The three-phase transformer

Three-phase connections

Three-phase transformers can have their windings connected in various ways: star, delta or zigzag connection. The connection type must be specified on the transformer’s rating plate.

Star, delta or zigzag connection is indicated by the letters Y, D and Z for the side with the highest voltage and y, d and z for the side with the lowest voltage. If the neutral point is connected to separate terminals, the code should be YN or ZN for the high-voltage side and yn or zn for the low-voltage side.

Common to all the connection types is that the transformer’s phase terminals are marked 1U, 1V and 1W on the high-voltage side and 2U, 2V and 2W on the low-voltage side. Any connection point which represents the windings’ neutral point is marked 1N or 2N.

Star connection

In the case of star connection the three windings are connected together at their end points. The connection point represents the windings’ neutral point. Star connection is indicated by Y on the high-voltage side and y on the low-voltage side. This connection type is used for both low and high voltages and for low currents.

Delta connection

In the case of delta connection the ends of the windings are connected together as shown in the diagram. We can see that both the ends are connected together. Delta connection is indicated by D or d. This connection type is used mainly for high rated currents and low voltages.

Zigzag connection

Each phase consists of two equal windings on unequal limbs. There will therefore be parts of two phases on each limb, with one winding on each limb being connected together at the end points. Zigzag connection is indicated by Z or z. This connection type requires 15.5% more windings than star or delta connection, resulting in a larger and more expensive transformer. It is mainly used where load unbalance can occur between the phases and neutral.
**Vector groups**

The connection of all the windings in a three-phase transformer is indicated by a vector group symbol. This symbol indicates the winding connections and their relative phase displacement by means of a numerical index (e.g., Dny11). The “clock method” is used to produce the numerical index of the vector group, with each hour representing 30 electrical degrees. The numerical index of the vector group comes from the clock hour figure the phase voltage hand (2U) is at when the phase voltage hand of the high-voltage winding (1U) is at 12 o’clock. The system’s phase sequence should be 1U, IV, 1W, or R, S and T. The following are common three-phase connections: