ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 1, January 2014

A Comparative study on different types of Integrated Boost Resonant Converters

B.Arunkumaran[1], G.Arthiraja[2], Ammal Dhanalakshmi[3] , S.Satishkumar[4]

PG Scholar, Dept of Electrical and Electronics, Jeppiaar Engineering College, Chennai, India [1,2,3]

Associate Professor, Dept of Electrical and Electronics, Jeppiaar Engineering College, Chennai, India[4]

ABSTRACT: This paper does a comparative study on different types of Integrated Boost Resonant converters like series LC, parallel LC, LLC, LCC converters. The IBR converter of different types was fed with input supply of 12 v dc from solar PV with Transformer turns ratio 1:n for Resistive loads. On this comparative study it was evaluated that the best performance was attained for Integrated Boost LCC Resonant converter , which gives high step up voltage with high efficiency. The above mentioned different configurations of IBR Converters was simulated by using MATLAB/Simulink.

Keywords: Integrated Boost Resonant (IBR), Photovoltaic (PV), Inductor (L), Capacitor (C).

I.INTRODUCTION

The Integrated Boost Resonant converter is a DC-DC Converter which has a dc input, Resonant Inverter which converts dc into ac and is given to a high step up transformer with turns ratio 1:n. The transformer does the step up in voltage and fed to a voltage doubler circuit [1]-[3] which converts ac into dc as well as doubles the voltage thus resulting in a high step up dc voltage in the output side. The different configurations of Resonant converters are series LC [4], parallel LC, LLC Resonant converter [5], LCC Resonant converter [6]-[8], and these topologies are simulated in IBR Converter with solar PV [9][10][11] as input for Resistive loads. Solar Photovoltaic cell produces dc electrical energy which is fed as input for the different IBR Converter Configurations. In the simulation, solar PV equivalent circuit is used from which the supply is given to the IBR Converter and here 12 v dc is given as input .The conventional IBR Converter [12][13]is shown in Fig1 which is modified with different Resonant topologies and analysed for Resistive loads with solar PV input source.

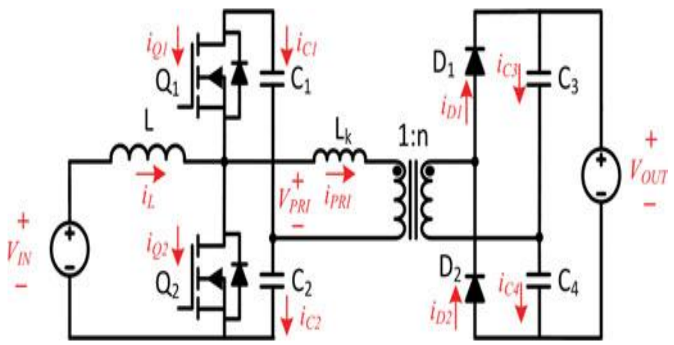

Fig 1.An Integrated Boost Resonant Converter

In recent years photovoltaic (PV) has become attractive as a result PV market would grow up to 30 GW by 2014, due to the following policy-driven scenario [13]. The generation of electricity from solar PV panel as shown in Fig 2.One type of renewable energy source is the photovoltaic (PV) cell, which converts sunlight to electrical current, without any form for mechanical or thermal interlink. Solar PV Energy has major advantages as they are Eco friendly,

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 1, January 2014

no noise, no moving parts, no emissions, no use of fuels and water, minimal maintenance requirements, Long lifetime up to 30 years. Thus Solar PV is used as the input source for the converter making this project as an Eco-Friendly one.

