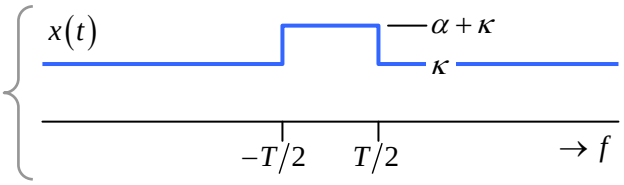
Sketching ESD and PSD

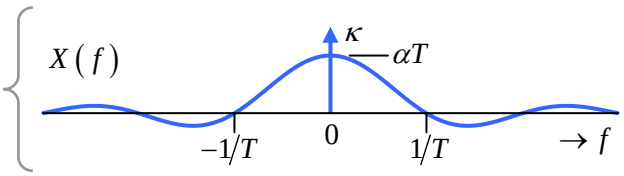
AN EXAMPLE:

Signal: $\left(x(t) = \kappa + \alpha \cdot \text{rect}\left(\frac{t}{T}\right) \right)$



Spectrum: $X(f) = \kappa\delta(f) + \alpha T \text{sinc}(Tf)$

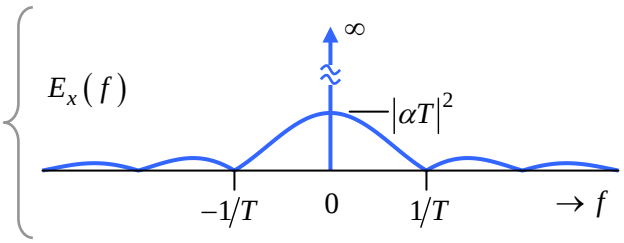
$X(f)$ comprises impulsive and non-impulsive parts.



ESD: $E_x(f) = |X(f)|^2$

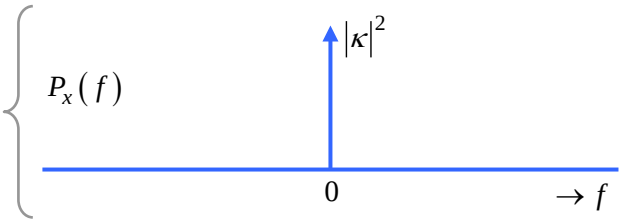
$= \infty\delta(f) + |\alpha T \text{sinc}(Tf)|^2$

All finite strength impulses in $X(f)$ are converted to impulses of infinite strength. The non-impulsive part of $X(f)$ is converted to $|X(f)|^2$



PSD: $P_x(f) = |\kappa|^2 \delta(f)$

All κ-strength impulses in $X(f)$ are converted to $|\kappa|^2$-strength impulses. The non-impulsive part of $X(f)$ is converted to 0.



This signal, $x(t)$, has finite average power $\left[P = \int_{-\infty}^{\infty} P_x(f)\,df = |\kappa|^2 < \infty \right]$ and infinite total energy $\left[E = \int_{-\infty}^{\infty} E_x(f)\,df = \infty \right]$. It is therefore a power signal.

NOTE: The power spectrum of a DETERMINISTIC signal consists of only impulses. This notion **does not** carry over to RANDOM signals.