AMP-204C / AMP-208C

Advanced DSP Pulse Motion Controller for 4/8 Axis

User Manual

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Revision History

Revision	Release Date	Description of Change (s)
2.00	2014-07-25	Initial release

Preface

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CAUTION	Information to prevent minor physical injury, ***component damage***, data loss, and/or program corruption when trying to complete a task.
WARNING	Information to prevent serious physical injury, ***component damage***, data loss, and/or program corruption when trying to complete a specific task.

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1 Introduction

The AMP-204C / AMP-208C, is a fully in-house developed DSP-based advanced motion control card from ADLINK. It supports 4/8 axis pulse type signal commands, provides open-loop circuit control options, and supports position commands for several different servo drives.

AMP-204C / AMP-208C exchanges data with operating system through high speed PCI bus including motion control command, feedback data, parameter, etc. Used with the ADLINK exclusive Softmove kernel, it offers scores of move control functions including T/S speed profile planning, point-to-point movement, multi-dimension interpolation, and master/slave motion.

The AMP-204C / 208C, see Figure 1 below for its system functions, uses one digital signal processor (DSP) from Texas Instrument (TI) as its main computing unit and integrates high speed large volume Field Programmable Gate Array (FPGA) to provide high speed encoder output, 2/4 high speed position compare and trigger output, move & general purposed I/O and logic control. It separates isolation circuit into exclusive terminal board DIN-825-GP4 to prevent the burning out of AMP-204C/208C from incorrect wiring. Thanks to full range of flexing resistant wires from ADLINK, it connects with market avaialble popular servo dirves easily.

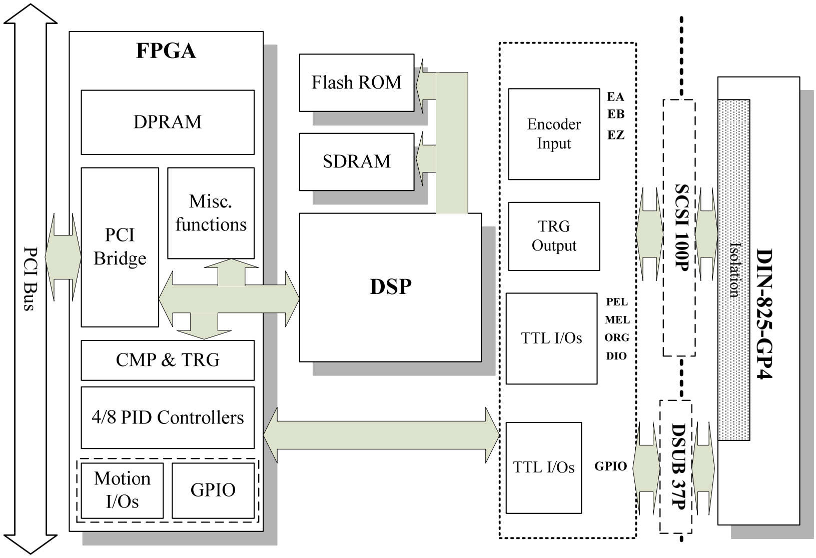


Figure 1-1: AMP-204C/208Csystem block diagram

Graphical motion control interface – MotionCreatorPro 2 is a Windows-based motion control software development tool for motion control and I/O status monitoring. It captures motion curves and data at the same time for analysis. Its Setup Wizard guides you through the hardware installation and wiring as well as single-axis manipulation step-by-step. This saves your development time and cost.

The ***Windows Programming Libraries*** supports Windows coding environment including: Visual Studio C++ 6.0, Microsoft .NET framework based VB.NET and C++, and Borland's C++ Builder. There are sample programs available in the installation folders. The flow chart below will guide you in using this manual as well as help you to locate any required information effectively.

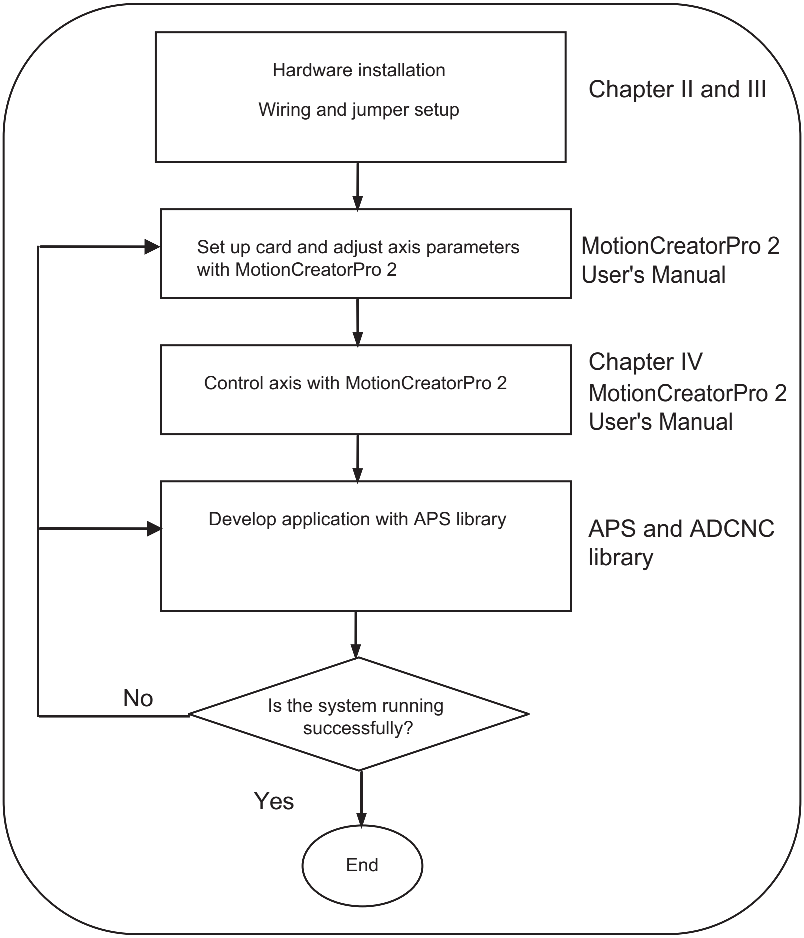


Figure 1-2: System installation flow chart

1.1 Product Specifications

	Item	Description
System	Bus information	PCI Rev. 2.2, 33MHz
	PCI bus width	32-bit
	PCI bus voltage	3.3V, 5V
	PCI bus IRQ settings	Assigned by PCI controller
DSP	Model	TI 375MHz floating DSP
	Memory (for program and data)	DDR2 SDRAM: 64Mx16bit Flash ROM: 16M-bit
Board-to-board interface	Connector	1x SCSI-II 100P for AMP-204C
		1x Dual SCSI VHDCI 100P for AMP-208C
Motion control	Number of axes supported	4/8 axis for AMP-204C / AMP-208C
	Track update rate	500us, 1ms, 2ms (programmable)
	Position / speed command range	32 bit
	Acceleration / deceleration range	32 bit
	Encoder input frequency	20 MHz @ 4x AB
	Encoder input mode	CW/CCW, 1x/2x/4x AB Phase
	Encoder input interface	±12 volts, TTL compatible
I/O interface	Motion control relevant I/O	Plus/Minus end limitsignal
		Zero-position for each axis
	Drive relevant I/O	Servo ON
		In-position signal / Zero-Speed detection
		Alarm
General purpose digital I/O	General purpose I/O	20/24-CH input & 20/24-CH TTL output (optical isolation design for DIN-825-GP4)

	Item	Description
Motion control function	Speed Profile Planning	Trapezoidal Curve and S-Curve
	Trajectory Planing	Jogging
		Point-to-point movement
	Linear interpolation: 2-6 axes	Online position/speed change
		3 axes arc interpolation
		3 axes spiral interpolation
		3 axes helix interpolation
	Home Return	User customization (see zero-position, limit switch, EZ signals for reference)

	Item	Description
	Point table	Each axis supports 50 points buffer memory (BUFs)
		Supports point-to-point/line/arc and spiral interpolation
		Supports dwell function
		Supports pause/resume function
		Supports DO function
	Motion Status Monitoring	Motion control relevant I/O monitoring
		Motion status monitoring
	Synchronous move	4/8 axes corresponding AMP-204C / AMP-208C
Industrial application	Master-client axes control	Up to 4/8 axis (including ganty control)
	Data sampling	Motion speed profile/ motion status/motion control relevant I/O
	System error diagnostics	Watchdog timer
Interrupt	Motion status event/error alarm/in position/ emergency stop	Planning in accordance with the manual
Position comparison & trigger output	Pulse output interface	Difference output
	Trigger channel	2/4 corresponding AMP-204C / AMP-208C
	Pulse logic	Programmable active-high or active-low
	Trigger output frequency	Linear compare trigger: 1MHz FIFO compare trigger: 255K ~ 1MHz
	Minimum pulse width	100ns programmable
	Position comparison mode	FIFO and linear comparison
	FIFO capacity	255 points (channel independent)

	Item	Description
PWM control	Maximum number of channels	2/4 CH correspondence AMP-204C / AMP-208C
	Control modes	● Fixed frequency, variable duty cycle ratio ● Variable frequency, fixed duty cycle ratio ● Variable frequency, variable duty cycle ratio
	Resolution	16 bit

Environment condition

	Item
Working ambient temperature	0~55°C
Storage ambient temperature	-20~75°C
Working ambient humidity	10~90%RH, without condensation
Storage ambient humidity	10~90%RH, without condensation
Noise impedance	Noise voltage 1500VPP noise frequency 25~60Hz using noise simulator
Environment condition	Minimal corrosive gas, dust
Cooling condition	Self-cooling
Power consumption	+3.3V @ 0.8A typical +5V @ 0.8A typical +/-12V @ 0.5A typical

1.2 Software Support

1.2.1 Software Support Library

AMP-204C / AMP-208C supports Windows XP/7 32/64 bit operating system and provides a complete function library and DLL files for easy application development by users.

1.2.2 MotionCreatorPro 2

MotionCreatorPro 2 is a user interface exclusively developed for ADLINK motion control products in common Windows environment. You may easily set up card and axis parameters with the help of MotionCreatorPro 2. Its Setup Wizard guides you through the hardware installation and wiring as well as single-axis manipulation in couple of minutes. MotionCreatorPro 2 not only effectively reduces your development time but also enables you to concurrently validate the overall mechanism and electric design with all its single axis and interpolation motion operation pages.

1.3 Terminal Board

ADLINK's exclusive terminal board DIN-825-GP4 for AMP-204C/208C can connect with market available servo drivers with special cables, e.g. Mitsubishi's J3A and Yaskawa's Sigma V series, or with third party's servo or stepper drivers by single ended open cables. Brands with exclusive cables support are listed below:

Pulse command:

Cable	Supported brands
HSL-4XMO-DM	Mitsubishi J2S series
4XMO-DM-J3	Mitsubishi J3A series
HSL-4XMO-DP	Panasonic A4 and A5 series
HSL-4XMO-DY	Yaskawa Sigma V series
4XMO-DA	Delta A2 series
4XMO-OPEN	General purpose

Table 1-1: Cross-reference table of exclusive cables for pulse servo drive

2 Getting Start with The Installation

This chapter teaches you how to install AMP-204C / AMP-208C hardware and software as well as its I/O wiring.

- Package Contents
- Hardware installation
- Software installation
- I/O wiring

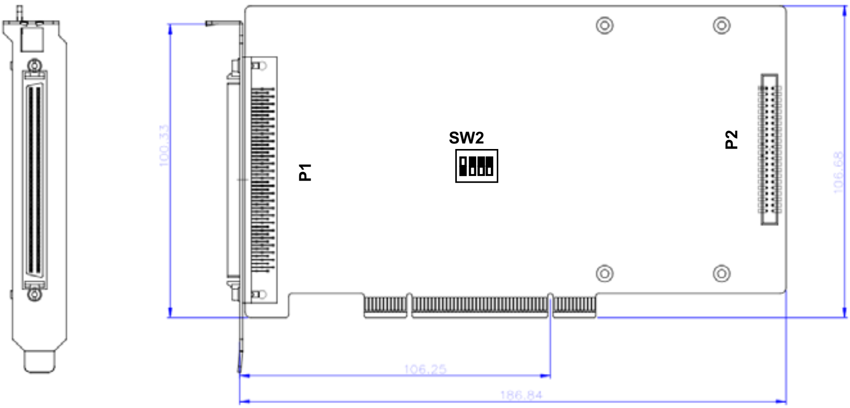
2.1 Package Contents

In addition to this manual you shall find the following item in the product package box:

- One AMP-204C or AMP-208C card
- IDE 44p – DSUB 37p flat cable x 1
- Product warranty card x 1

Should there be any item missed or damaged, please consult with your dealer immediately. Please keep the product along with items included in its package for easy replacement or repair.

2.2 AMP-204C / AMP-208C Exterior Profile Diagram



NOTE

Dimension in unit of millimeter (mm).

Figure 2-1: AMP-204C exterior profile diagram

P1: for Motion control command, Position feedback, and Servo I/O feedback. (with SCSI 100-PINS connector)

P2: for 16 channel digital TTL I/O. (with DSUB 37-PINS connector)

SW2: Card ID setup (0-15)

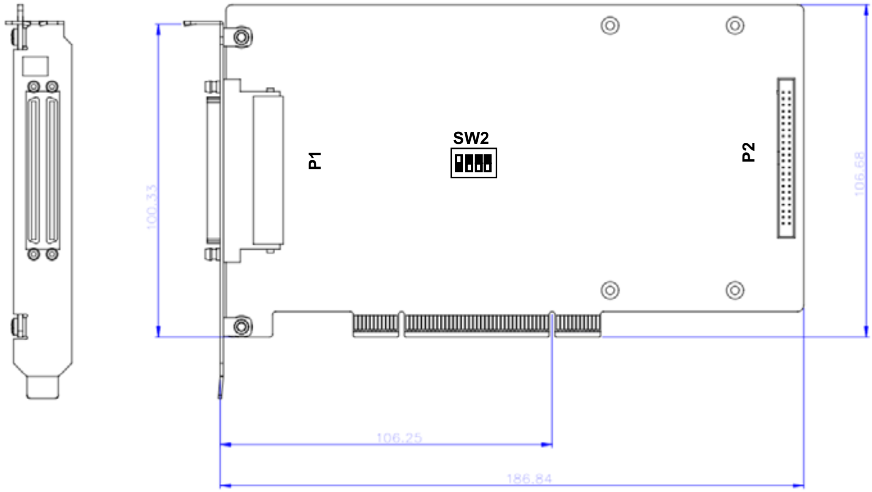


Figure 2-2: AMP-208C exterior profile diagram

P1: for Motion control command, Position feedback, and Servo I/O feedback. (with SCSI-VHDCI 200-PINS connector)

P2: for 16 channel digital TTL I/O. (with DSUB 37-PINS connector)

SW2: Card ID setup (0-15)

2.3 Hardware Installation

2.3.1 Hardware Configuration

AMP-204C/208C employs PCI Rev. 2.2 bus. System BIOS can auto configure memory and IRQ channel.

Exclusive terminal board DIN-825-GP4 provides isolation circuit and indicator lights for easy connections to varieties of servo drive and stepper drive.

2.3.2 Installation Procedures

1. Please read this manual carefully and set up signal I/O in proper mode.
2. Turn off power of your computer and all relevant terminal boards, insert your AMP-204C/208C to any 32-bit PCI slot in your computer. (The slot is usually in white color.) (Please make sure you have proper ESD (Electrostatic discharge) protection.)
3. Connect AMP-204C/208C and DIN-825-GP4 with SCSI 100p cable
4. Set up motion control relevant limit switch on DIN-825-GP4 board, servo signal and general purpose digital signal wiring
5. Set up servo or stepper drive connection
6. Turn on system power including computer power, terminal board relevant powers, and 24Vdc power
7. Verify all I/O signal and servo operation correctness with MotionCreatorPro 2

CAUTION

Please ground the shielding end of the power terminal to the earth to reduce risk of electric shock and ensure product operation of your electric appliances.

CAUTION

Please disconnect the motor drive from its load before using the card for the first time to protect your safety. Do not connect the motor drive to any mechanical devices before the completion of the installation and fine tuning of the control system. Connect the system only after the board is adjusted and the drive parameters can control the motor. Serious damage may be resulted in otherwise.

2.3.3 Troubleshooting

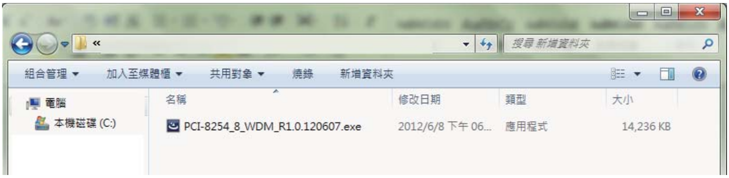
If the computer cannot power on normally or the motion control system operates abnormally after system installation, please follow steps described below for troubleshooting. If the problem persists after you have taken steps described, please consult the dealer where your product is purchased for technical services.

Abnormalities you encountered	Potential causes
The card does not show up in Windows Device Manager after its driver has been installed	Please turn off your computer, ensure the card is properly in PCI slot and the driver is properly installed by cheking its proper installation in Windows Control Panel's "Add remove programs"
MotionCreatorPro2 cannot open after installing driver in computer.	Ensure .NET framework v3.5 or later version has been installed in your system
The without signal indicator on MotionCreatorPro2 lights up after the motor is connected and the motor does not work.	Please ensure a 24Vdc power is connected to the terminal board
When using the MotionCreatorPro2 all the control indicators of the drive light correctly but the drive warns	Please ensure correctness of the axis parameter setup, alarm logic (ALM) and the EMG loop configuration
Value of output command differ from the feedback value from encoder	Please ensure feedback signal (CW/CCW, 1xAB, 2xAB, 4xAB) settings comply with that of the drive
If motion control, the motor moves only in one direction rather than back and forth two way movement	Please ensure setting of signal pattern (CW/CCW, OUT/DIR) comply with that of the motor drive

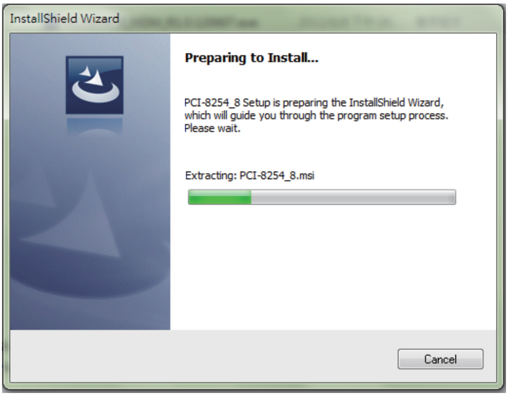
2.4 Software Installation Procedure

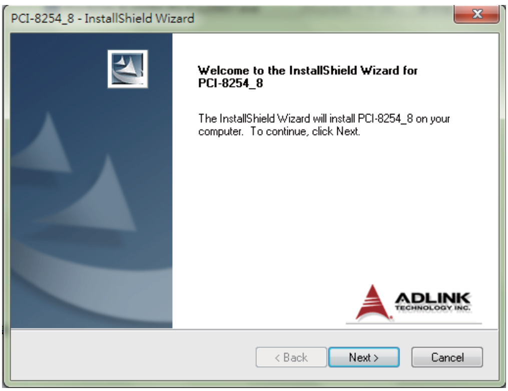
Windows driver installation procedure:

Step 1. Execute AMP-204C / AMP-208C WDM file and run installation procedure automatically.

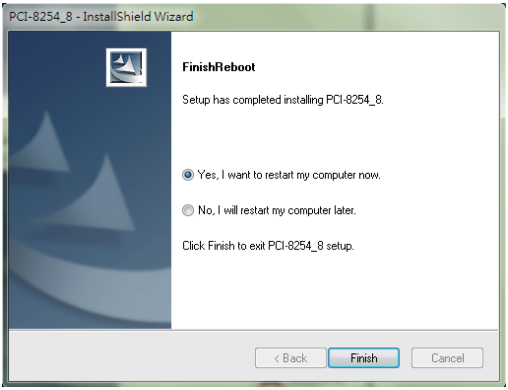


Step 2. Click "Next" as prompted to complete the installation process.

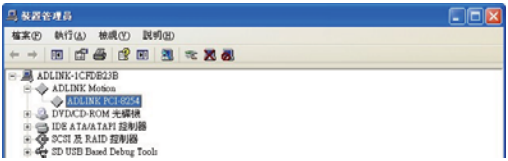




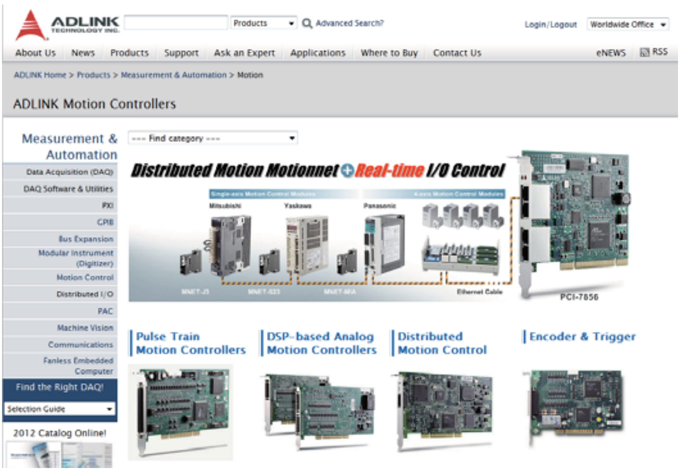
Step 3. Restart your computer after installation is completed.



Step 4. Ensure the Windows Device Manager identify your AMP-204C / AMP-208C correctly.

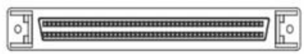


Recommendations: Please download latest installation software from ADLINK official website to maintain the optimum operation environment.
(http://www.adlinktech.com/Motion-Control/index.php)



2.5 Definitions to Key Connector Signal

2.5.1 AMP-204C:P1 Connector



- **P1**

No.	Name	I/O	Function of Axis	No.	Name	I/O	Function of Axis
1	DGND	--	Digital ground	**51**	IEMG	I	Emergency stop input
2	DGND	--	Digital ground	**52**	Rsv.	--	Reserved
3	Rsv.	--	Reserved	**53**	Rsv.	--	Reserved
4	Rsv.	--	Reserved	**54**	Rsv.	--	Reserved
5	Rsv.	--	Reserved	**55**	Rsv.	--	Reserved
6	Rsv.	--	Reserved	**56**	Rsv.	--	Reserved
7	Rsv.	--	Reserved	**57**	Rsv.	--	Reserved
8	Rsv.	--	Reserved	**58**	Rsv.	--	Reserved
9	Rsv.	--	Reserved	**59**	Rsv.	--	Reserved
10	Rsv.	--	Reserved	**60**	Rsv.	--	Reserved
11	EA5V	--	5V Power	**61**	DGND	--	Digital ground
12	EA5V	--	5V Power	**62**	DGND	--	Digital ground
13	OUT1+	O	Pulse output (+), (1)	**63**	OUT3+	O	Pulse output (+), (3)
14	OUT1-	O	Pulse output (-), (1)	**64**	OUT3-	O	Pulse output (-), (3)
15	DIR1+	O	Direction output (+), (1)	**65**	DIR3+	O	Direction output (+), (3)
16	DIR1-	O	Direction output (-), (1)	**66**	DIR3-	O	Direction output (-), (3)
17	OUT2+	O	Pulse output (+), (2)	**67**	OUT4+	O	Pulse output (+), (4)
18	OUT2-	O	Pulse output (-), (2)	**68**	OUT4-	O	Pulse output (-), (4)
19	DIR2+	O	Direction output (+), (2)	**69**	DIR4+	O	Direction output (+), (4)
20	DIR2-	O	Direction output (-), (2)	**70**	DIR4-	O	Direction output (-), (4)
21	TG1+	O	Trigger output (+), (1)	**71**	TRG2+	O	Trigger output (+), (2)
22	TRG1-	O	Trigger output (-), (1)	**72**	TRG2-	O	Trigger output (-), (2)
23	EA1+	I	Encoder A-phase (+),(1)	**73**	EA3+	I	Encoder A-phase (+),(3)
24	EA1-	I	Encoder A-phase (-),(1)	**74**	EA3-	I	Encoder A-phase (-),(3)
25	EB1+	I	Encoder B-phase (+),(1)	**75**	EB3+	I	Encoder B-phase (+),(3)
26	EB1-	I	Encoder B-phase (-),(1)	**76**	EB3-	I	Encoder B-phase (-),(3)

No.	Name	I/O	Function of Axis	No.	Name	I/O	Function of Axis
27	EZ1+	I	Encoder Z-phase (+),(1)	**77**	EZ3+	I	Encoder Z-phase (+),(3)
28	EZ1-	I	Encoder Z-phase (-),(1)	**78**	EZ3-	I	Encoder Z-phase (-),(3)
29	EA2+	I	Encoder A-phase (+),(2)	**79**	EA4+	I	Encoder A-phase (+),(4)
30	EA2-	I	Encoder A-phase (-),(2)	**80**	EA4-	I	Encoder A-phase (-),(4)
31	EB2+	I	Encoder B-phase (+),(2)	**81**	EB4+	I	Encoder B-phase (+),(4)
32	EB2-	I	Encoder B-phase (-),(2)	**82**	EB4-	I	Encoder B-phase (-),(4)
33	EZ2+	I	Encoder Z-phase (+),(2)	**83**	EZ4+	I	Encoder Z-phase (+),(4)
34	EZ2-	I	Encoder Z-phase (-),(2)	**84**	EZ4-	I	Encoder Z-phase (-),(4)
35	ALM1	I	Servo alarm,(1)	**85**	ALM3	I	Servo alarm,(3)
36	ORG1	I	Home limit, (1)	**86**	ORG3	I	Home limit, (3)
37	SVON1	O	Servo-ON, (1)	**87**	SVON3	O	Servo-ON, (3)
38	PEL1	I	Positive limit, (1)	**88**	PEL3	I	Positive limit, (3)
39	INP1	I	In-Position (1)	**89**	INP3	I	In-Position (3)
40	MEL1	I	Negative limit, (1)	**90**	MEL3	I	Negative limit, (3)
41	ALM2	I	Servo alarm,(2)	**91**	ALM4	I	Servo alarm,(4)
42	ORG2	I	Home limit, (2)	**92**	ORG4	I	Home limit, (4)
43	SVON2	O	Servo-ON, (2)	**93**	SVON4	O	Servo-ON, (4)
44	PEL2	I	Positive limit, (2)	**94**	PEL4	I	Positive limit, (4)
45	INP2	I	In-Position (2)	**95**	INP4	I	In-Position (4)
46	MEL2	I	Negative limit, (2)	**96**	MEL4	I	Negative limit, (4)
47	EDO1	O	Digital Output, (1)	**97**	EDO3	O	Digital Output, (3)
48	EDI1	I	Digital Input, (1)	**98**	EDI3	I	Digital Input, (3)
49	EDO2	O	Digital Output, (2)	**99**	EDO4	O	Digital Output, (4)
50	EDI2	I	Digital Input, (2)	**100**	EDI4	I	Digital Input, (4)

2.5.2 AMP-208C:P1-A/B Connector

- **P1-A**

No.	Name	I/O	Function of Axis	No.	Name	I/O	Function of Axis
1	DGND	--	Digital ground	51	IEMG	I	Emergency stop input
2	DGND	--	Digital ground	52	Rsv.	--	Reserved
3	Rsv.	--	Reserved	53	Rsv.	--	Reserved
4	Rsv.	--	Reserved	54	Rsv.	--	Reserved
5	Rsv.	--	Reserved	55	Rsv.	--	Reserved
6	Rsv.	--	Reserved	56	Rsv.	--	Reserved
7	Rsv.	--	Reserved	57	Rsv.	--	Reserved
8	Rsv.	--	Reserved	58	Rsv.	--	Reserved
9	Rsv.	--	Reserved	59	Rsv.	--	Reserved
10	Rsv.	--	Reserved	60	Rsv.	--	Reserved
11	EA5V	--	5V power	61	DGND	--	Digital ground
12	EA5V	--	5V power	62	DGND	--	Digital ground
13	OUT1+	O	Pulse output (+), (1)	63	OUT3+	O	Pulse output (+), (3)
14	OUT1-	O	Pulse output (-), (1)	64	OUT3-	O	Pulse output (-), (3)
15	DIR1+	O	Direction output (+), (1)	65	DIR3+	O	Direction output (+), (3)
16	DIR1-	O	Direction output (-), (1)	66	DIR3-	O	Direction output (-), (3)
17	OUT2+	O	Pulse output (+), (2)	67	OUT4+	O	Pulse output (+), (4)
18	OUT2-	O	Pulse output (-), (2)	68	OUT4-	O	Pulse output (-), (4)
19	DIR2+	O	Direction output (+), (2)	69	DIR4+	O	Direction output (+), (4)
20	DIR2-	O	Direction output (-), (2)	70	DIR4-	O	Direction output (-), (4)
21	TG1+	O	Trigger output (+), (1)	71	TRG2+	O	Trigger output (+), (2)
22	TRG1-	O	Trigger output (-), (1)	72	TRG2-	O	Trigger output (-), (2)
23	EA1+	I	Encoder A-phase (+),(1)	73	EA3+	I	Encoder A-phase (+),(3)
24	EA1-	I	Encoder A-phase (-),(1)	74	EA3-	I	Encoder A-phase (-),(3)
25	EB1+	I	Encoder B-phase (+),(1)	75	EB3+	I	Encoder B-phase (+),(3)
26	EB1-	I	Encoder B-phase (-),(1)	76	EB3-	I	Encoder B-phase (-),(3)
27	EZ1+	I	Encoder Z-phase (+),(1)	77	EZ3+	I	Encoder Z-phase (+),(3)
28	EZ1-	I	Encoder Z-phase (-),(1)	78	EZ3-	I	Encoder Z-phase (-),(3)

