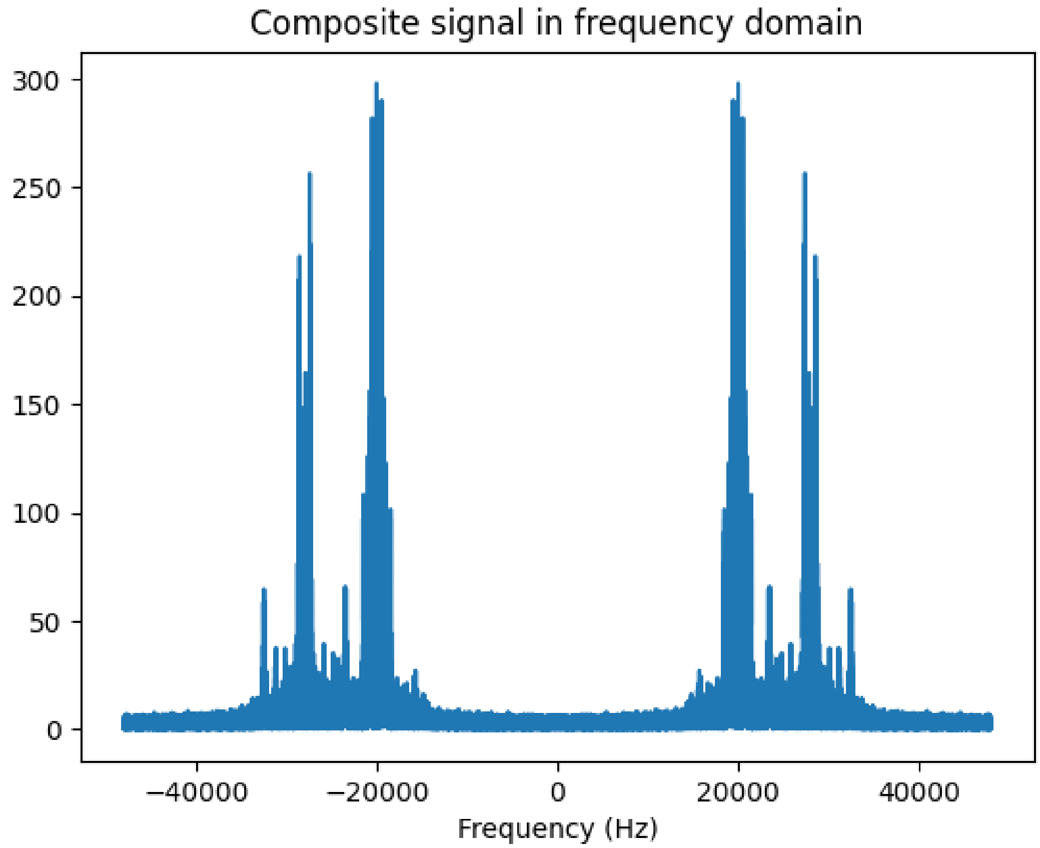
Müslim Yılmaz – 150119566

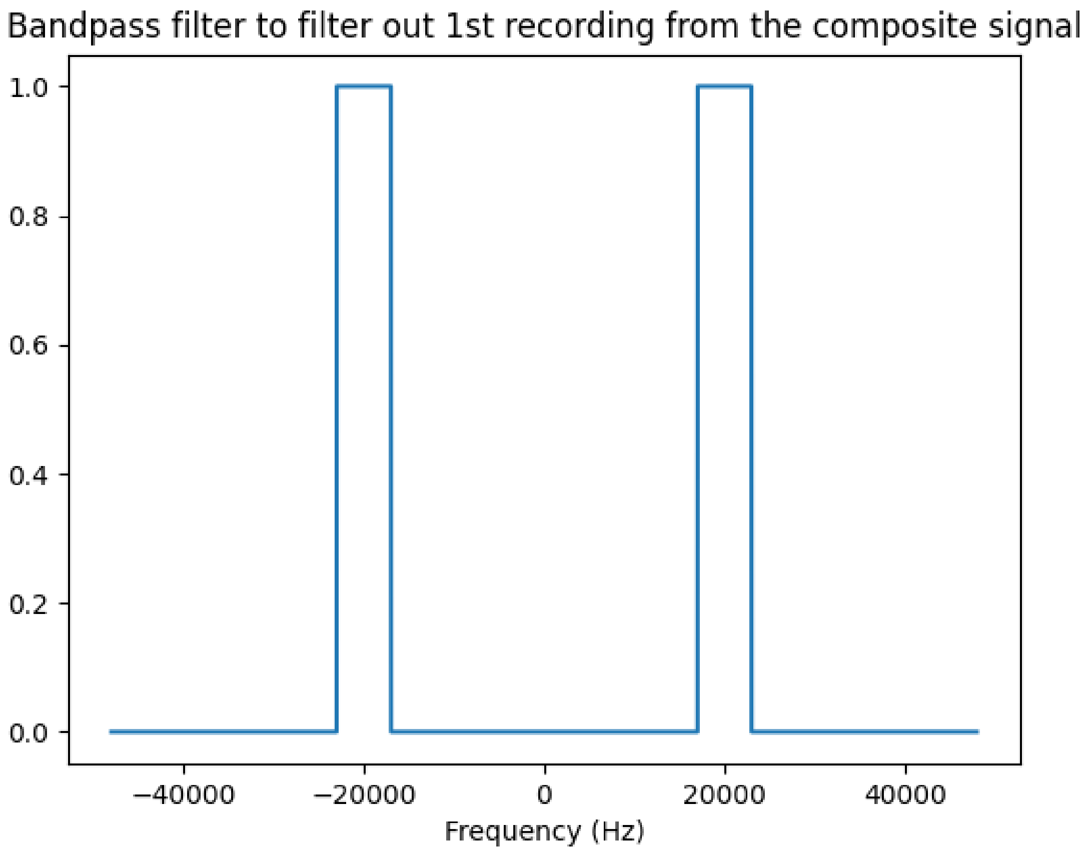
- Modulation frequency 1: **20kHz** Massage 1: **follow, ideal**
- Modulation frequency 2: **28kHz** Massage 2: **independent, look**

Demodulating of Massage 1 – 20kHz -

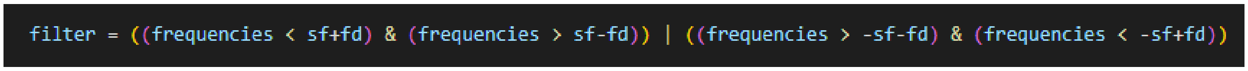
- **Composite signals in frequency domain**



- **Bandpass Filter for Massage 1**

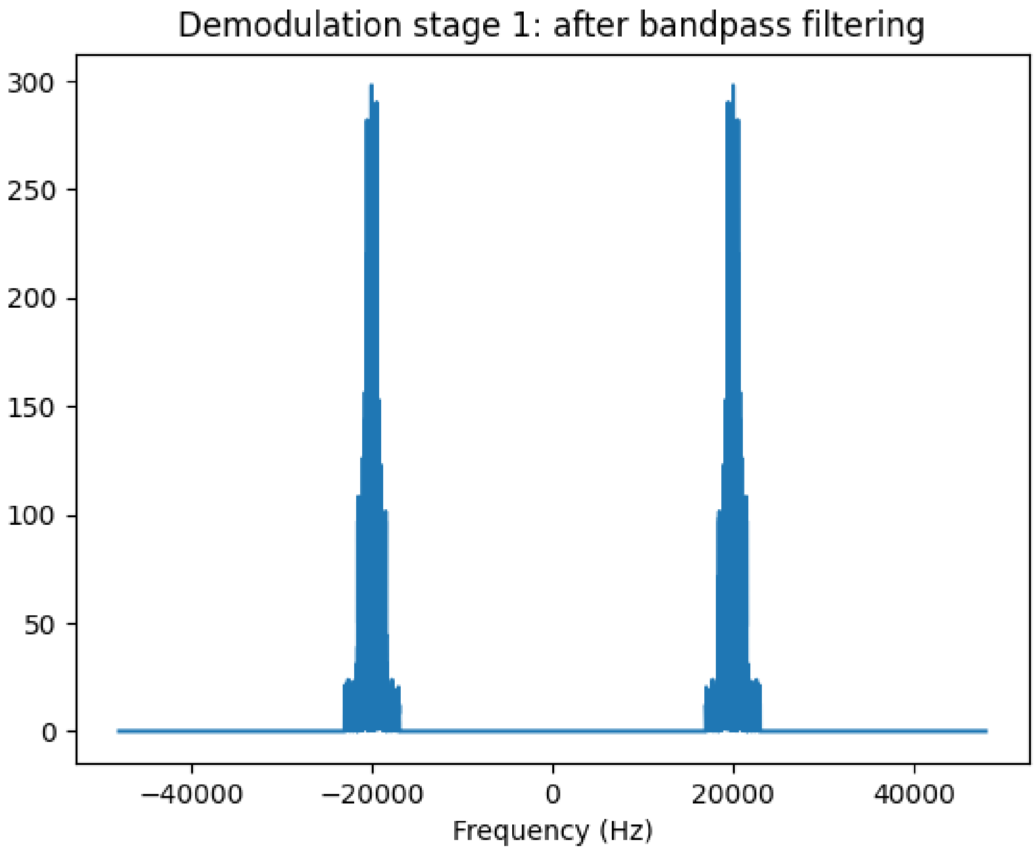


- Bandpass filter is in the range [- 20000 -3 kHz, -20000 + kHz],[20000- 3kHz, 20000+3 kHz]

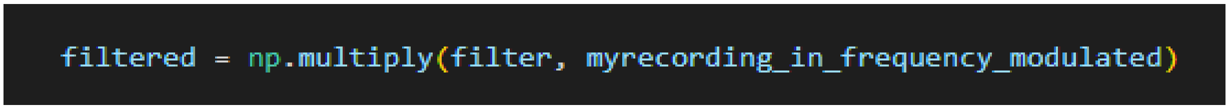


```
filter = ((frequencies < sf+fd) & (frequencies > sf-fd)) | ((frequencies > -sf-fd) & (frequencies < -sf+fd))
```

- **Demodulation Stage 1**

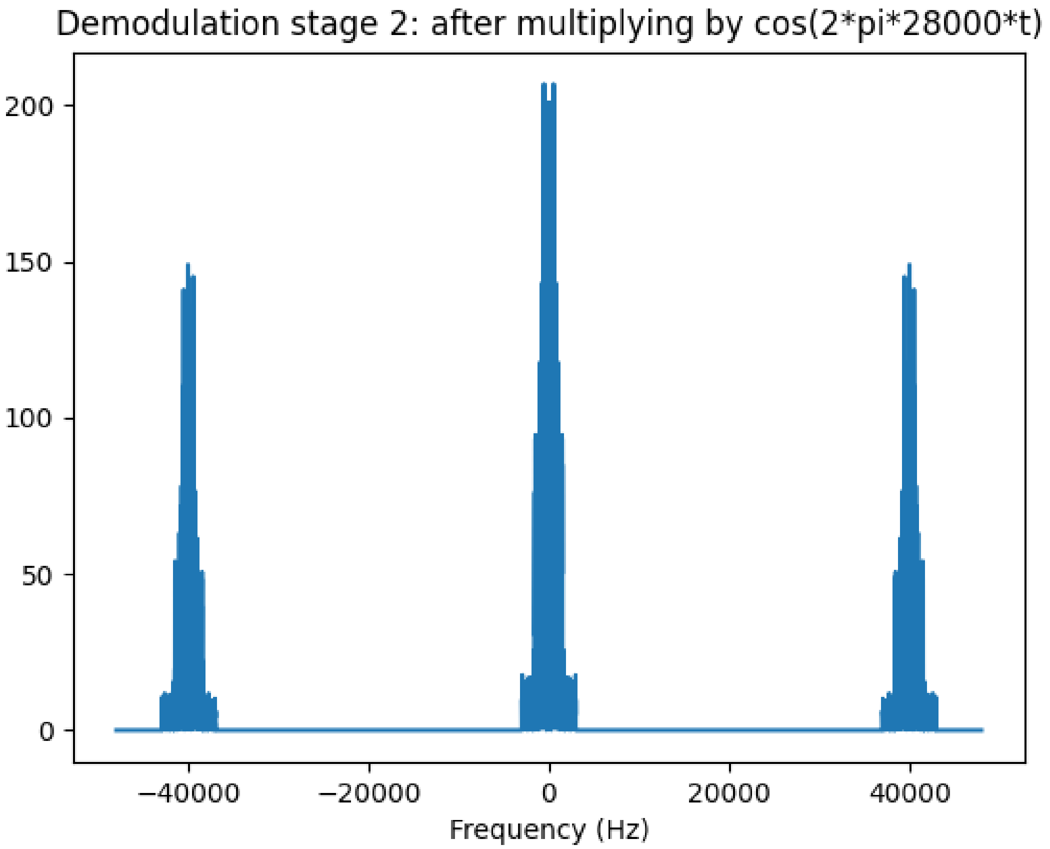

Demodulation stage 1: after bandpass filtering

- Filtered result after the bandpass filtering.

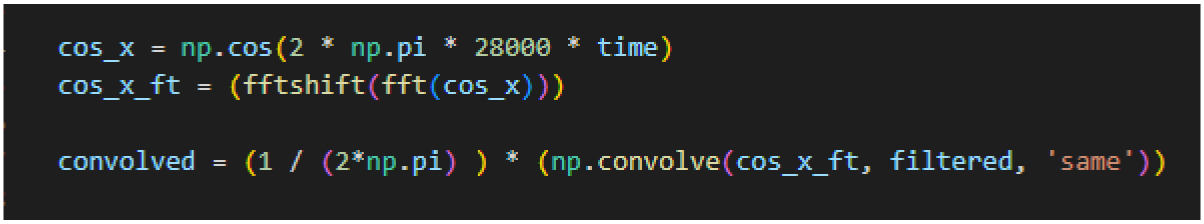


```
filtered = np.multiply(filter, myrecording_in_frequency_modulated)
```

- **Demodulation Stage 2**



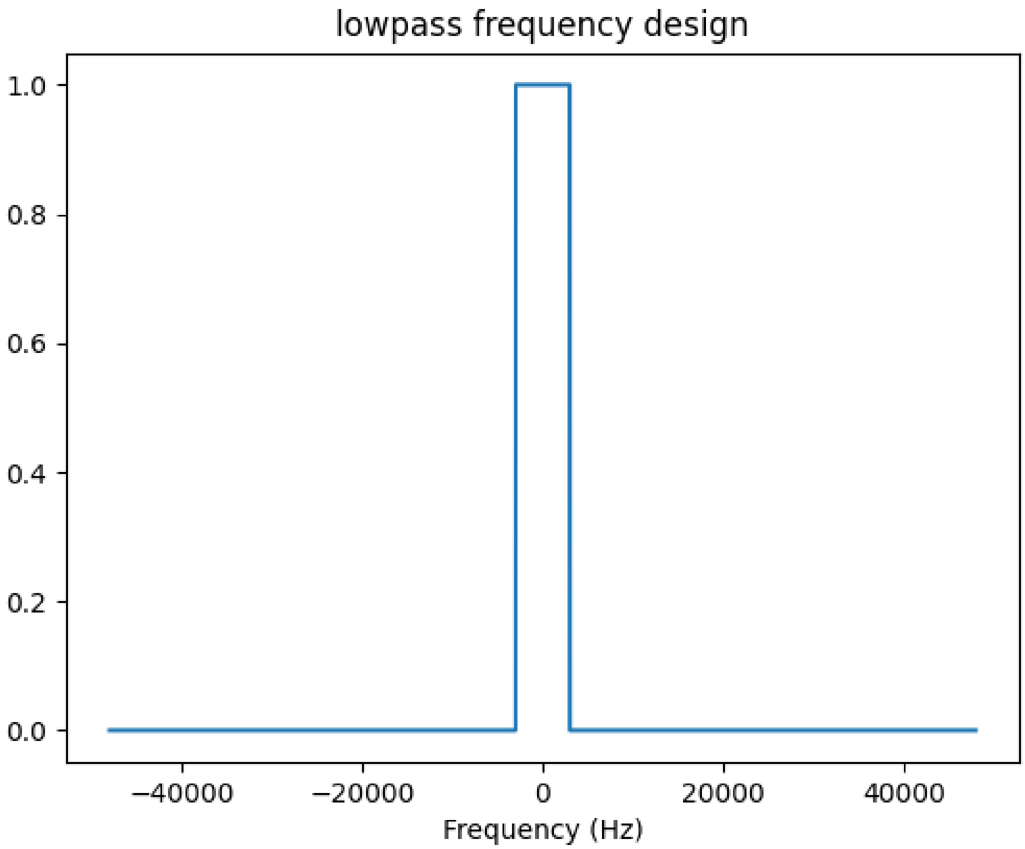
- We get rid of the sidelobes after the convolution.



