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A New Bidirectional Intelligent Semiconductor Transformer for SMAR GRITD Application

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***Abstract*: This paper includes a better topology of solid-state transformer (SST). In the process of designing the Ac to DC, DC to AC and Ac to AC conversions have been united in order to achieve greater efficiency. To get good and better efficiency from various SST, the AC to AC converters are being united in one matrix converter for better output performance. The newly proposed solid state transformer performs critical functions and has many more advantages such as correction in power factor, sag and swell elimination, flicker of voltage reduction and safe capability in order of error situations. Now additionally, it has includes many other benefits also such as low weight, minimum volume and reduction of dangerous liquid dielectrics includes just because it involves medium frequency transformer. The working and some actions of the newly proposed SST have been tested by the results via simulations.**

***Keywords*—Alternative current, Dual active bridge, Direct current, Distributed renewable energy resourses, Solid state transformer**

I. INTRODUCTION

Transformer are highly used in the transformation of electric power in the power station. On the usage of transformer it may leads to high cost. Hence overall in the power system transformer include much cost due to the windings, cores etc. In order to overcome this problem a newly designed power electronics transformer or solid state transformer are implemented. This new method will tense to reduce the sag, swell of the voltage ofcource the interruption also. This type of transformer are very flexible to use also. It mainly reduces the step down transformer power burden as well as utility. The normally transformer which are used to the convert one form to another form of electrical supply. It does not change with the supply frequency. The transformer is the very important device of the electrical power transformation.The normal transformer system does not have any features such as combination of the voltage sag compensation and voltage regulation due to the lack of the energy storage.It's all the disturbances overcome introducing the power electronic transformer. The power electronic transformer or solid state transformer which have the combination of the voltage sag compensation and voltage regulation with matrix convertor. Here isolation transformer which are used to the eliminate the radio frequency interference, electromagnetic interference and common mode voltage. Isolation transformer is mainly used to the allow the very pure AC supply to the matrix convertor. The limitation of the traditional transformer is the harmonics may presented. So the output current and voltage waveform are distorted. The control mechanism of the traditional transformer is absence. Losses are increased due to absence of the control mechanism. The drop voltage is occurred. Mainly power factor improvement is reduced.

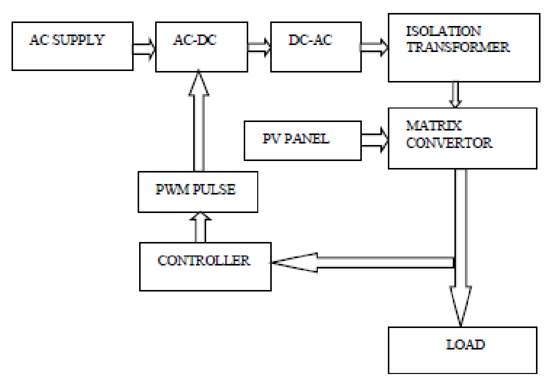

Fig.1 Block Diagram

II. SOLID STATE TRANSFORMER

In order to give importance to the complexity a new better control methods are required in the grid. Solid state transformer is the very new method in order to eradicate the problem in the domestic transformer. This power electronic transformer has various performance it tends to operate in 60Hz.Very harmful to the transformer oil and it affected to the environment. The presence of large inrush current,it developed the harmonics due to the core saturation. The voltage dips are presented in input side, the output waveform harmonics are developed to the output current side. The increases the primary winding losses depons upon the transformer connection. The transformer has a high losses at average load operation. The transformer are normally designed maximum efficiency at full load condition. The frequency of switching with integrated gate bipolar transistor is between five to twenty KHz.

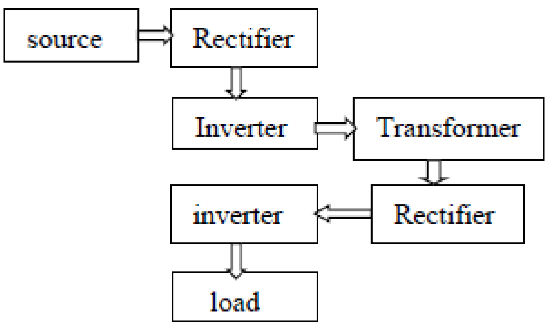

Fig.2 Solid State Transformer

Hence it is easy to indicate the phase locked loop and the control algorithm. The switching frequency shout be lower than one KHz. The power electronic device of the solid state transformer that replaced by the high frequency transformer.

