

The proposed antenna in this work can be either a single band or dual-band based on the status of the PIN-diode. One PIN-diode is incorporated to the stub, as shown in Fig. 1, to redirect and redistribute the surface current on the stub. For the forward biased (ON), the proposed antenna acts as a single folded slot antenna where the antenna has a single band due to the slot only and also its polarization is based on the slot orientation. However, when the PIN-diode is reversed biased (OFF), the diode is used to change symmetry of the stub with respect to the CPW feed line. As a result, the stub becomes asymmetrical and the surface current is redirected to be in phase on the asymmetrical part of the stub. Thus, the stub is radiating for a second resonant frequency. In this case, the antenna is dual band with two different polarizations, the first band is due to the slot while the second band is due to the stub. The polarization of the slot and the stub are interchanged according to the concept of Babinet's principle [6]. To ensure that the proposed antenna is well radiator for conformal configurations, the antenna is tested for two curved cylindrical configurations with a radius of curvature ($R = 25$ mm), which are the circumferential and axial configurations. The two configurations are defined based on the slot orientation with respect to the axis of the cylinder (z-axis), as shown in Fig. 2.

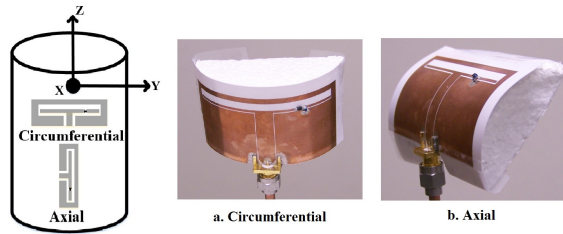


Fig. 2. Fabricated prototype: a) Circumferential configuration. b) Axial configuration.

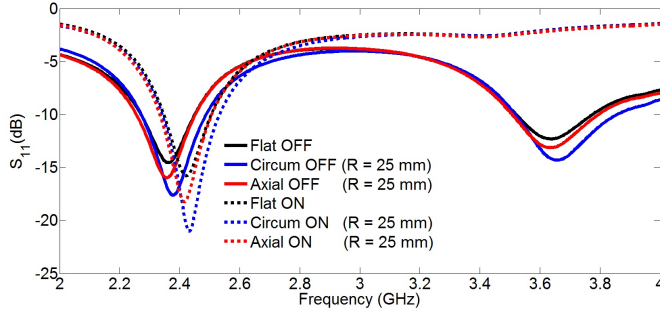


Fig. 3. Reflection coefficients of flat, axial and circumferential configurations for the two states of the PIN-diode.

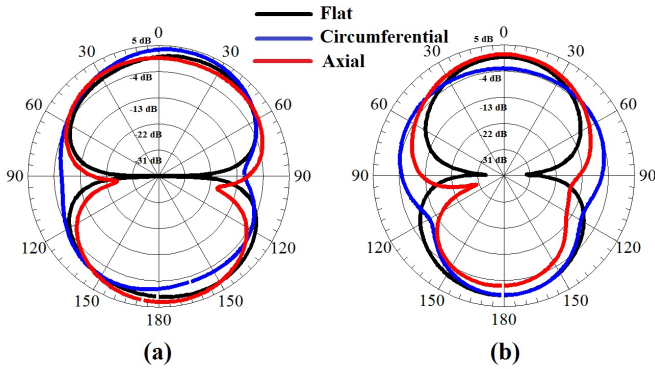


Fig. 4. Comparison between measured patterns for flat, axial and circumferential configurations ($R= 25$ mm): (a) E-plane for the slot. (b) E-plane for the stub.

III. RESULTS AND DISCUSSIONS

The proposed antenna was designed, simulated and fabricated. Inkjet printing technology was used to fabricate the antenna, where a copper metal was produced on the very thin flexible substrate (PET). The proposed antenna was tested in terms of reflection coefficients, amplitude patterns and gain for flat and curved cylindrical configurations. Fig. 3 shows the reflection coefficients of flat, circumferential and axial configurations for the two states of the PIN-diode. It was observed that the antenna maintains its resonant frequencies and bending the antenna does not have that much of impact on the resonant frequencies of the antenna. When the PIN-diode is ON, the antenna has a single band at 2.42 GHz with

single linear polarization due to the slot only. In this case, the antenna works for Wireless Local Area Network (WLAN) applications. When the PIN-diode is OFF, the antenna has a dual band and each band has different polarization. One polarization is attributed to the slot at 2.36 GHz while the other one is at 3.64 GHz, which is orthogonal to that of the slot, is due to the stub (the stub acts as dipole). In this case, the antenna provides wireless connectivity for WLAN and Worldwide Interoperability for Microwave Access (WiMAX) applications.

The radiation patterns (E-plane) for circumferential and axial configurations are compared with the flat configuration in Fig. 4. It is worth mentioning that for the flat configuration, the entire surface of the antenna is parallel to its principle axes, thus the null filling occurs at the expected position and the E-plane pattern is symmetrical. This is not the case when the antenna is curved where the entire antenna surface is not parallel to its principle axes. Thus, as expected there are some changes in the null filling, symmetry and also orientation of the patterns for curved configurations. It was observed, as shown in Fig. 4, the gain of the slot-stub combination at broadside ($\theta = 0$) is changing depending on their orientation: circumferential or axial orientation. For circumferential orientation, the gain of the slot is increased while the gain of the stub is decreased. However, for axial configuration, the gain of the slot is decreased while the gain of the stub is increased, as shown in Fig. 4. When the antenna is mounted on curved configurations, the antenna radiates energy not only in the forward hemisphere but also radiates energy on the curved surface, thus the pattern becomes broader.

IV. CONCLUSIONS

A flexible reconfigurable antenna with different cylindrical configurations is proposed. The antenna is either single band or dual band with different oriented polarization depending on the status of One PIN-diode, which is inserted to the stub to reconfigure antenna. The study of the radiation characteristics, such as reflection coefficients and amplitude patterns, of the curved proposed antenna shows that the antenna maintains its function when it is used for conformal applications.

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