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Requirements, Specification, and Interfaces for the RAON Control System

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Abstract

A naming convention for the RAON control system is a convention for naming signals and devices which will be used for the RAON accelerator in order to control the whole accelerator and monitor its signals as well. This document shows how to use the naming convention in any sub-system so that we may eliminate a typical burden to integrate them all into the RAON accelerator control system framework.

1 Motivation

The naming convention is a rule for matching signals, which are from devices and equipment of an accelerator, to signals. And an efficient naming rule quickly and easily lets us to know what the signal is, where the signal comes from, and which device or equipment is related with the signal. Therefore, an accelerator facility needs a well-defined naming convention.

To avoid confusion and conflicts, names of all devices, equipment and control system signals must be unique. In the case of a control system, signals uniqueness is a strict requirement. In EPICS based control system, signals are represented with process variables (PV). A PV is a named piece of data that is transmitted over the network and to

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ensure error free communication between different subsystems each PV name must be unique.

Another benefit of the naming convention is that names created according to a naming convention can provide some information about the device, equipment or signal. For a control system, signal that includes the name of the associated device, the location of the device within the logical structure of the facility, and the function or parameter the PV is associated with. It is recommended that the naming convention is such that names, when written, are difficult to confuse with other names. For example, names that differ only in case, the use of characters `l` (lower-case L), `I` (upper-case I) and `1` (one), letters `V` and `W`, etc., should be avoided.

2 Scope of the Naming Convention [1, 2, 3]

The naming convention should apply to all devices (beam instrumentation, sensors, actuators, etc.), equipment (power supplies, magnets, cavities, targets, moderators, instruments, etc.) and signals in technical systems and conventional facilities. And these requirements do not apply to cable numbering, pipe numbering, or location designations throughout facility.

The names determined through this naming convention should be used on operator screens, in the inventory system, drawings, design schematics, computer software, project databases, equipment name tags, test procedures, and other sources of technical information at RAON.

3 Naming Convention Scheme

Since the RAON integrated control system uses the EPICS framework, a standard EPICS naming convention is the basis of the naming convention for the RAON control system. The format is shown as

$$\underbrace{\textbf{SYS}-\textbf{SUBSYS}}_{\text{a system element}}:\overbrace{\text{DEVXXX}(-\text{SUBDEVXXX})}^{\text{a device element}}:\underbrace{\mathit{SignalName}.\text{Field}}_{\text{a signal element}}$$

, where

- **SYS** : a system name which is `UPPERCASE` or `UpperCamelCase`.
- **SUBSYS** : a sub-system name which is `UPPERCASE` or `UpperCamelCase`.
- **DEV** : a device name which is `UPPERCASE` or `UpperCamelCase`.
- **SUBDEV** : a sub-device which is `UPPERCASE` or `UpperCamelCase`, and is an empty option for future expansion.

- **XXX** : a device numbering assigned by a system or a sub-system. Numbering sequences starting at **1** in the RAON Naming convention. So the first device will be **001**. We do not use the Zero-based numbering [4].
- **SignalName** : a signal name which is `UPPERCASE` or `UpperCamelCase`. Also it has two parts as Quantities and Attributes.
- **Field** : a field name which is `UPPERCASE` and for the EPICS internal usage.

4 Naming Syntax Rules

When applying the naming convention to any subsystem signals, one should follow the following syntax rules :

1. Allowed characters for names are alphanumeric characters (`A-Z`, `a-z`, and `0-9`) and two separator characters (`-`, `:`)
   - Avoid using the uppercase letter `O`, be confused with the number `0`.
   - Avoid using the uppercase letter `I`, be confused with the number `1`.
2. The delimiter `:` separates name elements. There are three name elements as follows: the system, device, and signal name element.
3. The delimiter `-` separates system/sub-system segments and device/sub-device segments.
4. All three name elements are obligatory for signals. Device names may omit the signal name element when reference is made only to the device. Conventional facility names may omit device and signal name elements when reference is only being made to the system level (building) name and not to items or devices within the building.
5. If additional segmentation of the system or subsystem is required or for better clarity, an number can be appended to the system or subsystem segments, which we can call as *system or subsystem numbering*.
6. Letter case are used to improve readability but are not used to distinguish between names. That is, there will not be two names for which the only difference is the letter case.
7. The first letter of a word or abbreviation is uppercase and succeeding letters are lowercase. Acronyms are all uppercase.
8. The device numbering can be omitted if there is only one instance of the device present in the system/subsystem combination. For example, the event generator `Evg` instead of `Evg001` if there is only one event generator in the timing system. The device numbering can also be descriptive if the scope of the device allows it.

