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Modeling and Analysis of Micro Inverter Using Dual Switch Forward Converter Push-Pull Topology

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Abstract— **View of switching devices are now change for the integration of renewable Energy sources to the main system. Flyback micro inverter has some drawbacks that's overcome in this proposed forward micro inverter. By using sinusoidal PWM for main primary winding switches we can obtain the sinusoidal output. In this paper we propose micro inverter with Forward Push-Pull topology to perform better in comparison to normal inverter can be used for normal inverter as well as micro inverter for solar grid system and other location. By using double switch configuration high efficiency can be achieved. The above model is simulated in Matlab/Simulink.**

Keywords—Flyback converter, forward converter , forwardmicro inverter, Distributed generation,fossil fuel.

I. INTRODUCTION

Renewable energy sources are available in abundant and the use of these sources are now a more prominent by having some more advantage over the fossil fuel energy system. The use of solar energy [1]is also increasing because of the abundant quantity and clean energy concept. The output of the current source is directly proportional to the light falling on the solar cell. The PV system [2] is having PV Module and Energy Storage device in voltage range of 12 V to 70 V. The main conversion process from Solar to AC signal require Inverter configuration. The various type solar inverter topologies and its control and synchronization with solar grid system is discussed in [2] to [13]. Soft switching of these inverter is discussed from [14] to [15].

The operation of the inverter is depending on the switch operation and also the type of switch and switch is operated at the Zero crossing of the AC grid voltage.

For obtaining the energy from these sources we require Inverter/Converter, for this purpose DC to DC converter and DC to AC converter are now widely used. Flyback converter [8] is very popular due its simplicity and low cost and effective design and maintenance practices.

But flyback type micro inverter has some drawback, that in CCM [2] mode operation there is large distortion in output at nonlinear load. And control in CCM mode is also complex. In DCM mode operation peak current stress on switches are high and efficiency is also low. In this paper a dual switch forward micro inverter is proposed. This inverter can be used as normal inverter as well as micro inverter for solar grid system. This proposed inverter has only few components. In proposed inverter main primary switch is operated by sinusoidal PWM generator, so that sinusoidal output can be achieved. This proposed inverter can be made of higher rating 100W to 180W.

II. FORWARD CONVERTER BASED INVERTER (PUSH PULL TOPOLOGY)

The proposed forward micro inverter is shown in figure1.In this both primary winding switch S1 and S2 are operated by same pulse generator. Switch S1 and S2 operated at 60 KHz. While Switch S4 and S3 are alternately operated at 50Hz. These output Switches are ON for positive and Negative half cycle of output. It synthesizes the fictitious current signal help of fundamental components regarding the voltage gain [5].

Information regarding the inverter output voltage is obtained from the switching function used to trigger the inverter switches. The output voltages in solar system [15] vary according to weather condition and depend on the constant close loop control requirement [10].

Working of the circuit may be divided in following mode are as:

Mode- 1

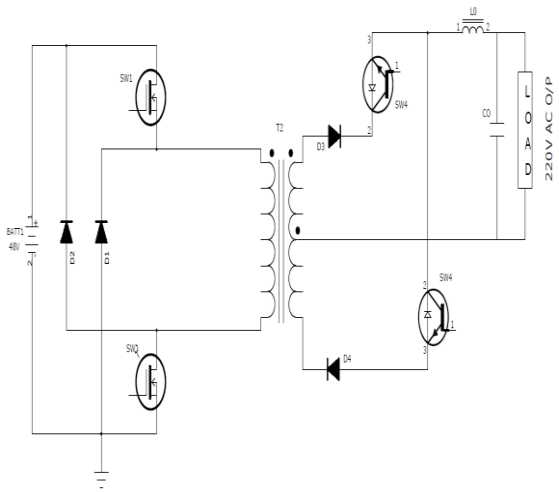

Fig-1 Forward Micro Inverter

From the above figure When switch Sw1 and Sw2 are ON , Input voltage VDC is applied across transformer primary winding . Primary winding current start flowing. During this time induced secondary winding voltage polarity is such as D3 and D4 are in forward bias and diode D1 and D2 are in reverse bias.

