ASK, FSK, BPSK, DBPSK

Modulator & Demodulator

Scientech 2807

Product Tutorial

Ver.1.1

Designed & Manufactured in India by-
An ISO 9001:2008 company
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Scientech 2807

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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

Scientech TechBooks are compact and user friendly learning platforms to provide a modern, portable, comprehensive and practical way to learn Technology. Each TechBook is provided with detailed Multimedia learning material which covers basic theory, step by step procedure to conduct the experiment and other useful information. Scientech TechBook 2807 provides an extensive hands on ASK, FSK, BPSK, DBPSK Modulator & Demodulator.

Features

- **Modulator and Demodulator on same board**
- **On-board Data Generator with various data patterns**
- **Selectable Data Frequencies and data patterns**
- **DDS Technology based Carrier Generator**
- **SMD LED Indicators**
- **Can be issued just like a book for hands-on learning**

Technical Specifications

Modulation & Demodulation		
Techniques	:	Amplitude Shift Keying
	:	Frequency Shift Keying
	:	Binary Phase Shift Keying
	:	Differential Binary Phase Shift Keying
Internal Data Generator	:	Digital Data
Data Pattern	:	8 Bit, 16 Bit, 32 Bit, 64 Bit
Frequency	:	2KHz, 4KHz, 8KHz, 16KHz, 32KHz
Internal Carrier Generator	:	Direct Digital Synthesized
Carrier Signal	:	Sine wave
SMD LED Indicators	:	26 nos for
		Digital Data Selection
		Data Frequency selection
		Technique selection
Crystal Frequency	:	8MHz
Selection Mode	:	Push switches
Number of Test Points	:	39 nos
Product Tutorial	:	Online
Dimensions (mm)	:	W 326 x D 252 x H 52
Power Supply	:	110V - 260V AC, 50/60Hz
Weight	:	1.5Kg (approximately)
Operating Conditions	:	0-40^{0}C, 85% RH

Amplitude Shift Keying

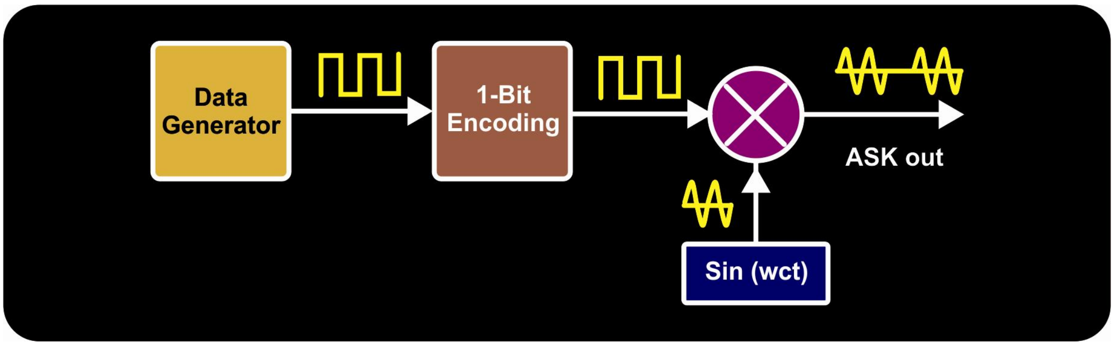
Introduction:

What is ASK ?

Amplitude-Shift Keying (ASK) or On Off Keying (OOK) is a form of modulation that represents digital data as variations in the amplitude of a carrier wave. The amplitude of an analog carrier signal varies in accordance with the bit stream (modulating signal), keeping frequency and phase constant.

How ASK Modulator works?

ASK Modulator:



In ASK Modulator level of amplitude can be used to represent binary logic 0s and 1s. We can think of a carrier signal as an ON or OFF switch. In the modulated signal, logic 0 is represented by the absence of a carrier, thus giving OFF/ON keying operation and hence the name given. Mathematically ASK is given by

$$v_{(ask)}(t) = [1 + v_m(t)]\left[\frac{A}{2}\cos(\omega_c t)\right]$$

where $v_{(ask)}(t) = amplitude\ shift\ keying\ wave$

$v_m(t) = digital\ information\ (modulating)\ signal$

$A/2 = unmodulated\ carrier\ amplitude$

$\omega_c = analog\ carrier\ radian\ frequency$

In the above equation, the modulating signal ($v_m(t)$) is a normalized binary waveform, where

+1V = logic 1 and -1V = logic 0. Therefore , for logic 1 equation reduces to

$$v_{(ask)}(t) = [1 + 1]\left[\frac{A}{2}\cos(\omega_c t)\right]$$

$$v_{(ask)}(t) = [A\cos(\omega_c t)]$$

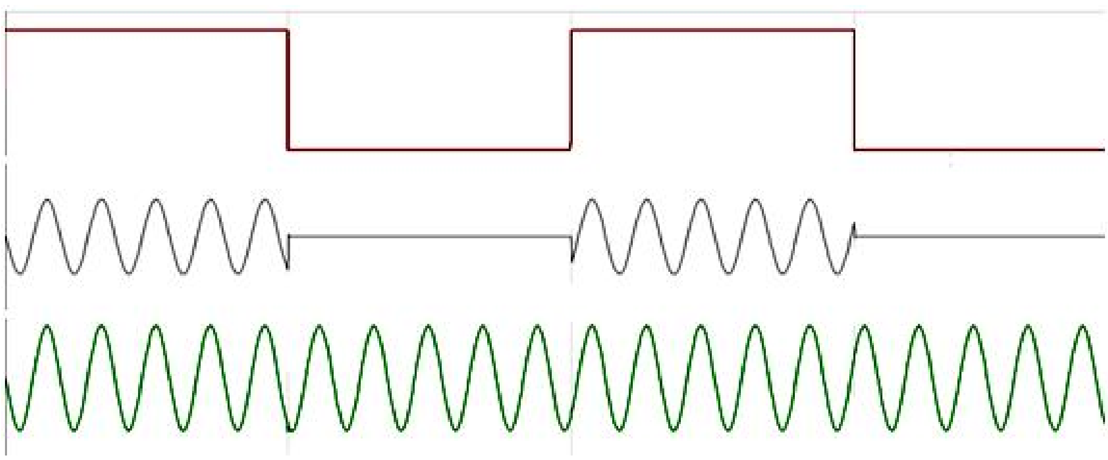
for logic0 equation reduces to

$$v_{(ask)}(t) = [1-1]\left[\frac{A}{2}\cos(\omega_c t)\right]$$

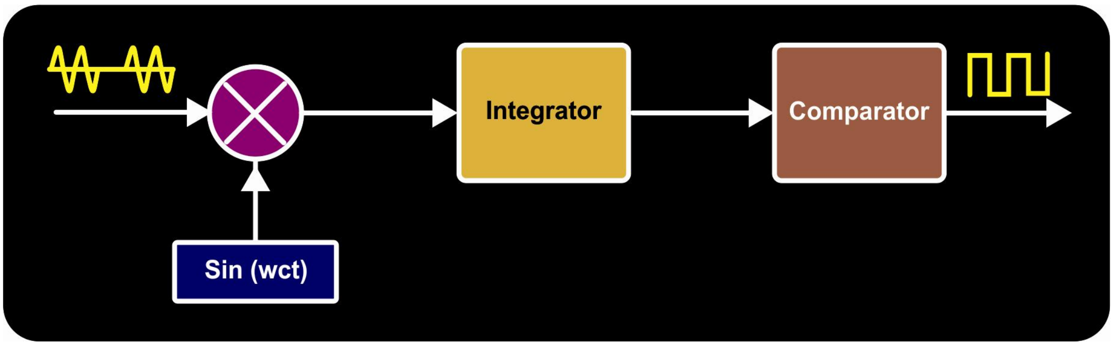
$$v_{(ask)}(t) = 0$$

Thus the modulated wave $v_{ask}(t)$ is either

[A cos (ωct)] or 0. As shown in the waveform diagram below. down,



ASK Demodulator:



At receiver side ASK modulated signal is multiplied by the carrier signal which is generated from the carrier generator the output of multiplier consist of higher frequency and lower frequency components this output then integrated by Integrator block and passed by comparator block . Comparator block recovers digital data by comparing threshold value with integrated signal.

Advantages:

- Amplitude-shift keying is used extensively for commercial terrestrial
- It's usefulness for satellite applications is limited.

Experiment 1

Objective:

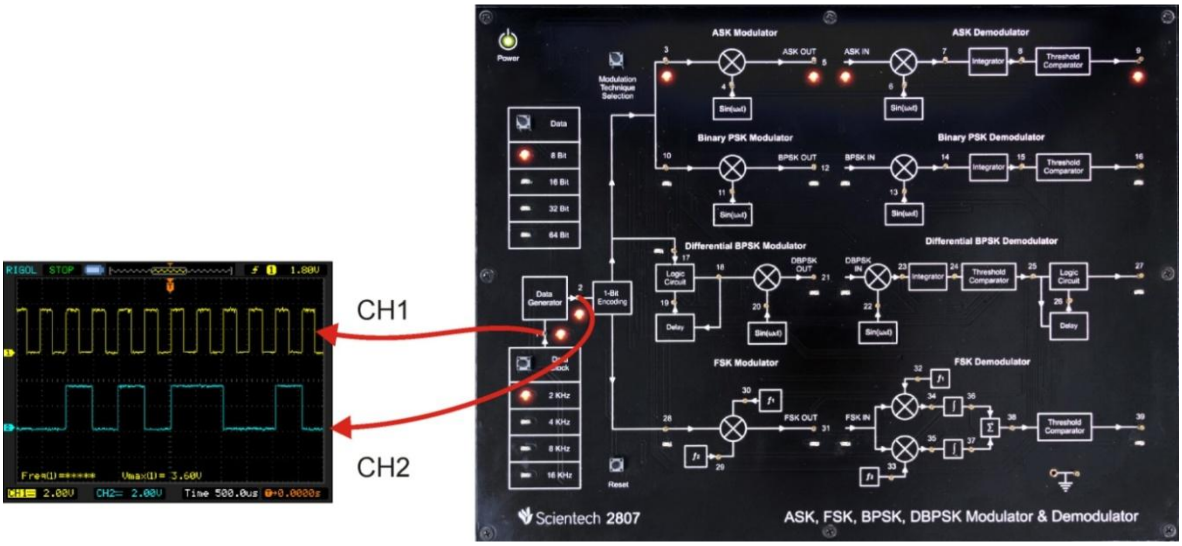
Study and analysis of 1-Bit Encoding

- Study and analysis 1-Bit Encoding.
- Analyze the data pattern on variable data rate.

Set Up:

- TechBook Board
- Power Supply
- Oscilloscope/DSO
- Test probe

Connection Diagram:



Procedure:

Step 1 : Connect and switch on the Power Supply of Scientech 2807.

Step 2 : Select input *Data pattern* using push button i.e. 8-Bit, 16-Bit, 32-Bit, 64-Bit. And respective LED will glow. Observe the input Data on test point (TP2).

Step 3 : Select input *data clock* using push button i.e. 2 KHz, 4 KHz, 8 KHz, 16 KHz. Observe the change in frequency on test point (TP1) .

Step 4 : Observe the 1-Bit encoded data on (TP3) .

Observation:

- Observe the input data clock at TP1.
- Observe the input data at TP2.
- Observe the encoded data at TP3.

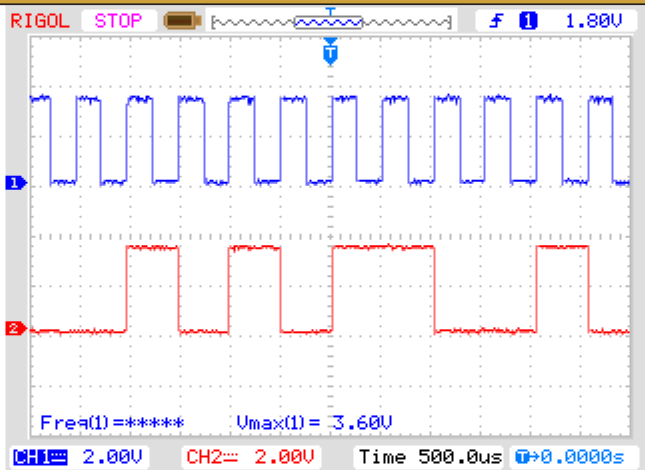
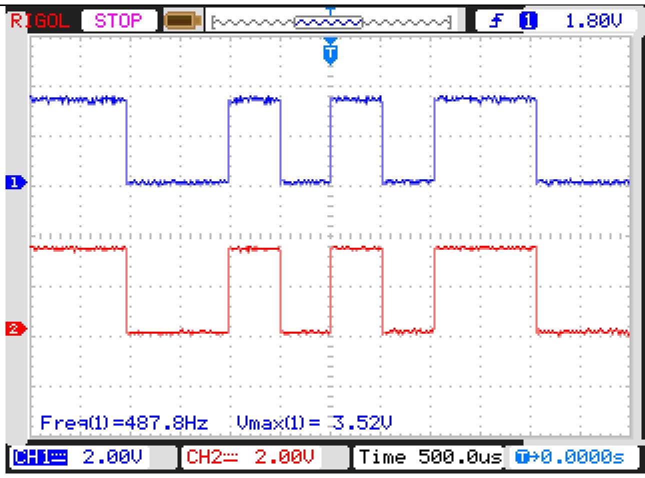
- Observe the following data Patterns on TP2

  8-Bit: “10110010 ”

  16-Bit: “0100110110110010 ”

  32-Bit: “00000101000101111100101000111111 ”

  64-Bit:
  “1010110011100011110000111110000011110000111000110010101000111101

Data Pattern	Data Frequency	Resulting Waveforms
8-Bit	2KHz	 CH1: Input Data Clock (TP1) and CH2: Input Data 8-Bit (TP2).
8-Bit	2KHz	 CH1: Input Data 8-Bit (TP2) and CH2: 1-bit encoded data (TP3).

Experiment 2

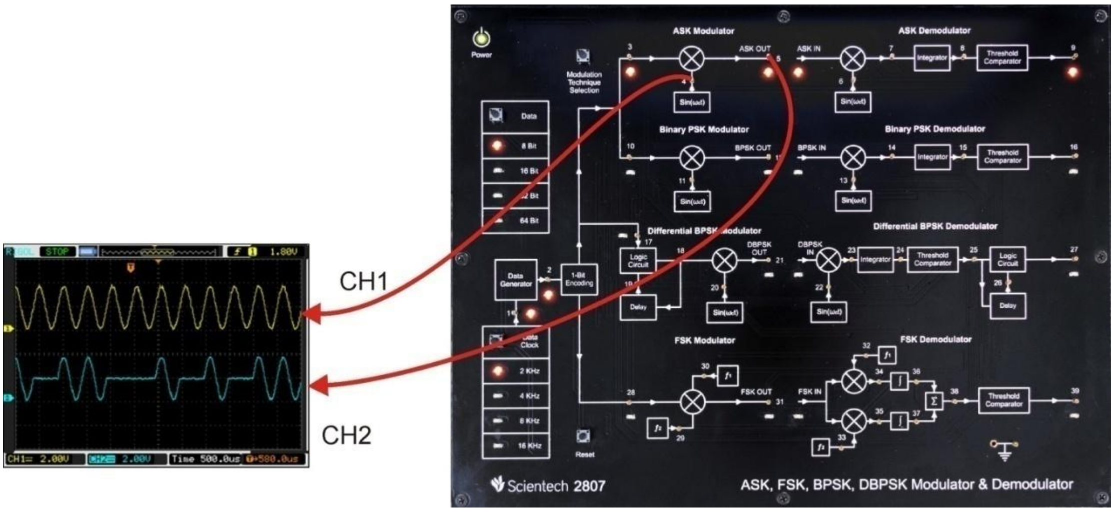
Objective:

Study and analysis of ASK modulator

Set up:

- TechBook Board
- Power Supply
- Oscilloscope/DSO
- Test probe

Connection Diagram:



Procedure:

Step 1 : Connect and switch on the Power Supply of Scientech 2807.

Step 2 : Select input *Data pattern* using push button i.e. 8-Bit, 16-Bit, 32-Bit, 64-Bit. And respective LED will glow. Observe the input Data on test point (TP2) .

Step3 : Select input *data clock* using push button i.e. 2 KHz, 4 KHz, 8 KHz, 16 KHz. Observe the change in frequency on test point (TP1).

Step 4 : Observe the change in frequency of carrier signal at (TP4).

Step 5 : ASK Modulator is by default selection when switch on the Power Supply of Scientech 2807 and LED of (TP3) will glow.

Step 6 : Observe the ASK modulator output on (TP5).

Observation:

- Observe the Input Data at TP2 .
- Observe the Input data clock at TP1.
- Observe the encoded data input at TP3.

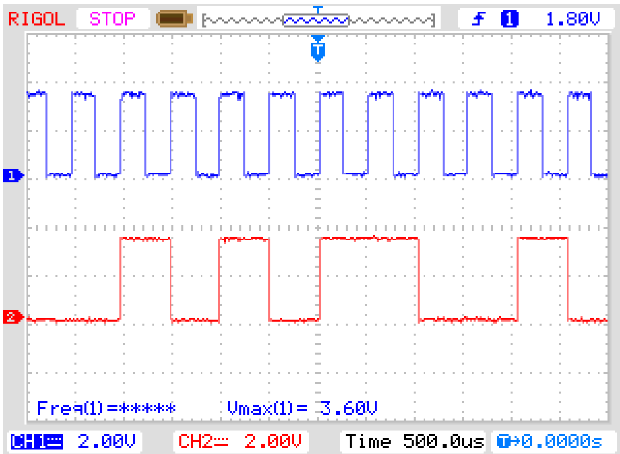
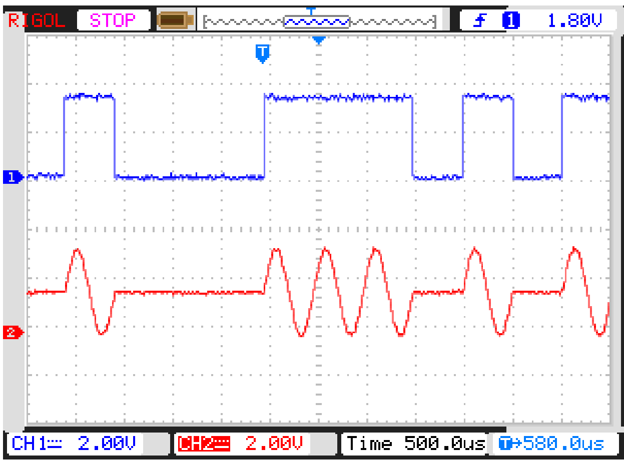
- Observe the Carrier signal at TP4 .
- Observe the Modulated output at TP5.
- Observe the following data Patterns on TP2

  8-Bit: "10110010 "

  16-Bit: "0100110110110010 "

  32-Bit: "00000101000101111100101000111111 "

  64-Bit: "1010110011100011110000011111000000111100001110001100101010001110 10"

Input Data Type	Data Clock Frequency	Resulting Waveforms
8-Bit	2KHz	 CH1: Input Data Clock (TP1), CH2: Input Data(TP2)
8-Bit	2KHz	 CH1: Input Data (TP3), CH2: Carrier Signal (TP4)

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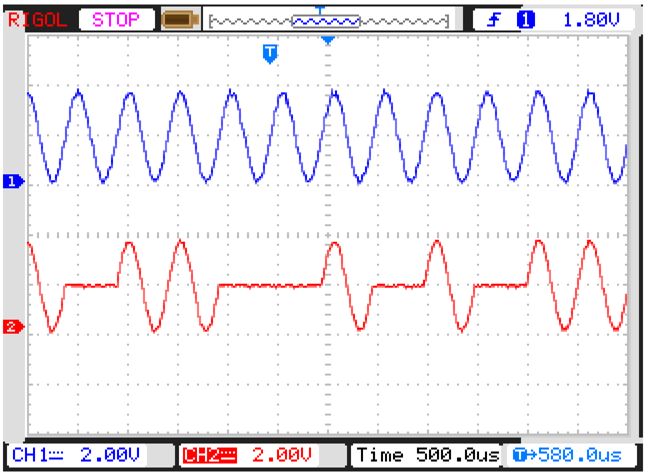
8-Bit	2KHz	 CH1: Carrier signal (TP4), CH2: ASK Output (TP5)

Experiment 3

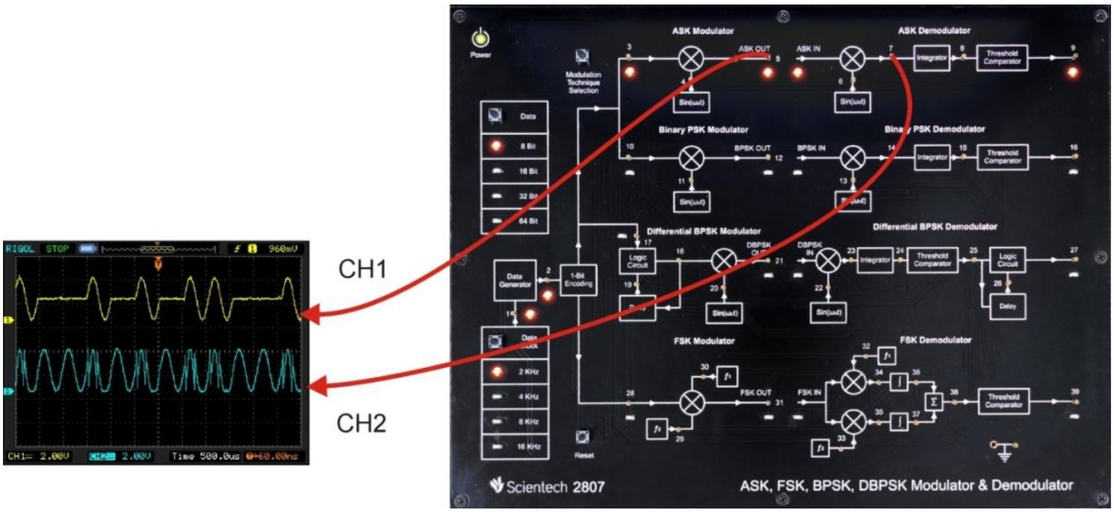
Objective:

Study and analysis of complex multiplier output

Set up:

- TechBook Board
- Power Supply
- Oscilloscope/DSO
- Test probe

Connection Diagram:



Procedure:

Step 1 : Connect and switch on the Power Supply of Scientech 2807.

Step 2 : Select input *Data pattern* using push button i.e. 8-Bit, 16-Bit, 32-Bit, 64-Bit. And respective LED will glow. Observe the input Data on test point (TP2).

Step3 : Select input *data clock* using push button i.e. 2 KHz, 4 KHz, 8 KHz, 16 KHz. Observe the change in frequency on test point (TP1) .

Step 4 : Observe the change in frequency of carrier signal at (TP4) .

Step 5 : ASK Modulator is by default selection when switch on the Power Supply of Scientech 2807 and LED of (TP3) will glow.

Observation:

- Observe the Input Data at TP2.
- Observe the Input data clock at TP1.
- Observe the 1-bit encoded input data at TP3.
- Observe the Carrier signal at TP4 and TP6.

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- Observe the Modulated output at TP5.
- Observe the multiplier output at TP7.

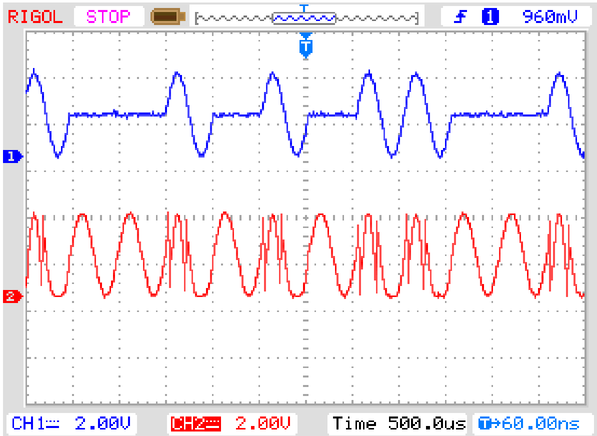
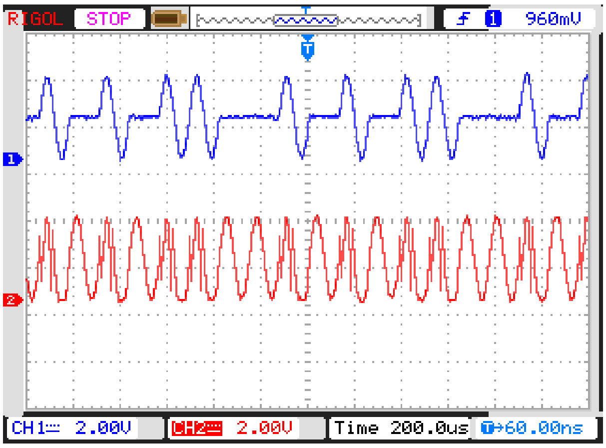
Observe the following data Patterns on TP2.

8-Bit: "10110010 "

16-Bit: "0100110110110010 "

32-Bit: "00001010001011111100101000111111 "

64-Bit:
"1010110011100011110000111110000001111000011100011001010100011101O"

Input Data Type	Data Clock Frequency	Resulting Waveforms
8-Bit	2KHz	 CH1: ASK output (TP5), CH2: multiplier output (TP7)
8-Bit	8KHz	 CH1: ASK output (TP5), CH2: multiplier output (TP7)

Experiment 4

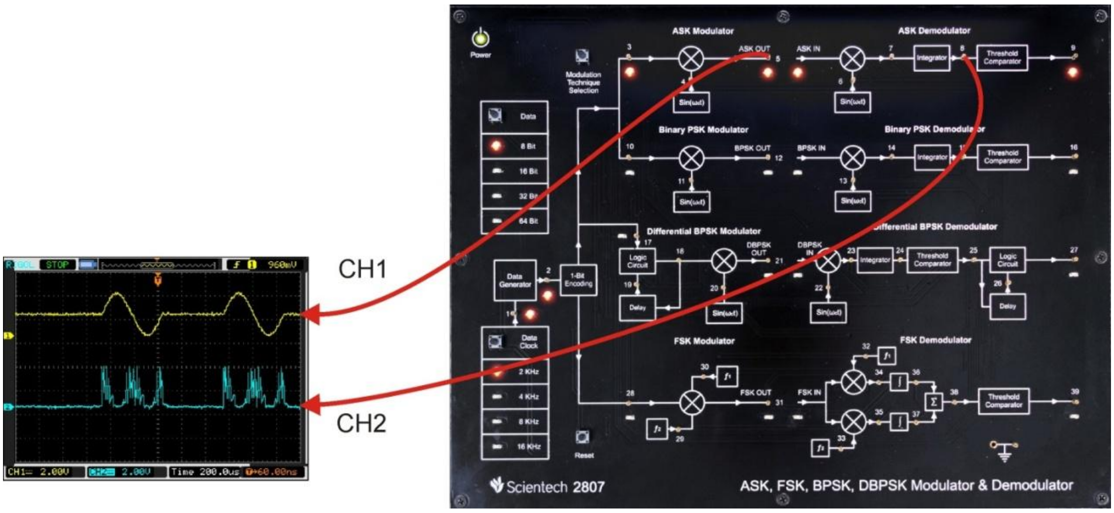
Objective:

Study and analysis of Integrator block .

Set up:

- TechBook Board
- Power Supply
- Oscilloscope/DSO
- Test probe

Connection Diagram:



Procedure:

Step 1 : Connect and switch on the Power Supply of Scientech 2807.

Step 2 : Select input *Data pattern* using push button i.e. 8-Bit, 16-Bit, 32-Bit, 64-Bit. And respective LED will glow. Observe the input Data on test point (TP2) .

Step3 : Select input *data clock* using push button i.e. 2 KHz, 4 KHz, 8 KHz, 16 KHz. Observe the change in frequency on test point (TP1) .

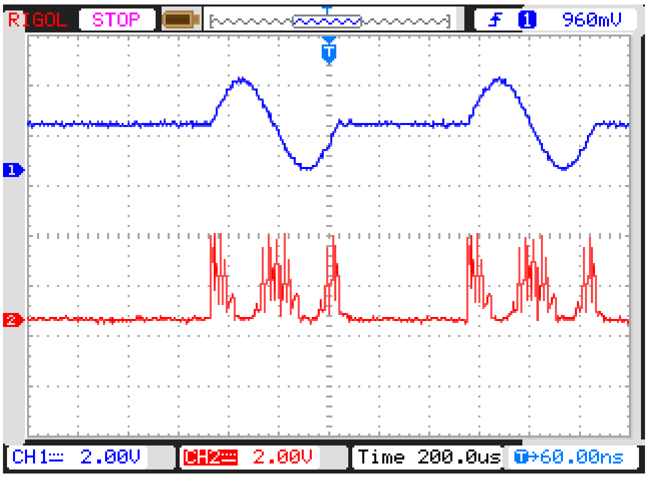
Step 4 : Observe the change in frequency of carrier signal at (TP4) .

Step 5 : ASK Modulator is by default selection when switch on the Power Supply of Scientech 2807 and LED of (TP3) will glow .

Observation:

- Observe the Input Data at TP2 .
- Observe the Input data clock at TP1.
- Observe the 1-bit encoded input data at TP3.
- Observe the Carrier signal at TP4 and TP6.
- Observe the Modulated output at TP5.
- Observe the multiplier output at TP7.
- Observe the Integrator output at TP8.

Observe the following data Patterns on TP2.
8-Bit:- "10110010 "
16-Bit:- "0100110110110010 "
32-Bit:- "00000101000101111100101000111111 "
64-Bit:-
"1010110011100011110000111110000001111000011100011001010100011101 0"

Input Data Type	Data Clock Frequency	Resulting Waveforms
8-Bit	2KHz	 CH1: ASK output (TP5), CH2: Integrator output (TP8)

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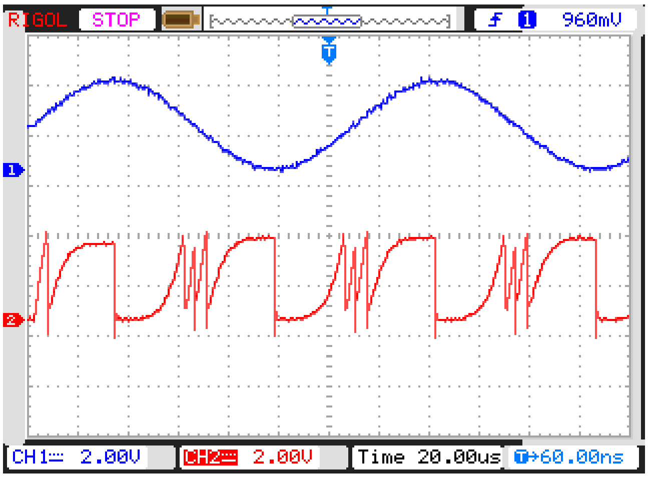
8-Bit	16KHz	 CH1: ASK output (TP5), CH2: Integrator output (TP8)

Experiment 5

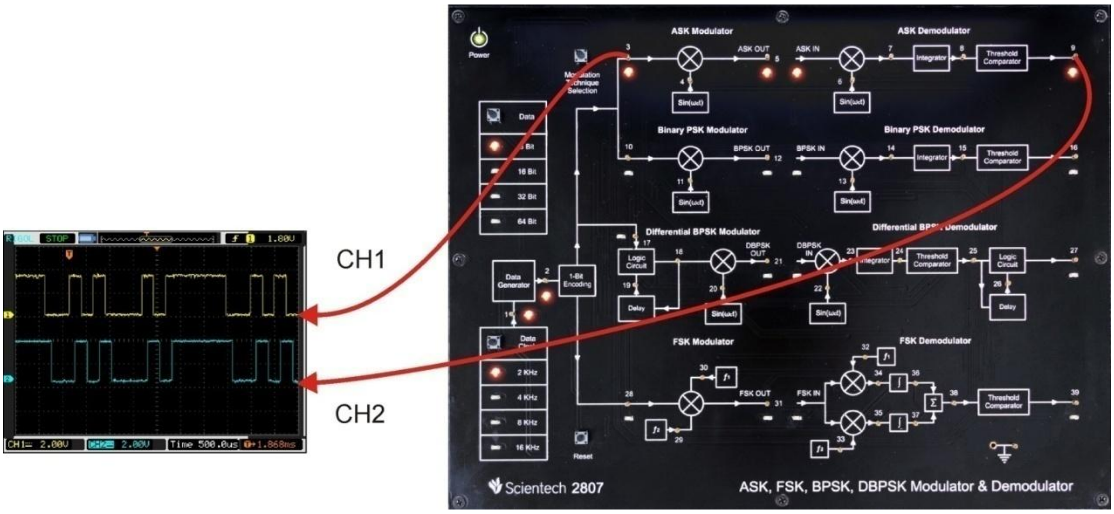
Objective:

Study and analysis of Comparator block.

Set up:

- TechBook Board
- Power Supply
- Oscilloscope/DSO
- Test probe

Connection Diagram:



Procedure:

Step 1 : Connect and switch on the Power Supply of Scientech 2807.

Step 2 : Select input *Data pattern* using push button i.e. 8-Bit, 16-Bit, 32-Bit, 64-Bit. And respective LED will glow. Observe the input Data on test point (TP2) .

Step3 : Select input *data clock* using push button i.e. 2 KHz, 4 KHz, 8 KHz, 16 KHz. Observe the change in frequency on test point (TP1) .

Step 4 : Observe the change in frequency of carrier signal at (TP4) .

Step 5 : ASK Modulator is by default selection when switch on the Power Supply of Scientech 2807 and LED of (TP3) will glow .

Observation:

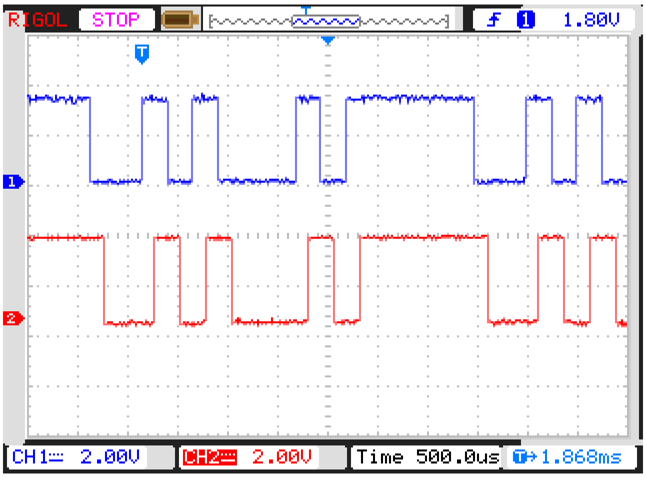
- Observe the Input Data at TP2 .
- Observe the Input data clock at TP1.
- Observe the 1-bit encoded input data at TP3.
- Observe the Carrier signal at TP4 and TP6.

- Observe the Modulated output at TP5.
- Observe the multiplier output at TP7
- Observe the Integrator output at TP8
- Observe the output at TP9

Observe the following data Patterns on TP2

8-Bit:- "10110010 "
16-Bit:- "0100110110110010 "
32-Bit:- "00000101000101111100101000111111 "
64-Bit:-
"1010110011100011110000011111000000111100001110001100101010001110 10 "

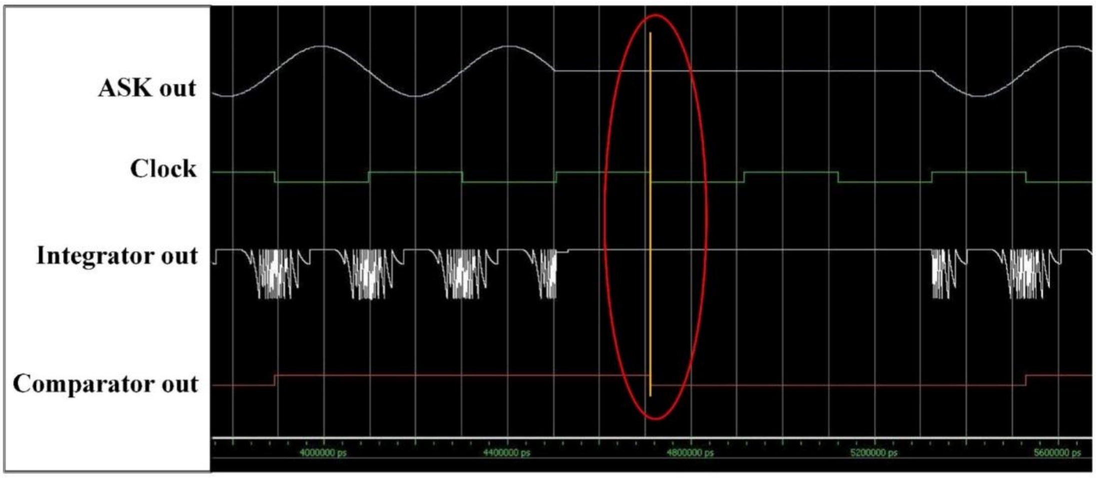
* Note: If output at any TP's not appear proper then Press **RESET** button

Input Data Type	Data Clock Frequency	Resulting Waveforms
8-Bit	2KHz	 CH1: Input Data (TP2), CH2: Comparator out (TP9)

* Note: If output at any TP's not appear proper then Press **RESET** button

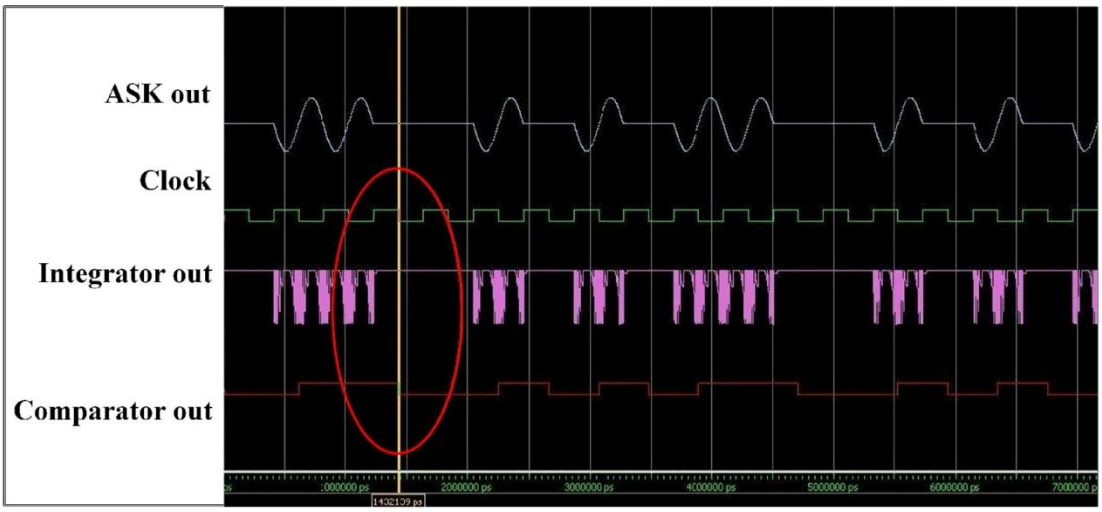
Working of Digital Comparator: As we observed the recovered digital data at output of comparator (TP9).

Now we can understand the working of comparator by following results:-



According to above results comparator compares integrator data at falling edge ( ) of clock signal. It checks that whether value of comparator exactly match with value of integrator data and then it gives logic ‘1 ’ or logic ‘ 0 ’ as a output of comparator .

Comparison indicate by red circle with yellow vertical line.



Comparison indicate by red circle with yellow vertical line . As indicated in Red circle when event of falling edge of clock occurs value of integrator signal at falling edge of clock compared with threshold value of comparator . if it matched comparator gives logic ‘ 0 ’ else logic ‘ 1 ’ as output , which is our recovered digital data .

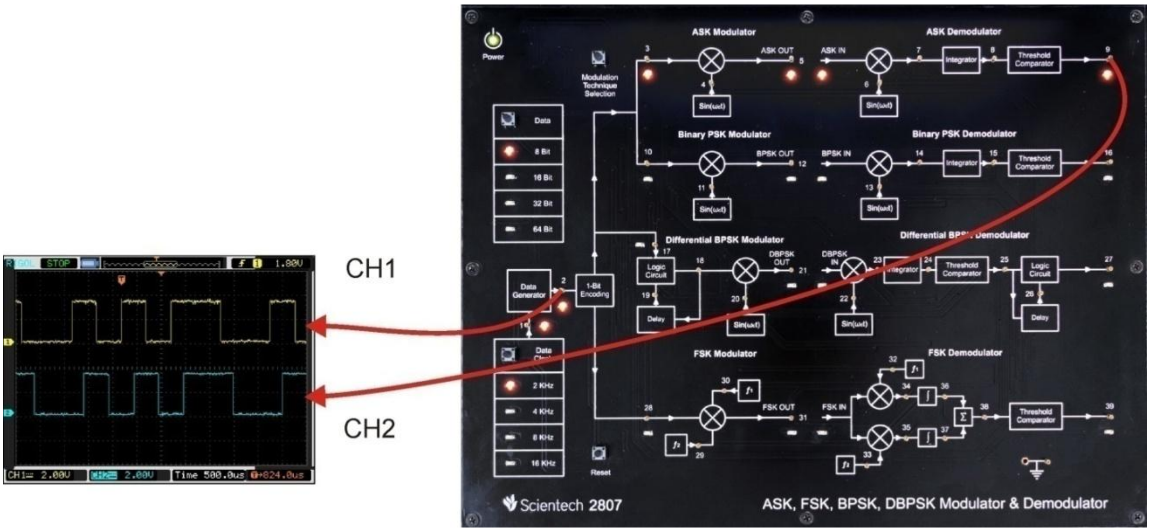
Experiment 6

Objective: Study and analysis of ASK Demodulator

Setup:

- TechBook Board
- Power Supply
- Oscilloscope/DSO
- Test probe

Connection Diagram:



Procedure:

Step 1 : Connect and switch on the Power Supply of Scientech 2807.

Step 2 : Select input *Data pattern* using push button i.e. 8-Bit, 16-Bit, 32-Bit, 64-Bit. And respective LED will glow. Observe the input Data on test point (TP2) .

Step3 : Select input *data clock* using push button i.e. 2 KHz, 4 KHz, 8 KHz, 16 KHz. Observe the change in frequency on test point (TP1) .

Step 4 : Observe the change in frequency of carrier signal at (TP4) .

Step 5 : ASK Modulator is by default selection when switch on the Power Supply of Scientech 2807 and LED of (TP3) will glow .

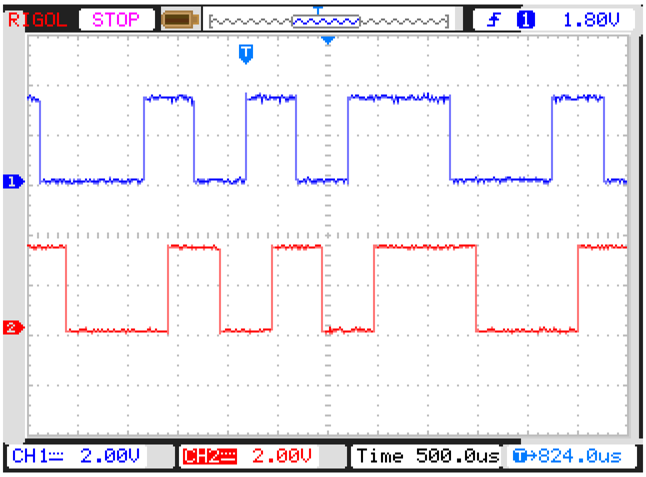
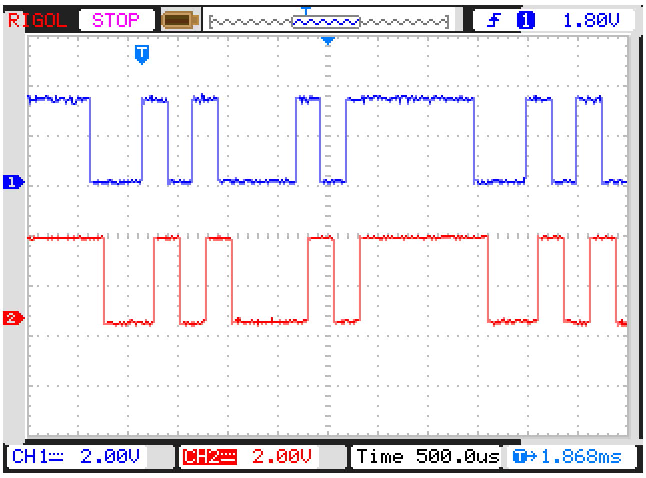
Observation:

- Observe the Input Data at TP2 .
- Observe the Input data clock at TP1.
- Observe the 1-bit encoded input data at TP3.
- Observe the Carrier signal at TP4 and TP6.
- Observe the Modulated output at TP5.
- Observe the multiplier output at TP7
- Observe the Integrator output at TP8
- Observe the output at TP9

Observe the following data Patterns on TP2

8-Bit: “10110010 ”
16-Bit: “0100110110110010 ”
32-Bit: “00000101000101111100101000111111 ”
64-Bit:
“1010110011100011110000111110000011110000111000110010101000111010

* Note: If output at any TP’s not appear proper then Press **RESET** button

Input Data Type	Data Clock Frequency	Resulting Waveforms
8-Bit	2KHz	 CH1: Input Data (TP2), CH2: Demodulator out (TP9)
8-Bit	2KHz	 CH1: Input Data (TP2), CH2: Demodulator out (TP9)

* Note: If output at any TP's not appear proper then Press **RESET** button

Binary Phase Shift Keying

Introduction:

What is BPSK ?

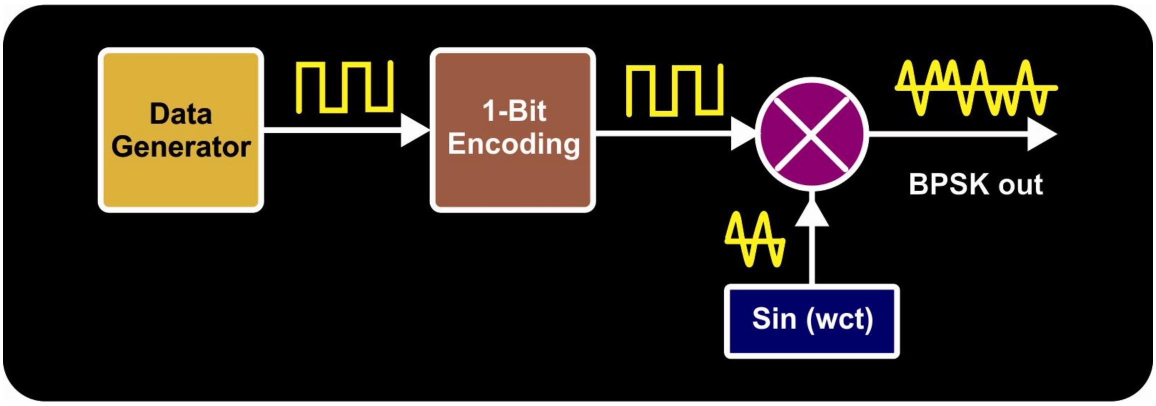
In BPSK modulation, the phase of the RF carrier is shifted 180 degrees in accordance with a digital bit stream. A "one" causes a phase transition, and a "zero" does not produce a transition.

How BPSK Modulator works?

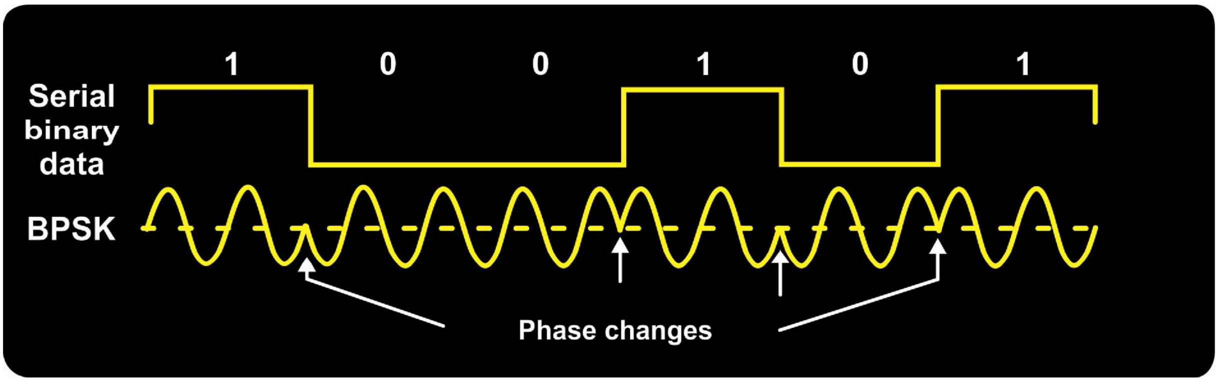
BPSK Modulator:

In BPSK (Binary Shift Keying) Modulator, the phase of the carrier is varied to represent binary 1 or 0. Both peak amplitude remains constant as the phase changes. For example, if we start a phase of 0 deg. to represent binary '1', then we can change the phase to 180deg. to send binary '0'.

Figure below shows the generation of BPSK with clock signal, pattern or baseband data, 1 bit encoded. Normal Sine wave or carrier is transmitted for logic 0 and 180. Phase shifted carrier is transmitted for logic 1.As shown in the waveform and block diagram

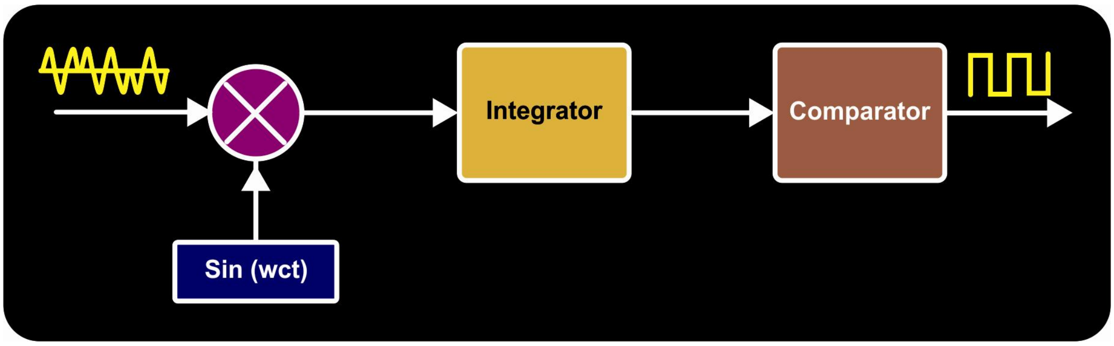


Waveform of BPSK modulation



BPSK Demodulator:

The incoming modulated BPSK signal is multiplied with the carrier signal generated from the carrier generator . The output of the multiplier contains high (f_{in}+f_{nco}) and low (f_{in} -f_{nco}) frequency components. The integrator block integrates multiplier output. With the help of comparator by comparing thresh hold value input data is received.



Experiment 7

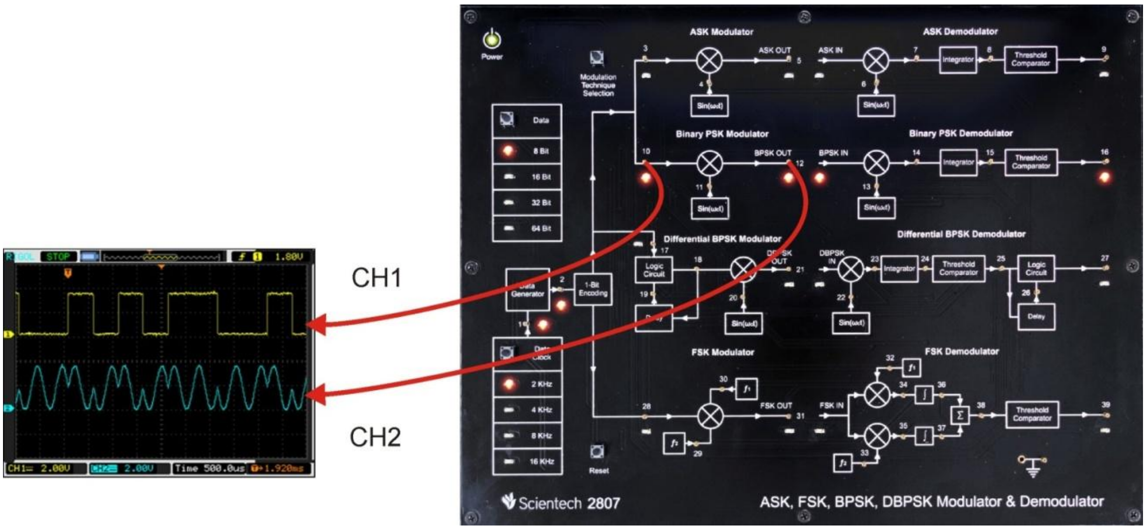
Objective:

Study and analysis of BPSK modulator

Set Up:

- TechBook Board
- Power Supply
- Oscilloscope/DSO
- Test probe

Connection Diagram:



Procedure:

Step 1 : Connect and switch on the Power Supply of Scientech 2807.

Step 2 : Select Binary PSK modulator by *Modulation technique selection* button. on selection Binary PSK LED on TP10 will glows.

Step 3 : Select input *Data pattern* using push button i.e. 8-Bit, 16-Bit, 32-Bit, 64-Bit. And respective LED will glow. Observe the input Data on test point (TP2).

Step 4 : Select input *data clock* using push button i.e. 2 KHz, 4 KHz, 8 KHz, 16 KHz. Observe the change in frequency on test point (TP1) .

Step 5 : Observe the change in carrier signal frequency on test point (TP11) .

