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 impedance 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 figure 1. That indicates the lab Equipment under test the connection of LISN diagram.

The stander 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 Figure 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 diagram. We can see the common mode and differerent 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 figure 4. The measurement frequency is from 9kHz to 30 MHz. The figure 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 150KHz 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 figure 2 with load. We can exquisite to decompose the LISN component as figure 5.

Figure 6: The noise source and coupling Path.

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

Figure 7: The differential mode current path IDM

Figure 8: The common mode current path IC

TESTING AND RESULT

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

We can confirm the noise from figure 10 to figure 12. All the noise should be fulfilled 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 figure 9 show the noise spectrum can’t pass FCC Class A Part 15 standard frist section. We design and adding a filter put in power supply, thus frist section can pass FCC Class A Part 15 standard as figure 13.
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 figure 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.](image)

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 maintenance 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.

REFERENCES