

Outline

- 1 Analysis of the sample and hold
- 2 Fourier transform
- 3 Spectrum of a sampled signal
 - Aliasing
 - Sampling theorem
 - Hidden oscillations
- 4 Data extrapolation (reconstruction)

Shannon-Nyquist sampling theorem

If all content above the half-sampling frequency is removed, no aliasing is introduced by sampling. Also the signal spectrum is not distorted, even though it is repeated endlessly, centered at $n2\pi/T$.

This critical frequency, π/T , is called the **Nyquist frequency**. Band-limited signals that have no components above the Nyquist frequency are represented unambiguously by their samples.

This is the **sampling theorem**: One can recover a signal from its samples if the sampling frequency ($\omega_s = 2\pi/T$) is at least twice the highest frequency (π/T) in the signal. This maximum frequency is also called the **bandwidth B**.

Shannon-Nyquist sampling theorem

The signal can be fully reconstructed if there are no overlaps in the frequency domain.

If the sampling frequency is at least twice the bandwidth B , then the signal can be reconstructed without a problem (no overlap). (fig. a)

If the sampling frequency is too low then information will be lost (overlap). (fig. b)

Sampling frequency $f_s \geq 2B$

