ANALYSIS AN INVESTIGATION ON PHOTO VOLTAIC SYSTEM STABILITY FOR GRID CONNECTED LOAD

K.K.Saravanan[1], S.A. Elankurisil[2]

[1]Assistant Professor, University College of Engineering, Panruti, Tamilnadu, India.
[2]Professor, Adhiparasakthi Engineering College, Melmaruvathur, Tamilnadu, India.
[1]e.mail: saravanan.santi@gmail.com, [2]e.mail: saelankurisil@gmail.com

Abstract-
This paper presents the inverter technology using photovoltaic system with maintain stability using dynamic voltage restorer in grid connected system. Sag and swell is maintaining at permissible level of the IEEE standard. The photo voltaic system is operated with in the small converter range. To boost the voltage using high step-up DC -DC coupled converter to reduce the losses and ripple reduction to produce high output voltage is applied in the pulse width modulation technique in the inverter circuit. To enhance the stability using dynamic voltage restorer in grid connected system. PV and DVR are very useful to reduce the voltage variation in the proposed circuit. The simulation using MATLAB gives the better result of performance of DVR technique.

Keywords: *DC–DC converter, Dynamic Voltage Restorer (DVR), Maximum Power Point Tracking (MPPT), Photovoltaic array and PI controller*

I. INTRODUCTION

Voltage reduction of power supply vary from 10% to 90% of normal value its utilisation of supply voltage is termed as sag. To sudden rise of supply voltage vary from 110% to 180% of normal value utilization of supply voltage is termed as swell. As per the IEEE standard, specification IEEE 519-1992 and IEEE 1159-1195 normally, time duration of voltage sag and swell are the range of timing is 10 ms to 1 minute [2-4]. A DC-DC converter is high step up gain using fuzzy logic controller based P&0 and MPPT algorithm has described in the PV array [1]. The review has synthesised the IEEE standard high step up DC -DC converter and versatile of inverter applying for PV and grid application. according to the circuit description to produce efficiency of 98% at full load [6].

The speciality of multilevel inverter circuit has improved the output voltage wave from in the reduction of switching losses and minimise the total harmonic distortion seven level inverter is an optional solution for grid connected system [7]. The current source inverter has utilised the voltage appear across the voltage appear across the switches during turn on and turn off. the total conduction losses have maintained constant in the entire circuit. conduction losses and switching losses analysed to evaluate the efficiency [8].

The operation principle of the converter has losses low input current ripples high voltage gain and all other salient feature are guaranteed in the high performance of grid connected system [9].The converter is controlled using DVR technique to stable the output voltage using the grid connected system the range the photo voltage system is applicable in the inverter system to reliable option of the power generation [10].This paper has described as simple phase inverter using high gain DC-DC converter for interconnected photo voltaic system to utilities the grid connected operation . to eliminate the problem of voltage across the stress in the semiconductor devices at turn off condition this converter maintain all the devices using soft switching technique as well as zero current commutation [11].

A step up DC-DC converter has analysed and review of adjustable voltage conversion ratio gives better input current and regulation this converter has raising of AC-DC, DC-AC are applying in the photo voltaic system to get better result [12]. The output voltage is regulated and sell value within the permissible limit of 5% the lord transient and steady state value has finally is reached within the value ranging from 28 us to 150 us. in this paper has evaluated the circuit best performance in term of power efficiency and load regulation [13].

