ZVS BASED DC-DC BOOST CONVERTER FED DC SERVO DRIVE

[1] Dr.T.Govindaraj and [2] Senthil kumar.A

[1] Professor and Head, [2] M.E., PED Scholar

Department of EEE, Muthayammal Engineering College,Rasipuram,India

Abstract-A non isolated high step-up DC-DC converter using zero voltage switching (ZVS) boost integration technique (BIT) and servo motor techniques is implemented in this project. The proposed zero voltage switching boost integration technique to integrates a boost converter with a series output is designed. This method is provides many advantages such as high device utilization and improved step up capability power and switching losses is reduced and improving soft switching capability In addition DC servo motor variable speed control is obtained by using zero voltage switching (ZVS) boost integration technique (BIT) and light load frequency modulation (LLFM) control method. This method using overall conversion efficiency is improved.

***Keywords*—boost integration technique (BIT), light load frequency modulation (LLFM), high step-ratio (HSUR), zero voltage switching (ZVS), and high-intensity-discharge (HID).**

I. INTRODUCTION

Non isolated DC-DC high boost converter applications is a Electric Vehicles (EV) and grid-connected power systems and High-Intensity-Discharge (HID) is a lamps for automobile headlamps call for high-performance step-up techniques. The general approach for this classical boost converter is simple structure. The operation is the continuous input current and clamped switch voltage stress to the series output voltage. The limited step-up soft switching capability is due to the resistances the reverse recovery problem caused by a high voltage rating of the diode and the large switching losses due to the normal switching are major problem is not allowed to the high step-up ratio and efficiency. The several converter topologies the voltage conversion ability performs of operation. For an example are a voltage-multiplier and a coupled-inductor. The transformer and an output capacitor is a high boost step-up converter proposed system. It can be mainly used for diode is voltage multiplier and capacitor is an output stage in a classical boost converter the operation is the high step-up ratio without duty ratio. The output is increased to the number on stage is increased. The more capacitors and diode is used to the production circuit. It is for the snubber circuit is switching losses reduced. The mainly used for the soft switching conduction losses reduced and improved switching efficiency. A coupled-inductor working is boost converter is also a variable step-up technique is used for achieve the high efficiency and protect the switches from the high peak voltage and current. An auxiliary circuit is used for commutation purpose. The active-clamp cell in the coupled-inductor scheme is used for the eliminating this problem. This problem is reduced to fast achieve the soft switching performance. The active-clamping is the cell is pair of switches and diodes. The active-clamping presented to reduce the number of active devices and the additional resonant inductor is used in zero voltage switching operation. Become used for the auxiliary turns of a coupled-inductor is increased to raise a step-up ratio of an input current and ripple becomes more in return of coupled-inductor. Thus more input current and ripple cleared to filter circuit is needed.

II. DC-DC CONVERTER

Isolated DC-DC converters convert a DC input power source to a DC output power while maintaining isolation between the input and the output, generally allowing differences in the input-output ground potentials in the range of hundreds or thousands of volts. They can be an exception to the definition of DC-DC converters in that their output voltage is often (but not always) the same as the input voltage. A current-output DC-DC converter accepts a DC power input, and produces as its output a constant current, while the output voltage depends on the impedance of the load. The various topologies of the DC to DC converter can generate voltages higher, lower, higher and lower or negative of the input voltage; their names are:

- Buck
- Boost
- Buck boost.

III. ZERO-VOLTAGE SWITCHING BOOSTINTEGRATION TECHNIQUE

The proposed zero voltage switching (ZVS) boost integration technique (BIT) diagram is an output current is connected in series and bidirectional boost converter operation this diagram. The series output module is the current-fed type classical boost converter operation. The mainly used for the secondary rectifier is full bridge voltage doublers operation for this diagram understands of the proposed zero-voltage switching boost integration technique. And fly back converter output module is implemented for this diagram Fig.1

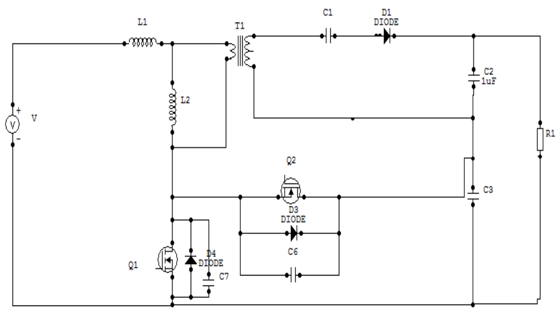

Fig.1. zero-voltage switching boost integration technique for fly back converter

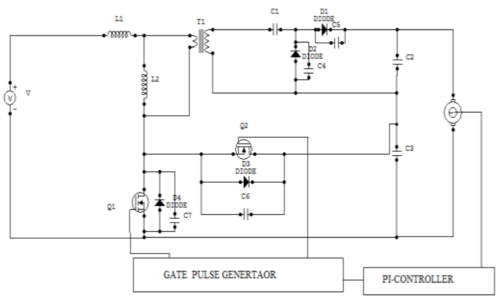

Fig.2. circuit diagram of ZVS fly back-boost converter with VDR

ZVS CONDITIONS

To achieve the ZVS of the switch Q1 is the energy stored in the leakage inductor is must be large enough to fully charge and discharge the junction capacitors of Q2 and Q1.Before The switch Q1 is turned ON. The ZVS conditions of the switch Q1 by neglecting the transformer parasitic capacitor.

HIGH STEP-UP CAPABILITY

The output capacitors are connected in series the output capacitor voltage is added. The overall output voltage can be written as:

$$V0 = V1 + V2 \qquad (1)$$

The output voltage of the converter operating is the proposed ZVS BIT is sum of the output voltages increased to the boost converter. This type of converter output is series output module is operated for high step-up applications.

IV. FLYBACK CONVERTER WITH VDR AS A SERIES OUTPUT MODULE

The proposed boost converter is designed for the zero voltage switching and boost integration method is voltage-doublers rectifier (VDR) and dc servo motor variable speed system is proposed system is this diagram is shown in Fig.2. This diagram is base on the circuit operation is voltage doublers rectifier is implemented the secondary side to output rectifier voltage stress is control. This type of VDR operation is the increase in a step-up ratio for the proposed converter. The proposed converter has the high step-up ratio capability is improved with the of both ZVS BIT methods. This method of converter is operated in the high frequency and high step-up ratio and low voltage stresses across the switches and reduced the losses in this method.

CIRCUIT OPERATION

The proposed converter is operated to the VDR method this method is operating is conventional forward converter the main switch Q1 is turned ON. The fly back-boost converter main switch Q2 is turned OFF. By using the NOT gate at the time boosting the phase Q1 is turned ON the transferred current in the transformer charges a link capacitor C1At the powering phase switch Q1 is turned OFF, C1 is discharged the C1capacitor current is can be written as:

$$R0 = (-IQ2) = ID1 \qquad (2)$$

After suing the second equation is the transformer turns ratio n is increased to the current distribution ratio at the primary side predictable and current distribution ratio is the power phase only.

Mode 1&2 operation

(t0–t1): At the time t= t0 is the transferred current from the transformer the output rectifier D1is charging the link capacitor c1 In the similar operation of the conventional forward converter is applied voltage across to the L1 inductor current is increased by using the c1 capacitor. The c1 capacitor output voltage is VC1/n. The inductorL1 current is linearly increased as follows:

$$L1(I) = {Vin - \frac{Vc1}{n}} \Big/ {L1(I)} \rightarrow (t - t0) + L1(I) \qquad (3)$$

After the second mode of this operation is (t1 –t2): At the time t = t1 is the switch Q1 is turned OFF. The current inductor L1 charges the junction capacitor of Q1 to VC1 and discharges that of Q2 to 0V in a short time interval conducting period of this operation.

Mode 3&4 operation

(t2 –t3): After time of this operation is the junction capacitor of Q1 is charged by using the VC1 capacitor at the time t = t2.The ant parallel diode of Q2 is conducted. To the no of protection circuit is required to the primary conduction loss is reduced by using the small rating power switches. The operation of the anti parallel diode is provides the zero voltage across Q2 in the next mode operation. The inductor currentL1 is linearly decreased as follows:

$$L1(I)Vin - Vc3 - (\frac{Vc1}{n}) \Big/ L1(I) \rightarrow \quad (t - t2) + L1(1) \quad (4)$$

This decreasing current in during of time t1 –t4 is also reflected to the D2 diode current ratio is the di/dt of D2 diode. This ratio is providing the D2 current snubbing effect can be reduce by the reverse recovery problem of diode D2.

