International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 3 Issue 1, January - 2014

Modeling of Green Energy Based Hybrid UPS with Backup Battery

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Abstract

Green energy is the recent trend that can be extracted, generated and consumed without any significant negative impact to the environment. In recent days the problem of power failure has complicated the scenario in medium and small scale industries. Moreover it's time to adopt renewable energy / green energy as the available resources keeps on depleting. This project aims in the development of self sustained Uninterrupted Power Supply (UPS) powered by Fuel Cells (FC) which helps in improving the power reliability, minimizing load fluctuations also reducing green house effects. Thus this project supplies superior fast responding reliable power performance using FC's which helps many small and medium scale industries to get benefited. Beyond this the proposed work (Hybrid UPS) has a wide scope in the areas of Research Laboratories, Data Centre's, Emergency Systems, Domestic Appliances, Industrial Power Supply Units, and Internet Workstations.

1. Introduction

AN Uninterruptible Power Supply or battery/flywheel backup is an electrical apparatus which provides uninterrupted power to the load (i.e., typically an industrial load or a commercial load or a home appliances) when source power fails to supply load. Modern UPS consist of varieties of features such as the systems are free from voltage spikes, over and under voltages also the system differs from an auxiliary or emergency power system or standby generator in that it will provide instantaneous protection from input power interruptions which is feasible by providing energy stored in batteries or a superconductor.

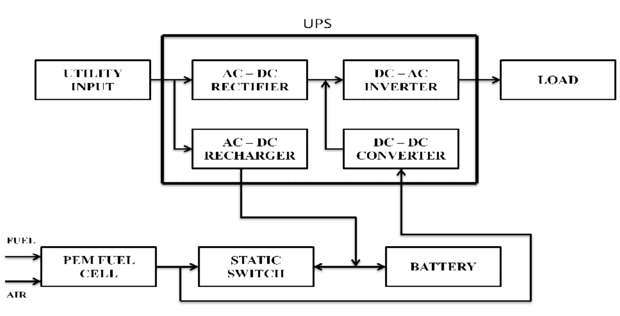

Fig.1 Proposed Structure of the Hybrid UPS

The proposed work illustrates the modeling of cost effective AC – DC, DC – DC, DC – AC converters along with the PEMFC and the block diagram is mentioned in Fig.1.The control of DC – AC converter is done with the help of Space Vector Pulse Width Modulation (SVPWM) technique. The proposed modeling of hybrid UPS is done with the help of MATLAB /SIMULINK simulation software.

The introduction of Switched Mode Power Supplies (SMPS) leads to a drastic change in the UPS design where the problem of non linear loads has been resolved. The soft switching technique for a buck type DC – DC converter with a coupled inductor thereby minimizing the switching and conduction losses. A coupled inductor is targeted to achieve the zero voltage and zero current switching conditions. Zero current turn on and zero voltage turn off condition can be ensured by Continuous Conduction Mode (CCM) and Boundary Conduction Mode (BCM). The presence of coupled inductor significantly reduces the auxiliary switches. The control method is simple as when compared to other conventional buck converters [1]. An isolated full bridge dc – dc boost converter is introduced for the effective minimization of current stresses on the switches. A double loop control scheme is chosen for the boost inverter control in order to attain wide operating points. A low pass filter is engaged in the circuit for the effective minimization of ripples and to smoothen the output power. The single stage power conversion has an attractive merit with respect to power conversion efficiency [2].

The design of interleaved boost converter results in reduction of size and weight of passive components thereby minimizing the input current and voltage ripples. A closed loop control strategy is achieved to improve the reliability and efficiency. Interleaved boost converter produces switching patterns in such a way that the switching frequencies are increased resulting in reduction of size of inductors and also the identical duty cycles for all the switches. A PI controller is designed to keep the bus voltage constant irrespective of the variations in load and input voltage. Direct digital control technique has been carried out to overcome the sampling and quantization errors. The load power profile is calculated based on the dynamic model and the driving cycle. The single stage power conversion based power electronic interface between the fuel cell and grid provides good voltage regulation even though the system is subjected to sudden load variations. Desired voltage level is obtained by the fusion of a single stage PWM inverter and a low pass filter along with a high frequency transformer. An interleaved type flyback forward converter along with active clamp is projected for high step up voltage. The primary main switch and active clamp switch carries out the ZVS soft switching condition and helps in achieving boost type conversion.

The primary switch conduction loss can be effectively reduced when the stress on the active clamp switch is low. The protective function such as undervoltage, overvoltage and over current is realized to improve the system reliability. An interleaved boost converter is implemented to combine the fuel cells in such a way that good voltage regulation is achieved also the voltage and current ripples are minimized. The sliding mode technique is implemented to equal the current sharing between modules.

Normally the converter works in both continuous and discontinuous mode in this work the discontinuous mode is enabled when the load faces sudden disturbances. A high level of performances in all operating conditions is noticed. The superiority of the adaptive controller over conventional linear controller is understood through this novel [3] – [6]. A telecommunication system mostly uses online resources for some specific applications such as military radar systems, railway traction systems so at this juncture this system cannot fulfill the expert's satisfaction. A hybrid structure which is the combination of fuel cell, battery and an ultra capacitor supplies the continuous power to the distribution system with the help of power converters, thereby minimizing the system losses also improving their efficiency. A sinusoidal pulse width modulation technique is implemented to alleviate the waveform distortions and voltage unbalances [7] – [8].

Pulse Width Modulation (PWM) also known as Pulse Duration Modulation (PDM) is a digital modulation technique whereby the width of a pulse carrier is made to vary in accordance with the modulation voltage. The SVPWM method is an advanced computation intensive PWM method and one of the best when compared to all other PWM. In recent years the implementation of SVPWM is drastic and wide spread due to its superior performance and controlling strategy. The SVM method considers the interaction of the phases and optimizes the harmonic content of the three phase isolated load. SVPWM provides a better technique compared to the more commonly used PWM or sinusoidal PWM (SPWM) techniques because of their easier digital realization and better DC bus utilization. Generally, the SVPWM implementation involves sector identification, switching time calculation, switching vector determination, and optimum-switching-sequence selection for the inverter voltage vectors. Sector identification can be done by coordinate transformation or by repeated comparison of the three-phase reference voltages [9] – [11]. The lookup table in Table I can be used for determining the switching vectors in best switching sequence.

TABLE I Switching Vector Table

Switching States			Corresponding Voltage Vectors		
a	b	c	Vector	Magnitude	Angle
0	0	0	V_0	0	0
1	1	1			
1	0	0	V_1	0.6 V_{dc}	0
1	1	0	V_2	0.6 V_{dc}	1.04
0	1	0	V_3	0.6 V_{dc}	2.09
0	1	1	V_4	0.6 V_{dc}	3.14
0	0	1	V_5	0.6 V_{dc}	4.16
1	0	1	V_6	0.6 V_{dc}	5.2

An inverter contains electronic switches, it is possible to control the output voltage as well as optimize the harmonics by performing multiple switching within the inverter with the constant dc input voltage, the PWM principle to control the output voltage. The fundamental voltage has the maximum amplitude ($4V/\pi$) at square wave, but by creating notches the magnitude can be reduced.

A hydrogen proton exchange membrane fuel cell is implemented as this type of fuel cell not only helps in size, weight and cost reduction but also performs secondary actions such as starts up and fast dynamics. The Bellman's principle of optimality is handled in order to minimize the consumption of hydrogen. The concept of operating reserve and spinning reserve is proposed to support the short term load fluctuations and extra operating capacity. The evolutions of H_2 content in its storage is modeled by an integrator as the design relates the variables are algebraic in nature. The key point here is that we assess not only the benefit of the fuel cell on generating electricity, but also the penalty the fuel cell system has on the airplane's performance due to its added weight and possibly drag. Combining these two is necessary to determine the overall effect of the fuel cell system [12] – [13]. For high end applications such as research laboratories, aircraft signal stations this concept will be more fruitful.

2. Interleaved AC – DC Converter

Power switches have to cut off the load current within the turn-on and turn-off times under the hard switching conditions. Hard switching refers to the stressful switching behavior of the power electronic devices. During the turn-on and turn-off processes, the power device has to withstand high voltage and current simultaneously, resulting in high switching losses and stress. Dissipative passive snubbers are usually added to the power circuits so that the dv/dt and di/dt of the power devices could be reduced, and the switching loss and stress are diverted to the passive snubber circuits. The circuit diagram of the proposed interleaved AC – DC converter is shown in Fig.2.

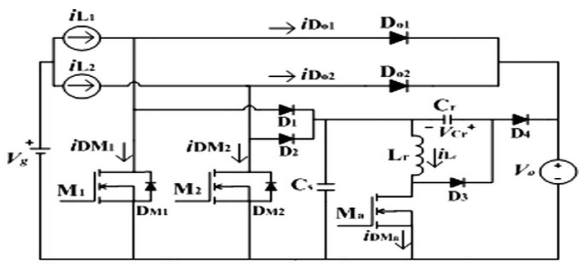

Fig.2 Proposed Interleaved AC –DC Converter

Two-stage approach is widely used in the AC-DC front-end converters for high power application. Because of its continuous input current and simplicity, Continuous Conduction Mode (CCM) boost topology is the most popular topology for high power applications. Various kinds of soft switching techniques have been proposed in the literature to minimize switching losses of the boost converters. The simulation model of an interleaved boost converter is illustrated in Fig.3.

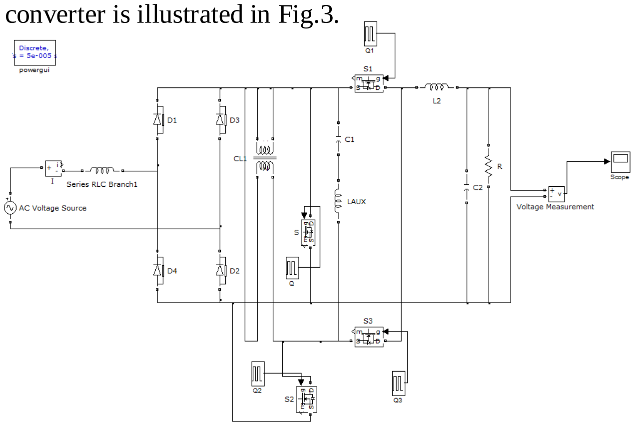

Fig.3 Simulation Model of an Interleaved Boost Converter

Converters operating at soft switching with passive snubbers are attractive, since there is no need for extra active switches and also the control scheme is simpler. The main problem with these kinds of converters is that the voltage stresses on the power switches are too high and the converter is bulky. In the analysis of the proposed converter, the output filter capacitor is assumed as a constant voltage source during a switching period. In addition, since the inductor of each cell is large enough and the switching frequency, f_s is very high compared to the line frequency f, the current of each inductor can be taken constant during a switching period. The voltage, V_g is the rectified input voltage. Since the input voltage is sinusoidal, the duty cycle ratio, D is not constant. The variation of the duty cycle for PFC circuits an input line voltage of 220 Vrms, 50 Hz line frequency and an output voltage 400 V_{dc}.

$$V_g\,(t) = V_m \sin(2 * pi * f) \quad (1)$$

$$D = 1 - \frac{V_g}{V_o} \quad (2)$$

The main switches of the converter are gated with 180° phase shift with identical frequencies and duty ratios. The auxiliary switch is gated with constant duty ratio just before the main switches. Since the cells of the proposed converter are identical with the same operating frequency and duty ratios and their main switches are operating with phase shift of 180°.

Stage 1:

This mode starts when the gate pulse is applied to S. Once the voltage is applied to the gate, S is turned ON under zero voltage. Since S and S2 are ON during this interval, the voltage across the auxiliary inductor is zero. Thus, the current through the auxiliary circuit remains constant at I aux. During this interval, the switch S current is given by

$$i_{s(t)} = I_v - I_{aux} - V_{in}\,\frac{1}{l_2}\,(t - t_0) \quad (3)$$

Stage 2:

This mode is the dead time between the phase B MOSFETs. During this interval, the auxiliary circuit current charges the output capacitance of S2 and discharges the output capacitance of S3. In this mode, the average voltage across the boost inductance l_2 is zero. Therefore, the current through the coupled inductor remains constant at its peak value. The voltage across the auxiliary inductor is given by:

$$V_{aux(t)} = \frac{V_o}{(t_2 - t_1)} * (t - t_1) \quad (4)$$

Stage 3:

Once the output capacitors of S2 and S3 have been charged and discharged completely, the gate signal of S3 is applied and S3 is turned ON under ZVS. During this interval, the voltage across the auxiliary circuit is $-V_o$. Thus the current through the auxiliary inductor:

$$i_{3(t)} = I_v - I_{aux} + V_{in}\frac{1}{2*f*L_a} - V_{in} * T_d \frac{1}{L_a} + \frac{V_0}{2*L_{aux}} T_d + \frac{V_o}{f*L_{aux}}(1-D) - \frac{2*V_o}{L_{aux}} T_d \quad (5)$$

Stage 4:

During this mode, the output capacitor of S_3 is charging from zero to V_o and the output capacitor of S_2 is discharging from V_o to zero. This period is actually the dead time between S_2 and S_3. The auxiliary inductor current, the boost inductor current, and the switch current, during this mode, is given by:

$$i_{s(t)} = I_V - I_{aux} - \frac{V_{in}}{l}(t - t_0) + \frac{V_o}{2*L_{aux}} T_d + \frac{V_o}{L_{aux}}(t - t_0) \quad (6)$$

Stage 5:

This mode starts when the gate signal is applied to S2. Once the gate has been applied, S2 is turned ON under ZVS. Since S and S2 are ON during this period, the voltage across the auxiliary inductor is zero; hence, the auxiliary inductor current remains constant at its peak value, I Aux. The boost inductor current and the switch current, during this mode are given by:

$$i_{s(t)} = I_v + I_{aux} - \frac{V_{in}}{f*l} D \quad (7)$$

Stage 6:

During this mode, the output capacitor of S is charging from zero to V_o and the output capacitor of S1 is discharging from V_o to zero. This period is actually the dead time between S and S1. In this period, the current through the boost inductor l remains constant at its peak value. The auxiliary inductor current is given by:

$$i_{aux\,(t)} = -I_{aux} + \frac{V_o}{2*T_d*L_{aux}}(t - t_5)^2 \quad (8)$$

Stage 7:

During this mode, the voltage across the auxiliary circuit is V_o. During this mode, the MOSFET channel S1 is conducting the current to the output. Hence the current flow through switch is given by:

$$i_{s(1)} = I_{aux} + \frac{V_o}{2*L_{aux}}(t_d) + \frac{V_o}{L_{aux}}(t - t_6) + i_p - \frac{V_{in} - V_o}{L_{aux}}(t - t_6) \quad (9)$$

Stage 8:

During this mode, the output capacitor of S is discharging from V_o to zero and the output capacitor of S1 is charging from zero to V_o. In this mode, the current through auxiliary inductor is at its minimum value and the excess current from the auxiliary circuit charges and discharges the output capacitors.

The switching operations of the output and auxiliary circuit diodes are also observed via simulation and it is observed that the output diodes and auxiliary circuit diodes turn on and turn off under soft switching and there is no voltage stress on the diodes in Fig.4. The simulation results are in very close agreement and the output voltage waveform attains steady state with slight disturbances and settled in a very short time.

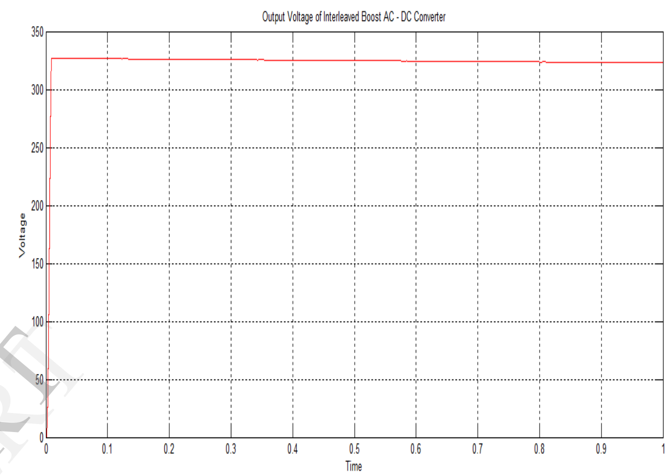

Fig. 4 Output Voltage Waveform of Interleaved Converter

3. Push Pull DC – DC Converter

The potential of a DC-DC converter is that, it can provide the inverter with a high voltage source. Because the desired output of the inverter is 220 volts RMS, the DC-DC converter must supply 380 volts consistently. Since the DC-DC converter is only half of the final product, the efficiency must be high in order for the final product to be economical. However minor improvements in efficiency should not be substituted for greatly increased price. This would take away from the purpose of the design. There are two types of DC – DC converter which are widely used today

1. Isolated DC – DC converter
2. Non – Isolated DC – DC converter

A Push–Pull converter is a type of isolated DC – DC converter, a switching converter that uses a transformer to change the voltage of a DC power supply. The distinguishing feature of this converter is that the transformer primary is supplied with current from the input line by pairs of transistors in a symmetrical Push – Pull circuit. The transistors are alternately switched on and off, periodically reversing the current in the transformer.

Therefore current is drawn from the line during both halves of the switching cycle. The circuit diagram of a push pull converter is illustrated in Fig.5.

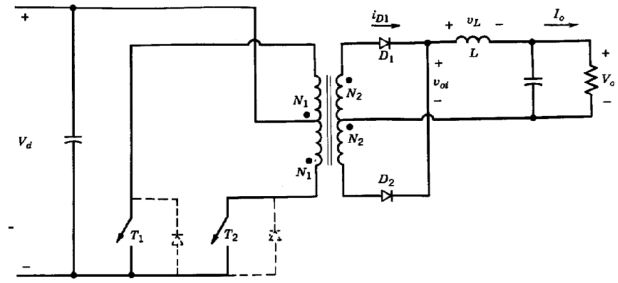

Fig.5 Circuit Diagram of a Push – Pull Converter

The Push Pull converter has eighty percent efficiency at five hundred watts of power. It also has a fifty percent duty cycle and isolates the input from the output through a two winding transformer. For the half bridge converter which is illustrated in Fig.5, when switch Q1 is on, current flows through the top half of the primary side of T1, expanding the magnetic field in T1. The expanding magnetic field induces a voltage across T1 secondary, such that diode D2 is forward biased and diode D1 is reverse biased. D2 conducts and charges capacitor. When Q1 turns off, the magnetic field in T1 collapses and after a period of dead time, Q2 switches on. Current flows through the bottom half of the transformer and the magnetic field in T1 expand. The direction of the magnetic flux is opposite that of Q1, so now D1 is forward biased and D2 is reverse biased. D1 conducts and charges C.

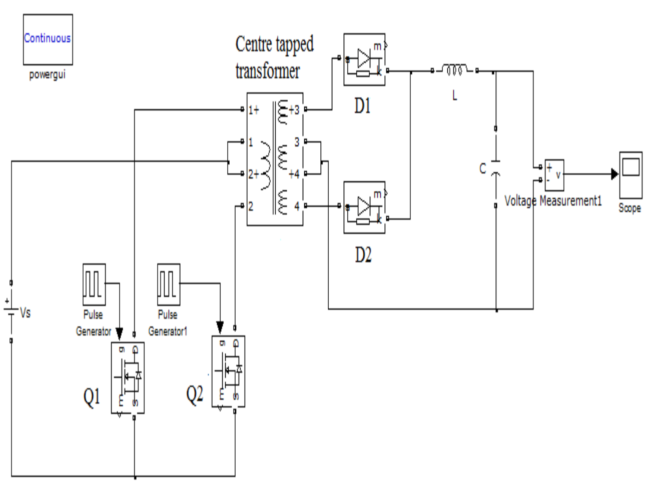

Fig.6 Simulation Model of a Push – Pull Converter

After a period of dead time, Q1 conducts and the cycle repeats. It is very important that Q1 and Q2 are not turned on at the same time. The simulation model is shown in Fig.6.

If they were, they would short circuit the supply. Therefore the conduction time of each transistor must not exceed half of the total period for one complete cycle. It is also important to make sure the magnetic behavior is uniform; otherwise the transformer will saturate and destroy switches. This requires that the individual conduction times of switches be exactly equal. In this push pull converter the feedback diodes connected in antiparallel to the switches were required to carry the reactive current and their conduction interval depend inversely on the power factor of the output load. The output voltage waveform of the push pull converter is illustrated in Fig.7. Which clearly shows voltage increases linearly and due to the presence of L and C the steady state voltage is achieved at 0.01secs.

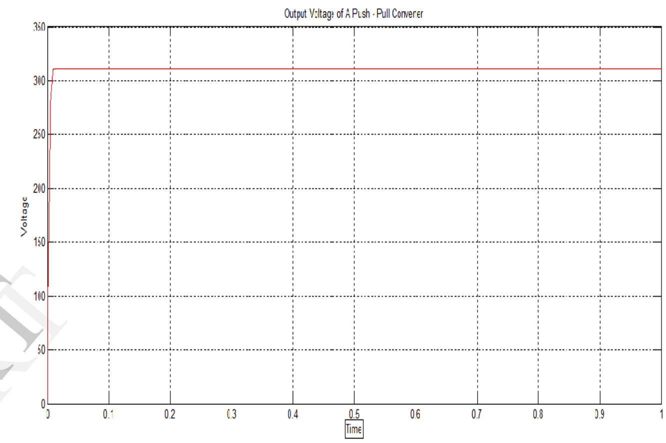

Fig.7 Output Voltage Waveform of a Push – Pull Converter

4. Space Vector Pulse Width Modulation

The SVPWM design considers eight possible switching vectors i.e., $2^3 = 8$ switching states. Six out of these eight vectors produce a non-zero voltage and are known as non-zero switching states: the remaining two vectors produce zero output voltage and known as zero switching states. The output voltages of the inverter are composed by these eight switch states.

