Title of Project

Project Report
Submitted in partial fulfillment of the requirements
For the completion of course

Analog and Digital Communication

in

ICT

By

Group no - 06

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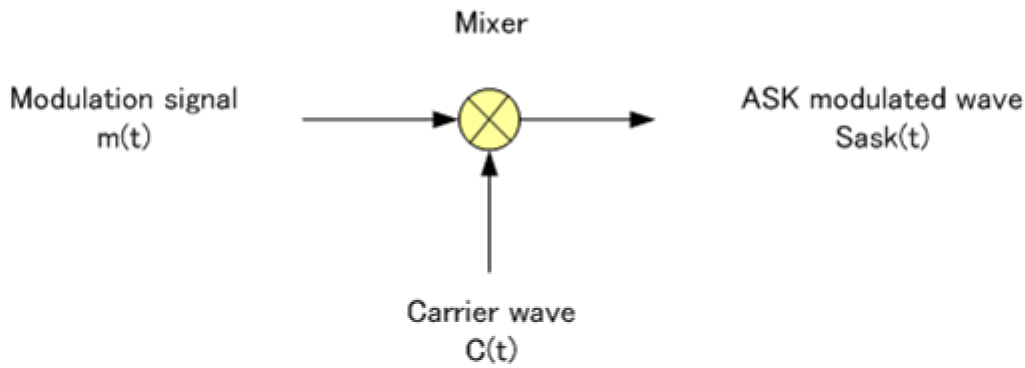
Amplitude Shift Keying

The amplitude of an analog carrier signal varies in accordance with the bit stream (message signal), keeping frequency and phase constant. The level of amplitude can be used to represent binary logic ‘0’ and ‘1’. We can think of a carrier signal as an ON or OFF switch. In the modulated signal, bit ‘0’ is represented by the absence of a carrier, thus giving OFF-ON keying operation and hence the name.

Amplitude shift keying is a type of modulation where the amplitude of the modulated signal is proportional to the modulating signal. The spectrum of the ASK modulated signal is centered on the carrier frequency.



Modulation

Binary Modulation

- In binary modulation, the message sequence has two levels, 0 and 1. Thus the modulated waveform consists of bursts of a sinusoid.

M-ary Modulation

- In M-ary modulation, the message sequence has M levels.
- A different amplitude of sinusoid is associated with each symbol.

Application

- ASK is used to transmit digital data over optical fiber.

Advantages

- ASK modulation and demodulation processes are relatively inexpensive.
- One important advantage of ASK is, it need less bandwidth than FSK.

Disadvantages

- ASK is very susceptible to noise interference. Noise usually affects the amplitude therefore ASK is the modulation technique most affected by the noise.
- Attenuation should not happen anywhere in between channels.

Demodulation

Types of demodulation:

- Coherent
- Non-Coherent

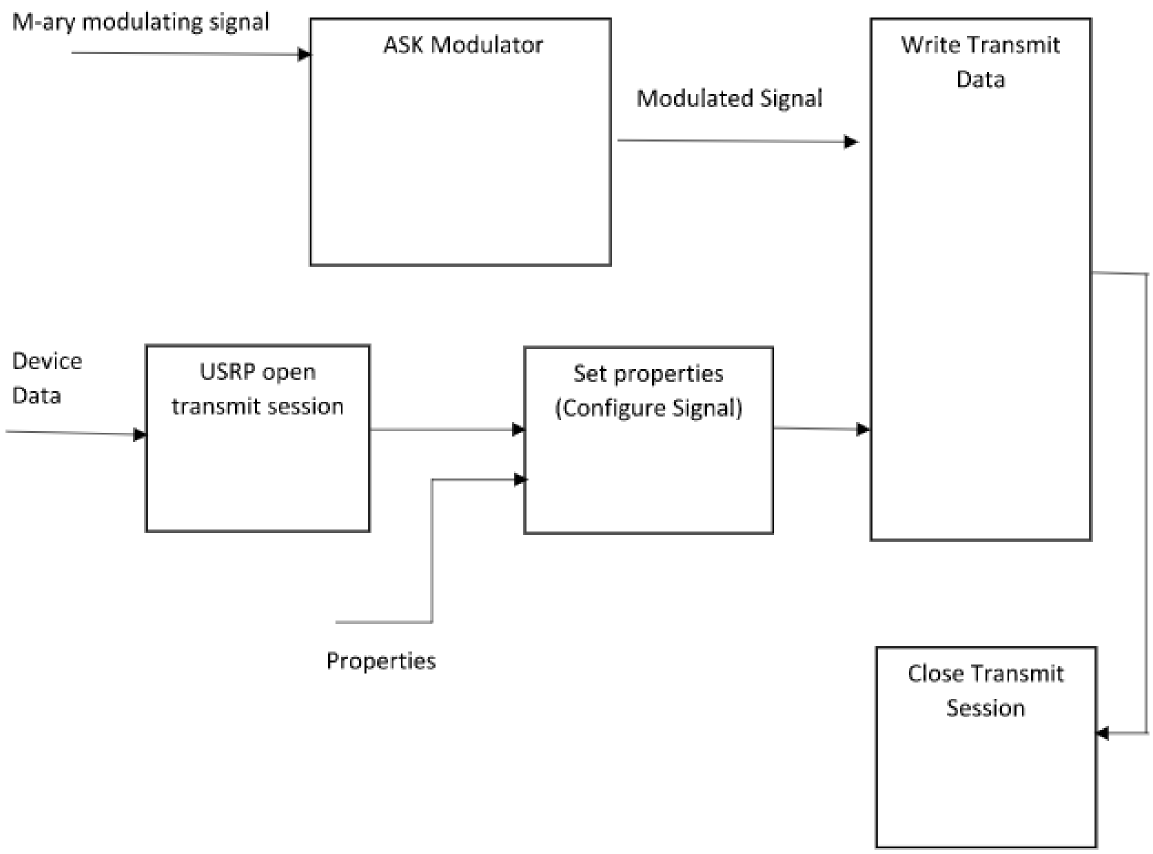
Demodulation point to point algorithm for binary system:

1. Start FOR loop.
2. Perform correlation of ASK signal with carrier to get decision variable.
3. Make decision to get demodulated binary data. If $x>0$, choose '1' else choose '0'.
4. Plot the demodulated binary data.

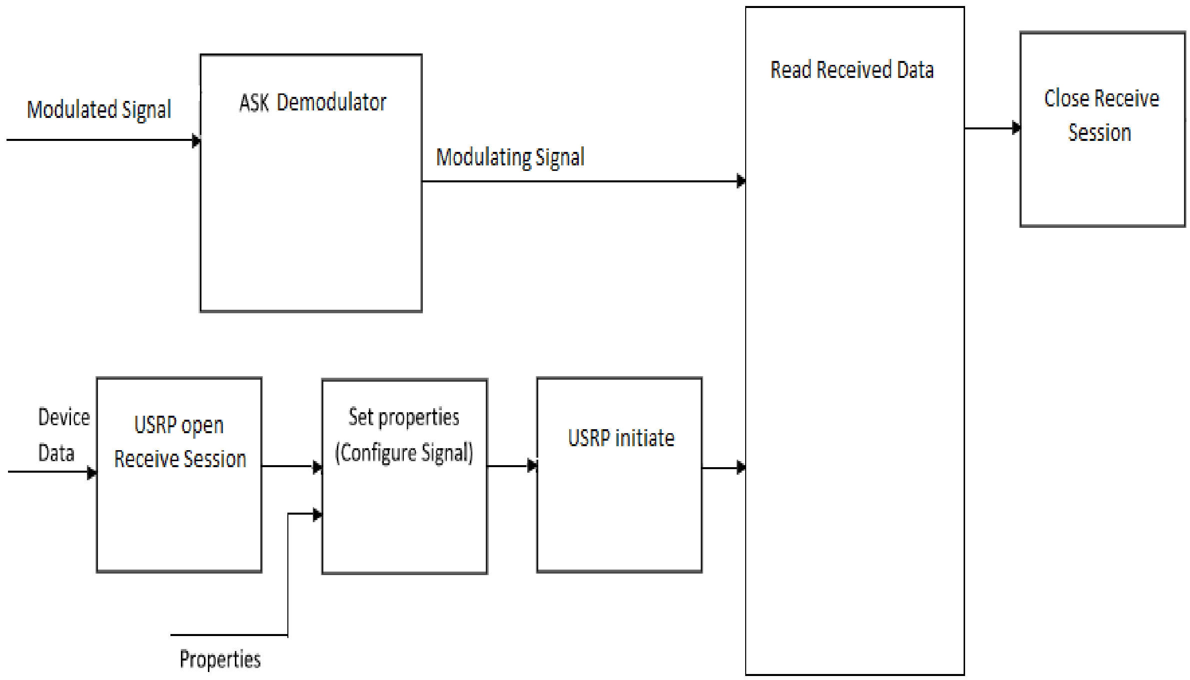
Demodulation point to point algorithm for M-ary system:

- Start FOR loop
- Pass the input signal to the Peak Detector and generate the demodulated square signal which contains digital information
    - Peak Detector Algorithm
        - Take current signal value, previous signal value and second previous value. Call then A, B and C respectively.
        - Whenever (B is greater than equal to A) and (B is greater than equal to C), then update the previous value of peak detector output by B.
        - B will be the new peak.
- Map the digital signal to appropriate symbols (if needed).

