ISSN 2395-1621

Power Electronic Assisted OLTC Using Arduino

[#1]Miss. Tamboli A. A., [#2]Mr. Lobhe Ganesh A., [#3]Mr. Patil Arjun S.,
[#4]Mr. Daphale Swapnil A., [#5]Mr. Sayyed Juber A., [#6]Mr. Mulani Muneer R.

B.E. Electrical,
Nanasaheb Mahadik Collage of Engineering,
Peth, Shivaji University, Kolhapur, Maharashtra, India. Pin-415407

ABSTRACT

In the distribution network has led to frequent voltage fluctuation due to high penetration of distribution generation. For both LV and MV 3-phase distribution network the OLTC system has been customized. A novel design of taps consisting of several no load switches and a single semiconductor mechanical hybrid switch has been proposed, that is used to reduce voltage rating and number of switches. During the tap change process, the OLTC uses semiconductor switches namely IGBT/MOSFET for archiving arc free tap change and long life time of switches purpose. In the steady state condition; the mechanical switch in the hybrid switch conduct the load current resulting in low steady state losses. For 3-phase MV distribution network , an open delta configuration has been proposed that requires to OLTC units to control all three line voltage. Simulation are carried out to verify the steady state and transient operation of proposed OLTC.

Keywords: Distributed power generation, four step commutation, hybrid switches, on load tap changer, series compensation, transformer, voltage fluctuation.

ARTICLE INFO

Article History

Received: 25th March 2017

Received in revised form :

25th March 2017

Accepted: 25th March 2017

Published online :

4th May 2017

I. Introduction

In recent years, high penetration of distribution generation has led to frequent voltage fluctuation as well as over voltages, this voltage control using tradition voltage. Regulator by OLTC this situation as frequent tap changes reduces the life time of mechanical taps due to arcing. But the nature of the European distribution network used to make voltage control through shunt compensation method, it is ineffective and very expensive. Thus the suitable strategy for voltage regulation in Europe is series compensation through centralized on load tap changing (OLTC) distribution transformer. On load tap changing transformer use taps made up of mechanical switches that can be operated under load. In DG there is always fluctuation thus mechanical switches undergoes frequent wear and tear during tap change due to the arcing phenomenon, this results in lower life time of the switches and necessitates repeated maintenance. High overload and low on states losses are the main advantages of mechanical taps.

On the other hand, use of semiconductor switches as electronic tap changer that do not have any arcing problem and it provide greater flexibility in operation but its main disadvantage it has suffer from higher steady state losses.

The basic idea is to power electronic assisted tap changer obtained by combination the advantages of both mechanical and electronic tap changer, to use the mechanical switch in steady state to ensure low steady state losses and semiconductor switches during tap change to provide arc free tap changing process respectively therefore the performance of hybrid OLTC for high fault current does not change. The narrative design of OLTC autotransformer Is cost effective, efficient and has not only long lifetime but also low maintenance, back to back series connected MOSFET/ IGBT with anti parallel diodes are used for two electronic switches , voltage polarity four step communication is used for when changing between taps which result in fast communication without need for current limiting impedance. For application in both MV and LV 3 phase distribution network. The OLTC has been customized .

Now a days power quality is very essential aspect ,power quality has been a major concern in power system design operation and these issue becoming more critical considering the growing attention on smart grid with unstable renewable energy sources such as PV 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. Otherwise problem such as over voltage and under voltage , voltage sag , voltage swell noise and harmonics caused by voltage distortions and fluctuations causing system disturbances in power supply systems.

This paper describe design of power electronics assisted OLTC autotransformer that provide voltage regulation.

II. LITERATURE SURVEY

Design of power electronic assisted OLTC for grid voltage regulation by Gautham Mouli ,pavol Bauer , Thiwanka Wijekon , Ara Panosyan and Eva martia Bartblein.

In the distribution network owing to large scale renewable energy source like PV , wind turbine etc . has frequent voltage fluctuation and over voltage are nearly observed . A narrative design for a power electronic assisted OLTC autotransformer by combination of no load switches and a single semiconductor mechanical hybrid switches and experiences a lot of advantages in dual benefit of low steady state losses and no arcing during tap changes with respect to mechanical switch during steady state and semiconductor switches during tap changes it exhibited several advantages the OLTC to sustain long life time , efficient and low maintenance when working in condition of frequent voltage fluctuation. The OLTC can provide both positive and negative compensation of the grid voltage. The use of polarity based 4 step commutation on back to back connected IGBT /MOSFET provides convenient as well as efficient method for performing a tap change without the occurrence of an open /short circuit and without the need for current limiting impendence .Voltage fluctuation and voltage regulation in distribution network- In modern power system, electric energy from the generating station is delivered to the ultimate consumer through network of transmission and distribution for satisfactory operation of consumer appliances. It is desirable that consumer are supplied with substantially constant voltage.

