EEP3010

Communication Systems Lab

To study pulse width modulation (PWM) and demodulation and pulse position modulation (PPM) and demodulation.

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Abstract:

The purpose of this experiment is to investigate and track the creation and identification of pulse modulation systems. First, we'll see how the DCS-B kit is used to do pulse width modulation (PWM) and pulse position modulation (PPM), and we'll watch the transmitted pulse at various points in time, including after it has been converted to analog and after filters. Additionally, we will contrast these two modulation techniques and discover their underlying principles. We also examine the difficulties involved in employing low pass filtering for the demodulation of PWM and PPM signals.

In the second section of the experiment, we'll see how to use PAM to send and receive band-limited pulse trains in a baseband system. We will also measure the BER using digital data. We want this bit error rate to be low so that we can transmit data more accurately.

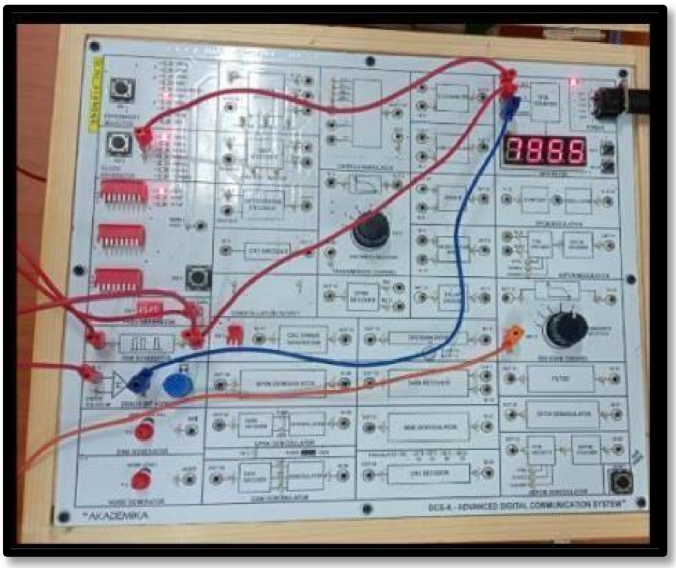
Objective:

- In this experiment our objective is to observe and understand pulse modulation techniques mainly pulse width modulation (PWM) and pulse position modulation (PPM). In this experiment we see the generation and detection of these modulation schemes.
- After these experiments we have to observe the transmission and reception of band-limited pulse trains in a baseband transmission system. At last we measure bit error rate (BER) using digital data.

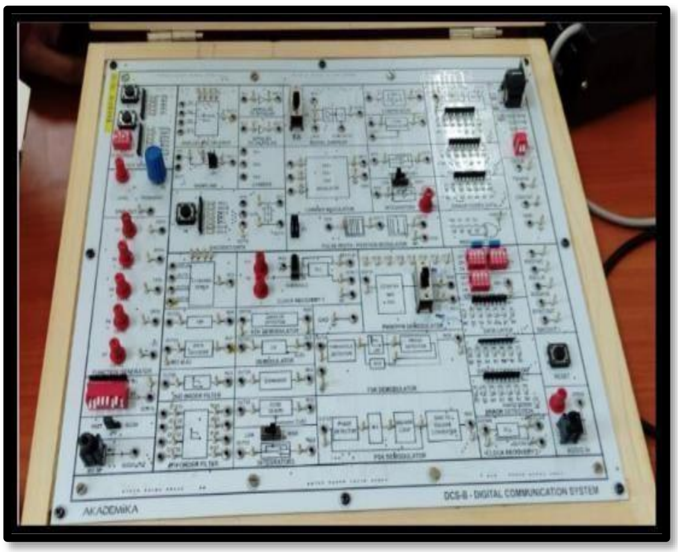
Equipment Used:

- DCS-B KIT
- Connecting chords
- Power supply
- 20Mhz Dual Scope Oscilloscope
- DCS-A kit

Procedure:



DCS-A



DCS-B

PWM

1. Connect a low frequency sine wave from the SINE OUTpost with an amplitude of 1Vpp using pot P2 from the function generator section to the IN18 post of the PWM/PPM section.
2. Keep jumper JP2 in 2nd position
3. Observe the variation in the width of the carrier at the OUT12 post
4. PWM/PPM section, vary the frequency of input sine wave from 1 to 30 Hz using pot P1, and observe the variation.
5. Now connect a 1 KHz sine wave with an amplitude of 1 Vpp using pot P5 from the Function generator section to the IN18 post of the PWM/PPM section. Also, observe the counter outputs at their corresponding test points (TP9 to TP16).
6. Observe the pulse width modulated output at OUT12 post of the PWM/PPM section.
7. Connect OUT12 post of the PWM/PPM to the IN20 post of the PWM/PPM
8. Keep switching S7 to PWM position. For demodulation purpose
9. Observe the pulse width demodulated output at OUT15 post of the PWM/PPM demodulator section.
10. Connect the OUT15 post of the PWM/PPM demodulator section to the IN33 post of the 2nd order LPF.
11. Connect OUT30 post of 2nd order LPF to IN 34 of4th order LPF
12. Observe the recovered signal at the OUT31 post of the 4th order LPF

PPM

1. Connect a low frequency sine wave from the SINE OUTpost with an amplitude of 1 pp using pot P2 from the function generator section to the IN18 post of the PWM/PPM section.
2. Keep jumper JP2 in 2nd position.
3. Observe the variation in the position of the carrier at the OUT13
4. PWM/PPM section. Change the frequency of input sine wave from 1 to 30 Hz using pot P1 and observe the variation.
5. Now connect a 1 KHz sine wave with an amplitude of 1 Vpp, using pot P5 to the IN18 post of the PWM/PPM section
6. Observe the pulse position modulated output at OUT13 post of the PWM/PPM section. Also, observe the counter outputs at their corresponding test points (TP9 to TP16)
7. Connect OUT13 post of the PWM/PPM to the IN20 post of the PWM/PPM
8. Keep switch S7 to PPM position.
9. Observe the pulse width demodulated output at OUT15 post of the PWM/PPM Demodulator section.
10. Connect OUT15 post of the PWM/PPM demodulator section to the IN33 post of the 2nd order LPF
11. Connect OUT30 post of 2nd order LPF to IN 34 of4th order LPF

