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Two Axis Solar Tracking System using Arduino for Boost Converter

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ABSTRACT

The Conventional sources of energy are rapidly depleting. Moreover the cost of energy is rising and therefore photovoltaic system is a promising alternative. They are abundant, pollution free, distributed throughout the earth and recyclable. The hindrance factor is it's high installation cost and low conversion efficiency. Therefore our aim is to increase the efficiency and power output of the system. The main aim of this project is to design a solar tracker which improves the conversion efficiency of the PV system. It is also necessary that constant voltage should be supplied to the load irrespective of the variations in solar irradiance and temperature. So it is necessary to couple the PV array with a boost converter. Moreover our system is designed in such a way that with variation in load, the change in input voltage and power fed into the converter follows the open circuit characteristics of the PV array. This system can be used to supply constant stepped up voltage to dc loads. Here there are two modes of operations are done based on weather condition. They are direct and indirect modes. In direct mode tracker uses LDR sensors to move the solar panel and in indirect mode it uses RTC to move the solar panel. Arduino UNO controller is used to control the motor rotation through motor driver IC based on the information coming from RTC and LDR.

Keywords : Photo Voltaic System, Boost Converter, LDR, RTC,555 Timer.

I. INTRODUCTION

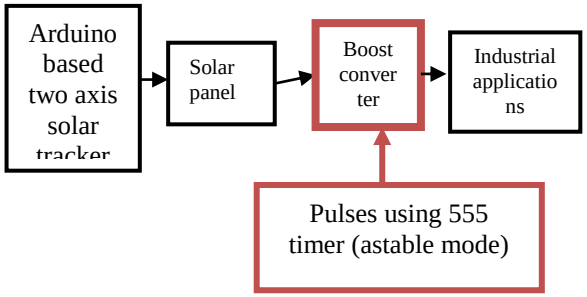
Electricity plays a key role now in our daily lives but the energy sources to electric power has been used in abundance and so researchers were compelled to find an alternate source of power leading to the discovery of solar energy. Solar energy is inexhaustible and eco-friendly and can be converted into electricity using photovoltaic panels. These panels can be used in a fixed form or used in a solar tracking system for single axis as well as for dual axis. In a fixed form their efficiency is low since the panels will be tilted in a particular angle whereas in a dual axis tracking system the panel is made to move either in single axis or dual axis. In a single axis system the panel is moved in an east to west direction with respect to the sun and it has better efficiency than panels in fixed form. But in a dual axis system the panel is made to rotate in all four directions in accordance with the sun,and dual axis tracker has more efficiency than fixed panels and single axis tracking system.

The proposed two axis solar tracking system consist Arduino UNO controller, LDR(light dependent resistors) sensors, permanent magnet D.C motors, motor driving IC, and RTC(real time clock). Arduino controller gives commands to DC motors via driver IC to change the azimuthal and altitude angles of solar panel to maintain the panel always perpendicular to sun light. Output of the solar panel is given to the

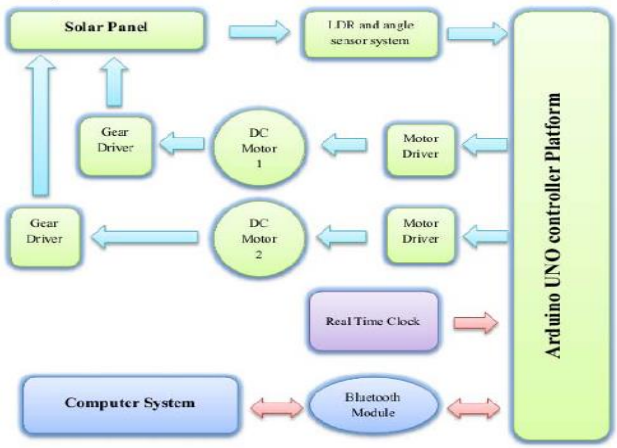
boost converter to step up the voltage level which is necessary for driving the loads. Design and Simulation of boost converter is done using MAT LAB software. Here a power MOSFET is taken as the switch which is fully controlled switch, and a 555 timer in astable mode is used to generate gate pulses for power MOSFET. 555 timer in astable mode is designed and simulated using MULTI SIM software.

