A Single-Phase Transformer less Inverter for Grid-Tied PV Applications by Using Hysteresis Controller

M Deepthi

PG scholar, Dept. of EEE, Malla Reddy Engineering College, Dulapally Road Maisammaguda Post via. Kompally Rangareddy Dt Secunderabad, Hyderabad, Telangana ,India.

Abstract- The main aim of this project is A single- phase transformer-less inverter for grid-tied PV applications by using hysteresis controller. The proposed system has charge pump circuit for decreasing the leakage current in the framework. The system contains PV, DC-DC boost converter, and transformer-less inverter with hysteresis controller. The charge pump circuit has 2 didoes, 2 capacitors&4 IGBTs. A hysteresis controller is recycled to regulate the transformer-less inverter. The major benefits of the proposed system are compact size, grounding configuration is flexible, capability of reactive power flow, reducing the harmonics&it gives high efficiency. Simulation results are studied for the proposed inverter&it is designed in the MATLAB/SIMULINK.

Key words- Transformer-less inverter, PV, grid, Hysteresis controller.

I. INTRODUCTION

In the world the usage of renewable energy sources i.e., pv, wind, fuel cell, etc[1]. These sources are more popular for pollution free for the world. In order to remove the leak currents, transformers are commonly made use of within the PV [2] gadget to deliver galvanic isolation. Nonetheless, it possesses unwanted houses at the side of plus period, immoderate cost with further losses [3] Thus, removing the transformer is a brilliant gain to greater boom the overall device overall performance, lessen the measurement, & moreover weight [4] Among the vital troubles within the transformer-less network associated PV packages is galvanic link of network & moreover PV device, which motives leak present problems. For transformer-less network associated-inverters, Neutral Factor-Fixed (NPC), Full-Bridge (FB) inverter, Dynamic-NPC (ANPC) inverter [5] in addition to several numerous different schemes such as H5, H6 in addition to HERIC had been suggested to moderate the leak modern-day with removing of the network from PV in the direction of the freewheeling settings [6] Nevertheless, those geographies are not absolutely without Usual Setting (CM) gift or leakage present [7]. The leak current nonetheless exists because of the parasitic capacitor of the transfer in addition to stray capacitance in among the PV panel & floor. So, a number of these geographies need 2 or additional clear out inductors to decrease leakage present day, which results in an increase within the extent & moreover fee of the device [8-11] Fig. 1 indicates a single-stage grid related transformer-less inverter through grid present day path [12].

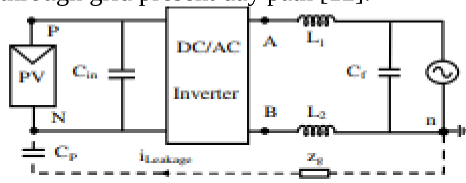

Fig.1: Scheatic circuit of 1-stage transformer-less inverter

In this paper transformer-less inverter with hysteresis controls is presented. The major benefits of the proposed system are producing less harmonic, less size&it gives high efficiency [13].

II. PROPOSED SYSTEM

Fig. 2 indicates the proposed transformer-less grid associated inverter. The total system contains PV, boost converter, transformer-less inverter&grid. The proposed circuit has 2 diodes, 2 capacitors&4 switches as shown in figure. The variable DC supply which is produced by PV source is passes through the DC-DC converter. Boost converter is regulated by P&O MPPT procedure. The main aim of boost converter is converts variable dc into step upcontinuous dc. It is given to the proposed inverter. This inverter is controlled by hysteresis controller. The output of proposed inverter is ripple free ac is given to the grid. The complete circuit diagram as shown in below.

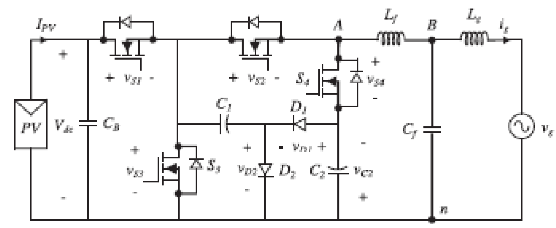

Fig.2: Proposed transformer-less grid associated inverter.

