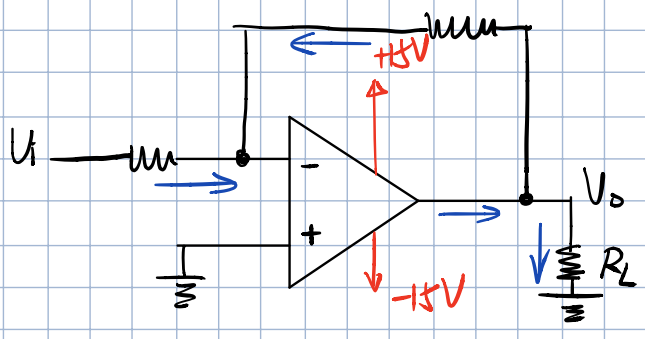
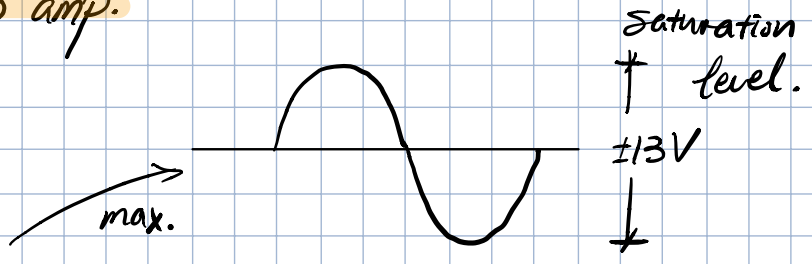
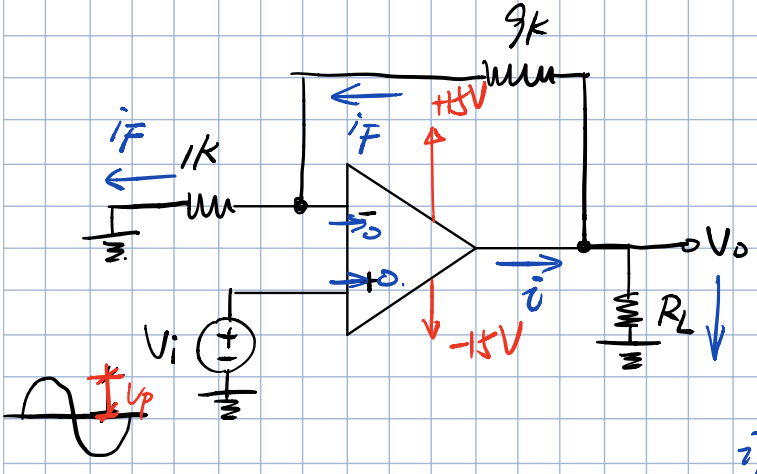
# Large signal operation of op amp.




741 op amp has a current limit ±20mA




a) for $V_p = 1V$ and $R_L = 1k\Omega$

$$V_{opk} = V_p\left(1+\frac{R_2}{R_1}\right) = 10V < 13V$$

ok. no saturation for voltage.

$$i_L = \frac{10V}{1k\Omega} = 10mA$$

$$i_F = \frac{10V}{1k+9k} = 1mA$$

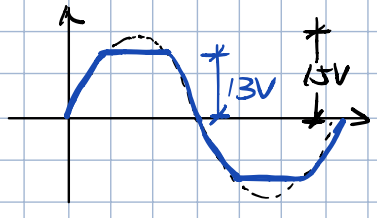
$$i = 10mA + 1mA = 11mA < 20mA$$

no issue.

b) for $V_p = 1.5V$, $R_L = 1k\Omega$

$$V_{opk} = 1.5\left(1+\frac{R_2}{R_1}\right) = 15V$$

(clipping at output voltage)




check the current:

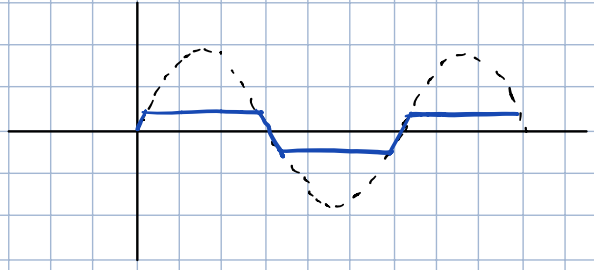
$$i = i_L + i_F = \frac{13V}{1k} + \frac{13V}{1+9} = 14.3mA \quad (< 20mA)$$

c) for $V_p = 1V$ and $R_L = 100\Omega$

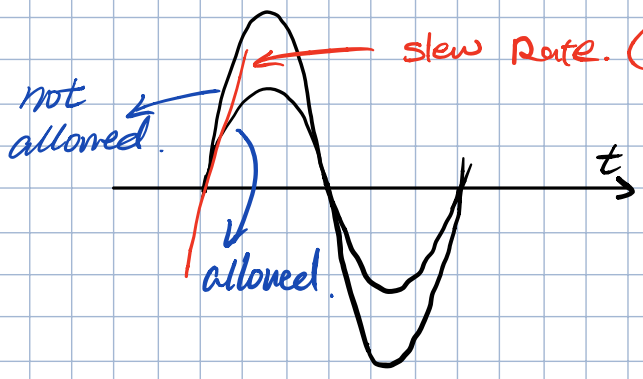
$V_{opk} = 10V$, $i_L = \frac{10V}{100\Omega} = 100mA$ (op-amp can only give 20mA)

with ← $V_{opk} = 10V$

reality ← $V_{opk} \doteq (20mA)(100\Omega) = 2V$



## Slew Rate. (SR)



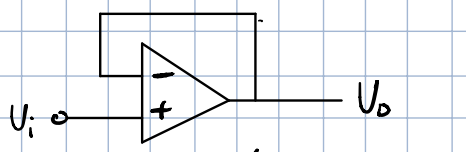

$$SR = \left.\frac{dV_o}{dt}\right|_{max}$$

typical value.