During this mode obtained output voltage polarity depend upon the ON/Off position of the output switches, as shown in the figure 2.

Power transfer is possible when switch Sw4 or sw3 is ON. When Sw4 is ON output current flow from A to B. and when Sw3 is ON output current flow from B to A. as shown in figure 2.

Mode-2

When switch Sw1 and Sw2 are OFF, then no energy transfer during this mode, because induced secondary voltage polarity is such that diode D1 and d2 are in forward bias. During this mode Diode D3 and D4 are in Reverse bias.

The magnetizing energy that is stored during mode 2, is supplied back to battery.

We can get sinusoidal output voltage by using sinusoidal PWM for primary winding main switches. This is shown in matlab simulation .

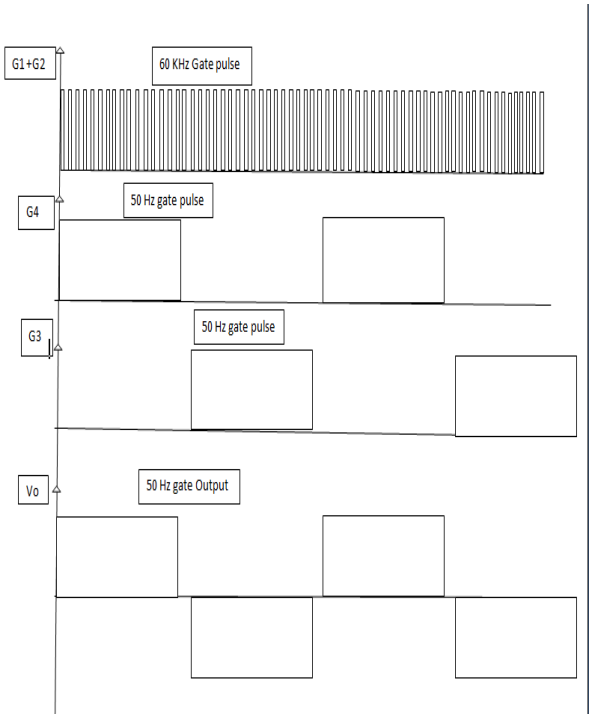

Fig-2 OutPut Wave form with Time Delay

III. DESIGN AND ANALYSIS:

For primary winding MOSFETs are used as a switch and for output switches IGBT are used Output voltage can be synchronized and controlled with grid voltage and wave form terms of the turn ration of the Transformer

Output of forward converter = Ns/Np * Vdc* D

Where D is duty cycle

D = Ton/(Ton+Toff)

Where Ton is ON Time of primary switch and Toff is OFF Time of primary switch

Voltage stress on output switches = Vs - (VL + Vp) to Vs + (VL + Vp)

A. Design a 100W forward micro inverter

Desired Rms output voltage = 230 V

Load = 100 W Resistive

Input Voltage (Vdc) = 48V

Peak output Voltage (Vp) = 325V

Turn Ratio = $\frac{Vp + Vd}{Vdc}$ = 6.78

Rms output current = 0.435A

Battery Rms current = 0.435*6.78

= 2.95A

B. Parameter and Specification

Where Vd is voltage drop across diode = 0.7V
Core used for transformer is = EE25/13/7
Secondary winding bifilar = 163 turn
Primary winding = 24 turn
Primary inductance = 1mH
Secondary inductance = 46 mH
Output switches are IGBT
Primary winding switches are MOSFET.

IV. MATLAB MODELING AND SIMULATION

MATLAB Simulation Model is shown in figure.3. With the help of Model switch simulation Sinusoidal PWM, we have tried to simulate for primary voltage

Table-1 Input & Output Parameter

Input DC voltage	48VDC
Output Voltage	325V peak
Primary winding inductance	1mH
Secondary winding inductance	46mH
Output inductor Lo	1.5mH
Output capacitor Co	1µF

