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EXPERIMENT NO. EL 1

ZENER DIODE CHARACTERISTICS

Aim

To study the forward and reverse bias characteristics of Zener diode

Apparatus required

1. Zener characteristics experiment trainer kit comprising of
   - a) Zener diodes
   - b) Resistors
   - c) Ammeter and voltmeter
   - d) DC power supply
2. Connecting wires

Description

The given trainer kit is accommodating the required apparatus and components like

- variable power supply for 0 – 15v range
- ammeter for 0 – 25mA and 0 – 150μA ranges
- voltmeter for 0 – 1.5v and 0 – 15v ranges
- zener diodes for 4.7v, 6.2v and 7.5v and
- three resistors of of 100Ω , 470Ω , and 1kΩ values

Circuits are to be wired by connecting single strand wires to the spring terminals provided on the kit.

Note: To make circuit connections, bend spring terminals and then insert a wire in between two spring coils. But, please don't pull the spring terminals.

PROCEDURE

a) Forward bias characteristics

In forward mode the anode of zener is connected to +ve and its cathode to -ve of dc power supply. Connect the circuit as shown in the fig.1 below and record the parameters I_F (forward current) and V_F (forward voltage) by varying the forward supply voltage from 0v onwards, graually.

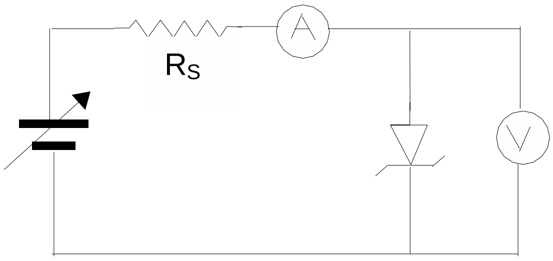

Fig. 1

S.No	V_F	I_F
1		
2		
3		
4		
5		
6		
7		
8		
9		

b) Reverse bias characteristics

In reverse mode the anode of zener is connected to -ve and its cathode to +ve of dc power supply. Connect the circuit as shown in the fig.2 below and record the parameters I_R (reverse current) and V_R(reverse voltage) by varying the forward supply voltage from 0v onwards, graually.

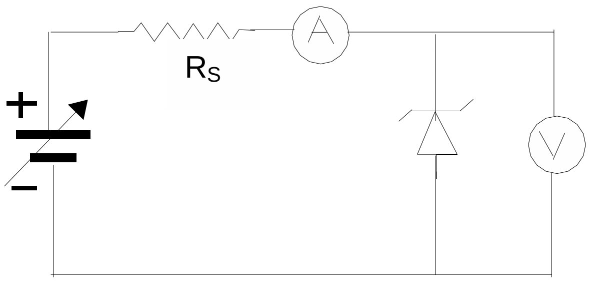

Fig. 2

S.No	V_R	I_R
1		
2		
3		
4		
5		
6		
7		
8		
9		

Review question 1

Q. What do you observe from forward and reverse characteristics of a zener? And how do you compare these to that of a rectifier diode?

Ans:

Zener as a Voltage Regulator

When the reverse bias characteristics of zener are observed it is noticed that once the input voltage rised above zener voltage (V_Z), the zener conducts and it maintains a constant, V_Z, across its anode and cathode irrespective of its load current. This property of zener diode has lead it to be used for voltage regultion purposes.

- Connect the circuit as shown below
- Increase the supply voltage till you get V_Z across load resistor, R_L
- Now by increasing input voltage in steps of 1v note down V_L , the voltage across R_L. This must be a constant and equal to V_Z. Change R_L with another resistor and repeat. Same thing is observed.

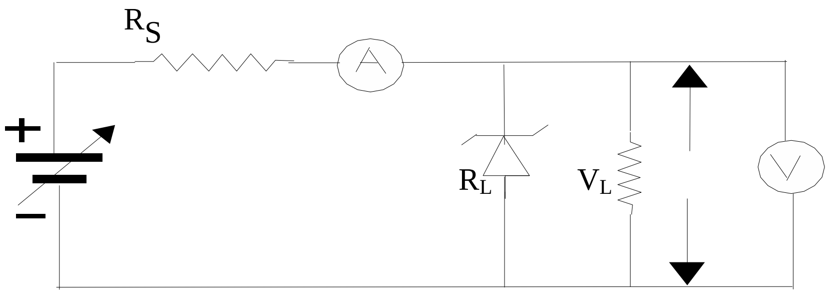

Fig.3 Zener as voltage Regulator

S.No.	V_{IN} (V)	Load Voltage - V_L	
		R_L 1000 Ω	R_L 500 Ω
1	V_Z		
2	V_Z +1		
3	V_Z +2		
4	V_Z +3		
5	V_Z +4		
6	V_Z +5		

Review question 2

Q. What is your conclusion from this experiment ?
Ans:

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EXPERIMENT NO. EL 2

TRANSISTOR CHARACTERISTICS

Aim

To study the common emitter characteristics of a transistor and to find out its current gain β, input resistance R_I and output resistance R_0 .

Apparatus required

1. Transistor characteristics experiment trainer kit comprising of
   a) Two transistors
   b) Three resistors of 470 Ω , 1k Ω and 100k Ω values
   c) Two Ammeter for 0 - 150μA and 0 – 15mA
   d) A voltmeter for 0 – 1.5v and 0 – 15v ranges
   e) Two variable power supplies for 0 -15v dc
2. Connecting wires

Theory

A transistor is also called as BJT, bipolar junction transistor. It consists of three leads connected to three regions of P and N type materials formed in PNP or NPN order. These metallic leads are named as emitter, base and collector respectively. Unlike diode a transistor is operated in three circuit configurations or ways called

- common base
- common emitter and
- common collector.

Note: To make circuit connections, bend spring terminals and then insert a wire in between two spring coils. But, please don't pull the spring terminals.

Among these only **Common Emitter** configuration is extensively used in numerous applications. Hence, we study here now only common emitter mode of operation.

