Research Journal of Engineering Technology and Medical Sciences (ISSN: 2582-6212), Volume 05, Issue 02, June-2022
Available at www.rjetm.in/

Indirect Matrix Converters as Generator Grid

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ABSTRACT

In this paper, the interfaces between generators and grids are based on the topology of ultra-solar matrix with a minimum number of semi-circular switches. The boosting networks are between the interfaces, the corrective system and the reverse inverter. A technique of space-vector modulation was designed to achieve high versatility improvements and minimal switching losses. A quick research on the stimulation factor in the input-output currents of the converters is carried out by Fourier. The simulation and test results assess the effectiveness of geometries and control methods proposed in order to achieve high boosting capacity while preserving a reasonable range of current input/output efficiency improvements.

I. INTRODUCTION

The turbines are organized into power plants forming self-sufficient power stations. In accepting such systems, the relation between a wind energy system and the grid is an important public issue. A lightweight, efficient, maintenance-free, secure, and inexpensive grid interface must be provided. Also, a generator, typically a permanent magnet synchro unit, should be operated directly by the wind turbine to prevent a costly and unsafe transmission box. In essence, this means that the generator's low rate and voltage and the voltage of this transformer need to be improved. The review paper [1] The traditional Direct Matrix converter describes many attractive features which do not use a very capable DC link commonly used to convert back-to-back. These matrix converters have an input power unit and a sinusoidal current, but are effectively limited to 0. 866. In nine bidirectional switches, the classical 3-phase matrix converter is integrated. Two unidirectional switches and two dioceses or single switches are given on each switch and on four diodes. In order to reduce switch numbers [2], spare-driven, highly sparse indirect optimization techniques have recently been proposed for converter tops. Direct matrix converters' low benefit disadvantage has been solved by indirect matrix converters. A voltage increase between the input corrections and the output phases of the converter is added in these environments. This role is carried out quite well by the popular Z-source network proposed in [3]. Ge et al. [4] describes a group of three-phase direct Z source converters with various control systems. The indirect sparse matrix converters are given in [5,8] with a similar classic Z-source. Present modulative techniques are being investigated in [9] for indirect Z-source converters. Optimal modulation offers versatility in buck enhancing, minimal switching and fast implementation. This loss of harmonics decreases efficacy and increases thermal load. The higher the material, the more performance is reduced, and therefore the thermal load is increased even at low loads. The mmf and air gaps are not stationary in relation to each other, generated by various harmonics, including fundamental. As a result, pulsating harmonics with a zero average value are produced.

A rotor mmf Wave is produced by the fifth harmonic flux wave series, which reverse five times its synchronous base speed. At the relative speed six times the base of the harmonic fifth rotor mmf and its fundamental air gap, its contact leads 6 times the basic frequency to a pulsating acceleration.

The positive 7th harmonic wave series produces a mmf rotor wave that rotates seven times its key synchronous speed. Since the relative speed of the base air gap wave is six times that of the basic, synchronous speed of the seventh harmonic mmf rotor wave, the pulsating torque is also 6 times higher. The 11th and 13th harmonics both emit nearly twice the torque of the fundamental frequency, however small amplitudes.

Pulses respond to generator rpm variations. The speed changes are small enough due to inertia, if it is sufficiently high at the base frequency. If the generator's base frequency and speed is minimal, major changes in the generator speed leds to a retrenchment of motion. The pulse amplitude depends on the harmonic tension and the response from the generator.

To overcome the limitations, a matrix converter is used to power the induction generator. This is an AC-AC converter in one stage which supplies the induction generator with pure sinusoidal input. The power electronics trend is to boost contact with the electricity grid, provide two-directional power flow, increase the efficiency and size of a drive wiring that operates in the matrix converter profile at higher switching frequency.

The potential is low manufacturing & maintenance costs and higher power/weight/volume relationships in relation to other traditional drives. The matrix converter circuit directly and inherently double-way power flow connects the charge to the grid and also provides a sinusoidal input current without harmonics connected to trade inverters.

II. MODELLING OF CASE STUDY

In order to ensure other devices on one row experience interference and running disability such as common faults, electro - magnet interference, the PWM diode rectifier feeds harmonics into the utility network. They do not have regeneration ability, and the regenerated energy is dissipated into a small resistance circuit for most standard regeneration mode applications.

The serious inconvenience of PWM inverters is the non-sinusoidal performance tension. The function of a non-sinusoidal induction generator reduces the generator's efficiency and the generator derivation considerably. A non-sinusoid waveform that is determined by Fourier analysis to form fundamental, harmonic components

$$I_s = \sum_{n=1}^{\infty} a_n \sin n\omega t + \sum_{n=1}^{\infty} b_n \cos n\omega t$$

half wave symmetry[7] as in (1). where,

$$a_n = \frac{1}{\pi}\int_0^{2\pi} I_s \sin n\omega t \; d(\omega t)$$

$$b_n = \frac{1}{\pi}\int_0^{2\pi} I_s \cos n\omega t \; d(\omega t)$$

The rms value of nth harmonic in the source current is

$$I_n = \frac{1}{\sqrt{2}}\left[a_n^2 + b_n^2\right]^{\frac{1}{2}}$$

found by using (1) and (2). The phase displacement of the nth

$$\varphi_n = \tan^{-1}\frac{b_n}{a_n}$$

Due to half-wave symmetry, harmonics as given in (3), only strange harmonics such as positive harmonics 5th, negative sequence 7th, and zero will be present. Harmonics are not attributable to the generator's output strength. Certainly, they cause further generator losses. The Kth harmonic induction generator circuit shown in Fig.1

