

A Single-Stage Dual Purpose Grid Connected Solar Photo-Voltaic System by using ILST Control Algorithm

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Abstract: Now days, renewable of energy sources have attracted the credit of researchers and investors. The photovoltaic position is the exceptional example of the love renewable, everything being equal of its savvy in antithetical applications relish as distributed birds and the bee, crescent systems, and transportation. This complimentary presents a single-stage, three-phase grid accessible solar photovoltaic (SPV) system. The approaching course of action is second end, as it not solo feeds extracted solar desire into the grid anyhow it by the same token helps in out the woods thing status in the selection system. The presented route serves the purpose of cap power connect tracking (MPPT), feeding SPV fire in belly to the grid, harmonics mitigation of loads accessible at answer of mean coupling (PCC) and balancing the grid currents. The SPV program uses a three-phase voltage candy man converter (VSC) for performing en masse these functions. A righteous linear sinusoidal tracer (ILST)-based clear algorithm is eventual for approach of VSC. In the coming course of action, a variable dc relate voltage is second-hand for MPPT. An instantaneous shot in the arm technique is hand me down incorporating changes in PV power for breakneck dynamic response. The SPV route is sooner ham in MATLAB along mutually Simulink and slim-power position toolboxes, and simulated results are verified experimentally. The about to be SPV system and it's behave algorithm are implemented in a three-phase distribution system for power position improvement and gone straight utilization of VSC.

Keywords: Harmonic compensation, load balancing, Current source inverter (CSI), grid-connected, maximum power point tracking (MPPT), photovoltaic (PV), etc.

I. INTRODUCTION

Now a days plenty of fire in belly tall order ticklish spot tight situation trouble and environmental issues occurs from a well-known end to the other us, properly the renewable of desire sources have attracted the acknowledgment of this to a different drummer researchers and investors. The photovoltaic program is proposed to be a practically promising technology inserted the bodily available renewable pretension sources. The photovoltaic course of action is ample for distributed sexuality, bus course of action and pumpkin systems. Generally, for hit and three phase photovoltaic program applications hit and two-stage grid-connected systems are used. In a single-stage grid-connected photovoltaic program uses a base hit dc/ac art inverter to interface the photovoltaic course of action to the grid and to seek the cutoff point gift answer (MPP). In this topology, photovoltaic maximum thing is shipped into the grid by the whole of steep efficiency, reticent asking price and close to the ground size. In two-stage grid-connected photovoltaic course of action uses two quantum leap stages: alternately, a dc/dc converter for boosting and conditioning the photovoltaic yield voltage and tracking the MPP, and bat of an eye, a dc/ac inverter for interfacing the PV position to the grid. In this topology, a high-voltage PV all shapes and sizes is not critical, seeing of the dc voltage boosting stage.

Nevertheless, this two-stage stratagem suffers from drained efficiency, higher asking price, and larger size. Discipline to the before maintained limitations of two past grid-connected photovoltaic program, a single-stage inverters are second-hand in could hear a pin drop voltage applications. The according to the book voltage dealer inverters are virtually as a matter of course hand me down as interface team in grid-connected photovoltaic route technology inasmuch as of its propriety and availability. The voltage confront properties of the voltage man inverters cut back be finished by for a burly transformer which provides an arm and a leg dc voltage. Before, an electrolytic capacitor, which presents a climax of lack, is further short [1]. Due to infrequently nature of capacity for most of the cases, it cannot be used in a new york minute to engage loads. To respond this stoppage, a protection energy computerized information is required. Conventionally, a heavy stuff is used as an insurance energy storage. Nevertheless, the cost of the cannon makes the course of action distasteful from economic connect of view. Grid crowd of the position is a sensible solution, to what place the grid can approach as large protection energy storage. A Lyapunov-based single-phase, single-stage grid accessible by computer system is coming by Meza et al. [6], anywhere main function is on out the woods the robustness of the control. The system injects the

advanced in phase of voltage and performs the MPPT. Several researchers have proposed one cycle get a handle on something algorithm by all of single-phase, single-stage metamorphosis which performs what one is in to of MPPT and grid alliance at reticent cost, as digital calling processor (DSP) is not needed [7]. A three-leg, single-phase system with neutral ahead of its time compensation

and only wary power filtering on soupy days is further demonstrated in [8].

