

CSE251

Electronic Devices and Circuits

Fall-24

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Date of performance : 02.11.24

Date of Submission : 09.11.24

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## Experiment-01

### Review of Lab Equipment



CSE251 - Electronic Devices and Circuits Lab

## Objective

1. To review the basics of lab equipment for comprehensive understanding

## Equipment

1. Breadboard
2. Digital Multimeter
3. DC power supply
4. Oscilloscope
5. Function Generator
6. Resistance ( $1k\Omega$ ,  $2.2k\Omega$ ,  $2.7k\Omega$ )
7. Chords and Wire

## Breadboard

A breadboard, also known as a prototyping board, is a device used for building and testing electrical and electronic circuits. It is a reusable platform that allows us to quickly prototype and experiment with different electrical and electronic components without the need for soldering.

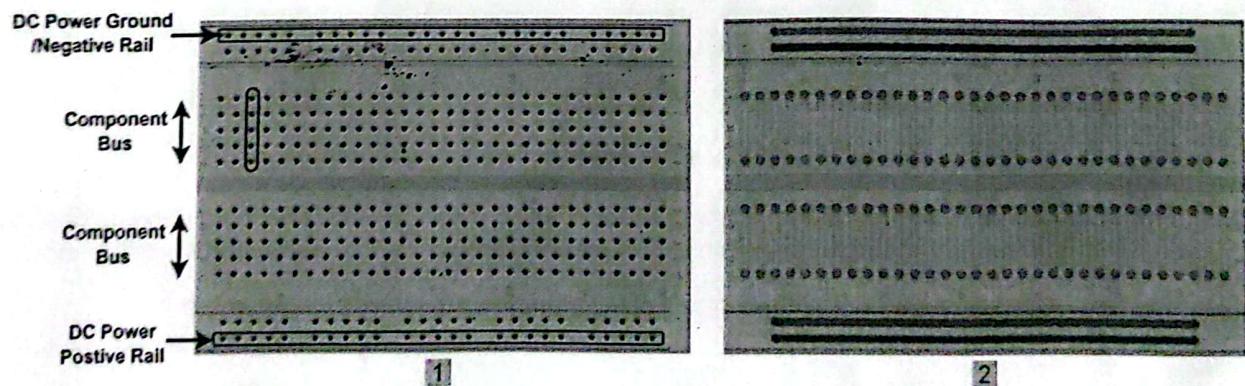


Figure 1: (1) Breadboard (2) Unseen Backside of Breadboard

A typical breadboard consists of a plastic board with a grid of holes and metal clips or sockets that run beneath the holes. The holes are arranged in a pattern that matches the layout of integrated circuits (ICs) and electronic components such as resistors, capacitors, LEDs, and wires. The unseen backside contains interconnections. As a result, component bus is internally short. DC Negative Rail and DC Positive Rail are also internally short.

## DC Power Supply

A DC Power Supply is a device that is used to provide a steady and controlled DC voltage to power up a circuit. There are 4 channels in 2 different groups on this device. The display allows us to observe either CH1 or CH3, along with either CH2 or CH4 simultaneously. The buttons on the top-left and top-right corners of the device are used to switch between the channels. Two push buttons are used to operate the two groups in independent, series, or parallel mode (for our lab experiments, we will use them in "independent" mode).



Figure 2: 4-Channel DC Power Supply

To use this device as a voltage source with a desired dc voltage, we need to set the current limit of a channel first. Let's say, we are using CH1. The following steps demonstrate how to use a DC Power Supply:

1. Turn on the device using the power button
2. Check the switches and make sure CH-1 is selected
3. Set the current limit using the current knob (around 0.5 A)
4. Set the desired value of voltage using the voltage knob
5. Once you set the voltage to your desired value push the *Output* button left corner of the knob panel. The power will not be supplied to the external circuit until you push the *Output* button
6. The *red wire* indicates the positive terminal of the power supply and the *black wire* indicates the negative terminal of the power supply

## Digital Multimeter

A Digital Multimeter is a versatile electronic instrument used to measure various electrical quantities in circuits. It combines several measurement functions into a single device, making it an essential tool. For example, it can measure - voltage, current, resistance, capacitance etc.