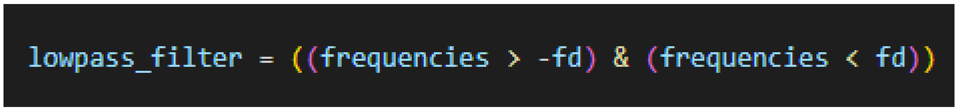
```
cos_x = np.cos(2 * np.pi * 28000 * time)
cos_x_ft = (fftshift(fft(cos_x)))

convolved = (1 / (2*np.pi) ) * (np.convolve(cos_x_ft, filtered, 'same'))
```

2 * np.pi * 20000 * time

- **Lowpass frequency design**

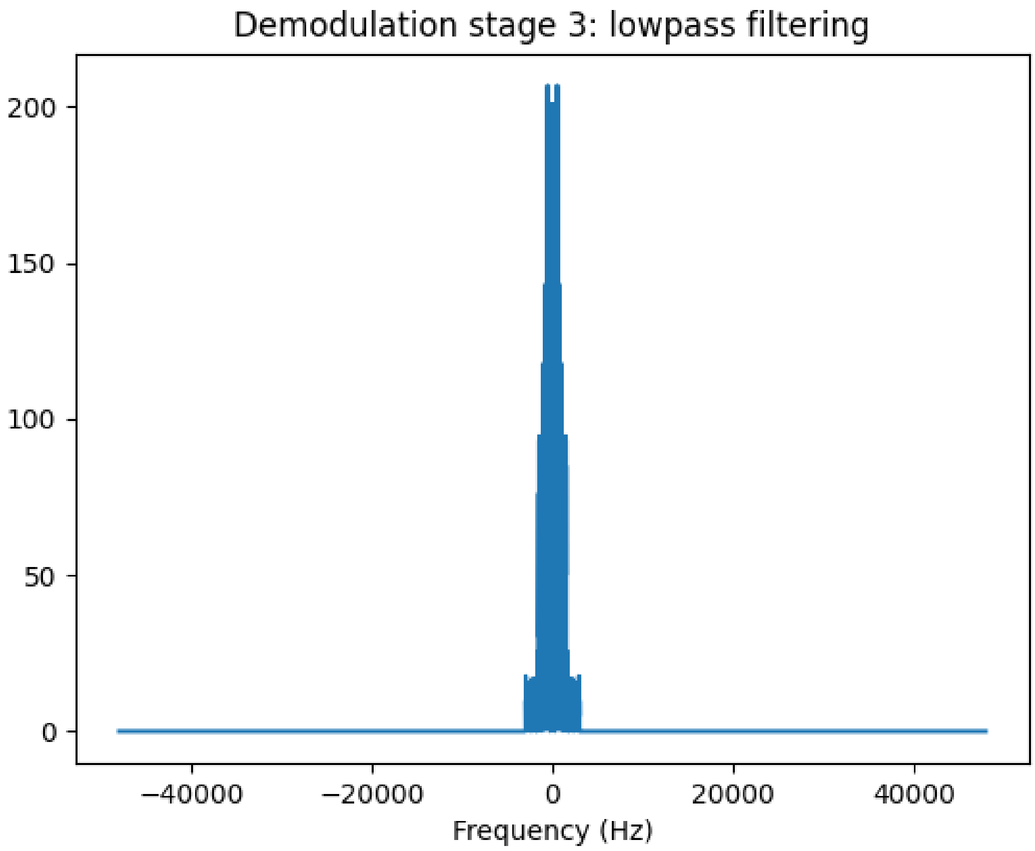


- We design new lowpass filter to get 0 around signals.

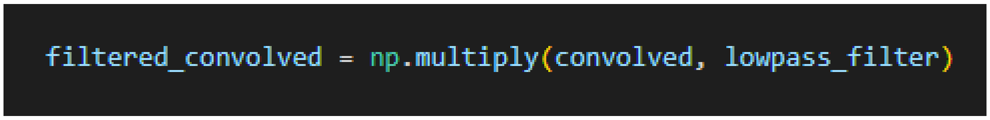


```
lowpass_filter = ((frequencies > -fd) & (frequencies < fd))
```

- **Demodulation Stage 3**

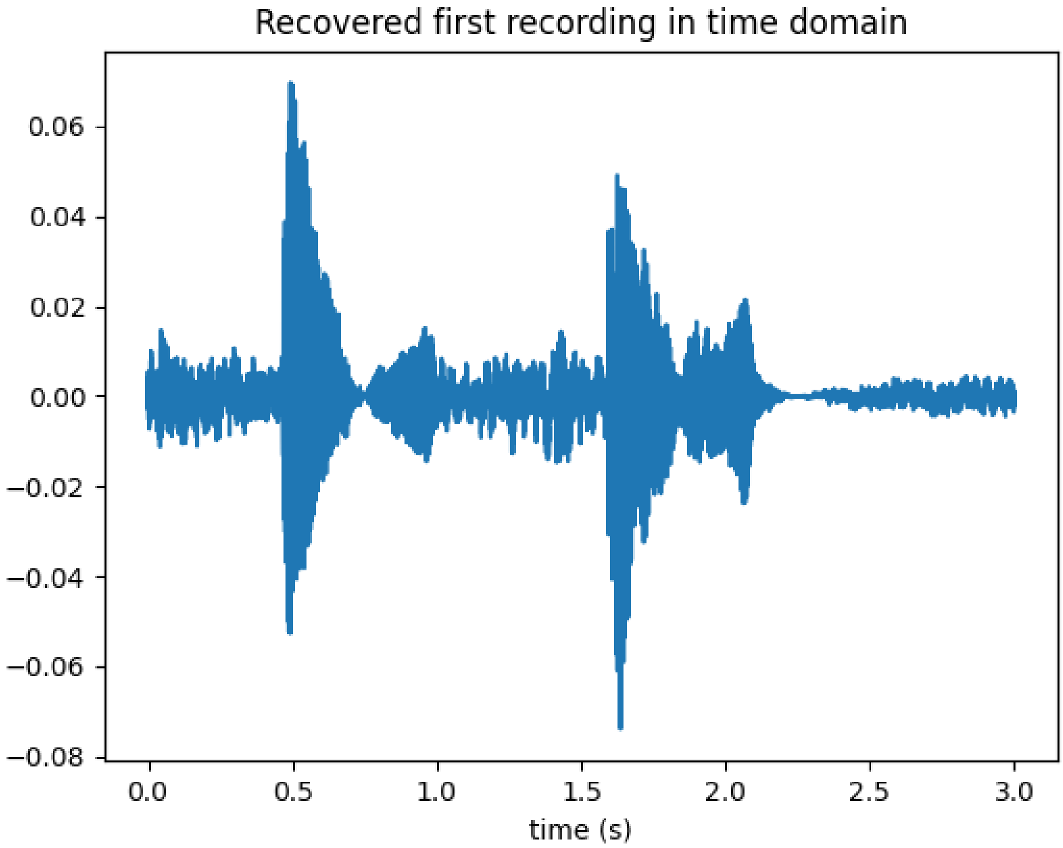


- After the multiplicaiton in frequency domain we get around 0 signals.

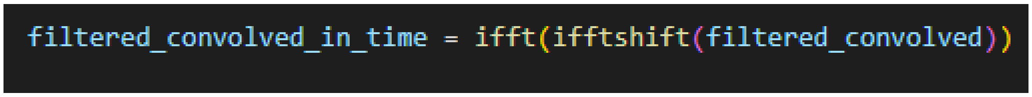


```
filtered_convolved = np.multiply(convolved, lowpass_filter)
```

- **Recoverd first recording in time domain**



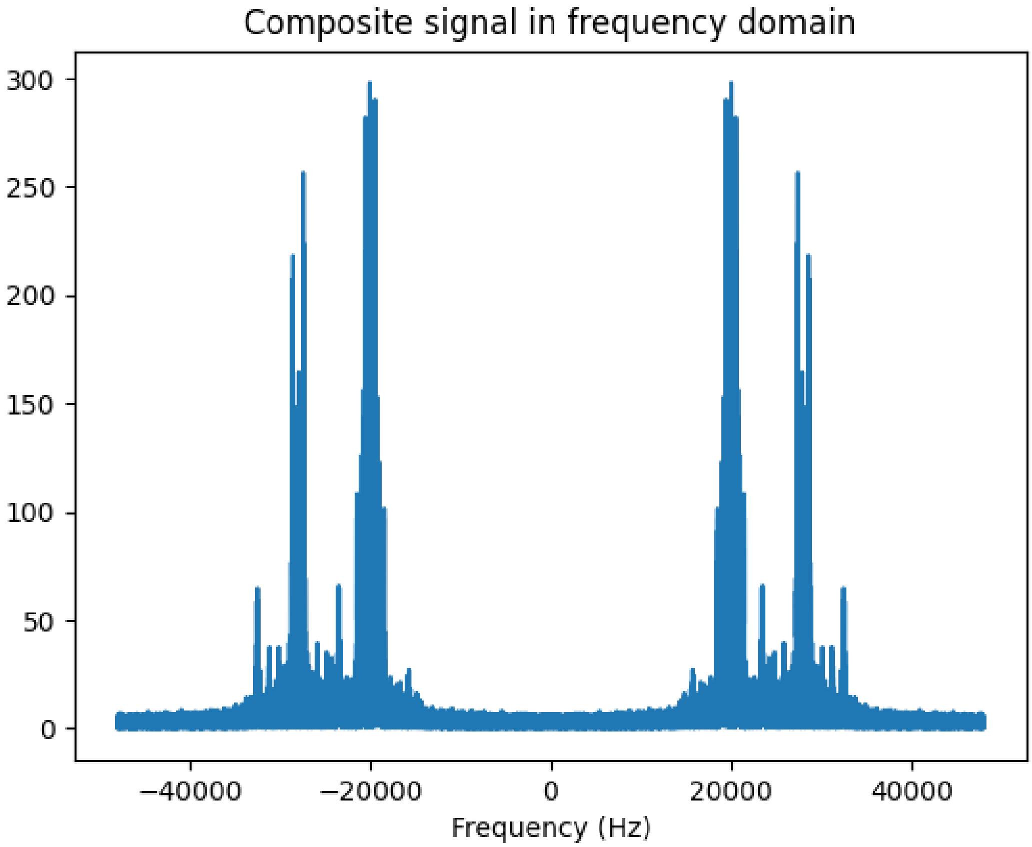
- After the inverse fr transform we get the signal.



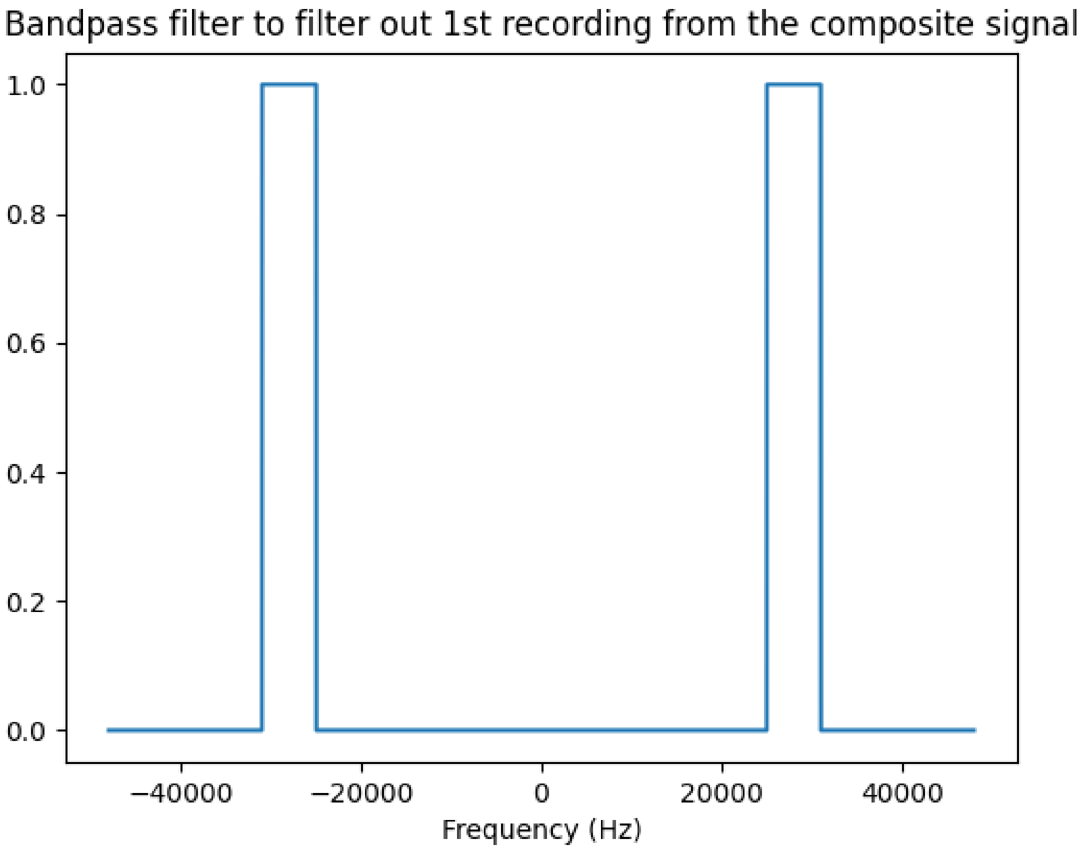
```
filtered_convolved_in_time = ifft(ifftshift(filtered_convolved))
```

