

Only three things can be measured.

Voltage (V) - measured as Volts - is the potential force or pressure in a circuit. It exists whether anything is connected or not. Voltage is measured across, or as the difference between, two points. Voltage is similar to pounds per square inch (psi) on a water line.

Current (I) - measured as Amps - is the rate or quantity of flow through a path. Current can be measured only if a load or fault is connected and operating. An Amp is a quantity of electrons per second. Current is similar to gallons per minute on a water line.

Time event (t) - measured in seconds - is the elapsed time between events. The reciprocal of time is the frequency (f), which is measured in oscillations or cycles per second called Hertz (Hz).



Only three things can be calculated.

Power (S) - expressed in Volt-Amps - is the product of voltage and current. Power is energy or work that occurs over some period of time. The asterisk simply notes a time change on the current. *Real or DC power (P)* - is expressed in Watts.

$$S = V \times I$$

$$Z = V / I$$

$$\text{SWR optimum} = 1:1$$

Impedance (Z) - expressed in Ohms - is the ratio of voltage to current (Volts per Amp). Impedance is the opposition to current flow. The relationship is called Ohm's Law.

Delay (t_d) - is the difference in the time or phase shift between voltage and current being at maximum. It may be expressed in seconds, in angular terms, or Standing Wave Ratio (SWR).

Only 3 components of Impedance.

Resistance (R) is natural opposition of any conductor. Most conductors are wires made of copper or aluminum. Resistance is the friction in a conductor. A resistor *converts electrical energy* into mechanical energy in the form of heat. Basic unit is Ohm.



Inductance (L) results from a conductor being bent into a coil. A coil *converts electrical energy* into a magnet. A coil *stores magnetic energy*. Coils are used to make relays, motors, and transformers. Unit is Henry.

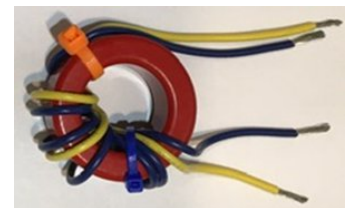


Capacitance (C) results from two conductors or plates being close to each other. A capacitor *stores electrical energy*. A capacitor can be used to smooth out the electrical energy. Capacitors are used in electronic circuits and to reduce the effect of time delay from a coil. Basic unit is Farad.



Transformer is two coils of wire wrapped around a common iron-type material.

The number of turns are adjusted to change the impedance, for example to an antenna. A transformer can change 120 VAC to lower voltage.



Variable resistor, inductor and capacitor have an arrow added to the diagram.

Variable resistor (R) is a potentiometer (pot) or volume control.

Variable inductor (L) is a coil used to tune a frequency.

Variable capacitor (C) is a condenser used to tune a frequency.

Series / Parallel

Series has components connected end to end, with same current through all components. The voltage is split by components. Old Christmas tree lights were series, when one goes out all are out. Connect ammeter in series.

Parallel has components side by side with same voltage across all components. Wall receptacles are parallel, with all measuring 120 VAC. Connect voltmeter in parallel.

A *Meter* displays electrical quantity as a numeric value or with a swinging needle. Think SWR or wattmeter.

A multi-meter measures voltage and resistance.

Damage occurs if meter is set to Ohm but connected to voltage.

Resistor / variable		
Capacitor / variable		
Inductor / variable		
Transformer		
Ground / chassis gnd		
Lamp / LED		
DC, battery, 12V / AC, receptacle, 120V		