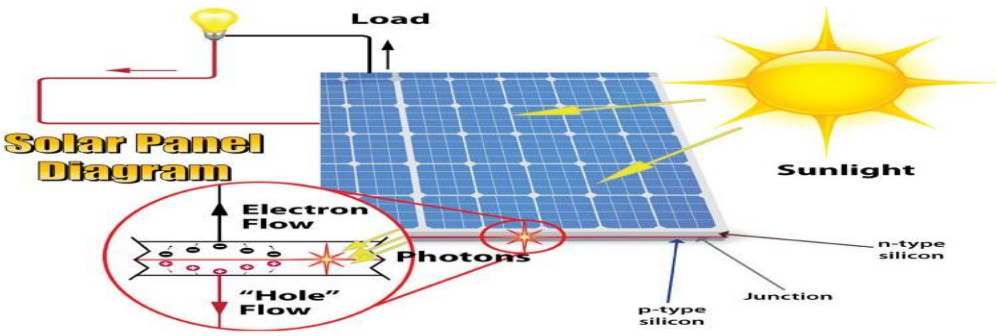

Fig 2 Production of electricity from Solar PV Panel

II.PROPOSED DIFFERENT IBR CONVERTERS

The Proposed different IBR converter configurations like IB Series LC Resonant converter, IB Parallel LC Resonant converter, IB LLC Resonant converter, IB LCC Resonant converter with Solar PV as input for Resistive loads are discussed below.

A. IB Series LC Resonant Converter:

The Integrated Boost Series LC Resonant converter Fig 3 consists of Solar PV input, boost inductor L, Series LC Resonant Inverter, high step up Transformer, Voltage Doubler Circuit and a Resistive Load Ro. In this configuration the transformer Leakage Inductance L_k and capacitor C_3 are in series forming Series LC Resonant configuration in which for 12 V dc input from Solar PV panel, the measured output voltage was 101V dc for Resistive load.

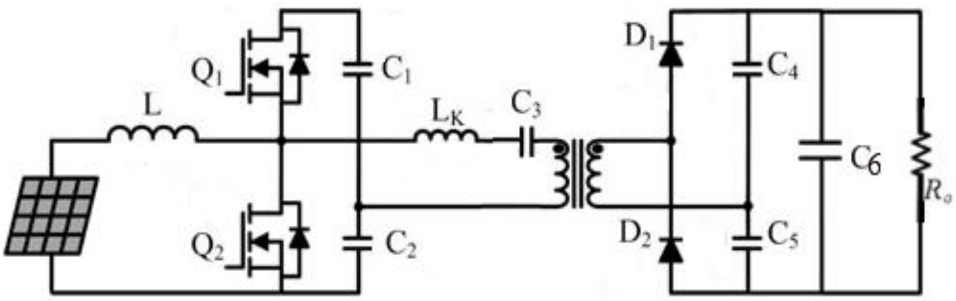

Fig 3.Integrated Boost Series LC Resonant Converter

B. IB Parallel LC Resonant Converter:

The Integrated Boost Parallel LC Resonant converter Fig 4 consists of Solar PV input, boost inductor L, Parallel LC Resonant Inverter, high step up Transformer, Voltage Doubler Circuit and a Resistive Load Ro. In this configuration the transformer Leakage Inductance L_k and capacitor C_3 are in parallel combination forming Parallel LC Resonant configuration in which for 12 V dc input from Solar PV panel, the measured output voltage was 109 V dc for Resistive load.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 1, January 2014

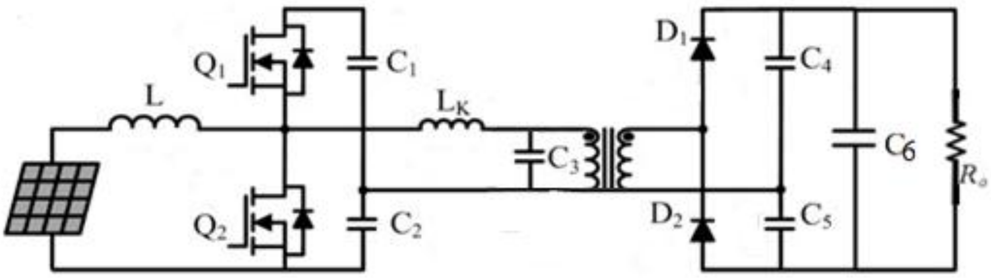

Fig 4.Integrated Boost Parallel LC Resonant Converter

C. IB LLC Resonant Converter:

The Integrated Boost LLC Resonant converter Fig 5 consists of Solar PV input, boost inductor L, LLC Resonant Inverter, high step up Transformer, Voltage Doubler Circuit and a Resistive Load Ro. In this configuration the transformer Leakage Inductance L_k ,L_2 and capacitor C_3 are in parallel combination forming LLC Resonant configuration in which for 12 V dc input from Solar PV panel, the measured output voltage was 112 V dc for Resistive load.

