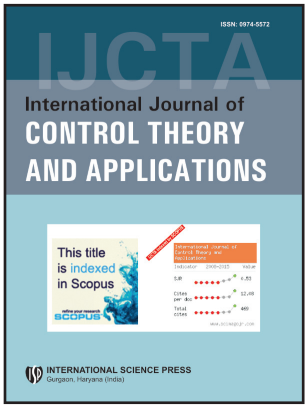

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Multiple PV Source Fed Isolated Multiple Port DC-DC Converter

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Abstract: A new isolated multiple DC-DC converter is used to manage the power of multiple renewable energy sources. When source is connected to dc-dc converter, but the converter use only one controllable switches. It is a simple topology and here we using minimum number of power switches. The maximum power point tracking (MPPT) is proposed in this paper. It is used to control the multiple PV source directly fed to the DC-DC converter. The results are simulated in MATLAB\Simulink.

Keywords: Maximum Power Point Tracking (MPPT), Photovoltaic (PV) source, isolated dc-dc converter, renewable energy source.

1. INTRODUCTION

The possibility of developing the electricity from distributed renewable energy sources. In few applications, we required to connect multiple renewable energy sources of different types of the power grid. The efficient of multiport dc-dc converter has been proposed to manage the power and the grid integration for the multiple sources. The isolated dc–dc converter has multiple input ports for connecting different sources, such as photovoltaic (PV) panels, wind turbine generators (WTGs), fuel cells, etc. The multiport dc–dc converter not only regulates the low-level of dc voltages of the sources to a constant high level required by the inverter, such as maximum power point tracking (MPPT). The proposed isolated multiport dc–dc converter for simultaneous power management of multiple renewable energy sources uses only one power electronic switch in each input port connected to a source. The proposed converter does not use any controllable switch on the secondary side of the transformer. There are two categories of integrated isolated multiport converters. One category of converters uses a transformer with a separate winding for each port. Therefore, all ports are electrically isolated. The other category of converters has multiple ports connected to a single winding on the primary side of a transformer. It requires a common ground point for all the input sources. The second topology is preferable due to the advantage of using less number of windings in the transformer. A number of isolated multiport converters belonging to the second category have been proposed. A widely used topology is the isolated half-bridge converter, which used $2m + 2$ controllable switches, where m ($m \geq 2$) is the number of input ports. Thereafter, in this paper, controllable switches are also called switches. The number of switches was reduced to $2m$ by either using one source as the dc link, reducing switches on the secondary side of the transformer. Recently, a multiport converter topology with $m + 3$ power switches has been proposed. When $m > 3$, this multiport converter has the least number of switches among the existing topologies. The proposed converter has the least number of switches and thereby a lower cost. The newly introduced converter is applied for power management of a wind/solar hybrid generation systems, which consists of a WTG and two varied PV panels. The power generation from solar and wind energy are designed using perturbation and observation (P&O) MPPT algorithm, in which the WTG and PV panels can be controlled at the same time and extract the maximum power.

2. PROPOSED ISOLATED MULTIPLE DC-DC CONVERTER

The Figure 1 shows the block diagram of the proposed isolated multiport DC-DC converter. It consists of the PV panels, Boost converter, inverter and High frequency transformer. This paper proposes a new isolated multiport dc-dc converter for simultaneous power management of multiple renewable energy sources, where only one switch is used in each input port connected to a source. The proposed converter does not use any controllable switch on the secondary side of the transformer. The switches are selected based on their peak voltage and maximum currents. The MPPT controller uses a P&O MPPT algorithm to maximize the output power of three PV panels simultaneously under various weather conditions. The MPPT controller uses the output voltage and current of each source as the input to generate signal for the corresponding switch.

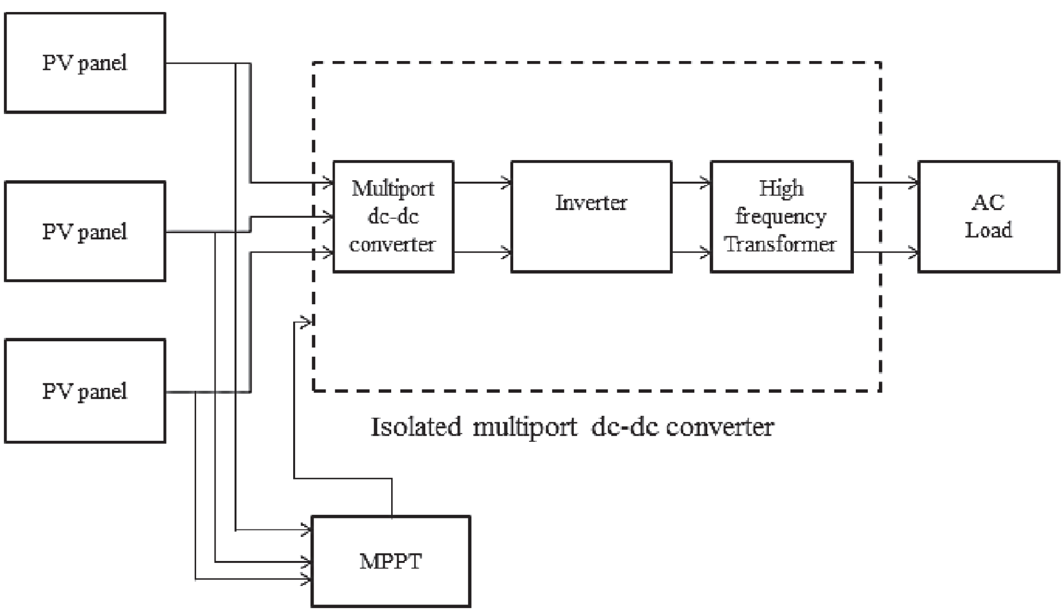

Figure 1: Schematic diagram of proposed system

3. CONTROLLER OPERATION OF PROPOSED SYSTEM

The Figure 2 shows the circuit diagram of the isolated multiport dc-dc converter. It consists of a low-voltage side (LVS) circuit and a high-voltage-side (HVS) circuit connected by a high-frequency transformer TX. The LVS circuit consists of m ports in parallel, one energy storage capacitors C_s, and the primary winding of the transformer. Each port contains a controllable power switch, a power diode, and an inductor, The HVS circuit of the secondary winding of the transformer connected to a full bridge diode rectifier and a low frequency LC filter. The transformer's turn ratio is defined as $n = N_P/N_S$. This converter has three operating modes: (1) All switches are on; (2) Switch S_1 is off while at least one of the other switches is on; and (3) All switches are off. The equivalent circuits of the converter in the three operating modes are shown in Figure 2(a) and (b) and so on.

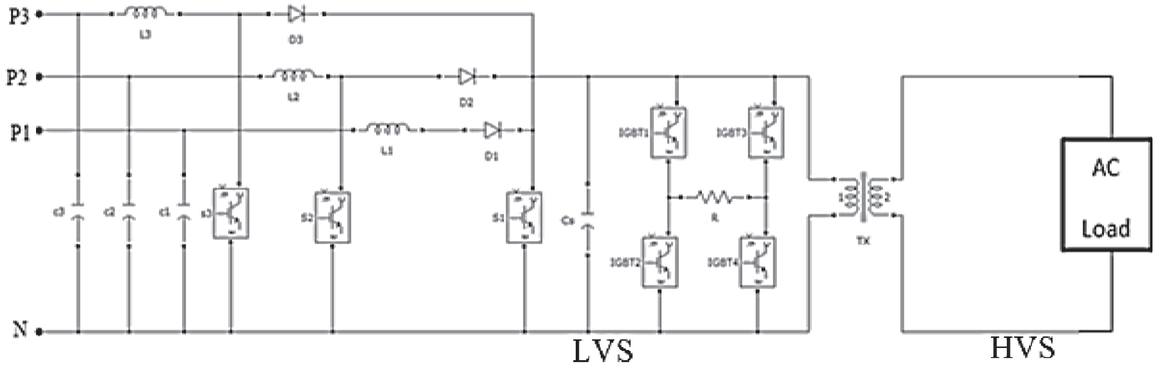

Figure 2: Circuit Diagram of the isolated multiport dc-dc converter

The Figure 3(a) which shows the equivalent circuit diagrams of mode 1 for all switches are on and also signal flows in the generation system managed by the proposed dc-dc converter.

