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DESIGN DEVELOPMENT OF PHOTOVOLTAIC SYSTEM USING INTELLIGENT CHARGING METHODS

B. Padmanabhan
Assistant Professor,
Department of Electrical and Electronics Engineering,
Sathyabama Institute of Science
Technology,
Chennai, India.
padmanabhan4eee@gmail.com

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Abstract

A new Bridgeless boost AC to DC converter using Fuzzy logic controller is discussed. Power factor and THD is concentrated and they are regulated using voltage and current controlling method. The proposed converter has two boost converters each for one half cycles producing a output voltage of 490V. The comparison of the regulated parameter for two different controller is depicted and proved that a FLC produce a suitable output for the specified application with a output ripple voltage of 8V, power factor of 0.9859 and a current of 3 A which improves the reliability of the designed converter. The prototype of bridgeless boost converter validates the simulated result.

***Keywords*:** Intelligent charging, Battery charging, solar panel, battery storage plant, photo- voltaic (PV) systems, Microcontroller, MPPT techniques.

1 INTRODUCTION

The exhaustion of fossil fuels and environmental pollution has compelled the human race to use non-conventional energy more than the conventional energy. The advantage being economy, cost saving in long terms, and no pollution endangers the environment. Wind Energy, Tidal energy, solar energy being the examples of non-conventional energy source. Among these the solar energy is freely available [1-3]. They have the advantage of being maintenance and pollution-free but their initial installation cost is high. So photovoltaic based system such as water pumping, home power supplies, drying food and satellite systems are widely used. Photovoltaic battery Charging System acts as electric power source and consists of following main parts:

1. Solar Panel: For the purpose of collecting solar energy and converting it to electricity.
2. Battery: To store electricity and supply it to load.

Technology improvements have helped to face this situation better, but it also have created other more challenges regarding the quality of power and efficiency. As per present geographical conditions, it is very important to have an effective and appropriate maximum power point tracking (MPPT) algorithm for the photovoltaic system. If there is a good irradiance condition, the photovoltaic system can generate maximum power efficiently while an effective MPPT algorithm is used with the system. A lot of MPPT algorithms have been developed by researchers and industry delegates all over the world. They are voltage feedback method, perturbation and observation method, linear approximation method, incremental conductance method, hill climbing method, actual measurement method, etc [5-8].

2 TRADITIONAL SYSTEM

The Figure 1 shows blocks diagram operation of the existing conventional system. A DC to DC boost converter is used as power conditioner for charging a battery through an unregulated power supply. From previous methods used for charging battery it has

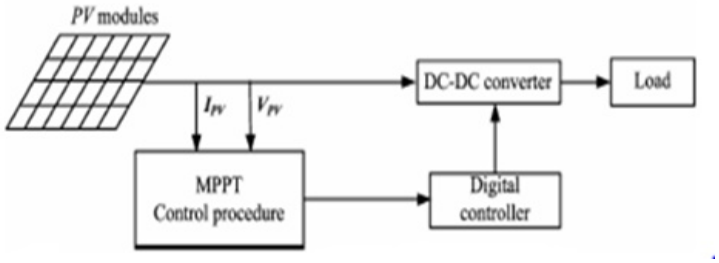

Figure 1: Block diagram of existing system

been found that the current loop used in parallel operation of a power conditioner suffers an inborn problem of stability, which affects the overall system performance and power extracting potential of the solar panel [9 15]. The expected battery lifetime is reduced if there is low PV energy availability for prolonged periods or improper charging control, both resulting in low battery state of charge (SOC) levels for long time periods.

In existing system contains fail in track maximum power from solar system and No effective charge management is implemented. Meantime the safety of the converter unit is poor this leads to Shortens the life of battery. Only one battery can be charged at a time during positive pulse period from the boost converter. So the efficiency of the solar energy is not fully utilized.

3 INTELLIGENT MANAGEMENT SYSTEM

Intelligent management system is developed with three charge state Power is made to available throughout the day. The Maximum power is obtained from the solar system. Fly back converter is implemented for maximum efficiency [16 18]. Because of this Life of the battery is improved. The figure 2 shows the functions of the proposed system. PV charging system (PV-CS) proposed is to make PV energy pump continuous with optimum maximum power point tracking (MPPT), which increases the PV utilization ,and to dispatch the remaining PV energy for further storage in the pulse break period.

