International Journal of Research in Engineering and Science (IJRES)
ISSN (Online): 2320-9364, ISSN (Print): 2320-9356
www.ijres.org Volume 9 Issue 5 ǁ 2021 ǁ PP. 33-37

Earth Orbit Prophylaxis – Power System Solution for Satellite Propulsion

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Abstract
This project proposal has to design a power system that incorporates the concept of maximizing the energy availability to the propulsion system for the Earth Orbit Prophylaxis EOP satellite from the connected solar module array at any time during its operation using Maximum Power Point Tracking (MPPT algorithm) using ***Incremental Conductance Perturbation Observe*** *technique. A specially designed solar panel such as perovskite PV panel will help to generate the required output voltage of 500 volts and short circuit current of 5 amps constantly even if the temperature and irradiance ranges varies with the sun co incidence on the PV panel. A current source inverter is employed to convert DC voltage to 3phase AC output voltage which is then given to the two AC motors to confirm the capability of AC output power from the inverter.*

Keywords: *Perovskite solar panel - Maximum Power Point Tracking – Incremental Conductance Perturbation Observe algorithm – DC Boost Converter – 3Phase current Source Inverter – 3Phase Output.*

Date of Submission: 27-04-2021 Date of acceptance: 11-05-2021

I. INTRODUCTION

With the greater ability of acquiring the higher efficiencies and lower the production costs, perovskite solar cells has achieved to be a commercially attractive equipment over every power generating plants and industries. It has also playing a very big role in the field of space research industries. This proposal has used perovskite PV panel to get a required output of 500volts and short circuit current of 5 amps constantly. MPPT plays a main role to maximize the power availability for the propulsion of satellite. The voltage at which PV module can produce maximum power is called maximum power point. It can vary with solar radiation and solar cell temperature. MPPT checks out PV module, compares it to a battery voltage then fixes what is the best power that PV module can produce it. the algorithm used inside the MPPT controller is the combination of both incremental conductance and perturb observe algorithm which gives a power output double times the existing. The main aim of this proposal is to produce a three phase AC output so that the propulsion for satellite can be boosted by this three phase AC output power and it is achieved by connecting three phase current source inverter that converts DC voltage into three phase AC source. Henceforth the life time of the satellite will be increased.

II. CONVENTIONAL METHOD

2.1 Synchronous Motor for propulsion in ships

The propulsion system consisted by the permanent magnet synchronous motor that has low noise, high efficiency, maintenance and gives much better performance. It consists of AC – AC converter and such a motor could be designed for unity power factor with the resulting saving in cost, weight.

III. PROPOSED SYSTEM

3.1 Synchronous Motor for propulsion in EOP satellite

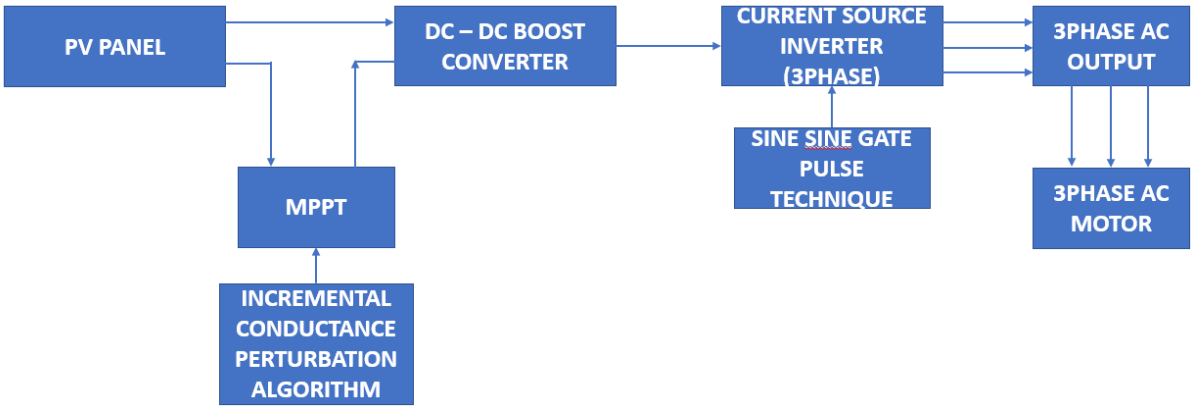
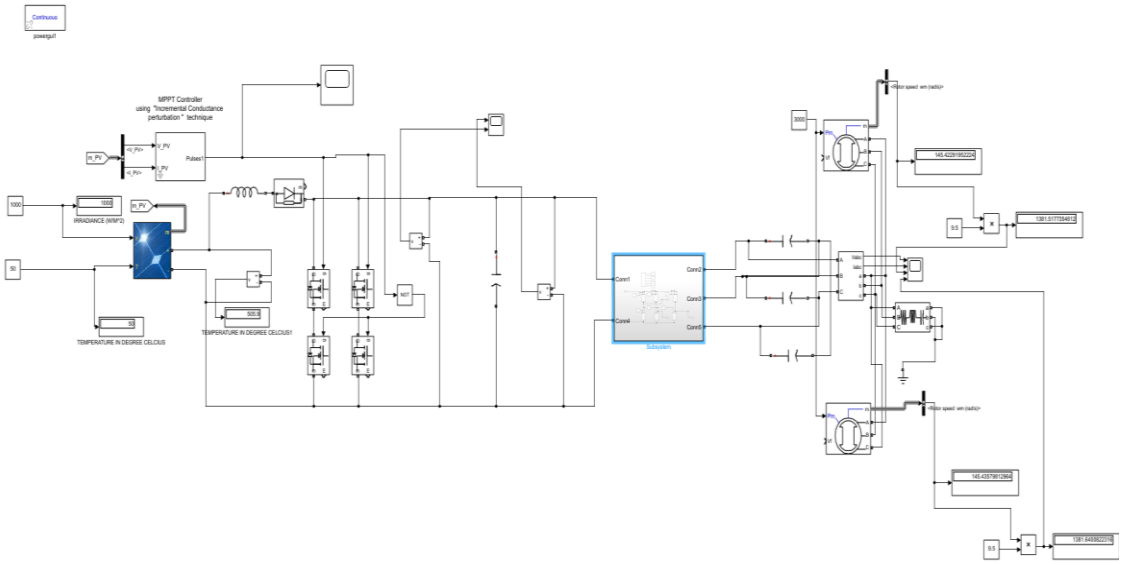


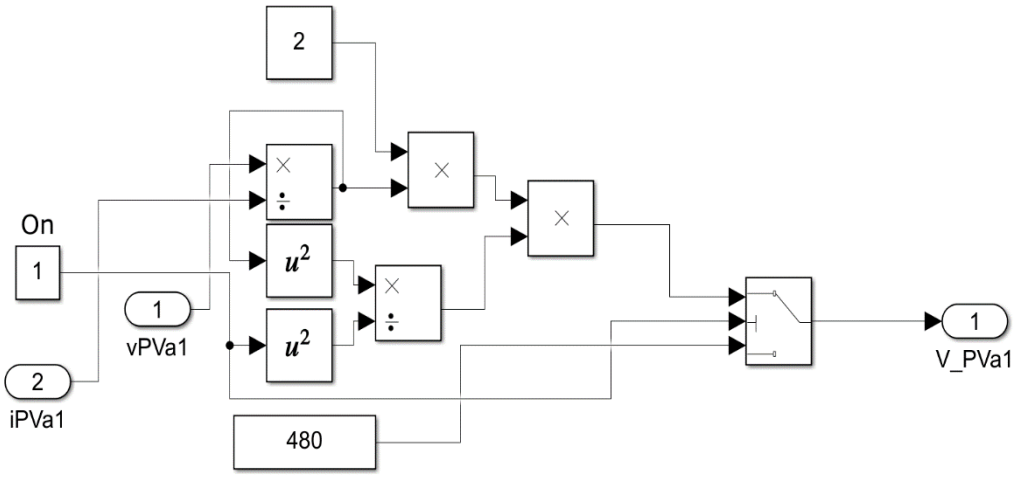
Figure I : Block diagram for proposed system

1.2 Simulation Circuit for Proposed System



The solar panel produces an output voltage of 500volts 5amps when the temperature and irradiance are measured to be 50 degree Celsius and 1000 WM^2. The output of PV is then sent to MPPT controller by means of GOTO block **m_PV**. In addition to it, the output of PV is then sent to DC - DC boost converter where the MOSFET occupies the circuit. The gate pulse is given to the MOSFET from the pulse generated by the MPPT controller. The algorithm which is designed inside the MPPT controller is the combination of both Incremental Conductance Pertubation and Observe techniques. The developed algorithm is explained briefly with the simulation circuit.

1.3 Incremental Conductance Perturbation Observe Algorithm



We know that,
P = VI – **(1)** and V = IR – **(2)**
Substitute **(2)** in **(1)**
We get $P = I^2R$
Differentiating with respect to 't' we get
$dp/dt = 2I^* (di/dt)^*R + (0)^*I^2$
$dp/dt = 2I^* (di/dt)^*R$ – **(3)**
from perturbation and Observe,
$IV = IV + \phi_s * f(s)$
Differentiating with respect to 't' we get
$(di/dt)^*V + I^*(dv/dt) = (di/dt)^*V + I^*(dv/dt) + \phi'_s * f(x) + f'(x)^*\phi_s$
$\phi'_s * f(x) + f'(x)^*\phi_s = 0$
$f(x) = P = VI \quad f'(x) = dp/dt$
we get, $(\phi'_s / \phi_s)^*VI = -(dp/dt)$
Taking MOD on both sides we get,
$dp/dt = (VI * \phi'_s) / \phi_s)$
$E = (Q / 4\pi\varepsilon_o\varepsilon_r r^2)$
As we know $Q = \phi$
$E = (\phi / 4\pi\varepsilon_o\varepsilon_r r^2)$
$\phi = E * 4\pi\varepsilon_o\varepsilon_r r^2$
$d\phi / dt = 4\pi\ \varepsilon_o\varepsilon_r\ 2r$
$\phi' = E * 4\pi\ \varepsilon_o\varepsilon_r\ 2r$
$d\phi / dt = E * 8\pi\ \varepsilon_o\varepsilon_r r$
$d\phi / dt = K.E \quad$ where $K = 8\pi\ \varepsilon_o\varepsilon_r r$
$dp/dt = (VI * K.E) / (E * 4\pi\varepsilon_o\varepsilon_r r^2)$
on solving we get
$dp/dt = (2VI / r)$
"change in power is directly proportional to 2times the product of V & I and inversely proportional to resistance."
hence the advantage of using the combined algorithm of incremental conductance perturbation observe technique.