III. IMPLEMENTATION OF MATRIX CONVERTOR

Matrix convertor is the AC to AC convertor. As with the voltage source inverter is based to the DC link and the separate stages are provided in the current source inverter controllers for current and voltage conversion. The storage element of DC link are eliminated by employing matrix convertor. The matrix convertor has a several advantages over power frequency convertor type of traditional rectifier and inverter. The matrix convertor are provided input and output sinusoidal waveforms, and absence of sub harmonics with higher order harmonics is minimal. It has the capability of inherent bidirectional energy power flow. The matrix convertor controlled to the input power factor condition. That required more number of semiconductor switches.

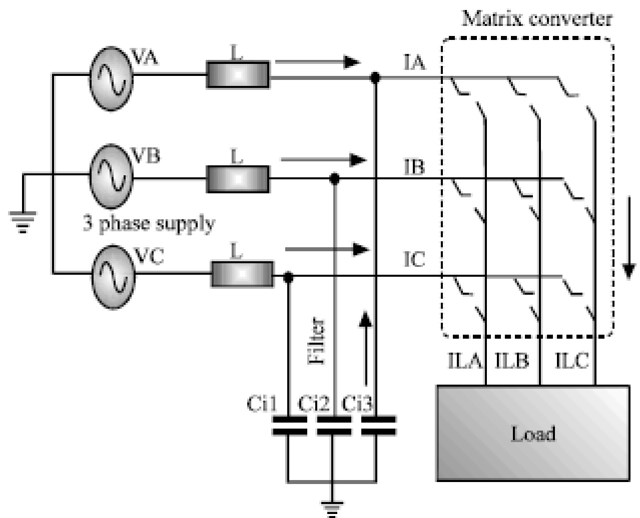

Fig.3 Block Diagram of Matrix Convertor

The matrix convertor which allow the both AC and DC supply from the source and it has a nine bidirectional semiconductor switches. The three phase voltage fed system is connected to the input terminal of the matrix convertor. The three phase current fed system is connected to the output terminal of the matrix convertor. The voltage fed side capacitive filter are used and the current fed side inductive filter are used.

A. Control technology of the matrix convertor

The usage of matrix convertor the input current and output voltage is possible and the controlling action of the same is possible. The control method is very unique to the matrix convertor. Here the pulse pattern is calculated directly for the generation purpose. It is very impossible to control input current also.

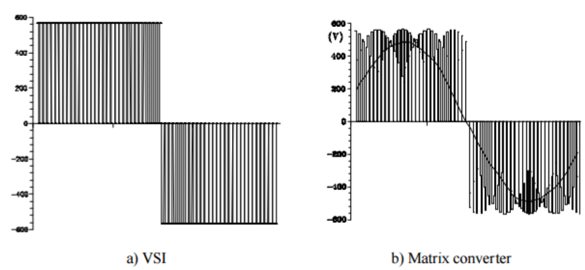

Fig.4 Waveform of VSI and Matrix Convertor

The matrix convertor has the pure sinusoidal input and output waveform. The voltage source inverter has the square wave output. The matrix convertor get pure sinusoidal waveform using large number of semiconductor switches.

IV. OPERATION OF MATRIX CONVERTOR

The two types working involved in the case of matrix convertor .There are

A. Input stage

In this stage the lower frequency, voltage are converted voltage of DC by the use of rectifier. There are many control methods involved in the controlling action of input current. To get the constant input current adoption is done of the rectifier section. The rectifier are controlled to the shaping of input current and also controlling to the input power factor. The DC voltage are keeping desired reference value. This input stage condition to set the reactive current is zero for the reference.

