DEVELOPMENT OF A MULTIFUNCTIONAL UNIT: BLANC4

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Abstract

A beamline experimental station control system at SPring-8 has two types of systems installed. One is the VMEbus system and the other is the desktop PC-based system. The VMEbus system was adopted to develop a flexible control system by combining VME modules. However, if the VMEbus system is adopted, it is overengineering for a compact control system to handle a few I/O signals or a few motor axes. Further, the VMEbus system is difficult to handle by beamline staffs who are not experts of the control system. The desktop PC-based system is relatively low cost and suitable for a small system. However, the system is inferior to the VMEbus system in stability and scalability. To develop a reliable, flexible, compact, low-cost, and user-friendly system, we developed a multifunctional unit, Blanc4, which is a flexible embedded computer supporting the COM Express basic form factor. Blanc4 has two PCI slots and two PCI Express (PCIe) slots with just 1 U height. Blanc4 can replace the connector panels and signal conditioning boards customized for each control target. We assemble Blanc4 as a flexible multifunctional unit.

INTRODUCTION

In synchrotron radiation facilities, many kinds of experiments are performed. We have to construct the control systems to satisfy the varieties of experiments. A beamline experimental station control system at SPring-8 has two types of control systems installed under historical circumstances. One is the VMEbus system developed by the control group and the other is the desktop PC-based system developed by the beamilne staffs. At SPring-8, the VMEbus system is a main stream that controls the accelerators and the insertion device, the front end and the transport channel of beamlines. MADOCA [1], which is the SPring-8 control framework operating on UNIX, has been implemented into the VMEbus system and it has contributed toward a stable operation at SPring-8. An advantage of the VMEbus system is that it can be used to develop a flexible control system by combining many VME modules. However, in a small experimental control system that handles a few I/O signals or a few motor axes, it is inappropriate to set up the VMEbus computer with a chassis in a 19-inch rack because of the large amount of space required for installation, low portability, and high cost. Further, the VMEbus system is difficult to handle by beamline staffs who are not experts of the control system. The desktop PC-based system is relatively low cost and suitable for a compact experimental system. However, the system is inferior to the VMEbus system in stability and

scalability. Additionally, beamline staffs have been adapting their control system to the experimental condition in their own way; the system is not unified at SPring-8. Generally, beamline staffs tend to save the time to develop the application software for a stable operation.

The important thing for the beamline experimental station control system is to provide a reliable, flexible, low-cost, and user-friendly system. To satisfy these requirements, we needed a new approach in the aspects of hardware and software.

DEVELOPMENT OF BLANC4

Requirements

As a new approach, we aimed to develop a convenient multifunctional unit instead of a VMEbus system for a compact control system. Our requirements of the multifunctional unit are follows:

- It is just 1 U in height and it is a 19-inch rack mount-type for high portability and easy setup.
- It can develop a flexible control system by combining many modules. It can provide at least four cards supporting PCI or PCIe.
- It has a reliable hardware system, i.e., it has zero spindles. It is a low power consumption system.
- It dose not require a dedicated component to connect external equipment.
- It is easy for beamline staffs to develop the application software.
- It is low cost.

We developed a multifunctional unit, Blanc4, in order to satisfy these requirements.
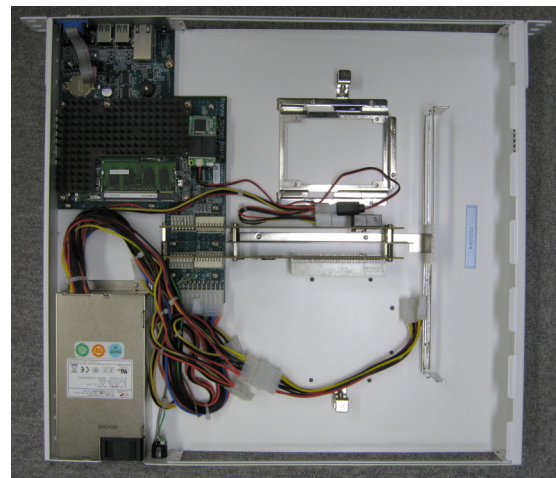

Figure 1: A photograph of Blanc4. The upper space is a PCI Express slot area. The lower space is a PCI slot area.

