Flyback topology
- Quasi resonant switching benefits

Describes how Quasi Resonant techniques help in flyback topology

- Quasi resonant (valley switching) techniques minimise EMI effects in flyback topology
- Introduces natural frequency jittering to reduce EMI
- Improves efficiency by minimising switching losses.

Overview

The use of SMPS topologies such as RCC (Ringing Choke Converter) and flyback have considerable efficiency and other performance benefits over older technologies such as linear power supplies. However one of the downsides to these hard switching topologies is that they generate EMI, which is costly to remove from an application.

There are many techniques to reduce EMI but one of the most effective is quasi resonance or valley switching, which has the added benefit of also improving efficiency.

History

1933 - Special Committee on Radio Interference (CISPR) was set up to deal with the problem of EMI

1979 - legal limits were imposed on electromagnetic emissions from all digital equipment by the FCC in the USA.

1980s - the European Union member states adopted a new EMC Directive (89/336/EC)

This was the first legal requirement for EMC and today many countries have similar standards.

Electromagnetic Interference (EMI)

Radiated EMI

An electromagnetic (EM) wave is produced when there is a magnitude change in voltage and current. If that change in voltage is coupled to a conductor of suitable length by direct connection, stray capacitance or parasitic inductance, then the EM wave propagates through space and affects a large area.

This generated wave can affect nearby equipment.

Conducted EMI

Changes in voltage and current can be imposed on any cables connected to a piece of equipment and conducted to another piece of equipment, compromising its operation. Connecting cables include mains supply cabling, audio connection leads, data transfer cables and telephone cabling.

Switch Mode converters & EMI

EMI emissions are the main concern for switch mode converters because these AC/DC converters cause changes of hundreds of volts (where large current and voltage changes result in larger EMI issues). Also the converters are connected to mains supply cabling, which provides an excellent transmitting antenna for radiated EMI.

A flyback or Ringing Choke Converter (RCC) topology switching waveform is also quite rectangular and spreads noise over a wide part of the electromagnetic spectrum.

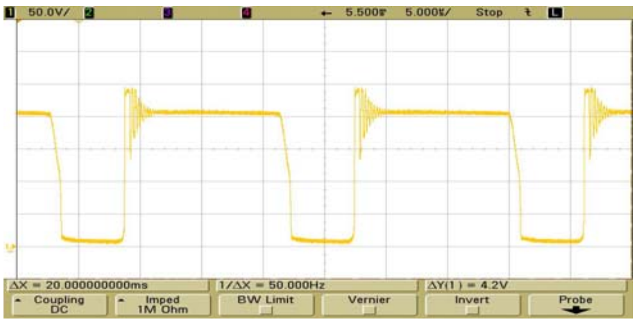

Figure 1: Flyback & RCC switching waveform

With its hard switching, fast falling and rising voltage edges, it can be difficult to prevent a normal flyback or RCC converter from exceeding the limits for radiated and conducted emissions at output powers above a few watts. Extra costs are often needed for filter components, such as X & Y capacitors (special safety capacitors for use across mains supply) and a common mode choke (like an extra transformer) to enable compliance with EMC regulations.

Quasi Resonant Switching

Quasi resonant or valley switching switches at the lowest voltage point or valley.

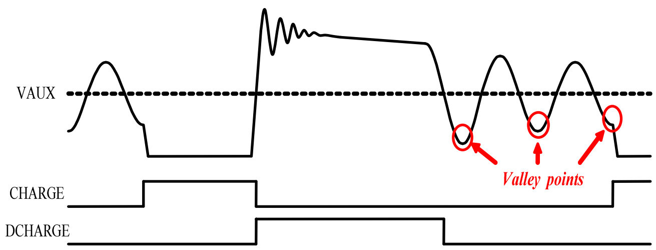

Figure 2: Flyback waveform showing valley points

EMI Benefits

Minimising Hard Switching Effects

Switching the bipolar switch when the voltage is at a minimum (in the valley) reduces the hard switching effect that causes EMI.

Frequency Jitter

Instead of switching at a fixed frequency, but rather when a valley is detected, introduces frequency jitter that has the benefit of spreading the RF emissions spectrum and reducing overall EMI.

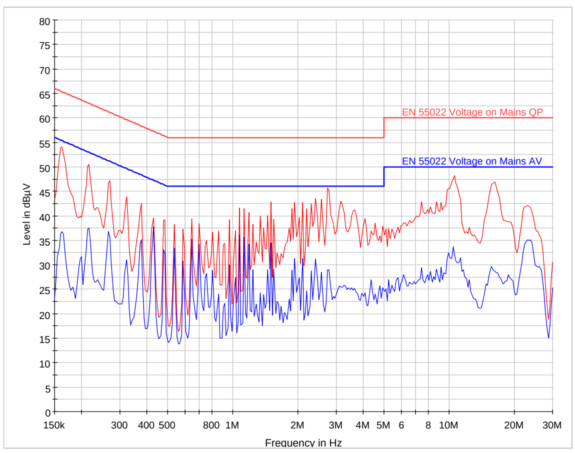

Figure 3: Example CamSemi design showing 10 dB margin with limited EMI components

Efficiency Benefits

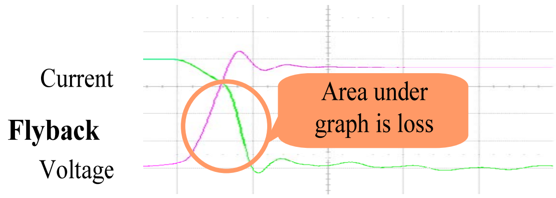

Figure 4: Traditional switching losses

Minimising switching losses- Quasi Resonant

Zero current (quasi resonant) switching is used to minimise the switching losses in the primary switch. The bipolar switch is turned on when the voltage across it is at a minimum (in a valley), minimising the captive switching losses and improving efficiency.

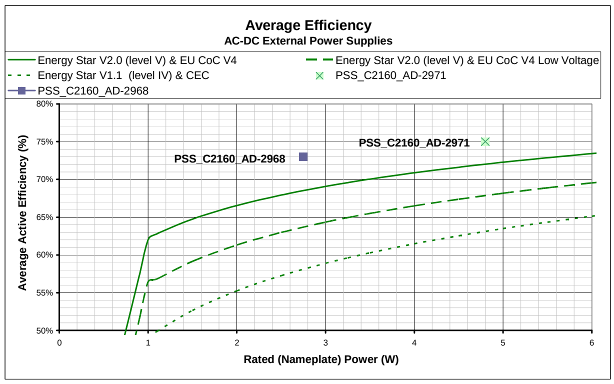

Figure 5: Example CamSemi designs compared with latest efficiency requirements

For more Information

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Contact Information

European Design Centre

CamSemi
St Andrews House
St Andrews Road
Cambridge, CB4 1DL
United Kingdom

Tel: +44 1223 446450

Taiwan Design Centre

CamSemi
6F, No.58, Zhouzi St.,
Neihu District,
Taipei City 114,
Taiwan (R.O.C.)

Tel: +886 2 8178 1010

China Design Centre

Room 201, 2F
Shenzhen Academy of
Aerospace Technology,
Tower B, 10th Kejinan Rd.
Nanshan District,
Shenzhen, China 518057

Tel: +86 755 8611 7778

Korea Design Centre

No. 808 KOFOMO Tower,
16-2 Sunae-Dong, Bundang-GU,
Sungnam-Si, Kyunggi-Do,
463-825,
SOUTH KOREA

Tel: +82 31 711 1415