Implementation of the control system and the data processing logic for the mass flow controller of the MWIS

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1. Introduction

Korea Multi-purpose Accelerator Complex (KOMAC) has been operating 100MeV proton linear accelerator. The Linear Accelerator (linac) is designed to accelerator a 20mA, 100MeV proton beam. The injector of the KOMAC proton accelerator is a microwave ion source with the extraction voltage of 50kV. When the hydrogen gas is injected in the line, the Mass Flow Controller (MFC) can control and read the gas flow rate. In order to control and monitoring, it must need to locally control box. However, the hardware stability doesn't enough when the control box was connected on the control network. So we had been looking for a replacement, and found the Digital Mass Flow Controller (DMFC). Because it has a digital input/output signal, the local control box doesn't need anymore. In other words, the hardware can directly communicate to the control network. So the control and monitoring system for the DMFC is configured on the integrated KOMAC control system based on Experimental Physics and Industrial Control System (EPICS) framework [1].

This paper explains the implementation of the integrated MFC control system and introduces the data processing logic that is a converting code four byte little endian hex string to float value.

2. The Control system for the DMFC

The MFC is installed between the pipes flowed the hydrogen gas in the gallery. The specification of the DMFC shown in Table. 1. [2]

Hardware spec.	
Max flow	10
unit	SCCM
Gas	H2
Pressure range	1~3 (kg/cm^2)
Supply voltage	+15V or +24V
Communication setting	
Baud rate	9600 bps
Data bits	8
Stop bits	1
Parity	None
Interface	Rs-485 2-Wire

Table. 1. the specification of the DMFC

The Control system is configured according to two-step. First, the system is configured using SCPI commands based on EPICS IOC. And the next step is the data processing for raw data. The layout of the MFC control system is shown in Fig. 1.

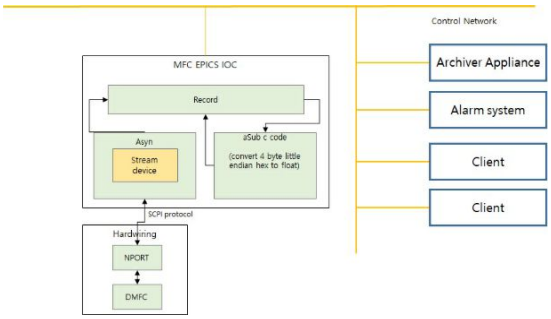

Fig. 1. The layout of the mass flow controller control system

2.1 The implementation of the control system based on EPICS

The device was installed on the test bench for communication test. The test bench is shown in Fig. 2.

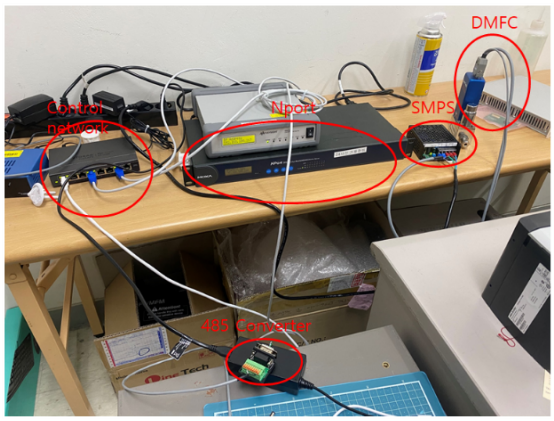

Fig. 2. The test bench for communication test

The environment of development is shown in Table. 2.

Name	Version
OS	Centos7
epics base	3.15.6
Asyn	4.34
streamDevice	master

Table. 2. the IOC working environment

The hardware is communicated with the control system using the protocol written the SCPI commands. So the Input Output Controller (IOC) needs to Asyn module included streamdevice [3].

Protocols were written as a command frame

generated in hexdecimal. Because SCPI commands send and receive ASCII, it converts to ASCII command when the command output from the IOC Process Variables (PV)s.

2.2 The data processing logic for converting

When the device sends the data about the flow rate and set value, the data is formatted to 4 byte little endian hex value. The value is changed to ASCII format under the sending and receiving. So each place value needs to be understood to a string value. Each string sends from the protocol to string record. Each string record sends the value to aSub record [4]. This record works conversion function. The strong point of this record can process an array data unlike the Sub record. The mechanism of the record is shown in Fig. 3.

