SMALL EPIDERMAL ANTENNAS

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***Abstract*—Small magnetic loop antennas are proposed as skin transfer tattoos to overcome the efficiency limitations of human tissue and variability of detuning.**

Keywords—transfer tattoo antennas, RFID

I. INTRODUCTION

Various epidermal antennas have been reported for use very close to, or mounted directly onto the skin surface [1]. While providing a convenient and conformal solution for skin-mounted communications, these antennas are inherently limited by their close proximity to lossy skin tissue and have radiation efficiencies usually worse than -11dB and as low as -20dB [2, 3]. Additionally, the variability of human tissue means that detuning can be a significant problem with permittivity and conductivity varying in the order of 20% and 40% respectively across individuals. To address the detuning and efficiency problems of epidermal mounting, it is proposed to create small magnetic loop antennas as transfer tattoos.

II. TRANSFER TATTOO MAGNETIC LOOPS

A magnetic loop (electrically small) antenna is defined as having a circumference of more than one-eighth wavelength but somewhat less than one-third wavelength. This results in an approximately uniform current distribution around the perimeter and the structure behaves as a lumped inductance.

In this application a UHF skin based RFID tag is developed, meaning that the loop self-inductance is resonated with a lumped or distributed capacitance to form a high-Q parallel tuned circuit.

The vertically oriented loop maximum radiation pattern is in the plane of the loop (across the skin surface) with nulls at right angles to the plane of the loop. Energy radiated by the loop is vertically polarized on the horizon and horizontally polarized overhead at the zenith. This makes the antenna attractive for systems were various tattoos on the skin surface may need to communicate within a local network.

The loops to be reported are matched to the feed characteristic impedance via a Gamma match feed, which acts as a tapped autotransformer with the feed return connected to the loop's central neutral point and the center conductor connected via a parallel conductor to the loop, and tapped at a point where the voltage to current ratio matches the desired impedance. There is some inherent loop imbalance and asymmetry with this arrangement, though these issues are not anticipated to be significant compared to the pattern fragmentation arising from the human body mounting.

The reported antennas operate at 865MHz with 15mm diameter loops resonated with a 1pF capacitor. The measured S_{11} of a ring on tattoo transfer paper is shown in Fig. 1 demonstrating a good match and high Q. The wavelength at 865MHz is 35cm resulting in a loop of 0.13λ which makes it electrically small.

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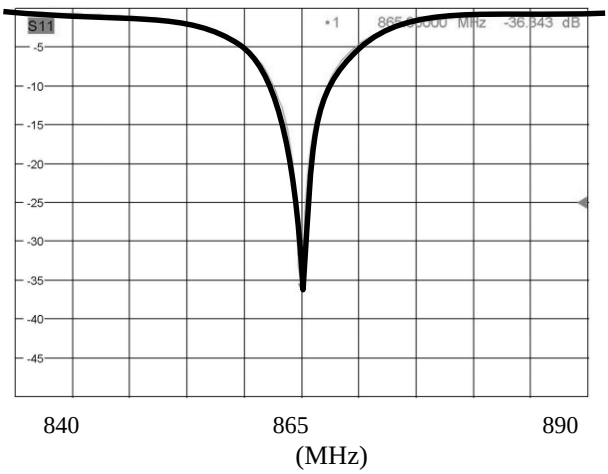

Fig. 1. Measured S_{11} of tattoo transfer small loop antenna