Chapter 14
Power Quality Assessment of Solar PV Standalone System Using Various DC-DC Converters

Surbhi Shringi, Santosh Kumar Sharma, and Utkarsh Gupta

1 Introduction

Today the increasing energy demands with urbanization, industrialization, and increasing population have led to the need to find substitutes for conventional energy sources. Many renewable sources have lead to replacing conventional sources with time [1, 2].

The most used types of renewable power sources include solar and wind. Both of these sources use various types of power electronics devices in order to get synchronized with the grid [3].

The main issues that are created with the power electronics devices are the ripples and the Total Harmonic distortion which are introduced in the power supply. Hence in order to reduce these above-discussed problems, THD analysis of various DC-DC converters is done in order to find the suitable and best converter amongst the three [4, 5].

S. Shringi (✉) · S. K. Sharma · U. Gupta
Rajasthan Technical University, Kota, Rajasthan, India
e-mail: surbhishringi96@gmail.com

S. K. Sharma
e-mail: santoshelect@yahoo.com

U. Gupta
e-mail: utkarshgupta3095@gmail.com

M. Shorif Uddin et al. (eds.), *Intelligent Energy Management Technologies*,
Algorithms for Intelligent Systems,
https://doi.org/10.1007/978-981-15-8820-4_14

2 System Description with Simulation Models and Results

The system consists of a PV array which acts as a power source keeping the irradiation and the temperature to be fixed which is further given to the DC-DC converter followed by the P&O MPPT technique to extract maximum power from the PV array this power is collected and measured at the DC link as it is considered as one of the parameters for power quality assessment. This DC voltage is converted into AC using the Voltage source converter and then this is connected with the Power grid or with the Load (Fig. 1).

2.1 System with Boost Converter

The simulation model of the system with Boost converter is shown in Fig. 2.

Figure 3 shows the output voltage at DC link of the Boost converter.

