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Performance Investigation of Single Phase AC/DC Power Factor Corrected Boost Converter for PHEV Battery Charger

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Abstract: ***Air conditioning DC Converters are the most significant segment of the battery charger in Plug-in Hybrid Electric Vehicles (PHEV). By and large used AC/DC Power Factor editing (PFC) topologies in PEHV battery chargers are standard PFC bolster converter, interleaved PFC help converter and Bridgeless PFC help converter looking the obstacles of the above topologies BLIL PFC bolster converter has been created. In this paper customary PFC bolster converter and bridgeless interleaved PFC Boost topology has been arranged and imitated using MATLAB/SIMULINK. A short definite expository model of this topology has been displayed in this paper. Bridgeless interleaved PFC help topology was worked for the obligation cycle D>0.5 and D<0.5. By utilizing bridgeless lift converter topology misfortunes of the framework are decreased, improved capability of the plan has been cultivated .The area of the charger, charging time and cost of power tired from the service of PHEV are diminished. The information execution, for example, Total Harmonic Distortion and power factor for the two topologies was acquired and examination was made. Keeping AC supply voltage of converters 240V at exchanging recurrence of 69.77 kHz with 4.4 kW burden determined THD is not exactly or equivalent to 5% and effectiveness is 98.9% from half burden to full load. Along these lines paper features the improved THD with limited misfortunes with given topologies.***

Keyword: AC–DC converters, boost converter, bridgeless (PFC) interleaved PFC, plug-in hybrid electric vehicle (PHEV) charger.

I. INTRODUTCION

PHEV is a rechargeable battery or, as an energy storage device, they are fully charged for connection via an external power source [1]. The most common charger is the AC input filter connected to the input side of the systems, the PFC AC / DC method [2] and the DC output filter are correctly connected to the output side of the system. PFC air conditioning dc topologies are fundamental to conform to administrative necessities for info current music and the usage of rectification of information power factor. The front AC-DC pastor is a key segment of the framework battery charger. The right choice of this topology is fundamental to meet the administrative necessities for the info current music [3] - [4], the guideline of the yield voltage and the usage of the power factor adjustment [6].

Fig 1.Block diagram of charging system

II. REVIEW OF COMMON AC–DC PFC TOPOLOGIES.

The conventional pulse converter, the bridgeless pulse converter and the interleaved pulse converter are controlled for application in the AC-DC front-end conversion for charging the PHEV battery in the following subsections.

A. Conventional Boost Converter

The essential cooling/DC power factor the right topology is a PHEV battery charger. The usual PFC help converter is used as a diode connection rectifier that can be changed to the air conditioning input voltage at a controlled DC supply voltage, as appeared in the figure 1. The reconsidered yield voltage is given to a nursery emanation encourage convertor once the data voltage is adventure up .At that centers it's worked in 2 strategies for activities. Inside the essential mode, of activity switch are shut, starting at present inductance can charged to its divine point estimation of give voltage (VL) [4].Right once inductors are charged then capacitance can support the best voltage over the heap. during the time strategy for development switch are open, the inductance can release through

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the heap then the yield capacitance swell current is high [8] .the swell current is that the unpredictability between the rectifier current and in this manner the reconsidered dc yield current. For sure, by the by the capacity levels of the convertor are additions.

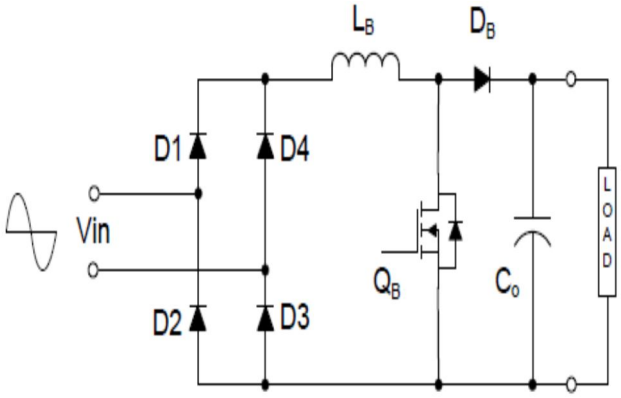


Fig 2. Conventional PFC boost converter

B. Bridgeless Boost Converter

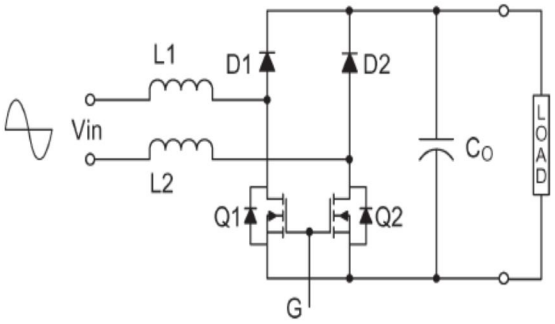


Fig.3.Bridgeless PFC boost converter

The bridgeless raise nursery outflow topology doesn't required the AC/DC explored information interface, it's 2 methodology for activity, all through the fundamental half cycle of activity MOSFET switch one and 2 are worked, by then inductors can charged through the way, input voltage - L1-Q1-Q2 (body diode) - L2-input give. At the reason once the MOSFET switches are off, the inductors can release the essentialness through the path inside which information supply-L1-D1-Load-Q2 (body diode)- L2-input give. All through the negative 0.5 cycle of development the voltage over the inductance L1 and L2 can rises and in this way the blessing courses through the way, Supply-L2-Q2-Q1 (body diode) L1-supply voltage. Precisely once the switches are off, the inductors L1 and L2 can release through the way: L2-D2-Load-L1-supply. The premier significant loads of this technique it's offered expanded Electrical Magnetic Interference and drifting data through the nursery outflow stage ground [5].