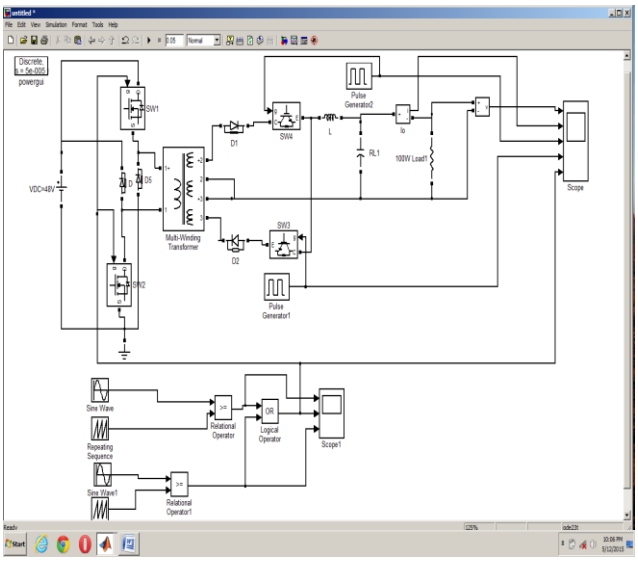

Figure.3 Matlab Modeliing of Forward Micro Inverter

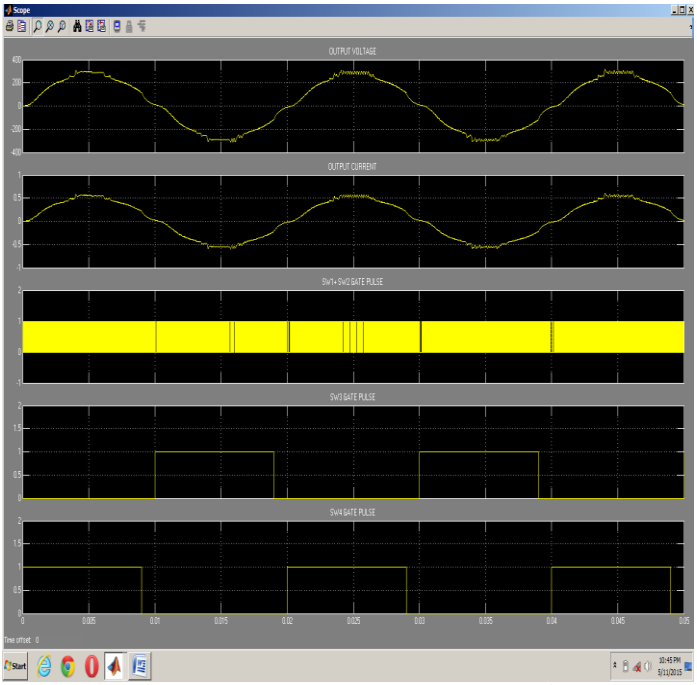

Figure-4 Output Voltage and Output current Waveform

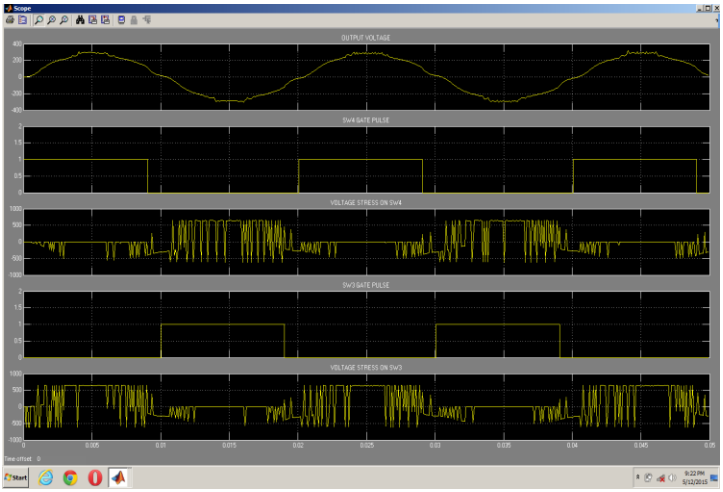

Figure-5 Voltage stress on Output Switches (IGBT)

