# Grid Connected Based Solar Photovoltaic with Battery as Energy Storage System

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***Abstract:*** **Solar photovoltaic (PV)-based stand-alone systems have evolved as a promising solution to the problem of electrification in areas where the grid is not available. The major challenges in designing such systems are as Extraction of maximum power from the PV array, Protection of the battery from overcharge and over discharge. A multiple objectives are required to be satisfied, the existing system for stand-alone systems require a minimum of three converter stages, leading to considerable reduction in the reliability and efficiency of the system. To solve this problem, a two-stagestand-alone scheme consisting of a novel transformer coupled dual-input converter (TCDIC) followed by a conventional full-bridge inverter is proposed in this paper.The proposed TCDIC can be realized maximum power pointtracking and battery charge control while maintaining theproper voltage level at the load terminal. A suitablecontrol strategy for the proposed TCDIC is devised. Theoperation of this system is verified by performing detailedsimulation studies. A laboratory prototype of the system isdeveloped. Detailed experimental validation of the schemeutilizing the laboratory prototype is carried out to confirmthe viability of the scheme.Reformation of the electricity sector along with different renewable energy promotion policies has incremented importance of small grid-connected photovoltaic (PV) systems utilizing single-stage single-phase inverters.**

***Keywords*****: Matlab, pv cells, grid**

## 1. INTRODUCTION
### 1.1. PHOTOVOLTAIC SYSTEMS

The Photovoltaic system are composed of interconnected components designed toaccomplish specific goals ranging from powering small device to feeding electricity into the distribution grid. Photovoltaic systems are classified based to the diagram in Figure1. The two main general classifications are depicted in the figure are the stand-alone and the grid-connected systems .The main factor between these two systems is that instand-alone systems the solar energy output is matched with the load demand. To distribute fordifferent load, storage elements are generally used and most systems currently usebatteries for storage. The balances of system(BOS) components are a major contribution to the life cycle costs of a photovoltaic system.They include the power conditioning units, storage elements and mechanical structures thatare needed.

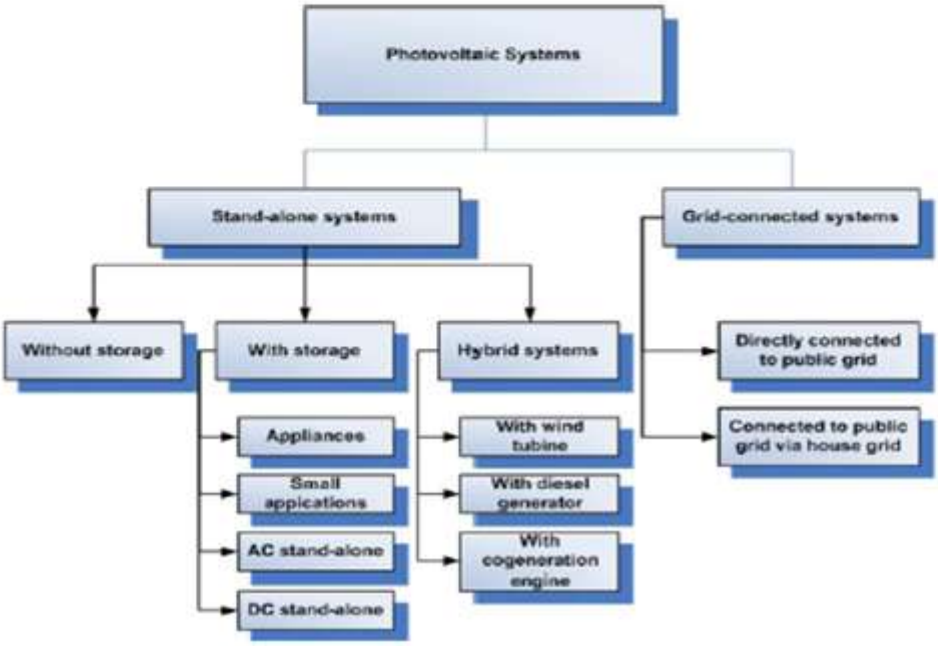



Fig 1: Classification of PV Systems

PV Module

The majority of applications multiple solar cells need to be connected in series or inparallel to produce voltage and power. Individual cells are usually connected in aseries string of cells to achieve the desired output voltage. Completeassembly is usually referred to as a module and manufacturers basically sell modules tocustomers. The modules serves another function of protecting individual cells from water, dustetc. as the solar cells are placed into an encapsulation of single or double at glasses.

