# Understanding Sampling and the Nyquist Frequency

Sampling means taking regular "snapshots" of a continuous signal. Every snapshot records the signal's value at that moment, and the number of snapshots per second is called the sampling rate ($f_s$).

**Nyquist Frequency:** To properly capture all details of the signal, you must sample at least twice as fast as the highest frequency in the signal. The Nyquist Frequency is given by:

$$f_{\text{Nyquist}} = \frac{f_s}{2}.$$

This is the highest frequency you can accurately record. Frequencies higher than this will show up as lower frequencies in your data (a problem known as aliasing).

**Why More Samples Matter:** The total number of samples $N$ you collect affects how detailed your frequency view is. The frequency resolution ($\Delta f$)—the gap between frequency bins in your spectrum—is:

$$\Delta f = \frac{f_s}{N}.$$

A larger $N$ gives you a finer, more detailed spectrum because the bins are closer together.

Below are two examples to show you the difference:

### Example: 1000 Samples

### Example: 10,000 Samples

# Quick Takeaways

- **Sampling** converts a continuous signal into discrete data points.
- The **Nyquist Frequency** ($f_s/2$) is the maximum frequency that can be accurately captured.
- Increasing the number of samples improves the **frequency resolution**, letting you see more details.

Experiment with different sample counts in our tool to see how these changes affect your frequency spectrum!

