EXPERIMENT No.- 03

**TITLE:** Generation and detection of Binary Phase shift keying BPSK.

**AIM:** To Generate and detect Binary Phase shift keying BPSK signal.

**EQUIPMENTS:** Scientech 2156 and Scientech 2157, 2 mm Banana cable, Oscilloscope, Power supply.

**THEORY:**

**Phase Shift Keying (BPSK):**

Phase shift keying involves the phase change of the carrier wave between 0° and 180° in accordance with the data levels to be transmitted. Phase shift keying is also known as phase reversal keying (PRK). The PSK waveform for a given data is as shown in figure 1.

For Binary PSK

$S_0(t) = A \cos ( wt )$ represents binary '0'

$S_1(t) = A \cos ( wt+ \pi)$ represents binary '1'

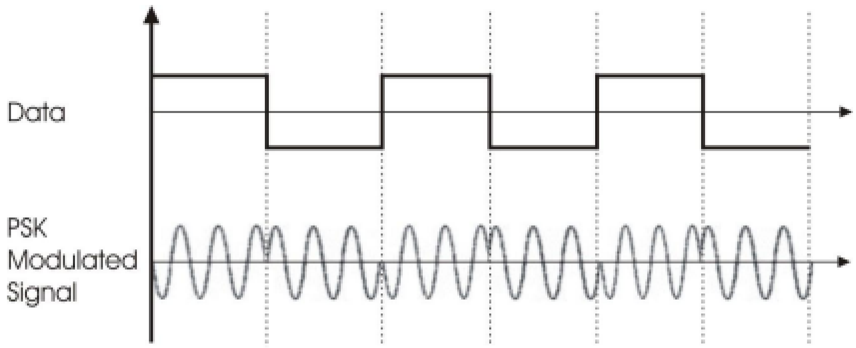



Fig.1 Binary Phase Shift Keying Waveform

**Phase Shift Keying Modulator:**

Functionally, the PSK modulator is very similar to the ASK modulator. Both uses balanced modulator to multiply the carrier with the modulating signal. But in contrast to ASK technique, the digital signal applied to the modulation input for PSK generation is bipolar i.e. have equal positive and negative voltage levels. When the modulating input is positive the output of modulator is a sine wave in phase with the carrier input. Whereas for the negative voltage levels, the output of modulator is a sine wave which is shifted out of phase by 180° from the carrier input. This happens because the carrier input is now multiplied by the negative constant level. The functional block representation of the PSK modulator is shown in the figure 2.

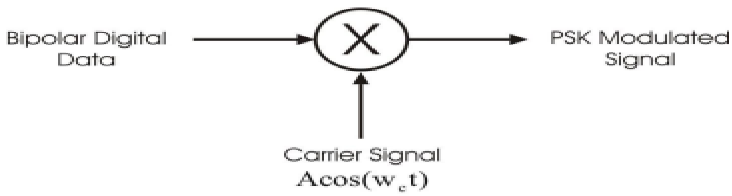


Fig.2 Phase Shift Keying Modulator

**Phase Shift Keying Demodulator:**

For PSK signal demodulation the square loop detector circuit is used. The PSK demodulator is as shown in figure 3.

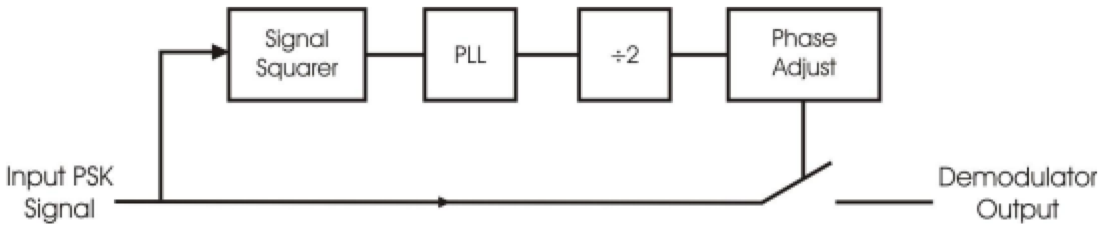



Fig. 3 Phase Shift Keying Demodulator

The incoming PSK signal with 0° & 180° phase changes is first fed to the signal squarer, which multiplies the input signal by itself. The output of this block is a signal of having twice the frequency to that of the input carrier frequency. As the frequency of the output doubled, the 0° & 180° phase changes are reflect as 0° & 360° phase changes. Since phase change of 360° is same as 0° phase change, it can be said that the signal squarer simply removes the phase transitions from the original PSK waveform.

The PLL block locks to the frequency of the signal square output & produces a clean square wave output of same frequency. To derive the square wave of same frequency as the incoming PSK signal, the PLL output is divided by two. The following phase adjust circuit allows the phase of the digital signal to be adjusted with respect to the input PSK signal. Also its output controls the closing of an analog switch. When the output is high the switch closes & the original PSK signal is switched through the detector. When the output of phases adjust block is low, the switch opens & the output of detector output falls to 0 Volts. The demodulator output contains positive half cycles when the PSK input has one phase & only negative half cycles when the PSK input has another phase. The phase adjust potentiometer is adjusted properly. The average level information of the demodulator output which contains the digital data information is extracted by the following low pass filter. The low pass filter output is too rounded to be used for digital processing. Therefore it is 'Squared Up' by a voltage comparator.

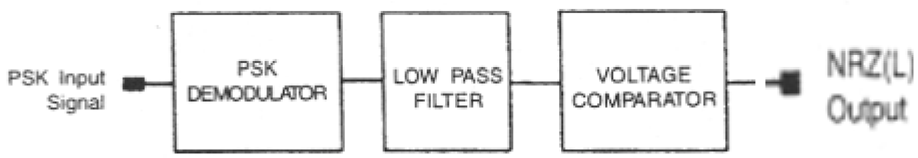



Fig.4 Phase Shift Keying Receiver System

**Advantages and limitations of Phase Shift Keying Modulation:**

It carries data over RF signal more efficiently compare to other modulation types. Hence it is more power efficient modulation technique compare to ASK and FSK.

It is less susceptible to errors compare to ASK modulation and occupies same bandwidth as ASK.

It has lower bandwidth efficiency.

The binary data is decoded by estimation of phase states of the signal. These detection and recovery algorithms are very complex. Coherent detection, which is often used in PSK demodulation, requires accurate phase synchronization between the transmitter and receiver. Achieving and maintaining this synchronization can be challenging in certain scenarios.

The term PSK or Phase shift keying is broadly used in a radio communication system. This kind of technique is mostly compatible with data communications. It allows information in a more efficient way to be carried over a radio communications signal compare with other modulation forms. Data communication is rising with different forms of communication formats like analog to digital to carry data along with different modulation forms.

**PROCEDURE:**

1.Connect the power supplies of Scientech 2156 and Scientech 2157 but do not turn on the power supplies until connections are made for this experiment.

2. Make the connections as shown in the figure.

3. Switch 'ON' the power.

4. On Scientech 2156, connect oscilloscope CH1 to ‘Clock In’ and CH2 to ‘Data In’ and observe the waveforms.

5. On Scientech 2156, connect oscilloscope CH1 to ‘NRZ (L)’ and CH2 to ‘Output’ of Modulator Circuit (l) on Scientech 2156 and observe the waveforms.

6. Adjust the ‘Gain’ potentiometer of the Modulator Circuit (l) on Scientech 2156 to adjust the amplitude of PSK waveform at output of Modulator Circuit (l) on Scientech 2156.

7. Now on Scientech 2157 select Carrier frequency selection switch to 1.6MHz and connect oscilloscope CH1 to ‘Input’ of PSK demodulator and connect CH2 one by one to output of double squaring circuit, output of PLL, output of Divide by four (÷ 2) observe the wave forms.

8.On Scientech 2157 connect oscilloscope CH1 to output of Phase adjust and CH2 to ‘output’ of PSK demodulator and observe the waveforms. Set all toggle switch to 0 and compare the waveform now vary the phase adjust potentiometer and observe its effects on the demodulated signal waveform.

9. Now connect oscilloscope CH1 to ‘PSK’ output of PSK demodulator on Scientech 2157 and connect CH2 ‘Output’ of Low Pass Filter on Scientech 2157 and observe the waveforms.

10. Connect oscilloscope CH1 to ‘Output’ of Low Pass Filter on Scientech 2157 then connect CH2 to ‘Output’ of Comparator on Scientech 2157 and observe the waveforms, now vary the reference voltage potentiometer of first comparator to generate desired data pattern.

11. On Scientech 2156, connect oscilloscope CH1 to ‘NRZ (L)’ and CH2 to ‘Output’ of comparator on Scientech 2157 and observe the waveforms.

