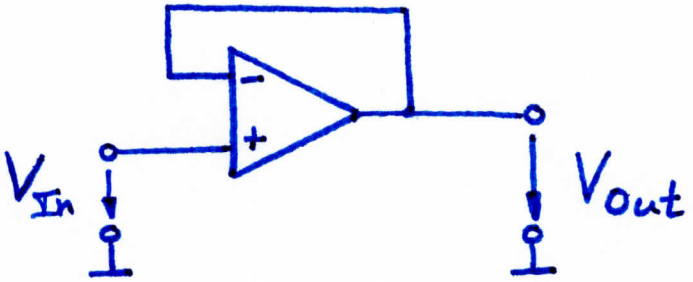
Slew rate of Op Amp

The response of an Op Amp is not instantaneous. Consider the circuit:

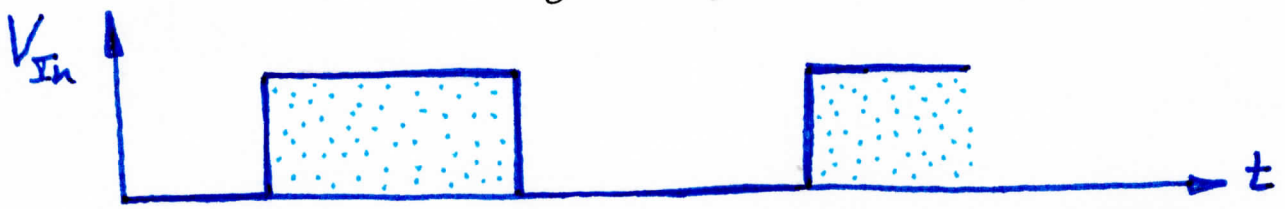


Analysis: $V_+ = V_- \Rightarrow V_{out} = V_{In}$

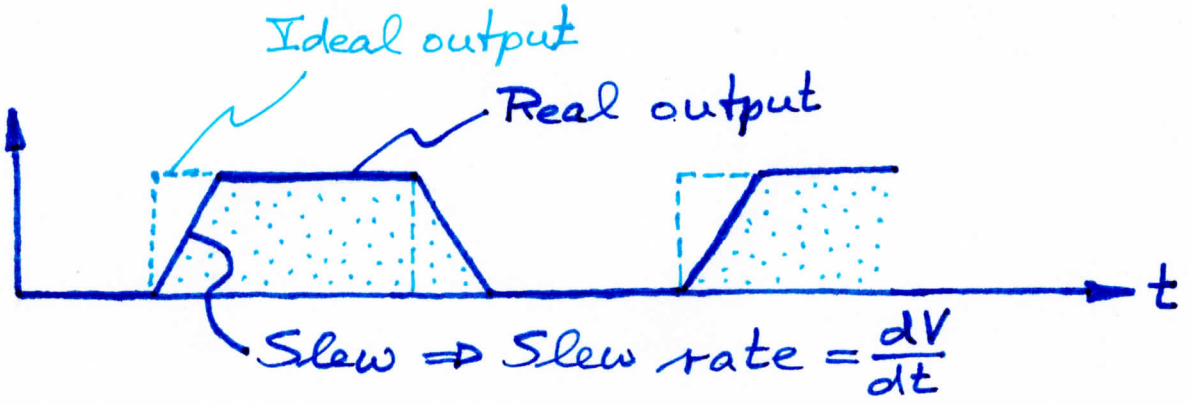
$\Rightarrow$ Voltage follower

Q: What is a voltage follower useful for? $\Rightarrow$ Impedance transformation

Consider the following **input**:



Output:



Slew rate $= \frac{dV_{out}}{dt} \Rightarrow$ Fastest $\frac{dV_{out}}{dt}$ the Op Amp is capable of. Example:

Slew rate = 1 V/μs

Q: **Ideal** slew rate ? $\Rightarrow SR = \infty$ (SR → Slew Rate)