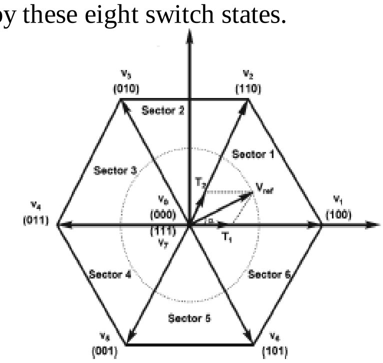

Fig. 8 Output Voltage Space in dq Components

The six active vectors divide the space vector plane into six equal sized sectors of 60◦ with equal magnitude which forms an origin centered hexagon, and two zero space vectors found at the origin shown in Fig.8.

The SVPWM technique uses five different steps to produce the firing angle includes some vital steps such as sector identification, phase angle determination, gate timings determination and gate pulse generation. Consider state 1, when switches Q_1, Q_6, Q_2 are closed in such a way that phase a is connected to the positive bus and phase b and c are connected to negative bus. Fig.9 shows the circuit diagram of different switching states. At low switching frequencies, it is necessary to maintain perfect synchronization of inverter output voltage with respect to its own fundamental to avoid sub harmonics. The three-phase symmetry will ensure that all the harmonics and the fundamental of all the three phases will he perfectly balanced. So the triplen harmonics will he cancelled from the line voltage. The six active vectors divide the space vector plane into six equal sized sectors of 60◦ with equal magnitude which forms an origin centered hexagon, and two zero space vectors [13].

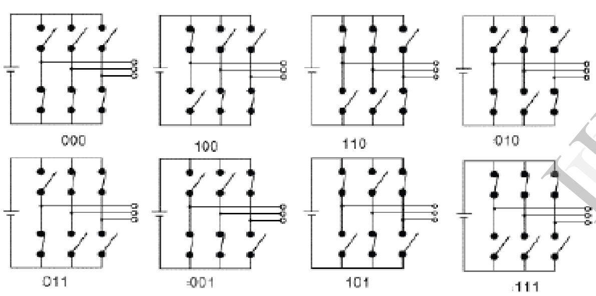

Fig.9 Different Possible Switching States

The determination of sector of the reference voltage plays a vital role in the SVPWM technique as the six active states which we discussed earlier can be found out by comparing different angles. The modulation index should be kept always less than 1 (typically 0.9). The firing angle is developed with the help of switching states.

The idea behind the SVPWM is to determine the sampled reference phase from three sampled reference frames which crosses the triangular first and the reference phase which crosses the triangular carrier last. The Fig.10 shows the overall simulation circuit of a space vector pulse width modulation controlled full bridge inverter.

The crisp summary of the SVPWM is

a. To generate the three phase sinusoidal input with important parameters such as variable frequency, amplitude, and direction, DC bus voltage. Each of the three signals is separated 120° apart.
b. Convert the three phase voltages into two phase voltages.

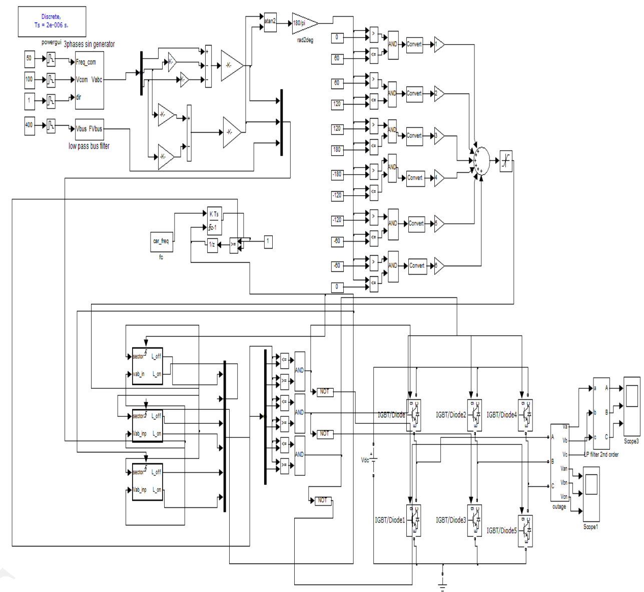

Fig.10 Space Vector Pulse Width Modulation Controlled Full Bridge Inverter

c. Determination of the phase angle which helps in mobilizes out the sector.
d. Calculate the switching time.
e. The triangular waveform from the triangular generator is compared with the gate timing helps to produce the gate signals.

The output line voltage of the inverter (Vab) which is applied to an R-L load. As can be seen the output voltage waveform has five levels. Although 1 KHz of switching frequency is used the current waveforms have sinusoidal shape.