Step 6 : Observe the encoded input data pattern at test point(TP10).

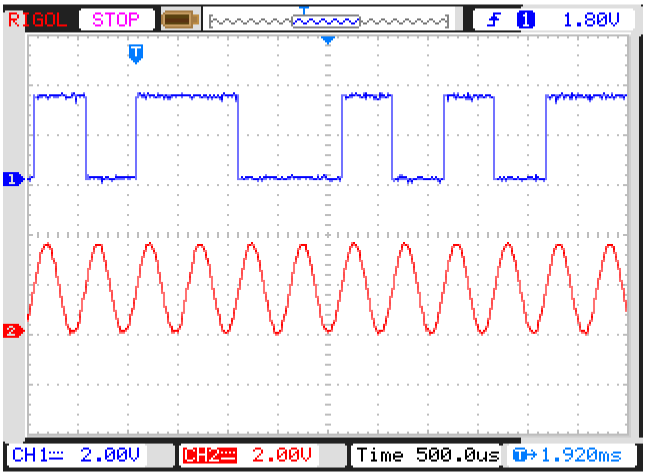
Step 7 : Observe the BPSK modulated output at test point (TP12)

Observation:

- Observe the input data clock at TP1.
- Observe the input data at TP2.
- Observe the encoded input data at TP10.
- Observe the carrier signal at TP11.
- Observe the BPSK modulated output at TP12

Observe the following data Patterns on TP2

8-Bit:- "10110010 "
16-Bit:- "0100110110110010 "
32-Bit:- "00000101000101111100101000111111 "
64-Bit:-
"1010110011100011110000111110000001111000011100011001010101000111010"

Data Pattern	Data Frequency	Resulting Waveforms
8-Bit	2KHz	 CH1: Input Data (TP10) and CH2: Carrier signal (TP11).

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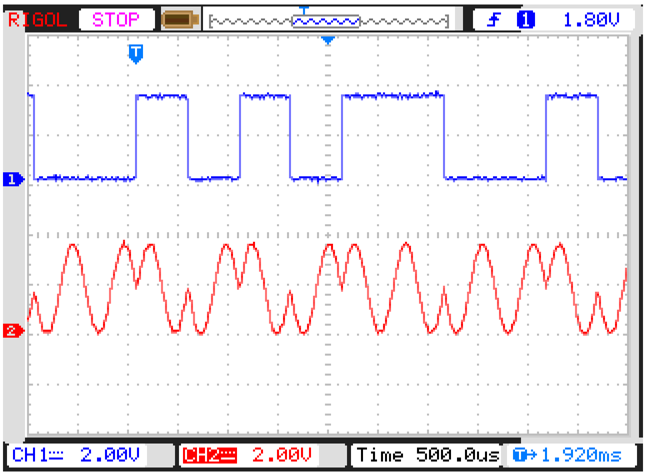
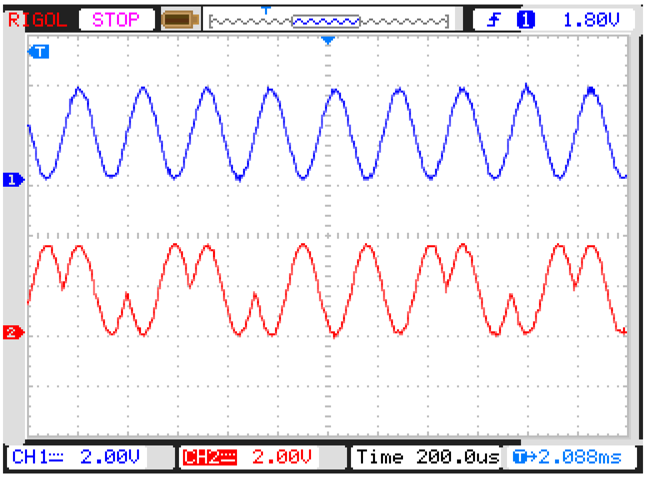
8-Bit	2KHz	 CH1: Input Data (TP10) and CH2: BPSK out (TP12).
32-Bit	4KHz	 CH1: Carrier signal (TP11) and CH2: BPSK out (TP12).

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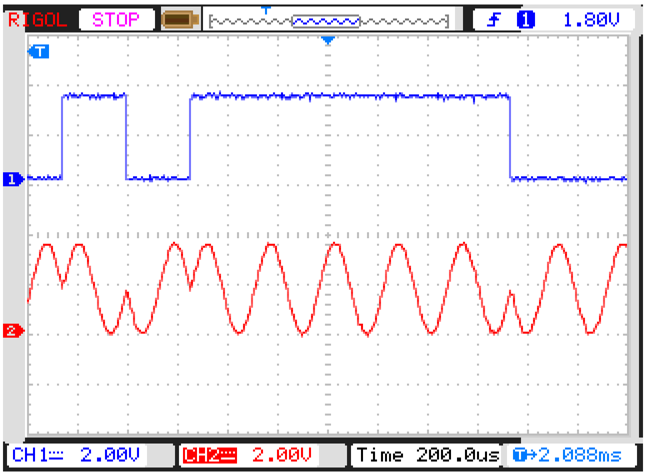
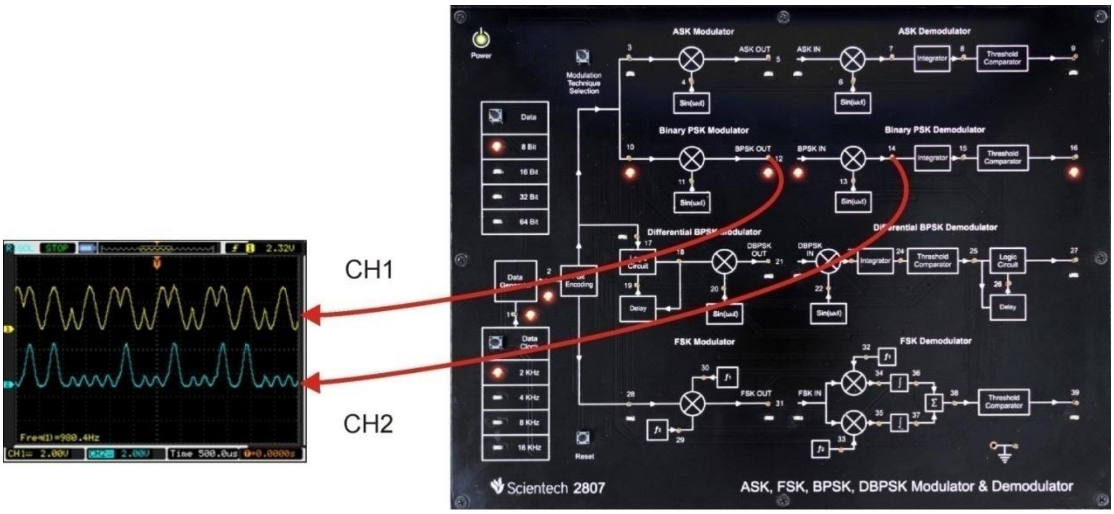
32-Bit	4KHz	 CH1: Input Data (TP10) and CH2: BPSK out (TP12).

Experiment 8

Objective:
Study and analysis of complex multiplier output

Set up:
- TechBook Board
- Power Supply
- Oscilloscope/DSO
- Test probe

Connection Diagram:



Procedure:

Step 1 : Connect and switch on the Power Supply of Scientech 2807.

Step 2 : Select Binary PSK modulator by *Modulation technique selection* button. on selection of Binary PSK technique LED on TP10 will glows.

Step 3 : Select input *Data pattern* using push button i.e. 8-Bit, 16-Bit, 32-Bit, 64-Bit. And respective LED will glow. Observe the input Data on test point (TP2).

Step 4 : Select input *data clock* using push button i.e. 2 KHz, 4 KHz, 8 KHz, 16 KHz. Observe the change in frequency on test point (TP1) .

Step 5 : Observe the change in carrier signal frequency on test point (TP11) & test point (TP13).

Step 6 : Observe the encoded data pattern at test point (TP10).

Step 7 : Observe the BPSK modulated output at test point (TP12)

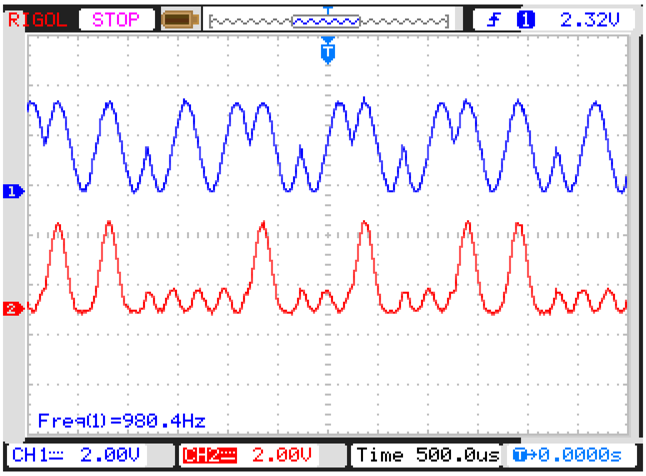
Step 8 : Observe the complex multiplier output at test point (TP14)

Observation:

- Observe the input data clock at TP1.
- Observe the input data at TP2.
- Observe the encoded input data at TP10.
- Observe the carrier signal at TP11.
- Observe the BPSK modulated output at TP12
- Observe the complex multiplier output at TP14

Observe the following data Patterns on TP2

8-Bit: “10110010 ”
16-Bit: “0100110110110010 ”
32-Bit: “00000101000101111100101000111111 ”
64-Bit:
“1010110011100011110000111110000011110000111000110010101000111010”

Input Data Type	Data Clock Frequency	Resulting Waveforms
32-Bit	4KHz	 CH1 BPSK out (TP12). and CH2: multiplier out (TP14).

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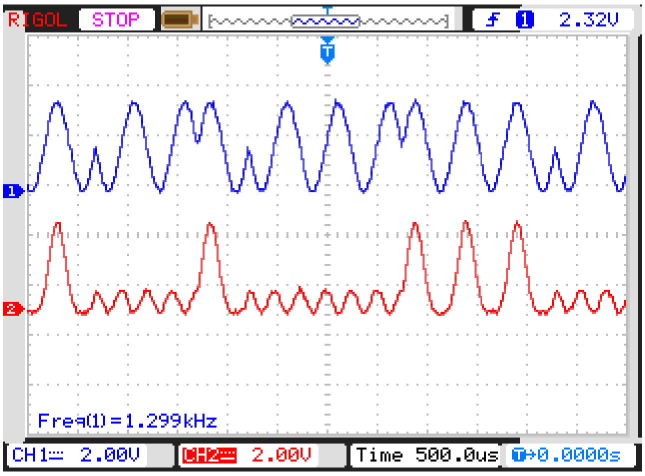
8-Bit	2KHz	 CH1 BPSK out (TP12). and CH2: multiplier out (TP14).

Experiment 9

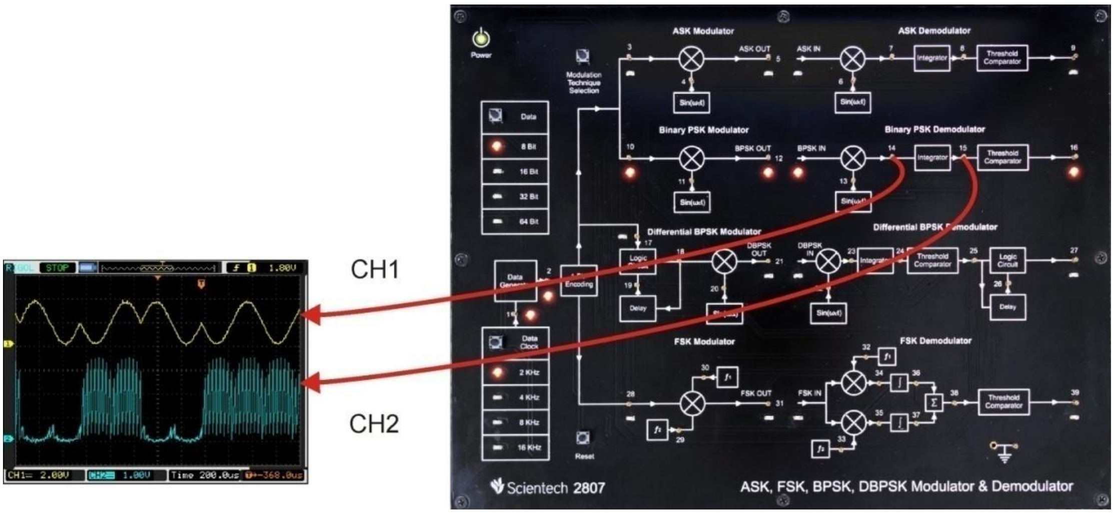
Objective:

Study and analysis of Integrator block .

Set up:

- TechBook Board
- Power Supply
- Oscilloscope/DSO
- Test probe

Connection Diagram:



Procedure:

Step 1 : Connect and switch on the Power Supply of Scientech 2807.

Step 2 : Select Binary PSK modulator using *Modulation technique selection* button. On selection of Binary PSK technique LED on TP10 will glows.

Step 3 : Select input *Data pattern* using push button i.e. 8-Bit, 16-Bit, 32-Bit, 64-Bit And respective LED will glow. Observe the input Data on test point (TP2).

Step 4 : Select input *data clock* using push button i.e. 2 KHz, 4 KHz, 8 KHz, 16 KHz. Observe the change in frequency on test point (TP1) .

Step 5 : Observe the change in carrier signal frequency on test point (TP11) & test point (TP13).

Step 6 : Observe the encoded data pattern at test point (TP10).

Step 7 : Observe the BPSK modulated output at test point (TP12)

Step 8 : Observe the complex multiplier output at test point (TP14)

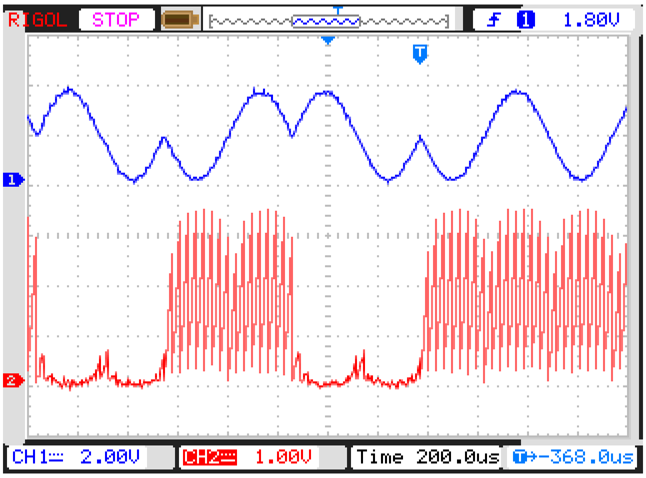
Step 9 : Observe the Integrator output at test point (TP15)

Observation:

- Observe the input data clock at TP1.
- Observe the input data at TP2.
- Observe the encoded input data at TP10.
- Observe the carrier signal at TP11.
- Observe the BPSK modulated output at TP12
- Observe the complex multiplier output at TP14
- Observe the Integrator output at (TP15)

Observe the following data Patterns on TP2

8-Bit: "10110010 "
16-Bit: "0100110110110010 "
32-Bit: "00000101000101111100101000111111 "
64-Bit:
"1010110011100011110000011111000000111100001110001100101010001111010"

Input Data Type	Data Clock Frequency	Resulting Waveforms
32-Bit	2KHz	 CH1 BPSK out (TP12). and CH2: Integrator out (TP15).

Experiment 10

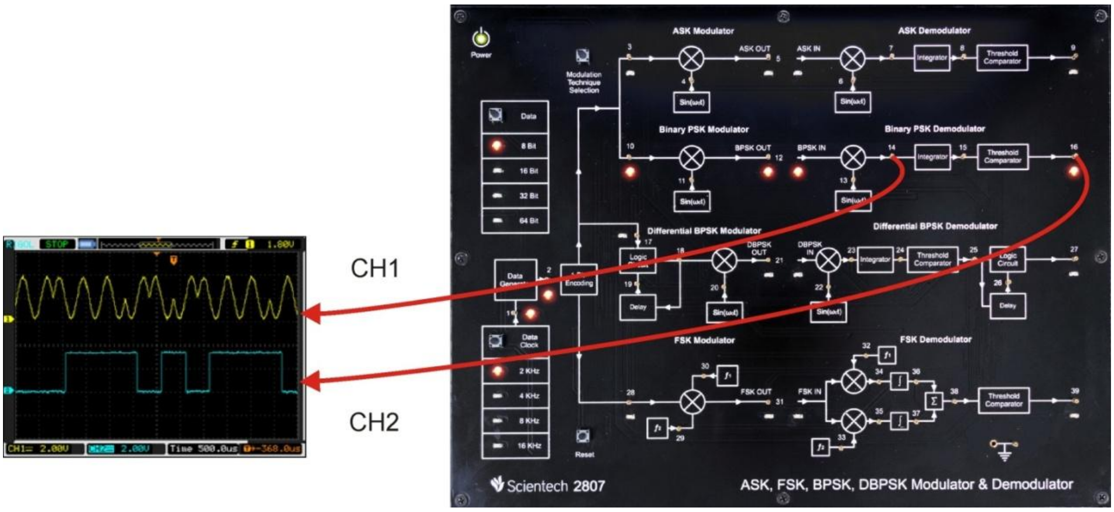
Objective:

Study and analysis of Comparator block.

Set up:

- TechBook Board
- Power Supply
- Oscilloscope/DSO
- Test probe

Connection Diagram:



Procedure:

Step 1 : Connect and switch on the Power Supply of Scientech 2807.

Step 2 : Select Binary PSK modulator using *Modulation technique selection* button. On selection of Binary PSK technique LED on TP10 will glows.

Step 3 : Select input *Data pattern* using push button i.e. 8-Bit, 16-Bit, 32-Bit, 64-Bit And respective LED will glow. Observe the input Data on test point (TP2).

Step 4 : Select input *data clock* using push button i.e. 2 KHz, 4 KHz, 8 KHz, 16 KHz. Observe the change in frequency on test point (TP1) .

Step 5 : Observe the change in carrier signal frequency on test point (TP11) & test point (TP13).

Step 6 : Observe the encoded data pattern at test point(TP10).

Step 7 : Observe the BPSK modulated output at test point (TP12)

Step 8 : Observe the complex multiplier output at test point (TP14)

Step 9 : Observe the Integrator output at test point (TP15)

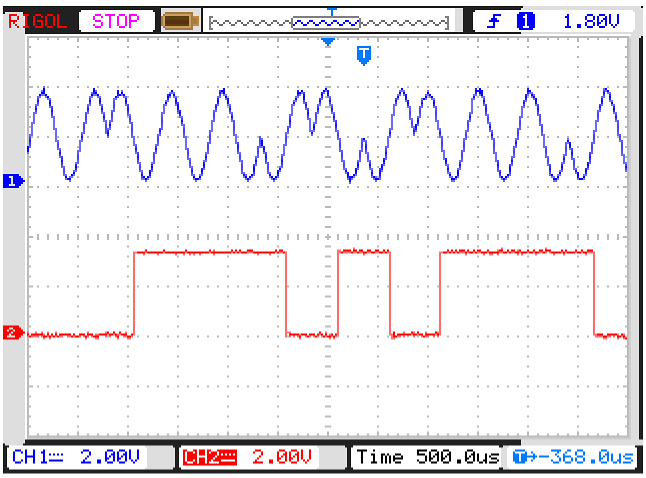
Step 10 : Observe the Comparator output at test point (TP16)

Observation:

- Observe the Input Data at TP2 .
- Observe the Input data clock at TP1.
- Observe the 1-bit encoded input data at TP10.
- Observe the Carrier signal at TP11 and TP13.
- Observe the BPSK Modulated output at TP12.
- Observe the multiplier output at TP14
- Observe the Integrator output at TP15
- Observe Comparator output at TP16

Observe the following data Patterns on TP2

8-Bit: " 10110010 "
16-Bit: " 0100110110110010 "
32-Bit: " 00000101000101111100101000111111 "
64-Bit:"
1010110011100011110000011111000001111000011100011001010100011101 0 "

Input Data Type	Data Clock Frequency	Resulting Waveforms
32-Bit	2KHz	 CH1 BPSK out (TP12). and CH2: Comparator out (TP16).

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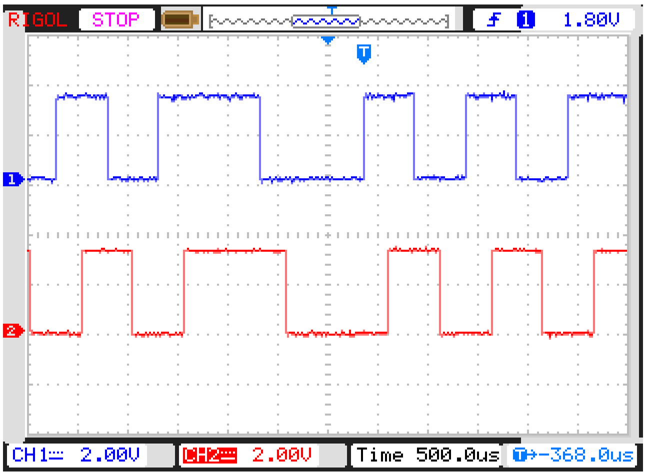
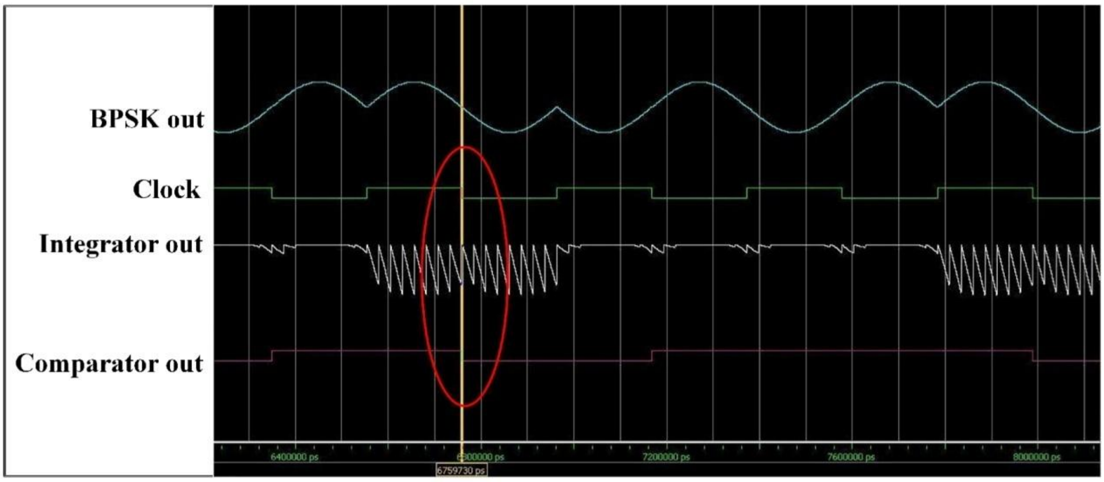
8-Bit	2KHz	 CH1 Encoded Input data (TP10). and CH2: Comparator out (TP16).

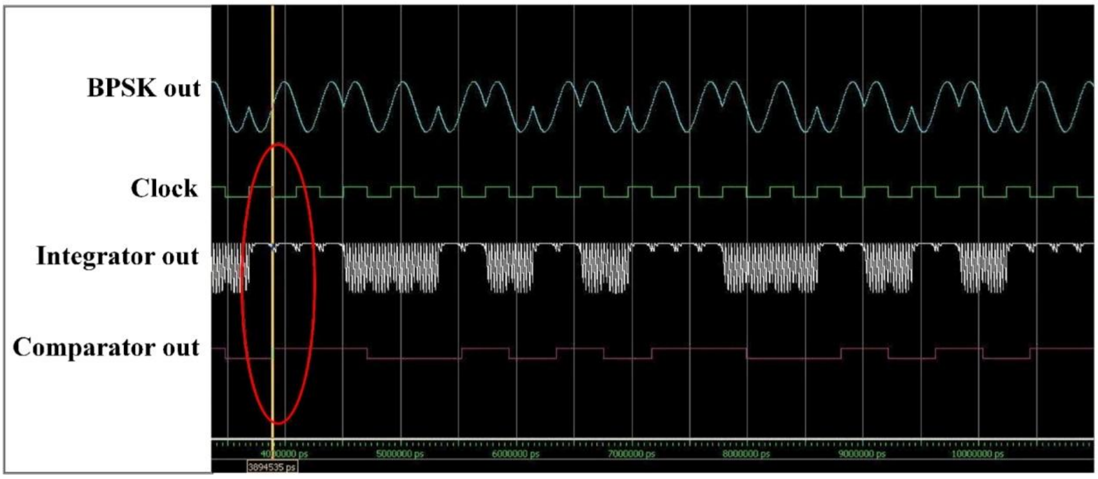
Working of Digital Comparator:- As we observed the recovered digital data at output of comparator (TP9) .

Now we can understand the working of comparator by following results:-



According to above results comparator compares integrator data at falling edge(⌐) of clock signal . it checks that whether value of comparator exactly match with value of integrator data and then it gives logic ‘ 1 ’ or logic ‘ 0 ’ as a output of comparator .

Comparison indicate by red circle with yellow vertical line .



Comparison indicate by red circle with yellow vertical line. As indicated in Red circle when event of falling edge of clock occurs value of integrator signal at falling edge of clock compared with threshold value of comparator. If it matched comparator gives logic ‘ 0 ’ else logic ‘ 1 ’ as output , which is our recovered digital data .

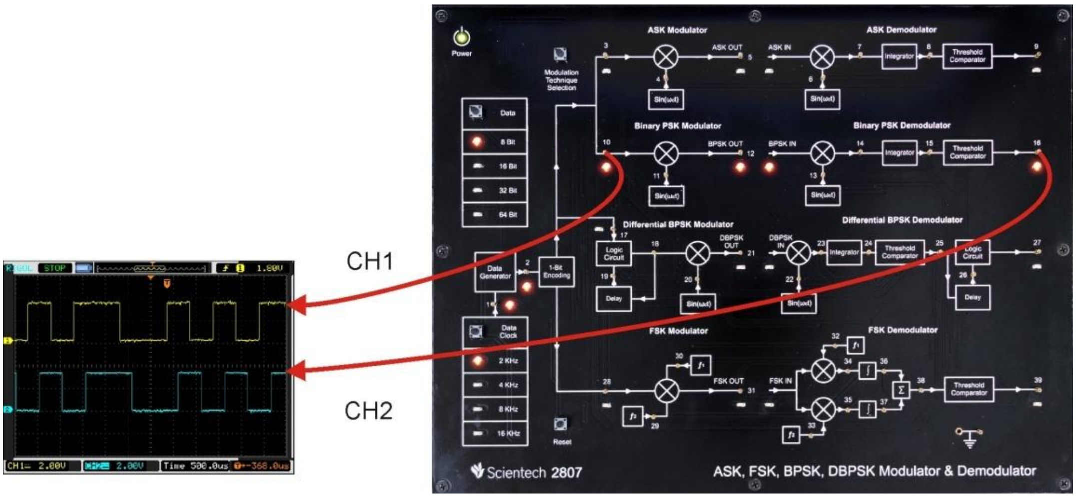
Experiment 11

Objective: Study and analysis of BPSK Demodulator

Setup:

- TechBook Board
- Power Supply
- Oscilloscope/DSO
- Test probe

Connection Diagram:



Procedure:

Step 1 : Connect and switch on the Power Supply of Scientech 2807.

