Digital System Design Lab

Lab 2
Measurement of Gate Electrical and Timing Characteristics

Student ID: D1166506
Name: 周嘉禾
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1. Objectives

- To become familiar with the functions and capabilities of the digital multi-meter and the digital oscilloscope
- To learn how to make voltage and current measurements using the digital multi-meter
- To learn how to measure logic signal transition times and propagation delays using the digital oscilloscope

2. Theorem

(1) Multimeter

A multimeter, also known as a multitester or VOM (Volt-Ohm-Milliammeter), is a versatile electrical measurement tool used to measure various electrical parameters. In this section, we will introduce how to use a multimeter to measure DC voltage, current, and resistance.

a. Measuring DC Voltage:

1. Turn the multimeter dial to the voltage (V) setting.
2. Connect the red probe to the positive (+) terminal and the black probe to the negative (-) terminal of the circuit or component you want to measure.
3. Read the voltage value displayed on the multimeter's screen.

b. Measuring DC Current:

1. Turn off the power in the circuit you want to measure.
2. Turn the multimeter dial to the current (A) setting.
3. Connect the multimeter in series with the circuit by breaking the circuit and placing the multimeter probes in line with the current flow.
4. Turn the power back on.
5. Read the current value displayed on the multimeter's screen.

c. Measuring Resistance:

1. Turn the multimeter dial to the resistance (Ω) setting.
2. Disconnect the component or circuit from any power source.
3. Connect the multimeter probes to the two ends of the component or circuit you want to measure.
4. Read the resistance value displayed on the multimeter's screen.

(2) Oscilloscope

An oscilloscope, often referred to as a scope or a DSO (Digital Storage Oscilloscope), is a powerful tool for visualizing electrical signals in the time domain. It helps engineers and technicians observe the waveform of signals, which is crucial for diagnosing and troubleshooting electronic circuits.

a. Using an Oscilloscope:

1. Connect the oscilloscope probe to the signal source or circuit you want to analyze.
2. Turn on the oscilloscope.
3. Adjust the vertical and horizontal settings to get a clear view of the

signal.

4. Trigger the oscilloscope to stabilize and capture the waveform.
5. Observe the waveform on the oscilloscope screen, which displays voltage (vertical axis) against time (horizontal axis).

(3) IC Circuits

a. Potentiometer

A variable resistor, often referred to as a potentiometer, is a three-terminal passive component used to vary the resistance in a circuit manually. It is commonly used for volume control, brightness adjustment in displays, and various other applications.

b. Oscillator

An oscillator is an electronic circuit that generates an oscillating (repetitive) waveform, typically a sine, square, or triangle wave. Oscillators are essential for creating clock signals in digital electronics, generating audio tones, and producing radio frequency signals in communication systems.

c. 7414 ICs

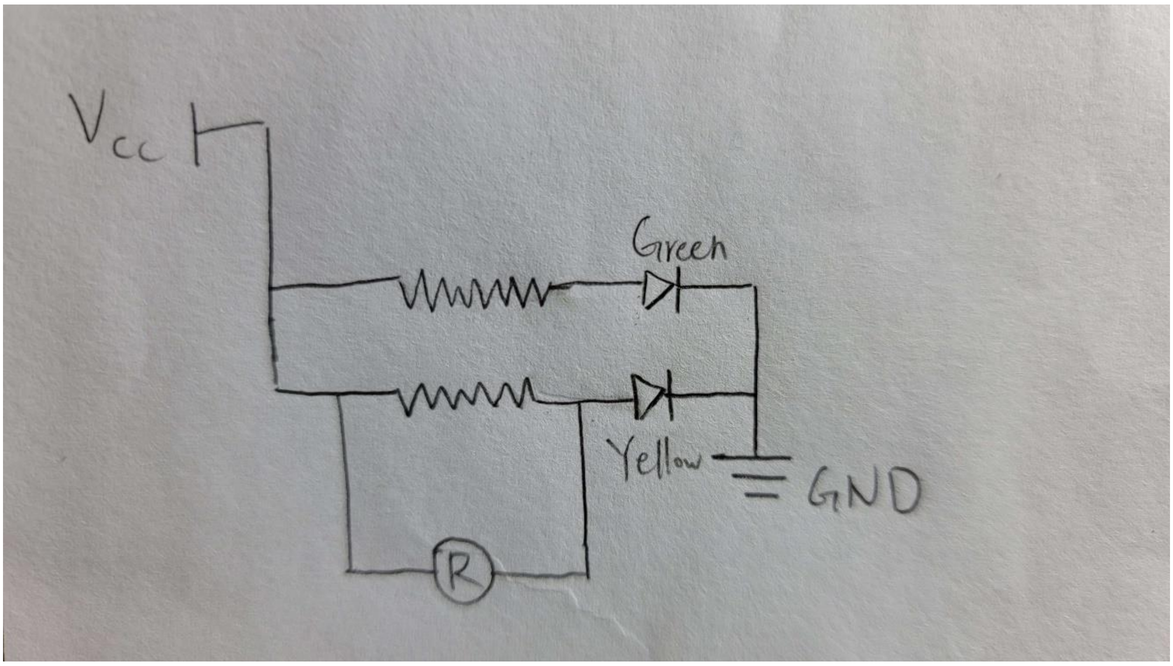
This IC contains six Schmitt-trigger inverters, which are used to convert non-sinusoidal input waveforms into square waves with well-defined thresholds. It is often used for signal conditioning and waveform shaping.