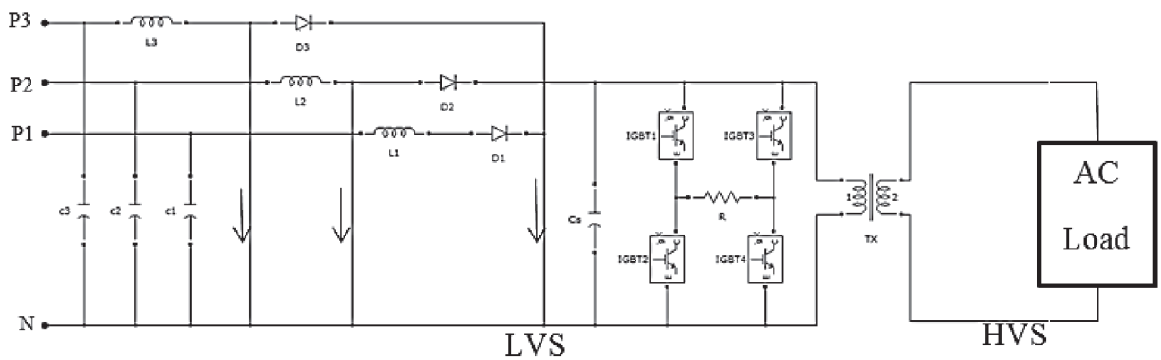

Figure 3: (a) Equivalent circuits of the operating Mode 1

The Figure 3(b) which shows the equivalent circuit diagram of mode 2 i.e., switch S_1 is off and at least one of the other switches is on and also signals flows in the generation system managed by the proposed dc-dc converter. The Figure 3(c) which shows the equivalent circuit diagram of mode 3 i.e., all switches are off and also signal flows in the generation system managed by the proposed dc-dc converter.

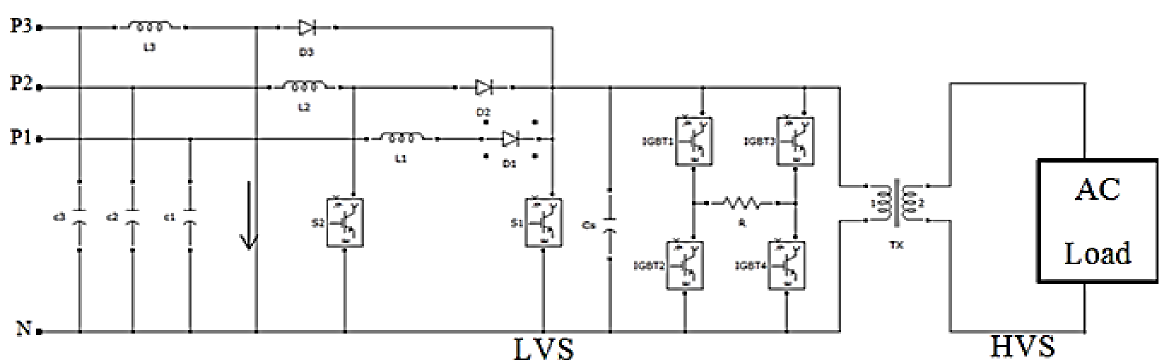

Figure 3: (b) Equivalent circuits of the Mode 2:S_1 is off and at least one of the other switches is on

The MPPT controller uses a P&O MPPT algorithm to maximize the output power of the three PV panels simultaneously under various weather conditions. The MPPT controller uses the output voltage and current of each source as the input to generate an appropriate pulse width modulated signal for the corresponding switch.

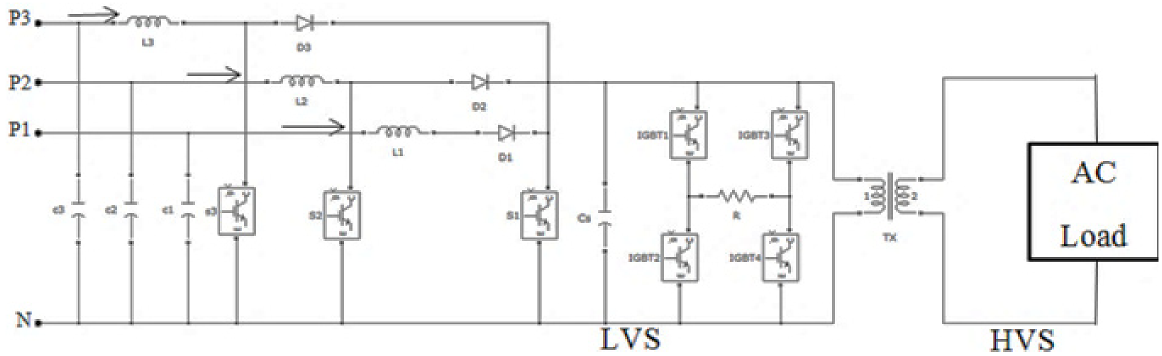

Figure 3: (c) Equivalent circuits of the mode 3 all switches are off

4. POWER MANAGEMENT OF MULTIPLE ENERGY SOURCES USING THE PROPOSED CONVERTER

The flowchart of the P&O MPPT algorithm is shown in Figure 4, where $V_S(k)$ and $P_s(k)$ are the sampled voltage and power of each source at the *k*th step. The updated duty cycle causes a change in the source current, which leads to the variation of the output power of the source. The power variation and duty cycle perturbation in the previous step are used to determine the direction (i.e., positive or negative) of the duty cycle perturbation in the next step. To test the MPPT results for the three PV panels, it is necessary to obtain the ideal maximum power points (MPPs) of the three sources under various conditions. For a PV panels, the power-voltage (P-V) characteristic curve can be assumed unchanged within every 3-min interval in a clear day. Then, the MPPs can be derived by gradually increasing the duty ratio from a low to a high value.

