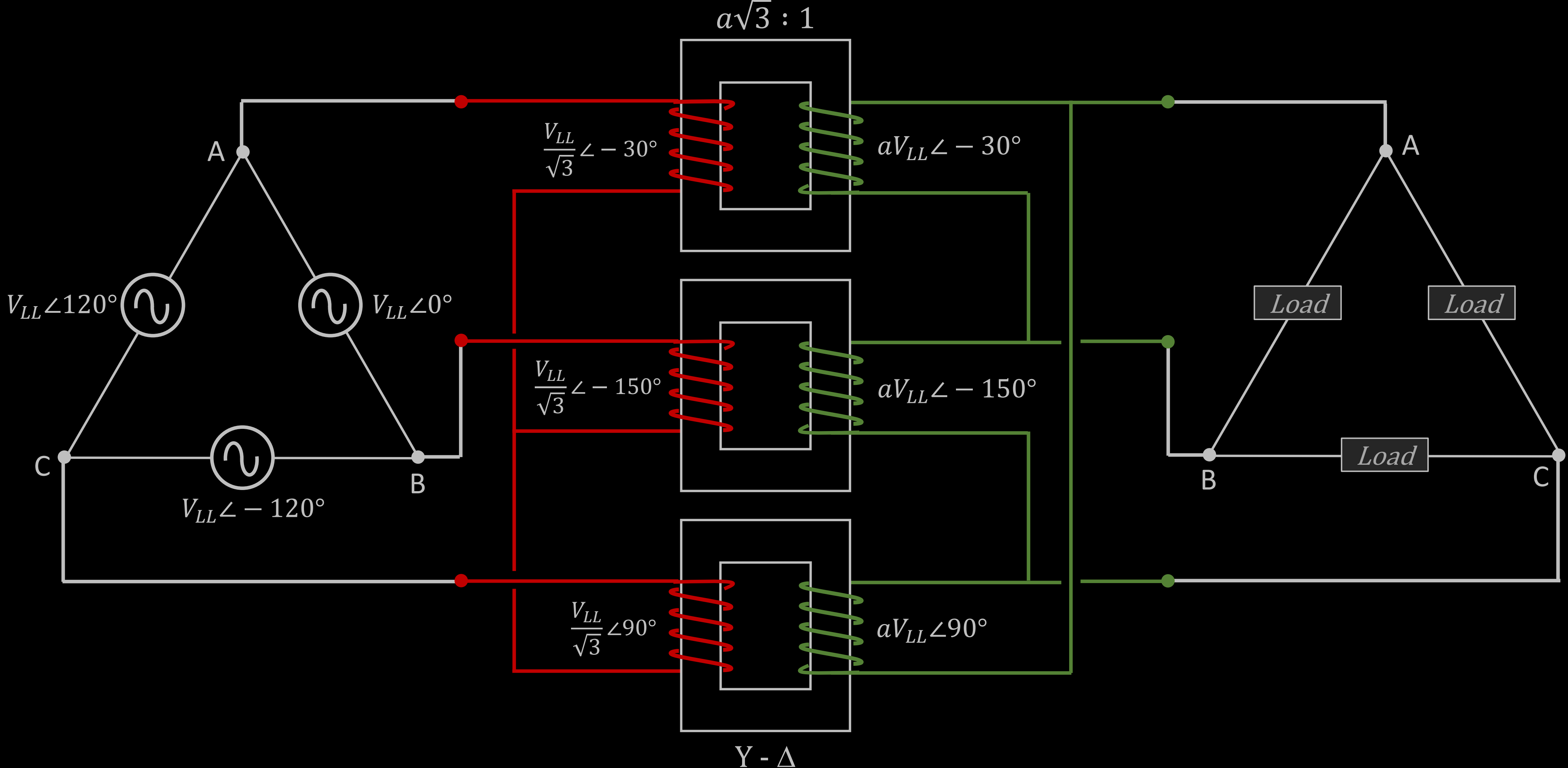
Wye – Delta Transformer Phasing Explained

the question is often asked why the phase voltage of the secondary is 30° out of phase compared to the primary of a Y-Δ connected transformer.

