

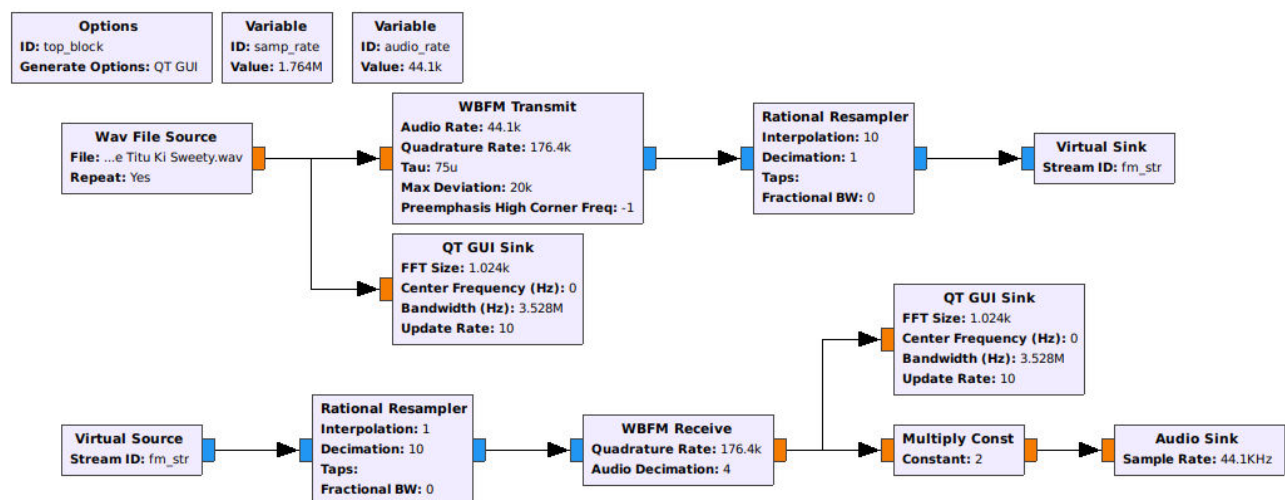
EXPERIMENT-2

WIDEBAND FREQUENCY MODULATION

Transmit and Receive Audio using WBFM Modulation and Demodulation

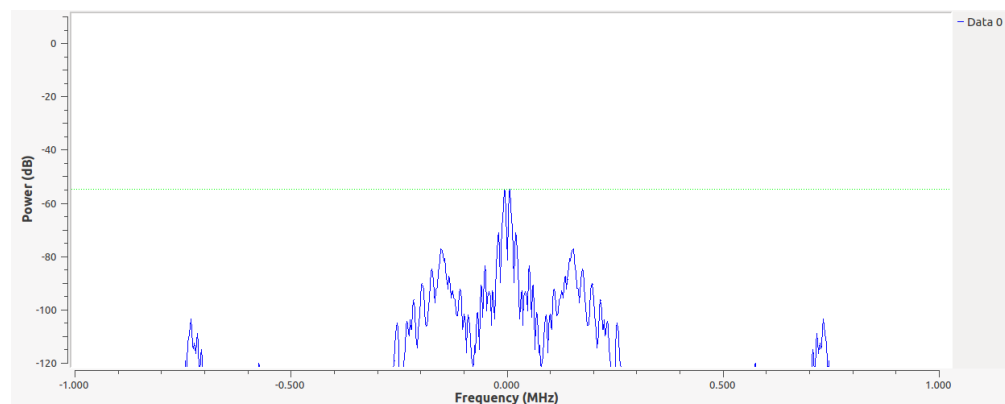
Simulation of WBFM using GNU Radio

Flowgraph for simulation is shown below:



Transmitter:

1. At the transmitter side an audio signal (in .wav format) file is fed into “WBFM Transmit” block which does the frequency Modulation (FM).
2. Then the modulated signal is resampled using “Rational Resampler” block to increase the number of samples.
3. WBFM signal is then transmitted virtually using an “Virtual Sink” block with Stream id “fm_str”.

