Shamim
EEE-11
111093

DEPARTMENT OF ELECTRICAL & ELECTRONIC ENGINEERING
RAJSHAHI UNIVERSITY OF ENGINEERING AND TECHNOLOGY
EEE 212: Electronics Circuit – I Sessional

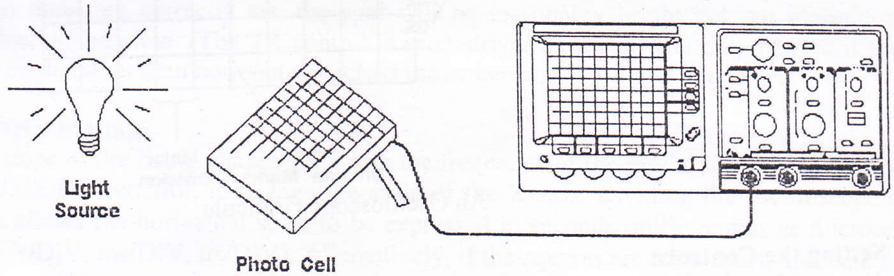
Expt. No.: 01 **Name of the Experiment:** Oscilloscope Fundamentals

Introduction:

The word "Oscilloscope" can be separated into two parts "oscillo" and "scope"; the first is short for "oscillations" and the second means "to view or see". The oscilloscope is basically a graph-displaying device - it draws a graph of an electrical signal. In most applications the graph shows how signals change over time: the vertical (Y) axis represents voltage and the horizontal (X) axis represents time. The intensity or brightness of the display is sometimes called the Z axis.

An oscilloscope is easily the most useful instrument available for testing circuits because it allows us to see the signals at different points in the circuit. The best way of investigating an electronic system is to monitor signals at the input and output of each system block, checking that each block is operating as expected and is correctly linked to the next.

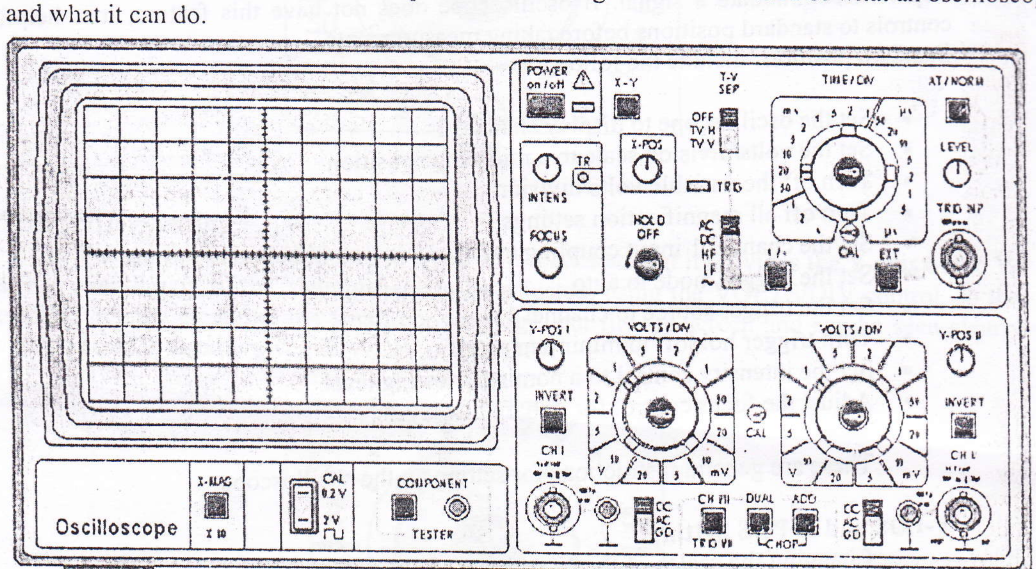
Oscilloscopes are used by everyone from television repair technicians to physicists. They are indispensable for anyone designing or repairing electronic equipment. The usefulness of an oscilloscope is not limited to the world of electronics. With the proper transducer, an oscilloscope can measure all kinds of phenomena. A transducer is a device that creates an electrical signal in response to physical stimuli, such as sound, mechanical stress, pressure, light, or heat. For example, a microphone is a transducer. An automotive engineer uses an oscilloscope to measure engine vibrations. A medical researcher uses an oscilloscope to measure brain waves. The possibilities are endless.



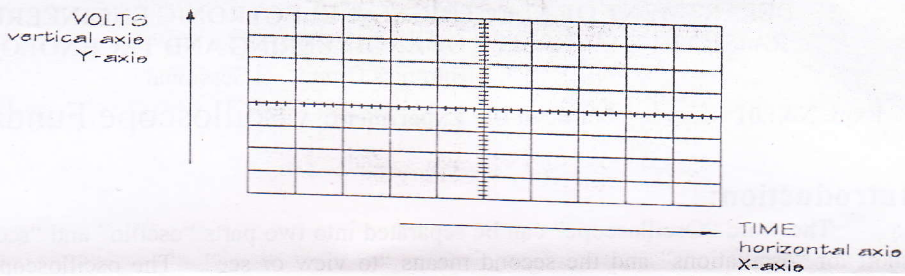
Scientific Data Gathered by an Oscilloscope (in Diagram)

Oscilloscope Front Panel:

The diagram shows an oscilloscope, it may look different but will have similar controls. Faced with an instrument like this, we typically respond either by twiddling every knob and pressing every button in sight, or by adopting a glazed expression. Neither approach is especially helpful. Following the systematic description below will give us a clear idea of what an oscilloscope is and what it can do.

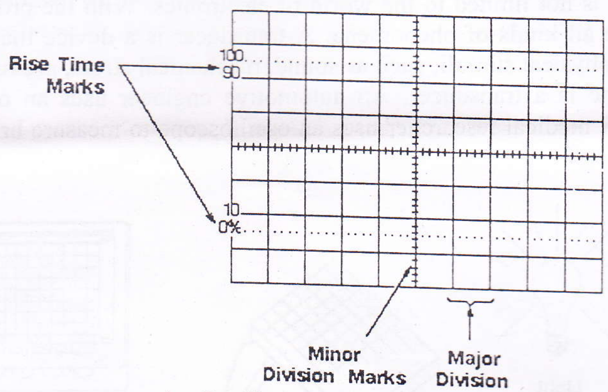


The function of an oscilloscope is extremely simple: it draws a *V*/*t* graph, a graph of voltage against time, voltage on the vertical or Y-axis, and time on the horizontal or X-axis.



Take a look at the oscilloscope display. Notice the grid markings on the screen - these markings create the graticule. Each vertical and horizontal line constitutes a major division. The graticule is usually laid out in an 8-by-10 division pattern. Labeling on the oscilloscope controls (such as volts/div and sec/div) always refers to major divisions. The tick marks on the center horizontal and vertical graticule lines are called minor divisions.

Many oscilloscopes display on the screen how many volts each vertical division represents and how many seconds each horizontal division represents. Many oscilloscopes also have 0%, 10%, 90%, and 100% markings on the graticule to help make rise time measurements



An Oscilloscope Graticule

Setting the Controls:

After plugging in the oscilloscope, take a look at the front panel. It is divided into three main sections labeled Vertical, Horizontal, and Trigger. Oscilloscope may have other sections, depending on the model and type (analog or digital).

Notice the input connectors on oscilloscope. This is where probes are attached. Oscilloscopes have at least two input channels and each channel can display a waveform on the screen. Multiple channels are handy for comparing waveforms.

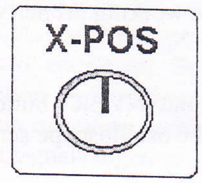
Some oscilloscopes have an AUTOSET or PRESET button that sets up the controls in one step to accommodate a signal. If oscilloscope does not have this feature, it is helpful to set the controls to standard positions before taking measurements.
Standard positions include the following:

- Set the oscilloscope to display channel 1
- Set the volts/division scale to a mid-range position
- Turn off the variable volts/division
- Turn off all magnification settings
- Set the channel 1 input coupling to DC
- Set the trigger mode to auto
- Set the trigger source to channel 1
- Turn trigger holdoff to minimum or off
- Set the intensity control to a nominal viewing level
- Adjust the focus control for a sharp display

These are general instructions for setting up the oscilloscope.

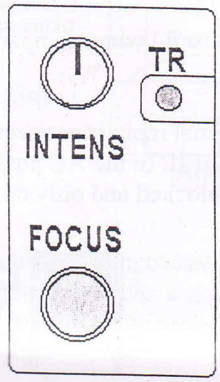
Y-POS and X-POS Setting:

Changing the scales of the X-axis and Y-axis allows many different signals to be displayed. Sometimes, it is also useful to be able to change the positions of the axes. This is possible using the X-POS and Y-POS controls. For example, with no signal applied, the normal trace is a straight line across the centre of the screen. Adjusting Y-POS allows the zero level on the Y-axis to be changed, moving the whole trace up or down on the screen to give an effective display of signals like pulse waveforms which do not alternate between positive and negative values.



This is useful when we want to use the grid in front of the screen to make measurements, for example, to measure the period of a waveform.

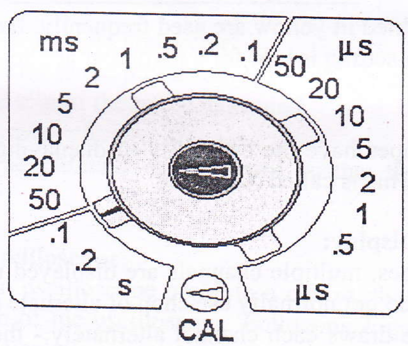
INTENSITY and FOCUS Setting:



When these are correctly set, the spot will be reasonably bright but not glaring, and as sharply focused as possible. (The TR control is screwdriver adjusted. It is only needed if the spot moves at an angle rather than horizontally across the screen with no signal connected.)

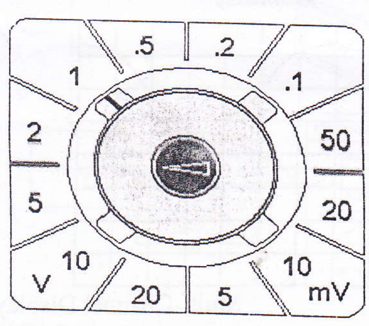
The TIME/DIV Setting:

The slope of the rising phase varies with the frequency of the saw tooth and can be adjusted, using the TIME/DIV control, to change the scale of the X-axis. Dividing the oscilloscope screen into squares allows the horizontal scale to be expressed in seconds, milliseconds or microseconds per division (s/DIV, ms/DIV, µs/DIV). Alternatively, if the squares are 1 cm apart, the scale may be given as s/cm, ms/cm or µs/cm.



The VOLTS/DIV Setting:

The Y-amplifier is linked in turn to a pair of Y-plates so that it provides the Y-axis of the V/t graph. The overall gain of the Y-amplifier can be adjusted, using the VOLTS/DIV control, so that the resulting display is neither too small nor too large, but fits the screen and can be seen clearly. The vertical scale is usually given in V/DIV or mV/DIV.



The oscilloscope has a built in source of signals which allow us to check that the oscilloscope is working properly.

Invert:

When the INVERT button is pressed IN, the corresponding signal is turned upside down, or inverted, on the oscilloscope screen.

This feature is sometimes useful when comparing signals.

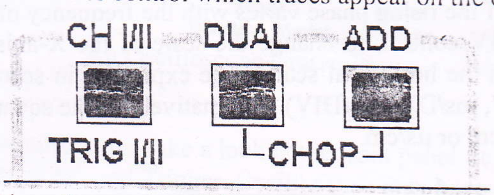
DC/AC/GND slide switches:

In the DC position, the signal input is connected directly to the Y-amplifier of the corresponding channel, CH I or CH II. In the AC position, a capacitor is connected into the signal pathway so that DC voltages are blocked and only changing AC signals are displayed.

In the GND position, the input of the Y-amplifier is connected to 0 V. This allows us to check the position of 0 V on the oscilloscope screen. The DC position of these switches is correct for most signals.

Trace selection switches:

The settings of these switches control which traces appear on the oscilloscope screen.



Settings highlighted in yellow are used frequently. Experience with the oscilloscope will help us to decide which setting is best for a particular application.

XY Mode:

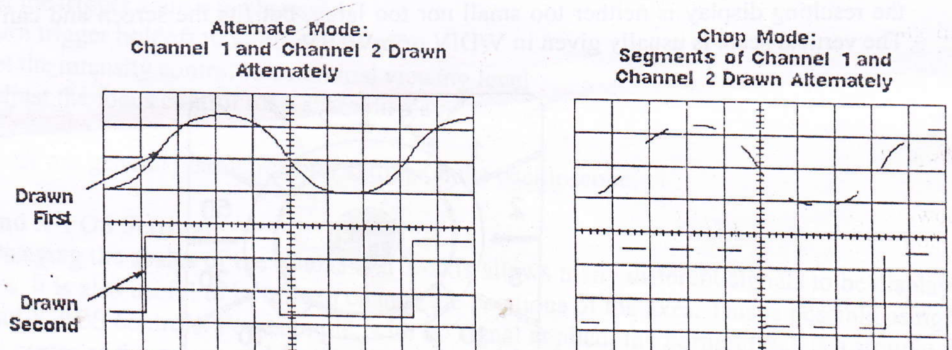
Most oscilloscopes have the capability of displaying a second channel signal along the X-axis (instead of time). This is called XY mode

Alternate and Chop Display:

On analog scopes, multiple channels are displayed using either an alternate or chop mode. (Digital oscilloscopes do not normally use chop or alternate mode.)

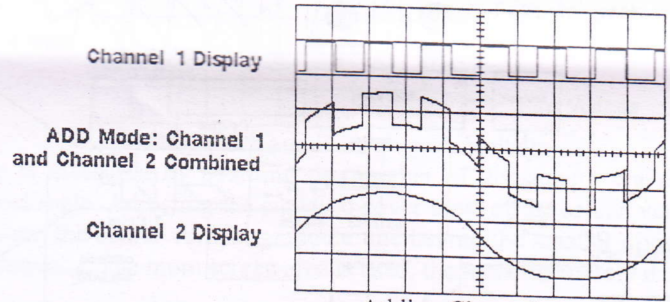
Alternate mode draws each channel alternately - the oscilloscope completes one sweep on channel 1, then one sweep on channel 2, a second sweep on channel 1, and so on. Use this mode with medium- to high-speed signals, when the sec/div scale is set to 0.5 ms or faster.

Chop mode causes the oscilloscope to draw small parts of each signal by switching back and forth between them.



Multi-Channel Display Modes

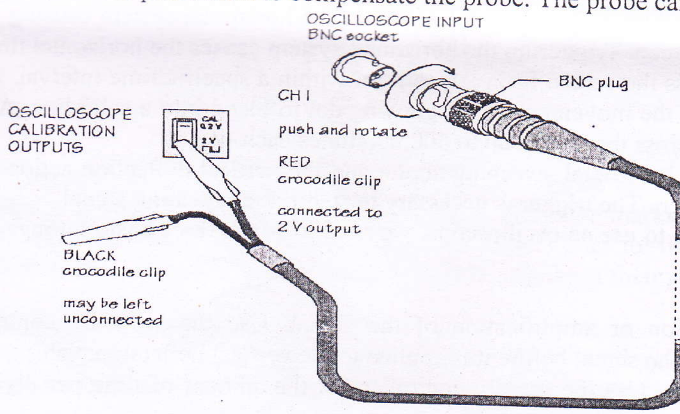
Oscilloscope may also have operations to add waveforms together, creating a new waveform display. Analog oscilloscopes combine the signals while digital oscilloscopes mathematically create new waveforms. Subtracting waveforms is another math operation. Subtraction with analog oscilloscopes is possible by using the channel invert function on one signal and then use the add operation. Digital oscilloscopes typically have a subtraction operation available. Following Figure illustrates a third waveform created by adding two different signals together.



