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Selection of Filter And Reduction of Ripple in The Output of Boost-Converter for Four Bus Micro Grid System

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***Abstract*: Boost converter finds a way amidst RES and inverter. This work investigates selection of filter and reduction of ripple in the output of boost-converter for four bus Micro- Grid- System. The objective of the proposed micro grid system was to improve the performance of four bus Micro Grid System (FB-MGS). Simulation studies were performed with C, L-C, Pi and cascade filters and the outcome shows an enhanced -performance by employing cascade-filter for FB- MGS. The outcomes specify that MGS with cascade-filter has diminished-voltage ripple.**

***Index Terms*: Renewable energy sources(RES), four bus Micro Grid System (FB-MGS), Pi-Filter, Cascade-Filter.**

I. INTRODUCTION

These days, inexhaustible and clean-energy has taken an extraordinary part in power sources, particularly in some remote zones with little confined networks, for example, islands and towns. A solid answer for power supply is utilizing diesel motors coupled to a synchronous machine working parallel with sustainable power sources [1-2]. Notwithstanding, in an AC network, both voltage and recurrence ought to be all around controlled for a stable function that the combination control might reason a lot-challenges. "Combination of breeze-power & wave-power generation frameworks utiliizing a DC micro-grid" was proposed by Anton. This proposes an incorporated breeze and wave power-generation framework nourished to a power framework or associated with a separated burden utilizing a DC-microgrid. A two directional DC/DC converter is proposed to accomplish the combination of both breeze &wave-power-generation-frameworks with uncertainty&irregular characteristics[3]. Building up a SC to oversee power-stream in a micro-grid so as to accomplish a harmony between power deliver and production demand is a standout amongst the most critical necessities for productive activity of the micro-grids [5]– [6]. In [7], a standard based framework is proposed to deal with the power stream in a hybrid-ac/dc-micro-grid. In [8], [9], a droop-based controller is demonstrated to manage power-sharing among the both micro-grids. These research shows, the ac&dc-micro-grids are consider while two take apart substances with individual droop-portrayals, where the data from these 2-droop-qualities is converged to choose the measure of capacity to trade between the microgrids. In [10-11], a standard based administration framework with four predefined working modes is displayed to decide the measure of power which ought to be traded between the micro-grids.

A typical SC in favor of a mix - ac/dc-micro-grid was proposed in [12], somewhere 15 unmistakable task methods are measured. At long last, a robust ideal SC in favor of a hybrid-ac/dc-MGS was proposed in [13], in which suspicions and mistakes in age gauge are considered in the structure system. Notwithstanding blunders in generation gauge, conceivable disappointments in generation frameworks may likewise seriously influence the got ideal solution, with the end goal that the ideal solution may never again be ideal or even feasible.

Thus, SC must be embraced to properly treat disappointments of generation frameworks. In this unique circumstance, a few works are accounted for which basically manage structuring a SC to oversee control stream without failed assets [14]– [17]. Besides, a few strategies are accounted for to seclude the broken part and reconfigure the framework quickly [18], [19]. It is important that a few SCs for shipboard power frameworks under failure-condition are additionally revealed, which mostly deals with network-reclamation through load-shedding and don't consider non-basic load-support as an performance characteristic [20]– [23]. In these works, no compelling failure-recognition plans are accounted for &failures are thought to be known from the earlier. In addition, the failed-assets are not used for power-demand- fulfillment, which can hamper the effectiveness of the framework. Fulfilling demanded-power with most extreme use of sustainable assets, least use of fuel-based generator, uncertainties in the assets yield power &generation-forecast-blunders, expanding batteries lifetime[24-28], and restricted use of the fundamental power converter between the ac& dc-microgrids are vital variables that are considered in this methodology. Besides, the tolerance of the proposed supervisory controller towards deficiencies in sun based and wind frameworks is likewise considered in the plan system. For this reason, a method to identify shading and converter issue in the solar- system is exhibited, and resistance of the proposed SC toward these issues is considered.

