Proceedings of ISAP 2014, Kaohsiung, Taiwan, Dec. 2-5, 2014

VHF/UHF band antenna measurement using return loss compensation

Hu Chufeng, Li Nanjing, Chen Weijun
Science and Technology on UAV Laboratory, Northwestern Polytechnical University, Xi'an, China

***Abstract* - VHF / UHF band antenna measurement is easily influenced by surroundings. Since the bandwidth of antenna is narrow, the corresponding time-domain resolution is low, so it is difficult to eliminate the effect of multipath signals by adding a time domain gating. This paper presents a method which uses the return loss of antennas to compensate the spectrum of signals. The method extends the test bandwidth of antenna and improves the time domain resolution of signals, thus multipath interference signals are more easily to separate. The experiment of a half wavelength dipole antenna is measured in an anechoic chamber, the results show that the method can eliminate the influence of multipath interference; the measured pattern is consistent with the theoretical value.**

Index Terms —VHF / UHF band antenna measurement, multipath interference, time domain gating, return loss compensation

I. INTRODUCTION

VHF / UHF band antenna typically covers 30MHz to 1000MHz[1]. The band has large communication capacity and strong anti-jamming ability, which are widely used in FM radio, radar, navigation, mobile radio communications and other business equipment[2]. In order to ensure that these antennas work properly, high-precision measurement should be carried out. Antenna measurement is usually divided into outdoor test and indoor test according to different fields. Outdoor test is susceptible to environmental and weather, which is difficult to obtain accurate data and thus the conventional antenna measurement are usually completed at indoor.

Anechoic chamber can provide a free space for antenna measurement. However, when test frequency is low (especially on VHF band), then the size of absorbing materials is compared with wavelength, the properties of absorbing materials will be deteriorated[3]. Interference signals from side walls and the ground may affect accuracy. Since the propagation of multipath signals are delayed on time compared to the transmitted signals, therefore separation of them with time domain measurement is an effective method. Time domain measurement can be divided into direct and indirect methods. Direct method transmits a series of short pulse and uses a FFT to the received pulses, then obtains the radiation pattern[4,5]. However, the average signal power is low for this method, so the results are susceptible to the interference signals. Indirect method transmits continuous wave at each frequencies, then convert the frequency response to time domain with inverse Fourier transform, and using time domain gating to remove interference signals[6,7]. The advantage of this method is to achieve a high SNR integrated pulse, which is widely used in high-precision antenna test. However, the width of band is narrow on VHF / UHF band antenna measurement, and the equivalent width of time domain response is wide, so it is difficult to obtain a good resolution to distinguish main path from multipath signals.

This paper presents an improved indirect time domain technique for high-precision VHF/UHF band antenna measurement. The idea of method is to compensate the spectrum of transmitted and received signals on a wide band using the return loss of antennas. After compensating, the amplitude of frequency response of signals substantially uniform, which is to expand the measurement bandwidth of the antenna. The principle of method is described in second part. In third part, the measured data in anechoic chamber is validated to prove the effectiveness of its engineering applications.

II. RETURN LOSS COMPENSATION PRINCIPLE

The principle of method is shown in Figure 1. Since the antennas are not perfectly matched, the spectral of signal is regard as to be weighted, so the time domain resolution is low after using inverse Fourier transform to the frequency-domain response. By compensating the return loss of antennas, the power of signals are equivalent to be transmitted and received entirely, and the time domain resolution will be improved, thereby main path and multipath signals may be separated.

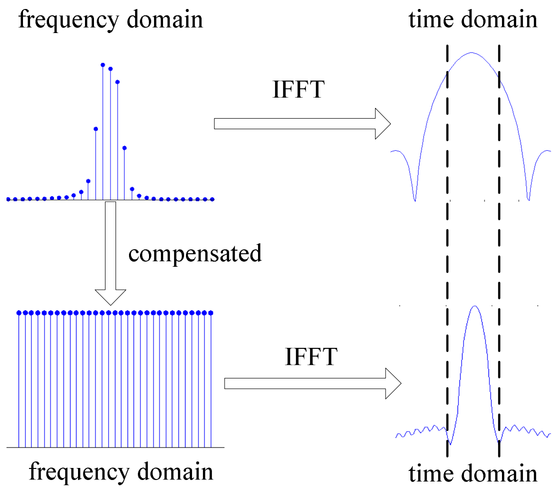

Fig.1 the principle of method

III. Experimental Results

The antenna test system was constructed in the anechoic chamber of Science and Technology on UAV Laboratory, which is shown in Figure 2. The walls and ground of anechoic chamber are covered by lots of absorbing material, whose reflectivity is approximately -30dB at 500MHz. A half-wavelength dipole antenna is measured, whose center frequency is about 350MHz and the bandwidth is 100MHz. A broadband log-periodic antenna is used as auxiliary antenna. A large metal plate is placed at the rear of the measured antenna, which is to simulate the multipath interference signal. The distance between them is 2.1m. If the indirect time-domain measurement is used, it is difficult to distinguish the interfering signal of metal plate and the antenna signal.

