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An Effective Space Vector Pulse Width Modulation Based Dual UPQC to Reduce the Power Quality Issues



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Abstract:

A space vector pluse width modulation control strategy with fixed switching frequency for dual Unified Power Quality Conditioner (iUPQC) is proposed. This method researches thesvpwm control strategy with fixed switching frequency. On this basis, it combines the hysteresis control strategy with fixed switching frequency and space vector control by the conversion of the filter hysteresis tracking control. In thefinal control strategy, it judges the region of command voltage vector by using the sign ofphase to phase currenterror vector . Compared with the traditional current trackingalgorithm, detection of three phase grid voltage is notneeded and the algorithm is optimized. The control strategycan solve the problem that switch frequency is unstable andovercome the problem of interphase interference in threephasethree wire system. Through the MATLAB/Simulinksimulation, proved that this kind of control strategy forUnified Power Quality Conditioner proposed in this paper is
feasible and effective.

Index Terms:
I-Unified Power Quality Conditioner;svpwm.

I.INTRODUCTION:

In recent years, with the continuous development ofelectric power industry, the power quality problemsget more and more attention . With the using of a largenumber of non linear loads and impact loads, thepower quality is deteriorating and the user hassuffered a great loss .As a power quality comprehensive compensationdevice, Unified Power Quality Conditioner combinesthe function of the series compensation part and the parallel compensation part.

UPQC can compensatefor not only harmonics and reactive current by theload, but also supply voltage rise, drop, filcker and other voltage quality problems. It usually consists ofa series active power filter, a shunt active power filterand the DC link capacitors. Through the DC linkcapacitors, the series active power filter and the shuntactive power filter are connected in back to backstructure .The rapidity and accuracy of tracking control has agreat influence on UPQC compensating effect. Now,Unified Power Quality Conditioner(UPQC) because ofits quick response, high tracking accuracy andsimplicity, but unstable switching frequency causesgreat switching loss. Furthermore,the interphase interference is very serious in threephasethreewire system. Based on the shortcomings ofthe above, a space vector based pwm controlwith fixed switching frequency strategy for UPQC isproposed in this paper, which can not only achieve thefixed frequency, but also overcome the interphaseinterference. The control strategy is possible andeffective by theoretical analysis and simulation.

II. IUPQC:

A Unified Power Flow Controller (or UPFC) is an electrical device for providing fast-acting reactive power compensation on high-voltage electricity transmission networks. It uses a pair of three-phase controllable bridges to produce current that is injected into a transmission line using a series transformer. The controller can control active and reactive power flows in a transmission line. The UPFC uses solid state devices, which provide functional flexibility, generally not attainable by conventional thyristor controlled systems. The UPFC is a combination of a static synchronous compensator (STATCOM) and a static synchronous series compensator (SSSC) coupled via a common DC voltage link. The main advantage of the

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UPFC is to control the active and reactive power flows in the transmission line. If there is any disturbances or faults in the source side, the UPFC will not work.The UPFC operates only under balanced sine wave source. The controllable parameters of the UPFC are reactance in the line, phase angle and voltage. The UPFC concept was described in 1995 by L. Gyugyi of Westinghouse. [1] The UPFC allows a secondary but important function such as stability control to suppress power system oscillations improving the transient stability of power system.

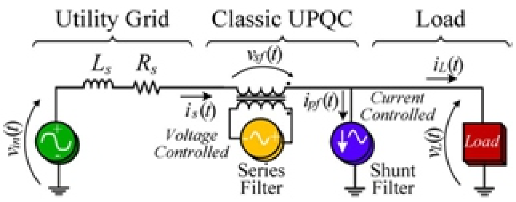

Fig. 1. Conventional UPQC.

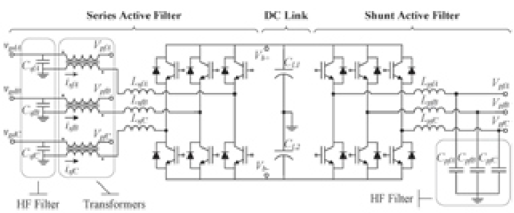

Fig. 3. Power circuit of the iUPQC.

III. PROPOSED CONTROL SCHEME:

SV-PWM is actually just a modulation algorithm which translates phase voltage (phase to neutral) references, coming from the controller, into modulation times/duty-cycles to be applied to the PWM peripheral. It is a general technique for any three-phase load, although it has been developed for motor control. SV-PWM maximizes DC bus voltage exploitation and uses the "nearest" vectors, which translates into a minimization of the harmonic content.The classical application of SV-PWM is vector motor control, which is based on the control of currents' projection on two orthogonal coordinates (direct and quadrature, dq), called Field Oriented Control (FOC). For induction machines, the most common choices for the direct axis is to align it to the rotor field (rotor FOC) or to the stator field (stator FOC). The basic concept is that with a known motor and known voltage output pulses you can accurately determine rotor slip by monitoring current and phase shift. The controller can then modify the PWM "sine" wave shape, frequency or amplitude to achieve the desired result.

