Research on On-line Testing Technology of Electronic Equipment for New Anti-aircraft Missile

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Abstract. In this paper, the new anti-missile missile electronic equipment LRU on-line testing technology is proposed and the test equipment is developed. The disassembly test technology of the circuit board and the replaceable unit (circuit board or replaceable module) is discussed for the structural characteristics of the new radar equipment. The economical and practical on-line test device (three-way signal conditioning adapter board) designed will locate the fault to the LRU, for meeting the base level of the rapid maintenance of the plate needs.

1. Introduction
With the rapid development of electronic technology and computer technology, modern missile weapon system widely used high-tech, in order to improve the overall performance of the system. The new missile integration and complexity are getting higher and higher, the equipment structure has undergone great changes [1-3]. New missile ground equipment site replaceable unit (LRU) basically use the machine unified large board plug structure, the main function unit circuit scale, interface standard unified. Commonly used by the equipment level (system - combination - unit) gradually on-line detection means more and less suited to the new equipment testing needs, large board structure of the off-line test diagnostic method to test the cost of resources is too high [4-5]. The traditional detection ideas have been unable to meet the new missile ground equipment to replace the LRU maintenance of the rapid protection requirements, to this end, to explore new online testing technology is imperative.

In this paper, the structure of the new anti-aircraft missile equipment characteristics, to explore the equipment circuit board and replaceable units (circuit board or replaceable module) online disassembly test technology. Designed the economical and practical on-line test device (three-way signal conditioning adapter board), will locate the fault to the LRU, to meet the base level of the rapid maintenance of the plate needs.

2. Test Requirements Analysis

2.1. Measured Object Signal Analysis
Missile weapon system is a complex system, the missile ground radar signal from the launch to receive, and then signal processing, data processing and eventually displayed on the terminal, its type and parameters according to the specific functions of the radar module has undergone a series of changes. Therefore, signal feature analysis and fault diagnosis can not be separated from the analysis of the structure of the equipment itself, the function of different extension systems, the interconnection between functional modules and the flow and transmission of signals between different LRUs.
New missile ground equipment, the whole machine signal can be divided into analog and digital signals as a whole. Analog signals are mainly concentrated in the launch system, receiving system, power supply system and some other sensors containing the system. The signals and echo signals in these signals account for the majority of the measured signals, ranging from the μW level of the weak echo signal to the hundreds of kW stages of the transmitted signal. The rest of the analog signal ranges from a few V to several tens of Vs. Digital signals are mainly concentrated in the receiving system of the analog-to-digital conversion module, the letter system, the terminal system and the monitoring system, these signals are mainly the CMOS level signal, the signal processing uses the high performance digital chip.

From the frequency analysis of the signal, the analog signal can be divided into RF signal, IF signal, video signal and DC voltage signal, the digital signal data rate ranging from kHz to several MHz, the latest missile up to dozens of MHz or even hundreds of MHz. The different frequency range of the signal acquisition method is also very different, the signal conditioning, test equipment selection and the adoption of the test strategy is also very different.

2.2. Analysis of Object Structure
(LRU) uses a unified large board connector, that is, using a unified standard connector, the LRU as a function module plug-in installed on the backplane, all the functional modules of the timing, triggering and other The control is controlled by the timing control module. Because all the functional modules and backplane have a unified interface, it is possible for the three-way online test.

The sub-modules of the system extension are connected to the backplane through a standard connector, and all data and control information of the module is transmitted through the backplane. Different sub-systems between the backplane through a variety of connecting cables to connect to complete the data sharing and distribution. The backplane is not necessarily a standard bus, but it is the same as the physical form of each LRU connection, so you can use the general three-way signal conditioning adapter board to lead the signal. In order to improve the electromagnetic compatibility characteristics, the radar LRU and backplane components are fixed in the cabinet, the LRU arranged closely, it is difficult to test its pin. Therefore, the equipment in the design of the time in order to improve the testability, equipped with a transfer board. The adapter board is used to connect the LRU and the backplane and expose the LRU connector pins to the outside of the cabinet for easy manual testing of the LRU pins. LRU connection structure diagram shown in Figure 1.

![Figure 1 LRU Connection Structure Diagram](image)

3. Online Test System Design

3.1. System Overall Design
The new radar LRU online test system design idea is to three-way way from the radar leads to the signal, through the online signal isolation and conditioning, using automatic test system, according to the test description information to collect data and storage. Combined with statistical information and
expert knowledge, through signal analysis and data processing, identification of abnormal information extraction fault symptoms. According to the sign, the fault diagnosis method based on signal analysis and knowledge reasoning is used to complete the fault location of LRU. The main work of this paper is to carry out the overall planning of the online test system on the basis of the demand analysis, and complete the signal acquisition and storage of the online test system. The overall structure of the system is shown in Figure 2.

![Figure 2 Missile electronic equipment on-line test system structure](image)

3.2. Hardware Design
The online test system can be tested without dismantling the measured LRU in order to keep the missile electronic system in operation during testing. The hardware system mainly includes three-way signal conditioning adapter board, PXI test resources and power supply. The function of the three-way conditioning board is to draw the signal from the missile electronic system, and the signal gated, isolated and conditioning. PXI chassis installed test instrument board, the use of the host to control the board to complete the signal test and control of the control board. The power supply section is powered by the test system. The hardware structure of the schematic diagram shown in Figure 3.

The measured LRU is connected through the backplane of the tee board and the backplane of the missile electronic system cabinet, and the test signal is drawn from the secondary line. The signal passing through the main line can be regarded as the response signal of the measured LRU and the response signal generated by the LRU from the test point of view. In the test, the excitation signal and the response signal can be led out for testing. The only difference is that when the excitation signal is tested, the measured LRU is the signal load, and when the response signal is tested, the response signal is driven by the backplane. The In most cases, the LRU excitation signal is provided by the missile electronic system. When the excitation signal provided by the missile electronic system is an uncertain missile electronic system echo, so that the response signal is difficult to capture, it is possible to provide the partial external excitation signal. Leads to the low frequency analog signal or digital signal through the gating, isolation and conditioning circuit into the PXI acquisition card to complete the signal acquisition. A three-way signal conditioning adapter board, can support multiple interface signal type distribution similar to the LRU signal leads, isolation and conditioning, when the same interface with both digital signals and analog signals, need to use different ways to isolate, conditioning. And the collection, the use of switches on the path for gating. The control of the switch can be controlled by the digital I/O in the capture card of the master computer.
For low-frequency analog signals, usually its larger amplitude, the need to use the attenuation network to attenuate the signal into the radio with the network. For IF signals, the amplitude is usually small, you can use the switch to switch to the through-path, directly into the radio with the network isolation. For higher quality requirements of the signal, need to use the filter for conditioning. For digital signals, if the LRU input and output interfaces are simple CMOS drivers and input circuits, the buffering chip can be used to isolate the signal directly. If the LRU input and output level standards are not uniform and the interface circuit is more complex, the use of comparator isolation method to complete the signal isolation.

Complete the gating, isolation and conditioning signals using PXI acquisition card for signal acquisition. The digital signal can use static I / O, mode I / O, DA card, serial card and other collection, the RF signal can be used RF analyzer (AD), the digital signal can be used for the analog signal can be used for analog signal can be used oscilloscope card, AD card, multimeter card collection, Complete the collection. In this paper, the use of the oscilloscope card and mode I / O card on the LRU, low-frequency signals and digital signals to complete the signal acquisition. The RF signal discussed earlier will be further completed in the future using RF analyzers.

Three-way signal conditioning adapter board includes three functional areas: signal extension board function area, signal isolation and conditioning function area, instrument connector function area and power area. Its structure as shown in Figure 4.

Figure 3 Online test system hardware structure schematic diagram

Figure 4 Three-way conditioning transfer board diagram
3.3. Software Design

The acquisition software system mainly includes the man-machine contact surface, the main test procedure, the test description, the test result storage database, the driving function library and the report printing. The main test program calls the driver library control instrument according to the test description, completes the signal acquisition, and collects the collected data and real-time diagnosis result into the database. Collected the test results through the project research and development of the fault diagnosis software to complete intelligent diagnosis, fault prediction and so on. According to the test needs, generate a Word report on the test results are displayed. Acquisition software structure shown in Figure 5.

![Figure 5 Collect software structure](image)

When the program starts, first of all, the system initialization, read the test description file and parse the parsed information in a binary tree structure in memory to be stored. Then, enter the main interface of the acquisition software, in the main interface to determine the test tasks and other operations, start the test. And then initialize the instrument, if the initialization error, directly close the instrument to terminate the test. If the initialization is normal, according to the test task, the use of digital I / O output coding, the need to pass the test channel to control. Using the board to test the three-board board leads to the signal, including voltage testing, analog waveform acquisition and digital waveform acquisition. After the acquisition of the instrument off, the implementation of fault diagnosis, data storage or report printing, the test process is completed. If you need a new operation, re-assign tasks in the main interface.
4. Conclusion
The new anti-missle missile electronic equipment LRU on-line detection and diagnosis equipment has studied the key technology of on-line testing, and discussed the online disassembly test technology for the circuit board and replaceable unit (circuit board or replaceable module) for the structural characteristics of missile electronic equipment. Designed the economical and practical on-line test device (three-way signal conditioning adapter board), will locate the fault to the LRU, to meet the base level of the rapid maintenance of the plate needs.

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