Adding Channels

Compensating the Probe:

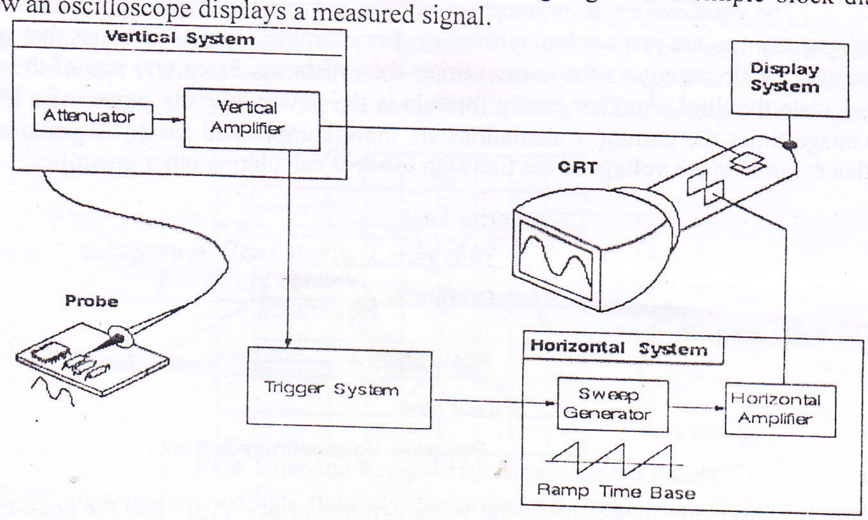
Before using a probe, it should be compensated - to balance its electrical properties to a particular oscilloscope. Most oscilloscopes have a square wave reference signal available at a terminal on the front panel used to compensate the probe. The probe can be compensated by:



- Attaching the probe to an input connector
- Connecting the probe tip to the probe compensation signal
- Attaching the ground clip of the probe to ground
- Viewing the square wave reference signal
- Making the proper adjustments on the probe so that the corners of the square wave are square

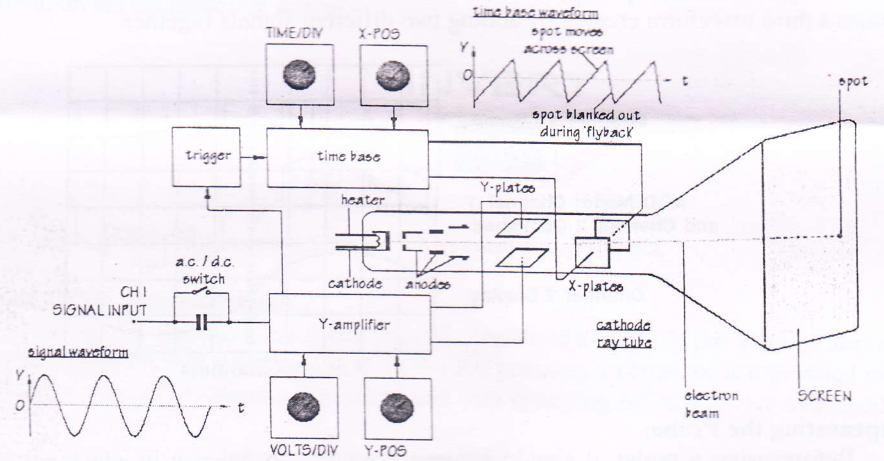
Basic Block Diagram of Oscilloscope:

When we connect an oscilloscope probe to a circuit, the voltage signal travels through the probe to the vertical system of the oscilloscope. Following Figure is a simple block diagram that shows how an oscilloscope displays a measured signal.



Depending on the vertical scale setting (volts/div control), an attenuator

Next, the signal travels directly to the vertical deflection plates of the cathode ray tube (CRT). Voltage applied to these deflection plates causes a glowing dot to move. (An electron beam hitting phosphor inside the CRT creates the glowing dot.) A positive voltage causes the dot to move up while a negative voltage causes the dot to move down.



The signal also travels to the trigger system to start or trigger a "horizontal sweep." Horizontal sweep is a term referring to the action of the horizontal system causing the glowing dot to move across the screen. Triggering the horizontal system causes the horizontal time base to move the glowing dot across the screen from left to right within a specific time interval. Many sweeps in rapid sequence cause the movement of the glowing dot to blend into a solid line. At higher speeds, the dot may sweep across the screen up to 500,000 times each second.

Together, the horizontal sweeping action and the vertical deflection action trace a graph of the signal on the screen. The trigger is necessary to stabilize a repeating signal.

In conclusion, to use an oscilloscope, we need to adjust three basic settings to accommodate an incoming signal:

- The attenuation or amplification of the signal. Use the volts/div control to adjust the amplitude of the signal before it is applied to the vertical deflection plates.
- The time base. Use the sec/div control to set the amount of time per division represented horizontally across the screen.
- The triggering of the oscilloscope. Use the trigger level to stabilize a repeating signal, as well as triggering on a single event.

Also, adjusting the focus and intensity controls enables you to create a sharp, visible display.

Measurements with Oscilloscope:

Voltage Measurements

Voltage is the amount of electric potential, expressed in volts, between two points in a circuit. Usually one of these points is ground (zero volts) but not always. Voltages can also be measured from peak-to-peak - from the maximum point of a signal to its minimum point.

The oscilloscope is primarily a voltage-measuring device. Once the voltage is measured, other quantities are just a calculation away. For example, Ohm's law states that voltage between two points in a circuit equals the current times the resistance. From any two of these quantities we can calculate the third. Another handy formula is the power law: the power of a DC signal equals the voltage times the current. Calculations are more complicated for AC signals, but the point here is that measuring the voltage is the first step towards calculating other quantities.

Ohm's Law:

$$\text{Voltage} = \text{Current} \times \text{Resistance}$$

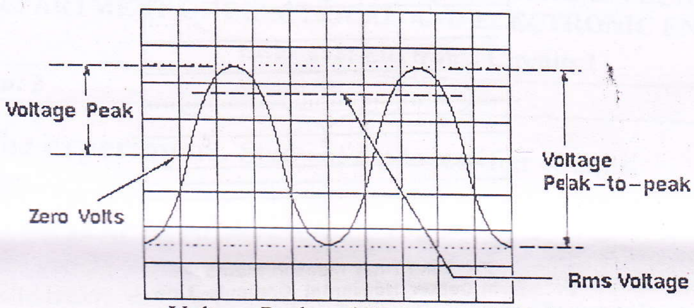
$$\text{Current} = \frac{\text{Voltage}}{\text{Resistance}}$$

$$\text{Resistance} = \frac{\text{Voltage}}{\text{Current}}$$

Power Law:

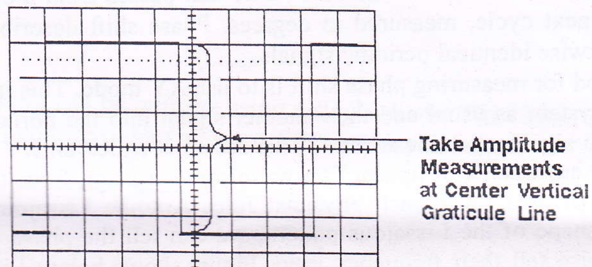
$$\text{Power} = \text{Voltage} \times \text{Current}$$

Following figure shows the voltage of one peak - V[p] - and the peak-to-peak voltage - V[p-p] -, which is usually twice V[p]. Use the RMS (root-mean-square) voltage - V[RMS] - to calculate



Voltage Peak and Peak-to-peak Voltage

The voltage is measured by counting the number of divisions a waveform spans on the oscilloscope's vertical scale. Adjusting the signal to cover most of the screen vertically, then taking the measurement along the center vertical graticule line having the smaller divisions makes for the best voltage measurements. The more screen area is used, the more accurately data can be read from the screen.



Measure Voltage on the Center Vertical Graticule Line

Many oscilloscopes have on-screen cursors that can be used take waveform measurements automatically on-screen, without having to count graticule marks. Basically, cursors are two horizontal lines for voltage measurements and two vertical lines for time measurements that we can move around the screen. A readout shows the voltage or time at their positions.

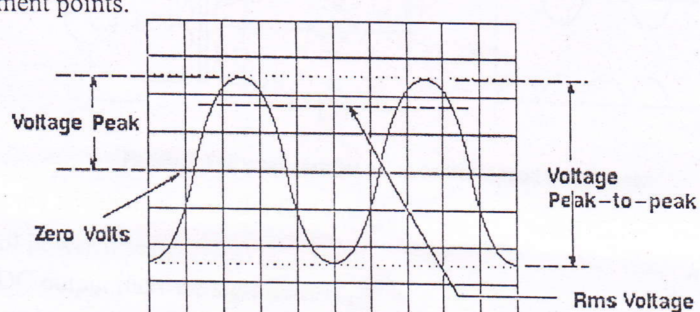
Time and Frequency Measurements

We can take time measurements using the horizontal scale of the oscilloscope. Time measurements include measuring the period, pulse width, and timing of pulses. Frequency is the reciprocal of the period, so once we know the period, the frequency is one divided by the period. Like voltage measurements, time measurements are more accurate when we adjust the portion of the signal to be measured to cover a large area of the screen. Taking time measurement along the center horizontal graticule line, having smaller divisions, makes for the best time measurements.

Pulse and Rise Time Measurements

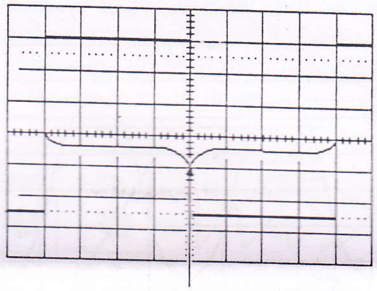
In many applications, the details of a pulse's shape are important. Pulses can become distorted and cause a digital circuit to malfunction, and the timing of pulses in a pulse train is often significant.

