AMERICAN INTERNATIONAL UNIVERSITY-BANGLADESH

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Assignment Title:

Assignment No: 08 Date of Submission:

Course Title: ELECTRONIC DEVICE

Course Code: Section: P

Semester: 20___-___ Course Teacher:

* *Student(s) must complete all details except the faculty use part.*
** Please submit all assignments to your course teacher or the office of the concerned teacher.

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	Total Marks	

American International University- Bangladesh
Faculty of Engineering (FE)
Department of Electrical and Electronic Engineering (EEE)
EEE 2104: Electronic Devices Lab

Title of the Experiment: Study of Single-Stage Bipolar Junction Transistor (BJT)-Based Common Emitter Amplifier Circuit.

Objectives:

The objectives of this experiment are to

1. Trace the circuit diagram of a single-stage transistor amplifier.
2. Establish the proper DC operating point (Q-point) of a bipolar transistor-based amplifier circuit.
3. Measure the Beta (β) of the transistor with a multimeter.
4. Measure the maximum signal that can be amplified with the amplifier without any distortion.
5. Measure the voltage gain of the amplifier at an input frequency of 1 kHz.
6. Measure the voltage gain of the amplifier at different values of load resistances.

Theory:

The aim of the AC analysis is to determine the Q point of a common emitter configuration which will ensure an undistorted amplification of a signal. In this regard, a DC analysis will be performed to adjust Q at a suitable location on the characteristic curve. After performing the DC analysis, the small signal parameters will be calculated depending on the model being used. Gain dependency on the load resistors will also be observed. The most common circuit configuration for an NPN transistor is that of the Common Emitter (CE) amplifier and a family of curves known commonly as the output characteristics curves, which relate the collector current (I_C), to the output or collector voltage (V_{CE}), for different values of base current (I_B). All types of transistor amplifiers operate using AC signal inputs which alternate between a positive value and a negative value. Presetting the amplifier circuit to operate between these two maximum or peak values is achieved using a process known as biasing. Biasing is very important in amplifier design as it establishes the correct operating point of the transistor amplifier ready to receive signals, thereby reducing any distortion to the output signal.

The single-stage common emitter amplifier circuit shown in Fig. 1 uses a 'Voltage Divider Biasing' circuit. The base voltage (V_B) can be easily calculated using the simple voltage divider formula as in equation (1) from Fig. 1.

$$V_B = \frac{R_2}{R_1 + R_2} V_{CC} \qquad (1)$$

Thus, the base voltage is fixed by biasing and independent of the base current provided the current in the divider circuit is large compared to the base current. Assuming $I_B \approx 0$, one can do the approximate analysis of the voltage divider network without using the transistor gain, β in the calculation. Note that the approximate approach can be applied with a high degree of accuracy when the following condition is satisfied: $\beta R_E \geq 10R_2$.

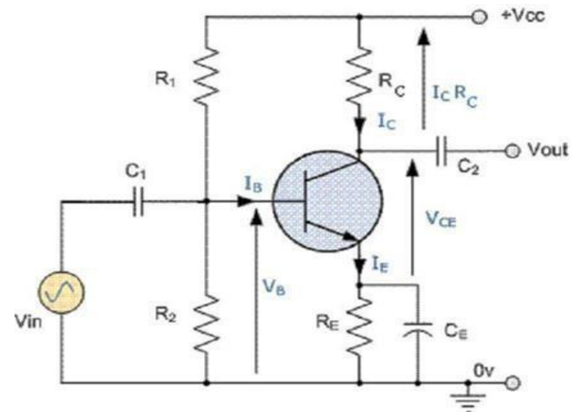


Figure 1: Circuit diagram of an npn transistor-based common emitter amplifier.

Load Line and Q-point

A static or DC load line can be drawn onto the output characteristics curves of the transistor to show all the possible operating points of the transistor from fully ON ($I_C = \frac{V_{CC}-V_{CE}}{R_C+R_E} \cong \frac{V_{CC}}{R_C+R_E}$) to fully OFF ($I_C$ = 0). The quiescent operating point or Q-point is a point on this load line that represents the values of I_C and V_{CE} that exist in the circuit when no input signal is applied. Knowing V_B, I_C, and V_{CE} can be calculated to locate the operating point of the circuit as follows:

$$V_E = V_B - V_{BE}$$

So, the emitter current, $I_{EQ} = I_{CQ} = \frac{V_{CC} - V_{CEQ}}{R_C + R_E}$ and $V_{CEQ} = V_{CC} - I_{CQ}R_C - I_{EQ}R_E$.

It can be noted here that the sequence of calculation does not need the knowledge of β and I_B is not calculated. So, the Q-point is stable against any replacement of the transistor. Since the aim of any small signal amplifier is to generate an amplified input signal at the output with the minimum distortion possible, the best position for this Q-point is as close to the center position of the load line as reasonably possible, thereby producing a Class A type amplifier operation, i.e., $V_{CEQ} = \frac{V_{CC}}{2}$.

Coupling and Bypass Capacitors

In CE amplifier circuits, capacitors C_1 and C_2 are used as coupling capacitors to separate the AC signals from the DC biasing voltage. The capacitors will only pass AC signals and block any DC component. Thus, they allow the coupling of the AC signal into an amplifier stage without disturbing its Q point. The output AC signal is then superimposed on the biasing of the following stages. Also, a bypass capacitor, C_E is included in the emitter terminal. This capacitor is an open circuit component for DC bias, meaning that the biasing currents and voltages are not affected by the addition of the capacitor maintaining good Q-point stability. However, this bypass capacitor acts as a short circuit path across the emitter resistor at high frequency signals increasing the voltage gain to its maximum. Generally, the value of the bypass capacitor, C_E is chosen to provide a reactance of at most, 1/10th the value of R_E at the lowest operating signal frequency.

Amplifier Operation

Once the Q-point is fixed through DC bias, an AC signal is applied at the input using coupling capacitor C_1. During the positive half cycle of the signal, V_{BE} increases leading to increased I_B. Therefore, I_C increases by β times leading to a decrease in the output voltage, V_{CE}. Thus, the CE amplifier produces an amplified output with a phase reversal. The voltage gain of the common emitter amplifier is equal to the ratio of the change in the output voltage to the change in the input voltage. Thus, the voltage gain expression can be written as,

$$A_v = \frac{V_{out}}{\quad} \quad \frac{\Delta V_{CE}}{\quad} =$$

$$V_{in} \qquad \Delta V_{BE}$$

The input (Z_i) and output (Z_o) impedances of the circuit can be computed for the case when the emitter resistor, R_E is completely bypassed by the capacitor, C_E.

$$Z_i = R_1 \parallel R_2 \parallel \beta r_e \text{ and } Z_o = R_C \parallel r_o$$

Where, r_e (26mV/I_E) and r_o are the emitter diode resistance and output dynamic resistance (can be determined from output characteristics of the transistor). Usually $r_o \geq 10R_C$, thus, the gain can be approximated as,

$$A_v = \frac{V_{out}}{V_{in}} = -\frac{I_C Z_o}{I_B Z_i} = -\frac{\beta I_B R_C \| r_o}{I_B \beta r_e} = -\frac{R_C}{r_e}$$

The negative sign accounts for the phase reversal at the output. In the circuit diagram, the emitter resistor is split into two to reduce the gain to avoid distortion. So, the expression for gain is modified as,

$$A_v = \frac{V_{out}}{V_{in}} = -\frac{R_C}{R_E + r_e}$$

Biasing Issues:

We will use the most applied biasing circuit to operate the BJT as an amplifier. A single power supply is used and the **voltage divider network** consisting of two resistors at the base, R_{B1} and R_{B2} is used to adjust the base voltage. Using the Thevenin theorem, the voltage divider network may be modeled by a Thevenin equivalent circuit and is replaced by Thevenin equivalent voltage, V_{TH} and Thevenin equivalent resistance, R_{TH} where,

$$V_{TH} = \frac{R_{B2}}{R_{B1}+R_{B2}} V_{CC}$$, applying the VDR across two-resistor network.

$$R_{TH} = \frac{R_{B1} R_{B2}}{R_{B1}+R_{B2}}$$, shorting the voltage source, V_{CC} at the base terminal.

The DC analysis of the circuit is simple by applying KVL at the input and the output loops of Fig. 1 (b). Applying KVL in the input loop of Fig. 1 (b).

$$V_{TH} = I_B R_{TH} + V_{BE} + I_E R_E = I_B R_{TH} + V_{BE} + (I_B + I_C) R_E$$

$$\Rightarrow V_{TH} = I_B R_{TH} + V_{BE} + (I_B + \beta I_B) R_E = I_B\{R_{TH} + (1+\beta) R_E\} + V_{BE}$$

$$\Rightarrow I_B = \frac{V_{TH} - V_{BE}}{R_{TH} + (1+\beta) R_E}$$

Applying KVL in the output loop of Fig. 1 (b).

$$V_{CC} = I_C R_C + V_{CE} + I_E R_E = I_C R_C + V_{CE} + (I_B + I_C) R_E$$

$$\Rightarrow V_{CC} = I_C R_C + V_{CE} + I_C R_E; \; I_C \gg I_B$$

$$\Rightarrow I_C = \frac{V_{CC} - V_{CE}}{R_C + R_E}$$

So, the quiescent point collector and emitter currents as well as collector-to-emitter voltage can be written as-

$$I_{CQ} = \beta I_B$$

$$I_{EQ} = (1+\beta) I_B$$

$$V_{CEQ} = V_{CC} - I_{CQ} R_C - I_{EQ} R_E$$

If the BJT is in the active mode, the following typical values can be observed-

$$V_{BE} = 0.7 \text{ V and } I_C = \beta I_B$$

The collector resistance, R_C is used to adjust the collector voltage, V_C. Finally, the emitter resistance, R_E is used to stabilize the DC biasing point (operating point or quiescent point or Q-point). Using the above equations, the stability of biasing points for different transistors of β can be calculated.

Note: It is a good idea to set the bias for a single stage amplifier to half the supply voltage, as this allows maximum output voltage swing in both directions of an output waveform. For maximum symmetrical swing, it is clear from the figure that the collector-to-emitter voltage, V_{CE} should be equal to the half of the collector supply voltage, V_{CC} that is, $V_{CE} = V_{CC}/2$.

Circuit Configuration:

The **common emitter configuration** is used for voltage and current amplification and is the most common configuration for transistor amplifiers. In this configuration, the emitter terminal is common between the input (base) and collector (output) terminals of the transistor.

Biasing of Bipolar Junction Transistors:

Active Mode: The emitter junction is forward-biased, and the collector junction is reverse-biased. If the BJT is operated in active mode, then the BJT can be used as an amplifier.

Output Characteristics:

The output characteristics curves for a common emitter configured BJT are plotted between the collector current, I_C, and the collector-to-emitter voltage drop by keeping the base current, I_B constant as shown in Fig. 2. These curves are almost horizontal. The output dynamic resistance again can be calculated from the ratio of the small change of emitter-to-collector voltage drop to the small change of the collector current.

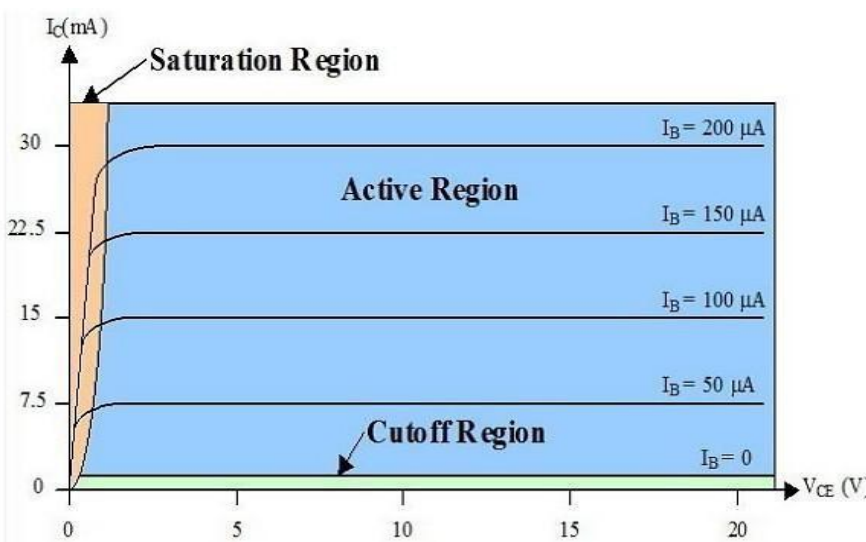


Figure 2: BJT Common Emitter Output Characteristics.

Pre-Lab Homework:

Students will be provided with the upcoming lab manuals, and they will be asked to prepare the theoretical (operations/working principle) information on the topic from the textbook.

Besides, they must implement the circuit (as given in Figure 3) using a MultiSIM simulator. Observe the base and collector currents as well as collector to emitter voltage through simulations (I_B, I_C, V_B, V_C, V_E, and V_{CE}) and take

snapshots using the snipping tool. Measure the values of different key parameters and fill up the table (Table 1) based on the simulation results. For simulation, use a 2N2222, or a C828, or BD135 transistor.
Perform a transient analysis of a sinusoidal input signal. The input signal, V_s exhibits a frequency of 1 kHz and an amplitude 10 mV peak. Display the input voltage and the voltage across load resistance R_L together to see the transistor amplification characteristics. Also, display the base voltage, V_B.

Apparatus:

SL#	Apparatus	Quantity
1	BJT (2N2222, C828, BD135)	1 each
2	Resistance ($R_{B,POT}$ = 0-500 k □□ $R_{L,POT}$ = 0-100 k □□ R_C = 470 □□ R_E = 560□□ R = 33 k □□ R_{B2} = 3.3□k)	1 each
3	Capacitor (10 F□and 100 F)□	2 + 1
4	Project Board	1
5	Signal Generator and DC Power Supply	1 + 1
6	Oscilloscope and Probes	1 + 2
7	DC milliammeter (0-50 mA)	1
8	DC microammeter (0-500 A□)	1
9	Multimeter	1
10	Connecting Leads	10

Precaution!

