Analog Communications

MATLAB implementation of a superheterodyne receiver

Contents

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1. ***The transmitter***

This part contains the following tasks

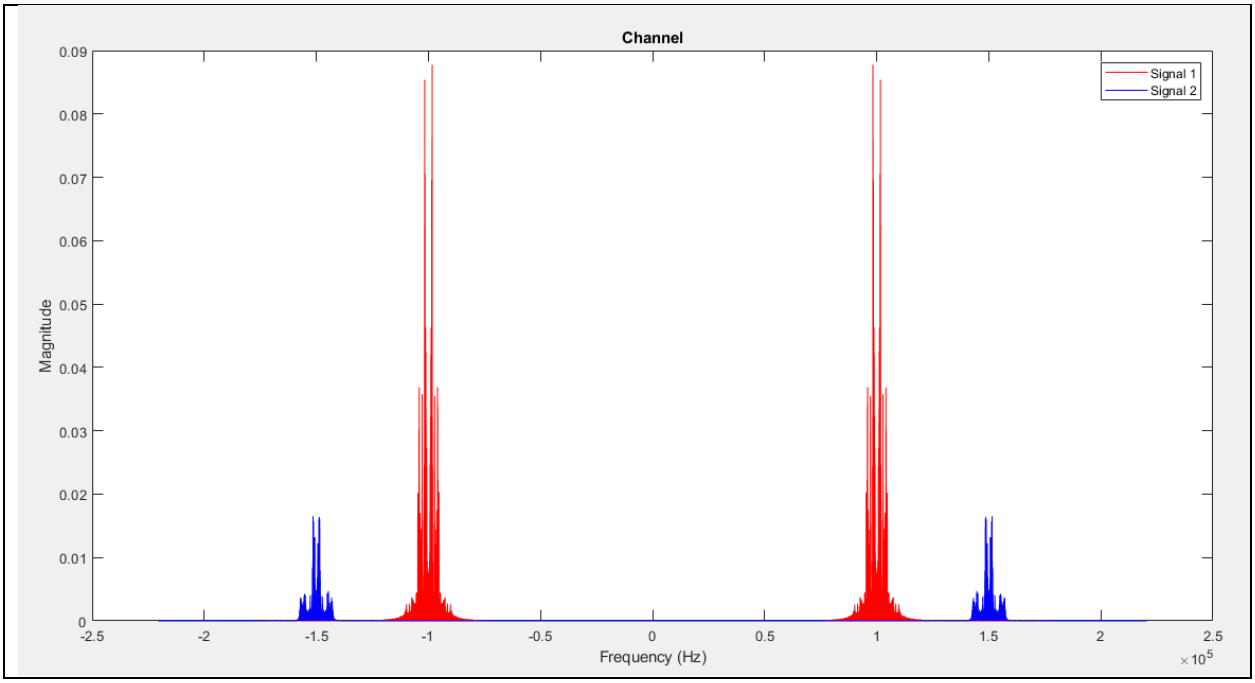
1. Reading monophonic audio signals into MATLAB.
2. Upsampling the audio signals.
3. Modulating the audio signals (each on a separate carrier).
4. Addition of the modulated signals.

Discussion

```
First of all I read the file and the sampling frequency then checked if the
file is in mono mode or stereo mode to convert it to mono mode. I created
carriers through function GetCarrier(I codded it) at the required
frequencies then I multiplied the signal by the carrier to get the modulated
signal and then added the two signals as this will happen in the real state
```

The figures

Figure 1: The spectrum of the output of the transmitter



2. ***The RF stage***

This part addresses the RF filter and the mixer following it.

Discussion

```
This stage is required to remove the image frequency (signals at FC+IF, FC-
IF) where FC is the frequency of the carrier and IF is the intermediate
frequency
```

The figures

Assume we want to demodulate the first signal (at ω_o).

