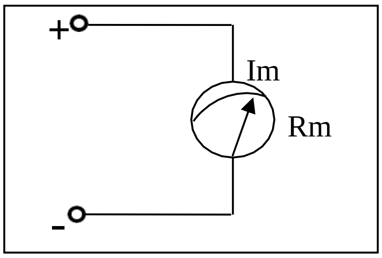
1- ***D.c Ammeter:***

An Ammeter is always connected in series with a circuit branch and measures the current flowing in it. Most d.c ammeters employ a d'Arsonval movement, an ideal ammeterwould be capable of performing the measurement without changing or distributing the current in the branch but real ammeters would possess some internal resistance.

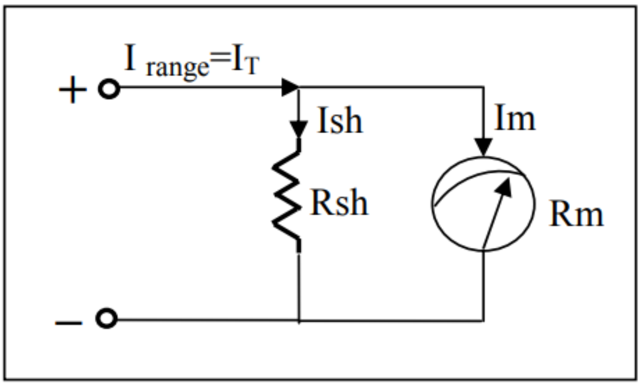


Extension of Ammeter Range:

Since the coil winding in PMMC meter is *small and light*, they can carry only small currents (μA-1mA). Measurement of large current requires ***a shunt external resistor*** to connect with the meter movement, so only a fraction of the total current will passes through the meter.

$$Vm = Vsh$$
$$\text{Im}\, Rm = Ish Rsh$$
$$Ish = I_T - \text{Im}$$

$$\boxed{Rsh = \frac{\text{Im}\, Rm}{I_T - \text{Im}}}$$



Example:

If PMMC meter have internal resistance of 10Ω and full scale range of 1mA. Assume we wish to increase the meter range to 1A.

Sol.

So we must connect shunt resistance with the PMMC meter of

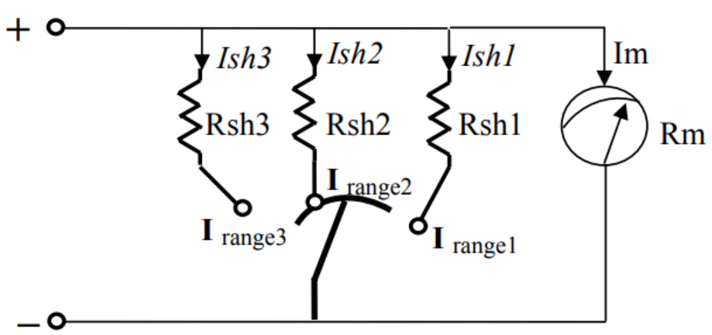
$$Rsh = \frac{\mathrm{Im}\,Rm}{I_T - \mathrm{Im}}$$

$$Rsh = \frac{1\times10^{-3}\cdot 10}{1-1\times10^{-3}} = 0.01001\Omega$$

a) Direct D.c Ammeter Method (Ayrton Shunt):

The current range of d.c ammeter can be further extended by a number of shunts selected by a range switch; such ammeter is called a multirange ammeter.

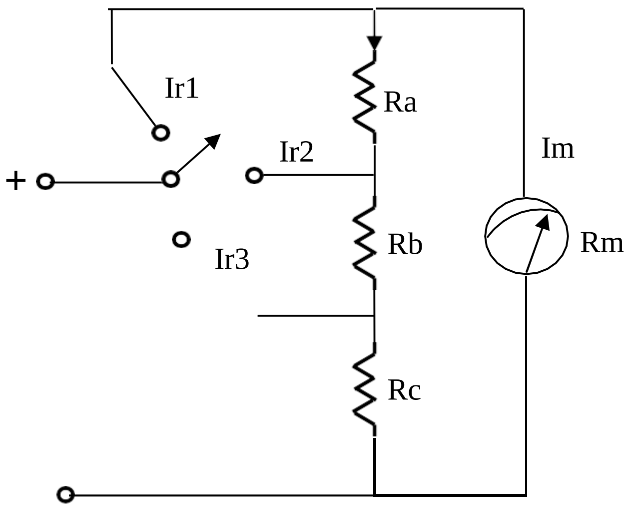
$$Rsh_* = \frac{\mathrm{Im}\,Rm}{Ir_* - \mathrm{Im}}$$



b) Indirect D.C Ammeter Method:

Where R=Ra+ Rb+ Rc

And r = parallel resistors branch with the meter



Example (1):

Design a multirange ammeter by using ***direct method*** to give the following ranges 10mA, 100mA, 1A, 10A, and 100A. If d'Arsonval meter have internal resistance of 10Ω and full scale current of 1mA.