IV. RESULTS AND DISCUSSION

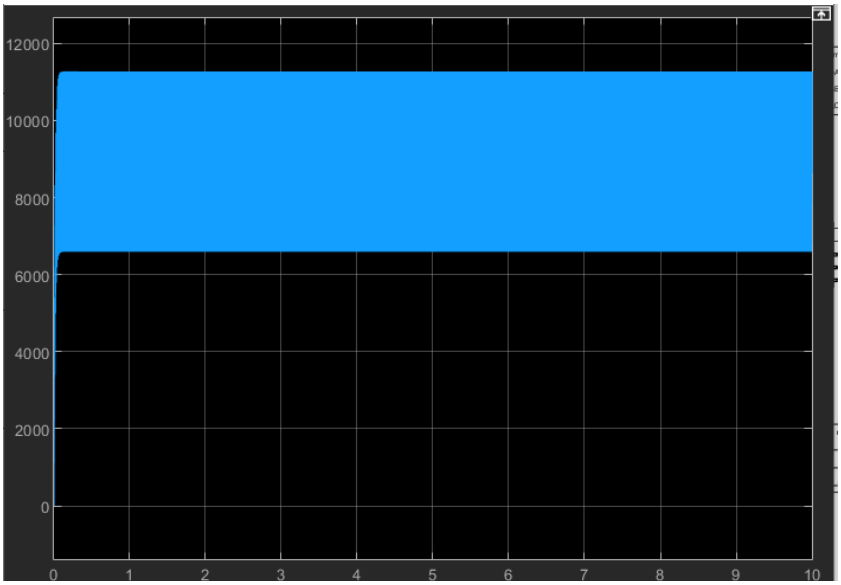


Figure 2 : Simulation Results of DC - DC boost converter

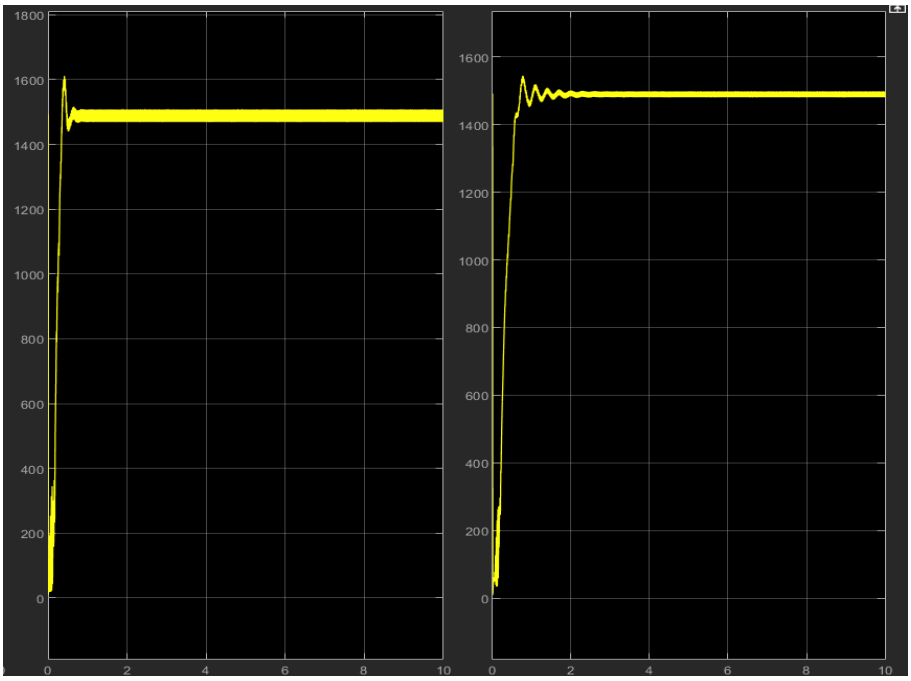


Figure 3 : Simulation Results for speed of Main and Auxillary synchronous motors

V. CONCLUSION

Hence the work has been carried over with the power system for the propulsion of the EOP payload that has paved a way to increase the energy availability to the electric propulsion system from the connected solar module array at any time during its operation using Maximum Power Point Tracking (MPPT algorithm) using Incremental Conductance Perturbation technique. The three-phase output can also be used for powering the other electrical components and devices used in the EOP satellite. The future work in this proposed system is to analyse and derivate the stability issues while using the synchronous motors to stay in orbit for satellite propulsion.

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