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C2Po1E-09: Design and Development of EPICS-based 6kW Helium Cryogenic Control System

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CRAFT is a fusion reactor research facility initiated by the Institute of Plasma Physics, Chinese Academy of Sciences, as part of the national scientific strategy. CRAFT 6kW helium refrigerator is used to provide 4.5K cryogenic test environment for superconducting magnets. The EPICS (Experimental Physics and Industry Control System) architecture allows direct access to the PLC controller via the S7 protocol. Both the IOC and the S7-1500R PLC are designed for master-slave redundancy. The entire system communicates with the EPICS Channel Access Bus (LAN) protocol. The control system of the 6kW helium refrigerator based on EPICS architecture is designed and developed, aiming at realizing the efficient and stable supervision operation for the helium refrigerator through automated control and real-time monitoring means. The system adopts EPICS distributed control architecture, combined with sensor data acquisition of key parameters such as temperature, pressure and flow rate, to adjust the operating status of the helium cryogenic system in real time, and is equipped with alarm functions to improve the reliability and safety of the system. During the system design process, this study combines the openness and flexibility of the EPICS platform to design a multi-level and modular control system architecture. In the research methodology, the IOC redundancy design ensures that when the main control unit fails, the standby unit can quickly take over to avoid a single point of failure affecting system operation. The data storage scheme utilizes an efficient database for real-time data acquisition and storage, supporting long-term data analysis. The supervisory control interface is developed using Phoebe software to display the operating parameters of the helium cryogenic system in real time through the graphical interface, which is convenient for the operator to monitor and adjust the control parameters, and at the same time, has a fault alarm function.

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