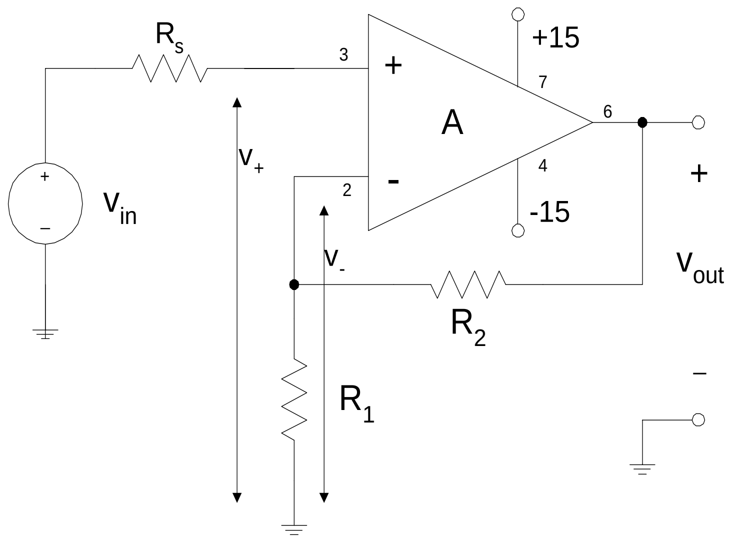
# NON-INVERTING AMPLIFIER GAIN DERIVATION
## with FINITE OPEN LOOP GAIN ANALYSIS

ASSUMPTIONS: INFINITE INPUT IMPEDANCE: $\therefore i_+ = 0; \quad i_- = 0$
ZERO VOLTAGE DROP BETWEEN INPUTS, and $A = \infty$.
ZERO AC INPUT CURRENT.
ASSUMPTIONS HOLD FOR $A >> A_V = 1 + \frac{R_2}{R_1}$




$$\text{Let } R_s = 0; \text{ Therefore } v_+ = v_{in}$$

$$v_- = \frac{R_1}{R_1 + R_2} \times v_{out}; \qquad \text{but } v_+ = v_-$$

$$\text{so } v_{in} = \frac{R_1}{R_1 + R_2} \times v_{out};$$

$$\frac{v_{out}}{v_{in}} = \frac{R_1 + R_2}{R_1}$$

$$\text{or } A_v = 1 + \frac{R_2}{R_1}$$

FINITE OPEN-LOOP GAIN ANALYSIS:

$$v_{out} = Av_{id} = A(v_+ - v_-) = A(v_{in} - v_-); \qquad v_- = \frac{R_1}{R_1 + R_2} v_{out} = \beta v_{out} \text{ where } \beta = \frac{R_1}{R_1 + R_2}.$$

$\beta$ is called the feedback transfer function and represents the fraction of the output voltage that is fed back from the output to the input. Combining the equations above gives:

$$v_{out} = A[v_{in} - \beta v_{out}]; \qquad v_{out} + A\beta v_{out} = Av_{in}; \qquad \frac{v_{out}}{v_{in}} = A_v = \frac{A}{1 + A\beta}$$

This gives the classic negative feedback amplifier gain expression. The product $A\beta$ is called the loop gain or loop transmission. For $A\beta >> 1$, $A_v$ approaches the ideal gain expression found above [$=1/\beta$]. In reality, A is a function whose value decreases with increasing frequency, until, at some point when $A\beta$ is no longer $>>1$, the ideal gain equation, a function of only two resistor values, no longer applies. $A_v$ drops at those high frequencies where the value of A approaches the value of $A_v$. [Note: $A = A_{vol}$]