Standard pulse measurements are pulse width and pulse rise time. Rise time is the amount of time a pulse takes to go from the low to high voltage. By convention, the rise time is measured from 10% to 90% of the full voltage of the pulse. This eliminates any irregularities at the pulse's transition corners. This also explains why most oscilloscopes have 10% and 90% markings on their screen. Pulse width is the amount of time the pulse takes to go from low to high and back to low again. By convention, the pulse width is measured at 50% of full voltage. See Figure below for these measurement points.



Rise Time and Pulse Width Measurement Points

Pulse measurements often require fine-tuning the triggering. To become an expert at capturing pulses, we should learn how to use trigger holdoff and how to set the digital oscilloscope to capture pretrigger data, as described earlier in the Control section.



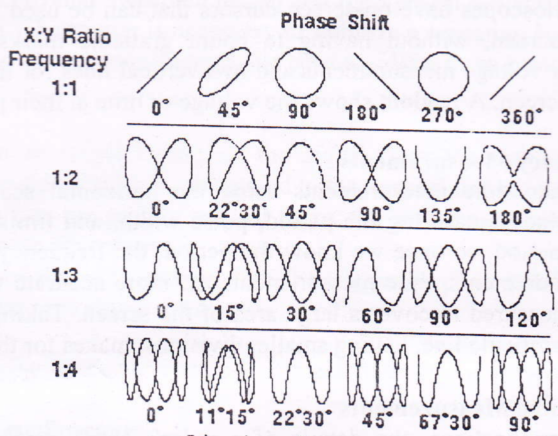
Measure Time on the Center Horizontal Graticule Line

Phase Shift Measurements

The horizontal control section may have an XY mode that display an input signal rather than the time base on the horizontal axis. (On some digital oscilloscopes this is a display mode setting.) This mode of operation opens up a whole new area of phase shift measurement techniques.

The phase of a wave is the amount of time that passes from the beginning of a cycle to the beginning of the next cycle, measured in degrees. Phase shift describes the difference in timing between two otherwise identical periodic signals.

One method for measuring phase shift is to use XY mode. This involves inputting one signal into the vertical system as usual and then another signal into the horizontal system. (This method only works if both signals are sine waves.) This set up is called an XY measurement because both the X and Y axis are tracing voltages. The waveform resulting from this arrangement is called a Lissajous pattern (named for French physicist Jules Antoine Lissajous and pronounced LEE-sa-zhoo). From the shape of the Lissajous pattern, we can tell the phase difference between the two signals. We can also tell their frequency ratio. Figure shows below Lissajous patterns for various frequency ratios and phase shifts.



Lissajous Patterns

RAJSHAHI UNIVERSITY OF ENGINEERING & TECHNOLOGY
DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

EEE- 212: Electronic Circuits I

Experiment no: 2

Name of the experiment: Study of diode rectifier circuits.

Introduction:

A rectifier converts an AC signal into a DC signal. From the characteristic curve of a diode we observe that it allows the current to flow when it is in the forward bias only. In the reverse bias it remains open. So, when an alternating voltage is applied across a diode it allows only the half cycle (positive half depending on orientation of diode in the circuit) during its forward bias condition, other half cycle will be clipped off. In the output the load will get DC signal.

Diode rectifier can be categorized in two major types. They are-

a) Half-wave rectifier.
b) Full-wave rectifier.

Half-wave rectifier:

Half-wave rectifier circuit can be built by using a single diode. The circuit diagram and the wave shape of the input and output voltage of half wave rectifier are shown bellow:

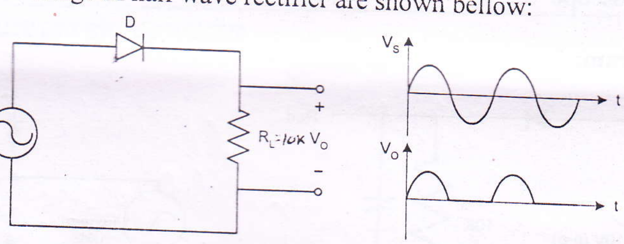


Figure 1: Half wave rectifier

- In this circuit the load receives approximately half of the input power,
- Average dc voltage is low,
- Due to the presence of ripple output voltage is not smooth one.

Full-wave rectifier:

In the full-wave rectifier both the half cycle is present in the output. Two circuits are used as full-wave rectifiers are shown bellow:

a) Full-wave rectifier using center-tapped transformer and
b) Full-wave bridge rectifier.

Using a center-tapped transformer: Two diodes will be connected to the ends of the transformer and the load will be between the diode and the center tap. The circuit diagram and the wave shapes are shown in figure 2:

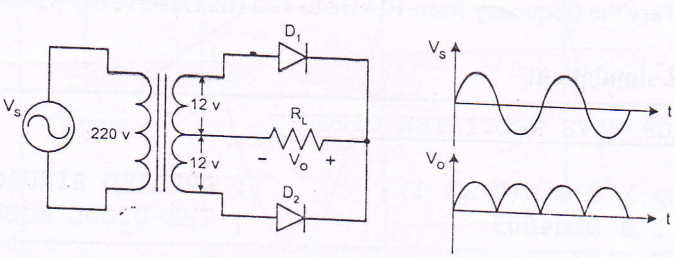


Figure 2: Full wave rectifier using center tapped transformer

This circuit has some advantages over the first one:

- Wastage of power is less,
- Average DC output increase significantly,
- Wave shape becomes smoother.

Disadvantages are:

- Require more space and becomes bulky because of the transformer,

Bridge rectifier: a bridge rectifier overcomes all disadvantages described above.

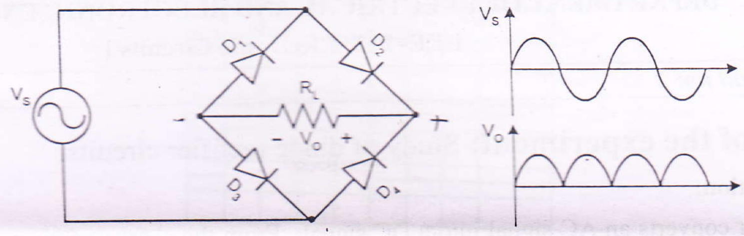


Figure 3: Bridge rectifier

A rectifier however cannot produce a smooth dc voltage. It produces some ripple in the output. This ripple can be reduced using filter capacitor across the load.

Equipment:

1. Diodes (1N 4007) (4 pieces)
2. Signal generator (1 piece)
3. Resistor (10K) (1 piece)
4. Capacitor (0.22μF, 10μF) (1 piece each)
5. Oscilloscope chord (2 pieces)
6. Oscilloscope (1 piece)

Circuit diagram:

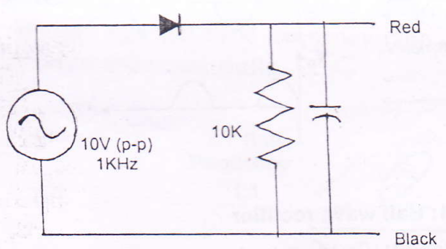


Fig:1

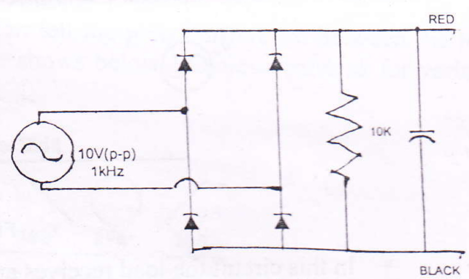


Fig. 2

Procedure:

1. Connect the circuit in breadboard as shown in Fig: 1 without capacitor.
2. Observe the output and input voltages in oscilloscope and draw them.
3. Connect the 0.22μF capacitor and repeat step 2.
4. Connect the 10μF capacitor and repeat step 2. **How does the output wave-shape differ fr that in step 3?**
5. Vary the frequency from 10 kHz to 100 Hz. **What effect do you observe when frequency is changed?**
6. Connect the circuit in breadboard as shown in Fig: 2 without capacitor.
7. Observe the output and input voltages in oscilloscope and draw them.
8. Connect the 0.22μF capacitor and repeat step 7. **How does the output wave-shape differ from that in step 3?**
9. Connect the 10μF capacitor and repeat step 7. Observe the wave-shapes.
10. Vary the frequency from 10 kHz to 100 Hz. Observe the wave-shapes.

