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Modeling and Simulation of Power Control of a Wind Turbine Permanent Magnet Synchronous Generator System

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Abstract:

In this paper, the reactive power control of a variable speed permanent-magnet synchronous wind generator with a matrix converter at the grid side is improved. A generalized modulation technique based on singular value decomposition of the modulation matrix is used to model different modulation techniques and investigate their corresponding input reactive power capability.

Based on this modulation technique, a new control method is proposed for the matrix converter which uses active and reactive parts of the generator current to increase the control capability of the grid-side reactive current compared to conventional modulation methods. A new control structure is also proposed which can control the matrix converter and generator reactive current to improve the grid-side maximum achievable reactive power for all wind speeds and power conditions. Simulation results prove the performance of the proposed system for different generator output powers.

Index Terms:

Matrix converter, permanent-magnet synchronous generator (PMSG) , reactive power control, singular value decomposition(SVD) modulation, variable-speed wind generator.

INTRODUCTION:

AMATRIX converter is a direct ac/ac frequency converter which does not require any energy storage element. Lack of bulky reactive components in the structure of this all silicon-made converter results in reduced size and improved reliability compared to conventional multistage ac/dc/ac frequency converters. Fabrication of low-cost and high-power switches and a variety of high-speed and high-performance digital signal processors (DSPs) have almost solved some of the matrix converterDraw backs, such as complicated modulation, four-step switching process of bidirectional switches, and the use of a large number of switches [1]. Therefore, its superior benefits such as sinusoidal output voltage and input current, controllable input power factor, high reliability, as well as a small and packed structure make it a suitable alternative to back-to–back converters. One of the recent applications of matrix converters is the grid connection of variable-speed wind generators [2]–[14]. Vary- able-speed permanent-magnet synchronous (PMS) wind generators are used in low-power applications. The use of a matrix converter with a multi pole PMSG leads to a gearless, compact, and reliable structure with little maintenance which is superior for low-power micro grids, home, and local applications [13],[15]–[17]. The wind generator frequency converter should control the generator-side quantities, such as generator torque and speed, to achieve maximum power from the wind turbine, and the grid-side quantities such as grid-side reactive

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power and voltage to improve the system stability and power quality(PQ) [17]–[19]. Unlike conventional back-to–back convertersin which a huge dc-link capacitor makes the control of the generator and grid-side converters nearly independent [20], a matrix converter controls the generator and grid-side quantitiesSimultaneously. Therefore, the grid-side reactive power of a matrix converter is limited by the converter voltage gain and the generator-side active or reactive power [21].One necessary feature for all generators and distributed generators(DGs) connecting to a grid or a micro grid is the reactive power control capability.

The generator reactive power can beused to control the grid or micro grid voltage or compensate local loads reactive power in either a grid-connected or an is landed mode of operation [19], [20]. In this paper, the grid-side reactive power capability and control of a PMS wind generator with a matrix converter is improved. For this purpose, in Section II, a brief study of a matrix converter and its singular value decomposition(SVD) modulation technique, which is a generalized modulation method with more relaxed constraints compared to similar modulation methods is presented.

In Section III, the SVD modulation technique is used to model different modulation techniques and study the reactive power capability of a matrix converter. It is shown that in some modulation techniques, such as Alesina and Venturini, the grid-side reactive current is synthesized only by the reactive part of the generator-side current. In other modulation techniques, such as indirect methods or direct and indirect space vector modulation (SVM) methods, the grid-side reactive current is synthesized only by the active part of the generator-side current. To increase the matrix converter reactive current gain, the SVD modulation technique is used such that both active and reactive parts of the generator-side current can contribute to the grid-side reactive current.