Study of Transmission and Reception of Band Limited Pulse Train in Base Band Transmission System

1. For this experiment we will have to use DCS -A kit
2. Connect the power supply to the kit and switch it on
3. Select the PAM experiment using SW1. Observe the corresponding led indication.
4. Set the switch SW7 in the PRBS Generator Section as per block biagram to generate the PRBS. Observe the 16 Bit PRBS data at PRBS Data Post
5. Set the Clock to 16 KHZ using SW2 in Clock Generation Section. Observe the Clock at Clock OUT Post
6. Connect PRBS Data to IN 1 of PAM GENERATOR. Observe the PAM Data at OUT 1 Post Of PAM GENERATOR
7. Connect OUT1 Post to IN 5 of the transmission channel. Set SW8 to Position 1.
8. Observe the Output of the transmission channel at OUT 5 Posts
9. Connect Out 5 to In 8 on the Adder. Connect Noise from noise generator Section to Noise In Post of Adder. Initially keep Noise to Minimum Level by Rotating P3 fully Anticlockwise Direction
10. Observe the Adder Output at OUT 9 Posts. Observe the Adder Output by increasing the Noise in Pot P3.
11. Connect OUT 9 Post to IN 14 Post of Receiver Channel. Set SW11 to Position 1. Observe the Output of Receiver Channel at OUT 12 Posts.
12. Connect OUT 12 to IN 16 of Decision Devise. Observe the Output of Decision Device at Out 15 Posts.
13. Observe the Led Indication by Changing the Noise Level
14. Connect OUT15 to IN 19 Post of Data Recovery. Observe Clk7 at Test Point, it should be the same
15. Clock which is used to generate PRBS. Observe the received data at OUT18 post of data recovery.
16. Compare it with PRBS
17. Observe the received data by increasing clock frequency and by increasing noise level. Also observe data by changing transmitter and receiver channel bandwidth.

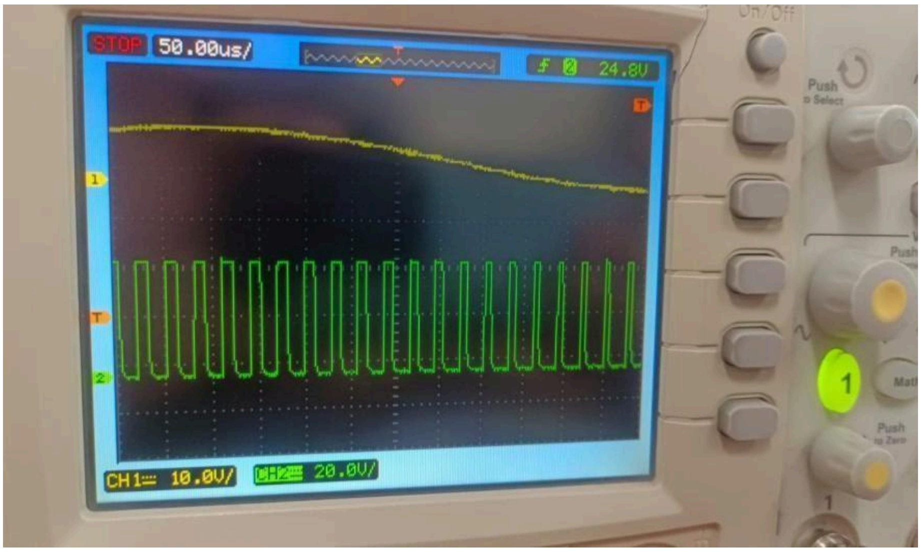
Measurement of Bit Error Rate Using Digital Data

1. For Connect the Power Supply to the DCS-A Kit And switch it on.
2. Select the PAM experiment using SW1. Observe the corresponding Led indication.
3. Set The Switch SW7 In PRBS Generator Section as per block diagram to generate The PRBS. Observe the 16-bit PRBS Data at PRBS Data Post.
4. Set the Clock to 16 KHZ Using SW2 In Clock Generation Section. Observe the Clock at Clock OUT Post

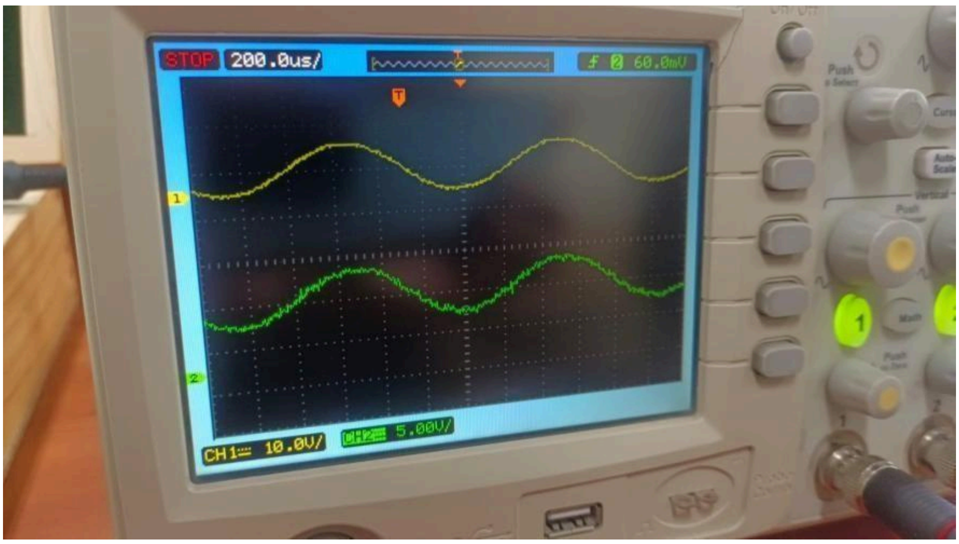
5. Connect PRBS Data To IN 1 of PAM GENERATOR. Observe the Pam Data at OUT 1 Post of PAM GENERATOR
6. Connect OUT1 Post To IN 2 Of Error Bit Adder. Keep P1 fully Anticlockwise Position So That No Error Is Added In Data. Observe the error pulses at the test point provided.
7. Connect OUT 2 Post of Error Bit Adder to Rx data Post of BER Meter. Also Connect Clock OUT Post to Clk6 Post and PRBS Data Post To In 11 post
8. To Clear the Display to 0 Press Clear switch to start the counting, Press Start. The Counting Process will run for Approximately 10 -15 Seconds. The Counting Process will be indicated By Tc Led.

Test Result

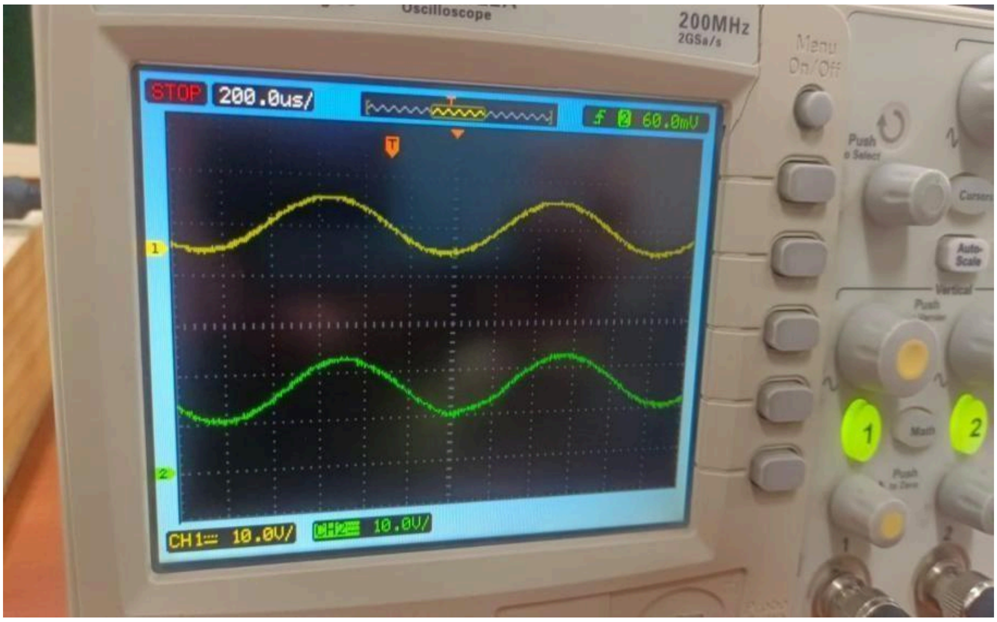
Pulse Width Modulation



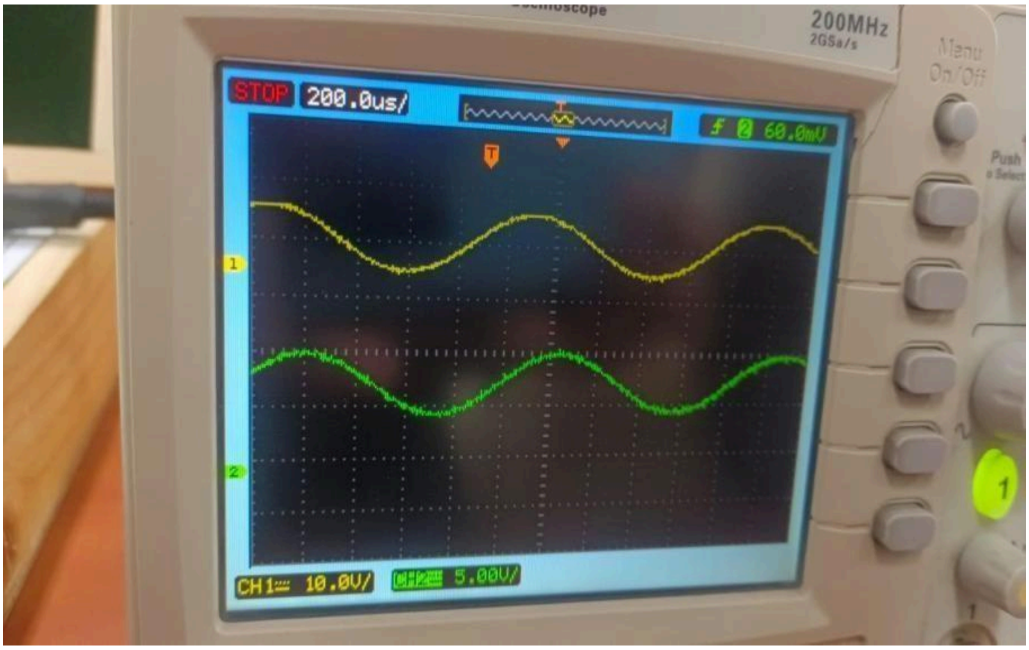
Input and PWM Modulation



(Green) - DAC Out & Input

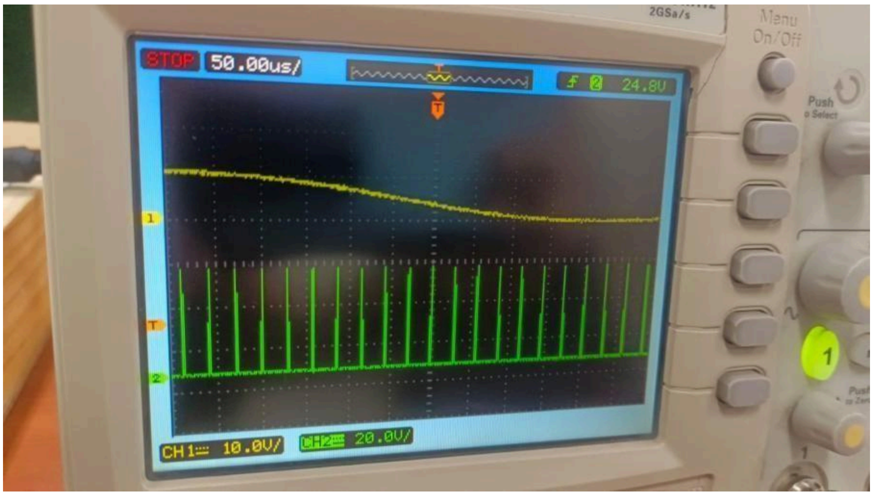


(Green)2nd Order Filter Output

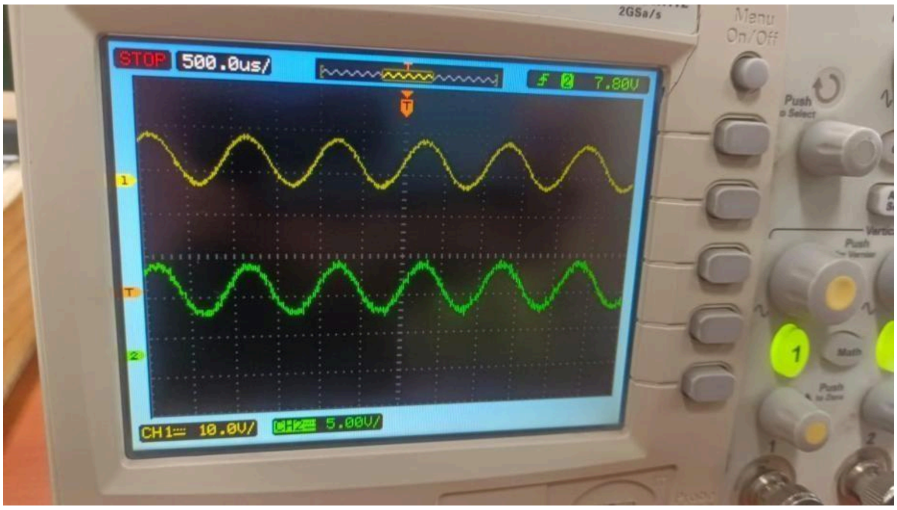


(Green)4th Order output with less noise

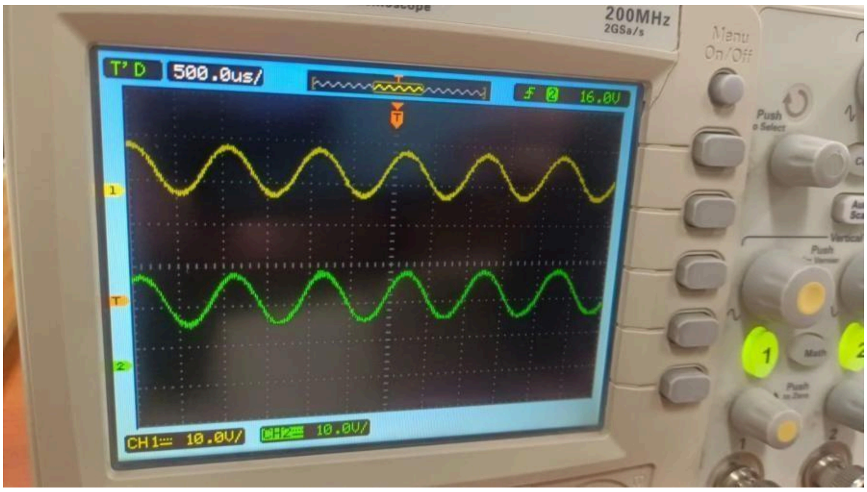
Pulse Position Modulation



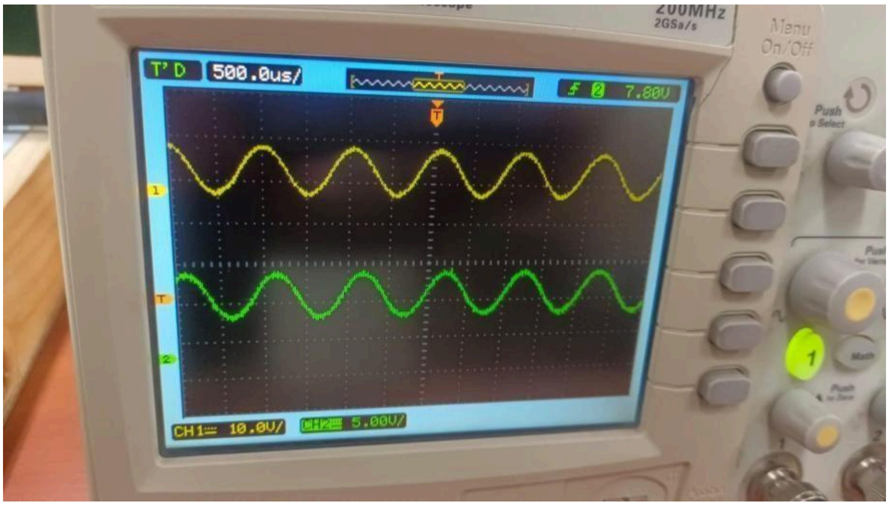
PPM Modulation & Input (Yellow)



DAC output (Green)

