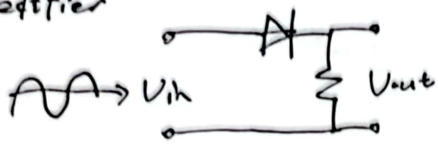
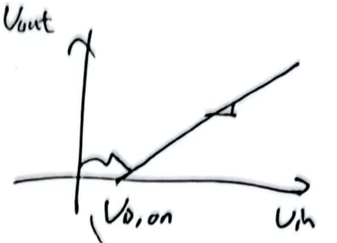
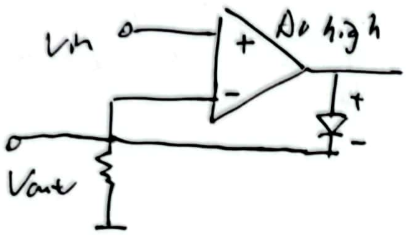
· Precision Rectifier

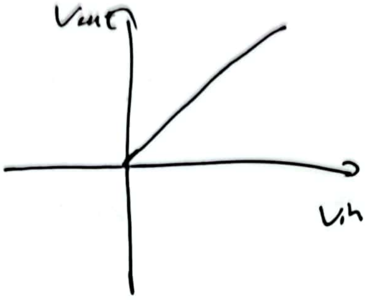
simple Rectifier





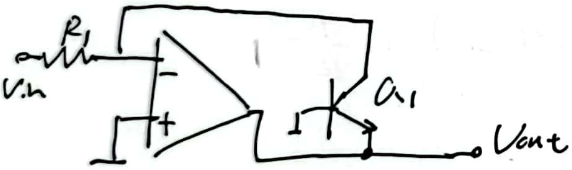
有一段不让整流



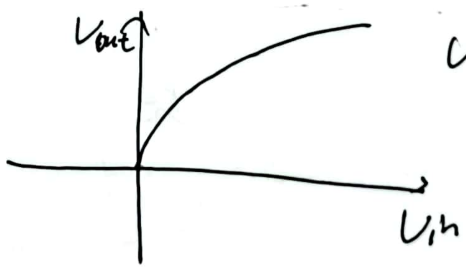


ensure $V_{in} \simeq V_{out}$ ⇒ low V_{in} still can be rectified

· Logarithmic Amplifier

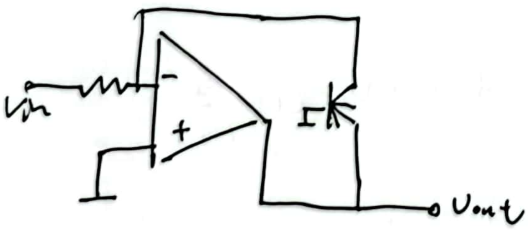


$$\frac{V_{in}}{R_1} = I_{C1} = I_S \exp \frac{V_{BE}}{V_T} \qquad V_{BE} = -V_{out}$$



$$V_{out} = -V_T \ln \frac{V_{in}}{R_1 I_S}$$

If $V_{in} < 0$,
Op Amp sat.
not defined.



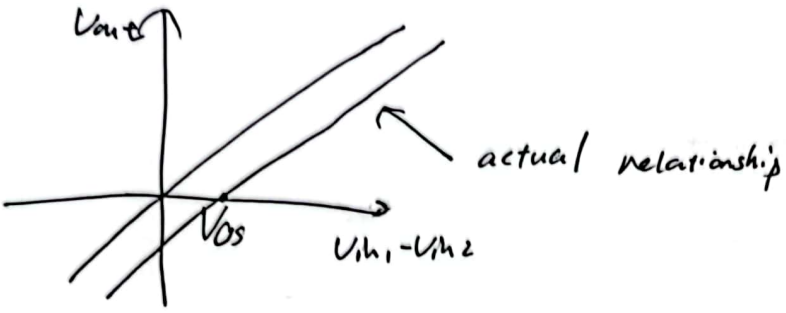
$$\frac{-V_{in}}{R_1} = I_S \exp \frac{V_{EB}}{V_T}, \quad V_{out} = V_{EB}$$

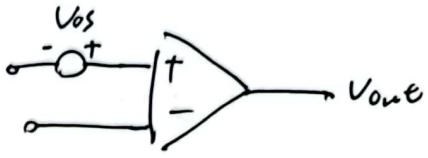
$$V_{out} = V_T \ln \frac{-V_{in}}{R_1 I_S}$$

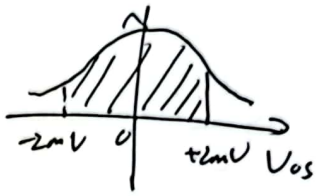
1.0 Amp.

·DC offsets.

same imperfections of Op Amp.