It is shown in Section IV that the generator free reactive power capacity can be used to increase the grid-side reactive power. A new control structure is also proposed which can control the generator and matrix converter reactive power to increase the controllability of the grid-side reactive power at any

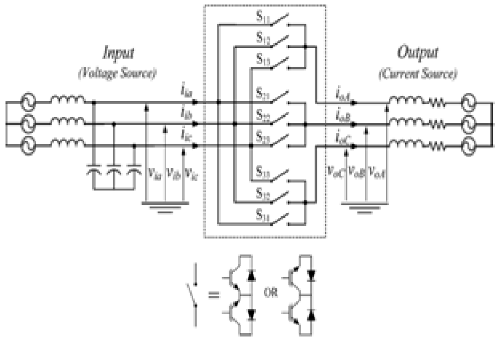

Fig. 1. Typical three-phase matrix converter schematic.

wind speed and power. The proposed control structure is simulated with a simple adaptive controller (SAC) on a gearless multi pole variable-speed PMS wind generator, and the results are presented to verify its performance under different operating conditions. The simulations are performed using PSCAD/ EMTDC software.

II. MATRIX CONVERTER:

Fig. 1 shows a typical three-phase matrix converter. In a matrix converter, the input and output phases are related to each other by a matrix of bidirectional switches such that it is possible to connect any phase at the input to any phase at the output. Therefore, the controllable output voltage is synthesized from discontinuous parts of the input voltage source, and the inputcurrent is synthesized from discontinuous parts of the output current source or

$$\begin{aligned}
&V_{o,ABC} = \mathbf{S} V_{i,abc} \\
&I_{i,abc} = \mathbf{S}^T I_{o,ABC} \\
&\mathbf{S} = \begin{pmatrix} s_{11} & s_{12} & s_{13} \\ s_{21} & s_{22} & s_{23} \\ s_{31} & s_{32} & s_{33} \end{pmatrix} \\
&\begin{cases} s_{kj} \in \{0,1\} \\ s_{k1} + s_{k2} + s_{k3} = 1 \end{cases} \qquad k,\ j = 1,2,3 \\
&V_{i,abc} = \begin{pmatrix} v_{ia} \\ v_{ib} \\ v_{ic} \end{pmatrix}, \quad I_{i,abc} = \begin{pmatrix} i_{ia} \\ i_{ib} \\ i_{ic} \end{pmatrix} \\
&V_{o,ABC} = \begin{pmatrix} v_{oA} \\ v_{oB} \\ v_{oC} \end{pmatrix}, \quad I_{o,ABC} = \begin{pmatrix} i_{oA} \\ i_{oB} \\ i_{oC} \end{pmatrix} \qquad (1)
\end{aligned}$$

where v_ojand i_oj (j= A,B,C) are the output phase voltages and currents, respectively; v_ijand i_ij(j= A,B,C) are the input phase voltages and currents; s_kj and is the switching function of switch k_ij.Lack of an energy storage component in the structure of a matrix converter leads to an equality between the input–output active power, i.e.,

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$$p_i = V_{i,abc}^T \cdot I_{i,abc} = V_{o,ABC}^T \cdot I_{o,ABC} = p_o. \qquad (2)$$

A. SVD Modulation Technique

Different modulation techniques are proposed for a matrix converter in the literature [21]–[23]. A more complete Modulation technique based on SVD decomposition of a modulation matrix is proposed in [24]. Other modulation methods of a matrix converter can be deduced from this SVD modulation technique. The technique proposed in [24] has more relaxed constraints compared to other methods.The SVD modulation method is a duty cycle method in which the modulation matrix M, which is defined in (3), is directly constructed from the known input voltage and output current and desired output voltage and input current, i.e.,

$$\mathbf{M} = \underset{T_s}{Ave}\{\mathbf{S}\} = \begin{pmatrix} m_{11} & m_{12} & m_{13} \\ m_{21} & m_{22} & m_{23} \\ m_{31} & m_{32} & m_{33} \end{pmatrix}$$

$$\begin{cases} 0 \le m_{kj} \le 1 \\ m_{k1} + m_{k2} + m_{k3} = 1 \end{cases} \quad k,\, j = 1,2,3 \qquad (3)$$

