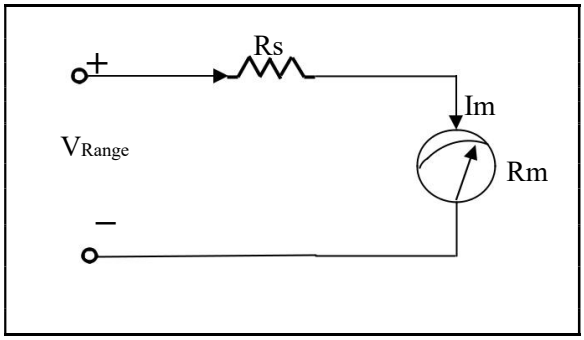
D.C Voltmeter:

A voltmeter is always connect in parallel with the element being measured, and measures the voltage between the points across which its' connected. Most d.c voltmeter employ PMMC meter with 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 Rm.

$$Rs = RT - Rm$$

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



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 voltmeter or the input resistance of voltmeter is

Rv= V_{FSD} x sensitivity

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 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 voltmeter

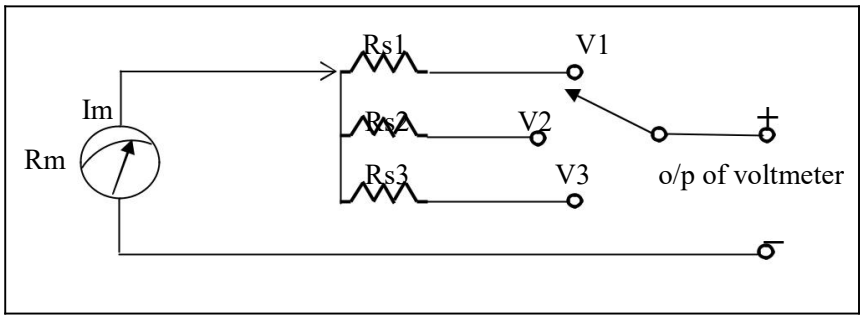
Extension of Voltmeter Range:

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.

$$Rs = \frac{V}{Im} - Rm$$



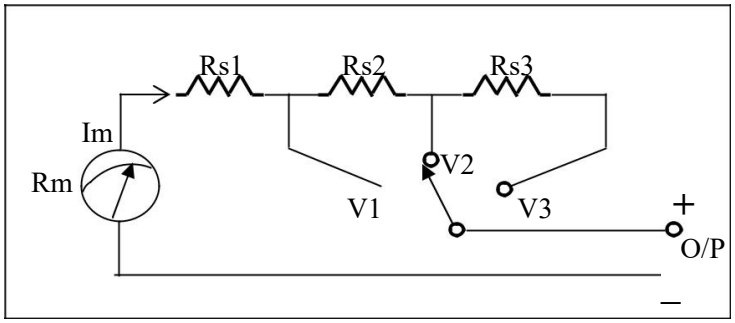
b) ***Indirect D.c Voltmeter Method:***

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

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

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

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



Example (1):

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:

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

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

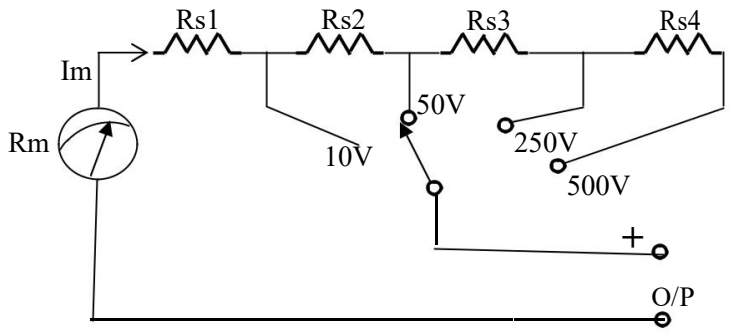
$$Rs1 = \frac{V1}{Im} - Rm \qquad Rs1 = \frac{10}{1mA} - 100 = 9.9K\Omega$$

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

$$Rs2 = \frac{50 - 10}{1\times10^{-3}} = 40K\Omega$$

$$Rs3 = \frac{250 - 50}{1\times10^{-3}} = 200K\Omega$$

$$Rs4 = \frac{500 - 250}{1\times10^{-3}} = 250K\Omega$$



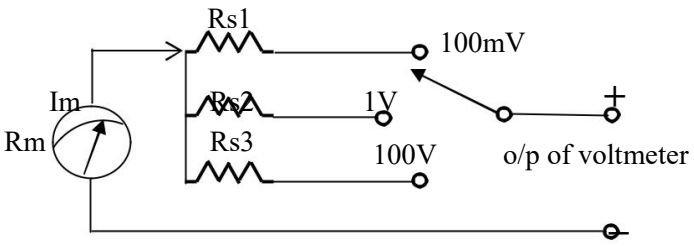
Example (2):

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:

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

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



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

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

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