INTERNATIONAL JOURNAL OF TECHNO-ENGINEERING
IJTE

ISSN: 2057-5688

A NOVEL BRUSHLESS DC MOTOR WITH STANDALONE PV APPLICATION

Dr.N Lakshmi Narayana [1], G Ravi Kumar [2], J Vanaja [3]
[1] Professor, [2] Assistant Professor, [3] Associate professor
Department of Electrical and Electronics Engineering
Priyadarshini Institute of Technology & Science, Tenali,Guntur

***Abstract*— This work oversees utilization sun controlled photovoltaic (SPV) energy in brush_less DC (BLDC) motor decided water siphon. A DC-DC support converter (CONV), used as center of street power forming unit accepts an essential part in viability improvement of SPV show and sensitive start of BLDC motor with fitting control. The speed control of BLDC motor executed by PWM (Pulse Width Modulation) regulator of voltage source inverter (VSI) using DC interface voltage regulator. No additional control or current identifying part enquired for rate control. The direct of projected siphoning system shown by evaluating its various displays through MATLAB/simulink based entertainment learning.**

Keywords—PV;_BLDC; Boost_CONV; Soft_starting; PWM; VSI; Speed_control.

I.INTRODUCTION

The water siphoning developed greatest alluring utilization of SPV energy especially in distant provincial zones where power spread either practically inconceivable or inefficient if conceivable [1]. By & large, DC-DC CONV utilized for greatest force point following (MPPT) of SPV exhibit. A DC-DC buck CONV utilized in [2] for perpetual lodestone DC (PMDC) engine driven radiating siphon. A PMDC engine in spite of fact that evades one of force change stage for example VSI, lamentably it has low productivity, high support price & needs regular upkeep [3]. Then again, buck CONV fundamentally requires wave channel at its info bringing about expanded expense & size, subsequently not adjusted.

In this work, DC-DC help CONV used in MPPT of PV exhibit. The explanations for picking this CONV its natural properties least conceivable exchanging pressure, high change proficiency in view of less number parts, excellent switch usage & disposal of info swell channel since information inductor itself goes about as wave channel [4]. But three traditional DC-DC CONVs viz. buck, lift & buck-support CONV, any remaining created geographies [5] have higher number of parts bringing about effectiveness crumbling, expanded cost, weight & size. Also, these CONVs, including traditional buck-support CONV, experience ill effects

ISSN: 2057-5688

of higher weight on their capacity gadgets & exceptionally helpless switch use. These issues empower utilizing lift CONV for wanted undertaking.

In this effort, DC-DC support CONV used MPPT of PV cluster. The explanations for picking CONV are its intrinsic possessions of least conceivable exchanging pressure, high transformation proficiency due to less number parts, naturally excellent switch use & disposal of info swell channel since information inductor itself goes about as wave channel [4]. But three old style DC-DC CONVs viz. buck, lift & buck-support CONV, any remaining created geographies [5] have higher number of segments bringing about effectiveness decay, expanded cost, weight & size. Furthermore, these CONVs, including old style buck-help CONV, experience ill effects of higher weight on their capacity gadget & helpless switch usage. These issues energize utilizing a lift CONV for wanted assignment. In this work, a DC-DC support CONV utilised in MPPT of PV cluster. The explanations for picking this CONV are its innate properties of least conceivable exchanging pressure, high change productivity on account of less number of segments, excellent switch usage & disposal of info swell channel since information inductor itself goes about as wave channel [4]. But three traditional DC-DC CONVs viz. buck, lift & buck-support CONV, any remaining created geographies [5] have higher number of segments bringing about productivity crumbling, expanded cost, weight & size. What's more, these CONVs, including traditional buck-support CONV, experience ill effects of higher weight on their capacity gadgets & extremely helpless switch advantage. These issues energize utilizing lift CONV for wanted errand.

