

# INVESTIGATION OF TRANSFORMER LESS PV INVERTER TOPOLOGY

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## Abstract

The proposed PV inverter overcomes different issue of present PV inverter, because of the consideration of Quasi Z system and framework converter in the PV framework. Blend of these circuit in PV framework has different critical points of interest, for example, voltage and recurrence doublers capacity, diminished consonant substance with legitimate current and voltage regulation. Different benefits incorporates it is a Single stage change process with Zero voltage turn on and delicate turn off which thus lessens the voltage push and exchanging misfortunes in the PV framework. This proposed PV inverter is joined with PMSM through Quasi Z system which is substitution of DC connection. The vicinity of massive electrolytic capacitor as DC connection is most problematic segment for the greater part of the inverter's disappointment, especially at high temperature. Along these lines this substitution of circuit fundamentally enhances the effectiveness and dependability of complete framework. This is demonstrated in the palatable execution saw by RL burden associated with the PV inverter utilizing MATLAB programming and equipment usage.

**Keywords**—Photovoltaic (PV) inverter, Quasi Z network, Zero voltage turn on, soft turn off.

## INTRODUCTION

Because of consumption of fossil powers and customary vitality emergency has relentlessly expanded the natural concern. This worry has prompted significant enthusiasm for abusing the renewable type of vitality for the era of electrical force. Most encouraging vitality is the Solar and Wind. Though Solar has high unwavering quality with minimum 20 years of adjusting time, As there is no moving or turning part included. The fundamental trademark in the renewable vitality is that they are discovered plenitude in nature, they can be reestablished and certain disadvantage is that they are uncontrolled and constantly fluctuating which is valid for wind. The unique methods and control calculation is created in force hardware region for legitimate regulation of the electrical force delivered and amplification of extricating force. The sun powered vitality can be

utilized through the Photo voltaic impact i.e. changing over the sun powered vitality into electrical vitality. Because of the PV framework versatility and convenience it has great regulation. In past outline, brought together converter based PV framework was a generally utilized sort.

This module were joined with three stage voltage source, and so as to decrease the symphonious substance, the inverter's every yield stage was associated with LC channel. A three stage transformer either for venture up or venture down voltage ability additionally gives galvanic seclusion is associated with the utility side low recurrence transformer which makes the complete framework enormous and lessen the effectiveness of the system[1],[5],[6]. To stay away from this later came numerous stage change framework which was broadly utilized as a part of PV framework. Regardless of having great boosting capacity numerous stage

discussion framework additionally have downside, for example, decreased force thickness and low proficiency. With late advancements in force electronic field high dependability and high productivity converters are utilized for different renewable innovation application. The usage of different imaginative plan and advanced control calculation has prompted change in vitality generation and nature of operation. The proposed topology presents in this paper is effectively connected to the PV inverter joined with the PMSM drive. They can be utilized as a part of high power application with the variety of rating in bidirectional switch utilized.

The PV inverter are the sort of inverter which changes over the DC force of sun based into AC power for business or private use and framework power. They additionally have exceptional element for extraction of most extreme force from the sunlight based through different calculation, for example, P&O or Incremental conductance technique and so on which is likewise called as Maximum force point tracking(MPPT)Techniques They are by altering the voltage and current supplied from the PV board.

PV board force is specifically identified with power of daylight which is influenced every day by sun shades from close-by article (i.e. trees, utility posts, tall structures), mists and so forth. PV inverters are intended to work over extensive variety of voltage to catch force amid lower light power.

PV inverters are intended to work over an extensive variety of voltage to catch force amid lower light power. Giving power in the morning and after that later toward the evening expands the vitality supply, in

this way it abbreviates the payback period for sun based establishments.

The third significant part is to boost the force yield of sun based establishment is to use high proficiency of PV inverters. Proficiency is termed as the apportion of force of the inverter as a rate of the force into the inverter. High effectiveness of PV inverters utilize less of force in the change process and supply more power for the usability.

## **II. SURVEY OF EXISTING SYSTEMS**

Essential piece of dissemination framework is force gadgets, with help of which they change over the created power into utility-perfect structures. Be that as it may, the option of force gadgets typically includes dependability issues and also costs. [1], [2]. Alluding to the report by Sandia National Laboratories [3], which in Most of the PV framework issues confronted in the field is that they are intricate and unreasonable. The inverter disappointment prompts problematic PV framework which thusly prompts loss of trust in renewable innovation. Hence, to make progress for long haul in PV framework, new power converters with higher unwavering quality and productive long life time are required [3] [4].

In past configuration utilized, brought together converter-based PV framework was the most normally utilized kind of PV framework. The framework, PV modules are associated with 3phase voltagesource inverter. The yield of every stage has a LC channel which is utilized to confine the music. A 3phase transformer, which is utilized to venture up the voltage and gives a galvanic separation, which join the inverter to the utility.

Entirely recurrence transformers are viewed as poor hardware essentially

because of their expansive size and low effectiveness. To stay away from this low recurrence transformers PV framework utilize numerous stage change framework [1], [5], [6].The most basic plan, incorporates dc to air conditioning voltage source inverter and dc to dc converter. Regularly, the dc to dc converter contain Offering a high boosting capacity and galvanic detachment, this converter create low effectiveness generally speaking because of the vicinity of Multiple-stage transformation framework. Also, massive electrolytic capacitor is required for dc join. Electrolytic capacitors, which are exceptionally delicate to the temperature, may bring about dependability issue to the general framework

The PV inverter which comprises of electrolytic capacitor does not give the same life time as PV modules. Hence, the PV framework requires regular substitution of the inverter. So as to beat all the aforementioned issue it is crucial to take up an option inverter outline topologies in order to make the inverter conservative while additionally expanding their reliability[7].There are a few arrangement proposed to conquer the issue mostly.

Reference [5] actualized a transformer-less plan in which ground spillage current is minimized, however it had a downside that voltage can't be changed for wide range. Reference [9] presented a coordinated answer for PV/FC based crossover dispersed era framework to dispose of the necessity of high voltage support capacitor for inverters; this inverter does not give disconnection. In [10], little film capacitors supplanted the vast electrolytic capacitor. This proposed system is pertinent for both low and medium force application.

### III. QUASI Z-NETWORK

The semi Z inverter is a solitary stage power converter created from Z source inverter plan, Which utilizes a novel impedance system. The routine VSI and CSI has a disadvantage that Triggering two switches of same leg of stage prompts shortcircuiting furthermore the greatest yield got can't surpass the DC data, Since they are buck converter and produce a voltage lower than the DC information voltage. Though both Z source and semi system beats the aforementioned disadvantage; by using a few shoot through Zero states. The Quasi Z system is not quite the same as that of Z Source inverter in the LC impedance system interfaced between the source and the inverter which is appeared in Fig1..The one of a kind outline of this system, i.e. LC and diode system joined with the lattice converter adjust the operation of the circuit, permitting the shoot through state which is prohibited in customary VSI. This system will adequately shield the circuit from harm when the shoot through happen and by utilizing the shoot through state and that system help the connection voltage

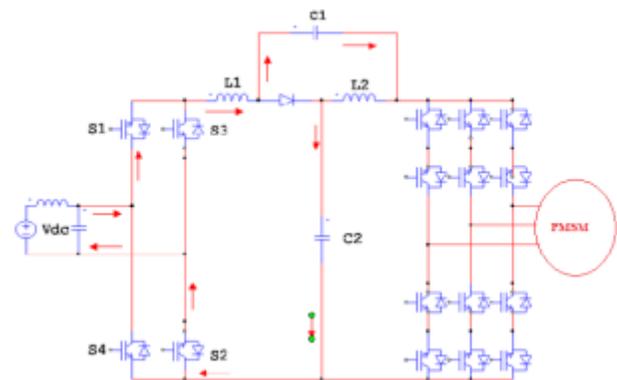


Fig.1. The proposed circuit Quasi Z network connected between single phase inverter and matrix converter.

A Zero state is delivered when both upper and lower switches of same leg is let go at the same time to support the yield voltage. Managing the six allowable dynamic exchanging condition of ordinary VSI, the zero state can be incompletely or totally supplanted by the shoot through state contingent on the boosting voltage necessity. This semi Z system has all the benefit of Z source inverter with both voltage support and reversal capacity in single stage. By utilizing this new system, the inverter draws a consistent current from the PV board and is equipped for taking care of a wide voltage range in info side. It likewise elements diminished changing swells to the PV board, bring down the part appraising, cause low EMI issues and decreased source anxiety contrasted with the conventional ZSI.