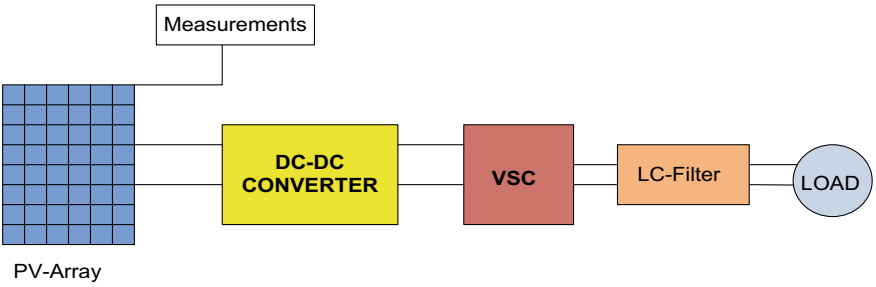

Fig. 1 Block diagram of the system

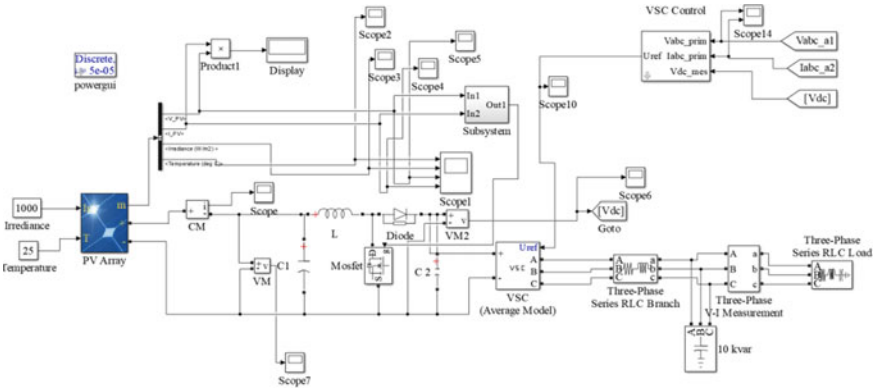

Fig. 2 Simulation diagram of the system using Boost converter

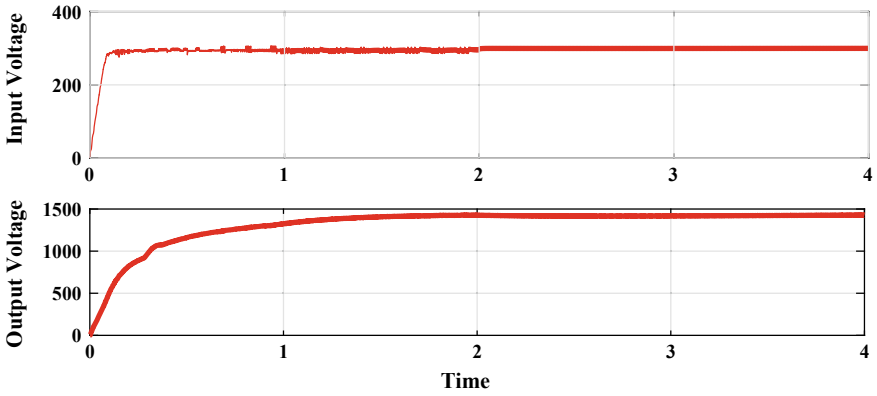

Fig. 3 Output Voltage of the DC link with Boost converter

The THD analysis of the VSC output waveforms is done whose results are shown below in Fig. 4.

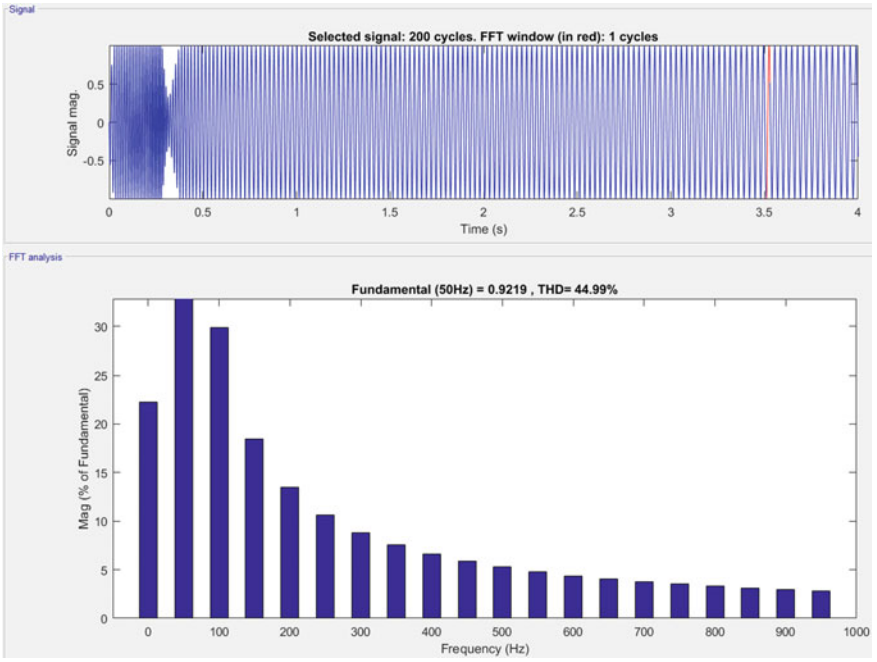

Fig. 4 THD analysis of VSC waveforms with Boost converter

2.2 System with Buck Converter

The simulation model of the system using Buck converter is shown in Fig. 5.

Figure 6 shows the output voltage at the DC link with the Buck converter.

The THD analysis of the VSC output waveforms is done whose results are shown below in Fig. 7.

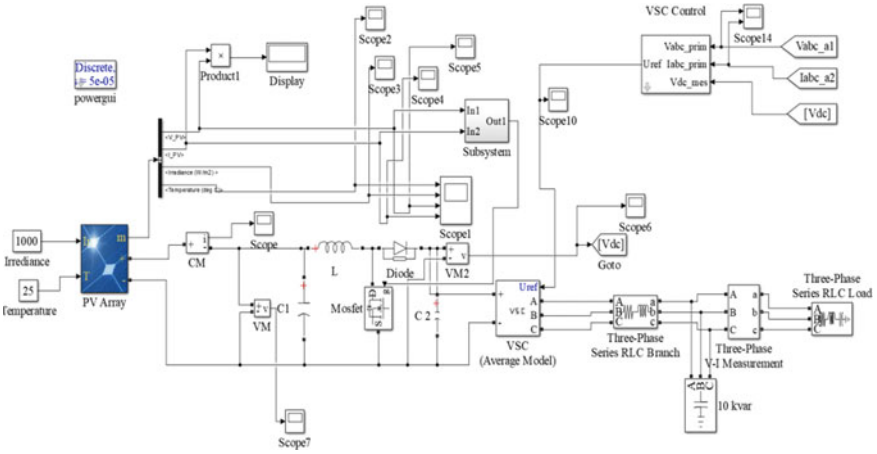

Fig. 5 Simulation model of the system with Buck converter

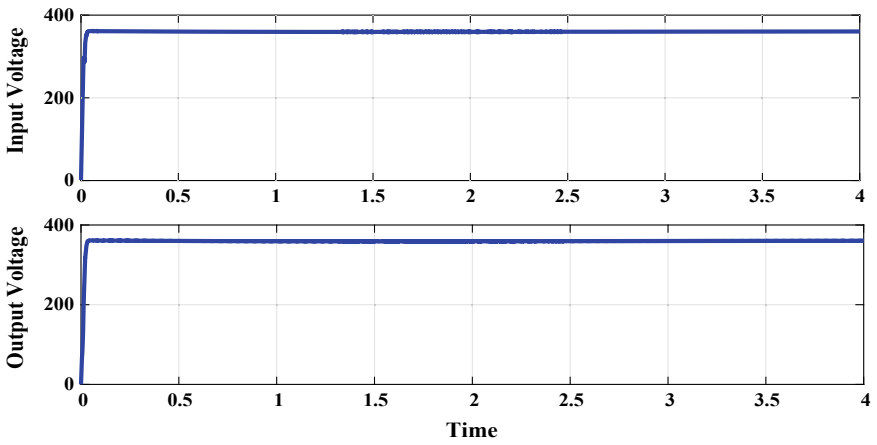

Fig. 6 Output voltage of the DC link with Buck converter

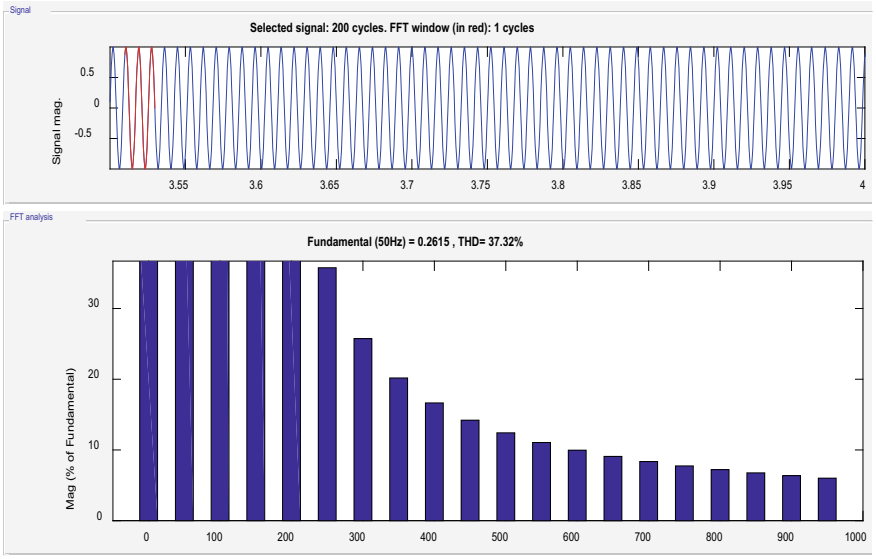

Fig. 7 THD analysis of VSC waveforms with Buck converter

2.3 System with Buck-Boost Converter

The simulation model of the system using Buck-Boost converter is shown in Fig. 8. Figure 9 shows the output voltage at the DC link with the Buck-Boost converter.

