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Simulation and Hardware Implementation of Grid Connected Solar Charge Controller with MPPT

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Abstract: **A renewable energy source plays an important role in electricity generation. Various renewable energy sources like wind, solar, geothermal, ocean thermal, and biomass can be used for generation of electricity and for meeting our daily energy needs. Energy from the sun is the best option for electricity generation as it is available everywhere and is free to harness. On an average the sunshine hour in India is about 6hrs annually also the sun shine shines in India for about 9 months in a year. Electricity from the sun can be generated through the solar photovoltaic modules (SPV). The SPV comes in various power output to meet the load requirement [1]. Maximization of power from a solar photo voltaic module (SPV) is of special interest as the efficiency of the SPV module is very low. A peak power tracker and DC-DC Boost Converter is used for Extracting the maximum power from the SPV module. And simulation in PSIM software and hardware result is compare and solar panel maximum efficiencies is increase nearby 85% using dither routine algorithm method use.**

Keyword: PV module, Grid, Maximum Power Point Tracking (MPPT) module, Inverter, PSIM, Boost converter.

I. INTRODUCTION

Renewable energy sources play an important role in electricity generation. Various renewable energy sources like wind, solar, geothermal, ocean thermal, and biomass can be used for generation of electricity and for meeting our daily energy needs. Energy from the sun is the best option for electricity generation as it is available everywhere and is free to harness. On an average the sunshine hour in India is about 6hrs annually also the sun shine shines in India for about 9 months in a year. A worldwide concern for future access to affordable, sustainable energy is driving the development of more efficient solar power generation [2]. In any photovoltaic (PV) based system, the master controller is a critical component responsible for the control of electricity flow between the module, battery, loads, grid. The proposed for maximum power point tracking, boost converter, battery charging, and load control. The main elements of maximum power point tracking system for dc-dc boost converter, battery charging circuit, PIC controller which selects energy sources to continue supply the load. Using the simulation software PSIM proposed boost converter topology with predictive control has been chosen. The final simulation of dc-dc boost converter has been done, which was made in PSIM. It is shown that the output voltage (30V dc) to supply the load and, to charge the battery if solar output power is greater than the load power. The proposed control algorithm including the whole system control is implemented on a low cost, microcontroller PIC16F690.solar system efficiency increase near 90%.

II. SIMULATION AND HARDWARE OF DC-DC BOOST CONVERTER IN PSIM

The boost converter, also known as the step-up converter, is another switching converter that has the same components as the buck converter, but this converter produces an output voltage greater than the source.

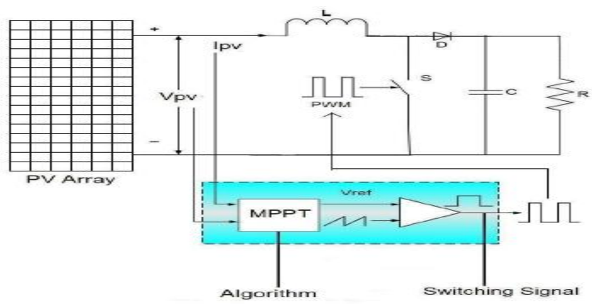

Fig.1 Basic of DC-DC Boost Converter Circuit Diagram [4]

