LAB 1. INTRODUCTION

1. Goals

- Know how to use basic electronic components and equipment.

2. Electronic Equipment

2.1. Breadboard

A *breadboard* is used to rapidly create an experimental or prototype circuit without having to design and manufacture a costly PCB. There are different types of breadboards. Figure 1 shows a typical breadboard. The breadboard consists of an array of holes in which wires or component leads can easily be inserted.

- The holes are spaced 100 mils (.1 inch) apart from each other.
- Columns of 5 holes (***a, b, c, d, e*** or ***f, g, h, i, j***) are electronically connected to form a single node.

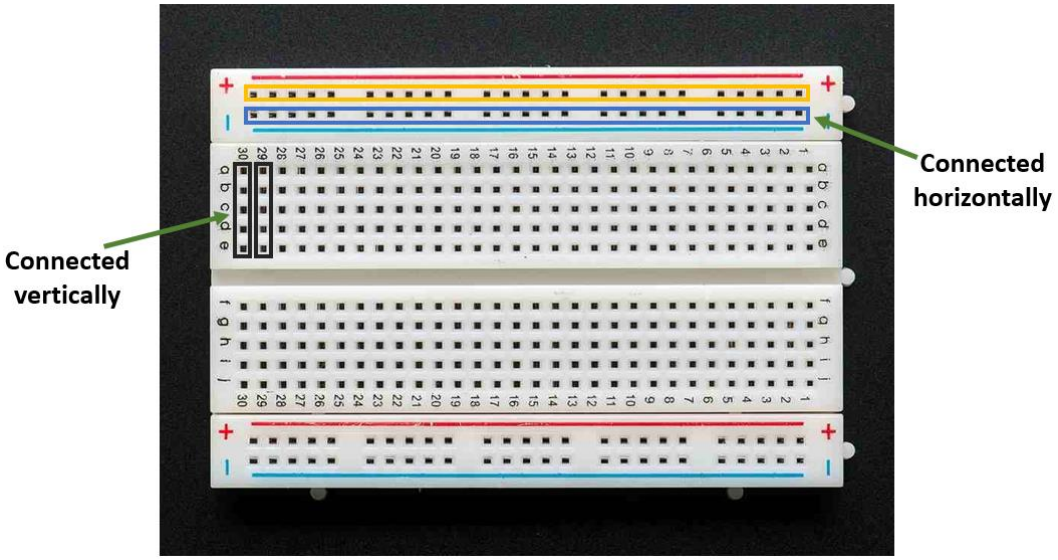


Figure 1: *Small breadboard.*

2.2. Power Source

To supply an electronic circuit, you need a DC *voltage source* that is constant regardless of the change of the input. DC batteries can be an option; however, they are expensive and require replacement from time to time. Alternatively, you can use a DC power supply or an AC power adapter, as shown in Figure 2.

Specifications of the Aditeg PS-3030DD Power Supply:

- Output Voltage: (C.V.) 0~30V dual, 5V (Fixed)
- Output Current: (C.C.) 0~3A dual, 3A (Fixed)
- Operation Mode : two independent outputs and one 5V fixed output
- Series : One 0~60V, 0~3A output and 5V fixed output
- Parallel : One 0~30V, 0~6A output and 3A fixed output
- Voltage Accuracy : 5V ± 0.25V
- Output Current : 3A

