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Design Of Charge Controller Using MPPT Algorithm

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ABSTRACT: *Recently non-conventional sources are in huge demand than the conventional sources of energy. Solar energy, though it is in great demand but it has low efficiency. So, to increase the efficiency of the system, we need to find the exact MPP. For this we employ a tracker called MPPT. The main aim will be to track the maximum power from the photovoltaic and feed the extracted power to the load via buck-boost converter. The purpose of this converter is to maintain the required voltage magnitude necessary for the load. In this paper, I have used P&O Algorithm to get the maximum power point and for efficiently designing the charge controller.*
Keywords: *Solar PV panel, MPPT algorithm, Charge controller*

I. INTRODUCTION

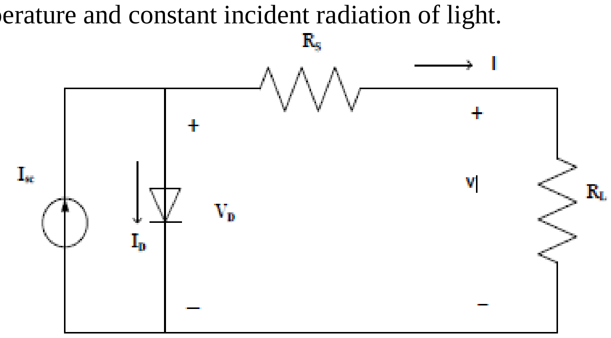
In order to tackle the present energy crisis it is necessary to develop an efficient manner in which power has to be extracted from the incoming solar radiation. The use of the newest power control mechanisms called the Maximum Power Point Tracking (MPPT) algorithms has led to the increase in the efficiency of operation of the solar modules and thus is effective in the field of utilization of renewable sources of energy and other useful applications. In this research my aim is to design a solar charge controller using MPPT Algorithm. The MPPT works on certain algorithm to maintain the constant peak power throughout the application.A PV system when equipped with an MPPT system, it includes a solar panel, an MPPT algorithm, and a DC-DC converter.

II. LITERATURE STUDY

SOLAR PV PANEL

A solar panel is a packaged connected assembly of photovoltaic cells. The solar panel can be used as a component of a larger photovoltaic system to generate and supply electricity in commercial and residential applications.Solar panels use light energy photon from the sun to generate electricity through the photovoltaic effect. Light which shines on a PV cell, may be reflected, absorbed, or passed through; however, only absorbed light generates electricity.

The use of equivalent electric circuit makes it possible to model characteristics of a PV cell. The PV model consists of a current source (Isc), a diode (D) and a series resistance (Rs). The effect of parallel resistance (Rp), represents the leakage resistance of the cell is very small in a single module, thus the model does not include it. The current source represents the current generated by photons (Iph), and its output is constant under constant temperature and constant incident radiation of light.



The current-voltage relationship of a PV cell is given below:

$$I = I_{SC}\text{-}I_D$$

$$I_D = I_S[\frac{qV_D}{e^{nKT}} - 1].$$

Combining these equations,

$$I = I_{sc}\text{-}I_s[\frac{qV_D}{e^{nKT}} - 1].$$

Where, I= output current (A)

q= electron charge ($1.6\text{x}10^{-19}$C)

k= boltzmann's constant ($1.381\text{x}10^{-23}$ J/K)

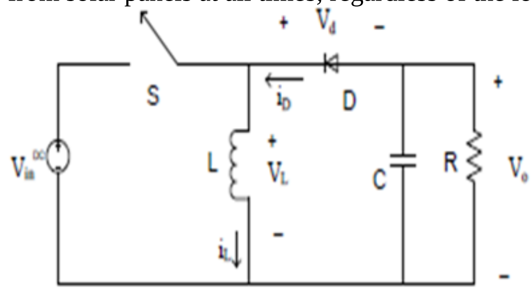
T= junction temperature (K)

n= diode ideality factor (1~2)

BUCK-BOOST CONVERTER

For PV system with batteries, the MPP of commercial PV module is set above the charging voltage of batteries for most combinations of irradiance and temperature. A buck converter can operate at the MPP under most conditions, but it cannot do so when the MPP goes below the battery charging voltage under a low-irradiance and high-temperature condition. Thus, the additional boost capability can slightly increase the overall efficiency.

To obtain a stable voltage from an input supply (PV cells) that is higher and lower than the output, a high efficiency and minimum ripple DC-DC converter required in the system for residential power production. Buck-boost converters make it possible to efficiently convert a DC voltage to either a lower or higher voltage. Buck-boost converters are especially useful for PV maximum power tracking purposes, where the objective is to draw maximum possible power from solar panels at all times, regardless of the load.



The basic principle of the buck–boost converter is fairly simple.