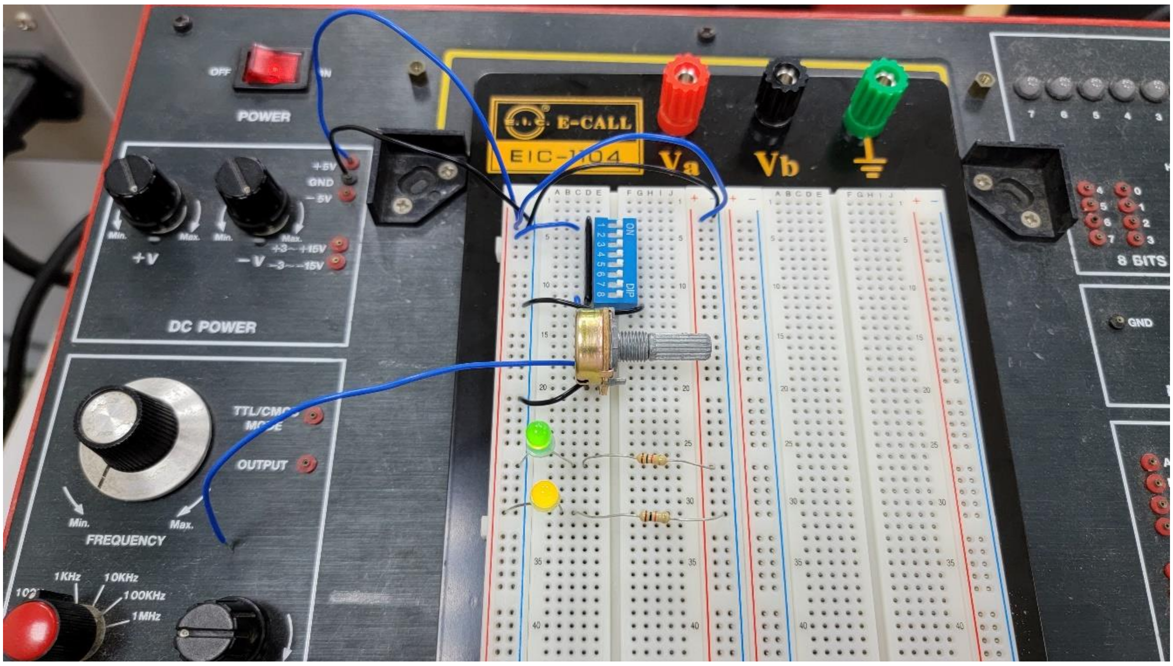
d. 7474 ICs

This IC is a dual D-type flip-flop with clock and set/reset inputs. It is commonly used for storing binary data and synchronization in digital circuits.

3. Experimental Results

(1) Step 2

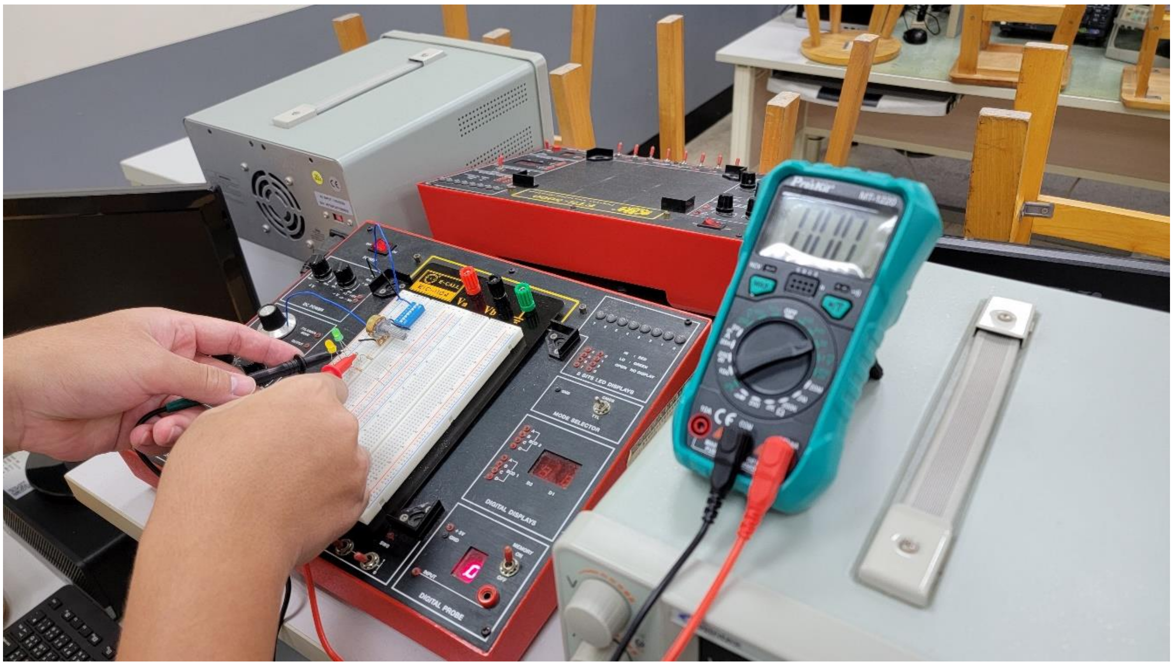




a.

V_{LED} (green)	1.96 V
I_{LED} (green)	3.18 mA
V_{LED} (yellow)	1.83 V
I_{LED} (yellow)	3.29A

b.



$R_{measured}$ of a “brown-black-red” resistor is 990Ω

c.

I_{LED} (green, calculated) = (5 - V_{LED} (green))/ $R_{measured}$

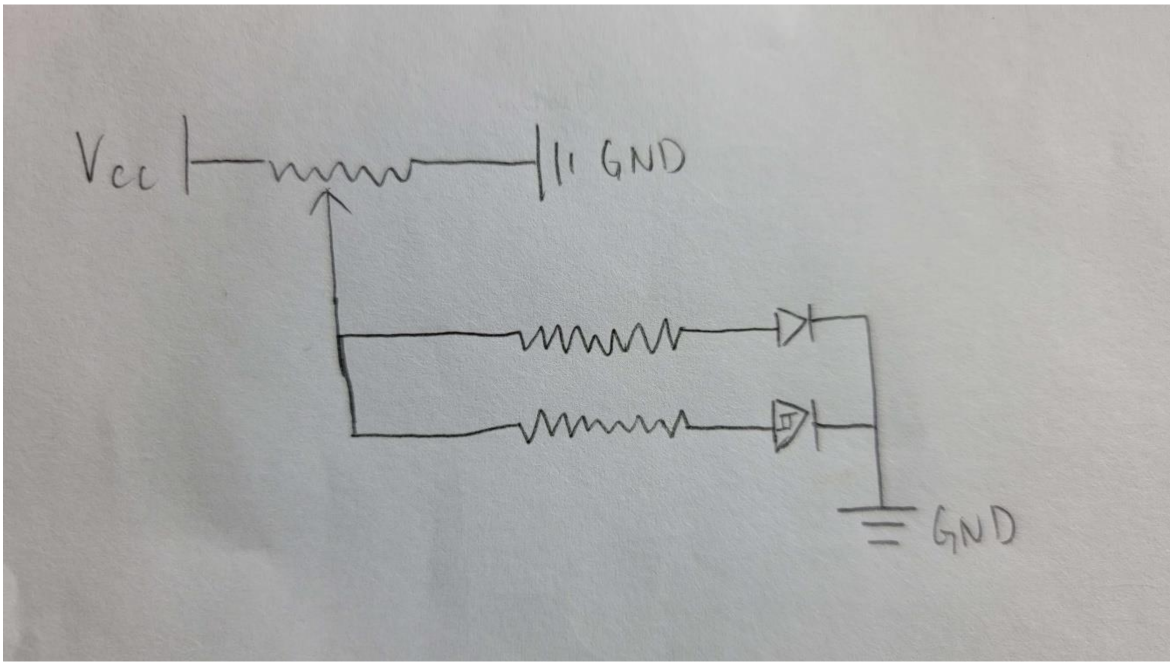
$= (5 - 1.96) / 990 \fallingdotseq 3.07$ mA

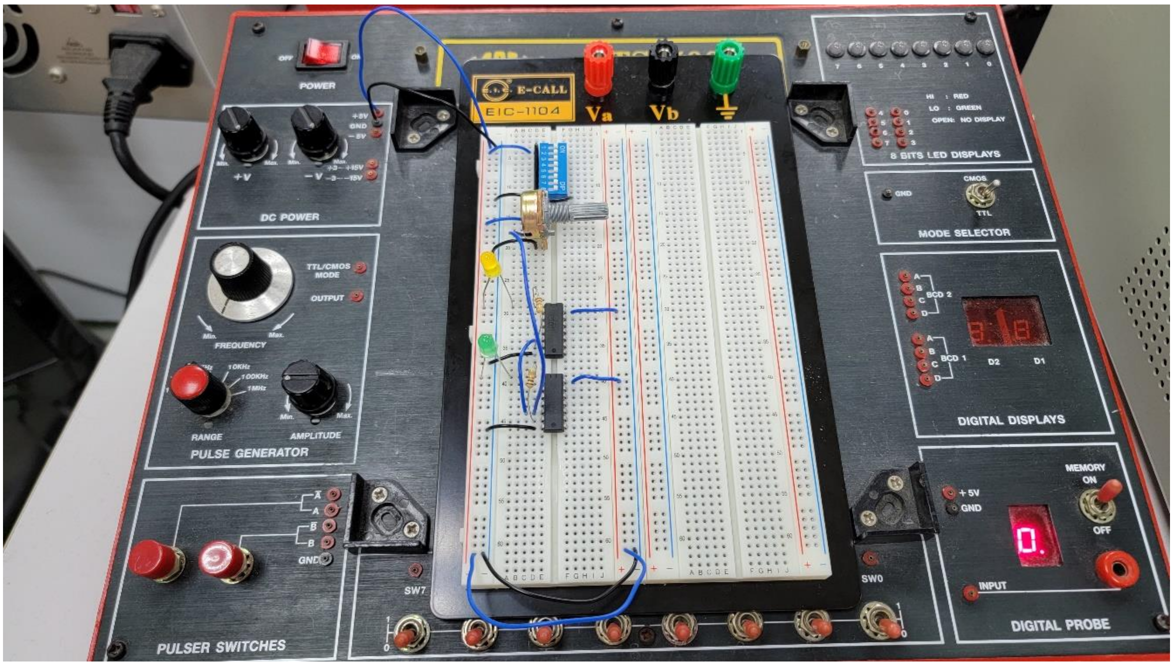
I_{LED} (yellow, calculated) = (5 - V_{LED} (yellow))/ $R_{measured}$

$= (5 - 1.83) / 990 \fallingdotseq 3.20$ mA

The calculated value is a little bit smaller than the value I measured.

(2) Step 3





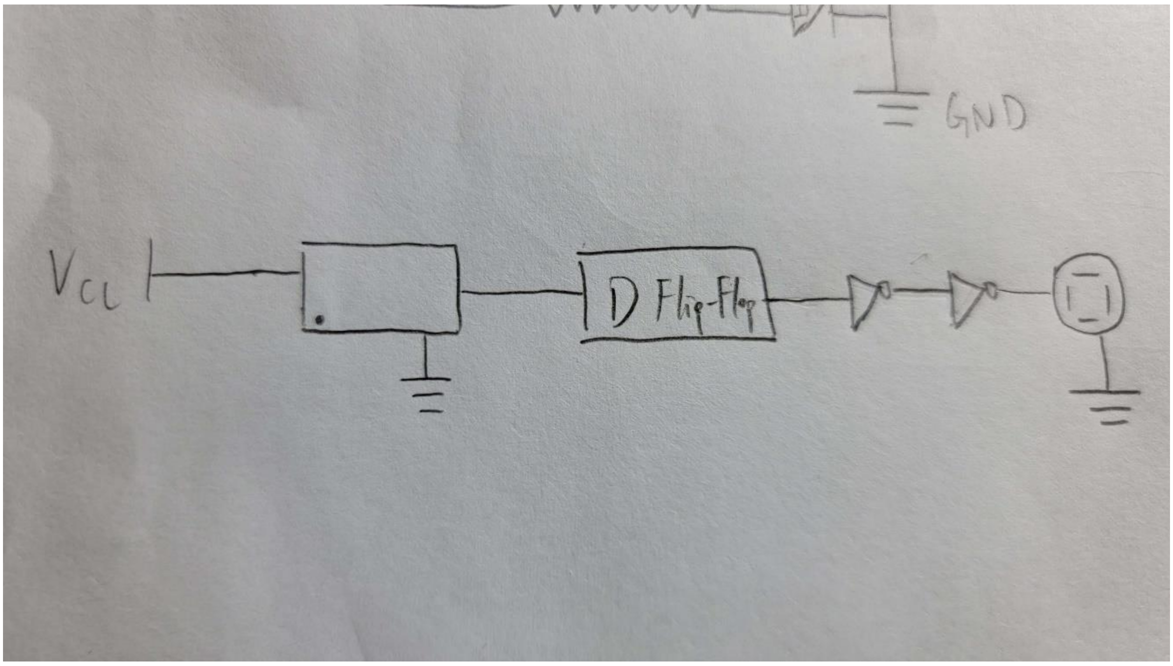
a.

V_{OH}	5.15 V
I_{OH}	3.18 mA
V_{OL}	0.04 V
I_{OL}	0.00 mA

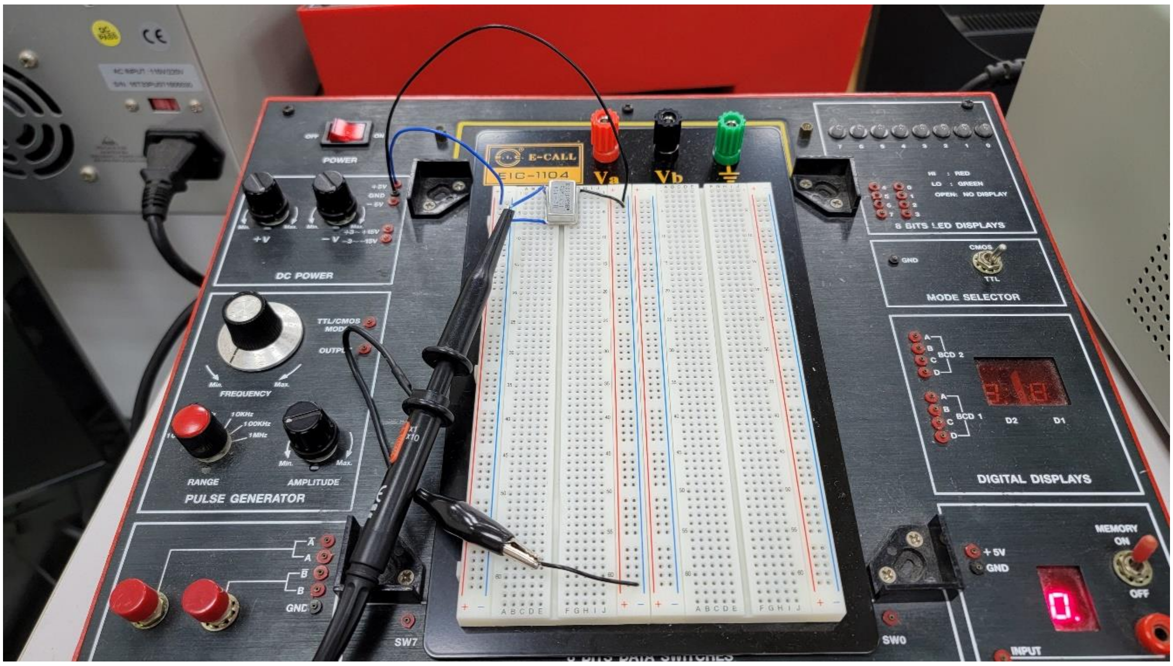
b.

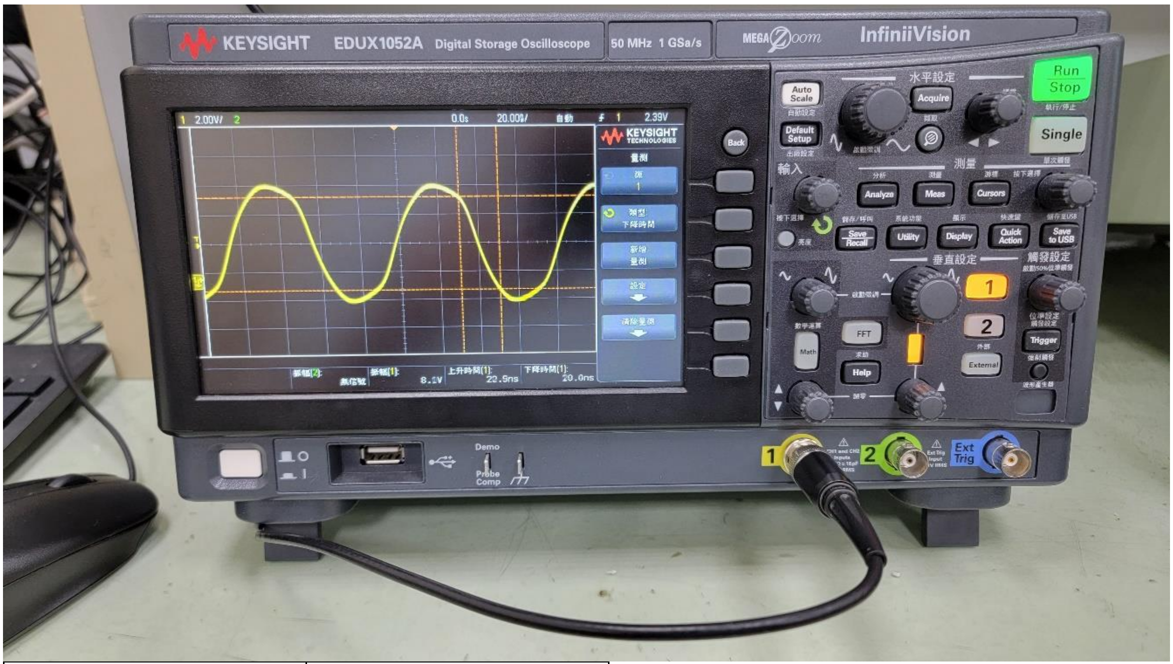
V_T	2.43 V
V_{T-}	2.79 V
V_{T+}	2.20 V

(3) Step 4


GND
Vcc
D Flip-Flop

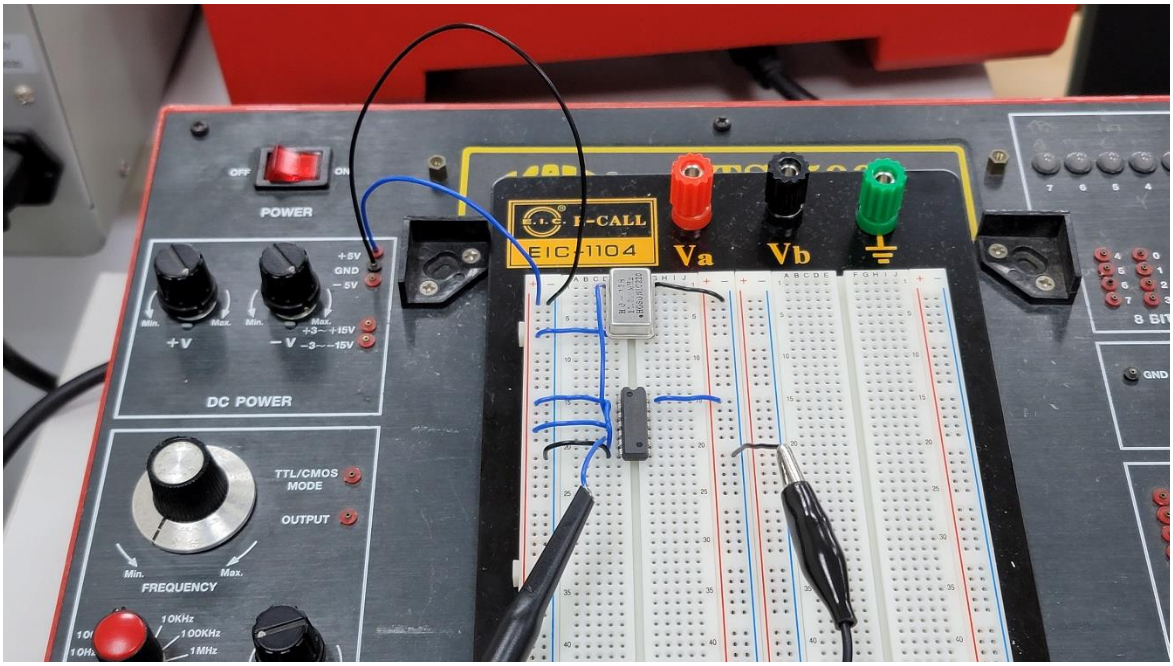
a.

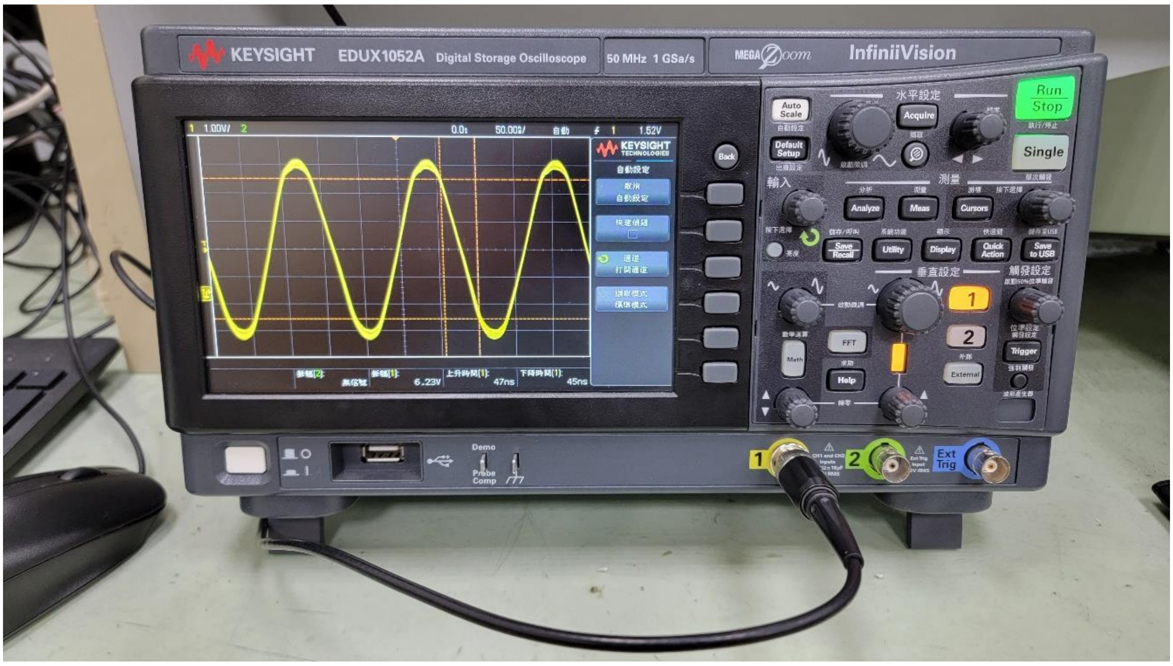

E-CALL
EIC-1104
POWER
DC POWER
FREQUENCY
RANGE
AMPLITUDE
PULSE GENERATOR
MODE SELECTOR
DIGITAL DISPLAYS

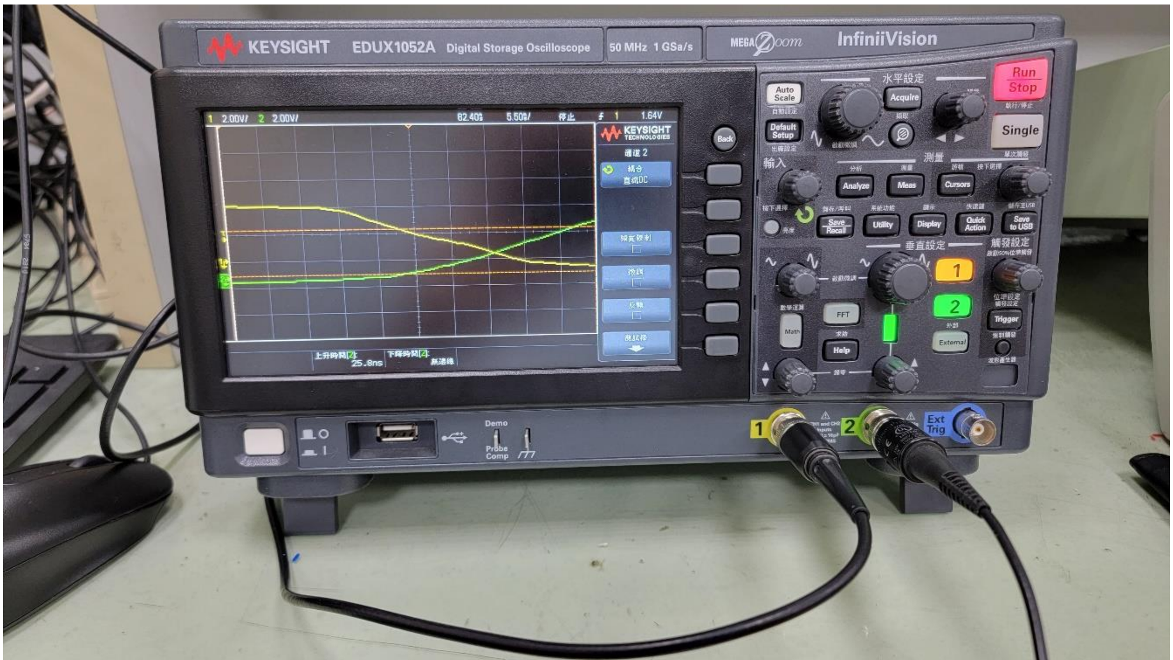


t_{TLH}	21.6 ns
t_{THL}	19.7 ns

b.




KEYSIGHT
EDUX1052A Digital Storage Oscilloscope
50 MHz 1 GSa/s
InfiniiVision
Run Stop
Single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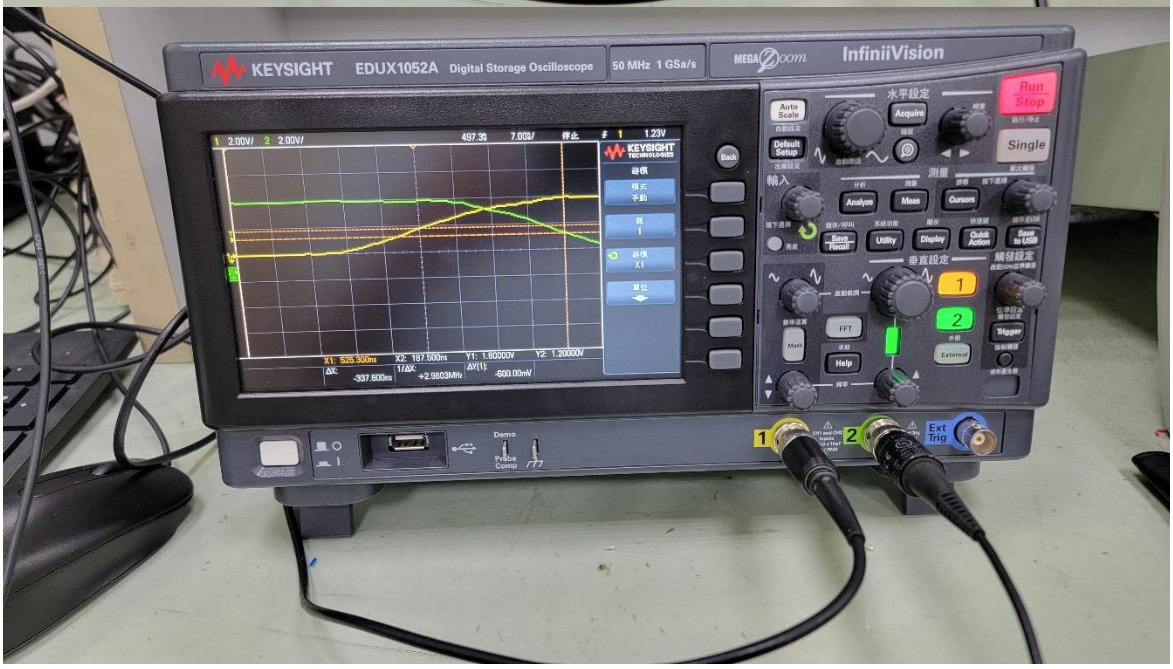
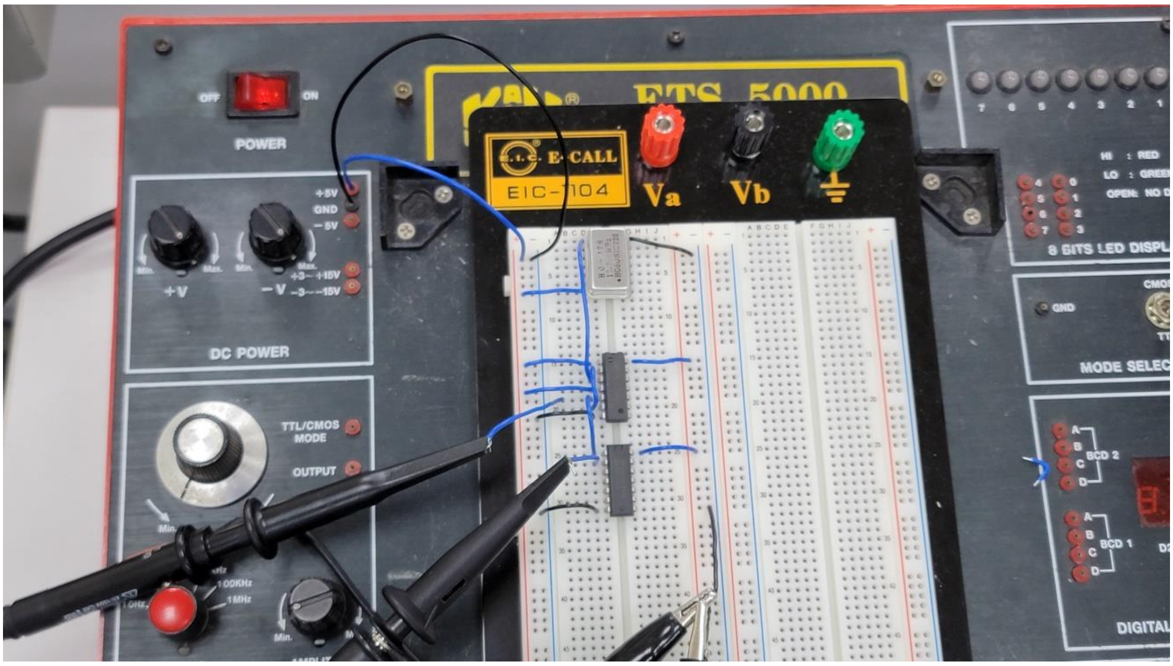
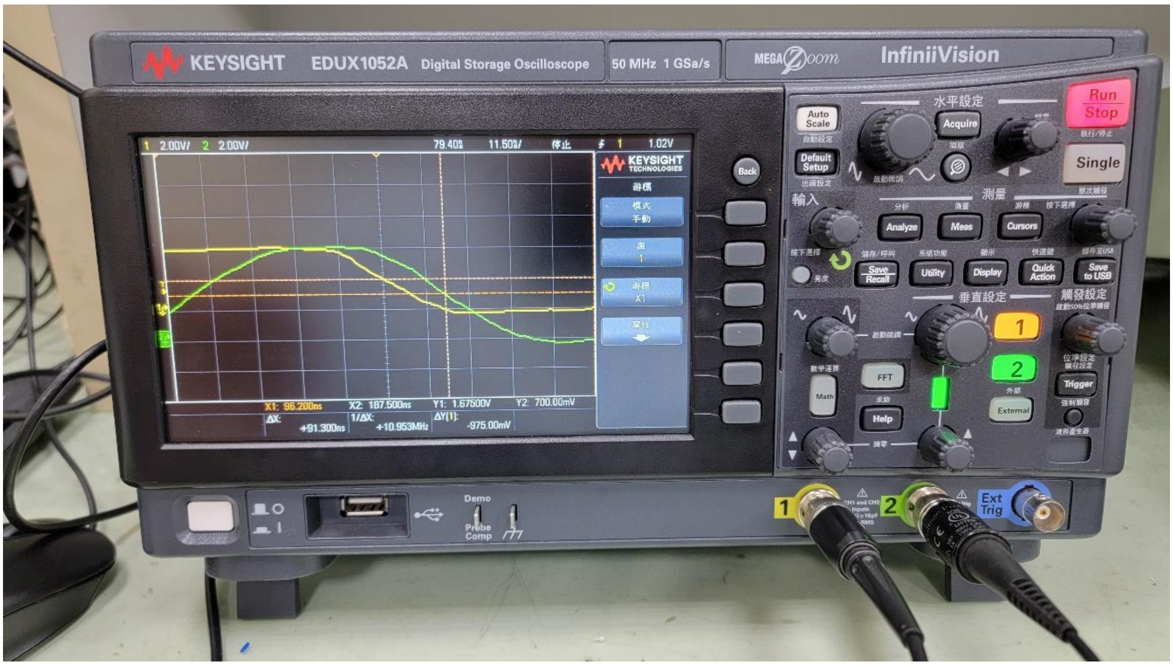
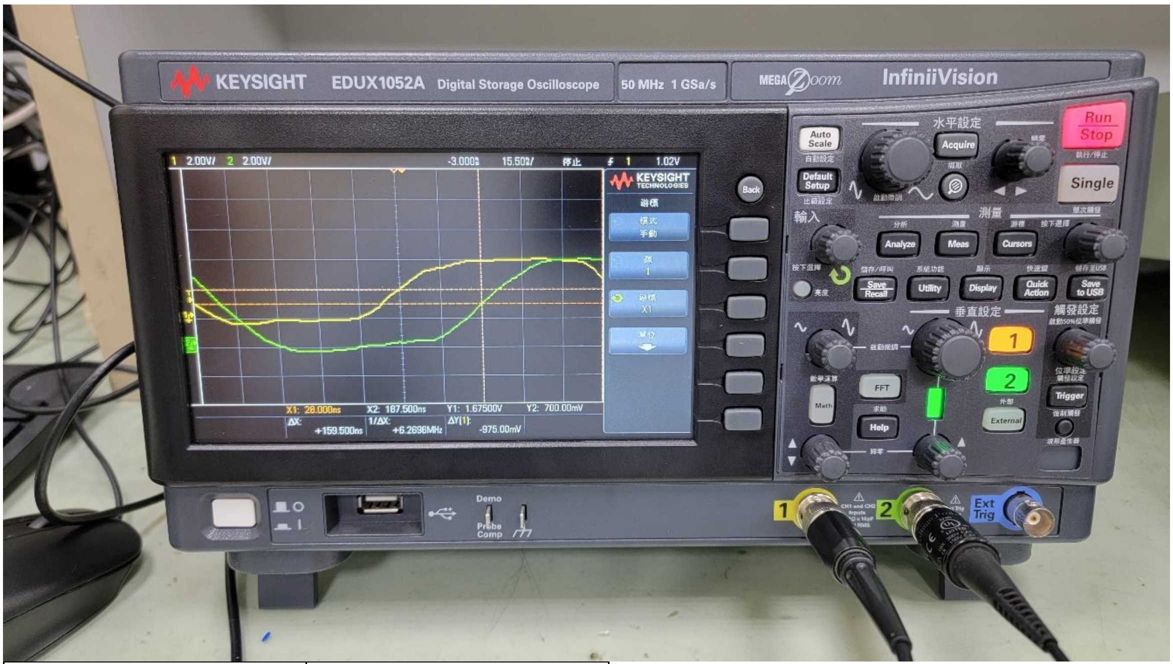

KEYSIGHT
EDUX1052A Digital Storage Oscilloscope
50 MHz 1 GSa/s
InfiniiVision
Run Stop
Single

t_{PLH}	28.0 ns
t_{PHL}	16.0 ns

c.







t_{PLH}	31.0 ns
t_{PHL}	16.8 ns

3. Comments

- Did any of the measurements you made (electrical or timing) vary from what you anticipated? Why or why not?

  The vary of oscillator was fit what I anticipate, since the circuit was used and connected well.

- Describe the procedure you would use to measure the I_{IH} and I_{IL} parameters of a logic gate (illustrate using a schematic).

  If we want to measure I_{IH} and I_{IL}, then we should let oscilloscope and the logic gate in series.

4. Problems & Solutions

N/A

5. Feedback

The content of report is a lot!!!!!