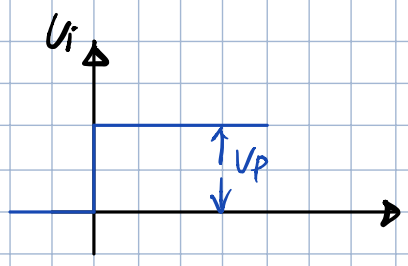
$SR = 1V/\mu s.$

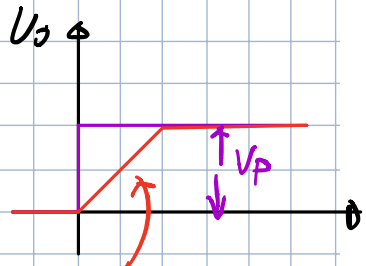
## SR offset

1) Unity gain circuit



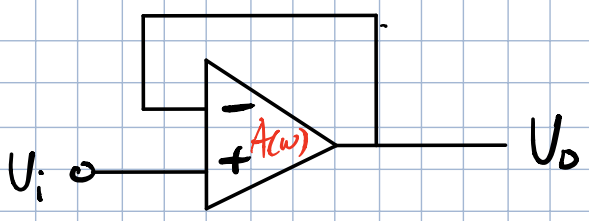

ideal op-amp.




you get this b/c of SR.

2) Unity gain cct (real op-amp)

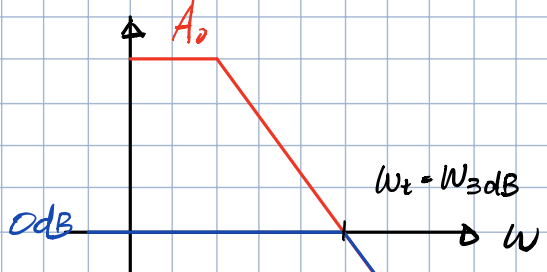



$$\frac{V_o}{V_i} = \frac{1}{1 + jw/w_{3dB}}$$

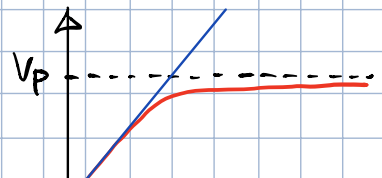
$$w_{3dB} = \frac{w_t}{1 + \frac{R_2}{R_1}}$$

$$= \frac{w_t}{1 + \frac{0}{\infty}}$$

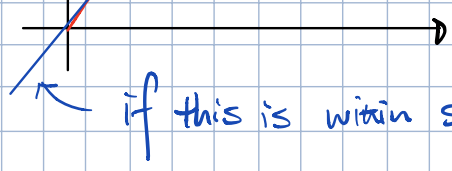
$$= w_t$$




STC network, RC cct.




$$V_o = V_p(1 - e^{-w_t t})$$

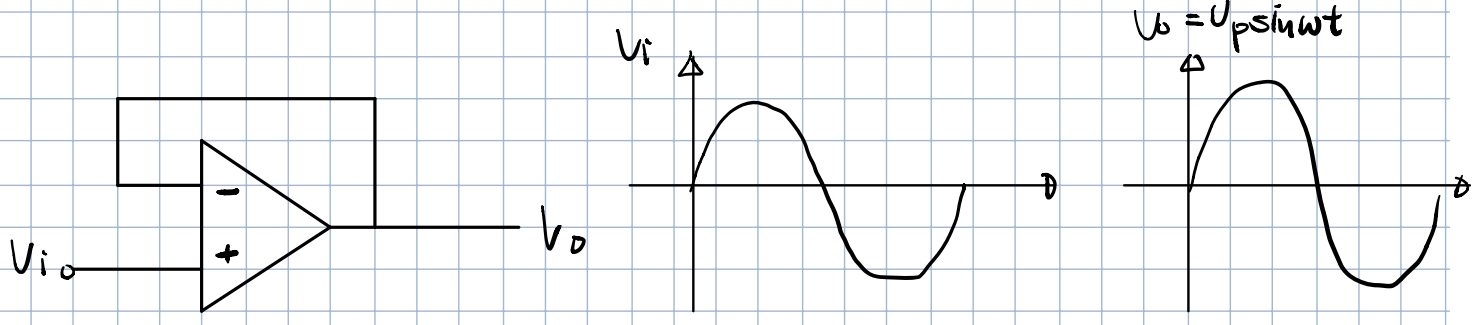


if this is within SR limit there will be no distortion.

$$SR = \left.\frac{dV_o}{dt}\right|_{max.} \quad , \quad \left.\frac{d}{d}\left[V_p(1-e^{-\omega_t t})\right]\right|_{max} = \left.V_p \omega_t e^{-\omega_t t}\right|_{t=0}$$

$$= V_p \omega_t \;//\; (SR)$$

3) unity gain cct (ideal op-amp)




$$SR = \left.\frac{dV_o}{dt}\right|_{max} = \frac{d}{dt}\left[V_p \sin \omega t\right]\Big|_{max} = \left. V_p \omega \cos \omega t \right|_{max} = V_p \omega$$

$SR = V_p \omega$ ← trade off btw $V_p$ and $\omega$.

$$V_p = \frac{SR}{2\pi f} \quad \text{or} \quad f = \frac{SR}{2\pi V_p}$$

full-power bandwidth. - it's the freq. at which an output sinusoid w/ amplitude equal to the rated output voltage of the Op-amp begin to show distortion due to the SR limiting.

$$f_M = \frac{SR}{2\pi V_{omax.}}$$