No.	Name	I/O	Function of Axis	No.	Name	I/O	Function of Axis
29	EA2+	I	Encoder A-phase (+),(2)	**79**	EA4+	I	Encoder A-phase (+),(4)
30	EA2-	I	Encoder A-phase (-),(2)	**80**	EA4-	I	Encoder A-phase (-),(4)
31	EB2+	I	Encoder B-phase (+),(2)	**81**	EB4+	I	Encoder B-phase (+),(4)
32	EB2-	I	Encoder B-phase (-),(2)	**82**	EB4-	I	Encoder B-phase (-),(4)
33	EZ2+	I	Encoder Z-phase (+),(2)	**83**	EZ4+	I	Encoder Z-phase (+),(4)
34	EZ2-	I	Encoder Z-phase (-),(2)	**84**	EZ4-	I	Encoder Z-phase (-),(4)
35	ALM1	I	Servo alarm,(1)	**85**	ALM3	I	Servo alarm,(3)
36	ORG1	I	Home limit, (1)	**86**	ORG3	I	Home limit, (3)
37	SVON1	O	Servo-ON, (1)	**87**	SVON3	O	Servo-ON, (3)
38	PEL1	I	Positive limit, (1)	**88**	PEL3	I	Positive limit, (3)
39	INP1	I	In-Position (1)	**89**	INP3	I	In-Position (3)
40	MEL1	I	Negative limit, (1)	**90**	MEL3	I	Negative limit, (3)
41	ALM2	I	Servo alarm,(2)	**91**	ALM4	I	Servo alarm,(4)
42	ORG2	I	Home limit, (2)	**92**	ORG4	I	Home limit, (4)
43	SVON2	O	Servo-ON, (2)	**93**	SVON4	O	Servo-ON, (4)
44	PEL2	I	Positive limit, (2)	**94**	PEL4	I	Positive limit, (4)
45	INP2	I	In-Position (2)	**95**	INP4	I	In-Position (4)
46	MEL2	I	Negative limit, (2)	**96**	MEL4	I	Negative limit, (4)
47	EDO1	O	Digital Output, (1)	**97**	EDO3	O	Digital Output, (3)
48	EDI1	I	Digital Input, (1)	**98**	EDI3	I	Digital Input, (3)
49	EDO2	O	Digital Output, (2)	**99**	EDO4	O	Digital Output, (4)
50	EDI2	I	Digital Input, (2)	**100**	EDI4	I	Digital Input, (4)

- **P1-B**

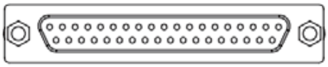
No.	Name	I/O	Function of Axis	No.	Name	I/O	Function of Axis
1	Rsv.	--	Reserved	**51**	Rsv.	--	Reserved
2	Rsv.	--	Reserved	**52**	Rsv.	--	Reserved
3	Rsv.	--	Reserved	**53**	Rsv.	--	Reserved
4	Rsv.	--	Reserved	**54**	Rsv.	--	Reserved
5	Rsv.	--	Reserved	**55**	Rsv.	--	Reserved
6	Rsv.	--	Reserved	**56**	Rsv.	--	Reserved

No.	Name	I/O	Function of Axis	No.	Name	I/O	Function of Axis
7	Rsv.	--	Reserved	57	Rsv.	--	Reserved
8	Rsv.	--	Reserved	58	Rsv.	--	Reserved
9	Rsv.	--	Reserved	59	Rsv.	--	Reserved
10	Rsv.	--	Reserved	60	Rsv.	--	Reserved
11	EA5V	--	5V power	61	DGND	--	Digital ground
12	EA5V	--	5V power	62	DGND	--	Digital ground
13	OUT5+	O	Pulse output (+), (5)	63	OUT7+	O	Pulse output (+), (7)
14	OUT5-	O	Pulse output (-), (5)	64	OUT7-	O	Pulse output (-), (7)
15	DIR5+	O	Direction output (+), (5)	65	DIR7+	O	Direction output (+), (7)
16	DIR5-	O	Direction output (-), (5)	66	DIR7-	O	Direction output (-), (7)
17	OUT6+	O	Pulse output (+), (6)	67	OUT8+	O	Pulse output (+), (8)
18	OUT6-	O	Pulse output (-), (6)	68	OUT8-	O	Pulse output (-), (8)
19	DIR6+	O	Direction output (+), (6)	69	DIR8+	O	Direction output (+), (8)
20	DIR6-	O	Direction output (-), (6)	70	DIR8-	O	Direction output (-), (8)
21	TRG3+	O	Trigger output (+), (3)	71	TRG4+	O	Trigger output (+), (4)
22	TRG3-	O	Trigger output (-), (3)	72	TRG4-	O	Trigger output (-), (4)
23	EA5+	I	Encoder A-phase (+),(5)	73	EA7+	I	Encoder A-phase (+),(7)
24	EA5-	I	Encoder A-phase (-),(5)	74	EA7-	I	Encoder A-phase (-),(7)
25	EB5+	I	Encoder B-phase (+),(5)	75	EB7+	I	Encoder B-phase (+),(7)
26	EB5-	I	Encoder B-phase (-),(5)	76	EB7-	I	Encoder B-phase (-),(7)
27	EZ5+	I	Encoder Z-phase (+),(5)	77	EZ7+	I	Encoder Z-phase (+),(7)
28	EZ5-	I	Encoder Z-phase (-),(5)	78	EZ7-	I	Encoder Z-phase (-),(7)
29	EA6+	I	Encoder A-phase (+),(6)	79	EA8+	I	Encoder A-phase (+),(8)
30	EA6-	I	Encoder A-phase (-),(6)	80	EA8-	I	Encoder A-phase (-),(8)
31	EB6+	I	Encoder B-phase (+),(6)	81	EB8+	I	Encoder B-phase (+),(8)
32	EB6-	I	Encoder B-phase (-),(6)	82	EB8-	I	Encoder B-phase (-),(8)
33	EZ6+	I	Encoder Z-phase (+),(6)	83	EZ8+	I	Encoder Z-phase (+),(8)
34	EZ6-	I	Encoder Z-phase (-),(6)	84	EZ8-	I	Encoder Z-phase (-),(8)
35	ALM5	I	Servo alarm,(5)	85	ALM7	I	Servo alarm,(7)
36	ORG5	I	Home limit, (5)	86	ORG7	I	Home limit, (7)
37	SVON5	O	Servo-ON, (5)	87	SVON7	O	Servo-ON, (7)

No.	Name	I/O	Function of Axis	No.	Name	I/O	Function of Axis
38	PEL5	I	Positive limit, (5)	**88**	PEL7	I	Positive limit, (7)
39	INP5	I	In-Position (5)	**89**	INP7	I	In-Position (7)
40	MEL5	I	Negative limit, (5)	**90**	MEL7	I	Negative limit, (7)
41	ALM6	I	Servo alarm,(6)	**91**	ALM8	I	Servo alarm,(8)
42	ORG6	I	Home limit, (6)	**92**	ORG8	I	Home limit, (8)
43	SVON6	O	Servo-ON, (6)	**93**	SVON8	O	Servo-ON, (8)
44	PEL6	I	Positive limit, (6)	**94**	PEL8	I	Positive limit, (8)
45	INP6	I	In-Position (6)	**95**	INP8	I	In-Position (8)
46	MEL6	I	Negative limit, (6)	**96**	MEL8	I	Negative limit, (8)
47	EDO5	O	Digital Output, (5)	**97**	EDO7	O	Digital Output, (7)
48	EDI5	I	Digital Input, (5)	**98**	EDI7	I	Digital Input, (7)
49	EDO6	O	Digital Output, (6)	**99**	EDO8	O	Digital Output, (8)
50	EDI6	I	Digital Input, (6)	**100**	EDI8	I	Digital Input, (8)

2.5.3 AMP-204C/208C:P2 Connector

- **P2**



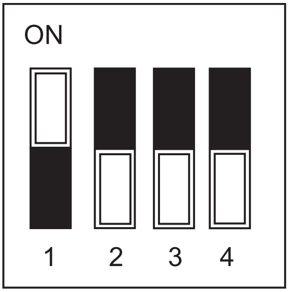
No.	Name	I/O	Function of Axis	No.	Name	I/O	Function of Axis
1	Rsv.	- -	Reserved	**20**	VDD	I	+5V power supply input
2	TDI1	I	TTL input, (1)	**21**	TDO1	O	TTL output, (1)
3	TDI2	I	TTL input, (2)	**22**	TDO2	O	TTL output, (2)
4	TDI3	I	TTL input, (3)	**23**	TDO3	O	TTL output, (3)
5	TDI4	I	TTL input, (4)	**24**	TDO4	O	TTL output, (4)
6	TDI5	I	TTL input, (5)	**25**	TDO5	O	TTL output, (5)
7	TDI6	I	TTL input, (6)	**26**	TDO6	O	TTL output, (6)
8	TDI7	I	TTL input, (7)	**27**	TDO7	O	TTL output, (7)
9	TDI8	I	TTL input, (8)	**28**	TDO8	O	TTL output, (8)
10	TDI9	I	TTL input, (9)	**29**	TDO9	O	TTL output, (9)
11	TDI10	I	TTL input, (10)	**30**	TDO10	O	TTL output, (10)
12	TDI11	I	TTL input, (11)	**31**	TDO11	O	TTL output, (11)
13	TDI12	I	TTL input, (12)	**32**	TDO12	O	TTL output, (12)

No.	Name	I/O	Function of Axis	No.	Name	I/O	Function of Axis
14	TDI13	I	TTL input, (13)	**33**	TDO13	O	TTL output, (13)
15	TDI14	I	TTL input, (14)	**34**	TDO14	O	TTL output, (14)
16	TDI15	I	TTL input, (15)	**35**	TDO15	O	TTL output, (15)
17	TDI16	I	TTL input, (16)	**36**	TDO16	O	TTL output, (16)
18	DGND	-	Digital ground	**37**	DGND	-	Digital ground
19	VDD	I	+5V power supply input	**--**	--	--	--

2.6 DIP Switch

2.6.1 SW2: Card ID Switch

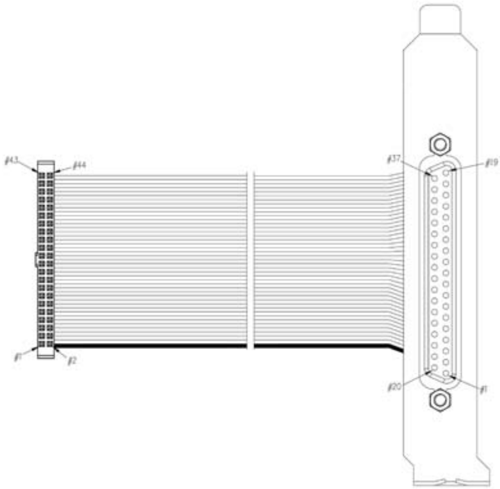
This switch is used for adjusting card ID for easy identification in user application programs. Take example. If you set card ID to "0-0-0-1" (OFF-OFF-OFF-ON) then the card ID is "1" and the ID table should be set up as described below:



Card ID	Switch Setting (ON=1)
0	0000
1	0001
2	0010
3	0011
4	0100
5	0101
6	0110
7	0111
8	1000
9	1001
10	1010
11	1011
12	1100
13	1101
14	1110
15	1111 (default)

2.7 IDE 44p – DSUB 37p Bus

This card include one IDE cable from IDE 44 pin to DSUB 37 pin. It is used for AMP-204C / AMP-208C P2 extension 16 channel digital input and 16 channel digital output.



2.8 Exclusive Board - DIN-825-GP4

The "DIN-825-GP4" terminal board is designed for PCI-8254 / PCI-8258 and AMP-204C / AMP-208C exclusively. It connects with market available servo drives with special cables, e.g. Mitsubishi's J3A and Yaskawa's Sigma V series, or third party's servo or stepper drives with single end open cables.

CAUTION

The DIN-825-GP4 board supports both PCI-8254 / PCI-8258 and AMP-204C / AMP-208C. DO NOT connect it to other ADLINK's motion controllers as it may be damaged.

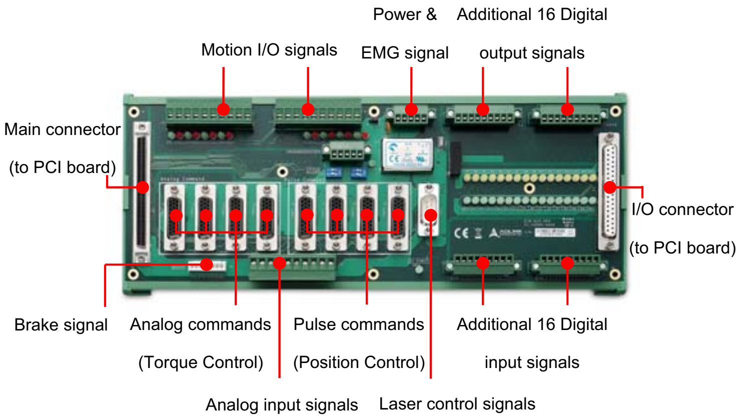


Figure 2-3: Exterior of DIN-825-GP4

2.8.1 Definitions to Connector

1. P1: This is one SCSI 100-PINS connector for motion control signals.
2. CMA1–4: These are four 26-PINS connector for connecting to servo drive to do S/T mode control and analog control commands output.
3. CMP1–4: These are four 26-PINS connectors for connecting to servo drive to do P mode control or stepper drive to output pulse control commands. It may be connected to Mitsubishi J3A series, Yaskawa Sigma II, III & V series, and Panasonic MINAS A4&A5 with exclusive cables.
4. J1–J3: These are three sets of 10-pins screw lock connectors (screwed series, Delta A2 series, or connection to other servo or stepper drivers with single end open cables). It may be connected to any analog input signal, comparing trigger signal, plus/minus limit switch and homing signal.
5. J4: This is one 8-PINS connector for connecting to Brake Signal.
6. J5: This is one 5-PINS connector for connecting to tenminal board main power and emergency stop signals.

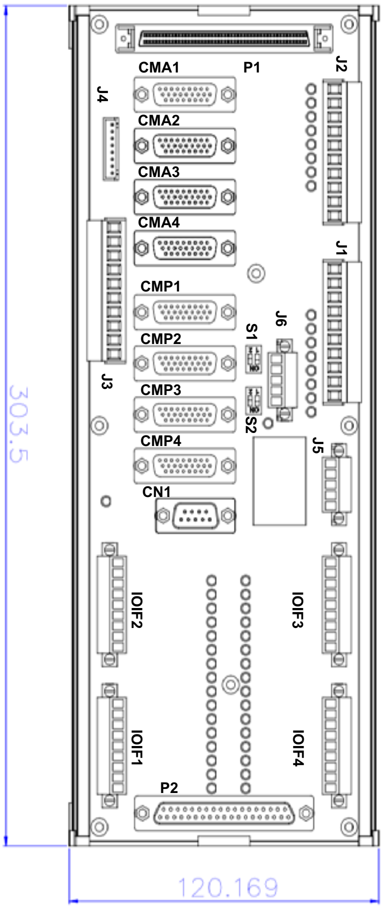
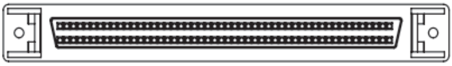


Figure 2-4: Exterior of DIN-825-GP4

7. J6: This is one 5-PINS connector for connecting to four isolation digital output channel.
8. P2: This is one DSUB 37-PINS connector for connecting to 16 channel digital input signal and 16 channel digital output signal in the controller (TTL).
9. IOIF1-IOIF4: These are four 9-PINS connectors for connecting to 16 channel digital input signal and 16 channel digital output signal for common uses.
10. CN1: This is one 9-pin connector for laser control.

2.8.2 P1 Connector: For Connecting to PCI-8254 / PCI-8258 / AMP-204C / AMP-208C

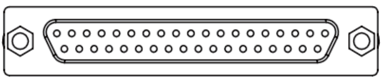
- **P1:**



No.	Name	I/O	Function of Axis	No.	Name	I/O	Function of Axis
1	DGND	--	Digital ground	**51**	IEMG	I	Emergency stop input
2	DGND	--	Digital ground	**52**	Rsv.	--	Reserved
3	Rsv.	--	Reserved	**53**	Rsv.	--	Reserved
4	Rsv.	--	Reserved	**54**	Rsv.	--	Reserved
5	Rsv.	--	Reserved	**55**	Rsv.	--	Reserved
6	Rsv.	--	Reserved	**56**	Rsv.	--	Reserved
7	Rsv.	--	Reserved	**57**	Rsv.	--	Reserved
8	Rsv.	--	Reserved	**58**	Rsv.	--	Reserved
9	Rsv.	--	Reserved	**59**	Rsv.	--	Reserved
10	Rsv.	--	Reserved	**60**	Rsv.	--	Reserved
11	EA5V	--	5V power	**61**	DGND	--	Digital ground
12	EA5V	--	5V power	**62**	DGND	--	Digital ground
13	OUT1+	O	Pulse output (+), (1)	**63**	OUT3+	O	Pulse output (+), (3)
14	OUT1-	O	Pulse output (-), (1)	**64**	OUT3-	O	Pulse output (-), (3)
15	DIR1+	O	Direction output (+), (1)	**65**	DIR3+	O	Direction output (+), (3)
16	DIR1-	O	Direction output (-), (1)	**66**	DIR3-	O	Direction output (-), (3)
17	OUT2+	O	Pulse output (+), (2)	**67**	OUT4+	O	Pulse output (+), (4)
18	OUT2-	O	Pulse output (-), (2)	**68**	OUT4-	O	Pulse output (-), (4)
19	DIR2+	O	Direction output (+), (2)	**69**	DIR4+	O	Direction output (+), (4)
20	DIR2-	O	Direction output (-), (2)	**70**	DIR4-	O	Direction output (-), (4)
21	TG1+	O	Trigger output (+), (1)	**71**	TRG2+	O	Trigger output (+), (2)
22	TRG1-	O	Trigger output (-), (1)	**72**	TRG2-	O	Trigger output (-), (2)
23	EA1+	I	Encoder A-phase (+),(1)	**73**	EA3+	I	Encoder A-phase (+),(3)
24	EA1-	I	Encoder A-phase (-),(1)	**74**	EA3-	I	Encoder A-phase (-),(3)
25	EB1+	I	Encoder B-phase (+),(1)	**75**	EB3+	I	Encoder B-phase (+),(3)
26	EB1-	I	Encoder B-phase (-),(1)	**76**	EB3-	I	Encoder B-phase (-),(3)

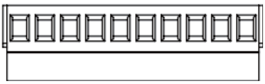
No.	Name	I/O	Function of Axis	No.	Name	I/O	Function of Axis
27	EZ1+	I	Encoder Z-phase (+),(1)	**77**	EZ3+	I	Encoder Z-phase (+),(3)
28	EZ1-	I	Encoder Z-phase (-),(1)	**78**	EZ3-	I	Encoder Z-phase (-),(3)
29	EA2+	I	Encoder A-phase (+),(2)	**79**	EA4+	I	Encoder A-phase (+),(4)
30	EA2-	I	Encoder A-phase (-),(2)	**80**	EA4-	I	Encoder A-phase (-),(4)
31	EB2+	I	Encoder B-phase (+),(2)	**81**	EB4+	I	Encoder B-phase (+),(4)
32	EB2-	I	Encoder B-phase (-),(2)	**82**	EB4-	I	Encoder B-phase (-),(4)
33	EZ2+	I	Encoder Z-phase (+),(2)	**83**	EZ4+	I	Encoder Z-phase (+),(4)
34	EZ2-	I	Encoder Z-phase (-),(2)	**84**	EZ4-	I	Encoder Z-phase (-),(4)
35	ALM1	I	Servo alarm,(1)	**85**	ALM3	I	Servo alarm,(3)
36	ORG1	I	Home limit, (1)	**86**	ORG3	I	Home limit, (3)
37	SVON1	O	Servo-ON, (1)	**87**	SVON3	O	Servo-ON, (3)
38	PEL1	I	Positive limit, (1)	**88**	PEL3	I	Positive limit, (3)
39	INP1	I	In-Position (1)	**89**	INP3	I	In-Position (3)
40	MEL1	I	Negative limit, (1)	**90**	MEL3	I	Negative limit, (3)
41	ALM2	I	Servo alarm,(2)	**91**	ALM4	I	Servo alarm,(4)
42	ORG2	I	Home limit, (2)	**92**	ORG4	I	Home limit, (4)
43	SVON2	O	Servo-ON, (2)	**93**	SVON4	O	Servo-ON, (4)
44	PEL2	I	Positive limit, (2)	**94**	PEL4	I	Positive limit, (4)
45	INP2	I	In-Position (2)	**95**	INP4	I	In-Position (4)
46	MEL2	I	Negative limit, (2)	**96**	MEL4	I	Negative limit, (4)
47	EDO1	O	Digital Output, (1)	**97**	EDO3	O	Digital Output, (3)
48	EDI1	I	Digital Input, (1)	**98**	EDI3	I	Digital Input, (3)
49	EDO2	O	Digital Output, (2)	**99**	EDO4	O	Digital Output, (4)
50	EDI2	I	Digital Input, (2)	**100**	EDI4	I	Digital Input, (4)

- **P2:**

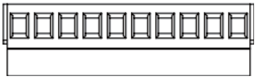


No.	Name	I/O	Function of Axis	No.	Name	I/O	Function of Axis
1	Rsv.	- -	Reserved	**20**	VDD	O	+5V power supply output
2	TDI1	I	TTL input, (1)	**21**	TDO1	O	TTL output, (1)

No.	Name	I/O	Function of Axis	No.	Name	I/O	Function of Axis
3	TDI2	I	TTL input, (2)	**22**	TDO2	O	TTL output, (2)
4	TDI3	I	TTL input, (3)	**23**	TDO3	O	TTL output, (3)
5	TDI4	I	TTL input, (4)	**24**	TDO4	O	TTL output, (4)
6	TDI5	I	TTL input, (5)	**25**	TDO5	O	TTL output, (5)
7	TDI6	I	TTL input, (6)	**26**	TDO6	O	TTL output, (6)
8	TDI7	I	TTL input, (7)	**27**	TDO7	O	TTL output, (7)
9	TDI8	I	TTL input, (8)	**28**	TDO8	O	TTL output, (8)
10	TDI9	I	TTL input, (9)	**29**	TDO9	O	TTL output, (9)
11	TDI10	I	TTL input, (10)	**30**	TDO10	O	TTL output, (10)
12	TDI11	I	TTL input, (11)	**31**	TDO11	O	TTL output, (11)
13	TDI12	I	TTL input, (12)	**32**	TDO12	O	TTL output, (12)
14	TDI13	I	TTL input, (13)	**33**	TDO13	O	TTL output, (13)
15	TDI14	I	TTL input, (14)	**34**	TDO14	O	TTL output, (14)
16	TDI15	I	TTL input, (15)	**35**	TDO15	O	TTL output, (15)
17	TDI16	I	TTL input, (16)	**36**	TDO16	O	TTL output, (16)
18	EGND	-	External power ground	**37**	EGND	-	External power ground
19	VDD	I	+5V power supply input	**--**	--	--	--

- **J1:** 

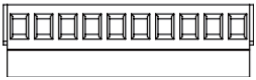
No.	Name	I/O	Function of Axis	No.	Name	I/O	Function of Axis
1	DICOM	--	Digital input common	**6**	EDI4	I	Isolated digital input, (4)
2	EDI3	I	Isolated digital input, (3)	**7**	PEL4	I	Positive limit, (4)
3	PEL3	I	Positive limit, (3)	**8**	ORG4	I	Origin Signal, (4)
4	ORG3	I	Origin Signal, (3)	**9**	MEL4	I	Negative limit, (4)
5	MEL3	I	Negative limit, (3)	**10**	DOCOM	--	Digital output common

- **J2:** 

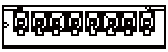
No.	Name	I/O	Function of Axis	No.	Name	I/O	Function of Axis
1	DICOM	--	Digital input common	**6**	EDI2	I	Isolated digital input, (2)
2	EDI1	I	Isolated digital input, (1)	**7**	PEL2	I	Positive limit, (2)
3	PEL1	I	Positive limit, (1)	**8**	ORG2	I	Origin Signal, (2)
4	ORG1	I	Origin Signal, (1)	**9**	MEL2	I	Negative limit, (2)
5	MEL1	I	Negative limit, (1)	**10**	DOCOM	--	Digital output common

NOTE

1. Please connect DICOM to external power supply (24VDC in general) if possible.
2. Please connect DOCOM to ground (GND) of external power supply if possible.

- **J3:** 

No.	Name	I/O	Function of Axis	No.	Name	I/O	Function of Axis
1	DGND	--	Isolated digital ground	**6**	AGND	--	Analog ground
2	TRG2-	O	Trigger output (-), (2)	**7**	AI4	I	Analog input, (4)
3	TRG2+	O	Trigger output (+), (2)	**8**	AI3	I	Analog input, (3)
4	TRG1-	O	Trigger output (-), (1)	**9**	AI2	I	Analog input, (2)
5	TG1+	O	Trigger output (+), (1)	**10**	AI1	I	Analog input, (1)

- **J4: Brake Connector** 

No.	Name	I/O	Function of Axis	No.	Name	I/O	Function of Axis
1	BRAKE 1+	--	Brake signal (+), (1)	**6**	BRAKE 3+	I	Brake signal (+), (3)
2	BRAKE 1-	I	Brake signal (-), (1)	**7**	BRAKE 3-	I	Brake signal (-), (3)
3	BRAKE 2+	I	Brake signal (+), (2)	**8**	BRAKE 4+	I	Brake signal (+), (4)
4	BRAKE 2-	I	Brake signal (-), (2)	**9**	BRAKE 4-	I	Brake signal (-), (4)

- **J5** 

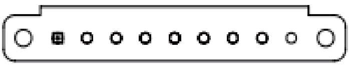
No.	Name	I/O	Function of Axis	No.	Name	I/O	Function of Axis
1	I24V	--	Ext. power supply, +24V	**4**	DOCOM	--	Digital output common
2	IGND	--	Ext. power ground	**5**	EEMG	I	Ext. Emergency signal
3	DICOM	--	Digital input common	**6**	--	--	--

NOTE

1. Please connect DICOM to external power supply (24VDC in general) if possible.
2. Please connect DOCOM to ground (GND) of external power supply if possible.

- **J6** 

No.	Name	I/O	Function of Axis	No.	Name	I/O	Function of Axis
1	EDO1	O	Digital output, (1)	**4**	EDO4	O	Digital output, (4)
2	EDO2	O	Digital output, (2)	**5**	DOCOM	O	Digital output common
3	EDO3	O	Digital output, (3)	**6**	--	O	--

- **IOIF1:** 

No.	Name	I/O	Function of Axis	No.	Name	I/O	Function of Axis
1	DI1	I	Additional isolated digital input, (1)	**6**	DI6	I	Additional isolated digital input, (6)
2	DI2	I	Additional isolated digital input, (2)	**7**	DI7	I	Additional isolated digital input, (7)
3	DI3	I	Additional isolated digital input, (3)	**8**	DI8	I	Additional isolated digital input, (8)
4	DI4	I	Additional isolated digital input, (4)	**9**	DICOM	--	Digital input common
5	DI5	I	Additional isolated digital input, (5)	--	--	--	--

- **IOIF2:**

No.	Name	I/O	Function of Axis	No.	Name	I/O	Function of Axis
1	DI9	I	Additional isolated digital input, (9)	**6**	DI14	I	Additional isolated digital input, (14)
2	DI10	I	Additional isolated digital input, (10)	**7**	DI15	I	Additional isolated digital input, (15)
3	DI11	I	Additional isolated digital input, (11)	**8**	DI16	I	Additional isolated digital input, (16)
4	DI12	I	Additional isolated digital input, (12)	**9**	DICOM	--	Digital input common
5	DI13	I	Additional isolated digital input, (13)	--	--	--	--

- **IOIF3:**

No.	Name	I/O	Function of Axis	No.	Name	I/O	Function of Axis
1	※DO1	O	Additional isolated digital output, (1)	**6**	DO6	O	Additional isolated digital output, (6)
2	※DO2	O	Additional isolated digital output, (2)	**7**	DO7	O	Additional isolated digital output, (7)
3	※DO3	O	Additional isolated digital output, (3)	**8**	DO8	O	Additional isolated digital output, (8)
4	※DO4	O	Additional isolated digital output, (4)	**9**	DOCOM	--	Digital output common
5	※DO5	O	Additional isolated digital output, (5)	--	--	--	--

NOTE

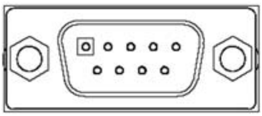
※The digital output current may reach 250mA

- **IOIF4:**

No.	Name	I/O	Function of Axis	No.	Name	I/O	Function of Axis
1	DO9	O	Additional isolated digital output, (9)	6	DO14	O	Additional isolated digital output, (14)
2	DO10	O	Additional isolated digital output, (10)	7	DO15	O	Additional isolated digital output, (15)
3	DO11	O	Additional isolated digital output, (11)	8	DO16	O	Additional isolated digital output, (16)
4	DO12	O	Additional isolated digital output, (12)	9	DOCOM	--	Digital output common
5	DO13	O	Additional isolated digital output, (13)	--	--	--	--

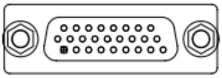
NOTE

1. Please connect DICOM to external power supply (24VDC in general) if possible.
2. Please connect DOCOM to ground (GND) of external power supply if possible.

- **CN1:** 

No.	Name	I/O	Function of Axis	No.	Name	I/O	Function of Axis
1	EDO4+	O	Digital output (+), (4)	6	EDO4-	O	Digital output (-), (4)
2	TG1+	O	Trigger output (+), (1)	7	TRG1-	O	Trigger output (-), (1)
3	TRG2+	O	Trigger output (+), (2)	8	TRG2-	O	Trigger output (-), (2)
4	Rsv.	--	Reserved	9	DGND	--	Digital ground
5	Rsv.	--	Reserved				

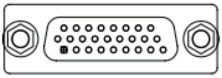
- **CMA1-CMA4 (compatible with PCI-8254/8258 only):**



No.	Name	I/O	Function	No.	Name	I/O	Function	No.	Name	I/O	Function
1	SVON	O	Servo On signal	10	ALM_RST / DO	O	Reset driver signal / Digital output signal	19	EMG	I	Emergency signal
2	ZSP	I	Zero speed signal	11	ALM	I	Servo alarm signal	20	IGND	--	Ext. power ground
3	Rsv.	--	Reserved	12	I24V	--	Ext. power supply, +24V	21	IGND	--	Ext. power ground
4	Rsv.	--	Reserved.	13	IGND	--	Ext. power ground	22	IGND	--	Ext. power ground
5	AOUT-	O	Analog command output (-)	14	BRAKE-	O	Brake signal(-)	23	Rsv.	--	Reserved
6	AOUT+	O	Analog command output (+)	15	AGND	--	Analog ground	24	Rsv.	--	Reserved
7	EA-	I	Encoder A-phase(-)	16	EB-	I	Encoder B-phase(-)	25	EZ-	I	Encoder Z-phase(-)
8	EA+	I	Encoder A-phase(+)	17	EB+	I	Encoder B-phase(+)	26	EZ+	I	Encoder Z-phase(+)
9	BRAKE+	O	Brake signal(+)	18	AGND	--	Analog ground				

NOTE

ALM_RST / DO: You may set this signal to general purpose digital output signal (EDO) or alarm clearance function (ALM_RST) by switch S1 or S2.

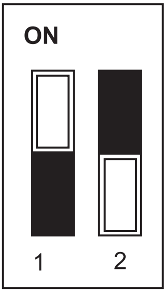
- **CMP1~CMP4:** 

No.	Name	I/O	Function	No.	Name	I/O	Function	No.	Name	I/O	Function
1	SVON	O	Servo On signal	10	ALM_RST / DO	O	Reset driver signal / Digital output signal	19	EMG	I	Emergency signal
2	INP	I	In-position signal	11	ALM	I	Servo alarm signal	20	IGND	--	Ext. power ground
3	ERC	O	Dev. ctr, clr. signal	12	I24V	--	Ext. power supply, +24V	21	IGND	--	Ext. power ground
4	RDY	I	Servo ready signal	13	IGND	--	Ext. power ground	22	IGND	--	Ext. power ground
5	OUT-	O	Pulse signal (-)	14	BRAKE-	O	Brake signal(-)	23	DIR-	O	Dir. Signal(-)
6	OUT+	O	Pulse signal (+)	15	IGND	--	Ext. power ground	24	DIR+	O	Dir. Signal(+)
7	EA-	I	Encoder A-phase(-)	16	EB-	I	Encoder B-phase(-)	25	EZ-	I	Encoder Z-phase(-)
8	EA+	I	Encoder A-phase(+)	17	EB+	I	Encoder B-phase(+)	26	EZ+	I	Encoder Z-phase(+)
9	BRAKE+	O	Brake signal(+)	18	IGND	--	Ext. power ground				

NOTE

ALM_RST / DO: You may set this signal to general purpose digital output signal (EDO) or alarm clearance function (ALM_RST) by switch S1 or S2.

2.8.3 S1, S2: EDO/ALM_RST Selection Switch



ON = Reset servo drive

S1	**1**	**2**		
	ON		Reset servo drive	#1
		ON	Reset servo drive	#2
S2	**1**	**2**		
	ON		Reset servo drive	#3
		ON	Reset servo drive	#4

OFF is default

DIN-825-GP4 is equipped with 4 servo drive reset signals. You may set up CMA1~CMA4 PIN 10 and CMP1~CMP4 PIN 10 for servo drive rest or J6 connector DO.1~DO.4 by switch S1 and S2.

3 Signal Connection

AMP-204C / AMP-208C must connect to servo or stepper motor drive with exclusive terminal board DIN-825-GP4. All optical isolation circuit of mechanical relevant I/O and servo relevant I/O are set to DIN-825-GP4 to prevent damages to primary controller AMP-204C / AMP-208C from any invalid signal connection to it. This may effectively reduce difficulites and times required in replacing controller relevant products when doing customer service maintenance tasks. See sections below for detailed descriptions on precautions required to connect to various mechanical I/O and servo I/O signals. Contents:

Section 3.1: Pulse Command Signal

Section 3.2: Encoder Input Signal

Section 3.3: Emergency Stop Signal

Section 3.4: Mechanical Limit Switch Signal

Section 3.5: Original Position Switch Signal

Section 3.6: In-position/Zero Speed Signal

Section 3.7: Servo Alarm Signal

Section 3.8: Servo On Signal

Section 3.9: Comparing Trigger Signal

Section 3.10: General Purpose Digital Input and Output Signal

3.1 Pulse Command

AMP-204C / AMP-208C can provide 4/8 pulse control command channel with each of them supports up to 6.5MHz output frequency.

In general, you may set the servo driver to P (position) mode for open-loop control with AMP-204C / AMP-208C pulse control commands.

In addition to servo drive, the Stepper drive also employs pulse command interface as the primay control input commands. See below for corresponding pins of pulse command output against differential pulse signals to DIN-825-GP4:

CMPx Pin No (x=1~4)	Signal Name	Description (n=1~8)	Axis #
6	OUT+	Pulse signal, (+) (n)	1~8
5	OUT-	Pulse signal, (-) (n)	1~8
24	DIR+	Dir. Signal, (+) (n)	1~8
23	DIR-	Dir. Signal, (-) (n)	1~8

NOTE

AMP-208C requires two DIN-825-GP4 for eight axes motion control functions
1 controls axes 1 ~ 4 and #2 controls axes 5 ~ 8

Either servo motor drive or stepper motor drive employs one of the two input interfaces described below:

1. Line Driver input interface provides better anti noise-resistant and longer wiring length.

- **Signal connection diagram:**

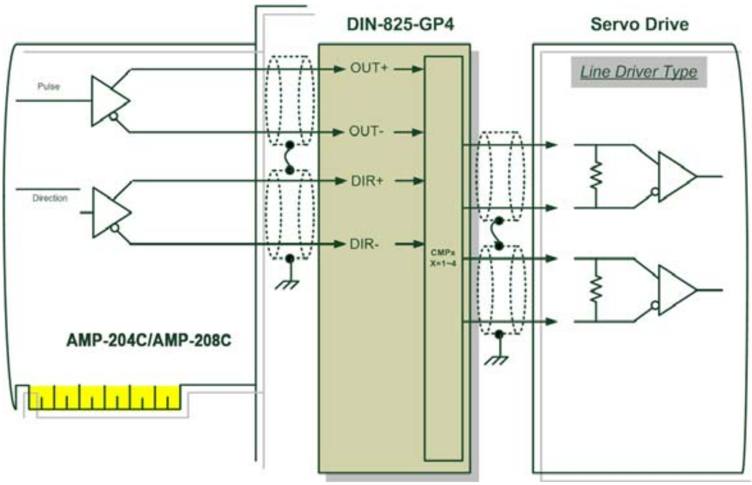


Figure 3-1: Line Driver type pulse control command signal connection example

2. Open-Collector input interface can increase passing current capacity of signal by adjusting pull-up resistance value at the shorter wiring length.

- **Signal connection diagram:**

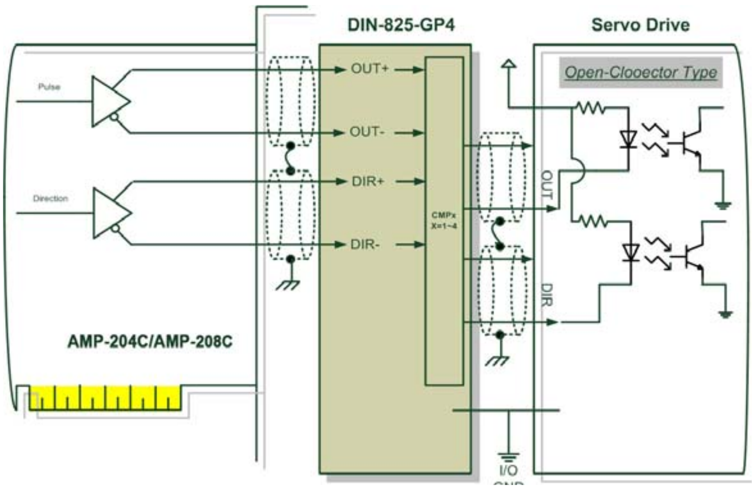


Figure 3-2: Open-Collector type pulse control command signal connection example

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CAUTION

To avoid damages to Line Driver components on controller casued by invalid wiring please connect the OUT-, DIR- pins of controller to OUT, DIR pins of motor drive.

CAUTION

The controller employs Line Driver component -26LS31 with maximum Sink Current at 20mA. Do not use it at current above this value, the component may be damaged otherwise.

3.2 Encoder Input, EA & EB & EZ

AMP-204C / AMP-208C provides 4/8 encoder input channels respectively which accept single end input frequency up to 5MHz with each channel containing EA, EB, and EZ signal. Each group of EA, EB, and EZ signal contains a pair of differential signal, e.g. the EA signal contains EA+ and EA-. See Section 4.1.1.4 for how to use the encoder. See below for corresponding pins of encoder input on DIN-825-GP4:

CMAx / CMPx Pin No (x=1~4)	Signal Name	Description (n=1~8)	Axis #
8	**EA+**	Encoder A-phase (+),(n)	1~8
7	**EA-**	Encoder A-phase (-),(n)	1~8
17	**EB+**	Encoder B-phase (+),(n)	1~8
16	**EB-**	Encoder B-phase (-),(n)	1~8
26	**EZ+**	Encoder Z-phase (+),(n)	1~8
25	**EZ-**	Encoder Z-phase (-),(n)	1~8

NOTE

AMP-208C requires two DIN-825-GP4 for eight axes motion control Function
1 controls axes 1 ~ 4 and #2 controls axes 5 ~ 8

CAUTION

The controller employs Line Receiver component -26LS32 with maximum Sink Current at 20mA@5V. Do not use it at current above this value, the component may be damaged otherwise.

- **Signal connection diagram:**

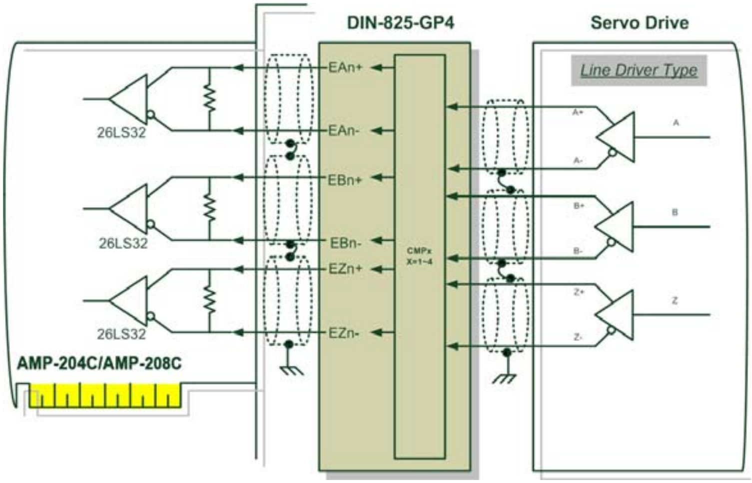


Figure 3-3: Line driver type encoder input signal connection example

3.3 Emergency Stop Input

AMP-204C/ AMP-208C provides one hardware input emergency stop signal (EMG). If the external emergency stop signal is triggered, all motion control commands will be stopped immediatly. In addition, the DIN-825-GP4 is designed to transmit external emergency stop signal to servo/stepper motor drive to stop operation of every motor immediately. See below for corresponding pins of emergency stop signal input on DIN-825-GP4:

J5 Pin No	Signal Name	Description	Axis #
5	EEMG	External emergency stop input (external input)	-

CMPx / CMAx Pin No (x=1~4)	Signal Name (n=1~8)	Description	Axis #
19	EMG(n)	Emergency stop (output to drive)	1~8

NOTE

AMP-208C requires two DIN-825-GP4 for eight axes motion control functions
1 controls axes 1 ~ 4 and #2 controls axes 5 ~ 8

- **Signal connection diagram:**

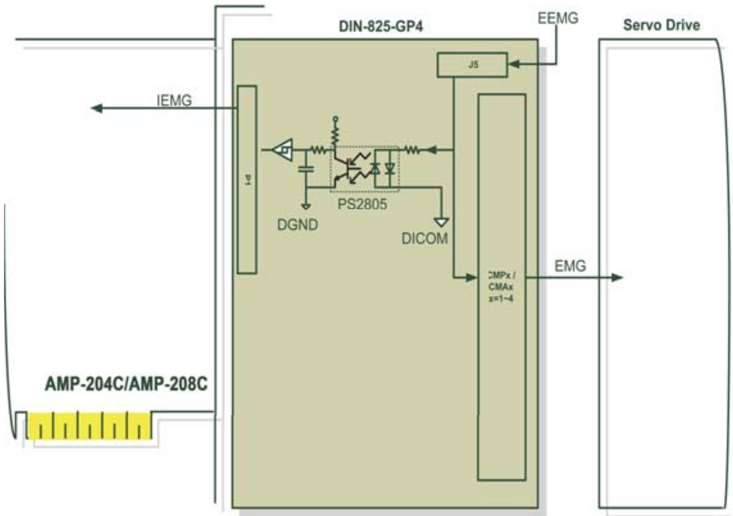


Figure 3-4: Emergency stop signal connection example

3.4 PEL/MEL Input

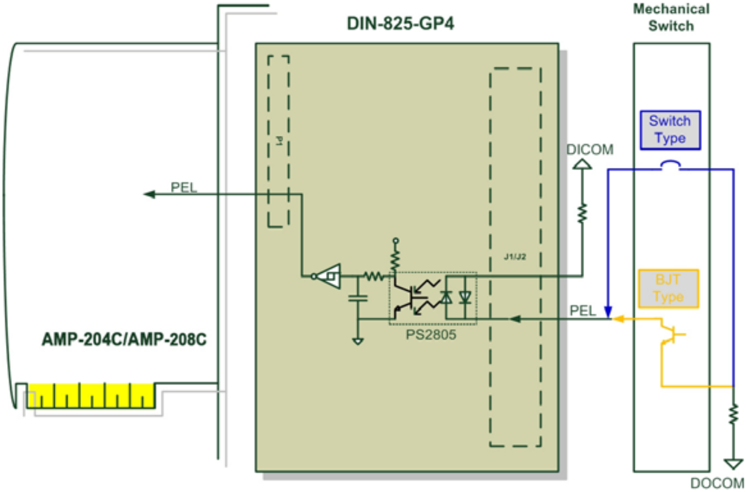
AMP-204C / AMP-208C provides 4/8 End-limited switch input channels. The Plus Limited Switch (PEL) is used as the mechanical protection switch for movement in the positive direction. When this switch is triggered the AMP-204C / AMP-208C stops its positive direction movement immediately. The Minus Limited Switch (MEL) is used as the mechanical protection switch for movement in the negative direction. When this switch is triggered, the AMP-204C / AMP-208C stops its negative direction movement immediately. See below for corresponding pins of mechanical limit switch signal input on DIN-825-GP4:

J1/J2 Pin No	Signal Name	Description	Axis #
3	**PEL(3) / PEL(1)**	Plus limit switch input (3) / (1)	3 / 1
7	**PEL(4) / PEL(2)**	Plus limit switch input (4) / (2)	4 / 2
5	**MEL(3) / MEL(1)**	Minus limit switch input (3) / (1)	3 / 1
9	**MEL(4) / MEL(2)**	Minus limit switch input (4) / (2)	4 / 2

NOTE

AMP-208C requires two DIN-825-GP4 for eight axes motion control Function
1 controls axes 1 ~ 4 and #2 controls axes 5 ~ 8

- **Signal connection diagram:**



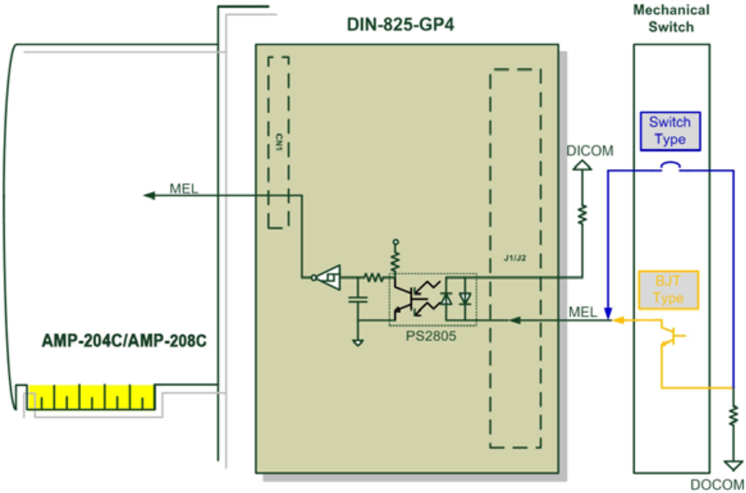


Figure 3-5: Mechanical limit switch signal connection example

3.5 ORG Input

AMP-204C / AMP-208C provides 4/8 original position switch input channels. Working together with the home movement described in Section 4.3, this function returns the body to its original position (also known as the zero position). See below for corresponding pins of original position switch signal input on DIN-825-GP4:

J1/J2 Pin No	Signal Name	Description	Axis #
4	**ORG(3) / ORG(1)**	Original position switch input (3) / (1)	3 / 1
8	**ORG(4) / ORG(2)**	Original position switch input (4) / (2)	4 / 2

NOTE

AMP-208C requires two DIN-825-GP4 for eight axes motion control Function
1 controls axes 1 ~ 4 and #2 controls axes 5 ~ 8

- **Signal connection diagram:**

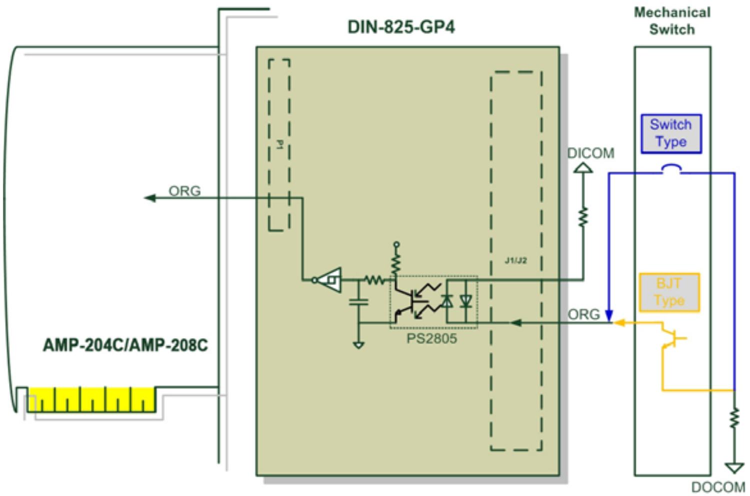


Figure 3-6: Original position switch signal connection example

3.6 INP Input

AMP-204C / AMP-208C provides 4/8 In-position (INP) input channels. Working with function described in Section 4.8, it can be used as the trigger source for in-position events of individual motion. In general, when servo drive is set to position mode (P mode), the servo issues a (INP) pulse signal to controller when movement get into position. See below for corresponding pins of in-position or zero speed detection signal input on DIN-825-GP4:

CMPx Pin No (x=1~4)	Signal Name (n=1~4)	Description	Axis #
2	INP(n)	In-position Input (for pulse output mode only)	1~4

NOTE

AMP-208C requires two DIN-825-GP4 for eight axes motion control functions
1 controls axes 1 ~ 4 and #2 controls axes 5 ~ 8

- **Signal connection diagram:**

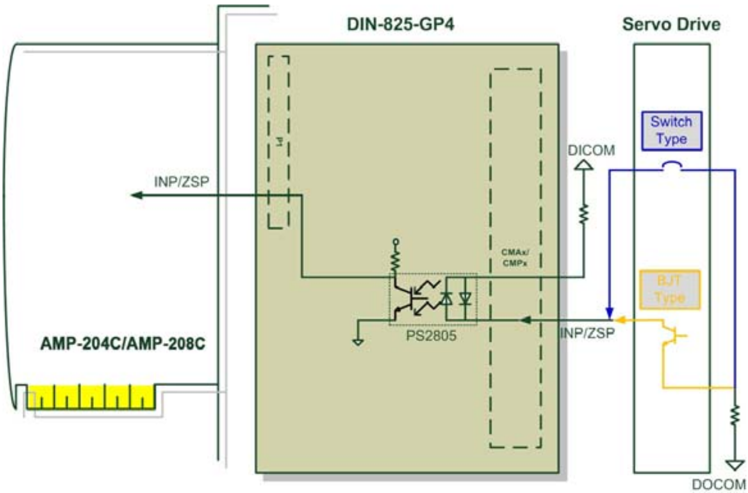


Figure 3-7: In-position signal connection example

3.7 ALM Input

AMP-204C / AMP-208C provides 4/8 servo alarm input channels. Working with function described in Section 4.11 it can be used as the trigger source for motion interrupt event. In general, when abnormality is encountered during servo drive movement, it issues an (ALM) pulse signal to controller for abnormality occurrence. See below for corresponding pins of servo alarm input on DIN-825-GP4:

CMAx / CMPx Pin No (x=1~4)	Signal Name (n=1~4)	Description	Axis #
11	**ALM(n)**	Servo alarm input	1~4

NOTE

AMP-208C requires two DIN-825-GP4 for eight axes motion control functions
1 controls axes 1 ~ 4 and #2 controls axes 5 ~ 8

- **Signal connection diagram:**

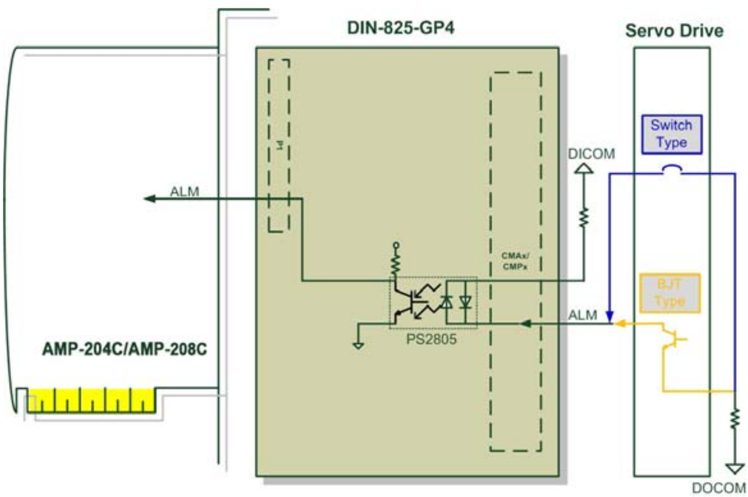


Figure 3-8: Servo alarm signal connection example

3.8 SVON Output

AMP-204C / AMP-208C provides 4/8 servo-on output channels and utilize the servo-on signal to enable servo drive for pulse or analog commands input. If there is abnormality is encountered during movement, the AMP-204C / AMP-208C turns off this signal automatically and stops all motion control commands. See below for corresponding pins of servo-on signal output on DIN-825-GP4:

CMAx / CMPx Pin No (x=1~4)	Signal Name (n=1~4)	Description	Axis #
1	SVON(n)	Servo-on output	1~4

NOTE

AMP-208C requires two DIN-825-GP4 for eight axes motion control functions
1 controls axes 1 ~ 4 and #2 controls axes 5 ~ 8

- **Signal connection diagram:**

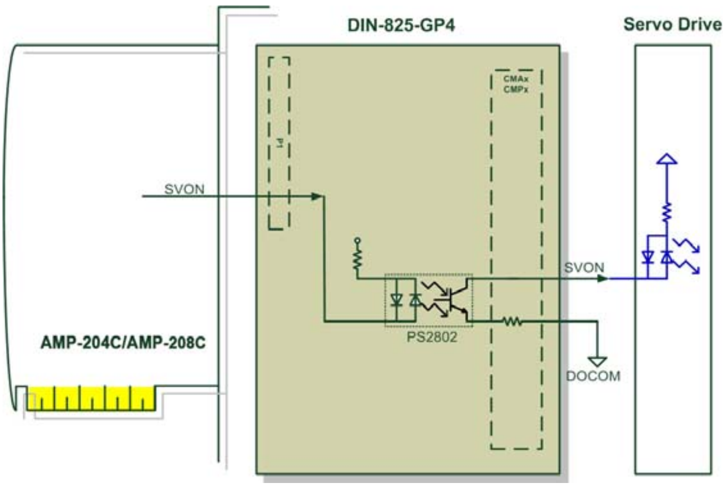


Figure 3-9: Servo-on signal connection example

3.9 Comapre & Trigger Output:

AMP-204C / AMP-208C provides 2/4 comparing trigger pulse output channels. Each comparing trigger channel can output pulse commands up to 1 MHZ. See Section 4.9.2 for its detail and how to use it. See below for corresponding pins of pulse command output against differential pulse signals to DIN-825-GP4:

J3 Pin No	Signal Name	Description
2	TRG2-/TRG4-	Trigger output (-), (2)/(4)
3	TRG2+ / TGR4+	Trigger output (+), (2)/(4)
4	TRG1-/TRG3-	Trigger output (-), (1)/(3)
5	TRG1+/TRG3+	Trigger output (+), (1)/(3)

NOTE

The compare trigger pulse output channel of AMP-204C / AMP-208C employs line driver output interface for better noise signal resistance and wiring length where trigger output (3) & (4) require #2 DIN-825-GP4 for wiring.

- **Signal connection diagram:**

1. Line Driver interface:

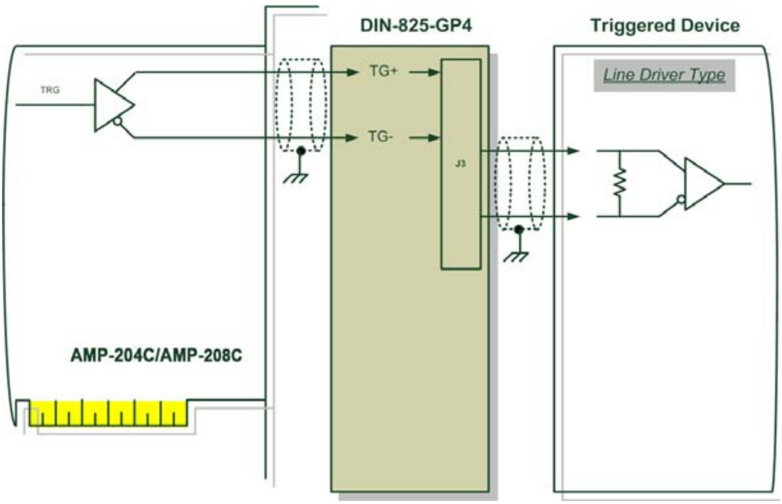


Figure 3-10: Line Driver type compare trigger signal connection example

2. Open-Collector interface:

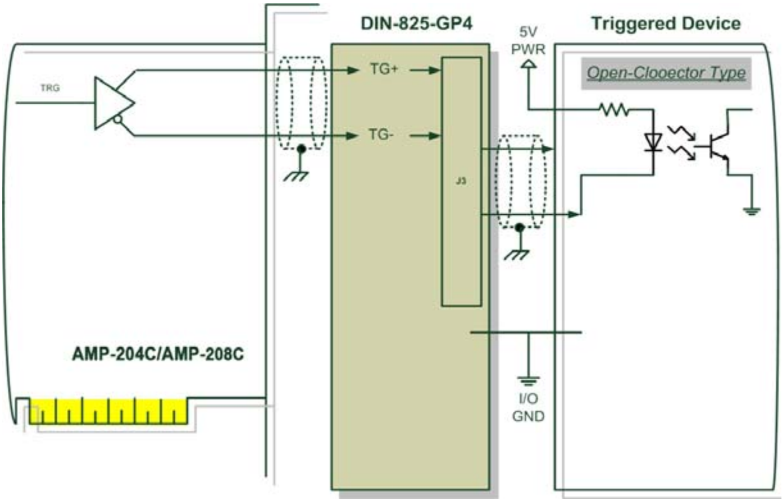


Figure 3-11: Open-Collector type compare trigger signal connection example

3.10 Digital Output/Input

AMP-204C / AMP-208C provides 20/24 digital output/input channels. See below for corresponding pins of general purpose digital input and output signals on DIN-825-GP4:

J1/J2 Pin No.	Signal Name	Description
2	**EDI(3) / EDI (1)**	General purpose digital input signal (3), (1)
6	**EDI(4) / EDI (2)**	General purpose digital input signal (4), (2)

J6 Pin No.	Signal Name	Description
1	**EDO(1)**	General purpose digital output signal (1)
2	**EDO(2)**	General purpose digital output signal (2)
3	**EDO(3)**	General purpose digital output signal (3)
4	**EDO(4)**	General purpose digital output signal (4)

NOTE

AMP-208C requires two DIN-825-GP4 for eight axes motion control Function
1 controls axes 1 ~ 4 and #2 controls axes 5~ 8

NOTE

1. Please connect DICOM to external power supply (24VDC in general) if possible.
2. Please connect DOCOM to ground (GND) of external power supply if possible.

- **Signal connection diagram:**

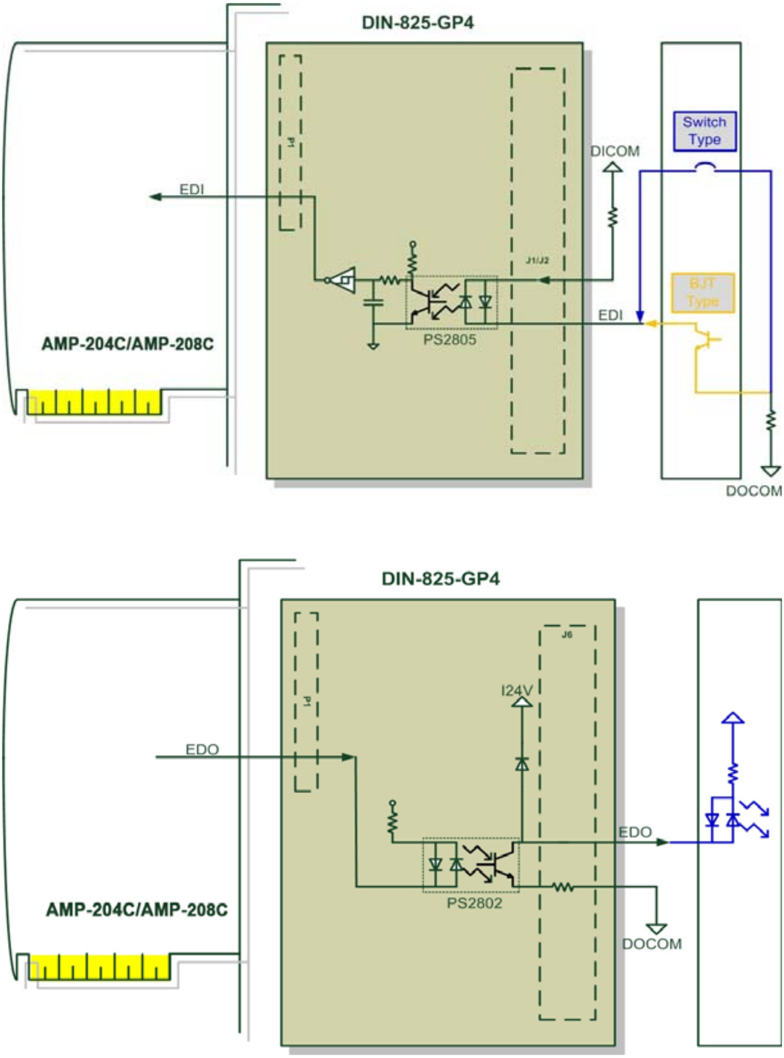


Figure 3-12: General purpose digital I/O signal connection example

IOIF1 Pin No.	Signal Name	Description
1~8	DI(1)~(8)	General purpose IOIF2 digital input signal (1)~(8)

IOIF2 Pin No.	Signal Name	Description
1~8	DI(9)~(16)	General purpose digital input signal (9)~(16)

IOIF3 Pin No.	Signal Name	Description	Axis #
※1~5	DO(1)~(5)	General purpose digital output signal (1)~(5)	-

NOTE

※The digital output current may reach 250mA

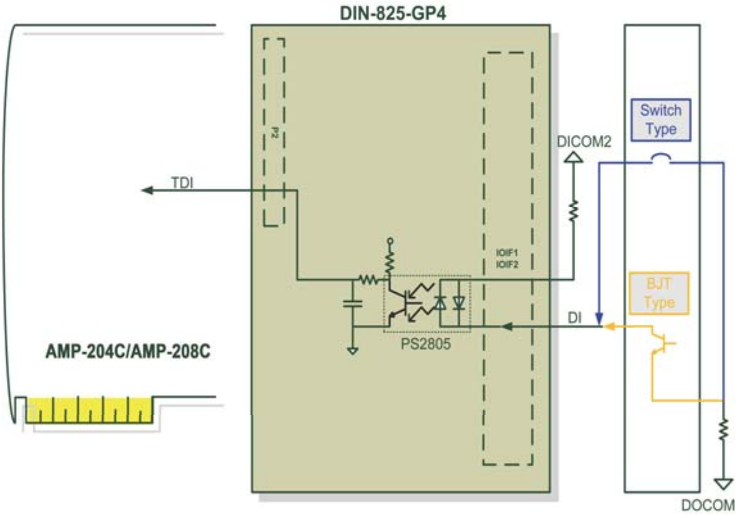
IOIF3 Pin No.	Signal Name	Description	Axis #
6~8	DO(6)~(8)	General purpose digital output signal (6)~(8)	-

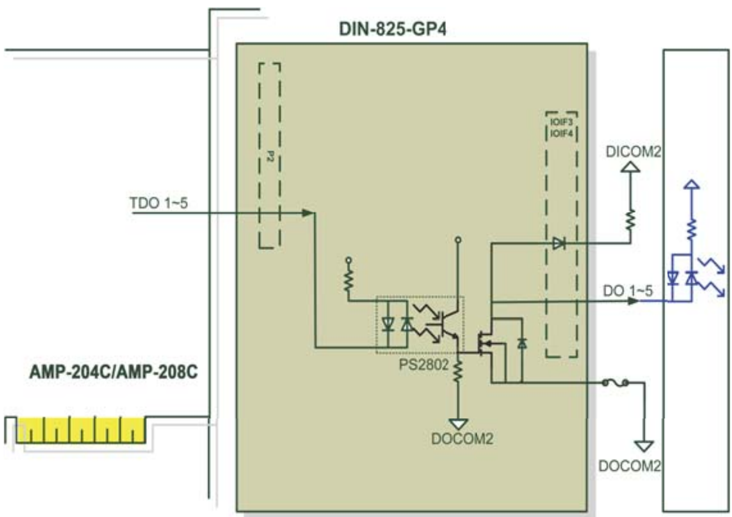
IOIF4 Pin No.	Signal Name	Description	Axis #
1~8	DO(9)~(16)	General purpose digital output signal (9)~(16)	-

NOTE

1. Please connect DICOM to external power supply (24VDC in general) if possible.
2. Please connect DOCOM to ground (GND) of external power supply if possible.