Traditionally power grid assume a downstream power flow that result in voltage drop along the feeder causing under voltage at feeder end hence to counteract this effect OLTC mechanism in voltage regulators and in sub-transmission transformer are used to set the voltage at the feeder head at higher value to compensate for line drop. The voltage at customer utilization point can't exceed the tolerance level of ±10%.

Distribution generation is mainly affected due to voltage fluctuation because of ,

1) Non-uniform distribution load
2) Time varying nature of feeder length from bus bar

To overcome these problems, a comprehensive strategy is used for insuring permissible voltage level. voltage regulation through OLTC transformer can be achieved through shunt and series compensation. Shunt compensation are mechanically switched capacitor/inductor bank, (TCR) thyrister control reactor and (TSC) thyrister switched capacitor are act as variable current source and it is based on that injecting a leading current decreases the voltage while injecting a lagging current increases the voltage at that point on the other hand series compensation work on the basis of injecting a series voltage that compensates for the voltage drop along the line example of series compensation are on load and off load tap changing transformer at self commutated switch based on FACTS devises like (UPFC) unified power flow controller.

Block diagram of OLTC for voltage grid regulation

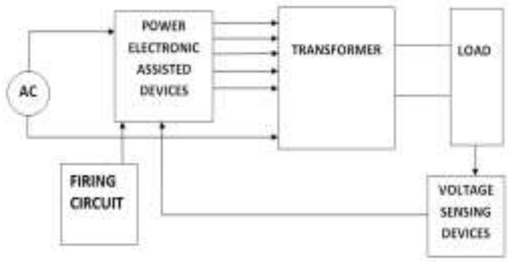

Fig .4.Block Diagram of OLTC for voltage grid regulation.

Primary tapping of OLTC for power electronic assisted device which shown in fig 4. Usually constant output voltage is obtained from secondary side if transformer ,the block diagram is so designed that the primary side of transformer designed with tapping unlike than secondary side of transformer , so we get constant output voltage , the voltage sensing device is provide feedback from the transformer load to the power electronic assisted device. The main purpose of voltage sensing device is useful for triggering as well as unlatch the power electronics device and giving a constant output voltage.

Design of OLTC using no load switches and hybrid switches

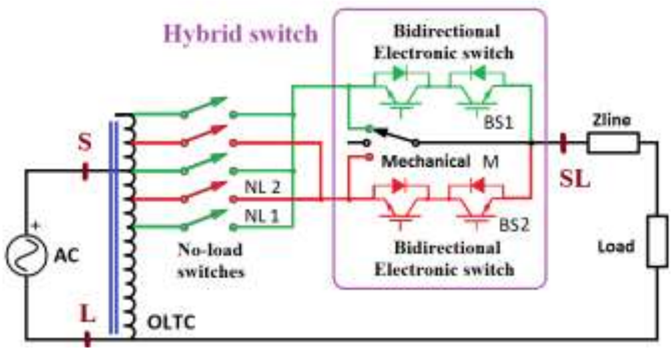

Fig. 1.OLTC Transformer using No- load switch and hybrid switch.

The OLTC autotransformer having taps on the load side very suitable for chosen is shown in fig.1. It is used to save the material and cost, the auto-transformer turn ratio input to output is approximately 10:11, for example- If the rated input voltage is 1 P.U then taps are present on the secondary winding either 0.9 P.U to 1.1 P.U. Thus it can provide ±10% compensation the mechanism is simple by using no load switches and single hybrid switch, there are use two type of switches mainly mechanical switch and selector switch- mechanical switch that open/close under no load condition that is ‘diverter’ switch and to movable no-load switches referred to as ‘selector’ switch are used to select the taps and mechanical switch is used for the tap change process for OLTC as shown in fig 2.

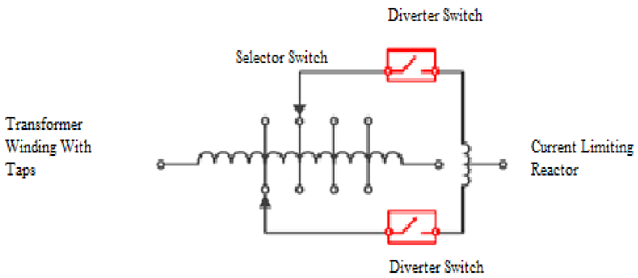

Fig.2. Diverter Switch type Voltage regulator using No-load selector switch.

The OLTC autotransformer topology is shown in fig 3.There are no of no load switches connected in autotransformer and alternately connected to each other- shown by red and green taps .The taps changing process are based on bidirectional electronic switches BS1 and BS2 are used and mechanical switch “M” conduct the load current in steady state. The taps changes are always made in step 1 this means that if tap NL2 is on ,then tap change can be made only to tap NL3 or NL1 and hence when we move tap NL1 to NL2 is done through the mechanism. The bidirectional switch BS1 and BS2 block both positive and negative voltage when OFF condition and conduct current of both direction when ON.
In this design we can used two back to back IGBT(having anti-parallel diode in a common emitter configuration) otherwise MOSFET are used for switch BS1 and BS2 for MV and LV distribution network, Thyrister are not used because of inability to control the switch turn OFF , di/dt limitations and need for current limiting ,impedance during tap changes but mostly MOSFET /IGBT are widely available in market.

Working of the project as shown in table below:

7 STEP COMMUTATION BETWEEN TAPS

Step	No Load Switch		Hybrid Switch		
	NL1	NL2	BS1	M	BS2
0	1	0	0	1	0
1	1	1	0	1	0
2	1	1	1	1	0
3	1	1	1	0	0
4	1	1	0	0	1
5	1	1	0	0	1
6	1	1	0	0	0
7	0	1	0	0	0

Table NO.1 shows the 7 step commutation between two taps.

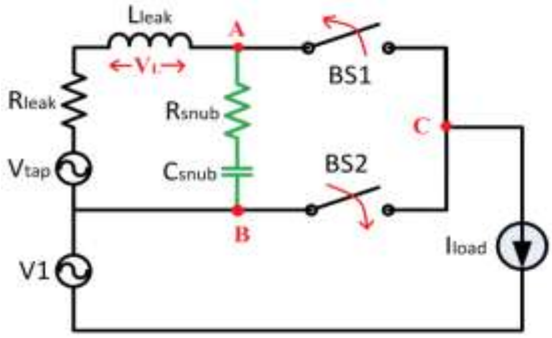

Fig.3. Snubber Circuit connected across electronic switches.

As shown in fig 3. Over voltage snubber connected across electronic switch that is hybrid switch To prevent overvoltage during changing of taps due to the leakage inductance $_{L\ leak}$ of the transformer winding, the overvoltage snubber is connected across electronic switches BS1 and BS2, during change of tap leakage inductance of transformer winding is interrupted causes leading to an overvoltage, thus these problem can be minimized using snubber circuit .

As shown in fig 3. V_{tap} ,L_{leak} and R_{leak} are the voltage , the leakage inductance and winding resistance of one tap respectively, with load modeled as a current source. Let BS1 is ON then voltage at C=(v1+vtap), now a tap change is made from BS1 To BS2 so the load voltage at point (c =v1),during the tap changing process GS1 interrupt the load current with a slope = (di/dt),as current commutates a switch BS2 the over voltage is experienced son that ,to overcome the above problem overvoltage snubber circuit is designed.

III. CONCLUSION

A novel design for a power electronic assisted OLTC auto transformer to reduces various problems like arcing due to over voltage, high cost of servicing, losses in switching as well as slow response of mechanical taps.

The OLTC taps were made from a combination of no load switches and a single semiconductor mechanical hybrid switch it experiences several advantages, this model is customized for the MV and LV scenario, the distinct nature of operation in the MV and LV OLTC system is validated where the motive is to control the line-line voltage and also phase voltage.

In proposed system power electronics assisted device triggers use IGBT /MOSFET provided a convenient method for performing change in suitable typing of the transformer, improving the efficiency, power quality, stability, and reliability of the system giving a faster response than conventional method. It will eliminate the mechanical contact wear and tear, making the switching process lighter, quicker, and more efficient.

REFERENCES

[1] Gautham Ram, Chandra Mouli, Pavol Bauer, ThiwankWijekoon, AraPanosyan , “Design of Power Electronic Assisted OLTC for Grid Voltage Regulation “2013 IEEE.

[2] A. Woyte, v. Van Thong, R. Belmans, J. Nijs, “Voltage fluctuation on distribution level introduced by photovoltaic system”IEEE Trans. Energy convert. VOL 21, no.1, tp202-209 mar.2006.

[3] L.Kojovic, “Impact of DG on voltage regulation “2012 IEEE.

[4] F.Q.Y.Zai, D. O’Kelly ”Solid State on-loadtransformer tap- changer”, nov.1996.

[5] J.Faiz,n B. Siahkolah, “ new solid state on load tap-changer topoiogy for distribution transformer”, IEEE Trans.Jan.2003.

[6] Federico Milano, ‘Hybrid control model of under load tap changer’,IEEE.