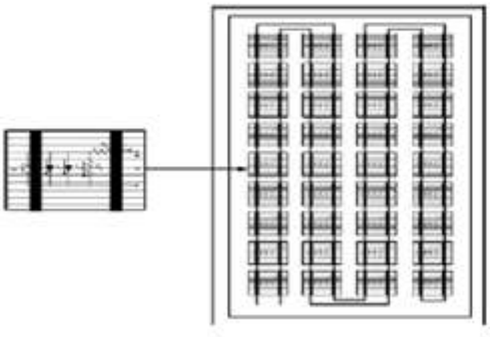


Fig 2: Structure of a PV module with 36 cells connected in series

Within themodule different cells are connected electrically in series or in parallelalthough most modules have a series connection. Figure 2 shows a typical connection of how36 cells are connected in series. In a series connection the same current flows through all thecells and the voltage at the module terminals is the sum of the individual voltages of each cell.

## 2. OBJECTIVES OF THE PAPER

Solar photovoltaic (PV)-based stand-alone systems have evolved as a promising solution to the issue of electrification in areas where the grid is not available. The major challenges in designing such systems are as follows:

1) Extraction of maximum power from the PV array;
2) Protection of the battery from overcharge and over discharge;
3) DC to ac conversion; and
4) provision for adequate voltage boosting

## 3. SCOPE OF THE PAPER

PV panels are coupled with battery systems for the purpose of navigation aids, relay stations, and for other low power but critical needs. There was also a groundswell of public interest in solar energy use as a result of the energy shortage, and standalone PV systems started appearing in domestic applications. petroleum companies started to purchase solar panels to power warning lights and corrosion prevention equipment at oil rigs. A significant proof-of-concept of standalone PV systems is the powering of a village in a Native American Reservation in Arizona in 1978. The system which is powered for 15 homes and water pumps for the village for 10 years, until the reservation became connected to the grid. By the end of the decade the use of standalone PV was being implemented in development projects in developing countries around the globe.

## 4. EXISTING SYSTEM

The household appliances in India generally require or use a single phase 230-V 50-Hz supply.As the power output from the PV array and battery is in dc form, dc to ac inverter is requiredto feed the load. Single-phase full-bridge inverters which are employed for thispurpose are required to maintain a dc voltage of magnitude of 350 V or more to generate an acvoltage of 230 V. The requirement of high-input dc-link voltage for the inverter can be fulfilledby connecting several PV modules and/or batteries in series. However, a serially connected PVsystem results in considerable reduction in power yield when subjected to non uniforminsolation levels. To overcome this issue, either a complex maximum power point (MPP) tracking(MPPT) algorithm [5], [6] or an additional converter is required.

The serialconnection of several standard 12-V batteries leads to an increment in the cost and size of thesystem. Further, the application of a high voltage level for the PV array and batterydemands an involved design for the system to adhere to the safety of personnel and equipment.In view of the limitations, a stand-alone system is generally designedwith low voltage levels for the PV array and the batteeries in the range of 24–36 V. However, thisresults in the requirement of a high voltage gain for the overall system to ensure a 230-V acsupply at the load terminal.