In this work, a DC-DC support CONV used in MPPT of PV cluster. The purposes for picking this CONV are its characteristic properties of least conceivable exchanging pressure, high transformation proficiency due to less number segments, generally excellent switch use & end of information swell channel since info inductor itself goes about as wave channel [4]. But three traditional DC-DC CONVs viz. buck, lift & buck-support CONV, any remaining created geographies [5] have higher number of parts bringing about the effectiveness weakening, expanded cost, heaviness and extent. Also, these CONVs, with the traditional buck-help CONV, experience the ill effects of higher weight on their capacity gadgets & extremely helpless switch use. These issues energize utilizing lift CONV for wanted undertaking.

In this work, a DC-DC support CONV used in MPPT of PV cluster. The purposes for picking this CONV are its intrinsic properties of least conceivable exchanging pressure, high transformation productivity due to less number parts, excellent switch use & end of info swell channel since information inductor itself goes about as wave channel [4]. But three

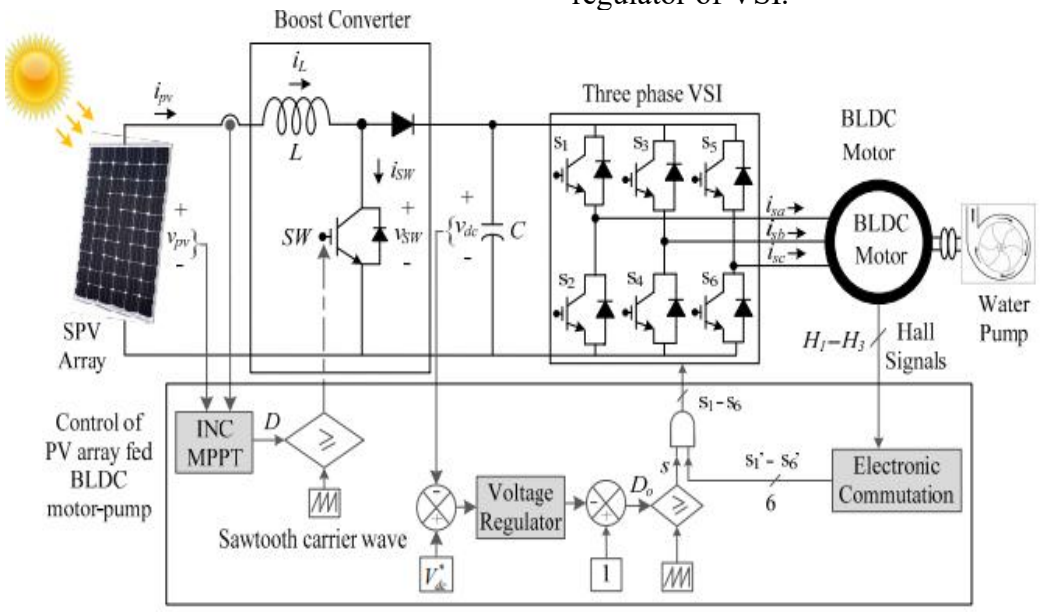
INTERNATIONAL JOURNAL OF TECHNO-ENGINEERING
IJTE
ISSN: 2057-5688

traditional DC-DC CONVs viz. buck, lift & buck-support CONV, any remaining created geographies [5] have higher number of parts bringing about proficiency disintegration, expanded cost, weight & size. What's more, these CONVs, including traditional buck-support CONV, experience ill effects of higher weight on their capacity gadgets & helpless switch usage. These issues support utilizing lift CONV for wanted errand.

In this work, a DC-DC help CONV used in MPPT of PV exhibit. The explanations for picking this CONV are its characteristic properties of least conceivable exchanging pressure, high change effectiveness due to less number of parts, awesome switch usage & disposal of information swell channel since information inductor itself goes about as wave channel [4]. But three old style DC-DC CONVs viz. buck, lift & buck-support CONV, any remaining created geographies [5] have higher number of segments bringing about proficiency decay, expanded cost, weight & size. Also, these CONVs, including old style buck-help CONV, experience ill effects of higher weight on their capacity gadgets & extremely helpless switch usage. These issues energize utilizing a lift CONV for wanted undertaking.

II.SYSTEM MODELLING

Fig.1 shows point by point schematic of proposed PV cluster took care of BLDC engine driven water siphon. This framework establishes a SPV cluster, help DC-DC CONV, VSI, BLDC engine & water siphon. A steady conductance MPPT strategy is practical for productivity upgrade of PV exhibit finished lift CONV activity. Then again, speed regulator of BLDC engine & electronic compensation achieved by PWM regulator of VSI.



ISSN: 2057-5688

Fig.1 Formation of PV array fed BLDC motor-pump

An integral encoder, straddling on BLDC engine itself, gives 3 Hall signals subsequent rotor location is additionally changed over into six heartbeats. Following segments expand plan & control philosophies of proposed framework.

A. Projected system design

The plan of projected water siphoning framework depends on choice of BLDC engine & siphon. A BLDC engine with 1.8 kW power rating is chosen, as demonstrated in Table I, & different stages viz. PV exhibit, support DC-DC CONV & water siphon needs be planned. The assessment different boundaries explained in after segments.

B.Design of SPV Array

The SPV cluster of 2.24 kWatts most extreme force assessment is chosen to take care of BLDC engine - siphon of 1.8 kWatts power assessment. The excess force from SPV cluster is needed to repay misfortunes of CONVs & engine siphon. To gauge different boundaries, SPV exhibit VOL is first thought to be as per appraised DC VOL of BLDC engine & ideal plan of lift CONV. It chosen with end goal that ideal obligation proportion at MPP is at its base conceivable worth, which brings about an excellent switch use, decreased VOL & current weight on force gadgets, diminished current rating of inductor level of 1000 W/m2 is considered to plan a SPV cluster of required limit. Table II portrays assessment of its boundaries.

C. Strategy of Boost DC-DC CONV

The MPP VOL of SPV cluster, vpv = Vmpp = 238 Volts is helped to DC transport VOL of VSI, Vdc = 310 Volts. This offers base obligation proportion, D, bringing about benefits referenced in past segment. Table III sums up assessment of inductance, L [4] and capacitor, C [1], where fsw exchanging recurrence of lift CONV; IL is normal inductor current; ΔIL is swell substance in inductance current;

TABLE 2

SPECIFICATIONS OF BLDC MOTOR

Power, p	1.8 kW
Speed, Nr	3000 rpm
DC voltage, Vdc	310 V
Poles, P	4
Inertia, J	3.5 kg.cm^2
Current, I	5.64 A
Voltage constant, Ke	78V/krpm
Torque constant, Kt	0.74 Nm/A
Phase resistance, Rs	2.3 Ω

TABLE III

DESIGN OF SPV ARRAY

INTERNATIONAL JOURNAL OF TECHNO-ENGINEERING
IJTE
ISSN: 2057-5688

Solar pv module	
Cells	36
Module voltage	21 V
Module current	5.6 A
Module MPP voltage, Vm	17 V
Module MPP current Im	4.75 A
Solar pv array	
MPP voltage, Vmpp=Vpv	238 v
Power at MPP, Pmpp = ppv	2240 W
Current at MPP, Impp = ipv	Pmpp/Vmpp = 2240/238 = 9.4 A
Numbers of modules in series, Ns	Vmpp/Vm = 238/17 = 14
Numbers of modules in parallel, Np	Impp/Im = 9.4/4.75 = 1.98 ≈ 2

TABLE IV

DESIGN OF BOOST DC-DC CONV

Parameter	Data	value	Selectec value
D	vpv = 238 V Vpv = 310 V	0.23	0.23
L	D = 0.23 vpv = 238 V fsw = 20 kHz Np = 2 Im = 4.75 A ΔIL = 10% of IL	2.88 mH	3 mH
C	P = 4 Nr = 3000 rpm Vdc = 310 V Pmpp= 2240 W ΔVdc=2%of Vdc	309 µF	500 µF

* DC transport of VSI includes 6th symphonies segment of VSI yield VOL

ΔVdc is swell substance in capacitor VOL; Idc is normal current coursing finished DC transport of VSI; f & ω are info VOL regularities of BLDC engine in Hz & rad/second. separately. The posts of BLDC engine are meant by P, & rapidity of BLDC engine is indicated by Nr. The estimations of CONV boundaries are chosen with end goal that proposed framework performs sufficiently even at terrible climate condition too.

