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Development of a Test Program for the Control Rods in HANARO

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1. Introduction

CAR(Control Absorbing Rods) Signal processing unit that recently succeeded in a localization is used for an operation of control rods that controls the reactivity of reactor. A test program based on a personal computer was developed to verify a normal operation before a actual application.

In this study, characteristics, composition of input and output signal device and testing procedure for this test program were briefly described. Reliability of CAR Signal processing unit was demonstrated through this test to contribute to safe operation of reactor.

2. Development and Test of the Program

2.1 Driving Principles of the Control Rod

The Signal processing unit receives the binary number of driving steps computed by MLC. 8 out of 9 data bits are the CAR motor driving signals and the remaining 1 signal is for reset. MLC receives the rotating state of the CAR motor driven according to these signals with 6 signals. 4 out of 6 signals are related to CAR problems, the other 2 signals are about the driving state of the CAR motor.[1]

The Signal processing unit produces step pulse to drive the CAR motor. The Rotary Encoder rotated by these commands estimate the number of steps of the driving CAR motor and send feedback to the interface device, and by using this, the break state of CAR shall be determined.[2] The hardware composition for this process is described in Figure 1.

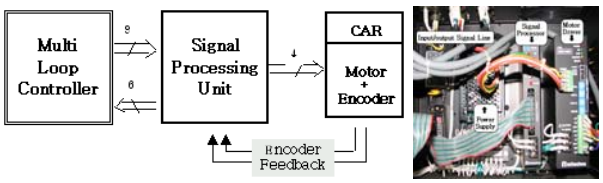

Fig. 1 Hardware Composition of the Control rod and Signal Processing Unit

2.2 Development purposes of the Program

In order to apply the developed signal processing unit in a reactor, soundness of this unit must first be demonstrated. The method of using MLC accompanies a risk of taking off circuit boards in the local panel and violates safe operation of reactors. Instead of using MLC, a test program was developed to give operation commands to the unit and monitor the motor status.

2.3 Composition of Test Device with the Program

Verification of signal processing unit with the test program is composed of the test program developed using Visual C++ 6.0, I/O module in charge of input and output for signal processing unit, and an RS485 communication card. This composition is shown in Fig. 2.

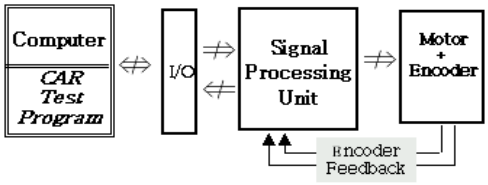

Fig. 2 Hardware Composition for Pre-verification of the Signal Processing Unit

2.3.1 Features of the program and components

Main screen of the test program is composed of DEVICE INFO, 1 STEP MODE, TEST MODE and INPUT as shown in Fig. 3. Ring and Device can be selected in the DEVICE MODE, and the mode shows connection state of the signal processing unit.

1 STEP MODE repeatedly gives 1 step command to the motor and verifies the output status using check box. TEST MODE gives a random step between 1-15 to the motor, configures the number of commands and repetitions, and verifies the output status using check box.

INPUT shows the signal processing unit currently in operation and error state from the motor.

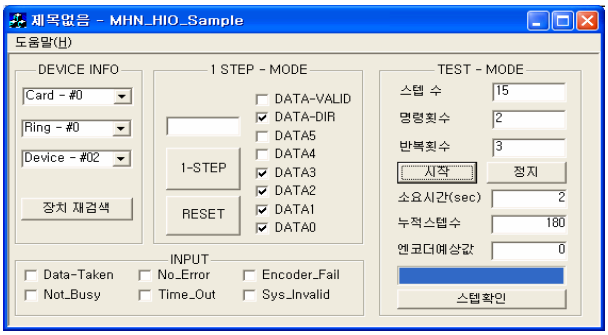

Fig. 3 Main Screen of the Test Program

RS-485 type communication PCI card allows simultaneous control of 128 slaves at the maximum communication speed of 20Mbps. I/O module has 2 ports each for input and output and 2 ports for input only and output only (8 points).

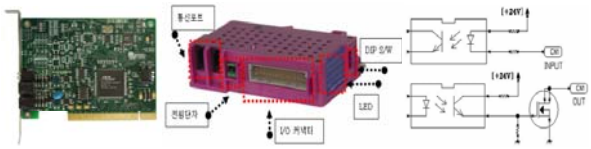

Fig. 4 PCI Card and I/O Module

2.4 Test Result of the test Program

6 localized signal processing units were manufactured including 2 spare units, and all units were tested with a PC equipped with the test program.

For the test method, 1 STEP MODE identical to manual operation mode of control rod and TEST MODE identical to automatic operation mode of control rod were performed. 1 STEP MODE test was repeated 100 times from ±1 step to ±15 step, and tests for all units were completed without error. Steps similar to automatic operation of reactors were selected for TEST MODE test. 1, 2, 3, 15 and -60 steps were repeated 1,000 times each and all tests were completed without error signal.[3][4] Results shown in Fig. 4 and Fig. 5 were identical for all 6 units.

Step	Command	Iteration	Accumulation
1	10	10	200
2	10	10	400
3	10	10	600
4	10	10	800
5	10	10	1,000
6	10	10	1,200
7	10	10	1,400
8	10	10	1,600
9	10	10	1,800
10	10	10	2,000
11	10	10	2,200
12	10	10	2,400
13	10	10	2,600
14	10	10	2,800
15	10	10	3,000

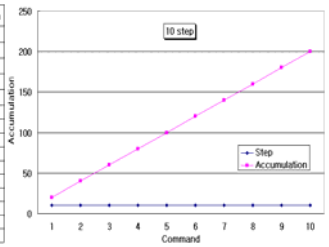

Fig. 5 Test Results in 1 Step Mode

Step	Command	Iteration	Accumulation
1	2	10,000	40,000
2	2	10,000	80,000
3	2	10,000	120,000
15	2	10,000	600,000
-60	1	10,000	600,000

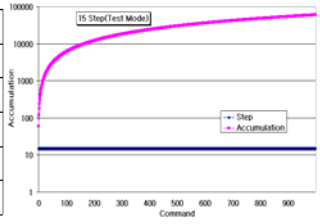

Fig. 6 Test Results in Test Mode

3. Conclusions

Once the development of the control rod test program was complete, inspection on the signal processing unit was performed before use, thereby achieving a technological independence from overseas manufacturer.

The study contributed to safe operation of the reactor by increasing reliability of control rods operation.

Accordingly, a localization of mechanical device, signal processing unit and test program was achieved 100% with domestic technologies.

With the progress of technology exports through research, the author of this study anticipates to manufacture and supply control rod operation device using domestic technology, announcing our technological capability abroad.

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