The following is a list of some of the special safety precautions that should be taken into consideration when working with transistors:

1. **Never remove or insert a transistor into a circuit with voltage applied.**
2. **Ensure a replacement transistor into a circuit is in the correct direction.**
3. **Transistors are sensitive to being damaged by electrical overloads, heat, humidity, and radiation. Damage of this nature often occurs by applying the incorrect polarity voltage to the collector circuit or excessive voltage to the input circuit.**
4. **One of the most frequent causes of damage to a transistor is the electrostatic discharge from the human body when the device is handled.**
5. **The applied voltage and current should not exceed the maximum rating of the given transistor.**
6. **Change the components or any of their properties by turning off the power/stopping the simulation.**

Experimental Procedures:

1. Measure the actual values of the base, emitter, and collector resistors.

2. Identify the terminals of the transistor and measure the value of Beta (□).
3. Connect the circuit and connect the microammeter and milliammeter as shown in Fig. 3.
4. Connect the multimeter (voltmeter mode) to measure the base resistance voltage (V_B) and input voltage (V_{BE}).
5. Turn on both the DC power supply with the voltage control nob at 0 V and then set the collector supply voltage, V_{CC} to 15 V.
6. Now, adjust the 500 kΩ potentiometer until the collector-to-emitter voltage, V_{CE} is approximately equal to the half of the collector supply voltage, V_{CC} that is, $V_{CE} = V_{CC}/2$.
7. Measure collector-to-emitter voltage, V_{CE}, base-to-emitter voltage, V_{BE}, base current, I_B, emitter current, I_E, and collector current, I_C. Calculate the based current, I_B from the collector current, I_C using the value of□. Record the measured values in Table 1.
8. Now, feed a sinusoidal AC signal of 1 kHz at the input with 10 mV peak value as shown in Fig. 3.
9. Observe the input and output signals on the oscilloscope screen in DUAL mode.
10. Increase the input signal till the output wave shape starts getting distorted. Measure this input signal. This is the maximum input signal that the amplifier can amplify without any distortion.
11. Now feed an AC signal that is less than the maximum signal handling capacity of the amplifier. Fix the input signal frequency at 1 kHz, Draw the input and output voltage wave shape, and calculate the voltage gain, A_V.
12. Connect a potentiometer (0-100 k□) as the load resistor, vary the potentiometer knob, and measure the output voltages for each case. Record them in Table 2. Also, find the voltage gain, A_V of the amplifier for each case.
13. Compute the voltage gain, A_V of the amplifier circuit for each case in decibels ($A_{V,dB} = 20log_{10}{}^{AV}$). 14. Record the images of the hardware and simulation circuit diagrams as well as various wave shapes.
15. Turn off the DC power supply, function generator, and oscilloscope.

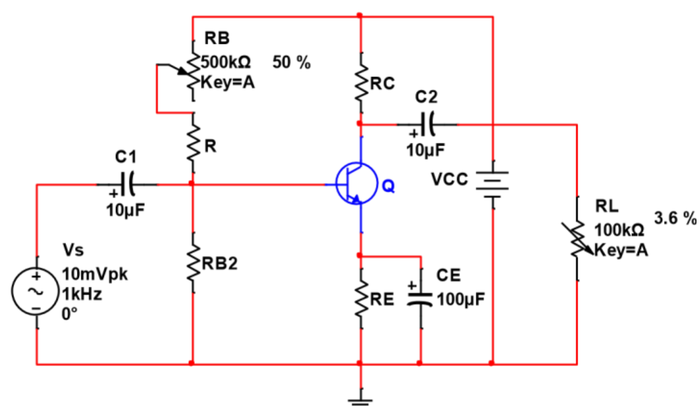


Figure 3: Circuit diagram for the study of CE BJT amplifier circuit

Table 1 Measured data of the voltage divider bias circuit, operating point, and transistor parameter

V_{CC}	β	V_{CE}	V_{BE}	I_B	I_C	I_E
1.5	3.92	7.5	0.75	1.3	2.8	2.7

Table 2 Measured data of the voltage gain of the amplifier circuit against the load resistances.

Load Resistor, R_L (k□)	**Input voltage, V_i (mV)**	**Output Voltage, V_o (V)**	**Gain, $A_v = \frac{V_{out}}{V_{in}}$**	**Gain in dB $A_{V,dB} = 20log_{10}A_V$**
1	59	380	6.44	16.18
3.3	42	460	10.95	20.79
4.7	43	480	11.16	20.96
5.6	44	500	11.36	21.11
8.2	45	520	11.56	21.26
10	46	560	12.17	21.71
20	48	580	12.08	21.64

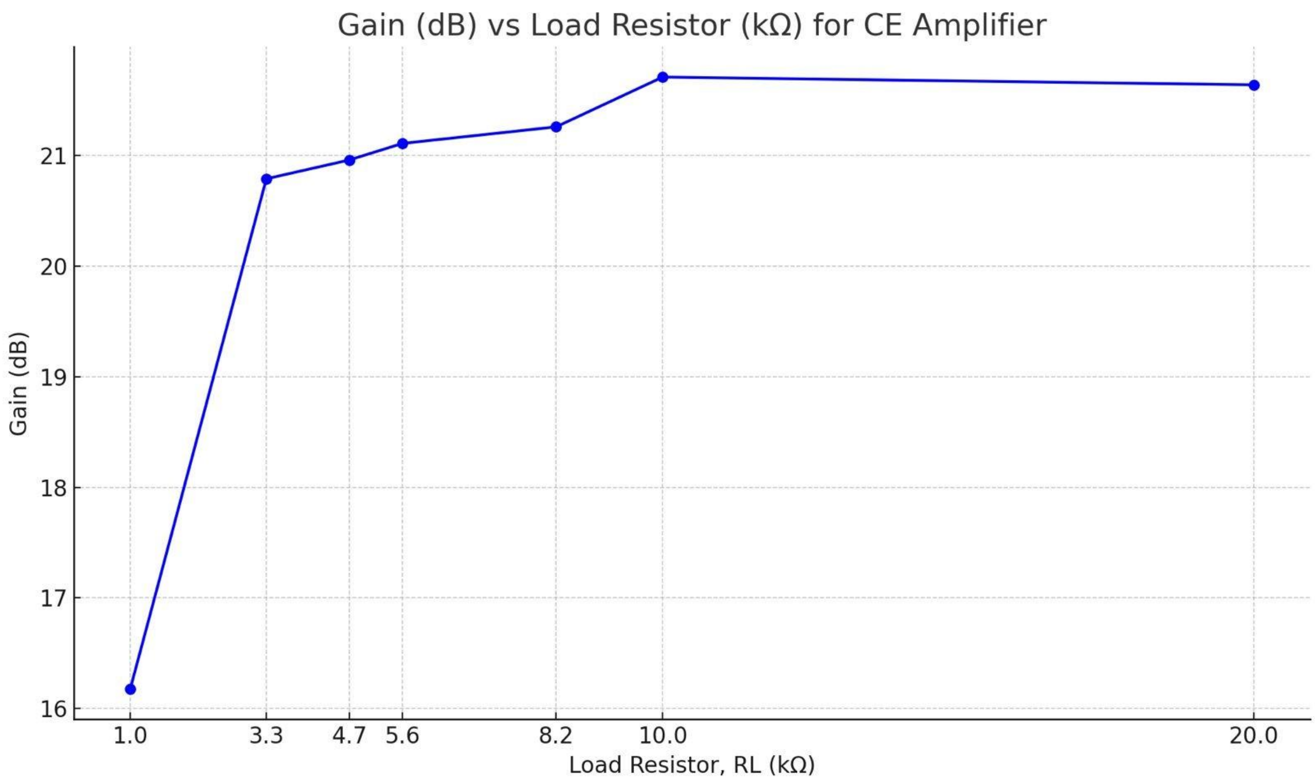
1. Show the difference between your simulated and measured values. Comment on the results and interpret the experimental and simulation data.
2. From the obtained data, draw the load characteristic curve of the voltage gain in dB ($A_{V,dB}$) vs. the load resistance (R_L) for a BJT common emitter (CE) amplifier circuit.
3. Explain the behavior of the CE amplifier circuit in the active, saturation, and cut-off regions of operation.
4. Determine the BJT parameters from the data sheet. Compare it with the experimental values.
5. Why biasing is necessary for BJT amplifier circuit?
6. Why do we need all the capacitors and resistors shown in the circuit? Explain with necessary equations.
7. Give your suggestions regarding this experiment.
8. Discuss the overall aspects of the experiment. Did your results match the expected ones? If not, explain.

