We will discuss and define three types of sampling models:

1. Impulse sampling
2. Natural Sampling
3. Flat Top sampling

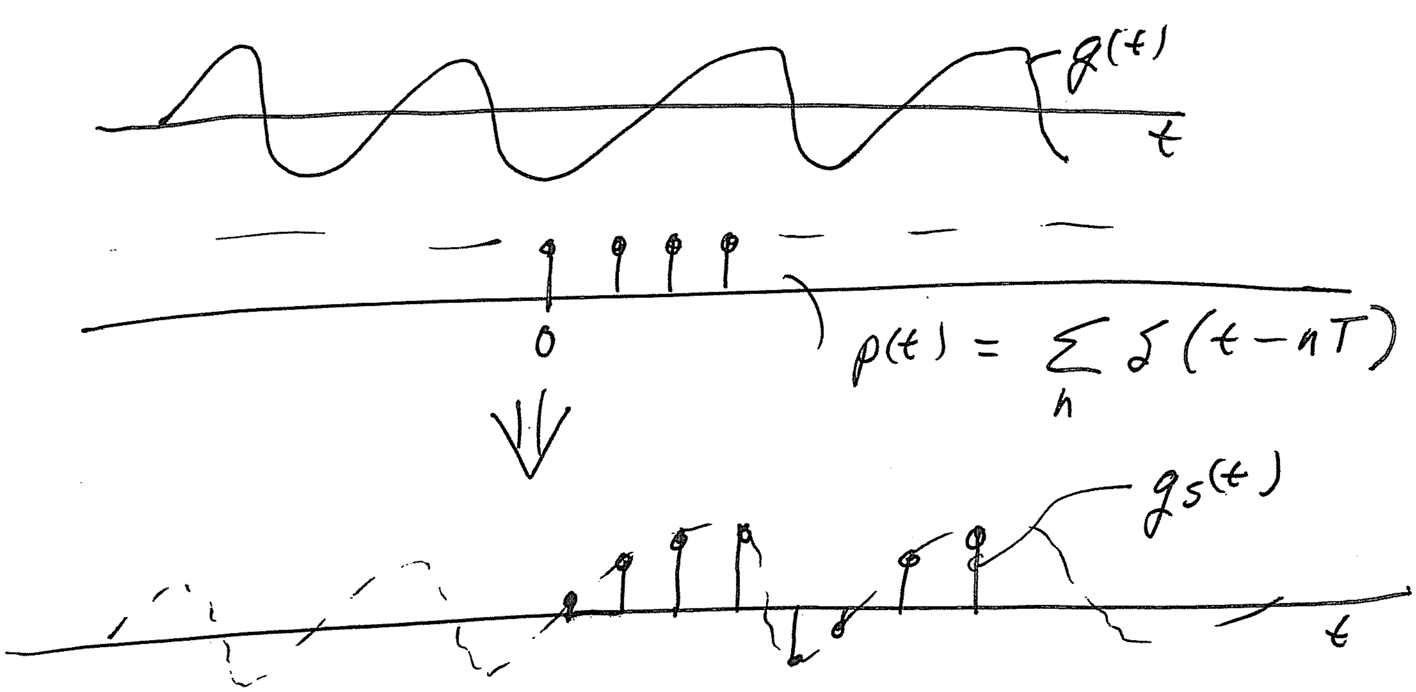
Impulse sampling

Consider a CT signal $g(t)$

We impulse sample $g(t)$, by multiplying $g(t)$ by a train of dirac delta functions s.t.

$$g_s(t) = g(t) \sum_n \delta(t - nT)$$ where T is the sample Period.

Ex:

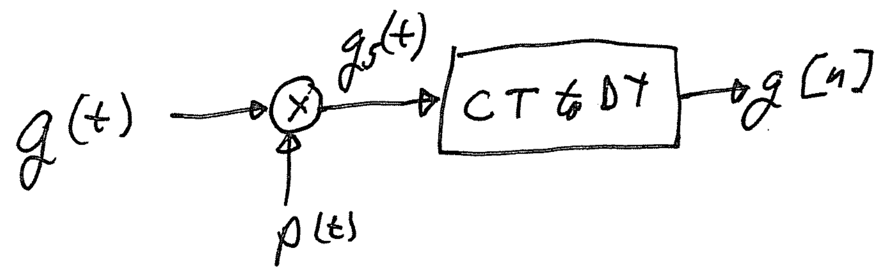


$$p(t) = \sum_n \delta(t - nT)$$

The DT values $g[n]$ are the non-zero values of $g_s(t)$ s.t.

