Adjustable Simultaneous Inductive Decoupling of Large Arrays

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INTRODUCTION

Parallel imaging methods involving large arrays are becoming a common practice in MR imaging [1-2]. With the increasing number of coils, effectively decoupling the array elements can is also increasing in complexity. Conventionally, decoupling is achieved in one of the following ways: (1) geometric decoupling either through overlap or coil design; (2) capacitive or inductive networks [3, 4, 5]; (3) using isolating preamplifiers [6]. Our group has presented a 64-element planar pair array and the ability to simultaneously capacitively decouple the coils using distributed capacitive pads [7]. In an effort to increase the SNR of the array ensemble, we modified the design of the planar pairs. The modified elements required inductive decoupling and therefore a method was developed to simultaneously decouple them when in the large array construct. This abstract presents a simple and elegant approach to inductively decouple arrays comprised of identical parallel elements. The results demonstrate a simple, adjustable decoupling method capable of isolation greater than 20 dB between neighboring elements.

MATERIAL AND METHODS

A 7-element array comprised of a modified version of the planar pair element was fabricated on industry standard 0.062” FR-4 laminate. The center leg of the planar pair (carrying twice the current) was raised towards the field of view and the ground legs were etched on the bottom layer. This modified design proved to require inductive decoupling between elements. Overlapping loops for inductive decoupling were fabricated at the ends of the long narrow elements as shown in Figure 2. In order to adjust the amount of decoupling, a flux ‘blocking pad’, reminiscent of the flux steering paddle used by Hoult [8], was used to effectively control the surface area of the overlap, and thus the amount of mutual inductance. To verify the ability to control the value, two elements were matched and tuned to 50 ohms and decoupling measurements were collected using standard S21 measurements from an HP4195A network analyzer. All seven elements were then matched and tuned, a single flux pad laid across the loops, and decoupling measurements between the center coil (#4) and its neighbors were obtained, with coils #1 and #7 acting as “dummy” coils.

RESULTS AND DISCUSSION

The ability to control the decoupling value between two coil elements by adjusting the position of the flux pad is clearly demonstrated in Figure 3. It is apparent that there is one optimal value at which the coupling is minimized. Table 1 presents the decoupling matrix for coil #4, the center coil, showing nearest neighbor decoupling of over 20dB. An unexpected result is the increased coupling between next-nearest neighbors (coils 2 and 6), most likely due to the finite size of the array. This will be further investigated when a full size array of 32 elements is implemented. Because the flux pad is simultaneously adding capacitance along the traces of the coil, the relationship between the amount of inductive loop left “open” cannot be directly translated to a fixed loop size to decouple the coils. Instead, it will be most effective to fabricate the loops near the projected length and use the flux blocking pad as a fine tuning method.

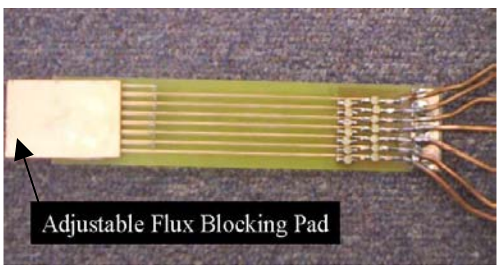

Figure 1: 7-element array coil showing the flux blocking pad covering the decoupling loops.

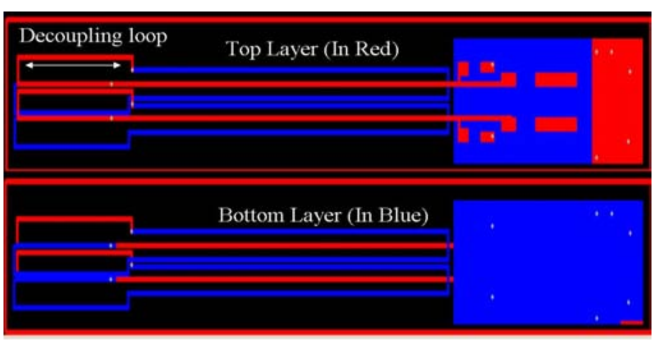

Figure 2: Schematic of the 2 element coil showing the top and the bottom layers.

Coil #	1	2	3	4	5	6	7
1	-34.7	-	-	-	-	-	-
2		-41.3	-	-23	-	-	-
3			-31.3	-25.4	-	-	-
4				-26.1	-	-	-
5				-33.8	-25.9	-	-
6				-17.7		-26.5	-
7				-			-31.2

Table 1: Matrix showing the decoupling [dB] between the center coil #4 and other coil elements.

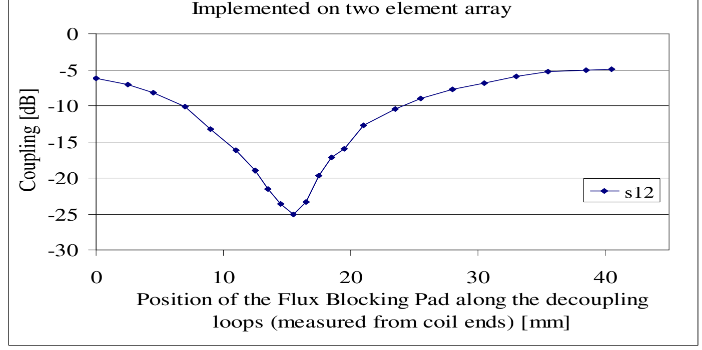

Figure 3: Coupling Vs the Position of the pad. Implemented on two element array

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