High-Efficiency Soft-Switching AC–DC Converter with Single-Power-Conversion Method

Introduction:

Increase in the use of ac–dc converters in various industrial fields, demand for the development of an ac–dc converter with high efficiency and high power density has increased. Traditionally, ac–dc converters with a Two-stage circuit configuration have been widely used. They consist of an ac–dc converter with power factor Correction (PFC) followed by an isolated dc–dc converter and provide nearly unity power factor and reliable Output regulation.

In , a two-stage ac–dc converter employing an interleaved boost pfc converter and an llc Resonant converter was introduced. Because the converter increases the effective switching frequency using the interleaved technique and employs soft-switching operation of all components in the dc–dc stage, it improves both efficiency and power density.

Existing system:

The single-stage circuit configuration is an alternative that may overcome the drawbacks of the conventional two-stage converters. Single-stage converters have been developed based on various converter topologies involving, e.g., a flyback, a forward converter, and a full-bridge converter. Such converters are simpler and more cost effective than two-stage ac–dc converters; however, they suffer from huge switching losses owing to their hard-switching operation.
Furthermore, the single-stage approach performs ac–dc power conversion depending on the circuit design without any PFC control, which results in a poor power factor and very large harmonics. In single-stage converters using an additional auxiliary circuit were developed; the use of the additional circuit provides high power factor and power quality.

**Dis-advantages:**
- Additional power losses
- Highly complex circuit structure.

**Proposed system:**

A high-efficiency isolated ac–dc converter topology is proposed. The proposed converter consists of a Full-bridge diode rectifier, an isolated resonant dc–dc converter, and only one controller. To obtain high power density without a cost of power-conversion efficiency, the proposed converter provides soft switching for all components operating at high frequency.

The proposed converter performs both PFC and output power control in only one power-processing step by using a novel control algorithm; thus, the converter provides high power Quality, producing a high power factor and low total harmonic distortion without requiring a PFC circuit.
The dc–dc converter is derived from a current-fed push–pull converter. It employs an active-clamp circuit and a series resonant circuit. The active-clamp circuit is composed of the auxiliary switches S1a, S2a and the clamping capacitor $C_c$. The active-clamp circuit increases conversion efficiency by reducing the switching losses on the switches and by recycling energy stored in the leakage inductance $L_{lk}$. Moreover, this circuit limits voltage stresses across the switches and avoids damage caused by the surge voltage.

**Advantages:**

- Without an additional circuit, the proposed converter can provide a high power factor using its control algorithm,
- The proposed converter can achieve high efficiency and high power density.

**Applications:**

- Power factor correction applications.
- Zero-voltage switching applications.

**Block Diagram:**