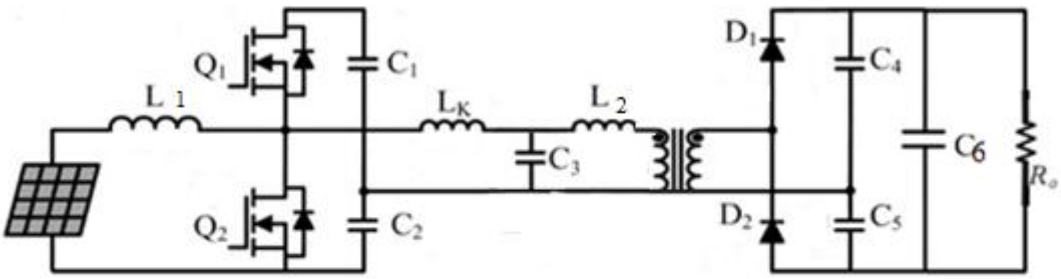

Fig 5.Integrated Boost LLC Resonant Converter

D. IB LCC Resonant Converter:

The Integrated Boost LCC Resonant converter Fig 6 consists of Solar PV input, boost inductor L, LCC Resonant Inverter, high step up Transformer, Voltage Doubler Circuit and a Resistive Load Ro. In this configuration the transformer Leakage Inductance L_k ,and capacitor C_3,C_4 are in parallel combination forming LCC Resonant configuration in which for 12 V dc input from Solar PV panel, the measured output voltage was 121 V dc for Resistive load.

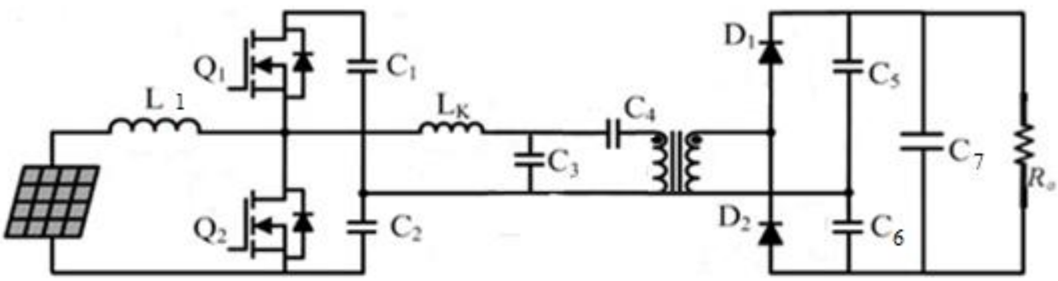

Fig 6.Integrated Boost Series LC Resonant Converter

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 1, January 2014

III.DESIGN OF PROPOSED CONVERTERS

A. *Duty Cycle:*

The total voltage gain of the circuit is given by $V_{out}/ V_{in} = n/1\text{-}D$ (1)

In this proposed converter the duty cycle is taken as 0.5. The duty cycle can be maximum or minimum and is given by

$$D_{max} = 1\text{-} T_{res1} /T_{sw} \quad (2)$$

$$D_{min} = T_{res2} /T_{sw} \quad (3)$$

B. *Determing Resonant Period Lengths:*

The Resonant periods may be calculated on the desired switching period T_{sw} using the following equations

$$T_{res1,max} = (1 - D_{max})T_{sw} \quad (4)$$

$$T_{res2,max} = D_{min} T_{sw} \quad (5)$$

C. *Design Transformer:*

The following equation can be used to calculate the necessary transformer turns ratio, *n*

$$n = n_{sec}/n_{pri} = Vout/Vin \quad (6)$$

IV.SIMULATION RESULTS AND DISCUSSION

The comparative analyses of different types of IBR Converter are simulated using MATLAB/SIMULINK Model which is discussed here. Table 1 shows the different types of IBR Converters and its corresponding input voltage and output voltage. On this comparative table it clearly shows that the Integrated Boost LCC Resonant Converter does the maximum step up voltage of 121 V yielding high Efficiency.