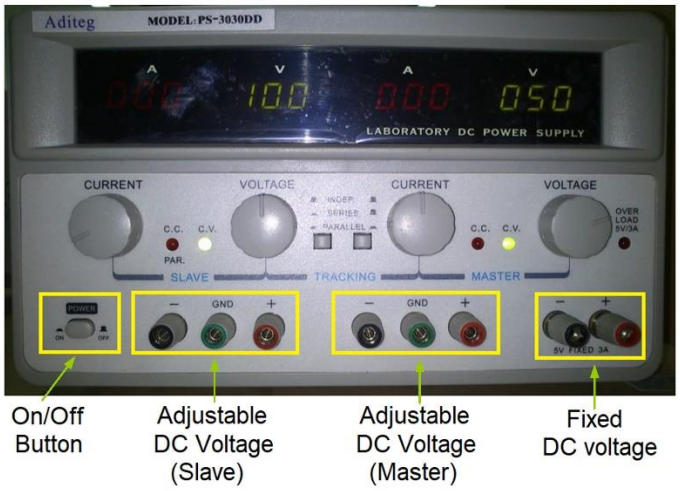


Figure 2: *DC power supply and AC power adapter 5V-2A.*

2.3. Multimeter

A *multimeter* is an indispensable tool that you can use to diagnose a circuit, learn about other people's electronic design. Figure 3 shows a digital multimeter. The display has four digits and a negative sign. Two probes are plugged into two ports on the front of the unit.

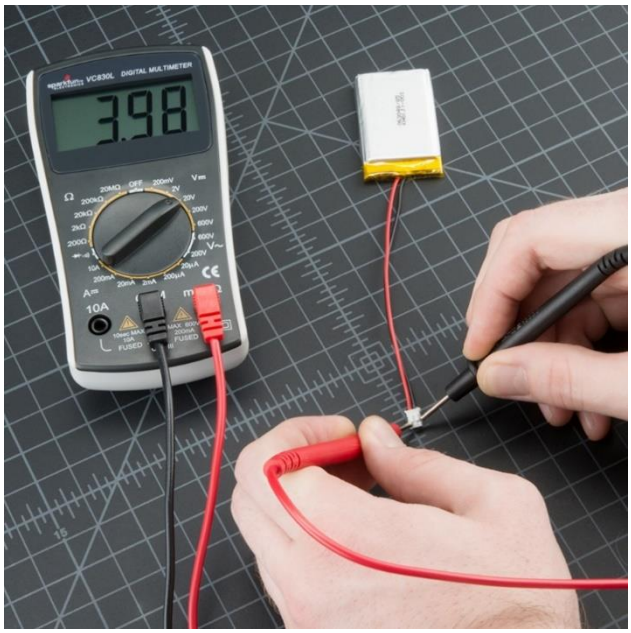


Figure 3: *Digital multimeter.*

- **COM** stands for common and is almost always connected to Ground or '-' of a circuit.
- **10A** is a special port used when measuring large currents (greater than 200mA).
- **mAVΩ** is a port that the red probe is conventionally plugged into. This port allows the measurement of current (up to 200mA), voltage (V), and resistance (Ω).

2.4. Function Generator

A *function generator* is an electronic equipment that generates standard waveforms (e.g., sine, square, ramp, sawtooth waves, etc.) used for testing circuit designs or devices. By using stable and reliable waveforms from a function generator (i.e., known input signals), you can figure out the operation of your circuits or devices under different conditions. Figure 4 shows a UNI-T UTC962E digital function generator.

Figure 4: *UNI-T UTC962E function generator.*

Specifications of the UNI-T UTC962E function generator:

- Vertical resolution: **14 bit**
- Frequency range: **1 µHz - 60 MHz**
- Frequency resolution: **1 µHz**
- Number of channels: **2**
- Sample rate: **200 MSa/s**
- Maximum waveform length: **4k points**
- Amplitude range, **for ≤10 MHz: 1 mVpp - 10 Vpp**, **for ≤60 MHz: 1 mVpp - 5 Vpp**
- Output Precision: **± (3% + 2 mVpp)**
- Display: **4.3" (480 x 272) color LCD**
- Output impedance: **50 Ω**

- Output signals: **Sine, Square, Pulse, Ramp, Noise, DC, Arbitrary**
- Modulation functions: **AM, FM, PM, FSK**
- Connectivity: **USB**

2.4. Oscilloscope

An *oscilloscope* is an electronic instrument that graphically displays varying voltages of electrical signals as a function of time. The captured waveforms of the signals can be used for the purpose of debugging and analyzing, through their properties such as amplitude, frequency, phase, distortion, and others. Figure 5 shows an OWON SDS1102 digital oscilloscope.

