

Phase Detection of Horn Antenna arrays

Ling-Yun Luo^{1,2} and Qing-Xin Chu¹

1.School of Electronic and Information Engineering South China University of Technology

Guangzhou, China. Email:qxchu@scut.edu.cn

2.School of Electronic Engineering, Xidian University, Xi'an, China

Abstract—An simple approach for phase matching in horn antenna arrays is presented, in which a waveguide detector is used to measuring the phase distribution on the horn aperture plane. The relative phase differences can become almost the same by adjusting the phase shifter, thus phase matching is achieved. The coupling between detector and horns and the phase difference between horns are acquired by simulation. The measure and the simulation testify the availability of the method.

I. INTRODUCTION

Horn as a most familiar aperture antenna is widely used as feed of high gain antenna and units of antenna array. A horn antenna array can improve the direction of pattern, suppress the radiation pattern. At the same time, this kind of antenna array can be an offset feed of a big parabolic cylindrical reflector antenna, increasing gain and the power capacity. The horn antenna array is widely used in many fields because of its high efficiency, wide frequency band, high power capacity and low VSWR.

Phases play a important role on the antenna arrays, the phase distribution of the horn antenna array determine the radiation pattern, so it is needed to match phase for the antenna array in order to keep the phase almost the same. A general way is that the near filed phases are measured, then according to the measure results, the phase shifter is adjusted, then the phase is measured again, until the phase is as much as the same. The method is work with no doubt, but it will also cost so much time and energy. Either the accuracy of detector compensation or the mechanism return error lead to the measure system can not satisfied the measure condition [1]. In this paper, a simple method is presented. A waveguide detector is used to measuring phases on horn aperture plane. The advantage of the method is that measure equipment is simple, operation is easy, and

efficiency is much higher. But it also has problem such as orientation of detector, influence of detector to aperture fields. By this method, the radiation pattern of a horn antenna array is measured when the units are in phase and phase difference is 15 degree. And it contrasts to the result of simulation, which convinces the validity of the method. Then the effect of detector to measurement is acquired by simulation, and the radiation pattern considering measure error and detector effect is compared.

II. MEASUREMENT

Measurement scheme is shown in Fig.1. It consists of a vector network analyzer, a power divider, phase shifter, horn array and a waveguide detector. The detector used is a waveguide connecting to coaxial cable through a waveguide-coaxial switch. In the experiment, the detector is placed in the position of the side beam of the horn array so as to reduce the coupling between horns and detector, reduce the measure errors. The frequency is so high that the detector is sensitive to position, so it is very important to keep the relative position of detector to horn the same.

The phases of transmission coefficient each channel is measured. The relative phases difference between a channel and the reference channel is considered as the phase shifts of the channel. When relative phases are close to zero though adjusting phase shifter, the phase matching is realized.

Firstly, the phase shift of the first channel is measured, and it is made as a reference. Then other channels are measured, their phases are changed by adjusting phase shifter to close to the reference value.

The measured phase value of each channel after adjusting phase shifter is listed in TABLE 1. H plane radiation patterns are measured and simulated by high frequency simulation soft Ansoft-HFSS, as shown in Fig.2. The measured and simulated results have a good agreement.

III. ANALYSIS OF DETECTOR EFFECT

Because of the simplicity of method, there are errors inevitably. The first error is from orienting of the detector. The detector is fixed by hand, thus it is hard to assure the uniformity of detector's position. The second error is from the coupling effect between the horn and detector, the detector influences the aperture fields of horns, though the detector is putted in the position of side beam of horn.

The relative phase differences between channels are obtained by simulation as list in TABLE 2. Moreover, coupling between detector and horns is shown in Fig.3, when detector is placed in channel 8. It is found that the phase fluctuate is within 5 degree. The radiation patterns taking two errors into account are shown in Fig.4, in which line 1 (real line) is the H plane radiation pattern when the array is in phase, line 2 (broken line) is the radiation pattern when the coupling error is considered; line 3 (× line) is one when both errors are considered. It is known that the main beam is invariable and the side beam is disturbed slightly. And the simulation results can be used to revise the error lead by detector.

TABLE 1 Phase shifter values (In Phase)

Channel	1	2	3	4	5	6	7	8
Phase	0	-3	-2	-4	0	-1	2	0
Channel	9	10	11	12	13	14	15	16
Phase	1.5	2	0	0	3	1	3	6

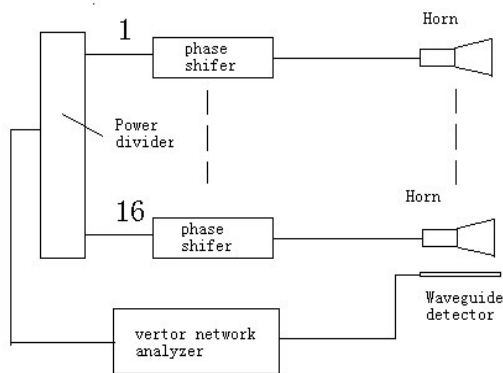


Figure 1. Measurement scheme

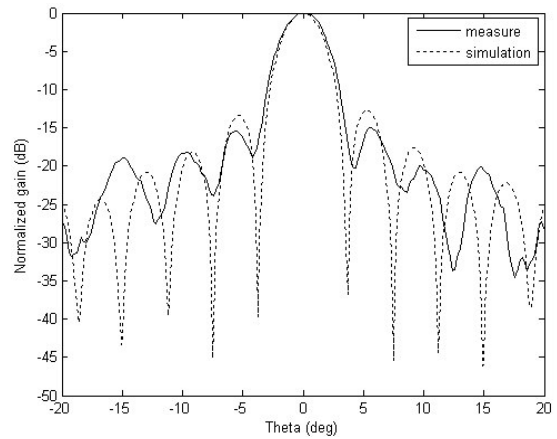


Figure 2. H plane radiation pattern in phase

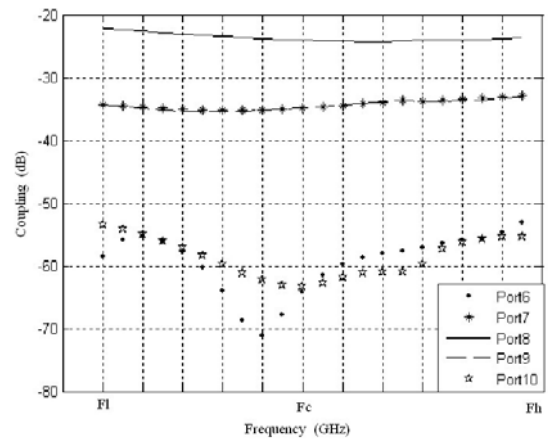


Figure 3. Coupling between horn and detector

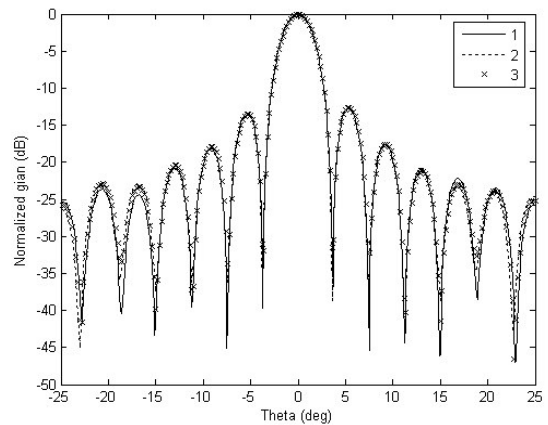


Figure 4. H plane radiation pattern. line 1 (real line) when the array is in phase, line 2 (broken line) consider coupling error; line 3 (× line) consider both errors.

REFERENCES

- [1] Nai-Hong Mao, and Xin-De Ju, *The Handbook of Antenna Measure*, Nation Defense Industry Publishing Company, August 1987.
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IV. CONCLUSION

A simple method of phase matching for a horn antenna array has been presented. The results of measure and simulation have testified the validity. And the effects of detector on phase and radiation pattern have been analyzed.

TABLE 2
Detector Affect On Phase In Different Frequency

Port \ F	F=F _l	F=F _c	F=F _h		F=F _l	F=F _c	F=F _h
1	-0.28	4.55	4.08	9	-0.54	0.4	2.53
2	0.39	2.7	0.71	10	0.52	-1.83	1.04
3	1.02	3.54	3.31	11	-0.06	2.1	3.6
4	5.15	3.66	3.62	12	0.12	-2.97	-3.12
5	-3.1	-2.33	-2.25	13	2.43	-4.66	-1.97
6	-5.02	-0.89	-0.43	14	-2.04	2.53	2.94
7	4.99	4.76	4.7	15	1.54	3.02	3.54
8	0	0	0	16	0.04	-1.74	-0.44