Design of Intelligent Testing Device for Airplane Navigation Radar

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***Abstract*—Modern airborne radar systems are very complex electronic equipment systems, high reliability is demanded, and fine functions of automatic detect is needed for guarantee. In this dissertation, we have studied the detect method of a new kind of airborne radar systems. With Embed machinery control as its core, adoption unit wooden blocks type construction, examining the faults of radar one by one by exciting the fault models input and checking out the response, to get the faults localized. Being programmed by Visual Basic6.0, the software can be enlarged and advanced and it provides the users with an intelligent and automatic testing environment and amicable interface. Under the guidance of testing interface, testers can complete the fault localization of radar circuit automatically. By testing, this intelligent and synthesis detect system holds well-found function advanced techniques and predominant capabilities. It can proceed the all-directions performance test to airplane navigation radar. So it has important significance for ensuring flight safety and increasing combat effectiveness.**

***Keywords*—Navigation Radar, Automatic Detect, Fault Localization, Digital Synthesis**

I. INTRODUCTION

The modern war is actually a resistant war of high technical synthesis technique. The one who owns fast responded weapon equipment which can persist in keeping the fighting strength can occupy the initiative power of obtaining the victory. At the realm of aviation electronics, as the airplane works in the environment of the high risk, a minor malfunction of airborne electron equipment may result in a disaster.

Maintaining and guarantee have already become the precondition and necessary condition of airplane's usage. The automatic examination system for radar is used to fast and accurately insulate malfunctions to Line Replace Unit in order to maintain quickly and reduce the radar's repair time. When be checked, a certain airborne radar mainly depends on the artificial test and trouble diagnosis. We developed this intelligent synthesis testing system for navigation radar to improve the efficiency and quality of maintaining and examining. It can check the function of equipment, automatically diagnose the breakdown's position separately, completely and quickly, and greatly improve the equipment's technical guarantee ability. On the function, it also can be expanded and upgraded expediently, having an important military economy benefit and a good extended application foreground.

II. DESIGN OF THE HARDWARE SYSTEM

The intelligent synthesis testing system for airborne navigation radar's breakdown is a system which adopts the modern calculator software and hardware technique, the modern electronics measure and control technique, the measure instrument and instrument Bus as well as the information synthesis disposal technique etc. It constitutes an automatic testing system for radar's breakdown system we can measure and gather the radar signal. The system can achieve the function of automatically measuring a series of electric parameters of the radar and the function of analysis and disposing, swiftly and accurately insulating the breakdown to the line replaceable unit etc. That intelligent synthesis testing system by the composing of the system's hardware and the integration of the software .Through the is mainly composed of embedding industrial controlling microcomputer, keyboard, display, the GPIB interface, the parameter measuring system, the radar control system, the data collecting system, various signal analog regulating and processing system and so on. The total design frame diagram is as the figure 1.

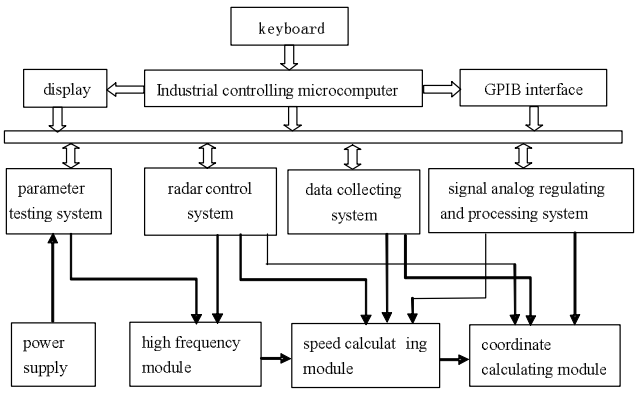

Figure.1 Frame of intelligent test device for airplane navigation radar

Testing hardware is a carrier which can adjust nearly 20 important parameters for navigation radar and collect data. It can provide various interfaces that the function mold piece needs as well as insulation and enlargement of each kind of in-out signals

Industry's controlling microcomputer which is responsible for the control and the management of the whole system is the

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control centre of the whole system. In order to make the system have a stronger enlargement, a higher credibility and the anti-interference ability, the system chooses industrial control microcomputer of the kind of IPC-X. First, it analyzes and estimates the parameters of the subsystem of the radar which will be measured by high-speed I/O card and the digital switch card, so as to ascertain various signals which are needed when the subsystem is being measured, then it sends request to the signal source card, the card puts out various signals that are needed, through digital to analog conversion card the signals can be conversed to or directly put out to the analog and digital signals that the function module of radar requires[1]. The keyboard and display can be operated manually.

The parameter measuring system is responsible for measuring the parameters such as each power voltage, biased voltage of mixer diode in the port of sending frequency, unlocking signals, voltage representing speed which is put out by speed calculating module and so on.

