Nondestructive Inductive Measurement of Local Critical Current Densities in Large Bulk and Thick-Film Superconductors

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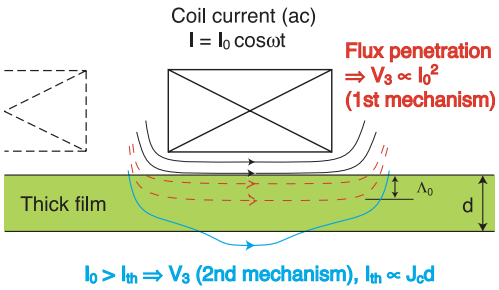
We have developed an ac inductive technique that measures local critical current densities J_c of large bulk and thick-film superconductors. In this method an ac magnetic field is generated by an ac drive current ($I_0\cos\omega t$) in a small flat coil placed just above the superconductor, and a third-harmonic voltage ($V_3\cos 3\omega t$) generated in the same coil due to the nonlinear magnetic response of type-II superconductors is measured. Because this V_3 (due to the first mechanism by flux penetration) is proportional to I_0^2 and inversely proportional to J_c, J_c can be measured in the surface region (typically down to $\Lambda_0 \sim$ 0.1 mm beneath the surface) of the superconductor by measuring V_3 as a function of I_0. In case of the thick-film superconductor, it is also possible to measure the J_c for the total thickness. The I_0 vs V_3 curves suddenly change the curvature at a threshold current I_{th} when the magnetic field penetrates the bottom surface of the film (the second mechanism). Because I_{th} is proportional to the product of J_c and the film thickness d, we can obtain the average J_c for the total thickness from I_{th}.



Schematic of the generation mechanisms of third-harmonic voltage V_3 in inductive J_c measurement in thick films

Development of Time and Frequency Calibration System

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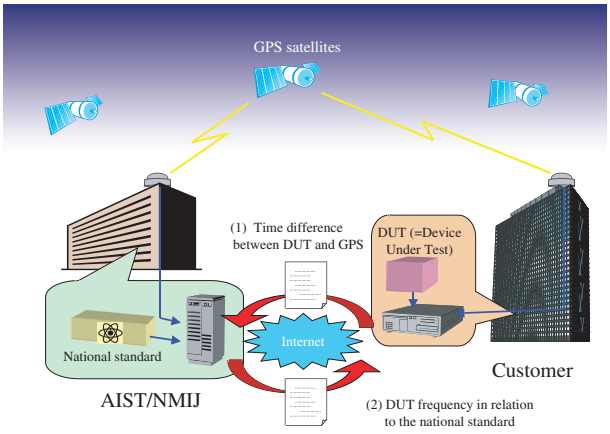
NMIJ has been giving calibration service of time and frequency standards. At present, the client must carry their frequency standards (DUT = Device under Test) into our laboratory. Therefore, DUT must be stopped and suffer disturbances caused by carrying. And furthermore, the frequency of DUT is never calibrated in usual circumstances. Then, new calibration system using GPS (= Global Positioning System) and the Internet is developed in NMIJ. This system consists of two processes as follows; 1) frequency measurement using GPS common-view technique and 2) data transfer from client to NMIJ via the Internet. We have tested the validity of this system by experiment.



Overview of the time and frequency remote calibration system