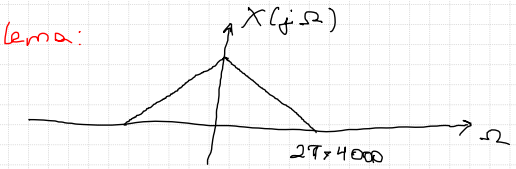
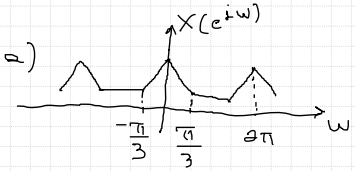
Problema:

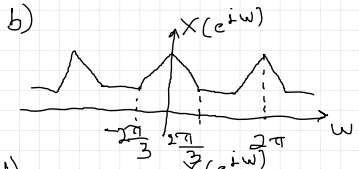


$f_s = 6000$ $f_s = 8000$

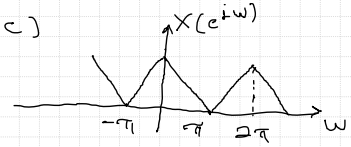
a)



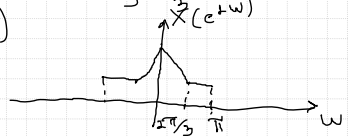
b)



c)



d)



Pq. espectro $X(e^{jw})$ é periódico

$x_1[n] = e^{jw_0 n}$ e $x_2[n] = e^{j(w_0+2\pi)n}$

$= e^{jw_0 n} e^{j2\pi n} = e^{jw_0 n} = x_1[n]$

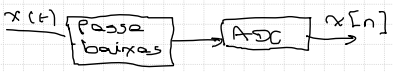
Como $x_1[n] = x_2[n]$, componente de um sinal na frequência w_0 é necessariamente igual à sua componente na freq. $w_0+2\pi$, pois ambas as freqs. correspondem ao mesmo sinal.

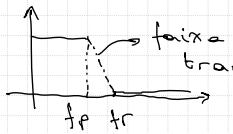
Consequência prática: filtro anti-aliasing

CD: $f_s = 44100$

Maior freq. de interesse: 20000

Especificar freq. passagem e rejeição do filtro passa-baixas colocado antes do ADC





a) $f_p = 20000$, $f_r = 22050$

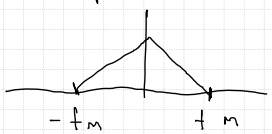
b) $f_p = 10000$, $f_r = 22050$

c) $f_p = 20000$, $f_r = 44100$

d) $f_p = 20000$, $f_r = 24100$

e) $f_p = 22050$, $f_r = 44100$

Condição para evitar aliasing:



Separação deve ser menor que $f_s \Rightarrow$

$2f_M < f_s \Rightarrow f_M < f_s/2$ Taxa de Nyquist

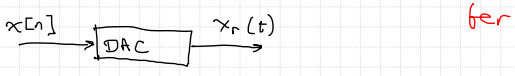
Tem que ser estritamente menor. Exemplo:

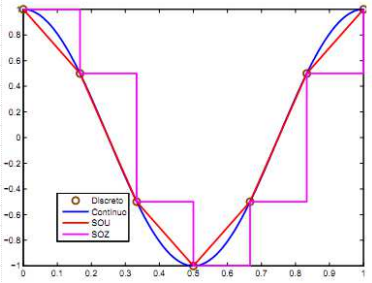
$x(t) = \text{sen}\left(2\pi \frac{f_s}{2} t\right) \Rightarrow x[n] = \text{sen}(\pi n) = 0$

No futuro, discutir que cos(2*pi*fs/2*t+fase), não dá para saber se as amostras diferem por amplitude ou pela fase.

Reconstrução

Recado: aulas de ferça.



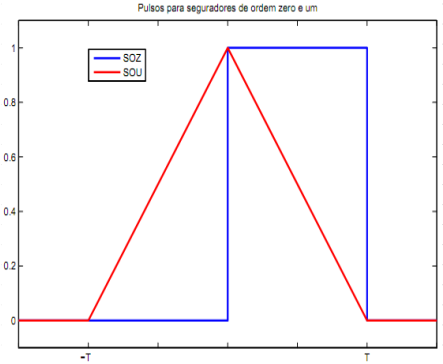


Zoom

Como descrever as distorções, as altas frequências que aparecem?