The navigation posture and course for the signal analog unit is responsible for producing three-phase signal of pitching angle, slope angle and course angle.

The signal which the radar's control system produces is used to control the work state of the radar. For example when we test a certain module, we can use the system to switch the input of the module from normal channel to excited channel. Such kind of control signals are all switch signals.

The data collecting system collects and stores all kinds of digital and analog signals from the radar's subsystem in work state, analyzes and estimates them by software, compares them with parameters of radar system, finds out the work state of the subsystem. If something abnormal appears, it can remind the operator of it immediately and eliminate the breakdown of the subsystem according to the breakdown leading program.

III. DESIGN OF THE SOFTWARE SYSTEM

The test of the automatic testing system for airborne radar's breakdown is carried out by the testing leading software which adopts Visual Basic6.0 to draw up.

According to its function and structure, we have the airborne radar delaminated carefully and then select the important subsystem and parts which often appear breakdowns to research and analyze. For example, as most high frequency modules are analog electric circuits with relatively high rate of breakdown occurrence, so it is the main testing object. Any SRU (Shop Replaceable Unit) of it with wrong is a kind of breakdown mode, so each SRU needs breakdown examination and capability testing. The testing of three signal occurrence units, sending frequency, intermediate frequency and benchmark frequency in the high frequency module is only need to test the frequency, amplitude and power of the output signal whether they satisfy the requirement or not.

As the function structures of the port of sending frequency, intermediate frequency demodulator and narrow band filter are in series class by class, it is the most proper way to use the in–out measurement on basis of the function validation. For the subsystem or module with inconvenient in–out measurement, we can achieve the breakdown testing by measuring work parameters of the key apparatuses whether satisfy the request. The whole test procedure of automatic testing system for airborne navigation radar's breakdown provide an intelligent and automatic test environment and test interface .Just according to the lead of test interface ,the examiner can make the system complete automatic examination of the radar's breakdown automatically. In allusion to the examination of the airborne radar, firstly we should check the radar's power supply whether works in a good state, or the later examinations to each malfunction mold of the radar are all inaccurate.

On the interface of the operation, the function modules of the radar which will be checked should be chosen first of all. Different function modules of the radar have different testing methods, each function module has its particular examination arithmetic. After entering the testing step of that radar function module, first of all it remind the operator of connecting each interface concerning module, according to the multi-media information such as word, video, picture and so on. Then it adds the electricity to the examination platform. The controlling machine begins to enter into the automatic examination process, including putting out all kinds of signals that are needed and collecting different responding signals step by step, and then it analyzes and processes the signals that are collected, putting out the result of the test and the position of the breakdown. Finally, we can store the data and print it according to the need, finishing the testing process. The examiner can do circulating test for many times or chose other function modules to test.

IV. THE MAIN TECHNIQUE AND SOLUTION

A. Problem of breakdown diagnosis according to the data fusion and artificial intelligence

Improving the testing depth of the intelligent synthesis testing system for airborne navigation radar and achieving the insulation and orientation of breakdown are important tasks and are also difficult points in the course of testing. For testing data of one item obtained in the testing process can not entirely be the token of the module with breakdown, so we must set up the relationship between the testing result database obtained in the module of data management and the possible breakdown parts in each system of radar. So, we can identify the most possible breakdown module by making use of the method of data fusion and artificial intelligence, according to a certain discretion rule. On this basis, by using the programmer technique for calculator software, the cross and transfer of data and the connection technique, we can develop the module for breakdown diagnosis[2].

B. Direct digital synthesis technique

When the intelligent synthesis testing system for airborne navigation radar tests the intermediate frequency demodulator for radar, the testing instrument needs to solve the problem of shifting the higher frequency signal to lower frequency. On the premise of ensuring the accuracy and stability of testing system, in order not to make the electric circuit too complicated and the cost too high, we adopt the analog method of radar intermediate frequency echo in direct digital synthesis technique. Direct digital synthesis technique is mainly composed of five parts: the phase accumulator, sine lookup

table, Read Only Memory, digital–to–analog conversion and low–pass filter. Direct digital synthesis technique is essentially a sampling system whose ideal output signal is a discrete line .If you want to get back the ideal wave shape, the output frequency of direct digital synthesis technique can not exceed half of the reference one, or the filter no can not get it back. In practical application, for the low–pass filters have a problem of transition band, we limit the output frequency to a smaller range so as to get rid of the garbage signals brought by one order image frequency greatly .The direct digital synthesis technique is just about using the theory that the frequency of ideal sine wave signal and the phase increment at unit time are linearity to achieve frequency synthesis. By adopting the digital technical, we solve the problem of shifting the higher frequency signal to lower frequency [3].

C. *Design of limited band white noise occurrence instrument*

For the sake of testing the sensitivity of the narrow band filter, it is necessary to produce the excited signals with certain power and controlling Signal–to–Noise ratio. The signals are produced by the adding of white noise and Doppler signals. As an ideal signal, the bandwidth of white noise can completely cover the frequency scope of Doppler.

