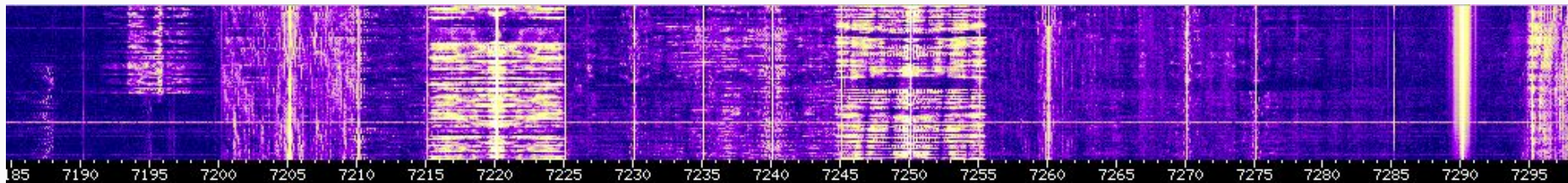
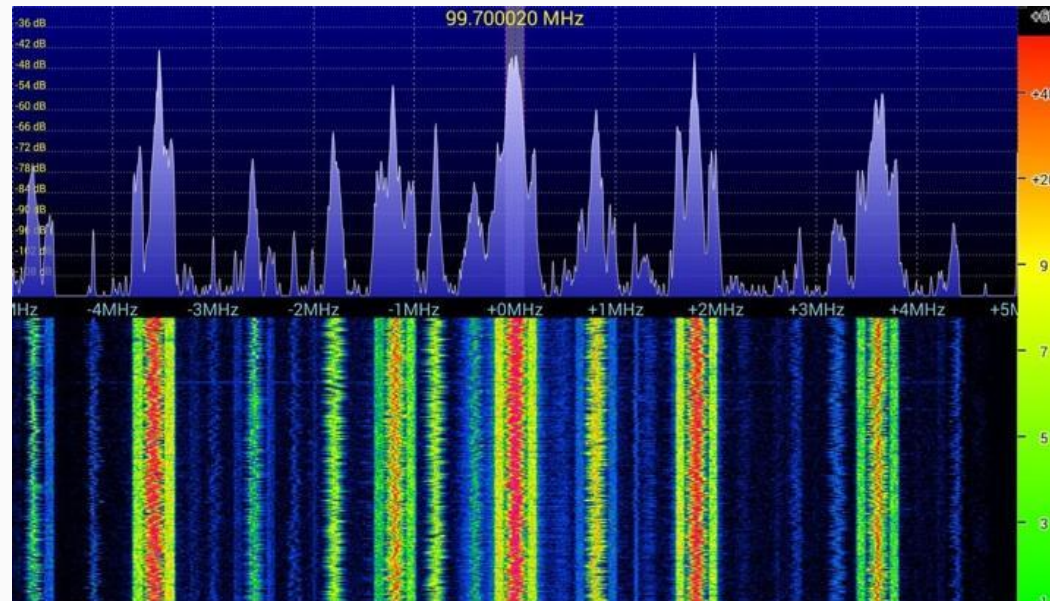


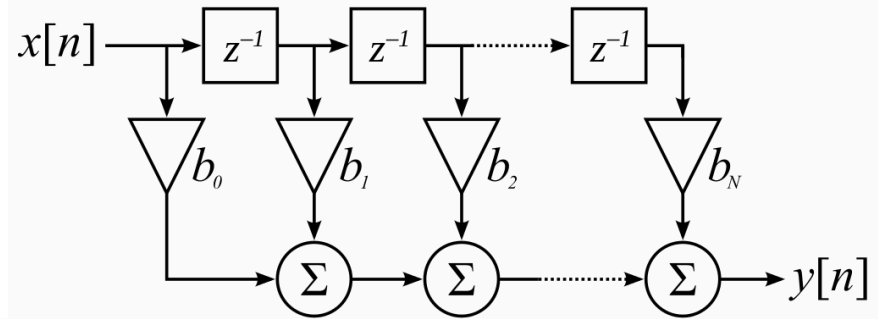
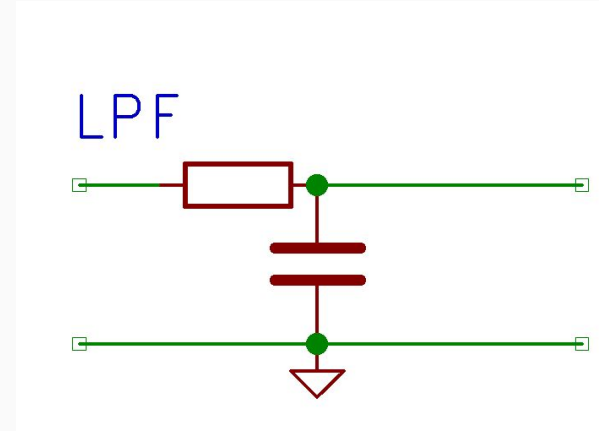
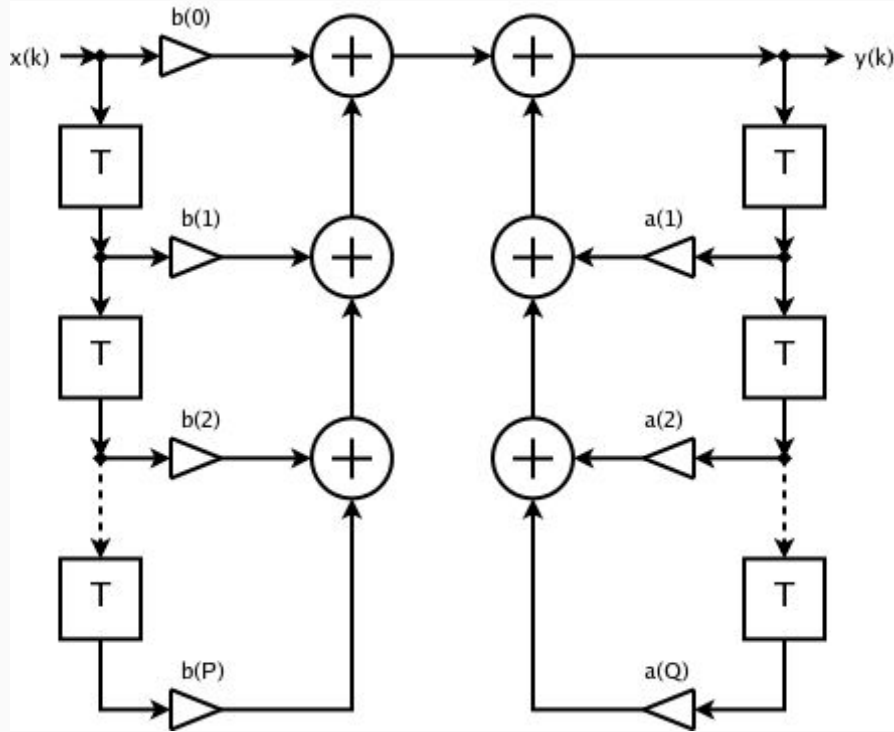
Szűrők

