LANSCE-R WIRE-SCANNER SYSTEM*

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Abstract

The National Instruments cRIO platform is used for the new LANSCE-R wire-scanner systems. All wire-scanner electronics are integrated into a single BiRa BiRIO 4U cRIO chassis specifically designed for the cRIO crate and all interface electronics. The BiRIO chassis, actuator and LabVIEW VIs provide a complete wire-scanner system integrated with EPICS. The new wire-scanner chassis includes an 8-slot cRIO crate with Virtex-5 LX 110 FPGA and Power-PC real-time controller, the LANL-developed cRIO 2-axis wire-sensor analog interface module (AFE), NI-9222 cRIO 4-channel 16-bit digitizer, cRIO resolver demodulator, cRIO event receiver, front-panel touch panel display, motor driver, and all necessary software, interface wiring, connectors and ancillary components. This wire-scanner system provides a complete, turn-key, 2-axis wire-scanner system including 2-channel low-noise sense-wire interface with variable DC wire bias and wire-integrity monitor, 16-bit signal digitizers, actuator motor drive and control, actuator position sensing, limit-switch interfaces, event receiver, LabVIEW and EPICS interface, and both remote operation and full stand-alone operation using the touch panel.

INTRODUCTION

The LANSCE accelerator at Los Alamos National Laboratory is undergoing major upgrades of many of the systems to replace aging mechanical components, to update electronics to state-of-the art systems, and to add additional diagnostic capabilities infrastructure. The wire-scanner systems are a substantial part of the systems being replaced in the LANSCE upgrade.

All elements of the LANSCE wire-scanner systems are being replaced. The electronics are being replaced with a new electronic system configuration based on the National Instruments (NI) CompactRIO (cRIO) platform [1] being developed to provide high-performance control, signal capture and signal processing in a small, self-contained 4U 19-inch rack unit. The cable plants are being replaced with individual cables dedicated to specific wire-scanner functions both to provide signal isolation and to organize and simplify installation and maintenance. A new actuator is being developed to provide a more robust design requiring less maintenance and improved positioning accuracy. A block diagram of the wire-scanner system is shown in Figure 1.

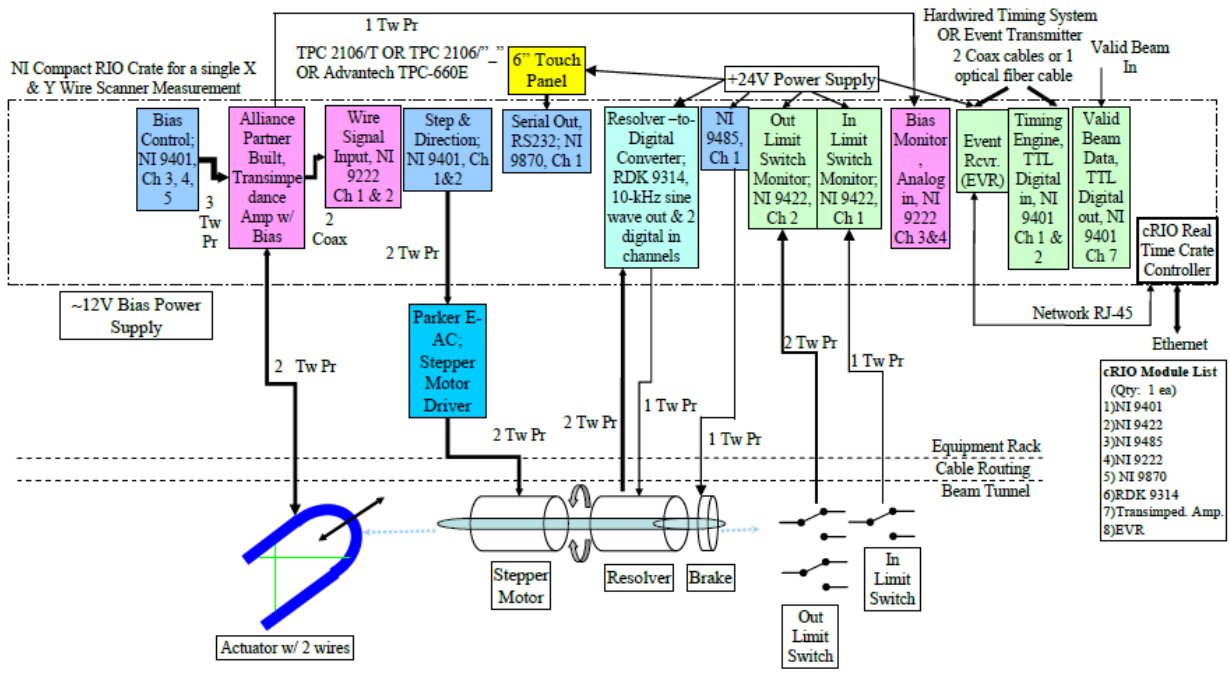

Figure 1: LANSCE-R Wire-Scanner System Block Diagram.

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WIRE-SCANNER cRIO SYSTEM

The LANSCE-R wire-scanner electronics is based on the National Instruments cRIO platform. The basic cRIO crate being used in the LANSCE-R wire-scanner electronics is shown in Figure 2.

Figure 2: cRIO Crate.

An eight-position cRIO crate with a Power PC real-time processor is being used to provide all of the wire-scanner functions including command and control of the actuator, capture and digitizing of the analog wire signals, precise timing and EPICS interface. The complement of cRIO modules in the LANSCE-R wire-scanner electronics system include:

- NI cRIO 9118 Eight-Slot Crate
- NI cRIO-9025 Real-Time Processor
- Custom-Designed Analog Front-End Electronics
- Micro-Research Finland [2] Event Receiver (EVR)
- Smart Embedded Technologies (SET) RDK9314 Resolver-to-Digital Converter
- NI cRIO-9222 Four-Channel Digitizer Module
- NI cRIO-9401 Digital I/O Module
- NI cRIO-9422 Digital Input Module
- NI cRIO-9485 Relay Module

WIRE-SCANNER cRIO CHASSIS

A cRIO chassis system (BiRIO) developed by BiRa Systems [3] specifically for cRIO applications is being used for the LANSCE-R wire-scanner systems as well as several other LANSCE-R applications. The complete BiRIO cRIO chassis unit is shown in Figure 3.

Figure 3: LANSCE-R cRIO Chassis Unit.

The BiRIO chassis is a standard 4U 19-inch configuration. An NI TPC-2206 Touch Panel Computer is integrated into the chassis front panel to provide real-time visual display of wire-scanner operation and direct manual control of the wire-scanner actuator.

Direct manual control has proven to be quite useful in initial instillation and service diagnostics. This feature is also useful for various beam diagnostics where simple real-time positioning of the sense wires is desired.

Figure 4 shows the front interior of the chassis with the front panel open. All interconnect wiring is removed in these figures to allow the cRIO and chassis elements to be seen unobstructed.

Figure 4: cRIO Crate Mounting in Chassis Unit.

All wiring to the cRIO modules is dropped below the cRIO crate through a slot in the sub-panel to the rear volume of the chassis. The rear area of the BiRIO chassis is shown in Figure 5.

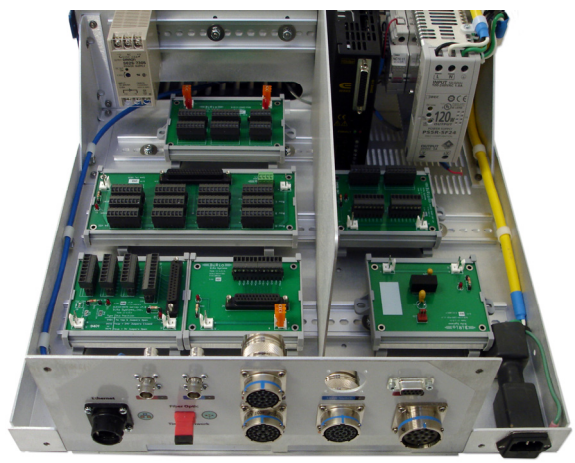

Figure 5: cRIO Chassis Rear Access.

Therefore, in the LANSCE-R cRIO chassis systems, all wiring from the cRIO modules is carried directly down from each module to interface modules in the rear of the chassis to maintain neat, well-organized lead dress of the wiring plant in the chassis. There are no interconnections

directly between cRIO modules at the cRIO crate. This wiring management allows any module to be very easily removed without the need to disturb any other modules or any wiring other than that associated with the module being removed.

LANSCE-R WIRE-SCANNER ACTUATOR DEVELOPMENT

A new wire-scanner actuator design is being developed for the LANSCE-R program to provide a single actuator design that is capable of being utilized in all locations of the LANSCE accelerator. Having a single common actuator configuration throughout the accelerator will both minimize implementation cost and simplify maintenance and repair. The first prototype of the new LANSCE-R wire-scanner actuator is shown in Figure 6.

Figure 6: LANSCE-R Actuator Prototype.

This prototype unit has been successfully installed and tested on the LANSCE beam line in late December 2010. The closed-loop operation utilizing the cRIO control was successfully demonstrated, and the desired position accuracy and analog data acquisition was achieved.

A second prototype actuator is being developed as a very compact design providing the same stroke, rigidity and positioning accuracy as the first prototype. This unit is currently in the final detailed design phase. It is a goal to have fabrication of this second prototype completed and available for testing on the LANSCE accelerator during available beam-development time in July 2011.

This second prototype actuator is a more compact physical configuration, while maintaining all the operational features of the first prototype, to provide a single design that may be deployed in all the intended locations on the accelerator. A rendering of this second actuator prototype as presently envisioned is shown in Figure 7.

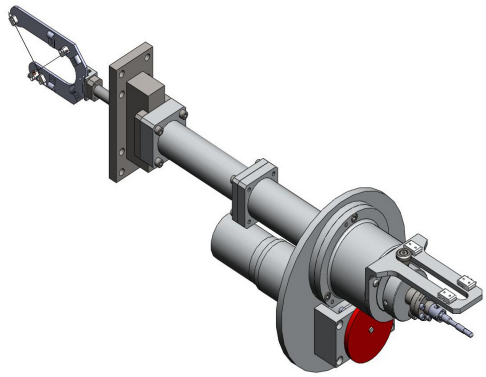

Figure 7: LANSCE-R Actuator Second Prototype.

WIRE-SCANNER CABLE PLANT

The cabling between the wire-scanner control chassis and the actuator is divided by function into four cables:

- Motor drive and brake
- Resolver drive and signals
- Limit switches
- Analog wire signals

CONCLUSIONS

All of the LANSCE wire scanners are being replaced in the LANSCE-R program. The NI cRIO system integrated in a BiRA BiRIO chassis is being utilized for all wire-scanner functions and EPICS interface. A LANL-developed analog cRIO module provides capture of the wire signals. Fiber-optic timing is being implemented throughout the accelerator, and the Micro Research Finland cRIO EVR module provides the timing to each cRIO system.

REFERENCES

[1] National Instruments, Inc., Austin, Texas, USA, www.ni.com/compactrio.
[2] Micro Research Finland, Helsinki Finland, www.mrf.fi.
[3] Bira Systems, Inc., Albuquerque, New Mexico, USA, www.bira.com.