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COMMON-MODE NOISE REDUCTION THROUGH SHIELDING TECHNIQUE

The continuous technology development of power converters is giving rise to highly reduced and compact systems where components are very closed to each other. Power converters can be considered as noise sources that require EMI filters to assure their correct function without exceeding the electromagnetic interferences allowed by the standards. Filters could take up to 25 % of the system size and therefore any effort made to attenuate EMI noise is appreciated.

CM NOISE SOURCES AND PROPAGATION PATHS

CM mode noise is produced by the switching actions (high dv/dt and di/dt) that generate voltage pulses on the parasitic capacitances of the circuit. The voltage difference along the parasitic capacitances produce a displacement current that flows through the circuit in the form of CM noise.

Figure 1 shows the CM noise path in a flyback converter and Figure 2 shows the voltage distribution along the inter-winding capacitance of the transformer which is one of the major paths for the CM noise. The other path comes from parasitic capacitance created between the MOSFET and the heat sink attached to it. The larger the value of these parasitic capacitances, the larger the amplitude of the CM noise.

Although reducing the inter-winding capacitance would involve a lower CM noise, the transformer coupling and leakage inductance would be affected and efficiency would be compromised. For this reason, other solutions need to be pursued.

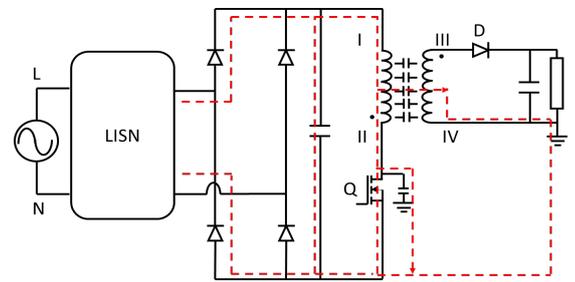


Figure 1. CM noise propagation path in flyback converter.

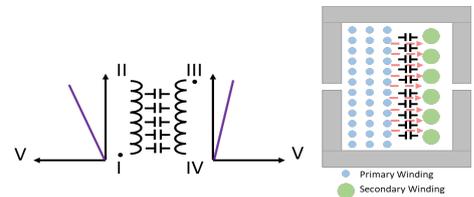


Figure 2. Voltage distribution of transformer's inter-winding capacitance.

CM NOISE REDUCTION TECHNIQUE

Several CM noise cancellation techniques have been proposed in the literature. Some of them involve actions from the complete system design point of view (soft switching, snubbers circuits...) and others make use of complex winding arrangements difficult to be implemented in practice. One of the simplest and scalable ways of completely cancelling the CM noise is to place two shielding layers between the primary and secondary windings and connect them to ground as Figure 3 shows.

The shielding layers block the electric coupling between primary and secondary windings cancelling thus the displacement current and therefore CM noise.

This technique has some limitations for transformers with multiple interleaved layers since multiple shielding layers will also be needed reducing thus the available window area and increasing manufacturing complexity. It should be noted as well that the eddy currents induced on the shielding layers would involve some extra losses that need to be considered.

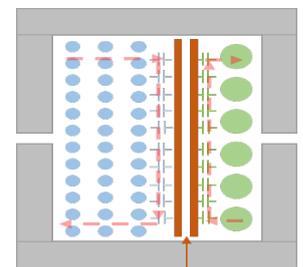


Figure 3. Shielded transformer

CONCLUSIONS

The introduction of shielding layers between transformer windings is an easy and effective way to cancel the CM noise present in power converters. This approach would allow to reduce the EMI filter requirements and therefore improve the whole system efficiency.



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