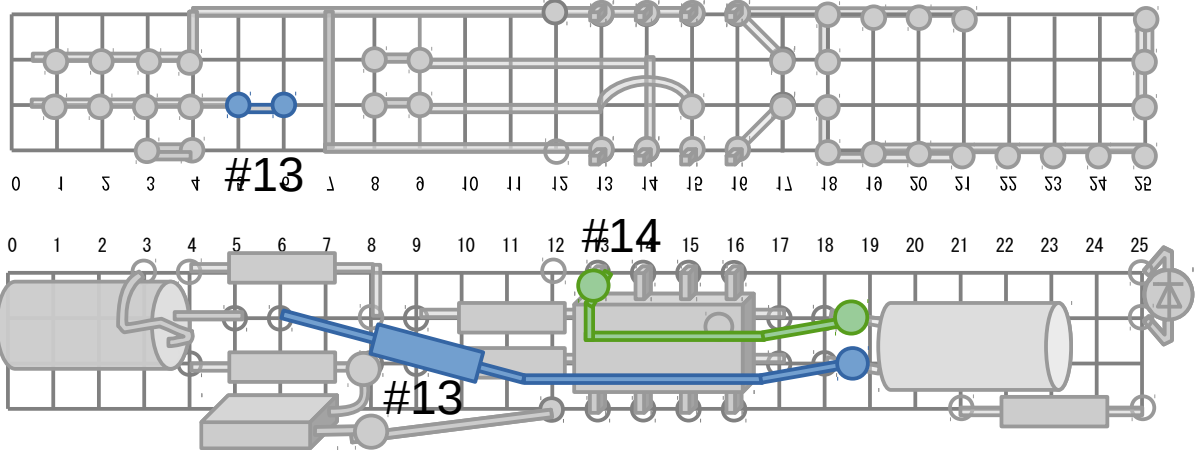
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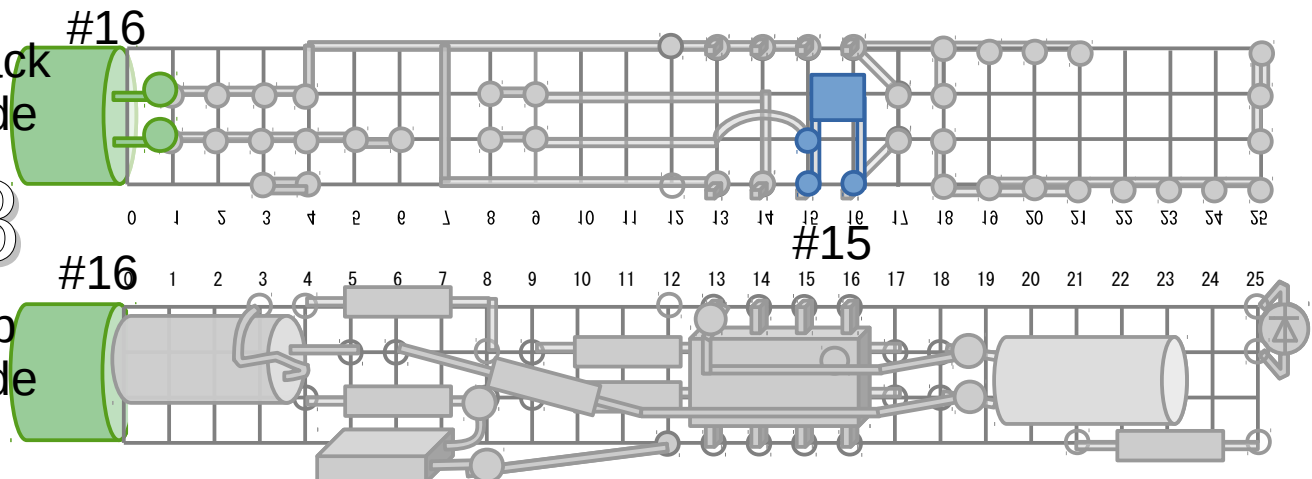
