ULTRA – WIDEBAND RADIO FREQUENCY VEST ANTENNA

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1. Introduction

The COMbat Wear INtegration (COMWIN) concept, developed by the authors, is based upon the idea of integrating communication antennas into the items of combat gear (flak vest, helmet, etc.) of the dismounted infantryman. The Ultra-Wideband Radio Frequency Vest Antenna (UWRFVA) is a COMWIN component intended to operate from 30 MHz to 500 MHz. The RF vest antenna has been designed such that it can be integrated as an external layer of the existing military flak vest or worn as a "cover" over the Kevlar flak vest.

The process of designing the UWRFVA started with the analysis of the ultra-wideband antenna concepts, followed by computer simulation of potential designs. Next, the UWRFVA prototype, referred to as Mk I, was constructed and measured in order to verify the simulation results. Ongoing work includes the design optimization and the fabrication and measurements of the second prototype (Mk II).

This paper focuses on the results obtained from the measurements of the first physical prototype (Mk I). Specifically, the measured input impedance, VSWR, and sample radiation patterns are presented. Results of computer simulations are also included for comparison with the measured data.

2. UWRFVA Design

The basic design of the UWRFVA is shown in Figure 1 (the front view of the Mk I prototype on a styrofoam man model). The UWRFVA is constructed out of a type of conducting cloth (polyester fibers interwoven with copper fibers) called FLECTRON [1]. Copper tape is used to reinforce certain areas of the vest and to allow soldering of the feed transmission line (Figure 2). The thin conducting cloth is applied to a canvas base to provide mechanical strength to the UWRFVA and prevent tearing. A gap separates the upper and the lower half of the UWRFVA, as shown in Figure 1, into two sections of approximately equal surface areas. The UWRFVA is fed by a coaxial cable in the back. Depending on how the radio is positioned relative to the gap, the coaxial shield is attached to either the upper or the lower half of the vest, while the center conductor is attached to the opposite half, across the gap (Figure 2). On the UWRFVA side opposite the feed (the front side of the UWRFVA), the upper and the lower halves of the UWRFVA are "shorted" by thin copper tape (Figure 1).

A conceptual operational description of the underlying antenna concept that provides the wideband operation of the UWRFVA is to consider the UWRFVA as a limiting case of a horizontal slot antenna on a vertical cylinder of finite height, with the gap between the upper and the lower halves of the RF vest representing the "slot". In order to get the lowest possible low cutoff frequency the "slot" length needs to be as large as possible and so the gap ("slot") extends all around the cylinder.

Figure 1: Ultra - Wideband Radio Frequency Vest Antenna

The impedance and the bandwidth of a slot antenna depend on the slot shape/width. Variations of the gap shape and width have been investigated in order to maximize the operating bandwidth. The Mk II version of the RF vest currently under development has a uniformly serrated gap.

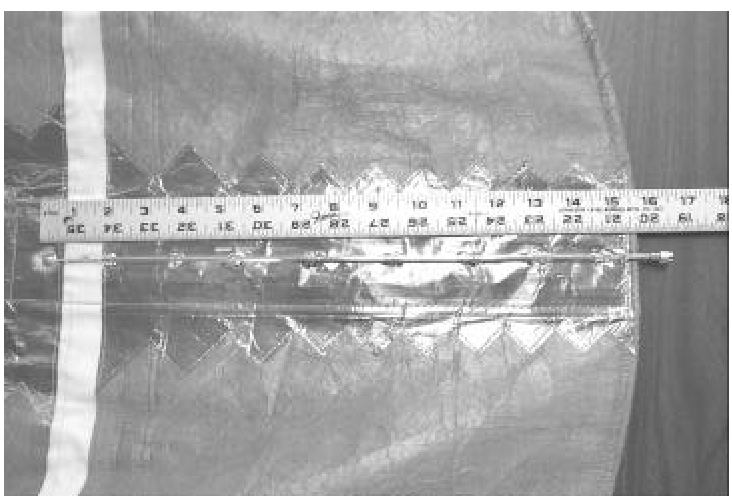

Figure 2: RF Vest Rear View (feed region)

3. **Computer Simulations and Prototype Measurements**

The computer simulation was modeled in GNEC, which provide results based upon the Finite Method of Moments technique. The wire grid model represents the surface of the conducting cloth. Figure 3 is the GNEC model of MKI.

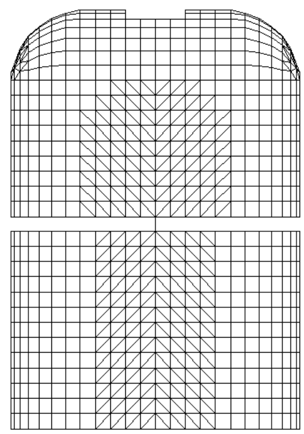

Figure 3 MKI, GNEC Wire Grid Model

The computer simulations predicted the lowest frequency response for this design to be around 100 MHz and this was verified by a separate testing agency (SPAWAR San Diego). Figures 3, 4, and 5 reflect the comparisons of the input impedance, VSWR, and Radiation patterns respectively.