D. Design of Pump

The water siphon is planned based on its power rapidity qualities [1, 7, 13]

$$K_p = \frac{P}{\omega_r^3} = \frac{1800}{(2*\pi*3000/60)^3} = 5.8*10^{-5}$$

as, W/(rad/sec)^3 .....(1)

Where Kp is proportion steady & ωr means BLDC engine rapidity in rad/sec.

III.PROPOSED SYSTEM CONTROL

The controlling methods utilized at different phases of planned water siphoning framework are isolated into subsequent 3 sections.

A.MPPT of Solar PV Array

To upgrade productivity of SPV cluster, MPPT is compulsory because of mutable climate disorder. The projected framework adjusts an INC kind of MPPT strategy [2, 14-15]. This method less delicate to framework elements & clamor.

ISSN: 2057-5688

The immediate obligation proportion control is utilized on grounds that it offers great steadiness qualities & straightforwardness. The underlying obligation proportion is set as zero considering delicate turning over of engine. Similarly, irritation size is 0.001 to get decreased swing about ideal working point.

B. Electronic Commutation of Brushless (BL) DC Motor

The VSI takes care of BL-DC engine is exchanged in predefined arrangement to play out alleged hardware replacement [1, 6]. It is strategy of changing over 3 Hall signals into 6 exchanging signals, s1, - s6. The 3 Hall signals created by encoder, straddling on tube, as indicated by rotor place. The transmission of just 2 switches all at once brings about a diminished conduction misfortunes.

C. Speed Control of BL- DC Motor-Pump

PWM exchanging of VSI though controlling its DC transport VOL. As outlined in Fig. 1 orientation & detected DC transport VOL, Vdc* & vdc separately, are analyzed & mistake is gone through VOL controller which is PI regulator. Additional, yield estimation of VOL controller is contrasted & most extreme conceivable estimation of obligation proportion for example 1 to get last obligation proportion, Do. The correlation of Do and high recurrence transporter wave brings about a PWM gesture, s. At last, the PWM exchanging signals for VSI are produced by tweaking s1 , - s6 , with s utilizing & rationale.

The obligation proportion of switches of VSI, Do fluctuates subsequent variety in climate ailment, bringing about BLDC engine siphon speed control. This proposed strategy for rapidity regulator totally takes out engine current detecting components & requires just a VOL sensor at DC connects, bringing about a decreased intricacy, cost & size.

IV.SIMULATION RESULTS AND PERFORMANCE ANALYSIS

The projected water siphoning framework is re-enacted in MATLAB climate to show its beginning, consistent state & active conduct exposed to quick variety in climate conditions. This presentation, introduced in Figs. 2-7, incorporates exhibition of sunlight based PV cluster, help DC-DC CONV & brushless DC engine siphon as explained in accompanying segments. This presentation investigation shows predominant exhibition of proposed water siphoning framework.

INTERNATIONAL JOURNAL OF TECHNO-ENGINEERING
IJTE
ISSN: 2057-5688

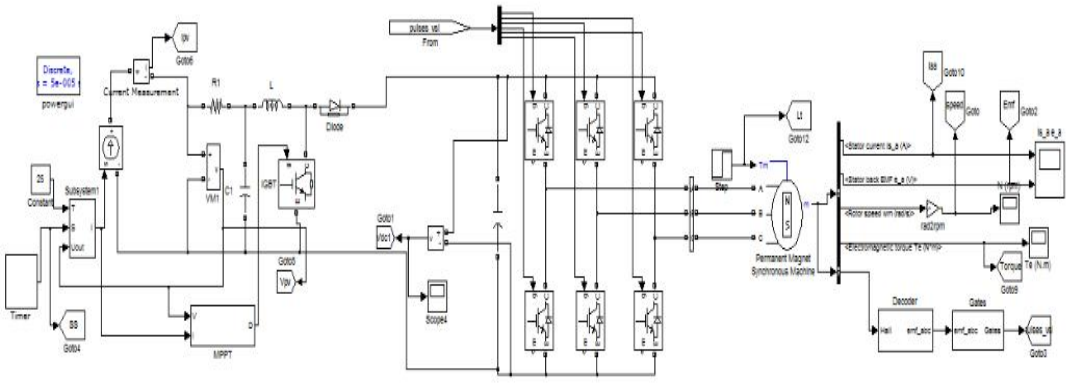


Fig:2. Simulation modelling of pv array fed bldc motor-pump.

