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Lab Manual:

ANALOG AND PULSE CIRCUITS LABORATORY (AECB11)

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INTRODUCTION

1.1 Introduction

This course is intended to enhance the learning experience of the student in topics encountered in Analog and Pulse circuits Course AECB11.In this lab, students are expected to develop the practical skills required to do the experiments and gain experience in using the basic measuring devices used in Electronics and Communication Engineering. Students also learn to interpret the experimental results in terms of the concepts introduced in the Analog and Pulse circuits course.How the student performs in the lab depends on his/her preparation and participation. Each student must participate in all aspects of the lab to ensure a thorough understanding of the equipment and concepts. The student, Faculty teaching the lab course, Laboratory In-charge and faculty coordinator all have certain responsibilities towards successful completion of the lab's goals and objectives.

1.1.1 Student Responsibilities

The student is expected to come prepared for each lab.Lab preparation includes understanding the lab experiment from the lab manual and reading the related textbook material.

Students have to write the allotted experiment for that particular week in the work sheets given and carry them to the Lab. In case of any questions or problems with the preparation, students can contact the Faculty Teaching the Lab course, but in a timely manner.

Students have to be in formal dress code, wear shoes and lab coat for the Laboratory Class.

After the demonstration of experiment by the faculty, student has to perform the experiment individually. They have to note down the observations in the observation Tables drawn in work sheets, do the calculations and analyze the results.

Active participation by each student in lab activities is expected. The student is expected to ask the Faculty any questions they may have related to the experiment.

The student should remain alert and use commonsense while performing the lab experiment.They are also responsible for keeping a professional and accurate record of the lab experiments in the files provided.

1.1.2 Responsibilities of Faculty Teaching the Lab Course

The Faculty shall be completely familiar with each lab prior to the laboratory. He/She shall provide the students with details regarding the syllabus and safety review during the first week.Lab experiments should be checked in advance to make sure that everything is in working order.The Faculty should demonstrate and explain the experiment and answer any questions posed by the students.Faculty have to supervise the students while they perform the lab experiments. The Faculty is expected to evaluate the lab worksheets and grade them based on their practical skills and understanding of the experiment by taking Viva Voce. Evaluation of work sheets has to be done in a fair and timely manner to enable the students, for uploading them online through their CMS login within the stipulated time.

1.1.3 Laboratory In-charge Responsibilities

The Laboratory In-charge should ensure that the laboratory is properly equipped, i.e., the Faculty teaching the lab receive any equipment/components necessary to perform the experiments.He/She is responsible for ensuring that all the necessary equipment for the lab is available and in working condition. The Laboratory In-charge is responsible for resolving any problems that are identified by the teaching Faculty or the students.

1.1.4 Course Coordinator Responsibilities

The course coordinator is responsible fo rmaking any necessary corrections in Course Description and lab manual. He/She has to ensure that it is continually updated and available to the students in the CMS learning Portal.

1.2 Lab Policy and Grading

The student should understand the following policy:

ATTENDANCE: Attendance is mandatory as per the academic regulations.

LAB RECORD's: The student must:

1. Write the work sheets for the allotted experiment and keep them ready before the beginning of eachlab.
2. Keep all work in preparation of and obtained during lab.
3. Perform the experiment and record the observations in the worksheets.
4. Analyze the resultsand get the work sheets evaluated by the Faculty.
5. Upload the evaluated reports online from CMS LOGIN within the stipulated time.

Grading Policy:

The final grade of this course is awarded using the criterion detailed in the academic regulations. A large portion of the student's grade is determined in the comprehensive final exam of the Laboratory course (SEE PRACTICALS),resulting in a requirement of understanding the concepts and procedure of each lab experiment for successful completion of the lab course.

Pre-Requistes and Co-Requisties:

The lab course is to be taken during the same semester as AECB15, but receives a separate grade. Students are required to have completed AECB11 with minimum passing grade or better grade in each.

1.3 Course Goals and Objectives

The Analog and Pulse circuits Laboratory course is designed as a foundation course to provide the student with the knowledge to understand the basic concepts in Analog and Pulse circuits which have lot of applications in the field of Engineering.

The experiments are designed to complement the concepts introduced in AECB11. In addition, the student should learn how to record experimental results effectively and present these results in a written report.

More explicitly, the class objectives are:

- The concept of single stage amplifiers using frequency response of transistor in CE configuration.
  - The behavior of transistor at high frequency using multistage amplifier
  - To enhance understanding of theoretical concepts including:
  - The working and plot the frequency response of single tuned amplifier
  - The resonant frequency, gain and bandwidth of a single tuned voltage amplifier
  - The concept of feedback in amplifiers and plot the frequency response of current shunt and voltage series feedback amplifier.
- Types of oscillators the practical frequency of RC Phase shift oscillators.
- The theoretical and practical frequencies for Hartley and colpitts oscillators by changing the capacitor values.
  - The behavior of output which is altered using linear wave shaping and non linear wave shaping.
  - The linear wave shaping circuits for square wave input for different time constant.
  - nonlinear wave shaping circuits for square wave input for different time constant.
  - The switching times of transistors to relate ton and toff time period with theoretical values.
  - Timing circuits using cross coupled transistors to check the output wave forms across two transistors
  - Interference in thin Films
  - Diffraction due to Single slit
- To develop communication skills through:
  - Verbal interchanges with the Faculty and other students.
  - Preparation of succinct but complete laboratory reports.
  - Maintenance of laboratory worksheets as permanent, written descriptions of procedures, analysis and results.
- To compare theoretical predictions with experimental results and to determine the source of any apparent errors.

1.4 Use of Laboratory Instruments

One of the major goals of this lab is to familiarize the student with the proper equipment and techniques for conducting experiments. Some understanding of the lab instruments is necessary to avoid personal or equipment damage.By understanding the device's purpose and following a few simple rules, costly mistakes can be avoided.

The following rules provide a guideline for instrument protection.

1.4.1 Instrument Protection Rules

- check the proper ground connections to avoid errors in multisim.
- checks the presents of node where ever necessary.
- Study the analog discovery kits for proper connection with waveform generator.

1.5 Data Recording and Reports

1.3.1 The Laboratory Worksheets Students must record their experimental values in the provided tables in this laboratory manual and reproduce them in the lab worksheets. Worksheets are integral to recording the methodology and results of an experiment. In engineering practice, the laboratory worksheet serves as an invaluable reference to the technique used in the lab and is essential when trying to duplicate a result or write a report. Therefore, it is important to learn to keep accurate data. Make plots of data and sketches when these are appropriate in the recording and analysis of observations. Note that the data collected will be an accurate and permanent record of the data obtained during the experiment and the analysis of the results. You will need this record when you are ready to prepare a lab worksheet.

1.5.1 The Laboratory Worksheets

Reports are the primary means of communicating your experience and conclusions to other professionals. In this course you will use the lab report to inform your LTA about what you did and what you have learned from the experience. Engineering results are meaningless unless they can be communicated to others. You will be directed by your LTA to prepare a lab report on a few selected lab experiments during the semester. Your laboratory report should be clear and concise. The lab report shall be typed on a word processor. As a guide, use the format on the next page. Use tables, diagrams, sketches, and plots, as necessary to show what you did, what was observed, and what conclusions you can draw from this. Even though you will work with one or more lab partners, your report will be the result of your individual effort in order to provide you with practice in technical communication.

Formatting and Style The lab report shall be hand written in a lab worksheet. The first line of each paragraph should have a left indent. All the tables should have titles and should be numbered. Tables should be labeled numerically as Table 1, Table 2, etc. Table captions appear above the table. Graphs should be presented as figures. All the figures should have titles and should be numbered. Figure captions appear below the figure. Graphs should have labeled axes and clearly show the scales and units of the axes. All the figures and tables must be centered on the page. Do not place screenshots of your lab worksheet.

1.5.2 The Laboratory Files/Reports

Questions pertaining to this lab must be answered at the end of laboratory report. 7

LAB-1 ORIENTATION

2.1 Introduction

In the first lab period, the students should become familiar with the location of equipment and components in the lab, the course requirements, and the teaching instructor. Students should also make sure that they have all of the co-requisites and pre-requisites for the course at this time.

2.2 Objective

To familiarize the students with the lab facilities, equipment, standard operating procedures, lab safety, and the course requirements.

2.3 Prelab Preparation:

Read the Introduction and Appendix A, of this manual. Download and install the “Multisim 14.0 edition” and “Waveform genarator “ software on your personal computer.

2.4 Equipment needed

2.4.1 Hardware Requirements:

1. Analog Discovery 2 Instrument.
2. Personal computer.
3. Trainer Kit.
4. Connecting jumper and Connecting Wires.

2.4.2 Software Requirements:

1.Muitisim software 14.0 edition.
2.Waveform generator software.

2.5 Procedure

1. During the first laboratory period, the instructor will provide the students with a general idea of what is expected from them in this course. Each student will receive a copy of the syllabus, stating the instructor’s contact information. In addition, the instructor will review the safety concepts of the course.

2. During this period, the instructor will briefly review the equipment which will be used throughout the semester. The location of instruments, equipment, and components (e.g. resistors, capacitors, connecting wiring) will be indicated. The guidelines for instrument use will be reviewed.

LAB-2 BASIC AMPLIFIER

3.1 Introduction

The CE amplifier provides high gain wide frequency response. The input signal is applied to base terminal of the transistor and amplifier output is taken across collector terminal. A very small change in base current produces a much larger change in collector current. Frequency response of an amplifier is defined as the variation of gain with respective frequency.

3.2 Objective

By the end of this lab, the student should learn how to Calculate the maximum gain and bandwidth using bode plotter. Compare the values with the practical circuit values. Also, the student should understand the output which is amplified for respective input.

3.3 Prelab Preparation:

Read the Introduction and Appendix A, of this manual. Download and install the "Multisim 14.0 edition software" on your personal computer.

3.4 Equipment needed

3.4.1 Hardware Requirements:

1. Analog Discovery 2 Instrument.
2. Personal computer.
3. Trainer Kit.
4. Connecting jumper and Connecting Wires.

3.4.2 Software Requirements:

1.Muitisim software 14.0 edition.
2.Waveform generator software.

3.5 Background

• The CE amplifier provides high gain wide frequency response. The emitter lead is common to both input and output circuits and is grounded.The emitter base is forward biased. The collector current is controlled by the base current rather than emitter current.
• The input signal is applied to base terminal of the transistor and amplifier output is taken

across collector terminal. A very small change in base current produces a much larger change in collector current.
• Frequency response of an amplifier is defined as the variation of gain with respective frequency.The gain of the amplifier increases as the frequency increases from zero till it becomes maximum at lower cut-off frequency and remains constant till higher cut-off frequency and then it falls again as the frequency increases At low frequencies the reactance of coupling capacitor CC is quite high and hence very small part of signal will pass through from one stage to the next stage .
• At low frequencies the reactance of coupling capacitor CC is quite high and hence very small part of signal will pass through from one stage to the next stage At high frequencies the reactance of inter electrode capacitance is very small and behaves as a short circuit.
This increases the loading effect on next stage and service to reduce the voltage gain due to these reasons the voltage gain drops at high frequencies. At mid frequencies the effect of coupling capacitors is negligible and acts like short circuit, where as inter electrode capacitors acts like open circuit. So, the circuit becomes resistive at mid frequencies and the voltage gain remains constant during this range.

3.6 Procedure

Part (0) After answering the following questions, review the laboratory exercise procedures and plan how you will use the experience gained in these calculations to find the values sought!

Step 1: Connect the circuit diagram as shown in figure Adjust input signal amplitude in the function generator and observe an amplified voltage at the output without distortion.

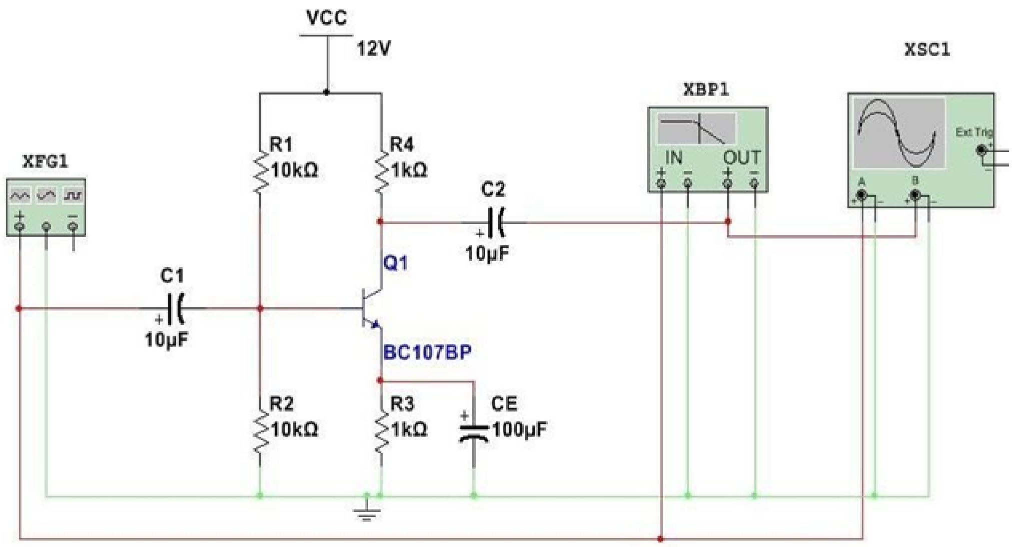


Figure 3.1:

Step 2: By keeping input signal voltages at 50mV, vary the input signal frequency from 0 to 1MHz in steps as shown in tabular column and note the corresponding output voltages (You can change it later from project window.)

Step 3: Save the circuit and simulate.

Step 4: Calculate the maximum gain and bandwidth using bode plotter. Compare the values with the practical circuit values

Table 3.1: Obervation Table

Frequency in HZ	Gain in DB
200	
600	
1k	
2K	
3K	
4K	
5K	
6K	
7K	
8K	

3.7 Precautions

1. Use the updated version of the Multisim 14.0edition tool.
2. Make sure proper circuit connections.
3. Observe the results carefully in CRO and Bode Plotter.

3.8 Further Probing Experiments

Q1. Plot the frequency response of CE amplifier with different values input and output capacitors?

Q2. Design a CB amplifier with different biasing values, Summarize your comparisons with CE Amplifier? Justify your conclusion?

Q3. Design a CE amplifier for gain = 80db and find bandwidth?

LAB-3 TWO STAGE RC COUPLED AMPLIFIER

4.1 Introduction

As the gain provided by a single stage amplifier is usually not sufficient to drive the load, so to achieve extra gain multi-stage amplifier are used. In multi-stage amplifiers output of one- stage is coupled to the input of the next stage. The coupling of one stage to another is done with the help of some coupling devices. If the circuit is coupled by RC to next stage is called rc coupled amplifier.

4.2 Objective

4.2.1 Educational

- Learn to measure Gain.
- Understand how bandwidth is calculated in frequency response t.
- Learn to simulate Multisim software.

4.2.2 Experimental

- Explain the need for cascading and advantages of RC coupled amplifier.
- Determine the effect of bypass Capacitor on frequency response.
- Explain the of types of Coupling Schemes for Cascading.

4.3 Prelab Preparation:

4.3.1 Reading

- Read and study the Background and procedure sections of this Laboratory.

4.3.2 Written

- After coming to lab, student should write the experiment on the worksheets provided by the teaching faculty on his/her own.

4.4 Equipment needed

4.4.1 Hardware Requirements:

1. Analog Discovery 2 Instrument.
2. Personal computer.
3. Trainer Kit.
4. Connecting jumper and Connecting Wires.

4.4.2 Software Requirements:

1.Muitisim software 14.0 edition.
2.Waveform generator software.

4.5 Background

A capacitor is formed whenever two conductors are separated by an insulating material. Consider the simple example of two parallel conducting plates separated by a small gap that is filled with an insulating material (vacuum, air, glass, or other dielectric). If a potential difference exists between the two plates, then an electric field exists between them, and opposite electric charges will be attracted to the two plates. The ability to store that electric charge is a fundamental property of capacitors. The larger the plates, the more charge can be stored. The closer the plates, the more charge can be stored at least until the charges leap the gap and the dielectric breaks down.
• If a voltage source is connected across a capacitor, charge will flow in the external circuit until the voltage across the capacitor is equal to the applied voltage. The charge that flows is proportional to the size of the capacitor (its "capacitance") and to the applied voltage. The relationship is given by the equation: Q = CV.
• where Q is the charge in coulombs, C is the capacitance in farads, and V is the applied voltage in volts.

•Frequency response of an amplifier is defined as the variation of gain with respective frequency. The gain of the amplifier increases as the frequency increases from zero till it becomes maximum at lower cut-off frequency and remains constant till higher cut-off frequency and then it falls again as the frequency increases.
•At low frequencies the reactance of coupling capacitor CC is quite high and hence very small part of signal will pass through from one stage to the next stage.
•At high frequencies the reactance of inter electrode capacitance is very small and behaves as a short circuit. This increases the loading effect on next stage and service to reduce the voltage gain due to these reasons the voltage gain drops at high frequencies.
•At mid frequencies the effect of coupling capacitors is negligible and acts like short circuit, where as inter electrode capacitors acts like open circuit. So, the circuit becomes resistive at mid frequencies and the voltage gain remains constant during this range

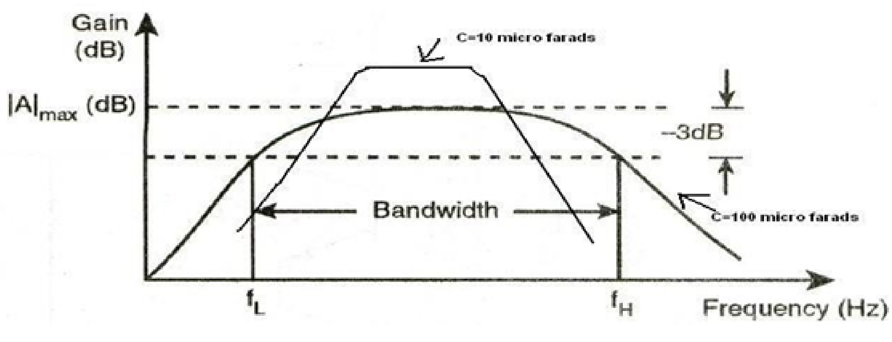


Figure 4.1:

4.6 Procedure

Step 1: Connect the circuit as shown in figure for 10μF.

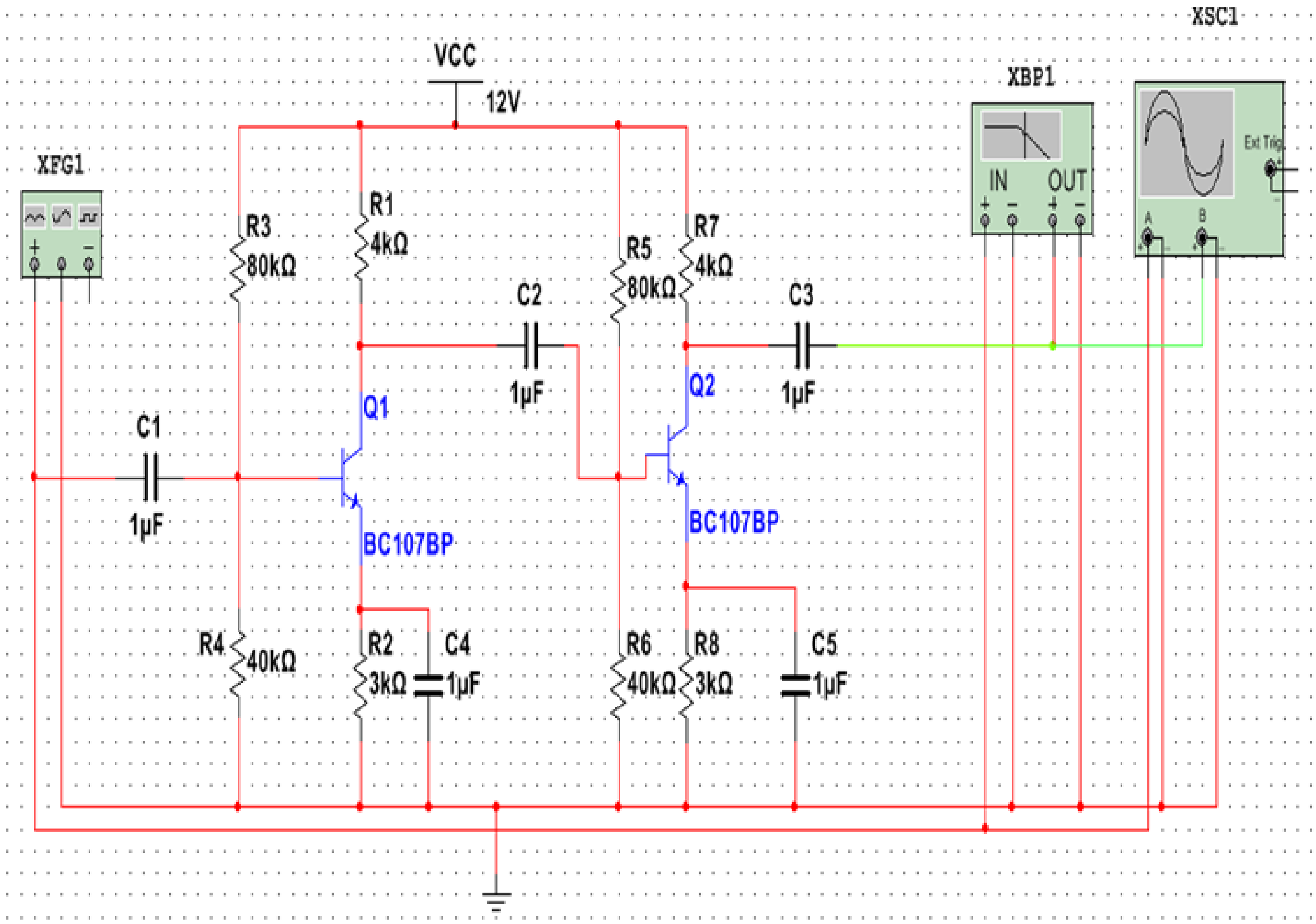


Figure 4.2:

Step 2: Adjust input signal amplitude in the function generator and observe an amplified voltage at the output without distortion.

Step 3: By keeping input signal voltage, say at 50 mV, vary the input signal frequency from 0-1 MHz as shown in tabular column and note the corresponding output voltage Save the circuit and simulate

Step 4: Calculate the maximum gain and bandwidth using Bode plotter. Compare the values with the practical circuit values Repeat the same procedure for C=100μF.

4.7 Precautions

1. Use the updated version of the Multisim 14.0edition tool.
2. Make sure proper circuit connections.
3. Observe the results carefully in CRO and Bode Plotter.

Table 4.1: Observation Table

Frequency in HZ	Gain in DB
200	
600	
1k	
2K	
3K	
4K	
5K	
6K	
7K	
8K	

4.8 Further Probing Experiments

Q1. Obtain expressions for voltage gain at middle and low frequency for two stage RC-coupled amplifier.

Q2. . Obtain the expression for CE Current gain with RL and explain the variation of frequency response with RL using hybrid-πmodel.

Q3. Explain how f and fT of a BJT can be determined to obtain the expression for the Gain Bandwidth product of a transistor.

LAB-4 FEEDBACK AMPLIFIERS

5.1 Introduction

This laboratory continues the study of Feedback which plays a very important role in electronic circuits and the basic parameters, such as input impedance, output impedance, current and voltage gain and bandwidth, may be altered considerably by the use of feedback for a given amplifier. A portion of the output signal is taken from the output of the amplifier and is combined with the normal input signal and thereby the feedback is accomplished.

5.2 Objective

5.2.1 Educational

• Learn concepts of feedback and need for feedback in amplifiers.
• Learn to measure current shunt feedback amplifier circuit with and without capacitor.
• Learn the voltage series feedback amplifier.

5.2.2 Experimental

• Determine Frequency responses for voltage series (with and without feedback amplifier).
• Draw frequency responses current shunt with and without capacitor is plotted.
• Determine maximum gain and bandwidth using bode plotter.

5.3 Prelab Preparation:

5.3.1 Reading

• Read and study the Background section of this Laboratory.

5.3.2 Written

• After coming to lab, student should write the experiment on the worksheets provided by the teaching faculty on his/her own.

5.4 Equipment needed

5.4.1 Hardware Requirements:

1. Analog Discovery 2 Instrument.
2. Personal computer.
3. Trainer Kit.
4. Connecting jumper and Connecting Wires.

5.4.2 Software Requirements:

1.Muitisim software 14.0 edition.
2.Waveform generator software.

5.5 Background

Feedback plays a very important role in electronic circuits and the basic parameters, such as input impedance, output impedance, current and voltage gain and bandwidth, may be altered considerably by the use of feedback for a given amplifier. A portion of the output signal is taken from the output of the amplifier and is combined with the normal input signal and thereby the feedback is accomplished. There are two types of feedback. They are i) Positive feedback and ii) Negative feedback Negative feedback helps to increase the bandwidth, decrease gain, distortion, and noise, modify input and output resistances as desired A current shunt feedback amplifier circuit is illustrated in the figure. It is called a series- derived, shunt-fed feedback. The shunt connection at the input reduces the input resistance and the series connection at the output increases the output resistance.

5.6 Procedure

Step 1: Connect the circuit as shown in figure.

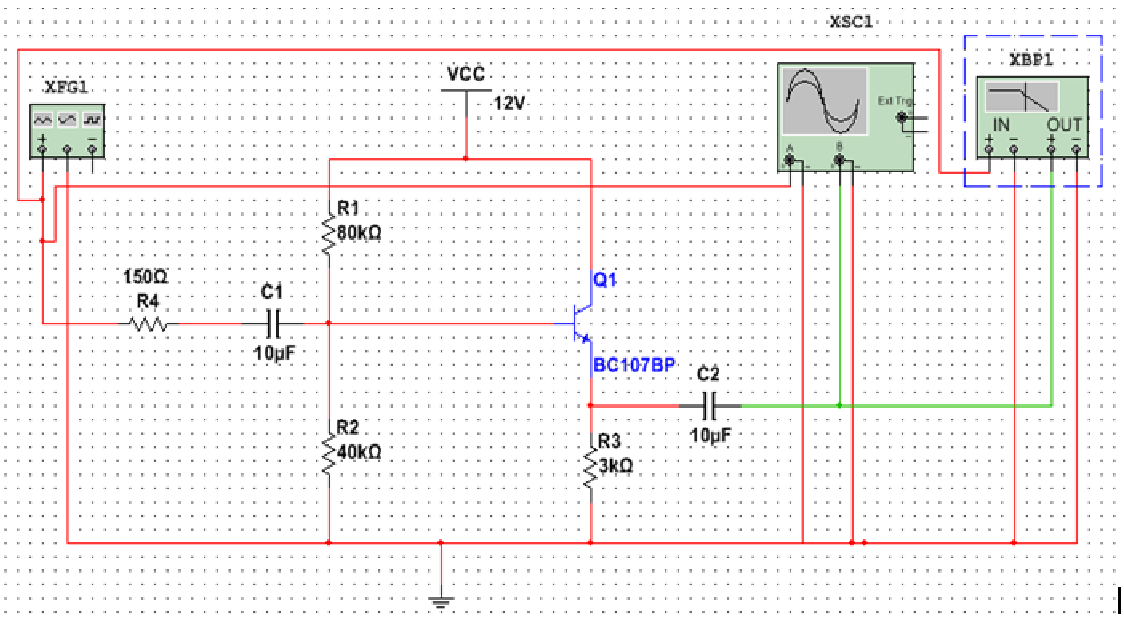


Figure 5.1:

Step 2: Adjust input signal amplitude in the function generator and observe an amplified voltage at the output without distortion.

Step 3: By keeping input signal voltage, say at 50 mV, vary the input signal frequency from 0-1 MHz as shown in tabular column and note the corresponding output voltage.

Step 4: Save the circuit and simulate.

Step 5: For current shunt feedback amplifier with shunt capacitor (with and without capacitor) voltage series feedback amplifier (with and without feedback resistance). Repeat the above procedure.

Step 6: Calculate the maximum gain and bandwidth using Bode plotter. Compare the values with the practical circuit values

Table 5.1: Obervation Table

Frequency in HZ	Gain in DB
200	
600	
1k	
2K	
3K	
4K	
5K	
6K	
7K	
8K	

5.7 Precautions

1. Use the updated version of the Multisim 14.0edition tool.
2. Make sure proper circuit connections.
3. Observe the results carefully in CRO and Bode Plotter.

5.8 Further Probing Experiments

Q1. Design the voltage shunt feedback amplifier and plot the frequency response.

Q2. The gain of an amplifier is decreased to 10,000 with negative feedback from its gain of 60,000. Calculate the feedback factor. Express the amount of negative feedback in db.

LAB-5 SINGLE TUNED AMPLIFIER

6.1 Introduction

Tuned amplifiers are used to for the amplification of a specific frequency signal or a narrowband frequency signal. Basically high frequency or radio frequency signals are amplified using tuned amplifiers. Tuning (i.e., selecting) of frequency is done by using a tuned or resonant circuit at the load..

6.2 Objective

6.2.1 Educational

- Learn the concepts of tuned amplifier.
- Learn the types of tuned amplifiers.

6.2.2 Experimental

- Interface LCD display with 8051 in trainer board using jumpers.
- Understand the hardware connections of interfacing of buzzer and switch with 8051 microcontroller.
- Understand the usage of Keil IDE tool.

6.3 Prelab Preparation:

6.3.1 Reading

- Determine practical frequency of single tuned amplifier.
- Draw frequency responses compare it with theoretical frequency.
- Determine maximum gain and bandwidth using bode plotter.

6.3.2 Written

- After coming to lab, student should write the experiment on the worksheets provided by the teaching faculty on his/her own.

6.4 Equipment needed

6.4.1 Hardware Requirements:

1. Analog Discovery 2 Instrument.
2. Personal computer.

3. Trainer Kit.
4. Connecting Wires.

6.4.2 Software Requirements:

1.Muitisim software 14.0 edition.
2.Waveform generator software.

6.5 Background

Tuned amplifiers are amplifiers involving a resonant circuit, and are intended for selective amplification within a narrow band of frequencies. Radio and TV amplifiers employ tuned amplifiers to select one broadcast channel from among the many concurrently induced in an antenna or transmitted through a cable. Selected aspects of tuned amplifiers are reviewed in this note. Parallel Resonant Circuit An idealized parallel resonant circuit, i.e. one described by idealized circuit elements, is drawn below.

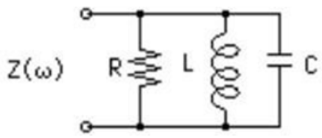


Figure 6.1:

input impedance of this configuration, shown below the circuit diagram, is readily obtained. A modest algebraic restatement in convenient form also is shown. The significance of the definitions of the 'quality factor' Q and the resonant frequency o will become clear from the discussion. The influence of the Q parameter on the tuned-circuit impedance for several values of Q is plotted below for a normalized response.

6.6 Procedure

Step 1: Connect the circuit as shown in figure.

Step 2: Connect the 0.022F capacitor

Step 3: Adjust input signal amplitude in the function generator and observe an amplified voltage at the output without distortion

Step 4: By keeping input signal voltage, say at 50 mV, vary the input signal frequency from 0-200KHz as shown in tabular column and note the corresponding output voltage

Step 5: Repeat the same procedure for 0.033F capacitor.

