

TEXTILE-INTEGRATED TRANSMITTING UNIT

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Key words: Textile-integrated antenna, screen printing, 3D knitted fabric

Abstract. This contribution deals with the main parts of the textile-integrated transmitting unit, a transmitter and an antenna, operating in the ISM 5.8 GHz band. The transmitter is based on commercially available WLAN UART Serial Port OWS451 and it is controlled via the UART interface by microprocessor ATmega328. The antenna is based on the circular ring-slot concept and it is able to provide monopolar radiation pattern to ensure maximum coverage of the unit. The unit will be integrated in a seat cover and it will transmit the telemetry of sensors integrated in the seat (temperature, pressure...).

1 INTRODUCTION

In order to reduce weight of small airplanes and consequently decrease their fuel consumption, there is strong motivation to develop and use multifunctional structures. E.g. if textile materials are used, they can fulfill different functions. Apart from their conventional roles of seat or upholstery covers, they can be considered for thermal insulation or mechanical attenuation. In addition, textile materials are nowadays very popular for development of electronic components where they usually play the role of a substrate [1], [2].

In our previous work [2], the attention was focused on the integration of wireless sensor network components into 3 dimensional (3D) knitted fabrics (produced by SINTEX) exploited on a board of a small airplane EV-55 (developed by EVEKTOR) with particular attention on optimized 3D knitted fabric and textile-integrated receiver. In this paper, we will describe the main parts of the textile-integrated transmitting unit, a transmitter and an antenna, operating in the ISM 5.8 GHz band.

2 TRANSMITTER

The transmitter is based on IEEE 802.11a standard that can communicate over the 5 GHz frequency band [3]. The WLAN UART Serial Port OWS451 module has UART interface and fully embedded TCP/IP stack and driver. For real-time data acquisition, due to the dimensions and the selected frequency band, it seems to be the best choice. The module itself is controlled via the UART interface by microprocessor ATmega328. The microprocessor is as well connected through A/D converters to a sensor matrix for mechanical pressure sensing. The pressure sensors are piezoresistive fabrics that are made by coating regular fabrics in an inherently conductive polymer. In order to provide data to user, the wireless module is then connected to an AP (Access Point) router or ad-hoc network. Sensor data is sent to a user application that communicates using UDP (User Datagram Protocol). A Python visualization program is created on the user side.

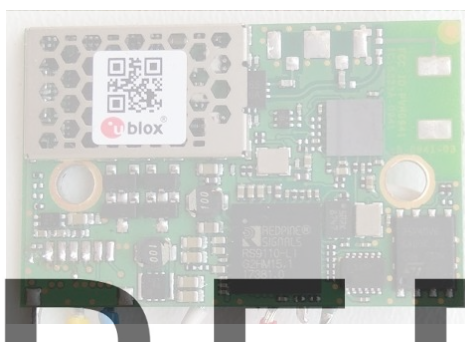


Figure 1: Photo of transmitter.



To ensure maximum coverage of the unit, a ring slot antenna [4] was used and integrated for a monopole-like radiation pattern. However, in comparison to the antenna with shorting vias [5], the designed antenna is free of vias since the monopole-like radiation pattern is generated by the excitation of higher order mode in the slot. On the other hand, it is larger than it could be if the shorting vias were used.

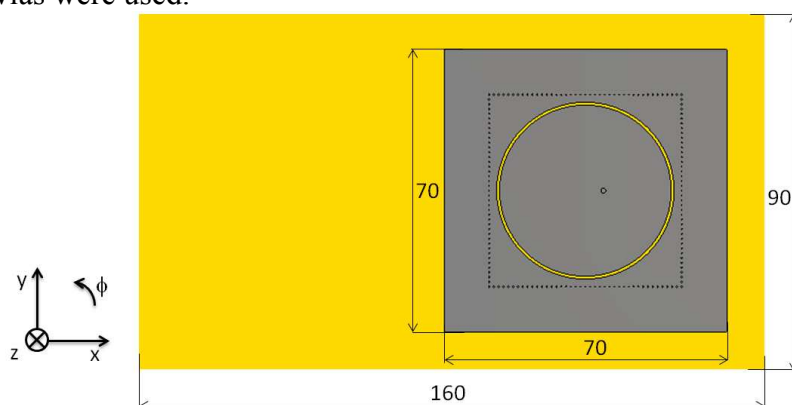


Figure 2: Top view of antenna realized on 3D knitted fabric.

The geometric configuration of the substrate integrated waveguide (SIW) circular ring-slot antenna is depicted in Figure 2. The antenna is designed on 3D knitted fabric of the thickness 3.4 mm and the relative permittivity 1.2. The fabric is from both sides covered by Digiflex – Master foil from the company Alphaset. The foil was ironed on the fabric. The radiator was screen printed on the top side of the fabric covered by the foil using Aurel mod. C880 semiautomatic screen printer. For the printing, the ESL 1901-S polymer silver conductor paste with good electrical conductivity was used. The same procedure was applied on the bottom side of the fabric covered by the foil to create continuous conductive surface of the same size and position, but without the circular slot. To create the vertical walls of the SIW cavity, conductive thread ELITEX® Art, SC 110/f34_PA/Ag was used. To experimentally verify the properties of the antenna, it is equipped by SMA connector. In the final phase, the SMA connector will be replaced by UFL one and the antenna will be connected by a coaxial cable with the transmitter. The fabricated sample of the antenna is depicted in Figure 3.



Figure 3: Fabricated sample of the antenna (left) and the antenna with connected transmitter (right)

The reflection coefficient of the antenna is depicted in Figure 4. Although the measured data shows narrower band response than the simulated one, the antenna is still very well matched in the desired ISM 5.8 GHz band (5.725 – 5.875 GHz). The difference of simulated and measured response is probably caused due to manufacturing tolerances.