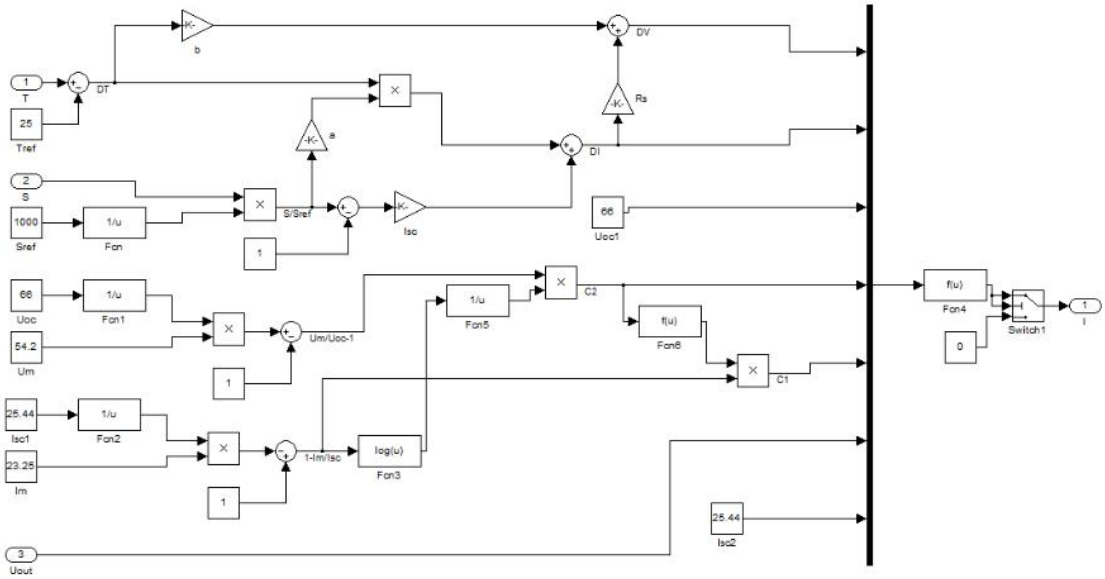


Fig: 3.Simulation modelling of pv system

INTERNATIONAL JOURNAL OF TECHNO-ENGINEERING
IJTE
ISSN: 2057-5688

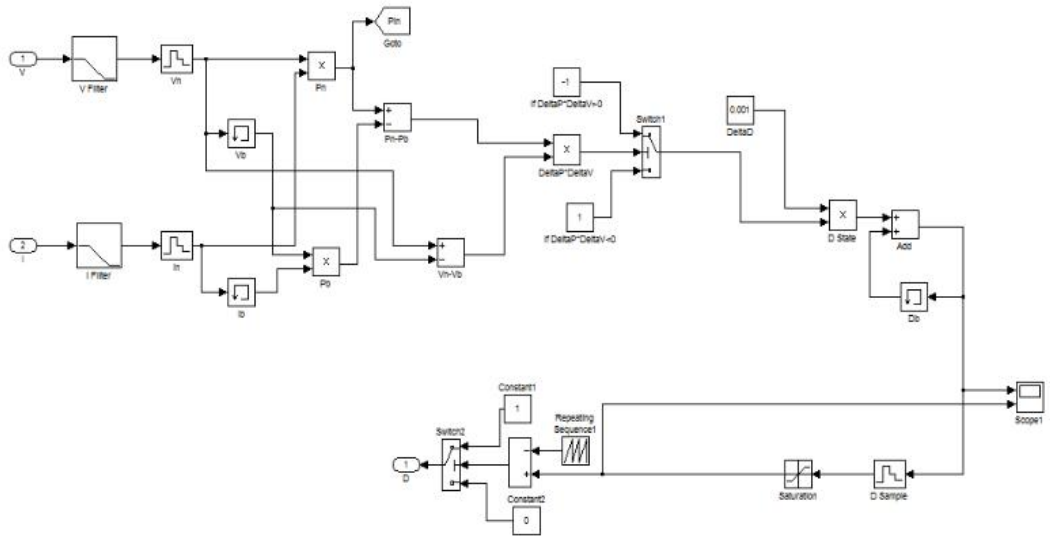


Fig: 4.Simulation modelling of mppt charge controller system

A. Preliminary and steady state presentations of projected system at 1000 w/m2

The beginning & consistent state conduct of different files of sun oriented PV exhibit, support DC-DC CONV & BL DC engine siphon introduced in Figs. 2-4 separately. As appeared in Fig. 2, MPP-SPV cluster is appropriately followed; subsequently SPV exhibit is working at 2240 Watts. The lift CONV is working in CCM & DC transport VOL of VSI is directed at three Ten Volts as appeared in Fig. 3. The pinnacle VOL weight on switch is 310 V. Additionally pinnacle current weight on switch is seen as 9.5 A. Fig. 4 shows that engine ebb & flow is restricted to passable reach at turning over & engine is consecutively at its appraised speed of 3 thousands rpm, siphoning water with occupied limit.

