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.

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.

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.

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

<table>
<thead>
<tr>
<th></th>
<th>Original PSICM</th>
<th>New PSICM</th>
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<tbody>
<tr>
<td>Microprocessor</td>
<td>AM186</td>
<td>MPC8306</td>
</tr>
<tr>
<td>Clock frequency</td>
<td>20MHz</td>
<td>133MHz</td>
</tr>
<tr>
<td>Data memory</td>
<td>256kB SRAM</td>
<td>128MB DDR2 SDRAM</td>
</tr>
<tr>
<td>Program memory</td>
<td>256kB EPROM</td>
<td>64MBit NOR FLASH</td>
</tr>
<tr>
<td>ARCNET interface</td>
<td>2.5Mbps Backplane mode</td>
<td>2.5/5/10Mbps Backplane mode</td>
</tr>
<tr>
<td>Controller</td>
<td>COM2002</td>
<td>COM20022</td>
</tr>
<tr>
<td>Media driver</td>
<td>HYC2485</td>
<td>HYC5000</td>
</tr>
<tr>
<td>Power required</td>
<td>5V 0.4A</td>
<td>5V 1A</td>
</tr>
</tbody>
</table>
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.

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.

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.

REFERENCES