9. Vendor specific, contemporary, or *funny* naming should be avoided.

5 System element

5.1 System code : SYS

A system is at the highest level in the logical structure of the RAON accelerator. Table 1 shows an incomplete list of the system codes. In case of multiple systems sharing the same system code it is possible to differentiate between them by adding a number (*a system numbering*). Figure 1 shows the system code according to the site layout.

Table 1 System Codes

System	code description	Sectors
ECR11	1st ECR-IS for SCL1	Injector
ECR12	2nd ECR-IS for SCL1	Injector
LEBT11	1st section of LEBT for SCL1	Injector
LEBT12	2nd section of LEBT for SCL1	Injector
RFQ1	RFQ for SCL1	Injector
MEBT1	MEBT for SCL1	Injector
ECR31	ECR-IS for SCL3	Injector
LEBT31	1st section of LEBT for SCL3	Injector
LEBT32	2nd section of LEBT for SCL3	Injector
RFQ3	RFQ for SCL3	Injector
MEBT3	MEBT for SCL3	Injector
SCL11	1st section of SCL1	SCL
SCL12	2nd section of SCL1	SCL
SCL21	1st section of SCL2	SCL
SCL22	2nd section of SCL2	SCL
SCL31	1st section of SCL3	SCL
SCL32	2nd section of SCL3	SCL
IF	IF System	IF
Cyc	Cyclotron	Cyclotron
Cryo	Cryogenic System	Cryogenic

Table 1 – *Continued on next page*

System	code description	Sectors
Ctrl	Control System	Control
Elec	Power and Communication	Conventional
Mech	HVAC and utilities system	Conventional
Dmp	Dump	TBD
FA	Fire Alarm	Safety
CF	Conventional Facility	Conventional
FE	Front End	TBD

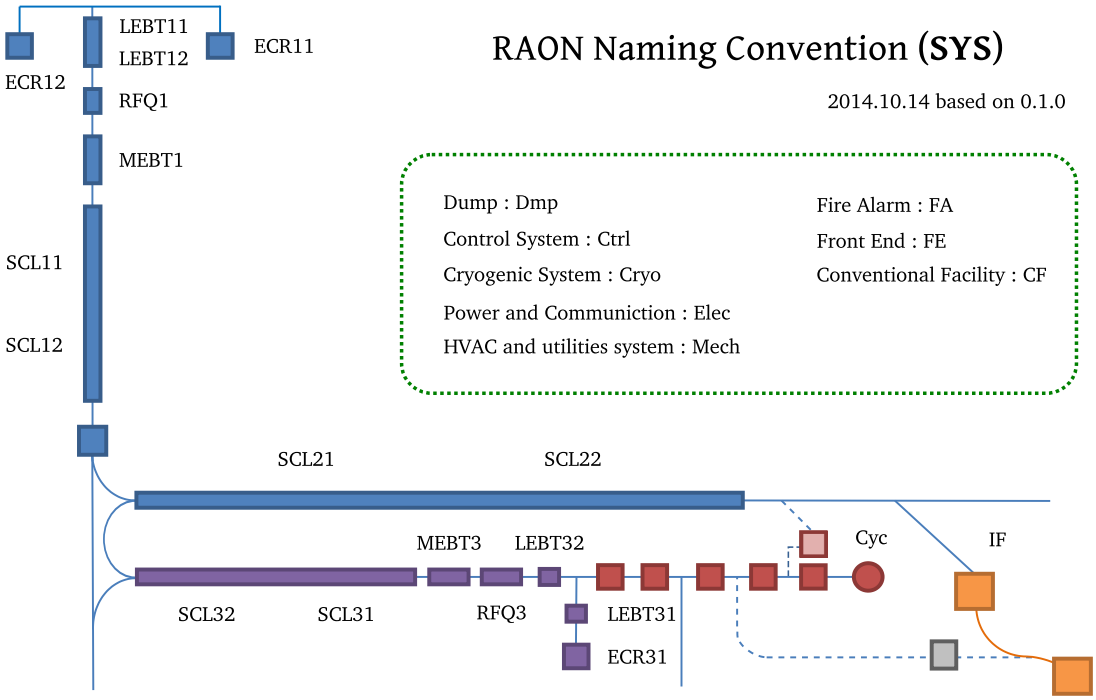

Figure 1 System Code **SYS** according to the RAON Site layout in the RAON control system naming convention.

