Improved Monitoring System Using NHDL-1Q for POSAFE-Q PLC

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***Keywords :** *Serial Communication, Safety Programmable Logic Controller, Safety PLC, POSAFE-Q*

1. Introduction

POSAFE-Q consists of processor, communications, analog & digital input/output modules. The monitoring system monitors and records not only the self-diagnosis data, but also input/output data of module using NHDL-1Q module which is serial communication module of POSAFE-Q [1,2].

In this paper, several issues with the existing monitoring system are addressed. The solution which improved data reliability is offered. The improved monitoring system examination was conducted using POSAFE-Q, which is a nuclear safety grade PLC.

2. Design Methods and Improvements

This chapter discusses the hardware configuration of the monitoring system, the identified problems, and the implemented improvements.

2.1 Configuration of the Monitoring System

In figure 1, the monitoring system is composed of POSAFE-Q, including power, processor, analog output and serial communication module. Serial communication module is directly linked to a PC which can be a desktop or laptop to run the monitoring program via serial port.

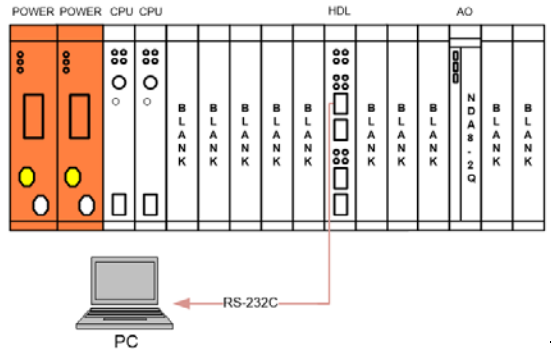


Fig. 1. Configuration of monitoring system

2.2 Serial Communication Module

The type of communication module of POSAFE-Q consists of High Reliable-Safety Data Link (HR-SDL), which facilitates one-to-one communication, High Reliable-Safety Data Network (HR-SDN) that supports configurations for network communication, and NHDL-1Q module designed for serial communication.

Among them, the data reception method of NHDL-1Q module involves receiving data from the connected device, which is host via RS-232C signals and transmitting it to POSAFE-Q processor module through a bus. In the case of transmission, NHDL-1Q module receives data from the processor module through a bus and transmits the data to the connected device.

Fig. 2. Communication structure of NHDL-1Q

2.3 Improved Method

The existing monitoring program was designed to record packet information as received, even if the data was compromised due to factors such as physical shocks, cable damage, or static electricity. The aforementioned approach seems to have a problem that the integrity of the packet is not checked when receiving data. By applying a method to check the health of the packets, it is possible to detect corrupted data and enhance the stability of the system.

The improved monitoring program receives calculated cyclical redundancy check (CRC) values through CRC operations from the NHDL-1Q. After that, it compares the CRC values with the CRC operation results of the received data. If they turn out to be different, the data is considered corrupted and discarded, else match, the data is deemed intact and correctly recorded.

3.Implementation

3 .1 Test Configuration

In order to confirm the integrity of the improved monitoring system, a PC with the monitoring program installed and POSAFE-Q configuration are required, as shown in Figure 3. The analog output values are measured using an oscilloscope, and a set of communication data of the NHDL-1Q module is checked through the improved monitoring program.

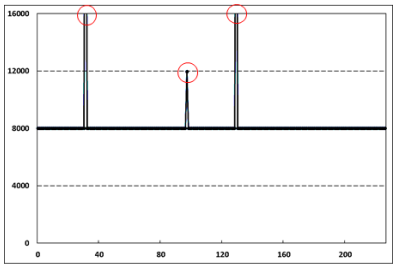
Fig. 3. Configuration of improved monitoring system test

3. 2 Test Procedures

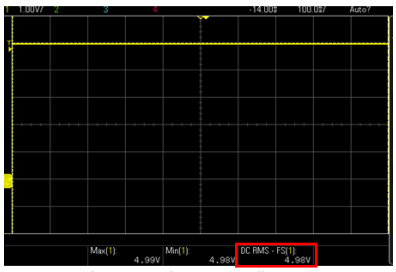
The value generated by the POSAFE-Q application is entered equally into the output value of the analog output module and the transmission data of the NHDL-1Q module. The presence of a discrepancy between the analog output value observed on the oscilloscope and the value of the monitoring program indicates that the received data by the NHDL-1Q module is corrupted.

3.3 Test result

Based on the analysis of Figure 4, the test results obtained with the existing monitoring program were evaluated to confirm whether the values of (a) and (b) in Figure 4 were identical. However, since the analog output values as identified in Figure 4 (b) were constant, the values received from the NHDL-1Q module via the monitoring program should have been constant as well. But the actual values observed were not consistent, similar to Figure 4 (a), thereby confirming that the data received from the NHDL-1Q module was corrupted.



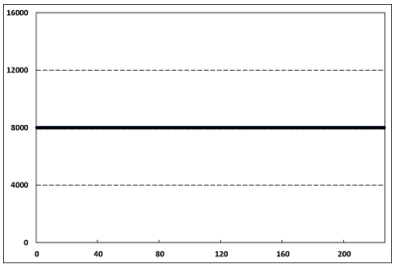
(a) Acquired Data in Monitoring System



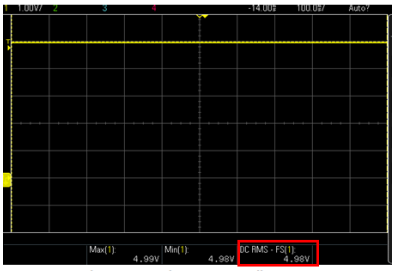
(b) Measured Data in Oscilloscope

Fig. 4. Existing monitoring system test results

After the improvements, the analog output values were consistent, and the values stored by the monitoring program had also become consistent as shown in Figure 5. The corrupted data received from the NHDL-1Q module was discarded, thereby enhancing the data stability and reliability of the monitoring system.



(a) Acquired Data in Improved Monitoring System



(b) Measured Data in Oscilloscope

Fig. 5. Improved monitoring system test results

4. Conclusion

Based on the test results, the development of an improved monitoring system shows data stability and reliability. The improved monitoring system is expected to be utilized in situations where data verification and storage are required through serial communication. In the future, this research will aim to develop status diagnostic tool for POSAFE-Q.

REFERENCES

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[2] Ka-Ram Park et al., "Design of the FPGA based Safety PLC for the Nuclear Power Plants.", Proc. of KIEE, Summer, 2020, 459-460.