PSPICE simulation:

```
* HALF WAVE RECTIFIER CIRCUIT

V_app 1 0 sin(0 12 1)          ; APPLIED SINUSOIDAL VOLTAGE
D_1 1 2 D1n4003                ; THE DIODE MODEL
R_1 2 0 2K
.lib nom.lib                   ;THE LIBRARY FILES USED TO OBTAIN
                               THE REQUIRED INFORMATION FOR DIODE
                               MODEL

.tran 1ns 2s                   ; THE TRANSIENT ANALYSIS
.probe                         ;THE PROBE ANALYSIS USED IN
                               VIEWING GRAPHICAL RESULT

.end
```

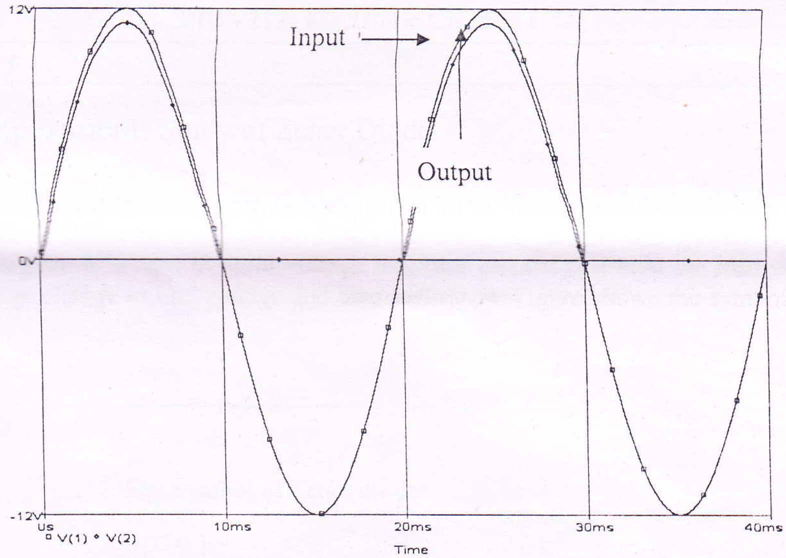


Fig: Input, output wave-shapes of a Half wave Rectifier

```
* FULL WAVE RECTIFIER CIRCUIT

V_app 1 0 sin(0 12 1)

D_1 1 2 D1n4003
D_2 3 1 D1n4003
D_3 3 0 D1n4003
D_4 0 2 D1n4003

R_1 2 3 2K

.lib nom.lib
.tran 1ns 2s
.probe
.end
```

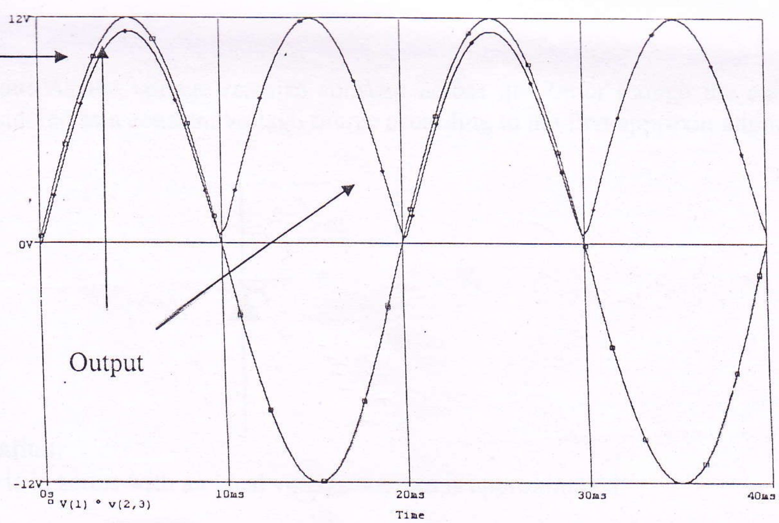


Fig: Input, Output wave-shape of full wave rectifier

Report:

1. Write the answers that were asked during the working procedure.
2. Draw the input wave, output wave (without and with capacitor) for both the circuits.
3. What is the frequency of the output of the circuit shown in Fig: 2.
4. What is the function of capacitor in the both circuits? Why a capacitor of higher value is preferable?

Md. Rabiul Islam, Assistant Professor, EEE, RUET.

RAJSHAHI UNIVERSITY OF ENGINEERING & TECHNOLOGY
DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING
EEE- 212: Electronic Circuits I

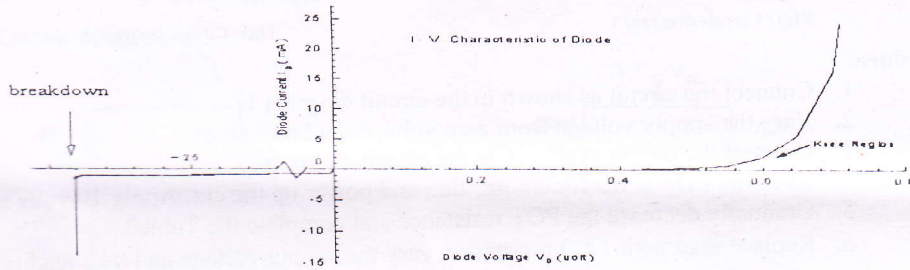
Experiment no: 3

Name of the experiment: Study of Zener Diode.

Introduction:

The diodes we have studied before do not operate in the breakdown region because this may damage them. A *Zener diode* is different; it is a silicon diode that the manufacturer has optimized for operation in the breakdown region. It is used to build voltage regulator circuits that hold the load voltage almost constant despite large change in line voltage and load resistance. Figure shows the symbol of the Zener diode.

Fig: symbol of Zener diode



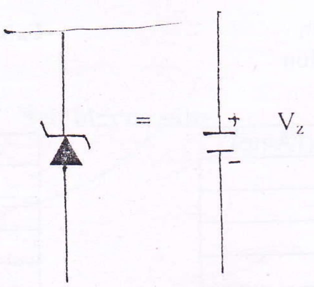
I-V characteristic curve:

The Zener diode may have a breakdown voltage from about 2 to 200 V. These diodes can operate in any of the three regions: forward, leakage and breakdown. Figure shows the I-V graph of *Zener diode*.

- In the forward region it works as an ordinary diode.
- In the leakage region (between zero and breakdown) it has only a small reverse saturation current.
- In the breakdown it has a sharp knee, followed by an almost vertical increase in current without changing the voltage.
- The voltage is almost constant, approximately equal to V_Z over most of the breakdown region.

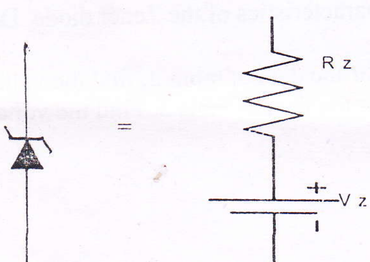
Approximation

First approximation: As the voltage remains constant across the Zener though the current changes through it, it is considered as a constant voltage source according to the first approximation.



Second approximation:

A Zener resistance is in series with an ideal voltage sources is approximated.



Equipments:

1. Zener diode (5 volt) / 6.8 V
2. Resistance (220 Ω, 470 Ω, 1 kΩ)
3. POT 10 kΩ
4. DC Power supply
5. Trainer board / Project Board.
6. Multimeter.

Experimantal Setup:

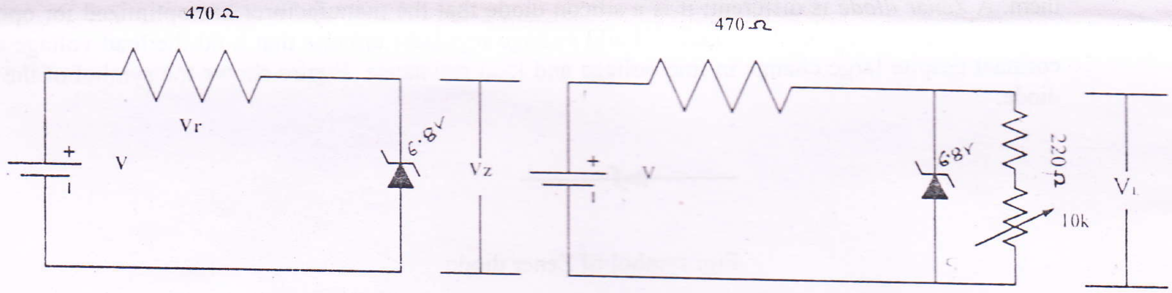


Fig1: Circuit diagram 1

Fig1: Circuit diagram 2

Procedure:

1. Connect the circuit as shown in the circuit diagram 1.
2. Vary the supply voltage from zero volts, complete Table1.
3. Connect the circuit as shown in the circuit diagram 2.
4. Keep the POT at maximum position and power up the ckt. Apply 10 volts as V.
5. Gradually decrease the POT resistance and complete the Table2.
6. Replace load with 1 kΩ resistance, vary the supply voltage and take reading for Table3.

