Design Of High Attenuation and Less Damping Filter for Renewable Energy Source with Parallel Lrc Component

Sukriti, Sudeep Kumar Mohaney,

Abstract: ***Photovoltaic (PV) panel produces a DC voltage as output which is always having random variations which is further required to convert into a constant DC voltage output, a Voltage Source Inverter (VSI) is the required and further another DC to AC VSI convertor required. VSI used Pulse width modulation (PWM) for switching of metal Oxide semiconductor Field Effect Transistor (MOSFET) and a very fast switch cause harmonics in the circuits, which further need to remove by filters. The available filters are good but reducing either the overall efficiency by 2-3 percentage or giving high damp at resonant frequency. that issue must be resolve, proposed work has come up with a new design in which Parallel LCL-R (PLCL-R) type filter which has high efficiency and high attenuation than previous and better response at high frequencies. Proposed design is been developed with help of Matrix laboratories (MATLAB) Simulink design, where power electronics component tool box 'sim-electronics and sim-escape' used. The results of proposed work found better then LCL filter, TRAP filter and other filters of base works.***

Keywords: Voltage Source Invertors, Pulse width modulation, Photovoltaic, L-Inductor, C-Capacitor, R-Resistor

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I. INTRODUCTION

Inverters with PV panel are highly used in power generation and distribution systems now a days. very high switching frequency of VSI based Direct current to Direct current (DC2DC) and Direct Current to Alternate Current (DC2AC) circuits operates in ranges of frequency from 5kHz to 20kHz and this causes generation of harmonics in output AC supply this harmonics cannot be directly provide to Loading devices and must need to be remove. Selection of different harmonics filters may filter this harmonics but there are certain limitation of available filters as mentioned in table below.

Table 1 Harmonic Filter Analysis

Filter Type	L Filter	LC filter	LCL Filter	LCL-R filter	TRAP filter
Damping	0 db	2.2 db	1.5 db	More than 100 db	9 db
Attenuation	16 db	20 db	22 db	39 db	28 db
Maximum Freq	3.8 Khz	6.21 Khz	11.7 Khz	12 Khz	21.4 Khz

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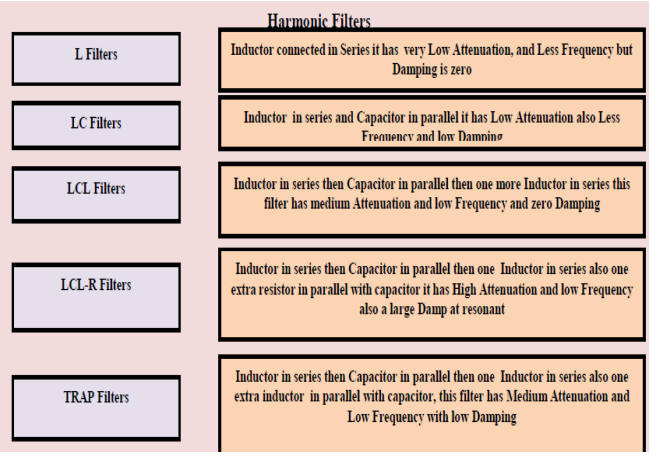

Figure 1 Harmonic Filters types

II. METHODOLOGY

The harmonics are harmful for the load and it is required to have high attenuation of harmonics at the same time also there should be no damping proposed filter is a design which is using Inductor in series then Capacitor in parallel with one inductor in parallel then one Inductor in series then one capacitor in parallel with a extra variable resistor also in last one extra inductor in series. the idea is to merge TRAP filter with LCL-R and L filters in one circuits and to choose appropriate values which can cause very low damping and very high attenuation.

Proposed PLCL-R filter: In proposed work damping is a easy parallel capacitor damping and a variable resistor cause high attenuation for LCL filters, in proposed filter damping is not completely depends resistance it also depends on (C_2 / C1) ratio, which cause less damping with resistance.

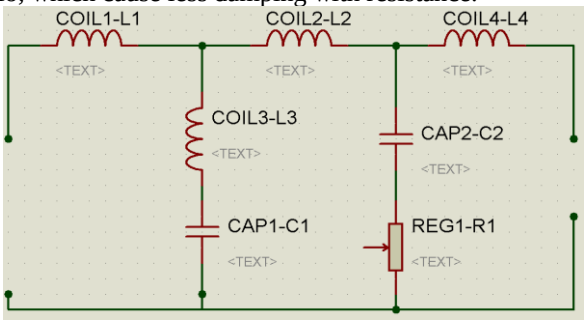

Figure 2: Proposed PLCL-R Filter

Now if we see transfer function

$$\frac{I_{R_f}}{V_{in}} = \frac{1 + sC_2L_4R_1}{s^4C_1C_2L_1L_3L_2 + s^3L_1L_3(C_1 + C_2) + s^2C_2R_1(L_1 + L_3) + s(L_2 + L_3)}$$

L1=1 H, L2=1 H, $L_f = 1H$, $L_d = 1H$ C_f = 1mF, C = 1mF , R=1000Ω and $\omega = 50Hz$

$$TF = \frac{1 + j\omega C_2L_4R_1}{\omega^4C_1C_2L_1L_3L_2 - j\omega^3L_1L_3(C_1 + C_2) - \omega^2C_2R_1(L_1 + L_3) + j\omega(L_2 + L_3)}$$

$$TF = 20\log\left(\frac{1 + j*0.00005*100*10000}{625*100*1000*0.000001*0.00005 - j100*625*\frac{5}{1000} - 10000*\frac{5}{100000}(625 + 1000) + j(100 + 1100)}\right)$$

$$= -74.083$$

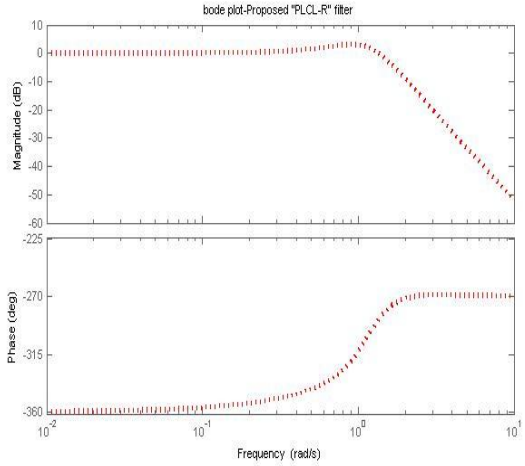

Figure 3 Proposed Filter bode plot

Harmonic tuned order is

$$n = \sqrt{\frac{X_C}{X_L}}$$

And Quality factor is

$Q = nX_L/R = X_C/nR = 0.5$

figure 4 below shows Comparative Results and bode plot for all methods which are been discussed above and plot is been developed for phase and frequency both for figure it may be clearly observed that attenuation and damping in proposed work is best in proposed work.