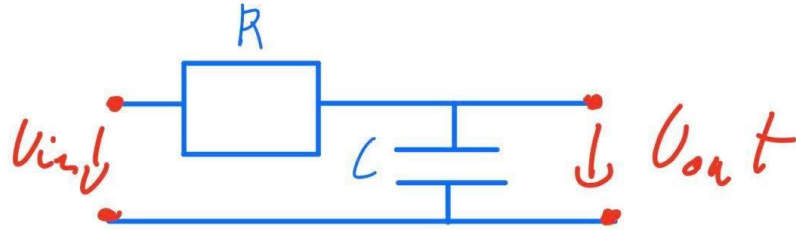


Alphelyzet



Analóg, FIR, IIR, FFT konvolúció





$$H(\omega) = \frac{V_{out}}{V_{in}}$$

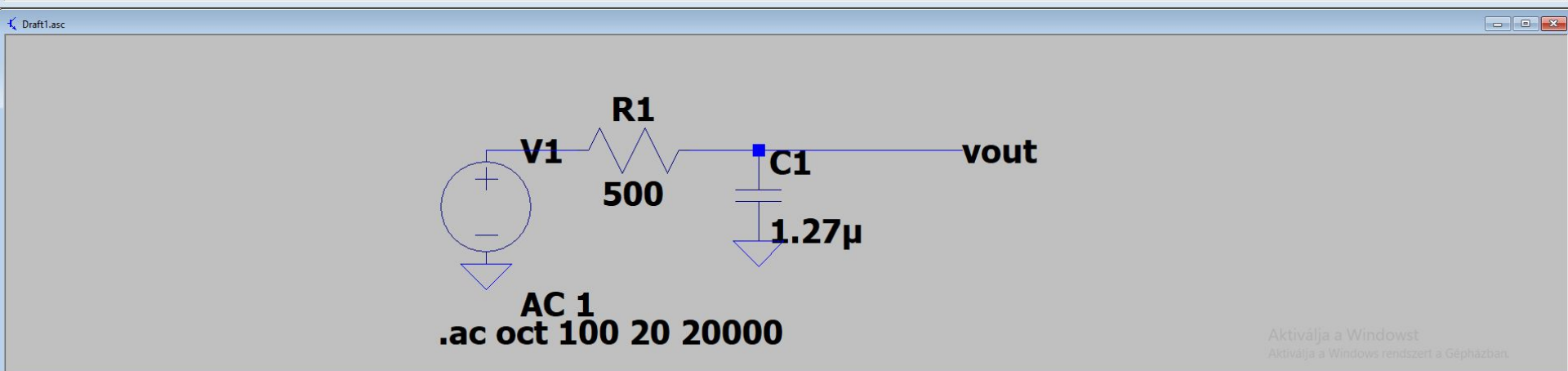
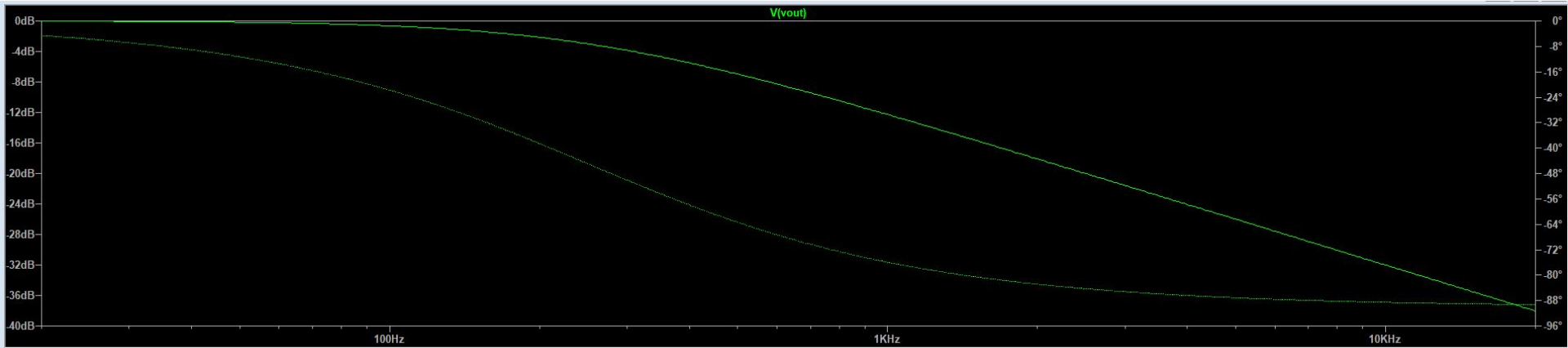
$$H(j\omega) = \frac{1}{RCs + 1}$$

$$(s = j\omega)$$

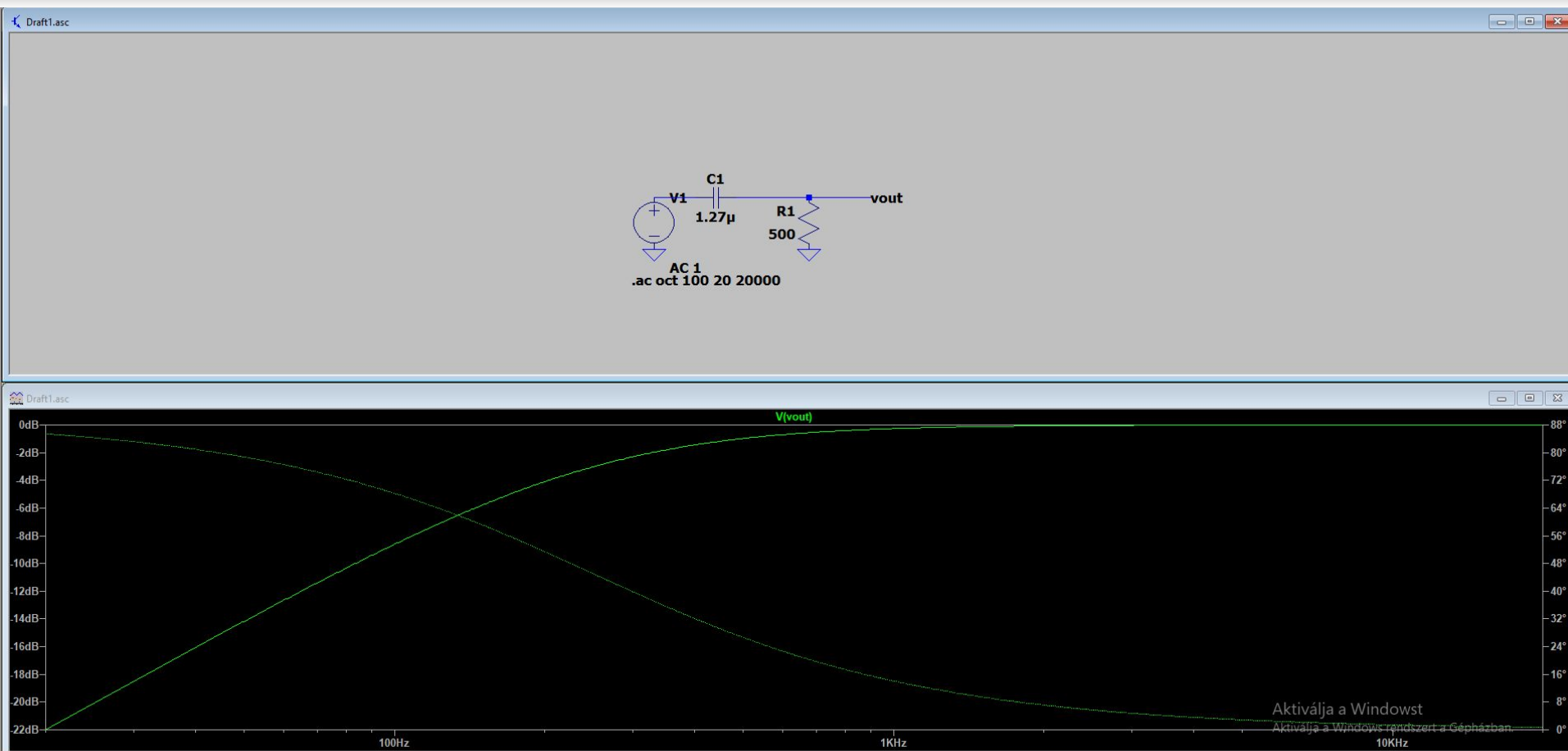
$$V_{out} = V_{in} \cdot \frac{\frac{1}{j\omega C}}{R + \frac{1}{j\omega C}} =$$

$$= V_{in} \frac{\frac{1}{j\omega C}}{R + \frac{1}{j\omega C}} = \frac{1}{RCs + 1}$$

