Single-Stage AC/DC Single-Inductor Multiple-Output LED Drivers

Introduction:

Light-Emitting Diodes (LED) are increasingly gaining acceptance in lighting industry with a growing list of applications, such as general, decorative, and display lighting applications. The four major factors supporting their popularity are 1) preponderant long lifetime; 2) mercury free and environmental friendly; 3) high luminous efficiency; and 4) flexibility to perform color mixing and dimming control. Depending on the specific application requirements, the LED can either be arranged in series as a single string (or a single LED chip), or in parallel forming a multi-string structure (for medium- and high-power applications). Many LED drivers achieving small form factor and low cost have been proposed for the single LED chip/string applications. However, achieving a compact and low-cost LED driver design is challenging for applications where multiple parallel LED strings are needed. This is because extra functionalities, such as current balancing, individual string current regulation, or open-/short-circuit fault protection are typically demanded in such multi-string LED systems.

Existing system:

The ac/dc front-stage is simply a diode bridge rectifier with a large capacitor. An unregulated dc voltage is produced without performing
any PFC. Such a configuration is only useful for low-power LED applications, of which the power factor (PF) requirement is less stringent. Also, the SIMO converter is operating in continuous-conduction mode (CCM) and suffers from cross-regulation issues. Therefore, individual current regulation of LED strings is unviable, and only current sharing function is performed. On the other hand, a boost PFC converter is implemented as the ac/dc frontstage converter, providing a well-regulated dc voltage and a high PF.

**Drawbacks:**
- Two sets of controllers (one for the ac/dc stage and the other for the post regulators) are required, which complicates the system design.
• Higher system cost.
• Increased power loss.
• Large form factor.

Proposed system:
A single-stage ac/dc single-inductor multiple-output LED driver is proposed. It uses only one single inductor and \( N + 1 \) active power switches (\( N \) being the number of LED strings) with reduced component count and smaller form factor. The proposed driver can achieve both functions of ac/dc rectification with a high power factor and precise independent current control of each individual LED string simultaneously.
Advantages:

- Intermediate dc-link stage is eliminated.
- One single inductor to drive multiple independent LED strings.
- Lower component count.
- Reduced BOM cost.
- Simplified control scheme.
- Ease of implementation.

Applications:

- Flexible color-mixing and wide-range dimming for high-quality lighting applications.
Block diagram:

- Input AC Supply → Full Bridge Diode Rectifier → Switched inductor → Regulating circuit 1 → Load 1
- 12V DC → Isolation Circuit → Regulating circuit 2 → Load 2
- 5V DC → Buffer Circuit → Micro Controller Circuit → Regulating circuit 3 → Load 3