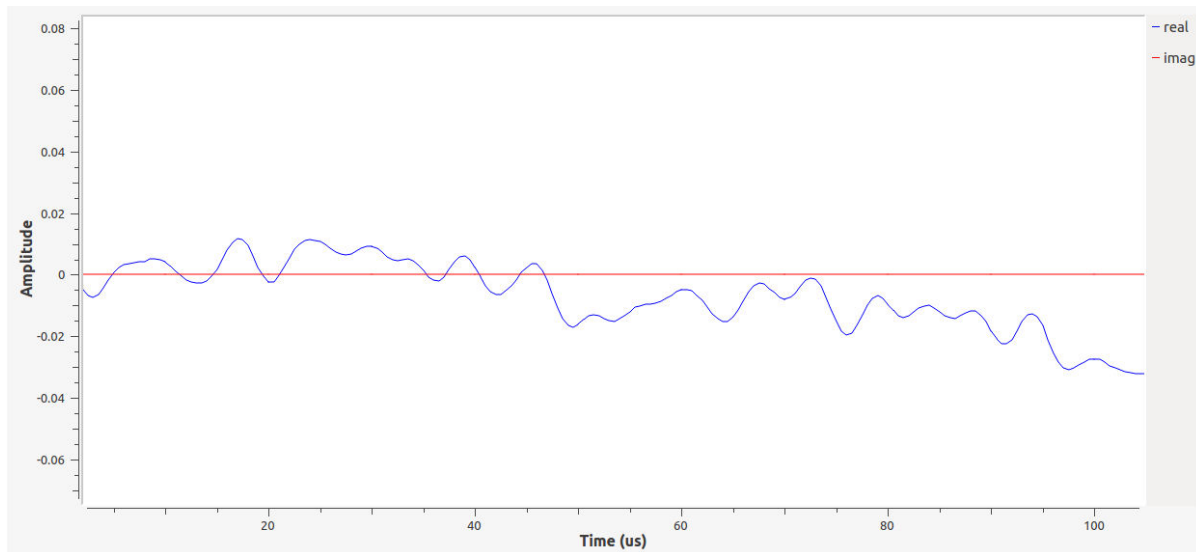


Receive

1. At receiver side, a “Virtual Source” block is used to

virtually receive the transmitted signal at stream id “fm_str”.

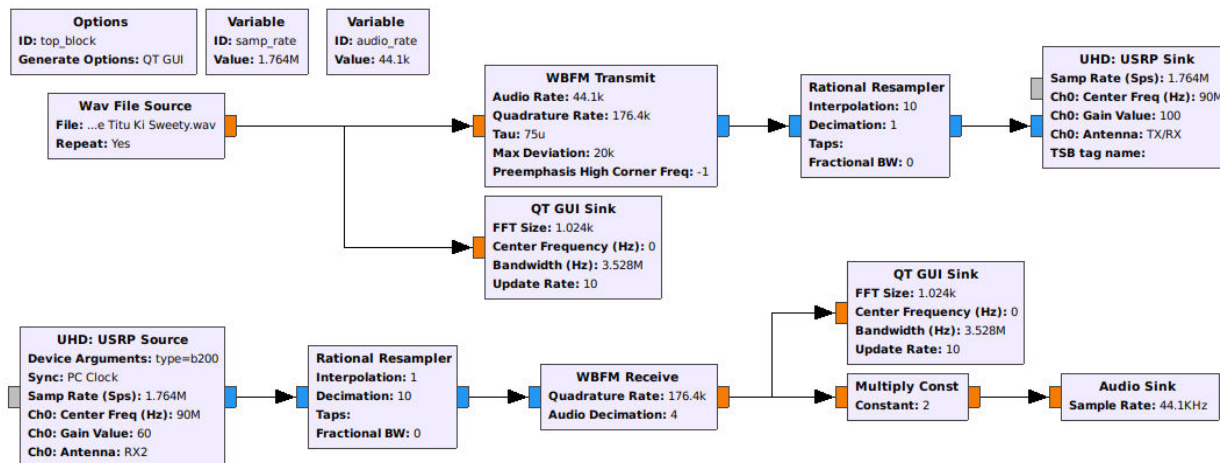
2. This received signal is then fed into “Rational Resampler” block to decrease the number of samples. Then a “WBFM Receive” block demodulate the FM signal.
3. Output is multiplied by a constant to increase its gain and then fed into “Audio Sink” block to hear it.



Testing WBFM using USRP

The final testing was done using USRP. The only change in flowgraph is that we replaced “Virtual Sink” block on transmitter side by “UHD: USRP Sink” block and “Virtual Source” block on receiver side by “UHD: USRP Source”.

Flowgraph for testing using USRP is shown below:



We transmitted our FM signal at 90 MHz and received it using both USRP and mobile phone.

Key Points:

The Quadrature rate parameter indicates, at what rate the demodulated signals are passed out. The desired quadrature rate in this case is 176.4 KHz with a decimation factor of 4. The quadrature rate is always a multiple of Audio rate.

Results

The audio signal is successfully transmitted using USRP. Following observations are made:

1. **Noise:** When transmitting using USRP we observed some white noise but it was less as compared to the case of Amplitude Modulation. Audio quality in FM is better than AM. Thus we can conclude that FM has better noise immunity than AM.
2. **Attenuation and Fading:** We observed significant loss in power of transmitted signal. When relative position of transmitting and receiving antennas are changed then we observed fading.