

SIMPLE AND ACCURATE DETERMINATION AND VISUALIZATION OF TRUE QUADRATURE SETTINGS ON COMMERCIAL MULTIPLE CHANNEL TRANSMITTERS USING ANTI-QUAD

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Introduction: The development and application of RF coils for multichannel transmitters requires accurate knowledge of the relative magnitude and phase of the B1+ produced by each element. In the system used for this study, the commercial vendor-provided software is designed to determine drive voltages and relative phase for optimal B1 homogeneity. In addition to this general marker for B1 improvement, searching for the most efficient (true quadrature) B1+ is desirable for a number of applications, especially those that require high power, e.g. proton decoupled spectroscopy. This abstract discusses a simple method for calibration of the drive phases in a two channel transmit system. Setting the phases for reverse circular polarization (anti-quad) provides greater sensitivity for the validation of the phase calibration for ‘steering’ to a point of interest. In addition to its general applicability for coil calibration, this method may find application in steering the zero effective field needed for catheter-tracking based on reverse polarization.

Methods: The study was performed on a 7T whole body scanner (Philips Medical Systems, Cleveland OH) with a commercial dual-channel parallel transmission capable of providing independent amplitude and phase on both channels. The RF coil used has been described previously [1]. It is a combination Helmholtz – saddle pair system designed for imaging of a single breast. In principle each coil pair can be fed through a quadrature combiner to achieve the appropriate circular polarization (“quad”). At high fields, however, propagation effects prevent good quadrature polarization at all points.

B1 amplitude maps were obtained using the 3D dual-TR method [2], using an ACRIN breast phantom. A relative phase map was obtained by exciting each element in turn at zero phase. The Helmholtz pair was used as the receiver in each case, so that following subtraction of the phase maps from the individual channels only the effective (rotating frame) phase difference between transmit paths remained. This quick calibration enabled the relative phase and amplitude of the system to be set for quadrature field at any ROI. To verify that the phase was set correctly, the system was first adjusted for anti-quad at the desired point. This results in a more sensitive adjustment, as is illustrated in the simulation in Fig. 1. Figure 1 plots the normalized magnitude of B_1^+ as a function of the relative amplitude and phase of the two channels, and illustrates the sharp anti-quad null vs. a broad true-quad peak.

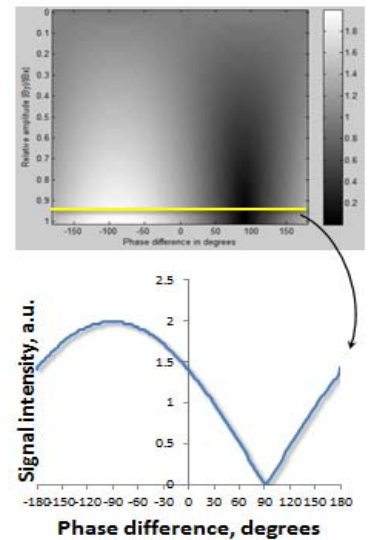


Figure 1. Normalized B1+ vs. the relative drive amplitude and phase and a line profile illustrating the broad maximum at true quadrature and the relative narrow anti-quadrature minimum.

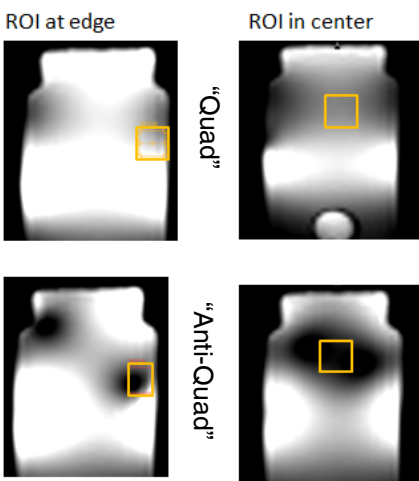


Figure 2. Visual inspection of the images obtained in a quad mode (top) fails to confirm if true quadrature was achieved either for the ROI at the edge (left) or the center (right) of the phantom. Running the system in anti-quad (bottom) allows for easy visualization of the null steered at the desired ROI.

Results: The inherent inhomogeneity of the small breast volume coil makes it difficult to verify that true quadrature drive is obtained by simple visual inspection of the resulting image. Figure 2 illustrates the usefulness of the anti-quad image for the steering of the true quad field

at any desirable region of interest in the image. The top row shows quadrature images for the ROI (shown as a small yellow box) steered either at the edge of the phantom (left column) or the center (right column). Visual inspection of these images fails to fully confirm that true quadrature (most efficient field) was achieved at the selected ROI. However, when the system was run in the complementary anti-quadrature mode (Fig. 2, bottom row), simple visual inspection confirms good agreement between the desired ROI and the achieved anti-quad null.

Conclusion: Calibrating for reverse CP, or anti-quad, is a sensitive and easily visualizable method for verifying the proper drive in multiple channel systems. The sharp ‘null’ behavior of the anti-quad mode as opposed to the broad peak of the quad mode enables greater confidence and more accuracy in this calibration. This has been found to be useful for calibrating and validating the phase settings for experimental coils used for multi-transmit at 7T. Additionally, there may be applications where it is desirable to create the highest quality anti-quad polarization at a point, such as catheter tracking using reverse polarization [3,4].

References: [1] J.R. Rispoli et al., Proc.20th ISMRM, p. 2635, 2012. [2] V.L. Yarnykh, Magn Reson Med. 2007 Jan;57(1):192-200. [3] Celik et al., Magn. Reson. Med. 2007 Dec; 58(6): 1224-1231. [4] W.R. Overall et al., Magn. Reson. Med. 2010;64(3):823-833.