为什么有负值

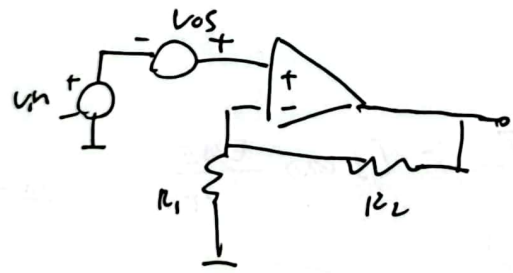
Observations:

① Vos is random

② Vos can be placed in series with either input

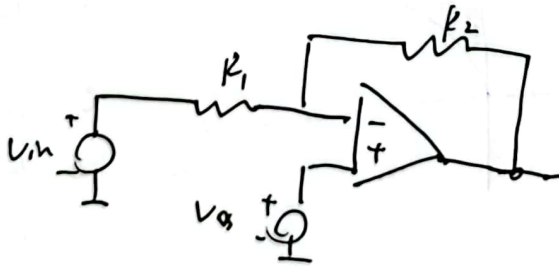
Effect of Offset on Amplifiers

①



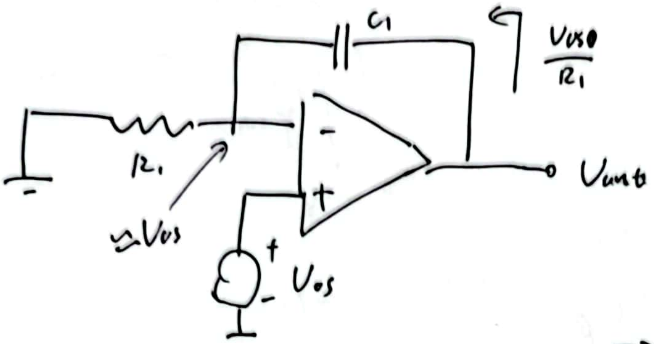
$$V_{out} = (V_{in} + V_{os})\left(1 + \frac{R_2}{R_1}\right)$$

②



$$V_{out} = -\frac{R_2}{R_1}V_{in} + V_{os}\left(1 + \frac{R_2}{R_1}\right)$$

Effect of DC offsets on Integrators

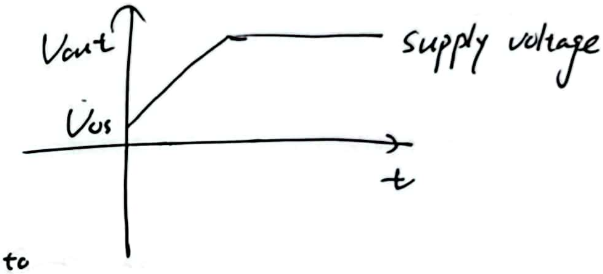


$I = C\frac{dV}{dt}$

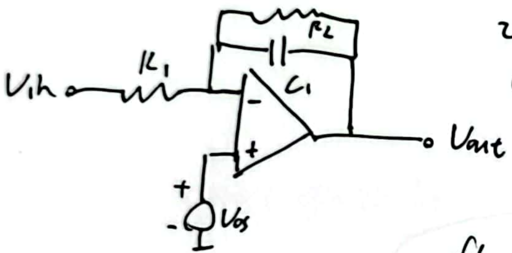
$V = \frac{1}{C}\int I\,dt$

$V_{out} - V_{os} = \frac{1}{C_1}\int \frac{V_{os}}{R_1}dt$

$\Rightarrow V_{out} = V_{os} + \frac{V_{os}}{C_1 R_1}t$



To fix the circuit:



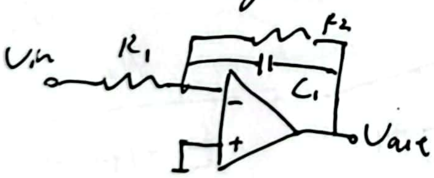
If $V_{in}=0$:

$V_{out} = (1+\frac{R_2}{R_1})V_{os}$

$\frac{V_{os}}{R_1}$ prefers to flow through rather than C_1 (at $t=\infty$)

Ideal Integrator Transfer Function: $-\frac{1}{R_1C_1s}$

New Integrator:

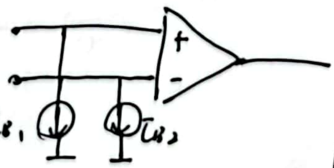


$\frac{V_{out}}{V_{in}} \approx -\frac{\frac{R_2}{R_2C_1s+1}}{R_1} = -\frac{R_2}{R_1(R_2C_1s+1)}$

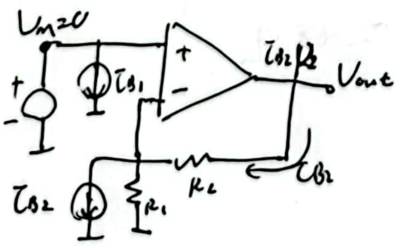
To be a good integrator, the circuit requires that $|R_2C_1s| \gg 1$