$$g[n] = g_s(nT)$$

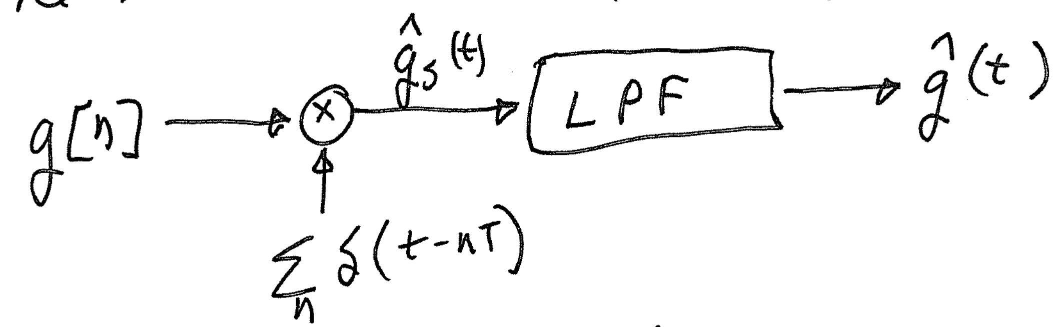
The block diagram is



To convert $g[n]$ back to CT, another impulse train is multiplied s.t.

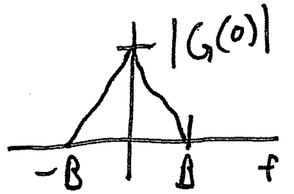
$$\hat{g}_s(t) = \sum_n g[n]\,\delta(t-nT)$$

The reconstructed signal $\hat{g}(t)$ is obtained by



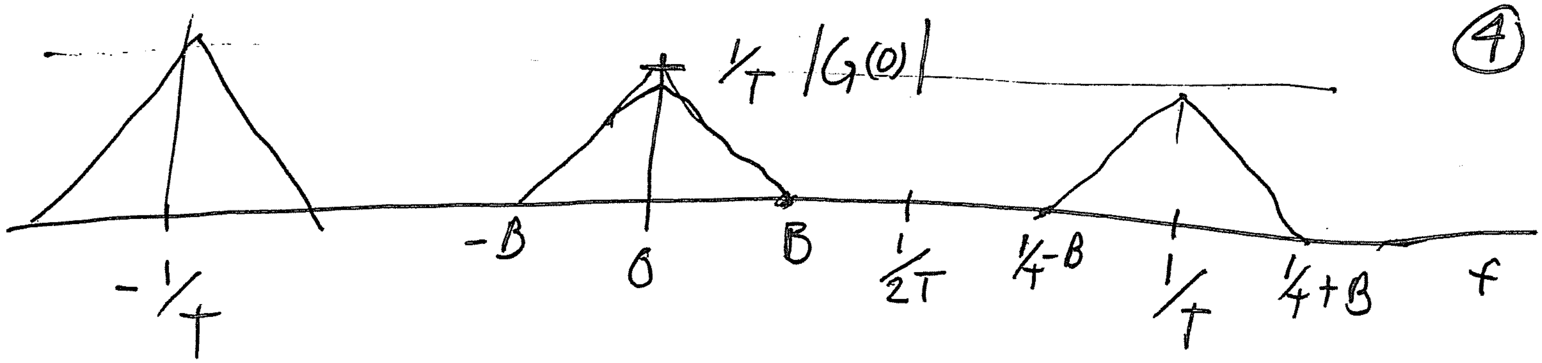
The frequency domain reveals the limitations and capabilities of impulse sampling.

Assume $G(f)$ is bandlimited s.t.



