Digital Automation of the 3-Phase Modular PFC Converter under Modified Current Sharing Approach.

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Abstract: This paper deliberates on the new modular 3-phase topology of the Power Factor Correction converter and employs a proposed method of current share for high voltage gain. The current sharing control method allows for a current sensing circuit capable of manipulating the switch current for the PFC. The features of the proposed converter topology allow for good power factor and improved performance. Unlike conventional current control schemes, the proposed current sharing method paves way for low harmonic distortions and unity power factor. This approach has been investigated through simulation and useful combinations and performance of the novel converter.

**Index Terms**-Power Factor Correction, Current Sharing, Low Harmonic Distortions, 3-Phase Modular PFC

1. **Introduction**

With the emergence of power supply applications be it industrial and laboratory uses such as radar systems, renewable energy systems and X-ray Systems, it is essential that three-phase PFC performance goes with the criteria of high-power factor, reduction of size, high quality input current and mitigation of total harmonic pollution. [1]-[2]

In regards to the features and topology of the converter. It boasts of a high structure of active components that allows for high voltage gain and an efficient current control scheme. According to various studies and simulation studies, Total-Harmonic Distortions account for 3% of the input current of typical 3-Phase PFC Rectifiers. However, this type of rectifier makes it practically advantageous since it implements a Total-Power-Factor of more than 99%. The diversification of the three-phase PFC converter has been instituted in two forms based on their classifications; Modular converters and Single-Stage converters. Under the single stage criteria, the topology makes way for a simple circuitry but tends to be cumbersome and has low voltage stresses in diodes and switch mechanisms. [3]-[4]



Fig.1. Circuit diagram for the three phase Modular PFC Converter

However, the three-phase modular converter though unique in feature has a demerit of unequal supply and reverse current which has been resolved in [5]-[6]. Thereby creating unity power factor solutions for high gain applications.

This paper has been divided into major sections and not limited to Operation of Proposed three-phase Modular PFC Converter, Control Method and Circuit configurations, Current Sharing method, Design study with its respective mathematical equations and calculations, Simulation study and results.

The paper delves into digitalized approach for a current sharing method for the proposed converter leading to a

favorable dynamic response, prototypes are developed and analyzed and experimental results verified.

1. **Operation of Proposed Three-Phase Modular PFC Converter (System Configuration)**

In order for all components of the proposed converter to function properly they operate at voltage stress equal to half of the output voltage. As enunciated earlier, the topology initiates for high voltage gain as compared with conventional PF converters. Thus, we have the following in relation to converter operation;

Taking into account the input voltages:

 

Phase currents gives us

 

When switching mechanism goes off the storage and release elements capacitor and inductor (1.3) produce the gain for this system. Also provided the system is lossless the gain, G will be (1.4)

 

 

Where Dk is the duty ratio of each phase, Vk is the voltage stress from the diodes of each leg.



Fig.2. Digitally controlled Operation of the proposed three phase Modular PFC Converter

1. **Digital Control Method and Circuit Considerations**

The sharing method evaluated in this section indulges various methods of power sharing of which the spectrum of the input line currents draws high quality waveforms, reducing the Total Harmonic Distortion, THD to a minimal. d