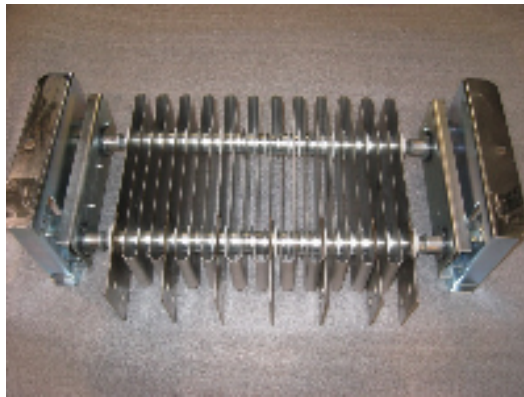


## What are the different types of resistors?

- **Ribbon wound:**

Continuous metal strips in ribbon shape. Depending on the design, ribbon-wound resistors can be broken down by wave-pattern "folded" ribbons or spot-welded ribbons connected in series as individual strips. With this method, high-performance resistors with low-resistance are obtained. The advantage of ribbons is that large surfaces can be achieved at a comparably low material weight, the former being crucial for the heat transfer at high continuous rating. Cooling by natural or forced air convection (fan).



- **Grid:**

In heavy duty industrial high current applications, a grid resistor is a large convection cooled lattice of stamped metal alloy strips (nickel plated or steel) connected in rows between two electrodes. Such industrial grade resistors can be as large as a refrigerator; some designs can handle over 600 amperes of current, with a range of resistances extending lower than 0.04 ohms. Cooling by natural or forced air convection (fan).



- **Case:**

Power resistor encapsulated in an aluminum case which permits the heat dissipation generated under operation with the mounting surface. Up to 400W. Cooling by conduction.



- **Wire wound:**

Are commonly made by winding a metal wire in helicoil shape, usually nichrome, around a ceramic, plastic, or fiberglass core. The ends of the wire are soldered or welded to two caps or rings, attached to the ends of the core. The assembly is protected with a layer of paint, molded plastic, or an enamel coating baked at high temperature. Because of the very high surface temperature these resistors can withstand temperatures of up to 450°C. Wire leads in low power wire wound resistors are usually between 0.6 and 0.8 mm in diameter and tinned for ease of soldering. For higher power wire wound resistors, either a ceramic outer case or an aluminum outer case on top of an insulating layer is used. The aluminum cased types are designed to be attached to a heat sink to dissipate the heat; the rated power is dependent on being used with a suitable heat sink, e.g., a 50 W power rated resistor will overheat at a fraction of the power dissipation if not used with a heat sink. Large wire wound resistors may be rated up to 25KW or more. Cooling by natural or forced air convection (fan). Because wire wound resistors are coils they have more undesirable inductance than other types of resistors, although winding the wire in sections with alternately reversed direction can minimize inductance. Other techniques employ bifilar winding, or a flat thin former (to reduce cross section area of the coil). Applications of wire wound resistors are similar to those of composition resistors with the exception of the high frequency. The high frequency of wire wound resistors is substantially worse than that of a composition resistor.



- **Neutral grounding resistors:**

The purpose of a neutral grounding resistor is to limit the ground fault current to a safe level (typically up to 400 amps based on the guidelines contained in IEEE-142) so that all the electrical equipment in the power system is protected. The resistor should be the only current path between the neutral of power transformers or power generators and ground.

When the neutral of a system is not grounded it is possible for destructive transient overvoltages (high ground fault currents up to 20000 amps) to appear from line to ground during normal switching of a circuit having a line to-ground fault. Experience has proved that these overvoltages cause aging and failure of insulation at locations on the system other than at the point of fault. In this way, a relatively unimportant line-to ground fault on one circuit may result in considerable damage to equipment and interruption of service on other circuits, not to mention the increased difficulty in finding the original location of the problem.

A neutral grounding resistor is designed to limit the ground fault current to a safe value while at the same time letting enough current to flow to operate the protective relays that will clear the fault. While the disturbance lasts the resistor must be capable of absorbing and dissipating the energy generated without exceeding the temperature limits established by IEEE-32 Standards. In this way the fault is safely limited, isolated, and the power system is protected against overvoltages.

