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Implementation of Cascaded H-Bridge Control Scheme for SSSC using Zero Sequence Voltage and Negative Sequence Current

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ABSTRACT

This paper focuses on a control scheme of cascaded H-bridge scheme implemented in SSSC for enhance the three phase power systems. Cascaded H-bridge based SSSC has offer low switching losses and less total harmonics distortion, and reduces the number of circuit components. Each H-bridge cell has isolated dc capacitors which is exist balanced capacitor voltages. Since SSSC is often requested to operate under asymmetrical condition by power system faults such as one line grounding or two line short circuit and it can be the control output current almost freely. Cascaded H -bridge based SSSC needs wide range of margin of dc voltage for operates in large unbalanced voltage power system. This proposed system focused on to avoids wide range of margin of dc voltage by exclusively using the two methods such has zero sequence voltage and negative sequence current. By this scheme, the SSSC is allowed to operate under asymmetrical condition by power system faults. The validity is examined by digital simulation under one line and two line fault in power system.

KEYWORDS: *Cascaded H-bridge, SSSC, Zero Sequence Voltage, Negative Sequence Current, and Capacitor Voltage Balancing*

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I. INRODUCTION

CASCADED H-bridge consists of series connected H-bridge cells. It has merits of switching losses of semiconductor device and harmonics in output voltage. SSSC means controlling the power transmitted across transmission lines by altering or changing the characteristic impedance of the line. The power flow problem may be related to the length of the transmission line. The transmission line may be compensated by a fixed capacitor or inductor to meet the requirements of the transmission system. Every H- bridge cell has isolated dc capacitor and balancing problem of capacitor voltages exists in this configuration. SSSC is often requested to operate under asymmetrical condition by power system faults, such as one line grounding or two line short circuit.

Recently, several methods of voltage balancing between phase clusters are proposed. One method is based on zero sequence voltage. However it need wide margin of dc capacitor voltage compared with rated power system voltage. The other method is based on negative sequence current. It does not need wide margin of dc capacitor voltage compared with rated power system voltage.

So we introduce a different control method using zero sequence voltage. To avoid this, we exclusively use the two methods depending on the extent of the voltage unbalance. The validity isexamined by digital simulation under one line and two line fault in power system.

II. Main Circuit of SSSC (STATIC SYNCHRONOUS SERIES COMPENSATOR)

SSSC consist of solid state voltage source converter (VSC), which feeds sinusoidal voltage of variable magnitude in series with transmission line. Voltage injected in the line is in quadrature with the line converter. A small part of voltage which got injected in phase with the line current is considered as a loss in the inverter. Voltage injected in quadrature of line current is considered as inductive or capacitive reactance in series with the transmission line, which affects the power transfer capability of transmission line.

Energy source is equipped beyond VSC in SSSC, capable of providing active power exchange with line. SSSC i as similar as variable reactance as injected voltage changes continuously depending on system conditions. Figure 1 given below shows single line diagram of SSSC.

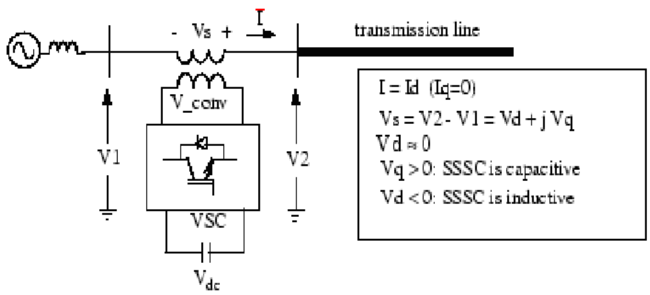

Fig.1. Single line diagram of SSSC Configuration

As from above model, SSSC consist of series insertion transformer which injects voltage in series with line in quadrature of the line current, this voltage provided by thevery next consecutive block which is voltage source converter. This performs task to produce variation in injected voltage as per requirement of the transmission line. VSC is consisting of power electronics devices such as GTO, IGBT which are forced commuted. Across VSC, battery or a DC link capacitor is used as supply. Small amount of power is drawn from the line to make capacitor charged and which acts as DC supply to the VSC. SSSC provides advantage over TCSC that if removes gigantic passive component of reactors and capacitor. An expression for injected voltage by SSSC is given as, Vsssc = ± j Vsssc (e) (I/I).

SSSC consist of its own controlling unit which controls the switching action for VSC, it is also necessary to check real time network condition so that according to requirement of network, SSSC will able to inject voltage.