B. Dynamic presentation of projected system

To exhibit active conduct of projected water siphoning framework, irradiance is expanded from Two Hundred W/m2 to1000 W/m2 and decreased to Two Hundred W/m2 as appeared in Fig. 5. The SPV exhibit, independent of variety in irradiance, works at its MPP. The lift CONV works in CCM & DC transport VOL is directed at 310 V as appeared in Fig. 6. Subsequent variety in sun powered irradiance, speed of engine is controlled & engine magnets comparing current as introduced in Fig. 7. The rapidity of engine at Two Hundred W/m2 is seen as 1310 rpm, an adequate speed to siphon about measure of water.

INTERNATIONAL JOURNAL OF TECHNO-ENGINEERING
IJTE
ISSN: 2057-5688

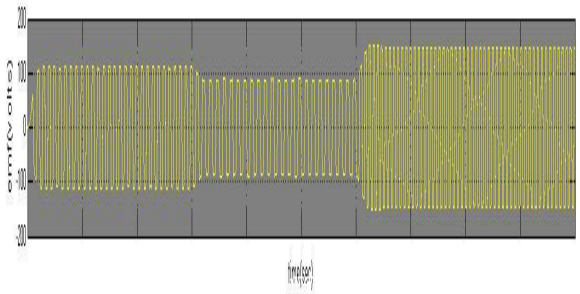


Fig:5. Simulation results for back emf of bldc motor operated with pv.