- **Signal connection diagram:**





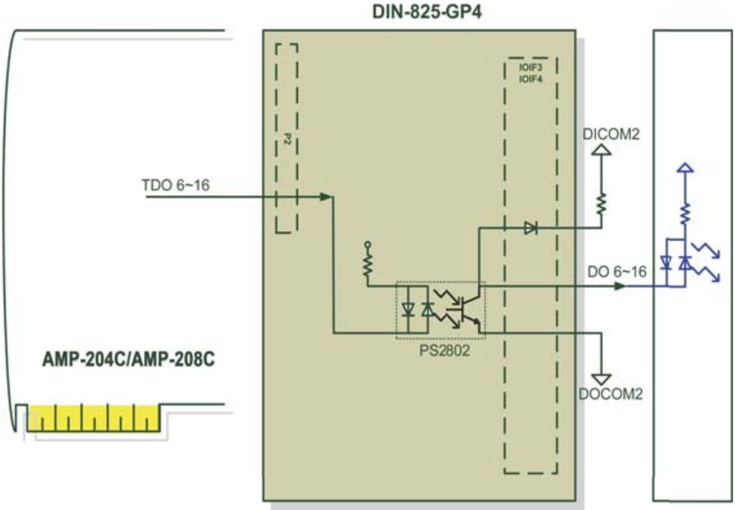


Figure 3-13: General purpose digital I/O signal connection example

4 Motion Control Theory

This chapter introduces you the motion control function of AMP-204C / AMP-208C as well as relevant precautions in using them. Contents:

Section 4.1: Motion Control Mode and Interface Overview

Section 4.2: Motion Control Operations

Section 4.3: Home Move

Section 4.4: Velocity Move

Section 4.5: Jog Move

Section 4.6: Point-to-Point Move

Section 4.7: Interpolation

Section 4.8: Motion Status Monitoring

Section 4.9: Application Functions

Section 4.10: Safety Protection

Section 4.11: Host Interrupt

4.1 Motion Control Mode and Interface Overview

This section describes basic setups of AMP-204C and AMP-208C before doing motion control and fundamental concepts of its core operations.

4.1.1 Motion Control Interface

4.1.1.1 Control Mode and Output Interface

You may use the **MotionCreatorPro2** application program to set up these two output interface and save your desired setting in non-volatile memory, the so-called ROM, of the controller for automatic loading when the controller power on. You may use API listed below to retrieve current settings to ensure their correctness.

APS_get_eep_curr_drv_ctrl_mode ()

4.1.1.2 Pulse Type

You can use this control mode to control stepper motor or set it to P control mode to control servo motor with pulse format signal input. The output interface of controller is OUT / DIR [1..8] pins. (Please refer Chapter 3 for detail.)

This is the so called open-loop or semi closed-loop control model where the upper controller output position command in digital pulse format signal to lower stepper motor or servo motor to form a close-loop control in servo drive. In this mode, number of pulses indicates actual distance traveled by the machine (vary with the relation between mechanical shift and pulse) while the pulse output frequency indicates speed of the machine traveling at (in unit of pulse per second, PPS).

In this mode users must pay special attention to pulse signal format acceptable to the motor to be drived. The motor works normally only when being drived by correct pulse format signal, otherwise the motor may fail to work in erroneous direction or with abnormal shaking. Users must correctly set up the controller before any motion control after the software is initialized. This controller provides two pulse signal output format:

- OUT / DIR signal format: At this mode, the OUT signal indicates frequency and amount of output pulses where DIR indicates direction of machine movement.
- CW / CCW signal format: At this mode the CW/CCW signal indicates both machine movement direction and pulse output frequency and amount

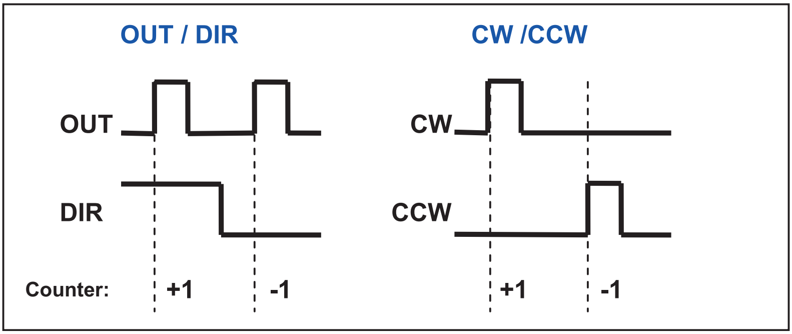


Figure 4-1: Format of pulse signal

The signal format can be set up in axis parameters:

Param. No.	Define symbol	Description
81h (129)	PRA_PULSE_OUT_MODE	Pulse output format setup

4.1.1.3 Encoder

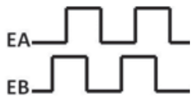
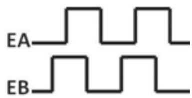
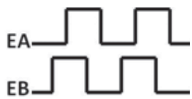
The positon encoder of this controller supports 9 kinds of digital signal input formats as described below.

CAUTION

Please set up the position encoder before doing motion control. This is especially true for analog output type closed-loop control as invalid setup may lead to motor burst.

NOTE

You may set up and test your controller with MotionCreatoPro 2 software. You can check this by manually spinning the motor (or move the workbench) and verify the encoder signal from motor or linear scale to the controller.

No	Decode Mode	Positive direction		Negative direction	
		EA	EB	EA	EB
0	OUT/DIR (1)		High		Low
1	CW/CCW (1)		Low	Low	
2	1X AB				
3	2x AB				
4	4x AB				
5	OUT/DIR (2)		High		Low
6	OUT/DIR (3)		Low		High
7	OUT/DIR (4)		Low		High

No	Decode Mode	Positive direction		Negative direction	
		EA	EB	EA	EB
8	CW/CCW (2)		High	High	

Table 4-1: Encoder input format

- **Axis parameter setup:**

Param. No.	Define symbol	Description
80h (128)	PRA_ENCODER_MODE	Encoder input signal format
85h (133)	PRA_ENCODER_DIR	Encoder counting direction setup

Table 4-2: Encoder input format

- **Axis parameter setup API:**

  APS_set_axis_param (); // write in axis parameter

  APS_set_axis_param (); // read out axis parameter

4.1.1.4 Motion Control I/O

Some motion control I/O signal of this controller definition are summarized in table below:

Param.	Defined Symbol	Type	Description
0	ALM	Input	Servo alarm
1	PEL	Input	Plus end limit
2	MEL	Input	Minus end limit
3	ORG	Input	Home input
4	EMG	Input	Emergency stop input
5	EZ	Input	Servo index input
6	INP	Input	In-Position input
7	SVON	Output	Servo ON output status

Here ALM, EZ and INP are signals sent by servo drive and SVON (Servo on) signal is the receiving signal of servo drive for driving the servo motor.

And PEL, MEL, ORG and EMG are mechanical I/O signals. Safety relevant signals, e.g. EMG, PEL and MEL are used to work together with motion control. Take example, the home movement will use ORG, PEL, MEL, EZ and other signals.

You may use following API functions to get I/O status with each bit of the parameter representing status of the axis motion control I/O.

I32 APS_set_servo_on (I32 Axis_ID, I32 Servo_on);

I32 APS_motion_status (I32 Axis_ID);

- **Signal direction**

  These signal logic may be inversed by software. Relevant axis parameters are listed below:

- **Board parameter**

Param. No.	Define symbol	Description
00h (0)	PRA_EL_LOGIC	PEL/MEL input logic
01h (1)	PRA_ORG_LOGIC	ORG input logic
04h (4)	PRA_ALM_LOGIC	Set ALM logic
05h (5)	PRA_ZSP_LOGIC / PRA_INP_LOGIC	Set INP logic
06h (6)	PRA_EZ_LOGIC	Set EZ logic

- **Board parameter**

Param. No.	Define symbol	Description	Value	Default
00h (0)	PRS_EMG_LOGIC	EMG input logic	0: Not inverse 1: Inverse	0

- **Filter**

  This controller features filters to screening out High-frequency noise against motion control I/O to prevent abnormal motion control action caused by external noise. The filter is defaulted at ON status.

4.1.2 Control Cycle

In general, a motion controller features three control cycles for different works. They are:

1. Servo control cycle
2. Motion control cycle
3. Host control cycle

4.1.2.1 Servo Control Cycle

The servo control cycle is the time required to complete one close loop control. Servo control cycle of this controller can be up to 20KHz, that is 50 microsecond for each cycle. In each control cycle, the controller finish various servo control relevant jobs including PID compensation and filter compensation.

4.1.2.2 Motion Control Cycle

Default motion control cycle is set at 1KHz, i.e. 1 millisecond for each cycle. Varieties of peripheral hardware components controls, including host communication, trajectory calculation and data sampling, are finished in it.

4.1.2.3 Host Control Cycle

Default host control cycle is 0.5 KHz. That is, it takes 2 millisecond to finish jobs in one control cycle including communications between hosts, watch dog, kernel update, parameter management and other non-realtime jobs.

The servo control cycle runs independetnly while the motion control and host control cycle are done in the same processor. The controller completes scheduled jobs automatically with the motion control ones has higher priority than the host control one.

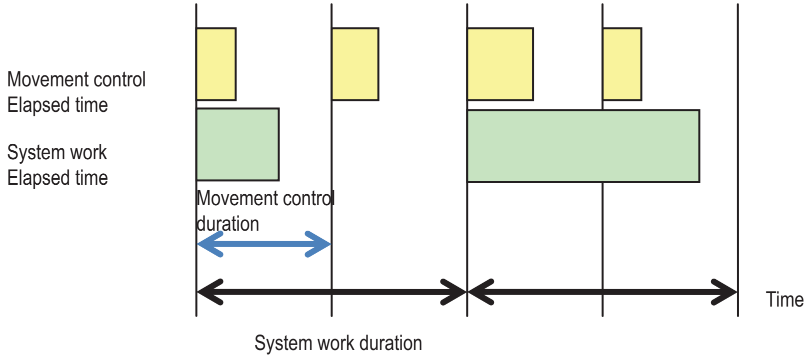


Figure 4-2: Control cycle

The motion program is executed in motion control cycle to control jobs to be executed in each motion control cycle directly for more precise completion of realtime jobs. Please pay attention to DSP loading when doing this.

Loading of CPU in controller is hard to predict as the controller is affected by many factors, e.g. external signals, user operations, and algorithm process during its operations. In most cases, please try to keep CPU utilization rate to below 70% and reserve 30% of CPU capacity to the processing of system jobs and momentary work loads.

Overloading (work loads exceed control cycle) may lead to unpredictable results. This controller provides you with some functions and tools to monitor processor utilization rate and adjust control procedures. In case of any processor overloading, the controller logs and warns (interrupt, plase refer to section of interrupt) that you may take for proper responses in your program.

How to use API:

get_motion_control_timing () // get usage amount of current motion control cycle
get_max_ motion_control_timing ()// get maximum usage amount of motion control cycle
get_motion_control_timing () // get usage amount of current host control cycle
get_motion_control_timing () // get maximum usage amount of host control cycle
reset_max_motion_control_timing()
reset_max_host_control_timing()
get_over_cycle_event()
get_over_cycle_count()
reset_over_cycle_count ()

4.2 Motion Control Operations

This section describes motion control modes provided by the controller and their operation principle. The objective is to help users make most of the motion control capacity of your controller to accomplish desired applications.

4.2.1 Coordinated System

This controller employs Cartesian coordinate system where one or more axes motion can be executed by one-to-one mapping each axis to a motor. There exists a conversion relation between axis of the Cartesian coordinate system and the motor being controlled. This conversion relation enables users to set up their own coordinate system without restricitons. Figure below indicates a coordinate system relation. The unit conversion factor will be reviewed in next section.

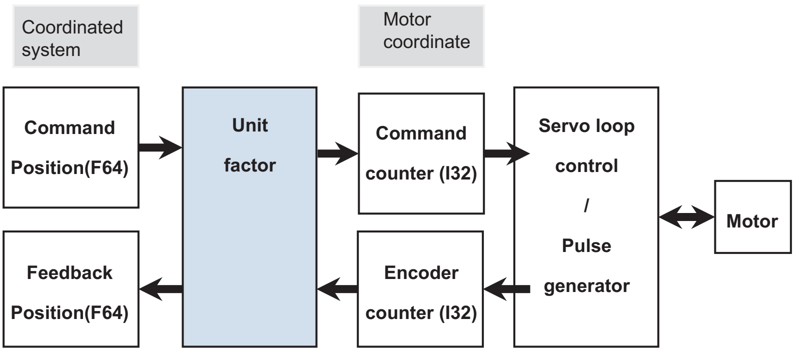


Figure 4-3: Controller coordinates system block

You may read out or set up coordinate command location or actual coordinate location

I32 APS_get_command_f (I32 Axis_ID, F64 *Command);
//command location reading
I32 APS_get_command_f (I32 Axis_ID, F64 *Command);
//command location setup
I32 APS_get_command_f (I32 Axis_ID, F64 *Command);
//actual location reading
I32 APS_get_command_f (I32 Axis_ID, F64 *Command);
//actual location setup

I32 coordinate format compliant API functions the same as API described above

I32 APS_get_command(I32 Axis_ID, I32 *Command);

I32 APS_set_command(I32 Axis_ID, I32 Command);

I32 APS_get_position(I32 Axis_ID, I32 *Position);

I32 APS_set_position (I32 Axis_ID, I32 Position);

API listed below can read motor coordinates

I32 APS_get_encoder(I32 Axis_ID, I32 *Encoder);

I32 APS_get_command_counter (I32 Axis_ID, I32 *Counter);

NOTE: In close loop control procedure you cannot set up command counter and encoder counter and so relevant setup API are not provided.

4.2.2 Unit Factor

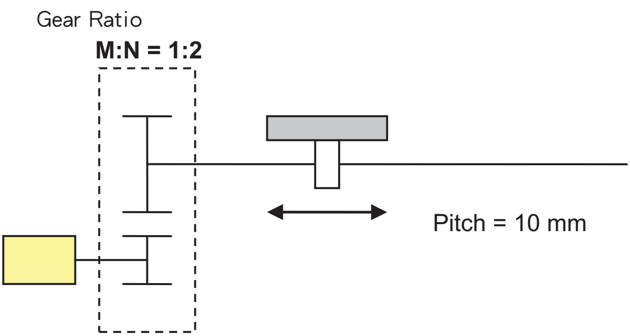
Location unit (or motion mechanism) of motor can have actual mapping against physical distance unit of coordinate system by setting up proper unit factor. The calculation formula is described below

$$\text{Unit Factor} = \frac{\text{Encoder Resolution}}{\text{Pitch (User define unit)}} \times \frac{\text{N (Deductor gear)}}{\text{M (Drive gear)}}$$

We use three examples to explain the way how unit factor is calculated

Example 1: Ball screw carrier

Assume encoder counts (resolution) generated by one spin of the motor is 10000 and the screw pitch is 10mm and the user desired distance unit of measure is micrometer,

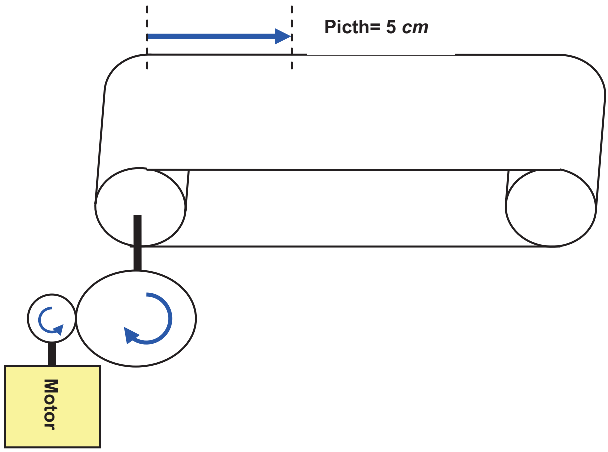


Unit factor can be calculated as described below:

$$Unit\ factor = \frac{10000}{10\text{mm} \times 1000\ \mu m} \times \frac{2}{1} = 2$$

Example 2: Conveyor system

Assume number of pulses generated by one spin of the motor is 8192, the conveyor belt shift 5cm by one spin of the belt pulley, the gear ratio is 1:2, and the user desired distance unit of measure is milimeter then the unit factor can be calculated as :



Unit factor can be calculated as described below:

$$Unit\ factor = \frac{8192}{5cm \times 100\ mm} \times \frac{2}{1} = 32.768$$

Example 3: Linear Motor system with Linear Scale

Take optical resolution at 1 micrometer and distance at millimeter then the unit factor should be:

$$Unit\ factor = \frac{1}{1\mu\text{m} \times 1000\ mm} = 0.001$$

Unit factor can be set up in axis parameter:

Param. No.	Define symbol	Description	Value	Default
86h (134)		Unit factor	F64 value	1

In general, you should define unit of measure at first and set up other position relevant parameter before designing any motion control application.

NOTE

If unit factor setting are changed during operation, other parameters related with distance unit of measure (e.g. position, velocity, and acceleration unit of measure) will be affected and you are required to change and adjust relevant setting on your own.

Relevant axis parameters can be found in table below:

Param. No.	Define symbol
07h (7)	PRA_SD_DEC
0Ah (10)	PRA_SPEL_POS0
0Bh (11)	PRA_SMEL_POS1
13h (19)	PRA_HOME_ACC
15h (21)	PRA_HOME_VM
17h (26)	PRA_HOME_SHIFT
19h (25)	PRA_HOME_VO
1Bh (27)	PRA_HOME_POS
21h (33)	PRA_ACC
22h (34)	PRA_DEC
23h (35)	PRA_VS
24h (36)	PRA_VM
25h (37)	PRA_VE
2Ah (42)	PRA_PRE_EVENT_DIST
2Bh (43)	PRA_POST_EVENT_DIST
43h (67)	PRA_JG_ACC
44h (68)	PRA_JG_DEC
45h (69)	PRA_JG_VM
46h (70)	PRA_JG_OFFSET

NOTE

Some API may have encoder signal of position related input parameter.

4.2.3 Acc/Deceleration Profile

Basic motion command usually contains distance, velocity, and acceleration data. This controller plans and calculates Acceleration & Deceleration profile based on these motion command parameters to make motion operation completed as desired by users. This controller provides following acceleration profiles:

1. Trapezoidal speed profile, T-curve
2. S-curve

4.2.3.1 Trapezoidal Speed Profile, T-curve

Trapezoidal speed profile (the so called T-curve) is a curve where the acceleration zone and deceleration zone matches first-order linear speed profile (equivalent acceleration). As shown in the velocity-time chart (V-T):

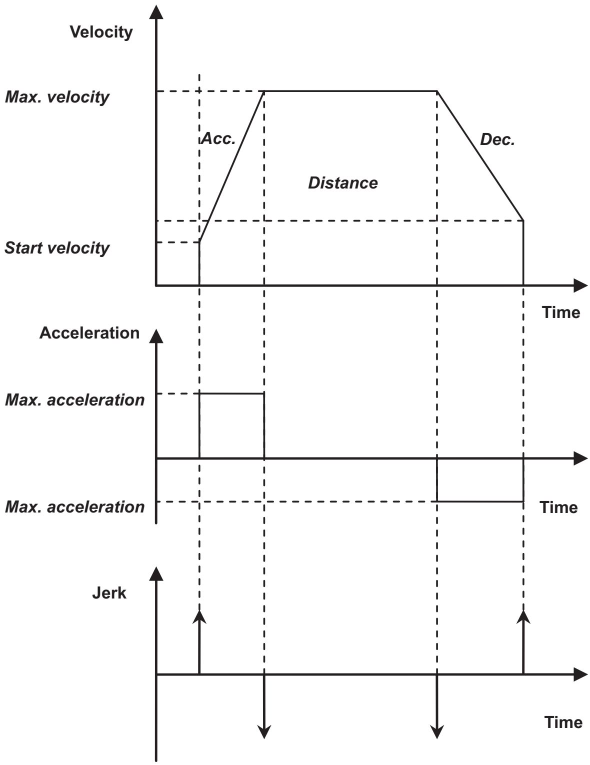


Figure 4-4: Relation of trapezoidal speed profile's speed/acceleration/jerk VS time

In a V-T chart the area under the trapezoidal curve equals motion distance. If the user does not set up sufficient motion distance the controller shall increase (decrease) the maximum speed while maintian the acceleration, as shown in figure below:

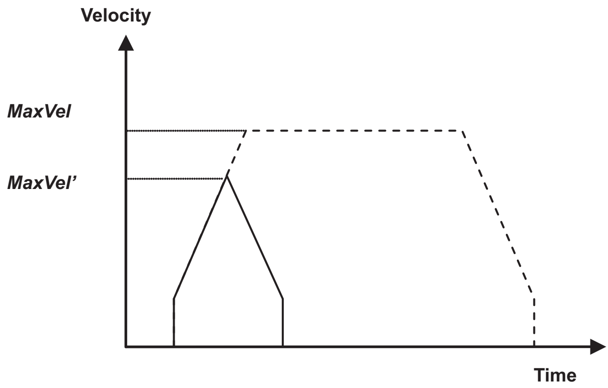


Figure 4-5: Maximum speed by auto-planning

MaxVel is the maximum velocity set up by user, dotted line indicate speed profile with sufficient distance. As the movement distance is insufficient, the controller adjust the maximum velocity to *MaxVel'* automatically. The acceleration and deceleration rate remain intact to maintain the best (shortest) motion time.

4.2.3.2 S-curve

An S-curve is a curve where the speed profile in the jerk area can be represented by second-order profile. This helps to reduce motor vibration at start up and stop time as indicated by points (t1, t3, t5, t7) in figure below.

To shorten acceleration and deceleration time the linear section (t2, t6) is inserted in these area to maintain the maximum accleration and so get an accleration-time (A-T) chart in trapezoidal.

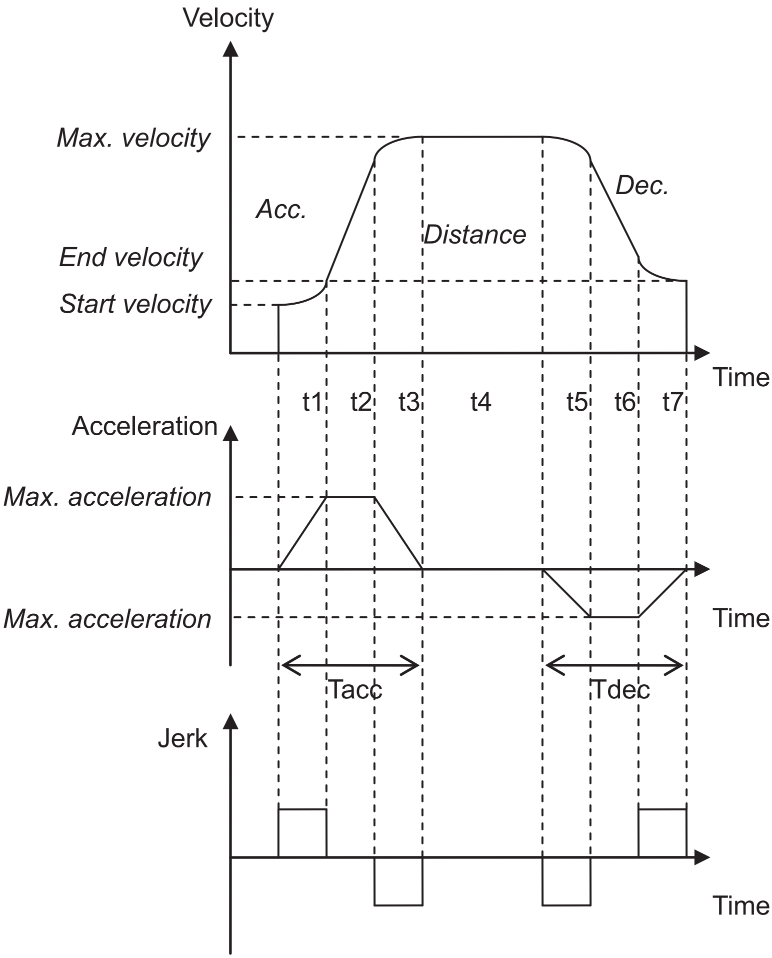


Figure 4-6: Relation of S-curve speed profile's speed/acceleration/jerk VS time

This controller employs S-factor (S) to control jerk ratio. Its equation is described below

$$S = \frac{t1}{t1 + t2}; and \quad t1 = t2$$

Value of S is between 0 and 1, when

S = 0, the speed profile becomes a T-curve

S >0 and S<=1: S - curve

When S = 1, the profile comes to a Pure S– curve with its A-T chart become a triangle.

The equation above indicate that the greater the value of S is the more smooth the speed profile and the smaller jerk value will become. This helps in reducing motor vibration. However, the motion process takes more time to complete. On the contrary, the smaller the S value is the greater the jerk value become and the motion time reduces to the shortest.

As with a T-curve, when motion distance is insufficient, the controller adjust the maximum velocity automatically to maintain smooth movement. Acceleration ACC and DEC and S-factor remain consistent to maintain acceleration rate and the jerk rate will be changed, as shown in figure below

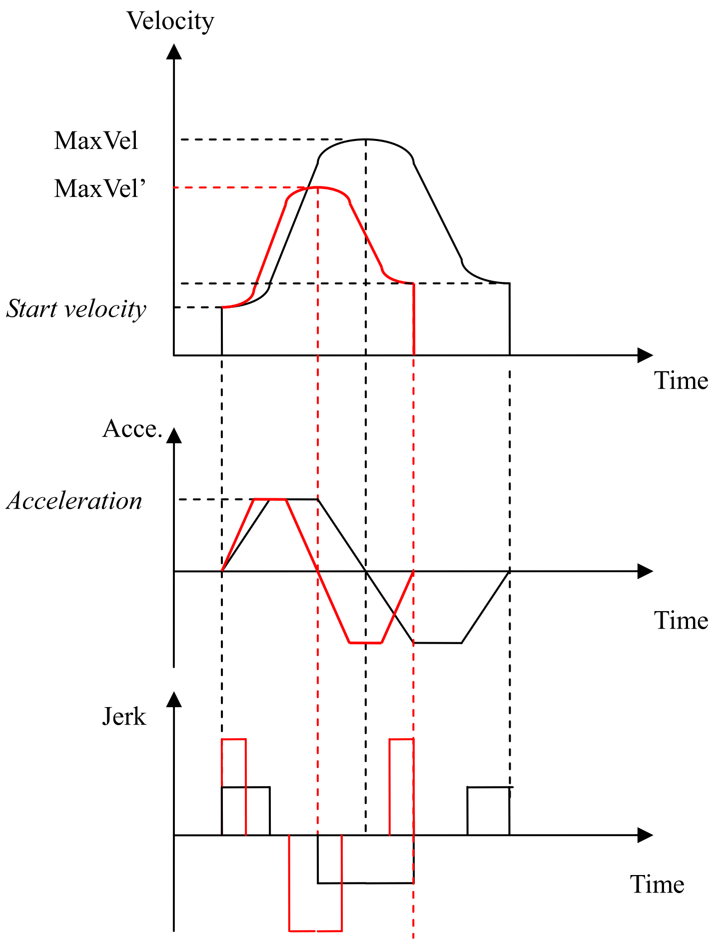


Figure 4-7: Auto-planning the maximum velocity

Acceleration profile and its rule described above applies with single axis point-to-point movement (PTP), velocity movement, home movement, and interpolation among multiple axis.

- **Relevant axis parameters**

Param. No.	Define symbol	Description
12h (18)	PRA_HOME_CURVE	Home move S-factor
20h (32)	PRA_SF	Move S-factor
42h (66)	PRA_JG_SF	Jog S-factor

NOTE

You may set up S-factor directly in some API, please refer to Function library manual for detail.

4.3 Home Move

After power on and before executing any motion control, a motion control system executes home movement to set up the zero position of the coordinate system.

Commonly available stepper motor, servo drive or linear motor mechanism accompanied by optical scale employs incremental type encoder which requires some mechanical signal to set up the original position during home operation. These mechanical signals are ORG, EZ, PEL, and MEL. Some servo drives are featured with absolute type encoder, e.g. J3-B type (SSCNET 3) of Mitsubishi, that require at least one home movement after system initialization. No more homing operation is required after the absolute coordinate system is established.

After the homing command is received, the controller starts searching for original position / zero position with the help of some external signals. After the home movement is completed the controller axis stops at the original postion while command position and feedback position reset to zero. All the home movement related operations are executed by the controller automatically. No user interaction is required. Just wait it to complete automatically.

