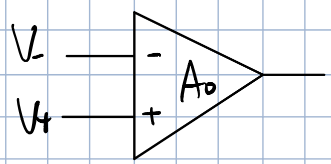
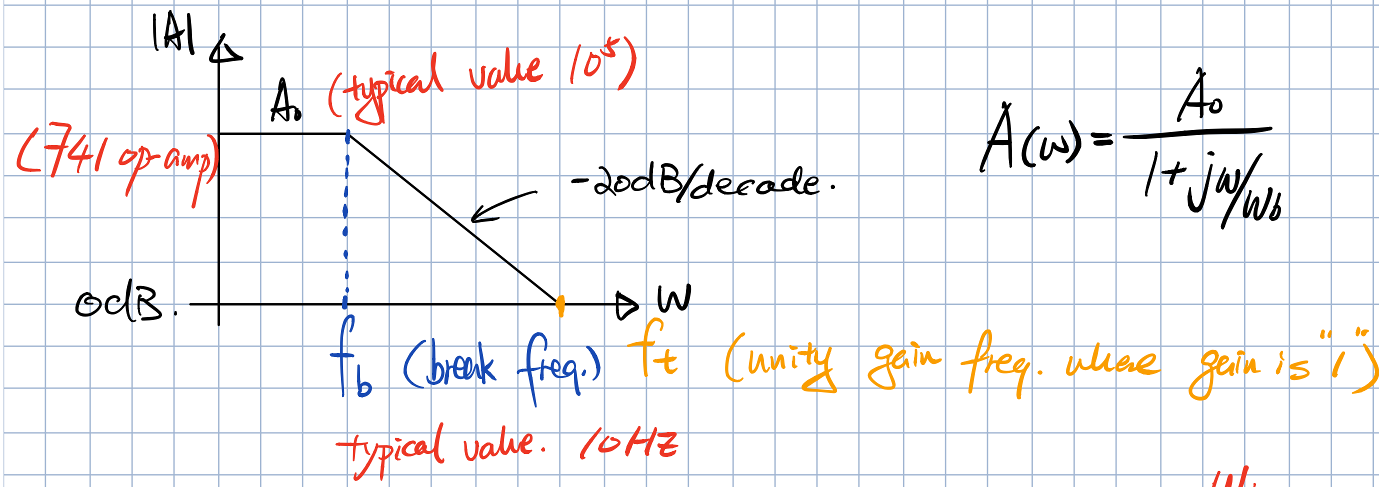
Open-Loop Gain, BW.

ideal op-amp.



$V_o = A_o(V_+ - V_-)$



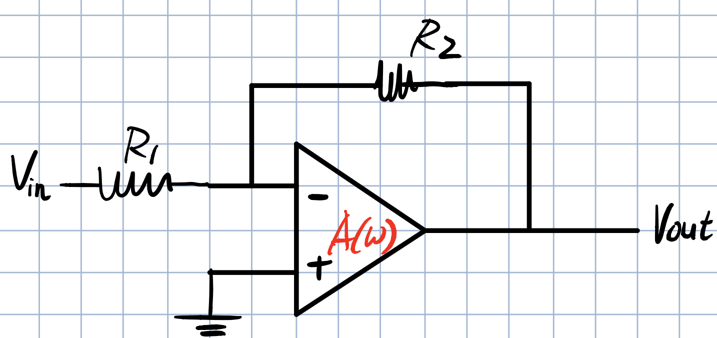
$$A(\omega) = \frac{A_o}{1 + j\omega/\omega_b} \qquad \omega_b = 2\pi f_b$$

$$\text{for } f \gg f_b, \quad A(\omega) \simeq \frac{A_o}{j\omega/\omega_b} = \frac{\overset{\omega_t}{\overbrace{A_o\omega_b}}}{j\omega} \;(1 \text{ is neglectable})$$

$$= \frac{\omega_t}{j\omega}$$

Frequency response of closed loop amplifier. $\left(A(\omega) = \frac{\omega_t}{j\omega}\right)$

1) Inverting configuration.



$$\frac{V_o}{V_i} = \frac{-R_2/R_1}{1 + \left(\frac{R_2}{R_1}+1\right)/A(\omega)}$$

$$= \frac{-R_2/R_1}{1 + \left(1+\frac{R_2}{R_1}\right)/\frac{\omega_t}{j\omega}}$$

$$\omega_{3dB} = \frac{\omega_t}{1+R_2/R_1}$$

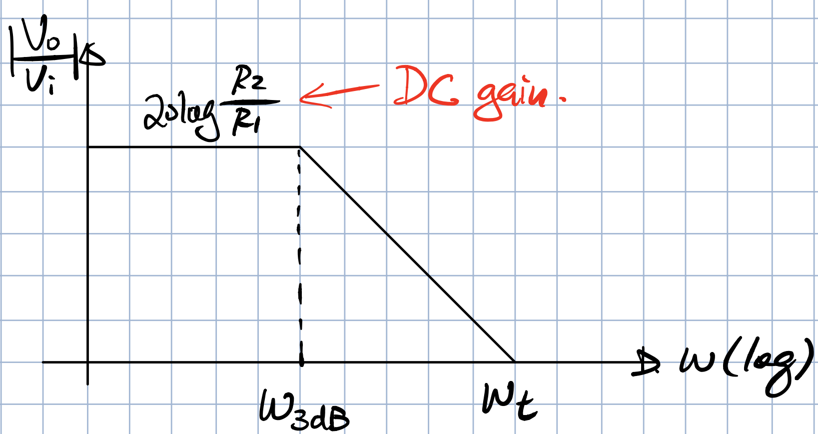
ω_t: unity gain frequency. (from datasheet)

