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Measurement of Dielectric Properties of Textile Substrate

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Abstract: This study presents the measurement of dielectric properties of textile substrate in which is used in fabricating the textile antenna. The measurement setup of felt’s dielectric properties is shown in this study. The results were compared to the previous work where the dielectric properties of felt was found to be consistent with the one reported in the literature. This research provides dielectric properties value of felt textile which will be used widely for all-textile based antennas.

Key words: Dielectric properties, textile antenna, textile substrate, fabricating, dielectric, Malaysia

INTRODUCTION

Textile-based antennas have gained in popularity recently because they provide flexibility, conformality and ergonomics to the users. Several textile-based antennas have been proposed both for narrowband and wideband Wireless Body Area Network (WBAN) (Mantash et al., 2011; Rais et al., 2013; Soh et al., 2012; Shakirul et al., 2014). One of the most important materials to fabricate the textile-based antennas is the substrate textile which is a non-conductive textile material.

There are many types of non-conductive textiles available in the market such as cotton, denim, felt, fleece fabric, hypalon coted dacron fabric, woven fiberglass, flannel and jeans fabric. Shakirul et al. (2014) showed the detail specification of substrate materials in terms of permittivity, thickness, characteristics and performances. Thus, the aim of this work is to measure and determine the dielectric properties of felt textile in which is used to design and fabricate all-textile based antennas.

MATERIALS AND METHODS

Experimental: An Agilent 85070B high temperature dielectric probe kit was used to determine the dielectric properties of felt used as a substrate in both wearable textile antenna topologies. The dielectric probe technique is performed by contacting the sample with the probe. In this measurement, setup the Agilent 85070B high temperature dielectric probe an agilent Performance Network Analyzer (PNA) (Model Agilent PNA E8362B) and Agilent 85070 Software were used. Figure 1 shows experimental procedure for using the high temperature probe the probe makes contact with the flat surface of a
solid which in this case was felt. The felt was folded to
form three layers of flat surfaces before the dielectric
probe was pressed on the layered felt, ensuring the
minimum air gap between the layers of felt.

The Agilent 85070 Software, featuring frequency
ranges from 200-20 GHz, computes the measured reflected
response which consists of the dielectric constant and the
dielectric loss of the flat felt. The reflected signal, S11 is
measured and then associated with εr. The calibration is
conducted prior to using of the high temperature
Dielectric Probe kit, involving three components and the
software. The components used in the calibration are air
a metallic shorting block and water. The water was
measured using commercially available natural mineral
water (Locher et al., 2006) at a temperature of 25°C. The
dielectric constant and loss tangent of the mineral water
after the calibration measurement was consistent with.
Cylindrically-shaped dielectric material blocks were used
in measuring the dielectric properties. Figure 2 shows the
measurement of dielectric properties of felt textile material
using Agilent flexible coaxial cable.

RESULTS AND DISCUSSION

Five repetitive readings of the dielectric properties
were obtained and averaged. Figure 3 shows the dielectric
properties, i.e., dielectric constant and dielectric loss) of
felt textile. It was observed that a slight decrease in
dielectric constant of felt across the frequency range from
200-20 GHz while the dielectric loss of felt remained
constant across the frequency range from 2-20 GHz.
Furthermore, in order to design the textile-based antenna
resonated at 2.45 GHz the felt’s dielectric properties are
determined at that particular frequency. The Software
computes the values of felt’s dielectric Ghz. Thus, it
was concluded that the dielectric properties of the felt
substrate measured at 2.58 GHz essentially was the same
as the dielectric properties measured at 2.45 GHz (±0.01).

CONCLUSION

In this research, the measurement of dielectric
properties of textile substrate was determined for
frequency range from 200-20 GHz. This felt textile is used
to design and fabricate the all-textile based antennas. A
detailed measurement setup of felt’s dielectric properties
was described in this study. The results were found to be
consistent with the one measured at 2.45 GHz in the open
literature.

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