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A Novel Hybrid VI Control Strategy for DG-Grid Interfacing Converters based on RES

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Abstract:
This paper develops a fuel cell source Based DG-Grid Interfacing Converters using a novel hybrid voltage and current control method (HCM). To overcome the drawbacks of voltage- and current controlled DG units. The proposed method allows the coordinated closed-loop control of the DG unit fundamental voltage and line harmonic currents. With the HCM, local harmonic loads of the DG unit can even be compensated without using harmonic current extraction. In addition, the HCM guarantees smooth transition during the grid-connected/islanding operation mode transfer. Simulation results are provided to verify the feasibility of the proposed approach.

Index Terms—Active power filter (APF), current control, distributedgeneration (DG), LCL filter,RES,Fuel Cell.

I.INTRODUCTION

The concept of multifunctional DG units with shunt active power filter (APF) capabilities, DG units can also be applied to improve the distribution system power quality by canceling the harmonic currents of local loads [8], [9].In spite of the advantages of using CCM, the increasing penetration of current-controlled DG units also brings some concerns of conventional power distribution system stability[10]–[12]. The stability problems can be more serious when the power distribution system switches to an off-grid system. In this circumstance, the control mode of DG units is preferred to be changed to voltage-controlled method (VCM) [10]–[15], [17].However, at the operation mode transfer instant, the conflicts between the conventional CCM and VCM may cause nontrivial transient currents [15], [16]. To ensure a smooth operation mode transfer, some improved methods have been developed[15], [16], where the grid-connected DG system first reduces the line current before switching to an islanded system. When the DG system is isolated from the main grid, a voltage controllers immediately applied to regulate the capacitor voltage of the LCL filter. With this method, transient currents are suppressed at the costs of a few cycles transition delay.

On the other hand, the adoption of VCM for DG units in both grid-connected and islanding modes has no transient issue during the grid-connected/islanding operation mode transfer, which provides opportunities to achieve the “plug and play “operation of DG units in a micro grid [10], [30]. Unfortunately, as the focus of VCM is the fundamental power flow, it cannot directly regulate DG line current harmonics. Therefore, the voltage-controlled DG units are usually sensitive to the disturbances from upstream main grid and local harmonic loads. A modified VCM-controlled DG unit was recently proposed, which realizes enhanced line current quality control through adjusting

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equivalent converter series harmonic impedances In this method, the performance of indirect DG harmonic linecurrent regulation relies on the accuracy of point of commoncoupling (PCC) voltage measurement. For a stiff grid withreduced PCC voltage distortions, it will be less effective as theextraction of PCC harmonic components is difficult.In order to overcome the limitations of the aforementionedCCM and VCM, this paper proposes an improved DG controlmethod through the simultaneous control of the LCL filter capacitorvoltage and line current harmonics. Similar to the VCM,the output power of a DG unit is controlled by the regulationof fundamental filter capacitor voltage. At the same time, aclosed-loop harmonic current compensator regulates the linecurrent harmonics. Owing to the frequency selective featuresof resonant controllers [6], there is little interference between the fundamental voltage tracking and the harmonic current regulation.Further analysis on the structure of the proposed hybridcontrol method (HCM) indicates that local harmonic loads caeven be compensated without any harmonic extraction process.Finally, the DG unit using HCM can be switched between gridconnectedand islanding modes at any time instant, withoutusing additional transient mitigation methods.

II.PROPOSED SYSTEM

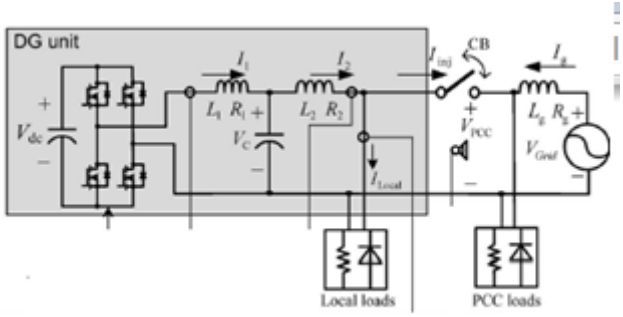

Fig. 1. Block diagram of grid-interfacing converter systems.

III.PROPOSED CONTROL STRATEGY

Proposed HCM

Although the CCM and VCM have similar controller structure,to maintain proper operation of interfacing converters,their operation principles have been developed separately so far.Due to the conflicts between CCM and VCM, the outer loopsof these methods cannot be simply merged together to controlboth voltage and current.Nevertheless, it can be noticed that the resonant controllers(2) have a high gain Kih at the selected frequency ωh, andthis gain decreases rapidly when the frequency is out of thebandwidth (ωch). Due to this frequency selective feature, it ispractical to control the capacitor voltage and line current atdifferent frequencies without noticeable interferences.

