STATIC VOLTAGE OPTIMIZER

[1]DHAWAL HINGANKAR
DEPARTMENT OF ELECTRICAL ENGINEERING (ELECTRONICS & POWER)
KARMAVEER DADASAHEB KANNAMVAR COLLEGE OF ENGINEERING, NAGPUR
[1]dhawalhingankar221@gmail.com

Abstract*—Good functioning of the majority of electrical and electronic equipment depends on the supply voltage correctness and steadiness. Nowadays, many industries and private users are subjected in long-lasting voltage fluctuations that can be inconvenient or even dangerous. The static stabilizer offers a reasonable improvement on slow servo controlled stabilizer as well as other static tap changing stabilizers. This paper consists of details of static voltage stabilizer, its working and its modes of operation. The basic topology is with buck-boost transformer with high primary to secondary ratio for voltage correction of ± 25%. The control voltage is imposed on the primary of this buck-boost transformer. The voltage regulation with help of buck and boost topology is achieved electronically without the step changes in voltage that occur when the system regulates. The system uses IGBTs as power switches. Direct AC-AC converter circuit improve the overall system response and fast voltage correction. Absence storage capacitor increase life of the system. 20 KHz PWM control operation using MICROPROCESSOR 8051 controller achieves correction time of 1 to 1.5 cycles.

I. INTRODUCTION

AC voltage stabilzers are used for obtaining a steady state AC supply with very close tolerances from fluctuating mains. They find applications in a very wide variety of fields. Static voltage stabilizer is an IGBT based PWM type buck-boost voltage stabilizer which has tight regulation and fast speed correction speed which is impossible to obtain using conventional methods. This is a Switch Mode Power Supply (SMPS) type voltage stabilizer for mains voltage(AC input and AC output) is a new switching topology where PWM is used directly in AC-to-AC switching, without any harmonic distortion. In this topology there is no need to convert the AC input to DC and again convert it back to regulated AC output. This simplifies the design, reduces the component count and improves the efficiency and reliability. The power stage is an IGBT chopper control. The chopping frequency is around 20KHz which ensures absolutely silent operation and pure sine wave output (no waveform distortion).

The control section is based on micro-controller which ensures quick correction of output which is not possible in conventional relay type stabilizer or servo controlled stabilizers. Since the circuit is fully solid state (no mechanical or moving parts) there will not be any wear and tear like the brush tear in servo stabilizer or relay degrading in relay based stabilizer. This is specially useful in places where we need very fast correction speed, constant output voltage, overload current limiting and short circuit protection, soft start, high voltage cut-off and low voltage cut-off, automatic bypass, no wear and tear, long life and maintenance free which is impossible with other conventional relay type or servo control stabilizers.

II. BACKGROUND STUDY

Highly fluctuation in AC supply is a common phenomenon. The voltage requirements of different electrical appliances vary to a great extent. The electronics equipments like spectrophotometers, PH-Meter, X-Ray plant, recorders are affected by high main voltage, whereas the other compressors are affected by low main voltage. However in industries, which are running 24 hours, also affected by this fluctuation voltage. So to achieve constant voltage, Voltage Stabilizers are used.

Earlier to obtain the constant voltage the devices like servo voltage stabilizer, regulators, AC regulators etc were used.

III. THE OUTSTANDING FEATURES OF STATIC VOLTAGE STABILIZER

- Direct AC-AC conversion without rectifying to DC improves the efficiency, reliability and reduces the components.
- By rapid cycle by cycle correction of output. It can correct sudden fluctuations in the line voltage.
- Output regulation of +/- 1% which is impossible in conventional stabilizers.
- No distortion in output waveform.
- Over voltage and under voltage cut-off.
- LCD display for displaying all parameters and your company name.
- Small transformer size ($1/5^{th}$ of the capacity).
- Compact size and light weight.
- 20HZ PWM control.
- Highly reliable.
- Fully solid state. No moving part, hence more life and no maintenance.
- Silent operation.

