

Fig: Three phase Transformer

AIM:- Verify the relationships (line-line voltage, phase-to-neutral voltage & line and phase currents) in three-phase transformers for star and Delta connections. What are phase shifts between the primary & secondary side?

Required Apparatus:

| S.No | Material required       | Specification/<br>Rating | Quantity           |
|------|-------------------------|--------------------------|--------------------|
| 1.   | Transformer Panel       | 3-Phase                  | 1                  |
| 2.   | Variable Resistive Load | 0-1500 W                 | 1                  |
| 3.   | Connecting Leads        | 1mm square               | as per requirement |

Theory:-

A transformer for use with 3-phase power is constructed by winding three phase single phase transformers on a single core. In a three-phase transformer, there is a three-legged iron core as shown in fig.

Each leg has a respective primary and secondary winding. As can be seen, the three-phase transformer actually has 6 windings



(or coils) 3 primary and 3 secondary.

Connection of Three Phase Winding:

In power applications, these windings are usually connected in one of two configurations.

- Delta or
- Wye

In a Delta connection, there are three phase and no neutral. An output Delta connection can supply a three-phase load.

In a Wye connection, there are three phase and a Neutral. An output Wye connection enables the transformer to supply a three phase voltage and also a voltage for single phase loads, namely the voltage between any phase and neutral. The Neutral point can also be grounded to provide greater safety.

When circumstances permit, most industry professionals prefer to use the Delta input. Wye output connection for connecting a 3-phase transformer connection in power distribution applications.



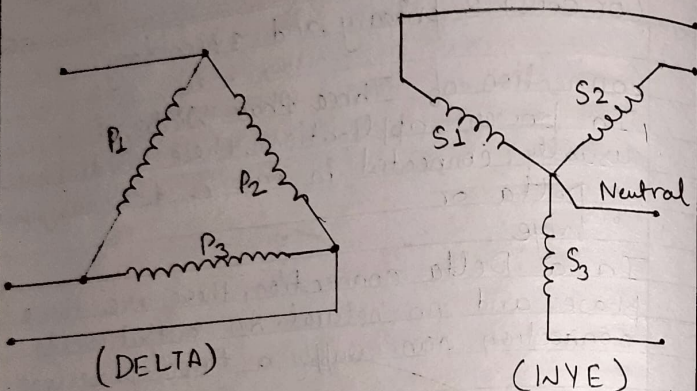


Fig: Three Phase Winding Connection

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Relationship. In between voltages or / and currents:

Star connection: In a 3-phase AC circuit, line voltage is equal to 1.732 times of the phase voltage and line current is equal to the phase current.

$$V_L = \sqrt{3} V_{ph}$$

$$I_L = I_{ph}$$

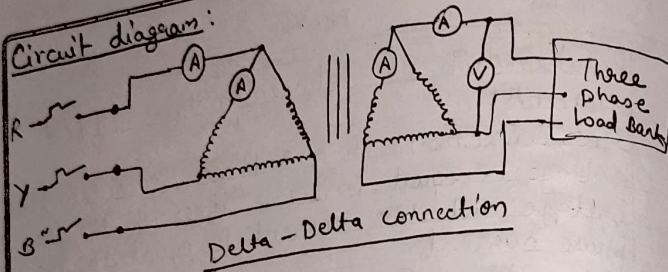
Delta connection: In a 3-phase delta connection line current is equal to 1.732 times of the phase current and line voltage is equal to phase voltage.

$$I_L = \sqrt{3} I_{ph}$$

$$V_L = V_{ph}$$

Observation Table:

Circuit diagram:



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- \* Phase shift b/w the primary and secondary side:  
The angle b/w primary and secondary side line voltage is known as phase shift.

| Primary | Secondary | Displacement |
|---------|-----------|--------------|
| Delta   | Wye       | $30^\circ$   |
| Wye     | Delta     | $30^\circ$   |
| Delta   | Delta     | None         |
| Wye     | Wye       | None         |

\* Precaution:-

- Do not put on the supply until the circuit is checked by connected teacher.
- Do not touch any live part of circuit.
- Be careful primary & secondary winding rated current.

\* Result:-

We have successfully performed measurement of the primary and secondary voltages and current, in various connections of windings of 3-phase transformer and studied about phase shift.



## Viva - Questions

Q.1 What are the uses of three phase transformer?

Ans. 3-phase power is used by electric power distribution grids and to power large motors and other large loads. Like other types of transformers, three phase transformers are used to increase or decrease the voltage from one side of the transformer to the other.

Q.2 What is the difference between single phase and three phase transformer?

Ans. Single-phase transformer contains two coils, one on the primary side, and another one on the secondary side, while three phase transformer contains six coils, three for primary side and three coils for the secondary side.

Q.3 What is 3-phase transformer explain construction and connections of 3 phase transformer?

Ans. The three phase transformer is constructed in two ways. Three separate single phase transformer is suitably connected for three phase operation. A single three-phase transformer in which the cores and windings for all the three phases are merged into a single structure.



Q.4. What are the two general types of three phase transformer?

Ans → The primary may be connected phase to ground or phase to phase. The secondary is usually grounded on one terminal. There are three primary types of voltage transformers (VT): electromagnetic, capacitor, and optical. The electromagnetic voltage transformer is a wound - wound transformer.

Q.5. What are the advantages of three-phase transformer?

Ans → To provide the same KVA, the core material required is very less compared to a bank of three single phase transformers. Low cost compared with three units of single phase transformers. Transportation is easy and also transportation cost is less.

Q.6. What is the advantage of 3 phase over single phase?

Ans → The advantages of three phase over a single phase system are: The amount of conductor material required is less for three phase system. Domestic power and industrial/commercial power can be provided from the same source for three phase system. Voltage regulation of



a three phase system is better.

Q.7. Can single phase transformers be used for three phase applications?

Ans. Yes, Three phase transformers are sometimes not readily available whereas single phase transformers can generally be found in stock. Three single phase transformers can be used in delta connected primary and wye or delta connected secondary.

Q.8. What is advantage of Delta connection?

Ans. An advantage of the Delta connection is higher reliability. If one of the three primary windings fails, the secondary will still produce full voltage on all three phases. The only requirement is that the remaining two phases must be able to carry the load.

Q.9. What is difference between Star and delta Connection?

Ans. In star connection, line voltage is equal to root three times of the phase voltage, whereas in delta line voltage is equal to the phase voltage. In star connection, phase voltage is low as  $1/\sqrt{3}$  times of the line voltage.



whereas in Delta connection Phase voltage is equal to the line voltage.

Q.10. What happens if transformer is overloaded?

Ans. Overload is when a transformer is subjected to voltages and/or currents that exceed its design specifications. During overloading conditions, excess heat will cause the insulation system to break down, resulting in decreased life expectancy of the transformer.

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