Reconfigurable Embedded Interface System for High Energy Accelerators

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Abstract- A reconfigurable embedded interface system has been developed using micro-controllers for high energy accelerators. The system has up to 28 digital I/Os and 8-channel AD converters(10 bits), interrupt functions allowing control systems to access any accelerator components over the network. The interface is programmed to carry out specific tasks in accordance with requirements for experiments and research purpose. The interface is easily reconfigured using its bootloader by uploading a new program from the remote distributed control system through the network. It can, thus, reduce cost of reconfiguring procedures that would have otherwise caused costly implementation.

1. INTRODUCTION

- High energy accelerators comprise a large number of components and sensors such as digital and analogue I/Os[1].
- These components are controlled by a control system, composed of client/server computers connected to the network.
- An intelligent embedded interface is necessary to interconnect between the server and accelerator components.
- The interface has to be reconfigurable so that it can upgrade its control software in accordance with requirement of physics experiments and when the accelerator components has to be improved to achieve better performance of the accelerator.
- A reconfigurable embedded interface system for high energy accelerators has been developed using micro-controllers for high energy accelerators. It can reduce cost of reconfiguring procedures that would have otherwise caused costly implementation.

2. CONFIGURATION

2.1 Overview

- The reconfigurable embedded interface system is designed and implemented using embedded micro-controller, PIC 16F87* series.
- The hardware configuration of the interface system is kept as simple as possible to reduce cost.It has been designed and implemented using embedded micro-controller, PIC 16F87* series and additional circuitry such as analogue buffers, level-shifters and digital interfaces.
- A commercially available network interface, X-Port, is employed to interconnect between the network and the serial ports of the micro-controller[2].
- The software of the interface is composed of two pieces of program :
    - → control program for interfacing/controlling the accelerator components,
    - → bootloader program, resides at the bottom of the EPROM area.
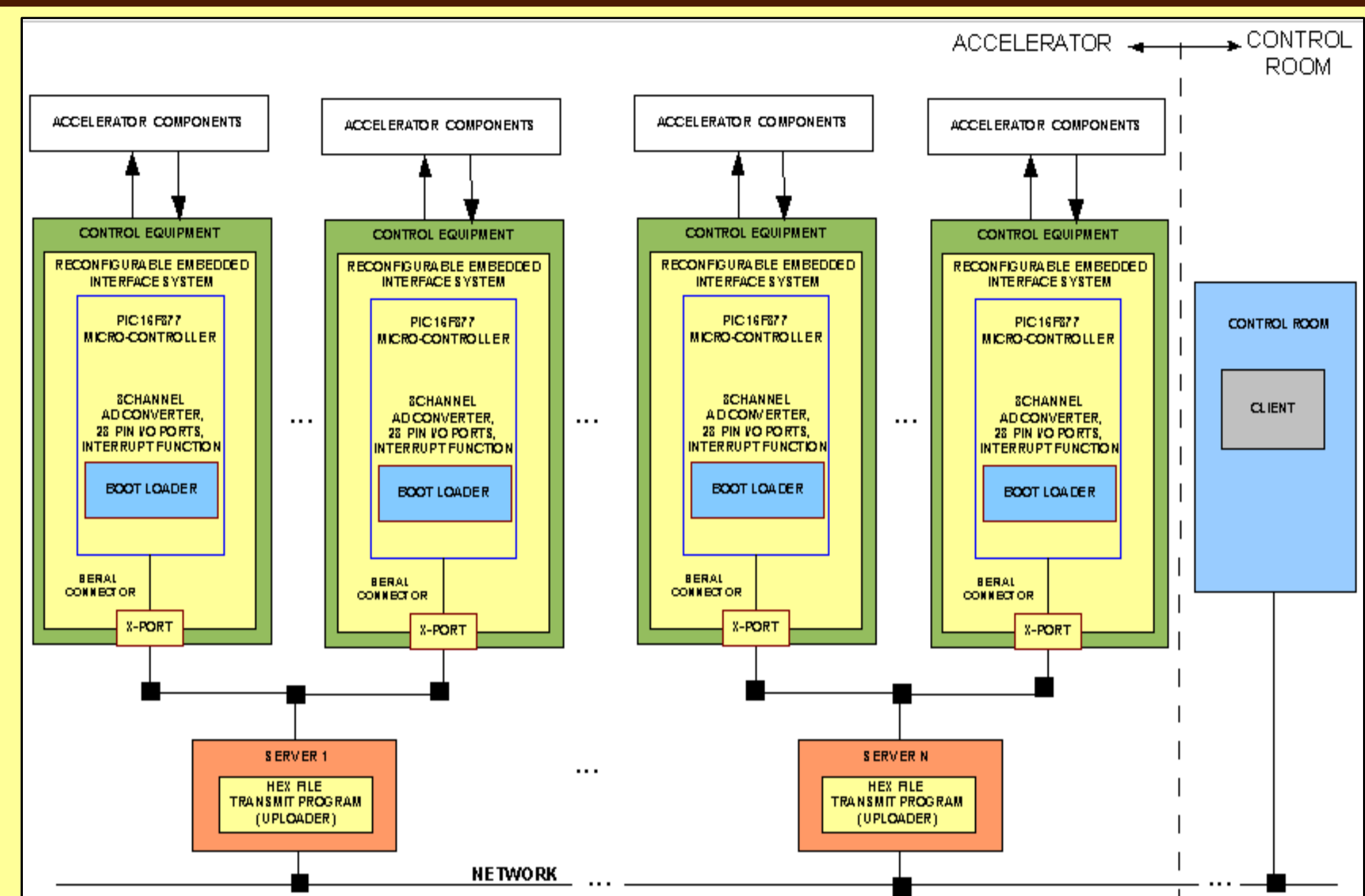