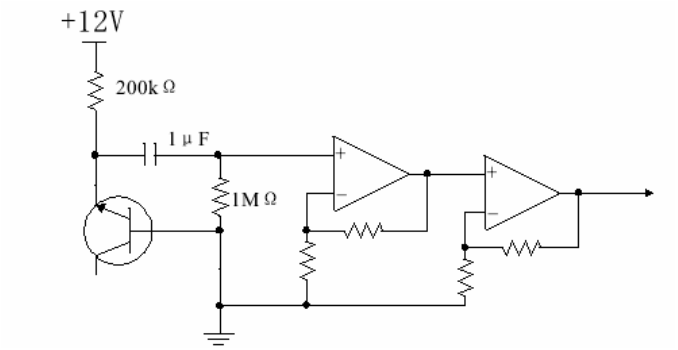

Figure.2 Limited band white noise occurrence instrument

According to the method shown in figure 2, we can make a simple and effective limited band white noise occurrence instrument by using some characteristics of the transistor's PN knot. We make its collector opened, its base—emitter reverse biased and then the 12V makes it produce the phenomenon of Zener breakdown. Observing the output of transistor through the spectrum instrument, we can find the bandwidth of the noise is 180MHZ and the power is about -50 dBm. In order to increase the power of noise, the latter circuit need to use the circuit composed of the bigger capacitances and resistances to get rid of the direct current elements, then the power will be amplified and exported through two in–phase amplifiers with bigger amplified multiple. In the end, after debugging we should make the peak value of the unloaded noise reach to 80mv and the bandwidth not lower 8 kHz. The noise of the electronics circuit is always inevitable because of various interferences, but its amplitude generally can't be over 12mV, which is far lower than the amplitude put out by the noise occurrence instrument, as a result, it can be neglected. Finally, we can add the output signal of the noise occurrence instrument to the Doppler signal of each channel separately through the in-phase adding circuit which is composed of operational amplifier so as to make sure that the Signal–to–Noise ratio can be regulated in the requested design range[4].

D. *Design of electromagnetic compatibility*

As the development and application of electronic technique, the danger of electromagnetism interference is gradually known and valued by people. Because of the strong radiation of the radar, we must take the electromagnetic compatibility of the testing device for airborne navigation radar into consideration. If we want to improve the electromagnetic compatibility of testing system, we must set about improving the anti-jamming degree of the equipment and avoiding the leakiness of the electromagnetism.

Commonly, we can start with three main inference problems such as interference source, spread path of the interference, sensitive equipment and so on. On the one hand we should choose the parts or parts of an apparatus with minimum interference and arrange them reasonably, on the other hand we can restrain and insulate the electromagnetic interference by methods of grounding, shielding, filtering wave and so on. The synthesis testing system for airborne navigation radar is an analog circuit mixed with digital. When we choose analog instruments of the equipment, in addition to meeting the request of bandwidth, we should select the instrument with low density of equivalent noise and narrow bandwidth in order to reduce the noise that the instrument itself produces. The electric power is the important spread path for various interference signals invading equipments and each part inside the equipment interfering mutually. Because of high efficiency and being capable of putting out various voltages, the engine box of the intelligent synthesis testing system for airborne navigation choose the switching power. For the inherent characteristics of the switching power, the noise of the output lining wave is bigger. [5]

Therefore, we make the output of the switching power firstly pass the filter of the electromagnetism compatibility and anti–jamming magnetic core , and then supply it for the circuit board after getting rid of the high frequency .The grounding systems all need separate layouts and single connections to reduce the mutual interference. All the lines which connect the circuit board to the external need to adopt good grounding coaxial–cables so as to insulate the external electromagnetism interference in the greatest degree. In order to reduce the internal noises brought by the working circuit, when we print the circuit board ,the layout of the lines should be reasonable, such as adopting multilayer boards, short distance between power lines and grounding lines, between clock lines and grounding lines, between signal lines and grounding lines and so on. And the analog and digital circuits are arranged separately so as that each circuit on the board can reach mutual compatibility [6].

V. CONCLUSION

In the development of intelligent testing system for airborne navigation radar, we broke out some original design methods of the testing equipment for radar, have creatively managed advanced calculator techniques and digital electronic techniques that are home and abroad, achieved the automation of testing process, ensured high reliability of the system and

improved the speed and precision of testing. Meanwhile we make the modern testing and calculator technique merged into a whole, strength the testing function as well as optimizing the human and machine's interface, make the system more predigested and operation more convenient, and inaugurate a new technique path for update of the desk form instrument with low automatic degree and single function. Through modifying the software and adding trifling interfaces, the function of the system can be expanded, and it has an important push function for airborne testing equipment developing toward the synthesis and intelligence [7].

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