Preliminary study of development of DAQ monitoring system for RF power at KOMAC

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1. Introduction

The 100 MeV linear accelerator (Linac) has been successfully operated for over a decade at Korea Multi-purpose Accelerator Complex (KOMAC). The control system is implemented based on a distributed control system Experimental Physics and Industrial Control System (EPICS) which can organically link and control various accelerator components. Recently, new ADC device was developed that the Zynq SoC based ADC [1]. This ADC device can not only visually show signals from the accelerator without an oscilloscope, but also enable real-time data processing without any additional device.

In this paper, we present a preliminary study to upgrade the Zynq SoC-based ADC for RF power monitoring. The goal is to upgrade the EPICS IOC for data processing of ADC and Zynq. We will improve the stability of the accelerator through this upgrade by monitoring the RF power in real-time.

2. Implementation of the RF monitoring system

The 100 MeV Linac at KOMAC typically consists of a microwave ion source, RFQ, DTL, and various accelerator components. To operate and extract proton beams, an RF source is supplied at 350 MHz. RF directly affect acceleration and focus the proton beams inside the DTL, therefore RF state monitoring system is essential to provide high quality proton beams. To check the RF state, RF power is monitored through EPICS IOC. This converts the RF voltage signal measured from the oscilloscope into RF power through an EPICS subroutine record.

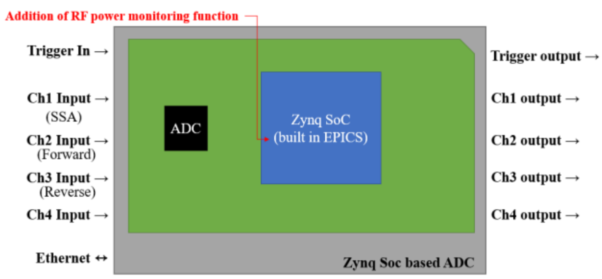

Fig. 1. Configuration of Zynq SoC based ADC and upgrade strategy.

Fig. 1 shows the configuration of the Zynq SoC based ADC. And it represents the upgrade strategy of the Zynq SoC based ADC in Fig. 1, which converts the SSA, Forward, and Reverse RF signals input to the ADC channels into their respective RF powers. The function to convert RF voltage signals input to the ADC into RF power will be implemented by including it in the subroutine record. To calculate the RF power, the mean value of the RF voltage signal measured by the ADC is applied. In the EPICS IOC, the function is implemented to simultaneously change the RF power every time the mean value of the RF voltage signal measured by the ADC changes. In addition, the IOC is configured with PVs that can indicate the RF power.

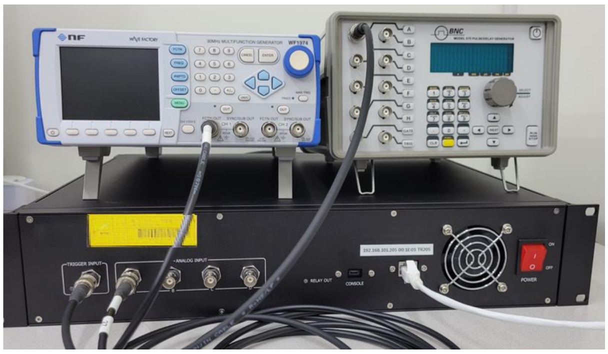

Fig. 2. Test bench for the upgraded Zynq SoC based ADC.

Fig. 2 shows the test bench for upgraded Zynq SoC based ADC.

It consists of an upgraded with involved RF power monitoring functionality Zynq SoC based ADC, a waveform generator (WF1974, NF corporation, Japan), and a pulse/delay generator (Model 575, BNC, USA). The trigger for the ADC operation is applied through the pulse/delay generator. During the input of the trigger, the voltage signal values of each channel are sampled by the ADC and the data processing is performed. The appropriate voltage for each channel is input through the waveform generator, and the ADC monitors the RF power by connecting to a PC via a LAN port.

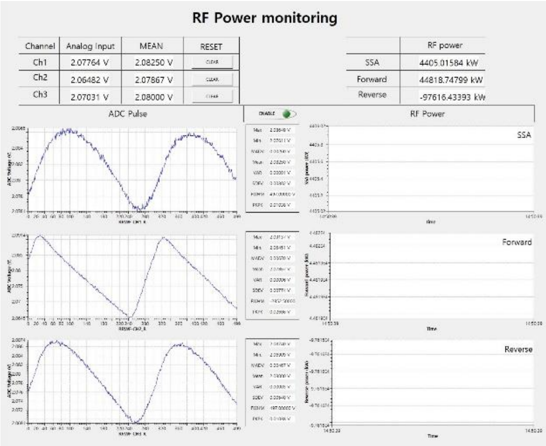

Fig. 3. Screen of RF power monitoring by using CS-Studio (Disable state)

To monitor and visualize the RF power, CS-Studio was used, which is shown in Fig. 3. At the top of the screen, the ADC signal and RF power value input to the channel are displayed, which can be operated by turning the 'ENABLE button' on/off. In the left site Fig. 3, it shows the voltage input to the ADC and the corresponding RF power is shown on the right site. The RF power graph shows the RF power for each SSA, Forward, and Reverse in order from top to bottom.

We have checked the operation of the upgraded EPICS IOC and the RF power calculation function. First, we ran the EPICS IOC. It operates normally without any problem, and the PV for RF power calculation also appeared. Next, we checked that each PV operates correctly with CS-Studio. To demonstrate the RF power for the input values in each channel, DC 700 mV signal was input using a signal generator, and a trigger with a pulse width of 10 μs was set for operation. The results show that the RF power values are successfully converted for an input voltage of 700 mV, and there are stable within a deviation of ±0.1 kW, as shown in Fig. 4.

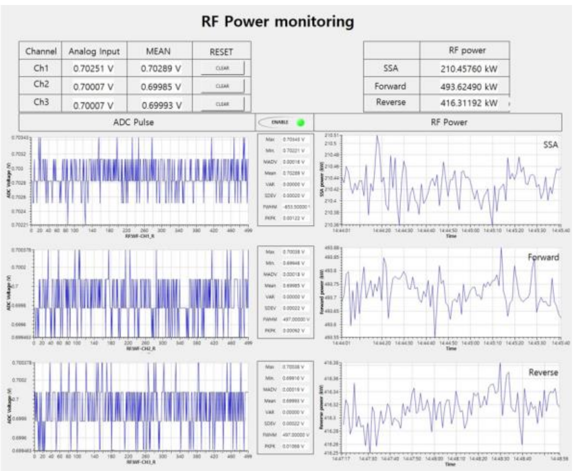

Fig. 4. Results of RF power output with respect to ADC input voltage (Enable state)

3. Conclusion

In this study, we upgraded the Zynq SoC based ADC for monitoring RF power and verified its performance. The upgraded Zynq SoC based ADC successfully converts the voltage signals read from the ADC channels into RF power and displays them. In the future, we plan to implement pulse data and apply it to the accelerator RF monitoring system to improve its stability.

REFERENCES

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