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Also, lubricant framework-failure& converter fault in wind framework is considered and a strategy to recognize lubricant framework failure is displayed. The tolerance of the projected SC on the way to lubricant-framework-failure and converter deficiency in wind framework is likewise clarified. Also, "_the forbearance of the anticipated-manage -controller for energy-storage-framework failure during every micro-grid be consolidated in the planned system[29]".

The MG-central-controller is creating it in the MG framework for improving the season of accessibility. In this way, lessening the total-energy-costs of MG and improving the sustainable power sources (BES) are viewed as together with the operation-management of the MG framework.

II. PROBLEM FORMULATION

It is required to minimize the effect of ripple in the output of boost-converter in FB- MGS. It is also required to reduce THD. FB- MGS system suffers from the drawback of high ripple in the out-put of BC. It is required to reduce ripple in the output of BC in FB- MGS system using C/L-C/Pi/cascade filters. This work proposes cascade-filter for boost-converter in FB- MGS.

III. SYSTEM DESCRIPTION

The block illustration of MGS is revealed in Fig 1. Bus 1 is a generator bus with a star connected generator. Buses 2 and 3 are load buses. Three wind- generators are connected at bus4. They are connected through rectifier-inverter-module. At bus-1, PV and fuel cell are connected through boost-converter and inverter. The details of MGS system are as follows: Photo voltaic sourcer rated at 1.4 MW, voltage rating 3.0 kv. Fuel cell rated at 3.0KW, voltage rating 500V. Battery rated at 3.5KW, voltage rating 500V. Diesel generator rated at 3.0 MW, voltage rating 3kV Transformer rated 3.0MVA Wind generator rated 6.0MW, voltage rating 3.3 kv.

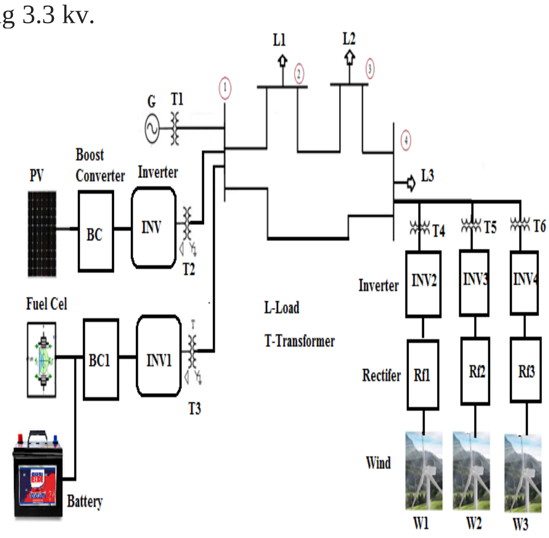

Figure 1. Block diagram of MGS

Table-1 Load data

BUS NO	Real power (MW)	Reactive power(MVAR)
BUS-2	0.469	0.287
BUS-3	0.471	0.293
BUS-4	0.514	0.315

Table2- Line Data

BUS NO	RESISTANCE	INDUCTANCE
1-2	0.001Ω	33mH
2-3	0.05Ω	30mH
3-4	0.01Ω	20mH

IV. ANALYSIS

Ripple Factor for C filter

The rms value is the half of the peak value(Vpeak).

Vac rms = Vpeak/2

Vpeak = Idc/fC

Ripple Factor = $V_{ac\ rms}/V_{dc} = (V_{peak}/2) * (1/I_{dc}.R_{Load})$

$=I_{dc}/(2.I_{dc}.R_{Load}.f.C)= \frac{1}{4\sqrt{3}\,fCR_L}$

Ripple Factor for LC filter

Ripple Factor = Vac rms/Vdc $= \frac{\sqrt{2}}{3}\frac{X_C}{X_L}$

X_L = 2(2ΠfL) Henries

Where L & C are element of LC filter

X_C = 1 / 2(2pi x fc) Farads

Ripple Factor for pi filter

Pi filter is combination of C & LC filter

r = $1/(4\sqrt{2}\,\omega^3 L C_1 C_2 R)$

L, C_1 & C_2 are elements of Pi filter. R is the load resistance

V. SIMULATION RESULTS

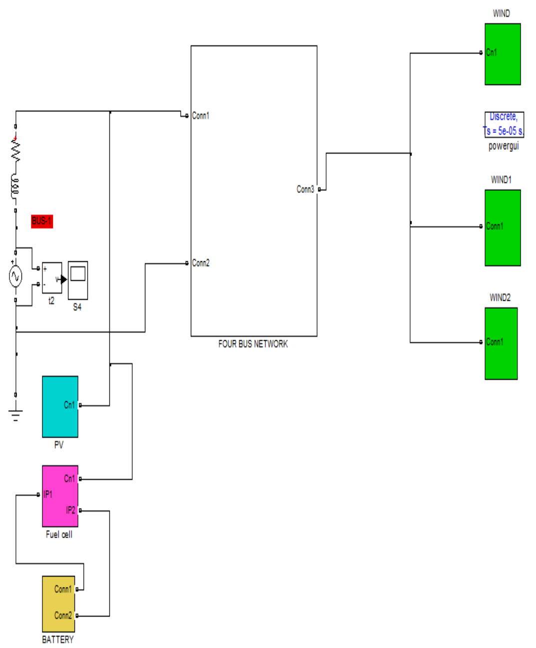

Figure 2. Circuit diagram of boost converter with C-filter in four bus system

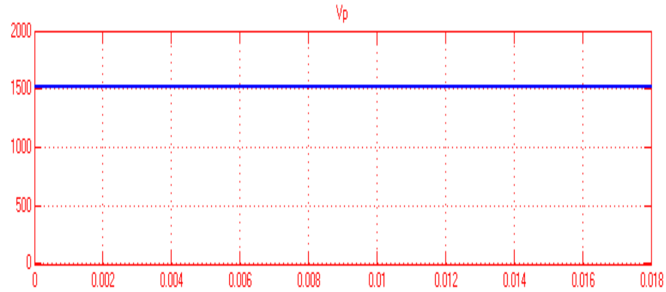

Figure 3. Output voltage across PV

PV-boost converter with C-Filter is delineated in Figure 4. Voltage across boost converter is delinated in Fig. 5 and its value is 3080 V.

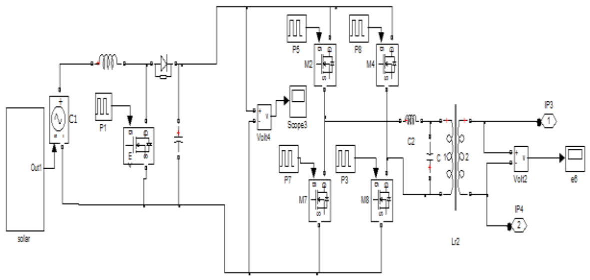

Figure 4. PV-boost converter with C-Filter

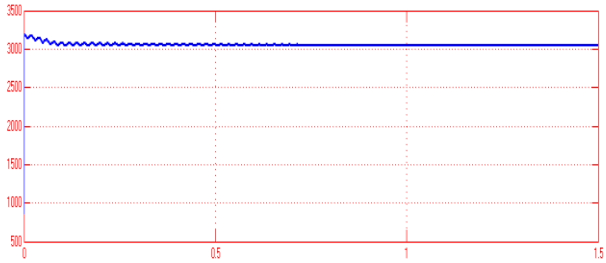

Figure 5. Voltage across boost converter

Voltage ripple across boost converter is appeared in Figure 6 and its value is 3047 V.

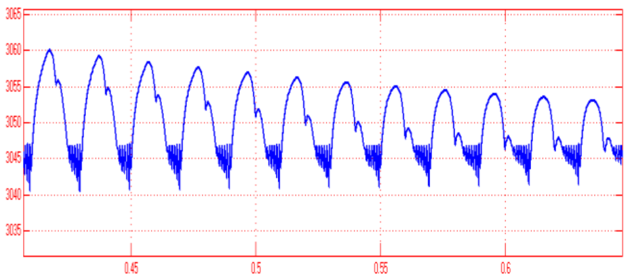

Figure 6. Voltage ripple across boost converter

Voltage at bus-4 of boost converter with C-filter is delineated in Fig. 7 and its value is $0.95*10^4$V.

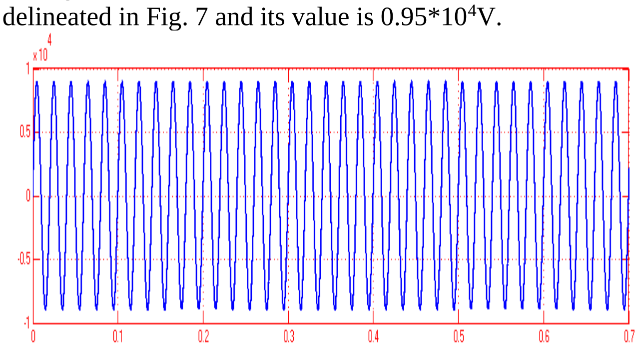

Figure 7 Voltage at bus-4

Real power at bus-4 and Reactive power at bus-4 are appeared in Figure 8 and 9 and the value of real power is $4.5*10^5$ Watts where as the value of reactive power is $8.99*10^4$ VAR

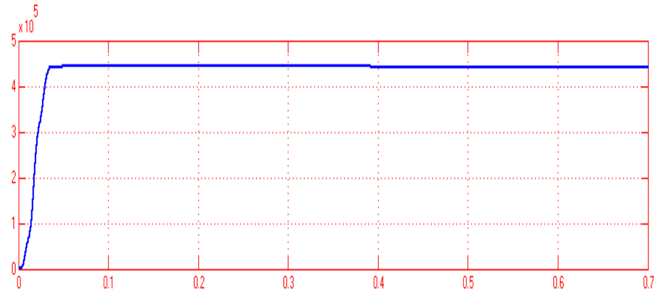

Figure 8 Real power at bus-4

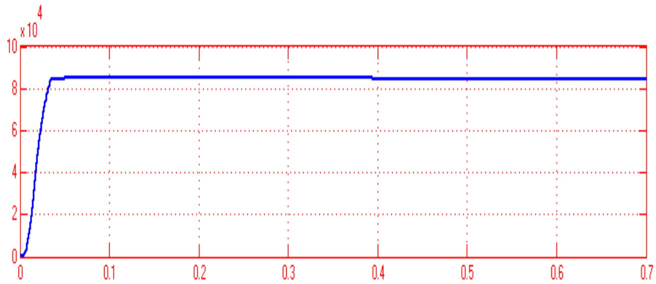

Figure 9 Reactive power at bus-4

Circuit diagram of boost converter with Cascade-filter in four bus system is delineated in Figure 10. The output voltage across PV is appeared in Figure 11 and its value is 1500V

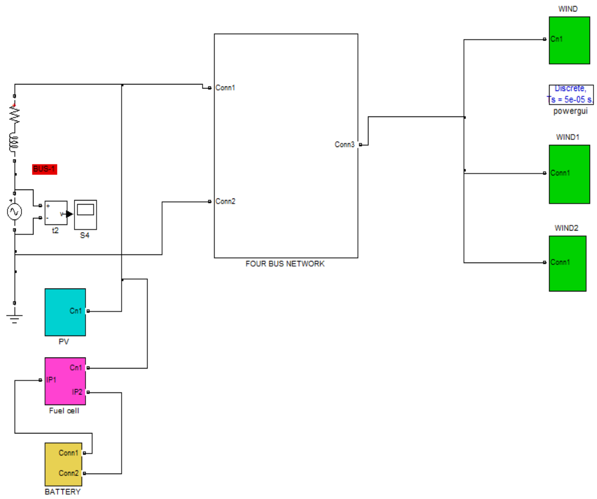

Figure 10 Circuit diagram of boost converter with Cascade-Filter in four bus system

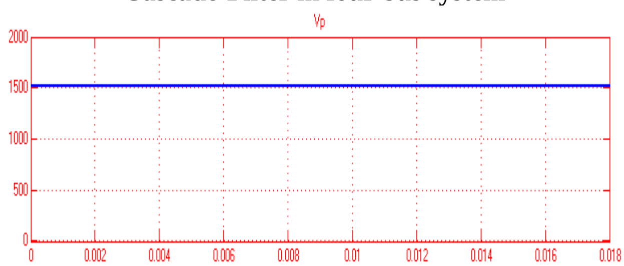

Figure 11 Output-Voltage across PV

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PV boost converter with cascaded-filter is delineated in Figure 12. Voltage across boost converter is delinated in Figure 13 and its value is 3000 V.

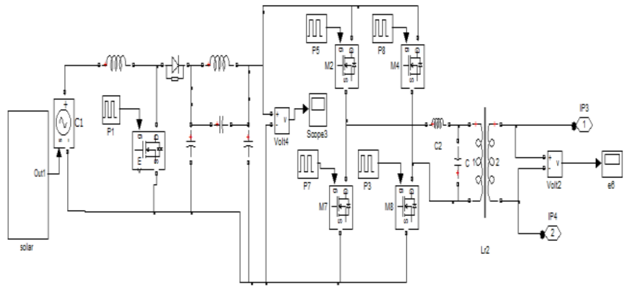

Figure 12 PV boost converter with cascade Filter

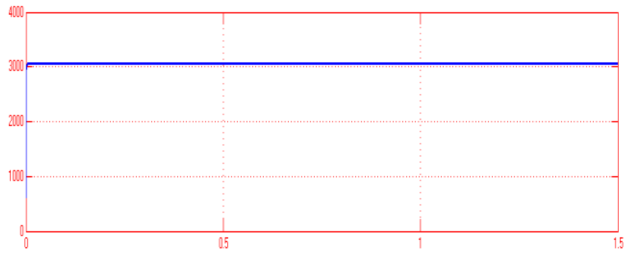

Figure 13 Voltage across boost converter

Voltage ripple across boost converter is appeared in Figure 14 and its value is 3048 V.

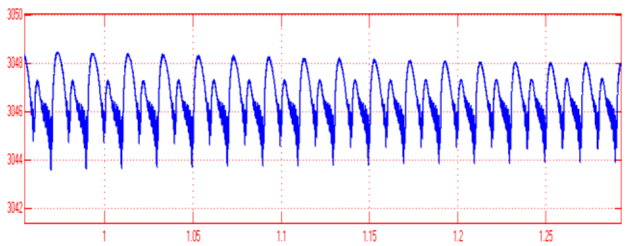

Figure 14 Voltage ripple across boost converter

Voltage at bus-4 of boost converter with Cascaded-filter is delineated in Figure 15 and its value is 0.95*104V.

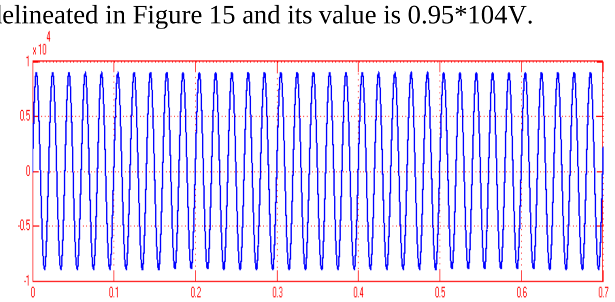

Figure 15 Voltage at bus-4

Real power at bus-4 and Reactive power at bus-4 are appeared in Figure 16 and 17 and the value of real power is $4.5*10^5$ Watts, where as the value of Reactive power is $8.80*10^4$ VAR.

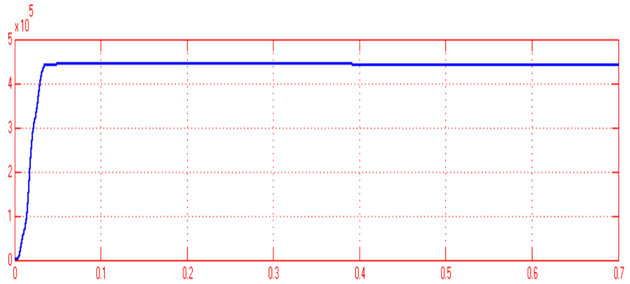

Figure 16 Real power at bus-4

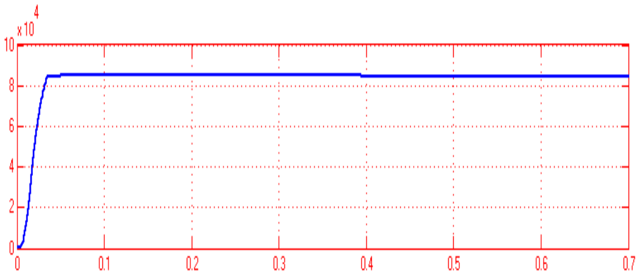

Figure 17 Reactive power at bus-4

Summary of output voltage with different filters is given in Table-3. output -voltage is higher with c-filter ie 3057 V and By using cascade-filter, output-voltage is 3048V. This is due to voltage-drop in the internal-resistances.

