

The Design of Four-Port Microwave Signal Conditioning Box

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Abstract. In the process of microwave signal testing, aiming at the problems of various kinds of equipment under test, various output signals of equipment, and the safety risk of direct access of microwave signals to the testing system, this paper designs a four-port microwave signal conditioning box, which realizes signal conditioning before microwave signals are connected to the testing system. The four-port microwave signal conditioning box is composed of signal attenuation module, signal filtering module and link conditioning module. According to the actual test requirements, users configure the resources of these modules through the main control computer to achieve microwave signal conditioning.

Keywords: microwave, test, signal conditioning.

1. Introduction

In the process of microwave signal testing, there are many kinds of equipment under test and various types of microwave signals. If the microwave signal output from the equipment under test is directly connected to the testing system for testing, it will increase the complexity of testing to a certain extent, and even some high-power signals will pose a threat to the security of the testing system[1-3]. Therefore, it is particularly important to adjust the microwave signal before the microwave signal from the equipment under test enters the test system.

The microwave signal can be accurately, reliably and safely acquired by computer instrument module by adjusting the microwave signal. It usually includes signal amplification, filtering, isolation, multi-channel conversion, signal distribution and other functions [4,5]. It can be said that signal conditioning accessories are an indispensable part of most test systems. The signal conditioning module is mounted on the signal conditioning platform and the signal conditioning platform is also the signal path from the test system resources to the tested object. Its main functions include: as a connection between test resources and the cable under test, path conversion and selection of direct output of some test resources, connection with signal conditioning module, on-off and polarity change control of power supply, et. al [6].

In this paper, a four-port microwave signal conditioning box is designed. The signal conditioning box includes three parts: signal attenuation module, filter module and link conditioning module. In the process of microwave signal conditioning, users can configure the signal conditioning resources in the signal conditioning box according to the test requirements, so as to achieve the purpose of signal conditioning.

2. System Architecture

Microwave signal testing system is composed of PXI-based testing platform and signal conditioning box. It includes four parts: main control computer, test resource, microwave signal conditioning box and the tested object. Its structure is shown in Figure 1. The PXI-based test platform integrates the main control computer and test resources into the PXI chassis. The physical diagram is shown in Figure 2. The main control computer in the test platform is the control core of the system. It controls the test resources through PXI bus interface, completes the functions of data processing, printing and display. The test resource completes the test task under the control of the host computer and transmits the data to the host computer. The main control computer configures the signal conditioning module by controlling the on-off of the radio frequency switch. It provides different signal path selection for the microwave signal test and realizes different signal conditioning functions [7,8].

In the test system, the main control computer, test resources and microwave signal conditioning box are universal. It will not change with the change of the equipment under test. The microwave signal conditioning box contains two inputs and two outputs. During testing, the connection between the microwave signal conditioning box and the test resources integrated in the PXI cabinet is relatively fixed. For the inconsistency of signal output interfaces of different equipment under test, only the appropriate microwave adapters need to be replaced according to different interfaces to complete the corresponding test tasks, which meets the test requirements of various types, combinations, complex signals and different interfaces of the equipment under test.

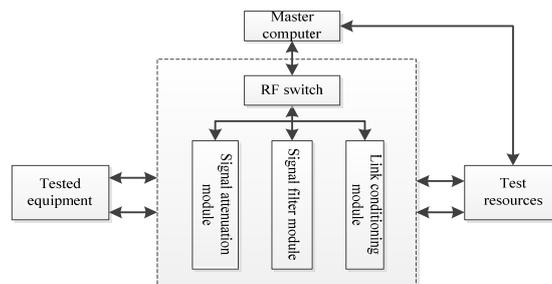


Fig 1. Architecture of Microwave Test System



Fig 2. Physical diagram of PXI-based test platform

3. System Design

3.1 Design of Signal Attenuation Module

The inappropriate signal input in the test platform is one of the causes of measurement problems and instrument damage. In the process of microwave signal testing, the microwave signal power output of the equipment under test is on the high side, which exceeds the power bearing range of the test resources in the testing platform. It is urgent to attenuate the microwave signal output.

The signal attenuation module designed in the four-port microwave signal conditioning box is responsible for attenuating the high-power microwave signal. Because the microwave signal power output of different equipment is different, it is difficult to meet the demand by using fixed attenuator, so step attenuator is used in signal attenuation module to realize the signal attenuation function. The attenuation of step attenuator varies with the rated value. The common steps are 0.1dB, 0.5dB, 1dB and 10dB. According to the actual output microwave signal power of the equipment under test and the test requirements, two kinds of stepping attenuators, 1dB and 10dB, can basically meet the test requirements.

3.2 Design of Signal Filtering Module

In order to obtain more effective signals, it is necessary to filter the interference signal and adjust the signal as far as possible to facilitate signal processing. To process the interference signal, a filter is needed. The four-port microwave signal conditioning box connects many kinds of tested objects, and the frequency bands of the output microwave signal are different, but the frequencies are all

below 3GHz. When designing the signal filtering module, we make full use of the existing low-pass filter in the laboratory to realize the filtering function. There are three kinds of low-pass filters in the laboratory, which are up to 300 MHz, 1 GHz and 2.4 GHz. When carrying out the test task, according to the microwave signal frequency of the tested object, the selective switching of the low-pass filter can greatly improve the filtering efficiency of noise and interference signals, and realize the signal conditioning function.

