Experiment 7

Objective:

1. Study of Pulse Amplitude Modulation using Natural & Flat top Sampling
2. Study of PAM using Sample & Hold sampling
3. Study of Pulse Amplitude Modulation & Demodulation with Sample, Sample & Hold & Flat Top.

Equipment Required:

1. ST2110 with power supply cord
2. CRO with connecting probe
3. Connecting cords

Theory: **Introduction of Pulse Modulation**

Pulse modulation may be used to transmit information, such as continuous speech or data. It is a system in which continuous waveforms are sampled at regular intervals. Information regarding the signal is transmitted only at the sampling times, together with any synchronizing pulses that may be required. At the receiving end, the original waveforms may be reconstituted from the information regarding the samples, if these are taken frequently enough. Despite the fact that information about the signal is not supplied continuously, as in AM and FM, the resulting receiver output can have negligible distortion.

Pulse modulation may be subdivided broadly into two categories, analog and digital. In the former case, the indication of sample amplitude is the nearest variable, while in the latter case, a code, which indicates the sample amplitude to the nearest predetermined level, is sent. Pulse amplitude and pulse time modulation, to be treated next, are both analog.

Pulse Amplitude Modulation

Pulse amplitude modulation, the simplest form of pulse modulation, is illustrated in Figure 2. It forms an excellent introduction to pulse modulation in general. Pulse amplitude modulation is a pulse modulation system in which the signal is sampled at regular intervals, and each sample is made proportional to the amplitude of the signal at the instant of sampling. As shown in Figure 2. The two types are double polarity pulse amplitude modulation, which is self-explanatory and single polarity pulse amplitude modulation, in which a fixed DC level is added to the signal, to ensure that the pulses are always positive. As will be seen shortly, the ability to use constant-amplitude pulses is a major advantage of pulse modulation, and since Pulse Amplitude Modulation does not utilize constant amplitude pulses, it is infrequently used. When it is used, the pulses frequency modulates the carrier. It is very easy to generate and demodulate pulse amplitude modulation. In a generator, the signal to be converted to Pulse Amplitude Modulation is fed to one input of an AND gate. Pulses at the sampling frequency are applied to the other input of the AND gate to open it during the wanted time intervals.

The output of the gate then consists of pulses at the sampling rate, equal in amplitude to the signal voltage at each instant. The pulses are then passed through a pulse shaping network, which gives them flat tops.

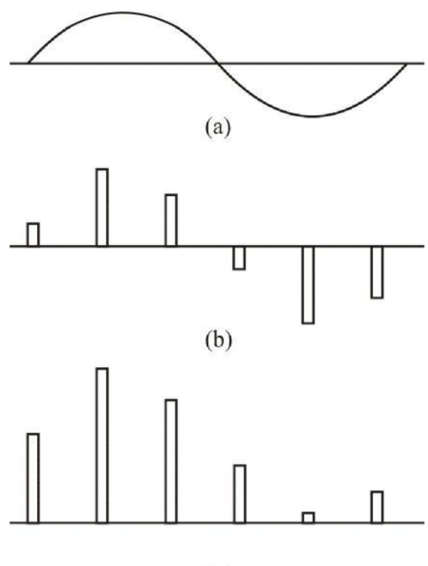


Figure 1 Sample and Sample / Hold Outputs :

If the pulse width of the carrier pulse train used in natural sampling is made very short compared to the pulse period, the natural pulse amplitude modulation is referred to as instantaneous pulse amplitude modulation, As it has been discussed, shorter pulse is desirous for allowing many signals to be included in TDM format but the pulse can be highly corrupted by noise due to lesser signal power.

One way to maintain reasonable pulse energy is to hold the sample value until the next sample is taken. This technique is formed as sample and-Hold techniques. The Sample-and-Hold waveform looks as shown under Figure 1.