Fig.3 indicates the suggested framework switching process.as per the output current&output voltage of the inverter it is divided into 4 sections.

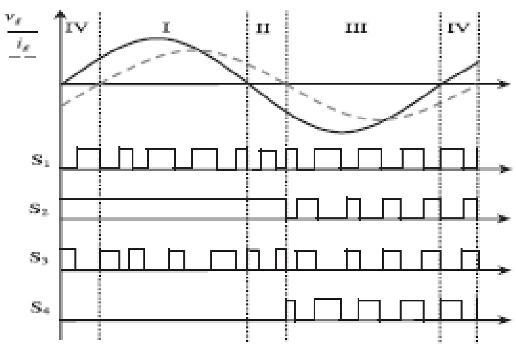

Fig.3: switching operation of the proposed inverter

III. OPERATION OF THE PROPOSED SYSTEM

In section 1 the inverter currents&voltages are positive, in this cased power conveyed from DC to network as indicated in fig. 4(a). In section 2 the inverter voltage is negative&output current is positive in this case the power conveyed from grid to DC association capacitor as indicated in fig.4(c).In section 3 thee output currents&inverter output voltages are negative the energy conveyed form dc link to network as indicated in fig.4 (e). In section 4 the output current is negative&the inverter output voltage is positive in this case the energy conveyed from dc association to network as indicated in fig. 4(g).

Based on given above explanation, by taking inverter voltage the sequences as given in below

1) If segment is I-III, the inverter power factor is 1.
2) If segment is IV-I-II-III, the inverter current is lagging situation
3) If segment is I-IV-III-II,the inverter current is leading situation

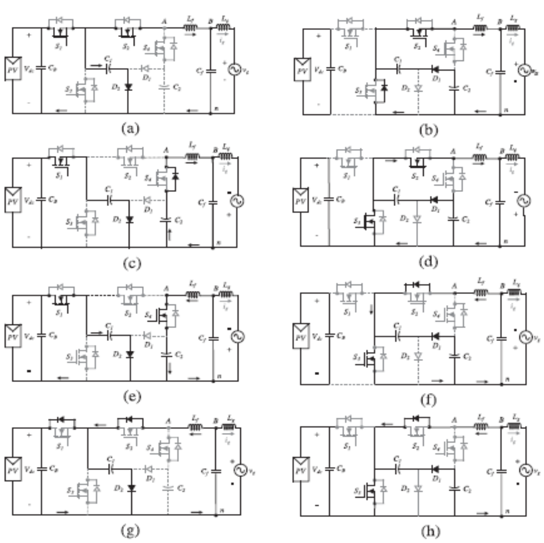

Fig. 4. Functioningtimes of suggested inverter through (a), (b) section I, (c), (d) section II, (e), (f) section III,&(g), (h) section IV. (a) *v*An = +*V*dc, *ig* >0. (b) *v*An = 0, *ig* >0. (c) *v*An = −*V*dc, *ig* >0. (d) *v*An = 0, *ig* >0. (e) *v*An = −*V*dc, *ig* <0. (f) *v*An = 0, *ig* <0. (g) *v*An = +*V*dc, *ig* <0. (h) *v*An = 0, *ig* <0.

IV. PV PANEL WITHMPPT

By operating dc/dc boost converter used P&O MPPT procedure is recommended. Compared to another mppt algorithms (i.e., Incremental conductance, hill climbing, fuzzy control) P&O mppt process is little bit efficient. The fig.5 indicates the flow chart of P&O process. P&O algorithm depending upon the measured power&old power. By flow chart firstly we measure the voltage&current from PV panel. The product of voltage&current is power is nothing but measured power. When the measured power increases the process will continues otherwise perturbation reverses. If the Voltage increases it indicates to power increases in this case the functioning point is right of MPP. If the voltage decreases it indicates to power decreases in this case the function point is left of MPP. When the voltage increases it indicates to power decreases in this case the function point is right of MPP, otherwise the functioning point is left of MPP. The process of P&O mppt algorithm as indicate in figure.

