Hybrid Modulation Method for Single-Phase Full-Bridge CRM Inverter to Improve Reactive Power Capability

The rapid growth of the electrical vehicle (EV) market has increased the need for EV onboard chargers (OBC). The inverter mode operation of EV OBC enables vehicle-to-grid (V2G) operation, which requires a reactive power capability. Additionally, according to the Institute of Electrical and Electronics Engineers (IEEE) Standard 1547, any grid-tied inverter should be capable of delivering reactive power to the power grid. With the development of wide-bandgap (WBG) power semi-conductor devices, critical conduction mode (CRM) soft switching converters have become popular. The most popular OBC CRM power factor correction (PFC) stage topology is the totem-pole PFC. When working reversely, it's known as a full-bridge inverter, as shown in Fig. 1. However, the modulation designed for CRM totem-pole PFC cannot work properly when delivering reactive power in inverter mode.

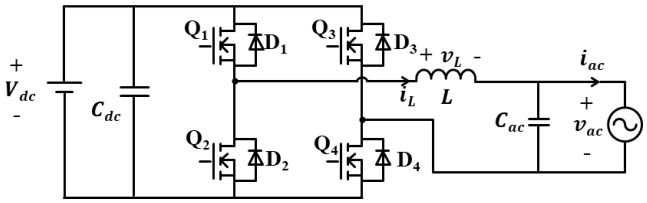

Fig.1. Full-bridge inverter

This paper presents a hybrid modulation method for single-phase, full-bridge CRM inverters aimed at improving reactive power capability. The conventional unipolar modulation method causes a current distortion issue under non-unity power factor operation and faces an extremely high switching frequency problem at the line current i_{ac} zero-crossing point. The proposed approach, as shown in Fig. 2, combines the benefits of unipolar modulation and bipolar modulation and resolves the current distortion problem. The discontinuous current mode (DCM) modulation is applied during the i_{ac} zero-crossing area to eliminate the high switching frequency problem.

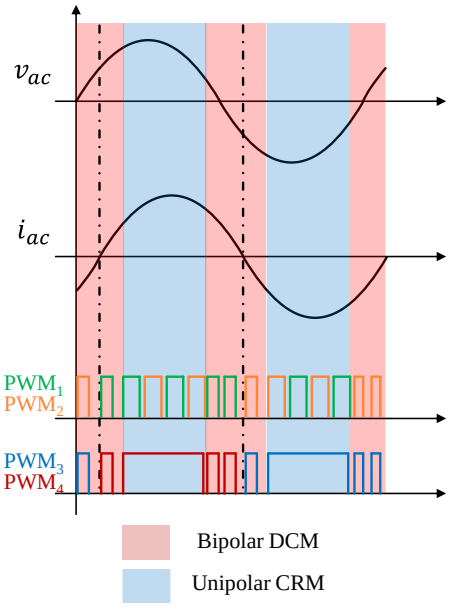

Fig. 2. Proposed modulation scheme