Figure 2: the output of the RF filter (before the mixer)

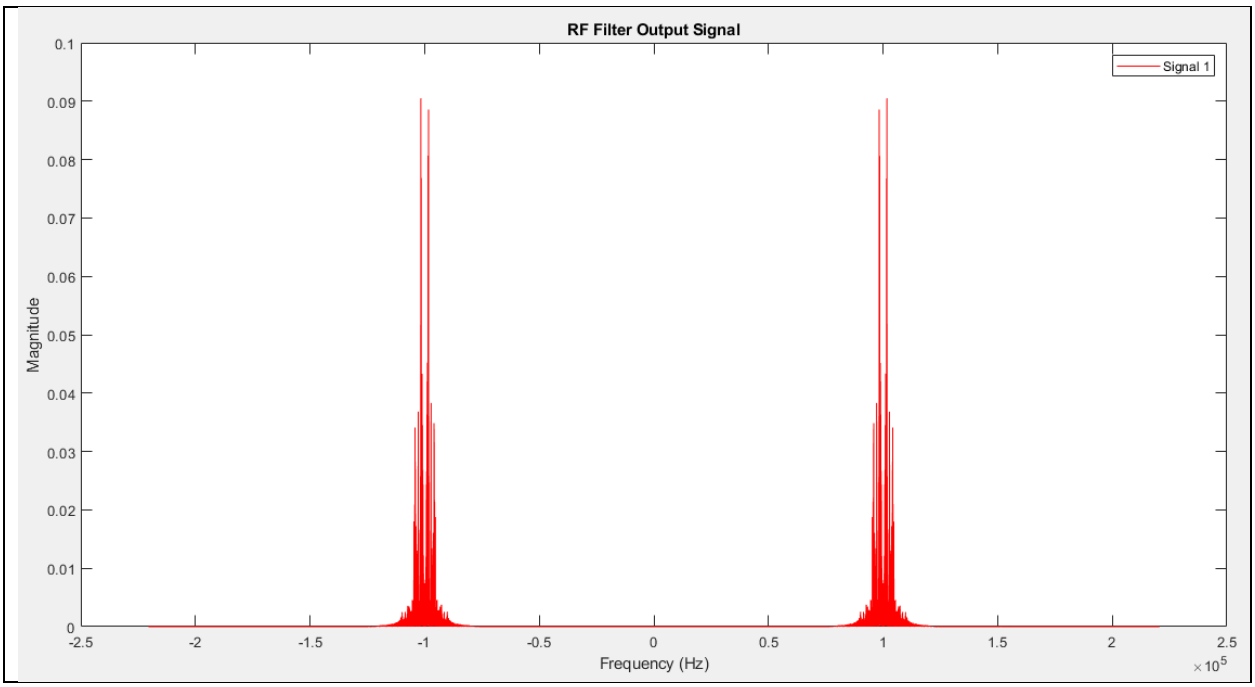
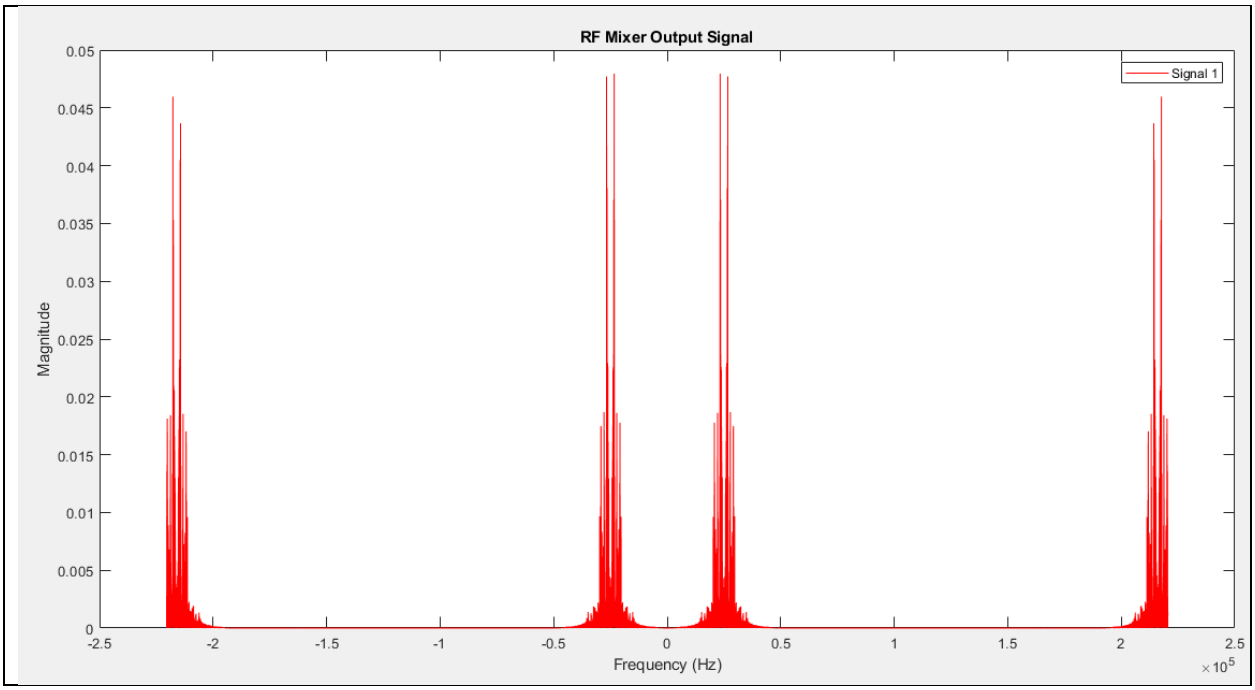