ANSWERS:

1.

The measured values from the experiment closely resemble the expected outcomes from the simulation, but some differences were observed due to real-world circuit conditions. The base-emitter voltage (V_BE) was slightly higher, and the gain showed minor variation. Despite these, the collector-emitter voltage (V_CE) was accurately set to 7.5 V, indicating proper biasing. The transistor's performance overall aligned well with theoretical and simulated expectations. Some minor differences in current measurements were likely due to meter precision and transistor tolerances. Overall, the experimental results confirmed the theoretical behavior of the common emitter amplifier circuit.

2.



3.
In the active region, the common emitter amplifier operates in its intended amplification mode. The baseemitter junction is forward-biased while the collector-base junction is reverse-biased, allowing the transistor to control the large collector current with a small base current. In saturation, both the base-emitter and collector-base junctions are forward-biased, and the transistor acts like a closed switch, resulting in minimal voltage drop across the collector-emitter junction. In the cut-off region, both junctions are reverse-biased, and the transistor remains off with almost no collector current. These three regions define how the transistor functions in amplification and switching applications.

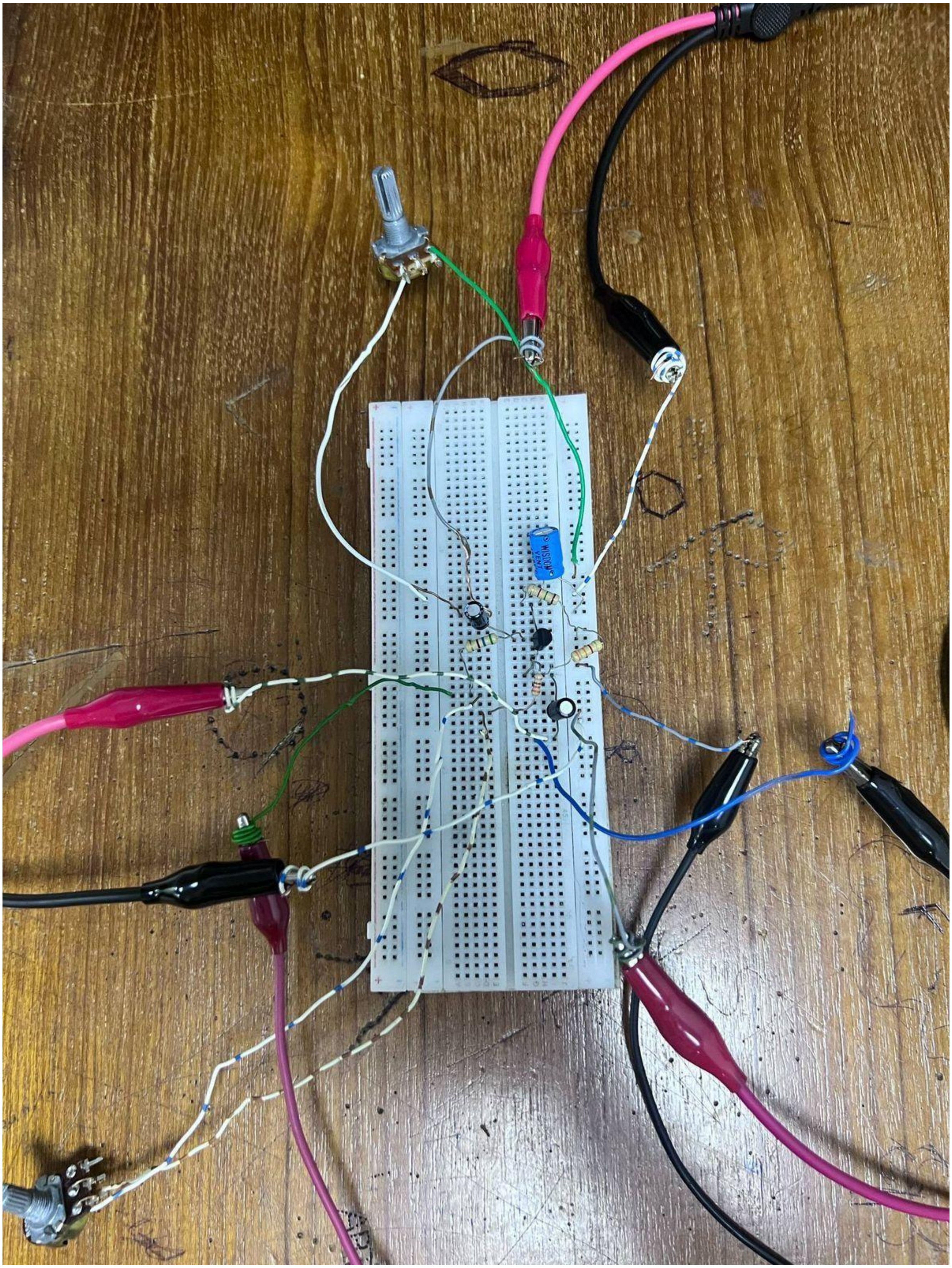
4.
According to the datasheet, the 2N2222 transistor has a current gain (β) typically ranging from 100 to 300, and a base-emitter voltage (V_BE) of around 0.7 V when conducting. In the experiment, the measured β was approximately 215, which lies within the expected range. The measured V_BE was about 0.75 V, which is slightly higher but still within acceptable tolerance. These findings indicate that the transistor used in the experiment performed consistently with the manufacturer’s specifications, validating the accuracy and reliability of the practical setup.

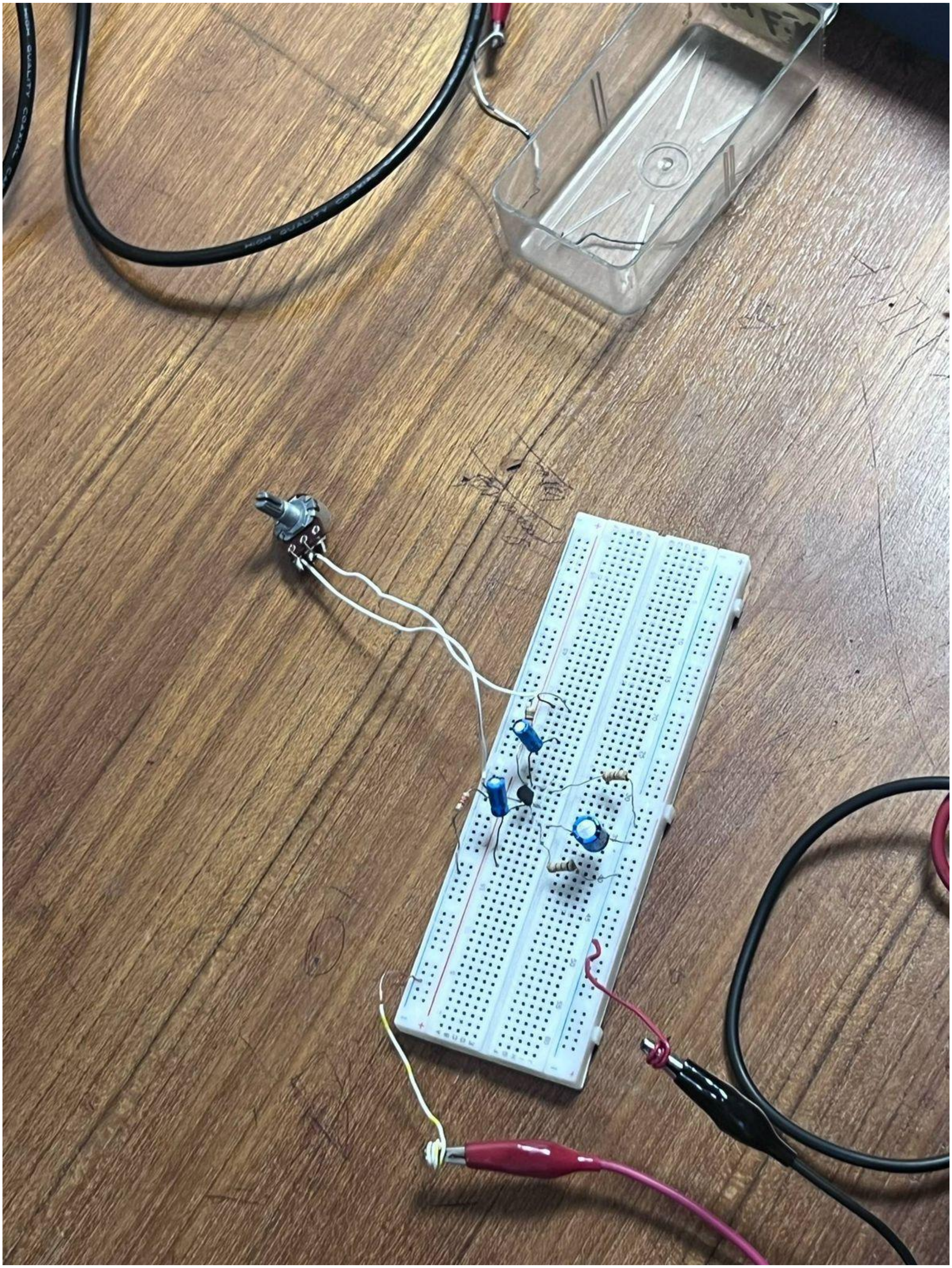
5.
Biasing is necessary in a BJT amplifier circuit to establish the correct operating point or Q-point, ensuring that the transistor remains in the active region throughout the signal cycle. Proper biasing allows the amplifier to produce an undistorted and linear output. Without appropriate biasing, the transistor may operate in the cutoff or saturation region, leading to clipping or signal distortion. Biasing also stabilizes the transistor’s performance against variations in temperature or transistor parameters, making the circuit more reliable and predictable.

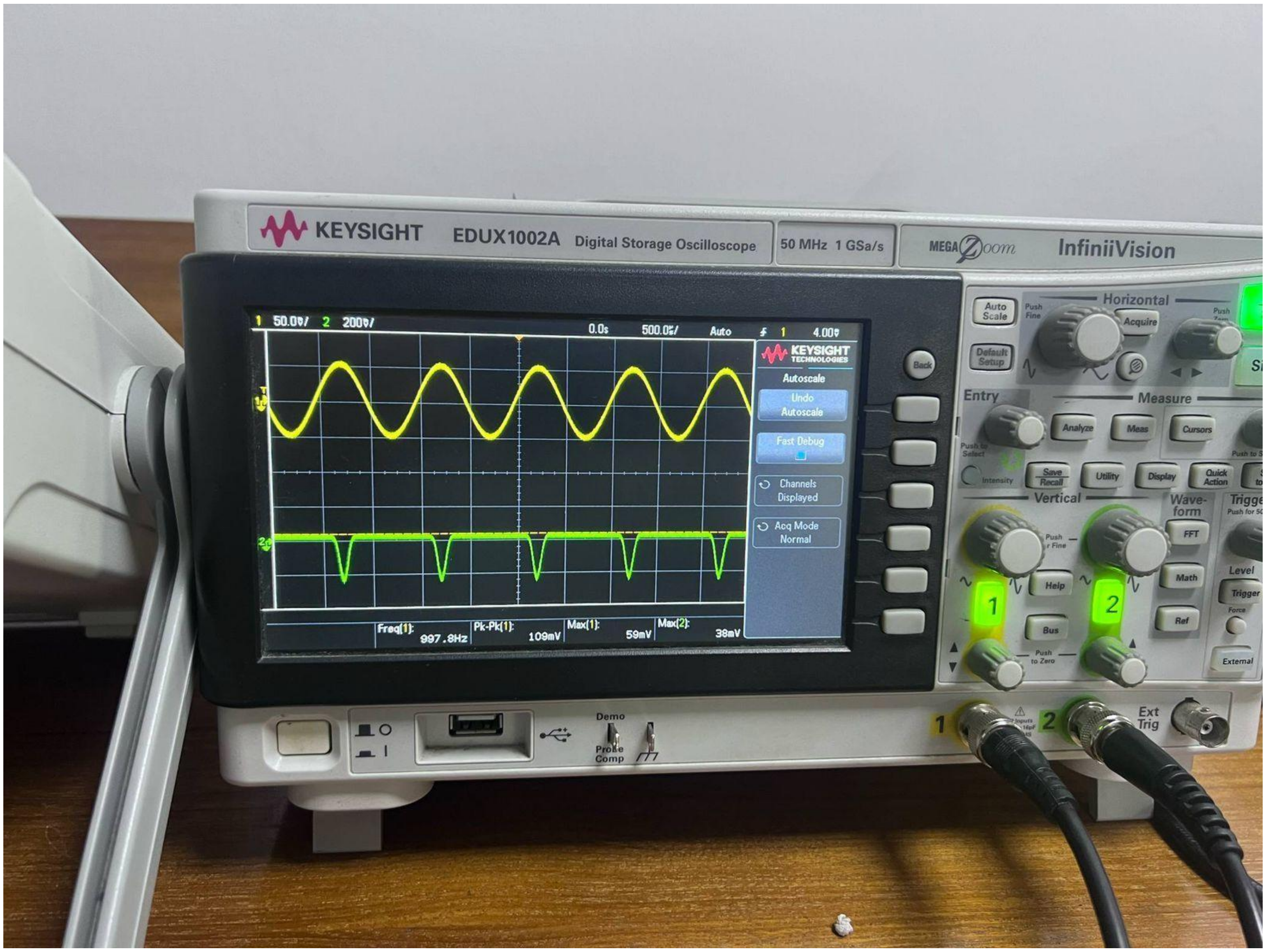
6.
Each resistor and capacitor in the common emitter amplifier circuit plays an essential role in the amplifier's performance. The resistors R1 and R2 form a voltage divider network that sets the base voltage for proper transistor biasing. The collector resistor RC converts the collector current into a voltage output and helps determine the voltage gain. The emitter resistor RE provides thermal stability through negative feedback, reducing the effect of temperature changes on the operating point. The bypass capacitor CE short-circuits RE for AC signals, thereby increasing the voltage gain at high frequencies. The coupling capacitors C1 and C2 block DC while allowing AC signals to pass. C1 ensures that only the AC input is applied to the base, and C2 allows the amplified AC output to pass to the load without affecting the DC biasing.

7.
It is suggested to use precision measurement instruments to reduce experimental error, especially when dealing with small currents like the base current. Proper verification of all connections and circuit elements before powering the system can help avoid damage and improve accuracy. It is also helpful to simulate the circuit beforehand to predict expected outcomes. High-quality oscilloscopes should be used for clear visualization of waveforms. Additionally, using fixed resistors instead of adjustable ones after calibration ensures stability during testing.