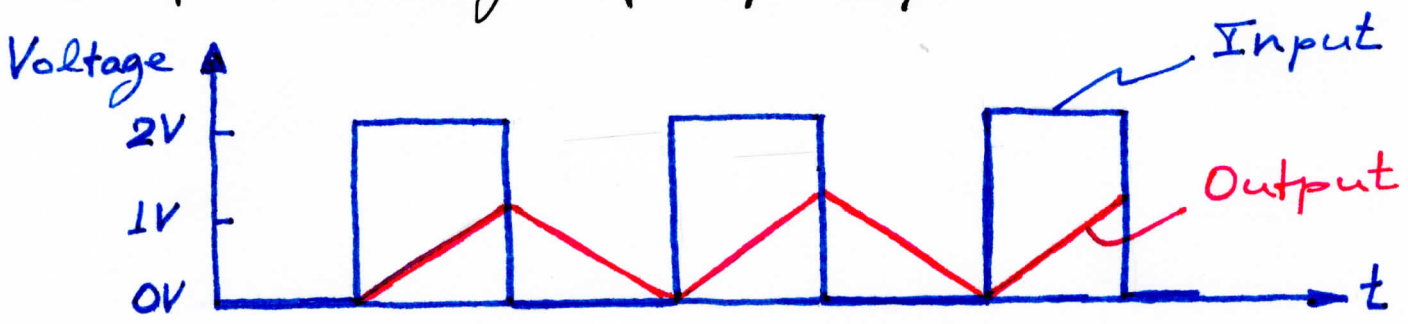
Q: What is cause of finite slew rate ?

$\Rightarrow$ Parasitic capacitances inside Op Amp.

Recall $Q = CV \Rightarrow \underbrace{I}_{\text{Charging current}} = \frac{dQ}{dt} = C\underbrace{\frac{dV}{dt}}_{SR}$

Example

Consider Op Amp voltage follower with SR = 1 V/μs being subjected to a square wave input with $V_o = 2V$ and $T = 2\,\mu s$. Construct output voltage of Op Amp

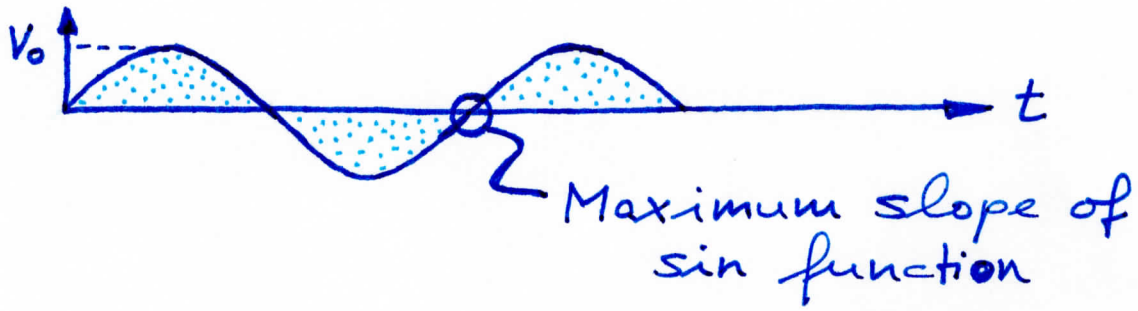


$\Rightarrow$ Distortion $\Rightarrow$ SR must be sufficiently high to not distort the signal

Example

Consider sinusoidal input of Op Amp

$$V_{In} = V_o \sin \omega t$$



Q: What is maximum slope?

$$\frac{dV_{In}}{dt} = V_o \cos(\omega t)\ \omega$$

$$\left.\frac{dV_{In}}{dt}\right|_{t=0} = \omega V_o = 2\pi f V_o$$

To faithfully reproduce the sin function

$$\boxed{SR \geq 2\pi f V_o}$$

↳ Slew rate

Q: What happens if SR is too slow?

⇒ Distortion

⇒