Voltmeters (and beyooo$_{ooond!}$)

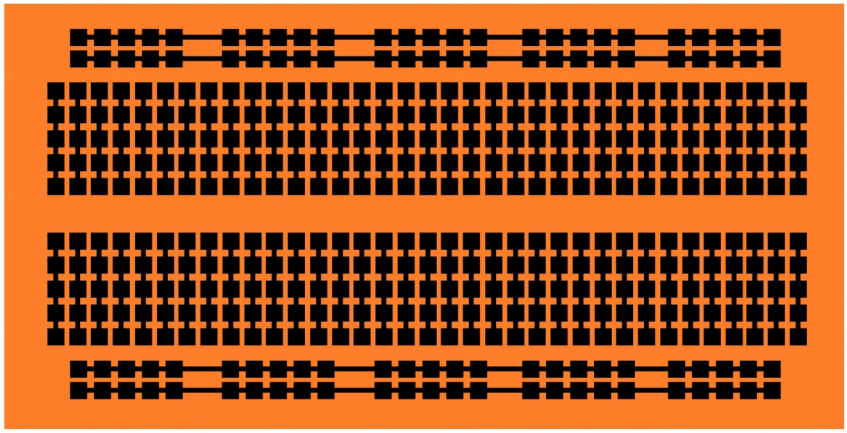
This is a digital multimeter, its a multifunctional device that can act as a volt meter, amp meter, ohm meter, and can be used to check for whether a complete conductive path is present or not, ie continuity check.

To use this particular model, turn the dial to the desired function with the appropriate range, plug the test leads into the corresponding jacks at the bottom of the device, and test.

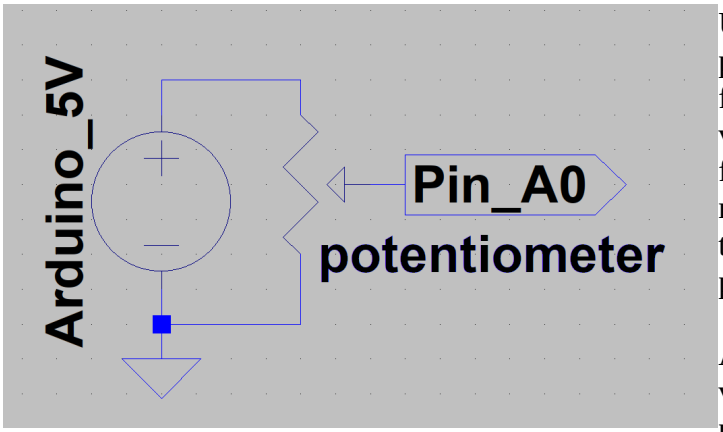
In volt meter mode, the device acts as a very high resistor value and measures the target voltage without acting as an easy path for electrons to flow, ensuring the reading is accurate.

In amp meter mode, the device acts as a very low resistance and is actually inserted into the circuit to pass current through it. The electric current is then displayed on screen. Note that this has two plugs, the normal range and the high current range, which have two different fuse values to protect the meter. Since this mode acts as a very low resistance, if the user is intending to measure voltage, but is set on current, this will short circuit and likely damage the circuit being tested. Pay attention to what you're doing!

In Ohm meter and continuity modes, the device acts as a low value power source and passes a current through the circuit under test, and uses a resulting current and voltage to calculate and display the desired data. Note that since this acts as a power source itself in these two modes, it is unsafe for the meter to use these modes while the target circuit is powered externally. Continuity mode usually doubles as a diode checker and displays how much voltage a diode will absorb.



This is a representation of a breadboard and how the holes are connected to each other. Breadboards are used to construct temporary circuits without the need for soldering. The connections can be verified using the continuity setting of a multimeter.



Use the breadboard, jumper wires, a potentiometer, and arduino to construct the following circuit. The 5V pin is a regulated voltage source if the arduino is receiving power from a USB cable. The resistor with a contact meeting at the middle is a representation of a 3 terminal variable resistor, also known as a potentiometer.

After constructing the circuit, open the example volt meter program using the arduino ide program on a host computer or laptop, and press the  upload button or use the hotkey CTRL-U. The bottom of the arduino IDE will show the process of compiling code into binary and uploading to the Atmega328 core of the arduino. When the process is done, open the serial plotter or serial monitor through tools → serial monitor/plotter.

The potentiometer is a resistor with the twistable knob controlling the position of a wiper contact along the main resistor body. This creates a pair of variable resistors with a total resistance that stays constant, and they are used here to create what is called a voltage divider. The output of the voltage divider follows the proportionality $Vout = Vin * \left(\frac{Rbottom}{Rtop + Rbottom}\right)$ and is being connected to the analog input 0 of the arduino uno board. The serial monitor will show the voltage data coming from the arduino, and the serial plotter will plot the values on a graph as they are transmitted by the board.

Twist the potentiometer knob and observe the resulting output voltage through the serial monitor and plotter, and use a digital multimeter to compare accuracy of the multimeter to the arduino volt meter. If multimeter reports a potentiometer output voltage different from what the arduino prints out, use the multimeter to check the voltage of the 5V pin with the multimeter's common lead connected to an arduino ground pin.

The following is the content of the arduino volt meter program:

```
float railVoltage = 5.00;

void setup() {
   Serial.begin(9600);
}

void loop() {
   float voltage = (railVoltage / 1023) * analogRead(A0);
   Serial.println(voltage, 2);
}
```

This is smaller than the one uploaded to the arduino because all of the lines starting with // are removed. Those lines are comments and they signal to the program that they are lines that are not to be executed. This means that when the code is uploaded, these lines are removed. They are only there for the programmer to describe and document their program. The programs contents are simple, the setup function runs and starts the serial port to be able to communicate with the serial monitor or plotter on the host computer. Then in the looping function, the arduino uses the power supply voltage declared at the top of the program to convert the signal it reads on analog pin 0 to a human readable decimal number. After the conversion, the arduino then prints this data to the serial port for viewing through the serial monitor. Because no artificial delays are present, the arduino is doing this at its top speed.