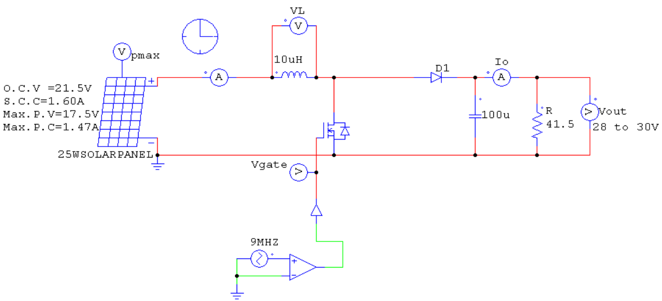

Fig.2 Simulation of PV with Open Loop DC-DC Boost Converter

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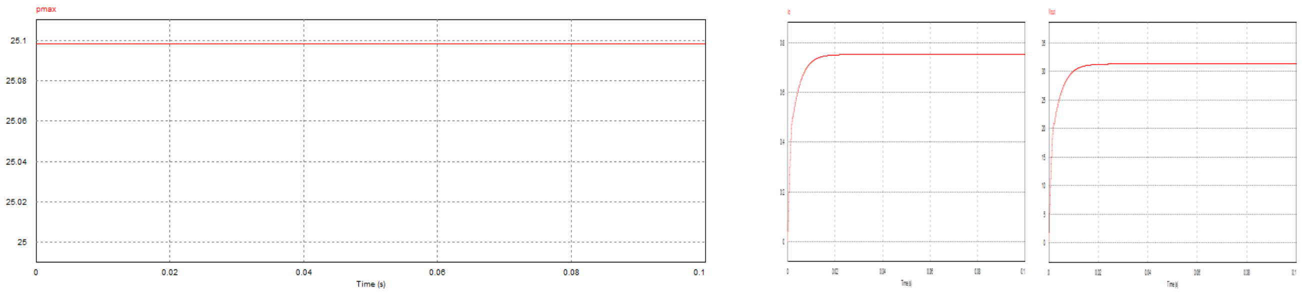
Fig.1 shows that the ideal boost converter has the five basic components, namely a power semiconductor switch, a diode, an inductor, a capacitor and a PWM controller. The placement of the inductor, the switch and diode in the boost converter is different from that of the buck converter. The simulation of DC-DC Boost converter is shown in the Fig.2

A. Simulation of open loop DC-DC boost converter & results

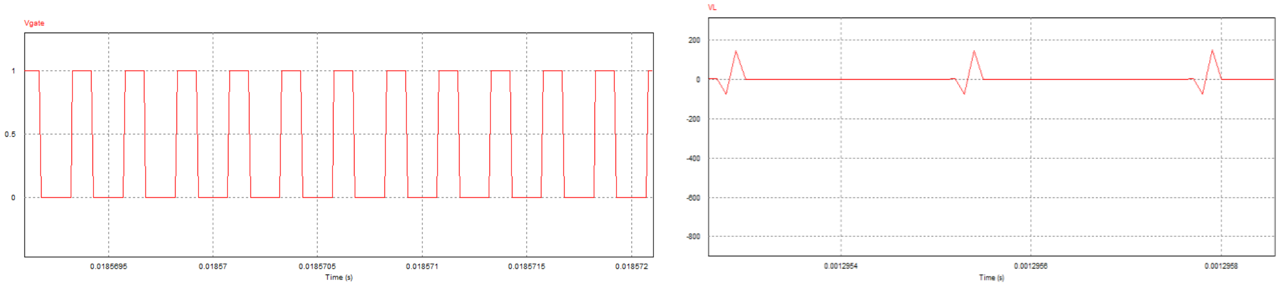
Fig.3 (a),(b) and (c) shows that the output waveform of open loop DC-DC Boost converter of solar panel output power 25W, output current 0.75A and output voltage of 30V respectively.



(a) (b) (c)

Fig.3. (a) Result of Open Loop DC-DC Boost Converter of Solar Panel Power 25W, (b) Result of Open Loop DC-DC Boost Converter for Output Current 0.75A, (C)Result of Open Loop DC-DC Boost Converter output voltage 30V.

Fig.4 (a) and (b) shows that the switching wave of MOSFET Using Open Loop DC-DC Boost Converter and Voltage across Inductor Wave of Open Loop DC-DC Boost Converter respectively [6].



(a) (b)

Fig.4 (a) Switching Wave of MOSFET Using Open Loop DC-DC Boost Converter, (b) Voltage across Inductor Wave of Open Loop DC-DC Boost Converter

B. Hardware of DC-DC boost converter

A circuit diagram is required to implementation of hardware model, which is shown in the Fig.5 [5].

