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# Study of Dual type of Voltmeter: Analog and Digital

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**ABSTRACT:** A voltmeter, also known as a voltage meter, is an instrument that measures the voltage or potential difference between two points of an electronic or electrical circuit. Usually, the voltmeter is used for Alternating Current (AC) circuits or Direct Current (DC) circuits. Alternatively, Radio Frequency (RF) voltage can also be measured by specialised voltmeter. A voltmeter measures voltages usually calibrated in volts, milli volts (0.001 volt), or kilovolts (1,000 volts). In order to measure a device's voltage, a voltmeter is connected in parallel to a device. This setup is important as objects in parallel usually tend to experience the same potential difference. It is connected in parallel with the circuit, mainly because the same voltage drop occurs across it.

**KEYWORDS:** Voltmeter, Analog, Digital, Potentiometer, voltage,

## I. INTRODUCTION

Edward Weston developed the first voltmeter in 1888. A voltmeter, also known as a voltage meter, is a device that measures the electrical potential difference between two points in an electrical or electronic circuit. Voltmeters are used to test either alternating current (AC) or direct current (DC) circuits. The scientific basis of a voltmeter depends on Ohm's law, which states that voltage across a resistance is directly proportional to the current traveling through it.

Voltmeters are connected in parallel and usually have a high resistance so that they take negligible current from the circuit. They use a scale that is commonly in volts, millivolts (0.001 volt), or kilovolts (1,000 volts). Many voltmeters are digital, giving readings as numerical displays.

Voltmeters are made in a wide range of styles, some separately powered (e.g. by battery), and others powered by the measured voltage source itself. Instruments permanently mounted in a panel are used to monitor generators or other fixed apparatus. Portable instruments, usually equipped to also measure current and resistance in the form of a multimeter are standard test instruments used in electrical and electronics work. Any measurement that can be converted to a voltage can be displayed on a meter that is suitably calibrated; for example, pressure, temperature, flow or level in a chemical process plant.[3]

There are seven types of voltmeters based on construction principles given as follows:

1. Permanent magnet moving coil voltmeter (PMMC): A voltmeter that measures the current in a coil by measuring the coil's angular deflection in a uniform magnetic field is known as a Permanent Magnet Moving Coil (PMMC) voltmeter, also known as a D'Arsonval meter or simply galvanometer. The measured voltage induces a current in the PMMC instrument, which causes the pointer to deflect. For DC measurements, the PMMC voltmeter is used.

2. Moving iron voltmeter: The moving iron voltmeter (MI) is a device that can measure both AC and DC voltages. The deflection of this device is exactly proportional to the coil voltage. It can be further bifurcated into two types; Attraction moving iron voltmeter and repulsion moving iron voltmeter.

3. Electro dynamometer type voltmeter: The voltage of both AC and DC circuits is measured using this voltmeter and both the AC and DC measurements are normally calibrated the same way.

4. Rectifier type voltmeter: These are commonly used to measure voltage in AC circuits. With the help of a rectifier, this voltmeter converts AC to DC.

5. Electrostatic type voltmeter: The deflection torque is generated by a static electrical field. Several voltmeters are utilized just to evaluate high voltage.

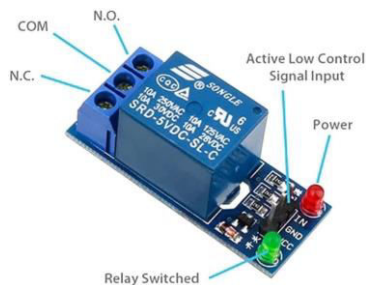
6. Digital voltmeter: A digital voltmeter (DVM) measures an unknown input voltage by converting it to a digital value, which it then displays in numeric form.

The First digital voltmeter was invented and produced by Andrew kay of Non-linear system (and later founder of kaypro in 1954. Digital voltmeters (DVMs) are usually designed around a special type of analog-to-digital converter called an integrating converter. Voltmeter accuracy is affected by many factors, including temperature and supply voltage variations. To ensure that a digital voltmeter's reading is within the manufacturer's specified tolerances, they should be periodically calibrated against a voltage standard such as the Weston cell.

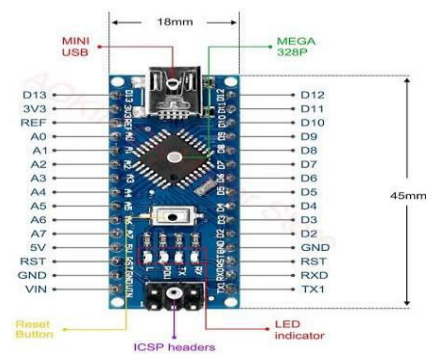
Digital voltmeters necessarily have input amplifiers, and, like vacuum tube voltmeters, generally have a constant input resistance of 10 megaohms regardless of set measurement range.

