Homemade Broadband Pulsed NMR Spectrometer for Studying Magnetic Materials

S. B. Belmonte, R. S. Sarthour, I. S. Oliveira, A. P. Guimarães

Centro Brasileiro de Pesquisas Físicas

The Pulsed Nuclear Magnetic Resonance technique has several important applications. From an apparent harmless way of making body tomography to the characterization of materials. One of the most relevant uses is the study of the magnetism of metals and alloys by investigating their hyperfine interactions. The nuclear resonance frequencies of the nuclides is magnetic field dependent, and inside a sample of magnetic material they may vary from a few megahertz (usually transition metals) up to tens of gigahertz (rare earth elements). Therefore, broadband NMR spectrometer are necessary to study the magnetism of magnetic alloys, formed of rare-earth and transition elements. In the current work, we present a homemade broadband NMR spectrometer. The original parts which were built were the transmitter, receiver, pulse programmer, active NMR duplexer and the acquisition control software. The transmitter and receiver were built using hybrid components, such double balanced mixers (DBM), radio-frequency (RF) switches, power splitters and phase shifters. These operate from 250 to 1000 MHz, depending on the assembly of some separated modulus. The pulse programmer, developed using a Field Programmable Gate Array (FPGA), is capable of generating a pulse sequence of seven events, and has five independent channels. These are combined to form the pulse sequence which is inputted into the transmitter where they are used to generate the RF pulses. The active duplexer uses PIN diodes which have high switching speed, and supports more than 10 Watts of peak power. The new spectrometer has been tested and the $^{55}\text{Mn}$ resonance in $\text{LaSr}_{0.3}\text{MnO}_3$ has been observed at $\approx 380$ MHz.