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Automatic Voltage Control of Load using on Load Tap Changer

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Abstract: The Power quality is essential prerequisite of todays required load. Power system has been facing many problems due to variation in loads. Conventional on load tap changer (OLTC) is being used since long time for any momentary changes in load requirement. Conventional tap changers uses mechanical switches for tap changing. Mechanical tap changer has some drawbacks, like they takes more time for operation, arching, mechanical losses, manpower required, continues maintenance. Also sometimes mechanical tap changer get stuck between two taps, which leads to damage of whole system, it affects stability of the system etc. The ceaseless development in utilization of energy using semiconductor gadgets, for example, the TRIAC, Metal-oxide-semiconductor field-effect transistor (MOSFET), Insulated gate bi-polar transistor (IGBT) and Gate turn off thyristor (GTO) has helped for the working of OLTC controllers.

To eliminate the drawbacks of mechanical tap changer, this paper presents implementation of Automatic Voltage Control on load (AVCL) tap changer for maintaining constant output voltage. The implemented design of AVCL can be suitable in smart grid technology as an advance technology. The designed and fabricated of AVCL system is using tapings on primary side instead of secondary side, which will provides the quick response, no arcing problems, no wear and tear, reduction of losses, safety towards equipment and human beings.

Keywords: Automatic load voltage control (ALVC), Primary taping OLTC, TRIAC, comparator, Potential Transformer.

I. INTRODUCTION

On Load Tap Changer are used since many years ago. For voltage profile regulation change primary tap according requirement of under input voltage variation in conventional tap changer there are many problems like arcing, high maintenance, slow response time, wear and tear is high so this is big challenge to remove that drawbacks with the automatic voltage contract OLTC. [5] By using MOSFET, GTO, IGBT and the controlling device by using of this automatic voltage OLTC adding taps this increases efficiency and system is steady after large changes of voltage. [1]

On load Tap Changer is equipment which can be used for improving the voltage quality or power quality, by using of TRIAC which provides more advantages reduces arc and increasing the switching operation. The advantage of using only TRAIC is it can act in both positive and negative half cycle. As switching of TRAIC can be done at zero degree firing angle there will no issue of harmonics. This controlling circuit is also too small compared to mechanical tap charger. This controlling circuit installed outside the transformer. [3] The power electronics devices are the smooth operating devices and have better efficiency source voltage. Due to this above all drawbacks we are implementing the OLTC with power electronics device. To overcome all this problem Automatic voltage control of load using OLTC we have proposed this system. Literature survey is given below in section II, Proposed system in section III, Circuit diagram in section IV, Followed by conclusion in section V.

II. 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.[8]

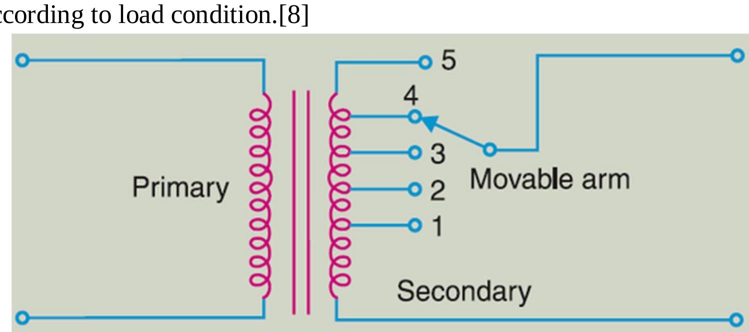

Fig.1 Tap changer with tapings on secondary side

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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 problems between contacts, mechanical wear and tear due to frequent use. Require regular maintenance and service, noisy operation.

III. PROPOSED SYSTEM

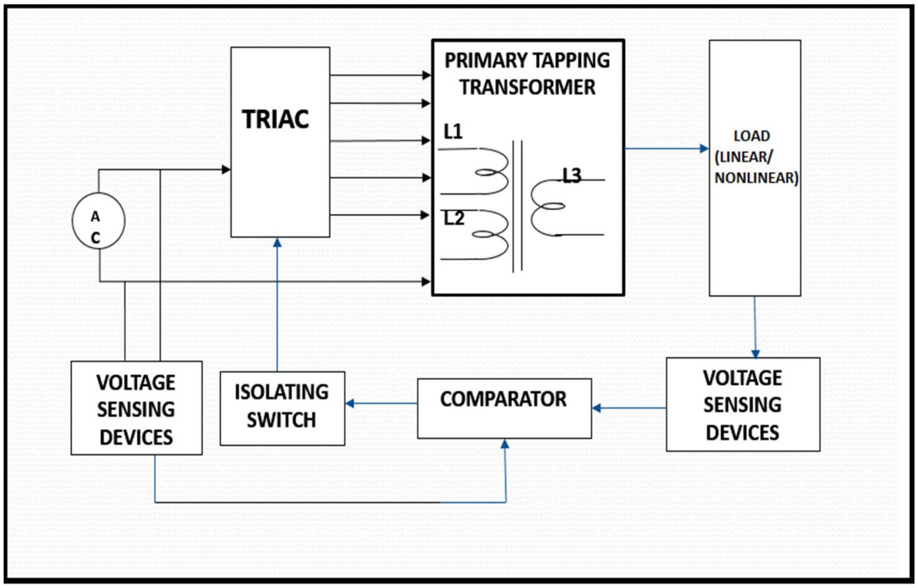

Fig.2 Block Diagram Of Automatic voltage control of load using OLTC

The square chart for control electronic helped gadgets in light of load tap changer with essential tapping is as appeared in Fig.2. Typically tapings for a transformer are given at the primary side to steady yield voltage. Following are the key blocks from figure 1.

A. Voltage detecting gadgets

The voltage detecting gadgets are available on both the side i.e. in input side and yield side. Voltage detecting gadgets are used for sensing the voltage on both side of transformer. It is helpful for activating and also unlatch the power electronic gadget i.e. Triac(BT136, 4A, 500V). This voltage detecting gadget will contrast with its present esteem given to the sensor. [10]

B. 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]

C. 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, Traic 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]

D. Source

AC source is used which is further controlled for implementation of Automatic voltage control of load using OLTC for maintaining the constant output voltage. It will reduce the arcing problems; provide safety to equipment as well as human being. In this proposed framework as the voltage either on the essential side or the heap side changes, the voltage detecting gadget detects the adjustment in the estimation of voltage and in like manner the power electronic helped gadget is activated and proper hostile to parallel thyristor is chosen and the tap is changed likewise utilizing power electronic helped gadgets giving us a steady yield voltage.

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IV. IMPLEMENTED SYSTEM

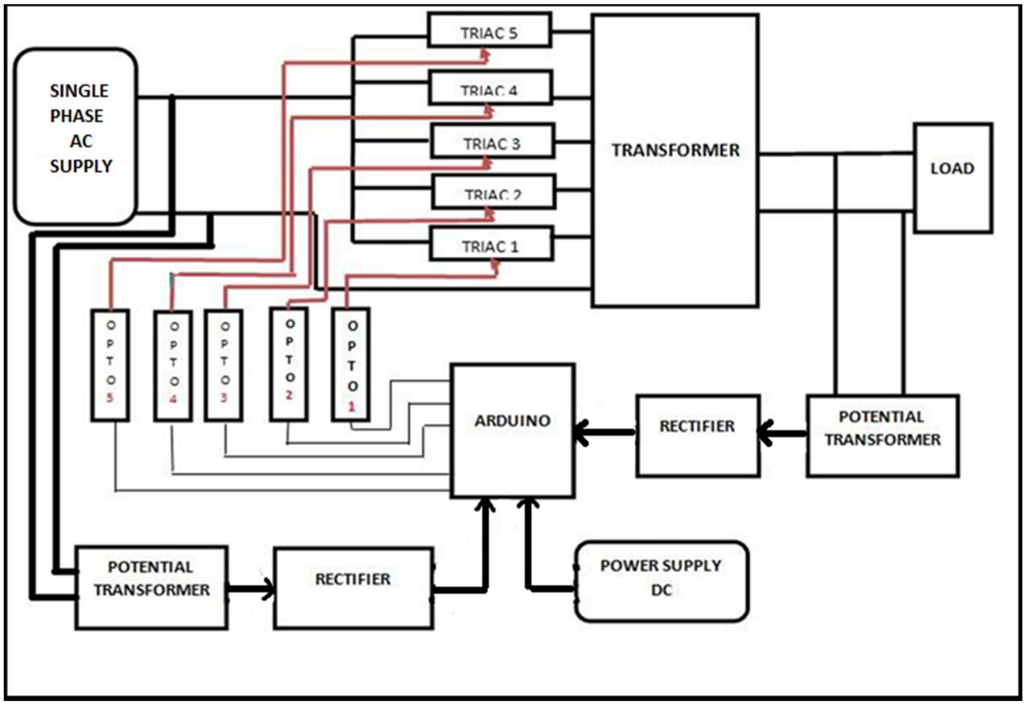

Fig. 3 Implemented Automatic voltage control of load using OLTC

Above fig. 3 shows circuit diagram of automatic voltage control of load using OLTC. It consists of 4 main parts:

A. Voltage Sensors(PT)

These sensors are used sensing the voltage. Potential transformer use to measure change in voltage at the output side of OLTC. Measured or sensed voltage is given to the microcontroller through rectifier.