Step 6: Plot the graph between gain versus frequency.

Step 7: Calculate the f1, f2 and bandwidth.

Step 8: Compare the resonant frequency with theoretical value in both the cases.

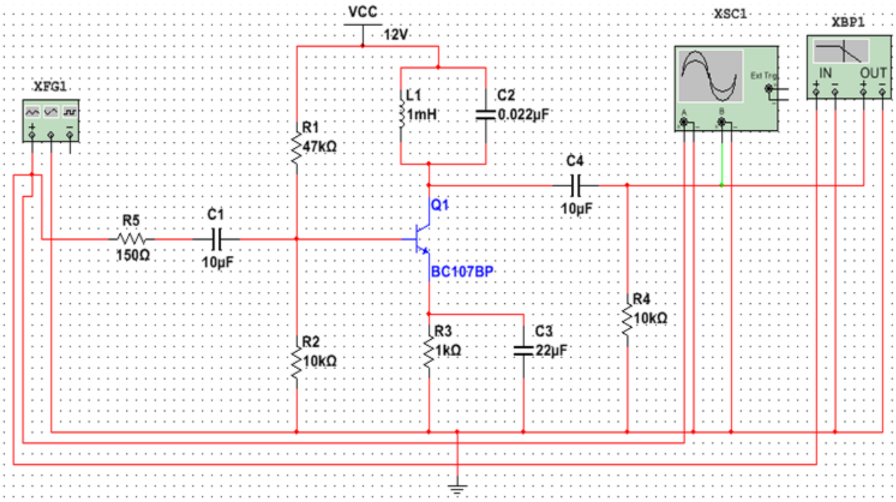


Figure 6.2:

6.7 Precautions

1. Use the updated version of the Multisim 14.0edition tool.
2. Make sure proper circuit connections.
3. Observe the results carefully in CRO and Bode Plotter..

6.8 Expected waveform

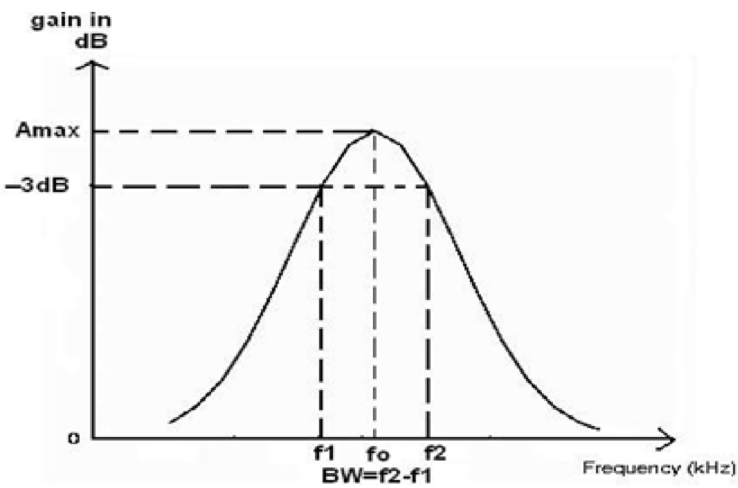


Figure 6.3:

6.9 Tabular Column

TABULAR COLUMN:

	C=0.022μF, V_{in} = 50 mV				C= 0.033μF, V_{in} = 50 mV			
S.No	Frequency (in Hz)	V_o (V)	Gain, A $=V_o/V_i$	Gain(dB) 20 log(V_o/V_i)	Frequency (in Hz)	V_o (V)	Gain, A $=V_o/V_i$	Gain(dB) 20 log(V_o/V_i)
1	100 Hz				100 Hz			
2	200 Hz				200 Hz			
3	400 Hz				400 Hz			
4	800 Hz				800 Hz			
5	1 KHz				1 KHz			
6	2 KHz				2 KHz			
7	4 KHz				4 KHz			
8	8 KHz				8 KHz			
9	10 KHz				10 KHz			
10	20 KHz				20 KHz			
11	40 KHz				40 KHz			
12	80 K Hz				80 K Hz			
13	100 KHz				100 KHz			
14	200 KHz				200 KHz			

Figure 6.4:

6.10 Further Probing Experiments

Q1. Define unloaded and loaded Q of tuned circuit.

Q2. What is the effect of cascading single tuned amplifiers on bandwidth.

Q3. What is the use of Neutralization.What are the different types of neutralization?

LAB-6 RC PHASE SHIFT OSCILLATOR

7.1 Introduction

To find practical frequency of RC phase shift oscillator and to compare it with theoretical frequency for R=10K and C = 0.01F, 0.0022F 0.0033F respectively.

7.2 Objective

7.2.1 Educational

• Learn to concepts of oscillators.
• Learn to types of oscillators.

7.2.2 Experimental

• Determine practical frequency of RC phase shift oscillator.
• Draw frequency responses compare it with theoretical frequency.
• Determine maximum gain and bandwidth using bode plotter.

7.3 Prelab Preparation:

7.3.1 Reading

• Learn the circuit diagram and program given in the background section of this Laboratory exercise.

7.3.2 Written

• After coming to lab, student should write the experiment on the worksheets provided by the teaching faculty on his/her own.

7.4 Equipment needed

7.4.1 Hardware Requirements:

1. Analog Discovery 2 Instrument.
2. Personal computer.
3. Trainer Kit.
4. Connecting Wires.

7.4.2 Software Requirements:

1.Muitisim software 14.0 edition.
2.Waveform generator software.

7.5 Background

RC – phase shift oscillator has a CE amplifier followed by three sections of RC phase shift feedback networks. The output of the last stage is return to the input of the amplifier.the values of R and C are chosen such that the phase shift of each RC section is 600.thus,the RC ladder network produces a total phase shift of 1800 between its input and output voltage for the given frequencies since CE amplifier produces 1800 phase shift the total phase shift from the base of the transistor around the circuit and back to the transistor will be exactly 3600 or 00.The frequency of oscillation is given by F = 1/2RC6

7.6 Procedure

Step 1: Connect the circuit as shown in figure.

Step 2: Connect the 0.0022 F capacitors in the circuit and observe the waveform.

Step 3: Save the circuit and simulate.

Step 4: Calculate the time period and frequency of the resultant wave form. Compare the values with the practical circuit values.

Step 5: Repeat the same procedure for C=0.033 F and 0.01F and calculate the frequency and tabulate as shown.

Step 6: Find theoretical frequency from the formula f = 1/2RC6 and compare theoretical and practical frequency

7.7 Observation

S.No	C(μF)	R(Ω)	Theoretical Frequency (KHz)	Practical Frequency (KHz)	V_o(p-p) (Volts)
1	0.0022	10K			
2	0.0033	10K			
3	0.01	10K			

Figure 7.1:

7.8 Precautions

1. Use the updated version of the Multisim 14.0edition tool.
2. Make sure proper circuit connections.
3. Observe the results carefully in CRO and Bode Plotter.

7.9 Further Probing Experiments

Q1. Design How can we get a maximum phase angle of 90 degrees in RC phase shift oscillator.

Q2. How is phase angle determined in RC phase shift oscillator.

Q3. How can we get a maximum phase angle of 90 degrees in RC phase shift oscillator.

LAB-7 HARTLEY OSCILLATOR AND COLPITTS OSCILLATOR

8.1 Introduction

To find practical frequency of Hartley and Colpitt's oscillator and to compare it with theoretical Frequency for L= 5mH and C= 0.001uF, 0.0022uF, 0.0033uF respectively.

8.2 Objective

8.2.1 Educational

• Learn the Hartley oscillator.
• Learn the Colpitts oscillator.
• Learn the difference between hartley and colpitts oscillator in terms of frequency.

8.2.2 Experimental

• Understand the frequency of oscillation is approximately the resonant frequencyof the tank circuit.
• Understand the frequency of oscillation if two uncoupled coils of inductance L1 and L2 are used .

8.3 Prelab Preparation:

8.3.1 Reading

• Understand the circuit diagram given in the background section of this Laboratory exercise.
• Learn the program given in the background section of this Laboratory exercise.

8.3.2 Written

• After coming to lab, student should write the experiment on the worksheets provided by the teaching faculty on his/her own.

8.4 Equipment needed

8.4.1 Hardware Requirements:

1. Analog Discovery 2 Instrument.
2. Personal computer.
3. Trainer Kit.

4. Connecting Wires.

8.4.2 Software Requirements:

1.Muitisim software 14.0 edition.
2.Waveform generator software.

8.5 Background

•The Hartley oscillator is an electronic oscillator circuit in which the oscillation frequency is determined by a tuned circuit consisting of capacitors and inductors, that is, an LC oscillator. The circuit was invented in 1915 by American engineer Ralph Hartley.
•The Hartley oscillator is an electronic oscillatorcircuitin which the oscillation frequency is determined by a tuned circuitconsisting of capacitorsand inductors, that is, an LC oscillator. The circuit was invented in 1915 by American engineer Ralph Hartley. The distinguishing feature of the Hartley oscillator is that the tuned circuit consists of a single capacitor in parallel with two inductors in series (or a single tapped inductor), and the feedbacksignal needed for oscillation is taken from the center connection of the two inductors. The frequency of oscillation is approximately the resonant frequencyof the tank circuit. If the capacitance of the tank capacitor.
• Colpitts oscillator, invented in 1918 by American engineer Edwin H. Colpitts,is one of a number of designs for LC oscillators,electronic oscillatorsthat use a combination of inductors(L) and capacitors(C) to produce an oscillation at a certain frequency.
•The distinguishing feature of the Colpitts oscillator is that the feedbackfor the active device is taken from a voltage dividermade of two capacitors in series across the inductor.The frequency of oscillation is approximately the resonant frequency of the LC circuit, which is the series combination of the two capacitors in parallel with the inductor.

8.6 Procedure for hartley oscillator

Step 1: Connect the circuit as shown in figure.

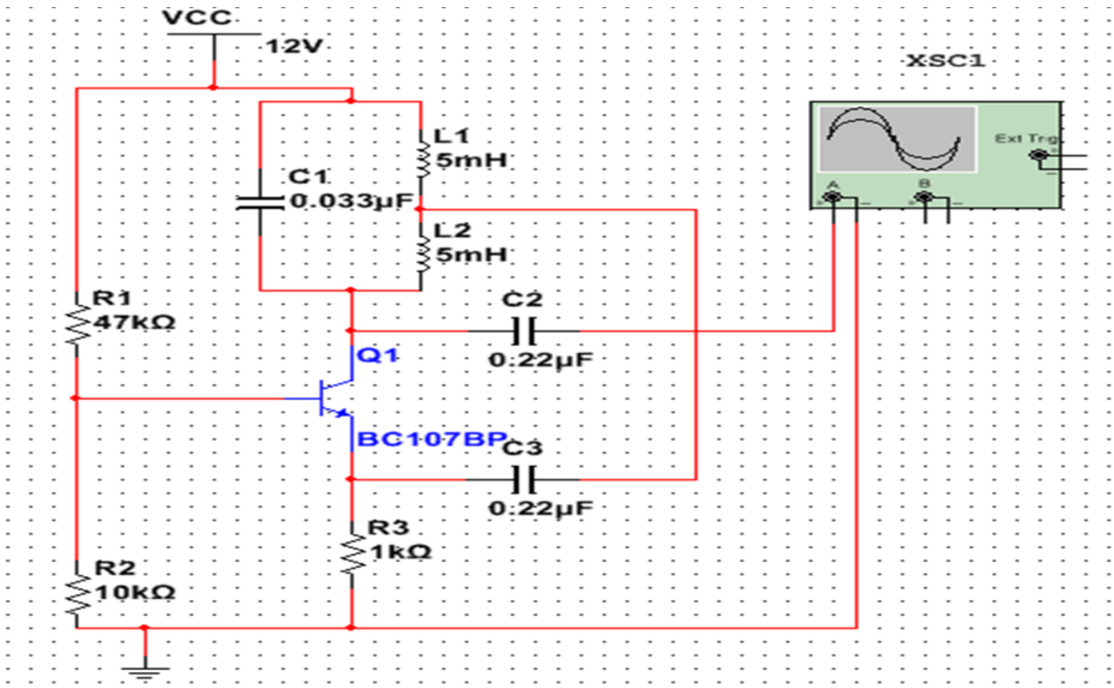


Figure 8.1:

Step 2: Connect 0.01uF capacitor in the circuit and observe the waveform.

Step 3: Note the time period of the waveform and calculate the frequency: f = 1/T .

Step 4: Now connect the capacitance to 0.033 uF and 0.047uF and calculate the frequency and tabulate the readings as shown.

Step 5: Find the theoretical frequency from the formula. Where L T= L1 + L2 = 5 mH + 5mH = 10 mH and compare theoretical and practical values.

8.7 Observation

1. For C = 0.01F, LT = 10 mH;
   Theoretical frequency =
   Practical frequency =

2. For C = $0.033\mu F$, LT = 10 mH;
   Theoretical frequency =
   Practical frequency =

3. For C = $0.047\mu F$, LT = 10 mH;
   Theoretical frequency =
   Practical frequency =

8.8 Procedure for colpitts oscillator

Step 1: Connect the circuit as shown in figure.

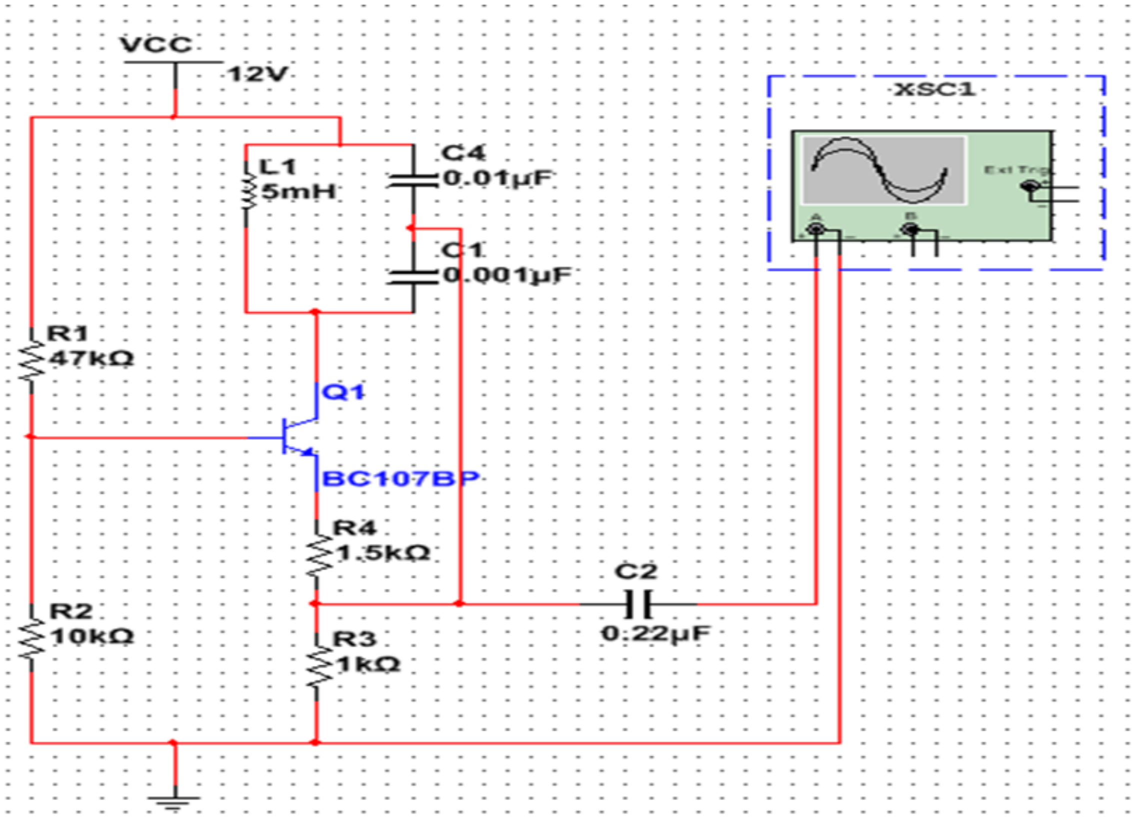


Figure 8.2:

Step 2: Calculate the time period and frequency of the waveform (f=1/T).