III. Cascaded H-Bridge Multilevel Inverter

The cascaded H- bride multilevel inverter can be used for both single and three phase conversion. It uses H-bridge including switches and diodes. At least three voltage levels are required for a multilevel inverter. It is composed of multiple units of single phase h-bridge power cells. The h-bridge cells are normally connected in cascade on their ac side to achieve medium voltage operation and low harmonic distortion. An h-bridge is an electronic circuit that switches the polarity of a voltage applied to a load, these circuits are often used in robotics and other applications to allow DC motors to run forwards or backwards.

Multilevel cascade inverters are used to eliminate the bulky transformer required in case of conventional multiphase inverters, clamping diodes required in case of diode clamped inverters and flying capacitors required in case of flying capacitor inverters. The figure.2. In cascaded h bridge multilevel inverter consists of series of power conversion cells and power can be easily scaled. The combination of capacitors and switches pair is called an H-bridge. The common use of the h bridge is an inverter. The arrangement is sometimes known as a single phase bridge inverter. The h bridge with a DC supply will generate a square wave voltage waveform across the load. But this diagram represent the five level cascaded h bridge multilevel inverter in h bridge cells are normally connected in cascaded on their ac side to achieve medium voltage operation and low harmonic distortion.

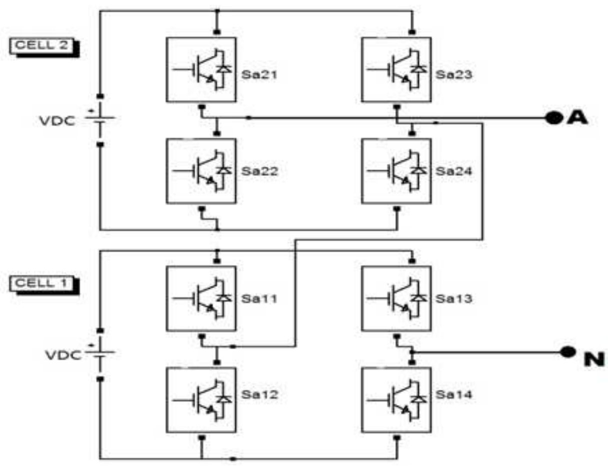

Fig.2. Five Level Cascaded H-bridge Multilevel Inverter

IV. Zero Sequence Voltage

It has been shown in figure that the zero-phase sequence component of voltage is equal to one-third of the residue phase voltages Va0=1/3(Va+Vb+Vc). Use of this relationship is made in the measurement of zero sequence voltage.

Three single-phase voltage transformers are connected as shown in Fig 3 with their primary windings connected in star with their star point connected to the neutral and the opposite ends of the windings connected to the three Uses.

The secondary windings are connected in open delta so that the voltage across them will be proportional to the vector sum of the three-phase voltages. A voltmeter *V*, shown in the circuit, is used to measure this voltage and if suitably calibrated may be used to measure the zero-sequence voltage.

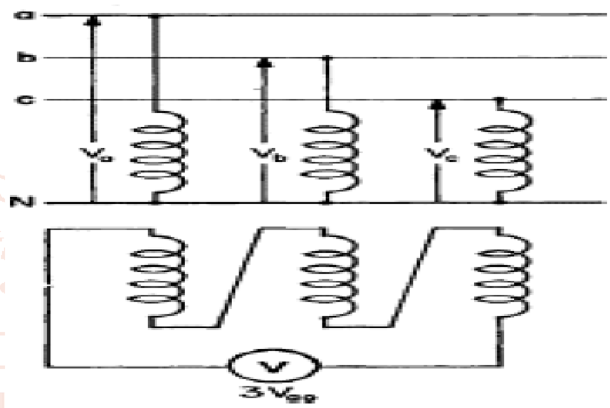

Fig.3.Measurement of Zero Sequence Voltage Method 1

A point worthy of note here is that it is important that the voltage transformers must be quite separate and magnetically isolated, otherwise the true value of residual voltage will not be measured. A second method which may be used. Three accurately balanced impedances *Z* are connected in star and to the three lines. The star point is then connected through a voltmeter to neutral. Here it is necessary for the voltmeter to be calibrated to take into account the three parallel impedances connected in series with it.

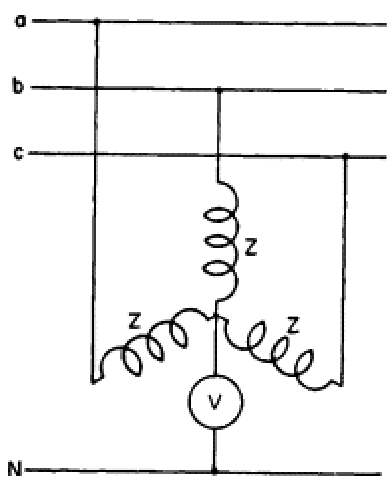

Fig.4.Measurement of Zero Sequence Voltage Method 2

V. NEGATIVE SEQUENCE CURRENT

A current or voltage unbalance between phases in magnitude or phase angle gives rise to negative sequence current. The negative sequence component has a rotation opposite that of the power system.