S.NO	IBR Converter Type	Input			Output			Efficiency
		Current	Voltage	Power	Current	Voltage	Power	
1	Conventional	5.10	12.00	61.20	0.52	98.80	51.38	83.95%
2	Series LC	5.60	12.00	67.20	0.58	101.00	58.58	87.17%
3	Parallel LC	6.80	12.00	81.60	0.66	109.00	71.94	88.16%
4	LLC	7.10	12.00	85.20	0.69	112.00	77.28	90.70%
5	LCC	7.80	12.00	93.60	0.73	121.00	88.33	94.37%

Table 1. Comparative table showing different types of IBR Converters

The Simulink model of the Integrated Boost LCC Resonant Converter as shown in Fig.7 which gives the maximum output voltage for 12V dc input from solar panel, giving maximum Efficiency. The solar PV
Equivalent Circuit as shown in the Fig.8 is used in the simulation .The output step up voltage of 121V dc is obtained as shown in Fig.9.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 1, January 2014

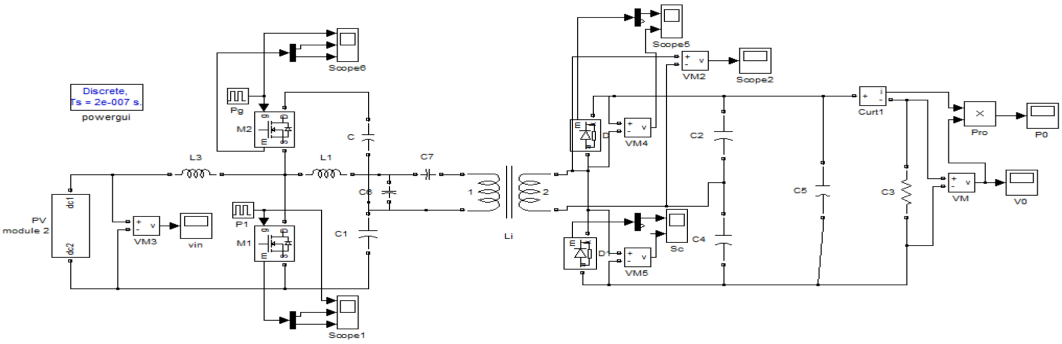

Fig .7 Simulink Model of Integrated Boost LCC Resonant Converter

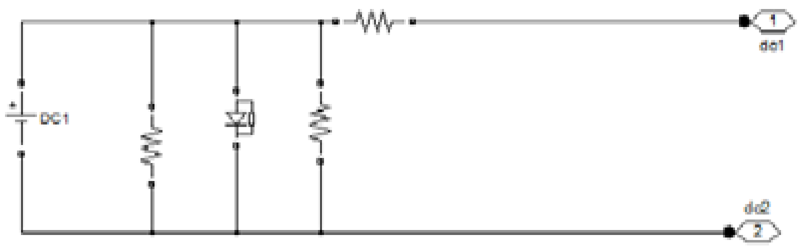

Fig .8 Solar PV Equivalent Circuit

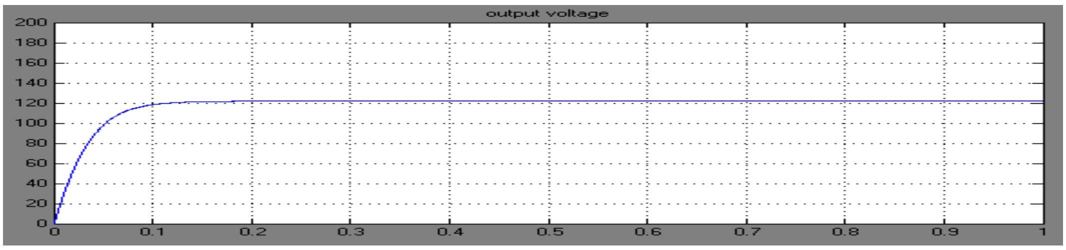

Fig 9.Output Voltage of Integrated Boost LCC Resonant Converter

The comparison graph showing the rise in the output voltage and output Efficiency for different IBR converter configurations are shown in Fig.10 and 11.For the Integrated Boost LCC Resonant converter the maximum dc output voltage was obtained.

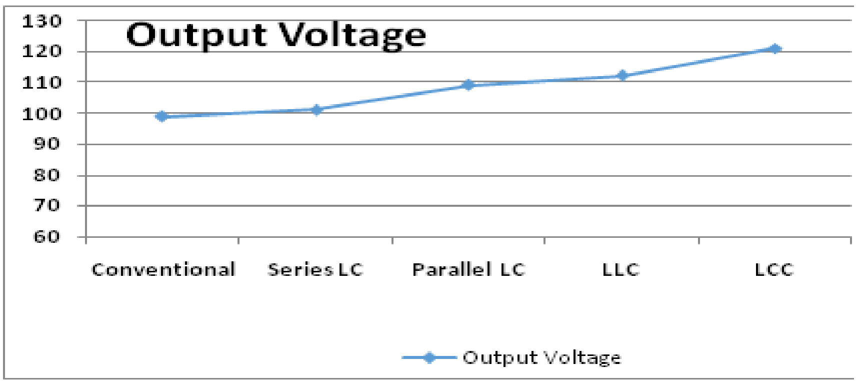

Fig 10.Output Voltage vs Different Integrated Boost Resonant Converter

IJAREEIE

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 1, January 2014

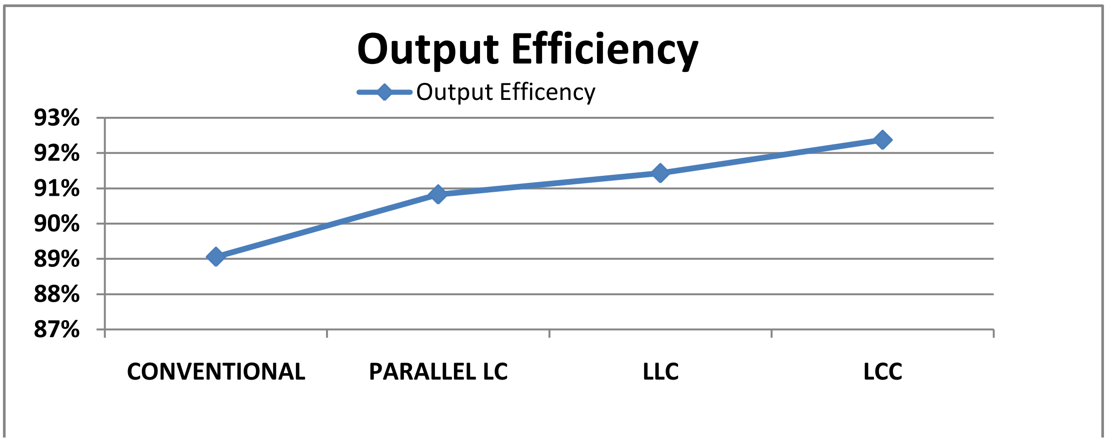

Fig.11.Output Efficiency vs Different Integrated Boost Resonant Converter

V.CONCLUSION

This paper does a comparative study of different types of IBR Converters for which the best performance was obtained for the Integrated Boost LCC Resonant Converter, giving high step up output voltage and high Efficiency for Resistive loads. The best performance IB LCC Resonant converter Simulink model and results are shown in the paper.

