International Journal of Advance Research in Engineering, Science & Technology(IJAREST),
ISSN(O):2393-9877, ISSN(P): 2394-2444,
Volume 2,Issue 5, May- 2015, Impact Factor:2.125

Phase-Shifting Transformer

Anuj Patel, Henil Patel, Ruchi Joshi, Milap Patel

anujpatel0311@gmail.com, henil.patel003@gmail.com

ruchijoshi2014@gmail.com, milap786@gmail.com

Abstract

In this paper Phase-shifting transformer is discussed Using appropriate connection of transformer. Phase-shifting will be reviewed as one concept for solving certain types of problems related to power quality. A phase-shifting transformer is a special type of system intertie transformers which Control the power flow through specific lines in a complex power transmission network by providing the possibility to insert a voltage with an arbitrary phase angle in the power system. Phase-shifting involves separating the electrical supply into two or more outputs; each output being phase shifted with respect to each other with an appropriate angle for the harmonic pairs to be eliminated.

KEYWORDS- *Phase-shifting Transformer,*

INTRODUCTION

This Special transformer is a Phase-shifting transformer which is an indispensable device in multi-pulse diode rectifier. Phase-shifting transformers help control the real power flow in transmission lines and systems interties. They allow for better utilization of existing networks concerning load growths.This special transformer is a phase shifting transformer which is an indispensable device in multiple diode rectifier.

It provides three main functions:

- A required phase displacement between primary and secondary line-line voltage for harmonic cancellation.
- A proper secondary voltage.
- An electrical isolation between the rectifier and the utility supply.

According to the winding arrangements, the transformer can be classified into:

- Y/Z
- Δ/Z

The application of phase shifting transformers is mainly in high voltage systems (up to 420 KV) and the throughput power rating is quite large (up to 1630 MVA).

PURPOSES OF PHASE-SHIFTING TRANSFORMER:

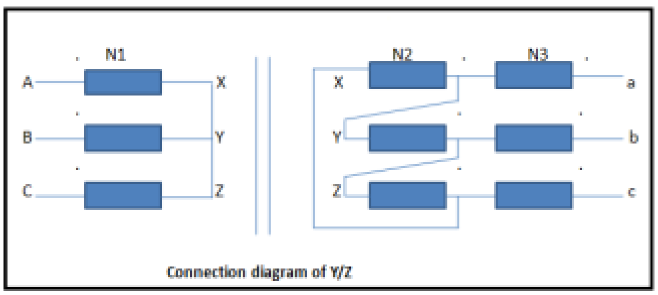
- To control the power flow between two large independent power systems
- To change the effective phase displacement between the input voltage and the output voltage of a transmission line, thus controlling the amount of active power that can flow in the line.
- To balance the loading when power systems are connected together in more than one point so that loops exist and the impedances in parallel paths results in undesired distribution of power flow in the paths.

- To Protect from thermal overload and to improve transmission system stability.

Y/Z PHASE-SHIFTING TRANSFORMER:

The primary winding is connected in wye N1 tunes per phase. The secondary is composed of two sets of coils having N2 and N3 tunes per phase.

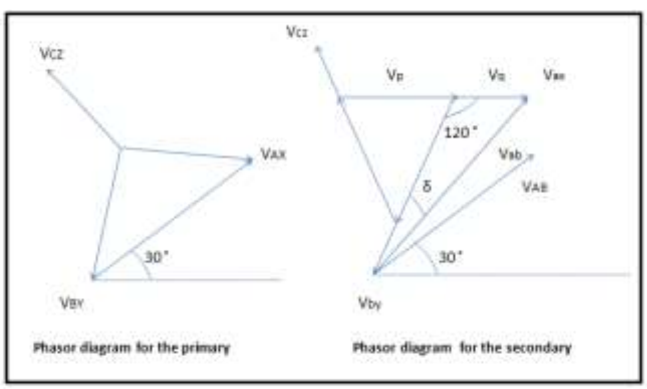
The N2 coil is connected in delta and then in series with the N3 coils. such arrangement is known as zigzag or extended-delta connection.



Connection diagram of Y/Z

Fig.- shows a Y/Z phase-shifting transformer and its phasor diagram which shows that transformer can produce a phase-shifting angle (δ) defined by,

δ = Vab - VAB



Phasor diagram for the primary   Phasor diagram for the secondary

Where Vab and VAB are the primary and secondary line to line voltages respectively. To determine the turns ratio for the transformer, lets consider s triangle composed of VQ, Vby and Vab in the phasor diagrams, from which,

$$\frac{VQ}{Sin(30° - \delta)} = \frac{Vby}{Sin(30° + \delta)} \quad 0° \leq \delta \leq 30°$$

Where VQ is the r.m.s voltage the N3 and Vby is r.m.s phase voltage between terminal b and y. since Vby is equal to Vax in a balance three phase system,

$$\frac{VQ}{Vax} = \frac{Sin(30° - \delta)}{Sin(30° + \delta)}$$

From which turns ratio of the secondary coil is,

$$\frac{N3}{N2 + N3} = \frac{VQ}{Vax} = \frac{Sin(30° - \delta)}{Sin(30° + \delta)}$$

