Q-Band Computerized Slotted Line System

An Tongyi, Mao Jiaheng, Meng Qingxiang, Yan Hua and Fang Jinlin

Microwave Institute, East China Normal University
Shanghai, China

Abstract

A new auto-test system for measuring network parameters at Q-band is developed. The system is based on the conventional slotted line system and controled by the APPLE II microcomputer. It has all the functions which the manual one has and performs much better than the latter in accuracy, reliability, speed and automatic. The principles, constructions and features of the system are introduced. The typical results for complex reflection coefficient, voltage standing wave ratio, impedance, attenuation and S-parameters are given.

The system may be valuable in developing test system at short millimeter wave band and seems to make a new life of the slotted line system.

Introduction

Slotted line as the first generation of the measurement system at microwave frequencies played great role before 60's and is still in wide spread use especially in developing countries. Its advantages such as simplicity, multifunction, low cost and reliability are atractive inspite of the existence of the modern facilities such as ANA and Six-port systems. For the demands on the auto-test system at mm-wave frequencies, we have developed a Q-band APPLE II microcomputer controled slotted line system which performs much better than the manual one. The system may be valuable in developing short mm-wave test system and seems to make new life of the slotted line system.

Construction

The system is based on a conventional manual slotted line measurement system and controled by an APPLE II microcomputer. The block diagram of the system is shown in Fig.1. The carriage of the slotted line is driven by a stepmotor. The detected signal is amplified and then put into the computer via a spetial interface card. The step length of the carrige movement is about 10.6μm. There are about one thousand steps per wavelength.

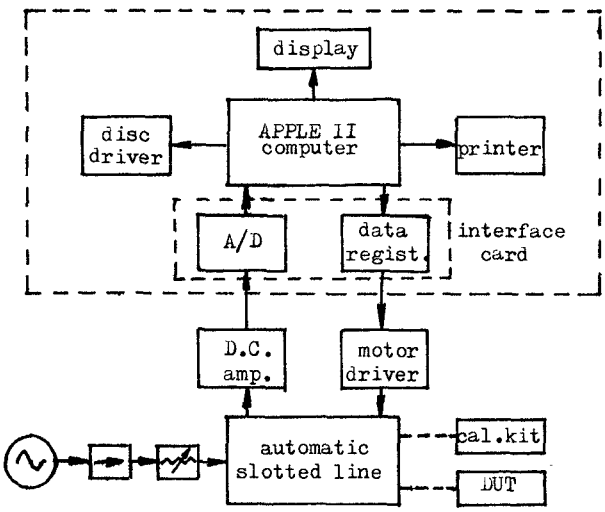

Fig.1 The block diagram of the system

Performance

The system not only has the functions which the manual one has but also has many advantages over the latter. Such as auto-test, more accurate, more reliable, much faster and so on. It can measure signal characteristics (source frequency, guided wavelength and relative field strength in waveguide) as well as network characteristics (complex reflection coefficient, VSWR, complex transmission coefficient, impedance and attenuation). The main program is written on BASIC language while data collection is on programing language. The user operates according to the menu shown on the terminal screen. The measured results can be shown on the screen or on the print paper with standing wave form or Smith Chart form.(see Fig.2 and Fig.3)

The computer techniques are made use of during the course. Such as the detection law calibration, VSWR minima determination,

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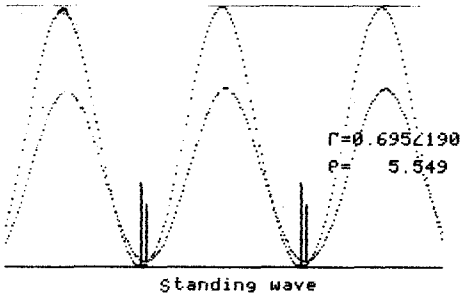

Fig.2 Standing wave form of Γ

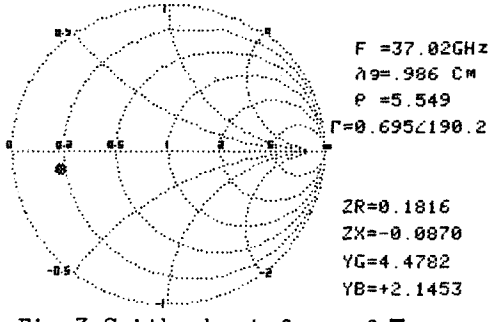

Fig.3 Smith chart form of Γ

circle regression in Deshamps method for measuring insertion loss A and S-parameters (see Fig.4 and Fig.5).

