for a square law device

analyzing a current loop at the bottom region of the text figure

$$R \cdot I + vgsM4 = vgsM1$$

where

$$I = \frac{1}{2} \mu n \cdot Cox \cdot \frac{W \cdot 4}{L} \cdot (vgsM4 - vt)^2$$

and

$$I = \frac{1}{2} \mu n \cdot Cox \cdot \frac{W}{L} \cdot (vgsM1 - vt)^2$$

$$\sqrt{I} = \sqrt{\frac{1}{2} \cdot \left(\mu n \cdot Cox \cdot \frac{W}{L}\right)} \cdot (vgsM1 - vt)$$

solve for vgs

$$vgsM1 = \sqrt{\frac{I}{\left[\frac{1}{2} \cdot \left(\mu n \cdot Cox \cdot \frac{W}{L}\right)\right]}} + vt$$

and

$$vgsM4 = \sqrt{\frac{I}{\left[\frac{1}{2} \cdot \left(\mu n \cdot Cox \cdot \frac{W \cdot 4}{L}\right)\right]}} + vt$$

returning to original loop eqaution and substituting

$$R \cdot I + \sqrt{\frac{I}{\left[\frac{1}{2} \cdot \left(\mu n \cdot Cox \cdot \frac{W \cdot 4}{L}\right)\right]}} + vt = \sqrt{\frac{I}{\left[\frac{1}{2} \cdot \left(\mu n \cdot Cox \cdot \frac{W}{L}\right)\right]}} + vt$$

neglecting body effect- vt's are the same for the same device

$$R \cdot I + \frac{1}{2} \cdot \sqrt{\frac{I}{\left[\frac{1}{2} \cdot \left(\mu n \cdot Cox \cdot \frac{W}{L}\right)\right]}} = \sqrt{\frac{I}{\left[\frac{1}{2} \cdot \left(\mu n \cdot Cox \cdot \frac{W}{L}\right)\right]}}$$

$$R \cdot I = \frac{1}{2} \cdot \sqrt{\frac{I}{\left[\frac{1}{2} \cdot \left(\mu n \cdot Cox \cdot \frac{W}{L}\right)\right]}}$$

simplifying above equation

$$R \cdot I = \frac{1}{2} \cdot \sqrt{\frac{2 \cdot I}{\mu n \cdot Cox \cdot \frac{W}{L}}}$$

remembering that

$$gm1 = \sqrt{2\ \mu n \cdot Cox \cdot \frac{W}{L}} \cdot \sqrt{\frac{1}{2}\ \mu n \cdot Cox \cdot \frac{W}{L}} \cdot (vgsM1 - vt)$$

$$\frac{gm1}{\sqrt{\mu n \cdot Cox \cdot \frac{W}{L}}} = \sqrt{\frac{2}{2}\ \mu n \cdot Cox \cdot \frac{W}{L}} \cdot (vgsM1 - vt) = \sqrt{I \cdot 2}$$

solving for 1/2sqrt(un*Cox*W/L) gets

$$\frac{1}{\sqrt{\mu n \cdot Cox \cdot \frac{W}{L}}} = \frac{\sqrt{2 \cdot I}}{gm1}$$

substituting above to below

$$R \cdot I = \frac{1}{2} \cdot \sqrt{\frac{2 \cdot I}{\mu n \cdot Cox \cdot \frac{W}{L}}} = \frac{I}{gm1}$$

$$R = \frac{1}{gm1}$$