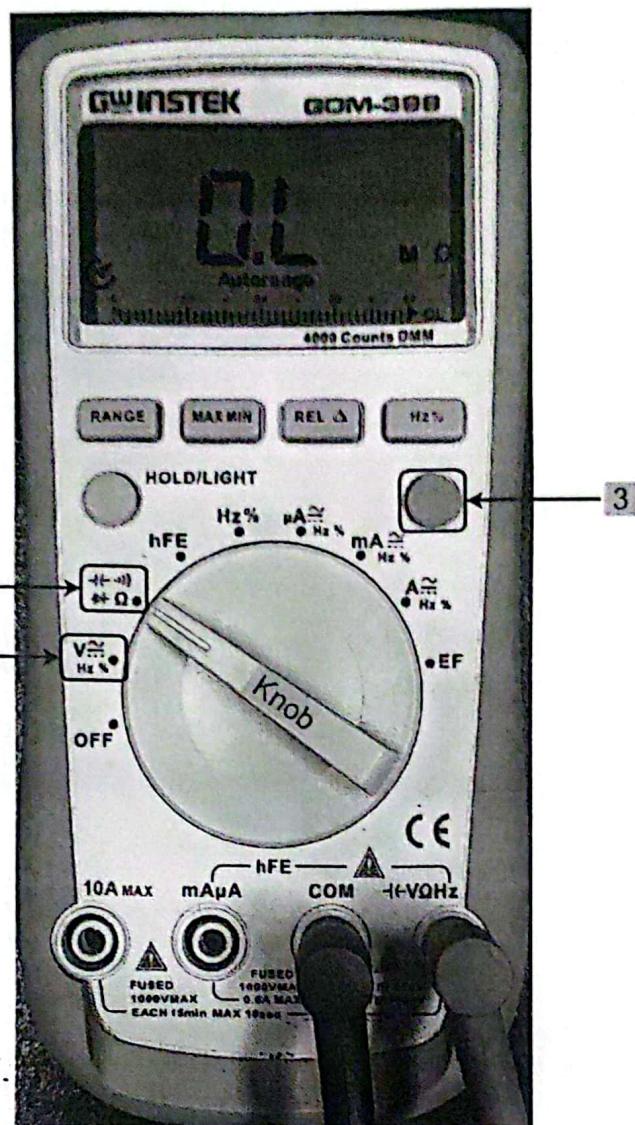


Figure 3: Digital Multimeter

The knob of the multimeter is rotated to change the measuring mode of the device. In position “1”, it can measure voltage. In position “2”, it can measure the resistance, capacitance etc. There is a *Blue* button indicated by “3” which is used for selecting the required measurement function when there is more than one function at one position of the knob. The red and black wire of the multimeter represents the positive and negative terminal respectively.

For example, voltage can be measured in DC and AC mode. If AC voltage (or current) is to be measured, one must use the multimeter in AC mode. The Blue button on the top-right corner of the multimeter (indicated by “3”) is used to switch between DC and AC mode.

It is very important to check the wires before constructing a circuit. Multimeter can be used to test wires. Following steps can be followed To test wires,

1. Set the knob to position “2” as indicated in the figure above
2. Press the *Blue* button to select the  $\Omega$  mode
3. If the buzzer sounds continuously, the wire is ok. If the buzzer does not sound continuously, then the wire is damaged and should not be used in the circuit

## Oscilloscope

Oscilloscope is a device that enables the visualization and analysis of electrical signals with precision and accuracy. It is a versatile instrument to understand the behavior of circuits.

The primary function of an oscilloscope is to display and measure voltage waveforms over time. It provides a graphical representation of electrical signals in the form of waveforms on a screen, allowing users to observe the amplitude, frequency, phase, and other characteristics of the signal.