C. Interleaved PFC Boost Converter

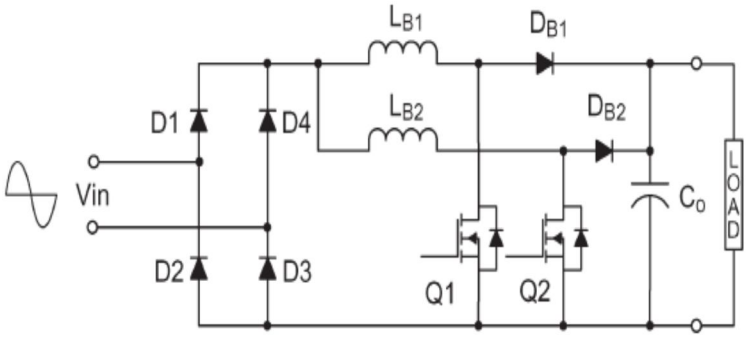


Fig. 4. Interleaved boost converter

Interleaved bolster converter are involve two lift converter are working in parallel anyway 180^0 out of stage [9]–[10].when the two converter are related out of stage with respect to each other, by then the swells of the present will be drop to each other and the size of the channel are decreased. It has two handles Q1 and Q2 through the essential half cycle the switch Q1 will be on, the inductance LB1 can start to charge. Right once the flip Q1 is off the inductance can start to release through the diode DB1. all through the negative 0.5 cycle of progress the switch Q2 can on , The inductance LB2 can start to charged .when the flip Q2 is off the inductance can start to release through the diode DB2.The one most fundamental hindrance of the interleaved PFC gadget is that the outcome scenes are high a postponed result of data diode help rectifier.

D. BLIL PFC Boost Converter

Bridgeless Interleaved PFC support gadget is that a similar gadget that tallies the interleaved lift converter. BLIL ozone depleting substance support gadget presents 2 a great deal of MOSFETs and two all the more snappy diodes in situ of four moderate diodes utilized.

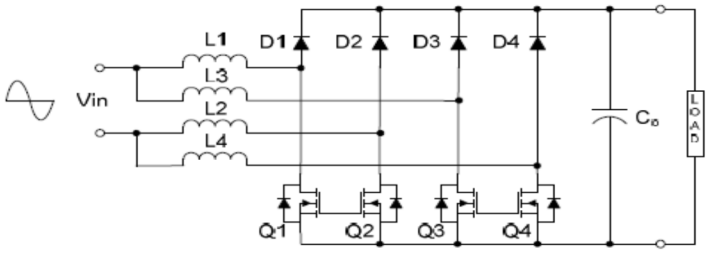


Fig.5. BLIL PFC boost converter

In the information extension of the interleaved lift PFC converter. The circuit outline of the BLIL help converter is indicated Fig 4. The circuit activity can be isolated into two method of activity one is certain half cycle and another is negative half cycle task. This kind of activity is relying upon the turn ON/OFF time of the converter switches, and the circuit tasks are additionally relies upon the obligation cycle (D) of the converter .The opening circuit task for the supporting half rotation and negative half cycle (D<0.5 and D>0.5).

E. Positive Half Cycle Operations

In the event of half cycle, once the MOSFET switches one and two are operated, at that time inductors one and two get charged through the method input voltage- L1-Q1-Q2 - L2 -input provide. At the purpose once the switches Q1 and Q2 are killed, inductors L1 and L2 unleash through the method provide - L1 - D1 - Load - Q2 - L2 - provide. The availability voltage aboard the voltage over the inductance can show up over the heap, which is able to produce a helped voltage over the heap. Throughout the interleaving task, the switches Q3 and this fall are going to be worked with a stage slack of 180^0. At the purpose once the switch Q3 and this fall are turned on, the inductance L3 and L4 can get charged through the way: provide - L3 - Q3 - this fall - L4 - provide. At the purpose once the switches Q3 and this fall are killed, inductors L3 and L4 can get discharged through the way, provide - L3 - D3 – Load - this fall - provide. because the switch try Q1, Q2 and Q3, this fall are worked at a stage move of 180^0, the swell current in 2 inductors L1 and L3 are against stage with each other, therefore web swells within the info current can get born and on these lines decreasing the all out harmonious accidental injury in positive 0.5 cycle.

F. Negative Half Cycle Operation

During the negative 0.5cycle, once switch Q1 and Q2 are turned on the electrical device L2 and L1 get charged through the way: offer - L2 - Q2 - Q1 - L1 - offer. At the purpose once the switches Q1 and Q2 are killed, inductors L2 and L1 can unharnessed through the way: offer - L2 - D2 – Load - Q1 - L1 - offer. Just like the interleaving task in positive 0.5 cycles, the switches Q3 and this autumn are worked with a stage slack of 180^0. Yet, once the switches Q3 and this autumn are turned on, the inductors L4 and L3 can get charged through the way: offer - L4 - this autumn - Q3 - L3 - offer. At the purpose once the switch Q3 and this autumn are killed, inductors L4 and L3 can unharness through the approach offer - L4 - D4 – Load - Q3 - L3 - offer. Since the swell current in 2 inductors L2 and L4 are hostile to stage with each other, internet swells within the data current can get born and consequently decreasing the whole harmonious bending in negative 0.5 cycle.

III. SIMULATION RESULTS& DISCUSSIONS

Conventional power issue remedy bolster convertor related bridgeless interleaved power factor amendment encourage converter with a commitment extent a great deal of significant than 0.5 and beneath 0.5 are repeated using MATLAB. The arrangement angle power issue amendment and IL activity that will build as results of dropping of swells in BLIL fluorocarbon encourage convertor are showed up inside the accompanying components.

A. Analysis of Conventional PFC Boost Converter

The regular PFC help converter is mimicked with obligation proportion more noteworthy 0.5. The recreation graph appeared in Fig. 7.