You can finish home movement operation by steps described below:

- Set up home mode and relevant parameters
- Start up home move
- Wait for home move to complete. (You may check the status by polling or interrupt.)
- If home move does not complete successfully you may troubleshooting by steps described below

Relevant APS API described below:

I32 APS_motion_status (I32 Axis_ID);

Relevant axis parameters:

Param. No.	Define symbol	Description
10h (16)	PRA_HOME_MODE	Home mode settings
11h (17)	PRA_HOME_DIR	Homing direction settings
12h (18)	PRA_HOME_CURVE	Home move S-factor
13h (19)	PRA_HOME_ACC	Homing acceleration/deceleration settings
15h (21)	PRA_HOME_VM	Homing maximum velocity
17h (23)	PRA_HOME_SHIFT	Home position and shift distance of positioning signal

Param. No.	Define symbol	Description
18h (24)	PRA_HOME_EZA	EZ alignment enable
19h (25)	PRA_HOME_VO	Homing velocity away from ORG signal
1Bh (27)	PRA_HOME_POS	Position command setup after homing completion

- **Example:**

```
#include "APS168.h"
#include "APS_define.h"
#include "ErrorCodeDef.h"

void home_move_example()
{
  //This example shows how home move operates
  I32 axis_id = 0;
  I32 return_code;
  I32 msts;

  // 1. Select home mode and config home parameters
  APS_set_axis_param( axis_id, PRA_HOME_MODE,    0 ); //Set home mode
  APS_set_axis_param( axis_id, PRA_HOME_DIR,     1 ); //Set home direction
  APS_set_axis_param( axis_id, PRA_HOME_CURVE,   0 );   // Set acceleration pattern (T-curve)
  APS_set_axis_param( axis_id, PRA_HOME_ACC, 1000000 ); // Set homing acceleration rate
  APS_set_axis_param( axis_id, PRA_HOME_VM,   100000 );  // Set homing maximum velocity.
  APS_set_axis_param( axis_id, PRA_HOME_VO,    50000 );  // Set homing
  APS_set_axis_param( axis_id, PRA_HOME_EZA,     0 );  // Set homing
  APS_set_axis_param( axis_id, PRA_HOME_SHIFT,   0 );  // Set homing
  APS_set_axis_param( axis_id, PRA_HOME_POS,     0 );  // Set homing
```

```
// 2. Start home move
return_code = APS_home_move( axis_id ); //Start homing
if( return_code != ERR_NoError )
{ /* Error handling */ }

// 3. Wait for home move done,
do{
  Sleep( 100 );
msts = APS_motion_status( axis_id );// Get motion status
msts = ( msts >> MTS_NSTP ) & 1;    // Get motion done bit
}while( msts == 1 );

// 4. Check home move success or not
msts = APS_motion_status( axis_id ); // Get motion status
msts = ( msts >> MTS_ASTP ) & 1;     // Get abnormal stop bit
if( msts == 1 )
{ // Error handling ...
I32 stop_code;
APS_get_stop_code( axis_id, &stop_code );

}else
{ // Homing success.
}
}
```

This controller provides multiple auto-home searching process for different hardware platform which may refer to three mechanical signals: ORG, EL, and EZ. You may define three homing mode with these reference signal. User may design required homing process by any combination of these three signals. Each mode can have multiple parameters to meet various positioning requirements. These three homing mode are desinged in accordance with relevant system configurations and have included commonly available hardware configurations. These three modes are:

1. **ORG signal homing (Home mode = 0) (Home return by ORG signal)**
2. **EL signal homing (Home mode = 1)**
3. **Single EZ signal homing (Home mode = 2)**

Homing process and relavant parameters of these three modes are described below.

4.3.1 OGR Signal Homing - Home Mode = 0

There are three cases for this mode according to its initial position:

Condition A:The initial position is located between MEL and ORG signals or at MEL signal.

Condition B: Ths initial position is located at ORG signal

Condition C: The initial position is located between PEL and ORG signals or at PEL signal.

Table and figure below represent homing steps of these three situations with their speed and position. The three gray area in figure below represent the ON region of MEL, ORG, and PEL from left to right respectively. Move forward at the highest speed VM to search for ORG, decelerate to fully stop when ORG signal is detected. Then move away from ORG signal in VM speed. Search ORG again with low speed VO to complete the Home procedure.

- **Relevant axis parameters setup**

Axis parameters	Axis parameter values	Description to axis parameter value
PRA_HOME_MODE	0	Employing home mode 0 (homing by ORG signal)
PRA_HOME_DIR	0	Homing by moving forward in positive direction
PRA_HOME_EZA	0	Further align with signal EZ, 0: No, 1: Yes
PRA_HOME_S	0	S-curve factor
PRA_HOME_ACC	ACC	Acceleration and deceleration in unit of (distance unit of measure/sec.^{2})
PRA_HOME_VS	VS	Initial speed in unit of (distance unit of measure/sec.)
PRA_HOME_VM	VM	Speed of original postion searching in unit of (distance unit of measure/sec.)
PRA_HOME_VO	VO	Homing speed in unit of (distance unit of measure/sec.)
PRA_HOME_SHIFT	0	Shift amount of final homing position against alignment signal (disantace unit of measure / pulse)

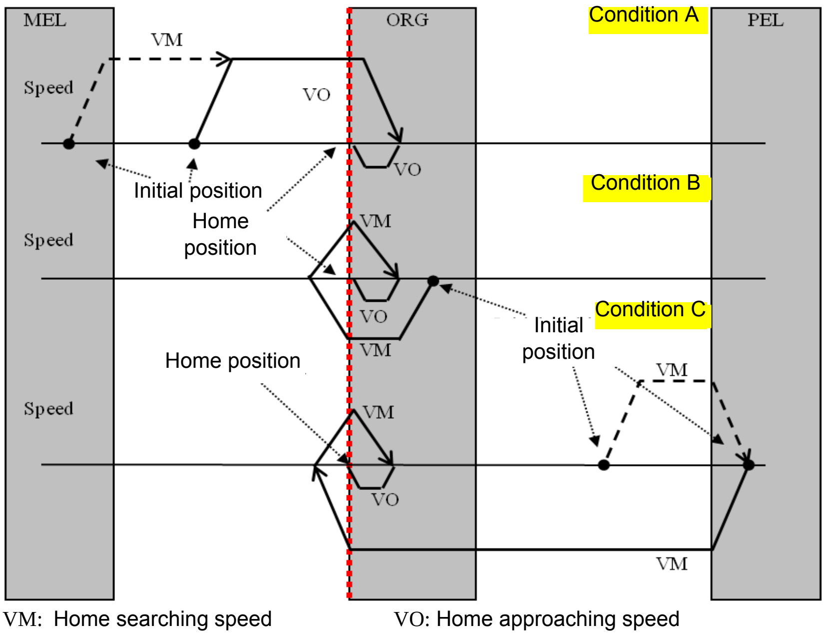


Figure 4-8: Home mode 0 (Case: ORG)

ORG signal of most mechanical device has two directional edges (the two ends of signal fender). Figure above indicates that when the homing direction parameter in axis parameters is set to positive direction (PRA_HOME_DIR), the control axis starts searching from positive direction (the ascending direction of position command). And stops at the left edge of ORG signal (close to MEL mechanical signal).

On the contrary, if the homing direction parameter in axis parameters is set to negative direction (PRA_HOME_DIR), the control axis starts seraching from negative direction (the descending direction of position command). And stops at the right edge of ORG signal (close to PEL mechanical signal). Figure below indicates home movement when "PRA_DIR" is set to negative direction:

- **Relevant axis parameters setup**

Axis parameters	Axis parameter values	Description to axis parameter value
PRA_HOME_MODE	**0**	Employing home mode 0 (homing by ORG signal)
PRA_HOME_DIR	**1**	By negative direction forward homing
PRA_HOME_EZA	**0**	Further align with signal EZ, 0: No, 1: Yes
PRA_HOME_S	0	S-curve factor
PRA_HOME_ACC	ACC	Acceleration and deceleration in unit of (distance unit of measure/sec.^{2})
PRA_HOME_VS	VS	Initial speed in unit of (distance unit of measure/sec.)
PRA_HOME_VM	VM	Speed of original postion searching in unit of (distance unit of measure/sec.)
PRA_HOME_VO	VO	Homing speed in unit of (distance unit of measure/sec.)
PRA_HOME_SHIFT	0	Shift amount of homing position (distance unit onf measure / pulse)

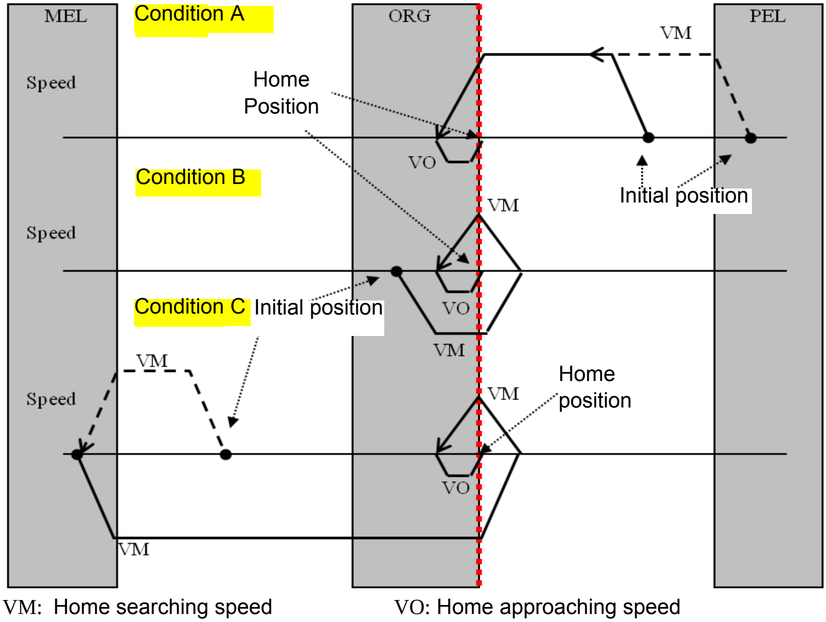


Figure 4-9: Home mode 0 (Case: ORG)

When axis parameter PRA_HOME_EZA is set to 1 it means to align with EZ, move forward to homing direction, until the first EZ is detected and place control axis at the edge of EZ, then the home movement is completed.

The motions are described below:

- **Relevant axis parameters setup**

Axis parameters	Axis parameter values	Description to axis parameter value
PRA_HOME_MODE	0	Home mode 0
PRA_HOME_DIR	0	Homing by moving forward in positive direction
PRA_HOME_EZA	1	Further align with signal EZ, 0: No, 1: Yes
PRA_HOME_S	0	S-curve factor
PRA_HOME_ACC	ACC	Acceleration and deceleration in unit of (distance unit of measure/sec.^{2})
PRA_HOME_VS	VS	Initial speed in unit of (distance unit of measure/sec.)

Axis parameters	Axis parameter values	Description to axis parameter value
PRA_HOME_VM	VM	Speed of original postion searching in unit of (distance unit of measure/sec.)
PRA_HOME_VO	VO	Homing speed in unit of (distance unit of measure/sec.)
PRA_HOME_SHIFT	0	Shift amount of homing position (distance unit onf measure)

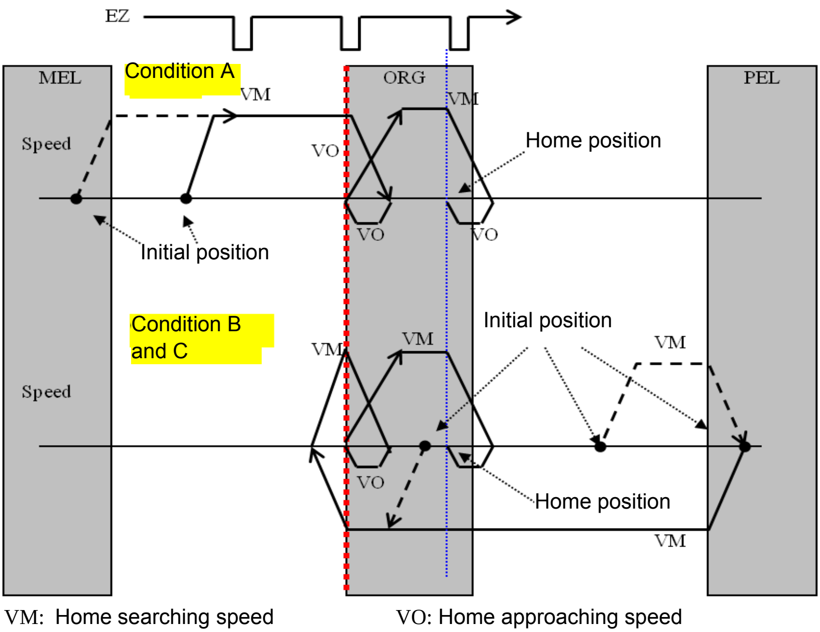


Figure 4-10: Home mode 0 (Case: ORG+EZ)

Figure below indicates a negative direction example:

- **Relevant axis parameters setup**

Axis parameters	Axis parameter values	Description to axis parameter value
PRA_HOME_MODE	**0**	Employing home mode 0 (homing by ORG signal)
PRA_HOME_DIR	**1**	By negative direction forward homing
PRA_HOME_EZA	**1**	Further align with signal EZ, 0: No, 1: Yes
PRA_HOME_S	0	S-curve factor

Axis parameters	Axis parameter values	Description to axis parameter value
PRA_HOME_ACC	ACC	Acceleration and deceleration in unit of (distance unit of measure/sec.^{2})
PRA_HOME_VS	VS	Initial speed in unit of (distance unit of measure/sec.)
PRA_HOME_VM	VM	Speed of original postion searching in unit of (distance unit of measure/sec.)
PRA_HOME_VO	VO	Homing speed in unit of (distance unit of measure/sec.)
PRA_HOME_SHIFT	0	Shift amount of homing position (distance unit onf measure)

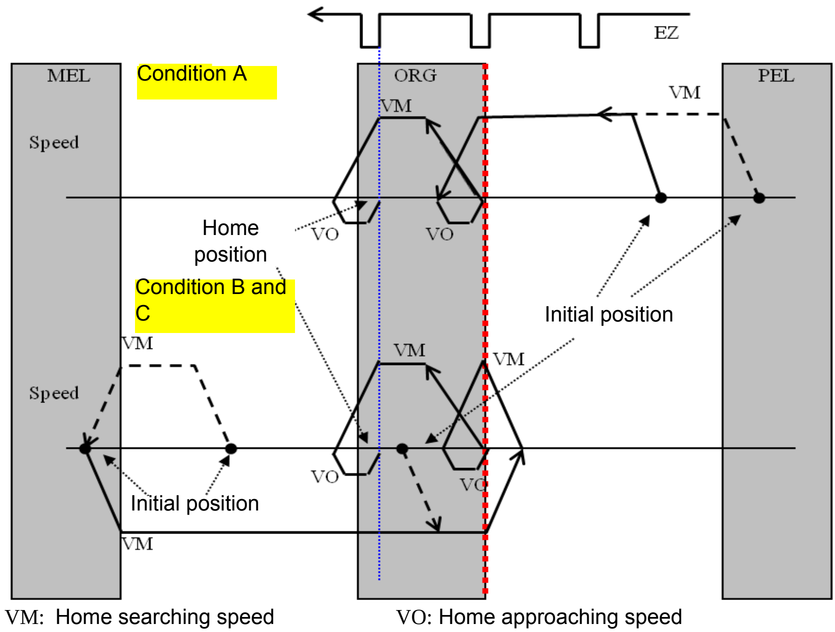
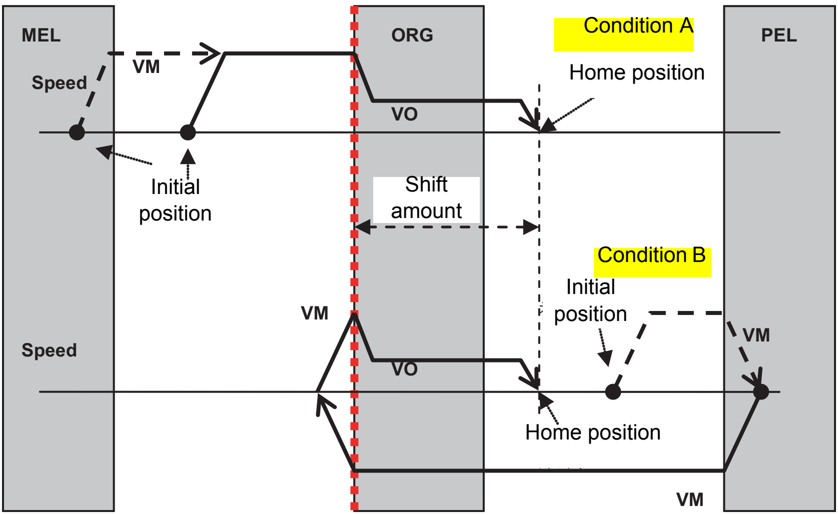


Figure 4-11: Home mode 0 adverse (Case: ORG+EZ)

You may set up homing position shift amount to fine tune the final position. Figure and table below indicate an example of setup and motion diagram.

- **Relevant axis parameters setup**

Axis parameters	Axis parameter values	Description to axis parameter value
PRA_HOME_MODE	**0**	Employing home mode 0 (homing by ORG signal)
PRA_HOME_DIR	**0**	Employing positive direction forward homing
PRA_HOME_EZA	**0**	Further align with signal EZ, 0: No, 1: Yes
PRA_HOME_S	0	S-curve factor
PRA_HOME_ACC	ACC	Acceleration and deceleration in unit of (distance unit of measure/sec.^{2})
PRA_HOME_VS	VS	Initial speed in unit of (distance unit of measure/sec.)
PRA_HOME_VM	VM	Speed of original postion searching in unit of (distance unit of measure/sec.)
PRA_HOME_VO	VO	Homing speed in unit of (distance unit of measure/sec.)
PRA_HOME_SHIFT	**Shift amount**	Shift amount of homing position (distance unit onf measure)



VM: Home searching speed VO: Home approaching speed

Figure 4-12: Home mode 0 decelerate to stop (Case: ORG)

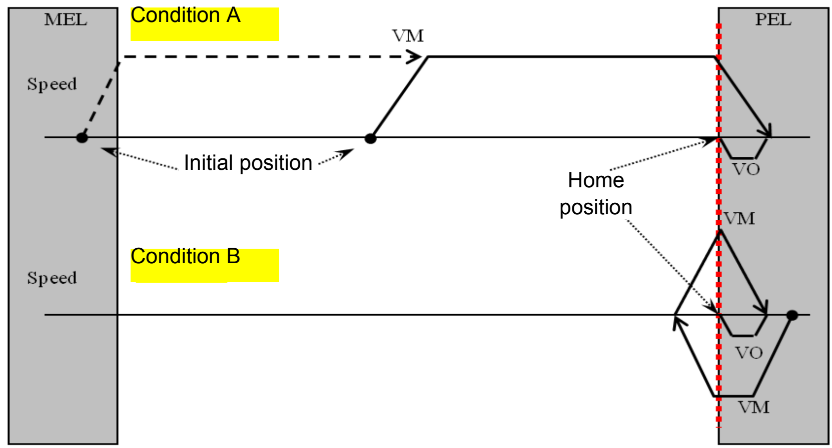
4.3.2 EL Signal Homing - Home Mode 1

This is a home movement based on PEL or MEL mechaincal signal. After the homing command is received, the control axis searches PEL or MEL signal position and stops at edge of the signal. You may set up to align with EZ signal and to set up shift amount.

Figure 1 below illustrates how to set up Home mode 1 (EZ signal) with postive direction homing and without EZ alignment. After home movement is completed the control axis stops at the edge of PEL signal.

- **Relevant axis parameters setup**

Axis parameters	Axis parameter values	Description to axis parameter value
PRA_HOME_MODE	**1**	Employing home mode 1 (homing by EL signal)
PRA_HOME_DIR	**0**	Employing positive direction forward homing
PRA_HOME_EZA	**0**	Further align with signal EZ, 0: No, 1: Yes
PRA_HOME_S	0	S-curve factor
PRA_HOME_ACC	ACC	Acceleration and deceleration in unit of (distance unit of measure/sec.^{2})
PRA_HOME_VS	VS	Initial speed in unit of (distance unit of measure/sec.)
PRA_HOME_VM	VM	Speed of original postion searching in unit of (distance unit of measure/sec.)
PRA_HOME_VO	VO	Homing speed in unit of (distance unit of measure/sec.)
PRA_HOME_SHIFT	0	Shift amount of homing position (distance unit onf measure)

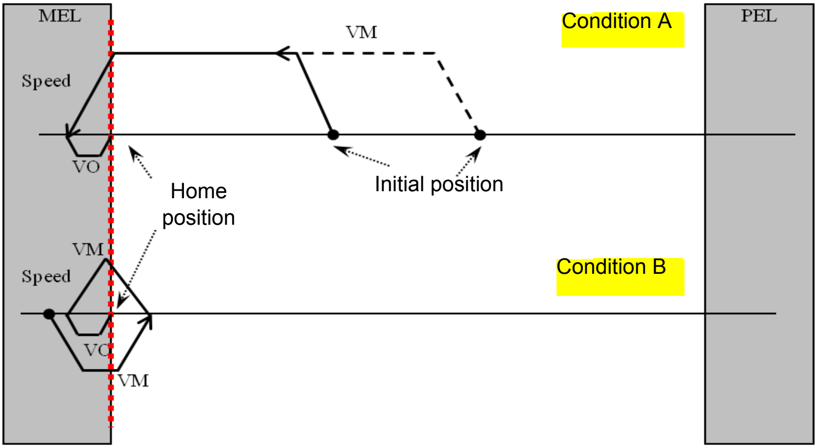


VM: Home searching speed VO: Home approaching speed

Figure 4-13: Home mode 1 (Case: EL)

EL homing mode: Positive direction home movement with control axis stops at edge of PEL signal

For EL signal homing mode with negative direction homing and without EZ alignment, the control axis stops at MEL signal edge after home movement is completed as shown in figure below.



VM: Home searching speed VO: Home approaching speed

Figure below illustrates how to set up Home mode 1 (EZ signal) with positive direction homing and EZ alignment. After home movement is completed the control axis stops at the edge of EZ signal.

- **Relevant axis parameters setup**

Axis parameters	**Axis parameter values**	**Description to axis parameter value**
PRA_HOME_MODE	**1**	Employing home mode 1 (EZ signal) homing
PRA_HOME_DIR	**0**	Employing positive direction forward homing
PRA_HOME_EZA	**1**	Further align with signal EZ, 0: No, 1: Yes
PRA_HOME_S	0	S-curve factor
PRA_HOME_ACC	ACC	Acceleration and deceleration in unit of (distance unit of measure/sec.^{2})
PRA_HOME_VS	VS	Initial speed in unit of (distance unit of measure/sec.)
PRA_HOME_VM	VM	Speed of original postion searching in unit of (distance unit of measure/sec.)
PRA_HOME_VO	VO	Homing speed in unit of (distance unit of measure/sec.)
PRA_HOME_SHIFT	0	Shift amount of homing position (distance unit onf measure)

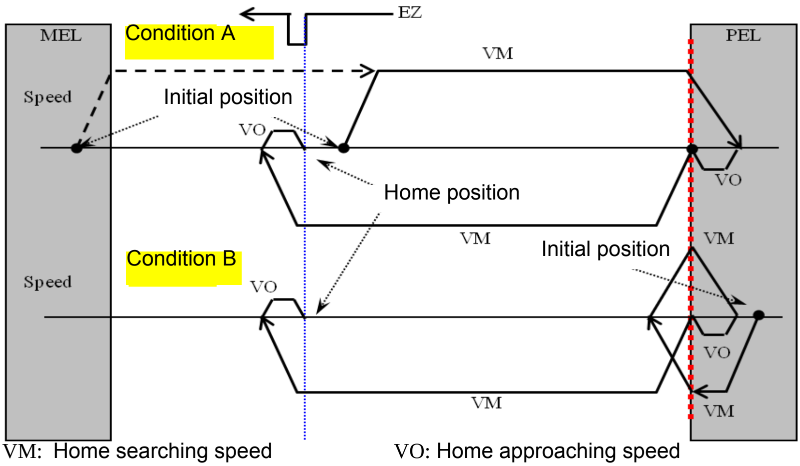
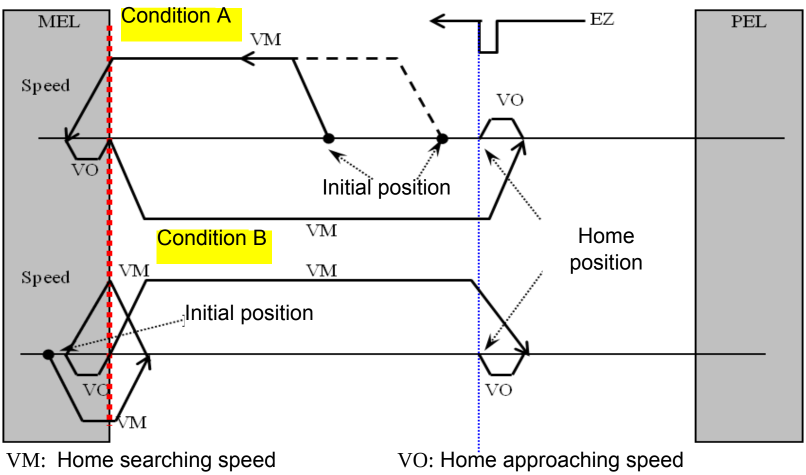


Figure 4-14: Home mode 1 (Case: EL+EZ)

For EL signal homing mode with negative direction homing and EZ alignment, the control axis stops at EZ signal edge after home movement is completed as shown in figure below:



4.3.3 Single EZ Signal Homing

Most linear motor mechanism set up only one position mark signal. This mode is used in the said mechanism.

Figure below illustrates how to set up Home mode 2 (single EZ signal) with positive direction homing. After home movement is completed the control axis stops at the edge of EZ signal.

- **Relevant axis parameters setup**

Axis parameters	Axis parameter values	Description to axis parameter value
PRA_HOME_MODE	**2**	Employing home mode 2 (single EZ signal) homing
PRA_HOME_DIR	**0**	Employing positive direction forward homing
PRA_HOME_EZA	0	Further align with signal EZ, 0: No, 1: Yes
PRA_HOME_S	0	S-curve factor
PRA_HOME_ACC	ACC	Acceleration and deceleration in unit of (distance unit of measure/sec.^{2})
PRA_HOME_VS	VS	Initial speed in unit of (distance unit of measure/sec.)
PRA_HOME_VM	VM	Speed of original postion searching in unit of (distance unit of measure/sec.)
PRA_HOME_VO	VO	Homing speed in unit of (distance unit of measure/sec.)
PRA_HOME_SHIFT	0	Shift amount of homing position (distance unit onf measure)

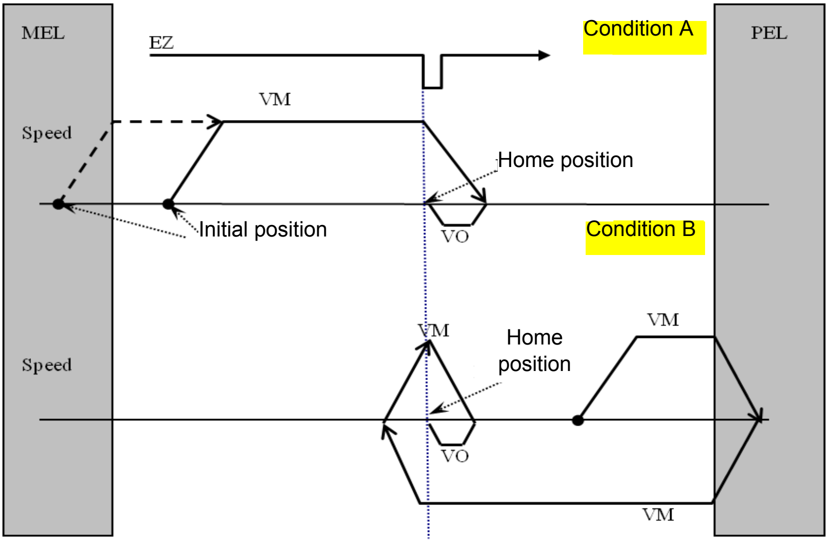


Figure 4-15: Home mode 2 (Case: EZ)

Figure below set up "Home mode 2 (single EZ signal)" with negative direction homing. After home movement is completed the control axis stops at the edge of EZ signal.

- **Relevant axis parameters setup**

Axis parameters	Axis parameter values	Description to axis parameter value
PRA_HOME_MODE	**2**	Employing home mode 2 (single EZ signal) homing
PRA_HOME_DIR	**1**	By negative direction forward homing
PRA_HOME_EZA	0	Further align with signal EZ, 0: No, 1: Yes
PRA_HOME_S	0	S-curve factor
PRA_HOME_ACC	ACC	Acceleration and deceleration in unit of (distance unit of measure/sec.^{2})
PRA_HOME_VS	VS	Initial speed in unit of (distance unit of measure/sec.)
PRA_HOME_VM	VM	Speed of original postion searching in unit of (distance unit of measure/sec.)
PRA_HOME_VO	VO	Homing speed in unit of (distance unit of measure/sec.)
PRA_HOME_SHIFT	0	Shift amount of homing position (distance unit onf measure)

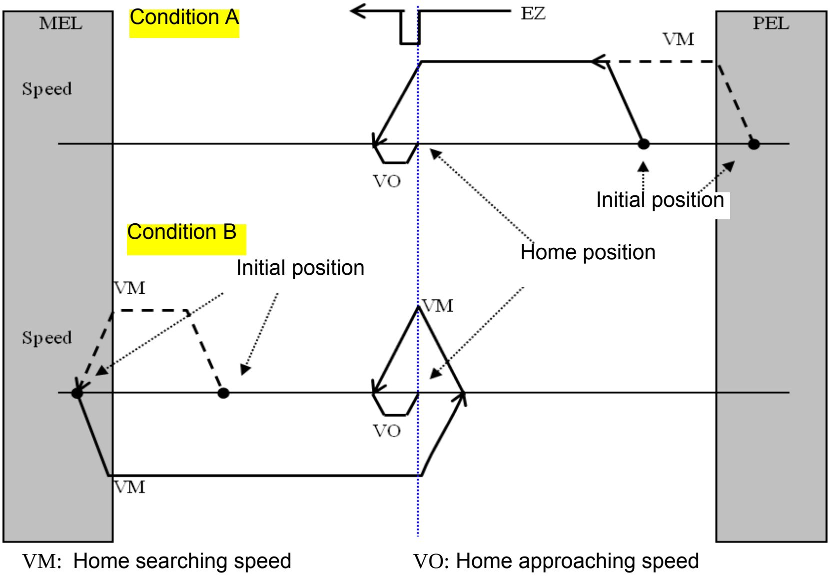


Figure 4-16: Home mode 2 adverse (Case: EZ)

NOTE

In this mode parameter PRA_HOME_EZA is functionless

4.4 Velocity Move

In this motion mode, the motion axis move along specified speed profile after proper command is received. Movement continues untill a stop movement command is received. In velocity movement mode functions listed below are supported:

- Dynamic changing maximum speed: You may change to any maximum speed during movement.
- Dynamic giving point-to-point (PTP) command: Switch velocity movement to PTP movement and then move to given position.
- Synchronized trigger: This movement can set to be enabled by trigger. When proper command is received, the axis enters a waiting-for-trigger-signal status and starts moving after the triggering signal is received. When multiple axes are in waiting-for-trigger-signal status you may send triggering signal at the same time for synchronized enabling. Please note that movement of each axis is independent from each other and so the end time varies with setup values of given parameters.