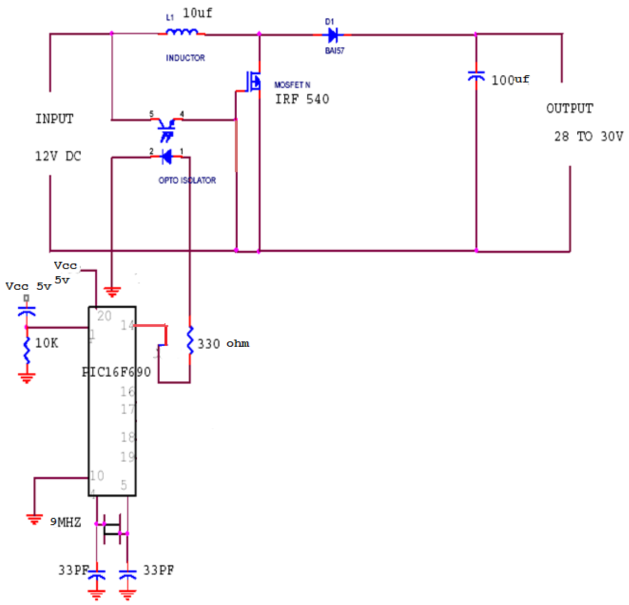


Fig.5 Circuit Diagram of Open Loop DC-DC Boost Converter

TABLE NO.1

NO OF READING	SOLAR PANEL O/P (I_0)	SOLAR PANEL O.C.V(V)	MAXIMUM POWER(W)	DUTY CYCLE (%)
1	0	21.5	0*21.5=0	0
2	0.2	20	0.2*20=4	10
3	0.4	19.5	0.4*19.5=7.8	20
4	0.6	18.5	0.6*18.5=11.1	30
5	0.8	17.8	0.8*17.8=14.24	40
6	1.47	17.5	1.47*17.5=25.7	48
7	1.47	16	1.47*16=23.52	60
8	1.47	15	1.47*15=22.05	70
9	1.47	14.5	1.47*14.5=21.3	80
10	1.47	10	1.47*10=14.7	90
11	1.47	0	1.47*0=0	100

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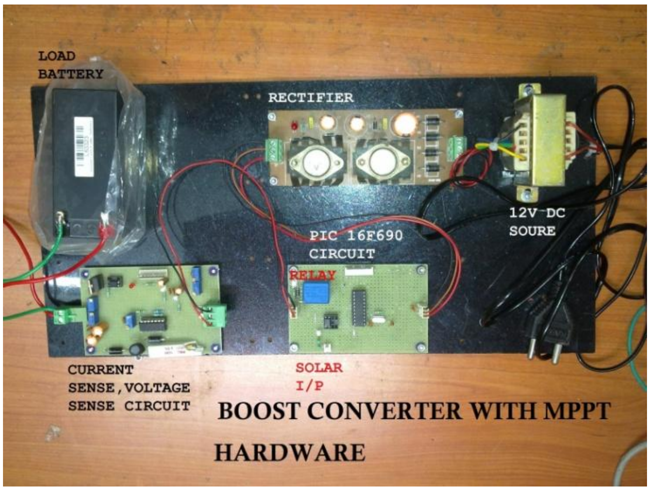
Based on the hardware circuit diagram the model could be prepared, which is shown in the Fig.6.



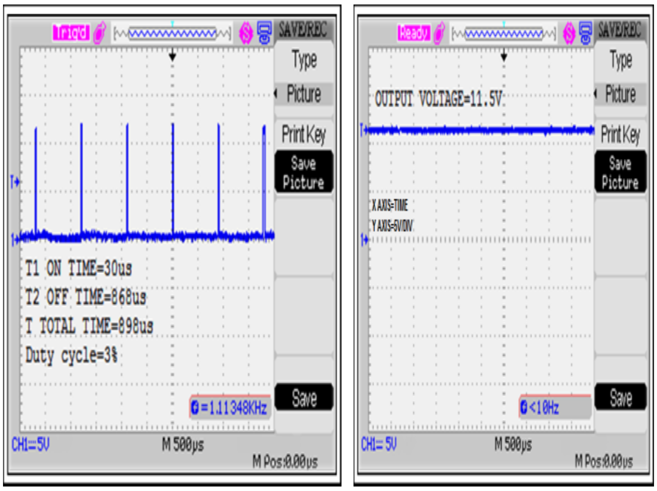
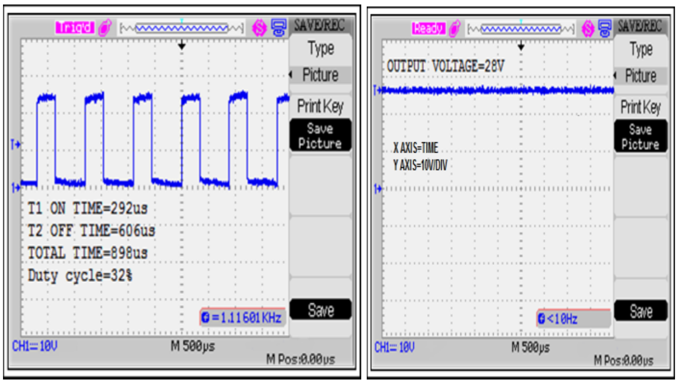


Fig.6 Snapshot of Open Loop DC-DC Boost Converter

Fig.7 3% Input duty Cycle and o/p voltage 11.5V waveform

Fig.7 shows that the hardware result of boost converter with MPPT.



