Wideband Sleeve Dipole Antenna for Range Calibration

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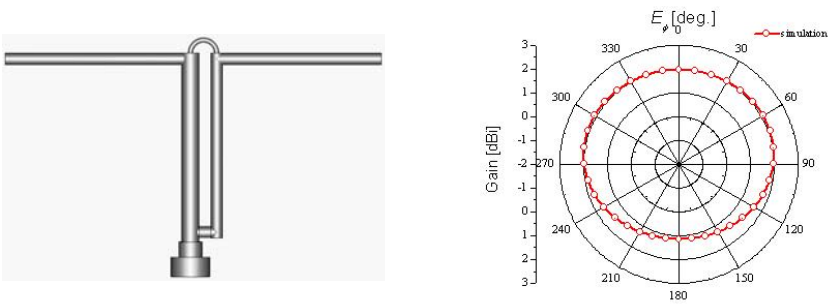
Abstract

A wideband sleeve dipole antenna used for range calibration is developed. RF choke and dielectric loading adapted to the sleeve dipole antenna improve the bandwidth characteristic of the dipole antenna. -10 dB return loss bandwidth has been measured 200 MHz from 650 to 850 MHz. Also, the designed antenna meets the CTIA requirement of ± 0.1 dB symmetry in the azimuth radiation pattern for ripple test measurements.

Keywords : Sleeve dipole, RF choke, Tapered dielectric, Omnidirectional pattern, Reference antenna

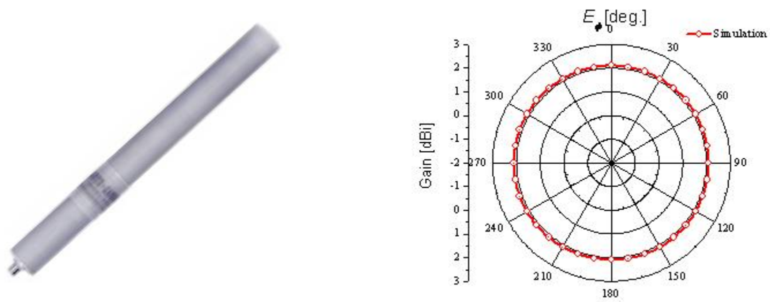
1. Introduction

In mobile communication test, the procedure for ensuring sufficient quiet zone performance of an anechoic chamber is required. The deviation of the reference antenna pattern from a perfect circle causes errors in evaluating the anechoic chamber. Since the symmetrical radiation pattern of the reference antennas is important, an omnidirectional antenna is often used[1].



(a) (b)

Fig. 1: (a) A half-wave resonant dipole with balun, (b) its azimuth radiation pattern.



(a) (b)

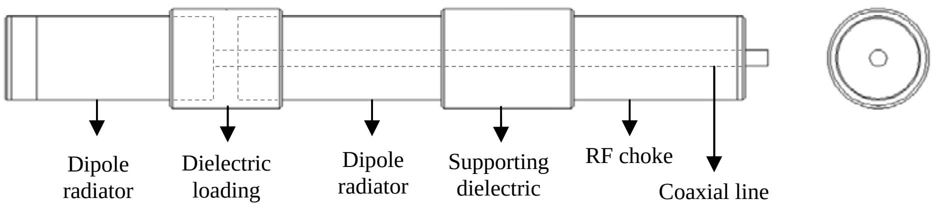
Fig. 2: (a) An end-fed sleeve dipole, (b) its azimuth radiation pattern.

To obtain an omnidirectional azimuth pattern, a half-wave resonant dipole antenna may be used. However, since the dipole antenna has a conductor balun for excitation, the azimuth radiation pattern is no more omnidirectional as shown in Fig. 1. Moreover, the half-wave resonant dipole antenna has narrow-band characteristic. To improve the bandwidth and the omnidirectional characteristic, a sleeve dipole antenna shown in Fig. 2 is often used[2-4]. The sleeve dipole antenna design allows the antenna to be end-fed in order to avoid cable and feedpoint degrade interfere with the performance of the antenna.

Several reference antennas having omnidirectional pattern are used to cover a wide frequency range in the range calibration procedure[2,3]. If a reference antenna had wider bandwidth characteristic, smaller number of reference antennas were needed in the test. A commercially available sleeve dipole antenna, ESCO Tech. Co.'s Model 3126-700, has 200 MHz bandwidth from 600 to 800 MHz with return loss < -6 dB over the entire band[1].

