

## Fault Current Distribution in Star– Zig Zag Transformer with source on Zig Zag side

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Figure 1 shows a transformer with a Star–Zig Zag vector group, with the source connected to the Zig Zag winding. Consider a line-to-ground (L–G) fault on the R phase of the star side of the transformer. The possible current distribution on both the star side and the Zig Zag side is shown.

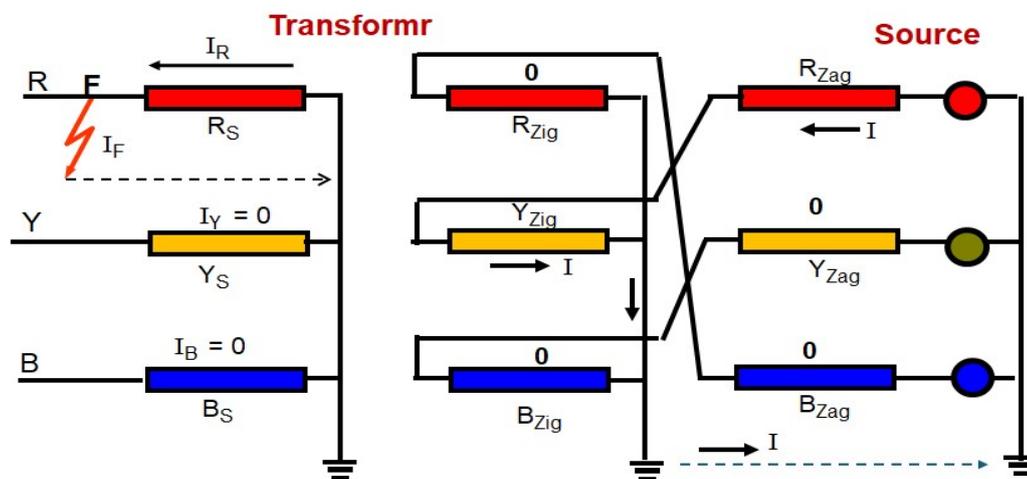


Fig 1

Assuming the transformer is initially operating under no-load conditions, the currents on the star side are  $I_Y = I_B = 0$ . There is no ambiguity for the B phase, as currents on both the star side and the Zig Zag side are zero, thereby maintaining ampere-turn (AT) balance, which is a fundamental requirement for transformer operation.

For the sake of argument, assume that a fault current  $I_R = I_F$  flows in the faulted phase, and that an equivalent reflected current  $I$  flows through the  $R_{Zag}$  winding. Due to the Zig Zag winding connection, this would imply that the same current  $I$  must also flow through the  $Y_{Zig}$  winding connected in series. However, this violates the AT balance principle, since the corresponding reflected current on the star side is  $I_Y = 0$ . As a result, no current can flow on either the Zig Zag side or the star side. Therefore, for an (L–G) fault on the star side,  $I_R = 0$ .

Despite the fact that the neutrals of both the star winding and the Zig Zag winding are solidly grounded, for ground fault on star side, it acts like ungrounded system! Consequently, current-based protection relays will not operate. Only voltage-based protection schemes (for example, relays connected to an open-delta PT) will respond. Since voltage-based relays are not feeder-specific, identifying and isolating the fault requires that feeders be tripped sequentially, as described in Chapter 4 of Reference [1].

In summary, caution is advised when using a Star–Zig Zag transformer with the source connected to the Zig Zag side. For an (L–G) fault on the star side, the system behaves almost like an ungrounded system, even when the star neutral is solidly grounded.

The fault current distribution when the source is connected to the star side of a Star–Zig Zag transformer is discussed in detail in Reference [2].

### **References**

[1] K. Rajamani, *Application Guide for Power Engineers, Part 1 – Earthing and Grounding of Electrical Systems*, Notion Press, 2018.

[2] K. Rajamani and Bina Mitra, “Zig Zag Transformer – Fault Current Distribution, Short Circuit Testing and Single-Phase Loading,” *IEEMA Journal*, July 2013, pp. 84–91.