International Journal of Research in Engineering, Science and Management
Volume-1, Issue-12, December-2018
www.ijresm.com | ISSN (Online): 2581-5792

Power Electronic based On-Load Tap Changer

Harshal R. Sawake[1], Bilal V. Sande[2], Venugopal A. Ekkaldevi[3], Sourabh R. Argade[4], Narendra P. Zinjad[5]

[1,2,3,4]*UG Student, Department of Electrical Engineering, Dr. D. Y. Patil Institute of Technology, Pune, India*

[5]*Professor & HoD, Department of Electrical Engineering, Dr. D. Y. Patil Institute of Technology, Pune, India*

***Abstract*: This paper represents a new tap changing method which is designed. Now a days, the power quality issue increases day by day. Then new method is required for improvement of power quality. In this paper, design switching topology of transformer by using relay take place. Because of this topology fast tap changing can be takes place. There are no arc will be produce. In mechanical switching arc is produced and required more time than other technologies due to voltage sag and voltage swell as well as more maintenance required. This problem is removed in this switching technology. It has been tested for reliability and for maintaining the operation voltage of the system.**

***Keywords*: TRIAC based on load tap changer , Primary taping OLTC, TRIAC, Comparator, Potential Transformer, opto-coupler, Arduino , MOSFET ,GTO .**

1. Introduction

Power quality has long been a major concern in power system design and operation. And this issue is becoming more critical considering the growing attention on smart grid with unstable renewable energy source, such as solar panel and wind turbine. Several measures can be taken to stabilize power transmission and improve power quality, such as voltage regulator, reactive power compensation, large scale energy storage, etc. In today's power system design the most widely used technology for voltage regulation is to adjust the transformer voltage through a tap changer. Traditional On load tap changer (OLTC) works with mechanical switches (interrupter) it has the drawback of wearing on electrical contacts and mechanical parts which requires service/overhaul operation and relatively low tap changing speed limiting to its possible functional performance. With advancement of technology things are becoming simpler and easier for us. The concept of power electronics tap change (PE-OLTC) has been proposed to address the drawback of traditional OLTC. In general the PE-OLTC can be categorized into 2 major types: a) Full-PE OLTC in which no mechanical moving part is used b) Hybrid OLTC- in which the function of mechanical switch and power electronic switch are combined for different purpose. For applications demanding higher tap changing frequency, the Full- PE solutions will show more advantage. But for higher voltage and power rating applications number of semiconductor component used in OLTC will play an essential role affecting hardware cost as well as reliability and then PE-OLTC appears to be more attractive solution.

2. Existing system of on and off load tap changing

Tap changer is connection point selection mechanism along a transformer winding which allows a variable number of turn selected for obtaining output voltage according to load condition. Fig.1 Tap changer with tapings on secondary side

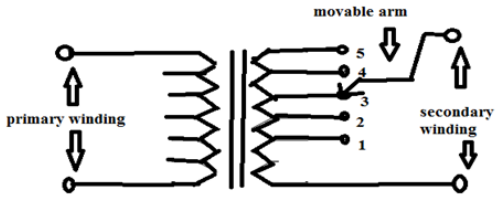

Fig. 1. Tap changer with tapings on secondary side

Fig.1 shows the constructional detail of existing tap changer in which numbers of tapings are provided on secondary side of transformer, by changing the tap position we get desired output. Mechanical devices or switches are used for the changing the tap position. There are several problems associated with existing on load tap chargers. [7] Problems in mechanical oltc are arcing noisy operation

3. Proposed system

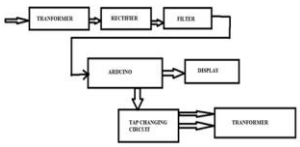

Fig. 2. Block diagram of power electronic based on load tap changer

Fig.2. Typically tapings for a transformer are given at the primary side to steady yield voltage. Function of each component showing in fig 2 is as follow,

A. Transformer

To reduce switching losses primary tapings are designed. The transformer is composed with recordings on its primary side instead of the optional side of transformer which is by and large tapped for consistent yield voltage. Changing the information

supply is conceivable as transformer is composed and furnished with essential recordings so we get a steady yield voltage on its auxiliary side [4].

