A CLCL Resonant DC/DC Converter for Two-Stage LED Driver System

Introduction:

In virtue of their excellent light intensity per Watt, very long lifetime, eco-friendliness, and good color rendering, light emitting diodes (LEDs) are quickly replacing previous artificial light sources in indoor and street lighting, display backlighting, lighting in plant factory, and automotive applications. LEDs require constant current which can be supplied by an electronic circuit commonly known as driver which usually consists of either a two-stage circuit (the most common) or a single-stage circuit. Although single-stage drivers use less number of switches, they have some disadvantages, such as high-voltage stress and very wide variation of bus voltage.

Existing system:

The flyback converter is the most applied converter topology in the power rating bellow 250W. Conventional fix frequency controlled flyback converter has the benefit of easy design the simple control, but it is suffer from the switching losses of high voltage stress and hard switching of MOSFET. The switching frequency increases with reducing load. Switching losses in light load condition is the significant drawback to the efficiency performance. To overcome this issue the highest switching frequency clamping control must be used, and force the converter operated in DCM. In heavy load condition, the peak currents of the power MOSFET and major current path are very high, and it will cause higher conduction losses and lead to poor...
efficiency. To solve this problem, the flyback converter is operated in CCM with the lowest switching frequency limit control.

**Drawbacks:**
- High-voltage stress
- Very wide variation of bus voltage

**Proposed system:**
A two-stage LED driver is proposed in this paper, consisting of a boost circuit operating as PFC front-end and a novel CLCL resonant converter. At full load operating condition, MOSFETs at primary side turn-on in ZVS mode and turn-off at extremely low current condition, which is named “quasi-ZCS mode.” Moreover, the ZVS turn-on characteristics of the switches and the ZCS turn-off characteristics of diodes are ensured both at full load and during dimming, thus resulting reduced power losses and increased overall efficiency. $Q_1$ and $Q_2$ are the two switches, $Cr$ and $Lr$ are in series; the series branch $Cp$ and $Ls$ form a π-type network. $Lm$ is the magnetizing inductor, and $R_{led}$ is the equivalent impedance of the LED load. Figure shows the main voltage and current waveforms obtained through proper operations, which consists of ten distinct modes.
Advantages:
- High power factor
- Low total harmonic distortion

Applications:
- indoor and street lighting, display backlighting,
- lighting in plant factory, and automotive applications
Block diagram:

DC Supply → Half-bridge Inverter → CLCL Resonant Tank Circuit → Isolation Transformer → Rectifier

- Isolation circuit
- 12V DC supply
- Buffer circuit
- 5V DC supply
- Micro-controller circuit

Output:
- Filter
- Strip LED