After the fourth mode of this operation is (t3 -t4): At t = t3 time is turn on the switch Q2 is under ZVS conditions. The inductor currentL1 is continuously decreeing the magnetizing current L2.

Mode 5&6 operation

(t4 –t5): At the time t = t4 is the diode D2 is reverse-biased conduction of operation. The transferred the currents from transformer to charging to the junction capacitor of D2 to V2 the discharges of the diode are D1 for a short time interval mode of operation. During this period of the operation is abrupt build-up current occurs to the both at the primary and secondary sides due to the resonance between L1 inductor. The junction capacitors are acting as the secondary rectifiers this resonant current

After the sixth mode of this operation (t-t5) is completing the diode voltage transition from D2to D1 diode of operation. The diode D2 is conducted and capacitor current is discharged. The L1 inductor current is linearly decreased to zero in this condition.

Mode 7&8 operation

(t6 –t7): At the time is t = t6 is the inductor current L1 current changes from in the direction are positive to negative direction. The switch Q2 is turned OFF at the time t7. TheL1 inductor current is goes to back to the input dc source.

After the eighth mode of this operation is the time is t = t7 is the switch Q2 is turned OFF .The primary leakageL1inductor current is charges from the junction capacitor of Q2 to V1 and discharges from the switch Q1 to output load.

Mode 9&10 operation

(t8 –t9): At the time is t8 after the junction capacitor of Q2 is charged to V1 output voltage. The anti-parallel diode is conducting to the Q1. The L1 inductor current is linearly increased to the following this condition.

$$L1(I) = \frac{V1 + \frac{Vc2 - Vc1}{n}}{L1(I)}(t - t8) + L1(I) \rightarrow (t8) \qquad (5)$$

After the tenth mode of this operation is the time t = t9 is the switch Q1 is turned ON under ZVS conditions. TheL1 inductor current is increased to the magnetizing current is L2 inductor at the mode is t = t10.

STEP-UP RATIO

The step up ratio operation is the convenience to derive the step-up ratio is the operational interval is the t1 –t5 and t7 –t0. This time of interval is assumed to be zero and the ripple-free L2 inductor current is assumed. By applying the volt-second balance rules on L1 inductor current andL2 inductor I current second balance rule on capacitor C1is considering to the step-up ratio of the proposed converter can be written as:

$$M = \frac{V0}{V1} = \frac{(n+1)}{(1 - D + (2n^{2/D^2})Q} \qquad (6)$$

The boost converter operating is the overall step-up ratio M by adding the step-up ratio. The step-up ratio of the proposed converter is higher than the fly back converter. Since the overall step-up ratio M falls as Q increases is the turns ratio n and the nominal duty ratio D should be selected by considering the damping effect is Q.

$$\frac{\Delta Vc1}{Io} = \frac{n}{4DIoC1fs} \qquad (7)$$

By calculating the electric charge or discharge capacitor on C_1 and C_2 is the output voltage on the each capacitor can be derived. To calculating the dc link capacitor can be voltage ripple equation is

$$C1 = \frac{Io}{Rofs\Delta Vc1} \qquad (8)$$

V.SIMULATION RESULT

MATLAB has evolved over a period of years with input from many users. In university environments, it is the standard instructional tool for introductory and advanced courses in mathematics, engineering and science. In industry, MATLAB is the tool of choice for high productivity research, development, and analysis. MATLAB features a family of add-on application-specific solutions called toolboxes. Very important to most users of MATLAB, toolboxes allow you to learn and apply specialized technology. Toolboxes are comprehensive collections of MATLAB functions (M-files) that extend the MATLAB environment to solve particular classes of problems. Areas in which toolboxes are available include signal processing, control systems, neutral networks, fuzzy logic, wavelets, simulation, and many others.

Sim Power Systems libraries contain models of typical power equipment such as transformers, lines, machines, and power electronics. These models are proven ones coming from textbooks, and their validity is based on the experience of the Power Systems Testing and Simulation Laboratory of Hydro-Québec, a large North American utility located in Canada, and also on the experience of École de Technologies Superior and Universities Level. The capabilities of SimPowerSystems software for modeling a typical electrical system are illustrated in demonstration files. And for users who want to refresh their knowledge of power system theory, there are also self-learning case studies. The Sim Power Systems main library, powerlib, organizes its blocks into libraries according to their behavior. To open this library, type powerlib in the MATLAB Command Window. The power lib library window displays the block library icons and names. Double-click a library icon to open the library and access the blocks. The main powerlib library window also contains the Powergui block that opens a graphical user interface for the steady-state analysis of electrical circuits. The simulation circuit diagram is shown in figure