12. Connect oscilloscope CH1 to ‘Data In’ then connect CH2 output to Bit decoder and observe the waveforms. If both data does not matches then try to match it by varying the phase adjust potentiometer on QPSK Demodulator.

13. Now try to match the LED sequence by once pressing the reset switch on Scientech 2156.

**OBSERVATIONS:**

1.The output at ‘Data In’ is repeating sequence of bits generated by Data Source.

2. The ‘Output’ of Modulator Circuit (l) is Phase Shift Keying modulated signal.

3. The output of Double squaring circuit is sinusoidal signal (carrier signal) but frequency is four times higher than that of carrier used for modulation.

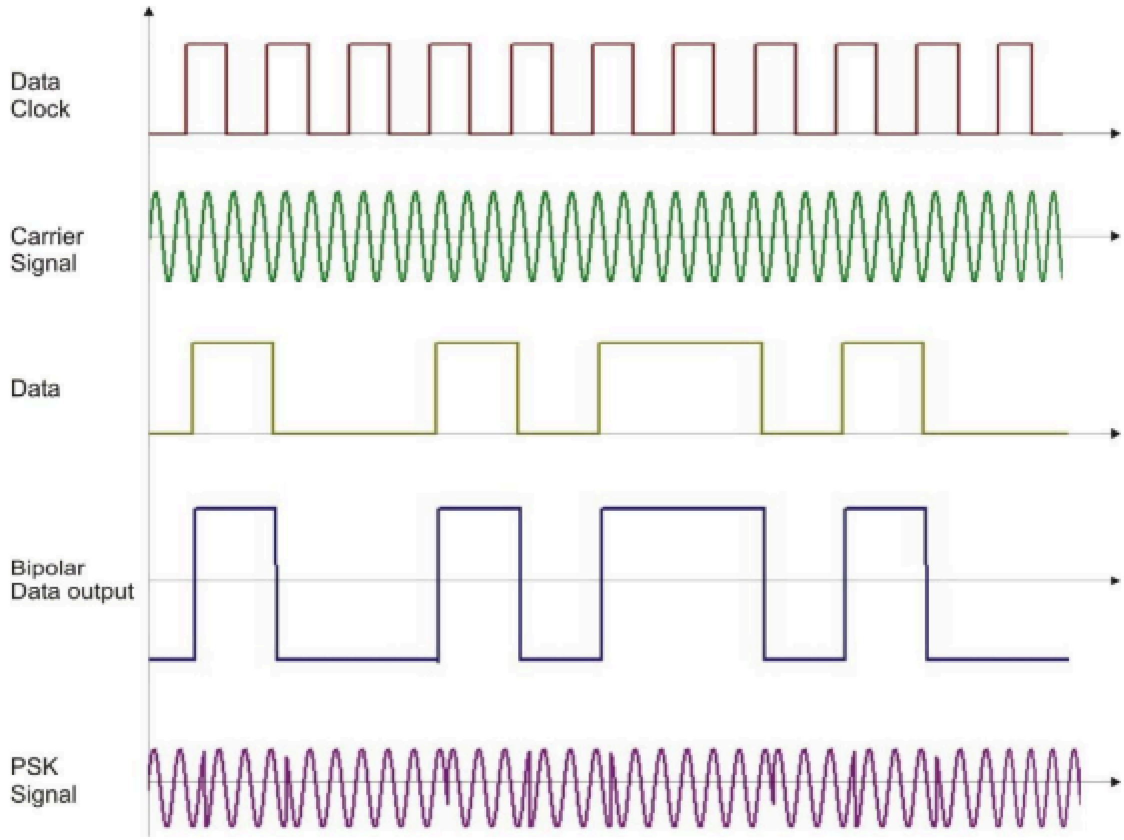
4. The output of Phase Lock Loop (PLL) is clock signal of same frequency as that of the output of double squaring circuit and output of Divide by two (÷ 2) is clock signal of frequency two times less than the output of PLL signal.

5. The output of PSK demodulator is a signal having group of positive half cycles and group of negative half cycles of the carrier signal.