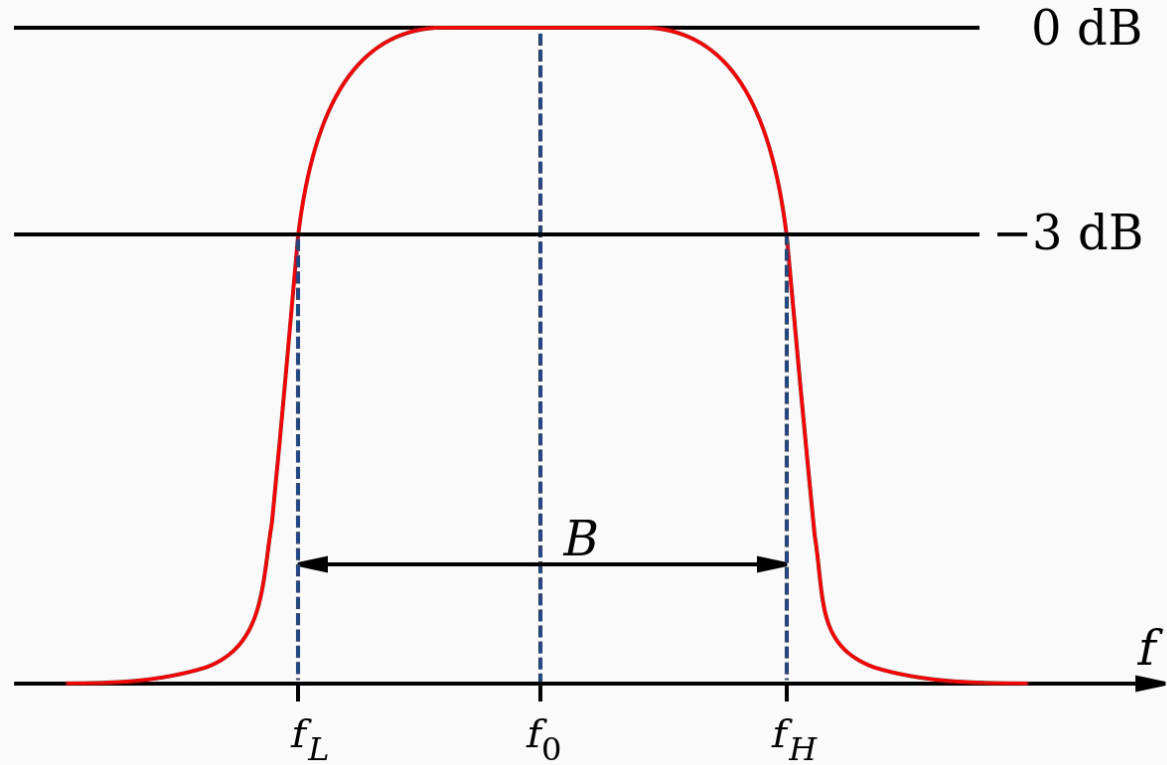
Analóg Szűrők



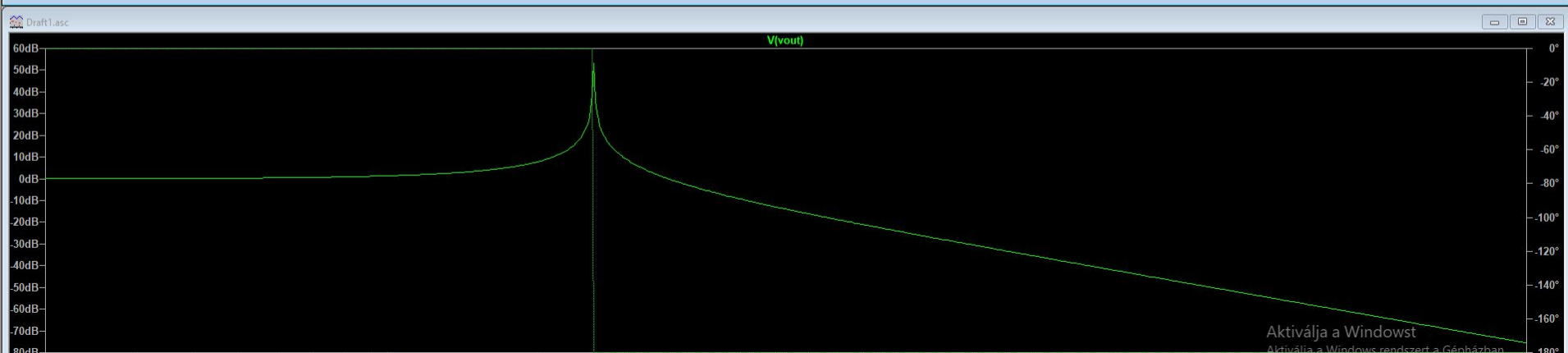
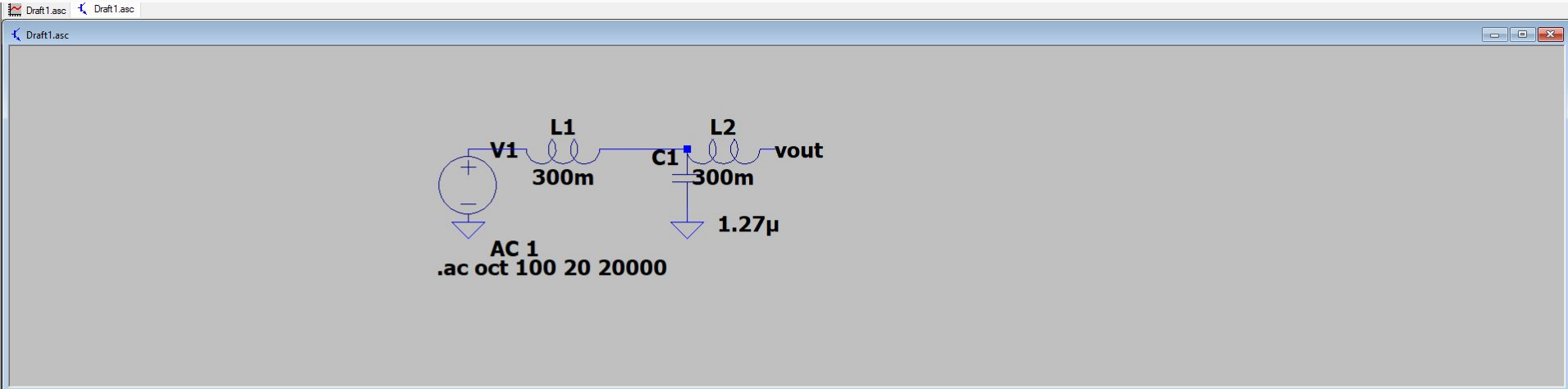
HPF