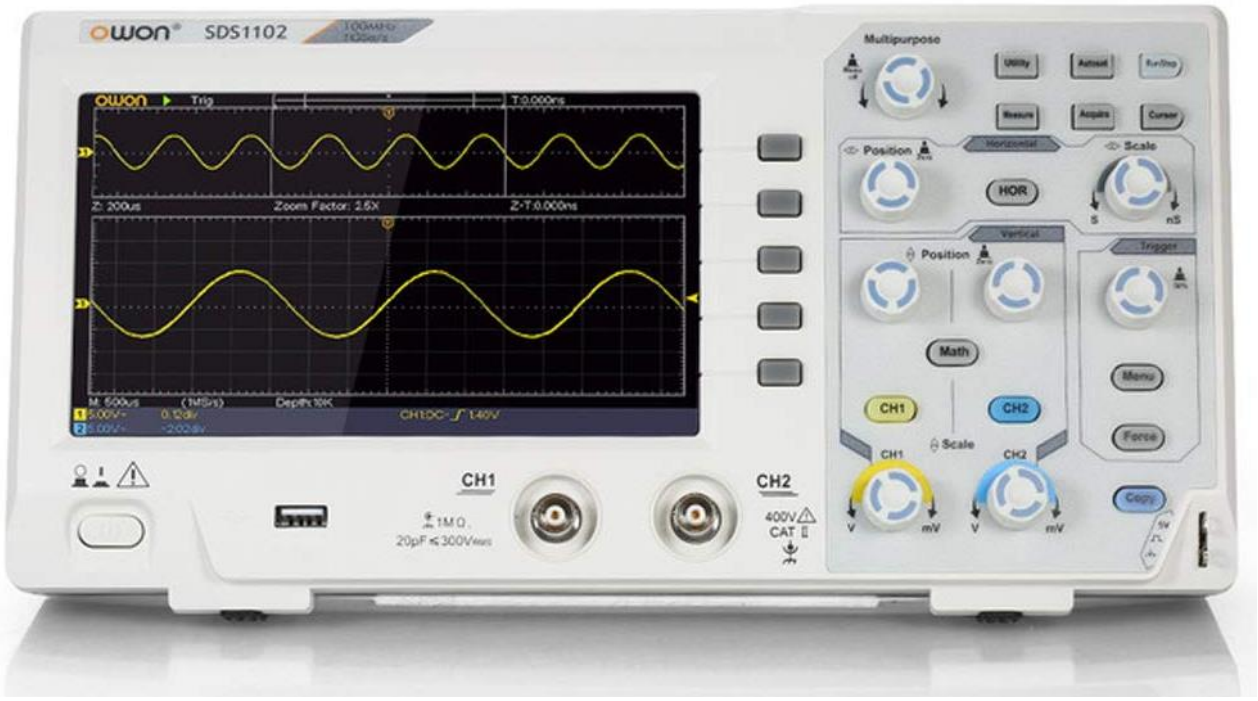


Figure 5: *OWON SDS1102 oscilloscope.*

Specifications of the OWON SDS1102 oscilloscope:

- Number of channels: **2**
- Band: **20MHz**
- Sampling: **100Msps**
- Memory record length: **10kpts**
- Kind of display used: **LCD 7"(**display resolution: **800x480)**
- Trigger modes: **automatic, normal, single**
- Trigger: **falling-edge, rising-edge, video signal**
- Time base: **5n...1ks/div**
- Max. input voltage: **400V**
- Vertical resolution: **8bit**
- Input coupling: **AC, DC, GND**
- Interface: **USB**

- Rise time: **≤17.5ns**
- Input impedance: **1MΩ/20pF**
- Input sensitivity: **5mV/div...5V/div**
- Power consumption: **15W**
- Measurement memory: **16**

3. Electronic Components

3.1. Resistor

A *resistor* is a passive two-terminal electrical component, which are commonly used as pull-up/pull-down resistors, current limiting resistors, transistor biasing resistors, and others in electronic circuits. Figure 6 shows carbon film resistors with different tolerance (±5% ~ ±20%).

