Design and Steady-State Analysis of Parallel Resonant DC–DC Converter for High-Voltage Power Generator

Introduction:
High-voltage dc power supplies are widely used in many applications, such as extra oral source X-ray System, plasma processing, electron beam systems, etc. In high-voltage applications, it is important to reduce the output voltage ripple and increase output voltage. Therefore, the voltage-doubling circuit plays an important role.

There are two basic topologies for voltage-doubling circuits: half-wave voltage-doubling circuits and full-wave voltage-doubling circuits. Different voltage-doubling circuits can significantly decide whether the output voltage ripple was reduced or not.

Existing system:
The full-bridge dc–dc converter and phase-shift control technique are widely used in high-voltage dc power supply. The adopted conventional full-bridge dc–dc converter usually does not contain resonant tanks. However, the voltage across the transformer’s primary side will ring and cause the consumption of the power converter to increase and the stress of the circuit components to increase.

Two basic topologies of resonant circuits are commonly used in the full-bridge dc–dc converter, resonant circuits including the series-resonant circuit and parallel-resonant
circuit. Both of the topologies can make all the switches in the circuit achieve zero voltage switching (ZVS) or zero current switching. Therefore, it can reduce the voltage or current stress of the switches and increase the whole efficiency of the converter. Normally, the dc–dc resonant converter can be examined in the time domain or in the frequency domain.

**Dis-advantages:**
- It cannot decide the output ripple and the capacitance of the voltage-doubling circuit.

**Proposed system:**
A novel voltage-doubling circuit with parallel resonant dc–dc converter is proposed. A novel voltage doubling Circuit can not only reach a higher output voltage but also reduce output ripple to a lower level than the conventional one. Therefore, while having the same voltage multiple levels as conventional ones, the proposed converter can have a smaller output voltage ripple. In addition, the output power can be adjusted by the phase-shift control technique. Using this technique with the parallel resonant tank can make all the switches achieve zero voltage turn on (ZVS).
The novel dc–dc converter circuit consists of power switches Sa–Sd, a resonant inductor \( L_r \), a resonant capacitor \( C_r \), a leakage inductor \( L_p \), a high-frequency high-voltage transformer \( T_r \), voltage-doubling capacitors \( C_1–C_{2n+1} \) and \( C_2 – C_{2n} \), rectifier diodes, and a high-voltage load \( R_L \).

**Advantages:**
- Reduce the output voltage ripple.
- It can decide not only the output ripple but also the capacitance of the voltage-doubling circuit.

**Applications:**
- High power conversion applications.
Block Diagram:

- DC Input
- Full bridge converter
- Resonant Tank
- High frequency transformer
- Voltage doubler circuit

- 12VDC
  - Gate driver circuit

- 5VDC
  - Buffer circuit
  - Microcontroller circuit