

Design of a Broadband Conformal Antenna for Ingestible Capsules

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A broadband slot antenna which is conformal to the inner-wall of a capsule is proposed. The proposed antenna has a miniature size, and yet it provides a wide impedance bandwidth, ranging from 1.67GHz to 3.5GHz (71.8%). Given the application scenario that the capsule is to move inside the digestive tract and thus experience a variety of surrounding environments, such a wide bandwidth is helpful for achieving good impedance match in such an operating environment. The procedure for designing the antenna is presented to provide an insight into its development. In addition, it is shown that the proposed conformal antenna maintains a stable impedance match when a battery is added inside or when the size of the battery is changed.

The capsule shell has a height of 21 mm and a diameter of 7.5 mm, which is the about the same as that of a typical prescription pill. The proposed design for the capsule can be easily tailored to fulfill the request for a larger size, if this is required for some applications. For simulations, the capsule is placed at the center of muscle box with a size of $60 \times 60 \times 70 \text{ mm}^3$. Evolution of the antenna geometry is shown in Fig. 1(a), and the simulated return loss characteristics of the corresponding antennas are provided in Fig. 1(b). The proposed antenna originates from a loop that conforms to the inner wall of a capsule shell. The bandwidth of the conformal loop is 16.1%. Next, we test the loop slot, which is complementary to the loop, and find that it has a much wider bandwidth of 49.2%. To widen the bandwidth even more, additional slots are employed on the inner patch of the loop-slot antenna. We find that the C-shaped slot helps to obtain a bandwidth of more than 71.2%.