Where m_kj is the average of s_kjover a switching period. To represent the input and output voltages and currents in space vector forms, all quantities of the input and output of the matrix converter are transferred from the abc reference frame to the αβoreference frame by the modified Clarke transformation of (4). Therefore, the new modulation matrix M_αβo is obtained as

$$\begin{aligned} V_{o,\alpha\beta0} &= \mathbf{M}_{\alpha\beta0} V_{i,\alpha\beta0} \\ I_{i,\alpha\beta0} &= \mathbf{M}_{\alpha\beta0}^T I_{o,\alpha\beta0} \\ \mathbf{M}_{\alpha\beta0} &= \mathbf{K}\mathbf{M}_{abc}\mathbf{K}^T \\ \mathbf{K} &= \sqrt{\frac{2}{3}} \begin{pmatrix} 1 & -\frac{1}{2} & -\frac{1}{2} \\ 0 & \frac{\sqrt{3}}{2} & -\frac{\sqrt{3}}{2} \\ \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} \end{pmatrix} \\ \mathbf{K}^{-1} &= \mathbf{K}^T \text{or } \mathbf{K}\mathbf{K}^T = \mathbf{I}. \end{aligned} \qquad (4)$$

The last equality means that matrix K is a unitary matrix or its transpose is equal to its inverse. Considering the condition set by (3) and using (4), the following basic form for theM_αβo is obtained:

$$\begin{aligned} \mathbf{M}_{\alpha\beta0} = \mathbf{K}\mathbf{M}_{abc}\mathbf{K}^T &= \begin{pmatrix} g_{11} & g_{12} & 0 \\ g_{21} & g_{22} & 0 \\ c_1' & c_2' & 1 \end{pmatrix} \\ &= \begin{pmatrix} \mathbf{M}_{\alpha\beta_{2\times2}} & 0 \\ 0 & 0 \end{pmatrix} + \underbrace{\begin{pmatrix} 0 & 0 \\ \mathbf{C}_{1\times2}' & 1 \end{pmatrix}}_{\mathbf{M}_0} \end{aligned} \qquad (5)$$

Where $M_{\alpha\beta}$ generates$V_{o,\alpha\beta}$ and$I_{i,\alpha\beta}$ from$V_{i,\alpha\beta}$ $I_{o,\alpha\beta}$ and M_0 generates $V_{o,O}$ and $I_{i,O}$ from $V_{o,\alpha\beta0}$ and $I_{o,\alpha\beta0}$, respectively.

Since, in a three-phase three-wire system, no zero-sequence current can flow, the zero-sequence voltage can be added to the output phase voltages to increase the flexibility of the control logic. Therefore, in all modulation methods, the main effort is devoted to selecting suitable in M_αβ (6) to control the output voltage and input current and a suitable M_oto increase the operating range of the matrix converter, i.e.,

$$\begin{aligned} \begin{pmatrix} v_{o\alpha} \\ v_{o\beta} \end{pmatrix} &= \begin{pmatrix} g_{11} & g_{12} \\ g_{21} & g_{22} \end{pmatrix} \begin{pmatrix} v_{i\alpha} \\ v_{i\beta} \end{pmatrix} \\ \begin{pmatrix} i_{i\alpha} \\ i_{i\beta} \end{pmatrix} &= \begin{pmatrix} g_{11} & g_{12} \\ g_{21} & g_{22} \end{pmatrix}^T \begin{pmatrix} i_{o\alpha} \\ i_{o\beta} \end{pmatrix}. \end{aligned} \qquad (6)$$

HOJABRI et al.: REACTIVE POWER CONTROL OF PM SYNCHRONOUS WIND GENERATOR

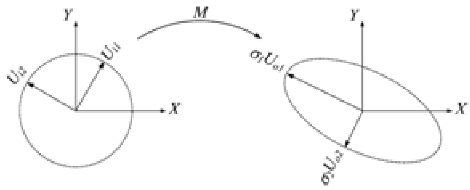

Fig. 2. Concept of the SVD of a matrix.