Demodulating of Massage 2 – 28kHz –

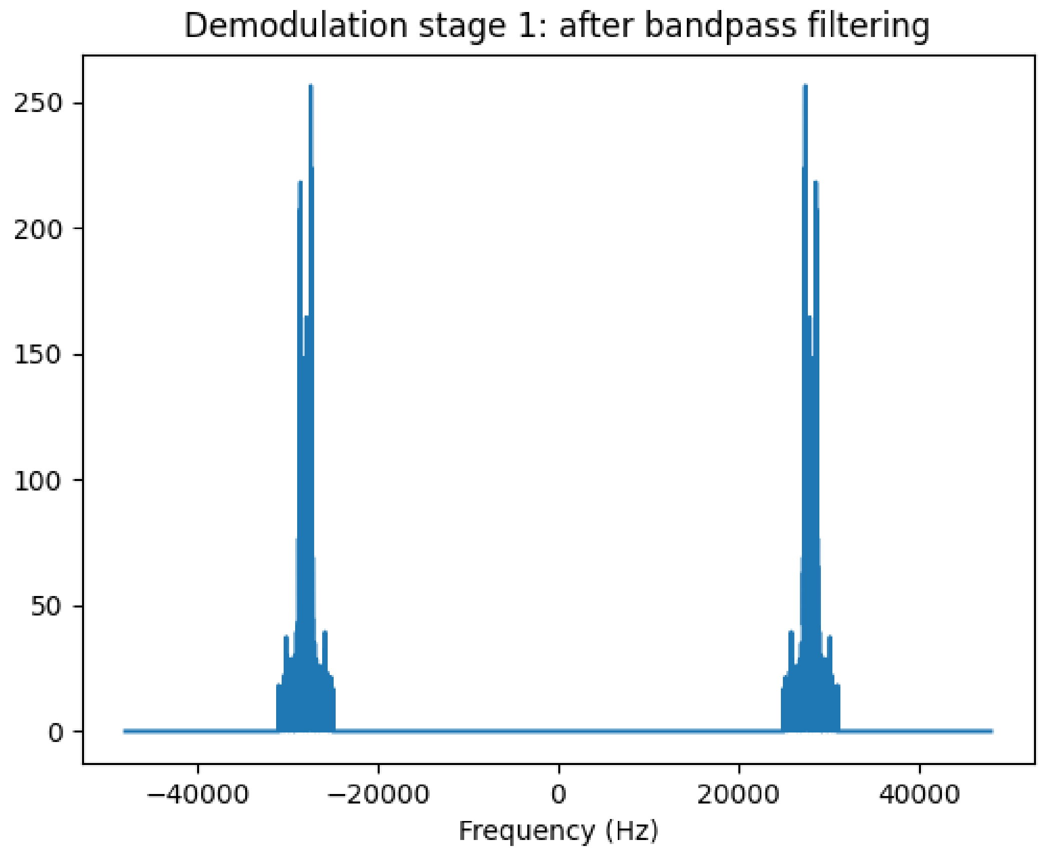
- **Composite signals in frequency domain**