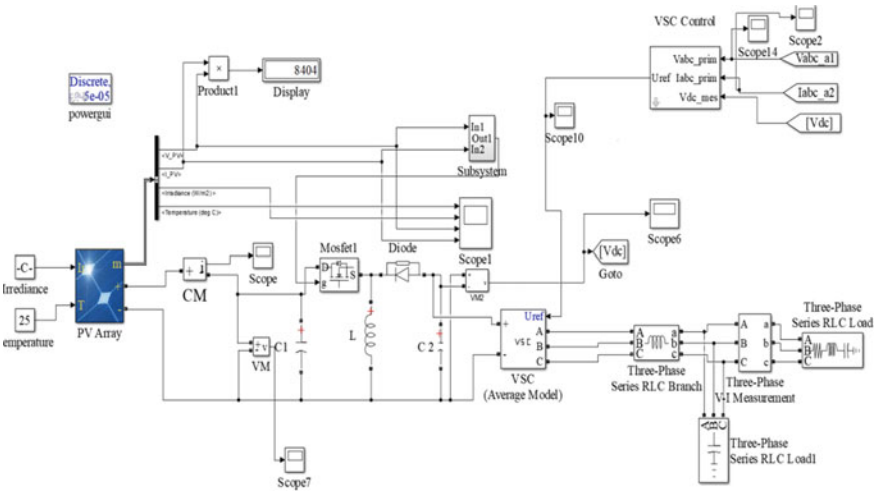

Fig. 8 Simulation model of the system with Buck-Boost converter

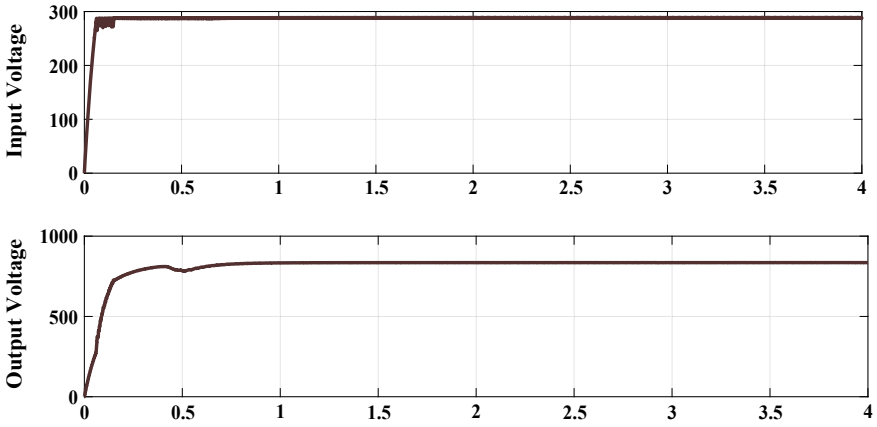

Fig. 9 Output voltage of the DC link with Buck-Boost converter

The THD analysis of the VSC output waveforms is done whose results are shown in Fig. 10.

