UPGRADE OF THE POWER SUPPLY INTERFACE CONTROLLER MODULE FOR SUPERKEKB

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Abstract

There were more than 2500 magnet power supplies for KEKB storage rings and injection beam transport lines. For the remote control of such a large number of power supplies, we have developed the Power Supply Interface Controller Module (PSICM), which is plugged into each power supply. It has a microprocessor, ARCNET interface, trigger signal input interface, and parallel interface to the power supply. The PSICM is not only an interface card but also controls synchronous operation of the multiple power supplies with an arbitrary tracking curve. For SuperKEKB, the upgrade of KEKB, most of the existing power supplies continue while hundreds of new power supplies are also installed. Although the PSICMs have worked without serious problem for 12 years, it seems too hard to keep maintenance for the next decade because of the discontinued parts. Thus we have developed the upgraded version of the PSICM. The new PSICM has the fully backward compatible interface to the power supply. The enhanced features are high speed ARCNET communication and redundant trigger signals. The design and the status of the upgraded PSICM are presented.

INTRODUCTION

KEKB is an asymmetric electron-positron collider, which is dedicated to the B-meson physics. Its operation started in December 1998 and finished in June 2010. The KEKB accelerator control system has been constructed based on EPICS (Experimental Physics and Industrial Control System) tool kit. EPICS provides core mechanism for the distributed control system. EPICS runtime database is running on a local control computer called IOC (Input/Output Controller). More than 100 VME/VxWorks computers were installed as IOC in the KEKB accelerator control system. Several server workstations (HP-UX and Linux) are also installed to run the high level application programs. The runtime database is downloaded from the central server workstation when the IOC starts up.

In the KEKB storage rings and the injection beam transport lines, about 2500 magnet power supplies are installed [1] and controlled by 11 IOCs. To connect such a large number of power supplies to the IOCs, we adopted ARCNET as the field bus and developed the PSICM (Power Supply Interface Controller Module) [2], which is the ARCNET interface board for the power supply. The PSICM has the shape of 3U Euro-card format (100mm × 160mm) with a DIN 64-pin connector and can be plugged into the power supply. Fig. 1 shows the photo picture of the PSICM and the magnet power supply with PSICM. Fig. 2 shows the details of the interface between the PSICM and the power supply. The hardware specifications of the PSICM are listed in Table 1.

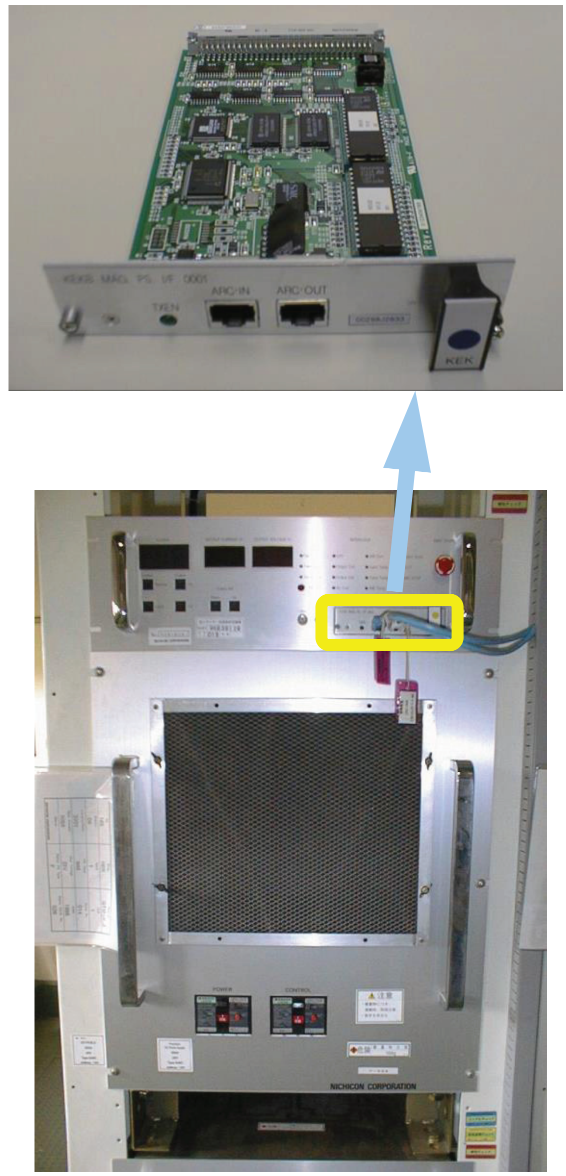

Figure 1: whole shape of the PSICM (above) and the PSICM plugged in a magnet power supply (below).