5.2 Subsystem code : SUBSYS

A subsystem is at the second highest level in the logical structure of the RAON accelerator system. It is a grouping of devices that fulfill a specific function. Table 2 shows

an incomplete list of the subsystem codes. In case of multiple subsystems sharing the same subsystem code, it is possible to differentiate between them by adding a number (*a subsystem numbering*).

Table 2 Subsystem Codes

Subsystem	code description	Sectors
CM	Cryomodule	SCL
HDS	Helium Distribution System	Cryogenic
HRS	Helium Refrigeration System	Cryogenic
RFS	Radio Frequency System	RF
LLRF	Low Level Radio Frequency	RF
TS	Timing System	Control
MPS	Machine Protection System	Control
Vac	Vacuum System	TBD
TFc	Test Facility	TBD
Diag	Diagnostics	TBD
Mag	Magnets	TBD
Tagt	Target	TBD
PPS	Personnel Protection System	Safety
Pwr	Power Station	Conventional
Watr	Water Cooling System	Conventional
PrWTS	Process Waste Treatment System	Conventional
PrWatrS	Process Water System	Conventional

6 Device element

6.1 Device code : DEV

The device code segments the abbreviation of the device type that identifies a certain class of devices. Table 3 shows an incomplete list of device codes. We reserve the subdevice code for possible future expansions.

Table 3 Device Codes

Device Code	code description	Comments
BCM	Beam Current Monitor	
BPM	Beam Position Monitor	
BLM	Beam Loss Monitor	
BHM	Beam Halo Monitor	
RrM	Radiation Monitor	
PS	Power Supply	
PSC	Power Supply Controller	
Cable	Cable	
Cath	Cathode	
Cav	Cavity	
CBox	Cold Box	
Chllr	Chiller	
Chop	Chopper	
Cmp	Compressor	
Coll	Collimator	
Cpl	Coupler	
Pmp	Pump	
CPmp	Cryopump	
CV	Valve, control	
GV	Gate Valve	
DMH	Dipole Magnet Horizontal	
DMV	Dipole Magnet Vertical	
Dri	Drift Space	
HKick	A horizontally steering magnet	
VKick	A vertically steering magnet	
QD	Defocusing Quadrupole	
FD	Focusing Quadrupole	
Fan	Fan	
Dr	Door	
IX	Ion Exchanger	
Rack	Cabinet, Rack	
SCav	Superconducting Cavity	
Sol	Solenoid	
Twr	Electrical Tower	

Table 3 -*Continued on next page*

Device Code	code description	Comments
WS	Wire Scanner	
EvG	Event Generator	Control
EvR	Event Receiver	Control
EvFIFO	Event FIFO	Control
IOC	Input Output Controller	

6.2 Subdevice code : SUBDEV

This subdevice code is reserved for future expansions.

6.3 Device Numbering : XXX

The device numbering is used to differentiate between multiple devices of the same type in a single system and subsystem combination. And the device numbering can be omitted if there is only one type device present. An index **xxx** starts at `1, one` for each system and subsystem combination.

7 Signal element

The signal element has three codes, such as quantity, attribute, and field. However, end users could see only the first two codes, quantity and attribute, because field should be used for the EPICS internal record. Thus, in order to make a signal element, one could use quantity and attribute together. For example, to make a signal name for *current setpoint*, `CurrentSetpt` should be the right choice.

7.1 Quantity code

Table 4 shows a collecting list of several quantity codes.

Table 4 Quantity codes

Quantity Code	code description	Comments
Ampl	Amplitude	
Count	Count	
Current	Current	
Energy	Energy	
Volt	Voltage	
Freq	Frequency	
Gain	Gain	
Offset	Offset	
Phase	Phase	
Power	Power	
Speed	Speed	
Temp	Temperature	
Time	Time	
Vacuum	Vacuum	
X	Beam Position X	
Y	Beam Position Y	
Xp	The ratio of horizontal component to longitudinal component of momentum p_t : $x' = p_x/p_t$	horizontal angle
Yp	The ratio of vertical component to longitudinal component of momentum p_t : $y' = p_y/p_t$	vertical angle
B	Magnetic Field	

Table 4 -*Continued on next page*

Quantity Code	code description	Comments
EvtCode	Event Code	
Fw	Firmware	
Hw	Hardware	
Sw	Software	

7.2 Attribute code

Table 5 shows a working list of attribute codes.

