A Cascaded Coupled Inductor-Reverse High Step-Up Converter Integrating Three-Winding Coupled Inductor and Diode–Capacitor Technique

Introduction:

Renewable energy is increasingly becoming a hot research topic, the high step-up converter is also widely employed as an interface in many industry applications, such as fuel cell system, photovoltaic system, electric vehicles, and so on. In general, conventional boost converter can satisfy the requirement in such applications. However, some typical drawbacks exist: The voltage stress of main switch is equal to the output voltage; hence, a high voltage rating switch with high on-resistance should be used, generating high conduction losses.

In addition, an extremely high duty ratio will induce large conduction losses on power devices and serious diode reverse recovery problem. Based on the above drawbacks, the conventional boost converter is not suitable for realizing high step-up voltage gain together with high efficiency. Many other techniques have been researched to achieve a high conversion ratio and avoid operating at extreme duty ratio.

Existing system:

Typical isolated flyback converter is often adopted for achieving high voltage gain by adjusting the turns ratio, but the leakage inductance may cause high voltage spikes on the switch and induce
energy losses. In order to improve the problems, passive snubber circuit or active clamp circuit can be applied, but this makes cost high and circuit complex.

Many nonisolated converters based on coupled inductor are presented. However, under the condition of large voltage conversion gain, the turns ratio must be very high. Using a coupled inductor with a large turn ratio also introduces several problems. For example, the leakage inductance and parasitic capacitance formed by secondary winding of the coupled inductor may cause voltage and current spikes and increase loss and noise that will dramatically degrade the system performance. In order to satisfy the large high step-up applications, cascaded high step-up converters were proposed.

But among these converters, the voltage conversion gain is approximately proportional to the turn’s ratio. Sometimes, the problem of high turns ratio still exists.

Dis-advantages:
- Cause voltage and current spikes.
- Increase loss and noise that will dramatically degrade the system performance.

Proposed system:
A novel cascaded high step-up converter with three-winding coupled inductor and diode–capacitor structures is proposed. The proposed converter features that the smaller the turn’s ratio, the larger the conversion gains. So, the name coupled inductor-reverse is given to represent reverse-coupled inductor principle of operation. In addition, diode–capacitor circuit is introduced to not only recycle leakage energy to Output, but also further lift voltage conversion gain.
In the proposed converter, voltage gain formula is different from other converters. The voltage gain formula combines both square feature and inverse ratio feature of the turn’s ratio. The two features can reduce the duty cycle, winding turns, voltage stress, and coupled inductor volume and so on when operating at the same condition.

The numbers of capacitors are large, but the capacitor $C_c$ and $C_1$ have low voltage stresses. The cost of capacitors mainly is determined by other two capacitors. Therefore, the overall cost does not increase a lot compared with other high step-up converters.

**Advantages:**
- Low voltage stresses.
- Less cost.
- Lift voltage conversion gain.

**Applications:**
- High step-up Power conversion applications.
Block Diagram:

- **Dc input**
- **Cascaded high step-up converter with coupled inductor**
- **Load**
  - **Gate driver circuit**
  - **Buffer circuit**
  - **Microcontroller circuit**

12VDC and 5VDC sources are connected to the respective circuits.