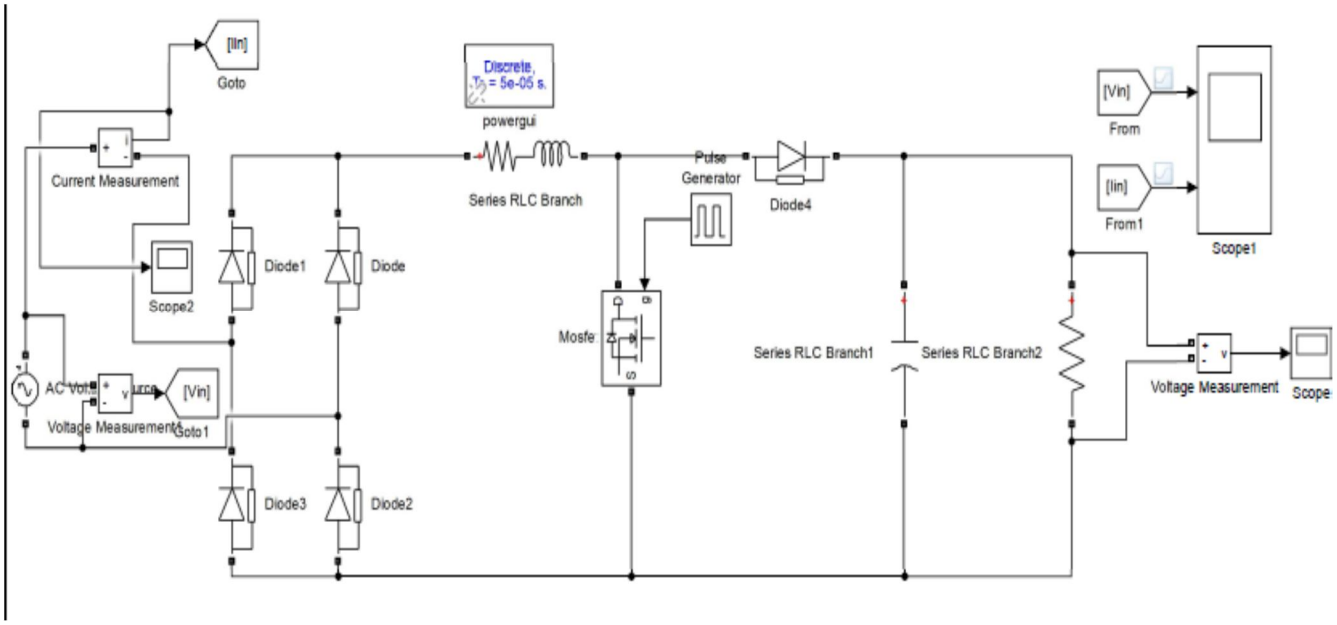


Fig 6.Simulinkmodel of conventional PFC boost converter

The information of voltage and current waveform of PFC boost converter is shown in 6. Info current slacks voltage because of the inductive impact of the converter. The slack in information current can be determined from the waveform appeared in Fig. 7. The exchanging activity of the MOSFET will produce swells at the contribution of the converter which will build the absolute symphonious bending of the converter. The absolute symphonious bending of the converter can be acquired with FFT analyzer device. The perceptions produced using the investigation of regular PFC support converter is given beneath.

1) The whole symphonious contortion gotten by utilizing FFT examinations instrument is 15.66%.

2) The lingering of current lag the voltage for example the relocation factor K_d = 0.6235.

3) The power factor determined from over two perceptions is 62.48%.

Simulation parameter of conventional PFC boost converter (supply voltage is 20V, D= 0.6, L=1.1 MH, C=800µF, R=28 ohm, switching frequency is 35 kHz).

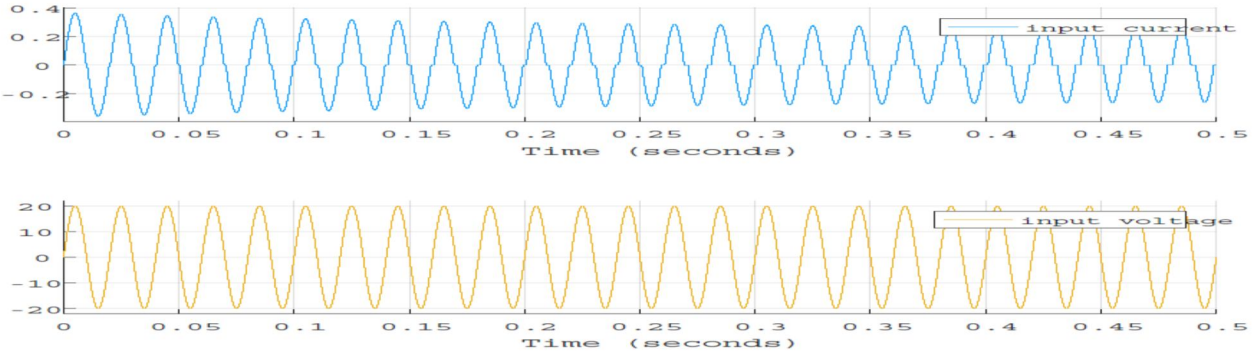


Fig. 7.Waveform of input current & voltage of conventional boost converter.

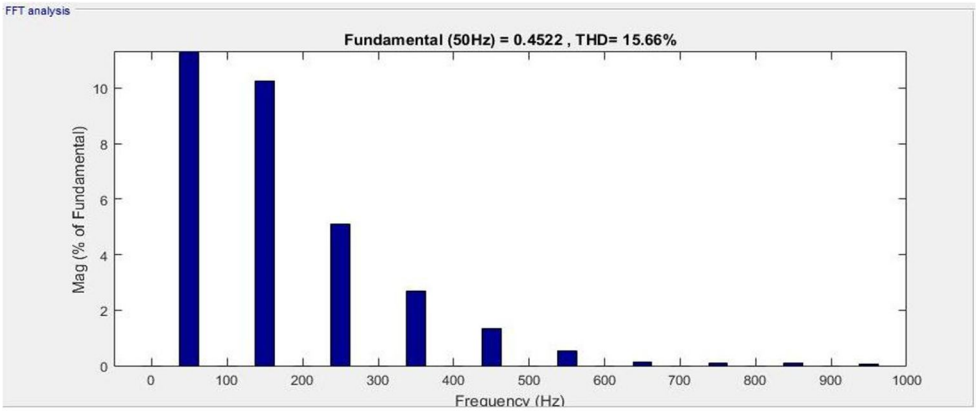


Fig.8. FFT study of Conventional PFC boost converter.

