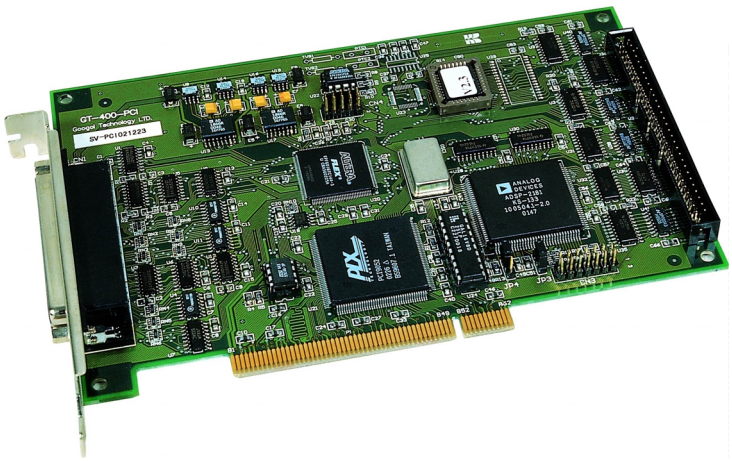
GOOGOL TECHNOLOGY (HK) LTD

User's Guide

For

GT Series Motion Controller



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Foreword

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Use of This User's Guide

This guide helps the user to understand the basic architecture of GT series of motion controllers, and to learn how to install the motion controller, wire the controller with the motor control system and conduct the basic debugging of the motion control system.

Users

This guide is suitable to those engineering personnel who are having the basic knowledge of hardware and good understanding of motion control.

Main Topics

This guide consists of three chapters and some appendixes.

Chapter One "Overview" introduces GT series of motion controllers and how to implement the motor control system. Chapter Two "Quick Start" explains how to install the controller card, configure components and install the driver program. Chapter Three "Test and Tune the System" introduces how to use the supplied software controller to tune the system. The appendixes provide the usage description of technical parameters of controller, setting position, velocity and acceleration, typical wiring, troubleshooting and use of GT Commander, the software provided.

Related Documents

For the programming of GT series motion controller, please refer to "**Programming Manual of GT Series Motion Controller**" provided together with the product.

Contents

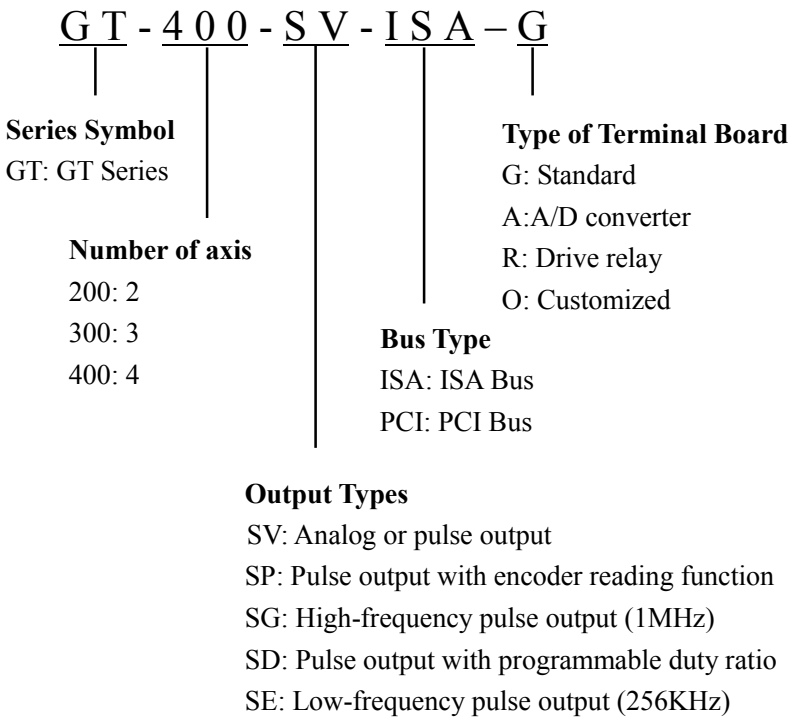
Chapter 1: Overview

1.1 Introduction

GT series of motion controllers can control four motion axes at synchronous, achieving multi-axis coordinated motion. The cores of these controllers consist of ADSP2181 digital signal processor and FPGA, which process high-performance control computation. GT controllers find applications in a wide range of industries including robotics, CNC machinery, carpentry machinery, printing machinery, assembly lines, processing equipments in electronics, laser processing equipments.

GT motion controller uses PC as its host, and offers two versions of products - ISA and PCI bus versions. In either version, RS232 serial communication and PC104 interface socket are available to facilitate users in configuring their systems. The C function library and Windows DLL are also provided to accomplish more complicated control functions. A Uses may combine these control functions with the data processing, user interface and other application modules as required by one's specific control system, to implement a control system of specific application requirements. To operate the motion controller a user is required to have the programming experience with C language or DLL in Windows environment.

1.2 Terminology of GT Series Motion Controllers



1.3 Function List of GT Series Motion Controllers

√ Included - Excluded * Optional

Features		SV	SP	SG	SD	SE
BUS	ISA/ PCI	√	√	√	√	√
	RS232	*	*	*	*	√
Program memory	64K Byte ROM	*	*	*	*	*
	512K Byte SRAM	*	*	*	*	*
Sampling rate	User adjustable (200us by default)	√	√	√	√	–
Analog output	4 axes. Range: -10V to +10V	√	–	–	–	–
Pulse output	4 axes	√	√	√	√	√
Duty Cycle, programmable	1 axis	–	–	–	√	–
Encoder channel	4 channels of quadrature incremental encoder. Max. Counting frequency: 8MHz.	√	√	–	–	–
Auxiliary encoder	2 channels of quadrature incremental encoder. Max. Counting frequency: 8MHz.	√	√	√	√	–
Limit switch	Left and right limit switch of each axis	√	√	√	√	√
Home switch	Home switch of each axis	√	√	√	√	√
Driver alarm signal	1 channel of driver alarm signal of each axis	√	√	√	√	√
Driver enable signal	1 –channel driver enable signal of each axis	√	√	√	√	√
Driver reset signal	1 channel driver reset of each axis	√	√	√	√	√
Uncommitted digital input	16 channels	√	√	√	√	√
Uncommitted digital output	16 channels	√	√	√	√	√
Probe input	Occupy 1 channel of Uncommitted digital input	√	√	√	√	√
A/D	8 channels	*	*	*	*	*
Watchdog	Monitor DSP work status in real time.	√	√	√	√	√
On-board linear and	DSP firmware	√	√	√	√	√

Features		SV	SP	SG	SD	SE
circular interpolation						
Program memory	Motion code compiling	√	√	√	√	√
Point-to-point motion	S-curve, T-curve, jogging motion and electronic gear motion modes	√	√	√	√	√
Filter	PID + Velocity Feed forward + Acceleration Feed forward	√	–	–	–	–
Hardware capture	Index signal of encoder	√	√	–	–	–
	Home switch	√	√	√	√	√
Safety	Following error limit.	√	√	–	–	–
	Acceleration limit.	√	√	√	√	√
	Controller output limit.	√	–	-	–	–

1.4 Configuration of Motion Control System

1. Motion controller.

2a. PC with ISA slot for ISA bus version controller,

-- Or --

2b, PC with PCI slot for PCI bus version controller.

3. Servo motor with incremental encoder or step motor.
4. Driver.
5. +12V to +24V DV power (for terminal board).
6. Home switch, positive/negative limit switches (optional as needed).

GT controller works with both AC and DC servomotors. To control the servomotor, the controller outputs +/-10V analog voltage signal to control the servomotor. When selecting a servomotor, make sure the appropriate driver and accessories are selected. If there is any question, please consult your motor supplier.

To control a step motor, the motion controller provides two kinds of control signals, one is a positive pulse/negative pulse signal, and the other is a pulse and direction signal. Thus, the controller can be used to work with any step motor currently available in the market. When controlling a step motor, the control mode is open loop and no encoder is needed. For SP model of controller controlling a step motor, the controller provides channels to read encoder signal.

A typical connection of motion control system using GT motion controller is illustrated in Fig.1-1.

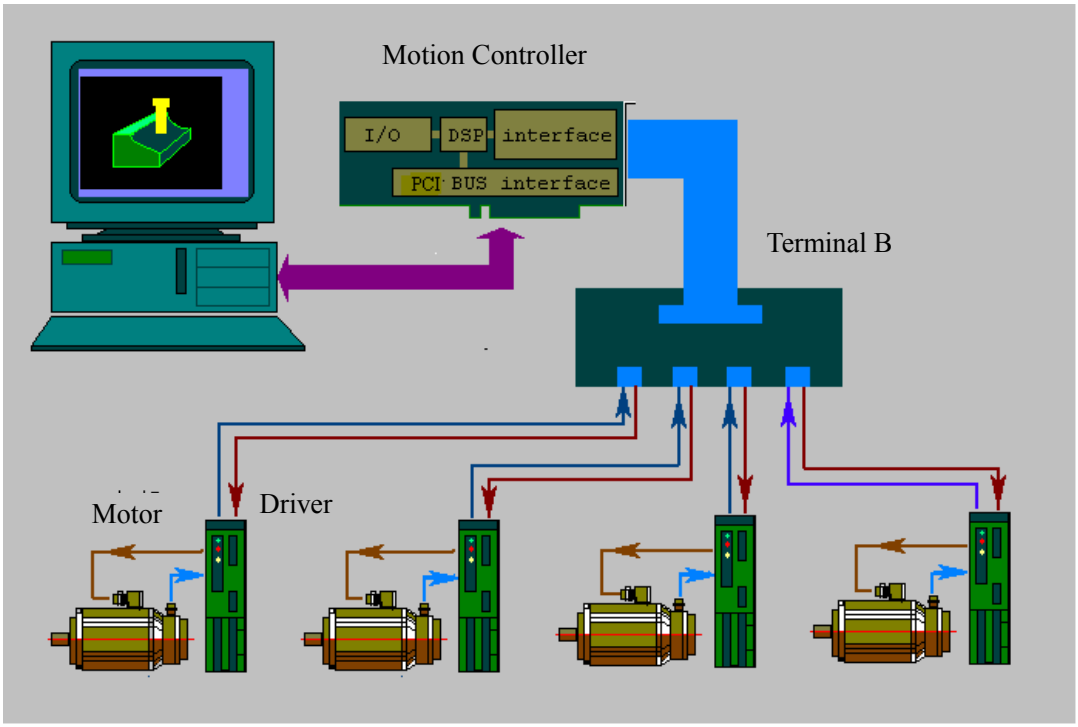


Fig. 1.1 Schematic Diagram of Motion Control system using GT motion controller

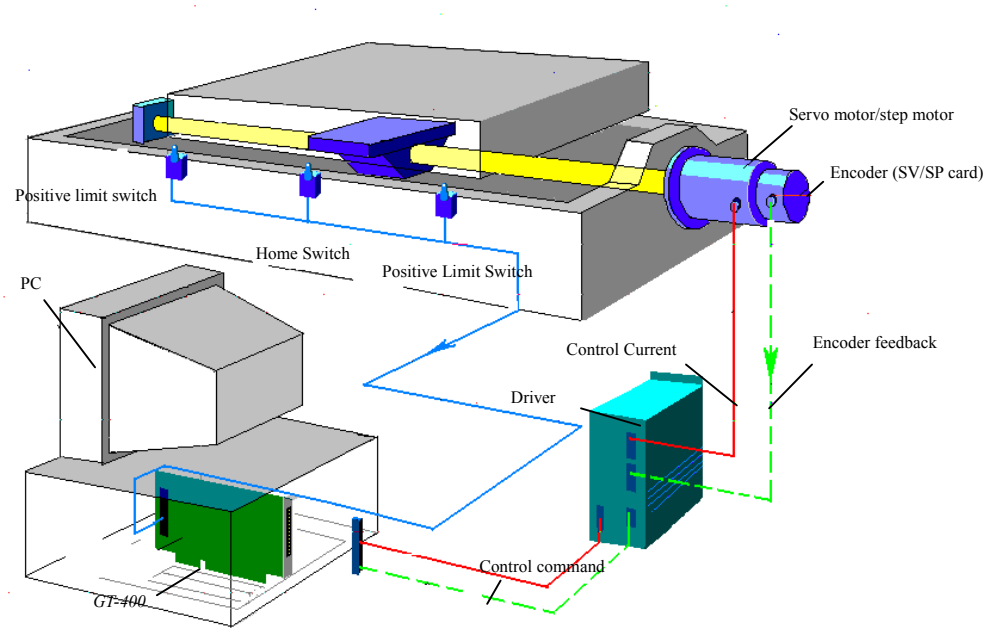


Fig. 1-2 Typical Application of GT Series Motion Controller

Chapter 2: Quick Start

2.1 Open the Package and Check

Before opening the package, please check whether the product type marked on the package is consistent with your purchase. After opening the package, first check whether there is any mechanical damage on the motion controller. Then check carefully whether the accessories are complete. If there is mechanical damage on the controller, or any item is missing in the package, please do not use the product and contact Googol Technology or our distributor immediately.

注意 **Warning**	*To avoid any electrostatic from damaging the motion controller, please discharge static in your body before touching the controller or inserting/removing the controller to/from a slot of PC.*

2.2 Layout of GT Series Motion Controller

The layout of ISA series motion controller is illustrated in Fig. 2-1.

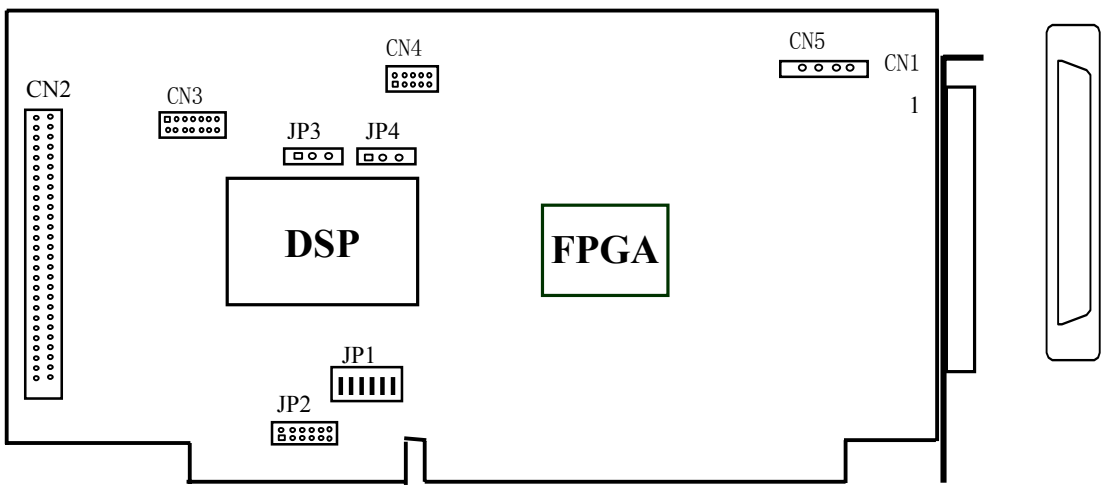


Fig. 2-1 ISA Series Motion Controller

The layout of PCI series motion controller is illustrated in Fig. 2-2.

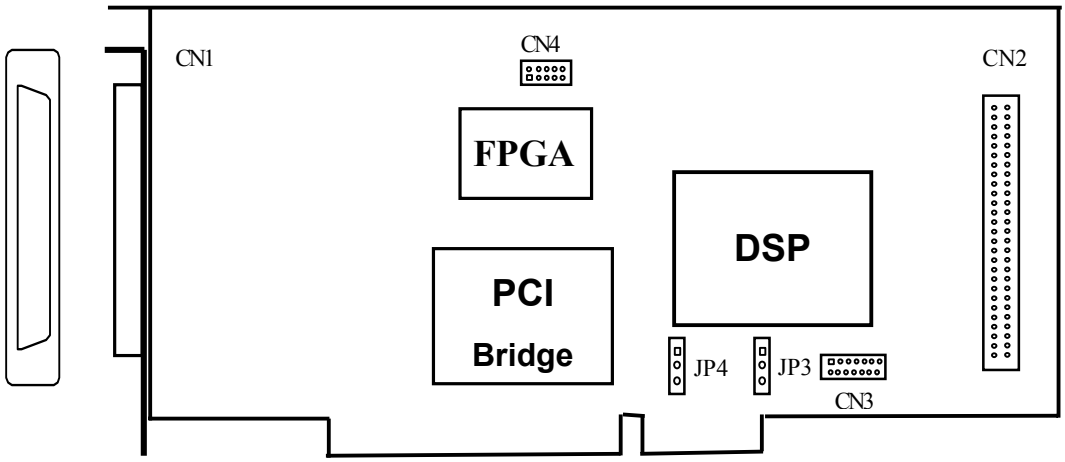


Fig. 2-2 PCI Series Motion Controller

Table 2-1 lists the description of each connector and jumper. Please locate their positions and know their functions. The following section on Installation Procedures will describe these connectors and jumpers in details.

Table 2-1 Definitions of Connectors and Jumpers

Definition	Description
JP1	Base address switch (only for ISA/PC104)
JP2	Jumper of IRQ (only for ISA/PC104)
JP3	Jumper of watchdog
JP4	For debugging (not user Jumper)
CN1	Connector of axis control interface
CN2	Connector of I/O interface
CN3	Debugging port (not for user)
CN4	Debugging port (not for user)
CN5	Connector of power supply (for PC104 modules)

2.3 Installation Procedures

Install the controller according to the following 7procedures.

Step 1: Set jumper on motion controller (only for ISA bus controller. Skip to Step 2 for PCI bus controller.).

Step 2: Insert the controller into PC.

Step 3: Install the Windows driver of the controller (only for Windows environment).

Step 4: Establish communication between the host and controller.

Step 5: Connect the motor with driver.

Step 6: Connect the controller with terminal board.

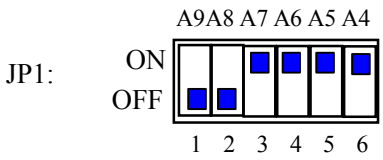
Step 7: Connect the driver and system I/O with terminal board.

2.3.1 Step 1: Set Jumpers on Motion Controller (Only for ISA bus controller).

2.3.1.1 Set base address by Dip switch JP1

To establish communication between the host PC and motion controller, user must select and set the base address of the controller. JP1 is the base address-selecting switch of the motion controller. For its location, please see *Fig. 2-1*. The factory default base address of the controller is 0x300 (hex), as shown in Fig. 2-3. From this address, the controller occupies 14 consecutive I/O addresses to communicate with the host PC. Please check the address occupation of the host to avoid conflict on address and the influence on system operation. Table 2-2 is a list for selecting base address Dipswitch of the motion controller. Table 2-3 lists the I/O addresses occupied by PC, for reference when setting base address.

Suggest that user do not change the initial setting of base address when installing the motion controller for the first time, because this address is idle for most computers. If communication problem is encountered in the following test, please refer to Table 2-3 and 2-3 to modify the setting of base address.



