§7. Construction of High Voltage Power Supply for Pulsated Excitation of Superconducting Coils of the LHD

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Intorduction Although the basic operation of an LHD is performed under the DC magnetic field, some experiments require dynamic control of magnetic field. For the dynamic excitation of coils, the current DC power supplies do not have enough output voltage because they were designed and constructed for the steady state excitation of the superconducting coils. For this purpose, pulse power supplies for the dynamic experiments are designed and constructing.

Pulse power supplies At beginning, required voltage to dynamic magnetic axis control are calculated. As the result, it was shown that the voltage of the IS and IV coils are bottle neck and we decided to construct the additional power supplies in series connected to the IS and IV power supplies.

Figure 1 shows the circuit diagram of the IV power supply. In the figure, DC power supply shows the current power supply and the pulse power supply means the additional one.

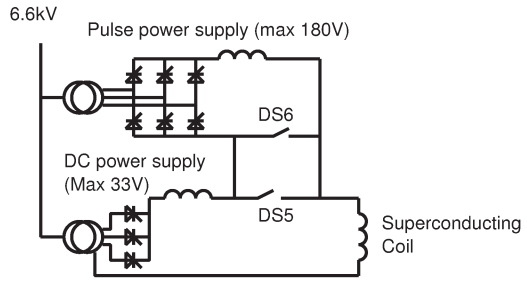

Figure 1: Circuit diagram of the power supply for IV coil.

In the designed of the pulse power supplies, the following operation scenario is considered.

- Turn on the DS 5. The coil is excited by the DC power supply only. With this operation, 3 T of steady state excitation field is available.
- Turn off the DS 5 and turn on the DS 6. The coil is excited by the DC power supply and the pulse power supply stand-by for operation. . With this operation, 1.5 T of steady state excitation is available.
- Turn off the DS 5 and turn off the DS 6. and the coil is excited by the DC power supply. With this operation, dynamic swing operation is available. In this mode, the coil is excited by the both of the DC power supply and the pulse power supply series.

The whole state control is show in Figure 2. The turning of DS 5 is done while the STOP status. The control of DS 6 is perforfed in the RUN status.

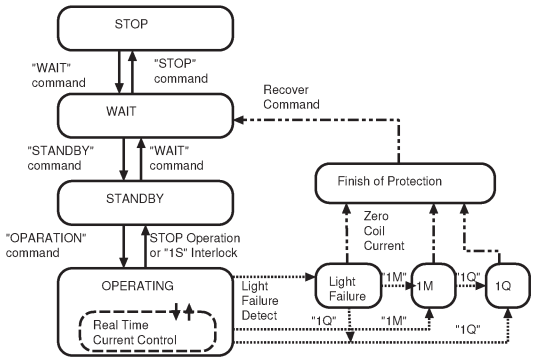

Figure 2: State transition of the power system.

Table 1: Specifications of the power supplies

Output voltage	180 V
Output current	6.2 kA
Operation time	120 s
Operation time	120 s
Duty ratio	1/20

When we use the pulse power supplies, the available transition time for plasma axis sweep is carried out as shown in Table 2. In these transition, the output voltages of the helical power supplies limits the minimum transition time. For more dynamic control, it become necessary to reinforce of the power supplies, but it needs more cost for construction of the system.

Table 2: Typical transition time for plasma axis control at $B = 1T$.

	3.55	3.60	3.65	3.70	3.75
3.55	—	3.09	5.67	7.81	9.98
3.60	1.49	—	2.58	4.72	6.88
3.65	2.72	1.25	—	2.14	4.31
3.70	3.78	2.89	1.64	—	2.16
3.75	5.26	4.44	3.19	1.55	—

H.Chikaraishi, S.Takami, T.Inoue, T.Ise, H.Niwa, T.Haga: "Control System of DC Power Supplies for LHD Superconducting Coils", Fusion Engineering and Design, (2008) 04 vol.83 no.2-3 pp.260-264