A 16-Channel Transceiver Array for 7 Tesla Equine Joint MRI

Hai Lu[1], Ziyuan Fu[2], and Shumin Wang[2]

[1]*Auburn University, Auburn, Alabama, United States,* [2]*Auburn University, Alabama, United States*

Introduction: Multi-channel transceiver arrays are highly desirable for 7 Tesla MRI due to the lack of volume transmitters[1]. We developed a 16-channel transceiver array for equine joint MRI at 7T by splitting the single-channel power input equally into 16 coil elements. The design and implementation details are discussed. Actual imaging results further demonstrate the feasibility of the design.

Methods: Figure 1 shows the schematic of the transceiver system. It consists of three independent modules. Fig. 2a shows the 5.5" ID transceiver array. The RF coil array has two rows of each eight elements. The nearest neighbors were decoupled by overlapping. The next neighbor is decoupled by orthogonal positioning or transformer. The assembled array is shown in Fig. 2b, where balun banks were used to cutoff shield currents. All cables were adjusted so that they have equal electric lengths. The Tx was implemented by a corporate-feed network of Wilkinson power dividers and phase shifters[2]. The 16 outputs were designed with equal magnitudes (-12dB) and consecutive 45° phase delay. High-power chip resistors were used to protect Wilkinson power dividers in case of severe load mismatching. The T/R switch and pre-amplifier bank are shown in Fig. 3. It consists of 16 sets of T/R switch and RF pre-amplifier designed at 297 MHz (Fig. 3b). The pre-amplifier has low input impedance to help further decouple the coils on the receive side[3].

Results and Discussion: The measured S_{21} between one coil and its nearest neighbor decoupled by overlapping is shown in Fig. 2c. The measured S_{21} ranges from -13dB to -22dB. It was found the orthogonal positioning and using transformer give the worst and the best decoupling results respectively. For all T/R switches, the S_{21} of the Tx channel is about -0.2dB and -36dB during its "on" and "off" state respectively. For each Rx channel, the S_{21} is around -0.25dB and -45dB during its "on" and "off" state respectively. No significant performance variation was found.

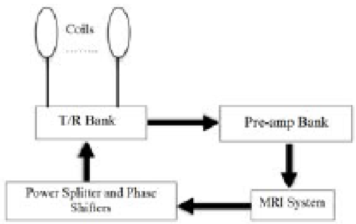
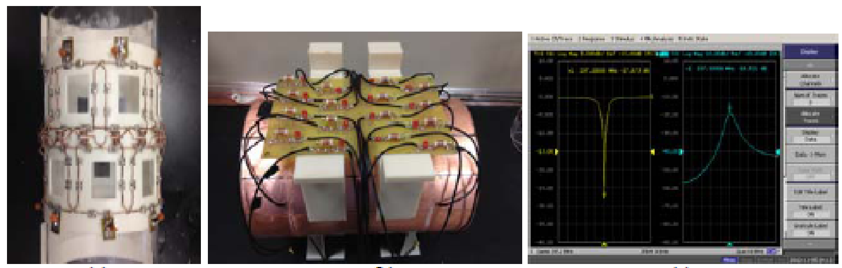


Figure 1. Schematic of the re-configurable transceiver system



(a) (b) (c)

Fig. 2. (a) The 16-channel coil array and (b) the complete assembled with on-board baluns. (c) The measured mutual coupling of two coils decoupled by transformer.

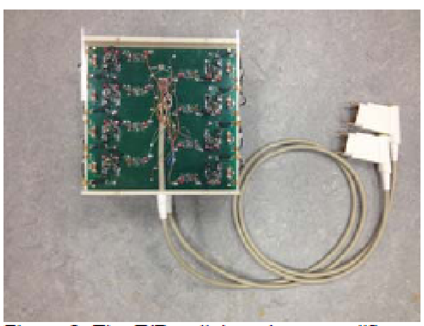


Figure 3. The T/R switch and pre-amplifier bank.

(a) (b)

Figure 4., Gradient-echo images of a human hand (a) a sagittal slice of equine joint (b).

Figure 4 shows the gradient-echo image of a human hand and a turbo spin-echo image of an equine joint acquired on a MAGNETOM 7T scanner (Siemens Healthcare, Erlangen, Germany). The parameters of the TSE sequence are TR = 1500 ms and TE = 64 ms. The in-plane resolution is 0.44-by-0.44 mm and slice thickness is 2 mm. The peak RF voltage was 130 Volt and 16 averages were taken with a total scan time of 22 minutes. Good image quality was observed.

Conclusions: We developed a 16-channel transceiver array for equine joint MRI at 7 Tesla. The design principle and implementation details are presented. MR images further validate the feasibility.

References: 1) K. Ugurbil, et al. MRI, (2003): 21:1263–1281 2) X. Yang et.al. Proceedings of ISMRM, 2006 3) Roemer P B, et.al., MRM (1990): 6:192–225