

## §12. Reliability Test of Quench Protection Circuit

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Each power supply for superconducting coil of LHD uses a new type opening switch, that consists of a vacuum circuit breaker and power fuses, in the quench protection circuit. This paper reports about experiments to confirm reliability of an actual quench protection circuit.

In these experiments, a load coil, which has enough inductance and low resistance, is required to keep output current while protection sequence is running. For this purpose, a liquid nitrogen cooled coil was built and used. Figure 1 shows a diagram of test circuit. This test uses the OV coil power supply because it is the largest one in the power supplies.

In the beginning of the experiments, a trouble, that a rush current flows through DS2 when it closes, is found out. To suppress this rush current, modification of quench protection sequence is done. Also additional arcing contacts are installed in DS2. After these corrections, no rush current is observed.

Figure 2 shows one of current and voltage waveforms in quench protection. In this figure, the sequence is as follows: (1) After protection signal, the output voltage of power supply turns to 0V, (2) DS2 close, (3) power supply changes into regeneration and current transfers to DS2, (4) DS1 open, (5) VCB open and current transfers to fuses, (6) fuses break and current transfers to dump resistor. This figure shows the above sequence is finished within 550 milliseconds and it satisfies a request that the delay must be less than 1 second.

The experiments are done with operation currents of 3.7kA, 10kA, 16kA and 22kA. We made 50 shots of tests for each current without failure. Figure 3 shows the characteristics of melt-down time of power fuse.

With these experiments, the reliability of quench protection system used in OV power supply is confirmed.

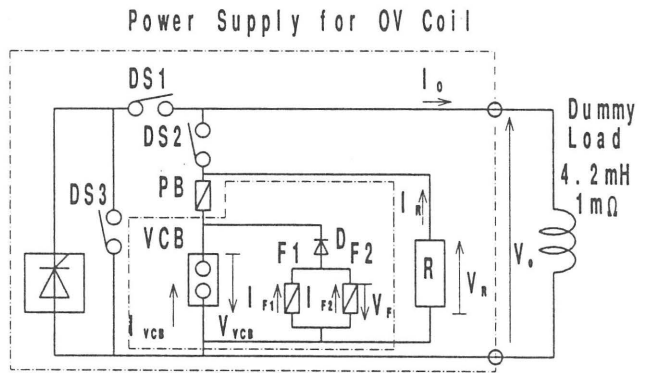


Fig. 1. Diagram of Test Circuit

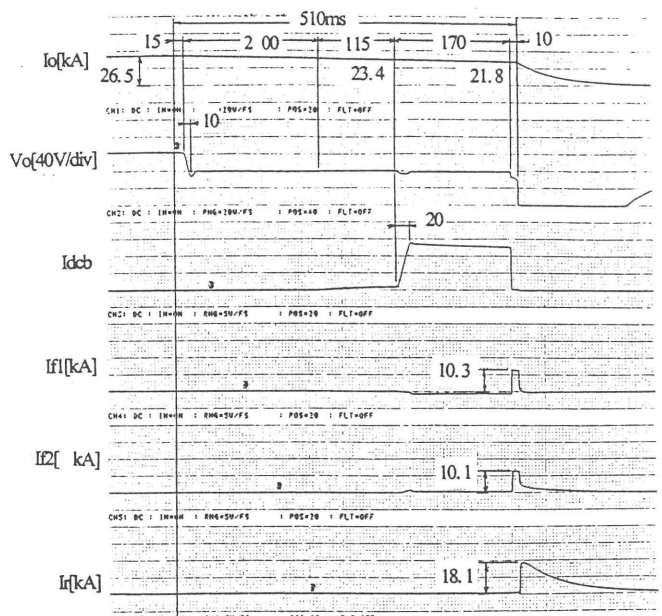


Fig. 2. Voltage and Current Waveforms in Quench Protection

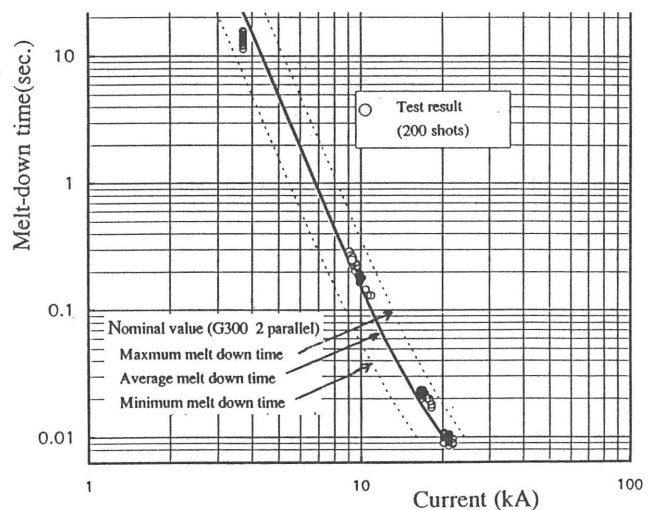


Fig. 3. Melt-down Time of Power Fuse