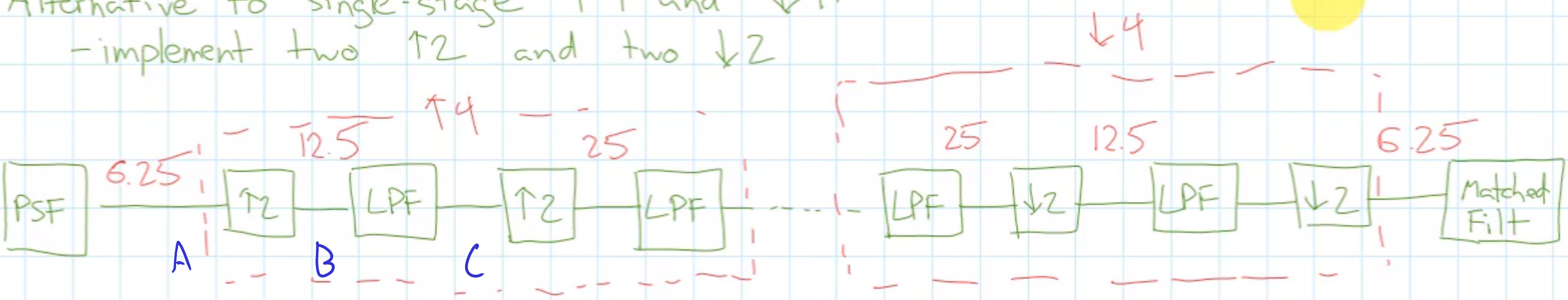
Alternative to single-stage $\uparrow 4$ and $\downarrow 4$:
- implement two $\uparrow 2$ and two $\downarrow 2$



- key advantage: filters can be half-band filters (every 2nd coeff is 0)

- looks more complicated than $\uparrow 4$ and $\downarrow 4$, but may be more economical

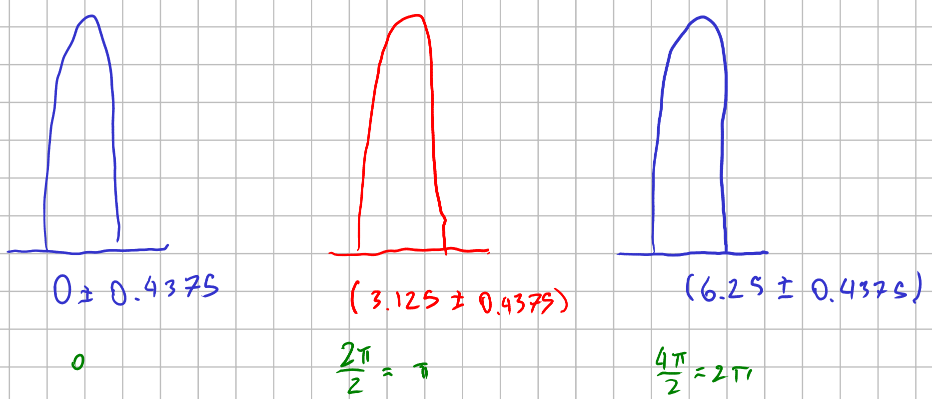
@ A

upsample by $L=2$

$F_s = 6.25$ MHz

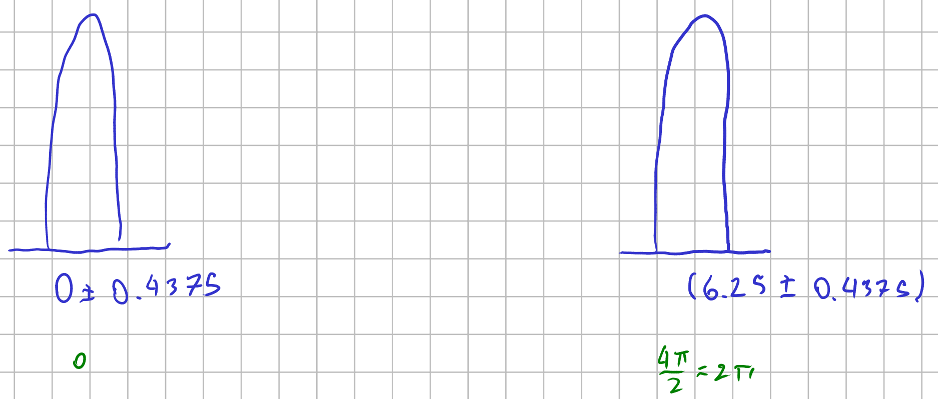
Upsampling doesn't affect Amp

@ B (output of $L=2$)