II. OVERALL VIEW OF DESIGN

Here entire project is divided into two parts. They are (i) design of two axis solar tracking system and (ii) simulation of boost converter using matlab and 555 timer(astable mode) using multisim.

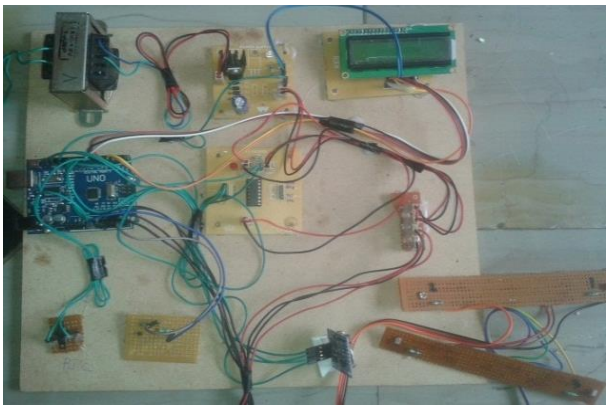


2.1. TWO AXIS SOLAR TRACKING SYSTEM :



Overall operation of tracker is divided into two parts. One is direct sensing mode and another one is indirect sensing mode. In direct sensing mode four LDRS are connected in bridge form to locate the sun location by continuous trimming of angle of inclination of solar panel. DS1307 IC(RTC) is used in indirect sensing mode. Based on the time input from RTC, arduino rotates the motors according to coding we have written for this mode.

A.Hard ware setup of controller:



Controller is the heart of the entire design. Here a centre tapped transformer (230/12-0-12) is used. This 12 volts is given to the diode bridge rectifier to get the dc voltage from ac supply input.12 volts from bridge rectifiers is reduced to 5 volts by using voltage regulator(7805). Dc voltage is necessary to operate the motor driver IC(L293D), LDR, RTC and arduino.

B. Mechanical structure of tracker:

Mechanical structure of the tracker is shown in above figure. Here two brushless dc motors are used. One

motor is to vary the altitude angle of the solar panel which connected left side in the figure. Another motor is to vary azimuthal angle of the solar panel which is connected at the bottom of the structure. These motors are driven by the motor driver IC(L293D) which takes input from arduino uno controller.

2.2. SIMULATION OF BOOST CONVERTER AND 555 TIMER (ASTABLE MODE):

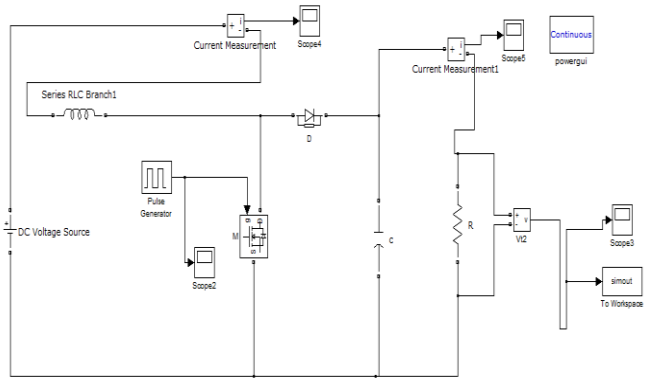
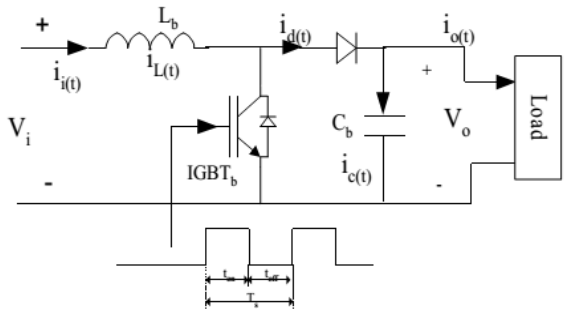


Figure (1) : simulation diagram of boost converter

2.2.1. BOOST CONVERTER DESIGN:

The figure above shows a step up or boost converter. It consist of a dc voltage source input V_i, inductor, switch(fully controlled switch is preferred), diode, filter capacitor, and the load resistance.

