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Maximum Power Point Tracking Of DFIGS for Power Quality Improvement

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Abstract: This paper proposes a brand new control technique of doubly given induction machines (DFIGs) under unbalanced grid current conditions. The suggested controller features a model predictive direct power control (MPDPC) method along with a power compensation plan. In MPDPC, the right current vector is chosen based on an optimization cost function, therefore, the immediate active and reactive forces are controlled directly within the stator stationary reference frame without the advantages of coordinate transformation, PI government bodies, switching table, or PWM modulators. Additionally, the behavior from the DFIG under unbalanced grid current is investigated. Next, an electrical compensation plan with no need of removing negative stator current sequence is developed. An unbalanced three- phase system could be discomposed to 3 balanced symmetric three- phase system, i.e., the zero sequence, positive sequence, and negative sequence. The 3-phase system considered within this analysis is really a three-wire connection system without neutral point connection. By mixing the suggested MPDPC strategy and also the power compensation plan, altered power injected in to the power company through the DFIGs could be removed effectively. Consequently, apparent harmonic components are presented both in stator and rotor power.

I.INTRODUCTION

With the steady growth of distributed generation (DG) units connected to the utility grid, power quality has become a major concern . In distorted network conditions, the wind turbine system could be damaged because of oscillated electromagnetic torque, and the main grid could be polluted due to the distorted stator current. The wind turbines might be disconnected from the distorted network to protect themselves from overcurrents and overvoltages, which, however, is generally not allowed by the latest grid codes . Therefore, the system controller must react to the perturbation and mitigate the adverse effects on the wind turbine systems themselves and the utility grid. There are various control strategies for the DFIGs under unbalanced grid voltage conditions. The most common approaches are based on field-oriented control (FOC) or vector control (VC).owever, it requires complex decoupling and coordinate transformation, resulting in slow transient performance. All these drawbacks will deteriorate the system performance. Besides, the positive and negative sequence current components need to be extracted. To overcome the large among of tuning work and reduce the control complexity in VC, direct torque control (DTC) and direct power control (DPC) were proposed in recent years. DTC and DPC algorithms are much simpler and more robust than the VC algorithms. Later on, improved DTC and DPC strategies are utilized to control DFIGs under unbalanced grid voltage conditions. Nevertheless, larger power ripples due to the use of hysteresis controller and the predefined switching table seriously deteriorate the performance of the system controller. There are also other improved control strategies worth being mentioned. For example, a predictive current control approach was presented to obtained rapid dynamic response . Nevertheless, the algorithm was relatively complex and not easy to implement. Sliding mode control (SMC) is employed to control DFIGs in , but only the fluctuations of torque and reactive power are addressed without considering the power quality improvement of the stator currents. An improved system configuration is proposed . However, an additional series grid-side converter is required, which will increase the system cost. To overcome the drawback mentioned above and enhance the control flexibility of the DFIGs, this paper proposes a model predictive direct power control (MPDPC) strategy with power compensation schemes for power quality improvement under unbalanced grid voltage conditions. The negative-sequence stator current component is not needed to be extracted. Coordinate transformation, PI regulators, switching tables, and PWM modulators are all avoided; hence, excellent dynamic response is achieved.

