§2. Real-Time Plasma Current Control System for LHD

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For the steady-state operation in LHD, real-time (and/or feedback) plasma control system is one of the most essential techniques. Externally controllable parameters are a gas puffing rate, the number and the repetition time of injecting pellets, heating power of ECH, NBI and ICRF, and a combination of coil currents (one pair of helical coil currents and three pairs of poloidal coil currents). Each device forms an individual system called sub-system. They are controlled and operated by their own control computers.

As the first step of the real-time control system, we designed the real-time plasma current control (RPCC) system. Figure 1 shows the configuration diagram of the plasma current control system. This system is linked to the real-time computer for the power-supply control through the reflective memory chain. The RPCC computer which operating system is Windows-NT reads the momentary value of each coil current from the reflective memory, which is written by the coil current monitor output computer. After some calculations according to the PI algorithm RPCC computer writes the data set of the coil current for the next step time. Power-supply real-time control (PSRC) computer reads these data set, checks rationality, and controls power-supplies of each coil according to these data set. Calculations to get coil currents are carried out in a digital signal processor (DSP). Plasma current is inputted to the DSP through an analog digital converter (A/DC) module. Receiving trigger pulses and sending system status are carried out through a digital I/O (DIO) module. The same inductance matrix that the PSRC computer uses is applied in these calculating algorithm. Figure 2 shows the simulation result of the plasma current control. All coil currents are controlled to keep the position of the magnetic axis and the ellipticity and to change the plasma current. Changing rate of each coil current (dI/dt) is limited to 5 kA/sec maximum by the limitation of the power supply.

All interlock systems and the security systems for the power supplies are kept as before. For the safety the control priority is back to the power-supply computer with keeping the present conditions when any abnormal state is detected.

This system is applicable to a magnetic axis control system directly because the magnetic axis control system controls the coil current essentially as same as this system.

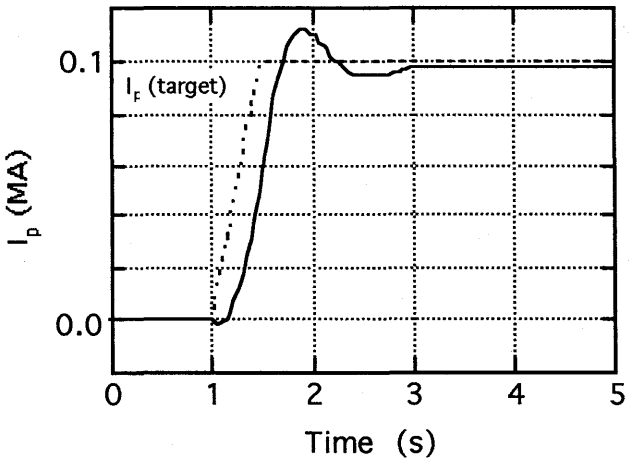

Fig. 2. Result of plasma current control simulation.

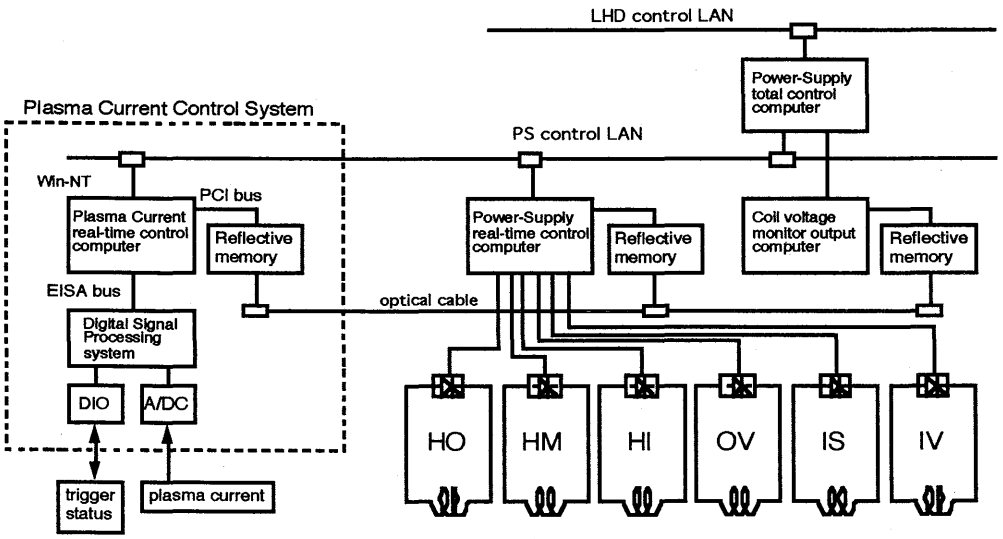

Fig. 1. Configuration diagram of the Plasma Current Control System.