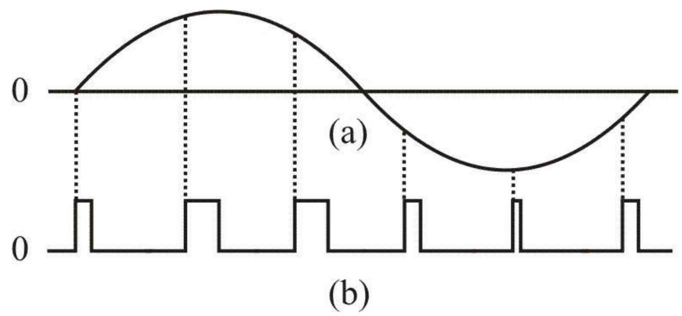
Pulse Position Modulation

The Amplitude and width of the pulses is kept constant in this system, while the position of each pulse, in relation to the position of a recurrent reference

Pulse is varied by each instantaneous sampled value of the modulating wave. As mentioned in connection with pulse width modulation, pulse-position modulations has the advantage of requiring constant transmitter power output, but the disadvantages of depending on transmitter receiver is synchronization.

Pulse Width Modulation

In pulse width modulation of pulse amplitude modulation is also often called PDM (pulse duration modulation) and less often, PLM (pulse length modulation). In this system, as shown in Figure 6, we have fixed amplitude and starting time of each pulse, but the width of each pulse is made proportional to the amplitude of the signal at that instant.



Pulse width modulation. (a) Signal (b) PWM (width variations exaggerated)
Figure2

In Figure 2, there may be a sequence of signal sample amplitudes of (say) 0.9, 0.5, 0 and -0.4V. These can be represented by pulse widths of 1.9, 1.5, 1.0 and 0.6μs respectively. The width corresponding to zero amplitude was chosen in this system to be 1.0μs, and it has been assumed that signal amplitude at this point will vary between the limits of + 1 V (width = 2μs) and -1 V (width = 0μs). Zero amplitude is thus the average signal level, and the average pulse width of 1μs has been made to correspond to it. In this context, a negative pulse width is not possible. It would make the pulse end before it began, as it were, and thus throw out the timing in the receiver. If the pulses in a practical system have a recurrence rate of 8000 pulses per second, the time between the commencements of adjoining pulses is 10^6 /8000 = 125μs. This is adequate not only to accommodate the varying widths but also to permit time-division multiplexing. Pulse width modulation has the disadvantage, when compared with pulse position modulation, which will be treated next, that its pulses are of varying width and therefore, of varying power content. This means that the transmitter must be powerful enough to handle the maximum-width pulses, although the average power transmitted is perhaps only half of the peak power. On the other hand, pulse width modulation still works if synchronization between transmitter and receiver fails, whereas pulse-position modulation does not, as will be seen.

Objective :

Study of Pulse Amplitude Modulation using Natural & Flat top Sampling

Procedure :

1. Connect the circuit as shown in Figure 16 and also described below for clarity.

   a. Output of sine wave to modulation signal input in PAM block keeping the switch in 1 KHz position.

   b. 8 KHz pulse output to pulse

input. **2.** Switch 'On' the power supply.

3. Monitor the outputs at TP3, & 5 these are natural flat top outputs respectively.

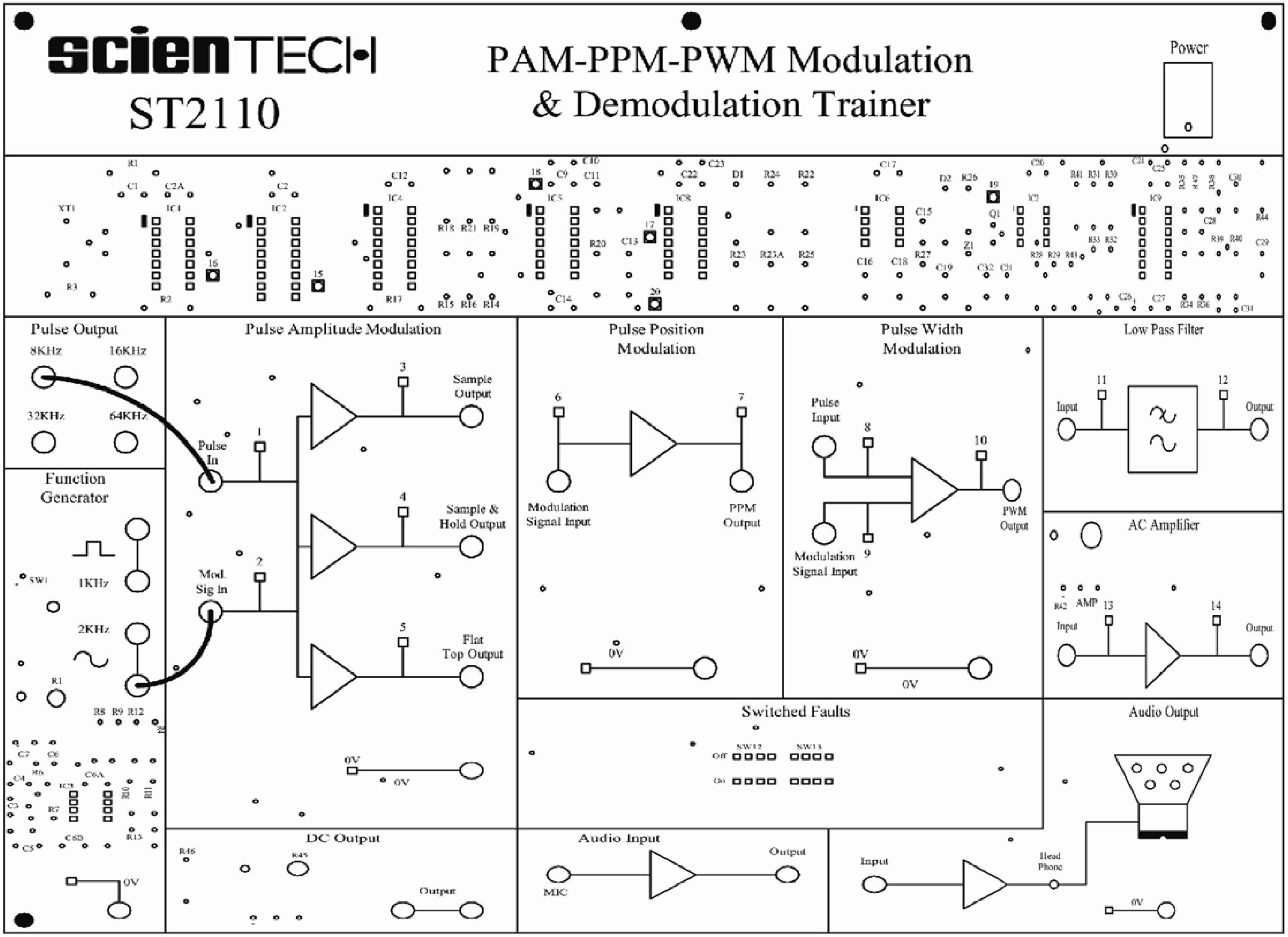
4. Observe the difference between the two outputs and try giving reasons behind them.

5. Try Varying the amplitude & frequency of sine wave by amplitude potentiometer and frequency change over switch. Observe the effect on all the two outputs.

6. Also, try to vary the frequency of pulse, by connecting the pulse input to the 4 frequencies available i.e. 8, 16, 32, 64 KHz in Pulse output block.

7. Switch 'On' fault No. 1, 2, 3, 4 one by one & observe their effect on Pulse Amplitude Modulation output and try to locate them.

