International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 06 Issue: 03 | Mar 2019 www.irjet.net p-ISSN: 2395-0072

MPPT Technique based Hybrid Solar Charge Controller

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Abstract: - Electricity is one of the pinnacle usable forms of energy and is used throughout the world. With the development of modern technology, the usage of electricity has been escalating gradually. Also, its requirement is increasing hastily as the world's population is increasing day by day. It's almost predictable that renewable energies like solar, wind, tides, geothermal etc. will be utilized efficiently by replacing the non-renewable energies to produce electricity. In the above all, solar energy is and will be the widely used renewable energy all over the world. Solar panels are the one which traps the energy from sun, converts them and gives us electricity. The DC output from the panel is supposed to charge a DC battery and store energy. The battery has to be charged constantly with a constant voltage which is impossible from panel output. Hence a controller has to be fixed amidst the panel and battery so that the controller gives a constant output to charge the battery. MPPT charge controllers are the high efficient controllers available at low cost.

Keywords*: - Electricity, Solar, MPPT, Charge controller.*

I. INTRODUCTION

Electricity is one of the most important sectors for the economic development of a country, storing it for now and using it for later purpose. When it falls under the category of storing, DC is the word that is used all over. For producing and storing DC, solar panels are the only choice. The solar panels are used for charging and storing electricity in a battery. But the significant obstacle is that the battery has to be charged at its charging voltage that has to be constant. Hence a controller is preferred so that the controller does the necessary operations and charges the battery at its charging voltage. Even in a controller, choosing them wisely will increase the efficiency and also allows the battery to charge at its charging voltage. There are various charge controllers available at a low cost but its efficiency is poor. To overcome this major drawback we ourselves made a solar charge controller using the efficient technique called MPPT (Maximum Power Point Tracking).

MPPT technique is a technique used in a solar charge controller to track the maximum power in the PV (Photovoltaic) array by changing the duty cycle of the converter subsequently even under low sunlight condition. The controller after a voltage sensor checks the output voltage from the panel and performs the MPPT technique. Based on irradiations from the sun and the output from the panel, the relay switches between the buck converter and boost converter and charges the battery at its safest charging voltage (24 volts).

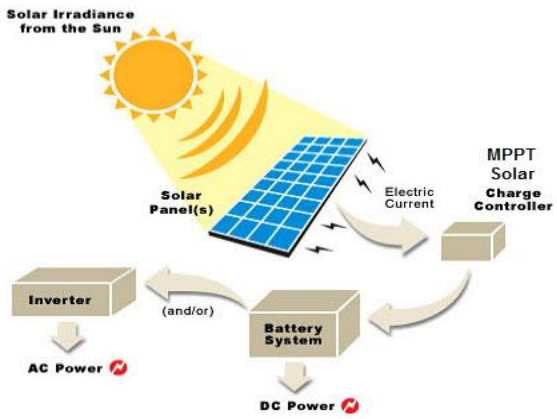

Fig 1: Basic solar charge controller

II. BLOCK DIAGRAM

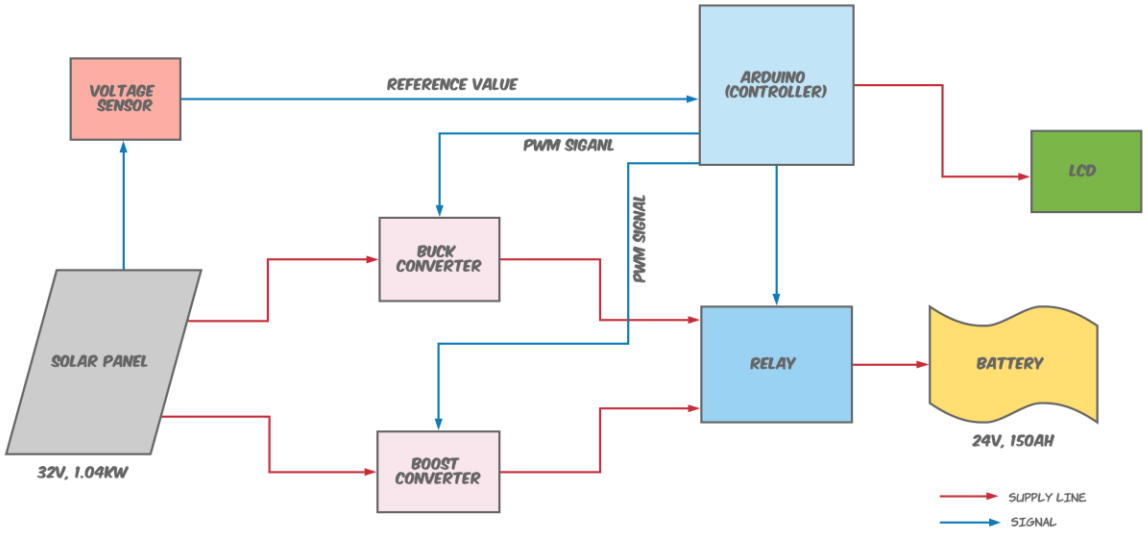

Fig 2: solar charger controller block diagram

III. HARDWARE USED

1. Buck Converter:

A buck converter is a DC-DC step down voltage converter. It contains two semiconductors and at least one energy storing component. For reducing the ripple, a capacitor is in parallel. N - Channel MOSFET is the switching device used in this project. As per the gate pulse triggered in the MOSFET, the output voltage changes.

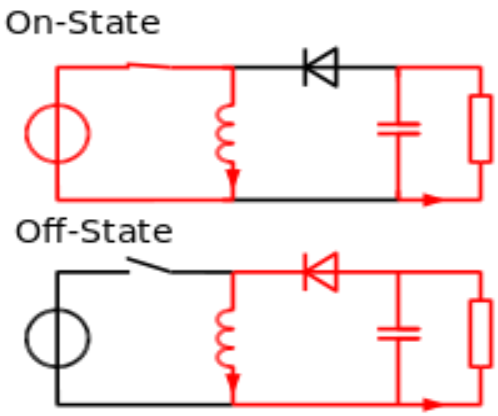

Fig 3: A basic buck converter

2. Boost Converter:

A boost converter is a DC-DC step up voltage converter. Only the construction is the major difference between buck and boost converter.

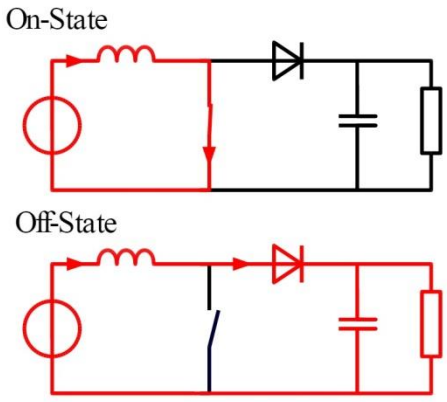

Fig 4: A basic boost converter

3. Arduino UNO:

The Arduino UNO is an open-source microcontroller. The board has 14 Digital pins, 6 Analog pins, and programmable with the Arduino IDE (Integrated Development Environment) via a type B USB cable. It can be powered by a USB cable or by an external 9 volt battery, though it accepts voltages between 7 and 20 volts.

4. Relay:

A relay is an electrically operated switch. In this project when the relay is in the normally closed condition, buck converter operates and when the relay trips to normally open, boost converter operates. The switching process is rapid and relays output serves as the input to the battery.

IV. TECHNICAL DESCRIPTION

The sun's irradiations differ with time and also the solar panel's output varies. The controller gets its input from the panel. The voltage sensor sends the panel's voltage as a reference signal to the arduino and by that signal the relay switching takes place.

For instance, the maximum output voltage from the panel is 32 volt and the charging voltage is 24 volt, then the buck converter operates till the reference value reaches to switch to boost converter. When the irradiations from the sun are low, the panel's output is also low thus boost converter operates. We can only boost the voltage and not the current and hence the battery's charging speed is low.

As the controller uses MPPT technique the efficiency is high when compared with other local charge controllers.

V. WORKING

- The solar charge controller is connected amidst the solar panel and battery.
- When its day time, the relay is normally closed and hence buck converter operates.
- When its night time, the relay switches to normally open and hence boost converter operates.
- The duty cycle of both the converters changes with respect to time and irradiations of the sun.
- The arduino generates the PWM signal and serves as the gate pulse to MOSFETs.
- At low voltage conditions, the relays trips the battery from charging as the battery tries to draw more current at low voltage condition and thus affecting the converters.
- The LCD displays the converters output voltage and also the charge present in the battery.

VI. RATINGS & FORMULAS

Our ratings:

Solar panel rating:

Open circuit voltage: 32.4 volt

Short circuit current: 32.8 amps (Four 260watts panel in parallel)

Battery rating: Two 12volt, 150Ah battery in series.

Formulas:

Boost converter:

$D = 1 - (Vs - Vo)$ $IL = Vo * Io / Vs$

$L = Vs * D / (\Delta IL * Fs)$

Buck converter:

$D = Vo / Vs$ $L = Vo * (Vs - Vo) / (\Delta IL * Fs * Vs)$

$C = \Delta IL / (8 * Fs * \Delta Vo)$

where,

D- Duty cycle

L-Inductor value

C- Capacitor value

Vs- Input voltage

Vo- Output voltage

Fs- Switching frequency.

VII. ADVANTAGES

- Manless operation.
- Rapid switching between the converters.
- Battery charges even in monsoon climatic conditions.
- Higher efficiency.
- Low ripple because of the usage of capacitor.

VIII. DISADVANTAGES

- At night time battery's charging speed is low.
- Cannot charge when the battery is at zero voltage as it draws more current higher than the rated current that damages the components.

IX. CONCLUSION

Arbitrating, this solar charge controller is capable of charging the battery for more hours without any ripple and also maintains the charging voltage of the battery at constant.

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