Feng Chia University

Electrical Engineering Fundamentals I Lab

Laboratory 10

Diodes Switching Speed and LED

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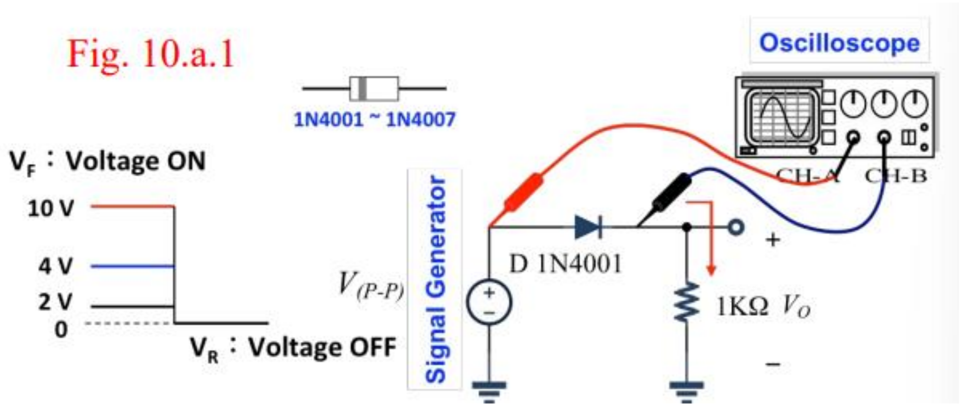
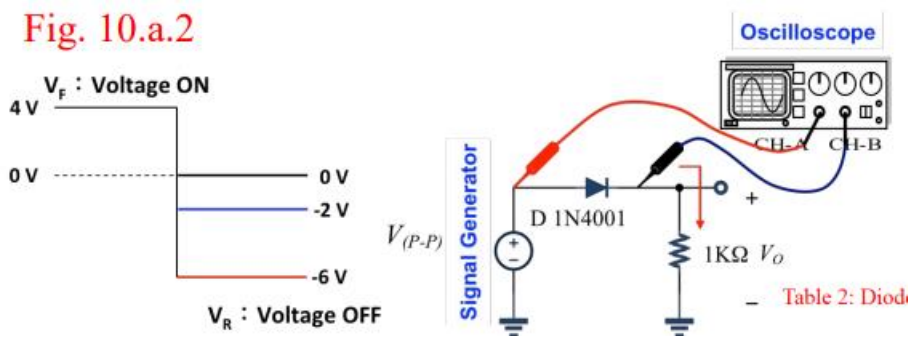
Experiment Date:21/12/2023

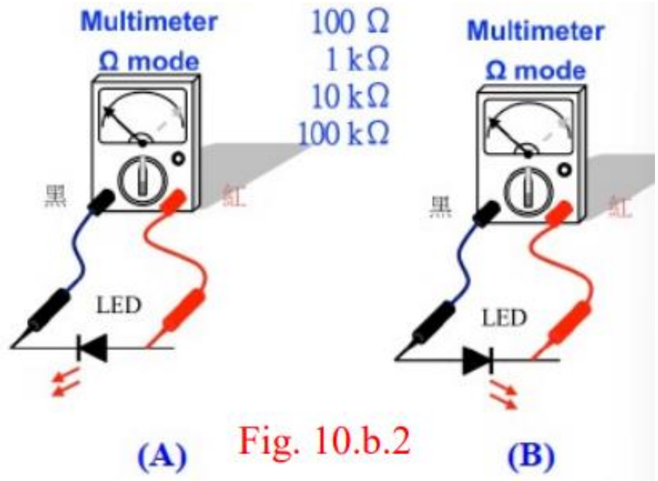
I. Introduction
   a. What is Switching Time and Switching Speed
   b. How to Speed up the Switching Time
   c. What is LED (Light-Emitting-Diode)
II. Materials
   a. Oscilloscope
   b. Digital multimeter
   c. Waveform Generator
   d. Devices
      1. Resistors: R = 1 kΩ ×1
         Diode: D 1N4001 ×1
      2. Resistors: R = 300 Ω ×1, 1 kΩ ×1
         LED ×1
III. Circuit diagram



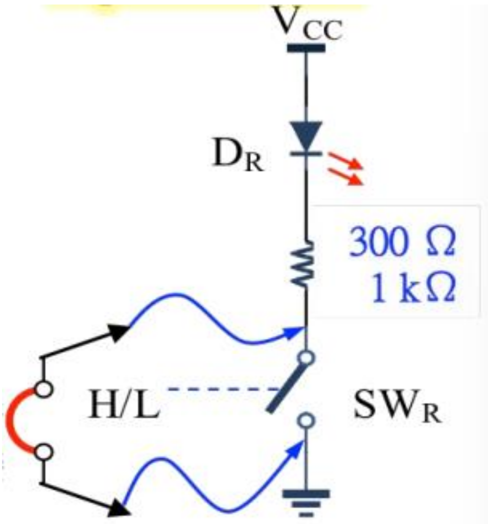
▲ Figure 1. Circuit of Experiment 10.a.1 Effects of conduction current $I_{D(ON)}$



▲ Figure 2. Circuit of Experiment 10.a.2 Effect of Switch-OFF Voltage V_R



▲ Figure 3. Circuit of Experiment 10.b.1 LED Measurements



▲ Figure 4. Circuit of Experiment 10.b.2 LED Driving Circuit

IV. Methods

Use Digital multimeter and Waveform Generator to observe the results.

V. Experiments data

a. Experiment 10.a Measurement of Diode Switching Speed

1. Effects of conduction current $I_{D(ON)}$

(1) +2 V → 0 V

Scale: 200 μs/Div

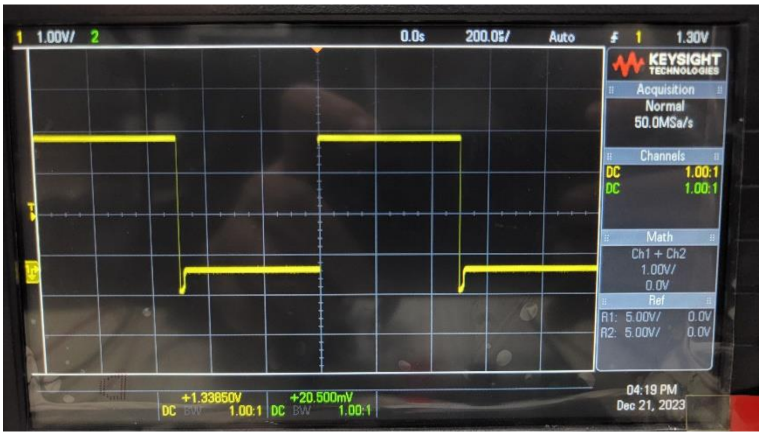
500 mV/Div

t_{OFF}: 16.9 μs

t_S: 10.4 μs

t_T: 6.5 μs

(2) +4 V → 0 V



Scale: 200 μs/Div

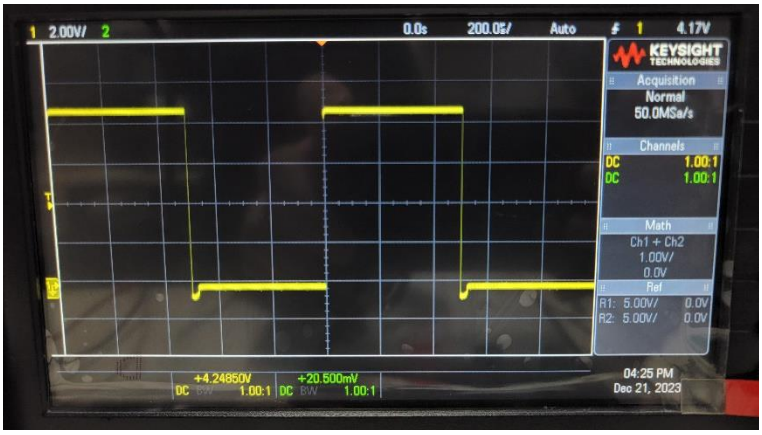
1 V/Div

t_{OFF}: 24.7 μs

t_S: 16.8 μs

t_T: 7.9 μs

(3) +10 V → 0 V



Scale: 200 μs/Div

2 V/Div

t_{OFF}: 33.4 μs

t_S: 24.8 μs

t_T: 8.6 μs

2. Effect of Switch-OFF Voltage V_R

(1) +4 V → 0 V

Scale: 200 μs/Div

1 V/Div

t_{OFF}: 24.7 μs

t_S: 16.8 μs

t_T: 7.9 μs

(2) +4 V → -2 V

Scale: 200 µs/Div

1 V/Div

t_{OFF}: 14 µs

t_S: 7.3 µs

t_T: 6.7 µs

(3) +4 V → -6 V

Scale: 200 µs/Div

2 V/Div

t_{OFF}: 8.7 µs

t_S: 6 µs

t_T: 2.7 µs

b. Experiment 10.b LED Measurements and Driving Circuit

1. LED Measurements

(1) Forward Bias

100 Ω: Light
1 kΩ: Light
10 kΩ: Dark
100 kΩ: Dark

(2) Reverse Bias

100 Ω: Dark
1 kΩ: Dark
10 kΩ: Dark
100 kΩ: Dark

2. LED Driving Circuit

300 Ω: Light
1 kΩ: Light
N/A Ω: Dark

VI. Results

None

VII. Discussion

- What is the effect of the diode conducting current $I_{D(ON)}$ on the resulting switching time t_{OFF}? Why?

  t_{OFF} becomes greater by the time because when a diode is switched from the conducting state (ON) to the blocking state (OFF), it doesn't immediately stop conducting. This is due to the stored charge in the junction region that needs to be removed. The time it takes for the diode to fully switch off is known as the reverse recovery time. The magnitude of the conducting current $I_{D(ON)}$ can affect this time, as a higher current can lead to more stored charge and thus a longer recovery time

- How to utilize your oscilloscope to observe a waveform in a tiny period of time range?

  To observe tiny period of time on Oscilloscope, just adjust horizontal time per division and the wave can be easy to observe.

- What is the difference between this waveform and the normal waveform from oscilloscope?

  The waveform we observe is not a pure square wave. Instead, it's a square wave with a recovery time when the diode switched OFF.

- What is the effect of the switching off voltage V_R on the resulting switching speed of the diode? Why?
  When the diode switches from forward bias (conducting state) to reverse bias (blocking state), the reverse voltage helps to remove the stored charge in the junction, thus speeding up the switching process.
- How does the LED behave?
  When the resistor increases, LED becomes darker and can't see the light.
- Compare the emitted lightness of LED under different Ω-scales
  100 Ω: Lightest
  1 kΩ: Light
  10 kΩ: Dark
  100 kΩ: Dark
- What is the relationship between the switch and the LED?
  When switch is open, LED won't emit light.
  When switch is closed, LED will emit light.
- What is the relationship between the resistor and the LED?
  When the resistor increases, the current will decrease and make LED become darker.

VIII. Conclusion

With Oscilloscope, we can easily observe the wave go through the diode.