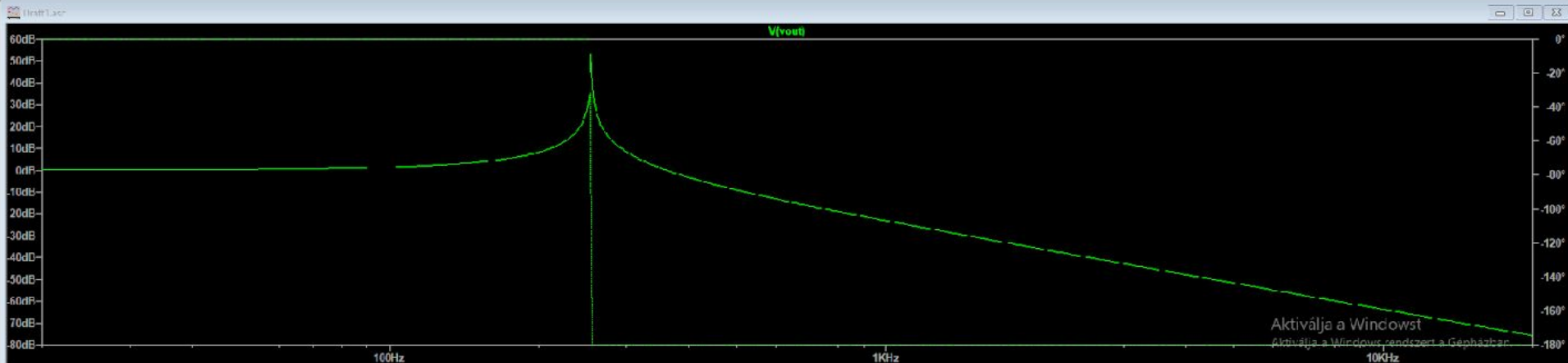
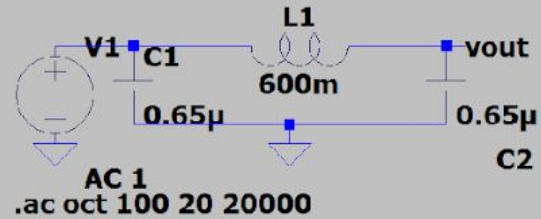
Bandpass



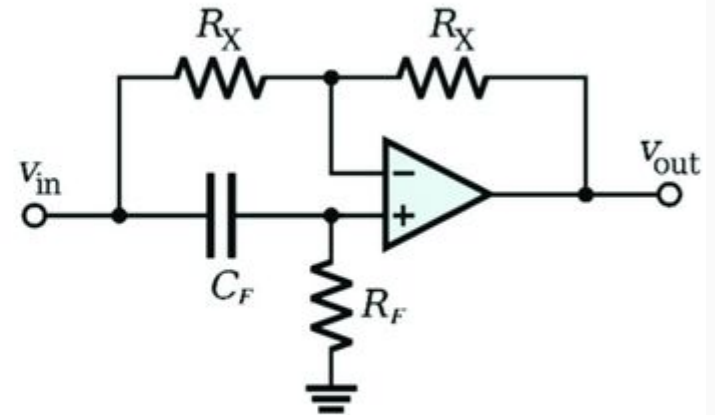
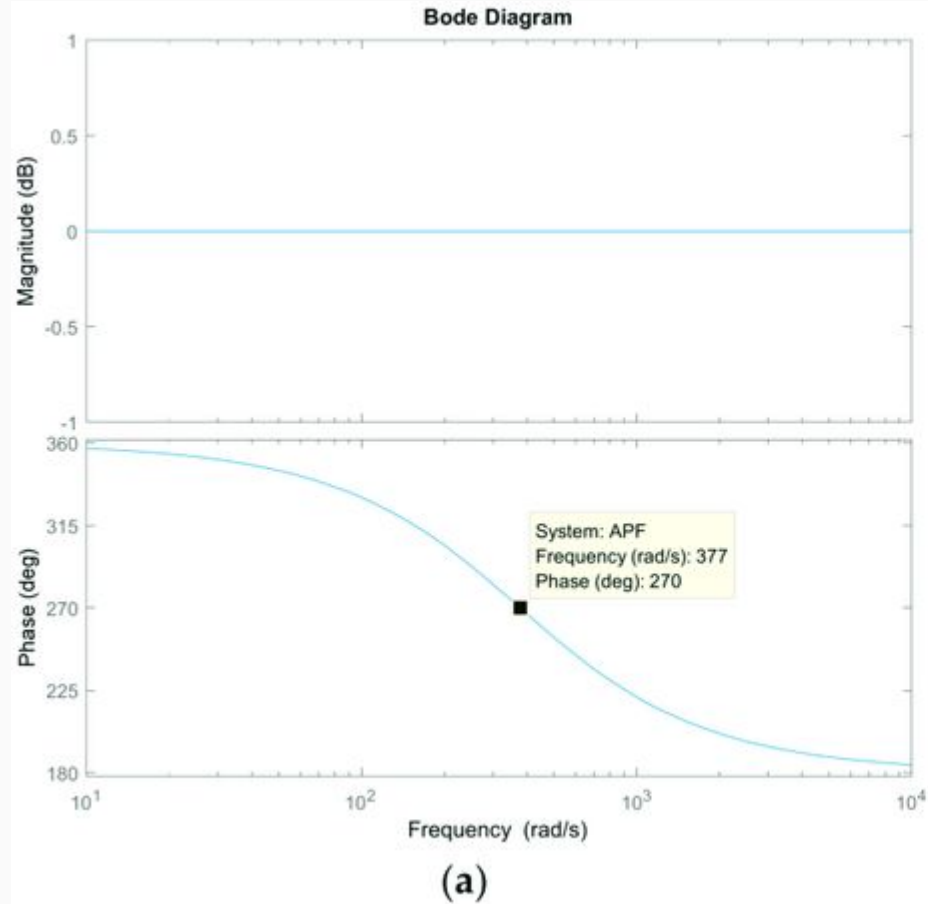
Constant K filter T