S.no	L(mh)	C1 (uf)	C2 (uf)	CT (uf)	Theoretical frequency $f_0 = \frac{1}{2\pi\sqrt{L\left(\frac{C_1C_2}{C_1+C_2}\right)}}$	Practical frequency	Vo(V) p to p
1	5	0.01	0.001				
2	5	0.01	0.0022				
3	5	0.01	0.0033				

Figure 8.3:

8.9 Precautions

1. Use the updated version of the Multisim 14.0edition tool.
2. Make sure proper circuit connections.
3. Observe the results carefully in CRO and Bode Plotter.

8.10 Further Probing Experiments

Q1. What are the types of sinusoidal oscillator? Mention the different types of sinusoidal oscillator

Q2. What are the essential parts of an Oscillator? What is Barkhausan criterion.

Q3. Why is the circuit not oscillating? I'm measuring a DC voltage of 1.87 V at my probe point.

Q4. What's the base cap used for? Just power decoupling.

LAB-8 CLASS A and CLASS B POWER AMPLIFIER

9.1 Introduction

A power amplifier is an electronic amplifier designed to increase the magnitude of power of a given input signal. Then the signal is passed through a tone and volume control circuit, which makes aesthetic adjustments to the audio waveform.

9.2 Objective

9.2.1 Educational

- To study and working of Class A Power Amplifier.
- To calculate efficiency of Class A Power Amplifier.

9.2.2 Experimental

- To study and plot the frequency response of a Class A Power Amplifier.
- To calculate efficiency of Class A Power Amplifier.

9.3 Prelab Preparation:

9.3.1 Reading

- Learn the working of power amplifiers.
- Study the Background section given below.

9.3.2 Written

- After coming to lab, student should write the experiment on the worksheets provided by the teaching faculty on his/her own.

9.4 Equipment needed

9.4.1 Hardware Requirements:

1. Analog Discovery 2 Instrument.
2. Personal computer.
3. Trainer Kit.
4. Connecting Wires.

9.4.2 Software Requirements:

1.Muitisim software 14.0 edition.
2.Waveform generator software.

9.5 Background

•Power amplifiers are mainly used to deliver more power to the load. To deliver more power it requires large input signals, so generally power amplifiers are preceded by a series of voltage amplifiers. In class-A power amplifiers, Q-point is located in the middle of DC-load line.
•So output current flows for complete cycle of input signal. Under zero signal condition, maximum power dissipation occurs across the transistor. As the input signal amplitude increases power dissipation reduces. The maximum theoretical efficiency is 50

9.6 Procedure

Step 1: Connect the circuit as shown in figure.

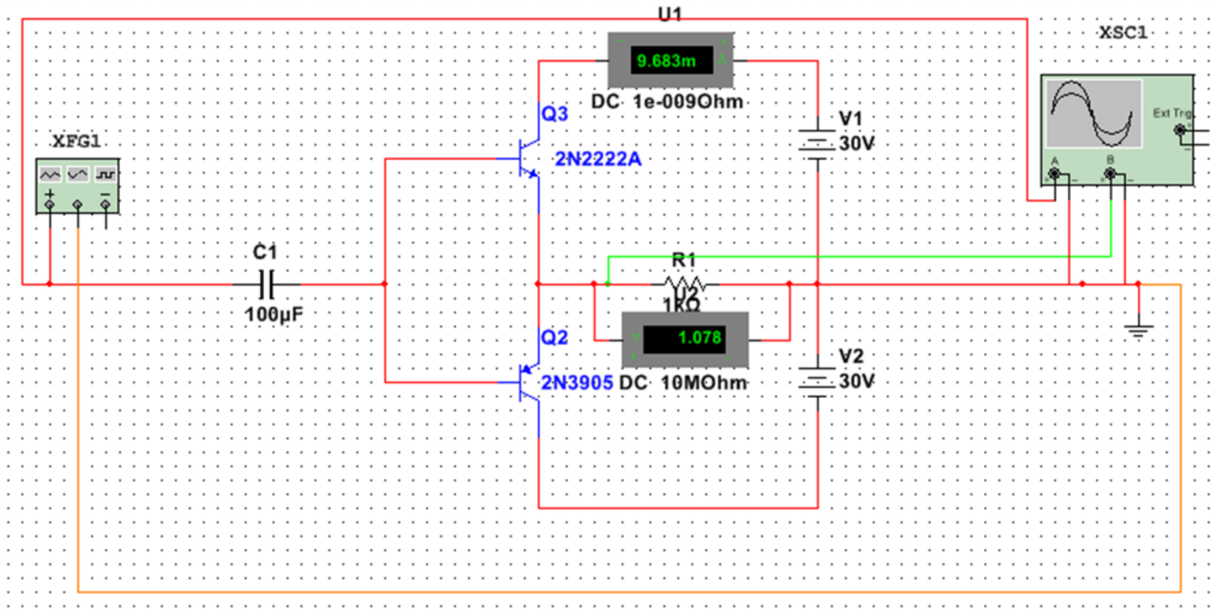


Figure 9.1:

Step 2: Adjust input signal amplitude in the function generator and observe an amplified voltage at the output without distortion.

Step 3: By keeping input signal voltage, say at 150 mV, vary the input signal frequency from 0-1 MHz as shown in tabular column and note the corresponding output voltage.

Step 4: Measure and note down the zero signal dc current by disconnecting the function generator from the circuit.

Step 5: 5. Calculate the efficiency according to the expressions given. Plot the graph between the o/p gain and frequency and calculate the bandwidth.

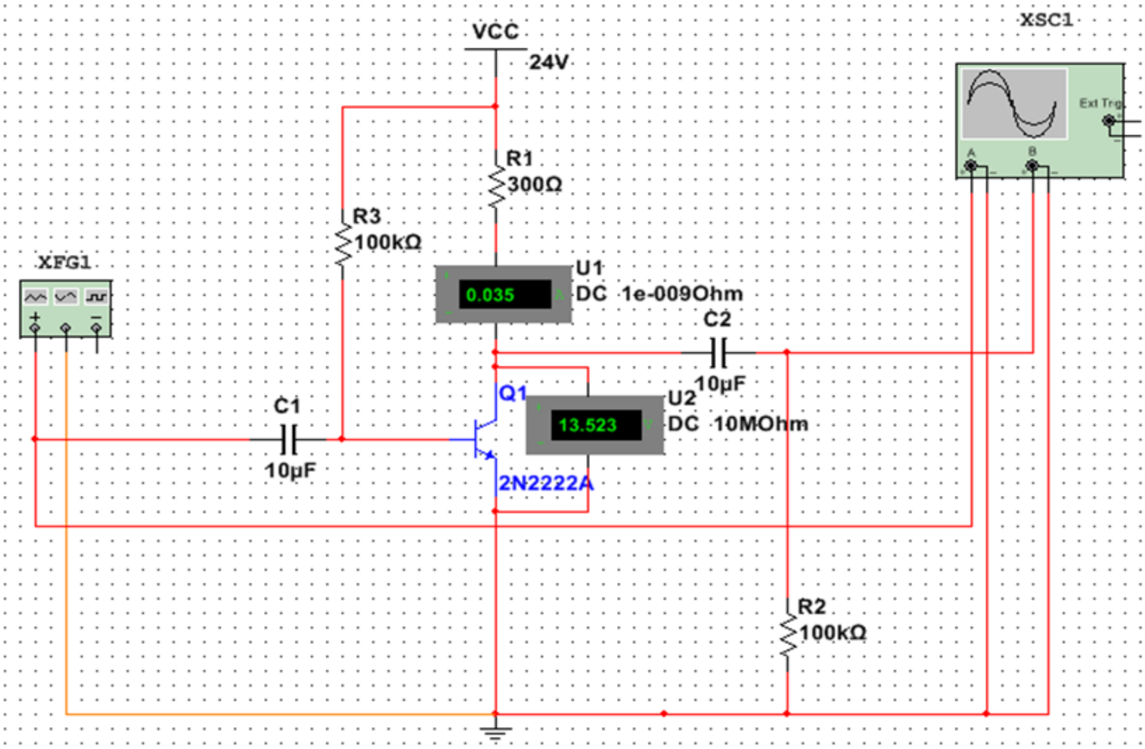


Figure 9.2:

9.7 Calclations

i. Efficiency is defined as the ratio of AC output power to DC input power DC

ii. input power = Vcc x ICQ

iii. AC output power = VP-P2 / 8RL

iv. Under zero signal condition:

- Vcc = IBRB + VBE IBQ =(Vcc - VBE) / RB
- ICQ = x IBQ VCE = Vcc - ICR

9.8 Expected graphs

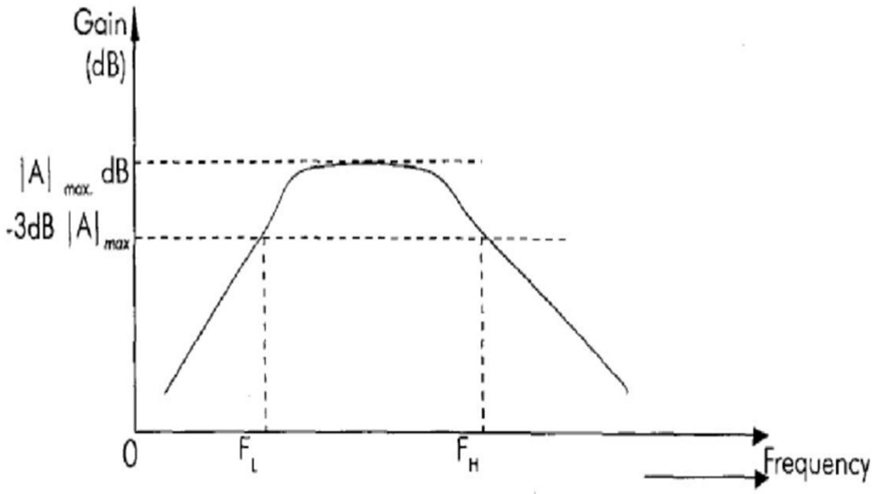


Figure 9.3:

9.9 Tabular Column

Table 9.1: Obervation Table

Frequency in HZ	Gain in DB
200	
600	
1k	
2K	
3K	
4K	
5K	
6K	
7K	
8K	

9.10 Precautions

1. Use the updated version of the Multisim 14.0edition tool.
2. Make sure proper circuit connections.
3. Observe the results carefully in CRO and Bode Plotter

9.11 Further Probing Experiments

Q1. Select a suitable value for the emitter bypass capacitor in Fig. 1 if the amplifier is to operate over a frequency range from 2 kHz to 10 kHz.

Q2. An amplifier has a voltage gain of 132 and $= 200$. Determine the power gain and output power of the amplifier if the input power is 60 w.

Q3. Determine the input impedance of the amplifier circuit shown in Fig

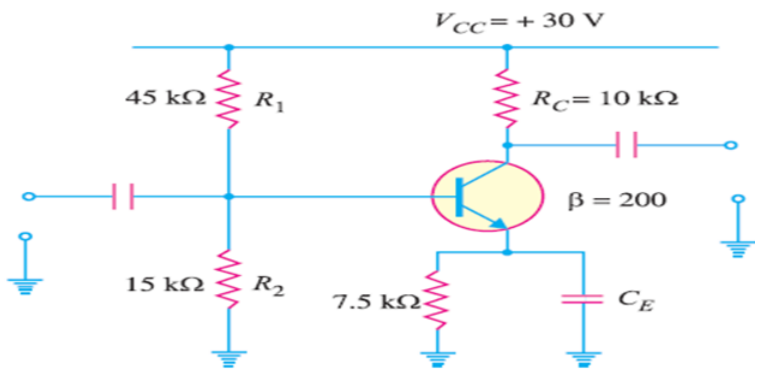


Figure 9.4:

LAB-9 LINEAR WAVE SHAPING CIRCUIT

10.1 Introduction

A Signal can also be called as a Wave. Every wave has a certain shape when it is represented in a graph. This shape can be of different types such as sinusoidal, square, triangular, etc. which vary with respect to time period or they may have some random shapes disregard of the time period. Linear elements such as resistors, capacitors and inductors are employed to shape a signal in this linear wave shaping. A Sine wave input has a sine wave output and hence the nonsinusoidal inputs are more prominently used to understand the linear wave shaping. Filtering is the process of attenuating the unwanted signal or to reproduce the selected portions of the frequency components of a particular signal.

10.2 Objective

10.2.1 Educational

• To design low pass RC and high pass RC circuits for different time constants and verify their responses for a square wave input of given frequency.

10.2.2 Experimental

• Determine the time constants for given resistor and capacitor values and compare theoretical values

10.3 Prelab Preparation:

10.3.1 Reading

• Study the Background section below.
• Read the chapter in your textbook on linear wave shaping. Pay particular attention to the way in which how the wave form is altered for different values of RC.

10.3.2 Written

• After coming to lab, student should write the experiment on the worksheets provided by the teaching faculty on his/her own.

10.4 Equipment needed

10.4.1 Hardware Requirements:

1. Analog Discovery 2 Instrument.

2. Personal computer.

3. Trainer Kit.
4. Connecting Wires

10.4.2 Software Requirements:

1. Muitisim software 14.0 edition.
2. Waveform generator software.

10.5 Background

High Pass RC circuit: The reactance of the capacitor depends upon the frequency of operation. At very high frequencies, the reactance of the capacitor is zero. Hence the capacitor in fig.1.1 acts as short circuit. As a result the entire input appears at the output. At low frequencies, the reactance of the capacitor is infinite. So the capacitor acts as open circuit. Hence no input reaches the output. Since the circuit allows only high frequencies, therefore it is called as high pass RC circuit.
Low Pass RC circuit: The reactance of the capacitor depends upon the frequency of operation. At very high frequencies, the reactance of the capacitor is zero. Hence the capacitor in fig.1.2 acts as short circuit. As a result, the output will fall to zero. At low frequencies, the reactance of the capacitor is infinite. So the capacitor acts as open circuit. As a result the entire input appears at the output. Since the circuit allows only low frequencies, therefore it is called as low pass RC circuit.

10.6 Procedure

Step 1: Connect the circuit, as shown in figure

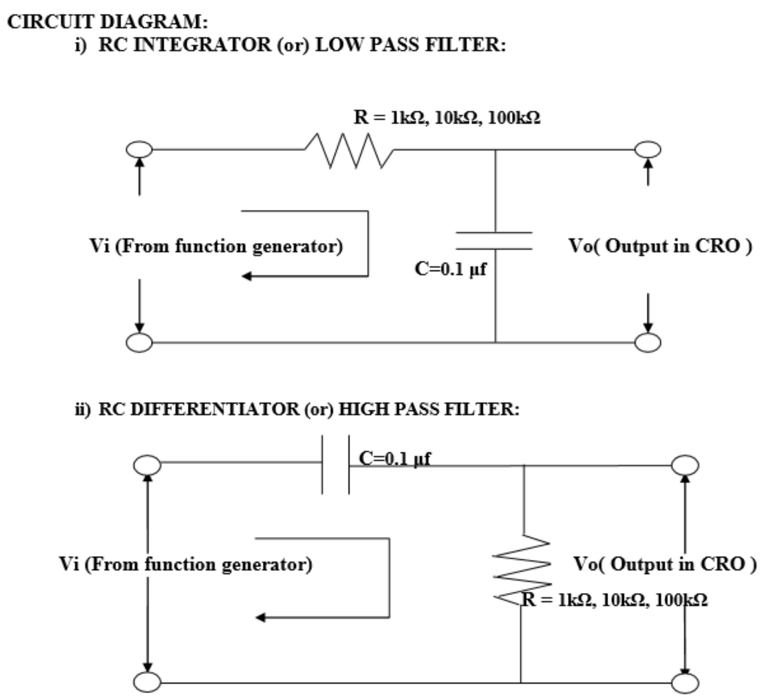


Figure 10.1:

Step 2: Apply the Square wave input to the circuit (Vi = 10 VP-P, f = 1KHz)

Step 3: Calculate the time constant of the circuit by connecting one of the Capacitor provided.