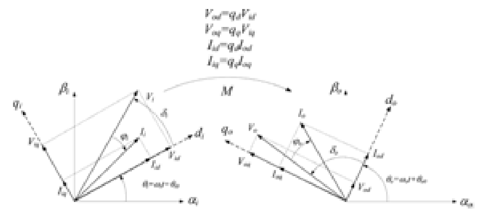

Fig. 3. SVD of. $M_{\alpha\beta}$

$M_{\alpha\beta}$ maps$V_{i,\alpha\beta}$ from the input αβ space onto $V_{o,\alpha\beta}$ in the output αβ space and $M_{\alpha\beta}^T$ maps$I_{o,\alpha\beta}$ from the output αβ space onto $I_{i,\alpha\beta}$ in the input αβ space. Each matrix can be decomposed into a product of three matrices as shown in (7) which is called SVD of a matrix [25]

$$\begin{aligned} &\mathbf{M} = \mathbf{U}_o \boldsymbol{\Sigma} \mathbf{U}_i^* \\ &\boldsymbol{\Sigma} = \begin{pmatrix} \sigma_1 & 0 \\ 0 & \sigma_2 \end{pmatrix}, \begin{cases} \mathbf{U}_{o,2\times2} = (U_{o1,2\times1} \quad U_{o2,2\times1}) \\ \mathbf{U}_{i,2\times2} = (U_{i1,2\times1} \quad U_{i2,2\times1}) \end{cases} \\ &\mathbf{U}_i \mathbf{U}_i^* = \mathbf{U}_o \mathbf{U}_o^* = \mathbf{I} \end{aligned} \qquad (7)$$

where U_iand U_oare unitary matrices meaning that their columns are ortho normal vectors, and *the operator is conjugate transpose. σ_1and σ_2 are the gains of matrix M in the direction of U_i1and U_i2.

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As Fig. 2 depicts, the SVD of a matrix means that this matrix will transform the vectors in the direction of U_i1,2X1toward the direction ofU_01,2X1 by a gain of. σ_1 and vectors in the direction of U_i2,2X1toward the direction ofU_02,2X1 by a gain of σ_2.As presented in Fig. 3, M_αβ also has an SVD decomposition whereU_i1,2X1 andU_i2,2X1 are orthonormal vectors rotating at a speed equal to the input frequency (i.e., U_idand U_iq, andU_01,2X1 and U_02,2X1are orthonormal vectors rotating at the output frequency, that is, U_odand U_oq).

$$\begin{pmatrix} g_{11} & g_{12} \\ g_{21} & g_{22} \end{pmatrix} = \begin{pmatrix} U_{od} & U_{oq} \end{pmatrix} \begin{pmatrix} q_d & 0 \\ 0 & q_q \end{pmatrix} \begin{pmatrix} U_{id} & U_{iq} \end{pmatrix} = \begin{pmatrix} \cos\theta_o & -\sin\theta_o \\ \sin\theta_o & \cos\theta_o \end{pmatrix} \begin{pmatrix} q_d & 0 \\ 0 & q_q \end{pmatrix} \times \begin{pmatrix} \cos\theta_i & -\sin\theta_i \\ \sin\theta_i & \cos\theta_i \end{pmatrix}^T. \quad (8)$$

By substituting (8) into (5), M_abc is obtained as

$$\begin{aligned} \mathbf{M_{abc}} &= \mathbf{K}^T\mathbf{M}_{\alpha\beta 0}\mathbf{K} = \mathbf{K}^T\mathbf{M}_{\alpha\beta}\mathbf{K} + \mathbf{K}^T\mathbf{M_0}\mathbf{K} \\ &= \mathbf{M}_{\mathbf{abc},\alpha\beta} + \mathbf{M_{abc,0}} \\ &= \mathbf{P}(\boldsymbol{\theta_o})^T \underbrace{\begin{pmatrix} q_d & 0 \\ 0 & q_q \end{pmatrix}}_{\mathbf{M_{dq}}} \mathbf{P}(\boldsymbol{\theta_i}) + \mathbf{M_{abc,0}} \end{aligned}$$

$$\mathbf{P}(\boldsymbol{\theta}) = \sqrt{\frac{2}{3}} \begin{pmatrix} \cos\theta & \cos\left(\theta - \frac{2\pi}{3}\right) & \cos\left(\theta + \frac{2\pi}{3}\right) \\ -\sin\theta & -\sin\left(\theta - \frac{2\pi}{3}\right) & -\sin\left(\theta + \frac{2\pi}{3}\right) \end{pmatrix} \quad (9)$$