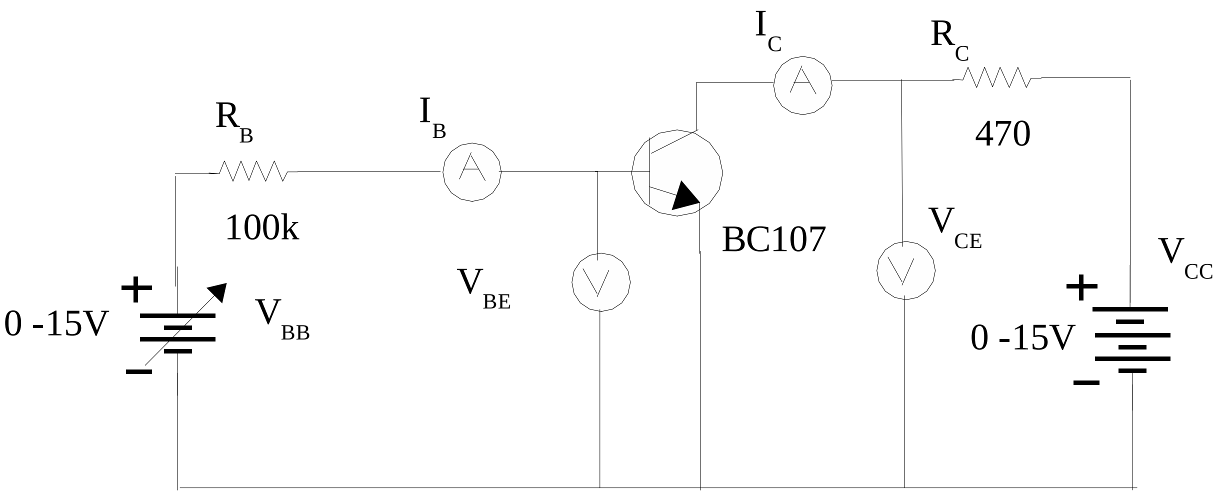

Fig. 1 Common Emitter Circuit Diagram

INPUT CHARACTERISTICS

1. Connect the circuit as shown in the above figure
2. Take readings for finding **input characteristics** as given in the table -1 below.

- Keep V_{CE} constant at 0v
- Record V_{BE} and I_B readings by increasing V_{BB} from 0v onwards
- Repeat twice the measurement of V_{BE} and I_B for fixed values of V_{CE} at 5v and 10v
- Using these readings plot the input characteristics curves for CE mode of the given transistor.
- Now calculate the input resistance of the transistor from the plot

V_{CE} at 0V		***V_{CE} at 5V***		***V_{CE} at 10V***	
V_{BE}	**I_B**	**V_{BE}**	**I_B**	**V_{BE}**	**I_B**

V_{CE} at 0V		V_{CE} at 5V		V_{CE} at 10V	

Table 1 - Intput chacteristics readings

Input Characteristics Curves

Calculate the input resistance of the given transistor from the above plot using the formula

$$\text{Input Resistane ,} \quad R_{IN} = \frac{\Delta V_{BE}}{\Delta I_B}$$

OUTPUT CHARACTERISTICS

1. Using the same circuit shown in the above figure
2.Take readings for finding **output characteristics** as given in the table below.

- Keep I_B constant at some value (ex: 20µA)
- Record I_C and V_{CE} by increasing V_{CC} from 0v onwards
- Repeat twice the measurement of I_C and V_{CE} for fixed values of I_B at 40µA and 60µA
- Using these readings plot the output characteristics curves for CE mode of the given transistor.

♦ Now calculate the output resistance of the transistor from the plot

I_B **at 20**µA		I_B **at 40**µA		I_B **at 60**µA	
V_{CE}	I_C	V_{CE}	I_C	V_{CE}	I_C

Table 2 - Output chacteristics readings

<u>Output characteristics curves</u>

Calculate the **output resistance** and **current gain** of the given transistor by

$$R_O = \frac{\Delta V_{CE}}{\Delta I_C}$$

output resistance **,** and

current gain , $\beta = \dfrac{\Delta I_C}{\Delta I_B}$

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EXPERIMENT NO. EL 3

SCR CHARACTERISTICS

Aim

To study the characteristics of Silicon Controlled Rectifier (SCR) and finding its holding current (I_H)

Apparatus required

1. SCR characteristics experiment trainer kit comprising of
   a) SCR
   b) Resistors
   c) DC power supplies
2. Ammeter, voltmeter and multimeter
3. Connecting wires

Description

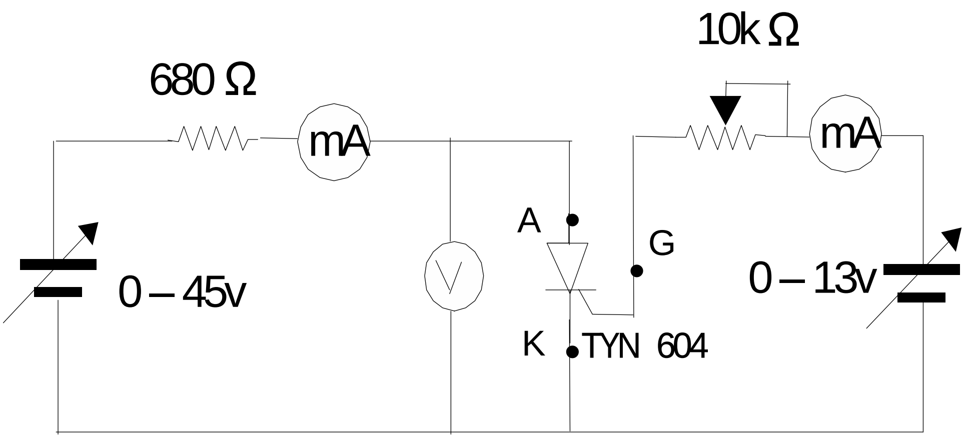
The given trainer kit is accommodating the required apparatus and components like

- variable power supplies for 0 – 45v and 0 -13v
- SCR -TYN 604 and
- one resistor of 680Ω and
- one potentiometer of 10kΩ

PROCEDURE

1. Connect the circuit as shown in diagram
2. Keep both supply knobs in min. position.

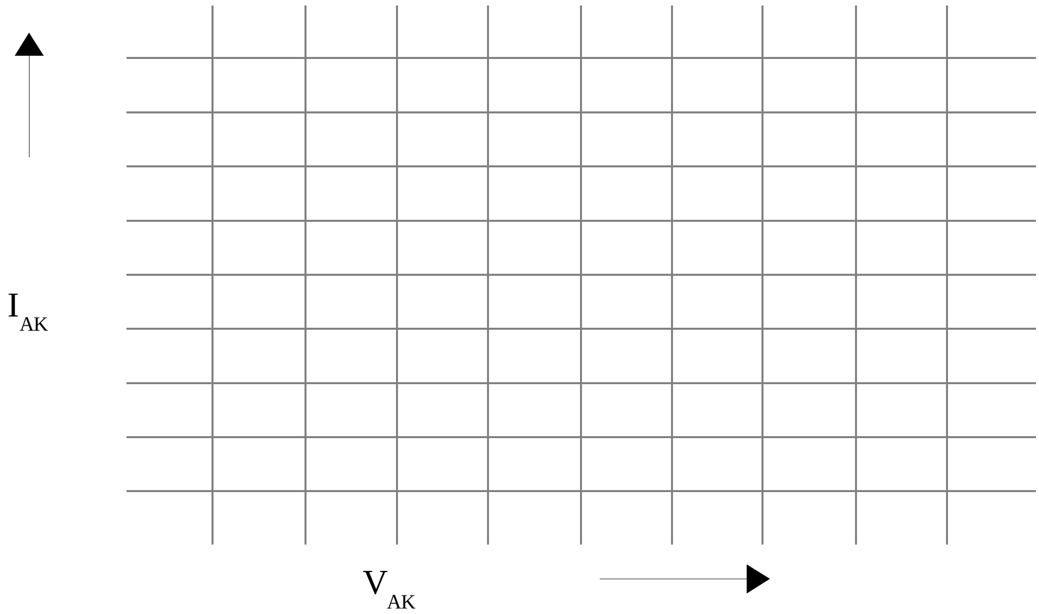
3. Keep the 10k pot in max. position (fully anti-clockwise)
4. Plug-in the kit power cord to mains and switch on supply
5. Apply 5V of V_{AK} across anode and cathode
6. Apply +ve gate voltage with respect to cathode
7. Slowly vary V_{GK} (gate to cathode supply) knob till the SCR triggers and voltage across it becomes 0v. Note down both I_G and I_{AK}
8. Now withdraw V_{GK} and observe whether SCR remains in ON state.
9. Keep on applying V_{AK} values as given in the table below and repeat the steps 6 to 8 till SCR remains in ON state even after disconnecting gate supply V_{GK}. Note down the SCR current I_{AK} at this point. Now carefully observing SCR current I_{AK} slowly decrease V_{AK} . After a value, I_{AK} suddenly becomes zero and SCR comes out of conduction. This minimum value of I_{AK} which is required to keep SCR in ON state gives the holding current, I_H , for the given SCR.
10. Plot characteristics curves with these readings