B. Study of BLIL PFC Boost Converter when Duty cycle < 0.5

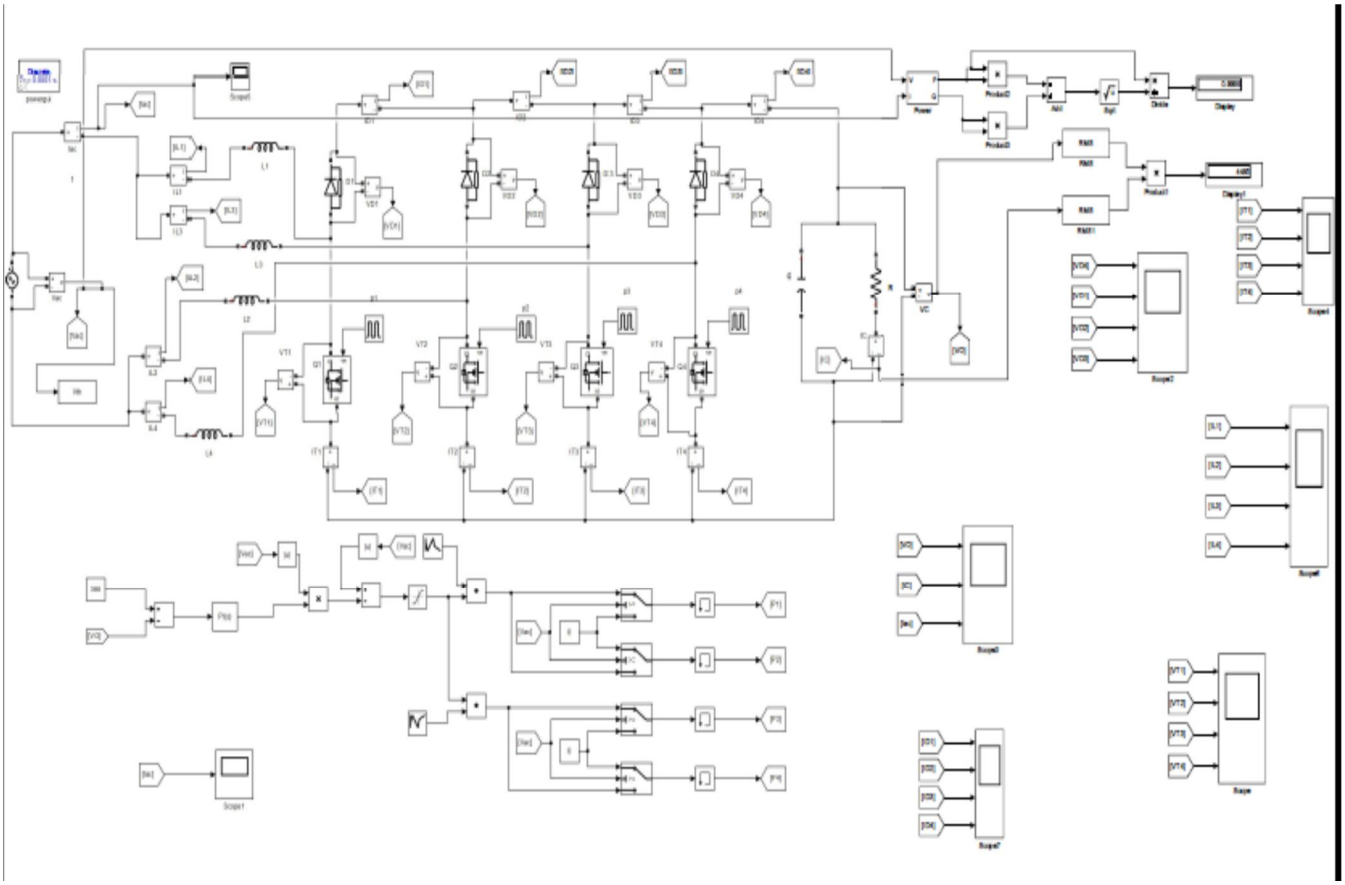


Fig. 9.Simulation model of BLIL PFC boost converter

The activity of the BLIL PFC help converter when the duty cycle is under 0.5 is reproduced with reproduction outline and with the recreation parameters Converter the inductive impact will get dropped. The information of current can be determined from the waveform The interleaving activity in positive half cycle will drop the swells in inductor flows IL1 and IL3.The swell crossing out in Input voltage and current waveform of the converter. With interleaving task in BLIL PFC help inductor flows IL1 and IL3 during the positive half cycle activity is similarly during the negative half cycle swells in inductor flows IL2 and IL4 will drop one another.

1) Complete symphonious contortion got from FFT investigations instrument is 4.47%.
2) The falling of current lag the voltage for example dislodging factor Kd= 1.
3) The power factor determined from over two perceptions is 99.7%.

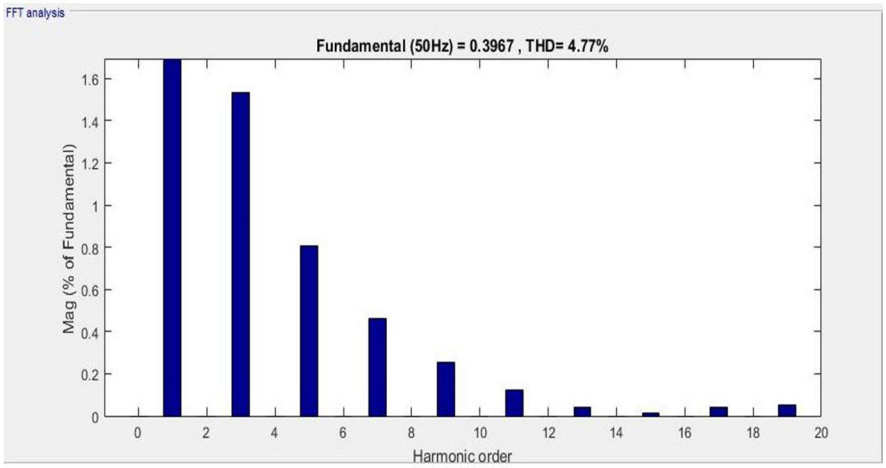


Fig 10.FFT study of BLIL PFC Boost converter when Duty cycle <0.5.

