# High-Speed Prepolarization Coil Driver for SQUID MicroTesla MRI

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Magnetic Resonance Imaging (MRI) has been a staple of medical diagnostics since its invention a few decades ago.? However, its need for very intense (~ few T) yet highly homogeneous magnetic field required use of bulky and very expensive superconducting magnet.? Recently however, an alternative method called Low-Field MRI or MicroTesla MRI has been introduced which reduced the measurement field ($B_0$) requirement by several orders of magnitude, to mere?hundreds of μT.? This lessened the requirement on the $B_0$ coil so that it can be constructed simpler with ordinary resistive copper coils.? The inevitable loss of signal strength,?leading to the loss of image quality, is countered with a prepolarization coil, which polarizes the subject with higher? field ($B_p$ ~ hundreds of T) prior to the scanning so that the resulting magnetization provides far stronger signals than the $B_0$ field alone could.? Since this $B_p$ need not be very homogeneous, the whole setup can be dramatically simplified and also much less expensive.? Also, the micro-tesla $B_0$ allows the use of Superconducting Quantum Interference Device (SQUID) sensors in place of the receiver coil used in traditional MRI systems.? SQUID receivers have several advantages over the traditional receiver coil including 1) significantly higher sensitivity, 2) reduced loss of SNR with lower $B_0$, 3) capable of multiple-sensor configurations, and related to 3), 4) capable of natural integration with multi-channel MEG and MCG systems.? Here, the authors present a prepolarization coil cooled with liquid nitrogen capable of $B_p$ = 0.2 T and a fast prepolarization coil driver employing a method of energy-transfer between the coil and a bank of capacitors switched by a couple of IGBTs and matching diodes, capable of cutting off $B_p$ within 20 ms with minimal loss of energy.

Keywords: SQUID, MRI, Prepolarization