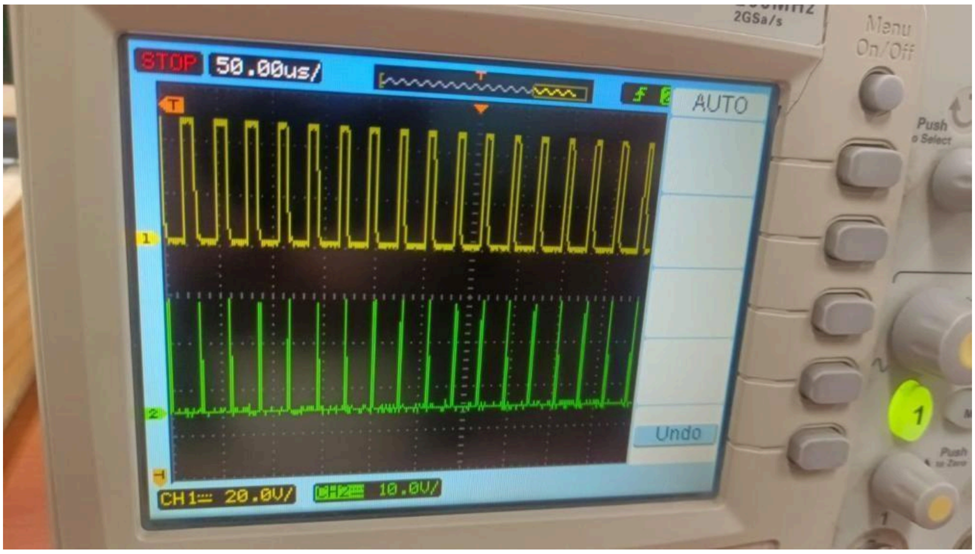


(Green)2nd Order Filter Output

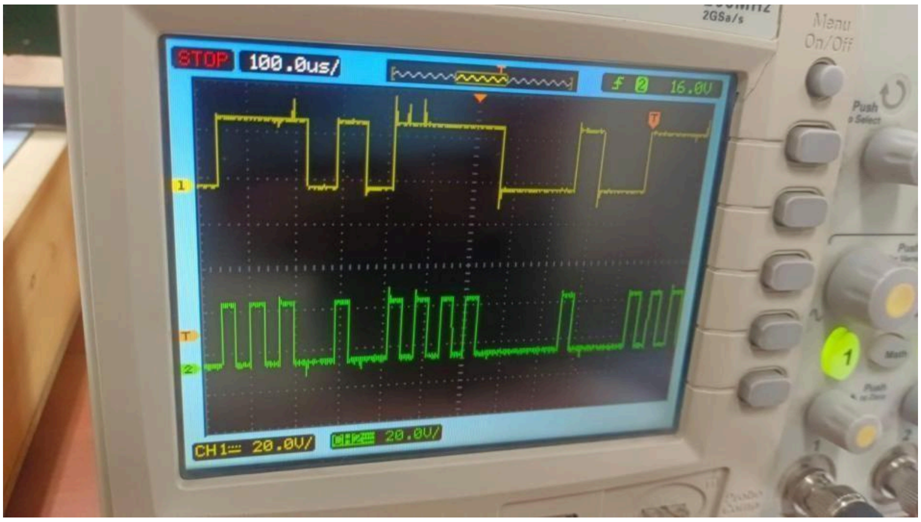


(Green)4th Order output with less noise

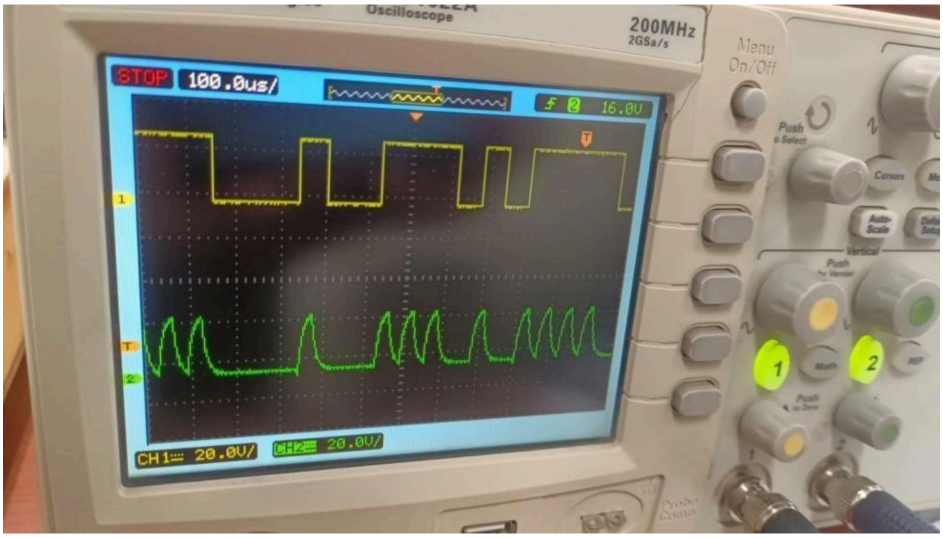
Pulse Width Modulation(G) v/s Pulse Position Modulation(Y)



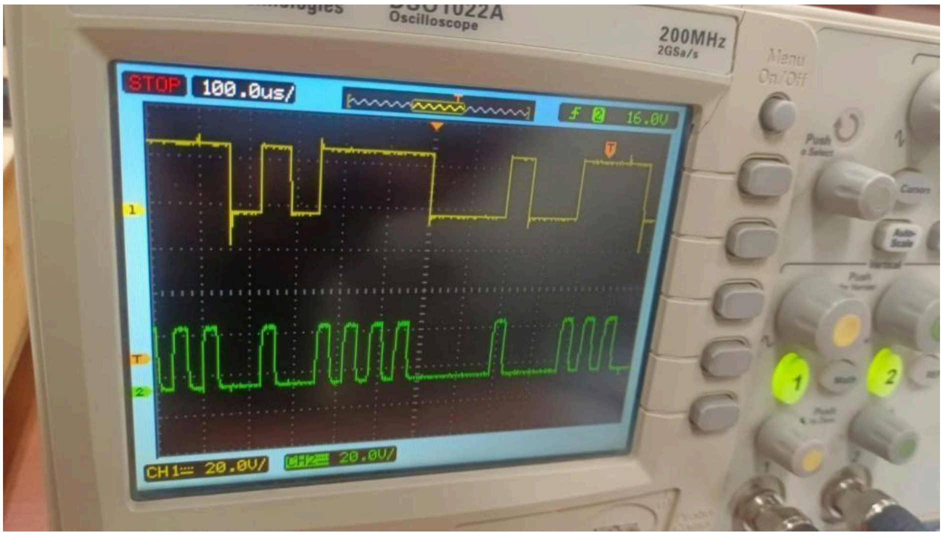
Transmission and Reception of Band Limited Pulse Train in BaseBand Transmission System



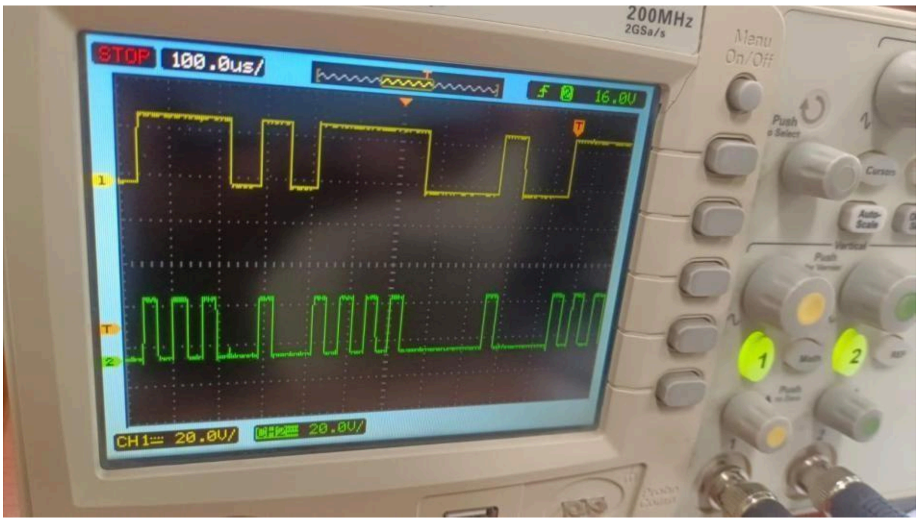
Y- PRBS Data & G-PAM Out



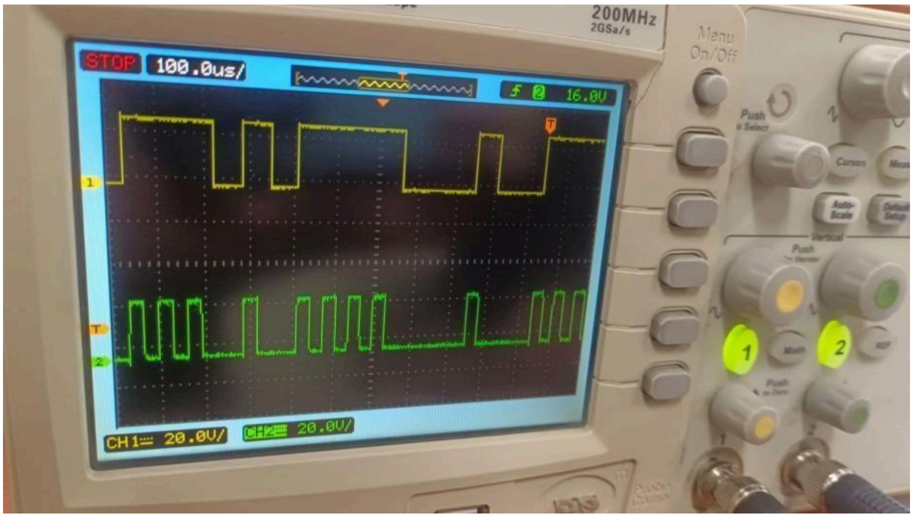
Prbs vs transmission min=1(G)



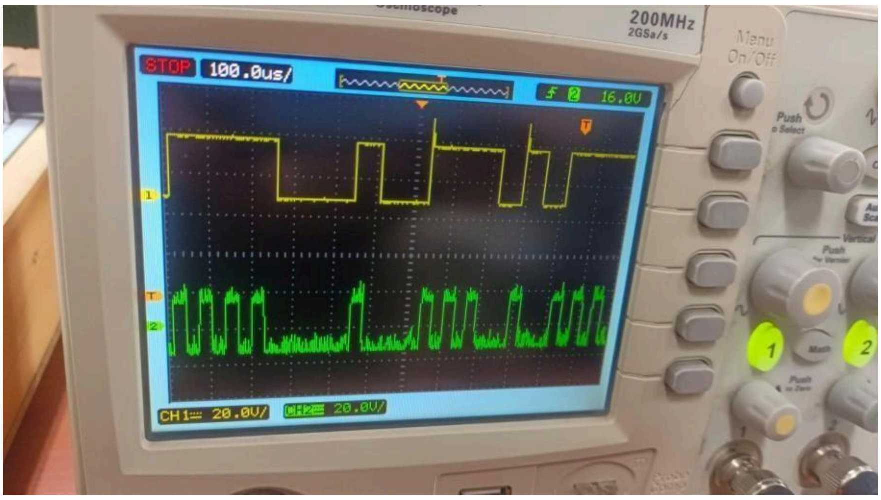
Prbs vs transmission mid=3(G)



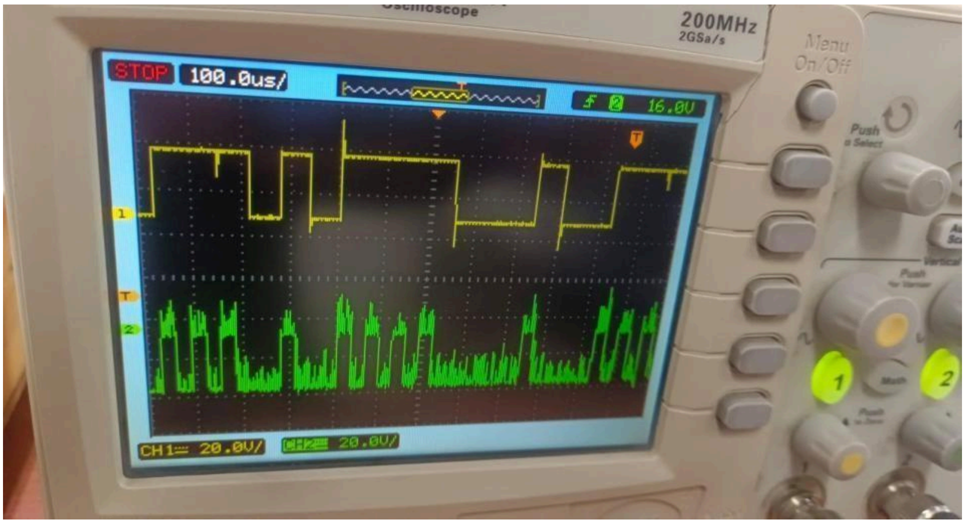
Prbs vs transmission max=5(G)