$$P_h = \sum_{k=5,7} I_{sk}^2 \left(R_{sk} + R'_{rk}\right)$$

harmonic copper loss is given in (4). where,

$$I_{sk} \cong \frac{V_k}{k(X_s + X'_r)}$$

here, k = Harmonic sequence

This harmonic loss lowers performance and increases thermal loading. The higher the material, the more efficiency is reduced and thermal stresses increase even at light charges. The waves producing mmf and gap in air are not stationary with each other, including the basic harmonics. They therefore generate pulsating harmonics which have an average value of zero. The fifth harmonic air - gap wave of this negative series generates a mmf rotor wave that shifts the basic synchronous rate 5 times backward. With its 6x-base interactions of a pulsating momentum at six times the main synchronous frequency, the relative speed between the fifth harmonic rotor mmf wave and the essential air gap wave.

A rotor-mmf wave rotates ahead at a fundamental synchronous speed seven times in the positive series of the seventh air-gap flux wave. Since the relative velocity is six times the fundamental synchronous velocity between the fundamental air-gap flow wave and the seventh harmonic rotor mmfwave, the pulsing couple is 6 times the basic frequency. Similarly, the 11th and 13th harmonics generate a torque twelve-fold pulsation, but their amplitude is small. The torque pulses lead to generator speed fluctuations. If the fundamental frequency is high enough, due to generator inertia, velocity fluctuations are lower enough. If the basic frequency and the generator speed are tiny, great generator speed fluctuations produce a jerky or stepped movement. The amplitude of the torque pulsations depends on the harmonic tension and on the reaction of the generator.

By operating the Induction Generator with a Matrix Converter the solution is achieved for these limitations. Since this is the only single AC-AC stage converter able to supply the induction generator with the pure sinusoidal input. The trend in power electronics is to improve the interplay of the grid, provide a two-directional power flow, enhance drive efficiency and decrease drive sizes that fit the profile of the converter matrix. The potential for lowering production and maintenance costs and improved power/weight and power/volume ratios compared with other traditional drive systems is higher.

MATRIX CONVERTERS:

Matrix Converter (MC) is a new kind of direct AC / AC converter that transmits voltages on the input line with no DC intermediate line.. MC represents a range of controlled semiconductor switches that connect the 3-phase source directly with the three-phase load. The MC consists of nine two-way tension block switches assigned to the output side by three classes. As shown in examples 2, which are output lines A, B, C, the switch connected bidirectionally to the input lines (a), (b) or (c).

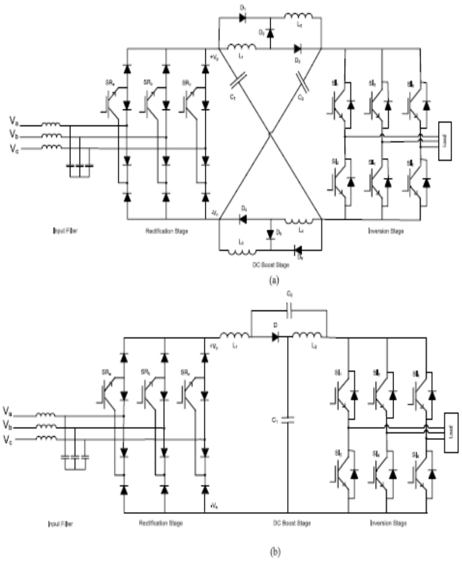

Figure 1: The practical scheme of matrix converter drive

To ensure the secure operation of the converter using bi-directional switches, two basic concepts need to be observed. The MC is usually supplied with a voltage source and does not shorten the input terminals. Furthermore, the load is usually inductive and for this reason, no production phase should be initiated. In accordance with the basic legislation, the maximum number of approved MC swapping countries is reduced to 27. There is a direct relation to the various input lines of the first six stages, producing a rotating tension vector with the same amplifying and input tensioning frequency and a sequence-related direction. Another 18 switches create variable active vectors in stationary position according to the selected line-to-line voltage.

When the outputs are attached to the same input line, the last 3 switching states create a zero-vector. The high frequency ripple from the input current needs an input filter to connect the charge to the grid. For safety purposes, a clamping circuit is essential if the converter is to be shut down securely during input and over current output disturbances.

A. BI-DIRECTIONAL SWITCHES

The devices must be in both directions able to block current and voltage. The two directional switches are called. The matrix converter development has been prevented by the absence of a forced, bi-directional turn. Three methods are available to achieve a bi-directional switch by using one-way switches.

a) The diode embedded unidirectional switch.
b) The two Common Emitter (CE) bi-directional switch
c) The two Common Collector(CC) bi-directional switch.

First, the loss of action attributable to two FRDs and one IGBT is increased. Additional losses in switching occur. The two topologies of the two unit switches (CE and CC) based on the serial-resistant link enable lower drive losses of one FRD and one IGBT as shown in Figure 3. This figure shows the different topologies of bidirectional switches. CC topology makes it very simple to transform the converter in a modular structure for high voltage, and this topology is the best combination to use industrial power.