PV inverter with high recurrence air conditioning connection overcomes the greater part of the issue connected with existing PV inverter. The exchanging misfortunes are low because of the delicate exchanging and the recurrence of the connection is high which brings about reduced connection inductor.

#### IV TRANSFORMERLESS TOPOLOGY ANALYSIS:

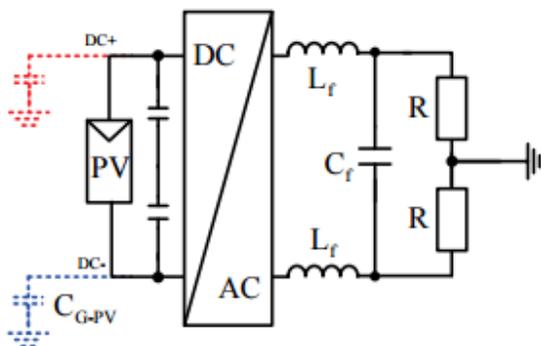


Fig. 2. Test setup used for common-mode voltage measurement

As talked about in past works [8],[11] the basic mode voltage created by a topology and adjustment technique can significantly impact the ground spillage current that moves through the parasitic capacitance of the PV cluster. For the most part the utility matrix does not impact the basic mode conduct of the framework, so it can be presumed that the produced normal mode voltage of a sure inverter topology and balance methodology can be indicated utilizing a straightforward resistor as burden. In this manner if there should arise an occurrence of the reproductions just a resistive burden is utilized and the basic mode voltage is measured between the DC+ terminal of the DC source and the grounded center purpose of the resistor as appeared in Fig. 2.

In the following simulation results obtained using Matlab Simulink with the PLECS toolbox are shown. The simulation step size is  $0.1\mu s$ , with an 8kHz switching frequency.

Simulation parameters:

$L_f=1.8mH$ , filter inductance  $C_f=2\mu F$ , filter capacitor  $R=7.5\Omega$ , load resistance

$V_{dc}=350V$ , input DC voltage  $C_{dc}=250\mu F$ , DC-link capacitor  $C_{G-PV}=100nF$ , parasitic capacitance of PV array  $F_{sw}=8kHz$ , switching frequency for all cases except the switching frequency for unipolar PWM has been chosen to be  $F_{sw}=4kHz$ , so the output voltage of the inverter has the same frequency for all cases.

#### HB with unipolar switching

Most single-stage HB inverters use unipolar changing keeping in mind the end goal to enhance the infused current nature of the inverter, which is finished by adjusting the yield voltage to have three levels with double the exchanging

recurrence. Additionally this sort of regulation diminishes the weight on the yield channel and declines the misfortunes in the inverter.

The positive dynamic vector is connected to the heap by turning ON S1 and S4, as appeared in Fig. 3.

The negative dynamic vector is done correspondingly, however for this situation S2-S3 is turned-ON.

If there should be an occurrence of the unipolar exchanging example, the zero voltage state, amid the positive voltage, is accomplished by shortcircuiting the yield of the inverter, as definite in Fig. 4, which brings about a high recurrence content in the created normal mode voltage.

As seen in Fig. 6, in case of a transformerless PV system using this type of topology and modulation, the high-frequency common-mode voltage, measured across CG-PV, will lead to very high leakage ground current, making it unsafe, therefore not usable (recommended) for transformerless PV applications.

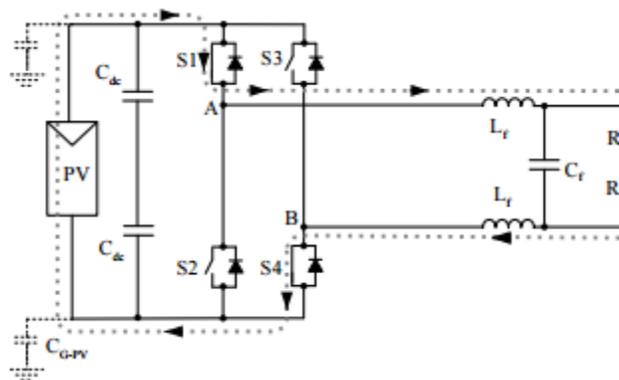


Fig. 3. HB-Unip topology, active vector applied to load, using S1-S4 for positive voltage

