16 QAM Training System
Scientech 2136

Product Tutorial

Ver. 1.1

Designed & Manufactured by-
An ISO 9001:2008 company
Scientech Technologies Pvt. Ltd.
94, Electronic Complex, Pardesipura, Indore - 452 010 India,
+ 91-731 4211100, : info@scientech.bz , : www.ScientechWorld.com

16 QAM Training System
Scientech 2136
Table of Contents

Safety Instructions

Read the following safety instructions carefully before operating the product.

To avoid any personal injury, or damage to the product, or any products connected to it;

Do not operate the instrument if you suspect any damage within.

The instrument should be serviced by qualified personnel only.

For your Safety:

Use proper Mains cord : Use only the mains cord designed for this product. Ensure that the mains cord is suitable for your country.

Ground the Instrument : This product is grounded through the protective earth conductor of the mains cord. To avoid electric shock the grounding conductor must be connected to the earth ground. Before making connections to the input terminals, ensure that the instrument is properly grounded.

Observe Terminal Ratings : To avoid fire or shock hazards, observe all ratings and marks on the instrument.

Use only the proper Fuse : Use the fuse type and rating specified for this product.

Use in proper Atmosphere : Please refer to operating conditions given in the manual.

1. **Do not operate in wet / damp conditions.**
2. **Do not operate in an explosive atmosphere.**
3. **Keep the product dust free, clean and dry.**

Introduction

Today advanced communication technologies are growing in a tremendous way. Technologies like Wireless communication, Mobile communication, Satellite communication, Data communication, RF ID etc enters in our daily lives. M-ary signaling schemes are preferred over Binary signaling schemes for transmitting digital information over band-pass channels when the requirement is to conserve bandwidth at the expense of increased power. In practice, we rarely find a communication channel that has the exact bandwidth required for transmitting the output of an information source by means of Binary signaling schemes.

Both the phase and amplitude can simultaneously be varied in Quadrature Amplitude Modulation (QAM). More bits can be send in each symbol, but an unavoidable decrease in the tolerance for noise results. Thus, 16-QAM with many possible values works very well in wired & wireless channels.

Scientech 2136

Features

16-QAM Transmitter and Receiver is based on VLSI and DSP techniques

Scientech 2136 covers

- Encoding: 4 Bit Encoding with Symbol Mapper
- Modulation: 16-QAM Modulation with I & Q Channel
- Constellation (Vector / XY) View
- Training System can be controlled in Hardware mode without need of external Data Acquisition Card
- Training System has more than 25 test points which will help students to observe the signal on Oscilloscope and Logic Analyzer.
- Online Product Tutorial

Technical Specifications

- On board Digitally Synthesized Sine and Cosine wave Generator
- On board Clock Generator with Step Variable Frequencies (150Hz, 300Hz, 600Hz, 1.2 KHz, 2.4 KHz, 4.8 KHz and 9.6 KHz and 19.2 KHz)
- On board Data generator with Step Variable data length (8, 16, 32, 64bits)
- Encoding Technique (4 Bit Encoding with Symbol Mapper, Binary to Gray Encoder)
- Modulation Technique (16QAM Modulation with I & Q Channel)
- Numerical Control Oscillator (on board NCO for demodulator)
- Decoding Techniques (4 Bit Decoding with Symbol Demapper, Gray to Binary Decoder)
- **Power Supply** : 100-240VAC; 50-60Hz
- **Power Consumption** : 2.5VA (approximately)
- **Weight** : 1.5Kg (approximately)
- **Dimension (mm)** : W365 X D260 X H175

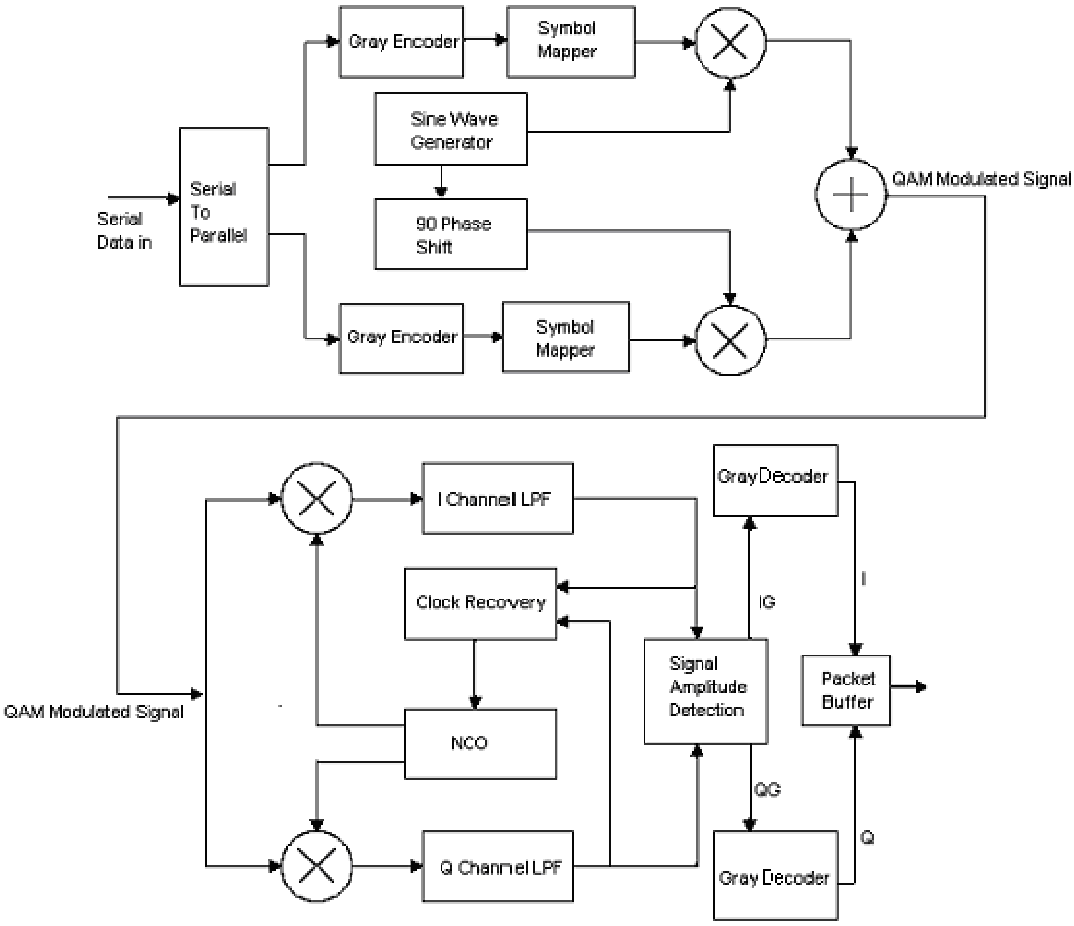
Introduction to 16 QAM Training System

Qudrature Amplitude Modulation (QAM) is a modulation scheme in which two sinusoidal carriers, one exactly 90 degrees out of phase with respect to the other, are used to transmit data over a given physical channel. Because the orthogonal carriers occupy the same frequency band and differ by a 90 degree phase shift, each can be modulated independently, transmitted over the same frequency band, and separated by demodulation at the receiver. The 16 QAM Training system is used for transmitting digital information over band-pass channels to conserve bandwidth at the expense of increased power. It is used to obtain higher spectral efficiency, which potentially results in higher throughput of packetized data.

The Digital Data Generator is provided with Variable data length (8, 16, 32, 64bits) and Variable Step Frequencies will flow through serially as an input to QAM transmitter. The serial data is encoded by four bits and it is divided into two streams as Inphase (I) & Quadrature (Q). I stream is called as odd sequence as it following odd values of the Data pattern. Q stream can be called as even sequence as it following even values of the Data pattern. The results from the Inphase (I) and Quadrature (Q) components are sent to Gray Encoder Block to minimizing the Bit Error Rate (BER) for a given symbol error rate Then the Inphase (I) and Quadrature (Q) components are multiplied with sine and cosine carriers to get I Modulation and Q Modulation and it's get added to give QAM Signal.

The QAM Receiver (Demodulator) takes the modulated output from transmitter signal as input, and it is multiplied with NCO Generated sine and cosine carriers to get I Demodulation and Q Demodulation Signals. The Results from the I Demodulator and Q Demodulator signals are send to Low pass filter to attenuate the high frequencies and pass them into low frequency. When the data's gets filtered in the Demodulator, it will flow through Signal Amplitude Detection to group data range to obtain transmitted data.

Hence, the results from the signal amplitude Detection have two bits of IG & QG are send to Gray Decoder. The result from the Gray Decoder block consist of two bits of I & Q and it will flow through the Four bits Decoding, which is used to Decode I & Q Bits into serial data.



16- QAM Training System

Figure 2

Experiment 1

Objective:

Study, Analysis & Measurement of Variable Clock and Variable Data

Theory:

Variable Clock Generator:

Clock Generator is the heart and is one of the important blocks in any digital sequential circuit design. In Scientech 2136 digitally synthesized clock of 50 % duty cycle with multiple of frequencies are generated.

The Clock Generator works with Variable Step Frequencies (150Hz, 300Hz, 600Hz, 1.2 KHz, 2.4 KHz, 4.8 KHz, 9.6 KHz and 19.2 KHz) can be controlled using DIP switches D2, D3, D4 both in Hardware mode and can be observed on test point TP 2.

Below Table shows, the position of DIP switches (D2, D3, and D4) and respective output clock frequency at test point TP 2.

Serial Number	DIP Switches	Clock Frequency
1	000	150 Hz
2	001	300 Hz
3	010	600 Hz
4	011	1.2 KHz
5	100	2.4 KHz
6	101	4.8 KHz
7	110	9.6 KHz
8	111	19.2 KHz

Variable Pattern Generator:

Pattern Generator or Data Generator is also a basic requirement for digital circuit analysis. Pattern or Data Generator is used in Digital Communication as a data source. In Scientech 2136 Data Generator is provided with Variable data length (8, 16, 32, 64 Bit) Pattern of different length can be selected using DIP switches (D5 – D6) and can be observed on the Test Point TP3.

Below Table shows, the position of DIP switches and respective Step Variable data length:

Serial Number	DIP Switches	Pattern Length
1	00	64
2	01	32
3	10	16
4	11	8

Figure below shows Patterns of 8-Bit length:

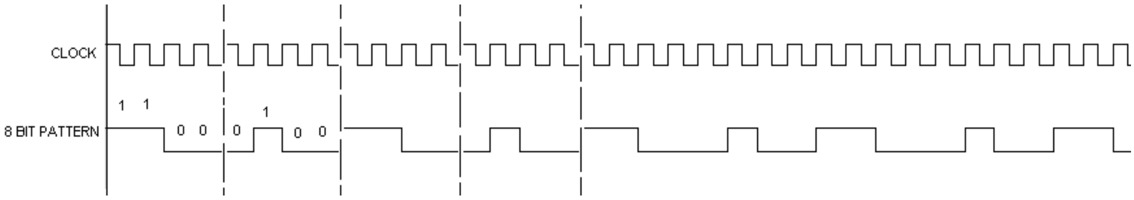


Figure below shows Patterns of 16-Bit length:

Figure 3

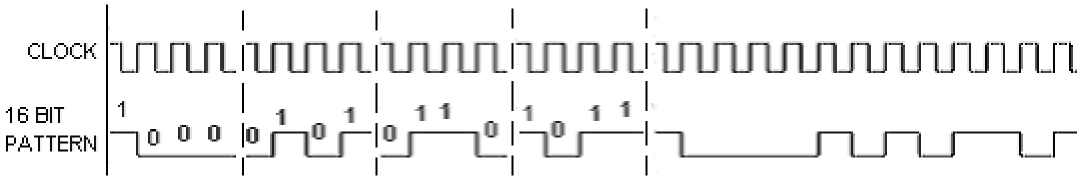


Figure below shows Patterns of 32-Bit length:

Figure 4

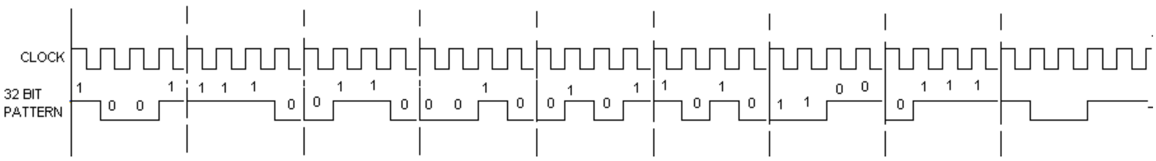


Figure 5

Figure below shows Patterns of 64-Bit length:

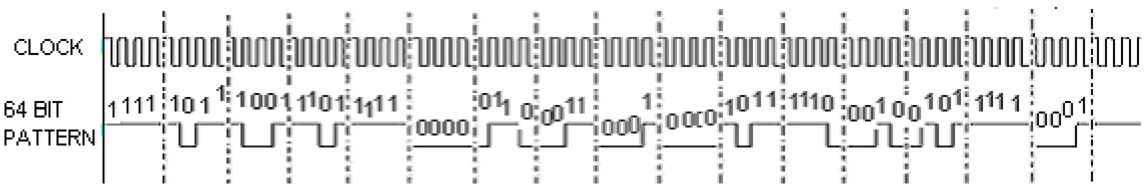


Figure 6

Procedure:

1. Hardware Mode Steps

- Switch 'On' Power Switch.
- For hardware mode Set DIP D1 to logic 0 (down position).
- Observe and measure System clock at Test Point TP1.
- Set DIP D2, D3, D4 to 000.
- Observe Clock frequency at test point TP2 with respect to Ground, it should be150Hz.
- Set DIP D1, D2, D3, D4 to 0000,0001,0010,0011, 0100, 0101, 0110, 0111 and Observe their respective frequencies at Test point TP2.
- Set pattern length by using DIP D5, D6 (00 – 64 bits, 01 – 32 bits, 10 – 16 bits, 11 – 8 bits), use Reset switch to analyze the better results for different pattern lengths and observe corresponding Bit patterns at Test Point TP3.

Observation:

DSO Result for Reference:

Figure below shows Patterns of 32-Bit length:

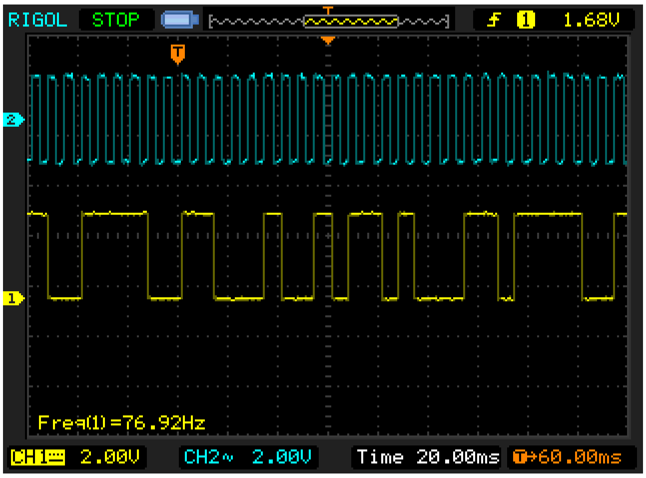


Figure 7

Experiment 2

Objective:

Study, Analysis & Measurement of 4 Bit Encoding with Input Serial Data

Theory:

Refer Experiment 1 Theory.

Four Bit Encoded data is similar to the data output from data/pattern generator and it is divided into two streams as Inphase (I) & Quadrature (Q). I stream is called as odd sequence as it following odd values of the Data pattern. Q stream can be called as even sequence as it following even values of the Data pattern. Frequency of the data after encoding will be 1/4th of clock generator.

Block Diagram For 4 Bit Encoding for 16 QAM Modulation is shown below

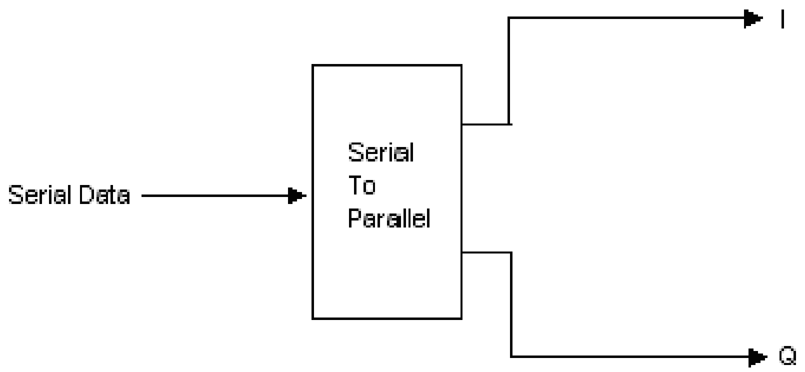


Figure 8

Figure below shows the output of 4 bits encoding for 32 Bit pattern

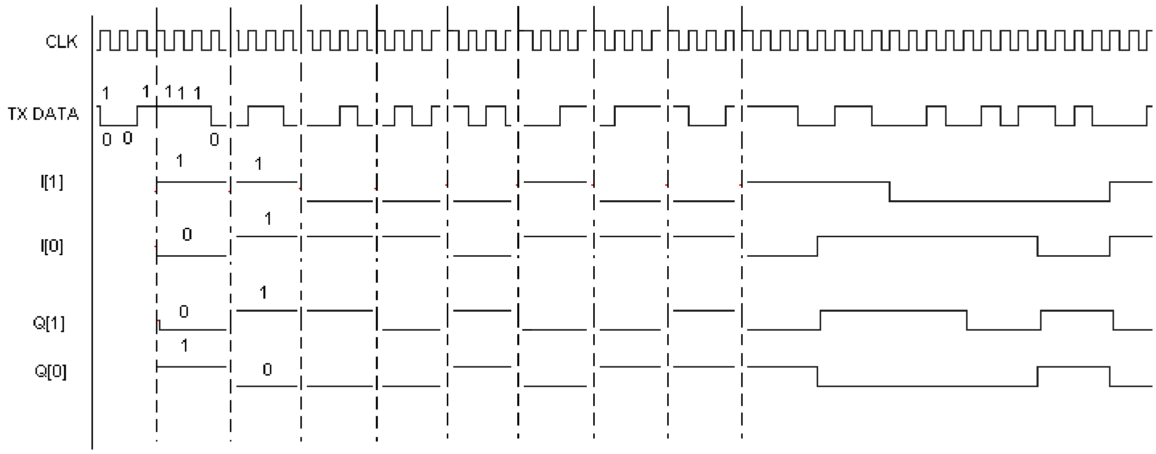


Figure 9

Procedure:

1. Hardware Mode Steps

- Observe 4 Bit Encoded data at test point TP3.
- Observe the 4 Bit Encoded ouputs of I [1] at test point TP4, I [0] at test point TP5, Q [1] at test point TP6, Q [0] at test point TP7.
- For clock frequency, pattern length setting refers Experiment 1.

Observation:

DSO Result for Reference:

Figure below shows the output of 4 Bit Encoding for 32 Bit Pattern

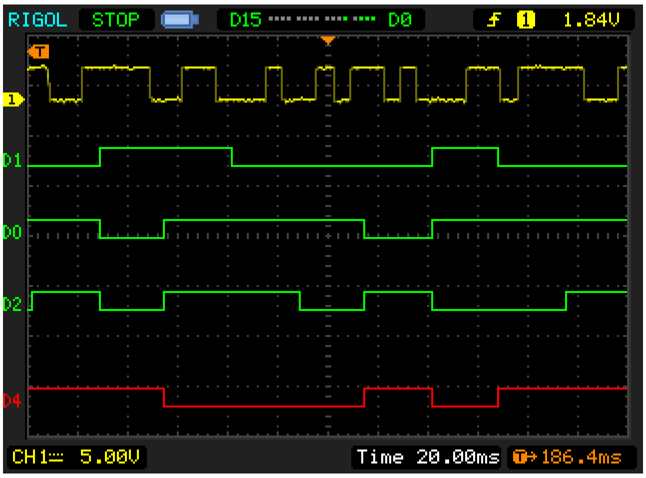


Figure 10

Experiment 3

Objective:

Study, Analysis & Measurement of I-Q Channel Binary to Gray Encoder

Theory:

Refer Experiment 2 Theory

The results from the Inphase (I) and Quadrature (Q) components are sent to Gray Encoder Block. The Gray encoder block belongs to a class of codes called minimum-change codes, in which only one bit in the code group changes when moving from one step to next step. Therefore, it is also called as a unit-distance code. Gray coding between bits and symbols is possible, minimizing the BER for a given symbol error rate.

Block Diagram for Binary to Gray Encoder is shown below

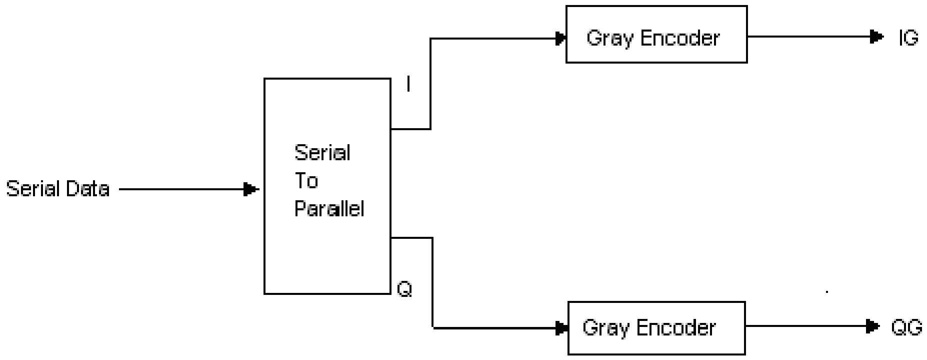


Figure 11

Figure below shows the Gray coded outputs for I & Q

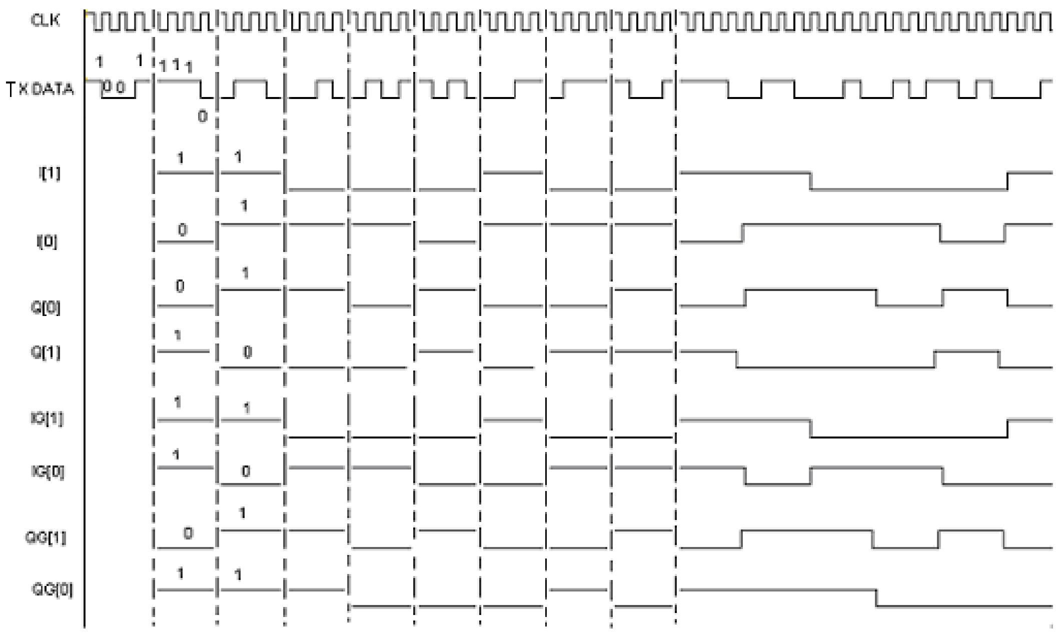


Figure 12

Procedure:

1. Hardware Mode Steps

- Observe the Binary to Gray coded outputs of IG [1] at test point TP8, IG [0] at test point TP9, QG[0] at test point TP10, QG[1] at test point TP11.
- For clock frequency, pattern length settings refer Experiment 1.
- For 4-Bit Encoding refer Experiment 2.