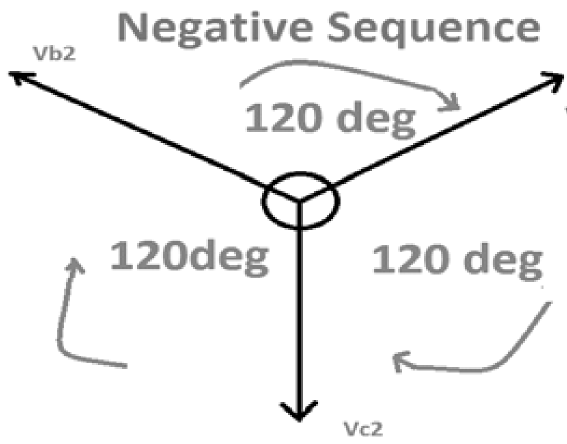

Fig.5. Negative Sequence Current

Negative sequence currents in three phase motors cause a magnetic field that rotates in the opposite direction to normal. These cause a torque in the opposite direction to normal. One of the most important problems in controlling a multilevel voltage source inverter is to obtain a variable amplitude and frequency sinusoidal output by employing simple control techniques. Indeed, in voltage source inverters, no fundamental current harmonics cause power losses, electromagnetic interference and pulsating torques in AC motor drives.

VI. PROPOSED SYSTEM

Static Synchronous Series Compensator (SSSC) is a solid-state voltage source inverter that injects variable magnitude sinusoidal voltage in series with the line, which is almost in phase with the line current that in turn, emulates an inductive or a capacitive reactance in series with the transmission line. This variable reactance influences the electric power flow through the transmission line. A portion of injected voltage provides the inverter loss thereby increasing the efficiency.

A SSSC can operate as in series compensator without external supply whose output voltage is in phase with, and controllable independently of, the line current for increasing or decreasing the overall reactive voltage drop across the line to control the active power transmission. This series compensator includes transiently rated energy storage and energy absorbing devices in order to enhance fluctuations in the power system by temporary real power compensation.

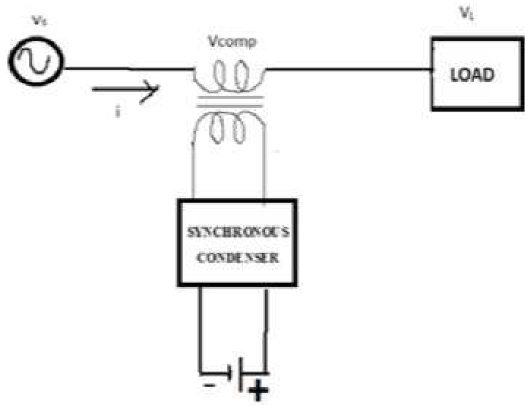

Fig.6. Proposed System of SSSC

VII. EXISTING SYSTEM

Synchronous Condenser controls voltage on an electric utility's transmission or distribution system. Voltage is the "pressure" needed to deliver electricity through such a system. SC supports network voltage by providing reactive power compensation and additional short circuit power capacity. Fundamentally, a synchronous condenser is a synchronous generator operating without a prime mover. The excitation current is regulated for the generation or consumption of reactive power.

The most important advantage of a synchronous condenser is that it contributes to the overall short circuit capacity in the installed network node, so that the network equipments can be safe guarded during faulty condition. This synchronous condenser can be operated in overload condition for both shorter and longer duration. Also it can increase the network inertia during prolonged sag to support the power system.

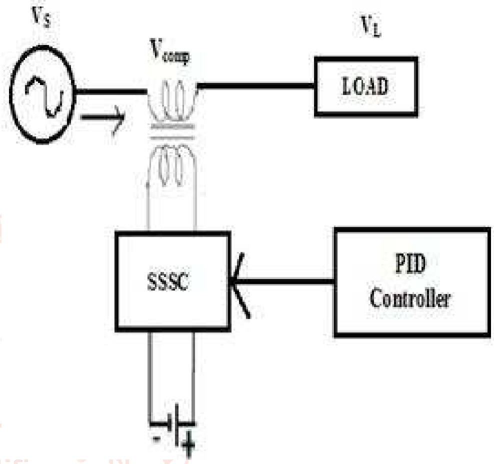

Fig.7. Block Diagram of Existing System

VIII. SIMULATION RESULT

The output current and output voltage of the implementation of cascaded h-bridge control scheme for sssc using zero sequence voltage and negative sequence current is given below. The main purpose of the proposed system is to balance the voltage, reduce harmonics distortion and switching losses. First, the output of zero sequence voltage to be considered they has to be followed for the sine wave form.