Relevant APS API described below:

I32 APS_vel (…); // give velocity movement (with F64 data format)

I32 APS_vel_all (…); // give velocity movement and all velocity parameters

I32 APS_stop_move (…); // stops by deceleration

I32 APS_emg_stop (…); // stops immediately

I32 APS_stop_move_multi (…); // give stop commands to multiple axis concurrently

I32 APS_emg_stop_multi (…); // give immediate stop commands to multiple axis concurrently

I32 APS_vel (…); // give velocity movement (with I32 data format)

I32 APS_move_trigger (…); // give synchronized startup command

- **Relevant axis parameters**

Param. No.	Define symbol	Description
20h (32)	PRA_CURVE	S-curve factor
21h (33)	PRA_ ACC	Acceleration in unit of (distance unit of measure/sec.^{2})
23h (34)	PRA_ VS	Initial speed in unit of (distance unit of measure/sec.)
24h (35)	PRA_VM	Maximum speed in unit of (distance unit of measure/sec.)

- **Example 1:**

  Set up parameters and start up velocity movement. See below for example process:

  1. Change maximum speed after 2 seconds
  2. Change maximum speed after 2 seconds
  3. Stop by deceleration after 2 seconds

```
#include "APS168.h"
#include "APS_define.h"
#include "ErrorCodeDef.h"
void velocity_move_example()
{
  I32 axis_id = 0;
  F64 speed_1 =  500.0;
  F64 speed_2 = 1000.0;
  F64 speed_3 =  600.0;

  APS_set_axis_param_f( axis_id, PRA_STP_DEC, 10000.0 );
  APS_set_axis_param_f( axis_id, PRA_CURVE,      0.5 ); //Set acceleration rate
  APS_set_axis_param_f( axis_id, PRA_ACC,    10000.0 ); //Set acceleration rate
  APS_set_axis_param_f( axis_id, PRA_DEC,    10000.0 ); //Set deceleration rate

  APS_vel( axis_id, 0, speed_1, 0 );  // Start a velocity move
  Sleep( 2000 );                      // Wait 2 second
  APS_vel( axis_id, 0, speed_2, 0 );  // Change speed on the fly
  Sleep( 2000 );                      // Wait 2 second
   APS_vel( axis_id, 0, speed_3, 0 );  // Change speed on the fly
  Sleep( 2000 );                      // Wait 2 second

  APS_stop_move( axis_id );           // Stop
}
```

CAUTION	Motion control input signal EMG, ALM, PEL, and MEL may lead to termination of movement, please refer to sections about safety protection

CAUTION	In velocity movement mode the target position may be updated from time to time as the command position does.

4.5 Jog Move

Jog operation is commonly available at control panel of machine. Its main function is to manually control the movement of motion axis or fucntion together with mechanical switch with digital input to use DI signal as the jog movement startup signal. You may use switch on control panel to operate jog movement by setting up relevant parameters instead of coding control program.

There are two jog movement modes:

1. **Continuous mode:** This is similar to velocity movement with given maximum speed and acceleration profile. When JOG-ON signal (*) produces rising edge event trigger then the specified control axis starts velocity movement. When JOG-ON signal (*) produces falling edge event trigger then the specified control axis starts deceleration stop. See figure below:

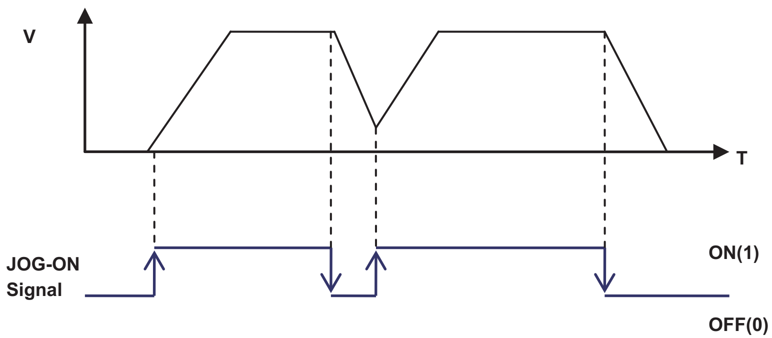


Figure 4-17: Relation between V-T chart of JOG movement and JOG-ON signal

NOTE

JOG-ON signal is a software digital signal where ON is represented by value 1 and OFF by 0

2. **Step mode:** In addition to velocity parameters this mode requires specific offset and so is easy for stop position prediction. After the JOG-ON control signal is triggered at the rising edge, the axis being controlled moves a distance of given offset then stops, pauses for a period of time (known as the delay time), if the control signal remains ON in delay time, the control axis moves in given speed profile until the signal disappears. It differs from continuous mode in that the total displacement will be increased to integer times of given offset value. This is useful in achieving more precise offset control during fine tuning.

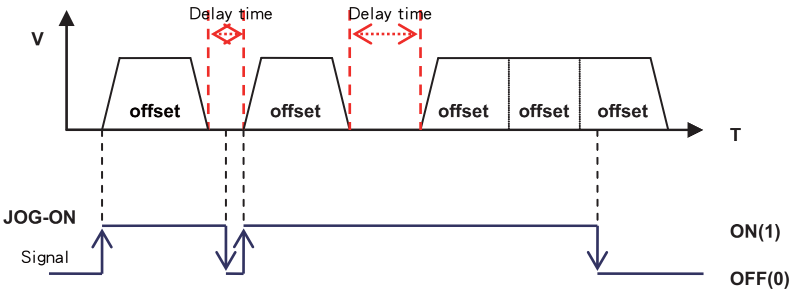


Figure 4-18: Jog step mode

- JOG-ON and digital input signal linkage:

The JOG-ON control signal not only can be given with API function but also can be used in setting digital input signal as control signal. You may set up axis parameter 48h, 49h, 4Ah, and 4Bh in two methods (distinguished by number of DI points):

1. Use two DI channel and set one of it to positive direction movement JOG-ON signal and the other to negative direction movement JOG-ON signal
2. Use one DI channel and set it to JOG-ON signal with its direction to be determined by axis parameter.

Relevant APS API described below:

I32 APS_jog_on (…); // give velocity movement command

- **Relevant axis parameters**

Parameter code	Parameter definition	Meaning of parameter value
40h ()	PRA_JG_MODE	Set up JOG mode [0: Continuous, 1: Step]
41h ()	PRA_JG_DIR	Set up JOG direction: [0: Negative, 1: Positive direction]
42h ()	PRA_JG_SF	Set up JOG S factor [0 ~ 1]
43h ()	PRA_JG_ACC	Set up JOG acceleration [Value 0]
44h ()	PRA_JG_DEC	Set up JOG deceleration [Value 0]
45h ()	PRA_JG_VM	Set up JOG Max.velocity [Value 0]
46h ()	PRA_JG_OFFSET	Set up JOG offset position. Step mode use [Value = 0]
47h ()	PRA_JG_DELAY	Set up JOG delay time, step mode use [0 ~ 10,000,000] us
48h ()	PRA_JG_MAP_DI_EN	Set up JOG signal and DI signal correlation, that is opposite direction DI signal
49h ()	PRA_JG_P_JOG_DI	Set DI signal of certain channel to positive direction JOG signal
4Ah ()	PRA_JG_N_JOG_DI	Set DI signal of certain channel to negative direction JOG signal
4Bh ()	PRA_JG_JOG_DI	Set DI signal of certain channel to JOG signal with direction settings by 0x41

- **Example:**

```
#include "APS168.h"
#include "APS_define.h"
#include "ErrorCodeDef.h"

void jog_move_example()
{
  //This example shows how jog move work
}
```

NOTE

1. Motion control input signal EMG, ALM, PEL, and MEL may lead to movement termination. Please refer to safety protection related sections.
2. In continuous mode the target position may be updated from time to time (so does the command position).
3. When control axis is in jog movement, other movement commands is disabled to prevent malfunctions.
4. When the control axis is running other movements (e.g. home movement) the jog command will be ignored.

4.6 Point-to-Point Move

4.6.1 Point-to-Point Move

Point-to-Point movement (PTP movement) is to move one axis fomr postion A to position B at given speed. PTP movement can be relative or absolute movement based on its given position parameter.

This controller provides T-curve and S-factor adjustable S-curve. Each profile contains start velocity, maximum velocity, end velocity, and acceleration / deceleration parameters that can be adjusted individually as shown in figure below. See Acceleration / Deceleration Profile in Section 4.2.3 for detail.

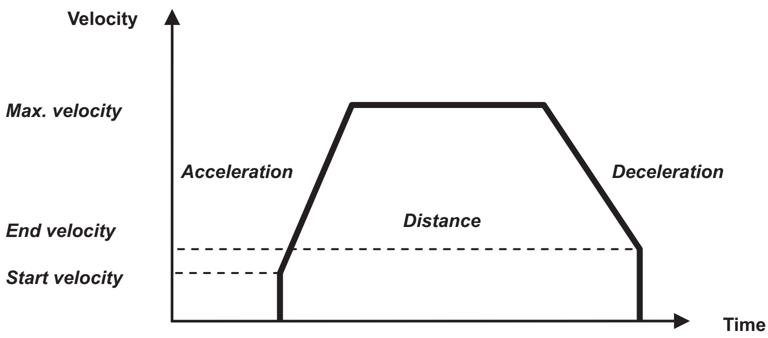


Figure 4-19: T-curve V-T chart

In addition, the APS_motion_status () function can be used to get motion status data of each axis to identify the end of PTP movement. See Section 4.8 for description on motion status. You may use APS_stop_move () or APS_emg_stop () function to abort in-progress movement.

Relevant APS API described below:

I32 APS_ptp (); // PTP move

I32 APS_ptp_v (); // PTP move with maximum speed parameter

I32 APS_ptp_all (); // PTP move with all speed parameter

I32 APS_relative_move (); // Relative PTP move in I32 data format

I32 APS_absolute_move (); // Absolute PTP move in I32 data format

I32 APS_stop_move (); // deceleration stop

I32 APS_emg_stop (); // immediately stop

- **Relevant axis parameters**

Param. No.	Define symbol	Description
07h (7)	PRA_SD_DEC	stop_move (), deceleration rate
20h (32)	PRA_SF	S-factor
21h (33)	PRA_ACC	Acceleration rate
22h (34)	PRA_DEC	Deceleration rate
23h (35)	PRA_VS	Start velocity
24h (36)	PRA_VM	Maximum velocity
25h (37)	PRA_VE	End velocity

4.6.2 Synchronous Start

Synchronous start: This movement can set to be enabled by trigger. When proper command is received, the axis enters a waiting-for-trigger-signal status and starts moving after the trigger is received. When multiple axes are in waiting-for-trigger-signal status you may send trigger at the same time for synchronized enabling. Please note that movement of each axis is independent from each other and so the end time varies with offset and acceleration profile.

4.6.3 On The Fly Change

You may dynamically change position and velocity parameter in PTP movement process by methods described below:

1. Dynamically change to new postion while the velocity parameter remain intact.
2. Dynamically change the maximum velocity while target position remian intact.
3. Dynamically change to new position and speed profile. That is, give whole new PTP command.

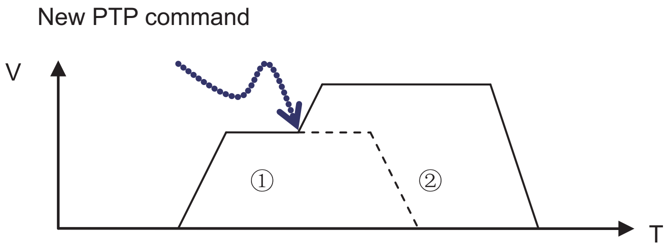


Figure 4-20: Dynamically change position and velocity

4.6.4 Continuous PTP Move

Each axis features one motion buffer that can contain 10 commands. After the first PTP command is received, the axis starts moving immediately. You may give PTP commands during movement in process. Following commands are stored in buffer queuing for execution. After the first movement arrived at given position, the controller continuous executing PTP commands in buffer until there is no new command in existence. You may set up blend mechanism for speed commands. Available speed command blending mechanism are:

1. Buffered: blending speed commands in unit of buffer
2. Blend low: Blend with the one with slower maximum speed
3. Blend high: Blend with the one with faster maximum speed
4. Blend previous: Blend in the maximum speed of the previous one
5. Blend next: Blend in the maximum speed of the next one

Take example. V-T chart with 3 continuous PTP movements and different speed blending settings:

1. **Buffered**

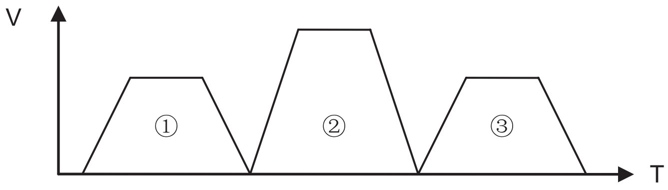


Figure 4-21: Continuous three position V-T chart

2. **Blend low: Blend with the one with slower maximum speed**

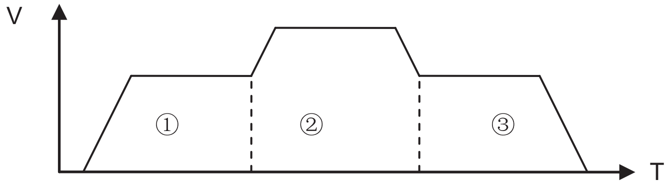


Figure 4-22: Continuous three position V-T chart (auto speed connection (1)

3. **Blend high: Blend with the one with faster maximum speed**

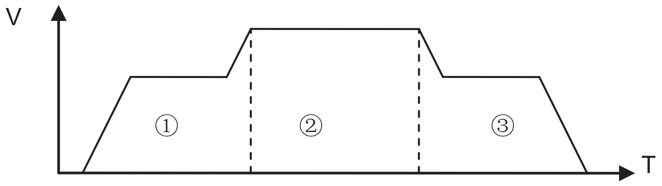


Figure 4-23: Continuous three position V-T chart (auto speed connection (2)

4. **Blend previous: Blend in the maximum speed of the previous one**

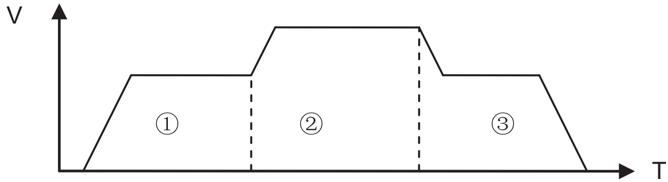


Figure 4-24: Continuous three position V-T chart (auto speed connection (3)

5. **Blend next: Blend in the maximum speed of the next one**

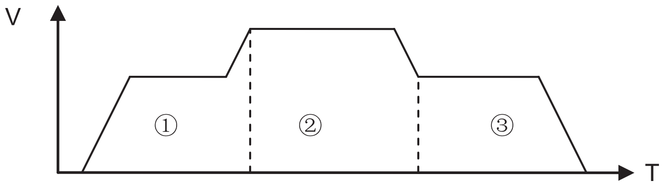


Figure 4-25: Continuous three position V-T chart (auto speed connection (4)

4.7 Interpolation

Interpolation is a multi-axes locus movement based on given locus properties, e.g. center of circle and end point, and velocity data. The controller then calculate relations between path and time. Axis involved in interpolation start up at the same and end at the same time after operation completed.

This controller supports couple of interpolations including straight line interpolation of any 2 ~ 6 axes, arc interpolation of any 3 axes and spiral interpolation of any 3 axes.

The interpolation usually requires two or more axes to complete. Required axes are assigned by array input. Here the axes array is defined by assuming the first axis ID to be the reference axis.

Axis parameters of the reference axis is used as the basis for setting up speed profiles of interpolation while settings of speed profile are all in vector (composite). Take example. To execute a 2 axes straight line interpolation by Axis 1 and Axis 2, the axis ID array can be declared as described below. In example below, the first axis ID in axes_array is Axis 1. Then the interpolation required initial speed, maximum speed, ending speed, and acceleration rate are all set up relative to axis parameters of Axis 1. If Axis 2 is the first elemnet in axes_array then Axis 2 is the reference axis.

I32 axes_array[2] = { 1, 2 };

Sections below describe straight line, arc, and spiral interpolation mechanism and operation and followed by continuous interpolation.

4.7.1 Linear Interpolation

This controller supports up to six axes straight line interpolation. After the straight line interpolation command is received, all relevant axes start up at the same time and move according to specified (relative or absolute) position, speed, and acceleration profiles, all relevant axes stop concurrently. The speed profiles are set by synthetic vector.

Assume you want to make a N (N=2~6) axes straight line interpolation with offset of each axes represented by ΔX0,ΔX1… ΔXN-1 then the synthetic shift ΔP shall be:

$$\Delta P = \sqrt{(\Delta X_0)^2 + (\Delta X_1)^2 + \ldots + (\Delta X_{N-1})^2}$$

If synthetic velocity is set to V, the velocity of each axes Vn should be:

$$V_n = \frac{\Delta X_n}{\Delta P} \times V$$

See figure below for a two dimension straight line interpolation with starting point at S and ending point at E:

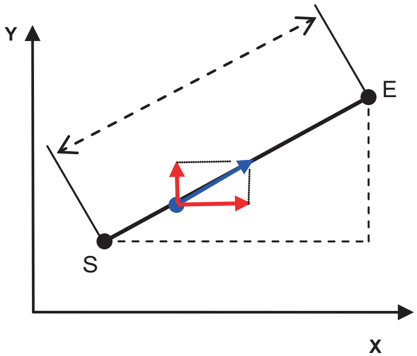


Figure 4-26: Two-dimension straight line interpolation

ΔX and ΔY is the offset at X-axis and Y-axis respectively. Interpolation distance is set according to component of each axis (e.g. relative distance ΔX and ΔY or absolute coordinates of ending point E). The composite shift ΔP can be calculated by formula described below:

$$\Delta P = \sqrt{(\Delta X)^2 + (\Delta Y)^2}$$

Velocity and acceleration are set by composite vectors. Component of each axis, take composite velocity Vx and Vy as example, can be calculated by formula described below:

$$V_x = \frac{\Delta X}{\Delta P} \times V \quad V_y = \frac{\Delta Y}{\Delta P} \times V$$

Relevant APS API described below:

I32 APS_line (); // multi axes straight line interpolation

I32 APS_line_v (); // multi axes straight line interpolation with maximum speed settings

I32 APS_line_all (); // multi axes straight line interpolation with all speed settings

I32 APS_stop_move (); // deceleration stop

I32 APS_emg_stop (); // immediately stop

I32 APS_absolute_linear_move (); // straight line interpolation with given absolute position
(in I32 data format)

I32 APS_relative_linear_move (); // straight line interpolation with given relative position
(in I32 data format)

- **Relevant axis parameters**

Param. No.	Define symbol	Description
07h (7)	PRA_SD_DEC	stop_move (), deceleration rate
20h (32)	PRA_SF	S-factor
21h (33)	PRA_ACC	Acceleration rate
22h (34)	PRA_DEC	Deceleration rate
23h (35)	PRA_VS	Start velocity
24h (36)	PRA_VM	Maximum velocity
25h (37)	PRA_VE	End velocity

4.7.2 Arc Interpolation

This controller supports 2-dimension and 3-dimension arc interpolation as well as multip input methods to deal with demands of various applications. 2D and 3D arc movement and its command composition methods are described below.

4.7.2.1 3D Arc Interpolation

An arc can be described by

method 1: given center of circle, angle and normal vector

method 2: given center of circle and end point

Relevant commands are described below:

Function name	Description
APS_arc3_ca APS_arc3_ca_v APS_arc3_ca_all	Execute 3-dimension arc interpolation with center, angle, and normal vector
APS_arc3_ce APS_arc3_ce_v APS_arc3_ce_all	Execute 3-dimension arc interpolation with center and end point **Limit:** Cannot execute half or full circle interpolation

- **method 1: given center of circle, angle and normal vector as shown in figure below:**

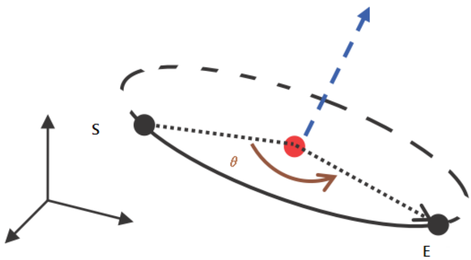


Figure 4-27: Three-dimension arc interpolation (method 1)

This entry method is easy for you to create an arc track without the restricion of half or full circle. You must ensure the correctness of normal vector. <u>This controller is default to correct your normal vector value if necessary</u>.

- **Auto Normal Vector Correct:**

If the normal vector entered by you is not the orthogonal vector from center of circle to starting point the controller correct your entry value automatically by Gram-Schmidt normalization,

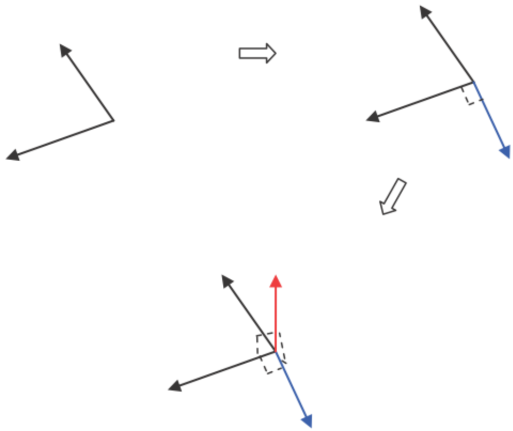


Figure 4-28: Defining spatial normal vector

- **How to determine arc direction and path of multiple laps**

Use the right-hand grip rule as shown in figure below, where the your thumb indicates normal vector direction and the other four fingers the positive rotating direction. Enter negative value for angle parameter to rotate in opposite direction.

Set up angle value directly to execute multiple laps (circles greater than 360 degrees), e.g. 2 laps = 720 degree.

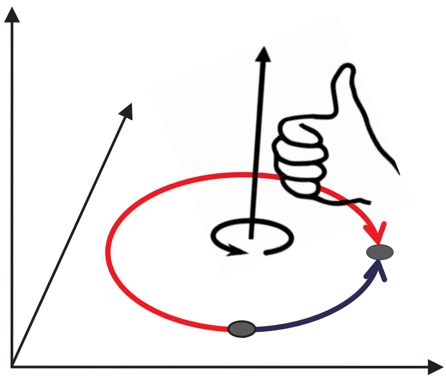


Figure 4-29: Determining arc direction in space

Coordinates of end point may have certain error caused by computing accuracy of your computer. To get precise end point position, you may use method 2 to enter exact end position accurately (as described in next section)

- **method 2: given center of circle and end point**

This method requires center of circle and position of end point only. Benefit of this method lies in that it does not need a normal vector and that it can have accurate ending position to meet demands from contour or applications that need accurate positioning. This method has two restrictions:

1. It cannot execute half circle (angle of 180 degree)
2. It cannot execute full circle (angle of 360 degree)

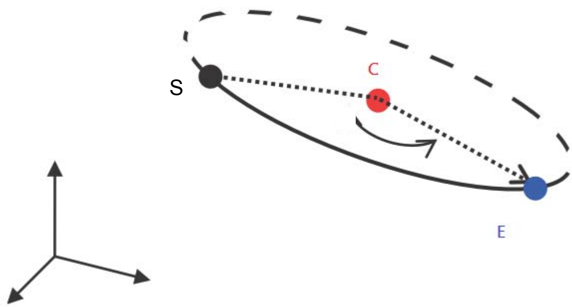


Figure 4-30: Three dimension arc interpolation (method 2)

- **How to determine direction of arc**

Use the right-hand grip rule as shown in figure below, where the your thumb indicates normal vector direction and the other four fingers the positive rotating direction.

Use parameter "I16 Dir" to determine direction, if Dir>= 0 then rotate in positive direction and negative direction if DIR <= -1

- **Path of multiple laps (arcs of angle greater than 360 degree)**

Use parameter "I16 Dir" to determine rotating angle with formula described below:

$$\text{Angle} = \theta + \text{Dir} * 2\text{PI}$$

Take example. If θ = 30 degree, then

Dir	calculation formula	Angle (Degree)
0	30 + 0 x 360	30
1	30 + 1 x 360	390
2	30 + 2 x 360	750
-1	30 + (-1) x 360	-330
-2	30 + (-2) x 360	-690

- **Example:**

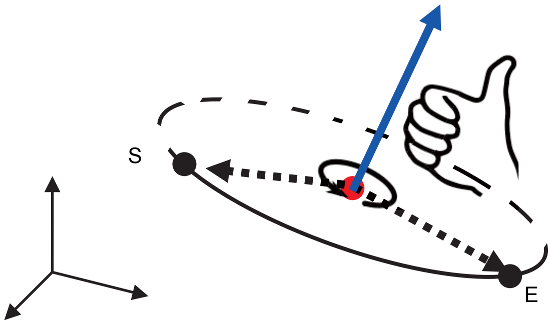


Figure 4-31: Three dimension arc interpolation example

4.7.2.2 2D Arc Interpolation

Same as 3D arc, two description methods are provided for 2D arc:

Method 1: given center of circle and angle

method 2: given center of circle and end point

2D arc has the same setup method as the 3D one does. See 3D arc interpolation for detail

Relevant APS API described below

I32 APS_arc2_ca ();

I32 APS_arc2_ca_v ();

I32 APS_arc2_ca_all ();

I32 APS_arc2_ce ();

I32 APS_arc2_ce_v ();

I32 APS_arc2_ce_all ();

4.7.2.3 Helical Interpolation

This controller supports 3-dimension helical interpolation (also known as Spiral–Helix interpolation)
as well as multip input methods to deal with demands of various applications. See below for its setup:

Method 1: Given center of circle and angle (Center-Angle)

Method 2: Given center of circle and end point (Center-End)

Both methods are described below.

- **Method 1: Given center of circle and angle (Center-Angle)**

See table and figure below for helical curve parameters

Parameters	Description
Center point	Center of circle (relative or absolute)
Angle	Starting point and ending point angle projected at the circle plane of starting point (as shown in figure below). Plus and minus sign indicate directions.
Normal vector	Normal vector of starting point circle plane
Height	Cone height (relative)
Final radius	Radius of circle where the ending point is

- **Example:**

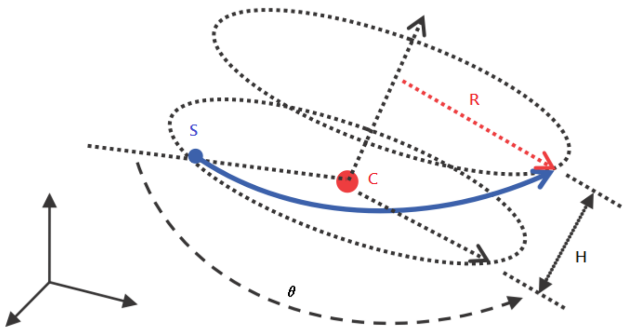


Figure 4-32: Three dimension spiral interpolation (method 1)

➢ Method 2: Given center of circle and end point (Center-End)

See table and figure below for helical curve parameters

Parameters	Description
Center point	Center of circle (relative or absolute)
Normal vector	Normal vector of starting point circle plane
End point	Ending point of cone (relative or absolute)
Direction	Rotating direction and laps

Direct parameters can be set up as the 3D arc does. See prior section for detail.

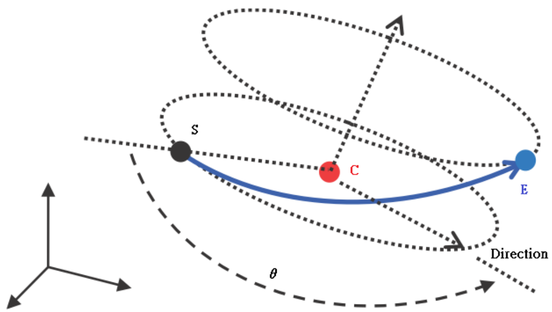


Figure 4-33: Three-dimension spiral interpolation (method 2)

All helical interpolation input methods described above requires giving normal vector. If there is error with the normal vector, the controller corrects it automatically. See Section 4.7.2 Arc interpolation for correction method.

Relevant APS API described below:

Input method	API	Description
Method 1 Center-Angle	I32 APS_sprial_ca ();	Start up 3D helical interpolation
	I32 APS_sprial_ca_v ();	Start up 3D helical interpolation + maximum velocity parameter
	I32 APS_sprial_ca_all ();	Start up 3D helical interpolation + all velocity parameter setup
Method 2 Center-End	I32 APS_sprial_ce ();	Start up 3D helical interpolation
	I32 APS_sprial_ce_v ();	Start up 3D helical interpolation + maximum velocity parameter
	I32 APS_sprial_ce_all ();	Start up 3D helical interpolation + all velocity parameter setup

Relevant axis parameters

Param. No.	Define symbol	Description
07h (7)	PRA_SD_DEC	stop_move (), deceleration rate
20h (32)	PRA_SF	S-factor
21h (33)	PRA_ACC	Acceleration rate
22h (34)	PRA_DEC	Deceleration rate
23h (35)	PRA_VS	Start velocity
24h (36)	PRA_VM	Maximum velocity
25h (37)	PRA_VE	End velocity

4.7.3 Continuous Interpolation

With continuous interpolation the controller continuously executes multiple interpolation paths including straight line, arc and helical interpolations described above. You do continuous interpolation by giving multipe interpolation commands in sequecne. These commands shall be saved in buffer of the controller queueing for execution.

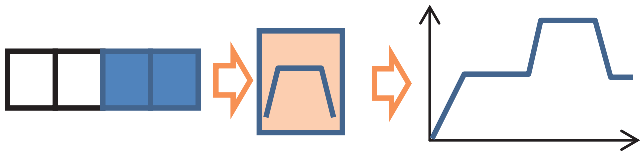


Figure 4-34: Illustration on continuous interplotation (Buffer) movement

For continuous interpolation the only restriction is that the dimension and axis ID must remain the same. E.g., 3D straight line must link with 3D arc but not 2D arc and axis to be used must be the same as well. This controller provides seven setup methods for speed blending between two adjacent paths.

1. **Aborting and blending**
2. **Aborting forced**
3. **Aborting stop**
4. **Buffered**
5. **Blending when deceleration start**
6. **Blending when residue-distance met**
7. **Blending when residue-distance % met**

You can set up this with input parameter "Flag". See ASP API user manual for detailed parameter description.

In essence, the first three methods, method (1), (2) and (3), stops any running interpolation when new interpolation command is received and start executing the new interpolation command immediately. Pending interpolation command in motion buffer shall be cleared now. These three methods differ in their termination approach and are commonly used in cases where immediate interpolation path change is required.

Method (4), (5), (6) and (7) executes by sequence in motion buffer. Method 4 features its exact execution per interpolation path and speed schedule without any path error.