Table 5 Attribute codes

Attribute Code	code description	Comments
Avg	Average	
Hist	Histogram	
Max	Maximum	
Min	Minimum	
Neg	Negative	
Pos	Positive	
Raw	Raw	
RB	Readback	
Ref	Reference	
Ripple	Ripple	
RMS	Root Mean Square	
Setpt	Set Point	
Status	Status	
State	State	
Ver	Version	
Rst	Reset	

7.3 Field codes

As mentioned before, typical end users are unnecessary to understand these codes, because field code is reserved for the EPICS internal records. Table 6 shows a selected example list of the field code. One can find the completed lists in the reference manuals [5, 6].

Table 6 An example of the Scan Fields in the reference [6] .

Field code	code description	Comments
SCAN	Scanning Rate	This can be one of the periodic intervals (.1 second, .2 second, .5 second, 1 second, 2 second, 5 second, 10 second, I/O Intr, Event, or Passive.
PINI	Process at Initialization	If this field is set to YES during database configuration, then the record is processed once at IOC initialization (before the normal scan tasks are started).
PHAS	Scan Phase Number	This field orders the records within a specific SCAN group. This is not meaningful for passive records. All records of a specified phase are processed before those with higher phase number. Whenever possible it is better to use linked passive records to enforce the order of processing rather than phase number.
EVNT	Event Number	Event number for scan type SCAN_EVENT. All records with scan type event and the same EVNT value will be processed when a call to post_event for EVNT is made. The call to post_event is: post_event(short event_number).
PRIO	Priority	Scheduling priority for processing I/O Event scanned records and asynchronous record completion tasks.
DISV	Disable Value	If DISV=DISA, then the record will be disabled, i.e. dbProcesswill not process the record.
DISA	Scan Disable Input Link Value	This is the value that is compared with DISV to determine if the record is disabled. Its value is obtained via SDIS if SDIS is a database or channel access link. If SDIS is not a database or channel access link, then DISA can be set via dbPutField or dbPutLink.

Table 6 – *Continued on next page*

Field code	code description	Comments
SDIS	Scan Disable Input Link	An input link from which to obtain a value for DISA. This field is ignored unless it is a database link or a channel access link. If it is a database or a channel access link, dbProcess calls dbGetLink to obtain a value for DISA before deciding to call the processing routine.
PROC	Process Record	A record will be processed whenever a dbPutField is directed to this field.
DISS	Disable Alarm Severity	When this record is disabled, it will be put into alarm with this severity and a status of DISABLE_ALARM.
LSET	Lock Set	The lock set to which this record belongs. All records linked in any way via input, output, or forward database links belong to the same lock set. Lock sets are determined at IOC initialization time, and are updated whenever a database link is added, removed or altered.
LCNT	Lock Count	The number of times in succession dbProcess finds the record active, i.e. PACT is TRUE. If dbProcess finds the record active MAX_LOCK (currently set to 10) times in succession, it raises a SCAN_ALARM.
PACT	Processing Active	PACT is TRUE while the record is being processed. For asynchronous records PACT can be TRUE from the time record processing is started until the asynchronous completion occurs. As long as PACT is TRUE, dbProcess will not call the record processing routine.
FLNK	Forward Link	This field is a database link. If FLNK is specified, processing this record will force a processing of the scan passive forward link record.
SPVT	Scan Private	This field is for private use of the scanning system.

This SCAN filed example is just one example of the EPICS record fields. Therefore, if anyone wants to know the further information, please see the reference [6].

Table 7 Naming Convention Usage for Several Signal Names (Process Variables)

SYS-SUBSYS:DEVXXX:SignalName	Comments
ECR13-Mag:PS012:CurrentRB	Current Readback value of the 12th Power Supply of the ECR13 for SCL3 (Magnetic)
MEBT3-Diag:BPM004:XRaw	Horizontal Raw Position of Beam Position Monitor number 004 at MEBT3 (Diagnostic)
SCL11-LLRF:Rack042:TempAvg	Average Temperature of the 42nd RACK of SCL11 (LLRF)
Cryo-TFC:Pmp014:PowerSetpt	Power SetPoint of the 14th Pump of Cryogenic (Test Facility)
Ctrl-TS:Evg001:EvtCodeRB	Event Code Readback of the first Event Generator in Timing System (Control)

8 Examples

Table 7 itemizes several examples of the PV names according to the mentioned naming convention.

9 Acknowledgment

The RAON naming convention is based on many other facilities that use the EPICS as their control system framework. Therefore, this document also re-uses the selected same or modified information from several references [1, 2, 3, 7].

Bibliography

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