where p()is the modified Park transformation matrix. It can be proved that if the following limitation onq_d andq_qis held, there exists a M_(abc,0)matrix for which the condition of (3) is correct [24]. Therefore

$$\left.\begin{matrix} |q_d| + |q_q| \leq 1 \\ \max\{|q_d|, |q_q|\} \leq \frac{\sqrt{3}}{2} \end{matrix}\right\} \Rightarrow \left\{\begin{matrix} 0 \leq m_{kj} \leq 1 \\ m_{k1} + m_{k2} + m_{k3} = 1 \end{matrix}\right. , \; k, j = 1, 2, 3. \quad (10)$$

There may be many solutions for matrix M_(abc,0) ; however, the following solution requires simple calculations [24]:

$$\begin{aligned} \mathbf{M}_{abc,0} &= \begin{pmatrix} c_1 & c_2 & c_3 \\ c_1 & c_2 & c_3 \\ c_1 & c_2 & c_3 \end{pmatrix} \\ c_k &= -\min_i\{\mathbf{M}_{\mathbf{abc},\alpha\beta}(\mathbf{i},\mathbf{k})\} \\ &+ \left\{1 + \sum_j \min_i\{\mathbf{M}_{\mathbf{abc},\alpha\beta}(\mathbf{i},\mathbf{j})\}\right\} \\ &\cdot \frac{1 - \max_i\{\mathbf{M}_{\mathbf{abc},\alpha\beta}(\mathbf{i},\mathbf{k})\} + \min_i\{\mathbf{M}_{\mathbf{abc},\alpha\beta}(\mathbf{i},\mathbf{k})\}}{3 - \sum_j \max_i\{\mathbf{M}_{\mathbf{abc},\alpha\beta}(\mathbf{i},\mathbf{j})\} + \sum_j \min_i\{\mathbf{M}_{\mathbf{abc},\alpha\beta}(\mathbf{i},\mathbf{j})\}}. \end{aligned} \quad (11)$$

The constraint obtained in (10) is an inherent constraint of a matrix converter which is more relaxed than the constraint of conventional modulation methods. Therefore, the use of theSVD modulation technique can improve the performance of a matrix converter when the input reactive power control is needed [23], [24].All of the existing modulation methods can be deduced from this simple and general method by choosing suitable q_d, q_q, , i, and o. On the other hand, (9) shows that if the input and output quantities are transferred onto their corresponding synchronous reference frames, the SVD modulation matrix becomes a simple, constant, and time-invariant matrix (i.e., M_dq). Therefore, as shown in Fig. 4, the SVD modulation technique models the matrix converter as a d_qtransformer in the input–output synchronous reference frame.

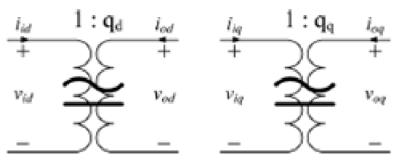

Fig. 4. Matrix converter steady-state and dynamic d_q transformer model.

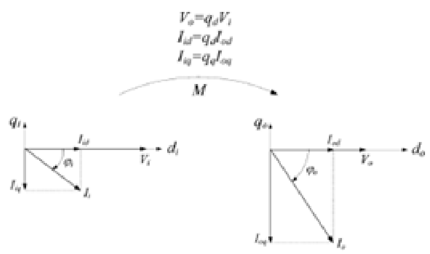

Fig. 5. Modeling of Alesina and Venturini modulation method by the SVD modulation technique.

III. MATRIX CONVERTER REACTIVE POWER CONTROL

Several control strategies based on different modulation techniques can be used to control the input reactive current and power of a matrix converter. All modulation techniques can be modeled by the SVD modulation method. Therefore, this method can be used to study the reactive power capability and control of a matrix converter. According to Fig. 3, the input reactive power of a matrix converter can be written in a general form as [26]

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$$
\begin{aligned}
Q_i &= \Im\mathrm{m}\{S_i\} = V_{iq} I_{id} - V_{id} I_{iq} \\
&= q_d V_{iq} I_{od} - q_q V_{id} I_{oq} \\
&= Q_{id} + Q_{iq} \qquad (12)
\end{aligned}
$$

where., S_i is the input complex power, is the part of the input reactive power made from , ., I_od. and ., Q_iq is the part of the input reactive power made from I_oq.