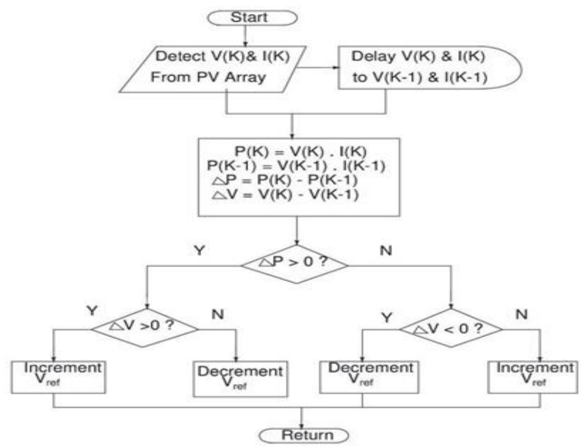

Fig.5: P&O Mppt algorithm

V. PROPOSED HYSTERISES CONTROLLER

To modify the controller and at a tantamount time balance out the structure all through the mode changes, a physical supernatural occurrence controller is used. When current ensures inside the rectifier mode, the entire potential unit seconds applied to the inductance L1 more than one move total square measure as searches for after

$(VDC/2 + VAC)D\ rA1 + (VDC/2 + VAC)\ (1 - DrA1) = 0$ …….. (1)

Here duty cycle used forcontrol A1 is resultant as,

$DrA1 = 0.5(1(VAC/\ (VDC/2)))$……… (2)

$= 0.5(1M\sin(\omega t)$……… (3)

Likewise, duty-cycle for switchA2 within rectifier mannerit is resultant as,

$DrA2=0.5(1+ (VAC/ (VDC/2)))$…… (4)

$=0.5(1+M\sin(\omega t))$… (5)

Duty _cycle for A1 within electrical converter approach is found as,

$DiA1=0.5(1+ (VAC/ (VDC/2)))$…. (6)

$= 0.5(1 + M \sin(\omega t))$

$=0.5(1+M\sin(\omega t)$…….. (7)

Duty _cycle for "A2" within electrical converter manner is found as

$DiA2=0.5(1(V_{AC}/ (V_{DC}/2)))$ (8)

$=0.5(1-M\sin(\omega t)$ (9)

It can be decided that DrA1 = DiA2&DrA2 = DiA1.

Fig. 6 indicate the proposed hysteresis controller loop. The ref active&reactive power command are often accustomed calculate Im&θ as shown below

$I_m= ((P_{ref}+Q_{ref})/ (V_{pk}/2))$…… (10)

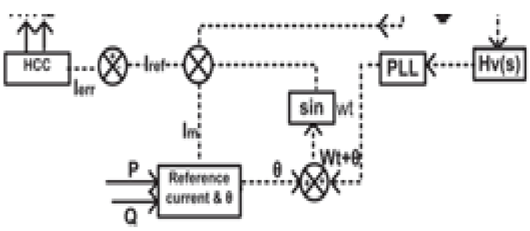

Fig.6: Proposed Hysteresis controller

From Fig.6, Hv(s) is that the voltage identifier gain, that is set up to reimburse assessment voltage trip from cross zone. PLL gives the voltage edge (ωt) of cross region. Adding θ to ωt produces reference current wave sort. It isolates and saturated current iac, maintained that the ruin beats zone unit passed on by common miracle current controller A1& A2. By giving exclusively +Pref vow to controller, it will make iref generally with plan voltage escape. The AC-DC contraption will fill in as converter, if we've a bent to supply negative intriguing power - Pref and iref is with 1800 half capacity with evade making the AC-DC device work as rectifier.