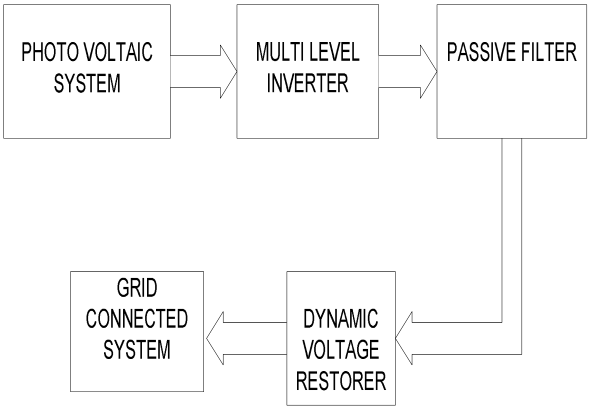

Figure 1. Block Diagram of Multilevel Inverter using DVR Technique

When the input voltage source is derived from photovoltaic module. The voltage is stored in battery bank, when the stored voltage is not sufficient to feed the full power generation. To enhance the voltage to use the high step up DC-DC converter to feed in the dynamic voltage restorer-DVR is applied to maintain the constant voltage at the load side. The series injection transformer is connected in series with the load. To compensate the voltage sag/swell is maintained with in the permissible limit. The circuit components are PV array, low DC-DC converter, battery, high DC-DC converter, series injection transformer, semiconductor switches are S_1, S_2, S_3, S_4, S_5,S_6 and S_7.The seven level inverter are more optimistic than the five level inverter. The photovoltaic array is applied to the high gain DC-DC converter is injected the power MOSFET switches are regulated by using the voltage sensor and logical function. The series injection transformer in the module of PV-DVR is reconstructed into parallel operation of the inverter function facilitate the uninterrupted power supply to the load do the duty of dynamic function in the grid connected system.

To sustain the output voltage and extend the voltage gain, in connection the function of the voltage gain extension to reduce the voltage stresses across the switches. But also achieve the soft switching operation to minimize the switching losses [14]. According to the converter circuit to reduce the switching losses of the power MOSFET to improve the converter efficiency. The passive component in the soft switching cell can be added in the suitable position [15]. To analysis and design of loss less soft switching technique in DC-DC converter. When the stress across the switches within the stress across the switches within the permissible limit and optimum efficiency can be attained [16]. Photovoltaic systems are designed to operate DC-AC inverter is independent of the electrical grid connected system various factor are analysed for the selection of super capacitor batteries for PV application. The function to regulate the charging of battery in dynamic voltage restorer controller system is used for lighting demand, flash light, solar street light, light for train parking and mountain cabins [17].

Electromagnetic interference noise is minimised appropriately compared with the conventional DC-DC converter about 5% efficiency is improved at full load generation over the conventional circuit [18]. This converter is used for high step up voltage gain to reduce the ripples in the output load side. The pulse with modulation converter is a simple and compact design. This converter has extreme advantages of better characteristic higher efficiency, higher power density and optimum component utilization [19].

The DC-DC converter a new multi loop controller has demonstrated to achieve regenerative electronic load, fast speed of response and tracking current demand [20].The high conversion ratio provides a high voltage gain without maximum switching duty cycle and enabling the utilization of low voltage converter MOSFET switches to reduce the cost, to reduce the conduction losses and reduce the switching losses [21-27].

II.Circuit description of Photovoltaic Dynamic voltage restorer

The modified circuit diagram of PV-DVR is shown in Figure 2.1.The photovoltaic array in this system consists of more number of solar cell which convert solar into electricity. The development of photovoltaic cell with MPPT algorithm to increase the electrical power corresponding to increase the efficiency. It is optimistic way of aliter method of one of the renewable energy source. The block diagram comprises PV array, modified DVR,low step up DC-DC converter in association with MPPT function as a DC voltage source is applied to the inverter of DVR.The DC link is connected between the photovoltaic array and lithium iron battery bank. In this system the photovoltaic array is generated to the solar power at the end of vary from time to time due to the weather condition. In connection the solar irradiation level and corresponding cell temperature.

The basic equation of photovoltaic array in addition to the causes of temperature and solar irradiation level based on that condition to structure the photovoltaic array.