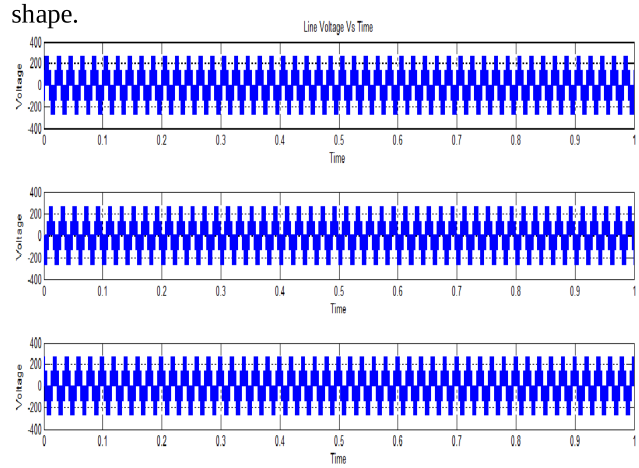

Fig.11 Output Voltage Waveform of an SVPWM Controlled Inverter

This is one of the most important advantages of multilevel inverters. The output voltage waveform is illustrated in Fig.11.

5. Modeling of Fuel Cell

Fuel cells have become increasingly important as alternative sources of power, offering the potential for drastic reduction in emissions in particulate matter (PM), nitrogen oxides (NOx), and CO_2. In addition, they offer exceptionally quiet operation, highly efficient use of the fuel energy, and a high energy storage density compared to batteries. During last two decades number of fighter aircrafts as well as commercial aircrafts use fuel cells as backup power supplies and it has various advantages when compared to the conventional backup systems as the black boxes in aircrafts realizes the need of fuel cells. Fuel cells are the part of green energy systems as it doesn't take part in the carbon emission as most of the systems emit carbon and effluents of carbon are most dangerous one. Fuel cells comprise the distributed power systems provides the power location and helps in mobilizing the usage of power also reduces the power consumption.

A. Proton Exchange Membrane Fuel Cell

PEM anode (site of oxidation) hydrogen gas ionizes (oxidizes), releasing protons and electrons for the external circuit. Simultaneously, at the cathode (site of reduction), oxygen molecules are reduced in an acidic environment by electrons from the circuit, forming water molecules. Protons pass through the PEM, from anode to cathode, completing the circuit. PEM fuel cells deliver high power density and offer lighter weight and smaller volume than other fuel cell systems. Traditional PEM fuel cells use a solid proton conducting polymer membrane called Nafion, a type of Poly Fluorinated Sulfonic acid (PFSA) material, which allows proton transfer between the anode and cathode. The fundamental structure of a PEM fuel cell is described as two electrodes (anode and cathode) separated by a solid membrane acting as an electrolyte. Hydrogen fuel flows through a network of channels to the anode, where it dissociates into protons that, in turn, flow through the membrane to the cathode and electrons that are collected as electrical current by an external circuit linking the two electrodes. The oxidant flows through a similar network of channels to the cathode in which the oxygen molecules combines with the electrons gives out hydrogen gas in the external circuit and the protons flowing through a membrane liberates water. The chemical reactions occurring at the anode and cathode electrode of a PEM fuel cell are as follows:

Anode reaction: $2H_2 \rightarrow 4H^+ + 4e^-$

Cathode reaction: $O_2 + 4H^+ + e^- \rightarrow 2H_2O$

Total cell reaction: $2H_2 + O_2 \rightarrow 2H_2O$ + electricity + heat

The behavior of a cell is highly non-linear and dependant on a number of factors such as current density, cell temperature, membrane humidity, and reactant partial pressure. The cell voltage decreases with increasing current. A PEM fuel cell generally performs best at temperatures around 70-80°C, at a reactant partial pressure of 3-5 atm, and a membrane humidity of ~ 100%. V-I Characteristics of a 1.2 W PEM fuel cell. The Simulink model of the fuel cell is illustrated in Fig.12.

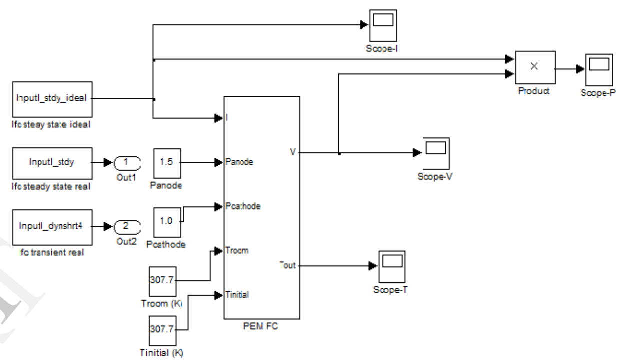

Fig.12 Simulation Model of Fuel Cell

Matlab-Simulink is used to simulate the PEM fuel cell system. Additional limiters are placed in various key locations in order to prevent problems arising from algebraic loops and extreme numerical values. The dynamic simulation of a PEM fuel cell system and simulation results are presented. A 36V DC is obtained as an output from the fuel cell model in Fig.13. The overshoot is about 10% and it settles at 8 seconds increase also the derivative weight as well as the settling time helps in decreasing the overshoot. There are three regions of operation

1. Activation region
2. Cut off region and
3. Ohmic region

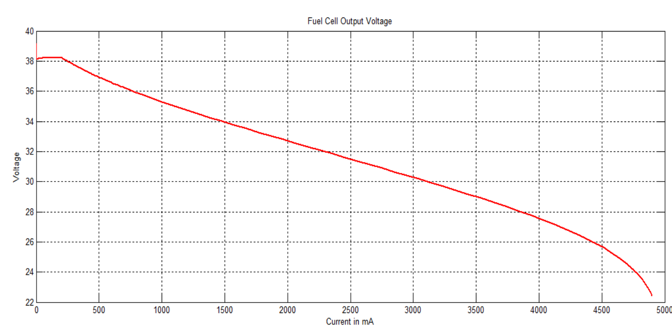

Fig.13 Output Voltage Waveform of a Fuel Cell

6. Modeling of Hybrid UPS

Hybrid UPS is the combination of fuel cell system and high end power electronic interfaces where the system is promised to deliver power to the load uninterruptedly. This project includes a fuel cell system connected to a DC bus through a DC – DC converter, a storage system typically a battery that are connected to the same bus through a DC – DC converter (Push- Pull), and a space vector pulse width modulation controlled inverter for the load. A static transfer switch is used to disconnect the system from the utility when the fuel cell fails to supply power to the utility.

A. Simulation Models of Hybrid UPS

Here two types of simulation models are illustrated in Fig.14 and Fig.15. The Fig.14 illustrates the working of system when AC mains are present. When AC mains are present, the battery is charged with the help of battery recharger circuit and direct link has been carried out to feed the load.

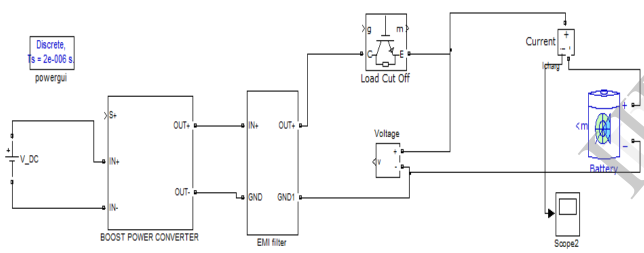

Fig.14 Battery Charging Circuit

When the mains are absent, as shown in Fig.15, the fuel cell, which has a capability of delivering 36V to the DC –DC converter which in turn boost the 36V DC to 320V DC. The output of the DC – DC converter is coupled with the inverter. The implementation of isolated type of converters helps in reducing the complexity of the circuit as well as in the maximization of the output voltage. In the case of non isolated converters the losses are high and efficiency is also diminished. The choice of SVPWM controlled inverter helps to minimize the conduction and switching losses and the gate pulses are fed to the inverter in a regular interval. The THD is reduced and the significance of SVPWM is one again proved. Even though the design of SVPWM is a bit complicated it provides a worthy output and satisfactory results. In Fig.14 a battery charging circuit is shown, when AC mains are present the boost AC – DC converter rectifies in to DC which is then utilized by battery charging model as shown.

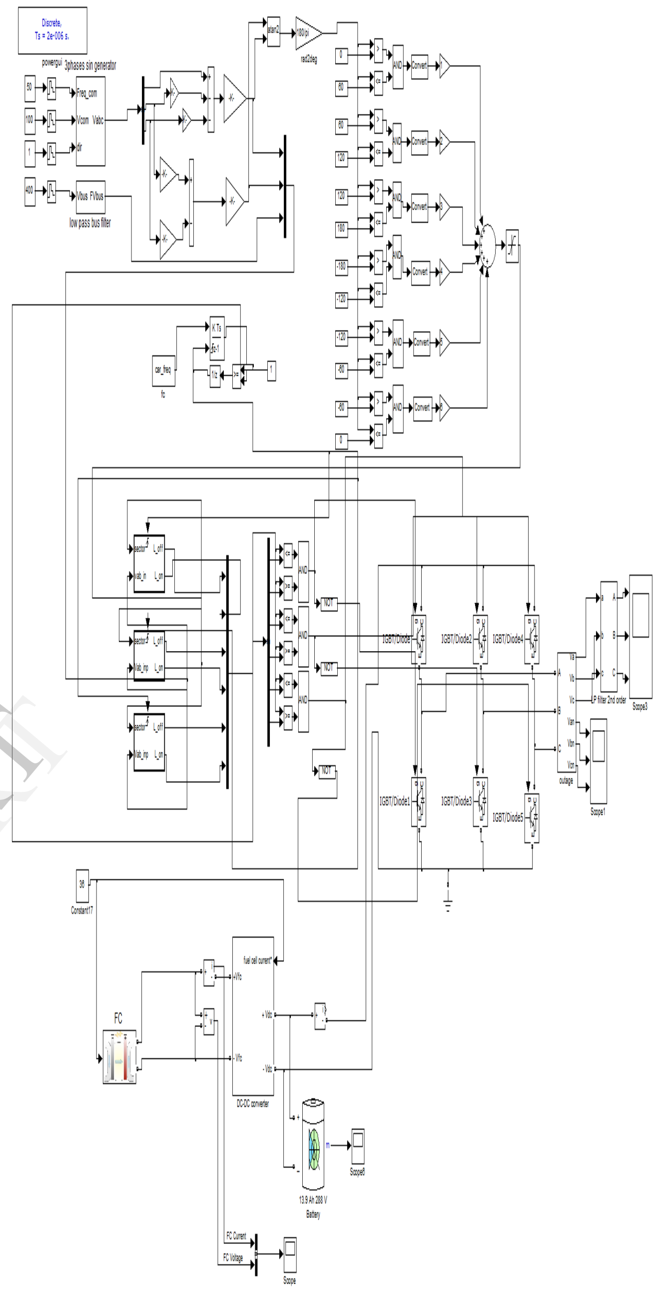

Fig.15 Simulation Model under the Absence of Main Supply

B. Results and Analysis

The output from the inverter is a five level square output and it has a capability of delivering 400 V AC which is shown in Fig.16 and Fig.17 shows the filtered output voltage. The effectiveness of the proposed method is demonstrated through simulation and results (clearly illustrated in previous chapters) and the SVPWM scheme can drive the inverter gating signals from the sampled amplitudes of the reference phase voltages. Since the triplen order harmonics are appeared in the phase-to-centre voltage of SVPWM, it has higher modulation index compared to the Sinusoidal PWM.