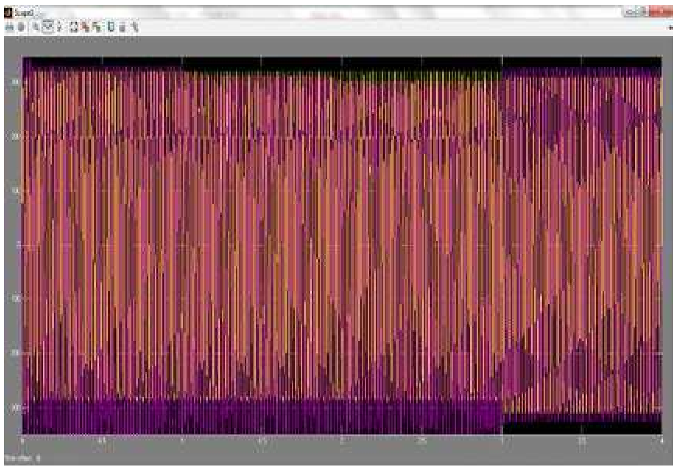

Fig.8. Output of Zero Sequence Voltage

This is the only method to balance the voltage and any distortion the source of current must be sinusoidal in multilevel inverter. Because of this we can preferred this proposed approaches method. In the output waveform of the current which is given below the starting and ending correctly they can be balance the current in multilevel inverter in sinusoidal waveform. The value of the amplitude of the current waveform varies from 380v to 440v. The three phase programmable voltage source inverter to implement the three phase zero impedance voltage source. The common node of the three sources is accessible via input 1(N) of the block. Time variation for the amplitude, phase and frequency of the fundamental can be pre-programmed. Then, the time starting and ending in 0to 4.

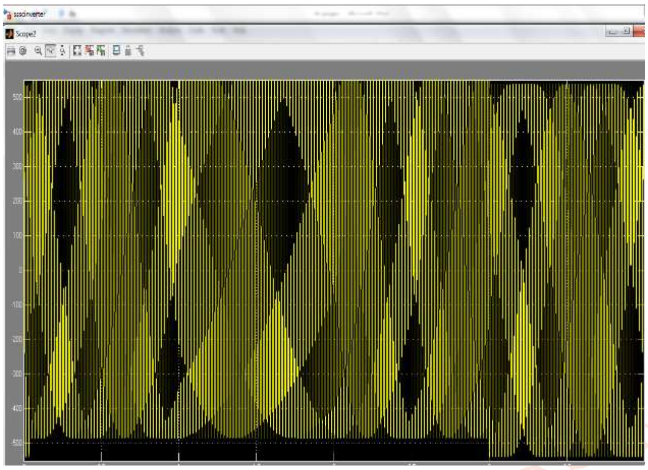

Fig. 9.Output of Negative Sequence Current

The overall output waveform are considered in first waveform are represent in positive sequence voltage and second waveform are considered in negative sequence current.

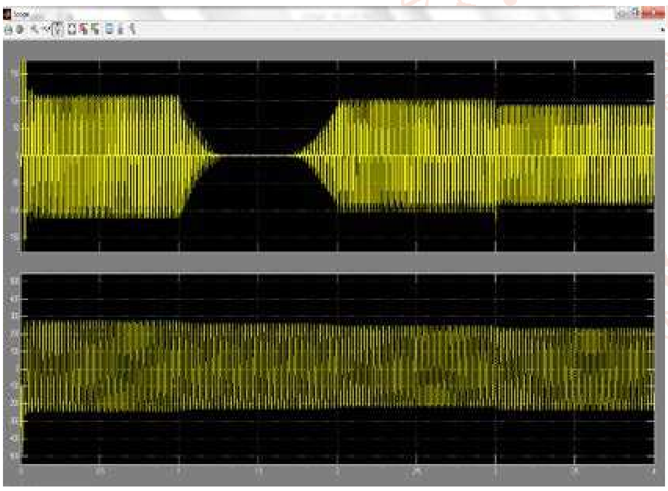

Fig. 10.Overall Output Waveform

IX. CONCLUSION

In this paper an effective configuration and control method is presented for a cascaded H- bridge SSSC in three-phase power system. The proposed control method is based on the zero-sequence voltage and negative sequence current, which is used exclusively depending on the extent of voltage unbalance. By this method, SSSC can operate flexibly under normal power system condition and does not need wide margin of dc capacitor voltage under large asymmetrical condition. The validity is examined by digital simulation under one line and two line fault conditions. The simulation results show the effectiveness of proposed SSSC.

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