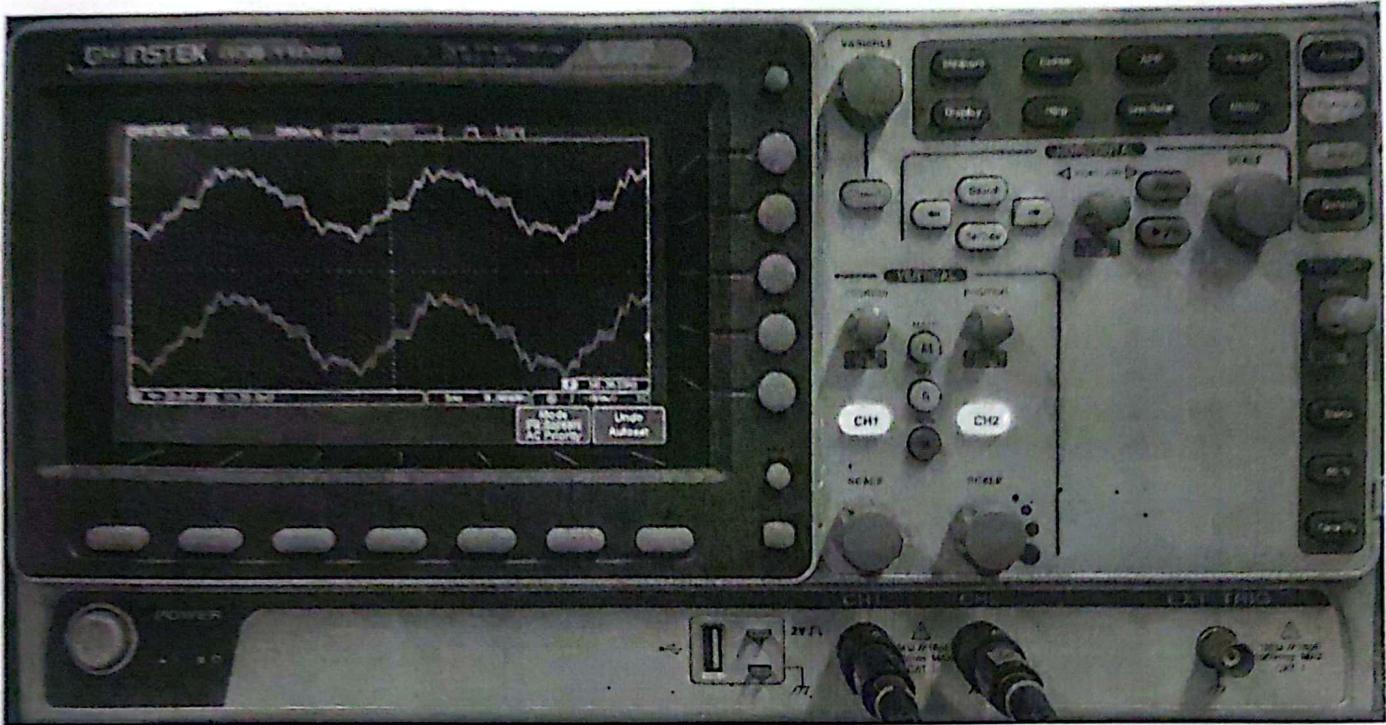


Figure 4: Oscilloscope

There are 2-channels in this oscilloscope that enables us observe 2 voltage waveforms simultaneously. The red and black wire of the probe of a channel represents positive and negative terminal respectively. The negative terminals of the probes are internally shorted.

Vertical **Scale** knobs and Horizontal **Scale** knob are used to adjust the scaling of voltage axis and time axis respectively. **Autoset** button is used to automatically scale the waveform(s). The user can also shift the position of the waveforms using the **Position** knobs both in the vertical and horizontal direction. **Measure** button enables the user to measure various quantities from the waveform(s). Oscilloscope also shows the value of voltage/division and time/division. Using these values, we can manually calculate voltage levels and frequency from the waveform(s). Oscilloscope also generates a 2V (p-p) 1 KHz Square Wave to provide a known and standardized test signal for various applications.

Furthermore, **X-Y mode** can be triggered to observe the I-V characteristic graph of any device. In the "XY" mode, we can plot voltage from CH1 on the x-axis vs voltage from CH2 on the y-axis. This is how we can plot the I-V characteristics of a device. If we connect the voltage, V across the two terminals to CH1 and the measure the current, I on CH2, we can plot the I-V characteristics. However, oscilloscopes can only measure voltages. This can easily be done using a  $1\text{ k}\Omega$  resistor since the voltage (in volts) across a  $1\text{ k}\Omega$  resistor is equivalent to the current (in mA) through that resistor.

## Function Generator



Figure 5: Function Generator

A function generator is a versatile instrument that is used to generate various types of electrical waveforms. It produces signals of different frequencies, amplitudes, and wave shapes, such as sine waves, square waves, triangular waves etc.

To generate a waveform, one needs to set the frequency to the desired value. This can be done by rotating the **Frequency** knob. There are also numerical buttons to set the exact frequency of the signal. For example, to generate a signal of 123 MHz / KHz / Hz,

1. Press the buttons 1, 2, 3 one after another. The display will show 123
2. Press **Shift** → Press 8 (for MHz) or, 9 (for KHz) or, 0 (for Hz) → Press the **Output On** button

The **Wave** button can be used to switch between sine, square and triangular waveform. One can also change the amplitude and DC offset of the signal by rotating the **AMPL** and **OFFSET** knob respectively.

## Task-01

In this task, we will verify KVL and KCL.

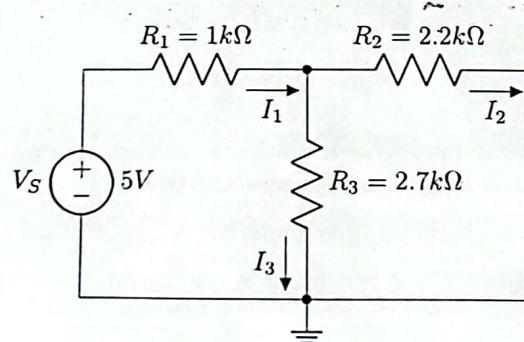


Figure 6: *Circuit-1*

## Procedure

1. Use the DC Power Supply to set  $V_S = 5V$  with 0.5A current limit
2. Use the Digital Multimeter to measure the resistances
3. Construct Circuit-1. Now, measure the voltages across the resistances
4. Fill out the table in the Data Sheet section. From the table, observe that KVL and KCL are verified.

Table for Task-01

$R_1$	$R_2$	$R_3$	$V_{R_1}$	$V_{R_2} = V_{R_3}$	$I_1 = \frac{V_{R_1}}{R_1}$	$I_2 = \frac{V_{R_2}}{R_2}$	$I_3 = \frac{V_{R_3}}{R_3}$	$V_{R_1} + V_{R_2}$	$I_2 + I_3$
1	2.2	2.63	2.2	2.6	2.2	1.18	0.98	4.9	3.38

## Task-02

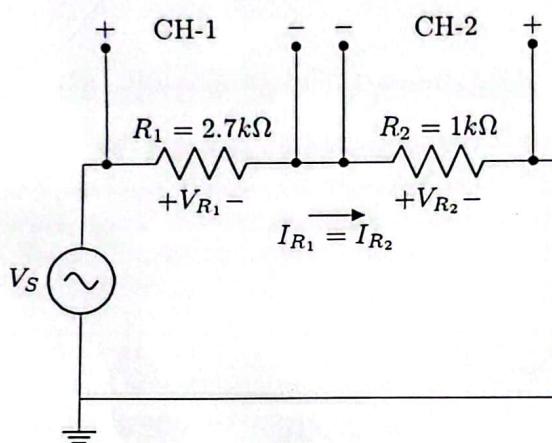
In this task, we will use an AC source and observe the voltage waveforms across resistances.

