Space Vector Modulation Based Three-Phase PWM Rectifier Voltage Oriented Control

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Abstract: The flow challenges urge the analysts to structure and advance the devices allowing the transformation and the control of energy. The power converters comprise in adjusting the wellspring of vitality to the requirements for the heap. In this paper, we present the investigation of voltage oriented control space vector modulation (VOC-SVM) methodologies for three-stage PWM rectifiers. This system of control established on the change between stationary directions α-β and synchronous rotating facilitates d-q, it depends on the input– output criticism linearization controller for which the goal is to control the framework current's d-and q-load part, while the dc-transport voltage is kept up at the ideal dimension and fulfil the solidarity control factor (UPF) activity. The system VOC-SVM guarantees high static execution and quick transient reaction by utilizing inward current control circle. In addition, the examinations were done by utilizing simulation under nature Matlab/Simulink.

Index terms: Voltage arranged control; PWM rectifier; Space vector balance; Input– output criticism linearization.

I. INTRODUCTION

A few mountings of three-stage PWM rectifiers are utilized in various mechanical divisions require critical power. In fact, these converters are nonlinear burdens which ingest non-sinusoidal flows and expend the responsive power which prompts a low power factor and a mutilation of the line voltage [1]. Thus, the three- stage PWM rectifiers are a standout amongst the most encouraging arrangements because of favourable circumstances, for example, the utilization of a present near a sinusoid by diminishing its consonant substance, the receptive power control assimilated and the dc-transport voltage and guaranteed it a bidirectional exchange of intensity [2]. The control of the PWM rectifier can be viewed as a typical issue with controlling a PWM inverter. A few methods of control of PWM converters were displayed in the writing which intends to have a diminished symphonies mutilation proportion and an exact power control [3-4].They can be ordered, as indicated by their standards in two classes: procedures dependent on the voltage and strategies based on the virtual-transition which were planned in [5] - [9]. The DPC techniques intends to wipe out the beat width adjustment square and the inside control circle by supplanting them with an exchanging table whose inputs are the mistakes between the reference esteems and the deliberate qualities and were created in [6-7],[10],[12]. The VOC technique is established on the facilitates change between the fixed directions framework α-β and arranges d-q, where the present control is conveyed in the voltage space vector of reference outline situated [2-3], [14]. In this paper, we propose another way to deal with control the three-stage PWM rectifiers which is the VOC with space vector tweak (SVM). For this we have executed a non-straight control strategy that considers non-linearity of the framework, this technique depends on an information yield input linearization so it guarantees, the control of the dc-transport voltage and the flows (id-iq) and furthermore guarantee solidarity controlfactor.

II. MATHEMATICAL MODEL

Fig. 1 demonstrates the square graph of the three-stage PWM rectifier, in which ea, eb and ec speak to the power source stage voltages; R and L is line obstruction and line inductance individually; ia, ib and icare the line current of PWM rectifier; va, vb and vc are the AC side voltages of the rectifier; C is dc-connect capacitor; idc is dc-interface current; iL is load current; RL is load opposition. From Fig. 1, we can deduct the conditions of the framework in the two-stage synchronous revolution d-qorganize:

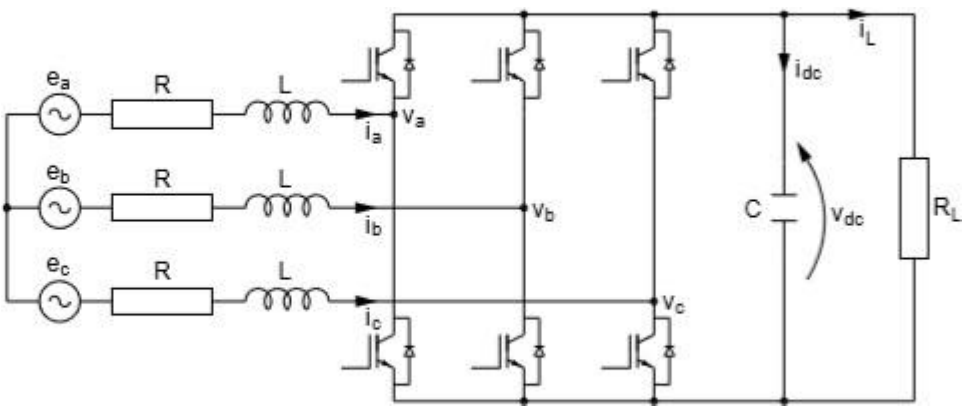

Fig 1.Schematic diagram of a PWM rectifier

$$\frac{di_d}{dt} = \frac{-R}{L} i_d + \varpi i_d + \frac{1}{L}(e_d - v_d)$$

$$\frac{di_d}{dt} = \frac{-R}{L} i_d - \omega i_d + \frac{1}{L}(e_d - v_d) \qquad (1)$$

