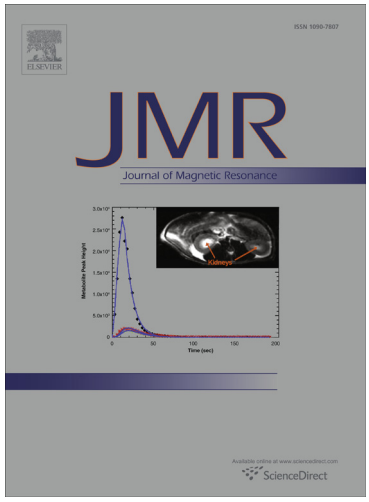

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An Ultra-Low Cost NMR Device with Arbitrary Pulse Programming

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Abstract

Ultra-low cost, general purpose electronics boards featuring microprocessors or field programmable gate arrays (FPGA) are reaching capabilities sufficient for direct implementation of NMR spectrometers. We demonstrate a spectrometer based on such a board, implemented with a minimal need for the addition of custom electronics and external components. This feature allows such a spectrometer to be readily implemented using typical knowledge present in an NMR laboratory. With FPGA technology, digital tasks are performed with precise timing, without the limitation of predetermined hardware function. In this case, the FPGA is used for programming of arbitrarily timed pulse sequence events, and to digitally generate required frequencies. Data acquired in a 0.53 T permanent magnet serves as a demonstration of the flexibility of pulse programming for diverse experiments. Pulse sequences applied include a spin-lattice relaxation measurement using a pulse train with small-flip angle pulses, and a Carr-Purcell-Meiboom-Gill experiment with phase cycle. Mixing of NMR signals with a digitally generated, 4-step phase-cycled reference frequency is further implemented to achieve sequential quadrature detection. The flexibility in hardware implementation permits tailoring this type of spectrometer for applications such as relaxometry, polarimetry,