Example: The Gain -Bandwidth Product

An op-amp has a **D.C.** differential gain of $A_0 = 10^5$.

At a frequency of **1MHz** (f=10^6), the differential op-amp gain **drops to 10** (i.e., $\left|A_{op}(f\!=\!10^6)\right| = 10$).

Q: *What is the **break** frequency and **unity-gain** frequency of this op-amp?*

A: We know that if $f > f_b$:

$$\left|A_{op}(f)\right| = \frac{A_0 f_b}{f}$$

and thus at a frequency of **1MHz**, we find for the parameters of this problem:

$$\left|A_{op}(f = 10^6)\right| = 10 = \frac{10^5 f_b}{10^6}$$

It's 10 MHz

It is apparent then that the **break frequency** of this op-amp must be:

$$f_b = \frac{(10)(10^6)}{10^5} = 100 \text{ Hz}$$

and since the **unity-gain bandwidth** f_t is related to the break frequency and D.C. gain as:

$$f_t = A_0 \, f_b$$

we find that:

$$\begin{aligned} f_t &= A_0 \, f_b \\ &= 10^5 (100) \\ &= 10^7 \end{aligned}$$

Thus, the **unity-gain frequency** (i.e., the **gain-bandwidth product**) for this problem is **10 MHz.**

The gain depends on frequency

Q: *What is the differential gain of this op-amp at a frequency of 10 kHz (i.e., $\left|A_{op}(f=10^4)\right|$)?*

A: We know that:

$$\left|A_{op}(f)\right| = \frac{A_0 f_b}{f} = \frac{f_t}{f}$$

therefore, using the values of this example:

$$\begin{aligned}\left|A_{op}(f=10^4)\right| &= \frac{f_t}{f} \\ &= \frac{10^7}{10^4} \\ &= 10^3\end{aligned}$$

Hence, the differential **op-amp gain at 10 kHz** is **1000**.