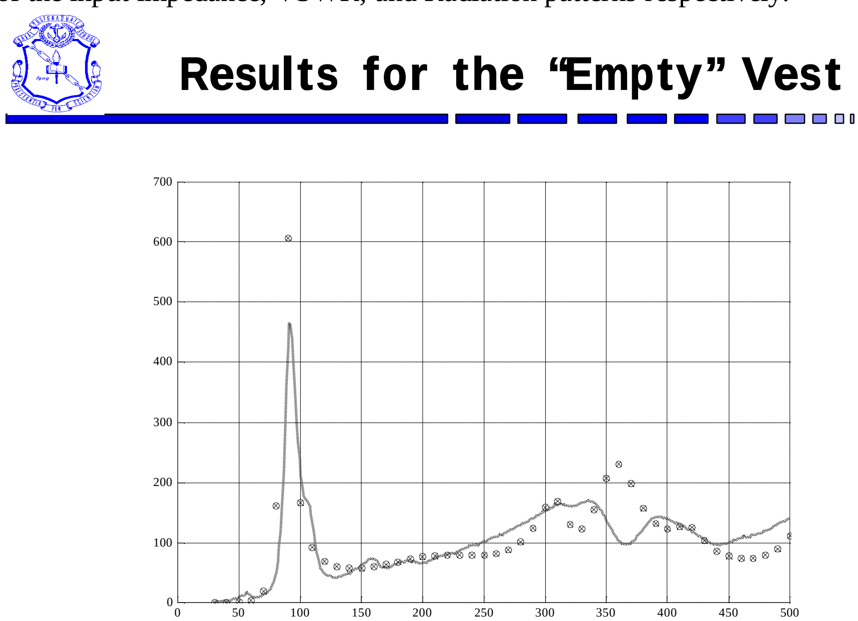

Figure 4 Input Impedance (solid is measured)

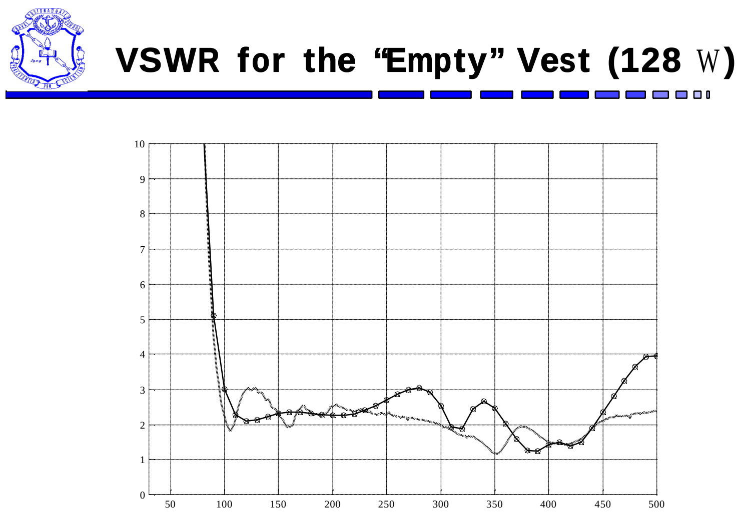

Figure 5 VSWR for MKI (Solid is measured)

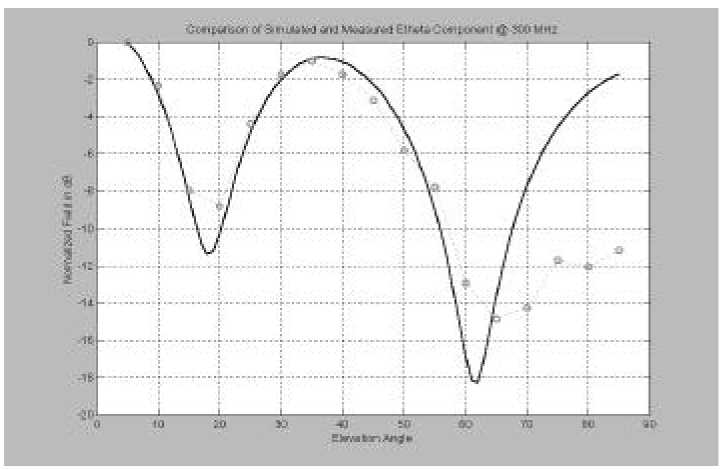

Figure 6 Radiation Pattern (solid line is simulation)

4. Current Developments

Current Research is focused towards developing wider bandwidth with the intent to obtain 30 MHz for a low frequency response for the final design. The MKII version of the vest has predicted results of 65-70 MHz. The lowering of input impedance in the absence of added circuitry has also been investigated. The input impedance has been lowered to between 50 – 70 Ohms by modifying the feed region of MKII. Further research is being conducted to determine the affects of Kevlar on the input impedance and bandwidth, initial prediction results with HFSS show an improvement of 30 – 40 MHz and a lowering of the input impedance. Radiation Hazards are also being considered, with SPAWAR (San Diego) or an independent agency being used to provide the Radiation Hazard study of the Ultra – Wideband Radio Frequency Vest Antenna.

5. References

[1] FLECTRON Metalized Materials, an Amesbury group, St. Louis, MO