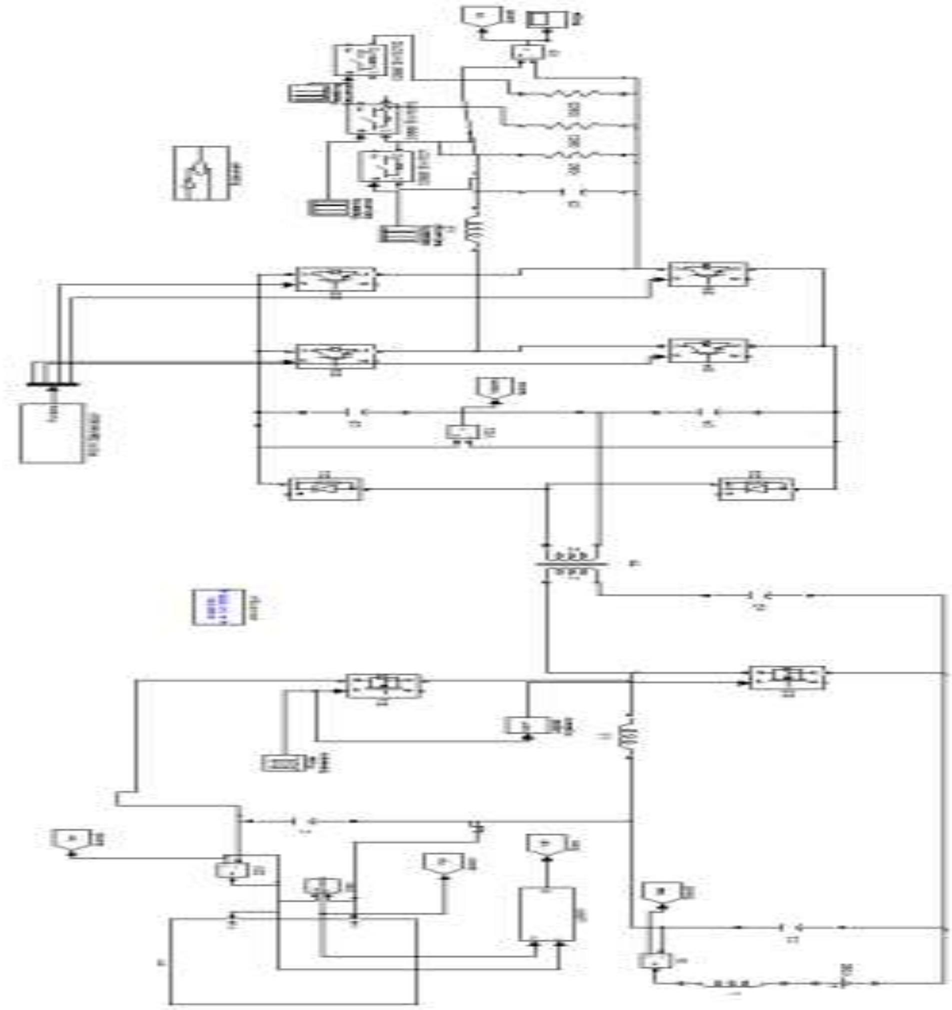
Such systems [14], [15] require a minimum of eight controlled switches. This is inaddition to the four switches that are required to realize the inverter. Furthermore, existingstand-alone system employ an additional dedicated dc–dc converter to realize MPP operation. A PV power remains unavailable for more than half of a day, the utilization of thismentioned dedicated converter becomes very poor. A system wherein the use of adedicated dc–dc converter for MPPT operation is avoided is proposed in [20]. This system hasthe PV array and battery connected in series and is designed for application in PV-poweredlighting system. However, the system presented in has the following disadvantages:

1) Thepresence of resonant elements makes the system sensitive to parameter variation

