

THE IMPORTANCE OF THE NEUTRAL CONNECTION IN 3-PHASE SURGE DIVERTERS

A surge diverter is a shunt, or parallel connected device, designed to conduct harmful surge energy away from equipment which might otherwise be damaged. A typical surge diverter contains metal oxide varistors (MOVs) and gas discharge tubes (GDTs) – at normal mains voltages, these components appear as a virtual open circuit and do nothing. When a surge is encountered on the line, the MOVs and GDTs go into a conductive state, dissipating the energy supplied by the surge.

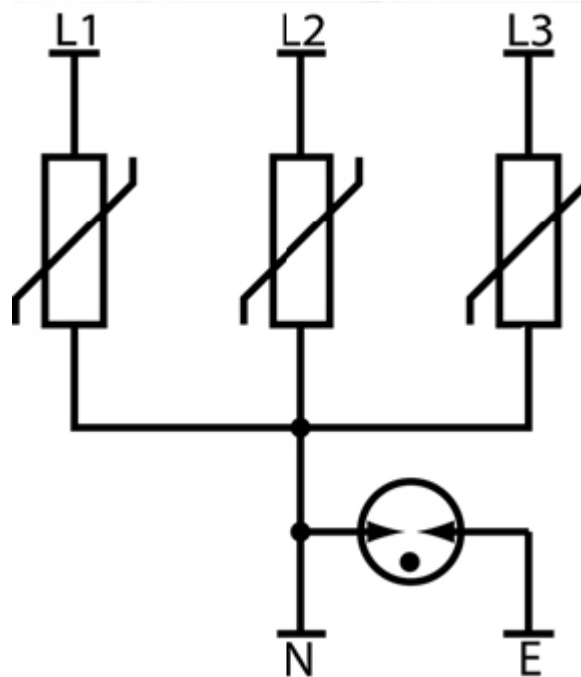


Figure 1: Representative surge diverter schematic

Figure 1 shows a representative schematic of a 3-phase surge diverter. Between each line and neutral there is a metal oxide varistor, between neutral and earth there is a gas discharge tube. Transverse mode protection is provided by the MOVs; common mode is provided by the addition of the GDT.

Under normal installation conditions, the diverter is virtually transparent to the overall system. MOVs feature some leakage current at mains voltages but it is negligible (10-100 μ A), whilst the GDT is totally benign until its break over voltage is reached (typically 350Vpk). In a properly installed MEN distribution system there should be negligible voltage between neutral and earth.

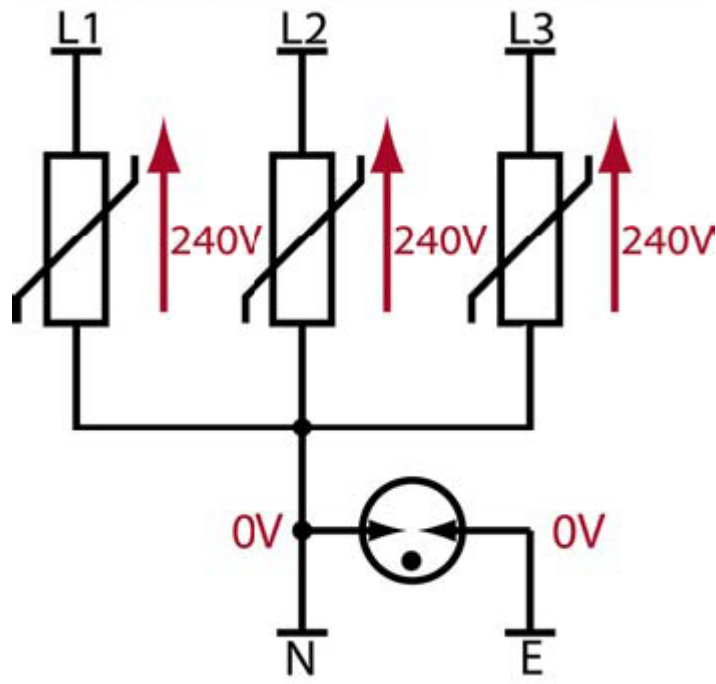


Figure 2: Normally connected surge diverter

Figure 2 shows the state of the surge diverter circuit during normal operation. Neutral and earth are bonded at the MEN link thus are, for all intents and purposes, at the same voltage reference. The MOVs are connected in a star configuration, with the phase-neutral voltage on each line dropped across the MOV.