$$\frac{dv_{dc}}{dt} = \frac{-v_{dc}}{L} + \frac{(e_d i_d + e_q i_q)}{CV_{dc}}$$

III. PRINCIPLE OF VOLTAGE ORIENTED CONTROLSPACE VECTORMODULATION

System configuration

VOC depends on the introduction of the present vector a similar way as that of the voltage vector, by controlling the present vector in the two pivoting facilitates dq. This control technique it conceivable to deal with the two parts of the present vector in the synchronous directions coordinated a similar way of the voltage vector of the framework. This which guarantees the PWM rectifier should draw of the sinusoidal line flows. This structure present a noteworthy hindrance lies in its variable exchanging recurrence. A motivation behind acquiring a steady exchanging recurrence, one uses the VOC-SVM. Therefore, the exhibitions of the control firmly rely upon the capacity of the control circle input-yield criticism linearization controller [8],[11], [14]. As appeared in Fig.2, the all out topology of the voltage situated control with space vector balance for a three-stage PWM rectifier, Sa, Sb and Sc speak to the exchanging condition of the rectifier; id-q are d-q parts of the matrix current; ed-q are d-q segments of the framework voltage; ud-q are d-q segments of the information voltage of the rectifier; uα-β are α-β segments of the information voltage of the PWM rectifier. The VOC depends on the synchronization by the PLL (Phase Locked Loop) to gauge and channel the edge of the source and the momentary adequacy of the identical period of a three-stage framework. The PLL ensure that it pursued by period of the immediate segment of the network voltage, ed, so as to take out the part in squaring, eq, which delivers the evaluated stage, θ, is equivalent to the period of the matrix[9].

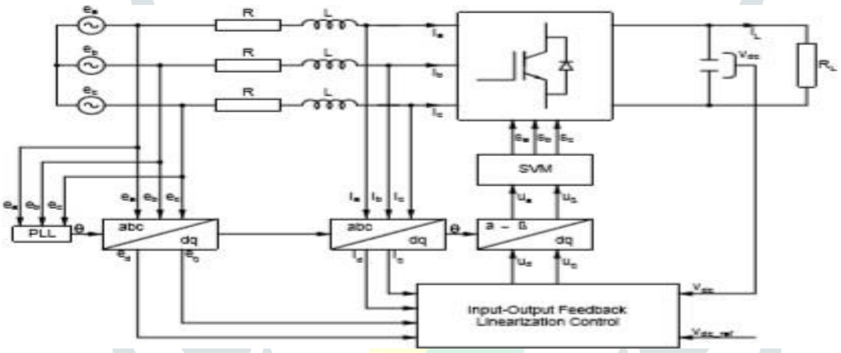

Fig. 2. Configuration of VOC for PWM rectifier

For the change of directions α-β to the coordinates d-q the point of voltage vector is given by:

$$\sin\theta = \frac{e_\beta}{\sqrt{(e_\alpha)^2 + (e_\beta)^2}} \quad (2)$$

$$\cos\theta = \frac{e_\alpha}{\sqrt{(e_\alpha)^2 + (e_\beta)^2}} \quad (3)$$

IV. SVPWM GENERATION

The Pulse Width modulation technique permits to obtain three phase system voltages, which can be applied to the controlled output. Space Vector Modulation (SVM) principle differs from other PWM processes in the fact that all three drive signals for the inverter will be created simultaneously. The implementation of SVM process in digital systems necessitates less operation time and also less program memory.

The SVM algorithm is based on the principle of the space vector u*, which describes all three output voltages u_a, u_b and u_c.

$$u^* = 2/3 .(u_a + a.u_b + a2 .u_c) \quad (4)$$

Where a = -1/2 + j .v3/2

We can distinguish six sectors limited by eight discrete vectors u0…u7 (fig: - inverter output voltage space vector), which correspond to the $2^3 = 8$ possible switching states of the power switches of the inverter.

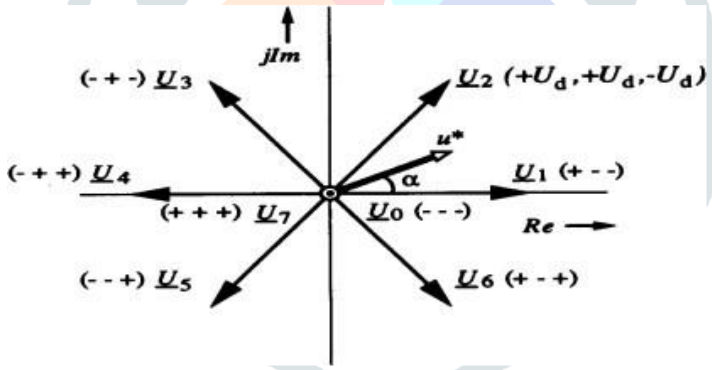

Fig. 3. Space vector Modulation

The amplitude of u0 and u7 equals 0. The other vectors u1…u6 have the same amplitude and are 60 degrees shifted.

By varying the relative on-switching time Tc of the different vectors, the space vector u* and also the output voltages ua, ub and uc can be varied and is defined as:

$$u_a = Re (u^*) \quad (5)$$

u_b = Re (u*. a-1) (6)

u_c = Re (u*. a-2) (7)

During a switching period Tc and considering for example the first sector, the vectors u0, u1 and u2 will be switched on alternatively.

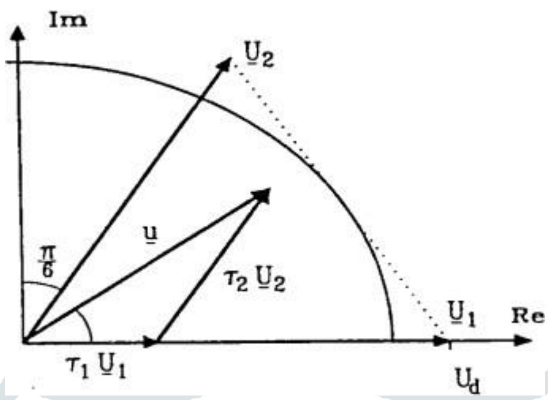

Fig. 4. Definition of the Space vector

V. PRINCIPLE OF THE INPUT OUTPUT FEEDBACK LINEARIZATION CONTROLLER

The information yield criticism linearization control approach permits of numerically changing the non-direct framework in a halfway or totally straight framework so as to have utilized the direct control strategies.

Either the framework characterized by:

$$=(x)+g(x)u \quad (8)$$

$$y=h(x) \quad (9)$$

Or

x = *x xx*is the vector of the states,
1 2 [, ,...] *p u* = *u uu*is the vector of the controls,
1 2 [, ,...] *p y* = *y yy*represents the vector of the output, f(x), g(x) and h(x) are non-linear functions.
This control technique consists in finding a relation linear between the input and the output by deriving the output until at least an entry appears by using the expression:
This control system comprises in finding a connection straight between the info and the yield by determining the yield until somewhere around a section shows up by utilizing the articulation:

$$y^{(r_j)} = L_f^{(r_j)} h_j(x) + \sum_{i=1}^{p} L_{g_i}(L_f^{(r_j-1)} h_j(x))\, u_i \quad (10)$$

Or:

$$L_{g_i} L_f^{(r_j-1)} h_j(x) \neq 0 \quad (11)$$

*r*is the relative degree of the system.
The derivatives of Lie are defined by the following relationship:

$$L_f h(x) = (\frac{\partial h(x)}{\partial x}) \quad —— \qquad (12)$$

By iteration (12), we have the following equation:

$$L_f^i h_j = (L_f^{i-1} h_j);\ i = 2,3,\ldots.. \qquad (13)$$

The expression (13) can be written in following matrix form:

$$\begin{bmatrix} y_1^{r_1} \\ \vdots \\ y_p^{r_p} \end{bmatrix} = \begin{bmatrix} L_f^{r_1} h_1(x) \\ \vdots \\ L_f^{r_p} h_p(x) \end{bmatrix} + D(x)u \qquad (14)$$

Or D(x) is the matrix of decoupling of the system.

The control law for linearization and decoupling input-output is given by:

$$[u]=D(x)^{-1}[-A(x)+[V]] \qquad (15)$$

Or:

[ ] 1 2 v = [v v]Trepresents the new vector of the input variables.

Substituting (15) in (14), the equivalent system becomes linear and totally decoupled from the form:

$$_1 \quad y_p]=[V_1,\ldots.V_p]$$

The variables vi and vi can be determined from dynamic equations of theerrors.

VI. CONCLUSION

This work proposes the displaying and re-enhancement of voltage arranged control space vector tweak dependent on nonlinear control of PWM rectifier. The scientific models of the worldwide framework are introduced. The recreation results demonstrated this proposed procedure and demonstrated their viability into keep up the dc-transport voltage and the current at the ideal dimension, just as music decrease. The proposed system gives great static, unique exhibitions by means of inside current control circle and has a fantastic vigour.

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