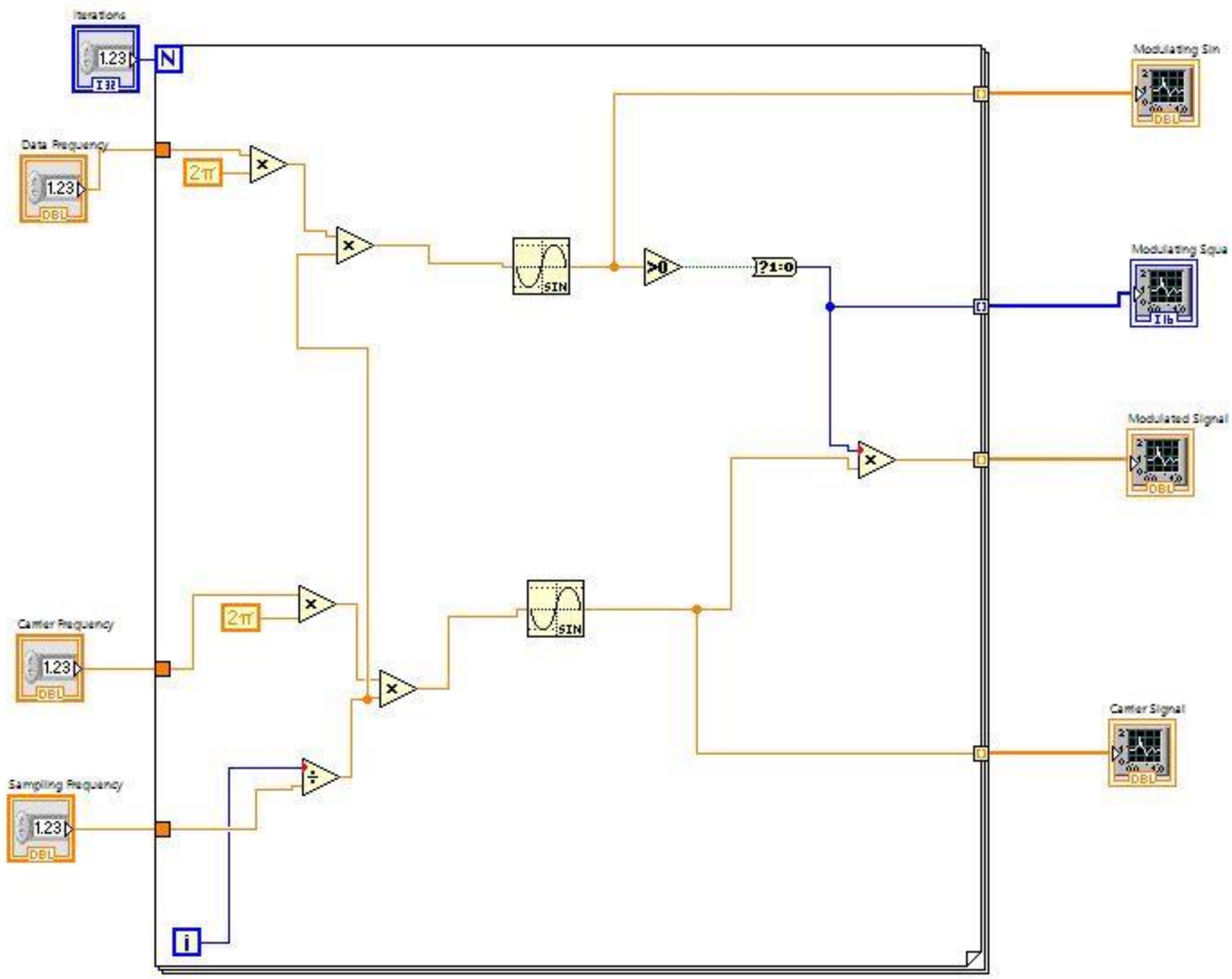
Block Diagram: Transmitter



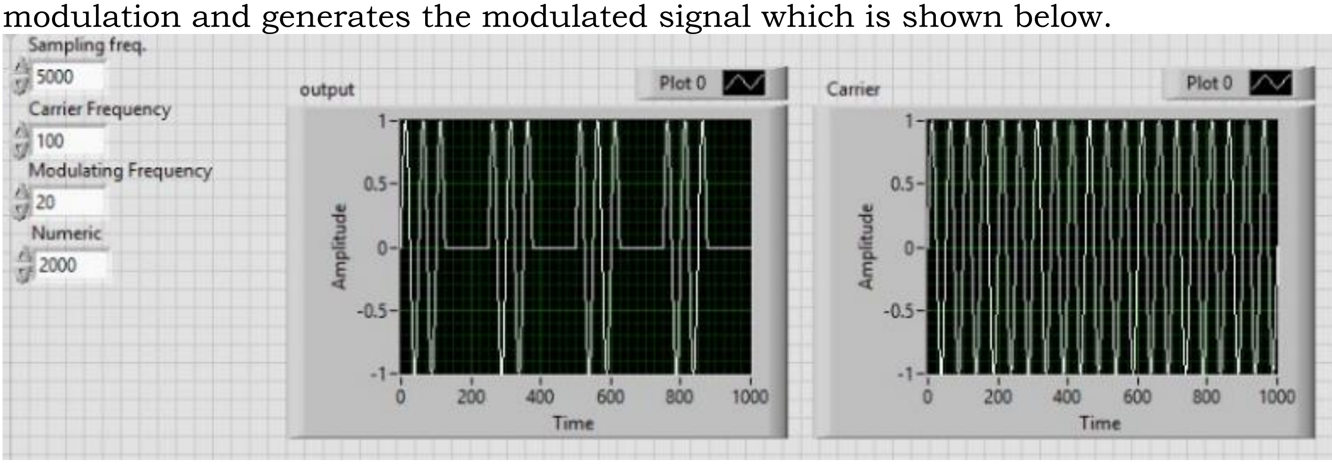
Block Diagram: Receiver



Binary Point to point modulator



Binary point to point modulator generates a single bit, does the ASK modulation and generates the modulated signal which is shown below.

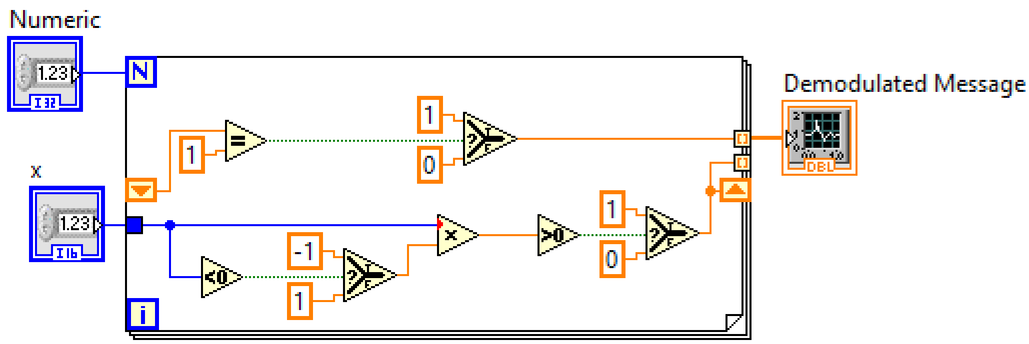


Steps for modulation:

- Generate a single bit digital message which we want to send through channel.

    - In this case, the message bit is generated using a sin wave.
    - If the output value of sine wave is greater than 0, then we generate +1 as message. If the output value of sine wave is less than 0, then we generate 0 as message.
- Generate a carrier signal with higher frequency having much higher frequency than the message signal, which would be used for transmission of the message signal
- To modulate the message signal, we multiply the message signal with carrier signal, which would be the **ASK modulated signal**.

Binary Point to point demodulator



Binary point to point demodulator takes the modulated signal as input, demodulates it and gives modulated digital message signal back.

