# §6. Liquid Stub Multi-computer Control System for ICH on LHD

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We developed a many-variable number feedback control system which could control 10 liquid stub tuners at the same time for the long-pulse plasma discharge on LHD. This control system is the multi-computer feedback system to maintain the reflected RF power fraction at the allowable level. There are many causes to increase the reflected RF power, such as plasma condition and expansion of the coaxial transmission line due to the temperature increase during the long-pulse plasma discharge. It is very important to reduce the reflected RF power because of effective ICRF heating and protecting a tetrode vacuum tube for an excess heat load on the anode plate. It is possible by employing the frequency control to keep the RF reflected power in the allowable level during the long-pulse plasma discharge. However a large shifted value of the frequency usually affects the high RF power output from the final amplifier. Therefore the method to control the liquid surface level was employed in the fixed frequency. This control system is composed by multi-computer, local LAN and UNIX server and does the compensation of liquid of the position of ten stub tuners using CW/CCW and Stop/Start of the pulse motor. Usually the liquid surface position control has a dead time and the measurement of the liquid surface level contains a noise, which results from the bubble on the liquid surface. The LAN system is usually employed at the fundamental control, but it can be used in the system, in which a waste time is abundant. If the LAN is available, the powerful control system is constructed by connecting the computer with LAN. This control system is the CINOS of the signal-processing unit, which has the multiple functions of multi-computer/multi-OS/no OS, and it is done with the computer group connected with LAN. The CINOS utilizes the Linear Time-Invariant Method (LTIM), which is the feature. Then, the CINOS can maintain LTIM when multiple interrupt from the I/O machine happens. Fundamental composition is shown in Fig.1. Two of Loder_1_3.5U/L and Loder_1_7.5U/L are used to control the 10 liquid stub tuners in two ICRF heating antenna systems (3.5U Antenna /7.5U Antenna): These two Loders are connected as a control device of the actuator of liquid stub tuners. That is, Loader reads the liquid surface position and drives the liquid cylinder using a pulse motor, and has the duty that makes a liquid surface keep a proper position. This Loader_1 and Loader_2 are connected in the LAN that is a special network. This LAN is connected to Loader_3. Loader_3 analyzes pre-process value of the feedback and acquires the data of the forward and the reflect RF power from the antennas. The UNIX servers of Unix_3.5U/L and Unix_7.5U/L are the main control devices, which are connected with special LAN. LAN uses the electric standard of IEEE802.3 and TCP/IP socket communication. LAN receives or sends the control information data from the computer and liquid stub tuners. The pre-process value, which has been sent by Loader_3, is changed into the speed value of liquid cylinder and the liquid cylinder shifted value to do PI control by the quadratic transformation with the Unix_3.5U/L and Unix_7.5U/L. The quadratic transformation value is sent back to Loder_1_3.5U/L and Loder_1_7.5U/L, which control an actuator to keep RF, reflected fraction less than 4%.

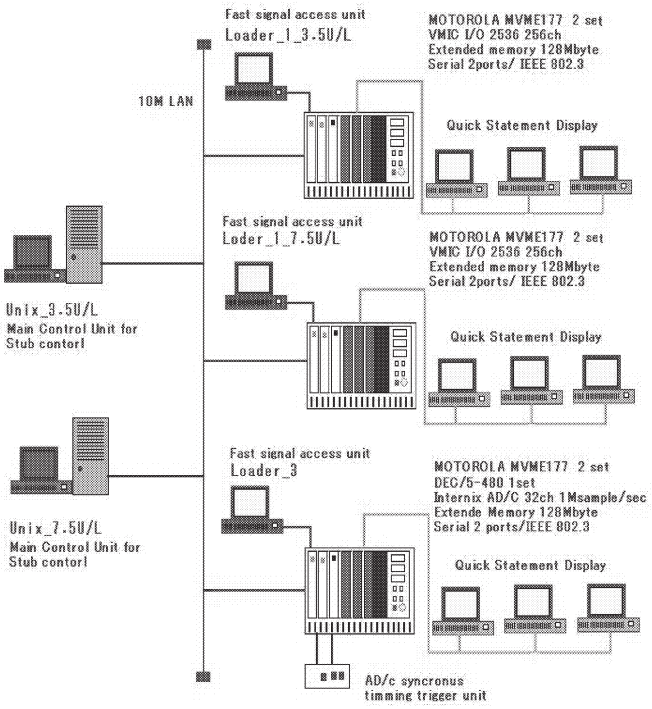


Figure.1. Liquid stub tuner control system by multi-computer control system with LAN.

Reference:

[1] Takahashi, C. et al., Annual report of NIFS, April 2002-March 2003 285(2003)

[2] G.Nomura, et al., 14th Topical Conference on Radio Frequency Power in Plasmas, AIP Conference Proceedings 595(2001), pp.502-505.