2- 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.

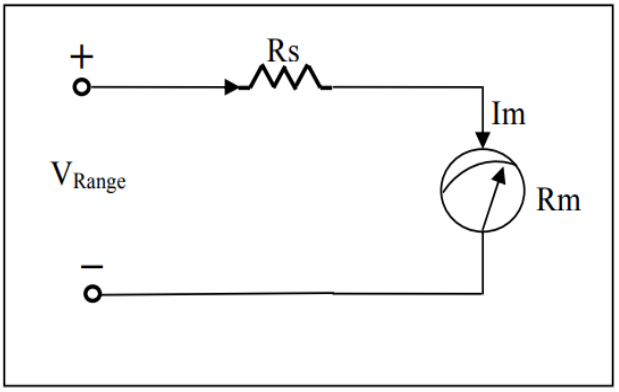
$$Rs = R_T - Rm$$

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

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

$R_V = V_{FSD}$ x sensitivity

Example:

We have a micro ammeter and we wish to adapted it so as to measure 1volt full scale, the meterhas 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

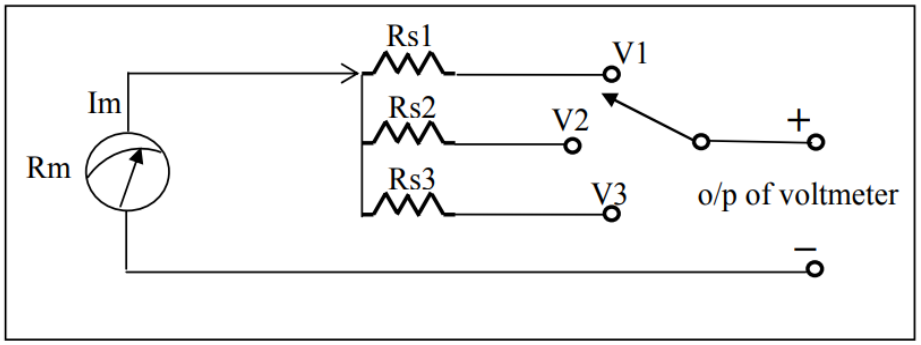
Extension of Voltmeter Range:

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.

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



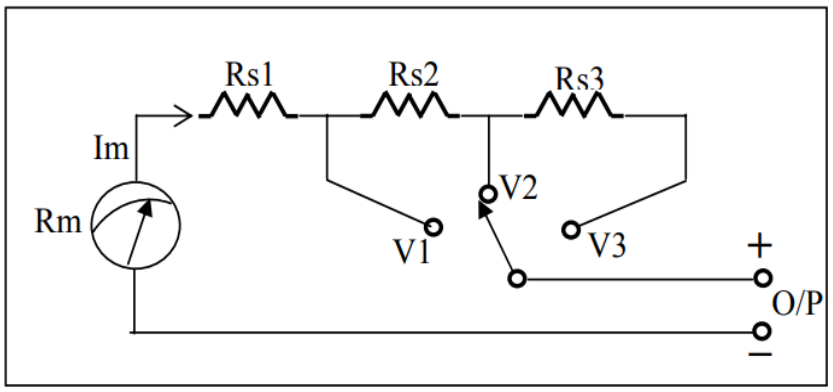
b) ***Indirect D.c Voltmeter Method:***

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

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

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

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



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:

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

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

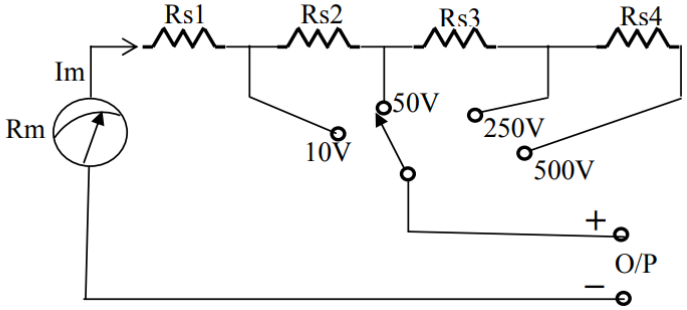
$$Rs1 = \frac{V1}{\text{Im}} - Rm \qquad Rs1 = \frac{10}{1mA} - 100 = 9.9K\Omega$$

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

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

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

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



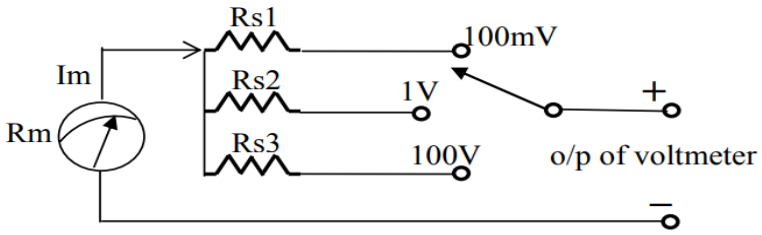
Example (2):

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:

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

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



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

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

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

3- Ohmmeter and Resistance measurement:

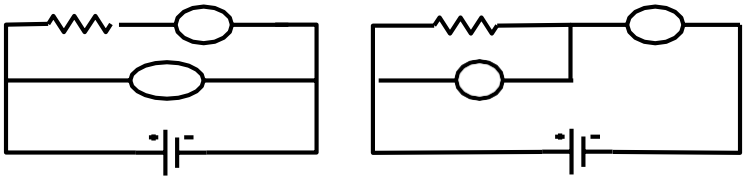
When a current of 1A flows through a circuit which has an impressed voltage of 1volt, the circuit has a resistance of 1Ω.

$$R = \frac{V}{I}$$

There are several methods used to measure unknown resistance:

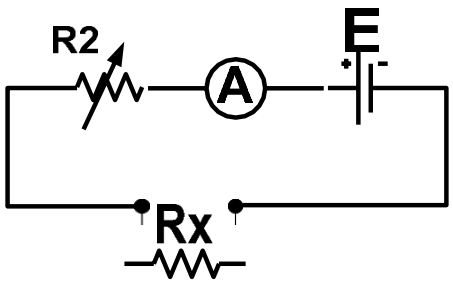
a) Indirect method by ammeter and voltmeter.

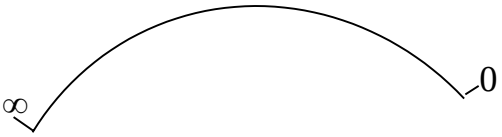
This method is inaccurate unless the ammeter has a small resistance and voltmeter have a high resistance.



b) Series Ohmmeter:

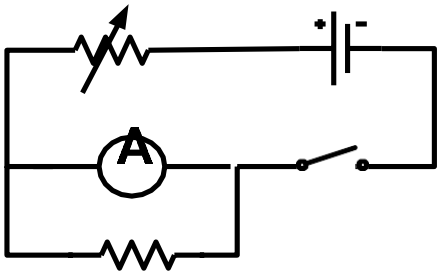
Rx is the unknown resistor to be measured, R2 is variable adjusted resistance so that the pointer read zero at short circuit test. The scale of series ohmmeter is nonlinear with zero at the right and infinity at extreme left. Series ohmmeter is the most generally used meter for resistance measurement.

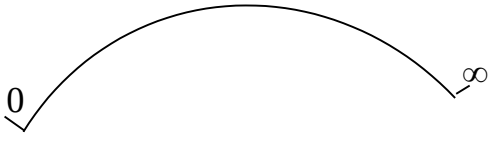




c) Shunt Ohmmeter:

Shunt ohmmeter are used to measure very low resistance values. The unknown resistance Rx is now shunted across the meter, so portion of current will pass across this resistor and drop the meter deflection proportionately. The switch is necessary in shunt ohmmeter to disconnect the battery when the instrument is not used. The scale of shunt ohmmeter is nonlinear with zero at the left and infinity at extreme right.





d) Voltage Divider (potentiometer):

The meter of voltage divider is voltmeter that reads voltage drop across Rs which dependent on Rx. This meter will read from right to left like series ohmmeter with more uniform calibration.