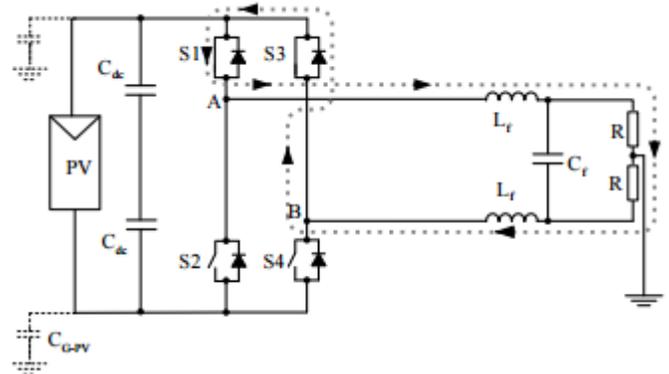


Fig. 4. HB-Unip topology, zero vector applied to load, using S1-S3 for positive voltage

### V. MATRIX CONVERTER

The fundamental element of the network converter has a few points of interest over customary rectifier-inverter sort power recurrence converters. They give sinusoidal yield waveform least higher request music and no sub music. It likewise has bidirectional vitality stream capacity. Here the force element can be completely controlled. Lattice converter has a negligible vitality stockpiling prerequisites, which permits to dispose of life time restricted and cumbersome vitality stockpiling capacitor. Framework converter has no yield recurrence limit, yet has limit in the plentifulness. This overcome of impediment is done utilizing regulation method. The network converter supplant the two vitality change stage with just single stage vitality transformation on the grounds that it has no vitality stockpiling component present. The converter use extraordinary bidirectional semiconductor switches. The switches which have blocking voltage and leading current ability in both headings. This bidirectional switch comprise of a couple of gadget with turn on capacity, are generally Insulated entryway bipolar

transistor (IGBT), they are either a typical gatherer or normal emitter consecutive game plan. Typically each IGBT is associated with an antiparallel diode. They have cluster of bidirectional semiconductor switches which is shown in Fig 1. They unite all information line to all the yield line. With the help of lattice converter it is momentary force in the data is same as the force in the yield side. They are additionally utilized as a part of controlling the stage point between the voltage and current in the information or the yield stage edge vary from the data stage.

The other point of interest is that type of waveform is autonomous. So the information can be Three stage AC and yield DC, or both could be DC, or both AC. Both structure AC waveform is utilized as a part of this paper for the RL application.

## **VI. MODE OF OPERATION**

In this paper the figure.1 demonstrates the complete PV framework joined with a resistive burden for basic examination. The heap can be any movable pace drives utilized as a part of business or modern application. The framework results in productive and solid result in three stage application in renewable innovation. The dc source can likewise be supplanted by the irradiance term which is utilized for getting variable DC. This DC force is changed over to AC. Through a solitary stage inverter which contain 4 bidirectional switches. This AC single stage voltage is multiplied with appropriate regulation, diminishing the consonant substance to the network converter. With a specific end goal to have legitimate transformation of single stage air conditioning to three stage air conditioning wave, grid converter is utilized. The grid converter utilized as a

part of this paper makes the complete framework conservative in structure and they specifically change over the air conditioner to air conditioning force through a controlled bidirectional switches.

The yield air conditioning signal's extent and recurrence is fluctuated by application in single stage itself. Lattice converter topology volume is likewise minimized when contrasted with the PWM-VSI. Notwithstanding conservative size and volume, the info current drawn has solidarity relocation variable and also consonant lessened sinusoidal yield streams. This grid converter works in high encompassing temperature because of the absence of electrolytic capacitor, which is extremely helpless against the temperature. They additionally have long life compass.

Operation of this framework can be comprehensively isolated as

- Charging mode and
- Discharging mode for the semi Z system

### **A. Charging Mode**

This mode happens when the DC supply is given and the switches S1 and S2 are in On condition and S3 and S4 are actually commutated from the past state i.e. in Off state. At this state the inductor and capacitor are in charging condition. The Fig.2 demonstrates the present way streaming. The positive stream of current through S1 then to the inductor, which charges through diode and capacitor charging likewise happens. In the following express the inductors L1 and L2 with capacitor C1 and C2 begins releasing, and in like manner the lattice converter works, i.e. the change from top and base of distinctive

## B. Discharging Mode

In this mode the voltage flows through the bidirectional switches, from top and bottom of different leg in order to produce proper amplified three phase output voltage and current. The average current through the inductors in both configuration have same value, which is give by,

$$I_l = P/V_{in}$$

In the above equation the P is the system power rating and  $V_{in}$  is the input voltage. Here the current is maximum on shoot through state. The capacitance of the Quasi Z network C1 and C2 is represented as,

$$C1 = C2 = (2.P.D_s)/(0.03.V_{in}.V_{dc}.f) \\ = P / (0.015.V_{in}^2.f).D_s.(1-2D_s)$$

## VII. CONCLUSION

This paper exhibited an exceptionally solid and minimal way utilizing effective PV inverter which has consideration of Quasi Z system with network converter. The benefits of executing this topology is that it is a solitary stage transformation framework, boosting up the voltage with low consonant substance. This network converter produce appropriate sinusoidal waveform low music in the yield side which is all that much required for driving RL load in proficient way.

The near execution is broke down in framework with and without semi Z system which thus finishes up the effective boosting ability roughly 2.6 times and long life compass. This is seen by reenacting in MATLAB and equipment model is actualized.

## REFERENCES

[1] "Trends in photovoltaic applications: survey report of selected IEA countries between 1992 and 2007"; Report IEAPVPS T1-T17:2008

[2] J.M. Carrasco, L.G. Franquelo et al.; "Power-Electronic Systems for the Grid Integration of Renewable Energy Sources: A Survey"; IEEE Transactions on Industrial Electronics, Volume 53, Issue 4, July 2008, Page(s): 1002- 1016

[3] Photon International, The Photovoltaic Magazine, Apr. 2007

[4] R. Gonzalez, J. Lopez, P. Sanchis, L. Marroyo; "Transformerless Inverter for Single-Phase Photovoltaic Systems"; IEEE Transactions on Power Electronics, Volume 22, Issue 2, March 2007, Page(s): 693 - 697

[5] B. Sahan, A.N. Vergara, et al.; " A Single-Stage PV Module Integrated Converter Based on a Low-Power CurrentSource Inverter"; IEEE Transactions on Industrial Electronics, Volume 55, Issue 7, July 2008, Pages(s): 2602- 2609

[6] R. Gonzalez; E. Gubia, J. Lopez, L. Marroyo; "Transformerless Single-Phase Multilevel-Based Photovoltaic Inverter"; IEEE Transactions on Industrial Electronics, Volume 55, Issue 7, July 2008, Page(s): 2694-2702

[7] J. Selvaraj, N.A. Rahim, "Multilevel Inverter For GridConnected PV System Employing Digital PI Controller"; IEEE Transactions on Industrial Electronics, Volume 56, Issue 1, January 2009, Page(s): 149-158

[8] E. Gubía, P. Sanchis, A. Ursúa, et al; "Ground currents in Single-phase Transformerless Photovoltaic Systems";

Progress in Photovoltaics: Research and Applications; 2007, Page(s): 629-650

[9] T. Kerekes, R. Teodorescu, U. Borup; "Transformerless Photovoltaic Inverters Connected to the Grid", Applied Power Electronics Conference, APEC 2007; 25th Feb. 2007- 1st Mar. 2007 Page(s): 1733 – 1737

[10] T. Kerekes, R. Teodorescu, C. Klumpner, M. Sumner, D. Floricau, R. Rodriguez; "Evaluation of three-phase transformerless photovoltaic inverter topologies"; European Conference on Power Electronics and Applications, 2nd-5th Sep. 2007, Page(s): 1-10

[11] T. Kerekes, R. Teodorescu, M. Liserre; "Common-mode voltage in case of transformerless PV inverters connected to the grid"; International Symposium on Industrial Electronics, ISIE 2008; 29th Jun. – 1st Jul. 2008, Page(s): 2390-2395

[12] EP 1 369 985 A2; Europäische Patentanmeldung, European Patent Office

[13] EP 1 626 494 A2; Europäische Patentanmeldung, European Patent Office

[14] D. Geibel, J. Jahn and R. Juchem; "Simulation model based control development of a multifunctional PV-inverter"; 12th European Conference on Power Electronics and Applications; 2nd-5th Sep. 2007,