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Hardware Technology

A Multifunctional Unit

We adopted the COM Express standardized by PICMG [2] as a core technology of Blanc4. The COM Express incorporates the latest technology standards based on serial differential signaling such as PCI Express, USB 2.0, Serial ATA, LVDS, and Serial DVO implemented on an extremely compact Computer-on-Module (COM). The COM Express form factor size is 95 mm x 125 mm.
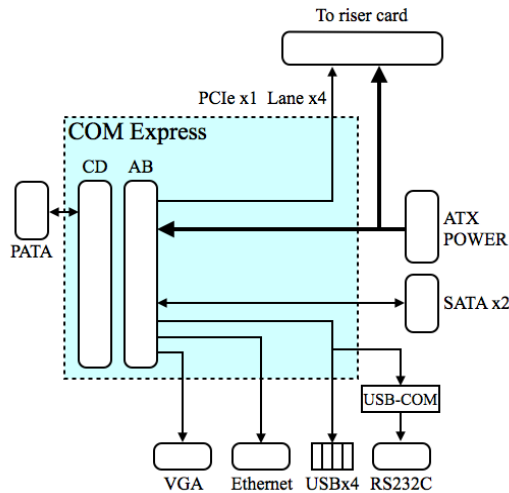

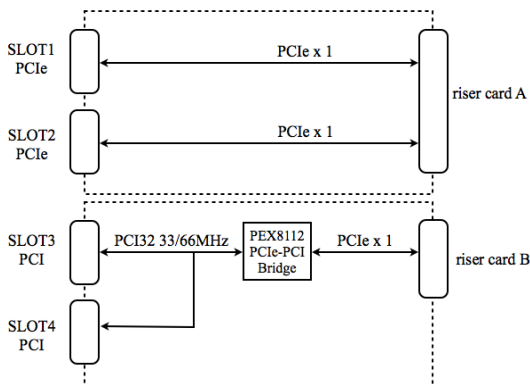Figure 2: A block diagram of COM express carrier board of Blanc4.

Figure 3: A block diagram of riser cards of Blanc4. Riser card A is for PCIe slot and a riser card B is for PCI slot.

Figure 1 shows the photograph of Blanc4. We adopted AM 105 Model 110 (PFU Ltd. [3]) equipped with Intel Atom processor Z530 as a COM Express module. The thermal design power of the processor is 2.2 W. Therefore, the module does not require a CPU fan. A carrier board was developed in accordance with the COM Express basic form factor, and we can choose other COM Express modules from many commercial products. Blanc4 can use Disk On Module (DOM) with the serial ATA interface. A DOM is compact in size (about 26 mm x 46 mm) and is plugged directly to the carrier board. As an option, Blanc4 can mount a 2.5-inch HDD or SSD on a PCI card slot area

or a PCIe card slot area instead of a DOM. In this case, the drive occupies a lower slot space of PCI or PCIe. Figure 2 shows the block diagram of Blanc4.

For saving space, we used riser cards for PCI and PCIe, and pulled each harness connector cable of cards from the front and rear of Blanc4. Blanc4 can equip two PCI slots and two PCIe slots with just 1 U height. Figure 3 shows the block diagram of riser cards. Two PCI slots are provided from a PCIe x 1 via a PCIe-PCI bridge. By using riser cards, the development of a carrier board became simple. Additionally, in the future when we will replace PCI to PCIe, we only have to set up a riser card of PCIe without remodeling a carrier board. Table 1 shows the specifications of Blanc4. Blanc4 was developed in cooperation with ARKUS Inc. [4].

