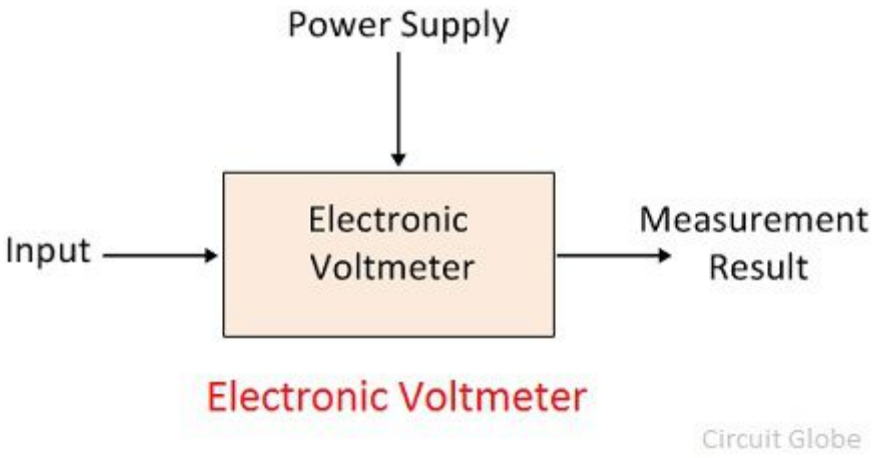
Electronic Voltmeter

Definition: The voltmeter which uses the amplifier for increasing their sensitivity is known as the electronic voltmeter. It is used for measuring the voltages of both the AC and DC devices. The electronic voltmeter gives the accurate reading because of high input resistance.

In all electronic voltmeter circuits the principle involved is that an indication on a permanent magnet moving coil instrument (normally abbreviated as PMMC or D'Arsonval movement) proportional to the input voltage is obtained by means of amplification in one or more stages with a high input impedance.

Drawbacks of moving coil voltmeter(PMMC):

1. **The moving coil voltmeter is not able to detect the low voltages. The electronic voltmeter overcomes this problem. The electronic voltmeter has high input impedance because of which it detects the signals of very weak strength, hence gives the accurate reading.**
2. A conventional voltmeter takes a non negligeable current from the circuit during measurement. Although this current may be in microampere range. But still this current affects the measuring voltage. A permanent magnet moving coil instrument normally draws a current of 50 microamperes for its full scale deflection. So, when it measures the voltage across a circuit it takes proportionate current from the circuit. Since the instrument takes a current from the circuit, the voltage profile of the circuit must be changed. Although during measurement this change of voltage may be quite small. But sometimes we need very accurate measurement of original voltage across the circuit.
3. In moving coil voltmeter the large power is drawn from the measured circuit because of which the error occurs in their reading. This problem is overcome in the electronic voltmeter.In electronic voltmeter, the pointer is deflected by taking the supply from the auxiliary amplifier circuit. The output voltages of the amplifier circuit are similar to the voltage of the test circuit. The extra power is not passing through the deflector because of which the meter gives the accurate reading.



Working Principle of Electronic Voltmeter

In this type voltmeter there is always at least an amplifier. This amplifier amplifies the very small current taken by the electronic voltmeter during measurement. Then this amplified current is measured by a conventional PMMC instrument. That means this voltmeter takes very small current from the circuit but it amplifies the current to higher value so that the current can be measured by conventional PMMC instrument. In this way an electronic voltmeter can measure a voltage without affecting the value of the original voltage.

An electronic voltmeter does have its own power supply. So, it needs not to take any significant current from the circuit under measurement. The amplifying arrangement makes it possible to measure very tiny current with the help of conventional PMMC instrument.

Advantages of Electronic Voltmeter

There are numbers of advantages of using an electronic voltmeter. Such as,

1. Its accuracy level is high.
2. A PMMC instrument can only measure direct currents. So, for measuring AC, electronic voltmeter, must have a rectifier circuit. Because of that

this instrument can measure alternating voltage for wide range of frequencies.