Table-3
Summary of output voltage with different filters

Type of filter	V_o
C-Filter	3057V
LC-Filter	3055V
Π-Filter	3054V
Cascade Filter	3048V

Simulation studies are performed for dissimilar values of C and the results are presented. Deviation of ripple voltage for different values of C is given in Table--4. As C is increased from 5 mF to 11mF, the ripple voltage reduces from 16V to 11 V. The minimum value of ripple voltage is 11V.

Table -4
Variation of ripple voltage with C

C	V_{or}
5 e-3F	16V
6 e-3F	15V
7 e-3F	14V
10e-3F	13V
11 e-3F	11V

Investigations are done for dissimilar values of L & C as well as the ripple voltage are noted. Variation of ripple voltage for dissimilar values of L& C is given in Table--5.

As L and C are increased, the ripple voltage reduces from 15V to 9 V. The minimum value of ripple voltage is 9V.

Table -5
Variation of ripple voltage with L and C

L	C	V_{or}
0.1 e-3H	5 e-3F	15V
0.3 e-3H	6 e-3F	14V
0.5 e-3H	7 e-3F	13V
0.7 e-3H	10e-3F	10V
0.9e-3H	11 e-3F	9V

Studies are does to find optimal value of L, C_1 & C_2. Variation of ripple voltage for different values of L & C_1 and C_2 is given in Table--6. As L and C are increased, the ripple voltage reduces from 14V to 8 V.

Table -6
Variation of ripple voltage with L and C_1 and C_2

C_1	L	C_2	V_{or}
5 e-3F	0.1 e-3H	5 e-3F	14V
6 e-3F	0.3 e-3H	6 e-3F	12V
7 e-3F	0.5 e-3H	7 e-3F	11V
10e-3F	0.7 e-3H	10e-3F	10V
11 e-3F	0.9e-3H	11 e-3F	8V

Studies are coordinated for different value is filter elements & the results are summarized. Variation of ripple voltage for different values of L& C_1,C_2 and C_3 is given in Table--6. As L and C are increased, the ripple voltage reduces from 12V to 5 V. The least value of ripple voltage is 8V.

Table -7
Variation of ripple voltage with L and C_1.C_2 and C_3

C_1	L	C_2	C_3	V_{or}
5 e-3F	0.1 e-3H	5 e-3F	5 e-3F	12V
6 e-3F	0.3 e-3H	6 e-3F	6 e-3F	10V
7 e-3F	0.5 e-3H	7 e-3F	7 e-3F	8V
10e-3F	0.7 e-3H	10e-3F	10e-3F	7V
11 e-3F	0.9e-3H	11 e-3F	11 e-3F	5V

A ripple voltage of 5V is obtained with C_1=C_2=C_3=11 mF, L=0.9mh.

VI. CONCLUSION

Boost converter with C-filter, LC-filter, Pi-filter and Cascade-Filter in FB-MG systems are simulated using Matlab simulink. The variation of ripple-voltage with values of filter-elements is presented. The ripple-voltage is 11 V ,9V,8V,5Vand with C-filter, LC-filter, PI-filter and cascade-filter respectively. By using cascade-filter, output-voltage-ripple is reduced from 12V to5V.Hence, Boost converter with Cascade-Filter in FB-MG system is superior to Boost converter with C-Filter in FB-MGsystem.

The opportunity of the current work is to compare performance of Boost converter with C-filter, LC-filter, Pi-filter and Cascade-Filter in FB-MG systems. The comparison of performances with outage of PV/wind units in FB-MG systems will be done in the future.

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