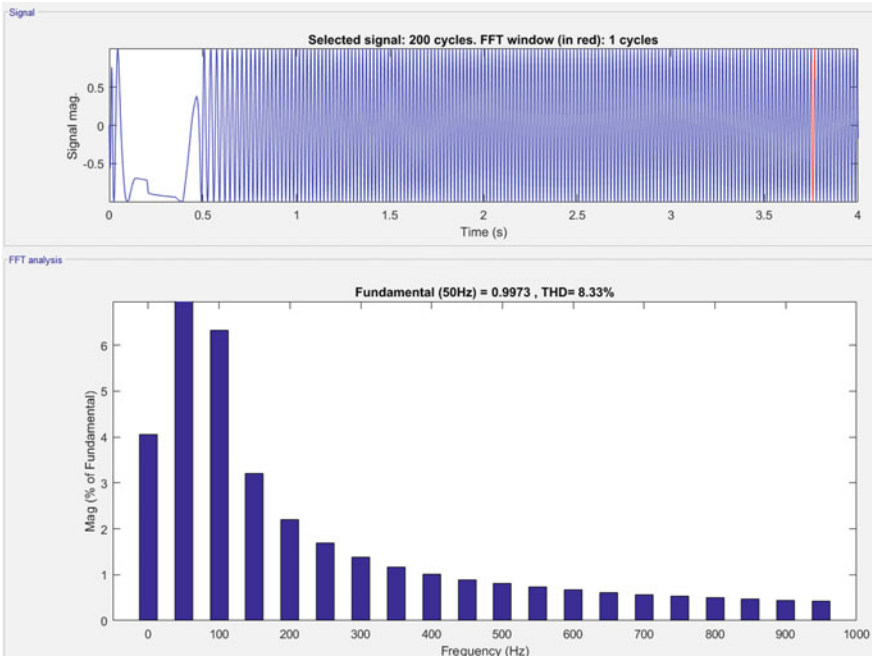

Fig. 10 THD analysis of VSC waveforms with Buck-Boost converter

2.4 System with Cuk Converter

The simulation model of the system using Cuk converter is shown in Fig. 11.

Figure 12 shows the output voltage at the DC link with the Cuk converter.

The THD analysis of the VSC output waveforms is done whose results are shown in Fig. 13.

