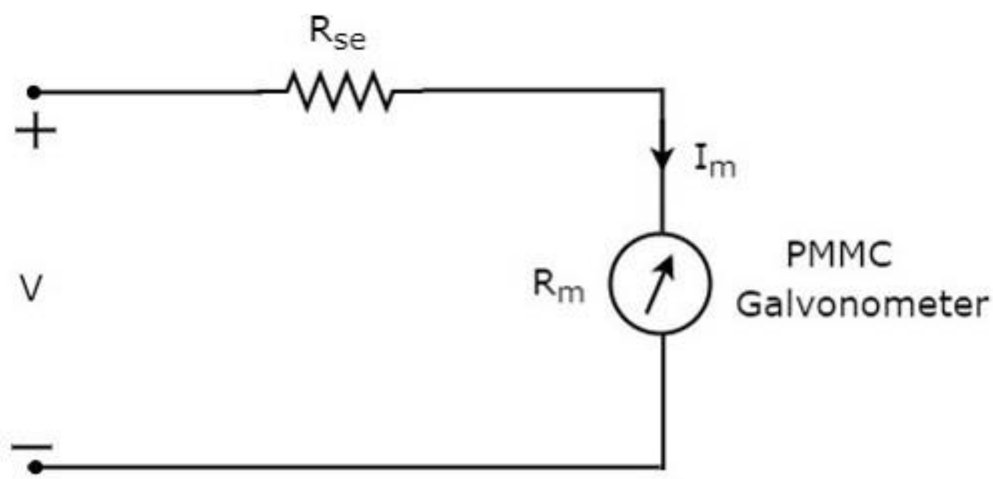
Moving Coil Instruments

D.C Voltmeter

DC voltmeter is a measuring instrument, which is used to measure the DC voltage across any two points of electric circuit. If we place a resistor in series with the Permanent Magnet Moving Coil (PMMC) galvanometer, then the entire combination together acts as **DC voltmeter**.

The series resistance, which is used in DC voltmeter is also called series multiplier resistance or simply, multiplier. It basically limits the amount of current that flows through galvanometer in order to prevent the meter current from exceeding the full scale deflection value. The **circuit diagram** of DC voltmeter is shown in below figure.



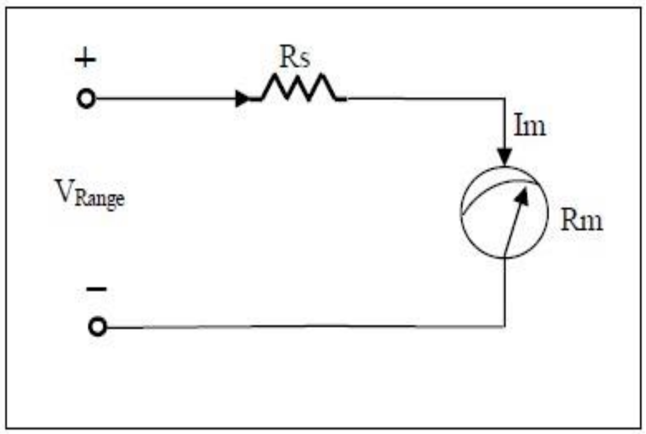
We have to place this DC voltmeter across the two points of an electric circuit, where the DC voltage is to be measured.

E-mail:zainab.kadum.jaber@uomus.edu.iq

The series resistance should be much larger than the impedance of the circuit being measured, and they are usually much larger than Rm.

$$Rs = R_T - Rm$$

$$Rs = \frac{V_{range}}{\text{Im}} - Rm$$



$\text{Im} = I_{FSD}$

The ohm/volt sensitivity of a voltmeter Is given by:

$$S_v = \frac{Rm}{V_{FSD}} = \frac{1}{I_{FSD}} = \frac{-}{V} rating$$

$$S_{Range} = \frac{Rm + Rs}{V_{Range}} = \frac{1}{I_{Range}} = \frac{\Omega}{V}$$

So the internal resistance of voltmeter or the input resistance of voltmeter is

$Rv = V_{FSD}$ x sensitivity

E-mail:zainab.kadum.jaber@uomus.edu.iq

Example:
We have a micro ammeter and we wish to adapted it so as to measure 1volt full scale, the meter has internal resistance of 100Ω and IFSD of 100μA.

Sol.:

$$Rs = \frac{V}{Im} - Rm \qquad Rs = \frac{1}{0.0001} - 100 = 9900\Omega = 9.9K\Omega$$

So we connect with PMMC meter a series resistance of 9.9KΩ to convert it to voltmeter

Extension of Voltmeter Range:

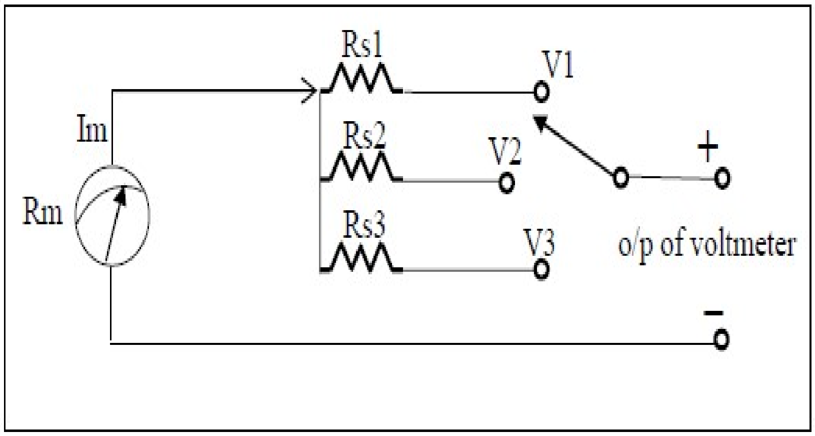
Voltage range of d.c voltmeter can be further extended by a number of series resistance
selected by a range switch; such a voltmeter is called multirange voltmeter.

a) Direct D.c Voltmeter Method:

In this method each series resistance of multirange voltmeter is connected in direct with
PMMC meter to give the desired range.

