PERFORMANCE OF AM RECEIVERS IN PRESENCE OF NOISE

IEC 214:Principles Of Communication

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AMPLITUDE MODULATION

Amplitude modulation is the process of varying the amplitude of a carrier signal following a baseband signal.

Carrier Signal: $c(t) = A_c \cos 2\pi f_c t$

Message Signal be m(t)

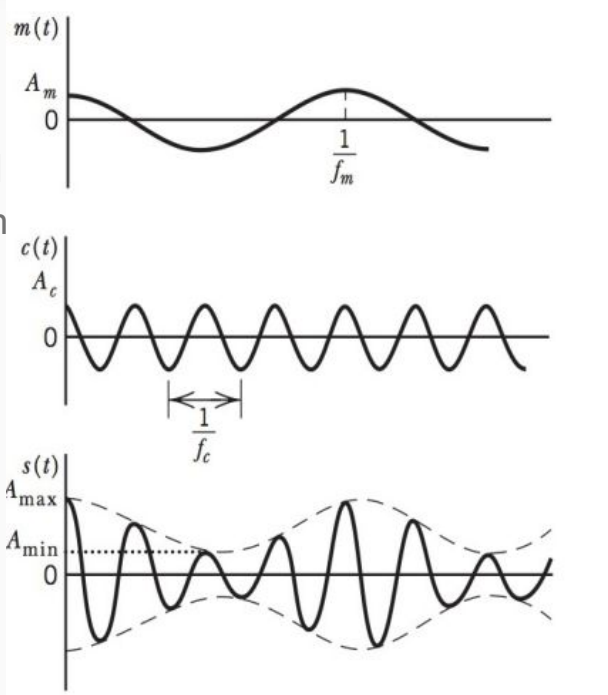
Then the Amplitude Modulated signal will be

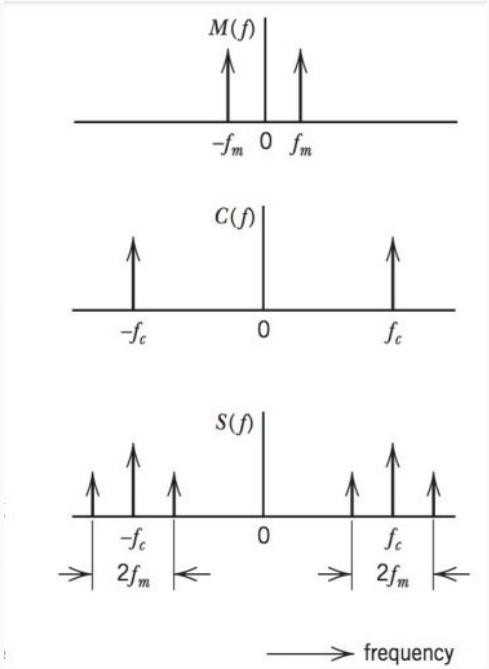
$$s(t) = A_c\left(1 + k_a m(t)\right)\cos 2\pi f_c t$$

AMPLITUDE MODULATION

Graphical Representation:

Time Domain and frequency domain

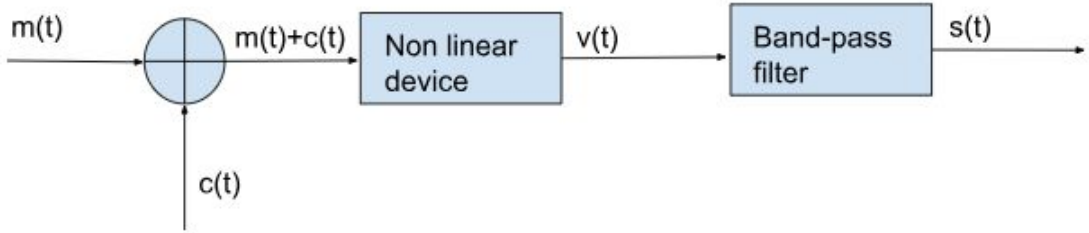




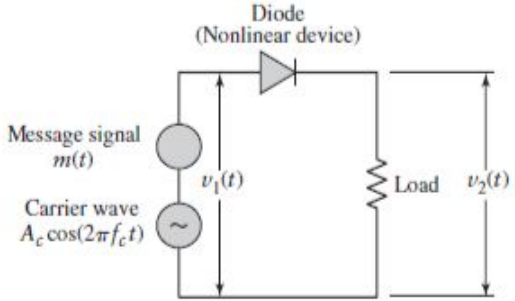
MODULATORS(Transmitters)