Table 1: Specifications of Blanc4

COM Express module (type 2)	AM 105 Model 110 (PFU Ltd.) Intel Atom processor Z530 (1.6 GHz) Memory: 1 GB
PCI Express slot (riser card A)	PCIe x 1-lane 2 slots Half size
PCI slot (riser card B)	PCI32 33/66 MHz 3.3 V 2 slots Half size
Interfaces	Analog RGB (1280 x 1024) x 1 GbE x 1 USB 2.0 x 4 RS232C x 1
On-board connector	Serial ATA (7 pins) x 2 Parallel ATA (44 pins) x 1
Size (mm)	433 (W) x 43.65 (H) x 400 (D)
Power supply	DC +5 V, -+5 VSB, +12 V, -12 V, +3.3V Total power 220 W

Motion Control

In a beamline experimental station control, a motion control is one of the most important controls and all beamlines have been using the SPring-8 standard stepping motor drivers (Melec Inc. [5]). In the case of a PC-based system, a 16ch pulse motor controller (PM16C, Tsuji Electronics [6]) is installed. As another case using the VMEbus system, an 8-axis pulse motor controller VME board (Advme2005, Advanet Inc. [7]) and a relay connector box between Advme2005 and the motor drivers with photocoupler isolation function (E-046, Advanet Inc.) are introduced. These motor control systems are a standard configuration at SPring-8. However, at points of installation space and cost, these systems are inappropriate for a compact system. Therefore, we assembled a motion control system as a first application of Blanc4. We adopted PCI-7414M (Interface corporation [8]) that is a 4-axis motion controller PCI card, and we developed a signal conditioning board with a connector panel for PCI-7414M. A signal conditioning board has four motor driver interfaces and four limit switch

interfaces. All interfaces are isolated by photocouplers. Figure 4 shows the photograph of the motion control part equipped with 8-axis motor drives. Blanc4 can control up to 8-axis motors.
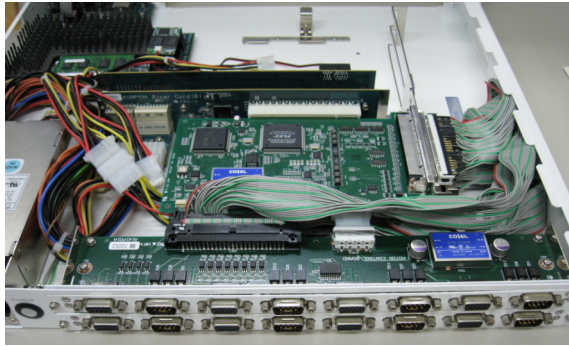

Figure 4: A photograph of a motion control part of Blanc4. The interfaces for motor drivers and limit switches are DE-9 connectors.

INSTALLATION AND FUTURE PLAN

In the summer of 2009, Blanc4 was installed to the radiation monitoring system of SPring-8 Compact SASE Source (SCSS). We installed Solaris 10 as the operating system and implemented a device control server process named as an Equipment Manager of MADOCA control framework. Blanc4 contributed toward a stable operation.

As an application of motion control, we are planning to control a stage setting up an ionization chamber or a diffractometer, and a slit. Currently, we are developing a PCIe counter board that is useful in synchrotron radiation experiments. In 2006, we developed a compact-PCI counter board. The counter board was successfully applied for the quick-XAFS measurement [9]. The PCIe

counter board adopted the specifications of the compact-PCI counter board. Blanc4 will expand its applications by the combining the motion control and the counter board.

We will develop a convenient and user-friendly tool of beamline experimental station control for Blanc4 users. We will focus on the development of user-friendly software applications so that users can easily set up the configuration of the control system even if they do not know how to use MADOCA.

SUMMARY

We developed a multifunctional unit called Blanc4. Blanc4 can develop a flexible control system by combining many modules. As a first application of Blanc4, we designed a signal conditioning board with a connector panel and assembled a motion control system. We implemented the MADOCA framework into Blanc4 and installed the radiation monitoring system of SCSS. Blanc4 contributed toward a stable operation.

REFERENCES

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