

Theory:

There are two types of system available in electric circuit, single phase and three phase system. In single phase circuit, there will be only one phase, i.e the current will flow through only one wire and there will be one return path called neutral line to complete the circuit.

Three phase circuit is the polyphase system where three phases are send together from the generator to the load. Each phase are having a phase difference of 120° , i.e 120° angle electrically. So from the total of 360° , three phases are equally divided into 120° each. The power in three phase system is continuous as all the three phases are involved in generating the total power.

In three phase circuit, connections can be given in two types:

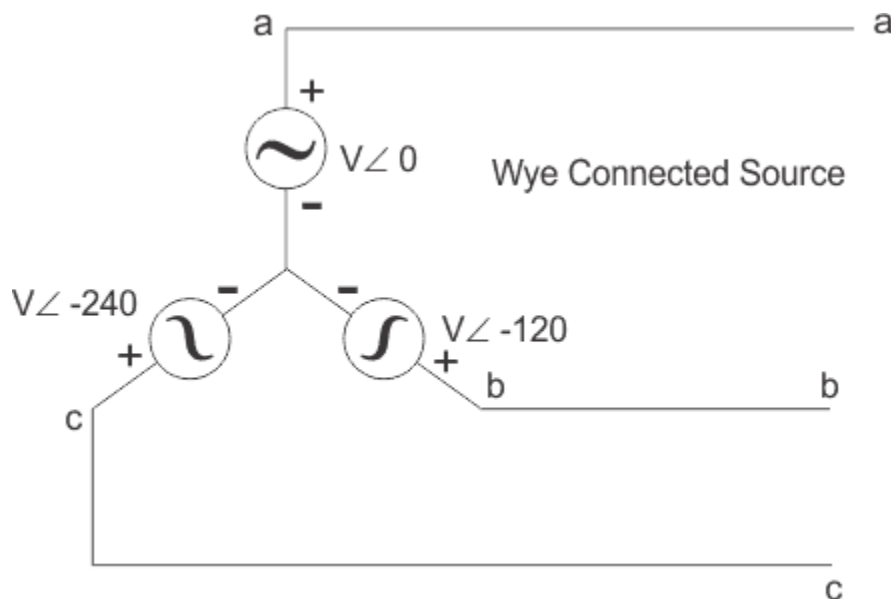
1. Star connection
2. Delta connection

1. Star Connection

In star connection, there is four wire, three wires are phase wire and fourth is neutral which is taken from the star point. Star connection is preferred for long distance power transmission because it is having the neutral point. In this we need to come to the concept of balanced and unbalanced current in power system.

When equal current will flow through all the three phases, then it is called as balanced current. And when the current will not be equal in any of the phase, then it is unbalanced current. In this case, during balanced condition there will be no current flowing through the neutral line and hence there is no use of the neutral terminal. But when there will be unbalanced current flowing in the three phase circuit, neutral is having a vital role. It will take the unbalanced current through to the ground and protect the transformer. Unbalanced current affects transformer and it may also cause damage to the transformer and for this star connection is preferred for long distance transmission.

The star connection is shown below-

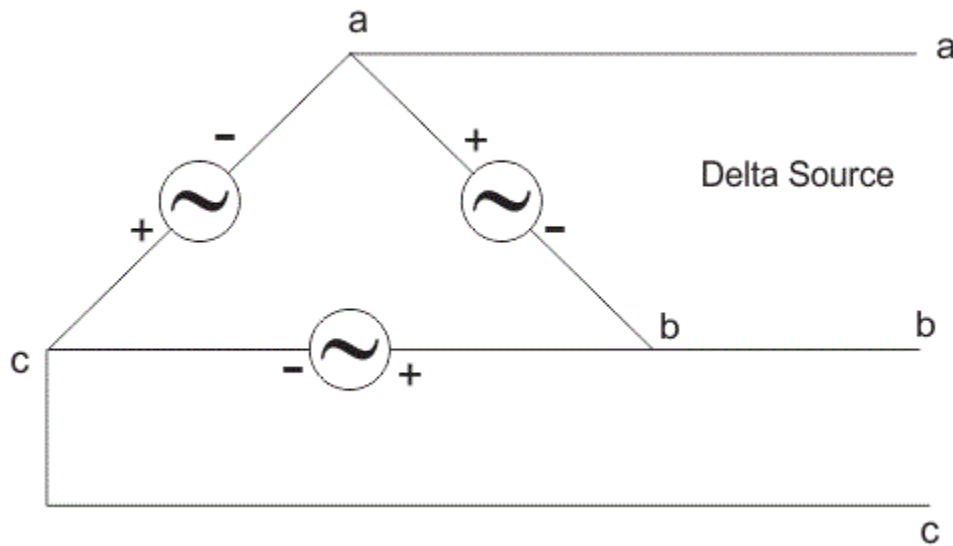


In star connection, the line voltage is $\sqrt{3}$ times of phase voltage. Line voltage is the voltage between two phases in three phase circuit and phase voltage is the voltage between one phase to the neutral line. And the current is same for both line and phase. It is shown as expression below

$$E_{Line} = \sqrt{3}E_{phase} \text{ and } I_{Line} = I_{Phase}$$

2. Delta Connection

In delta connection, there is three wires alone and no neutral terminal is taken. Normally delta connection is preferred for short distance due to the problem of unbalanced current in the circuit. The figure is shown below for delta connection. In the load station, ground can be used as neutral path if required.



In delta connection, the line voltage is the same as that of phase voltage. And the line current is $\sqrt{3}$ times of phase current. It is shown as expression below,

$$E_{Line} = E_{phase} \text{ and } I_{Line} = \sqrt{3}I_{Phase}$$

In a three-phase circuit, star and delta connection can be arranged in four different ways:

1. Star-Star connection
2. Star-Delta connection
3. Delta-Star connection
4. Delta-Delta connection

But the power is independent of the circuit arrangement of the three phase system. The net power in the circuit will be same in both star and delta connection. The power in three phase circuit can be calculated from the equation below,

$$P_{Total} = 3 \times E_{phase} \times I_{phase} \times PF$$