Slide 18:

Normalized relation of $v_o = \frac{R}{(R+R_c)} v_{ref}$: $\frac{v_o}{v_{ref}} = \frac{R/R_c}{(R/R_c+1)}$

This is nonlinear. Also, see the characteristic curve.

For small changes:

$v_o = \frac{R}{(R+R_c)} v_{ref}$ ➔ $\delta v_o = \frac{\partial v_o}{\partial R}\delta R + \frac{\partial v_o}{\partial R_c}\delta R_c$ (the familiar differential relation)

Differentiate the original relation wrt the two parameters:

$$\frac{\partial v_o}{\partial R} = \frac{(R+R_c)-R}{(R+R_c)^2} v_{ref} = \frac{R_c}{(R+R_c)^2} v_{ref} \ ; \qquad \frac{\partial v_o}{\partial R_c} = -\frac{R}{(R+R_c)^2} v_{ref}$$

Substitute: $\delta v_o = \frac{R_c}{(R+R_c)^2} v_{ref}\delta R - \frac{R}{(R+R_c)^2} v_{ref}\delta R_c = \frac{v_{ref}}{(R+R_c)^2}[R_c\delta R - R\delta R_c]$

Note: Now, it is linear.

Problem: In the beginning, the circuit output is $v_o = \frac{1}{2} v_{ref}$ if $R_0 = R_{0c}$

➔Any associated change (e.g., noise) can completely mask the needed output change.

Temperature Compensation:

For a temperature change of Δ*T* the corresponding change in the output is

$\delta v_o = \frac{v_{ref}}{(R_0+R_{0c})^2}[R_{0c}R_0(1+\alpha\Delta T) - R_0R_{0c}(1+\alpha\Delta T)] = 0$ where $()_0$ denotes initial values, and *α* denotes the coefficient of thermal resistance of the material

Note: Since the material is assumed to be the same for the two resistors, *α* is the same as well

Other assumption: The changes are small (O(2) terms in the Taylor series expansion are neglected.