Methods (5), (6) and (7) employs a mechanism of speed blending. Its benefits with smooth track, vibration free, and constant motion speed. These three methods differ in their beginning time of blending which may affect the actual calculation path in blending process and path errors against user's plan. You may select and adjust as required. These seven speed link methods are described below:

1. Aborting and blending

If the "aborting" is received the interpolation command take effects immediately and operation transfer to new command without slowing down the speed. The controller smooth the transition track automatically to avoid vibration and to ensure speed component of each axes translated smoothing. Take figure below. The first linear interpolation command is for moving from position S1 to E1, a "aborting" linear interpolation command is executed for moving to position E2. Figure in the left is the track diagram. The controller calculate smooth track (red line) automatically to transfer to new interpolation command. Figure at right hand side is a track combined velocity-time (V-T) chart.

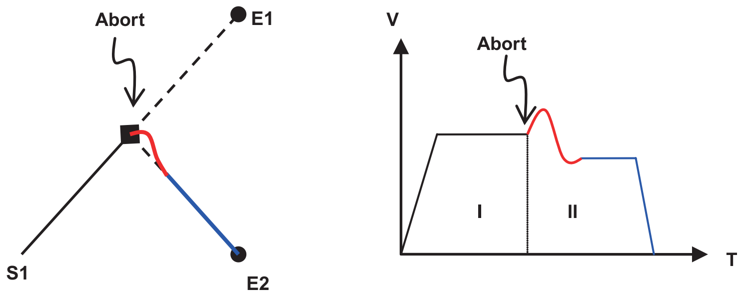


Figure 4-35: Velocity blending (method 1)

2. Aborting forced

Characteristics of this kind of command is that the track transfer to new command immediately. The controller makes no smoothing treatment and so the motion track match with the command exactly. In this mode speed component of each axes may become un-smooth. You must pay special attention to transfer speed and angle to prevent vibration from happening.

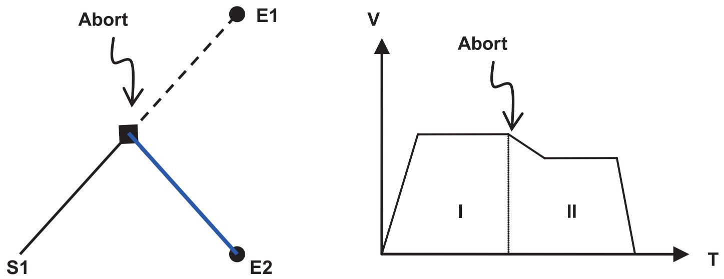


Figure 4-36: Velocity blending (method 2)

3. Aborting stop

After command is received the orignal interpolation command slows down to stop (deceleration rate adjustable), new interpolation command starts after movement fully stopped.

Take figure below. When exectuing a straight line interpolation command from S1 to E1, a "abort - decelerate" interpolation command is given at position E1’. The controller then slows down according to given deceleration rate and stops at S2, and then move to E2. Please note that if position is given by relative distance the relative starting point is E1’ rather than S2.

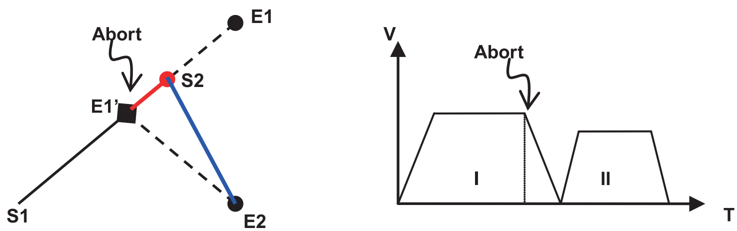


Figure 4-37: Velocity blending (method 3)

4. Buffered

When new interpolation command is received it is saved in motion buffer first. Commands in queue then continues to execute after the original interpolation command is finished. Take figure below. When exectuing a straight line interpolation command from S1 to E1, a "buffered" interpolation command is given during movement in progress. The controller then saves interpolation command in queue and move from E1 to E2 after interpolation command is completed. The speed profile follows user settings exactly. To ensure no slow down or minor slowdown between two interpolation commands you may set up ending speed of previous interpolation command and starting speed of next interpolation command properly.

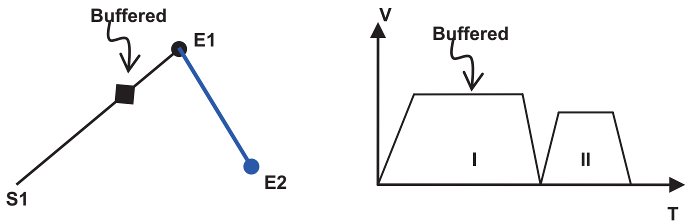


Figure 4-38: Velocity blending (method 4)

5. Blending when deceleration start

When new interpolation command is received it is saved in motion buffer first. When original interpolation command starts slowing down the new interpolation command also starts for blending as shown in figure below. You may determine blending time by adjusting deceleration rate. The higher the deceleration rate is the smaller the blending region will be and the smaller deviation form original interpolation command path will be.

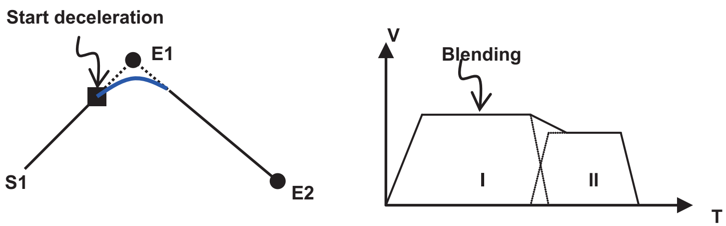


Figure 4-39: Velocity blending (method 5)

6. Blending when residue-distance met

The controller saves newly received command in motion buffer first. You may set up an offset amount, e.g. the so called residual distance as shown in figure below, and start the new interpolation command for blending after the distance of original interpolation command path from target position is smaller than the residual distance (E1) as shown in figure below.

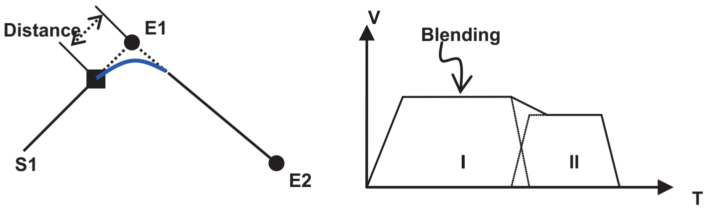


Figure 4-40: Velocity blending (method 6)

7. Blending when residue-distance % met

Similar to method 6 but with given residual distance ratio (percentage of residual distance to interpolation distance) as the P% in figure below.

Take figure below. If the residual distance ratio is set to 10% and the straight line interpolation distance from S1 to E1 is 1000, the the next interpolation command starts for blending when the motion axis move to position 900 (relative to starting point).

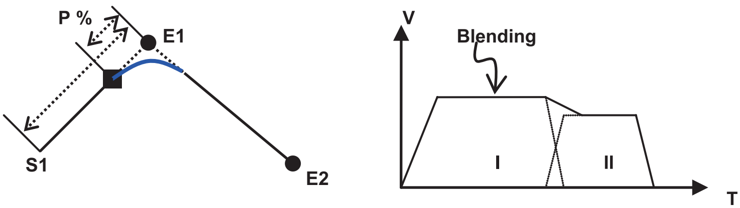


Figure 4-41: Velocity blending (method 7)

- **Example:**

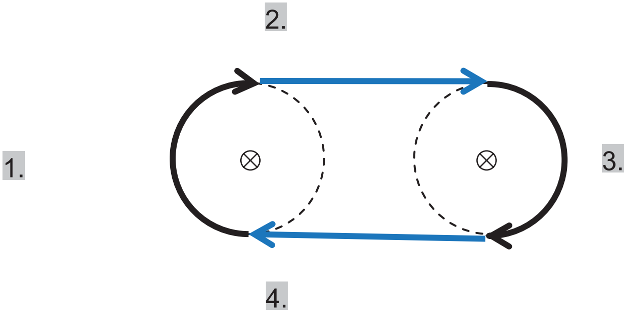


Figure 4-42: Continuous interpolation examples

4.8 Motion Status Monitoring

During the motion control process it is necessary to monitor motion status of control axis and convert to next process control at appropriate time. Take example. Druing system initialization the upper control program (the control program of user) execute homing operation to each control axis at first. The controller starts home movement once the command is received and the control program must wait for the completion of homing operation. Usually the polling method is used to determine the completion of homing process. That is, read motion status signal of controller at regular time span. Next stage control operation starts only after current movement is completed.

In addition, there may be exceptional situations occurred during motion operation. The upper control program must be able to detect abnormality and deal with exceptions accordingly. Take example. When emergency stop button is pressed during home movement or the end limit signal is triggered during movement. See figure below for basic flow chart of homing movement.

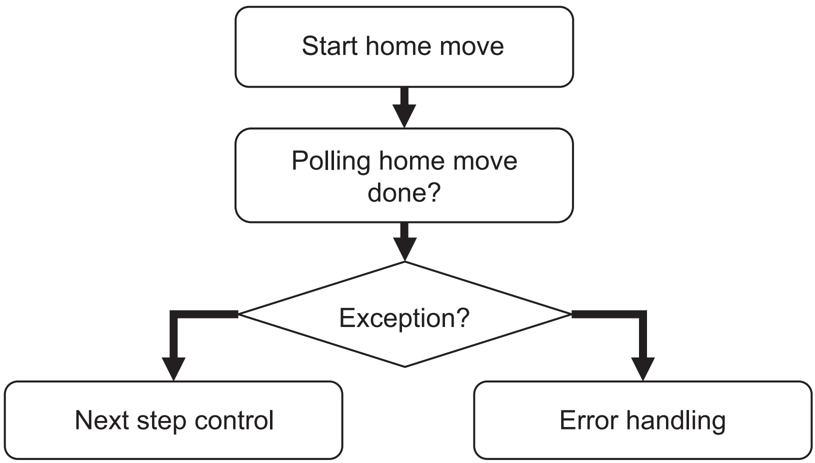


Figure 4-43: Motion status monitoring process

Motion control status and its behavior provided by this controller shall be described in Section 4.8.1.

4.8.1 Motion Status

Use following API functions to read motion status of each axes:

I32 APS_motion_status ();

Motion status data of individual axis is combined in return paramter I32 (32 bit integer). See table below for motion status and meaning represented by each bit:

Bit No.	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Status		HMV	MDN	DIR	DEC	ACC	VM	CSTP
Bit No.	**15**	**14**	**13**	**12**	**11**	**10**	**9**	**8**
Status	JOG				PTB	WAIT		
Bit No.	**23**	**22**	**21**	**20**	**19**	**18**	**17**	**16**
Status					POSTD	PRED	BLD	ASTP
Bit No.	**31**	**30**	**29**	**28**	**27**	**26**	**25**	**24**
Status				GER				

Table below describes meaning of motion status:

Bit No.	**Define**	**Description**
0	CSTP	End of single motion command
1	VM	At maximum speed
2	ACC:	Accelerating
3	DEC:	Decelerating
4	DIR:	Motion direction; 1: Positive and 0: Negative
5	MDN	End of motion command
6	HMV	Executing homing movement
7~9	--	(Reserved)
10	WAIT	Waiting for motion trigger
11	PTB	Executing PTB movement
12~14	--	(Reserved)

Bit No.	Define	Description
15	JOG	Jog movement in progress
16	ASTP	Abnormal stop. Clear this signal after next movement is executed
17	BLD	The axis is running blending movement
18	PRED	Pre-offset event, clear this signal after next movement is executed
19	POSTD	Post-offset event, clear this signal after next movement is executed
20~27	--	(Reserved)
28	GER	In geared, the axis is a slave one
29~31	--	(Reserved)

Motion status is described below in sequence of bit:

Bit0~ bit4:

CSTP (Command stop): When this signal is ON, the controller is not sending movement command.

VM: when this signal is ON, the movement reached its maximum velocity settings.

ACC: when this signal is ON, the movement is accelerating.

DEC: when this signal is ON, the movement is decelerating.

DIR: when this signal is ON, the movement is moving at positive direction. When movement stops, the DIR saves status right before movement stopped.

Relation between movement and signal shown in figure below:

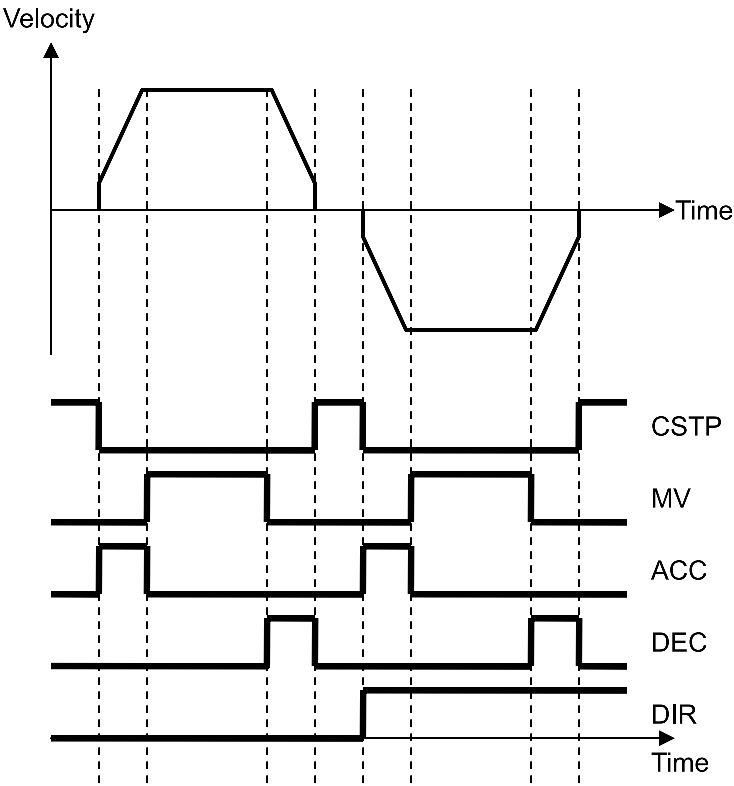


Figure 4-44: Relation of different motion signals VS motions

Bit 5: Motion Done – MDN

Single movement command or multiple movement command is completed. Single movement command is a single axis point to point movement and multiple axes point to point movement. Multiple movement is like homing movement combinated by a series of movement. With this signal you may use polling or interrupt event generation to schedule movement process.

Note: Abnormal movement stop will generate this signal as well. You may ensure abnaormal movement stop by checking ASTP signal.

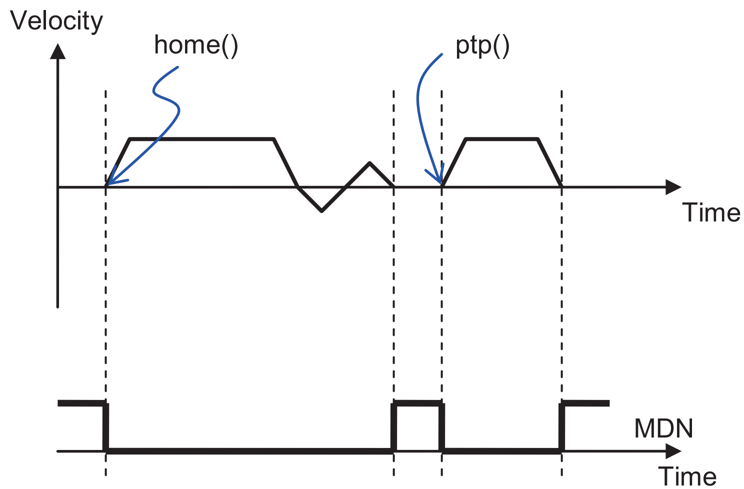


Figure 4-45: Relation of motion done (MDN) signal VS motion

Bit 6: In Homing Signal - HMV

When home movement command home () is received at the controller and home movement starts being executed, the HMV signal sets NO (=1). When home movement is completed or aborted, this signal is turned off (=0)

See Section 4.3 for detailed home movement.

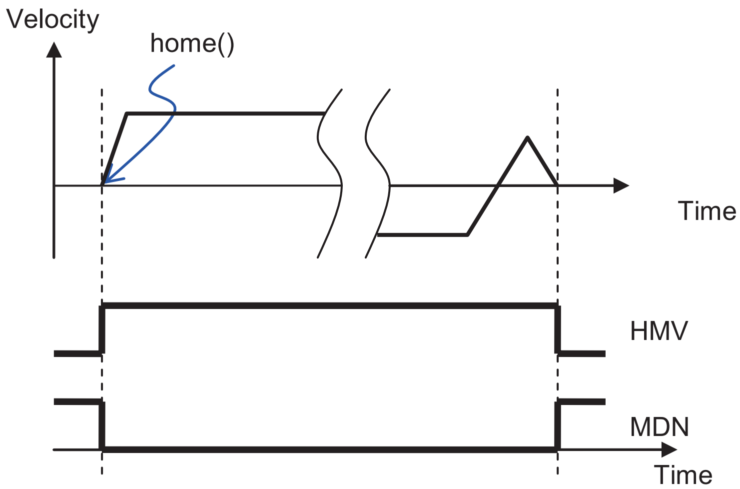


Figure 4-46: Relation of motion done (MDN), In-homing (HMV) signals VS motion

Bit10: Wait Move Trigger – WAIT

This signal is set ON when the signal is at status ready for movement triggering. When trigger is sent: Use move_trigger() function to trigger standby axis.

When parameter Flag is set to MF_WAIT (0x00100) for motion control functions listed below, the relevant commands are set to trigger initiated. The target axis do not start up immediately, only the WAIT signal is set to ON.

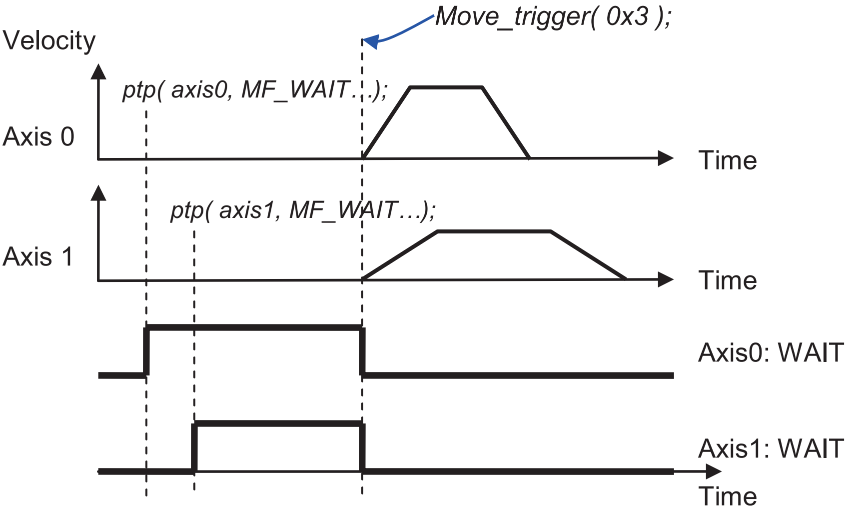


Figure 4-47: Relation of WAIT signals VS motion

Bit11: Point Buffer movement signal - PTB

When point buffer movement is started, this signal is set to ON and to OFF when movement is completed.

Bit 15: Jog movement signal - JOG

When an axis is doing jog movement, the JOG signal is set to ON and to OFF when jog movement is completed.

See Section 4.6 for detailed jog movement.

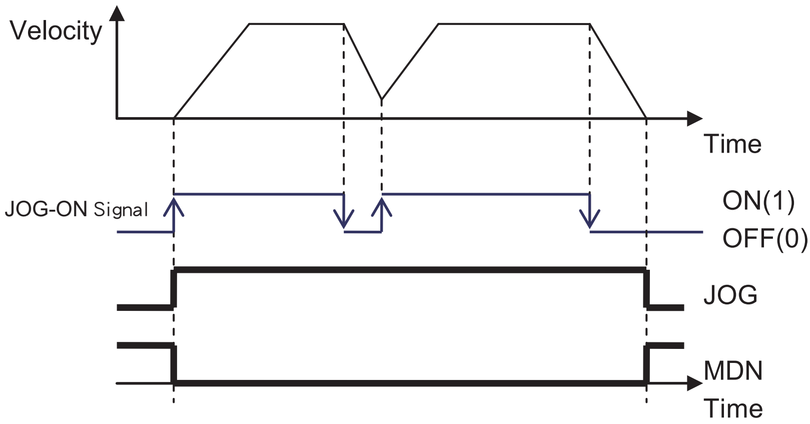


Figure 4-48: Relation of JOG and motion done(MDN) signals VS motion

Bit 16: Abnormal stop – ASTP

This signal turnes on when movement is aborted by certain reasons. See table below for causes to abnormal stop. You may use get_stop_code () function to get abnormal stop code (Stop code). This code can be used in followup error handling procedure.

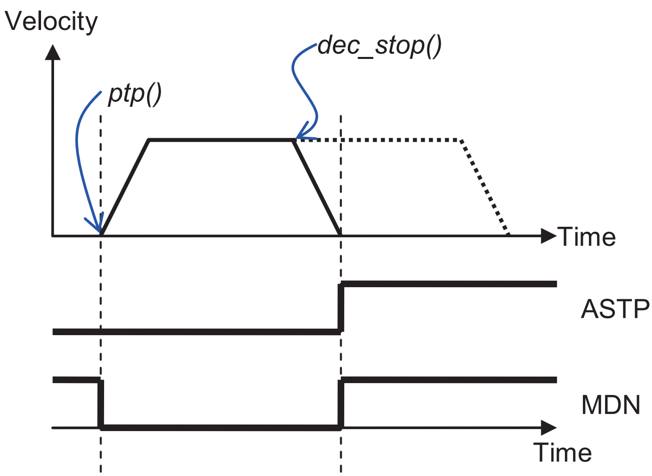


Figure 4-49: Relation of ASTP VS motion

Bit 17: Blending movement - BLD

Continuous interpolation has several speed succession method. The blending method has a transition region at the interconnection points of two paths (as shown in figure below). The BLD signal indicate that the axis is entering this area.

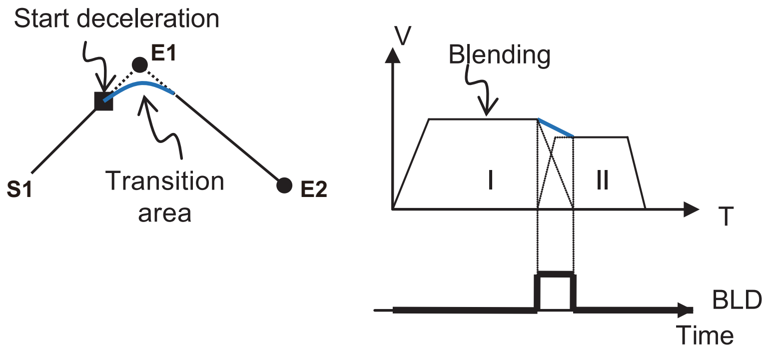


Figure 4-50: Relation of blending (BLD) signal VS motion

Bit 18 and 19: Pre- and post distance event

Every position movement command can set up pre-distance and post-distance to trigger the controller to issue signals when distance of movement meet given conditions.

The controller starts recording shift distance of movement when point to point movement is started. When distance of movement is greater than pre-distance, the pre-distance event occurs. Similarly, when remining shift distance of the point to point movement is less than the post-distance, then post-distance event occurs. Relation between movement and signal shown in figure below:

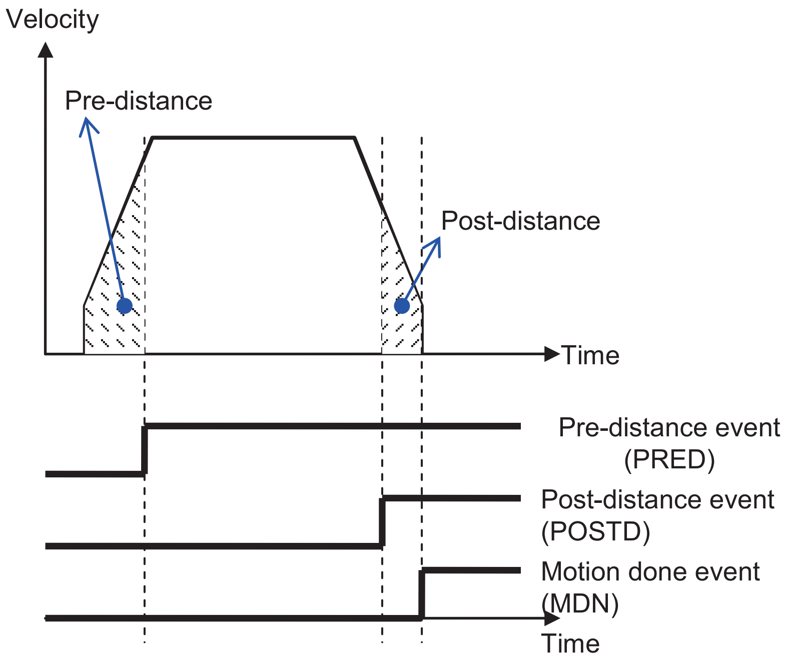


Figure 4-51: Relation between pre- and post-distance event signals and movement

4.9 Application Functions

4.9.1 Electronic Gearing

Electronic gear function: You may set up movement relation of one axis (slave axis) against another axis (master axis) that is similar to a mechanical gear structure. Relation between two gears is usually expressed with gear ratio. Take example. For a pair of gears with gear ratio 1:2, then the Y (slave) axis rotate 2 turns when the X (master axis) rotate 1 turn. Similarly, you can set up electronic gear ratio so that when the master axis executes control motions the slave axis rotate in accordance with given gear ratio.

This controller provides 2 modes: standard and gantry modes. These two modes differ in that the gantry mode is designed for dual drives gantry mechanism exclusively where two motors are used to drive one rigid coneccted mechanism. It features special safety and control behaviors. These two modes are described in sections below.

4.9.1.1 Standard Mode

To set up a electronic gear in standard mode: select a slave axis, all parameters and commands are set by reference to this axis. Set up axis parameters listed below before initiating electronic gear mode:

Param. No.	**Define symbol**	**Description**
60h (96)	PRA_GEAR_MASTER	Gear master
61h (97)	PRA_GEAR_ENGAGE_RATE	Engage rate
62h (98)	PRA_GEAR_RATIO	Gear ratio

Use APS_start_gear (slave axis ID) to enable electronic gear function after setup. After the electronic gear function is enabled, the slave axis moves along with the master axis by gear ratio setup values. As the master axis may not be motionless, you may set up appropriate engage rate for the slave axis to move at given velocity from zero to given gear ratio and to prevent vibration caused by very fast instant acceleration. In addition, gear ratio in this mode can be changed dynamically where the changing process is subject to engage rate.

Engage rate = Gear ratio / Engage time

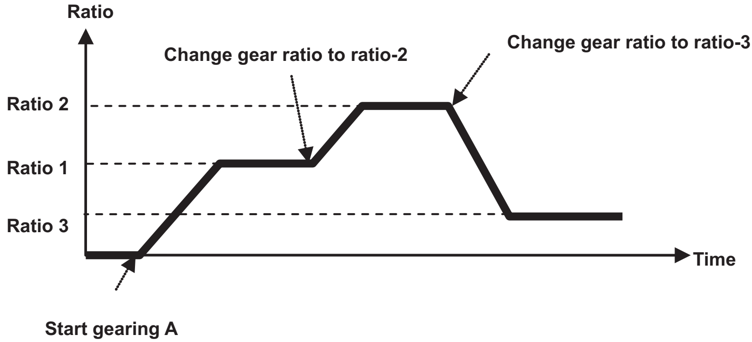


Figure 4-52: Adjust electronic gear's auto engagement speed

There are several conditions that may relieve gear relations in standard mode:

1. Relieve gear relation by APS_start_gear () manually
2. If the EMG / ALM / PEL / MEL / ALM signal of slave axis turns ON, the master axis is not affected if it is moving.
3. When slave axis received stop (), emg_stop (), and servo_off () commands

4.9.1.2 Gantry Mode

The dual drives gantry mechanism features the following:

1. Gear relation remains unless manually relieved by users.
2. Master axis stops when EMG / ALM / PEL / MEL / ALM signal of slave axis is set to ON.
3. Master and slave axes stop when stop (), emg_stop (), and servo_off () commands received by the slave axis.
4. Gear ration is fixed at 1:1 and cannot be changed.
5. Settings of engage rate are ignored.

In addition, this mode features a protection mechanism against two levels of mis-position errors. The controller checks position errors of both axes at every movement cycle for exceeding error setup. If error value is greater than position error settings of level 1, it starts the deceleration stop. If error value is greater than the level 2 position error settings the controller executes Servo-Off operation to both axes.

The setup value of this protection mechanism is to set axis parameter of slave axis by 1: master axis selected to follow and 2: two level of position error protection. Start up gantry mode with APS_start_gear (slave axis ID) after set up is completed. After the gantry mode is active, only the master axis need to be operated and the slave axis functions exactly the same as the master axis does.

Param. No.	Define symbol	Description
60h (96)	PRA_GEAR_MASTER	Gear master
63h (99)	PRA_GANTRY_PROTECT_1	Gantry mode protection level one
64h (100)	PRA_GANTRY_PROTECT_2	Gantry mode protection level two

4.9.2 High Speed Position Compare Trigger

This controller provides compare trigger with structure as shown in figure below. Trigger is sent by TRG0 ~3. You can set up two trigger output formats. The one is pulse output and other is level toggle output. Length and logic of pulse signal can be adjusted by embedded PWMn module. The PWM signal can be generated in two ways. The one is to generate trigger by manual trigger by calling API. The other is compare trigger that can be further divided into linear compare and table compare. Any one of these triggers is acceptable to PWM. Manual trigger and compare trigger are described in sections below.