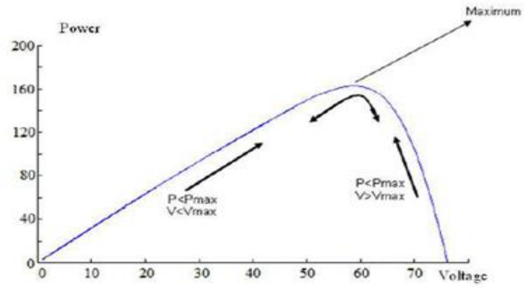
- ✓ While in the On-state, the input voltage source is directly connected to the inductor (L). This results in accumulating energy in L. In this stage, the capacitor supplies energy to the output load.
- ✓ While in the Off-state, the inductor is connected to the output load and capacitor, so energy is transferred from L to C and R.

MAXIMUM POWER POINT TRACKER

In a (Power-Voltage or current-voltage) curve of a solar panel, there is an optimum operating point such that the PV delivers the maximum possible power to the load. This unique point is the maximum power point (MPP) of solar panel. Because of the photovoltaic nature of solar panels, their current-voltage, or IV, curves depend on temperature and irradiance levels. Therefore, the operating current and voltage which maximize power output will change with environmental conditions. As the optimum point changes with the natural conditions so it is very important to track the maximum power point (MPP) for a successful PV system. So in PV systems a maximum power point tracker (MPPT) is very much needed. In most PV systems a control algorithm, namely maximum power point tracking algorithm is utilized to have the full advantage of the PV systems. In my work I have used P&O Algorithm.

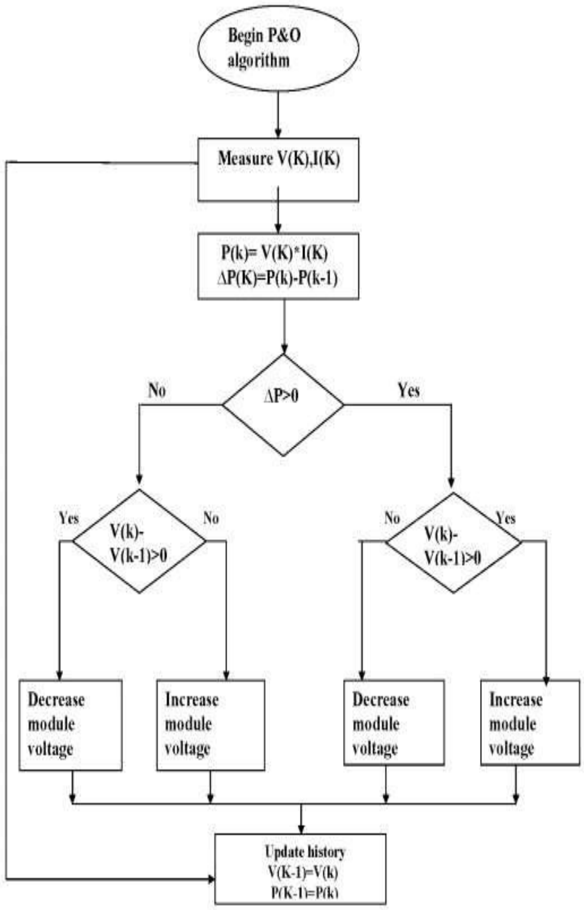
Perturb and Observe Method

In this method the controller adjusts the voltage by a small amount from the array and measures power, if the power increases, further adjustments in the direction are tried until power no longer increases. This is called P&O method.



In this algorithm the operating voltage of the PV module is perturbed by a small increment, and the resulting change of power, P is observed. If the P is positive, then it is supposed that it has moved the operating point closer to the MPP. Thus, further voltage perturbations in the same direction should move the operating point toward the MPP. If the P is negative, the operating point has moved away from the MPP, and the direction of perturbation should be reversed to move back towards the MPP.

The flowchart of this algorithm is given below:



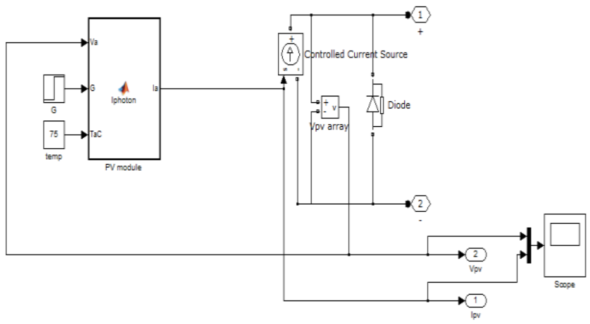
CHARGE CONTROLLER

A charge controller or charge regulator limits the rate at which electric current is added to or drawn from electric batteries. It prevents overcharging and may prevent against overvoltage, which can reduce battery performance or lifespan, and may pose a safety risk.The simple Solar Charge controller checks the battery whether it requires charging and if yes it checks the availability of solar power and starts charging the battery.The Functions of a microcontroller in charge controller are:

- ✓ Measures Solar Cell Voltage.
- ✓ Measures Battery Voltage.
- ✓ Decides when to start battery charging.
- ✓ Decides when to stop battery charging.
- ✓ Decides when to switch on the load.
- ✓ Decides when to switch odd the load.

