A High-Efficiency Flyback Micro-inverter with a New Adaptive Snubber for Photovoltaic Applications

Introduction:
Photovoltaic (PV) micro-inverters have gained a significant attention for grid-connected PV system applications during the past few years because of improved energy harvest, friendly “Plug-N-Play” operation, and enhanced modularity and flexibility. Various inverter topologies for PV micro-inverters applications have been introduced in the literature that perform the maximum power point tracking (MPPT) of PV module, high step-up voltage amplification, output current shaping, and galvanic isolation. Among them, the flyback-based micro-inverter is one of the most attractive solutions due to its simple structure and control and also inherent galvanic isolation.

Existing system:
The conventional flyback micro-inverter with the active clamping circuit to improve the weighted efficiency. It should be noted that output unfolding stage is replaced with the equivalent rectified sinusoidal voltage source in order to simplify the analysis of the operational modes. This flyback converter is normally operated in CCM or DCM and uses the active clamping circuit to clamp the voltage across the main switch, and prevent voltage overshoot at turn-off and achieve ZVS turn-on of the main switch. This enables the operation of the converter with higher efficiency through soft switching and also the use of MOSFET with
lower $R_{ds(on)}$. Furthermore, the non-complementary gate driving signal for the active clamp switch presented can reduce the circulating energy compared to the conventional complementary control signal, and the hybrid control method that disables the active clamp circuit at the low grid voltage improves the weighted efficiency by reducing the switching, conduction, and gate driving loss of the active clamp switch. Also, the active clamping circuit requires relatively a large capacitance in a range of hundreds of nanofarads, which is costly and bulky. Although a PMOS-based active clamp circuit can be used to simplify the clamp switch gate drive, its performance and cost are not comparable with NMOS; thus, the additional isolated power supply required for driving the active clamp switch adds to the cost and complexity of the micro-inverter system.
Drawbacks:
- Increases the driving loss.
- The active clamping circuit requires relatively a large capacitance in a range of hundreds of nanofarads, which is costly and bulky.

Proposed system:
Based on the hybrid operation of interleaved flyback micro-inverter in discontinuous and boundary conduction modes (DCM and BCM), a novel adaptive snubber is proposed. The proposed snubber limits the drain-to-source voltage overshoot of the flyback’s main switch during the turn-off process, enabling the use of lower voltage MOSFETs. It also recovers the stored energy in the leakage inductance of the flyback transformer and provides soft switching for the main flyback switch by limiting the rising slope of the MOSFET voltage during the turn-off process resulting in higher efficiency. Exploiting the natural resonant of the flyback converter in BCM, the adopted controller provides ZVS and ZCS for the main switch during the BCM operation.
Advantages:
- Reduces the cost and complexity controller and the gate drive circuit.
- Highly efficient.
- Lower voltage MOSFET and also providing soft switching.

Applications:
- Grid-connected PV system.
Block diagram: