An 8 Channel Transmit Coil for Transmit Sense at 3T

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Introduction:

Transmit B1 inhomogeneity at high field imaging causes both image intensity variations as well as unwanted flip angle variations across the object. The latter is especially problematic since it leads to spatially varying image contrast for sequences whose contrast depends on flip angle. For example, conventional "uniform" volume head coil designs at 7T yields substantial contrast loss in the temporal and occipital regions for T1 weighted sequences. A multiple channel transceive array offers the possibility for flexible mitigation of the transmit inhomogeneity through either B1 shimming (adjusting the global phase and amplitude relationship between the transmit coils) or by the use of spatially tailored RF excitation pulses accelerated to useful durations using transmit SENSE. [1,2,3] In this work, we describe a 8 channel 3T transmit array coil developed for parallel excitation. We validate the coil using spatially tailored RF excitation pulses.

Methods:

The coil was tested on a prototype 3T Siemens TIM Trio system (Siemens Medical Solutions, Erlangen Germany) with 8 independent transmit channels. Eight circular detunable surface coil TR elements (dia. 150 mm) were tuned to the Larmor frequency with 8 distributed capacitors and placed on the outer surface of a 280mm dia. acrylic tube. The coils were overlapped to null mutual inductance between nearest neighbors. Each coil contained a series pin diode that is controlled with a static bias to detune the coil if an additional coil (such as the systems body RF coil) is used for transmission or reception. The transmit coil was in the tuned state when the diode is forward biased. RF Cable traps were added to the coaxial cable to reduce cable interactions. Each transmit channel contained a T/R switch and preamplifier to allow the array to operate as a receive coil as well as a transmit coil. The schematic of an individual channel is shown in Fig. 2. The coils were characterized with S11 measures of coil match and S12 measures of coil couplings. Excitation B1 profiles were obtained by sending a non-selective RF pulse to one channel at a time and receiving through the body coil. During reception with the body RF coil, all the transmit coils were detuned by reverse biasing the pin diodes. The transmit B1 profiles were measured by recording the amplitude and phase of a 64x64x64 low flip angle GRE 3D sequence(TR/TE/Flip = 50ms, 5ms, ~10deg) and inferring the transmit map by reciprocity. All measurements were performed in a 17cm diameter low dielectric oil phantom.

The system was demonstrated in a phantom image using a 2D tailored spatial B1 profile excitation employing a spiral readout during RF excitation[5] with transmission of the calculated (unique) 2 fold accelerated RF waveforms simultaneously through all the 8 channels to excite a square box in the center of the phantom.

Results and Conclusion:

The S11 reflection of the 8 coils were each approximately -16dB. The S12 parameter measuring the coupling of any two coils is shown if Fig 3. Figure 4 and 5 show the individual coil's magnitude and phase profiles. Although the bench coupling measures were reasonable, there is still significant coupling among the transmit coils. The coils coupled with the opposite coil element more significantly than with the any other element. Figure 6 shows a spatially selective RF excitation obtained with separate RF waveforms sent to each of the 8 transmit channels.

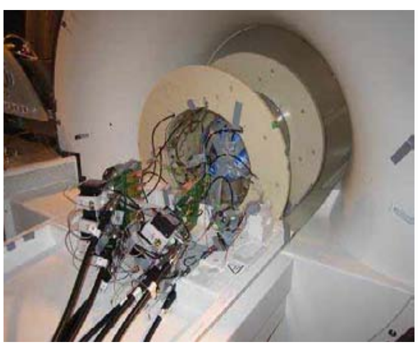

Fig 1 : 8 Ch Tx array setup

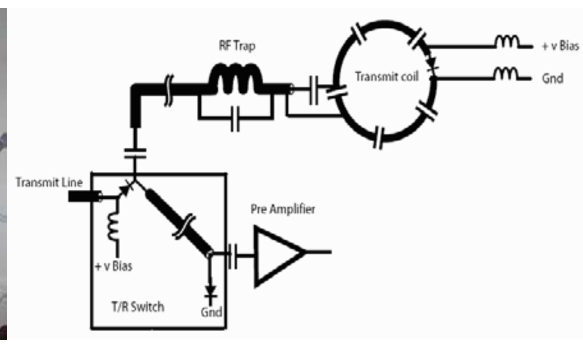

Fig 2 : Schematics of a single Tx Coil

Channels	1	2	3	4	5	6	7
1							
2	-14						
3	-14	-14					
4	-13.5	-10	-15				
5	-13.5	-9	-10	-14.5			
6	-14	-10	-11	-11.2	-14		
7	-13.5	-9.5	-11	-10	-11	-17	
8	-10	-11	-9	13.5	-11	-12	-9

Fig. 3 S12 parameters in dB

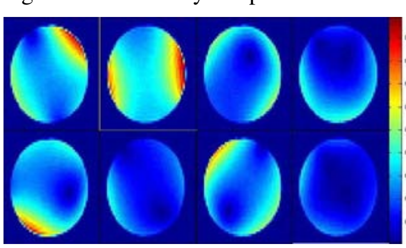

Fig 4: Magnitude profiles of the 8 Tx Ch

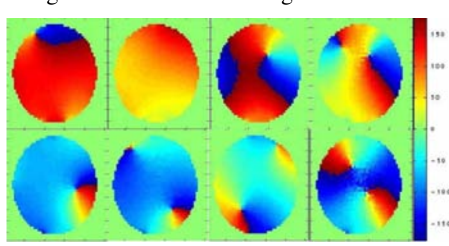

Fig 5: Phase profiles of the 8 Tx ch

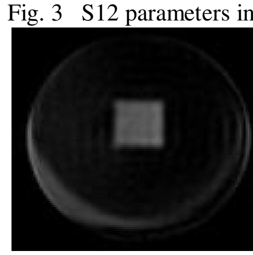

Fig 6: 2D Excitation

References:

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