Step 4: Observe the output wave forms for different input frequencies (RC¡¡T,RC=T,RC¿T) as shown in the tabular column for different time constants.

i) RC INTEGRATOR (or) LOW PASS FILTER:

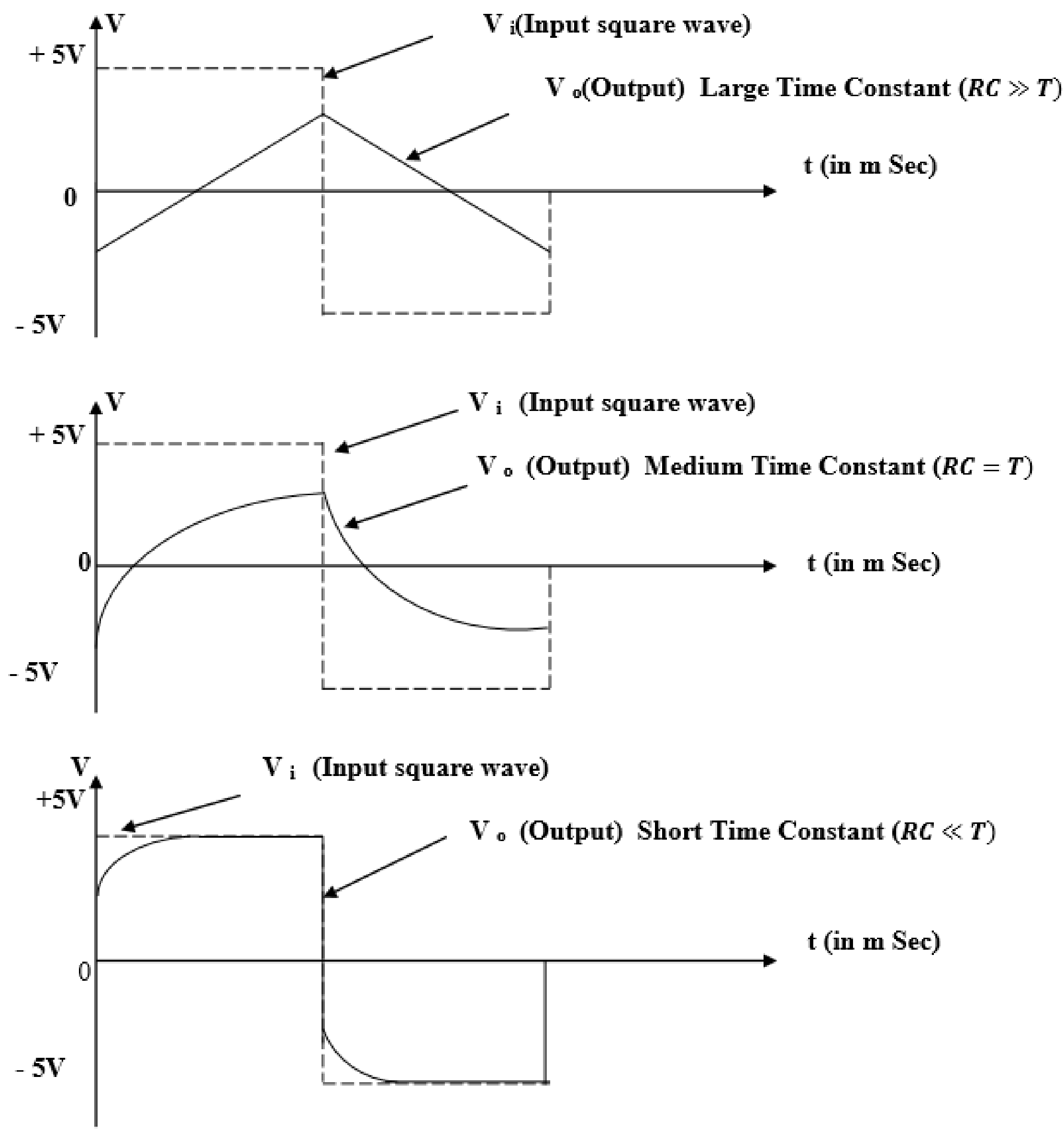


Figure 10.2:

ii) **RC DIFFERENTIATOR (or) HIGH PASS FILTER:**

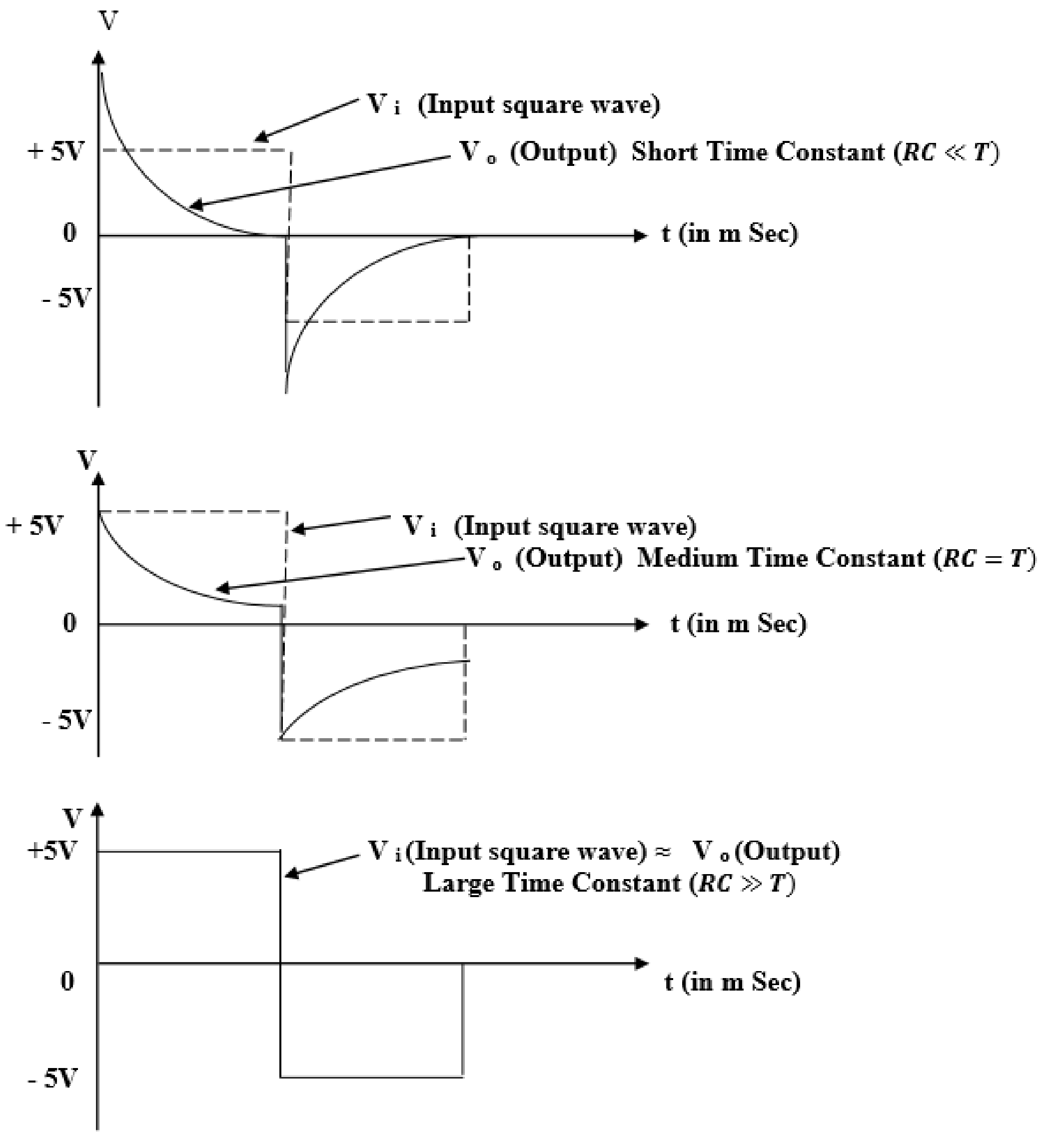


Figure 10.3:

10.7 Precautions

1. Use the updated version of the Multisim 14.0edition tool.
2. Make sure proper circuit connections.
3. Observe the results carefully in waveform generator software

10.8 Further Probing Experiments

Q1. Explain the fractional tilt of a high pass RC circuit. Write the Expression

Q2. State the lower 3-db frequency of high-pass circuit.

Q3. Show that a low pass circuit with a time constant acts as Integrator.

Q4. Name a wave shaping circuit which produces a Ramp wave as an output by taking a step signal as input and draw its output for a sinusoidal wave?

LAB-10 NON-LINEAR WAVESHAPING

11.1 Introduction

Along with resistors, the non-linear elements like diodes are used in nonlinear wave shaping circuits to get required altered outputs. Either the shape of the wave is attenuated or the dc level of the wave is altered in the Non-linear wave shaping. The process of producing non-sinusoidal output wave forms from sinusoidal input, using non-linear elements is called as nonlinear wave shaping.

11.2 Objective

11.2.1 Educational

- To teach the properties of non-linear wave shaping circuits to get required altered output.

11.2.2 Experimental

- Characterize the behavior of nonlinear wave shaping circuits like the Diode Clippers AND Clampers

11.3 Prelab Preparation:

11.3.1 Reading

- Study the Background section below.
- Read the chapter in your textbook on nonlinear wave shaping. Pay particular attention to the way in which how the given signal is altered.

11.3.2 Written

- After coming to lab, student should write the experiment on the worksheets provided by the teaching faculty on his/her own.

11.4 Equipment needed

11.4.1 Hardware Requirements:

1. Analog Discovery 2 Instrument.
2. Personal computer.
3. Trainer Kit.
4. Connecting Wires.

11.4.2 Software Requirements:

1. Muitisim software 14.0 edition.
2. Waveform generator software.

11.5 Background

Clamper Circuit

- A Clamper circuit can be defined as the circuit that consists of a diode, a resistor and a capacitor that shifts the waveform to a desired DC level without changing the actual appearance of the applied signal.
- In order to maintain the time period of the wave form, the tau must be greater than, half the time period discharging time of the capacitor should be slow.discharging time of the capacitor should be slow.

  $\tau = Rc = Rc$
  Where
  R is the resistance of the resistor employed
  C is the capacitance of the capacitor used
- The time constant of charge and discharge of the capacitor determines the output of a clamper circuit.
- In a clamper circuit, a vertical shift of upward or downward takes place in the output waveform with respect to the input signal.
- The load resistor and the capacitor affect the waveform. So, the discharging time of the capacitor should be large enough.

Clipper Circuits

- A Clipper circuit is a circuit that rejects the part of the input wave specified while allowing the remaining portion. The portion of the wave above or below the cut off voltage determined is clipped off or cut off.
- The clipping circuits consist of linear and non-linear elements like resistors and diodes but not energy storage elements like capacitors. These clipping circuits have many applications as they are advantageous.
- The main advantage of clipping circuits is to eliminate the unwanted noise present in the amplitudes.
- These can work as square wave converters, as they can convert sine waves into square waves by clipping.
- The amplitude of the desired wave can be maintained at a constant level.

11.6 Procedure for clippers

Step 1: Connect the circuit, as shown in figure.

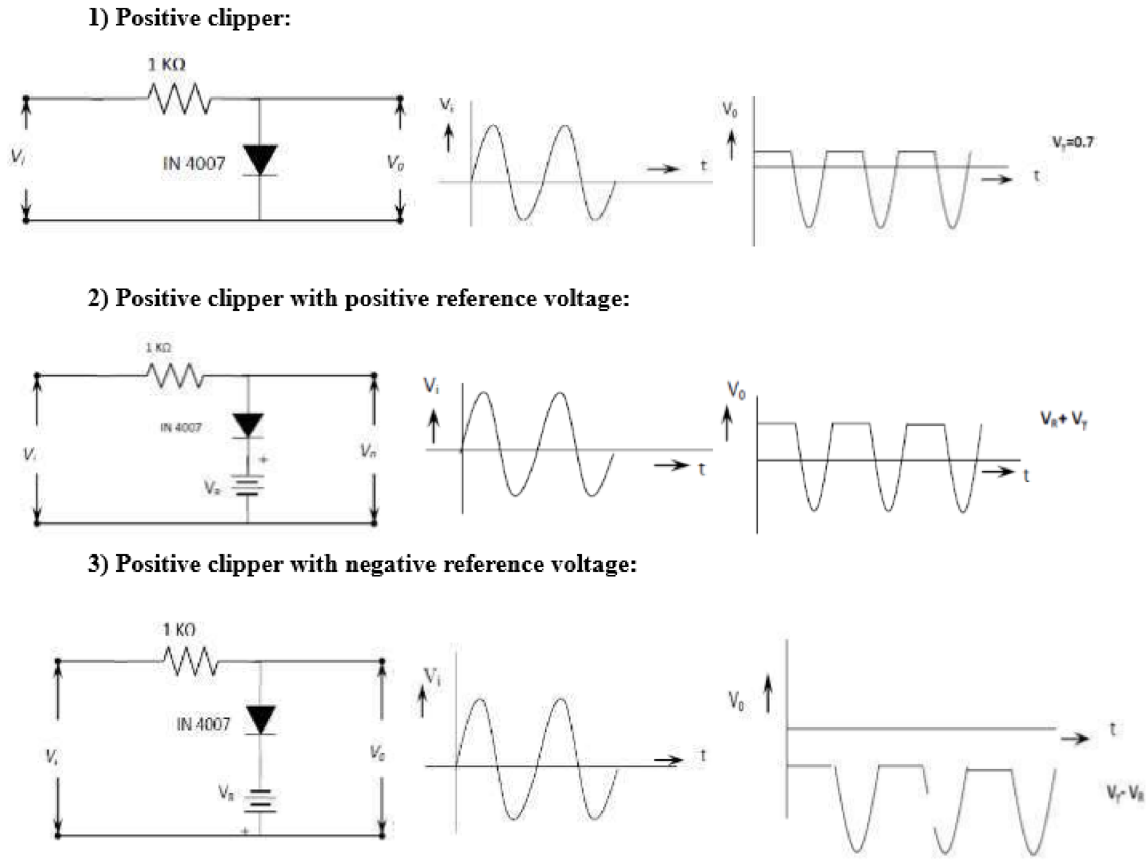


Figure 11.1:

Step 2: Apply the input Sine wave to the circuit. (8Vp-p, 2KHz)

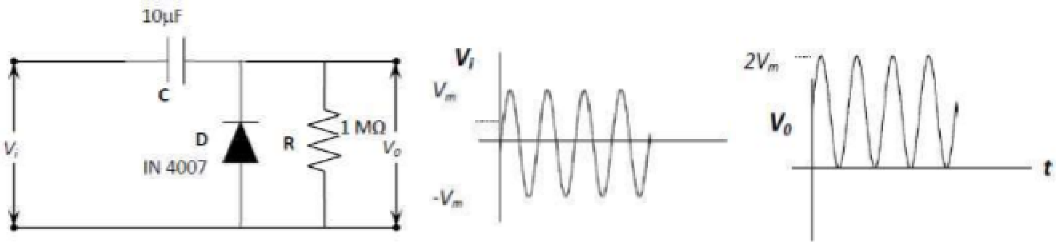
Step 3: Switch on the power supply and adjust the output of AF generator to 8V (peak to peak).