8. Switch 'Off' the power supply.



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ST2110
PAM-PPM-PWM Modulation
& Demodulation Trainer
Power
Pulse Output
8KHz
16KHz
32KHz
64KHz
Function
Generator
1KHz
2KHz
Pulse Amplitude Modulation
Pulse
In
Mod.
Sig In
Sample
Output
Sample &
Hold Output
Flat
Top Output
0V
Pulse Position
Modulation
Modulation
Signal Input
PPM
Output
Pulse Width
Modulation
Pulse
Input
PWM
Output
Low Pass Filter
Input
Output
AC Amplifier
AMP
Switched Faults
SW12
SW13
Off
On
Audio Output
Head
Phone
DC Output
Audio Input
MIC

Objective :

Study of PAM using Sample & Hold sampling

Procedure :

1. Connect the circuit as shown in Figure 17 and also described below for clarity. **a.** Output of sine wave to modulation signal IN of PAM block.

b. 8 KHz pulse output to pulse IN of PAM block.

c. Keep the frequency selector switch in 1 KHz position. **2.** Switch 'On' the power supply.

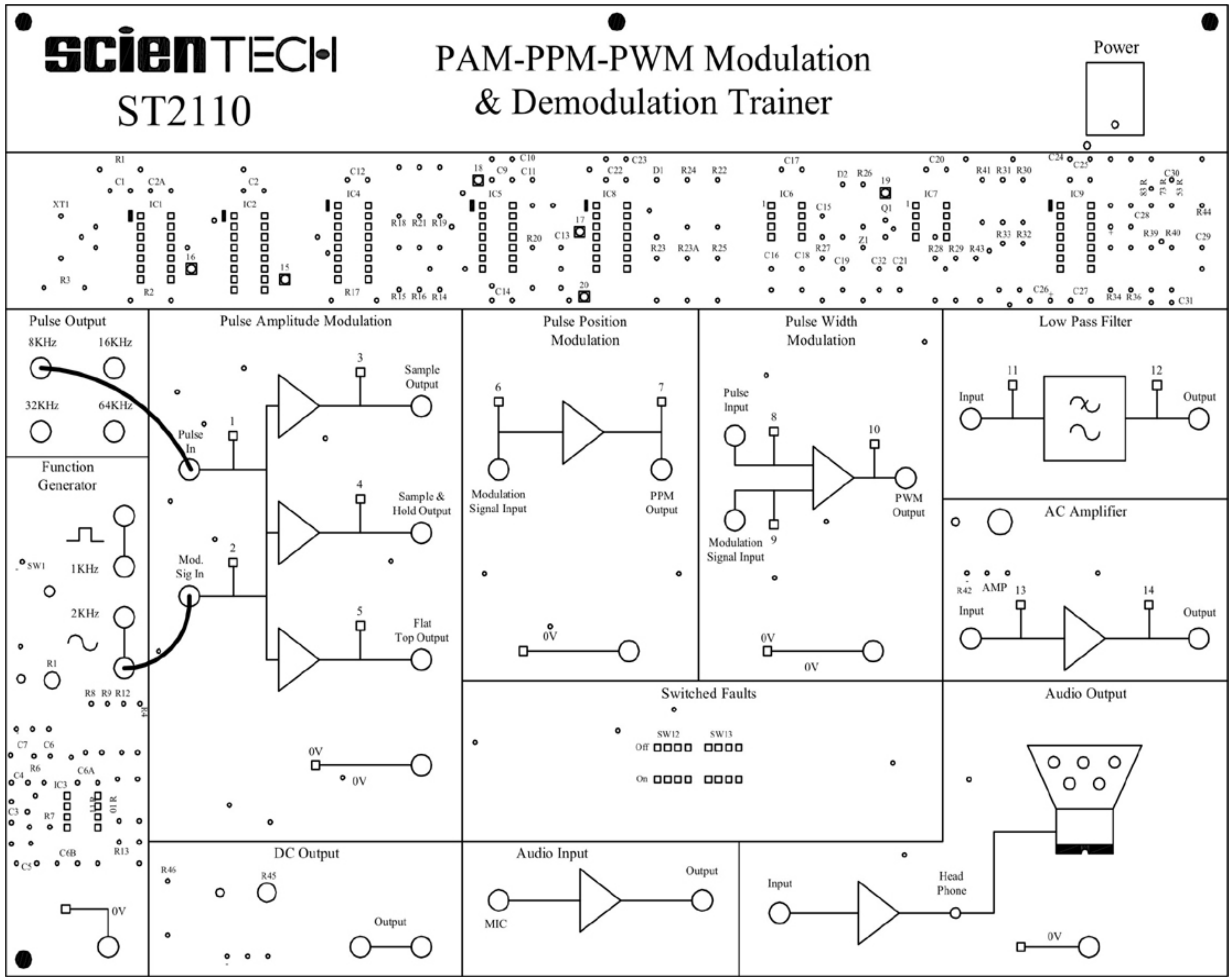
3. Monitor the output of sample & hold circuit at TP4.

