CONDUCTION EMI AND EMC MEASURE AND TEST POWER SUPPLY IN NSRRC

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Abstract

The correction power supplies are working in the storage ring of NSRRC. They are required to output high quality and high performance current that is long-term stability and output current ripple are required to be under 100ppm. The storage ring consists of more than one hundred units of independence power supplies working together when beam current in 1.5GeV status. The power supplies also are all working under current mode. We just build a new conduction EMI (Electromagnetic Interference) and EMC (Electromagnetic Compatibility) measurement laboratory to measure and test the switching power supplies. That is AC to DC voltage bus source to supply for the switching correction power supply. Using the LISN to obtain conduction noise, it is high frequency voltage noise generated by the switching mode of power supply conduction noise. The current signal pass AC source impendence stabilize network LISN and spectrum analyzer will obtain the conduction noise. We can use a noise separator to separate common EMI noise and difference-mode EMI noise for EMI filtering design. The measurement result will be illustrated in the paper.

INTRODUCTION

A LISN is used to ensure repeatable EMI and EMC measurement power frequency signal passing through LISN and LISN is not unaffected. It can fix the AC source line impedance network, so we call line impedance stabilizing network (LISN).

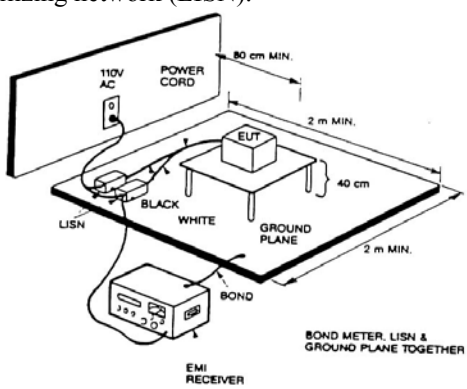

Figure 1: Indicates the lab Equipment under test the connection of LISN diagram.

The LISN is very important for noise measurement and AC source line impedance must fix in 50Ω. The 50Ω network can't change from 10kHz to 30MHz, when the voltage noise will be changing. Therefore, the Equipment is very important for noise measurement showed as Fig. 1. That indicates the lab Equipment under test the connection of LISN diagram.

The standard EUT is required to pass the environment for FCC or VDE measurement specification for EMI and EMC noise test.

We get the Vn that is EMI voltage generated by current noise pass to LISN. The LISN internal structure shows as Fig. 2. The component of LISN contains few spare parts, and all the spare parts are not allowed to change from 9kHz to 30MHz. In the other words, the LISN is a very difficult device.

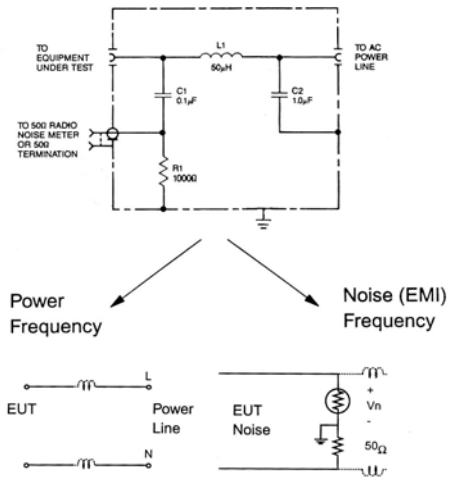

Figure 2: Shows the LISN internal structure and Vn, it obtains conducted voltage noise generated by LISN.

Figure 3 illustrates the detail of LISN internal structure and with EUT connecting diagam. We can see the common mode and different mode noise path. The noise was combined common mode and difference mode noise.

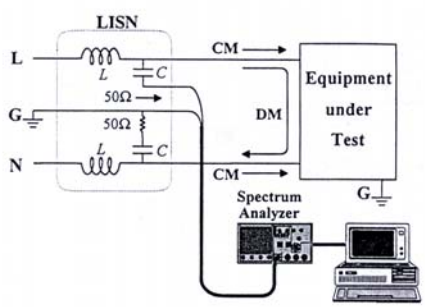

Figure 3: It shows the detail of LISN internal structure and with EUT connecting diagram and notice path loop.

