

# Modeling and Control of a Multiport Power Electronic Transformer using Soli



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## ABSTRACT

After the introduction of electrical energy, the on-load tap changing (OLTC) regulators have been widely used. They give a good regulation of the output voltage in presence of large variations of the input voltage with typical response time from several milliseconds to several seconds. Earlier mechanical type of on load tap changers were used in industry. But they had lots of limitations and drawbacks like arcing, high maintenance, service costs and slow reaction times. In order to decrease these limitations and drawbacks, electronic (or solid-state) tap-changers were developed. The continuous growth of power semiconductor devices, such as the insulated gate bipolar transistor (IGBT), Triac, Thyristor has allowed the development of fast operating On Load Tap Changing regulators which is also helpful in fixing other problems in the ac mains, like flicker and various noises present in it. The major idea in the solid-state-assisted tap changer is that solid-state switches which operate during the tap-changing process instead of mechanical switches which help in reducing the arcing phenomena during the tap-changing process. In this paper, working and implementation of a fast OLTC regulator is presented. The control strategy is Microcontroller-based, which further depends on programming. The experimental results demonstrate that the fast OLTC is able to correct several disturbances of the ac mains besides, the long duration in variation in time is much lower than the one corresponding to the older regulators. The main application of a tap-changer regulator is to regulate the amplitude of the output voltage. The major objective of the controller in the tap-changer system is to minimize the fluctuation and disturbances of voltage amplitude with respect to the reference voltage. The controller must regulate the voltage within a given range.

**Keywords :** OLTC, IGBT, Micro Controller, Electronic Switches.

## ARTICLE INFO

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## I. INTRODUCTION

This project proposes a multiport power electronic transformer (PET) topology with multi-winding medium frequency transformer (MW-MFT) isolation along with the associated modeling analysis and control scheme. The power balance at the different ports can be controlled using the multi-winding transformer's common flux linkage. The potential applications of the proposed multiport PET are

high power traction systems for locomotives and electric multiple units (EMU), marine propulsion, wind power

generation and utility grid distribution applications. The complementary polygon equivalent circuit modeling of a MW-MFT is presented. The current and power characteristics of the virtual circuit branches and the multi-ports with general-phase-shift (GPS) control are described. The general current and power analysis for the multiple

active bridge (MAB) isolation units is investigated. Power decoupling methods, including nonlinear solution for Power balancing are proposed. The zero-voltage-switching (ZVS) conditions for the MAB are discussed. Control strategies including soft-switching-phase-shift (SSPS) control and voltage balancing control based on the power decoupling calculations are described. Simulations and experiments are presented to verify the performance of the proposed topology and control algorithms.

## II. LITERATURE SURVEY

The idea of power electronics transformer is known already over 20 years. There are numerous papers written about power electronics transformers.

[1] B. Kasztenny, E. Rosolowski, J. Izykowski, M. M. Saha, and B. Hillstrom, "Fuzzy logic controller for on-load transformer tap-changer", This paper proposes a This paper presents a new fuzzy logic controller (FLC) for on-load tap change control for distribution transformers. The model of a transformer with its tap changing mechanism is given first. Next, the FLC is presented in detail. The proposed algorithm is optimized from the numerical point of view and proved to be implementable on contemporary programmable logic controllers (PLCs). Simulation results are included that compare the proposed control algorithm with the classical inverse-time controller and prove the efficiency of the new solution

[2] H. Jiang, R. Shuttleworth, B. A. T. Al Zahawi, X. Tian, and A. Power, "Fast response GTO assisted novel tap-changer". presented in his paper overview of the A new type of GTO thyristor assisted tap changer is outlined which addresses the problems of traditional schemes. The scheme minimizes conduction losses in the solid state devices and also permits a fast response speed through the adoption of fast actuator driven vacuum switches. This paper describes a prototype tap changer for a low voltage 300 kVA transformer using the new method of tap changing. The prototype operates at current levels similar to those at which a full scale tap changer would work. Test results are presented.

[3] In this paper, Tap changers have not changed radically since their invention in the early part of this century. They are slow in operation, typically traversing 19 taps in around 100 seconds, and require frequent maintenance. Previous attempts to devise improved tap changers have concentrated upon thyristor assisted or all solid-state units. For various reasons none of these schemes has been adopted. A new GTO thyristor assisted tap changer is introduced here which addresses the problems of previous schemes. It eliminates excessive conduction losses which are inherent in solid-state tap changers, and at the same time provides a fast response speed by means of fast acting vacuum switches. Calculations show that it will be possible to traverse a 19 tap range in around 0.5 s. A unit for a 240 MVA transformer will require minimal maintenance as the vacuum switches used in the selector and diverter never make or break more than a few amperes. Test results are given for a 3 kVA transformer and tap changer unit.

## III. SYSTEM ARCHITECTURE

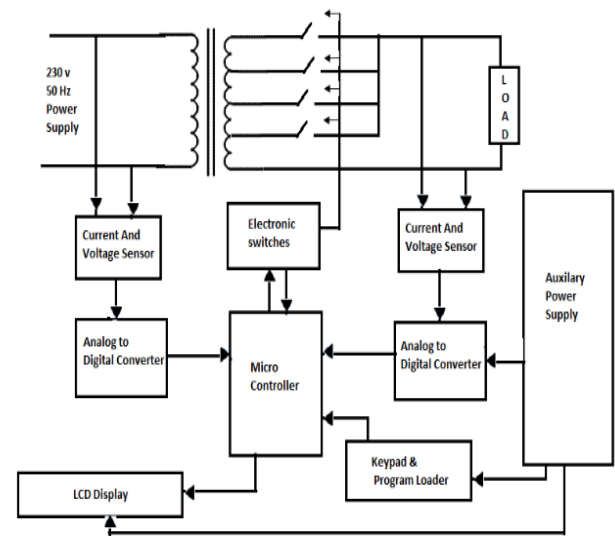


Fig 1. Block Diagram

Description:

The block diagram for Power Electronics based Multiport Transformer using Solid-State On Load Tap Changer is as shown in above diagram. There are n no. of windings on both sides of the transformer. Also, there are various switches on both side of the transformer. The functioning of the the various blocks as explained below :

Current And Voltage Sensor:

The current and voltage sensors are present on both side i.e. in input side and the output side. Current and voltage sensors sense the values of current and voltage on both side and measured it. It shows the different values in both the side of the transformer. It is useful for the calculation of the voltage drop on output side. The current and voltage values are displayed on the Lcd display.

Analog To Digital Converter:

As microcontroller understand the digital values, this analog to digital converter is connected in it. It converts the analog values into digital form and sends it to Microcontroller. This ADC is connected to both side i.e. input and output side.

Electronic Static Switches:

The Electronic static switches are used to select the single or multiple output terminals. This operates the terminal to be work on output side or load side in the circuit.

Microcontroller:

For the smooth and sharp output, this microcontroller is used in this circuit. Microcontroller operates all the circuit. Using programing, we can able to change the working of this microcontroller. Also, we can change the output using some connections and coding.

## V. CONCLUSION

### Program Loader:

This program loader is used to write a program. We can able to change this program or reinstallation of the program using this program loader.

### Keyboard:

This keyboard is used to type program and which is connected to the program loader.

### Auxiliary Power Supply Board:

This auxiliary power supply board is an external power supply. This auxiliary power supply board an external supply to the various components such as Microcontroller, Analog to Digital Converter, Keyboard, program loader, LCD display.

### LCD Display:

This LCD displays values of input supply, output supply, voltage drop at the output side. This LCD directly connected to the Microcontroller and which works on the auxiliary power supply.

## IV. CIRCUIT DIAGRAM

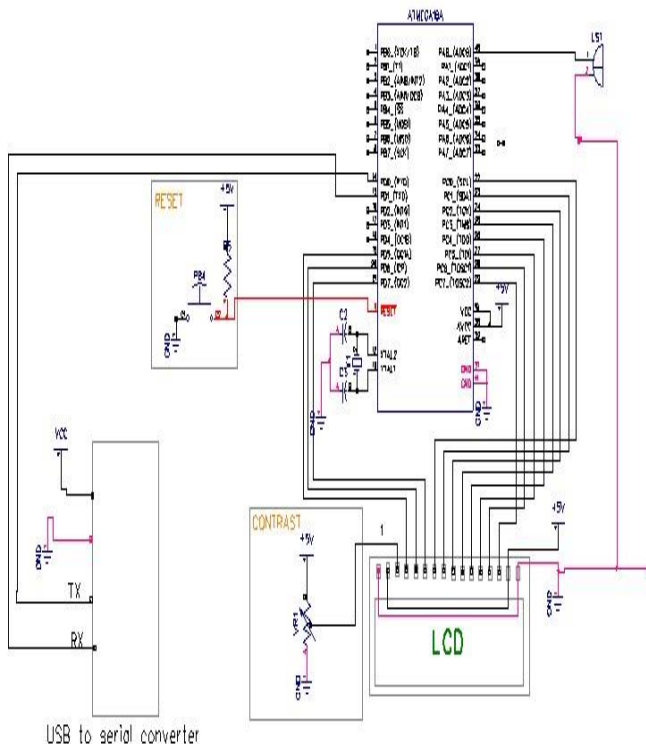


Fig 2. Circuit diagram for Multiport power electronics transformer using On Load Tap Changer

In this project we have conclude that, Any variation at the output voltage of the distribution transformer will be sensed by the microcontroller and compare with the reference value as per the program. This will produce appropriate command to trigger the appropriate pair of antiparallel thyristor for change in the suitable tapping of transformer. The system stability is improved, because of quick response. Because of static devices, maintenance cost is reduced due to elimination of frequent sparking. Output voltage can be regulated in the range of  $\pm 5V$  of nominal voltage.

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