III. III.DESIGN SIMULATION

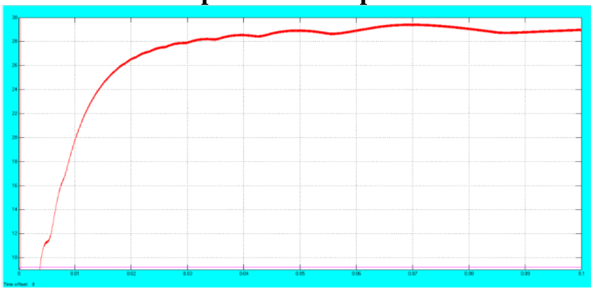
SOLAR PHOTOVOLTAIC PANEL



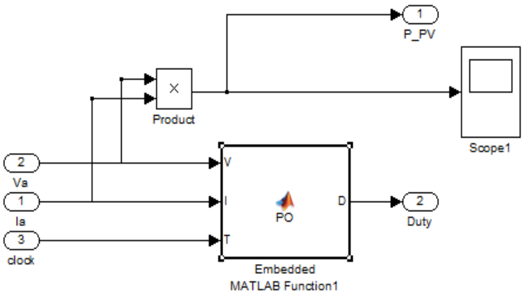
Programming:

```
function Ia=Iphoton(Va,G,TaC)
k = 1.381e-23;
q = 1.602e-19;
n = 1.3;
Eg = 1.12;
Ns = 10;
Np=6;
TrK = 298;
Voc_TrK = 37.51 /Ns;
Isc_TrK = 8.63/Np;
a = 1.33e-3;
TaK = 273 + TaC;
Vc = Va / Ns;
Isc = Isc_TrK * (1 + (a * (TaK - TrK)));
Iph = G * Isc;
 Vt_TrK = n * k * TrK / q;
 b = Eg * q /(n * k);
Ir_TrK = Isc_TrK / (exp(Voc_TrK / Vt_TrK) -1);
Ir = Ir_TrK * (TaK / TrK)^(3/n) * exp(-b * (1 / TaK -1 / TrK));
 dVdI_Voc = -2.0/Ns;
Xv = Ir_TrK / Vt_TrK * exp(Voc_TrK / Vt_TrK);
Rs = - dVdI_Voc - 1/Xv;
Vt_Ta = n * k * TaK / q;
Ia=zeros(size(Vc));
for j=1:5;
   Ia = Ia - (Iph - Ia - Ir * ( exp((Vc + Ia* Rs)/ Vt_Ta) -1))
else
   Ia= (-1 - Ir * (Rs / Vt_Ta)* exp((Vc + Ia * Rs)/ Vt_Ta));
end
Ia=Ia*Np;
end
```

Output of the PV panel:



<u>MAXIMUM POWER POINT TRACKER</u>

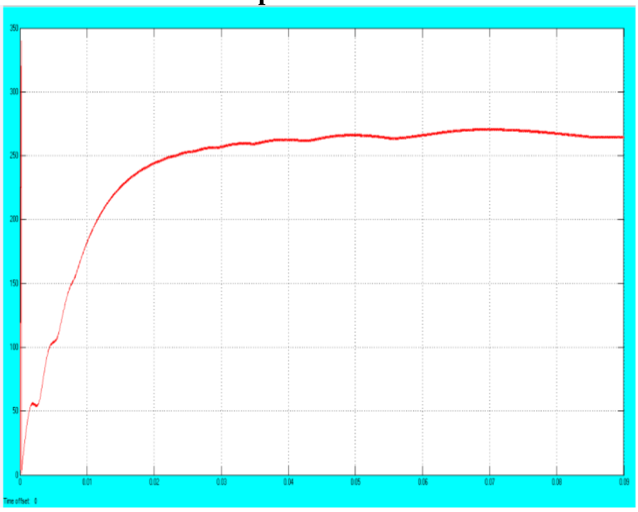


Programming:

