Auntie Spark's Guide to Breadboarding Circuits

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Breadboarding is a very quick way of constructing and testing a circuit based on its schematic. Generally, it works well for low frequency circuits (kHz up to a few MHz). Higher frequency circuits should use a PCB instead that better handles transmission lines and avoids stray breadboard capacitances and inductance from long wiring loops.

The power supply, the input signal generator, and the output measurement equipment are typically located off of the breadboard. Proper connection and arrangement to and from the board should be considered.

- If the circuit is battery powered, proper battery housing as shown in Fig.1 with wire extension is the easiest to use. If using HP6236B power supply to a large breadboard, then cables with banana connectors shown in Fig.2 are easy to use. For E80 small breadboard without separate banana connectors, then simple wires are easiest to connect power supply. It's a good practice to keep consistent color coding, such as red for power, black for ground, and another color for negative power if using both polarity.
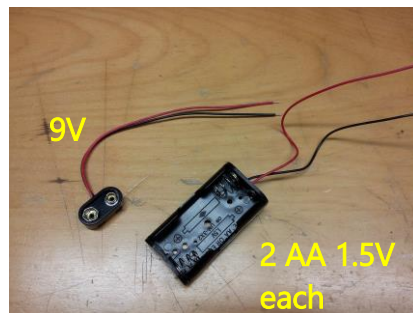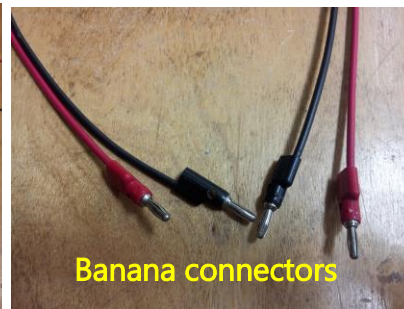

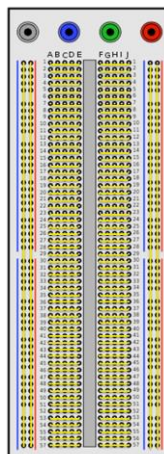Fig.1 Battery housing   Fig.2 Banana connectors

Fig.3 Small breadboard

- The input signal from a function generator requires BNC connector, so a cable with BNC connector on one end and two alligator clippers on the other end (red for signal and black for ground) is the easiest to connect an input signal to the breadboard. If input signals are from sensors on board as in E80 rockets, then proper wiring and interface should also be considered.

Fig.4 BNC to alligator clips

- The output signal requires 10x probe to connect to a scope, as shown in Fig.5. At low frequency measurement, below few kHz, regular 1x probe or BNC cable shown in Fig.6 would work OK, but you should by default use 10x probe because it provides less loading on your measurement circuit. Make sure 10x probe is calibrated properly, which can be conducted using "1kHz probe" from the scope. The observed 1kHz square wave should be good square wave if the adjustable capacitor of the 10x probe is tuned [2]. If measured with a multimeter, then the meter probes can be used to connect to the output signal on the breadboard. If the output signal is sent to data acquisition (DAQ) unit, proper interface and wiring should also be considered.
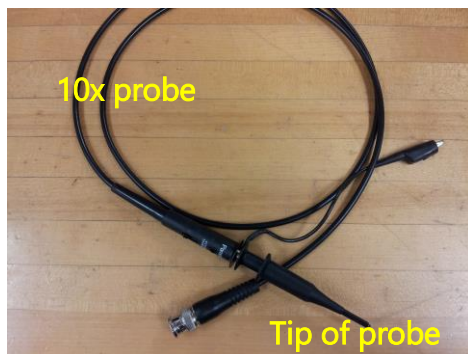