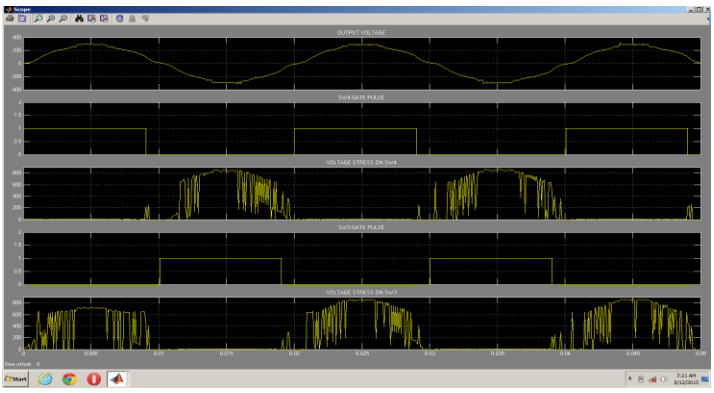

Figure-6 Voltage stress on Output Switches (MOSFET)

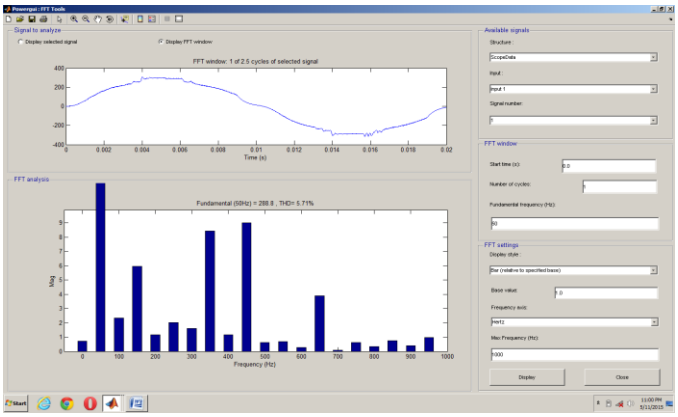

Figure-7 Total Harmonics Distortion

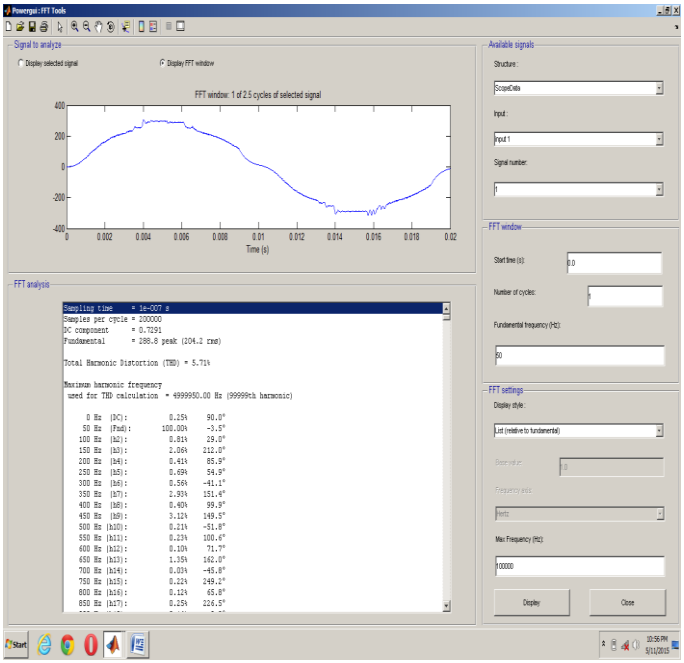

Figure-8 Harmonics Distortion at respective frequency

Obtained Peak Output voltage = 289 V
Output THD = 5.71%

V.CONCLUSION

The Output voltage wave form of forward inverter is dynamic change voltage which is shown in the above figure. By injecting 48 V DC supply and with the help of PWM Pulse and switches various voltage at output generated by using switches the output voltage can be improved very much and THD can be much reduced and voltage stress is also measured. this type forward micro inverter can be designed for rating from 100W to 180W.

References

[1] Guanghui TAN1, Yi TANG1, Bingtuan GAO1, Xinghe FU1, Yanchao JI2 **"***Soft-switching AC module inverter with flyback transformer for photovoltaic power system*" PRZEGLĄD ELEKTROTECHNICZNY (Electrical Review), ISSN 0033-2097, R. 88 NR 10a/2012.

[2] Anjali Menon1, R.Madhumitha2 "*Design and Simulation of Solar Micro- Inverter with Multiple Loads*" International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, Vol. 3, Issue 5, May 2014.