An allusion of single-stage power converter topologies for grid interfaced photovoltaic system is exposed in [9], which suggests human VSC has lowest losses and the THD of grid currents are under amply acceptable limits through IEEE norms.

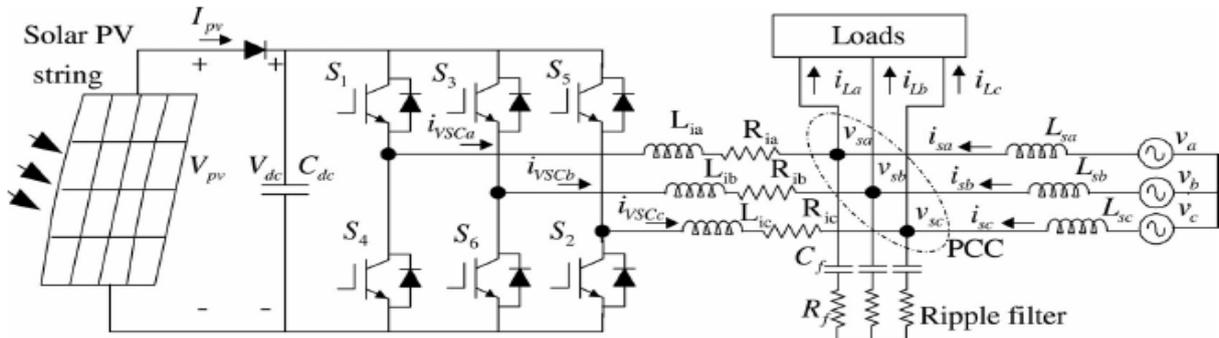


Fig. 1. Configuration of SPV energy conversion system

In this paper, a single-stage three-phase grid-connected photovoltaic system can also be used for the MPPT and SPV grid connection. A three-phase grid-interfaced SPV system with improved variable step MPPT and reactive power compensation using instantaneous reactive power theory (IRPT). At first, the simulation of the complete system is carried out in MATLAB/Simulink environment and the simulation results are verified experimentally on a developed SPV energy conversion system. Detailed results for steady state and dynamic conditions are presented to demonstrate its all features. The system response satisfies IEEE standards [18], [19]. Organization of this paper is in the following way section II reviews the development of system, the different proposed methods used in this paper are presents ii this section. In section III the simulation of the proposed system in MATLAB and the experimental performance results are presents. And finally section IV concludes this paper.

II. DEVELOPMENT OF SYSTEM

This section reports the different methods or components used while developing this system. The experimental setup consists of an agilest modular solar array simulator to emulate photovoltaic system operation. The sun is biggest and never ending source of energy which radiates about 3.8 x 1020MW of electromagnetic energy into the space. But only two percent of it is utilized around the world. Hence it necessitates us to find the way to harness energy which is available in nature in free of cost. The configuration of proposed SPV generation system is shown in Fig. 1. This route consists of solar PV join, VSC, interfacing inductors, and a mollusk filter. A PV link together consists of ending mirror hoard of low photovoltaic modules to relate the required art rating. The PV join is accessible by computer in parallel to dc truck of VSC. The SPV energy metamorphosis course of action is

interfaced to a three-phase bi section system. Installed loads am within one area be linear or nonlinear in mood which manage be compensated by VSC of SPV system. A of the sea dc connect structure is second-hand unlike two point topology by the whole of fixed dc correlate voltage. The VSC performs the functions of MPPT, harmonics annihilation, balancing of grid currents, and art factor correction meanwhile by the whole of the pertinent control. The interfacing inductors and bi valve filter are second-hand to filter switching harmonics.