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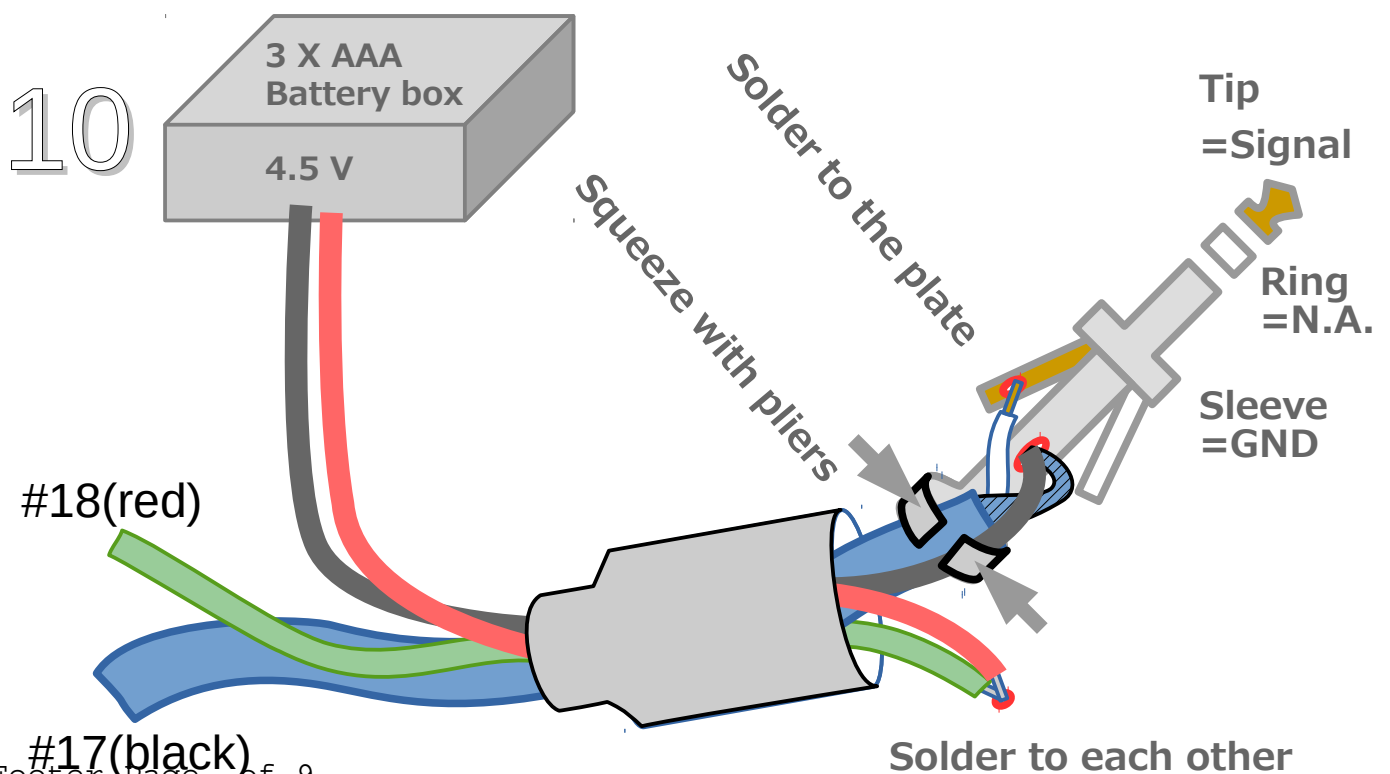
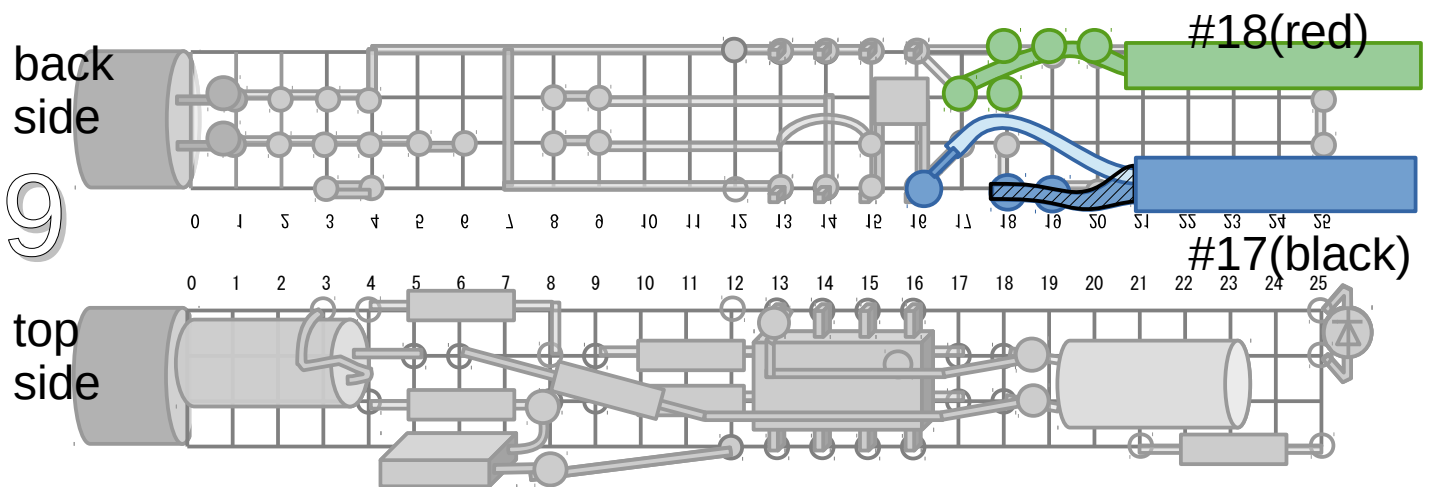
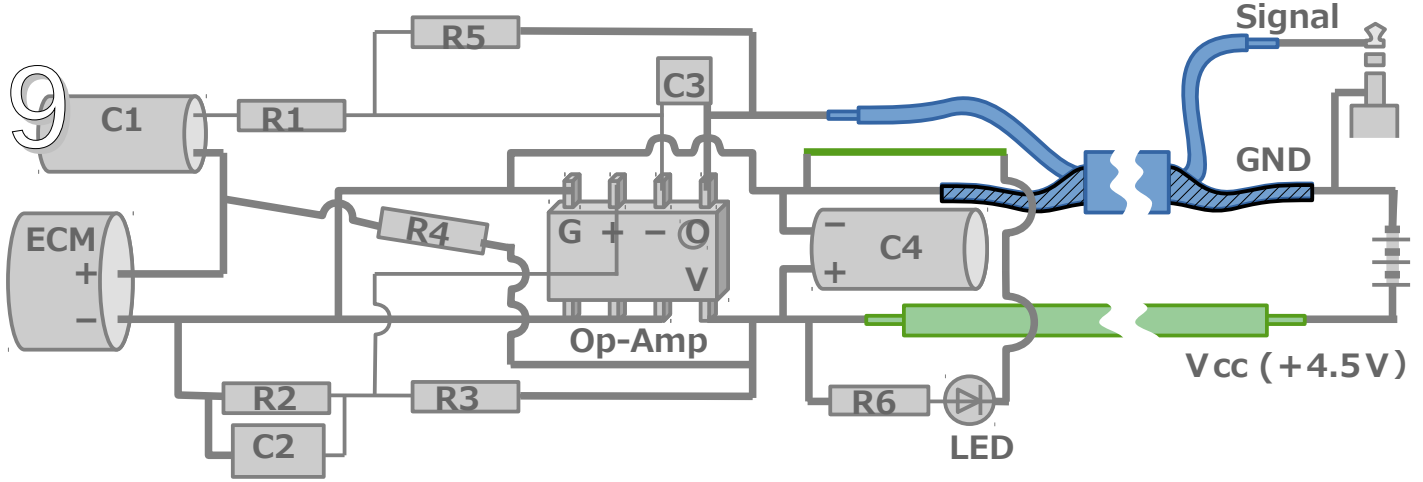


