A direct modulated optical fiber link for 0.3T MRI

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Introduction:

Optical fiber provides an electromagnetic immune interlink for multi-channel MRI arrays. Direct modulation [1] and external modulation [2] optical links have been presented in these years, respectively. A direct modulated optical link shows advantages on simple structure, low power consumption, compact size and high performance-to-cost ratio compared with an external modulated optical link. In this study, a direct modulated optical link has been designed and built. Its performance has been demonstrated by phantom and human head imaging on a 0.3T MRI system.

Methods and Results:

The architecture of the direct modulated optical link includes an optical transmitter and optical receiver as illustrated in Fig. 1(a) and Fig. 1(b), respectively. The frequency response and the 3rd order intermodulation free dynamic range (IMF3) of the optical link were measured on bench test. The measurement results are shown in Fig. 2 and Fig. 3 respectively. The optical link was used for phantom and in vivo human head imaging on a XinAoMDT 0.3T vertical MRI at the frequency of 12.64MHz. The images obtained by the optical link were compared with those obtained by the electrical coaxial cable link, as shown in Fig. 4 and Fig. 5. It is found in the phantom images that the SNR obtained by the optical link is comparable with that by the coaxial cable, only about 5% lower. There are no distortions found in the images obtained by the optical link as shown in Fig. 5.

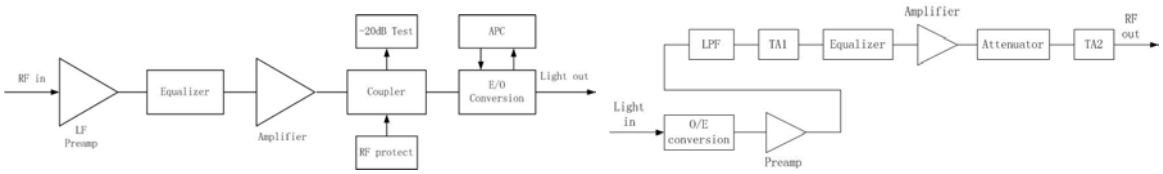

Fig. 1 The architecture of the direct modulated optical link: (a) the optical transmitter, and (b) the optical receiver

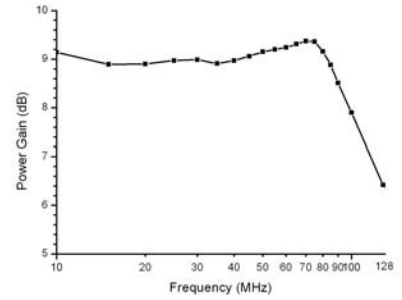

Fig. 2 Frequency response of the optical link

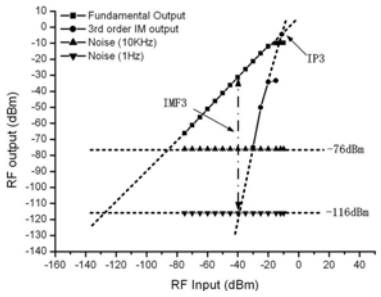

Fig. 3 IMF3 of the optical link

Discussion:

Fig.2 indicates the optical link could be used for MRI up to1.5T because its frequency response is almost flat from 10MHz to 80MHz. The power gain drop at frequencies over 80MHz is caused by the use of a commercial narrow band low-pass filter. It could be improved by the use of a wideband filter to satisfy higher field MRI systems. The link has an IMF3 of about 85dB normalized to 1Hz bandwidth. Fig. 5 indicates the optical link has a wide enough IMF3 for low field MRI signal transmission. However, for high field MRI systems, MRI signals often have much higher dynamic range. In addition, the IMF3 of an optical link decreases when the power gain of the preamp is too high [3]. Therefore, the dynamic range the optical link should be further testified in that case. The optical transmitter has been tested in the MRI room and no interference with the MRI signal was found. However, it still could not be placed inside of the magnet due to the ferromagnetic material in this laser package. The direct modulated optical link could be easily extended to multi-channels for coil array interlinks.

Acknowledgement:

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References:

[1] J. Yuan, G.X. Shen, 14th ISMRM, 2617 (2006); [2] G. P. Koste, M. C. Nielsen *et al*, 13th ISMRM, 411 (2005); [3] J. Yuan, P. Qu *et al*, 14th ISMRM, 2031 (2006);

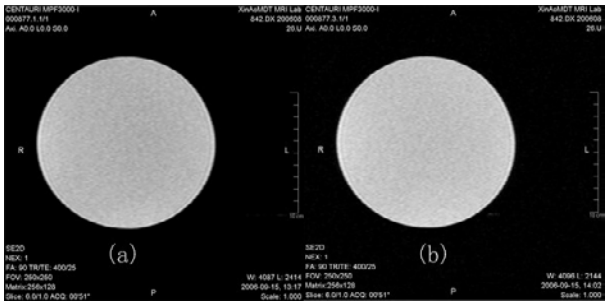

Fig. 4 Phantom images obtained by (a) coaxial cable, and (b) optical link

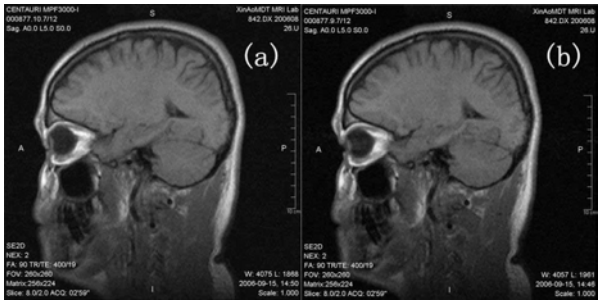

Fig. 5 *in vivo* Head images obtained by (a) coaxial cable, and (b) optical link