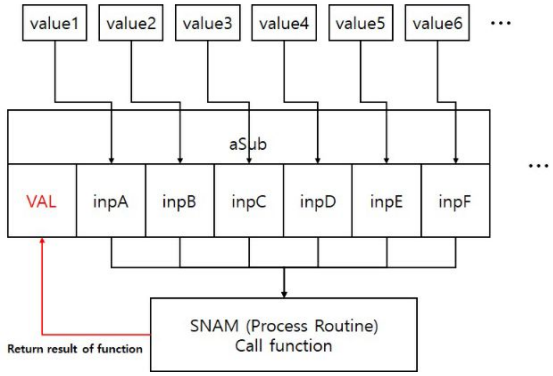

Fig. 3. the working mechanism of aSub record

The function converts the four byte little endian hex string value to float. The code was written on the c language using the pointer memory. The scale was matched using the memory address. For example, the value 00002041 is changed to 10 with the function. This processing is shown in Fig. 4.

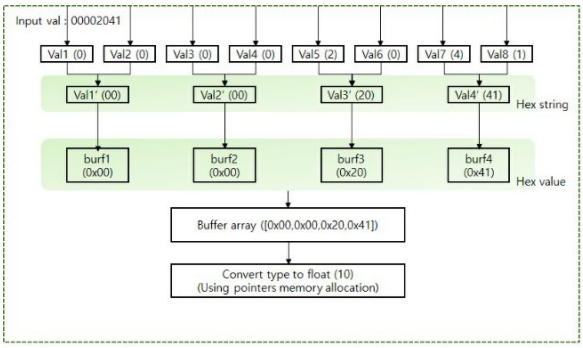

Fig. 4. change the type to float

On the other hand, when the value 10 is changed to 00002041, the process is shown in Fig. 5.

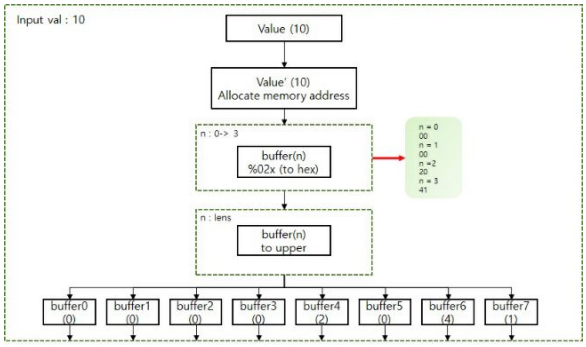

Fig. 5. change the format to four byte little endian

When the value is allocated to the memory address, The converted hex value extracted to each address. And each place value is output to stringout record.

2.3 The integrated interface based on CSS

The interface is designed using the Control System Studio (CSS) tool based on Java eclipse [5]. The functions are displayed which are the control on/off, digital mode, flow rate value, and set flow value. The interface was integrated with the KOMAC integrated Operation Interface (OPI) shown in Fig. 6.

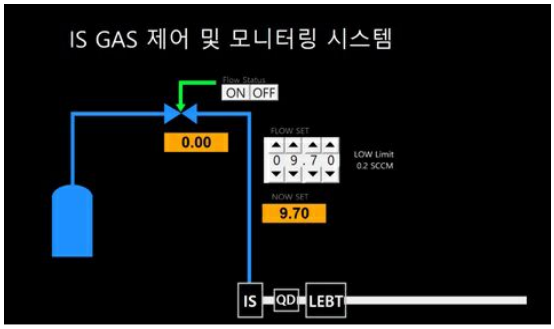

Fig. 6. The operation interface for MFC monitoring and control

3. Conclusions

The communication test has been complete and the control and monitoring system also has been configured onto the KOMAC integrated control system based on EPICS for DMFC. From now on, the DMFC will be installed between the hydrogen gas pipes during the maintenance days. And the operation test will be processed.

REFERENCES

[1] https://epics-controls.org/
[2] DMFC(Digital Mass Flow Controller) & DMFM Protocol Manual
[3] https://paulscherrerinstitute.github.io/StreamDevice/
[4] https://epics.anl.gov/base/R7-0/4-docs/aSubRecord.html
[5] http://controlsystemstudio.org/