A Development of Auto Calibration Analog Input Module for Safety-related Controller

Kwanwoo Yoo [a*], Donghwa Yun [a], Sungjae Hwang [a], Dongil Lee [a]
[a]*PONUTech Co., TechnoComplex Building, Korea University, 145, Anam-ro, Seongbuk-gu, Seoul, Korea*
[*]*Corresponding author: kwyoo01@ponu-tech.com*

1. Introduction

The purpose of this paper is to provide the auto calibration analog input module design of POSAFE-Q is a PLC(Programmable Logic Controller) that has been developed for the evaluation of safety-related.

Analog input module from the control equipment of the safety-related, has a very significant proportion.

Analog input module is a device that converts digital data that can be that the processor module recognizes the analog signals from the pressure device in the field, the flow rate, and temperature.

In this paper, to check the Auto Calibration function of the RTD (Resistance Temperature Detector) input module. In order to ensure the accuracy of the analog input module, calibration function is required, it is necessary to ensure the accuracy of ±0.1% (1% in the standard PT100 sensor).

2. POSAFE-Q PLC Structure

POSAFE-Q, which meets international standards such as IEEE 7-4.32 and EPRI TR-107330, is a safety grade Q Class 1E PLC for nuclear power plant systems.

POSAFE-Q has an input/output module that handles various input/output signals in both analog (current, voltage and temperature) and digital (AC, DC and pulse) form. In particular, the Loop Back Self-diagnosis for the input/ output channels, the hot swap function, and the plug-in terminal blocks allow the user to service and maintain the system easily and conveniently even online. POSAFE-Q also has special functions modules, including a redundant power supply module and a bus extension module.

Structure of POSAFE-Q seems in Fig. 1.

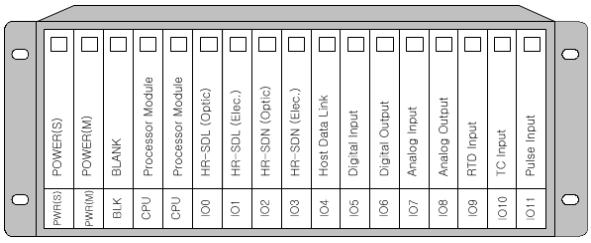

Fig. 1. POSAFE-Q Main Chassis and Structure

3. RTD Input Module

RTD input module is an 8-channel module that measures the temperature to enter the RTD sensor.

RTD input module is applied DPRAM(Dual Port Memory) for cooperation function with the processor module. Also, it is set to input/output port for processing the RTD inputs.

The operation of the processor RTD input module, with the XC161CJ of Infineon's analog input data coming into the channel comes to the processor via the AD converter. The data processed by the processor to share data with the processor module through the DPRAM. Respectively, all channels have been insulated from each other. (Fig. 2)

Stores a value of the Offset/Gain required for digital conversion of the analog input data, EEPROM is obtained values through a calibration operation. It will be stored in the internal variable XC161CJ Offset/Gain value from the EEPROM to the initialization operation.

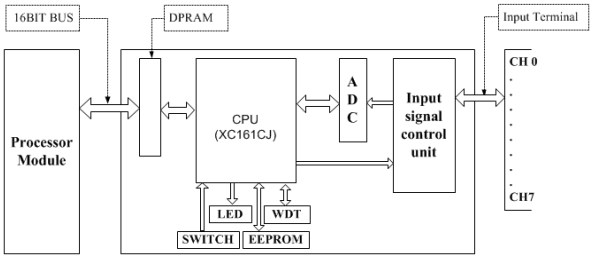

Fig. 2. RTD Input Module Hardware structure

The order of execution of the RTD input module is divided into calibration mode and normal mode as shown in the fig. 3.