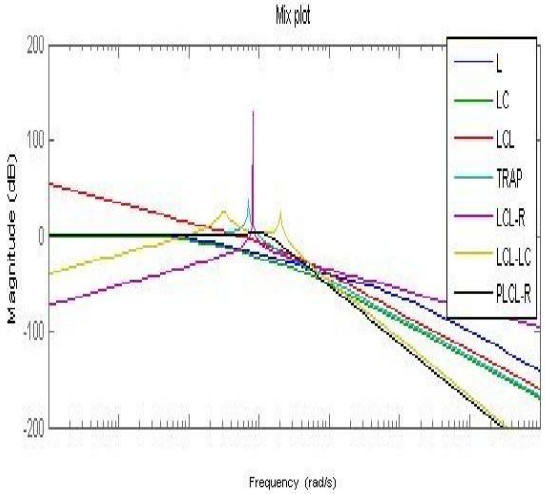

Figure 5 Comparative results

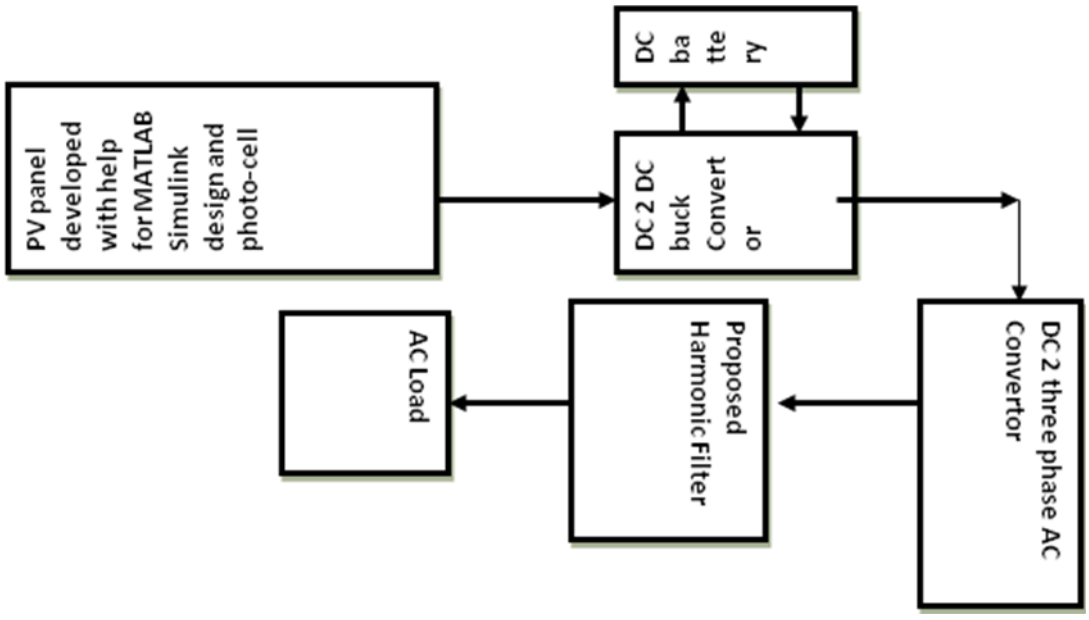

Figure 6 Flow of Proposed Design

Step1: PV panel development as in new version for MATLAB we have new features in its Simulink which is Simscape and Sim-Electronics this allows us to use photo cell as a physical component and also have few convertor like P to S (Physical to Simulink) and S to P (Simulink to Physical), this develops an DC voltage which varies with few control inputs (temperature, Radiation, maximum voltage etc.) given to it.

Step 2: DC 2 DC buck Convertor design is like a regulator which regulate DC input from PV panel and output regulated DC output and also down total voltage to

"$\sqrt{2} * maximum\ voltage\ requirs\ for\ AC$" and to have this if significant amout for sunlight is not there it will get values from DC battery attached with it and if radiation is higher than required it will store DC power into DC battery.
Step 3: Conversion DC input into 3 phase AC supply it is been done with help for Pulse Width Modulation (PWM) and for achieving this necessary a capacitor and a switch. Switch is controlled by PWM and this switch has to be switch at very high speed and this is main problem for generation for harmonics for this we necessary harmonic filter.
Step 4: filtering for harmonics generated during DC 2DC and DC 2 AC conversions, it is been done with proposed filter and harmonics removed with -74 db attenuation and very small damping.

III. RESULTS

Figure 4 shown below are block that is been developed, since design is too big so it is been shown by four various pictures. It may be seen that flow for design is exactly as explain in figure 3.17.

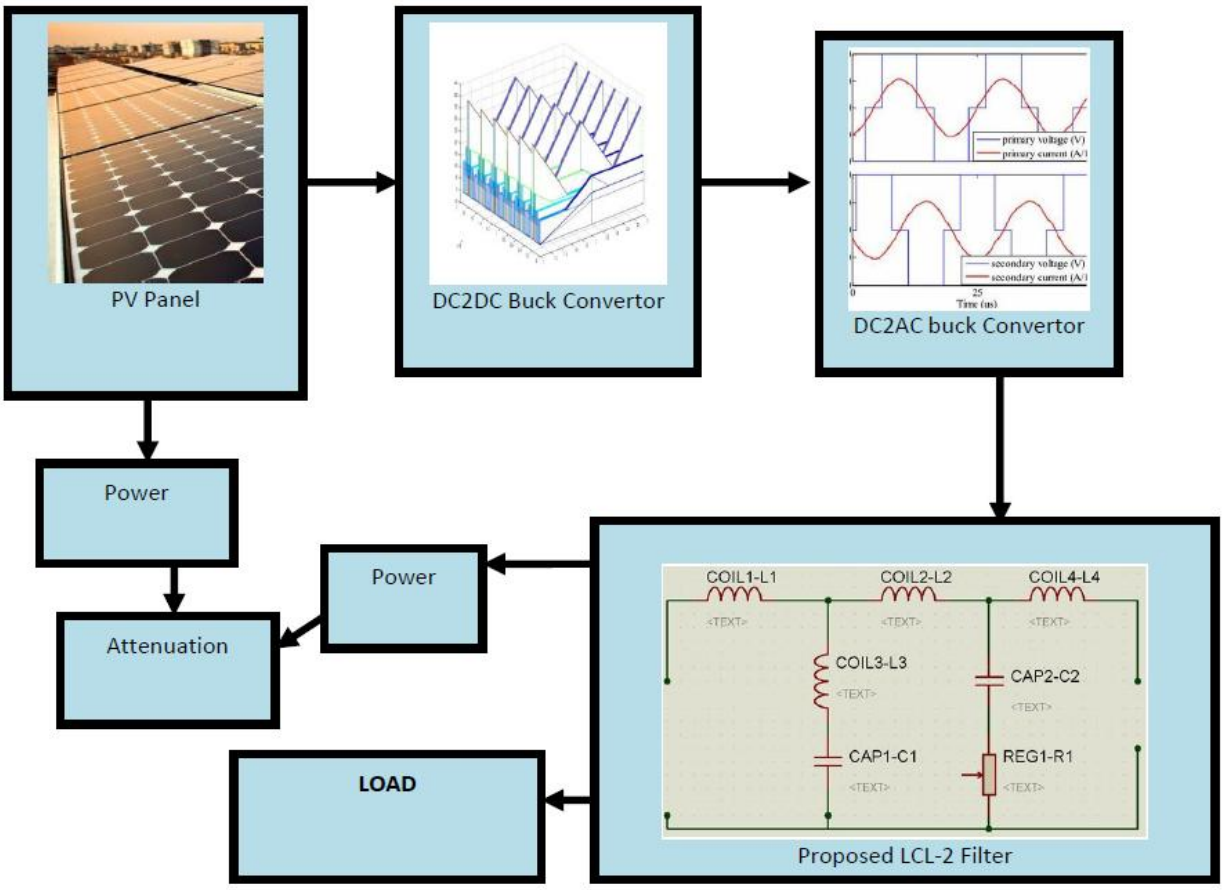

Figure 4 Propose block design

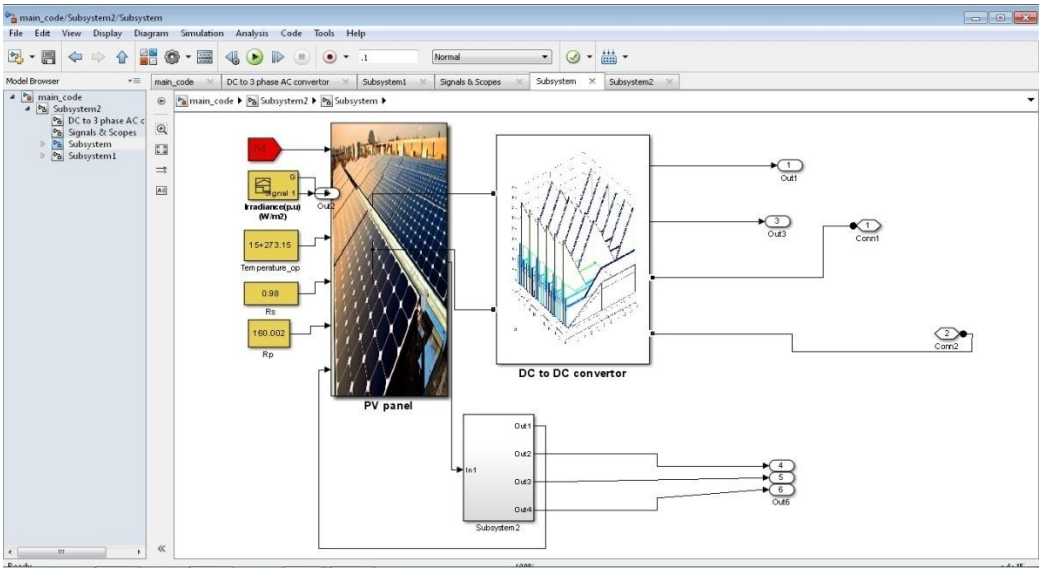

Figure 5 Simulink PV panal and DC2DC buck convertor design

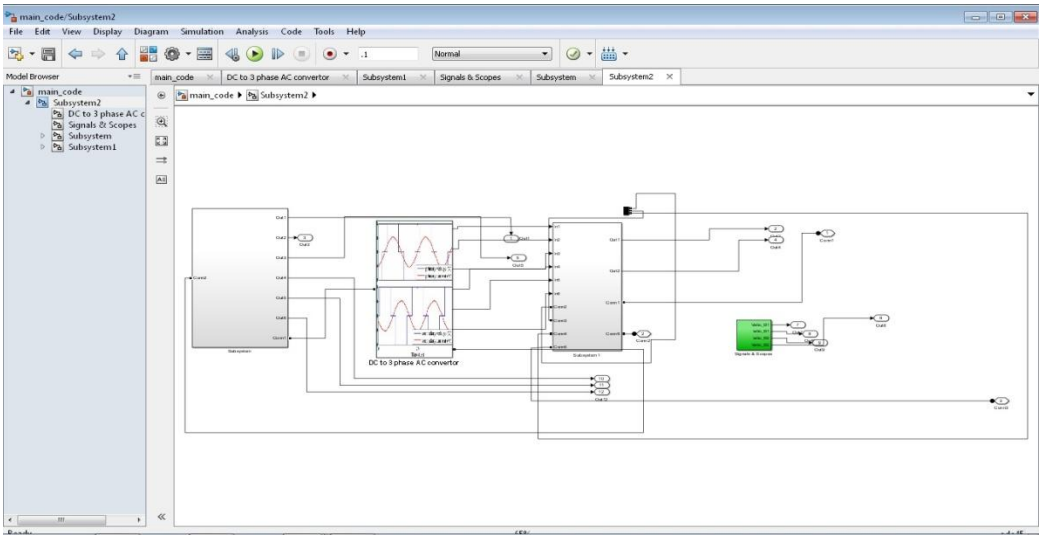

Figure 6 Simulink DC2AC buck convertor design

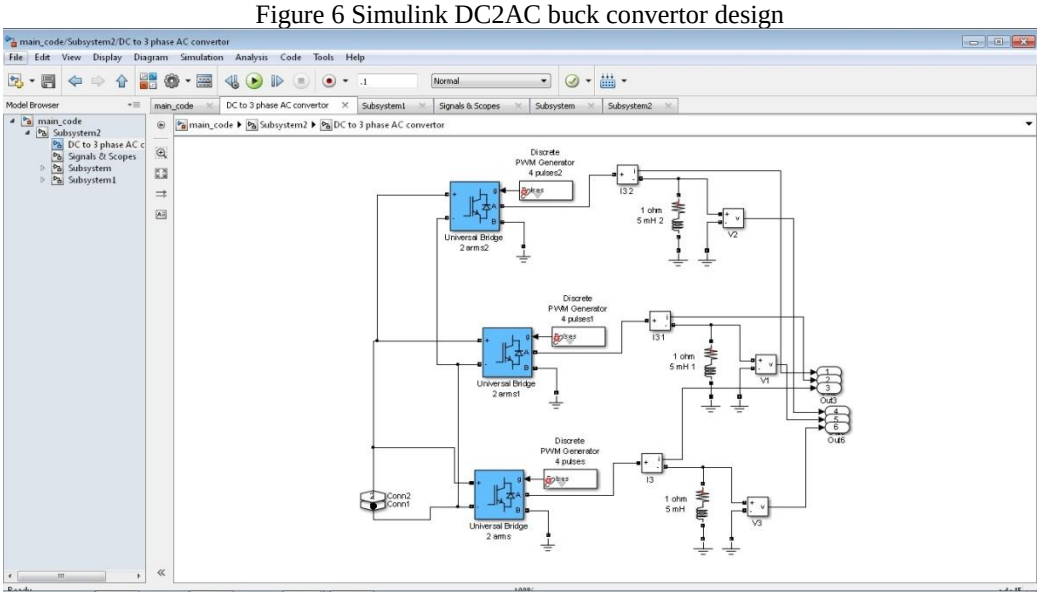

Figure 7 Simulink PWM Switch controller

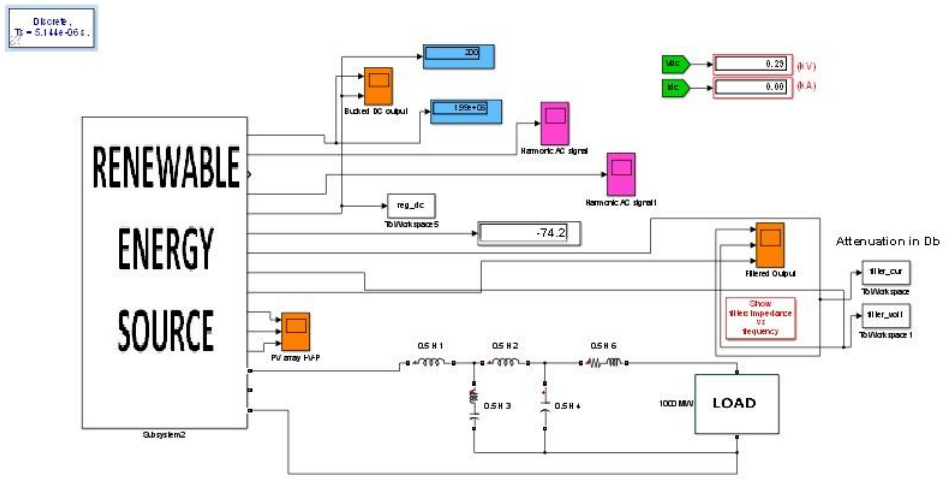

Figure 8 GUI after execution

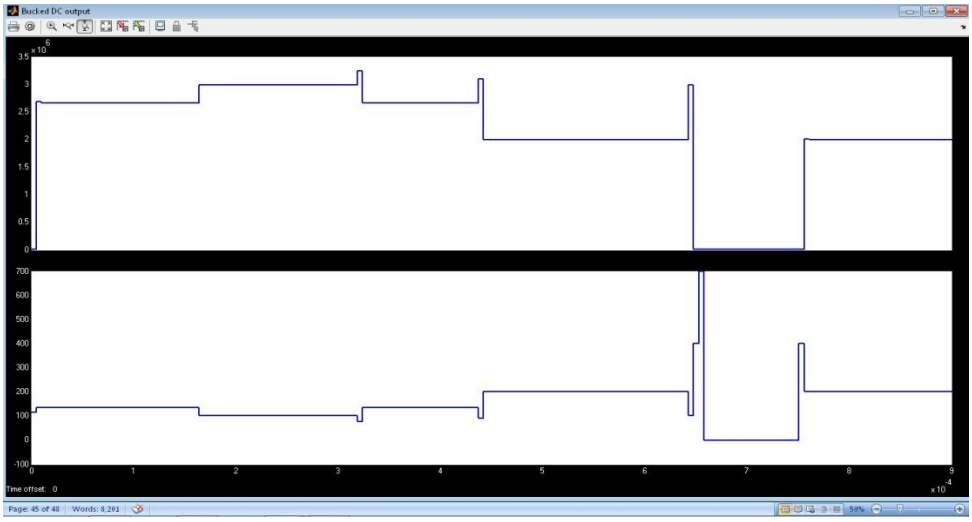

Figure 9: DC2DC convertor output

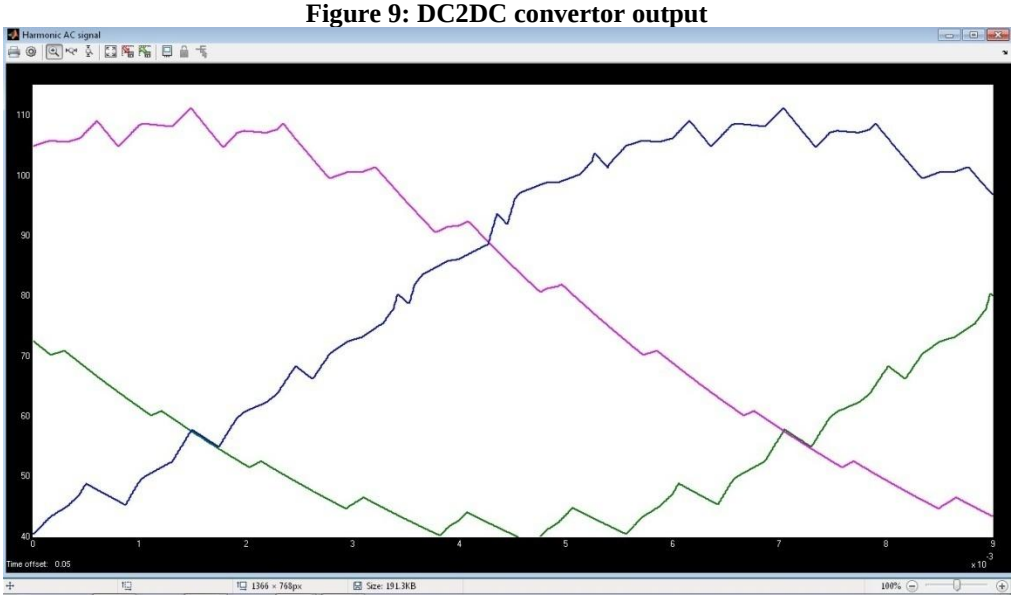

figure 10: AC output DC2AC convertor output with harmonics

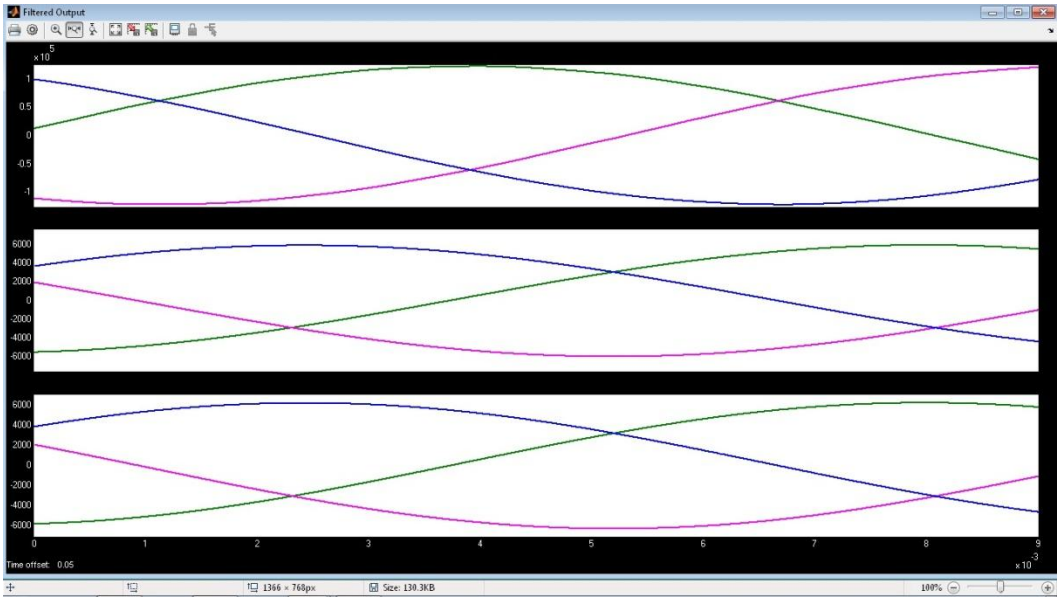

Figure 11:three phase filtered AC output

In figure 8,9,10 it may be seen that input from PV panel in have fluctuations and high value and at output side DC value is been regulated to its maximum value and also shows proposed filter at various frequency range ad for better loading it should be less so small amount for power dissipate at filtering circuit and most for power goes to load and our design maintain maximum efficiency.

Table 2 Comparative results

Work	Average Attenuation
L	16 db
LC	20 db
LCL	22 db
TRAP	28 db
LCL with passive Resistance	39 db
Subash chandar, LCL-LC	60 db
Proposed, PLCL-R	74 db

Table 2 shows comparative results between proposed work and other standard filters and base paper also. It may be seen the proposed work has highest attenuation among available methods.

Table 3 Comparison and analysis for results observed for various work

Work	Maximum Damping at Resonant Freq.
L	0 db
LC	2 db
LCL	0 db
TRAP	10 db
LCL with passive Resistance	100 db
LCL-LC [1]	6 db
Proposed	1.3 db

From table 3 it may be seen that L and LCL filters are generally excellent in damping at resounding recurrence and base work has damping around 6 db in proposed work it is 1.3 db which is superior to base work anyway not great as L and LCL filter. Vitality request has expanded significantly and furthermore sum for non-renewable energy sources has been exhausting to a base degree. So sustainable power source request more, anyway change effectiveness for these sources is less which prompts a mind-boggling expense for generation. In photovoltaic framework, cost for PV board is high and at same time vitality change just around 18%. After this another misfortunes that further happens like an inverter that is utilized to change over DC to DC first than DC to AC acquaints parts for music with lattice side current which may prompt harm for burden and diminish proficiency. The exchanging recurrence for converters is for the most part between 5 kHz and 20 kHz and causes high request music that may aggravate other EMI delicate burdens/gear on network side. Picking a high incentive for line-side inductance may resolve this issue, anyway this makes framework costly and massive. On opposite, to receive a LCL-LC [1] filter setup permits to utilize decreased qualities for inductances (saving unique execution) and to lessen exchanging recurrence contamination produced in matrix.

IV. CONCLUSION

The work is been completed with designing of grid array DC/DC convertor and DC/AC convertor and proposed PLCL-R power filter. A nitty gritty recreation model of the Photovoltaic Array with another Active Power Filter is actualized in MATLAB/SIMULINK utilizing SIMPOWER Systems library is proposed in this postulation, control framework for joined task of new power filter with PV age framework in lattice. This framework helps to supply a consistent capacity to the lattice. Additionally, a novel control methodology for dynamic power filter is created and recreated, the current and DC to DC buck and DC to AC voltage controllers are utilized to move the PV control and synchronize the yield converters with the framework. The controller structures for various task methods of dynamic power filter are considered. The reenactment results are done by MATLAB and SIMULINK programming devices.

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