Fig.1 Block Diagram of the Reconfigurable Embedded Interface System
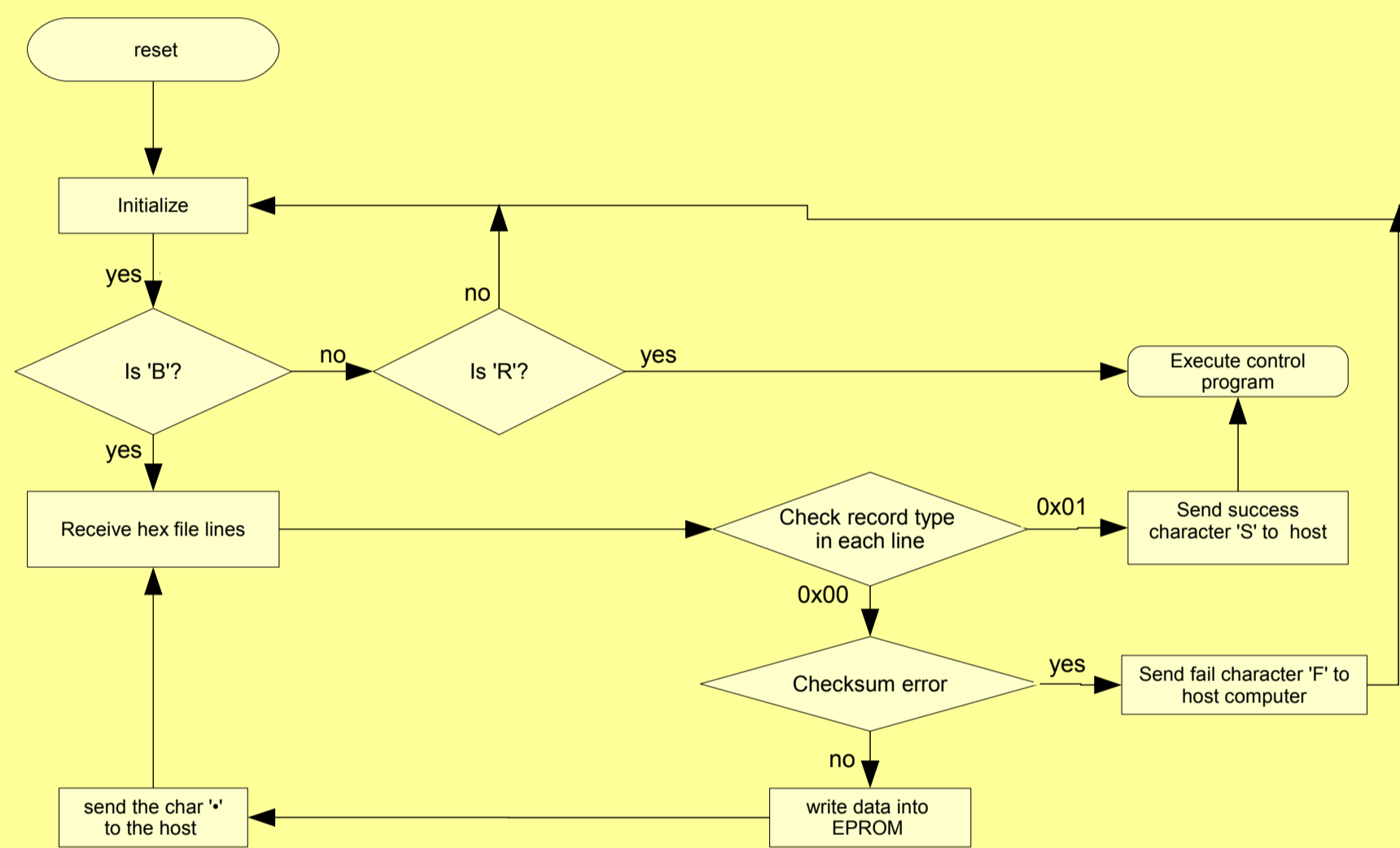
2.2 PIC Micro-controller Bootloader