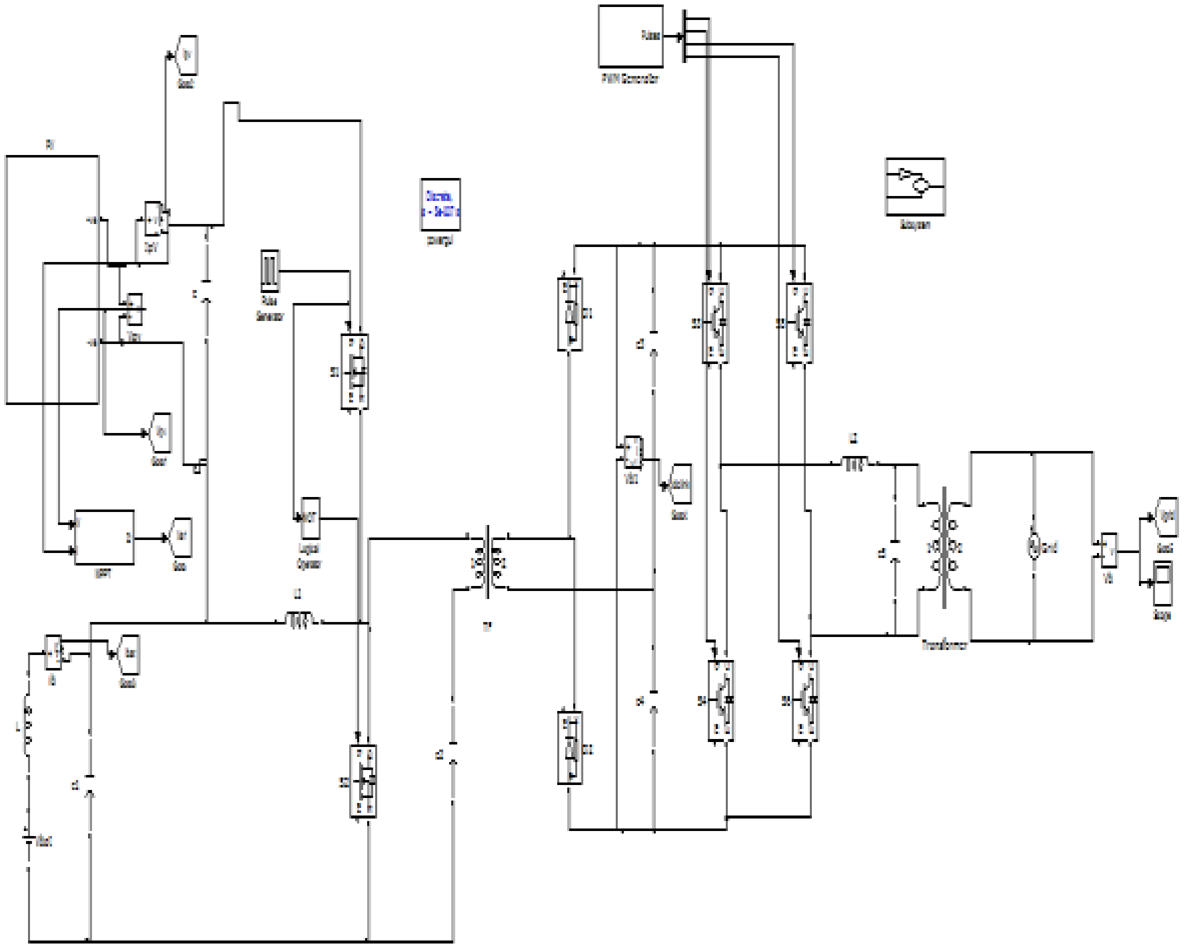
2) The permissiblevariation in the duty ratio of the switches is limited within a certain range
3)The voltage gainis quite limited. A similar approach has also been reported for application in a grid-connectedsystem.

