

# Requirements, Specification, and Interfaces for the RAON Control System

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## Abstract

This document is the Rare Isotope Science Project at Institute for Basics Science Requirements, Specification, and Interfaces for the RAON Accelerator Control System. It shows all general requirements and specifications for the RAON contron system.

## 1 General Requirements

### 1.1 Overview

The Control team has selected the Experimental Physics and Industrial Control System (EPICS) [1] as a main framework of the control system, because it is reliable, scalable, maintainable, low-cost system, and standard. The EPICS is an open-source, i.e. the source code is accessible, software that has various tools, libraries, and predefined applications developed by a world-wide user community and is used in large and small experimental physics projects such as particles accelerators, telescopes, and light sources since 1994. In addition, EPICS supports several hundred different modules with almost all bus types that produced by more than hundred manufacturers. One can find further information at <http://www.aps.anl.gov/epics/>.

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- The EPICS clients shall be Debian Linux Stable PCs. The current version is Debian 7 Wheezy [2].
- EPICS servers on PC hardware shall run Debian Linux Stable (or other version as approved by RAON Accelerator Control Team (RACT))
- EPICS servers on Versa Module Europa bus (VMEbus) hardware shall run Vx-Works version 6.9 (or other version as approved by RACT)

## 1.2 EPICS Versions

- All EPICS software submitted by the Contractors, Collaborators, or any other third party shall be based on EPICS base version 3.14.12 (or later version as specified by RACT).
- Where additional EPICS modules are used, the versions shall be according to Table 1. Later versions may be specified by RACT.
- If a module is not explicitly specified in Table 1, the default version of this module used shall be the version provided in the synApps packages version 5.7. One can see the further information at <http://www.aps.anl.gov/bcda/synApps/>.

**Table 1** EPICS Module Versions

Name	Version	comments
asyn	R4-24	<a href="http://www.aps.anl.gov/epics/modules/soft/asyn/">http://www.aps.anl.gov/epics/modules/soft/asyn/</a>
stream	2-6	<a href="http://epics.web.psi.ch/software/streamdevice/">http://epics.web.psi.ch/software/streamdevice/</a>
ether_ip	2-26	<a href="http://sourceforge.net/projects/epics/files/ether_ip/">http://sourceforge.net/projects/epics/files/ether_ip/</a>
seq	2.1.7	<a href="http://www-csr.bessy.de/control/SoftDist/sequencer">http://www-csr.bessy.de/control/SoftDist/sequencer</a>
areaDetector	R2-1	<a href="http://cars9.uchicago.edu/software/epics/areaDetector.html">http://cars9.uchicago.edu/software/epics/areaDetector.html</a>
motor	R6-8	<a href="http://www.aps.anl.gov/bcda/synApps/motor/">http://www.aps.anl.gov/bcda/synApps/motor/</a>

## 1.3 EPICS Support

Where the contract involves the development of an EPICS interface to the equipment and any devices, the following itemized list shall apply.

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## 1.4 Input Output Controller (IOC) platform

- The standard IOC hardware platform is an 1U rack mountable server.
- All IOC hardware shall be installed into the standard 19-in. rack by the Contractor.
- The IOC shall be included in the system performance tests at the Supplier's factory.

## 1.5 Database development

- The Contractor shall provide EPICS databases with layout information compatible with the Visual Database Configuration Tool (VisualDCT) EPICS database development tool [3].

## 1.6 Device support

- The Contractor shall supply EPICS device drivers and device support for any hardware delivered as part of this contract.
- Where the Contractor provides a motion controller, the EPICS interface shall be the standard Motor record, or a set of records that provides equivalent functionality.

## 1.7 RACT Supplied Items

- Debian Linux Stable, upon request.
- Control System Studio, upon request.
- A naming convention document for the control system.
- A specification for the file structure to be used for software development. **Need to be a section in this document**

## 1.8 Operator Interface (OPI)

Where the contract involves the development of an EPICS interface to the components, the following shall apply.

- The Contractor shall supply a GUI to perform the following functions:
  - Equipment control panel(s) showing the state of all signals associated with the equipment. These should enable users to monitor and control the equipment for routine operation. It shall be possible to call up the engineering control panels from the Equipment control panel.

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- The engineering control panels should enable engineers to monitor and control all the available parameters of the equipment for commissioning and for troubleshooting.
  - The OPI shall be implemented in CSS/BOY.
  - The version of CSS used shall be the stable release, currently 3.3.11, or later version as approved by RACT.
  - The version of BOY used shall be the stable release, currently 3.3.0, or later version as approved by RACT.
  - The OPI shall be implemented on a Linux PC. The version of Linux, defined in Section 1.1, shall be used.
  - The OPI for all optical elements shall include information about the direction and sign of the coordinate system used, including linear and rotations axes.

## 1.9 Software Development

- The Contractor shall provide current versions of all source code developed by the Contractor when the relevant Equipment is delivered to the Purchaser.
- The Contractor shall provide final versions of all source code developed by the Contractor at the completion of equipment commissioning.
- The Contractor shall provide software design documentation including functional specifications, sequence diagrams, class diagrams, and so on for the software developed to meet this contract.
- A suitable level of commenting shall be adopted for all developed software. As an indication, comments should be provided, on average, for every subroutine and any complex code segment.
- All software comments shall be in English or Korean. In case of Korean, UTF-8 encoding shall be used.
- The Contractor shall allow the source code developed to meet this contract to be open source, consistent with the EPICS Open license.