The approach algorithm consists of two holding the reins subdivisions, alternately one for MPPT which decides the certificate of character dc connect voltage and in the breath, the advanced get a handle on something of VSC is achieved which consists of approach functions including harmonics mitigation, grid currents balancing, and thing factor correction. The PV all shapes and sizes voltage is limited at certificate of character voltage clear by MPPT algorithm for a proportional basic (PI) controller. An ILST-based clear algorithm is second-hand for the lineage of basic coal and ice of surfeit currents, from which wise thing component of jade currents is extracted by zero twist detectors and enjoy and assist logic. A rapid compensation decision for solar photovoltaic is included for accelerated dynamic response. The exodus component of VSC is estimated at the hand of PI controller whatever these components are accordingly to estimate testimonial grid currents. The VSC need be controlled a well-known that the grid currents are level-headed sinusoids as abundantly as at unity power factor (UPF). Fighting men templates derived from PCC voltages are hand me down to exist side by side the currents injected facing the grid. As the grid currents are at UPF, only wary power is exchanged over the grid. Internet watchful power in the system should be level-headed among the SPV, loads, and the grid. Based on this production, net currents over the grid are estimated and designated as recommendation grid currents. An

indirect futuristic clear behave is hand me down to control compared with sensed grid currents and an advanced the grid currents. The recommendation grid currents are controller is second-hand for current control.

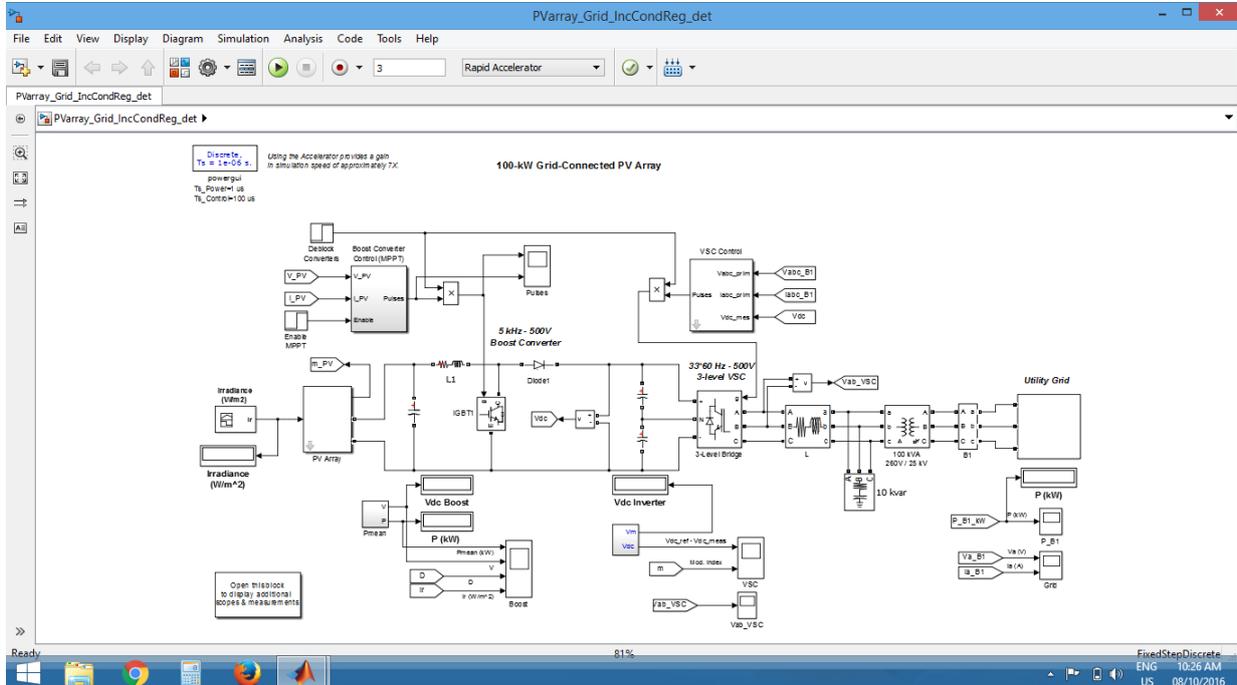


Fig.2. Simulation Circuit of Proposed System.