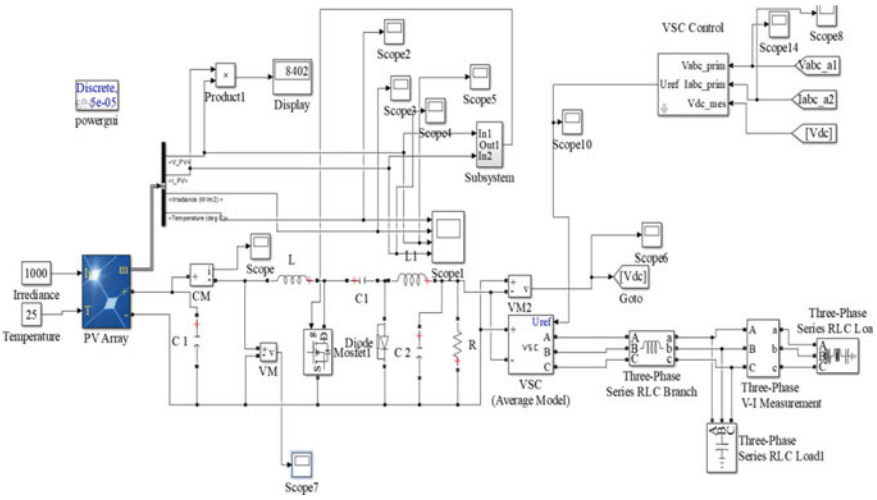

Fig. 11 Simulation model of the system with Cuk converter

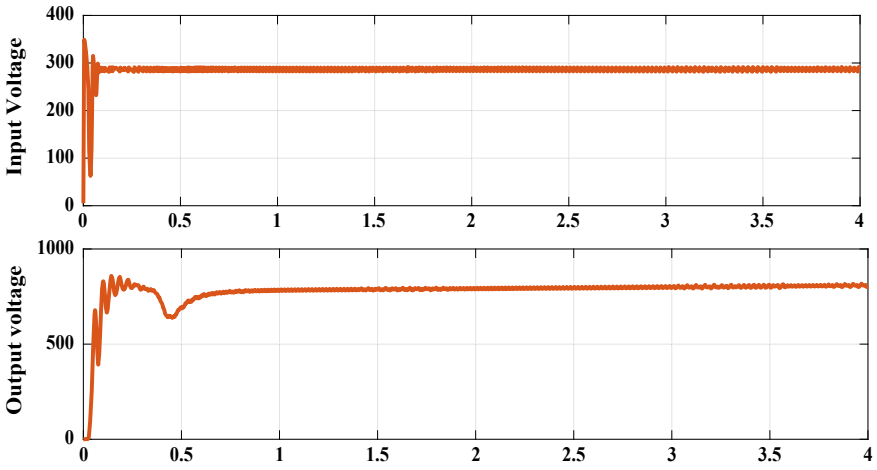

Fig. 12 Output voltage of the DC link with Cuk converter

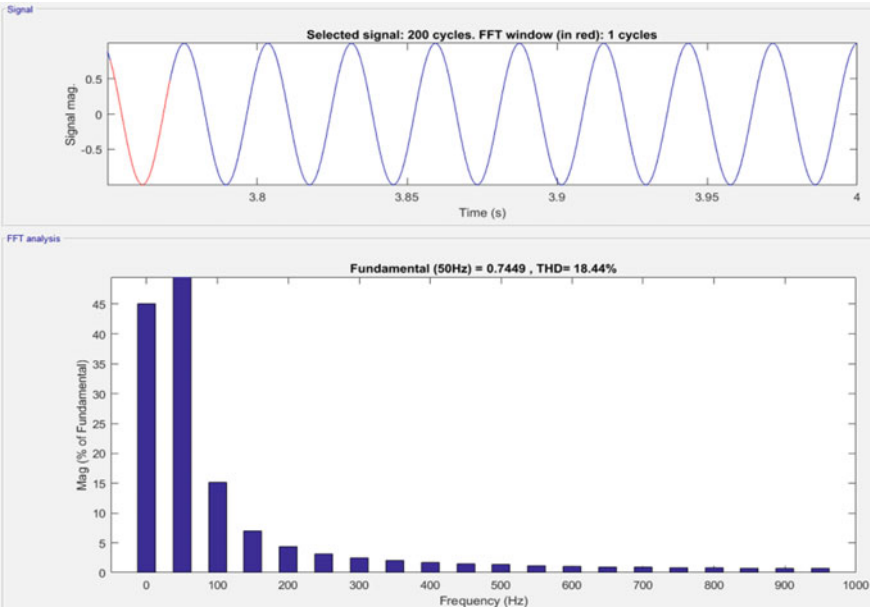

Fig. 13 THD analysis of VSC waveforms with Cuk converter

2.5 System with Zeta Converter

The simulation model of the system using Zeta converter is shown in Fig. 14.

Figure 15 shows the output voltage at the DC link with the Zeta converter.

The THD analysis of the VSC output waveforms is done whose results are shown in Fig. 16.

3 Conclusion

The analysis of various converters is done on the basis of the THD and the output voltage response. The Zeta and Boost converters are found to be better than the other converters while talking in terms of the THD and output voltage. The selection of the converters could be done according to the application and the user's needs.

