Design and Analysis Three-Phase Voltage Source Inverter with an Unbalanced AC Source

Thogaru venkateshwarlu
Assistant professor
Deportment of EEE
Sri Sai Educational society's group of institutions

ABSTRACT: Three-phase dc–ac power converters, inverters are suffer from power oscillation and over current problems in case of the unbalanced ac source voltage that can be caused by grid or generator faults. In many applications inverter circuits plays a vital role in power system network design such as power quality, renewal energy generation, motor drives, smart grid and micro grid. *Etc*... In this paper discussed, proper zero-sequence current controls and corresponding circuit configurations, the power converter can enable more flexible control targets, achieving better performances in the delivered power and the load current when suffering from the unbalanced ac voltage.

I.INRDUCTION:

In many important applications for power electronics such as renewable energy generation, motor drives, power quality and micro grid, etc., The three phase inverter circuits mainly contains power flow interface of dc and ac electrical systems [1], [2]. As shown in Fig. 1, a dc–ac voltage source converter with a corresponding filter is typically used to convert the energy between the dc bus and the three-phase ac sources, which could be the power grid, generation units, or the electric machines depending on the applications and controls [3]–[5]. Since the power electronics are getting so widely used and becoming essential in the energy conversion technology, the failures or shutting down of these backbone dc–ac converters may result in serious problems and cost. It is becoming a need in many applications that the power converters Should be reliable to withstand some faults or disturbances in order to ensure certain availability of the energy supply [6]–[8]. A good example can be seen in the wind power application, where both the total installed capacity and individual capacity of the power conversion system are relatively high.

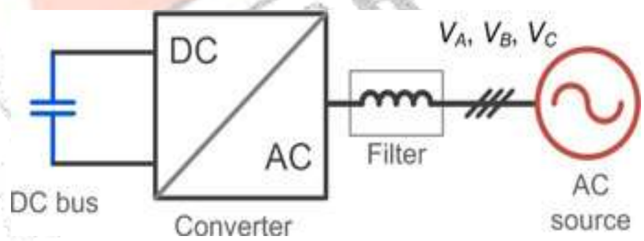

Fig. 1. Typical dc–ac power converter application.

II. Literature Survey:

The sudden disconnection of the power converter may cause significant impacts on the grid stability and also on the high cost for maintenance/repair [1]. As a result, transmission system operators (TSOs) in different countries have been issuing strict requirements for the wind turbine behaviour under grid faults. As shown in Fig. 2, the wind power converter should be connected (or even keep generating power) under various grid voltage dips for certain time according to the dip severity, and in some uncritical conditions (e.g., 90% voltage dip), the power converter may need long-time operation.

When the ac source shown in Fig. 1 becomes distorted under faults or disturbances, the unbalanced ac voltages have been proven to be one of the greatest challenges for the control of the dc–ac converter in order to keep them normally operating and connected to the ac source. Special control methods which can regulate both the positive- and negative sequence currents have been introduced to handle these problems, However, the resulting performances by these control methods seem to be still not satisfactory: either distorted load currents or power oscillations will be presented, and thereby not only the ac source but also the power converter will be further stressed accompanying with the costly design considerations.

II. Voltage Converter System:

In order to analyze the controllability and the performance of the power electronics converter under an adverse ac source, a severe unbalanced ac voltage is first defined as a case study in this paper. There are many other types of voltage faults which have been defined as type A–F in [22]. Distorted three-phase voltage can be expressed by the sum of components in the positive sequence, negative sequence, and zero sequence. For simplicity of analysis, only the components with the fundamental frequency are considered in this paper, however, it is also possible to extend the analysis to higher order harmonics.

A typically used three-phase three-wire two-level voltage source dc–ac converter is chosen and basically designed, as shown in Fig.2. Where the converter configuration and the parameters are indicated, respectively. It is noted that the three-phase ac source is represented here by three windings with a common neutral point, which can be the windings of an electric machine or a transformer.

