A Source of Accurately Calculable Quasi-Static Magnetic Fields

A Dissertation Presented

by

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This Ph.D. dissertation describes an electromagnetic position and orientation tracking system. In radio jargon, this is a near-field amplitude-based radiolocation system operating in the 20,000-meter band, using direct-conversion receivers, continuous-wave transmitters, and small loop antennas.

This document comprises three files: AndersonPeterDissertation.pdf, AndersonPeterDissertationReadme.pdf, and AndersonPeterDissertationFig14r1.jpg .

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AndersonPeterDissertationFig14r1.jpg is the original uncropped color version of Figure 14.1, with better image quality than that of the version in AndersonPeterDissertationReadme.pdf .

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See U.S. patent 1,172,017 (issued February 15, 1916) for Reginald A. Fessenden's heterodyne receiver using an electromechanial commutator. This is an additional reference to go with reference [16] in the Bibliography, as referenced in Chapter 13 section 13.1.

The Dolph-Chebyshev window function is mentioned in Chapter 13, section 13.2, and in references [18] and [19] and [20] in the Bibliography. Here is another window function to consider.

Nuttall, Albert H. (February 1981). "Some Windows with Very Good Sidelobe Behavior", IEEE Transactions on Acoustics, Speech, and Signal Processing, volume 29, issue 1, February 1982, pages 84-91, doi:10.1109/TASSP.1981.1163506, "U.S. Government work not subject to U.S. copyright", discusses many window functions.

In particular, the window in Nuttall's Figure 10 is easy to calculate and provides 61 dB attenuation of the first sidelobe, and 42 dB/octave for further sidelobes, giving 61 dB attenuation at 4.5 bins from the peak, 103 dB attenuation at 9.0 bins from the peak, 145 dB attenuation at 18.0 bins from the peak.

For symmetrical limits, where t lies between $-\frac{L}{2}$ and $\frac{L}{2}$ including the limits, Nuttall's Figure 10 window function $w(t)$ is:

$$w(t) = \frac{1}{L}(\frac{10}{32} + \frac{15}{32}cos(\frac{2\pi t}{L}) + \frac{6}{32}cos(\frac{4\pi t}{L}) + \frac{1}{32}cos(\frac{6\pi t}{L})) \tag{1}$$

For values of t outside the limits, $w(t)$ is zero.

The hardware described in AndersonPeterDissertation.pdf performs all measurements simultaneously using multiple transmitter frequencies and multiple receiver channels, to give fully consistent data sets even when the receiver is moving with respect to the transmitter. This simultaneous-measurement design gives better dynamic accuracy than do designs using sequential measurements.

The hardware described in AndersonPeterDissertation.pdf avoids the use of gain switches in the receiver preamps, as the ratios of the gain states are difficult to control with sufficient accuracy. Also, modern audio ADCs have enough dynamic range to do without gain switches.

The four Figures appear on the following pages, as they appear in the printed paper version.