S.No	V_{AK}	I_G	I_{AK}
1	5v		
2	10v		
3	15v		
4	16v		
5	18v		
6	20v		

Table of Readings

SCR Characterisics Curve



Review question

Q. What is the value of I_H (holding current) for the given SCR and state what is the relationship between V_{AK} and I_G

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EXPERIMENT NO. EL 4

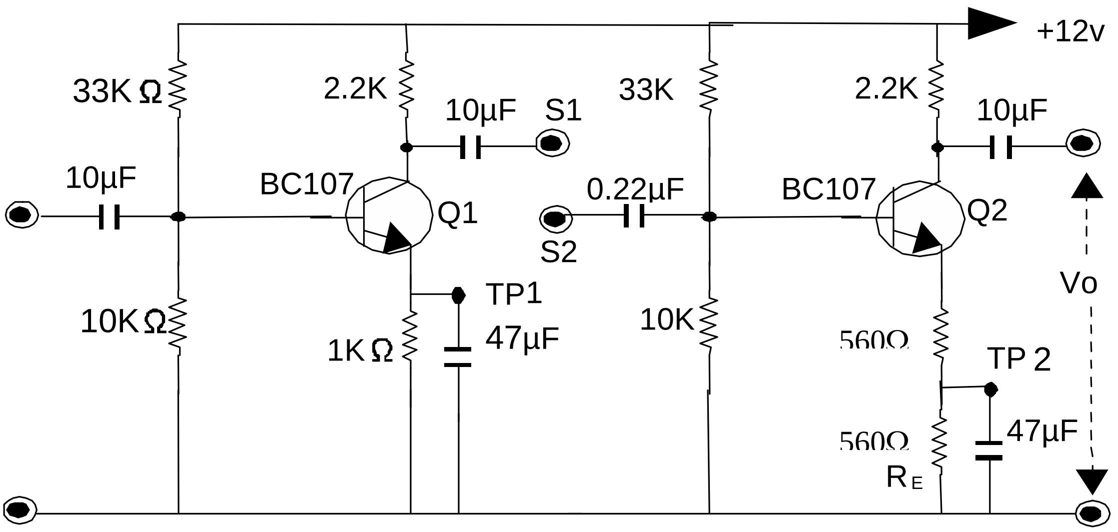
RC COUPLED BJT AMPLIFIER

Aim

To calculate voltage gain and frequency response characteristics of a two stage RC coupled amplifier using BJT.

Introduction

If the output of a single stage amplifier is insufficient to drive an output device additional amplification over two or three stages is necessary. To achieve this, the output of each amplifier stage is coupled in some way to the input of the next stage. RC coupling is one such means for coupling stages of electronic amplifiers. This method is quite simple among other methods of coupling. A two stage RC coupled amplifier is shown below



The figure shows a two stage RC coupled amplifier using two transistors Q1 and Q2. If each stage gain is G1 and G2 respectively then the overall gain after RC coupling will become

$$G = G1 \times G2.$$

A coupling capacitor Cc is used to connect the output of 1st stage to the input of 2nd stage. The output from 1st stage which is ac voltage is developed across its collector resistor Rc and this ac voltage is passed on to the base of next stage blocking the dc component. This type of arrangement is called as RC coupling.

Apparatus Required

- The experimental unit for RC coupled amplifier
- Signal generator
- Oscilloscope
- Multimeter
- Patch cords

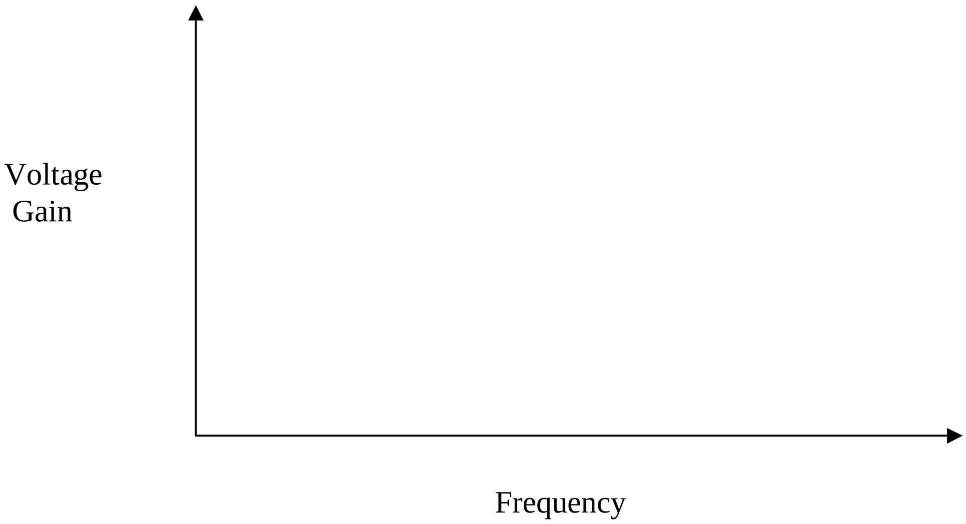
Procedure

1. Switch on the unit
2. Connect a 1kHz tone at 10mv to the input of first stage
3. Using a CRO or multimeter measure the output level of this stage
4. Calculate the gain as

   $$G = V_{out} / V_{in}$$

5. Now feed the same signal to 2nd stage input
6. After measuring its output level calculate 2nd stage gain
7. Now connect 1st stage output to 2nd stage input by looping S1 and S2 with a patch cord
8. Feed input at 1kHz and increase its level till the output of 2nd stage is not distorted
9. Now calculate the combined gain. Match this with the product of individual gains of each stage
10. Now vary the frequency of the input signal from 10Hz to 1MHz and tabulate as per table1
11. Draw frequency response characteristics with these values

S. No	**Frequency**	**V_{in}**	**V_{out}**	**Gain $=V_{out} / V_{in}$**
1	1kHz			
2	10kHz			
3	50kHz			
4	100kHz			
5	200KHz			
6	500KHz			



