AV241 - Instrumentation and Control Lab

Instrumentation Lab-2

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SC22B146

Experiment-4
Study of Precision Rectifier

Aim: Study the half wave and full wave precision rectifiers.

Components and Equipments Required:

① opamp IC0P07
② Diodes
③ Resistors
④ DC power supply
⑤ Function generator
⑥ Digital storage Oscilloscope

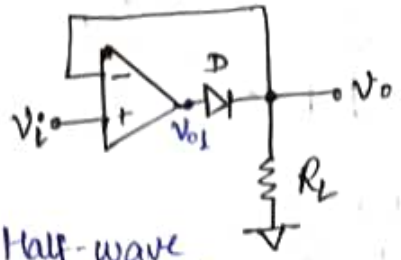
Theory:

In a normal diode rectifier, the cut-in voltage across the diode will result in reduction of output voltage and inaccuracy of rectification. If ideal rectifier is needed in an application, a precision rectifier may be used.

In order to avoid the slew rate issues at high frequencies, improved rectifier is used. Output of half wave rectifier is going to one input of summing amplifier in full wave rectifier.

① Half-wave precision rectifier

① Wire up the half-wave rectifier shown in figure. Use ±12V supply for the opamp.
② With a sinusoidal input V_i (1V peak, 100Hz), observe the output $V_o(t)$. Display V_o versus V_i using oscilloscope and verify that the circuit performs half-wave rectification.
③ Increase the frequency of the input signal to 5KHz and observe $V_o(t)$.

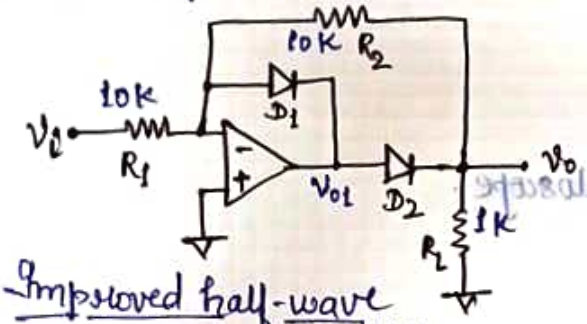


Half-wave Rectifier

(II) Improved Half-wave Precision Rectifier

(1) Repeat (I) for the improved half-wave rectifier shown below.

(2) Explain your observation with reference to the waveform $v_o(t)$ at the opamp output terminal.

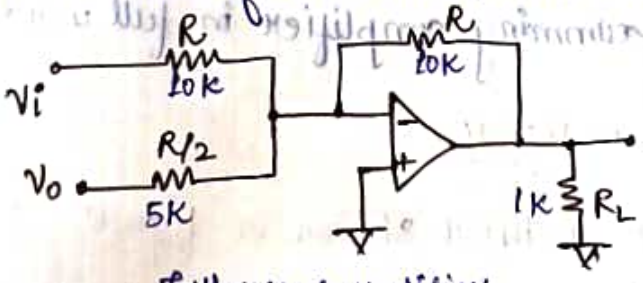


Improved half-wave rectifier

(III) Full-Wave precision rectifier

(1) Wire-up the full-wave rectifier circuit and verify its operation with a sinusoidal input voltage (1V peak, frequency ranging from 100 Hz to 5 KHz).

(2) Observe the waveform $v_o(t)$ at the output terminal of the opamp.



Full-wave rectifier

Study of LVDT (Linear Variable Differential Transformer)

Aim: To study the characteristics of Linear Variable Differential Transformer (LVDT).

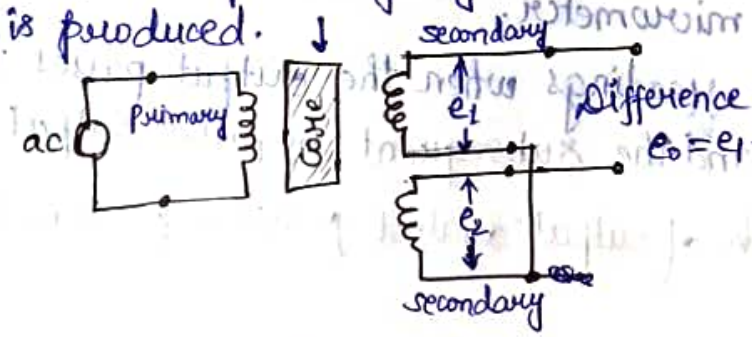
Components and Equipments Required:

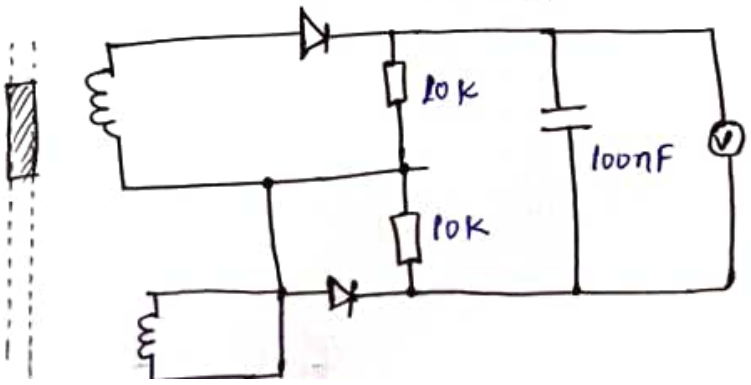
1. Linear Variable Differential Transformer (LVDT)
2. Calibration Jig with Micrometer
3. Digital Storage Oscilloscope
4. Multimeter
5. Frequency Generator
6. Diodes
7. Resistors
8. Capacitor.

Theory: The transformer consists of a primary winding P and two secondary windings S_1 and S_2 wound on a cylindrical former. Both the secondary windings have an equal no. of turns, and we place them on either side of primary winding. The primary is connected to an AC source so alternating current and voltages are produced in the secondary of the LVDT. The output in secondary S_1 is e_1 and in the secondary S2 is e_2. So, the differential output is

$$e_{out} = e_1 - e_2$$

This differential output is going to a demodulating circuit and dc voltages is produced.