Amplitude Modulation can be accomplished by various devices like switching modulators, square-law modulators, product modulators, quadrature amplitude modulators, and so many others.

Square Law Modulator



Switching Modulator



AMPLITUDE DEMODULATION

The process of reconstructing or retrieving the message signal from the amplitude-modulated signal is called demodulation.

Demodulation can be accomplished by some detection techniques. A major technique is the Envelope detection.

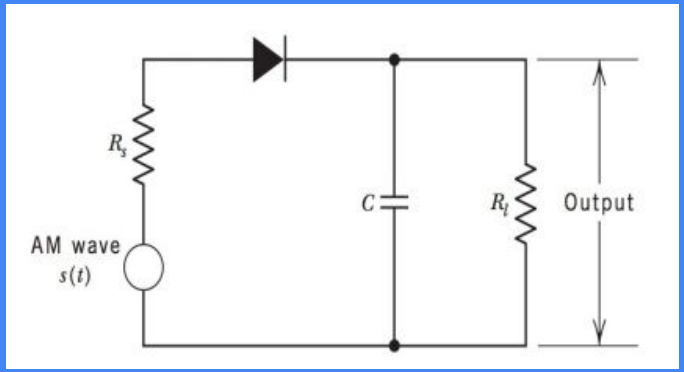
Amplitude demodulation can be done with the help of a detector or demodulator. Generally we use envelope detection method.But there are various other methods especially coherent detection(synchronised detection).

In the next slide an Envelope detector is described:

As the diode switches between ON and OFF state, the capacitor charges and discharges. Capacitor discharges through the load resistance. The charging and discharging forms an envelope which is the message signal. The discharging time must be larger and charging must be faster.

Charging Time $(r_f + R_C)C << \frac{1}{f_c}$

Discharging time $\frac{1}{f_c} << R_l C << \frac{1}{W}$



Disadvantages of Amplitude Demodulation

->Noise generally affects the amplitude of the signal. Hence the reception of the actual signal would be difficult since it's hard to separate noise from the actual signal.

->AM signals are less immune to atmospheric interference, hence when receiving the signal the demodulator interprets that as a part of the actual signal and thus results in distortion.

->Thus generally the demodulation process of AM signals is not so accurate.

ANALYZING PERFORMANCE IN PRESENCE OF NOISE IN RECEIVER

NOISE IN AM

Noise in communication systems is the unwanted signals that corrupt or disturb the signal that we are transmitting.

AM is more vulnerable to noise since the amplitude of the carrier is varied concerning the message signal. Since most types of noise also impact amplitude, AM receivers are especially sensitive to noise, resulting in a low signal-to-noise ratio.

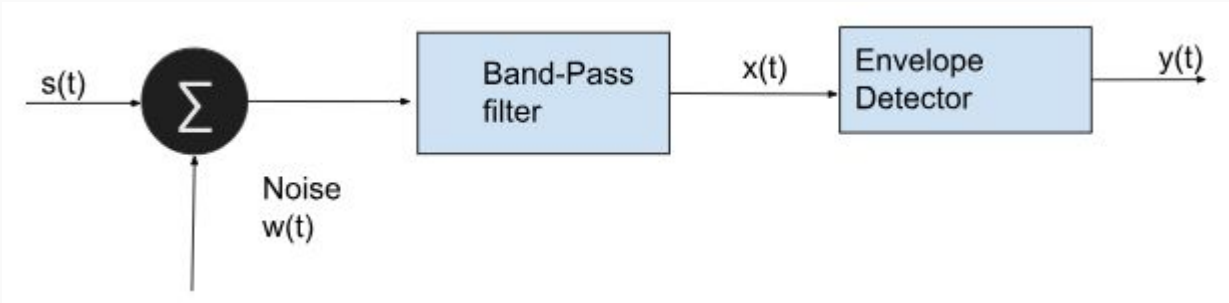
Hence for AM receivers, in the presence of noise, the reconstruction of the message signal will not be accurate.

