

§8. Preliminary Operation Test for Dynamic Current Control of LHD Superconducting Coils

Chikaraishi, H., Takami, S., Inoue, T., Ise, T. (Osaka Univ.)

In the future operation, more dynamic coil current control is planning for more dynamic plasma control such as high speed axis sweep. For this purpose, high voltage power supplies are planning. In the dynamic operation, the ramp up rate of coil currents becomes about 6 times higher than now, and more quick response is required to the current controller.

To evaluate the current control performance for dynamic operation using current controllers, the axis seep tests are performed under a low magnetic flux of 0.15 T. In this operation, magnetic axis is swept from 3.5 m to 3.9 m by the step of 0.05m and the ramp up time for the each step are set to same values in the dynamic control. Figure 1 and 2 show test results using advanced P control, which is combined with P control scheme, error observer and feed forward control, and H_∞ control. With both control schemes, the coil currents are well controlled. Especially, the response using the advanced P controller is about 0.1 s and it is enough for dynamic current control.

Figure 3 and 4 show voltage waveforms in a step. In the detail, the faster voltage setup was done using the advanced P control. This is caused by bandwidth limiter for current reference, which is required from the H_∞ controller design.

In the control program, the current reference is set to actual current value when the targets of current values are set. Therefore small jump of current reference was occurred and a peak voltage was observed at the ramp up point of the voltage when the advanced P control is used. This peak voltage can suppress with LPF set front of feed forward term.

The monitor signal of quench detector shows some noise when the coil currents are sweep. The noise level is about 30 mV for advanced P control and 5 mV for H_∞ control. They are equivalent to 180 mV or 30 mV of noise level when the high voltage power supplies are used, and they are enough small compared with the quench detect level. From the point of view of electro-magnetic noise for quench detector, the H_∞ control gives lower noise than the P controller.

With these experimental results, it is confirmed that the current controllers have enough performance.

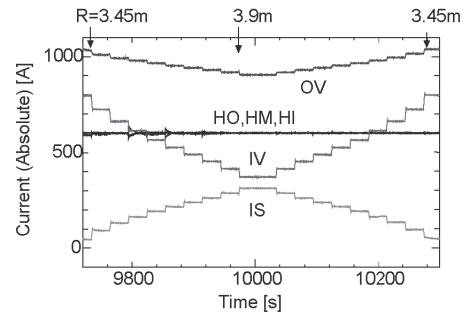


Figure 1: Coil current waveform with P control

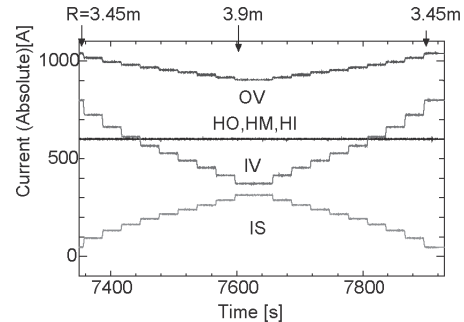


Figure 2: Coil current waveform with H_∞ control

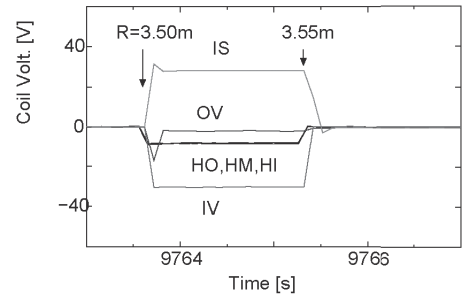


Figure 3: Voltage waveforms in a step with advanced P controller

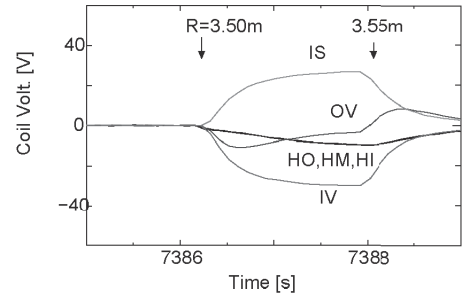


Figure 4: Voltage waveforms in a step with H_∞ controller