Iv. STUDY OF SYSTEM AND ITS DESCRIPTION

1. PRINCIPAL OPERATION

The secondary winding of the buck/boost control transformer is connected in series to the supply line going

to the load. Its primary winding is fed with a voltage from a IGBT based AC-AC converter. AC-AC converter input is connected across the output supply. The voltage is induced in the secondary winding gets added to or is subtracted from the mains voltage depending upon its phase with respect to the line voltage. The induced voltage will either be in phase or out of phase by 180^0 with the supply voltage.

Buck or boost voltage is obtained based on the output and is obtained by changing AC-AC converter output polarity. Output voltage amplitude is changed by changing the PWM duty cycle, PWM duty cycle of 20 KHz frequency vary from 0-95% to regulate the voltage in case of buck and boost mode. The correction time of the SVS is as low as 30ms. Microcontroller core based digital control ensures the cycle correction to meet the voltage sensitive machine and load voltage requirement. Static voltage stabilizer has inherent input and output voltage (high/low) cut off detection and will continue feeding the load at unregulated voltage. As soon as the unregulated voltage tries to cross the cut off limit, stabilizer will protect the load by disconnecting the supply.

The integrated controller for voltage stabilizer CONTROLS the output voltage, TRIPS under fault conditions and also DISPLAYS input, output voltage and load current, on LCD display panel simultanultaneosly.

2. BLOCK DIAGRAM

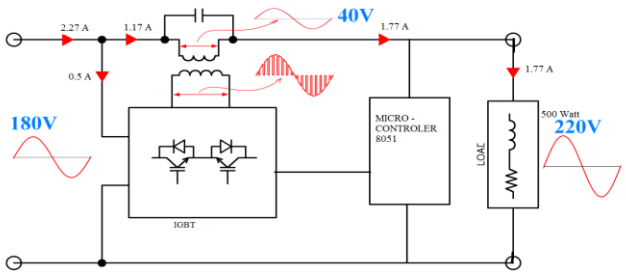

Fig: block diagram static voltage stabilizer (boost mode)

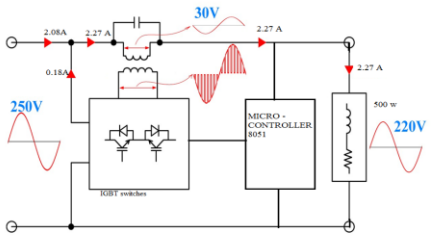

Fig: block diagram static voltage stabilizer (buck mode)

WORKING

In this IGBT based PWM type static voltage stabilizer only difference voltage is switched through IGBT and will be added or subtracted from the mains. This is done electronically without any step changing in voltage which occurs when the system regulates. This is achieved by a feedback control system using microcontroller. The output voltage is sensed by the up and corrections are made by varying the duty cycle of the PWM. This stabilizer boosts up the voltage if it is low and bucks the voltage if it is high.

For example- if the AC input is 200V and the AC output is set for 220V, only 20V will be regulated through the IGBT and will be added to the original mains source which is 200V. If the AC input is 195, then 25V will be added..

This means that we can use discrete IGBTs and make the circuit very compact and very high efficient and cost effective. The efficiency in worst case will also be above 97%. This stabilizer is ideal for mobile towers, CNC machines, medical equipment, textile industries, power plants and any industrial product that needs tight regulation and fast correction. We can also use this for Air conditioners, refrigerators, motor, pump etc.

REFFERENCES

1. “Muhammad H. Rashid” ,” Power Electronics Circuit, Devices & Application, Third Edition”, Prentice Hall India.(chapter 9 pg.406-430).
2. “Modeling of PWM rectifier for static automatic voltage regulator” Pratik J. Munjani , Nitin H. Adroja, Vinod J. Rupapara , ETCEE-2014.
3. “V.K. Mehta”, “Principle of Electrical Engineering, fifth edition”.
4. “B.L. Theraja” , ”Basic Electrical Engineering ,S Chand Volume II”.
5. “P.S Bimbhra”, “Power Electronics and Devices, Khanna Publication”.