PC/104 Embedded IOCs at Jefferson Lab*

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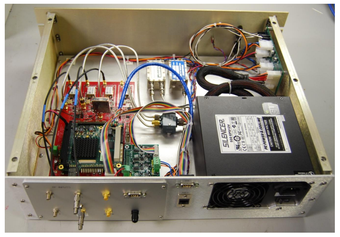
Abstract

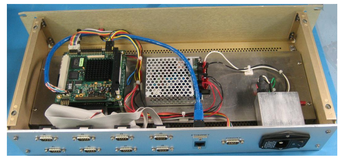
Jefferson Lab has developed embedded IOCs based on PC/104 single board computer (SBC) for low level control systems. The PC/104 IOCs run EPICS on top of the RTEMS operating system. Two types of control system configurations are used in different applications, PC/104 SBC with commercial PC/104 I/O cards and PC/104 SBC with custom designed FPGA-based boards. RTEMS was built with CEXP shell to run on the PC/104 SBC. CEXP shell provides the function of dynamic object loading, which is similar to the widely used VxWorks operating system. Standard software configurations were setup for PC/104 IOC application development to provide a familiar format for new projects as well as ease the conversion of applications from VME based IOCs to PC/104 IOCs. Many new projects at Jefferson Lab are going to employ PC/104 SBCs as IOCs and some applications have already been running them for accelerator operations. The PC/104 - RTEMS IOC provides a free open source Real-Time Operating System (RTOS), low cost/maintenance, easily installed/configured, flexible, and reliable solution for accelerator control and 12GeV Upgrade projects.

PC/104 SBC IOC Applications

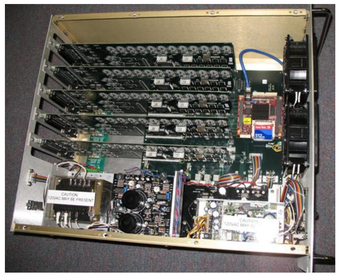
FEL Beam Viewer:
(ACCES PC/104 24-Channel I/O
and custom PCBs)



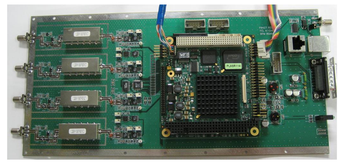
Diagnostic Receiver
(custom FPGA-based PCB)



8 Ch RS-232 Serial Com Port:
(Advanced Digital Logic
PC/104 8-Port RS-232/422/485)

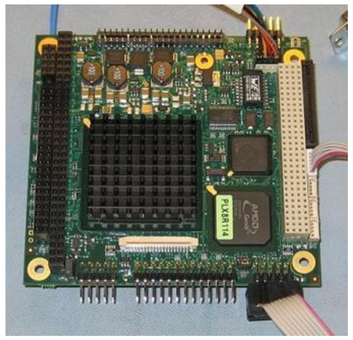


Distributed Data Acquisition
(custom FPGA-based PCB)



FEL BPM
(custom FPGA-based PCB)

Kontron PC/104



- AMD LX800 500MHz CPU
- System ROM with BIOS
- Up to 1 GB DDR-SDRAM support
- Interrupt controllers
- Onboard Video Graphics Array (VGA)
- Serial ports (COM1 and COM2)
- Keyboard/mouse Controllers and speaker
- IDE hard-disk and floppy-driver interface
- Real-time clock
- 10/100 Based-TX Ethernet
- PXE LAN-Boot-ROM
- ISA bus and PCI bus

Boot Procedure

PXE Network Boot
Obtain IP address from DHCP server and request bootstrap file.

↓

GRUB
Bootloader to load RTEMS firmware from TFTP server

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RTEMS
Real-time system started.

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CEXP
RTEMS generic “shell” to dynamically load objects.

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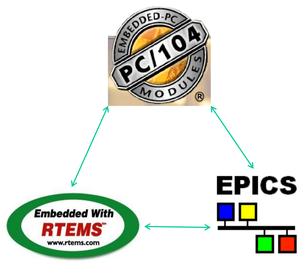
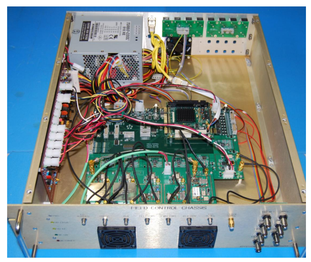
EPICS
EPICS applications (device drivers, device supports, database, etc) loaded.

Embedded IOC

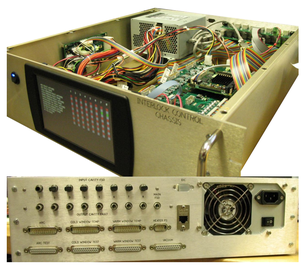


12 GeV Upgrade Low Level RF Systems: (PC/104 IOCs and custom FPGA-based PCBs)



Field Control

High Power Amplifier Controller



Interlocks and Control

Stepper Motor Controller

Conclusions

PC/104 SBCs have been developed as a standard front-end device embedded IOC. The PC/104 processors card was chosen to meet our hardware and control system requirements. The GRUB, RTEMS, CEXP, and EPICS software were successfully compiled and built to run on PC/104 IOCs. Some PC/104 IOCs have been running accelerator controls, and provides a reliable and easily maintained embedded IOC solution. A number of 12 GeV Upgrade and other applications will use PC/104 IOC to control many of different devices in the Accelerator.

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