Noisy Model Of AM Receiver

s(t)-Modulated signal

w(t)-white noise

x(t)=s(t)+w(t)or n(t)



SNR AND FIGURE OF MERIT(FOM)

SNR:Signal to Noise Ratio.

Here we discuss about Channel SNR and Output SNR or post SNR.

Channel SNR is the ratio of average power of modulated signal to the average power of noise in message signal

Output SNR:Ratio of avg power of demodulated output to ratio of output noise.

$$SNR_C = \frac{Average\ power\ of\ modulated\ signal}{Average\ power\ of\ noise\ in\ message\ signal}$$

$$SNR_C = \frac{(1+K_a^2 P)A_c^2}{2N_0 f_m}$$

$$SNR_O = \frac{Average\ power\ of\ demodulated\ output}{Average\ power\ of\ output\ noise}$$

$$SNR_O = \frac{A_c^2 K_a^2 P}{2N_0 W}$$

SNR AND FIGURE OF MERIT

Figure of merit(FOM) is the ratio of output SNR to channel SNR.

FOM plays a major role in performance of a receiver, since larger the FOM, better the performance of Receiver.

$$FOM = \frac{SNR_O}{SNR_C}$$

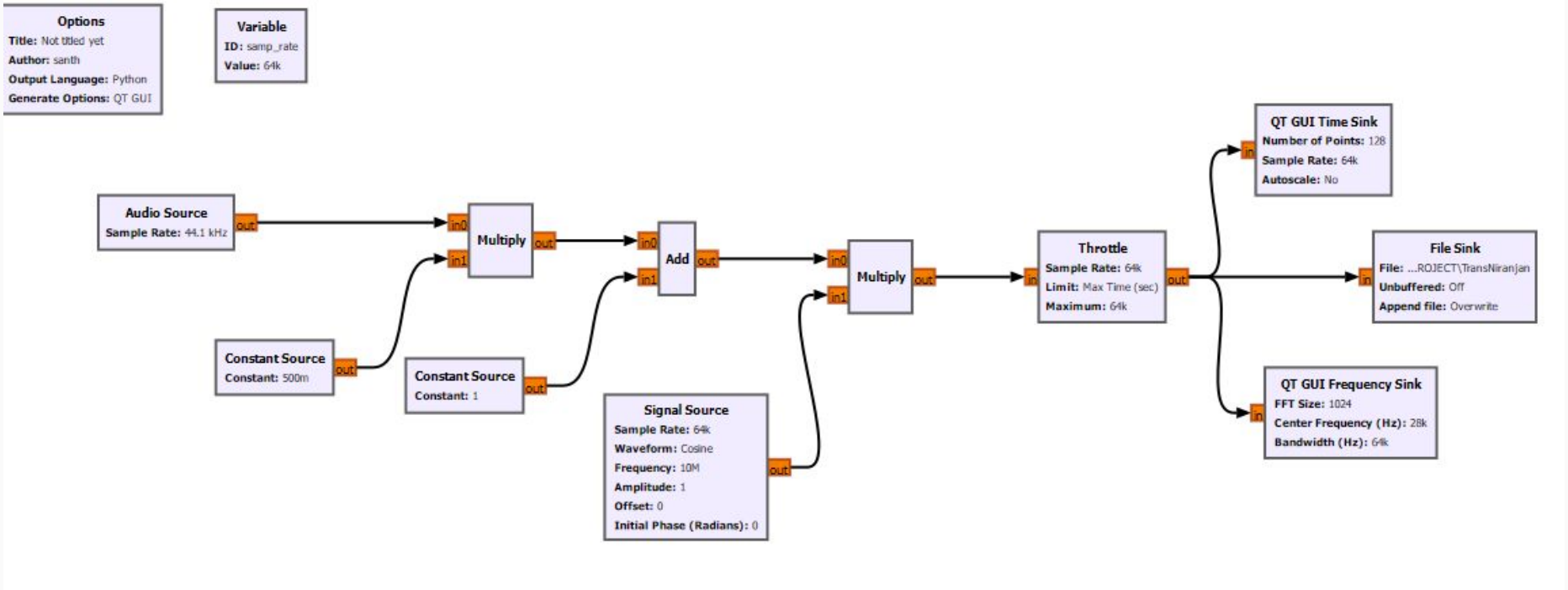
Generally AM Receivers do not perform efficiently in presence of noise since Amplitude is varied and noise affects amplitude directly. Hence it is difficult to capture or reconstruct the message signal. But we can enhance it up to a point, by increasing input signal strength, so that we may get more clear output, though it will not as clear compared to FM.