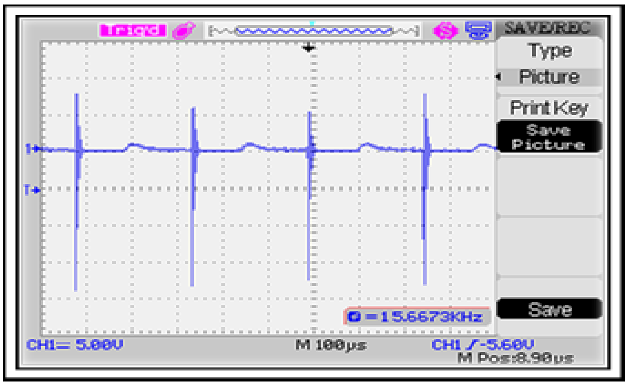
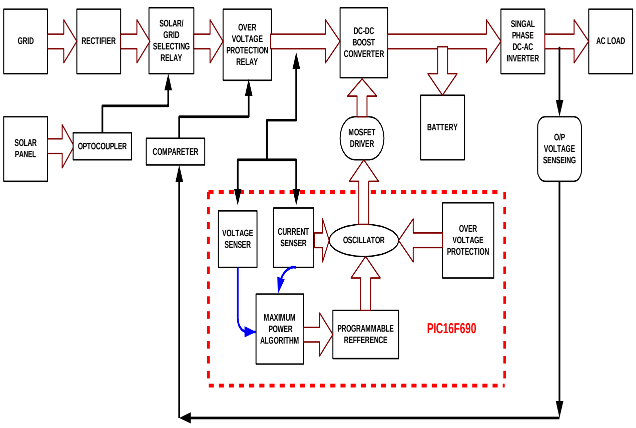


Fig.8 32% Input duty cycle and O/P voltage 28V waveform

Fig.9 Voltage across Inductor Wave of DC-DC Boost Converter Hardware Result

Table No.1 shows that the testing result of hardware with solar panel. Which is graphically represented in the Fig.12 and Fig.13 identically.The software to control the Maximum Power Point Converter can be broken into two algorithms: Current Reduction and the dither routine, which are controlled via the Interrupt Service Routine (ISR). Both algorithms manipulate the current of the solar panel via the Programmable Voltage reference generated by the PIC16F690's 10-bit PWM [7].



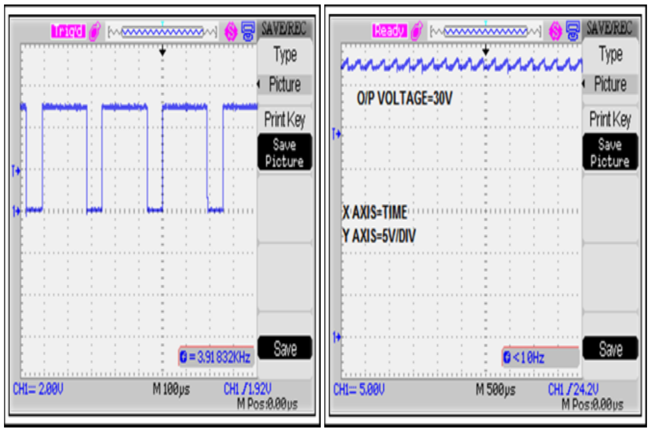


Fig.10 Hardware Block Diagram of MPPT

Fig.11 48% O/P Voltage Duty Cycle and O/P Voltage 30 V Waveform

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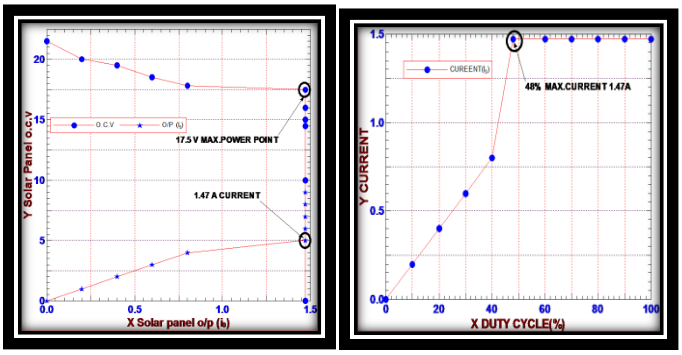