C. Study of BLIL PFC Boost Converter when Duty cycle >0.5.

BLIL ozone harming substance bolster convertor with commitment extent extra recognized than 0.5 is reproduced with reenactment chart and with the copy parameters are given in simply like the IL movement in BLIL ozone depleting substance encourage convertor with a commitment extent underneath 0.5 the inductive effect and furthermore the swells in inductors streams are drop one another. The leeway data of flow will be resolved from the undulation the swell withdrawal in electrical gadget streams IL1 and IL3 all through the positive cycle exercises in negative half cycle the swells in inductor streams IL2 and IL4 can drop one another. Since the in activity time of the switches is over the in BLIL ozone harming substance encourage convertor with commitment extent more than zero.5 the swell withdrawals are extra during this convertor. along these lines appeared differently in relation to BLIL ozone depleting substance encourage convertor with commitment extent underneath 0.5 and normal ozone harming substance bolster convertor the full scale symphonic incidental damage are less in BLIL PFC encourage converter with commitment extent extra recognized than 0.5. The swell cancelations are extra during this convertor. along these lines appeared differently in relation to BLIL ozone depleting substance bolster convertor with commitment extent underneath zero.5 and old ozone depleting substance encourage convertor the hard and fast consonant bending are less in BLIL PFC support converter with obligation proportion more noteworthy than 0.5.

1) All out consonant bending got from FFT examination device is 3.28%.
2) The waiting of current behind the voltage for instance the migration factor Kd = 1.
3) The power factor determined of two perceptions is 99.99%.

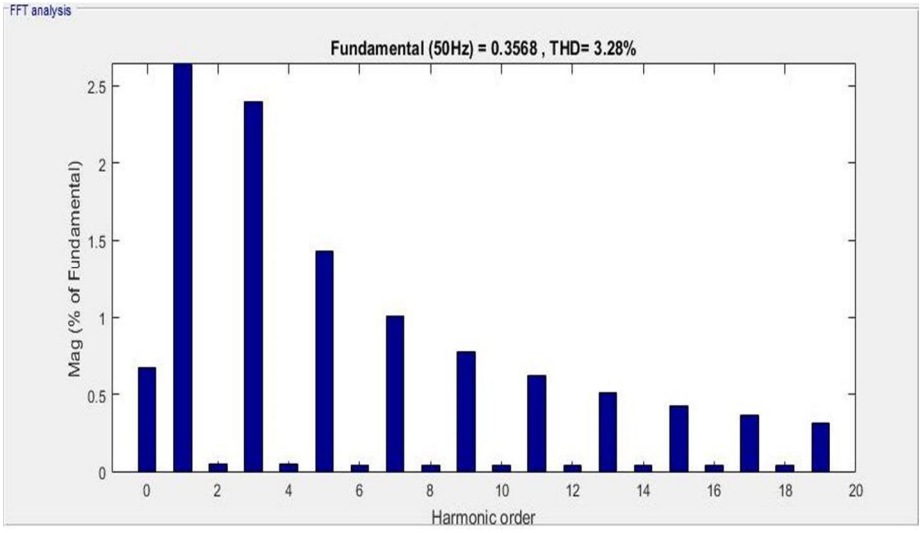


Fig11. FFT study of BLIL PFC boost converter when Duty cycle > 0.5.

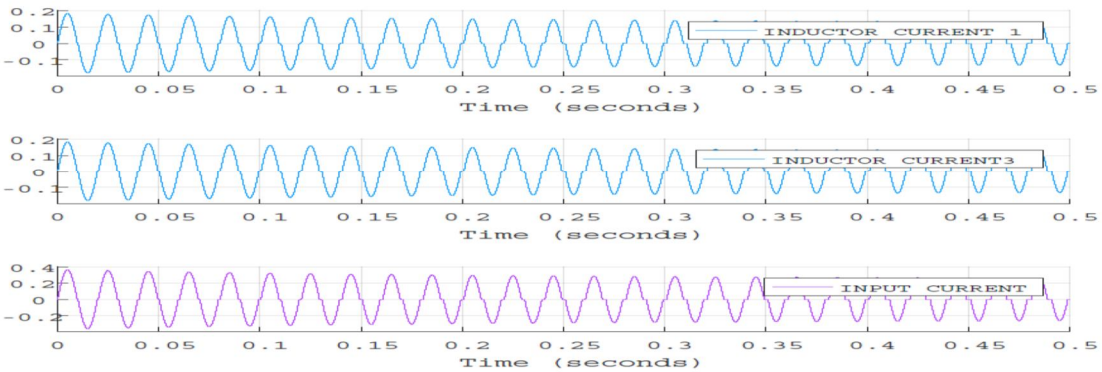


Fig.11. Interleaving operation across IL1 &IL3, BLIL PFC boost converter D>0.5.

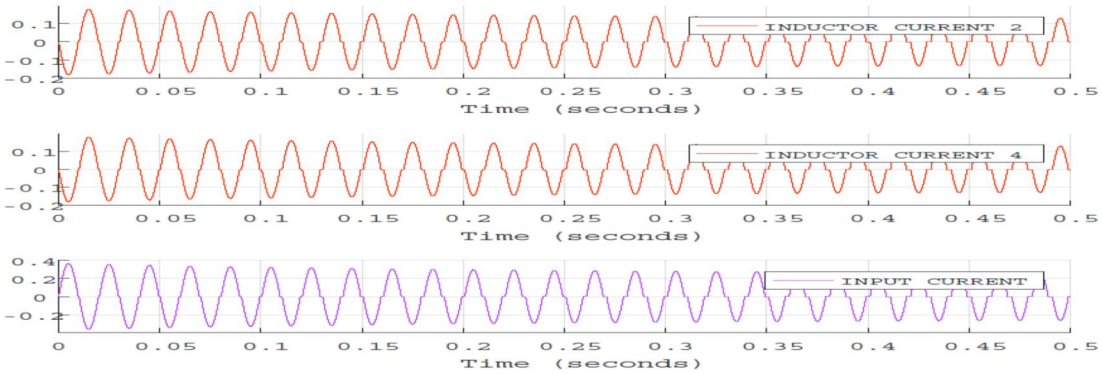


Fig12.interaling operation across IL2 &IL3 In BLIL PFC boost converter when Duty cycle>0.5.

