§36. Real Time Monitoring of Superconducting Coil using Fuzzy Theorem

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In a large superconducting coil system like a fusion reactor, continuous monitoring and evaluation of the state of superconducting coil is necessary. For the monitoring of these coil system, we have proposed a new method using Fuzzy theorem[1]. So far, we investigated about the relation between the number of membership functions and the state of the coil[2]. As a result, it has found that membership functions more than 4 is necessary to monitor the superconducting coil. These calculations carried out with some accumulated data.

So, this time, we have investigated real time monitoring system with A/D converter and D/A converter. Outline of this monitoring system is shown in figure 1. This system contain of three parts. First part is data acquisition part with 8 channel 12bit A/D converter. This converter has sampled-hold circuit. Then, 8 channel data can treat with the same time. Second part is fuzzy calculation part. This result shows that the state of the superconducting coil is indicated by a numerical value from 0.0 to 1.0 as a dangerous rate. And third part is the output signal part to display the state of superconducting coil. This part is 2 channel 12bit D/A converter. Using this signal, we can generate a warming signal and also can control a power supply. Here, the D/A converter output signals are connected with two LED ,which one is green and the other is red. If the state of superconducting coil is in a safe state,it means that a dangerous rate of the coil is lower than 0.6, a green LED is lighted. This state implies that superconducting coil is stable. And if the dangerous rate of the coil exceeds the value of 0.6, a red LED is lighted. This state is considered that the coil is in state of quench.
The calculation time of one cycle is about 200msec with the 4 to 6 membership function.

Figure 2 is the "EXSIV" experimental result with 5 membership functions(transport current,balance voltage, input pressure, input flow of liquid helium, and input temperature).
At this experiment, because of transport current is so small compare with the critical current, then the coil is not quench. Therefore, the state of the coil is in stable.

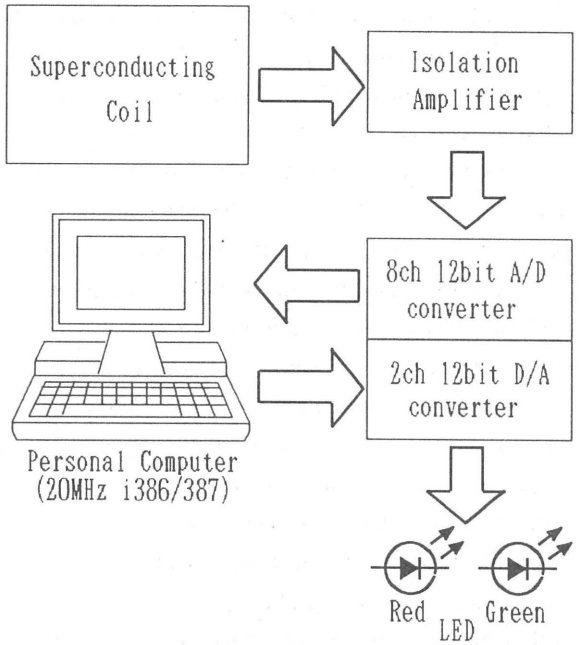

Fig.1 Schematic of Fuzzy real-time monitoring system

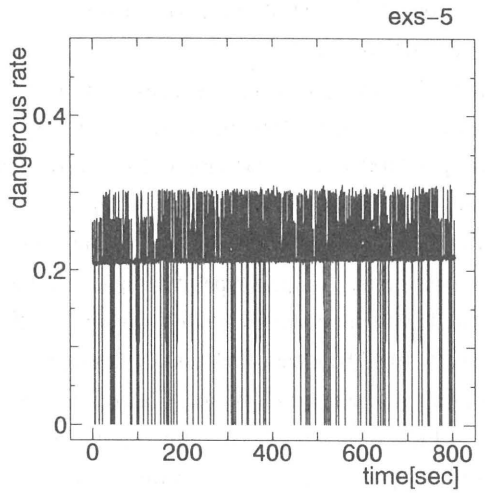

Fig 2. Calculation result(current : 2kA, sweep rate : 20A/sec, current hold time: 10 min.)

References
1)Ninomiya.A, et al. :IEEE Trans. on Appl. Super.Vol.3, No.1, march, pp 301-304,1993
2)Ninomiya.A, et al. :Cryogenics 1994 Vol.34 ICEC Supplement, pp 729-732