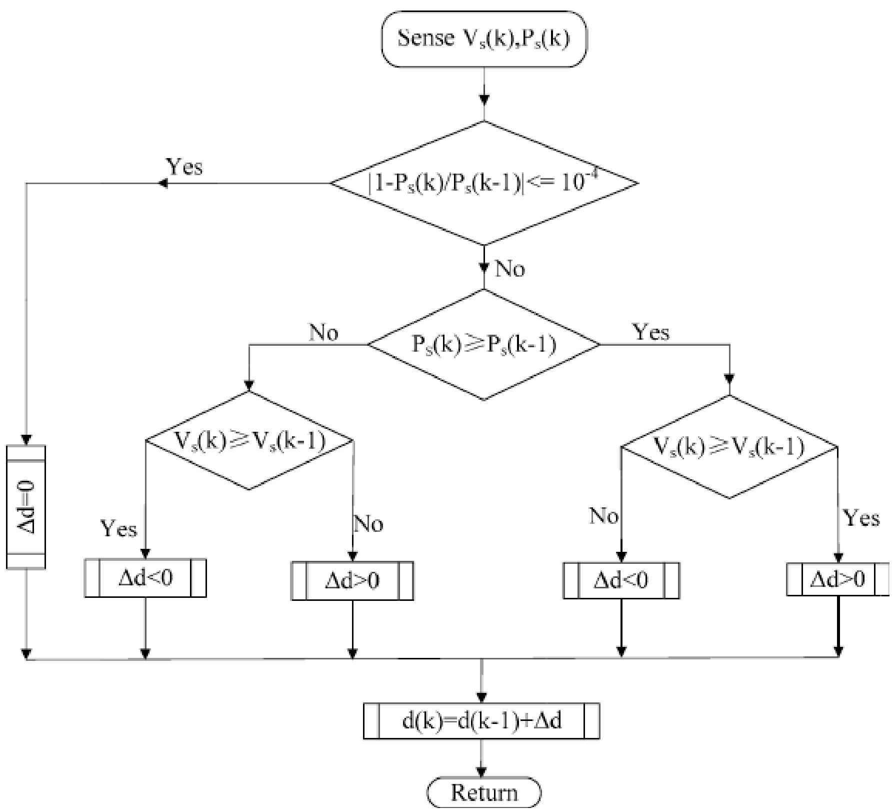

Figure 4: Flowchart of the P&O MPPT algorithm

5. SIMULATION RESULT

The Figure 5 shows the simulation circuit of proposed multiport DC-DC converter which is connected through the three PV panel and it is connected to the high frequency transformer through the inverter.

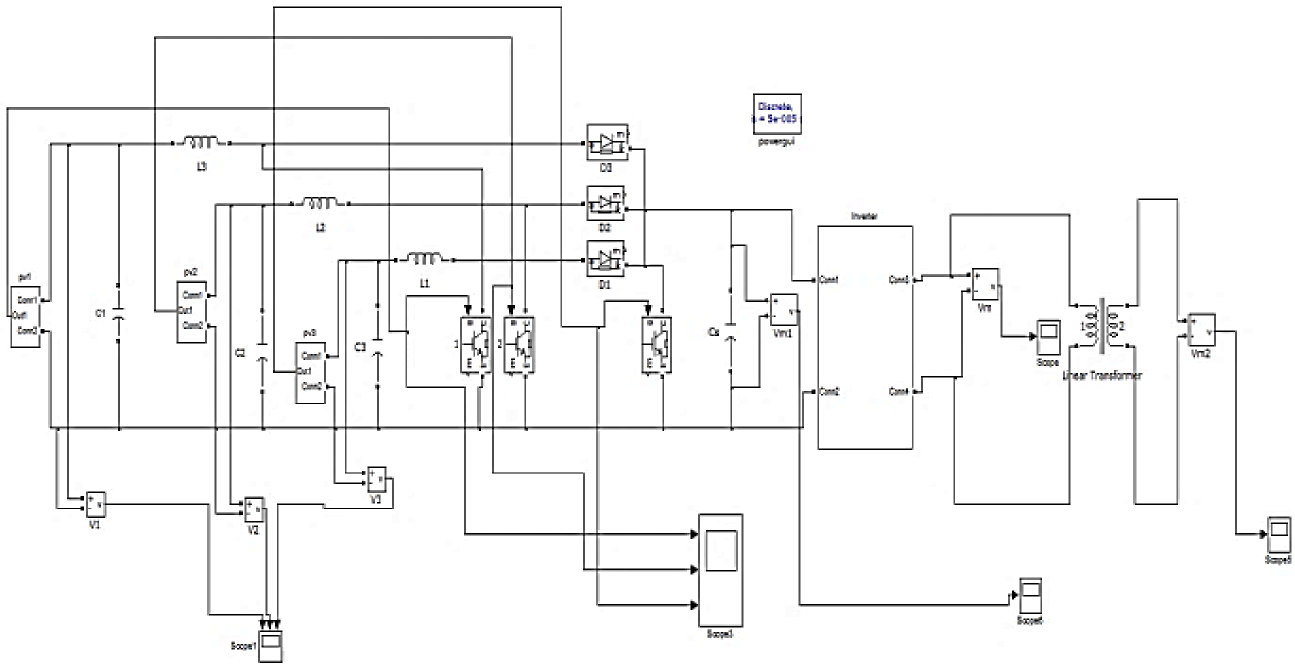

Figure 5: Simulation circuit for the proposed system

The following results show the output voltage of PV panels, gate pulse, capacitor voltage and transformer output voltage.

