Control of a Single-Stage Three-Phase Boost Power Factor Correction Rectifier

Introduction:

Traditional three-phase variable voltage and variable frequency AC/DC rectification topologies in airplane generators utilize passive diode bridges and large DC link capacitors. Passive diode-bridge based rectifiers generate higher harmonics in the input current, have poor input power factor, create input voltage source disturbances, and lack output voltage regulation [1]. To alleviate these problems, recent progresses in high-speed, power semiconductor devices have facilitated the development of active switched-mode AC/DC converters that are controlled by pulse width modulation (PWM) techniques. The dominant topologies for active, single-stage PWM-based AC/DC conversion are boost-type [1-4], buck-type [5-6] and buck-boost type rectifiers [7-8]. Three-phase, boost-type power factor correction (PFC) converters have received attention due to their simple structure with less number of power semiconductor devices, less passive components and more importantly capability of continuous current conduction mode operation. Besides, three-phase buck-boost-type and buck-type AC-DC converter have drawbacks such as operation with discontinuous current conduction mode, higher amount of power semiconductor devices, and lower conversion efficiencies.

Existing system:

A boost converter (step-up converter) is a DC-to-DC power converter steps up voltage (while stepping down current) from its input (supply) to its output (load). It is a class of switched-mode power supply (SMPS) containing at least two semiconductors (a diode
and a transistor) and at least one energy storage element, a capacitor, inductor, or the two in combination. To reduce voltage ripple, filters made of capacitors (sometimes in combination with inductors) are normally added to such a converter's output (load-side filter) and input (supply-side filter).

(a) When the switch is closed, electrons flow through the inductor in counter-clockwise direction and the inductor stores some energy by generating a magnetic field. Polarity of the left side of the inductor is positive.

(b) When the switch is opened, current will be reduced as the impedance is higher. The magnetic field previously created will be destroyed to maintain the current towards the load. Thus the polarity will be reversed (means left side of inductor will be negative now). As a result, two sources will be in series causing a higher voltage to charge the capacitor through the diode D.

![Circuit Diagram]

**Drawbacks:**

Operation with discontinuous current conduction mode, higher amount of power semiconductor devices, and lower conversion efficiencies
Proposed system:

A new control strategy utilizing the input currents and output voltage of the converter. The main objective of the control strategy is to make the input current controller as fast and as robust as possible; to produce high quality input currents (low THD percentage and unity power factor). Instead of using a conventional control loop, that performs Park Transforms from the three-phase (abc) reference frame to the dq0 reference frame, our research thrust proposes an input current control structure that manipulates the reference duty ratio of each switch, in order to maintain an appropriate/desired input current shape. The final duty ratio value is derived from a weighted, cross-coupled sum of required change in duty ratios, which are obtained from both active and reactive power controller outputs. This control structure excels in two separate areas: (1) obtaining a fast and robust input current response (with high power factor quality); and (2) achieving a steady state response in a significantly less amount of settling time, under a step change in load or reference output voltage, as compared to conventional PI current compensators. Simply put, the control strategy put forth in this research thrust is simple, fast, and reliable – and is perfectly suited for implementation in the active three-phase boost rectifiers.

Advantages:

- Input current by limiting harmonics content of the PFC stage
- and also enhancing the conversion efficiency
- operational feasibility of the converter in high-end switching frequencies.

Applications:

- More Electric Aircrafts (MEAs)
- Hybrid electric vehicles
Block diagram:

1. Input AC Supply
2. Three phase boost rectifier
3. C filter
4. Load
5. Driver Circuit
6. Buffer Circuit
7. Micro Controller Circuit
8. 12V DC
9. 5V DC