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Klystron Protection System for the PEFP 100MeV Linac

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1. Introduction

The Proton Engineering Frontier Project (PEFP) 100MeV proton linear accelerator has been developed and has been installed at the Gyeong-ju site [1-2]. The high power RF (HPRF) systems for the 100MeV linac will be installed at the second floor including klystrons, circulators, HPRF dummy loads, and waveguide components. Nine sets of klystrons will be used for the 1MW HPRF sources of the 100MeV linac. The protection devices are required to protect klystrons from arc, power supply faults, tube vaccum faults, and cooling water flow interlock during the klystron operation. In the case of a fault event, the klystron must be shut off within a few milli-seconds.

2. Klystron

The klystrons (TH2089K, Thales) have been installed and will be operated for the PEFP 100MeV linac at the Gyeong-ju site. Figure 1 shows the klystron fabricated at the Thales and the specifications are followings.

- Klystron : TH2089K (Thales)
- Operating frequency : 350 MHz
- Beam voltage (max) : 107 kV
- Beam current (max) : 26 A
- Mod. Anode voltage (max) : 71 kV
- Heater voltage (max) : 30 V
- Heater current (max) : 30 A
- Peak RF power (min) : 1.6 MW
- Gain (min) : 41 dB
- Efficiency (min) : 58 %
- Ion pump current (max) : 10 uA
- Electromagnet current (max) 12 A
- Electromagnet voltage (max) : 300 V

Fig. 1: Klystron for the PEFP 100MeV linac (TH2089K)

The klystron for the PEFP 100MeV linac is a high-power tube. Its operating conditions imply the use of very high energies and voltages. Therefore, it is necessary to take reasonable measure, and the klystron must be protected from arc, power supply faults, tube vacuum faults, and cooling water flow interlock during the 100MeV linac operation. The signals to protect the klystron were summarized in Table 1.

Table 1: Klystron protection signals

Klystron protection signal	Type of protection
Ion pump current (#1, #2)	Max.
Heater current	Min. / Max.
Electromagnet current (#1, #2)	Min. / Max.
Klystron window arc	On-off
VSWR in the waveguide	Max.
Water flow (all tubes)	Min.
Beam current	Max.

3. Klystron Protection System

The klystron protection chassis was fabricated to detect the fault signals and protect the klystron as shown in Table 1. Figure 2 shows the klystron protection chassis fabricated into 19" 2U rack. It includes a main interlock module as comparators and a latch circuit, an auto-reset module, a VSWR detecting module, and a power supply. The main interlock module has 8 channel input and 1 channel output, and a low limit and a high limit can be adjusted at each input channel. Therefore, the klystron protection signals listed in Table 1 can be detected and the klystron can be protected by shutting off a high voltage converter modulator (HVCM) through the TTL output of the chassis.

A relay system and water flow gauges will be installed to protect the klystron from a water flow interlock, and the relay system will shut off the electromagnet power supply and the heater power supply.

It is important that the klystron is shut off within a few milli-seconds after a fault state. The response time of the fabricated klystron protection chassis was measured as shown in Figure 3. The measured response time at the klystron protection chassis was 2.7μs approximately.

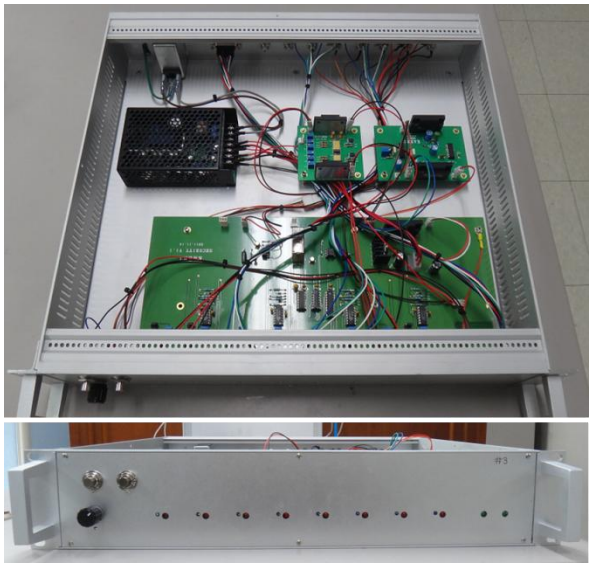

Fig. 2: The fabricated klystron protection chassis

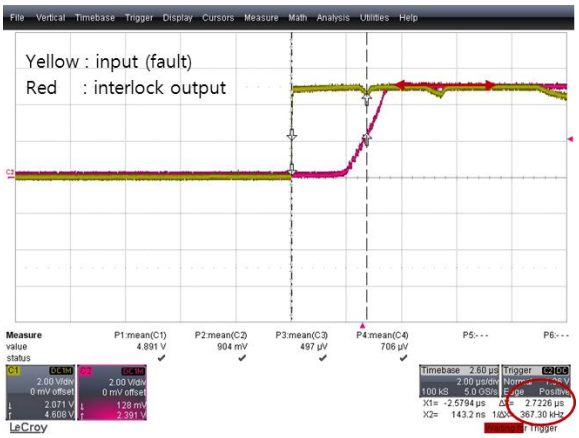

Fig. 3: The measured response time of the klystron protection chassis. (Yellow line : input, Red line : output)

4. Summary

A total of 9 sets of the klystrons will be installed for the 100MeV linac. A total 9 sets of the klystron protection chassis has been fabricated for each klystron operation. The relay system will be also installed for water flow interlock. The response time of the klystron protection chassis was within 3μs. The klystrons will be protected through the klystron protection system during the 100MeV linac operation.

Acknowledgements

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REFERENCES

[1] B. H. Choi, "The Proton Engineering Frontier Project", Proc. of International Particle Accelerator Conference, Kyoto, Japan, 2010

[2] H. J. Kwon, "Operation of the PEFP 20MeV Proton Linac at KAERI", Proc. of International Particle Accelerator Conference, Kyoto, Japan, 2010