Fig.2 Flowchart of the Bootloader

- Upon reset, the embedded interface system waits for a simple command from the Uploader running at a host computer until timeout occurs typically 3 seconds.
- The REIS passes control to the existing program when the timeout occurs and there is no command sent from the host.
- Upon receiving the character 'B' followed by ':' in consecutive text lines, the interface system verifies the contents whether there is an error in it by comparing the checksum and syntax of the format. This is carried out by line by line. Finally, it overwrites the existing control program in the EPROM area if there is no error in the lines. In response to each success line, REIS sends '.' to ask for a next line.
- In completion of the transfer, it replies 'S' implying that the transfer is success otherwise 'F' to let the host know the failure status during the upgrading process. The failure status 'F" is also sent if there is any communication error between the host and the embedded interface system.
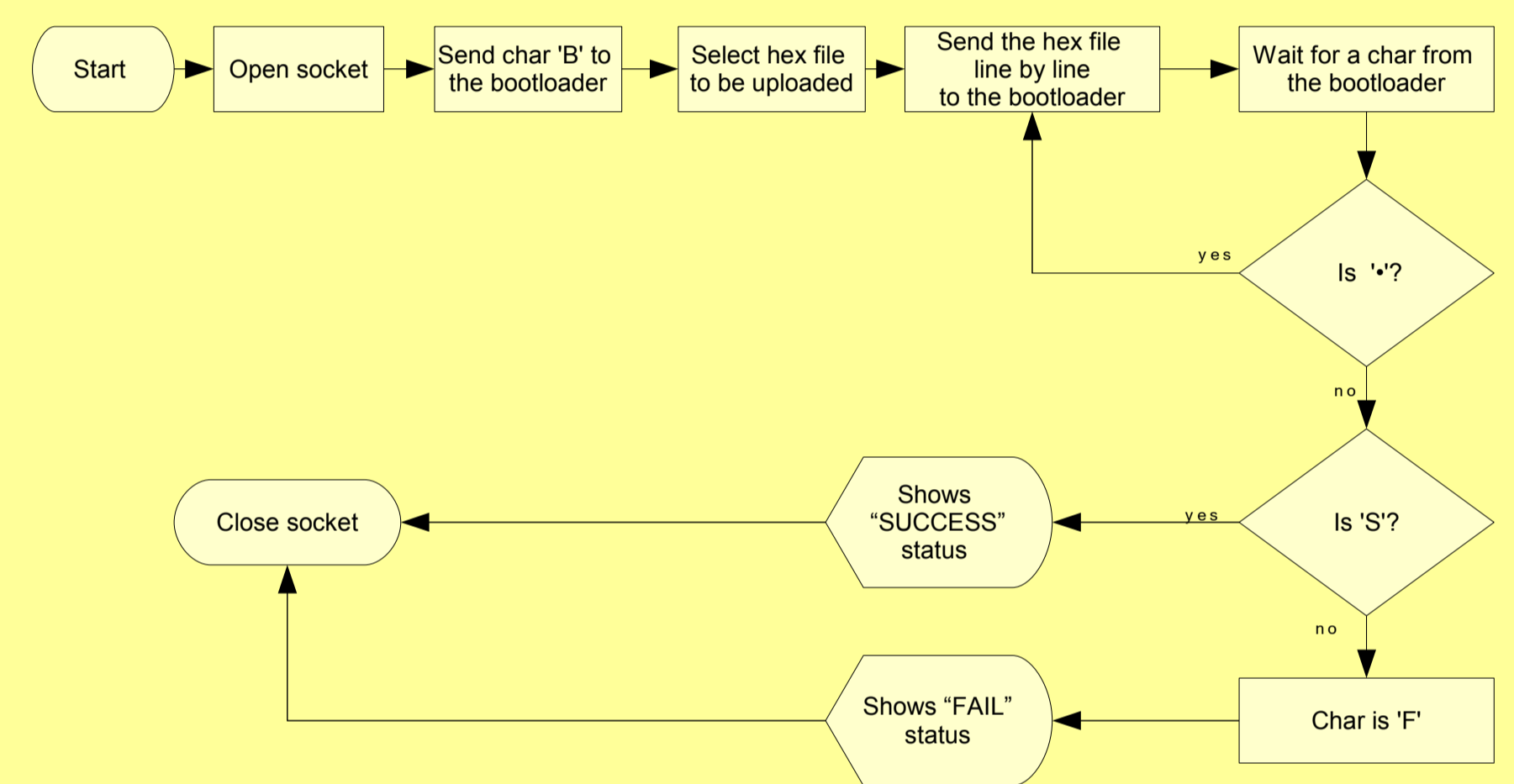
2.3 Hex File Transmit Program(Uploader)