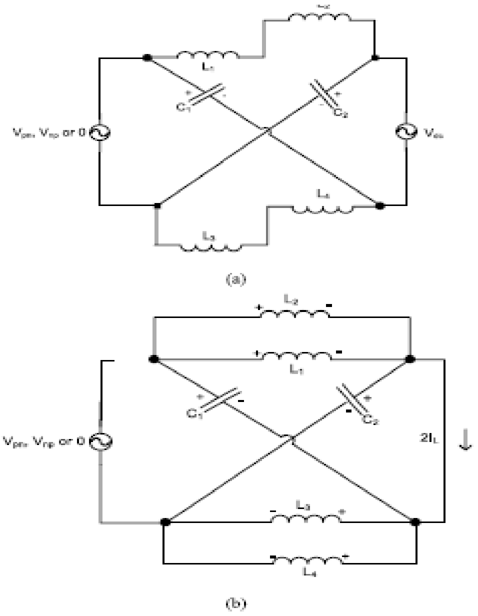

Figure 2: Bi-directional switch topologies using unidirectional switches

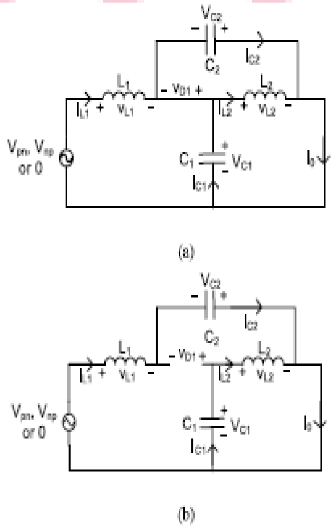

Figure 3: Mode of operations

INPUT FILTER

Matrix Converter is prone to draw grid data directly. The input filter[1] needs to be supported due to a grid relation between the matrix converter to eliminate harmonic switching within the input signal.

The filter criteria

1. Lower the cut-off frequency than the conversion frequency. 1. 1.

2. To reduce the grid frequency reactive capacity.

3. To reduce condensers and chokes volume and weight (inductors).

4. Reduce filter voltage at rated current to the minimum (in order to avoid a reduction in the voltage transfer ratio). Filter is not used to store load energy.

CLAMP CIRCUIT

The input side, created by the line or Grid disturbances, may appear in the matrix over voltages converter. More dangerous voltages over the output side due to a current failure will occur. Furthermore. The most popular way of avoiding overvoltage's from the grid and the generator is a clamp circuit. The clamping circuit includes 12 fast recovery diodes (FRD) for connecting the condenser to the input and output terminals.

MODULATION TECHNIQUE OF THREE PHASE TO THREE PHASE MATRIX CONVERTER:

Through nine bi-directional justifying, the Matrix Converter links any output line to any input line. To take into account the modulation problem, the switch on the converter assumes that the input supply is optimized and stabilize.

The input voltages are,

$$\begin{bmatrix} V_a(t) \\ V_b(t) \\ V_c(t) \end{bmatrix} = V_{im} \begin{bmatrix} \cos(\omega_i t) \\ \cos(\omega_i t + 2\pi/3) \\ \cos(\omega_i t + 4\pi/3) \end{bmatrix}$$

The inflationary pressure algorithm controls switches such as SAA, SBa etc. to enable the synthesized output voltage components VA, VB, VC and input currents to be fully sinusoidal with the output frequency, input frequency range and input displacement factor prescribed. Input frequency range Switch sequentially and respectively closed on each output step. The time of sequence, Ts, is the number of the switching times. For safe functioning of the

$$T_S = t_{Aa} + t_{Ab} + t_{Ac} = t_{Ba} + t_{Bb} + t_{Bc} = t_{Ca} + t_{Cb} + t_{Cc} = 1/f_S$$

Where fs is the frequency of switching and tAa is constant is the time of switching sAA. The device must not be short-circuited input terminals of the MC and not open output terminals via bi-directional MC switches.

For unity input displacement factor the duty cycle for the switch connected between the input phase β and output phase

$$T_{\gamma\beta} = T_s\left[\frac{1}{3} + \frac{2V_{o\gamma}V_{i\beta}}{3V_{im}^{2}} + \frac{2q}{3q_m}\sin(\omega_i t + \psi_\beta)\sin(3\omega_i t)\right]$$

γ can be defined as, where

$\psi\beta$: 0,2π/3,4π/3 corresponding to the input phases a, b and c respectively.

$$V_{o\gamma} = qV_{im}\left[\cos(\omega_o t + \psi_\gamma) - \frac{1}{6}\cos(3\omega_o t) + \frac{1}{4q_m}\cos(3\omega_i t)\right]$$

Equations for the measurement of the duty cycle of switches for Matrix Converter fed induction drive in open-loop control.

INDUCTION GENERATOR

This paper also explains modelling of the induction generator on the basis of the 3-phase matrix converter output and the torque pulsation, generator derivative and overarching efficiency of the induction generator when the induction generator is driven by the converter. As the action of stator and rotor flows, the electromagnetic forces for the induction generator equivalent circuit are determined. This paper and several other variations in the three-phase model of the induction generators are developed and simulated by the authors. For a sampling period of 500us simulations were performed. The power system block sets MATLAB/Simulink and literature have a Simulink machine inductive model.

III. MATLAB DESIGN AND RESULTS

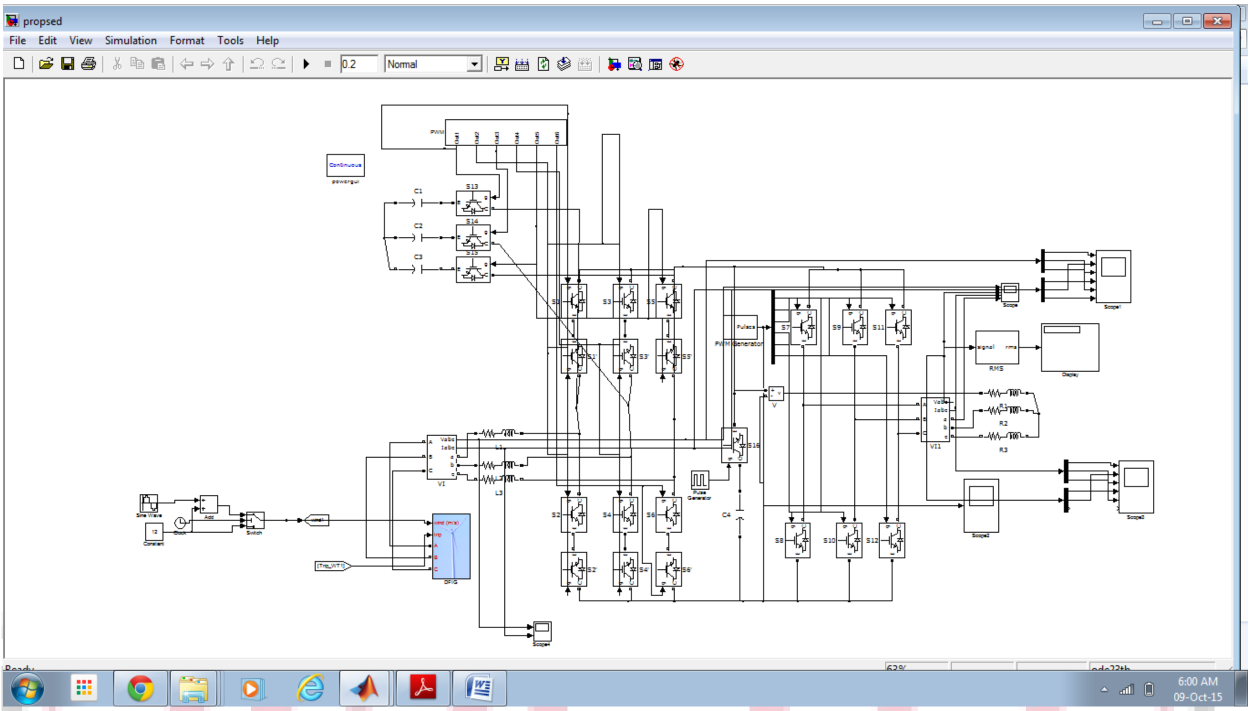

Figure 4: MATLAB Simulink model

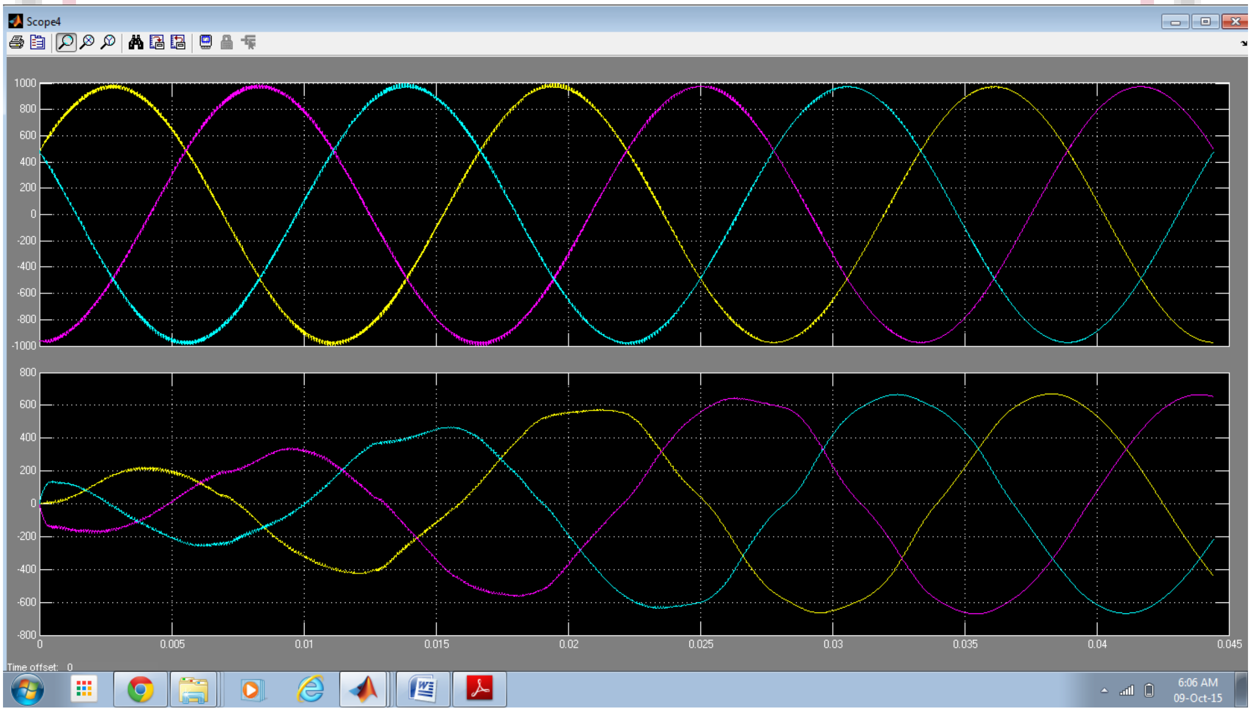

Figure 5: Supply voltage and current waveforms

