

Current and Voltage Measurements with Multimeter Experiment



I. INTRODUCTION

1.1. Multimeter

A multimeter is a measuring instrument that we will use frequently throughout electrical experiments. So it is better to learn how to use a multimeter.

A Multimeter is an electronic instrument, every electronic technician and engineers widely used piece of test equipment. A multimeter is mainly used to measure the three basic electrical characteristics of voltage, current, and resistance. It can also be used to test continuity between two points in an electrical circuit. This post mainly introduces the basic information of multimeters, applications, and types of multimeters are in. Let's see all of these. The multimeter has multi functionalities like, it acts like ammeter, voltmeter, and ohmmeter. It is a handheld device with positive and negative indicator needle over a numeric LCD digital display. Multimeters can be used for testing batteries, household wiring, electric motors, and power supplies.

1.1.1. Applications:

The applications of ammeter mainly involve in various electrical and electronic projects for components testing and also used in different measurement applications in the multimeter.

- 1 Temperature and Environmental Applications
 - Low-cost weather station
 - DMM internal temperature
- 2 Voltage Measurements
 - High and low-value DC measurement
 - Peak to Peak and DC average measurement
- 3 Current Measurements

- DC measurement
 - True RMS AC
- 4 Resistance Measurement
 - Micro ohmmeter
 - Measuring resistance with constant voltage
 - Measuring resistance with constant current
 - 5 Time and Frequency measurement
 - Fast frequency
 - Time measurement

1.1.2.Types of Multimeters:

There are different types of multimeters like Analog, Digital, and Fluke multimeters.

Digital Multimeter:

We mostly used multimeter is a digital multimeter (DMM). The DMM performs all functions from AC to DC other than analog. It has two probes positive and negative indicated with black and red color is shown in the figure. The black probe connected to COM JACK and red probe connected by user requirement to measure ohm, volt, or amperes. The jack marked $V\Omega$ and the **COM** jack on the right of the picture are used for measuring voltages, resistance, and for testing a diode. The two jacks are utilized when an LCD that shows what is being measured (volts, ohms, amps, etc.). Overload protection prevents damage to the meter and the circuit and protects the user.



Figure 1.Digital multimeter

The Digital Multimeter consists of an LCD, a knob to select various ranges of the three electrical characteristics, an internal circuitry consisting of a signal conditioning circuitry, an analog to digital converter. The PCB consists of concentric rings which are connected or disconnected based on the position of the knob. Thus as the required parameter and the range are selected, the section of the PCB is activated to perform the corresponding measurement. To measure the resistance, current flows from a constant current source through the unknown resistor and the voltage across the resistor are amplified and fed to an Analog to Digital Converter and the resultant output in form of resistance is displayed on the digital display. To measure an unknown AC voltage, the voltage is first attenuated to get the suitable range and then rectified to DC signal and the analog DC signal is fed to A/D converter to get the display, which indicates the RMS value of the AC signal. Similarly

to measure an AC or DC, the unknown input is first converted to a voltage signal and then fed to an analog to digital converter to get the desired output(with rectification in case of AC signal).

Advantages of a Digital Multimeter are its output display which directly shows the measured value, high accuracy, ability to read both positive and negative values.

Analog Multimeter:

The Analog Multimeter or VOM (Volt-Ohm-Milliammeter) is constructed using a moving coil meter and a pointer to indicate the reading on the scale. The moving coil meter consists of a coil wound around a drum placed between two permanent magnets. As current passes through the coil, the magnetic field is induced in the coil which reacts with the magnetic field of the permanent magnets and the resultant force causes the pointer attached to the drum to deflect on the scale, indicating the current reading. It also consists of springs attached to the drum which provides an opposing force to the motion of the drum to control the deflection of the pointer.

For the measurement of DC, the D Arsonval movement described above can be directly used. However, the current to be measured should be lesser than the full-scale deflection current of the meter. For higher currents, the current divider rule is applied. Using different values of shunt resistors, the meter can also be used for multi-range current measurements. For current measurement, the instrument is to be connected in series with the unknown current source.



Figure 2. Analog multimeter

For measurement of DC voltage, a resistor is connected in series with the meter, and the meter resistance is taken into account such that the current passing through the resistor is the same as the current passing through the meter and the whole reading indicates the voltage reading. For voltage measurement, the instrument is to be connected in parallel with the unknown voltage source. For multirange measurement, different resistors of different values can be used, which are connected in series with the meter.

For measurement of resistance, the unknown resistance is connected in series with the meter and across a battery, such that the current passing through the meter is directly proportional to the unknown resistance.

For AC voltage or current measurement, the same principle is applied, except for the fact that the AC parameter to be measured is first rectified and filtered to get the DC parameter and the meter indicates the RMS value of the AC signal.

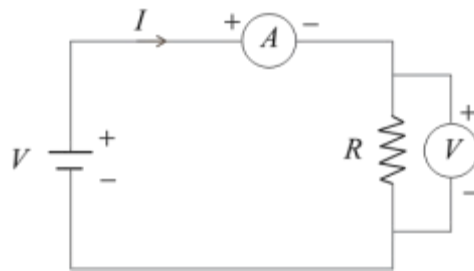
Advantages of an Analog Multimeter are that it is inexpensive, doesn't require a battery, can measure fluctuations in the readings.

The two main factors affecting the measurement are sensitivity and accuracy. Sensitivity refers to the reciprocal of the full-scale deflection current and is measured in ohms per volt.

II. APPARATUS

Resistance, cables, multimeter, basic electrical set.

III. EXPERIMENTAL PROCEDURE



- 1) Set up the circuit provided on the up side.
- 2) If you have one multimeter, prepare it for 2 situations. You can use your multimeter for measuring current and voltage.
- 3) Please make the connection of power supply.
- 4) Do not forget that Ammeters are connected in series so that the current flows through them. The ideal ammeter has a resistance of zero. Voltmeters are connected in parallel to resistive elements in the circuit so that they measure the potential difference across (on each side of) the element.
- 5) In this experiment, please fill the Table 1 for this circuit.

| Table1 | | | |
|--------|-------|--------------------|----------------------------------|
| V (V) | I (A) | R ₁ (Ω) | V ₁ (R ₁) |
| 9 | | | |

Ref.

- 1) Serway, R, Beichner, R. Physics for Scientists and engineers with modern physics, Fifth edition. 2000.
- 2) Rentech. Experiments in electricity, student guide. 2013.
- 3) <https://www.elprocus.com/multimeter-types-and-applications/>