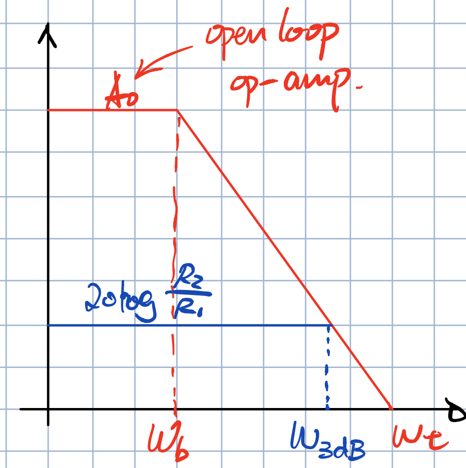
R_2/R_1: external resistor.

$$= \frac{-R_2/R_1}{1+j\dfrac{\omega}{\underbrace{\omega_t/(1+R_2/R_1)}_{\omega_{3dB}}}}$$

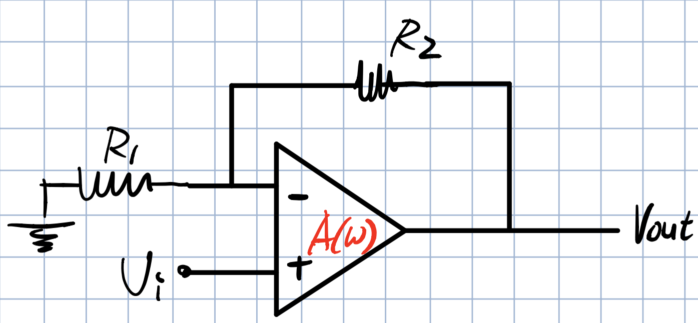
$$= \frac{-R_2/R_1}{1+j\omega/\omega_{3dB}} \quad //$$

3dB freq. can be controlled by changing R_2 & R_1 value.





2) non-inverting configuration.



$$\frac{V_o}{V_i} = \frac{1+R_2/R_1}{1+(1+R_2/R_1)/A(\omega)}$$

$$= \frac{1+R_2/R_1}{1+j\,\omega/\omega_{3dB}}$$

$$\omega_{3dB} = \frac{\omega_t}{1+\frac{R_2}{R_1}}$$

Gain Bandwidth product :

(closed loop gain) · BW = ω_t

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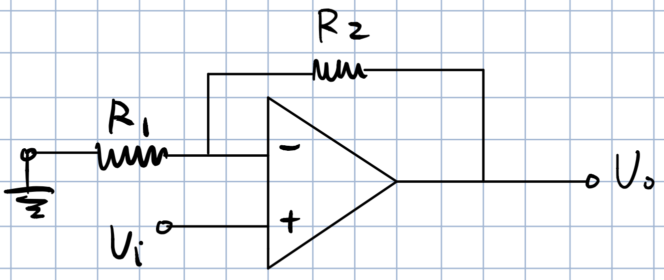
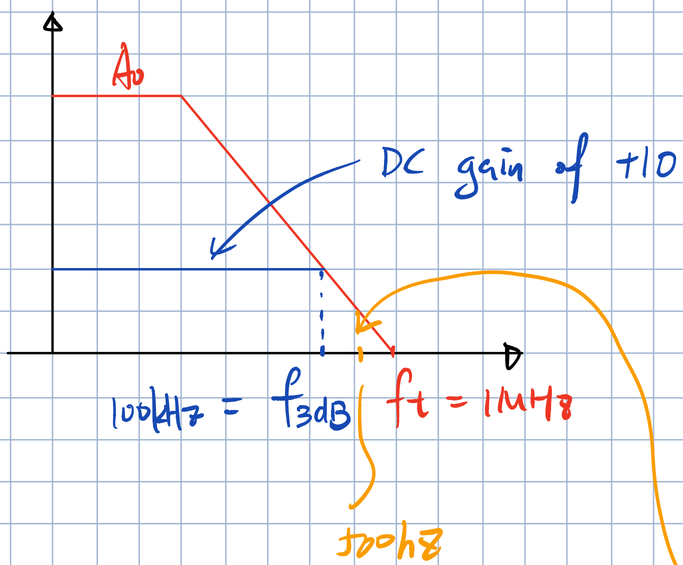
example. op-amp has $f_t = 1\text{MHz}$, find f_{3dB} of the closed loop amp for a gain of +10



$$\frac{V_o}{V_i} = 1 + \frac{R_2}{R_1} = 10 \Rightarrow \frac{R_2}{R_1} = 9$$

$$f_{3dB} = \frac{f_t}{1 + R_2/R_1} = \frac{1MHz}{10} = 100\,kHz$$



If an input signal of 10mV at 500kHz is used. what will V_o be?

$$\frac{V_o}{V_i} = \frac{10}{1 + f/f_{3dB}} = \frac{10}{1 + j500/100}$$

$$= \frac{10}{1 + j5}$$

$$\left|\frac{V_o}{V_i}\right| = \frac{10}{\sqrt{1+5^2}} = 1.96$$

$$V_o = 10mV \times 1.96 = 19.6mV.$$