In this paper, a sleeve dipole antenna having wider bandwidth than that of Model 3126-700 is realized which can be used as a reference antenna for range calibration. The size of the developed antenna is nearly the same as that of Model 3126-700. Adjusting RF choke structure and dielectric loading scheme enables the antenna to have wider bandwidth characteristic. The antenna is simulated by using CST's MWS(Microwave Studio). Measurement result shows 200 MHz bandwidth (return loss < -10 dB) from 650 to 850 MHz and the azimuth radiation pattern that meets the CTIA(Cellular Telecommunication and Internet Association)'s ± 0.1 dB symmetry requirement for ripple test measurements[1].

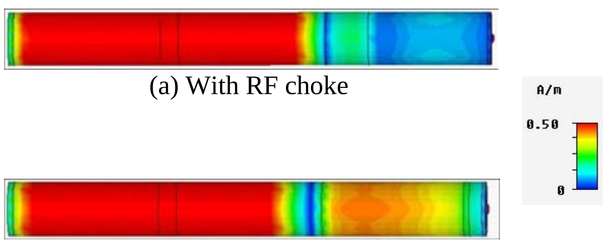
2. Design of sleeve dipole



(a) Side view (b) Cross-sectional view

Fig. 3: Structure of the proposed sleeve dipole antenna

Fig. 3 shows the proposed sleeve dipole antenna structure that consists of two dipole radiator, RF choke, and loading and supporting dielectrics in coaxial structure. The initial length of each radiator and the RF choke is chosen to quarter wavelength[5]. The lengths are then optimized by simulation. Fig. 4 shows the current distribution on the surface of the sleeve dipole. While Fig. 4(a) is for the case of replacing RF choke with the same-length dielectric ring, Fig. 4(b) is for the case of using RF choke.



(a) With RF choke

(b) Without RF choke

Fig. 4: Current distribution

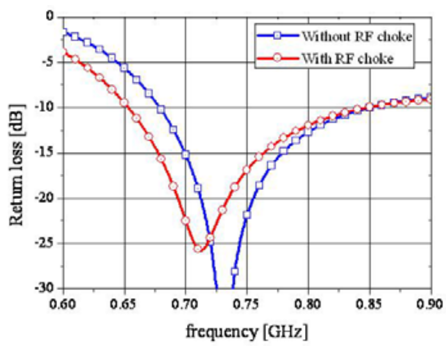


Fig. 5: RF choke effect

As shown in Fig. 4(a) the RF choke blocks the current in the direction of the feeding point so that the current distribution on the dipole radiator looks like that of a half-wave resonant dipole. Therefore, the radiation pattern also has the similar pattern to the half-wave resonant dipole. On the other hand, the current at the supporting dielectric section in Fig. 4(b) causes the elevation pattern move upward compared to the pattern of Fig. 4(a). Still the omnidirectional azimuth pattern is maintained but the gain is reduced in the azimuth direction.

Since the coaxial cable is electronically isolated from the dipole radiators due to the RF choke, a stable and repeatable measurement of the antenna free from the cable vibration noise is possible. Fig. 5 compares the return loss characteristic of Fig. 4(a) structure with that of Fig. 4(b) structure. It can be found that the bandwidth is also increased by using the RF choke.

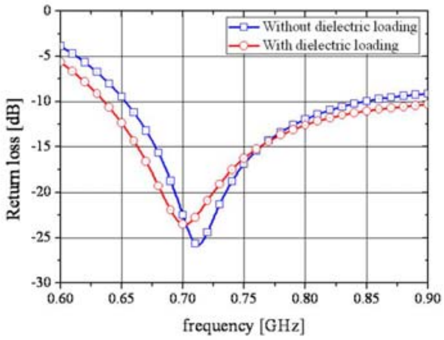


Fig. 6: Dielectric loading effect

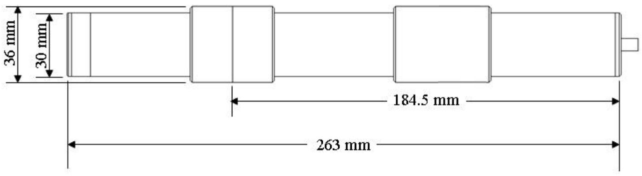


Fig. 7: Dimensions of the fabricated antenna

The dielectric loading at the center of the radiator section affects the bandwidth characteristics, too. As shown in Fig. 6, the bandwidth is widened with dielectric loading. In our case a dielectric whose relative permittivity is 2.8 has been used. The dielectric also helps the mechanical durability of the antenna, not affecting the omnidirectional pattern of the antenna. Fig. 7 shows the dimensions of the fabricated antenna.

