

# Design of motion control card for driverless vehicle based on CPCI bus

Wang Lin

Wuhan Institute of Shipbuilding Technology, Wuhan, Hubei, China

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**Abstract:** According to the high reliability requirements of motion control system and the unique advantages of CPCI bus technology, a motion control card with hot plug function is developed. The advanced technology used in the card ensures the high-speed and reliable transmission of the system, and makes the system have hot plug function, which is more convenient in use and maintenance. The hardware part of the board includes CPCI bus interface, hot plug controller and motion control circuit. The driver is written by WinDriver. Motion control card has been applied in automobile driving robot system. The results show that the motion control card has stable performance and convenient operation, and has a wide application prospect.

## 1. Introduction

In recent years, with the increasing demand for system reliability, CPCI bus is widely used in industrial control with its unique advantages. Since CPCI bus supports hot plug, this way ensures that any board can be detected and repaired without affecting the operation of the system. In this way, the flexibility of motion control system based on CPCI bus is improved, and the demand for motion control card applied in the system will be greater and greater. Therefore, it is urgent to develop a motion control card with high performance and high reliability based on CPCI bus to meet the needs of the development of motion control system.

## 2. CPCI bus

Compact PCI, referred to as CPCI, is a bus interface standard proposed by the International Federation of industrial computer manufacturers (PICMG) in 1994. CPCI is a high-performance industrial bus based on PCI electrical specification. In terms of electrical, logic and software functions, CPCI is fully compatible with PCI, and the operating system, driver and application program can not feel the difference between the two, which can provide higher data transmission speed. CPCI has high openness, high reliability and hot swap, which makes this technology not only widely used in communication and network, but also suitable for real-time system control, industrial automation, real-time data acquisition, military system and other fields<sup>[1]</sup>. Compared with PCI, CPCI bus has the following advantages: (1) It has better mechanical characteristics. It enhances the maintainability and reliability of PCI system in telecommunication equipment or other harsh industrial environment; (2) Eurocard package is adopted, and the air flow in the system is uniform; (3) The power supply and signal leads of CompactPCI connector support hot plug specification, which is very important for fault-tolerant system and can not be realized by standard PCI; (4) The bus is easy to expand and can support up to 256 standard PCI bus devices at the same time; (5) The connector pins of CompactPCI backplane are divided into long pin, medium long pin and short pin. The long pin is some power pins, the shortest pin is bd-sel#, and other bus signals and some power signals are medium and long pins<sup>[2]</sup>.

## 3. Hardware design

### 3.1 CPCI bus interface

Due to the complexity of CPCI bus specification, in order to reduce the design difficulty and shorten the development time, the system adopts the special interface chip pci9030 of PLX

company to realize the bus interface of CPCI. Pci9030 is the first interface chip supporting hot switching in the industry, which provides an excellent solution for CPCI interface. It adopts smarttarget technology, which can ensure high-performance hot exchange implementation function, support picmg2.1 target equipment with hot exchange function, and comply with the 32-bit 33 MHz target interface function specified in pciv 2.2 specification. It can obtain PCI burst transmission speed of up to 132 MB / s and local bus operation speed of up to 60 MHz, It supports the mapping of 5 local address spaces to PCI bus address space (spaces 0, 1, 2, 3, 4 and 1 extended ROM), and the transmission waiting cycle and bus width are programmable. In addition, pci9030 contains pre charging BIOS, early power support, hot exchange control / status register (hs-csr) and additional pin resources. These resources and enum #, cpcisw and ledon # can be used to realize the software and hardware control with hot plug of motion control board. Since pci9030 fully complies with pciv2.2 specification, it is only necessary to interconnect the corresponding pins, which will not be repeated here<sup>[3]</sup>. However, it should be noted that the bus pin requiring precharge should be pulled up to the precharge voltage, PME #, RST #, enum #, inta # should be pulled up to the I / O working voltage VI / O of PCI, and RST # should be connected to the combined logic output of bus health # and PCI RST #.

