University of California Berkeley
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EECS 100, Professor Bernhard Boser

LABORATORY 1 v1

MULTIMETER AND SUPPLIES

In this laboratory we will familiarize ourselves with the lab setup and learn about two important pieces of equipment: power supplies and digital multi-meters. You will also use resistors and characterize a solar cell.

Each laboratory bench features a computer and several instruments that you will become quite familiar with. This is a typical circuit laboratory setup. Although the models and brands of specific instruments may vary, you can find similar instruments in an industrial setting and in many research laboratories across campus.

Please consult the manual before you use a piece of equipment for the first time or if you do not know how to use a specific feature. Before continuing, download and read through the quick-start guides for the multimeter, power supply, and the solderless breadboard from the course website.

The **laboratory power supply** plugs into a standard outlet. It contains electronic circuits designed to convert standard household power (110V / 60Hz AC in the United States) to regulated DC power. DC stands for "direct current" and implies that the current does not change direction. By contrast, the current generated from an "AC power" supply alternates its direction periodically (60 times per second in the United States). The term "regulated" implies that the output voltage is independent of the current flowing. Ideally, the output voltage of the power supply would not fluctuate as the current changes, but most supplies (e.g. batteries) are not ideal and the power supply's output voltage is often partially dependent on the current.

Figure 1 Circuit symbols and diagrams for a 5V voltage and a 100mA current supply. In this example, both sources are loaded by resistors, but would power a more complicated load in a practical application.

DC supplies come in two varieties: constant voltage and constant current. The former produce a voltage that is essentially independent of current flow (e.g. batteries). By contrast, current supplies deliver a constant current that is independent of voltage. For example, a current supply set to 10mA produces a 10V drop across a 1kOhm resistor. If you change the resistor to a 100Ohm resistor, the current flowing through the circuit does not change, but the voltage drop across the resistor lowers to 1V.

Many DC supplies (including the one used here) can be set to operate either as voltage or current supplies by setting the maximum output voltage and current. For example, a supply set to 10V and 1A max operates as a constant voltage supply for currents up to 1A. Any attempt to draw more than 1A results in a reduced output voltage and a constant current of 1A. Shorting the supply (connecting the output terminals) with a laboratory cable produces 1A and near zero voltage.

It is always a good idea to set reasonable maximum values for current and voltage, about 50% higher than the maximum expected value. For example, when testing a circuit that operates from constant 5V and ordinarily draws no more than 100mA, the supply should be set to 5V exactly and about 150mA. This reduces the chance of inadvertently damaging a circuit when making a mistake.

Do not let this interfere with your desire to try things: most electronic components are inexpensive and easily replaced (ask the instructor if you need help). Laboratory equipment is also quite robust an unlikely to break if you follow the instructions on the website. Please let the instructor know when something breaks or does not work properly so he can have it repaired before the next laboratory session.

In circuit diagrams power supplies are represented by symbols, just like other circuit elements. Figure 1 shows the symbols for constant voltage and current supplies. Supplies are also referred to as sources.

Multimeters are used to measure voltage, current, and sometimes resistance. Good handheld multimeters can be purchased for less than $100. Benchtop versions are more accurate and expensive.

Warning: Most multimeters are well protected against using too high a voltage, but it is important to set the instrument to the desired measurement mode (voltage/current/resistance) and AC or DC setting. Be careful when measuring current: never expect the multimeter to limit the current. For example, trying to measure the current from a power outlet will blow fuse (hopefully) when the current reaches about 20 A—unfortunately this will probably not happen before melting cables and destroying a fuse in the instrument or worse. Do not try this; not only because of the damage but also since playing with 110V is dangerous (remember what your mother told you about sticking your fingers in an outlet)!

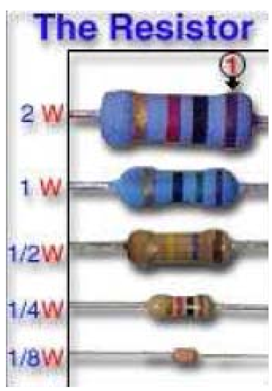

Figure 2 Resistors. The colored rings encode the resistance value. Larger sizes are for higher wattage.

In this laboratory and many circuit projects you will use resistors (Figure 2). A color-code painted on the resistor identifies its value. A good description is on Wikipedia under "electronic color code" or "resistor". Use the Ohmmeter (multimeter set to measure resistance) if you are not sure about the value of a resistor. You will find that only certain resistor values are available. Most resistor types are only made with values 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82 and decimal multiples or fractions thereof. In many situations the closest value can be substituted (e.g. 4.7kΩ for 5kΩ). It is also possible to combine two or more resistors in series and/or parallel to synthesize your desired resistor. When you design a circuit you need to round calculated component values to available ones and decide if the rounding error is acceptable or a more precise value must be synthesized from several parts.