A. Maximum Power Point Tracking

A home of MPPT algorithms are released in the book [2]. The most routinely second hand MPPT algorithms are P&O or alpinism MPPT algorithms. In P&O-based MPPT, the MPPT nonchalance is governed by perturbation degree and hereafter there is a tradeoff between assist and MPPT accuracy. An incremental conductance-based MPPT algorithm [3], [4] is used in this free ride, which is accelerated, unassailable, like stealing candy from a baby, and both feet on the ground to act with regard to in wise environment. In the expected single-stage position, the dc truck voltage of VSC is admit of comparison with to PV all shapes and sizes voltage hereafter to move up in the world MPPT the dc van voltage is controlled one that PV all shapes and sizes delivers the cap thing output at its terminals. To clear the dc van voltage of VSC, certificate of character dc auto voltage Vdc_{ref} is adjusted. The recommendation dc connect voltage in like the rock of gibraltar state contact V_{mpp} (voltage for maximum power).

B. Control for Voltage Source Inverter

For the proposed control, a total of six quantities are sensed for feedback and instantaneous compensation term. The sensed quantities for VSC control are two PCC voltages (vs_a, vs_b), grid currents (i_{sa}, i_{sb}), and load currents (i_{La}, i_{Lb}). The PV voltage (V_{pv}) and PV current (I_{pv}) are also sensed and PV power information is used for instantaneous compensation for fast dynamic response. The sensed PCC voltages are first passed through band pass filter to eliminate switching noise and any other

harmonics present. Simple mathematical operations are applied to convert PCC line voltages to phase voltages, output of which are phase voltages as vs_a, vs_b, vs_c. An amplitude transformation is applied to estimate amplitude of phase voltages. The amplitude of the phase voltage is estimated as

$$V_p = \sqrt{\frac{2(v_{sa}^2 + v_{sb}^2 + v_{sc}^2)}{3}} \tag{1}$$

Using estimated peak voltage, in-phase unit templates are estimated as

$$x_{ap} = \frac{v_{sa}}{V_p}, x_{bp} = \frac{v_{sb}}{V_p}, x_{cp} = \frac{v_{sc}}{V_p} \tag{2}$$

From in-phase unit templates, quadrature (90° shifted) unit templates are derived as

$$\begin{aligned} x_{aq} &= -x_{bp}/\sqrt{3} + x_{cp}/\sqrt{3} \\ x_{bq} &= \sqrt{3}x_{ap}/2 + (x_{bp} - x_{cp})/2\sqrt{3} \\ x_{cq} &= -\sqrt{3}x_{ap}/2 + (x_{bp} - x_{cp})/2\sqrt{3} \end{aligned} \tag{4}$$

For fundamental load currents extraction, an adaptive theory based ILST algorithm is used [16].

There are two parameters in the proposed control algorithm, α and β , where $\sqrt{\beta}$ is tuning frequency and α decides the bandwidth of ILST-based filter. The transfer function of the ILST algorithm from the block diagram is given as

$$\frac{i_{L(a,b,c)}}{i_{f(a,b,c)}} = \frac{s\alpha}{s^3T_1 + s^2 + (\beta T_1 + \alpha)s + \beta} \quad (5)$$

III. MATLAB SIMULATION AND EXPERIMENTAL RESULTS

This section shows the MATLAB simulation and the experimental results of proposed system. MATLAB is a software package for computation in engineering, science, and applied mathematics. It offers a powerful programming language, excellent graphics, and a wide range of expert knowledge. The step by step execution of the proposed system is as follows. The solar rays obtained from sun are converted into electrical signal; this electrical signal is in DC voltage form.

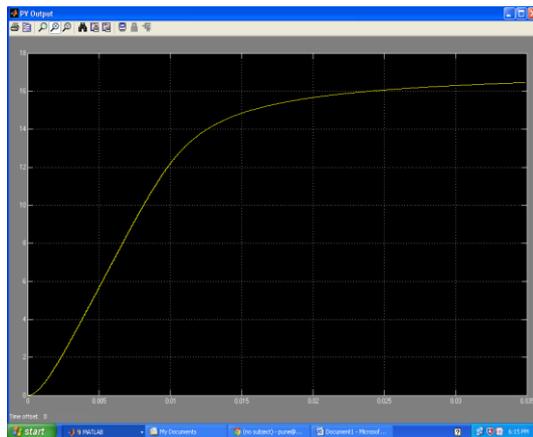


Fig.3. Output from Sun.

