

Filter selection:

Artifacts we want to mitigate:

- **Blink artifacts:** Large spikes caused by eyelid movements, typically in the 0–5 Hz range.
- **Baseline drift:** Low-frequency drift due to electrode movement or sweat.
- **Muscle (EMG) artifacts:** High-frequency noise (>30 Hz) from facial muscles.
- **Power line interference:** 50 Hz or 60 Hz contamination from electrical sources.

Do not apply since f_s is 50Hz. Because of the Nyquist theorem only frequencies between 0 Hz and 25 Hz can be analysed.

1. Butterworth 4th Order

Advantages:

- Maximally flat passband (no ripple)
- Smooth phase response
- Simple implementation
- Numerically stable

Disadvantages:

- Gradual roll-off (≈ 40 dB attenuation at 0-5Hz)
- Requires higher order for sharp transitions

2. Butterworth 8th Order

Advantages:

- ≈ 80 dB attenuation at 0-5Hz
- Still maintains no passband ripple
- Better stopband rejection than 4th order

Disadvantages:

- Increased phase distortion
- Slightly higher computational cost
- Potential stability issues in fixed-point implementations

3. Chebyshev Type I 6th Order (0.1dB ripple)

Advantages:

- $\approx 100\text{dB}$ attenuation at 0-5Hz
- Sharper transition than Butterworth
- Lower order needed for similar attenuation

Disadvantages:

- 0.1dB passband ripple
- Non-linear phase response
- More sensitive to coefficient quantization

4. Elliptic 4th Order (0.1dB ripple, 60dB attenuation)

Advantages:

- $\approx 120\text{dB}$ attenuation at 0-5Hz
- Sharpest transition of all
- Lowest order needed

Disadvantages:

- Ripple in both passband and stopband
- Worst phase linearity
- Complex design

5. Cascade: 6th Order Highpass (5Hz) + 6th Order Lowpass (24.9Hz)

Advantages:

- $\approx 120\text{dB}$ attenuation at 0-5Hz
- No passband ripple
- Independent control of cutoffs
- Better phase response than elliptic/Chebyshev

Disadvantages:

- Requires two filtering operations
- Slightly higher latency
- More parameters to tune