Step 4: Plot the graphs of input Vs output waveforms for different clipping circuits.

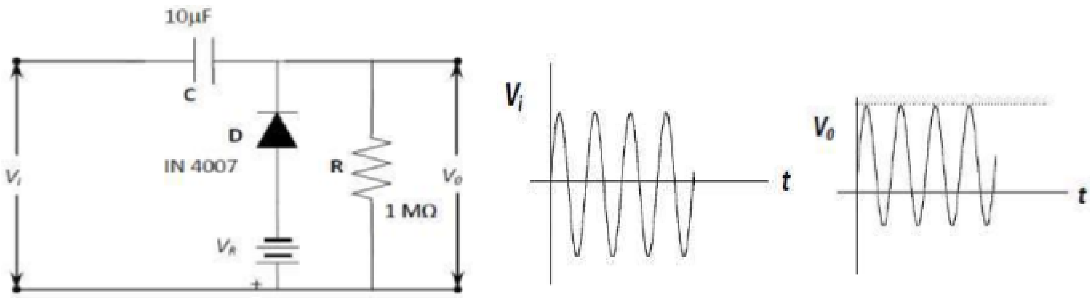
11.7 Procedure for clampers

Step 1: Connect the circuit, as shown in figure.

1. Positive Clamping Circuit:



2. Positive Clamping with negetive reference voltage:



3. Positive Clamping with Positive reference voltage:

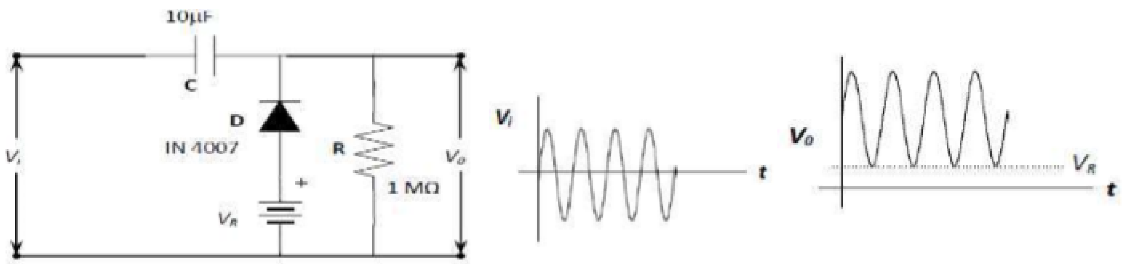


Figure 11.2:

Step 2: Apply the input Sine wave to the circuit. (8Vp-p, 2KHz)

Step 3: Switch on the power supply and adjust the output of AF generator to 8V (peak to peak).

Step 4: Plot the graphs of input Vs output waveforms for different clipping circuits.

11.8 Precautions

1. Use the updated version of the Multisim 14.0 edition tool.
2. Make sure proper circuit connections.
3. Observe the results carefully in waveform generator software

11.9 Further Probing Experiments

Q1. Design a step input of 10V when applied to the Low Pass RC circuit produces the output with a Rise time of 200 micro sec. Calculate the upper 3dB frequency of the circuit if the circuit uses a capacitor of 0.47µF, Determine the value of the resistance

Q2. A 1KHz square wave output from an amplifier has rise time tr = 250 ns and tilt = 10the value of Resistance R in clipper circuit when forward Resistance of diode is 10kohms and reverse resistance of diode is 100k ohms

LAB-11 ASTABLE MULTIVIBRATORS

12.1 Introduction

Multivibrator circuit is nothing but a switching circuit. It generates non-sinusoidal waves such as Square waves, Rectangular waves and Saw tooth waves etc. Multivibrators are used as frequency generators, frequency dividers and generators of time delays and also as memory elements in computers etc.
A Transistor basically functions as an amplifier in its linear region. If a transistor amplifier output stage is joined with the previous amplifier stage, such a connection is said to be coupled. If a resistor is used in coupling two stages of such an amplifier circuit, it is called as Resistance coupled amplifier.

12.2 Objective

12.2.1 Educational

- The objectives of this laboratory know the types of multi-vibrator using regenerative feed-back network and observe the output wave forms .
- Observe the output across the capacitor for any of the transistor T1 or T2.

12.2.2 Experimental

- The objective of this laboratory exercise is to output

12.3 Prelab Preparation:

12.3.1 Reading

- Study the Background section below.
- Read the chapter in your textbook on relays.

12.3.2 Written

- Review the steps in the procedure below and plan how you will interface relay with P89V51RD2 microcontroller.

12.4 Equipment needed

12.4.1 Hardware Requirements:

1. Analog Discovery 2 Instrument.
2. Personal computer.

3. Trainer Kit.

4. Connecting Wires.

12.4.2 Software Requirements:

1. Muitisim software 14.0 edition.

2. Waveform generator software.

12.5 Background

Astable multivibrator has two quasi – states and it keeps on vibrating between these two states by itself. No external signal is needed. The astable remains indefinitely in any of these two states.
Assuming that the multivibrator is already in action and is switching between two states.
Let it be further observed that at the instant considered Q1 is OFF and Q2 is ON. Since Q2 is ON, the capacitor is charged through RC1 and capacitor C1 discharges through R1 the voltage across C1 when it is about to start discharging in Vcc.
As capacitor C1 discharges more and more the identical at the point A becomes more and more positive, and eventually VA = Vr the cut in voltage Q1 states conducting. When Q1 is ON Q2 becomes OFF.
Similar operation repeats when Q1 becomes ON and Q2 becomes OFF and vice versa.

12.6 Procedure

Step 1: Connect the circuit as shown in figure.

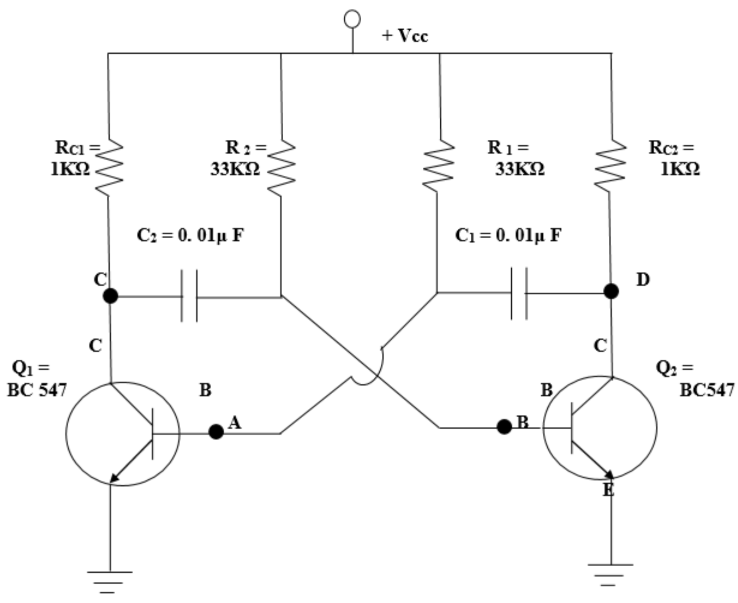


Figure 12.1:

Step 2: Observe the output of the circuit using oscilloscope and measure the time period of the signal and compare it with theoretical value by varying dc source v (5v to 10v) in steps (take minimum two readings).

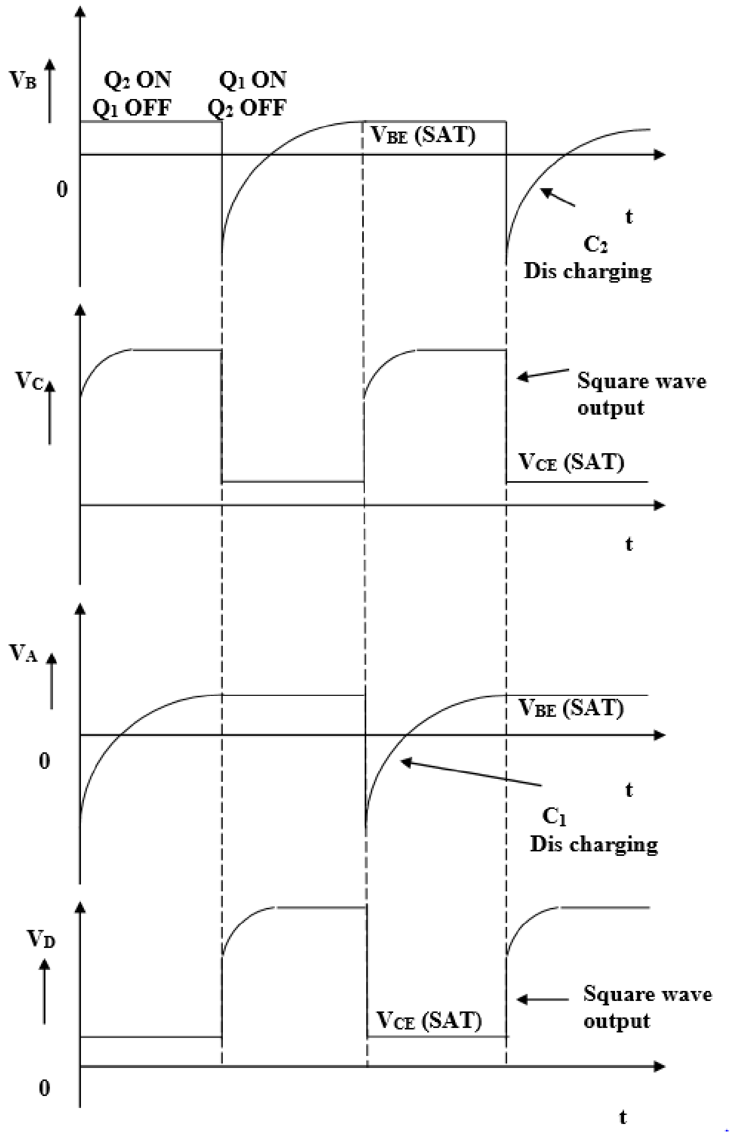


Figure 12.2:

Step 3: Plot the output waveforms on the graph paper for one set of values

Step 4: Repeat the steps from 1 to 3 with timing capacitor 0.01F.

12.7 Precautions

1. Use the updated version of the Multisim 14.0 edition tool.

2. Make sure proper circuit connections.

3. Observe the results carefully in waveform generator software.

12.8 Further Probing Experiments

Q1. For the multivibrator having values R1 = R2 = R = 47 k, C1 = C2 = C = 0.01 F. Find the time period and frequency.

Q2. Design a symmetric collector-coupled astable multivibrator to generate a square wave of 10 kHz having peak-to-peak amplitude of 10 V where hFEmin = 30, VCE(sat) = 0.2 V,IC(sat) = 2 mA.

Q3. Design an un-symmetric astable multivibrator having duty cycle of 40 per cent. It is required to oscillate at 5 kHz. Ge transistors with hFE = 40 are used. The amplitude of the square wave is required to be 20 V. IC = 5 mA, VCE(sat) = 0.1 V and VBE(sat).

LAB-12 TRANSISTOR AS A SWITCH

13.1 Introduction

One of the most common uses for transistors in an electronic circuit is as simple switches. In short, a transistor conducts current across the collector-emitter path only when a voltage is applied to the base. When no base voltage is present, the switch is off. When base voltage is present, the switch is on.

13.2 Objective

13.2.1 Educational

- To study and observe the switching characteristics like rise time, fall time, storage time and delay time of a transistor.

13.2.2 Experimental

- The objective of this laboratory exercise is to understand the switching characteristics.

13.3 Prelab Preparation:

13.3.1 Reading

- Study the Background section below.
- Read the chapter in your textbook on switching characteristics.

13.3.2 Written

- Review the steps in the procedure below to observe the switching characteristics like rise time, fall time, storage time and delay time of a transistor .

13.4 Equipment needed

13.4.1 Hardware Requirements:

(a) Analog Discovery 2 Instrument.

(b) Personal computer.

(c) Trainer Kit.

(d) Connecting Wires.

13.4.2 Software Requirements:

(a) Muitisim software 14.0 edition.

(b) Waveform generator software.

13.5 Background

The transistor Q can be used as a switch to connect and disconnect the load RL from the source VCC. When a transistor is saturated, it is like a closed switch from the collector to the emitter. When a transistor is cut-off, it is like an open switch.
Saturation: The point at which the load line intersects the IB = 0 curve is known as cut-off. At this point, base current is zero and collector current is negligible small i.e., only leakage current ICEO exists.
At cut-off, the emitter diode comes out of forward bias and normal transistor action is lost. The transistor appears like a closed switch.VCE(sat) ˜ VCC.
The intersection of the load line and the IB = IB(sat) is called saturation.
At this point base current is IB(sat)and the collector current is maximum. At saturation, the collector diode comes out of reverse bias, and normal transistor action is again lost.

13.6 Procedure

Step 1: Give a double click on µvision 4 icon on the desk top, it will generate a window.

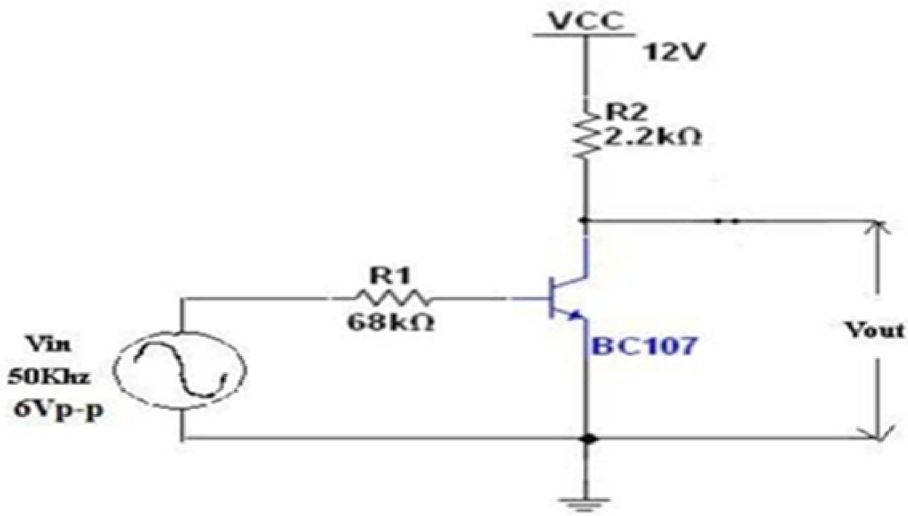


Figure 13.1:

Step 2: Switch on the power supply and observe the output of the function generator on CRO.

Step 3: Adjust input signal amplitude such that output signal peak-to peak value is less than the Saturation level.

Step 4: Observe output waveforms on CRO and note down the readings

Step 5: Plot the graphs between input and output waveforms at a given input frequency

13.7 Expected output waveform

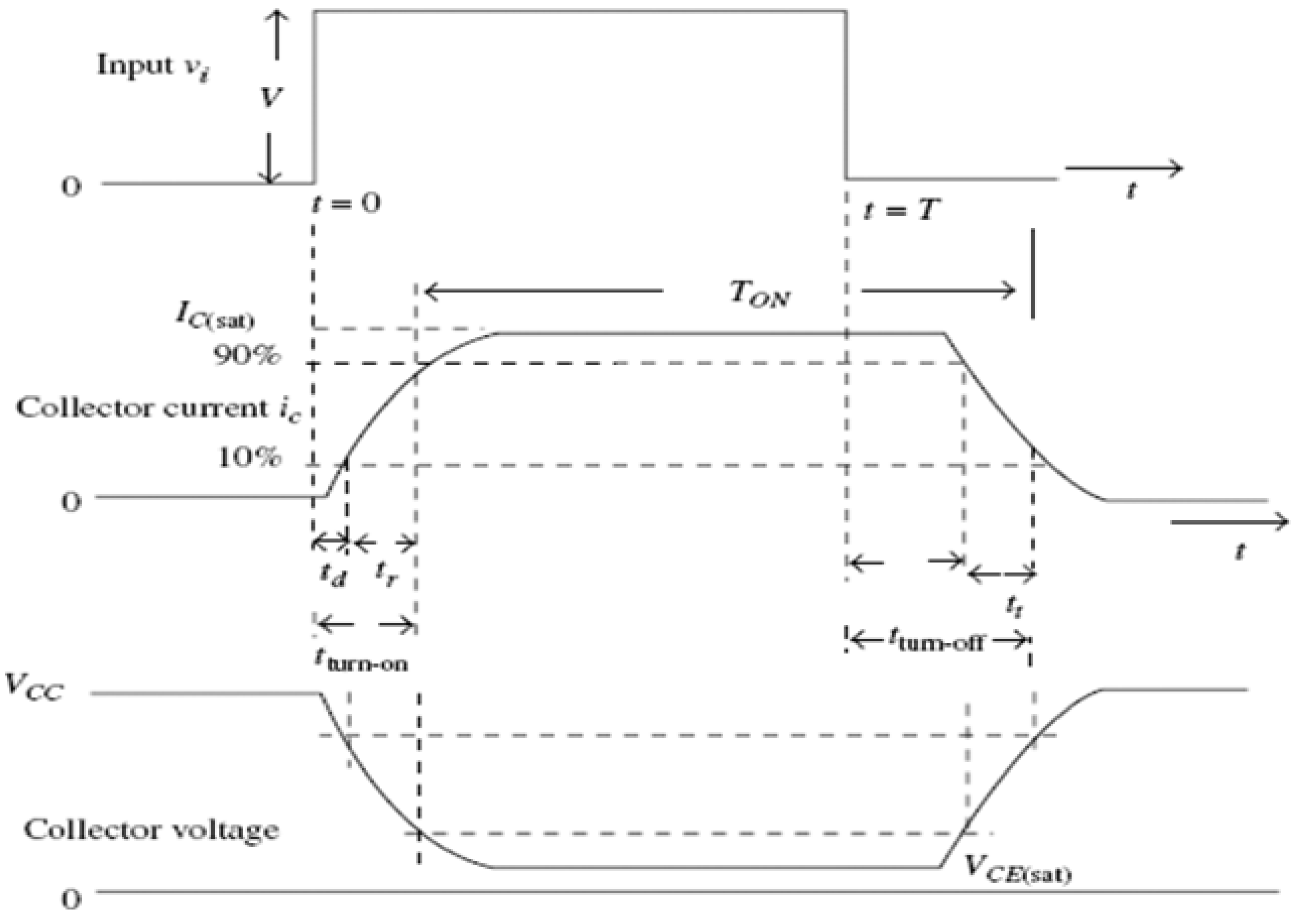


Figure 13.2:

13.8 Precautions

1. Use the updated version of the Multisim 14.0 edition tool.
2. Make sure proper circuit connections.
3. Observe the results carefully in waveform generator software

13.9 Further Probing Experiments

Q1. Explain the fractional tilt of a high pass RC circuit. Write the Expression

Q2. State the lower 3-db frequency of high-pass circuit

Q3. Show that a low pass circuit with a time constant acts as Integrator.

Q4. Name a wave shaping circuit which produces a Ramp wave as an output by taking a step signal as input and draw its output for a sinusoidal wave

LAB-13 COMPARATOR

14.1 Introduction

A comparator circuit compares two voltages and outputs either a 1 (the voltage at the plus side, VDD in the illustration) or a 0 (the voltage at the negative side) to indicate which is larger. Comparators are often used, for example, to check whether an input has reached some predetermined value.

14.2 Objective

14.2.1 Educational

- To Design a comparator circuit and plot the response with sinusoidal waveform with 8VP-P and 2KHz

14.2.2 Experimental

- To learn how to measure the response of comparator output by comparing the input sinosoidal with dc referance .

14.3 Prelab Preparation:

14.3.1 Reading

- Study the Background of transistor pn junctions

14.3.2 Written

- Review the steps in the procedure below to measure th output which is clipped at the diode cut-in voltage.

14.4 Equipment needed

14.4.1 Hardware Requirements:

1. Analog Discovery 2 Instrument.

2. Personal computer.
3. Trainer Kit.
4. Connecting Wires.

14.4.2 Software Requirements:

1. Muitisim software 14.0 edition.
2. Waveform generator software.

14.5 Background

The transistor Q can be used as a switch to connect and disconnect the load RL from the source VCC. When a transistor is saturated, it is like a closed switch from the collector to the emitter. When a transistor is cut-off, it is like an open switch. A comparator compares a signal voltage on one input of an opamp with a known reference voltage on the other input. We can say A comparator has two inputs one is usually a constant reference voltage VR and other is a time varying signal Vi and one output V0. A comparator is an electronic component that compares two input voltages. Comparators are closely related to operational amplifiers, but a comparator is designed to operate with positive feedback and with its output saturated at one power rail or the other.

14.6 Procedure

Step 1: Connect the circuit as shown in figure

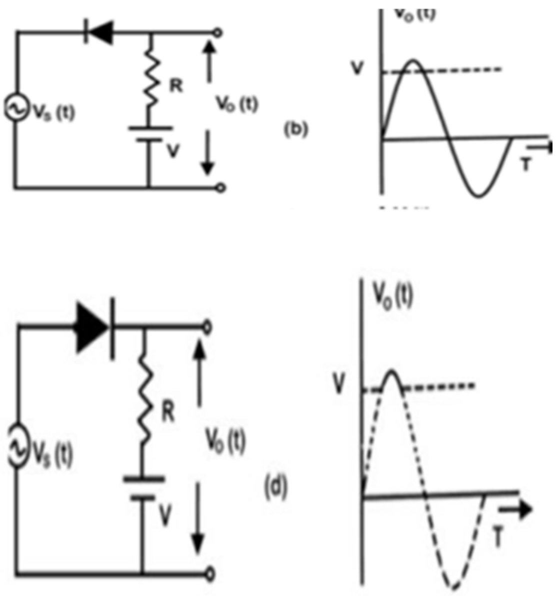


Figure 14.1:

Step 2: Apply the input Sine wave to the circuit. (8Vp-p, 2KHz).

Step 3: Switch on the power supply and adjust the output of AF generator to 8V.

Step 4: Observe the input and output waveforms on CRO and note down the readings

Step 5: Open that project folder and give a name of your project executable and save it.

Step 6: Plot the graphs of input Vs output waveforms for different clipping circuits.

14.7 Precautions

1. Use the updated version of the Multisim 14.0 edition tool.
2. Make sure proper circuit connections.
3. Observe the results carefully in waveform generator software

14.8 Further Probing Experiments

Q1. Generate the output waveform for reference voltage 2v and input 4v p-p

Q2. Deign a positive clipper for reference colatage of 0.7

Q3. Modify the design of your comparator with a positive feedback network to add a total hysteresis of approximately 0.2 V.

Q4. Design a comparator that will switch when the input signal crosses +2.5 V with no hysteresis

Appendix A - Safety

Electricity, when improperly used, is very dangerous to people and to equipment. This is especially true in an industrial environment where large amounts of power is used, and where high voltages are present [1]; in environments where people are especially susceptible to electric shock such as maintenance of a high voltage system (while in operation) or in hospitals where electrical equipment is used to test or control physiological functions [2, 3]; and in an experimental or teaching laboratory where inexperienced personnel may use electrical equipment in experimental or nonstandard configuration.

Engineers play a vital role in eliminating or alleviating the danger in all three types of environments mentioned above. For conditions where standard equipment is used in standard configurations, govern- mental agencies and insurance underwriters impose strict laws and regulations on the operation and use of electrical equipment including switchgear, power lines, safety devices, etc. As a result, corporations and other organizations in turn impose strict rules and methods of operation on their employees and contractors. Engineers who are involved in using electrical equipment, in supervising others who use it, and in designing such systems, have a great responsibility to learn safety rules and practices, to observe them, and to see that a safe environment is maintained for those they supervise. In any working environment there is always pressure to "get the job done" and take short cuts. The engineer, as one who is capable of recognizing hazardous conditions, is in a responsible position both as an engineer and as a supervisor or manager and must maintain conditions to protect personnel and avoid damage to equipment.

Because of their non-standard activities, experimental laboratories are exempt from many of these rules and regulations. This puts more responsibility on the engineer in this environment to know and enforce the safest working procedures.

The knowledge and habit-forming experience to work safely around electrical equipment and the ability to design safe electrical equipment begins with the first student laboratory experience and con- tinues through life. This includes learning the types of electrical injuries and damage, how they can be prevented, the physiology of electrical injuries, and steps to take when accidents.

Physiology of Electrical Injuries

There are three main types of electrical injuries: electrical shock, electrical burns, and falls caused by electrical shock. A fourth type, 'sunburned' eyes from looking at electric arcs, such as arc-welding, is very painful and may cause loss of work time but is usually of a temporary nature. Other injuries may be indirectly caused by electrical accidents, e.g., burns from exploding oil-immersed switch gear or transformers.

Although electric shock is normally associated with high-voltage AC contact, under some circum- stances death can occur from voltages from substantially less than the nominal 120 Volts AC found in residential systems. Electric shock is caused by an electric current passing through a part of the human body. The human body normally has a high resistance to electric currents so that a high voltage is usually required to cause lethal currents. This resistance is almost all in the skin, but when the skin is wet its resistance is much lower. When a person is hot and sweaty or is standing in water, contact with 120 Volts or less is likely to cause a fatal shock.

Electric shock is not a single phenomenon but is a disturbance of the nerves that is caused by electric current. A current through a part of the body such as the arm or leg will cause pain and muscle contraction. If a victim receives an electric shock from grasping a live conductor, a current of greater than 15 to 30 mA through the arm will cause muscle contractions so severe that the victim cannot let go. Similar currents through leg muscles may cause sudden contractions causing the victim to jump or fall, resulting in possible injuries or death. It is also possible for a prolonged period of contact of more than a minute or so to cause chest muscles to be contracted, preventing breathing and resulting in suffocation or brain damage from lack of oxygen.

The predominant cause of death by electric shock is generally attributed to ventricular fibrillation, which is an uncontrolled twitching or beating of the heart that produces no pumping action and therefore no blood circulation. Unless corrective action is taken, death follows quickly from lack of oxygen to the brain. While the amount of current that will cause fibrillation depends on several variables, 0.5 to 5A through the body will normally cause the very small current through the heart that causes fibrillation in most people. Larger currents than this through the heart causes contraction or clamping of the heart muscle and resulting death unless corrective action is taken. Prolonged contact of more than a minute or so may cause chest muscles to contract, preventing breathing and resulting in suffocation or brain damage from lack of oxygen.

Death by electric shock is most often attributed to ventricular fibrillation, which is an uncontrolled twitching or beating of the heart that produces no pumping action and therefore no blood circulation. Unless corrective action is taken, death follows quickly from lack of oxygen to the brain. While the amount of current that will cause fibrillation depends on several variables, 0.5 to 5 amperes through the body will normally cause the very small current (approximately 1 mA) through the heart that is sufficient to cause fibrillation in most people. Larger currents than this through the heart cause contraction or clamping of the heart muscle, resulting in death unless corrective action is taken.

Electric burns may be caused by electric currents flowing in or near parts of the body. Such burns are similar to burns from ordinary heat sources, except that those caused by high-frequency currents are generally deeper and take longer to heal the other burns. Electrocution will often leave severe burns at the points where the current entered and left the body.

Source of Electric Shock

Since electric shock is caused by an electric current through a part of the body, it is prevented by not allowing the body to become part of any electric circuit. From this viewpoint, electric circuits may be classified as either grounded or ungrounded.

Electric circuits may be classified as either grounded or ungrounded. Grounded circuits are safer for most conditions, since they result in known voltages at other points in the circuit and provide easier and better protection against faulty conditions in the circuit. The disadvantage is that a person standing on a non-insulated floor can receive a shock by touching only one conductor.

Almost all electric power generation, transmission, and distribution systems are grounded to pro- tect people and equipment against fall conditions caused by windstorms, lightning, etc. Residential, commercial, and industrial systems such as lighting and heating are always grounded for greater safety. Communication, computer, and similar systems are grounded for safety reasons and to prevent or reduce noise, crosstalk, static, etc. Many electronic equipment or instruments are grounded for safety and noise prevention, also. Common examples are DC power supplies, oscilloscopes, oscillators, and analog and digital multimeters.

Ungrounded circuits are used in systems where isolation from other systems is necessary, where low voltages and low power are used, and in other instances where obtaining a ground connection is difficult or impractical. In the ungrounded circuit, contact with two points in the circuit that are at different potentials is required to produce an electrical shock. The hazard is that with no known ground, a hidden fault can occur, causing some unknown point to be grounded, in which case, touching a supposedly safe conductor while standing on the ground could result in an electric shock.

Protecting People and Equipment in the Laboratory

Prevention of electric shock to individuals and damage to equipment in the laboratory can be done by strict adherence to several common-sense rules summarized below:

Protecting People

(a) When hooking up a circuit, connect to the power source last, while power is off.

(b) Before making changes in a circuit, turn off or disconnect the power first, if possible.

(c) Never work alone where the potential of electric shock exists.

(d) When changing an energized connection, use only one hand. Never touch two points in the circuit that are at different potentials.

(e) Know that the circuit and connections are correct before applying power to the circuit.

(f) Avoid touching capacitors that may have a residual charge. The stored energy can cause a severe shock even after a long period of time.

(g) Insulate yourself from ground by standing on an insulating mat where available.

The above rules and the additional rules given below also serve to protect instruments and other circuits from damage.

Protecting Equipment

(a) Set the scales of measurement instrument to the highest range before applying power.

(b) Before making changes in a circuit, turn off or disconnect the power first, if possible.

(c) When using an oscilloscope, do not leave a bright spot or trace on the screen for long periods of time. Doing so can burn the image into the screen.

(d) Be sure instrument grounds are connected properly. Avoid ground loops and accidental grounding of "hot" leads.

(e) Check polarity markings and connections of instruments carefully before connecting power.

(f) Never connect an ammeter across a voltage source, but only in series with a load.

(g) Do not exceed the voltage or current ratings of circuit elements or instruments. This particularly applies to wattmeters, since the current or voltage rating may be exceeded with the needle still reading on the scale.

(h) Be sure any fuses and circuit breakers are of suitable value.

When connecting electrical elements to make up a network in the laboratory, it easy to lose track of various points in the network and accidentally connect a wire to the wrong place. One procedure to help avoid this problem is to connect first the main series loop of the circuit, then go back and add the elements in parallel.

Types of Equipment Damage Excessive currents and voltages can damage instruments and other circuit elements. A large over- current for a short time or a smaller over-current for a longer time will cause overheating, resulting in insulation scorching and equipment failure.

Blown fuses are the most common equipment failure mode in this laboratory. The principal causes for these failures include:
• incorrectly wired circuits;
• accidental shorts;
• switching resistance settings while power is applied to the circuit;
• changing the circuit while power is applied;
• using the wrong scale on ammeter;
• connecting an ammeter across a voltage source;
• using a low-power resistor box (limit 1/2 amp) when high power is required;

- turning on an auto-transformer at too high a setting.

All of these causes are the result of carelessness by the experimenter.

Some type of insulating material, such as paper, cloth, plastic, or ceramic, separates conductors that are at different potentials in electrical devices. The voltage difference that this material can withstand is determined by design (type, thickness, moisture content, temperature, etc.). Exceeding the voltage rating of a device by an appreciable amount can cause arcing or corona, resulting insulation breakdown, and failure.

Some electrical devices can also be damaged mechanically by excessive currents. An example is the D'Arsonval meter, the indicator in most analog metering instruments. A large pulse of over current will provide mechanical torque that can cause the needle to wrap around the pin at the top of the scale, thereby causing permanent damage even though the current may not have been on long enough to cause failure due to overheating.

After Accident Action

Since accidents do happen despite all efforts to prevent them, plans for appropriate reaction to an accident can save time and lives. Such a plan should include immediate availability of first aid material suitable for minor injuries or for injuries that are likely because of the nature of the work. Knowledge of how to obtain trained assistance such as Emergency Medical Services (EMS) should be readily available for everyone.

Treating victims for electrical shock includes four basic steps that should be taken immediately. Step two requires qualification in CPR and step three requires knowledge of mouth-to-mouth resuscitation. Everyone who works around voltages that can cause dangerous electrical shock should take advantage of the many opportunities available to become qualified in CPR and artificial respiration.

Immediate Steps After Electric Shock

(a) Shut off all power and remove victim from the electric circuit. If the power cannot be shut off immediately,use an insulator of some sort, such as a wooden pole, to remove victim from the circuit. Attempts to pull the victim from the circuit with your hands will almost always result in your joining the victim in the electric shock.

(b) If you are qualified in CPR, check for ventricular fibrillation or cardiac arrest. If either is detected, external cardiac massage should be started at once. Whether you are qualified in CPR or not, notify EMS and the ECE Department at once, using the telephone numbers listed below.

(c) Check for respiratory failure and take appropriate action. This may have resulted from physical paralysis of respiratory muscles or from a head injury. Sometimes many hours pass before normal respiration returns. Artificial respiration should be continued until trained EMS assistance arrives.

(d) Check for and treat other injuries such as fractures from a fall or burns from current entry and exit sites. Investigations are always after accidents. As an engineer you will be involved as a part of the investigating team or in providing information to an investigator. Information obtained and notes written immediately after the emergency will aid this investigation and assist in preventing future accidents of a similar nature.

Investigations are always made after accidents. As an engineer, you will be involved as a part of the investigating team or in providing information to an investigator. Information obtained and notes written immediately after the emergency will aid the investigation and assist in preventing future accidents of a similar nature.

Emergency Numbers
Fire / EMS: 911 or (864) 656-2222
Student Health Center: (864) 656-2233
ECE Department Office: (864) 656-5650

Appendix A References

(a) W.F. Cooper, Electrical Safety Engineering, Newnes-Butterworth, London-Boston, 1978.

(b) W.H. Buschsbaum and B. Goldsmith, Electrical Safety in the Hospital, Medical Economics Company, Oradel, NJ, 1975.

(c) J.G. Wester, editor, Medical Instrumentation Application and Design, Houghton Mifflin Company, Boston, 1978.

Appendix B - Wave form generator software

1. Plug in the Test Measurement Device, then start WaveForms and make sure the device is connected. If no device is connected to the host computer when WaveForms launches, the Device Manager will be launched. Make sure that the device is plugged in and turned on, at which point it will appear in the Device Manager's device list (1). Click on the device in the list to select it, then click the Select button (2) to close the Device Manager. Note: "DEMO" devices are also listed, which allow the user to use WaveForms and create projects without a physical device. Note: The Device Manager can be opened by clicking on the "Connected Device" button in the bottom right corner of the screen (3.), or by selecting "Device Manager" from the "Settings" menu at the top of the screen.

2. Once the Welcome page loads, in the instrument panel at the left side of the window, click on the Wavegen button to open the Waveform Generator instrument.

3. Once the Wavegen instrument opens, the window contains the preview plot (1.) showing what the expected waveform is, the configuration panel Using the WaveGen This section details how to configure and run the Wavegen instrument

B.1 Hardware Setup

To demonstrate the capabilities of the Waveform Generator instrument, the Scope instrument is used to visualize the Waveform Generator's output signal. This step describes setting up a simple loopback circuit that connects the Test and Measurement device's Waveform Generator and Oscilloscope.

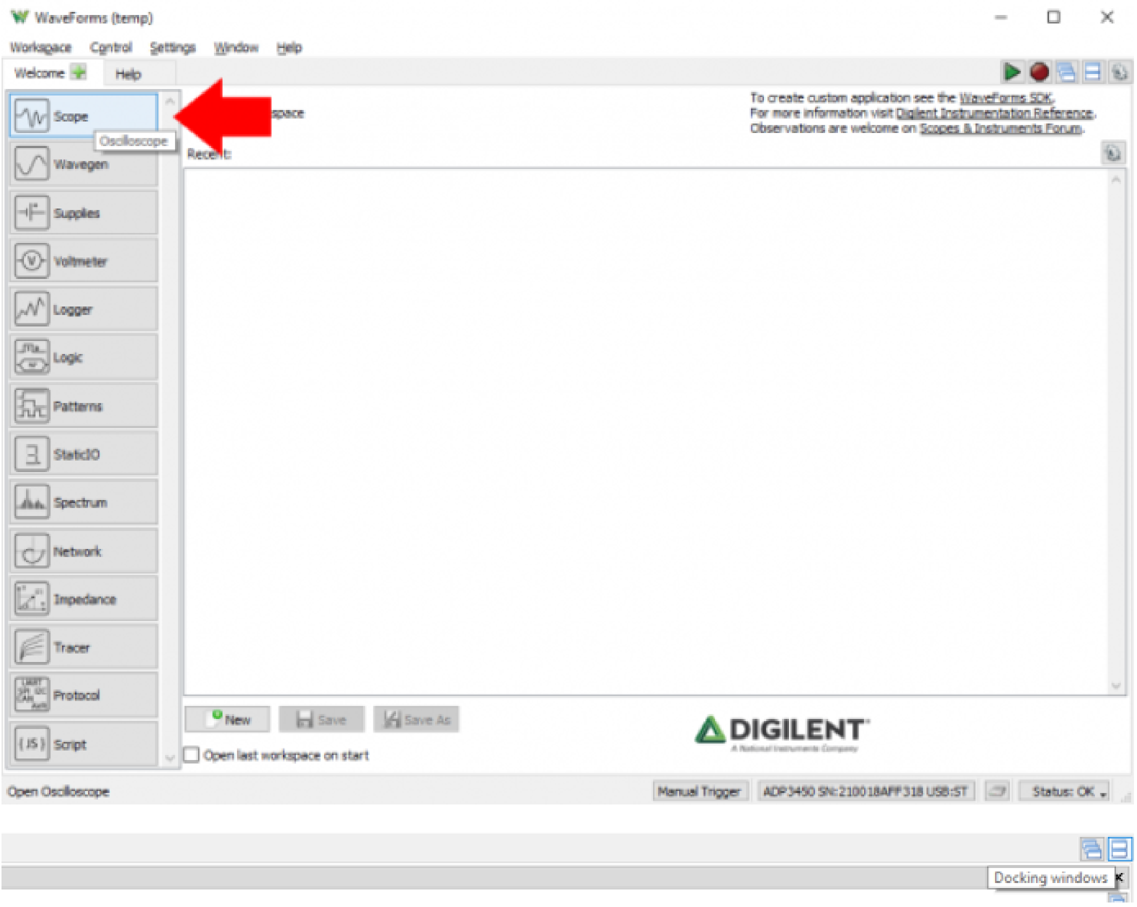


Figure B.1:

1. Set Up the Oscilloscope

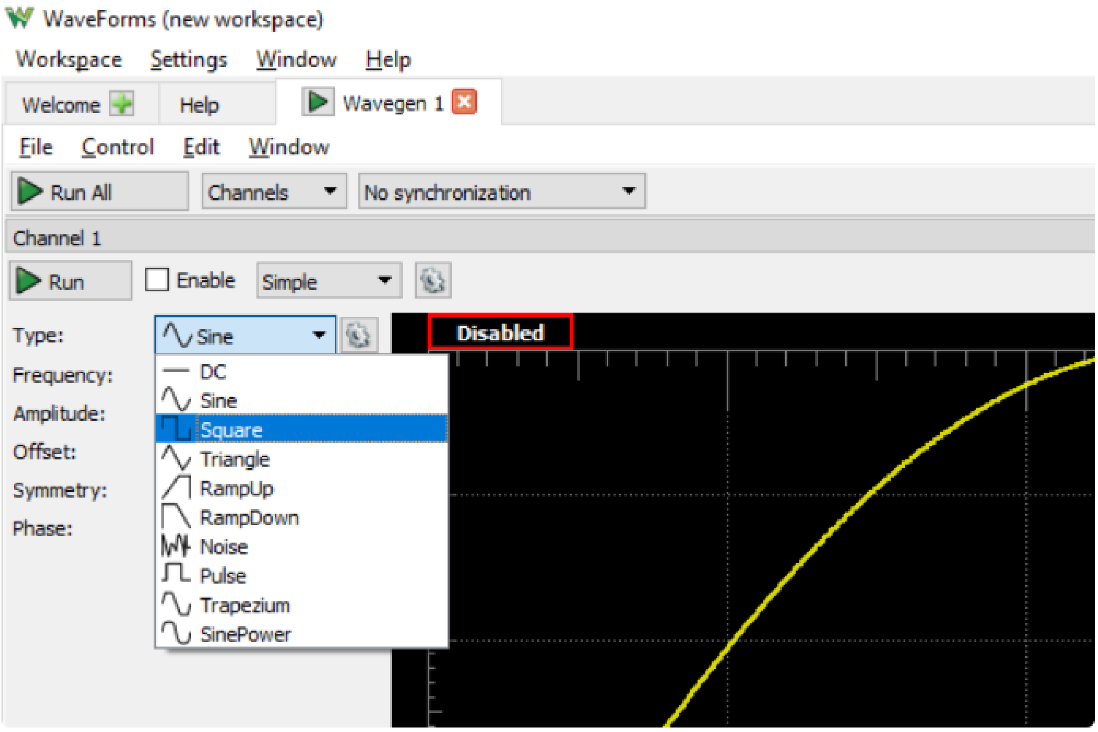


Figure B.2:

2. Configure Signal Type

3. The frequency is configured by selecting the value from the Frequency drop-down list, or by clicking into the field and manually typing it in (including units and an SI suffix). Set the frequency to 200 Hz.

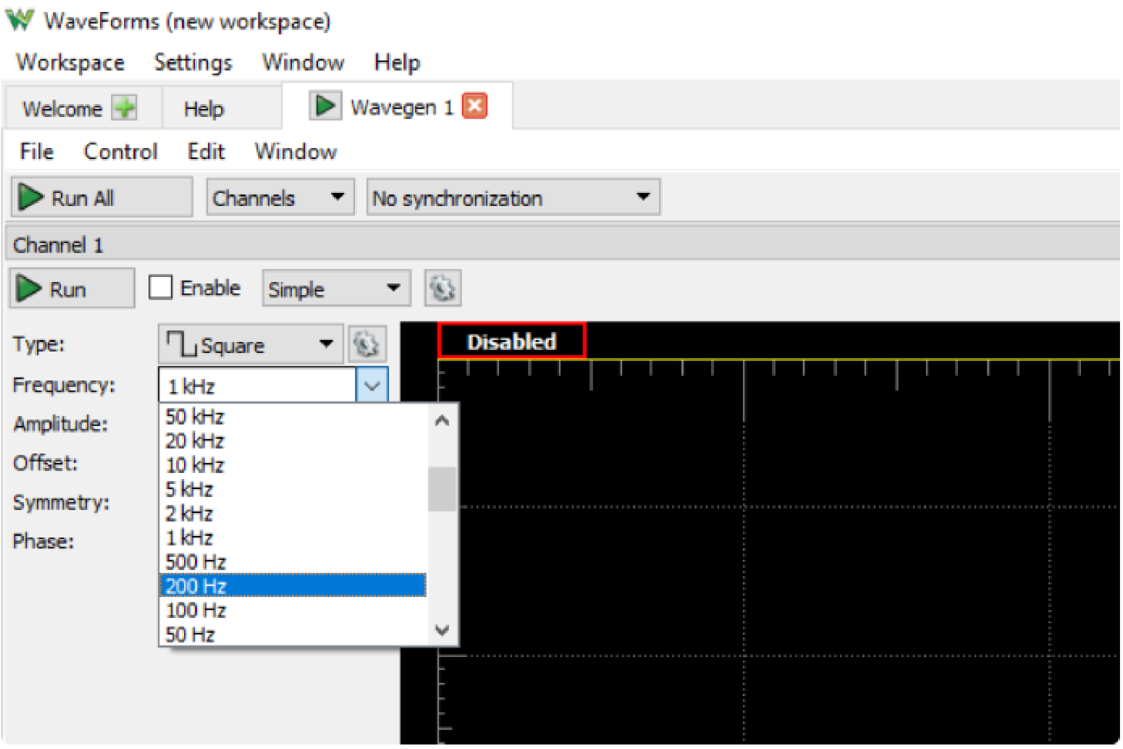


Figure B.3:

4. Configuring the amplitude is similar to changing frequency. Proceed by setting the amplitude to 2 V.

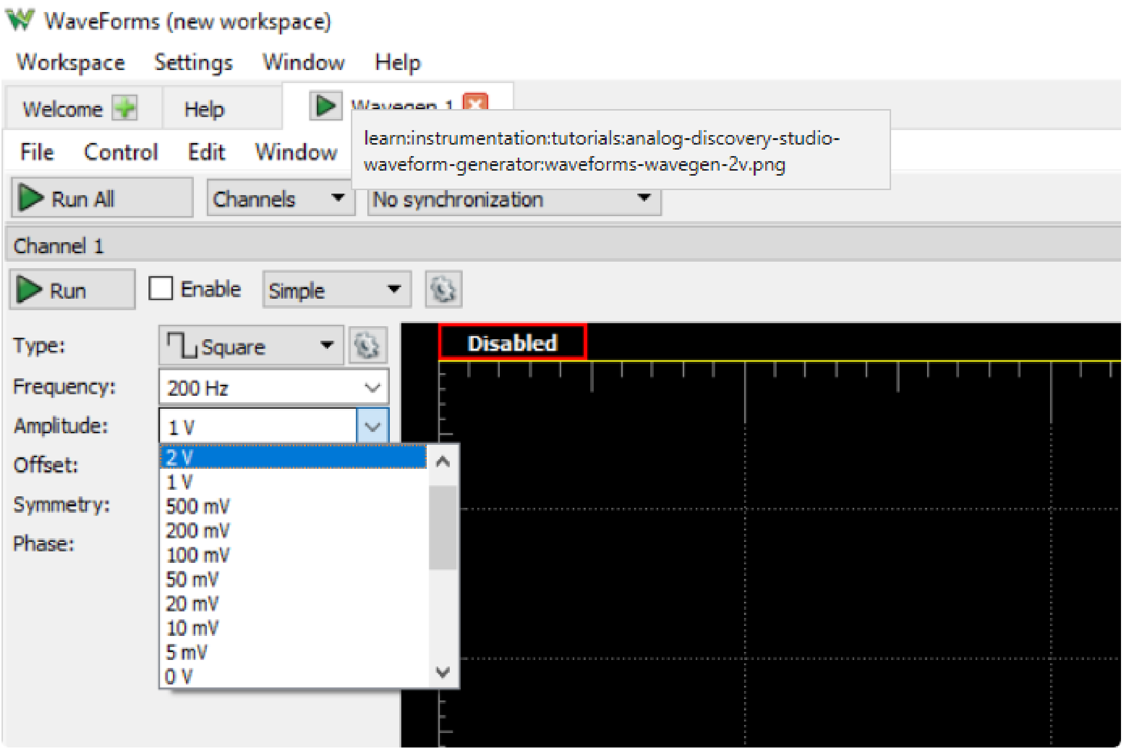


Figure B.4:

5. Back in the Wavegen instrument, click Stop () to turn off the output signal, leaving the channel enabled and idle. Clicking Stop All will stop all active channels while clicking "Stop" stops only that particular channel.

Figure B.5: