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A High Efficient Bidirectional DC-DC Converter for Nano Grid Application

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***Abstract*—This paper proposes a brand new non-isolated, three-port, bidirectional, DC-DC converter for nanogrid software with the aid of using enforcing zero voltage switching withinside the circuit to lessen the switching loses and improve the system's efficiency. The proposed converter has the benefit of the use of the least variety of switches and smooth switching of the primary switch, that's found in the use of an LC-resonant circuit. The circuit has a PV panel and a battery because the assets are used to deliver energy to the DC nano grid.The energy balancing element was designed with the aid of using boost, and the manipulation techniques for the single module to recognize Maximum Power Point Tracking (MPPT), battery price manipulate, and predominant bus regulation is proposed. Zero-voltage switching is found out for two predominant switches. Experimental results confirm the proposed topology and verify its cappotential to attain low losses withinside the switching and it enables to improve the performance of the system.**

***Index Terms*— DC-DC converter, Nano grid, multiport circuits, MPPT.**

I. INTRODUCTION

As a large number of places in the world live in country isde or isolated regions without access to power grid-based electricity. Nano grid which makes a major role in the supply of energy to these places.Nano grid is a type of microgrid that is capable of supplying these places for household uses.[1, 2]

The multiport converter topologies can be two categories: nonisolated and isolated topologies. Nonisolated multiport converters, that take the form of buck, boost, and in this proposed system boost operation as well as buck-boost operation are used to improve the a low voltage regulation ratio.

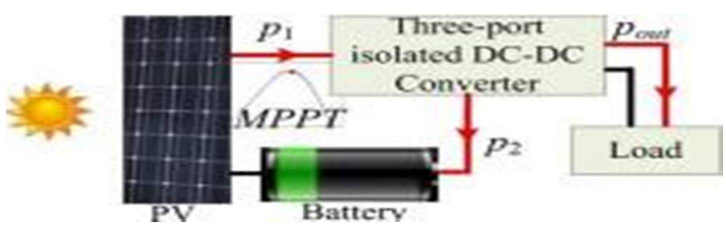

Fig.1 Block diagram of.Three-port dc/dc converter[4]

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The fig1 which shows the block diagram of the bidirectional dc-dc converter for nanogrid. In this, it has a PV panel as the main supply and battery which is fed into the nano grid. The PV panel performs boost operation and the battery performs the buck and boost operation for the system.

Maximum Power Point Tracking (MPPT) manipulate set of techniques of PV energy converter is the feature to maximize the energy technology performance with the aid of using regulating the PV array voltage, i.e. the enter voltage of the to tovercome over energy mismatch in a microgrid.Converter.which increases the efficiency of the system by using this algorithm.

Bidirectional converters interfaced with the battery storage space balance the power levels between deliver and charge through the charging/discharging process.In the generation part the buck operation of the battery takes place. By boost operation, the battery charge will discharges to the grid. [4].

Nanogrids adeals with a much less number of problems, however with lot of extra utility; thus, they capable of the development of well-designed technology that can quickly become extensive.[5]The converter has only two activeelements and a new control scheme, which controls both the duty cycle as well as switching frequency to perform accurate power flow management between the junctions.[1]. Most of the nanogrid literature supply interest at the manipulate and hardware, with numerous algorithms and strength converter topologies. The concept of utilising the nanogrid's modular nature to shape a community of interrelated nanogrids is likewise offered inside the literature, aleven though in maximum instances it's miles nevertheless at a conceptual intensity only.[10].

In this proposed system response has a inverter that doesn't have an effect on the responsibility cycleand output current does have an effect on the enter strength of the PV panel, while it does now no longer want extra auxiliary circuitry and hardware modification.But the presence of isolation transformers and switches makes the system more complicated. [12].

The other Converter incorporates an (LC)-resonant circuit to reap ZVS and zero-cutting-edge switching (ZCS) for the switches.It will assist to lessen the switching faults. In this it applies the proposed converter for simultaneous energy control of a PV machine with battery storage. A most energy factor tracking (MPPT) set of rules is designed for the PV panel to generate the most energy whilst sun radiation is available.[16].