REFERENCES

[1] C.-E. Kim, G.-W. Moon, and S.-K. Han, "Voltage doubler rectified boost integrated half bridge (VDRBHB) converter for digital car audio amplifiers," *IEEE Trans. Power Electron.*, vol. 22, no. 6, pp. 2321–2330, Nov. 2007.
[2] . C. Yoon and S. Choi, "Multi-phase dc-dc converters using a boost half bridge cell for high voltage and high power applications," in Proc. IEEE 6th Int. Power Electron. Motion Control Conf., pp. 780–786, May 2009,
[3] X .Wang, F. Tian, and I. Batarseh, "High efficiency parallel post regulator for wide range input dc-dc converter," *IEEE Trans. Power Electron.*, vol. 23, no. 2, pp. 852–858, Mar. 2008.
[4] . C. Lippincott and R. M. Nelms, "A capacitor-charging power sup- ply using a series-resonant topology, constant on-time/variable frequency control, and zero-current switching," *IEEE Trans. Ind. Electron.*, vol. 38, no. 6, pp. 438–447, Dec. 1991.
[5] R. Beiranvand, B. Rashidian, M. R. Zolghadri, and S. M. H. Alavi, "Op- timizing the normalized dead-time and maximum switching frequency of a wide-adjustable-range LLC resonant converter," *IEEE Trans. Power Electron.*, vol. 26, no. 2, pp. 462–472, Feb. 2011.
[6] M. Youssef, J. A. Abu Qahouq, and M. Orabi," Analysis and Design of LCC Resonant Inverter for the Tranportation Systems Applications," 2010 IEEE Applied Power Electronics Conference, Feb. 2010.
[7] Zhe Li, Chun-Yoon Park, Jung-Min Kwon And Bong-Hwan Kwon," High-Power-Factor Single-Stage LCC Resonant Inverter For Liquid Crystal Display Backlight" IEEE Transactions On Industrial Electronics, Vol. 58, No. 3, March 2011.
[8] A. Bucher, T. Duerbaum, D. Kuebrich, and S. Hoehne, "Multi -resonant LCC converter - comparison of different methods for the steady-state analysis," Power Electronics Specialists Conference, 2008, pp.1891-1897.
[9] F. Max Savio, R. Hemantha Kumar and M. Sasikumar , "Power Optimisation and Performance Evolution of High Step-Up Solar PV System For Dc Drives", International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering (IJAREEIE),Vol. 2, Issue 10, October 2013.
[10] G.Arthiraja, M.AmmalDhanalakshmi, B.Arunkumaran and M. Sasikumar, "Solar PV Based Zeta Converter with Capacitor Multiplier and Coupled Inductor for DC drive Applications ", International Journal of Engineering and Technical Research (IJETR),Vol. 1, Issue 10, Dec 2013.
[11]] D. C. Martins and R. Demonti, "Photovoltaic energy processing for utility connected system," in *Proc. Ind. Electron. Soc.*, 2001, vol.no 2, pp. 1292–1296..
[12] Ben York,Wensong Yu and Jin-sheng "An Integrated Boost Resonant Converter for Photovoltaic Applications" *IEEE Trans. Power Electron.*, vol. 28, no. 3,March 2013.
[13] Ben York,Wensong Yu and Jin-sheng "Hybrid Frequency Modulation For PWM Integrated Boost Resonant Converters" *IEEE Trans. Power Electron.*, vol. 28, no. 2,Feb 2013.
[14] Global Market Outlook for Photovoltaics Until 2014, Eur. PhotovoltaicInd. Assoc. (EPIA), Brussels, Belgium, May 2010.

BIOGRAPHY

B. ArunKumaran is currently pursuing Master of Engineering in Power Electronics and Drives in Jeppiaar Engineering College, Anna University, Chennai, Tamilnadu. Earlier he received his B.E degree in Electronics and Instrumentation Engineering in Thangavelu Engineering College, Anna University, Chennai in 2011. His current research interests includes DC-DC Converters, Resonant converters, Renewable Energy Sources.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 1, January 2014

G.Arthiraja is currently pursuing Master of Engineering in Power Electronics and Drives in Jeppiaar Engineering College, Anna University, Chennai, Tamilnadu. Earlier he received his B.E degree in Electrical and electronics Engineering in Sri Sairam Engineering college, Anna University, Chennai in 2012. His current research interests include Renewable Energy Sources and DC-DC Converters.

M. Ammal Dhanalakshmi is currently pursuing Master of Engineering in Power Electronics and Drives in Jeppiaar Engineering College, Anna University, Chennai, Tamilnadu. Earlier she received her B.E degree in Electrical and Electronics Engineering in Vels Srinivasa College of Engineering, Anna University Chennai in 2009. Her current research interests include soft switching DC-DC Converters.

Mr. S.Satish Kumar has received the Bachelor degree in Electrical and Electronics Engineering The Indian Engineering College, Vadakkangulam, Kanyakumari Tamilnadu, India in 2000. He completed Master of Engineering in Power Electronics and Drives from Sathyabama University, India in 2007. Currently he is working as a Associate Professor in Jeppiaar Engineering College, Chennai Tamilnadu, India.