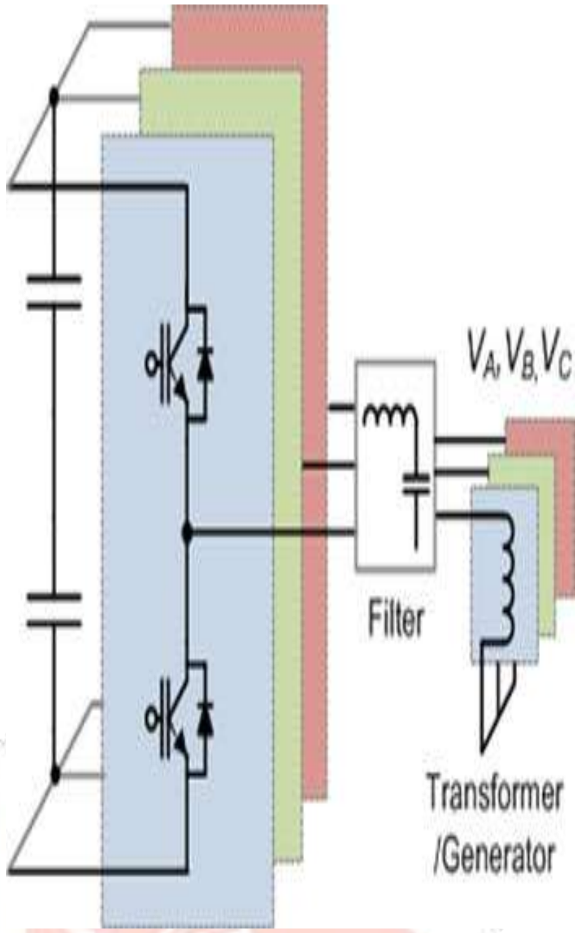

Fig. 2. Typical three-phase three-wire 2L-voltage source converter

IV. CONTROL SCHEME:

Three-phase three-wire converter system, there are only two more current control freedoms left to achieve another two control targets besides. These two adding control targets may be utilized to further improve the performances of the converter under the unbalanced ac source, which have been generally investigated in [2] and . However, this paper focuses more on the evaluation of control limits and the control possibilities under the whole voltage dipping range. In the following, two of the most mentioned control methods achieved by three-wire converter structure are investigated under the unbalanced ac source. PI control strategies are adopted to operate gate pulses in a sequence.

V. Simulation Results:

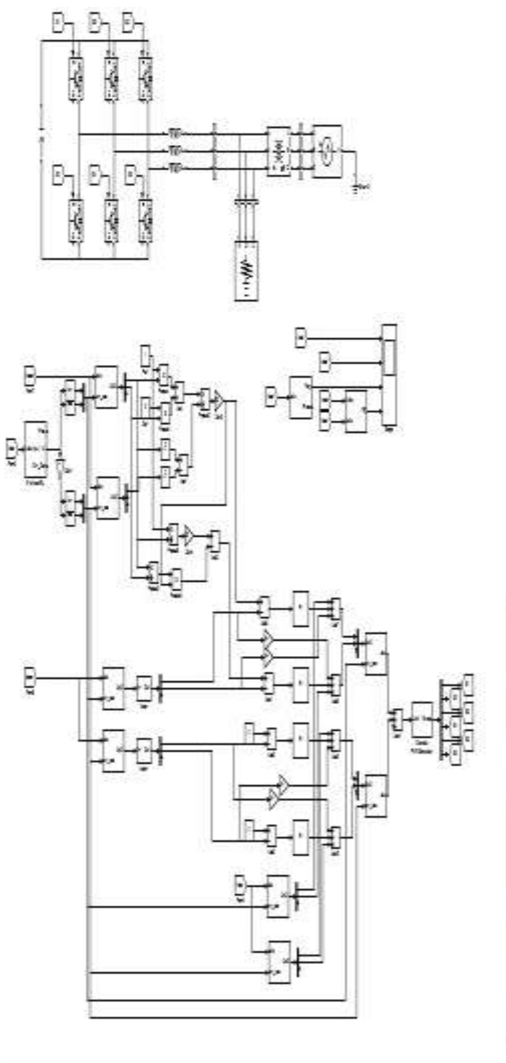

Fig.3: Network modelling in MATLAB.