$$|V_{inj}| = |V_{pre\text{-}sag}| - |V\ sag| \quad (2.1)$$

$$V_{DVR} = V_{inj} \quad (2.2)$$

$$|V_{DVR}| = |V_{pre\text{-}sag}| - |V\ sag| \quad (2.3)$$

The angle of the injected voltage can be calculated as follows

$$< V_{inj} = \theta_{inj} = \theta s \quad (2.4)$$

The PV cell output voltage is expressed as,

$$V_c=(AkT_c/e)\ln((I_{ph}+I_0+I_c)/I_0)-R_sI_c \quad (2.5)$$

$$V_{PV}=V_C*N_s \quad (2.6)$$

$$I_C=I_{PV}/N_p \quad (2.7)$$

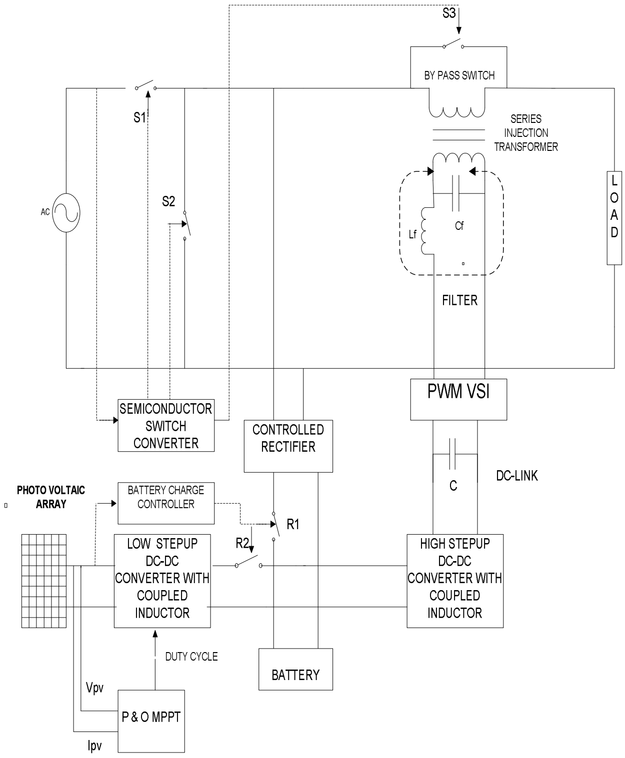

Figure 2.1. Modified circuit diagram using PV-DVR

$$C_{TV} = 1+ \beta_T (T_a - T_y) \quad (2.8)$$

$$C_{TI} = 1 + \gamma_T / S_r (T_a - T_y) \quad (2.9)$$

The supply voltage is equal to the phase angle of load voltage. Voltage sag or swell of the supply voltage depend upon the condition voltage has rise or fall less than or greater than the permissible value. The function of DVR is enacting to the sag or swell to inject the compensating voltage is equal to the supply voltage to restore the voltage at normal value. Due to the weather condition the change in ambient temperature and solar irradiation level are modelled by the temperature coefficient C_{TV} and C_{TI}. β_T is the slope of the coefficient (C_{TV}) causing the change in temperature, γ_T is a constant corresponding change in operating temperature due to the solar irradiation. Where T_a and T_y are abbreviated as ambient temperature of the cell and atmosphere. Where β_T = 0.004 and γ_T = 0.006, the two parameter can cause the effect of temperature and solar irradiation level of photovoltaic cell voltage and current.

III. Simulation Result

The simulation model diagram of modified photovoltaic array in connection with dynamic voltage restorer of power generation in the grid system using solar power non-conventional source as shown in Figure 3.1.