Frequency Response Characteristics

Review questions

Q1. Does the overall gain match with the product of individual gains of two Stages

Q2. What is the Bandwidth obtained from the plotted frequency response curve

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EXPERIMENT NO. EL 5

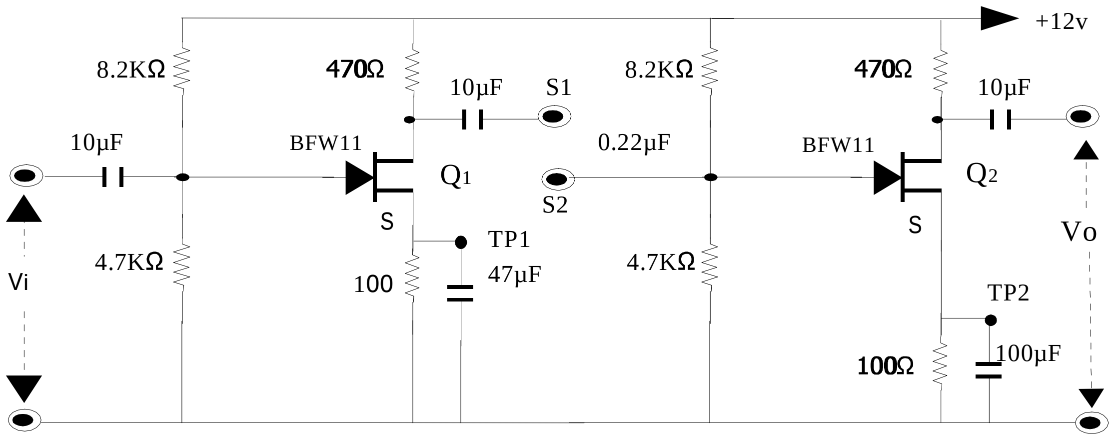
RC COUPLED FET AMPLIFIER

AIM

To calculate voltage gain and frequency response characteristics of a two stage RC coupled amplifier using FET s

INTRODUCTION

If the output of a single stage amplifier is insufficient to drive an output device additional amplification over two or three stages is necessary. To achieve this, the output of each amplifier stage is coupled in some way to the input of the next stage. RC coupling is one such means for coupling stages of electronic amplifiers. This method is very simple. The circuit diagram of a two stage RC coupled amplifier using FETs



The figure shows a two stage RC coupled amplifier using two transistors Q1 and Q2. If each stage gain is G1 and G2 respectively then the overall gain after RC coupling will become

$$G = G1 \times G2.$$

A coupling capacitor Cc is used to connect the output of 1st stage to the input of 2nd stage. The output from 1st stage which is ac voltage is developed across its collector resistor Rc and this ac voltage is passed on to the base of next stage blocking the dc component. This type of arrangement is called as RC coupling.

Apparatus Required

- The experimental unit for RC coupled amplifier
- Signal generator
- Oscilloscope
- Multimeter
- Patch cords

Procedure

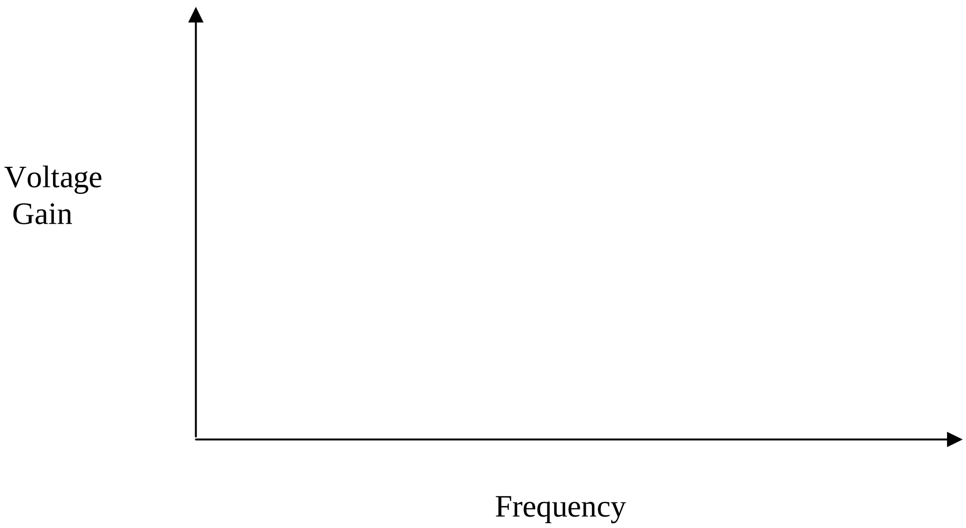
1. Switch on the unit
2. Connect a 1kHz tone at 10mv to the input of first stage
3. Using a CRO or multimeter measure the output level of this stage

Calculate the gain as $G = V_{out} / V_{in}$

4.
5. Now feed the same signal to 2nd stage input
6. After measuring its output level calculate 2nd stage gain
7. Now connect 1st stage output to 2nd stage input by looping S1 and S2 with a patch cord
8. Feed input at 1kHz and increase its level till the output of 2nd stage is not distorted
9. Now calculate the combined gain. Match this with the product of individual gains of each stage
10. Now vary the frequency of the input signal from 10Hz to 1MHz and tabulate as per table1

11. Draw frequency response characteristics with these values

S. No	**Frequency**	**V_{in}**	**V_{out}**	**Gain $=V_{out} / V_{in}$**
1	1kHz			
2	10kHz			
3	50kHz			
4	100kHz			
5	200KHz			
6	500KHz			



Frequency Response Characteristics

Review questions

Q1. Does the overall gain match with the product of individual gains of two Stages

Q2. What is the Bandwidth obtained from the plotted frequency response curve

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EXPERIMENT NO. EL 6

FEED BACK AMPLIFIER

AIM

To study different circuits of feed back amplifier and the effects of feedback on parameters like voltage gain, frequency response, bandwidth, non-linear distortion, input impedance and output impedance.