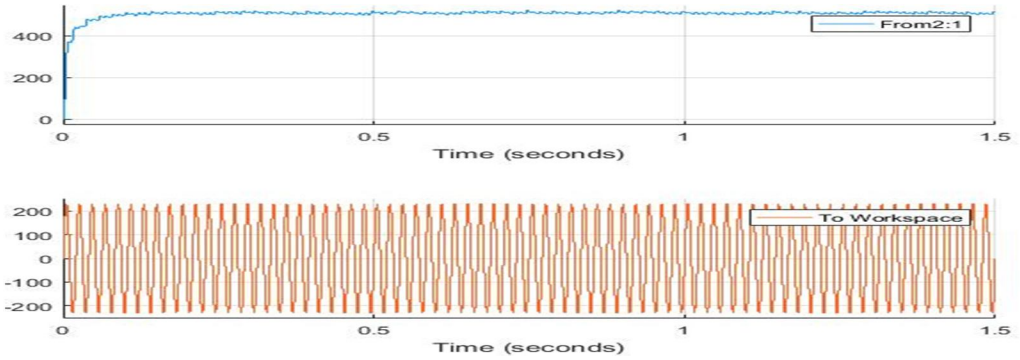


Fig13. Input & output voltage waveform at 550v (input supply is 230

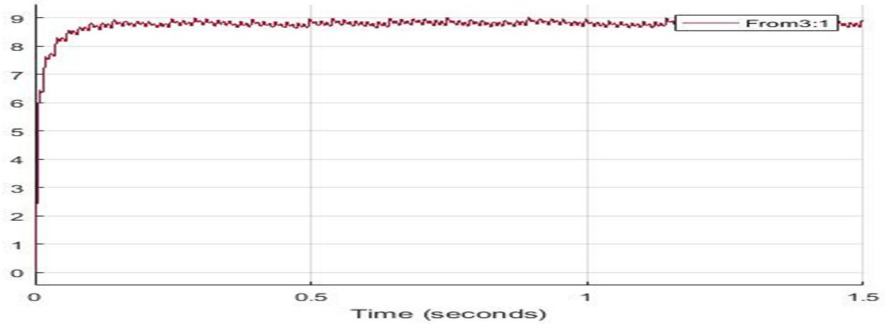
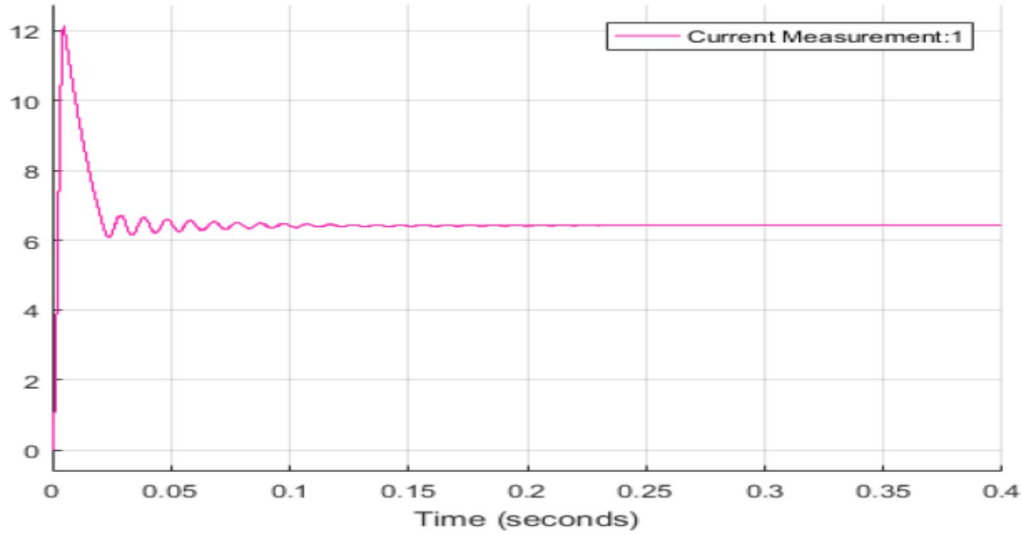
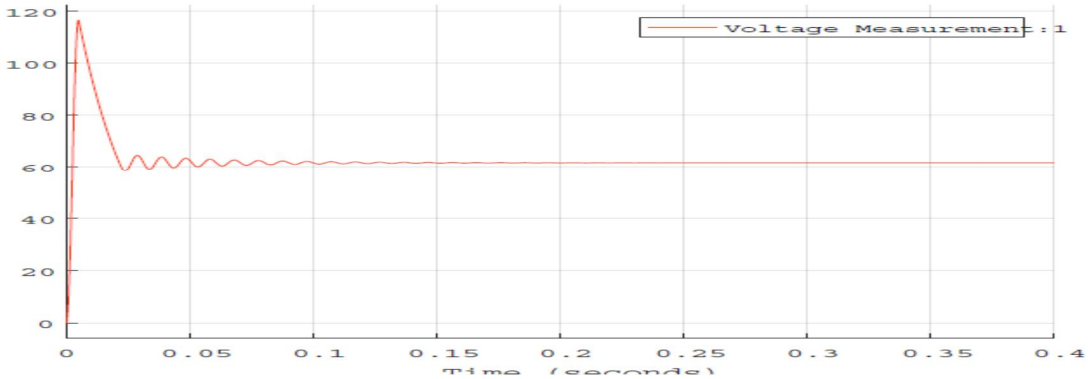


Fig14. Load current waveform



(a)



(b)

Fig15. Output current and voltage boost converter waveform on 40V input supply.