4. Vary the amplitude of input sine wave & its frequency by the frequency change over switch to 2 KHz.

5. Also vary the input pulse's frequency by connecting the pulse input to different Square wave frequencies available on-board viz. 16, 32, & 64 KHz.

6. Switch 'On' fault No. 1, 2 & 3, one by one & observe their effect on Pulse Amplitude Modulation output, and try to explain reason behind them.

7. Switch 'Off' the power supply.



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Pulse
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Modulation
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Output
Low Pass Filter
Input
Output
AC Amplifier
AMP
Switched Faults
SW12
SW13
Off
On
DC Output
Output
Audio Input
MIC
Audio Output
Head
Phone

Objective :

Study of Pulse Amplitude Modulation & Demodulation with Sample, Sample & Hold & Flat Top

Procedure :

1. Connect the circuit as shown in Figure 18 and also described below for clarity.

- **a.** Output of sine wave to modulation signal IN in PAM block keeping the switch in 1 KHz position.
- **b.** 8 KHz pulse output to pulse input.
- **c.** Connect the sample output low pass filter input.
- **d.** Output of low pass filter to input of AC amplifier. Keep the gain pot in AC amplifier block in max position.

2. Follow the steps of experiment 1.

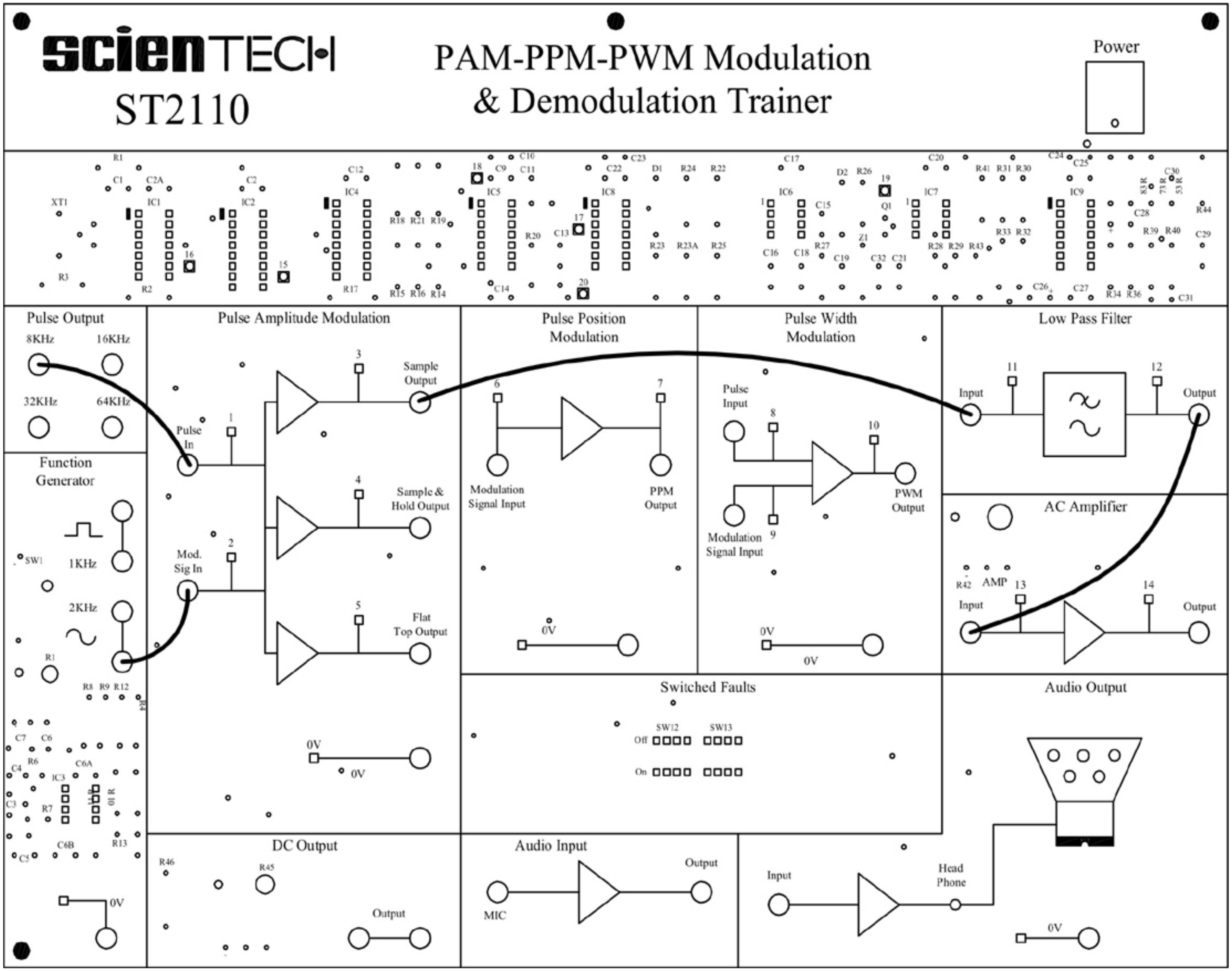
3. Monitor the output of AC amplifier. It should be a pure sine wave similar to input.

4. To vary the amplitude of input, the amplitude of output will vary.

5. Similarly connect the sample & hold & flat top outputs to low pass filter and see the demodulated waveform at the output of AC amplifier.

6. Switch 'On' the switched faults No. 1, 2, 3, 4, 5 & 8 one by one and see their effects on output.