B. Power electronic as TRIAC

Due to property of semiconductor device to control voltage, power electronics based devices are used. Power electronic helped gadgets, for example, MOSFET, IGBT, Triac and GTO which deals with AC. It can be utilized as a part of circuits for recurrence change, voltage alter and control. It likewise has a speedier reaction which will very help with exchanging [11].

4. Guidelines

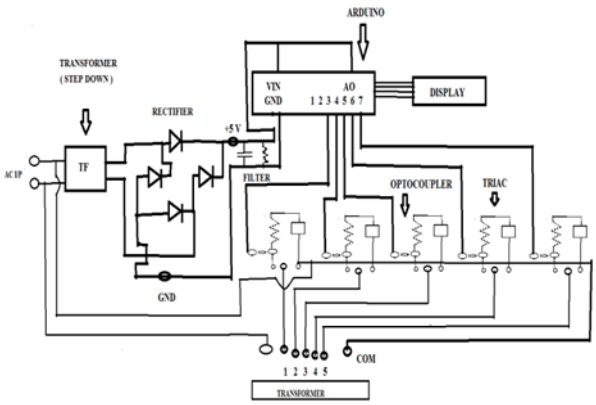

Fig. 3. Implemented system of power electronic based on load tap changer

Above figure 3 show implemented system of TRIAC based on load tap changer. It consists four main parts

A. Voltage sensors (PT)

These sensors are used for the sensing change in voltage. The potential transformer (P.T.) is used to measure the change in voltage. The measured voltage is given to the microcontroller through rectifier.

B. Rectifier

The rectifier converts the AC (alternating current) to DC (direct current). The measured value of potential transformer (P.T.) is given to the rectifier, and then it converts AC to DC. This rectified signal or value can be given to the microcontroller.

C. Microcontroller

The Atmega 328P is used as the microcontroller. It takes the voltage values from potential transformer through the rectifier. It senses the change in the voltage and gives the corresponding signal to the driver and switching circuit for further process.

D. Electronic switches & drivers

Opto coupler MOC3021 is used as a driver. Opto coupler MOC3021 can used to trigger the static switches such as triac. The signals coming from the microcontroller is used as an input for the Opto coupler MOC3021. TRIAC (BT136) is used as a switch. The Opto coupler MOC3021 gives the gate pulse to the TRIAC. By using the TRIAC the recommended ratio of the tapping is selected.

E. Working

The on load tap changing device is changes voltage level at output side whenever needed. The tapings are provided to the primary side with the high voltage to low current, to reduce the switching problem. In the existing system there are some disadvantages as mentioned in above. So to overcome this problem addition of power electronics devices in circuit then the performance of the systems drastically changes. When output voltage of load changes this changed voltage sensed by the devices connected to output terminal ‘voltage sensing device’ and provide this data to Comparator. Comparator is the device which connected in the intermediate between the input supply ‘voltage sensing device’ to output ‘voltage sensing voltage’. So it compare voltage and active the isolating device which turn on the TRIAC semi-conductor device and then this semiconductor device adjust the taps according to the output voltage which is totally automatic operation. [6]

F. Design specifications of transformer

Transformer is a static device which transfers the power from one ac circuit to another ac circuit without change in frequency. It works on the principle of Faraday’s law of electromagnetic induction VA rating of transformer =500VA, Primary side voltage= 240V, Secondary side voltage= 110V, N1 = Number of turns on Primary Side, VS = Secondary voltage.

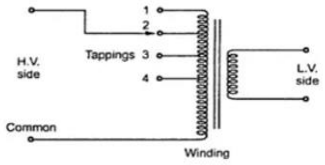

Fig. 4. Design of primary side tapings of transformer

Tapping for Primary Side of different secondary voltages from the voltage ratio of designed transformer, (N2/N1) = (V2/V1).

Table 1
Primary voltages as per primary turns

Primary Voltage	Primary Turn
$V_{p=}$ 200 v	N1 =400 turn
V_p =210 v	N1 =420 turn
V_p =220 v	N1 =440 turn
V_p=230 v	N1 =460 turn
V_p =240 v	N1 =480 turn

5. Result

Above voltage on primary side is adjusted as per load variation. When load requirement is changed appropriate TRIAC gets selected and tapings on primary side is changed primary turns are adjusted to get desired output. Following is the comparison between conventional Tap changer and Power electronic based on load tap changer.

Table 2
Comparison between conventional Tap changer & Automatic Voltage Control of load using OLTC

Conventional Tap changer	Automatic voltage control of load using OLTC
Mechanical switches are used for tap changing purpose	PE switch (triac) is used for tap changing Purpose.
Arcing problem occur during the changing of tap	Arcing problem is reduced.
Maintenance and service cost is high	Maintenance and service cost is low.
Switching time is more than PE based on load tap changer	Switching time is less than conventional tap Changer.
Stability is not appropriate	The stability improves and quick response

6. Conclusion

In existing system we used mechanical type on load tap changer having limitation and drawbacks like arcing, high maintenance, service cost, losses in switching, slow response of mechanical taps. These factors cause several disturbances and fluctuations in the system reducing the stability and reliability of the system. Due to this the life of switches gets shortened and cause arcing problems. In our system as we use power electronic devices i.e. TRIAC there are no mechanical losses, reduction in arcing problems, faster response for switching increasing the reliability and stability of the system. TRIAC is used as maintenance cost is low. In our system TRIAC triggers the appropriate pair of anti-parallel thermistors for change in the suitable tapings of the transformers improving the power quality and stability of the system giving a faster response than the conventional tap changers. Any variation in the output voltage of the transformer is sensed by the voltage sensing device and the appropriate triac and the tap will get selected. As TRIAC is a static device it has several advantages. Use of a power electronic device i.e. TRIAC it will eliminate the contact wear making the switching process lighter, quicker and more efficient.

7. Acknowledgement

The design is done at the Institute and transformer design at reliable electrical.

References

[1] B. Subhramanyeshwar, Bhuvanika Rao S.V.M., “Fine Control using OLTC by static tap change mechanism.” International Journal of Advanced Computer Research, Vol-2, Dec.2012.
[2] Jitendra G. Jammani , Nikunj R Patel, Makarand M. Lokhande, “Solid-State on Load tap-changer for transformer using microcontroller” IJEDR, 2014.
[3] Lars E. Jonsson, Nan-CHEN, “A new hybrid PE-on load tap changer for the power transformer” The Fall resort and conference centre, Livingstone, IEEE 2011, Zambai, 13-15 September 2011.
[4] M. Cotorogea, R. Echavarria, A. Claudio, V. Sanchez, “Design and Implementation of Fast on- Load Tap Changing Regulator,” 2000 IEEE.
[5] Thiwanka Wijekoon, Pavol Bauer, Gautham Ram Chandra Mouli, Ara Panosyan, Eva-Maria Bärthlein, “Design of a Power-Electronic-Assisted OLTC for Grid Voltage Regulation” 2014 IEEE.
[6] Sonawane Akshay Dinkar, Prof. Neelam Labhade , Patil Swapnaja Sunil, Pandhawale Smita Shivaji, “Modeling and control of multiport PE-Transformer using A Soli ” IERJ Pune vol. 2, pp. 279-281, 2016.
[7] Behzad Siahkolah, Jawad Faiz, “New Controller for an Electronic Tap Changer, Part II: Measurement Algorithm and Test Results”, IEEE Power delivery, vol.22, January 2007.
[8] W. G. Ashman and M. E. Robert, “A thyristor assisted mechanical on-load tap-changer”, Proc. Inst. Elect. Eng., Power Thyristors and Their Applications, pp.185–192, 1969.
[9] S. M. Bashi, “Microcontroller-based fast On-load semiconductor tap changer for small power transformer”, Journal of applied sciences, Jun-2005, pp.999-1003.
[10] G.H. and K.T. Williams, Cooke, 1992 “New thyristor assisted diverter switch for on-load transformer tap changers” IEE Proc. B Elect. Power Appl., 139: 507-511.