

Noise Characteristics of 64-channel DROS Second-gradiometer System inside Poorly Magnetically-shielded Room

J. M. Kim^{*a}, Y. H. Lee^a, K. K. Yu^a, K. Kim^a, H. Kwon^a, Y. K. Park^a, Ichiro Sasada^b

^a *Bio-signal Research Lab, Korea Research Institute of Standards and Science, Daejeon, Korea*

^b *Department of Applied Science for Electronics and Materials, Kyushu University, Fukuoka, Japan*

We have developed second-gradiometer double relaxation oscillation SQUIDs (DROSs) with a baseline of 35 mm, and constructed a poorly magnetically-shielded room (MSR) with an aluminum layer and permalloy layers for magnetocardiography (MCG) measurement. The 2nd-gradiometer DROSs have the noise level of 20 fT/ $\sqrt{\text{Hz}}$ at 1 Hz, 7 fT/ $\sqrt{\text{Hz}}$ at 100 Hz inside the heavy MSR that has a shielding factor of 1000 at 1 Hz and $10^4 - 10^5$ at 100 Hz. The poor MSR, made up of an aluminum layer of 12 mm thick added with 4 permalloy layers of 0.35 mm thick, possesses a shielding factor of 40 at 1 Hz, 10^4 at 100 Hz, and a size of 2.4 m x 2.4 m x 2.4 m. A 64-channel second gradiometer MCG system consists of 2nd-gradiometer DROSs, flux-locked loop electronics, and analog signal processes. After installing 2nd-gradiometer DROSs and flux-locked loop electronics inside the poor MSR, and analog signal processes outside it, we have measured the noise level of 20 fT/ $\sqrt{\text{Hz}}$ at 1 Hz, 7 fT/ $\sqrt{\text{Hz}}$ at 100 Hz on the average though the MSR door is open, which results in low-noise enough to obtain a human MCG as same as in the heavy MSR, but low-frequency noise signals below 10 Hz generated from a heavy air conditioning under the MSR, are detected. Therefore, filters or active shielding are needed for clear MCG when large and low-frequency noise signals from such as heavy air conditionings or large ac power consumers occur near to the poor MSR. In addition, when the MCG system is located on outside the MSR, we have measured a noise to know the possibility that the 2nd gradiometer system can detect a MCG without a MSR.

Keywords : DROS, magnetocardiography, shielding, SQUID.