Figure 3: The output of the mixer



3. The IF stage

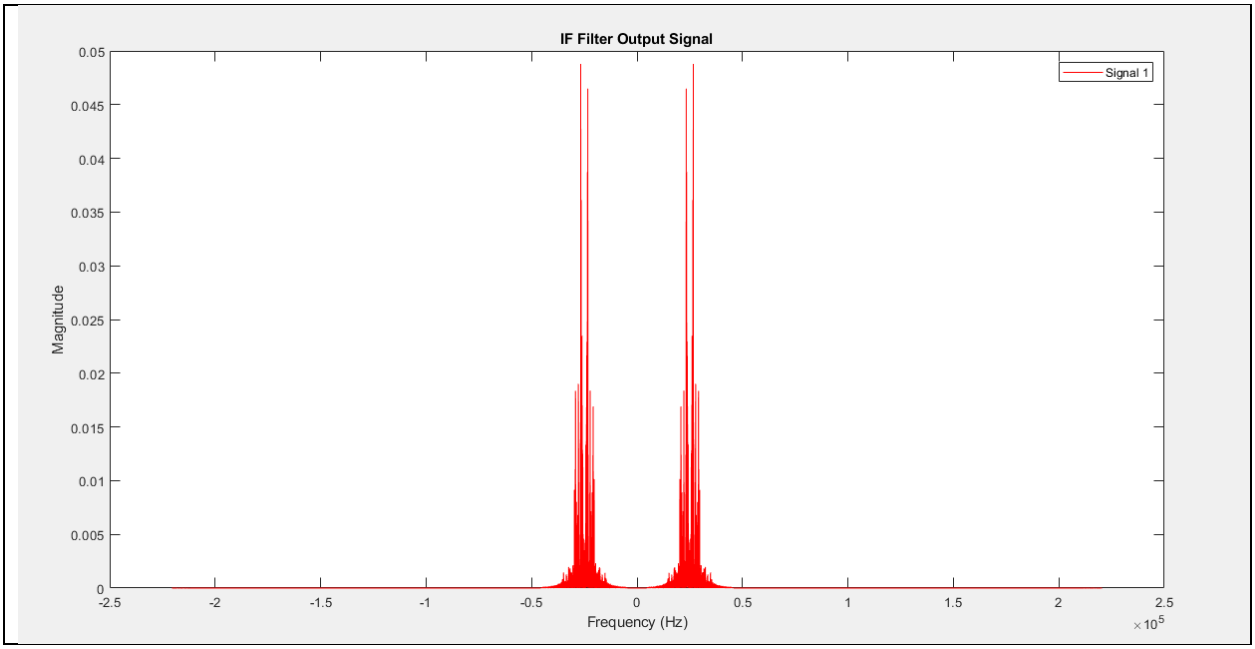
This part addresses the IF filter.

Discussion

```
IF filter selects and get the required message we need it to have only the required
message at the intermediate frequency. It has centre freq. at the IF_freq. and
BW_filter= 2*(message BW).
```

The figures

Figure 4: Output of the IF filter



4. The baseband demodulator

This part addresses the coherent detector used to demodulate the signal from the IF stage.