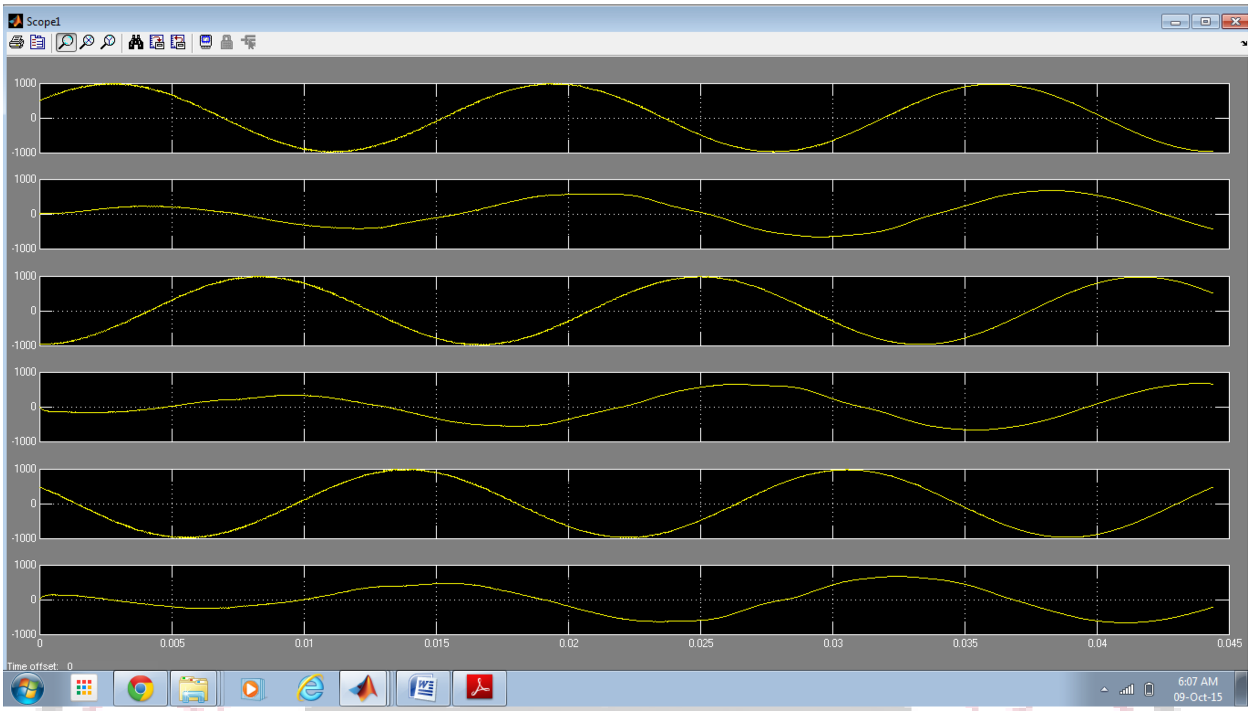

Figure 6: Output waveforms of matrix converter

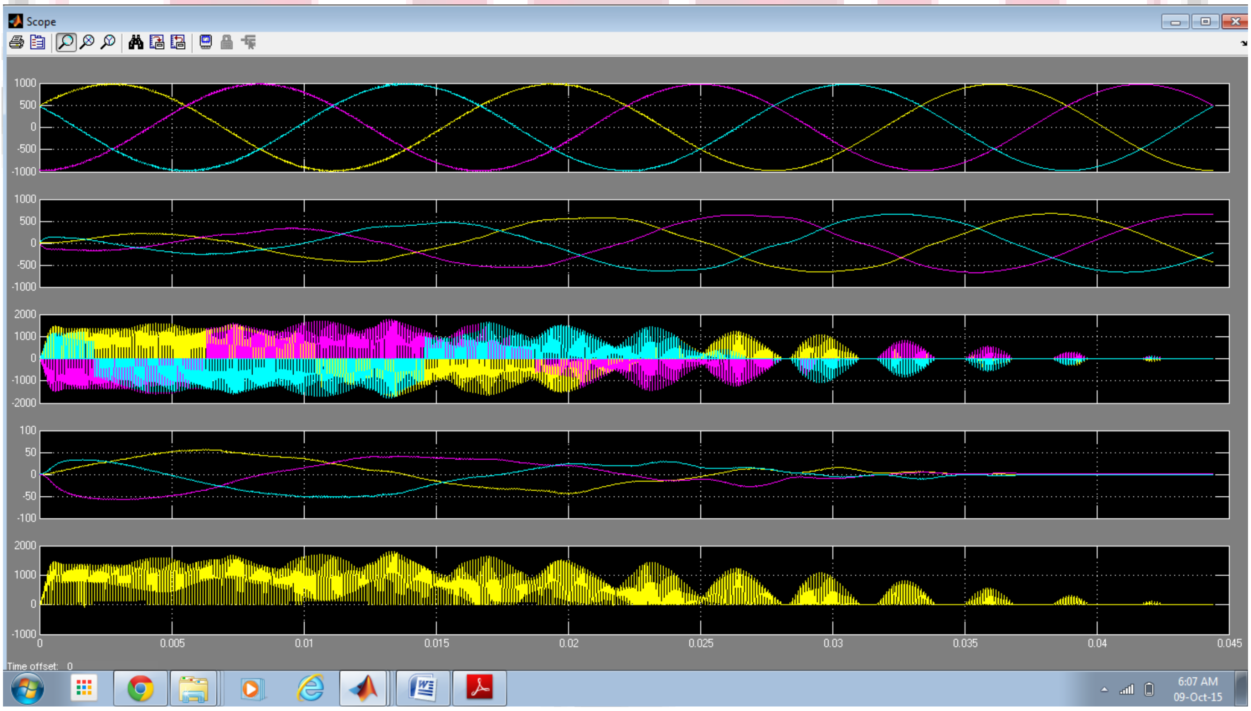

Figure 7: Load side waveforms