Furthermore, since the droop control of the DG unit wasdeveloped based on the steady-state analysis of power flowbetween two voltage sources [13], the DG output power flowcan be realized through fundamental capacitor voltage regulationusing the corresponding fundamental resonant controllerRf (s). Meanwhile, the harmonic line current can be regulated

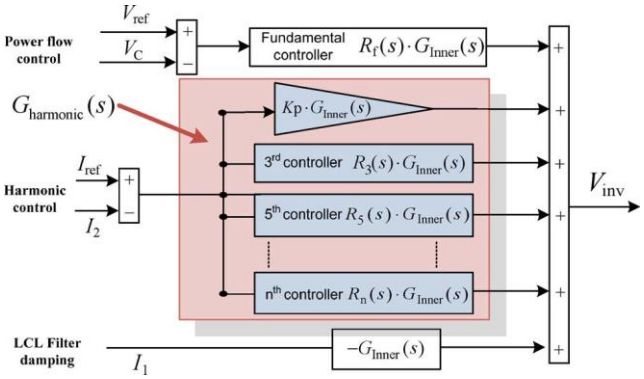

Fig. 2. Block diagram of the proposed HCM.

V.SIMULATION RESULTS

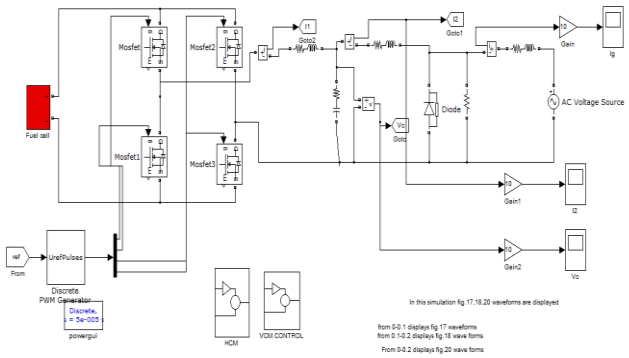

Fig.3 Simulation Circuit

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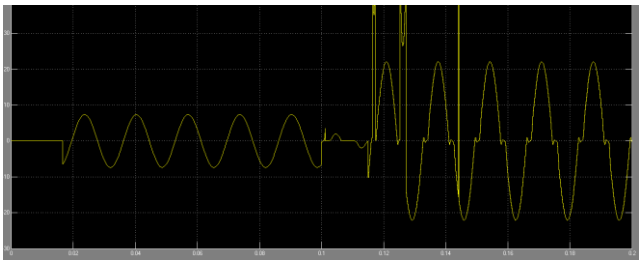

Fig.4 Grid Current

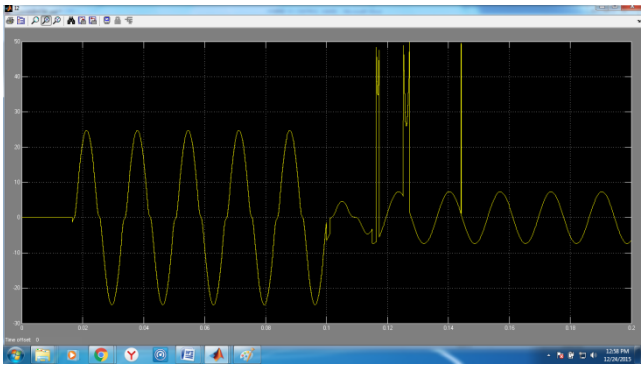

Fig.5 Load Current

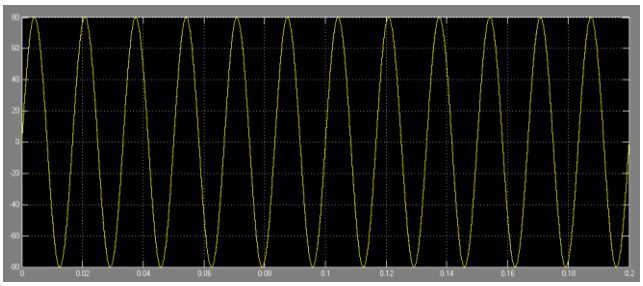

Fig.6 Capacitor Voltage

VI. CONCLUSION

This paper proposed a hybrid voltage and current control method (HCM) for DG interfacing converters with LCL filters.The proposed method realizes simultaneous control offundamental capacitor voltage and harmonic line current andtherefore can overcome the limitations of the traditional voltagecontrol method and current control method. Specifically, in theproposed control scheme, the DG unit's fundamental powerflow is regulated through the fundamental voltage tracking withdroop control, while the harmonic line current is regulatedto compensate local harmonic loads or to improve the linecurrent quality at the selected harmonic frequencies.

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