Offline Soft-Switched LED Driver Based on an Integrated Bridgeless Boost Asymmetrical Half-Bridge Converter

Abstract

Introduction:
While LEDs can have a lifespan ranging from 50 000 to 70–000 h, under some circumstances, the life of the LED driver circuitry could be shorter than that of the devices being driven. Thus, one current approach to make the lifespan of the driver compatible with that of the LEDs is to remove from the power circuitry critical and short-life components, such as the bulky electrolytic capacitors, which commonly sit at the output of the input stage (the dc bus). Thus, research effort is currently being focused in replacing these components for the more reliable metalized film capacitors, of smaller capacitance and longer lifespan.

Existing system:
One effective approach to reduce the bulk capacitance enough to employ film capacitors is to use two cascaded dc–dc conversion stages: one for power factor correction (PFC) and the
other for LED power control (PC), both sharing a common dc bus with a high-frequency decoupling capacitor. This introduces the bus voltage as an additional degree of freedom in the design of the converter, allowing the use of smaller capacitances. Alternative to increase efficiency while still reducing capacitance is to use two non cascaded converters, each of them processing only part of the power delivered to the load. This allows for reduced redundant power processing, thus increasing efficiency, but results in complex converter topologies and intricate control schemes.

Proposed system:
The proposed driver consists of two separate converters, which are integrated to form a single-stage solution. The first converter is the PFC stage, which is composed of a BLB rectifier working in discontinuous conduction mode (DCM). This stage synthesizes a quasi-sinusoidal current to the power grid, thus resulting in a high PF and low total harmonic distortion (THD) of the input current. The second converter is the PC stage, composed of an asymmetrical HB (AHB) SRC with a full-wave high-frequency bridge rectifier feeding the LEDs. The PC stage is mainly responsible for stepping down the voltage from the dc bus and regulating the LED array current.
Block diagram:

1. Single phase AC supply
2. Rectifier
3. Hard bridge converter
4. Load
5. Gate driver circuit
6. BUFFER circuit
7. PIC controller circuit
8. 12 V DC
9. 5 V DC
Advantages:
- Low-frequency ripple in LED arrays.
- Reduction of the bulk capacitance.
- Assuring high input PF.

Applications:
- Street lighting.

Tools and software used:
- MPLAB – microcontroller programming.
- ORCAD – circuit layout.
- MATLAB/Simulink – Simulation.