The ARCNET allows using several kinds of media. We adopted shielded twisted-pair (STP) cable as the media and HYC2485 as the media driver. This configuration allows up to 20 ARCNET nodes to be connected on single segment in the daisy chain manner. The STP cable includes an auxiliary twisted-pair for the external trigger signal together with the ARCNET. Fig.3 shows typical

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configuration of ARCNET used in the KEKB magnet power supply control system.

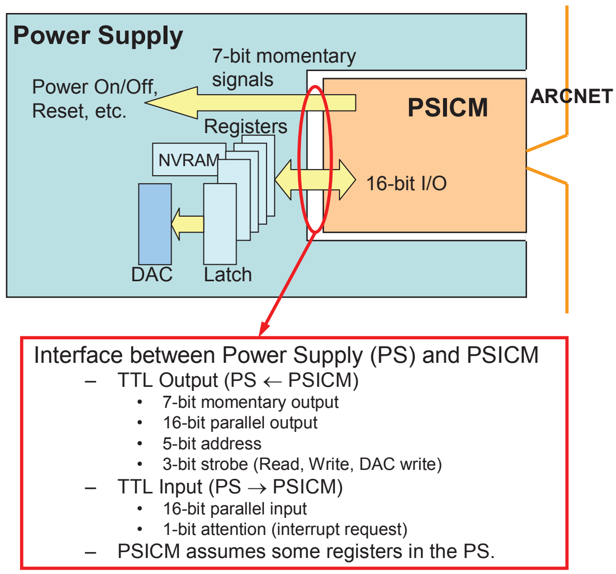

Figure 2: The interface to the magnet power supply.

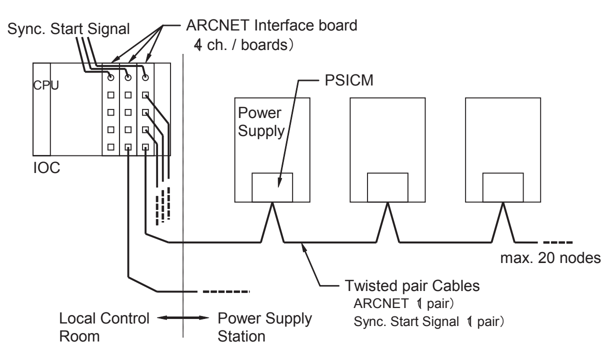

Figure 3: Typical configuration of ARCNET in KEKB.

The PSICM is designed to control the output current of the power supply according to the arbitrary tracking curve. The tracking data are sent from the IOC to the PSICM as an array of the output current values. After receiving the data the PSICM start tracking by a start command or an external trigger signal. Fig. 4 shows the schematic diagram of this sequence. Using the external trigger signal all magnets in the storage ring can be synchronously operated. The sequence control of the synchronous operation is performed by the IOCs with the arbitration by the server process on the central workstation [3].

The magnet power supplies of the Photon Factory Advanced Ring (PF-AR) in KEK are also controlled in the similar manner using the PSICM.

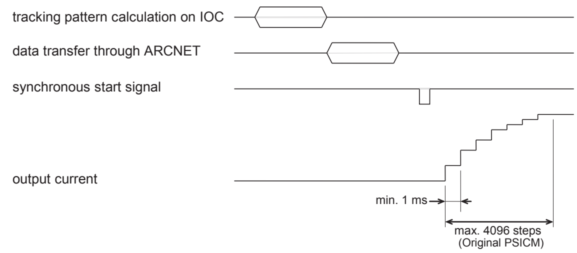

Figure 4: Schematic diagram of synchronous operation.