II.SYSTEM DESCRIPTION AND MODELING

The electricity motor is linked to a DFIG using a gear box for elevated torque at lower speed. For that DFIG, the stator is directly attached to the grid, as the rotor is given with a back-to-back power ripper tools. The suggested controller includes two blocks. 1) The first may be the MPDPC technique manipulating the stator active and reactive forces directly. 2) The 2nd block creates the needed power references to handle the problems under grid current unbalance. Prior to the control technique for DFIGs under unbalanced grid current conditions is developed, it's important to review the DFIG modeling [2]. However, grid altered conditions, for example unbalanced grid current, aren't considered. In MPC, the long run behavior from the product is first predicted while using system model, the right current vector will be selected according to an optimization cost function in every control period based on the predicted values and also the reference values. Here, a MPDPC of DFIGs is suggested. By neglecting the stator resistance, the connection between stator current and stator flux at steady condition could be described. According to this analysis, the fundamental from the MPDPC would be to assess the effects of all of the possible rotor current vectors around the stator output forces. The current vector that minimizes a particular cost function will be used. It may be observed that the DFIG continues to be modeled while using active and reactive power because the condition variables and also the rotor current as input. However, all of the possible current vectors in MPDPC are evaluated in each and every sampling period [3]. Therefore, better steady-condition performance that has been enhanced dynamic response could be acquired. An unbalanced three- phase system could be discomposed to 3 balanced symmetric three- phase system, i.e., the zero sequence, positive sequence, and negative sequence. The 3-phase system considered within this analysis is really a three-wire connection system without neutral point connection. Consequently, the zero sequences of the present are going to be zero, also is true for those voltages. Consequently, the stator current and also the current under unbalanced network could be expressed using positive sequence components and negative sequence components. It may be observed that negative sequence components will appear in the stator power once the grid current is unbalanced, which can result in altered stator power. To be able to obtain sinusoidal and balanced stator current, the negative sequence current should be removed. The positive sequence aspects of the stator current and also the negative sequence aspects of the stator current (i.e., the grid current) are first delivered to the ability compensators to create the compensation terms. This these compensation terms will be included to the initial constant power references to create the brand new references, which are shipped towards the MPDPC controller. It may be discovered that in stator current decomposition, just the positive sequence component is needed [4]. This is extremely helpful used, because the negative sequence component is comparatively smaller sized in comparison using the positive sequence component, resulting in the less accurate extraction from the negative sequence and therefore deteriorated performance. It's worth mentioning the electromagnetic torque under unbalanced network may also fluctuate because of the existence of oscillating terms. An unbalanced three- phase system could be discomposed to 3 balanced symmetric three- phase system, i.e., the zero sequence, positive sequence, and negative sequence. The 3-phase system considered within this analysis is really a three-wire connection system without neutral point connection. Within this paper, the ability quality improvement may be the primary focus. Consequently, apparent harmonic components are presented both in stator and rotor power [5].

CONTROL PRINCIPLES OF PROPOSED WIND POWER GENERATOR SYSTEM

Fig. 3 depicts the control framework of the proposed system. The control system design concepts maintain power flow balance between the input and the output and, simultaneously, force the generator frequency to synchronize with the utility grid. When the system complies with these conditions, the generator output can be connected to the utility grid network, subsequently reaching the high efficiency and maximum power tracking objectives. The control signals, including the generator voltage, current, grid phase, motor encoder, and output power, are sensed and transferred to the microprocessor control unit (MCU).

The servo motor controller plays an important role in output power and grid voltage phase tracking. A situation in which the controller detects a power increase from the servo motor implies decreasing wind speeds. At this moment, the system regulates the exciter current to reduce the excitation generator output power. A chain reaction subsequently occurs in which the servo motor power returns to a balanced level. During the energy balance periods, the servo motor consumes only a slight amount of energy to stabilize the shaft speed. Once (1) is satisfied, both the maximum power and the constant speed can be obtained by the designed control scheme. Fig. 4 schematically depicts the servo motor and maximum power tracking control (MPTC) loops which are designed to stabilize the speed, frequency, and output power of the excitation synchronous generator under wind disturbances. The wind turbine provides mechanical torque to rotate the generator shaft via the speed-increasing gear box. As the generator shaft speeds reach the rated speed, the generator magnetic field is excited. The MPTC then controls the output voltage reaching grid voltage. Moreover, the generator output waveform is designed in phase with the grid using the servo motor control track grid sine waveform. Owing to the difficulty in precisely estimating the wind speed, the proposed MPTC scheme measures the motor output power as the reference signals to determine the generator output power. The excitation synchronous generator output frequency, voltage-phase, and output power are fed back into the control scheme. The phase/frequency

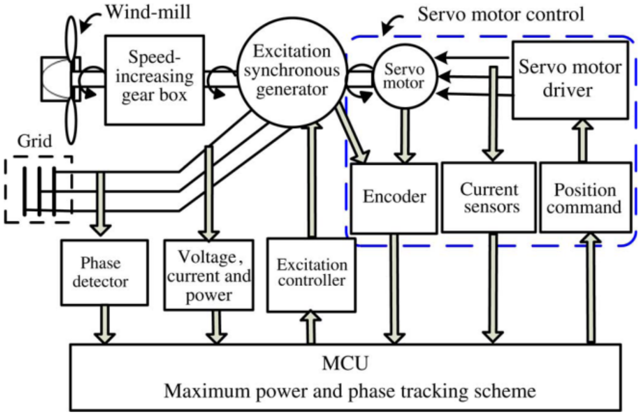


Fig. 3. Proposed wind power system framework.

