Detector Signal Simulator for Testing the Hall C Neutral Particle Spectrometer's Phoebus Alarm System

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To develop and test the Phoebus alarm system for Hall C's Neutral Particle Spectrometer (NPS), a detector signal simulator has been designed and is being implemented. The signal simulator is a software tool for the development and testing of EPICS client applications.

The Phoebus alarm system under development [1] for NPS is an EPICS client application that monitors process variables (PVs) from EPICS input/output controllers (IOCs) for alarm conditions.

The PVs of actual detector signals can be used for client development; however, the signal levels and frequency are usually not controllable. Additionally, a functioning detector and the supporting hardware to read out the signals are needed. Hence, a user controllable source of PVs without the requirement of a working detector and readout hardware has been designed as a software tool for EPICS client development and testing.

As part of the Phoebus test system, Fig. 1, a host-based softIOC [2] was designed and implemented, which functions as a detector signal simulator. The prototype softIOC simulates four detector signals and also checks for alarm conditions on the PVs generated by the softIOC. The alarm system under development is tested [3] by its appropriate responses to the PV alarm conditions.
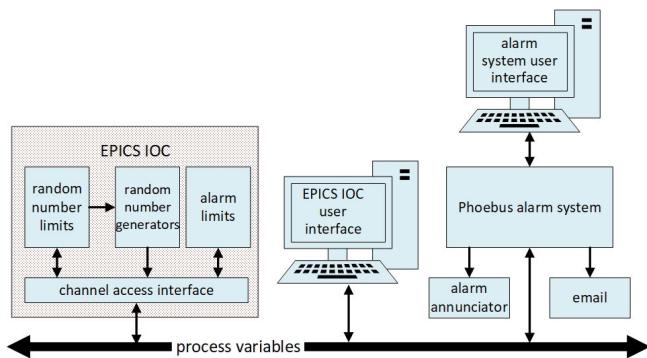

FIG. 1. Phoebus alarm test station.

In the next phase of development and testing of the alarm system, the softIOC is being expanded to simulate all of the NPS detector signal PVs produced from the hardware interlock system [4] [5].

The first group of simulated signals from the hardware interlock system to be implemented are the NPS crystal array thermocouples. There are 56 thermocouples in the front and 56 thermocouples in the back of the crystal array. To simulate these signals, an EPICS database template was designed via the EPICS Visual Database Configuration Tool program (VisualDCT). The template contains a group of EPICS records that are common to the generation of all 112 simulated thermocouple signals. The EPICS records in the template are duplicated for each individual thermocouple signal that is simulated.

To use the EPICS database template requires a text substitution file containing the PV information needed to generate the 112 individual simulated thermocouple signals. At the start of the signal simulator softIOC, the application startup script uses the database template and the text substitution file to form the complete database. Following the database formation, the startup script initializes it and starts the simulation of the 112 thermocouples, Fig. 2.
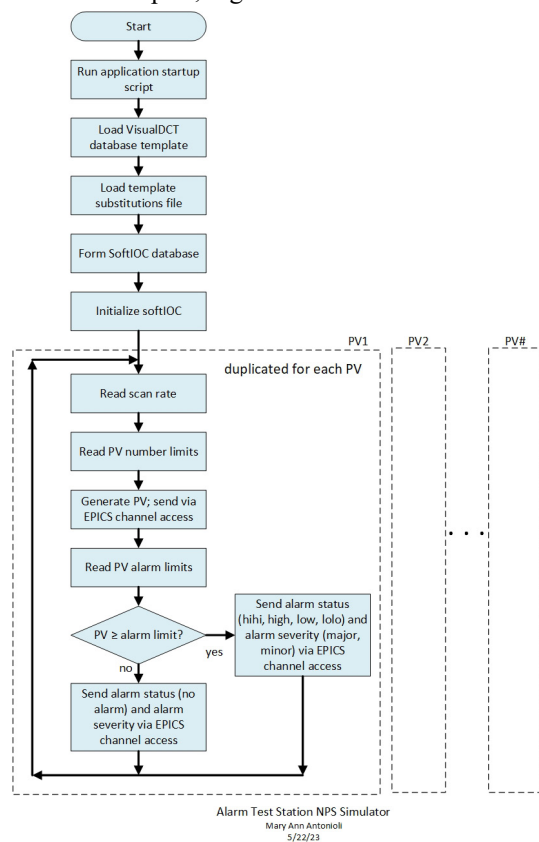

FIG. 2. Alarm test station signal simulator flowchart.

Via the user interface, Fig. 3, the softIOC signal simulator is set to produce a fixed or a randomly generated value for each of the independently simulated thermocouple temperatures. The simulated signal range, minimum value, and data scan rate are also adjustable via the user interface for each temperature. The output PVs with the simulated temperatures are broadcast to the network via EPICS channel access to EPICS clients.

PV name	Crystal	read	HIHI set	HIHI read	HIGH set	HIGH read	LOW set	LOW read	LOLO set	LOLO read	Alarm status	Alarm severity	Scan rate	range [°C]	Min T [°C]	Max T [°C]
hcnps_intlk_cz_t_back	0	21.00	21.00	21.00	20.98	20.98	15.02	15.02	15.00	15.00	HIHI	MAJOR	.1 second ▼	0	21	21.00
	5	20.98	21.00	21.00	20.98	20.98	15.02	15.02	15.00	15.00	HIGH	MINOR	.1 second ▼	0	20.98	20.98
	10	15.02	21.00	21.00	20.98	20.98	15.02	15.02	15.00	15.00	LOW	MINOR	.1 second ▼	0	15.02	15.02
	15	15.00	21.00	21.00	20.98	20.98	15.02	15.02	15.00	15.00	LOLO	MAJOR	.1 second ▼	0	15	15.00
	20	17.77	21.00	21.00	20.98	20.98	15.02	15.02	15.00	15.00	NO_ALARM	NO_ALARM	.1 second ▼	5.94	15.03	20.97
	25	15.43	21.00	21.00	20.98	20.98	15.02	15.02	15.00	15.00	NO_ALARM	NO_ALARM	.1 second ▼	5.94	15.03	20.97

FIG. 3. Alarm test station signal simulator user interface.

Via the user interface, individual EPICS alarm limits can be set for each temperature output PV. When the PV record is scanned, the EPICS alarm limits are compared with the PV value. If the PV value is outside of the limits, the alarm status and alarm severity are broadcast to the network via EPICS channel access to clients. The Phoebus alarm system under development uses the simulated thermocouple temperatures and the PV alarm status and severity for testing [3].

In conclusion, for the development and testing of the Phoebus alarm system, a detector signal simulator has been designed and is being implemented. The signal simulator is a software tool for the development and testing of EPICS client applications.

[1] P. Bonneau, et al., *Proposal to Implement Alarm System in Control System Studio Phoebus for the Hall C Neutral Particle Spectrometer*, DSG Note 2021-37, 2021.

[2] P. Bonneau, et al., *Development of the EPICS Software Input/Output Controller for Testing the Phoebus Alarm System of the Hall C Neutral Particle Spectrometer*, DSG Note 2022-06, 2022.

[3] P. Bonneau, et al. *Testing of the CS-Studio Phoebus Applications and Alarm System Core Programs*, DSG Note 2023-06, 2023.

[4] P. Bonneau, et al. *Hardware Interlock System for the Hall C Neutral Particle Spectrometer*, DSG Note 2021-15, 2021.

[5] P. Bonneau, et al. *Program for the Hardware Interlock System of the Hall C Neutral Particle Spectrometer*, DSG Note 2021-21, 2021.