- *the source is line-line or Δ connected …*
- *the load is line-line or Δ connected …*
- *why the phase shift ?*

short answer is because the transformer primary is <u>not</u> Δ connected.
consider the source-xfmr-load system below:



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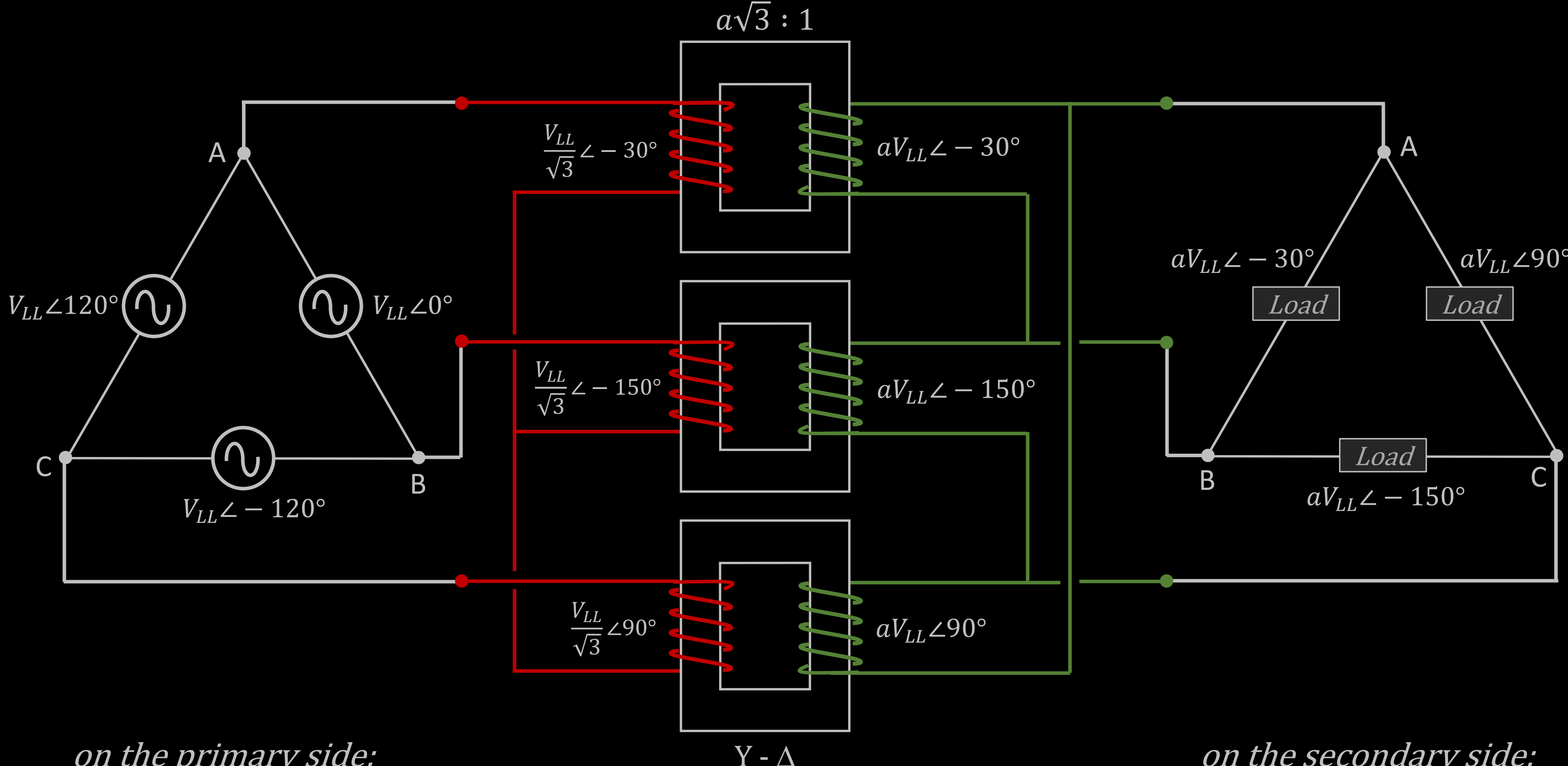


on the primary side:

$$V_{AB} = V_{LL}\angle 0°$$
$$V_{BC} = V_{LL}\angle -120°$$
$$V_{CA} = V_{LL}\angle 120°$$

the secondary voltages lag the primary voltages by 30°

(the delta winding could be wired to lead by 30°)

on the secondary side:

$$V_{AB} = aV_{LL}\angle -30°$$
$$V_{BC} = aV_{LL}\angle -150°$$
$$V_{CA} = aV_{LL}\angle 90°$$

Transformer Vector Groups

Transformer nameplates may carry a vector group reference such as Yy0, Yd1, Dyn11 etc.
This relatively simple nomenclature provides important information about the way in which three phase windings are connected and any phase displacement that occurs.