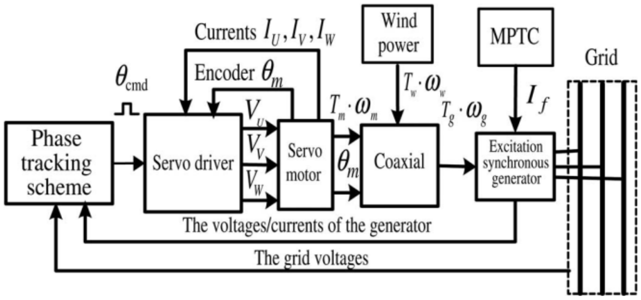


Fig. 4. Proposed wind power generator system.

synchronization strategy in Fig. 4 compares the grid voltage-phase and frequency with the generator's feedback signals, and produces the position command with pulse-type signals to the servo motor driver. The MPTC also adjusts the excitation field current based on the wind power and motor power inputs, where denotes the servo motor rotor mechanical rotor angular displacement detected by an encoder. Due to the coaxial configuration, detecting the relative position of the rotor allows us to determine the generator voltage phase during the wind power generator system

SYSTEM DESCRIPTION AND DFIG MODELING

The DFIG-based wind power system considered in this work is illustrated in Fig. 1. The dc motor is connected to a DFIG via a gear box for increased torque at lower speed. For the DFIG, the stator is directly connected to the grid, while the rotor is fed by a back-to-back power converter. The proposed controller consists of two blocks. 1) The first one is the MPDPC technique controlling the stator active and reactive powers directly.

2) The second block produces the required power references to deal with the problems under grid voltage unbalance. Before the control strategy for DFIGs under unbalanced grid voltage conditions is developed, it is necessary to study the DFIG modeling. The mathematical equations for a DFIG can be expressed in the stator stationary frame using complex vectors as

$$\boldsymbol{V}_s = R_s\boldsymbol{I}_s + \frac{d\boldsymbol{\psi}_s}{dt} \tag{1}$$

$$\boldsymbol{V}_r = R_r\boldsymbol{I}_r + \frac{d\boldsymbol{\psi}_r}{dt} - j\omega_r\boldsymbol{\psi}_r \tag{2}$$

$$\boldsymbol{\psi}_s = L_s\boldsymbol{I}_s + L_m\boldsymbol{I}_r \tag{3}$$

$$\boldsymbol{\psi}_r = L_m\boldsymbol{I}_s + L_r\boldsymbol{I}_r \tag{4}$$

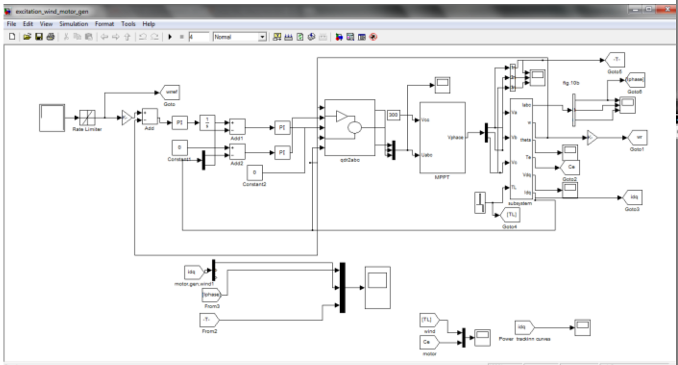
$$T_e = \frac{3}{2}p\mathrm{Im}\{\boldsymbol{\psi}_s^*\boldsymbol{I}_s\} \tag{5}$$

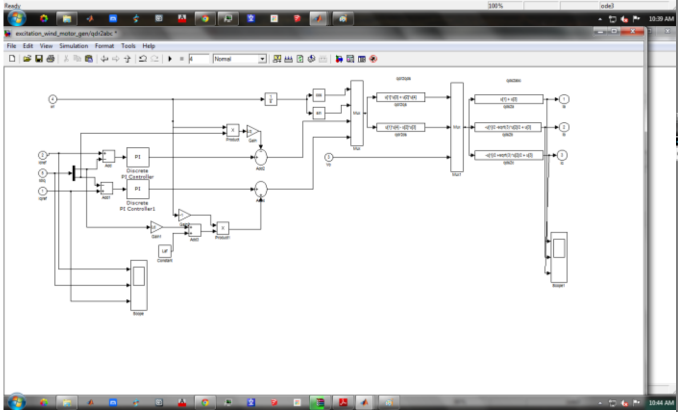
$$\boldsymbol{S} = P + jQ = \frac{3}{2}\boldsymbol{I}_s^*\boldsymbol{V}_s \tag{6}$$