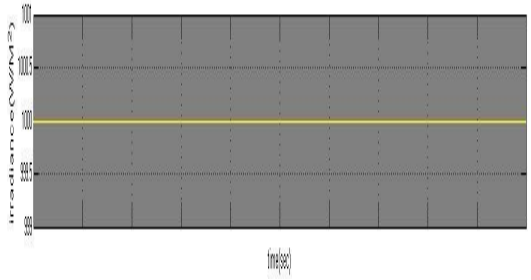


Fig: 6.Simulation results for irradiance apply to the pv cells

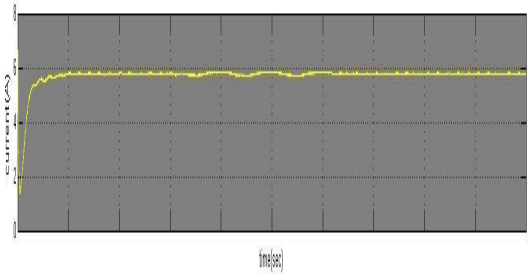


Fig: 7.Simulation results for output current from pv cell

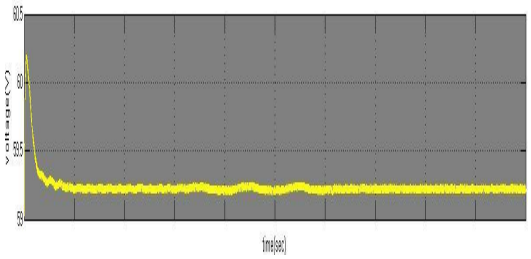


Fig:8. Simulation results for output VOL from pv cell

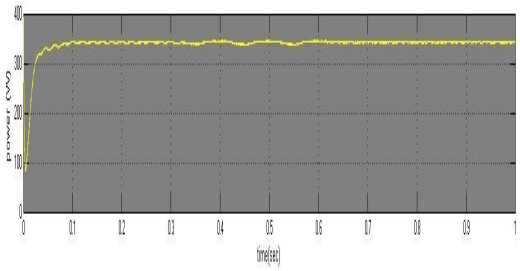


Fig:9. Simulation results for power from pv cell

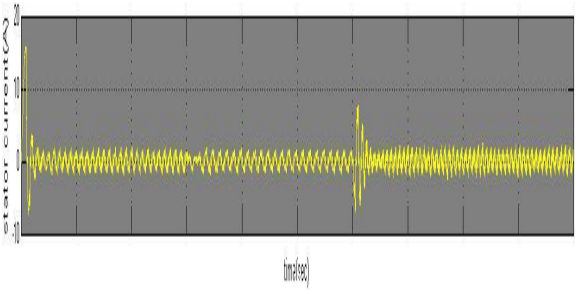


Fig: 10. Simulation results for stator currents induced in bldc motor

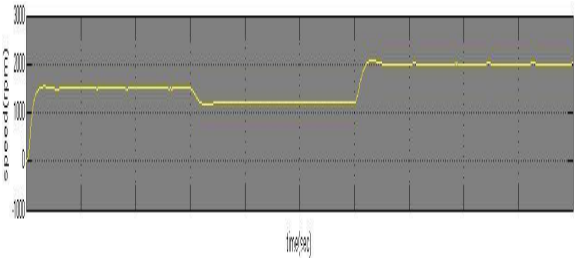


Fig: 11. Simulation results for the speed of bldc motor

INTERNATIONAL JOURNAL OF TECHNO-ENGINEERING
IJTE
ISSN: 2057-5688

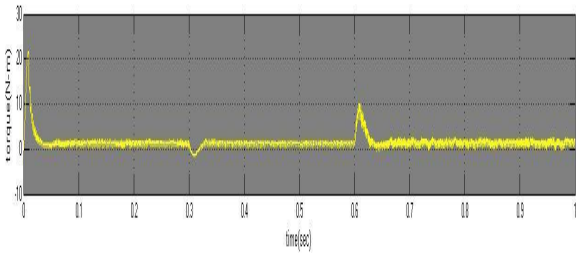


Fig: 12. Simulation results for the torque developed in bldc motor operated with pv

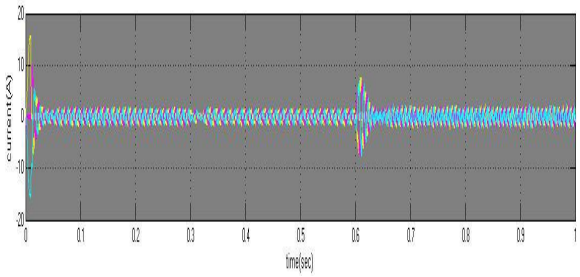


Fig: 13. Simulation results for three phase currents in bldc motor

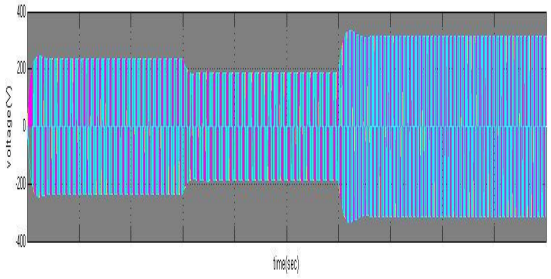


Fig: 14. Simulation results for three phase VOLs in bldc motor.