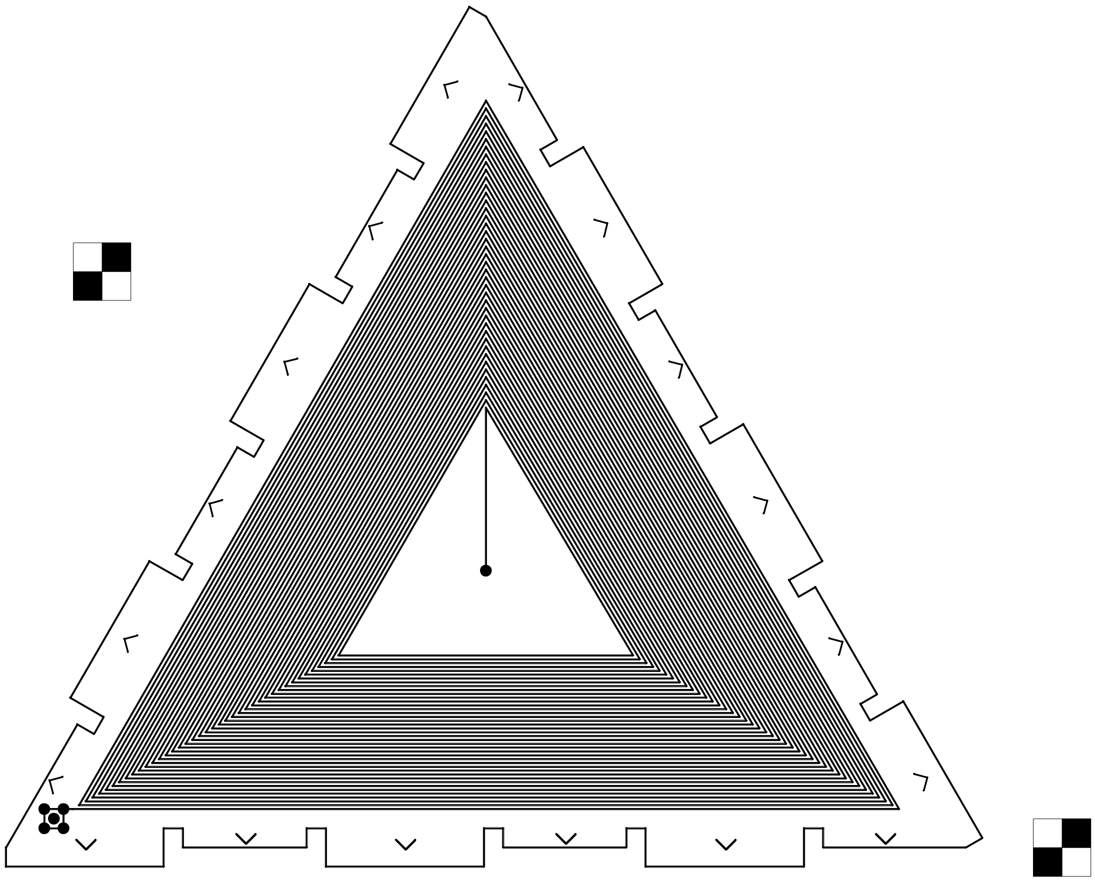

Figure 5.1: ANT-003 component-side printed circuit board artwork

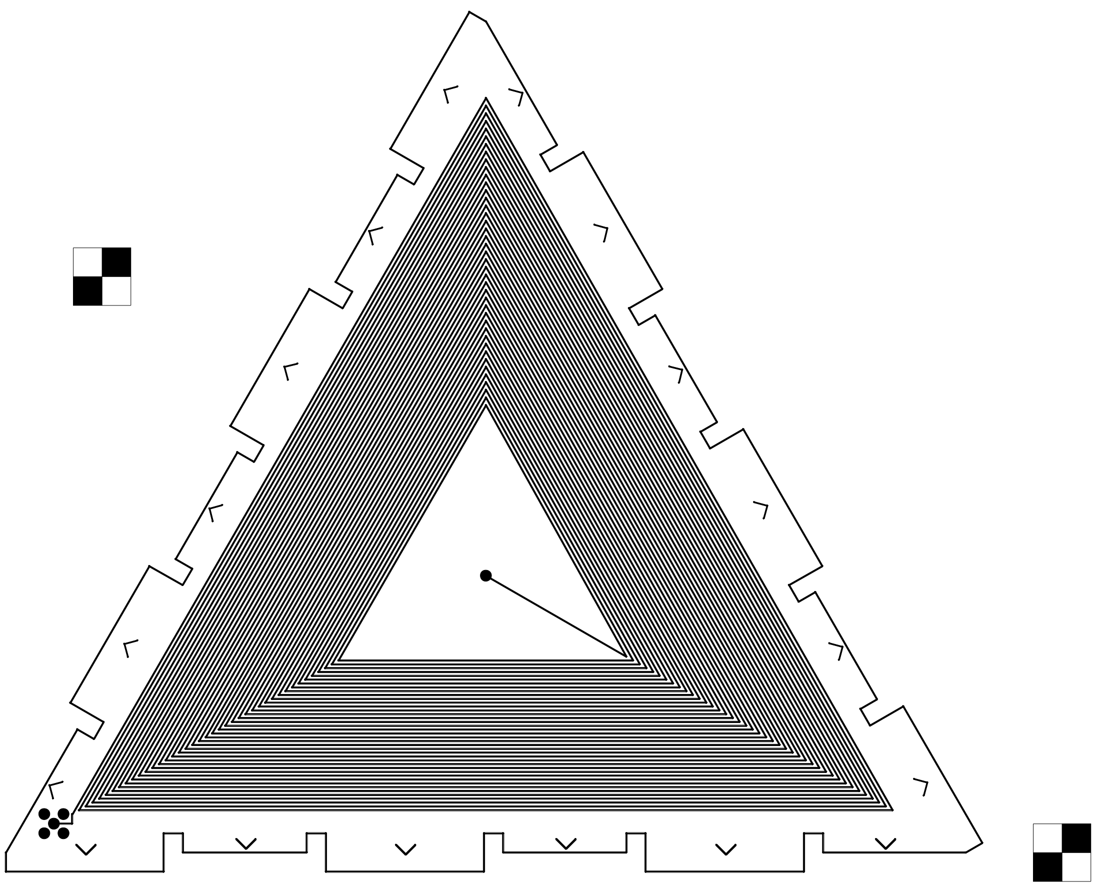

Figure 5.2: ANT-003 solder-side printed circuit board artwork

Figure 6.1: Tetrahedron of four ANT-003 printed-circuit boards

The picture is printed sideways on the following page.

Figure 14.1: Experimental fixture showing receiver in position 7