3. Simulation and Measurement Results

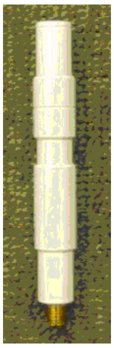


Fig. 8: Fabricated sleeve dipole

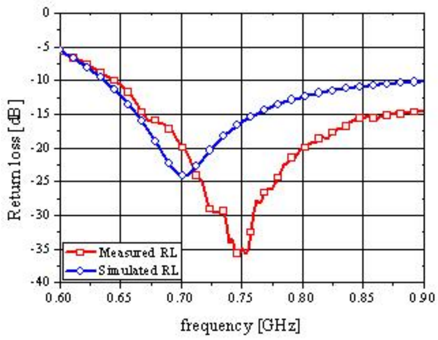


Fig. 9: Simulated and measured return losses

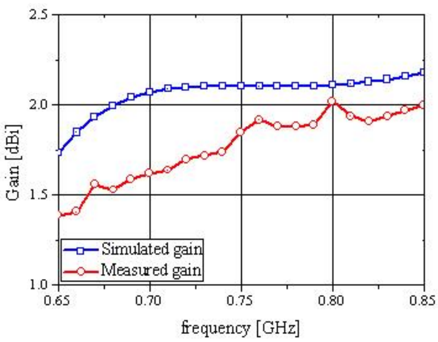
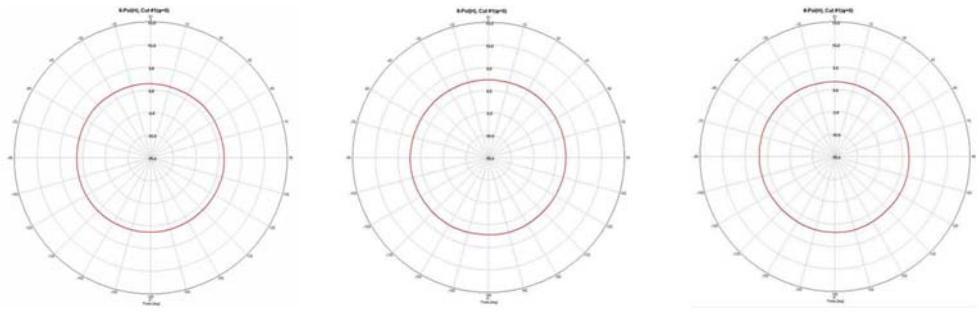


Fig. 10: Simulated and measured gains

Fig. 8 shows the fabricated sleeve dipole whose dimensions are shown in Fig. 7. Fig. 9 shows the simulated and measured return losses of the sleeve dipole. Both results meet < -10 dB return losses from 650 to 850 MHz. Fig. 10 shows the simulated and measured gains.



(a) 650 MHz (b) 750 MHz (c) 850 MHz

Fig. 11: Measured azimuth radiation patterns

Fig. 11 shows the measured radiation patterns having omnidirectional characteristics. Measured result has a ripple less than ± 0.1 dB so that it meets CTIA's requirement for ripple test measurements.

4. Conclusion

A sleeve dipole antenna having wider bandwidth than a commercial antenna has been realized. Since a RF choke can control the current distribution on the antenna to have that of a half-wave resonant dipole, the radiation pattern of the realized sleeve dipole antenna has the similar pattern to that of the half-wave resonant dipole. Also, the RF choke increases the bandwidth of the antenna and enables a stable and repeatable measurement. Dielectric loading in the middle of the radiators improve bandwidth characteristic, too. The antenna is designed by CST's MWS simulations, realized, and measured. The antenna has 200 MHz bandwidth from 650 to 850 MHz. The measured pattern having an omnidirectional azimuth pattern meets CTIA's ± 0.1 dB symmetry requirement for ripple test measurements.

References

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