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DESIGN SIMULATION AND DEVELOPMENT OF ELECTRONIC TAP CHANGER DESIGN AND ANALYSIS

Meet Patel[1], Viral Desai[2], Shivang Desai[3] , Nilesh Jaiswal[4], Mulav Rathod[4]

[1]Student, Department of Electrical Engineering, SVIT-Vasad meet1294@gmail.com
[2]Student, Department of Electrical Engineering, SVIT-Vasad viral93@yahoo.co.in
[3]Student, Department of Electrical Engineering, SVIT-Vasad remebermethe1@gmail.com
[4]Assistant Professor, Department of Electrical Engineering, SVIT-Vasad nkjaiswal_svit@yahoo.com
[5]Assistant Professor, Department of Electrical Engineering, SVIT-Vasad rathodmulav_er@yahoo.co.in

Abstract- *By implementation of our project, we can change different voltage taping in any power transformer as required without any production of arcs by using thyristor modules. The design employs a low-voltage high-current switch-mode amplifier to divert current out of the mechanical contacts and into a pair of anti-parallel thyristors.The controlled source is switch mode in nature, employing four low-voltage, high-current devices in an H-bridge configuration. Thyristor module and control source are used for tap changing and with the help of the control source we can divert the load current to solve the problem of arcing at switching period. Control source acts as current and voltage source as per requirement. The inductor is included so that current-source behavior may be produced through suitable closed -loop control of the H-bridge duty cycle when one of the two switches (or) is closed and are present to define the voltage when both switches are open. Thus the operating device can be termed as Active Shunt Diverter.*

Keywords- *Thyristor module, H-Bridge, Tap changing switches, Transformer.*

I. INTRODUCTION

Different methods of Tap changer.

There are three types of diverter available for tap changing purpose that is passive type, active series, active shunt. Active shunt type diverter is the best out of the three diverter. Explanation of the three diverter as shown below:

1. Passive diverter

The passive-type of On Load Tap Changer relies on the process of mechanical contact or switch opening to drive current into an alternate path. The alternate path contains a pair of antiparallel SCR. An example passive diverter is that of where the increasing voltage drop across an opening mechanical contact or switch is used to trigger a SCR into conduction via a pulse transformer, providing an alternate current path at some instant after the moment of contact separation. The major drawback of passive-type schemes is that arcing at the switch contacts may never be entirely eliminated or reduced. The figure shown below is the example of passive type diverter.

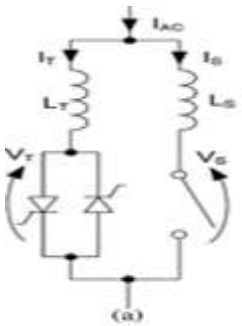


Figure1: passive diverter.

1. Active series type diverter.

Active-series type of On Load Tap Changer design are characterized by the 1onform of an opposing voltage source in series with the mechanical contact or switch. The activation of this voltage source causes current to transfer out of the switch path and into an alternative path containing semiconductor devices, such as SCR. This can achieved without opening the switch under load and the current has been fully transferred to the other path, the switch is opened at condition of zero current, eliminating contact arcing or arcing at the switch.

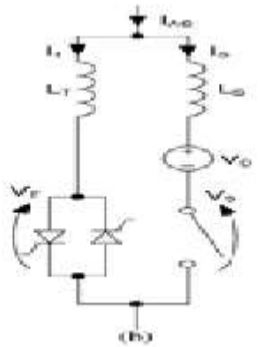


Figure2: active series diverter.

2. Active shunt type diverter

In active-shunt the voltage source is placed in the SCR diversion path instead of the switch path. The source is connected in such a way that it cancel the SCR forward voltage and is controlled to drive a current equal to the load current through the second path or the alternative path. The current in the switch will be zero, and the arcless operation of the switch is 1onformed.The main advantage of the active shunt type over the active series type is that no additional device is inserted in series with the steady-state load current way. Only during current diversion during a tap change operation is the active device or the pair of SCR required to conduct the

load current. The drawback of the active shunt is that active control of the voltage source is required to provide sustained zero-current condition in the switch or contact.

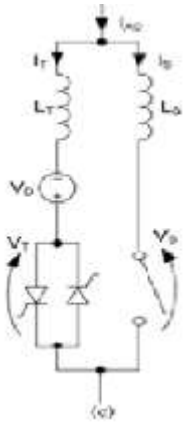


Figure3: active shunt diverter.

