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Fuzzy logic controller based multi-port LED Driving

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Abstract— **This paper is composed of an interleaved connection of resonant converter with snubber to drive multiple port light emitting diodes (LEDs) to achieve constant voltage. For an LLC converter the transformer is provided with very large value of inductance and therefore the magnetizing current in the secondary winding of the transformer has an effect on the current to the LED. The current balancing among LED string is highly improved. A high efficiency is guaranteed with a wide load range. Hence this structure is a convinient module for more then one channel LED driving application. A Fuzzy Logic control is a critical thinking control framework strategy utilized for keeping up the LED driver voltage constant with a power factor of 0.987.**

Keywords—: **LLC resonant converter; LED driver; PFC; ZCS and fuzzy logic control.**

I. INTRODUCTION

A cascade connection of one-stage LLC full converter with snubber circuit to drive multiple channel multi string light emitting diodes (LEDs) ports[1][2] for a constant output power with a closed loop control is proposed . The circuit has two transformers and each transformer secondary is tapped at the centre and connected to two multiple string LED to form a multiple port LED and thereby the sharing of current in the LED is explained. As a result the current from the transformer secondary is rectified by a single switch and balanced between two LED string is improved highly. Two backup buck-help composed force variable correctors (PFCs) with variation in operation are facilitated with a LLC resonating converter outline the is explained in the circuit[3]. A Fuzzy Logic control is a basic deduction control structure method used for keeping up the LED driver voltage[4][5]. In the momentum system, a resonant converter is to drive LED to reduce dc-transport voltage. Since the dc-transport voltage is highly deduced, the circuit is more comfortable for low power appliances [6]. Two subordinate buck-supports with power-factor correctors (PFCs) with interleaving operation are incorporated with two inductor and one capacitor converter operating at resonating frequency to frame the displayed circuit. Two coupled inductors are used to accomplish buck change. The present nerves and constrain dispersals of the half-interface switches are close enough and balanced, provoking fundamental circuit blueprint and high structure relentless quality. Besides, the information current sounds can be lessened by the interleaved structure working of PFCs thereby the measure of data low-pass channel can be downsized. Still, the sounds and power variable alteration issues are happened so the structure profitability does almost no upgraded. Therefore we get our proposed system with a snubber circuit. An interleaved single-stage LLC converter with buck-boost operation multi-channel LED driver with snubber circuit to significantly more diminish the music and improve the adequacy[7][8]. The snubber is a circuit which is put over the semiconductor contraptions for certification and to improve execution. It is moreover cover or wipe out the voltage or current spikes and clammy brought on by the circuit magnetizing inductance when the switch opens. The power MOSFET switches with n^- substrate can be made to conduct on with ZVS, and the entire yield rectification diodes can follow with zero-current-trading (ZCS), inciting high system viability[9]. A Fuzzy Logic control system is used to keep up the voltage of the LED driver Working of the Fuzzy Logic control is according to the accompanying. The yield voltage is brought and is differentiated and a set worth using a comparator. By then the mix-up got reinforced to the fleecy method of reasoning control close by the estimation of bungle between over a wide span of time slip-ups. The cushioned method of reasoning control conveys the required control signal close by the carrier banner and is urged to PWM generator. The PWM generator makes the required PWM beat in reverence with the bumble regard. In this way the yield voltage is controlled. To attain high step up voltage ratio to operates in an interleaved fashion to reduce the output current ripple and to balance current sharing within multiple channels [10]. Increase in switching frequency decreases the switching losses and results in the improvement of overall efficiency or a wide range of load and therefore the powerfactor of this multiport LED driver is also

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preserved[11]. The approach based on parallel resonant converter provides increased efficiency and minimum switching losses[12]. The converter is analyzed for different values of input voltage with the linear behaviour of frequency[13][14]. These system can achieve zero voltage switching and it has no output cross regulation problems[15].

II. EXISTING BLOCK DIAGRAM

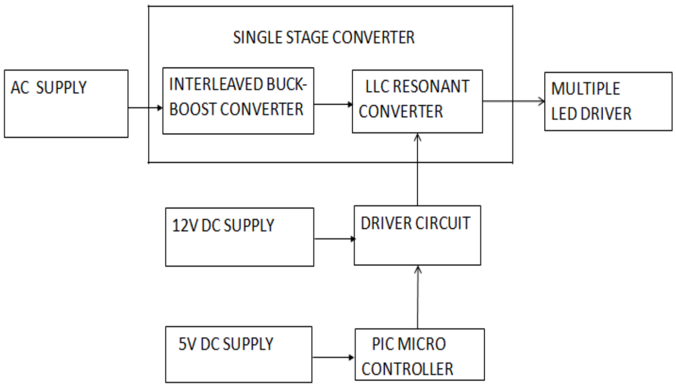

Fig. 1. Existing block diagram

A snubber protected one-stage buck-boost LLC circuit driven LED driver to deduce dc-transport voltage is explained with reference to fig 1. The framework module and financial expence can be diminished by sparing force switches and intelligent control over the components in the circuits. Two coupled inductors are utilized to perform buck-support change. The present hassles and power disseminations of the half-connect switching components are close and adjusted, prompting straightforward circuit configuration and high framework dependability. Moreover, the information current ripple can be eliminated hence the measure of data low-pass channel can be scaled down. Still, the ripple and force element adjustment issues are happened so the framework proficiency does very little moved forward.

III. PROPOSED BLOCK DIAGRAM

This paper proposes the closed loop control of cascaded one-stage converter to operate a many port LED with snubber to much more reduce the harmonics and improve the efficiency at resonant frequency. By saving power across the switches and control circuits the size of the system and the cost can be reduced. The snubber protection circuit is used to protect the circuit and to improve the performance of the system. It also suppress or eliminate the voltage or current spikes and damp the ringing caused by circuit inductance when a switch opens. The power MOSFET switches are triggered with zero voltage switching (ZVS), and all the output rectifier diodes can commutate with zero-current-switching (ZCS), leading to improve the system efficiency. A Fuzzy Logic control system is used to maintain the voltage of the LED driver constant by generating pulses to the switches .

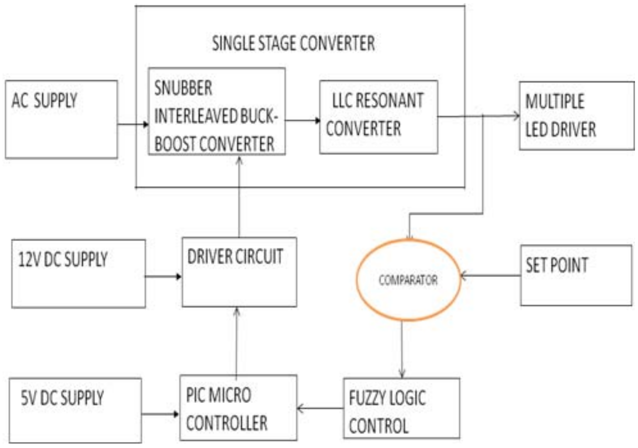

Fig. 2. Proposed block diagram

IV. PROPOSED CIRCUIT DIAGRAM

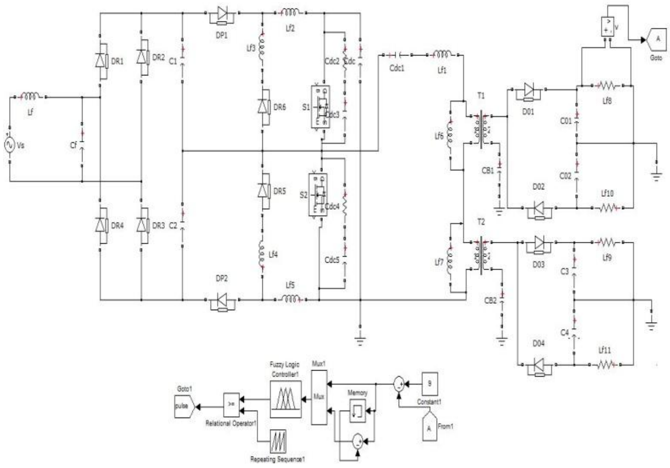

Fig. 3. Proposed circuit diagram

V. CIRCUIT EXPLANATION

The improved power factor along with many port LED driver circuit as described in Fig. 3, composed of buck-boost PFCs with two inductor and one capacitor connected converter in cascade provided with snubber protecting circuit .The output voltage is regulated by fuzzy logic controller to obtain a constant voltage to the output terminals. The two inductors which is coupled have been employed in place of single winding inductors to achieve the conversion of buck-boost . The single phase ac is fed to the bridge rectifier which in turn is fed to a sepic converter with interleaved connection. The proposed interleaved, single-stage LLC resonant converter with snubber circuit LED load can be propagated as shown in Fig. 3. The PN diodes D5 and D6 block the current flowing from ac supply into the magnetizing windings L2 and L4. Dl and D2 is used to prevent the currents in inductors from flowing backward to C1 and C2. The switches S1 and S2 consists of MOSFET Q1 and Q2 and diodes D1 and D2 which is connected across in opposite direction. The resonating capacitor Cr, resonating inductor L1 are combined to form a resonant tank as well as magnetizing inductors Lml, Lm2 of transformers T1 and T2. By applying gate pulses to the power switches S1 and S2 alternately, a symmetrical square waveform along with the magnitude of Vd2 can be obtained. The proposed converter offers a simplicity in structure and appreciable reliability. .

VI. Fuzzy Logic Control

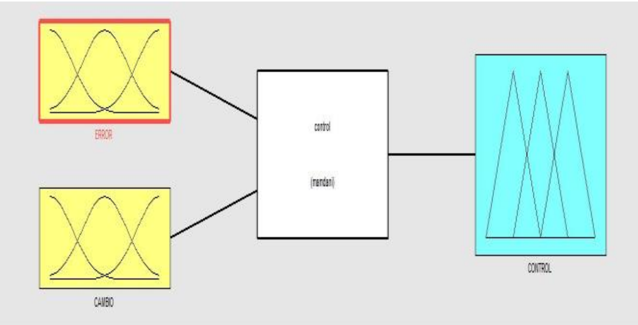

Fig. 4. Fuzzy logic control

Fuzzy Logic requires some numerical parameters recollecting the completed target to work, for occasion, what is seen as colossal oversight and key rate-of-development of-botch up, yet cure estimations of these numbers are commonly not essential unless inside and out responsive execution is required in which case observational tuning would pick them. Case in point, an indispensable temperature control structure could utilize a solitary temperature information sensor whose information is subtracted from the charge sign to process and after that time-limited to yield the oversight review or rate-of-development of-blunder, later on called "misuse spot". Blunder may have units of F and a little goof thought to be 2F while a tremendous oversight is 5F. The "mess up spot" may then have units of degrees/min with a little slip bit being 5F/min and a colossal one being 15F/min.

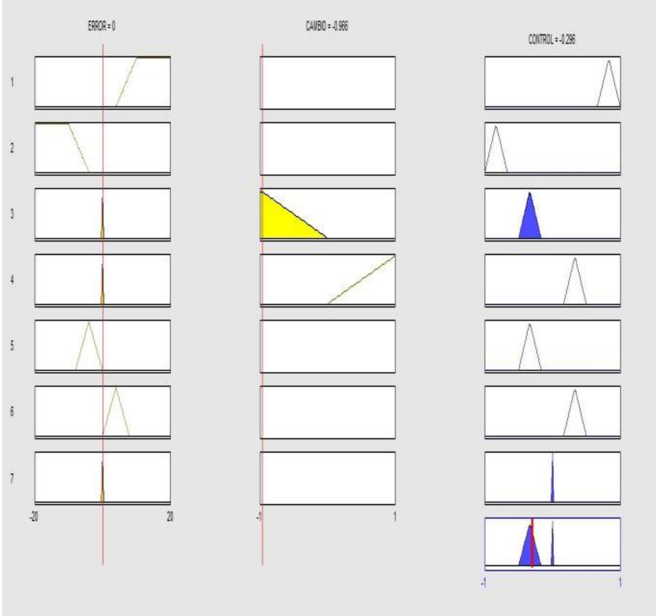
Fig. 5. Fuzzy Rules

VII. Modes Of Operation

A. Mode1

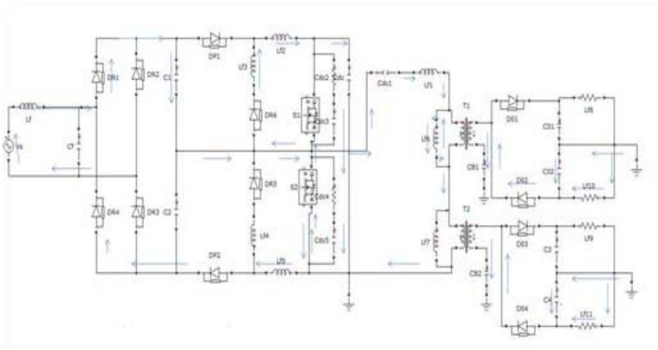
Fig. 6. Current flow in direction in mode 1

This mode operation starts with the one switching cycle for the positive input suppy input voltage when the power switch S2 is triggered on. When S2 is in OFF stage , the current iLr flows through diode D2 and D3 connected in anti parallel and energy is released to the resonanting capacitor Cr, which has soft switching ZVS operation for S2 turn-on. The voltage in magnetizing inductor Lm1 and Lm2 is connected across the transformer 2nVo with negative polarity so that the magnetizing current iLm1 and iLm2 becomes low linearly. The polarity across the inductors are reversed and it will release the energy stored in Lml and Lm2 through D2 and D4 to LEDs and also , the winding starts charging iL3 slowly from null value. The dc supply voltage Vdc reverse biases the winding L1 and L2 and discharge to the dc-bus capacitor.

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B. Mode2

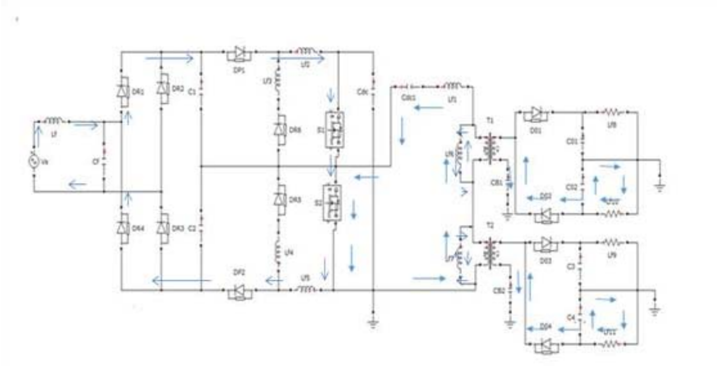

Fig. 7. Current flow in direction Mode2

With reference to Fig 7, the current through the resonant inductor flows in the opposite direction and ILr is reversed, the energy shifts from resonating capacitor Cr to the Lr. Lm1 and Lm2 will be in ON stage until their currents reaches zero. As the inductor L3 stores the charge iL3 raises rapidly and the polarity of the inductor L1 and L2 is reversed, therefore, iL1and iL2 remain decreasing, as done in mode 1.This mode completes only when iLm1 and iLm2 reach zero.

C. Mode3

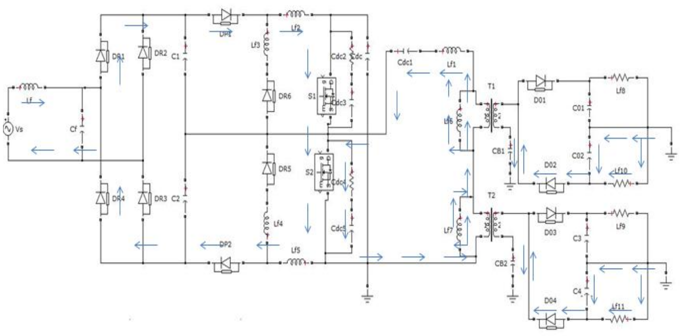

Fig. 8. Current flow in direction Mode 3

This operating mode starts with the decreasing current iLm2 and become negative. Both Cr and Lr release energy to the output. The voltage across Lm1 and Lm2 remains no change as in mode 2 hence iLm1 flows through both LEDs parallelly as shown in Fig 8.