Observation:

DSO Result for Reference:

Figure below shows the output of I Channel Binary to Gray Encoder

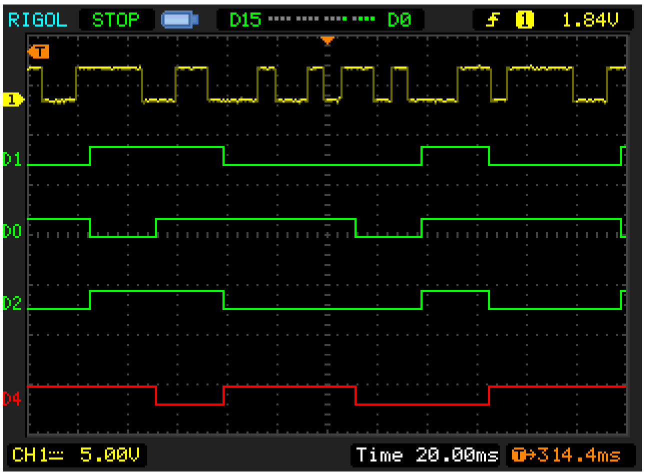


Figure below shows the output of Q Channel Binary to Gray Encoder

Figure 13

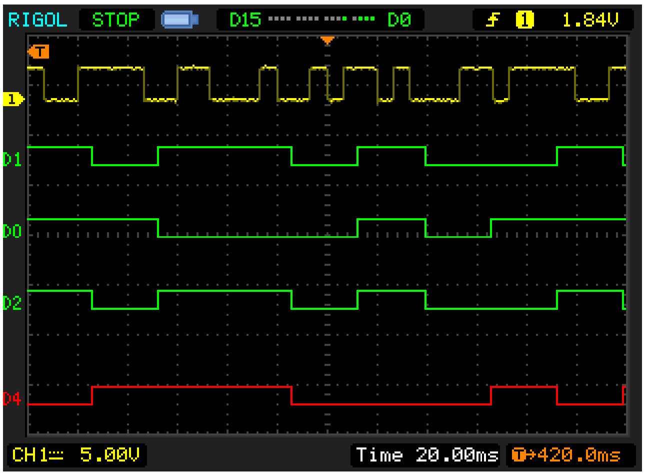


Figure 14

Experiment 4

Objective:

Study, Analysis & Measurement of I-Q Channel Symbol Mapper with Constellation Patterns

Theory:

The Symbol Mapper is explained by means of Constellation Diagram. A Constellation Diagram is a plot of the symbols on the rectangular space. In 16 QAM,

$16 = 2^4$, four bits per symbol can be sent. It consists of two bits for I component and two bits for Q component. This results in a total of 16 possible states for the signal. It can attain transition from any state to any other state at every symbol time.

I Channel and Q Channel are used to modulate respectively Sine and Cosine wave. The X-axis projection for each symbol is the I Channel amplitude and Y-axis projection for each symbol is the Q Channel amplitude.

Block Diagram for I-Q Channel Symbol Mapper is shown below

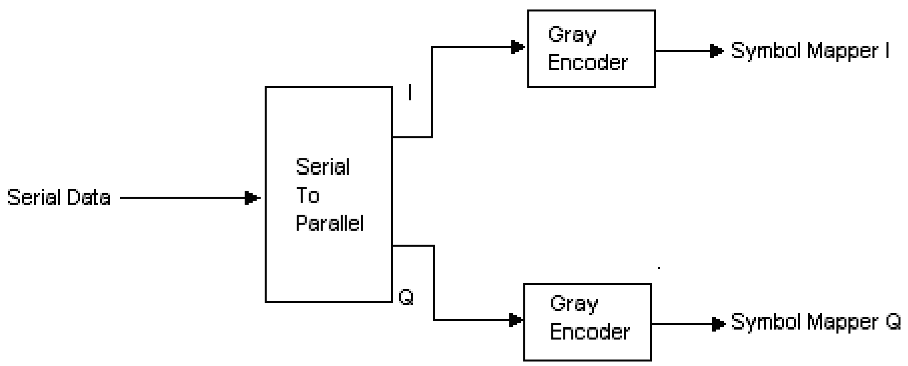


Figure 15

Constellation diagram for 16- QAM will look like figure shown below

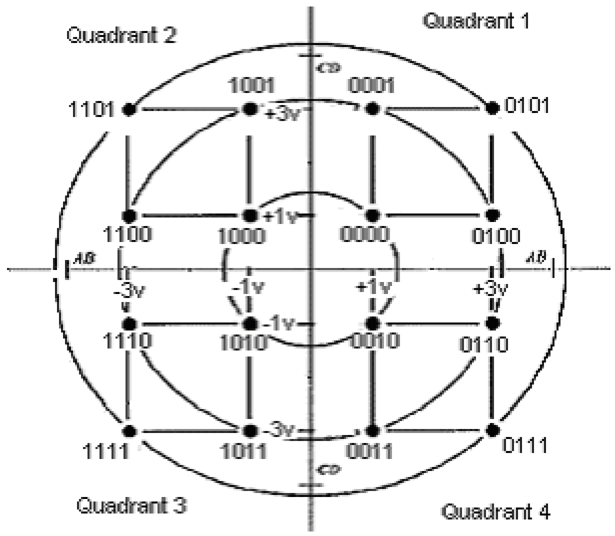


Figure 16

As I Channel and Q Channel both can be either Logic"0" or Logic"1" so total 16 combinations for (I, Q) are possible which are 0000 to 1111.

Note that 16- QAM has 4 Amplitudes and 12 phases. The I and Q values can each take on four discrete values: ±3, ±1. In the 16-QAM, the number of amplitude shift is fewer than the phase shifts. This is because, the amplitude changes are susceptible to noise and require greater shift difference than do phase changes, the number of phases shifts used by a QAM system is larger than the amplitude shifts. This meant that even with noise problem associated with amplitude shifting is reduced. So QAM is lower susceptibility to noise.

Figure below shows Symbol Mapper outputs for I Channel & Q Channel

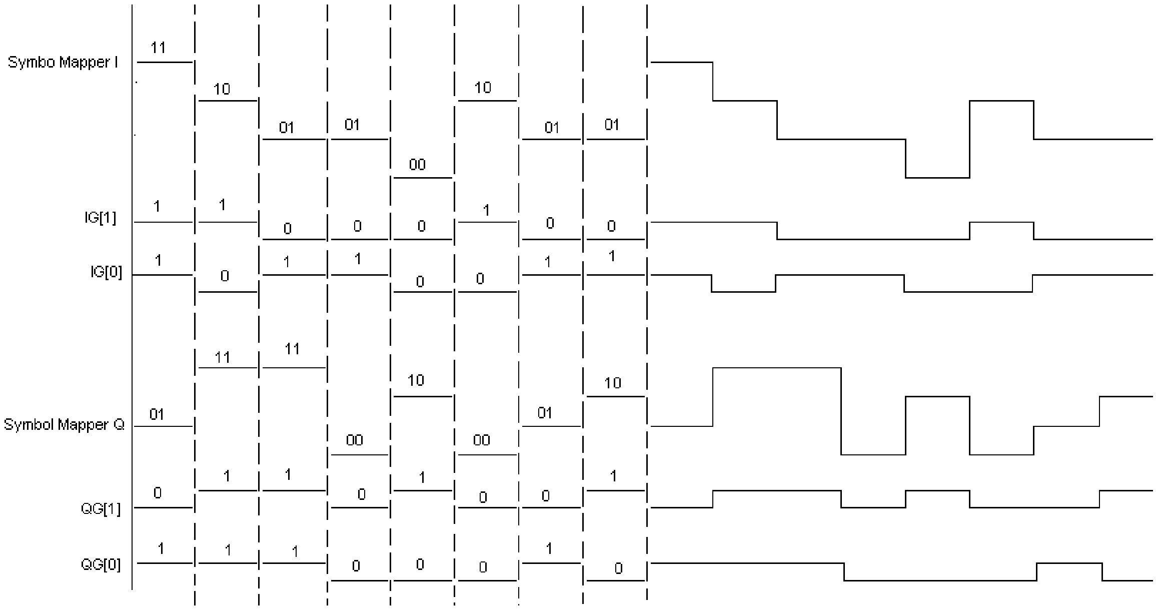


Figure 17

Procedure:

1. Hardware Mode Steps:

- Observe the Symbol Mapper outputs of I Channel at test point TP12 and Q Channel at test point TP13.
- Observe the ouput of the Constellation Patterns for I Channel at test point TP12 and Q Channel at test point TP13 by setting the DSO in X-Y Mode.
- For clock frequency, pattern length settings refer Experiment 1.
- For 4-Bit Encoding refer Experiment 2.
- For Binary to Gray Encoder refer Experiment 3.

Observation:

DSO Result for Reference:

Figure below shows the output of Symbol Mapper for I Channel & Q Channel

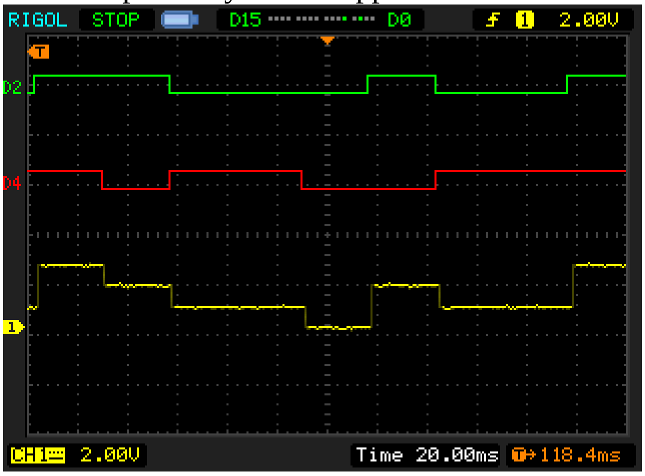


Figure 18

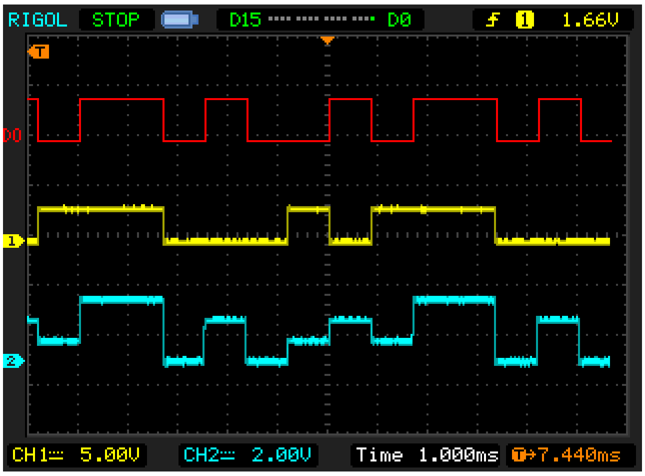


Figure 19

Figure below shows the Constellation Diagram for I-Q Channel

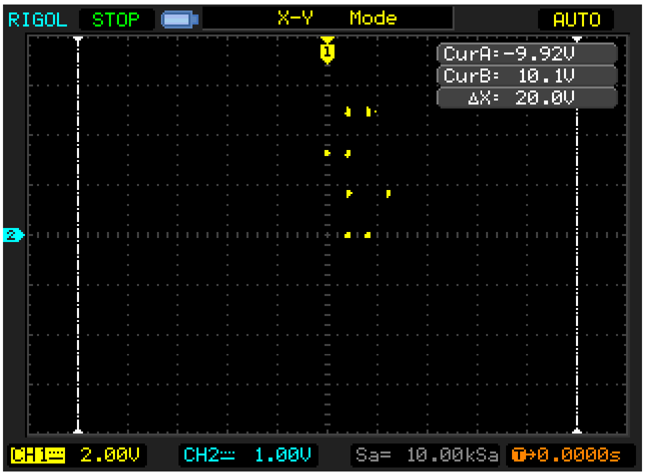


Figure 20

Experiment 5

Objective:

Study, Analysis & Measurement of I-Q Channel Modulation with Symbol Mapper

Theory:

The results of Gray Encoders are multiplied with sine and cosine carriers to get I Modulation and Q Modulation. QAM is a modulation scheme in which two sinusoidal carriers, one exactly 90 degrees out of phase with respect to the other, are used to transmit data over a given physical channel. Because the orthogonal carriers occupy the same frequency band and differ by a 90 degree phase shift, each can be modulated independently, transmitted over the same frequency band, and separated by demodulation at the receiver.

Block Diagram for I-Q Channel Modulation is shown below

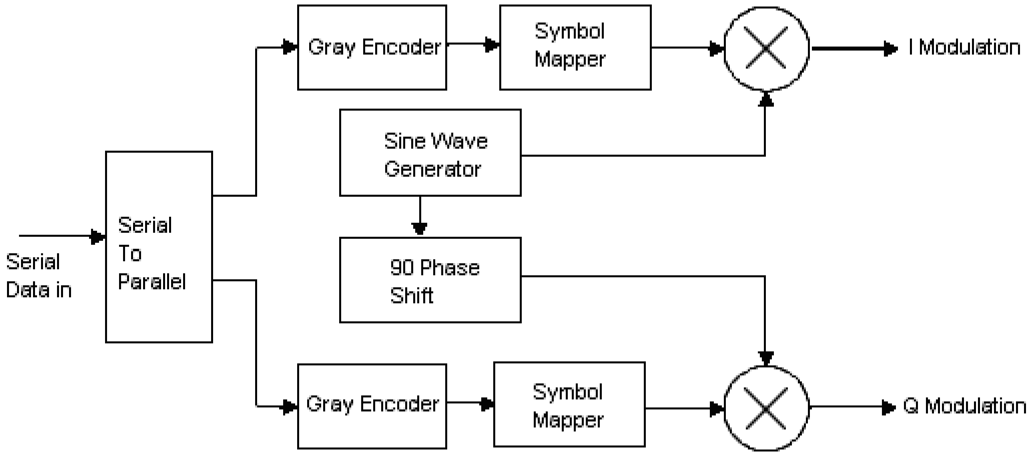


Figure 21

Below Table shows, the Phase and Magnitude values of I and Q Modulator with Variable Data

Data	I Modulator		Q Modulator	
	Phase	Magnitude	Phase	Magnitude
0000	sin 45^o	+ 1	cos 315 ^{o}	+ 1
0001	sin 67.5^o	+ 1	cos 337.5 ^{o}	+ 3
0010	sin 315^o	+ 1	cos 225 ^{o}	- 1

0011	sin 292.5^o	+ 1	cos 202.5^o	- 3
0100	sin 22.5^o	+ 3	cos 292.5^o	+ 1
0101	sin 45^o	+ 3	cos 315^o	+ 3
0110	sin 337.5^o	+ 3	cos 247.5^o	- 1
0111	sin 315^o	+ 3	cos 225^o	- 3
1000	sin 135^o	- 1	cos 45^o	+ 1
1001	sin 112.5^o	- 1	cos 22.5^o	+ 3
1010	sin 225^o	- 1	cos 135^o	- 1
1011	sin 247.5^o	- 1	cos 157.5^o	- 3
1100	sin 157.5^o	- 3	cos 67.5^o	+ 1
1101	sin 135^o	- 3	cos 45^o	+ 3
1110	sin 202.5^o	- 3	cos 112.5^o	- 1
1111	sin 225	- 3	cos 135^o	- 3

Figure below shows the outputs of I-Q Channel Modulation

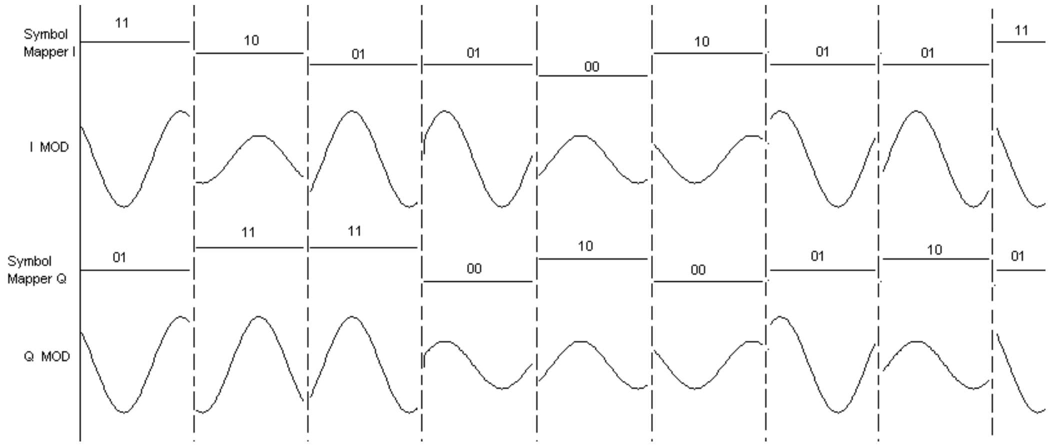


Figure 22

Procedure:

1. Hardware Mode Steps:

- Observe the outputs of I Channel Modulation at test point TP16 and Q Channel Modulation at test point TP17.
- Observe the outputs of Sine wave Generator at test point TP14 and Cosine wave Generator at test point TP15.
- For clock frequency, pattern length settings refer Experiment 1.
- For 4-Bit Encoding refer Experiment 2.
- For Binary to Gray Encoder refer Experiment 3.
- For Symbol Mapper outputs of I Channel and Q Channel refer Experiment 4.

Observation:

DSO Result for Reference:

Figure below shows the output of I Modulation

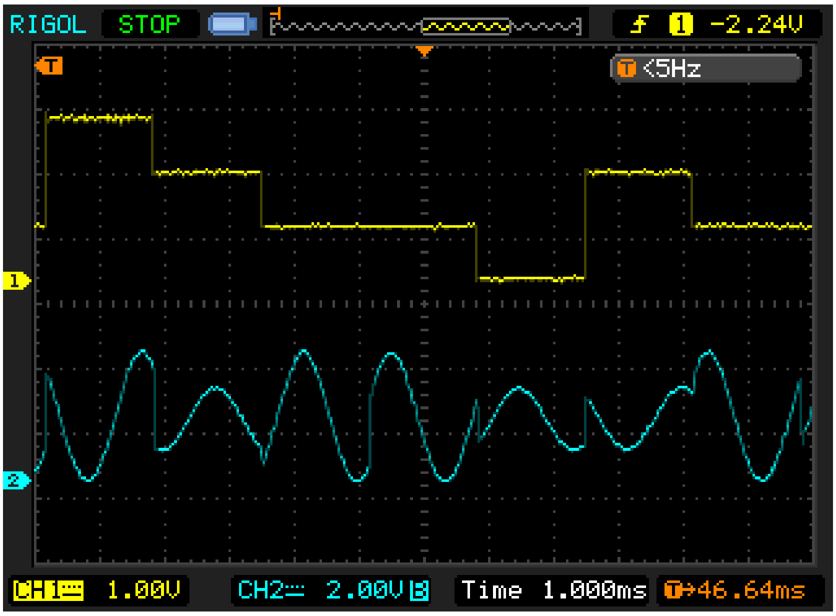


Figure 23

Figure below shows the output of Q Modulation

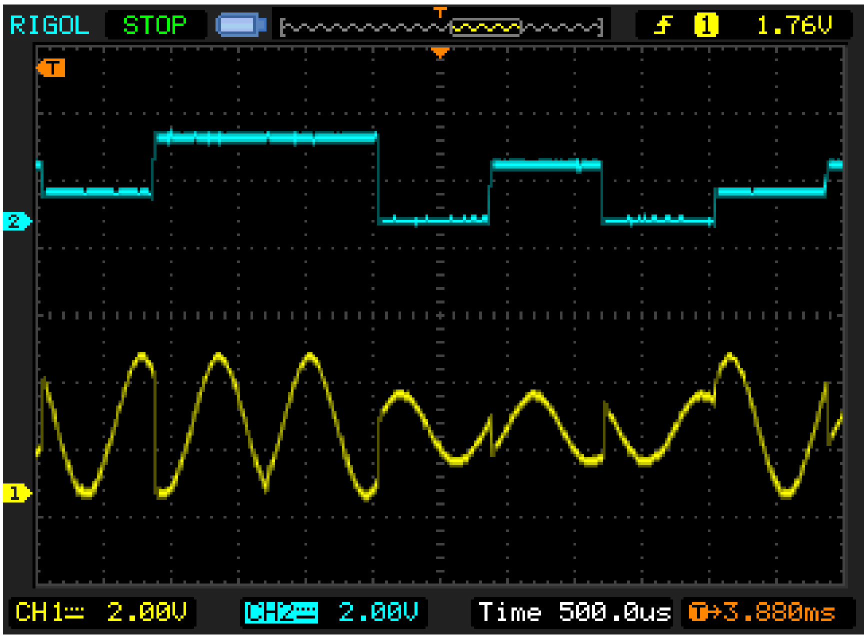


Figure 24

Experiment 6

Objective:
Study, Analysis & Measurement of 16-QAM Modulation with variable data

Theory:
The 16 – QAM Modulation Signal is the combination of I channel and Q channel. It has 16 symbol, each symbol consist of 4 bits (i.e. I – 2 bits and Q- 2 bits) is explained in the constellation Diagram. In the 16-QAM, the number of amplitude shift is fewer than the phase shifts. This is because, the amplitude changes are susceptible to noise and require greater shift difference than do phase changes, the number of phases shifts used by a QAM system is larger than the amplitude shifts. This meant that even with noise problem associated with amplitude shifting is reduced. So QAM is lower susceptibility to noise. QAM is used to obtain higher spectral efficiency, which potentially results in higher throughput of packetized data.