then $G_s(f) = G(f) * \frac{1}{T} \sum_k \delta(f - k/T)$

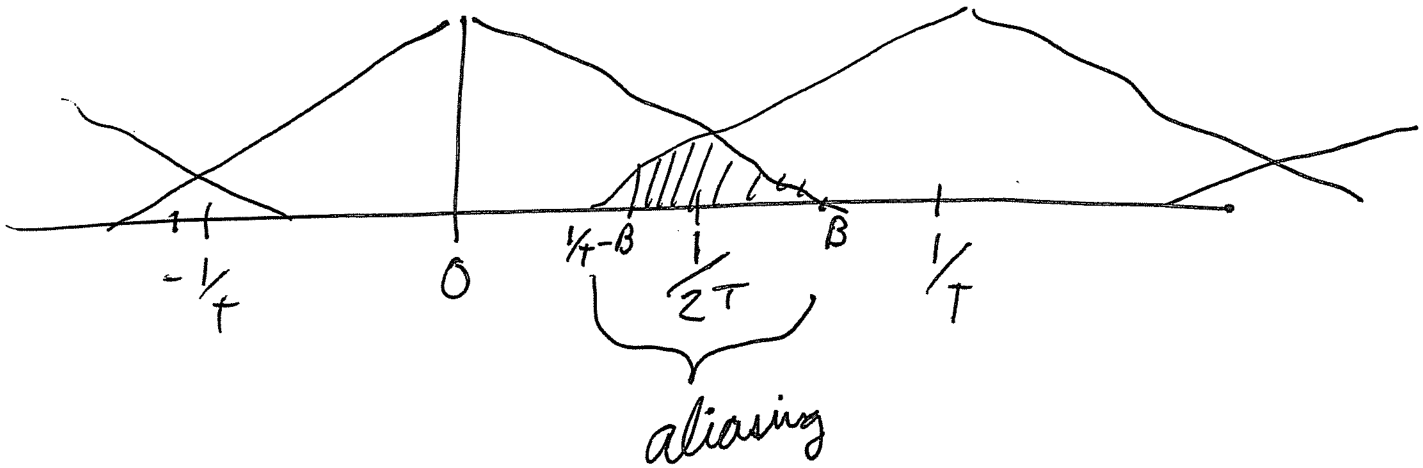
so $G_s(f) = 1/T \sum_k G(f - k/T)$



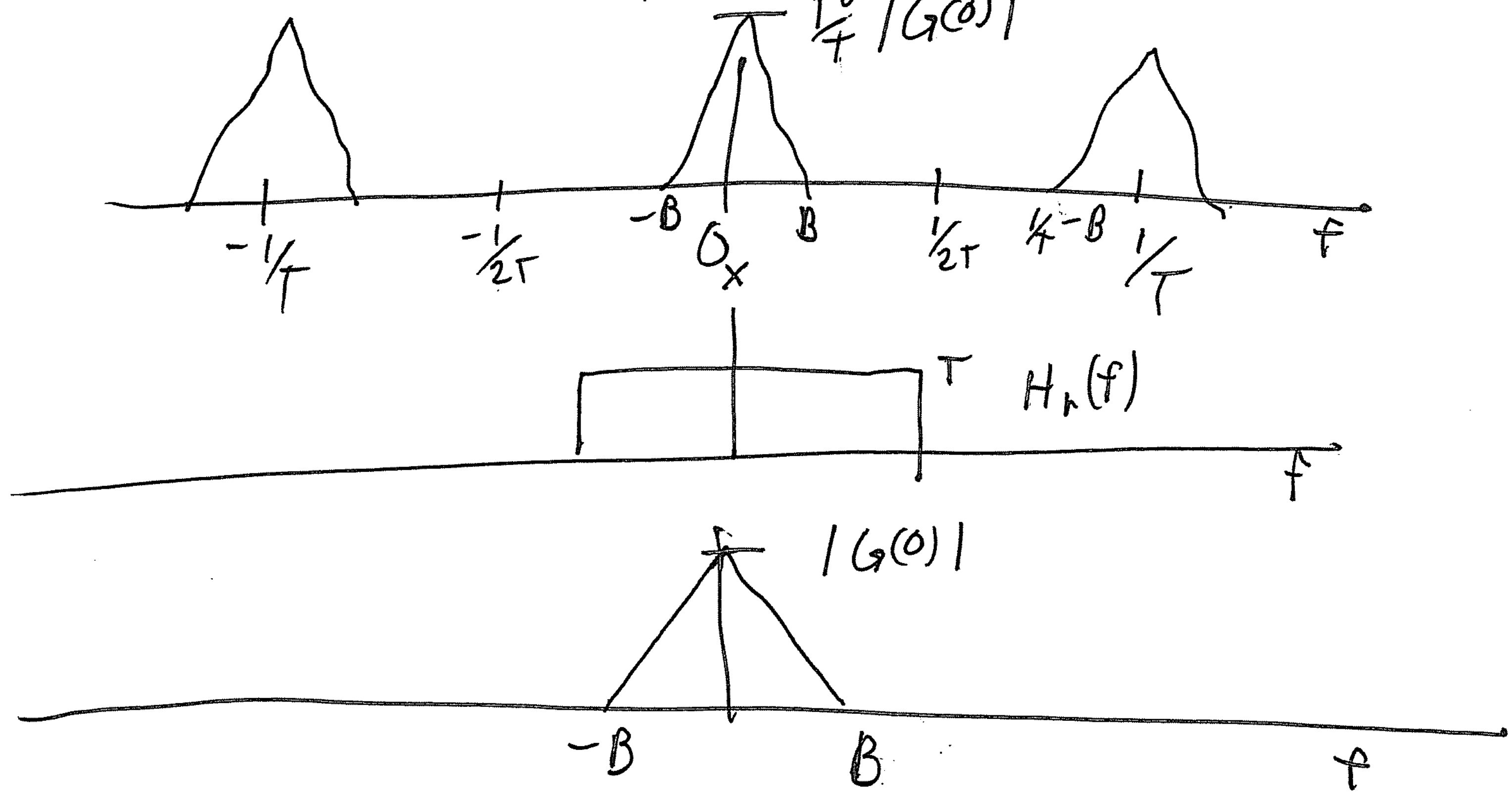
Aliasing occurs @ $B = \frac{1}{T} - B$

So no aliasing $T < \frac{1}{2B}$ or $\boxed{f_s = \frac{1}{T} > 2B}$

Ex: Aliasing



If there is NO aliasing we can reconstruct using an ideal low pass filter



Note that: $g_s(t) = g(t) \sum_n \delta(t-nT)$

$$= \sum_n g(nT)\,\delta(t-nT)$$

$$= \sum_n g[n]\,\delta(t-nT)$$