Fig.5 10x scope probe

Fig.6 BNC-BNC cable

Now let's take a look at arrangement of components on the breadboard. As shown in Fig.7, the long rows on the top of the board and long columns between the sections are all connected. These are used as power and ground nodes since it might be shared in

many places in the circuit. Each of the smaller rows is only connected within the same row. Here are some tips of organizing your components and wires.
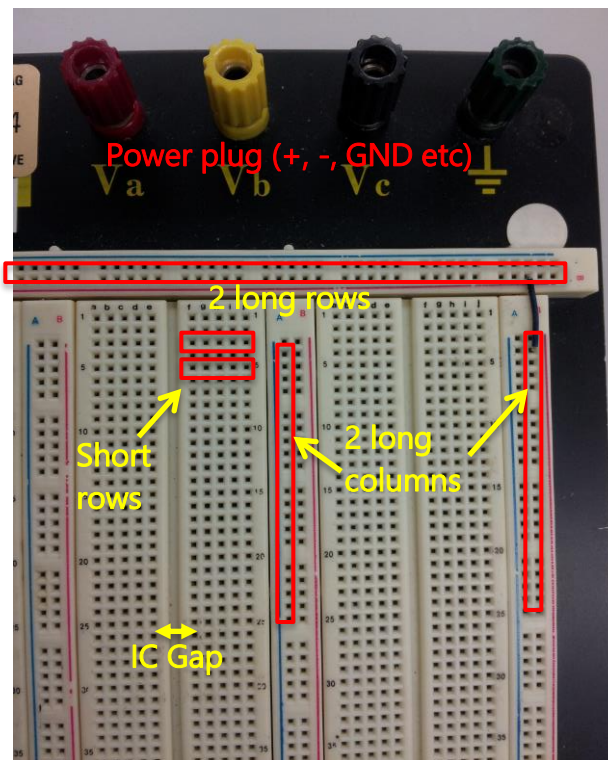

Fig.7 Breadboard layout

- Set your circuit close to a power and ground bus. It is a good practice to use a small bypass capacitor (0.01-0.1uF) between the power and ground to reduce noise. Consider having multiple ground pins [2].
- It is a good practice you have a circuit schematic ready before breadboarding. It is easiest to arrange your component physically as close to the schematic as possible.
- ICs can only be situated across an isolation column. Double check the pin layout of the IC.
- Set up a similar color coding for your wires, such as red for signal and black for ground so that you can track your layout quickly without much confusion. Use shorter leads and wires if possible. Resistors and capacitors should be trimmed to keep close to the board. They are good for both the neatness of the board and less noise.
- Always check every component values before put them on the board. Use Elenco multimeter to check R and C.
- Typically arrange your circuit so that input is fed from left and output is taken from right side. If your circuit has multiple sub-circuits, consider having test

points in between sub-circuits for testing and debugging purpose. A small loop of exposed wire is perfect for a test point as probe can be clipped on stably.

- If the circuit is not working, debug from input to output sequentially and check all connecting points. Check power and ground of the system and at IC chip.

As an example, a simple unity gain buffer is laid out on breadboard with op-amp as shown in Figure 8. The corresponding schematic is given in Figure 9.
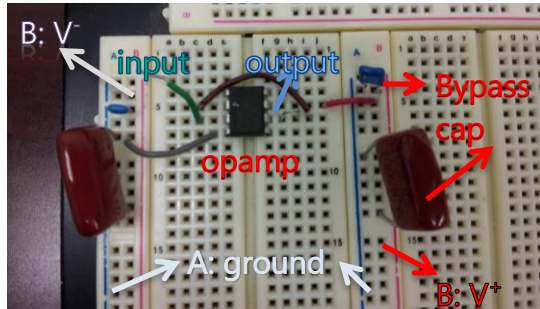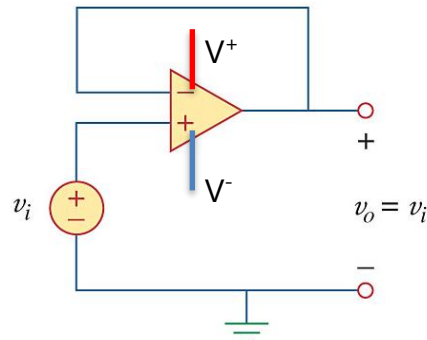

Fig.8 Unity-gain buffer on breadboard buffer

Fig.9 Schematic of unity-gain

Reference:
1. Calibrate 10x probe: www.jyetech.com/Support/HowToCalibrate10xProbe.pdf
2. Choose bypass capacitance: www.intersil.com/data/an/an1325.pdf