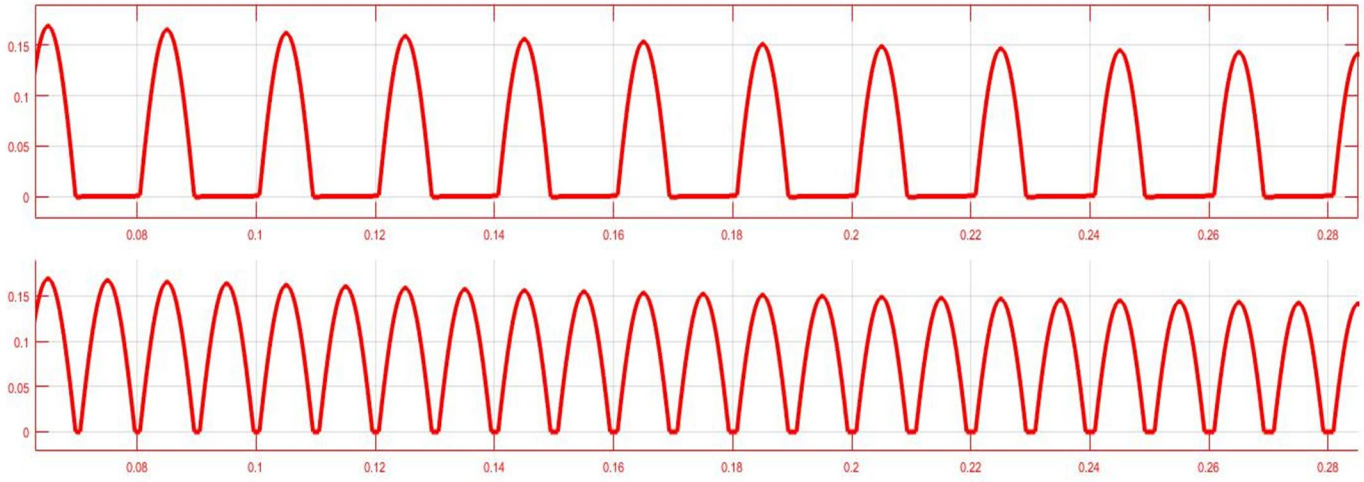


Fig 16.Current through diode.

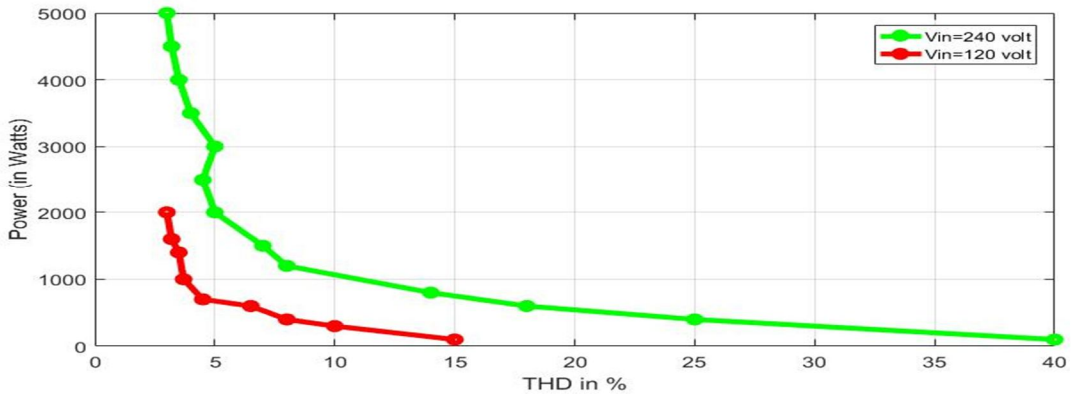


Fig 17.Output Power vs THD Po =1.9Kw for 120 input supply & P0= 4.4kW for 240 input supply.