B. Rectifier

Rectifier converts AC signals into DC. The measured value of PT is given to the rectifier for conversion of AC signal into DC. The Rectified signal or value can be given to microcontroller input i.e. ±5V

C. Microcontroller

The ATMEGA-328P is used as microcontroller. ±5V supply is given to microcontroller, it takes the value from PT through rectifier and then it compares change in voltage and gives corresponding signal generator to the driver of switching circuit for further process. [2]

D. Electronic Switches and Drivers

Opto-coupler MOC 3021 is used as a driver which can be used to trigger the static switches such as triac. The signal coming from microcontroller is used as an input for the opto coupler MOC3021 gives the gate pulse to the triac. By using the triac recommended ratio of the tapping is selected. [9]

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= 230V, Secondary side voltage= 110V, N_1 = Number of turns on Primary side, V_S = Secondary voltage

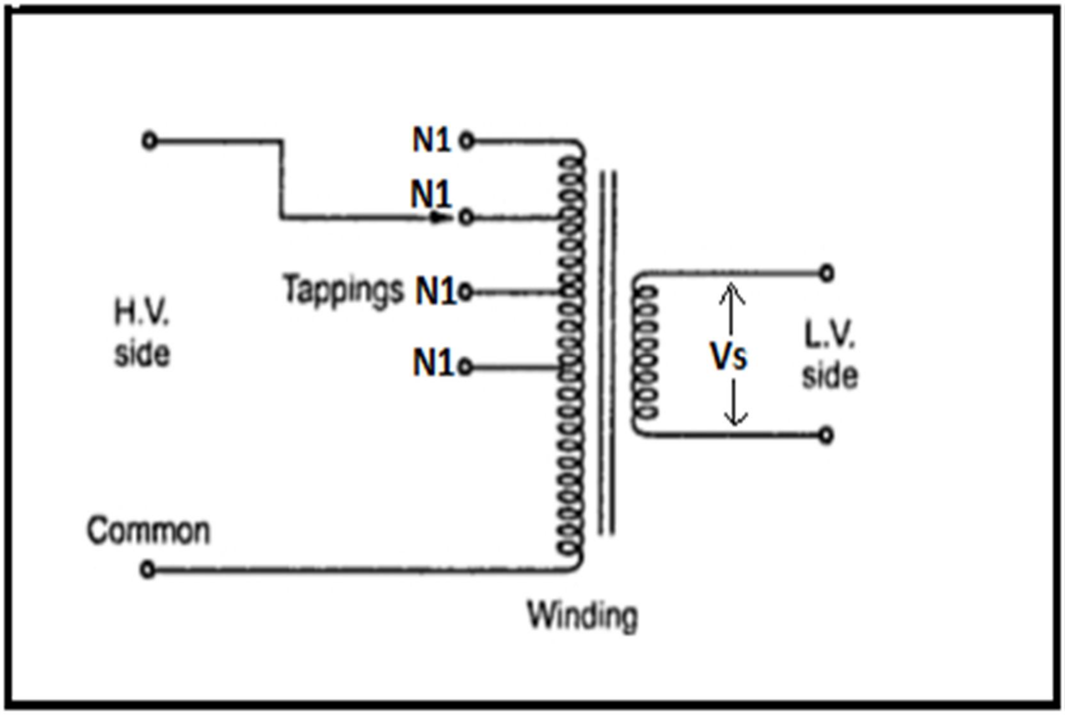

Fig.3 Design of Primary side tapings of transformer

Tapping for Primary Side of different secondary voltages:
From the voltage ratio of designed transformer , $(N_2/N_1) = (V_2/V_1)$

G. Results

Table I: Secondary Voltages as per Primary turns

V_s=90V	N_1=511 turns
V_s=95V	N_1=480 turns
V_s=100V	N_1=460 turns
V_s=105V	N_1= 438 turns
V_s=110V	N_1=418 turns

Above voltage on secondary 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 Automatic voltage control of load using OLTC

Table II: 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 Automatic voltage control of load using OLTC based tap changer.	Switching time is less than conventional tap changer.
Stability is not appropriate.	The stability improves and quick response.

V. CONCLUSION

Isolation of Primary's tapped winding and secondary winding is done by using power electronics device there can be a problem of sag, swells due to switching operation but as the implementation of switching circuits to reduce such problems. TRIAC gets the triggering pulse which is having zero firing angle due to zero firing angle selection and there will be no harmonics generation. TRIAC helps to reduce the cost, using any other semiconducting device will increase the complexity of the circuit and cost also. When applied voltage of the transformer which is to be analyzed by the arduino through potential transformer and then further it is processed to the opto-coupler, which sends triggering pulses to the TRIAC.

Conventional tap changer drawbacks are arcing, maintenance, wear and tear, service cost, switching time, lack of safety, stability problem, size all these drawbacks can overcome by our proposed system. Automatic voltage control of load using OLTC systems main aim is to maintain constant voltage of load, reduce losses, fast response improve the stability, reduce the size of circuit. By using this system instead of conventional tap changer reduces maintenance cost due to no wear and tear, mechanical losses. The design of the transformer is implemented considering quality and cost of material. The technology which is discussed in this paper is implemented.

VI. ACKNOWLEDGEMENT

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