A Current-fed Three-port DC/DC Converter for Integration of On-board Charger and Auxiliary Power Module in EV

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Background and motivation:

- On-board charger (OBC) and auxiliary power module (APM) are two important and high-cost power units in an EV;
- OBC and APM has some sharing structure and integrating OBC+APM is a possible;
- A novel converter is proposed to integrate an 11kW with 3.5kW APM, yielding 1/3 the cost reduction and 2X power density improvement.

Technical approach:

- Current-fed TAB topology are adopted for both HV and LV output for minimize switching current;
- Dedicated control algorithm to secure ZVS and minimize RMS current;
- Novel coupled inductor structure to shrink size and cost.

Conclusion:

- The integrated charger shows obvious advantages in following aspects:
  - Simultaneously charging for HV and LV batteries.
  - Full range ZVS operation for all ports;
  - Near-zero switching off current and low switching loss;
  - Compact and cost-effective output filters design.
- All these benefits make the proposed converter a good fit for the EV application to save both cost and space.
Operation of proposed converter

- With properly control, the current-fed tab shows negative conducting current and low switching-off current of the bottom switches;
- It’s extremely important for the LV output ports, because of low output voltage (12V) and high current (>300A), the LV port is sensitive to switching current.

Fig.3. Key waveforms of three ports
Coupled inductor for output filter

- The coupled inductor cancels the DC flux generated by average output current;
- Only ripple current magnetizing the core and the flux density is low;

Fig. 4 Key waveforms of coupled inductors
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