

An Efficient Switched Double-Frequency Birdcage Coil for ^3He and ^1H Imaging

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Introduction: In lung imaging applications where hyperpolarized ^3He gas is used as the image contrast agent, anatomic ^1H images are frequently desired, preferentially without moving the subject or changing the RF coil. Dual tuned coils [1] were previously developed for this purpose, although such coils commonly suffer from reduced imaging performance at one or both nuclei. We present a prototype electronically switched double-frequency birdcage hybrid volume coil for ^3He and ^1H imaging for 3T clinic MR scanner use. This prototype coil is a small-scale model used in development of a clinical switched double-frequency 3T body coil that does not compromise patient-bore diameter relative to commercial proton body coils.

Theory: The starting point for our switched tuned coil design is a conventional proton birdcage coil. For that purpose, a regular 8-rung birdcage volume coil was built for proton imaging at 3T (127.73 MHz). An additional end-ring pair was then added onto the proton coil, with switching diodes powered by DC current via RF chokes (Figure 1). When the diodes are in the "OFF" state, only the inner end-rings operate and the coil works at the proton frequency. When the diodes are in the "ON" state, the outer end-rings operating together with the inner end-rings and the coil works at the ^3He (97.32 MHz) frequency. All 8 diodes on the same end-ring are powered in series to insure an equal DC current.

Methods: The main coil support is a 3mm thick acrylic cylinder. The coil size was chosen for imaging of small animals, in combination with a dedicated high-performance gradient coil. The diameter of the coil is 16.5cm; the total end-ring-to-end-ring length is 20cm for proton and 25cm for helium. The entire coil is shielded with a 20cm diameter, 38cm long copper foil (Figure 2). Proton ports are at 0 & 90 degrees; helium ports are at 180 & 270 degrees. For proton imaging, the I & Q signals are fed from the head coil connector of a GE 3T MR scanner (GEHC, Waukesha, WI, USA). For helium imaging, the I & Q signals are fed into the T/R switch (GEHC) that is connected onto the multi-nuclear transmit/receive port. The diode bias signal is derived from the system DC bias driver that is made available at the proton head coil connector.

Results and Discussion: Figure 3 shows the through probe response of the coil without and with the diodes powered ON. The frequency switching is prompt and clean. This work provided a general method for switched double-frequency or multi-frequency birdcage volume coil for transmit only or transmit-receive applications and it would be easy to be implemented into clinic body coil.

References: [1] G. X. Shen et al, MRM 38 (1997) 717-725

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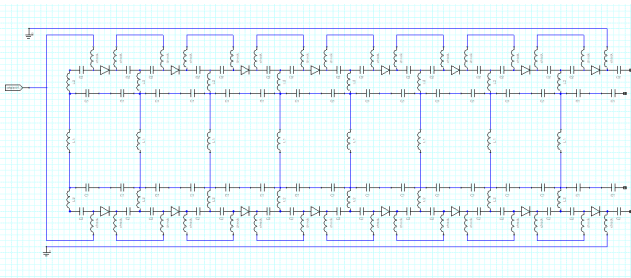


Figure 1, the principle diagram of the switched double-frequency birdcage volume coil.

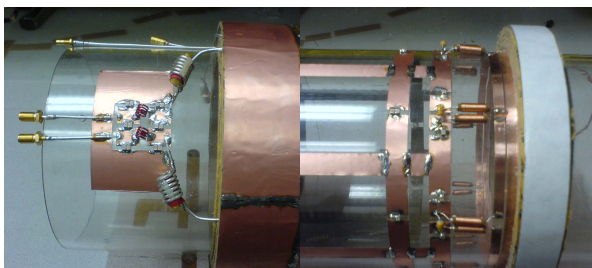


Figure 2, photographs of the switched double-frequency coil. Left: the connectors and shielding; right: double end-ring and switching mechanism.

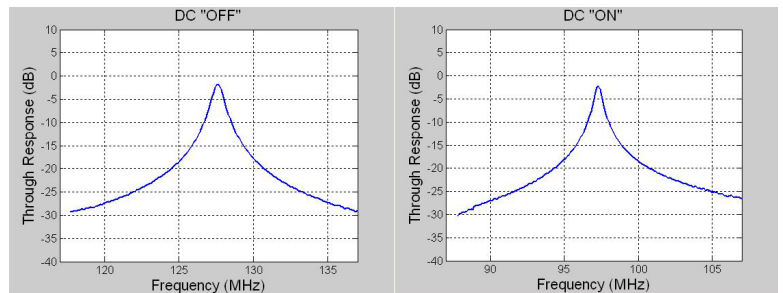


Figure 3, through probe response of the switched double-frequency coil. Left: diodes "OFF", coil resonates at ^1H frequency (127.7MHz); right: Diodes "ON", coil resonates at ^3He frequency (97.3MHz).