NEW VERSION OF THE PSICM

For the SuperKEKB, the upgrade of the KEKB, significant numbers of power supplies are newly manufactured. The PSICMs have worked in KEKB for 12 years. During these years some of the parts have been discontinued and it becomes much harder to reproduce the PSICM. At this moment we decided to develop the new version of the PSICM.

In this decade the Ethernet becomes much popular and wide variety of the inexpensive commercial products become available. We think the Ethernet is the most probably surviving technology in the next decade. Once we thought Ethernet could be candidate as the field bus for the new PSICM [4]. On the other hand ARCNET is still available in the market. The cost of the development can be minimized when we adopt ARCNET again because the application-level communication protocol defied for the original PSICM can be reused without any modifications. ARCNET controller chip, which takes care of ARCNET protocols, is available. It enables software development much easier. This is also the advantage of ARCNET. We also have to consider the option of the partial replacement of the PSICM depending on the budget. In such case the mixture of ARCNET and Ethernet is undesirable. Thus we decided to adopt ARCNET again.

Table 1 shows the hardware specifications of the new PSICM together with the original one.

Table 1: Hardware Specifications

	Original PSICM	**New PSICM**
Microprocessor	AM186	MPC8306
Clock frequency	20MHz	133MHz
Data memory	256kB SRAM	128MB DDR2 SDRAM
Program memory	256kB EPROM	64MBit NOR FLASH
ARCNET interface	2.5Mbps Backplane mode	2.5/5/10Mbps Backplane mode
Controlle	COM2002	COM20022
Media driver	HYC2485	HYC5000
Power required	5V 0.4A	5V 1A

COMPATIBILITY AND NEW FEATURE

Compatibility for the power supply

The specifications of the interface to the power supply are fully backward compatible to the original PSICM. The new PSICM can be plugged into any existing power supplies.

Compatibility for the control software on IOC

The application-level communication protocol between the IOC and the new PSICM is backward compatible to the original PSICM. All of the command messages defined for the original PSICM can be accepted also by the new PSICM. In addition some extensions are introduced because of the additional features described below.

Additional features of the new PSICM

Following are major changes.

(1) The high speed ARCNET communication is supported. 10Mbps, 5Mbps and 2.5Mbps are supported for the new PSICM while the original PSICM supports 2.5Mbps only.

(2) 32-bit data handling of the tracking data array is available in order to support high resolution DAC (24-bit, 20-bit and 18-bit). The original PSICM supports 16-bit DAC only. (Later special version for 18-bit DAC was developed based on the original PSICM. But this version was ad hoc and limited.)

(3) Dual trigger inputs for synchronous start signals are available. This feature enables trigger signals redundant. More reliable synchronous operation is expected.

(4) More reliable RJ-45 connectors which have optional protectors against dust are adopted.

STATUS OF THE NEW PSICM

Now we have finished the test of prototype modules of the new PSICM. Fig. 5 shows the prototype #2, which is almost final version.

Figure 5: Prototype of the new PSICM.

For mass production we are planning to produce 3000 modules. First mass production of 1000 modules is in progress. It is scheduled to be completed in March 2014.

UPGRADE OF THE RELATED HARDWARE

We have also upgraded the related hardware. One is the VME board of the 4-channel ARCNET interface. It can accept dual synchronous start signals and deliver them together with the ARCNET. It also supports the high speed ARCNET communication (10Mbps, 5Mbps and 2.5Mbps). Another development is the upgraded ARCNET hub, which also supports the high speed communication and the dual synchronous start signals. Mass production of them has been already completed. Fig. 6 shows these products.

a) b)

Figure 6: a) 4-ch. ARCNET interface board (VME module) of original version (left) and new version (right); b) ARCNET hub of new version mounted on the top of the test bench.

CONCLUSION

We have developed the new PSICM for SuperKEKB. It is backward compatible to the original PSICM. Several enhancements are introduced. The high speed ARCNET communication is expected to enable more efficient operation of the magnet power supplies. Wide variety of the high resolution DAC can be supported by 32-bit data handling. Dual trigger input for the synchronous start signals, together with the dust protectors of the RJ-45 connectors, is expected to enable more reliable and stable operation of nearly 3000 magnet power supplies.

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