Winding Connections

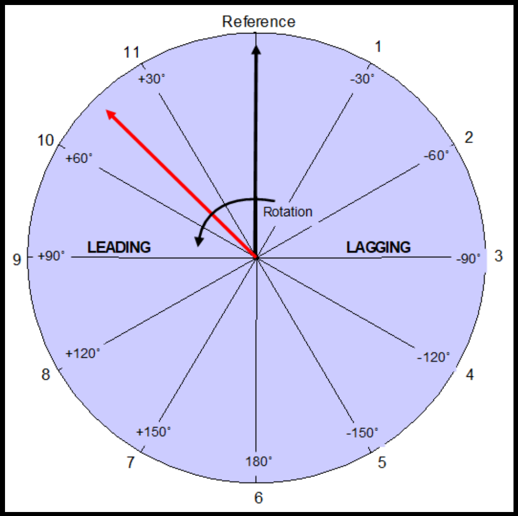
HV windings are designated: **Y**, **D** or **Z** (upper case)
LV windings are designated: **y**, **d** or **z** (lower case)
Where:
Y or **y** indicates a star connection
D or **d** indicates a delta connection
Z or **z** indicates a zigzag connection
N or **n** indicates that the neutral point is brought out
a indicates and autotransformer

Phase Displacement

The digits (0, 1, 11 etc.) relate to the phase displacement between the HV and LV windings using a clock face notation. The phasor representing the HV winding is taken as reference and set at 12 o'clock. Using counterclockwise rotation, It then follows that:
Digit 0 means that the LV phasor is in phase with the HV phasor
Digit 1 that it lags by 30 degrees
Digit 11 that it leads by 30 degrees
etc.

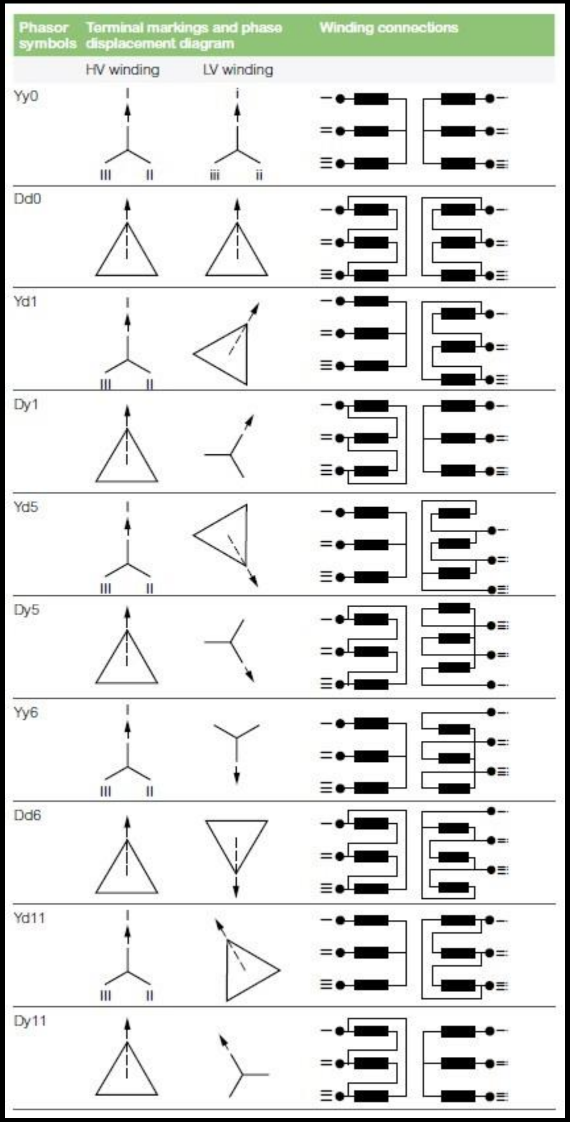
2 Winding Examples:

Vector Designation		LV Angle
Yy0	Dd0	In Phase
Yd1	Dy1	30 lag
Dd2	Dz2	60 lag
Yd5	Dy5	150 lag
Yy6	Dd6	180 lag
Yd7	Dy7	150 lead
Dd8	Dz8	120 lead



Under ANSI standards, there is a standard phase-angle relationship. High voltage quantities always lead low voltage quantities by 30° on Δ-Y transformers.

IEC standards don't define a standard transformer, but rather define a standard nomenclature for describing the vector group. Physically, a Δ-Y transformers can be wound in six different ways resulting in six possible vector groups. The ANSI "standard" transformer could be designated as Dyn1, while the IEC standard would designate it as Ynd1



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Questions or Comments …

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