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Simulation of 3-Phase PWM Line Converter Based on Direct Voltage Control

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Abstrac: The objective of this project is to model and simulate a three-phase Voltage Source Pulse Width Modulation (PWM) Rectifier Based on Direct Voltage Control feeding an indirect vector controlled Induction Motor Drive (VCIM) . Based on the mathematical model of PWM rectifier, the dual close loop design with decoupled feed-forward control is applied to the three phase voltage source rectifier. The objective of this project is to model and simulate a three-phase Voltage Source Pulse Width Modulation (PWM) Rectifier The first objective is to realize unity power factor at the input ac mains and regulate output voltage. The second one is to realize that the above designed PWM rectifier will always give its objectives of stiff dc voltage and unity power factor irrespective of the load and its controlling methods. Considered resistive load on rectifier and check the performance of the PWM rectifier with direct current control. So as to reflect the most practical aspect of the load for checking the viability of the rectifier design. The operation is not disturbed the PWM rectifier objectives. The designed PWM rectifier is considered as capable of feeding the Common DC coupling point (dc bus).

Keywords: Pwm rectifier, Direct voltage Control (DVC),

I. INTRODUCTION

Power electronics equipment used nowadays very more. The standard diode/Thyristor bridge rectifiers at the input side several problems come as: Low input power factor, high values of harmonic distortion of ac line currents, and harmonic pollution on the grid. In nowadays, the PWM rectifier offers several advantages such as: control of DC bus voltage, bi-directional power flow, unity power factor, and sinusoidal line current. Many pulse-width modulation (PWM) techniques have been adopted for these rectification devices to improve the input power factor and shape the input current of the rectifier into sinusoidal waveform. The current regulating fashion in synchronous frame has the advantages of fast dynamic current response, good accuracy, fixed switching frequency and less sensitive to parameter variations. In actual implementations, the direct current control scheme is used. Various control strategies have been proposed to regulate the dc bus voltage while improving the quality of the input ac current in direct current control scheme. The expanding use of electric loads controlled by power electronics such as PC's, TV's, stereos, and adjustable speed drives (ASD's) has made power converters an important. Nevertheless, the increasing use of power converters has also led to an increase of current harmonics drawn from the utility grid. In the last decade, main research focus has been on harmonic reduction techniques and, as a result of this, several useful harmonic reduction techniques exist for the single-phase rectifier. However, finding the right solution for the three-phase rectifiers is still very difficult.. Various methods based on the principle of increasing the number of pulses in ac–dc converters have been reported in the literature to mitigate current harmonics. These methods use two or more converters, where the harmonics generated by one converter are cancelled by another converter, by proper phase shift. To ensure equal power sharing between the diode bridges and to achieve good harmonic cancellation, this topology needs Inter phase transformers and impedance matching inductors, resulting in increased complexity and cost. Moreover the dc-link voltage is higher, making the scheme non applicable for retrofit applications. The solution is either only practical for low-power applications or the price and complexities are too high. Some summaries on three-phase harmonic reduction techniques can be found. Harmonic reduction Equipment such as an active filter or active rectifier is only used when there are severe problems with harmonic distortion. Due to the new standards, such as IEEE 519-1992 and EN 61000-3-2/EN 61000-3-12. Figure 1 shows a three phase diode-rectifier working as a line side Converter, with this common DC Link, many of the Drives Vector Controlled IM Drive, systems are inter connected. Due to the rectification process, the input current is highly discontinuous and contains excessive low frequency harmonics resulting in high total harmonic distortion (THD). The IEEE-519 recommended practices specify limits on the harmonics generated. Also, with this configuration, power can flow only in one direction making the PWM drive system incapable of regenerating. In order to meet clean input power requirements and allow regeneration, the diode rectifier shown .

B.Three-phase voltage source PWM Rectifier model

In the set up math model, it is assumed that the AC voltage is a balanced three phase supply, the filter reactor is linear, and IGBT is ideal switch and lossless. Where u_a , u_b and u_c are the phase voltages of three phase balanced

voltage source, and i_a , i_b and $i_c$are phase currents,V_{dc} is the DC output voltage, $R_1$and L mean resistance and inductance of filter reactor, respectively, C is smoothing capacitor across the dc bus, R_l is the DC side load, u_{ra} , u_{rb} , and u_{rc} , are the input voltages of rectifier, and i_L is
Load current

