Design and Implementation of EMC Test Software for Military Electronic Equipment

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Abstract. In order to overcome the limitations of EMC test software, design ideas and function realization method of EMC test software for military electronic equipment are proposed. The EMC database is established to manage data and to provide data support for software. Based on the factors that influence the test results, the calibration factors of test instruments and test laboratories are added to the database. So that the software has good test environment adaptability, instrument flexibility and historical data query capabilities. Finally, a comparative experiment is given to demonstrate the feasibility of the software and the accuracy of the test results.

1. Introduction

With the development of the national defense weapon industry, the increasing number of military electronic devices, these devices will produce electromagnetic energy during the working process, also will be affected by the electromagnetic interference (EMI) that generated by the same system or other electronic devices in the surrounding environment. All countries are increasingly demanding electromagnetic compatibility (EMC) requirements for military products, China has developed strict standards for electromagnetic compatibility testing of military equipment [1].

In order to complete the electromagnetic compatibility index tests in the national military standard, the electromagnetic compatibility test system is usually constructed by computer, test instrument, test laboratory and test software. The test software plays an important role, but there are still some problems based on the national military standard test software: (1) Software environment, poor adaptability, especially foreign imports of software on the test environment requirements are higher, small non-standard laboratory is difficult to bear the test task, resulting in higher test costs. (2) Software scalability is poor, some software only supports fixed hardware, using of equipment is not flexible enough. (3) The lack of scientific database to manage the data, to provide data support, resulting in data calls, information query is not convenient enough. Aiming at these problems, this paper designs a kind of electromagnetic compatibility test software with good human-computer interaction, and elaborates its design method in detail, which provides a reference for the optimization of electromagnetic compatibility test software.

2. Software Design Ideas

2.1. Introduction of the Software
Military electronic equipment electromagnetic compatibility testing software is mainly used for electronic equipment, electromagnetic compatibility testing and information query, the test software and supporting test equipment can be calibrated in the laboratory according to GJB151A-97, GJB152A-97 [2-3] and other military standards for the requirements of the equipment test, and the test data and the standard limit value comparison, to determine the electromagnetic emission and sensitivity characteristics of the equipment are normal.

In the design of software, first consider the overall needs of the software-control the test system hardware to complete the electromagnetic compatibility test, the establishment of electromagnetic compatibility information database, management system information and test data. From the demand, and consider the specific steps in the software implementation process, the work flow chart is as follows:

![Software Work Flow Chart](image)

2.2. Software Design Framework
Military electronic equipment electromagnetic compatibility test software adopts modular design thought, mainly by the user interaction module, hardware control module, database management module, text file module, the function of each module are as follows:

1. User interaction module: the entire software top function module, can control the overall module from the overall, complete the corresponding indicators test and display the test results.
(2) Hardware control module: the realization of software and hardware communication, the user will test instructions issued to the spectrum analyzer, control the spectrum analyzer to a certain rate and step scan signal, and read the test data from the spectrum analyzer to the software for processing.

(3) Database management module: the data classification and storage, for the software to provide data support, including data processing, query, display and so on.

(4) Text file module: the test data stored in form of text, and can be processed on the text data.

The function of each module of the software is realized by the port between the software and the interface of each module. The port between the software and each interface is shown in Figure 2. The interaction with the text file port is mainly by I/O stream (input and output stream). And the interaction with the user port is mainly by the users own interface in the corresponding fill or choose. Interaction with the database port is mainly through the SQL Server database access language. Interaction with the spectrum analyzer port is mainly connected through the network cable, call VISA function library for the corresponding control operation.

![Software and External Port Interaction Diagram](image)

3. Detailed Method of Software Design

Military electronic equipment electromagnetic compatibility test software running on Windows XP system, mainly developed by the VC ++ 6.0 editor, external software, including Oracle 8i database software, Agilent's Keysight IO Libraries Suite software, NI's Measurement studio. The detailed design of each interface is as follows:

3.1. User Interaction Port

The software uses the Windows graphical interface as the user interaction port. Software running results through the graphical display controls, text list controls, etc. to display for the user to view. Graphic display control using NI's Cwgraph graphics control, the software installation should be installed accordingly NI's Measurement studio, graphics control to provide the underlying support [4].

When used, the user can operate the software through input control, select control, etc., such as user filling out test personnel, selecting test items, etc., controlling software to perform various functions. The control can be multiple sets of frequency amplitude data displayed on the drawing control at the same time, with different colors, different linear curves displayed to the user, the user can also press the corresponding button on the curve to zoom in, move, check point coordinates and other refinement operating.
3.2. Spectrum Analyzer Port
The software is installed on the test host and tested using the Agilent E444X series. You need to install the Agilent Kevsight IO Libraries Suite software to provide the VISA (Virtual Instrument Software Architecture) library for implementing test software and instrument communication [5]. The user sends the test parameters (such as the test band, sweep mode, etc.) to the spectrum analyzer by calling or filling the determined test parameters in the software, calling the corresponding function in the VISA library, and receiving the instruction and automatically completing the specified operation, the software through the library function from the spectrum analyzer to obtain the test results.

3.3. Database Port
This software uses the ADO (ActiveX DATA Objects) technology to establish communication between the software and Oracle database, and the Oracle 8i database software is required to be installed on the test host. Oracle 8i database not only has the test antenna factor, the laboratory calibration factor, the standard limit value and other data, but also includes the users who fill or select the test personnel, test sites and other test basic information and test the frequency amplitude data and excessive punctuation data. The operation of the user on the interface corresponds to the software to add, delete, modify and query operations in the database with a specific statement.

3.4. Text File Port
The software through the I/O stream on the operation of the text file, the software will process the data through its resolution, the use of part text file; software final test results stored in addition to the database will be stored To the CSV (comma separated value) file, this type of file support Windows Excel software to open, user-friendly follow-up data classification and other operations.

4. Database Internal Data Management

4.1. Test Basic Information Management
The basic information of the test includes the item number, the test time, the tester, the test site, the test equipment, the status description, the test item, the limit level, the polarization direction, the starting frequency and the termination frequency. The information is filled in by the user in the software interface or select, by the software automatically processed into the library after the corresponding sequence [6].

4.2. Test Instrument Calibration Factor Management
The test instrument calibration factor covers the calibration factors of the equipment required for all indicators, such as the LISN (Line Impedance Stable Network) used by the CE102 indicator test, the current probe used for the CE101 test, and so on. The receiving antenna or the LISN receives the signal radiated or transmitted from the test equipment and converts it into an electrical signal for transmission to the spectrum analyzer via a coaxial cable. Therefore, the receiving antenna or the LISN receives the signal radiated or transmitted from the test equipment and converts it into an electrical signal for transmission to the spectrum analyzer via a coaxial cable. Therefore, the data transmitted to the test host by the spectrum analyzer is different from the exact value required the test data are calibrated according to the calibration factors of the corresponding instrument. The conduction interference level in the CE102 test can be calculated by the following formula:

\[ V(\text{dB}_{\mu}\text{V}) = P(\text{dBm}) + 107 + \Sigma CL(\text{dB}) + LISNF(\text{dB}) + LF_{CE}(\text{dB}) \]  

\[ V \text{ - Conduction interference voltage level on the power bus} \]
\[ P \text{ - Power level that spectrum analyzer transmits value to the test host} \]
\[ 107 \text{ - Power level unit dBm converted to electric field strength unit dB}_{\mu}\text{V conversion factor} \]
\[ CL \text{ - Cable loss factor} \]
LISNF - Line impedance stability network factor

$LF_{CE}$ - Laboratory conduction emission calibration factor

Therefore, to ensure the accuracy of the final test data, calibration of the instrument equipment and test lab is required, and the calibration factor is added to the database.

4.3. Laboratory Calibration Factor Management

Due to the limited conditions, the laboratory used for the test is often not the standard microwave darkroom, even though other test instruments are the same, the test results are still different from those in the standard darkroom environment. So before applying this software test, not only to the test equipment calibration, and according to the standard darkroom test results of laboratory for calibration, the calibration factors including conduction emission calibration factor and radiation emission calibration factor two sets of data, software by calling the laboratory calibration factor in the library data to the corresponding test data for correction.

4.4. Standard Limit Management

The standard limit value refers to GJB151A-97 and GJB152A-97. The software calls the corresponding limit value data table in the standard limit value library according to the test item and the limit value selected by the user. The test result is compared with the standard limit value, and the same frequency is greater than the limit Value of the data (punctuation data) to be recorded, the corresponding limit curve can be drawn in the drawing control [7].

5. Software Practice

In order to verify the feasibility of the software, first of all for a type of missile secondary power supply combination in the assembly of certified military microwave dark room for CE102 test (test frequency range of 10kHz-10MHz), the test results shown in Figure 3. For the half-wave dark room application of the software and calibration of the test equipment, the same product CE102 test (frequency range of 10kHz-30MHz), the test results shown in Figure 4. The comparison between the two can be found in the test frequency range, the application of this software test results and standard laboratory test results tend to coincide, the same frequency range of the difference in the range of less than 3dB, indicating that the military electronic equipment, electromagnetic compatibility testing software Meet the requirements of the index test, but also has a high accuracy.

Figure 3  CE102 Test Result of the Standard Microwave Darkroom
6. Conclusion
This paper designs a EMC test software for military electronic equipment capable of completing a number of indicators in the national military standard. The software is easy to operate and can be used in small and medium-sized non-standard laboratories. The software database has the ability of data management and information query, in which the calibration factor application, makes the test system has good hardware scalability, can support different test equipment and test laboratories. Finally, an experiment is conducted to test the feasibility and accuracy of the software.

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