# Safety

**Current, not voltage, kills** (high voltage makes it easier)

**Don’t let yourself become part of a live circuit**

15mA AC can be lethal (disrupts heart rhythm)

Can get burned without getting electrocuted

When working with high voltages, work with one hand behind your back

# Fundamentals

**Current** (): flow of electric charge

**Voltage** ()**:** potential difference that makes current flow

**I-V Curves**: current-voltage relationship for components

# Components

**Resistor**: resists flow of current



Has resistance (in Ohms, Ω)

I-V relationship follows Ohm’s Law

C:\Users\Ducky\Desktop\calsol-training\ee1\images\inline_pot.png **Potentiometer**: variable resistor

**Capacitor**: stores charge

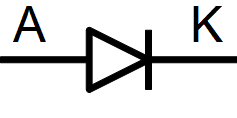


Has capacitance (in Farads, F)

Stored charge related to voltage,

C:\Users\Ducky\Desktop\calsol-training\ee1\images\inline_switch.png **Switch**: breaks / makes electrical connection

**Diode**: restricts current flow to one direction



**LED**: lights up when current applied



**Transistor**: voltage-controlled electrical switches

**MOSFET**: gate voltage controls source-drain channel

# Resistor Color Chart

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| C:\Users\Ducky\Desktop\calsol-training\ee1\images\chart_resistor.png | | | | 4.7 kΩ example  **47** × **100** = 4700 Ω | |
| **Color** | **Value** | **Multiplier** | | | **Tolerance** |
| **Black** | **0** | ×100 | | | --- |
| **Brown** | **1** | ×101 | | | 1% |
| **Red** | **2** | ×102 | | | 2% |
| **Orange** | **3** | ×103 | | | --- |
| **Yellow** | **4** | ×104 | | | --- |
| **Green** | **5** | ×105 | | | 0.5% |
| **Blue** | **6** | ×106 | | | 0.25% |
| **Violet** | **7** | ×107 | | | 0.1% |
| **Gray** | **8** | ×108 | | | 0.05% |
| **White** | **9** | ×109 | | | --- |
| **Gold** | --- | ×10-1 | | | 5% |
| **Silver** | --- | ×10-2 | | | 10% |
| **None** | --- |  |  | | 20% |

# Switches

## Switch Connections

|  |  |  |  |
| --- | --- | --- | --- |
| **Pole** | Independent circuits | C:\Users\Ducky\Desktop\calsol-training\ee1\images\inline_switch_spdt.png | (DPST) |
| **Throw** | Switch positions | C:\Users\Ducky\Desktop\calsol-training\ee1\images\inline_switch_dpst.png | (SPDT) |

## Momentary (Pushbutton) Switches

|  |  |  |  |
| --- | --- | --- | --- |
| C:\Users\Ducky\Desktop\calsol-training\ee1\images\inline_pushbutton_no.png | **NO** | *“normally open”* | Disconnected when unpressed |
| C:\Users\Ducky\Desktop\calsol-training\ee1\images\inline_pushbutton_nc.png | **NC** | *“normally closed”* | Connected when unpressed |

# Multimeter Usage

|  |  |  |
| --- | --- | --- |
| **Mode** | | **Function** |
| C:\Users\Ducky\Desktop\calsol-training\ee1\images\inline_meter_vdc.png | **DC Volts** | Measures voltage between the probes  AC mode measures RMS voltage |
| C:\Users\Ducky\Desktop\calsol-training\ee1\images\inline_meter_vac.png | **AC Volts** |
| C:\Users\Ducky\Desktop\calsol-training\ee1\images\inline_meter_adc.png | **DC Current** | Measures current flowing through the probes |
| C:\Users\Ducky\Desktop\calsol-training\ee1\images\inline_meter_aac.png | **AC Current** |
| **Ω** | **Resistance** | Measures resistance between the probes |
| C:\Users\Ducky\Desktop\calsol-training\ee1\images\inline_meter_continuity.png | **Continuity** | Checks if probed points are electrically connected |
| C:\Users\Ducky\Desktop\calsol-training\ee1\images\inline_meter_diode.png | **Diode** | Measures voltage drop across a diode  Sometimes also used as continuity mode |

# Schematics

**Schematic**: abstract circuit drawing showing connectivity

**Node**: electrical connection

Crossing lines not connected unless indicated by dot

## Connections

|  |  |  |  |
| --- | --- | --- | --- |
| C:\Users\Ducky\Desktop\calsol-training\ee1\images\inline_parallel.png | parallel | C:\Users\Ducky\Desktop\calsol-training\ee1\images\inline_series.png | series |

# Datasheets

**Datasheets** are like the user’s manual for a component

Contains **pin diagrams** and **absolute maximum ratings**

# Breadboard

|  |  |
| --- | --- |
| **Internal Connectivity**  C:\Users\Ducky\Desktop\calsol-training\ee1\images\breadboard-internals.png | Some have power strips broken down the middle  **C:\Users\Ducky\Desktop\calsol-training\ee1\images\breadboard-internals-broke.png** |