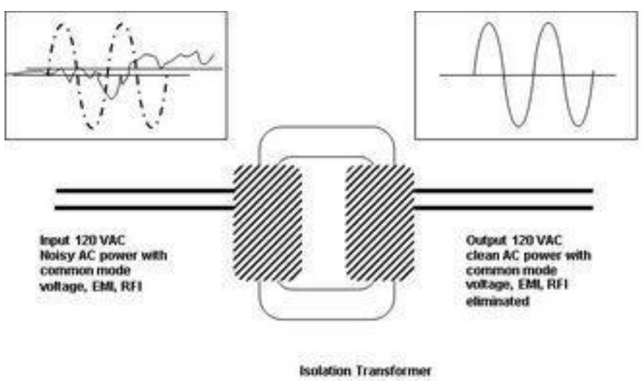

Fig.5 Isolation Transformer

B. Stage of isolation

This stage involves only medium frequency of single phase voltage source convertor which convert DC to AC voltage. To simplified this method convert open loop system is improved much. The solid state transformer are mainly applied for bidirectional power of application. The power electronic transformer might be used for higher voltage application also. This stage consist of voltage source convertor of single phase medium frequency transformer. The medium frequency transformer main function is the transformation of voltage and isolation between the load and source. The stage of isolation contained two condition.

Condition 1 If P0 of sine wave, turned on the H1 and H2.

Condition 2 If <0 of sine wave, turned on the H3 and H4.

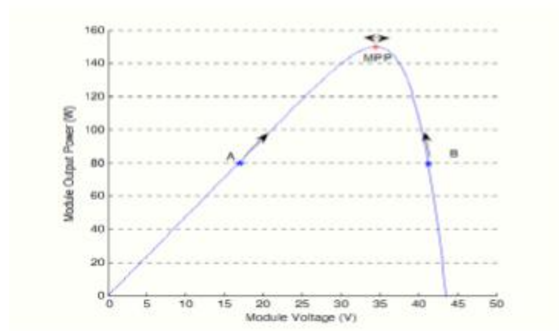

Fig. 6 Graph for module power and voltage

The stage of isolation medium frequency transformer which allow the only medium frequency. The solid state transformer consist of the convertor ,inverter, isolation transformer and convertor, inverter. The convertor which are used to the convert the AC into DC. The inverter which are used to the convert the DC into AC.

V. CONVERTOR PERFORMANCES

The matrix convertor performance involved in three stage condition

A. The output voltage

The energy storage components does not present between the input and output of the matrix convertor. The output voltages directly generated from the input voltages. The each output voltages are synthesized by input voltage waveform of the sequential piecewise sampling. The sampling rate is set to be higher than both input and output frequencies. The voltage source inverter output voltage can assume two fixed discrete

B. The Input Current

The output current are directly generated from the input current. The output current are synthesized by input current waveform of the sequential piecewise sampling. The matrix convertor switching frequency is set a value, that is higher than the input and output frequencies. The input filter is required to reduce the harmonic distortion from input line current. The matrix convertor performance represented to the input current drawn by voltage source inverter.

C. The Input Power Factor Control

The another attractive feature of the matrix convertor is the input power factor control. The algorithm is does not required for the angle displacement control. Matrix convertor which are used to the control to input power factor.

