

A NEW EMBEDDED CONTROLLER FOR DATA ACQUISITION AND CONTROL APPLICATIONS

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Abstract

Developing high performance data acquisition and control systems takes better tools than the industry normally provides. As the most common controllers, PLCs can be still weak in many applications, and especially they are not good choice for data acquisition due to their limited capability of computation, speed, memory and programming constraints. The fact that today's PCs have many advantages compared with their relatively low price made them very popular in industrial environments. In this project a PC based controller was designed for data acquisition and control purposes. Although such similar systems exist, this product with some advantages could be a good alternative to the existing ones.

Keywords

Data Acquisition, Embedded Computer, PC/104 Standard, Digital I/O, Analog Input, Analog to Digital Conversion, Real-Time.

1. Introduction

A PC controller should consist of basically a PC mainboard, digital and analog input/output boards, a power supply unit, an enclosure and suitable software for a harmonious working of all these parts. This project deals with designing the digital and analog I/O boards, the enclosure and developing the software. Analog input and power supply board and digital I/O board were designed in accordance with the PC104 standard which is the format of the PC mainboard. Then an executive running on DOS and providing a real time multitasking environment was developed.

Features:

- AMD5x86 133 MHz
- Power Supply:24 V Unregulated
- VGA, KB, RS232 Connections
- 2Mb Flash Disk, 4Mb DRAM
- 24 opto-isolated Digital Input
- 24 Relay Output (C.R. 250v, 6A)
- 16 Single-Ended or 8 differential Analog Input
- 250x170x75 mm enclosure, Panel Mounting



Figure 1: The Embedded Controller

2. What is an Embedded PC ?

An embedded PC is a digital system which is acting as part of a larger system. The term *embedded* means being part of a larger system and providing a dedicated service to that unit. A PC which provides a dedicated software and some graphics and communication interfaces can be an embedded control system in a production line of a factory. Embedded systems and their applications are highly common in industrial environments. The embedded PC can be very different from a desktop PC. It can be hidden from user, it might not have user interface, a display or keyboard, or it might have a different user dialog unit. They have the distinct advantage of using a PC platform. This provides user with PC development tools and desktop PC's all advantages.

3. What is PC104 Standard?

Due to some difficulties in using desktop PCs, companies which design PCs as controllers began to seek a new product that reaps the benefits of using the PC architecture. However, the standard PC bus form-factor (12.4" x 4.8") and its associated card cages and backplanes are too bulky (and expensive) for most embedded control applications. A need therefore arose for a more compact implementation of the PC bus, satisfying the reduced space and power constraints of embedded control applications. PC/104 was developed in response to this need. It offers full architecture, hardware and software compatibility with the PC bus, but in ultra-compact (3.6" x 3.8") stackable modules. PC/104 is therefore ideally suited to the unique requirements of embedded control applications.

4. The Description of the PC Controller Developed in this Project

This embedded system had to be small in size so that it might be practical. Therefore a PC mainboard in PC/104 format has been chosen. The chosen mainboard has a AMD 5x86 133 MHz processor, 4 MB dram, 2 MB flash disk, SVGA display driver, two RS232C ports, a parallel port and an ISA bus connector. The digital and analog boards are connected to the PC through the ISA bus connector. When we open the enclosure, physically three layers appear. The first layer is the analog input board which also includes the power supply unit, the second layer is PC104 main board which can be regarded as the brain of the system, and the third is the digital I/O board with all opto-isolators and relay modules. All of them are connected to eachother through the 64 pin ISA bus connector so that the PC may control the other two boards. The controller also has connectors for user to reach the analog and digital I/Os. Some standard connectors like serial I/Os, keyboard and VGA connectors, and power supply input are also available on the enclosure.

4.1. The Digital I/O Board

The digital I/O board consists of 24 relays for output and 24 opto-isolated inputs. With relays, the board gives the user actually computer-controlled switches. Relays also provide isolation up to 2500 volts between the computer and the real world. The digital inputs are optically isolated with the opto-couplers. This again provides a protection up to 2500 volts. Like the outputs, the digital inputs can be at two states. In order for the computer to perceive "1" state, the input must be nominally within the range from 20 to 48 volts, and for "0" state, it must be from 0 to 8 volts.

4.2. The Analog Input Board

This board converts analog signals to digital world so that we can measure many quantities such as temperature, pressure, flow, displacement, etc. The analog input board provides with 16 analog inputs each of which has 12-bit resolution and input range from -10 to +10 volts. Inputs are all single-ended. However it is possible to make differential measurements using two consequent single-ended inputs. A vital specification of the board is the maximum sampling rate and it is 1,000 samples per second for each channel. This sampling rate may meet almost all applications in industry.

4.3. Software

Embedded systems generally perform time critical processes. The correctness of the system depends not only on the result of computations but also on the time at which it is produced. Such systems are called “real-time”. The mainboard used in this project has AMD 5x86 133 MHz which is quite sufficient for these purposes. It has also a two Megs FlashDisk. For many applications, this amount of disk is sufficient for preserving an operating system, application programs and data altogether. The last step of this project was to develop an executive running on DOS which will provide user with a real-time multitasking environment. This executive schedules and performs many tasks concurrently and runs in real-time without losing data.

5. Conclusion

This embedded system has a large application area including data acquisition, control and also it has the capability of doing very complicated tasks such as *fast fourier transform, pid control, high speed data processing, digital filtering and linearization of devices*. It may be used in production lines, in product test machines or even in the products like industrial laundry machines. In brief, the high-end specifications of this system make it ideal for wide range of applications requiring 12-bit data acquisition and basic on-off control operations at low cost. Figure 2 gives an idea about the usage of this controller.

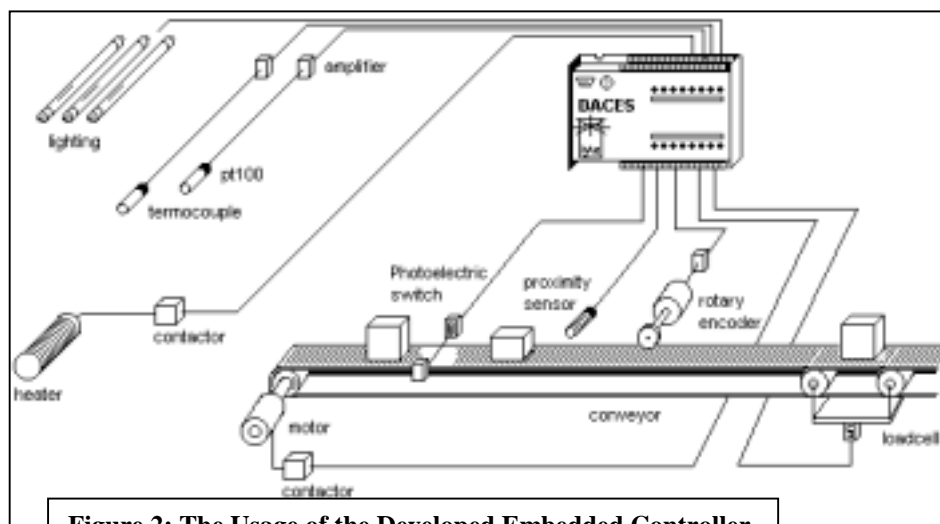


Figure 2: The Usage of the Developed Embedded Controller