VI. SIMULATION RESULTS

Fig.7 indicates the MATLAB/SIMULINK diagram of proposed system which consists of PV, DC-DC converter, transformer less inverter&grid. Fig.8 shows subsystem of hysteresis controller

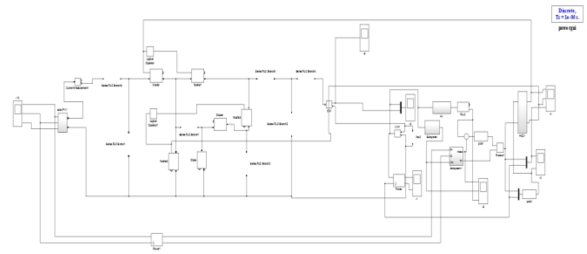

Fig.7: MATLAB/SIMULINK diagram of proposed system

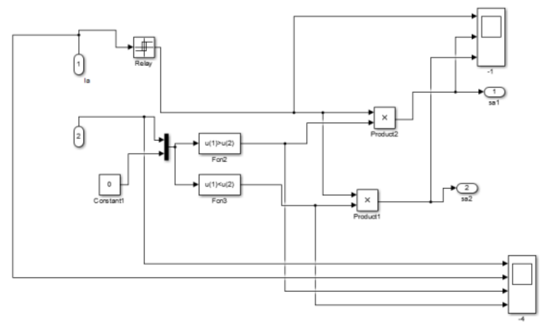

Fig.8: Controller subsystem

Fig.9 indicates the input voltage, fig.10 indicates Output-current, fig.11 indicates Output voltage&fig.12 indicates the THD% current. The comparison of existing&proposed system voltages as tabled.

