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Application of Software Radio Technology in Electromagnetic Compatibility Test System

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Abstract: Wireless technology develops rapidly. It is widely used in various industries, especially in the navigation system field. At present, there are many navigation products that implement multiple wireless standards on the same device to fulfill different needs. However, this also brings great challenges to the development and testing of wireless technology, especially in electromagnetic compatibility. In the research, the electromagnetic compatibility test system based on software radio technology is introduced. This system is used to carry out simulation tests with navigation and RFID as objects, in order to provide reference for the construction of micro-power electromagnetic compatibility test system.

1. Introduction

Wireless technology is widely used in all walks of life and has almost become an indispensable function. Many products simultaneously implement multiple wireless standards for data, voice and other communications on the same device [1]. While this is convenient for users, it also brings great challenges to the development and testing of wireless technologies. At the same time, various companies and standardization organizations are formulating a large number of wireless communication standards according to their specific needs. These emerging new standards make manufacturers and product designers face the challenge of huge short-term changes in products [2]. Faced with this challenge, more and more companies are adopting software-centric platforms, coupled with modular hardware, to meet evolving technology needs. The platform helps users test the latest standards in the first place, so as to accelerate time-to-market for products or solutions. And as long as adjustments are made in the software, it has great flexibility [3].

2. Literature Review

Software Defined Radio (SDR) enables devices and terminals to be reconfigured through the combination of hardware and software. The key of Software Defined Radio (SDR) is to use software to complete the work that used to be done using dedicated hardware radio platforms [4]. Its structural feature is to place ADC and DAC as close as possible to the radio frequency side, so that the signal can be digitized as soon as possible, and then the powerful signal processing functions and flexible reconfigurable features of programmable devices (FPGA/CPU/DSP, etc.) are used to support a variety of communication standards [5].

3. Construction of Electromagnetic Compatibility Test System Based on Software Radio

In the research, the software radio architecture is adopted and the PXIe test platform is chosen. LabVIEW is a graphical programming language specially designed for engineers [6-7]. The system architecture of the software and hardware of this project is shown in Table 1.

Table 1: Software Radio System Architecture

Vector signal analyzer module	Vector signal analyzer modular devices	Function
Antenna, RF Application	Wifi/GSM/GPS/RFID/Bluetooth/Digital Video Broadcasting	Complete the functions of signal generation and signal acquisition and analysis for a variety of wireless standards
RF Kit	LabVIEW platform and Wireless Test Suite	The core software of software radio architecture
PXIe Test Platform	High-speed dedicated programmable processor	Data interaction and communication of hardware modules
PXIe Modular Devices	5668R high performance vector analyzer/5646 high performance vector signal generator	Vector signal generator and vector signal analyzer modular equipment

4. Analysis of Navigation, Rfid Electromagnetic Compatibility Simulation Test

4.1 Simulation Test of Various Navigation Systems

The navigation system consists of a signal generation module and a signal analysis module to support the electromagnetic compatibility analysis capability between satellite navigation systems and other systems such as mobile communication and broadband wireless access systems [8-9]. An example of electromagnetic compatibility analysis between satellite navigation systems and other systems is shown in Figure 1.

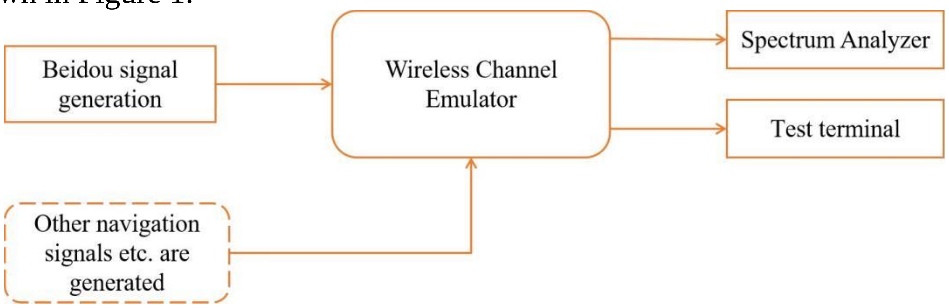

Figure 1: Example Diagram of Electromagnetic Compatibility Analysis between Satellite Navigation System and Other Systems

Here how to generate Beidou signals based on the PXIe platform is first described. Based on the NIPXIe1075 chassis, LabVIEW can customize the FPGA board 7976 and the RF modular hardware 5646R, and realize the configuration of the corresponding functional parameters of Beidou and the function of Beidou satellite navigation satellite signal generation [10-11]. The details are as follows.

(1) The host computer performs functions such as user position parameter setting, satellite visibility judgment, pseudo-range setting, reading ephemeris parameters, etc., and generates the original navigation message [12].

(2) The NI7976 hardware performs channel simulation functions such as CDMA spread spectrum, BPSK modulation and pseudorange generation on the original navigation message generated by the host computer.

(3) The modulated baseband signal is sent to the PXIe-5646R through NI's PeerToPeer

(point-to-point) technology, and the RF output of multiple visible satellites is realized through this RF board [13].

Due to the openness and reconfigurability of the software LabVIEW, programs such as Beidou's signal modulation and simulation algorithms can be written on the FPGA onboard chip NI7976 through LabVIEW software, and downloaded and deployed on the 7976 FPGA chip. The further settings of the DAC and RF front-end on the RF module 5646 make this general FPGA module and RF module have the function of Beidou signal generation.

It can be seen from the simulation test results that the software radio technology can simulate the electromagnetic situation of the navigation system well [14]. At the same time, it has a completely open software and hardware platform function to realize the simulation of one or more navigation signals. Therefore, software radio has a unique advantage in the application of this navigation signal simulation [15-16].

In addition to using FPGA and RF module to cooperate for signal simulation, based on the powerful streaming hardware HD8266 of NIPXIe platform, the read and write speed is up to 3.6GB/S, and the combination of RF module can also realize the generation of navigation signal data [17].

4.2 Application Examples of Rfid

The RFID test system in this project consists of three subsystems: signaling simulation, RF transceiver, and measurement calibration. The test system has FPGA programming interface, which meets the real-time requirements of RFID communication protocol, and provides PXI instrument bus control interface [18]. The hardware architecture includes two elements: modular instrument and open high-speed bus. The main controller, frequency source module, RF transceiver module and power amplifier module exchange data and instructions through PXI or PXIExpress open high-speed bus. The clock signal and the radio frequency signal are transmitted between the radio frequency modules through the radio frequency cable, and the radio frequency signal interface with the RFID tag under test is provided [19].

For different requirements of RFID reader, tag or system test, the functions of different test modes are shown in Table 2.

Table 2: Test Mode Functions for Different Requirements

Test mode	Function	Applicable scenario
Reader simulation	Actively transmit command signals and receive and analyze tag response signals	It is suitable for label compliance and performance testing
Label simulation	Receive and analyze command signals, while transmitting response signals	It is suitable for reader conformance and performance testing
Signal monitoring	Signal monitoring mode can collect, real-time stream disk and play back the communication signal of RFID system	It is suitable for the overall performance test and fault diagnosis of RFID system

In the research, the work of the reader simulation mode is taken as an example. When generating RFID signals in this experiment, the modular hardware of NI5646 is also used to complete [20-21]. Because 5646 has integrated transceiver and rich FPGA resources to complete real-time processing capabilities, it is an ideal for RFID test [22].

The test engine on the FPGA is the key to the entire RFID test[23-24]. It mainly uses the real-time processing capability of the FPGA to simulate the communication process of various RFID protocols. The test engine on the HOST implements the specific functions of each test item according to the test specification. The test engine is encapsulated upwards into the instrument soft panel and software toolkit, which provides a friendly graphical user interface. And it can complete each test one by one through the manual control. The software toolkit is an encapsulated functional module for secondary development, or unified control and invocation by the top-level automatic test suite [25].

5. Conclusions

In the face of more and more wireless application standards appearing in the market, the software-centric test platform based on software radio technology adopts high-performance modular hardware and flexible software platform to provide a unified platform to deal with the emerging standard testing challenges, and can easily meet new demands brought about by the ever-changing evolution of industry standards. In this way, the technical innovators are no longer subject to the restrictions of test manufacturers. Through software programming and code design, the test application of new standards or new standards is completed.

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