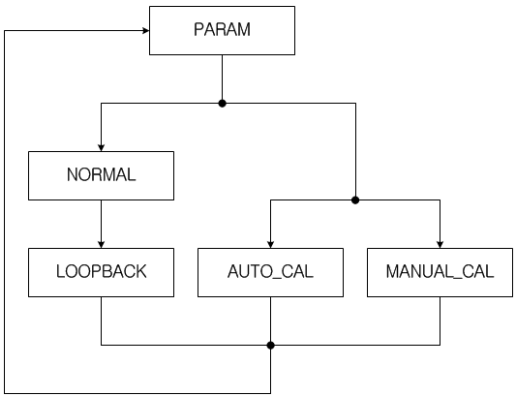

Fig. 3. RTD Input Module Sequence

Under normal conditions, operates at nomal mode, the serial communication is performed to switch the calibration mode.

4. Implementation

4.1 Prototype

Prototype of the RTD input module that has been manufactured, is shown in Fig. 4. I tested the auto calibration function in this chapter.

Fig. 4. Prototype of RTD Input Module

4.2 Manual Calibration Function Test

This chapter provides a description of the RTD input module manual calibration. Supports serial communications port(RS-232), RTD input module, used to run the manual calibration of the module through the hyper-terminal as shown in the fig. 5.

RTD input module, determine the value of the slope and offset by entering each offset (0V), negative gain (-2.048V), positive gain (+2.048V) through a calibrator for manual calibration.

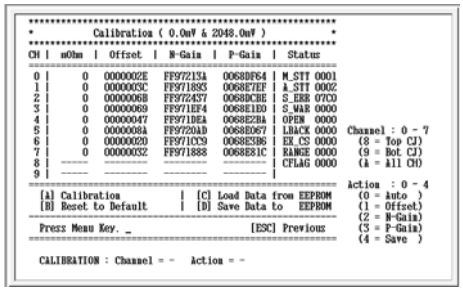

Fig. 5. Manual calibration using the hyper-terminal

4.3 Auto Calibration Function Test

This chapter provides a description of the RTD input module auto calibration. Supports serial communications port(RS-232), RTD input module, used to run the auto calibration of the module through the hyper-terminal as shown in the fig. 6.

Precision power supply inside the module for automatic calibration function, to determine the Offset/Gain value.

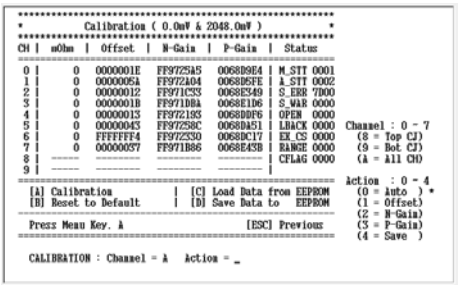

Fig. 6. Auto calibration using the hyper-terminal

5. Conclusions

5.1 Compare between Manual Calibration and Auto Calibration

Measurement the accuracy of the module running the Auto calibration and Manual calibration based on the PT100 sensor. It is within 0.03% as table 1 the manual calibration results. It is also within 0.05% as table 2 the auto calibration results.

Table 1: Manual Calibration Result Value

Value[Ω]	Expectation	Manual Calibration	Accuracy [%]
18.52	-2000	-1999	0.01
100	0	2	0.02
197.71	2600	2603	0.03
287.62	5200	5202	0.02
390.48	8500	8500	0.00
Max.	-	-	0.03

Table 2: Auto Calibration Result Value

Value[Ω]	Expectation	Auto Calibration	Accuracy [%]
18.52	-2000	-1998	0.02
100	0	5	0.05
197.71	2600	2604	0.04
287.62	5200	5204	0.04
390.48	8500	8503	0.03
Max.	-	-	0.05

5.2 Advantage for Auto Calibration

It was confirmed that satisfies 0.1% or more target accuracy through the Auto calibration proposed.

Auto calibration may be without an external device. to perform the calibration module itself, to reduce the working time calibration.

Such advantages can improve the usability of the field and reduce the manufacturing time.

REFERENCES

[1] EPRI TR-107330, Generic Requirements Specification for Qualifying a Commercially Available PLC for Safety-Related Applications in Nuclear Power Plants, 1996.
[2] IEEE 7-4.3.2, Standard Criteria for Digital Computers in Safety Systems of Nuclear Power Generating Stations, 2003