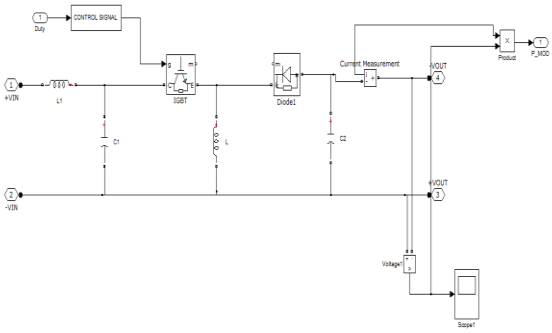
```
function D   = PO(V,I,T)
persistent P2  P1  dP d dd n;
if isempty(V)
    V=20;
end
if isempty(I)
    I=0;
end
if isempty(P2)
    P2=0;
end
if isempty(P1)
    P1=0;
end

if isempty(dP)
  dP=0;
end
if isempty(d)
    d=1;
end
if isempty(dd)
    dd=0;
end
if isempty(n)
    n=1;
end

    if  (T > n*0.02)
    n = n + 1;
    P1=P2;
    P2=V*I;
```

```
    dP=P2-P1;
    if (dd==0)
        if dP>1
            dd=0.01;
            d=d+dd;
        else
            if dP<-1
                dd=-0.01;
                d=d+dd;
            else
                dd=0;
            end
        end
    else
        if ((dP<1)&&(dP>-1))
        dd=0;
        d=d+dd;
        else
            if ((dP/dd)>0)
                dd=0.01;
                d=d+dd;
            else
                dd=-0.01;
                d=d+dd;
            end
        end
    end
    end
D=d/(d+1);
if D<0.1
    D=0.1;
    d=D/(1-D);
else
    if D>0.9
        D=0.9;
        d=D/(1-D);
    else
    end
end
end
```

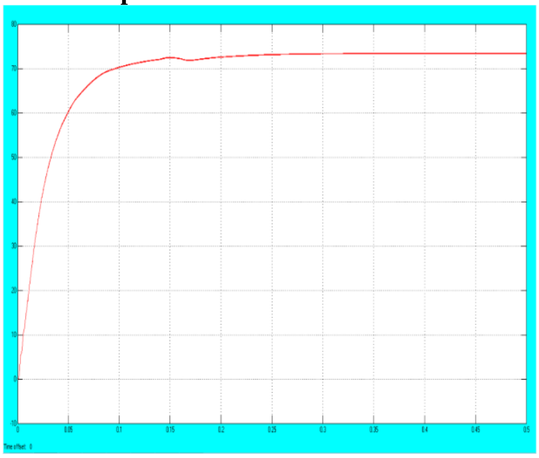
Output of MPPT:



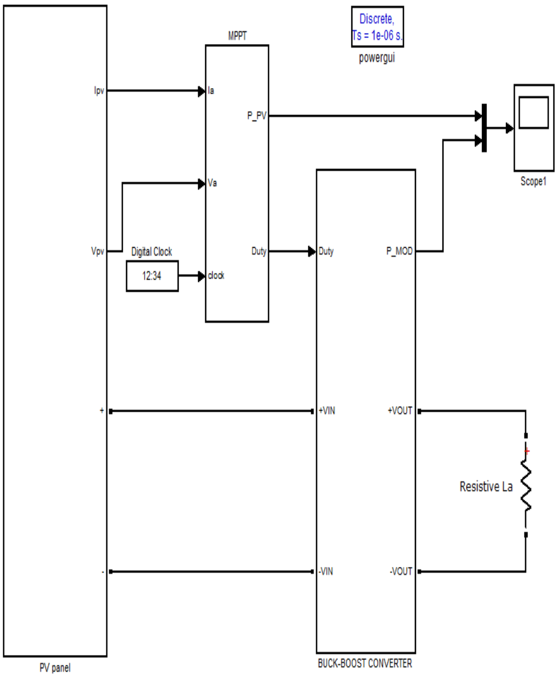
BUCK-BOOST CONVERTER



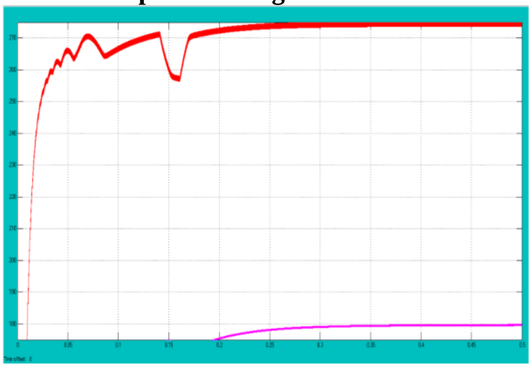
Output of Buck-Boost Converter:



CHARGE CONTROLLER



Output of Charge Controller:



IV. CONCLUSION

When the solar PV panel is directly connected to the load, the power delivered is not optimal. Moreover, solar PV power fluctuates due to variations in irradiance and temperature levels. So , it is necessary to use a maximum power point tracker in ensure minimal energy loss. Thus, an MPPT system is used to achieve the optimum or peak power under changing environmental operating conditions.

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