## II. COMPONENTS MATERIAL REQUIRED

### 1. 5v Relay module



### 2. Arduino Nano



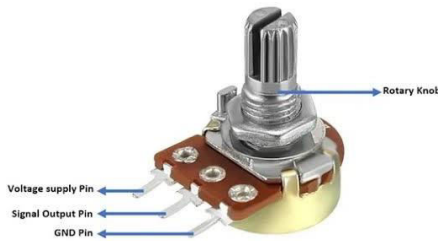
### 3. 16x2 LCD display



### 4. Analog voltmeter 0-25v



## 5. Potentiometer 10k



## 6. Lithium iron battery 3-7v



### III. METHODOLOGY

Steps:

1. Select the PMMC meter movement:

Choose a PMMC meter movement with a full-scale deflection (FSD) suitable for the desired voltage range (0-10V). Ensure that the internal resistance of the meter movement is known.

2. Calculate series resistance:

Calculate the series resistance needed to limit the current flowing through the meter movement. Use Ohm's law:  $R = \frac{V}{I}$

), where  $V$  is the maximum voltage (10V) and  $I$  is the full-scale current (1mA).

$R = \frac{10V}{0.001A} = 10000 \Omega$

This resistor is used to limit the current through the meter movement to 1mA.

3. Connect the circuit:

Connect the meter movement in series with the calculated series resistor and the voltage source.

4. Calibration (optional):

Use a potentiometer in series with the voltage source or in parallel with the series resistor to calibrate the meter for precise readings.

5. Testing:

Apply different voltages within the range (0-10V) and verify the readings using a multimeter. Adjust the potentiometer if calibration is required.

6. Finalization:

Once calibrated, secure all connections properly and ensure the voltmeter is properly labeled with its range (0-10V)

### IV. WORKING

It operates on the basis of Ohm's law. According to Ohm's law, the voltage across a resistance is precisely proportional to the current travelling through it. When a full-scale current runs through a basic meter, there is a potential difference across its terminals.

A voltmeter is always placed in parallel to the element in a circuit that is to be tested for voltage. A polarity symbol can be found on a DC voltmeter. To produce a meter deflection, connect the positive (+) terminal of the voltmeter to the higher point of potential and the negative (-) terminal to the lower point of potential.

An AC voltmeter has no polarity indications and can be attached in any case. However, in this situation as well, the voltmeter is still linked in parallel to the component being monitored. As illustrated in the figure below, a voltmeter with a high voltage range is constructed by connecting a series resistance with a meter mechanism with full-scale voltage capabilities.



A Permanent Magnet Moving Coil (PMMC) voltmeter, also known as a D'Arsonval meter or simply a galvanometer, is an instrument that measures electrical current by observing the deflection of a coil of wire suspended in a magnetic field. The current flowing through the coil creates a magnetic field that interacts with the magnetic field of the permanent magnet, causing the coil to deflect. The amount of deflection is proportional to the current flowing through the coil. PMMC voltmeters are used to measure direct current (DC) voltages.

## V. CONSTRUCTION

### 1.PMMC Meter Movement (suitable range):

Choose a PMMC meter movement with a full-scale deflection (FSD) close to 10V. This ensures the meter needle reaches its maximum deflection at the highest voltage (10V) you want to measure.

Identify the meter's internal resistance value by consulting its datasheet. This value will be crucial in the next step.

### 2.Resistor:

You'll need one resistor to limit the current flowing through the PMMC meter movement. The value of this resistor will be calculated in step 2.

### 3.Connecting Wires:

Use these to make proper connections between the components in your circuit. Choose wires with appropriate insulation for the voltage levels involved

### 4.Voltage Source (0-10V):

This will provide the voltage you want to measure. You can use a variable DC power supply or a battery pack that can be adjusted to output voltages within the range of 0-10V.

### Tools Required:

- Soldering Iron (optional, but recommended for stronger connections)
- Wire Stripper
- Pliers

### Uses

The following are certain applications of voltmeter:

- Voltmeters are frequently used to produce exceedingly exact measurements in electric circuits and hardware.
- It monitors voltage and the dependability and safety of the circuit and its components.
- They are also useful in circuits for troubleshooting and checking the presence of the appropriate voltage value.
- They are also employed with cathode ray tubes to verify the accuracy of the findings and readings.
- It is used for testing and analyzing in laboratories.

Voltmeters are often used to monitor voltage, the dependability of a circuit, and the safety of its components. They are also useful for troubleshooting and checking the presence of the appropriate voltage value.

For example, they can check the voltage of the battery, test sensors, and troubleshoot the vehicle's electrical systems.

## Advantages And Disadvantages

### Advantages:

- Readings are accurate and fast compared to analog meters.
- Digital voltmeter is more stable and reliable.
- Smaller in size and cost-effective.
- DVM can measure both AC and DC voltages of the electrical appliances.

### Disadvantages: -

Digital voltmeters can overheat while measuring voltage, resulting in inaccurate readings. In the event of fluctuating readings, a digital voltmeter will not be able to quantify the variations and will instead display an incorrect measurement or error.



## VI. CONCLUSION

A voltmeter is connected in parallel to the source across which the voltage is to be measured. To measure the voltage across the load, a voltmeter is connected in parallel with the load.

Digital voltmeters are more programmed than analog voltmeters, and they offer more speed of operations. They also give an overload indication. However, voltage potential can be ascertained through both analog and digital voltmeters, and they are being replaced nowadays by multimeter. The positive input terminal is usually red and the negative terminal is black.

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