High-Tc Superconductive Active Shield based Magnetocardiography At Liquid Nitrogen Temperature and the research activities at SERLs

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Abstract

After a short review on high temperature Superconductive QUantum Interference Devices (SQUIDs) and principal operation of rf-SQUIDs, advantages of Magnetocardiography (MCG) versus the well known ECG will be discussed. Incorporating special active shielding for unshielded SQUID based applications, a Magnetocardiograph system has been designed and implemented at SERL. The MCG system consists of two High Tc rf SQUID magnetometers which are placed in an axial gradiometer arrangement. The system is based on a designed liquid nitrogen dewar with rf-interference shield and appropriate structure for short liftoff. The implemented active shield is a two-stage of shielding system while each of them has been designed for different frequency and dynamic range characteristics. For this purpose, a feedback control system is implemented for environmental noise cancelation, and an optimized control system, for the internal and external compensation coils, controllers, and filters are designed. Using the developed shielding system, the disturbing magnetic signals of the environment could be attenuated such that an artificial heart signal could be obtained in our unshielded highly noisy laboratory environment. The system incorporates two channel rf SQUID electronic readout and also the required PID circuit controllers for active shielding system. The used SQUIDs are step-edge junction rf type fabricated using rf-Magnetron sputtering system. The talk will be followed by a short introductory presentation on the SERL research activities at Sharif University of Technology, including the topics of recent activities on multi-layer device fabrication, superconductive digital circuits (RSFQ), IR sensors, Microwave devices, High temperature superconductive coil design for MRI systems, and SQUID based double frequency excitation nondestructive tests of conductive materials.

Biography

Professor Mehdi Fardmanesh received his B.S. degree in EE from Amirkabir (Polytechnic) University in Tehran in 1987, and the M.S. and Ph.D. degrees in EE from Drexel in Pennsylvania in 1991, and 1993, where he joined Ben Franklin Superconductive Research. From 1994 to 1996, he was with the Departments of EE and Physics of Sharif University of Technology in Tehran. In 1996, he joined the EEE Department of Bilkent University in Ankara, and in 1998 he also started his collaboration with Forschungszentrum Jülich, in Germany. From 2000 to 2004, he was the Director of a Bilkent-Juelich joint project for the development of high-resolution high-T_c SQUID-based magnetic imaging system. In 2000, he reestablished his activities with the EE Department of Sharif University, where he is presently tenured professor and head of the Superconductive Electronics Research Laboratory (SERL), which he established in 2003. He teaches more than ten courses in major fields of Electronics, Solid state devices, and Bioengineering. Presently his research interests have been focused on the design, fabrication, and modeling of superconductor and semiconductor devices and circuits, in the areas of IR-radiation sensors, bolometers, microwave devices, Josephson junctions, RSFQ digital circuits, Biosensors, and power devices such as Magnets and SFCLs. He has also been pursuing research in the field of bioelectronics such as works on "Design of Self Powered Artificial Retina" and "DNA conductivity characterization and analysis" in addition to thermal imaging and SQUID based Magneto-Cardiography (MCG).

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