II. EXISTING CONVERTER TOPOLOGY

The current converter gives a low range of components, and occasional cost, however it has excessive switching losses. It is able to imparting bidirectional energy float for the electricity garage machine. The manipulate machine is able to controlling energy float among the PV panel, battery, and dc nanogrid through controlling the switching frequency and responsibility cycle, respectively. The converter indicates excessive layout flexibility in accommodating special applications.The important drawback of this converter which has excessive switching losses which end result of a lower in efficiency[1].

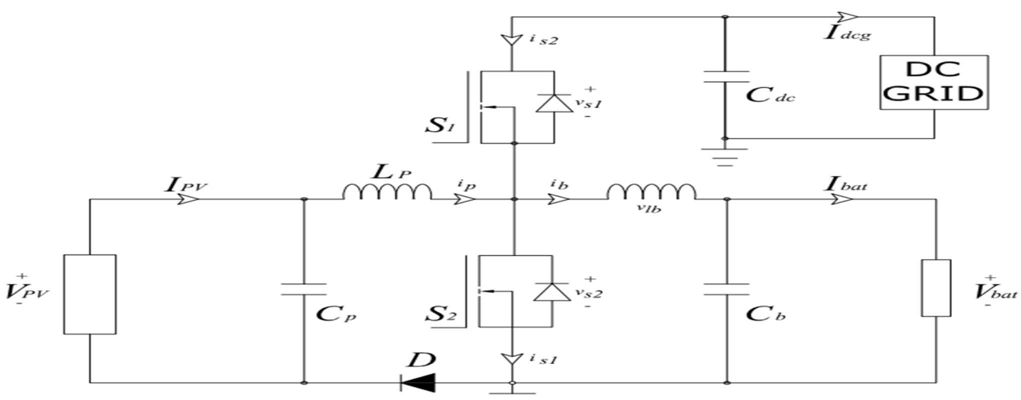

Fig.2.Three-port dc/dc converter to integrate PV panel and battery into dc nanogrid

A review on the multiport dc-dc converter for nano grid application. The number of switches is high for this topology so the conduction and switching losses are high for this type of converter. There should not be any control method on the secondary side of the system then it will cause an overflow of voltage to the secondary side. In this, they are using an isolated transformer which will also increase the leakage reactance in the circuit[2].

III. PROPOSED CONVERTER TOPOLOGY

In the proposed system the converter is modified by adding an LC circuit to the system. The LC circuit is used to reduce switching losses and to improve the efficiency of the system. The number of the switches gets increased and the capacitor and the inductor on the PV side which worked as in the resonant operation reduce the losses in the circuit.

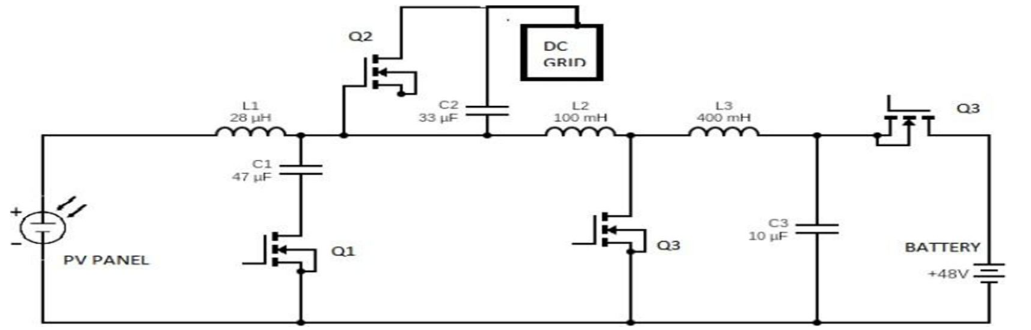

Fig.3.High efficient low loss dc/dc converter for DC nano grid

The system has three modes of operation

Mode 1
In the first mode of operation the PV panel gets charged, and a boost operation is performed.

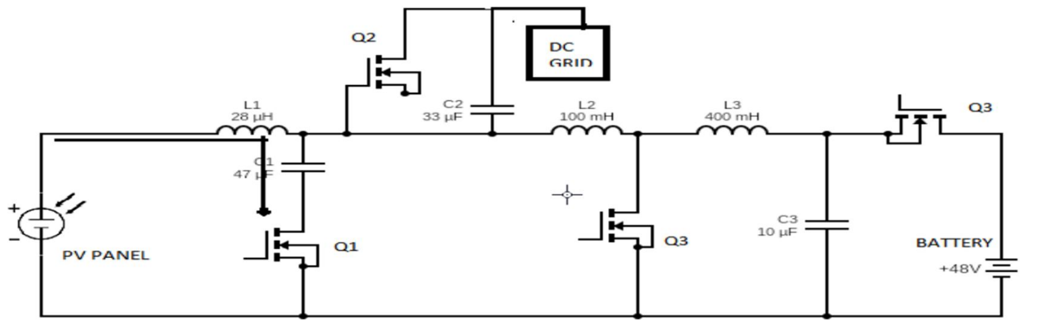

Fig 4. Mode1 operation

The energy from the PV panel is delivered to the nanogrid. This is the charging mode. The switch Q1 gets on in this mode.

Mode 2

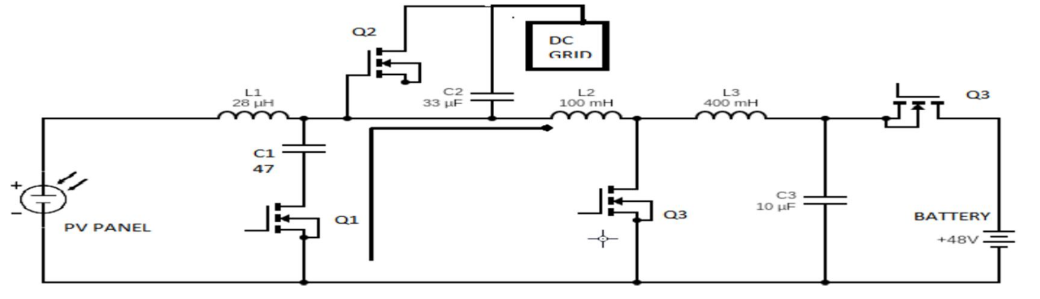

Fig 5. Mode2 operation

In mode 2 the switch Q1 didn't get turned off until the capacitor discharged completely. This is the discharging mode of the grid. It is also the buck operation period where the battery gets charged.

Mode 3
In the third mode operation the switch Q1 turned off completely and Q2 turned on.

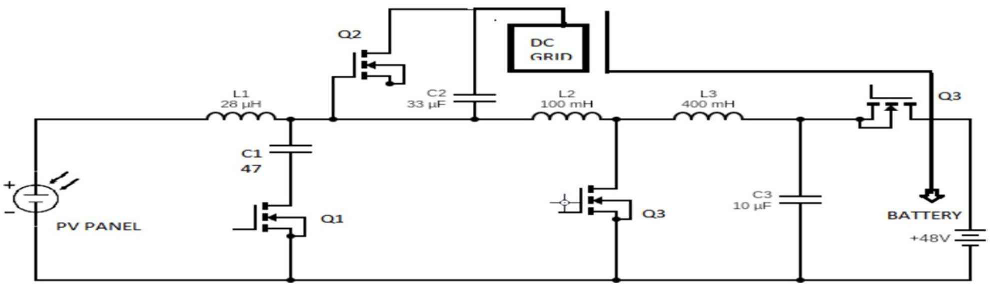

Fig 5. Mode 3 operation

The battery is in the boost operation mode. The energy is delivered to the nanogrid through the battery in this mode of operation. The parallel MPPT guarantees the MPP operation of the PV array via way of means of providing the electricity distinction among PV technology and load demand.