Procedure:

① Connect the LVDT as per the diagram giving AC power supply from frequency generator to primary coil & output from secondary windings e_1 & e_2 to oscilloscope.

② LVDT has to be mounted perfectly on the calibration Jig. LVDT should be mounted to the center plate by the two nuts provided.

③ Switch on the power supply.

④ By pressing the rod against the return spring, move the ferrite core through the body of transducer and observe the variation of secondary winding voltages.

⑤ Now, connect the series substractive polarity output from secondary windings to a rectifier to convert the ac output to dc output and connect this output to oscilloscope.

⑥ Again by pressing the rod against the return spring, move the ferrite core through the body of transducer and observe the secondary output waveform on oscilloscope. Observe the 180° phase change as centre of core passes the null position.

⑦ Now, set the Micrometer to 0.00mm position and slider index to the 55 mm position on scale.

⑧ Using micrometer, move the core through the coils in 1mm steps recording the output voltage at each step, to a final setting of 25 mm on micrometer.

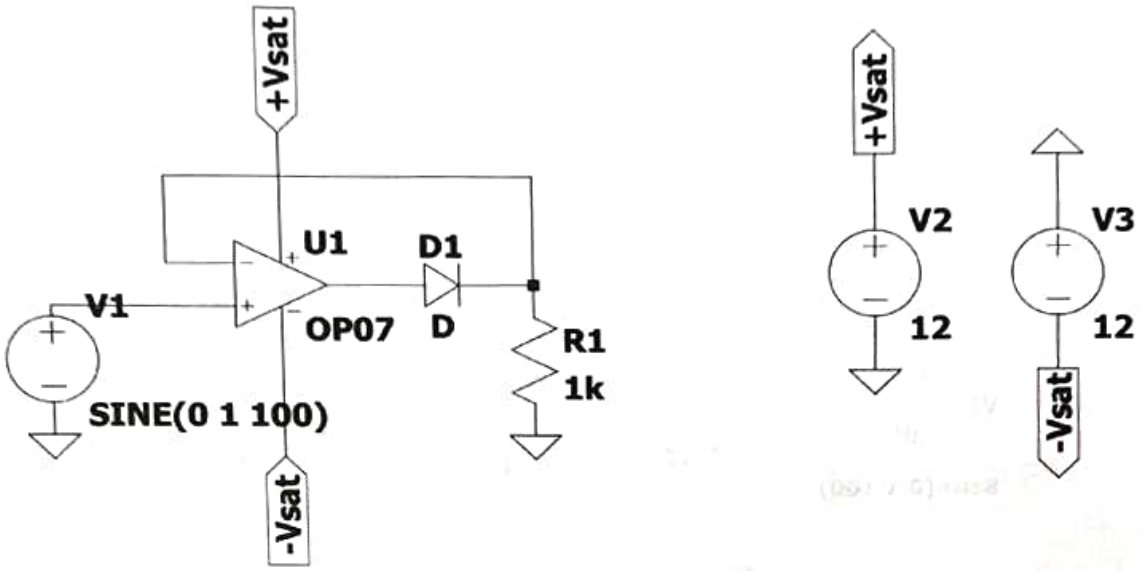
⑨ Tabulate the readings when the output passes through the null position and the subsequent negative output values.

⑩ Plot a graph of output against position for whole range of movement.

Experiment Simulation:

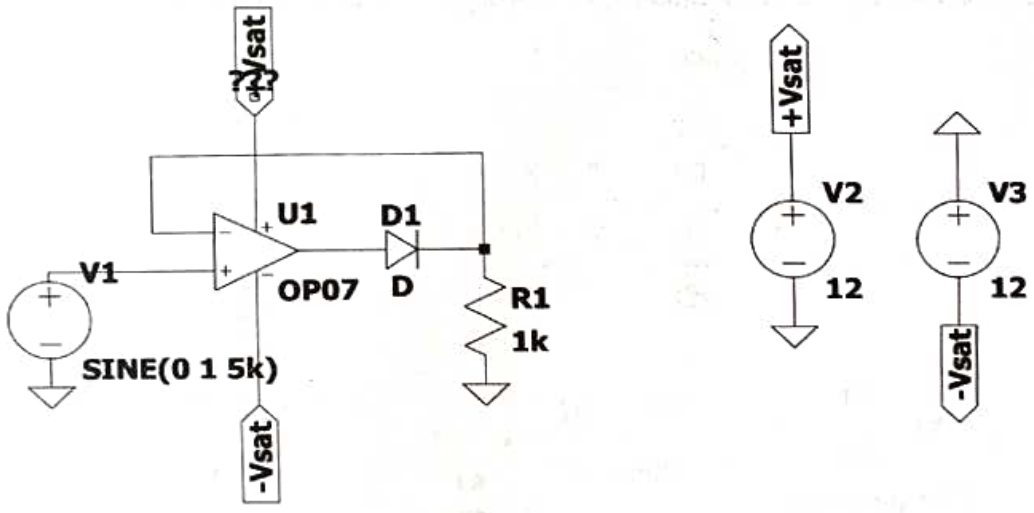
Half Wave Precision Rectifier:

Case 1: frequency = 100 Hz and Input Voltage: 1 V peak to peak.



.tran 0.1

Case 2: frequency = 5 kHz and Input Voltage: 1 V peak to peak.