3. The meters are compact and portable in shape and size.
4. Also it has high sensitivity.
5. It offers very high input impedance. This is why it draws a very low current.
6. Since current taken by the instrument is very negligible, the loading effect is quite low.
7. **Detection of Low-level signals** – The electronic voltmeter uses the amplifier which avoids the load error. The amplifier detects the very small signals which produce the current of approximately 50μA. The detection of low-level signals is essential for determining the true value of the measurement.
8. **Low Power Consumption** – The electronic voltmeter has vacuum tubes and the transistor which has the amplifying properties. It uses the auxiliary source for the deflection of the pointer. The measurand voltage controls the deflection of the sensing element. Thus, the circuit of the electronic voltmeter consumes very less power.
9. **High-Frequency Range** – The working of the electronic voltmeter is free from frequency range because of the transistor. Along with the voltage, the signal of very high and low frequency can also be measured through it.

Comparison between Electronic Mechanical Voltmeter and Electronic Voltmeter

1. Power consumption in an electronic voltmeter is much lower than that of an electromechanical voltmeter.
2. An electro mechanical type voltmeter is much robust in construction than that of an electronic type.
3. An electronic variant of voltmeters must have at least an amplifier but a conventional voltmeter does not have an amplifier.
4. The electronic type of voltmeter can measure much higher voltage than a conventional type.
5. The loading effect (mentioned earlier) is much lower in an electronic variant.

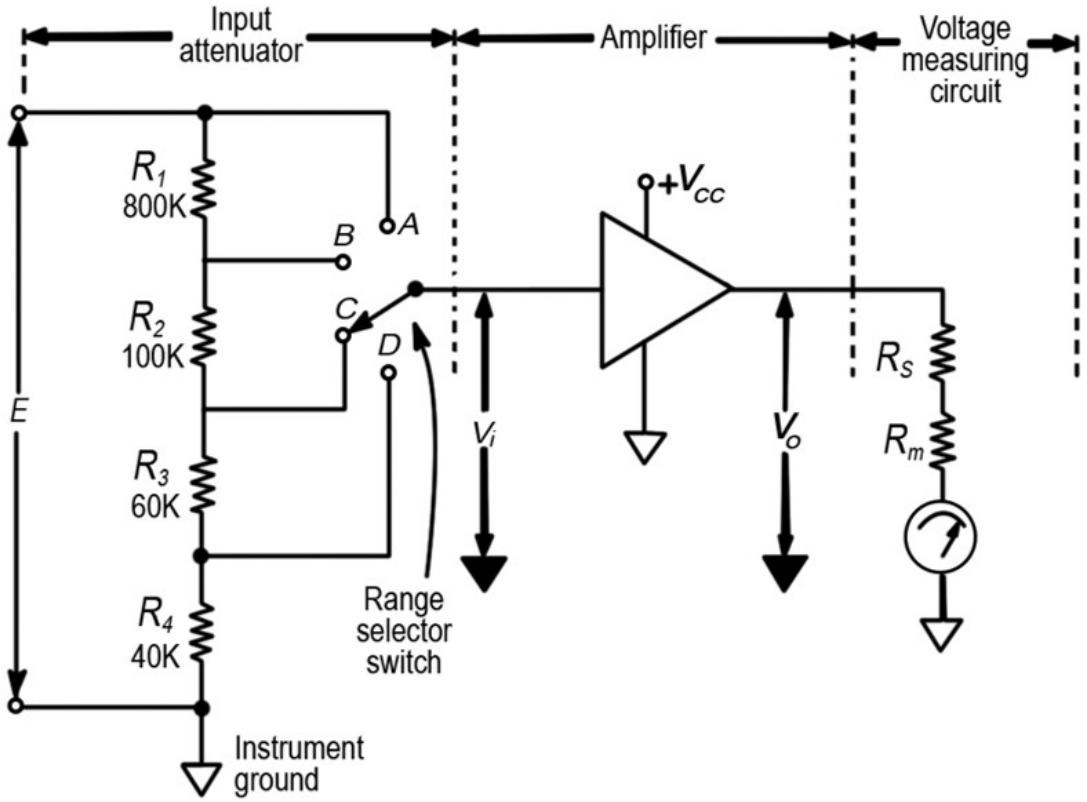
6. We can measure very low level of voltage signal by EVM which is not possible with help of a conventional analogue voltmeter.
7. The sensitivity, frequency range and input impedance are higher in an electronic voltmeter than that in an equivalent electro mechanical voltmeter.