back
side

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top
side





Item list (Prices for the case purchased 100 items at once at specified shops)

Procedure No.	Symbol	Characteristics	
----	----	a piece of universal board (5x25 divisions)	
#01	----	tinned wire	
#02	----	tinned wire	
#03	R3	resistance 10 k metal-film $\frac{1}{4}$ W	(¥ 3)
#04	R5	resistance 1 M Ω metal-film $\frac{1}{4}$ W	(¥ 3)
#05	R6	resistance 15 k Ω carbon $\frac{1}{4}$ W	(¥ 2)
#06	C4	capacitor electrolytic for acoustic use 33 μ F 25 V	(¥ 11)
#07	LED	LED 3 mm ϕ red, OSDR3133A	(¥ 4)
#08	Op-Amp	operational amplifier hi-fi NJM4580DD	(¥ 19)
#09	R1	resistance 10 k Ω metal-film $\frac{1}{4}$ W	(¥ 3)
#10	R2	resistance 12 k Ω metal-film $\frac{1}{4}$ W	(¥ 3)
#11	C1	capacitor nonpolar electrolytic acoustic 10 μ F 25 V	(¥ 11)
#12	C2	capacitor film 0.1 μ F 50 V	(¥ 10)
#13	R4	resistance 2.2 k Ω metal-film $\frac{1}{4}$ W	(¥ 3)
#14	----	tinned wire	
#15	C3	capacitor laminates ceramic 15 pF 50 V	(¥ 3)
#16	ECM	electret condenser microphone C9767	(¥ 22)
#17	----	co-axial cable 0.8D-HQ-SUPER 5m	(¥ 160)
#18	----	red 1 m AWG28	(¥ 2)
----	----	battery box for 3 x AAA batteries	(¥ 60)
----	----	TRS plug, 3.5 mm ϕ	(¥ 50)

Reference

Op-Amp NJM4580 <http://www.e-ele.net/NJM4580.pdf> power supply min., 4 V (± 2 V)

ECM C9767 <http://akizukidenshi.com/download/ds/db/C9767BB422LFP.pdf>

Internet shops (Japanese websites)

Akiduki 秋月電子通商 <http://akizukidenshi.com/catalog/c/cparts/>

Sengoku 千石電商 <http://www.sengoku.co.jp/>

Low-cut circuit for Oscilloscope observation

(to remove DC part)

R=47 k Ω

C=4.7 μ F

Microphone

⇒⇒⇒Plug