3.3 Design of Link Conditioning Module

According to the requirements of the test project, microwave signals need to be shunted and combined, which can be realized by shunts and combiners. The four-port microwave signal conditioning device has two input ports and two output ports. If it is necessary to realize the direct, shunt and shunt of single or double signals, it can be realized by using a shunt, a direct link and a shunt. The structure layout of link conditioning module is shown in Figure 3. Microwave signal link conditioning is realized by radio frequency switch to control link interruption. Three single-pole three-throw radio frequency switches and one single-pole four-throw radio frequency switch are adopted. A-terminal interface 1 is connected with link conditioning module interfaces 1, 2 and 3 through SPT radio frequency switch. A-terminal interface 2 is connected with link conditioning module interfaces 4, 5 and 6 through SPT radio frequency switch. B-terminal interface 1 is connected with link conditioning module interfaces a, b, d and e through SPT radio frequency switch. B-terminal interface 2 is connected with link conditioning module interface c, f and g through SPT radio frequency switch.

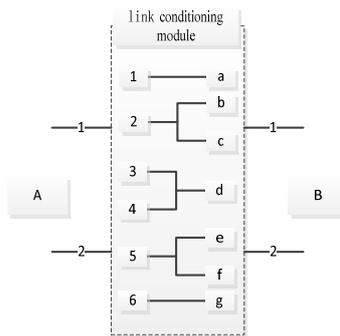


Fig 3. Link conditioning module layout

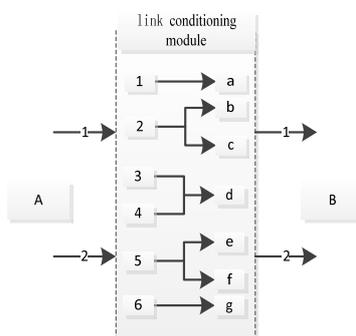


Fig 4. Signal Flow Link Diagram at A-terminal

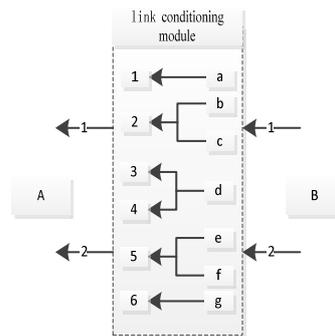


Fig 5. Signal Flow Link Diagram at B-terminal

A-Terminal and B-Terminal can be used as input ports for microwave signal conditioning respectively. When port A-Terminal is the input, the link conditioning module can be regarded as a combination of a combiner, two splitters and two through links. Its microwave signal transmission link is shown in Fig. 4. When B-Terminal is the input, the link conditioning module can be regarded as a combination of a splitter, two combiners and two through links. Users can selectively control the radio frequency switch through the main control computer to realize the regulation of the microwave signal link. According to the input and output of microwave signals, the signal flow links can be divided into four categories, there are single-in-single-out, single-in-double-out, double-in-single-out and double-in-double-out. The RF switching port connections corresponding to different signal flow links are different, and the specific connections are shown in Tables 1 and 2.

Table 1. Switch Port Connection Table for A-Terminal Input

signal classification	Input Port 1	Input Port 2	Output Port 1	Output Port 2
single-in single-out	1	none	a	
	none	6		g
single-in double-out	2	none	b	c
	none	5	e	f
double-in single-out	3	4	d	
double-in double-out	1	6	a	g

The four-port microwave signal conditioning box is connected with the test resource in the PXI cabinet through the programmable switch M9161D. The testing resources in PXI chassis include oscilloscope, power meter, spectrum analyzer, modulation domain analyzer, vector signal analyzer, audio analyzer and signal source. The connection of signal conditioning box, programmable switch and test resource is shown in Fig. 6.

Table 2. Switch Port Connection Table for B-Terminal Input

signal classification	Input Port 1	Input Port 2	Output Port 1	Output Port 2
single-in single-out	a	none	1	
	none	g		6
single-in double-out	d	none	3	4
double-in single-out	b	c	2	
	e	f	5	
double-in double-out	a	g	1	6

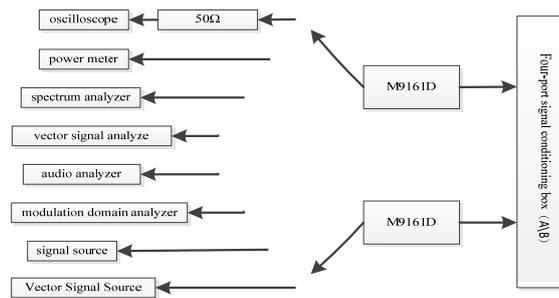


Fig. 6 Connection Diagram of Test Resources, Programmable Switches and Signal Conditioning Box

The test platform uses two M9161Ds to realize the program control of test resources. When the tested object is a transmitting system, only one test resource is needed to connect a single test resource with an M9161D, and the signal conditioning box can be completed with a through link. When the object under test is a receiving device, it is necessary to generate signals with specific requirements as the excitation of the object under test. At this time, it is usually necessary to use a combiner to synthesize the two signals. The two signal sources are connected to the signal conditioning box through two M9161Ds, and the combined link is used to achieve signal synthesis to meet the test requirements.

4. Conclusion

In this paper, a four-port microwave signal conditioning box is designed. And the signal conditioning box cooperates with the PXI-based test platform to complete the microwave signal testing task. The four-port signal conditioning box is composed of signal attenuation module, signal filtering module and link conditioning module. When carrying out the test task, users can configure the resources in the signal conditioning box according to the test requirements, achieve the purpose of conditioning the microwave signal, improve the security and accuracy of the test, and meet the actual needs of equipment testing.

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