STANDARD DIAGRAM

We tested correction power supply and only inspected the current long-term stability (8 hours) and low span current ripple (0kHz to 1kHz) for standard confirmation in TLS, but never to verify the high frequency noise of the

AC to DC voltage power supply. The standard diagram of FCC Part 15 and VDE 0871 is indicated in the Fig. 4. The measurement frequency is from 9kHz to 30 MHz. The Fig. 4 is FCC Part 15 and VDE 0871 with frequency diagram.

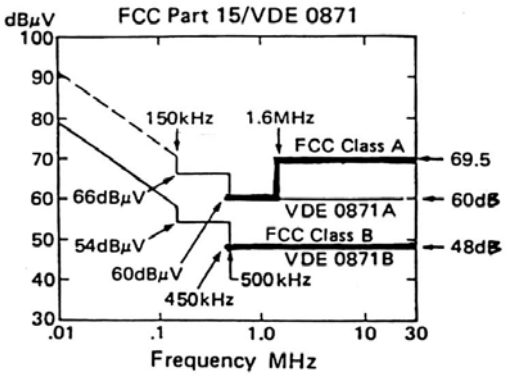

Figure 4: FCC Part 15 and VDE 0871 with frequency diagram.

We expect the power supply add the FCC standard testing and put measurement in the future. For example, TPS power supply must be fulfilled the requirement of the standard.

CONDUCTED EMI TESTING

In the first section,we must adjust the measurement for resolution bandwidth (RBW) from 9KHz to 150KHz,and the RBW is setting 200 Hz. The second section is from 150 KHz to 30 MHz, and the RBW is setting 9 KHz.

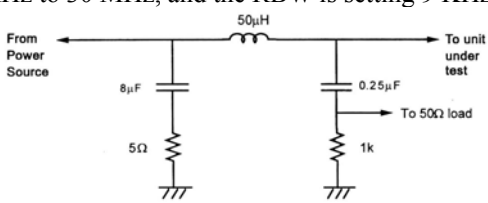

Figure 5: Indicates the LISN component of decomposed diagram.

The detail of LISN is showed in Fig. 2 with load. We can exquisite to decompose the LISN component as Fig. 5.

NOISE SOURCES

The coupling Paths of the D.M. Noise comes from current(i) while the C.M. Noise caused by Parasitic Capacitances. Therefore, we must reduce current(i) and the Parasitic capacitances. The Fig. 6 shows the noise source and coupling Path. The diagram is input stage of the fly-back converter. We can flow D.M. path and C.M. path to find the noise source and coupling Pathes.

If the voltage converter power supply had followed the detail to design, its nosice will be in to the specification and no noise to interfere the other power supply.

Refer to Fig. 7, it shows IDM which is differential mode current path. Figure 8 indicates ICM which is the common mode ground current path.

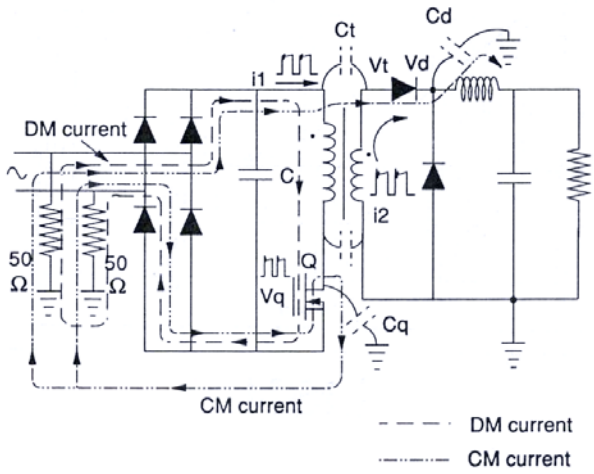

Figure 6: The noise source and coupling Path.

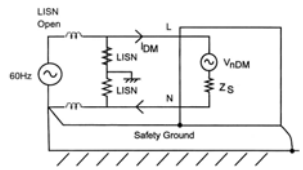

Figure 7: The differential mode current path IDM

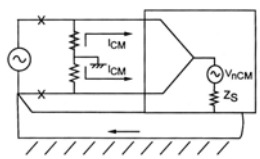

Figure 8: The common mode current path IDM.

TESTING AND RESULT

Comparing to Fig. 4, we can separate the FCC Class A Part 15 stantard to four sections for measurement. The section 1 is from 9kHz to 150kHz. The section two is from 150kHz to 450kHz. Section three is from 450kHz to 1.6MHz. Section four is from 1.6MHz to 30 MHz.

We can confim the noise from Fig. 10 to Fig. 12. All the noise should full fill the standard of FCC Class A Part 15 standard and VDE 0871A. As the result, the noise can't reach to FCC Class A Part 15 standard and VDE 0871A. But only the Fig. 9 show the noise spectrum can't pass FCC Class A Part 15 standard first section. We design and adding a filter put in power supply, thus first section can pass FCC Class A Part 15 standard as Fig. 13.

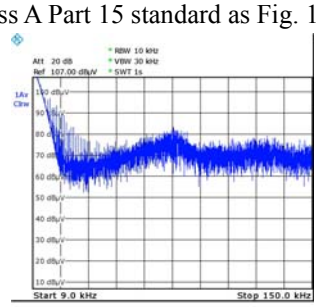

Figure 9: Noise spectrum cant't pass FCC Class A Part 15 standard first section without filter.

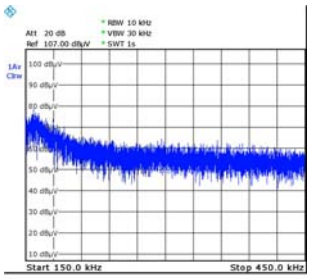

Figure 10: Noise spectrum matches FCC Class A Part 15 standard second section.

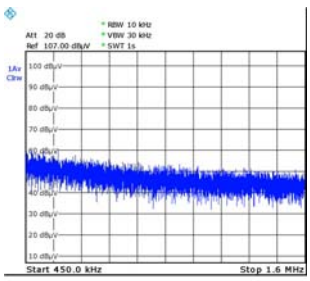

Figure 11: Noise spectrum matches FCC Class A Part 15 standard 3rd section.

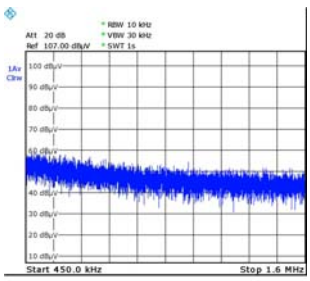

Figure 12: Matching FCC Class A Part 15 standard 4th section.

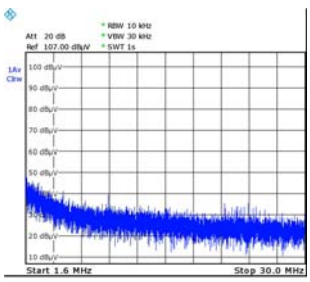

Figure 13: Matching FCC Class A Part 15 standard first section with filter.

If we want to Cure EMI (Electromagnetic Interference Compatibility) noise, the techniques should contain Filtering, Shielding, Grounding, Isolation, Orientation and Separation method. Of course, every nice filter design of the power supply is better Cure for EMI and EMC. The idea is very important, if you are EMI and EMC Engineer. We can see the Fig. 14 that shows the EMI and EMC pass path from noise source to reviver.

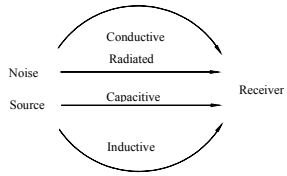

Figure 14: The diagram is showing the EMI and EMC pass path from noise source to reviver.

CONCLUSION

Storage ring of the Taiwan Light Source contains lots of independence power supplies working together when the beam current runs in vacuum pipe. The AC to DC power supply is for the switching correction power supplies bus voltage. The noise electromagnetic interference and compatibility can't be reduced much, because the power supplies of TLS have been built for a long time. Thus, we must add test standard and verify for conduction noise and radiation interference. We can improve a few machines in maintance time.

Since we design the power supply for TPS now, the power supply units are more than thousand pieces in TPS ring. The specification must add the verified standard, not only just test the long stability and low frequency current noise ripple. The noise will be reduced more. For example, the CERN European Organization for Nuclear Research is defining the FCC Class C for new power supply. It is an index point for the EMI EMC noise measurement and design in the future.

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[2] H. Thiesen, D. Nisbet, "Review of the Initial Phases of the LHC Power Converter Commissioning", EPAC 2008, Italy, Genoa, 2008.

[3] International Electron-technical commission, "IEC 1000 for EMC Part 15", NIST, Washington, D.C, USA.