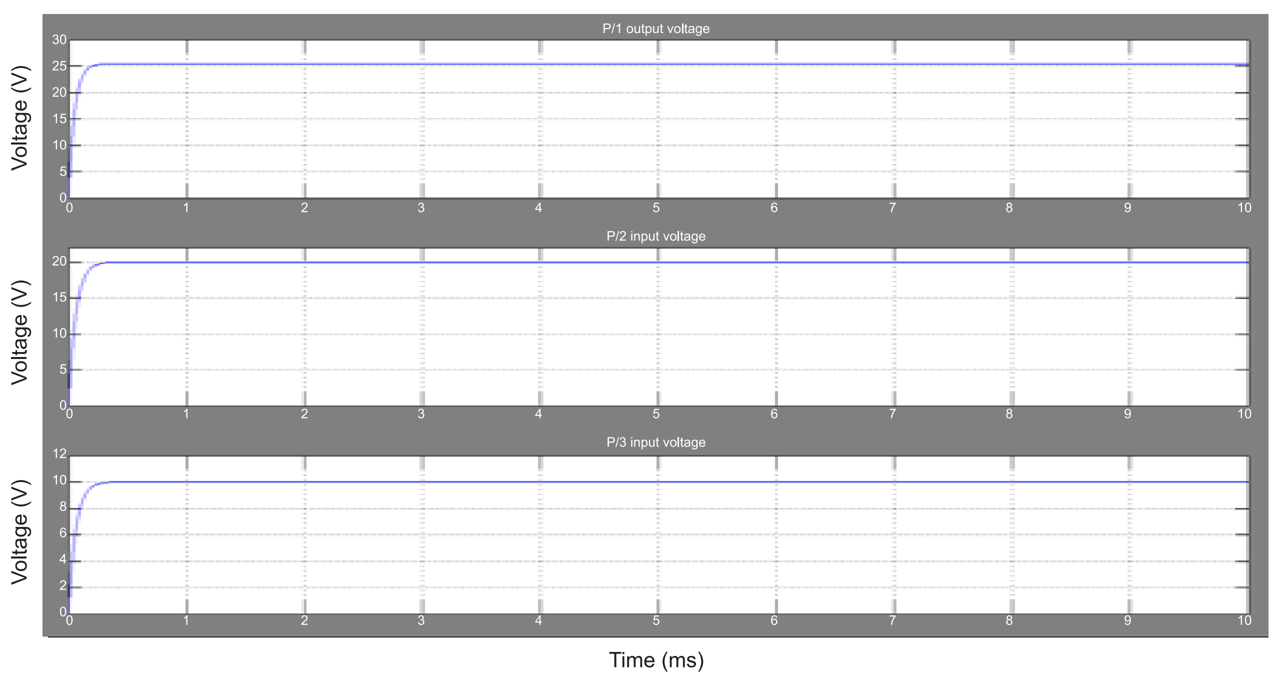

Figure 6: (a) PV panels output voltage waveform

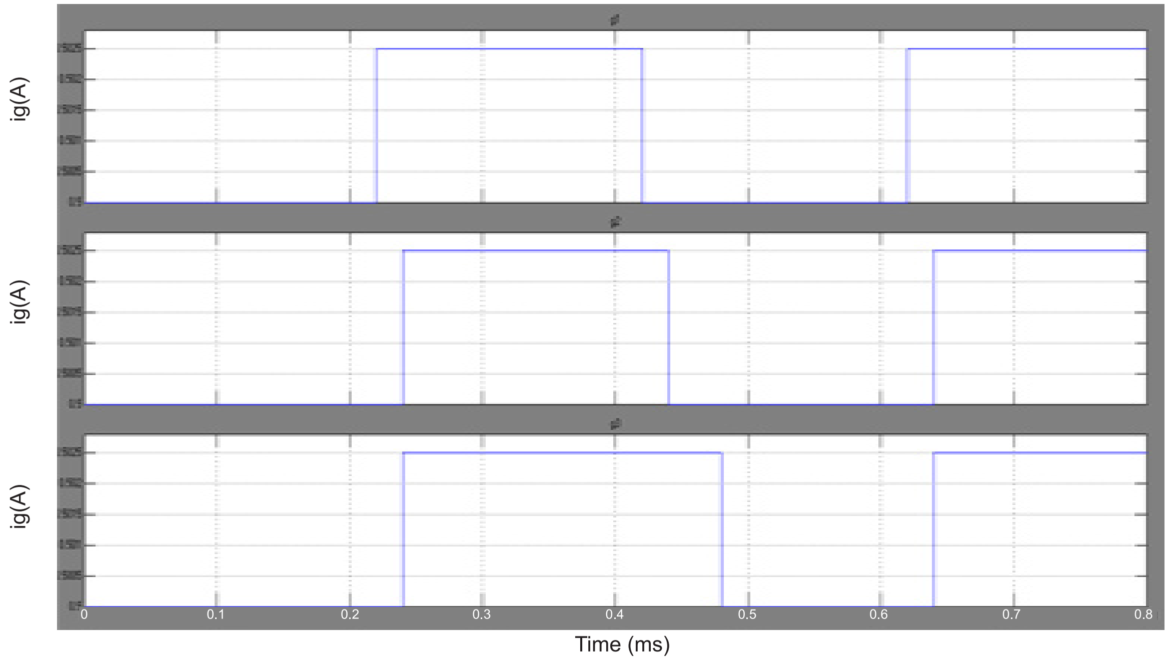

Figure 6: (b) Gate pulse generated from MPPT

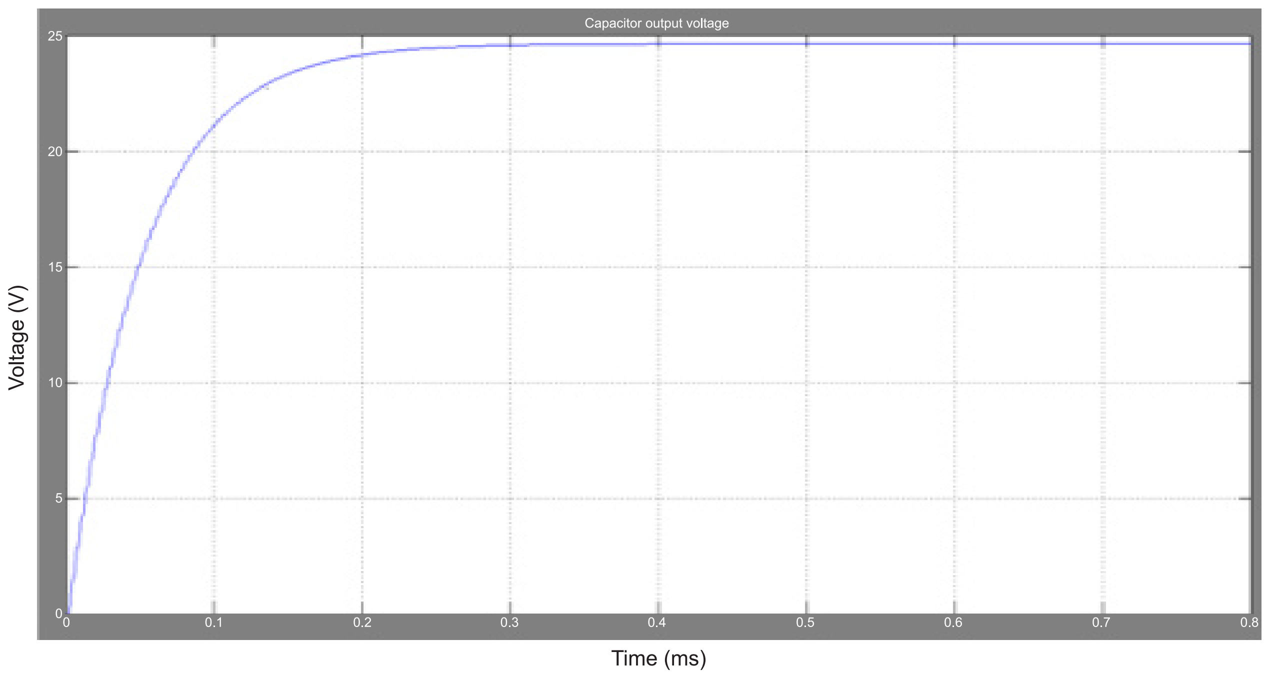

Figure 6: (c) Capacitor output voltage waveform

6. CONCLUSION

An isolated multiport dc–dc converter that uses the minimum number of switches has been proposed for simultaneous power management of multiple renewable