8.
The overall experiment was successful, with results that closely matched theoretical predictions. The voltage gain trend, Q-point positioning, and amplification behavior were all consistent with the expected outcomes of a properly biased common emitter amplifier. Minor deviations in measurements were observed but remained within acceptable limits and could be attributed to component tolerances, environmental factors, or measurement inaccuracies. The experiment effectively reinforced the theoretical concepts of transistor operation, biasing, and amplification, providing practical insight into analog circuit behavior.



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EDUX1002A Digital Storage Oscilloscope
50 MHz 1 GSa/s
InfiniiVision
Autoscale
Undo Autoscale
Fast Debug
Channels Displayed
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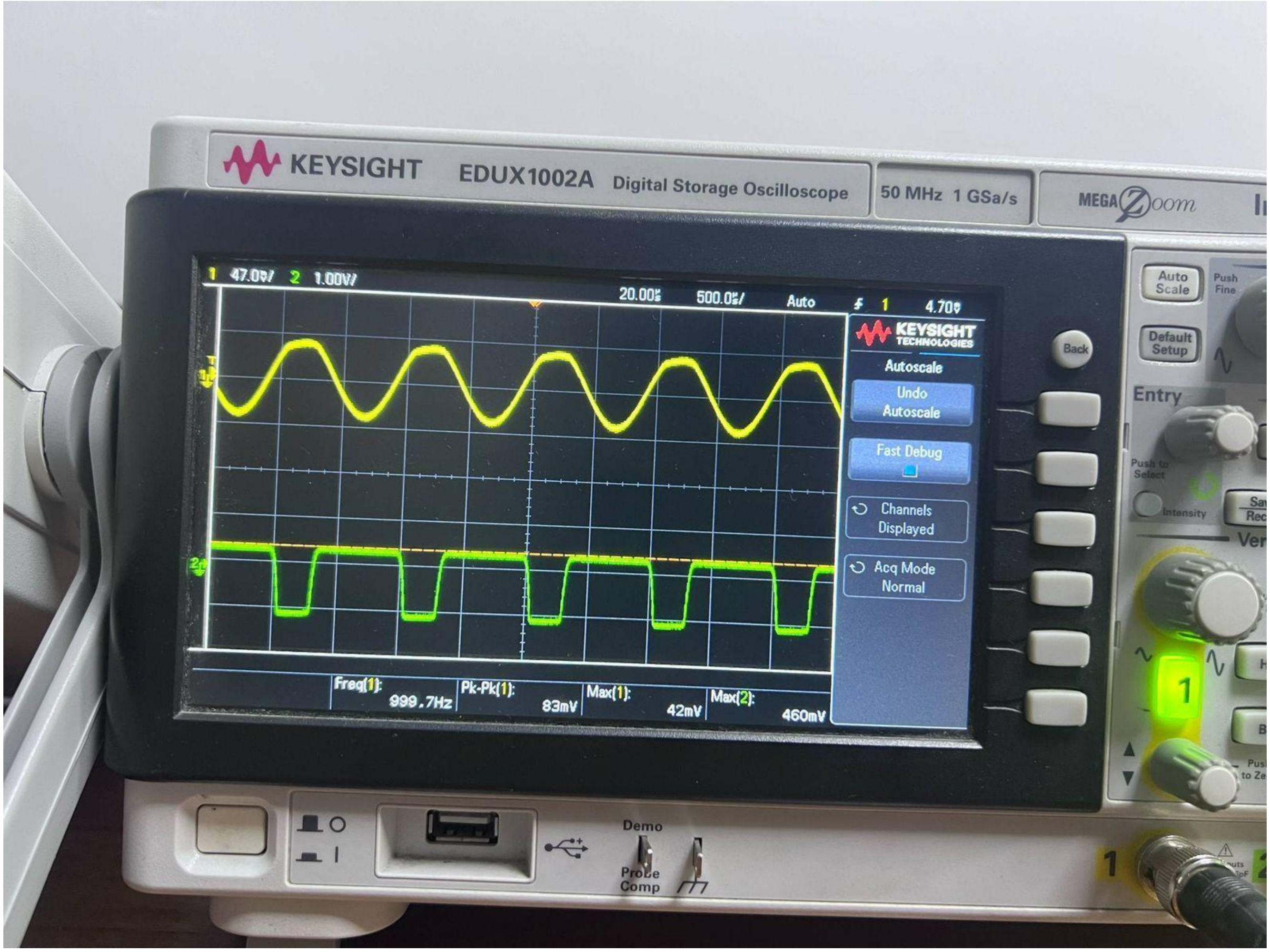
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Entry
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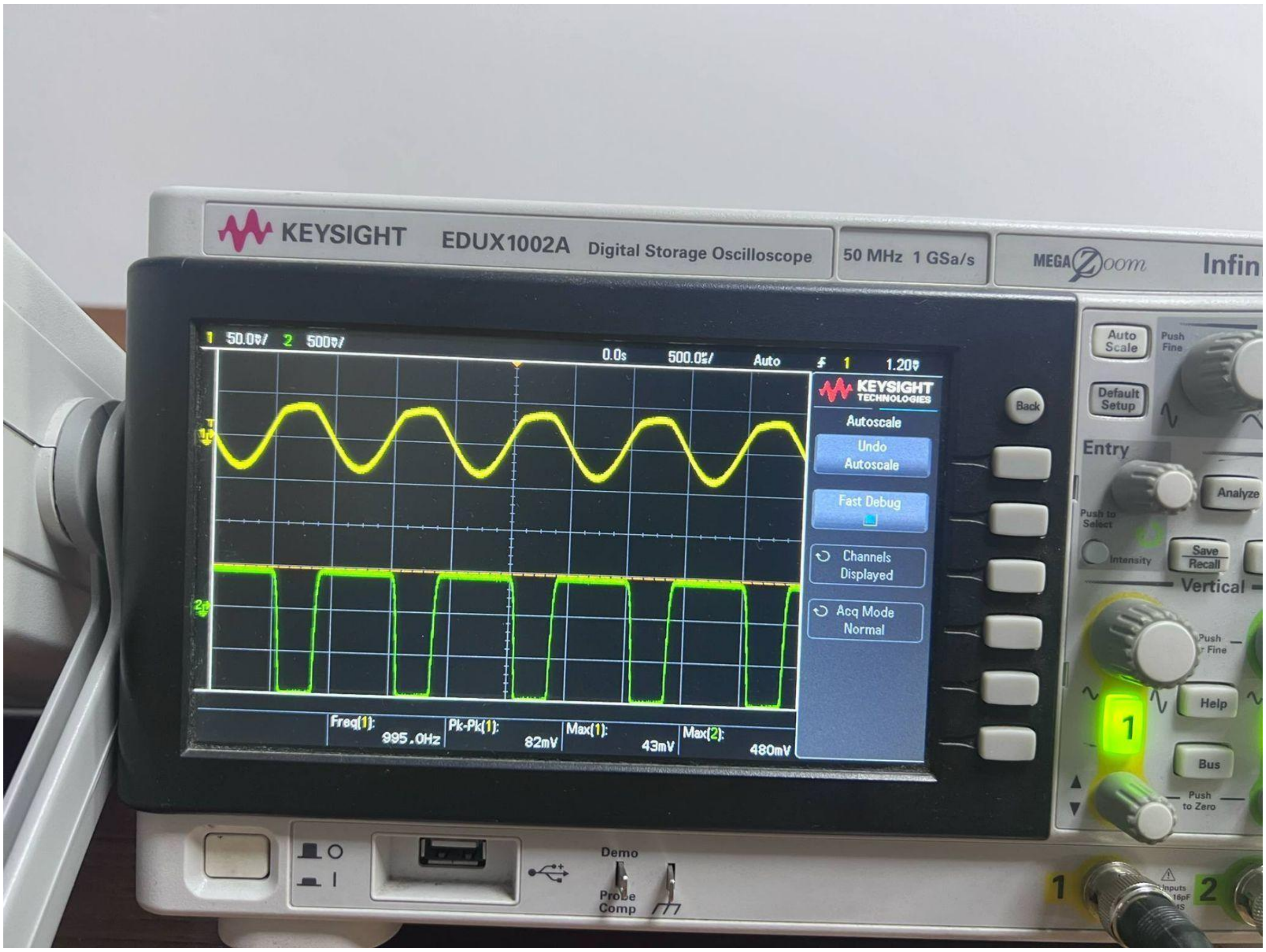
Demo
Probe Comp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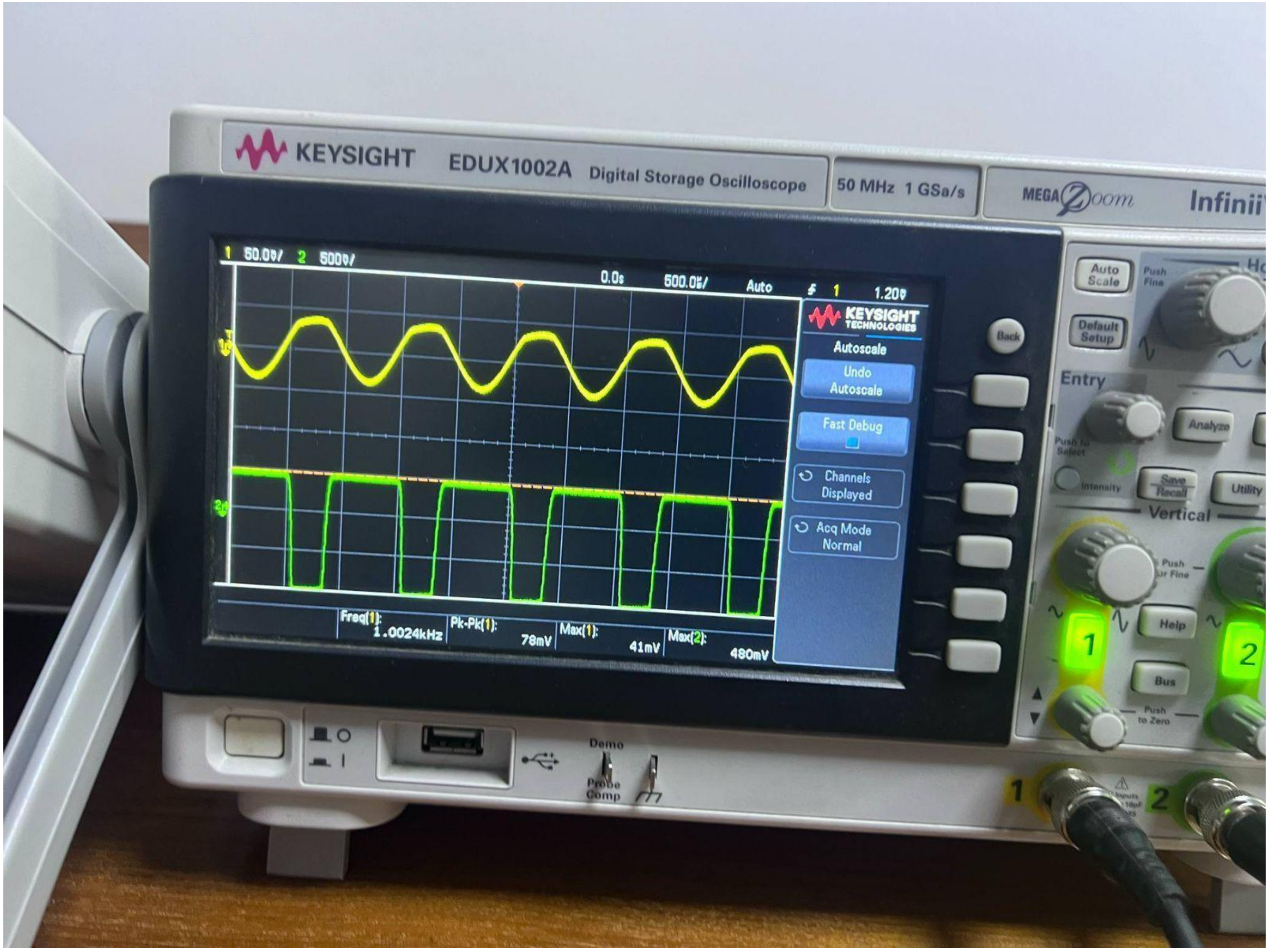