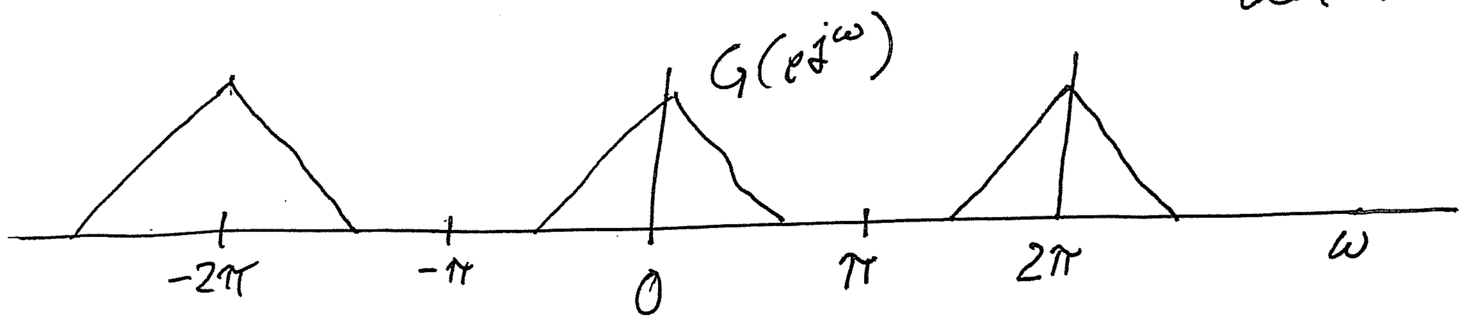
Also note: The DTFT of $g[n]$ is

$$G(e^{j\omega}) = \sum_n g[n] e^{-j\omega n} \Rightarrow$$

Note $G(z) = \sum_n g[n] z^{-n}$

if $z = e^{j\omega}$

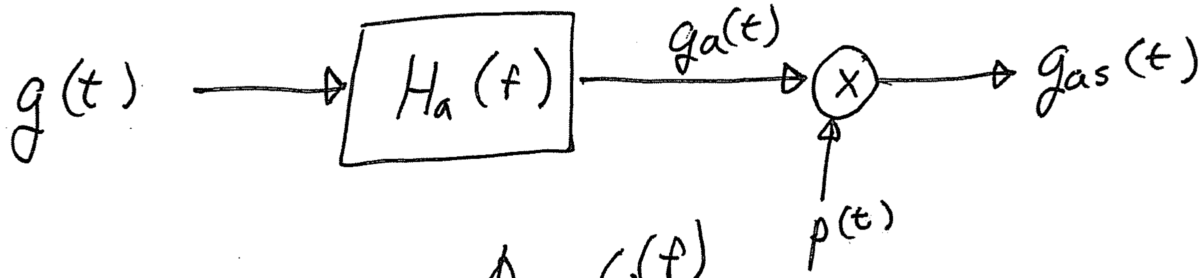
then $G(e^{j\omega}) = \sum_n g[n] e^{-j\omega n}$



which is proportional to $G_s(f)$ for $\frac{2\pi}{T} = 2\pi$ or $T = 1$

Anti - Aliasing

We can prevent aliasing using anti-aliasing filter at the cost of losing bandwidth s.t.



where