Research and Development of a Novel DeviceNet-Oriented Interface System for IC Equipment

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Abstract. At present, the interface system in IC equipment control software system has to be changed even when a small hardware change occurs, which increases the time and cost of system debugging. This is one of the technical problems needed to be solved in course of development of IC equipment control system software. Therefore, the characteristics of the semiconductor device in IC equipment which used the DeviceNet has been analyzed in this paper. Then one DeviceNet-Oriented interface system, which is capable of shielding the difference of the details of the hardware, has been designed and developed.

Introduction

[1] At present, the investment of domestic semiconductor factory has been directed to wafers with a diameter of 12 inches. The wafer production procedures are getting more and more complicated day by day. DeviceNet protocol is a simple, cheap and efficient protocol which has been widely used in IC equipment. The semiconductor device, include light barrier and Vacuum pump and so on, can be connected via DeviceNet bus. While many kinds of production device may be purchased from different equipment manufacturers, which brings difficulty to wafer processing and production management.

Usually, the application layer software directly call the driver software in the IC equipment control software system. If the device object has changed that will lead to the changes of interface of driver software and the interface of software in application layer will changed in according with it.

Therefore, small hardware changes will lead to software changes, thus increasing the time of system debugging and the cost of manpower. That is one of the technical problems needs to be solved in IC equipment control system software.

Application of DeviceNet Bus Technology in Semiconductor Devices

DeviceNet is developed by Rockwell company in 1994, and it is a kind of opened and device level fieldbus technology which is based on CAN-bus[IEC15011898][2]. The DeviceNet technology has the characteristics of opened, efficient, low-cost, strong anti-interference ability, high accuracy of measurement and control[3]. It is particularly suitable for semiconductor devices. Fast speed and high precision of information transmission are required for the control system of IC equipment.

DeviceNet is the industry standard network which is based on fieldbus technology, it provides the connection between industrial device and high-level device such as computer, PLC and other devices. DeviceNet is also a kind of low-cost communications connection, which can make connection among IO module, MFC mass flowmeter, valve, slide, thermostat, RF, throttle valve in the semiconductor equipment. DeviceNet is widely used in IC equipment.

Design and Realization of Devicenet-Oriented Interface System

[4] This paper introduces the research on DeviceNet protocol and characteristics of the semiconductor device in IC equipment. And then designs and develops one DeviceNet-Oriented interface system which is capable of shielding the difference of the details of the hardware. The
interface system can be connected to the device object which is convenient for application layer unit to access the semiconductor device in IC equipment control system, and for system debugging and maintenance.

Figure 1 shows that the DeviceNet-oriented interface system lies on between the functional unit module and application layer. It provides a standard interface which is capable of shielding the difference of the details of the hardware to the application layer unit[5][6].

![Diagram of DeviceNet-oriented interface system]

Figure 1 Location of DeviceNet-oriented interface system  
(CTC: Cluster Tool Controller, PMC: Process Module Controller, TMC: Process Module Controller)

The interface system is divided into two layers, IOServer layer and ADMP layer. IOServer layer is responsible for providing service to the application layer software. ADMP (Address Mapping) layer is responsible for mapping address for the functional unit, it is used for the configuration management for physical address of device object and maps the physical address to the memory address space, this is showed in figure 2.

![Diagram of the interface system structure]

Figure 2 Structure of the interface system

IOServer layer includes DeviceNet card initialization interface, Digital input and output interface, Analog input and output interface, as follow:

- DeviceNet card initialization interface is needed for application layer software before it access to the semiconductor device in IC equipment control system to complete connection between host and DeviceNet device.
• Digital input and output interface realizes the read and write operations of digital data from application layer software to DeviceNet device according to the request of application layer software.

• Analog input and output interface realizes the read and write operations of analog data from application layer software to DeviceNet device according to the request of application layer software.

In digital input and output interface, message type flag and offset is added in parameter design. It can make read address and write address unified. The program flow chart of input interface is showed in figure 3.

![Diagram](image)

**Figure 3** The program flow chart of input interface

In analog input and output interface, message type flag and range switching is added in parameter design. The program flow chart of input interface is showed in figure 4.
The interface system has the characteristics as follow:

- The interface system provides a DeviceNet-oriented standard interface which is capable of shielding the difference of the details of the hardware to the application layer software in IC equipment control system. It connects the application software to the functional software which is convenient for system debugging, maintenance and transplantation.
The interface system provides an address mapping function, it is used for the configuration management for physical address of device object and maps the physical address to the memory address space.

In digital input and output interface, message type flag and offset is added in parameter design. It can make read address and write address unified, it also realizes two ways that scan message and explicit message to access the digital data of DeviceNet device by one interface, and unifies the read address and write address of DeviceNet device by offset.

In analog input and output interface message type flag and range switching is added in parameter design. It realizes two ways that scan message and explicit message to access the analog data of DeviceNet device by one interface, and meets the demand of reading the actual data from DeviceNet device by range switching function.

Summaries

By adopting the above technical scheme that adding a software interface between functional software and application layer software, a standard interface is provided to application layer software which is capable of shielding the difference of the details of the hardware. That provides a constant interface to application layer software while hardware changed. It makes software system structure more clear and is convenient for system debugging, maintenance and transplantation. The DeviceNet-oriented interface system lies between application layer software and functional software in IC equipment control system. It reflects the superiority of the interface system solution in larger and modulized IC equipment control system.

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