Address Line	Definition
A 4	ON
A 5	ON
A 6	ON
A 7	ON
A 8	OFF
A 9	OFF

Fig. 2-3 Default setting of Dip switch JP1

Table 2-2 Lists of Base Address and Setting of Dip Switch

Hex Address	Decimal Address	A 9	A 8	A 7	A 6	A 5	A 4
0x100	256	ON	OFF	ON	ON	ON	ON
0x120	288	ON	OFF	ON	ON	OFF	ON
0x140	320	ON	OFF	ON	OFF	ON	ON
0x160	352	ON	OFF	ON	OFF	OFF	ON
0x180	384	ON	OFF	OFF	ON	ON	ON
0x1a0	416	ON	OFF	OFF	ON	OFF	ON
0x1c0	448	ON	OFF	OFF	OFF	O N	ON
0x1e0	480	ON	OFF	OFF	OFF	OFF	ON
0x200	512	OFF	ON	ON	ON	ON	ON
0x220	544	OFF	ON	ON	ON	OFF	ON

Hex Address	Decimal Address	A 9	A 8	A 7	A 6	A 5	A 4
0x240	576	OFF	ON	ON	OFF	ON	ON
0x260	608	OFF	ON	ON	OFF	OFF	ON
0x280	640	OFF	ON	OFF	ON	ON	ON
0x2a0	672	OFF	ON	OFF	ON	OFF	ON
0x2c0	704	OFF	ON	OFF	OFF	ON	ON
0x2e0	736	OFF	ON	OFF	OFF	OFF	ON
0x300 (Default)	**768**	**OFF**	**OFF**	**ON**	**ON**	**ON**	**ON**
0x320	800	OFF	OFF	ON	ON	OFF	ON
0x340	832	OFF	OFF	ON	OFF	ON	ON
0x360	864	OFF	OFF	ON	OFF	OFF	ON
0x380	896	OFF	OFF	OFF	ON	ON	ON
0x3a0	928	OFF	OFF	OFF	ON	OFF	ON
0x3c0	960	OFF	OFF	OFF	OFF	ON	ON
0x3e0	992	OFF	OFF	OFF	OFF	OFF	ON

Table 2-3 Typical Mappings of Addresses

Allocation of ISA Bus Addresses		Uses
Hex	Decimal	
000～01F	00～31	DMA controller 1
020～03F	32～63	Interrupt controller 1
040～05F	64～95	Timer
060～06F	96～111	Keyboard
070～07F	112～127	Real-time clock NMI
080～09F	128～159	DMA page register
0A0～0BF	160～191	Interrupt controller 2
0C0～0DF	192～223	DMA controller 2
0F0～0FF	240～255	Math co-processor
1F0～1F8	496～504	Hard disk drive
200～20F	512～527	Game port
210～217	528～535	Expansion unit
278～27F	630～639	Parallel port 2
2B0～2DF	688～735	Optional EGA
2F8～2FF	760～767	Asynchronous communication port 2
300～31F	**768～799**	**Prototype card**
360～36F	864～879	PC network card
378～37F	888～895	Parallel port 1
380～38F	896～911	SDLC communication port 2
390～393	912～915	Reserved
3A0～3A9	928～937	SDLC communication port 1
3B0～3BF	944～959	IBM single-color monitor
3C0～3CF	960～975	EGA

3D0～3DF	976～991	Color monitor/Graphic monitor
3F0～3F7	1008～1015	Floppy driver
3F8～3FF	1016～1023	Asynchronous communication port 2
X2E1		GPIB adaptor
X390～X393		Asynchronous communication port 1

2.3.1.2 Set IRQ lines by JP2

The motion controller provides ***timer interrupt*** and ***event interrupt*** signals for the PC. JP2 is the selection of IRQ jumper of the controller. The description of jumper pins is listed in Table 2-4. The default setting of IRQ line by the controller is IRQ10.

JP2:

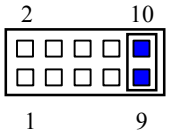
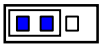


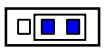
Table 2-4 Selection of IRQ lines

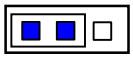
Jumper Pin	IRQ line
1 - 2	IRQ15
3 - 4	IRQ14
5 - 6	IRQ12
7 - 8	IRQ11
9~10 (Default)	IRQ10

2.3.1.3 Set watchdog by JP3

The motion controller provides a watchdog to monitor its work status in real time. JP3 is the jumper selector of the watchdog. After the watchdog is set to be enable with the jumper, when the controller downs, the watchdog will automatically reset the controller after a delay time of 150ms. The watchdog is disabled by default.

JP3: Watchdog is enabled  1 2 3

Watchdog is disabled (By default):  1 2 3

注意 **Warning**	*JP4 is the selector of debugging jumpers of the controller. It has been set before leaving the factory and cannot be changed.* *JP4 (By default):*  *1 2 3*

2.3.2 Step 2: Insert the controller into the PC.

注意 **Warning**	*Please be careful when handling. Discharge static in your body before touching the controller circuit or inserting/removing the controller, to avoid any static from damaging the motion controller.*

1. Connect the CN2 connector of the controller and the accessory board (ACC1) with a 62-pin flat cable provided with the board.
2. Turn off the PC.

3a. For ISA bus controller, select a free ISA slot in the PC.
3b. For PCI bus controller, select a free PCI slot in the PC. .

4. Insert the controller card into this slot firmly

5. Fix the controller card in the slot by tightening the screw.
6. Remove the cover of a nearby slot. Fix the accessory board (ACC1) on the PC frame with screws.
7. Close the PC cover and restart the PC.

2.3.3 Step 3: Install the Windows driver of the controller (for Windows environment)

If you are using DOS, skip this step and go to Step 5 directly.

For ISA Card:

1. Insert the product CD into the CD-ROM.
2. Run **WinSetupCH.exe** from the directory "CD-ROM: \Windows\setup".
3. Restart the computer when prompted.

For PCI Card:

Install the driver in Windows98/2000

1. After installing hardware and starting computer, Windows98/2000 will detect automatically the motion controller, and start **Add hardware** wizard. Click **Next** when prompted.
2. At the prompt of **What do you want "Windows" to operate?** select **Search the driver of equipment (recommended)**. Then click **Next**.
3. Insert the product CD into the CD-ROM.
4. Select **Appoint position**. Use **Browse** to select the appropriate operating system under "CD-ROM: \Windows". For example, in Windows 2000, select "CD-ROM: \Windows\Win2000". Then click **Next**.
5. Follow **Add hardware** wizard. Click **Next** until installation is finished.

Install the driver in Windows NT

1. Put the product CD into the CD-ROM.
2. Run **setup.exe** from the directory "CD-ROM: \Windows\setup\WinNT40".

2.3.4 Step 4: Establish communication between the PC and controller (for Windows)

If you are in DOS environment, skip this step and go to Step 5 directly.

GTCmdISA_CH and GTCmdPCI_CH are the motion control demo program used under Windows operating system. GTCmdISA_CH is for the ISA bus motion controller and GTCmdPCI_CH is for the PCI bus motion controller. With the demo program, user can just use mouse clicks and keyboard inputs send commands to the motion controller, performing simple motion control, without C/C++ programming. This software is saved at "CD-ROM: \DEMO\GTCmdPCI_CH.exe". Now, we can use this software to establish communication between the PC and the motion controller.

For ISA Card:

First copy the folder "CD-ROM: \DEMO" into the hard disk. Remove the "Read only" property of the file "GTCmd.ini" from the directory "DEMO" in the hard disk. Open the file "GTCmd.ini" and modify corresponding parameters according to the product as follows.

[CARD0]

```
LimitSense=0                ；Effective electrical level of limit switch
EncoderSense=0              ；Counting direction of encoder
IntrTime=1000               ；Interrupt interval time
SampleTime=200              ；DSP sampling period

//cardtype 1: SV 2:SG 3:SP
CardType=1                  ；Type of motion controller
Address=768                 ；Base address of motion controller

//irq=0 is recemended
Irq=0                       ；Interrupt vector number (0 is recommended.)
```

The setting of base address and interrupt vector number must be corresponding to the setting of hardware jumpers JP1 and JP2 (Please see *Step 1: Set jumper on motion controller*.). If the interrupt function of the motion controller is not needed, set the IRQ as 0.

After modifying parameters, save the file. Run GTCmdISA_CH.exe. If the program runs normally, it proves that the motion controller ***successfully communicates to the host PC.*** If an information box "Fail to open GT equipment" appears, it proves that the motion controller ***fails to communicate with the host PC***. Only the controller ***successfully communicating to the PC***, then user continues to next step. Otherwise, please refer to *Appendix D Troubleshooting*. If needed, please contact us.

For PCI Card:

Running the program GTCmdISA_CH.exe, if the program runs normally, it proves that the motion controller ***successfully communicates to the PC***. If an information box "Fail to open GT equipment" appears, it proves that the motion controller ***fails in communication to the PC***. Only the controller ***successfully communicating,*** then user continues to next step. Otherwise, please refer to *Appendix D Troubleshooting*. If needed, please contact us.

2.3.5 Step 5: Connect the motor with driver.

注意 **Warning**	*For the purpose of safety, we suggest that user do not connect the motor with any mechanical device before installing and debugging the control system. Please check that there is really no load in the motor.*

Before connecting the driver to the controller, connect the driver with the motor. For correct wiring, please refer carefully to the manual of the drive. Test the driver and the motor as required in the manual to ensure them are working properly.

2.3.6 Step 6: Connect the controller with the terminal board.

注意 **Warning**	*Refer carefully to the signal description of the connectors in the controller and the pin description of the connectors in motor driver. Wire them correctly and* ***avoid connecting them when power is on.*** *Otherwise, wrong connection may cause the positive feedback of the system and operation with power may cause damage on hardware, so as to make the system unable to work properly.*

Turn off the PC. Take out the two-shielded cables supplied with the controller. Connect CN1 on the controller with CN1 on the terminal board, and CN2 on the accessory board with CN2 on the terminal board. (Fig. 2-4).

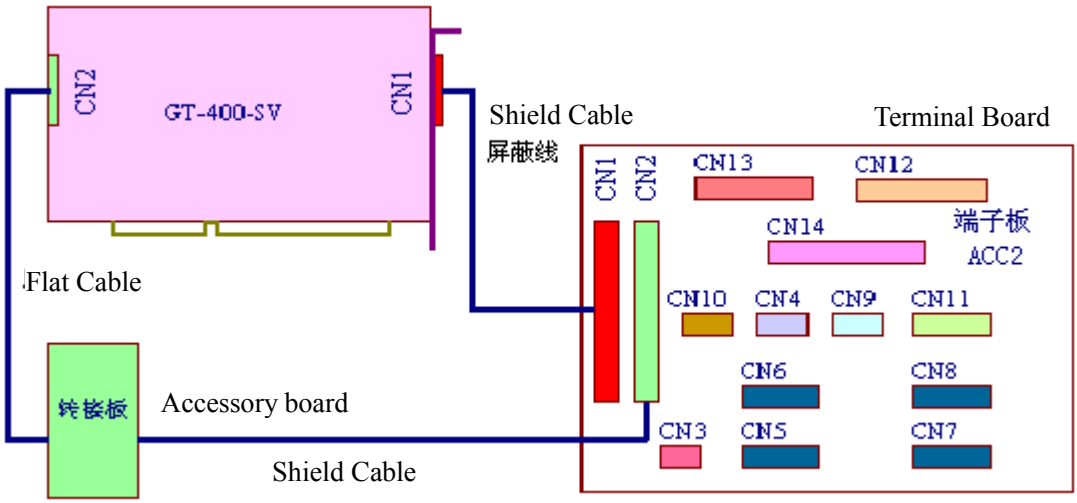


Fig 2-4 Wiring of the Motion Controller and Terminal Board

2.3.7 Step 7: Connect the driver and system I/O with terminal board.

2.3.7.1 Connecting user-supplied power to the terminal board

CN3 on the terminal board connects to the external power supply (user-supplied). The connector marked +12V - +24V on the board wires to the power of +12V - +24V, and that marked OGND wires to the ground of external power supply. The value of voltage of the external power to be used depends on the requirements of the sensors and switches in the equipment. For the wiring diagram, refer Fig. 2-5.

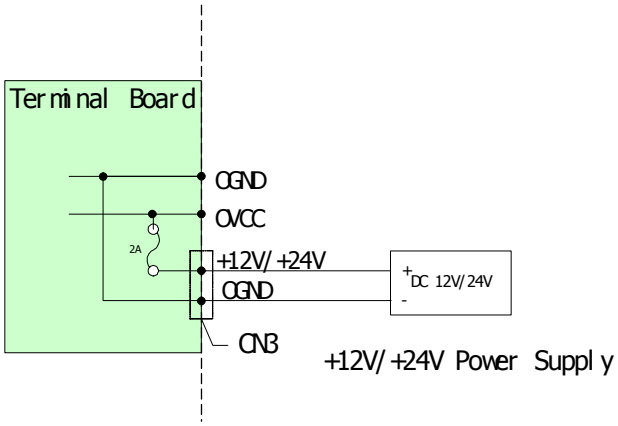


Fig. 2-5 Wiring Power Supply to the Terminal Board

2.3.7.2 Connect Dedicated Inputs/Outputs

The dedicated inputs include the driver alarm signal, home signal and limit signal, which are connected with the driver and sensors through CN5 (CN6, CN7, CN8) and CN12 on the terminal

board. For the definition of pins of CN5, please see Table 2-5. For the definition of pins of CN12, please see Table 2-6. For wiring, please see Table 2-6.

The dedicated outputs include enable driver signal and reset of driver alarm, which are also connected to the driver through CN5, CN6, CN7 and CN8 on the terminal board. CN 5, CN6, CN7 and CN8 are for axis 1 to 4 respectively. The definitions of pins of CN 5 to CN8 are the same (Table 2-5). For wiring, please refer Table 2-6.

 **Warning**	*According to safety standard:* *1. The alarm signal of driver is in normally closed status (If user doesn't use it, please wire this input signal to OGND.).* *2. The limit switch of the system shall be in normally closed status.* *3. The home switch is in normally open status.*

Table 2-5 Definition of pins of CN5 (CN6, CN7, CN8) on terminal board

Pin	Signal	Description	Pin	Signal	Description
1	OGND	Ground of external power supply	14	OVCC	+12V/+24V external power
2	ALM	Driver alarm	15	RESET	Reset driver alarm
3	ENABLE	Enable driver	16	Reserved	Reserved
4	A-	Phase A- of Encoder signal	17	A+	Phase A+ of Encoder signal
5	B-	Phase B- of Encoder signal	18	B+	Phase B+ of Encoder signal
6	C-	Phase C- of Encoder signal	19	C+	Phase C+ of Encoder signal
7	+5V	Power	20	GND	Digital ground
8	DAC	Analog output	21	GND	Digital ground
9	DIR+	Direction+ signal	22	DIR-	Direction- signal
10	GND	Digital ground	23	PULSE+	Pulse+ signal
11	PULSE-	Pulse- signal	24	GND	Digital ground
12	Reserved	Reserved	25	Reserved	Reserved
13	GND	Digital ground			

Table 2-6 Definition of pins of CN12 on Terminal Board

Pin	Signal	Description
1	HOME0	Home switch signal of axis 1
2	HOME1	Home switch signal of axis 2
3	HOME2	Home switch signal of axis 3
4	HOME3	Home switch signal of axis 4
5	LIMIT0+	Positive limit switch signal of axis 1
6	LIMIT0-	Negative limit switch signal of axis 1
7	LIMIT1+	Positive limit switch signal of axis 2
8	LIMIT1-	Negative limit switch signal of axis 2
9	LIMIT2+	Positive limit switch signal of axis 3
10	LIMIT2-	Negative limit switch signal of axis 3
11	LIMIT3+	Positive limit switch signal of axis 4
12	LIMIT3-	Negative limit switch signal of axis 4
13	EXI0	Uncommitted input
14	EXI1	Uncommitted input
15	OGND	Ground of external power supply
16	OVCC	+12V/+24V power

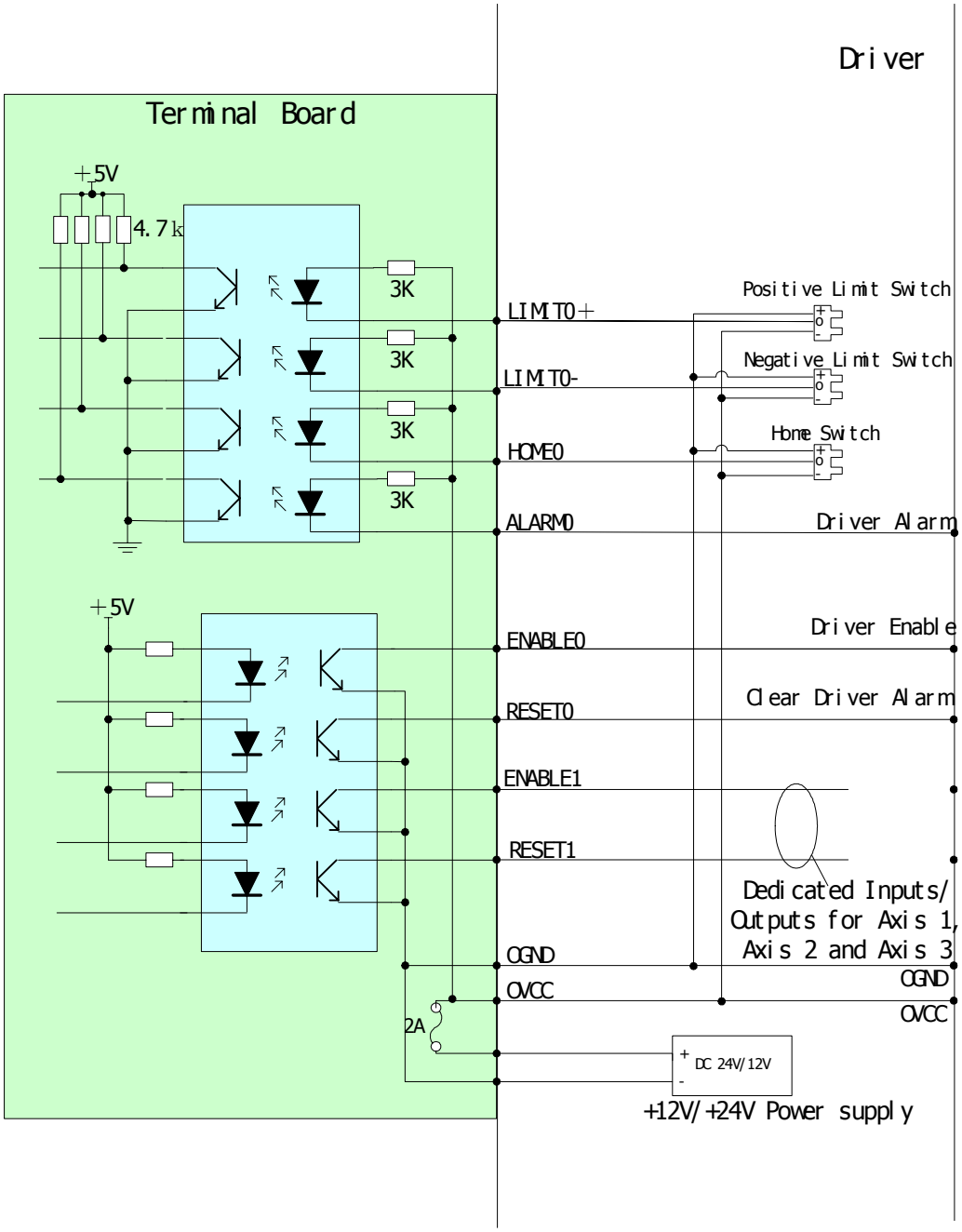


Fig. 2-6 Wiring Diagram of Dedicated Input/Output Signals

2.3.7.3 Wiring of encoder feedback signals (only for SV card)

User not using SV model of controller may skip to step 2.3.7.4.

If the encoder signals are differential, wire the signals directly to A+, A-, B+, B-, C+, C-, VCC and GND of CN5 (CN6, CN7 and CN8). If the encoder signal is single input, wire the signals to A+, B+, C+, VCC and GND of CN5 (CN6, CN7 and CN8), and meanwhile suspend A-, B- and C-. For the definition of pins of CN5 to CN8, please see Table 2-5. For wiring, please see Fig. 2-7 and 2-8.

