Spectral densities of variations of sampled signals

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Ideal sampling: Using a periodic train of impulses

$$x_\delta(t) = x(t) \cdot \sum_{n=-\infty}^{\infty} \delta(t - nT_s) \quad \leftrightarrow \quad X_\delta(f) = \frac{1}{T_s} \sum_{n=-\infty}^{\infty} X\left(f - \frac{n}{T_s}\right)$$

Natural sampling (switching): Using a periodic train of rect pulses

$$x_s(t) = x(t) \cdot \sum_{n=-\infty}^{\infty} \Pi\left(\frac{t - nT_s}{\tau}\right) \quad \leftrightarrow \quad X_s(f) = \frac{\tau}{T_s} \sum_{n=-\infty}^{\infty} \text{sinc}\left(n\frac{\tau}{T_s}\right) X\left(f - \frac{n}{T_s}\right)$$

Sample-and-hold: Constant sample value over T_s seconds

$$x_{SH}(t) = \sum_{n=-\infty}^{\infty} x(nT_s)\, \Pi\left(\frac{t - nT_s}{T_s}\right) \quad \leftrightarrow \quad X_{SH}(f) = \text{sinc}\left(\frac{f}{T_s}\right) \sum_{n=-\infty}^{\infty} X\left(f - \frac{n}{T_s}\right)$$