DESIGN OF PLC TEMPERATURE FLOW ACQUISITION SYSTEM BASED ON EPICS

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Abstract

In the design of the ADS injector II, the RFQ cavity holds a supreme status, and the RFQ temperature and flow information are the key parameters for the cavity frequency tuning. To ensure the long-term, stable and accurate acquisition of temperature flow data is the essential task of control. In this paper, the PLC temperature flow acquisition system which is based on EPICS design was described, and the EPICS driver of this PLC was developed independently. The driver uses TCP/IP connection to EPICS IOC, and the communication protocol uses the "data block overall transmission protocol", to ensure the stability of the device's data communications. After 3 months of long-term operation inspection, this acquisition system can ensure long-term and stable acquisition of real-time temperature and flow data of the equipment, and be able to send control information to related controlled equipment. In addition, redundant PLCs and redundant IOCs were adopted in this acquisition system to make the switch to alternate channels within milliseconds once a channel fails.

TECHNICAL SOLUTIONS AND IMPLEMENTATION

Hardware Components

The water temperature flow monitoring of the RFQ is implemented by two FC 460R controllers which can be backed up each other. The PROFINET protocol is used to connect four sets of PROFINET slaves. The slaves use analog modules to collect temperature and flow signals. The temperature signals are collected by a resistive temperature sensor. The acquisition of flow signal is collected by the rotameter and converted into a current value. The operation schematic diagram of RFQ the temperature flow acquisition system is shown in Fig. 1. The collected signal is transmitted by the analog module from the PROFINET bus to the FC 460R controller. The gathered data is transmitted periodically by the controller to the EPICS IOC, published and archived. If the temperature and flow values exceed the threshold, an alarm message will be transmitted by the controller, and the corresponding action will be executed.

In order to overcome the on-site interference signal, the isolation modules are adopted by the temperature acquisition. In addition, the temperature and flow data are processed by average and anti-shake modes to prevent large fluctuations in data.
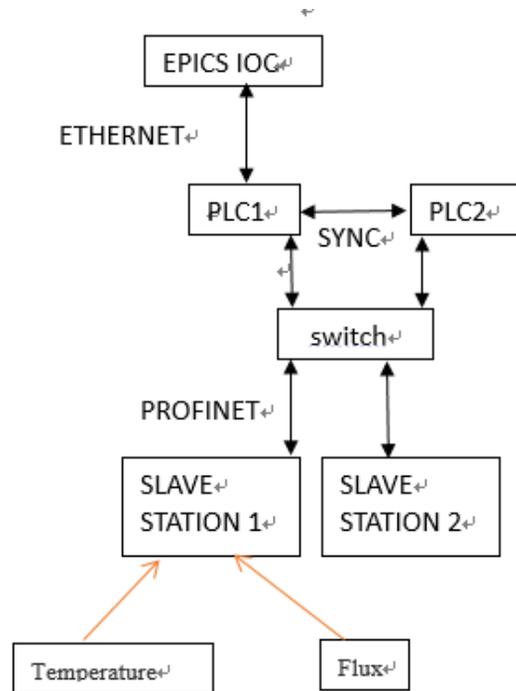

Figure 1: The operation schematic diagram of RFQ the temperature flow acquisition system.

All temperature and flow data are set with threshold comparison. It can be clearly seen through the OPI interface whether the threshold is exceeded. Moreover, the damaged signal of the sensor can be shielded quickly by the 'bypass' on the interface without affecting the beam debugging.

IOC Implementation

This driver is used to connect a Phoenix redundant PLC to the EPICS IOC via TCP/IP. A so-called "whole data-block transmission protocol" is used by the communication protocol. This driver is written by the Swiss PSI laboratory for the Siemens S7 PLC based on the basis of the EPICS driver to support redundant PLC pairs.

The data is periodically exchanged between the driver and the PLC through the network, and the size of the data block is fixed. All process variables are arranged in a data block in a certain way, with an offset in the data block as the flag. The process variables could be of all types supported by EPICS. The programmers of IOC and PLC should reach an agreement on the size of the data block and

the arrangement of the process variables in advance. Because after the operation, the size of the data block and the arrangement of the process variables cannot be dynamically adjusted.

On the other hand, the output records connected to the PLC are checked periodically by the driver whether they have been processed since the last cycle. If there is one and only one output record has been processed, the driver will send the data block containing all output variables to the PLC. When the IOC is started, the output data block is sent only after the "PINI" is run.

OPERATION INTERFACE

The interface of RFQ is mainly composed of two parts: RFQ cavity temperature and RFQ cavity flow, as shown in Fig. 2. The monitored temperature and flow of the RFQ cavity and water are clearly indicated in the interface. The interface state (interface configuration) is refreshed every second, and there is an indicator light indicating its fault status, the green light is normal while the red light is fault. There is a button on the right side of each indicator to shield the fault temperature or flow signal. The green light is on to enable the bypass function, otherwise is to disable the bypass function. The green small light on the right side of the temperature box will turn red once the temperature exceeds the threshold. If the time exceeds the threshold value for more than 30ms, the temperature display box will turn red, indicating that the temperature of the road actually exceeds the threshold. Then the RFQ power source will be cut off. The anti-shake processing of temperature monitoring is realized by the delay of 30ms.

TECHNICAL TEST, CONCLUSION

The redundant controllers and redundant IOCs are used to develop the RFQ water temperature flow monitoring system and therefore the high system reliability can be achieved. The temperature and flow signals are quickly transmitted by the high-speed PROFINET bus, thus ensuring the signal stability from hardware and software. In addition, the fault can be detected rapidly and the power source is cut off promptly to protect the RFQ cavity.
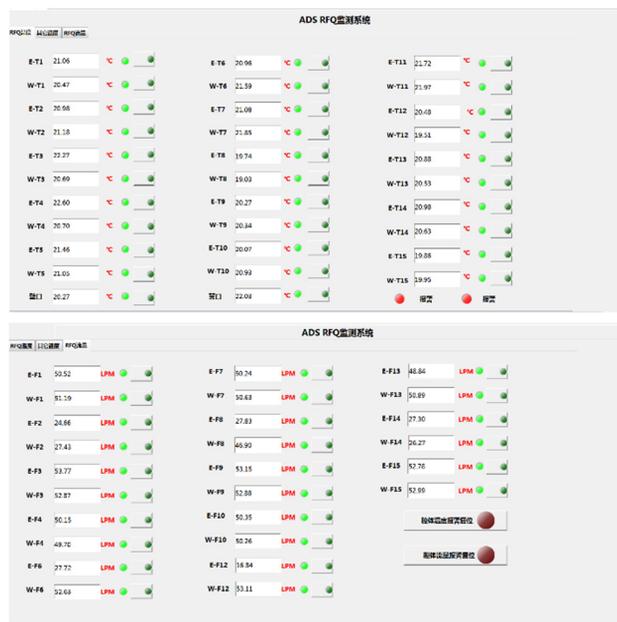

Figure 2: The interface of RFQ temperature and flow.