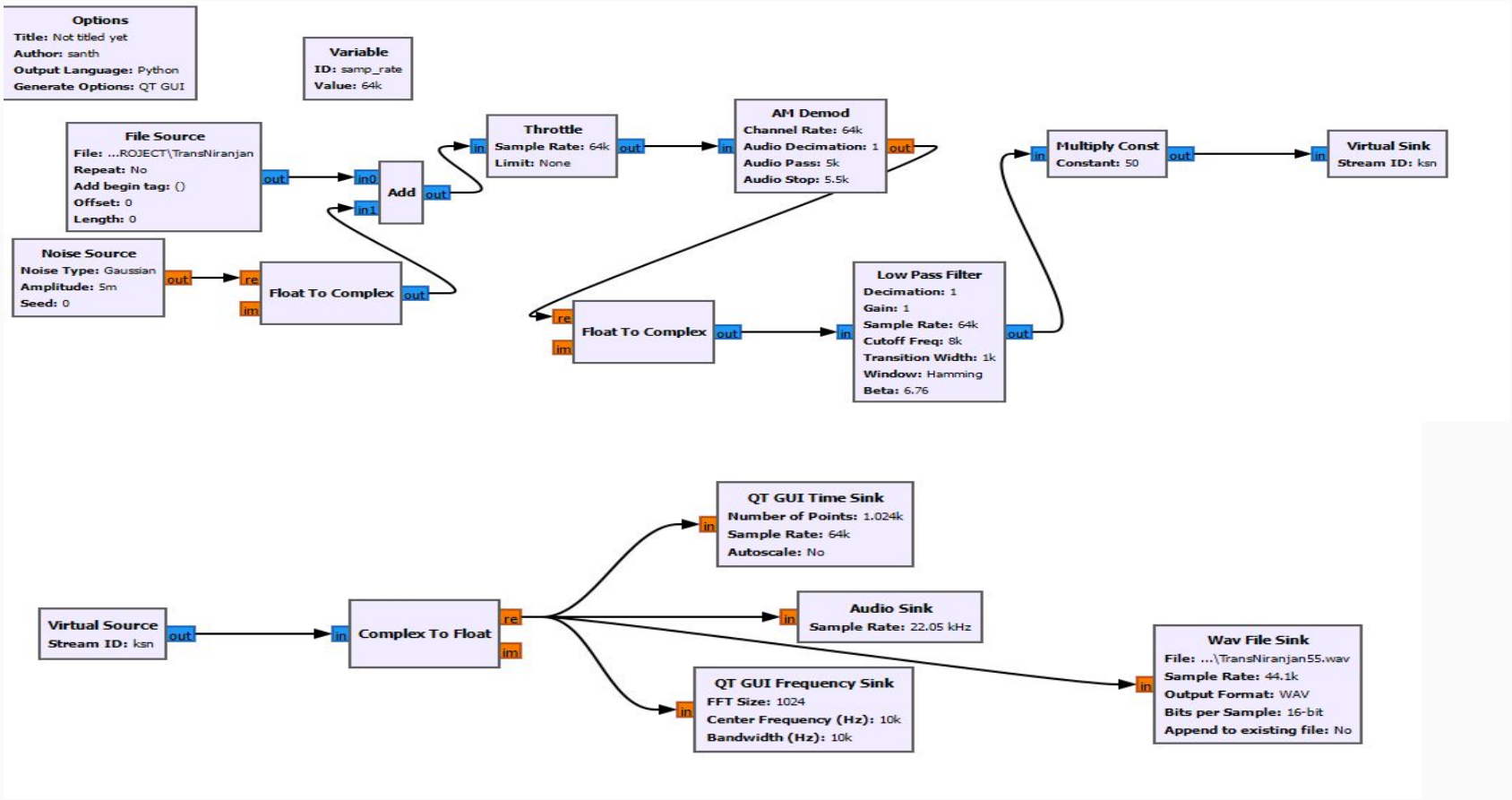
Some real world applications are:

Due to high coverage area and lower infrastructure requirements for AM Radio, it is majorly used during natural disasters and in other emergency situations so that everyone receives the information in a broad way.

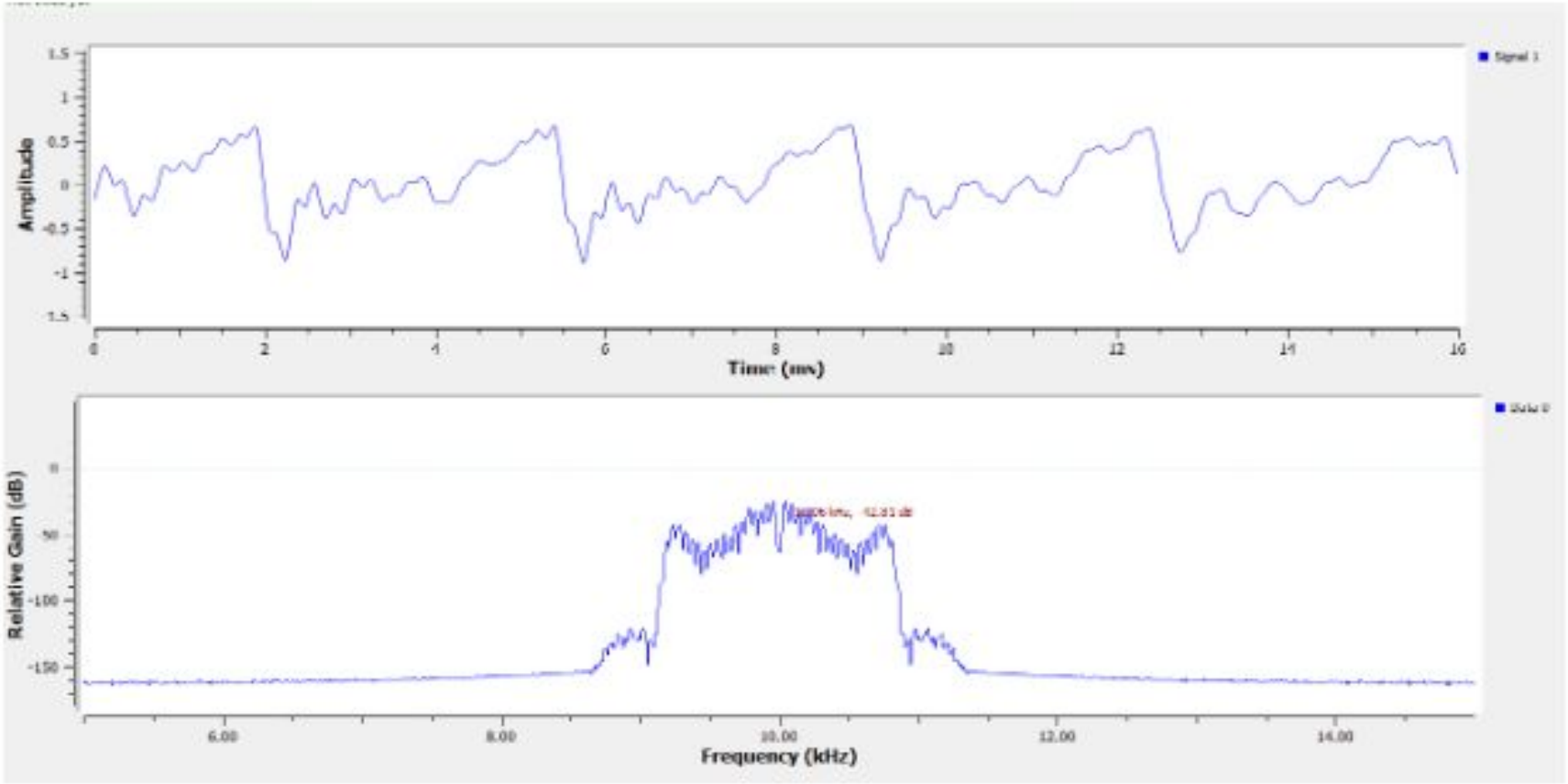
AM Radio has a long wavelength, therefore it is used in remote areas where other communication methods may not be feasible.