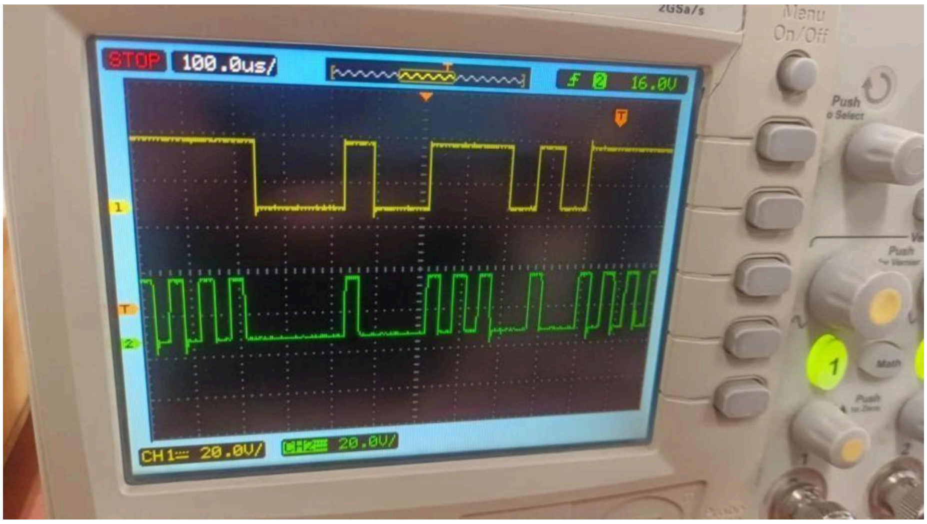
Prbs vs Adder at Minimum Noise(G)



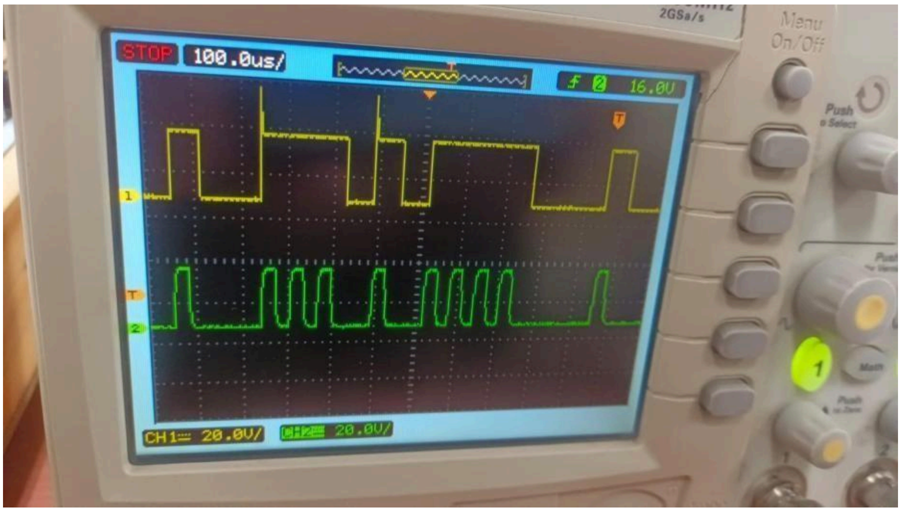
Prbs vs Adder at Medium Noise(G)



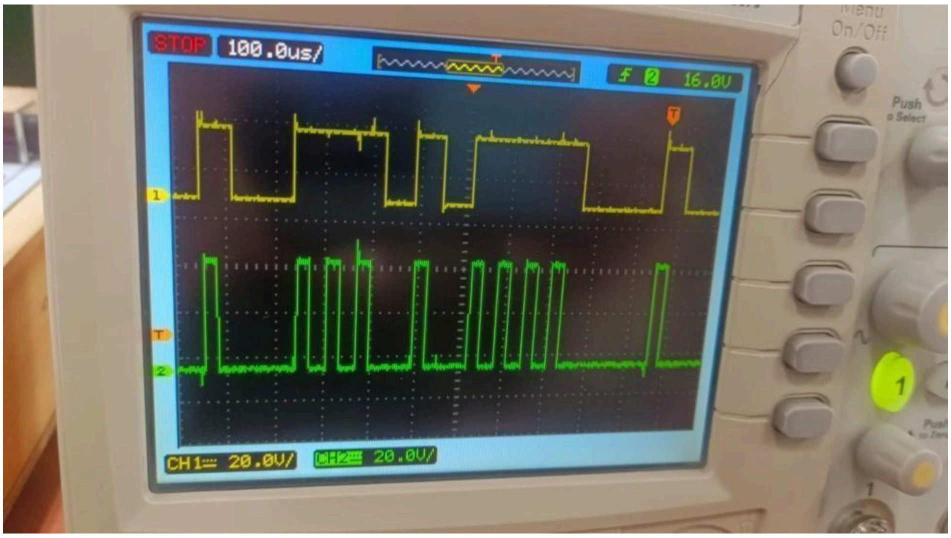
Prbs vs Adder at Maximum Noise(G)



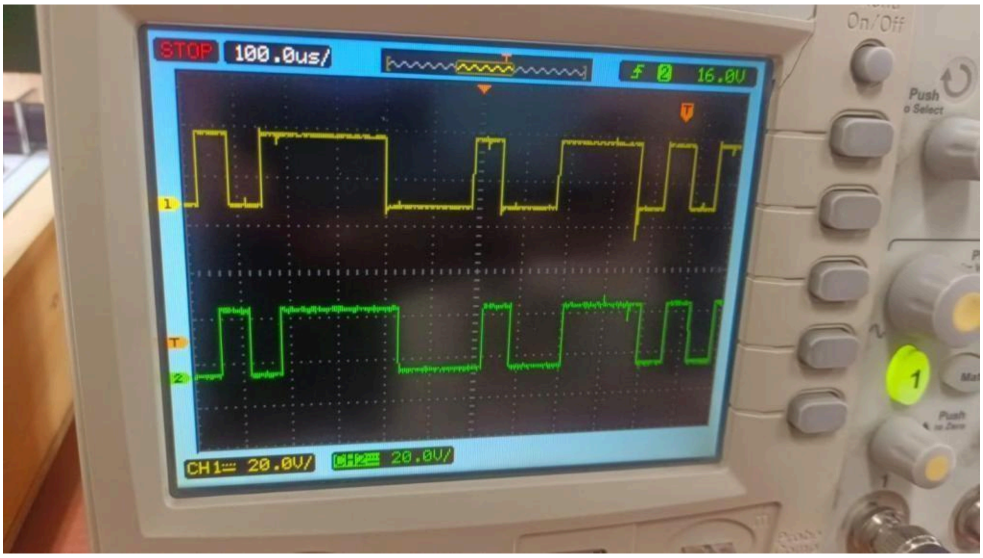
Prbs vs receiver max=5(G)



