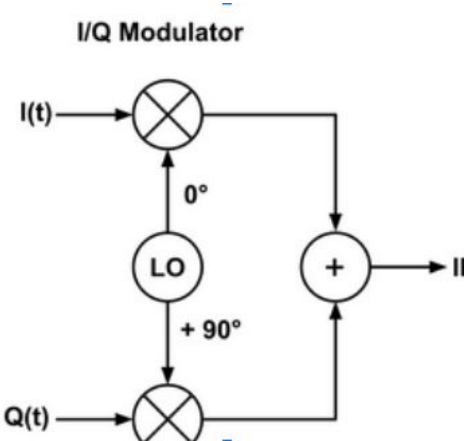
EE 340: Communication Laboratory
Autumn 2021

Lab 4: IQ Modulation-Demodulation
&
Single Sideband Modulation

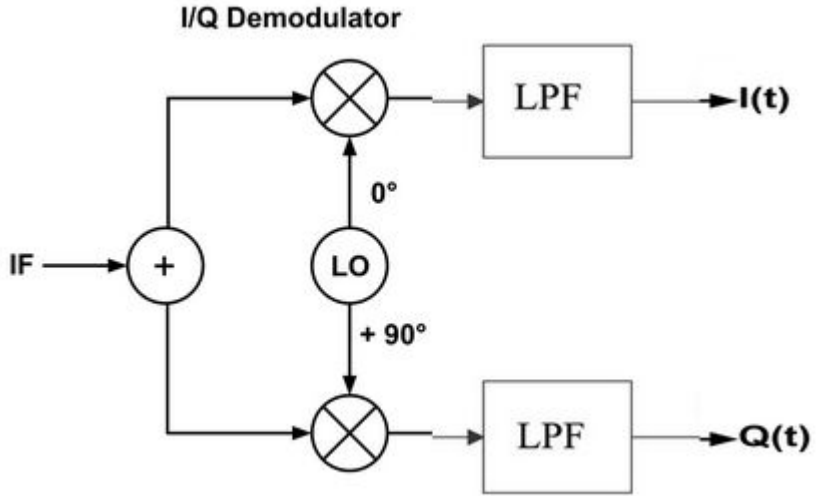
Task 1.1: IQ Modulation

- An IQ modulator is typically used for upconverting a complex baseband signal to a passband intermediate frequency (IF) or radio frequency (RF) signal.
- Its equation can be given as, $s(t) = I(t)*\sin(2\pi f_c t) + Q(t)*\sin(2\pi f_c t + 90_o)$
- Implement the IQ modulation using two music files given (music.wav & vocal.wav)
  - Treat one as in-phase signal and the other as quadrature-phase.
- Use the carrier frequency as 100KHz, sampled at appropriate rate.
- Store the modulated signal in data1.dat file in file sink.



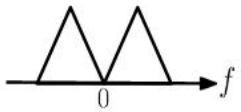
Task 1.2: IQ Demodulation

- Demodulate the IQ modulated signal using shown block diagram, from data stored in data1.dat file.
- Use a low pass filter to filter higher unwanted frequencies.
- Play the demodulated audio files. Observe if you get a faithful reconstruction.

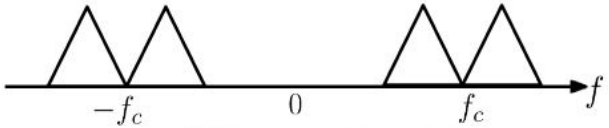


Task 2: Single Sideband Modulation

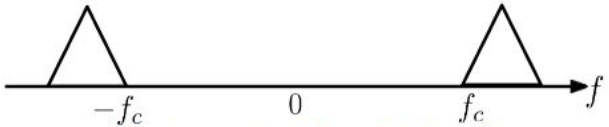
- You have already implemented DSB-SC modulation. Our goal today is to implement single sideband modulation – here, only one sideband of the message is transmitted. For real messages, note that this is sufficient. This requires only half the bandwidth of DSB transmission!



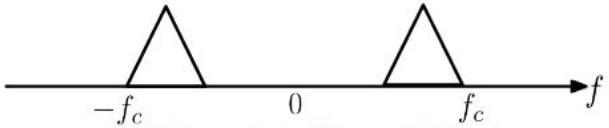
Message signal



DSB-SC transmitted signal



SSB-SC (upper sideband) transmitted signal



SSB-SC (lower sideband) transmitted signal

Task 2: SSB Contd

- Implement the modulation flowgraph for SSB-SC (upper sideband) transmission. Use a single tone at 10kHz as the message and 500 kHz as the carrier frequency.

Hint: Think of the transmitted (passband) signal as

$$s_p(t) = \mathrm{Re}\left([s_I(t) + js_Q(t)]e^{j2\pi f_c t}\right)$$
$$= s_I(t)\cos(2\pi f_c t) - s_Q(t)\sin(2\pi f_c t)$$

What should s_I and s_Q be for SSB transmission? Use Hilbert Txform

- Observe the spectrum of the modulated signal.
- Implement the demodulation flowgraph.
- Observe the spectrum of the demodulated message signal
- Replace the tone message signal with an audio message. Can you recover the message post-demodulation?
- Repeat the above to achieve lower sideband transmission.