D. Mode 4

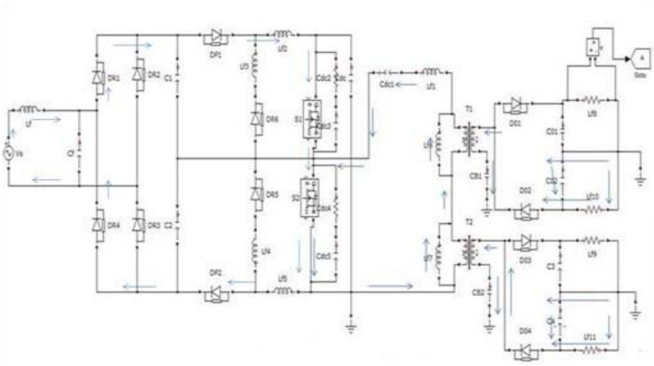

Fig. 9. Current flow indirection Mode 4

This mode operates when the inductor currents iL1 and iL2 reaches null set. The high power-factor can be achieved by triggering the switch S1 when the current reaches zero. The current flow direction is shown in Fig 9.

E. Mode5

Mode 5 refers to the equal inductor currents in iLr and iLm. Current flows in the diodes Do2 and Do4 decrease to null set to commutate by soft switching technique. The magnetizing inductance are connected with Lr, and resonate with Cr. Fig10 identifies the direction of current in this duration. iL3 is grows up with time untill MOSFET S2 is commutated.

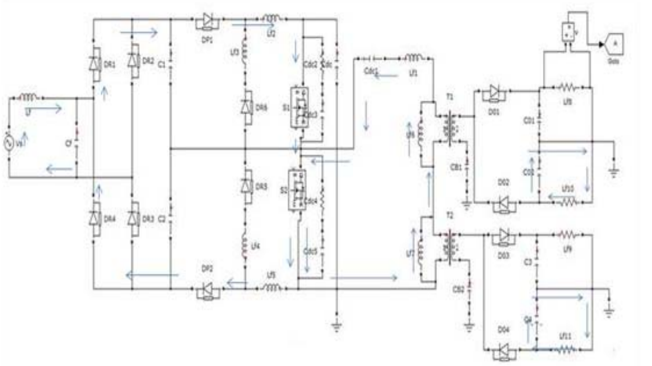

Fig. 10. Current flow in direction Mode5

F. Mode6

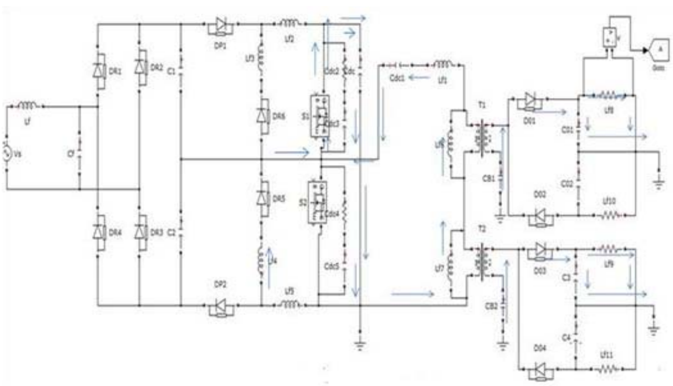

Fig. 11. Current flow in direction Mode 6

As S2 switch is in ON state, the resonant current iLr in C1 is discharging as the capacitor act like a battery the charge stored in it has to discharge and hence the polarity is reversed and charging through C2 with the positive polarity on its left plate. During this instant of time, the diodes Do1 and Do3 are forward biased. The current iLm1 and iLm2 increases linearly throughout. Lml and Lm2 are not connected with Lr and Cr under same resonant frequency. When the S1 is in ON state under ZVS. iL3 is equal to the current in L1. The MMF should maintain balance in ampere turns. The inductor current iL3 decreases drastically at t5.

G. *Mode7-12*

In the proposed converter module, the operation of the second half cycle (Mode 7 to mode 12) are same as the operation of the first half cycle as mentioned in the above six modes. Mode 1 starts with providing gate pulse for S1. Similarly her mode 7 starts with providing gate pulse Vgs2 to put S2 on conduction under ZVS at t = t2.

VIII. EXPERIMENTAL RESULTS

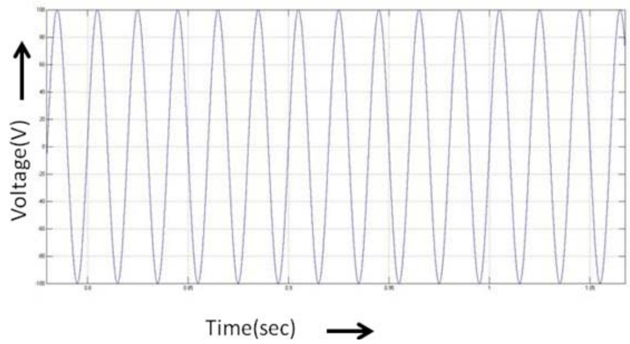

Fig. 12. Input voltage

The fig 12 shows the input voltage given to the proposed system. Input voltage given is about 100v and the voltage given is ac. As the voltage given is AC, a sinusoidal waveform is obtained. In the graph, time (sec) is taken along the X-axis and voltage (V) is taken along the Y-axis. The input voltage is taken for a time period of 1.05 secs.

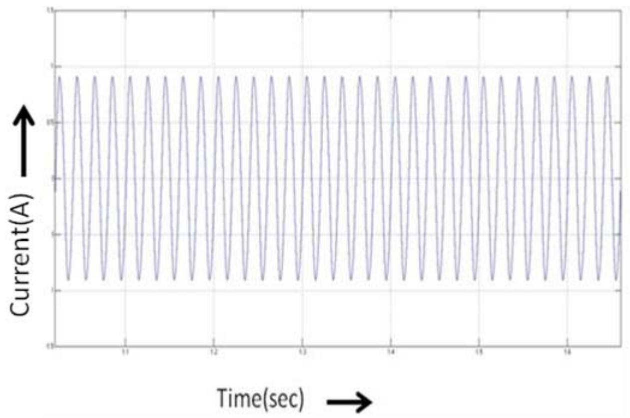

Fig. 13. Input current

The input current given to the proposed system is about 0.85A and the current given is ac is shown in fig 13 . As the current given is ac, we can notice a sinusoidal waveform ranging between +0.85 and -0.85. In the graph, time (sec) is taken along the X-axis and current(I) is taken along the Y -axis . The input current is taken for a time period of 1.5 seconds.

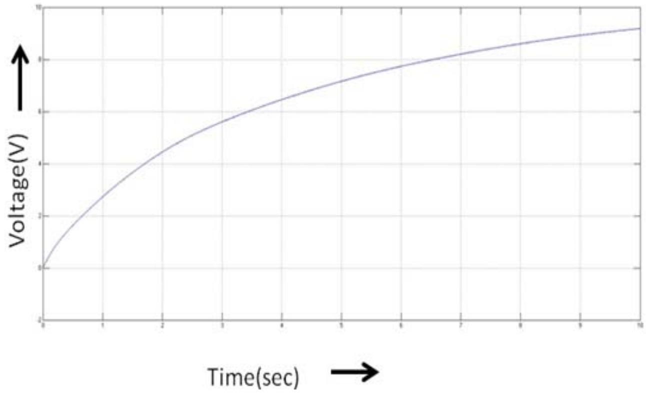

Fig. 14. Out put voltage at LED

The fig14 demonstrates the yield voltage got from the proposed framework. The yield voltage acquired is around 8.9 v and the yield voltage got is dc. As the yield voltage got is dc, a swell free chart in the positive hub is acquired. In the chart, time (sec) is taken along the X-hub and voltage (v) is taken along the y-pivot. The yield voltage diagram is taken for a period interim of 10 sec.

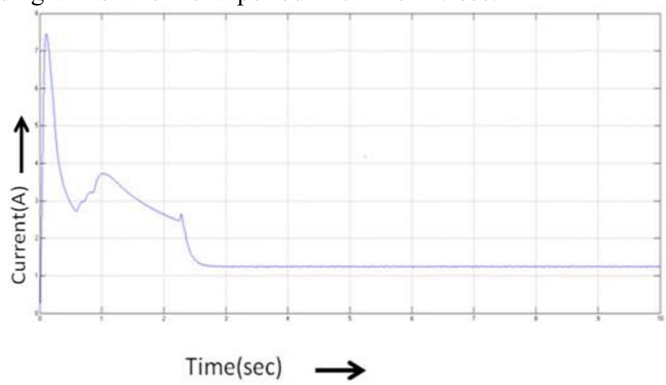

Fig. 15. Out put current at LED

The fig 15 demonstrates the yield current acquired from the proposed framework. The yield current acquired is around 1.25A and the yield current got is dc. As the yield current got is dc , a swell free diagram in the positive hub is gotten. In the diagram , time(sec) is taken along the X-hub and current(I) is taken along the y-pivot. The yield current diagram is taken for a period interim of 10 sec.