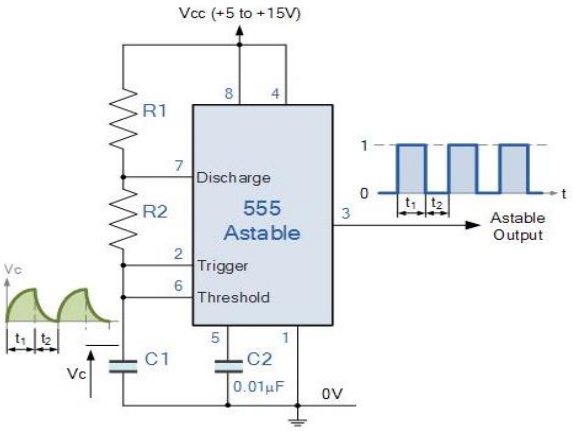


When the switch is ON, current flows through inductor, switch from source. Inductor does not allows sudden changes in the current flowing through it, so the current increase slowly in linear way and the diode is turn off at this time. inductor stores energy according to lenz law to oppose the cause of current changes. When the switch is OFF, diode gets turned ON, the energy stored in the inductor is summed up with source voltage and causes more voltage at the load which is more than source voltage. Output voltage of boost converter is given by

$$Vo=Vi/(1-D)$$

D=ton/T
T=total time period
T=ton+toff

2.2.2. 555 TIMER(ASTABLE MODE) DESIGN:



The 555 timer is highly stable device for generating accurate time delays or oscillations. We can operate it in three modes. They are monostable, bistable and astable mode. The output of the 555 timer in astable mode is pulses, these pulses are given to the power MOSFET as it's gate supply. The values of variable resistors and capacitor are selected according to the required frequency and duty ratio of the output pulse.

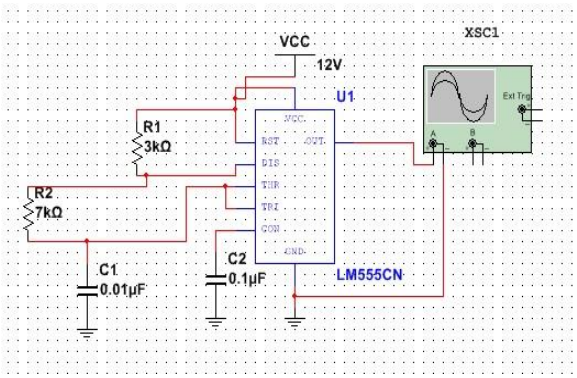
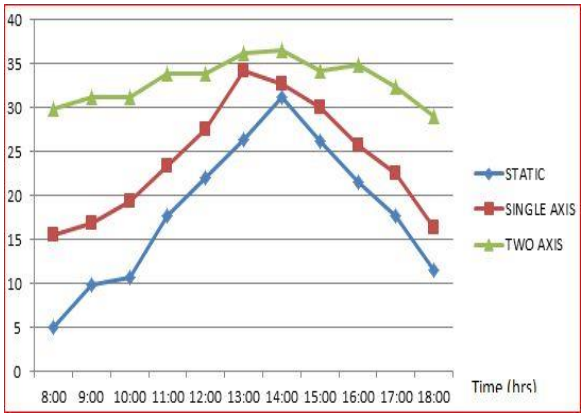


Figure 2 : simulation diagram of 555 timer (astable mode)

$$\text{Duty Cycle} = \frac{T_{ON}}{T_{OFF} + T_{ON}} = \frac{R_1 + R_2}{(R_1 + 2R_2)} \%$$

