A novel 7 T microstrip element using meanders to enhance decoupling

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Introduction

Microstrip lines are often used in ultra-high-field MRI for birdcage resonators and transceiver arrays (e.g. [1]). In this work we describe a novel method to distinctly increase the decoupling of neighbouring coil elements at 7 T. The novelty implemented in this coil is the use of meanders at both ends of the coil elements.

Materials and Methods

The single elements were built on an PMMA substrate (ε_r~2.2, tan(δ)~0.02). Each PMMA-Block is 250 mm long, 100 mm in width and 20 mm thick.

To investigate the characteristics of coil elements with meanders, four different types of elements were designed. The width of each strip was 15 mm. The width of the copper lines within the meander structure was 2 mm for all elements. Elements with 1, 2 and 3 meanders were designed. For comparison, a standard line was also examined. The feeding network is almost equal to the feeding network presented in [2]. The end-capacitors C_e were tuned for maximum homogeneity along the element.

Simulations for all elements were done using the commercially available software package Empire™.

The first simulations to determine coupling were done with a flat phantom ($\varepsilon_r = 43.6$, $\sigma = 0.8$ 1/Ωm) positioned 20 mm above two elements. The gap between two elements was 5 mm.

Measurements were done for the standard-strip-element and the Element with 3 meanders. The feeding network was attached to the backside of each element.

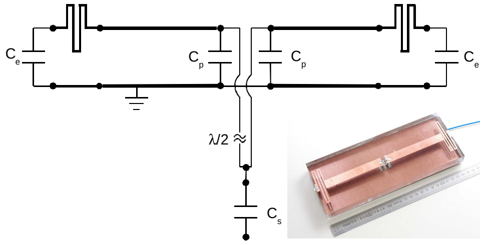

Figure 1: Schematic view of the novel microstrip element

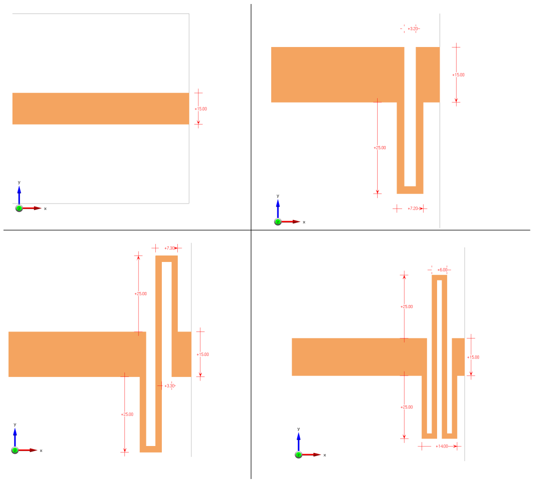

Figure 2: Structures under investigation, from top left to bottom right: Standard-Stripline, 1 meander, 2 meanders, 3 meanders. All strips have a width of 15 mm.

Results and Discussion

All elements show the same homogeneity along the longitudinal axis. Coupling between neighbouring elements decreases with increasing number of meanders. Penetration depth and absolute field strength are improved in comparison to the strip line element without meanders.

	S_{11} [dB]	S_{12} [dB]	penetration depth [mm]
Standard	-38	-8.1	22.9
Meander 1	-36	-10.7	25.9
Meander 2	-40	-14.7	26.8
Meander 3	-34	-18.5	24.6

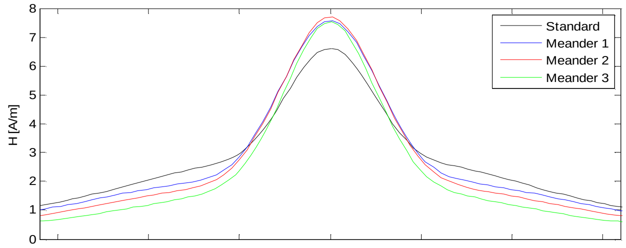

Figure 3: Absolute of magnetic field 10 mm inside the described flat phantom along a central transversal line

The lower coupling is caused by a better concentration of the magnetic field in the transversal direction (see Figure 3). Good agreement is observed between measured and simulated values.

The steeper slope also results in a better separation between neighbouring sensitivities, which can provide improved performance for parallel transmit and receive techniques.

The excellent decoupling the rearrangement of the array in little time without the necessity of decoupling capacitors.

The next step will be measurements on a SIEMENS 7 T whole body scanner with an 8 channel head array based on the meander line structure (see Figure 4).

Figure 4: 8-channel head array

[1] G. Adriany et al. Proc. Intl. Soc. MRM 14 (2006). [2] D.O. Brunner et al. Proc. Intl. Soc. MRM 15 (2007)