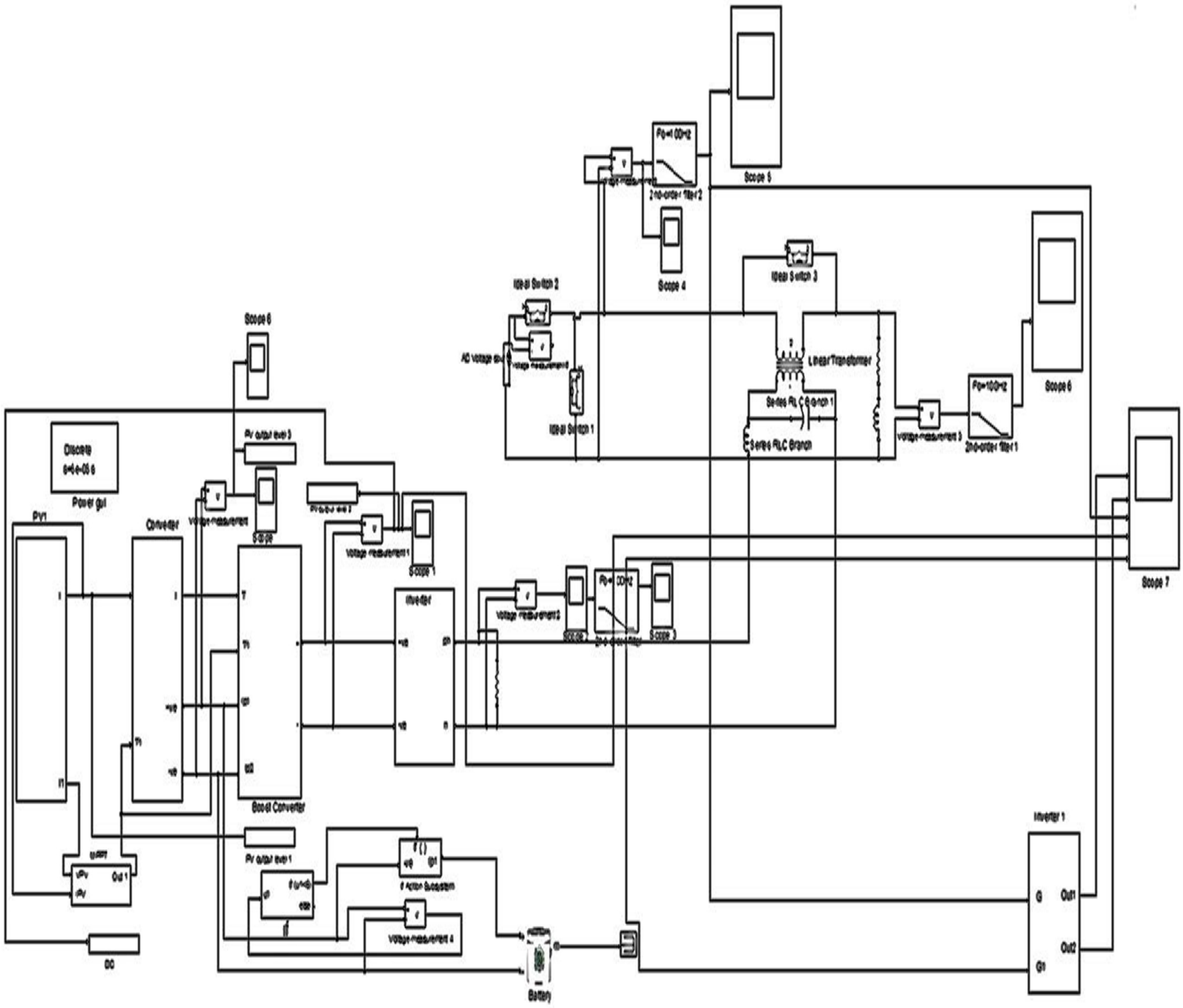

Figure 3.1. Simulink diagram of single phase PV- DVR system

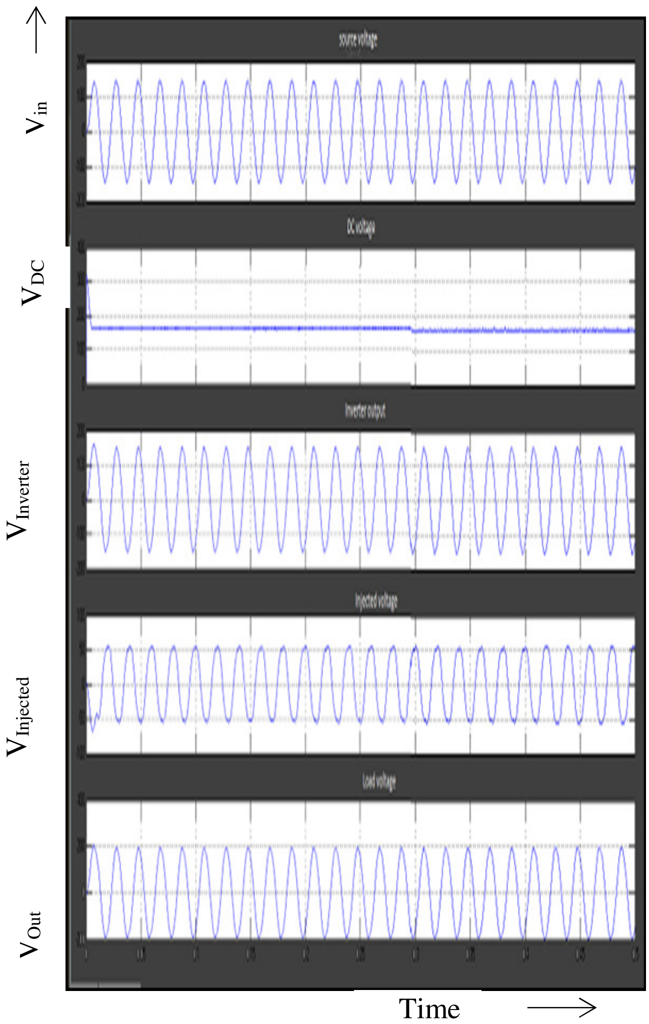

Figure 3.2. Simulation output of PV system with DVR

Table 1.Simulation parameters

Item	Parameter Value
Battery bank	2 X 24 V
PV module	12V,220W
Injection transformer	1 KVA
Filter	40 mH,25 uF
DC bus voltage	230V
Load resistance	20 Ω
Load inductance	11 mH
PI gain	0.2