Therefore, the following three different strategies of synthesizing the input reactive power of a matrix converter can be investigated:

• Strategy 1: synthesizing from the reactive part of the output current (i.e. Q_iq);

• Strategy 2: synthesizing from the active part of the output current (i.e. Q_id);

• Strategy 3: Synthesizing from the active and reactive parts
of the output current (i.e., Q_id+Q_iq);

A. Synthesizing From the Reactive Part of the Output Current

If in the SVD modulation technique, i is set to the input voltage phase angle as shown in Fig. 5, the output voltages will also be aligned with the –axis of the output synchronous reference frame which is defined by , and the generalized modulation technique will be the same as the Alesina and Venturini modulation technique with a more relaxed limitation on . Q_id and. Q_iq[24].

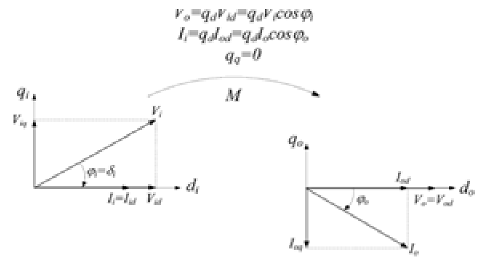

Fig. 6. Modeling the SVM modulation method by the SVD modulation technique

In this case, controls the voltage gain and controls the reactive current gain of the matrix converter. Therefore, the input reactive power is limited by the voltage gain and the output reactive power as given by (13)

$$
\begin{cases} V_o = V_{od} = q_d V_{id} = q_d V_i \\ I_{id} = q_d I_{od} \\ I_{iq} = q_q I_{oq} \end{cases} \Rightarrow \begin{cases} Q_i = Q_{iq} = \frac{q_q}{q_d} Q_o \\ q_d = G_v = \frac{V_o}{V_i} \end{cases}
$$

$$
(10) \Rightarrow |Q_i| \le \frac{1-q_d}{q_d}|Q_o| = \frac{1-G_v}{G_v}|Q_o| \qquad (13)
$$

where. Gv = v_o /v_i is the voltage gain of the matrix converter and Qo is the output reactive power

B. Synthesizing From the Active Part of the Output Current

If, Qq is set to zero, as shown in Fig. 6, the output voltage will be aligned with the axis of the output reference frame and the input current will be aligned with the –axis of the input reference frame. Therefore, the SVD modulation technique will be the same as the SVM modulation technique [24].In this case, qd controls the voltage gain øi and controls the input reactive current of the matrix converter. Therefore, the input reactive power is limited by the voltage gain and the output active power as given by

$$
\begin{cases} V_o = q_d V_{id} = q_d V_i \cos\phi_i \\ I_i = q_d I_{od} = q_d I_o \cos\phi_o \end{cases} \Longrightarrow
$$

$$
\left.\begin{aligned} Q_i = Q_{id} = V_i I_i \sin\phi_i = P_i \tan\phi_i = P_o \tan\phi_i \\ G_v = q_d \cos\phi_i \le \tfrac{\sqrt{3}}{2}\cos\phi_i \Rightarrow \tan\phi_i \le \frac{\sqrt{\frac{3}{4}-G_v^2}}{G_v} \end{aligned}\right\}
$$

$$
\Rightarrow |Q_i| \le \frac{\sqrt{\frac{3}{4}-G_v^2}}{G_v}|P_o| \qquad (14)
$$

where Po is the output active power.

C. Synthesizing From Both the Active and Reactive Parts of the Output Current

The two previous strategies do not yield the full capability of a matrix converter. To achieve maximum possible input reactive power, both active and reactive parts of the output current can be used to synthesize the input reactive current .To increase the maximum achievable input reactive current in a matrix converter for a specific output power, its input current.

