Quality conditioner using nine switch converter for power quality enhancement and voltage sag alleviation

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ABSTRACT

In conventional back-to-back power converter which uses 12 switches recently was projected from nine switch power converter available with two pairs of resultant terminals. The nine-switch converter has previously illustrated to have certain merits, in addition to its element saving topological feature. Despite these compensation the nine-switch converter has so far initiate inadequate applications due to its many real performance tradeoffs like requiring an super dc-link capacitor, limited amplitude sharing, and limit phase shift between its two pairs of resultant terminal. To overcome the restrictions of the tradeoffs in our proposed work a power conditioner with nine transistors that virtually converts most of these topological shortcomings are implemented to get attractive presentation merits. We aim for supplementary to reduce its switching losses, an appropriate irregular modulation scheme is proposed in detail to particularly guarantee that maximal decrease of commutations is gained. A suitably designed control scheme then built-in the nine-switch converter is shown to positively raise the overall voltage quality in experiment, hence explanatory its function as a power conditioner by means of decreased semiconductor prices. Aiming further to decrease its switching losses, a suitable irregular modulation scheme is proposed and studied here in detail to doubly ensure that maximal reduction of commutations is achieved. With an appropriately designed control scheme then included the nine-switch converter is shown to sympathetically raise the overall power quality in experiment, hence mitigating its role as a power conditioner at a reduced semiconductor cost.

Keywords: Total harmonic distortion (THD), nine-switch power conditioners, Unified power quality conditioner (UPQC)

INTRODUCTION

Due to recent advancements in technology are many converter technologies readily available due to the rapid growth of static power converter development. Accompanying this expansion is the equally rapid identification of purpose areas, where power converters be able to make positively toward raising the on the whole system quality. In maximum cases, the known applications would necessitate the power converters to be associated in series or shunt based on the functioning scenarios underneath contemplation. In accumulation they need to be planned with voltage, current, and/or power regulation scheme so that they can efficiently compensate for harmonics, reactive power flow and voltage variations. For even more severe regulation of power quality, to maintain voltage and current regulation we use both series and shunt converter.

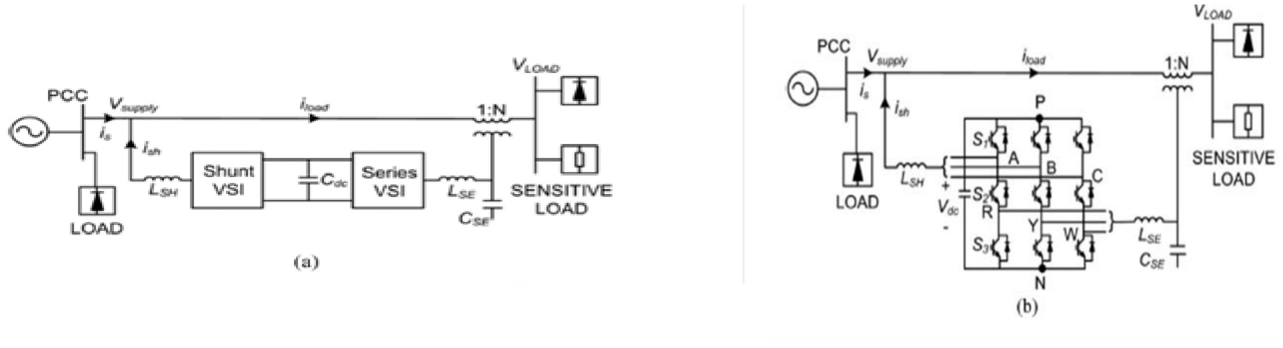

Fig.1.Representation of (a)back-to-back and (b)nine-switch power conditioners

Approximately for all time both of these converters are coupled in a back to- back configuration, with 12 switches in total as well as sharing a common voltage dc-link, as reflected by the configuration shown in Fig. 1(a). Where available, a micro resource can also be inserted to the common voltage dc link, if the purpose is to afford for dispersed generation into a micro grid with no considerably impacting on the extensive established appropriate performance of the back-to-back configuration**.**

DESIGN AND CONFIGURATION OF NINE-SWITCH POWER CONDITIONERS

To validate its performance, a nine-switch power conditioner was implemented in the laboratory, and controlled using a displace DS1103 controller card. The displace card was also used for the final acquisition of data from multiple channels simultaneously, while a 4-channel Lecoy digital scope was simply used for the initial debugging and verification of the displace recorded data, but only four channels at a time. The final hardware setup, where parametric values used are also indicated. Other features noted from the figure include the shunt connection of the upper UPQC terminals to the supply side, and the series connection of the lower terminals to the load side through three single-phase transformers. Reversal of terminal connections for the setup, like upper series and lower shunt, was also affected, but was observed to produce no significant differences, as anticipated. For flexible testing purposes, the setup was also not directly connected to the grid, but was directed to a programmable ac source, whose purpose was to emulate a controllable grid, where harmonics and sags were conveniently added.