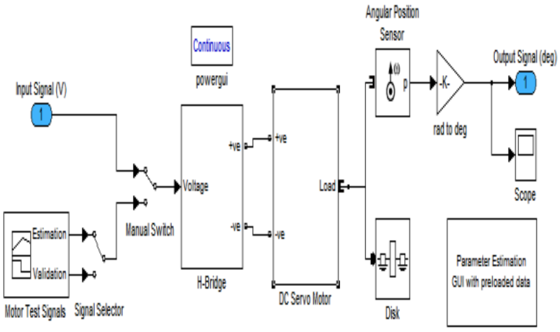

Fig.3. Servo motor model simulation circuit.

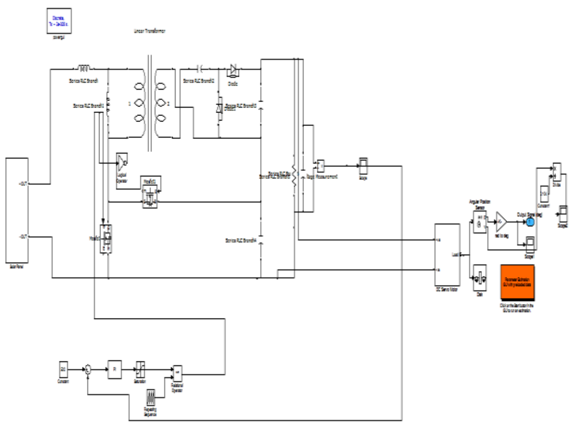

Fig.4. main converter simulation circuit.

VI.RESULTANT OUTPUT WAVEFORMS

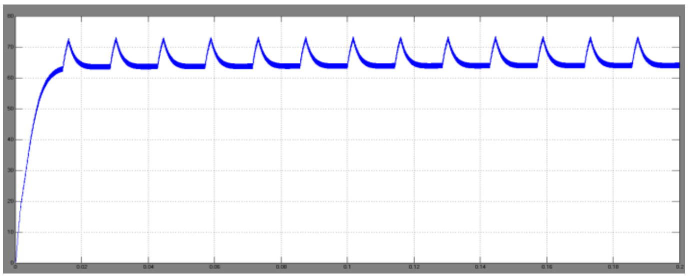

Fig.5. converter output voltage waveform.

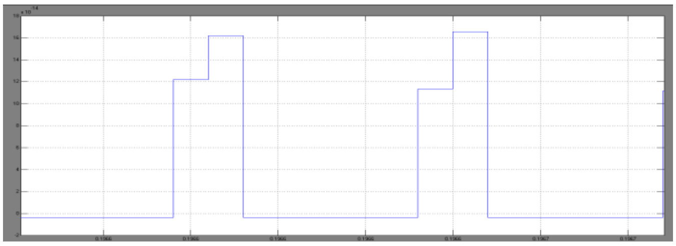

Fig.6. converter output current waveform.

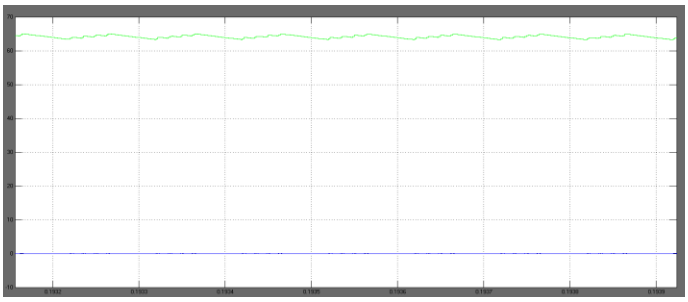

Fig.7.converter output power waveform.

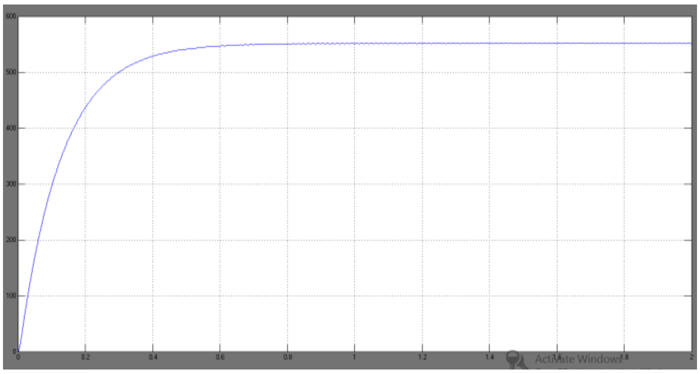

Fig.8.Dc servomotor speed wave form.

CONCLUSION

In this paper we are proposing the variable speed operation of servo motor. Due to that we can be improved the motor efficiency and also maintain constant speed reliability is good. Switching losses is reduced the compare to the other type of dc motor.the proposed topologies achieve a self-balanced voltage. This set-up is makes it possible to low on-resistance and are low cost. Because of large production volume for switching power supplies used in communications and industrial application. This is low cost and small size switches proportionate the possibility of integrating converter in essay to control the dc servo motor and to achieve the constant speed and to maintain the converter output current to reduced the converter output power losses.

REFERENCES

[1] Daniel Montesano's-Miracle, Senior Member, IEEE, Miguel Mascot-Campos, Joan Bergas-Jan´e, Senior Member, IEEE, Samuel Glycerin-Arellano, and Alfred Rufer, Fellow, IEEE,Aug.2013.

[2] O. Hejaz, J. van Merlo, and P. Latrine, "Analysis, modeling, and implementation of a multiservice interleaved DC/DC converter for fuel cell hybrid electric vehicles," IEEE Trans. Power Electron., vol. 27, no. 11, pp. 4445–4458, Nov. 2012.

[3] W. Li and X. He, "Review of no isolated high-step-up DC/DC converters in photovoltaic grid-connected applications," IEEE Trans. Ind. Electron.,vol. 58, no. 4, pp. 1239–1250, Apr. 2011.

[4] X. Fang, N. Kotuku, J. Sheen, and I. Batarseh, "Analysis of generalized parallel-series ultra capacitor shift circuits for energy storage systems," Renewable Energy, vol. 36, no. 10, pp. 2599–2604, Oct. 2011.

[5] S. Dwarf and L. Parse, "An efficient high-step-up interleaved DC-DC converter with a common active clamp," IEEE Trans. Power Electron., vol. 26, no. 1, pp. 66–78, Jan. 2011.

[6] A. Naomi, F. Zara, A. Gosh, and F. Bleiberg, "A hybrid cascade converter topology with series-connected symmetrical and asymmetrical diode clamped h-bridge cells," IEEE Trans. Power Electron., vol. 26, no. 1, pp. 51–65, Jan. 2011.

[7] J. Zhang, X. Huang, X. Wu, and Z. Quran, "A high efficiency fly back converter with new active clamp technique," IEEE Trans. Power Electron.vol. 25, no. 7, pp. 1775–1785, Jul. 2010

[8] K.-B. Park, G.-W. Moon, andM.-J.Youn, "No isolated high step-up boost converter integrated with Sepik converter," IEEE Trans. Power Electron., vol. 25, no. 9, pp. 2266–2275, Sep. 2010.

[9] W. Li, Y. Zhao, Y. Deng, and X. He, "Interleaved converter with voltage multiplier cell for high step-up and high efficiency conversion," IEEE Trans. Power Electron., vol. 25, no. 9, pp. 2397–2408, Sep. 2010.

[10] J. M. Miller, Propulsion Systems for Hybrid Vehicle (Renewable Energy Series), 2nd ed. Steven age, U.K.: Institution of Engineering and Technology, 2010.

[11] S. Base and T. M.Undeland, "Voltage and current ripple considerations for improving lifetime of ultra-capacitors used for energy buffer applications at converter inputs," in Proc. 25th Annul. IEEE Appl. Power Electron. Conf. Expo., 2010, pp. 244–247.

[12] E. Adie and H. Farzanehfard, "Zero-voltage transition current-fed full bridgePWM converter," IEEE Trans. Power Electron., vol. 24, no. 4,pp. 1041–1047, Apr. 2009.

[13] J.-M. Kwon and B.-H. Kwon, "High step-up active-clamp converter with input-current doublers and output-voltage doublers for fuel cell power systems," IEEE Trans. Power Electron. vol. 24, no. 1, pp.108–115, Jan.2009.

[14] J. Dixon, S. Bosch, C. Castillo, and M. Mura, "Ultra capacitors as unique energy storage for a city-car using five-level converter," in Proc. 35th Annul. Conf. IEEE Ind. Electron., 2009, pp. 3854–3859.

[15] W. Li and X. He, "A family of interleaved DC-DC converters deduced from a basic cell with winding-cross-coupled inductors (WCCIs) for high step-up or step-down conversions," IEEE Trans. Power Electron., vol. 23,no. 4, pp. 1791–1801, Jul. 2008.

[16] M. Prudent, L. L. Pitcher, G. Emmendoerfer, E. F. Comaneci, and R. Gules, "Voltage multiplier cells applied to non-isolated DC-DC converters," IEEE Trans. Power Electron., vol. 23, no. 2, pp.871–887, Mar.2008.

[17] E. H. Ismail, M. A. Al-Safer, A. J. Subsalt, and A. A. Far-out, "A family of single-switch PWM converters with high step-up conversion ratio,"IEEE Trans. Circuit Syst. I, vol. 55, no. 4, pp. 1159–1171, May 2008.

[18] Y.-K. Lo and J.-Y. Lin, "Active-clamping ZVS fly back converter employing two transformers," IEEE Trans. Power Electron., vol. 22, no. 6,pp. 2416–2423, Nov. 2007.

[19] Y.-K. Lo, T.-S. Kao and J.-Y. Lin, "Analysis and design of an interleaved active-clamping forward converter," IEEE Trans. Ind. Electron., vol. 54,no. 4, pp. 2323–2332, Aug. 2007.

[20]Dr.T.Govindaraj, and M. Gunasegaran," PV Micro inverter System based Electric Drive , " *International Journal Of Advanced and Innovative Research.*ISSN: 2278-7844, Dec-2012, pp 458-467.

[21**]** Govindaraj Thangavel, Debashis Chatterjee, and Ashoke K. Ganguli,"FEA based Axial Flux permanent Magnet Linear Oscillating Motor**,"** ***International Journal THE ANNALS OF "DUNAREA DE JOS" UNIVERSITY OF GALATI F ASCICLE III, ELECTROTECHNICS, ELECTRONICS, AUTOMATIC CONTROL, INFORMATICS*** , July 2010

[22] Govindaraj Thangavel, Debashis Chatterjee, and Ashoke K. Ganguli,"FEA Simulation Models based Development and Control of An Axial Flux PMLOM,"***International Journal of Modelling and Simulation of Systems***, Vol.1, Iss.1, pp.74-80, 2010

[23]Dr.T.Govindaraj, and S.Deepika, "Hybrid input Boost converter Fed BLDC Drive," *International Journal Of Advanced and Innovative Research*. ISSN: 2278-7844, Dec-2012, pp 444-451

[24]Govindaraj Thangavel, Debashis Chatterjee, and Ashoke K. Ganguli," Modelling and Simulation of Microcontroller based Permanent Magnet Linear Oscillating Motor,"*International Journal of and Modelling Simulation of Systems*, Vol.1, Iss.2, pp. 112-117, 2010

[25]Govindaraj Thangavel," Design, Development, Analysis and Control of an Axial Flux Permanent Magnet Linear Oscillating Motor suitable for short strokes using Finite Element Method," *International Journal of Electronic Engineering Research* Volume 2 Number 3 pp. 419–428, 2010

[26] Dr.T.Govindaraj, and V.Purushothaman**, "**Simulation Modeling of Inverter Controlled BLDC Drive Using Four Switch**,"** *International Journal of Advanced and Innovative Research.*ISSN: 2278-7844,Dec- 2012**,** *pp* 554-559.

[27] Govindaraj Thangavel, Debashis Chatterjee, and Ashoke K. Ganguli,"Design, Development and Control of an Axial Flux Permanent Magnet Linear Oscillating Motor using FE Magnetic Analysis Simulation Models," Int. Journal of Electrical and Electronics Engineering, Oradea, Romania, October 2010

[28] R.Narmatha and T.Govindaraj, "Inverter Dead-Time Elimination for Reducing Harmonic Distortion and Improving Power Quality", *International journal of Asian Scientific Research*, vol.3, April 2013

[29] Dr.T.Govindaraj, and A.Kanimozhi," Instantaneous Torque control of Small Inductance Brushless DC Drive,"*International Journal Of Advanced and Innovative Research.*ISSN: 2278-7844, Dec-2012 ,pp 468- 474.