IV. PMS WIND GENERATOR REACTIVE POWER CONTROL:

The three methods of controlling the input reactive power of a matrix converter described in the previous section can be used to control the reactive power of a PMS wind generator. A gearless Multi pole PMS wind generator, which is connected to the output of a matrix converter, is simulated to compare the improvement

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in the matrix converter input or grid-side reactive power using the proposed strategy. The control block diagram of the system is shown in Fig. 9, and its parameters are listed in Table I. The simulations are performed using PSCAD/EMTDC software.control the generator torque and speed, generator quantities are transferred onto the synchronous reference frame such that the rotor flux is aligned with the d–axis of the dqo reference frame. Therefore, Igq will become proportional to the generator torque, Igd and can be varied to control the generator outputreactive power.

Usually, Igd is set to zero to minimize the generator current and losses. However, in this section, the effect of Igd on the input reactive power is also studied, and a new control structure is proposed which can control the generator reactive power to improve the reactive power capability of the system [27].

A. Fixed Igd

If is set to zero, the generator output current and losses will be minimized. However, since the reactance of a syn

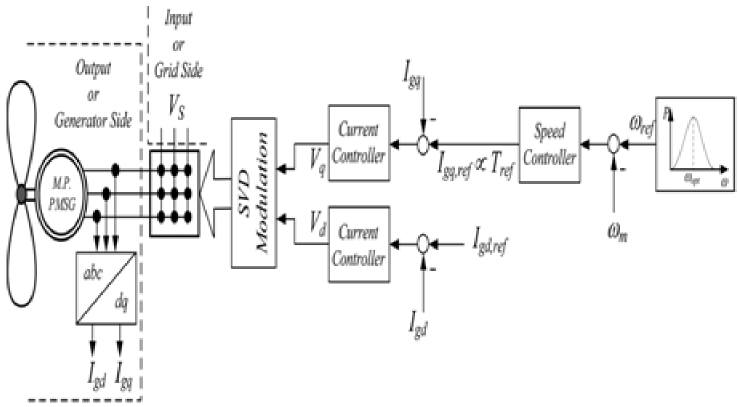
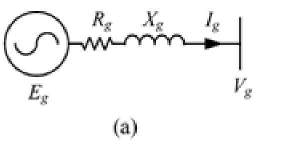


Fig. 9. Simplified control block diagram of a PMSG.

TABLE I: SIMULATED SYSTEM PARAMETERS

Source	V_S	530 V
	f_S	50 Hz
Matrix Converter	L_f	0.5 mH
	C_f	9 μf
	f_{SW}	10 kHz
Generator & Turbine	S_g	50 kVA
	E_g	380 V
	n_p	58
	f_g	50 Hz
	R_g	0.1 p.u.
	$L_{dg} \approx L_{qg}$	0.8 p.u.
	H_g	1 sec.
	$P_{W,opt}$	$K_{opt}\omega_m^3$
	K_{opt}	314



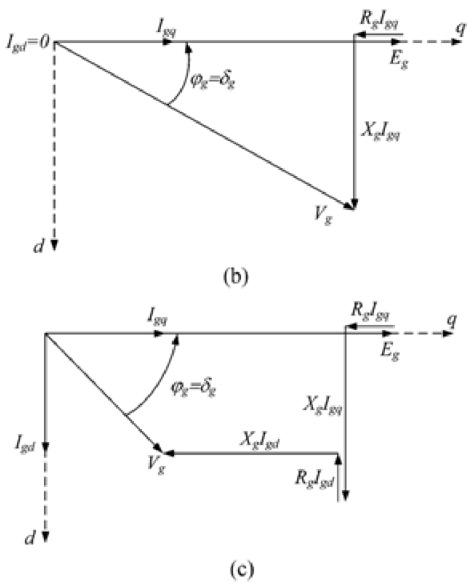


Fig. 10. Phasor diagram of PMSG for different values of Igd. (a) PMSG equivalent circuit. (b) Igd=0 (c) Igd>0

chronous generator is typically large, an increase in the wind speed and generator output power leads to an increase in the