II. ELECTRONIC TAP CHANGER.

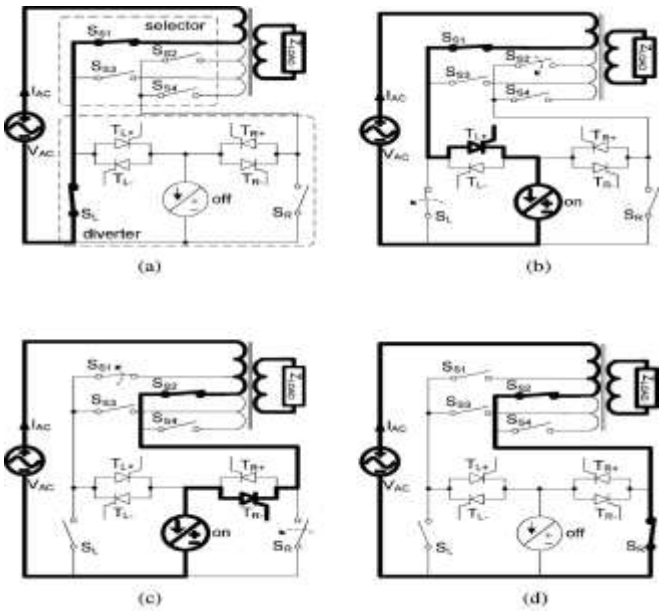


Figure4: on load electronic tap chnager.

The above shown is the electronic tap changer with four tapping. S1, S2, S3, S4 are the normal switch or mechanical contact. The anti-parallel pair of thyristor module and the H- bridge are the important active shunt type diverter. The fig shown below is the pair of anti-parallel thyristor and a H-bridge instead of mosfet the alternative diode can also be used.

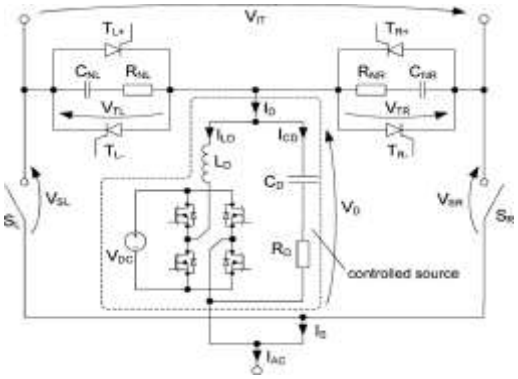


Figure5: control source and H-brigde.

MODE 1:

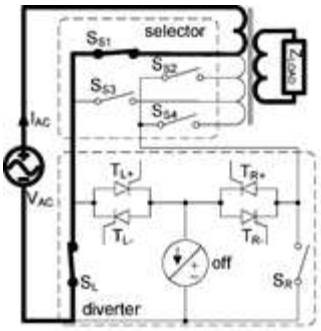


Figure6:mode1.

Ac source is connected to the four tapping transformer. Switch SL is connected to the odd numbered taps and switch SR is connected to the even numbered taps. Consider we want to change the tapping from tap 1 to tap 2.As seen from figure, the ac source is connected to tap 1 in this mode. The alternative path do not come in this tap changing this the main path.

MODE 2:

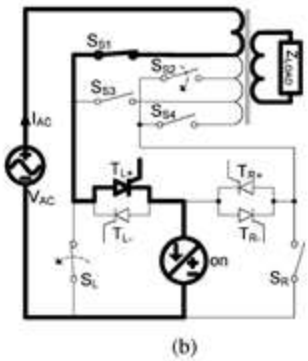
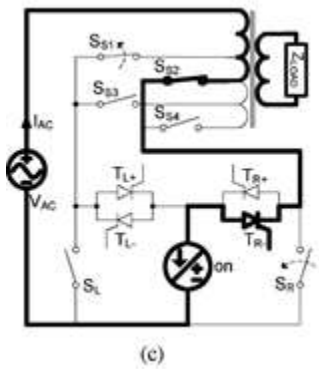


Figure7: mode2.

Now to change the tapping to tap 2, TL pair of thyristor antiparallel connected are triggered .So the current will be diverted to the diverter circuit. Open the switch SL which can be done at zero current so arcless operation obtained. The alternate path is selected over here that is the pair od SCR.

MODE 3:



Figur8: mode3.

Trigger the another pair of thyristor TR to diverter. Simultaneously open the tapping switch S1 and close S2.Thus we see that tapping is changed to tap 2. The alternate path is selected over here to reach the main path of the flow.

