

UNIVERSITY OF NORTH CAROLINA AT CHARLOTTE

Department of Electrical Engineering

Three-Phase Transformer Connections

INTRODUCTION

Three single-phase transformers can be connected in one of four ways to form a three-phase bank. The wye-delta connection is commonly used to step from a high voltage down to a medium-to-low voltage. This configuration also permits a neutral on the high voltage side, which is desirable in most cases. To accomplish just the opposite, the delta-wye connection would be used.

The delta-delta connection has the advantage that one transformer can be removed for maintenance while the remaining two transformers can continue to supply 58% of the original rated capacity of the bank. Such a configuration is often called an open-delta connection.

The wye-wye is seldom used due to the difficulties that occur (exciting-current phenomena) when the source-side neutral is missing or becomes disconnected.

Also quite common are three-phase transformer banks in which all three phases (six windings) are wound on a common multi-legged core and placed in a single container. The advantages of such a design is that it weighs less, cost less, require less floor space, and is somewhat more efficient.

ASSIGNMENT

The student is to study unbalanced load conditions in various three-phase transformer connections using three, single-phase transformers and WITHOUT USING A NEUTRAL CONNECTION!

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REFERENCES

1. References on reserve in the library.
2. Textbooks on electromagnetic devices and power distribution systems.
3. Faculty with expertise in the area of electromagnetic devices and power distribution systems.

EXPECTED RESULTS (as a minimum)

The answers to the following questions and problems should be included the discussion and conclusion of the report.

- I.
 1. Why was it necessary to set circuit breakers at a current of much more than rated current?
 2. What precaution was taken with the load circuit?
- II.
 1. Using primary line voltage, type connection, and the turns ratio of the transformers, calculate secondary phase and line voltages.
- III.
 1. Draw phasor diagrams showing secondary voltage and current phasors for parts b-2, c-2, and d-2.
- IV.
 1. Why is it necessary to measure the voltage across the open corner of the low-side delta before completing the connection?
 2. If a single-phase load had been connected to the delta-delta bank, would the voltage unbalance have been appreciable?
- V.
 1. Was the voltage unbalance appreciable for the open-delta bank supplying single-phase load?
 2. Would a greater unbalance of voltages exist with the single-phase load connected across one transformer secondary? If so, would the unbalance be too great?
- VI.
 1. Under no-load conditions, does the line-to-line voltage on the low side of the delta-Wye obey the $\sqrt{3}$ times line to neutral conditions?
 2. Did the connection under load conditions yield practically balanced voltage?
 3. Under load condition, was all the load supplied by one transformer?
- VII.
 1. Did the line-to-neutral voltage and line-to-line voltage on the high side of the Wye-delta obey the $\sqrt{3}$ relationship? If not, why?
 2. Why is 3rd harmonic voltage present from line-to-neutral?
 3. What was the magnitude of the voltage measured across the open corner expressed as a percentage of the voltage across one transformer?
 4. What contributed to the voltage across one transformer low side?
 5. What happened to the fundamental voltage of the transformer low sides at the open corner?
 6. What effect would a solid primary neutral connection have on the wave shapes of the low-side voltages?
- VIII.
 1. In the delta-delta connection, the voltage across an open corner must be zero before the corner may be closed. Why was this requirement unnecessary for the Wye-delta connection?
 2. After closing the delta corner, did the line-to-line voltage on the high sides obey the $\sqrt{3}$ times the line-to-neutral voltage?
 3. Were the low side voltages practically balanced when load was applied?
 4. Discuss the results obtained with respect to currents in the individual transformer secondaries.
- IX.
 1. What is the magnitude of the third-harmonic voltage of each transformer in the Wye-Wye connection?
 2. Compare the line-to-neutral voltages on the low side measured under load conditions with the low-side line-to-line voltages. What peculiarity is evident?
 3. Explain the results for loaded condition.

