010113026

Digital Logic Lab (L.1)

Lab Instructor: RSP

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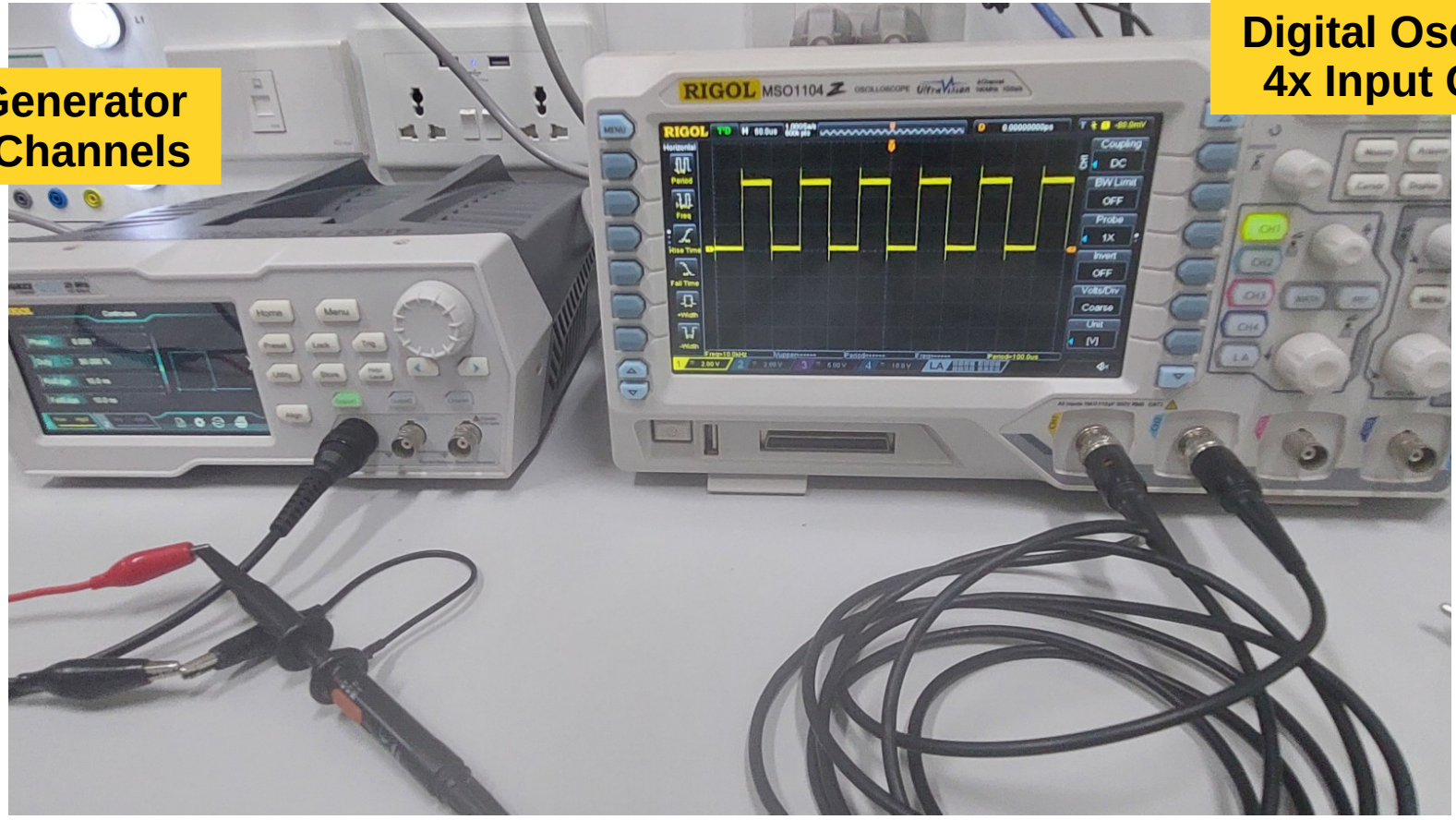
Getting Started with Lab Instruments:

Oscilloscope, Function Generator, and Power Supply

Test & Measurement Instruments

Function Generator
2x Output Channels

Digital Oscilloscope
4x Input Channels

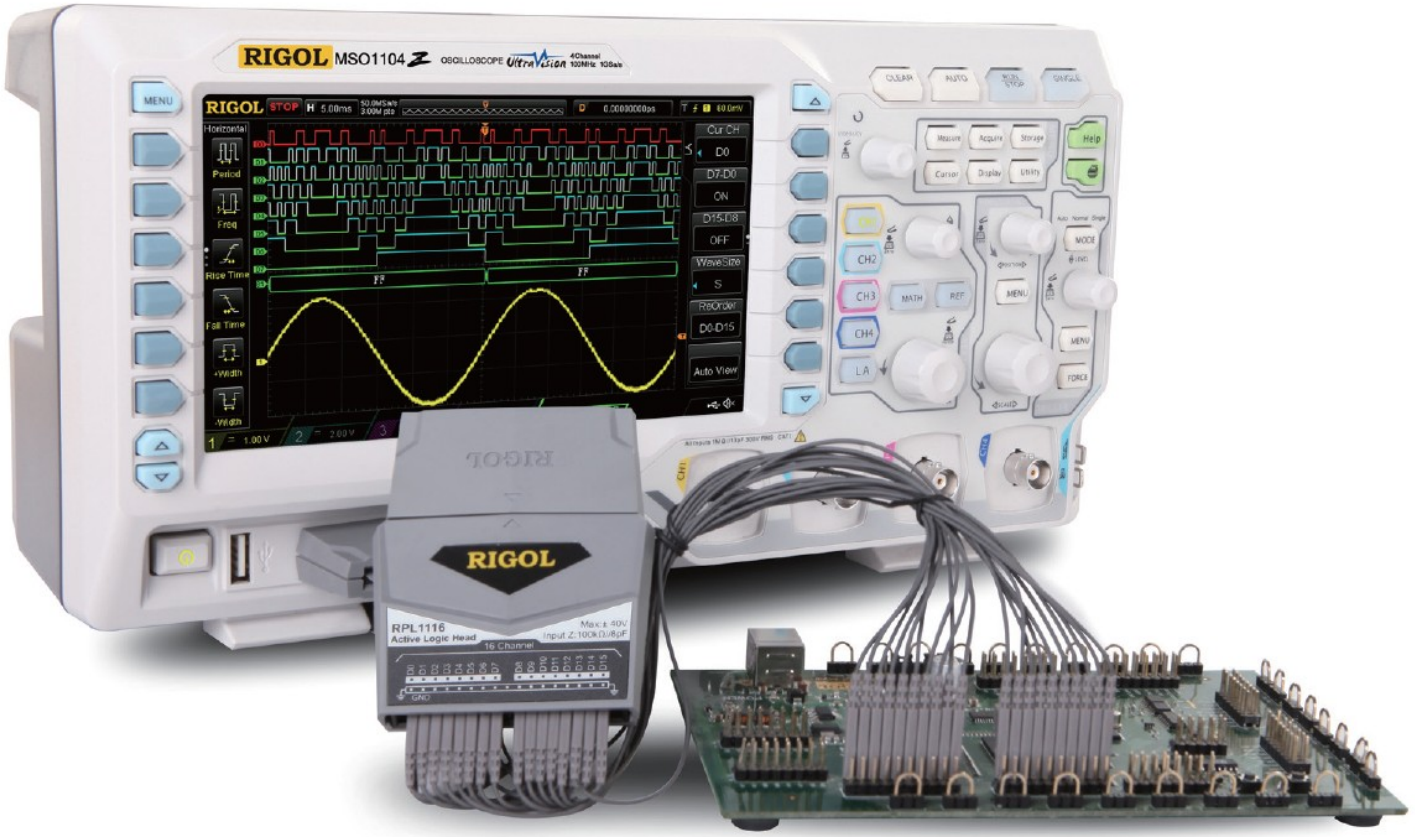


Digital Oscilloscopes

- Used to **measure & analyze electrical signals**.
  - Waveforms: voltage vs. time plot
  - Advanced features: **Protocol analyzer** (UART, SPI, I2C,...)
- Basic types of digital oscilloscopes
  - **Digital Storage Oscilloscopes**
    - Typically with two or four analog input channels
  - **Mixed-Signal Oscilloscopes (MSO)**
    - With a **Logic Analyzer (LA)** connector + 16-channel Probes

https://iot-kmutnb.github.io/blogs/electronics/oscilloscopes/

RIGOL MSO Scope



RIGOL DSO

RIGOL Scope Comparison

Model	DS1054Z	DS1074Z Plus	DS1074Z-S Plus	DS1104Z Plus	DS1104Z-S Plus
		MSO1074Z	MSO1074Z-S	MSO1104Z	MSO1104Z-S
Analog BW	50 MHz	70 MHz		100 MHz	
Number of Analog Channels	4				
Number of Digital Channels	None	16 digital channels for MSO1000Z; MSO upgradable for DS1000Z Plus			
Max. Sample Rate	Analog channel: 1 GSa/s (single-channel), 500 MSa/s (dual-channel), 250 MSa/s (three/four-channel) Digital channel: 1 GSa/s (8-channel), 500 MSa/s (16-channel)				
Max. Memory Depth	Analog channel: standard 12 Mpts (single-channel), 6 Mpts (dual-channel), 3 Mpts (3/4-channel); optional 24 Mpts (single-channel), 12 Mpts (dual-channel), 6 Mpts (3/4-channel) Digital channel(MSO): standard 12 Mpts (8-channel), 6 Mpts (16-channel); optional 24 Mpts (8-channel), 12 Mpts (16-channel)				
Max. Waveform Capture Rate	30,000 wfms/s				
Hardware Real-time Waveform Recording and Playback Functions	Up to 60,000 frames (optional)				
Std. Probes	PVP2150 150 MHz Passive HighZ Probe: 4 sets; 1 set RPL1116 LA Probe for MSO1XX4Z/1XX4Z-S				
Built-in 2Ch 25MHz Source	No		Yes	No	Yes

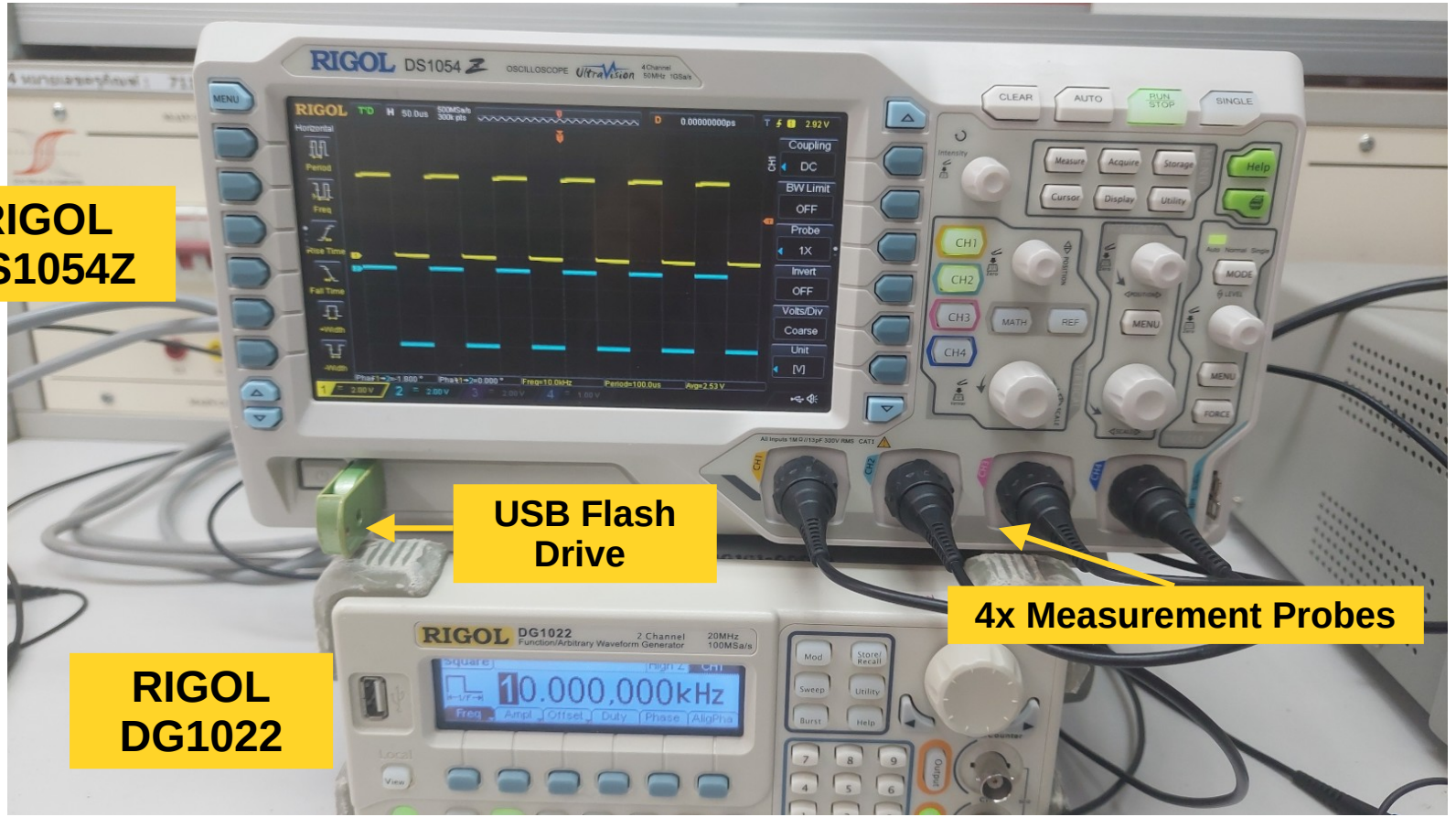
Function Generators

- Used to **generate electrical signals** of basic types:
  - Mostly **periodic signals**
  - Common **waveforms**: sinusoidal, triangular, rectangular, PWM.
  - More advanced: modulated signals, random or noise signals.
- Typically with t**wo independent output channels**.
- Signal parameter settings
  - **Amplitude** (peak-to-peak or low and high voltage levels)
  - **Frequency** or **Period**
  - **Phase shift**

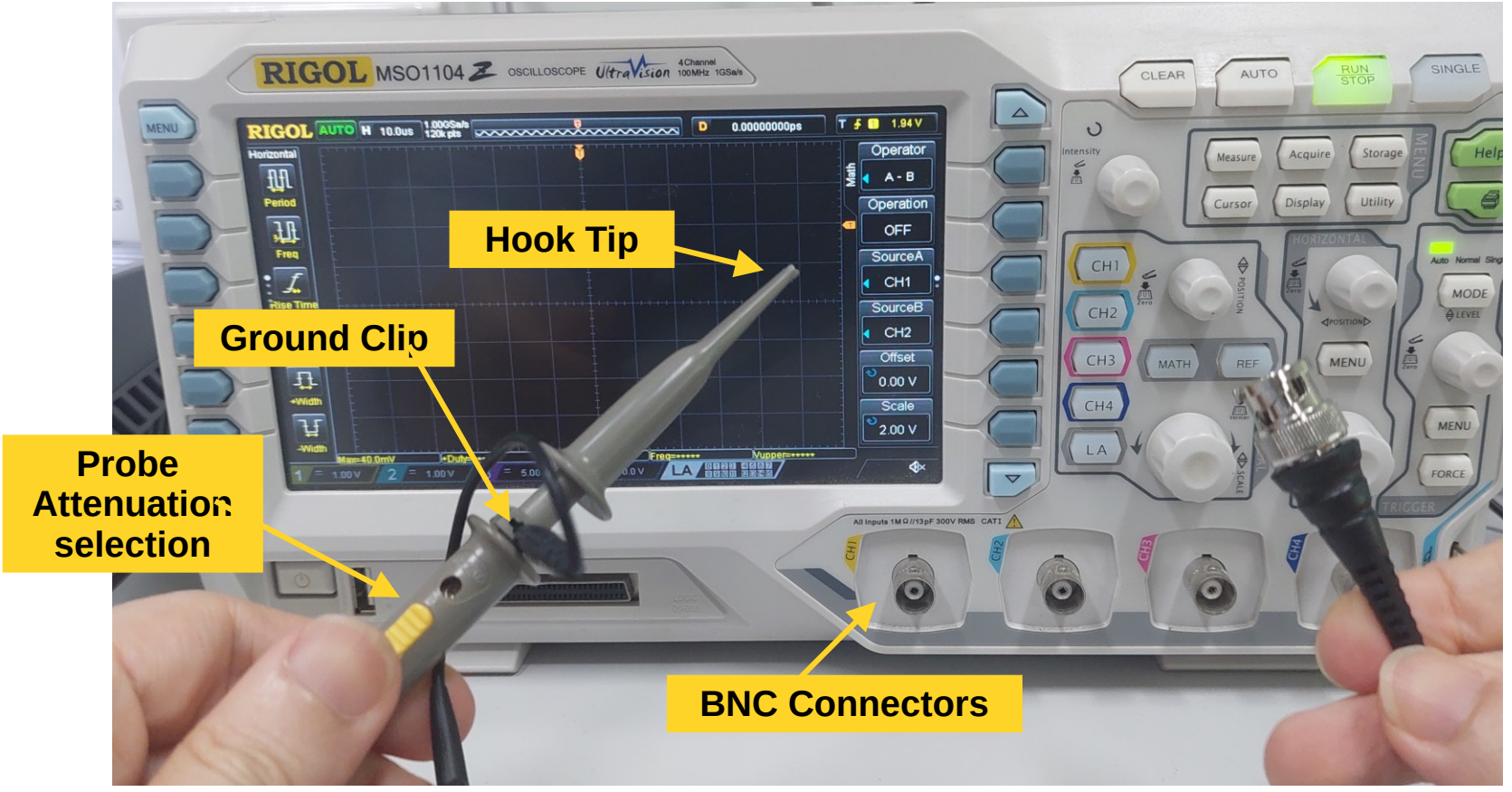
DC Power Supply

- Used to **provide DC supply voltage(s)** to the circuit under test.
  - For digital circuits: only positive DC voltages.
  - Voltage levels used depend on IC standards
    - 3.3V-LVCMOS or 5V-TTL as examples
  - For analog circuits: typically both positive and negative voltages (e.g. +/-9V or +/-12V rails).
- With current-limit (over-current protection) function.

Scope + Signal Generator: RIGOL

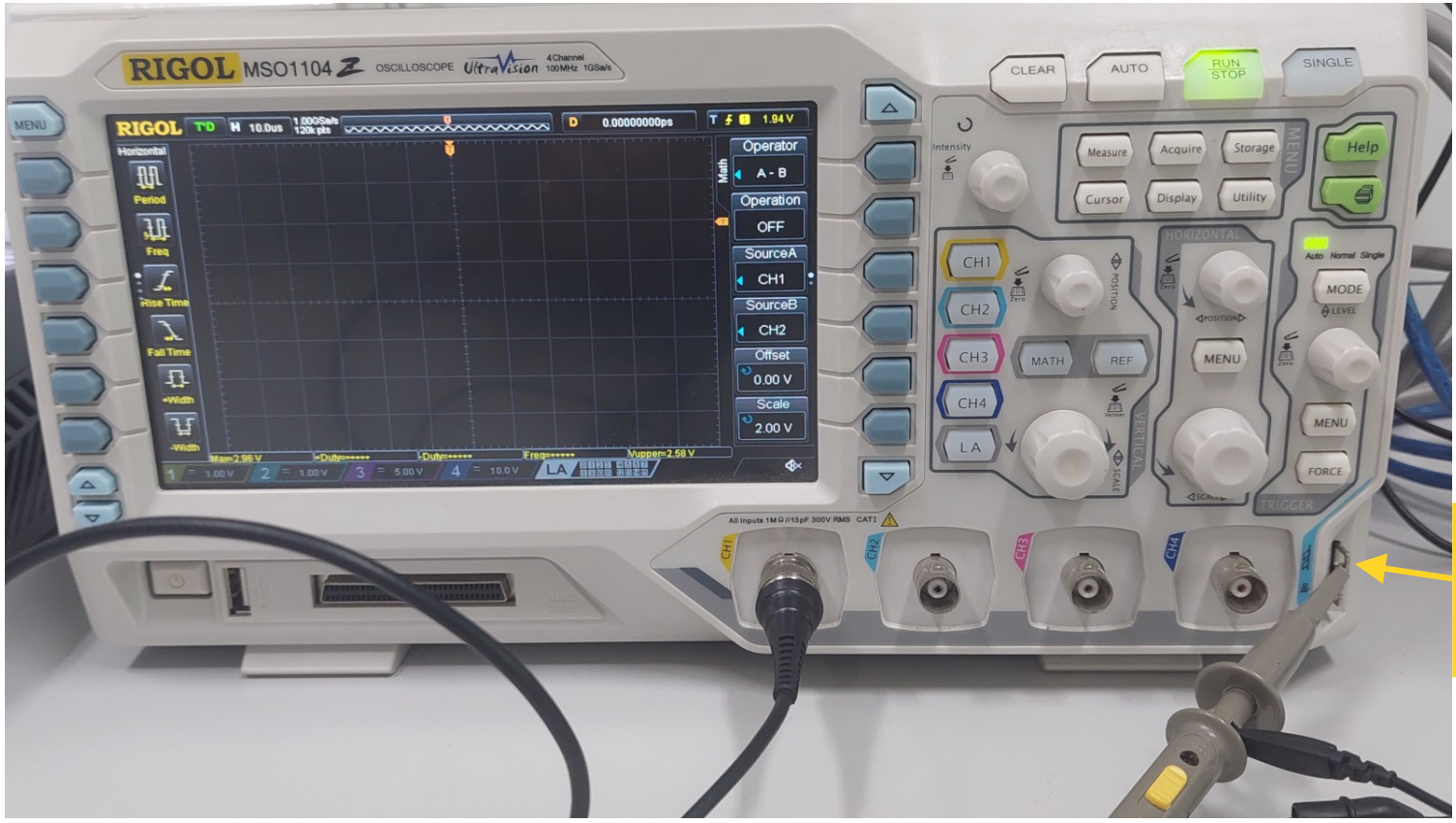


RIGOL MSO1104Z

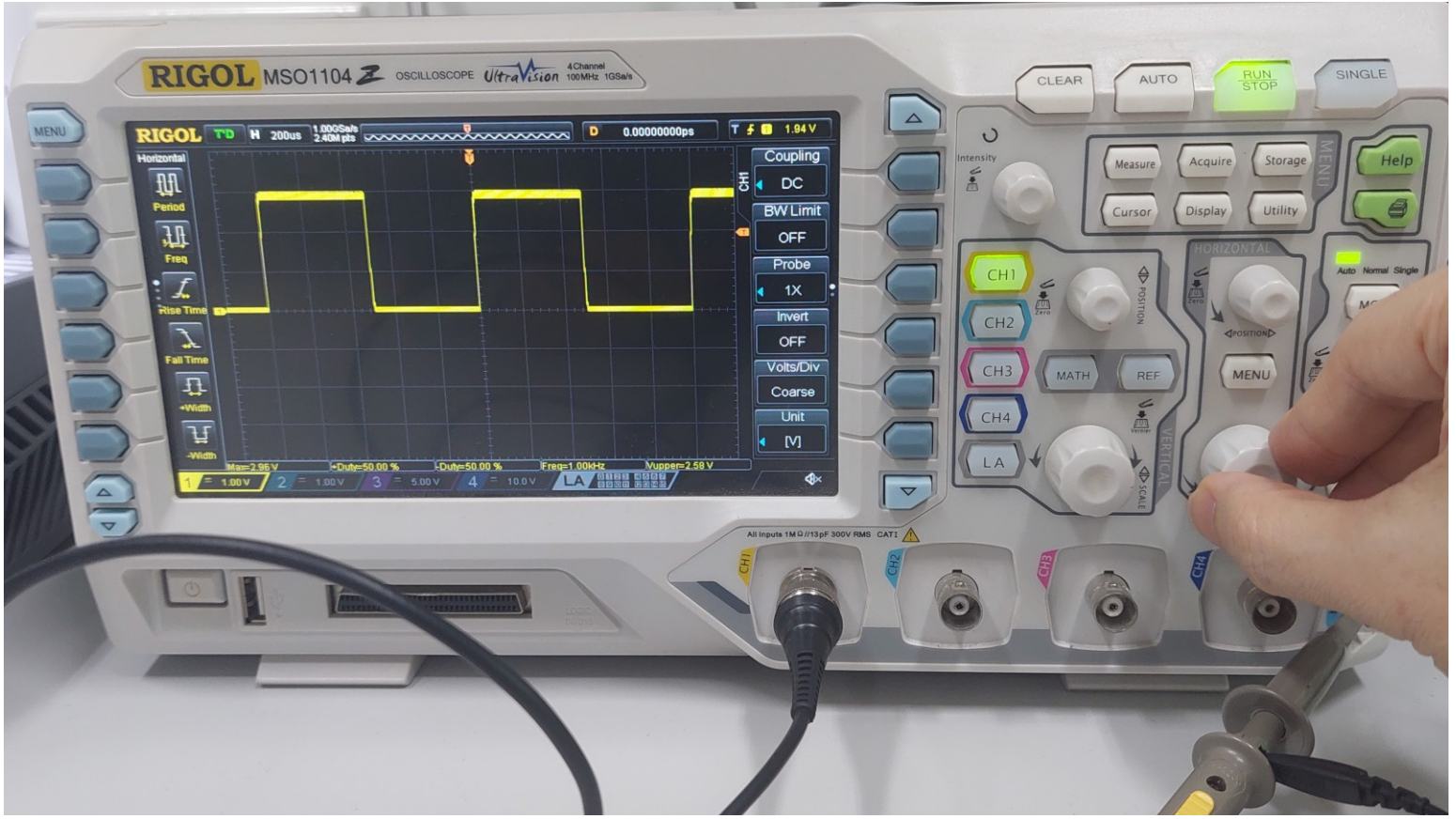


RIGOL MSO1104Z

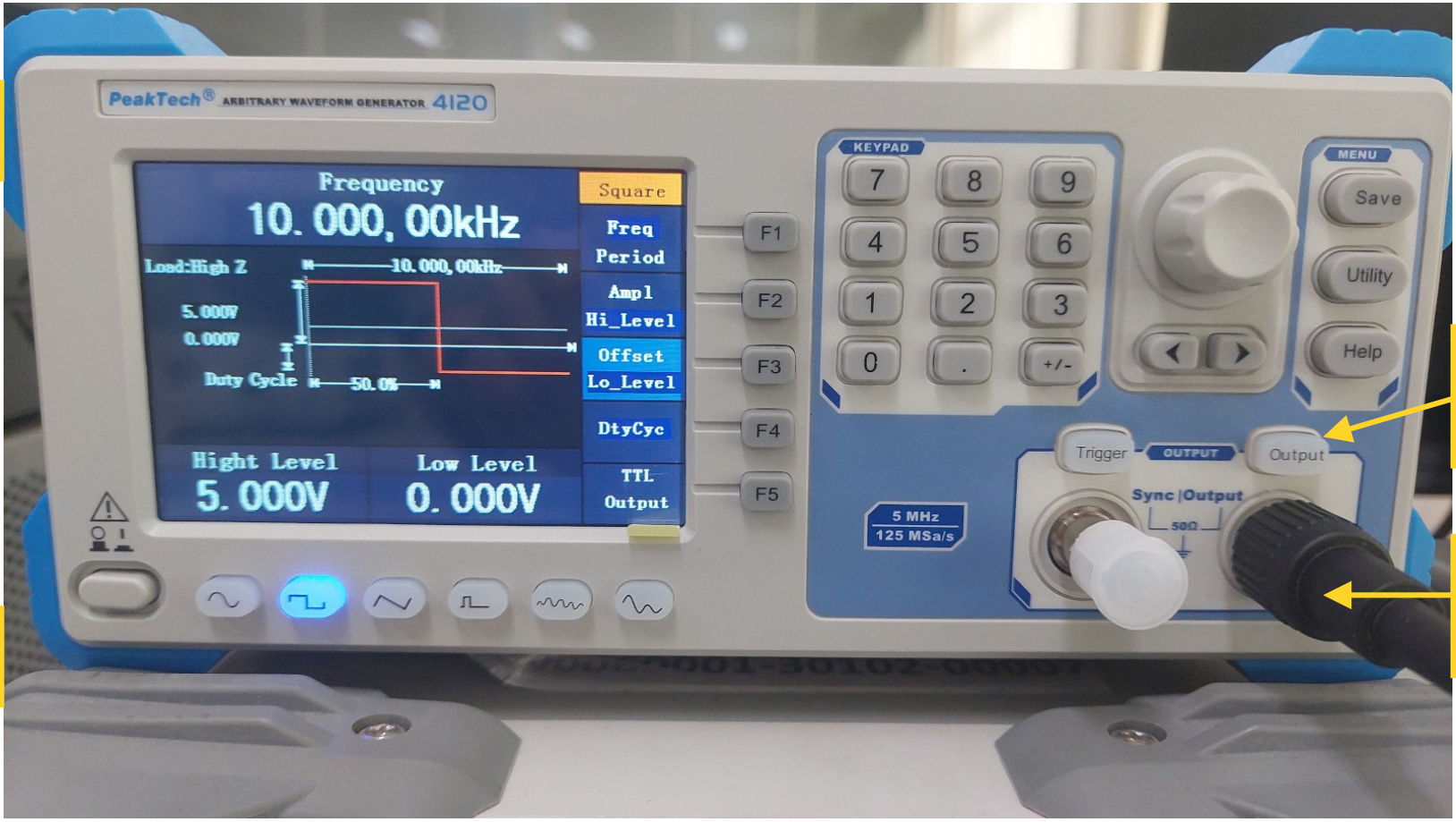
Built-in Test Signal



Built-in Test Signal



Function Generator: PeakTech



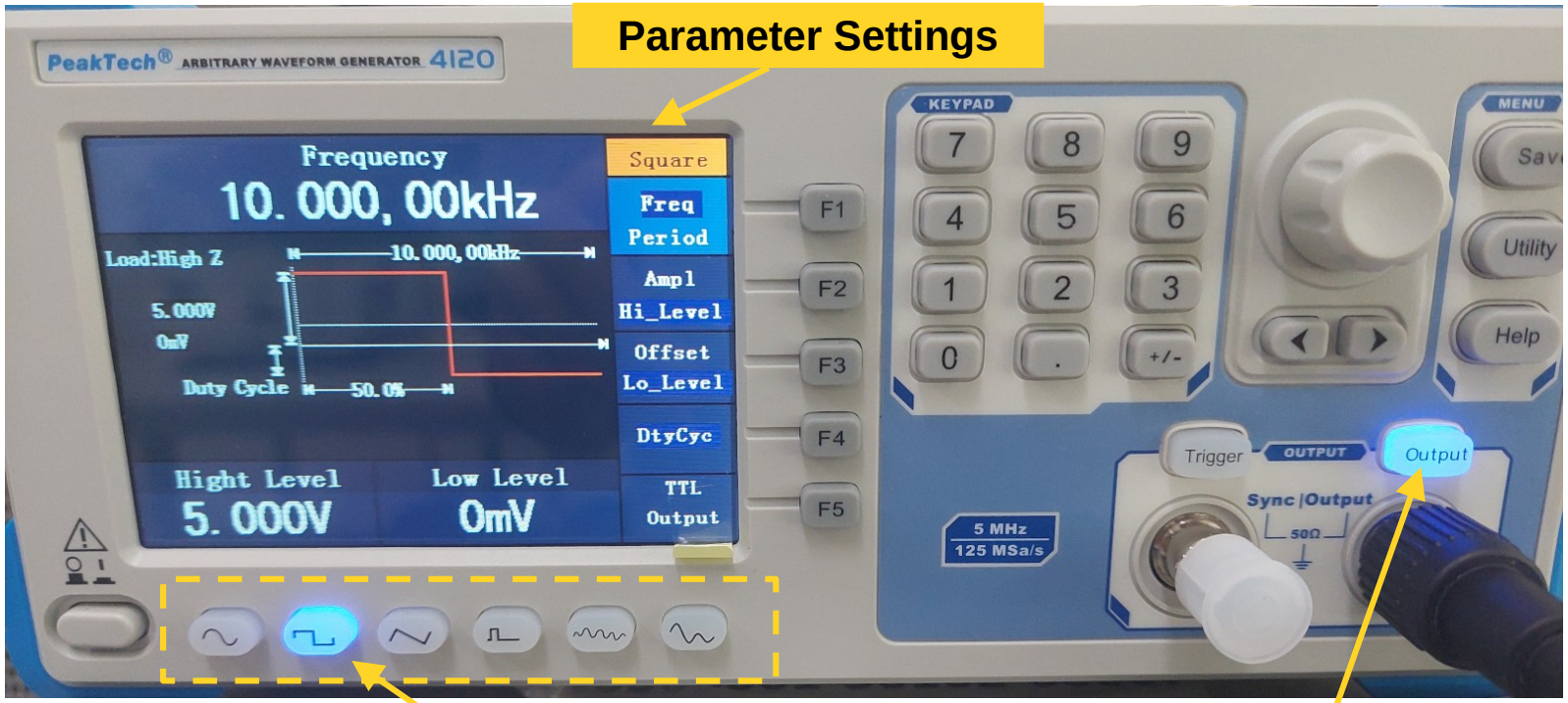
PeakTech 4120

Function Generator

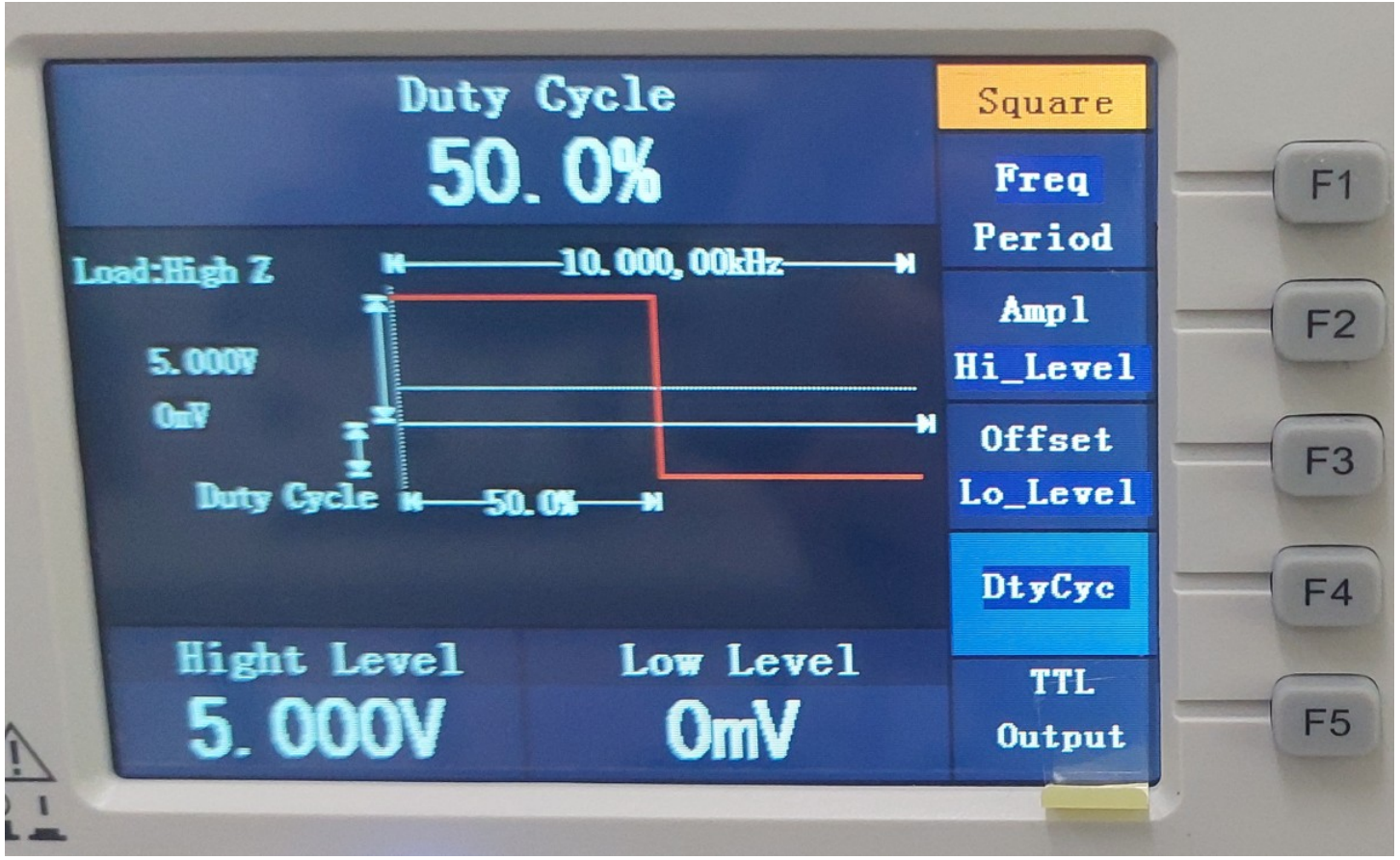
Toggle Button for Output

Single Output Channel

Function Generator: PeakTech



Parameter Settings for Square Wave



Frequency or Period

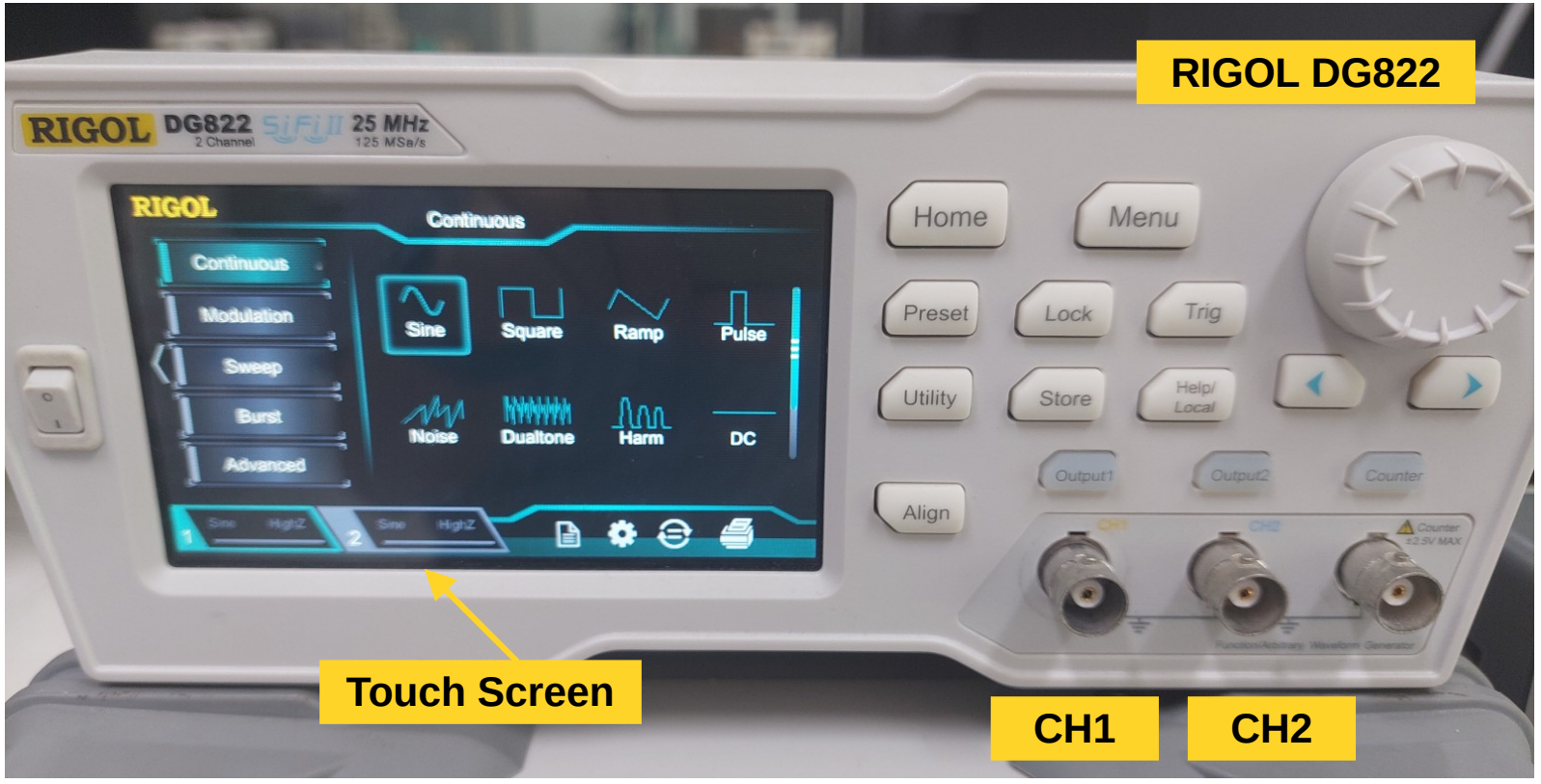
Amplitude or High Level

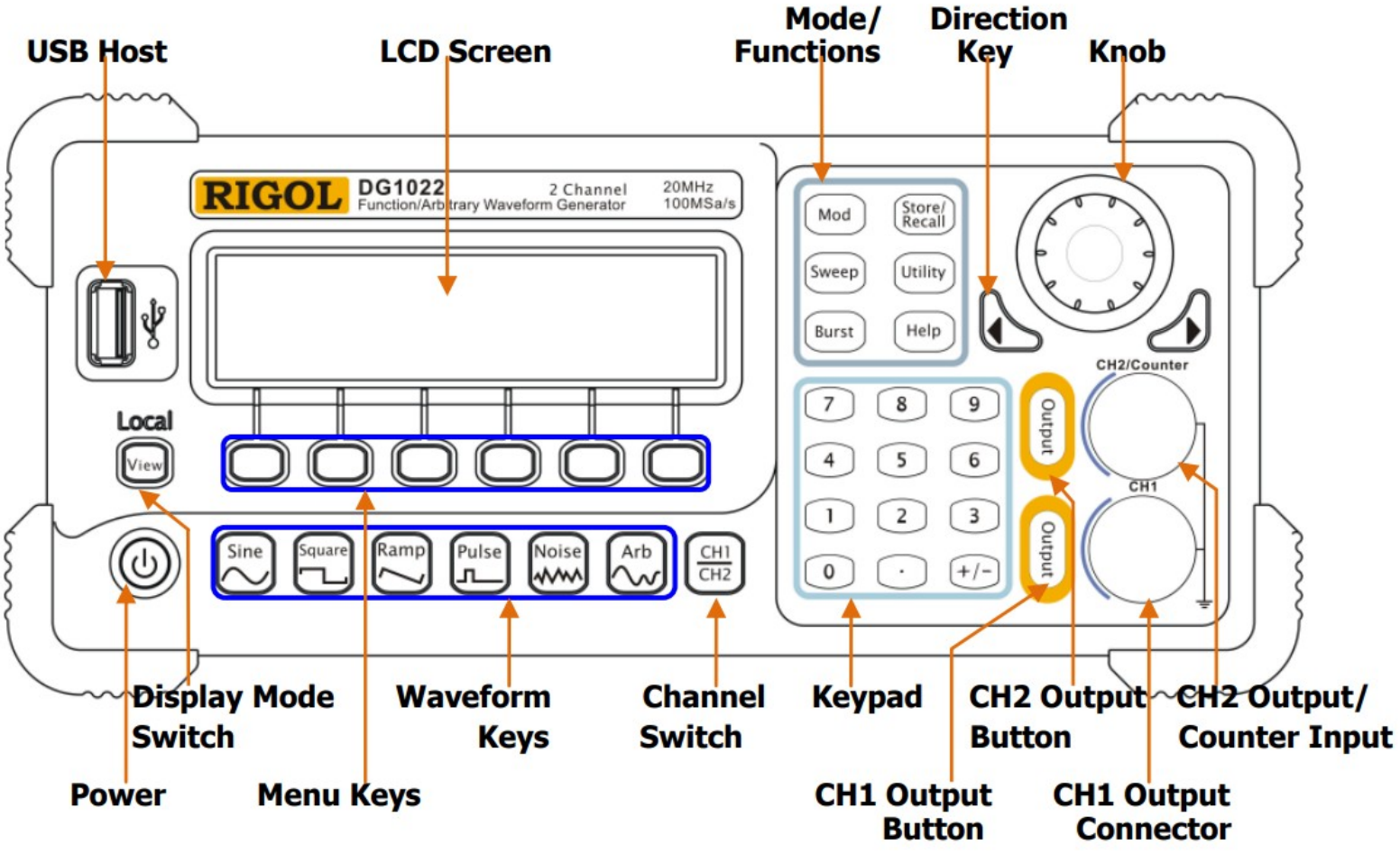
DC Offset or Low Level

Duty Cycle

TTL Output

Function Generator: RIGOL




USB Host
LCD Screen
Mode/
Functions
Direction
Key
Knob
RIGOL
DG1022
2 Channel
Function/Arbitrary Waveform Generator
20MHz
100MSa/s
Mod
Store/
Recall
Sweep
Utility
Burst
Help
CH2/Counter
Local
View
7
8
9
4
5
6
1
2
3
0
·
+/-
Output
Output
CH1
Sine
Square
Ramp
Pulse
Noise
Arb
CH1
CH2
Display Mode
Switch
Waveform
Keys
Channel
Switch
Keypad
CH2 Output
Button
CH2 Output/
Counter Input
Power
Menu Keys
CH1 Output
Button
CH1 Output
Connector

Analog DC Power Supply

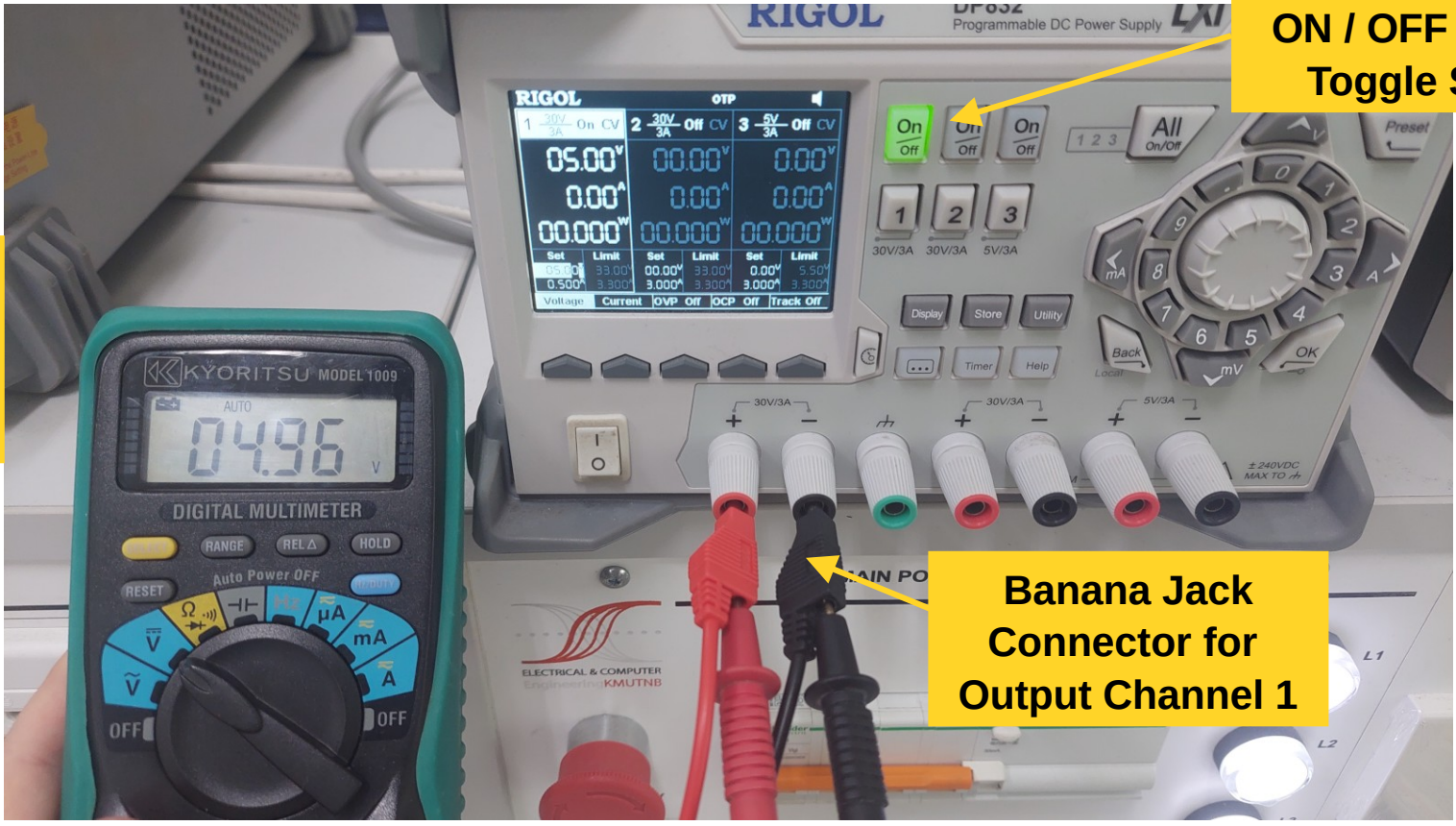
Power Supply
2x Output Channels

Programmable DC Power Supply

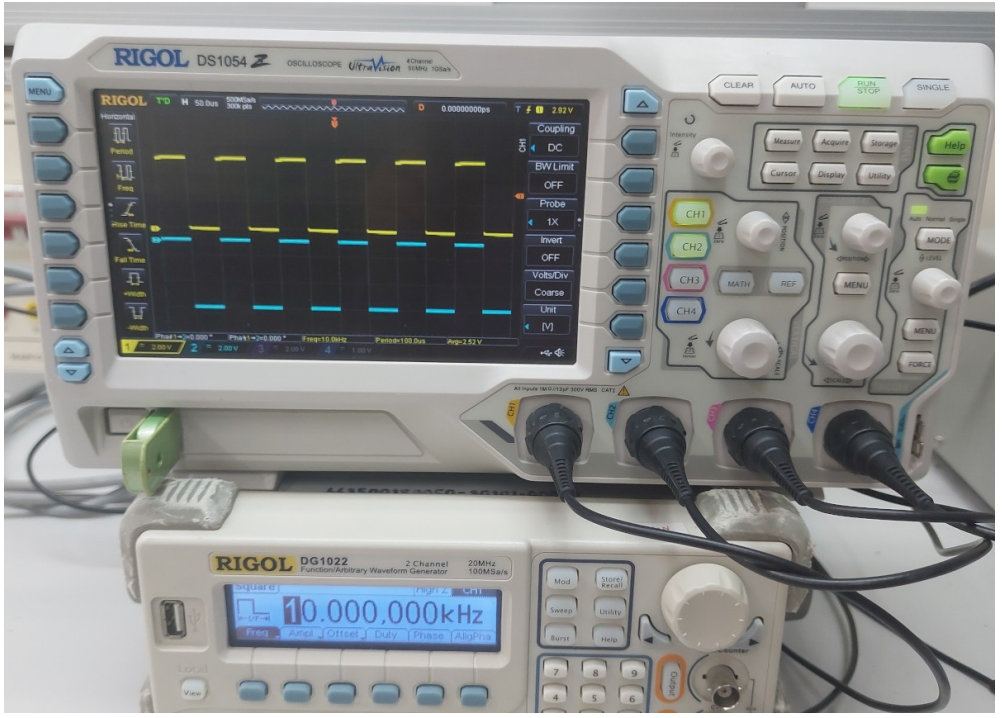
Programmable Power Supply
3x Output Channels

Programmable DC Power Supply

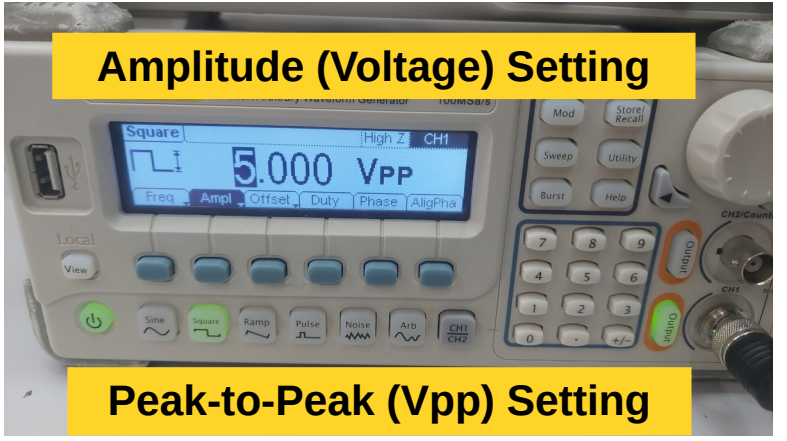
Using a DMM To measure and check the output voltage.



Square Waveform Configuration

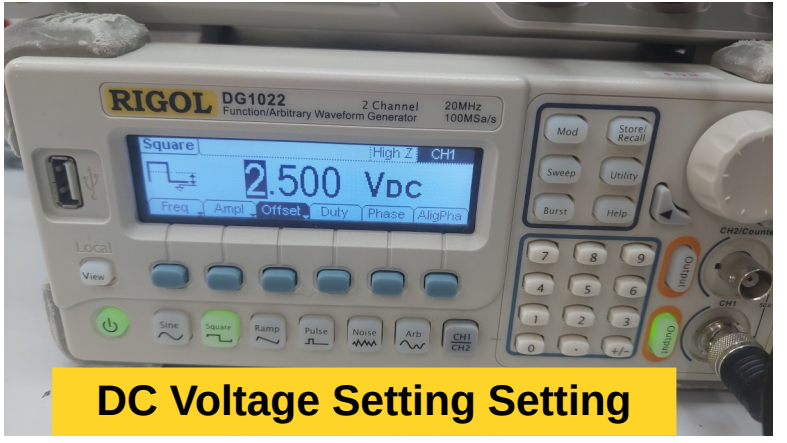


Frequency Setting (10KHz)



Amplitude (Voltage) Setting

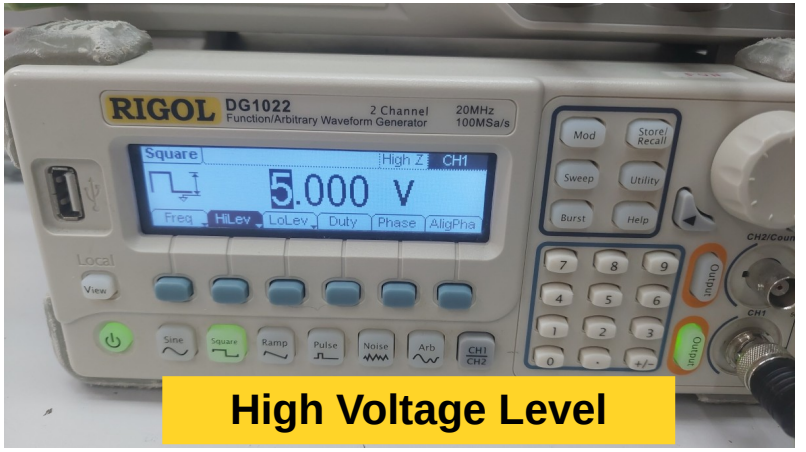
Peak-to-Peak (Vpp) Setting



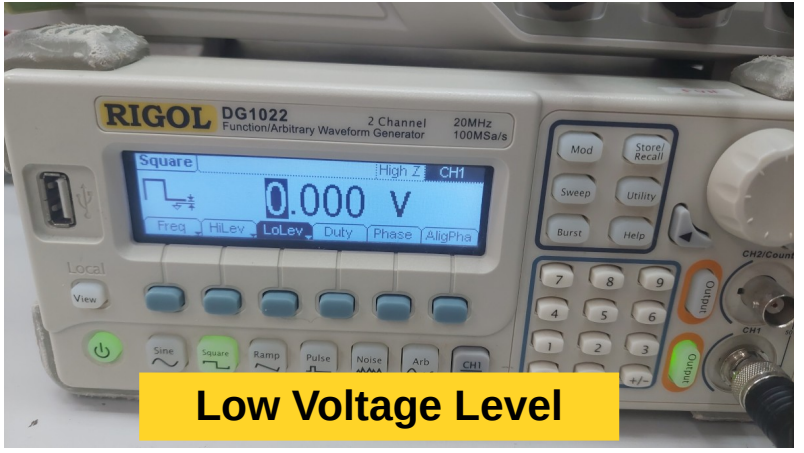
DC Voltage Setting Setting

Square Waveform Configuration

Amplitude (Voltage) Setting

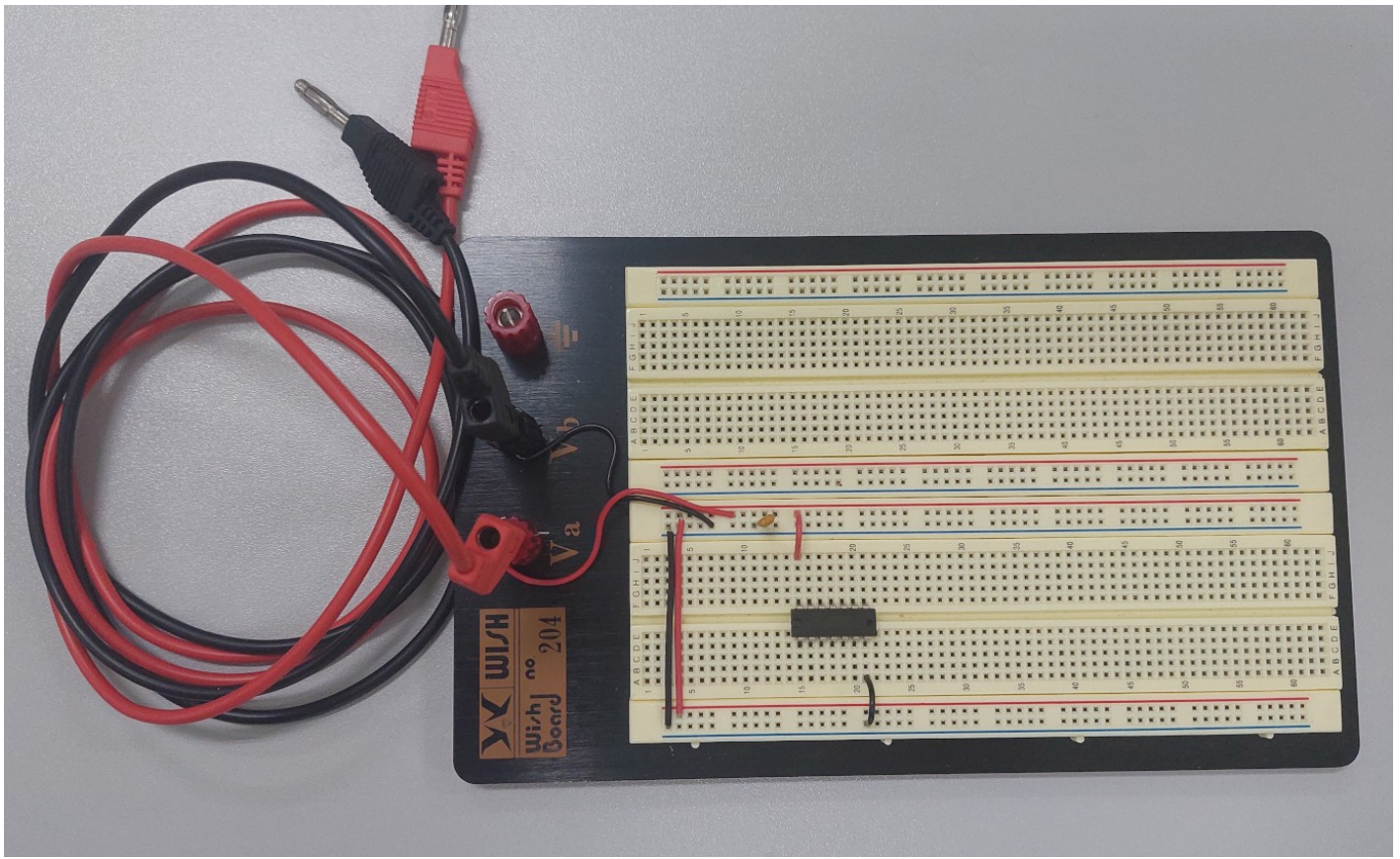


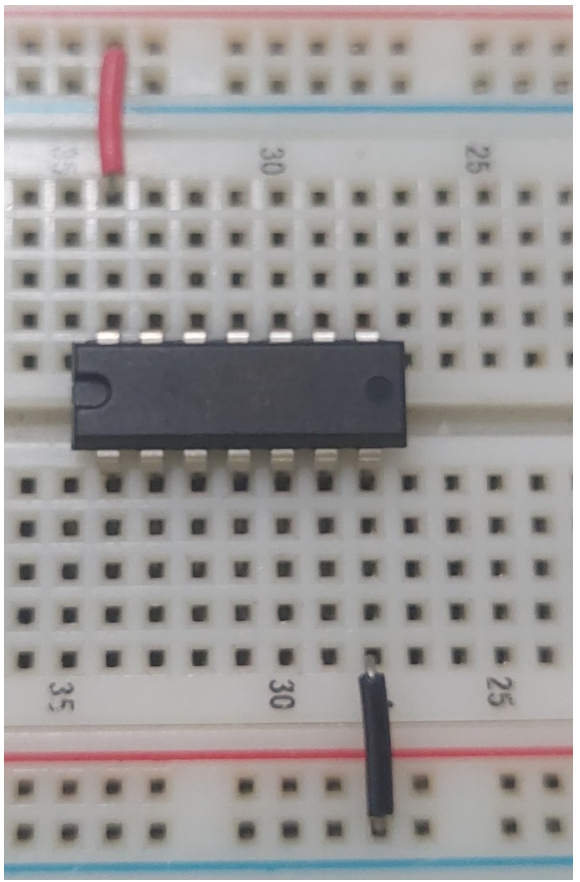
High Voltage Level



Low Voltage Level

Supply Voltage: Connectors & Wires



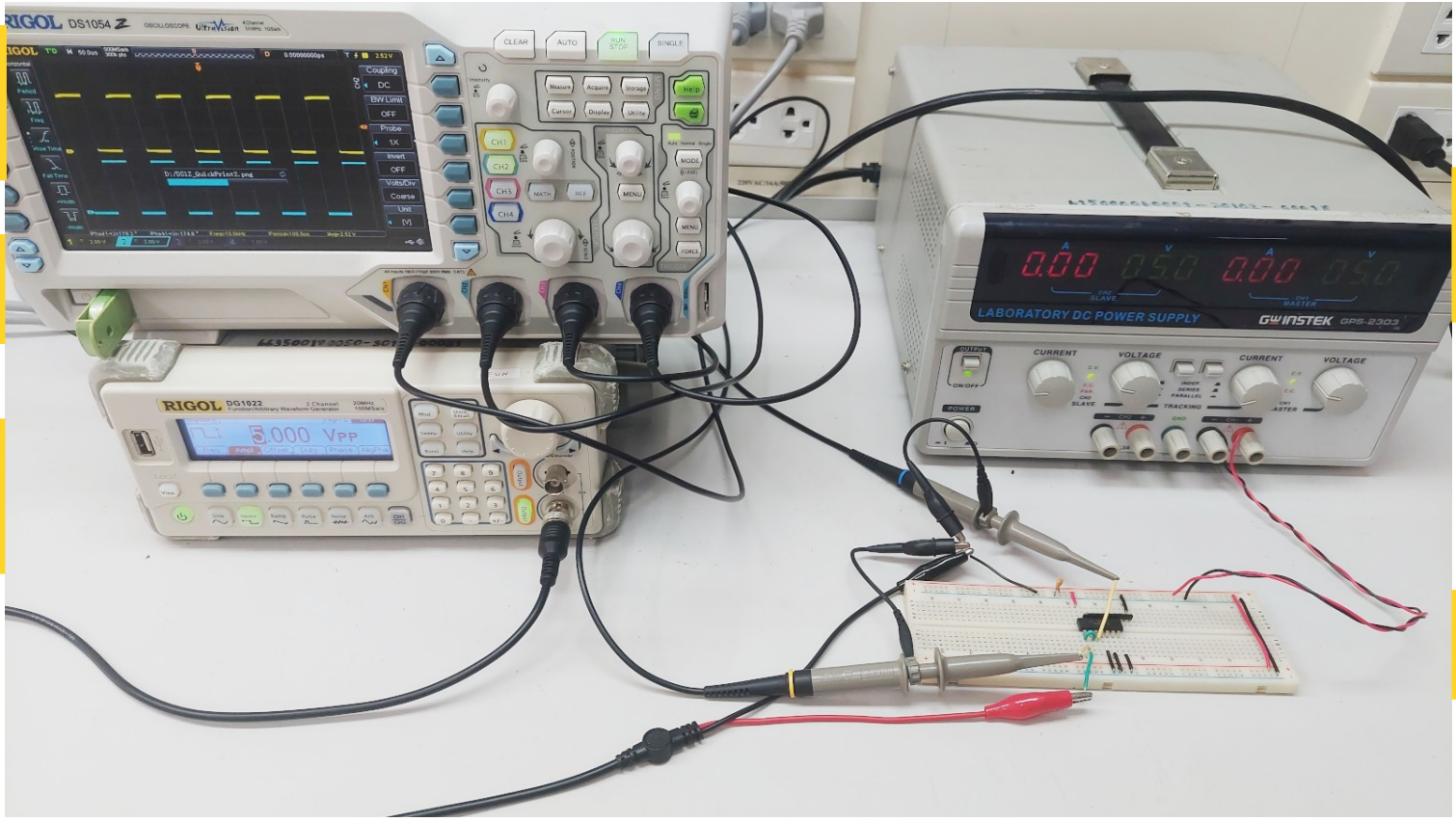


Measurement Setup

Digital I/O Signal Measurement

CH1: Input
CH2: Output

Test Input Signal Generation



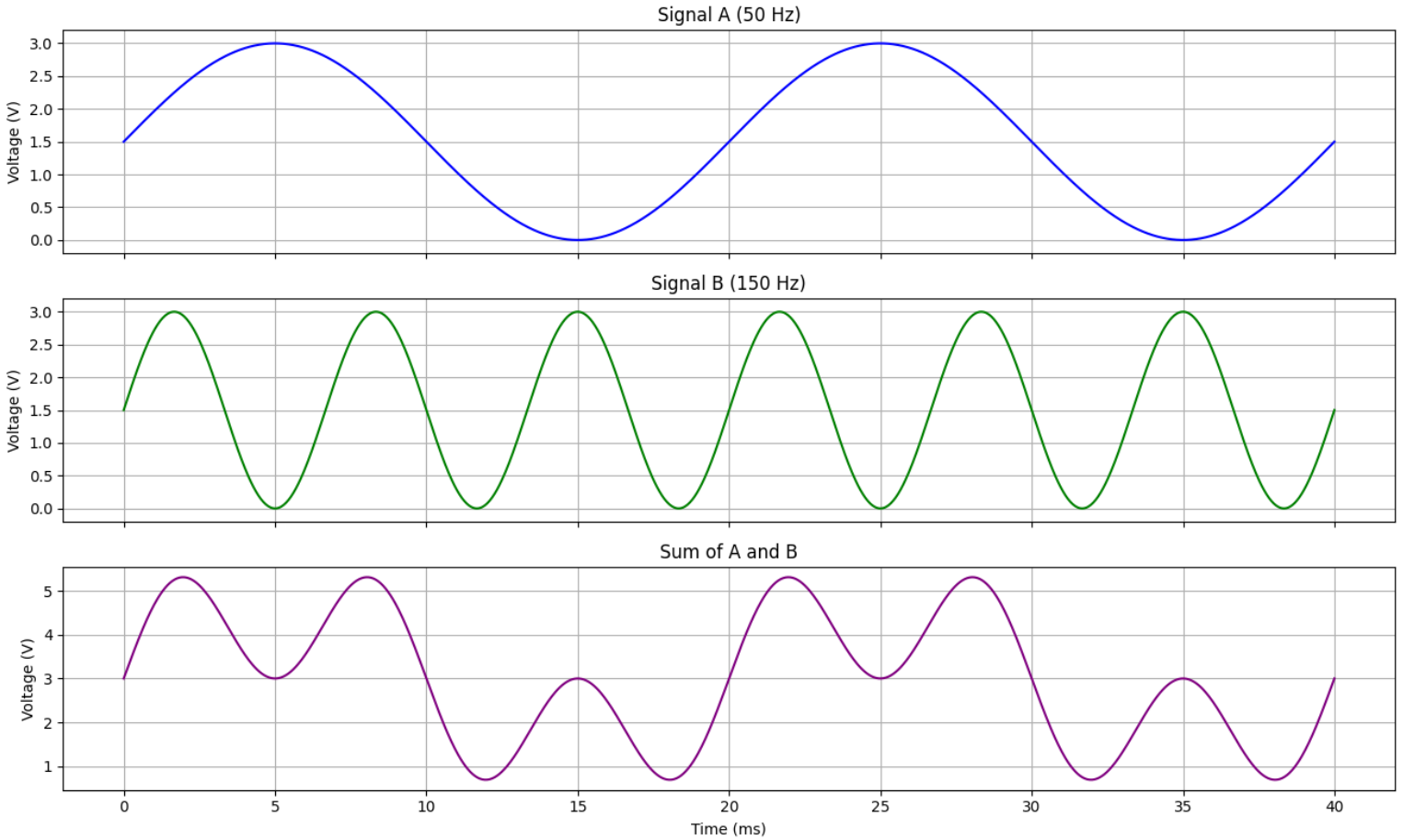
+5VDC Voltage Supply

Logic IC Breadboard

Task 1: Signal Generation

- Generate **two sinusoidal test signals (A and B)** using a function generator, as illustrated in the provided figure (see the next page).
- Connect the test signals to the **CH1** and **CH2** input channels of a digital oscilloscope.
- Use the **MATH mode's ADD function** to display the sum of **A** and **B**.
- Ensure the **Time/Div and Volt/Div settings** are properly configured for clear waveform visualization.

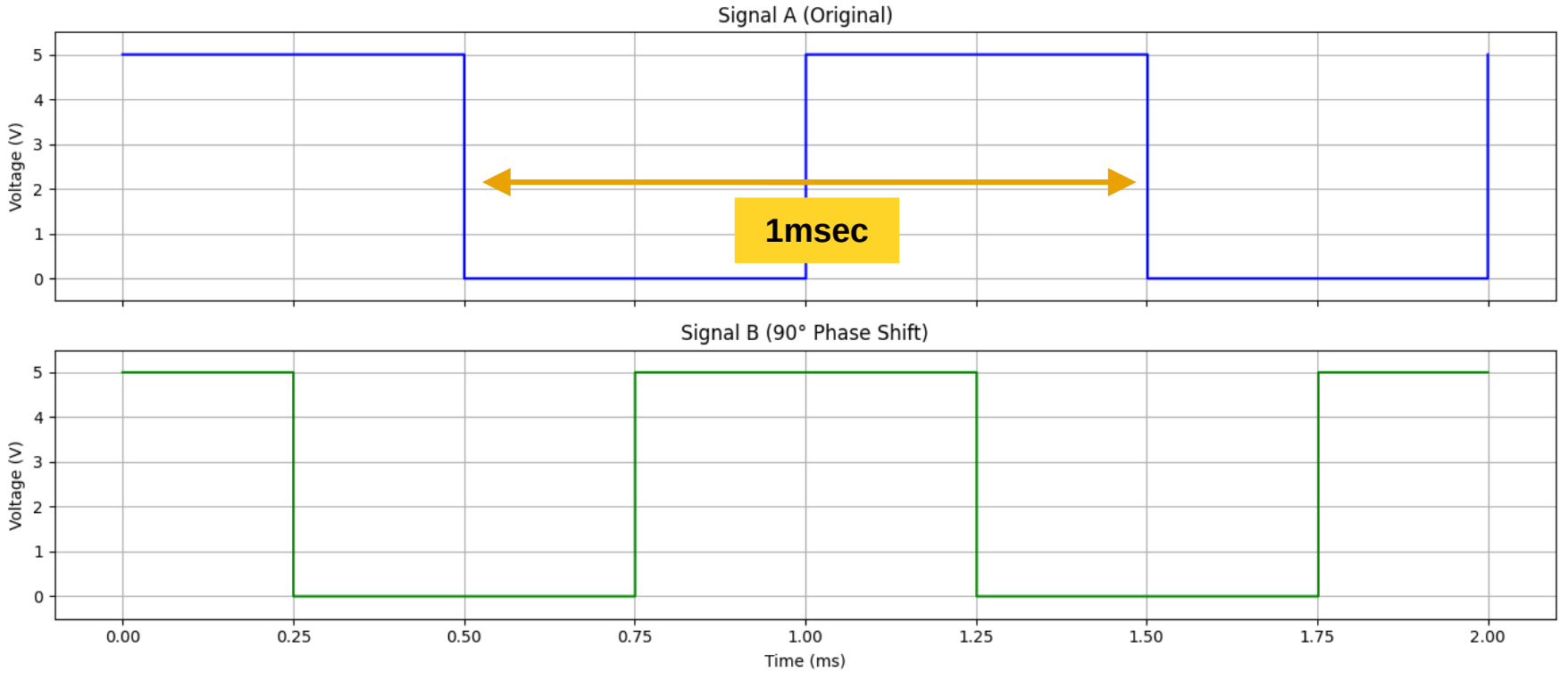
Waveforms for Task 1



Task 2: Signal Generation

- Use a function generator to generate **two periodic rectangular signals**, labeled **A** and **B**, whose characteristics match those illustrated in the provided figure on the next page.
- Measure both signals with a **digital oscilloscope**
  - Use **CH1=A** and **CH2=B**
- Ensure the **Time/Div and Volt/Div settings** are properly configured for clear waveform visualization.

Waveforms for Task 2



Task 3: PWM Control of LED Brightness

- Connect an **LED** and a **current-limiting resistor** on the breadboard.
- Use a function generator to produce a **PWM signa**l with the following settings:
  - **Vpp: 5 V**
  - **Voffset: 2.5 V**
  - **Frequency: 500 Hz or 1 kHz**
  - **Duty Cycle: 50%**
- Use a **digital oscilloscope** to measure the PWM signal.
  - Gradually change the duty cycle of the PWM signal and observe the change in the **LED’s brightness**.

Virtual Circuit Simulation for Task 3