E-mail:zainab.kadum.jaber@uomus.edu.iq

$$Rs_* = \frac{V_*}{Im} - Rm$$

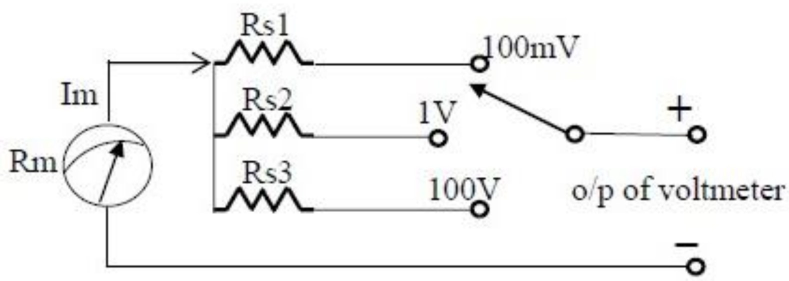


Example (1):
Design d.c voltmeter by using direct method with d'Arsonval meter of 100Ω and full
scale deflection of 100µA to give the following ranges: 10mV, 1V, and 100V.

E-mail:zainab.kadum.jaber@uomus.edu.iq

Sol:

$$Rs_{*} = \frac{V_{*}}{Im} - Rm$$



$$Rs1 = \frac{V1}{Im} - Rm$$

$$Rs1 = \frac{10mV}{100\mu A} - 100 = 0\Omega$$

$$Rs2 = \frac{1}{100 \times 10^{-6}} - 100 = 9.9K\Omega$$

$$Rs3 = \frac{100}{100 \times 10^{-6}} - 100 = 99.9K\Omega$$

b) Indirect D.c Voltmeter Method:

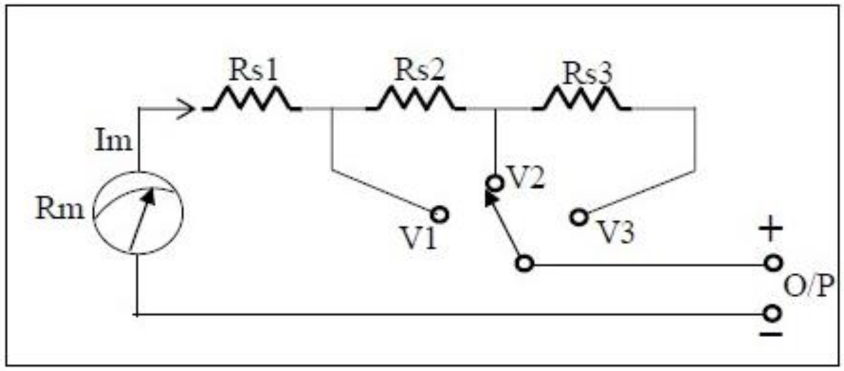
In this method one or more series resistances of multirange voltmeter is connected with
PMMC meter to give the desired range.

E-mail:zainab.kadum.jaber@uomus.edu.iq

$$Rs1 = \frac{V1}{\text{Im}} - Rm$$

$$Rs2 = \frac{V2 - V1}{\text{Im}}$$

$$Rs3 = \frac{V3 - V2}{\text{Im}}$$



Example (2):

A basic d'Arsonval movement with internal resistance of 100Ω and half scale current
deflection of 0.5 mA is to be converted by indirect method into a multirange d.c voltmeter with
voltages ranges of 10V, 50V, 250V, and 500V.

Sol:

$I_{FSD} = I_{HSD} \times 2$

$I_{FSD} = 0.5mA \times 2 = 1mA$

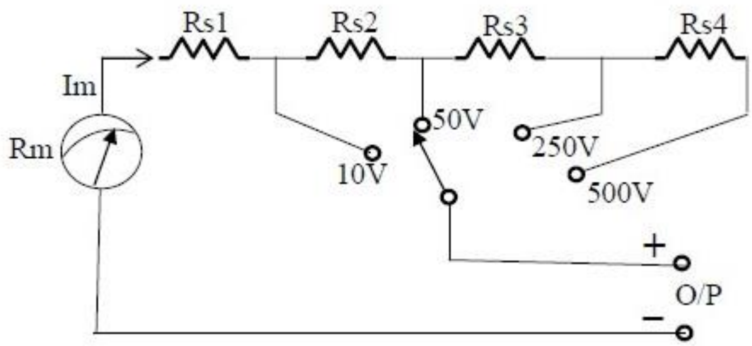
$$Rs1 = \frac{V1}{\text{Im}} - Rm \qquad\qquad Rs1 = \frac{10}{1mA} - 100 = 9.9K\Omega$$

$$Rs2 = \frac{V2 - V1}{\text{Im}}$$

$$Rs2 = \frac{50 - 10}{1 \times 10^{-3}} = 40K\Omega$$

$$Rs3 = \frac{250 - 50}{1 \times 10^{-3}} = 200K\Omega$$

$$Rs4 = \frac{500 - 250}{1 \times 10^{-3}} = 250K\Omega$$



E-mail:zainab.kadum.jaber@uomus.edu.iq