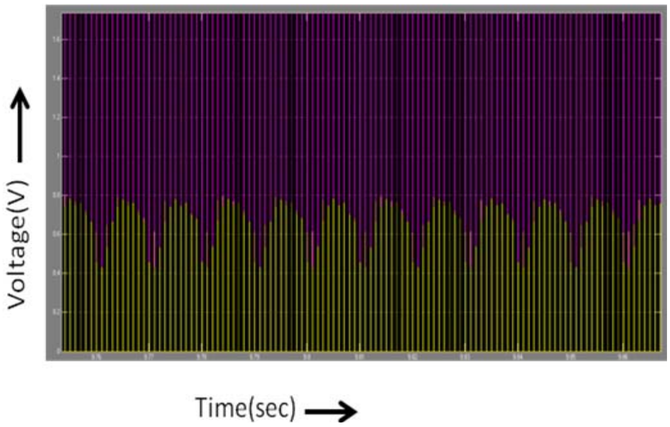

Fig. 16. Switching losses

The fig 16 demonstrates the changing misfortunes got from the proposed framework. The exchanging misfortunes got is around 0.8 v and the exchanging misfortunes acquired is dc. As the exchanging misfortunes got are dc, a diagram in the positive pivot is gotten. In the diagram, time (sec) is taken along the X-pivot and voltage (v) is taken along the y-hub. The yield current chart is taken for a period interim of 10 sec.

IX. THD ANALYSIS

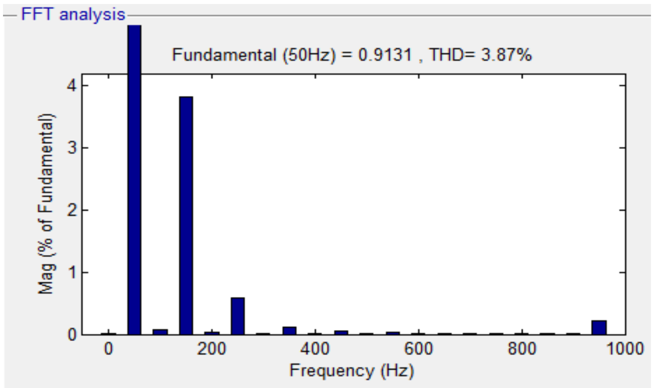

Fig. 17. FFT Analysis

Total harmonic distortion obtained for The the existing system is 5.82% and it is decreased to 3.87%. The THD analysis is taken for 10 cycles

X. POWER FACTOR CORRECTION

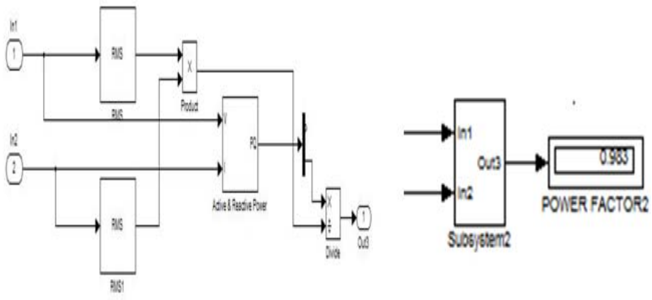

Fig. 18. Power Factor correction

The power factor correction circuit is shown in fig 18. The power factor obtained for the existing system is 0.983.

XI. CONCLUSION

By sharing force switch, utilizing various transformers and utilizing a snubber circuit the proposed system is effectively utilized for performing multichannel LEDs with more power yielding element. PFCs with cascaded operation are incorporated with a LLC converter to shape the modified single stage circuit. The circuit is improved because of reduced number of switches and fuzzy based controller. Softswitching results in enhancing framework effectiveness. Test aftereffects of the proposed framework have really proved that powerfactor of 0.983 with diminished THD of 3.87% and sharing the current between LEDs can be achieved by the buck-boost multi-port LED. Fuzzy Logic Controller is utilized to control the yield voltage to be given to drive the LED.

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