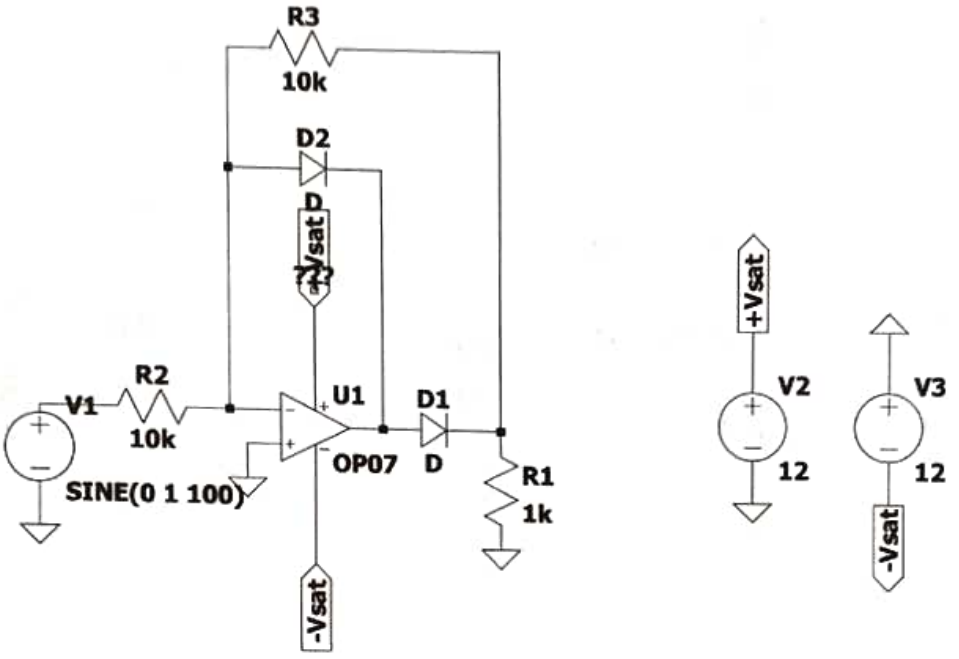


.tran 0.002

Experiment Simulation:

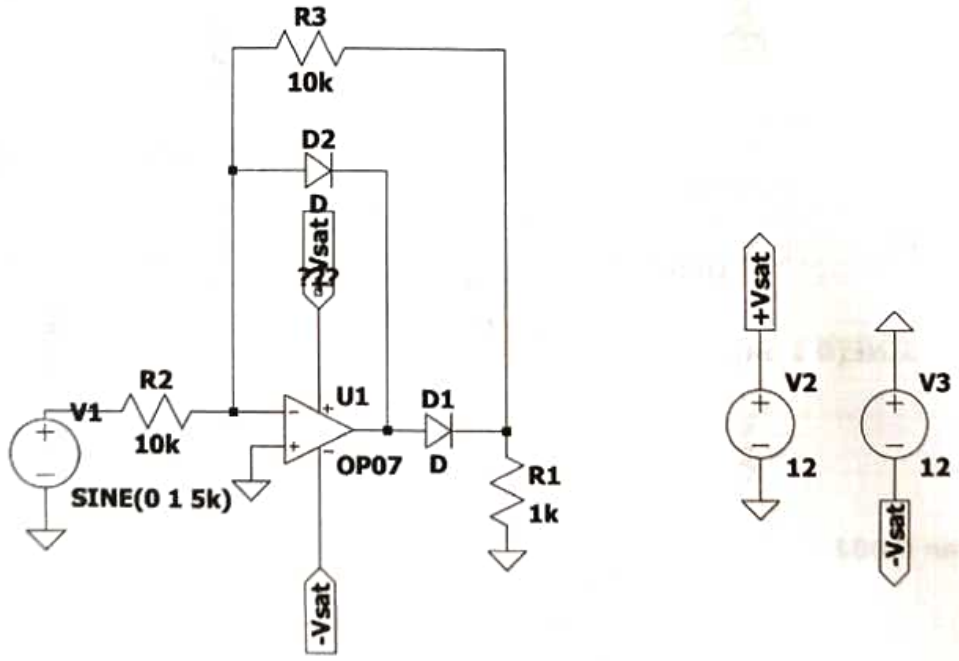
Improved Half Wave Precision Rectifier:

Case 1: frequency = 100 Hz and Input Voltage: 1 V peak to peak.



.tran 0.1

Case 2: frequency = 5 kHz and Input Voltage: 1 V peak to peak.

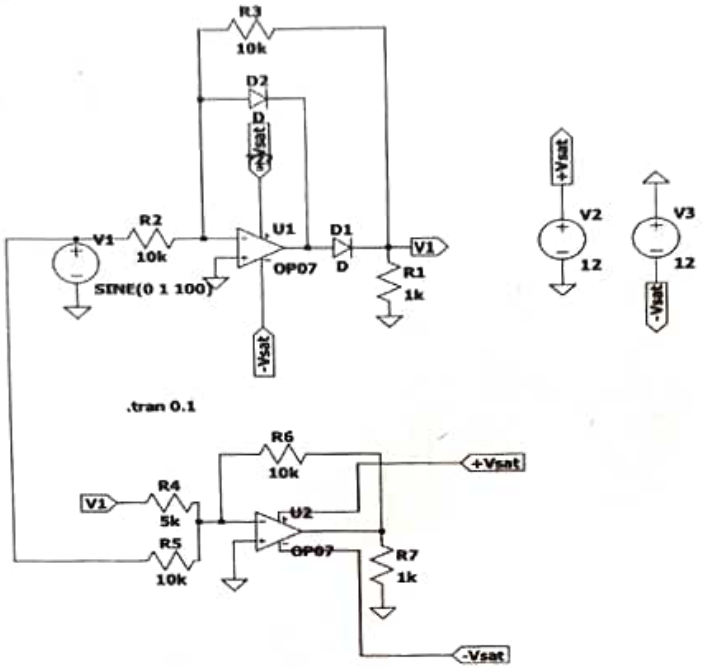


.tran 0.002

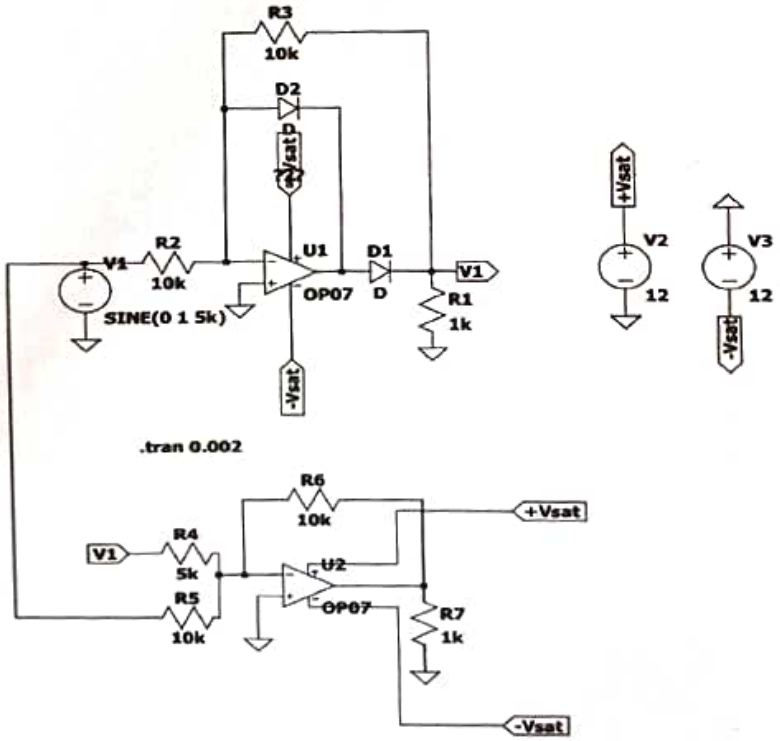
Experiment Simulation:

Full Wave Precision Rectifier:

Case 1: frequency = 100 Hz and Input Voltage: 1 V peak to peak.



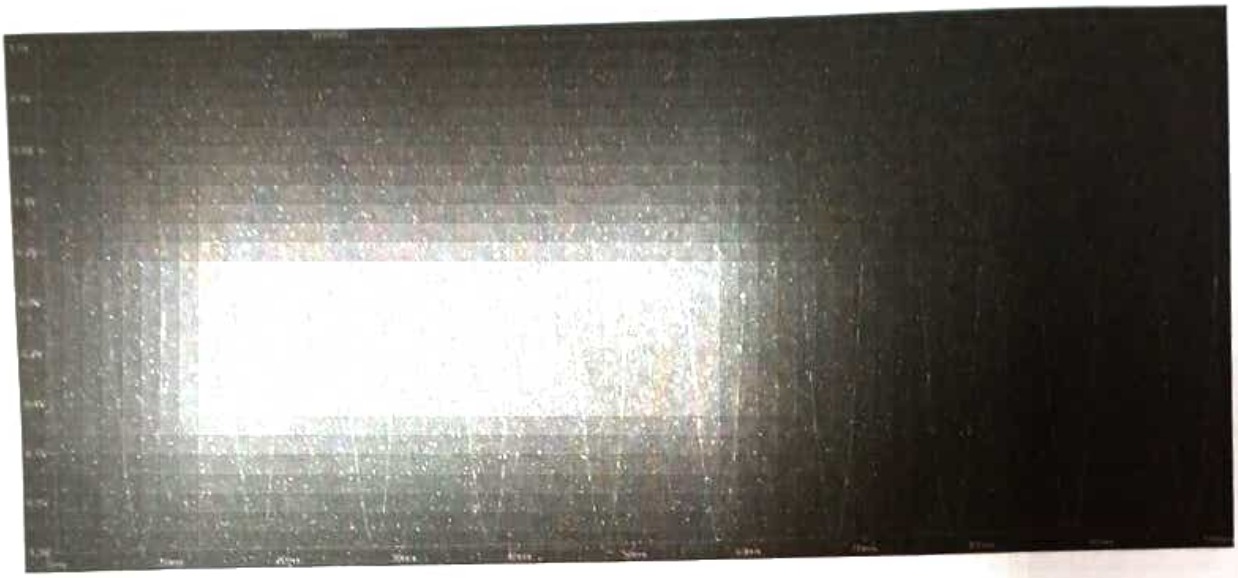
Case 2: frequency = 5 kHz and Input Voltage: 1 V peak to peak.



Experiment Simulation Results:

Half Wave Precision Rectifier:

Case 1: frequency = 100 Hz and Input Voltage: 1 V peak to peak.



Case 2: frequency = 5 kHz and Input Voltage: 1 V peak to peak.

Experiment Simulation Results:

Improved Half Wave Precision Rectifier:

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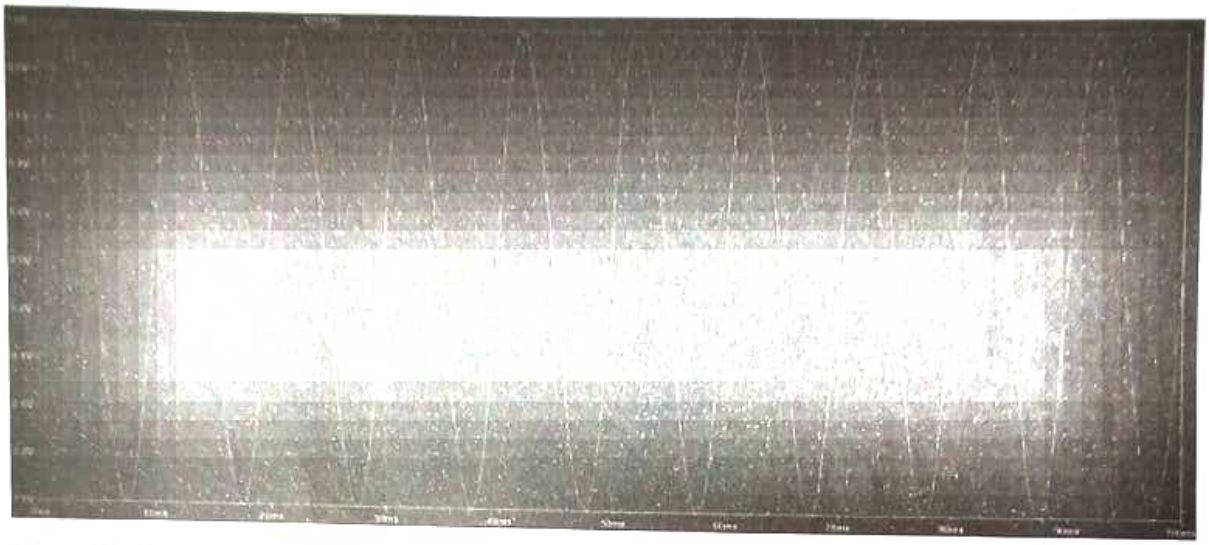
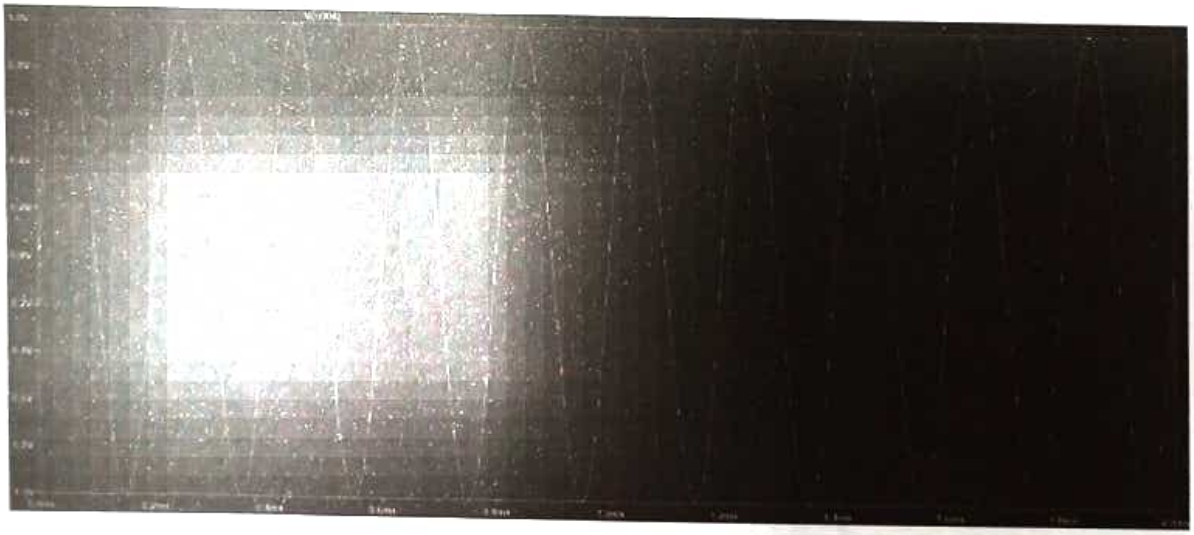


Case 2: frequency = 5 kHz and Input Voltage: 1 V peak to peak.



Experiment Simulation Results:

Full Wave Precision Rectifier:

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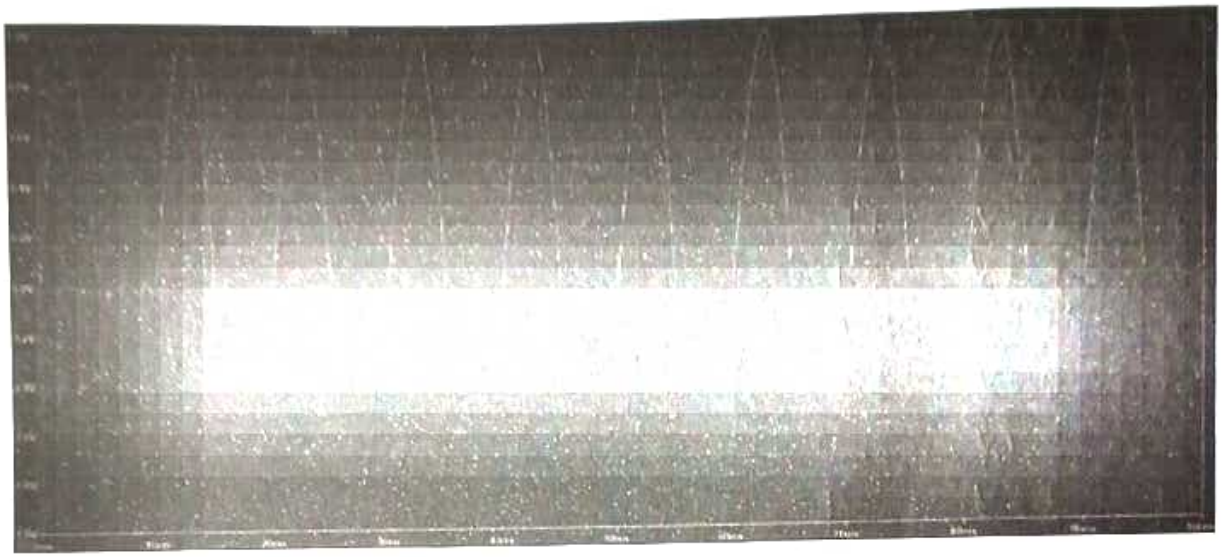
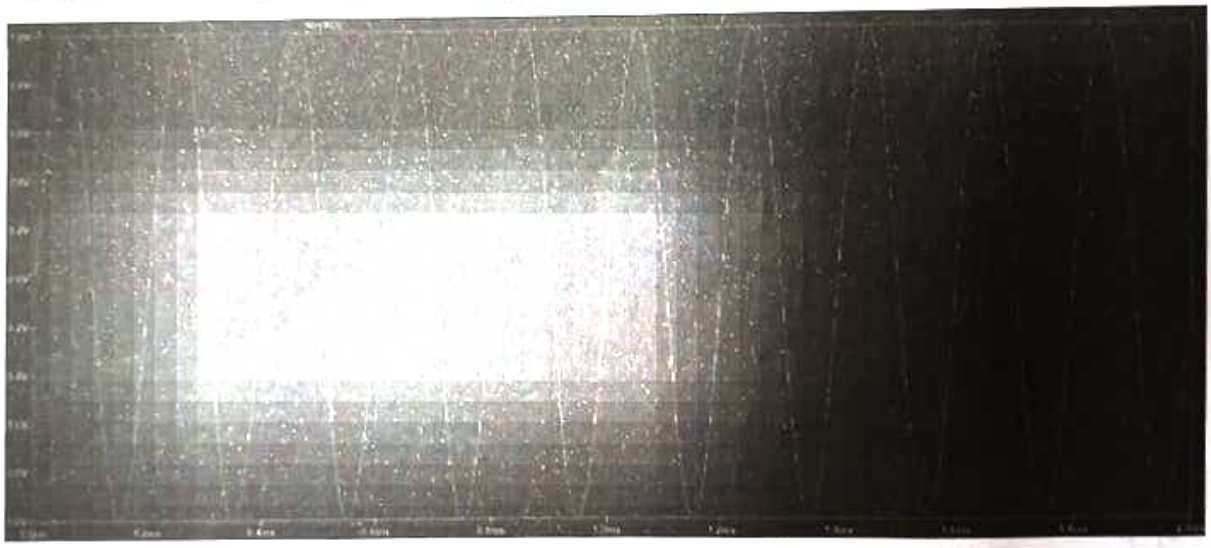


Case 2: frequency = 5 kHz and Input Voltage: 1 V peak to peak.



Results: AC Measurement

Mean: 5.5 position

For input: 8 Vpp @ 400 kHz

Position	Voltage	Displacement about mean (mm)
3.0	180 mV	2.5
3.2	209 mV	2.3
3.4	360 mV	2.1
3.6	600 mV	1.9
3.8	960 mV	1.7
4.0	2 V	1.5
4.2	2.97 V	1.3
4.4	4.3 V	1.1
4.6	5.1 V	0.9
4.8	5.0 V	0.7
5.0	4.0 V	0.5
5.2	2.7 V	0.3
5.4	1.6 V	0.1
5.6	300 mV	0 - 0.1
5.8	1.4 V	-0.3
6	2.71 V	-0.5
6.2	4 V	-0.7
6.4	5 V	-0.9
6.6	5.5 V	-1.1
6.8	4.8 V	-1.3
7	3.2 V	-1.5
7.2	2.3 V	-1.7
7.4	1.3 V	-1.9
7.6	700 mV	-2.1
7.8	500 mV	-2.3
8	300 mV	-2.5
8.2	200 mV	-2.7

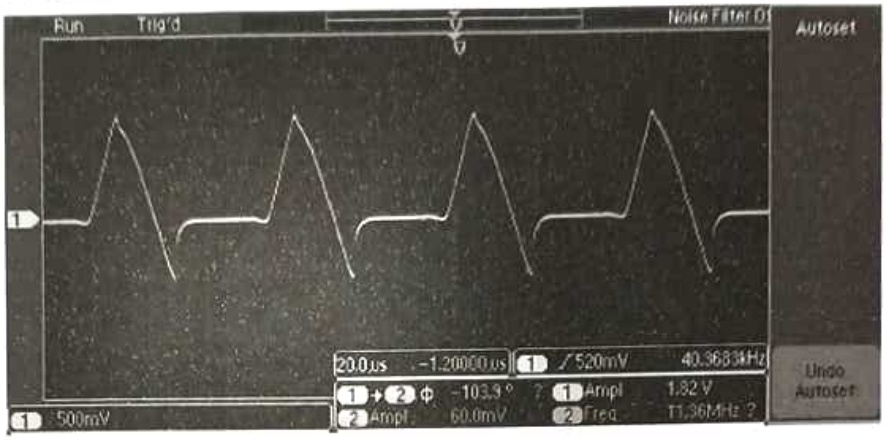
DC Measurement:

Input: $8V_{pp}$ @ 400kHz

Position	Voltage	Displacement (mm) about mean (5.5 position)
3	10 mV	2.5
3.2	13 mV	2.3
3.4	18 mV	2.1
3.6	25 mV	1.9
3.8	41 mV	1.7
4.0	76 mV	1.5
4.2	124 mV	1.3
4.4	160 mV	1.1
4.6	172 mV	0.9
4.8	171 mV	0.7
5.0	165 mV	0.5
5.2	153 mV	0.3
5.4	84 mV	0.1
5.6	9 mV	-0.1
5.8	-92 mV	-0.3
6.0	-155 mV	-0.5
6.2	-196 mV	-0.7
6.4	-214 mV	-0.9
6.6	-214 mV	-1.1
6.8	-196 mV	-1.3
7.0	-135 mV	-1.5
7.2	-82 mV	-1.7
7.4	-37 mV	-1.9
7.6	-21 mV	-2.1
7.8	-13 mV	-2.3
8.0	0	-2.5
8.2	0	-2.7

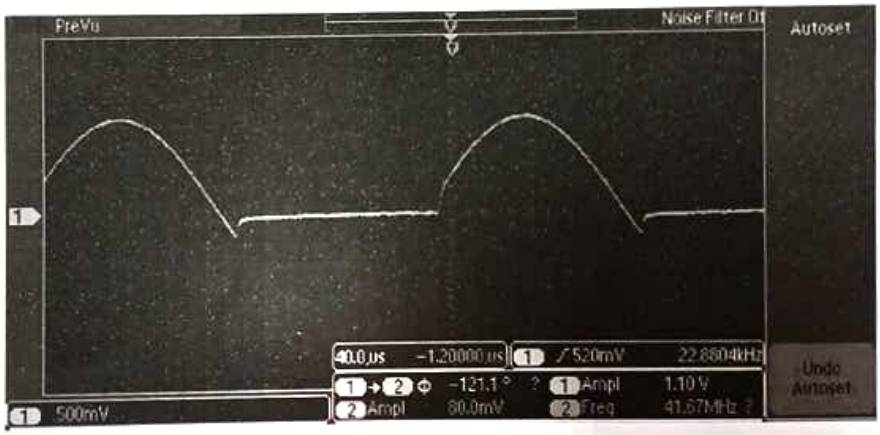
OBSERVATIONS (DSO)

1. Half Wave Precision Rectifier



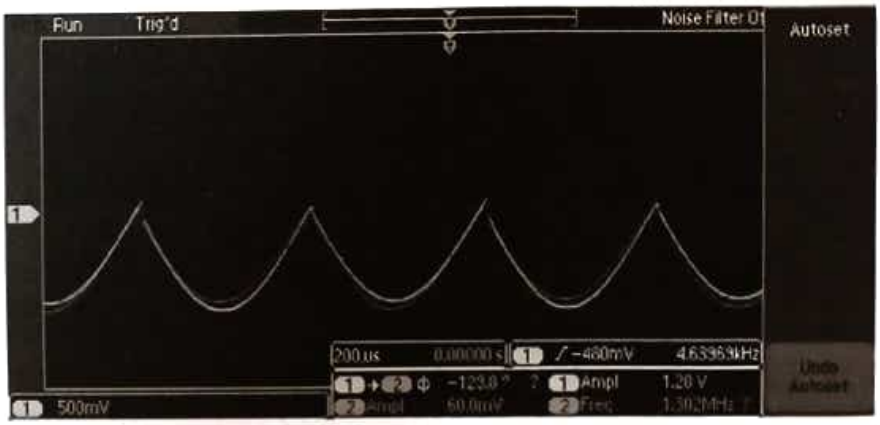
1V @5KHz

2. Improved Half Wave Precision Rectifier

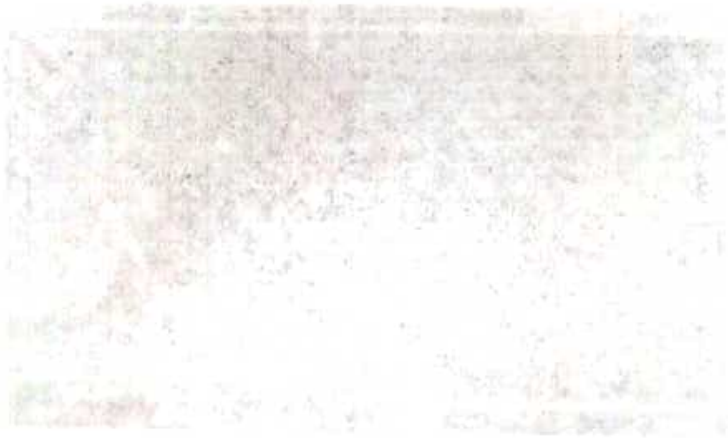


1V @5KHz

3. Full Wave Precision Rectifier

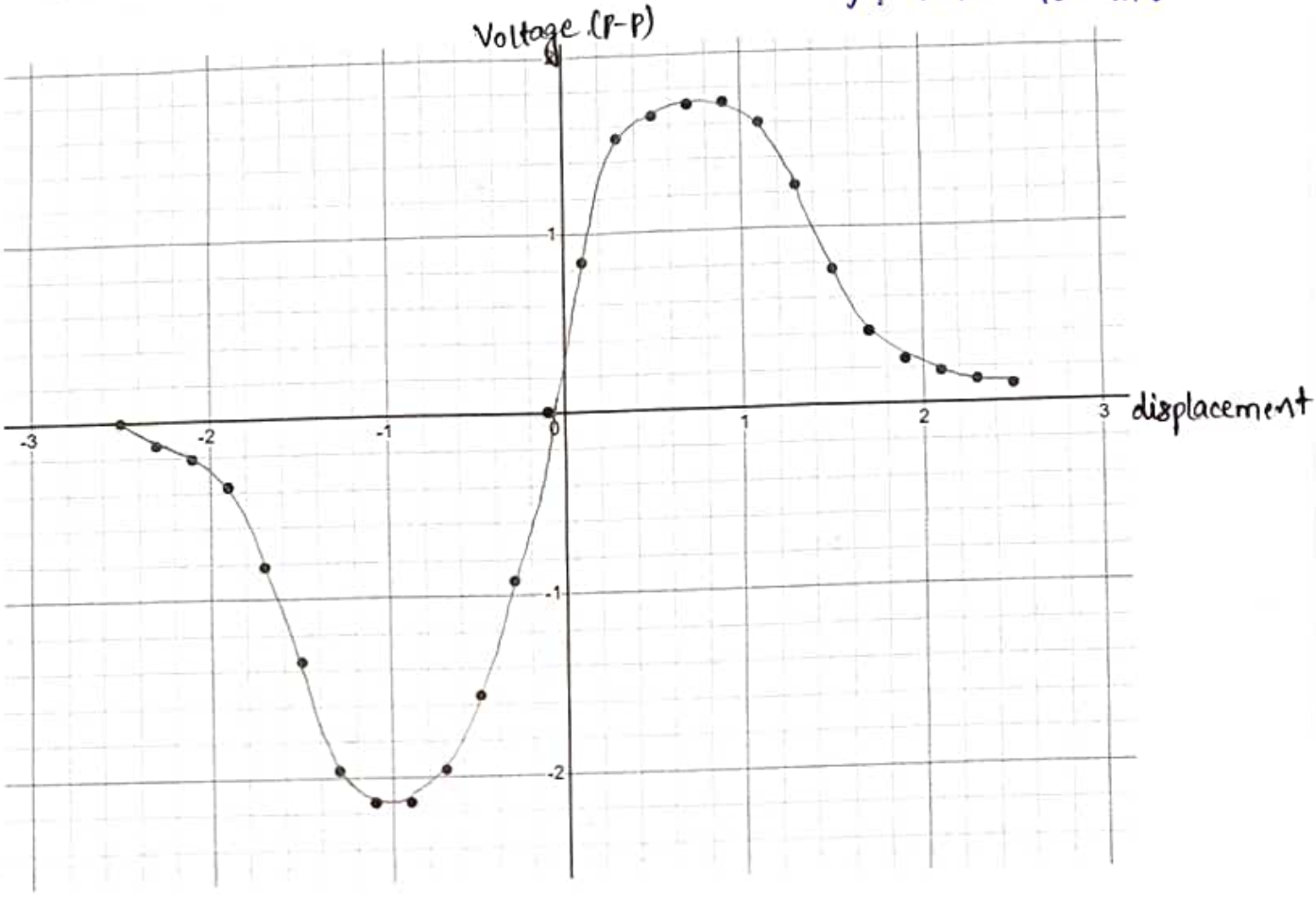


1V @ 5KHz



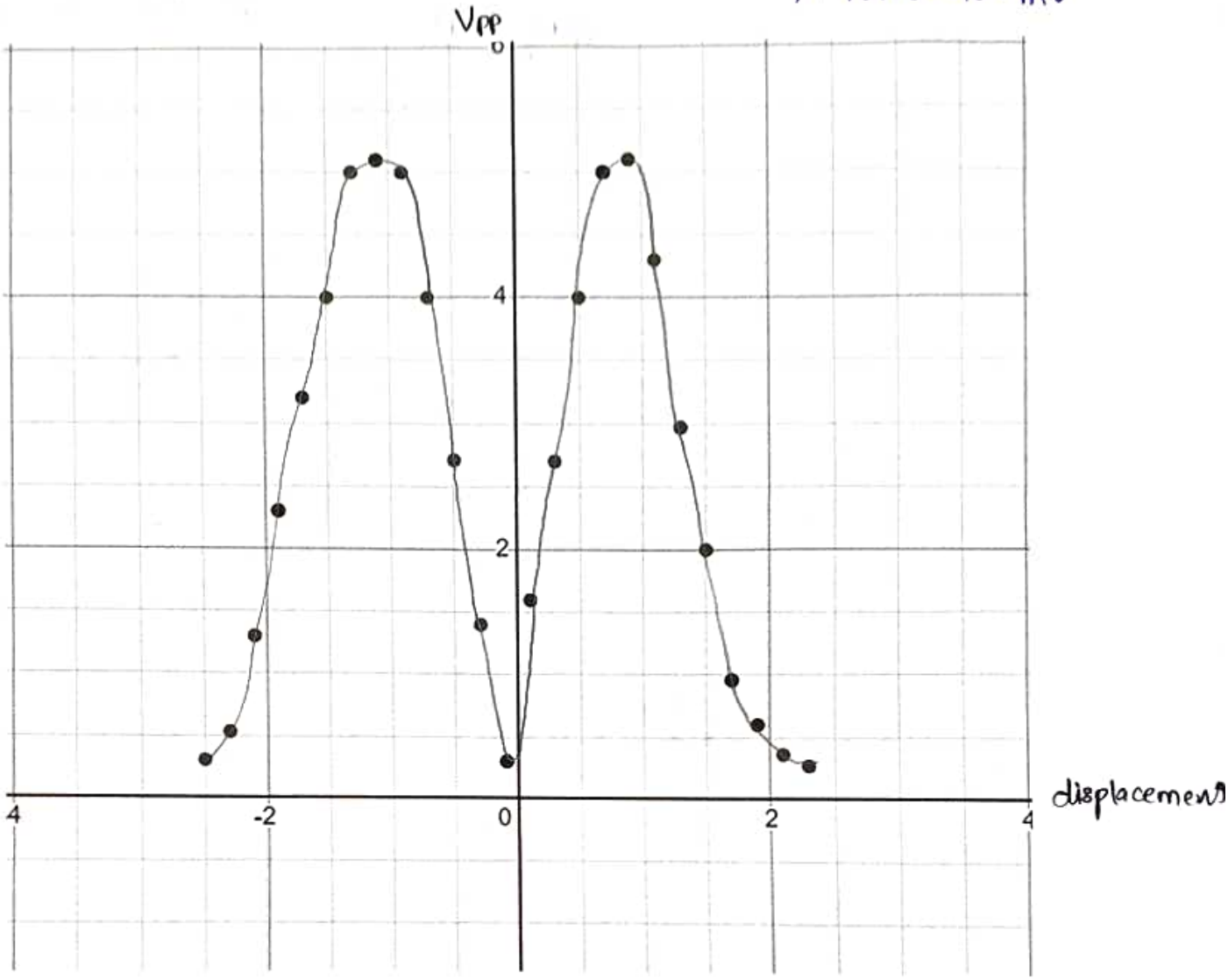
DC input Measurement :

Scale:
x: 1unit = 1mm
y: 1unit = 10^{-2} mV



Ac input Measurement :

Scale :
X : 1unit = 1mm
Y : 1unit = 10^{-3} mV



Conclusion :

The dc measurement helps to find the phase change as the core moves.

The ac measurement helps to find the variation in magnitude measurement.