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A Closed Loop Solid State Transformer Based Grid Tied Hybrid System

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Abstract

Grid tied system with non-transformer inverter is implemented in wide range of PV applications due to their benefits of high efficient and lower investment. More over the use of non-transformer inverters have isolation from main system addressing specific problems with constant voltage on the PV panels. In order to eliminate the leakage current and non-isolated grid synced system eliminates the high frequency with negative PV terminal to mains commutating on the frequency. The proposed model has 4 power switches. The inverter has an ability to achieve the shape controlled PWM for the MP-Point tracking from the PV panel arrays.

Keywords: Transformer less Grid Tie Inverter, Photovoltaic, Power Factor, Maximum Power Point Tracking,Closed loop

1 Introduction

In this decade the alternate power source plays vital roles due to the current power consumption and demand situation, for this problem statement the use of renewable of low cost energy sources is necessary. The renewable based energy sources are mainly deals with the solar and wind power models. The design and space allocation the solar energy is normally applicable one. But the wind areas or the high humid areas solar based power system did not

give full efficient way of power. So the wind model based power system is successfully implemented in those places. For the wind based model power generating system so many considerations are takes place for achieve high efficiency and the space reduction. The design aspects are done by the both closed loop control and the wind model. For the better performance the double fed induction drive system is mainly used. It's mainly applicable for the variable speed drive applications[1-8]. Figure 1 shows Conventional Hybrid Power Generation with Grid Interface

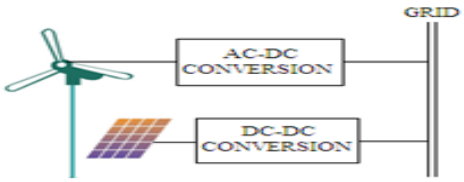

Figure 1 Conventional Hybrid Power Generation with Grid Interface

The previous demonstration model states that the hybrid model based grid tied system is implemented for the atmosphere conditions. This hybrid model consists of the mechanical shaft design and the rotor blade shapes same as the panel rating for the output power statements. The DFIG based power system consists of the two converters that is rotor side converter and the grid side converters both converters performs the overall power achievement with the closed loop control medium. Figure 2 shows SST Based DFIG Configuration.

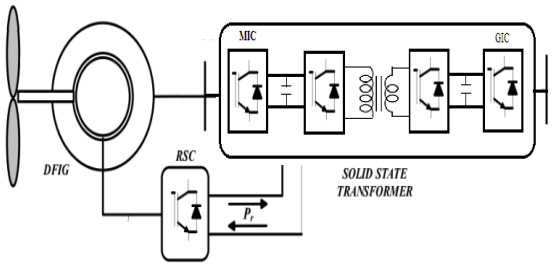

Figure 2 SST Based DFIG Configuration

The system of 450 V-740 V and is associated with the transmission arrange through a transformer that goes about as a necessary piece of the WECS to interface the breeze turbine and the network. The overall advantages like economic, high reliable ,and better efficient and mainly it has the sensitive control technique for the harmonics as well as the voltage drop at no load and loaded conditions, No protection from system disruptions and overloads, Environmental concerns regarding mineral oil, Poor performance

under DC-offset load unbalances, less power factor improvement.

The conversion of different kind of functions in solid state transformer is generally defined by ac-ac conversion, with dc link and without dc link. There are important points to taking into an account of implementation

i). Change of the voltage level straightforwardly with no disengagement transformer,

ii) Proper switching condition required, that is proper voltage passed to ON state and zero voltage level at OFF state.

iii) Control technique is more complicated for the applications.

iv) The separation of power lossless to address power quality. In this proposed model the transformer eliminated inverter based grid synchronization is implemented with the source of solar input.

2 Proposed Configuration and Modeling

With this DFIG, the stator side converted is designed by the matrix type converter while the rotor side is designed by the slip rings. The DFIG has been regularly utilized with variable speed drives. This is because of the high electric converter deals with the 30% power for the generator speed. This small size transformer eliminated inverter will reduce the cost and overcome the previous model demo. Alongside the consecutive converter, which is remembered for the two sorts of drive trains, DFIG likewise requires extra force electronic circuits and parts, for example, to build up the over-current assurance of the rotor-side converter during power framework unsettling influences when the stator is associated with the matrix. Additional enemy of parallel Thyristor in the stator circuit or a third voltage source converter to substitute the Y-purpose of the stator circuit have likewise been proposed to improve the generally poor damping of the stator transition and torque motions brought about by the lattice voltage plunges and to accomplish adequate FRT execution. In spite of these extra parts, DFIG still generally experiences deficient responsive current infusion limit required in the most recent network code determinations during matrix shortcomings. Figure 3 shows Conventional Block Diagram of SST.