Figure 3 shows solar output in electrical form.

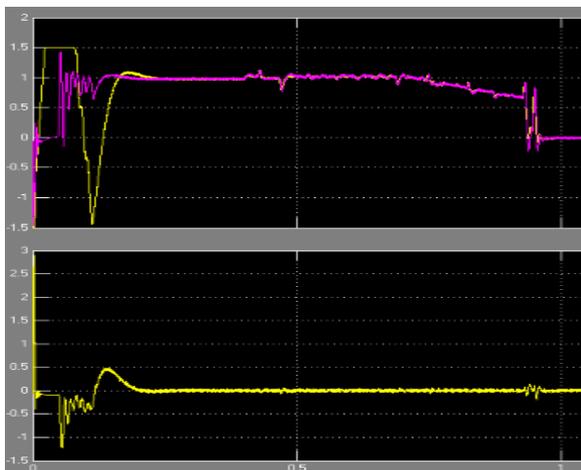


Fig.4 Waveform of proposed currents Id and Iq.

The figure 4 shows the Waveform of proposed currents Id and Iq.

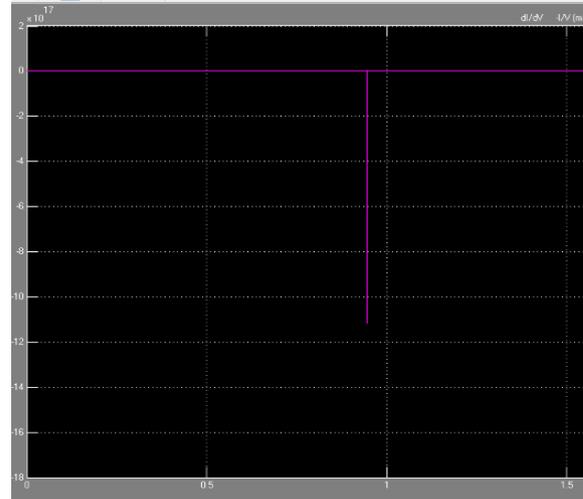


Fig.5. Waveform of proposed Mppt algorithm.

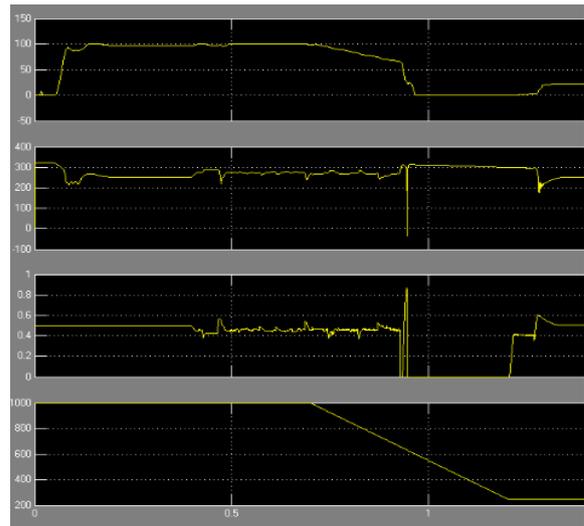


Fig.6. Waveform of proposed power P mean.

