An 8-channel TX, 16-channel RX flexible body coil at 7 Tesla using both branches of centrally fed strip lines as individual receive elements

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Introduction

The strip line element with meanders has proven its capability for head and body imaging at 7 Tesla due to its good decoupling and penetration depth [1, 2]. Previously presented Tx/Rx arrays consisting of elements with central feeding [1, 2, 3] do not support pMRI acceleration in the direction parallel to the strips of the elements. To overcome this drawback, each branch of the element can be used as a separate receiver coil while keeping the advantages of the combined element during transmission. An 8-ch transmit / 16-ch receive flexible body coil was built and tested in phantom measurements and in vivo and compared to an array of the same dimensions but with conventional strip line elements with meanders.

Materials and Methods

The modified element's mechanical layout is the same as described previously [1]: 25 cm length, 10 cm width, 20 mm thickness, with a strip of 15 mm thickness and meanders of 3 mm thickness. Figure 1 shows the electrical schematic of the element. The end capacitor remains with a value of C_e = 1 pF. To get good decoupling between the two branches of the element, a coupling capacitor is introduced as a trim capacitor C_c = 1.5 – 5 pF. Since both branches are used separately for reception, the λ/2-line is no longer needed and each feeding port gets a separate matching network consisting of a parallel capacitor C_p and a series capacitor C_s.

Each of the two ports is connected via a coaxial cable to a T/R-switch with a preamplifier situated in a multipurpose pre-amp box at the head of the patient table. Extra cable traps had to be included, since the feeding is no longer symmetric. Because only 8 transmit channels were available on the MR system used, each pair of branches is fed with a Wilkinson power divider with one branch fed through an extra length of cable to achieve the necessary 180° phase shift.

To estimate the g-factor of the array, two fully sampled gradient echo images with an image matrix of 384 by 384 voxels were acquired in an elliptical oil phantom in an oblique plane rotated 45° from axial to coronal and reconstructed with openGRAPPA [4]. 48 autocalibration lines and a reduction factor of 2, 3 and 4 were used. SNR for each reduction factor was determined with a dual acquisition and subtraction method [5].

All images were acquired on a Siemens 7T whole-body system (Magnetom 7T, Siemens Healthcare, Erlangen, Germany).

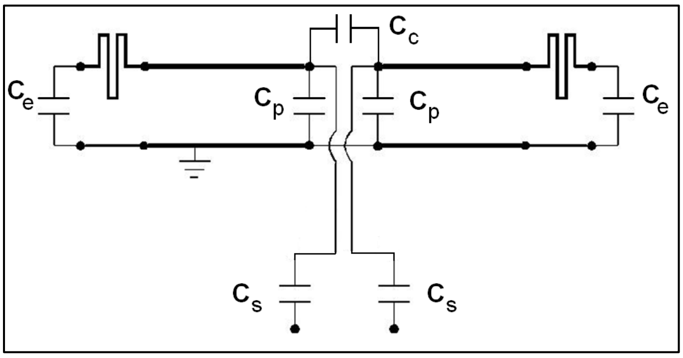

Figure 1: Electrical schematic of the improved strip line element with meanders. The capacitor C_c is the newly introduced decoupling capacitor to decouple the two branches of the element.

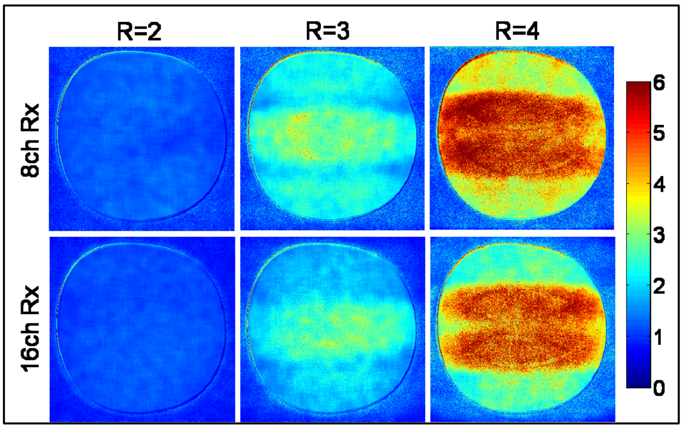

Figure 2: GRAPPA g-factor measurements for nominal reduction factors of 2, 3 and 4. For comparison, the conventional 8ch Rx coil results are shown in the upper row.

Figure 3: 2D Flash image of the abdominal region. The resolution is 0.78 x 0.78 x 5.0 mm³. The image was acquired with an acceleration factor of 2.

Results and Discussion

Coupling between neighboring branches on the same element as well as branches on neighboring elements was less than -20 dB at a reflection factor of less than -15 dB. Figure 2 shows that the GRAPPA g-factor is lowered by using both branches of the strip line as individual receive elements. However, the g-factor reduction from the greater number of receive elements is not as large as expected. This is due to an overlap in the reception profiles of the two branches of each element, even though the ports are well decoupled. Figure 3 shows a 2D Flash image acquired with the 8ch transmit / 16ch receive coil. The image shows good homogeneity and good image contrast over the entire axial slice. Note that no intensity correction was applied. In summary, the concept of using each branch of a centrally fed element improves acceleration capabilities. The presented flexible array shows good performance in abdominal and cardiac imaging (data not shown).

References

[1] Orzada et al, Abstract #2999, Proc. Intl. Soc. MRM 17 (2009); [2] Orzada et al, Abstract #3010, Proc. Intl. Soc. MRM 17 (2009); [3] Brunner et al, Abstract #448, Proc. Intl. MRM 15 (2007); [4] Griswold et al, MRM 47, (2002); [5] Firbank et al, Phys. in Med. and Biol. (1999)