Experiment -1: Introduction to Various Equipment Typically Used in an Electronics Laboratory

Aim: - Study of various measurement equipment listed below:

a) To find the amplitude and frequency using CRO
b) Study of Multimeter
c) Bread Board
d) Signal Generator
e) DC Voltage Source

Components and Equipment's Required: Cathode Rays Oscilloscope (CRO), Signal generator, resistances, capacitors, multimeter, breadboard, CRO probes, testing probes and a DC voltage source

Theory: The block diagram of an analog CRO is shown in the Fig.1, which explains the internal functioning of an oscilloscope.

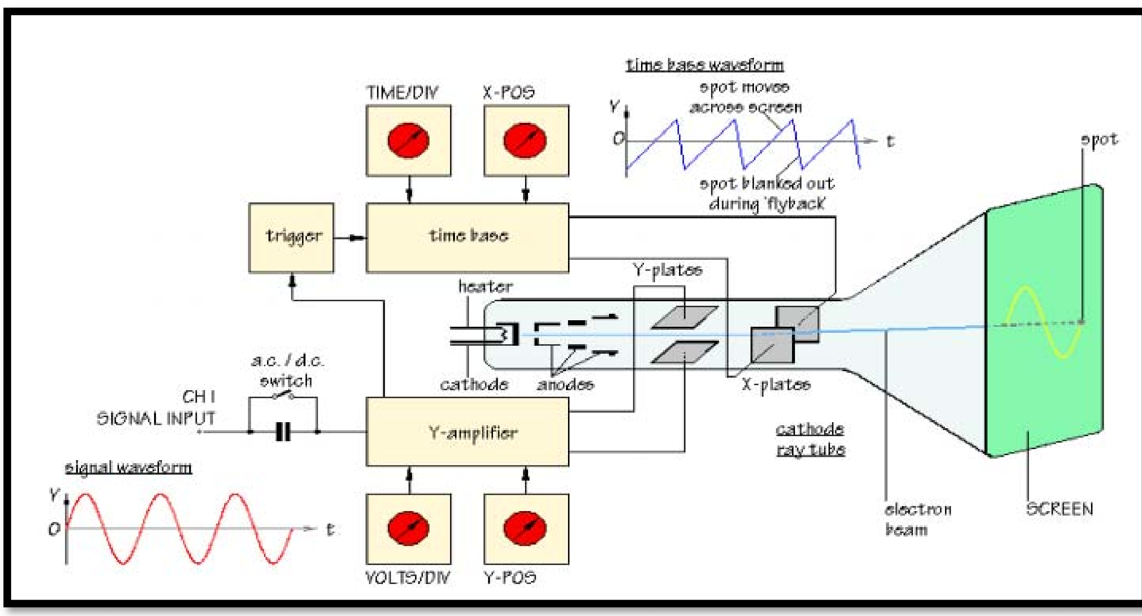


Fig.1: Cathode Rays Oscilloscope

Like a television screen, the screen of an oscilloscope consists of a Cathode Ray Tube (CRT) which is also called the heart of CRO. Although the size and shape are different, the operating principle is the same. Inside the tube is a vacuum. The electron beam emitted by the heated cathode at the rear end of the tube is accelerated and focused by one or more anodes, and strikes the front of the tube, producing a bright spot on the phosphorescent screen. The electron beam is bent, or deflected, by voltages applied to two sets of plates fixed in the tube. The horizontal deflection plates or **X-plates** produce side to side movement.

As you can see, they are linked to a system block called the time base. This produces a sawtooth waveform. During the rising phase of the sawtooth, the spot is driven at a uniform rate from left to right across the front of the screen. During the falling phase, the electron beam returns rapidly from right to left, but the spot is 'blanked out' so that nothing appears on the screen. In this way, the time base generates the **X-axis** of the **V/t graph**. The slope of the rising phase varies with the frequency of the sawtooth and can be adjusted, using the **TIME/DIV** control, to change the scale of the **X-axis**. Dividing the oscilloscope screen into squares allows the horizontal scale to be expressed in seconds, milliseconds or microseconds per division (s/DIV, ms/DIV, µs/DIV). The signal to be displayed is connected to the input. The AC/DC switch is usually kept in the DC position (switch closed) so that there is a direct connection to the Y-amplifier. In the AC position (switch open) a capacitor is placed in the signal path. The capacitor blocks DC signals but allows AC signals to pass. The Y-amplifier is linked in turn to a pair of Y-plates so that it provides the Y-axis of the Y-amplifier is linked in turn to a pair of Y-plates so that it provides the Y-axis of the V/t graph.

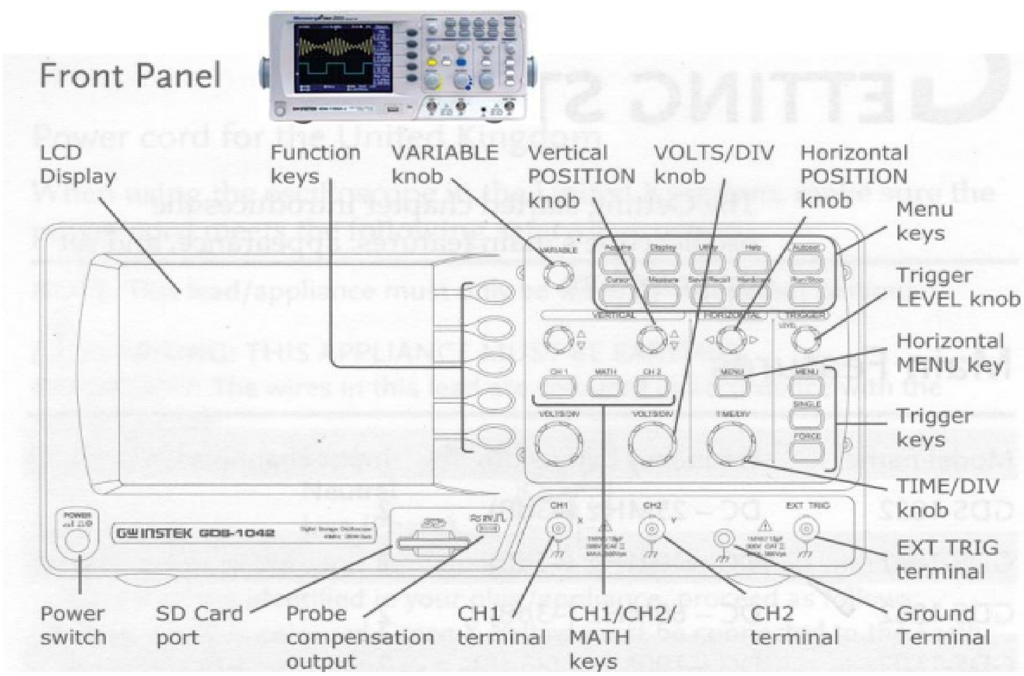


Fig. 2: Front view of Digital Oscilloscope

The overall gain of the Y-amplifier can be adjusted, using the VOLTS/DIV control, so that the resulting display is neither too small nor too large, but fits the screen and can be seen clearly. The vertical scale is usually given in V/DIV or mV/DIV. The trigger circuit is used to delay the time base waveform so that the same section of the input signal is displayed on the screen each time the spot moves across. The effect of this is to give a stable picture on the oscilloscope screen, making it easier to measure and interpret the signal Changing the scales of the X-axis and Y-axis allows many different signals to be displayed. Sometimes, it is also useful to be able to change the positions of the axes. This is possible using the X-POS and Y-POS controls. For example, with no signal applied, the normal trace is a straight line across the center of the screen. Adjusting Y-POS allows the zero level on the Y-axis to be changed, moving the whole trace up or down on the screen to give an effective display of signals like pulse waveforms which do not alternate between positive and negative

Measurement of Amplitude and Frequency:

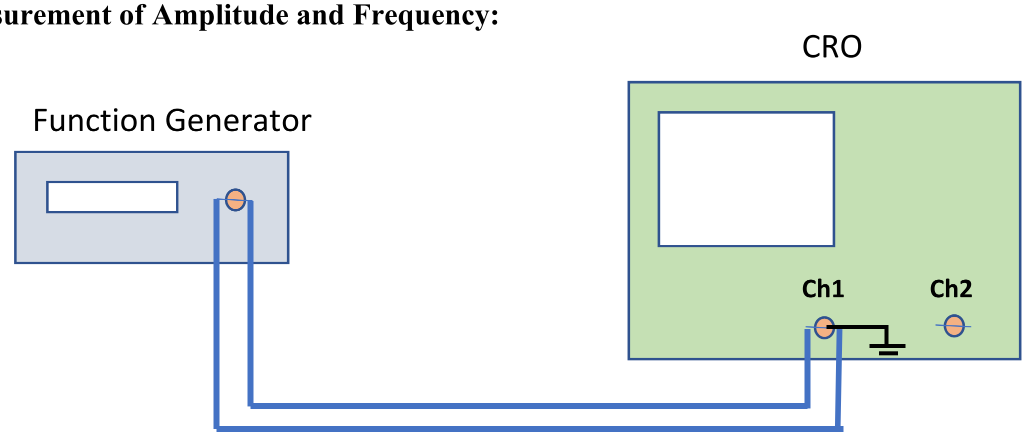


Fig. 3: Measurement of Amplitude and Frequency

A) Measurement of Amplitude:

Procedure:

1. Make the connections as per the diagram is shown above.

2. Put the CRO on a single channel mode and bring the CRO into operation by adjusting the trace of the beam to normal brightness and into a thin line.

3. Now apply the sinusoidal wave of different amplitudes by using the LEVEL and COARSE buttons of the function generator.

4. Note on the vertical scale the peak to peak amplitude (Vpp).

Observation Table:

S.no.	No. of Vertical Divisions (X)	Voltage/Division (Y)	V(p-p) = X*Y	Vm = V(p-p)/2

B) Measurement of Frequency:

Procedure:

1. Make the connections as per the diagram is shown above.

2. Put the CRO on a single channel mode and bring the CRO into operation by adjusting the trace of the beam to normal brightness and into a thin line.

3. Now apply the sinusoidal wave of different frequencies by using the LEVEL and COARSE buttons of the function generator.

4. Note down the horizontal scale period (T) in the second by observing the difference between the two successive peaks of the waveform.

Observation Table:

S.no.	No. of Horizontal Divisions (X)	Time/Division (Y)	T = X*Y	F = 1/T

b) Multimeter:

A **multimeter** is an instrument that allows us to make multiple electrical measurements using the same tool. We can use a multimeter as:

- A **voltmeter** to measure the voltage
- An **ammeter** to measure current
- An **ohmmeter** to measure resistance

There are two basic types of multimeters: **digital multimeters** and **analog multimeters**. Digital multimeters are superior to analog multimeters because of their better accuracy in measurements, sensitivity to very small changes in input voltages, and clear and easy-to-read displays.

However, unlike analog multimeters, digital multimeters need a power supply, such as batteries. Also, because they digitize the analog signals, multimeters can add noise, and it sometimes becomes difficult to isolate the signal from the noise. Also, digital multimeters are not the best when it comes to testing semiconductor electronic parts.

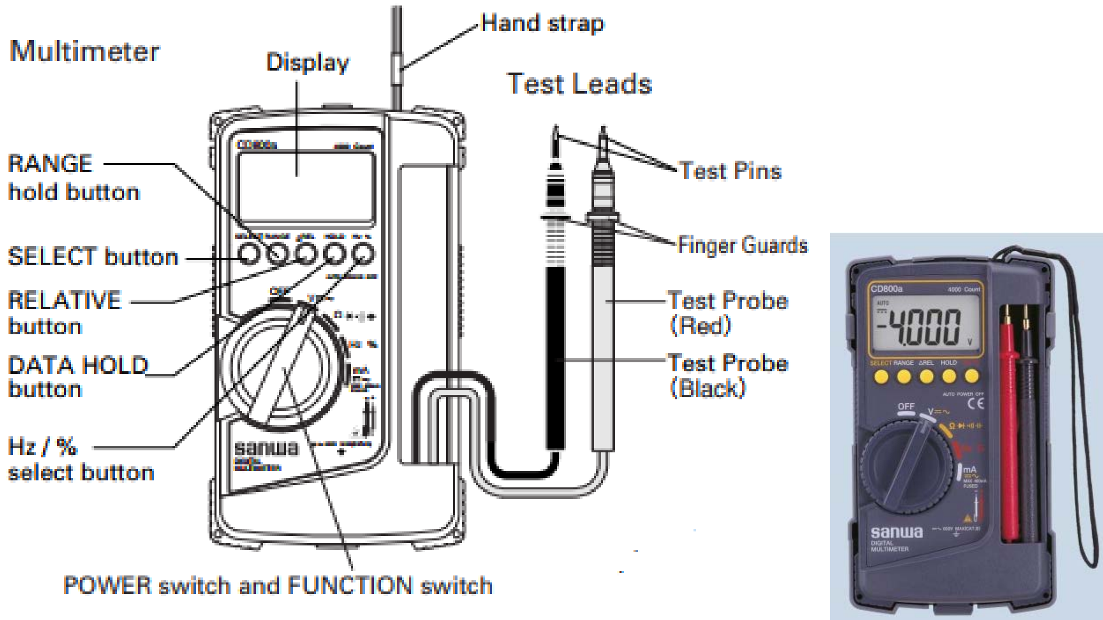


Fig. 4: Digital Multimeter with front panel

Start-up Measurement Setup:

(1) Check the lead and fuse by continuity check as shown in fig. below

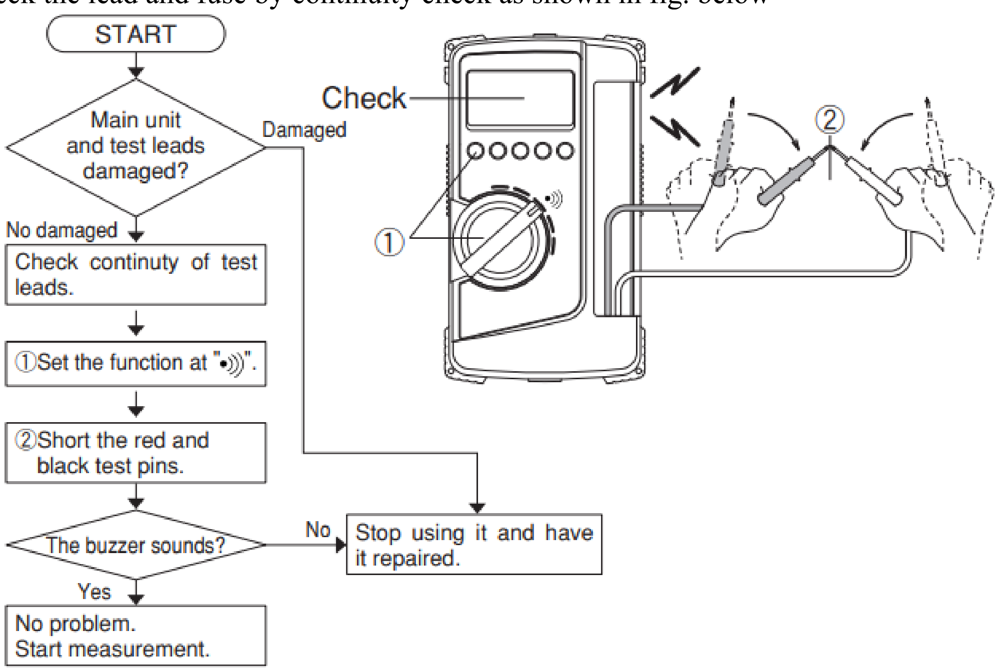


Fig. 5: Continuity checking of wire or fuse

(2) Voltage Measurement:

1. Set the FUNCTION switch at “V” and select either DC or AC with the SELECT button.
2. Apply the red and black test pins to the circuit to measure.
3. For measurement of DCV, apply the black test pin to the potential negative side of the circuit to measure and the red test pin to the positive potential side.
4. For measurement of ACV, apply the red and black test pins to the circuit to measure.
5. The reading of Voltage is shown on display.
6. After measurement, release the red and black test pins from the object measured.

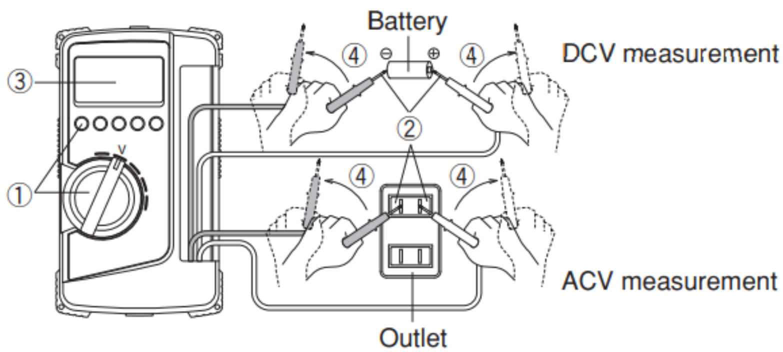


Fig. 6: Testing of AC/DC voltage

(3) Current Measurement:

1. Never apply a voltage to the input terminals.
2. Be sure to make a series connection via load.
3. Do not apply an input exceeding the maximum rated current to the input terminals.
4. Before starting measurement, turn OFF the power switch of the circuit to separate the measuring part, and then connect the test leads firmly.
5. Set the function switch at “mA” and select either DC or AC with the SELECT button.
6. In the circuit to measure and apply the red and black test pins in series with the load.
7. For measurement of DCA, apply the black test pin to the potential negative side of the circuit to measure and the red test pin to the positive potential side in series with the load.
8. For measurement of ACV, apply the red and black test pins to the circuit to measure in series with the load.
9. Read the value on the display.

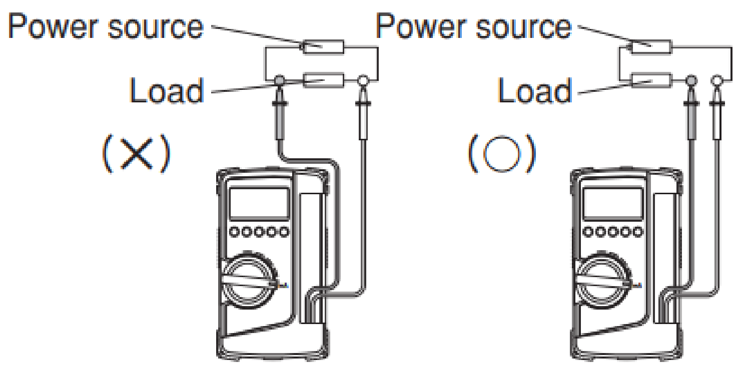


Fig. 7: Current Measurement setup

(4) Resistance Measurement:

1. Set the FUNCTION switch at Ω/ ▶|/ •)))/ ⊣⊢ and select Ω with the SELECT button.
2. Apply the red and black test pins to an object to measure.
3. The reading is shown on display.

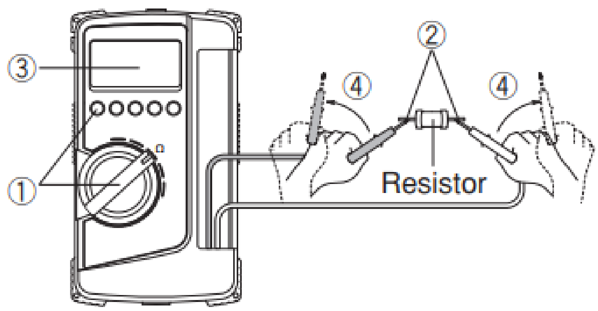


Fig. 8: Resistance Measurement setup

4. After measurement, release the red and black test pins from the object measured.
5. Note: If the measurement is likely to be influenced by noise, shield the object to measure with negative potential (COM). If a finger touches a test pin during measurement, the measurement is influenced by the resistance in the human body, and that results in measurement error. Open Circuit Voltage.

(5) Capacitance Measurement:

1. Set the FUNCTION switch at Ω/ ▶|/ •)))/ ⊣⊢ .
2. Select by pressing the SELECT button ⊣⊢.
3. Press the REL button for zero setting (00.00 nF).
4. Apply the red and black test pins to a conductor to measure.
5. Read the value on the display.
6. After measurement, release the red and black test pins from the object measured.
   - The manual range is not available in capacitance measurement.
   - Readings are unstable because of stray capacitance in test leads or noise

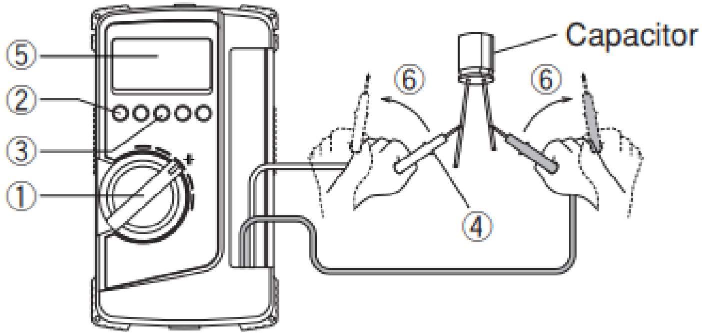


Fig. 9: Capacitor testing

(6) Diode Testing:

Applications The quality of diodes is tested.

How to use:

(1) Set the FUNCTION switch at Ω/ ⯈|/ •)))/ ⊣⊢
(2) Select by pressing the SELECT button.
(3) Apply the black test pins to the cathode of the diode and the red test pin to the anode.
(4) Make sure that the display shows a diode forward voltage drop.
(5) Replace the red and black test pins, make sure that the display is “OL” reading.
(6) After measurement, release the red and black test pins from the object measured.
(7) The input terminals open voltage is about 1.5 V

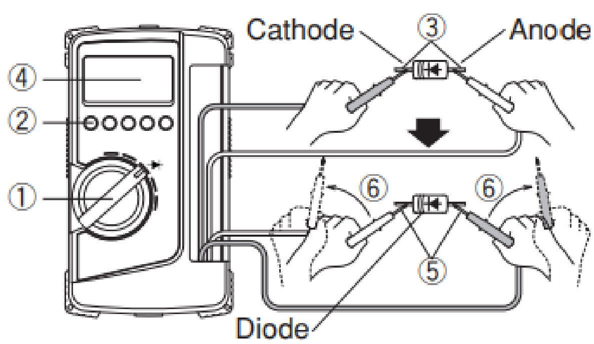


Fig. 10: Diode testing

c) Bread-Board

To temporarily construct a circuit without damaging the components used to build it, we must have some a platform that will both hold the components in place and provide the needed electrical connections. In the early days of electronics, most experimenters were amateur radio operators. They constructed their radio circuits on wooden breadboards. Although more sophisticated techniques and devices have been developed to make the assembly and testing of electronic circuits easier, the concept of the breadboard remains in assembling components on a temporary platform. A breadboard is shown in Fig. 11(a) and the connection details on its rear side are shown in Fig. 11(b). The five holes in each column on either side of the central groove are electrically connected to each other but remain insulated from all other sets of holes.

In addition to the main columns of holes, however, you'll note four sets or groups of holes along the top and bottom. Each of these consists of five separate sets of five holes each, for a total of 25 holes. These groups of 25 holes are all connected on either side of the dotted line indicated on Fig.1(a) and needs an external connection if one wishes the entire row to be connected. This makes them ideal for distributing power to multiple ICs or other circuits.

(a)

(b)

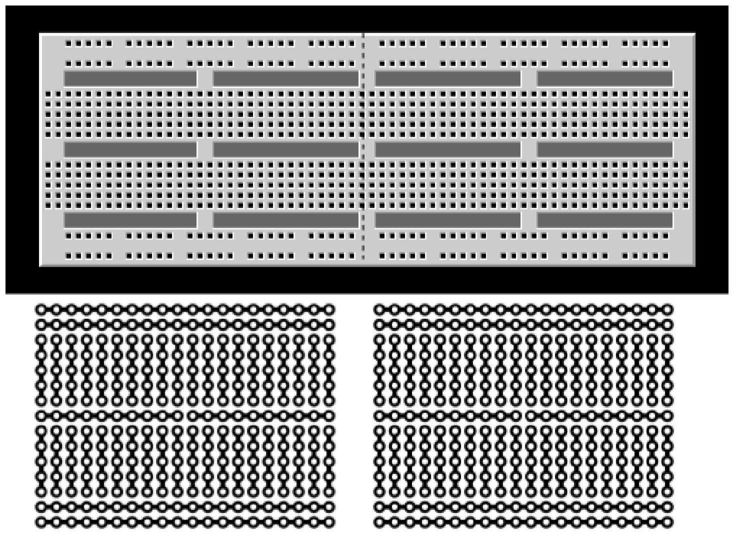


Fig. 11: Internal connection structure in a breadboard

These breadboard sockets are sturdy and rugged and can take quite a bit of handling. However, there are a few rules you need to observe, to extend the useful life of the electrical contacts and to avoid damage to components.

These rules are:

- Always make sure power is disconnected when constructing or modifying your experimental circuit. It is possible to damage components or incur an electrical shock if you leave power connected when making changes.
- Never use larger wire as jumpers. #24 wire (used for normal telephone wiring) is an excellent choice for this application.
- Observe the same limitation concerning the size of the component leads
- Whenever possible, use ¼ watt resistors in your circuits. ½ watt resistors may be used when necessary; resistors of higher power ratings should never be inserted directly into a breadboard socket.
- Never force component leads into contact holes on the b Doing so can damage the contact and make it useless.
- Do not insert stranded wire or soldered wire into the breadboard socket. If you must have stranded wire (as with an inductor or transformer lead), solder (or use a wire nut to connect) the stranded wire to a short length of solid hookup wire, and insert only the solid wire into the breadboard.

d) Signal Generator:

Signal generator, also called as function generator is useful in generating different types waveforms (signals), namely, sine wave, rectangular wave (pulse with a variable duty cycle), and a triangular wave with a choice on frequency and amplitude.

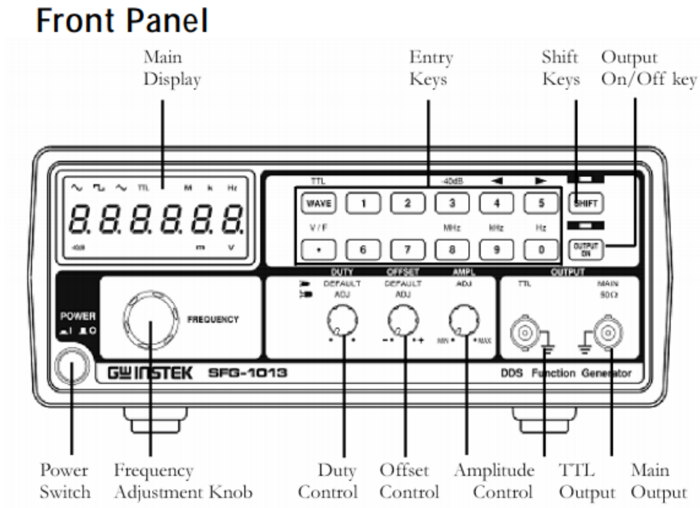
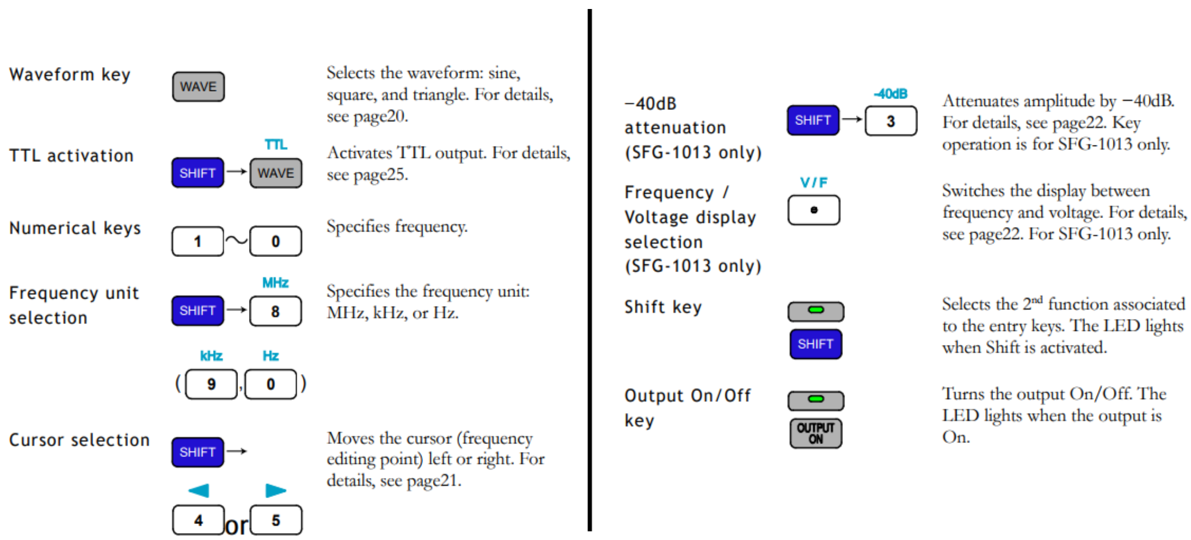


Fig. 12: Front Panel of Function Generator



Waveform key	WAVE	Selects the waveform: sine, square, and triangle. For details, see page20.
TTL activation	SHIFT → WAVE (TTL)	Activates TTL output. For details, see page25.
Numerical keys	1 ~ 0	Specifies frequency.
Frequency unit selection	SHIFT → 8 (MHz) (9 (kHz), 0 (Hz))	Specifies the frequency unit: MHz, kHz, or Hz.
Cursor selection	SHIFT → 4 (◄) or 5 (►)	Moves the cursor (frequency editing point) left or right. For details, see page21.
−40dB attenuation (SFG-1013 only)	SHIFT → 3 (-40dB)	Attenuates amplitude by −40dB. For details, see page22. Key operation is for SFG-1013 only.
Frequency / Voltage display selection (SFG-1013 only)	• (V/F)	Switches the display between frequency and voltage. For details, see page22. For SFG-1013 only.
Shift key	SHIFT	Selects the 2nd function associated to the entry keys. The LED lights when Shift is activated.
Output On/Off key	OUTPUT ON	Turns the output On/Off. The LED lights when the output is On.

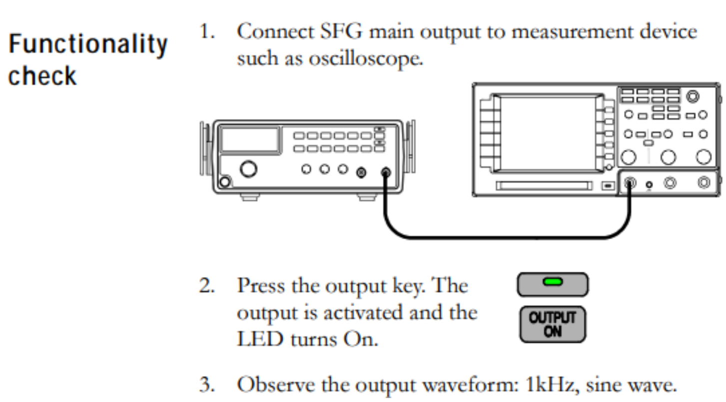
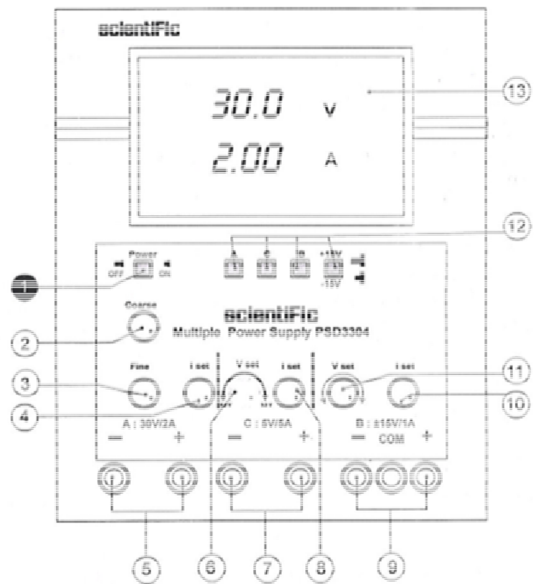


Fig. 13: Functionality Testing

e) **DC Source or Power Supply**

The power supply has an electrically floating output. This permits easy series or parallel connection with other power supply units, to increase supply voltage or current respectively. The power supply is constituted by rectifier, filters and regulator circuits for constant voltage supply. Here in the figure given below shows the test setup to supply the DC supply.



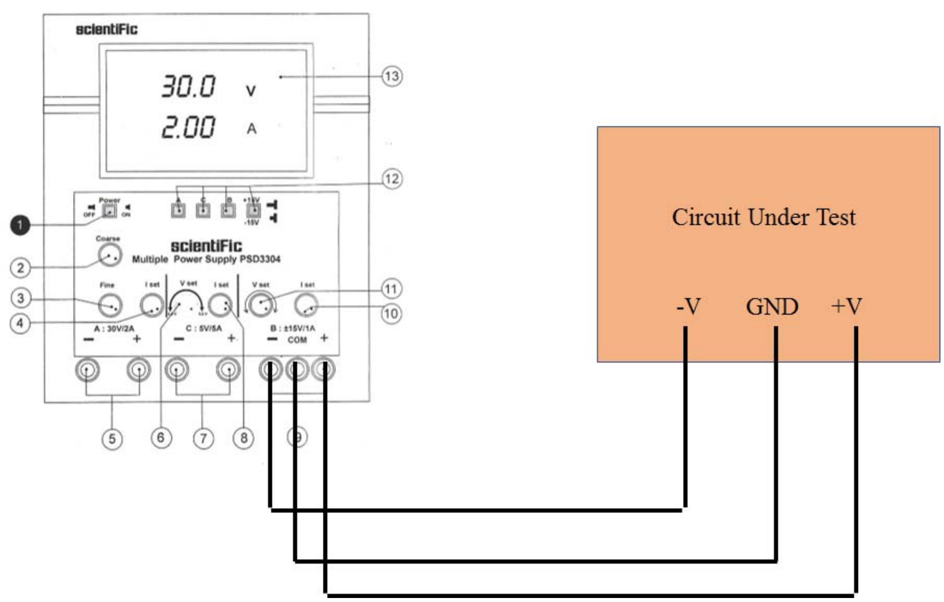


Fig. 14: Front Panel of DC Power Supply