## 5. SIMULINK RESULTS

**Matlab/simulation conventional method of Schematic of the complete stand-alone scheme.**



**Matlab/simulation proposed method of Schematic of the grid connected system**



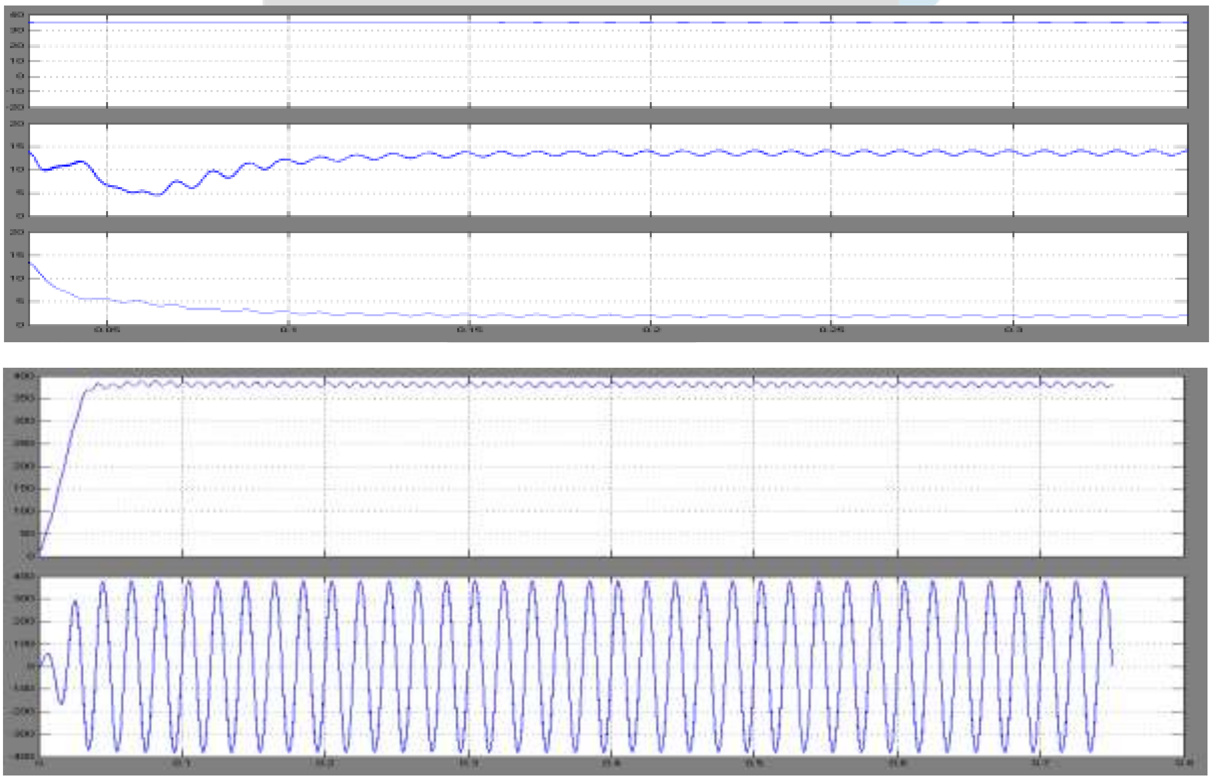


Fig.3 Simulated response of the system under steady-state operationin MPPT mode. (a) *vpv*, *ipv*, and *ib*. (b) *vd*cand load voltage.