GNU RADIO IMPLEMENTATION (WITH Live AUDIO)


Options
Title: Not titled yet
Author: santh
Output Language: Python
Generate Options: QT GUI
Variable
ID: samp_rate
Value: 64k
Audio Source
Sample Rate: 44.1 kHz
out
Multiply
in0
in1
out
Add
in0
in1
out
Multiply
in0
in1
out
Throttle
Sample Rate: 64k
Limit: Max Time (sec)
Maximum: 64k
in
out
QT GUI Time Sink
Number of Points: 128
Sample Rate: 64k
Autoscale: No
File Sink
File: ...ROJECT\TransNiranjan
Unbuffered: Off
Append file: Overwrite
QT GUI Frequency Sink
FFT Size: 1024
Center Frequency (Hz): 28k
Bandwidth (Hz): 64k
Constant Source
Constant: 500m
Constant Source
Constant: 1
Signal Source
Sample Rate: 64k
Waveform: Cosine
Frequency: 10M
Amplitude: 1
Offset: 0
Initial Phase (Radians): 0


Options
Title: Not titled yet
Author: santh
Output Language: Python
Generate Options: QT GUI
Variable
ID: samp_rate
Value: 64k
File Source
File: ...ROJECT\TransNiranjan
Repeat: No
Add begin tag: ()
Offset: 0
Length: 0
Noise Source
Noise Type: Gaussian
Amplitude: 5m
Seed: 0
Add
Throttle
Sample Rate: 64k
Limit: None
AM Demod
Channel Rate: 64k
Audio Decimation: 1
Audio Pass: 5k
Audio Stop: 5.5k
Float To Complex
Float To Complex
Low Pass Filter
Decimation: 1
Gain: 1
Sample Rate: 64k
Cutoff Freq: 8k
Transition Width: 1k
Window: Hamming
Beta: 6.76
Multiply Const
Constant: 50
Virtual Sink
Stream ID: ksn
Virtual Source
Stream ID: ksn
Complex To Float
QT GUI Time Sink
Number of Points: 1.024k
Sample Rate: 64k
Autoscale: No
Audio Sink
Sample Rate: 22.05 kHz
QT GUI Frequency Sink
FFT Size: 1024
Center Frequency (Hz): 10k
Bandwidth (Hz): 10k
Wav File Sink
File: ...\TransNiranjan55.wav
Sample Rate: 44.1k
Output Format: WAV
Bits per Sample: 16-bit
Append to existing file: No

RECEIVER


Amplitude
Time (ms)
Relative Gain (dB)
Frequency (kHz)
6.00
8.00
10.00
12.00
14.00

OUTPUT

THANK YOU

For detailed information refer to the report(pdf) on this presentation