7. Try to locate the fault and explain the reason behind them. **8.** Switch 'Off' the power supply.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Frequently Asked Questions

1.What is the pulse amplitude modulation?

Ans Pulse-amplitude modulation, is a form of signal **modulation** where the message information is encoded in the **amplitude** of a series of signal **pulses**. It is an analog **pulse modulation** scheme in which the **amplitudes** of a train of carrier **pulses** are varied according to the sample value of the message signal.

2.What is a pulse signal?

Ans In **signal** processing, the term **pulse** has the following meanings: A rapid, transient change in the amplitude of a **signal** from a baseline value to a higher or lower value, followed by a rapid return to the baseline value.

3.What is a sample and hold circuit?

Ans In electronics, a **sample and hold** (S/H, also "follow-and-**hold**") **circuit** is an analog device that **samples** (captures, grabs) the voltage of a continuously varying analog signal and holds (locks, freezes) its value at a constant level for a specified minimum period of time.

4.What is a holding circuit?

Ans The **holding circuit** interlock is a normally open auxiliary contact on magnetic starters or contactors. Used in three wire control schemes with momentary inputs. It closes when the coil is energized to form a **holding circuit** for the starter or contactor after the ``Start`` button or input has been released.

5.What is a zero order hold?

Ans The **zero-order hold** (ZOH) is a mathematical model of the practical signal reconstruction done by a conventional digital-to-analog converter (DAC). That is, it describes the effect of converting a discrete-time signal to a continuous-time signal by holding each sample value for one sample interval.