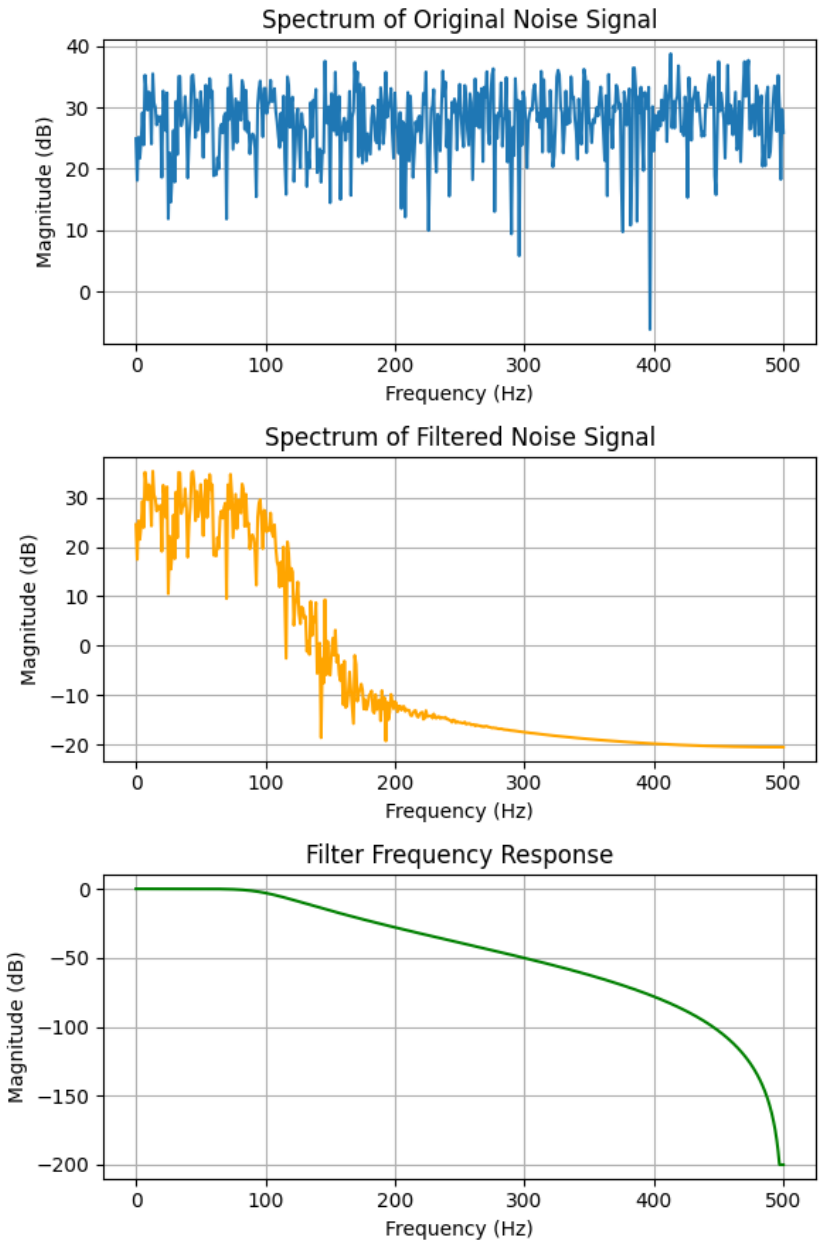


Figure 1: Spectrum with 1000 samples. The frequency bins are wider, so details in the spectrum are less sharp.

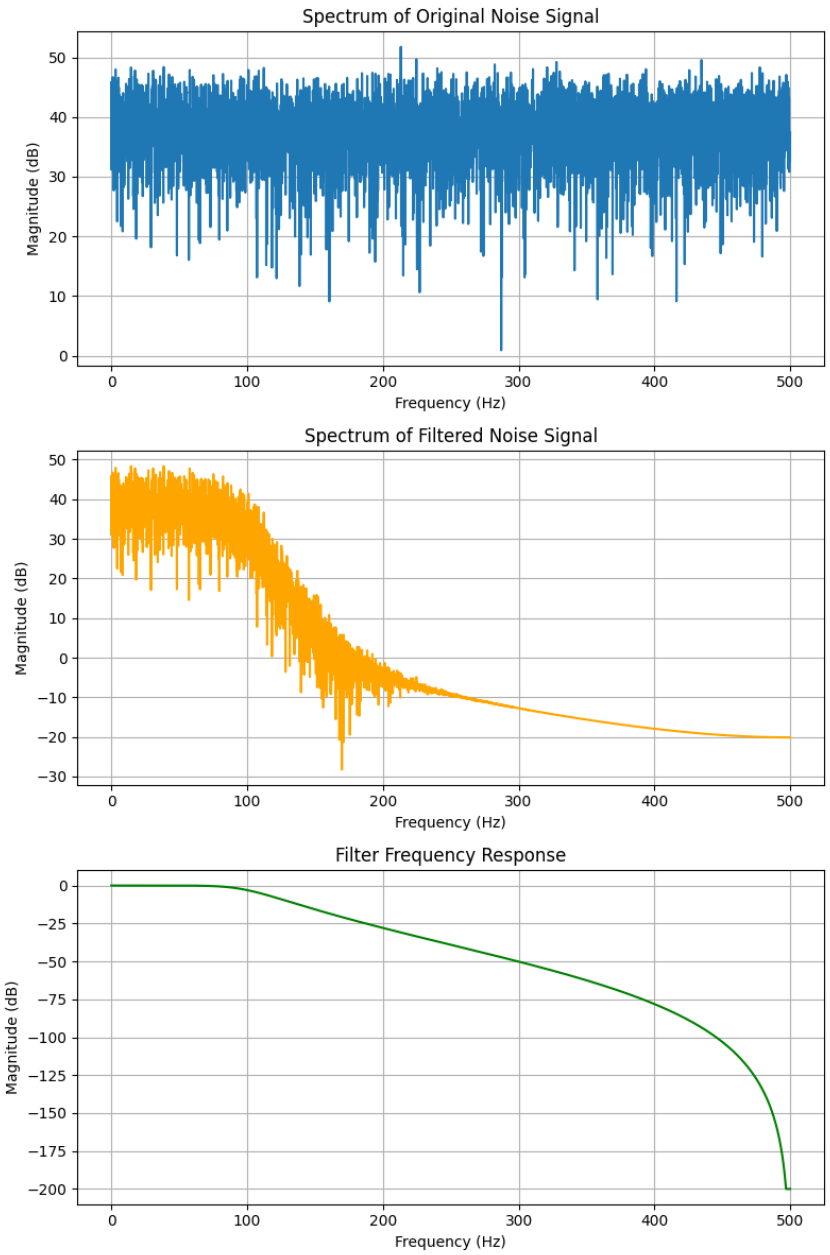


Figure 2: Spectrum with 10,000 samples. More samples mean a finer frequency resolution and a clearer picture of the signal's frequency content.