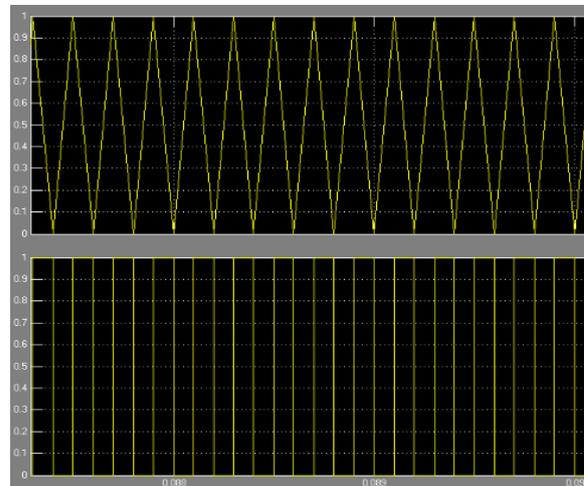


Fig.7. Waveform of proposed solar pulse in electrical form.

The figure 5 shows the Waveform of proposed Mppt algorithm. The figure 6 shows the Waveform of proposed power P mean. Figure 7. Waveform of proposed Solar pulse in electrical form.

To validate the performance of the proposed system, simulations are performed using MATLAB/Simulink. The results of the proposed system are taken under normal weather conditions.

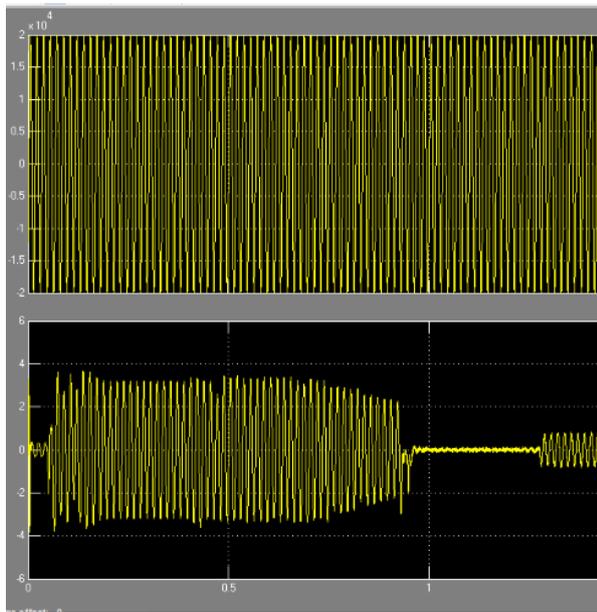


Fig.8. Waveform of proposed Va and Ia



Fig.9. Waveform of proposed Maximum power Tracking.

Figure 8 shows the Waveform of proposed Va and Ia. Figure 9 shows the Waveform of proposed Maximum power Tracking.