INTRODUCTION

In a feed back amplifier the output voltage or current is sampled and applied to the input through a feed back network. Feedback may be either *positive* or *negative*. Positive feedback is utilised in oscillators whereas negative feedback improves the overall performance of amplifiers and also stabilises gain. There are different types of feed back amplifier. These are :

- voltage shunt feed back amplifier
- current shunt feed back amplifier
- voltage series feed back amplifier
- current series feed back amplifier

Apparatus Required

- The feedback amplifier experimental module
- CRO

- Signal generator
- Patch cords

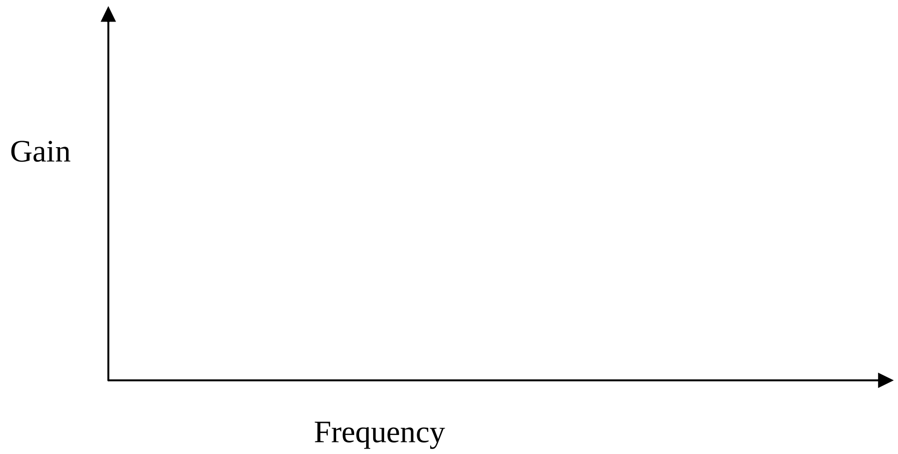
Voltage Shunt Feed Back Amplifier

Procedure

- Without connecting the feed back loop switch on the supply
- Feed input signal of 1 KHz at a convenient level up to 200mv so that a proper output is obtained on the CRO.
- Measure the output level on the CRO. Calculate the voltage gain.(V_{OUT} / V_{IN})
- Now keeping the input signal **amplitude (V_{IN}) constant** vary its frequency from 1Hz to 1MHz and note down corresponding output levels on CRO. For each of these readings find out the gain. Using these gains plot frequency response curve and then find out the bandwidth of the amplifier.
- Repeat the above steps by connecting the feedback loop (short GREEN and ORANGE terminals)

S.No.	V_{in} =	Output Voltage		Voltage gain	
	Input Frequency	Without feedback	With feedback	Without feedback	With feedback
1	100Hz				
2	1KHz				
3	10KHz				
4	100KHz				
5	1MHz				

Table1



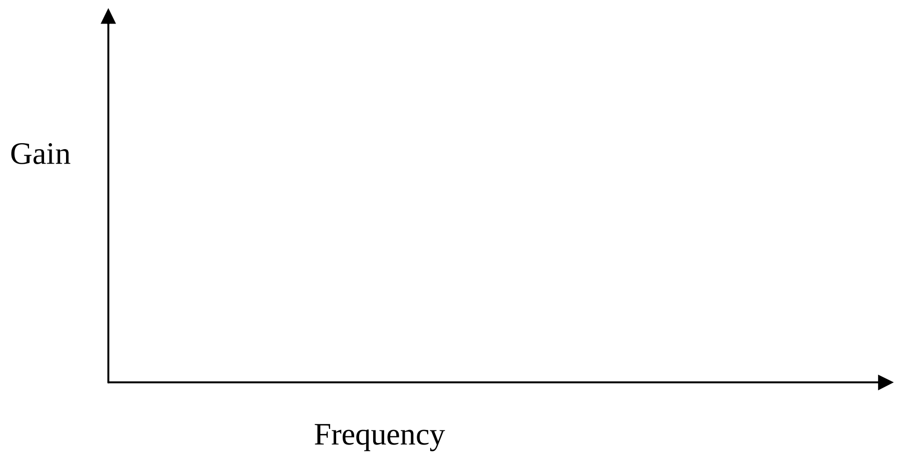
Frequency Response Curve

Now apply the same **procedure** for plotting the frequency response curves and finding the bandwidths for

<u>Current Series Feed Back Amplifier</u>

S.No.	V_{in} =	Output Voltage		Voltage gain	
	Input Frequency	Without feedback	With feedback	Without feedback	With feedback
1	100Hz				
2	1KHz				
3	10KHz				
4	100KHz				
5	1MHz				

Table 2



Frequency Response Curve

Q. What is the effect of feed back on the parameters mentioned in the table below in each feed back method ?

S.No	Feed back Method	Gain	Frequency Response	Bandwidth
1	Voltage Shunt Feed Back Amplifier			
2	Current Series Feed Back Amplifier			

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EXPERIMENT NO. EL 7

RC PHASE SHIFT OSCILLATOR

AIM

1. To study the attenuation and phase response characteristics of RC phase shift network and
2. To construct RC phase shift oscillator and to measure the output frequency.

Principle

It is well known that an amplifier plus a positive feedback network makes an oscillator. The feedback network should introduce a shift of 180° in the phase of the output signal of a common emitter amplifier, before a part of it is fed to its input in same phase. In an RC phase shift oscillator the required shift in phase is achieved by a three stage RC network wherein each stage introduces a phase shift of 60°.

Apparatus required

1. RC phase shift oscillator experiment trainer kit comprising of
   a) Resistors and capacitors
   b) Single stage transistor oscillator
   c) DC power supplies
2. Oscilloscope (CRO)
3. Oscillator
3. Connecting wires

Description

The given trainer kit is accommodating the required apparatus and components like

- 3-Resistors of 10kΩ and 3-capacitors 0.01μF needed for 3 phase shifts of 60° each

- Single stage transistor oscillator
- two resistors – one of 680Ω and another of 10kΩ

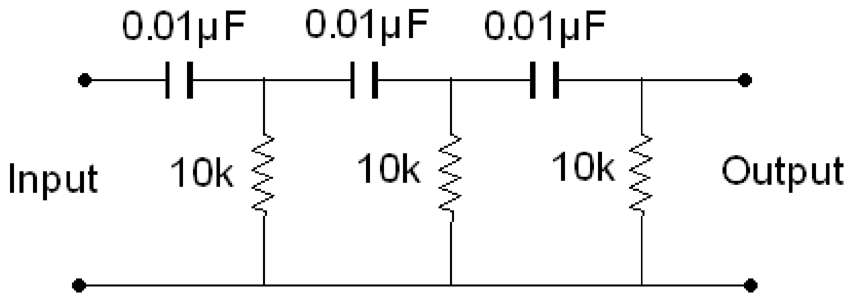

Fig. 1

Step1:

3. Connect the circuit as shown in fig.1
4. Connect a low distortion oscillator to the input terminals.
5. Adjust the frequency of the oscillator until you get 180° phase difference between input and output.
6. Note down this frequency and find out the attenuation of the network at this frequency.