Matematicamente, DAC é caracterizado por um pulso $p(t)$

$$x_r(t) = \sum_{n=-\infty}^{\infty} x[n]\, p(t - nT_s)$$



Em freq,

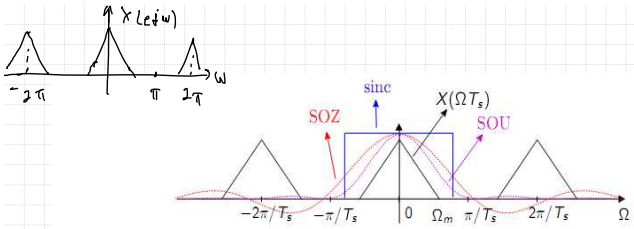
$$X(j\Omega) = \int_{-\infty}^{\infty} x_r(t)\, e^{-j\Omega t}\, dt \qquad \mathcal{F}\{p(t - nT_s)\}$$

$$= \sum_{n=-\infty}^{\infty} x[n] \int_{-\infty}^{\infty} p(t - nT_s)\, e^{-j\Omega t}\, dt$$

$$= \sum_{n=-\infty}^{\infty} x[n]\, e^{-j\Omega T_s n}\, P(j\Omega)$$

$$= P(j\Omega)\, X\left(e^{j\Omega T_s}\right)$$

$\mathcal{F}\{x[n]\} = X(e^{jw}) = \sum_{n=-\infty}^{\infty} x[n]\, e^{-jwn}$



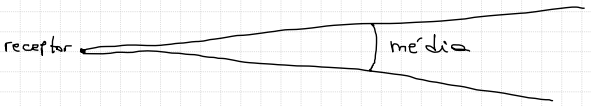
Pulsos práticos

- Distorção na faixa de freqüência de interesse.
- Introdução de componentes de alta freqüência.

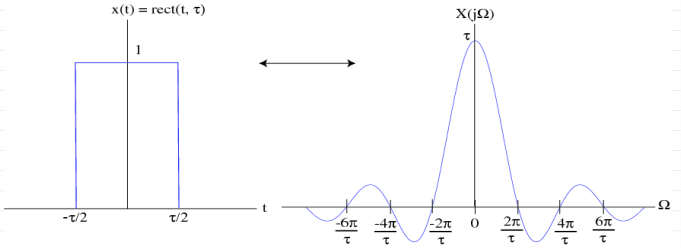
Pulso sinc

- Permite recuperação perfeita do sinal se $\Omega_m < 2\omega_s$.

Voltando ao olho

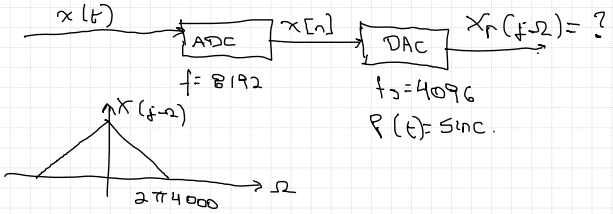


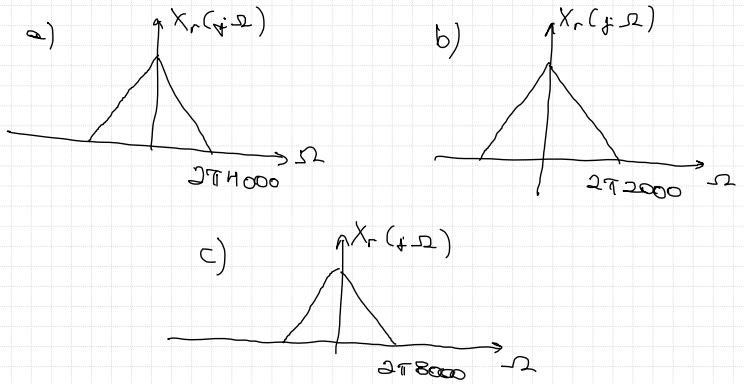
média é filtro passa-baixas. Quanto mais longe, mais longa a média, mais corta altas freqs.



Fonte: http://cnx.org/content/m32899/1.8/

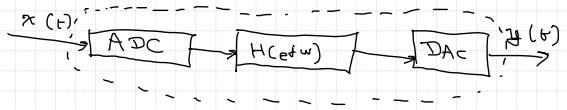
Problema:

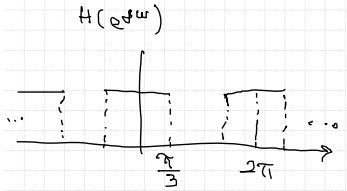




Problema:

Processamento digital de sinais analógicos:

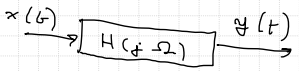




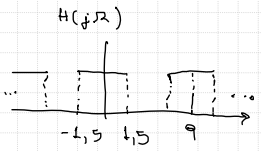
$f_s = 9000$

ADC e DAC ideais

Qual o sistema analógico equivalente?



a)



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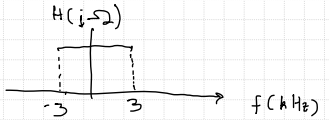
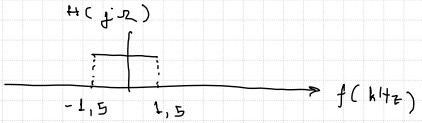


c)



d)