Block Diagram For 16-QAM Modulation is shown below:

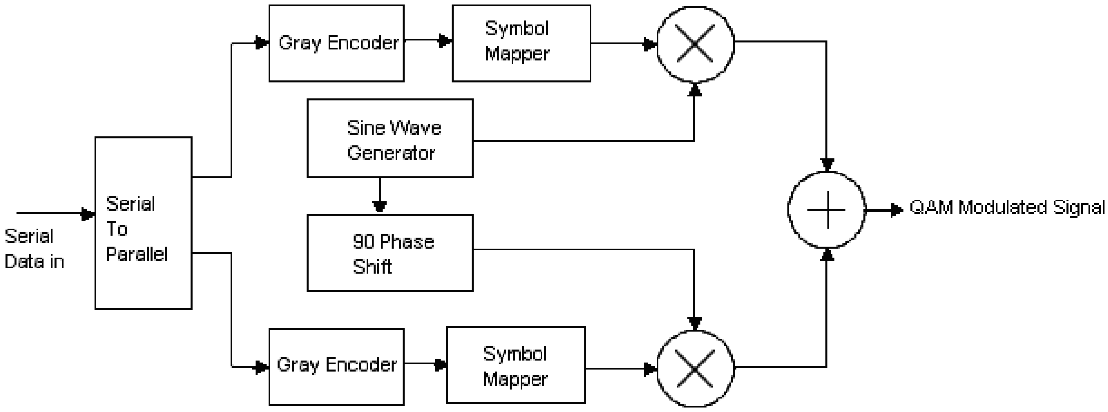


Figure 25

Figure below shows the output of 16-QAM Modulation Signal with Variable Data

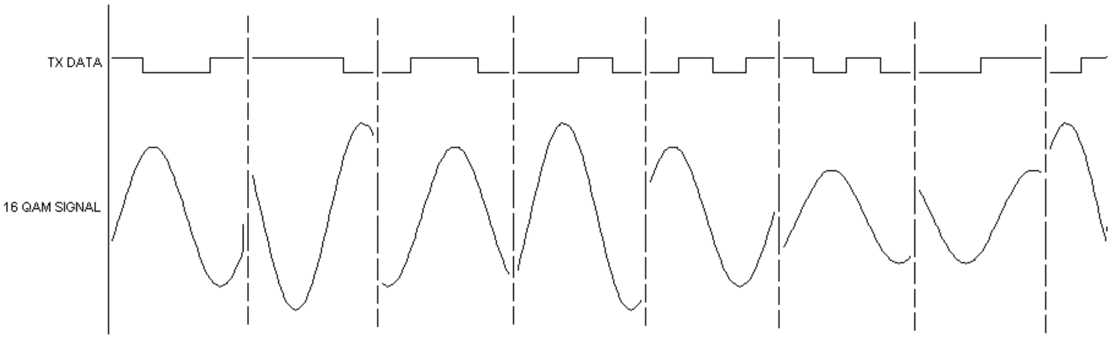


Figure 26

Procedure:

1. Hardware Mode Steps:

- Observe the output of 16-QAM Modulation at test point TP18.
- For clock frequency, pattern length settings refer Experiment 1.
- For 4-Bit Encoding refer Experiment 2.
- For Binary to Gray Encoder refer Experiment 3.
- For Symbol Mapper outputs of I Channel and Q Channel refer Experiment 4.
- For Sine wave Generator, Cosine wave Generator, I Channel Modulation and Q Channel Modulation refer Experiment 5.

Observation:

DSO Result for Reference:

Figure below shows the output of QAM Signal with Variable Data

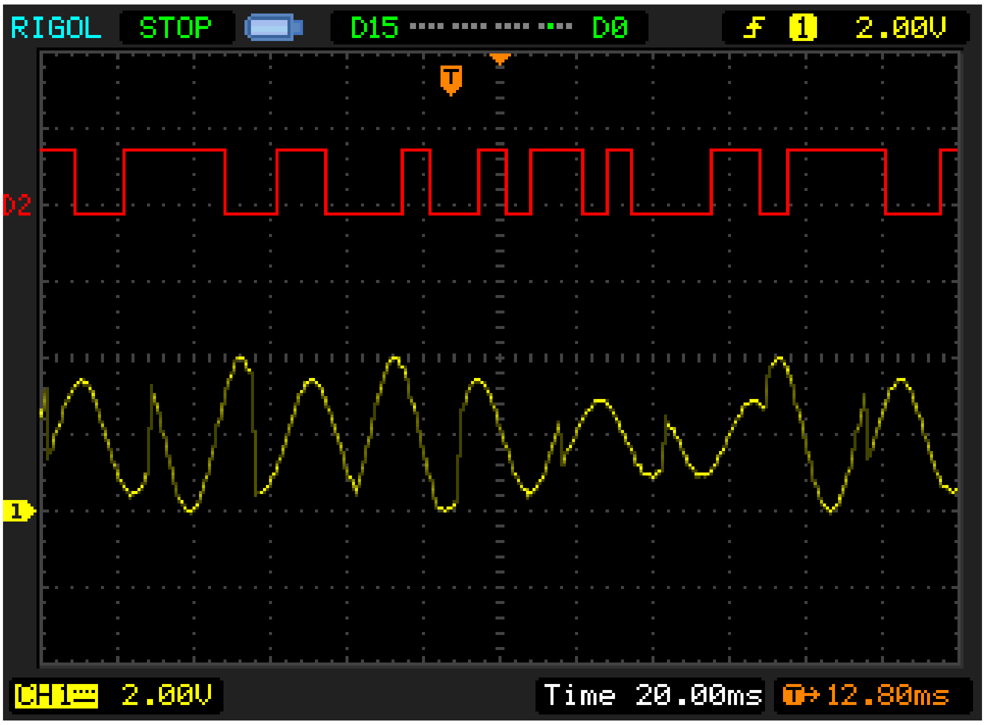


Figure 27

Experiment 7

Objective:

Study, Analysis & Measurement 16-QAM Demodulator

Theory:

The QAM Receiver (Demodulator) takes the modulated output from transmitter signal as input, and it is multiplied with NCO Generated sine and cosine carriers to get I Demodulation and Q Demodulation Signals. It is apparent that the demodulator performs the complement functions to those in the modulator to get the transmitted data in the receiver.

Block Diagram For 16-QAM Demodulator is shown below:

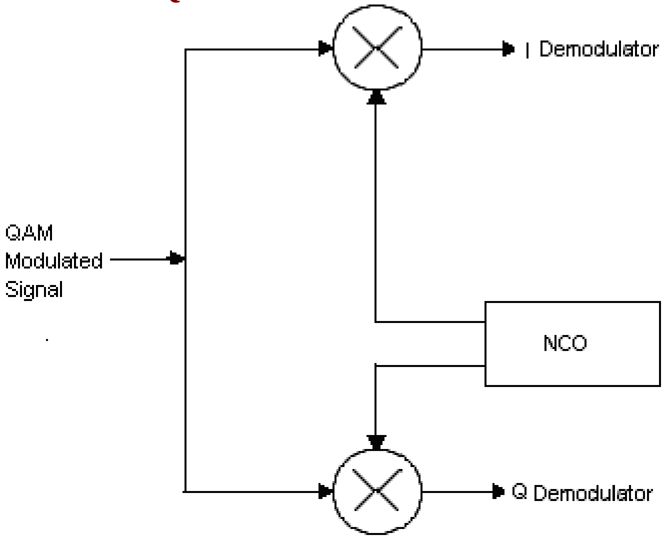


Figure 28

Figure below shows the outputs of Sine and Cosine Demodulator

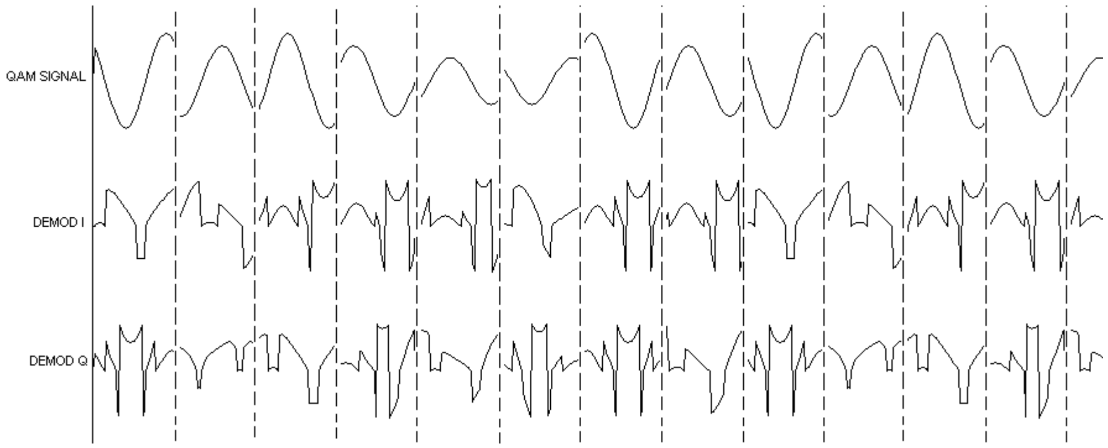


Figure 29

Procedure:

1. Hardware Mode Steps

- Observe the outputs of I Channel Demodulation at test point TP21, Q Channel Demodulation at test point TP22, NCO Sine wave Generator at test point TP19 and NCO Cosine wave Generator at test point TP20.
- For clock frequency, pattern length settings refer Experiment 1.
- For 4-Bit Encoding refer Experiment 2.
- For Binary to Gray Encoder refer Experiment 3.
- For Symbol Mapper outputs of I Channel and Q Channel refer Experiment 4.
- For Sine wave Generator, Cosine wave Generator, I Channel Modulation and Q Channel Modulation refer Experiment 5.
- For 16-QAM Modulation refer Experiment 6.

Observation:

DSO Result for Reference:

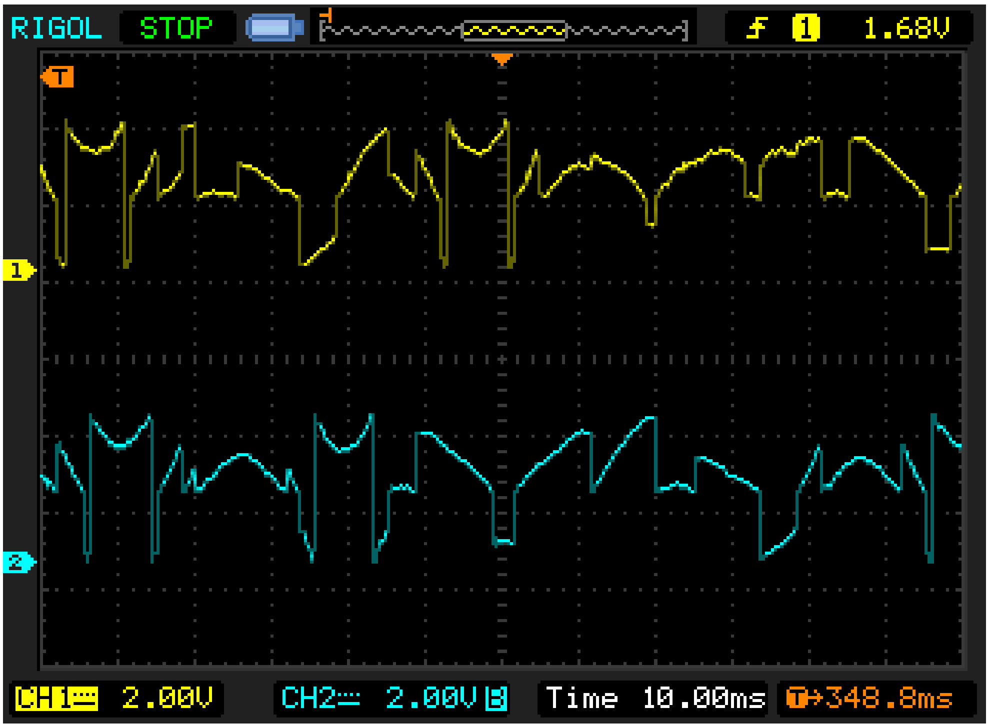


Figure 30

Figure below shows the outputs of Sine and Cosine Demodulator

Experiment 8

Objective:

Study, Analysis & Measurement of I-Q Channel Symbol Demapper

Theory:

The Results from the I Demodulator and Q Demodulator signals are send to Low pass filter to attenuate the high frequencies and pass them into low frequency. By means of Low pass filter, we can reduce the Noise and Intersymbol interference (ISI) in the received data. When the data's gets filtered in the Demodulator, it contains large data in it which has to be identified with respect to the amplitude and detected for receiving the actual data. The range of amplitude is used to group data range to obtain transmitted data. Hence, the results from the signal amplitude Detection has Gray coded bits of IG & QG each consist of 2 bits.

