Design of the Automatic Test System of Active T/R module

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Abstract- Active array radar (DAR) is a kind of phased radars, which utilizes beam-forming technique both in receiving and transmitting. Active T/R module is a key technique in the next generation of T/R modules for active array radar. In order to realize the automatic test of the active T/R modules, the advanced modern automatic test system (ATS) is built based on GPIB bus. The principle of the ATS for the active T/R module is introduced. The composition and structure of the ATS is described and the designing method of the hardware and software is discussed. The measurement results of the ATS verify that the design of the ATS is reasonable, because its performance is stable and the efficiency of the active T/R module test increases by using it.

I. INTRODUCTION

Active array radar technology has been an important development for the Radar industry [1, 2]. The active array radar has dramatically increased the operational capability of modern Radars compared to the conventional phased array radars [3, 4]. The Beam Forming technology can not only improve the performance of phased array radars, but also can extend their function, so it has been increasingly used in modern radar system [5, 6].

Active T/R module is a core part of the active array radar. The performance index of it will have a direct impact on that of the active array radar. The performances tests of the active T/R module are complex and hard work. In order to meet the measurement requirement of radar system, new advanced automatic test system (ATS) for active T/R modules are needed.

II. THE PRINCIPLE AND FUNCTION INDEX OF THE ACTIVE T/R MODULE

A typical active T/R module is composed of phase shifter, TR switch, power amplifier, circulator, LNA etc [7-9]. A schematic presentation of the active T/R module is shown in Fig1.

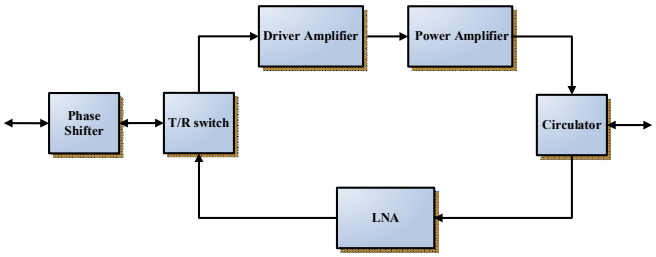

Figure1.A schematic representation of the active T/R module

In the transmitter mode, the signal is generated by the microwave signal source. The signal is amplified by the driver amplifier and power amplifier. The transmitted signals are transferred to the antenna though circulator. In the receiver mode, the received signal is received though the circulator and amplified by a low noise amplifier (LNA). The Phase Shifter in each channel translates the control signal to phase variation. The measurements of the active T/R module in transmitter mode are as follows:

Output Power
Efficiency
Spurious
Harmonic
Droop
Rise Time
Fall Time

III. HARDWARE DESGIN OF AUTOMATIC TESTING SYSTEM

Automatic testing systems of active T/R module can automatically do system testing, data recording and data processing for active T/R module with the least manual participation, and output result in the appropriate mode. The development of it is based on the technologies of computer and test bus. The computer brought the automation of test technology, and the GPIB bus is bringing the test system into network era. A schematic presentation of the ATS setup used in this work is shown in Fig2.

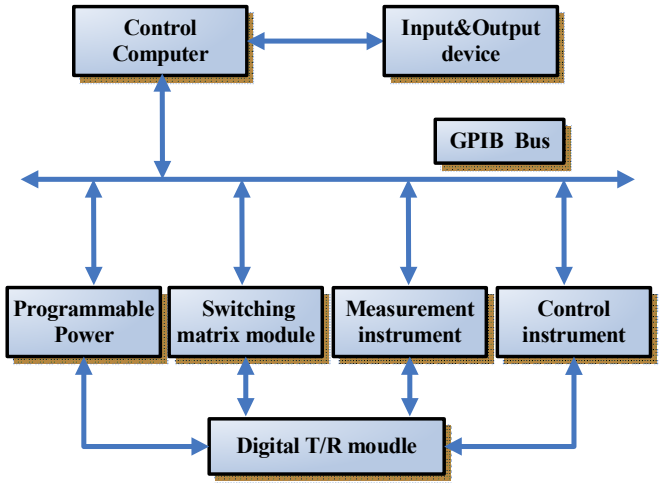

Figure2.hardware architecture of ATS of active T/R modules

The ATS of active T/R modules is constituted of programmable power, switching matrix module, measurement instrument, control instrument and other peripheral devices. All of devices are connected with each other by GPIB bus. The programmable power can supply multiplexing programmable control power motivations, and give the measurements a practical work power environment. The test channel and working mode is selected by control computer though the switching matrix module and control instrument. The measurement instrument modules include the following devices, which are random curve generator, lowpass filter, highpass filter, spectrum analyzer, power

analyzer, vector signal generator. The filter and spectrum analyzer can realize the measurement of harmonic and spurious. Random curve generator is used to supply the mandatory actuating signals and self-check signals of the system such as square wave, TTL clock and so on. The power analyzer is used to test output power, droop, risetime and falltime. The vector signal generator can supply the frequency actuating signals and some other special actuating signals.

IV. SOFTWARE DESGIN OF AUTOMATIC TESTING SYSTEM

The system software architecture is the key factor that affects the usability of general test system and the operability of test system development. The modularization and hierarchy design is adopted in software architecture that accomplishes the transplantation and expansibility of the system. Fig. 3 shows the basic software architecture. The system module is reducible, transplantable and exchangeable with users and provides relevant service through interface.

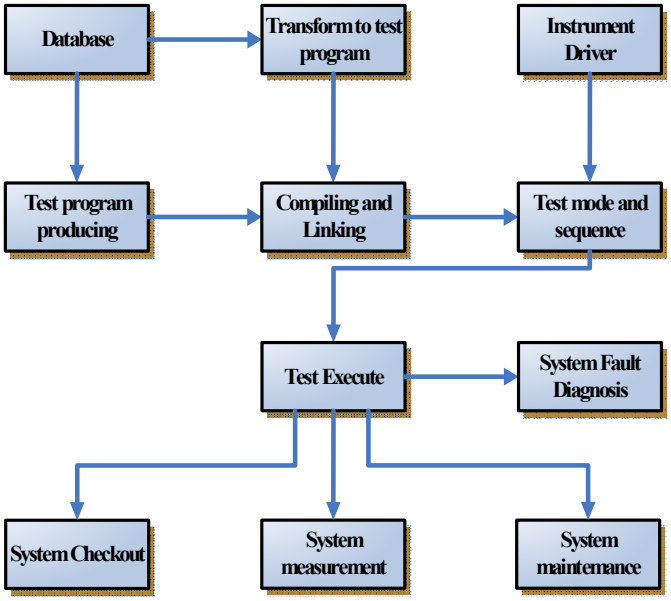

Figure3.software architecture of ATS of active T/R modules

V. TEST RESULT

Once the ATS had been built, the measurement of active T/R modules could be made. Take one channel of active T/R module for example. The test results are as follows:

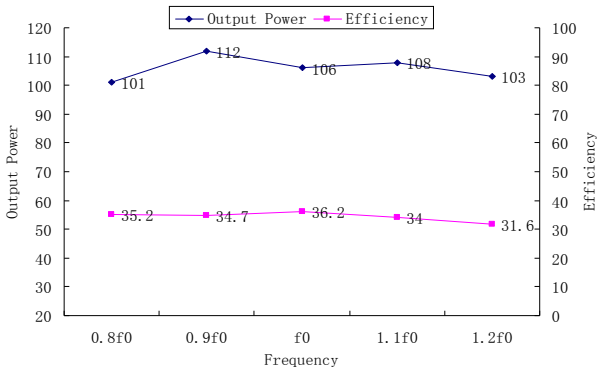

Figure4.Output Power & Efficiency of ATS of active T/R modules

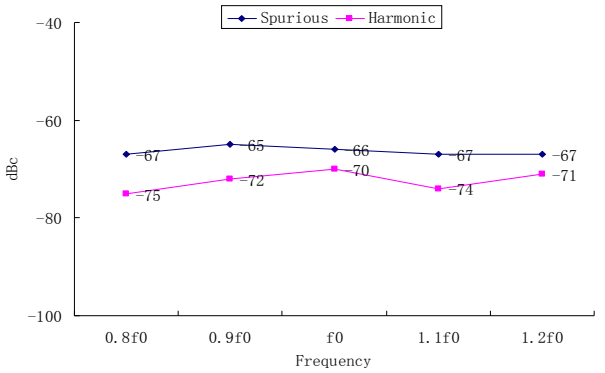

Figure5. Spurious & Harmonic of ATS of active T/R modules

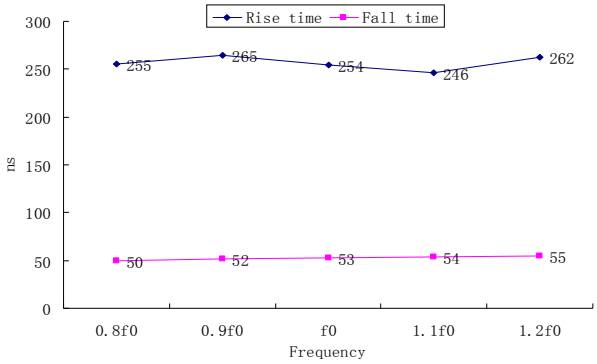

Figure6. Rise time & Fall time of ATS of active T/R modules

The picture of the ATS of active T/R modules is shown as figure 7.

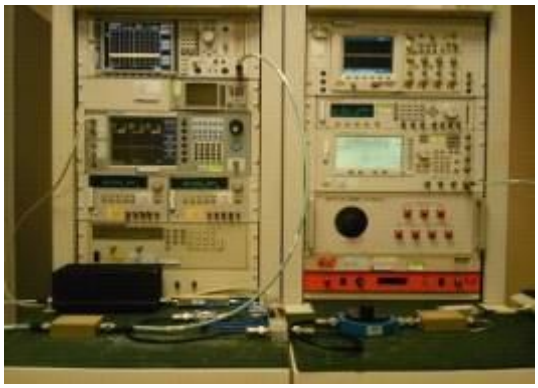

Figure7. The picture of ATS of active T/R modules

VI. CONCLUSIONS

We have demonstrated an automatic test system (ATS) that can be used to measure the active T/R module. The system can perform automatic test and fault diagnosis of the active T/R module. The hardware and software architecture is researched and described based on the system. The results showed the ATS can meet application requirements and it increases the efficiency of the active T/R module test.

REFERENCES

[1] YU Zhen-kun, ZHENG Xin . "The application analysis of SiC power device in radar transmitter" ,journal of microwaves. Vol 23,pp.61-65, 2003.

[2] Liu Han, ZhengXin, Shang Jian-gang et al. Design and practice of SiC wide band gap power amplifier〔J〕 Journal of microwaves. 2008, 5: 40 - 44

[3] Daniel J. Rabideau, et al, "An S-band active Array Radar Tested," 2003 IEEE Int. Symp. On Phased Array System and Technology pp. 113-118, 2003.

[4] WU Man-qing, The Development of Active Array Radar. Journal of CAEIT, 2006, pp.11-16.

[5] Wang Yan, Wu Manqing. "The Development of DBF Phased Array Radar System," 2001 CIE Int. Conference on Radar Proceeding,2001, 61-64

[6] R. Ney, J.J. Berthelier . "Electronic Active Beamforming Implementation For Radars," MST 10 Workshop on Technical and Scientific Aspect of MST,Session 5,2003..

[7] Lu Jiaguo Wu Manqin Jin Xueming, et al. Active phased-array antenna based on DDS[J]. Acta Electronica Sinica, 2003,31(2) :199-202.

[8] Chen Tian, Chen Zhuming ,Zhou Peng, et al. Design and implement of wide band active T/R module[J]. Modern Radar, 2008,30(3):89-92.

[9] Inder Bahl Prakash Bhartia. "Microwave Solid State Circuit Design "ZHENG Xin translate publishing house of Electronics Industry. 2006.