### 3.2 Connection between E2PROM and pci9030

E2PROM is used to complete the initialization of pci9030 and plays an extremely important role in the whole system. The E2PROM of the system adopts nm93cs66l of national company. It is a 4KB low-power serial memory, which is used to store the configuration information of pci9030 and load it when the chip is reset, so that the motion control card has the function of plug and play. The schematic diagram of its connection with pci9030 is shown in Figure 1. The chip selection signal CS, serial clock signal SK, data input Di and data output signal d0 of nm93cs66l are respectively connected with the signals corresponding to pci9030; The protection register enable signal pre is grounded to enable the operation of the storage space and prohibit the operation of the protection register; The programming enable signal PE is connected to 3.3 V to allow the operation of the storage area.

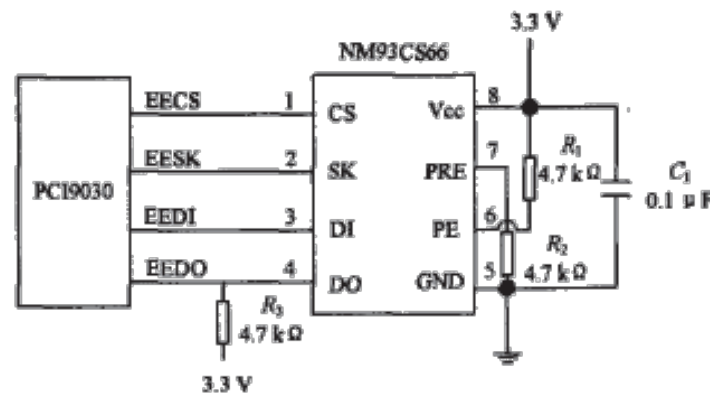


Figure 1 Schematic diagram of connection between nm93cs66l and pci9030

### 3.3 Connection between hot plug controller and CPCI bus

In order to make the board have no impact on the CPCI bus during hot plug and do not affect the data transmission on the CPCI bus, a good power switching control circuit is needed. Ltcl643al is selected here to realize this function. The schematic diagram of the connection between ltcl643al and CPCI bus is shown in Figure 2.

During power on, the 3.3 V and 5 V power supplies are controlled by n-channel path transistors, and the  $\pm 12$  V power supply is controlled by internal path transistors. Resistance R. And ruler. Provide current failure detection, R5 and C1 provide current compensation, and R3 and R4 are used to prevent high-frequency oscillation at Q1 and Q2. When the on # pin is pulled low, the path transistor is turned on and there will be 22  $\mu$  The current source of a is connected to the timer pin. With the gradual increase of the current through the path transistor, the supply voltage reaches the limit value. The power on rate of each power supply is determined by 62  $\mu$  Determined by a / C1.

When the voltage of timer pin is less than  $12 \text{ vin} - 0.9 \text{ V}$ , the current limit failure detection is ignored. Once the four supply voltages reach the normal range,  $\text{pwr}g\#$  will be pulled down. For CPCI data bus, the 1 V precharge voltage is generated by  $\text{ltll17}$ , its output voltage is set at 1.8 V, and the 1 V precharge voltage is generated after passing through diode 1N4148.