### Procedure

1. Use the circuit of the previous task but replace the  $V_S$  with a 4V (p-p) sine wave. Use the Function Generator and the Oscilloscope to do so.
2. Set the frequency of  $V_S$  to,  $f = \text{Last 3-digit of the student ID of any group member}$  949
3. Connect the CH1 of the oscilloscope across  $R_1$ . Observe the waveform and capture it using a camera.
4. Disconnect CH1 from  $R_1$  and connect it across  $R_2$ . Observe the waveform and capture it using a camera.

## Task-03

In this task, we will observe the I-V characteristics of a resistance,  $R_1$ .



### Procedure

1. Construct the circuit given above. Use the function generator for the supply voltage  $V_S$ . Keep the amplitude and frequency unchanged from the previous task.
2. Connect the CH-1 and CH-2 of the oscilloscope to the circuit as shown in the figure above.
3. Observe the I-V characteristics of the resistance  $R_1$  in the XY mode of the oscilloscope and capture the image. To use the XY mode:
  - (a) Press the **Autoset** button → Push the **Position** knobs of both channels (i.e. push to zero).
  - (b) We need to invert the CH-2 in the oscilloscope due to its inverted connection to the circuit.  
To do so: Press **CH-2** button → Press the **Invert** button (which can be found on the bottom of the display of the oscilloscope) → select the option **On**.
  - (c) Press the **Acquire** button → Press the **XY** button which can be found below the display → Press the **Triggered XY** button which can be found on the right side of the display.
  - (d) Change the scaling and position of the plot using the **Scale** knob and **Position** knob of both channels respectively if you need.

You will see a small screen showing the I-V characteristics graph using the XY mode of the oscilloscope. The XY mode plots the voltage data of CH1 and CH2 in the x-axis and y-axis respectively. So, the x-axis represents  $V_{R_1}$ . As,  $I_{R_1} = I_{R_2} \propto V_{R_1}$ , the y-axis represents  $I_{R_1}$ .

## Task-04: Report

1. Cover page [include course code, course title, name, student ID, group, semester, date of performance, date of submission]
2. Attach the signed Data Sheet
3. Attach the captured images
4. Answer the questions in the "Test Your Understanding" section
5. Add a brief Discussion at the end of the report

*Mohsin Ishaq*  
Signature of the lab faculty

### Test Your Understanding

1. Which one is the correct way to connect the 2 channels (CH1 and CH2) of the oscilloscope to observe the voltages  $V_{R_1}$  and  $V_{R_2}$ ? Justify your answer

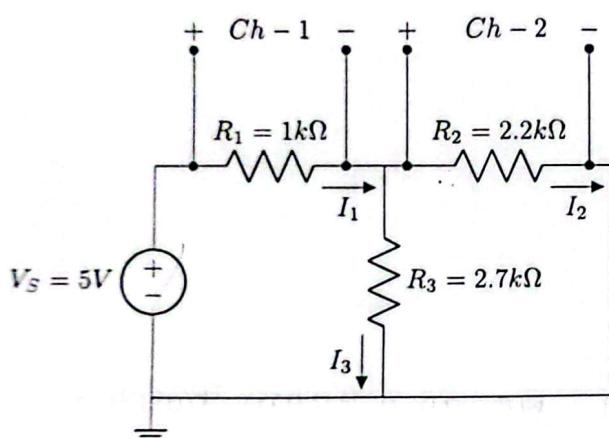


Figure 7: Option-A

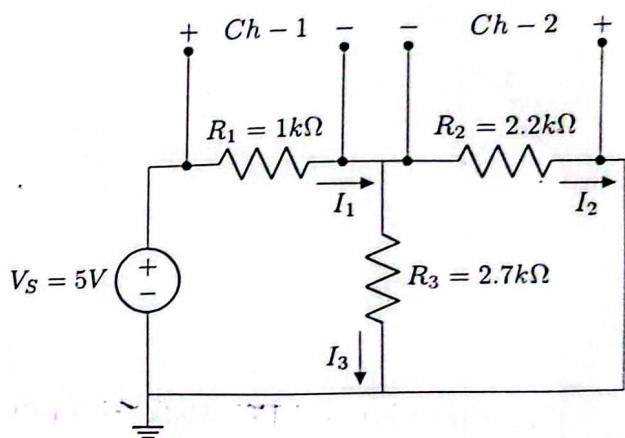


Figure 8: Option-B

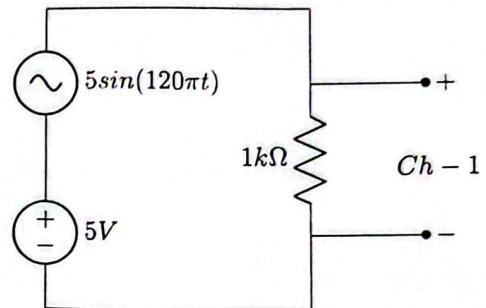
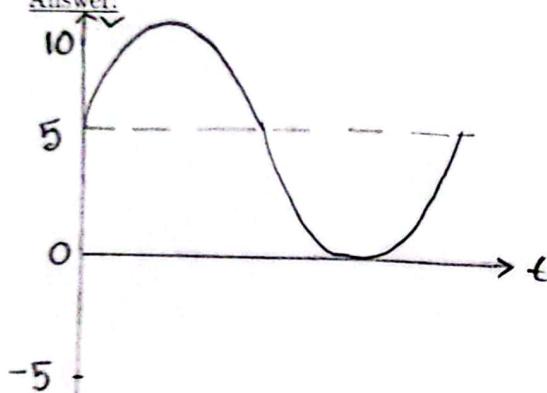
Answer: The correct way to connect the 2 channels (CH1 and CH2) of the oscilloscope to observe the voltages  $V_{R_1}$  and  $V_{R_2}$  is option-B. Because both negative terminal of CH-1 and CH-2 are internally sorted. So to get correct result, we need to invert the waveform of CH-2. Otherwise if the positive terminal and negative terminal of CH-1 and CH-2 are connected together, then the positive terminal will be sorted with ground and we will get incorrect result.

2. We used Ohm's law to measure the current in the circuit instead of using the multimeter as an ammeter. What is the advantage of this method?

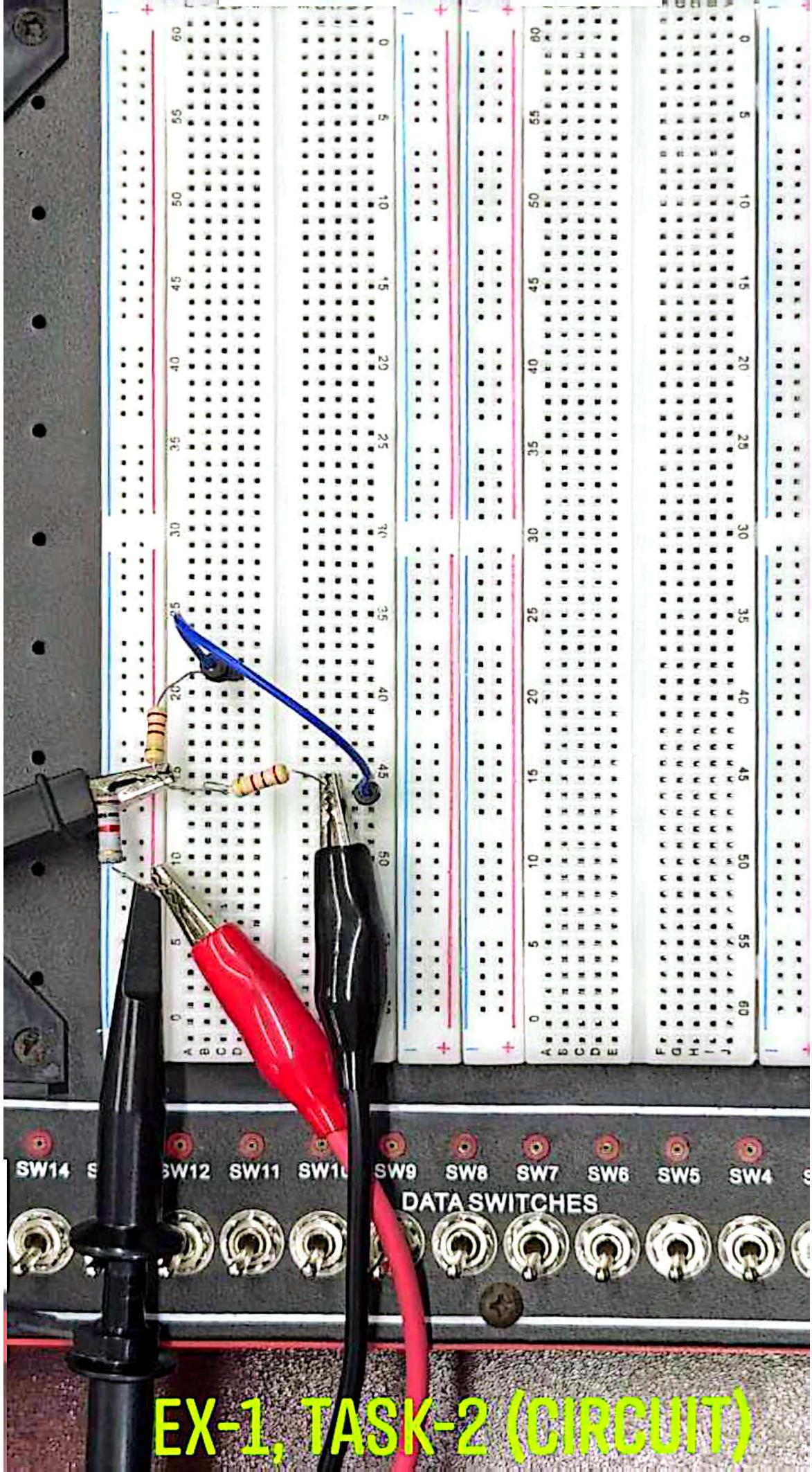
Answer: If we use multimeter as an ammeter, we have to disconnect the circuit and connect it in series with the resistors separately, that's why the result may not be accurate. Again, a multimeter can include additional resistance which may affect the result. On the contrary, when we use ohm's law to measure current and determine the voltage across the resistor, we can easily find the value of current passing through it.