Table 1: Data for I-V characteristics

V (Volt)	V_R (Volt)	V_z (Volt)	$I_z=V_R/R_1$ (mA)
1.0			
2.0			
3.0			
4.0			
5.0			
6.0			
7.0			
8.0			
9.0			
10.0			
11.0			

Table 2: Data for regulation due to load variation

V_{220} (mv)	V_L (Volt)	I_L(Amp)

Table 3: Data for regulation due to supply voltage variation

V (volts)	V_L (Volt)
5.0	
6.0	
…	
12.0	

Report:

1. Plot the I-V characteristics of the Zener diode. Determine the Zener breakdown voltage from the plot.
2. Plot I_L vs V_L for the data of table-2, find the voltage regulation.
3. Plot V_L vs V for the data of table 3. Find the voltage regulation.

Md. Rabiul Islam, Assistant Professor, EEE, RUET.

RAJSHAHI UNIVERSITY OF ENGINEERING & TECHNOLOGY
DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING
EEE- 212: Electronic Circuits I

Experiment no: 4

Name of the experiment: Study of BJT biasing circuits.

Objective: The objective of this experiment is to establish the proper operating point and to study the stability of the operating point with respect to changing β in different biasing circuits

Apparatus:

1) Transistors (Q).
2) Trainer Board.
3) Resistors.
4) Power supply.
5) Multimeter.
6) Potentiometer.

Circuit Diagrams:

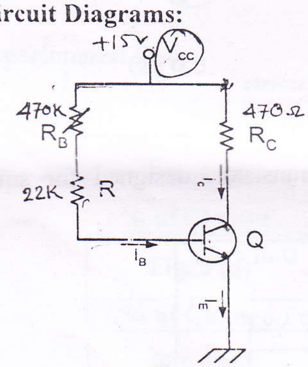


Fig. 1(a)

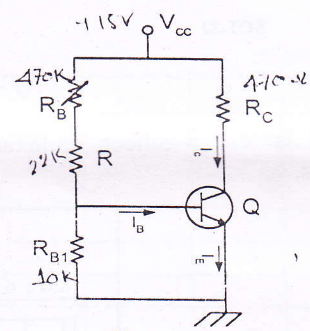


Fig. 1(b)

Fixed bias circuits

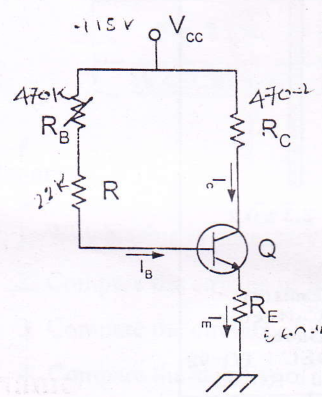


Fig. 2(a)

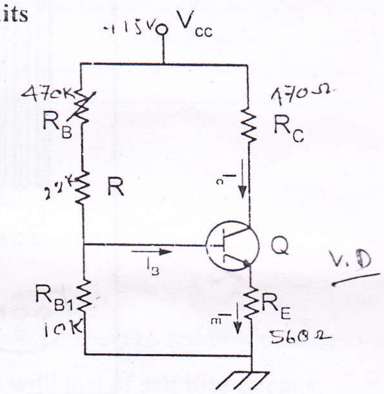
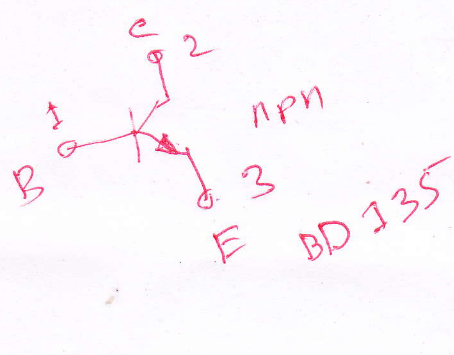


Fig. 2(b)

Self bias circuits

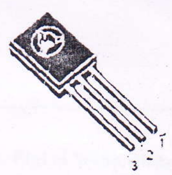
কাল বাদামি → blue → বেগুনী → ধূসর
B B R O Y G B V G
0 1 2 3 4 5 6 7 8
সাদা 9



List of Components:

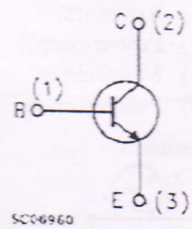
Transistors: BD 135 (NPN), C828 (NPN)
V_{cc} = +15V (DC)
R_B = 500K (Variable) / 470 kΩ
R =22K (Fixed)
R_C =470 Ω (Fixed)
R_{B1}= 10K (Fixed)
R_E = 560 Ω (Fixed)

BD135: It is a silicon NPN transistor in Jedec SOT-32 plastic package, designed for audio amplifiers and drivers utilizing complementary or quasi compementary circuits.

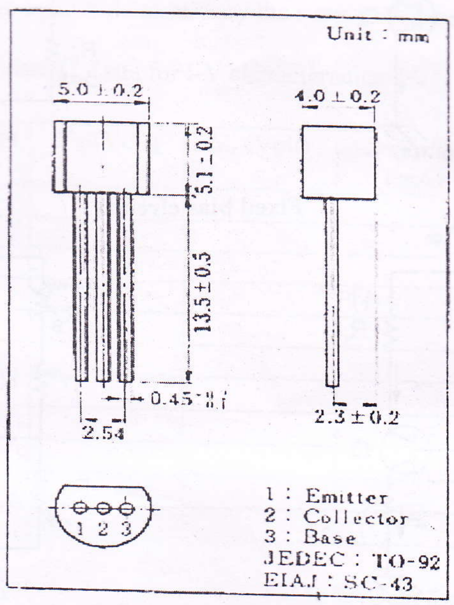


SOT-32

INTERNAL SCHEMATIC DIAGRAM



C828: It is also a silicon epitaxial planar NPN transistor, designed for small signal amplifiers.



Procedure:

1. Measure the value of R_C by using multimeter and record.
2. Measure the value of β for each transistor by using multimeter.
3. Construct the fixed bias circuit with transistors as shown in fig. 1(a).
4. Adjust 500K potentiometer until V_{CE} is approximately equal to $V_{CC}/2$.
5. Measure V_{CE}, V_{BE} and V_{RC} then calculate I_C from V_{RC} and R_C. Also calculate I_B from I_C.
6. Now replace the first transistor by second one (Different β) and repeat the step 5.
7. Construct the fixed bias circuit shown in fig. 1 (b) and repeat step 4, 5, 6.
8. Construct the self bias circuit shown in fig. 2 (a) and repeat step 4, 5, 6.
9. Construct the self bias circuit shown in fig. 2 (b) and repeat step 4, 5, 6.

Put all of the measured and calculated data into the following table.

Experimental Data:

	β	V_{CE}	V_{BE}	V_{RC}	I_C	I_B
Fig. 1 (a)						
% of Change.						
Fig. 2 (a)						
% of Change.						
Fig. 1 (b)						
% of Change.						
Fig. 2 (b)						
% of Change.						

Report:

1. Why biasing is necessary?
2. Compare the circuits of Fig. 1(a) and 1(b) with respect to stability against variation in β.
3. Compare the circuits of Fig. 2(a) and 2(b) with respect to stability against variation in β.
4. Compare the stability of fixed bias circuits with that of self bias circuits.
5. What is DC load line and Q-point?
6. What do you mean by stability?

Md. Rabiul Islam, Assistant Professor, EEE, RUET.

RAJSHAHI UNIVERSITY OF ENGINEERING & TECHNOLOGY
DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING
EEE- 212: Electronic Circuits I

Experiment no: 5

Name of the experiment: Study of Common Emitter amplifier Circuit.

Introduction: When the output is taken from the collector terminal and input signal is applied to the base of the transistor then the network is referred to common emitter. The CE amplifier can be designed to provide substantial voltage and current gains, it has an input resistance of moderate value, and it has a high output resistance (a disadvantage).

Objective: The objective of this experiment is to study of a common emitter amplifier and determine the frequency response.