Fig.3 Flowchart of the Uploader

- An uploading program, or 'Uploder' which can transfer the program in the Intel format from the host to the interface system has been developed in Java.
- Using the Uploder, the control program in the embedded interface system can be upgraded by uploading a revised program from a host computer, or the server of the control system, connected to the network.
- The Uploader of the host computer send the 'B' character followed by the new program line by line.
- The Uploader suspends the procedure when it receives 'F' and then resumes from the beginning.
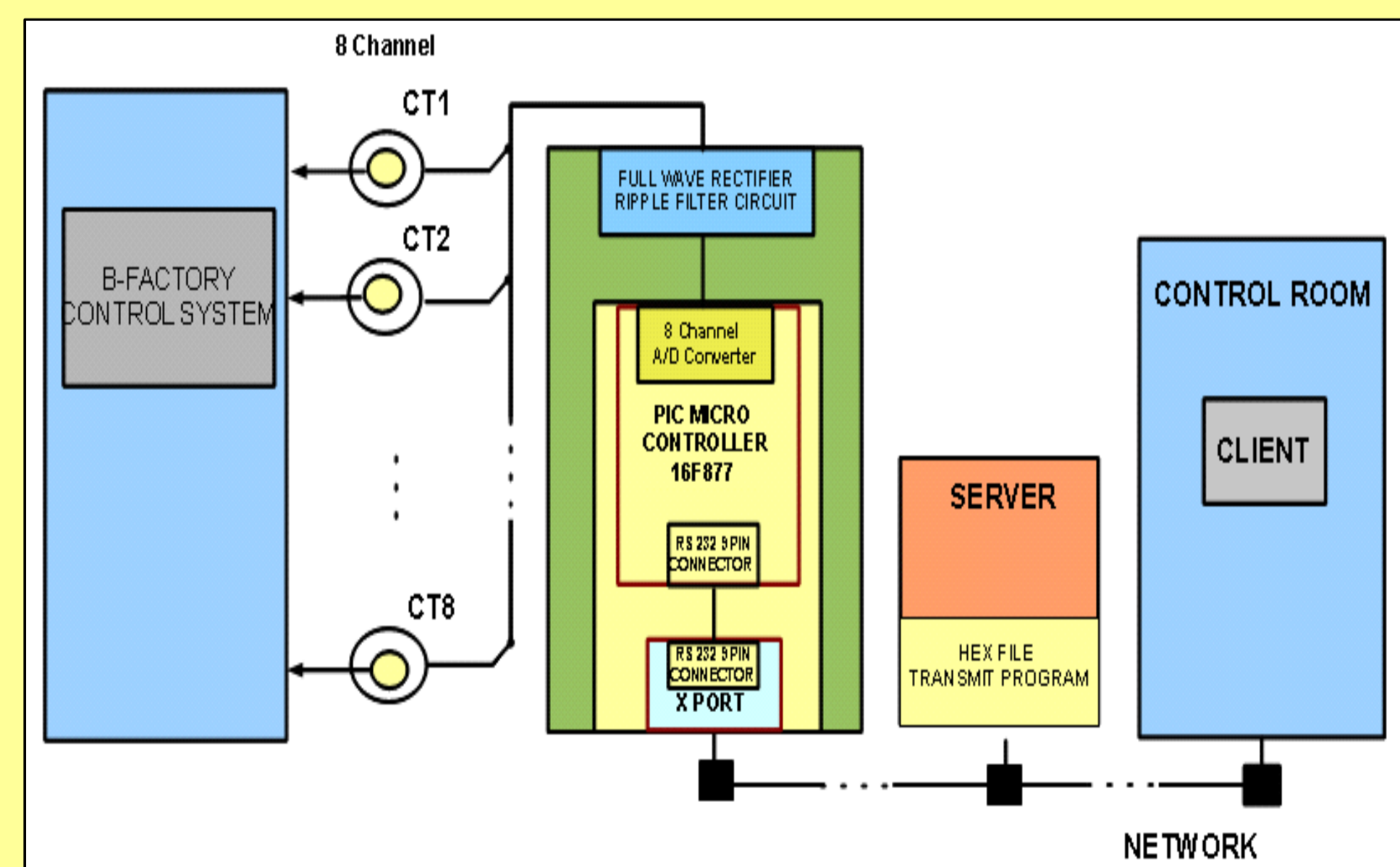
3. APPLICATION

- The reconfigurable embedded interface system has been applied to a prototype for the monitoring system of power consumption rate at the B-Factory control system at KEK[4].
- The monitoring system consists of clients/ servers that fetches AC current data from embedded interface systems connected to a number of sensors, i.e., the current transformers(CT).
- The CTs are clumped across the AC power lines. Each interface system has eight CTs with different I-V characteristics in terms of sensitivity, offset, and magnetic saturation characteristics caused by ferrite-cores.
- The characteristic transfer function of the CT have been measured, and expressed with polynomial functions in terms of AC current passing through the CT and it output voltages. Then, the coefficients of the polynomial functions of the CT have been calibrated to achieve better accuracy.
- The interface system is measuring the output voltages of the eight CTs at an interval of 50ms.
- On receiving an inquiry from a server, the interface system converts the latest output voltages of the CT, and then calculate/convert them into actual AC currents corresponding to the power consumption rate.
- Finally it replies the power consumption rate to the server.
- After receiving the power consumption data, the clients depict the present status of the power consumption rate onto the graphic displays.

Fig.4 The Monitoring System using the Reconfigurable Embedded Interface System

4.CONCLUSION

The reconfigurable embedded interface system has been designed and implemented for high energy accelerators. The system has successfully tested at KEK's B-Photon Factory. Experimental results at the B-Factory, KEK, show that the embedded interface system allows client/server computers to access accelerator components over the network. Furthermore, it is capable of being upgraded through the network, providing rich flexibility at a low cost.

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