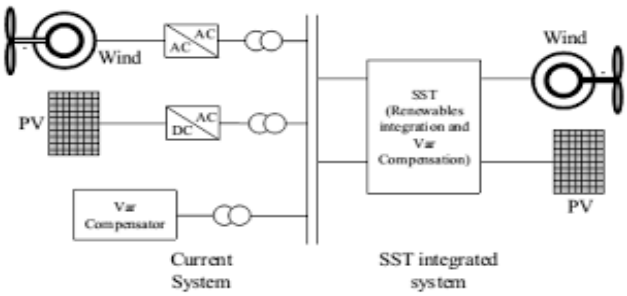

Figure 3 Conventional Block Diagram of SST

The principal recurrence step-up transformer goes about as a key interface between the breeze turbine and the matrix. As of late, there have been endeavors to supplant this transformer by a propelled power hardware based strong state transformer (SST). Ordinary actualized a design that consolidates the doubly taken care of enlistment generator (DFIG) based breeze turbine and SST activity. The fundamental target of that arrangement is to interface the turbine with the lattice while giving upgraded activity and execution. SST controls the dynamic capacity to/from the rotor side converter (RSC), accordingly, taking out the matrix side converter (GSC). Furthermore, it can gracefully receptive capacity to the framework when the breeze age isn't up to its appraised esteem. SST can go about as an interface between the matrix and age sources. Nonetheless, research indicating point by point arrangements for incorporating existing advances is restricted. In any case, an itemized examination on shortcoming ride through necessity and receptive force support has not been led. Because of Bulky size and High exchanging misfortune the proposed framework has changed.

3 Proposed Methodology

PV (DC) and wind (AC) generate the power with 12 v and given to the dc-dc converter for charge the battery. Then the boost converter will step-up the voltage level in to the 320v dc formation for the inversion purpose. The solid state transformer will interfaced in the boost converter.

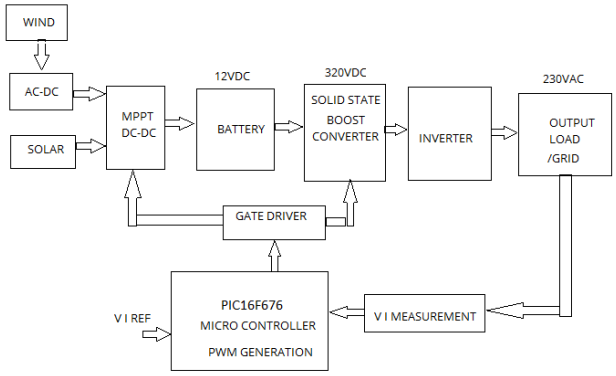

Figure 4 Proposed Block Diagram of SST

After that the boosted voltage given to the inverter circuit for AC output form. Finally the output is fed to loads. The feedbacks from the load i.e. voltage and current were given to the PIC16f676 controller, and it's compared to the reference signal. After comparison it will generate the PWM signal to the gate driver circuit. Figure 4 shows Proposed Block Diagram of

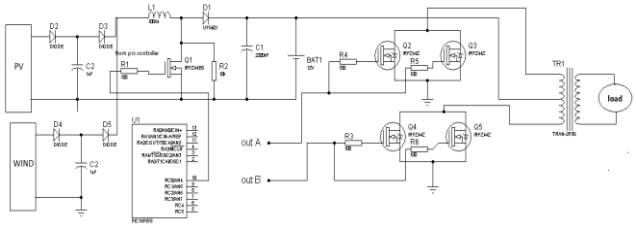

Figure 5 Proposed Circuit Diagram

SST. The gate driver will control the dc-dc converter as well as inverter for the rated output. Figure 5 shows Proposed Circuit Diagram. Figure 7 shows Functional Diagram of SST.