List of Components:

1) Transistors: C828 (NPN)
2) Trainer Board.
3) Resistors: R1 = 30K (Fixed), R2"= 10K (Variable), R2' =4.75K (Fixed) R_e = 560 (Fixed), Rc = 470(Fixed) , Ri = 1K .
4) Power supply: Vcc
5) Multimeter.
6) Potentiometer.
7) Capacitors: Ce = 10μF, Co = 47μF, Ci = 10μF

Circuit Diagrams:

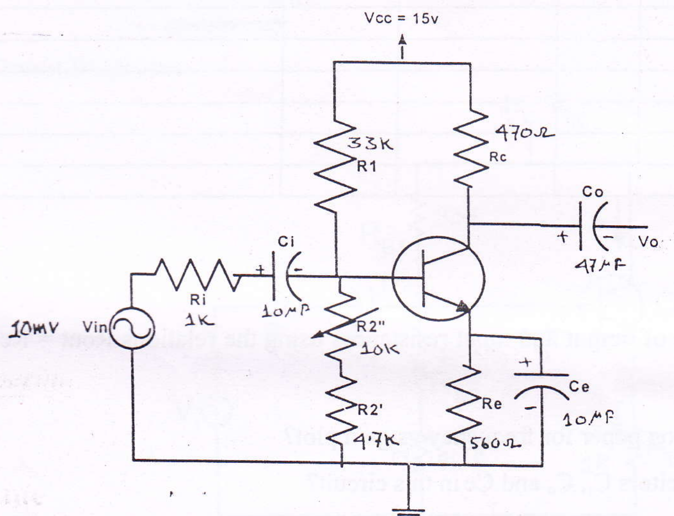


Fig.1: Common Emitter Amplifier Circuit.

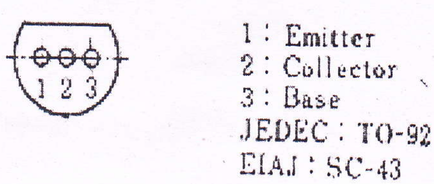


Fig. 2: Pin Configuration of C828

Procedure:

1. Construct the circuit with transistors as shown in fig.1.
2. Adjust R2" potentiometer until V_{CE} is approximately equal to $V_{CC}/2$.
3. From the function generator set the Vi at 10 mV (Sine wave).
4. Measure the output voltage by changing the input signal frequency from 10 Hz to higher frequency.
5. Calculate the gain and convert it into dB according to the given formula for each reading.
6. Plot the gain at different frequencies in the semi-log paper (gain in linear scale and frequency in logarithmic scale).
7. Determine the lower and upper cut off frequency from the frequency vs gain curve.
8. Set the oscilloscope in dual mode and observe the phase relationship of Vo and Vi
9. Connect the 10K potentiometer from Vo to ground, adjust the 10K potentiometer until Vo is half of the open circuit value then measure the value of output impedance from the potentiometer.

Experimental Data:

Frequency	V_o	$A_v = \frac{V_o}{V_i}$	A_{vmid}	$dB = 20\log\left(\frac{A_v}{A_{vmid}}\right)$

Report:

1. Calculate the value of output and input resistances using the relations Rout = Rc, and Rinput = R1 || R2 || βr_e.
2. Why we use semi-log paper for frequency vs gain plot?
3. Why we used capacitors C_i, C_o and Ce in this circuit?
4. Compare the common emitter amplifier circuit with common collector amplifier circuit according to their response.

****

RAJSHAHI UNIVERSITY OF ENGINEERING & TECHNOLOGY
DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

EEE- 212: Electronic Circuits I

Experiment no: 6

Name of the experiment: Study of common collector (emitter follower) circuit.

Introduction: When the out put is taken from the emitter terminal of the transistor the network is referred to as an emitter follower. In this configuration both V_o and V_i will attain their positive & negative peak values at the same time i.e. V_o 'follows' the magnitude of V_i with an in-phase relationship that is why this configuration is called emitter follower.

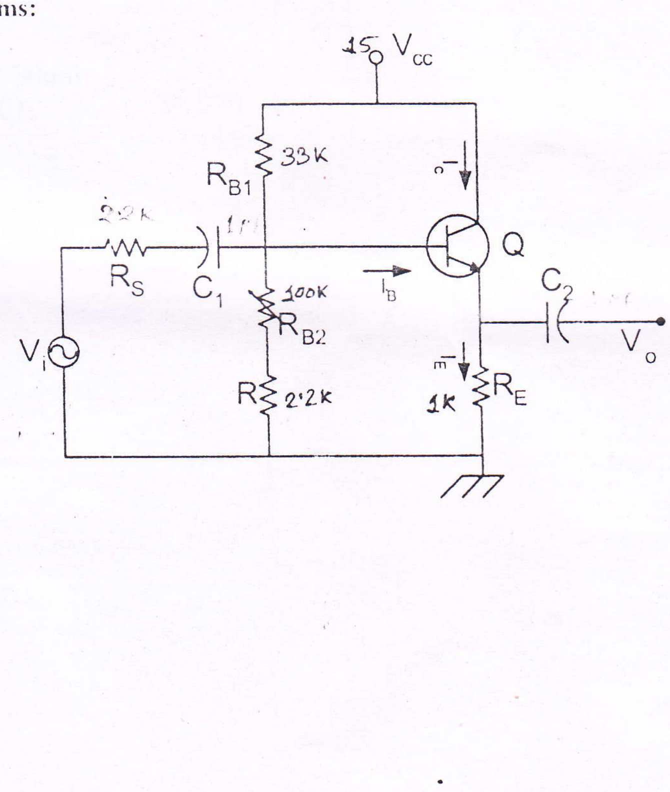
Emitter follower does not amplify voltage. Gain of the emitter follower will never be greater than 1. However, due to its large input resistance drawing little current from the source, and its small output resistance capable of driving heavy load, it is widely used as both the input and output stages for a multi-stage voltage amplification circuit due to its property of very favorable input/output resistances.

Objective: The objective of this experiment is to study of a common collector amplifier and determine the frequency response.

Components, devices, meters, instruments of experiment:

1) Transistors (Q).
2) Trainer Board. (Project Board)
3) Resistors.
4) Power supply.
5) Multimeter.
6) Potentiometer.
7) ~~Multimeter.~~

Circuit Diagrams:



RAJSHAHI UNIVERSITY OF ENGINEERING & TECHNOLOGY
DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING
EEE- 212: Electronic Circuits I

Experiment no: 6

Name of the experiment: Study of common collector (emitter follower) circuit.

Introduction: When the out put is taken from the emitter terminal of the transistor the network is referred to as an emitter follower. In this configuration both V_o and V_i will attain their positive & negative peak values at the same time i.e. V_o 'follows' the magnitude of V_i with an in-phase relationship that is why this configuration is called emitter follower.

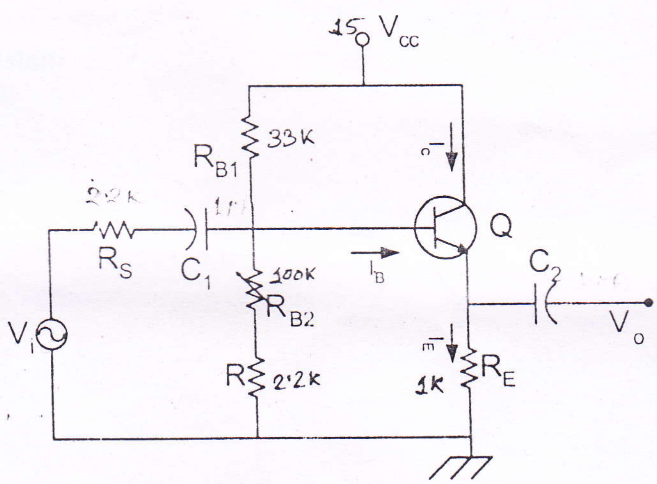
Emitter follower does not amplify voltage. Gain of the emitter follower will never be greater than 1. However, due to its large input resistance drawing little current from the source, and its small output resistance capable of driving heavy load, it is widely used as both the input and output stages for a multi-stage voltage amplification circuit due to its property of very favorable input/output resistances.

Objective: The objective of this experiment is to study of a common collector amplifier and determine the frequency response.