Discussion

```
The mixer in this stage is to multiple signal with carrier freq.= IF_freq.
we need it to get the signal at the baseband. LPF filter selects and get the
required message. we need it to have only the required message at the baseband.
```

The figures

Figure 5: Output of the mixer (before the LPF)

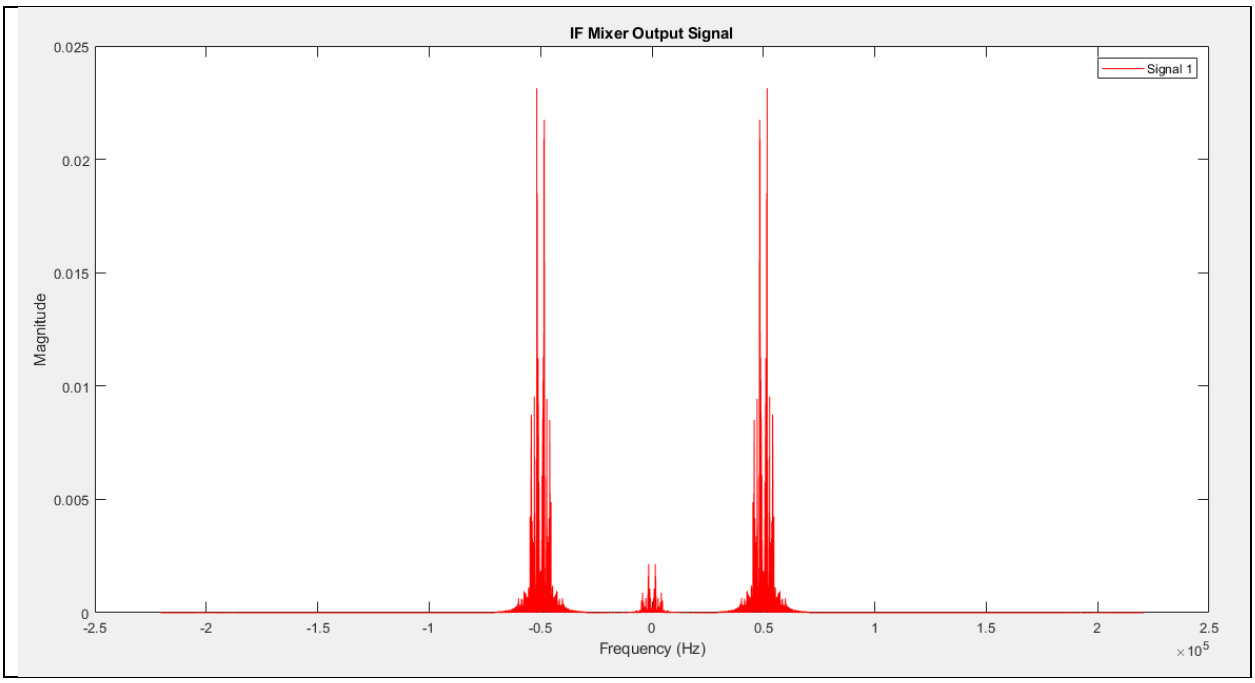
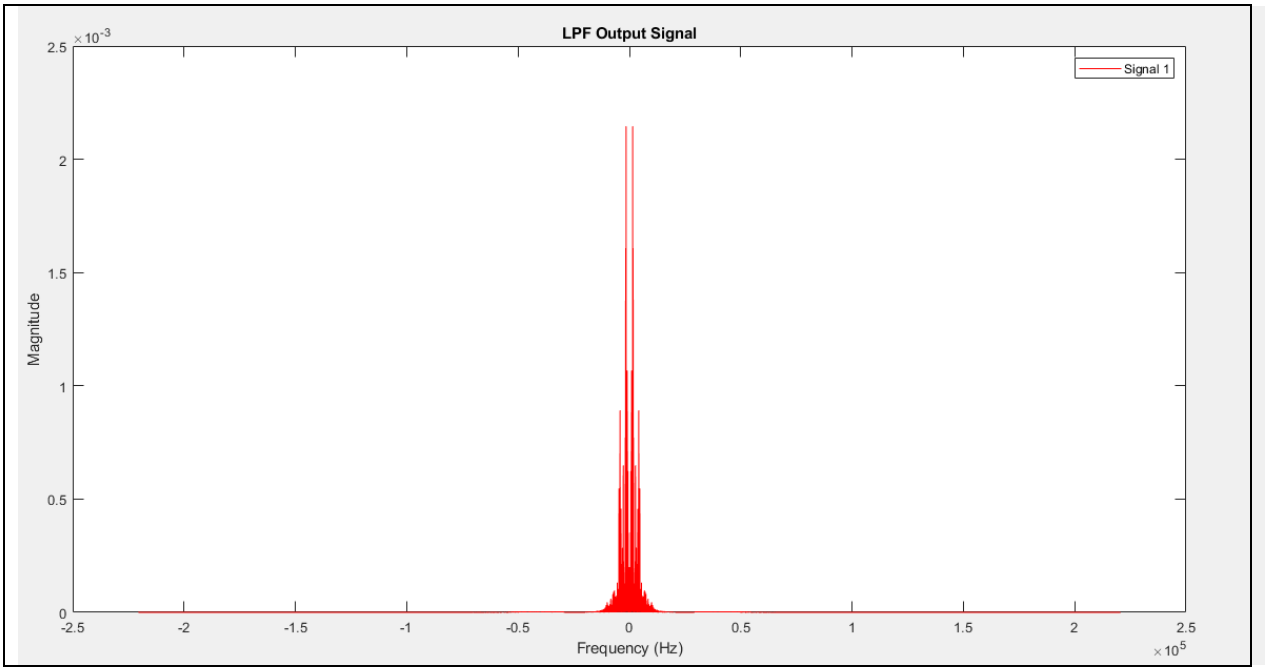


Figure 6: Output of the LPF



5. ***Performance evaluation without the RF stage***

The figures

Figure 7: output of the RF mixer (no RF filter)

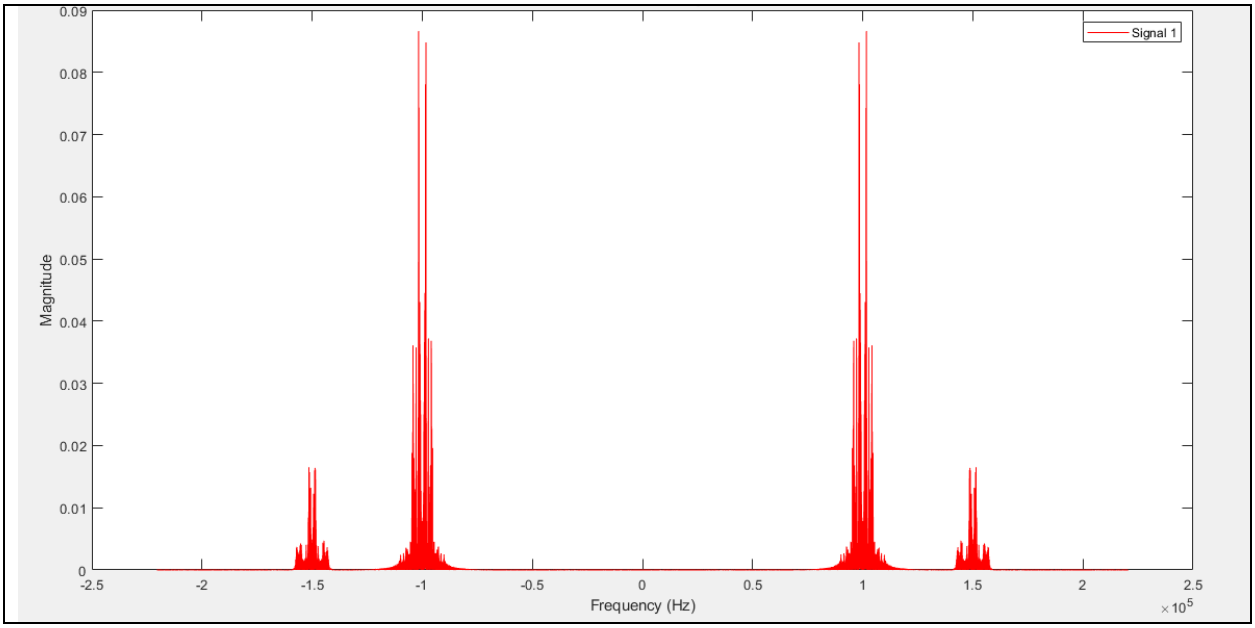


Figure 8: Output of the IF filter (no RF filter)

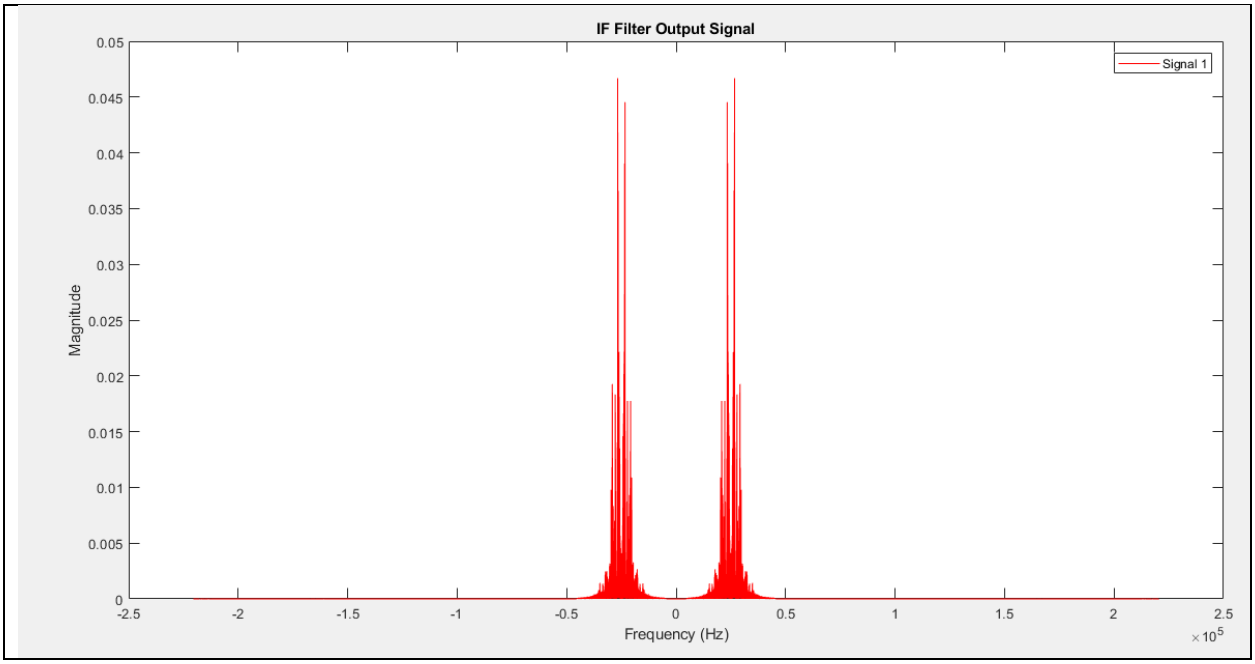


Figure 9: Output of the IF mixer before the LPF (no RF filter)

