2- *D.C Voltmeter:*

A voltmeter is always connected in parallel with the element being measured and measures the voltage between the points across which it's connected. Most d.c voltmeters employ a PMMC meter with a series resistor as shown. The series resistance should be much larger than the impedance of the circuit being measured, and they are usually much larger than R_m.

$$Rs = R_T - Rm$$

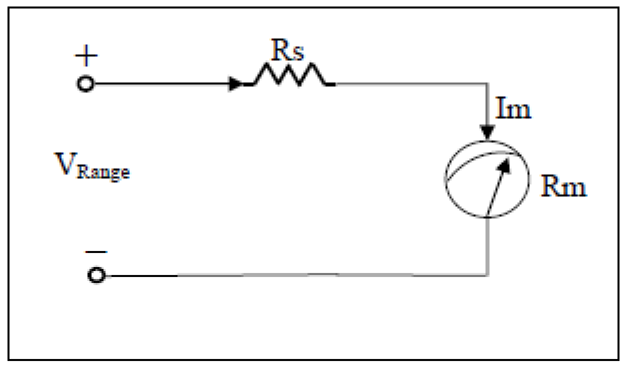
$$Rs = \frac{V_{range}}{\text{Im}} - Rm$$

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

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

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

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



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

$R_v = V_{FSD}$ x sensitivity

Example:

We have a micro ammeter and we wish to adapted it to measure 1volt full scale, the meter has an internal resistance of 100Ω and I_{FSD} of 100μA.

Sol:-

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

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

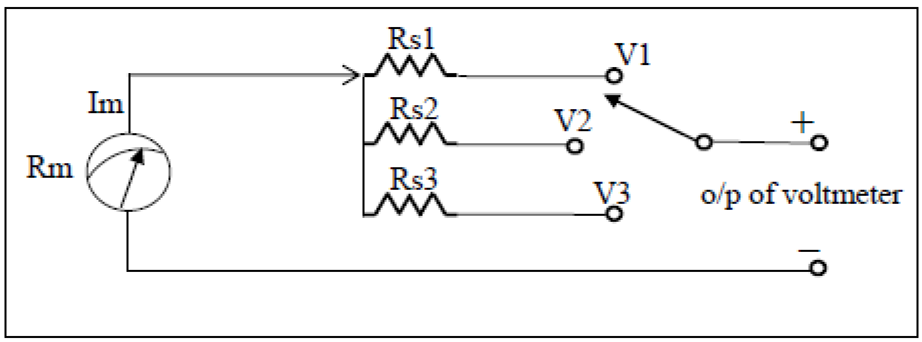
Extension of Voltmeter Range:

The 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 a multirange voltmeter.

a) *Direct D.c Voltmeter Method:*

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

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



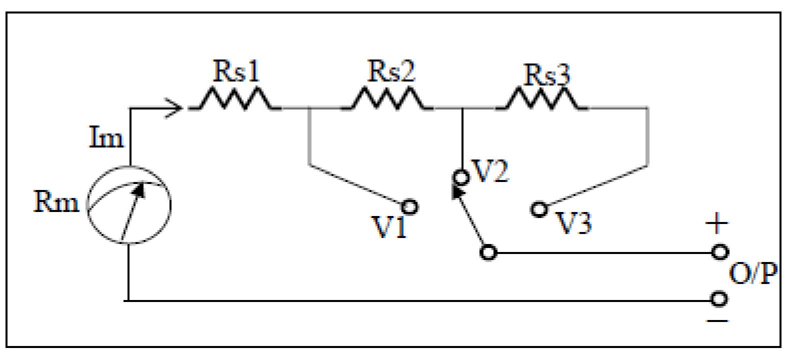
b) *Indirect D.c Voltmeter Method:*

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

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

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

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



Example (1):

A basic d'Arsonval movement with an 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.

<u>*Sol:*</u>

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

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

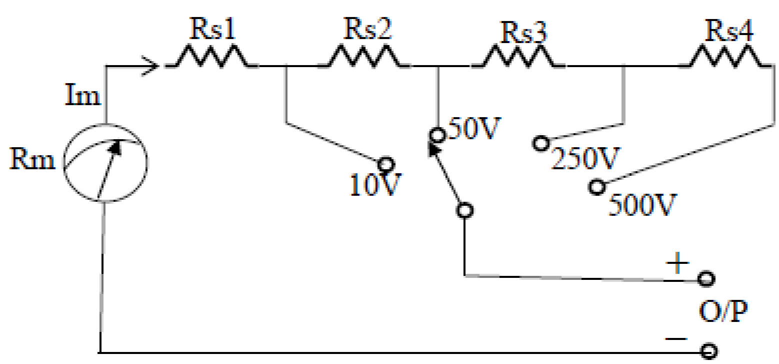
$$Rs1 = \frac{V1}{Im} - Rm \qquad Rs1 = \frac{10}{1mA} - 100 = 9.9K\Omega$$

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

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

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

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

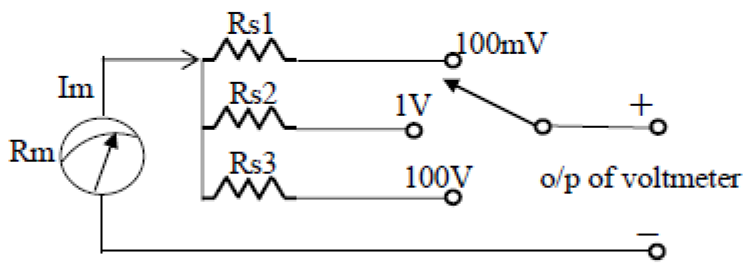


Example (2):

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.

Sol:

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



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

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

$$Rs2 = \frac{1}{100\times10^{-6}} - 100 = 9.9K\Omega$$

$$Rs3 = \frac{100}{100\times10^{-6}} - 100 = 99.9K\Omega$$