Components, devices, meters, instruments of experiment:

1) Transistors (Q).
2) Trainer Board. (Project Board)
3) Resistors.
4) Power supply.
5) Multimeter.
6) Potentiometer.
7) ~~Multimeter.~~

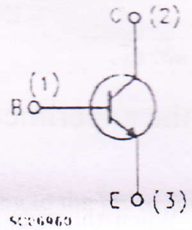
Circuit Diagrams:



List of Components:

Transistors: C828 (NPN)
V_{cc} = +15V (DC)
R_{B1} = 33K (Fixed)
R_{B2} = 100K (Variable)
R =2.2K (Fixed)
R_E = 1K (Fixed)
R_S =

INTERNAL SCHEMATIC DIAGRAM



Procedure:

1. Construct the circuit with transistors as shown in fig. 1(a).
2. Adjust R_{B2} potentiometer until V_{CE} is approximately equal to $V_{CC}/2$.
3. From the function generator set the Vi at 1volt (Sine wave).
4. Measure the output voltage by changing the input signal frequency from 10 Hz to higher frequency.
5. Calculate the gain and convert it into dB according to the given formula for each reading.
6. Plot the gain at different frequencies in the semi-log paper (gain in linear scale and frequency in logarithmic scale).
7. Determine the lower and upper cut off frequency from the frequency vs gain curve.

Experimental Data:

Frequency	V_o	$A_v = \frac{V_o}{V_i}$	A_{vmid}	$dB = 20\log\left(\frac{A_v}{A_{vmid}}\right)$

Report:

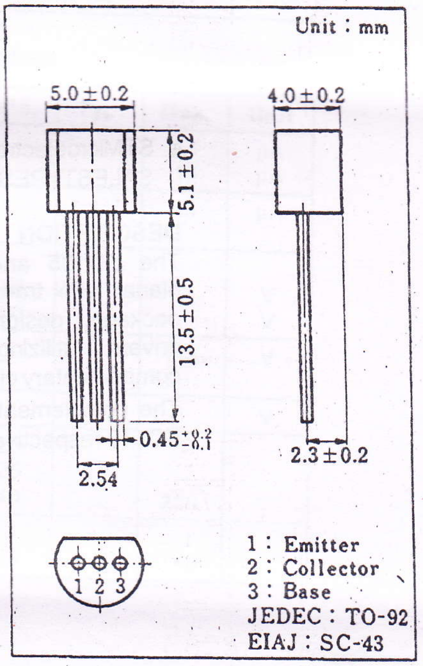
1. Why the Voltage gain of emitter follower is less then 1?
2. Why we use semi-log paper for frequency vs gain plot?
3. Why we used capacitors C_1 and C_2 in this circuit?

Md. Rabiul Islam
Lecturer-EEE

2SC828, 2SC828A

シリコン NPN エピタキシアルプレーナ形／Si NPN Epitaxial Planar

小信号増幅用／Small Signal Amplifier



■ 特　徴／Feature

● 直流電流増幅率 h_{FE} が高い。／High h_{FE}

■ 絶対最大定格／Absolute Maximum Ratings (Ta＝25 ℃)

Item		Symbol	Value	Unit
コレクタ・ベース電圧	2SC828	V_{CBO}	30	V
	2SC828A		45	
コレクタ・エミッタ電圧	2SC828	V_{CEO}	25	V
	2SC828A		45	
エミッタ・ベース電圧		V_{EBO}	7	V
せん頭コレクタ電流		I_{CP}	100	mA
コレクタ電流		I_C	50	mA
コレクタ損失		P_C	400	mW
接合部温度		T_j	150	℃
保存温度		T_{stg}	−55～＋150	℃

■ 電気的特性／Electrical Characteristics (Ta＝25 ℃)

Item		Symbol	Condition	min.	typ.	max.	Unit
コレクタ・ベース電圧	2SC828	V_{CBO}	$I_C=10\,\mu A$, $I_E=0$	30			V
	2SC828A			45			
コレクタ・エミッタ電圧	2SC828	V_{CEO}	$I_C=2$ mA, $I_B=0$	25			V
	2SC828A			45			
エミッタ・ベース電圧		V_{EBO}	$I_E=10\,\mu A$, $I_C=0$	7			V
直流電流増幅率		h_{FE}*	$V_{CE}=5$ V, $I_C=2$ mA	130		520	
トランジション周波数		f_T	$V_{CB}=10$ V, $I_E=-2$ mA		220		MHz
ベース・エミッタ電圧		V_{BE}	$V_{CB}=5$ V, $I_C=10$ mA			0.8	V
コレクタ・エミッタ飽和電圧		$V_{CE(sat)}$	$I_C=50$ mA, $I_B=5$ mA		0.14		V
雑音指数		NF	$V_{CE}=5$ V, $I_C=0.2$ mA, $R_g=2\,k\Omega$, $f=1$ kHz		6		dB

*h_{FE} ランク分類／h_{FE} Classifications

Class	Q	R	S
h_{FE}	130～260	180～360	260～520

BD135
BD139

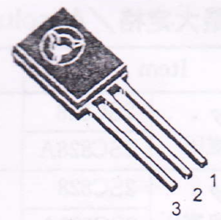
NPN SILICON TRANSISTORS

- STMicroelectronics PREFERRED SALESTYPES

DESCRIPTION

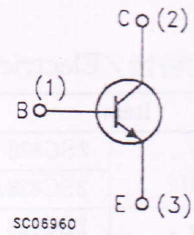
The BD135 and BD139 are silicon epitaxial planar NPN transistors in Jedec SOT-32 plastic package, designed for audio amplifiers and drivers utilizing complementary or quasi compementary circuits.

The complementary PNP types are BD136 and BD140 respectively.



SOT-32

INTERNAL SCHEMATIC DIAGRAM



ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value		Unit
		BD135	BD139	
V_{CBO}	Collector-Base Voltage (I_E = 0)	45	80	V
V_{CEO}	Collector-Emitter Voltage (I_B = 0)	45	80	V
V_{EBO}	Emitter-Base Voltage (I_C = 0)	5		V
I_C	Collector Current	1.5		A
I_{CM}	Collector Peak Current	3		A
I_B	Base Current	0.5		A
P_{tot}	Total Dissipation at $T_c \leq 25\ ^oC$	12.5		W
P_{tot}	Total Dissipation at $T_{amb} \leq 25\ ^oC$	1.25		W
T_{stg}	Storage Temperature	-65 to 150		^oC
T_j	Max. Operating Junction Temperature	150		^oC

THERMAL DATA

$R_{thj\text{-}case}$	Thermal Resistance Junction-case	Max	10	°C/W

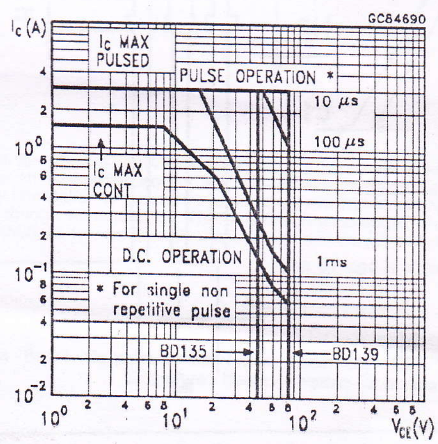
ELECTRICAL CHARACTERISTICS (T_{case} = 25 °C unless otherwise specified)

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
I_{CBO}	Collector Cut-off Current (I_E = 0)	V_{CB} = 30 V V_{CB} = 30 V T_C = 125 °C			0.1 10	µA µA
I_{EBO}	Emitter Cut-off Current (I_C = 0)	V_{EB} = 5 V			10	µA
$V_{CEO(sus)}$*	Collector-Emitter Sustaining Voltage	I_C = 30 mA for **BD135** for **BD139**	45 80			V V
$V_{CE(sat)}$*	Collector-Emitter Saturation Voltage	I_C = 0.5 A I_B = 0.05 A			0.5	V
V_{BE}*	Base-Emitter Voltage	I_C = 0.5 A V_{CE} = 2 V			1	V
h_{FE}*	DC Current Gain	I_C = 5 mA V_{CE} = 2 V I_C = 0.5 A V_{CE} = 2 V I_C = 150 mA V_{CE} = 2 V	25 25 40		250	
h_{FE}	h_{FE} Groups	I_C = 150 mA V_{CE} = 2 V for BD139 group 10	63		160	

150

* Pulsed: Pulse duration = 300 µs, duty cycle 1.5 %

Safe Operating Area



SOT-32 (TO-126) MECHANICAL DATA

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	7.4		7.8	0.291		0.307
B	10.5		10.8	0.413		0.445
b	0.7		0.9	0.028		0.035
b1	0.49		0.75	0.019		0.030
C	2.4		2.7	0.040		0.106
c1	1.0		1.3	0.039		0.050
D	15.4		16.0	0.606		0.629
e		2.2			0.087	
e3	4.15		4.65	0.163		0.183
F		3.8			0.150	
G	3		3.2	0.118		0.126
H			2.54			0.100