Figure 6: *Carbon film resistors.*

3.2. Capacitor

A *capacitor* is a passive electrical component that is basically constructed of two parallel conductive plates separated by an insulating material called the dielectric (i.e. an insulator). Capacitor uses include electrical storage, power supply filtering, signal filtering, DC blocking and AC coupling, etc. There are many types of capacitors; however, in this course, you only work with ceramic capacitor (unpolarized) and electrolytic capacitor (polarized), as shown in Figure 7.

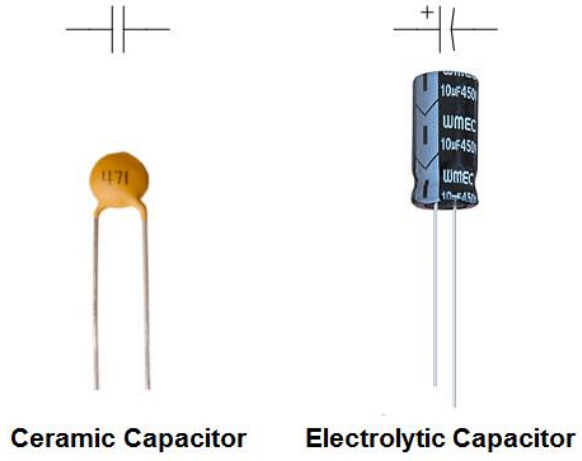


Figure 7: *Ceramic and electrolytic capacitors.*

3.3. Inductor

An *inductor* is a passive electrical component that is formed by a coil of wire and exhibits the property of inductance. Inductor uses include noise suppression, RF chokes, tuned, circuits, etc. Figure 8 shows different types of inductors.

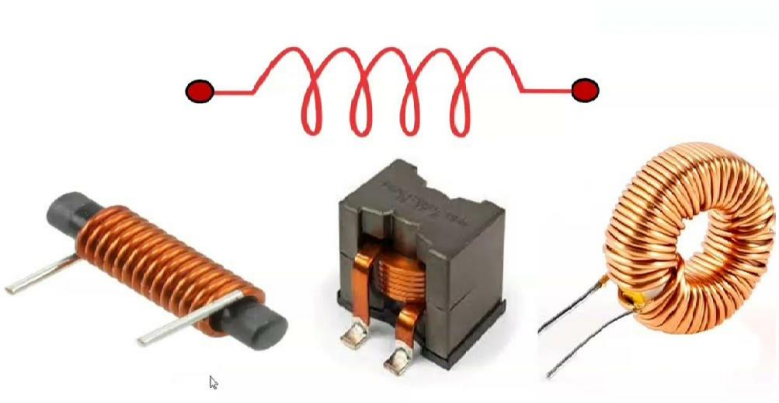


Figure 8: *Inductors.*

3.4. Diode and LED

A *diode* is a two-terminal electronic component that consists of an n-region and a p-region separated by a *p-n junction*. It conducts current primarily in one direction. Figure 9 shows an example of a diode and its symbol.

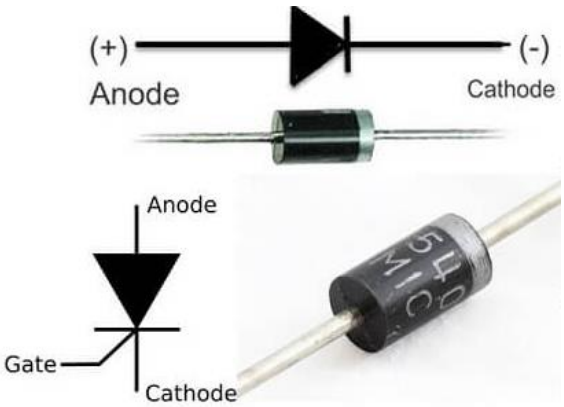


Figure 9: *Diodes.*

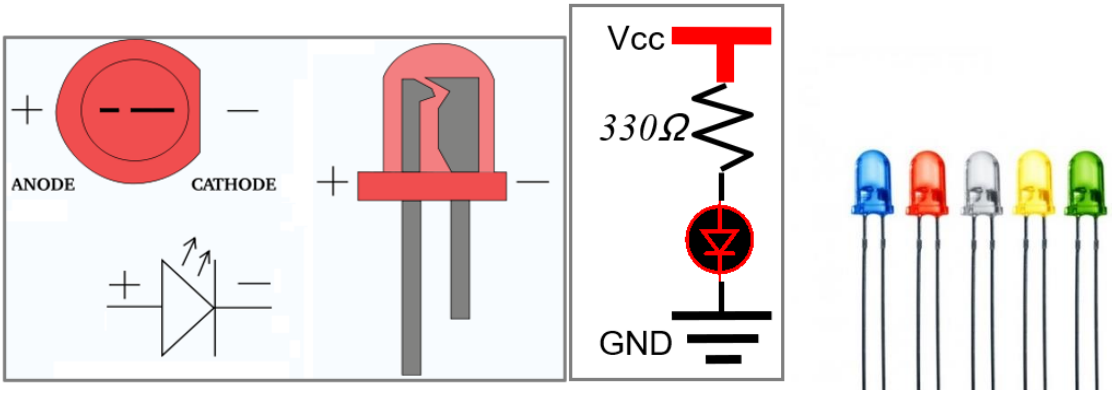


Figure 10: *LED circuits.*

An *LED* (Light Emitting Diode) is a type of diode which will light up when enough voltage is supplied. However, if too much voltage is allowed to pass through the LED, it can be damaged. In practice, you must connect a 330-Ω resistor to each LED in series to limit the voltage (or current), as illustrated in Figure 10.

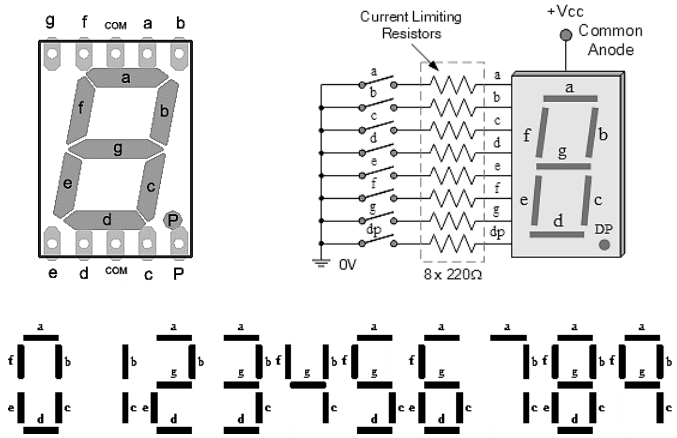


Figure 11: *7-segment display.*

A *seven-segment display* is a simple electronic display device which uses one LED for each segment or dot. Seven-segment displays are arranged in 2 configurations: *Common Anode* – all the LEDs' anodes are connected and *Common Cathode* – all the LEDs' cathodes are connected. Seven-segment displays are widely used in digital clocks, electronics meters, basic calculators, etc. for displaying decimal numerals. Figure 11 shows an example of a seven-segment display and how it is connected in electronic circuits.

3.5. Transistor BJT

Bipolar Junction Transistor (BJT) is a semiconductor component that has three separately doped regions and contains two p-n junctions. There are many applications of BJT depending on its operation modes. In this course, you will investigate two popular applications of BJT, *switching* and *amplification*. Figure 12 shows the pinout of a 2N2222 transistor.

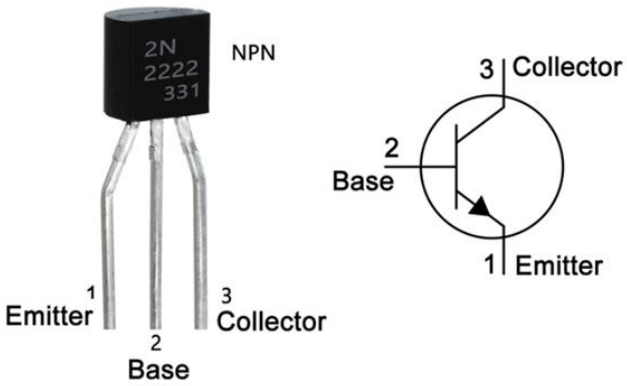
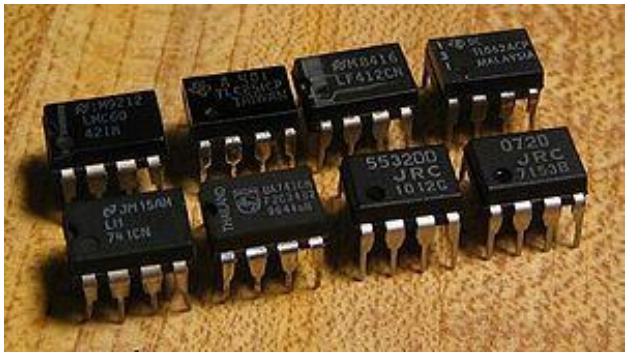
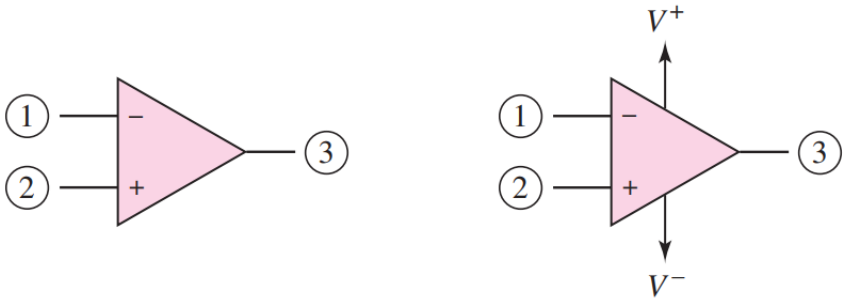


Figure 12: *Bipolar Junction Transistor.*

3.6. Op-amp

Op-amp (Operational Amplifier) is a very high gain amplifier circuit, which "senses" the difference between the voltage signals at the two input terminals (1 and 2). This difference is then amplified to generate the output signal at the output terminal (3). Figure 13 shows the IC package of an op-amp (LM741) and symbols of op-amp.





(a) (b)

Figure 13: *IC LM741 and symbols of op-amp (a) and op-amp with V+ and V- (b).*

3.7. Push Button

A *push button* is used to close an electronic circuit when it is pressed. Figure 14 shows a common 2-pin/4-pin push button.

Figure 14: *2-pin and 4-pin push buttons.*

To correctly bias the inputs of digital gates, you need to use *pull-up* or *pull-down resistors*. See Figure 15 for the use of pull-up/pull-down resistors.

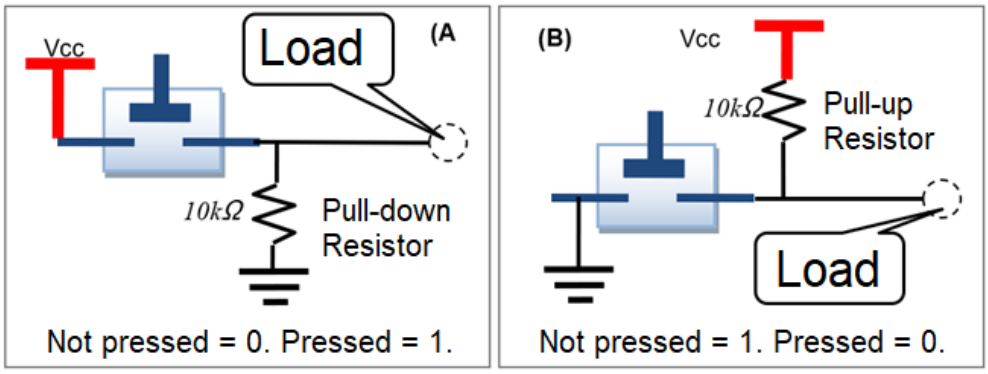


Figure 15: *Pull-up/pull-down resistor circuits.*

3.8. Slide Switch

Like push buttons, *slide switches* are used to control current flow in an electronic circuit. Figure 16 shows the constructional diagram of a slide switch. You also need to use pull-up or pull-down resistors with a switch to prevent floating input.

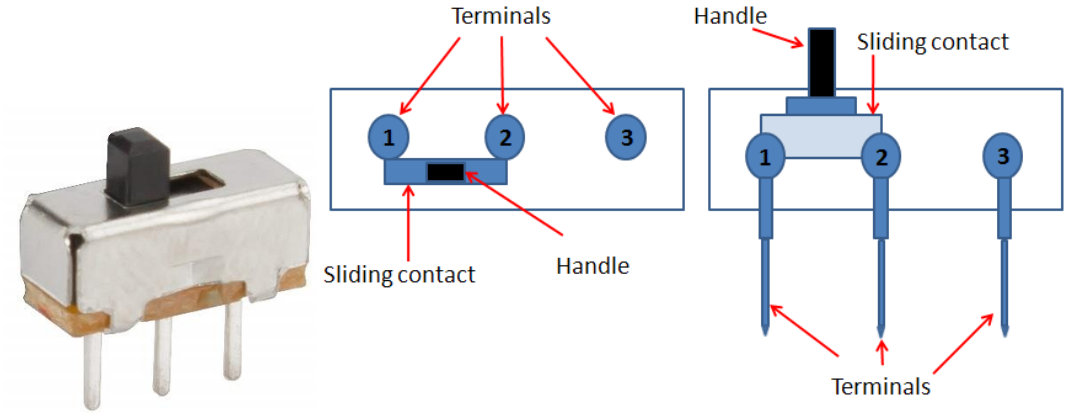
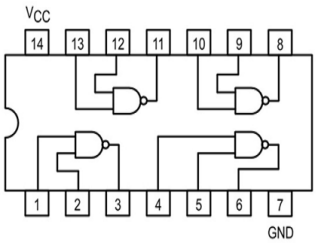


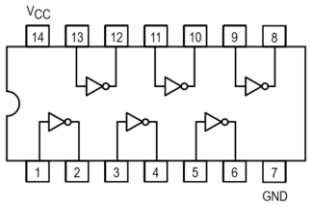
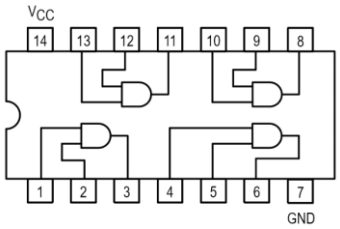
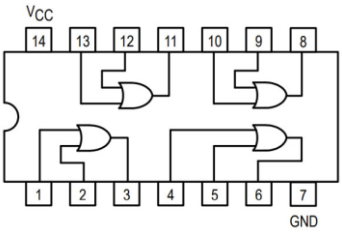
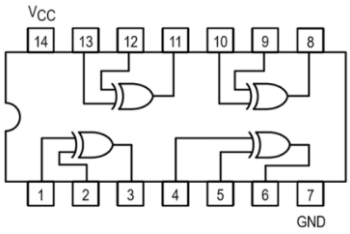
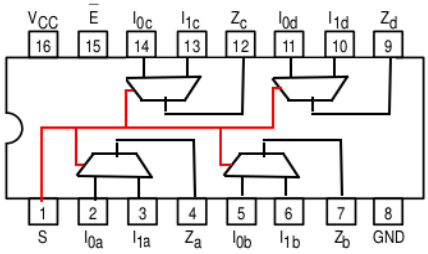
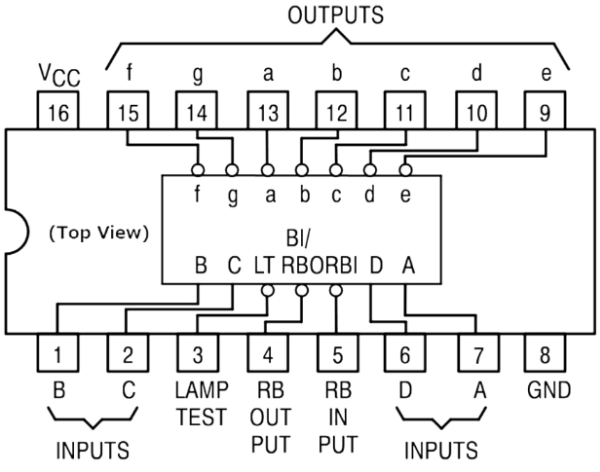
Figure 16: *3-pin slide switch.*

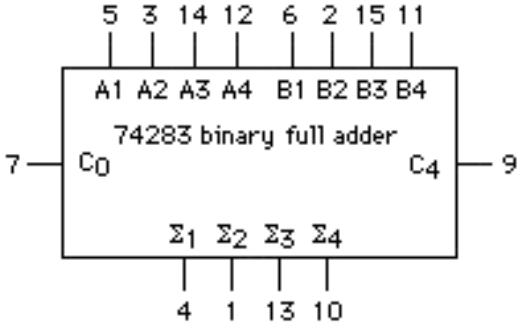
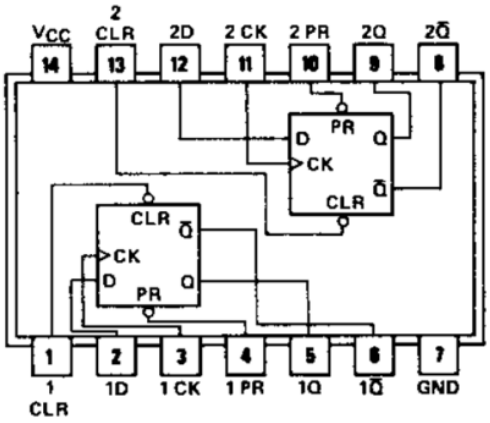
3.9. ICs

An *integrated circuit* (IC) is a small electronic device that is made up of basic electronic components, e.g., transistors, diodes, resistors, and capacitors to perform various functions in the field of electronics. These components are interconnected and etched onto a small piece of semiconductor material (Si, Ge, GaAs, etc.). In general, ICs are much smaller, faster, and cheaper than those constructed of discrete components.

In this course, you will work with various types of ICs to implement combinational and sequential logic circuits. For example:

• 74LS00: 2-input NAND gates	

• 74LS04: NOT gates	
• 74LS08: 2-input AND gates	
• 74LS32: 2-input OR gates	
• 74LS86: 2-input XOR gates	
• 74LS157: 2-to-1 MUX	
• 74LS247: BCD to 7-segment decoder	

• 74LS283: 4-bit full adder	
• 74LS74: D flip flop	
• 74LS76: J-K flip flop