V.CONCLUSION

The SPV Array took care of lift CONV based BLDC engine driven water siphon has been projected & its appropriateness has exhibited by breaking down its different execution files utilizing MATLAB based reproduction study. A straightforward, effective & conservative technique for hurry control of BLDC engine has been proposed, which has accessible outright end of current detecting components. The precise determination of SPV exhibit has made lift CONV equipped for following MPP independent of climate conditions. An ideal plan of lift CONV has been introduced. The protected beginning of brushless DC engine has been accomplished with no extra control. The ideal presentation of projected framework even at 20% of standard sun oriented irradiance has advocated its reasonableness for sun created PV based water siphoning.

REFERENCES

[1] R. Kumarr and B. Singgh, “Solar PV arrray fed Cuku convertter-VSI contrrolled BLDCc motor drive for water pumping,” 6th IEEE Power India Int. Conf. (PIIICON), 5-7 Decem. 2014, pp. 1-7.

[2] M. A. Elgendy, B. Zahawi and D. J. Atkinson, “Assessment of the Incremental Conductance Maximum Power Point Tracking Algorithm,” IEEE Trans. Sustain. Energy, vol.4, no.1, pp.108-117, Jan. 2013.

[3] J.V. Mapurunga Caracas, G. De Carvalho Farias, L.F. Moreira Teixeira and L.A. De Souza Ribeiro, “Implementation of a High-Efficiency,

ISSN: 2057-5688

High-Lifetime, and Low-Cost Converter for an Autonomous Photovoltaic Water Pumping System," IEEE Trans. Ind. Appl., vol. 50, no. 1, pp. 631-641, Jan.-Feb. 2014.

[4] N. Mohan, T. M. Undeland and W. P. Robbins, Power Electronics: Converters, Applications and Design, 3rd ed. New Delhi, India: John Wiley & Sons Inc., 2010.

[5] M. H. Rashid, Power Electronics Handbook: Devices, Circuits, and Applications," 3rd ed. Oxford, UK: Elsevier Inc., 2011.

[6] B. Singh and V. Bist, "A BL-CSC Converter-Fed BLDC Motor Drive With Power Factor Correction," IEEE Trans. Ind. Electron., vol. 62, no. 1, pp. 172-183, Jan. 2015.

[7] M. Ouada, M.S. Meridjet and N. Talbi, "Optimization Photovoltaic Pumping System Based BLDC Using Fuzzy Logic MPPT Control," Int. Renew. Sustain. Energy Conf. (IRSEC),7-9 March 2013, pp.27-31.

[8] Rajan Kumar and Bhim Singh, "Buck-boost converter fed BLDC motor drive for solar PV array based water pumping," in IEEE International Conference on Power Electronics, Drives and Energy Systems (PEDES), 16-19 Dec. 2014, pp.1-6.

[9] Rajan Kumar and Bhim Singh, "Solar photovoltaic array fed Luo converter based BLDC motor driven water pumping system," in 9th International Conference on Industrial and Information Systems (ICIIS), 15-17 Dec. 2014, pp.1-5.

[10] Rajan Kumar and Bhim Singh, "Solar photovoltaic array fed canonical switching cell converter based BLDC motor drive for water pumping system," in Annual IEEE India Conference (INDICON), 11-13 Dec. 2014, pp.1-6.

[11] M. H. Taghvaee, M. A. M. Radzi, S. M. Moosavain, Hashim Hizam and M. Hamiruce Marhaban, "A Current and Future Study on Non-isolated DC–DC Converters for Photovoltaic Applications," Renew. Sustain. Energy Rev., vol. 17, pp. 216-227, Jan. 2013.

[12] Standard Solar PV Module Specifications [Online]. Available:http://www.hbl.in/brochures%20pdf/SOLAR%20MODULE-Broucher.pdf

[13] W.V. Jones, "Motor Selection Made Easy: Choosing the Right Motor for Centrifugal Pump Applications,"