RF coil interface for translational research on clinical MR systems

D. M. Peterson[1], R. J. Fitzsimmons[2], J. R. Fitzsimmons[2]

[1]AMRIS, McKnight Brain Institute, University of Florida, Gainesville, FL, United States, [2]Radiology, University of Florida, Gainesville, FL, United States

Introduction

As clinical MR systems move toward translational research systems, there is a need to have an interface for rapid prototyping of coils. Most conventional MR systems are moving toward coils with integrated front end electronics (T/R switches, preamps, phase shifters, etc…) from a performance and product development stand point this makes sense. However, in the research environment, where one needs to rapid prototype several coil setups, designing and constructing T/R switches and preamps for each coil is impractical due to the limited resources of most academic environments. Therefore, an integrated 8 channel interface for a Siemens 3T Allegra system was constructed.

Methods

The system interface was designed with multi-channel transmission and reception in mind. The basic setup is a combination of a T/R switch [1] for each channel, along with the proper phase shift for transmission (variable, depending upon the coil configuration (geometry)). The entire setup was designed on three circuit boards, one for the transmit power splitting and phase shifting and the other two each contain a bank of four preamplifiers and T/R switches. The circuits were design using CirCad (Holophase, Davie, FL); the files were than processed at Advanced Circuits (Boulder, CO). The completed boards with the appropriate phase shifts (0, 45, 90, 135, 180, 225, 270 and 315 degrees) were designed for a eight channel system with circularly polarized transmission with equal power splitting, T/R switches (however, phase is adjustable with phase shift insert boards and preamplifiers were obtained from InVivo Corporation (Gainesville, FL).

Results

The T/R switch was measured in transmit and receive modes to ensure proper operation using an HP4396B network analyzer. Measurements of the switch were made and compared to the best case scenario of the switch circuit board with the proper opens and shorts. The T/R switch had an insertion loss of .3dB in the transmission mode and .7dB in reception. The transmit mode had high isolation between the transmitter and the preamp, being 80dB of isolation. In receive mode, the isolation was measured at 38dB.

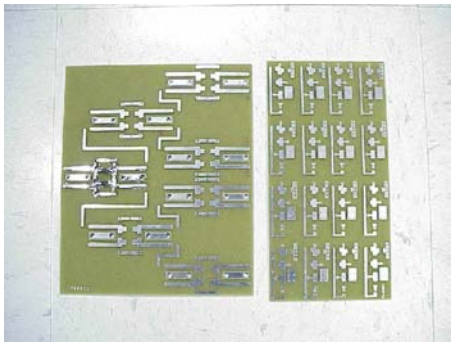

Figure 1. Power splitting circuits (left, uncompleted) and T/R switch circuits (right, 16 total on this board also uncompleted.

Figure 2. Completed interface including preamps and all wiring.

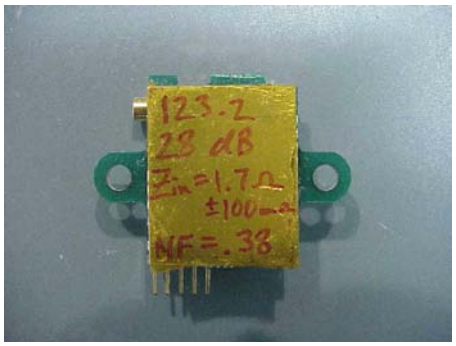

Figure 3. One of eight preamplifiers provided by InVivo Corporation.

Discussion and Conclusions

It is imperative for clinical systems to be prepared for translational research; in order to do this the system has to be capable of rapid RF coil prototype development. Such a system has been designed, verified and tested. Such systems will allow the advancement of animal models with direct applications to humans when a protocol is deemed as useful, without having to change pulse sequences or other factors, which make moving from animal systems to human systems difficult at this time.

Reference

1. P. Vizmuller, RF Design Guide Systems, Circuits and Equations, Artech House, Boston, MA, 1995.
2. D. Pozar, Microwave Engineering, John Wiley and Sons, New York, NY, 1998.

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