TOPIC: POWER QUALITY CONVERTER WITH IMPROVED POWER FACTOR

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INTRODUCTION

The current interest on IPQCs is stimulated by the need to conserve energy in view of the rising costs and fast depleting non-renewable energy sources, explore new effective methods to harness the alternate renewable energy resources that are inherently dilute by adopting high efficiency techniques in AC-DC power conversion, and conform to the contemporary stringent power quality standards. A meticulous study of the relevant literature reveals certain areas, in which there is scope to propose new methodologies and techniques, improvement and simplification of existing procedures and developing new algorithms for control of the IPQCs. The motivation for the present work is to develop simple switching strategies and highlight the desirable multifaceted features of the IPQCs vis-à-vis the various applications associated with AC-DC conversion and the standards thereof, so that they are accepted as a viable option in general, and become the preferred choice for industrial and domestic use in under-developed and developing nations, in particular.

WORK CARRIED OUT

The major contribution of the present work is comprehensive study comprising modeling, digital simulation, hardware implementation and performance analysis of the various IPQCs identified. The study is conducted to ascertain the efficacy of the open loop pseudorandom switching, and that of the closed loop HCC PWM switching, with regard to the IPQCs, to limit the harmonic content to acceptable levels as per the power quality norms. The performance evaluation has been conducted, adopting the two control approaches for a wide range of operating conditions, monitoring the response on the AC and DC sides of the converters. The different operating conditions for which simulations have been conducted include rectification operation, inversion operation, four-quadrant operation, high frequency operation, and dual DC output operation.

The computer simulation results indicate that the IPQCs function quite satisfactorily for the proposed switching strategy and can therefore be adopted readily, particularly where compliance with the relevant power quality standards, high efficiency and application specific compatibility are prime concerns.

To verify the feasibility of the proposed boost AC-DC converter, experimental setup is developed. The experimental AC-DC converter is used to drive a resistive lamp load and an SMPS based inverter. Normally, major chunk of power requirement is met using storage batteries and DC to AC converters. A novel 12V DC to 230V 50Hz, 200W system offering improved power factor at utility lines is developed. The same design with some modification can easily be adopted up to 2kW power levels. The power factor is measured using power harmonic analyzer and is found to be above 0.96.

The hardware results on a prototype confirm the theoretical analysis and performance of the proposed converter. The experimental testing of improved power quality converter is carried out for resistive load and switched-mode power supply (SMPS) inverter load.

In order to test the effectiveness of modern control technique, a neural network (NN) based switching strategy is also evolved for the control of single phase bi-directional AC-DC converter. The network receives the phase current error signals through the scaling gain K and generates the PWM logic signals for driving the converter main current devices. The sigmoid function is clamped to 0 or 1 when the threshold value is reached. The output signals have four possible states corresponding to four states of the converter switching conditions. If the current in a phase reaches the threshold value +0.01 the respective output should be 1 which will turn on the upper device of the leg. If, on the other hand, the error reaches – 0.01, the output should be 0 and the lower device will be switched on. The advantageous of the NN controller is that the switching frequency increases significantly. Second, the increase in switching frequency speeds up the switching element's turn ON and OFF operations. In this way, the effect of harmonics and disturbances is minimized. Thus, the control of power flow is done with the help of the NN controller, and the energy conserved in capacitor is transmitted to the main supply.

The work presents a comprehensive analysis of single phase power quality converters. It simulates conventional and modern switching strategies and control techniques for converter configurations. The results present a high displacement factor and improved power quality parameters. Experimental results validate simulation strategy.

CONCLUSIONS

- New Switching and control strategies for specific single phase IPQC has been conducted.
- Performance analysis of new switching strategies for single phase power quality converter topologies is presented.
- The performance analysis has been carried out on simulation circuit models, obtained by carefully considering, design aspects of the relevant circuit parameters.
- The simulation parameters are dependent on the control strategy deployed and prerequisite conditions that have to be complied with to ensure smooth operation
- Hardware results on a laboratory prototype are presented to confirm the theoretical simulation analysis and performance of the proposed converter for resistive and SMPS load.
- It simulates conventional (PWM) and modern (NN) switching strategies and control techniques for converter configurations.
- The results present a high displacement factor and improved power quality parameters.
- Experimental results validate simulation strategy.