## 1.10 Other Software

- The Contractor shall provide EPICS device support source code for all devices supplied as part of this contract.

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## 1.11 Naming

- All devices and database records shall be named in accordance with the technical document, which is Naming Convention for the RAON Control System [4].
- The naming document [4] does not provide the names required, the names shall be developed in consultation with RACT.
- The Contractor shall request the developed names via the RAON Naming Service at <http://10.1.5.14:8080/naming>. Since this site cannot be accessible outside the local intranet, the Contractor shall contact RACT in order to do so.
- The requested names will be reviewed by RACT, Accelerator Division Leader, or both.
- The Contractor shall received approval, in writing, from RACT for all names prior to final delivery of the devices and databases.

## 1.12 Computer and Electronics Hardware

- All devices and database records shall be named in accordance with the technical document, which is Naming Convention for the RAON Control System [4].
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- The Contractor shall received approval, in writing, from RACT for all names prior to final delivery of the devices and databases.

## 1.13 Computer and Electronic Hardware

- Electrical energy consumption of rack-mounted hardware (e.g., PCs, IOCs, and so on) shall be minimized where reasonably possible.
- Acoustical noise generation by rack-mounted equipment shall be minimized where reasonably possible.
- Electrical energy consumption of desk-mounted equipment (computers, monitors, etc) shall minimize the heat dissipated to the air.

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- Acoustical noise generation by desk-mounted equipment shall be minimized. A suggested maximum from each component, when operating, is 40 dBA, measured at 1 m.

### **1.14 Equipment Protection**

- All equipment protection instrumentation and logic shall be designed to be fail safe. Circumstances to be considered include, but are not limited to, electrical power failure, compressed air failure, and cable breakage.
- Software-based equipment protection solutions may only be used in addition to a hardware solution.
- For motions control, limit switches shall be directly connected to the limit switch inputs of the motion controller.
- All components, particularly those exposed to high heat loads, shall have sufficient instrumentation to allow monitoring the integrity of the equipment. This instrumentation will be interfaced to an interlock system which will take action to prevent any permanent damage to the component.
- The Contractor shall define the safe operating range for each component based on the instrumentation provided for that component.
- The Contractor shall define the required interlock actions when equipment is outside the safe operating range.
- The Contractor shall define the length of time required for protective action to occur.
- Where the Contractor implements the complete equipment protection system, it shall be a PLC based system.

### **1.15 Power Supplies**

- All equipment supplied by the Contractor shall be supplied with appropriate power supplies. These power supplies shall accept a standard 220 VAC supply as input.

## **2 Control System Interface Definitions**

### **2.1 Controls Network**

- Network-attached devices shall be compatible with a 1 Gb/s network.

- Network-attached devices shall operate at a minimum network speed of 100 Mb/s.
- Network-attached devices shall obtain their network address either through static address configuration or DHCP.
- Network-attached devices shall include a Standard RJ-45 modular connector.
- Standardized cables for Gigabit Ethernet shall be used the Category 6 one.
- The Cat 6 should be terminated using the T568B pin/pair assignment.

## 2.2 Serial Devices

- Any device that provides a serial communication interface to the accelerator control system shall be interfaced by a terminal server.
- The serial connection from the device to the terminal server shall be RS232, 422, or 485.
- The use of USB to connect a device to the control system shall be avoided, as far as practicable.
- Applications that are requiring high voltage isolation (e.g., vacuum gauge and pump controllers) shall use a Moxa CN2650I series terminal server, or equivalent with more than 2 kV optical isolation for the serial line protection.
- Applications that do not require high voltage isolation shall use a Moxa NPort 6650 series terminal server, or equivalent with data transmission integrity with support of EDS, 3DES, and AES encryption algorithms.

## 2.3 Triggers

- All generated triggers shall be TTL signal levels.
- All trigger inputs shall accept TTL signal levels.

## 3 Acknowledgment

The document is re-compiled by the author based on the original NSLS-II XFD RSI for the Controls and DAQ Systems [5] in order to use it for the RAON accelerator control system. I owe much to Bob Dalesio and Wayne Lewis for fruitful discussions about the requirements, specifications, and interface for controls systems.

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## **Acronyms**

**EPICS** Experimental Physics and Industrial Control System. 3–6

**IOC** Input Output Controller. 4

**OPI** Operator Interface. 5

**RACT** RAON Accelerator Control Team. 3, 4

**VisualDCT** Visual Database Configuration Tool. 4

**VMEbus** Versa Module Europa bus. 3



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## Bibliography

- [1] A Johnson et al. Experimental Physics and Industrial Control System - EPICS, 2010.  
URL <http://www.aps.anl.gov/epics/>.
- [2] Debian Linux Stable Distribution, 2013. URL <http://www.debian.org/>.
- [3] Visual Database Development Tool. URL [https://wiki-ext.aps.anl.gov/epics/index.php/VDCT\\_S](https://wiki-ext.aps.anl.gov/epics/index.php/VDCT_S)
- [4] Jeong Han Lee. Naming Convention for the RAON Control System, 2014.
- [5] Experimental Facilities Requirements, Specifications and Interface for the Controls and Data Acquisition System, Version 3, 2013.