

Sampling & Aliasing

Electrical Engineering

Nyquist's condition, where aliases land, and why the filter has to come first.

Sampling below twice the highest frequency present folds that content down as an alias.

$$f_s > 2 f_{\max} \cdot f_{\text{alias}} = |f - k f_s|$$

5 kHz at $f_s = 8$ kHz

8 - 5.

Alias at 3 kHz

Audio to 20 kHz

Room for the filter.

44.1 kHz sampling

Exactly $2 f_{\max}$

No filter is ideal.

Not enough in practice

THE COMMON MISTAKE

× **Filtering the aliases out after the converter**

✓ **Filtering in analogue, before the sampler**

Once folded, an alias sits at a perfectly legitimate frequency and no later processing can separate it from real signal.

Oversampling buys a gentler anti-alias filter, never the absence of one. The filter is always analogue and always first.