EMBEDDED PC BASED CONTROLLER FOR USE IN VME BUS BASED DATA ACQUISITION SYSTEM

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Abstract

An embedded PC based Controller module, named System Controller Module (SCM), has been developed at Reactor Control Division (RCnD), BARC. This module uses standard PC-104 bus based CPU module integrated with a protocol translator card to provide an interface between the CPU module and VME bus. The signal interface between PC-104 bus of CPU module and translator card is achieved through stackable connectors. SCM can be interfaced with 16- bit slave I/O modules on VME bus for Data Acquisition and Control. This development provides low cost PC based platform for developing I/O intensive embedded system requiring high processing power. SCM module is fully compatible with PC architecture and is available in Double Euro modular form factor. Module has self diagnostics features to test software integrity using onboard watchdog timer. The module provides dual Ethernet link for communication. The SCM has been assembled, integrated and successfully tested along with VME based high speed data acquisition system (Machinery Protection System), which has been developed in RCnD for condition monitoring of rotating machines. SCM acts as a configuration controller and data manager for this system.

INTRODUCTION

There are many different industrial buses and technologies used for different applications. VME is one of the popular 16/32/64 bit backplane bus [1] which has been used in many applications like control, aerospace, military etc. Embedded systems utilizing PC-104 bus based modules are also widely used in many data acquisition applications because of its features like small structure size, self-stacking, PC platform, high quality and low cost. Using these two widely used technologies, System Controller Module has been developed, which uses PC-104 bus based CPU module along with VME interface with standard VME based I/O modules for data acquisition and control. The VME interface is achieved by using a Protocol Translator Card, also known as Protocol Interface Card, which provides protocol interconnection between PC-104 bus signals and VME bus signals. The SCM has been designed, assembled, and successfully tested along with a VME based data acquisition system (Machinery Protection System).

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VME BUS STRUCTURE AND CHARACTERISTICS

VME bus is one of the most popular standard bus because of its mechanical and electrical robustness. A large number of commercial products are available for this open standard. A product designed using the VME bus standard can be easily interfaced with off the shelf standard products. The VME bus standard specifies a high-performance backplane bus. The VME bus supports 8-, 16-, 32-or 64 bit data transfers over a non-multiplexed data and address highway. The transfer protocols are asynchronous and fully handshaken. The mechanical specifications of boards, backplanes, subracks, and enclosures are based on IEC 297 specification, also known as the Eurocard form factor [1].

The mechanical structure of a VME bus system consists of a backplane on which system bus resides. The backplane has 21 slots where CPU boards, memory boards or I/O boards connect to the system bus.

PC-104 BUS BASED MODULES

PC architectures are popular in both general purpose and dedicated (embedded) applications [2]. But because of the large form factor of PC motherboards and I/O cards, its application in embedded systems is limited. The embedded PC-104 bus uses the PC card specification but changes the form factor. The specification defines a new mechanical foot print and card power requirements. The PC-104 bus is an adaptation of the ISA bus for embedded computing use. It uses the same signals as ISA, but uses a smaller connector and cards that are stackable, which eliminates the need for a backplane. Use of PC-104 bus-based CPU modules in embedded systems provides PC hardware and software platform and ensures upgradability and protects against chip obsolescence [3]. PC-104 bus supports 8- and 16-bit data transfers.

The PC-104 bus based CPU module used in System Controller Module consists of 300 MHz Geode processor and 256 MB of SDRAM system memory. It provides 10/100 Mbps dual Ethernet port which can be used for high speed data communication. It also provides standard interface for I/O devices like USB, CRT, TFT, Mouse and Keyboard. It implements a Watch dog timer for software and hardware integrity. PC-104 module provides PC-104 expansion interface which is utilized for development of a Protocol Interface Card to facilitate VME interface.

DESIGN OF INTERFACE

The PC-104 bus based CPU module along with the Protocol Interface Card forms the System Controller

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Module (SCM) as shown in Figure 1. The Protocol Interface card provides interfacing between PC-104 bus and VME bus. The interconnection between the CPU module and Protocol Interface Card is through stackable connector. The Protocol Interface Card has Eurocard formfacor. Figure 2 shows the block diagram of the SCM. SCM acts as a master module and can control slave I/O modules on the VME bus. The Protocol Interface card utilizes a CPLD which translates signals from one bus type to the other. VHDL language is used for the implementation of CPLD logic. The Algorithm implemented in CPLD for data transfer between the PC-104 card and VME slave module is as follows:

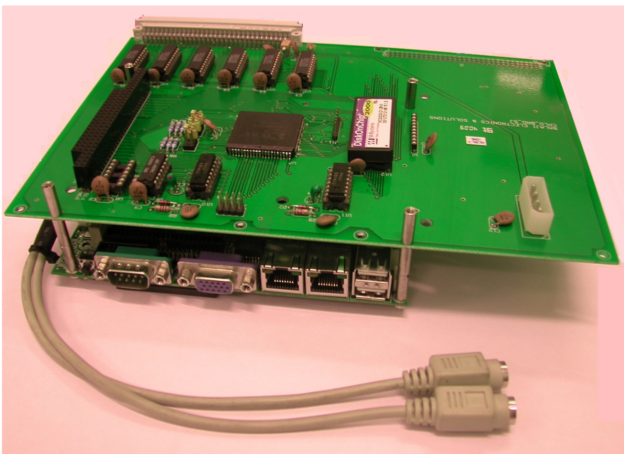

Figure 1: System Controller Module.

- Assert *address strobe* on VME bus on valid address of PC-104 bus.
- Wait for *write signal* from the PC-104 and assert *data strobes* and *write signal* on VME bus and de-assert *ready signal* on PC-104 bus on reception of write *signal* on PC-104 bus.
- Wait for *acknowledgement* on VME bus from I/O slave and assert *ready signal* on PC-104 bus after reception of *acknowledgement*.
- Wait for *write signal* to de-assert on PC-104 bus and then de-assert *data strobes*, *write signal* on VME bus.
- De-assert *address strobe* on VME bus after de-assertion of *acknowledgement*.

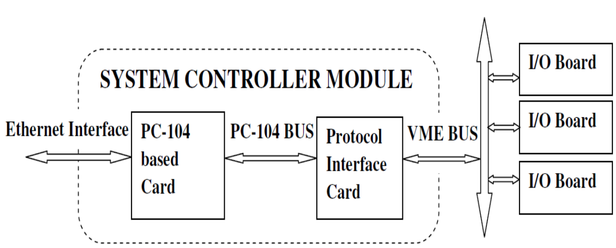

Figure 2: Block Diagram of System Controller Module.

EXPERIMENTS AND RESULTS

SCM has been tested and validated on two experimental setups. In the first experimental setup, the SCM is validated by integrating and testing it with standard VME bus based Analog Input Board (AIB). VME based AIB is a high performance analog I/O board designed for safety applications. Application software for SCM has been developed on Borland C. In this setup, one AI board and SCM sit on the VME back plane. A reference analog input is connected to the AI board. The SCM configures the AI board and periodically reads the analog input data. Reception of correct data validates the VME interface of the SCM. Figure 3 shows the timing diagram of the VME and PC-104 signals taken through oscilloscope for one cycle of data transfer. Diagram shows valid signal generation on the VME and PC-104 bus.

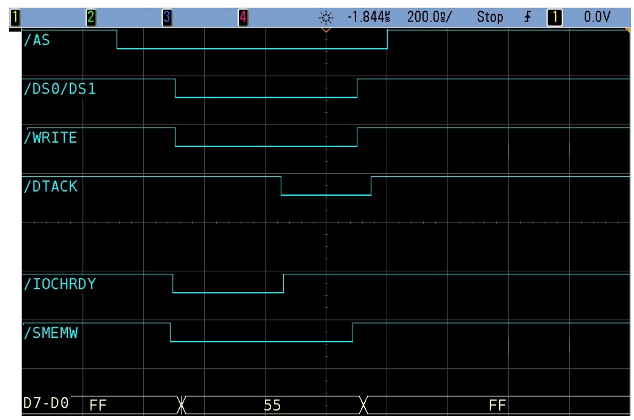

Figure 3: Timing diagram of VME and PC-104 Signals.

In the second setup the SCM has been assembled, integrated and successfully tested along with VME based high speed data acquisition system known as Machinery Protection System (MPS) [4]. This system has been developed in RCnD for condition monitoring of rotating machines. SCM acts as a configuration controller and data manager for this system. In this setup, processing module of MPS known as Machinery Protection Module (MPM), having VME interface, is mounted on the VME back plane along with SCM. MPM acts on the configuration data received from the user through Engineering Console. In this setup SCM provides configuration data to the MPM through VME interface. SCM receives configuration parameters from the Engineering Console through Ethernet communication. Reliable Ethernet communication between SCM and Engineering Console is achieved via TCP/IP over Ethernet. Open source TCP/IP stack is used to facilitate TCP/IP communication. In this experiment SCM is able to configure the system and the required data transfer rate of 2Mbytes/second is achieved.

CONCLUSION

This paper has presented an embedded PC based Controller module which provides interface between the

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CPU module and VME bus. The design provides a low cost PC based processing platform for VME bus based I/O boards.

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