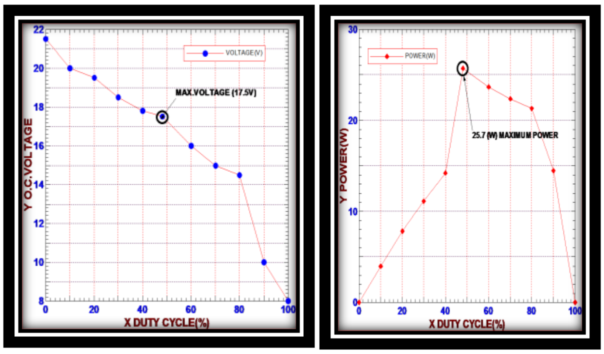

(a) (b) (a) (b)

Fig.12(a) V-I Characteristics Solar System,(b) Duty Cycle Vs I Fig.13 (a) Duty Cycle Vs O.C.Voltage, (b) Duty Cycle Vs Power

Fig.13 shows that the final implementetation of hardware with results.

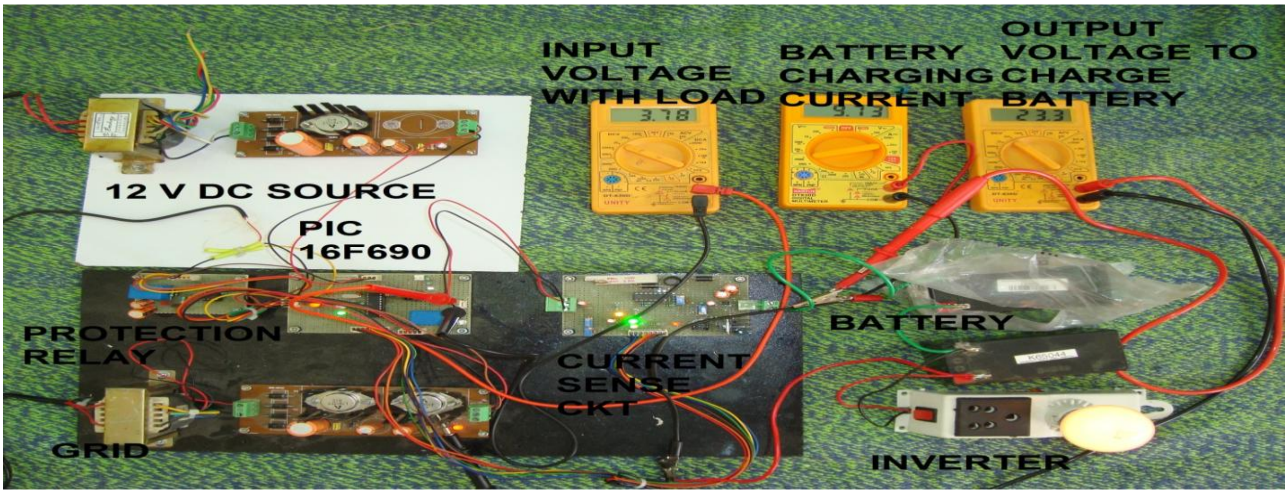

Fig.13 Snapshot of Final MPPT System Hardware

C. Acknowledgement

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III. CONCLUSION

Above hardware in Dither Routine technique and PIC Controller (16F690) can be used to implement MPPT logic and as a result we can tack maximum power at output (load) from solar panel. Increase solar system efficiency is near the 90%. Shortcomings and execution efficiency for three power-feedback type MPPT methods, including perturbation & observation, incremental conductance and Dither Routine. The PV Simulation in PSIM software use [8]. The model of PV modules used in PV simulation system is established according to the electrical specifications of the PV module after accomplishing the model of PV modules, the models of DC-DC boost converter and MPPT systems are combined with it to complete the PV simulation system with the MPPT function. The accuracy and execution efficiency for each MPPT algorithm can then be simulated under different weather conditions after in system to use battery is charge with connected inverter to dc o/p converted into ac power. This system improves maximum efficiency increase to near 90%.

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