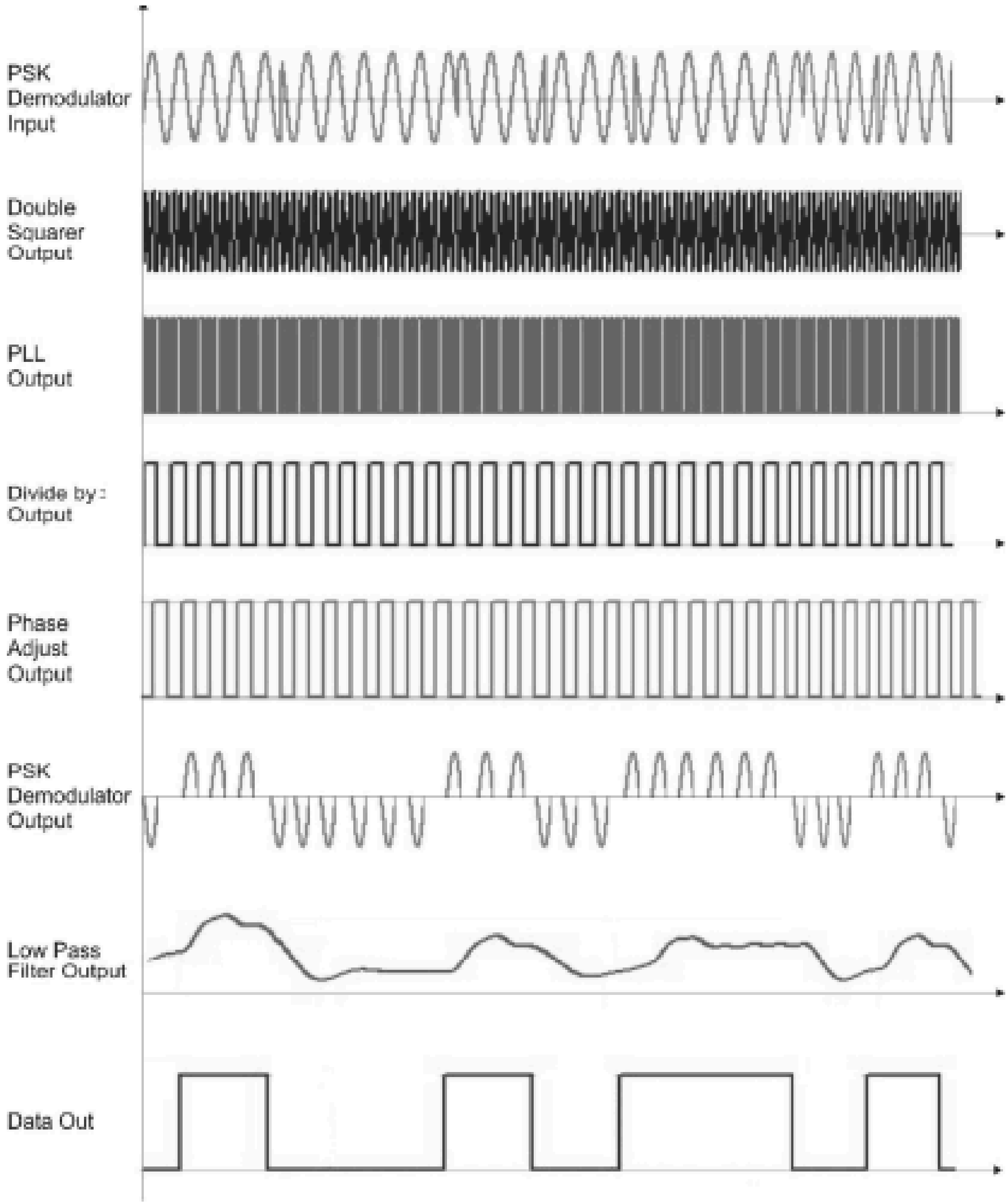
6. A low pass filter removes high frequency component from demodulated PSK signal and it makes the signal smooth.

7. The variation in reference voltage potentiometer affect the Data, to recover Data correctly potentiometer adjustment is necessary.

8. The Phase Adjust potentiometer on Scientech 2157 matches the phase of regenerated clock and carrier with input clock and carrier signal.




**Waveforms of PSK Modulation**




**Waveforms of PSK Demodulation**

**CONCLUSION:**

Now we can observe that the final data stream can be either the original data stream or its inverse, this is because the sine wave is symmetrical, the receiver has no way of detecting whether the incoming phase of the signal is 0° or 180°This phase ambiguity create two different possibilities for the receiver output i.e. the final data stream can be either the original data stream or its inverse.