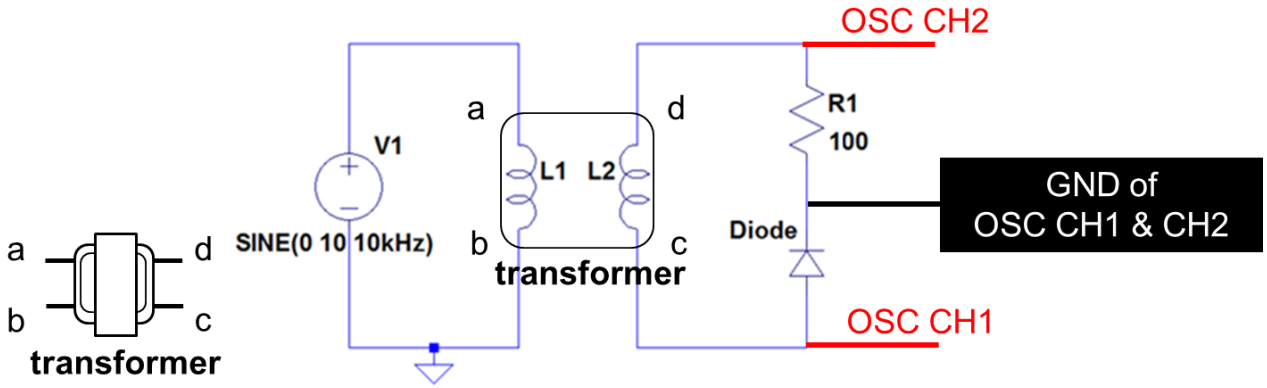
REPORT

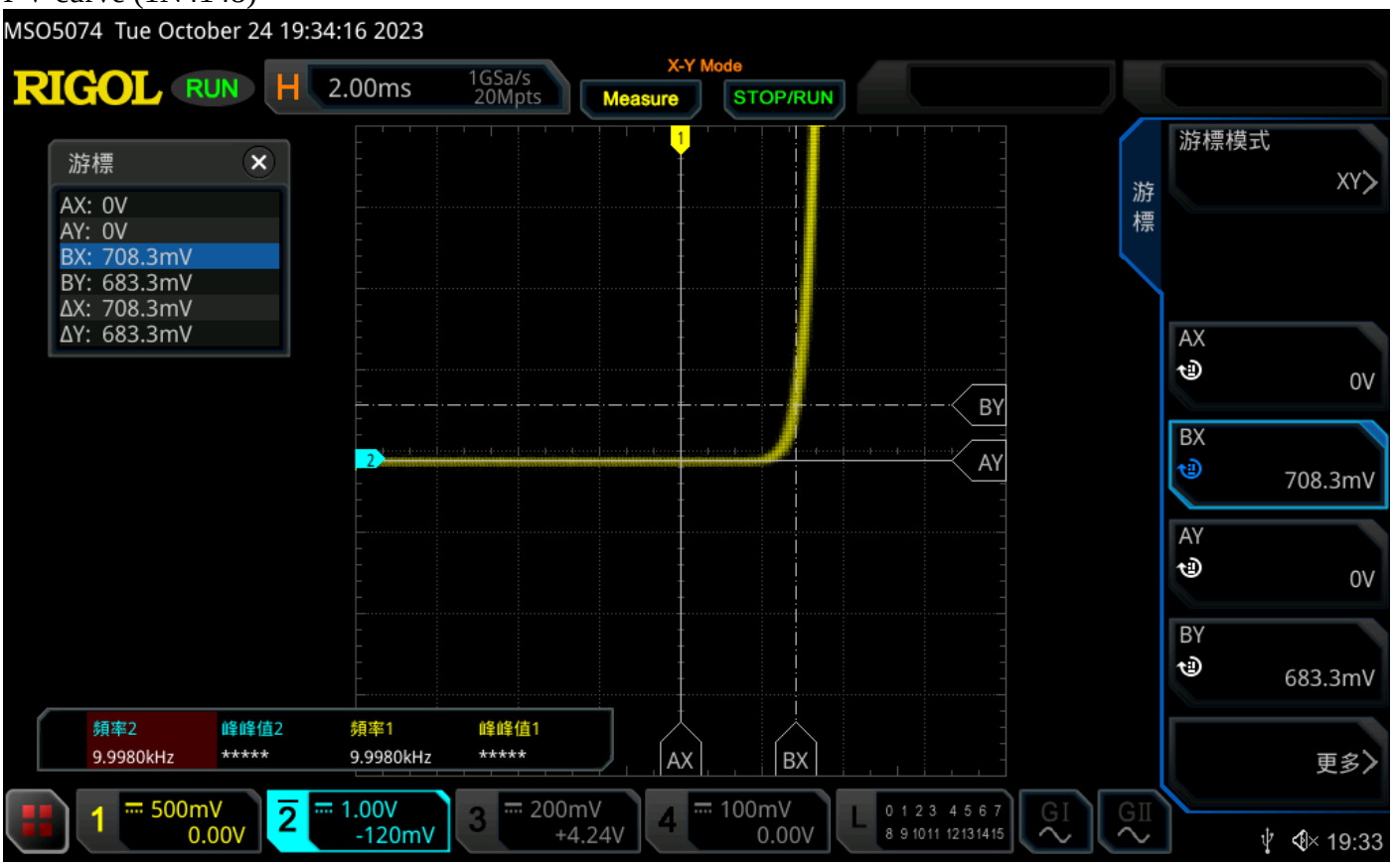
Experiment 1: Measure Cut-in Voltage of the Diode



Voltage Type	1N4148 (Si)	LED	Zener (Si)
Cut-in voltage, V_r (V)	**708.3m**	**1.833**	**766.6m**
break down voltage(V)	**X**		**-4.566**

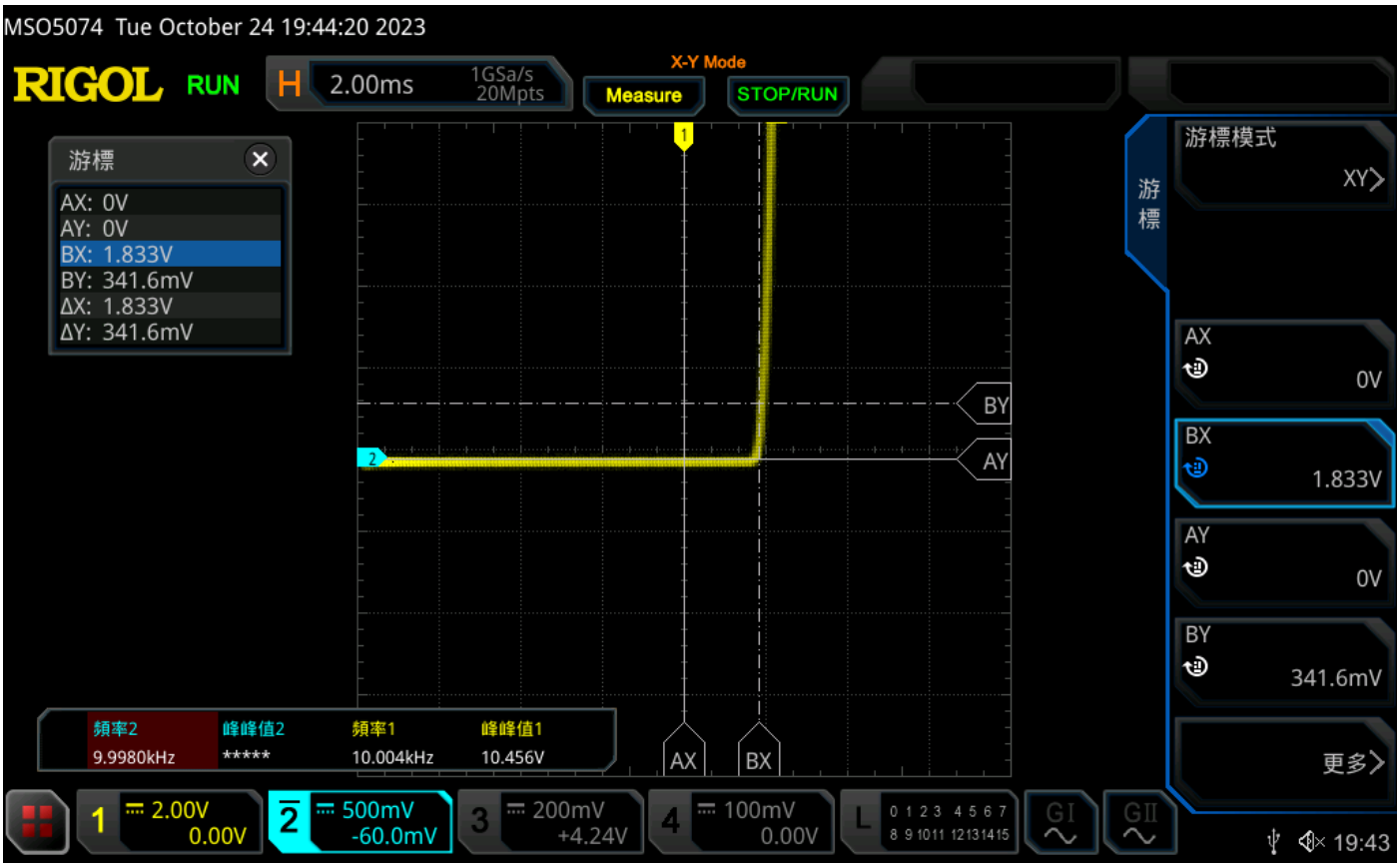
ADJUST THE OSCILLOSCOPE APPROPRIATELY

I-V curve (1N4148)

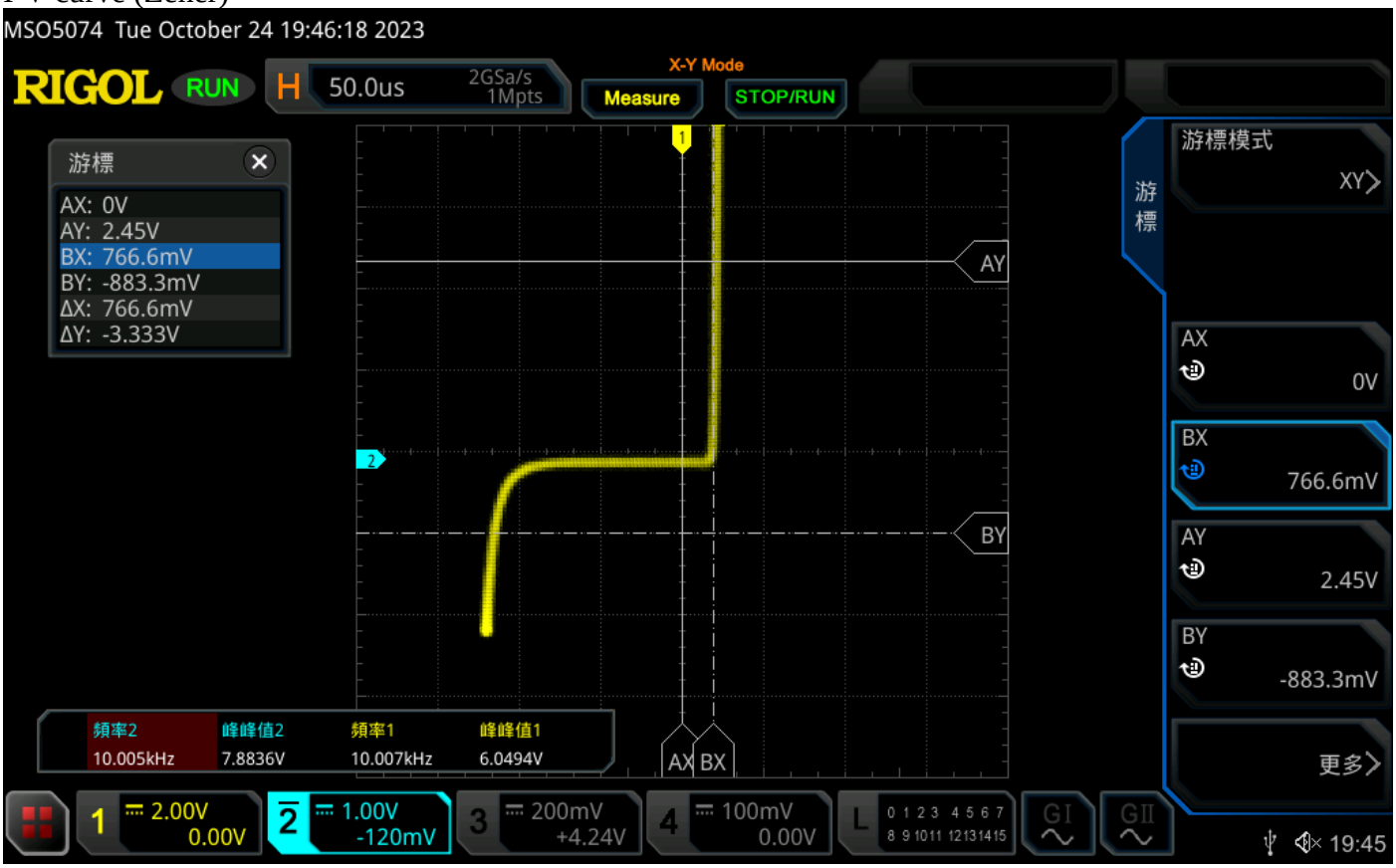


I-V curve (LED)

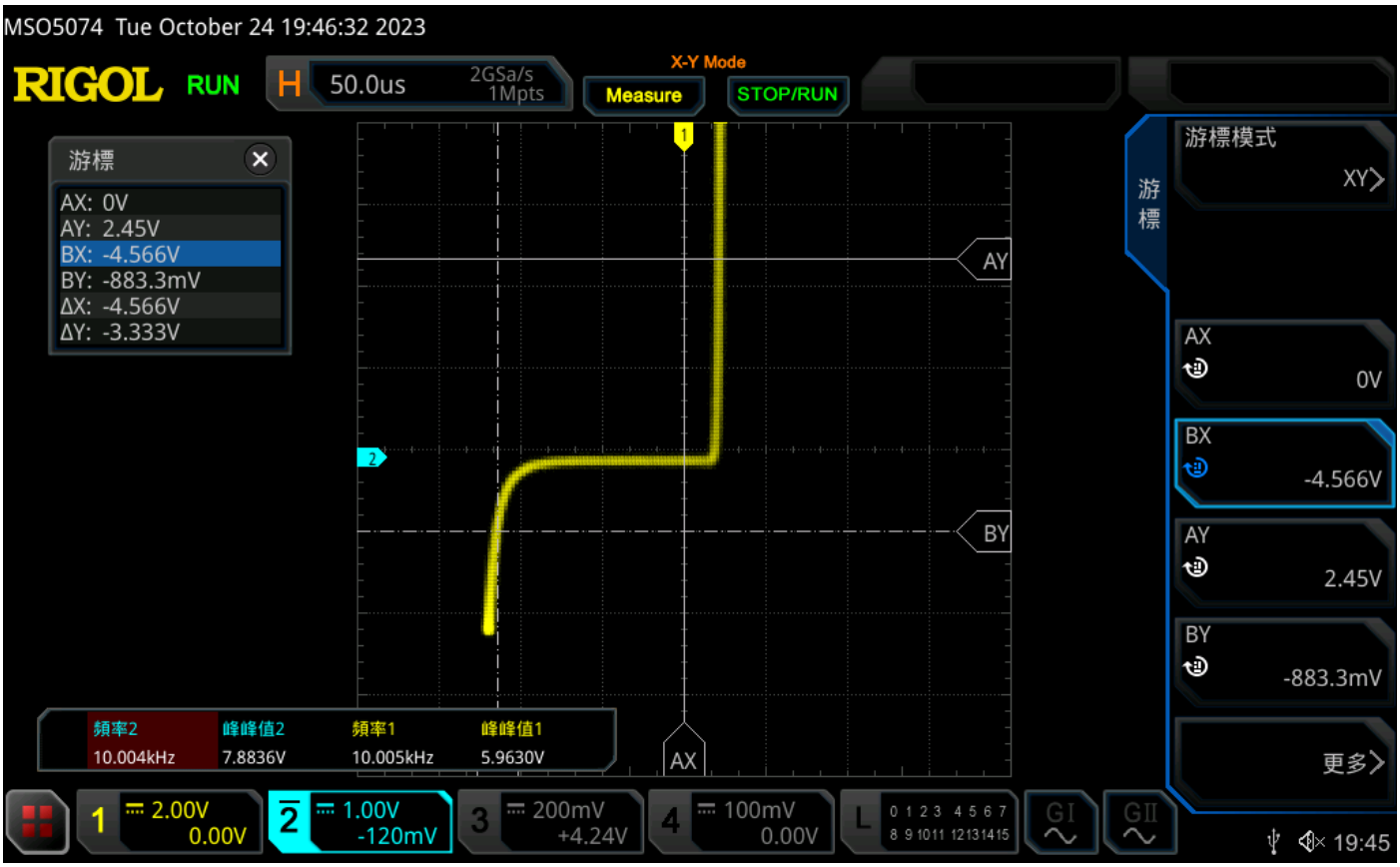
Diode



I-V curve (Zener)



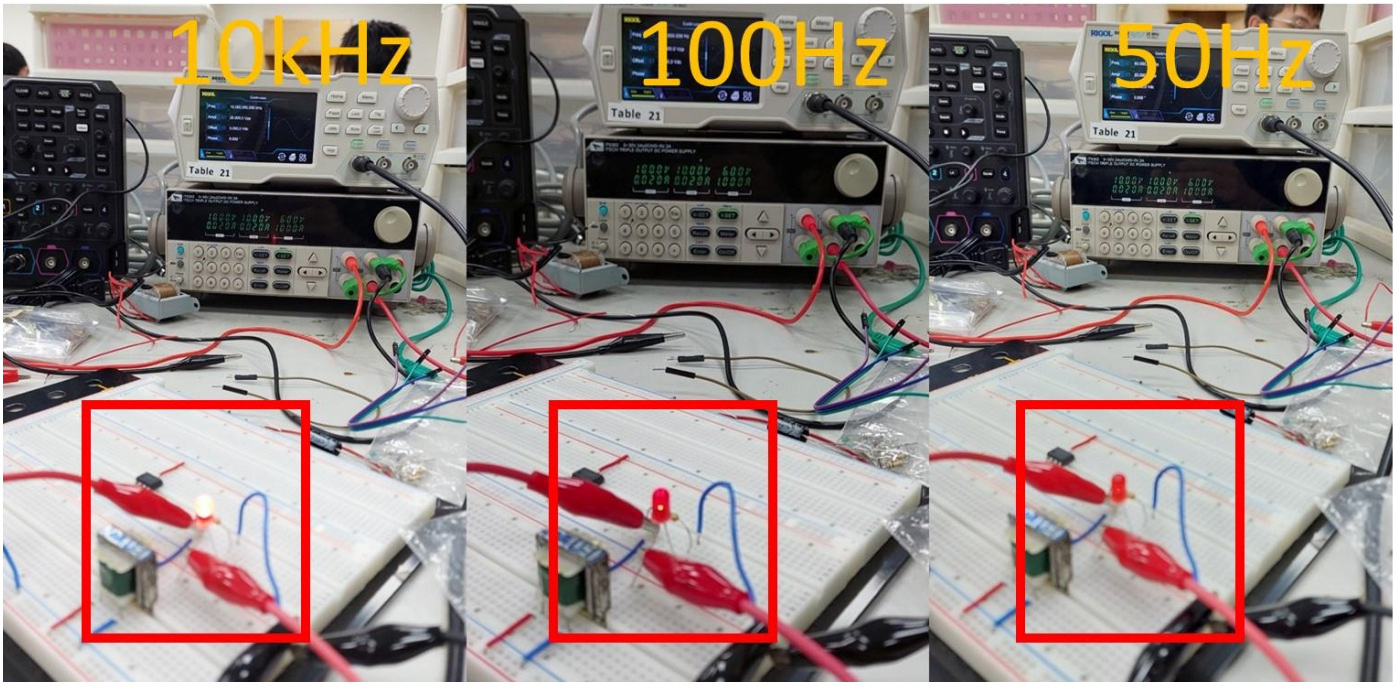
Diode



Question:

Please describe what happened when LED frequency decreasing below 100 Hz.

The light got dimmer and it appeared to flicker on camera. The reason behind this is when the frequency of the AC sine wave is low, it means that the LED is turning on and off at a rate close to the frequency of the AC wave. This creates a pulsing effect where the LED is illuminated only during a portion of each cycle. The human eye perceives this pulsing as a decrease in brightness, making the LED appear dimmer.



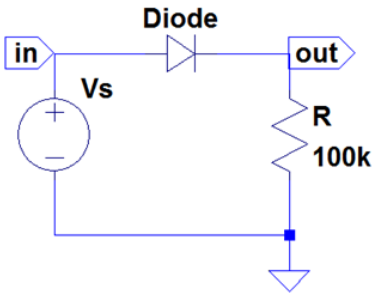
Diode

What is special about a Zener diode?

A Zener diode is a specialized type of semiconductor diode that is designed to operate in a reverse-biased mode and exhibit a very specific and useful electrical characteristic: the Zener voltage, or breakdown voltage. What makes Zener diodes special are their ability to maintain a nearly constant voltage across their terminals (the Zener voltage) when operated in the reverse-biased mode, even if the applied voltage varies within a certain range.

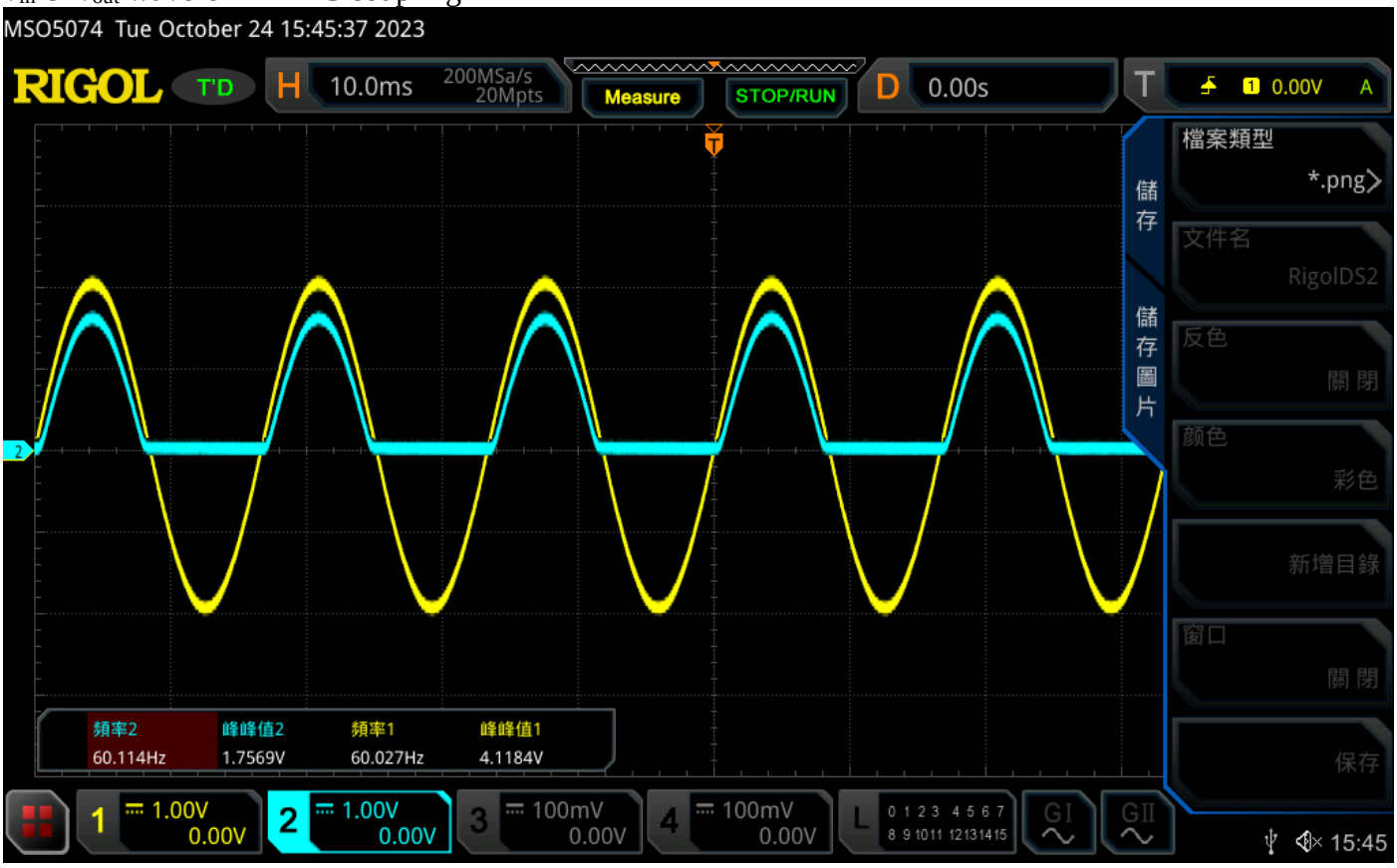
Experiment 2: The Characteristics of Halfwave Rectifier

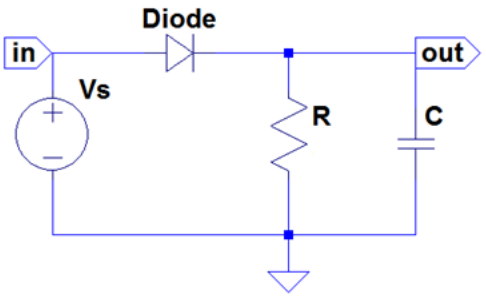
ADJUST THE OSCILLOSCOPE APPROPRIATELY



1.

v_{in} & v_{out} waveform in DC coupling

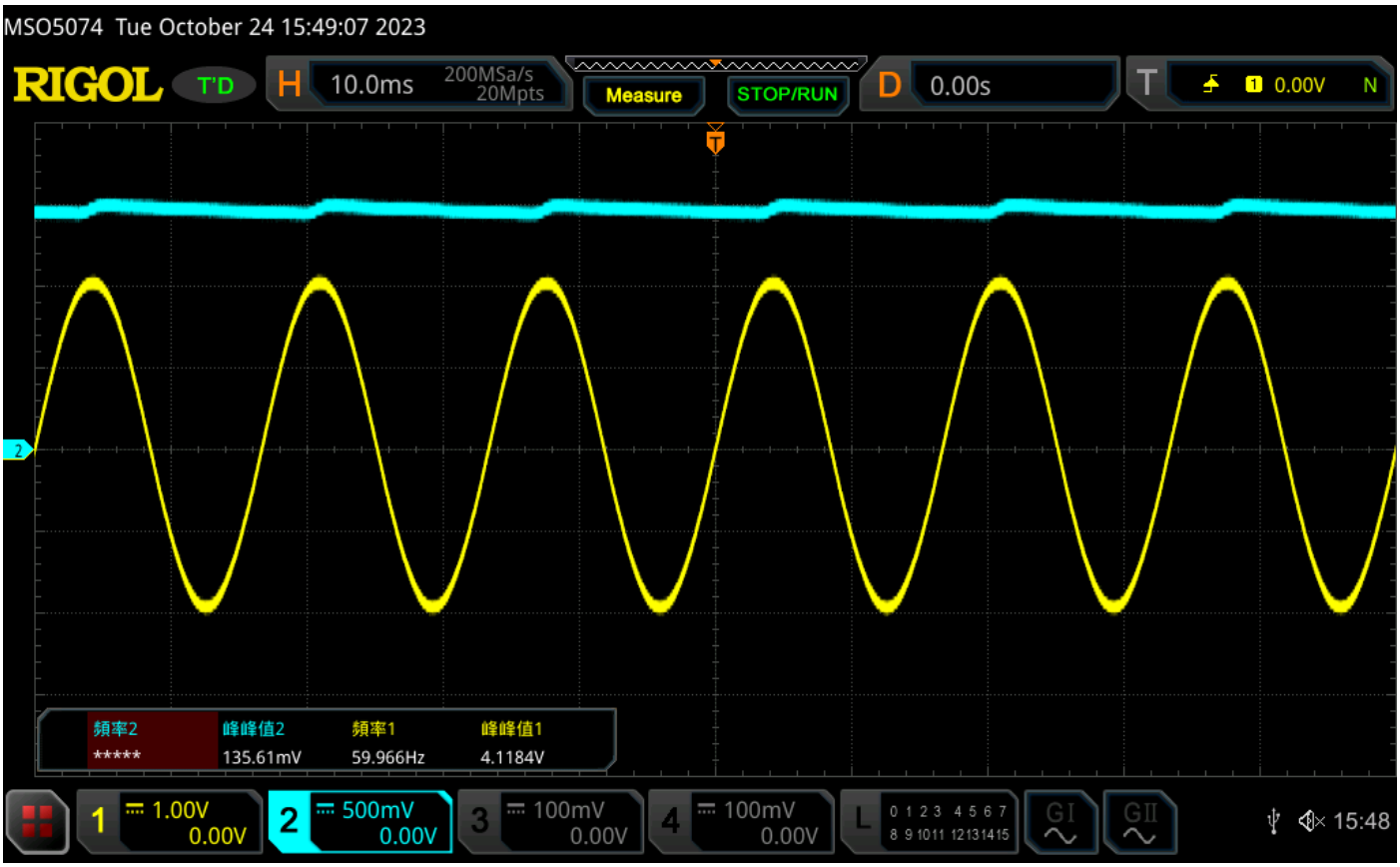




2.

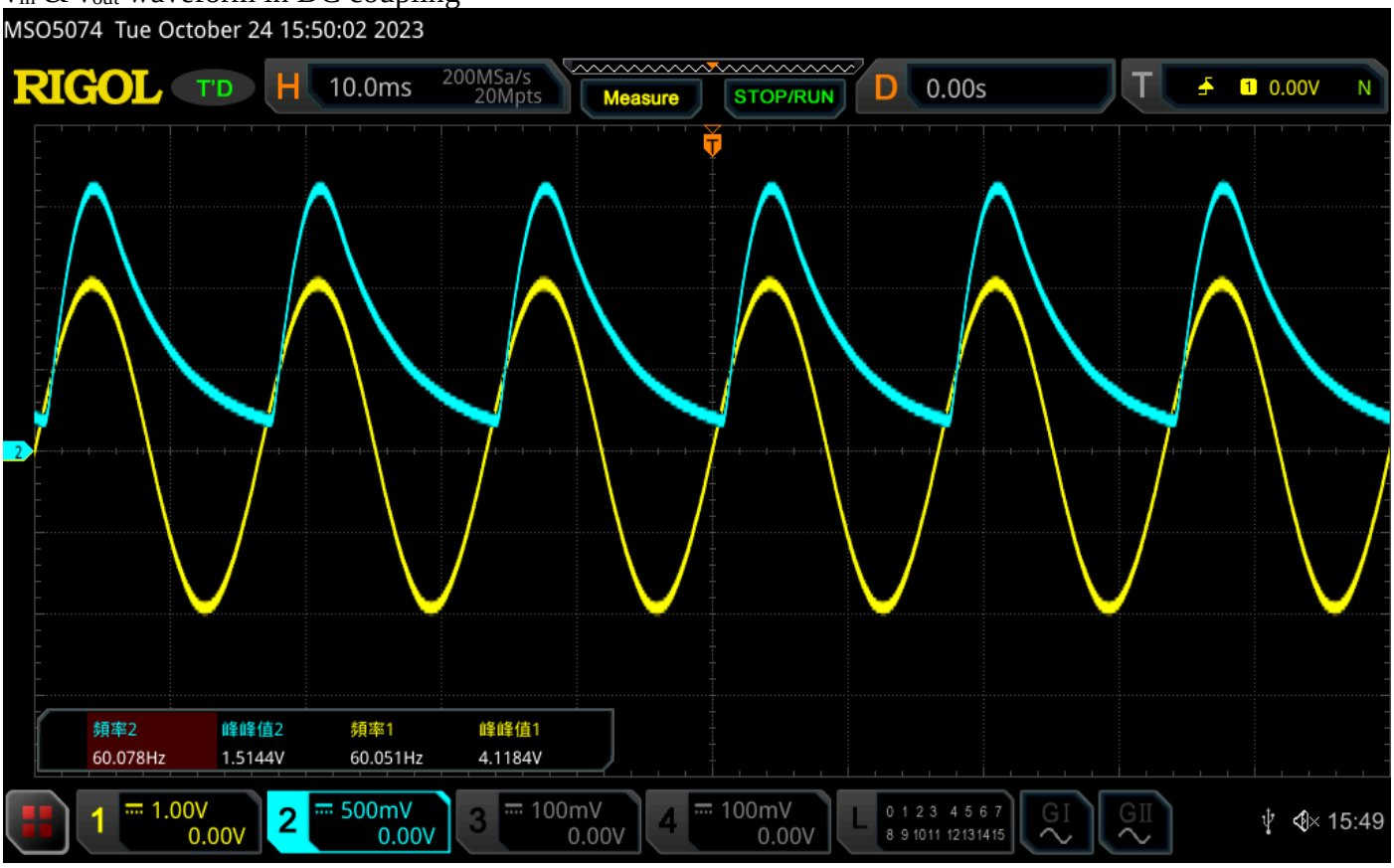
v_{in} & v_{out} waveform in DC coupling

Diode



3.

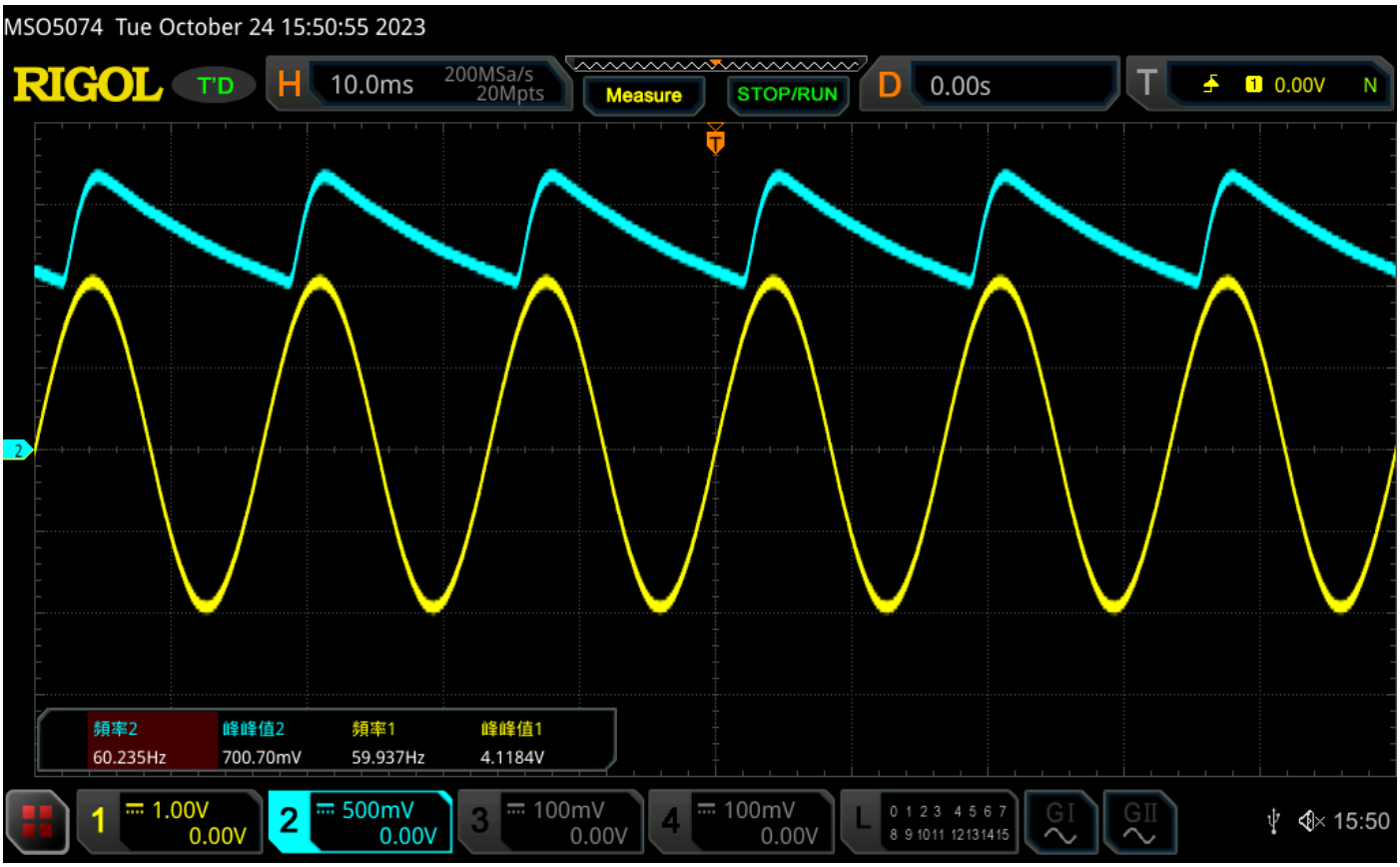
v_{in} & v_{out} waveform in DC coupling



4.

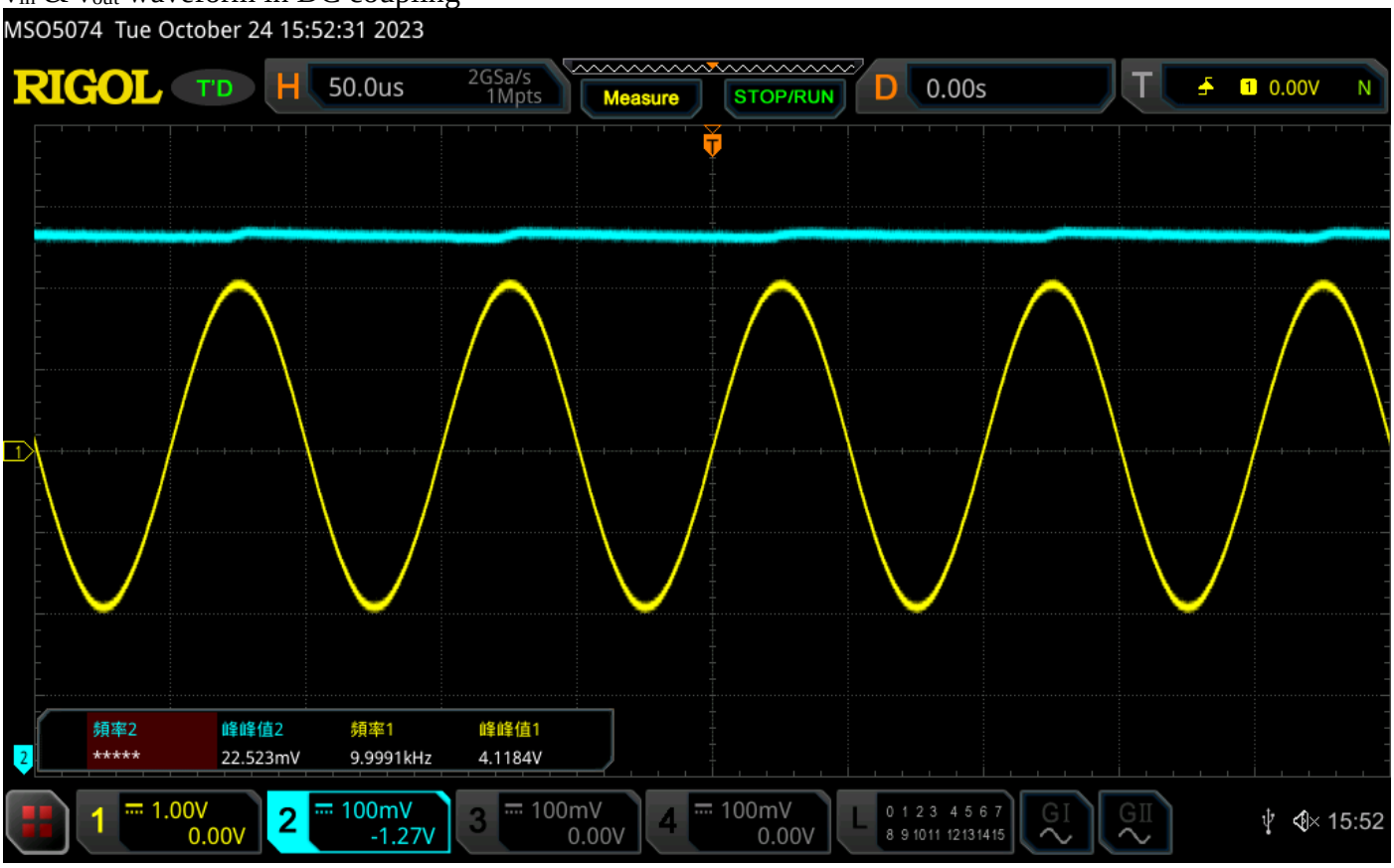
v_{in} & v_{out} waveform in DC coupling

Diode



5.

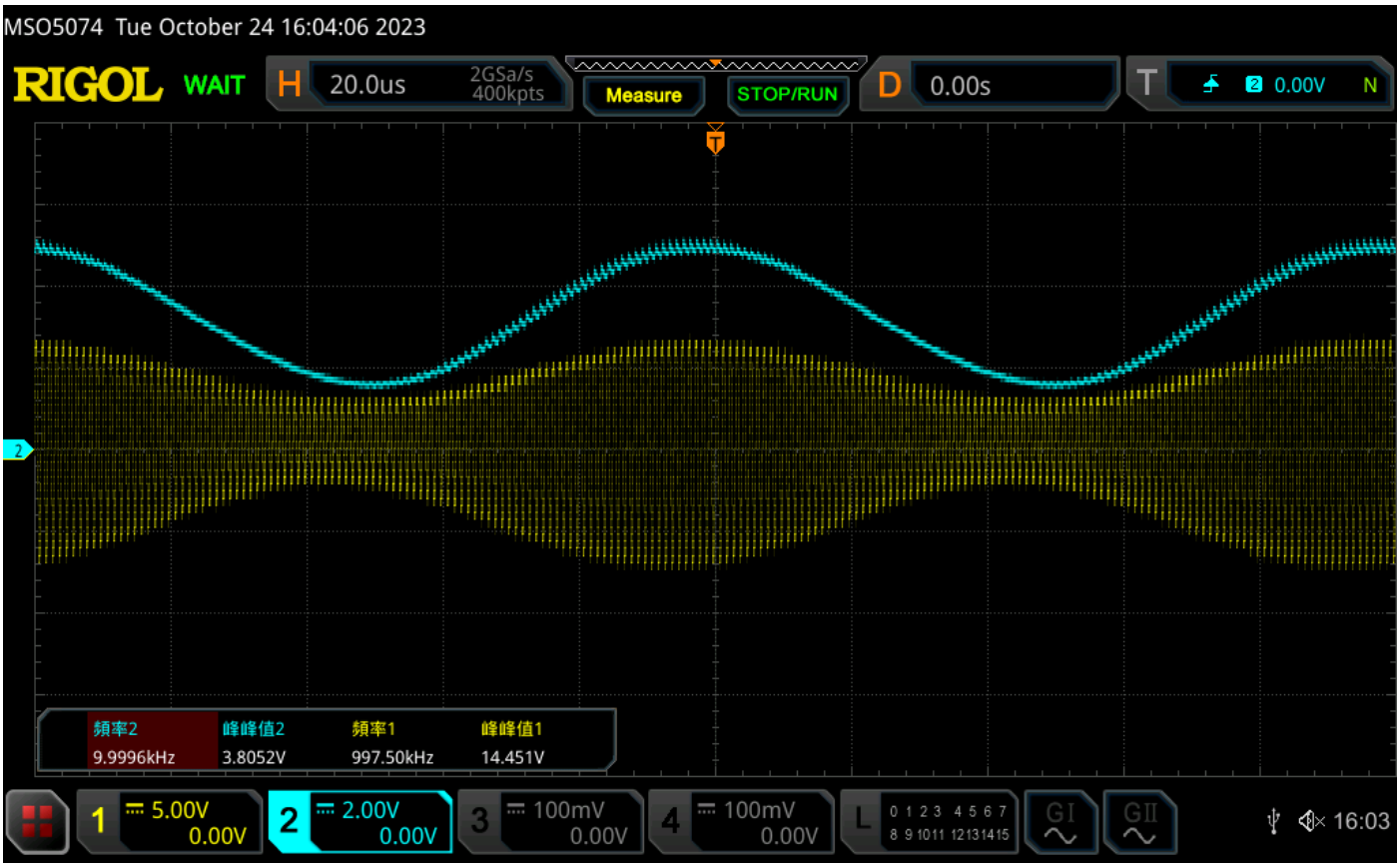
v_{in} & v_{out} waveform in DC coupling



6.

v_{in} & v_{out} waveform in DC coupling

Diode

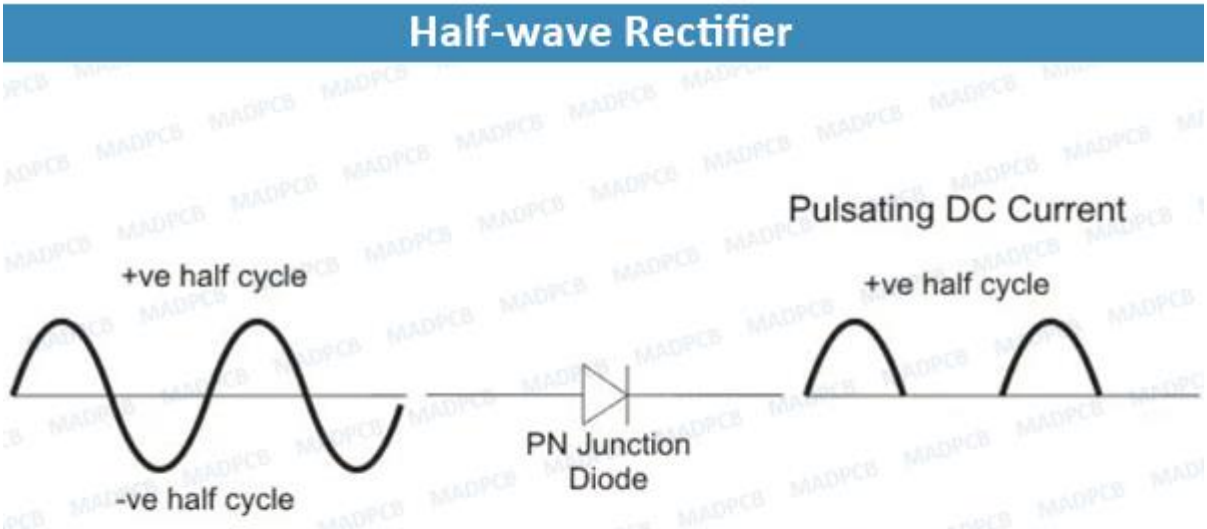


Question:

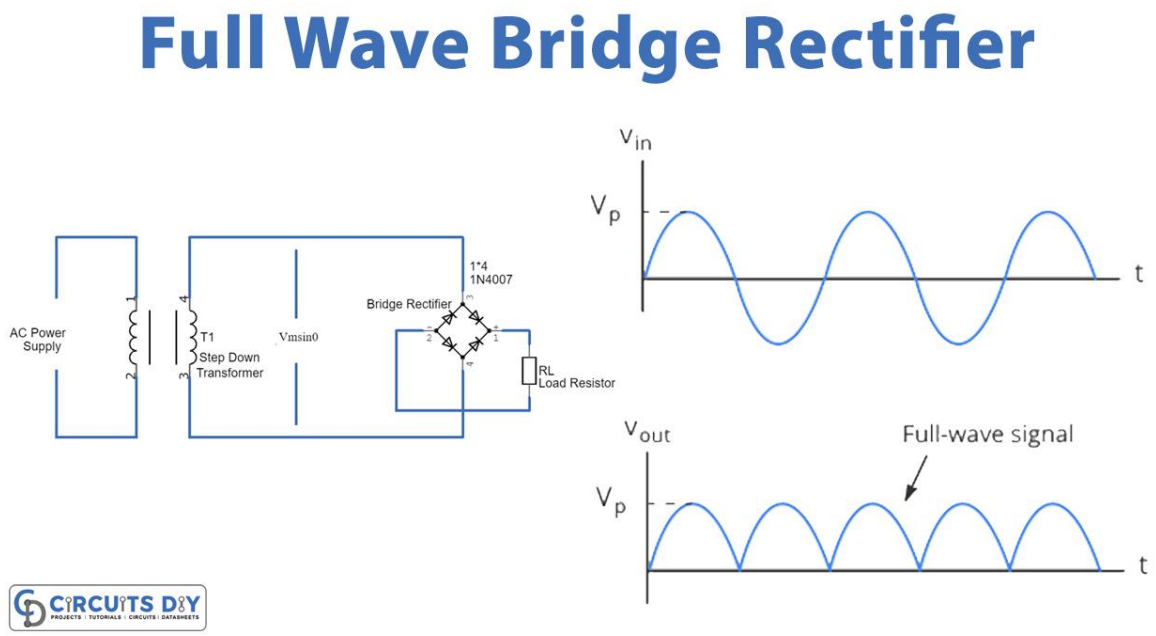
What is a rectifier?

A rectifier is an electronic device or circuit that is used to convert AC into DC. It does this by allowing current to flow in only one direction, effectively removing the negative or reverse portions of the AC waveform. Typically, a rectifier is implemented using diodes.

1. Half-Wave Rectifier: A half-wave rectifier allows only one half (either the positive or negative) of the AC input voltage to pass through to the output, effectively converting it into pulsating DC. It is a simple and cost-effective rectification method but results in a higher amount of ripple in the DC output.



2. Full-Wave Rectifier: A full-wave rectifier, in its various configurations (such as the bridge rectifier), rectifies both halves of the AC waveform, resulting in a smoother and more constant DC output. Full-wave rectification is more commonly used when a cleaner DC voltage is required.



What is ripple voltage?

Ripple voltage is primarily caused by imperfections in the rectification process in power supplies. When AC voltage is converted to DC using diodes or rectifiers, there is often a small amount of residual AC voltage left in the output due to the nature of the rectification process. This AC voltage component results in a ripple in the DC output, and its magnitude depends on various factors, including the quality of the rectification components, the load on the circuit, and the design of the power supply.

What purpose does the capacitor serve?

Capacitors are used to eliminate, or “smooth out” this ripple. Capacitance determines the amount of electric charge a capacitor can store for a given voltage. When a capacitor with higher capacitance is connected to a circuit, it can accumulate more charge for a given voltage level. This stored electrical charge acts as a reservoir of energy that can be used to counteract fluctuations in the supply voltage. When there is a sudden drop in the supply voltage, the capacitor releases its stored energy to compensate for the voltage drop, helping to maintain a more constant output voltage. Conversely, when the supply voltage increases, the excess energy is absorbed by the capacitor. Another way to understand to this is to look at the value of τ, a capacitor with higher capacitance has a longer time constant, which means it takes more time to charge or discharge when connected to a circuit. This extended charge and discharge time helps in gradual and continuous voltage adjustments, contributing to better smoothing. This is consistent with what we observed from the experiments.

Diode

Ripple Voltage Formula:

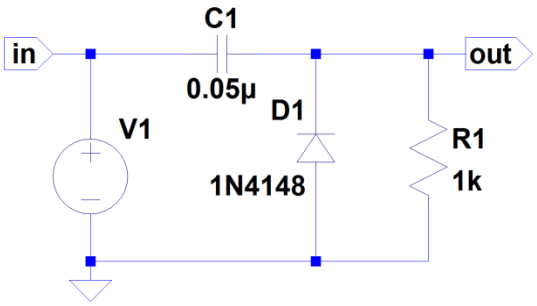
$$\text{Half Wave: } V_{rpp} = \frac{V_{peak}}{fRC} = \frac{V_{peak}}{f\tau}$$

$$\text{Full Wave: } V_{rpp} = \frac{V_{peak}}{2fRC} = \frac{V_{peak}}{2f\tau}$$

From the formula above, we can see that the larger the capacitance, the smaller the ripple gets. Additionally, the higher the frequency of the AC signal, the smaller the ripple gets.

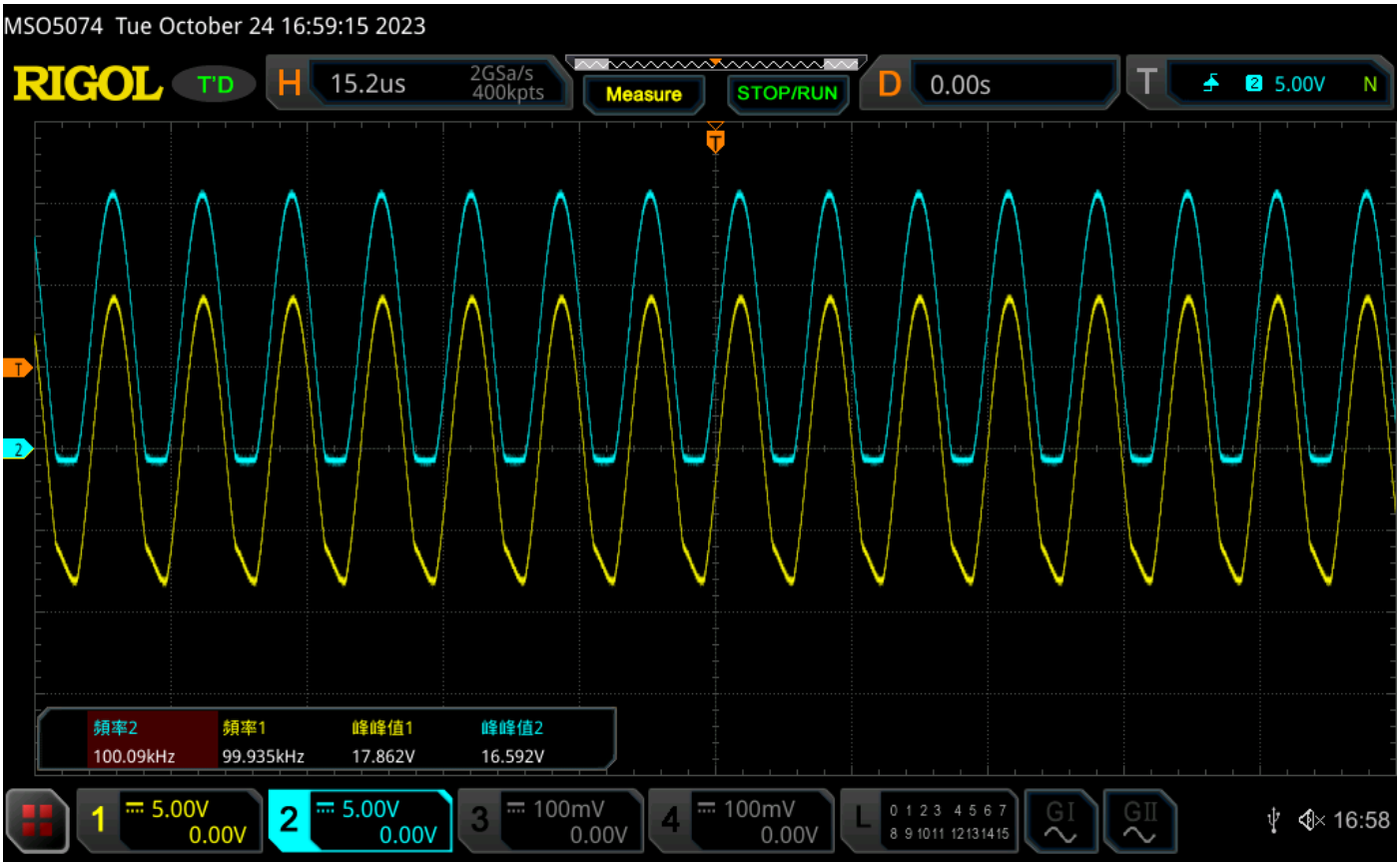
Experiment 3: Clamp circuit

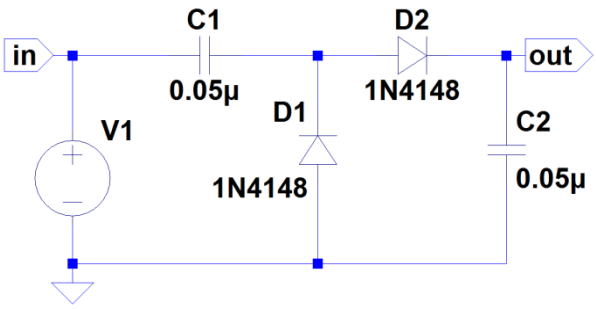
ADJUST THE OSCILLOSCOPE APPROPRIATELY



1.

v_{in} & v_{out} waveform in DC coupling



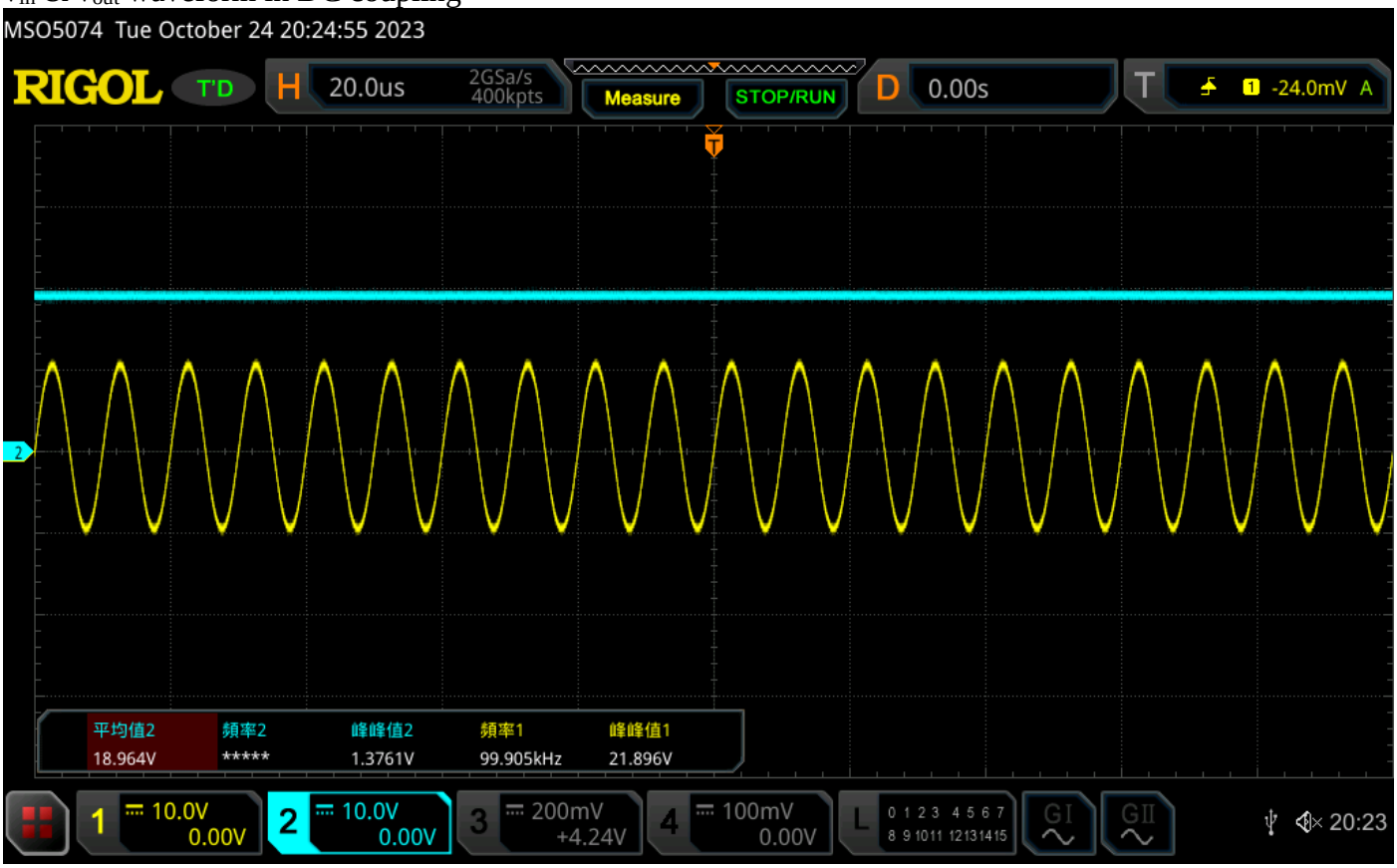


2.

Diode

	Type (DC or AC)	Measured	Theoretical(V_r=0)
v_{out} (V)	**DC**	**19.01**	**20**

v_{in} & v_{out} waveform in DC coupling



Question:

What is a clamp circuit?

A clamp circuit is a circuit used to fix or "clamp" the DC level of an AC signal to a specific voltage level. It is often used in electronics to ensure that a signal stays within a desired voltage range.

1. Positive Clamp Circuit: In a positive clamp circuit, the DC level of the input signal is shifted to a specific positive voltage level. This is typically done by adding a DC voltage source in series with the input signal using a diode or other components. The output of the circuit will have its DC level fixed at the desired voltage level.
2. Negative Clamp Circuit: In a negative clamp circuit, the DC level of the input signal is shifted to a specific negative voltage level. This is achieved by adding a DC voltage source in parallel with the input signal using diodes or other components. The output of the circuit will have its DC level fixed at the desired voltage level.

Clamp circuits are used for various purposes, such as removing DC offsets from AC signals, ensuring proper biasing of amplifiers, or preparing signals for further processing in electronic circuits. They are particularly useful in applications where the DC level of a signal needs to be controlled or adjusted to meet specific requirements without affecting the AC component of the signal.

Diode

Observation:

Greinacher circuit:

The circuit in exp 3-2 is a Greinacher circuit, or a half-wave voltage doubler. It is capable of outputting a DC signal that has a voltage of twice the AC input's amplitude. Here's how it operates:

1. During the positive half-cycle of the AC input voltage, one diode conducts, allowing the positive voltage to charge one of the capacitors. At the same time, the other diode is reverse-biased and does not conduct.
2. During the negative half-cycle of the AC input voltage, the roles of the diodes reverse. The previously conducting diode is now reverse-biased, and the other diode conducts, allowing the negative voltage to charge the other capacitor.
3. This alternating charging and discharging of the capacitors result in the two capacitors accumulating charge with the same polarity, effectively doubling the voltage across the output.
4. The capacitors smooth out the pulsating voltage, resulting in a nearly doubled DC voltage across the output terminals.

Reference:

1. BYJU'S - Full Wave Rectifier: https://byjus.com/physics/full-wave-rectifier/
2. The Organic Chemistry Tutor- Voltage Multipliers - Half Wave Voltage Doubler Circuit https://www.youtube.com/watch?v=yfykYXdAUNY
3. Tutorial's Point – Electronic Circuits – Clamper Circuits https://www.tutorialspoint.com/electronic_circuits/electronic_clamper_circuits.htm
4. Sunpower UK – What is ripple? https://www.sunpower-uk.com/glossary/what-is-ripple/