
# PRESENTATION AT

# RIVER CITY AMATUER RADIO SOCIETY MEETING

# AUGUST 7, 2007

# METERS

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**Electricity is something that is invisible. We need some sort of device to determine what is happening in an electrical circuit. There a number of electrical tools that will do this, and the "meter" is one. Below are some various meters: (left to right):**

**Cen-Tech DMM (Digital Multi Meters),**

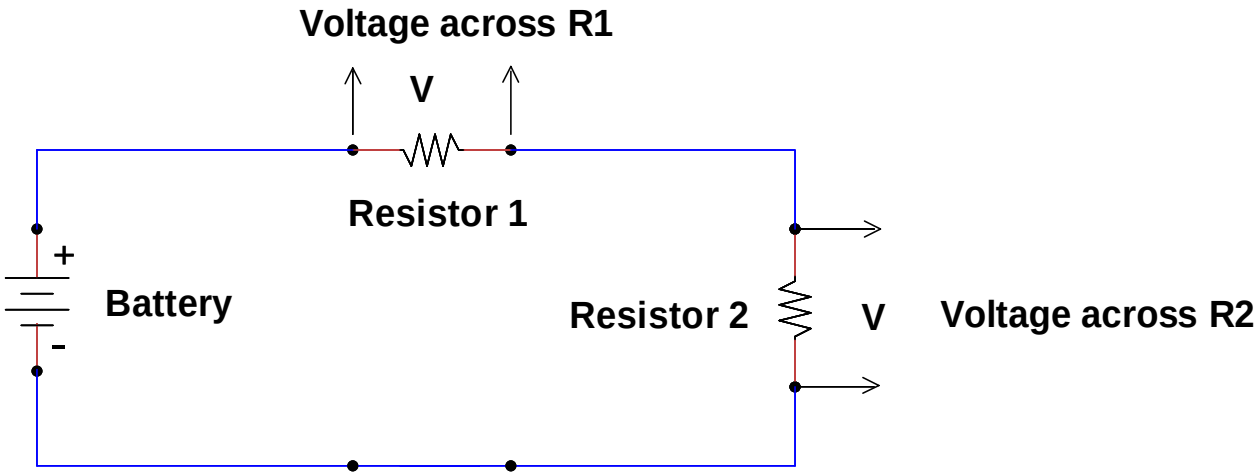
**Fluke DMM,**

**VOM (Volt Ohm Meter) and a**

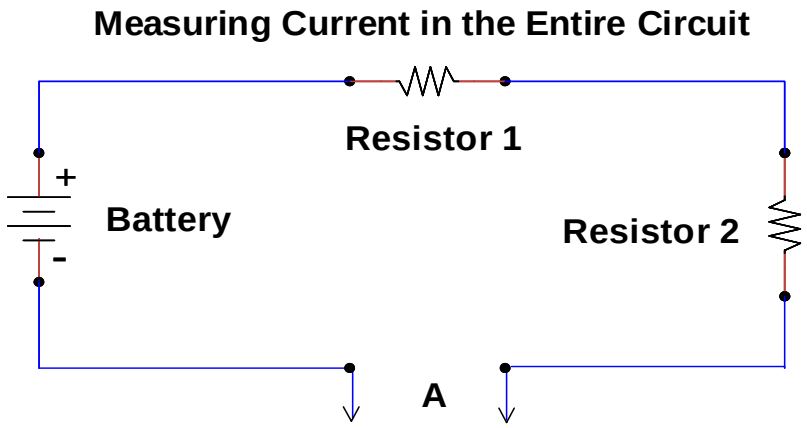
**ExTech Clamp-on**

# Basics

**Meters that measure voltage, sample part of the load they are measuring. The smaller the sample, the less effect they will have on the electrical system. Meters that have a high impedance have less of an effect than those with low impedances. Voltage samples are taken across the element being measured - in parallel with it.**




**Meters that measure current also sample the load they are measuring. Unlike the volt meter, the sample is taken in series with the element of interest. The lower the impedance the current meter offers, the less the effect it will have on the system.**



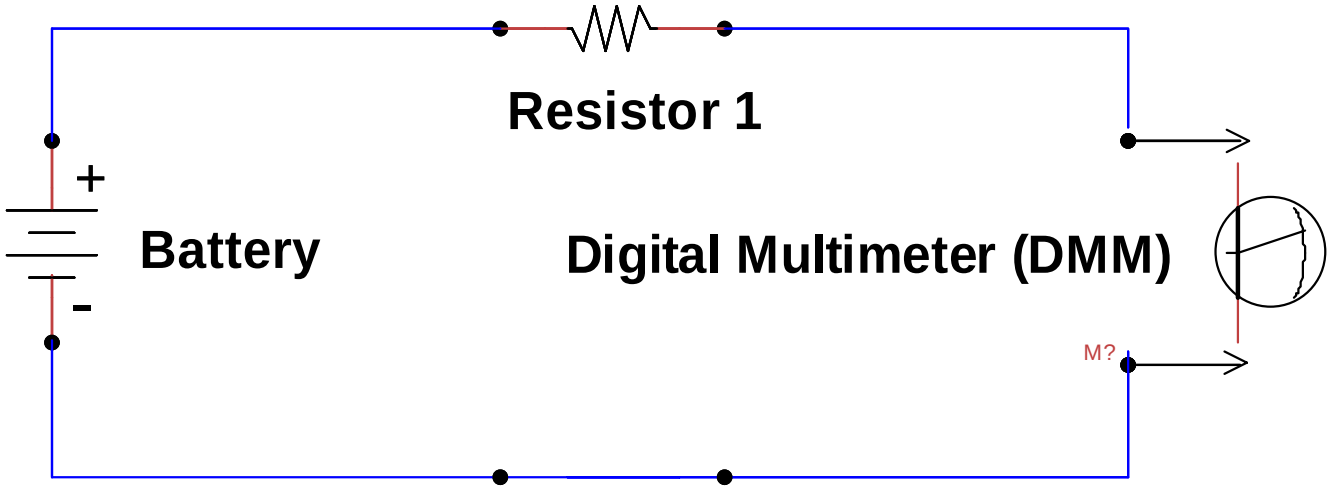
## Type of Multi-meters

There are several different types of multi-meters. Meters that have digital displays have amplifier circuits that offer very little loading to a system under measurement. They are complex system,

Ammeter meters are converters of electrical energy to mechanical. Their sensitivity values determine how much of a drain is needed to take a measurement on an electrical system.

To measure current, the DMM needs it's function switch turned to the proper setting and it's test probe plugged into the proper connections on the meter. It's leads need to be inserted in series with the element in which current flow is to be measured. The amount of current to be measured can not exceed the meter's maximum current measuring ability as select on it's function switch or damage may occur.

### A simple circuit to measure current



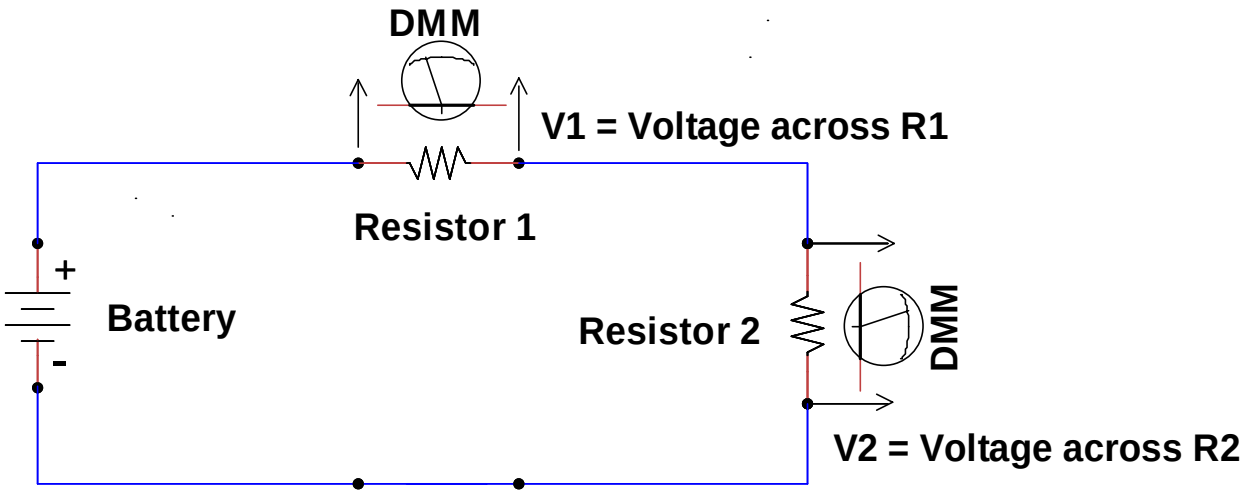
# Cen-Tech DMM


**To measure voltage, the DMM needs:**

**It's function switch set for voltage measurements**

**It's probes in the correct sockets and**

**The probes connected in parallel with the element in which the voltage measurement is to be made.**




**V1+V2 = V battery**

**To measure resistance, the DMM needs:**

**It's function switch set for resistance**

**At least one lead of the element being measured should be disconnected.**

**Resistive measurement should never be conducted with a system with power on**

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**If you have an old ammeter sitting around and don't know what to do with it, the following experiments may give you some ideas. First we need to find some of the meter's operating parameters.**

**The meter above is an old Weston "2 ma" meter that will be used as the test "meter" following.**

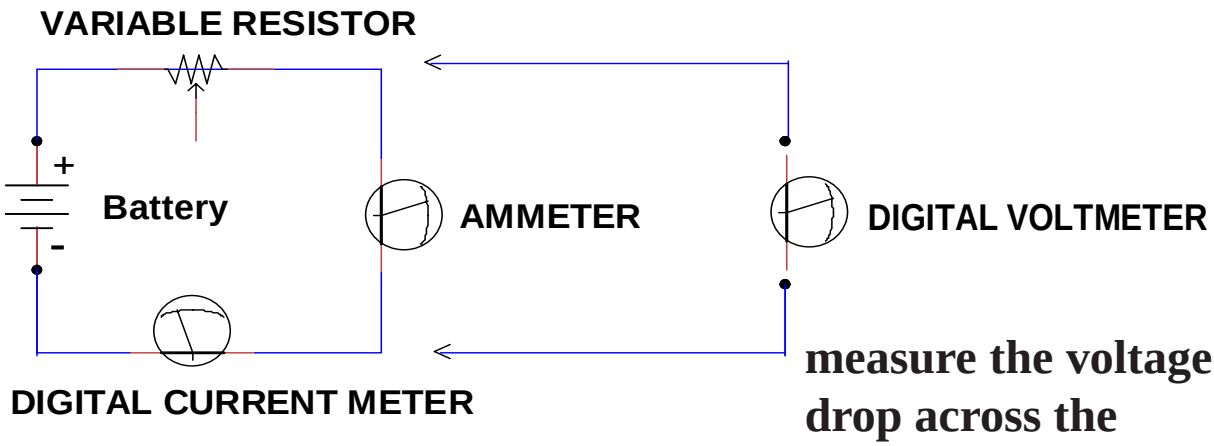
**Three things to be measured or calculated for a ammeter meter.**

**Measure full scale voltage - the voltage across the meter's terminal when the pointer is at full scale.**

**Measure full scale current - the current flow through the meter when the pointer is at full scale.**

**Calculate the meter's internal resistance. This value is best obtained by measuring different voltages across the meter's terminal and current flows through the meter for various meter deflections and the use Ohm's Law to determine the resistance.**

**A test system to determine a meter's electrical specifications**




**measure the voltage drop across the meter at full deflection.**

**measure the current flow through the system at full deflection.**

**Test results on a Weston meter, model 301, FS = 2ma (FS = Full Scale)**

| Weston | E across | I through | Calculation E/I | = R Intermal |
|---|---|---|---|---|
| 2.0 ma | 55.0 mvdc | 2.06 ma | 0.0550/0.00206 | 26.699</td> |
| 1.5 ma | 40.7 mvdc | 1.52 ma | 0.0407/0.00152 | 26.7763 |
| 1.0 ma | 27.1 mvdc | 1.02 ma | 0.0271/0.00102 | 26.5686 |
| 0.5 ma | 13.4 mvdc | 0.5 ma | 0.0314/0.00050 | 26.8 |

**Add a SHUNT to double the current reading of an meter.**

**If a resistive element (a shunt), equal to the meter's internal resistance, is placed in parallel with the meter (across it's terminals), there will be two paths for the current to flow.**

**Since both the meter and the shunt resistor are of the same values, the total current will be divided equally between the two paths. This in effect, reduces the indicated current flow in the meter by a half and will deflect the meter to one half the total current flowing in the system.**

## Constructing a volt meter from a current meter.

**Using the collected data from the Weston meter, a full scale reading was obtained when 0.055 volts was dropped across the meter's terminals. When this happened, 0.002 amps of current was flowing through the meter.**

**To utilize this meter's face plate, numbering from 0 to 2, to read in volts, that is 2 volts full scale DC, a resistor needs to be found that when it is connected in series with the meter, and then when this resistor and meter circuit is connected across a 2 volt source, will cause the meter to deflect to full scale. When the meter is at full scale, 0.055 volts is across the meter terminals and 1.945 volts is across the series resistor. The series resistor needs is calculated by subtracting meter full scale voltage from the maximum voltage the meter will read.**

**2.0 volts - 0.055 volts = 1.945 volts dropped across the se-**

**ries resistor.**

**Using Ohm's Law (E = IR or R = E/I) to determine the resistance. The current flowing though the series resistor and meter at full scale needs to be 0.002A. The series resistor then is R = E/I OR R = 1.945/.002 = 972.5 ohms**

**About this new meter**

**This meter is a functional 2 volt voltmeter, but not very practical as a useful test instrument. It's input impedance is very low, about 1000 ohms and this will put a drain on most circuit being measured. When using a multimeter in a circuit, be aware of:**

**what you are measuring**

**what the meter switches are selected to and**

**where the test probes are place on the meter and on the device being measured.**

***Resources***

***Navy Electricity and Electronic Training Series Module 3 - Introduction to Circuit Protection, Control and Measurements***

***All About Circuits (http://www.allaboutcircuits.com/)***