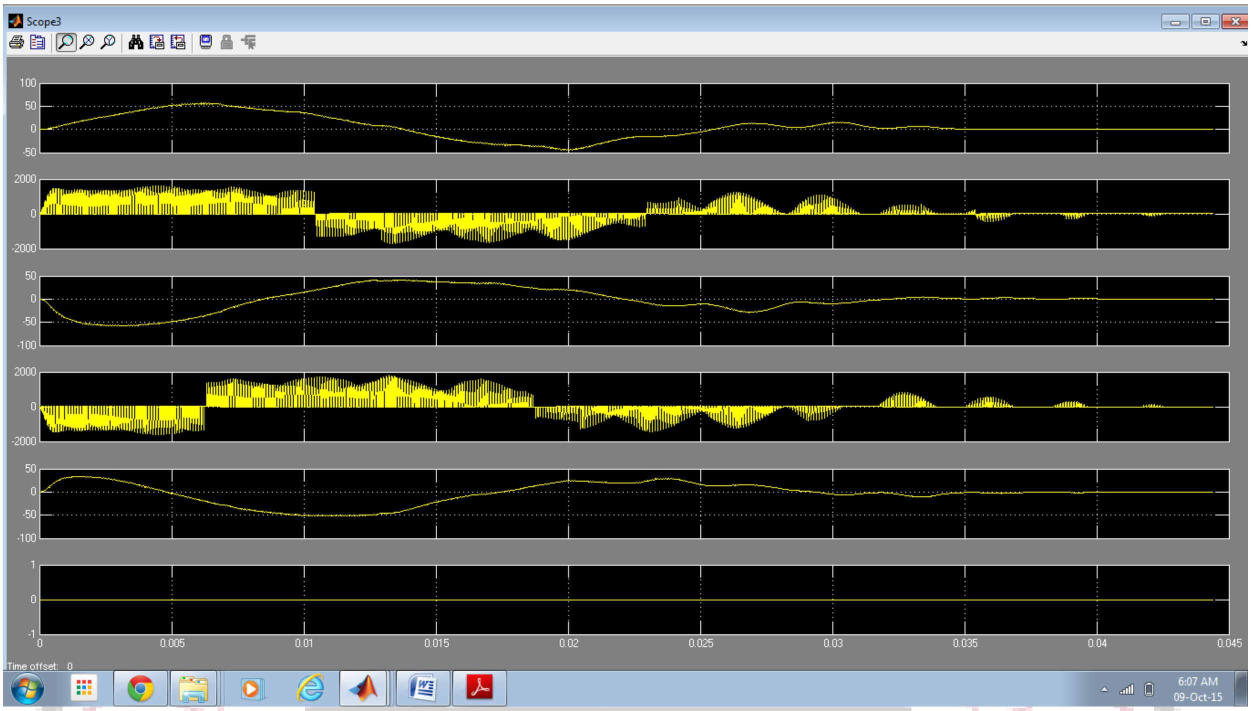

Figure 8: Load side waveforms

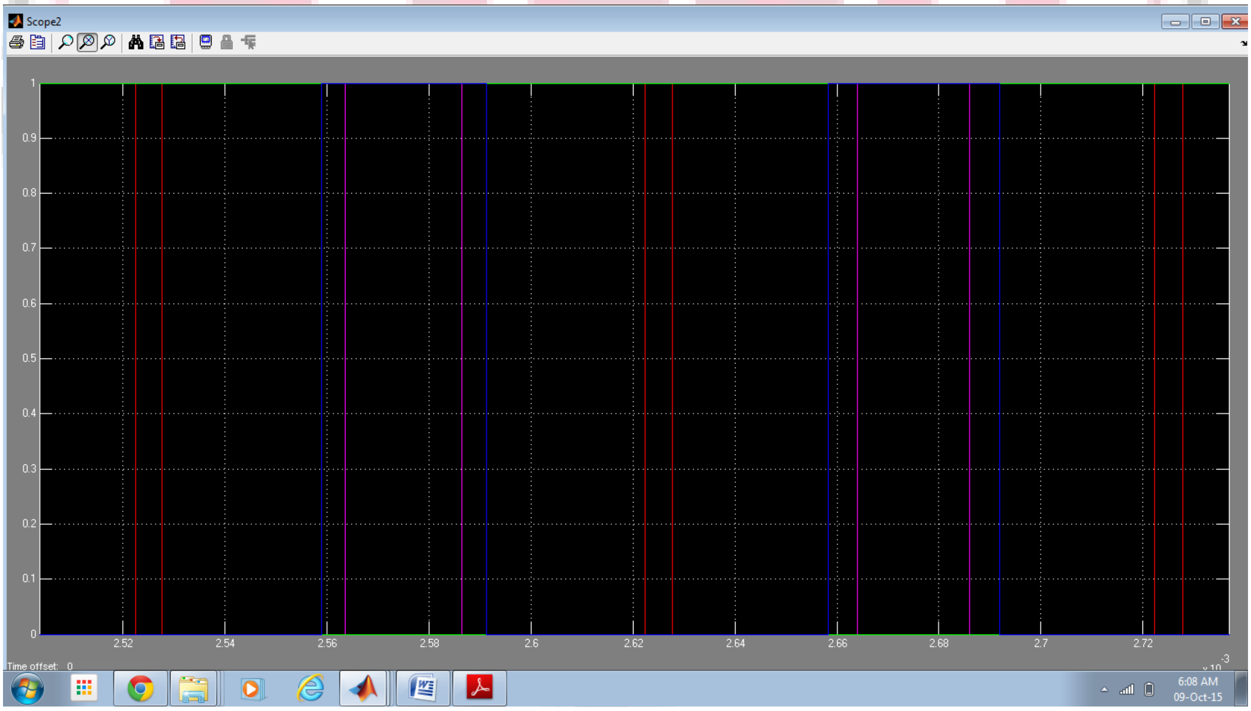

Figure 9: Switching pulses

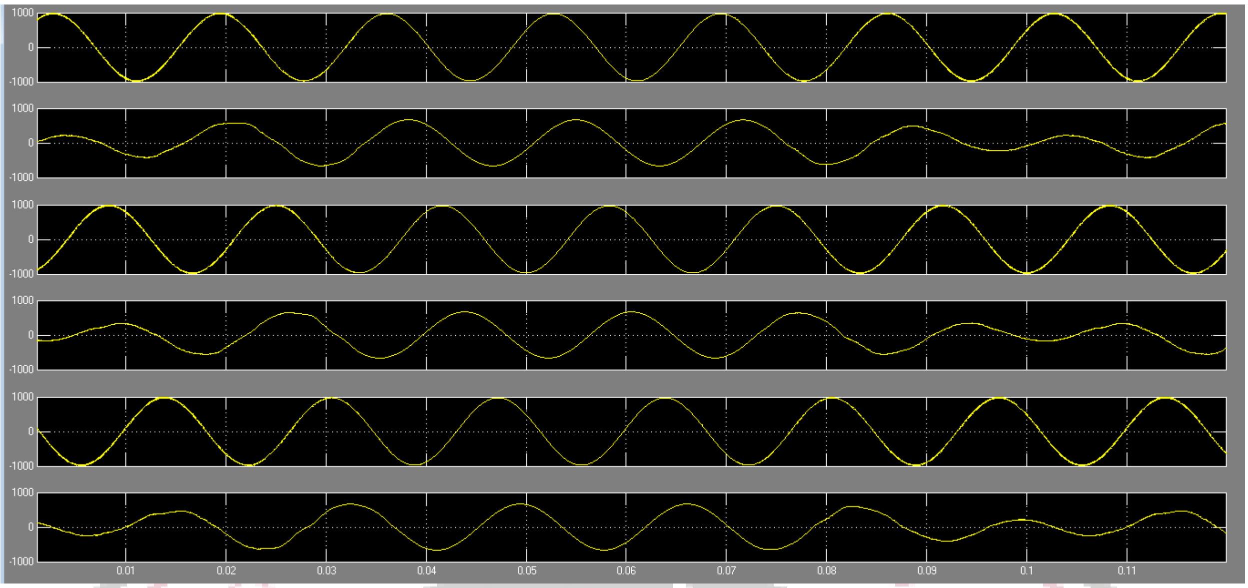

Figure 10: (a) DC voltage. (b) Input phase current and voltage for sub-synchronous speed. (c) Input phase current and voltage for super synchronous speed.

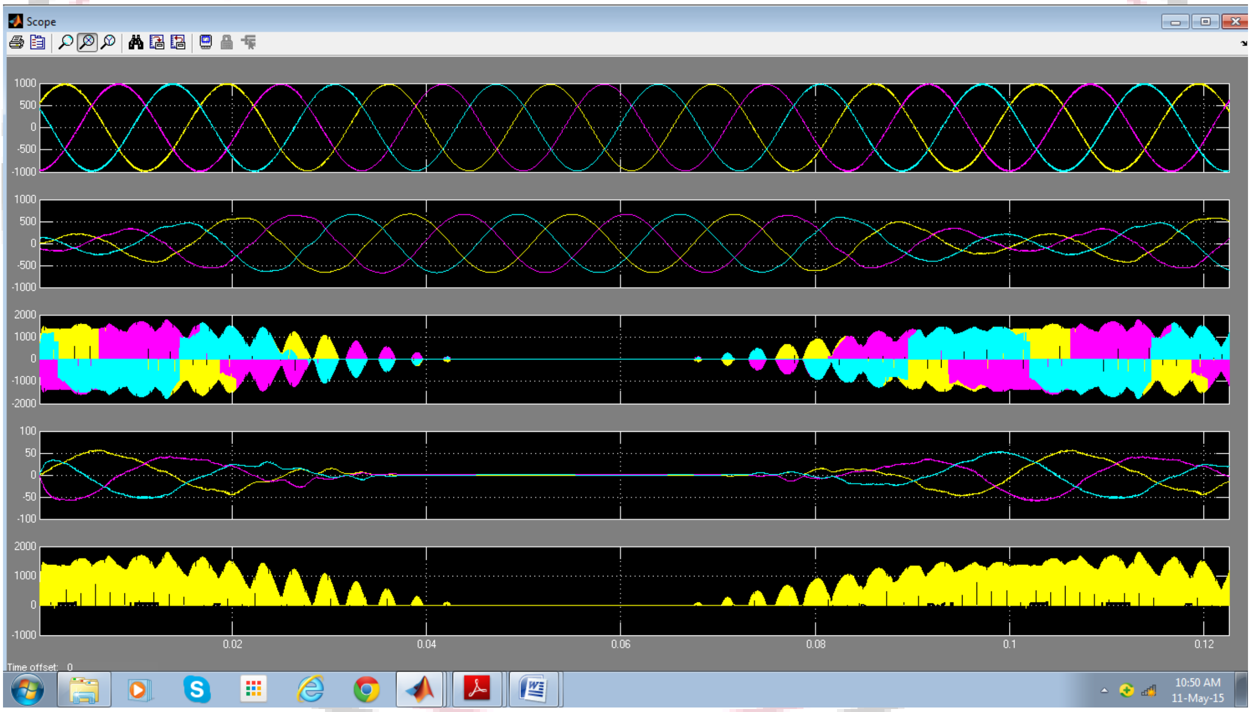

Figure 11 DFIG performance in a variable speed wind energy system.

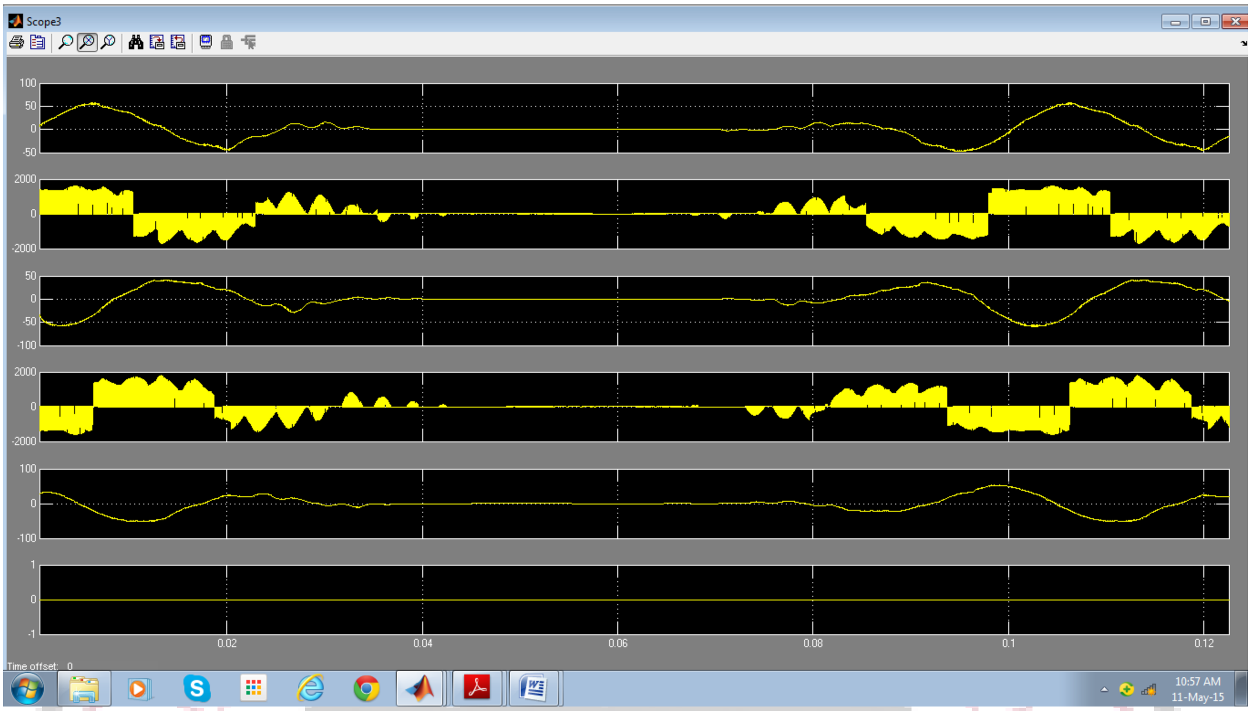

Figure 12: Current controller performance for both machines at variable speed

IV. CONCLUSION

Due to the limited number of electronic power changers, the efficiency of the proposed converters is expected to be high. Furthermore, the fired condition no longer represents a threat which increases converters' performance. Input and power currents were shown by the THD analysis to show that the SIZMC is somewhat superior to the QZMC in terms of the input current performance. Bidirectional reactive capacity is not possible in SIZMC and QZMC. Therefore, the turbine cannot be started using the generator. The rectifier will add three additional switches and transform the ultra-spacious matrix stage into one sparse matrix by a bidirectional power flow.

In the topology of ultrasparse matrix converter, interface with a low-voltage wind turbine with the grid can be done by switching inductor and close z-source circuits. Due to the limited number of electronic power changers, the efficiency of the proposed converters is expected to be high. Furthermore, the fired condition no longer represents a threat which increases converters' performance.

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