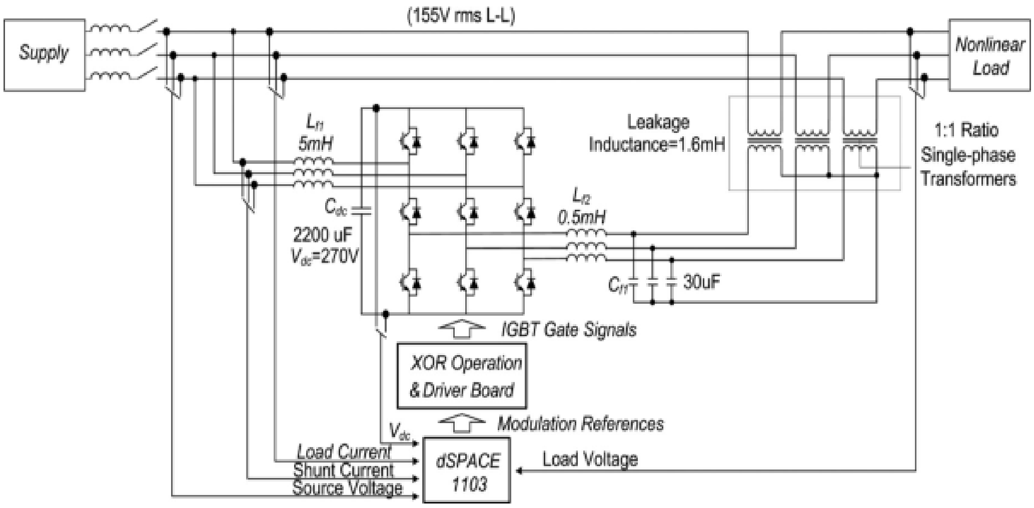

Fig.2. Experimental setup and parameters used for testing

With such flexibility built-in, two distorted cases were programmed with the first having a poorer total harmonic distortion (THD) of around 4.18%. This first case, being less rigorous represents most modern grids, regulated by grid code improved .The second case with a superior THD of around 11.43% was included mainly to show that the nine-switch UPQC can still function well in a heavily distorted grid, which might not be common in practice. Operational with these two trial cases, experiment be conduct with the shunt compensation proposal shown in Fig.2 always activate so as to produce the regulated dc-link voltage required for overall UPQC operation. The data obviously show that the proposed nine-switch UPQC is effective in smoothing the load voltage, in spite of the level of low order grid harmonic distortion introduced. The supply voltage is certainly distorted, and would appear across the load if series compensation is deactivated and the transformer is bypassed. The distortion would, however, be largely blocked from propagating to the load, and upon activating the series compensation scheme with the shunt compensation scheme still kept executing.

EXPERIMENTAL RESULTS

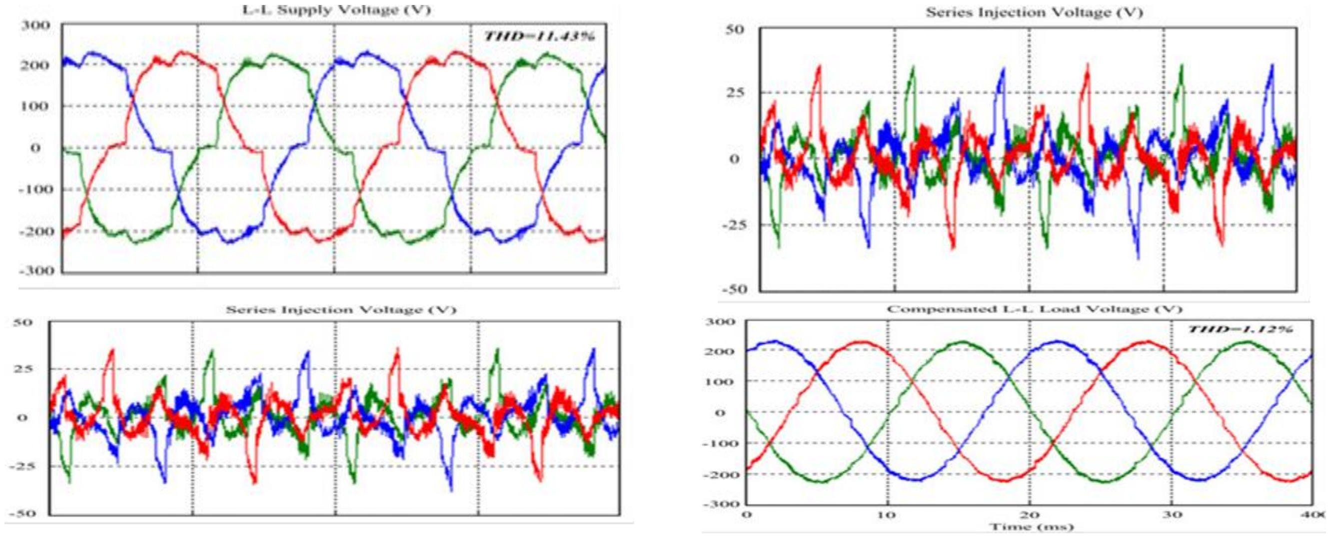

Fig.3.Experimental supply, series injection, and load voltages captured during normal power conditioning mode

CONCLUSION

This paper evaluates shortcomings experienced by previous applications of the newly proposed nine-switch converter. With a better understanding developed, the conclusion drawn is that the nine-switch converter is not an attractive alternative for replacing back-to-back converter with two shunt bridges. Instead, the nine-switch converter is more suitable for replacing back to- back converter in “series–shunt” systems, where one good example is the UPQC. As a further performance booster, a modified 120◦-discontinuous modulation scheme is presented for reducing the overall commutation count by 33%. Followed up next with proper shunt and series control, harmonics, reactive power, and voltage sags are compensated promptly with no appreciable degradation in performance. The nine-switch conditioner is therefore proved to be effective, while yet using lesser semiconductor switches. Experimental results for confirming its anticipated smooth performance have already been obtained through intensive laboratory testing

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