References:

[1] Robert L. Boylestad, Louis Nashelsky, Electronic Devices and Circuit Theory, 9th Edition, 2007-2008 [2] Adel S. Sedra, Kenneth C. Smith, Microelectronic Circuits, Saunders College Publishing, 3rd ed., ISBN: 0-03051648-X, 1991.

[3] American International University–Bangladesh (AIUB) Electronic Devices Lab Manual.

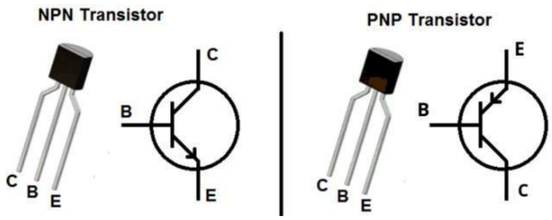
[4] David J. Comer, Donald T. Comer, Fundamentals of Electronic Circuit Design, John Wiley & Sons Canada, Ltd., ISBN: 0471410160, 2002.

[5] J. Keown, ORCAD PSpice and Circuit Analysis, Prentice Hall Press (2001)

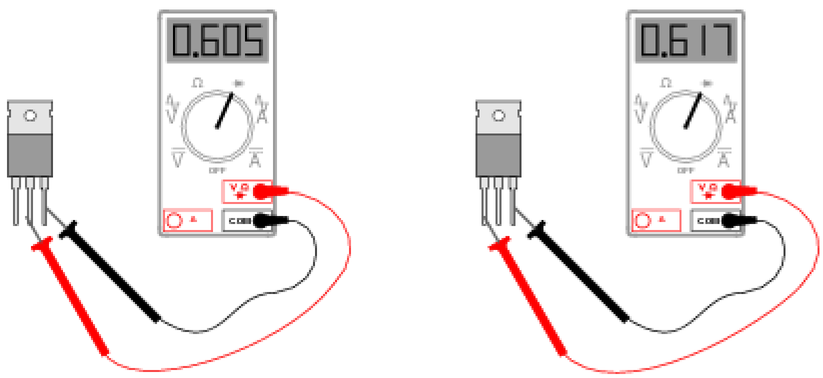
[6] Resistor values: *https://www.eleccircuit.com/how-to-basic-use-resistor/*, accessed on 20 September 2023.

List the references that you have used to answer the “Discussion” section.