Step 2 : Select Binary PSK modulator using *Modulation technique selection* button. On selection of Binary PSK technique LED on TP10 will glows.

Step 3 : Select input *Data pattern* using push button i.e. 8-Bit, 16-Bit, 32-Bit, 64-Bit And respective LED will glow. Observe the input Data on test point (TP2).

Step 4 : Select input *data clock* using push button i.e. 2 KHz, 4 KHz, 8 KHz, 16 KHz. Observe the change in frequency on test point (TP1) .

Step 5 : Observe the change in carrier signal frequency on test point (TP11) & test point (TP13).

Step 6 : Observe the encoded data pattern at test point (TP10).

Step 7 : Observe the BPSK modulated output at test point (TP12)

Step 8 : Observe the complex multiplier output at test point (TP14)

Step 9 : Observe the Integrator output at test point (TP15)

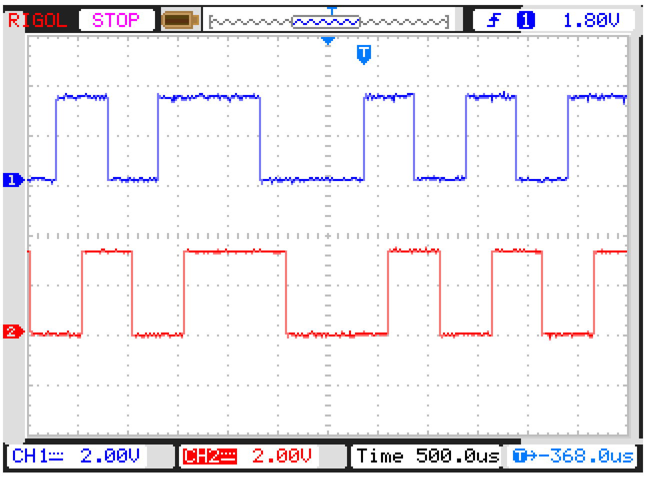
Step 10 : Observe Demodulated output at test point (TP16)

Observation:

- Observe the Input Data at TP2 .
- Observe the Input data clock at TP1.
- Observe the 1-bit encoded input data at TP10.
- Observe the Carrier signal at TP11 and TP13.
- Observe the Modulated output at TP12.
- Observe the multiplier output at TP14
- Observe the Integrator output at TP15
- Observe the Demodulated output at TP16

Observe the following data Patterns on TP2

8-Bit: “10110010 ”
16-Bit: “0100110110110010 ”
32-Bit: “00000101000101111100101000111111 ”
64-Bit:
“1010110011100011110000111110000011110000111000110010101000111010 ”

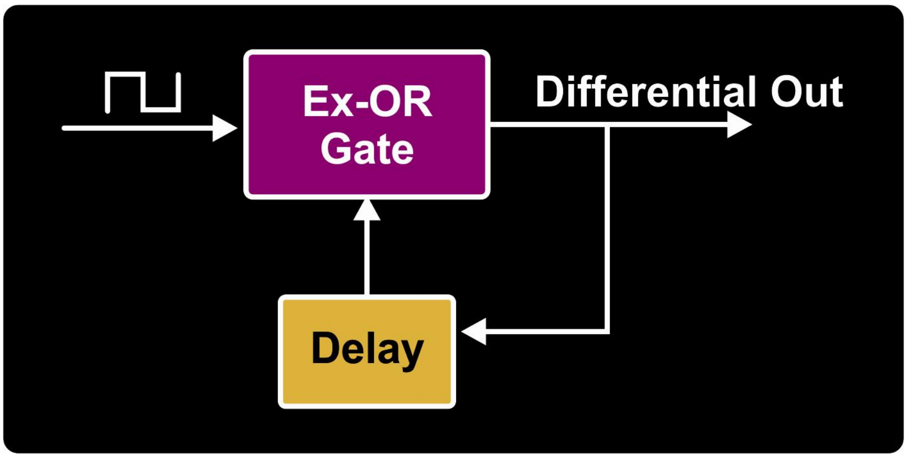
Input Data Type	Data Clock Frequency	Resulting Waveforms
8-Bit	2KHz	 CH1 Encoded Input data (TP10). and CH2: Demodulator out (TP16).

Differential Binary Phase Shift Keying

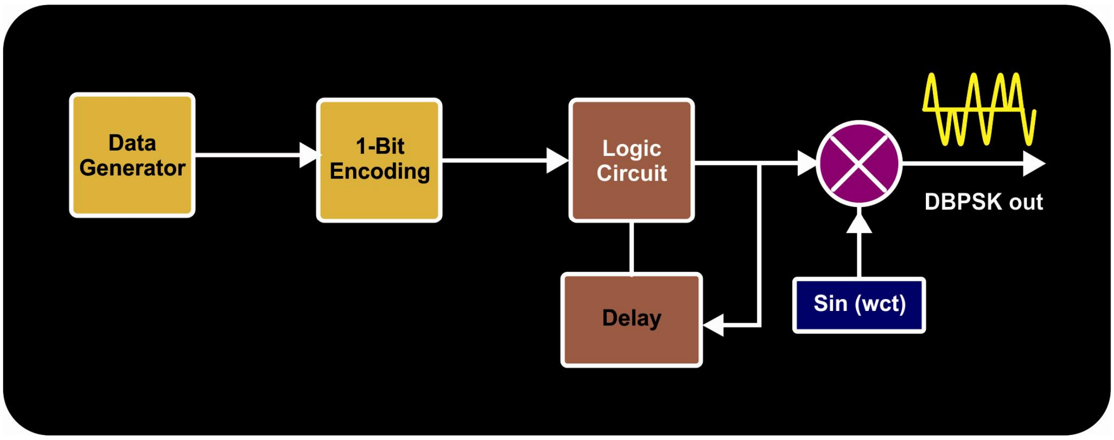
Differential coding – Is used to provide polarity reversal protection Bit streams going through the many communications circuits in the channel can be un-intentionally inverted. Most signal processing circuits can not tell if the whole stream is inverted. This is also called phase ambiguity. Differential Encoding is used to protect against this possibility. It is one of the simplest form of error protection coding done on a baseband sequence prior to modulation Then the phase of the carrier is varied to represent binary 1 or 0 of encoded data. Both peak amplitude remains constant as the phase changes.

A Differential Coding system consists of a modulo 2 adder operation as shown below.

Differential Encoder



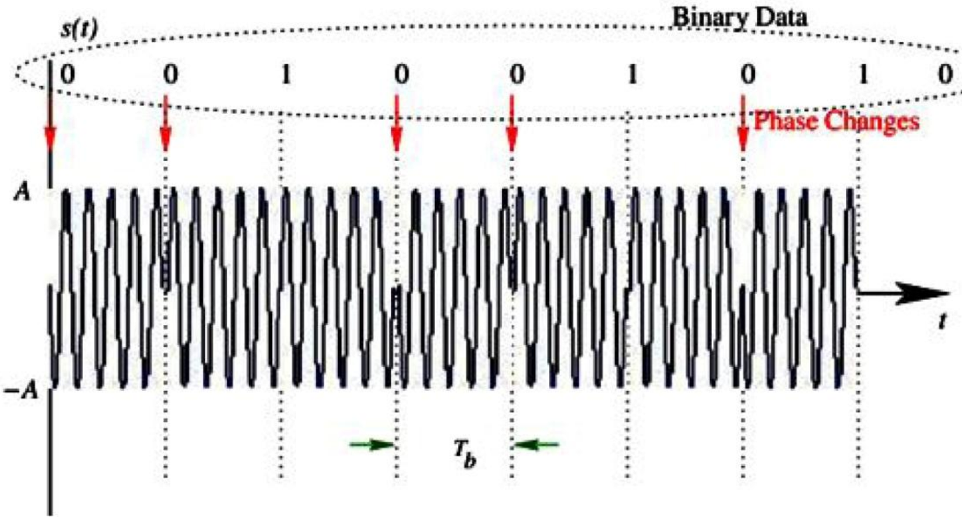
Block Diagram of DBPSK Transmitter



How DBPSK Modulator works?

In DBPSK modulator incoming NRZ encoded data is fed into differential decoder . the differential decoded output is then multiplied by carrier signal . the logic high is produce 180 deg. phase shift in carrier signal while logic '0' produce zero deg. Phase transition.

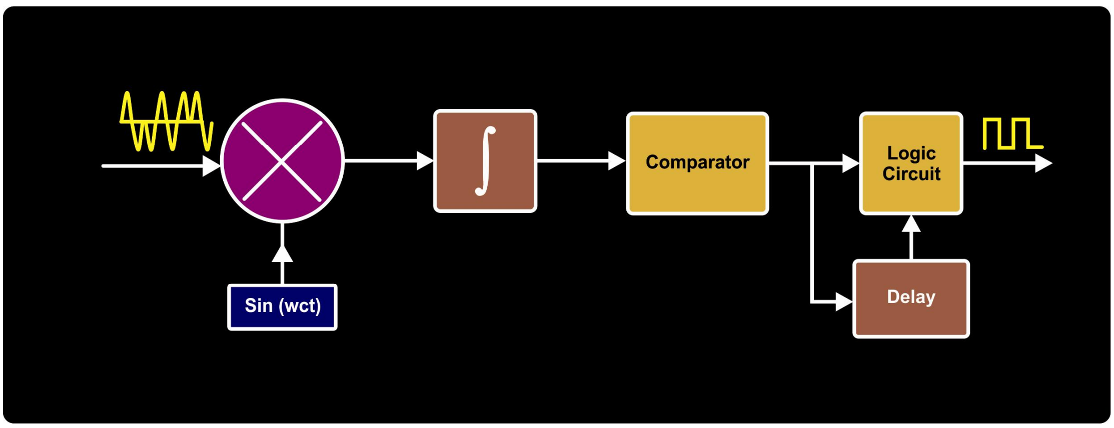
Waveform of DBPSK modulation



DBPSK Demodulator

The incoming modulated DBPSK signal is multiplied with the carrier signal . The output of the multiplier contains high ($f_{in}+f_{nco}$) and low ($f_{in}-f_{nco}$) frequency components. Multiplier output fed into integrator block . The output of Integrator is compared in comparator block based on threshold value . this output is decoded at differential decoder where we can recover input data .

Block Diagram of DBPSK Receiver



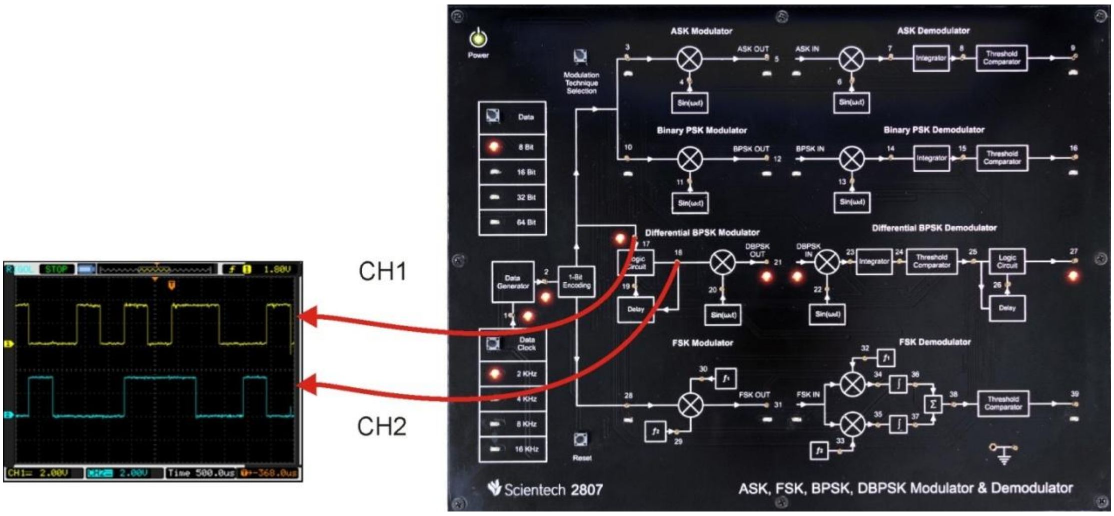
Experiment 12

Objective: Study and analysis of Differential Encoder

Setup:

- TechBook Board
- Power Supply
- Oscilloscope/DSO
- Test probe

Connection Diagram:



Procedure:

Step 1 : Connect and switch on the Power Supply of Scientech 2807.

Step 2 : Select Differential BPSK modulator by *Modulation technique selection* button on selection Differential BPSK LED on TP17 will glows.

Step 3 : Select input *Data pattern* using push button i.e. 8-Bit, 16-Bit, 32-Bit, 64-Bit. And respective LED will glow. Observe the input Data on test point (TP2).

Step 4 : Select input *data clock* using push button i.e. 2 KHz, 4 KHz, 8 KHz, 16 KHz. Observe the change in frequency on test point (TP1) .

Step 5 : Observe the Encoded input on test point (TP17) .

Step 6 : Observe the differential encoded output on test point (TP18) .

Step 7 : Observe the Delay output on test point (TP19).

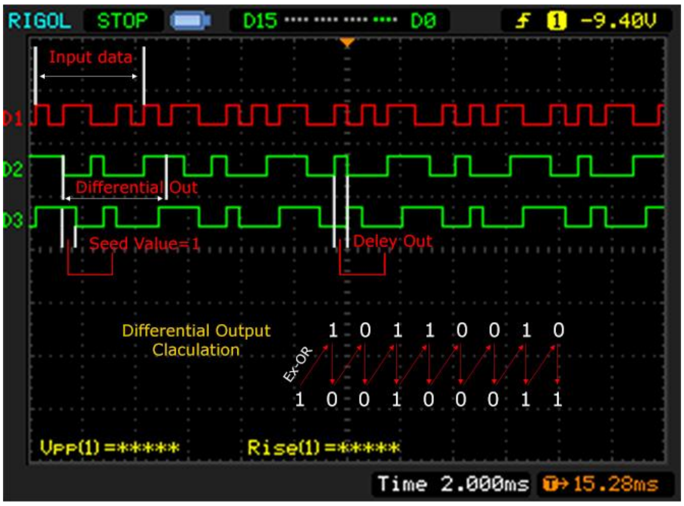
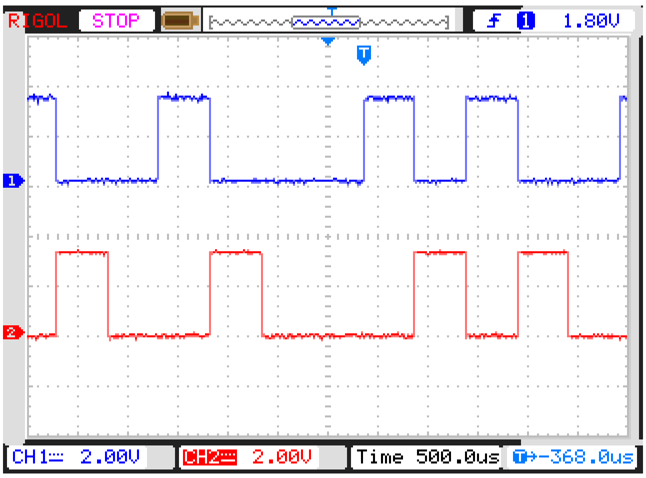
Observation:

- Observe the input data clock at TP1.
- Observe the input data at TP2.
- Observe the encoded input data at TP17.
- Observe the Differential encoded data at TP18.

- Observe the delay output at TP19

Observe the following data Patterns on TP2

8-Bit: “10110010 ”
16-Bit: “0100110110110010 ”
32-Bit: “00000101000101111100101000111111 ”
64-Bit:
“1010110011100011110000011111000000111100001110001100101010001110 10 ”

Input Data Type	Data Clock Frequency	Resulting Waveforms
8-Bit	2KHz	 D1: Input data (TP17), D2: Differential output (TP18) D3: Delay output (TP19)
8-Bit	2KHz	 CH1: Differential out (TP18) CH2: Delay output (TP19)

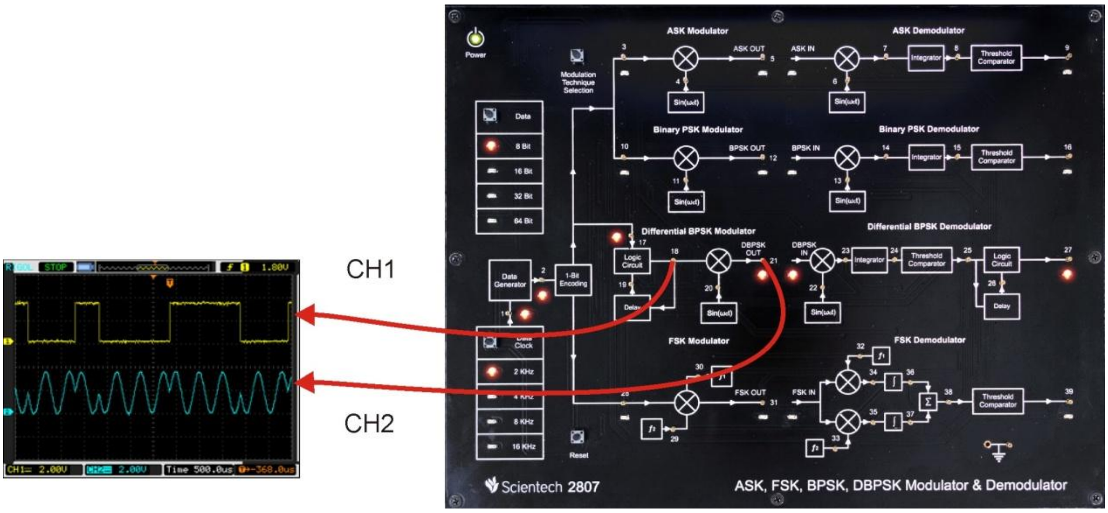
Experiment 13

Objective: Study and analysis of DBPSK Modulator

Setup:

- TechBook Board
- Power Supply
- Oscilloscope/DSO
- Test probe

Connection Diagram:



Procedure:

Step 1 : Connect and switch on the Power Supply of Scientech 2807.

Step 2 : Select Differential BPSK modulator by *Modulation technique selection* button. on selection Differential BPSK LED on TP17 will glows.

Step 3 : Select input *Data pattern* using push button i.e. 8-Bit, 16-Bit, 32-Bit, 64-Bit. And respective LED will glow. Observe the input Data on test point (TP2).

Step 4 : Select input *data clock* using push button i.e. 2 KHz, 4 KHz, 8 KHz, 16 KHz. Observe the change in frequency on test point (TP1) .

Step 5 : Observe the encoded input data on test point (TP17) .

Step 6 : Observe the carrier signal on test point (TP20).

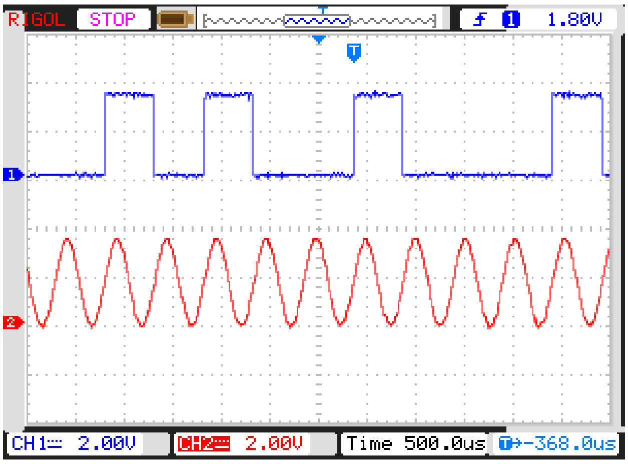
Step 7 : Observe the DBPSK modulated output at test point (TP21)

Observation:

- Observe the input data clock at TP1.
- Observe the input data at TP2.
- Observe the encoded input data at TP17.
- Observe the Differential encoder output at TP18
- Observe the carrier signal at TP20.
- Observe the DBPSK modulated output at TP21

Observe the following data Patterns on TP2

8-Bit: "10110010 "
16-Bit: "0100110110110010 "
32-Bit: "00000101000101111100101000111111 "
64-Bit:
"1010110011100011110000111110000011110000111000110010101000111010 "

Input Data Type	Data Clock Frequency	Resulting Waveforms
8-Bit	2KHz	 CH1: encoded input data (TP17), CH2: Carrier signal (TP20)

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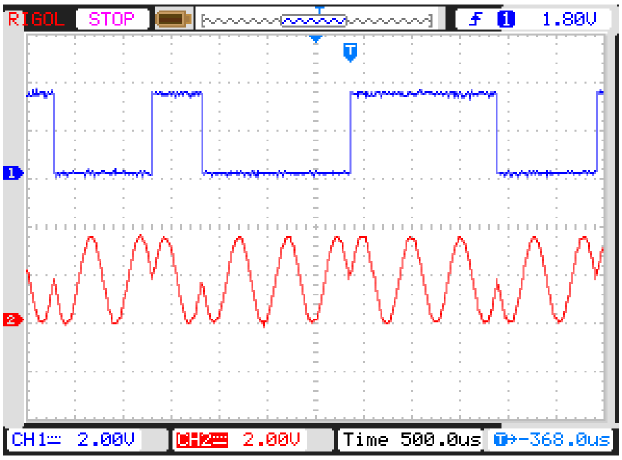
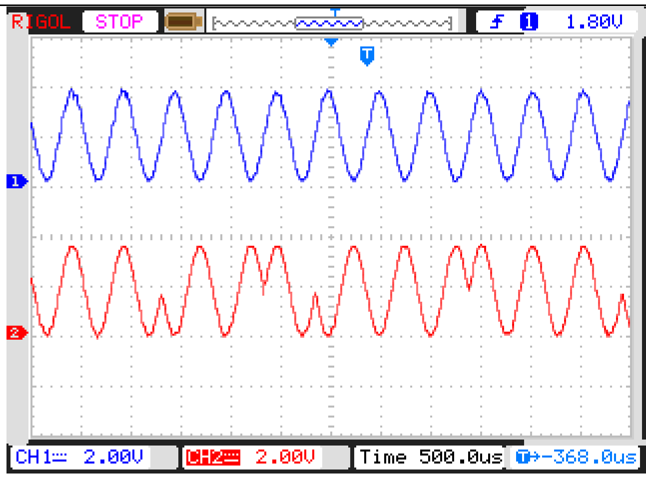
8-Bit	2KHz	 CH1: Differential out (TP18) CH2: DBPSK output (TP21)

8-Bit	2KHz	 CH1: Carrier signal (TP20) CH2: DBPSK output (TP21)

Experiment 14

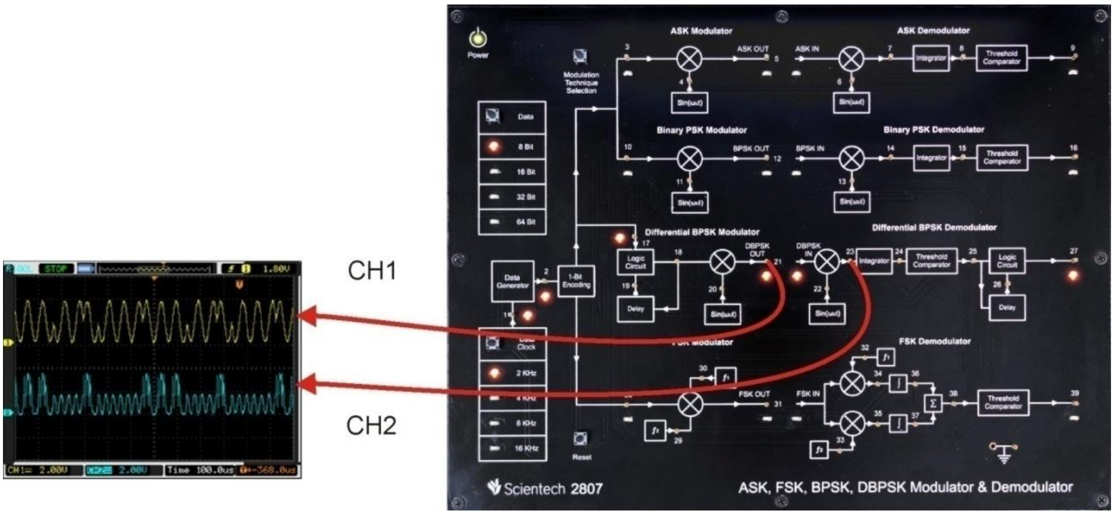
Objective:

Study and analysis of complex multiplier output .

Set up:

- TechBook Board
- Power Supply
- Oscilloscope/DSO
- Test probe

Connection Diagram:



Procedure:

Step 1 : Connect and switch on the Power Supply of Scientech 2807.

Step 2 : Select Differential BPSK modulator by *Modulation technique selection* button. on selection of Differential BPSK technique LED on TP17 will glows.

Step 3 : Select input *Data pattern* using push button i.e. 8-Bit, 16-Bit, 32-Bit, 64-Bit. And respective LED will glow. Observe the input Data on test point (TP2).

Step 4 : Select input *data clock* using push button i.e. 2 KHz, 4 KHz, 8 KHz, 16 KHz. Observe the change in frequency on test point (TP1) .

Step 5 : Observe the change in carrier signal on test point (TP20) & test point (TP22).

Step 6 : Observe the encoded input data pattern at test point (TP17).

Step 7 : Observe the DBPSK modulated output at test point (TP21)

Step 8 : Observe the complex multiplier output at test point (TP23)

Observation:

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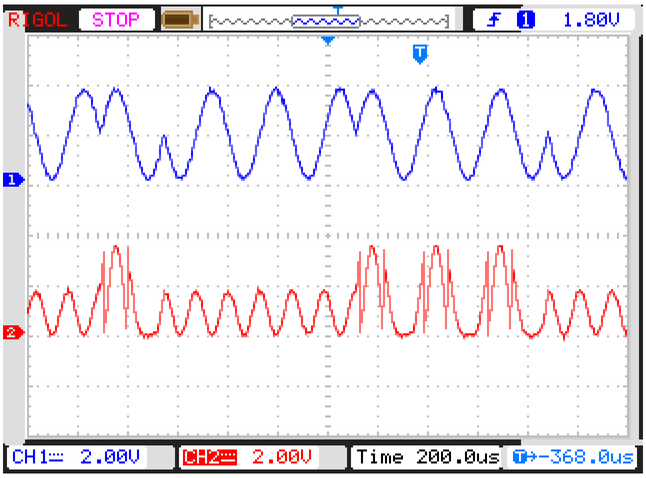
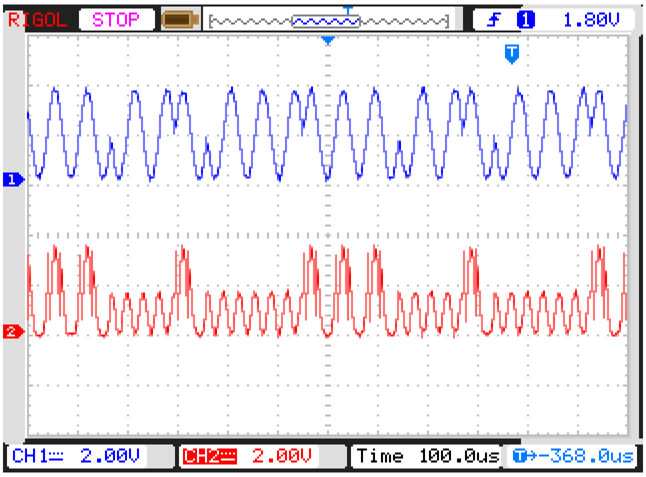
- Observe the input data clock at TP1.
- Observe the input data at TP2.
- Observe the encoded input data at TP17.
- Observe the Differential encoder output at TP18
- Observe the carrier signal at TP20 & TP22.
- Observe the DBPSK modulated output at TP21
- Observe the complex multiplier output at TP23

Observe the following data Patterns on TP2

8-Bit: “10110010”
16-Bit: “0100110110110010”
32-Bit: “00000101000101111100101000111111”
64-Bit:
“1010110011100011110000111110000011110000111000110010101000111010”

Input Data Type	Data Clock Frequency	Resulting Waveforms
8-Bit	4KHz	 CH1: DBPSK output (TP21) CH2: multiplier out (TP23)
8-Bit	16KHz	 CH1: DBPSK output (TP21) CH2: multiplier out (TP23)

Experiment 15

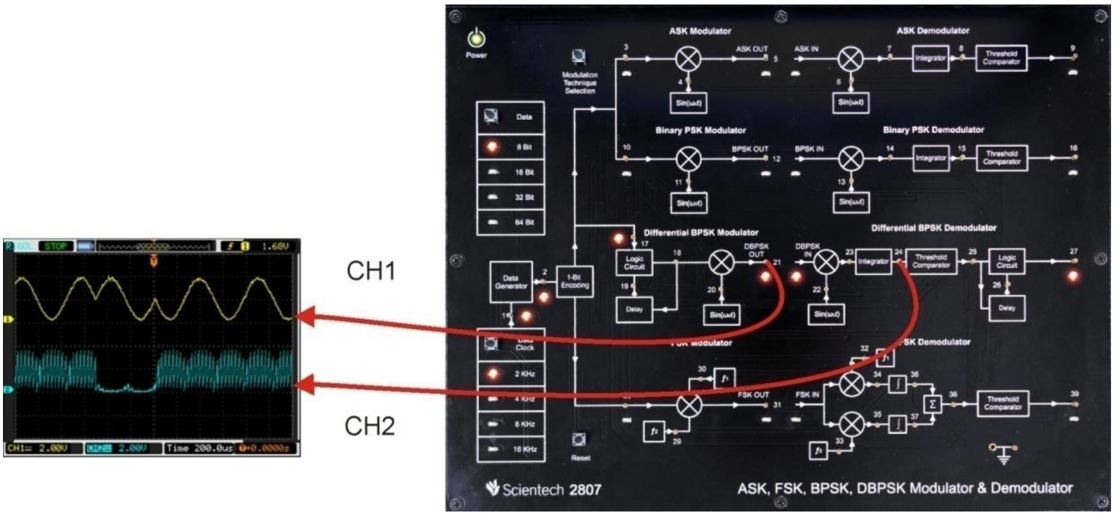
Objective:

Study and analysis of Integrator block .

Set up:

- TechBook Board
- Power Supply
- Oscilloscope/DSO
- Test probe

Connection Diagram:



Procedure:

Step 1 : Connect and switch on the Power Supply of Scientech 2807.

Step 2 : Select Differential BPSK modulator by *Modulation technique selection* button. on selection of Differential BPSK technique LED on TP17 will glows.

Step 3 : Select input *Data pattern* using push button i.e. 8-Bit, 16-Bit, 32-Bit, 64-Bit. And respective LED will glow. Observe the input Data on test point (TP2).

Step 4 : Select input *data clock* using push button i.e. 2 KHz, 4 KHz, 8 KHz, 16 KHz. Observe the change in frequency on test point (TP1) .

Step 5 : Observe the change in carrier signal on test point (TP20) & test point (TP22).

Step 6 : Observe the encoded input data pattern at test point (TP17).

Step 7 : Observe the DBPSK modulated output at test point (TP21)

Step 8 : Observe the complex multiplier output at test point (TP23)

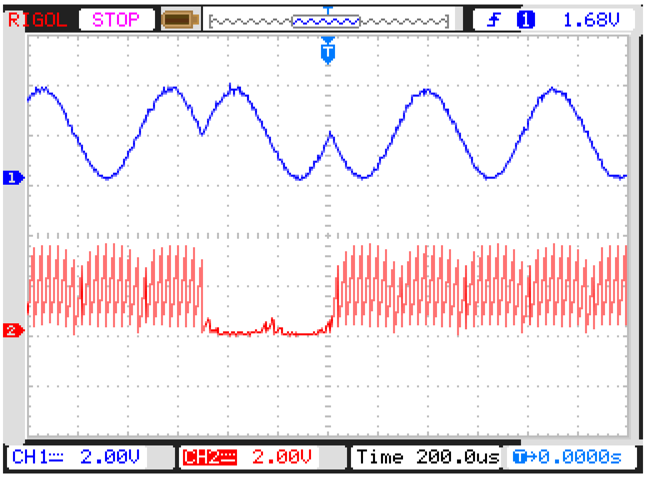
Step 9 : Observe the Integrator output at test point (TP24)

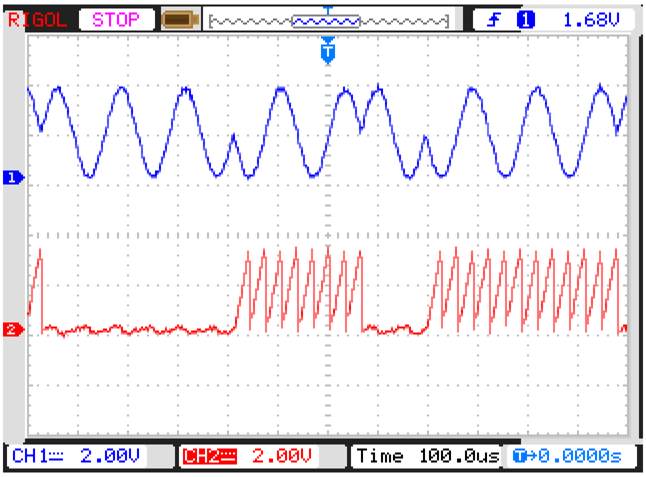
Observation:

- Observe the input data clock at TP1.
- Observe the input data at TP2.
- Observe the encoded input data at TP17.
- Observe the Differential encoder output at TP18
- Observe the carrier signal at TP20 & TP22.
- Observe the DBPSK modulated output at TP21
- Observe the complex multiplier output at TP23
- Observe the Integrator output at (TP24)

Observe the following data Patterns on TP2

8-Bit: “10110010 ”
16-Bit: “0100110110110010 ”
32-Bit: “00000101000101111100101000111111 ”
64-Bit:
“1010110011100011110000011111000001111000011100011001010100011101 0 ”

Input Data Type	Data Clock Frequency	Resulting Waveforms
8-Bit	2KHz	 CH1: DBPSK output (TP21) CH2: Integrator out (TP24)

8-Bit	8KHz	 CH1: DBPSK output (TP21) CH2: Integrator out (TP24)

Experiment 16

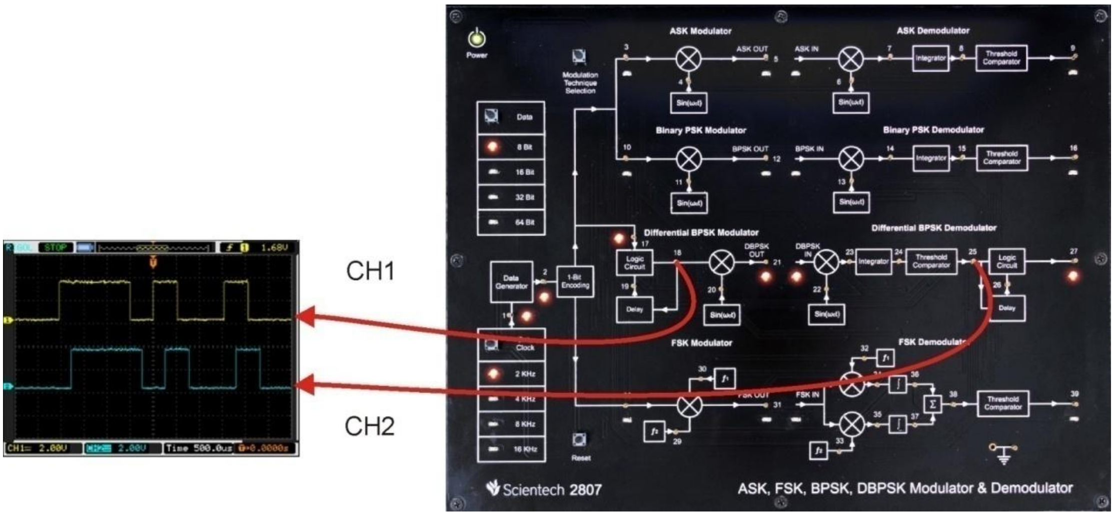
Objective:

Study and analysis of Comparator block .

Set up:

- TechBook Board
- Power Supply
- Oscilloscope/DSO
- Test probe

Connection Diagram:



Procedure:

Step 1 : Connect and switch on the Power Supply of Scientech 2807.

Step 2 : Select Differential BPSK modulator by *Modulation technique selection* button. on selection of Differential BPSK technique LED on TP17 will glows.

Step 3 : Select input *Data pattern* using push button i.e. 8-Bit, 16-Bit, 32-Bit, 64-Bit. And respective LED will glow. Observe the input Data on test point (TP2).

Step 4 : Select input *data clock* using push button i.e. 2 KHz, 4 KHz, 8 KHz, 16 KHz. Observe the change in frequency on test point (TP1) .

Step 5 : Observe the change in carrier signal on test point (TP20) & test point (TP22).

Step 6 : Observe the encoded input data pattern at test point (TP17).

Step 7 : Observe the DBPSK modulated output at test point (TP21)

Step 8 : Observe the complex multiplier output at test point (TP23)

Step 9 : Observe the Integrator output at test point (TP24)

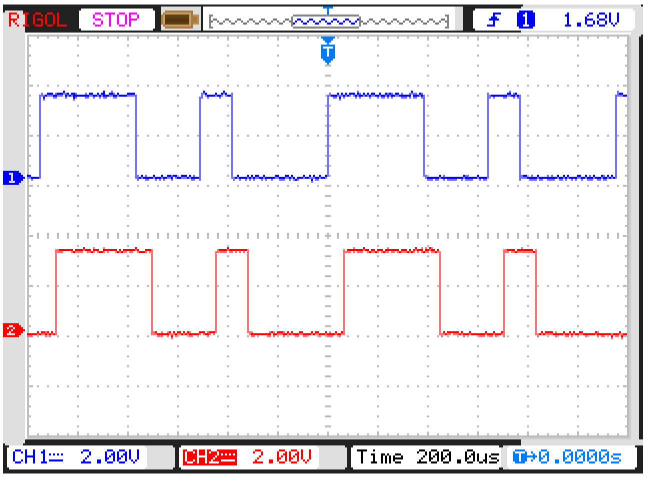
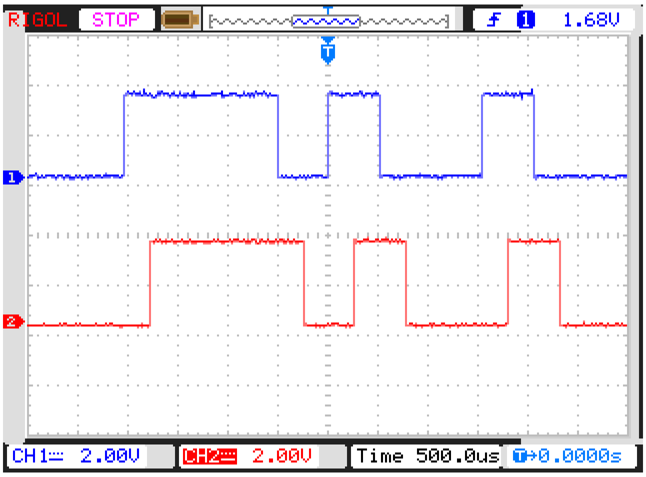
Step 10 : Observe the Comparator output at test point (TP25)

Observation:

- Observe the input data clock at TP1.
- Observe the input data at TP2.
- Observe the encoded input data at TP17.
- Observe the Differential encoder output at TP18
- Observe the carrier signal at TP20 & TP22.
- Observe the DBPSK modulated output at TP21
- Observe the complex multiplier output at TP23
- Observe the Integrator output at TP25

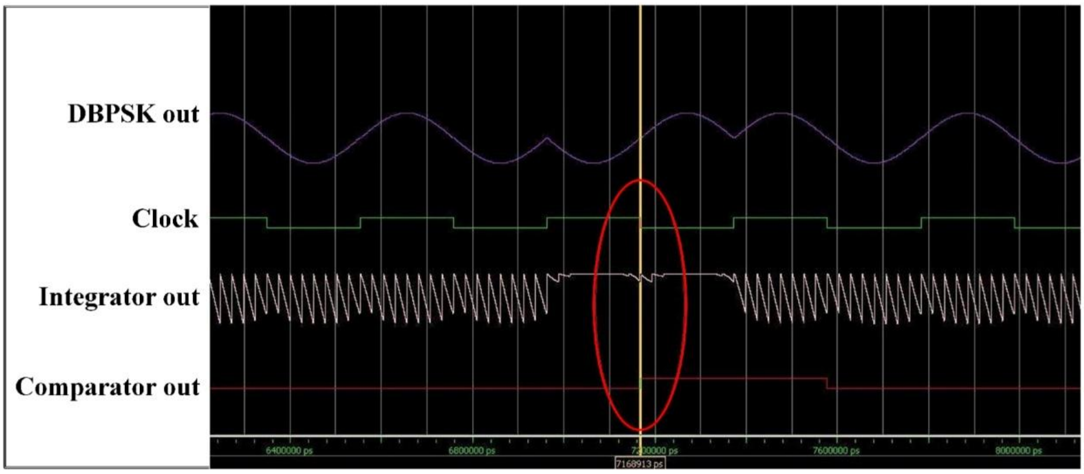
Observe the following data Patterns on TP2

8-Bit: “10110010”
16-Bit: “0100110110110010”
32-Bit: “00000101000101111100101000111111”
64-Bit:
“1010110011100011110000111111000000111100001110001100101010001110 10”

Input Data Type	Data Clock Frequency	Resulting Waveforms
8-Bit	8KHz	 CH1: Differential output (TP18) CH2: Comparator out (TP25)
16-Bit	2KHz	 CH1: Differential output (TP18) CH2: Comparator out (TP25)

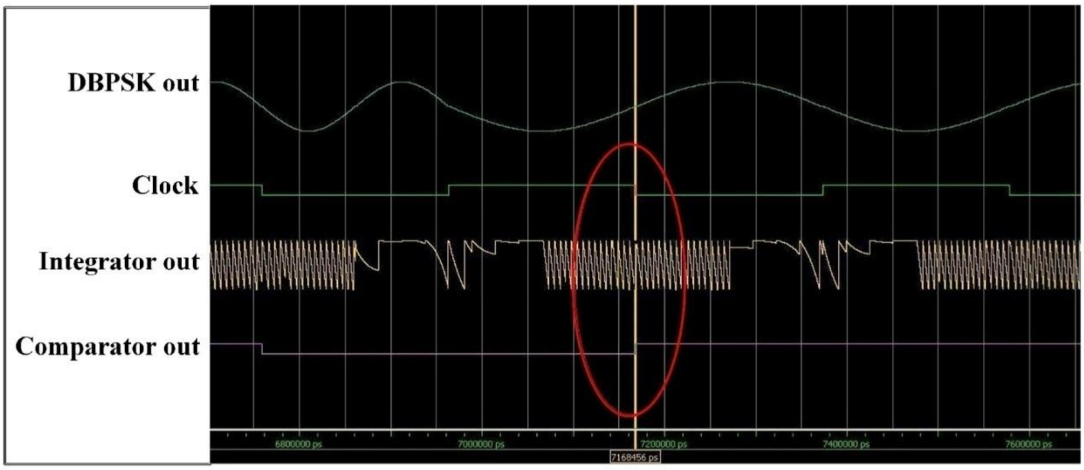
Working of Digital Comparator:- As we observed the recovered digital data at output of comparator (TP9) .

Now we can understand the working of comparator by following results:-



According to above results comparator compares integrator data at falling edge(⌐L) of clock signal . it checks that whether value of comparator exactly match with value of integrator data and then it gives logic ‘ 1 ’ or logic ‘ 0 ’ as a output of comparator .

Comparison indicate by red circle with yellow vertical line .



Comparison indicate by red circle with yellow vertical line . As indicated in Red circle when event of falling edge of clock occurs value of integrator signal at falling edge of clock compared with threshold value of comparator . if it matched comparator gives logic ‘ 0 ’ else logic ‘ 1 ’ as output , which is our recovered digital data .

Experiment 17

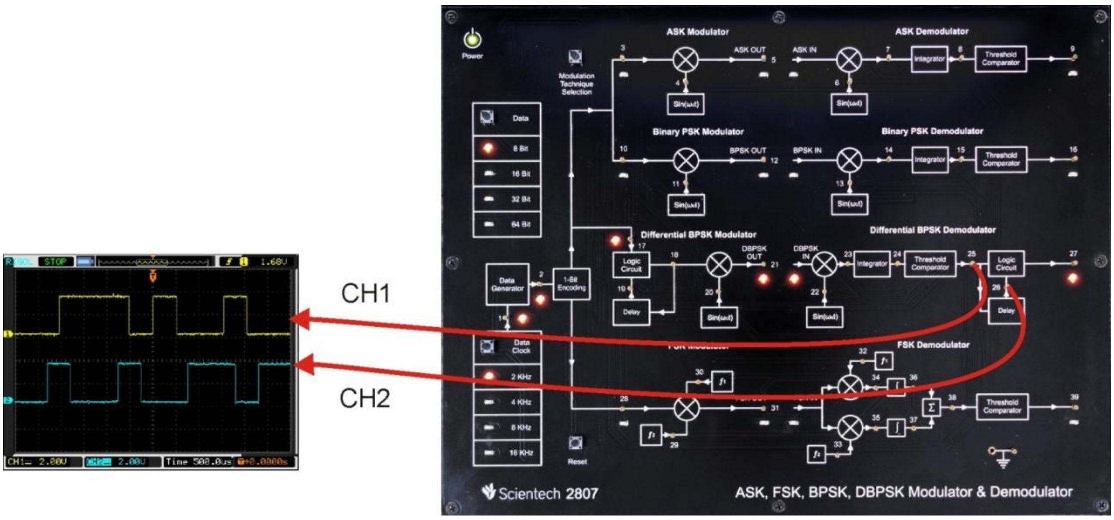
Objective:

Study and analysis Differential decoder

Set Up:

- TechBook Board
- Power Supply
- Oscilloscope/DSO
- Test probe

Connection Diagram:



Procedure:

Step 1 : Connect and switch on the Power Supply of Scientech 2807.

Step 2 : Select Differential BPSK modulator by *Modulation technique selection* button on selection of Differential BPSK technique LED on TP17 will glows.

Step 3 : Select input *Data pattern* using push button i.e. 8-Bit, 16-Bit, 32-Bit, 64-Bit. And respective LED will glow. Observe the input Data on test point (TP2).

Step 4 : Select input *data clock* using push button i.e. 2 KHz, 4 KHz, 8 KHz, 16 KHz. Observe the change in frequency on test point (TP1) .

Step 5 : Observe the change in carrier signal on test point (TP20) & test point (TP22).

Step 6 : Observe the encoded input data pattern at test point (TP17).

Step 7 : Observe the DBPSK modulated output at test point (TP21)

Step 8 : Observe the complex multiplier output at test point (TP23)

Step 9 : Observe the Integrator output at test point (TP24)

Step 10 : Observe the Comparator output at test point (TP25)

Step 11 : Observe the output of differential decoder on test point (TP27)

Step12 : Observe the delay output at test point (TP26)

Observation:

- Observe the input data clock at TP1.
- Observe the input data at TP2.
- Observe the encoded input data at TP17.
- Observe the Differential encoder output at TP18
- Observe the carrier signal at TP20 & TP22.
- Observe the DBPSK modulated output at TP21
- Observe the complex multiplier output at TP23
- Observe the Integrator output at TP25
- Observe the Delay output at TP26
- Observe the Differential decoder output at TP27

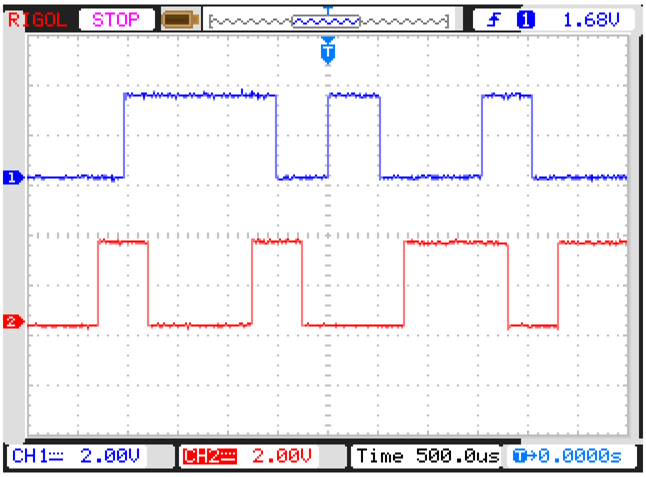
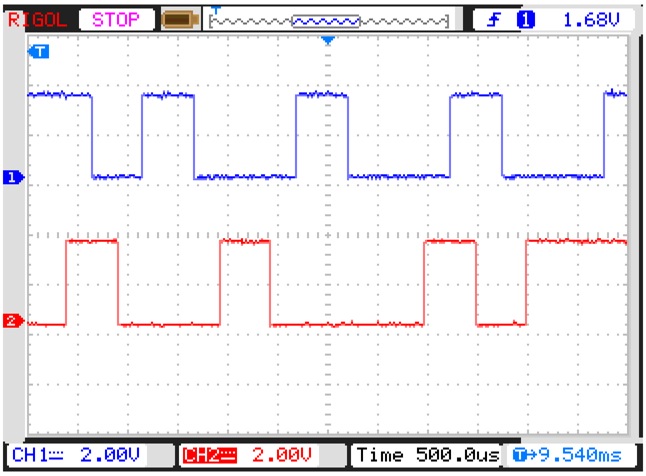
Observe the following data Patterns on TP2

8-Bit: “10110010”

16-Bit: “0100110110110010”

32-Bit: “00000101000101111100101000111111”

64-Bit:
“1010110011100011110000011111000000111100001110001100101010001110 10”

Data Pattern	Data Frequency	Resulting Waveforms
16-Bit	2KHz	 CH1: comparator out (TP25) CH2: Delay out (TP26)
16-Bit	2KHz	 CH1: comparator out (TP25) CH2: Delay out (TP26)

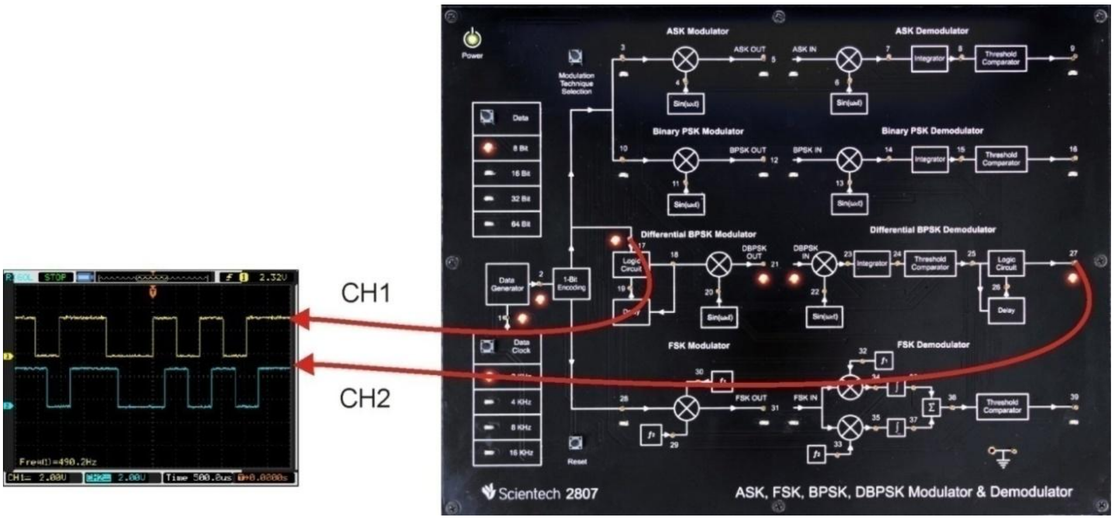
Experiment 18

Objective: Study and analysis of DBPSK Demodulator

Setup:

- TechBook Board
- Power Supply
- Oscilloscope/DSO
- Test probe

Connection Diagram:



Procedure:

Step 1 : Connect and switch on the Power Supply of Scientech 2807.

Step 2 : Select Differential BPSK modulator by *Modulation technique selection* button on selection of Differential BPSK technique LED on TP17 will glows.

Step 3 : Select input *Data pattern* using push button i.e. 8-Bit, 16-Bit, 32-Bit, 64-Bit. And respective LED will glow. Observe the input Data on test point (TP2).

Step 4 : Select input *data clock* using push button i.e. 2 KHz, 4 KHz, 8 KHz, 16 KHz. Observe the change in frequency on test point (TP1) .

Step 5 : Observe the change in carrier signal on test point (TP20) & test point (TP22).

Step 6 : Observe the encoded input data pattern at test point (TP17).

