# RF Interlock 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 will be installed in Gyeong-ju site [1]. The 20MeV linear accelerator (linac) already operated in Korea Atomic Energy Research Institute (KAERI) site will be also moved and re-installed with the 100MeV linac [2]. A RF interlock system is required for a high power RF (HPRF) system protection during a linac operation, and a security box (TH20404, Thales) has been used at the 20MeV linac operation in the KAERI site. The security box can shut off the RF drive to the cavity within a few micro-second in the case of a fault event. A 100MeV linac will be controlled and monitored in the control room, so an interface for a remote control and monitoring is required at the RF interlock system. A VSWR detection and an auto-reset function is also needed at the RF interlock system.

## 2. Fabrication

The RF interlock system for the HPRF system protection should shut off a RF signal within a few micro-second in the case of the faults such as arc and high reflected RF power during the 100MeV linac operation. The RF fault signals are summarized in Table 1. Figure 1 shows the block diagram of the RF interlock system for the 100MeV linac. It includes an RF interlock module, an auto-reset module, a divider module for the VSWR detection, and a power supply. In the case of a fault event, the RF interlock module transmits the interlock signal to a RF switch in a low-level RF (LLRF) system, and the RF drive to a cavity is shut off within a few micro-second. The RF faults are monitored in an EPICS control system, and they can be latched and reset through the control system.

Table 1: RF fault signal

| RF fault signal | Signal type |
|---|---|
| Klystron window arc | On-off |
| Circulator arc | On-off |
| RF window arc | On-off |
| High VSWR at the cavity | Analog |
| High VSWR at the klystron | Analog |
| Low vaccum | On-off |
| Modulator fault | On-off |

Figure 2 shows the fabricated RF interlock system for the 100MeV linac. A main interlock module, an auto-reset module, and a divider module for the VSWR detection were fabricated into a printed circuit board (PCB) type, and were installed in 19" 2U rack. The fault status of 8 channels can be monitored and be reset in the front panel as shown in Figure 2. During the normal linac operation, an input is latched after a fault state, and then the fault will be checked. The high VSWR from a cavity can occur frequently in the RF conditioning. The faults can be reset automatically with the auto-reset module, and the linac can operate to normal at the next pulse. Total 11 sets of the RF interlock boxes were fabricated for the 100MeV linac.

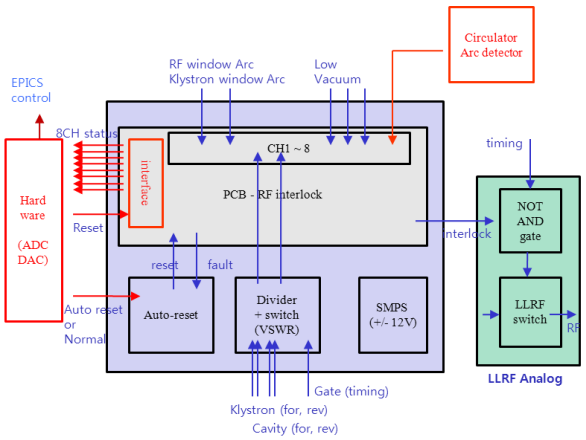


Fig. 1: Block diagram of the RF interlock system

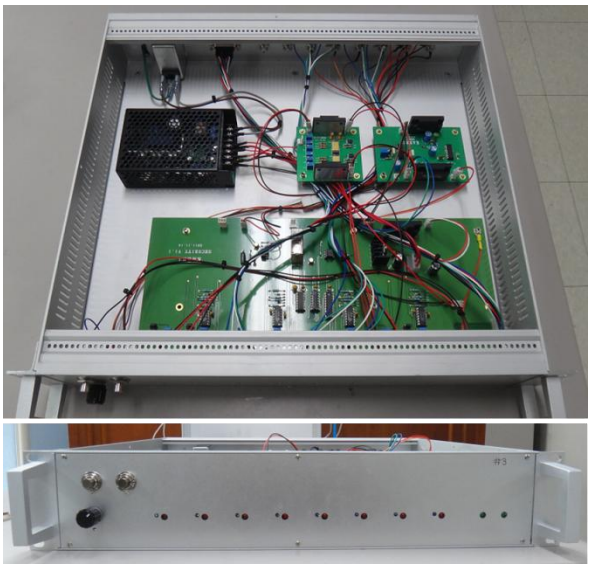

Fig. 2: The fabricated RF interlock system

### 3. Test results

It is important that the RF drive is shut off within a few micro-second after a fault state. The response time of the fabricated RF interlock system was measured. Figure 3 shows the measured response time, and the measured response time was 2.7μs approximately. Table 2 summarized the response time of 12 sets of the fabricated RF interlock system. The measured response time was 2.31μs in average and 0.8 in the standard deviation. These test results mean that the RF drive can be shut off within 3μs in the case of a fault event during the linac operation.

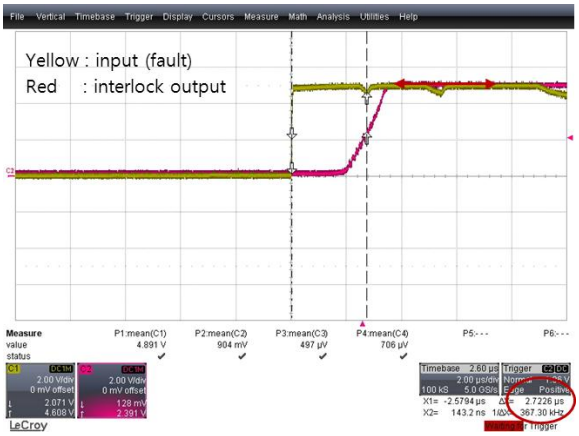


Fig. 3: The measured response time of the RF interlock system. (Yellow line : input, Red line : output)

Table 2: The measured response time

| RF interlock boxes | Response time (μs) |
|---|---|
| #1 | 2.82 |
| #2 | 1.50 |
| #3 | 1.53 |
| #4 | 3.10 |
| #5 | 2.65 |
| #6 | 1.51 |
| #7 | 1.12 |
| #8 | 1.47 |
| #9 | 2.93 |
| #10 | 3.31 |
| #11 | 2.85 |
| #12 | 2.90 |
| Average | 2.31 |
| STDEV | 0.80 |

### 4. Summary

Total 12 sets of the RF interlock system were fabricated for the 100MeV linac. The RF interlock system consists of an RF interlock module, an auto-reset module, a divider module for the VSWR detection, and a power supply. The interlock modules were installed in 19" 2U rack, and the response time was measured respectively. The measured response time was 2.31μs in average and 0.8 in the standard deviation. The test results mean that the RF drive can be shut off within 3μs in the case of a fault event during the linac operation, and the HPRF system can be protected from the faults.

### 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