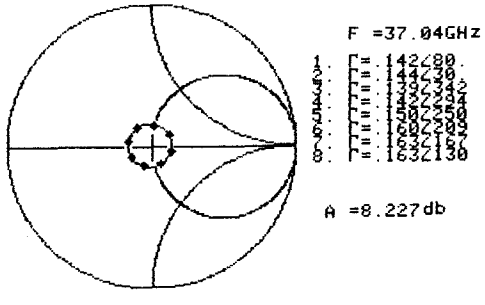

Fig.4 Insertion loss display

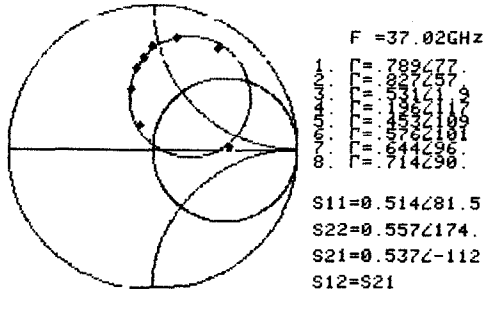

Fig.5 S-parameters display

It is a difficult task to measure large VSWR at low input power levels using a slotted line. But it does not metter for our auto-test system. We have developed a new method to solve this problem. In the method the measured points are neither the maxima nor the minima. Their power levels are all near the input power level so that are easy to measure without changing the probe penetration or the input power level. Fig.6 shows the result of a short plate with VSWR about 190.

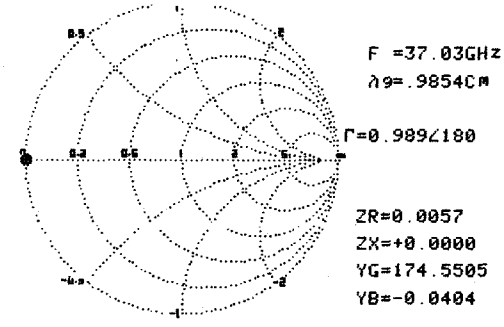

Fig.6 Γ of a short plate

The typical results for measuring reflection coefficients, attenuations and S-parameters are listed in Table 1 through 3.

standard number	standard		measured		error	
	VSWR	arg(Γ)	VSWR	arg(Γ)	VSWR	arg(Γ)
101	1.109	184.9	1.130	185.8	+1.9%	+0.5%
301	1.322	189.8	1.314	194.7	-0.6%	+2.6%
501	1.525	187.2	1.540	191.8	+1.0%	+2.5%
701	1.753	190.2	1.750	192.6	-0.2%	+1.3%

Table 1 Results of VSWR and arg(Γ), 37GHz

location(mm)	0.0	0.2	0.4	0.6	0.8
A (dB)	0.696	1.242	3.480	8.227	15.48

Table 2 Results of attenuator, 37.02GHz

location(mm)	0.2	0.4	0.6
S_{11}	.020∠37.1	.014∠28.0	.015∠-0.8
S_{22}	.029∠215	.023∠203	.037∠216
$S_{21}(S_{12})$	.867∠-32	.672∠-43	.392∠-39

Table 3 Results of attenuator, 37.02GHz

Conclusion

Computer controled Q-band slotted line system is a low cost, easy to use, autotest system. It has high performance in comparison with the manual one. It may be a complement for mm-wave measurements in parallel with ANA and Six-port techniques.