Step 7 : Observe the DBPSK modulated output at test point (TP21)

Step 8 : Observe the complex multiplier output at test point (TP23)

Step 9 : Observe the Integrator output at test point (TP24)

Step 10 : Observe the Comparator output at test point (TP25)

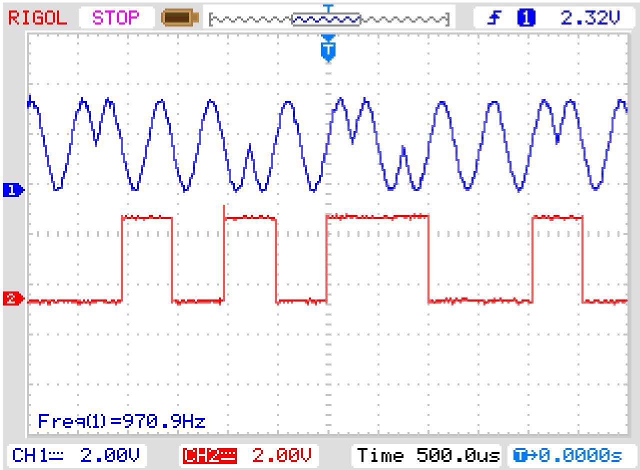
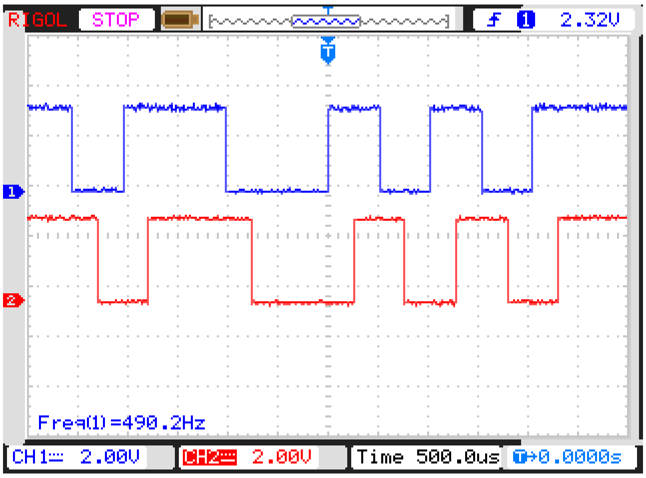
Step 11 : Observe the output of Demodulator on test point (TP27)

Observation:

- Observe the input data clock at TP1.
- Observe the input data at TP2.
- Observe the encoded input data at TP17.
- Observe the Differential encoder output at TP18
- Observe the carrier signal at TP20 & TP22.
- Observe the DBPSK modulated output at TP21
- Observe the complex multiplier output at TP23
- Observe the Integrator output at TP25
- Observe the Demodulator output at TP27

Observe the following data Patterns on TP2

8-Bit: “10110010”
16-Bit: “0100110110110010”
32-Bit: “00000101000101111100101000111111”
64-Bit:
“1010110011100011110000111110000011110000111000110010101000111010”

Input Data Type	Data Clock Frequency	Resulting Waveforms
8-Bit	2KHz	 CH1: DBPSK out (TP21) CH2: Demodulator out (TP27)
8-Bit	2KHz	 CH1: Encoded input data (TP17) CH2: Demodulator out (TP27)

Frequency Shift Keying

Introduction:

What is FSK ?

In FSK Modulation, we change the frequency in response to information, one particular frequency for Logic 1 and another frequency for Logic 0. For Example:-Sin (2πf1t) is transmitted for logic '1' and Sin (2πf2t) is transmitted for logic '0' .

The general expression for FSK is

$$v_{(fsk)}(t) = v_c(t)\cos 2\pi[f_c + v_m(t)\Delta f]t \qquad \text{..........equation1}$$

where

$v_{(fsk)}(t) = binary\ FSK\ waveform$

$v_c(t) = peak\ analog\ carrier\ amplitude$

$f_c = analog\ carrier\ center\ frequency$

Δf = *peak change in the analog carrier frequency*

$v_m(t)$ = *Binary input (modulating) signal*

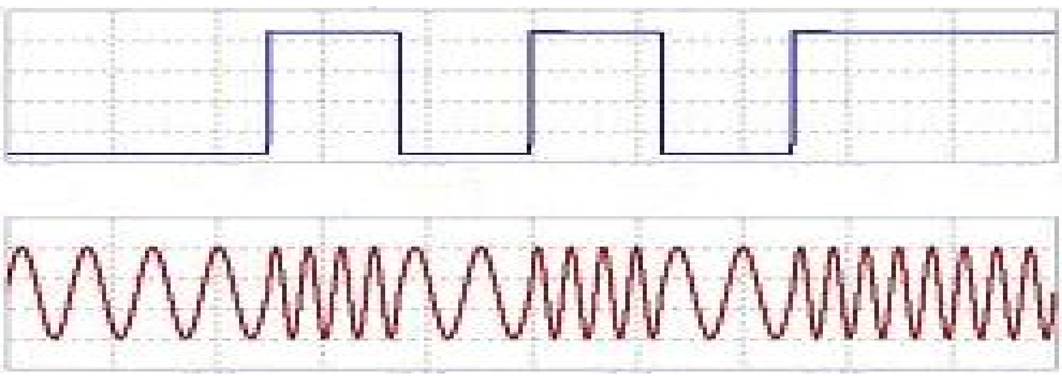
From equation 1, it can be seen that the peak shift in the carrier (Δf) is proportional to the amplitude of the binary input signal ($v_m(f)$), and the direction of the shift is determined by the polarity. The modulating signal is a normalized waveform where logic 1 = +1 volt and logic 0 = -1volt.Thus,for a logic1 input ,equation1 can be written as

$$v_{(fsk)}(t) = v_c(t)\cos 2\pi[f_c + \Delta f]t$$

For logic0 input , equation can be written as

$$v_{(fsk)}(t) = v_c(t)\cos 2\pi[f_c - \Delta f]t$$

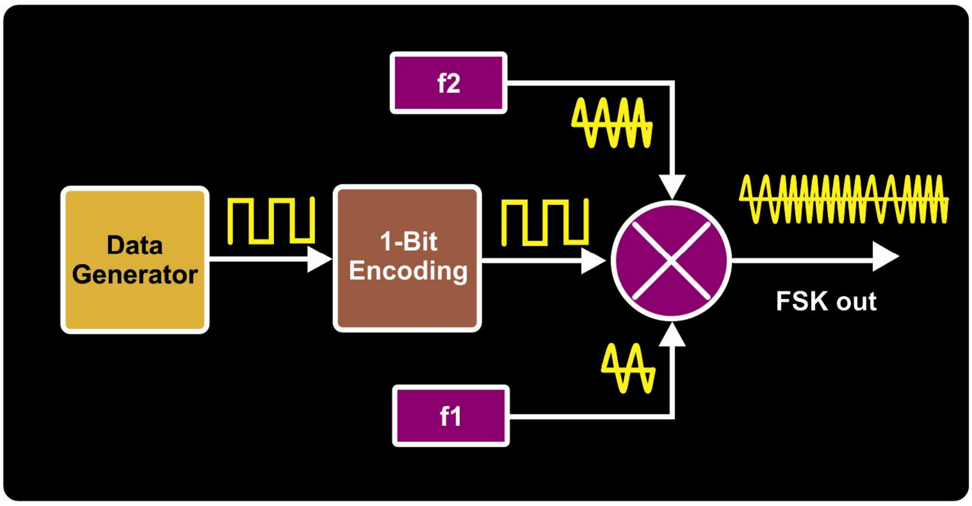
With binary FSK, the carrier center frequency (f_c) is shifted up and down in the frequency domain by binary input signal. As the input changes from logic 1 to a logic 0 and vice versa, the output frequency shift between two frequencies. The waveform of FSK is



How FSK Modulator works?

FSK Modulator:

In FSK modulator input binary data is converted into NRZ unipolar data using 1-Bit encoding method this encoded data then multiplied by carrier signals having different frequencies i.e F1 and F2 . In FSK when data has logic level '1' carrier signal of F1 frequency is transmitted while at logic level '0' carrier signal of F2 frequency is transmitted here F2=2 x F1 .



FSK Demodulator:

At receiver side FSK modulated signal is multiplied by the carrier signals having frequencies F1 and F2. The output of multiplier consist of higher frequency and lower frequency components this output then integrated by Integrator block . Summation of 1st Integrated output and 2nd Integrated output is performed in summer this output is then passed from comparator block. Comparator block recovers digital data by comparing threshold value with integrated signal.

Advantages:

- Useful for long distance communication.
- It has high security.
- Low noise
- Efficiency is high.
- Decoding of signal is easy.

Experiment 19

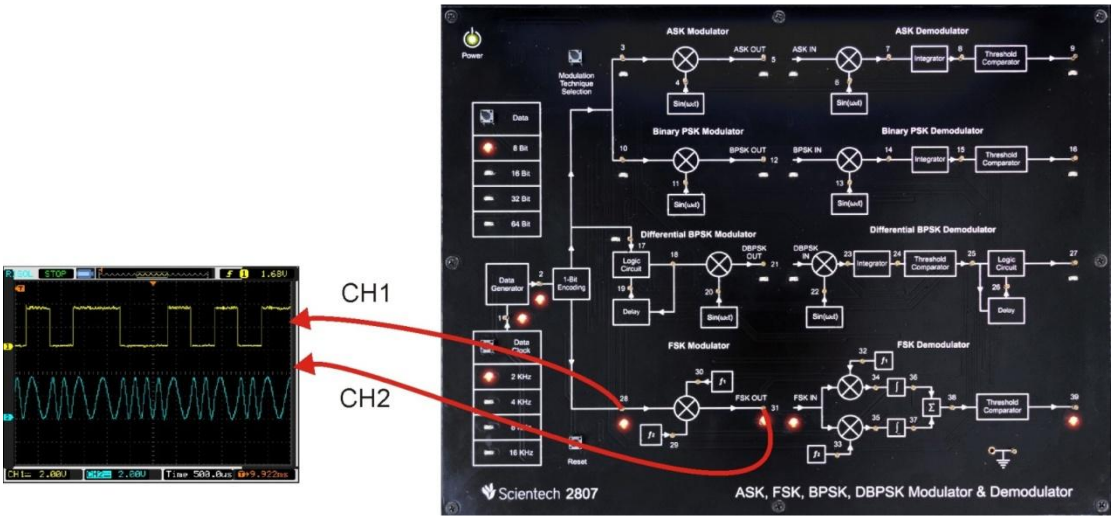
Objective:

Study and analysis of FSK modulator

Set up:

- TechBook Board
- Power Supply
- Oscilloscope/DSO
- Test probe

Connection Diagram:



Procedure:

Step 1 : Connect and switch on the Power Supply of Scientech 2807.

Step 2 : Select FSK modulator by *Modulation technique selection* button. on selection FSK , LED on TP28 will glows.

Step 3 : Select input *Data pattern* using push button i.e. 8-Bit, 16-Bit, 32-Bit, 64-Bit. And respective LED will glow. Observe the input Data on test point (TP2).

Step 4 : Select input *data clock* using push button i.e. 2 KHz, 4 KHz, 8 KHz, 16 KHz. Observe the change in frequency on test point (TP1) .

Step 5 : Observe the change in carrier signal frequency ($f1$) on test point (TP30).

Step 6 : Observe the change in carrier signal frequency ($f2$) on test point (TP29), which twice then frequency $f1$.

Step 7 : Observe the encoded input data pattern at test point (TP28).

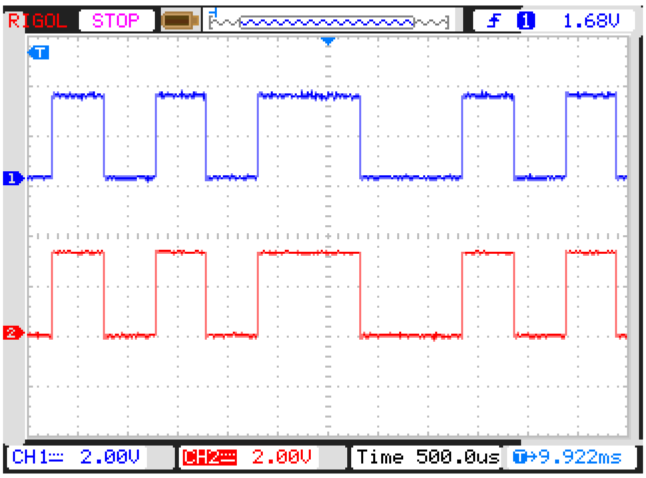
Step 8 : Observe the FSK modulated output at test point (TP31)

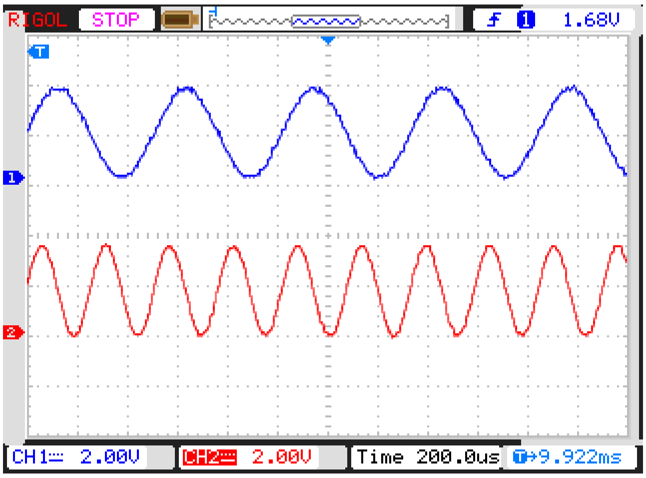
Observation:

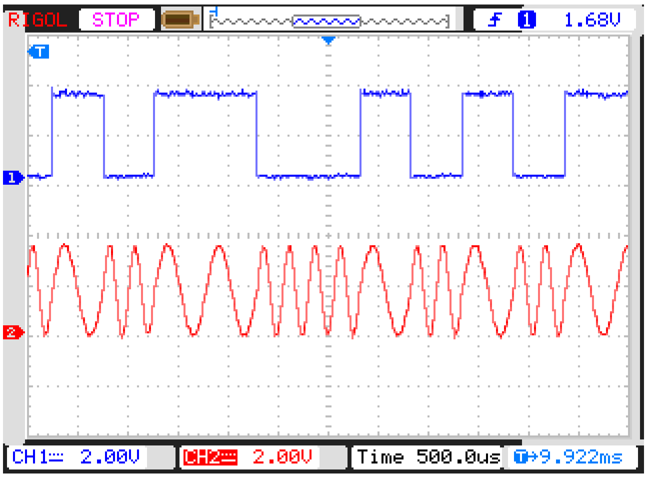
- Observe the input data clock at TP1.
- Observe the input data at TP2.
- Observe the encoded input data at TP28.
- Observe the carrier signal at TP29.
- Observe the carrier signal at TP30.
- Observe the FSK modulated output at TP31

Observe the following data Patterns on TP2

8-Bit: "10110010"
16-Bit: "0100110110110010"
32-Bit: "00000101000101111100101000111111"
64-Bit:
"1010110011100011110000011111000001111000011100011001010101000111010"

Input Data Type	Data Clock Frequency	Resulting Waveforms
8-Bit	2KHz	 CH1: Input Data (TP2), CH2: Encoded Input Data(TP28)

8-Bit	2KHz	 CH1: Carrier signal F1(TP30), CH2: Carrier Signal F2 (TP29)

8-Bit	2KHz	 CH1: Encoded Input Data (TP28), CH2: FSK Output (TP31)

Experiment 20

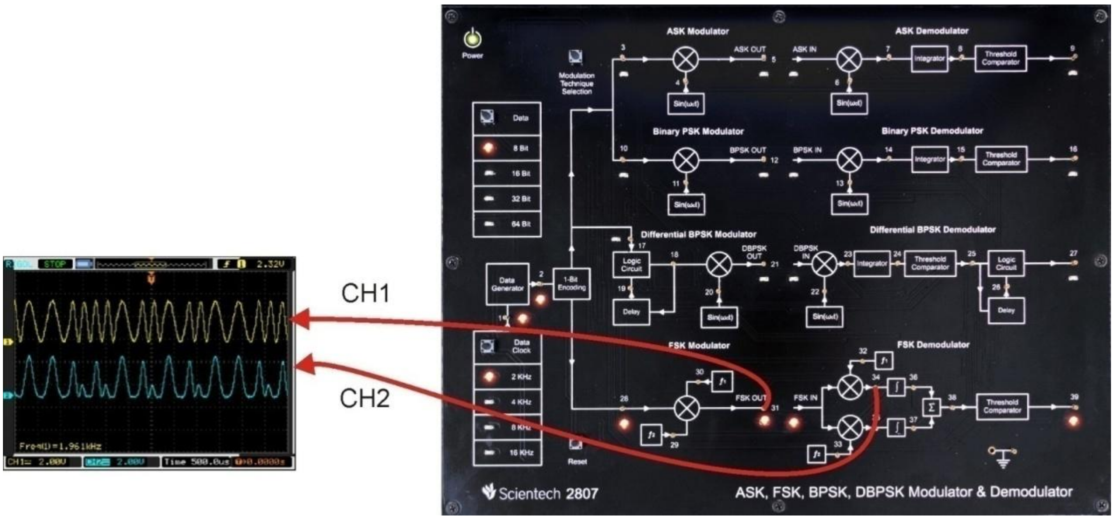
Objective:

Study and analysis of complex multiplier output

Set up:

- TechBook Board
- Power Supply
- Oscilloscope/DSO
- Test probe

Connection Diagram:



Procedure:

Step 1 : Connect and switch on the Power Supply of Scientech 2807.

Step 2 : Select FSK modulator by *Modulation technique selection* button. on selection FSK , LED on TP28 will glows.

Step 3 : Select input *Data pattern* using push button i.e. 8-Bit, 16-Bit, 32-Bit, 64-Bit. And respective LED will glow. Observe the input Data on test point (TP2).

Step 4 : Select input *data clock* using push button i.e. 2 KHz, 4 KHz, 8 KHz, 16 KHz. Observe the change in frequency on test point (TP1) .

Step 5 : Observe the change in carrier signal frequency ($f1$) on test point (TP30).

Step 6 : Observe the change in carrier signal frequency ($f2$) on test point (TP29), which twice then frequency $f1$.

Step 7 : Observe the encoded input data pattern at test point (TP28).

Step 8 : Observe the FSK modulated output at test point (TP31)

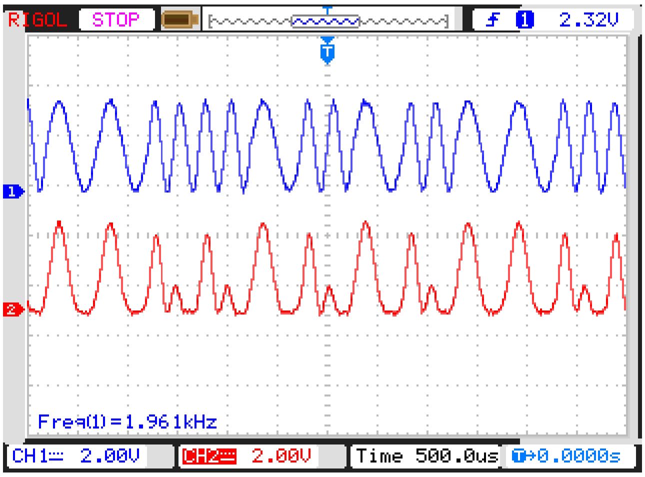
Step 9 : Observe the complex multiplier output at test point (TP34) and test point (TP35)

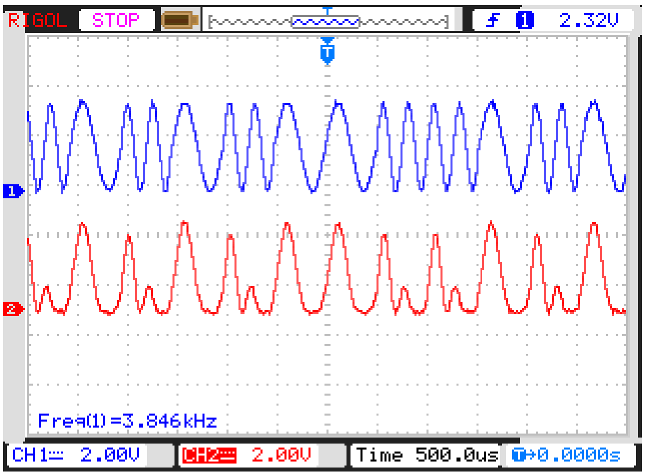
Observation:

- Observe the input data clock at TP1.
- Observe the input data at TP2.
- Observe the encoded input data at TP28.
- Observe the carrier signal at TP29 and TP30.
- Observe the FSK modulated output at TP31
- Observe the complex multiplier output at TP34 and TP35

Observe the following data Patterns on TP2

8-Bit: “10110010”
16-Bit: “0100110110110010”
32-Bit: “00000101000101111100101000111111”
64-Bit:
“1010110011100011110000111110000011110000111000110010101000111010”

Input Data Type	Data Clock Frequency	Resulting Waveforms
8-Bit	8KHz	 CH1: FSK output (TP31), CH2: multiplier out (TP34)

8-Bit	8KHz	 CH1: FSK output (TP31), CH2: multiplier out (TP35)

Experiment 21

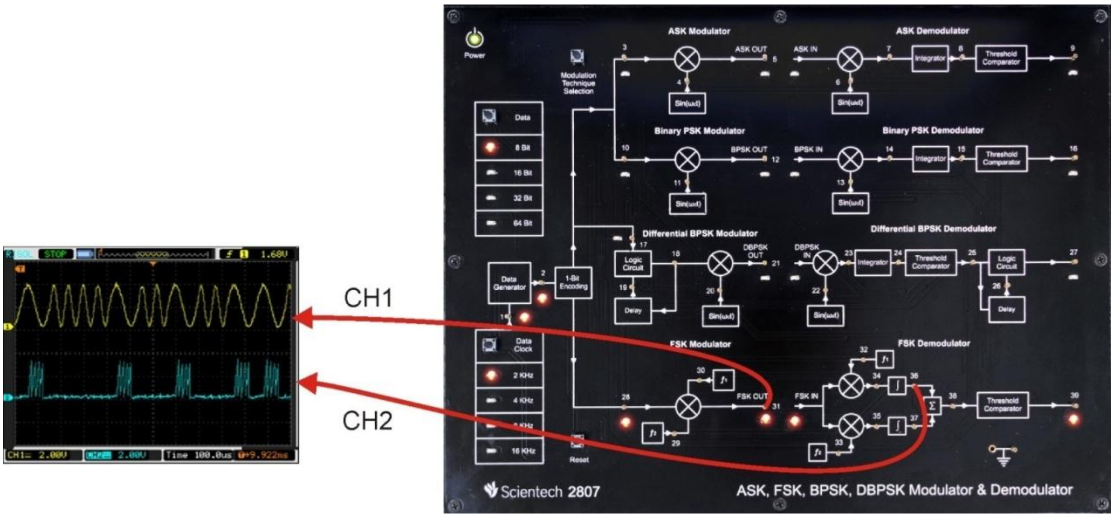
Objective:

Study and analysis of Integrator block

Set up:

- TechBook Board
- Power Supply
- Oscilloscope/DSO
- Test probe

Connection Diagram:



Procedure:

Step 1 : Connect and switch on the Power Supply of Scientech 2807.

Step 2 : Select FSK modulator by *Modulation technique selection* button. on selection FSK , LED on TP28 will glows.

Step 3 : Select input *Data pattern* using push button i.e. 8-Bit, 16-Bit, 32-Bit, 64-Bit. And respective LED will glow. Observe the input Data on test point (TP2).

Step 4 : Select input *data clock* using push button i.e. 2 KHz, 4 KHz, 8 KHz, 16 KHz. Observe the change in frequency on test point (TP1) .

Step 5 : Observe the change in carrier signal frequency ($f1$) on test point (TP30) .

Step 6 : Observe the change in carrier signal frequency ($f2$) on test point (TP29) , which twice then frequency $f1$.

Step 7 : Observe the encoded input data pattern at test point (TP28).

Step 8 : Observe the FSK modulated output at test point (TP31)

Step 9 : Observe the complex multiplier output at test point (TP34) and test point (TP35)

Step 10 : Observe the Integrator output at test point (TP36) and test point (TP37)

Observation:

- Observe the input data clock at TP1.
- Observe the input data at TP2.
- Observe the encoded input data at TP28.
- Observe the carrier signal at TP29 and TP30.
- Observe the FSK modulated output at TP31
- Observe the complex multiplier output at TP34 and TP35
- Observe the Integrator output at TP36 and TP37

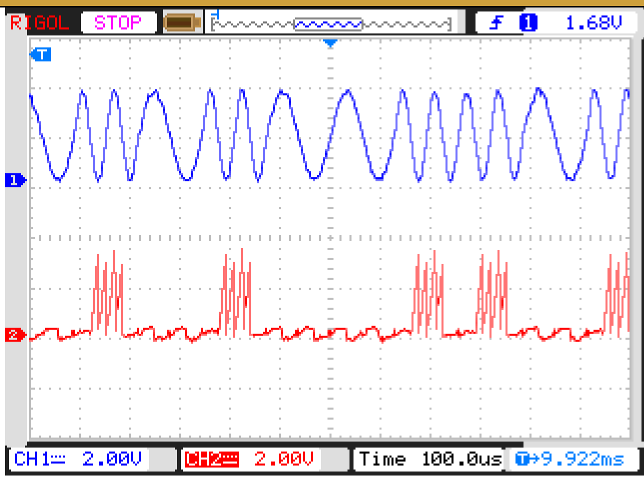
Observe the following data Patterns on TP2.

