Introduction

A well laid out PCB does not radiate much EMI all by itself from the current carrying traces. In order to get EMI compliance a PCB should have:

- Ideally six layer PCB with two full ground planes. Four layer PCBs are okay.
- Make sure there is sufficient vias between the ground planes.
- Make sure to minimize the switching current loops on the board.
- Current carrying traces must be kept as short as possible and running on a layer close to the ground plane.
- Power ground plane and the signal ground must be connected at only one point.

Most of the radiation takes place when we connect leads to the power source and the electronic load. These leads are usually about 0.5m to 1.5m and they act as a very good antenna for frequencies between 30MHz to 1GHz.

Figure 1 depicts a typical test setup in anechoic EMI test chamber. The high frequency power switching generates wide spectrum noise because of all the parasitic inductances and capacitances ringing at different frequencies and with different damping factor at different times of the switching period.

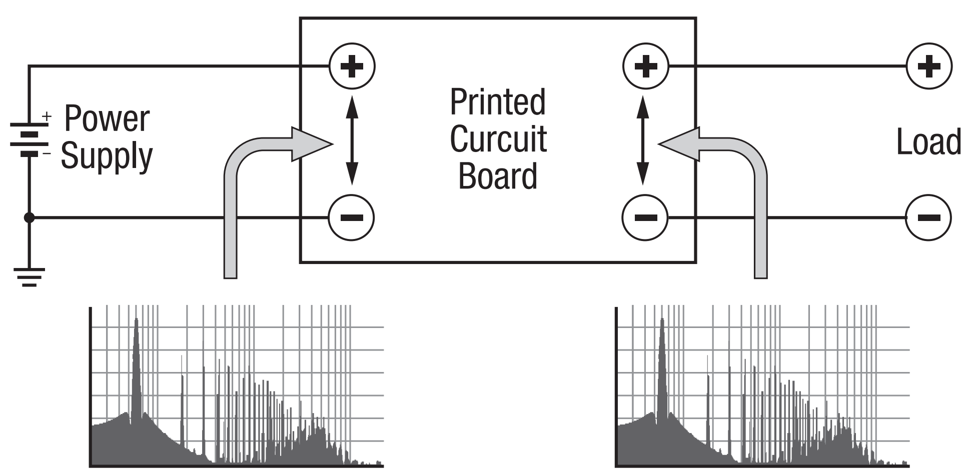

Figure 1. Typical Test Setup

Circuit Design Approach

In order to block this wide spectrum noise from traveling through the input and output leads, filters must be strategically placed on the PCB.

On the input terminals of the PCB, a differential filter should be used. The inductors should be between 100nH to 200nH while a series of three progressively smaller capacitors from 10nF to 10µF at the front end with two or three 10µF on the back end of the differential filter. Please refer to Figure 2.

For the output terminals, a ferrite bead should be used together with several capacitors with values from 1nF to 100nF. This RF filter follows the regular converter LC filter. The ferrite bead should have an effective frequency between 100MHz to 300MHz. Please refer to Figure 3.

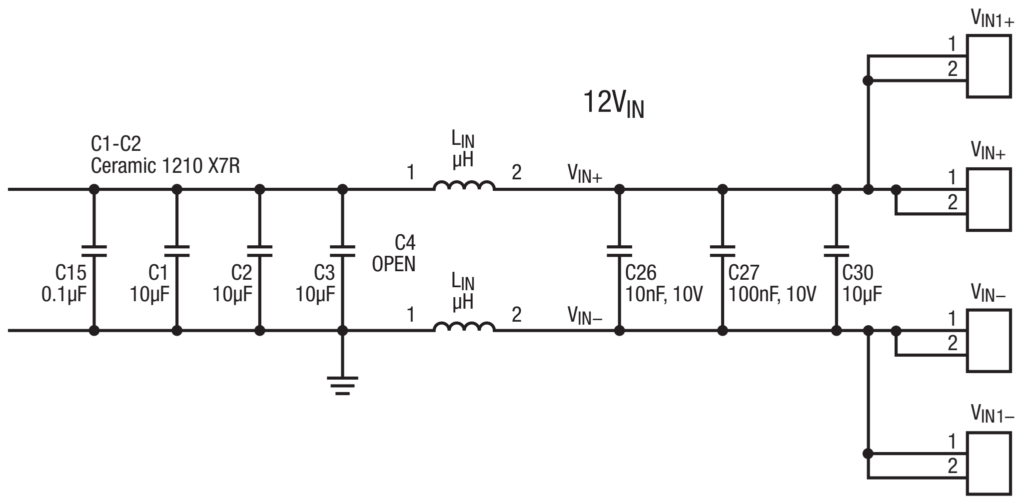

Figure 2. Input Filter

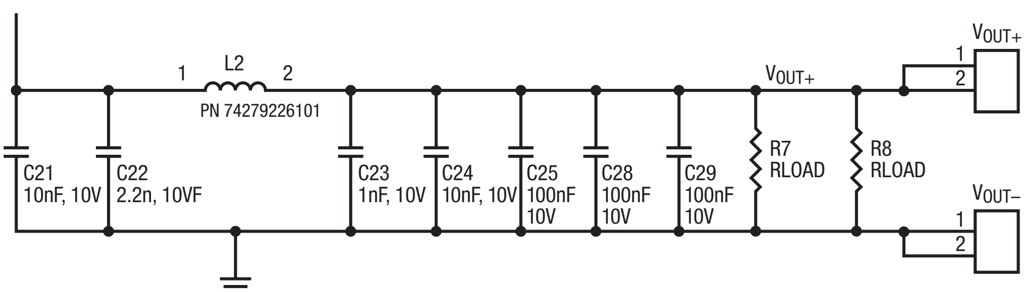

Figure 3. Output Filter

Test Results

Two identical eval board PCBs were used in the test. The first was completely populated with the converter components and the input/output filters. The second was populated with the converter components only and no filter components where inductors and beads were replaced with a short. Both were tested with identical setup.

Figure 4 show the results of the EMI test without filters while Figure 5 shows the results with the filters. The scanned frequency ranges were 30MHz to 300MHz and 300MHz to 1GHz. The red lines represents the maximum allowable level of EMI at any given frequency.

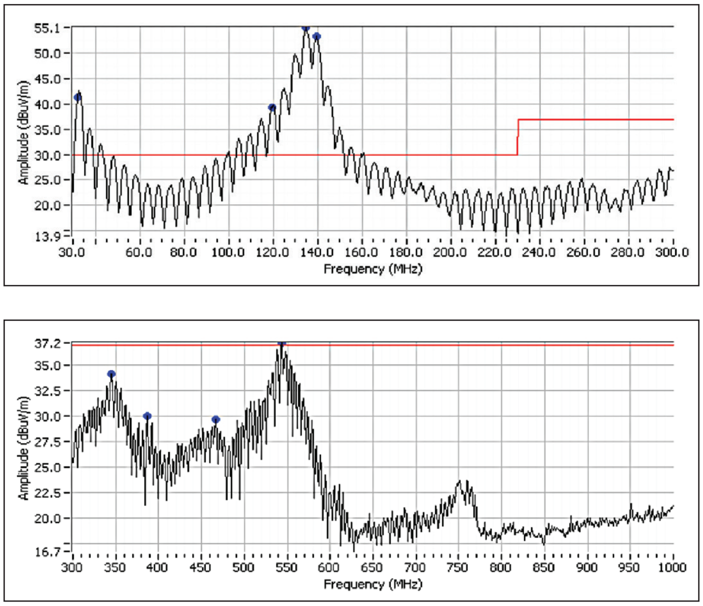

Figure 4. EMI Test Without Input/Output Filters

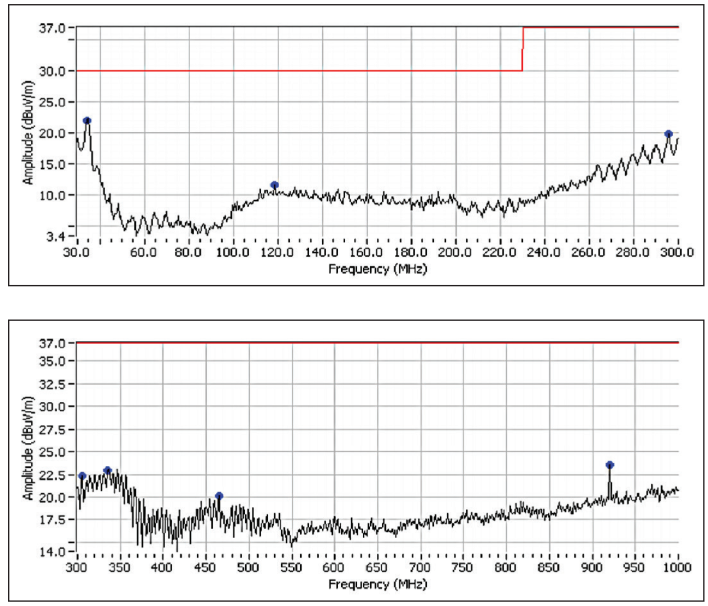

Figure 5. EMI Test With Input/Output Filters

Conclusion

It is abundantly clear from Figures 4 and 5 that very simple filters can block the wideband noise from being radiated from the leads connected to the load and the power supply.

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