Transactions of the Korean Nuclear Society Autumn Meeting
Gyeongju, Korea, October 24-25, 2013

Frequency Control Loop for Drift Tube Linac

Hyeok-Jung Kwon*, Han-Sung Kim, Kyung-Tae Seol, Young-Gi Song, Ji-Ho Jang, Yong-Sub Cho
KOMAC, KAERI, Gyeongju, Korea
**Corresponding author: hjkwon@kaeri.re.kr*

1. Introduction

A 100-MeV proton accelerator has been developed and the operation and beam service started at Korea Multipurpose Accelerator Complex (KOMAC) in June 2013. [1] The accelerator consists of a 50-keV proton injector, a 3-MeV radio frequency quadrupole (RFQ) and 100-MeV drift tube linac (DTL). The resonance frequency of the DTL tanks are controlled by using the resonance frequency control cooling system (RCCS), which are installed at every each tank. Until now, the RCCS has been operating in constant temperature mode which means that the frequency was measured with respect to the RCCS supply temperature before the RF operation, and then the RCCS operates with that temperature throughout the whole operation. The constant temperature operation is simple but the RF stability is not good because many perturbations such as RCCS supply temperature error can cause a frequency change. To stabilize the system better, it is necessary to operate the RCCS in frequency tracking mode. In this paper, the preparation of the frequency tracking of the RCCS by connecting the RCCS to low level RF (LLRF) system is described.

2. KOMAC LLRF System

The KOMAC LLRF system is digital based one. The LLRF control board can produce synchronized NCO output signal equipped in the board, therefore it does not need an analogue IQ modulator. By installing mixers at input and output section symmetrically, the LLRF system became more stable against the external reference signal perturbation. The delay of the system was measured to be less than 1us. The OPI interface of the LLRF system is GUI mode with EPICS. The RF control block diagram of the LLRF system is shown in Fig. 1. [2] Total 9 sets of LLRF system are installed and operating to drive 100-MeV proton accelerator.

3. KOMAC RCCS System

Total 11sets of RCCS are used to control the resonance frequency of the 100-MeV DTL. The specifications of the RCCS are summarized in Table 1. As shown in the Table, the RCCS should cover the temperature from 21°C to 33°C, heat load from magnet power only to full RF power in addition to the magnet power. The stability of the temperature control is less than 0.1°C. Two sets of 3-way control valve are used to satisfy the specification. [3] The installed RCCS is shown in Fig. 2.

Table 1: RCCS specification

Parameters	Values
Operating temperature	21°C ~33°C
Temperature stability	0.1°C
Chiller temperature	10°C ±0.2°C
Heat load (RCCS21 case)	Only magnet (75kW) ~ Full RF + magnet (95kW)
Valve	3-way mixing valve
Control	EPICS
Resistivity	> 1MΩ cm

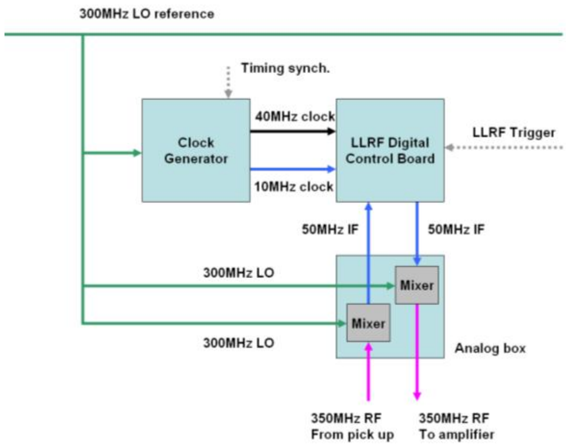

Fig. 1. Block diagram of the LLRF RF control system

Fig. 2. Resonance frequency control cooling system

4. Frequency Control

There are two control loops in order to send a frequency error signal to the RCCS, one loop is a fast one to control the RF amplitude and phase as shown in Fig. 1 and the other is a slow one to control the resonance frequency. The LLRF system is just a sensor in the viewpoint of the RCCS. The resonance frequency is measured at the falling edge of the RF phase pulse because the variation of the phase depending on time at the falling edge gives a frequency error. The measured IQ data in one pulse is send to the CPU in the carrier board and the frequency error is calculated there. Therefore one frequency error data is obtained in every one pulse whereas the RF amplitude and phase errors are calculated and used to control the RF in every clock during pulse in the FPGA. The block diagram of the frequency control system in addition to the RF amplitude and phase control system is shown in Fig. 3.

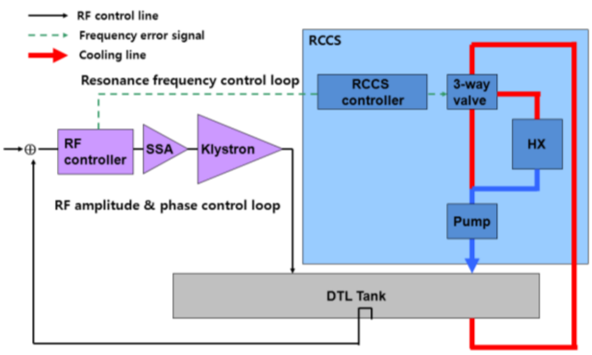

Fig. 3. Block diagram of the frequency control system

5. Conclusions

KOMAC 100-MeV proton accelerator is under operation and supply beam to users. We are developing frequency control function in the LLRF system to control the RCCS in frequency control mode. After the test in the test bench, the system will be applied to the 100-MeV DTL RCCS in order to supply better quality beam to users.

ACKNOWLEDGEMENT

This work was supported by the Ministry of Science, ICT & Future Planning of the Korean Government.

REFERENCES

[1] Y. S. Cho, The KOMAC Accelerator Facility, Proc. Of IPAC2013, May13~17, Shanghai, China, 2013.
[2] H. J. Kwon, et al., Operation of the PEFP 20-MeV Proton Linac at KAERI, Proc. Of IPAC2010, Kyoto, Japan, 2010.
[3] H. J. Kwon, et al., Resonance Frequency Control Characteristics of the 100-MeV Drift Tube Linac, Proc. Of IPAC2013, May13~17, Shanghai, China, 2013.