



Kent Academic Repository

Taylor, P.S. and Batchelor, John C. (2016) *Small Epidermal Antennas*. In: IEEE Proceedings of APSURSI. . p. 1. IEEE, Puerto Rico

Downloaded from

<https://kar.kent.ac.uk/57129/> The University of Kent's Academic Repository KAR

The version of record is available from

<http://www.2016apsursi.org/>

This document version

Publisher pdf

DOI for this version

Licence for this version

UNSPECIFIED

Additional information

Versions of research works

Versions of Record

If this version is the version of record, it is the same as the published version available on the publisher's web site. Cite as the published version.

Author Accepted Manuscripts

If this document is identified as the Author Accepted Manuscript it is the version after peer review but before type setting, copy editing or publisher branding. Cite as Surname, Initial. (Year) 'Title of article'. To be published in *Title of Journal*, Volume and issue numbers [peer-reviewed accepted version]. Available at: DOI or URL (Accessed: date).

Enquiries

If you have questions about this document contact ResearchSupport@kent.ac.uk. Please include the URL of the record in KAR. If you believe that your, or a third party's rights have been compromised through this document please see our [Take Down policy](https://www.kent.ac.uk/guides/kar-the-kent-academic-repository#policies) (available from <https://www.kent.ac.uk/guides/kar-the-kent-academic-repository#policies>).

SMALL EPIDERMAL ANTENNAS

Paul S Taylor and John C Batchelor

School of Engineering and Digital Arts, University of Kent, Canterbury, UK

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 where 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.

REFERENCES

- [1] M.A. Ziai and J.C. Batchelor, "Temporary On-Skin Passive UHF RFID Transfer Tag," *Antennas and Propagation, IEEE Transactions on*, vol.59, no.10, pp. 3565-3571, October 2011.
- [2] R.M. Makinen and T. Kellomaki, "Body Effects on Thin Single-Layer Slot, Self-Complementary, and Wire Antennas," *IEEE Trans. Antennas and Propagation*, vol. 62, no. 1, January 2014, pp. 385-392.
- [3] S. Amendola, S. Milici, G. Marrocco and C. Occhiuzzi, "On-Skin Tunable RFID Loop Tag for Epidermal Applications," *IEEE AP-S, Vancouver*, July 2015, pp. 202-203.

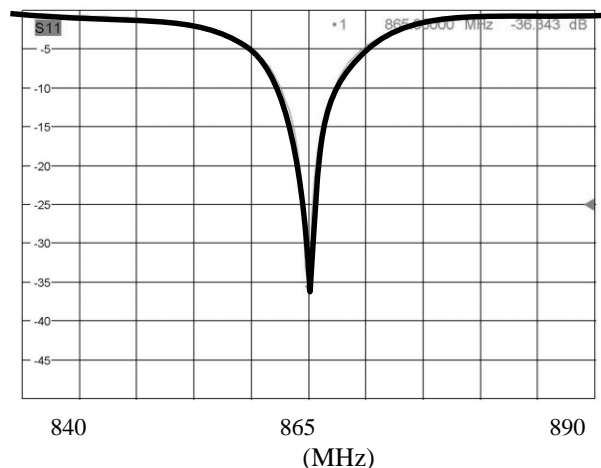


Fig. 1. Measured S_{11} of tattoo transfer small loop antenna