The Channel Switch Method of the Cambridge MK4 EIT System

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Abstract: With electrical impedance tomography (EIT) system's development, more electrodes is required to get better detection performance. In this paper, we proposed a circuit design to switch channels to different electrodes quickly and stably.

1 Introduction

Various EIT systems have been developed for 3D imaging[1-3].Cambridge MK4 EIT is a 3D medical imaging system for breast cancer detection. It permits visualization of the inner structure of the breast by measuring its impedance distribution.[4] The EIT hardware system is consisted of planar electrode sampling circuit, planar electrode driving circuit, multi-functional sampling card, 64-channel digital IO card, National Instrument(NI) chassis/controller. This system uses current excitation (1mAp-p) and voltage measurement covering frequency from 10kHz to 5MHz.

2 Methods

1. Planar electrode sampling circuit

The upper computer is in charge of the switching control.

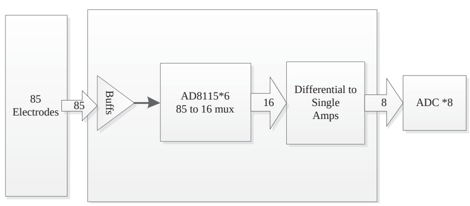

Fig 1. Planar electrode sampling circuit

As show in Fig 1, signals from 85 electrodes can be collected by planar electrode sampling circuit: analog voltage signals enters the DAQ board through a buffer amplifier, the buffered signals transformed into 16-lane voltage signals after a 85 × 16 switching matrix, it becomes 8-lane analog voltage signals after passing by a differential to single amplifier. Finally, voltage signals are sampled by the 8-channel AD card before the sampled data are transferred to the upper computer to form EIT images.

2. Planar electrode driving circuit

This sub-circuit can complete the switch from a pair of injecting current to 85 electrodes freely. The planar electrodes formed 2×85 switching matrix, in this way, 1-channel voltage signal can be produced by one DAC while another DAC can output a signal with same amplitude but reversed phase. These two signals have a phase difference of 180° and developed into I+,I- via Howland circuit. User can obtain a pair of pumping signals by switching matrix which illustrated as shown in Fig 2.

The function of planar electrode driving circuit is to realize the switching process between a pair of current sources to 85 electrodes. Single to differential amplifier, Howland V/I transform circuits and switching matrix constitute the driving circuit. At last, the two way Howland circuits get two way differential current respectively.

The types of chips are as follows:

1) Switching matrix: ADG2128. Which has double-buffered input logic and 300 MHz bandwidth. It's on resistance is 35 Ω maximum
2) Switching matrix: AD8115, which is a 16 × 16 high speed non-blocking switch array with 225 MHz −3 dB bandwidth.

As the chips we selected, the switching channel method of our system has many advantages. In our practical use, Its bandwidth can reach 5KHz to 10MHz, which is good enough to meet the system's requirement (10KHz to 5MHz). What's more, the new switch matrix we adopted also have outstanding performance in power dissipation, SNR and can allow more electrodes (up to 96) to be employed in future systems.

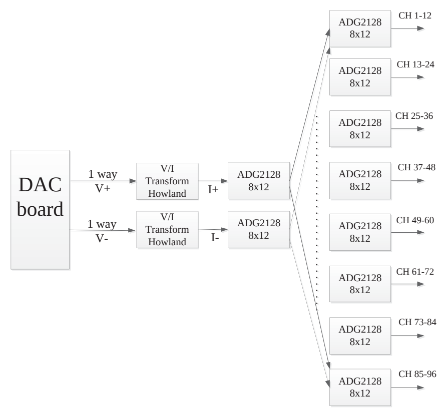

Fig 2. Planar electrode driving circuit

3 Conclusions

The testing results indicate that, for the Cambridge MK4 EIT system, the bandwidth of the channel without I/V circuit is 5KHz to 10MHz. In our design, the switching matrix is controlled by FPGA, hence the switch channel is stably during data acquisition. The test results proves the design is an outstanding scheme for channel switching of EIT System.

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