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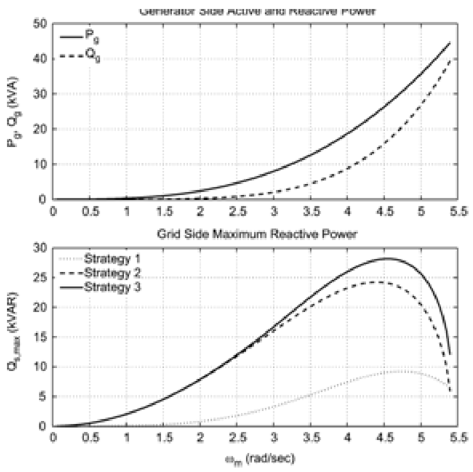
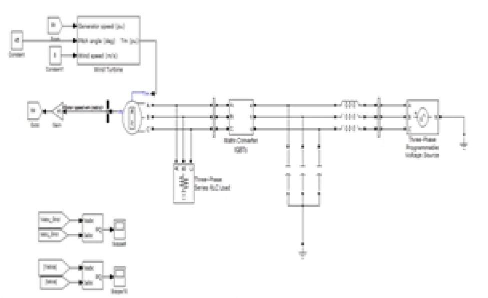


Fig. 11. Generator-side active and reactive power and the maximum grid side reactive power versus generator shaft speed ωm for different strategies.

generator output reactive power. Fig. 10(b) shows a typical phasor diagram of a generator for Igd=0 .Fig. 11 shows the generator active and reactive powers and the maximum grid-side reactive power which can be achieved by the three strategies described in the previous section for different wind speeds and powers. Since an increase in the wind speed leads to an increase in the generator active and reactive powers, the maximum grid-side reactive power, which can be achieved by the proposed strategy, is higher than that obtained by the other two methods.

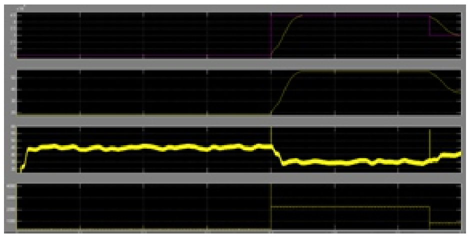
B. Controlled Igd

Although the maximum achievable grid-side reactive power is improved by the proposed strategy, at low wind speed conditions, the system reactive power capability will be decreased severely which may decrease the system voltage quality and stability. Since, in the proposed strategy, the grid-side reactive current is made from both active and reactive parts of the generator-side current, control of the generator-side reactive power

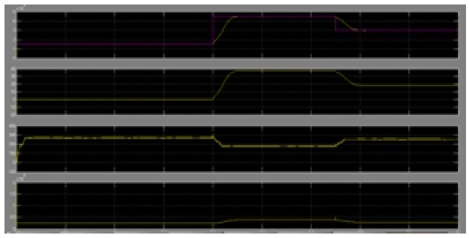


Proposed simulation diagram

Simulation results



Wind speed at 1 m/s:



Wind speed 4 m/s:

From above figures depict the simulation results for the proposed control structure for two different generator speeds. The controller used in these simulations for the grid-side reactive power control is a simple adaptive controller (SAC) which is presented in Appendix B. It can be seen from these figures that the controller increases Igd to track the desired grid-side reactive power, if the maximum achievable grid-side reactive power for Igd=0 is not sufficient. An increase in Igd will decrease the generator terminal voltage and increase the generator losses.

CONCLUSION:

In this paper, a new control strategy is proposed to increase the maximum achievable grid-side reactive power of a matrix converter-fed PMS wind generator. Different methods for controlling a matrix converter input reactive power are investigated.

It is shown that in some modulation methods, the grid-side reactive current is made from the reactive part of the generator-side current. In other modulation techniques, the grid-side reactive current is made from the active part of the generator-side current. In the proposed method, which is based on a generalized SVD modulation method, the grid-side reactive current is made from both active and reactive parts of the generator-side current.

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In existing strategies, a decrease in the generator speed and output active and reactive power, will decrease the grid-side reactive power capability. A new control structure is proposed which uses the free capacity of the generator reactive power to increase the maximum achievable grid-side reactive power. Simulation results for a case study show an increase in the grid side reactive power at all wind speeds if the proposed method is employed

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