National Instruments’ CompactRIO-Based Control, Monitoring, and Interlock Systems

Amanda Hoebel, Mary Ann Antonioli, Sahin Arslan, Peter Bonneau, Pablo Campero, Brian Eng, George Jacobs, Mindy Leffel, Tyler Lemon, Marc McMullen, and Amrit Yegneswaran

Physics Division, Thomas Jefferson National Accelerator Facility, Newport News, VA 23606
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National Instruments’ CompactRIO (cRIO)-based control, monitoring, and interlock system for detectors can be used either as the primary or as the backup system. This note describes the layout of a cRIO system and shows how it differs from EPICS-based systems.

The cRIO system’s hardware architecture, Fig. 1, consists of a chassis, I/O and relay modules, power supply, a reconfigurable FPGA, and an embedded controller, which can be programmed in LabVIEW, C/C++, or Java.

Typically, monitored detector signals are voltages, currents, ramp rates, temperatures, humidities; purities, flow rates, and pressures of fluids; and vacuum levels.

Signal levels are controlled by setting limits. If monitored signal values are outside set limits, corrective action is taken to adjust the signals to be within limits, or the instrumentation is powered off, i.e. interlocked.

A cRIO system, Fig. 2, obtains signals via hardwired connections to detector sensors and instrumentation, which in turn are hardwired to the detector (red lines). cRIO systems can be configured to send process variables to EPICS via Ethernet (black lines), using the standard cRIO/EPICS interface.

EPICS systems can obtain signals from the cRIO, Fig. 2, or via either a hardware or software EPICS IOC, bypassing the cRIO, Fig. 3. The disadvantage of this system is its dependency on the network. Network error probability should be taken into consideration when designing control, monitoring and interlock systems.

cRIO systems do not require network connectivity. It is this feature that makes cRIO control, monitoring, and interlock systems invaluable.

The Detector Support Group uses both EPICS and cRIOS, usually with the EPICS system as the primary and the cRIO as the backup, Fig. 4.