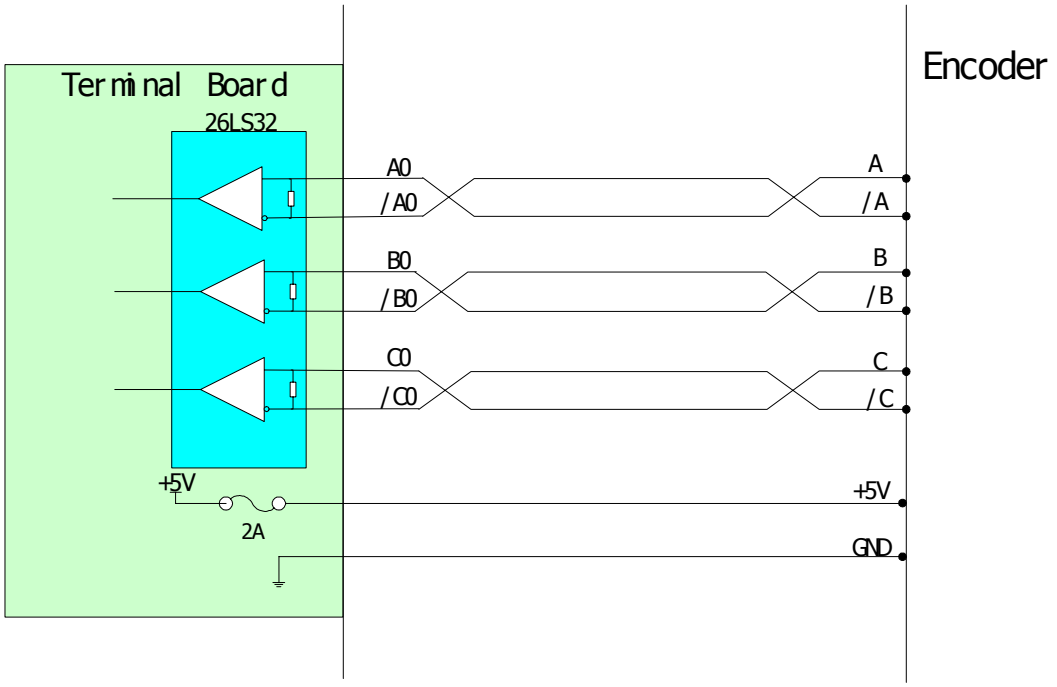


Fig. 2-7 Wiring Diagram of Encoder with differential signals

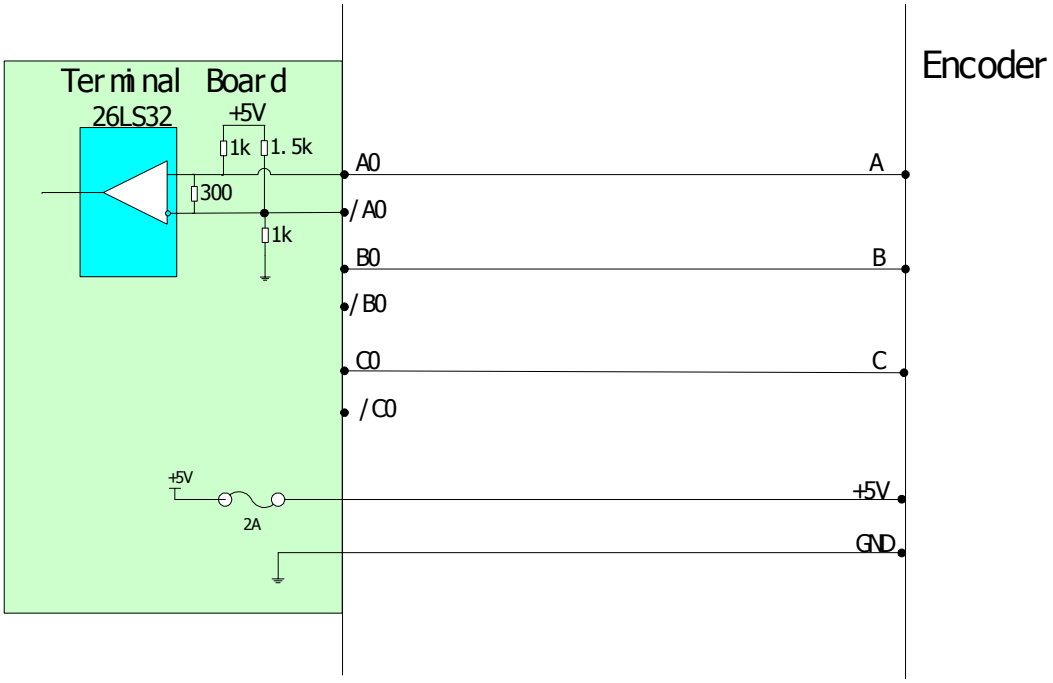


Fig. 2-8 Wiring Diagram of Encoder with single signal input

2.3.7.4 Wiring of Auxiliary Encoder Signals

The two auxiliary encoder input ports are CN9 and CN10. For the definition of pins of CN9 and CN10, please see Table 2-7 and 2-8. For wiring, please see Fig. 2-7 and 2-8.

Table 2-7 Definition of pins of CN9 on Terminal Board

Pin	Signal	Description	Pin	Signal	Description
1	A4+	Phase A+ signal of auxiliary encoder 1	6	A4-	Phase A_ signal of auxiliary encoder 1 signal
2	B4+	Phase B+ signal of auxiliary encoder 1	7	B4-	Phase B- signal of auxiliary encoder 1
3	C4+	Phase C+ signal of auxiliary encoder 1	8	C4-	Phase C- signal of auxiliary encoder 1
4			9	GND	Digital ground
5	+5V	Power			

Table 2-8 Definition of pins of CN10 on Terminal Board

Pin	Signal	Description	Pin	Signal	Description
1	A5+	Phase A+ signal of auxiliary encoder 2	6	A5-	Phase A- signal of auxiliary encoder 2
2	B5+	Phase B+ signal of auxiliary encoder 2	7	B5-	Phase B- signal of auxiliary encoder 2
3			8		
4			9	GND	Digital ground
5	+5V	Power			

2.3.7.5 Wiring of controller output signal

The SV model of controller can output two kinds of signals, analog or pulse signal. By default, the SV controller outputs analog signal from four axes. When an axis or some axes are used to control step motors (or servo motor operated in position mode), user can use the function GT_CtrlMode (1) to set the output of the axis as pulse signal output.

SG, SE, SD and SP models of controller only work in the pulse signal output mode. There are two kinds of pulse signal output mode. One is the pulse/direction signal mode and the other is the positive/negative pulse signal mode. By default, the controller operates in the pulse/direction signal mode. Using the command GT_StepPulse, user can set the axis operating in the positive/negative pulse signal mode, and use the command GT_StepDir to set the axis operating in the pulse/direction signal mode.

Wiring of Analog Output

The analog control output signal is output through Pin 8 of CN5 (CN6, CN7 and CN8) on the terminal board. The ground is the digital ground Pin. For the definition of pins of CN5, please see Table 2-5. For wiring, please see Fig. 2-9.

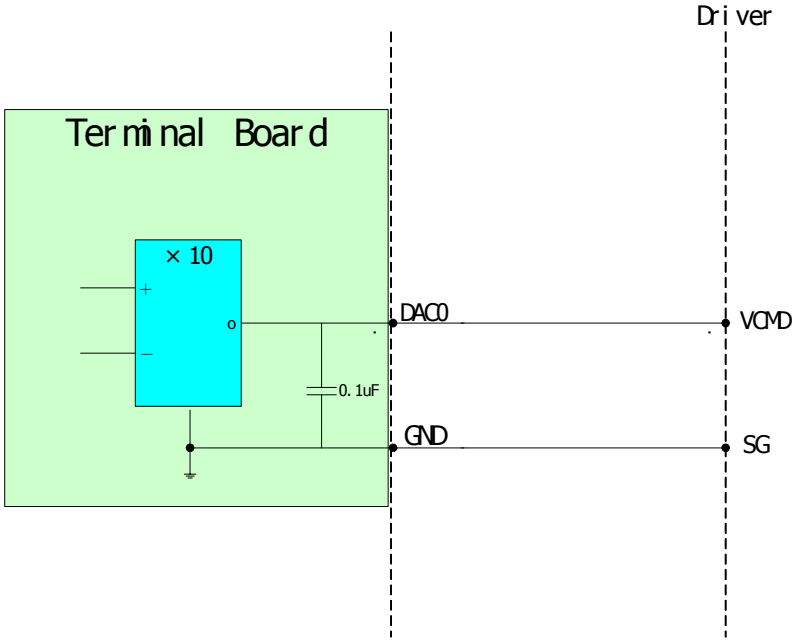


Fig. 2-9 Wiring Diagram of Analog Voltage Input

Wiring of Pulse Output

The pulse/direction output signals are output through Pins 9, 22, 23 and 11 of CN5 (CN6, CN7 and CN8) on the terminal board. The ground is the digital ground Pin. For the definition of pins of CN5, please see Table 2-5. For wiring, please see Fig. 2-10.

In the pulse/direction signal mode, Pins 23 and 11 output differential pulse signals and Pins 9 and 22 output differential motion direction signals.

In the positive/negative pulse output mode, Pins 9 and 22 output differential positive pulse trains and Pins 23 and 11 output differential negative pulse trains.

If the signals needed by the driver are not differential signals, wire the corresponding signal with the positive signal pins (i.e. Pins9 and 23) of the above differential signal output, and **suspend the negative signal pins.** For the output wave, please see Fig. 3-11.

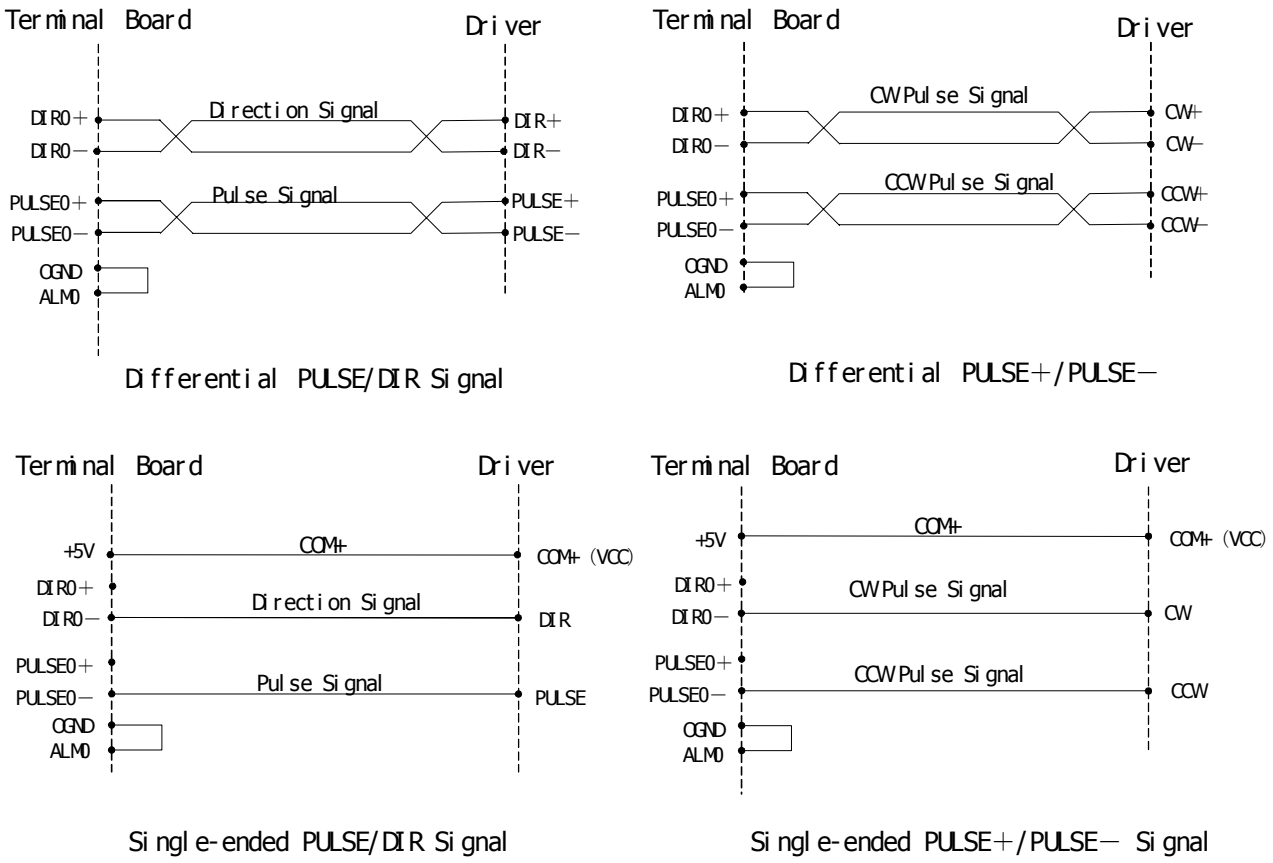


Fig. 2-10 Wiring Diagram of Pulse Output Signal

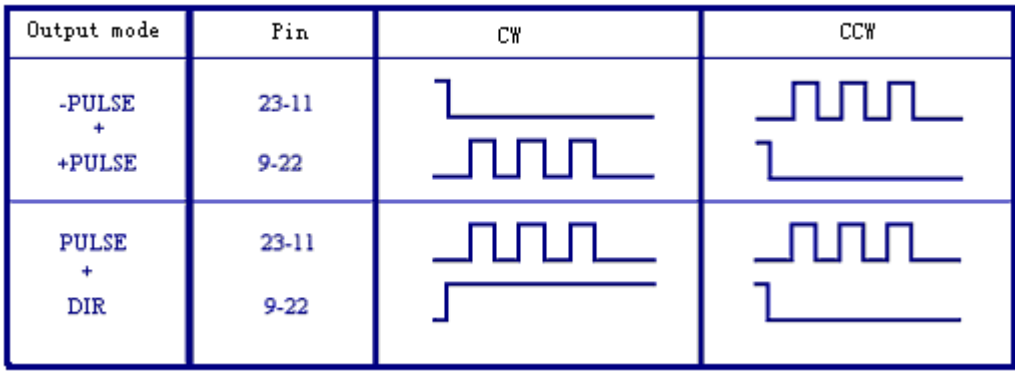


Fig. 2-11 Wave of Pulse and Direction Output

2.3.7.6 Wiring of Uncommitted Digital Input/Output

The uncommitted digital inputs are connected through CN12 and CN13 on the terminal board. For the definition of pins of CN12, please see Table 2-6. For the definition of pins of CN13, please see Table 2-9. For wiring, please see Fig. 2-12.

The uncommitted digital outputs are connected through CN14 on the terminal board. For the definition of pins of CN14, please see Table 2-10. For wiring, please see Fig. 2-12. The power supply for uncommitted outputs can be provided through CN12 or CN13.

提示 Hint	*Pin EXI0 can be used as external interrupt source of PC or a probe to capture encoder signal, as well as for uncommitted input.* *When these output driving inductive load, consider a linkage circuit of EMF.*

Table 2-9 Definition of pins of CN13 on Terminal

Pin	Signal	Description
1	EXI2	Uncommitted input
2	EXI3	Uncommitted input
3	EXI4	Uncommitted input
4	EXI5	Uncommitted input
5	EXI6	Uncommitted input
6	EXI7	Uncommitted input
7	EXI8	Uncommitted input
8	EXI9	Uncommitted input
9	EXI10	Uncommitted input
10	EXI11	Uncommitted input
11	EXI12	Uncommitted input
12	EXI13	Uncommitted input
13	EXI14	Uncommitted input
14	EXI15	Uncommitted input
15	OGND	Ground of external power supply
16	OVCC	+12V/+24V power

Table 2-10 Definition of pins of CN14 on Terminal

Pin	Signal	Description
1	EXO0	Uncommitted output
2	EXO1	Uncommitted output
3	EXO2	Uncommitted output
4	EXO3	Uncommitted output
5	EXO4	Uncommitted output
6	EXO5	Uncommitted output
7	EXO6	Uncommitted output
8	EXO7	Uncommitted output
9	EXO8	Uncommitted output
10	EXO9	Uncommitted output
11	EXO10	Uncommitted output
12	EXO11	Uncommitted output
13	EXO12	Uncommitted output
14	EXO13	Uncommitted output
15	EXO14	Uncommitted output
16	EXO15	Uncommitted output

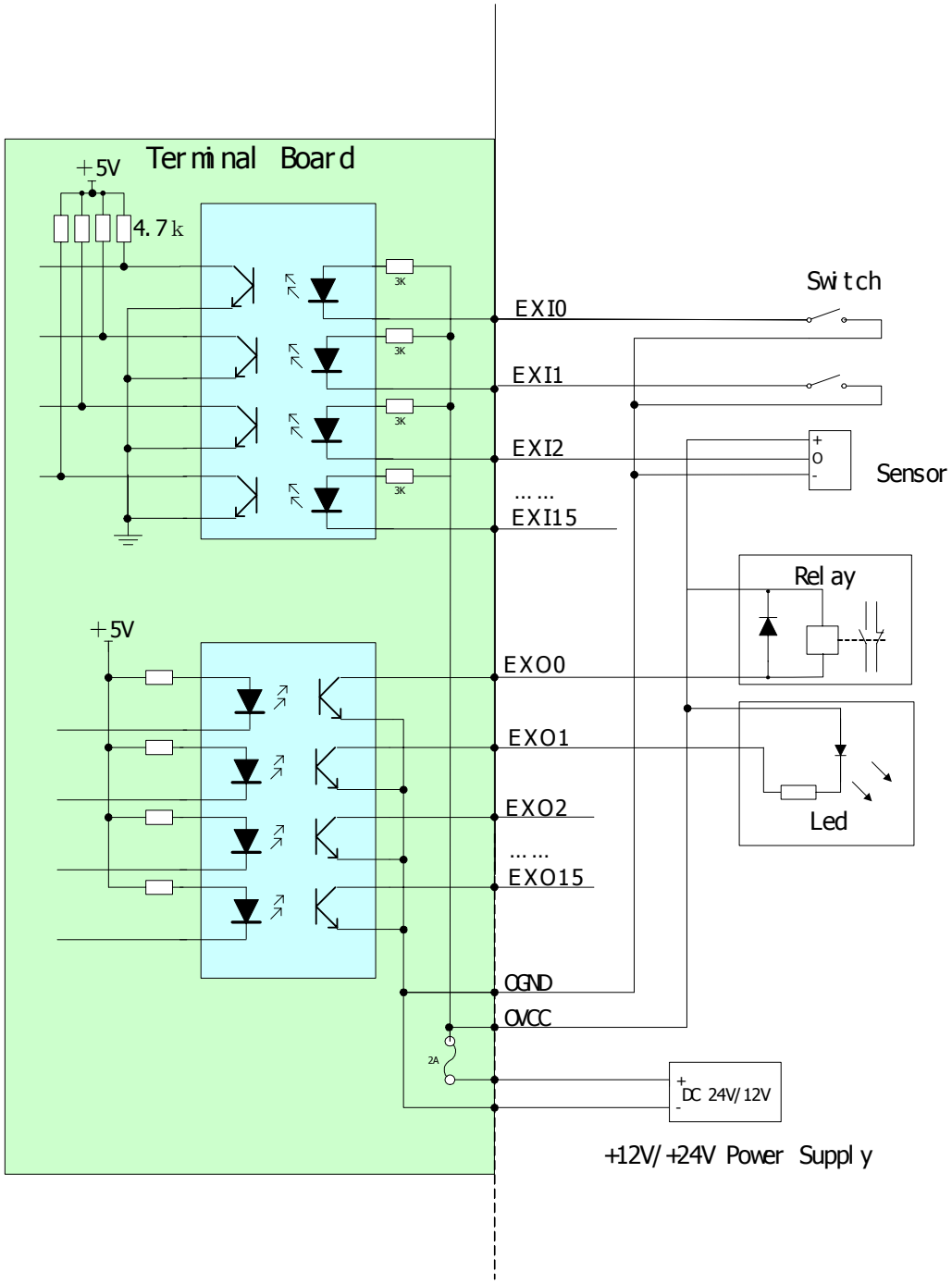


Fig. 2-12 Wiring Diagram of Uncommitted Input/Output Signal

2.3.7.7 RS-232 Interface (optional)

The motion controller provides a serial communication port to transfer information with the host, which is through CN4 on the terminal board. For the definition of pins of CN4, please see Table 2-11. For wiring, please see Fig. 2-13.

Table 2-11 Definition of pins of CN4 on Terminal

Pin	Signal	Description	Pin	Signal	Description
1			6		
2	RX	RS-232 receiver	7		
3	TX	RS-232 transmitter	8		
4			9		
5	GND	Digital ground			

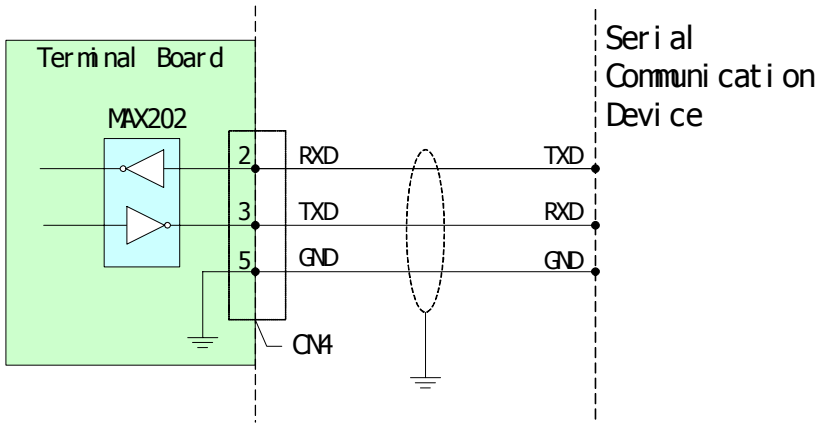


Fig. 2-13 Wiring Diagram of Serial Communication

2.3.7.8 Wiring of Analog Input

The motion controller provides optional analog input module, which is through CN11 on the terminal board. For the definition of pins of CN11, please see Table 2-12. For wiring, please see Fig. 2-14.