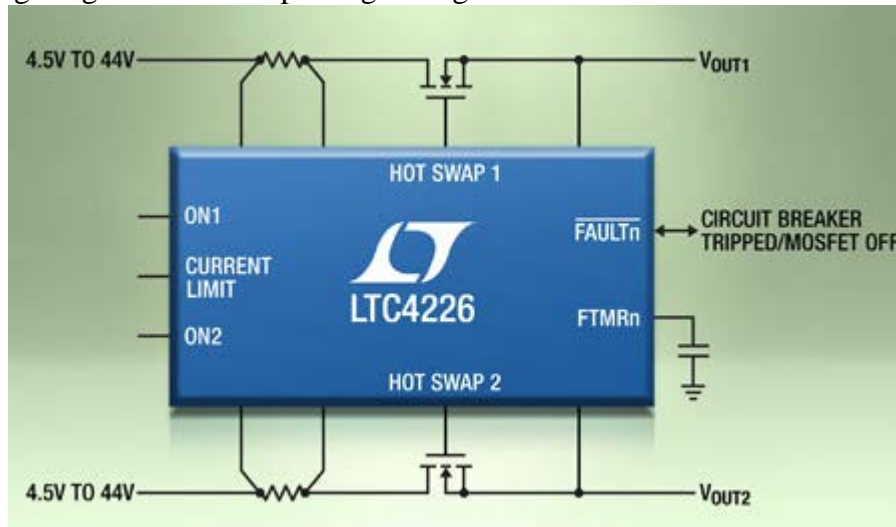


Figure 2 Hot plug controller

### 3.4 Connection between MCX314 and pci9030

MCX314 is a 4-axis motion special control integrated circuit launched by Nova company in Japan. It can be used for position, speed and interpolation control of stepping motor or pulse servo drive. It can be used in industrial automation equipment, industrial robots, measuring equipment, office equipment and household appliances. It can carry out independent positioning control and speed control of each axis (Z-axis, y-axis, Z-axis and  $\infty$  axis). It can also select any 2-axis among the 4-axis for circular interpolation and 2 or 3-axis for linear interpolation. The interpolation accuracy is  $\pm 0.5\text{lsb}$ . The default input clock is set high, and the test pin and external single step interpolation control pin are set high, that is, external single step interpolation of hardware is not allowed. It should be noted that if there is Z phase in the encoder, it is only necessary to connect the Z phase to any general input and read the encoder through software. 16 MHz, pulse output speed up to 4 MPPs. MCX314 also has the functions of servo motor feedback input (encoder signal, in place signal and alarm signal), an / deceleration drive, software and hardware limit, automatic origin search, synchronous action, input signal filtering and so on. MCX314 can be connected with 8-bit or 16 bit data bus. All its functions are realized by reading and writing internal command register, data register, status register and mode register. Each axis has a 32-bit logical position counter (counting the output drive pulse), an actual position counter (counting the external encoder) and a comparison register to realize the closed-loop control of the position. Each axis has 4 general inputs (which can be used for limit and origin signal input) and 4 or 8 general outputs (realized by software setting).

Pci9030 has programmable chip selection signal. Chip selection signal can be generated in a local address range by configuring chip selection base address register, which saves decoding circuit and makes application more convenient. By configuring the local address bus register, the data bus of pci9030 is configured as 16 bits. At this time,  $\text{lbe}\#$  is used as LAL. Since this design adopts the non multiplexing mode of address and data lines, the mode is grounded, and in order to ensure that all data of the data bus are available,  $\text{lbe}3\#$  and  $\text{lbe}0\#$  representing the valid high-8-bit data and the valid low-8-bit data are set low respectively<sup>[4]</sup>. In order to configure MCX314 as a 16 bit data bus, set  $\text{h16l8}$  high, and set the test pin and external single step interpolation control pin high, that is, external single step interpolation of hardware is not allowed. It should be noted that if there is Z phase in the encoder, it is only necessary to connect the Z phase to any general input and read the encoder through software.

#### **4. Driver programming**

After comparing similar driver development tools, it is decided to use wind driver to develop driver. This development tool can quickly develop drivers without being familiar with the kernel knowledge of the operating system, which is very convenient for developers. In the development process, use the driver framework code generated by the wizard, and then slightly modify it on this basis to debug the code in user mode. The specific process is as follows: in the driver wizard interface, select your own device and generate installation information, click next to debug I / O, memory and other resources, complete the configuration of working registers, and then generate corresponding codes. Finally, add your own required codes to the driver to complete the writing of the driver.

#### **5. Conclusion**

In order to meet the real-time and reliability requirements of motion control of automotive driverless robot system, a motion control card based on CPCI bus is developed, and the detailed process of driver design in VxWorks environment is given. The test results show that the motion control card and its driver work normally and reliably, which can better meet the requirements of motion control for automobile driverless robot, and has a wide application prospect. The motion control card has been applied in the control system of automobile driving robot. The application results show that the motion control card has stable performance, rich interfaces and convenient application. It can easily complete the real-time and effective motion control of four axes through the operation of registers, and has a good application prospect.

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