Appendix A: Identifying the terminals of an npn or a pnp transistor:



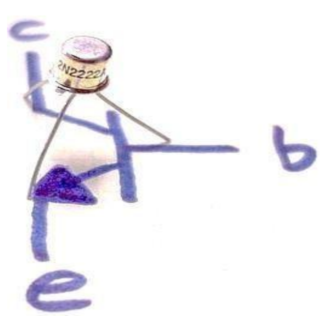
Following are the steps to identify npn and pnp transistors:
Step 1: Take the transistor you want to identify.
Step 2: Turn on a digital multimeter and set it to the DC voltage/resistance measurement mode.
Step 3: Make sure that you have connected the probes in their correct respective multimeter sockets, i.e., the black probe to the COM port and the red probe to the V/ □□ port.
Step 4: Randomly start connecting the multimeter probes to the terminal of an unknown type of transistor and watch readings on the screen.
Step 5: Now, some random connections will give you a voltage/resistance reading on the multimeter screen.
Step 6: Once you get results i.e., any values (must be less than 1 for voltage reading) on the screen, start from the right side with the transistor's flat side upward direction, and write or mark the probes attached to the terminals of the transistor.
Step 7: If it is a black probe first and a red probe second then transfer the black probe to the third terminal (left-most terminal). If you get a similar result on the screen then write n, p, and n, that is the transistor is of npn type.
Step 8: If it is a red probe first and then a black probe second then transfer the red probe to the third terminal (left-most terminal). If you get a similar result on the screen then write p, n, and p, that is the transistor is of pnp type.
Step 9: The values you get on the multimeter screen after and before transferring the probe from the right-most side to the left-most side will differ slightly, the higher value-giving terminal is called the emitter and the lower value-giving terminal is called the collector, and the common terminal in the middle is called the base.

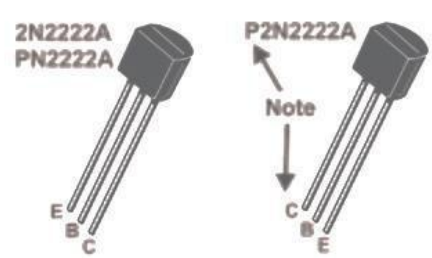


Based on the above procedural steps using a multimeter in diode mode, the left terminal of this transistor is a p-type emitter (producing larger value), the middle one is a p-type collector (less value), and the right one is called a base (common black terminal, so n-type). As such, this is a pnp-type transistor.

Appendix B: The 2N2222 Data Sheet

The 2N2222 is a common NPN bipolar junction transistor (BJT) used for general-purpose low-power amplifying or switching applications. It is designed for low to medium current, low power, medium voltage, and can operate at moderately high speeds. It was originally made in the TO-18 metal can as shown in the picture.





2N2222A in metal TO-18 package with the emitter, base and collector identified as E, B, and C respectively.

Pinout of 2N2222 variants in plastic TO-92 package.

2N2222A in metal TO-18 package with the emitter, base and collector identified as E, B, and C respectively.

NPN switching transistors — 2N2222; 2N2222A

FEATURES

- High current (max. 800 mA)
- Low voltage (max. 40 V).

APPLICATIONS

- Linear amplification and switching.

DESCRIPTION

NPN switching transistor in a TO-18 metal package.
PNP complement: 2N2907A.

PINNING

PIN	DESCRIPTION
1	emitter
2	base
3	collector, connected to case

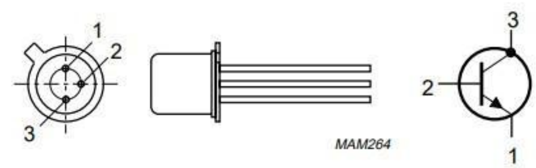


Fig.1 Simplified outline (TO-18) and symbol.

QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{CBO}	collector-base voltage	open emitter			
	2N2222		–	60	V
	2N2222A		–	75	V
V_{CEO}	collector-emitter voltage	open base			
	2N2222		–	30	V
	2N2222A		–	40	V
I_C	collector current (DC)		–	800	mA
P_{tot}	total power dissipation	$T_{amb} \leq 25$ °C	–	500	mW
h_{FE}	DC current gain	$I_C = 10$ mA; $V_{CE} = 10$ V	75	–	
f_T	transition frequency	$I_C = 20$ mA; $V_{CE} = 20$ V; f = 100 MHz			
	2N2222		250	–	MHz
	2N2222A		300	–	MHz
t_{off}	turn-off time	$I_{Con} = 150$ mA; $I_{Bon} = 15$ mA; $I_{Boff} = -15$ mA	–	250	ns

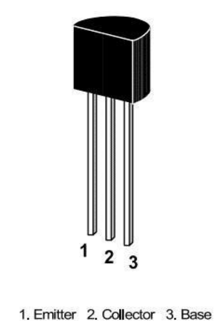
LIMITING VALUES

In accordance with the Absolute Maximum Rating System (IEC 134).

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{CBO}	collector-base voltage	open emitter			
	2N2222		–	60	V
	2N2222A		–	75	V
V_{CEO}	collector-emitter voltage	open base			
	2N2222		–	30	V
	2N2222A		–	40	V
V_{EBO}	emitter-base voltage	open collector			
	2N2222		–	5	V
	2N2222A		–	6	V
I_C	collector current (DC)		–	800	mA
I_{CM}	peak collector current		–	800	mA
I_{BM}	peak base current		–	200	mA
P_{tot}	total power dissipation	$T_{amb} \leq 25$ °C	–	500	mW
		$T_{case} \leq 25$ °C	–	1.2	W
T_{stg}	storage temperature		–65	+150	°C
T_j	junction temperature		–	200	°C
T_{amb}	operating ambient temperature		–65	+150	°C

Appendix C: The C828 Data Sheet

ST 2SC828 / 828A is an NPN Silicon Epitaxial Planar Transistor for switching and AF amplifier applications. These transistors are subdivided into three groups Q, R and S according to their DC current gain. On special request, these transistors can be manufactured in different pin configurations. TO-92 Plastic Package Weight approx. 0.19 gm.



Pin configuration of TO-92 Plastic Package.

Absolute Maximum Ratings ($T_a = 25^oC$)

	Symbol	Value		Unit
		ST 2SC828	ST 2SC828A	
Collector Base Voltage	V_{CBO}	30	45	V
Collector Emitter Voltage	V_{CEO}	25	45	V
Emitter Base Voltage	V_{EBO}	7		V
Peak Collector Current	I_{CM}	100		mA
Collector Current	I_C	50		mA
Power Dissipation	P_{tot}	400		mW
Junction Temperature	T_j	150		^oC
Storage Temperature Range	T_S	-55 to +150		^oC

Characteristics at T_{amb}=25 ^{o}C

	Symbol	Min.	Typ.	Max.	Unit
DC Current Gain at I_C=2mA, V_{CE}=5V Current Gain Group Q	h_{FE}	130	-	280	-
R	h_{FE}	180	-	360	-
S	h_{FE}	260	-	520	-
Collector Base Breakdown Voltage at I_C=10μA ST 2SC828	$V_{(BR)CBO}$	30	-	-	V
ST 2SC828A	$V_{(BR)CBO}$	45	-	-	V
Collector Emitter Breakdown Voltage at I_C=2mA ST 2SC828	$V_{(BR)CEO}$	25	-	-	V
ST 2SC828A	$V_{(BR)CEO}$	45	-	-	V
Emitter Base Breakdown Voltage at I_E=10μA	$V_{(BR)EBO}$	7	-	-	V
Collector Saturation Voltage at I_C=50mA, I_B=5mA	$V_{CE(sat)}$	-	0.14	-	V
Base Emitter Voltage at I_C=10mA, V_{CE}=5V	V_{BE}	-	-	0.8	V
Gain Bandwidth Product at I_C=-2mA, V_{CE}=10V	f_T	-	220	-	MHz
Noise Figure at V_{CE}=5V,I_E=0.2mA, R_G=2kΩ,f=1kHz	NF	-	6	-	dB