Block Diagram for I-Q Channel Symbol Demapper is shown below:

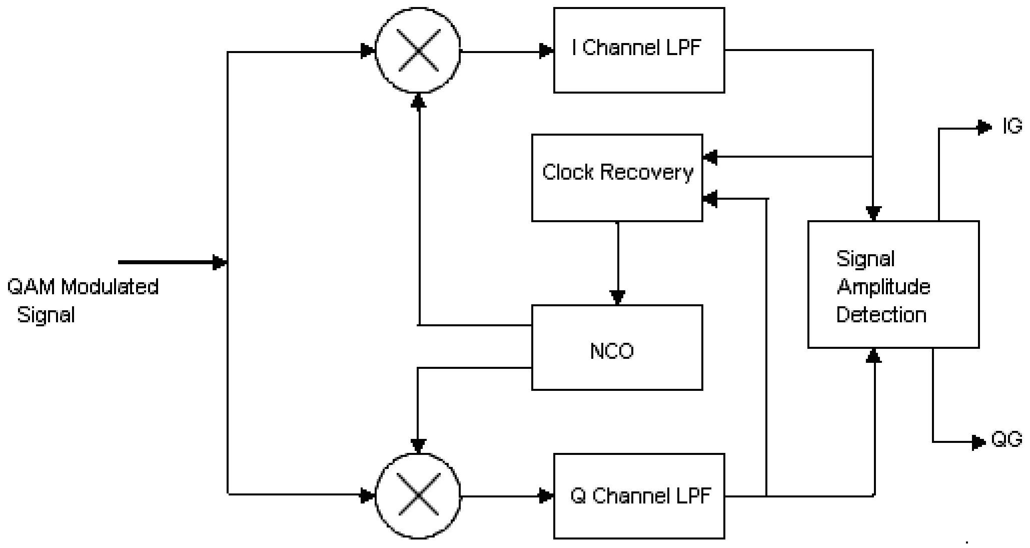


Figure 31

Figure below shows the Demodulated Outputs I Channel and Q Channel for Low Pass Filter and Signal Amplitude Detection

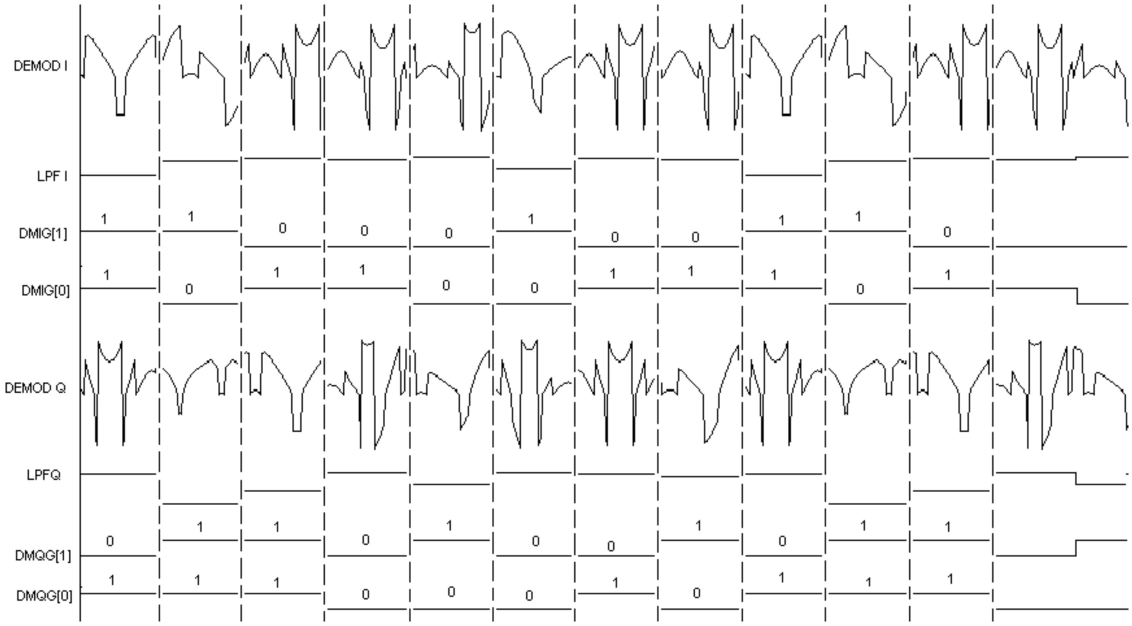


Figure 32

Procedure:

1. Hardware Mode Steps:

- Observe the outputs of I Channel LPF at test point TP24, Q Channel LPF at test point TP25, Demodulated Gray code of I [1] at test point TP26, I[0] at test point TP27, Q[1] at test point TP28, Q[0] at test point TP29 and Clock recovery of NCO at test point TP23.
- For clock frequency, pattern length settings refer Experiment 1.
- For 4-Bit Encoding refer Experiment 2.
- For Binary to Gray Encoder refer Experiment 3.
- For Symbol Mapper outputs of I Channel and Q Channel refer Experiment 4.
- For Sine wave Generator, Cosine wave Generator, I Channel Modulation and Q Channel Modulation refer Experiment 5.
- For 16-QAM Modulation refer Experiment 6.
- For I Channel Demodulation, Q Channel Demodulation, NCO Sine wave Generator and NCO Cosine wave Generator refer Experiment 7.

2. Observation:

DSO Result for Reference:

Figure below shows the Demodulated Output of Low pass Filter and Gray coded Data for I Channel

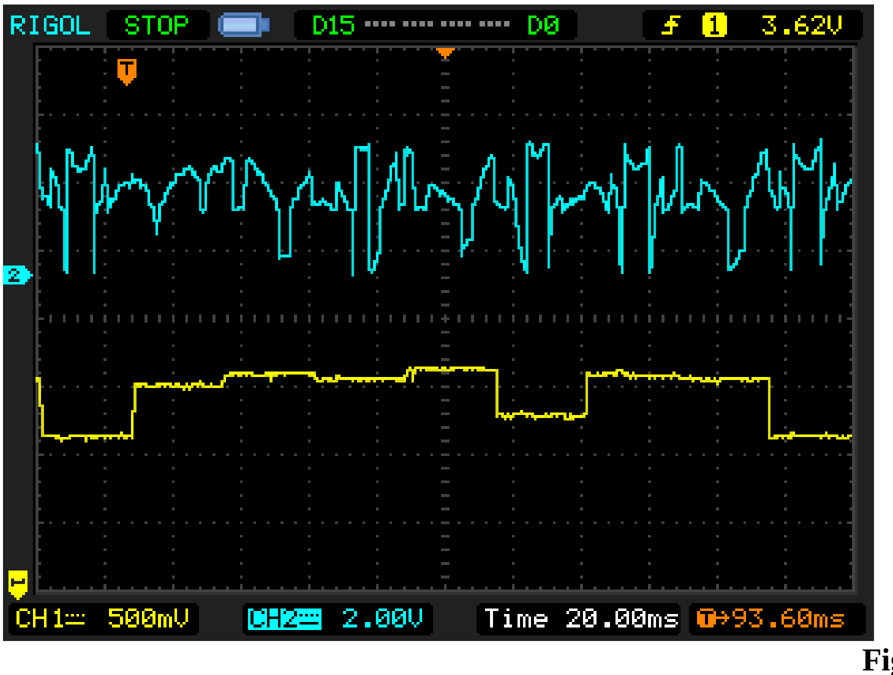


Figure 33

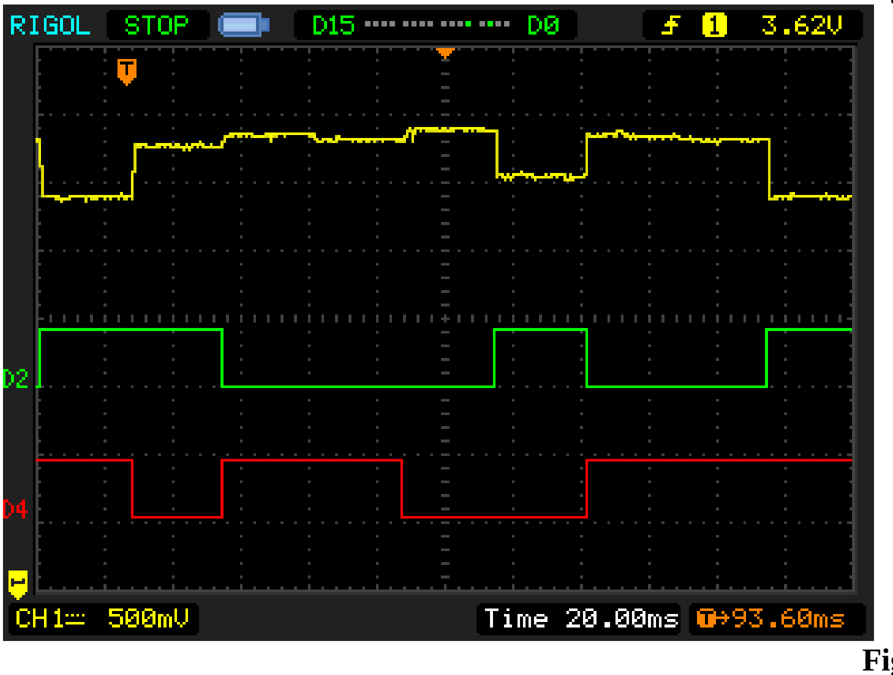


Figure 34

Figure below shows the Demodulated Output of Low pass Filter and Gray coded Data for Q Channel

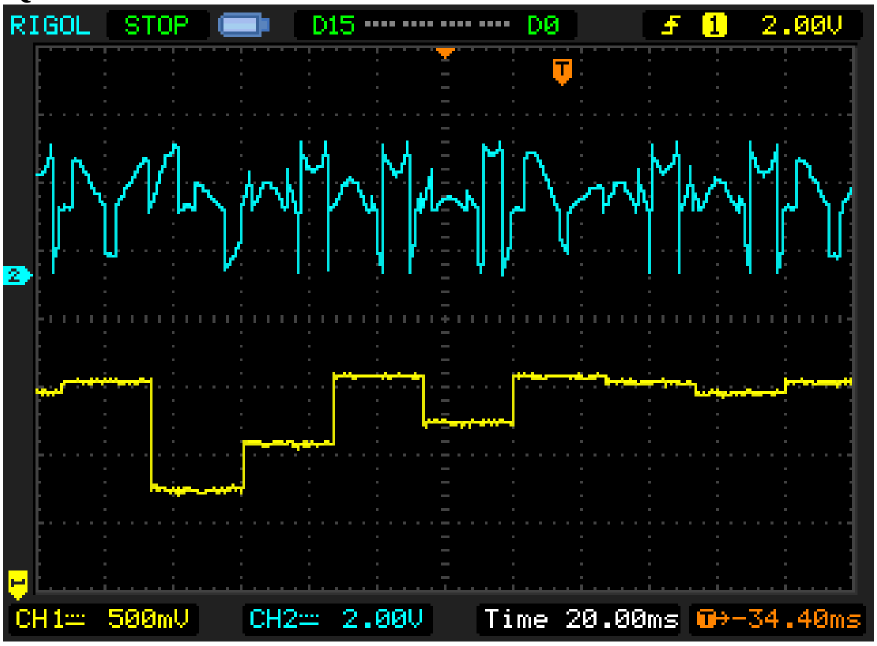


Figure 35

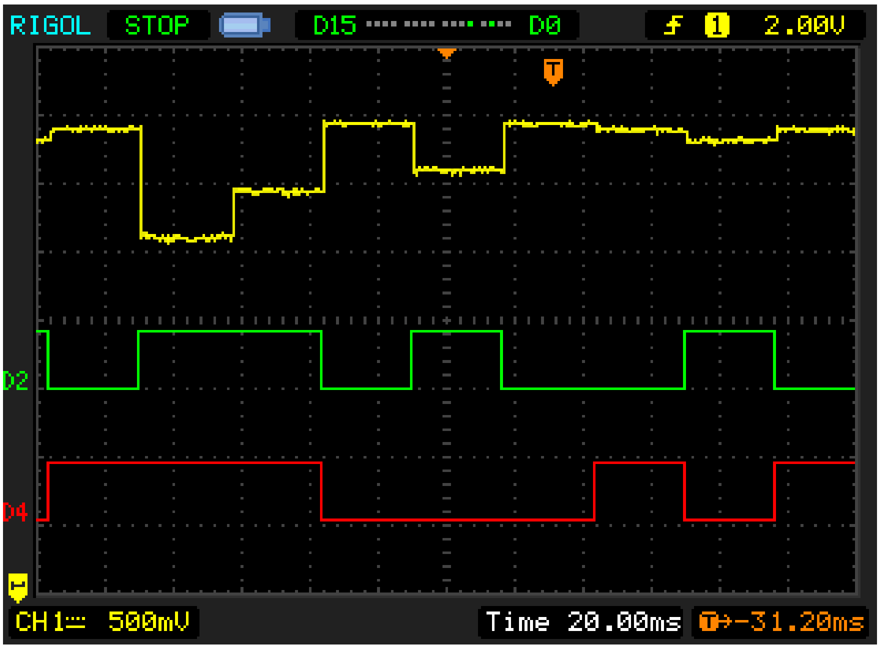


Figure 36

Experiment 9

Objective:

Study, Analysis & Measurement of I-Q Channel Binary Data and Gray Data for Transmitter and Receiver

Theory:

The results from the signal amplitude Detection have two bits of IG & QG are send to Gray Decoder. The Gray Decoder is used to decode the Gray data into Binary data to get transmitted data in the receiver. The result from the Gray Decoder block consists of two bits of I & Q. The Gray Decoder Process is the inverse operation of Gray Encoder in the transmitter. Gray coding between bits and symbols is possible, minimizing the BER for a given symbol error rate.

Block Diagram for I-Q Channel Gray to Binary Decoder is shown below:

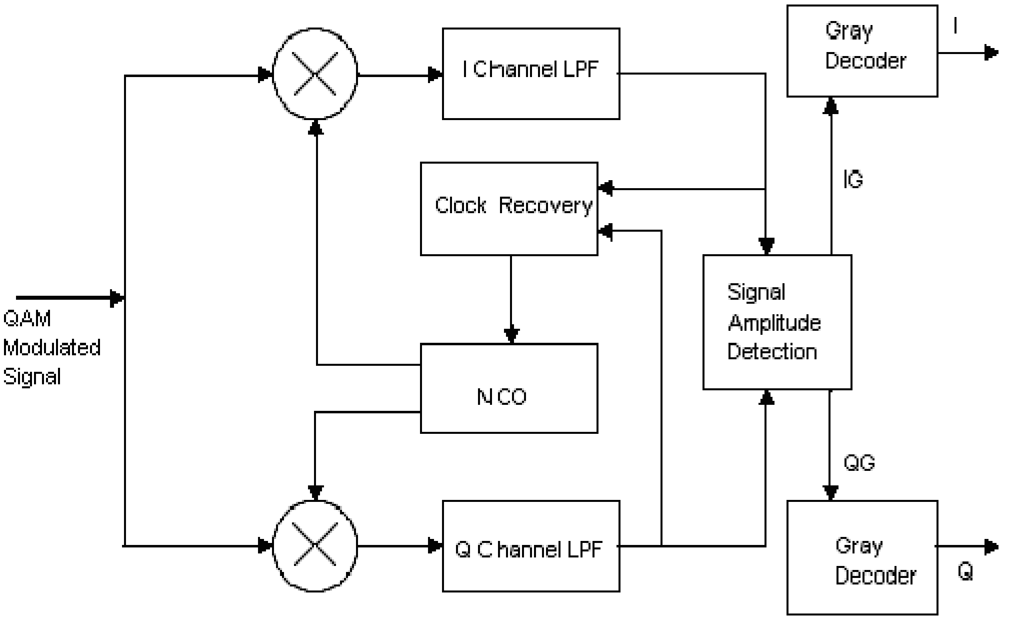


Figure 37

Figure below shows the outputs of I-Q Channel Gray to Binary Decoder

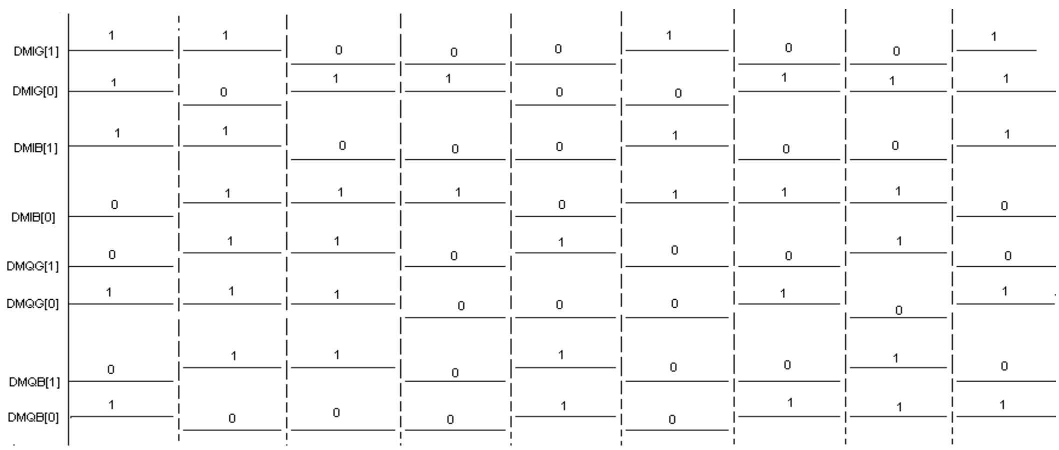


Figure 38

Procedure:

1. Hardware Mode Steps

- Observe the outputs of Gray Decoder I[1] at test point TP30, I[0] at test point TP31, Q[1] at test point TP32 and Q[0] at test point TP33.
- For clock frequency, pattern length settings refer Experiment 1.
- For 4-Bit Encoding refer Experiment 2.
- For Binary to Gray Encoder refer Experiment 3.
- For Symbol Mapper outputs of I Channel and Q Channel refer Experiment 4.
- For Sine wave Generator, Cosine wave Generator, I Channel Modulation and Q Channel Modulation refer Experiment 5.
- For 16-QAM Modulation refer Experiment 6.
- For I Channel Demodulation, Q Channel Demodulation, NCO Sine wave Generator and NCO Cosine wave Generator refer Experiment 7.
- For I Channel LPF, Q Channel LPF, Demodulated Gray code outputs and Clock Recovery of NCO refer Experiment 8.

Observation:

DSO Result for Reference:

Figure below shows the outputs of I Channel Gray to Binary Decoder

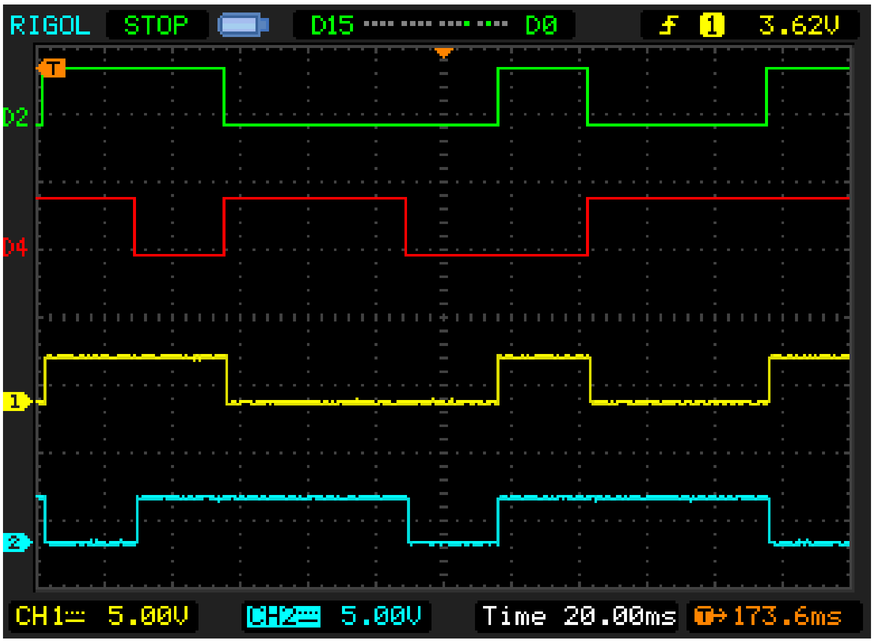


Figure 39

Figure below shows the outputs of Q Channel Gray to Binary Decoder

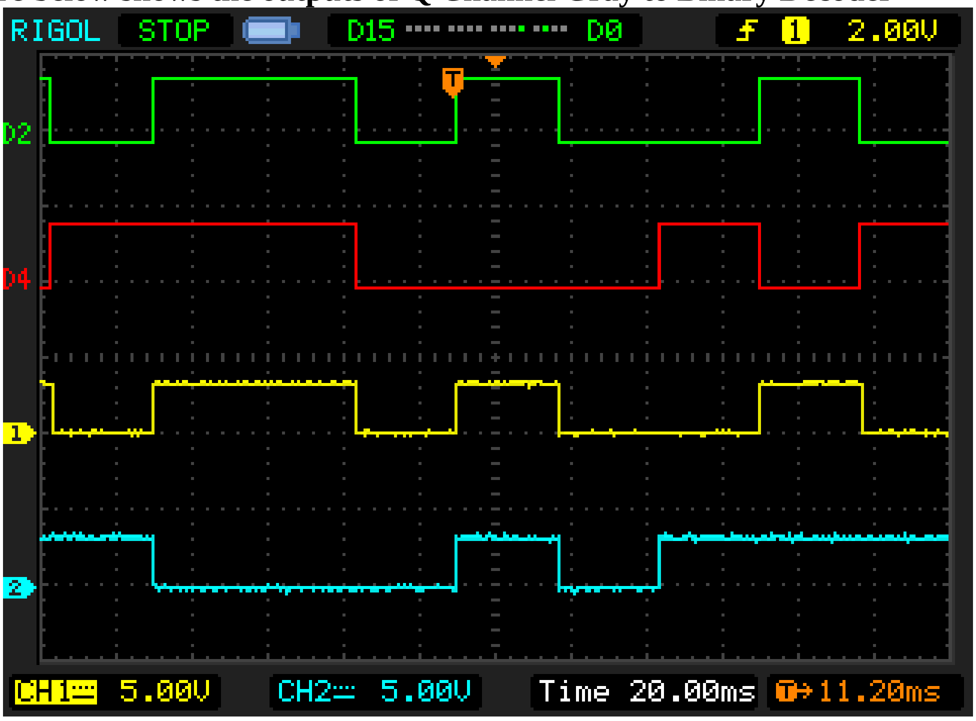


Figure 40

Experiment 10

Objective:

Study, Analysis & Measurement of I-Q Channel Decoded Data with Transmitter and Receiver

Theory:

Four Bit Decoded data is similar to the encoded process in the transmitter. It is used to decode the two streams of Inphase (I) & Quadrature (Q) into a single stream. I stream is called as odd sequence as it following odd values of the Data pattern. Q stream can be called as even sequence as it following even values of the Data pattern. The Four bits Decoding is used to decode I & Q bits into serial data. It is an inverse process of Four bits encoding in the transmitter. Frequency of the received data after decoding will remains the same as of clock generator.

