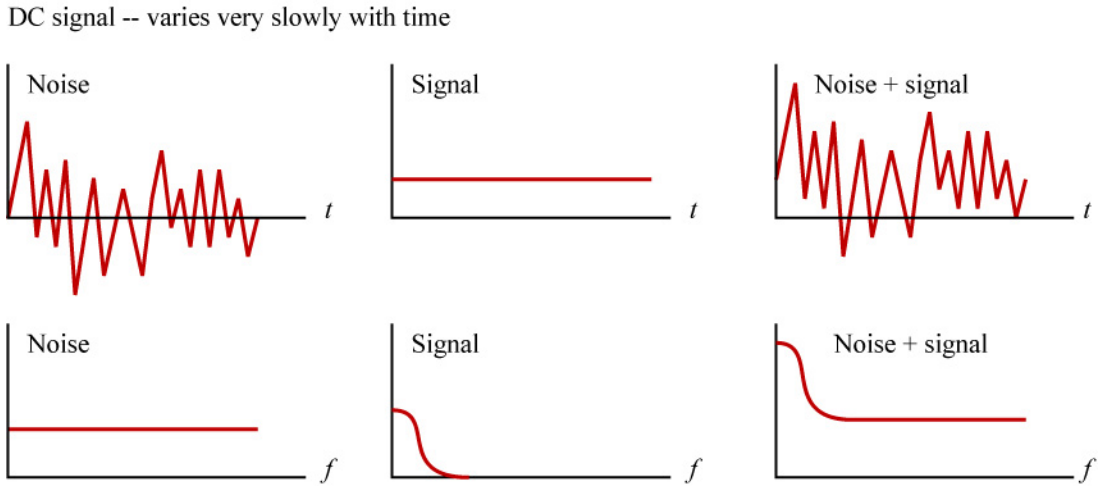
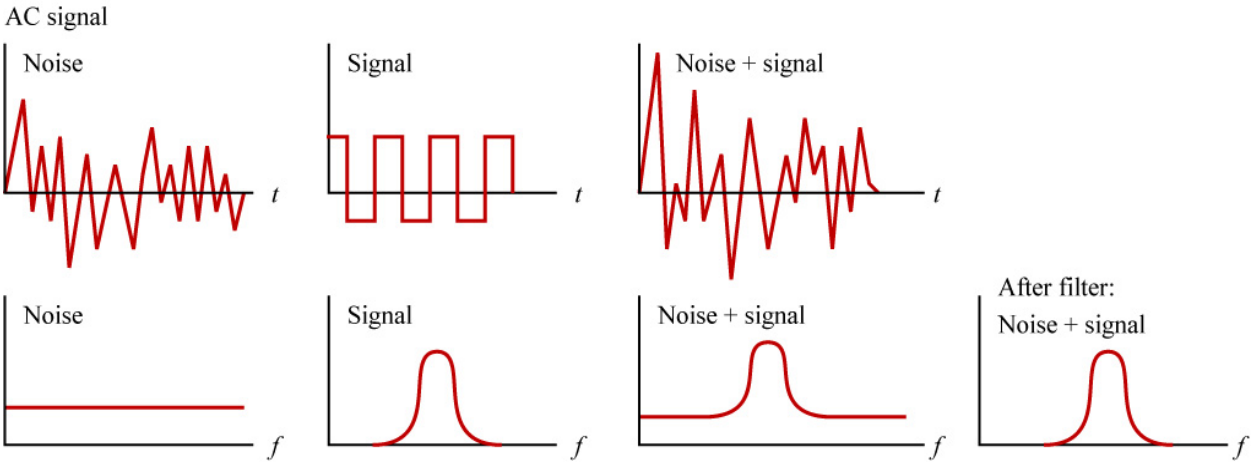
Lock-in amplifier

- Lock-in technique is used to recover a measurement signal when strongly compromised by noise.
- What is noise? (some random source)
- What is white noise? (noise distributed over all frequencies)
- What is Johnson noise? (same thing as white noise)
- What is 1/*f* noise? (noise with an approximate 1/*f* frequency dependence)
- What is thermal noise? (noise caused by thermal motion of carriers)
- What is the spectrum of white noise? (flat spectrum)
- Why is *white noise* called by this name? (white light has an approximately flat spectrum)

- Assume the following signal:



- How can the quasi-DC signal be recovered? (low-pass filter)
- Disadvantage? (long time constant)
- Consider an AC signal created by "chopping".



- Subsequent filtering will improve signal-to-noise ratio by a large factor.
- Lock-in amplifier has a *signal channel* and a *reference channel*.
- What is role of signal channel?
- What is role of reference channel?
- What is the role of the bandpass filter?
- How is the bandpass filter being implemented?
- What is role of quality factor ("*Q*") of bandpass filter?
- What does $Q = 10$, 50, or 100 mean? ($Q = f / \Delta f$)
- There is an option for non-phase-sensitive detection (PSD) and phase-sensitive detection.
- Phase-sensitive detection will further increase the signal-to-noise ratio.
- What is the range of the PSD? (360 °)
- After you find the maximum signal, assume that you switch the PSD to $+90°$ or $-90°$. What happens to the signal? (goes to zero)