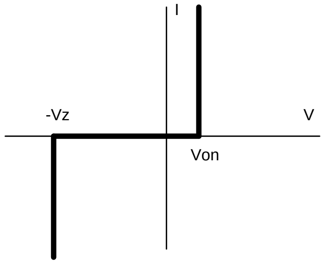
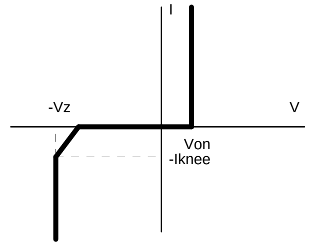
Zener Diodes:

Zener Diode



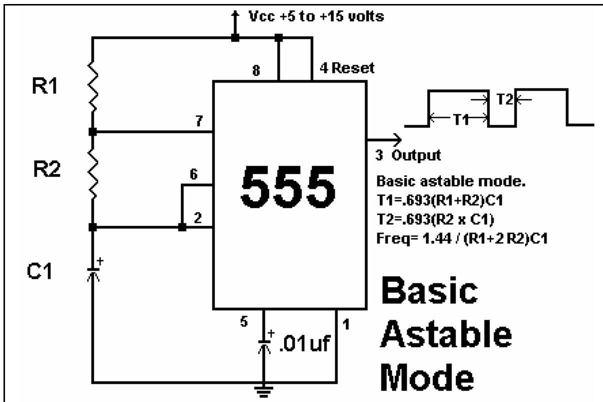
$$\begin{cases} On: & V_D = V_{on} & I_D > 0 \\ Off: & I_D = 0 & V_z < V_D < V_{on} \\ Zener: & V_D = -V_z & I_D < 0 \end{cases}$$

Zener Diode, with knee current



$$\begin{cases} On: & V_D = V_{on} & I_D > 0 \\ Off: & I_D = 0 & V_z < V_D < V_{on} \\ Zener: & V_D = -V_z & I_D < -I_{knee} \end{cases}$$

555 Timer:



On-Time: $T_1 = 0.693(R1 + R2)C1$

Off Time: $T_2 = 0.693(R2)C1$

Frequency: $f = \dfrac{01.44}{(R1 + 2R2)C1}$

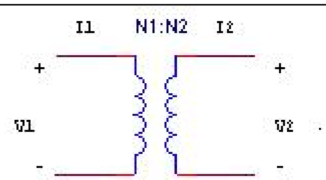
Period: $T = T_1 + T_2$

Duty Cycle (percentage): $D = \dfrac{T_1}{T} \times 100$

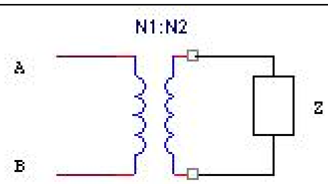
Inductance and Resistance:

Long Coil	**Ring shaped Coil**	**Wire Resistance**
$L = \dfrac{\mu N^2 \pi r_c^2}{d}$	$L = \mu N^2 r_c \left[\ln(\dfrac{8r_c}{r_w}) - 2 \right]$	$R = \dfrac{l}{\sigma A}$

Ideal Transformers:



$$a = \frac{N_2}{N_1} = \frac{V_2}{V_1} = \frac{I_1}{I_2} = \sqrt{\frac{L_2}{L_1}}$$

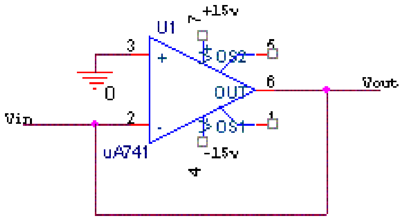


input impedance: $Z_{eq.} = Z_{AB} = \dfrac{Z}{a^2}$

power: $P = VI = I^2 R$

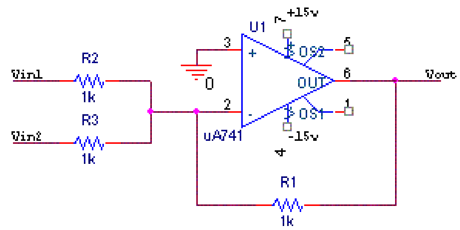
Op-Amp Circuits:

Buffer



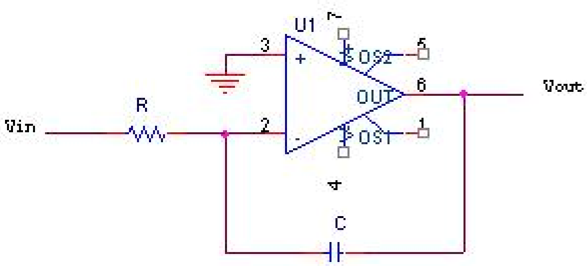
$$A_V = \frac{V_{out}}{V_{in}} = 1$$

Adder



$$V_{out} = -\frac{R_1}{R_2} V_{in1} - \frac{R_1}{R_3} V_{in2}$$

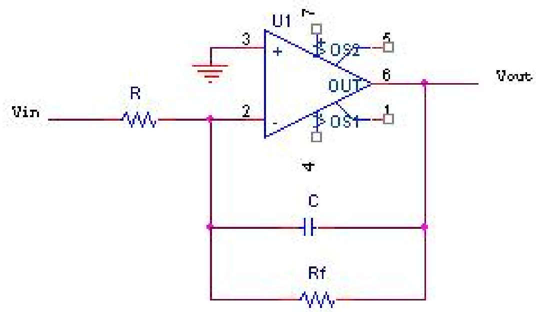
Ideal Active Integrator



$$H(j\omega) = \frac{V_{out}}{V_{in}} = -\frac{1}{j\omega RC}$$

$$v_{out}(t) = -\frac{1}{RC} \int v_{in}(t) dt$$

Miller Integrator

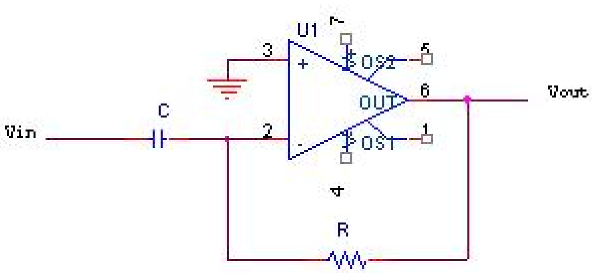


$$H(j\omega) = \frac{V_{out}}{V_{in}} = -\frac{R_f}{R(1 + j\omega R_f C)}$$

$$\omega >> \frac{1}{R_f C} \Rightarrow H(j\omega) \approx -\frac{1}{j\omega RC}$$

$$\omega >> \frac{1}{R_f C} \Rightarrow v_{out}(t) \approx -\frac{1}{RC} \int v_{in}(t) dt$$

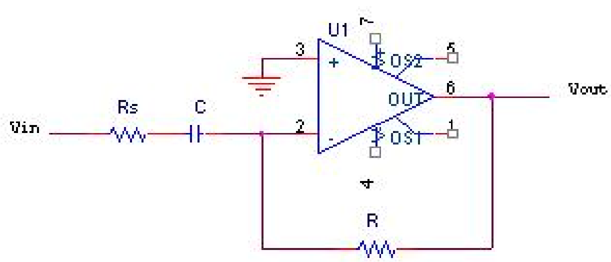
Ideal Active Differentiator



$$H(j\omega) = \frac{V_{out}}{V_{in}} = -j\omega RC$$

$$v_{out}(t) = -RC \frac{dv_{in}(t)}{dt}$$

Practical Active Differentiator



$$H(j\omega) = \frac{V_{out}}{V_{in}} = -\frac{j\omega RC}{1 + j\omega R_S C}$$

$$\omega << \frac{1}{R_S C} \Rightarrow H(j\omega) \approx -j\omega RC$$

$$\omega << \frac{1}{R_S C} \Rightarrow v_{out}(t) = -RC \frac{dv_{in}(t)}{dt}$$