Grid Resistors: Tied Live Designs

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WHAT IS “TIED LIVE”?

Tied live is a design feature used to reduce the voltage potential between two points in a high-voltage design. It has an added effect of fixing the voltages in a design so that they do not float.

WHEN IS "TIED LIVE" DESIGN USED?

Tied live construction is used on almost all designs greater than 1500 V_{AC}. The most common applications that use this construction are neutral grounding resistors (NGRs) and harmonic filter resistors (HFRs).

Example:

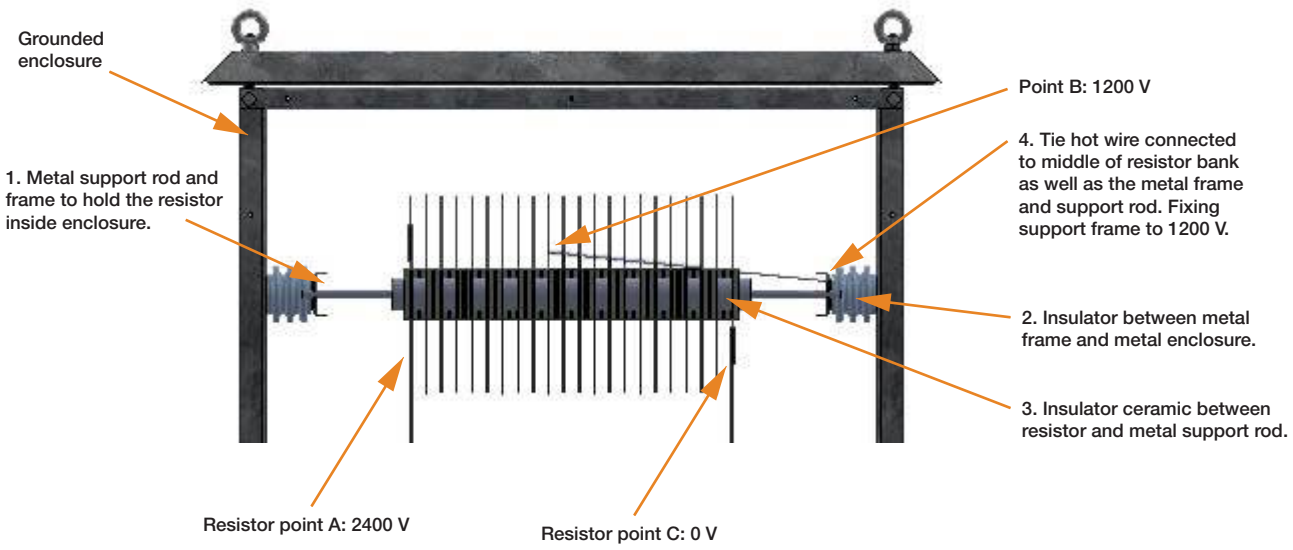

Fig. 1

In Figure 1 the resistor is mounted inside an enclosure with 2400 V across the resistor.

1. The resistor is suspended inside the enclosure by a metal support rod bolted to a metal frame on both sides.
2. The metal frame is then insulated from the enclosure by standoff insulators.
3. The resistors are insulated from the metal support rods by ceramic insulators.
4. There is a wire connecting the middle of the resistor bank to the support rod/frames and this is called the “Tie Hot” wire, which is the piece that changes the design to the “tied live” design.

In this example:

- Point A = 2400 V
- Point B = 1200 V (and because of the wire connection the support rod and frames are also set at 1200 V)
- Point C = 0 V