Table 2-12 Definition of CN11 Feet on Terminal Board

Pin	Signal	Description	Pin	Signal	Description
1	AIN0	Channel 0	9	AGND	Analog ground
2	AIN1	Channel 1	10	AGND	Analog ground
3	AIN2	Channel 2	11	AGND	Analog ground
4	AIN3	Channel 3	12	AGND	Analog ground
5	AIN4	Channel 4	13	AGND	Analog ground
6	AIN5	Channel 5	14	AGND	Analog ground
7	AIN6	Channel 6	15	AGND	Analog ground
8	AIN7	Channel 7			

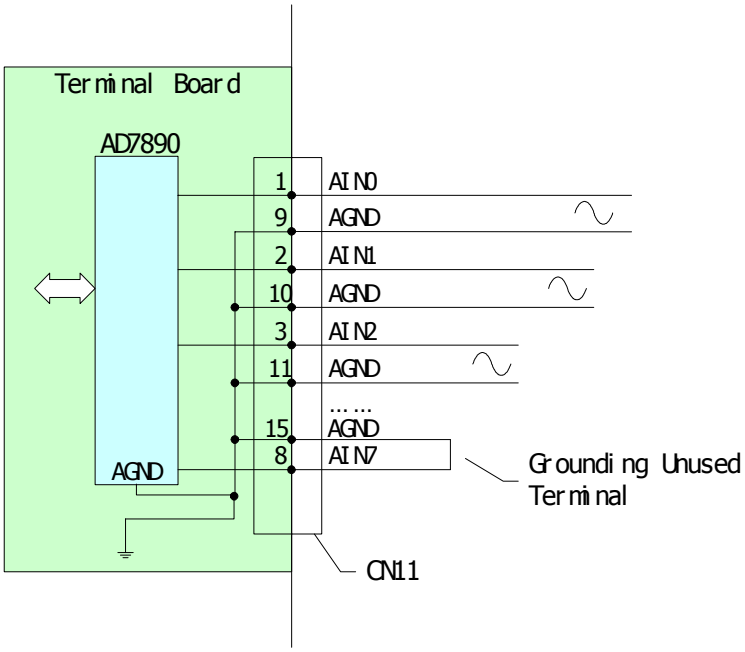


Fig. 2-14 Wiring Diagram of Analog Input Signal

Chapter 3: Test and Tune Motion Control System

After configuring the motion control system, user can now test the system with the software GTCmdISA_CH.exe for ISA bus controller or GTCmdPCI_CH.exe for PCI bus controller supplied with the controller. During debugging the system, we can check whether the controller is installed correctly, and whether the controller operates properly and performs a simple single-axis motion. GTCmdISA_CH is located in the directory DEMO in the CD provided together with the product.

User can conduct most functions of the motion controller through GTCmdISA_CH. In this chapter, we only use part of these functions. For more detailed description, please refer to *Appendix E Introduce of DEMO Software*.

 **Warning**	*For safety, we suggest that user **do not** connect the motor with any mechanical device when debugging the system. Please check that there is really no load in the motor.*

3.1 Setup System

Before starting the debugging, user need to initialize first the system that includes initialization of the controller and setting parameters on dedicated input signal. In the following function testing, we assume that the system has been initialized correctly.

1. Turn on PC, driver and external power supply for terminal board.
2. In Windows, run GTCmdISA_CH.
3. In the menu, click, l "Set Basic Parameters" appears.
4. User using only one card can skip this step. User using multiple cards opens the pull-down menu from the "Select Control Card" column to select the number of card to be operated.

 **Hint**	*The numbering of card is determined as that, generally according to the distance between the control card slot and BIOS on main board, the cards are numbered card 0, card 1, card 2, etc. from the near to the far. Of course, the main boards provided by each manufacturer are different. For some boards, the numbering of cards is reversed, i.e. card 0, card 1, card 2, etc. from the far to the near. But this is not a problem. In the following debugging, the numbers of each card can be determined. Hereafter, set the numbering of card according to the first case.*

5. In the "Select Control Card Type" column, open the pull-down menu and select the type of controller installed.
6. User using PCI bus controller can skip this step. User using ISA bus controller sets "Address and Interrupt" according to setting of those jumpers. Please refer to *Step 1: Set Jumper on Motion Controller*.

7. Click “Open Control Card” button.
8. Set “Effective Level of Limit Switch”. If the wiring is correct according to *2.3.7.5 Wiring of Dedicated Input*, user does not need to modify the default value (0) of motion controller. Otherwise, if user wants the limit switch signal to be triggered in a low voltage level trigger, set parameters according to Table 3-1. For example, the parameter “255” means that the positive and negative limit switches of all axes are all triggered in low voltage level trigger0.

Table 3-1 Setting of Effective Level of Limit Switch

Bit	Description	Definition
8-15	Reserved. Set to 0.	
7	Axis #4: Negative limit switch status bit	0: High voltage level trigger, 1: Low voltage level trigger.
6	Axis #4: Positive limit switch status bit	0: High voltage level trigger, 1: Low voltage level trigger.
5	Axis #3: Negative limit switch status bit	0: High voltage level trigger, 1: Low voltage level trigger.
4	Axis #3: Positive limit switch status bit	0: High voltage level trigger, 1: Low voltage level trigger.
3	Axis #2: Negative limit switch status bit	0: High voltage level trigger, 1: Low voltage level trigger.
2	Axis #2: Positive limit switch status bit	0: High voltage level trigger, 1: Low voltage level trigger.
1	Axis #1: Negative limit switch status bit	0: High voltage level trigger, 1: Low voltage level trigger.
0	Axis #1: Positive limit switch status bit	0: High voltage level trigger, 1: Low voltage level trigger.

9. User not using SV card skips this step. Otherwise, it is needed to set “Encoder Direction”. If the wiring is proper according to *2.3.7.3Wiring of Encoder Feedback*, user does not need to modify the default value (0) of motion controller. Or, if phase A and phase B of an encoder exchange, set the parameters reversed according to Table 2-2. For example, the parameter 15 is to reverse the encoder directions of all the four axes.

 注意 **Warning**	*The motion controller requires the positive direction of motor motion consistent with positive counting direction of corresponding encoder, only that can form the negative feedback. If due to wrong wiring or other reasons, the two directions were reversed, which will form positive feedback and cause the motor to out of control. User can set the encoder direction parameter to form negative feedback.*

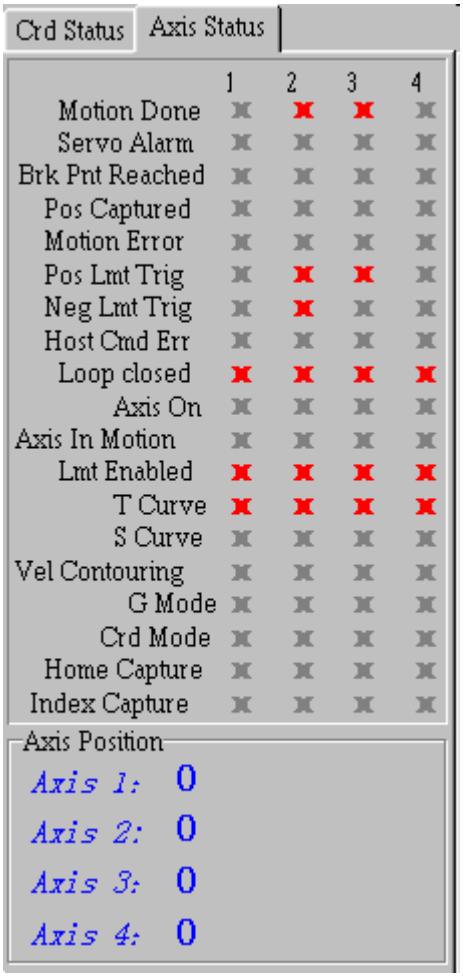
Table 2-2 Setting the direction of encoder feedback

Bit	Description	Definition
5-15	Reserved. Set to 0.	
4	Reserved.	
3	Axis #4	0: No change, 1: Signal reversed.
2	Axis #3	0: No change, 1: Signal reversed.
1	Axis #2	0: No change, 1: Signal reversed.
0	Axis #1	0: No change, 1: Signal reversed.

10. Set sampling period. The default period of the controller is 200μs. Note that user do not set a period less than 200μs. Otherwise, it may disable the controller.
11. Click "OK".
12. From the main menu of GTCmdISA_CH, click  to open the "Axis-based Control".
13. Open the pull-down menu for axis selection as illustrated in the following figure, and select the current axis (operation axis).

14. Select "Clear Status" as shown in the right figure. Clear the wrong status of the current axis.

15. View the right part of the main menu of GTCmdISA_CH. Assure that the axis has no abnormal status, as illustrated in the following figure.



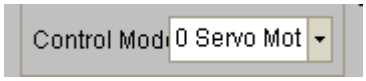
If the column "Servo Alarm" is triggered (with red cross), please check the wiring. See 2.3.7.5

Wiring of dedicated input. If the "Positive Limit switch " and "Negative Limit switch " are both triggered, please return back to Step 7 to reset "Limit Switch trigger voltage Level" and then repeat Step 11 to 15.

提示 Hint	*Definition of axis abnormal status: One or more status bits of "servo (drive) alarm, error in motion, positive and negative limit switch triggered and error in host command" are triggered.*

3.2 Set Output and Enable Driver (Axis on)

1. After initializing the system, select the current axis from the "Select Axis" box. According to the system requirement, set the output model. Pay attention to that, the setting of output model must be consistent with the setting of control mode of the motor driver of the current axis.



For SV Card,

Select analog output, i.e. 0,

Or, select pulse output, i.e. 1.

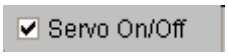
For SG, SE, SD and SP cards,

Set pulse/direction signal output, i.e. D mode,

Or, set positive/negative pulse signal output, i.e. P mode.

2. **For SV Card,**

Select the option "Enable Servo/Disable Servo" (as illustrated in the figure on the right hand side, check to enable or uncheck to disable).



Now, the driver is enabled, and the axis shall be in static status (The change of axis position can be viewed through the "Current Axis Position" column.). If the axis rotates slowly, first tune the "Zero Point Drift Parameter" of the driver. If it has been tuned to the critical point, fine-tune it through the "Zero Point Output Drift Value".

If the driver is not enable after the "Enable Servo" is selected please check the wiring referring to *output. If* the motor is out of control, check "Disable Servo" to disable servo. Then refer to Step 9 in Section 3.1 to reset the "Encoder Feedback Signal Direction".

For SG, SE, SD and SP cards,

Select the option "Axis On/Axis Off" (as illustrated in the right figure, tick for "Axis On" and no tick for "Axis Off"). Now, the driver is enabled, and the axis shall be in static status.

If the driver is not enabled after the "Enable Servo" is selected, please refer *2.3.7.2 Wiring of dedicated output* to check the wiring.

提示 Hint	*If there is an abnormal motion of axis, select ☼ to open the "Set Basic Parameters" interface and click "Reset Overall". Then, the motor will stop and all the motion parameter settings are all lost.*

3.3 Tune PID Parameters

In close-loop positioning system, the motion controller compares the command position (trajectory) to the actual position feedback and calculates a motor control signal. The position error is defined as the difference between the command and actual positions. As the position error increases, the motor control signal increases to counteract the error; the digital filter coefficients (proportional-integral-derivative gain) determine the computation of the value of the motor control signal based on the position error.

Tuning is the process of adjusting these coefficients to provide the best control for a particular system of motors and loads.

For SG, SE, SD and SP cards, and SV card operating in pulse signal output mode, skip this step.

When user uses SV card outputting analog voltage signal to control servo motor, in general, it needs to tune PID (proportional-integral-derivative gain) parameters. Before tuning parameters, set the driver of servo motor as in velocity control mode and tune the parameters of servo driver according to following factors including the coupling mode between the motor and mechanism, load, inertia and mechanical rigidity required, to assure the motor operating in a proper status. (If necessary, user can consult motor supplier or technicians of Googol Technology.) The SV model of motion controller provides the digital filter of PID with velocity and acceleration feed forward, i.e. PID+Kvff+Kaff filter. The filtering parameters include KP (proportional gain), KI (integral gain), KD (derivative gain), Kvff (velocity feed forward gain) and Kaff (acceleration feed forward gain).

There are two methods generally used for tuning these digital filter coefficients; calculation and trial-and-error. Control systems textbooks provide methods for calculation of the tuning parameters for a large variety of applications. Trial-and error has the advantage in that no knowledge of the control system possessive parameters is necessary and no calculations are needed. However, you may need to try a large number of trial parameters to tune a system and some combinations of the parameters may produce an unstable or runaway system. An organized approach to search the best combination of tuning parameters helps shorten the tuning time while avoiding an unstable combination that may damage the system. The following tuning method is what we suggest.

1. Run GTCmdISA_CH to initialize the system.
2. Select the current axis from the “Select Axis” column.
3. Select “Close Loop/Open Loop Servo Control” as illustrated in the right figure.

4. Click “Clear Status” button and view the status of current axis. Assure the axis has no abnormal status.
5. Set Kp = 1, Ki = 0, Kd = 0 and click “Update Parameters” button as illustrated in the right figure.

6. Enable driver and view whether the motor is in static status. If the motor is not static, tune the bias parameter to make the motor static.
7. According to *3.4 Implement single-axis motion in the T-curve motion mode*, set the axis motion. View the situation of the motion of current axis. Increase Kp gradually and update it as Step 5 until the motor begins to shake slightly. During this process, keep Ki and Kd the same.
8. Multiple the Kp value making the axis slight shaking by 0.8. Set the result as the new Kp value and update it. View the overshoot of the motion of the current axis. . If the overshoot is too large, add the Kd value gradually until the overshoot is obviously

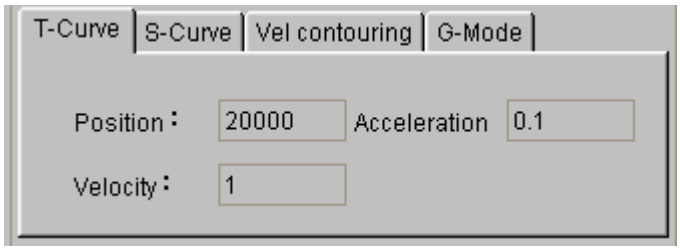
decreased.

9. After the axis motion completes, view whether there is error between the "actual position" and "command position". If there is error, add the Ki value gradually until the position error in the band of ±1 pulse. In the actual system, user shall select an appropriate Ki value according to the requirements for error range and settling time. Please pay attention to that when using the parameter Ki, user must set the integral limit.

3.4 Implement Single-axis Motion in T-curve Motion Mode

The motion controller provides four motion control modes, S-curve, T-curve, independent jogging and electrical gear modes. For their detailed description, please refer to "Programming Manual of GT Series Motion Controllers". Here, we only take the T-curve motion mode for example. For the other modes, user may refer to the .CMD file provided by the DEMO software.

1. Run GTCmdISA_CH and initialize the system, select the control output mode and enable the driver. For SV model of controller, tune PID parameters.
2. Clear the status, confirm the axis has no abnormal status and set "Axis On". The axis should be in static status.
3. Click "Reset Position" button. Check the "Current Position of Axis" is 0.
4. Set the axis motion parameters in the "Motion Control Mode" column as illustrated in the following figure. Set the parameters as required. The unit of velocity is "Pulse/ST", that of acceleration is "Pulse/ST^2", and that of position is "Pulse". For more details, please see Appendix B.



5. Click "Update Parameters" button as illustrated in the following box.

The axis will move to the target position at the setting of velocity and acceleration. Check whether the "current position of axis" is at the target position. If the motion completes, set a new "target position" and click "Update Parameters". The axis will move to the new target position. The range of target position is -1,073,741,824 to 1,073,741,823.

Now, the motion controller has been setup successfully. Next, if you want to use more functions of the controller, the DEMO software GTCmdISA_CH or GT_CmdPCI_CH provided with the controller will facilitate the usage quickly (For detailed usage description, please refer to Appendix E.). To program an application of control system, please refer to "Programming Manual of GT Series Motion Controllers".

Appendix A: Technical Specification

Bus

PC/AT bus: ISA/PC104 and PCI bus

Program Memory

ROM 64K Byte
SRAM 512K Byte

Sampling Rate

200us for SV, SP, SG and SD models of controller
400us for SE model of controller

Analog Output

Number of axes: 4
Voltage Range: -10V to +10V
Resolution: 16bit

Pulse Signal Output

Frequency of output pulse train: 1MHz (Maximum) for SV, SP, SG and SD card
Frequency of output pulse train: 256KHz (Maximum) for SE card
RS-422 line driver, +/-20mA
Duty cycle: 50%
Nonlinear: <1%

Encoder Signal Interface

6 quadrature incremental encoder inputs
Maximum counting frequency: 8MHz

Asynchronous Serial Port

1 channel of RS-232 (RX, TX, GND)

Synchronous Serial Port

1 channel (DT, DR, SCLK, TFS, GND)
Transferring speed: 2MHz

I/O: 56 channels, TTL compatible, no Pull-up Resistor

Dedicated input:	Positive limit switch	4 channels
	Negative limit switch	4 channels
	Home switch	4 channels
	Driver alarm	4 channels
Dedicated output:	Enable signal	4 channels
	Reset alarm signal	4 channels

Uncommitted input: 16 channels
Uncommitted output: 16 channels

Power Consumption

+5V Icc=1.5A
+12V Icc=30mA
-12V Icc=30mA

Dimension

122mmX185mm

Operating Temperature

0-60℃ （32℉-140℉）

Relative Humidity

5%-90%, no dew

GT-400-ACC2 Terminal Board

Optical- Isolated I/O

Specification for opto-isolated input:

Isolation voltage: 5000V RMS
Input voltage: +12V～+24VDC
Input current: 3.7mA～7.6mA
Set time: H→L 5us
L→H 3us

Specification for opto-isolated output:

Isolation voltage: 5000V RMS
Open-Collector output, without pull-up resistor
Vceo ≤ 50V
Veco ≤ 5V
Ic ≤ 30mA
Average set time: 8us

A/D Converter

Connect with the motion controller through the synchronous serial port.
Number of input channels: 8 (single-ended and bipolarity)
Input voltage range: -10V to +10V
Resolution: 12bit
Accuracy: +/-1bit
Maximum sampling rate: 50KHz (single channel)

Power Consumption

+12V DC Icc=1A
+24V DC Icc=1.8A

Dimension

220mm□132mm

Appendix B: Setting of Position, Velocity and Acceleration

Since most servo drivers have the frequency multiplying function and the motion controller has the quadrature of encoder feedback signal, the setting of the position, velocity and acceleration of the motion controller will be different for different control systems. This chapter conducts the calculation formulas one by one, which can be used by user directly to set the parameters on the position, velocity and acceleration.

Denoted the required motion velocity by V (m/min), acceleration by a (m/s^2), and the target position (absolute position) bys (mm). We denote the pitch of lead screw by L (mm/r), the amount of pulses per revolution by p, gear ratio by n (When the motor is coupled with the lead screw directly, the gear ratio = 1.) and multiplier of pulse output of the driver by m. We denote the parameters of the motion controller as following: the target position by Pos (Pulse), target velocity by Vel (Pulse/ST), target acceleration by acc ($Pulse/ST^2$) and control period ST by t (μs).

B.1 Setting of Position

For a close-loop control system of servomotor by using SV card (the driver operates in the velocity control mode.), we have

$$Pos = \frac{4 * p * s}{L}(Pulse)$$

For an open-loop control system of servomotor by using SV, SG, SP, SE and SD cards (The driver operates in the position control mode.), we have

$$Pos = \frac{m * p * s}{L}(Pulse)$$

For an open-loop control system of step motor by using SV, SG, SP, SE and SD cards, we have

$$Pos = \frac{p * s}{L}(Pulse)$$

B.2 Setting of Velocity

For a close-loop control system of servomotor by using SV card (the driver operates in the velocity control mode.), we have

Rotation speed of lead screw is $\frac{V(m/\min)}{L(mm/r)} = \frac{V*10^3}{L}(r/\min)$

Assume that gear ratio is n, then rotation speed of motor is $\frac{V*10^3*n}{L}(r/\min)$.

Since the encoder feedback signal from the motor is quadrature, and assume that the number of pulses per revolution of the motor is p, then the number of pulses per revolution to be set as 4p.

Hence the setting of the velocity will be

$$Vel = \frac{V*n*4p*10^3}{L}(Pulse/\min)*\frac{1}{60*10^6}(\min/\mu s)*t(\mu s/ST)$$

$$\boxed{Vel = \frac{V*n*4p*t}{L*6*10^4}(Pulse/ST)}$$

For an open-loop control system of servomotor by using SV, SG, SP, SE and SD cards (the driver operates in the position control mode.), we have

Assume that the multiplying coefficient of the pulse from the driver is m, and the number of pulse per revolution is m*p. Then the setting of velocity will be

$$\boxed{Vel = \frac{V*n*m*p*t}{L*6*10^4}(Pulse/ST)}$$

For an open-loop control system of step motor by using SV, SG, SP, SE and SD cards, we have

Assume that the number of pulse per revolution is p, then the setting of the velocity will be

$$\boxed{Vel = \frac{V*n*p*t}{L*6*10^4}(Pulse/ST)}$$

B.3 Setting of Acceleration

For a close-loop control system of servomotor by using SV card (the driver operates in the velocity control mode.), we have

Angular acceleration of the lead screw is $\frac{a(m/s^2)}{L(mm/r)} = \frac{a*10^3}{L}(r/s^2)$

Denoted the gear ration by n, then the angular acceleration of motor is $\frac{a*10^3*n}{L}(r/s^2)$

Since the encoder feedback signal from the motor is quadrature, and assume that the number of pulses per revolution of the motor is p, then the number of pulses per revolution to be set as 4p.

Hence the setting of the acceleration will be

$$acc = \frac{a*n*4p*10^3}{L}(Pulse/s^2)*\frac{1}{(10^6)^2}(s^2/\mu s^2)*t^2(\mu s^2/ST^2)$$

$$acc = \frac{a * n * 4p * t^2}{L * 10^9} (Pulse / ST^2)$$

For an open-loop control system of servomotor by using SV, SG, SP, SE and SD cards (the driver operates in the position control mode.), we have

Assume that the multiplying coefficient of the pulse from the driver is m, and the number of pulse per revolution is m*p. Then the setting of velocity will be

$$acc = \frac{a * n * mp * t^2}{L * 10^9} (Pulse / ST^2)$$

For an open-loop control system of step motor by using SV, SG, SP, SE and SD cards, we have

Assume that the number of pulse per revolution is p, then the setting of the velocity will be

$$acc = \frac{a * n * p * t^2}{L * 10^9} (Pulse / ST^2)$$

Example 1: Assume that a close-loop control system of servo motor is controlled by a SV card and the driver operates in velocity control mode. Assume V=30m/min; a=10m/s^2; s=100mm; n=1; P=2500 (Pulse/r); L=5mm/r; t=200us, then the setting of the acceleration and velocity of the controller will be

$$Pos = \frac{4 * 2500 * 100}{5} = 200000(Pulse)$$

$$Vel = \frac{30 * 1 * 4 * 2500 * 200}{5 * 6 * 10^4} = 200(Pulse / ST)$$

$$acc = \frac{10 * 1 * 4 * 2500 * 200^2}{5 * 10^9} = 0.8(Pulse / ST^2)$$

Example 2: For an open-loop control system of servomotor controlled by SV, (or SG, SP, SE and SD) card, and the driver operates in position control mode. Assume V=30m/min; a=10m/s^2; s=100mm; n=1; P=2500 (Pulse/r); L=5mm/r; t=200us, then the target position, acceleration and velocity of the controller will be

$$Pos = \frac{4 * 2500 * 100}{5} = 200000(Pulse)$$

$$Vel = \frac{30 * 1 * 4 * 2500 * 200}{5 * 6 * 10^4} = 200(Pulse / ST)$$

$$acc = \frac{10*1*4*2500*200^2}{5*10^9} = 0.8(Pulse/ST^2)$$

Example: For an open-loop control system of step motor controlled by SV (or SG, SP, SE and SD) card, assume V=30m/min; p=2500(Pulse/r); s=100mm; n=1; L=5mm/r; a=10m/s^2; t=200us,then the target position, acceleration and velocity of the controller will be

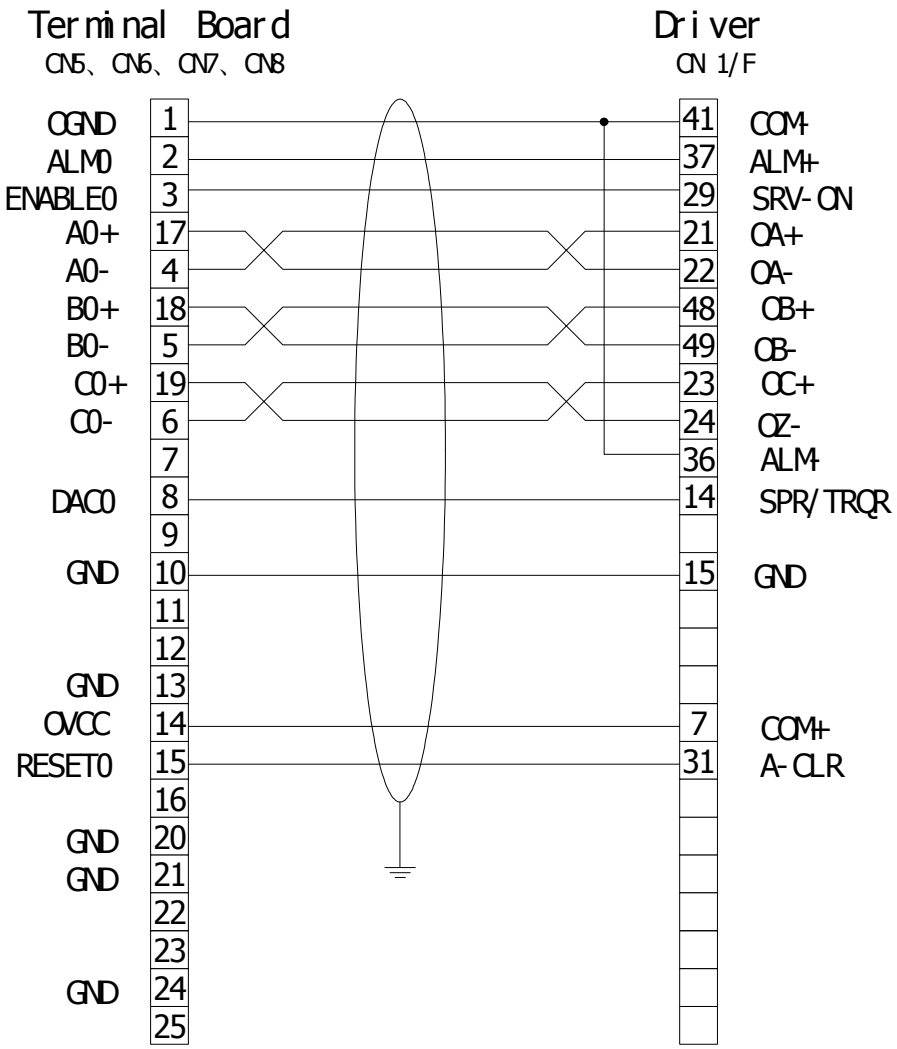
$$Pos = \frac{2500*100}{5} = 50000(Pulse)$$

$$Vel = \frac{30*1*2500*200}{5*6*10^4} = 50(Pulse/ST)$$

$$acc = \frac{10*1*2500*200^2}{5*10^9} = 0.2(Pulse/ST^2)$$

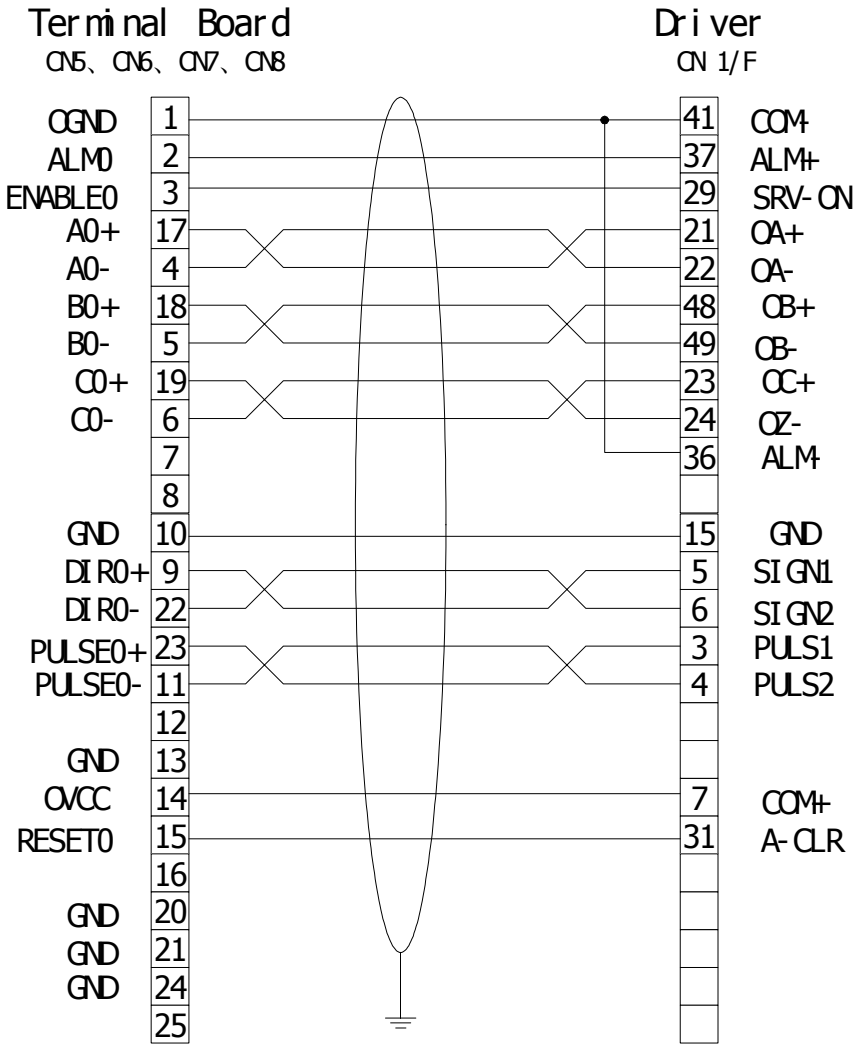
Appendix C: Typical Wiring

C.1 Wiring diagram of Panasonic MSDA series driver in velocity control mode.



Wiring Diagram of Panasonic Driver in Velocity Mode

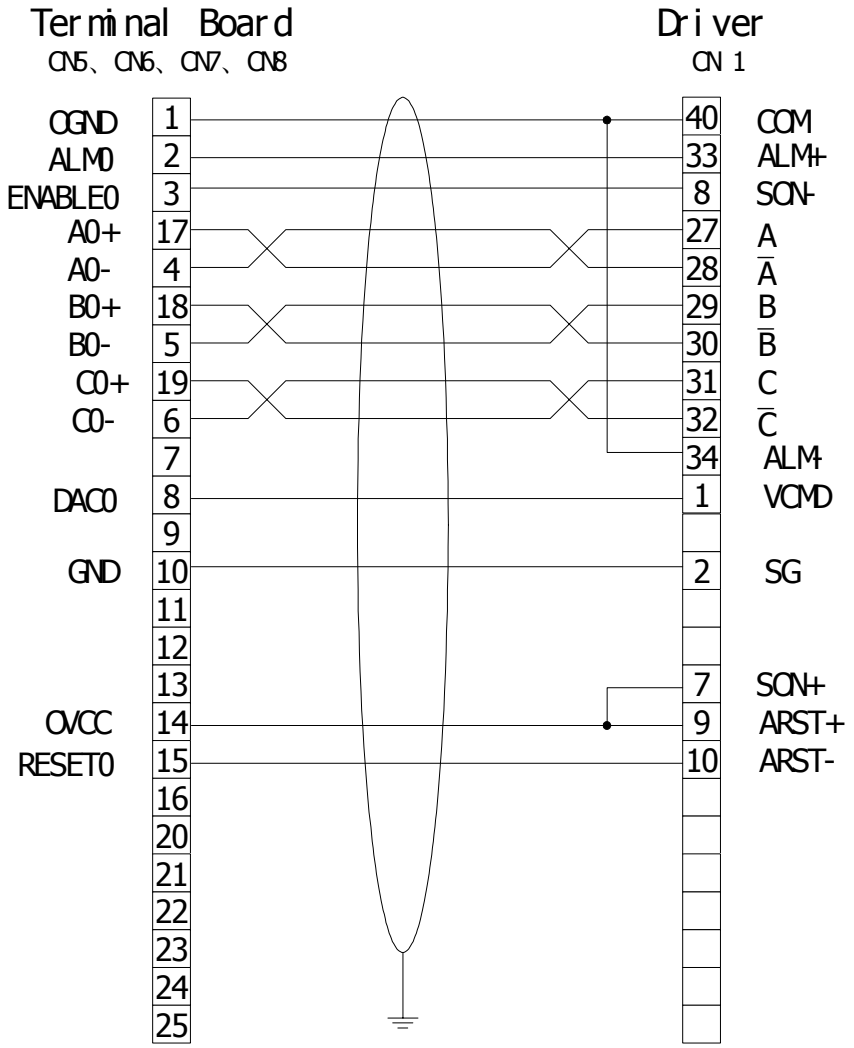
C.2 Wiring diagram of Panasonic MSDA series driver in position control mode.



Wiring Diagram of Panasonic Driver in Position Mode

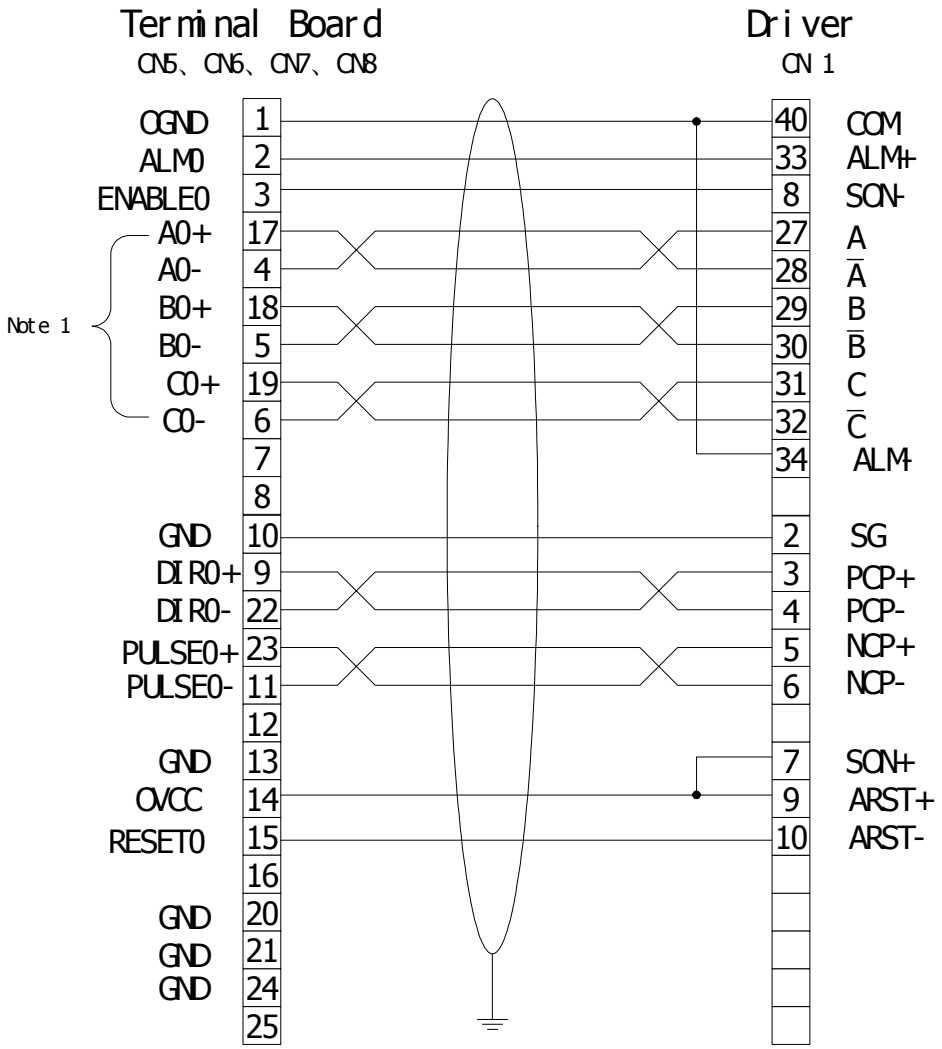
Note 1: For SG, SD and SE cards, the encoder feedback is not to be connected, and can be suspended.

C.3 Wiring diagram of SANYO DENKI PV1 series driver in velocity control mode.



Wiring Diagram of SANYO DENKI PV1 Driver in Velocity Mode

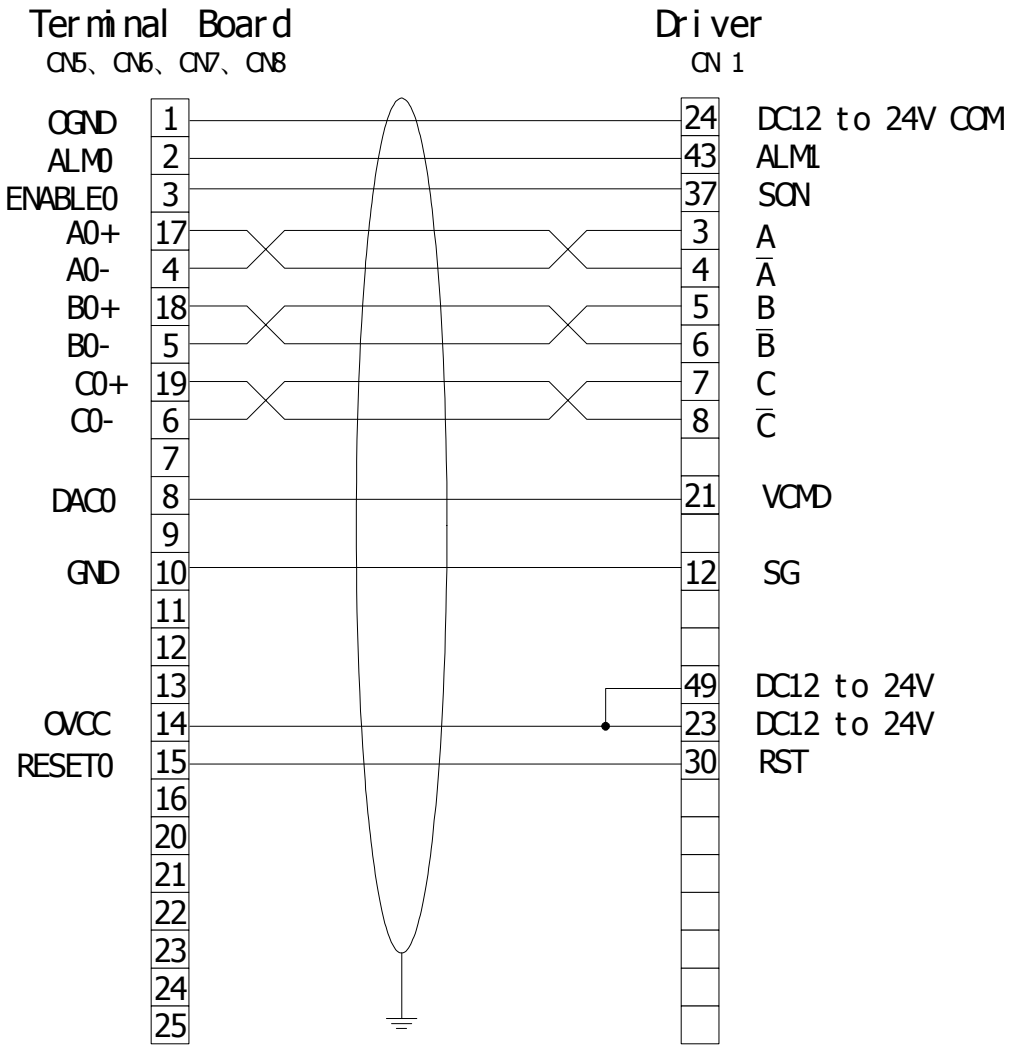
C.4 Wiring diagram of SANYO DENKI PV1 series driver in position control mode.