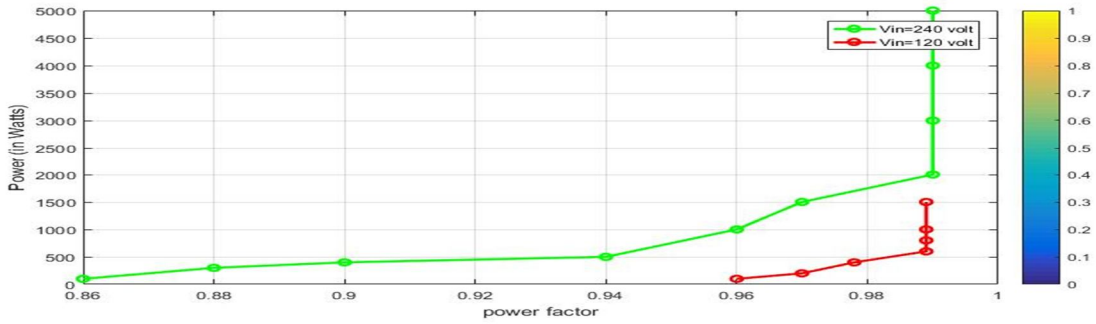


Fig.18. Output power Vs. power factor

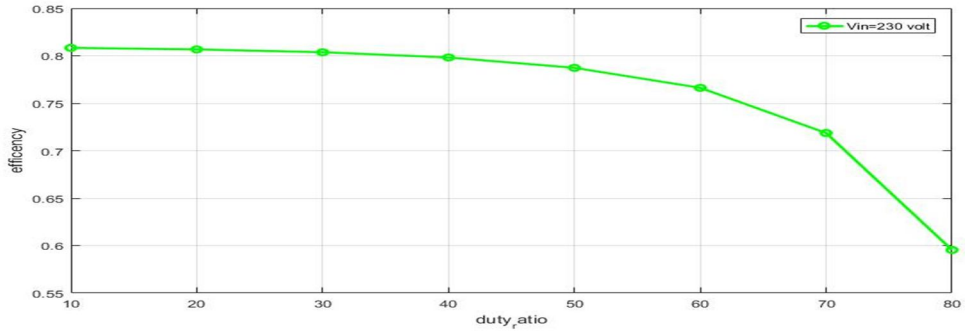


Fig 19.efficency vs duty ratio

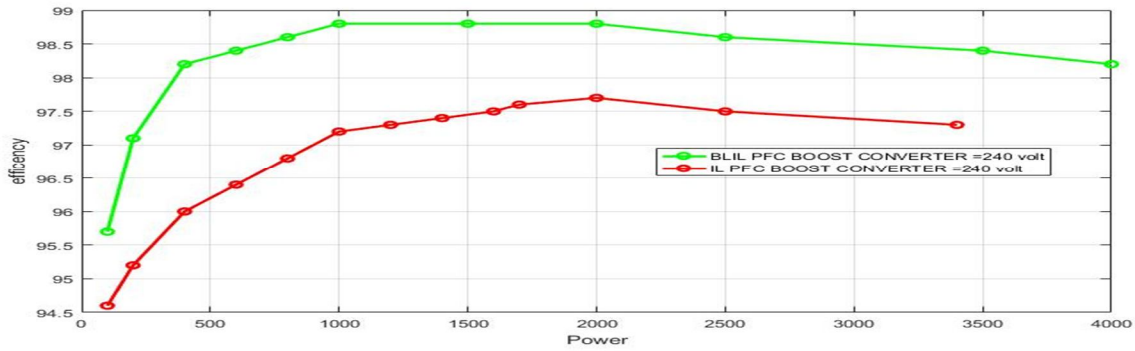


Fig.20. Efficiency Vs. Power

IV. CONCLUSION

Customary greenhouse emission facilitate device and BLIL PFC bolster converter are duplicated mistreatment MATLAB/SIMULINK. It had been found that the full symphonic distortion got diminished and also the. Knowledge aspect power issue got improved with BLIL greenhouse emission facilitate device. IL movement for example fixing of the swells at the info is gotten mistreatment propagations. Structure the over the observations plain the BLIL greenhouse emission bolster rectifier may be a prevailing strategy diverged from the customary PFC facilitate rectifier for the module cross breed electrical vehicle battery chargers. Division was obligated the device from the availability if there ought to arise an occasion of event of over current. THD and power issue of common greenhouse emission facilitate device and BLIL PFC bolster converter got from diversions are organized beneath.

Table 1. Compression between THD and Power Factor

converter	THD (%)	PF (%)
Conventional	15.66	63.5
BLIL, Duty cycle <0.5	4.77	99.7
BLIL, Duty cycle >0.5	3.28	99.9

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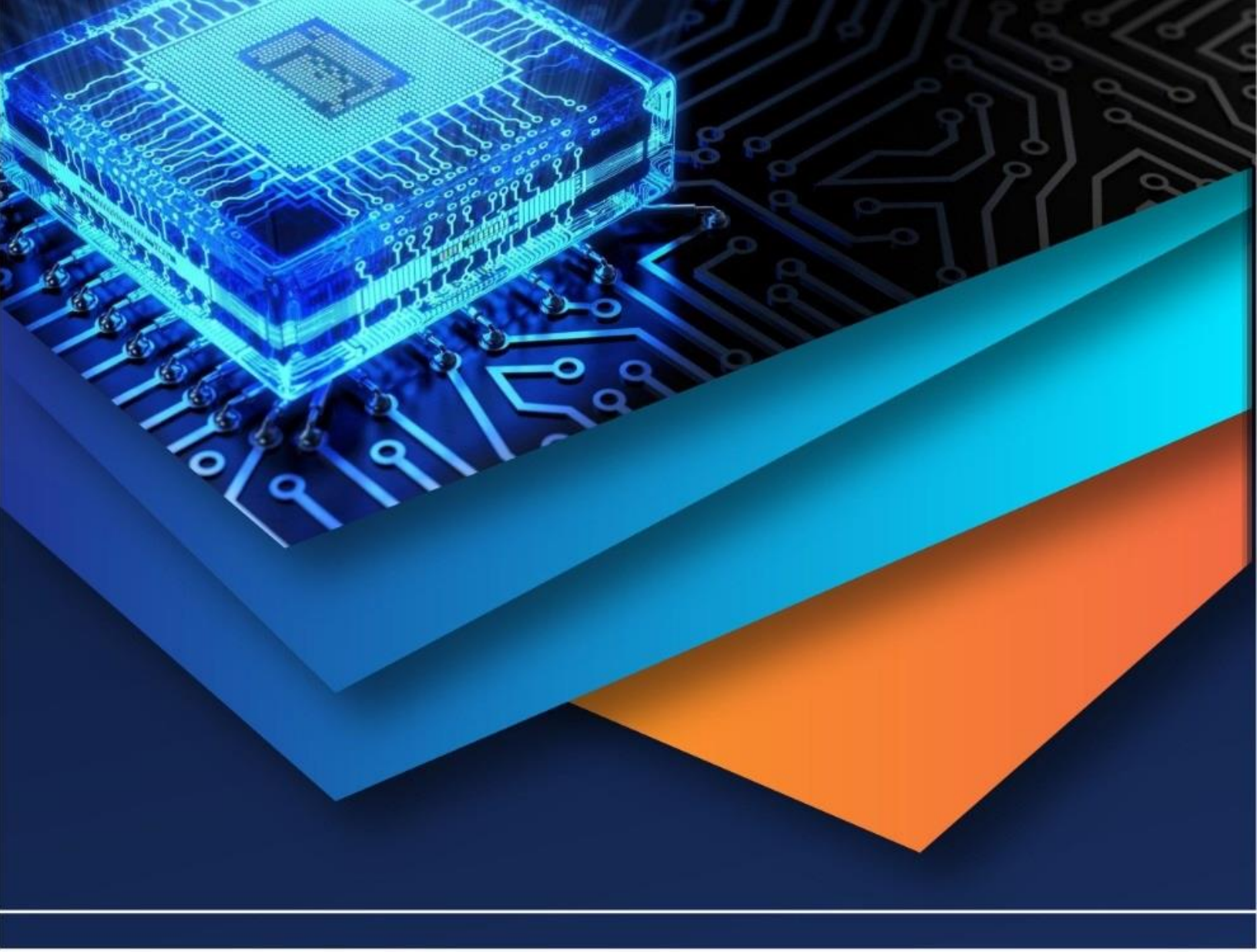

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