The resonant capacitor and inductor values are calculated based on the resonant equation.

$$Cp = Vpv\ (Vbat - Vdc)^2\ (Vbat - Vpv)^2\ /$$

$$2\Delta Vp,ppf^2sLpVdc(Vdc - Vpv)^2 \qquad (1)$$

$$Cb = 1/(8\Delta Vb,ppLbf^2s) * Vbat(Vdc - Vbat)\ /\ Vdc \quad (2)$$

Parameters Used

TABLE I. PARAMETERS OF PROPOSED SYSTEM

Symbol	Parameters	Values
Cp	PV side capacitor	47μF
L	Resonant inductor	28μH
C	Resonant capacitor	16μF
Lb	Battery side inductor	5mH
Cb	Battery side capacitor	10μF
R load	Resistance	25ohm
Vin	Input voltage	38V

IV. SIMULATION RESULTS

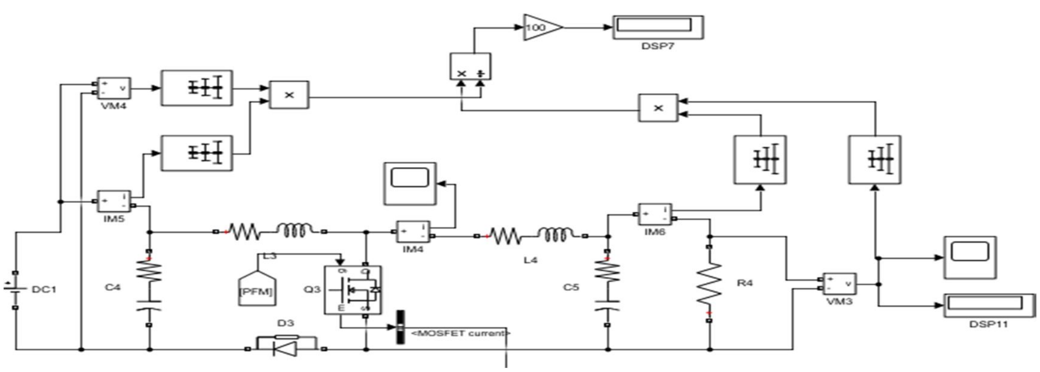

Fig.6.Simulation diagram of the existing system

The simulation diagram of the existing system is shown in fig 6. In this system has high losses across each element to get the exact value of efficiency under faulty conditions.

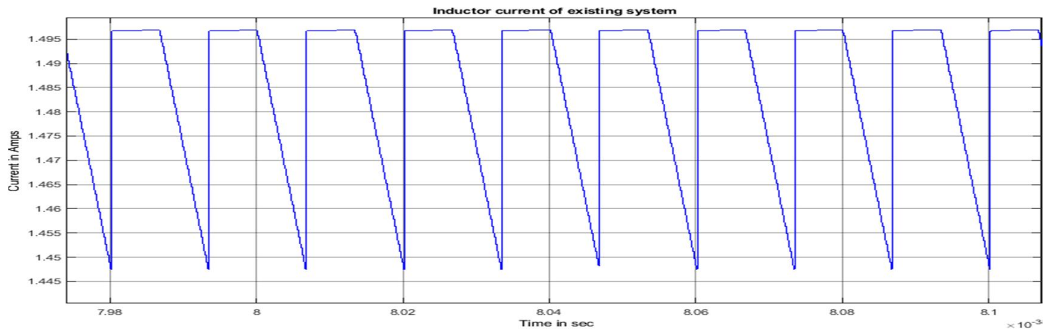

Fig.7.SimulationInductor current

The inductor current of the existing system was hard switching in nature. So the losses in the circuit will be high. In the fig 8,The output voltage of the existing system has been set to 37V. It is reduced because of the losses in the system. So the system is not reliable for the application.

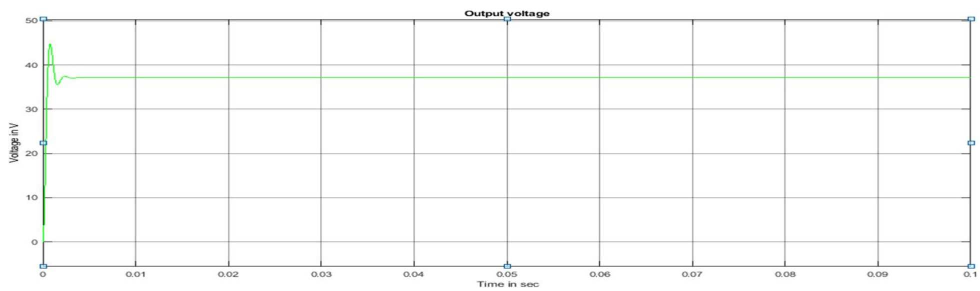

Fig.8.Simulation diagram of output voltage

The efficiency of the system is very much low in the lossy condition. The switching losses in the system are high so there should be losses in the efficiency also.fig 9.

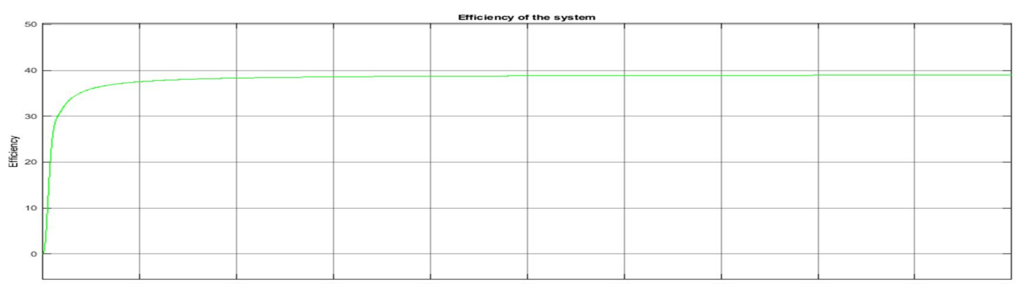

Fig.9.Simulation diagram of efficiency of the system

The simulation system of the proposed system was shown. The proposed system was done by applying losses in the system. An LC component was implemented in the system. Which is help to improve the system and increase its efficiency of the system.

V. PROPOSED SYSTEM SIMULATION AND RESULTS

In fig.10, The proposed system for the bidirectional DC-Dc converter with losses has been shown. The simulation has been performed by implementing fault in the circuit.

In fig.10, The proposed system for the bidirectional DC-Dc converter with losses has been shown. The simulation has been performed by implementing fault in the circuit.

In the fig.11,The capacitor voltage of the proposed system is shown above. By applying an LC circuit the capacitor voltage become a sine wave in nature.

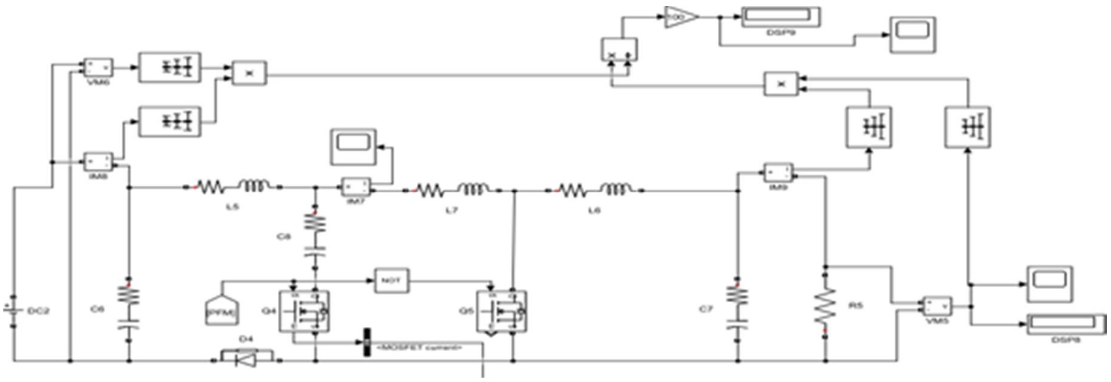

Fig.10.Simulation diagram of the proposed system

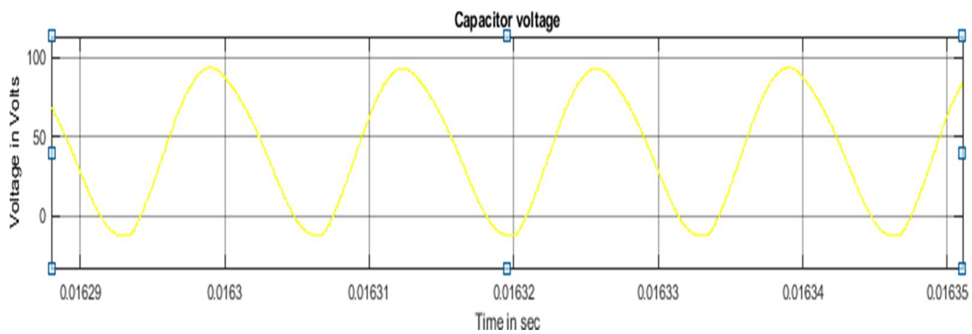

Fig.11.Capacitor voltage of the proposed system

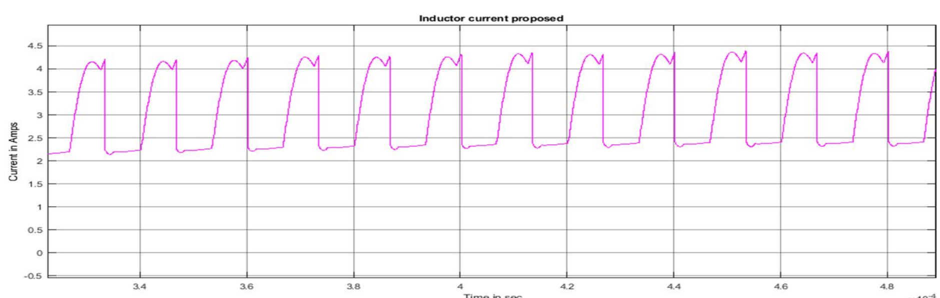

fig 12. Inductor Current of proposed system

The inductor current of the proposed system is shown above. The fig 12, shows that the resonance circuit was implemented and the inductor current which was reached zero crossing.

The output voltage from the load side was improved to 43V.Which was much better than that of the existing system. So the storage capacity of the system gets improved.

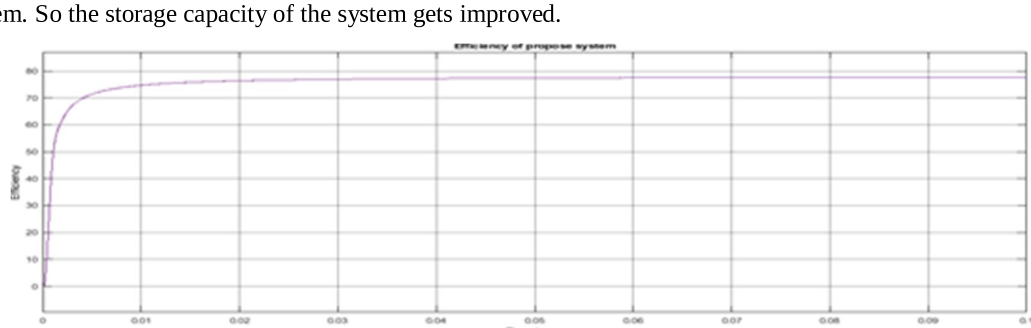

Fig.14.The efficiency of the proposed system

The efficiency of the system gets improved in the proposed system. The efficiency is getting increased to 77% in the loss condition. So the system efficiency can be in the range of 85% - 95%.

VI. Experiment Results

The machine simulated is built in hardware to in addition validate the proposed converter and manipulate set of rules thru experimental studies. Fig. 10 suggests the prototype of the complete machine. It includes the proposed DC-DC converter, that's related to the lead-acid battery, and the PV panel related to a energy deliver unit and to the DC nanogrid.

The voltage throughout the primary transfer drops to 0 earlier than the present day increases, which shows that the primary transfer has accomplished ZVS while turning on.

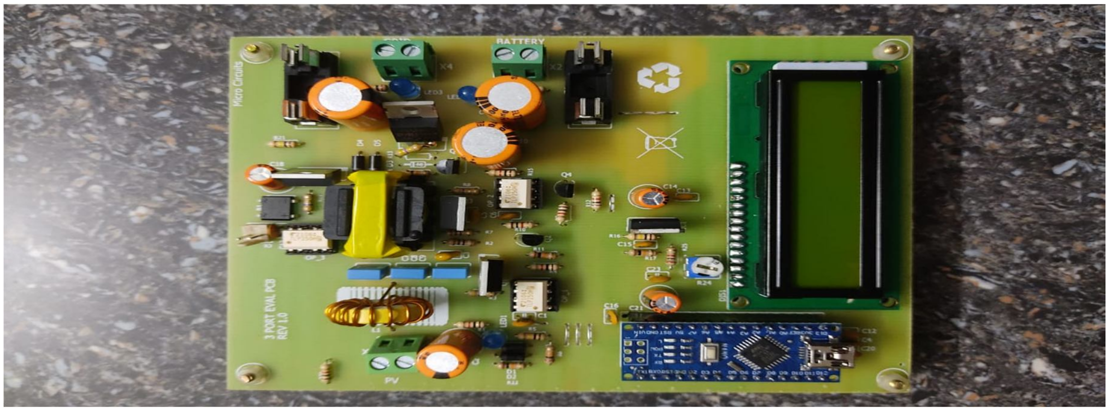

Fig. 15. The experimental system setup

Fig. 16. the gate signal and current waveform at input inductor

VII. Comparison of Existing and Proposed Systems

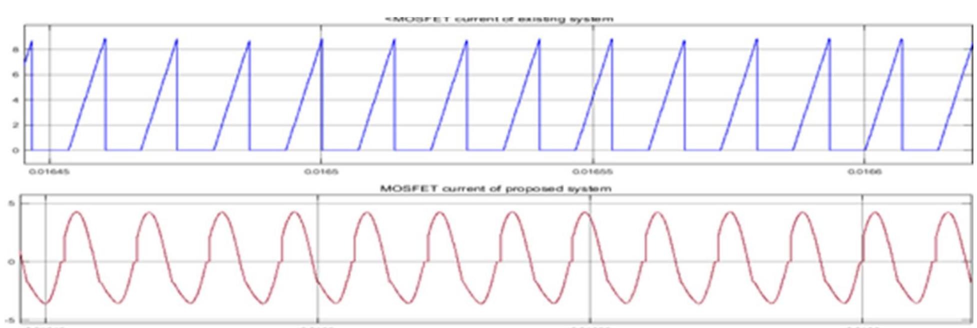

Fig.17.Comparison of the existing and proposed system

From the comparison, we can see that the existing system which has hard switching and the proposed system which has soft-switching properties. It increases the efficiency.

TABLE II. COMPARISON OF EXISTING AND PROPOSED SYSTEM

Parameters	Existing system	Proposed system
Efficiency with loss	39%	77%
Output Voltage	37V	43V
Number of switches	2	4
Number of capacitor	3	3
Number of inductor	2	2
Number of diodes	1`	1

VIII. CONCLUSION

A new high efficient low switching loss dc/dc converter for nanogrid turned into proposed to interface among 3 dc ports: a PV panel, a battery, and a dc nanogrid. The proposed converter gives a low quantity of components, low cost, and excessive reliability. It is able to presenting bidirectional energy go with the drift for the power garage machine even as having soft-switching for the switches. But the machine has various frequencies so it's going to have an effect on the Q aspect of the machine, So there ought to be resonant operation wanted for the machine. And a brand new manipulate machine turned into proposed this is able to controlling energy go with the drift among the PV panel, battery, and dc nanogrid via way of means of controlling the switching frequency and obligation cycle, respectively. It has low switching losses and excessive performance the machine. By the usage of hunch manipulate and the MPPT manipulate the overall performance of the machine has been increased. The converter suggests excessive layout flexibility in accommodating distinctive Applications. The simulation outcomes of the 2 structures has in comparison and verified.

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