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Modifying conducted interference in low-frequency stage based on improving the way of wilding of planar voltage transformer

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Abstract

Onboard DC/DC power supply has the features of small cubic measure, without ground point PE to link Y capacitor, as a result, it can't take common mode choke to reduce electrical magmatic compatibility which is very difficult to resolve in low-frequency stage. This article shows a kind of good methods to resolve this problem. The method improves the way of wilding of planar voltage transformer to reduce parasitic capacitance of both sides, which can modify 12dB in low-frequency stage.

Keywords: common mode interference, conducted interference, transformer wilding method , electrical magnetism compatibility

1. Problem description

On-board DC/DC power supply has the features of small cubic measure, without ground point PE to link Y capacitor, as a result, it can't take common mode choke to reduce electrical magnetic compatibility which is very difficult to resolve in low-frequency stage.

The average value of N line of some on-board DC/DC power supply is higher than standard value which displays in figure1.

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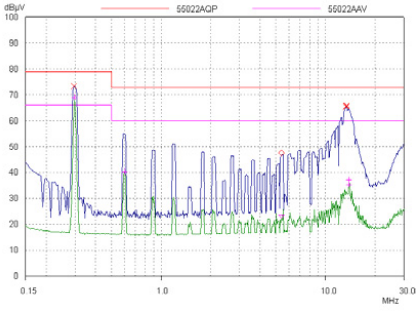

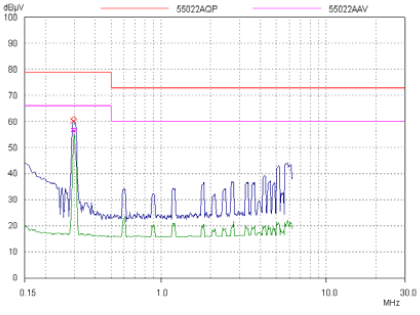

Figure 1. The transmission result of the first Nline. **Figure 2. The transmission result of N line without PE line.**

Transmission improvement measures taken in On-board DC/DC power supply,as fellows :

1、 increase different mode choke and X capacitance;

2、increase absorption circuit of diode;

3、adjust shake circuit ;

4、adjust insulation capacitance of transformer's both sides.

But it doesn't obviously be improved after taking these measures at point of 300KHz. so cutting PE line,it falls 12dB at point of 300KHz,which can be proved as common mode interference.

2. Causations analysis

According to PCB layout layer, transformer's both sides use so-called 'sandwich' wilding method, as table 1 shows. P denotes input side, S denotes output side, AUX denotes assistant power supply wilding. The first wilding takes "one layer input-two layers output" method, the second takes" three layers input-one layer output " method.

Table 1. Parallelism of the first and the second welding method in layer.

Layer / Version	1	2	3	4	5	6	7	8	9	10	11	12
First	AUX	P	S	S	P	S	S	P	S	S	P	AUX
Second	AUX	S	S	S	P	P	P	P	S	S	S	AUX

Symbiosis capacitance is the very important coupling path. The primary path is showed in figure3.Diode is the root of common mode interference which transmits signals from one side to the other side of transformer. GND is directly connected to PE, so the noise of negative output side is transmitted to PE directly. There is 110uF capacitance between positive and negative output of module, the noise of positive output is transmitted to negative output through the capacitance, then to PE. One part of the noise of PE feeds back through Y capacitance, the other part feeds back through LISN and detected by LISN. Adding an isolation capacitance to transformer between the

two sides to form a loop，but the value 1500pF of the capacitance is too low to completely reduce the electrical magnetism interference.

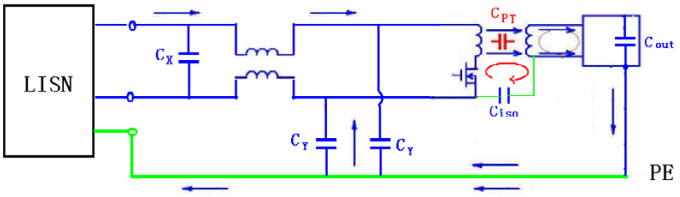

Figure 3. The main common mode interference way through Symbiosis capacitance of transformer.

Linking the "GND" of both sides of capacitance，which proves that common mode interference flows through Symbiosis capacitance and the function of isolation capacitance. Most of common mode interference consumes in the small loop as figure4 shows.

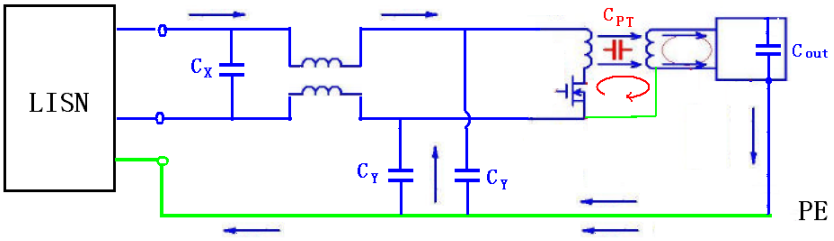

Figure 4. The main common mode interference way whiling linking both sides of transformer to"GND".

To prove the correctness of the analysis, at the point of 300 KHz the value achieves 12dB as figure5 shows.

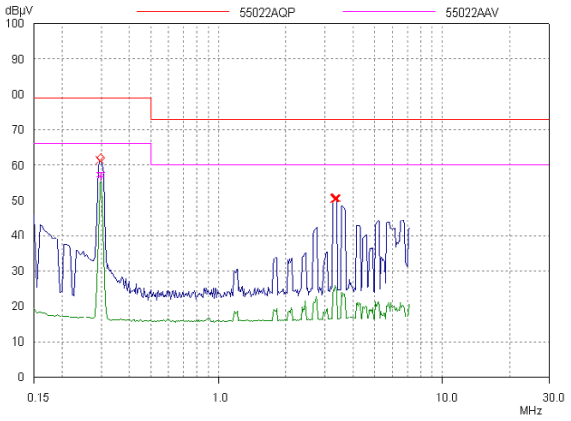

Figure 5. Test result of N line whiling linking both sides of transformer to"GND".

While distributing the lines of PCB,the designers try to reduce the Symbiosis capacitance.According to formula: $C = \frac{\varepsilon S}{4\pi kd}$,reducing superposition area and aggrandizing distance can reduce Symbiosis capacitance.

The curve of Symbiosis capacitance in the first PCB changes following along with frequency change as figure 6 shows.

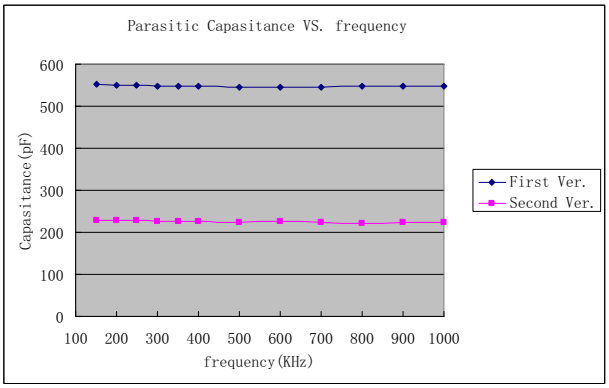

Figure 6. The curve of Symbiosis capacitance in the first PCB changes following along with frequency changing.

Input is put in middle position in the second PCB ,which reducing the layers and aggrandizing distance between the two sides as figure1 shows.The Symbiosis capacitance of transformer at the point of 300KHz is 226pF which is reduced 2.4 multiple comparing with the first PCB and aggrandizes the coupling impedance,which is showed in figure6.

The test result is showed in figure7 and figure8,there is 9.2dB superabundancein in lineL and 6.2dB superabundance in lineN.

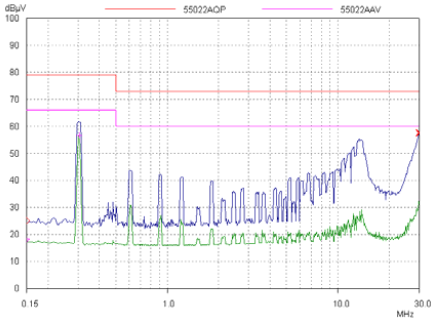

Figure 7. Test result of line L.

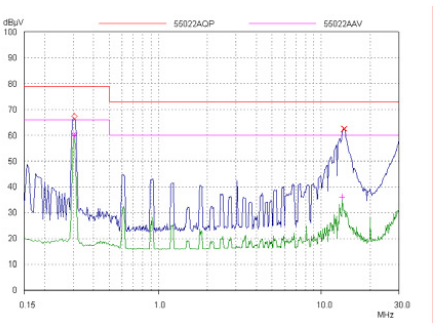

Figure 8. Test resul of line N.

Taking this wilding method,it may bring some aftereffect,such as,leakage inductance increase,magnetostrictive stress increase and the influence on efficiency.After testing ,magnetostrictive stress of the second PCB is 98V,comparing to the normal magnetostrictive stress 110V,which is a little higher,but the difference is smaller than 10V. Parallelism of the first and the second PCB in efficiency which doesn't deteriorate as table 2 shows.

Table 2. Parallelism of the first and the second PCB in efficiency.

Load% / Version	100	50	20
First	92.3%	90.89%	83.22%
Second	92.3%	90.83%	83.48%

3. Conclusions

Symbiosis capacitance has important influence on common mode interference, through the way of changing the welding method and wire disposal, the value has improved 9dB. So whiling disposing the wire, it is avoided compactness welding method, suggested to take the second way in table 1.

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