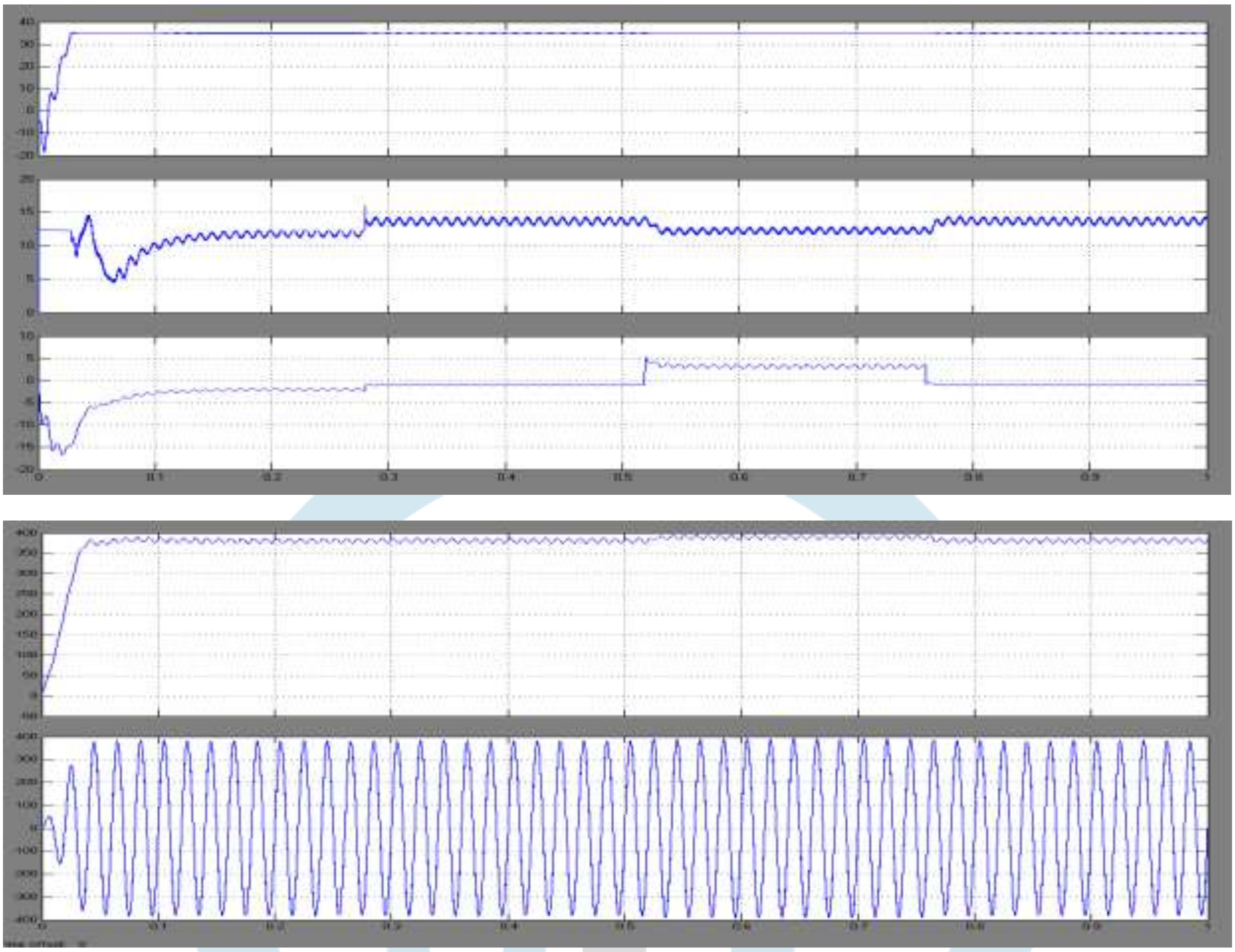


Fig. 4: Simulated response of the system under changes in load andinsolation level while operating in MPPT mode. (a) *vpv*, *ipv*, and *ib*.(b) *vdc*and load voltage.