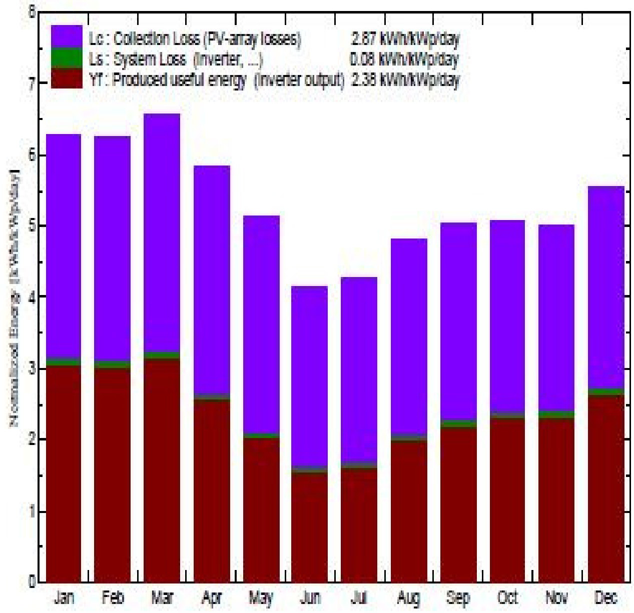

Figure 3.3 Inverter output and PV array losses of 10MW grid connected system

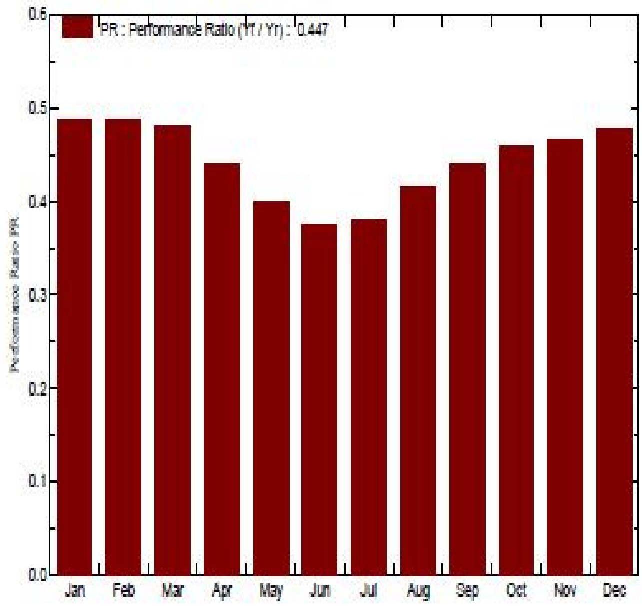

Figure 3.4 Performance ratio throughout the year

Table 2. Simulation various parameter over the period of a year

	GlobHor kWh/m^2	DiffHor kWh/m^2	T Amb °C	GlobInc kWh/m^2	GlobEff kWh/m^2	EArray MWh	E_Grid MWh	PR
January	166.1	60.35	25.19	194.8	109.8	981	951.8	0.489
February	158.5	62.09	26.20	174.9	99.4	879	852.3	0.487
March	196.8	72.03	27.94	203.7	115.3	1012	981.4	0.482
April	181.5	86.88	29.53	175.3	89.9	797	772.3	0.441
May	174.4	93.76	31.04	159.5	74.1	656	636.7	0.393
June	137.6	88.75	30.30	124.6	54.5	486	468.9	0.376
July	145.3	89.46	30.29	132.0	58.4	519	501.1	0.379
August	157.9	93.18	29.79	149.3	72.0	639	619.4	0.415
September	151.4	79.15	28.77	151.0	77.6	685	663.2	0.439
October	148.3	82.69	27.77	156.6	83.3	743	720.0	0.460
November	135.2	72.47	25.71	150.6	80.4	724	702.5	0.467
December	147.1	65.91	25.19	171.8	94.1	847	822.6	0.479
Year	1900.1	946.71	28.16	1944.1	1008.7	8968	8691.2	0.447

Legends:
GlobHor - Horizontal global irradiation
GlobEff - Effective Global, corr. for IAM and shadings
DiffHor - Horizontal diffuse irradiation
EArray - Effective energy at the output of the array
T Amb -AmbientTemperature
E_Grid - Energy injected into grid
GlobInc -Global incident in coil, plane
PR - Performance Ratio

Table 2 shows simulation various parameter over the period of twelve month. The table clearly mention the important design parameters considering one year period. The PV array comprises of 60 PV cells (6 X 10),10 cells are being connected in series to achieve the output voltage. There are 6 parallel branches to produce the power of 220W, a number of PV array consecutive connected in seriesly increases 12w to 4000w of power output is produced, the output voltage can be increase to a desired level with the help of boost converter. The modified DVR based PV array to produce 83% efficiency. The DVR recovers the system to reach the steady state voltage value of 1.0 pu with in 0.1 ms with reduced distortion.

Conclusion