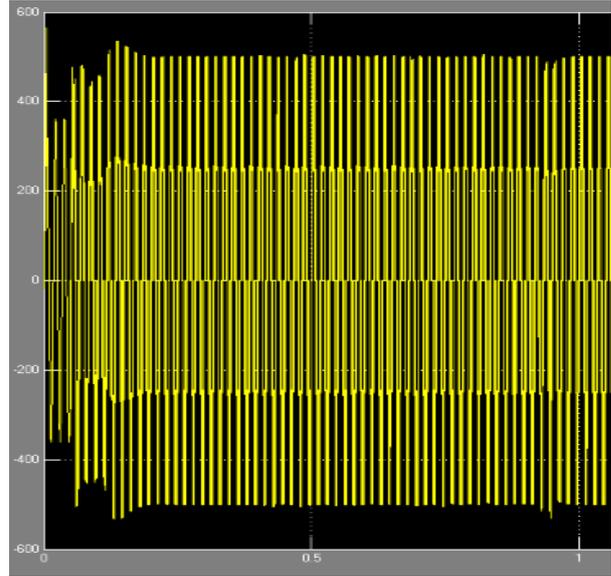


Fig.10. Waveform of proposed Vsc Voltage

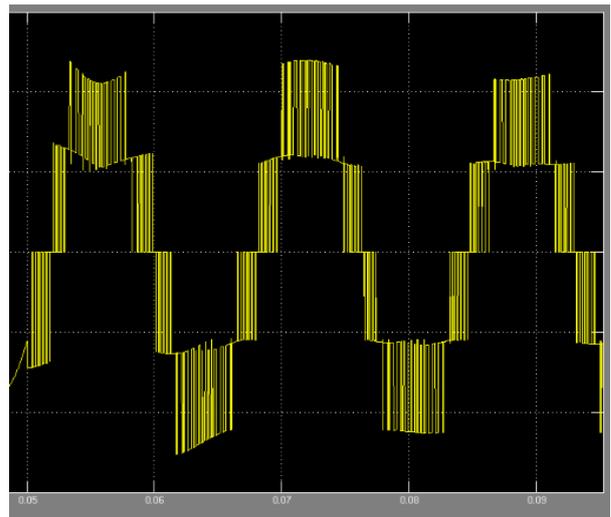


Fig.11. Waveform of proposed Vab vs c.

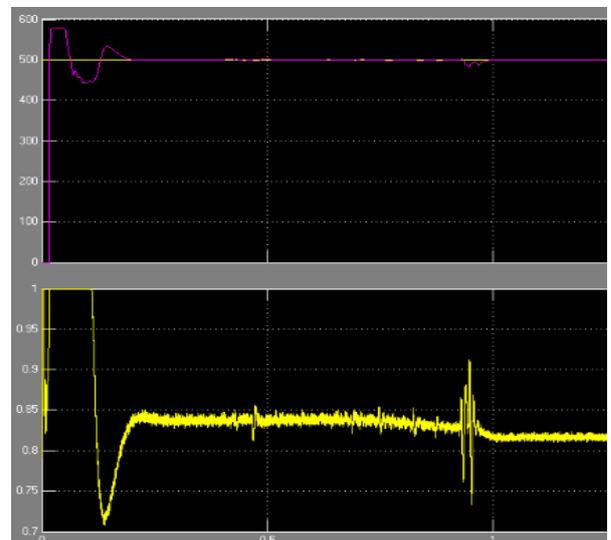


Fig.12 Waveform of proposed Vdc

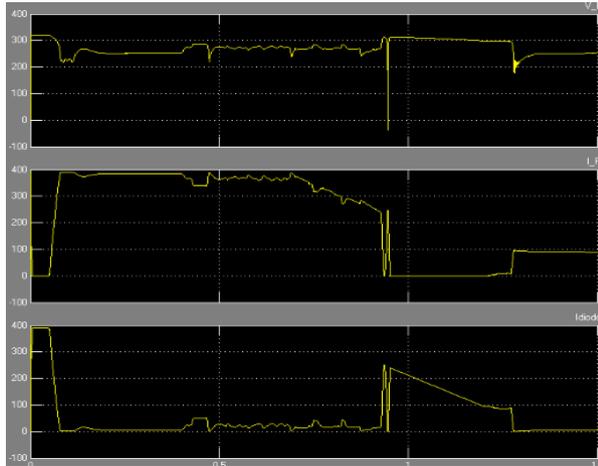


Fig.13. Waveform of proposed Vpv ipv diodepv

Figure 10 shows the Waveform of proposed Vsc Voltage. Figure 11 shows Waveform of proposed Vab vsc. Figure 12 shows the Waveform of proposed Vdc Figure 13 shows the Waveform of proposed Vpv ipv Diodepv

IV. CONCLUSION

The simulation and implementation of single-stage, twin purpose, and three-phase grid interfaced SPV are meted out with power quality improvement within the distribution system. Associate in nursing progressive conductance-based MPPT technique has been used for estimating reference dc link voltage. The dc link voltage has been regulated to reference worth employing a PI managementler and planned control formula. The performance of planned single stage grid interfaced SPV system together with harmonics compensation, power issue correction, and grid currents equalization has been found satisfactory and meeting IEEE standards. Improvement in existing ALST formula has been planned together with modifications to include feature of alternative energy injection into the grid. Associate in Nursing ILST-based management formula has been used for the elemental current extraction together with instant compensation for PV power for quick dynamic response. The options of plannedmanagementformulaare found straightforward to implement, quick convergence, and it needs terribly less machine effort. The transient responses of SPV system square measure found satisfactory. a large vary of simulation and experimental results has been found for supporting the satisfactory operation of the planned twin purpose grid interfaced SPV generating system.

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