Comparison Between Broadband Decoupling Methods for Microstirp Array

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Introduction: Conductive shields, screen tracks and sidewalls are often used to isolate conventional loop coils or microstrip RF coils [1-7]. They are frequency independent and therefore usually named "broadband decoupling". Due to the ground plane in the transmission line structure [1], microstirp arrays usually have better element isolation over the conventional loop arrays. Such ground planes or strips are also recently applied for conventional coils [2,3] for better element-isolation. The screen loops are recently placed around coils to provide enough isolation for arbitrarily placed coil elements [4,5]. Additionally, sidewalls are often used for microstrip coil elements with loop- or straight- shape [6,7]. In comparison with the decoupling L/C circuits, those broadband decoupling are easy to apply and are independent of the element arrangement. In this abstract, two broadband decoupling with sidewall and screen loop are applied for tunable loop microstrip (TLM) arrays [1] for comparison. The B_1 fields (SNR) and isolations are compared by simulation and bench test.

Method: TLM planar arrays associated with sidewall and screen loop were built and tested on bench. Simulations by FDTD were also performed to reveal the relationship between the screen placements, B_1 fields and S_{21}. TLM arrays with screen loops and sidewalls are shown in Figure 1**a** and 1**b**, respectively. S_1 in Figure 1 is defined as the gap between the copper strip loop of the TLM coil and its sidewall, or between the TLM coil and the screen loop. The TLM array consists of two coplanar elements with 2.5 cm inter-element gap. Each element is 8.0 cm × 8.0 cm in size and 1.0 cm in strip width (W = 1.0 cm). The ground plane of each element is made with a whole copper sheet. Teflon board with 6.0 mm thickness is chosen as the substrate. Each element is tuned to 64 MHz individually. The screen loop is made of a copper strip with 0.25 cm width. S_1 with 0.25 cm and 1.0 cm for the screen loop and S_1 with 0.25 cm, 0.50 cm and 1.0 cm for the sidewall are investigated. The results are listed in the table.

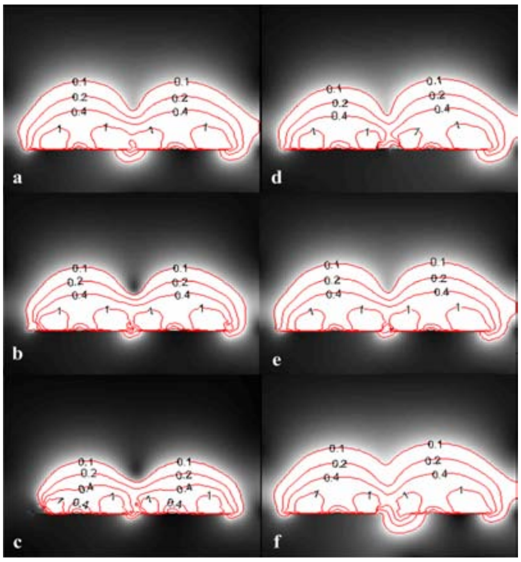

Figure 2.

Result Without using the screen loop and the sidewall, the mutual coupling is –7 dB when loaded with an 8 cm × 8 cm × 6 cm NaCl-solution phantom on each coil element, which indicates a strong interference between the elements. For the TLM array with screen loops, mutual coupling between elements is significantly reduced. Smaller S_1 leads to a better element isolation. When S_1 = 0.25 cm, S_{21} can reach -26 dB. However, this decoupling technique has serious B_1 field penalty. Displayed in Figure 2**a** is the B_1 profile without implementing the screen loops. Shown in Figure 2**b** and Figure 2**c** are B_1 fields of screened TLM arrays with 1.0 cm and 0.25 cm S_1, respectively. It is clearly that the B_1 field decreases when S_1 decreases. In Figure 2**c**, the B_1 fields through the center axis of each element or between the elements are all around half of those without using the screen loops. This reduced B_1 fields will cause a poor SNR. For the TLM array with sidewalls, 0.8 dB ~ 4.8 dB additional isolations are achieved when S_1 decreases from 1.0 cm to 0.25 cm. Figure 2**d-f** display the B_1 profiles of TLM arrays with the sidewalls. In contrast to the method with screen loops, the sidewalls have not reduced the B_1 field penetration. Along the center axis of each element, the magnitudes of the B_1 fields are similar to that without the sidewalls (B_1 field difference is within 2%). Figure 2**d-f** also shows that the sidewalls can increase the B_1 fields between the coil elements. Compared Figure 2**a** and **f**, up to 24% B_1 field can be achieved by the sidewall.

Conclusion Screen loops and sidewalls are efficient to reduce the mutual inductance between microstrip coil elements. Gap between the screen loops in a TLM array should be large enough, (greater than 1.0 cm for the prototype in our experiment), to maintain enough B_1 field penetration. The element isolation with the sidewalls is less than that of the screen loops, but the sidewalls in a TLM array will not reduce the B_1 field penetration, on the contrary, decreasing the gap results in an increasingly homogeneous field distribution.

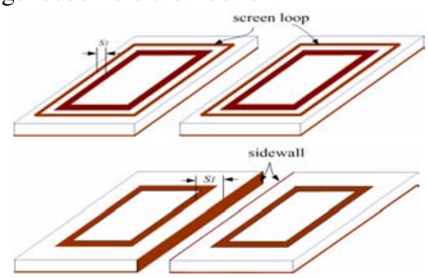

Figure 1.

	Gap S_1 (cm)	S_{21} (dB)	C_d (pF)	B_1 between elements	B_1 through element center
Screen loop	0.25	-26	67	0.43	0.55
	1.0	-11	58	0.74	0.87
Sidewall	0.25	-14	63	1.24	0.99
	0.5	-9	59	0.93	0.98
	1.0	-8	56	0.85	1.01
Without	***	-7	55	1	1

Table

References [1] Wu B ISMRM 12th (2004), 1576 [2]Qu P ISMRM 12th (2004), 1605 [3]Wang JX ISMRM 12th (2004), 1584 [4] Lanz T. ISMRM 12th (2006), 217. [5] Wichmann T, ISMRM 13th (2005), 680. [6] Beck BL, ISMRM 13th (2005), 943. [7] Adriany G, ISMRM 13th (2005) 673.