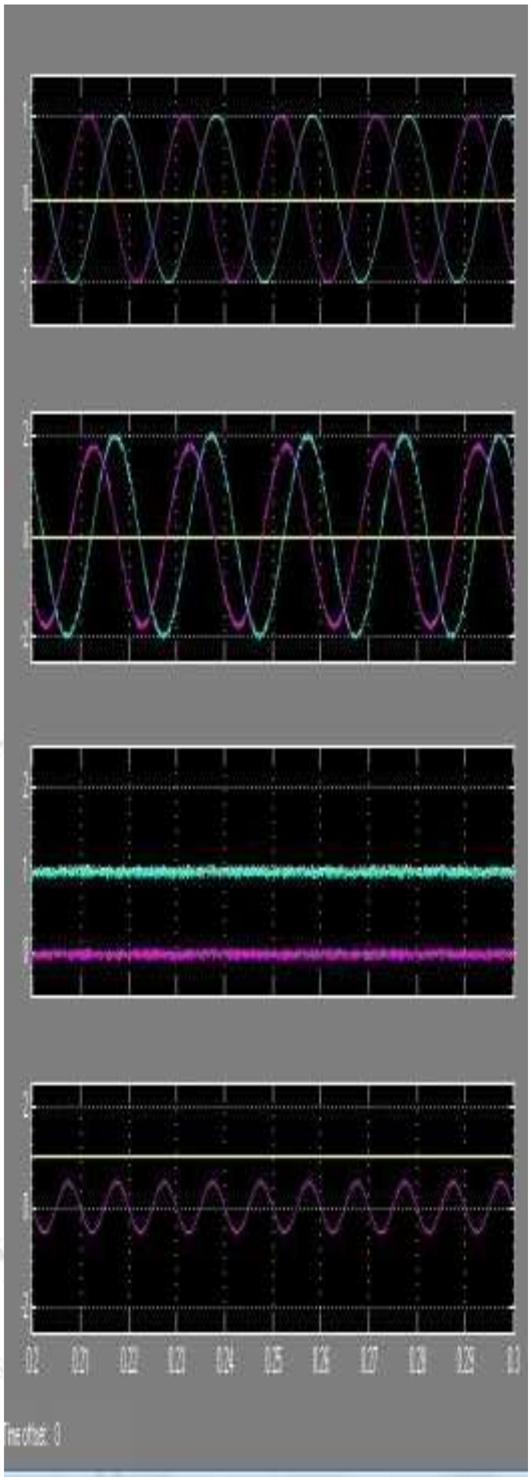

Fig.4. Simulation of the converter with no negative-sequence current control (three-phase three-wire converter, Pref = 1 p.u., Qref = 0 p.u., $Id-$ = 0 p.u., $Iq-$ = 0 p.u., VA = 0 p.u., $I+$, $I-$, and $I0$ means the amplitude of the current in the positive, negative, and zero sequences, respectively).