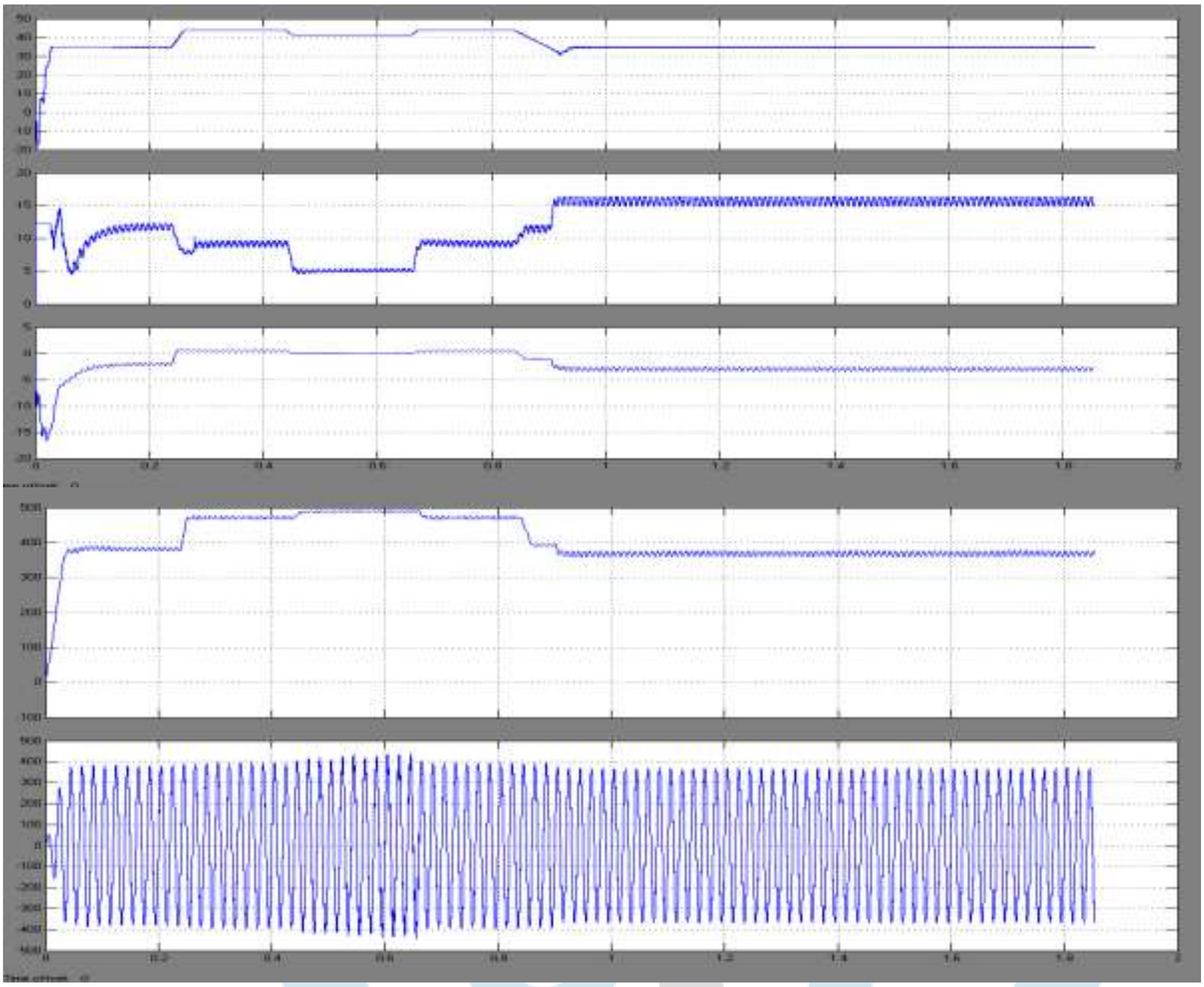


Fig.5: Simulated response of the system under mode transitionbetween MPPT and non-MPPT mode and the effect of load change innon-MPPT mode. (a) *vpv*, *ipv*, and *ib*. (b) *vdc*and load voltage.

## 6. CONCLUSION

The solar PV-based stand-alone system for application in rural areas is proposed in this paper. It is realized by involving a new TCDIC followed by a conventional full-bridge dc to acinverter. The salient features of the proposed system include the MPPT of thePV array, charge control of the battery, and boosting of the dc voltage are accomplished in asingle converter.

A conventional SPWM technique is proposed for five-level inverter. The main feature of the modulation scheme lies in its ability to eliminate the harmonics in the inverter output voltage. To assist the analysis and design of the classical system, the mechanism of the THD reduction with increase in level of inverter employing SPWM technique is discussed. The harmonic content and THD of the inverter output voltage produced are compared.

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