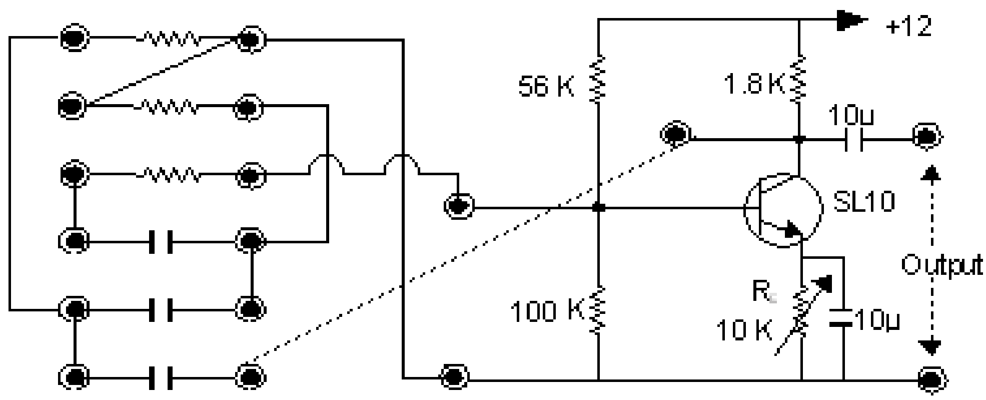

Fig. 2

Step2:

1. Connect the circuit as shown in fig.2
2. Observe output wave on CRO
3. Adjust R_E until you get distortionless output
4. Measure the frequency of this wave using CRO
5. Calculate the theoretical frequency using formula given below and compare this with the measured frequency. Both the frequencies should be almost equal.

$$f_c = \frac{1}{2\pi RC\sqrt{6}} = \frac{1}{2\pi \times 10 \times 10^{3} \times 0.01 \times 10^{-6}\sqrt{6}} = 650\text{ Hz}$$

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I R I S E T
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EXPERIMENT NO. EL8

CRYSTAL OSCILLATOR

AIM

To study the conditions required for oscillations with a crystal oscillator

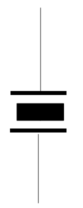
Principle

A crystal oscillator circuit comprises of

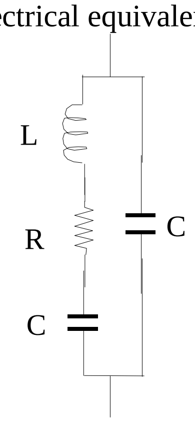
- A crystal acting as a tank circuit for generating the oscillations; these oscillations are not sustained ones
- A transistor amplifier circuit for amplifying the output of the crystal to get sustained oscillations

Theory

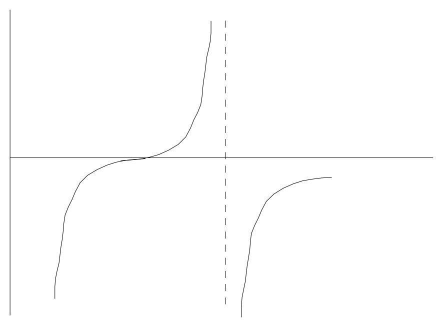
The crystal acting as the tank circuit provides the necessary source for oscillations. It can be represented by an electrical equivalent circuit as shown below in fig. 1



Crystal Symbol



Elecrical Equivalent circuit of Crystal



Reactance curve of a crystal

Fig .1. Crystal representation

Apparatus required

1. RC crystal oscillator experiment trainer kit comprising of
    - Crystal
    - Single stage transistor amplifier
    - 12VDC power supply
2. CRO
3. Connecting wires

Procedure

Connect the crystal and the single stage transistor amplifier as shown in the circuit diagram of fig.3 following the below given directions

1. Connect the collector output (RED) terminal to the trimming capacitor end (RED) terminal of the crystal
2. Connect the crystal other end (BLUE) terminal to the base input (BLUE) terminal of transistor amplifier
3. Switch on the supply
4. Observe output wave on CRO
5. Adjust R_E until you get distortion less output as shown below
6. Measure the frequency of this wave using CRO. This frequency should be equal to the resonant frequency of the crystal.

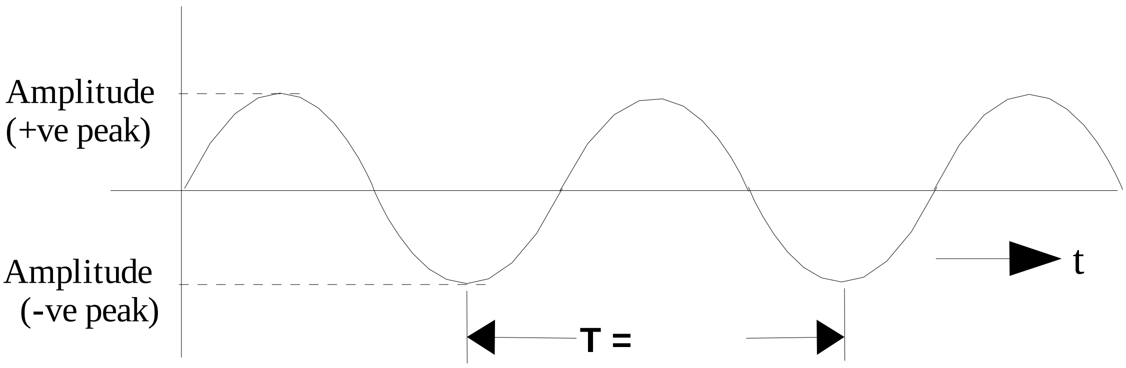


Fig. 2 Output waveform

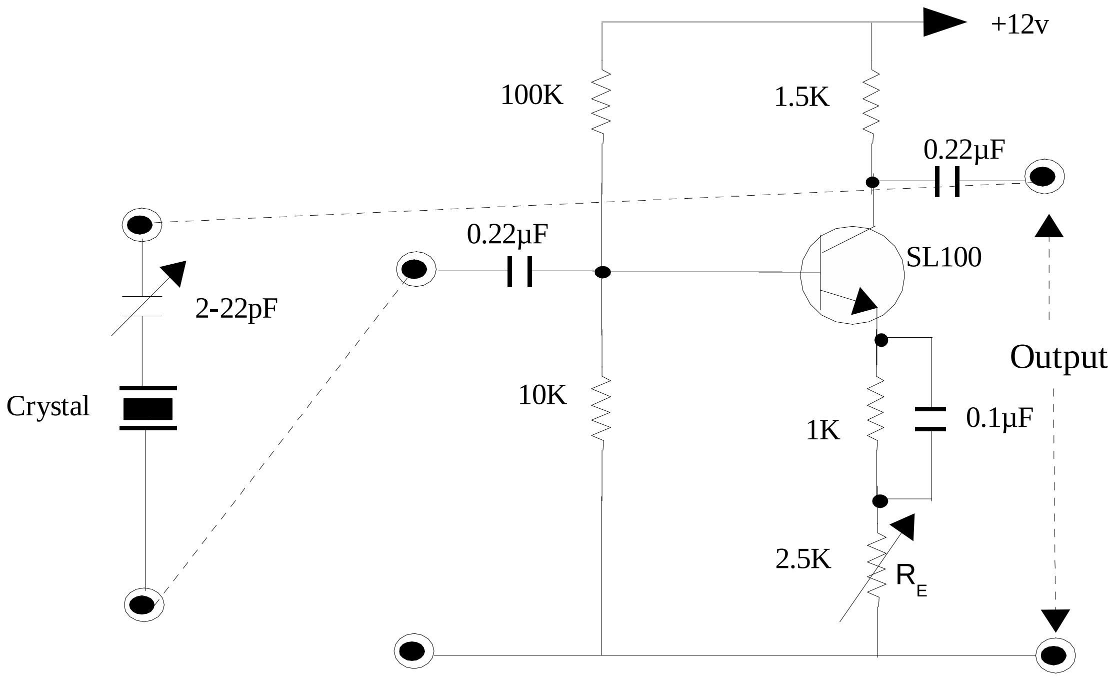


Fig. 3. Crystal oscillator circuit diagram

Review questions:

1. What is the output frequency of this oscillator?

2. What is the frequency of the crystal used?

3. Write down the amplitudes and T period of the output wave in the fig.2

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I R I S E T
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EXPERIMENT NO. EL9

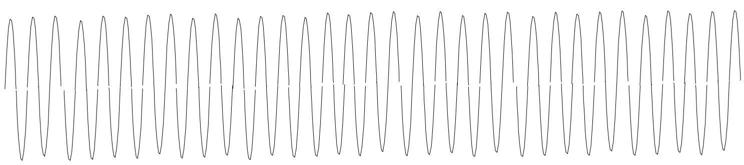
AMPLITUDE MODULATION / DEMODULATION

Aim

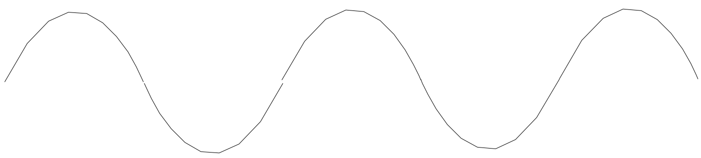
To study the amplitude modulation and demodulation processes

Introduction

It is practically not possible to set up a communication system to transmit directly a low frequency speech signal by wireless transmission. Hence a high frequency signal (RF) is used as carrier for transmitting the low frequency voice signal. These two frequencies are combined by one of the processes of modulation, for the sake of transmission. One of them is – *Amplitude Modulation.* In this method the amplitude of the carrier is modified as per the variations of the low frequency voice signal.



Carrier signal (High frequency)



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Modulating signal (Low frequency)

Fig.1

Apparatus Required

- Experimental model for Amplitude modulation
- Dual channel CRO
- AF Oscillator

Description

The given experimental model consists of

- High frequency internal Oscillator for carrier frequency generation
- Amplitude modulator
- Provision for feeding external AF frequency
- Detector for demodulation purpose

Amplitude Modulation

Objective: To generate Double Sideband Amplitude Modulation with carrier present or suppressed and to analyse the frequency components of the signal.

Procedure

- Switch on the unit and wait for 5 minutes for warm up
- Connect CRO channel1 to the RF input terminal of the modulator
- Adjust the controls for sine wave on CRO and measure this frequency
- Turn the DC LEVEL control fully clockwise and now connect CRO to modulator output and observe RF signal
- Reduce the DC LEVEL and note that the RF signal also reduces. This is because the output of modulator is the product of a constant (the DC at the input) and the RF signal at the input
- Turn the DC LEVEL fully anti-clockwise. Connect the AF oscillator to the AF input terminal on the modulator unit and adjust controls to give 10kHz signal at 4volts peak to peak amplitude
- Connect CRO channel 2 to AF input terminals and adjust trigger for steady display
- With the DC LEVEL still fully anti-clockwise the wave form at modulator output should look like the figure below. This is double side band modulation with suppressed carrier.

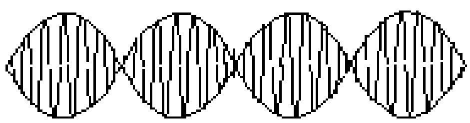


Fig.2
Double Side Band (DSB) Amplitude Modulation with suppressed carrier

- Keeping modulating AF signal constant at about 2v p-p gradually increase the DC LEVEL. Note the way in which the waveform at the output changes. Increase the DC LEVEL until the output waveform looks like below

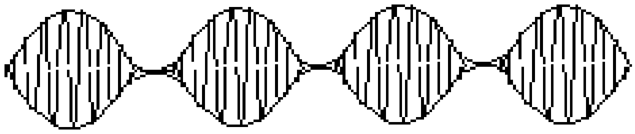


Fig.3
Double Side Band (DSB) Amplitude Modulation with carrier present

- This is double side band amplitude modulation with carrier present such that the dc input equals the peak value of the modulating AF signal. The modulation index is 100%.
- Connect the modulator output to the tuned circuit input, at the top right side of the panel
- Connect CRO channel 1 to the buffer output of tuned circuit. Adjust the tuned circuit control to resonate at f_c, carrier frequency. Measure the amplitude of this carrier signal. + 10kHz
- It is known that the modulated signal consists of three frequency components. One is carrier and two side bands. If AF signal is 10kHz then these two side bands are f_c + 10kHz and f_c - 10kHz.
- By adjusting tuned circuit measure amplitudes of each one of these. Two side bands will be equal and with 100% modulation index the amplitude of carrier should be double that of the side bands.
- Adjust Tuned circuit control to carrier frequency and monitor its amplitude in CRO while reducing the DC LEVEL to zero. The carrier becomes zero.
- Measure the side bands amplitudes in this condition.

Detection or **Demodulation**

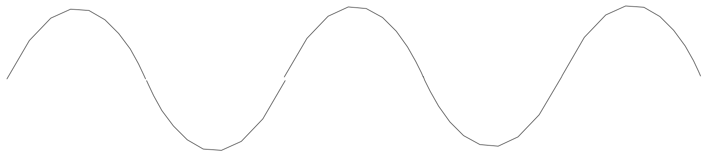
Objective: To demonstrate the Demodulation of double side band signal with carrier and with suppressed carrier.

1. **Demodulation with carrier present***

Procedure

- ♦ Connect AF signal to the AF input terminal. Connect CRO channel1 to the same terminal.
- ♦ Set AF signal to 100Hz at 5v p-p amplitude
- ♦ Connect modulator output to the diode input on the panel

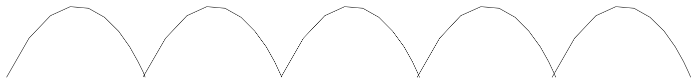
- Connect CRO channel 2 to the modulator output. By adjusting DC LEVEL control obtain 100% modulation index
- Now transfer CRO channel 2 to diode output terminal and observe the trace. This should show the envelop of the modulated signal, which is the original AF signal as shown below



Demodulated wave with carrier present

2. Demodulation with suppressed carrier

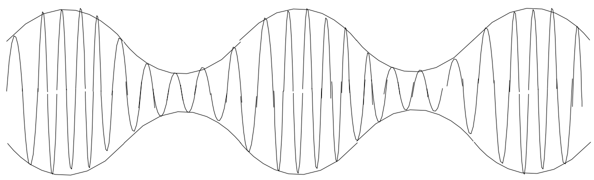
- Slowly reduce the DC LEVEL to zero and observe trace on CRO channel 2. The demodulated waveform gets distorted and becomes like a full-wave rectified sine wave as shown below



Demodulated wave with carrier suppressed

Exercise:

Q1. Adjust the DC Level to get a wave form like below and mention what could its modulation index.



