The EMI Testing System for the Civil Aircraft PEDs on-Ground Test

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Keywords: Portable electronic devices (PEDs), electromagnetic interference(EMI), Multi-Channel Time-Division Band-Pass filter, Multi-Channel switch.

Abstract: With the high-speed development of the network and Telecom, more and more Airline companies expect to use the PEDs (Portable Electronic Devices) on the Aircraft, which supplied more sophisticated goods and better services. However, some electromagnetic energy will be emitted by the PEDs and brings a potential EMI (Electromagnetic Interference) threats. The PEDs EMI aircraft test on ground shall be completed before allowing use of PEDs. The purpose of this project is to provide a PEDs EMI testing system for the aircraft on-ground test. Test system structure is explained in the overall technical scheme, including Multi-Channel Time-Division Band Pass Filter(MTBF) and Multi-Channel Switch(MCS). This test system has the characteristics of high reliability and automatic control function.

1. Introduction

It is well known that electromagnetic emission from Portable Electronic Devices (PEDs) carried on board aircraft has the potential to interfere with aircraft electronic systems[1]. The first report about the PEDs electromagnetic interference on aircraft appeared in 1994. In 2003, NASA issued two technical reports[2,3] to show that continuous use of RF radiated portable electronic device such as mobile phones can affect the GPS working status. In 2003, Kazuo Yamamoto, Kimio Yamada, Naruto Yonemoto issued a scientific paper[4], which described the EMI reports submitted voluntarily by Japanese operators when they face interference events suspected to be caused by PEDs in aircraft, shown as in Figure 1. The reports are classified and analyzed in terms of aircraft types, victim aircraft sub systems, details of the events and flight phases.

As early as 1988, RTCA had paid attention to the potential risk of PEDs to the aircraft equipment and investigated the effects of PEDs[5](RTCA DO-199), and issued a recommendation to restrict the use of PEDs in flight in 1996[6](RTCA DO-233). RTCA DO-294C were issued in 2008[7] to give the guidance on allowing transmitting portable electronic devices on aircraft. With the development of technology, the use of PEDs on board aircraft is becoming a mainstream trend. Some PEDs EMI testing methods were introduced in the document RTCA DO-307 and ED-

130[8,9]. The PEDs Electromagnetic effect test included in the HIRF test procedure in RTCA DO-160G[10].

As defined in the RTCA DO-307 and ED-130, the PEDs EMI test includes the front door test and back door test two parts. The PEDs EMI Testing System also include these two parts.

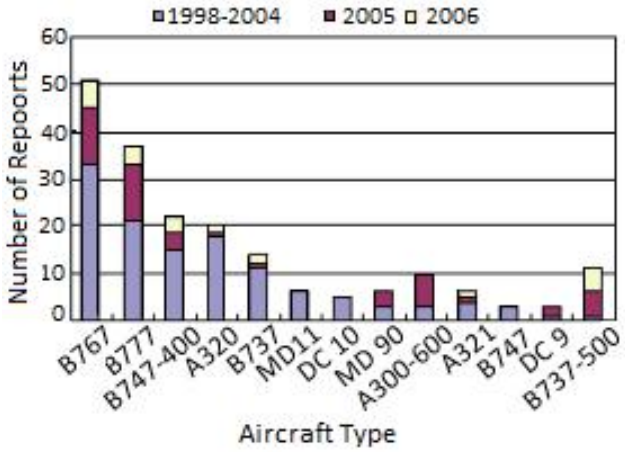


Figure 1: The number of EMI reports about PEDs[4].

2. The Front Door Test System

The front door coupling path is defined that the Intentional Radiated emissions (useful signals) or the Non Intentional Radiated emissions (spurious emissions) Coupling through the radio based equipment Antennas.

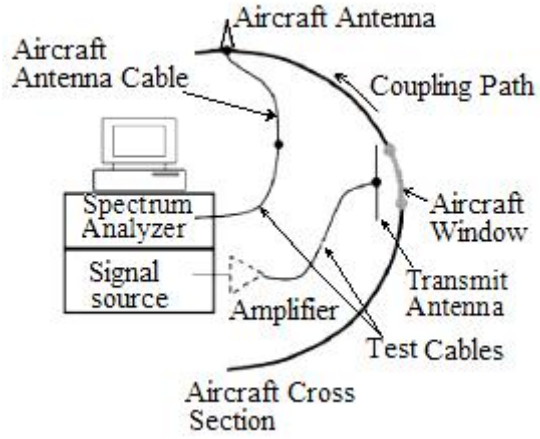


Figure 2: The schematic figure of front door coupling.

The front door testing system proposed in this paper includes the following equipment and harness:

1.Analog Transmit Antennas;
2.Optional Amplifier;
3.Signal Source;
4.Control Computer;
5.Spectrum Analyzer;
6.Multi-Channel Time-Division Band-Pass Filter (MTFB);
7.Test Cables.

This paper proposes an automatic muti-channel test method through the programmatic control software. The control software is embedded in the computer and controls the Optional Amplifier, Signal Source, Spectrum Analyzer and the MTBF through GPIB communication protocol. The schematic is shown as in Figure 3.

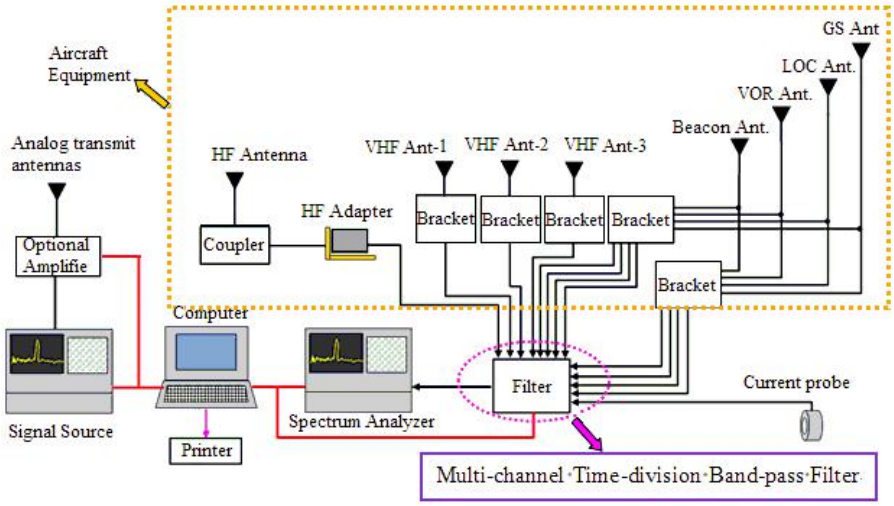


Figure 3: The front door test system.

In the actual test procedure, the analog transmit antenna need change the position in the aircraft cabin, put the MTBF in the Aircraft Electrical/Electronic Bay, and disconnect all the ports of the antennas on the aircraft, all the antennas access to the MTBF. During the test, any antenna port can be chosen by switching the MTBF, which is control by the computer. The test arrangement is shown as Figure 4, and the actual connection diagram of the front door test as shown in Figure 5.

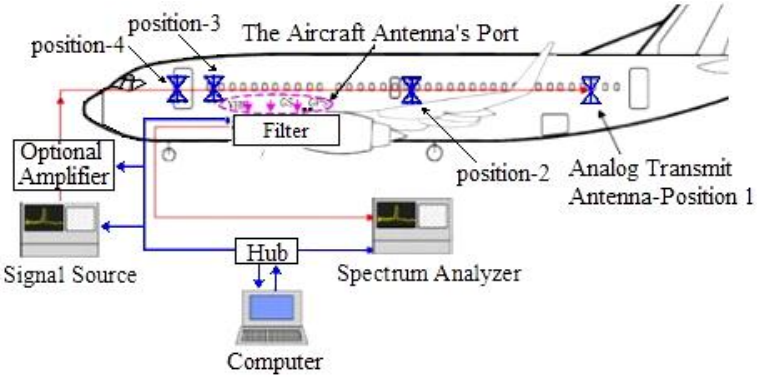


Figure 4: The front door test on aircraft.

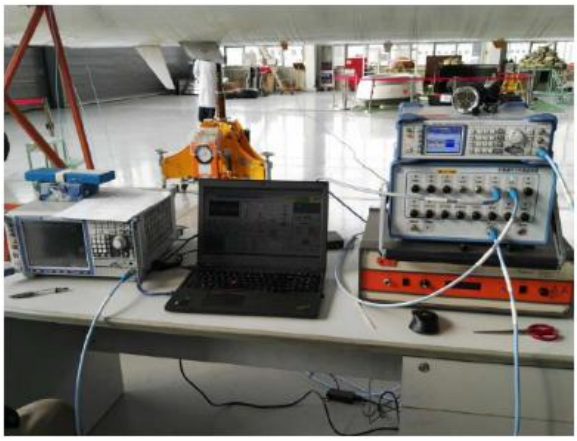
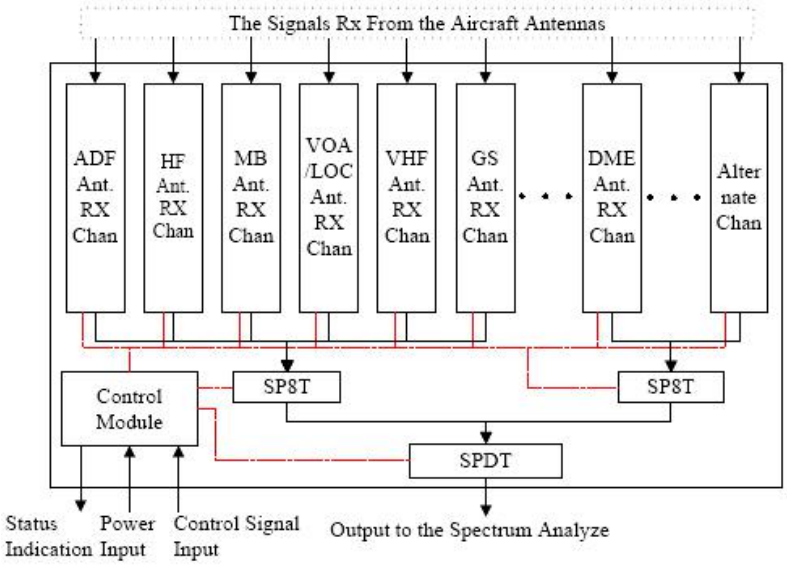


Figure 5: The actual connection diagram of the front door test system.

The MTBF is the core device for the front door test system to achieve intelligent control. It has 16 test channels, whose main function is to send the different frequencies signals which received from aircraft antennas to the spectrum analyzer. All the test channels are selected by the control signal. In order to reduce the noise figure, a preamplifier is placed in each test channel.



*Note1. SPDT - Single-Pole-Double-Throw;
*Note2. SP8T- Single-Pole-Eight-Throw;
Figure 6: The schematic diagram of MTBF.

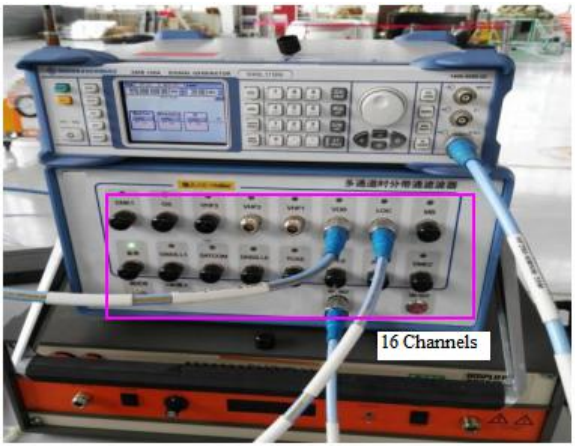


Figure 7: The actual test panel of MTBF.

The method proposed in this paper has the following advantages:

- Through the automatic muti-channel method, 16 channels can be tested in sequence, avoiding manual switching the test channel;
- The computer can remote control of the test equipment such as signal source and spectrum analyzer, and realized automatic test function;
- The test data is processed by the computer on test site, and the results can be directly compared and printed.

3. The Back Door Test System

The back door coupling path is defined that the Intentional Radiated Emissions (useful signals) or the Non Intentional Radiated Emissions (spurious emissions) direct coupling to equipment units or coupling to equipment input and cables.

The back door testing system in this paper includes the following equipment and harness:

1. Analog Transmit Antennas;
2. Optional Amplifier;
3. Signal Source;
4. Control Computer;
5. Spectrum Analyzer;
6. Multi-Channel Switch(MCS);
7. Current Probe ;
8. Field Probe or Receive Antenna;
9. Model Stirrer;
10. Test Cables.

The control software is embedded in the computer and controls the Optional Amplifier, Signal Source, Spectrum Analyzer and the MCS through GPIB communication protocol. The schematic of the back door test system is shown as in Figure 8.

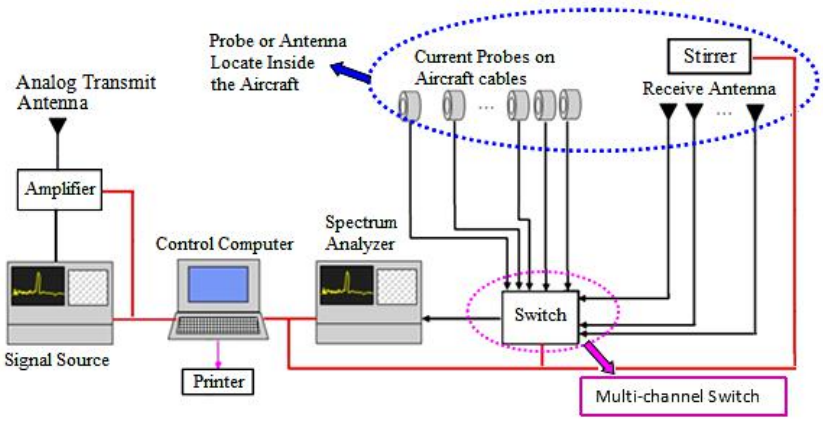


Figure 8: The schematic of the back door test system.

As shown in the Figure 8, The current probes locate inside the aircraft to monitor the conduction current on the aircraft cables, which induced by the PEDs radiated. The receive antenna or field strength probe locate in the cabin to monitor the field strength, which radiated by the PEDs. The back door test system has eight test channels, using computer can remote control of the test equipment such as signal source, spectrum analyzer and Multi-channel Switch, and realized automatic test function.

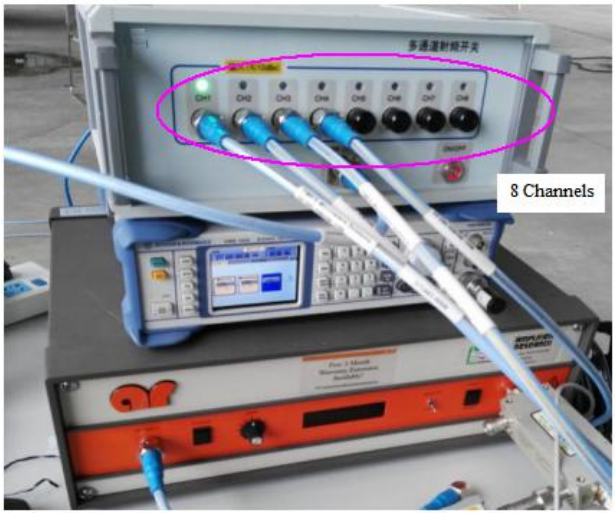


Figure 9: The test equipment of Multi-Channel Switch(MCS).

4. Testing Results

A verification test had been completed on aircraft ground test. The test procedures are same to the DO-294C or ED 130 definition. One result obtained by the manual operation, which is the traditional method. One result obtained by the automatic operation, which is proposed by this paper. The comparison of the testing results is shown in Figure 10.

By comparison, the results obtained by the two test methods are very consistent, which shows that the testing system proposed in this paper is effective and feasible.

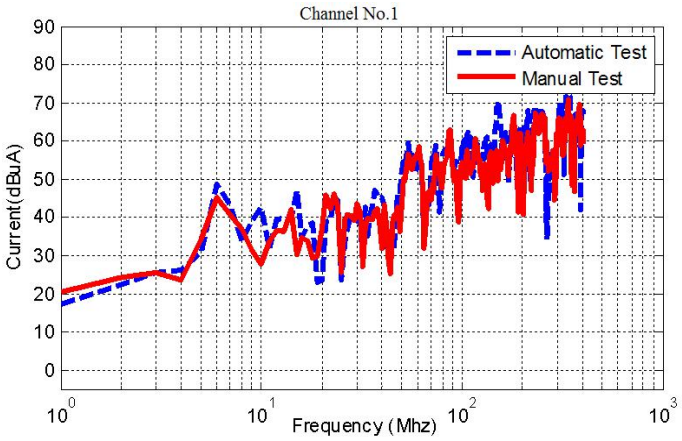


Figure 10: The comparison of the testing results.

5. Conclusions

The PEDs EMI testing system had finished the verification test at the aircraft on-ground test, which shows that the testing system proposed in this paper is effective and feasible, and it also can cover all the test requirements from the RTCA DO-294C or ED 130 and has the characteristics of high reliability and automation control.

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