APPLICATION NOTE

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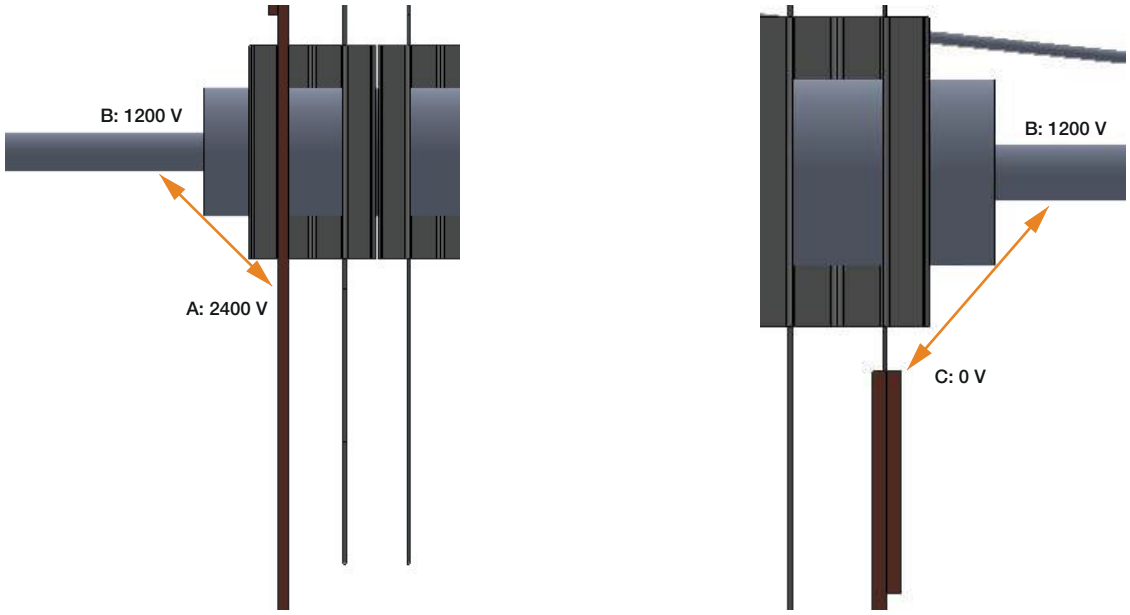
The potential difference between the resistor at Point A and the rod supporting it (fixed at 1200 V due to the Tie Hot wire) is 1200 V.

The potential difference between the resistor at Point C and the rod supporting it is also 1200 V.



Since the support rod and frames are insulated from the grounded enclosure as well as the resistor (except at the point it's tied to), there will be no current flow through the Tie Hot wire and through support rods/frames. The Tie Hot wire acts only to set the voltage potential of the support rods/frames to 1200 V.

WHY NOT LEAVE THE TIE HOT WIRE OFF AND USE A NON-TIED LIVE DESIGN?

In the Figure 1 example, if the Tie Hot wire was removed then the potential difference between the resistor at Point A and the supporting rod would be the full 2400 V (assuming the rod was 0 V). Without the Tie Hot wire the insulation has to work twice as hard (has to insulate twice the amount of voltage) as it does with the Tie Hot wire.

If the ceramic insulation separating the rod and the resistor was only good for 2000 V, then the insulation would be more than sufficient to insulate a 1200 V potential difference with the Tie Hot in place, but would be under-rated by 400 V with no Tie Hot wire connection, resulting in a much greater likelihood of experiencing an arcing situation between Point A and the supporting rod.

WHY IS THIS GOOD PRACTICE?

In high-voltage applications, any metal components (such as the support rod / frames) that are not fixed to a voltage are considered floating. A floating voltage means that the potential can shift and swing due to environmental fluctuations. Electromagnetic fields, weather, and other electrical phenomenon can cause floating metal components to change their electrical potential, leaving a much greater possibility of arcing of components to the floating metal components. This is why it is common to ground a metal enclosure for electrical cabinets and metal cabinets that house flammable components. Grounding the cabinet fixes the potential to 0 V or ground. A tied live design essentially does the same thing for the intermediate supporting structure inside the enclosure, but it fixes the supporting structure to a voltage value halfway between the extreme end of the resistor and the enclosure to increase the effectiveness of the insulation being used.

NGR datasheet	www.vishay.com/doc?31873
NGR Application Form	www.vishay.com/doc?49904