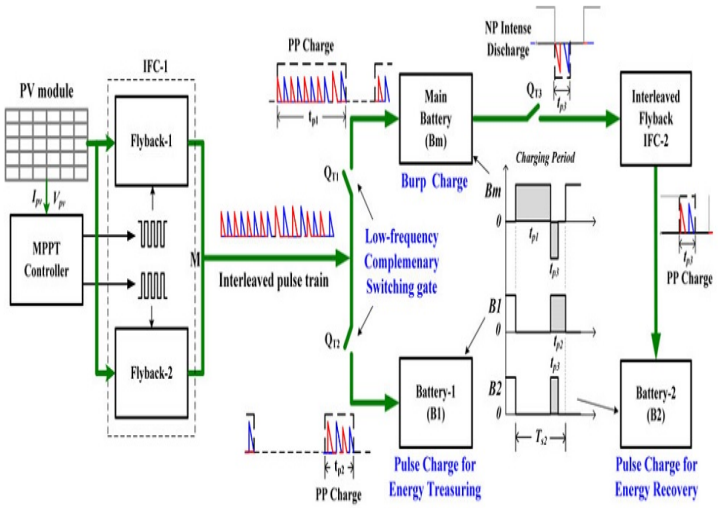

Figure 2: Block diagram of the proposed system

Some of the fast charging systems presently available incorporate negative pulse fast charging algorithms that claim to have great benefits to batteries including reduced recharge time, lower temperature rise, full recharge capabilities, as well as shorter equalization times. The proposed method is simple, flexible expandable as compared to previous existing methods. The proposed charging system enhances the PV output power. By implementing this concept the overall system cost can be reduced by the use of proper battery charging/discharging control techniques, which achieve high battery SOC and, consequently, longer lifetime.

A. CIRCUIT ARCHITECTURE

The below diagram shows the circuit architecture of the intelligent charge management system for photovoltaic system. This PV system consists of six major parts: (1) solar panels, (2) buck converter circuit as the battery charger, (3) Fly back converters, (4) PIC16F877A microcontroller to control power MOSFET switching duty cycle on the converter circuit, controlling the charge management module, acts as MPPT controller to send signals to converters (5) gate drive circuits, and (6) rechargeable batteries.

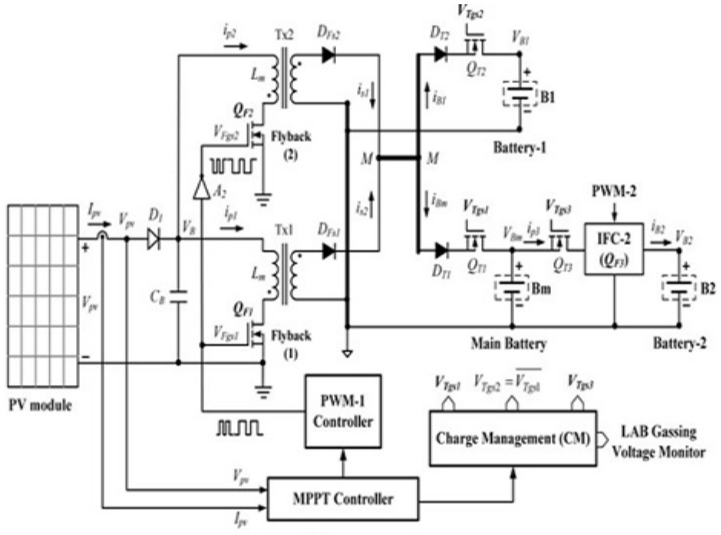

Figure 3: Hardware Circuit diagram

B. EXPERIMENTAL ANALYSIS

Incremental Conductance (IC) Flow Diagram of MPPT algorithm

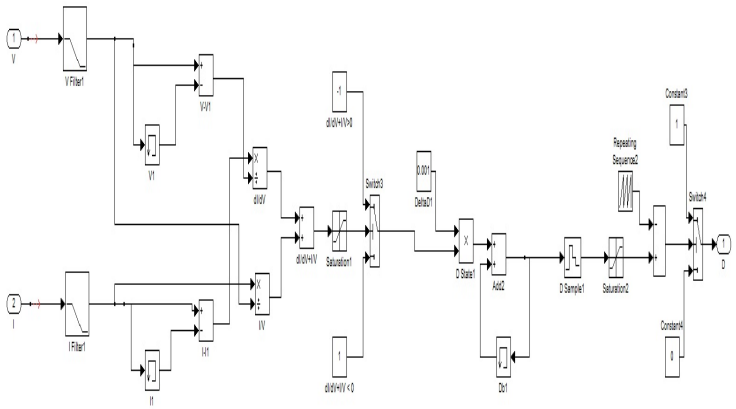

Figure 4: Simulation Circuit - MPPT Algorithm

The theory of the incremental conductance method is to determine the variation direction of the terminal voltage for PV modules by measuring and comparing the incremental conductance and instantaneous conductance of PV modules. If the value of incremental conductance is equal to that of instantaneous conductance, it represents that the maximum power point is found. When the operating behavior of PV modules is within the constant current area, the output power is proportional to the terminal voltage. That means the output power increases linearly with the increasing terminal voltage of PV modules. When the operating point of PV modules is exactly on the maximum power point, the slope of the power curve is zero (dP/dV = 0) and can be further expressed as,

$$\frac{dP}{dV} = \frac{d(VI)}{dV} = I\frac{dV}{dV} + V\frac{dI}{dV} = I + V\frac{dI}{dV}$$

C. FLOW DIAGRAM - MPPT ALGORITHM

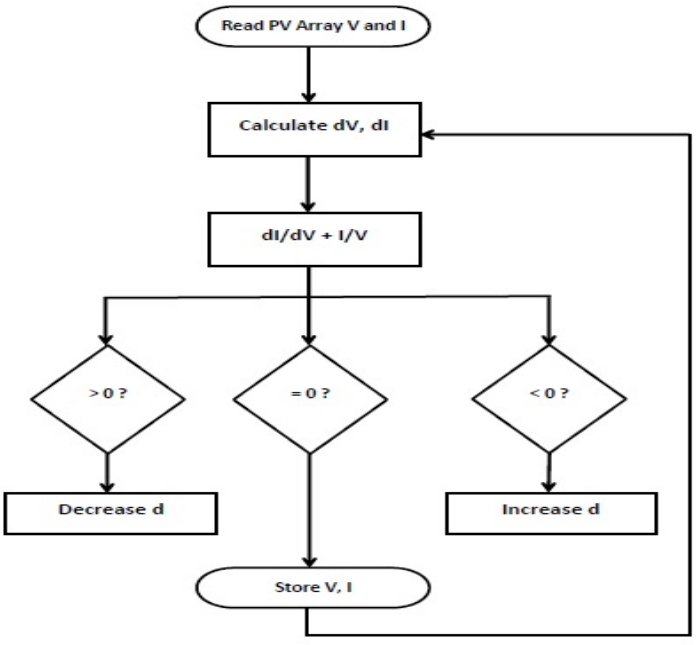

Figure 5: Flow Diagram-MPPT Algorithm

In this paper, a photovoltaic charge system (PV-CS) is proposed to perform the pulse charge with direct PV energy supply without using dc bus through an additional dc/dc converter. In reality, if a pulse charger is to be used in a PV system without using dc bus as energy buffer, it may happen that the PV energy supply will interrupt during the pulse break period. As a result, the maximum power point tracking (MPPT) may be intermittent to lose the tracking optimization. However, the proposed PV-BCS not only can make MPPT continuous for increasing the PV utilization, but also can dispatch and store the remaining PV energy for energy saving during the pulse break period, achieving energy treasuring and recovery concept. To achieve this we have used MATLAB for simulating the results.

4 SIMULATION RESULTS

Herewith used two fly back converters to generate PWM pulse for producing interleaved output signal to charge the batteries (Main Battery, Battery-1 Batterry-2) simultaneously. These fly back converters play a very important role in intelligent charge management system, Since the PWM pulses are continuously generated to utilize both +ve -ve pulse periods. Because of these conditions, solar energy generated from PV panel is fully utilized. The Simulation results of our proposed system are as follows,

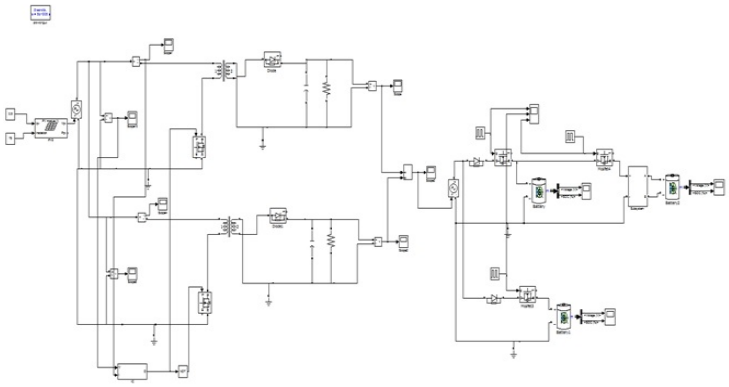

Figure 6: Simulation Circuit Configuration of the proposed system

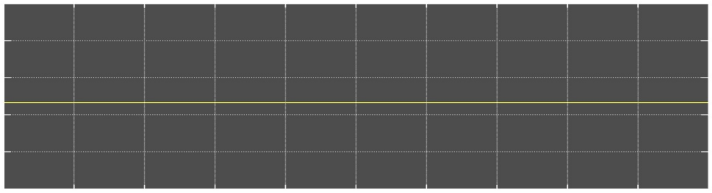

Figure 7: Solar Panel input Voltage Waveform

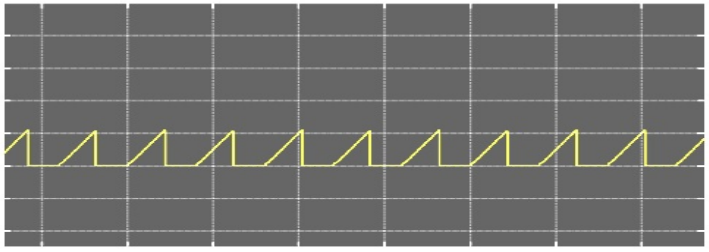

Figure 8: Solar Panel input current Waveform

The above waveforms (Figure 7 8) are generated from the PV Solar Panel. These waveforms are generated based on the solar energy that varies time to time. It is controlled stabled by using MPPT algorithm through incremental conductance method for both simulation hardware implementation.

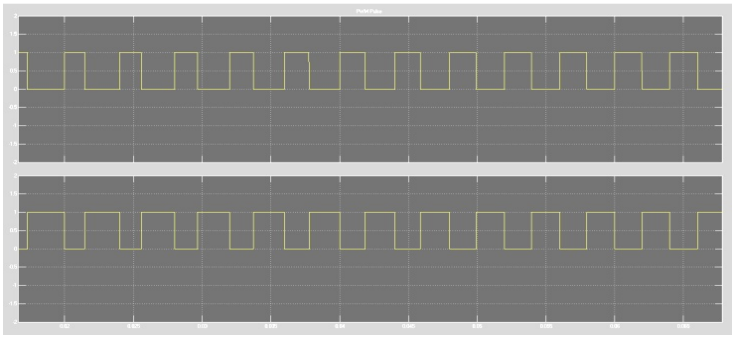

Figure 9: Fly back Converters Switching PWM

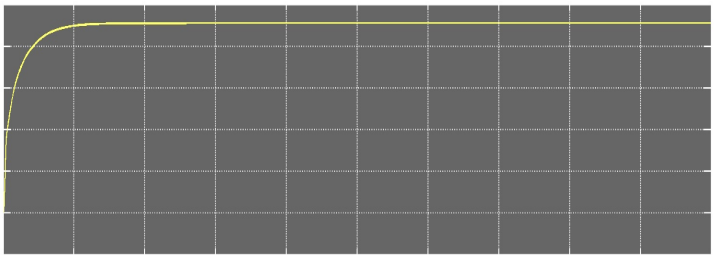

Figure 10: Output voltage from Fly back Converter-1

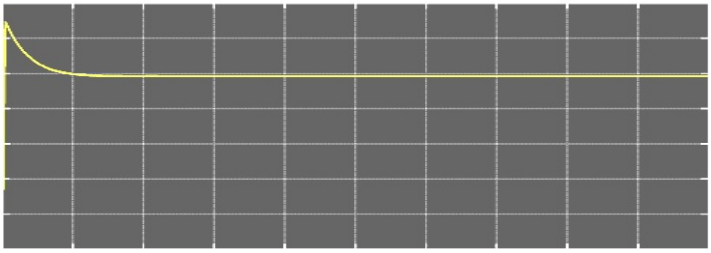

Figure 11: Output voltage from Fly back Converter-2

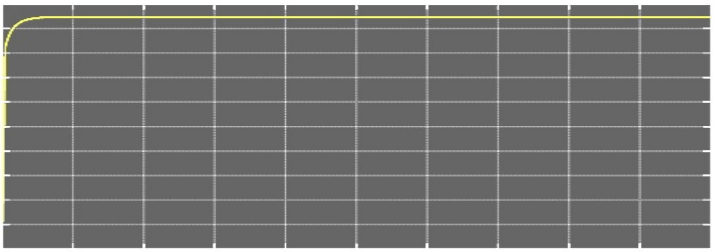

Figure 12: Combined output Voltages from Fly back Converters 1 2

The above three waveforms shows (Figure 10, 11 12) the output voltages from Fly back converter 1, 2 combined output from both converters respectively. In our simulation results we have found output voltage of fly back converter-1 is 45V, output voltage from fly back converter-2 is 40V. Similarly the combination of these two fly back converters shows 85V in Figure 12

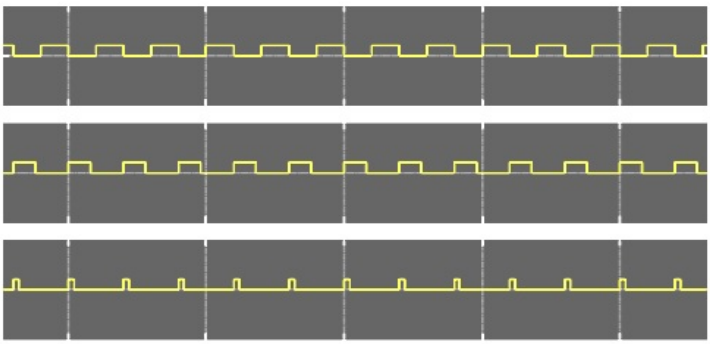

Figure 13: Pulse Charges to all three batteries

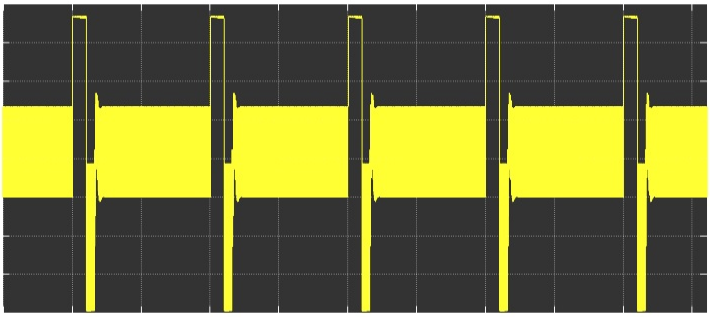

Figure 14: Input pulses to the third fly back converter

The above wave form shows the input signal fed into the third fly back converter to charge the battery 2(B2).

Depends on the output from the two fly back converters, the pulses will fed into all three batteries as per above pulse charging waveforms. Here main battery (Bm) will be charged during positive pulse generated from Fly back converters through switch I3. During negative pulse generation the Battery-2(B2) will get charged through switch I4. Similarly same condition the Battery 2 (B2) will also charge from Main battery (Bm) through third fly back converter switch I5. Input pulses from main battery are very low compared with the charging time of its own. This is to avoid complete discharges of the main battery.

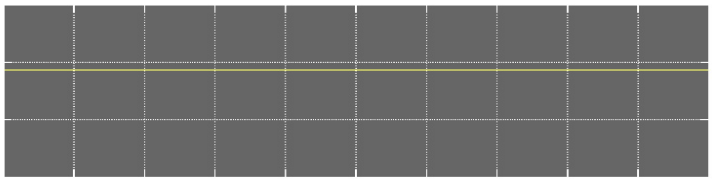

Figure 15: Output voltage of the main battery (BM) - 90V

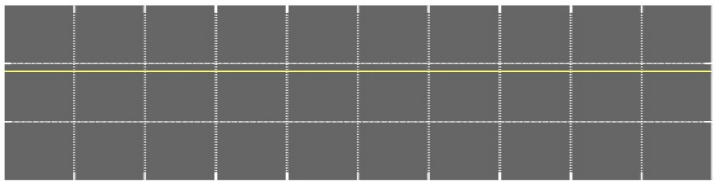

Figure 16: Output voltage of the battery-1 (B1) - 90V

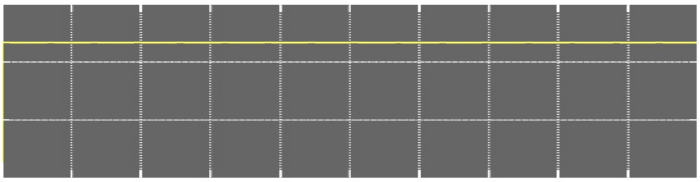

Figure 17: Output voltage of the battery-2 (B2) - 125V

The above three waveforms are output of all the batteries charged based on the PWM pulse control. The output voltages 90V from main battery (Bm), same 90V from Battery-1(B1) 125V from Battery 2(B2). Because of the third fly back converter the output voltage is higher than main battery (Bm) battery-1 (B1).

5 HARDWARE IMPLEMENTATION

The above photograph Figure 18 shows the implemented hardware structure of the proposed system. This has been done through various electrical electronic components specified in the hardware circuit diagram.

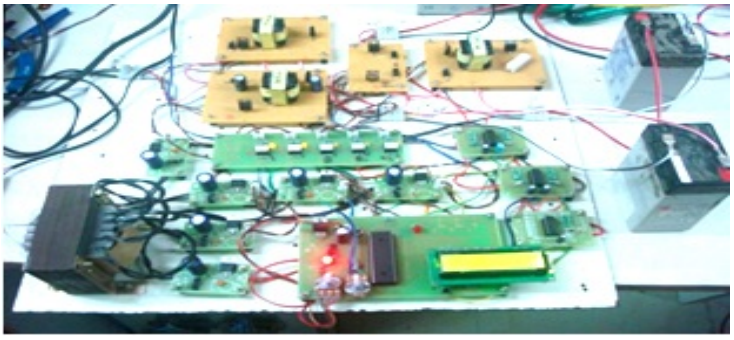

Figure 18: Hardware of proposed system

Input Parameters:
• Capacity from PV Panel : 20V
• Batteries capacity : 6.5 V Each
• Charging time of Main Battery : 1 Sec
• Charging time of B1 Battery : 0.7 Sec
• Charging time of B2 Battery : 0.4 Sec

Output Parameters:
• Output Voltages : 6.3V, 6.2V 6.4V respectively
• Charging current : 0.14A, 0.08A, 0.20A
• Pulse charging : 8V(Avg.)

6 CONCLUSION

In this paper, the PV-CS performs that the pulse charge can be realized by directly using renewable energy supply. The idea of simultaneous charging of three batteries by utilizing direct renewable source creates a new design development in solar energy, which makes it come true to achieve the energy treasuring and recovery concept. Except for a large-scale energy management to the life of battery, to implement in remote areas, the PV-CS can also be a hybrid charger for renewable energy application if additional renewable energy is mixed with the PV energy. In addition, despite the advantage of low-frequency pulse break aided for prolonging

the battery life, the tiny brief break between the adjacent high-frequency pulses also benefits the dissolve of sulfating crystallization

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