MODE 4:

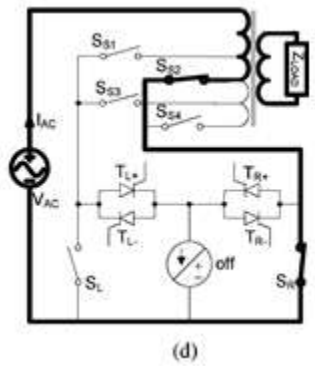


Figure9: mode4.

Now change current from diverter circuit to normal operation, close switch SR. Hence now tap is changed to tap 2. And now there is the main path again .If we need to tap change to 3 or 4 the same procedure should be repeated. And also the number of tapping can be done just by the two antiparallel SCR and the H-bridge this is the heart of the circuit.

III. SIMULATION AND ANALYSIS

The SCR used in the circuit of an electronic on load tap changer is triggered at 0 and 180 degree. So it is not that complicated. And only two control circuit are needed for two pair of SCR. The control circuit of the SCR contain a 741op-amp, 2N2222A transistor, 1:1 pulse transformer, 9V ac supply, 12V positive and negative voltage and resistance of 10 kilo-ohm and 1kilo-ohm. Here the op-amp used gives square pulse and the pulse transformer used make it in pulse form to trigger the SCR. The supply is 9volt ac is converted to the square pulse and further the square pulse is given to the transistor so it gives phase shift when one transistor is used the phase shit with supply voltage is zero. The figure shown below is zero degree phase shifted.

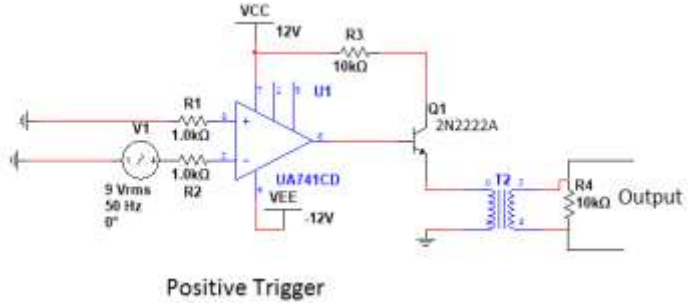


Figure10: zero degree phase shift.

When two transistor is used then there is a phase shift of 180 degree. The first transistor make it zero and second transistor make a phase shift of 180degree. The figure below is of 180 phase shift.

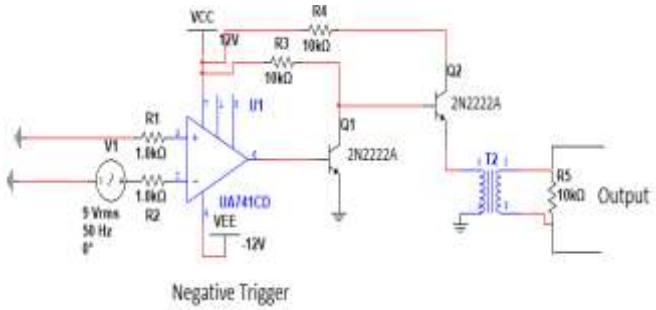


Figure11: 180 degree phase shift.

The phase shift wave form between the 0 and 180 is shown below.

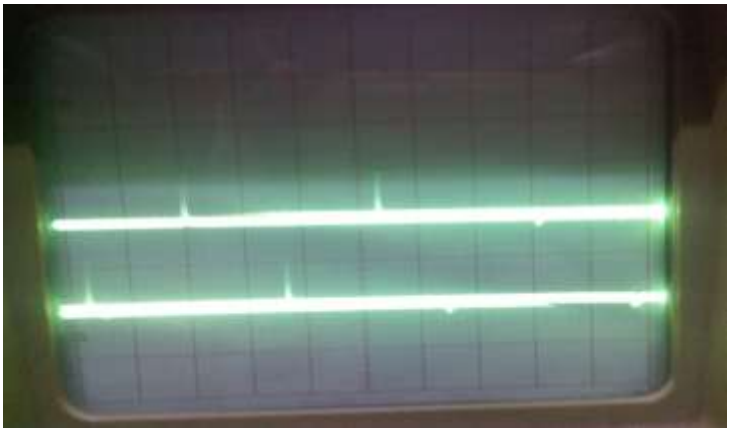


Figure12: comparison of 0 and 180 phase shift.

The ac supply and dc supply is made by the IC 7812(positive) and 7912(negative). As shown below.