Sol:

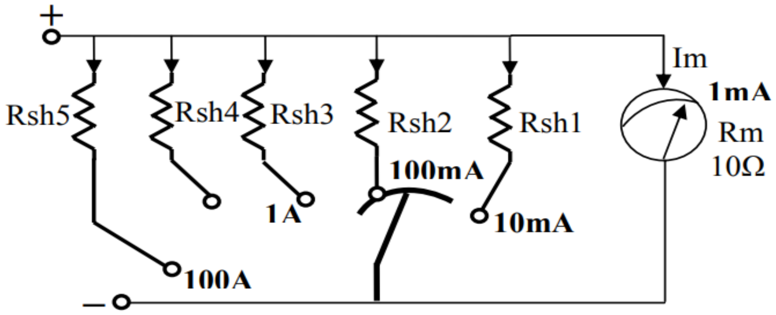
Rm=10Ω Im=1mA

$$\boxed{Rsh_* = \frac{\text{Im}\,Rm}{Ir_* - \text{Im}}}$$

$$Rsh1 = \frac{1\times10^{-3}\cdot10}{(10-1)\times10^{-3}} = 1.11\Omega$$

$$Rsh2 = \frac{1\times10^{-3}\cdot10}{(100-10)\times10^{-3}} = 0.101\Omega \qquad Rsh3 = \frac{1\times10^{-3}\cdot10}{1-10\times10^{-3}} = 0.0101\Omega$$

$$Rsh4 = \frac{1\times10^{-3}\cdot10}{10-1\times10^{-3}} = 0.0011\Omega \qquad Rsh5 = \frac{1\times10^{-3}\cdot10}{100-1\times10^{-3}} = 0.00011\Omega$$



Example (2):

Design an Ayrton shunt by ***indirect method*** to provide an ammeter with current ranges 1A, 5A, and 10A, if PMMC meter have internal resistance of 50Ω and full scale current of 1mA.

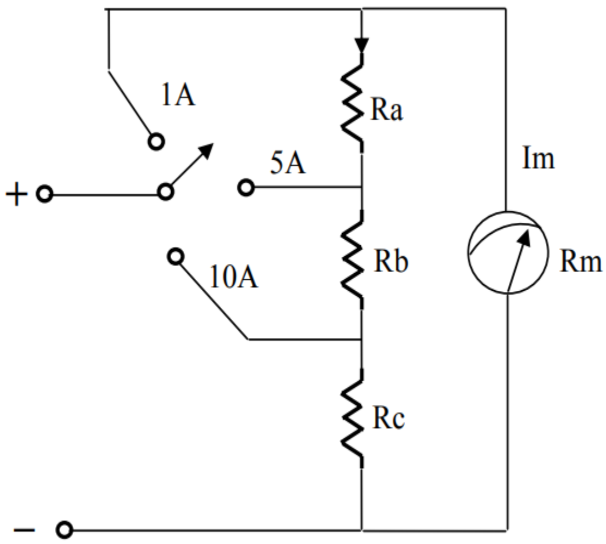
Sol.:

Rm=50Ω I_{FSD}=Im=1mA

$$\boxed{\frac{Ir_*}{\text{Im}} = \frac{Rm+R}{r_*}}$$

Where R=Ra+ Rb+ Rc

And r = parallel resistors branch with the meter



1- *For 1A Range:*

$$\frac{I1}{\text{Im}} = \frac{Rm+R}{R}$$

$$\frac{1A}{1mA} = \frac{50+R}{R}$$ R=0.05005Ω

2- *For 5A Range:*

$$\frac{I2}{\mathrm{Im}} = \frac{Rm+R}{Rb+Rc}$$ r =Rb+Rc

$$\frac{5A}{1mA} = \frac{50+0.05005}{Rb+Rc}$$ Rb+Rc= 0.01001Ω

Ra=R-(Rb+Rc) **Ra**=0.05-0.01001=0.04004 Ω

3- *For 10A Range:*

$$\frac{I3}{\mathrm{Im}} = \frac{Rm+R}{Rc}$$ r =Rc

$$\frac{10A}{1mA} = \frac{50+0.05005}{Rc}$$ **Rc**=5.005×10^{-3} Ω

Rb=$0.01001-5.005\times10^{-3}= 5.005\times10^{-3}$ Ω