To study Pulse Amplitude modulation and demodulation process with relevant waveforms.

**APPARATUS:**
1. Pulse amplitude modulation and demodulation kit
2. CRO
3. Signal generator
4. BNC probes, connecting wires

**CIRCUIT DIAGRAM:**

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**THEORY:**
In amplitude and angle modulation, some characteristic of the carrier amplitude, frequency, or phase is continuously varied in accordance with the modulating information. However, in pulse modulation a small sample is made of the modulating signal and then a pulse is transmitted. In this case, some characteristic of the pulse is varied in accordance with the sample of the modulating signal. The sample is actually a measure of the modulating signal at a specific time.

There are several types of pulse modulating systems. Some common types are; pulse amplitude modulation (PAM), pulse duration modulation (PDM) and pulse position modulation (PPM). In each of these systems, a characteristic of the pulse such as amplitude, duration, or position is continuously varied in accordance with the modulating signal. This type of pulse modulation, where pulse amplitude is varied in accordance with the amplitude of the message signal, is called pulse amplitude modulation.

**PROCEDURE:**
1. The 4016 integrated circuit is a CMOS bilateral switch which is used as a sampling switch. A positive voltage on pin 13 closes the CMOS transistor switch between pins 1&2. When pin13 is at zero volts, the switch is open.
2. Switch ON the trainer.
3. Connect a 10 KHz sine wave of 5V p-p from an audio generator at the point marked AF i/p.
4. Connect the oscilloscope to pin 2 of 4016 IC, adjust the 1K potentiometer (R1) to vary the amplitude of the modulating signal. Also adjust the frequency of the modulating signal to obtain stable display on the oscilloscope. The waveform obtained is a dual polarity PAM.
5. Vary the amplitude and frequency of the sine wave signal and observe the change in the output waveform.
6. Connect the modulated output to the input of the demodulator.
7. Connect channel 1 of the dual trace oscilloscope to the demodulator output and channel 2 to the input sine wave. Compare the two waveforms you will find that they are 180 out of phase.

Expected waveforms:

INFERENCE:
Pulse amplitude modulation and demodulation is observed and their respective wave forms are plotted.
PART- B

PULSE WIDTH MODULATION AND DEMODULATION

EXPERIMENT NO: 2

AIM:
To generate the pulse width modulated and demodulated waves.

APPARATUS:
1. PWM trainer kit
2. BNC probes and connecting wires

THEORY:
PWM is an analog modulation method. In this, we have a fixed amplitude and starting time of each pulse, is made proportional to the amplitude but the width of each pulse of the modulating signal at that instant.

A monostable multivibrator can generate PWM. The 555IC is connected in monostable mode. The sampling clock is given to pin 2 of 555 IC and modulating signal is given to the pin 5. The output is obtained at pin 3. If the amplitude of modulating signal is varied, the width of each pulse is also varied. The demodulated wave is obtained by low pass filter, whose amplitude at any time is proportional to the pulse width modulation at that time.

CIRCUIT DIAGRAM:

![PWM Modulator Circuit Diagram](image1)

![PWM Demodulator Circuit Diagram](image2)
PROCEDURE:

1. Switch “ON” the experimental kit.
2. Observe the clock generator output & modulation signal outputs.
3. Connect clock generator output to the clock input point of PWM modulator And observe the same clock on channel of a dual trace CRO.
4. Trigger the CRO with respect to CH 1.
5. Apply a variable DC voltage of 8 to 12 volts from any external regulated Power supply.
6. Observe the PWM output on CH 2.
7. If we observe the PWM output, it’s width varies according to the Modulating voltage.
8. A variable amplitude modulating signal is given to observe how the PWM are varying for AC modulating voltages.
9. In this case we have to trigger the CRO with respect to modulating voltage.

**EXPECTED WAVEFORMS**

**INFERENCES:**

Pulse width modulation and demodulation is observed and their respective wave forms are plotted.

**3. PULSE POSITION MODULATION.**

**AIM:**

To study the pulse position modulation and demodulation circuit.

**APPARATUS:**

1. Trainer kit of PPM.
2. BNC probes and connecting wires.

**Circuit Diagram:**

- **PPM Modulation**

- **PPM Demodulation**

**Modulation**

- IC 555
- 27k
- 1k
- 0.1uf
- +5V
- 10k
- 0.01uf
- 0.1uf
- AF signal
- PPM output
Demodulation

**THEORY:**

Pulse modulation is used to transmit analog information, such as continuous speech or data. The data is sent at sampling times, with synchronizing pulses. The pulse position modulation is an analog modulation method, where we have fixed amplitude of each pulse, but the position of each pulse is made proportional to the amplitude of the modulating signal at that instant. PPM is derived from the pulse width modulated signal. To demodulate the PPM signal, it is fed to an integrating RC circuit (LPF) to obtain the modulating signal.

**PROCEDURE:**

**MODULATOR:**

1. Switch On the experimental kit.
2. Observe the clock generator output and modulating signal outputs.
3. Connect the clock generator output to the clock input point of PPM modulator and observe the same clock on CH1 of dual trace CRO.
4. Trigger the CRO w.r.t CH1.
5. Apply a variable D.C voltage of 8-12V from any external regulated power supply.
6. Observe the PPM output on CH2.
7. By varying the modulating voltage, PPM output changes position, but the width is maintained constant.

**DEMODULATOR:**

1. Apply PPM signal to the PPM demodulator and observe the output.
2. The output almost coincides with modulating signal.

**EXPECTED WAVE FORMS:**
AIM:
To study the operation of frequency synthesizer using PLL.

APPARATUS:
1. Frequency synthesizer trainer AET-26A
2. Dual trace C.R.O (20MHz)
3. Digital frequency counter or multimeter.
4. Patch chords

BLOCK DIAGRAM:

\[
\begin{align*}
F_{in} &= f_{ut} \\
N &\quad \text{Div. N Network frequency divider} \\
F_{out} &= N \cdot f_{in}
\end{align*}
\]

CIRCUIT DIAGRAM:

THEORY:
Phase locked loop:

PLL stands for 'Phase locked loop' and it is basically a closed loop frequency control system, which functioning is based on phase sensitive detection of phase difference between the input and output signals of controlled oscillator.

Before the input is applied the PLL is in free running state. Once the input frequency is applied the VCO frequency starts change and phase locked loop is said to be in captured mode. The VCO frequency continues to change until it equals the input frequency and PLL is then in the phase locked state. When phase locked the loop tracks any change in the input frequency through its repetitive action.

Frequency synthesizer:

The frequency divider is inserted between the VCO and the phase comparator. Since the output of the divider is locked to the input frequency $f_{in}$, VCO is running at multiple of the input frequency. The desired amount of multiplication can be obtained by selecting a proper divide by $N$ network. Where $N$ is an integer. For example $f_{out} = 5 f_{in}$ a divide by $N=10$, 2 network is needed as shown in block diagram.

To verify the operation of the circuit, we must determine the input frequency range and then adjust the free running frequency $f_{out}$ of VCO by means of R (between 10th and 8th pin) and C (9th pin), so that the output frequency is midway within the predetermined input frequency range. The output of the VCO now should be $5f_{in}$.

PROCEDURE:

1. Switch on the trainer ad verify the output of the regulated power supply i.e. ± 5V. These supplies are internally connected to the circuit so no extra connections are required.
2. Observe output of the square wave generator using oscilloscope and measure the range with the help of frequency counter, frequency range should be around 1KHz to 10KHz.
3. Calculate the free running frequency range of the circuit (VCO output between 4th pin and ground). For different values of capacitances note down the different frequencies which are multiples of input frequency.

<table>
<thead>
<tr>
<th>Value of ‘C’</th>
<th>$f_{in}$ KHz</th>
<th>N</th>
<th>$F_{out} = N f_{in}$ KHz</th>
</tr>
</thead>
</table>

EXPECTED WAVEFORMS

TABULAR COLUMN:

<table>
<thead>
<tr>
<th>$f_{in}$</th>
<th>$f_{out}$</th>
<th>$T$ cycle</th>
</tr>
</thead>
</table>

INERENCE:

Functioning of Frequency synthesizer is observed.
AIM:
To Study the AGC characteristics of a Radio receiver.

APPARATUS:
1. AGC characteristics trainer.
2. 20MHz Dual trace Oscilloscope
3. Patch Chords.

BLOCK DIAGRAM:

THEORY:
The main purpose of the receiver is to recreate the original message signal from the degraded version of the transmitted signal after propagation through the free space.

**Automatic gain control (AGC).** The AGC signal is used as a bias signal to reduce the gain of the RF and the IF amplifiers to prevent detector overload on strong signals. AGC is a system by means of which the overall gain of a radio receiver is varied automatically with the changing strength of the received signal, to keep the output substantially constant. The audio signal from the detector is passed through a low pass filter to remove unwanted high frequency components and then through a volume control to an audio amplifier. The audio amplifier is usually one low-level audio stage followed by a power amplifier and a speaker.

The gain required in the RF and IF amplifier chain of the receiver depends on the required input and output. The input is the minimum variable signal level to be presented at the antenna terminals. The output is the minimum signal level at the input of the detector required to make the detector perform satisfactory.

PROCEDURE:
1. Select carrier frequency of 1000KHz. AF frequency 1KHz and apply AM signal to the input of receiver. Set amplitude to around 1 mV.
2. Connect CRO at the output of the Audio amplifier.
3. Tune the mixer-Local oscillator for maximum AF signal output at detector output and measure the audio signal.
4. Increase the RF level in appropriate steps and note down corresponding output A.F signal amplitude.
5. Plot the AF output vs RF input on graph which will be as shown in the fig.2.
TABULAR COLUMN:

<table>
<thead>
<tr>
<th>S.NO</th>
<th>RF INPUT VOLTAGE</th>
<th>AF output voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>

EXPECTED GRAPH:

INFORMATION: AGC characteristics of radio receiver is observed.

PART-B

SQUELCH CIRCUIT

EXPERIMENT NO: 6

AIM:

To study Squelch circuit.

APPARATUS:

1. Squelch circuit trainer Board
2. Dual trace Oscilloscope
3. Function generator
4. Patching wires.
THEORY:

The other name for squelch circuit is muting circuit. Radio telephone receivers and communication receivers use this circuit.

The muting circuit reduces the gain of the gain AF amplifier when the carrier is not present. The output of the detector is given normally to the audio amplifier. The output of the detector is used in a receiver to develop the AGC (Automatic gain control) bias. This AGC bias is used in a control transistor. A DC bias is developed from the collector circuit of the control transistor and is applied to the AF amplifier in such a way that this bias will reduce the gain of the AF amplifier. As long as the carrier is absent the reverse bias applied from the control transistor keeps the gain of the AF amplifier far lower than normal gain it can offer, by the positioning of volume control.

When the receiver is tuned in to the required signal frequency, presence of the carrier will raise the AGC bias. This in turn will reduce the collector current in the control transistor. Hence the applied reverse voltage to the AF amplifier is reduced and its gain resumes to normal value.

PROCEDURE:

1. Study the circuit operation of squelch circuit.
2. Apply the 500Hz of A.F signal to the input of AM generator (marked as A.F input). Observe the output of the AM generator using CRO. Adjust the amplitudes of A.F and A.M generators to get proper output of A.M wave form.
3. Now connect the A.M output to the input of the detector provided on board and monitor the detectors outputs of A.F and AGC. Measure the AGC output with a DC voltmeter.
4. Connect the A.F output from the detector to the input of the A.F. Amplifier and AGC output to the input of the DC amplifier.
5. Now you can study the effect of the squelch circuit by varying the amplitude of the A.M signal and adjust the sensitivity of squelch by varying the potentiometer provided at the base of the transistor Q2.

INFERENCER:

Functioning of Squelch circuit is observed.

EXPECTED WAVEFORMS:

INPUT WAVEFORM