Block Diagram For 4 bits decoding for 16 QAM Demodulation is shown below:

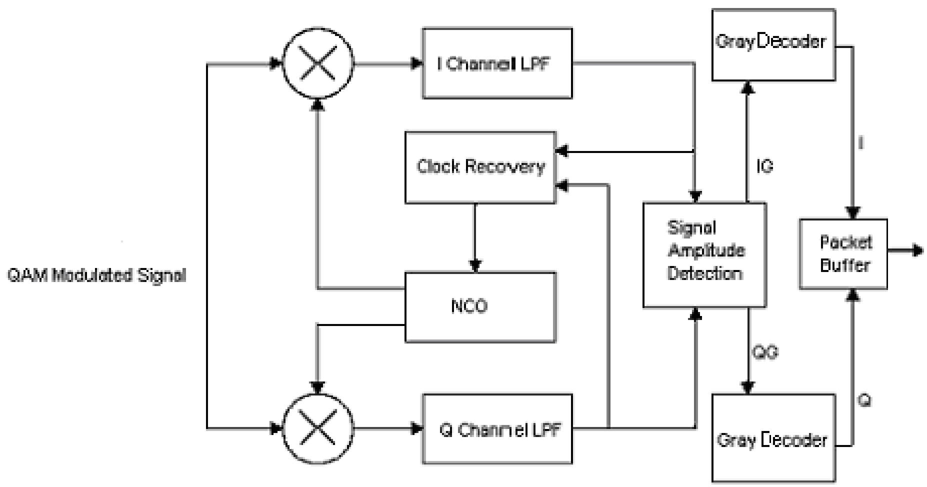


Figure 41

Figure below shows the output of 4 Bit Decoding for 16 QAM Demodulation:

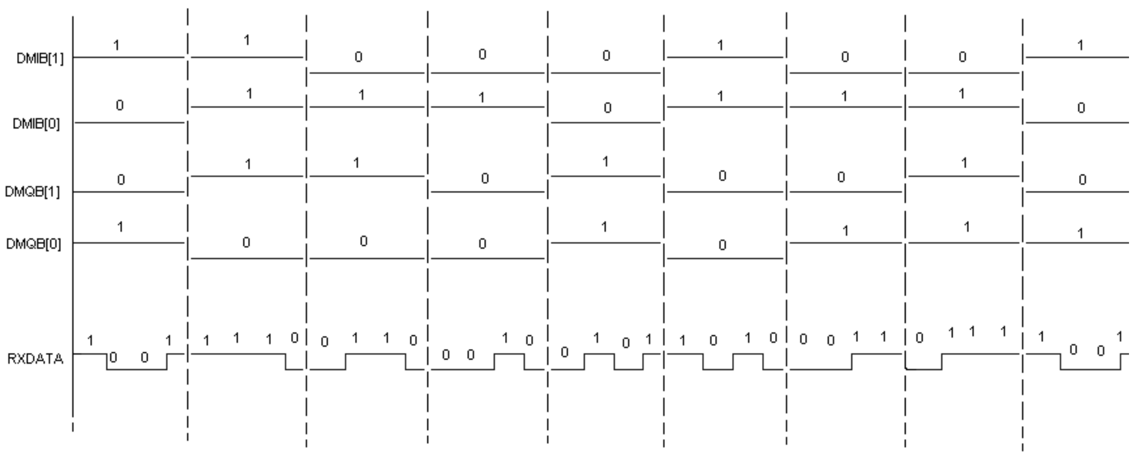


Figure 42

Figure below shows the output of Transmitter and Receiver Data

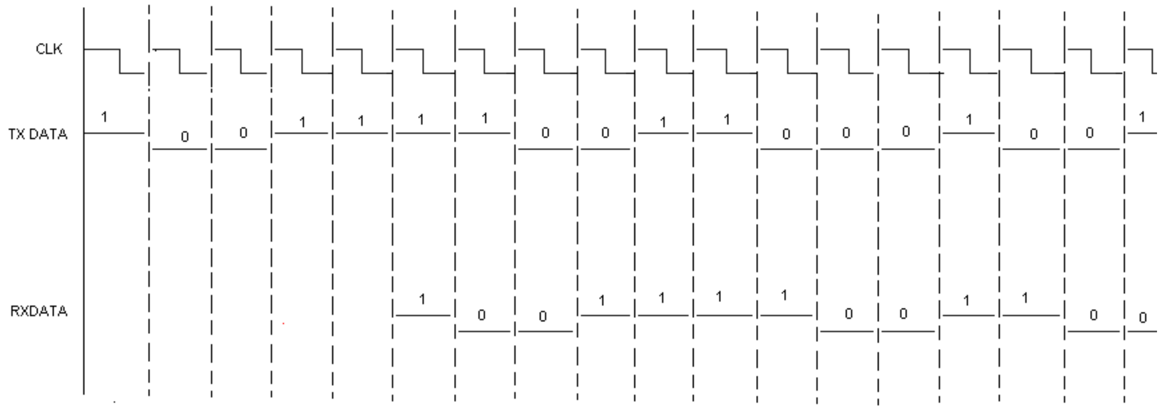


Figure 43

Procedure:

1. Hardware Mode Steps:

- Observe the outputs of 4-bit Decoder at test point TP34.
- For clock frequency, pattern length settings refer Experiment 1.
- For 4-Bit Encoding refer Experiment 2.
- For Binary to Gray Encoder refer Experiment 3.
- For Symbol Mapper outputs of I Channel and Q Channel refer Experiment 4.
- For Sine wave Generator, Cosine wave Generator, I Channel Modulation and Q Channel Modulation refer Experiment 5.
- For 16-QAM Modulation refer Experiment 6.
- For I Channel Demodulation, Q Channel Demodulation, NCO Sine wave Generator and NCO Cosine wave Generator refer Experiment 7.
- For I Channel LPF, Q Channel LPF, Demodulated Gray code outputs and Clock Recovery of NCO refer Experiment 8.
- For the outputs of Gray Decoder refer Experiment 9.

Observation:

DSO Result for Reference:

Figure below shows the output of Gray Decoder with Rx Data

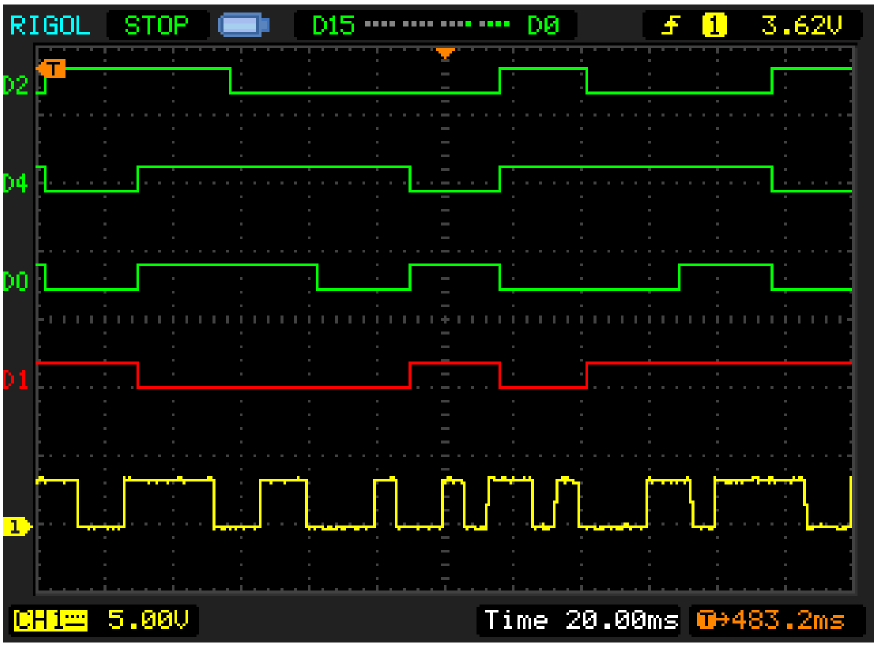


Figure 44

Figure below shows the output of Transmitter and Receiver Data

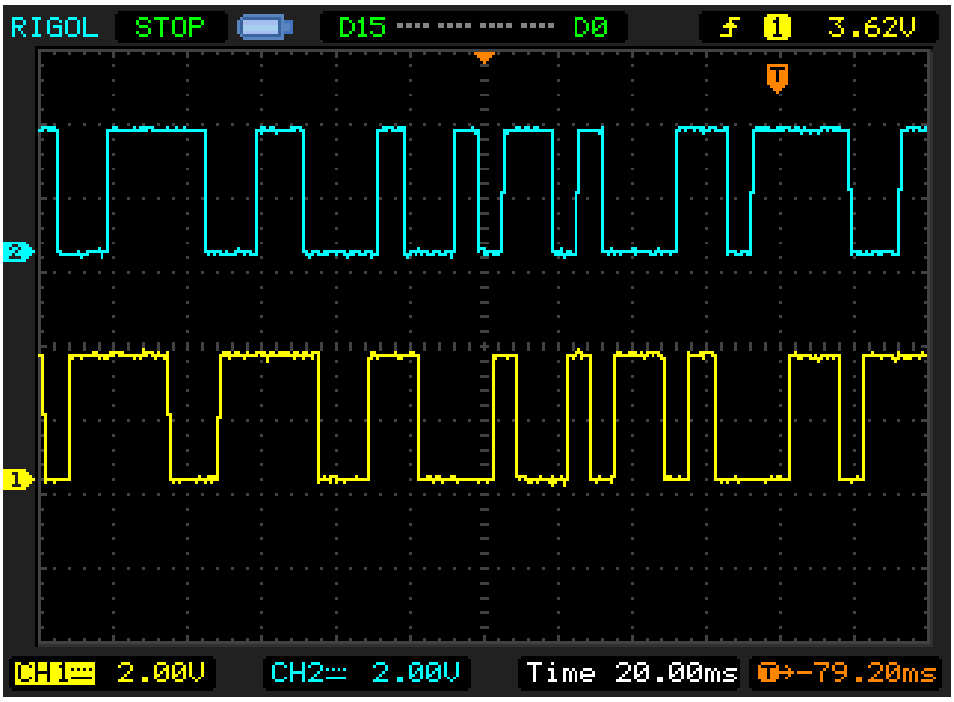


Figure 45

Warranty

1. We guarantee this product against all manufacturing defects for **12 months** from the date of sale by us or through our dealers.
2. The guarantee will become void, if
   a. The product is not operated as per the instruction given in the Learning Material.
   b. The agreed payment terms and other conditions of sale are not followed.
   c. The customer resells the instrument to another party.
   d. Any attempt is made to service and modify the instrument.
3. The non-working of the product is to be communicated to us immediately giving full details of the complaints and defects noticed specifically mentioning the type, serial number of the product and date of purchase etc.
4. The repair work will be carried out, provided the product is dispatched securely packed and insured. The transportation charges shall be borne by the customer.

Hope you enjoyed the Scientech Experience.

List of Accessories

1. Mains Cord...1 No.
2. Parallel Port Cable (Male – Male) ....1 No.
3. 2 mm Patch Cord (Blue) 16” ....2 Nos.