Development of Wireless E-field Detector for Nanosecond EM Radiation Source Location

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Abstract**—**A wireless E-field detector is designed for locating radiation source, based on FPGA technology. It has three main advantages, concluded as high-speed data acquisition, real-time remote data transmission, and accurate synchronization of both time and location. Hence, it can detect and locate radiation source characterized by tens of nanosecond pulse width. The maximum sampling rate of the detector is 2Gsps and the data transmission rate is 120k bits/s, with the location error less than 2.5m and the timing error less than 20ns.

Keywords: location; radiation source; FPGA; data transmission; synchronization

I. INTRODUCTION

In the research of lightning, partial discharge and IEMI source location, radiated electromagnetic field measurement is needed both in time and space[1]. Traditional location system has some disadvantages, such as inaccurate synchronization or limited measurement area [2]. Therefore, a new kind of location system is needed. Nowadays, the upgrade of electronic devices promotes the development of high-speed data communication and time synchronization [3], so based on which, the detector in this paper is designed.

II. SYSTEM DESIGN

A. *Design Principle*

The schematic of the detector is shown in Figure. 1. It has three functions, including signal digitization and storage without external communication lines, data transmission with connection of remote server, accurate synchronization of time and location. The picture of the detector and its high-speed PCB is shown in Figure. 2.

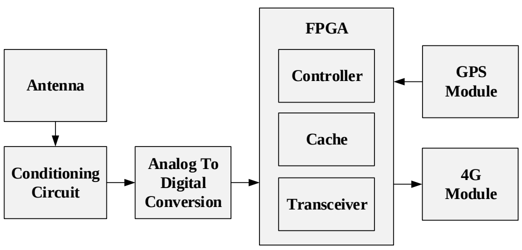

Figure 1. Schematic of the detector

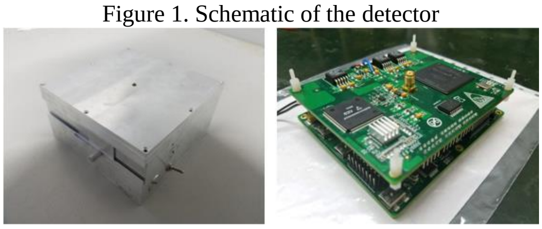

Figure 2. Picture of the detector and its high-speed PCB

B. *Signal Acquirement*

The transient E-field is usually a broadband signal and can be received by electrically small monopole antenna. To record the complete signal, a broad-band analog signal conditioning circuit is designed, composed of an operational amplifier and a differential amplifier. A 8-bit 2Gsps ADC chip is selected to accomplish the analog-to-digital conversion. A high-speed FPGA is selected as the CPU. The analog bandwidth is 500MHz and sample rate is up to 2Gsps.

C. *Data Transmission*

A wireless communication chip is installed in the detector. By using LTE Fourth-generation mobile communication technology, the detector could fulfill remote data transmission with TCP/IP protocol, of which the rate is 120k bits/s. In addition, a bluetooth module is installed in the detector as an alternative.

D. *Time and Location Synchronization*

A GPS chip is used to synchronize time and location, with the location error less than 2.5m and timing error less than 20ns. This module could output a pulse signal with frequency of 1Hz, which would be acquired and processed by FPGA to realize time synchronization accurately.

III. EXPERIMENT VERIFICATION

In order to test the performance of the detector, we set up an experiment platform based on impulse source and radiation antenna, which can produce nanosecond EM pulse radiation. Three detectors are placed in different location near the antenna. After measuring the radiated signal, the detectors send data and synchronization message to remote server, which will be processed by algorithm to estimate the source location and assess the location accuracy. The picture of the testing experiment is shown in Figure. 3.

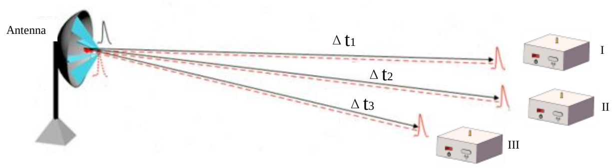

Figure 3. Picture of the testing experiment

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