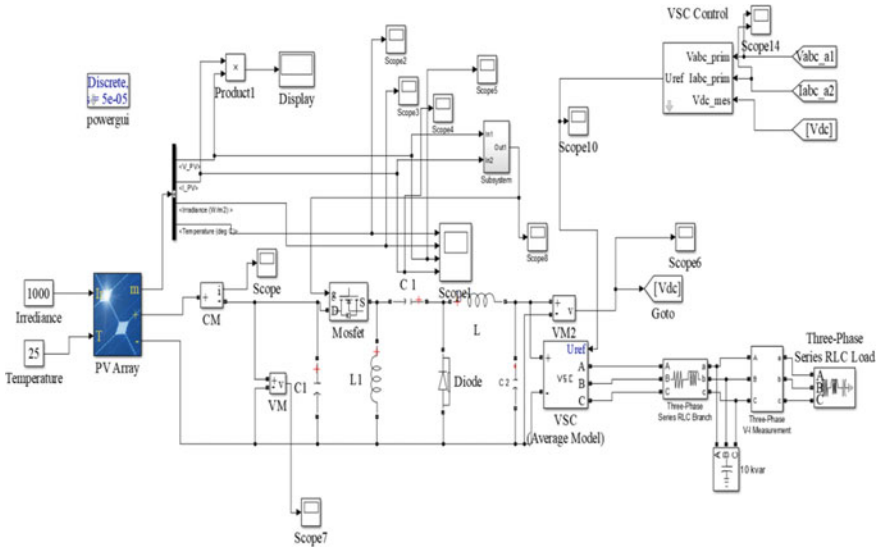

Fig. 14 Simulation model of the system with Zeta converter

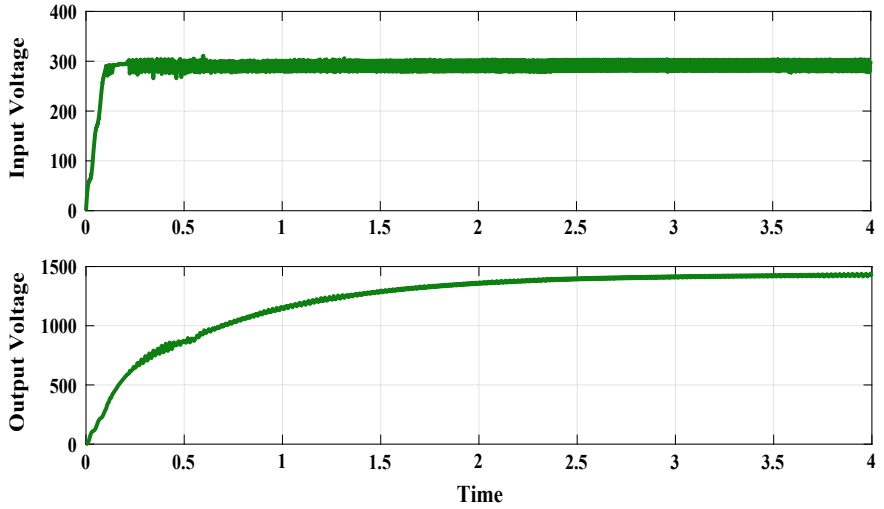

Fig. 15 Output voltage of the DC link with Zeta converter

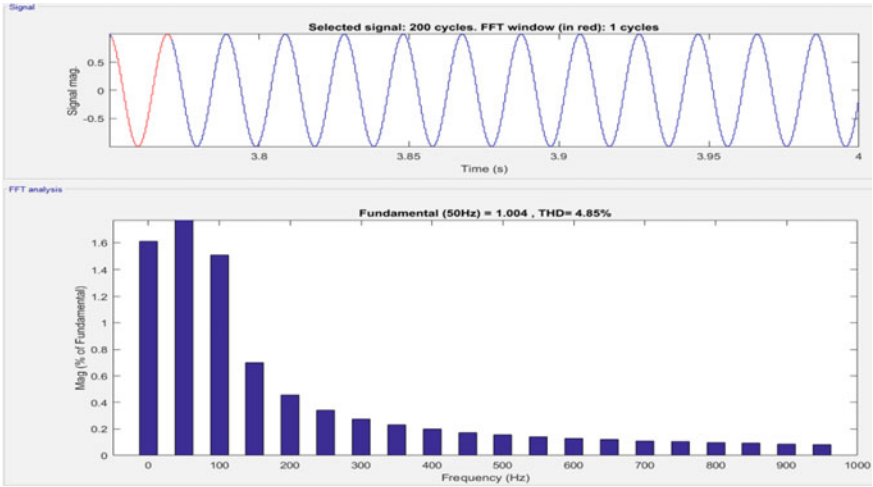

Fig. 16 THD analysis of VSC waveforms with Zeta converter

References

1. Bhattacharyya S, Samanta S (2018) DC link voltage control based power management scheme for standalone PV systems. In: 2018 IEEE international conference on power electronics, drives and energy systems (PEDES). https://doi.org/10.1109/pedes.2018.8707904
2. Fu J, Zhang B, Qiu D, Xiao W (2014) A novel single-switch cascaded DC-DC converter of Boost and Buck-boost converters. In: 16th European conference on power electronics and applications. https://doi.org/10.1109/epe.2014.6910723
3. Soheli SN, Sarowar G, Hoque MA, Hasan MS (2018) Design and analysis of a DC -DC buck boost converter to achieve high efficiency and low voltage gain by using buck boost topology into buck topology. In: 2018 International conference on advancement in electrical and electronic engineering (ICAEEE). https://doi.org/10.1109/icaeee.2018.8643001
4. Plotnikov I, Braslavsky I, Ishmatov Z (2016) The mathematical simulation of DC-DC coverter in the frequency-controlled electric drive with ultracapacitors. In: 2016 International symposium on power electronics, electrical drives, automation and motion (SPEEDAM). https://doi.org/10.1109/speedam.2016.7525910
5. Maroti PK, Padmanaban S, Wheeler P, Blaabjerg F, Rivera M (2017) Modified high voltage conversion inverting cuk DC-DC converter for renewable energy application. In: IEEE southern power electronics conference (SPEC). https://doi.org/10.1109/spec.2017.8333675