© 2018 IJNRD | Volume 3, Issue 5 May 2018 | ISSN: 2456-4184

# GRID CONNECTED PHOTOVOLTAIC MICRO INVERTER SYSTEM USING REPETITIVE CURRENT CONTROL AND MPPT FOR FULL AND HALF BRIDGE CONVERTERS

**M.Siva Rama Krishna**[1] **B.Siva Naga Raju**[2] **S.Ravikanth**[3]
[1]PG Scholar (EEE), GVR&S College of Engineering & Technology, Guntur, A.P India
[2] Associate Professor (EEE), GVR&S College of Engineering & Technology, Guntur, A.P India

***Abstract:** This paper presents a novel grid-connected boost half-bridge photovoltaic (PV) micro inverter system and its control implementations. In order to achieve low cost, easy control, high efficiency, and high reliability, a boost-half-bridge dc–dc converter using minimal devices is introduced to interface the low-voltage PV module. A full- bridge pulse width-modulated inverter is cascaded and injects synchronized sinusoidal current to the grid. Moreover, a plug-in repetitive current controller based on a fourth-order linear phase IIR filter is proposed to regulate the grid current. High power factor and very low total harmonic distortions are guaranteed under both heavy load and light load conditions. Dynamic stiffness is achieved when load or solar irradiance is changing rapidly. In addition, the dynamic behavior of the boost-half-bridge dc–dc converter is analyzed; a customized maximum power point tracking (MPPT) method, which generates a ramp-changed PV voltage reference is developed accordingly. Variable step size is adopted such that fast tracking speed and high MPPT efficiency are both obtained. Simulation results are provided to verify the validity and performance of the Boost Half Bridge and Full Bridge circuit operations, current control, and MPPT algorithm.***

## I. INTRODUCTION

As a solution for the depletion of conventional fossil fuel energy sources and serious environmental problems, focus on the photovoltaic (PV) system has been increasing around the world. Grid connected solar energy technology is the fastest growing technology in the world today. Grid connected converters are required to transfer green energy from solar system into the main grid. The first grid- connected inverters were based on Silicon Controlled Rectifiers (SCR) technology which was also limited in control and came with a high harmonic content which requires the use of bulky filters . With the introduction of MOSFET for high power applications, the control of the grid connected inverters became more advanced. In single phase grid connected photovoltaic power systems, the concept of micro inverter has become a future trend for its removal of energy yield mismatches among PV modules, possibility of individual PV module-oriented optimal design, independent maximum power point tracking, and “plug and play” concept. The low voltage solar output can be connected to the grid by using a converter with high step up ratio. Hence, a boost-half-bridge DC-DC converter cascaded by an inverter is the most popular topology, in which a HF transformer is often implemented within the DC-DC conversion stage. By replacing the secondary half bridge with a diode voltage doubler, a new boost-half- bridge converter can be derived for unidirectional power conversions.

The promising features such as low cost, high reliability and high efficiency, circuit simplicity can be obtained by use of the converter with minimal semiconductor devices. The repetitive current control technique is an effective solution for the elimination of periodic harmonic errors and has been previously investigated and validated in the un- interruptible power system, active power filters, boost- based PFC circuits, and grid-connected inverters/PWM rectifiers. In this paper, a plug-in repetitive current controller which is composed of a proportional part and an RC part is proposed to enhance the harmonic rejection capability. The synchronized sinusoidal current can be injected to the grid by using a full bridge PWM inverter with an output LCL filter. Sinusoidal current with a unity power factor is supplied to the grid through a third-order LCL filter. In general, its performance is evaluated by the output current total harmonic distortions (THDs), power factor, and dynamic response .The maximum Power Point (MPP) is the point in which maximum power is delivered from the solar cell to the PV system. MPPT is performed by the boost-half-bridge converter by using numerous MPPT techniques.

In this proposed system, an optimal P&O method has been developed to limit the negative effect of the converter dynamic responses on the MPPT efficiency. A closed-loop control technique has been proposed to minimize the PV voltage oscillation .The galvanic isolation is introduced on the DC side in the form of a high frequency DC-DC transformer. The pulse width modulation control is applied to both the dc–dc converter and the inverter. A constant voltage dc link decouples the power flow in the two stages such that the dc input is not affected by the double-line- frequency power ripple appearing at the ac side. The fast dynamic response is achieved during the transients of load. In order to reach an optimal efficiency of the boost-half- bridge converter, ZVS techniques can be considered for practical implementation. The MPPT function block in a PV converter system increases the efficiency.