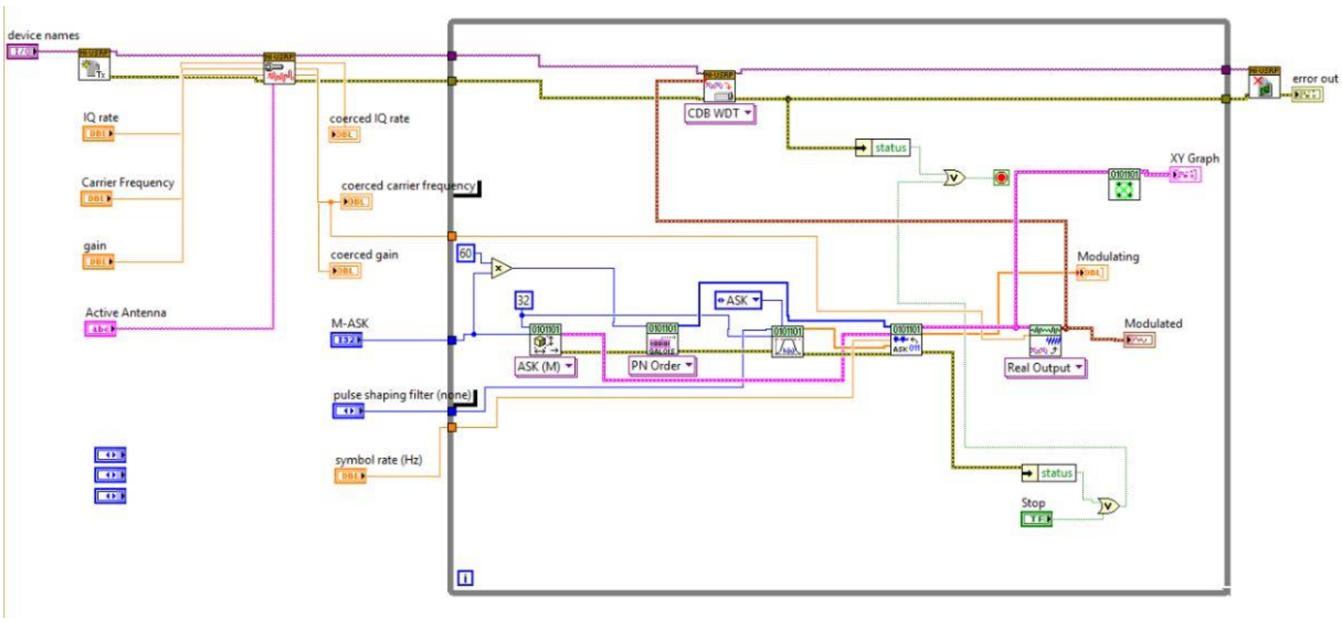
<u>Steps for demodulation:</u>

- Capture the modulated signal
- Pass the modulated signal through full wave rectifier.
- Give output 0 whenever the rectified signal is having amplitude 0. Give output 1 whenever the rectified signal is having amplitude non-zero.

<u>Drawbacks of the VI:</u>

- The VI cannot work in presence of noise as the noise may make the 0 amplitude to non-zero and hence detection would be incorrect.

Modulation using Modulation Toolkit



This VI is doing ASK modulation of input pseudo random number generator and send's the modulated signal through NiUSRP.

The modulation is done by using different VIs of Modulation Toolkit.

Below are the details of the VIs used here.

niUSRP Open Tx Session VI: Opens a transmit (Tx) session to the device(s) you specify in the device names input and returns session handle out, which you use to identify this instrument session in all subsequent NI-USRP VIs.

niUSRP Configure Signal VI: Configures properties of the transmit (Tx) or receive (Rx) signal.

niUSRP Write Tx Data (poly) VI: Writes data to the specified channel list.

MT Generate FSK System Parameters(M): Calculates parameters for use with modulation and demodulation VIs.

MT Generate Bits (poly) VI: Generates the sequence of data bits to be modulated. This polymorphic VI can generate Fibonacci or Galois pseudo noise (PN) bit sequences.

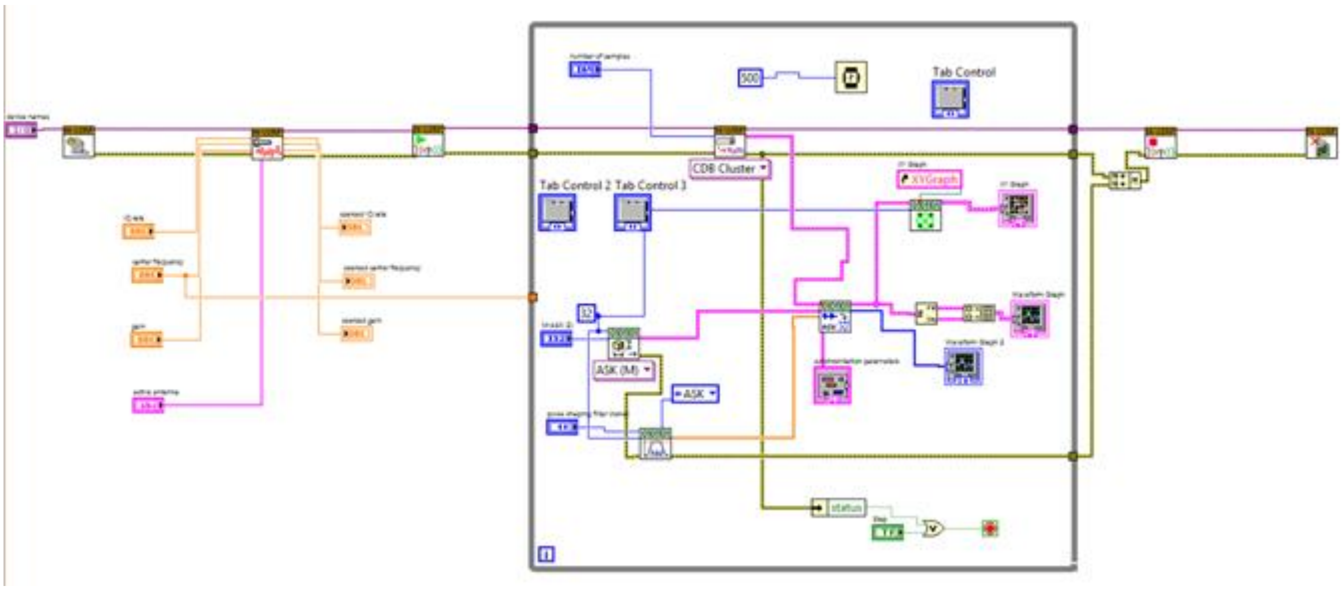
MT Generate Filter Coefficients VI: Calculates filter coefficients for pulse-shaping and matched filters applied by the digital modulation VIs and demodulation VIs.

MT Modulate ASK VI: Receives a sequence of data bits, performs ASK modulation, and returns the modulated complex baseband waveform in the output complex waveform parameter.

MT Upconvert Baseband VI: Upconverts baseband I/Q (complex envelope) signal data to its real passband equivalent or to a nonzero center frequency within the Nyquist bandwidth of the specified signal.

niUSRP Close Session VI: Closes the session handle to the device.

Demodulation using Modulation Toolkit



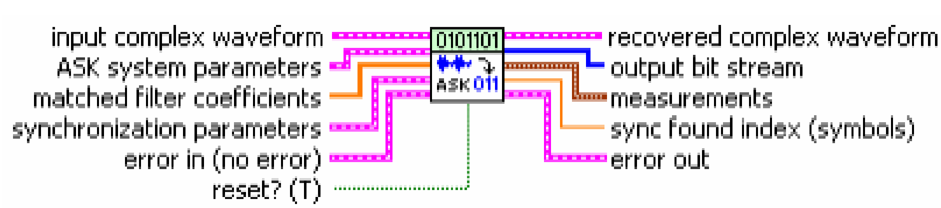
This VI receives the modulated signal through USRP, demodulates the modulated signal and gives message signal which was modulated during transmission.

niUSRP Open Rx Session VI: Opens a receive (Rx) session to the device(s) you specify in the device names input and returns session handle out, which you use to identify this instrument session in all subsequent NI-USRP VIs.

niUSRP Initiate VI: Starts the Rx acquisition.

niUSRP Fetch Rx Data (poly) VI: Fetches data from the specified channel list.

MT Demodulate ASK VI: Demodulates an ASK-modulated complex baseband waveform and returns the time-aligned oversampled complex waveform, the demodulated bit stream, and the results of offset and drift measurements. This VI attempts to remove carrier and phase offset by locking to the carrier signal.



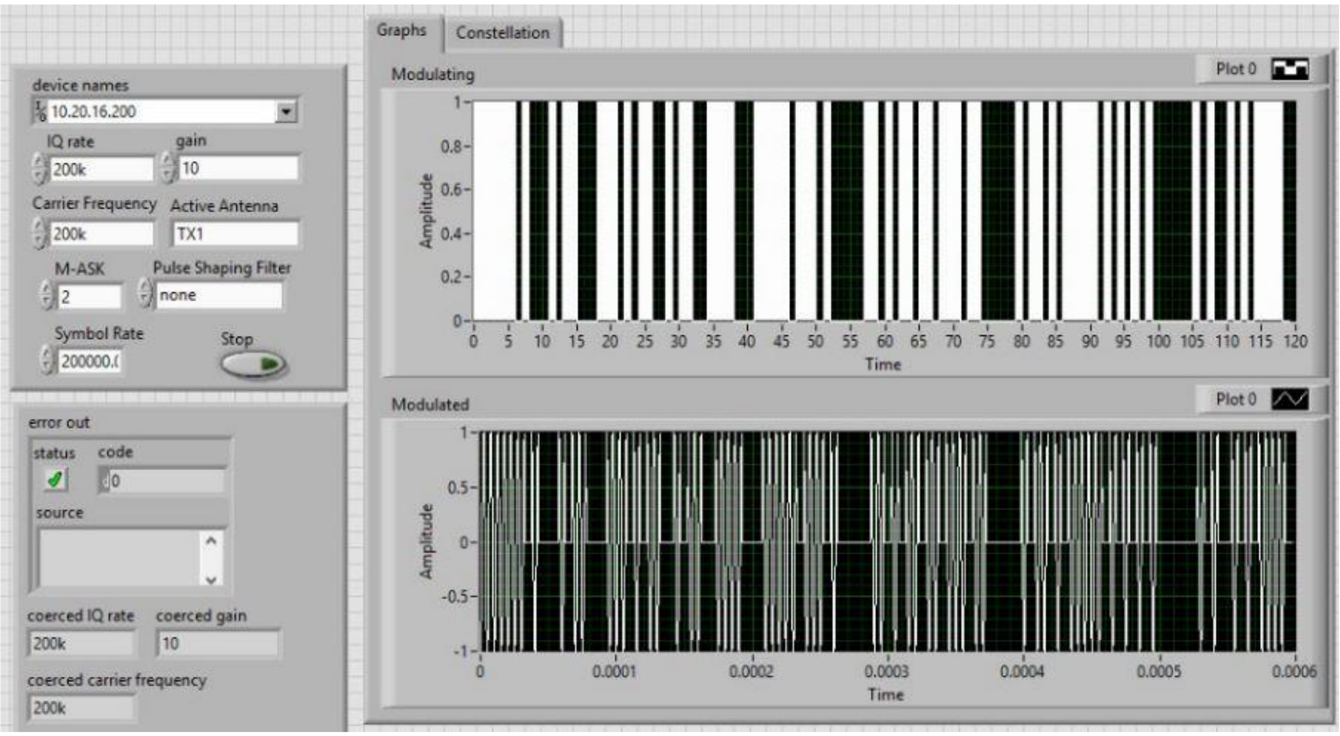
niUSRP Abort VI: Stops an acquisition previously started.

niUSRP Close Session VI: Closes the session handle to the device.

Simulation Results (Using Modulation Toolkit)

<u>Modulation</u>

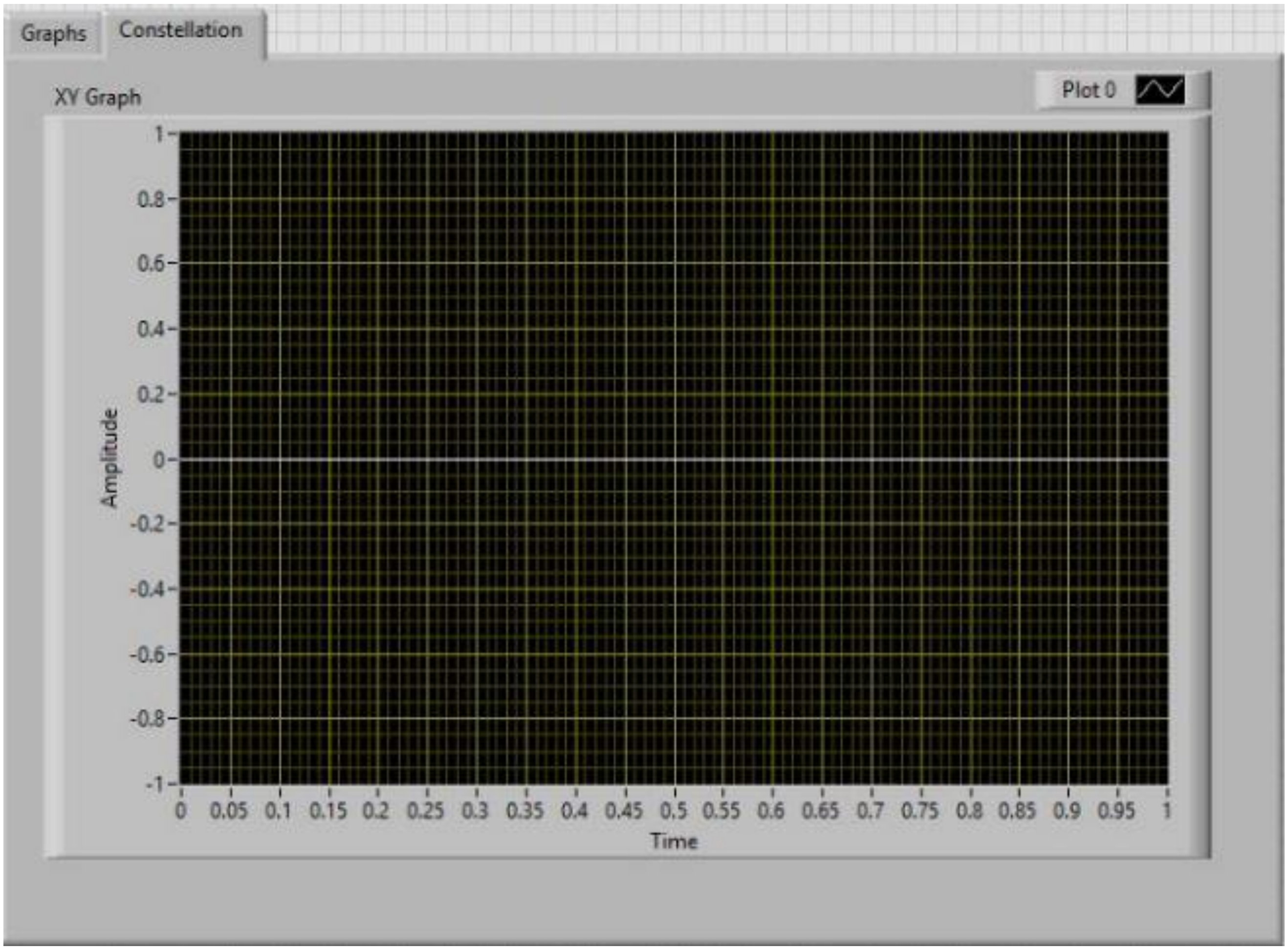
Message and Modulated Signal



Above image shows

- Configuration of modulation (i.e. device name, carrier frequency gain, number of levels, etc.) at left
- Modulating pseudo random digital signal (message signal) at top
- ASK modulated signal (bottom)

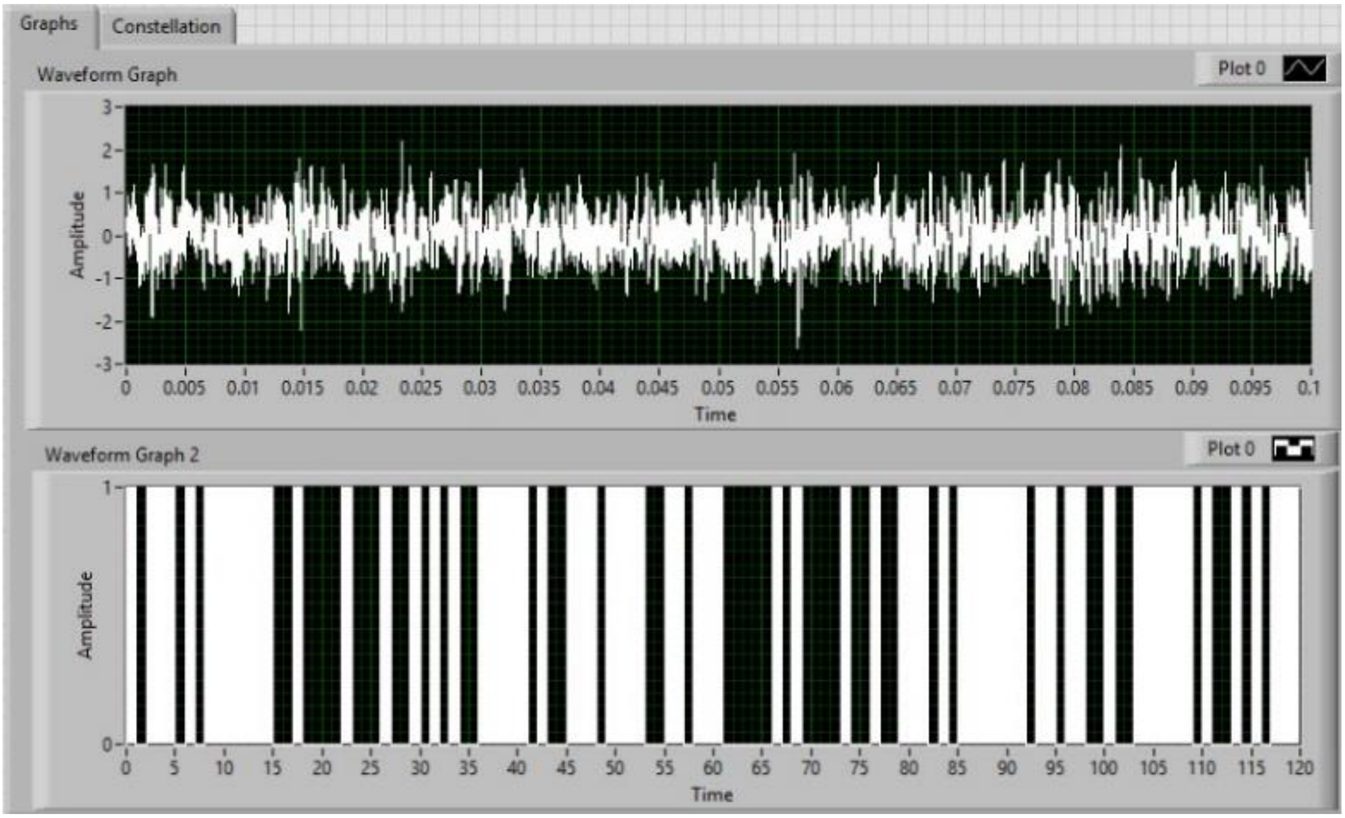
Constellation Diagram



Above image shows

- Constellation diagram of ASK modulated signal. Which has two points at (0,0) and (1,0). Which can be seen as a white line on the X-axes.

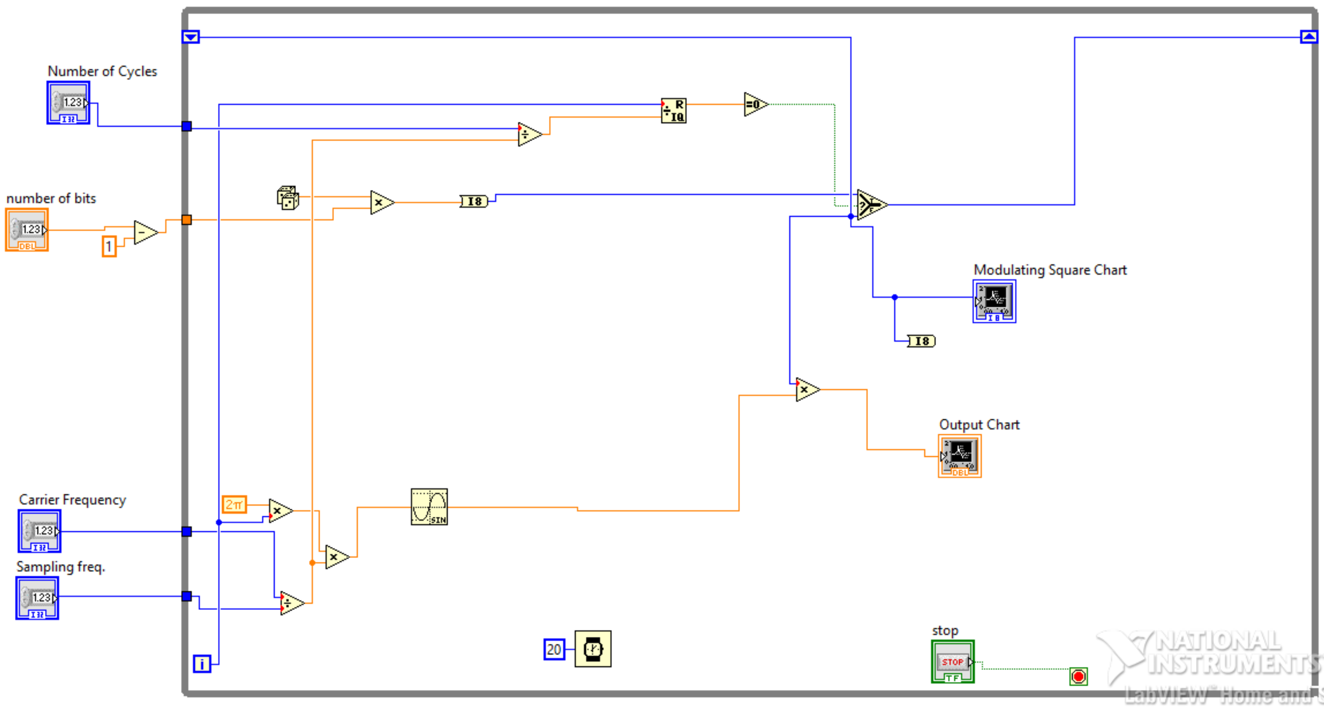
Demodulation



Above image shows

- Received ASK modulated signal with noise (above)
- Demodulated signal which should be same as the message signal which was modulated during transmission.

M-ary Point to point Modulation



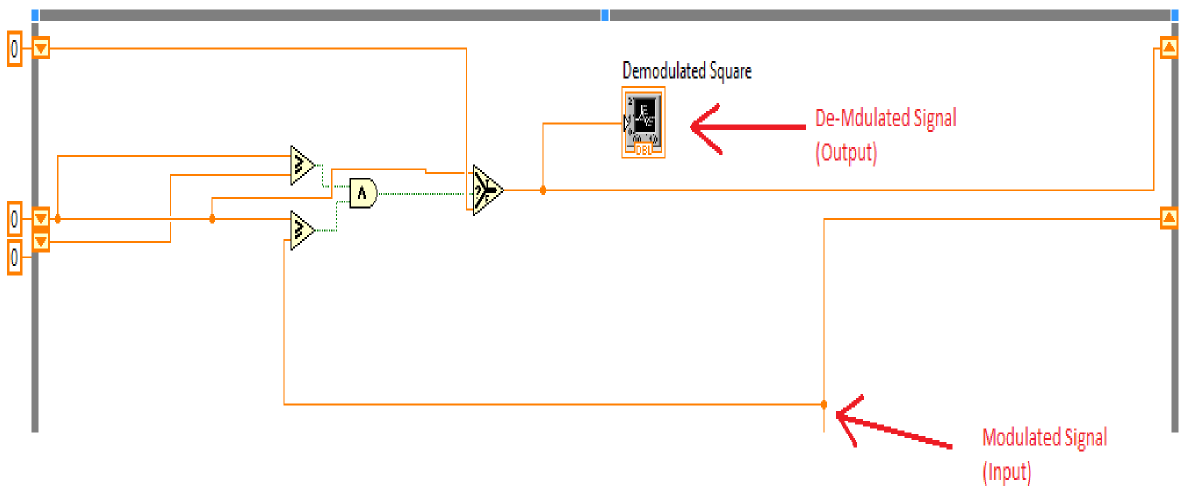
Steps for modulation:

- M-ary point to point modulator generates a random number between 0 to M-1, where M is total number of levels which can be used for k bits. (E.g. for k = 3, M is $2^3 = 8$ and for k=5, M is $2^5 = 32$.
- Generate a carrier signal with higher frequency having much higher frequency than the message signal, which would be used for transmission of the message signal.
- The generated digital signal is transmitted using ASK modulation which would be sent through the transmitter.

How random number is repeated for given number of cycles?

- Let carrier frequency be f_c and sampling frequency be f_s for given carrier signal, then the **total number of samples taken per cycle** is $\frac{fs}{fc}$.
- Now, we want same value for n samples, then total number of samples would be $n * \frac{fs}{fc}$
- We already have $\frac{fc}{fs}$, so to get total number of samples, we used $\frac{n}{(\frac{fc}{fs})}$

M-ary Point to point Demodulation



Steps for demodulation

- Get modulated signal
- Pass the modulated signal through peak detector
- Output of peak detector would be demodulated square wave having levels from 0 to M-1.
- Match the levels to appropriate symbol (if needed)

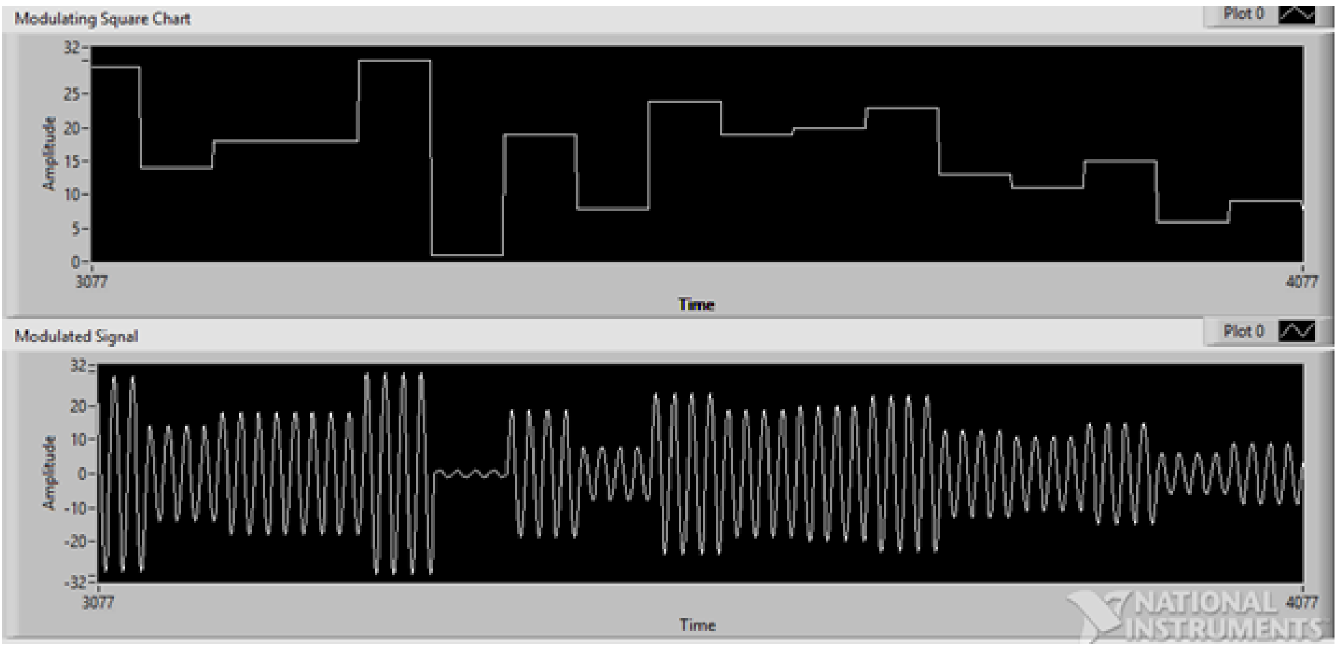
Algorithm for Peak Detector:

- Take current signal value, previous signal value and second previous value. Call then A, B and C respectively.
- Whenever (B is greater than equal to A) and (B is greater than equal to C), then update the previous value of peak detector output by B.
- B will be the new peak.

Here, a new peak would be detected when the input signal to the peak detector attains its maximum value. This is the reason behind having some delay for demodulating the signal.

Simulation Result (M-ary Point to point – Without USRP)

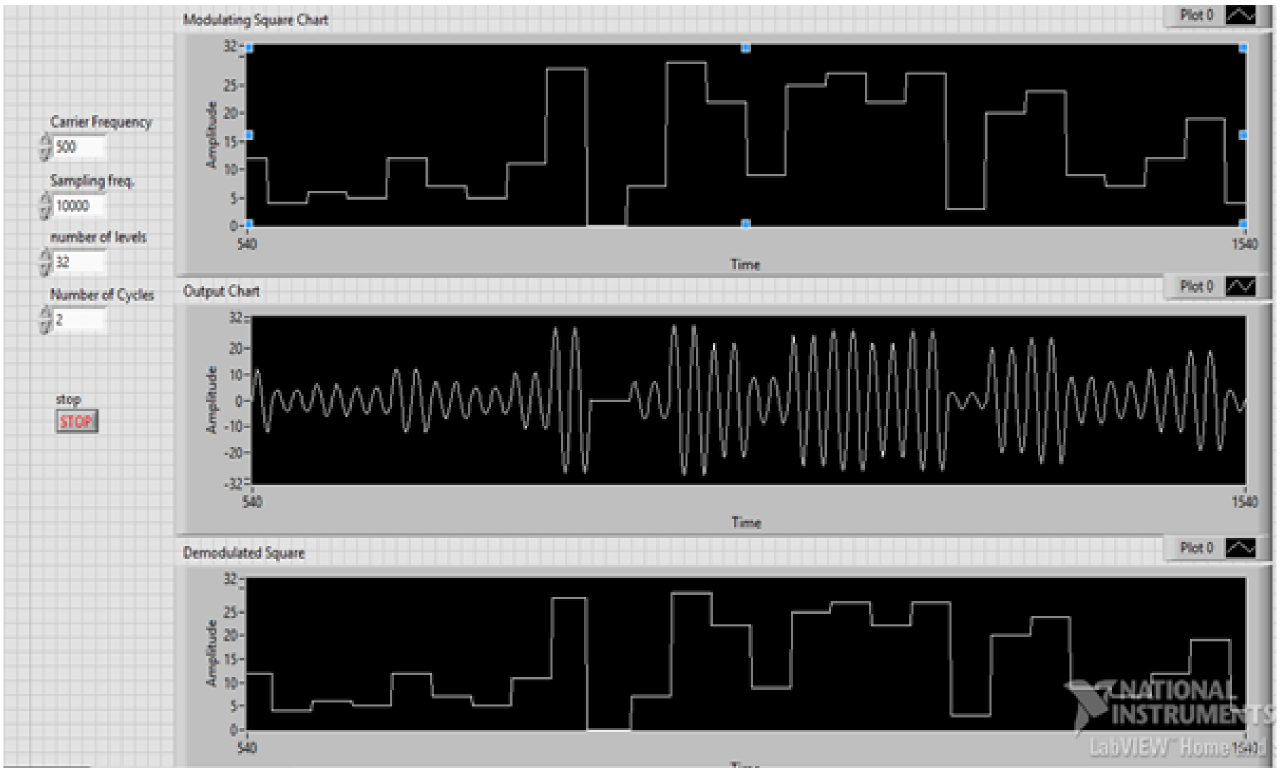
<u>Modulation</u>



Above image shows:

- **Input Random digital message signal** which will be modulated using the carrier signal. (at top)
- **ASK Modulated signal** of digital message signal. The modulated signal would be transmitted through channel. (at bottom)

Demodulation



Above image shows:

- **Digital message signal** which was modulated using the carrier signal. (at top) Which is used for comparison with demodulated signal
- Received ASK modulated signal, which is used for extracting digital message signal using demodulation. (at middle)
- Demodulated signal which is same as the message signal which was modulated during transmission. (at bottom)

Thank You