Recently, the artificial intelligence (AI) techniques are widely used in the power system application [28], [29]. Therefore, the mathematical model derived by using the DQ method from this paper can be also used as the objective function of the AI algorithm for the system design.

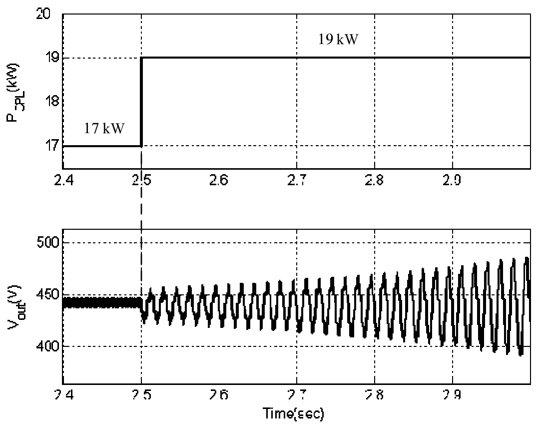

Fig.21 The simulation validation of Fig.17

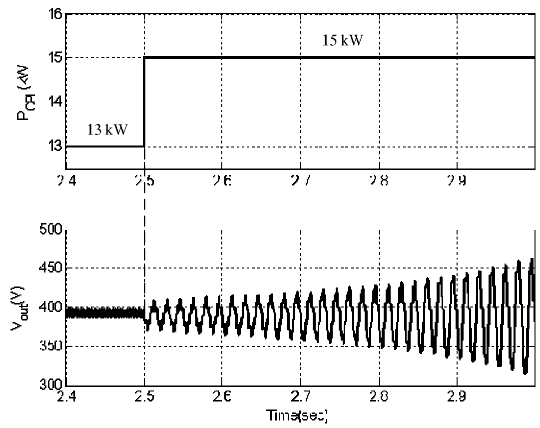

Fig.22 The simulation validation of Fig.18

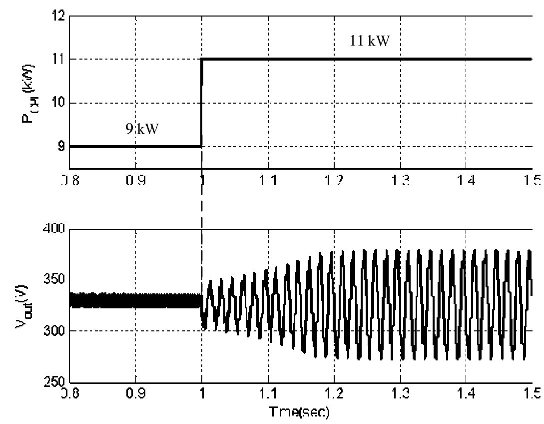

Fig.23 The simulation validation of Fig.19

6. Conclusion

In this paper, the DQ modeling method is presented for modeling a three-phase AC distribution system with a three-phase controlled rectifier, DC-link filters, and an ideal CPL connected to the DC bus. The proposed approach is very useful for modeling the AC distribution system and also concerning a phase shift between source bus and AC bus. Moreover, the resulting converter models can be easily combined with models of other power elements expressed in terms of synchronously rotating frames such as generators, front-end converters, and vector-controlled drives. This paper also present the DQ linearized model that is used to analyse the system stability due to the CPL. The three-phase benchmark model is used to verify the stability results in the paper. The results show that the mathematical model derived from the DQ method can predict the instability point with a high accuracy. Therefore, electrical engineers can use the mathematical model to study the power system behaviour and to avoid the unstable condition. In the future, the dynamic model will be used to predict the instability point for variations in system parameters. Moreover, the mathematical model from this paper can be also used for the AI application to the power system design to achieve the best performance.

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