

An Ultrawideband Patch Antenna for UHF Detection of Partial Discharge

Y. Zhang¹, D. Upton¹, A. Jaber¹, U. Khan¹, B. Saeed¹, H. Ahmed¹, P. Mather¹,
R. Atkinson², P. Lazaridis¹, M.F. Q. Vieira³ and I.A. Glover¹

¹Department of Engineering & Technology, University of Huddersfield, Huddersfield HD1 3DH, UK,
<http://www.hud.ac.uk/ce/>

²Department of Electrical Engineering, University Federal de Campina Grande, Campina Grande, Brazil

³Department of Electronic and Electrical Engineering, University of Strathclyde, Glasgow G1 1XW, UK

The location of partial discharge (PD) sources by free-space UHF detection is an attractive approach for condition monitoring of high voltage equipment in substations. A low-cost, radiometric, PD wireless sensor network (WSN) has been proposed to provide continuous real-time coverage for an entire substation (J.M. Neto, Y. Zhang, A. Jaber, M. Zhu, M. Judd, R. Atkinson, J. Soraghan, J.S. Neto, M.F. Vieira, I.A. Glover, *2014 XXXIth URSI General Assembly and Scientific Symposium (URSI GASS)*, Beijing, 16 - 23 Aug. 2014, pp.1-4). A suggested band for UHF PD detection is 0.3 - 1.5 GHz (Z. Tang, C. Li, X. Cheng, W. Wang, J. Li, *IEEE Trans. Dielectr. Electr. Insul.*, 6, 2006, pp. 1193–1199). A novel ultrawideband (UWB) printed monopole antenna is presented here for PD WSN applications.

Fig. 1 shows the configuration of the proposed antenna and a constructed prototype. It is constructed on FR4 substrate with thickness 1.6 mm and relative dielectric constant of 4.4. The width of the 50 Ω microstrip feed (W_2) is 3 mm. The antenna is compact (dimensions 24 cm $\times$ 20 cm). The optimised parameters are $L_1 = 50$ mm, $L_2 = 6$ mm, $L_3 = 2$ mm, $L_4 = 43$ mm, $L_5 = 90$ mm, $W_1 = 64$ mm, $W_2 = 3$ mm, $W_3 = 16$ mm, $W_4 = 50$ mm, $W_5 = 68$ mm, $h = 1.6$ mm. The impedance bandwidth is enhanced by the two steps ($L_4 \times W_3$) and bevelled shoulders (W_4). The slotted ground plane with a rectangular notch, $(L_2 - L_3) \times W_1$, and the offset L_3 between the radiating patch and ground plane are for impedance matching. Adjusting the latter controls coupling between the lower edge of the patch and ground plane. The low frequency limit is determined by the total effective length of the antenna current which includes the patch and ground plane.

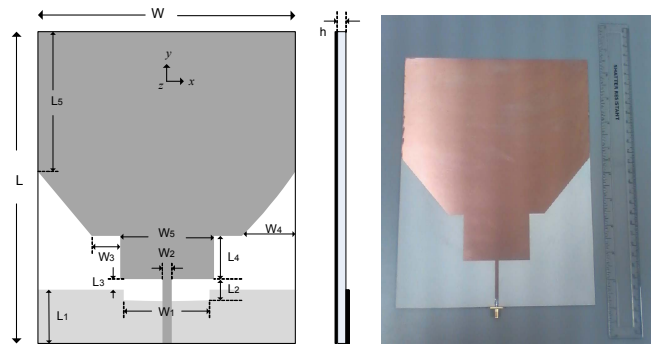


Fig. 1 Antenna configuration and constructed prototype

The bandwidth of a UWB antenna can be achieved by overlapping several adjacent resonances, each one represented by a parallel equivalent circuit. The proposed antenna structure is simulated using

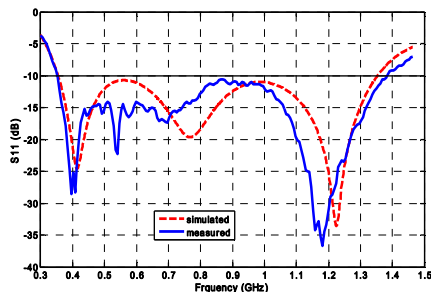


Fig. 2 Simulated and measured return loss

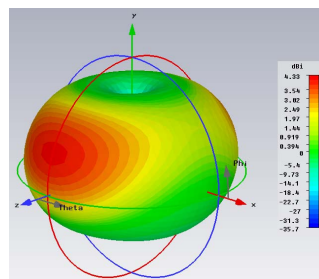


Fig. 3 Radiation pattern at 0.75 GHz

frequency the antenna has an approximately omnidirectional H-plane pattern but with maximum gain directed approximately 24 degrees offset from the x-z plane. The E-plane pattern is similar to that of a monopole antenna but with slightly greater gain in the y-z plane compared to the x-y plane.

CST Microwave Studio. Fig. 2 shows the measured and simulated return loss. -10 dB return loss (S_{11}) is achieved from 0.35 to 1.37 GHz. The three resonances (most obvious in the simulated S_{11}) are due to the three serial discontinuities moving from the feed line along the antenna. Fig. 3 shows the simulated far-field radiation pattern at 0.75 GHz. The peak directivity is 4.3 dBi. At this