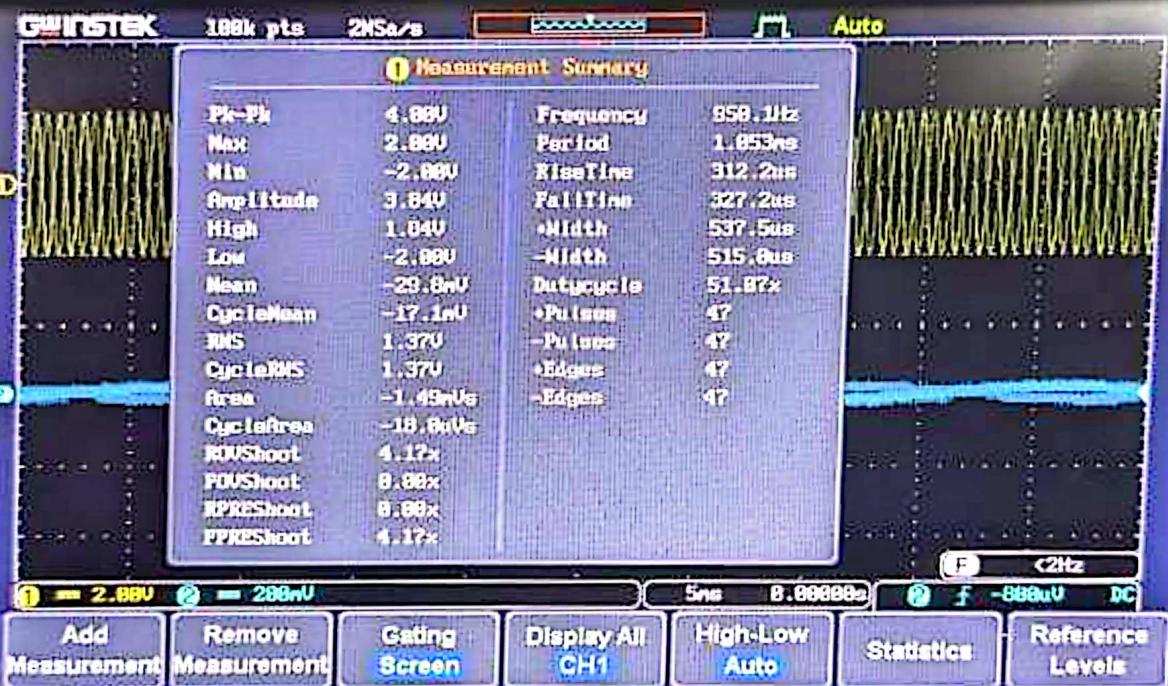
3. For the following circuit, draw the waveform that should be observed in CH1.

Answer:



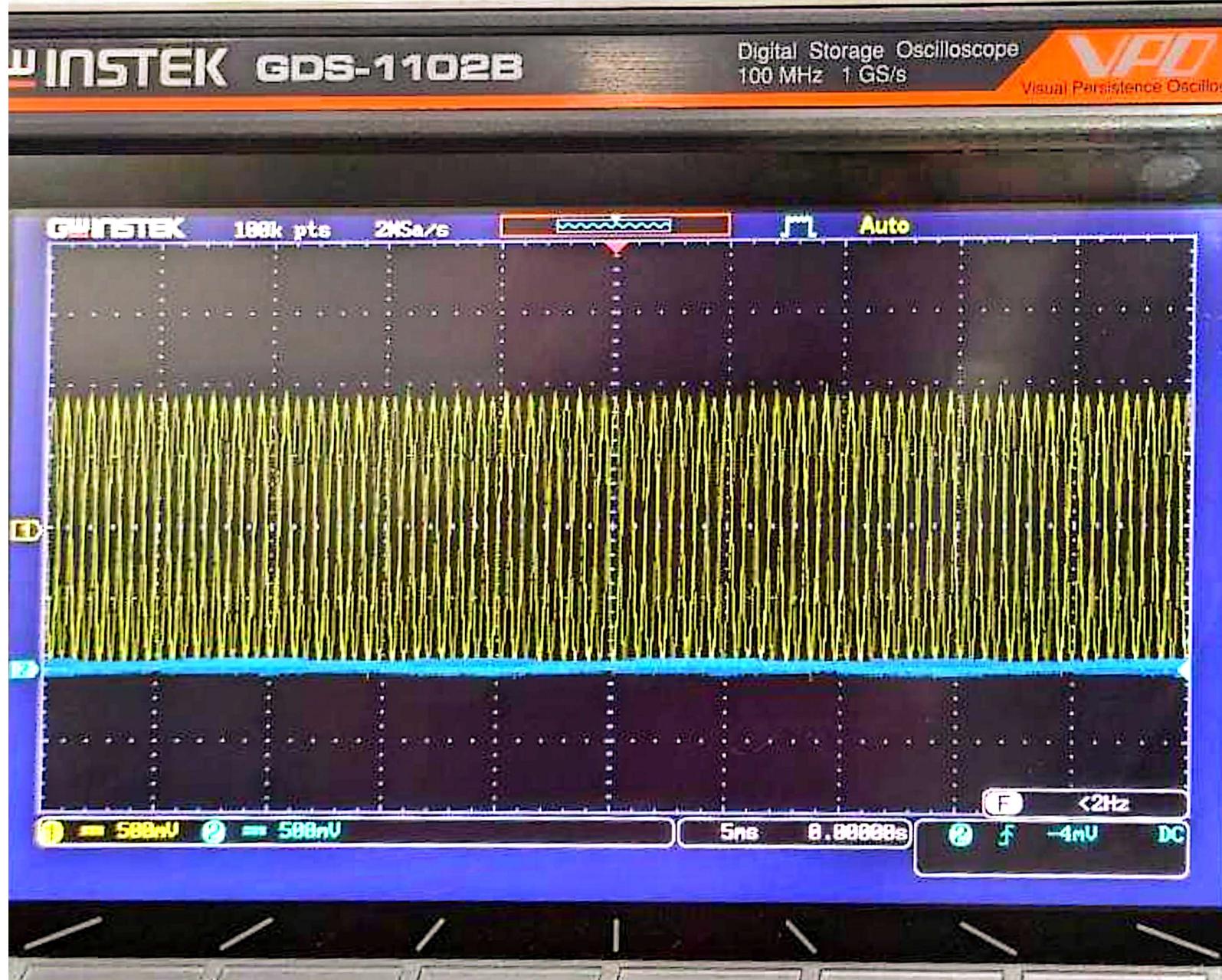
Discussion: In this experiment, we as a team built a circuit with three resistors and applied DC power supply to set the voltage  $V_s$  to 5V in task 1. Then we used a multimeter to measure the voltages across the resistances. After that, for task 2, we used the same circuit by replacing  $V_s$  with a 4V (P-P) sine wave. In this case, we used function generator and oscilloscope instead of DC power supply and observed the waveform. For task 3, we had to build a new circuit and use oscilloscope. In this task, we need to invert the CH-2 in the oscilloscope due to its inverted connection to the circuit. During this experiment, we used Ohm's law to find the current's values. For this experiment, I got to know more about multimeter and its functions, how to use oscilloscope, power supply, function generator and able to clear many confusions.