At the rated operating voltage, MOVs exhibit a small leakage current (in the vicinity of 100uA). Most MOVs are produced with tolerances of +/- 20%, which means that the leakage current through each MOV at any given voltage may vary by as much as this.

So long as the star point of the three phases is tied to a stable reference (i.e. ground, via the MEN link) the voltage seen between each phase and the star point will be the same as that of the supply. If however, the neutral connection is removed from the diverter, the star point will no longer be referenced to ground and will tend to float towards the potential of the phase with the greatest load. As the potential of one phase is approached, the potential between the other phases and the star point increases proportionally, until a point of equilibrium is reached.

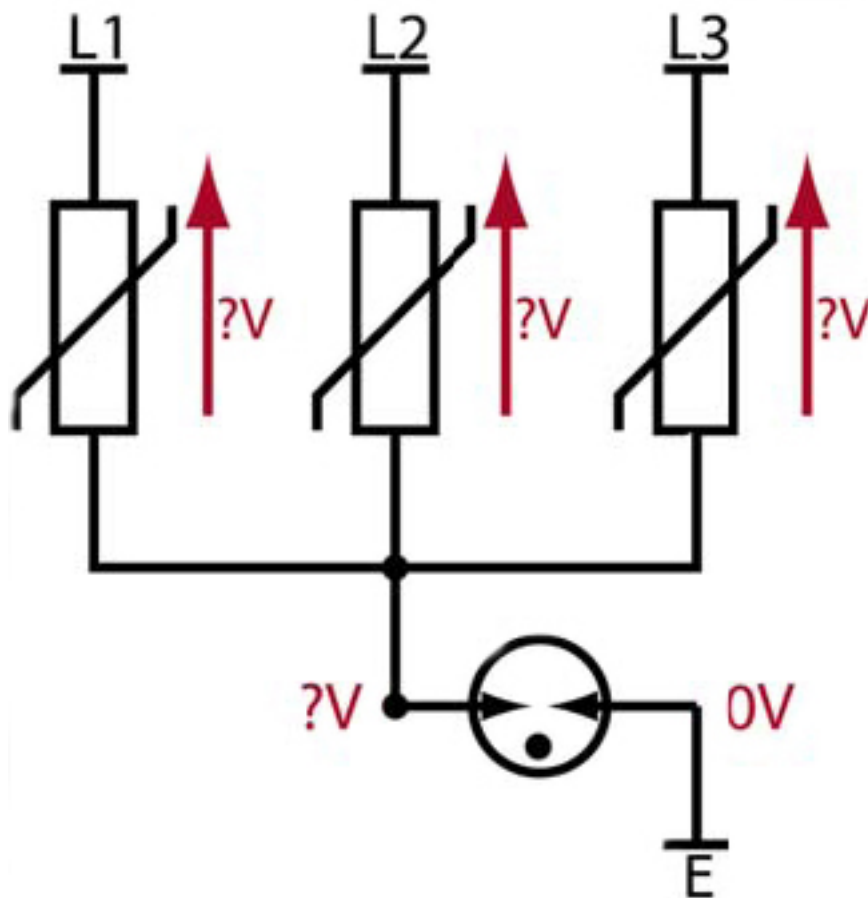


Figure 3: Surge diverter without neutral connection

The voltage dropped across a MOV needs only to increase by a small amount before heating effects will cause it to self-destruct. In the case of a 275V MOV, which are standard in surge diverters for Australia, 320V is more than enough to cause rapid heating and breakdown of the element. In a star connected surge diverter without a neutral reference, it is common for the voltage across two of the phases to reach this level as the star point drifts towards the remaining phase.

Examination by Novaris of surge diverters which have failed after being operated without a neutral reference has confirmed this phenomena. In most instances, the MOV elements of two phases have exhibited signs of overheating and failure, whilst the remaining phase is undamaged.

During installation of a surge diverter, the correct connection of all conductors is critical to the correct operation of the device. Not only does the ability of the diverter to provide surge protection depend on the availability of a neutral reference; the diverter itself is likely to fail even in its passive state.