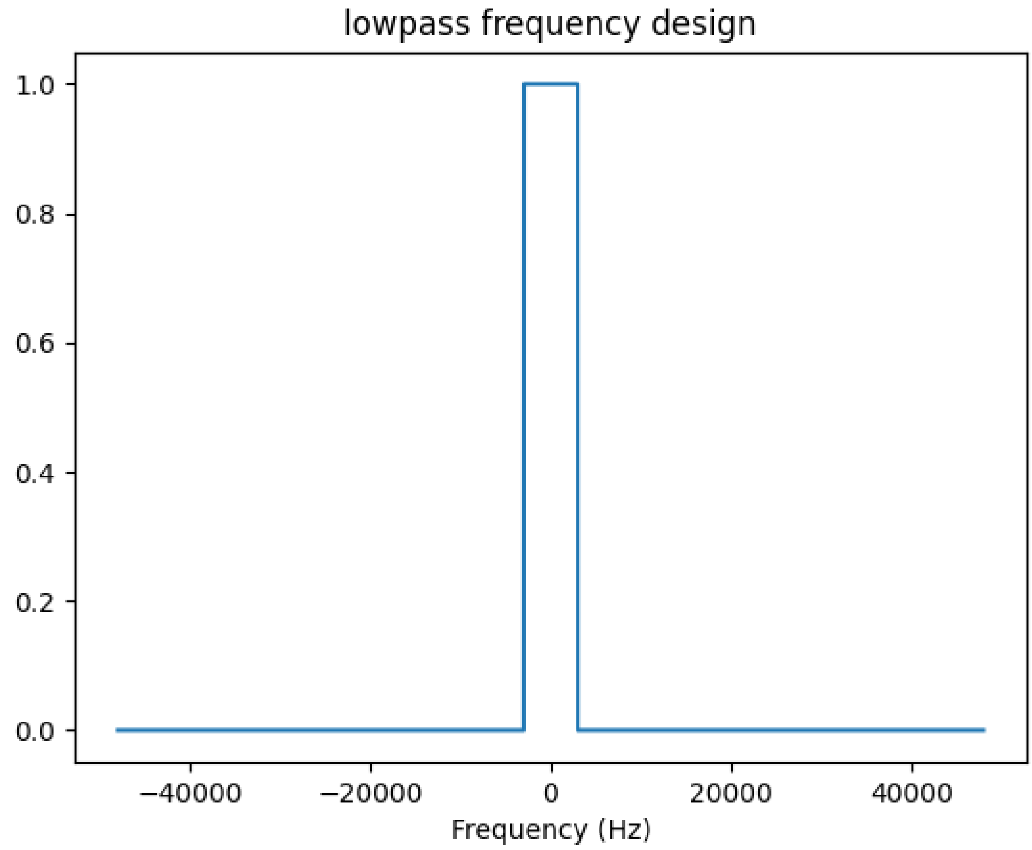
- **Bandpass Filter for Massage 2**



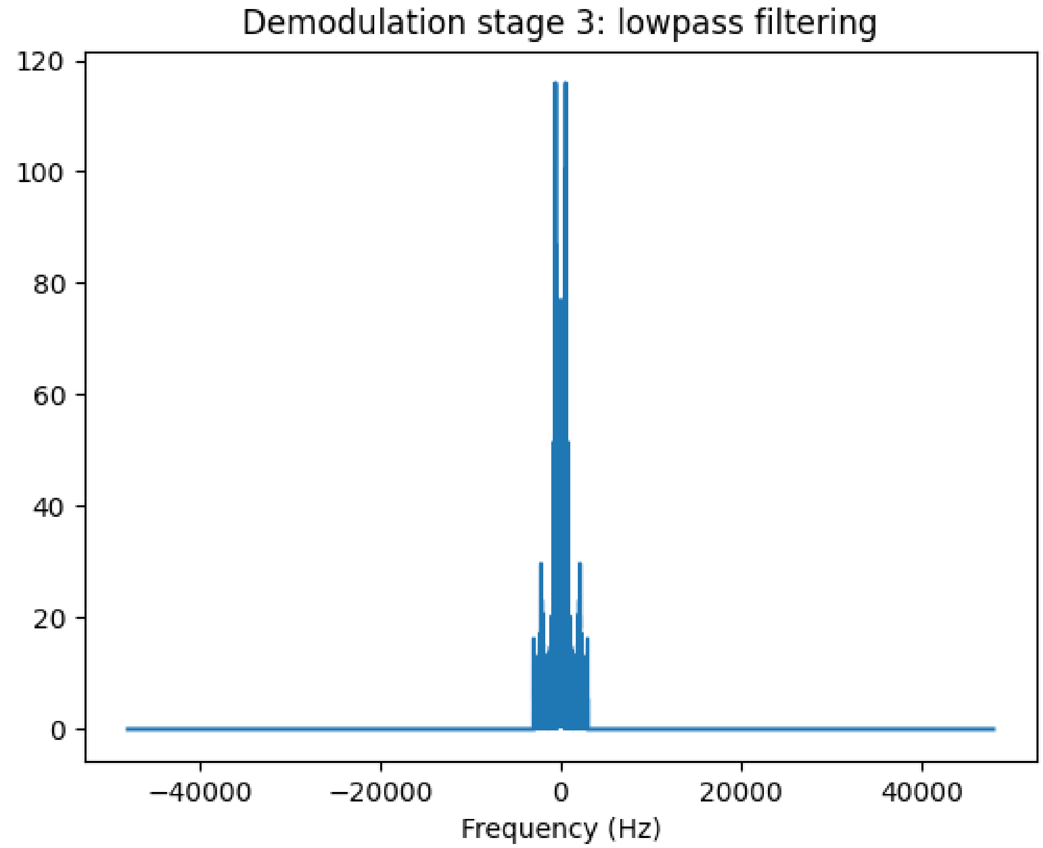
- **Demodulation Stage 1**



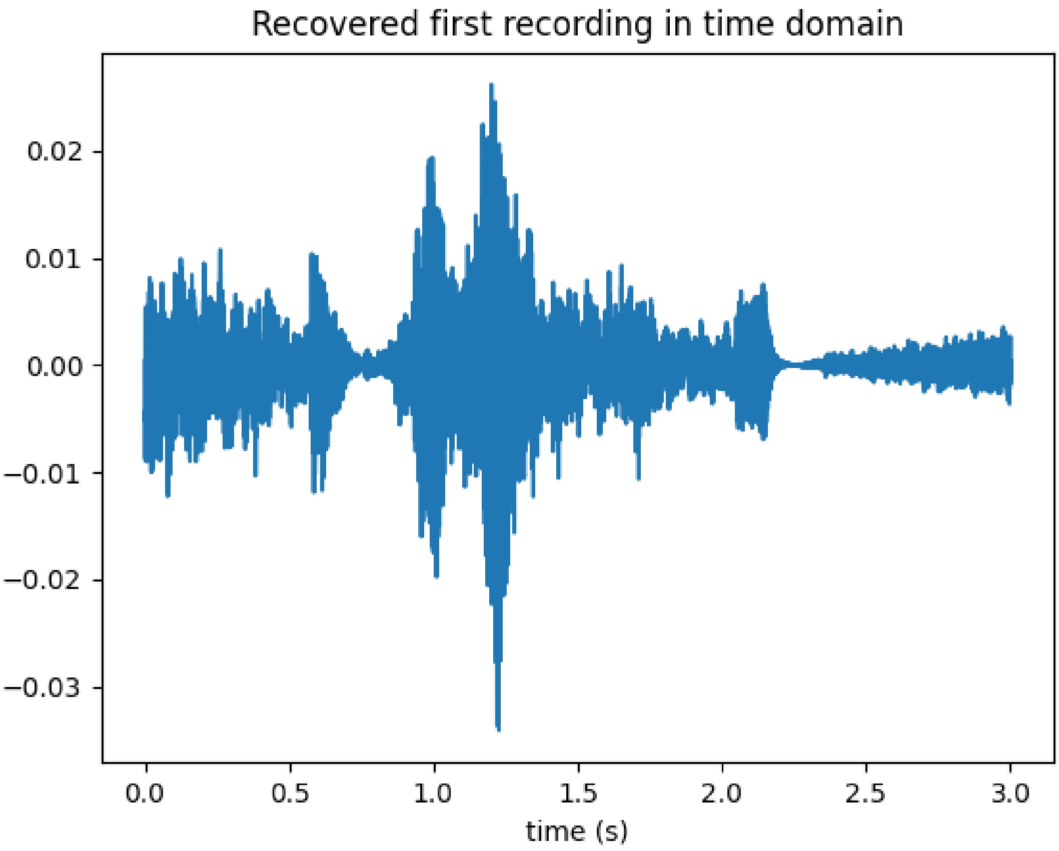
- **Lowpass frequency design**



- **Demodulation Stage 3**



- **Recoverd first recording in time domain**


Recovered first recording in time domain
time (s)