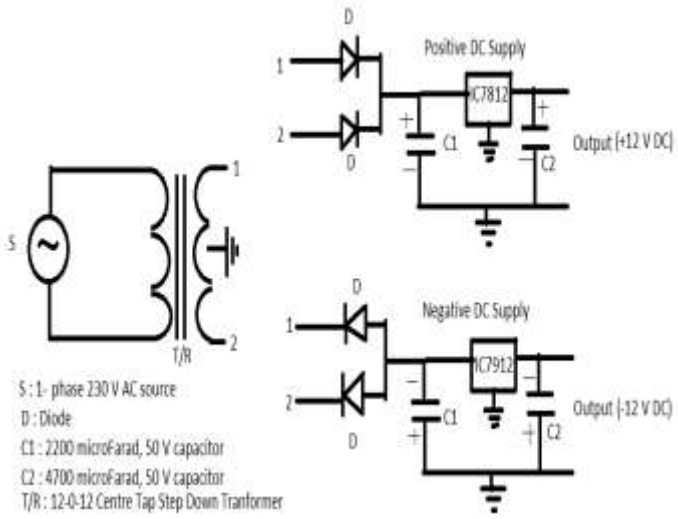


Figure13: DC source +12 and -12.

MODE 1:

In these simulation circuit the component designed are as follow. SCR used is 2N1599 having PIV rating 400V, 2mA to 10mA (max) gate current, holding current is 5mA, gate voltage 0.7V to 3V(max). Diode used is 1BH62. The inductor used is 10microH and capacitor used is 1microF the resistance at load is 100ohm. Transformer used is of 2 tapping each of 115V. A 1V DC source is used at the H-bridge. In this mode the full voltage is obtained that is 229.942V.

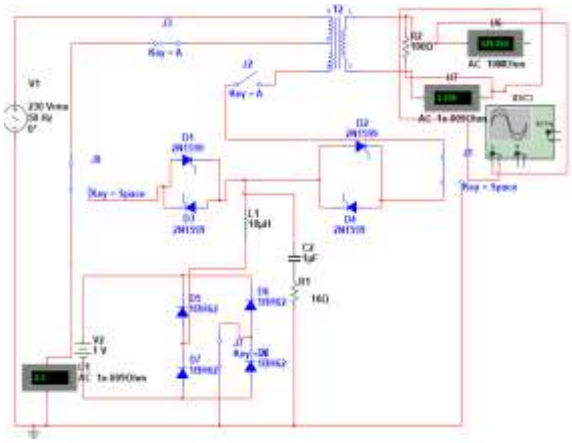


Figure14: simulation of mode 1.

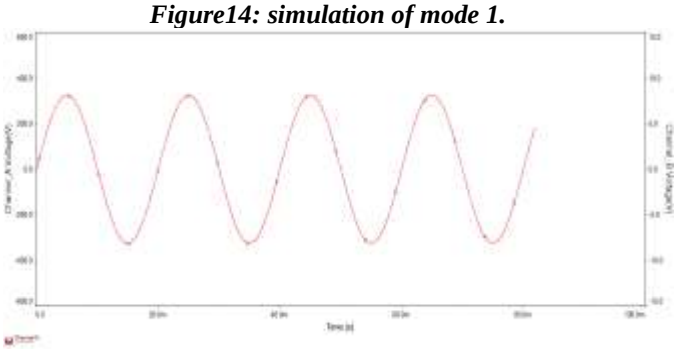


Figure15: result at the end of mode 1

MODE 2:

In these mode by triggering the SCR the alternate path is selected to get to tapping no. 2. The voltage observed is 225.004V. So a diverter path is selected in these mode.

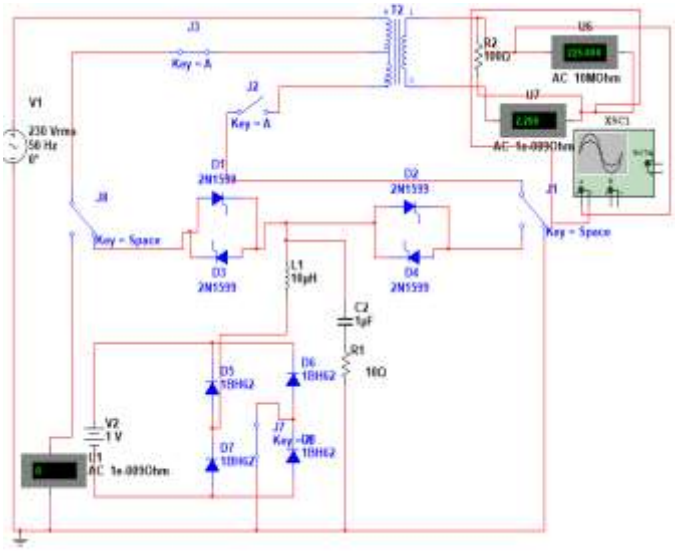


Figure16:simulation of mode 2

MODE 3:

In mode 3 the switch J3 is open and simultaneously J2 is turned on. Also another pair of SCR is triggered at the same time and again the diverter path is taken and the tap 2 is selected. Here the voltage observed across the load is 113.074V

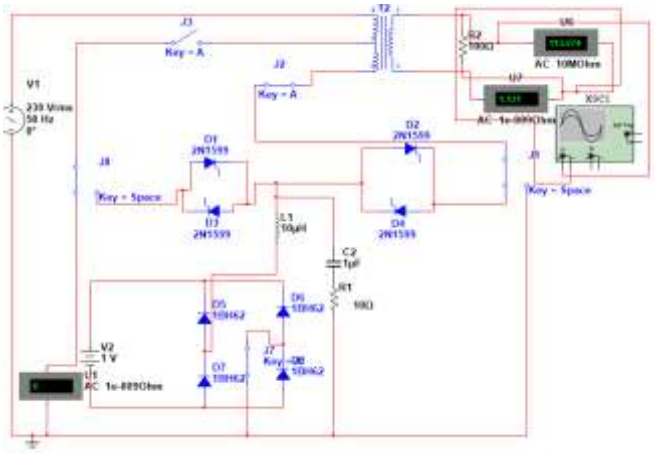


Figure17: simulation of mode 3

Voltage at the end of mode 3.

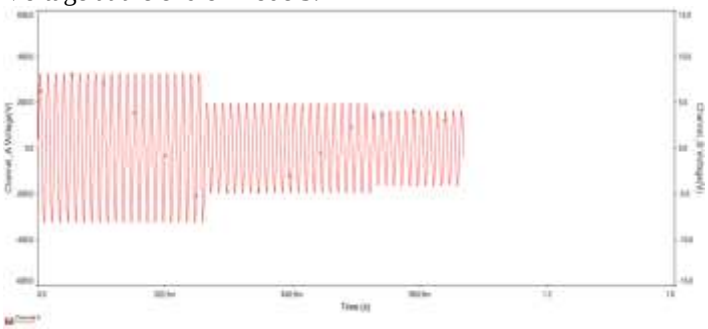


Figure18: result at the end of mode3.

MODE 4:

At last the mode 4 J1 switch is switched to the main path and the diverter path is removed from the way and back to the main path. So these was the easy operation.

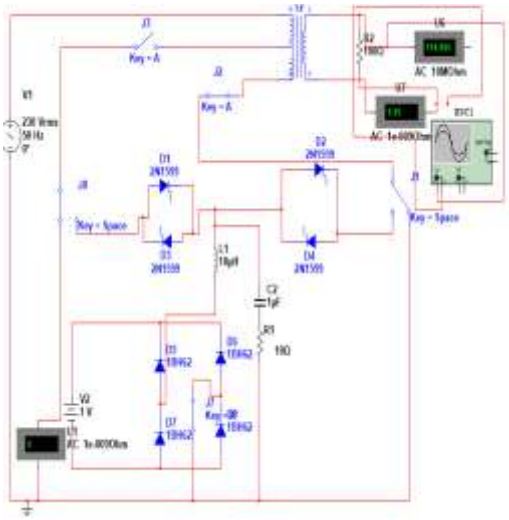


Figure19:simulation of mode 4

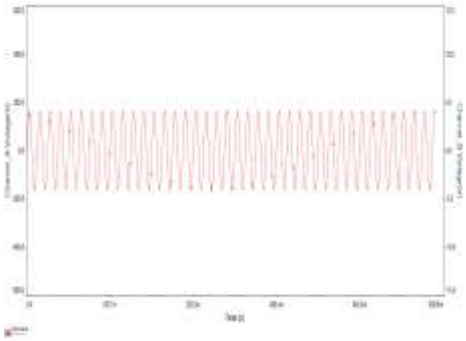


Figure20: result at the end of mode4.

IV. CONCLUSIONS

After carrying out the procedure for the simulation and analysis of on electronic tap changer it was observed that the tap changing took place at zero voltage and zero current. The control source is the heart of the circuit so we observed was the tapping no. is selected according to the application or requirement. But the diverter path and the component design remain the same. Due to electronic equipment the time consumed is reduced and the operation becomes faster. It is observed that we can jump from the highest to the lowest position of voltage instantaneously by operating few switches. The electronic tap changer is to ensure zero-current or zero-voltage conditions are maintained during switch operation. Arcing, High maintenance, service cost problem solved and efficiency is improved to a great extent.

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