[3] Nayas Qudrathulla.P.P1, P.Balaji "*Enhanced Flyback CCM Inverter for Voltage Stability Under non-linear Loads*" International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, Vol. 3, Issue 3, March 2014.

[4] Slamet Riyadi *" Single-Phase Single-Stage PV-Grid System Using VSI Based on Simple Control Circuit*" International Journal of Power Electronics and Drive System (IJPEDS) Vol. 3, No. 1, March 2013, pp. 9~16 ISSN: 2088-8694.

[5] Jaysing Kshirsagar1 and K. Vadirajacharya "*One-Cycle-Controlled Single-Phase Inverter for Grid Connected PV System*" Advance in Electronic and Electric Engineering. ISSN 2231-1297, Volume 4, Number 5 (2014), pp. 455-462 © Research India Publications http://www.ripublication.com/aeee.htm.

[6] Rafia Akhter, and Aminul Hoque "*Analysis of a PWM Boost Inverter for Solar Home Application*" World Academy of Science, Engineering and Technology Vol:2 2008-11-25. International Scholarly and Scientific Research & Innovation 2(11) 2008.

[7] Soeren Baekhoej Kjaer, Member, IEEE, John K. Pedersen, Senior Member, IEEE, and Frede Blaabjerg, Fellow, IEEE "*A Review of Single-Phase Grid-Connected Inverters for Photovoltaic Modules*" IEEE TRANSACTIONS ON INDUSTRY APPLICATIONS, VOL. 41, NO. 5, SEPTEMBER/OCTOBER 2005.

[8] Vikas Kulkarni, Rajesh Nehete "*Simulation and Analysis of Photo-Voltaic (PV) based Solar Inverter System*" International Journal of Soft Computing and Engineering (IJSCE) ISSN: 2231-2307, Volume-3, Issue-6, January 2014.

[9] P.Jeyankondan, V.Hemamageswari, Dr. M .Santhi " *Grid Connected Solar Microinverter Based On Single Stage Boost Conversion*" International Journal of Scientific & Engineering Research, Volume 5, Issue 4, April-2014 1099 ISSN 2229-5518.

[10] Nishit Kapadia1, Amit Patel2, Dinesh Kapadia3 *" simulation and design of low cost single phase solar inverter*" International Journal of Emerging Technology and Advanced Engineering Website: www.ijetae.com (ISSN 2250-2459, Volume 2, Issue 1, February 2012).

[11] N.Kamalakannan1, A.Arulvizhi2, C.Kirthana "*MATLAB SIMULINK Model for Flyback Inverter with Active Clamp Technique*" INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH IN ELECTRICAL, ELECTRONICS, INSTRUMENTATION AND CONTROL ENGINEERING Vol. 3, Issue 3, March 2015.

[12] Gibi Paul1, Kannan S.A2, Neethu Johnson3, Justin George4 " *Modeling And Analysis of PV Micro-Inverter*" INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH IN ELECTRICAL, ELECTRONICS, INSTRUMENTATION AND CONTROL ENGINEERING Vol. 2, Issue 2, February 2014.

[13] K Prasada Rao, Dr Sukhdeo Sao, Dr JBV Subrahmanyam " *Development of A Grid Connected Inverter for Solar PV Systems with Energy Capture Improvement Based On Current Control Strategy*" International Journal of Scientific and Research Publications, Volume 3, Issue 4, April 2013 1 ISSN 2250 3153.

[14] Toshihisa Shimizu, Senior Member, IEEE, Keiji Wada, Member, IEEE, and Naoki Nakamura "*Flyback-Type Single-Phase Utility Interactive Inverter With Power Pulsation Decoupling on the DC*

Input for an AC Photovoltaic Module System" IEEE TRANSACTIONS ON POWER ELECTRONICS, VOL. 21, NO. 5, SEPTEMBER 2006.

Oct 2014 ISSN:2393-992

[15] Shaik.Amanulla "*A Single-stage Photovoltaic Grid-Connected Inverter using SPWM*" Global Journal of Trends in Engineering, GJTE-Vol(1)-Issue(3)