[30] Dr.T.Govindaraj, and T.Keerthana," DFC And DTC Of Special Electric Drive Using PI And FLC, " *International Journal Of Advanced and Innovative Research.*ISSN: 2278-7844, Dec-2012 ,pp 475-481.

[31]Dr.T.Govindaraj, and T.Sathesh kumar, "New Efficient Bridgeless Cuk Converter Fed PMDC Drive For PFC Applications," *International Journal Of Advanced and Innovative Research.*ISSN: 2278-7844, Dec- 2012, *pp* 518-523

[32]Dr.T.Govindaraj, and B.Gokulakrishnan, "Simulation of PWM based AC/DC Converter control to improve Power Quality," *International Journal of Advanced and Innovative Research.*ISSN: 2278-7844,Dec'12, *pp* 524-533.

[33] Dr.T.Govindaraj, and M.Jagadeesh, "Resonant Converter Fed PMDC Drive Using Soft Switching Techniques," International Journal of Advanced and Innovative Research ISSN: 2278-7844, Dec-2012, pp 535-541.

[34] T.Govindaraj, Rasila R,"Development of Fuzzy Logic Controller for DC – DC Buck Converters", International Journal of Engineering Techsci Vol 2(2), 192-198, 2010

[35]Govindaraj Thangavel, Debashis Chatterjee, and Ashoke K. Ganguli," Design, Development and Finite Element Magnetic Analysis of an Axial

Flux PMLOM," *International Journal of Engineering and Technology,* Vol.2 (2), 169-175 , 2010

[36]Govindaraj Thangavel, Ashoke K. Ganguli and Debashis Chatterjee,"Dynamic modeling of direct drive axial flux PMLOM using FEM analysis" *International journal of Elixir Electrical Engineering* Vol.45 pp 8018- 8022, April 2012

Dr.Govindaraj Thangavel born in Tiruppur , India in 1964. He received the B.E. degree from Coimbatore Institute of Technology, M.E. degree from PSG College of Technology and Ph.D. from Jadavpur University, Kolkatta,India in 1987, 1993 and 2010 respectively. His Biography is included in Who's Who in Science and Engineering 2011-2012 (11th Edition). Scientific Award of Excellence 2011 from American Biographical Institute (ABI). Outstandin Scientist of the 21st century by International Biographical centre of Cambridge, England 2011.Since July 2009 he has been Professor and Head of the Department of Electrical and Electronics Engineering, Muthayammal Engineering College affiliated to Anna University, Chennai, India. His Current research interests includes Permanent magnet machines, Axial flux Linear oscillating Motor, Advanced Embedded power electronics controllers,finite element analysis of special electrical machines,Power system Engineering and Intelligent controllers.He is a Fellow of Institution of Engineers India(FIE) and Chartered Engineer (India).Senior Member of International Association of Computer Science and Information. Technology (IACSIT). Member of International Association of Engineers(IAENG), Life Member of Indian Society for Technical Education(MISTE). Ph.D. Recognized Research Supervisor for Anna University and Satyabama University Chennai. Editorial Board Member for journals like *International Journal of Computer and Electrical Engineering,*International Journal of Engineering and Technology,International Journal of Engineering and Advanced Technology (IJEAT).International Journal Peer Reviewer for Taylor &Francis International Journal "Electrical Power Components & System"United Kingdom,Journal of Electrical and Electronics Engineering Research,Journal of Engineering and Technology Research (JETR),International Journal of the Physical Sciences,Association for the Advancement of Modelling and Simulation Techniques in Enterprises,International Journal of Engineering & Computer Science (IJECS),Scientific Research and Essays,Journal of Engineering and Computer Innovation,E3 Journal of Energy Oil and Gas Research,World Academy of Science, Engineering and Technology,Journal of Electrical and Control Engineering （JECE),Applied Computational Electromagnetics Society etc.. He has published 155 research papers in International/National Conferences and Journals. Organized 40 National / International Conferences/Seminars/Workshops. Received Best paper award for ICEESPEEE 09 conference paper. Coordinator for AICTE Sponsored SDP on special Drives,2011.Coordinator for AICTE Sponsored National Seminar on Computational Intelligence Techniques in Green Energy, 2011.Chief Coordinator and Investigator for AICTE sponsored MODROBS - Modernization of Electrical Machines Laboratory. Coordinator for AICTE Sponsored International Seminar on "Power Quality Issues in Renewable Energy Sources and Hybrid Generating System", July 2013