## II.BOOST-HALF-BRIDGE PV MICROINVERTER

Table II summarizes the key parameters of the boost- half bridge dc–dc converter. As aforementioned, the PV voltage is regulated instantaneously to the command generated by the MPPT function block. The continuous- time control block diagram is shown. High bandwidth proportional-integral control is adopted to track the voltage reference *V*PV and to minimize the double- line-frequency disturbance from the LVS dc link. The Capacitor voltage differential feedback is introduced for active damping of the input *LC* resonance. Typically, the MPPT function block in a PV converter /inverter system periodically modifies the tracking reference of the PV voltage, or the PV current, or the modulation index, or the converter duty cycles. In most cases, these periodic perturbations yield step change dynamic responses in power converters. If the converter dynamics are disregarded in the MPPT control, undesirable transient responses such as *LC* oscillation, inrush.

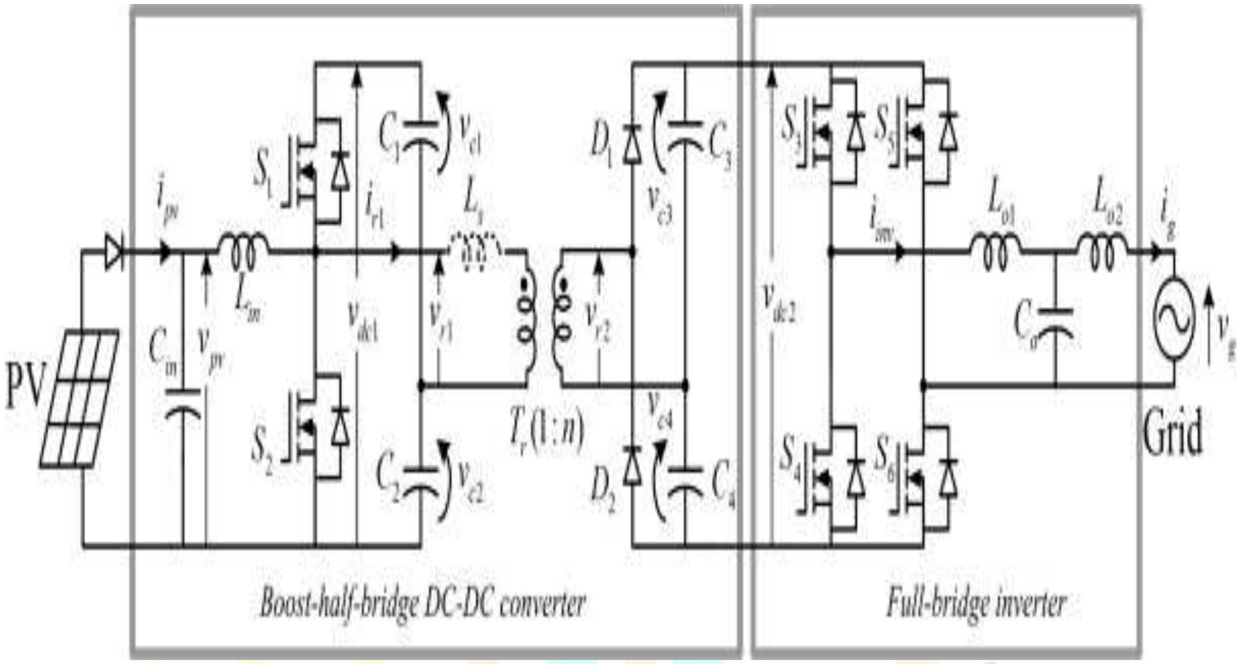



**Figure.1. The boost-half-bridge PV micro inverter topology.**

The topology of the boost-half-bridge micro inverter for grid connected PV systems is depicted in Fig 1.The proposed circuit is composed of two decoupled power processing stages. The conventional boost converter is modified by splitting the output dc capacitor into two separate ones. Cin and Lin denote the input capacitor and boost inductor, respectively. The center taps of the two MOSFETs (S1 and S2) and the two output capacitors (C1 and C2) are connected to the primary terminals of the transformer Tr, just similar to a half bridge. The transformer leakage inductance is reflected to the primary is represented by Ls and the transformer turns ratio is 1: n. A voltage doubler composed of two diodes (D1 and D2) and two capacitors (C3 and C4) is incorporated to rectify the transformer