Constant K Pi

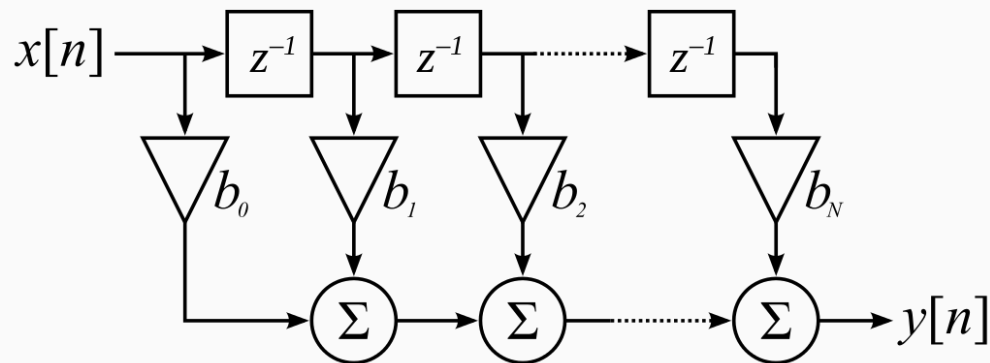


Allpassfilter



$$y[n] = b_0 x[n] + b_1 x[n-1] + \cdots + b_N x[n-N]$$

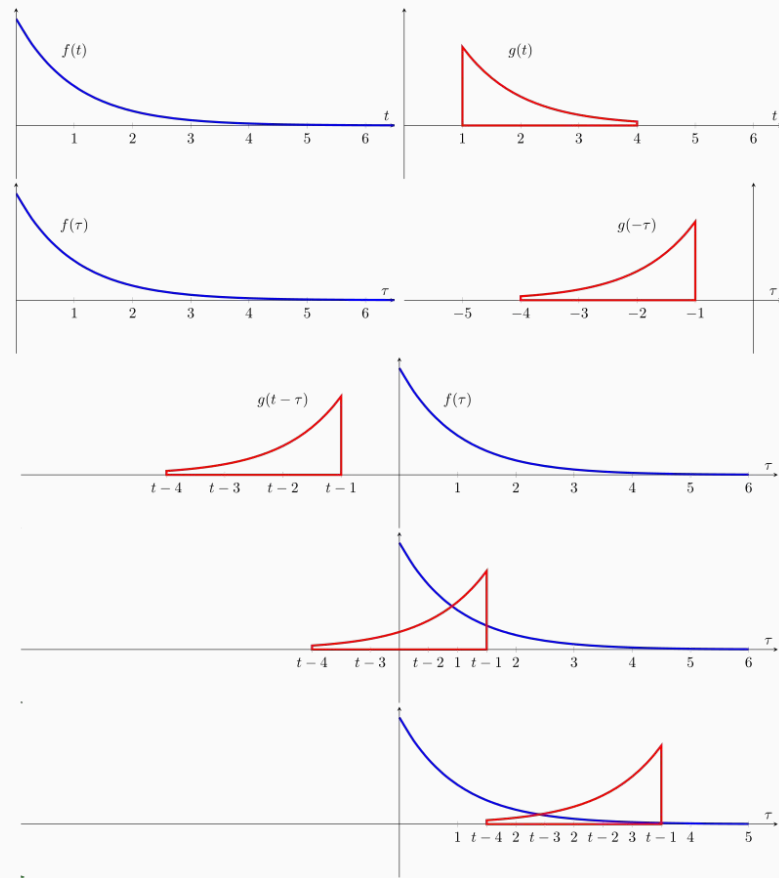
$$= \sum_{i=0}^N b_i \cdot x[n-i],$$



$$H(z) = \frac{P(z)}{Q(z)} = \frac{\sum_{m=0}^M b_m z^{-m}}{1 + \sum_{n=1}^N a_n z^{-n}} = \frac{b_0 + b_1 z^{-1} + b_2 z^{-2} \cdots + b_M z^{-M}}{1 + a_1 z^{-1} + a_2 z^{-2} \cdots + a_N z^{-N}}$$

Konvolúció

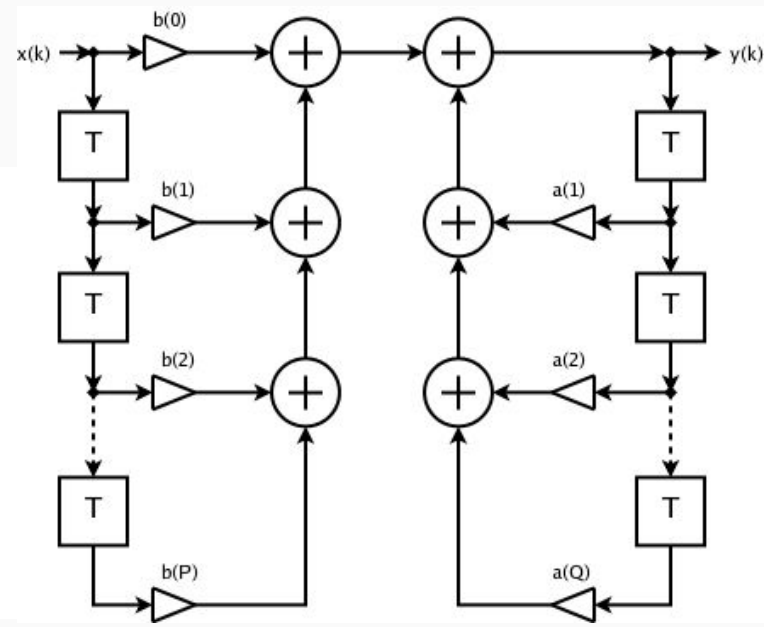
$$(f * g)(n) = \sum_{k \in D} f(k)g(n - k)$$



$$y[n] = \frac{1}{a_0} (b_0 x[n] + b_1 x[n-1] + \dots + b_P x[n-P] - a_1 y[n-1] - a_2 y[n-2] - \dots - a_Q y[n-Q])$$

$$H(z) = H\left(\frac{z}{T} \cdot \frac{z-1}{z+1}\right) = \frac{1}{1+RC} \left(\frac{z}{T} \cdot \frac{z-1}{z+1}\right) =$$

$$= \frac{1+z}{\frac{1-2RC}{T} + \frac{1+2RC}{T} \cdot z} = \frac{1+z^{-1}}{\frac{1+2RC}{T} + \frac{1-2RC}{T} z^{-1}}$$



FFT szűrés+ablakolás

$X(z)$: bemenet

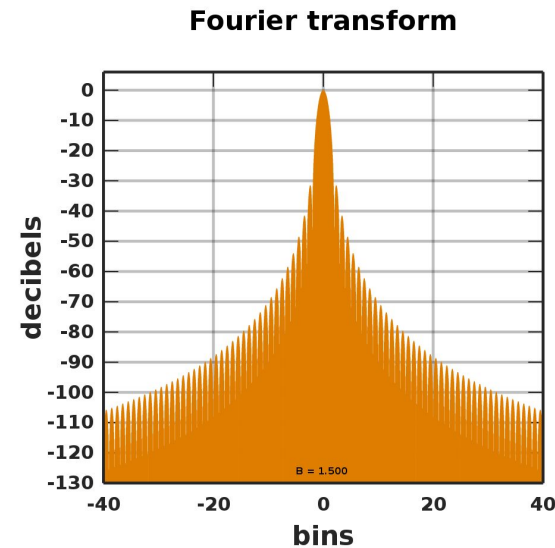
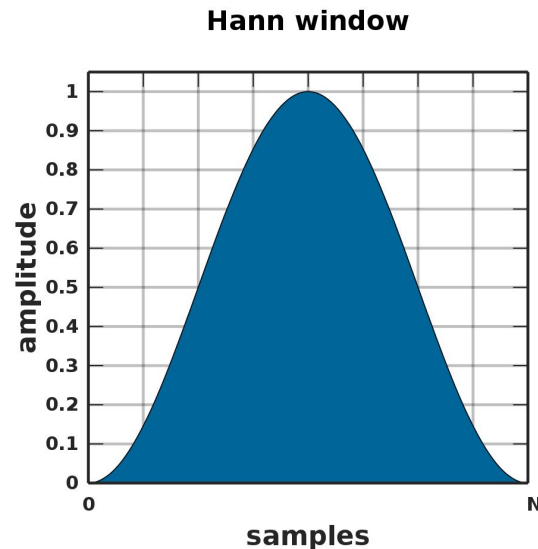
$Y(z)$: kimenet