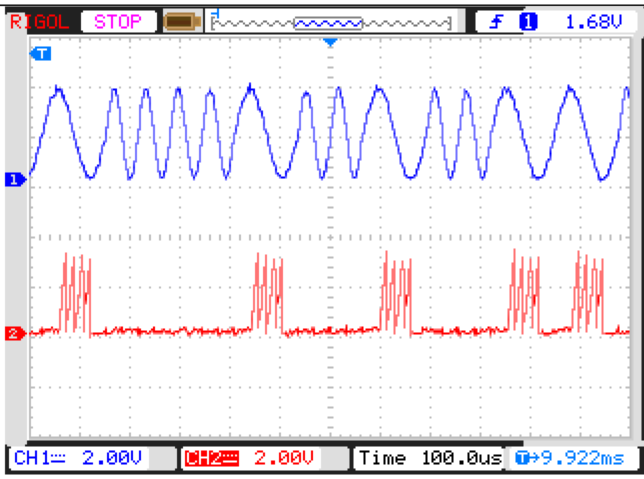
8-Bit: “10110010”

16-Bit: “0100110110110010”

32-Bit: “00000101000101111100101000111111”

64-Bit:
“1010110011100011110000111110000011110000111000110010101000111010”

Input Data Type	Data Clock Frequency	Resulting Waveforms
8-Bit	8KHz	 CH1: FSK output (TP31), CH2: Integrator out (TP36)

8-Bit	8KHz	 CH1: FSK output (TP31), CH2: Integrator out (TP37)

Experiment 22

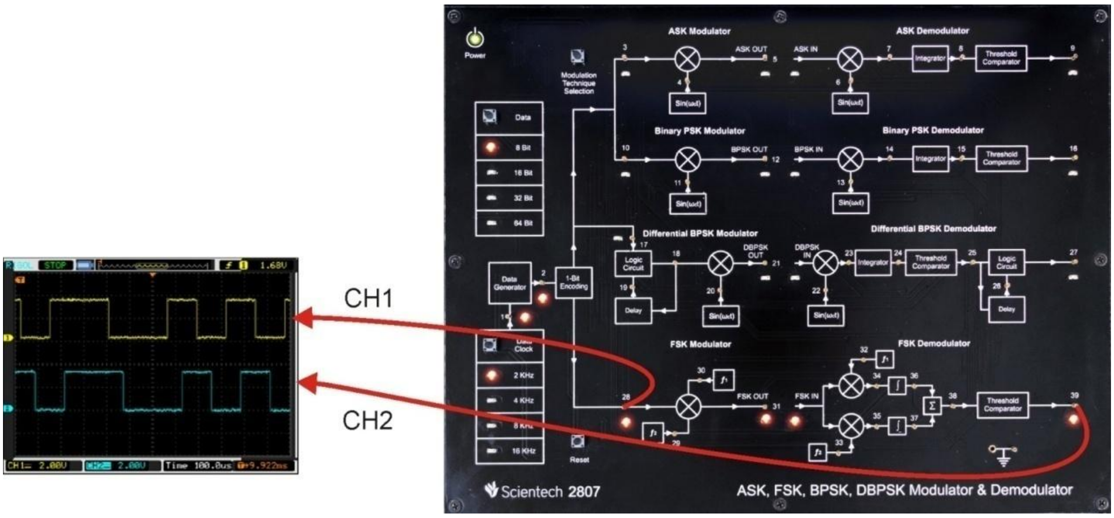
Objective:

Study and analysis of Comparator block.

Set up:

- TechBook Board
- Power Supply
- Oscilloscope/DSO
- Test probe

Connection Diagram:



Procedure:

Step 1 : Connect and switch on the Power Supply of Scientech 2807.

Step 2 : Select FSK modulator by *Modulation technique selection* button. on selection FSK , LED on TP28 will glows.

Step 3 : Select input *Data pattern* using push button i.e. 8-Bit, 16-Bit, 32-Bit, 64-Bit. And respective LED will glow. Observe the input Data on test point (TP2).

Step 4 : Select input *data clock* using push button i.e. 2 KHz, 4 KHz, 8 KHz, 16 KHz. Observe the change in frequency on test point (TP1) .

Step 5 : Observe the change in carrier signal frequency ($f1$) on test point (TP30).

Step 6 : Observe the change in carrier signal frequency ($f2$) on test point (TP29) which twice then frequency $f1$.

Step 7 : Observe the encoded input data pattern at test point (TP28).

Step 8 : Observe the FSK modulated output at test point (TP31)

Step 9 : Observe the complex multiplier output at test point (TP34) and test point (TP35)

Step 10 : Observe the Integrator output at test point (TP36) and test point (TP37)

Step 11 : Observe the sigma (Σ) output at test point (TP38)

Step12 : Observe output of Integrator block at test point (TP39)

Observation:

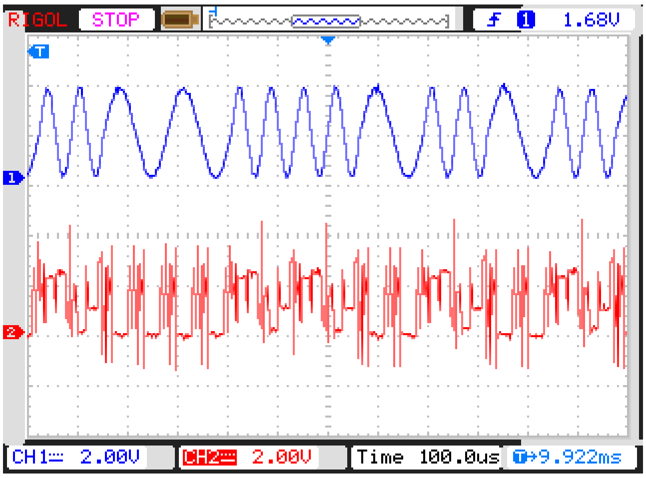
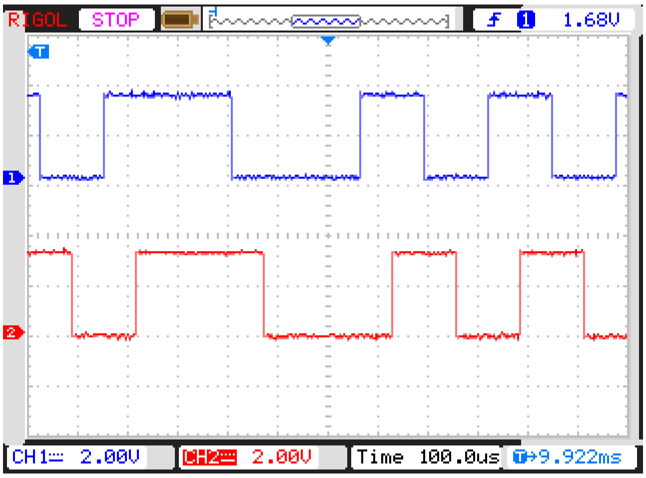
- Observe the input data clock at TP1.
- Observe the input data at TP2.
- Observe the encoded input data at TP28.
- Observe the carrier signal at TP29 and TP30.
- Observe the FSK modulated output at TP31
- Observe the complex multiplier output at TP34 and TP35
- Observe the Integrator output at TP36 and TP37
- Observe the sigma (Σ) output at TP38
- Observe comparator output at TP39
- Observe the following data Patterns on TP2

8-Bit:- "10110010 "

16-Bit:- "0100110110110010 "

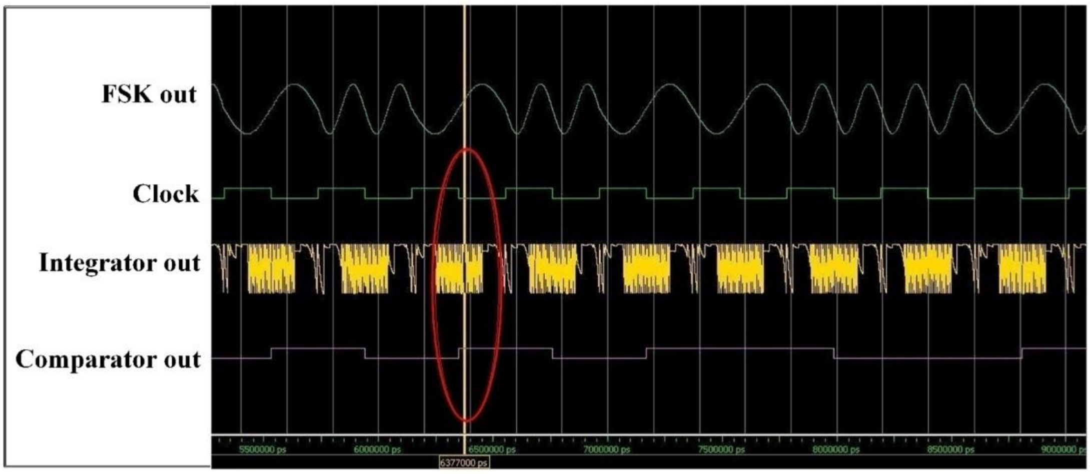
32-Bit:- "00000101000101111100101000111111 "

64-Bit:- "1010110011100011110000111110000001111000011100011001010101000111010 ".

Input Data Type	Data Clock Frequency	Resulting Waveforms
8-Bit	2KHz	 CH1: FSK output (TP31), CH2: Sigma out (TP38)
8-Bit	8KHz	 CH1: input data(TP28), CH2: Comparator out (TP39)

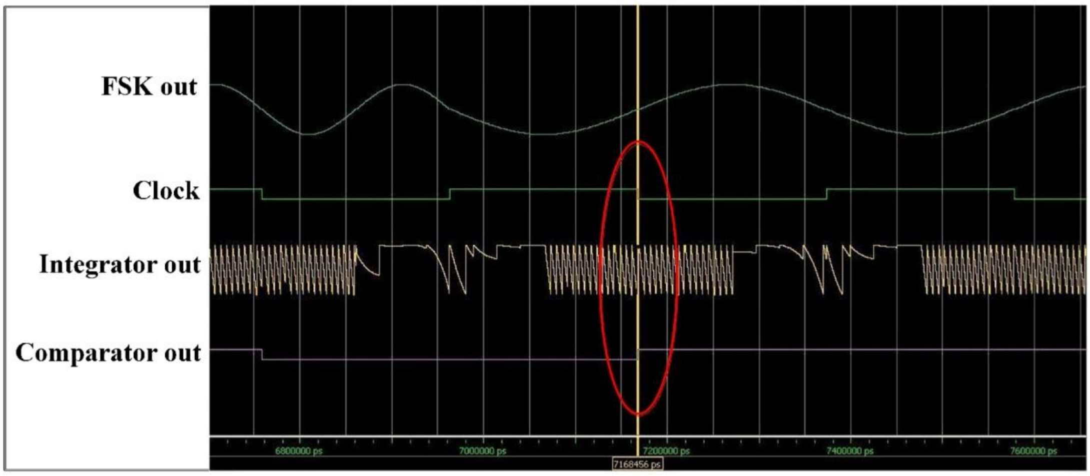
Working of Digital Comparator:- As we observed the recovered digital data at output of comparator (TP9) .

Now we can understand the working of comparator by following results:-



According to above results comparator compares integrator data at falling edge( ) of clock signal . it checks that whether value of comparator exactly match with value of integrator data and then it gives logic ‘ 1 ’ or logic ‘ 0 ’ as a output of comparator .

Comparison indicate by red circle with yellow vertical line .



Comparison indicate by red circle with yellow vertical line . As indicated in Red circle when event of falling edge of clock occurs value of integrator signal at falling edge of clock compared with threshold value of comparator . if it matched comparator gives logic ‘ 0 ’ else logic ‘ 1 ’ as output , which is our recovered digital data .

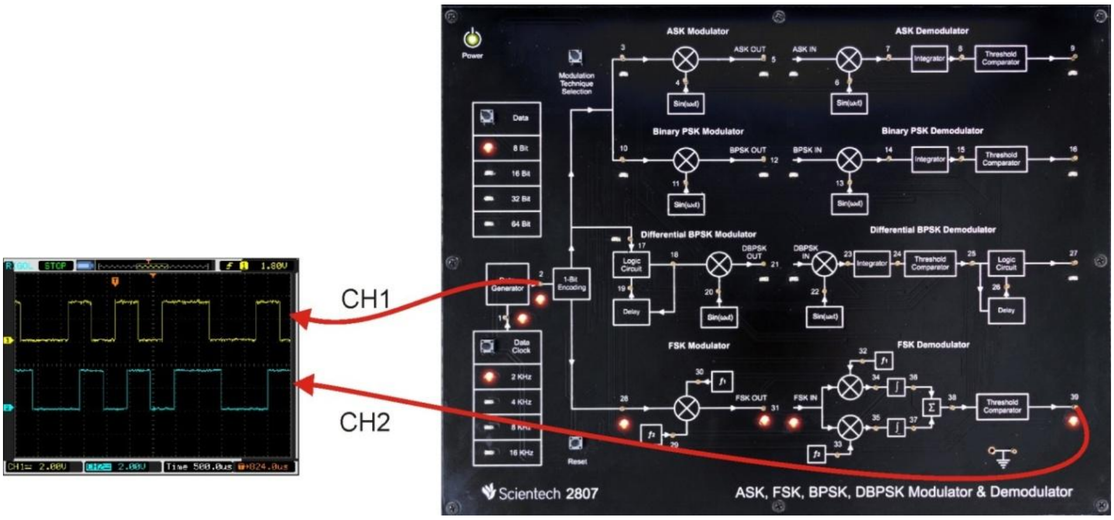
Experiment 23

Objective: Study and analysis of FSK Demodulator

Setup:

- TechBook Board
- Power Supply
- Oscilloscope/DSO
- Test probe

Connection Diagram:



Procedure:

Step 1 : Connect and switch on the Power Supply of Scientech 2807.

Step 2 : Select FSK modulator by *Modulation technique selection* button. on selection FSK , LED on TP28 will glows.

Step 3 : Select input *Data pattern* using push button i.e. 8-Bit, 16-Bit, 32-Bit, 64-Bit. And respective LED will glow. Observe the input Data on test point (TP2).

Step 4 : Select input *data clock* using push button i.e. 2 KHz, 4 KHz, 8 KHz, 16 KHz. Observe the change in frequency on test point (TP1) .

Step 5 : Observe the change in carrier signal frequency ($f1$) on test point (TP30) .

Step 6 : Observe the change in carrier signal frequency ($f2$) on test point (TP29) , which twice then frequency $f1$.

Step 7 : Observe the encoded input data pattern at test point (TP28).

Step 8 : Observe the FSK modulated output at test point (TP31)

Step 9 : Observe the complex multiplier output at test point (TP34) and test point (TP35)

Step 10 : Observe the Integrator output at test point (TP36) and test point (TP37)

Step 11 : Observe the sigma (Σ) output at test point (TP38)

Step12 : Observe FSK Demodulated output at test point (TP39)

Observation:

- Observe the input data clock at TP1.
- Observe the input data at TP2.
- Observe the encoded input data at TP28.
- Observe the carrier signal at TP29 and TP30.
- Observe the FSK modulated output at TP31
- Observe the complex multiplier output at TP34 and TP35
- Observe the Integrator output at TP36 and TP37
- Observe the sigma (Σ) output at TP38

Observe Demodulated output at TP39

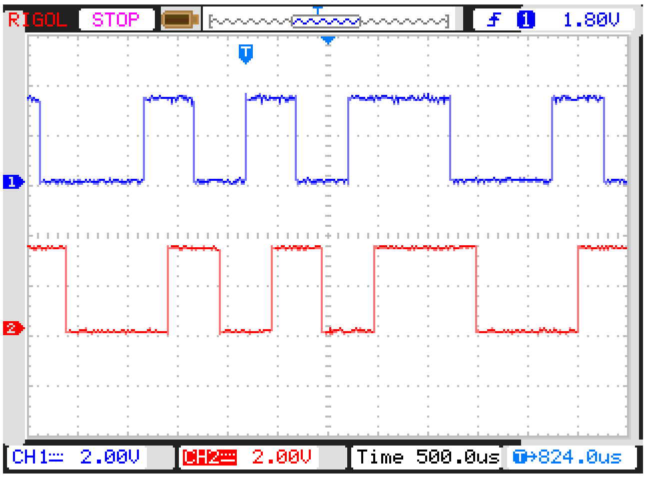
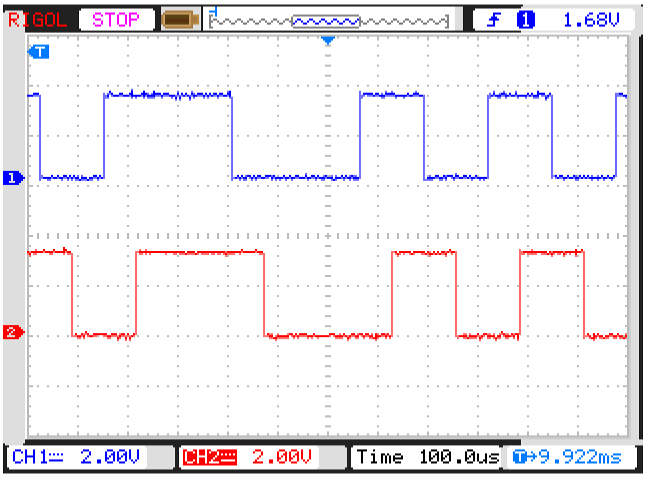
Observe the following data Patterns on TP2

8-Bit: "10110010"

16-Bit: "0100110110110010"

32-Bit: "00000101000101111100101000111111"

64-Bit: "1010110011100011110000111110000011110000111000110010101000111010"

Input Data Type	Data Clock Frequency	Resulting Waveforms
8-Bit	2KHz	 CH1: input data (TP28), CH2: demodulator out (TP39)
8-Bit	8KHz	 CH1: input data (TP28), CH2: demodulator out (TP39)

Case study

Case 1: ASK Modulator

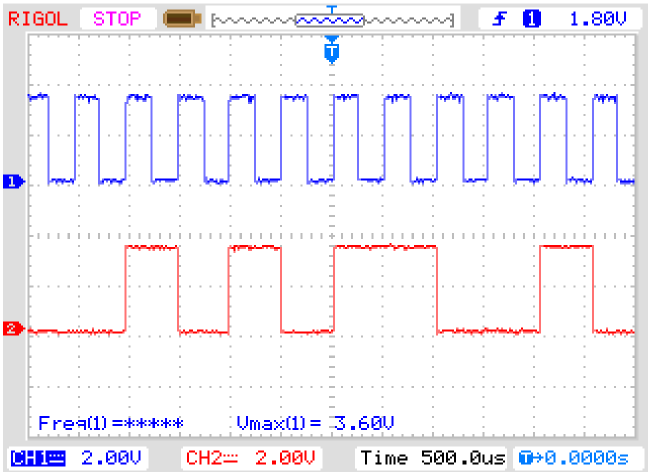
Specifications:

Input Data Type: 8-Bit

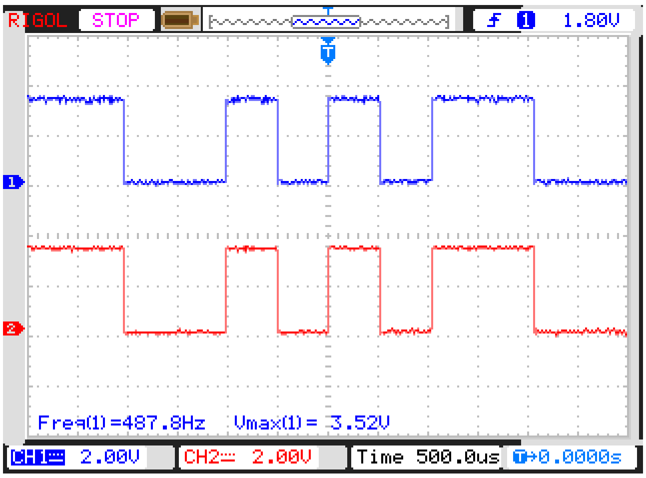
Input Signal Frequency: 2 KHz

Observations according to TPs:

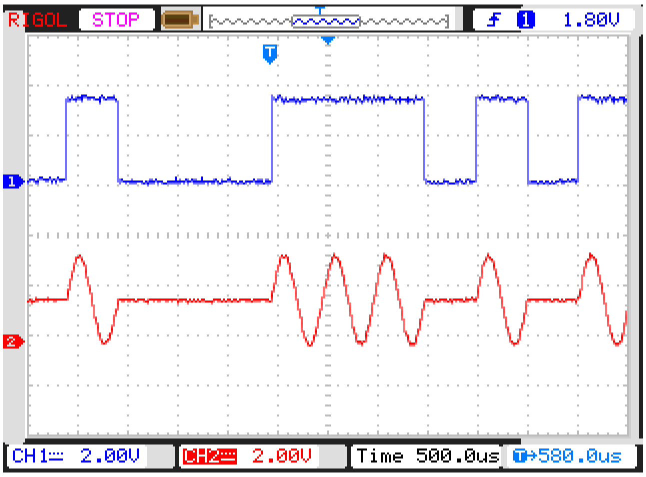
Input at TP1 & TP2



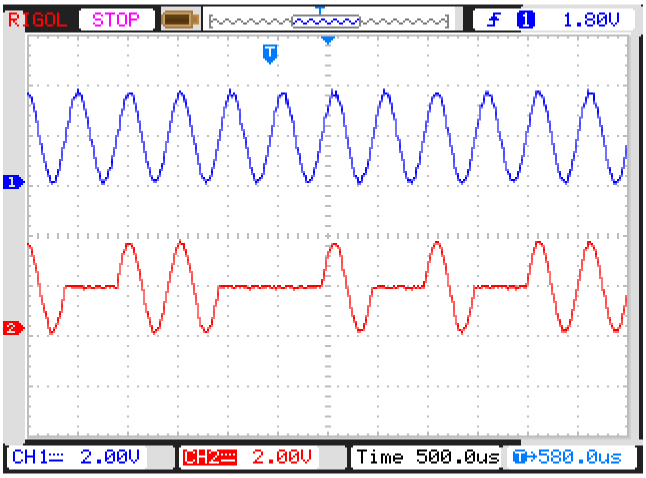
CH1: Input Data (TP2) and CH2: Data Clock (TP1)



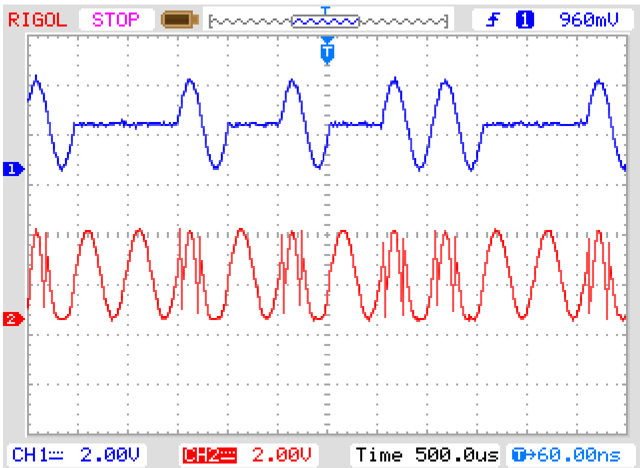
CH1: Input encoded Data (TP3) and CH2: carrier signal (TP4).



CH1: Input Data (TP3) and CH2: ASK modulated Output (TP5)



CH1: carrier signal (TP4) and CH2: ASK modulated Output (TP5)



CH1: ASK output (TP5) and CH2: multiplier Output (TP7)

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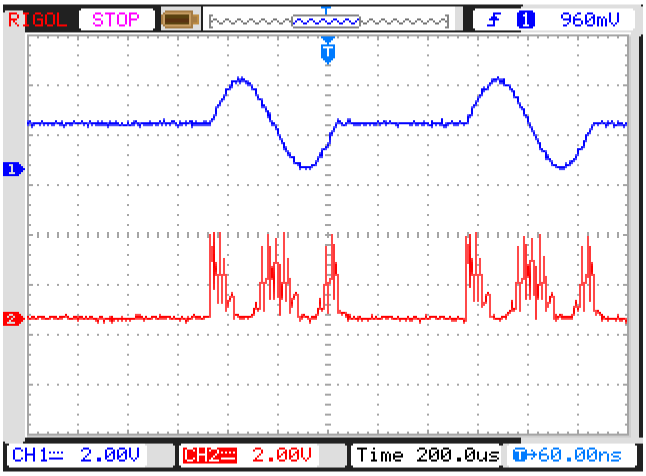
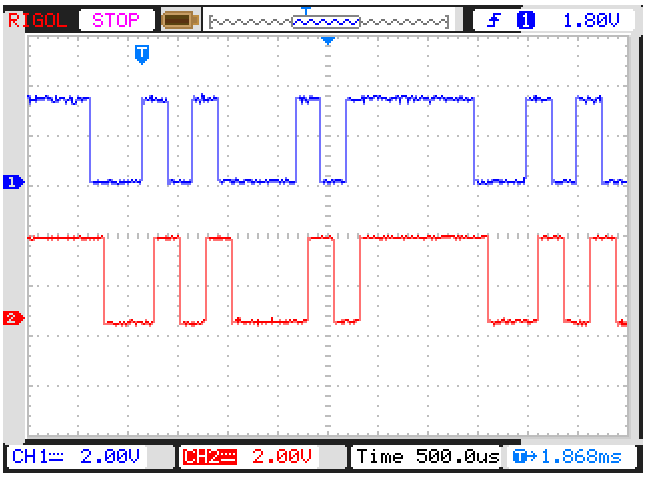


CH1: ASK output (TP5) and CH2: integrator Output (TP8)



CH1: Input Data (TP3) and CH2: Comparator Output (TP9)

Case 2: Binary PSK Modulator

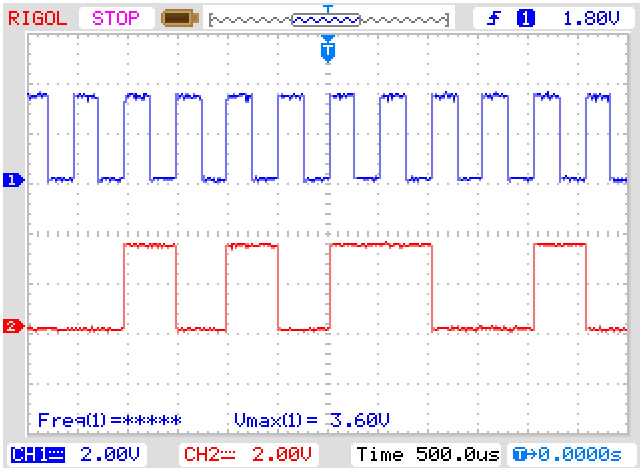
Specifications:

Input Data Type: 8-Bit

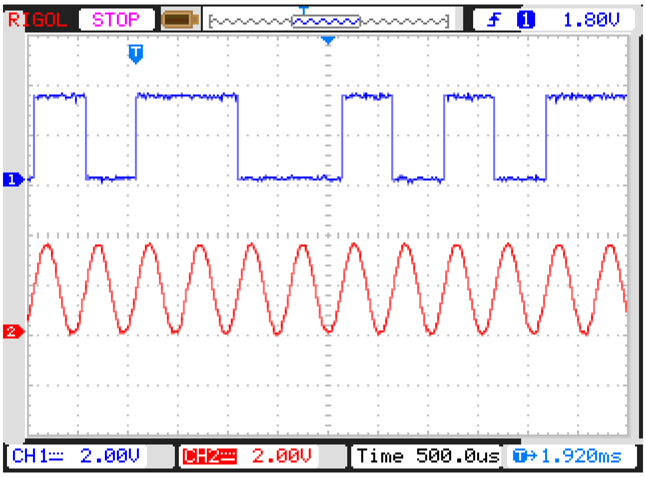
Input Signal Frequency: 2 KHz

Observations according to TPs:

Input at TP1 & TP2



CH1: Input Data (TP2) and CH2: Data Clock (TP1)



CH1: Input encoded Data (TP10) and CH2: carrier signal (TP11).