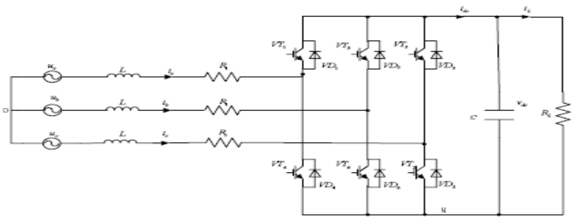

Figure1. Circuit schematic of three-phase two-level boost type Rectifier

The following equations describe the dynamical behavior of the boost type rectifier in Park coordinated or in d-q:

$$\frac{Ldi_d}{dt} = u_d - i_d R_1 + \omega L i_q - u_{rd}$$
$$\frac{Ldi_q}{dt} = u_q - i_q R_1 + \omega L i_d - u_{rq}$$

$$\frac{CdV_{dc}}{dt} = -V_{dc}/R_L + 3/2(S_d i_d + S_q i_q) \quad (1)$$

Where, $u_{rd} = s_d v_{dc}$,$u_{rq} = s_q v_{dc}$, u_{rd} , u_{rq} and s_d , s_q are input voltage of rectifier Switch function in synchronous rotating d-q coordinate, respectively. u_d , u_q andi_d,i_q are voltage source, current in synchronous rotating d-q coordinate, respectively. □□angular frequency respectively

C. Design of current loop

It is seen from (1) that mutual interference exists in the d-q current control loops. The voltage decouples are therefore designed to decouple the current control loops and suitable feed forward control components of source voltages are also added to speed up current responses. The d–q current control loop of the rectifier
in the proposed system is shown in Figure 1.Where the d – q voltage commands can be expressed as

$$u_{rd} = -u'_{rd} + \omega L i_q + u_d$$
$$u_{rq} = -u'_{rq} + \omega L i_d + u_q \quad (2)$$

Let us take into account this assumption in (1) and get the following equations

$$\frac{Ldi_d}{dt} = -i_d R_1 + u'_{rd}$$
$$\frac{Ldi_q}{dt} = -i_q R_1 - u'_{rq} \quad (3)$$

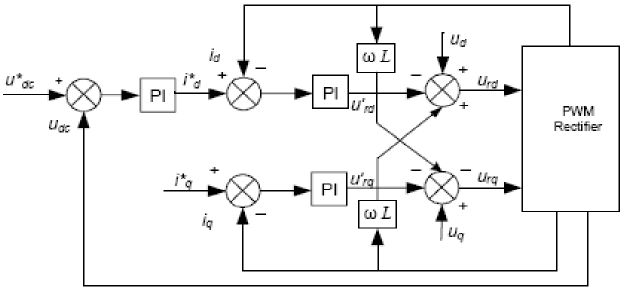

Figure2.Control block diagram of d-q dual closed-loop controller of rectifier

The simple proportional-integral (PI) controllers are Adopted in the current regulation, u_{rd} and u_{rq} are controlled by the following expression:

$$u_{rd} = -\left(K_{ip} + \frac{K_{il}}{s}\right)(i_d^* - i_d) + \omega L i_q + u_d$$
$$u_{rq} = -\left(K_{ip} + \frac{K_{il}}{s}\right)(i_q^* - i_q) + \omega L i_d + u_q \quad (4)$$

Assume that the d–q voltage commands are not saturated and the d–q current control loops have been fully decoupled. For d-axis current control loop, the structure can be simplified to Figure 2.

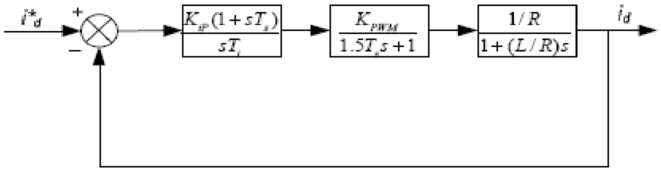

Figure3. Equivalent control block diagram of d-q current -loop

When the current responses speed is concerned, the current regulator can be designed as the typical Ⅰ model system. For pole-zero cancellation, take $T = L/R$. The open-loop current transfer function can be expressed as

$$W_i(s) = K_{ip}K_{PWM}/RT_i s(1.5T_s + 1) \qquad (5)$$

According to Parameter adjusting method for typical model I system, when damping ratio ξ=0.707, we have the following equation

$$\frac{1.5K_{ip}K_{PWM}\,T_s}{RT_i} = 1/2 \qquad (6)$$

The parameters of the PI controller should be chosen as

$$K_{ip} = RT_i/3T_s K_{PWM}$$
$$K_{il} = \frac{K_{ip}}{T_i} = R/3T_s K_{PWM} \qquad (7)$$

D. Design of voltage loop

The transfer function of voltage regulator is

G(s)= $K_{vp}(1 + T_s)/T_v$s (8)

Where
$K_{vl} = K_{vp}/T_v$ (9)

By Figure 4, the open transfer function of system can be expressed as

$$W_{ov}(s) = 0.75K_{vp}(1 + sT_v)/CT_v s^2(4T_v s + 1) \qquad (10)$$

Due to the main function of voltage control loop is to keep stability of output voltage, so the noise immunity must be taken into account in the course of design voltage loop. The proper choice to this end is to adopted typical model II system. So

$$\frac{0.75K_{vp}}{CT_v} = h_v + 1/32h_v^2T_s^2 \qquad (11)$$

Where $h_v = T_v/4T_s$is the frequency width in the voltage loop, take$h_v = 5$ then
$T_v = 20T_s$ (12)

Finally the result obtained is:
$K_{vp} = C/5T_s$
$K_{vl} = K_{vp}/20T_s$ (13)

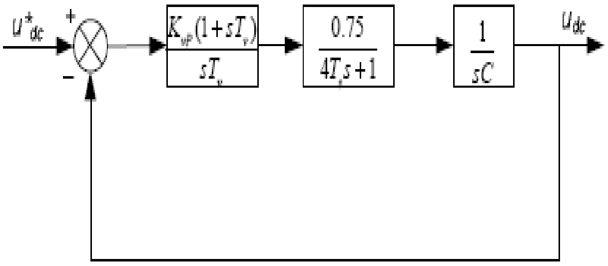

Figure4.Equivalent control block diagram of the voltage control loop

F. Simulation Results and Discussion

The circuit designing in MATLAB. MATLAB has been chosen in this work due to its versatility. To verify the above design, the proposed Converter-Drive system is simulated in MATLAB/SIMULINK. The simulation is carried out on

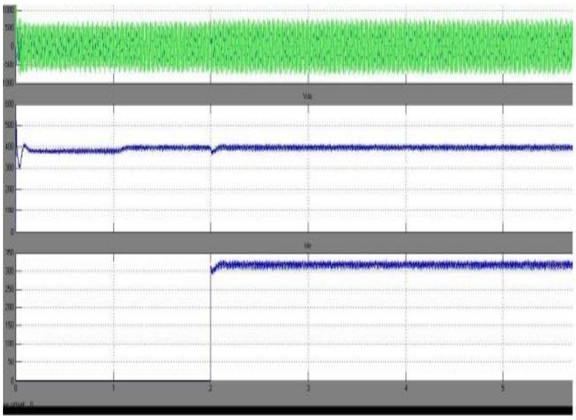

Figure5.source voltage, source current, Dynamics of DC link voltage and Current waveforms of PWM Rectifier with DCC

Direct current controlled PWM rectifier with the following load conditions.
Each time it is verified that the input power factor is unity and the DC voltage is stiff under all the conditions. Simulation results are presented here for different operating conditions

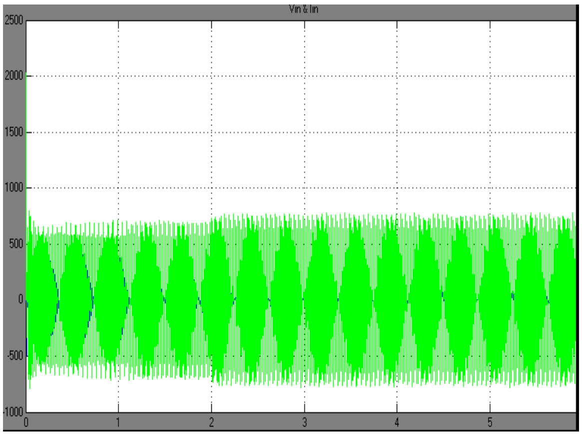

Figure6.Input voltage waveforms (at Boost Inductor) of PWM Rectifier with DCC

G.REFERENCE

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II. CONCLUSION

The DC bus voltage remains unchanged except with a very little dynamics for any load variation in the output rectifier side. The operation of the Drives will never makes the DC bus voltage to pulsate or fall. This is the most important requirement of the power System, particularly at common coupling. One more important aspect of the rectifier is that it is maintaining the unity power factor even under dynamic Loads and disturbances. so conclusion that for any load variation on converter does not change the unity power factor at input side.

ACKNOLEDGEMENT

I M .Deva Darshanam here by declared that the Project entitled " simulation of 3-Phase PWM line converter Based on Direct Voltage Control ". In this project observe the current and output voltage with different load variation.

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