Ans:

Q2. Write a brief summary of your observations and conclusions on the findings through this experiment.

Ans:

***** A simple diode with a smoothing capacitor can be used to demodulate a double side band signal provided the carrier is present. If the carrier is not present the demodulated signal gets distorted.

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EXPERIMENT NO. EL10

FREQUENCY MODULATION / DEMODULATION

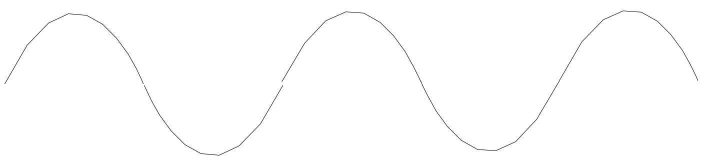
Aim

To study the frequency modulation and demodulation processes

Introduction

The second modulation technique used in communication is – *Frequency Modulation.* In this method the frequency of the carrier is modified as per the variations in the low frequency voice signal.

Carrier (High frequency)



Modulating signal (Low frequency)

Apparatus Required

- Experimental model for Frequency modulation
- Dual channel CRO
- AF signal generator

Description

The given experimental model for consists of

- High frequency internal Oscillator for carrier frequency generation
- Two Frequency modulators
- Provision for feeding external AF frequency
- Discriminator for demodulation purpose

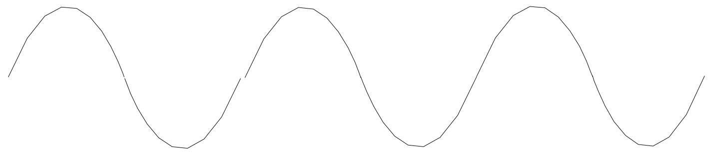
Frequency Modulation

Objective :

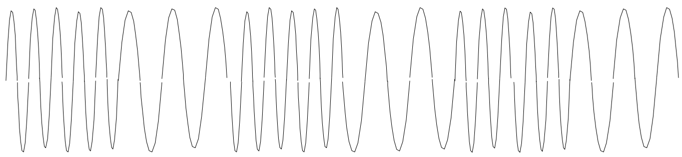
To observe a frequency modulated signal and to measure the voltage to frequency conversion factor.

Procedure

- Switch on the unit and allow it to warm up for 5 minutes
- Connect CRO channel 1 to the output of the 1st frequency modulator (upper one). Adjust the trigger to display the carrier signal steadily.
- Connect DC volts terminal to the input terminal of 1^{st} modulator. Set DC volts knob to mid position. Observe the carrier wave on CRO and measure its amplitude and frequency.
- Rotate the DC volts knob to max. position (+). Observe that the frequency of carrier increases. Now rotate the DC volts knob to min. position (-). Observe that the frequency of carrier decreases.
- This is the principle of frequency modulation
- Disconnect the modulator input from the DC volts terminal and connect it to the AF signal generator.
- Connect the oscilloscope to the modulator input terminal and adjust AF signal level to 10v p-p at 10kHz. Still keeping the trigger for the carrier trace, observe both the traces on the screen.
- Now carefully adjust AF frequency until both the traces are steady. They look like in figure below



Modulating signal



Modulated Carrier

- It is observed that by changing AF signal wave a change in the carrier frequency is also noticed
- Now it is necessary to observe at the modulator output how much frequency deviation per a volt change at the input.
- Disconnect the AF signal generator and reconnect between DC volts terminal and 1^{st} modulator input. Keep CRO channel 2 connected to the modulator input.
- Connect modulator output to buffer (spectrum analyser) input and CRO channel 1 to analyser (buffer) output
- Use CRO channel 2 to set DC volts control to exactly 0 and analyser control to exactly f_c. Adjust the 'Trim f_c ' control on the modulator to obtain a max. response on CRO screen. The modulator centre frequency is now set to f_c. Vary the buffer control knob to familiarise yourself with the quality of the resonant response. This is often known as Q factor.
- Using the oscilloscope set the DC volts control to +1 volt and re-tune the analyser control for max. response. Note the frequency given by the analyser. Do this at various settings of DC volts both positive and negative. Plot a gragh of frequency deviation versus DC voltage and by a straight line obtain the voltage to frequency conversion factor α in kHz per volt

Conclusion

The frequency modulator converts voltage at the input to frequency deviation at the output with a factor of α as measured.

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I R I S E T
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EXPERIMENT NO. EL11

TIME DIVISION MULTIPLEXING / DEMULTIPLEXING

Aim

To understand the principles of Time Division Multiplexing / Demultiplexing used in digital communication

Introduction

For transmitting no. of analog information channels over digital communication systems like electronic exchanges, digital microwave and OFC communication links etc. they must be converted to digital form by PCM technique and then multiplexed (or combined) by Time Division Multiplexing.

Purpose

This experimental module demonstrates both TD multiplexing and demultiplexing. It accommodates

1. Sample & Hold and Time Division Multiplexer
2. Time Division Demultiplexer
3. Low pass filter

Apparatus Required

- Sampling & TDM experimental model
- Dual channel CRO
- AF Oscillator

PROCEDURE:

Step1

- Switch on the unit
- Set the sampling rate to 2KHz
- Keep pulse width knob in mid-position
- Connect CRO channel1 to input channel1 (1KHz+3KHz)
- Observe output of T.D. multiplexer on CRO channel2
- Draw its shape in below space

Step2

- Connect the output of multiplexer to the input of T.D. demultiplexer
- On CRO channel2 observe the wave shape at channel1 output from 1st low pass filter
- Compare this with the signal on CRO channel1

Step3

- Feed external input of 2KHz on channel2 input of the unit
- Observe on CRO channel2 the output of channel at 2nd low pass filter
- Record its shape in below space

Step4

- Repeat the steps 1 & 2
- Now set the sampling rate at 4KHz
- Repeat steps 1& 2
- Record the output signal shapes

Q1. What is the conclusion you come to, after doing this experiment?

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EXPERIMENT NO. EL12

PULSE CODE MODULATION / DEMODULATION

Aim

To study the principles of PCM

Introduction

It is well known that the analog information, like speech signals, music, video etc., must be converted to digital form for transmitting them over a digital communication systems like electronic exchanges, digital microwave and OFC communication links etc. For achieving this conversion the analog signal should undergo the following processes:

- Sampling & Holding
- Quantisation
- Encoding

These processes are shown by this experimental model. It demonstrates all these functions in an integrated form. This means these functions cannot be viewed individually but the end result of converting an analog signal into digital form is achieved.

Apparatus Required

- PCM experimental model
- CRO
- AF Oscillator

Procedure

Step1

- Switch on the unit
- Feed 1KHz signal from the AF oscillator at 0 dB level
- set the word length switch to 3 bit first
- set sampling bit rate at 4 KHz
- Observe the output of PC modulator

Step2

- Connect modulator output to pulse code demodulator
- Observe on the CRO
- Selecting bit rate of 8KHz, 12KHz,16KHz repeat these steps

Q1. What is the conclusion you come to, at end of this experiment.