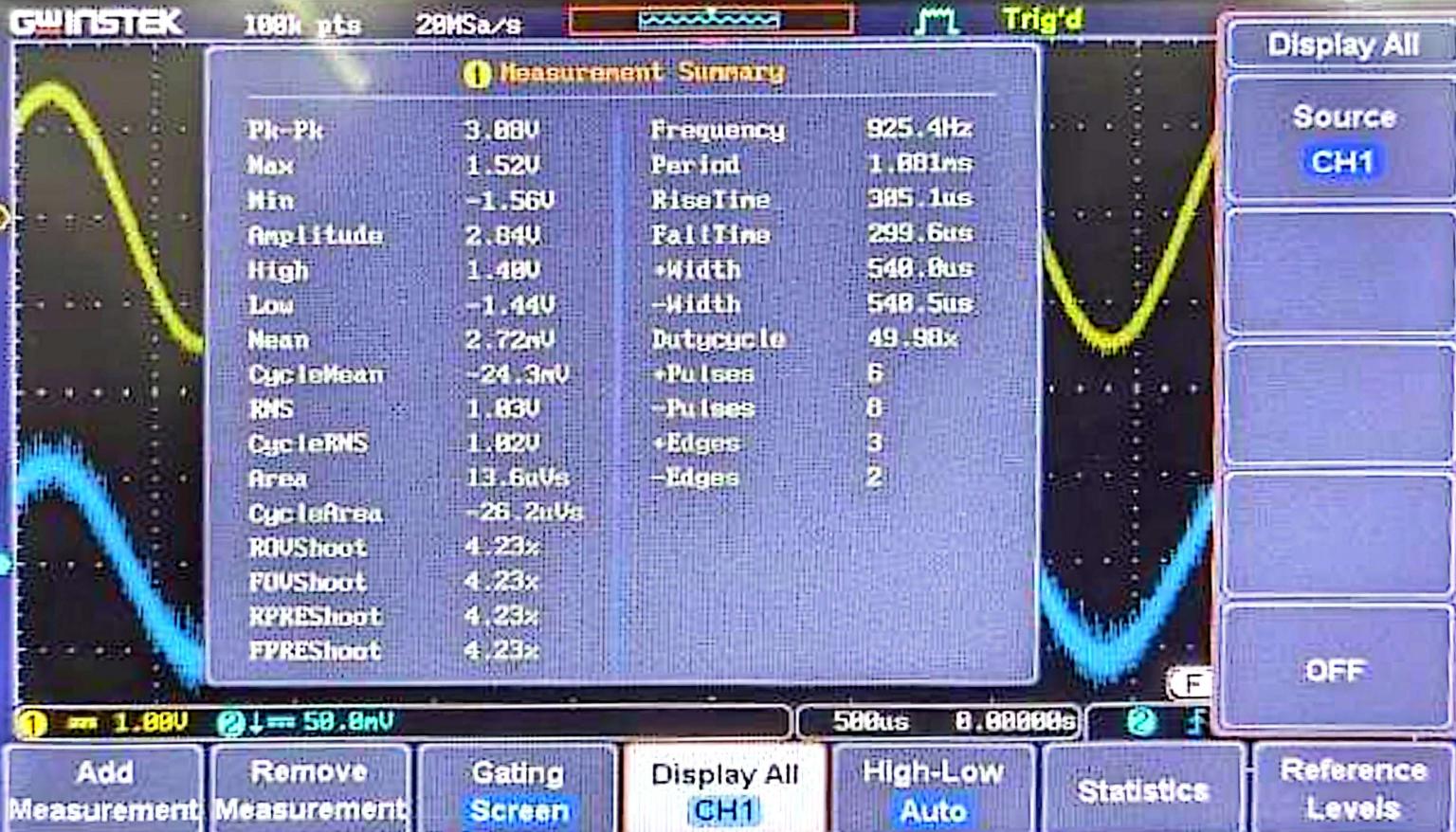




EX-1, TASK-2  
(MEASUREMENT )

# EX-1, TASK-2 (GRAPH)





POWER

**EX-1, TASK-3  
(MEASUREMENT) CH1**

GWINSTEK

100K pts

20MSa/s

Bandwidth

m

Trig'd

Display All

Source

CH2

OFF



Measurement Summary			
Peak	150mV	Frequency	929.9Hz
Max	98.8mV	Period	1.875ms
Min	-72.8mV	Risetime	397.4ns
Amplitude	150mV	Falltime	400.0ns
High	78.8mV	Width	544.8ns
Low	-72.8mV	Width	531.4ns
Mean	1.83mV	Dutycycle	58.59%
CycleRise	75.9ns	Pulses	157
RMS	48.8mV	Pulses	157
CycleRMS	48.2mV	Edges	8
Accs	9.66mVs	Edges	8
CycleRMS	828mVs		
RDSShoot	-6.67%		
FDUShoot	-5.33%		
RPRIShoot	?		
FPKEShoot	?		



① == 1.88U ② == 58.8mV

Status 0.000000

F

Add  
MeasurementRemove  
MeasurementGating  
ScreenDisplay All  
CH2High-Low  
Auto

Statistics

Reference  
Levels

POWER

EX-1, TASK-3  
(MEASUREMENT) CH2

GW INSTEK

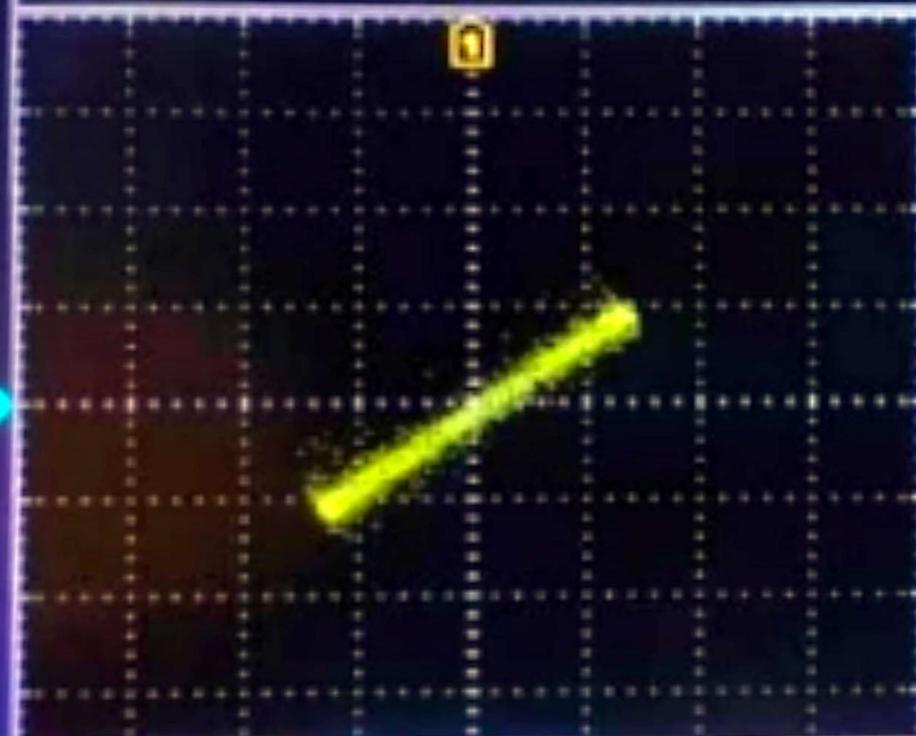
100k pts

1MSa/s



Trig'd

XY



Y = 1.00V

X = 5ns/D

1ns 0.00000s

f

Mode  
Sample

Reset H  
Position to 0s

XY

Record Length  
100k

Expand  
By Center