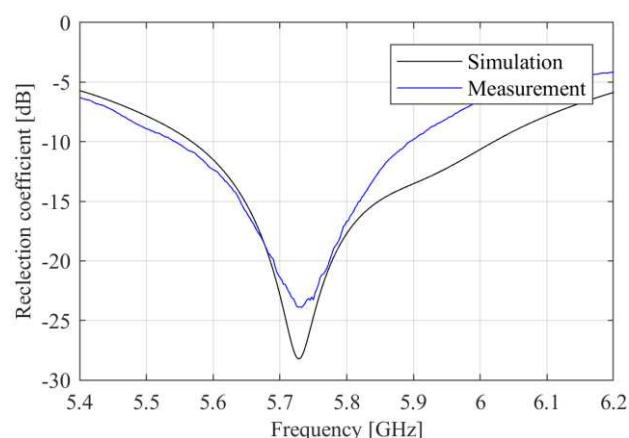


Figure 4: Reflection coefficient of simulated and measured antenna.

The simulated and measured radiation gain patterns are depicted in Figure 5. We can observe that the antenna is able to provide monopole like radiation pattern. The agreement of simulated and measured results is satisfactory. The measured peak gain of the antenna is about 5 dBi.

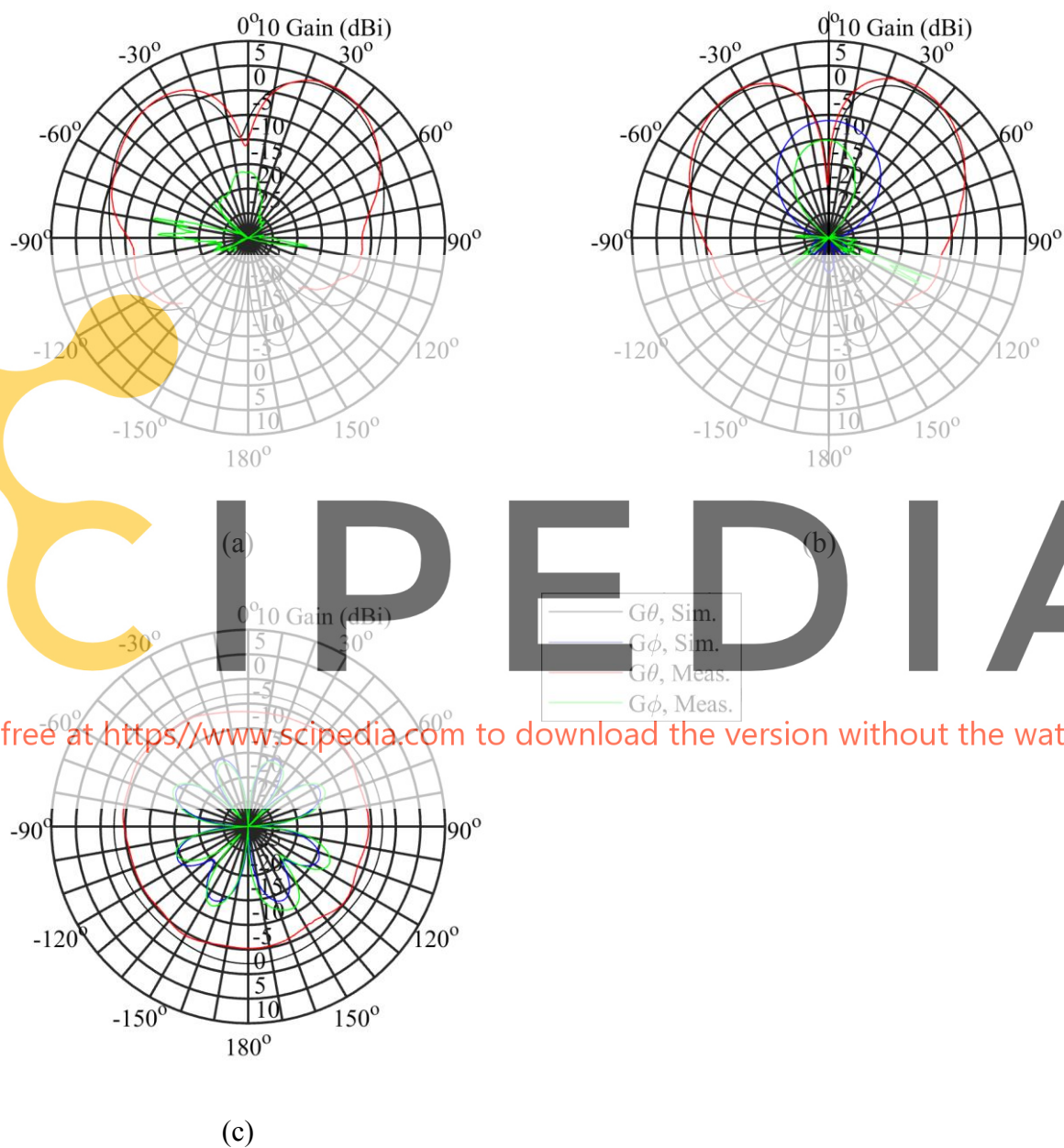


Figure 5: Radiation gain pattern of antenna at frequency of 5.8 GHz in xz-plane (a), yz-plane (b), and xy-plane(c).

4 CONCLUSIONS

In this contribution, the main parts of the textile-integrated transmitting unit, the transmitter and the antenna, operating in the ISM 5.8 GHz band has been described. Now both those parts are being integrated. The final data of the unit will be presented at the conference.

ACKNOWLEDGEMENT

The described development has been supported by the Czech Ministry of Industry and Trade by the grant FV10087 Intelligent upholstery of vehicles.

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