Design and Development of a Open Frame RFID System Unite Test Platform

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Abstract—RFID (Radio Frequency Identification) System Test Platform has attracted considerable attention in recent years because it has a great impact on many kinds of trade applications. However, there is dearth of available open frame test platform for RFID system. In this paper, we propose a new design and implementation of an open frame RFID test platform by thorough research which applies to almost Industrial Scientific Frequency Bandwidth. The hardware and software design of open test platform are introduced in detail. This paper also describes how we extended the open frame RFID test platform to include support almost trade application, which makes the platform is superior flexible for many kinds of applications.

Index term—RFID, open frame, unite, test platform

I. INTRODUCTION

RFID (Radio Frequency Identification) System Test Platform has attracted considerable attention in recent years because it has a great impact on many kinds of trade applications[1]. A typical RFID test platform usually consists of RFID test hardware architecture and RFID test software architecture. But its function is not comprehensive[2]. From another perspective, a typical RFID test platform should also consist of internationalization RFID standard test, physical layer test and protocol layer test.

In this study, we design and develop an open frame RFID unite test system platform which consists RFID test hardware architecture and RFID test software architecture. The design of architectures is introduced in detail. Key issue that should be considered during the design, development and establishment of the open frame RFID unite test system platform are discussed in the next section and followed the architecture design and its implementation is given. The remainder of this paper is organized as follows. A brief description of the open RFID test unite system platform is provided in Section 2. Section 3 describes the hardware software architecture and transaction flow investigation of the test platform. Section 4 tells of the test mode and projects. The conclusions and future work are contained in Section 5 and 6.

II. OPEN FRAME RFID SYSTEM UNITE TEST PLATFORM

The test platform is based on National Instruments vector RF modules, including the 2.7GHz Upconverter, the 2.7 GHz Downconverter, the 3 GHz RF Preamplifier and the FPGA-Based RF Transceiver[3]. With the capability of real-time vector RF signal generation and analysis, the tester is capable to generate and analyze the RFID signal according to almost all the RFID standards, such as ISO14443 Type A/B, ISO15693, ISO18000-3 Mode 1/2, EPC HF Class Version 2, ISO 18000-4 Mode 1/2, ISO18000-6 Type A/B/C, ISO18000-7, EPC HF Class 1, EPC Class 1 Generation 2, ISO18092 NFC, Customized Standard and so on. On the open frame platform, you can extend test module freely according to intraday variation of industry standard(Figure 1).

![Figure 1. NI-PXI RF Communication Tester Platform](image)

The suit of integral test platform comprises all kinds of typical practical transaction scene as far as possible. Building a test system that contains FE-DAQ(front-end of data acquisition) of RFID, BS-DTP (backstage of data transfer and press), comprehensive measures technique, products and applications of RFID, analyses principal problems and effect factors during testing RFID, and puts forward solutions for every walk of life.

III. HARDWARE AND SOFTWARE ARCHITECTURE DESIGN, AND TRANSACTION FLOW INVESTIGATION

Thinking about objective that provided an open frame RFID system unite test platform, which is expansive. We
choose the NI-VISN-100 RFID Tester. We can download the standard or customized command and parameters from the HOST controller into the RF modules. The baseband signal will be converted to the RF signal by the RF modules and transmitted to the RFID UUT via cable or air interface[4]. With the hardware trigger of the PXI system, the response RF signal from the UUT will be acquired by the RF modules at the same time, converted to the baseband signal and transferred to the HOST controller through the DMA channel. After the transparent baseband IQ data is gotten, all the mandatory or optional or customized analysis is possible to implement by the powerful HOST controller with high performance.

**Figure 2. Hardware Architecture**

The FPGA on the RF transceiver is the core of the tester. With the real-time process capability of the FPGA, the tester is capable to implement the real-time modulation and demodulation, encoding and decoding. (Figure3) It will be very useful to the RFID standards which request a real-time handshaking communication, eg. EPC Class 1 Generation 2. With the reconfigurable architecture of the FPGA, the tester is capable to implement different functions to support all the present standards and be upgradeable for the future standards.

**Figure 3. RF signal basic operate process**

With the capability of real-time vector RF signal generation and analysis, the tester can generate and analyze the RFID signal according to all RFID standards. (Figure4)

**Figure 4. RFID test software process**

The software Architecture of test platform adopts Labview technique. Labview is a program language based graphics program. In this paper we design and develop the software system, which comprises test management module, program module, project value module, Labview result module, project test report, version management module, data-base module etc. (Figure5)

The test platform supports the RF tag tests of high frequency (HF:13.56MHz) ISO 14443 Type A&B, ISO 15693, ISO 18000-3 mode 1&2, ISO 18092 NFC and Ultra-high frequency, 433.92MHz, ISO 18000-7 , (UHF:860-960MHz) ISO 18000-6, (2.45GHz) ISO 18000-4 Mode 1&2 RFID standard.

**Figure 5. Software Architecture**

IV. TEST MODE AND PROJECTS

The content of the research and design of the test platform primary consist of tag and reader capability research, complex scene capability research, measures single piece producing and full set of system respectively. The capability research of tag and reader is also named single channel RFID capability research, which measures mainly capability between tag and reader on condition that different media, different material, different magnetic field, different velocity and different distance. The capability research of complex scene is also named Multi-channel RFID capability research, which measures mainly capability research space distribution and effect among Multi-channel RFID by test result under RFID system scene, verify conformance, interoperability, veracity, efficiency and dependability of RFID information transmission between point-to-point by multipoint RFID system.

In this paper, there are three configurations of the tester for different applications, as Reader Emulator, Tag Emulator and Sniffer Tester[5].

**Figure 6. Block Diagram of RFID Tester**

The test system will act as an RFID reader, sending command to tag and receiving response from tag. All the parameters such as coding, modulation and timing can be
adjusted by the reader emulator. This configuration is suitable for RFID tag R&D test and conformance test.

![Figure 7. System Configuration of Tag Test with Reader Emulator](image)

The test system will act as an RFID tag, receiving command from reader and sending response to reader. The parameters of turn-around time and response amplitude can be adjusted by the tag emulator. This configuration is suitable for RFID reader R&D test and conformance test.

![Figure 8. System Configuration of Reader Test with Tag Emulator](image)

The test system will act as a third party sniffer, receiving the command and response signal between the reader and tag. This configuration is suitable for RFID reader and tag conformance test and RFID application environment test.

![Figure 9. System Configuration of Reader and Tag Test with Sniffer Tester](image)

Test results as follows:

1). **Tag Test** *(HF 13.56MHz)*

![Figure 10. ISO 14443 Type A (Tourist Ticket)](image)

![Figure 11: ISO 14443 Type B (identification card)](image)

2). **Reader Test**

![Figure 12. ISO 15693 / 18000-3 Mode 1](image)

![Figure 13. ISO 18092 NFC](image)

UHF 860~960MHz (Tag Test)

![Figure 14. ISO 18000-6 Type B](image)

![Figure 15. ISO 18000-6 Type C EPC Class 1 Generation 2](image)

![Figure 16. ISO 15693 / 18000-3 Mode 1](image)

![Figure 17. ISO 18000-6 Type C EPC Class 1 Generation 2](image)
There are three critical concepts that need to be addressed when setting up a production-test plan[6]. They are accuracy, repeatability, and correlation. In various areas of production testing, each concept has its respective importance, and often one has to be traded off for the others. Accuracy, which pertains to production testing, is how well the results of a test are in agreement with the actual value[7].

Accuracy is critical when a specific piece of information is needed from a test. However, incredulously, accuracy may not always be the most important target of a production test.

Repeatability is often far more important than accuracy. If the results are logical, or near the expected value, then, provided a constant offset can be determined, this is also acceptable. Ambient noise due either to the test system or the environment is often the cause of repeatability problems. In addition, mechanical wearing of connectors, contactor sockets, or wafer probe contacts can lead to repeatability problems[8].

When an acceptably accurate and repeatable value has been obtained from a production test, it is then critical to ensure that the results are not fine-tuned to the specific test system[9]. There must be some correlation to the bench top (laboratory) measurements. And furthermore, if a test house is used, the results must agree between the many different test systems that the test will be performed on. This is essential for minimizing the introduction of errors into the production tests.

V. CONCLUSION

The unique challenge of open frame RFID System Unite Test Platform has spawned a wide variety of testing methodologies. The open frame platform based FPGA, one can extend test module freely according to intraday variation of industry standard, so that satisfy uninterrupted evolution of RFID standard. Architecture of the platform combine advanced module instrument and software technique, apply to Making, debugging of tag and reader and OLD(On-Line Debugging) in the course of production. The platform has verified at an extensive set of tests that were performed on other single test platform. The obtained results provided comparative overview strengths of various test.

VI. FUTURE WORKING

The open frame RFID system unite test platform we have implemented is an open frame platform that can provide test on almost every walk of life in RFID system. We have used the open frame RFID system unite test platform work on tags, readers, antenna which is different from the way the RFID system operate. Although we are satisfied basically with our result and feasible of test system, there are many issues to resolve before any fully-fledged development. Some of the issues are (1)researching conformance test and physical layer test of tag and reader in different trade application, (2)researching evaluation model of RFID technique performance index, (3)researching protocol analyze and compatibility test method between tag and reader, emphasis researching air interface conformance method, (4)researching and developing the comprehensive simulation test analysis method of RFID middleware and application software, complex test of stability ,dependability , security, response speed, carrying capacity of system, and constructing complex test environment platform with various typical automation equipment. As future work, these issues will be investigated.

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