11. What are zero sequence harmonic filters and how do they reduce 3rd harmonic currents and prevent neutral conductor overheating?

Zero sequence currents, in simple terms, are those found in the neutral conductor. They include the unbalanced 60 Hz currents and the 3rd, 9th, 15th and other triplen harmonic currents. Zero sequence currents appear in the neutral because they do not cancel in the way that 60Hz currents cancel. This is due to the fact that the zero sequence component on one phase is always in phase with the zero sequence components of the other 2 phases (for further explanation of this see Question 7). 60 Hz current on one phase, on the other hand, is always 120° out of phase with the other phases 60 Hz current which causes their balanced portions to cancel in the neutral. The windings of a zero sequence filter (ZSF) are connected in a manner that exploits the fact that zero sequence currents are always in phase.

Figure 11-1 shows the windings of a simple ZSF. Here the coils on each phase are split between two core legs and wound in opposite polarity. Since the zero sequence current vectors (A_0, B_0 and C_0) are always in phase, the flux produced on one coil in each leg will cancel with the flux produced in the second coil on the same leg. Since the zero sequence flux is cancelled, the impedance to the flow of zero sequence currents will be extremely low. When connected in parallel at a power panel or busduct on the power distribution system, the low zero sequence impedance of the ZSF will attract the zero sequence harmonic currents and provide an alternate path back to the loads. This off-loads the neutral conductor and upstream transformer of these currents (see Figure 11-2).

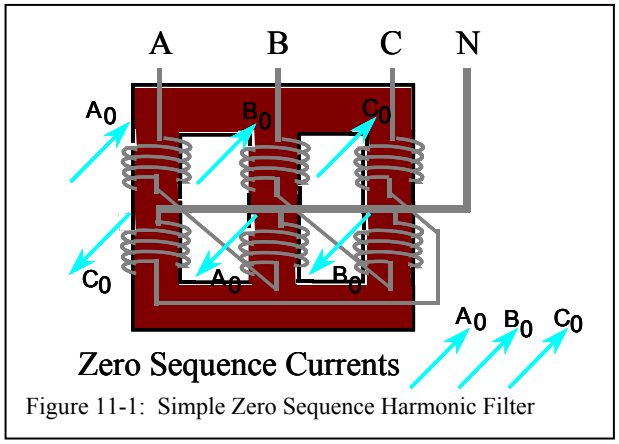

Figure 11-1: Simple Zero Sequence Harmonic Filter

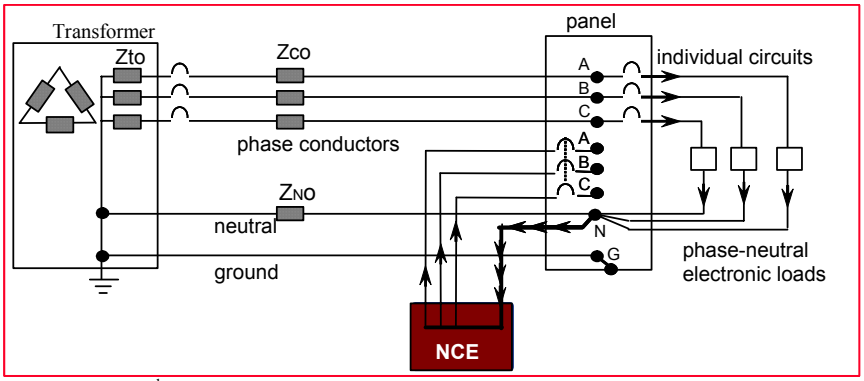

Figure 11-2: 3rd Harmonic and other zero sequence currents diverted through a zero sequence filter