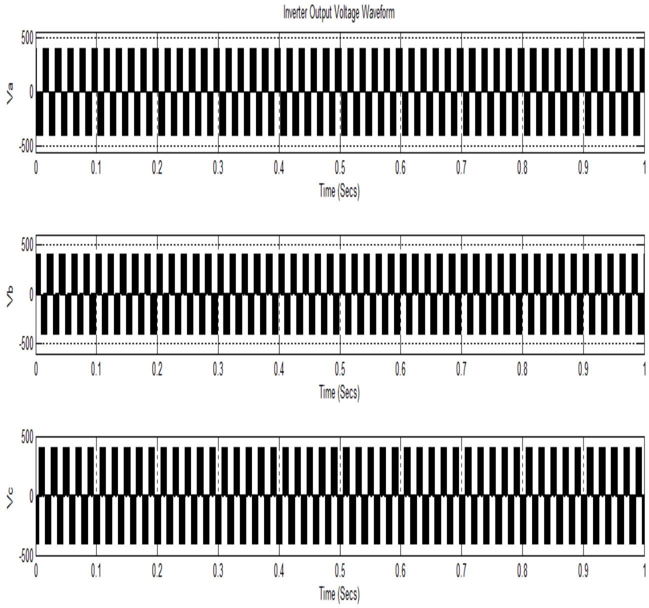

Fig.16 Inverter Output Voltage

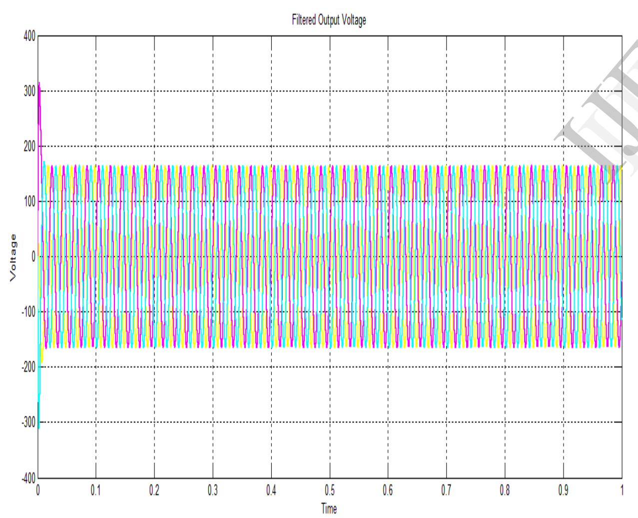

Fig.17 Filtered Output Voltage

In SVPWM only one phase is switch at a time. Hence SVPWM has reduced switching losses compared to SPWM. When the modulation index increases the THD of the output voltage decreases. Hence SVPWM has less amount of current and torque harmonics than those of sinusoidal PWM. The switching vectors for the inverter are derived using a simple digital logic which does not involve any complex computations and hence reduces the implementation time. The key feature in the simulation model is the choice of push pull converter and space vector pulse width modulation. The Push – Pull DC to DC converter reduces the switching and conduction losses and increases the reliability of the system.

7. Conclusion

Thus this project exemplifies the design of various high performance converters and inverter which helps in maintaining uninterrupted power flow to the load. Before building the prototype it is preliminary to structure it with the simulation model in such a way that the choice of push pull technology for DC – DC converter and interleaving technique for AC – DC rectifier improves the efficiency as well as it minimizes the losses of the overall converter. The implementation of soft switching topologies in this hybrid UPS system improves the reliability of the system. Special attentions were made in the modeling of high frequency transformer for boosting the DC voltage. The opted power electronic interface helps in balancing the load as well as minimizing the load fluctuations. The choice of Space Vector Pulse Width Modulation (SVPWM) technique helps in minimizing the total harmonic distortion of the inverter when compared to that of other pulse width modulation techniques. This technique not only minimizes the harmonic contents but also it improves the efficiency of the system. This hybrid structure is a most promising one for telecommunication sectors, aerospace power supplies and defense applications where the quality and precision is a precise one. These fuel cells based UPS can sustain under various operating conditions as well as it has capabilities to provide power continuously even during sudden disturbances. The world is running out of fossil fuels and demand for power is keep on increasing so it's time to adopt renewable energy as it provide energy without depleting any natural resources in such a way that the usage of fuel cell's has significantly increased. In this project special work has been carried out in the control of fuel cell by implementing adaptive neuro fuzzy inference system for the hydrogen mass flow control of the fuel cell. this hybrid ups is a technical rich model as it concentrates on efficiency, reliability, stability, low cost, flexibility and high performance.

Acknowledgment

A project of this nature needs co-operation and support from many persons for the successful completion. In this regard, I am fortunate to express my heartfelt thanks to the Head of the Department **Dr. S. THANGAVEL, M.E., M.B.A., Ph.D.,** for his effective leadership, encouragement and guidance in the project.

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