Transactions of the Korean Nuclear Society Spring Meeting
Chuncheon, Korea, May 25-26 2006

RF Phase Measurement and Adjustment for PEFP 20 MeV DTL

Han-Sung Kim, Hyeok-Jung Kwon, Kyung-Tae Seol, and Yong-Sub Cho
PEFP, KAERI, 150, Deokjin-dong,Yousung-gu, TaeJeon, 350-353, Korea
kimhs@kaeri.re.kr

1. Introduction

The 20 MeV drift tube linac (DTL) for Proton Engineering Frontier Project (PEFP) has been developed to accelerate the proton beam up to 20 MeV following the 3 MeV radio-frequency quadrupole (RFQ). The DTL consists of four tanks, which are driven by a single RF source[1].

To accelerate the proton beam efficiently, the RF phase between each tank must be synchronized. Four mechanical phase shifters are installed in each RF transmission line from the RF source to each tank to adjust the phase difference between each tank. The RF phase of each tank can be measured by using the analog phase comparator. The details of the RF phase measurement and the adjustment are reported in this paper.

2. Measurement Set-up

2.1 Layout for the RF phase measurement

The 20 MeV DTL for PEFP consists of four tanks and each tanks are driven by a single 1.1 MW klystron. The RF power generated in the klystron is divided into four ways by using the magic tees and supplied to each tanks through ridge-loaded waveguide and iris-type coupler. The low level RF signal to drive the klystron is coming from the signal generator, which is divided into three ways with the RF power divider. Two of the divided signals go to the solid state amplifier to drive the RFQ and the DTL respectively and the other is divided four ways and fed into the LO port of four phase comparators as a reference RF signal. The RF pickup is installed in each tank and samples the RF field in the tank. Four RF pickup signals are fed into the RF port of four phase comparators. The RF signal flow layout is shown in Fig. 1.

2.2 Characteristics of the RF phase comparator

Four phase comparators are used to measure the phase between the reference signal from the RF signal generator and the RF pickup signal from each tank. The phase comparator is four-port device with LO port for reference input, RF port for RF signal input and two output ports. Outputs of the phase comparator are $\sin\varphi$ and $\cos\varphi$, where φ is the phase difference

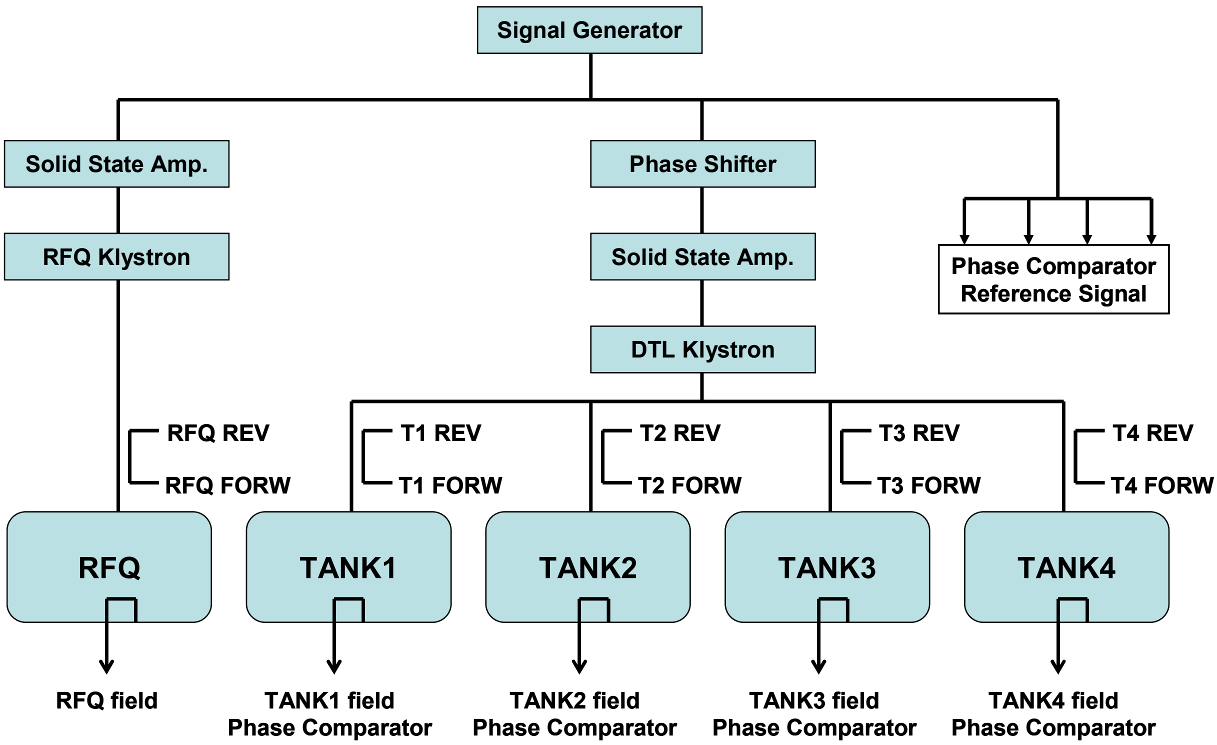

Fig. 1. RF signal flow layout for RF phase measurement

between the reference signal and the RF signal. Figure 2 shows the measured characteristics of the phase comparator.

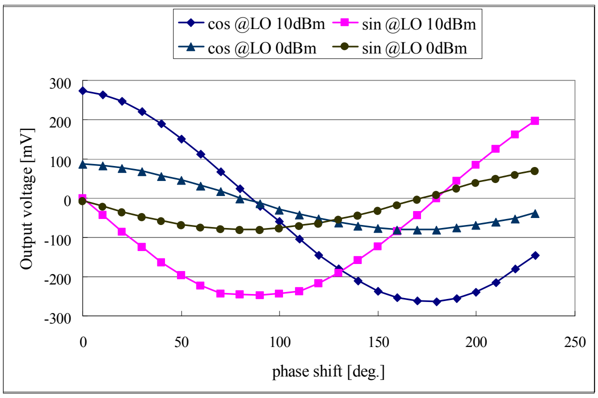

Figure 2. Measured characteristics of the phase comparator

2.3 Characteristics of the Mechanical Phase Shifter

Four mechanical phase shifters are installed to adjust the phase difference between each tank. The phase comparator is three-stub tuner type and the phase variable range is about 45˚ . The measured characteristics of the phase shifters are shown in Fig. 3.

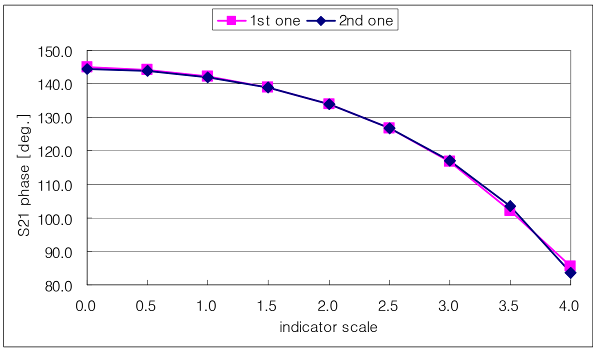

Figure 3. Measured characteristics of the phase shifters

3. Results and Discussion

The measured outputs from the phase comparators and the measured phase of tank1 and tank2 are shown in Fig. 4 and Fig. 5 respectively. The calculated tank phase should be compensated considering the phase delay of each signal line. Without phase shifter adjustment, the relative phase error between each tank is amount to about ±16˚. After rough adjustment by using the mechanical phase shifters, the relative phase error reduced to about ±6˚. The measured RF phases of each tank with respect to the tank1 are summarized in Table 1. To further reduce the relative phase error, the fine adjustments are required.

4. Acknowledgements

This work was supported by the 21C Frontier R&D program of Korea Ministry of Science and Technology.

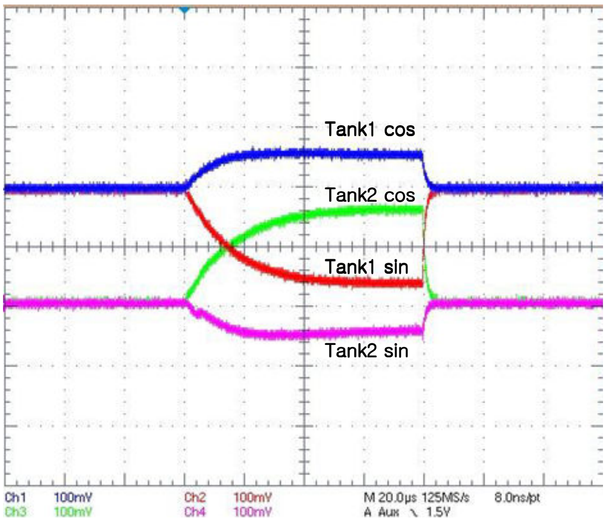

Figure 4. Phase comparator outputs of tank1 and tank2

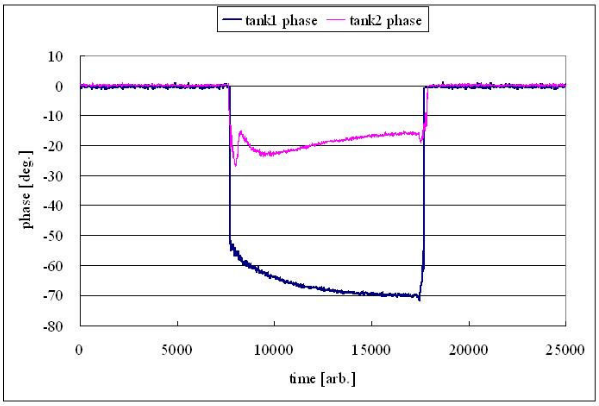

Figure 5. Measured phases of tank1 and tank2 relative to the signal generator
(before compensation of the line phase delay)

Table 1. Phase measurement summary

	without adjustment	with adjustment
Tank1	0˚	0˚
Tank2	18.4˚	1.4˚
Tank3	-14.2˚	-8.2˚
Tank4	-7.6˚	4.4˚

Reference

[1] Byung-Ho Cho, “Status of The Proton Engineering Frontier Project”, in Proceedings of PAC05, Knoxville, USA, 2005