III. HARD WARE DESIGN RESULTS OF TWO AXIS SOLAR TRACKING SYSTEM:



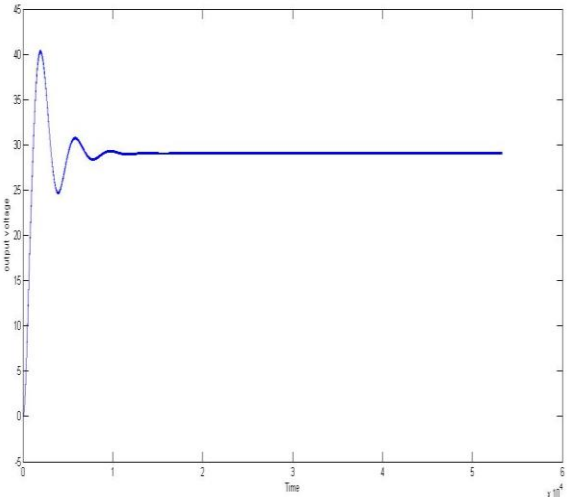
Figure(3): output power(in milli watts) versus time (in hours)

To compare the output power of fixed, single axis and two axis solar tracker, set of values are taken for each method with 1 hour interval from 08:00 AM to 06:00 PM. Average of the values is calculated, and the values obtained are 18.18 milli watts for static system, 24.03 milli watts for single axis solar tracker and 33.03 milli watts for two axis solar tracking system. Entire values are plotted as shown in above figure to show the comparison. From the obtained values the efficiency of the dual axis tracker is 81.69% more than that of fixed panel and 37.45% more than that of single axis solar tracking method.

IV. SIMULATION RESULTS OF BOOST CONVERTER AND 555 TIMER :

Using the matlab software boost converter is simulated. At first stage it is designed based on the obtained theoretical values. Set of formulas which are mentioned earlier are used to find the critical values of inductor and capacitor. Input voltage is taken as 15 volts, with 50 per cent of duty ratio, and the output I got is 30 volts as shown in figure(4).

Multisim software is used for the simulation of 555 timer in astable mode. Critical values of resistors and capacitor are designed by using the formulas discussed earlier. Values obtained with theoretical calculations are rounded off to near integer value, because of the availability of elements are in integer values only. Actually design started with an assumption of 60 per cent duty ratio, due to rounded off values it is obtained as 58.82 per cent. The output waveform is obtained as following figure(5)



Figure(4):simulation output of boost converter

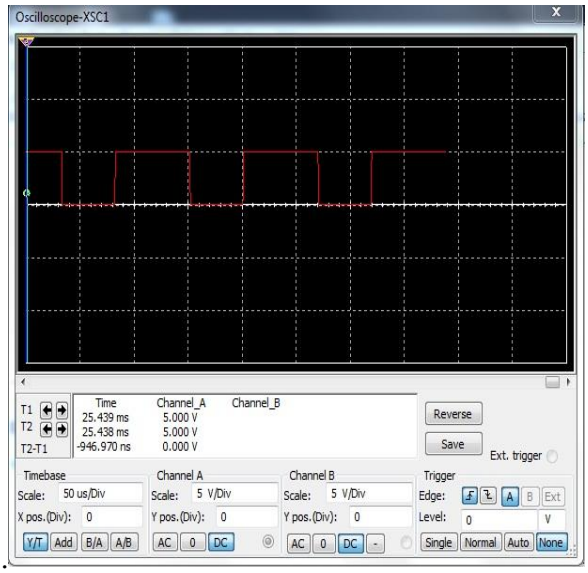


Figure 5 : Simulation output of 555 timer in astable mode

V.CONCLUSION

From the results obtained it is obvious that two axis solar tracking is best method compared to the fixed and single axis tracking solar panels. Boost converter is the best choice to increase the voltage level which is necessary for loads, and production of pulses for power switch of boost converter can be produced with minimum cost using 555 timer (astable mode). This entire design from tracking method to voltage improvement by boost is cost effective and it is best suitable for industries and educational institutes. Maximum energy extraction from solar panels can be further improved by using concave mirrors on the top side of panels.

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