Wiring Diagram of SANYO DENKI PV1 Driver in Position Mode

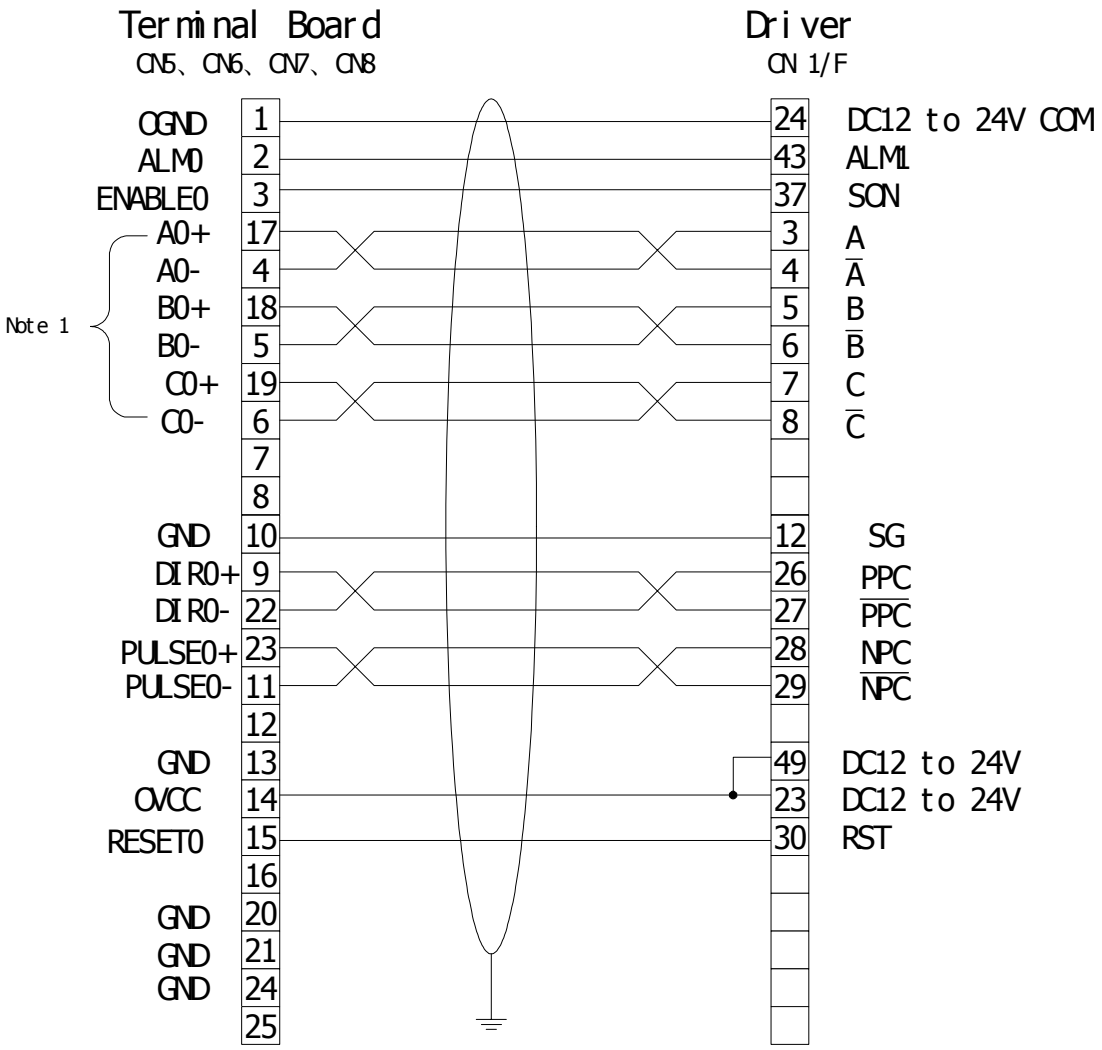
Note 1: For SG, SD and SE cards, the encoder feedback is not to be connected, and can be suspended.

C.5 Wiring diagram of SANYO DENKI PY0/PY2 series driver in velocity control mode



Wiring Diagram of SANYO DENKI PY0/PY2 Driver in Velocity Mode

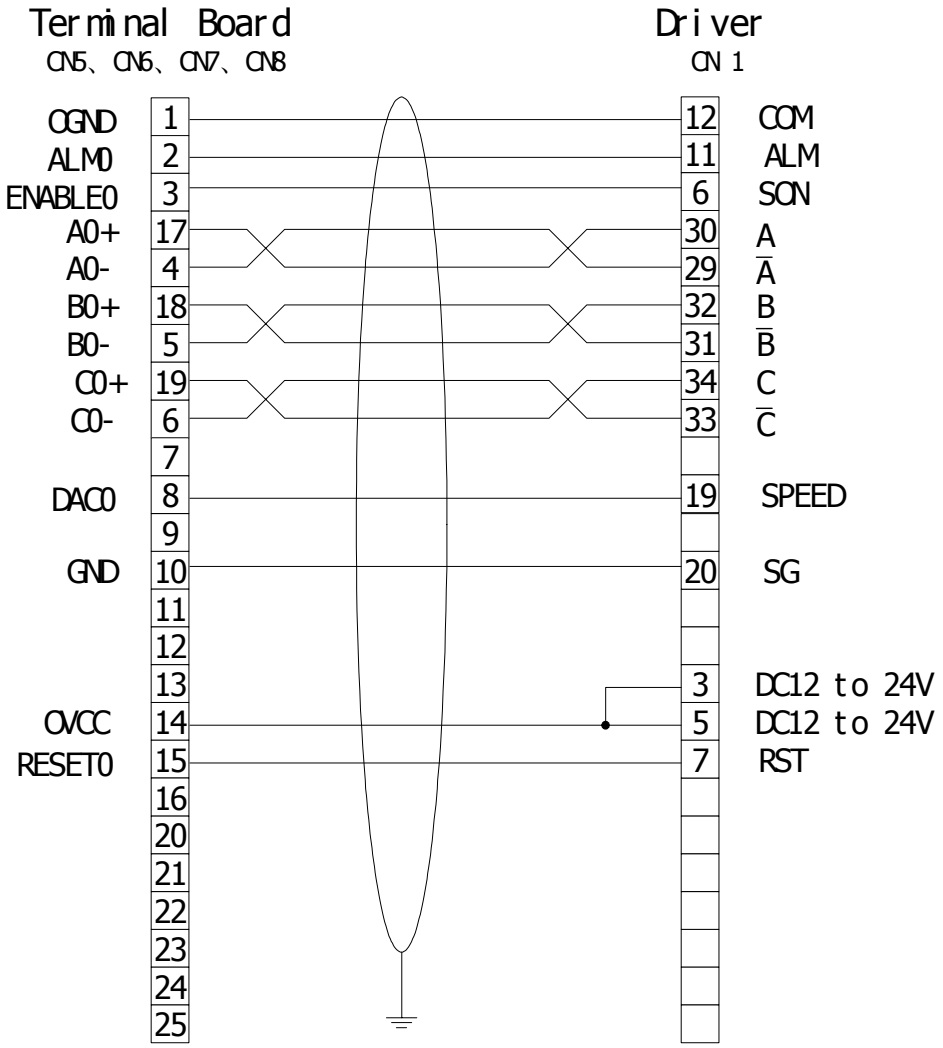
C.6 Wiring diagram of SANYO DENKI PY0/PY2 series driver in position control mode.



Wiring Diagram of SANYO DENKI PY0/PY2 Driver in Position Mode

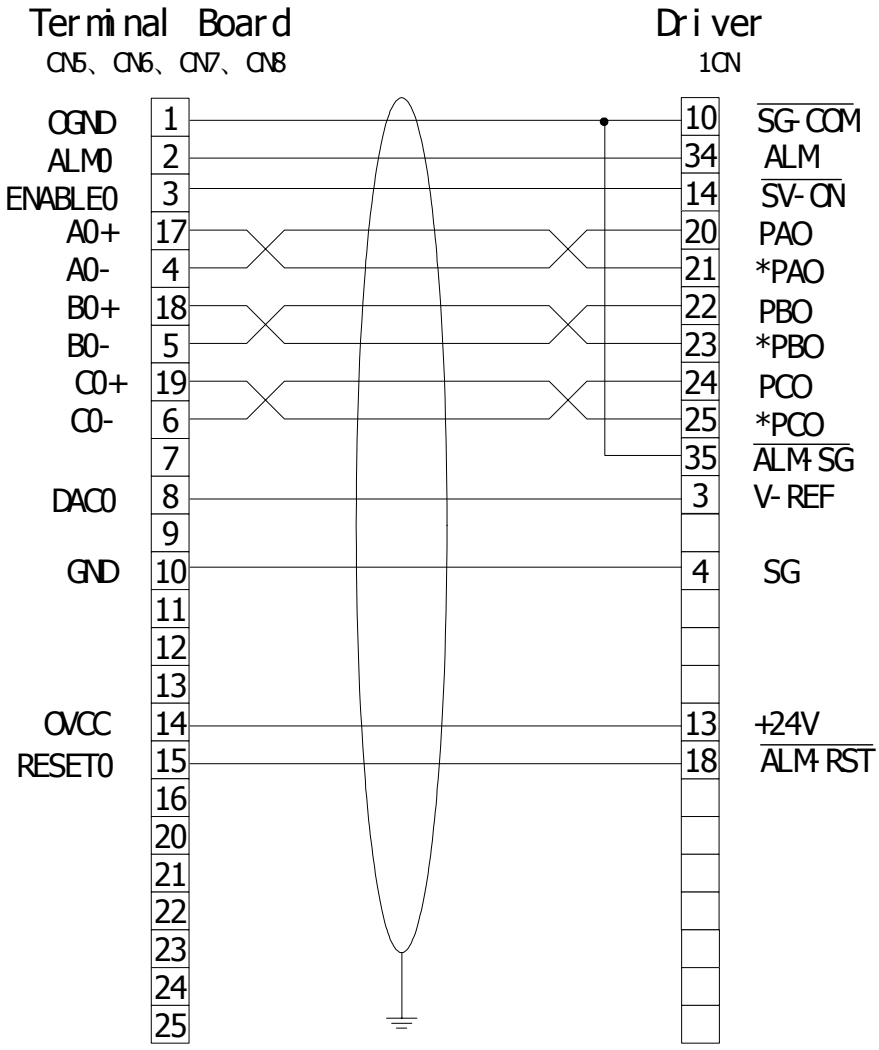
Note 1: For SG, SD and SE cards, the encoder feedback is not to be connected, and can be suspended.

C.7 Wiring diagram of SANYO DENKI PU series driver in velocity control mode.



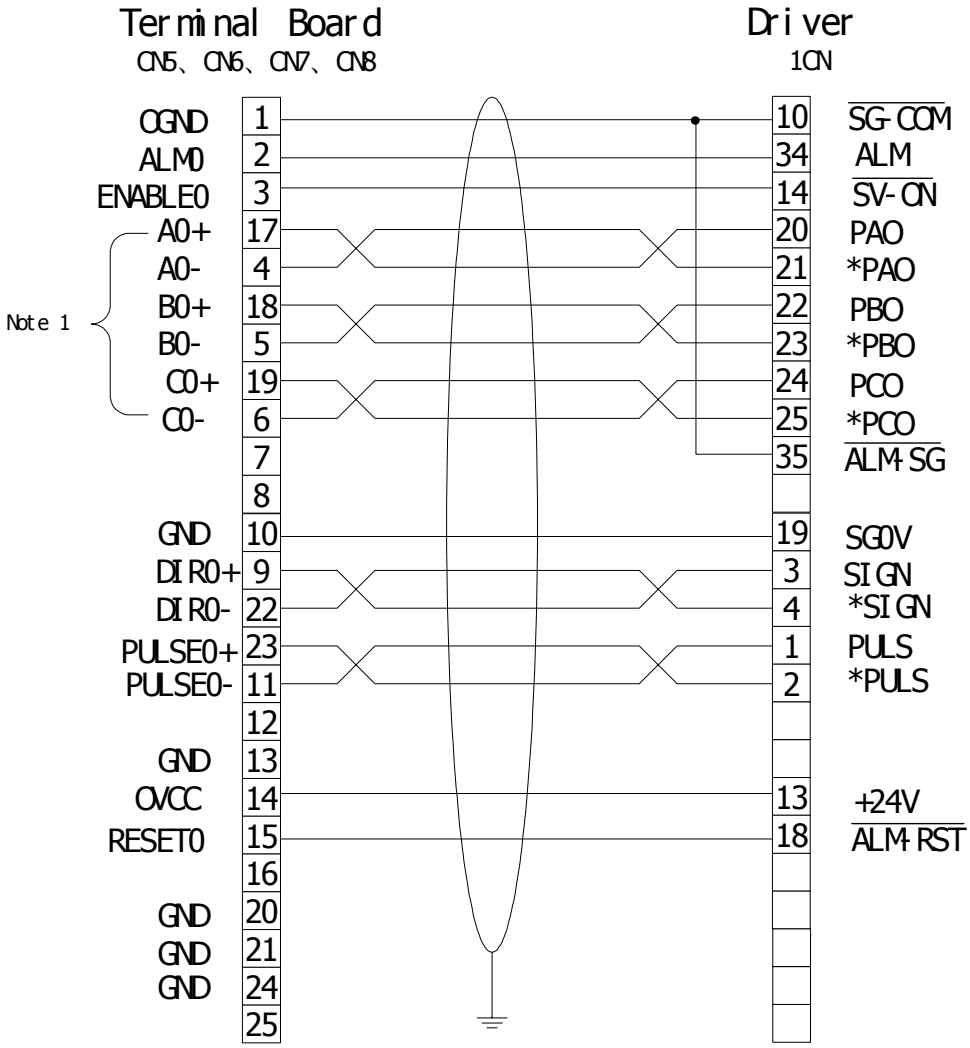
Wiring Diagram of SANYO DENKI PU Driver in Velocity Mode

C.8 Wiring diagram of YASKAWA SERVOPACK series driver in velocity / torque control mode.



Wiring Diagram of YASKAWA SERVOPACK SGDA-xxxS Series Driver in Velocity/Torque Mode

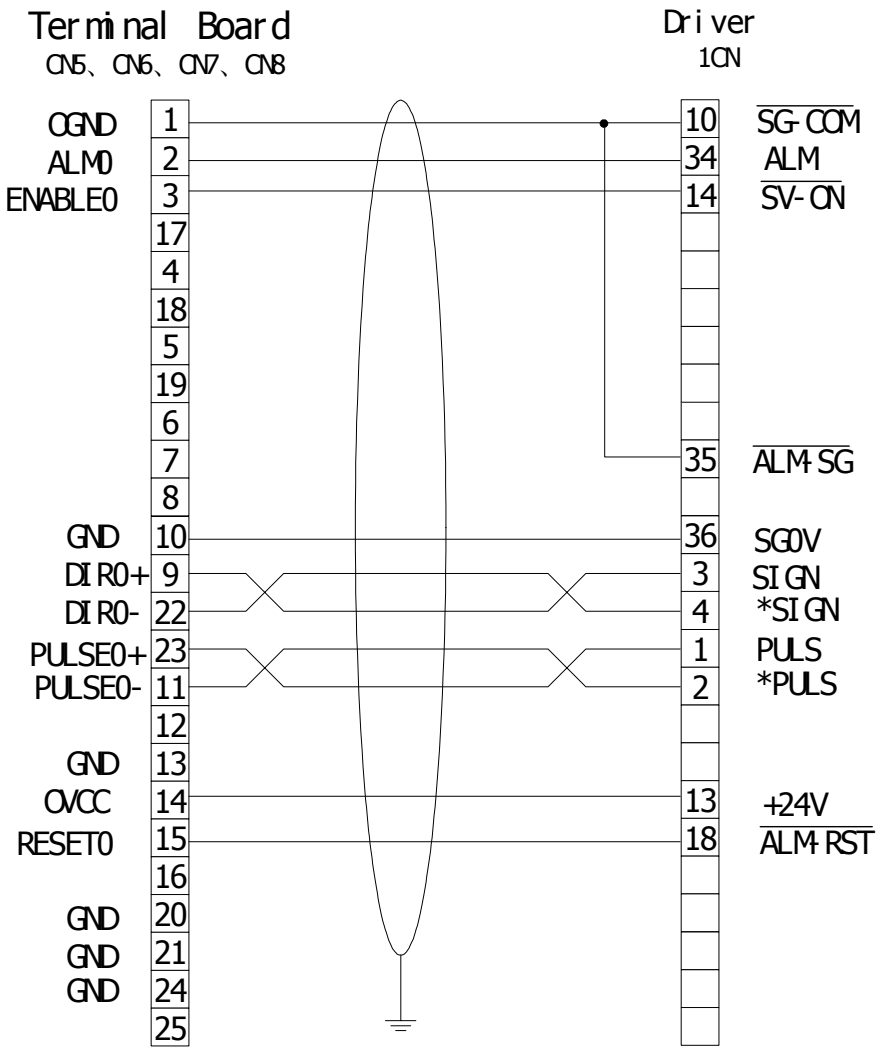
C.9 Wiring diagram of YASKAWA SERVOPACK series driver in position control mode.



Wiring Diagram of YASKAWA SERVOPACK SGDA-xxxP Series Driver in Position Mode

Note 1: For SG, SD and SE cards, the encoder feedback is not to be connected, and can be suspended.

C.10 Wiring diagram of YASKAWA SGDE series driver in position control mode.



Wiring Diagram of YASKAWA SERVOPACK SGDE-xxxP Series Driver in Position Mode

Appendix D Troubleshooting

Table D.1 Troubleshooting Methods for Motion Controller

Trouble	Cause	Action
After motion controller is installed, the host PC cannot start or other hardware equipment in the host PC cannot work normally.	Addresses conflict.	Reset base address selection switch according to Section 2.3 Chapter Two.
	Motion controller is not installed properly.	Reinstall motion controller.
	Interrupt conflicts.	Reset interrupt source selection jumper.
	ISA bus interface is damaged.	Replace motion controller or computer or ISA slot and retry.
Error in communication between host PC and motion controller.	See trouble that the host PC cannot start.	Same as above.
	The chip of motion controller is damaged.	Replace motion controller.
	Version of motion controller is not correct.	Replace motion controller or Windows driver, function library and dynamic link library (DLL).
The motor is out of control.	Motion controller always receives limit status of positive limit switch and negative limit switch, i.e. the setting of effective level of limit switch is not correct.	Reset the effective level of limit switch.
	Axis is closed	Evoke GT_AxisOn() to open the axis.
	Motor driver alarm signal triggered	Check cause of alarm. Reset motor driver.
	Motor controller has abnormal work status.	Check status and change it.
	Wiring of motor is wrong.	Check the wiring according to the wiring diagram in User Manual.
	Grounding is wrong.	Checking grounding
	The torque of motor is too small.	Check motor driver.
Stepper motor lose t step.	The output frequency of pulse is too high.	Decrease motion speed and set running parameters according to specification of step motor used.
Motor vibration	The output frequency of pulse is too low.	Increase motion speed and set running parameters according to the lowest frequency of the step motor used.

When motor driver (without servo on signal) powered on, power on host PC will cause motor to move suddenly.	Motion controller is in uncertain status when power on and motor will receive signal from motion controller.	Before power on host PC, make sure motor driver has been powered off.
Input/output status of motion controller is wrong.	Incorrect wiring.	Check wiring
	No external power is supplied.	Check external power supply.
	Grounding is wrong.	Connect grounding again.
	Input/output channel of motion controller is damaged.	Replace motion controller.

Appendix E Usage of GT Commander

GT Commander is a program for the function demo and test of the motion controller. From this demo program, user can find a short way to quickly master the functions and commands of GT400 motion controller, and directly run the batch program of GT commands to implement simple motion control. TGT Commander R3.1 has ISA bus and PCI bus versions. It can be run in WINDOWS98 and WINDOWS2000.GTCmdISA.exe is applicable to the controller with ISA bus, i.e. GT-400-SV-ISA, GT-400-SG-ISA and GT-400-SP-ISA. GTCmdPCI.exe is applicable to the controllers with PCI bus, i.e. GT-400-SV-PCI, GT-400-SG-PCI and GT-400-SP-PCI. These two versions of execution program are almost same. The difference is that the methods of opening devices. The details will be given in the following.

Before running GT Commander, make sure that the relevant driver has been installed correctly. Otherwise, GT Commander cannot start.

 **Warning**	*GTCmdISA.exe/GTCmdPCI.exe, GT400.dll, GTDll.dll, G.avi, GTCndLib.dll and Prog.dll must be located in the same directory. If any one of these six files is moved or deleted, the demo program cannot be run.*

E.1 GT Commander Windows and Basic Operation

GT Commander demo program runs in a resolution of 800×600 (or above). When it running, the program will create a text document for user to edit document of GT command (*.cmd) or other plain text documents (*.txt，*.ini, etc.), and also open a control window. By setting “Options” in the dialog box, user can select to create a document or not, to open a control window or not, and to open which control window. The main windows of this program are illustrated as following.