总的来说就是，加电阻给直流流过，但是又想让交流耦合，就要让直流交流区分明显一些，所以增益要高。

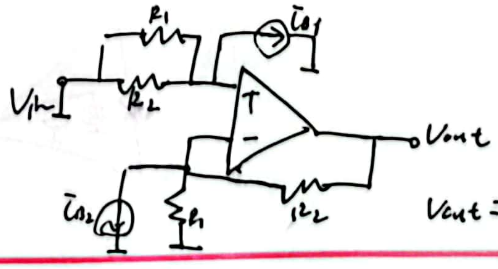
Input Bias Currents:



I_B表示运放+ -端吸收的电流

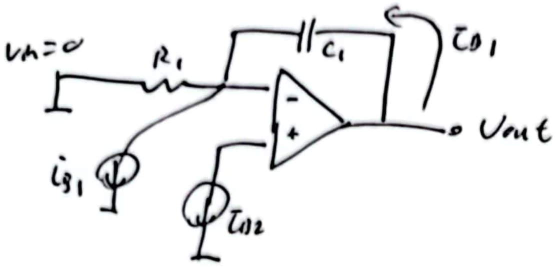


to fix

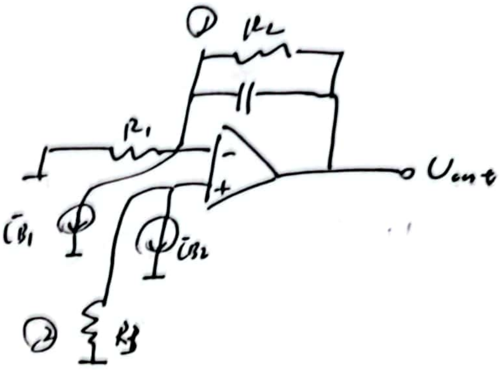


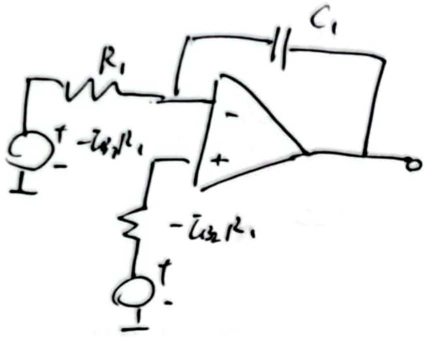
$V_{out} = -I_{B1}(R_1 \| R_2)(1+\frac{R_2}{R_1}) + I_{B2}R_2 = 0$

Input Bias Currents in Integrator



To fix ⟹



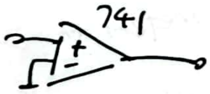


① Add R_2 for Bias currents.

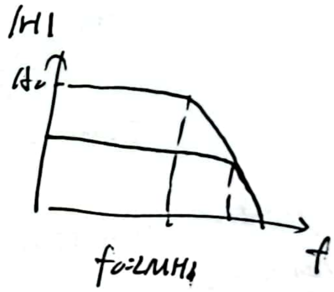
② Add R_3, + − have the same bias.

Speed Limitations.

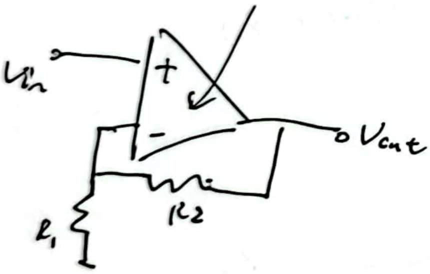
$$H(s)=\frac{A_0}{1+\frac{s}{\omega_0}} \quad \text{for}$$



$\omega_0=2\pi f$

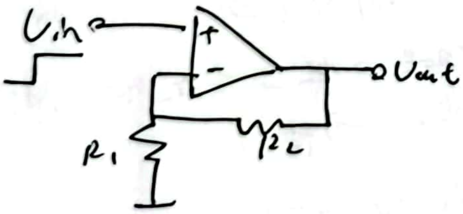


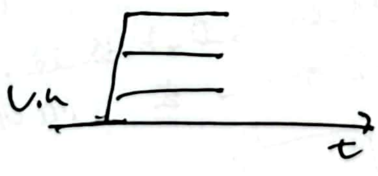
如果不接地，加反馈电路，带宽增加，增益降低

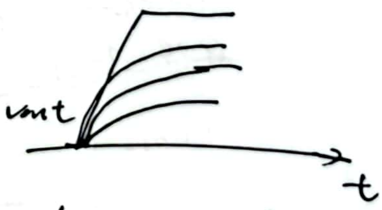


$$\frac{V_{out}}{V_{in}}(s)=\frac{\frac{A_0}{1+\frac{s}{\omega_0}}}{\frac{A_0}{1+\frac{s}{\omega_0}}\cdot\frac{R_1}{R_1+R_2}+1}=\frac{A_0}{\frac{s}{\omega_0}+1+A_0\frac{R_1}{R_1+R_2}}$$

Slew Rate







存在最大增速.

actual