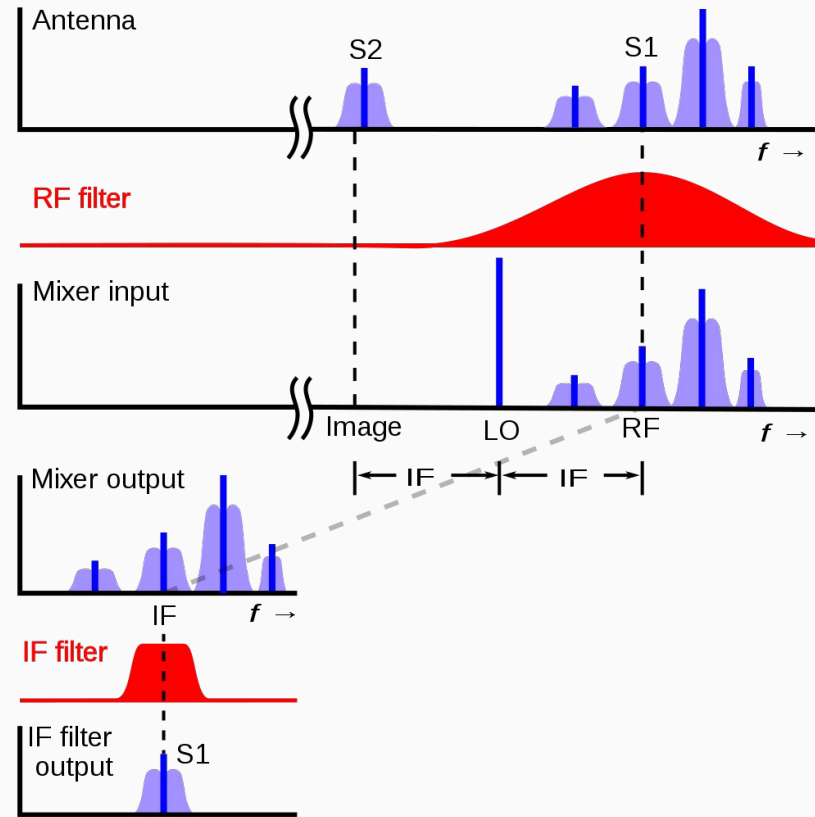
$G(z)$: szűrő

X és G végéhez 0-akat kell adni

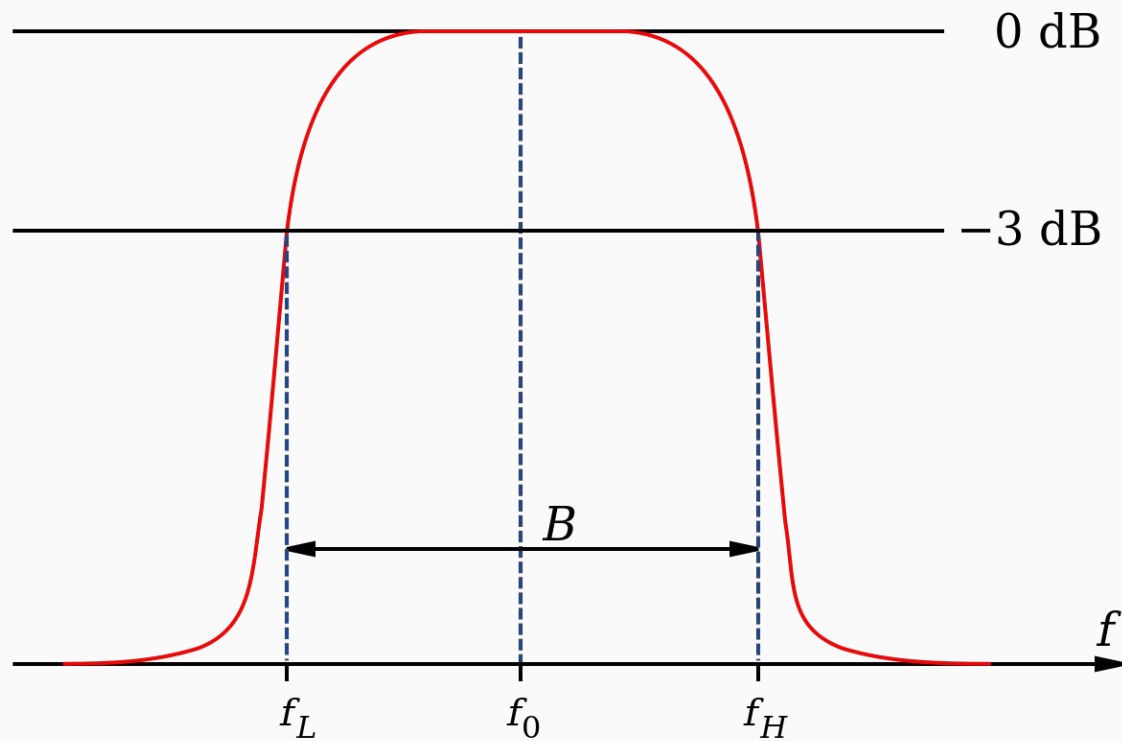
$Y(z) = \text{ifft}(\text{fft}(X) .* \text{fft}(G))$

$$w[n] = 0.5 \left[1 - \cos\left(\frac{2\pi n}{N}\right) \right] = \sin^2\left(\frac{\pi n}{N}\right),$$

