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Development of control and data processing system for ITER plasma diagnostic systems

ITER計測装置の制御・データ処理システムの開発

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ITER control system is composed of two layers, the central control system and the local control system. The local control system should be conducted well by the central control system. Japan domestic agency (JADA) will procure diagnostic systems for ITER. JADA determined concepts which satisfy requirements from both central control system and diagnostic systems. Based on these concept we designed the control and data processing system for ITER diagnostic system and developed a prototype system for ITER divertor thermocouples system.

1. Introduction

The ITER control system consists of central control and plant system control [1]. Plant systems should be conducted adequately by the central control system for plasma operations and physics studies. It is recommended in ITER that communication between the central control system and plant systems was performed by two types of state machine [2]. One state machine is place in the central control system and implements the common operation state (COS) which presents generic plant system operations. Another state machine runs in the plant system locally and implements plant system operation state (PSOS) which is specific to the plant system [1]. Six diagnostic systems (micro fission chambers, edge Thomson scattering system, poloidal polarimeter, divertor IR thermography, divertor impurity monitor and divertor thermocouples) including control and data processing systems are being developed in Japan[3]. To ensure efficient development of the diagnostic systems, we designed a generic control and data processing system for ITER diagnostic systems [4].

Detailed design of the control and data processing system and the prototype development are described in our presentation.

2. Design Concepts and Architecture

To satisfy requirements from both central control system and diagnostic systems, we determined the following design concepts:

- Compliance with ITER standards and guidelines.
- Modularization of functionalities to simplify software structure and to ensure generalization.
- Data centric design and automatic source generation to ensure flexibilities and to reduce designer’s mistakes.

Based on these concepts, we designed the control system which consists of three sub-systems, the supervisory, the plant control and the plant monitoring sub-system. Fig. 1 summarizes structure of the control system. The supervisory sub-system is the interface point with the central control system. The plant state and mode management function is included in the supervisory sub-system and constrains internal operations. The plant control sub-system controls detectors and auxiliary components in the diagnostic system. The sequential control function is also included in the plant control sub-system. The plant monitoring sub-system monitors status of the diagnostic system and provides access to input or output signals for other sub-systems.

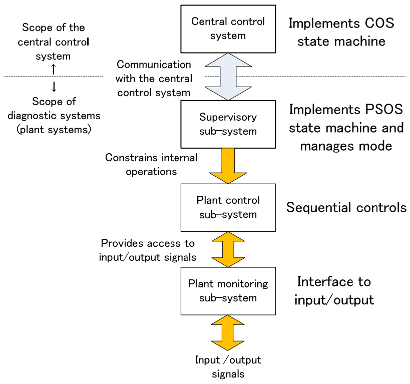

Fig.1. Structure of the control system and functions.

3. Development

The functionalities developed for the control system are described in this section. These functions were developed using EPICS (Experimental Physics and Industrial Control System), control system software development environment, which is recommend by ITER Organization [2].

3.1 *The plant state and mode management function*

The plant state and mode management function is implemented by the state notation language, which is a part of EPICS, and is associated with the central control system state machine using EPICS records. The plant state determines operations which are permitted to be performed. This function also manages central/local mode. Measurement in the plasma pulse should be performed in the central mode. Conditioning, for example calibration or optics alignment, should be performed in the local mode.

3.2 *Sequential control function*

Detectors and auxiliary components should be prepared and configured before measurement in accordance with procedure determined in advance. We implemented the sequential control function combined with EPICS records. Procedure of sequential control is described by the sequential function chart (SFC) notation. We also developed the tool which converts the SFC flowchart to EPICS record source codes.

Although it is required in ITER that interlock system is implemented separate from conventional control, conventional control also carries out machine protection parallel to the interlock system. We proposed a method to generate template of machine protection program codes from interlock descriptions.

3.3 *A prototype control and data processing system for ITER divertor thermocouples*

We developed a prototype control and data processing system for ITER divertor thermocouples system (DTC) to validate the design of supervisory sub-system [5]. In the prototype, the mini-CODAC simulates the central control system. Communication between the central control system and the plant state and mode management function worked well. Since EPICS records used in the sequential control function provides progress of sequence steps, the plant system status was monitored efficiently.

To test measurement function, thermocouples were welded to the SUS plate. The plate was heated in the oven and cooled by ice. An example of obtained data was shown in Fig. 2.

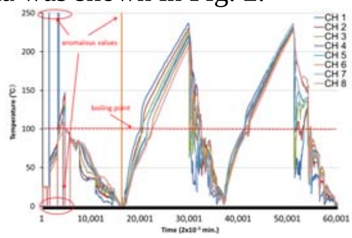

Fig.2. Example of obtained thermocouples data

4. Conclusion

We designed a control and data processing system for ITER diagnostic systems complying with ITER standards. We successfully developed a prototype control and data processing system for DTC.

Disclaimer

The views and opinions expressed herein do not necessarily reflect those of the ITER Organization.

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