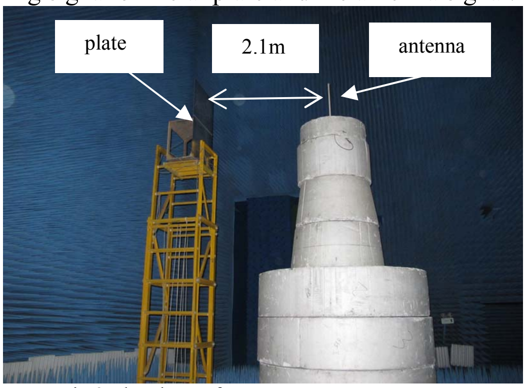

Fig.2 The photo of antenna measurement system

In order to verify effectiveness of the method, the test frequency is changed from 200MHz to 500MHz. Next, the spectral of two ends at frequency range are compensated by return loss of antennas; the time domain response after compensation is given in Figure 3.

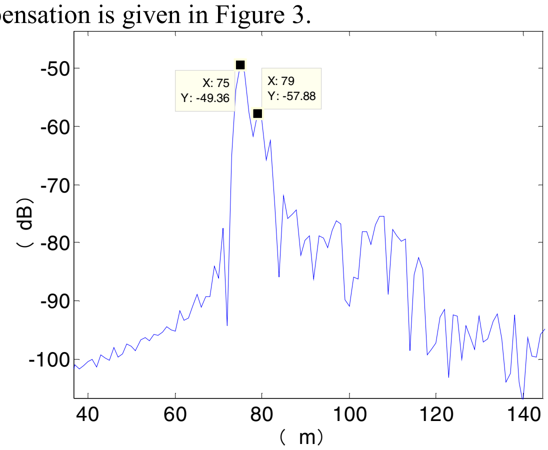

Fig.3 Time domain after compensation

In the figure, the signals of antenna and metal plate can clearly be seen. Then a time domain gating is used to select the antenna signal, so the multipath interference signal is accurately separated. Figure 4 gives the three unitary antenna patterns at 350MHz. When the metal plate is existed, the antenna pattern is distortion. After compensating the return loss, the result using indirect time domain method is coincident with the theoretical antenna pattern, and the interference of metal plate is mostly removed, which illustrates the effectiveness of this method.

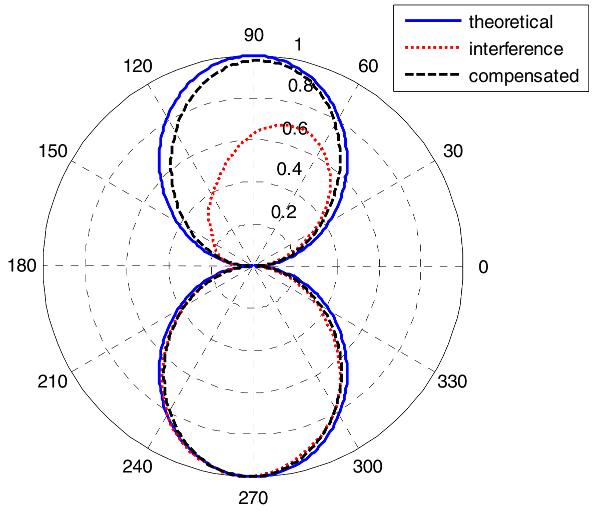

Fig.4 Unitary antenna patterns

IV. Conclusion

In this paper, return loss of antennas are compensated on the spectrum of signals to extend the test bandwidth of antenna and improve the received signals in the time domain resolution, which separates of multipath signals effectively. Experimental results show that the measured pattern after using this method is agreed with the theoretical value. This method can achieve high-precision measurement on VHF / UHF band antenna and has a well value in engineering.

References

[1] Y. T. LO, and S. W. Lee, Antenna Handbook, Van Nostrand Reinhold Company Press, New York, 1988.

[2] C. Papa, G. Alberti, G. Salzillo, etal. "Multimode Multifrequency Low Frequency Airborne Radar", in *Proc. Advances in Radar and Remote Sensing*, 2012, Napoli, Italy, pp. 247-251.

[3] J. Aubin, M. Winebrand, "Side Wall Diffraction & Optimal Back Wall Design in Elongated Chambers for Far–Field Antenna Measurements at VHFUHF Frequencies", in Proc. *IEEE Antennas Propagat. Soc. Int. Symp.*, 2010, Toronto, Canada, pp. 1-4.

[4] R. V. DeJongh, M. Hajian, L. P. Lighthart. "Antenna Time-Domain Measurement Techniques", *IEEE Antenna & Propagation Magazine*, vol.39, pp. 7-11, 1997.

[5] B. N. Levitas. "Time Domain Antenna Measurement Systems", in *Proc. Ultrawideband & Ultrashort Impulse Signals*, 2006, Sevastopol, Ukraine, pp.90-95.

[6] Y. T. Hsiao, Y. Y. Lin, et al. "Applications of Time-Gating Method to Improve the Measurement Accuracy of Antenna Radiation inside an Anechoic Chamber", in Proc. *IEEE Antennas Propagat. Soc. Int. Symp.*, 2003, Columbus, USA, pp. 794-797.

[7] H. J. Li, T. Y. Liu, J. L. Leou. "Antenna Measurements In The Presence of Multipath Waves", *Progress In Electromagnetics Research*, vol.30, pp. 157-178, 2001.