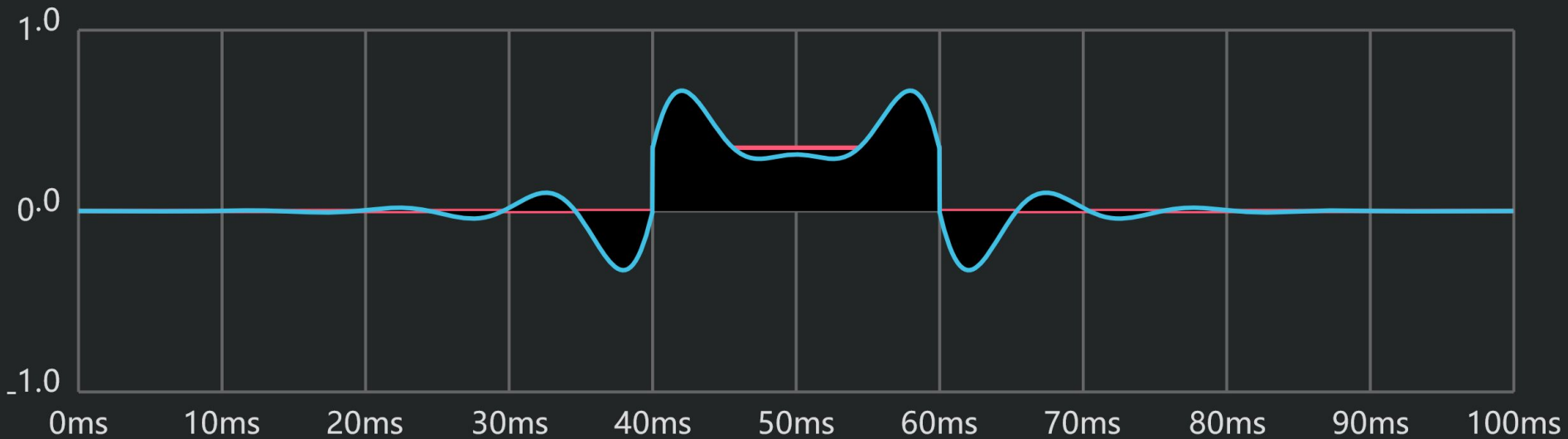




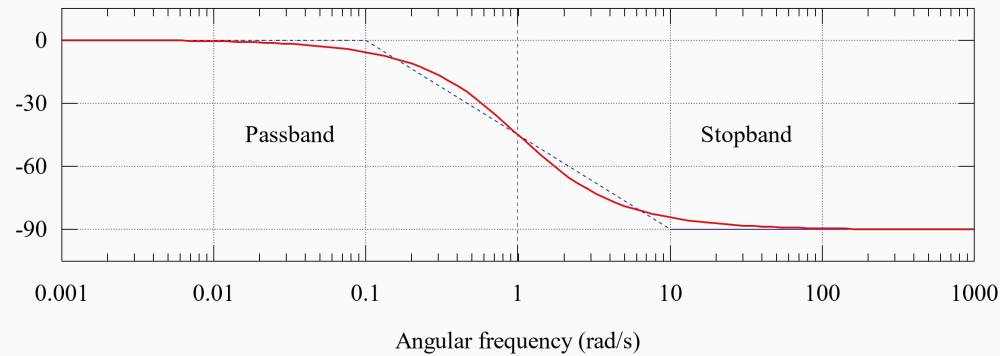
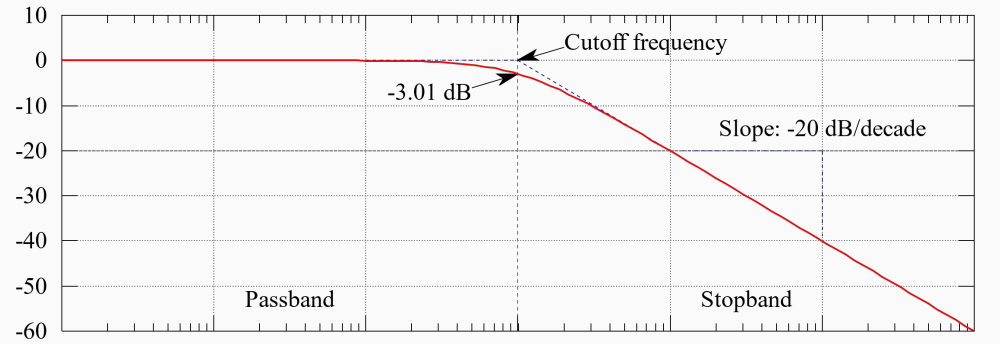
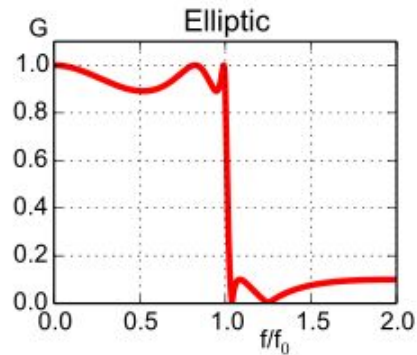
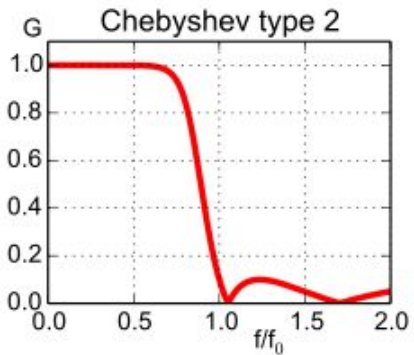
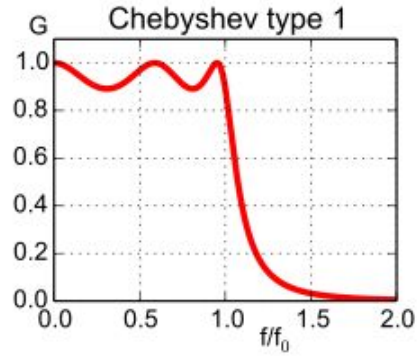
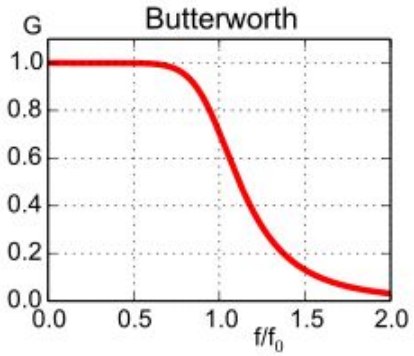
$$Q = \frac{2^{\frac{BW}{2}}}{2^{BW} - 1}$$



Linear Phase pre-ringing

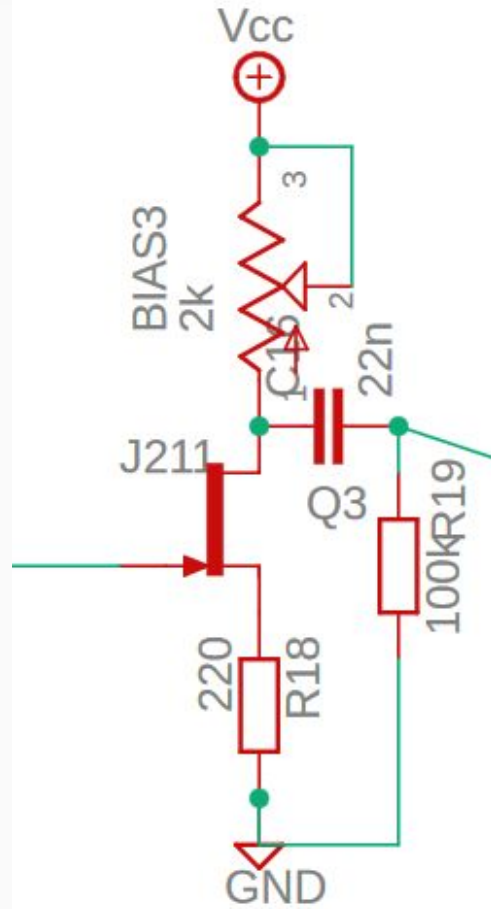


Butterworth és barátai

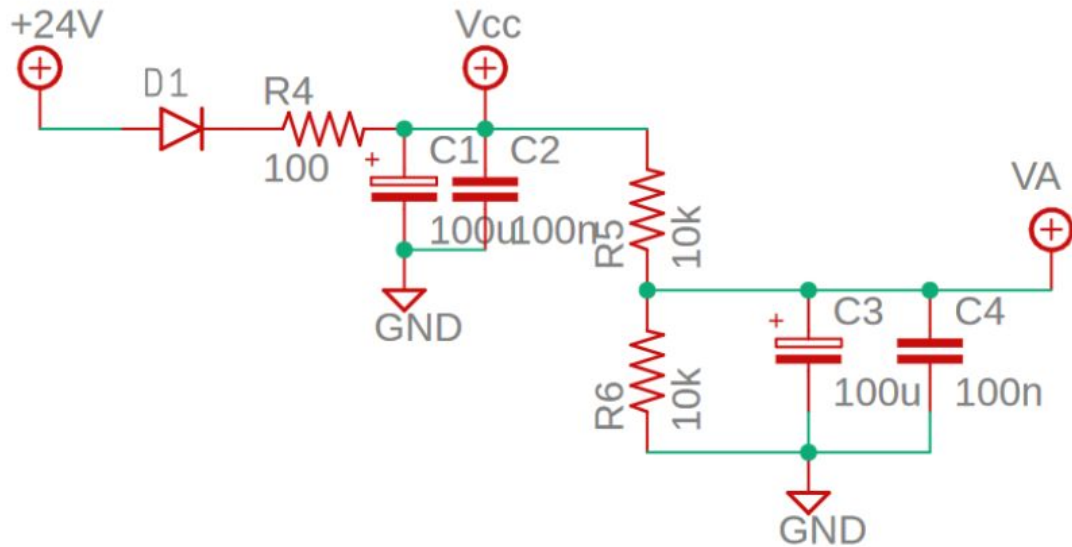


- Tápsimítás
- Sávkorlátozás
- Energiacsökkentés
- Interpolálás, decimálás

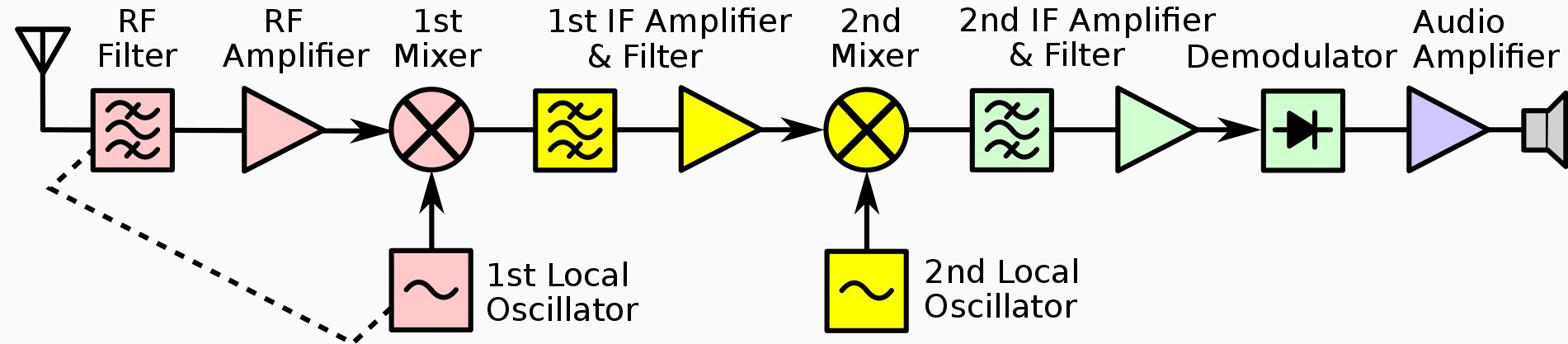
FET-es előerősítő



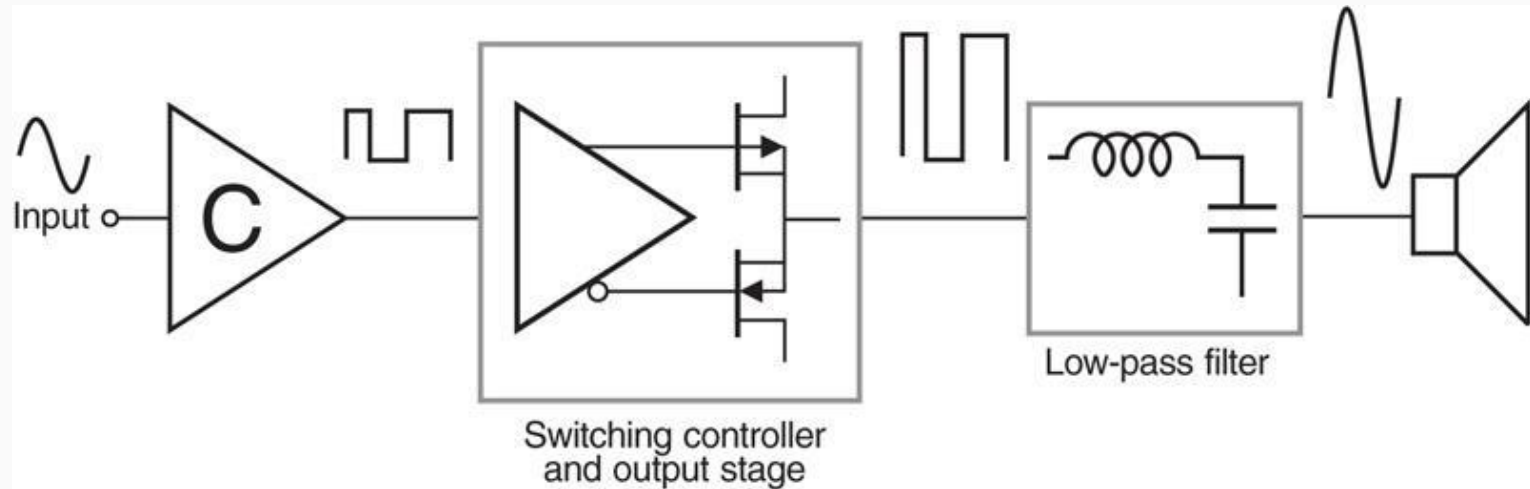
Tápszűrítés



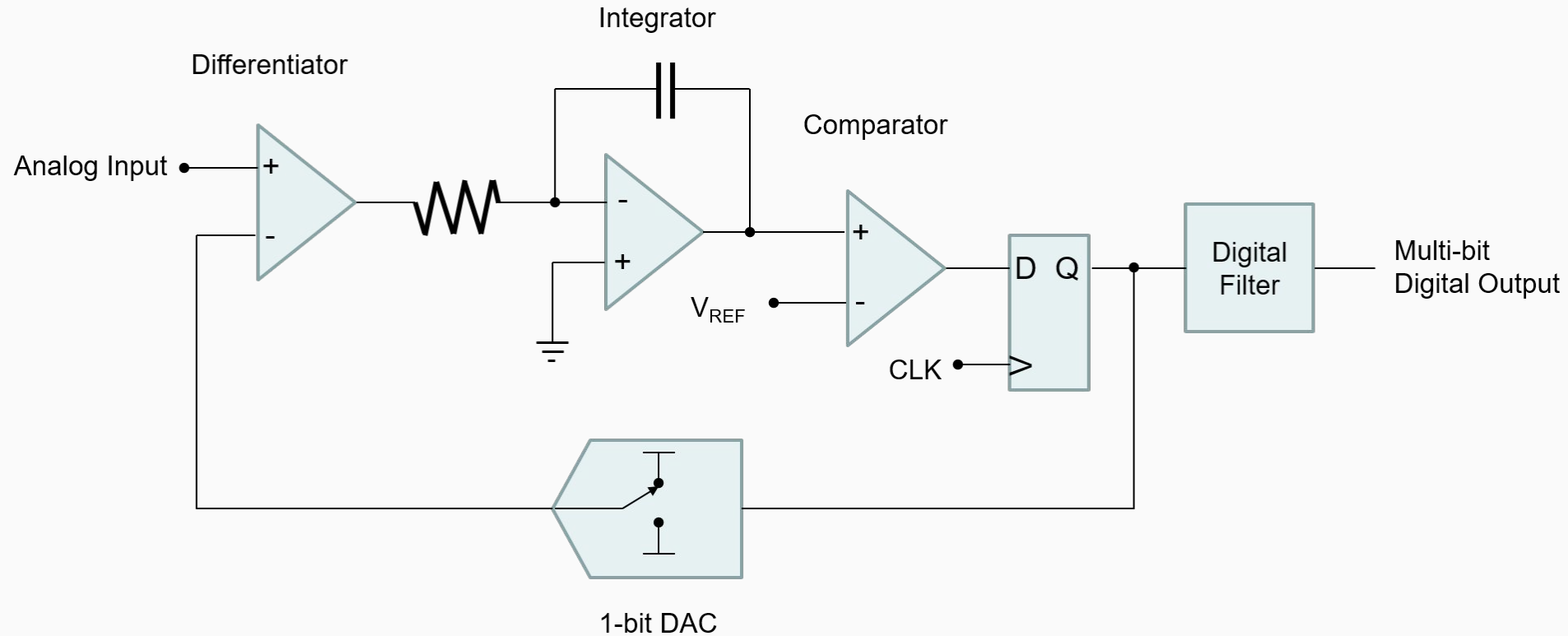
Szuperheterodin vevő



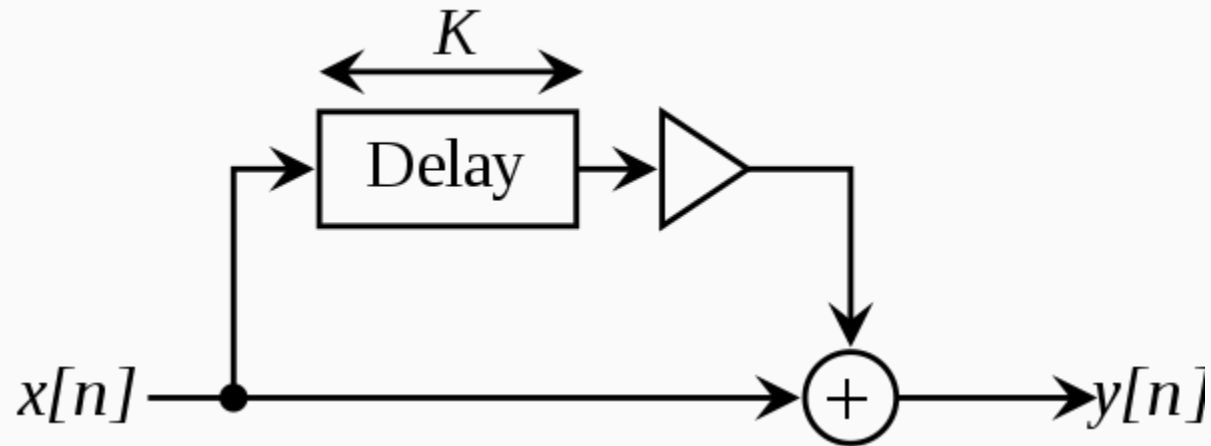
D osztályú erősítő



Sigma-Delta modulátor



Fésűszűrő



Tetőpont

Demo!

Megoldás

Kérdések?