$F_s = 2 \cdot 6.25 = 12.5$ MHz

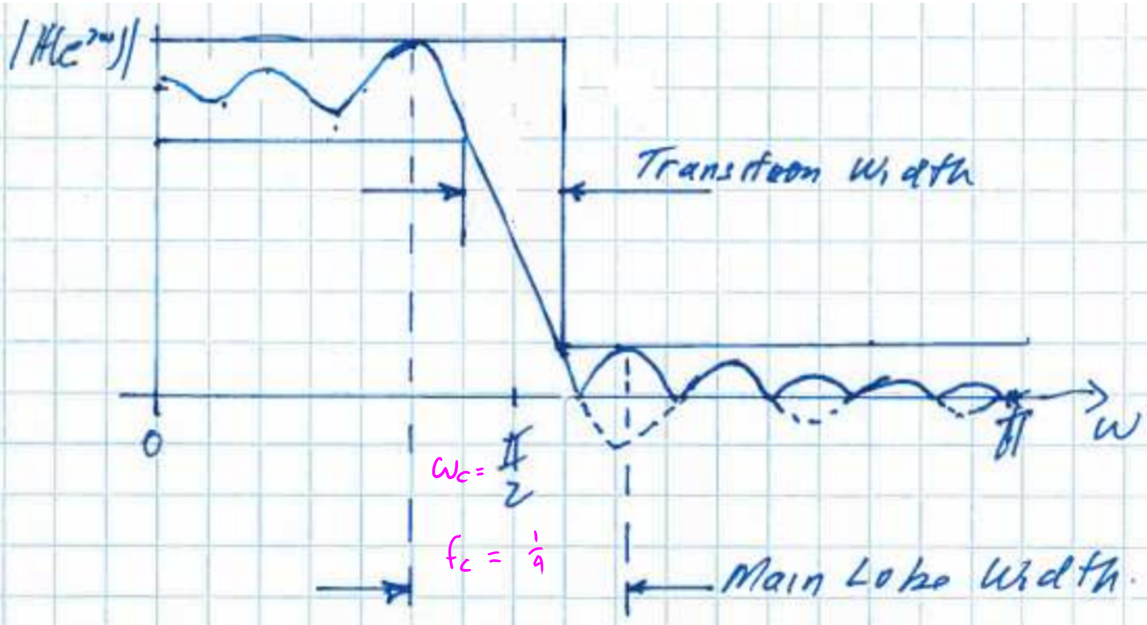
@ C filter out middle image



$F_s = 12.5$ MHz

$F_{pass} > 0.4375$ MHz

461 notes p.155; Halfbandfilters have fc @ pi/2



$F_p = 0.4375$ MHz

$F_c = f_c \cdot F_s$

$= 0.25 \cdot 12.5$ MHz

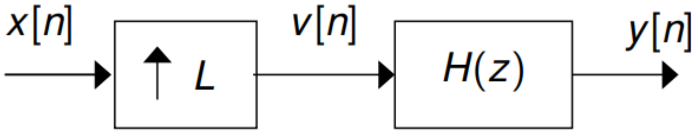
$= 3.125$ MHz

$F_s = F_c + \frac{(F_c - F_p)}{2}$

$= 3.125 + \frac{(3.125 - 0.4375)}{2}$

$= 4.46875$

A standard interpolator is defined as



L = 2 15 coeffs, all n coeffs where n%2 ≠ 0 are 0 EXCEPT PEAK

$H(z) = \sum_{i=0}^{N=14} h[i]\, z^{-i}$, $H(z) = h0 + h2 z^{-2} + h4 z^{-4} + h6 z^{-6} + \dots + h14 z^{-14}$

$+ z^{-1}\left[h1 z^{-1} + h3 z^{-3} + \dots + h7 z^{-7} + \dots h13 z^{-13} \right]$

$h_0 = h_{14}$

$h_2 = h12$

$\vdots$

$E_0 = h_0 + h_2 z^{-1} + h_4 z^{-2} + h_6 z^{-3} + h_8 z^{-4} + h_{10} z^{-5} + h_{12} z^{-6} + h_{14} z^{-7}$

$E_1 = h7\, z^{-3}$

x[n] — $E_n(z)$ — ↑2 — Y[n]