Types of Electronic Voltmeter

There are two types of electronic voltmeters available in the market.

1. Analogue Type.
2. Digital Type.

The basic circuit of one type of analog electronic voltmeter is illustrated in figure . This particular circuit is made up of three stages: **an input attenuator, an electronic amplifier, and an electromechanical voltmeter stage**



Note the large triangular graphic symbol normally used to represent an amplifier. Also, note the small triangular symbol representing the instrument

ground. The input attenuator is simply a voltage divider that divides (or attenuates) high input voltages to measurable levels.

The amplifier has a very high input resistance so that there is virtually no loading effect on the attenuator resistors. It also has a low output resistance to supply the current required by the electromechanical voltmeter stage.

Amplifier

The amplifier has voltage gain (or amplification) of 1, which means that a 1 V input produces a 1 V output. So, its function is solely to offer a high input resistance and a low output resistance. In this situation it is said to be a buffer between the attenuator and voltage-measuring stages; thus, it is termed a buffer amplifier.

A DC supply voltage (V_{cc}) must be provided for the amplifier, and this may be derived from a battery or power supply contained within the instrument. The operation of the amplifier cannot be understood until electronic devices are studied.

Electromechanical Voltmeter Stage

The electromechanical voltage-measuring stage is typically designed to give meter FSD for an amplifier output of 1 V. Because the amplifier has a gain of 1, its output voltage (V_0) is equal to the input (V_i) from the attenuator. Thus, meter FSD is obtained when the attenuator produces a 1 V output.

Attenuator

The attenuator switch is the voltmeter range-selection switch. With the switch at position A, an attenuator input of 1V is passed to the voltage measuring-stage to give FSD. This (1V) is the maximum input voltage that can be measured when the switch is at terminal A. Thus, position A of the range-selection switch is identified at the 1V range position [see Figure 2].

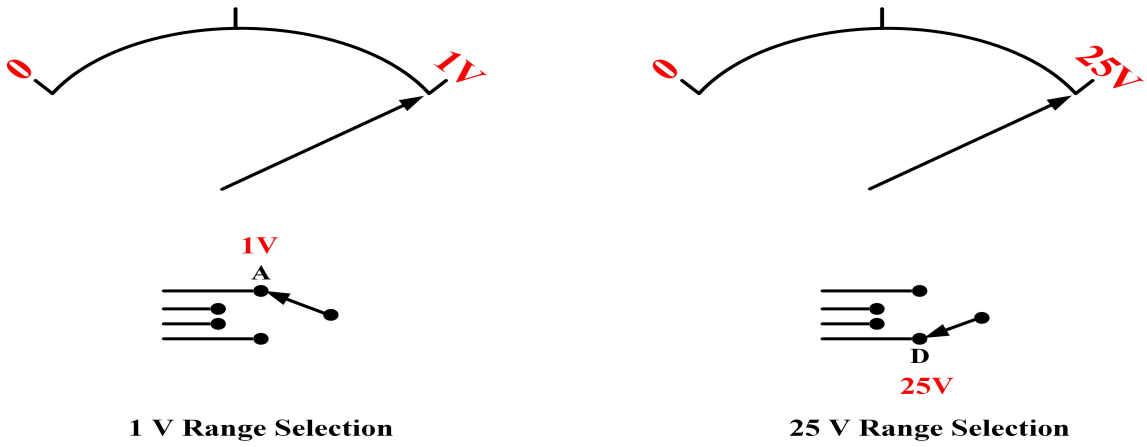
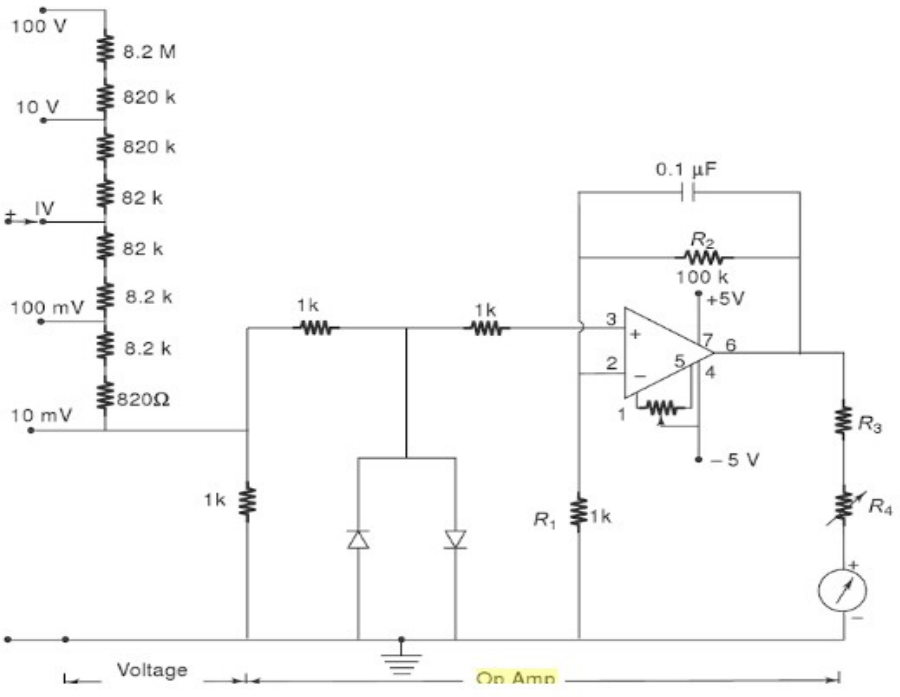


Fig.2: Electronic Voltmeter Range Selection

Solid State Voltmeter :

The circuit of an electronic voltmeter using an IC opamp 741C. This is directly coupled to very high gain amplifier. The gain of the opamp can be adjusted to any suitable lower value by provinding appropriate resistance between its output terminal. Pin No. 6, and inverting input, Pin No. 2, to provide a negative feedback.

The ratio R_2/R_1 determines the gain, i.e. 101 in this case, provided by the opamp. The 0.1 µF capacitor across the 100 k resistance R_2 is for stability under stray pick – ups. Terminals 1 and 5 are called offset null terminals. A 10 kΩ potentiometer is connected between these two offset null terminals with its center tap connected to a 5V supply. This poentiometer is called zero set and is used for adjusting zero output for zero input conditions.



Solid State mV voltmeter using an Op Amp

The two diodes used are for IC protection. Under normal conditions, they are non-conducting, as the maximum voltage across them is 10 mV. If an excessive voltage, say more than 100 mV appears across them, then depending upon the polarity of the voltage, one of the diodes conducts and protects the IC. A μA scale of 50 – 1000 μA full scale deflection can be used as an indicator. R_4 is adjusted to get maximum full scale deflection.

AC Voltmeter:

In electronic ac voltmeters input signal is firstly rectified and then supplied to the dc amplifier, as shown in figure. Sometimes signal is firstly amplified by AC amplifier and then rectified before supplying it to dc meter, as shown in figure. In the former case the advantage is of economical amplifiers and the arrangement is usually used in low priced voltmeters.