The photovoltaic solar system is used as DVR for controlling voltage sag or voltage swell that eliminate power faults at home or at lower power rating industry difficulties. DVR is a more optimistic device for improving the power quality due to the fast response and is more reliable. A bidirectional DC-DC converter with fuzzy logic controller based perturb and observe maximum power point tracking algorithm are utilized to track the maximum power point of the PV array. Unique PV-DVR is used in the modified circuit to reduce the energy utilization from grid by disconnecting the grid from the load through soft switching of the semiconductor devices. To increase the power level PV array has been used to meet the load demand, to reduce the tariff of the panel cost and lesser usage of utilization of UPS and stabilizer as an individual equipment available at a residence, and small scale industries and optimistic usage of limited power rating industries. Simulation result is matched with the theoretical result. MATLAB V13 and PVSYST V6.61 software are simulated with the same value of the components to produce the same simulation results. The performance of the PV-DVR is produced best result to utilising in the grid connected system with reduced steady state error, stable voltages and increases the gain. In review of power generation is increasing the demand to use the PV-DVR module.

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Biographical notes

K.K. SARAVANNAN is working as an Assistant Professor, Department of Electrical and Electronics Engineering,Anna University college of Engineering, Panruti India. He received the Bachelor degree in Engineering from the Annamalai University, Chidambaram, India in 2002 Master of Engineering in 2005 from Sathyabama University, Chennai, India.He has been pursuing Ph.D in Anna University Chennai, India from 2011. He has been in the teaching field for more than ten years. His areas of interests are Power Electronics Converters and its applications,Electrical machines and renewable energy sources.

S.A.ELANKURISILis working as a Professor, Department of Electrical and Electronics Engineering, Adhiparasakthi Engineering College, Melmaruvathur, Chennai, Tamilnadu, India. He received the Bachelor degree in Engineering from the Madras University, Chennai, India in 1998 and Master of Engineering and PhD in 2006 and 2014 from Sathyabama University, Chennai, India. He has been in the teaching field for more than eighteen years. His areas of interests are Power Electronics Converters and its applications, Intelligent controller, Fuzzy controller, Microprocessors and Microcontrollers DC and AC drives and renewable energy resources.