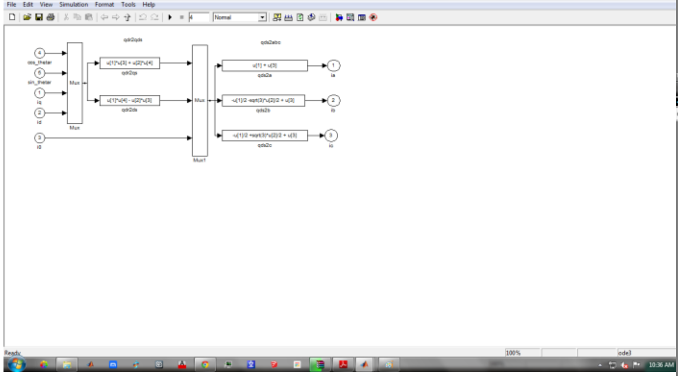
3. MPDPC OF DFIGS

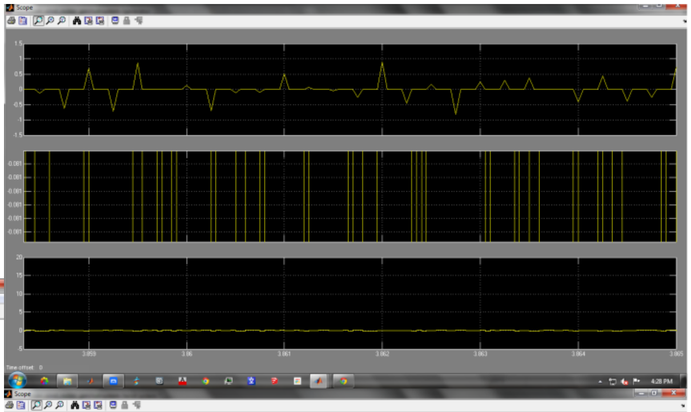
Although model predictive control (MPC) has been widely used in power electronics and electric drives it is seldom reported in the control of DFIGs in wind energy applications. In MPC is applied in DFIGs. However, grid distorted conditions, such as unbalanced grid voltage, are not considered. In MPC, the future behavior of the system is first predicted using the system model, the appropriate voltage vector is then selected based on an optimization cost function in each control period according to the predicted values and the reference values. Here, a MPDPC of DFIGs is proposed

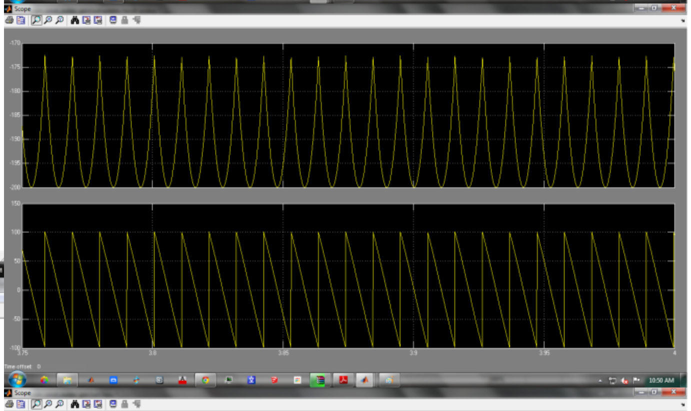
SIMULATION RESULTS:

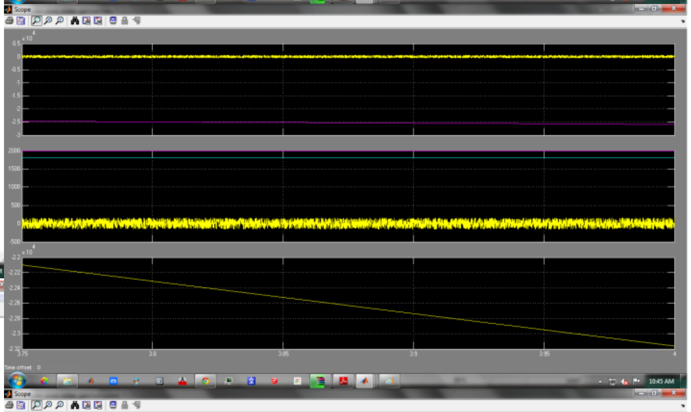


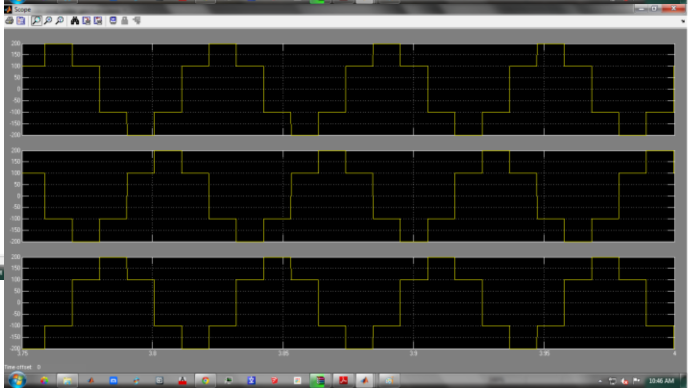


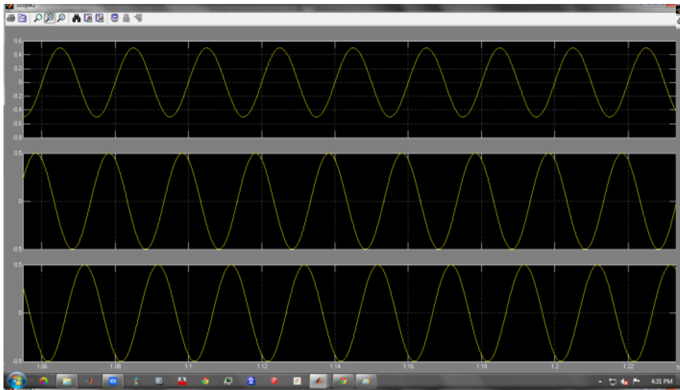


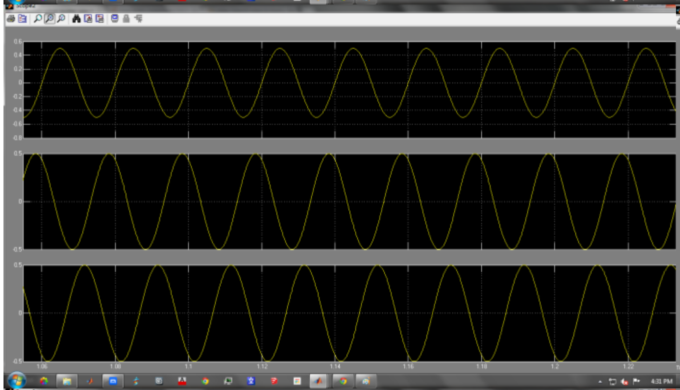


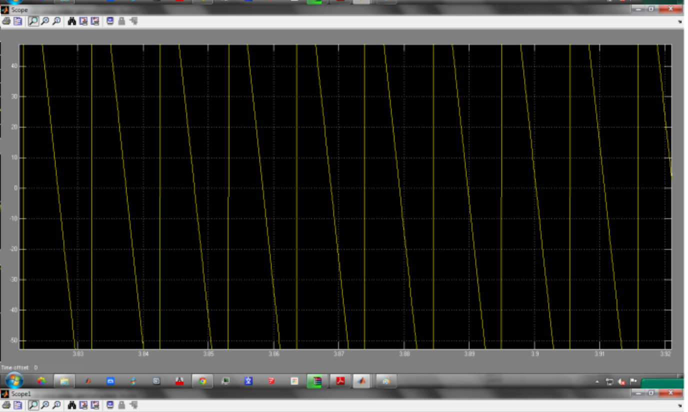


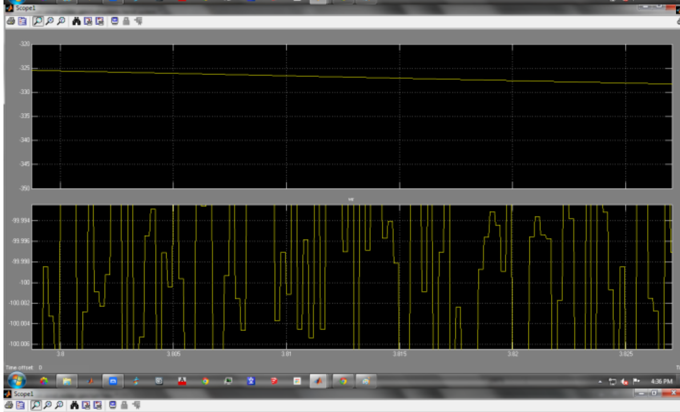


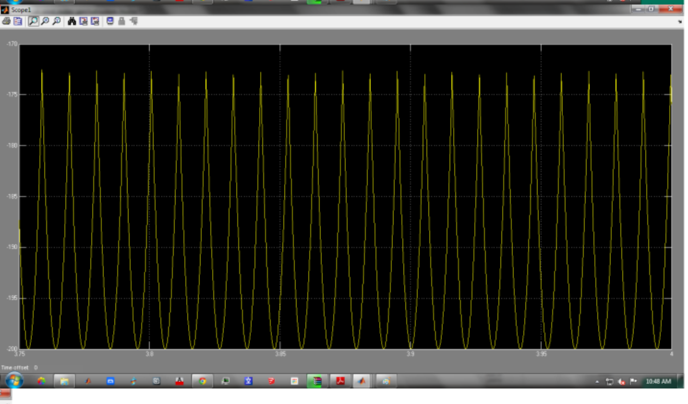


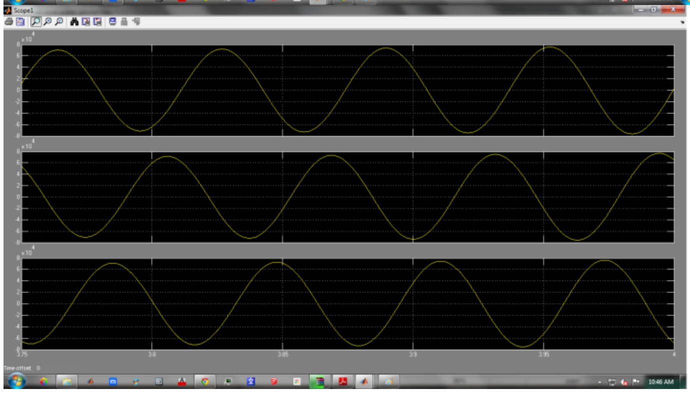












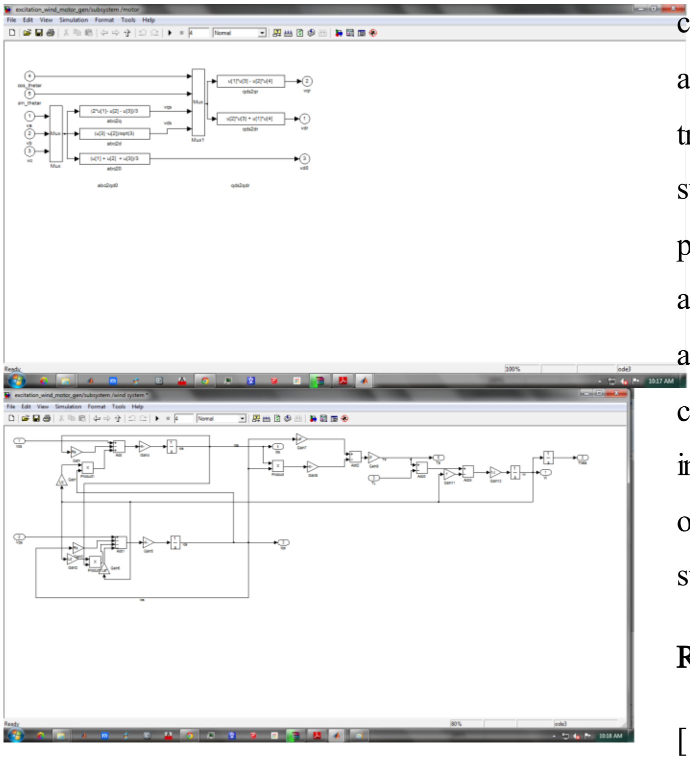


Fig: Circuit Diagram And Simulation Results

CONCLUSION

The wind generators may be disconnected in the altered network to safeguard themselves from over currents and overvoltages, which, however, is usually not permitted through the latest grid codes. Within this work, an easy and efficient MPDPC strategy coupled with power compensation plan is suggested for DFIGs under unbalanced grid current conditions. The primary contributions of the work are, first, a MPDPC technique for DFIGs is suggested. The current vector is chosen based on an expense function in each and every sampling period. The coordinate transformation, PI government bodies, switching tables, and PWM modulators are prevented, thus excellent steady-condition and dynamic performance could be accomplished. Second, an electrical compensation plan is designed to incorporate using the MPDPC method in order to enhance the power excellence of the stator power injected in to the grid.

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