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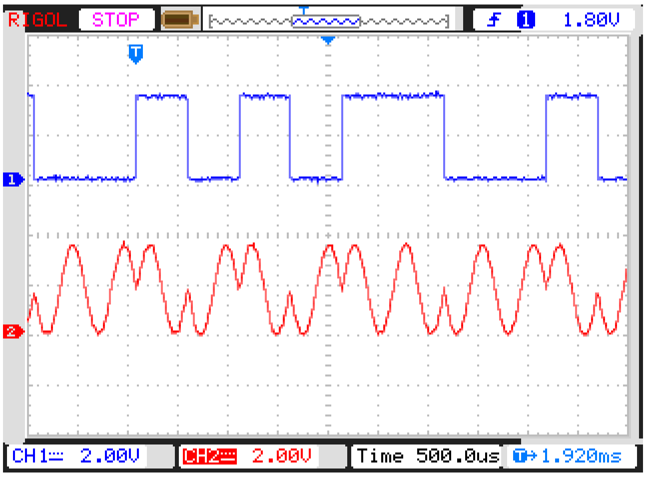
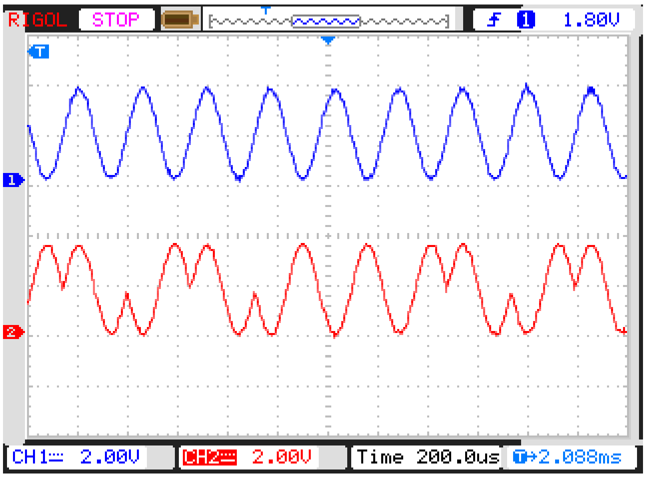
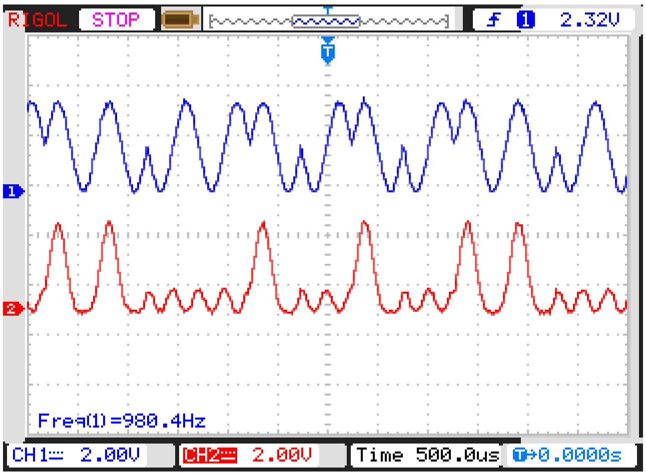


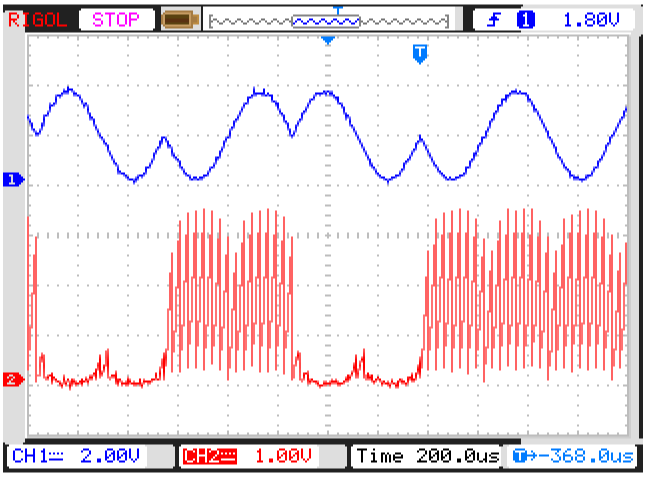
CH1: Input Data (TP10) and CH2: BPSK modulated Output (TP12)



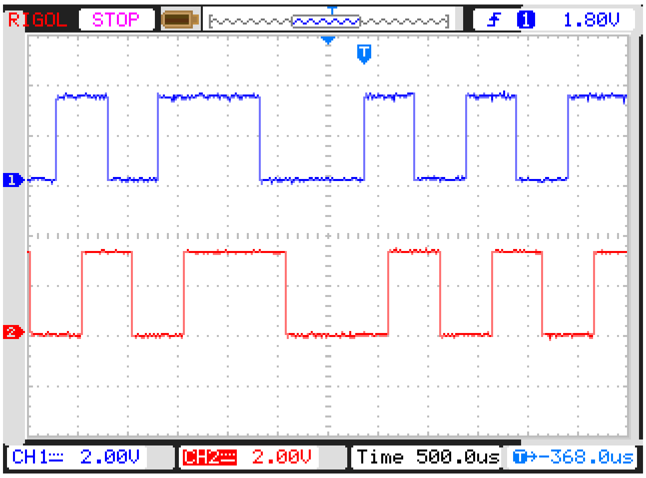
CH1: carrier signal (TP11) and CH2: BPSK modulated Output (TP12)



CH1: BPSK output (TP12) and CH2: multiplier Output (TP14)



CH1: BPSK output (TP12) and CH2: integrator Output (TP15)



CH1: Input Data(TP10) and CH2: Comparator Output (TP16)

Case 3: Differential BPSK Modulator

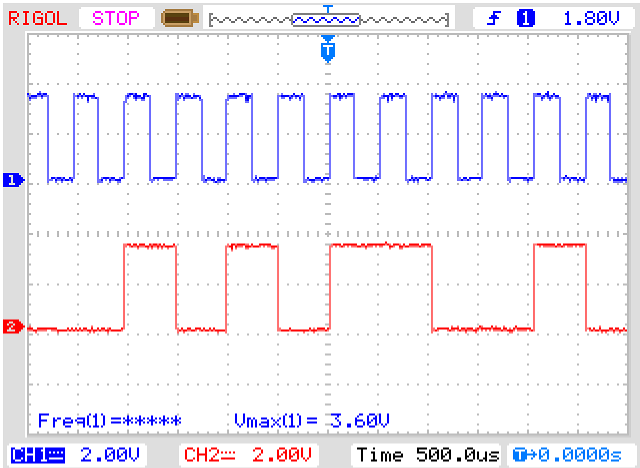
Specifications:

Input Data Type: 8-Bit

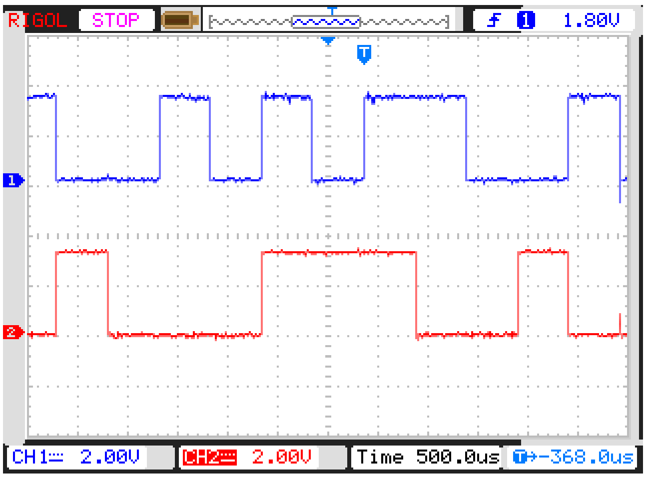
Input Signal Frequency: 2 KHz

Observations according to TPs:

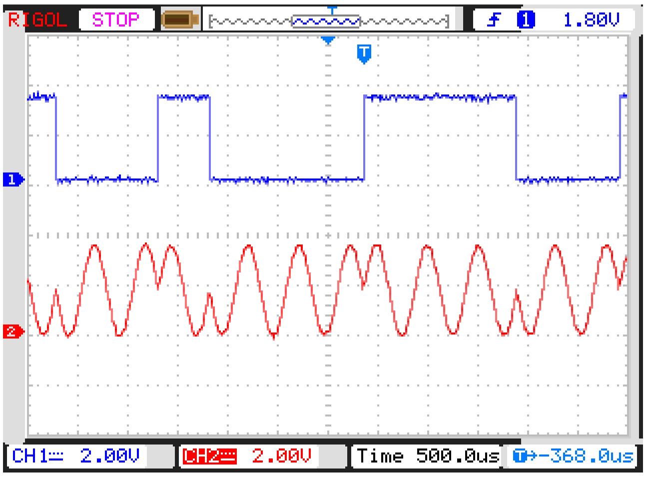
Input at TP1 & TP2



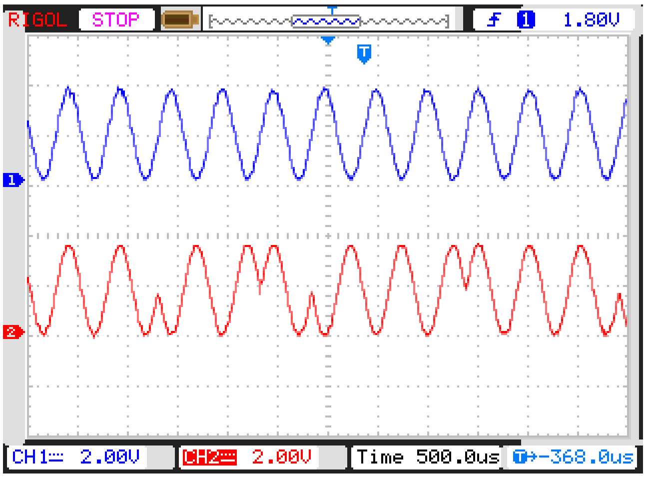
CH1: Input Data (TP2) and CH2: Data Clock (TP1)



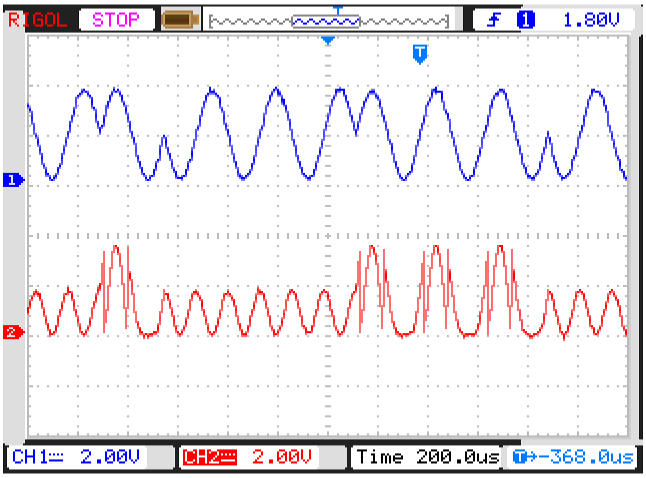
CH1: Input encoded Data (TP17) and CH2: differential output (TP18).



CH1: Input Data (TP17) and CH2: DBPSK modulated Output (TP21)



CH1: carrier signal (TP20) and CH2: DBPSK Output (TP21)



CH1: DBPSK Output (TP21)and CH2: multiplier Output (TP23)

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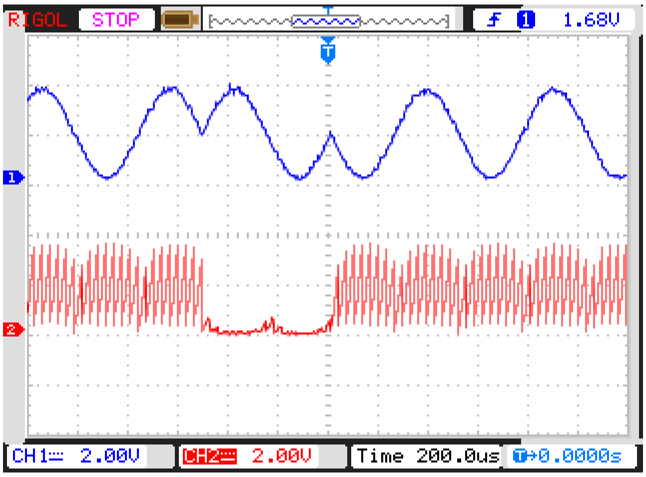
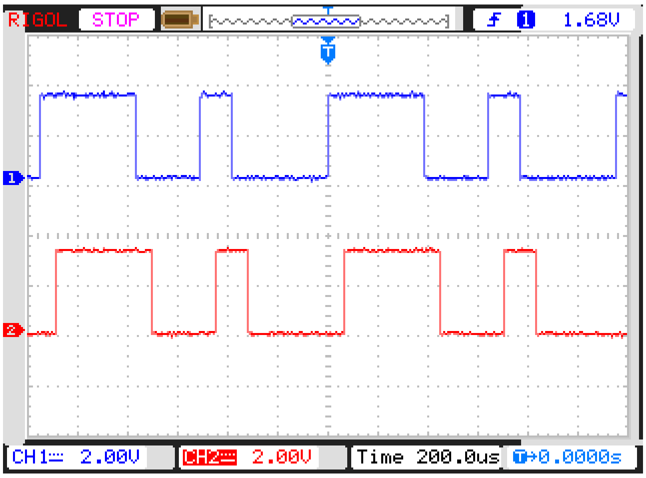
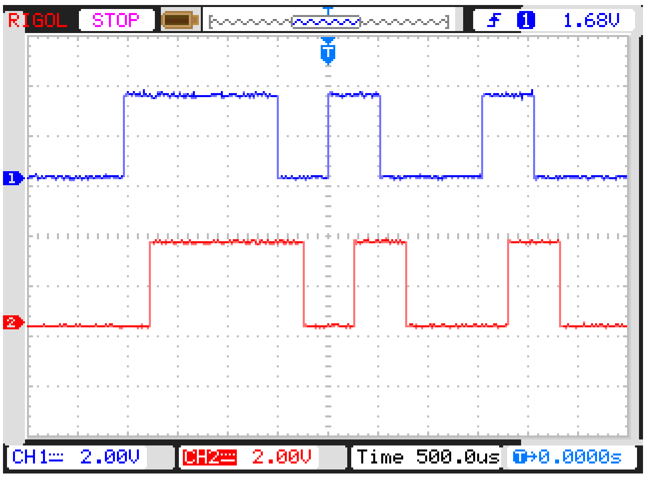


CH1: DBPSK output (TP21) and CH2: integrator Output (TP24)



CH1: Differential output (TP18) and CH2: comparator Output (TP25)



CH1: Input Data(TP10) and CH2: Differential decoder Output (TP27)

Case 2: Frequency shift keying Modulator

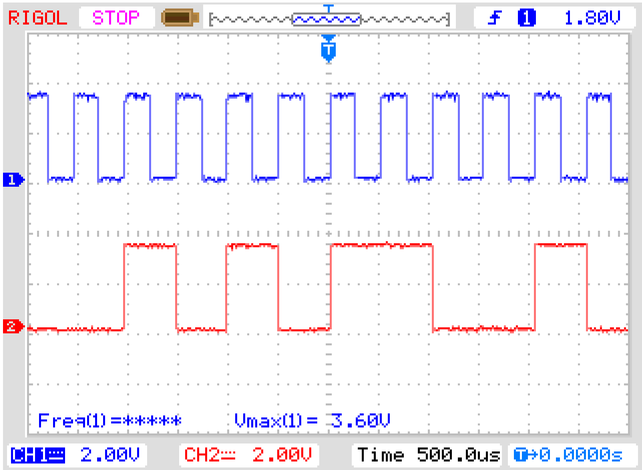
Specifications:

Input Data Type: 8-Bit

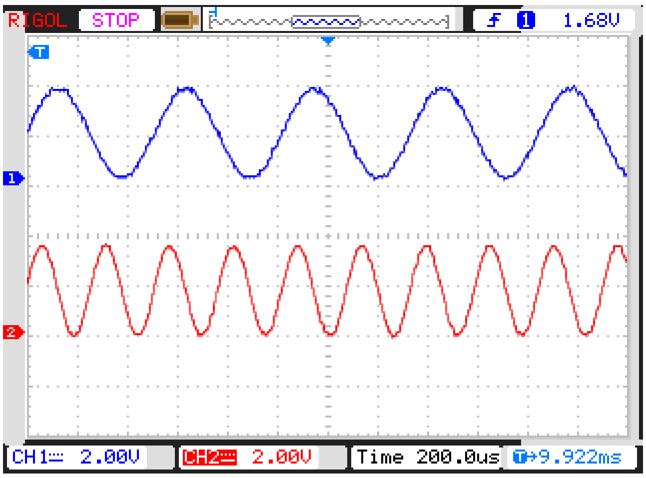
Input Signal Frequency: 2 KHz

Observations according to TPs:

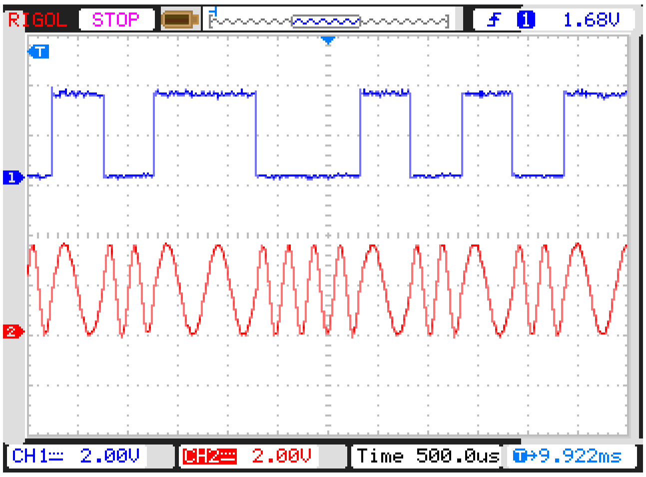
Input at TP1 & TP2



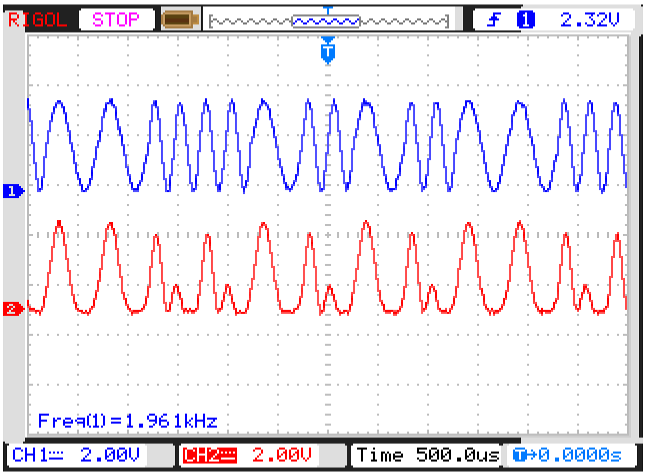
CH1: Input Data (TP2) and CH2: Data Clock (TP1)



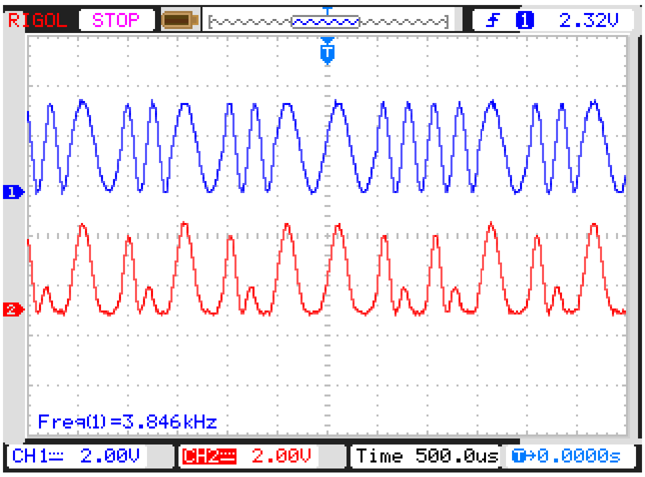
CH1: carrier signal f1 (TP30) and CH2: carrier signal f2 (TP29).



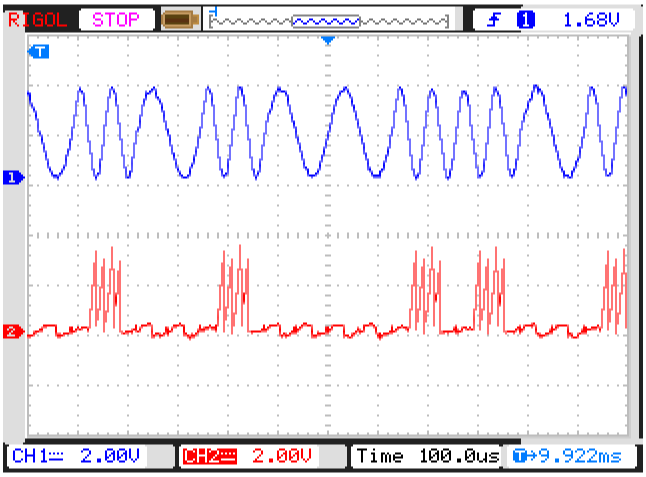
CH1: Input Data (TP28) and CH2: FSK modulated Output (TP31)



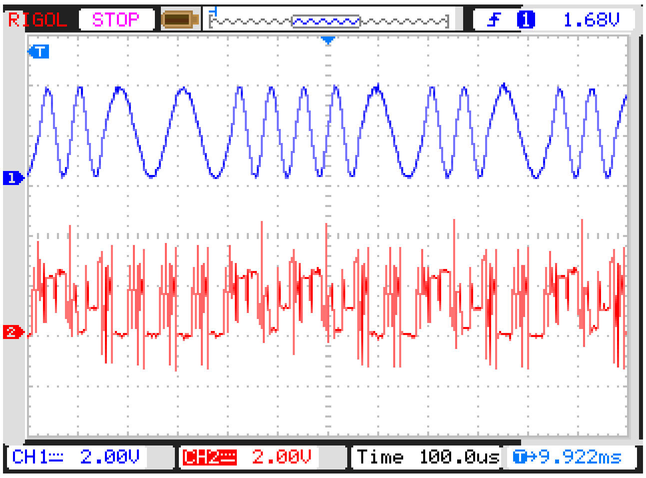
CH1: FSK Output (TP31)and CH2: multiplier Output (TP34)



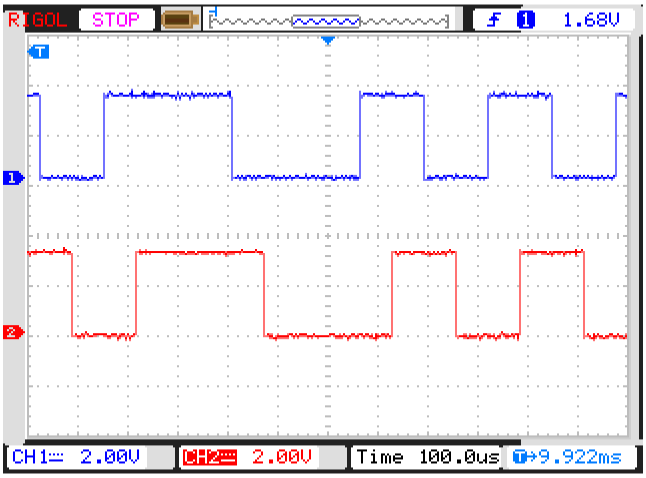
CH1: FSK Output (TP31)and CH2: multiplier Output (TP35)



CH1: FSK Output (TP31)and CH2: integrator Output (TP36)



CH1: FSK output (TP31) and CH2: sigma Output (TP38)



CH1: Input Data(TP28) and CH2: Comparator Output (TP39)

Glossary

Binary - A digital system with two states, 1 and 0. Contrast with octal (8 states), decimal (10 states), and hexadecimal (16 states).

Demodulation - The opposite of modulation, the process of retrieving data from a carrier signal.

Demodulator - The internal portion of a modem designed to convert the received analog line signals back to digital form.

Digit, Digital - A discretely variable signal as compared with analog, which is continuously variable. Data signals are coded in discrete and separate pulses.

Digital Data - Any information represented by digital code .

Encoding, Decoding - Formatting data into a pattern suitable for data communication.

FSK (Frequency Shift Keying) - A method of frequency modulation (FM) where one frequency would represent a mark (one) and another frequency would represent a space (zero).

Hertz (Hz) - The same as cycles per second, used as a measurement of bandwidth or frequency.

Keying - A method of encoding data by modulating the carrier either by phase or frequency.

KHz (kilo Hertz) - Abbreviation for 1000 Hertz (cycles per second). See also Hertz.

Modulator, Modulation - The function or process by which a carrier is varied to represent an information-carrying signal. This is the technique used in modems to allow computer signals compatibility with communications facilities.

Modulo - A term used to describe the maximum number of counter states, usually in describing packet-switched parameters such as packet number.

NRZ (Non-Return to Zero) - A transmission encoding scheme where the "zeros" and "ones" are represented by alternating and opposite high and low voltages. Two basic forms of NRZ coding exist: 1) In a Unipolar NRZ code the voltages would vary between 0v and +5V. This code works well for the shielded and short travel paths within a machine, but is not suited for long distances due to the residual dc shifts of the "zero" level.

Recovery - The procedure or process required to be performed to restore a computer system to a predetermined level of operation or availability after a failure.

Transmission - The sending of information over a data communications medium.

Transmit - To send out a signal over data communications media such as optical fiber, copper wire, or via radio waves through the atmosphere, from one station to another.

Word - The sequence of either bits or characters capable of being stored and processed as a unit.

Frequently Asked Questions

Q1. What is Digital Modulation?

Ans: In Digital Modulation analog carrier waveform is modulated by digital bit stream in this scheme analog signal is first converted into digital data by Analog to Digital conversion technique this digital data then transmitted by transmitter using modulation .

Q2. List some digital modulation techniques .

Ans: ASK (Amplitude Shift Keying), FSK (frequency Shift Keying), BPSK (Binary Phase Shift Keying), QPSK (Quadrature Phase Shift Keying), MSK (Minimum Shift Keying) ,M-ary ASK etc.

Q3. What is Carrier Signal?

Ans: A continuous waveform whose properties are modulated with an input *signal* for the purpose of conveying information upto far distances .

Q4. What is Encoding and Decoding?

Ans: Encoding is a process of converting series of symbols, characters etc. into digital stream of 1's and 0's (Binary form).

Decoding is reverse process of encoding in which we decode our original transmitted data from digital stream of 1's and 0's.

Q5. What is Differential Coding?

Ans: Most signal processing circuits cannot tell if the whole digital stream is inverted. This is also called phase ambiguity. Differential Encoding is used to protect against this possibility. It is one of the simplest form of error protection coding done on a baseband sequence prior to modulation Then the phase of the carrier is varied to represent binary 1 or 0 of encoded data. Both peak amplitude remains constant as the phase changes.

Q6. What is Roll of Complex Multiplier?

Ans: At Modulator side multiplier act as a switch (like analog switch) this act as ON condition when transmitting binary 1's and act as OFF condition when transmitting binary 0's .

At Demodulator end multiply operation is applied to the modulated signal to create harmonics of the carrier frequency with the modulation removed.

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

- Patch Cord 16"(Black).. 2 Nos.
- Mains Cord...1 No.