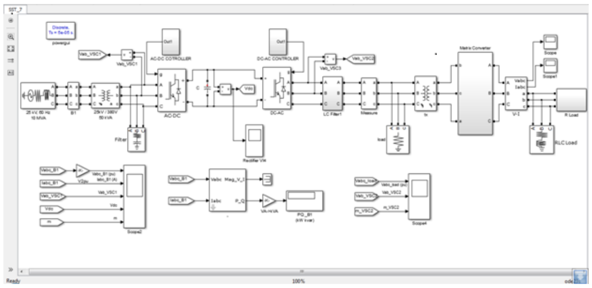

Fig.7 Simulink model of system

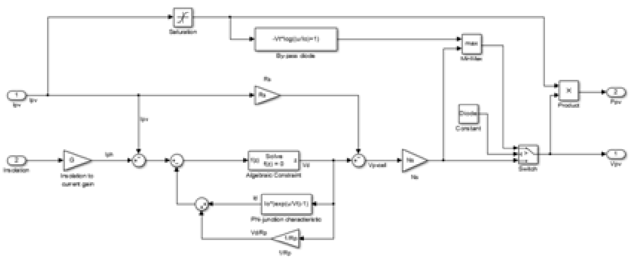

Fig.8 Simulink pv module

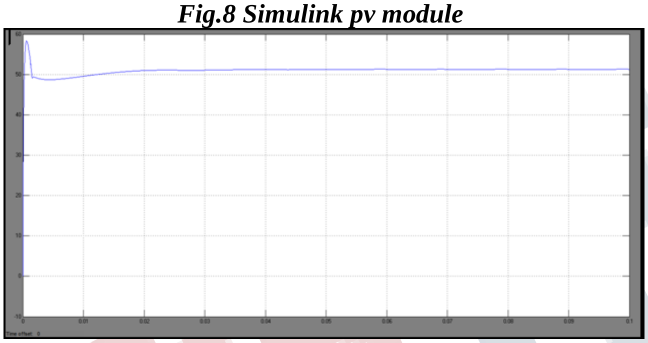

Fig.9 Generated DC

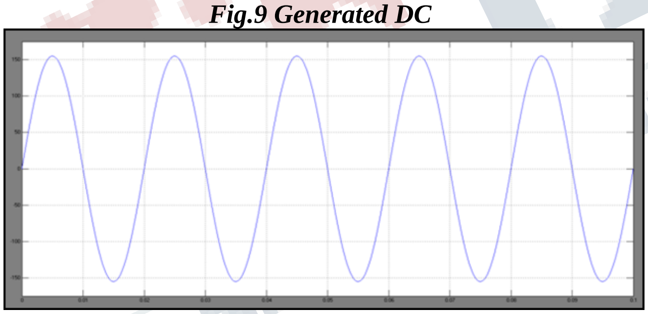

Fig.10 Output voltage across the invert or(vo)

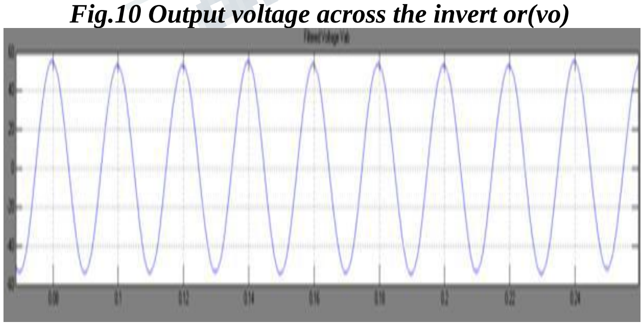

Fig.11 Filtered voltage Vab waveform

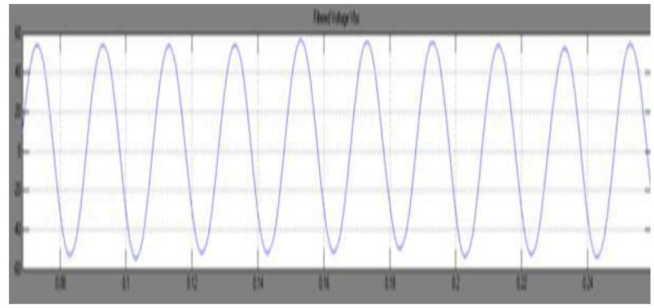

Fig.12 Filtered voltage Vbc waveform

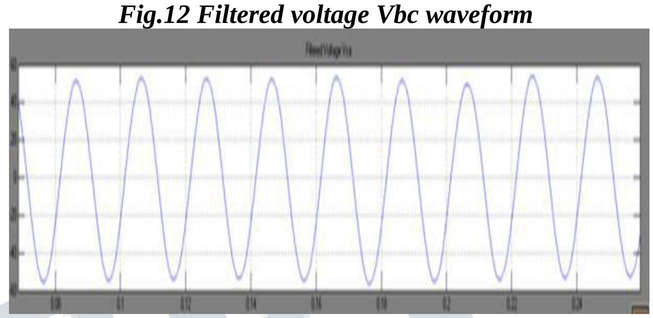

Fig.13 Filtered voltage Vca waveform

VI. CONCLUSION

In this newly proposed system a ultra configuration of Solid state transformer along with the perfect DC-Link capacitive element has been introduced here. Incase of obtaining the higher efficiency, the conversion operation has been accompanied in one converter and the same DC-link is used and introduced. In new SST one AC to AC matrix converter has been eradicated by two converters and matrix converter is easy and not complex.The plan is now decrease the area and improve dynamic of transformer. The complete topology is explained in this paper has many benefits such as correction of power factor, voltage regulation, sag and swell elimination, voltage flicker of voltage reduction. Simulation results viewed and some of benefits in the proposed SST method.

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