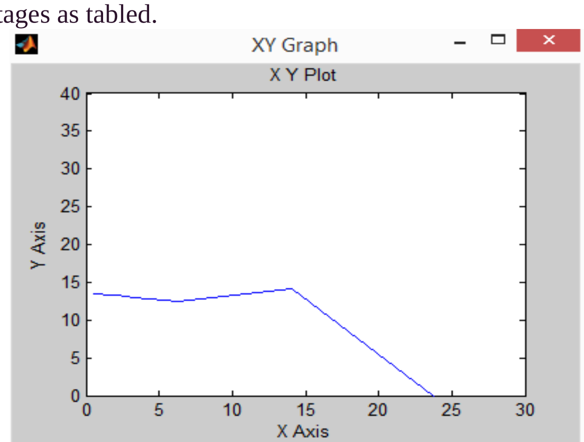

Fig.9: Input waveform

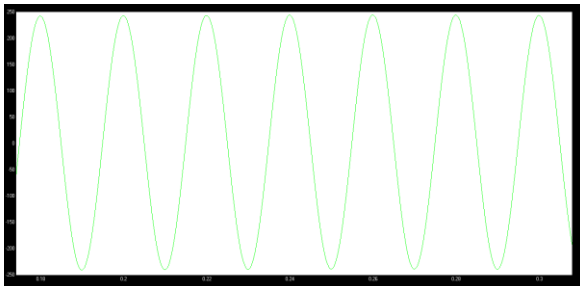

Fig.10: Output Current

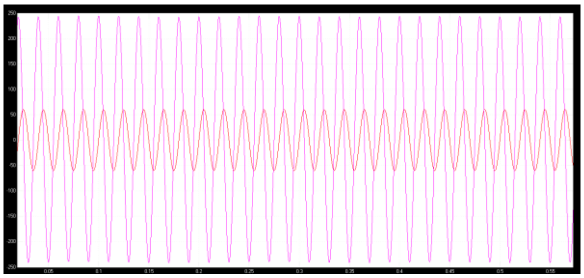

Fig.11: Output Voltage

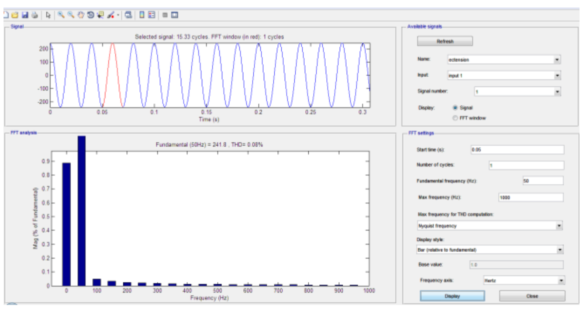

Fig.12: THD% of voltage

VII. COMPARISION RESULTS (THD)

BASE PAPER	EXTENSION
2.25%	0.08%

VIII. CONCLSION

This paper presents the single- stage transformer-less inverter associated grid with hysteresis controller. The proposed system has charge pump circuit for decreasing the leakage currents in the system. This charge pump circuit creates negative output-voltages of the suggested transformer-less inverter innegative cycles. The major benefits of the proposed system are compact size, reducing THD%, higher power density and less designing coast.Related to other surviving transformer-less topologies, the enactment represented by projected inverter is high efficient. A Simulation analysis performed by using MATLAB.

IX. REFERENCES

[1]. S.B.Kjaer, J.K. Pedersen,&F.Blaabjerg, “A reviewof single-phase grid connected inverters for photovoltaic modules,” IEEE Trans. Ind. Electron., vol. 41, no. 5, pp. 1292–1306, Sep./Oct. 2005.

[2]. X. Guo, R. He, J. Jian, Z. Lu, X. Sun,&J. M. Guerrero, “Leakage current elimination of four-leg inverter for transformer-less three-phase PV systems,” IEEE Trans. Power Electron., vol. 31, no. 3, pp. 1841–1846, Mar. 2016.

[3]. W.-J. Cha, K.-T. Kim, Y.-W. Cho, S.-H. Lee,&B.-H. Kwon, “Evaluation&analysis of transformer-less photovoltaic inverter topology for efficiency improvement&reduction of leakage current,” IET Power Electron., vol. 8, no. 2, pp. 255–267, 2015.

[4]. H. Xiao&S. Xie, “Leakage current analytical model&application in single-phase transformer-less photovoltaic grid-connected inverter,” IEEETrans. Electromagn. Compat., vol. 52, no. 4, pp. 902–913, Nov. 2010.

[5]. T. Br¨uckner, S. Bernet,&H. G¨uldner, “The active NPC converter&its loss-balancing control,” IEEE Trans. Ind. Electron., vol. 52, no. 3, pp. 855–868, Jun. 2005.

[6]. D. Barater, E. Lorenzani, C. Concari, G. Franceschini,&G. Buticchi, “Recent advances in single-phase transformer-less photovoltaic inverters,” IET Renewable Power Gener., vol. 10, no. 2, pp. 260–273, 2016.

[7]. W. Yu et al., “High-efficiency inverter with H6-type configuration for photovoltaic non-isolated ac module applications,” in Proc. Annu. IEEEAppl. Power Electron. Conf. Expo., 2010, pp. 1056–1061.

[8]. B. Yang, W. Li, Y. Gu, W. Cui,&X. He, “Improved transformer-less inverter with common-mode leakage current elimination for a photovoltaic grid connected power system,” IEEE Trans. Power Electron., vol. 27, no. 2, pp. 752–762, Feb. 2012.

[9]. F.Bradaschia, M. C. Cavalcanti, P. E. P. Ferraz, F. A. S. Neves, E. C. Santos,&J. H. G. M. da Silva, “Modulation for three-phase transformer-less z-source inverter to reduce leakage currents in photovoltaic systems,” IEEE Trans. Ind. Electron., vol. 58, no. 12, pp. 5385–5395, Dec. 2011.

[10]. Y. Gu, W. Li, Y. Zhao, B. Yang, C. Li,&X. He, “Transformerless inverter with virtual dc bus concept for cost-effective grid-connected PV power systems,” IEEE Trans. Power Electron., vol. 28, no. 2, pp. 793–805, Feb. 2013.

AUTHOR PROFILE

M DEEPTHI pursuing M.Tech in EPS from Malla reddy Engineering Collage (A) Hyderabad- Telangana and Completed B.Tech in Electrical and Electronics Engineering in 2017 from Malla reddy Engineering College, An Autonomous Institution.