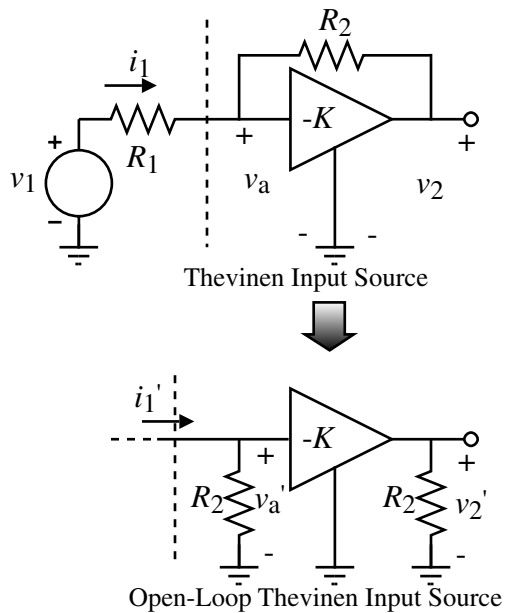


SHUNT INPUT FEEDBACK VERSUS A THEVENIN AND NORTON INPUT SOURCE

This example illustrates how to apply shunt-input feedback with either a Thevenin or Norton input source. The inverting voltage amplifier with a gain of K and infinite input and zero output resistance is shown in a shunt-shunt configuration but all results of this example are also applicable to shunt-series.

In the following, we will find the voltage gain, v_2/v_1 , and the input resistance defined as v_1/i_1 . The results for either case will be shown to be the same. The vertical dotted line illustrates the boundary for the feedback analysis method for either case.



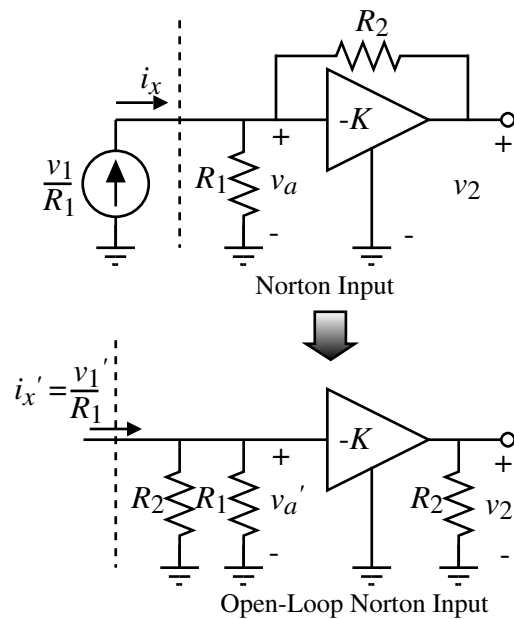
$$\beta = \frac{-1}{R_2}$$

$$v_2' = -KR_2 i_1' \Rightarrow \frac{v_2'}{i_1'} = R_T = -KR_2$$

$$\frac{v_2}{i_1} = \frac{-KR_2}{1 + (-KR_2)\left(\frac{-1}{R_2}\right)} = \frac{-KR_2}{1+K}$$

$$\frac{v_a}{i_1} = R_{inF} = \frac{R_2}{1+K}$$

$$\boxed{\frac{v_1}{i_1} = R_1 + R_{inF} = R_1 + \frac{R_2}{1+K}}$$



$$\beta = \frac{-1}{R_2}$$

$$v_2' = -K(R_1 \parallel R_2) i_x' \Rightarrow \frac{v_2'}{i_x'} = R_T = -K(R_1 \parallel R_2)$$

$$\frac{v_2}{i_1} = \frac{-K(R_1 \parallel R_2)}{1 + (-K(R_1 \parallel R_2))\left(\frac{-1}{R_2}\right)} = \frac{-K \frac{R_1 R_2}{R_1 + R_2}}{1 + K \frac{R_1}{R_1 + R_2}}$$

$$\frac{v_a}{i_x} = R_{inF} = \frac{\frac{R_1 R_2}{R_1 + R_2}}{1 + K \frac{R_1}{R_1 + R_2}}$$

$$\frac{v_a}{i_x} = \frac{v_a R_1}{v_1} \text{ which gives,}$$

$$\frac{v_2}{v_1} = \frac{v_2}{i_1} \frac{i_1}{v_1} = \left(\frac{-KR_2}{1+K} \right) \left(\frac{1}{R_1 + \frac{R_2}{1+K}} \right)$$

$$= \frac{-KR_2}{R_1(1+K) + R_2} = \frac{-KR_2}{R_1 + R_2 + KR_1}$$

$$\boxed{\frac{v_2}{v_1} = -\frac{R_2}{R_1} \frac{\frac{KR_1}{R_1+R_2}}{1 + \frac{KR_1}{R_2+R_1}}}$$

$$v_a = \frac{\frac{R_2}{R_1+R_2}}{1 + K \frac{R_1}{R_1+R_2}} v_1$$

i_1 can be expressed from the Thevenin form as,

$$i_1 = \frac{v_1}{R_1} - \frac{v_a}{R_1} = \frac{v_1}{R_1} - \frac{\frac{R_2}{R_1+R_2}}{1 + K \frac{R_1}{R_1+R_2}} \frac{v_1}{R_1}$$

$$\therefore \frac{i_1}{v_1} = \frac{1}{R_1} \left(1 - \frac{\frac{R_2}{R_1+R_2}}{1 + K \frac{R_1}{R_1+R_2}} \right)$$

$$= \frac{1}{R_1} \left(\frac{1 + K \frac{R_1}{R_1+R_2} - \frac{R_2}{R_1+R_2}}{1 + K \frac{R_1}{R_1+R_2}} \right) = \frac{1+K}{R_1+R_2 + KR_1}$$

Finally,

$$\boxed{\frac{v_1}{i_1} = R_1 + \frac{R_2}{1+K}}$$

Lastly,

$$\frac{v_2}{v_1} = \frac{v_2}{i_x} \frac{i_x}{v_1} = \frac{\frac{R_1 R_2}{R_1+R_2}}{1 + K \frac{R_1}{R_1+R_2}} \left(\frac{1}{R_1} \right)$$

$$\boxed{\frac{v_2}{v_1} = -\frac{R_2}{R_1} \frac{\frac{KR_1}{R_1+R_2}}{1 + \frac{KR_1}{R_2+R_1}}}$$

So the results are identical although one method is a lot more work than the other.