For given value of δ the ratio of N3 to N2+N3 can be determined. Similarly the following relationship can be derived:

$$\frac{Vab}{Sin120°} = \frac{Vby}{Sin(30° + \delta)}$$

From which,

$$Vax = Vby = \frac{2}{\sqrt{3}} Sin(30° + \delta).Vab$$

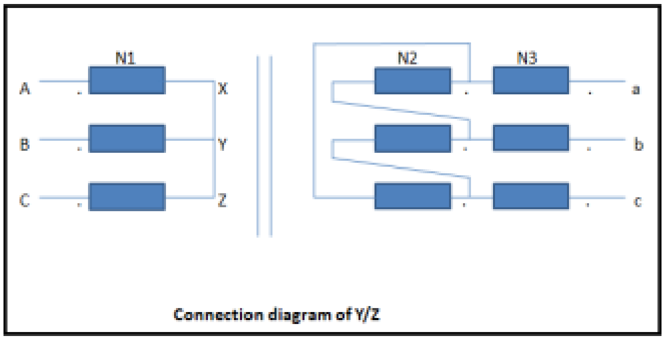
$$\frac{N1}{N2+N3} = \frac{VAX}{Vax}$$

Therefore,

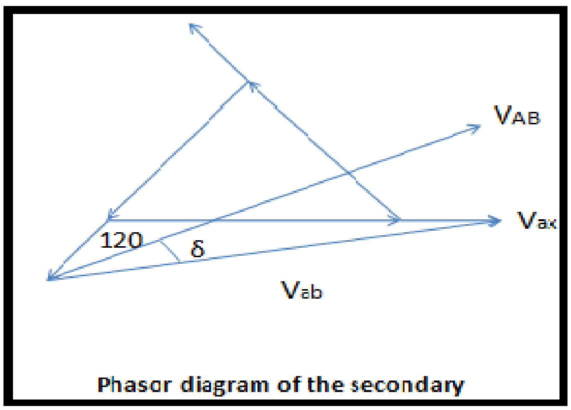
$$\frac{N1}{N2 + N3} = \frac{1}{2.Sin(30° + \delta)} \frac{VAB}{Vab}$$

Where VAB=√3. VAX.

Y/Z PHASE-SHIFTING TRANSFORMER:



Connection diagram of Y/Z



Phasor diagram of the secondary

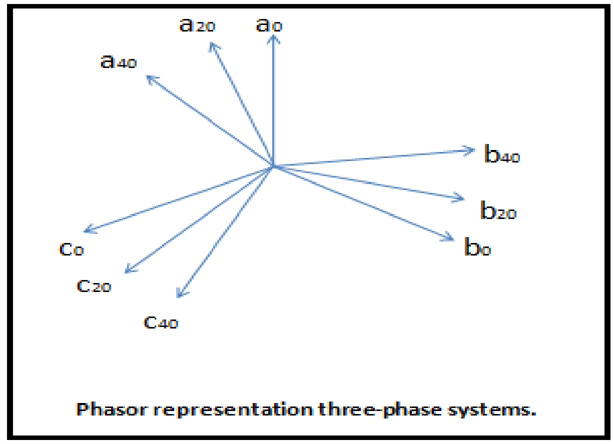
The transformer turns ratio can be found from,

$$\frac{N3}{N2+N3}=\frac{Sin(30°-\delta)}{Sin(30°+\delta)} \quad -30° \le \delta \le 0°$$

$$\frac{N1}{N2+N3}=\frac{1}{2.Sin(30°+\delta)}\cdot\frac{VAB}{Vab}$$

The phase angle δ has a negative value for the Y/Z transformer that Vab lags VAB by δ as shown in fig.-

This way we will get required phase displacement in output and all four different outputs which are 15° displaced are as follows:



Phasor representation three-phase systems.

PHASE-SHIFTING TRANSFORMER PROTECTIONS:

- The over voltage protection must be reviewed with the manufacturers to minimize the effects of transient voltages which can occur at the transformers windings resulting in a high voltages and high frequencies oscillations.
- A special differential protection scheme is required because the phase angle difference between the source and load current cause a much higher normal current difference than in ordinary power transformers.
- Because of harmful short circuit can occur in the connection between the two transformers, it is recommended that the bus ducts to be provided around the conductors connecting the secondary side of the magnetizing transformer to the primary side of the booster transformer.

CONCLUSION:

This paper presents a three-phase 18-pulse phase-controlled rectifier with unity displacement factor, low line current harmonic content, two quadrant operation and the absence of a phase shifting transformer. The circuit is composed by three three-phase 6-pulse rectifiers parallel connected by four balancing reactors. One is a conventional thyristor rectifier with a lag firing angle (δ). The other is an active rectifier composed by GTOs or IGBTs and diodes, operating with a lead (and symmetrical) firing angle (-δ). The 18-pulse operation with line frequency modulation provides a line current with reduction or cancellation of certain harmonics. Circuit operation, theoretical analysis, key equations are presented.

REFERENCES:

- R. K. Tiwari, J. S. Kuntia, and S. Sachdeva, "Development of Phase Shifting Transformers" Presented in International Conference on transformers-2009 held by CBIP in New Delhi, India.
- J. Verboomen, D. V. Herten, W. L. Kling, and R. Belmans, "Phase shifting transformers: Principles and applications," Future Power System, International Conference on, 2005.
- W. L. Kling et al, "Phase shifting transformers installed in the Netherlands in order to increase available international transmission capacity," in CIGRE Session 2004 – C2-207, 2004.
- Phase Shifting Transformers: Principles and Applications(Book by John Winders, CRC Press, Apr 12, 2002