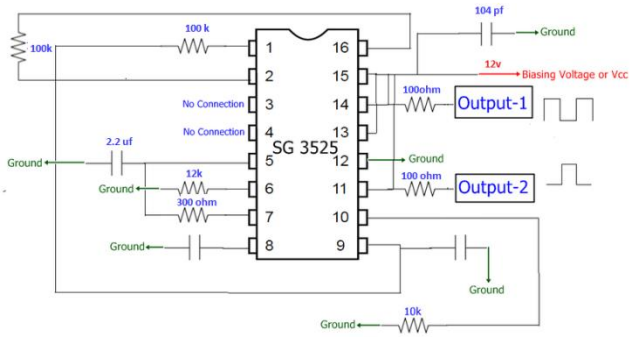

Figure 6 SG3525 PWM Generation Circuit

The solid state transformer has the power electronic devices for the conversion utility, the systematic of SST drive consist of three stages, (i.e.) AC to DC converter for the low voltage driven to the next part, second stage is DAB that to boost the low voltage into required DC voltage respect to voltage and current with the help of high frequency transformer. The third stage consists of DC to AC which generates the final required AC voltage to the grid synchronization. So this SST based drive is also called as three stage grid connected system. Figure 6 shows SG3525 PWM Generation Circuit.

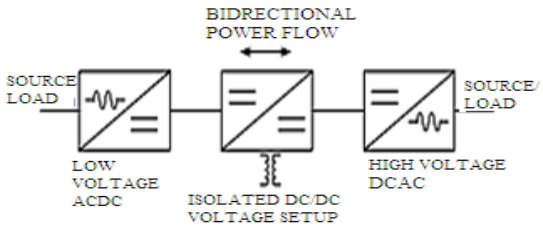

Figure 7 Functional Diagram of SST

Table 1 - Hardware System Parameter

PARAMETER	VALUES
PV	10 W, 12V, 0.34 Amps
DC MOTOR	12V, 100 RPM No-load current = 60 mA(Max), Load current = 300 mA(Max)
BATTERY	12V, 4.7Amps
INDUCTANCE	10mH, 100mH
CAPACITOR	1000 uF, 100 uF, 10uF
DIODE	1 Amps
RESISTOR	1KΩ, 10KΩ, 100Ω, 22KΩ
MOSFET	IRF540 N CHANNEL , P55
CONTROLLER	SG3525, PIC16F676

Table 2 - Input and Output Rating

MODULES	RATING
RENEWEABLE OUTPUT	12V
CONVERTER OUTPUT	12-300V
SST OUTPUT	230V, 1 AMPS

A grid tied system with hybrid source with closed loop system was designed. Based on the simulation outcome the Neuro-Fuzzy technique based closed loop controller (PIC16F676) will generate the closed loop signals. And the outcome from the DC-DC and DC-AC were given to the loads as well as grid and its verified by the hardware setup. Component rating and output values in Table 1 and 2. Table 1 is referred as hardware component rating for demo purpose and Table 2 for input and output rating of each stage output.

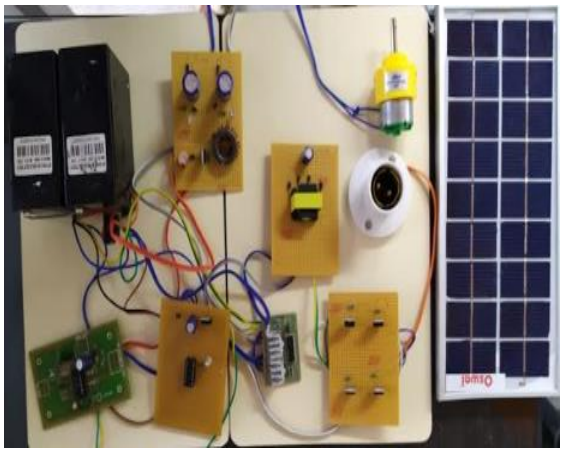

Figure 8 Hardware setup Demo architecture

A transformer less grid connected inverter was designed with solar PV array at its input. PV (DC) and Wind (AC) generate the power with 12 v and given to the DC-DC converter for charge the battery. Then the boost converter wills step-up the voltage level in to the 320v dc formation for the inversion purpose. The solid state transformer will interfaced in the boost converter. The buck mode converter allows the wide range of solar input and delivers the required level output. Further the system structure of the converter is deals with the toroid core which avoids leakage current in grid connected transformer lees system. After that the boosted voltage given to the inverter circuit for AC output form. Finally the output is fed to loads. The feedbacks from the load i.e. voltage and current were given to the PIC16f676 controller, and it's compared to the reference signal. After comparison it will generate the PWM signal to the gate driver circuit. The gate driver will control the dc-dc converter as well as inverter for the rated output. Figure 8 shows Hardware setup Demo architecture.

4 Conclusion

The non-transformer fed inverter was designed with the renewable interface and the converter will acts as the buck boost mode which is designed to handle the variation of solar voltage. Further the toroid core structure is eliminates the leakage current issue on grid synced PV system. Neuro-fuzzy system based closed loop controller generates the gating PWM signals which provides the fast response to the correction. The soft switching technique is used to control the switching stress in the system.

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