energy sources. It has been applied for simultaneous power management of a three-source wind/solar hybrid generation system. The experimental results have been provided to show the effectiveness of the proposed converter. The advantage of the proposed multiport

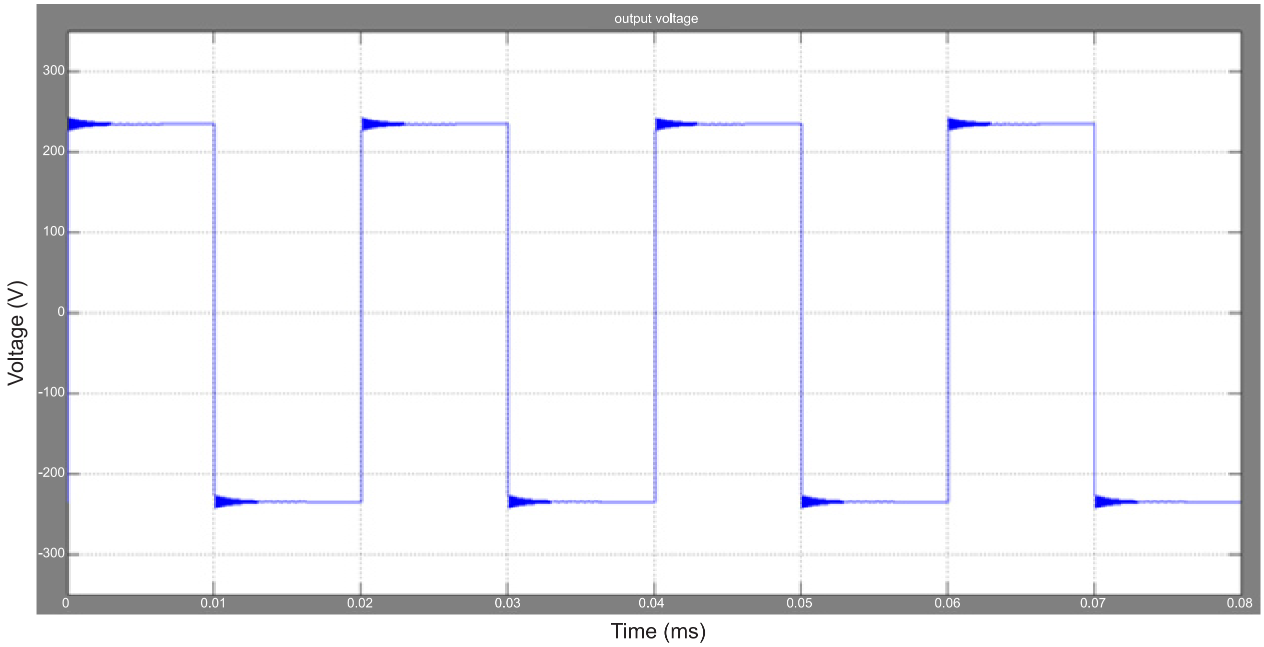

Figure 6: (d) Output voltage waveform of the high frequency transformer

dc–dc converter is its simple topology while having the capability of MPPT control for different renewable energy sources simultaneously. Moreover, the proposed converter can be easily applied for power management of other types of renewable energy sources. In future the hybrid energy system can be further altered to some other renewable sources like PV-Fuel cell Hybrid Energy System to meet large load depending on various applications.

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