For example the desired speed is 200 rpm and the control senses there is 2 rpm of slip so it increases the frequency slightly to bring the speed up. Since torque can also be determined it can also be controlled. SVPWM just does a lot of sampling, calculating and wave form manipulation. The specific algorithms and deciding what the best output solution is for different situations could fill up several books.SV means space vector, as in space vector modulation. SVM basically allows a 3-phase bridge PWM drive to supply about 15% higher peak voltage to a motor than the standard sine-triangle modulation scheme by allowing the neutral point of the motor to move away from the nominal 1/2 of the supply rail (it will look like a triangle wave). The characteristic voltage output of an SVM-modulated sine wave is a sine wave with a double-hump on the peaks.To be more precise, SVM output about 15% more "non over-modulated" voltage than the traditional carrier based PWM. That is the maximum voltage before over-modulation happens. The shape of the phase voltage has a double-hump as mentioned (similar to a standard PWM + third harmonic addition). The line-to-line voltage will not show the humps though.See a space vector control drive here.

IV SIMULATION RESULTS:

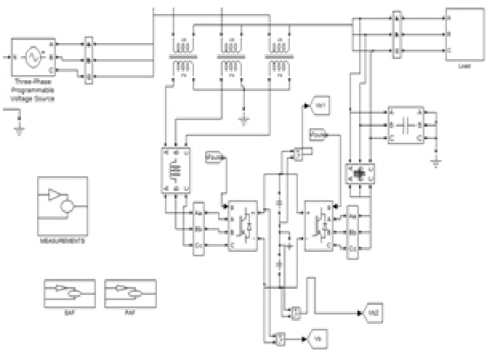

Fig.4. Mat lab Simulation Circuit

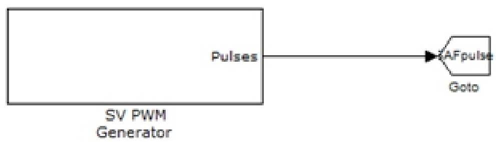

Fig.5. Mat lab control block

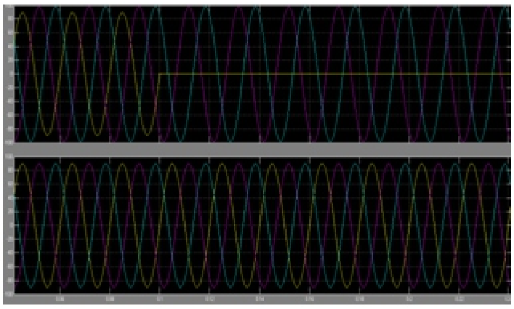

Fig..6Source voltages and load voltages

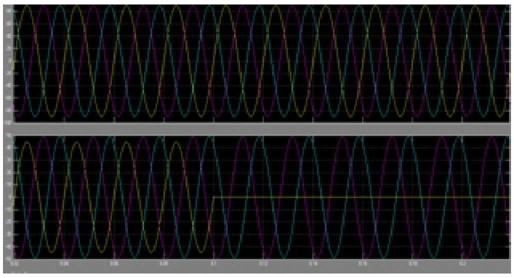

Fig.7 Load voltages (100 V/div and 10 ms/div) and sourcecurrents (5 A/div and 10 ms/div).

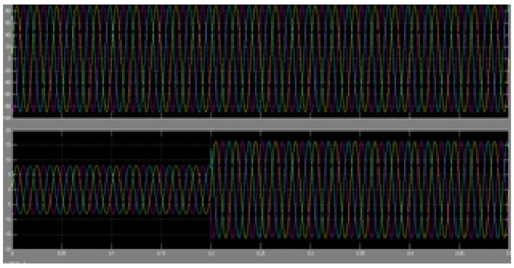

Fig .8 Load voltages (100 V/div and 5 ms/div) and load currents (5 A/div and 5 ms/div) during a load step from 50% to 100%.

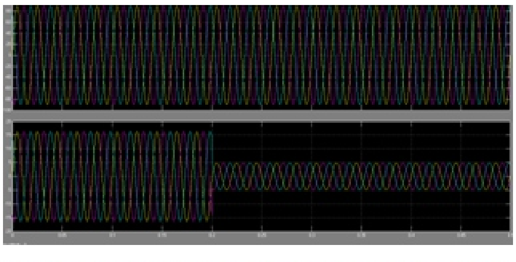

Fig. 9 Load voltages (100 V/div and 5 ms/div) and load currents (5 A/div and 5 ms/div) during a load step from 100% to 50%.

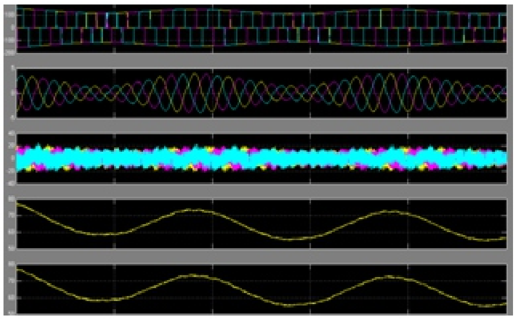

Fig 10 Filter & dc voltage outputs

V CONCLUSIONS:

Space vector pwm based control strategy withfixed switching frequency for IUPQC is proposed inthis paper. The improved SVPWM tracking algorithmis adopted in this control strategy. Compared withtraditional SVPWM tracking algorithm, the Simulation circuit is simplified and optimized.MATLAB/Simulink Simulation results provethis control strategy can compensate not only the harmonicand reactive current caused by nonlinear loadsb-utalso the supply voltage rise and drop. So the powerqual-ity gets improved. Furthermore, this controlstrategy can overcome the shortcoming of interphaseinterference and the problem of switching loss.

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