Development of an MTCA-Based Timing System for Replacement of Obsolete VME Equipment and Future Accelerator Expansion at KOMAC

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1. Introduction

A VME-based event timing system consisting of an MVME3100 processor running VxWorks 6.8 and MRF VME EVG-230 and VME EVR-230 modules has been used for long-term accelerator operation. Although the system has provided stable timing performance, the 230-series has reached end-of-life status, making spare-part procurement and long-term maintenance increasingly difficult. To address this issue and prepare for future accelerator energy expansion, a pre-R&D test platform based on the MRF 300-series has been established. The new system uses an MTCA-based EVM-300 and EVR-300 [1, 2]. The mrfioc2 software has been successfully compiled [3], and the EPICS IOC has been loaded and operated normally. Initial tests of event-code generation, event reception, and pulse generation are currently underway. The next stage will include the application of an external reference clock and verification of the delay compensation function. The proposed approach provides a practical transition path from the legacy VME-based timing system to a modern timing platform while minimizing operational risk and enabling early verification of timing functions required for future accelerator energy expansion.

2. System Overview

Precise and reliable timing synchronization is essential for accelerator operation because the timing system coordinates RF systems, beam diagnostics, beamlines, and other distributed accelerator devices. Figure 1 shows the existing VME-based timing system for KOMAC accelerator operation [4].

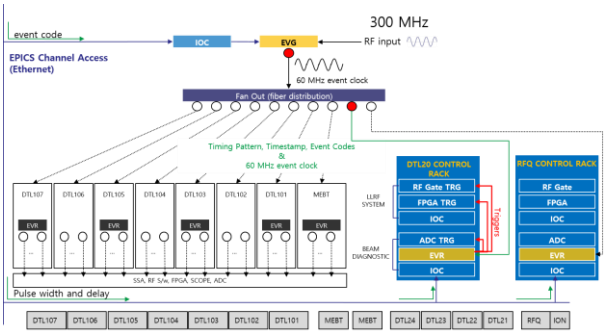


Fig. 1. Overall Architecture of the VME-Based Timing system

The existing timing system is based on an MVME3100 processor running VxWorks 6.8 with MRF VME-EVG-230 and VME-EVR-230 modules. The system has operated reliably for an extended period. However, the 230-series is now no longer commercially available, increasing the difficulty of securing spare parts and maintaining the system over the long term. This issue becomes more significant when considering future accelerator energy expansion. Additional RF systems, beamline components, diagnostics, and control devices will require an expandable and maintainable timing infrastructure. Therefore, a new-generation timing system is being investigated not simply as a replacement for obsolete hardware, but as a strategic spare and pre-R&D platform for future accelerator expansion.

3. Hardware Configuration

The existing VME-based timing system and the proposed MTCA-based system are compared in Table 1. The comparison focuses on hardware platform, operating environment, product availability, timing functions, and system scalability. The proposed system provides a more maintainable and expandable platform for future accelerator operation and pre-R&D.

Table 1. Comparison of the Legacy VME-Based and Proposed MTCA-Based Timing system

Item	Existing System	Proposed System
EVG	VME-EVG-230	MTCA EVM-300
EVR	VME-EVR-230	MTCA EVR-300
CPU	MVME3100 PowerPC MPC8349E	Intel Xeon E3-1505L x86-64
OS	vxWorks 6.8	Linux
Platform	VME	MicroTCA
Product status	No longer available	Current-generation platform
Delay compensation	Legacy	Supported
Scalability	Limited	Improved
Future R&D	Limited	Suitable

The existing VME system has the advantage of proven operational stability, but its dependence on obsolete hardware limits long-term maintainability. In contrast, the 300-series provides a more suitable platform for future expansion, including modern

hardware architecture and timing-delay compensation capabilities.

4. MTCA-Based Pre-R&D Test Platform

To reduce the risk of directly modifying the operational accelerator, an independent MTCA-based timing test platform has been established using the EVM-300 and EVR-300 as shown in Fig 2.

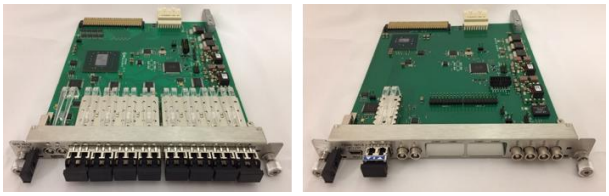


Fig. 2. EVM-300 Event Master and EVR-300 Event Receiver

The EPICS mrfioc2 software environment has been successfully prepared. Compilation of mrfioc2 was completed, and the EPICS IOC was successfully loaded and operated on the test system. Figure 3 shows the EVM-300 and EVR-300 installed in the MTCA chassis. Figure 4 shows the complete test environment used for EPICS IOC, event-code, pulse generation, and timing synchronization tests. Initial functional tests are currently being performed, including:

- Event-code generation and reception
- Event sequence verification
- Pulse generation
- EVR output operation
- EPICS control and monitoring



Fig. 3. MTCA Chassis with EVM-300 and EVR-300



Fig. 4. Overall Development and Test Setup of the MTCA-Based Timing System

These tests provide the basic verification required before connecting the new timing system to accelerator subsystems.

5. Future Test Plan

The next stage of the R&D will focus on timing accuracy and synchronization performance of the new MTCA-based timing system. Following the completion of the basic EVM-300 and EVR-300 functional tests, an external reference clock will be applied to provide a stable timing reference and to evaluate the operation and synchronization performance of the timing system under an external clock source. The delay compensation function will be investigated. Timing delays introduced by optical fibers and distributed timing paths will be measured, and the compensation function will be applied to minimize timing differences between distributed timing nodes. Through these tests, the synchronization performance and timing accuracy of the new system will be evaluated under conditions representative of accelerator operation. Based on the results of the event and pulse generation tests, external reference clock operation, delay measurement, and delay compensation, the overall timing performance of the new platform will be assessed. The validated timing system will subsequently be considered for application to the existing accelerator and as a baseline platform for future accelerator energy expansion.

6. Upgrade Strategy and Expected Benefits

A phased upgrade strategy is proposed rather than an immediate replacement of the operational timing system. In the first phase, the 300-series hardware is secured as strategic spare equipment. In the second phase, the MTCA test platform is used for pre-R&D and functional verification. After timing synchronization and delay compensation are validated, the new platform can be gradually introduced into the accelerator system.

This strategy provides three major benefits. First, it reduces the operational risk caused by the obsolescence of the existing VME timing system. Second, it provides a modern platform with improved maintainability and scalability. Third, it allows timing technologies required for future accelerator energy expansion to be verified in advance without affecting the existing accelerator operation.

7. Conclusions

The existing VME-based timing system has provided reliable accelerator operation for an extended period, but the discontinuation of the EVG-230 and EVR-230 has created a long-term spare-part and maintenance issue. To address this issue, an MTCA-based pre-R&D platform using the EVM-300 and EVR-300 has been established. The mrfioc2 software has been successfully compiled, and the EPICS IOC has been verified to load

and operate normally. Initial event-code and pulse-generation tests are currently in progress.

Future work will focus on external reference-clock operation and verification of the delay compensation function. Through these tests, the new timing platform will be evaluated as both a strategic replacement for the legacy system and a baseline platform for future accelerator energy expansion. The proposed phased approach enables spare-part preparation, technology validation, and future accelerator expansion with minimized operational risk.

Acknowledgement

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