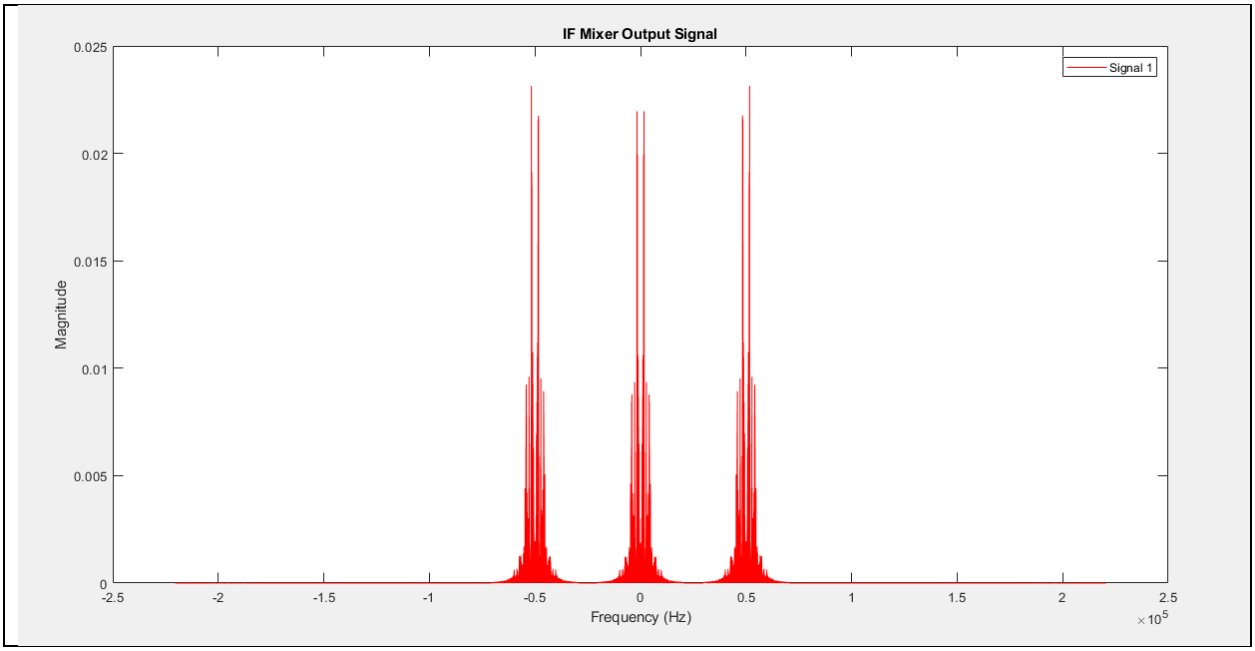
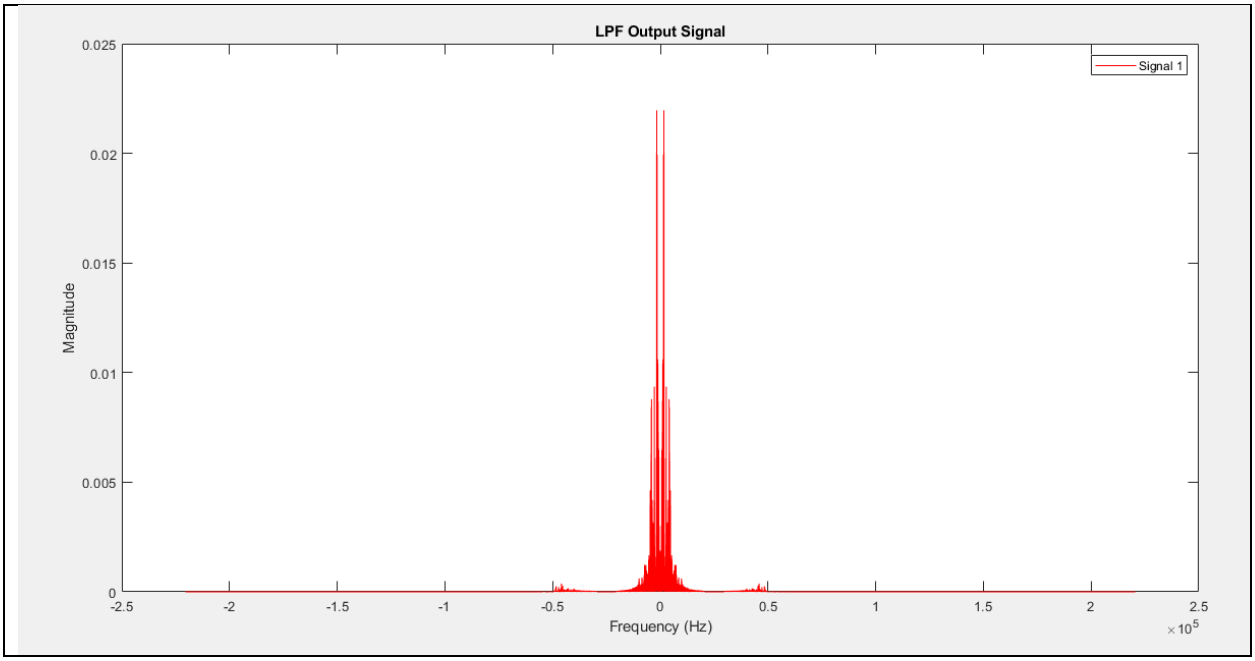


Figure 10: Ouptut of the LPF (no RF filter)



6. ***Comment on the output sound***

the sound at the existence of the RF stage is the required message loud and clear. The sound at the absence of the RF stage is the required message and the image message which is not recognisable.

What happens (in terms of spectrum and the sound quality) if the receiver oscillator has frequency offset by 0.1 KHz and 1 KHz

At offset= 0.1 KHz the sound of the message is not clear it has noise .This happens as freq. offset causes attenuation and distortion of signal spectrum as output will be multiplied by cos(freq.offset*t)