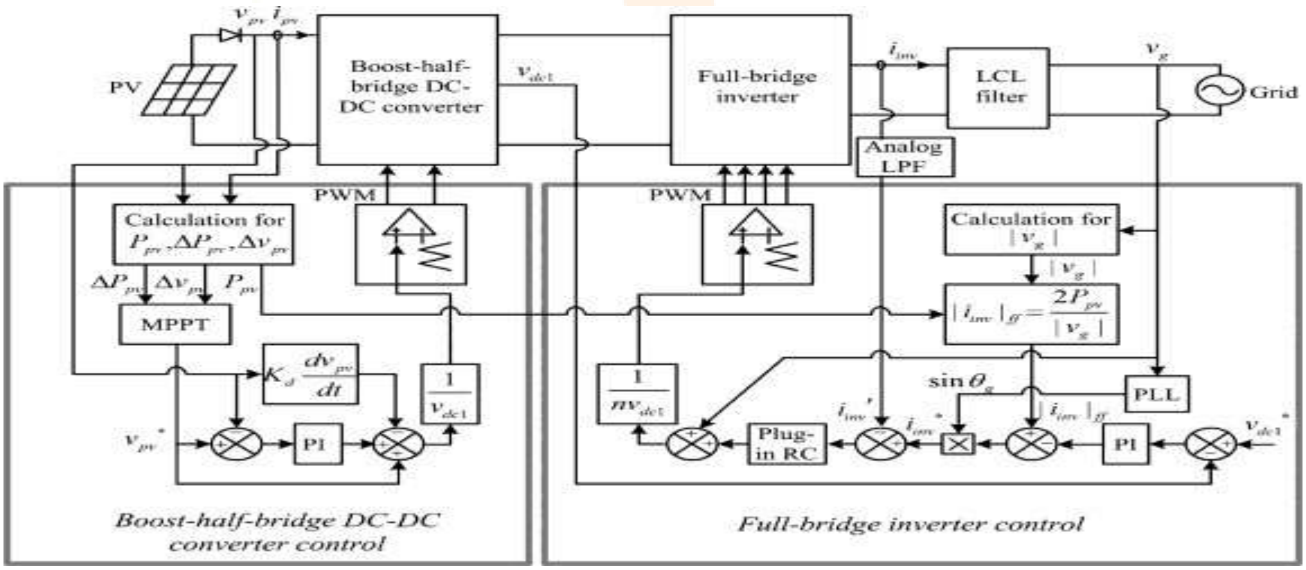



**Figure.2. Architecture of the proposed PV micro inverter system control**

III.MAXIMUM POWER POINT TRACKER

In a (Power-Voltage or current-voltage) curve of a solar panel, there is an optimum Operating point such that the PV delivers the maximum possible power to the load. This unique point is the maximum power point (MPP) of solar panel. Because of the photovoltaic nature of solar panels, their current-voltage, or I-V curves depend on temperature and irradiance levels. Therefore, the operating current and voltage which maximize power output will change with environmental conditions. As the optimum point changes with the natural conditions so it is very important to track the maximum power point (MPP) for a successful PV system. So in PV systems a maximum power point tracker (MPPT) is very much needed. In most PV systems a control algorithm, namely maximum power point tracking algorithm is utilized to have the full advantage of the PV systems. For any given set of operational conditions, cells have a single operating point where the values of the current (I) and voltage (V) of the cell result in a maximum power output. These values correspond to a particular load resistance, R= V/I, as specified by Ohm's Law. The power P is given by P = V*I. From basic circuit theory, the power delivered from or to a device is optimized where the derivative of the I-V curve is equal and opposite the I/V ratio. This is known as the maximum power point (MPP) and corresponds to the "knee" of the curve.

The load with resistance R=V/I, which is equal to the reciprocal of this value and draws the maximum power from the device is sometimes called the characteristic resistance of the cell. This is a dynamic quantity which changes depending on the level of illumination, as well as other factors such as temperature and the age of the cell. If the resistance is lower or higher than this value, the power drawn will be less than the maximum available, and thus the cell will not be used as efficiently as it could be. Maximum power point trackers utilize different types of control circuit or logic to search for this point and thus to allow the converter circuit to extract the maximum power available from a cell.

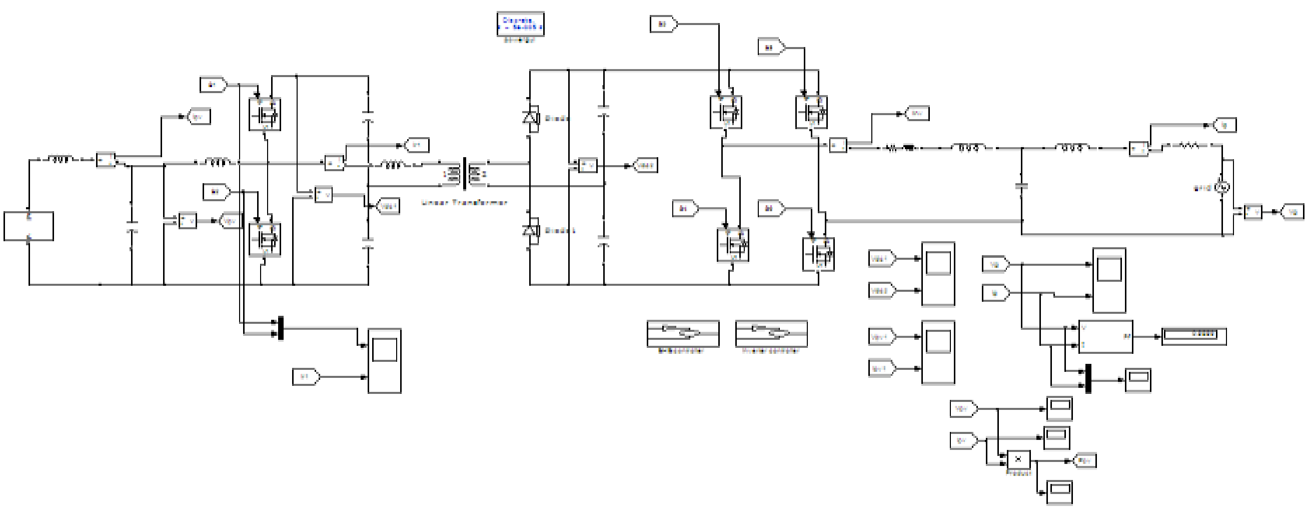
Maximum Power Point Tracking (MPPT) is used to obtain the maximum power from these systems. In these applications, the load can demand more power than the PV system can deliver. There are many different approaches to maximizing the

Power from a PV system, this range from using simple voltage relationships to more complexes multiple sample based analysis.

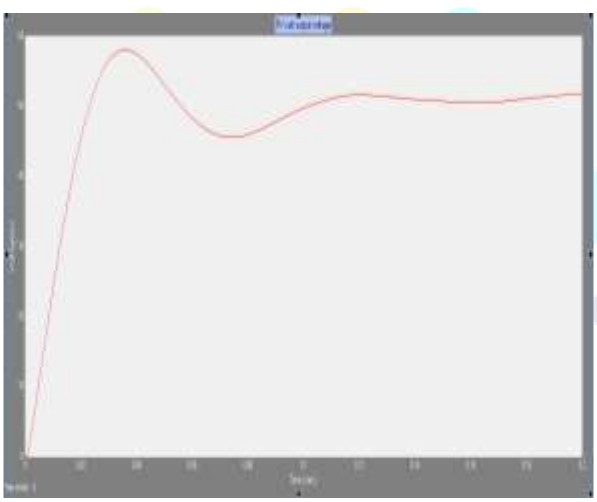
There are some conventional methods for MPPT. Seven of them are listed here.

These methods include:

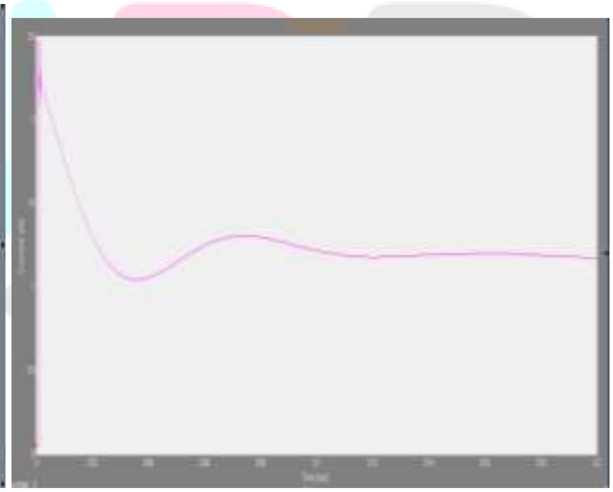
**1.** Constant Voltage method
**2.** Open Circuit Voltage method
**3.** Short Circuit Current method
**4.** Perturb and Observe method
**5.** Incremental Conductance method
**6.** Temperature method
**7.** Temperature Parametric method



Proposed Boost-Half-Bridge PV Micro inverter Simulation Diagram under Light Load Condition

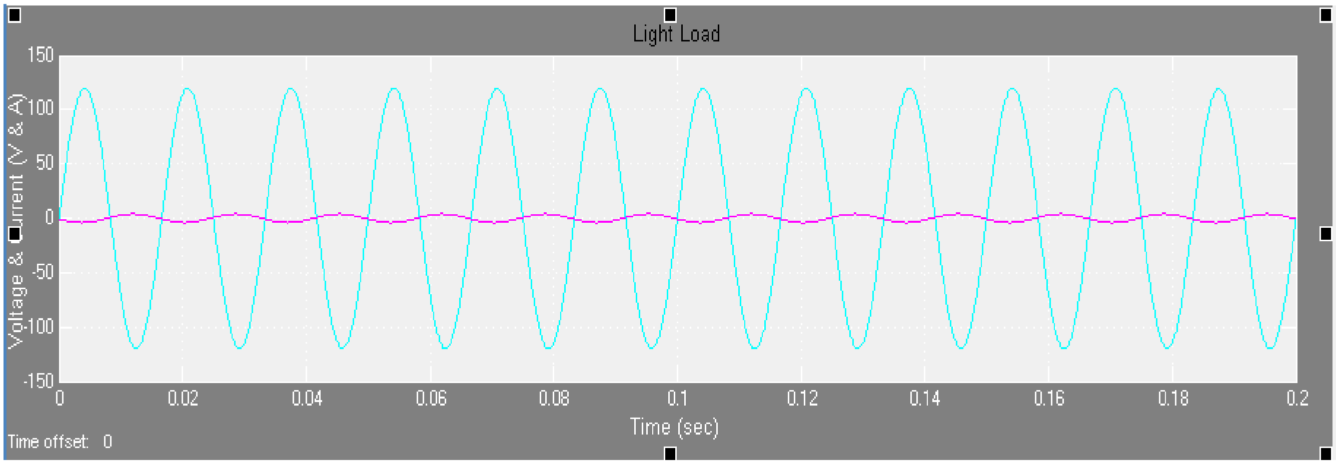


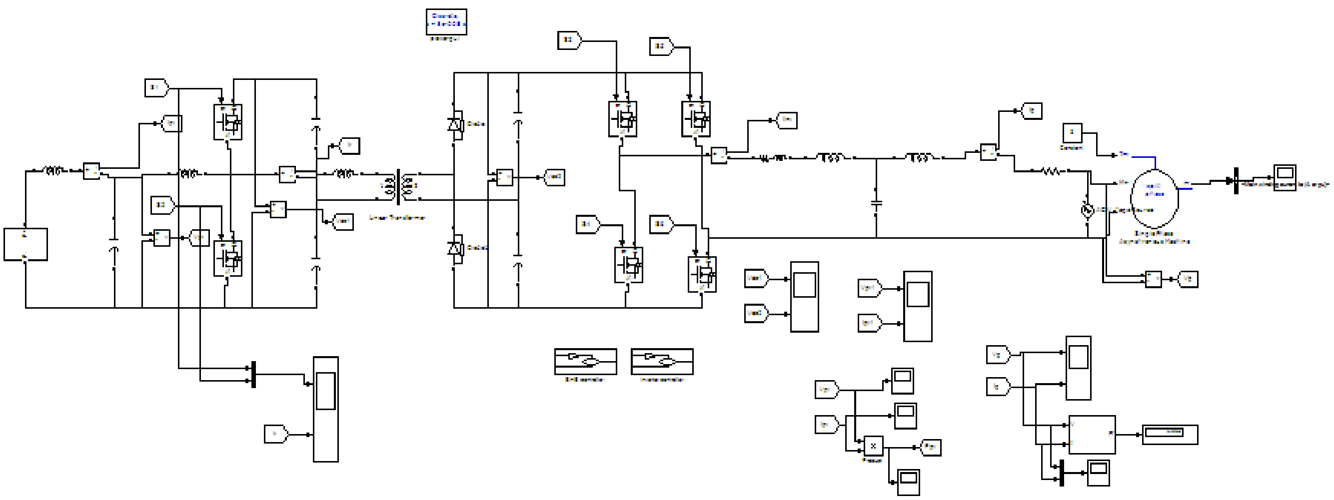
PV Cell Output Voltage



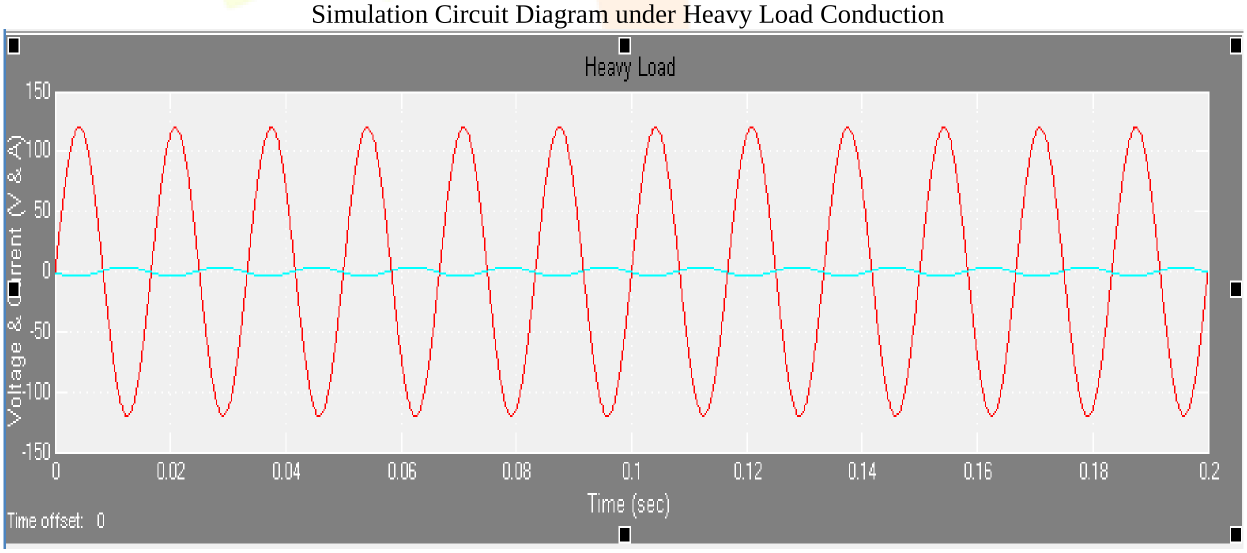
PV Cell Output Current

Steady State Grid Voltage and Current Under Light Load Conduction

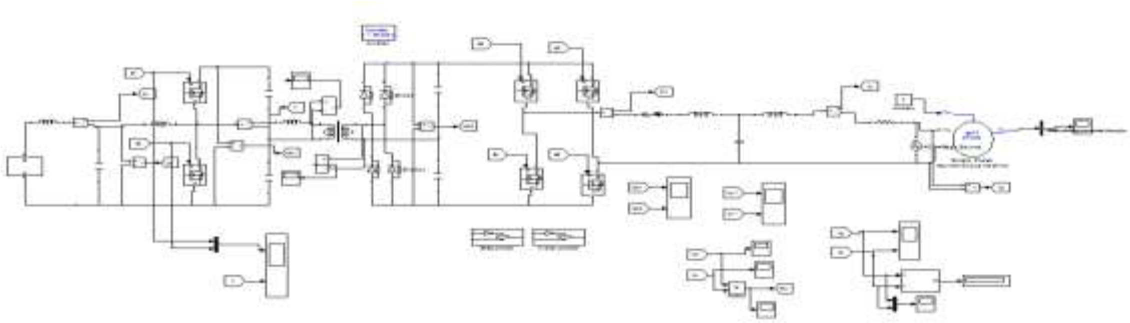


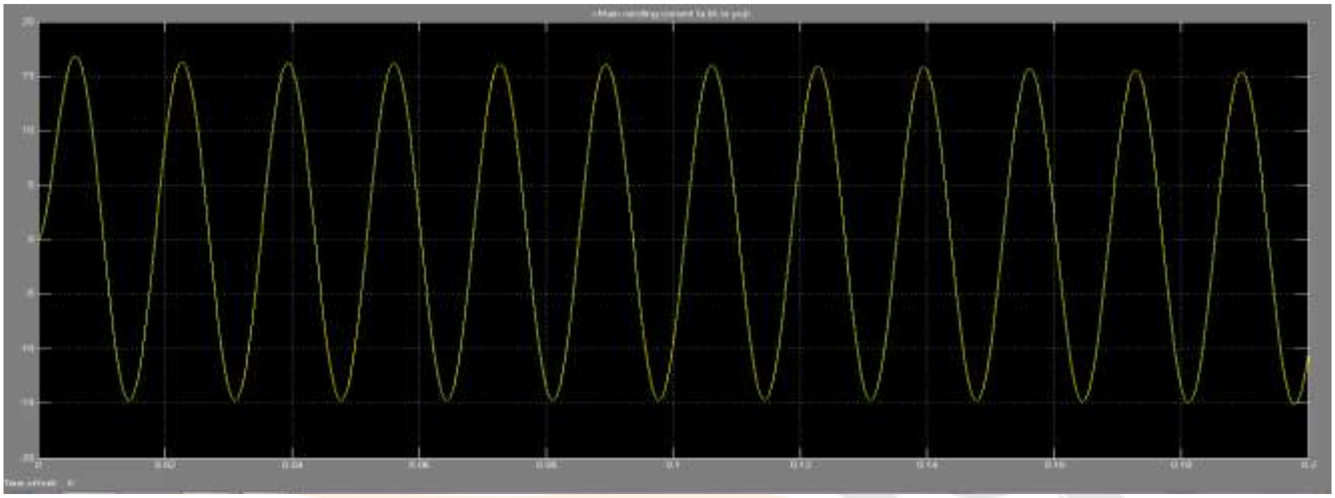
Simulation Circuit Diagram under Heavy Load Conduction




Steady State Grid Voltage And Current Under Heavy Load Conduction



Simulation Circuit Diagram of Full bridge circuit under Heavy Load Condition



Result of armature current in heavy load condition

CONCLUSION

A boost-half-bridge and full bridge micro inverter for grid-connected PV systems has been presented. The minimal use of semiconductor devices, circuit simplicity, and easy control, the boost-half-bridge PV micro inverter possesses features of low cost and high reliability. The boost- half-bridge dc–dc converter has a high efficiency (97.0%– 98.2%) over a wide operation range. And also the current injected to the grid is regulated precisely and stiffly. Under both heavy load and light load conditions, high power factor (>0.99) and low THD (0.9%–2.87%) are obtained. The ramp-changed reference generated by the customized MPPT method for the PV voltage regulation guarantees a correct and reliable operation of the PV micro inverter system. Fast MPP tracking speed and a high MPPT efficiency (>98.7) is achieved by the variable step-size technique provides a correct and reliable operation of the PV micro inverter system

REFERENCES

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

[2] Q. Li and P.Wolfs, “A review of the single phase photovoltaic module integrated converter topologies with three different DC link configurations,” *IEEE Trans. Power Electron.*, vol. 23, no. 3, pp. 1320–1333, May 2008.

[3] R. Wai and W. Wang, “Grid-connected photovoltaic generation system,” *IEEE Trans. Circuits Syst.-I*, vol. 55, no. 3, pp. 953–963, Apr. 2008.

[4] M. Andersen and B. Alvsten, “200W low cost module integrated utility interface formodular photovoltaic energy systems,” in *Proc. IEEEIECON*, 1995, pp. 572–577.

[5] A. Lohner, T. Meyer, and A. Nagel, “A new panel-integratable inverter concept for grid-connected photovoltaic systems,” in *Proc. IEEE Int. Symp. Ind. Electron.*, 1996, pp. 827–831.

[6] D. C. Martins and R. Demonti, “Grid connected PV system using two energy processing stages,” in *Proc. IEEE Photovolt. Spec. Conf.*, 2002, pp. 1649–1652.

[7] T. Shimizu,K.Wada, andN.Nakamura, “Flyback-type single-phase utility interactive inverter with power pulsation decoupling on the dc input for an ac photovoltaic module system,” *IEEE Trans. Power Electron.*, vol. 21, no. 5, pp. 1264–1272, Sep. 2006.

[8] N. Kasa, T. Iida, and L. Chen, “Flyback inverter controlled by sensorless currentMPPTfor photovoltaic power system,” *IEEE Trans. Ind. Electron.*, vol. 52, no. 4, pp. 1145–1152, Aug. 2005.