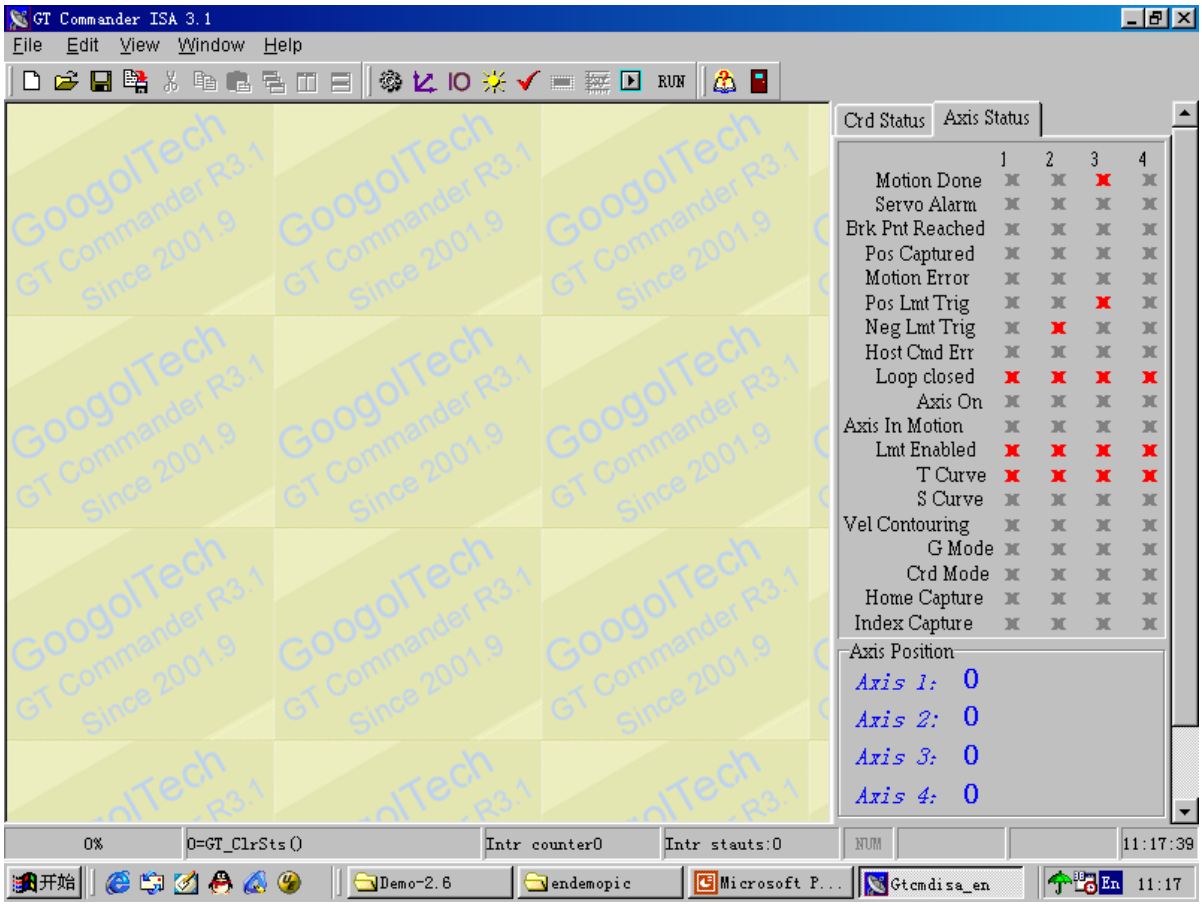


Fig. E-1 Software Starting Window

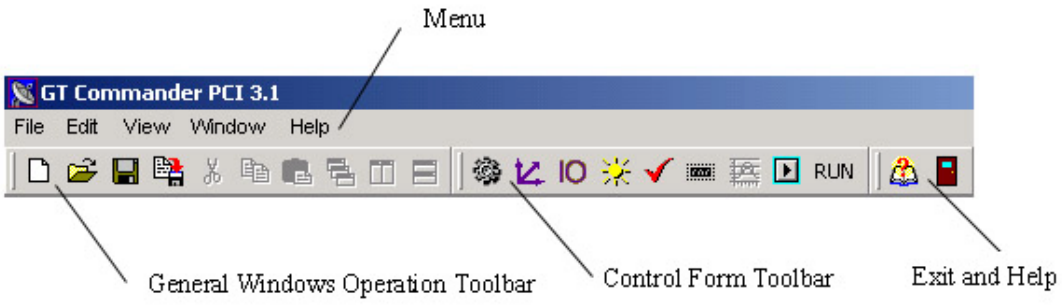


Fig. E-2 Menus and Toolbars

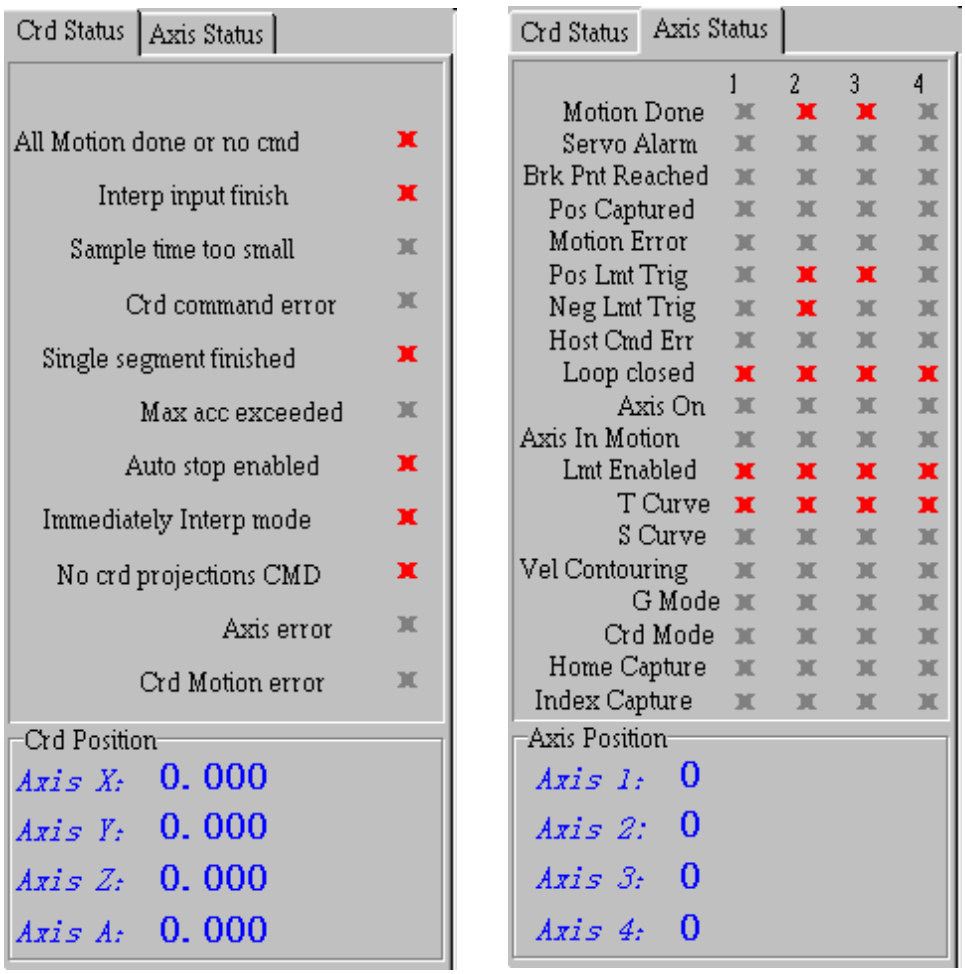


Fig. E-3 Status Window

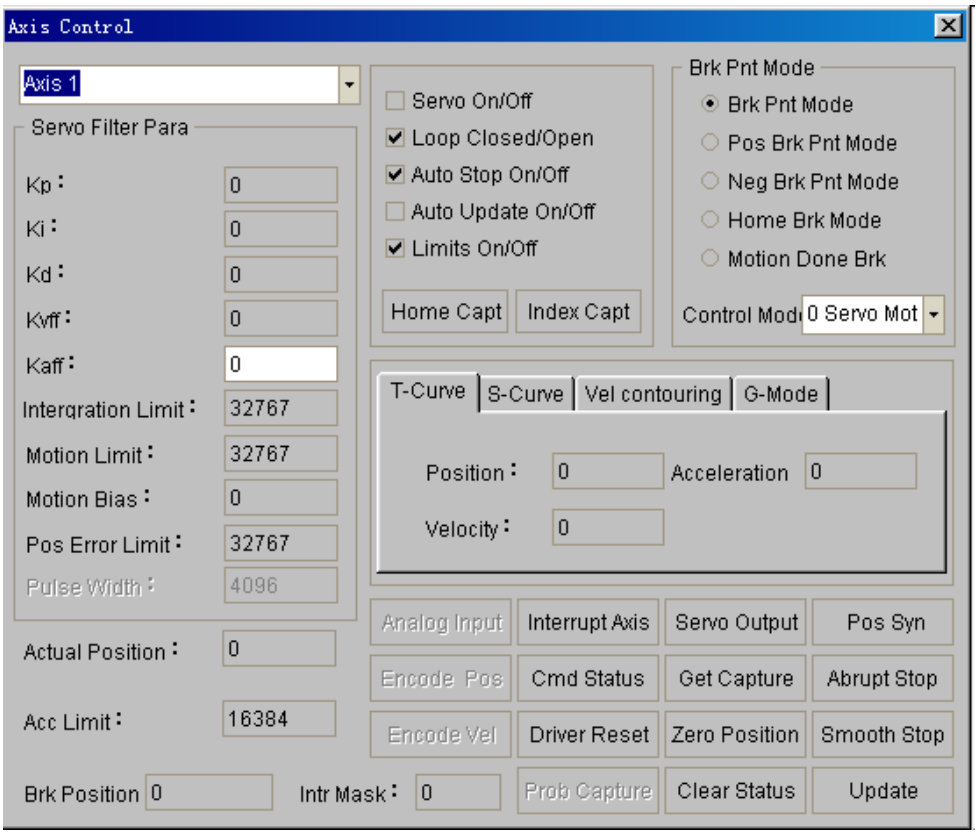


Fig. E-4 Axis-based Control (for SV Card)

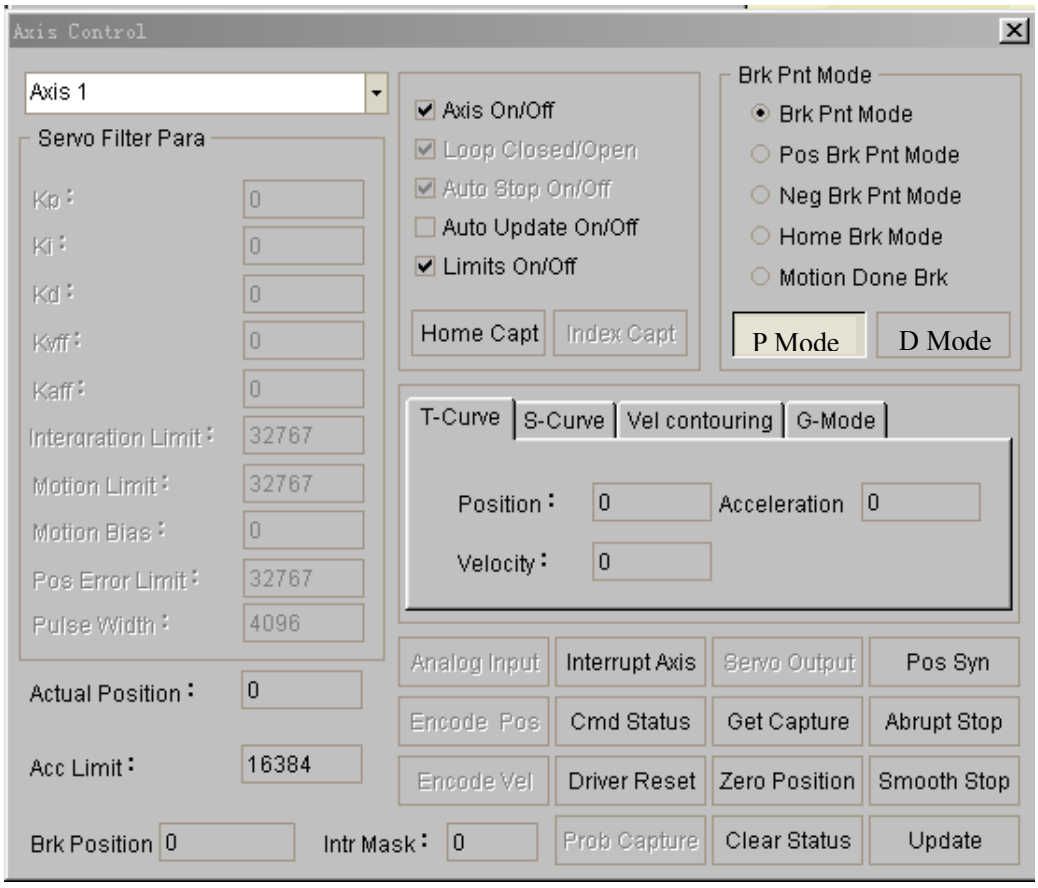


Fig. E-5 Axis-based Control (for SG Card)

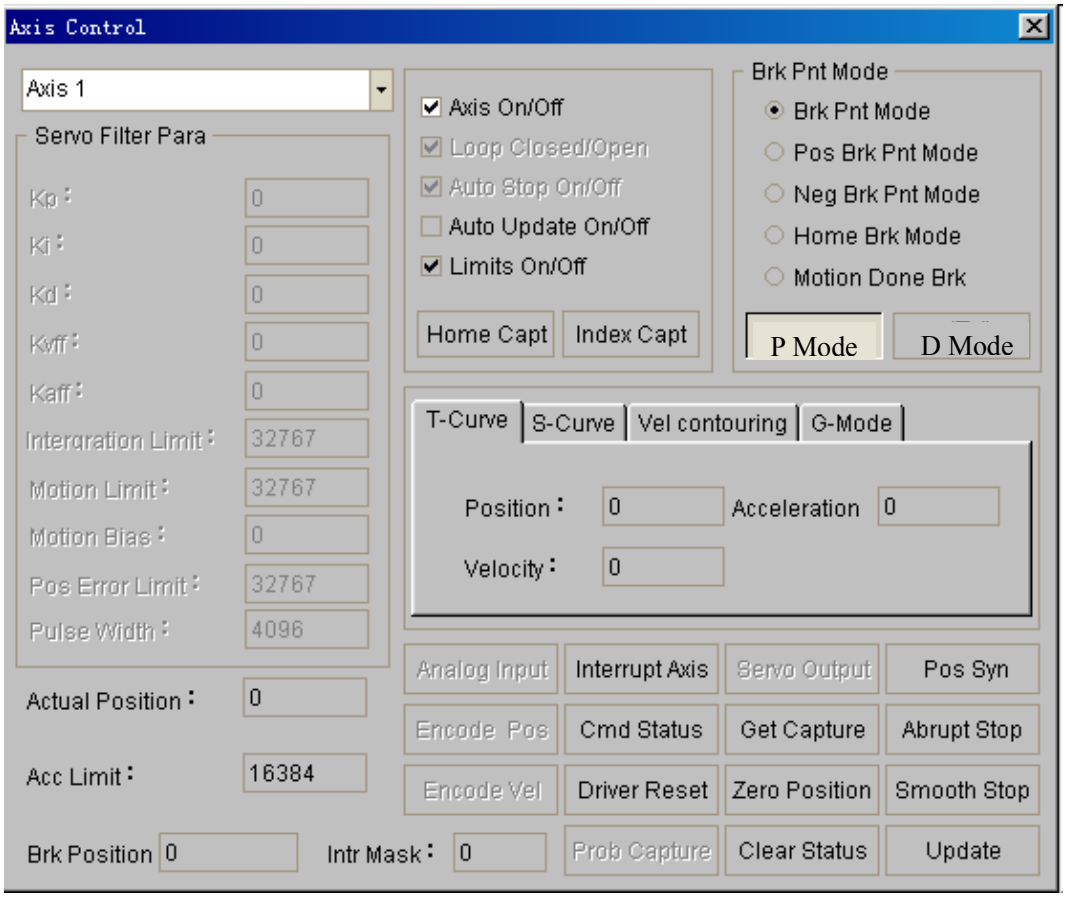


Fig. E-6 Axis-based Control (for SP Card)

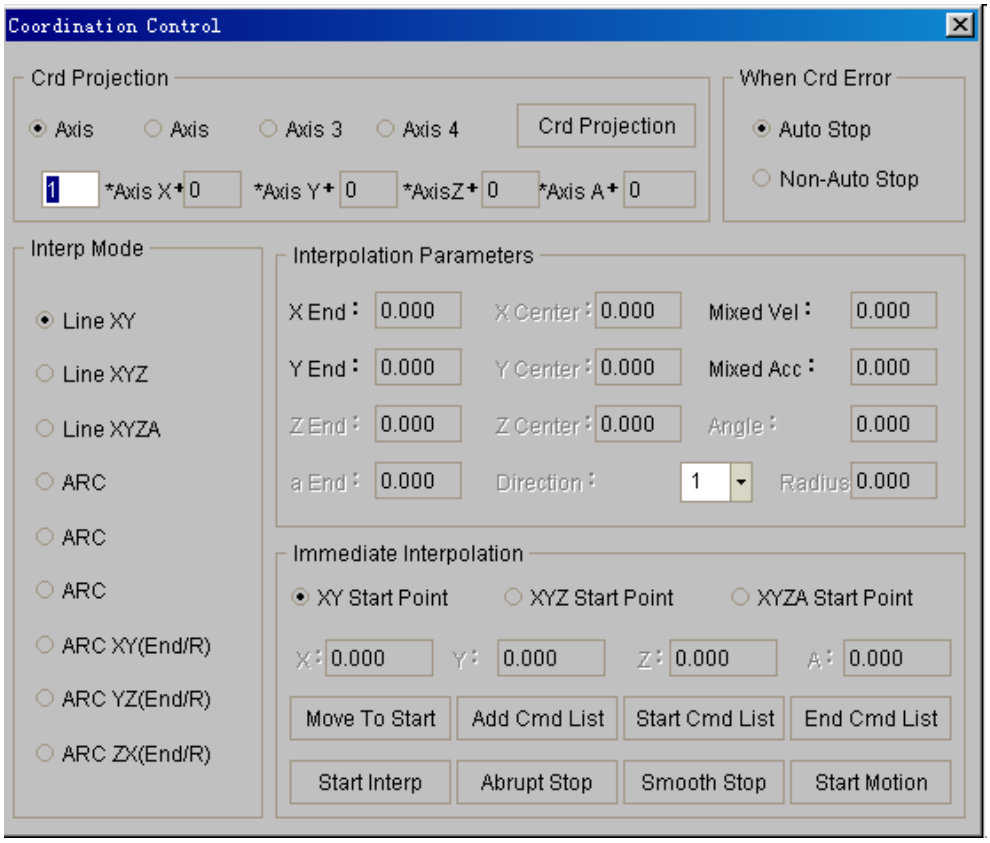


Fig. E-7 Control Based on Coordinate System

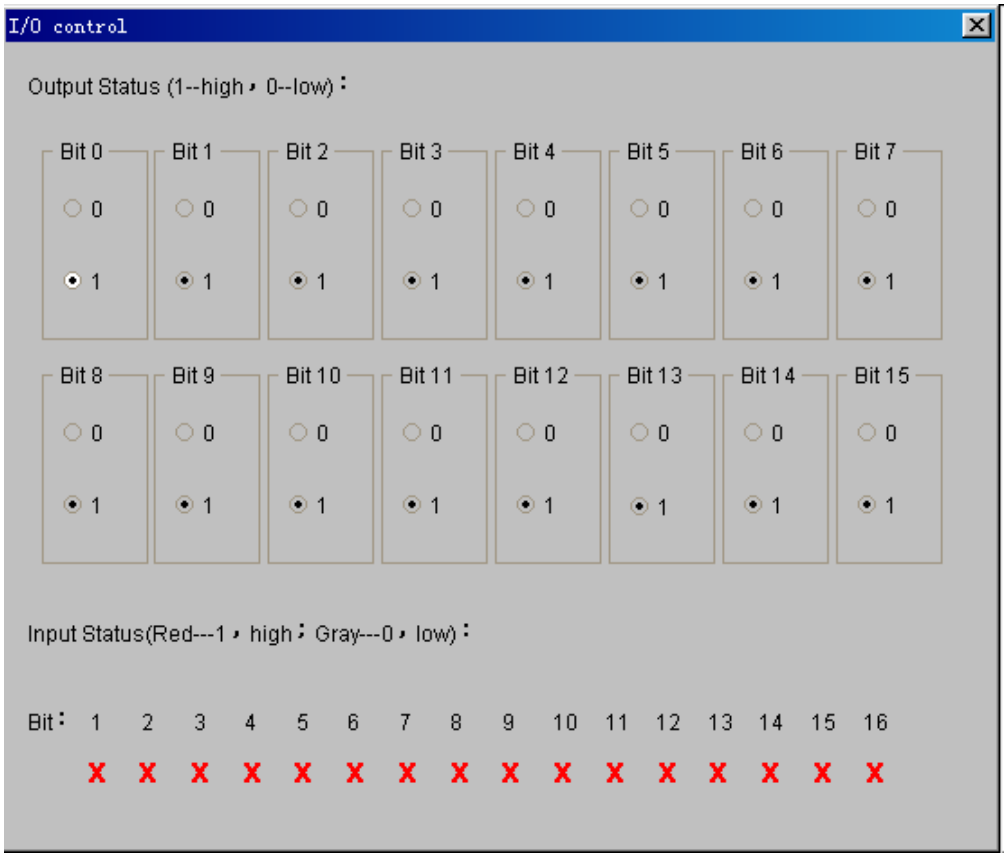


Fig. E-8 Input/Output Control

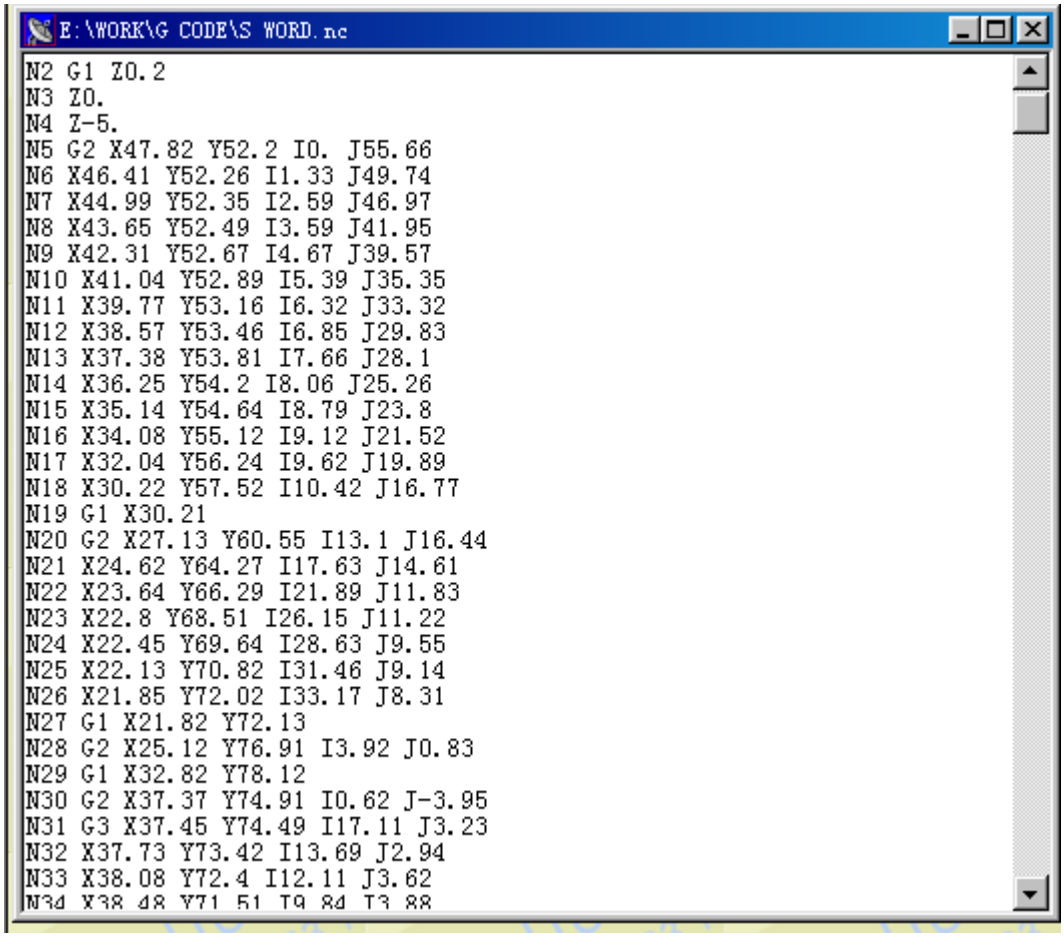


Fig. E-9 Edit and Run GT Commands

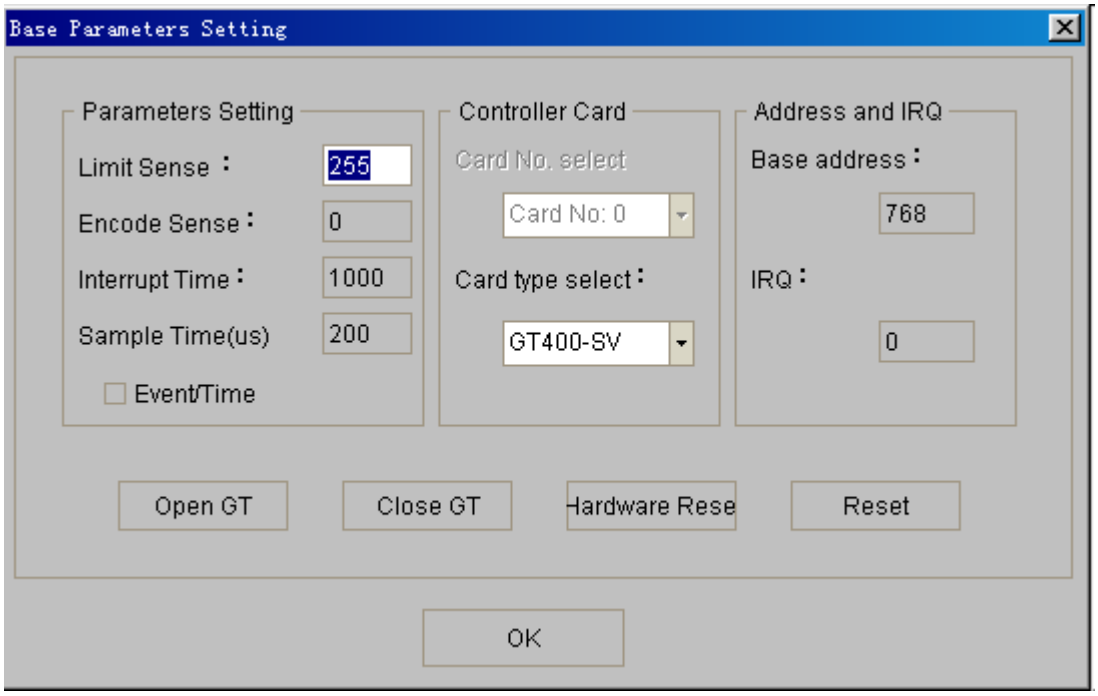


Fig. E-10 Set Basis Parameters

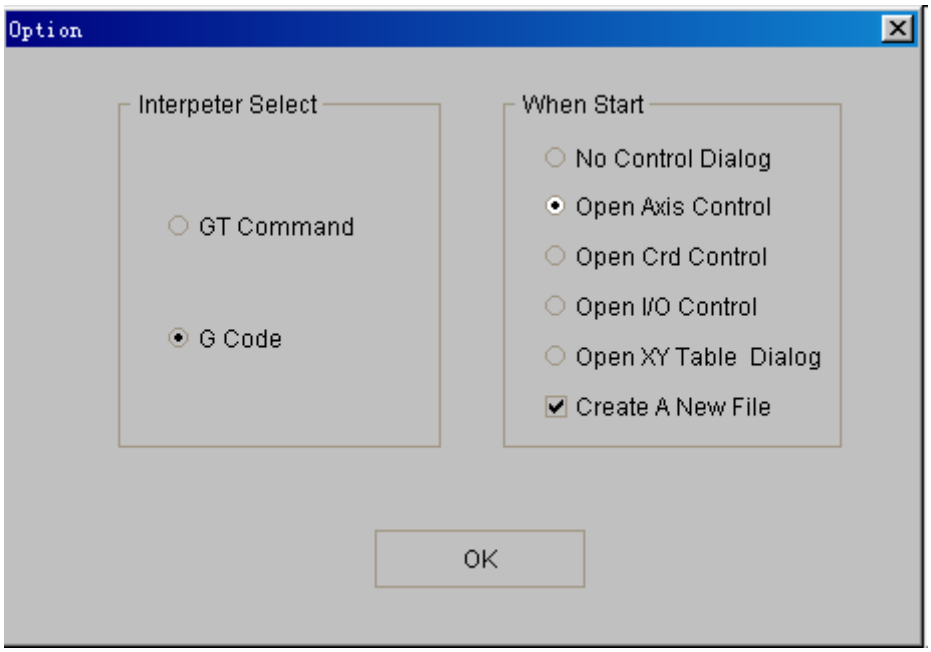


Fig. E-11 Options

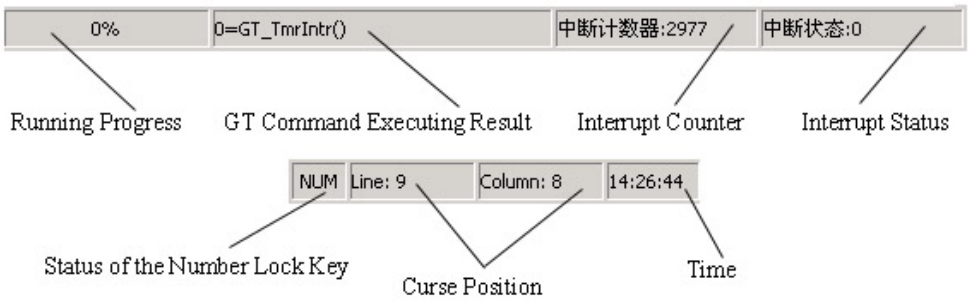


Fig. E-12 Status and Menu

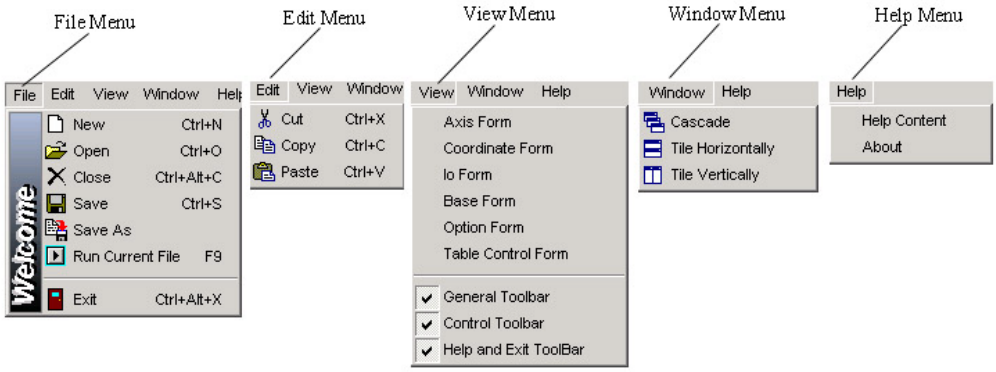


Fig. E-13 Menus

E.1.1 Menus and Toolbars

The File Management buttons are to open, save files and do other operations on file. The Clipboard buttons are to operate the clipboard. The File Window buttons are to rearrange the windows. The Control Window and Options window buttons are to display each control and option dialog boxes. The Running button is to run the GT batch program. The About and Exit buttons are to display the "About" window and exit the software. The menus are corresponding to all these buttons one by one. Please see Fig. *E-2* and *E-12*.

E.1.2 Display System Status

After the software runs, the system status display Window will show the values and status of the status register, mode register and coordinate system status register of each axis of the motion controller, and display the positions of axis and coordinate system in real time. Please see Fig. *E-3*.

E.1.3 Axis-based Control

This window is to control a single axis. Generally the process of controlling a single control axis is as follows.

Select the axis to be controlled. Set such parameters as those of servo filter (for SV card), motion mode, velocity, acceleration and target position. Tick Servo On/Off, clear the status, and update each parameter to start the motion of axis. The functions of SV, SG and SP models of control cards of GT400 series are different from each other. Please see Fig. *E-4*, *E-5* and *E-6*.

E.1.4 Control Based on Coordinate System

This window is to control the motion in the coordinate system. When the system is in the coordinate system motion control mode, the process of controlling motion is as follows. First to make sure that the parameters of the filters of all the axes in the coordinated system have been set in the Axis-based Control window and all axes are on. Map coordinates in the "Map Coordinate" box. Input interpolation instruction into the "Interpolation Instruction" box and click "OK" to start interpolating motion immediately. Another way is to input interpolation instruction into the interpolation instruction buffer, and then start interpolating motion in the buffer. Please see Fig. *E-7*.

E.1.5 Input/Output Control

This window is for I/O control. Please see Fig. *E-8*.

E.1.6 Edit and Run GT Commands

User can program a GT command in this window to realize the batch processing of GT commands. Click "Run" and the software will check the command one line by another. When the command and parameters are all legal, the running will continue. If something is wrong, the software will stop at the statement having error. Note that, only one statement is allowed in a line. User may program GT command according to the sample program. Please see Fig. *E-9*.

E.1.7 Set Basic Parameters

This window is to set such parameters as the Effective voltage level of limit switches (LmtSns), encoder direction (EncSns), sampling period (SmplTm) and timer interrupt period (IntrTm), and also to open, close and reset the controller. For GT400 card with ISA bus, user must specify the base address and interrupt number of the controller. But for GT400 card with PCI bus, user does not need to set such parameters. User can install 16 PCI bus controllers into a PC but only two ISA bus controllers in a PC. Please see Fig. *E-10*.

Since the effective voltage level of limit switch (LmtSns), encoder direction (EncSns), sampling period (SmplTm) and timer interrupt period (IntrTm), as well as card type, base address (for ISA card) and interrupt number (for ISA card) are all the basic parameters of the motion control system, it generally requires user to set them when starting the demo program each time. To make the use easy, the demo software saves the card No. 1 in the GTCmd.ini file, i.e. saving these basic parameters, and set these parameters automatically when the software starts. To change the basic parameters setting when starting the program, user may change the set value of relevant parameter in the GTCmd.ini file.

E.1.8 Options

This window is to specify whether to create a new file, open a control window or which control window to open when starting the program next time. Please see Fig. *E-11*.

E.1.9 Status Column

There is a status column at the bottom of the main window, consisting of four parts, to display the basic operation, GT command execution result, interrupt timer and interrupt status. Please see Fig. *E-12*.

E.2 Operation Samples

 **Notice**	*The following samples are based on the four-axis demo system. When referring to them, user should consider one's own system condition.*

E.2.1 Let Axis 3 to follow Axis 4 in the electrical gear motion mode with an electrical gear ratio of 0.3. Axis 4 rotates to CW direction by 300000 steps.

- Start GT Commander. If the basic parameters setting automatically when starting the software are not consistent with the actual situation, open the Set Basic Parameters window to set proper basic parameters (the effective electrical level of journey switch and encoder direction).
- Set Axis 3 in the axis control window.
- Set the proportional gain as 10 in the "Set Servo Filter Parameters" box. (If it is a GT card

of SG, skip this step.)

- Set the motion mode as “Electrical Gear Mode”, “Master Axis” as Axis 4, and “Electrical Gear Ratio” as 0.3. Then click “OK”.
- Click the option “Servo On” (SV Card)/”Axis On” (SG card) to make Axis 3 into the servo (open) status.
- Click “Clear Status” to clear the event status of Axis 3.
- Click “Update Parameters” to make the parameters of Axis 3 effective.
- Select Axis 4 in the axis control window.
- Set the proportional gain as 10 in the “Set Servo Filter Parameters” box. (If it is a GT card of SG, skip this step.)
- Set the “Target Position” as 300000, “Velocity” as 10, and “Acceleration” as 1 in the T-curve page.
- Click the option “Servo On” (SV Card)/”Axis On” (SG card) to make Axis 4 into the servo (open) status.
- Click “Clear Status” to clear the event status of Axis 4.
- Click “Update Parameters” to start the motion of Axis 4 and make Axis 3 follow Axis 4.

E.2.2 Set Axis 1, 2 and 3 as Axis X, Y and Z to be Cartesian coordinate system and implement linear interpolated motion with four segments of line in the buffer.

- Start GT Commander. If the basic parameters setting automatically when starting the program are not consistent with the actual situation, open the Set Basic Parameters window to set proper basic parameters (the effective voltage level of limit switch and encoder direction).
- Set Axis 1 in the axis control window.
- Set the proportional gain as 10 in the “Set Servo Filter Parameters” box. (If it is a GT card of SG, skip this step.)
- Click the option “Servo On” (SV Card)/”Axis On” (SG card) to make Axis 1 into the servo (open) status.
- Click “Update Parameters” to make the parameters of Axis 1 effective.
- Click “Clear Status” to clear the event status of Axis 1.
- For Axis 2 and 3, perform the same operations as above.
- Click the “Control of Coordinate System” in the main window to enter the coordinate system motion control mode.
- Check “Axis 1” in the “Map Coordinate” box. Input parameter 1 into the input box in front of “X+” and click “Make Effective” button.
- Check “Axis 2” in the “Map Coordinate” box. Input parameter 1 into the input box in front of “Y+” and click “Make Effective” button.
- Check “Axis 3” in the “Map Coordinate” box. Input parameter 1 into the input box in front of “Z+” and click “Make Effective” button.
- Click “Start Buffer Command”.
- Click the option “Set the start points XY(Z)Z” in the “Buffer Interpolation Status” box.
- Input “X”: 0, “Y”: 0 and “Z”: 0 in the “Buffer Interpolation Status” box. Input

"Synthesized Velocity": 10 and "Synthesized Acceleration": 0.5 in the "Interpolation Parameters" box.

- Click "Set Start Points Effective".
- Check "Line Interpolation 3" in the "Select Interpolation Method" box and input "X-end point": 400000, "Y-end point": -600000 and "Z-end point": 300000 into the "Interpolation Parameters" box.
- Click "Confirm Interpolation Command" in the "Buffer Interpolation Status" box.
- Check "Line Interpolation 2" in the "Select Interpolation Method" box and input "X-end point": 200000 and "Y-end point": -100000 into the "Interpolation Parameters" box.
- Click "Confirm Interpolation Command" in the "Buffer Interpolation Status" box.
- Check "XY(Z) – Arc Interpolation (Angel)" in the "Select Interpolation Method" box and input "X-circle center": 100000 and "Y-circle center": 0 and "Angle": 80 into the "Interpolation Parameters" box.
- Click "Confirm Interpolation Command" in the "Buffer Interpolation Status" box.
- Check "XY(Z) – Arc Interpolation (End Point)" in the "Select Interpolation Method" box and input "Z-end point": 0 and "Y-end point": 0, "Radius": 200000 and "Direction": 1 into the "Interpolation Parameters" box.
- Click "Confirm Interpolation Command" in the "Buffer Interpolation Status" box.
- Click "End Buffer Input" in the "Buffer Interpolation Status" box.
- Click "Execute Buffer Command" in the "Buffer Interpolation Status" box to start the interpolation motion in the buffer.

This software contains several GT instruction batch program samples, which can be opened and executed directly in GT Commander. But pay attention to whether the basic parameters set are consistent with the actual system. If not, modify the program sample or start the initializing file GTCmd.ini for modification appropriately.

E.3 Troubleshooting

After user sending a series of instructions and the motor doesn't move, check the following.

1. The positive and negative limit switches in the "Input Status and Information" box of the motor are triggered or not. If they are triggered, check whether the "Triggering Voltage Level of Limit Switch" is set correctly. Then check whether the limit switch of motor are really triggered or not and click "Clear Status" to clear the status of limit switch when
2. The proportional gain (Kp), integral gain (Ki), differential gain (Kd) in the "Set Servo Filter Parameters" of the motor are all set to 0 or not. If they are, reset them to the proper values. (For SV card.)
3. The parameters "Velocity" and "Acceleration" of the motor are all set to 0 or not. If they are, reset them to the proper values.
4. In the Status window, check whether there are other error and alarm status of the motor set as 1. Check and confirm that the motor and other relevant devices really have error or not. Click "Clear Status" to clear the relevant status symbols.
5. Contact Googol Technology.

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