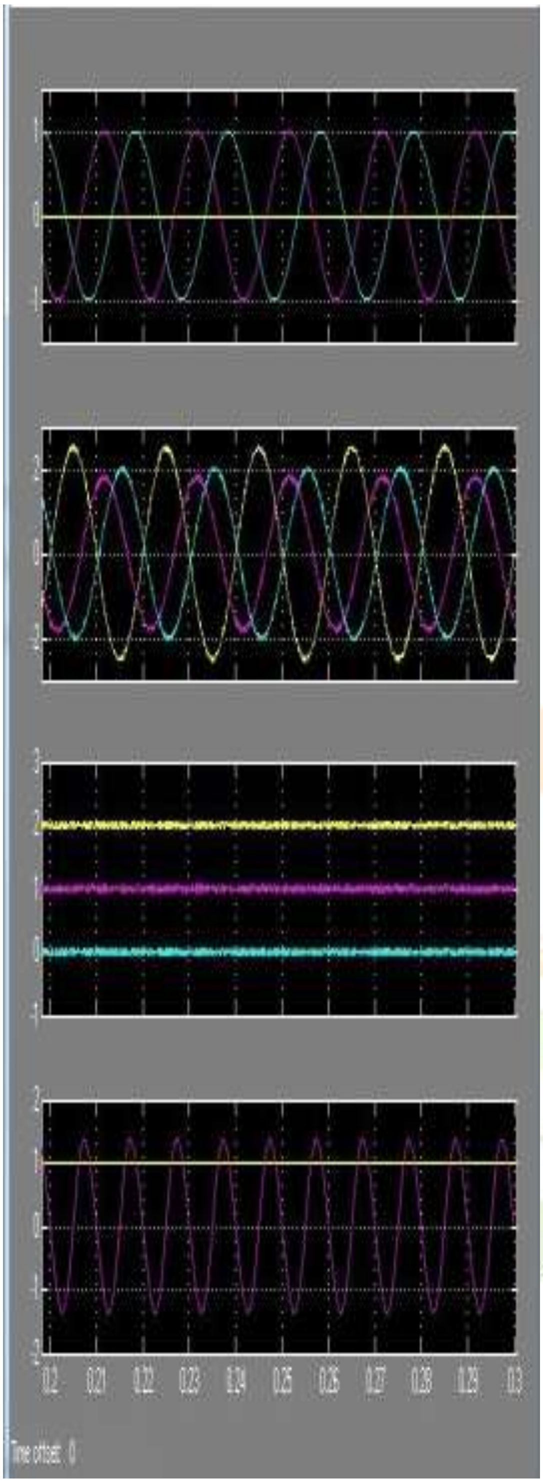

Fig.5. Simulation of the converter control with no active power oscillation (three-phase three-wire converter, Pref = 1 p.u., Qref = 0 p.u., $Ps2$ = 0 p.u., Pc 2 = 0 p.u., VA = 0 p.u. $I+$, $I-$, and $I0$ means the amplitude of the current in the positive, negative, and zero sequences, respectively.

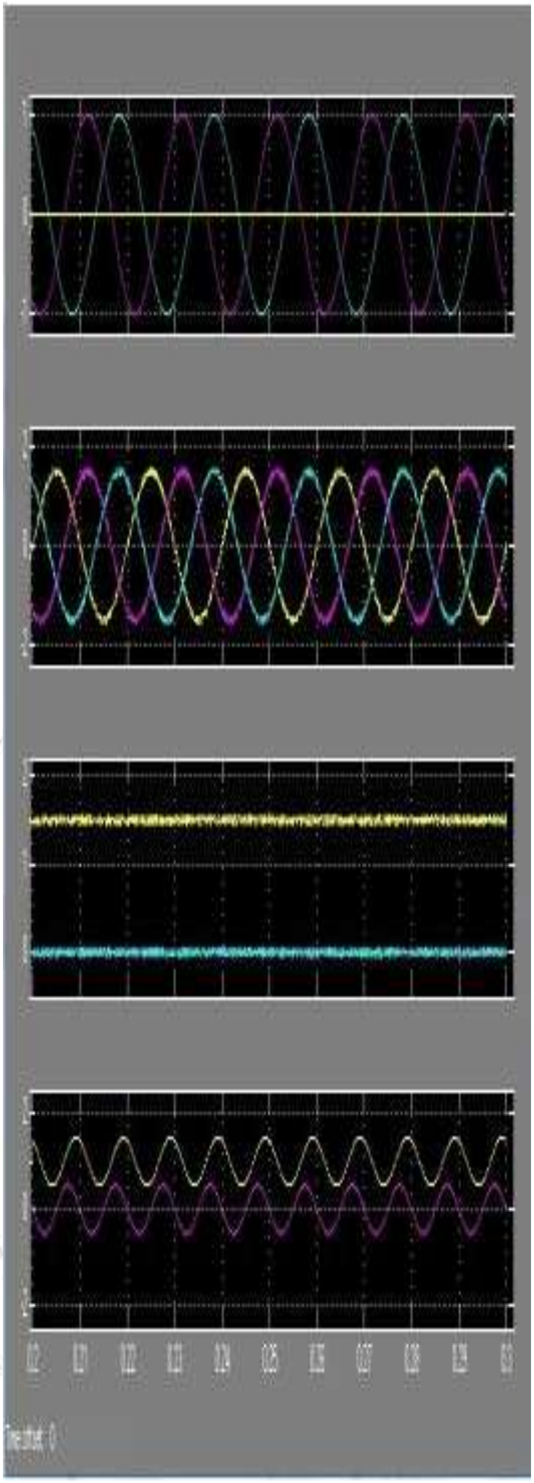

Fig.6. Simulation of converter control with no active and reactive power oscillation (three-phase converter with the zero-sequence path, Pref = 1 p.u., Qref = 0 p.u., $Ps2$ = 0 p.u., Pc 2 = 0 p.u., $Qs2$ = 0 p.u., Qc 2 = 0 p.u., VA = 0 p.u.).

VI. Conclusion:

In a typical three-phase three-wire converter structure, there are four current control freedoms, and it may be not enough In the three-phase converter structure with the zero sequence current path, there are six current control freedoms. The extra two control freedoms coming from the zero sequence current can be utilized to extend the controllability of the converter and improve the control performance under the unbalanced ac source. By the proposed control strategies, it is possible to totally cancel the oscillation in both the active and the reactive power, or reduced the oscillation amplitude in the reactive power. Meanwhile, the current amplitude of the faulty phase is significantly relieved without further increasing the current amplitude in the normal phases.

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