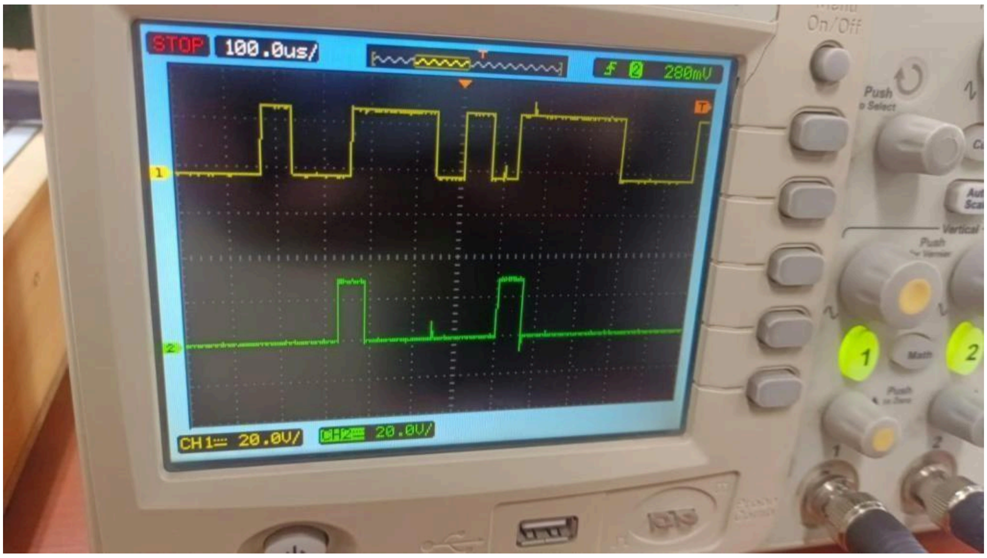
Prbs vs receiver mid=3(G)



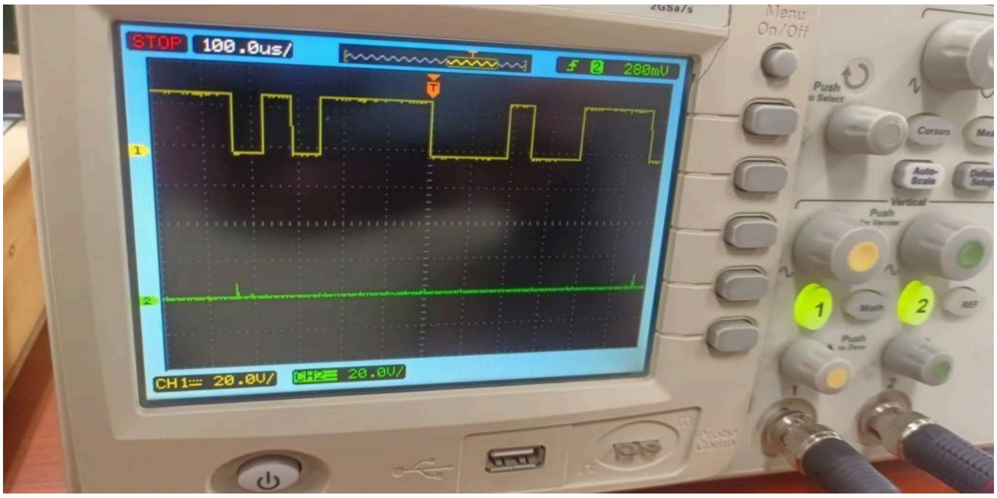
Prbs vs Decision Device Out(G)



Prbs vs Data Recovery min(G)



Prbs vs Data Recovery mid(G)



Prbs vs Data Recovery max(G)

Measurement Of BER

Eb	Time	Tb	BER = Eb / Tb
4625 bits	10s	320000 bits	0.01445
5868 bits	10s	320000 bits	0.01833
7163 bits	10s	320000 bits	0.02238

Discussion

- The PWM output waveform dynamically adjusts its pulse width based on the amplitude variations of the input sine wave, directly influencing the signal characteristics.
- In PPM, the pulse positions shift according to the amplitude changes of the sine wave, ensuring signal modulation based on input variations.
- The DAC converts the PWM/PPM signal back into an analog waveform resembling the original sine wave, but with significant noise, which is then reduced by the 2nd-order low- pass filter.
- The 4th-order low-pass filter further minimizes noise, nearly reconstructing the input sine wave, though with a slight time delay in the time domain.
- The adder introduces noise into the PAM signal, distorting the transmission, while noise fluctuations affect data clarity and signal integrity.
- The decision device attempts to extract the original data from the received signal, but high noise levels degrade its accuracy, necessitating an increase in bandwidth for better recovery.
- As noise levels rise, the bit error rate (BER) increases, making data transmission less reliable.

Conclusion

- This experiment focused on digital baseband transmission and pulse modulation techniques such as PWM and PPM, along with their demodulation processes.
- We evaluated the efficiency of these modulation techniques in reconstructing analog signals and transmitting digital data. In PWM, pulse width varied with the input sine wave's amplitude, while in PPM, pulse position was affected.
- A DAC was employed for demodulation, but its output contained significant noise, necessitating low-pass filtering. The fourth-order filter provided the best noise suppression, though it introduced a slight delay in the recovered signal.
- Furthermore, we examined how noise influenced PAM signal transmission and the accuracy of data recovery. An increase in noise levels led to a higher bit error rate (BER), indicating greater transmission errors.

Reference

- Lab Manual
- Principles of communication systems – S.Haykin