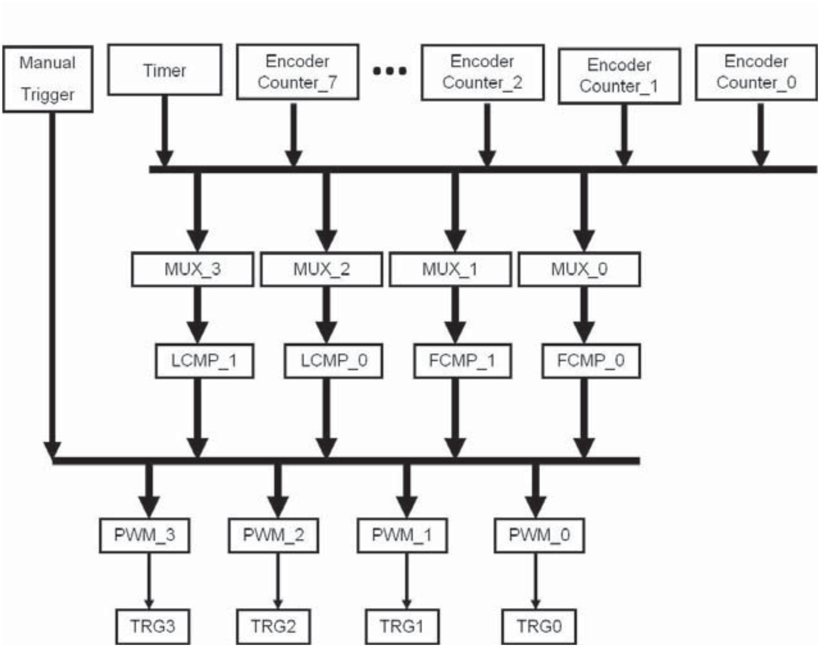


Figure 4-53: Compare trigger block diagram

TRG / PWM / Timer relevant parameter setup		
NO	**Define**	**Description**
0x06	TGR_TRG_EN	TRG0~3 output switch
0x10~0x13	TGR_TRGx_SRC	Set up TRG0~3 trigger source. You can have multiple sources to choose.
0x14~0x17	TGR_TRGx_PWD	Set up TRG0~3 pulse width
0x18~1B	TGR_TRGx_LOGIC	Set up TRG0~3 logic level
0x1C~1F	TGR_TRGx_TGL	Set up TRG0~3 output format
0x20	TIMR_ITV	Set up timer interval
0x21	TIMR_DIR	Set up timer counting direction
0x22	TIMR_RING_EN	Set up timer counter overflow activity
0x23	TIMR_EN	Start up timer

See APS Library operation manual for details on compare trigger relevant parameter list. Set up parameter APIs as described below

APS_set_trigger_param ();

APS_get_trigger_param ();

You may select either encoder counter or internal timer as the source of compare device. Relevant APIs are described below:

APS_get_timer_counter (); // read timer counter

APS_get_timer_counter (); // set up timer counter

4.9.2.1 Manual Trigger

Use APS_set_trigger_manual () API to output pulse signal. Please set up TRG with manual trigger source. See below for one operation example:

NO	Define	Description
0x10~0x13	TGR_TRGx_SRC	Set up TRG0~3 trigger source. You can have multiple sources to choose.

4.9.2.2 Compare Trigger

Compare trigger is a trigger generated when source value of comparator (CMP) matches with the value to be compared. There are two kinds of comparators, the one is the encoder counters (0~7) of each axis and the other is the timer. There are two compare methods too, linear compare trigger and table compare trigger. Operation rules and methods of both triggers are described below.

4.9.2.2.1 Linear Compare Trigger

You may need to define the subject to be compared, encoder counter or timer, before using the linear comparator. Then set up start point, repeat times and interval. The setup method, in terms of a position-time chart, is described below. Here P1 is the start point, repeat times is 4, interval is L, P1~P4 are four compare points separated by space I. When the motor move pass each compare points the TRG send pulse signals in sequence. The compare direction is determined by positive or negative value of interval. Linear compare trigger can have compare speed up to 1MHz and integral times of 32 bit comparable points.

Use APIs below to set up start point, repeat times and interval of linear compare.

APS_set_trigger_linear ();

Parameters of linear compare trigger		
NO	**Define**	**Description**
0x00	TGR_LCMP0_SRC	Compare source of linear comparator LCMP0
0x01	TGR_LCMP1_SRC	Compare source of linear comparator LCMP1

- **Example:**

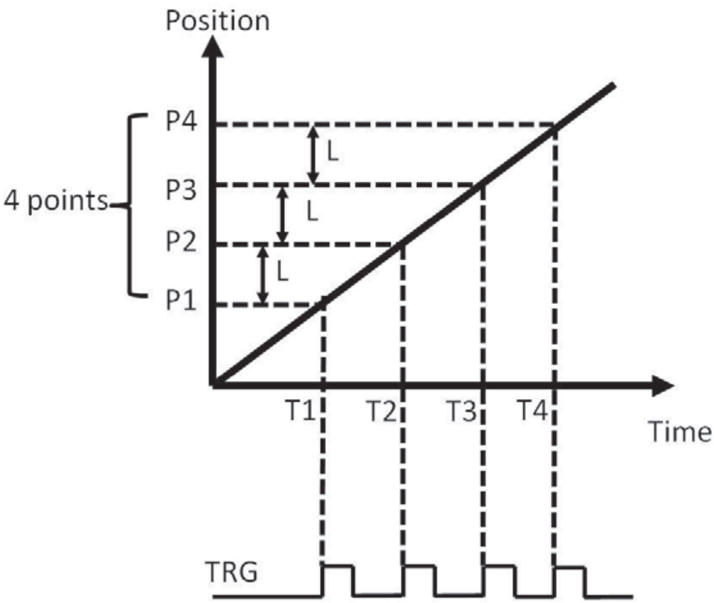


Figure 4-54: Linear compare trigger example

4.9.2.2.2 Table Compare Trigger

Table compare trigger differs from the linear compare trigger in that compare points can be determined by user. That is, intervals between compare points are variable. You may set up any four points (P1~P4) and send triggers when motor reaches each of them as shown in figure below.

Parameters of table compare trigger		
0x02	TGR_TCMP0_SRC	Set up compare subjects of table comparator CH0
0x03	TGR_TCMP1_SRC	Set up compare subjects of table comparator CH1
0x04	TGR_TCMP0_DIR	Set up compare direction of table comparator CH0
0x05	TGR_TCMP1_DIR	Set up compare direction of table comparator CH1

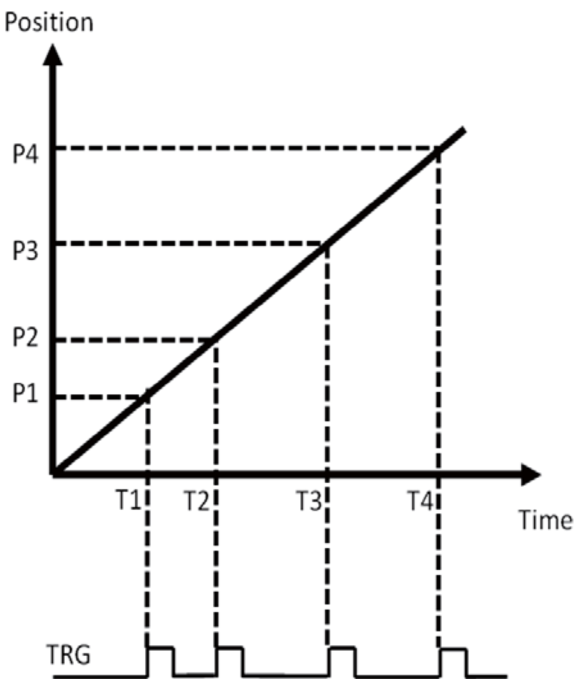


Figure 4-55: Table compare trigger example

There are two levels of FIFO buffer design contained in controller and hardware to accelerate compare speed. The hardware FIFO can have 255 records with compare speed up to 1 MHz. The controller contains 999 FIFO buffers and execute points filling in operation in every motion control cycle. You can input point array of any size in the APS function libray (limited by system memory size). The APS function libray shall load all compare points to the controller dynamically. No extra program coding is required for loading compare point dynamically in the controller even in case of many compare points.

APIs for loading compare table array:

APS_set_trigger_table ();

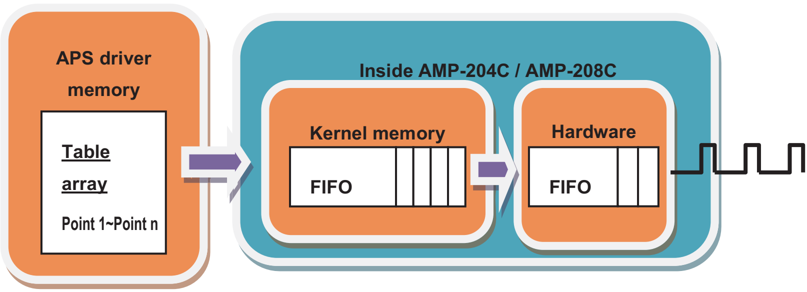


Figure 4-56: Table compare trigger block diagram

4.9.3 PWM Control (Laser Control) (VAO Table Control)

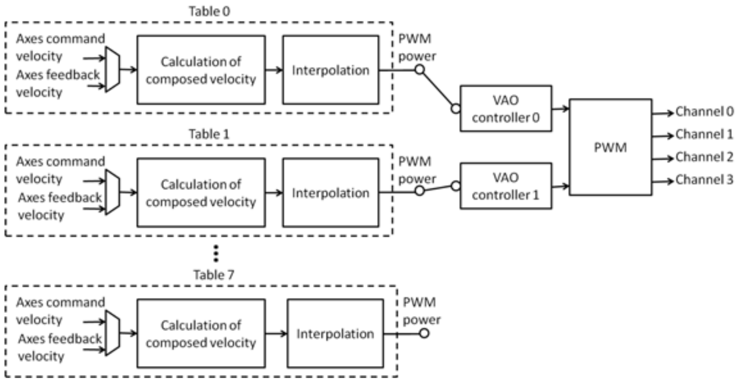
4.9.3.1 Structure Overview

Laser cutting is now commonly applied in various metal, non-metal, and composite material processing. The application is highly associated with motion control. To meet this requirements the VAO module is offered by ADLINK's DSP-based motion control card. The VAO module enables quality cutting by controling laser intensity with speed information. In general, laser intensity is commonly controlled by pulse-width modulation (PWM). ADLINK's DSP-based motion control card features multiple types of PWM controls for specific applications.

See figure below for the operation of VAO module. The VAO controller monitors PWM output with VAO table at different speeds. Your AMP-204C / AMP-208C features two VAO controllers with output channels that you can set as required. This enables it to output the same or different PWMs in multiple channels concurrently. Each VAO controller may switch among different VAO table to meet the multi-level cutting requirements. Your AMP-204C / AMP-208C features eight VAO tables, Table 0~7, to come up with corresponding PWM settings, by interpolating composite speed among multiple axes, for laser output intensity control. Source of speeds may come from individual axes' command or feedback velocity where the noise may be removed by embedded filters. The refresh frequency of feedback speed is 1KHz now. The VAO module can work together with the Point table.

Please set up PWM control mode and VAO table before using the VAO module. Please set up function parameters with the VAO parameter table. See below for descriptions and setup procedures.

Structure of the VAO module



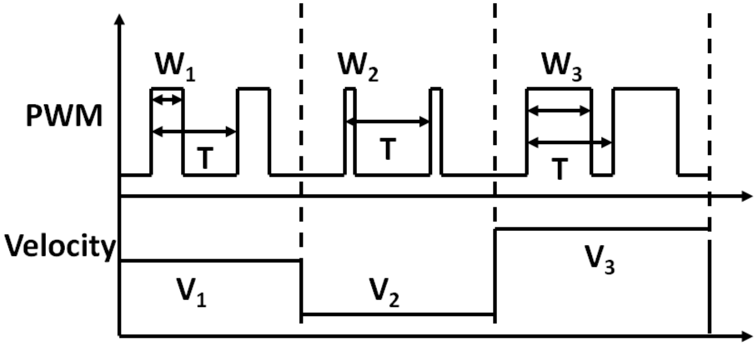
4.9.3.2 Control Modes

Your AMP-204C / AMP-208C VAO module now supports three control modes:

a. Mode1: PWM mode

This control mode adjust PWM duty cycle according to fixed PWM frequency and variable speeds as shown in figure below. The fixed PWM frequency is1/T and the PWM duty cycle W_1/T, W_2/T and W_3/T based on VAO table under speed V_1, V_2 and V_3 with different PWM pulse width at W_1, W_2 and W_3. See below for details on VAO table. To use this control mode to set

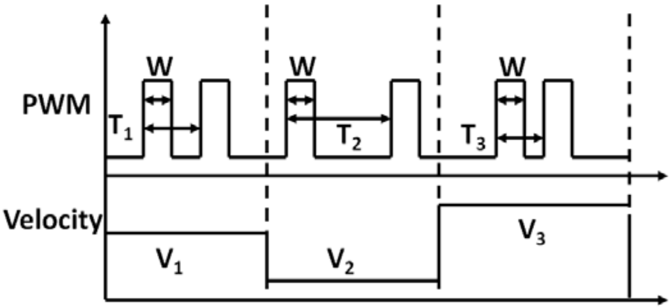
1. Set up control mode: Use APS_set_vao_param ( ) to set up value of VAO_TABLE_OUTPUT_TYPE parameter to 0x1.
2. Set up fixed PWM output frequency: Use APS_set_vao_param( ) to set up parameter VAO_TABLE_PWM_Config in unit of Hz. Valid frequency input range now is 3Hz ~ 50MHz.



b. Mode 2: PWM frequency mode with fixed width

This control mode changes PWM frequency according to speed at fixed PWM pulse width. Under fixed PWM pulse width W, the VAO table gives PWM frequency $1/T_1$, $1/T_2$ and $1/T_3$ at speed V_1, V_2 and V_3 as shown in figure below. To use this mode to

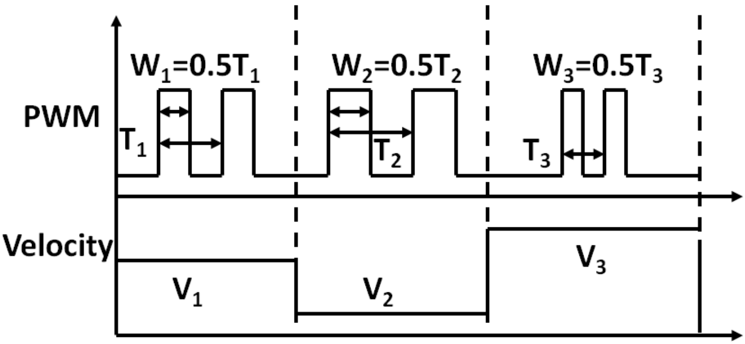
1. Set up control mode: Use APS_set_vao_param( ) to set up value of VAO_TABLE_OUTPUT_TYPE parameter to 0x2.
2. Set up fixed PWM output pulse width: Use APS_set_vao_param ( ) to set up parameter VAO_TABLE_PWM_Config in unit of ns. Valid input range is 20ns ~ 335544320 ns.



c. Mode 3: PWM frequency mode with fixed duty cycle

This control mode changes PWM frequency according to speed at fixed PWM duty cycle. As shown in figure below, the duty cycle W_1/T_1, W_2/T_2 and W_3/T_3 are the same under varying speed while thier frequency and pulse width changes according to the VAO table.

1. Set up control mode: Use APS_set_vao_param( ) to set up value of VAO_TABLE_OUTPUT_TYPE parameter to 0x3.
2. Set up fixed PWM duty cycle: Use APS_set_vao_param ( ) to set up parameter VAO_TABLE_PWM_Config in unit of %. Valid range is 0.05% ~ 100% now.



4.9.3.3 VAO Table

The VAO table is designed to give speed-based PWM power for VAO controller to control actual PWM output signal. The VAO module features eight VAO tables for layered cutting. Each table may contain up to 32 VAO pairs. See below for details on calculating speed-based power value. In figure below the X-axis is for composite speed of axes and the Y-axis its relevant PWM power. Please note the unit of power varies with control modes. Take example. If the control mode is set to mode 1: PWM mode the corresponding power is PWM duty cycle; if the control mode is set to mode 2: PWM frequency mode with fixed width then its power is PWM frequency. If the composite speed V_X is available, its corresponding power P_x can be interpolated as

$P_X = (P_3 - P_2) * (V_X - V_2) / (V_3 - V_2) + P_2$

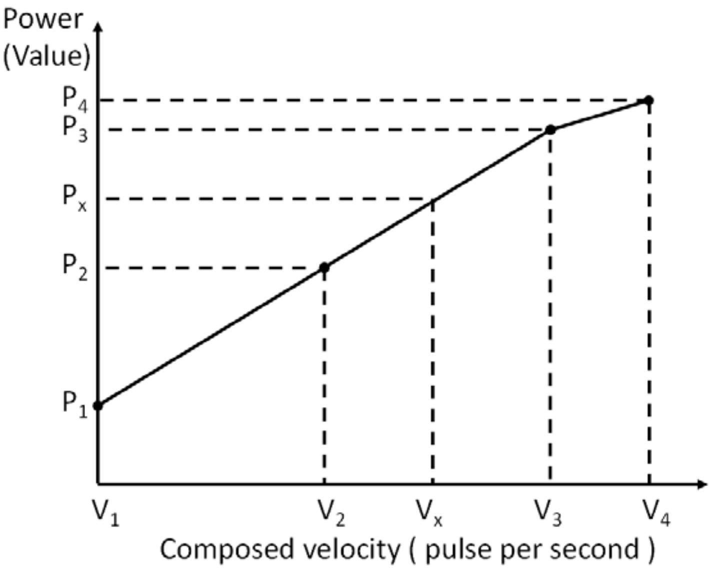


Table below suggests power range and resolution that can be set up by different control modes' VAO tables.

Mode	Power output range	Resolution
1: PWM mode	Duty cycle: 0~2000 (0.05%~100%)	0.05%
2: PWM frequency mode with fixed width	Frequency: 3Hz ~ 50MHz	1 Hz
3: PWM frequency mode with fixed duty cycle	Frequency: 3Hz ~ 50MHz	1 Hz

4.9.3.4 Output Settings

The VAO module now supports 4 PWM output channels for users' selection. You may set multiple channels to output the same control signals at the same time. Individual VAO modules are now opened with specific APS_start_vao() functions.

4.9.3.5 VAO Parameter Table

The VAO parameter table helps you in determining settings for control modes and VAO table. See table below on definitons of VAO parameters.

NO	Define	Description	Value	Default:
0x00 + (2 * N) Note: N is TableNo, range is 0 ~ 7.	VAO_TABLE_OUTPUT_TYPE	Table output type	1: PWM mode 2: PWM frequency mode with fixed width 3. PWM frequency mode with fixed duty cycle	1
0x01 + (2 * N) Note: N is TableNo, range is 0 ~ 7.	VAO_TABLE_INPUT _TYPE	Table input type	0: Feedback speed 1: Command speed	0
0x10 + N Note: N is TableNo, range is 0 ~ 7.	VAO_TABLE_PWM_Config	Configure PWM according to output type	a. Mode 1 - set a fixed frequency (3~50M Hz) b. Mode 2 - set a fixed Pulse Width (20~335544300 ns) c. Mode 3 – set a fixed duty cycle: N * 0.05 %. (N: 1 ~ 2000)	100
0x20 + N Note: N is TableNo, range is 0 ~ 7.	VAO_TABLE_SRC	Specify axisID for VAO table.	Bit0: Axis 0 On Bit1: Axis 1 On Bit2: Axis 2 On Bit3: Axis 3 On	0x01
0x30~	Reserved	Reserved	Reserved	Reserved

4.9.3.6 Digital Output and Relevant PWM Function

The VAO module features one special function to turn on or off the PWM with digital output control. It turns on or off the PWM signal output by working together with the point table's control options. Please use the board parameters to set up relations between PWM and digital outputs before using this function as shown in figure below. Here DO0~7 indicates digital output. Take example. If PWM 0 is set to DO2 and logic to 1, then PWM 0 starts output when DO2 changes from low to high and stops output vice versa. On the contrary, the PWM 0 starts output when DO2 changes from high to low when the logic is set to 0. Please note that if pairing relation is set before VAO module's PWM output opening, the

PWM output may start or stop in accordance with existing digital output and logic status. See description below for a use case outline.

1. Use APS_set_board_param() to set up PWM output channel and relevant digital output and judgment logic according to the board parameters.
2. Click Option indicated by point table to open DO_Enable, select DO_Channels and DO_ON or DO_OFF.

Pairing relation diagram

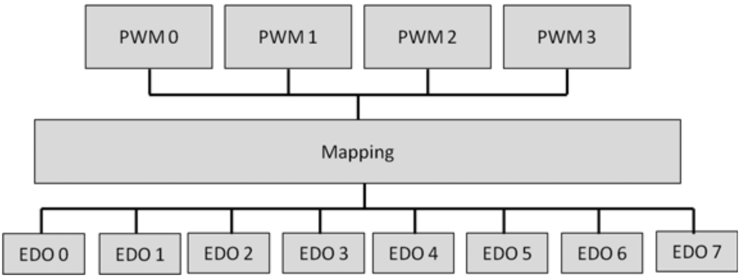


Table 4-3: Board parameter table

NO	SYMBOL	Description	Default
110h	PRB_PWM0_MAP_DO	(1) Disable mapping ; > 0: Enable mapping (2) Bit0~7: Specify a Do channel. (3) Bit8: Select logic; Set to 1: Turning on Do maps enabling PWM0. Turning off Do maps disabling PWM0. Set to 0: Turning on Do maps disabling PWM0. Turning off Do maps enabling PWM0.	-1
111h	PRB_PWM1_MAP_DO	Please see description of PRB_PWM0_MAP_DO	-1
112h	PRB_PWM2_MAP_DO	Please see description of PRB_PWM0_MAP_DO	-1
113h	PRB_PWM3_MAP_DO	Please see description of PRB_PWM0_MAP_DO	-1

4.9.3.7 Operation Process Examples

Operation flow for various control modes are outlined below for your reference.

Mode	Description
1: PWM mode	**a. VAO parameter table - APS_set_vao_param ()** 0x00: set to 1 – PWM mode 0x01: set to 1 – command speed 0x10: set to 1000 – set fixed frequency to 1000 Hz 0x20: set to 3 – Axis0 and Axis1 are selected **b. "Velocity to Power" mapping lookup table - APS_set_vao_table ()** Duty cycle range: 0 ~ 2000 units (Be equal to 0 ~ 100 %) Points range: 1 ~ 32 points **c. Switch VAO table - APS_switch_vao_table ()** **d. Enable VAO output channel - APS_start_vao ()**
2: PWM frequency mode with fixed width	**a. VAO parameter table - APS_set_vao_param ()** 0x00: set to 2 – PWM frequency mode with fixed width 0x01: set to 1 – command speed 0x10: set to 1000 – set fixed pulse width to 1000 ns 0x20: set to 3 – Axis0 and Axis1 are selected **b. "Velocity to Power" mapping lookup table - APS_set_vao_table ()** Frequency range: 1 ~ 25Mhz for PCI-8253/6 Points range: 1 ~ 32 points **c. Switch VAO table - APS_switch_vao_table ()** **d. Enable VAO output channel - APS_start_vao ()**
3: PWM frequency mode with fixed duty cycle	**a. VAO parameter table - APS_set_vao_param ()** 0x00: set to 3 – PWM frequency mode with fixed duty cycle 0x01: set to 1 – command speed 0x10: set to 200 – set fixed duty cycle to 10%. (200 * 0.05%) 0x20: set to 3 – Axis0 and Axis1 are selected **b. "Velocity to Power" mapping lookup table - APS_set_vao_table ()** Frequency range: 1 ~ 25Mhz for PCI-8253/6 Points range: 1 ~ 32 points c. Switch VAO table - APS_switch_vao_table () d. Enable VAO output channel - APS_start_vao ()

4.9.4 Motion Control and I/O Sampling Function

4.9.4.1 Sampling Source

This control card supports multiple signal sampling for analysis. There are two signal sources: the one belongs to motion kernel signal and the other the close-loop control signal. In figure below, the bottom layer's motion kernel and controller's adjustable update rate is 1ms and 250us respectively, sampling rate of the sampling process is 1ms, and the sampled signals are sent by APS library to MotionCreatorPro2 or other applications to display. The close-loop control signal would be a better choice for learning the system's overall control performance. Please note that close-loop control signal sampling is invalid in pulse control mode. See table below for meanings of individual signals and Section 4 of MotionCreatorPro 2 User Manual for operation pages and steps.

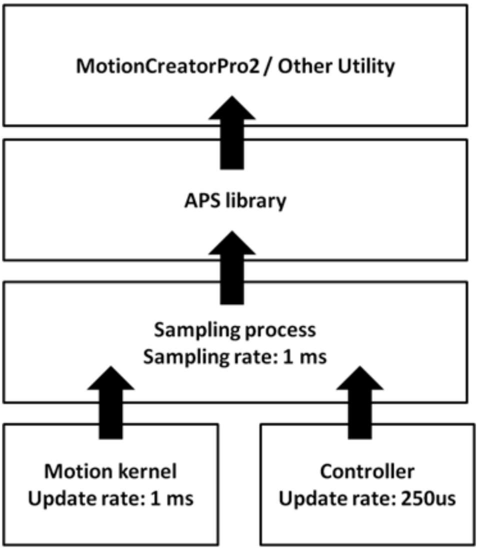


Figure 4-57: Signal sampling structure diagram

Table 4-4: Motion kernel signal table

Signal name	Range	Data type	Descriptions
SAMP_SRC_COM_POS	Axis 0~7	Integer	Position command: Unit: pulse
SAMP_SRC_FBK_POS	Axis 0~7	Integer	Feedback position Unit: pulse
SAMP_SRC_CMD_VEL	Axis 0~7	Integer	Command velocity; Unit: pulse/sec
SAMP_SRC_FBK_VEL	Axis 0~7	Integer	Feedback velocity; Unit: pulse/sec
SAMP_SRC_MIO	Axis 0~7	Integer	Motion I/O, see Note 1 for its definition.
SAMP_SRC_MSTS	Axis 0~7	Integer	Motion status, see Note 2 for its definition.
SAMP_SRC_MSTS_ACC	Axis 0~7	Integer	Motion status: Acceleration section (motion status acc); 0: Null acceleration 1: Current acceleration
SAMP_SRC_MSTS_MV	Axis 0~7	Integer	Motion status: Constant speed section (motion status at max velocity); 0: No constant speed 1: Current constant speed
SAMP_SRC_MSTS_DEC	Axis 0~7	Integer	Motion status: Deceleration section (motion status DEC); 0: Null deceleration 1: Current deceleration
SAMP_SRC_MSTS_CSTP	Axis 0~7	Integer	Motion status: The Stop motion command (motion status CSTP); 0: During movement 1: Stop the movement command
SAMP_SRC_MSTS_MDN	Axis 0~7	Integer	Motion status: Movement completed (motion status MDN); 0: During movement 1: Movement completed
SAMP_SRC_MIO_INP	Axis 0~7	Integer	Motion status: Movement in-place (motion status MDN); 0: Movement not in-place 1: Movement in-place
SAMP_SRC_MIO_ORG	Axis 0~7	Integer	Motion status: ORG signal (motion status OGR); 0: No ORG signal 1: Touches ORG signal
SAMP_SRC_CONTROL_VOL	Axis 0~7	Integer	Output voltage (Control command voltage); Unit: mV
SAMP_GTY_DEVIATION	Axis 0~7	Integer	Set up feedback offset (gantry deviation) between given and slave axes in gantry movement; Unit: pulse
SAMP_SRC_ENCODER_RAW	Axis 0~7	Integer	Drive's feedback position original signal (Encoder raw data) ; Unit: pulse
SAMP_SRC_ERR_POS	Axis 0~7	Integer	Error position; Unit: pulse
SAMP_SRC_COM_POS_F64	Axis 0~7	Double	Same as SAMP_SRC_COM_POS but presented in float point numbers

Signal name	Range	Data type	Descriptions
SAMP_SRC_FBK_POS_F64	Axis 0~7	Double	Same as SAMP_SRC_FBK_POS but presented in float point numbers
SAMP_SRC_CMD_VEL_F64	Axis 0~7	Double	Same as SAMP_SRC_CMD_VEL but presented in float point numbers
SAMP_SRC_FBK_VEL_F64	Axis 0~7	Double	Same as SAMP_SRC_FBK_VEL but presented in float point numbers
SAMP_SRC_CONTROL_VOL_F64	Axis 0~7	Double	Same as SAMP_SRC_CONTROL_VOL but presented in float point numbers
SAMP_SRC_ERR_POS_F64	Axis 0~7	Double	Same as SAMP_SRC_FBK_POS but presented in float point numbers
SAMP_PWM_FREQUENCY_F64	Channel 0~3	Double	PWM frequency; Unit: Hz
SAMP_PWM_DUTY_CYCLE_F64	Channel 0~3	Double	PWM duty cycle; Unit: %
SAMP_PWM_WIDTH_F64	Channel 0~3	Double	PWM width; Unit: ns
SAMP_VAO_COMP_VEL_F64	No. 0~1	Double	Composed velocity for Laser power control; Unit: pulse/sec
SAMP_PTBUFF_COMP_VEL_F64	Table 0~1	Double	Composed velocity of point table; Unit: pulse/sec
SAMP_PTBUFF_COMP_ACC_F64	Table 0~1	Double	Composed acceleration of point table; Unit: pulse/sec^2

Note 1: Motion I/O definition table

7	6	5	4	3	2	1	0
SVON	INP	EZ	EMG	ORG	MEL	PEL	ALM
15	14	13	12	11	10	9	8
			SMEL	SPEL			

Bit number detail description:

Bit	Define	Description
0	ALM	Servo alarm input status
1	PEL	Positive end limit
2	MEL	Minus end limit
3	ORG	Original input (Home input)
4	EMG	Emergency stop input
5	EZ	Servo index input
6	INP	In-Position input
7	SVON	Servo ON output status
…		
11	SPEL	1: Soft-positive-end limit condition match.
12	SMEL	1: Soft-minus-end limit condition match

Note 2: Motion status definition table

7	6	5	4	3	2	1	0
	HMV	MDN	DIR	DEC	ACC	VM	CSTP
15	14	13	12	11	10	9	8
JOG				PTB	WAIT		
23	22	21	20	19	18	17	16
				POSTD	PRED	BLD	ASTP
31	30	29	28	27	26	25	24
			GER				

Bit number detail description:

Bit	Define	Description
0	CSTP	Command stopped (But it could be in motion)
1	VM	In maximum velocity
2	ACC:	In acceleration
3	DEC:	In deceleration
4	DIR:	Move direction. 1:Positive direction, 0:Negative direction
5	MDN	Motion done. 0: In motion, 1: Motion done (It could be abnormal stop)
6	HMV	In homing
…		
10	WAIT	Axis is in waiting state. (Wait move trigger)
11	PTB	Axis is in point buffer moving. (When this bit on, MDN and ASTP will be cleared)
…		
15	JOG	In jogging
16	ASTP	0: Stop normally, 1: abnormal stop, When axis in motion, this bit will be clear.
17	BLD	Axis (Axes) in blending moving
18	PRED	Pre-distance event, 1: event arrived. The event will be clear when axis start moving
19	POSTD	Post-distance event. 1: event arrived. The event will be clear when axis start moving
…		
28	GER	1: In geared (This axis as slave axis and it follow a master specified in axis parameter.)
29	--	--

4.9.5 Simultaneous Movement

4.9.5.1 Simultaneous Start

Synchronized (Simultaneous) start: This movement can set to be enabled by trigger. When proper command is received, the axis enters a waiting-for-trigger-signal status and starts moving after the trigger is received. When multiple axes are in waiting-for-trigger-signal status you may send trigger signal at the same time for synchronized enabling. Please note that movement of each axis is independent from each other and so the end time varies with offset amount and acceleration profile.

Please enables simultaneous start by steps below:

a Set axis movement to triggered startup and check the axis status for waiting for trigger

b Send the trigger to run synchronized start

a Set axis movement to triggered startup and check the axis status for waiting for trigger

You may set up the startup-by-trigger mode by the Option parameter of the controller's function. The axis enters trigger waiting status once the command is received.

Take APS_ptp, the function prototype may look like

I32 APS_ptp(I32 Axis_ID, I32 Option, …);

See table below for definitons of Option. Please note that given axis is set to startup-by-trigger mode when Bit 8 is given value 1.

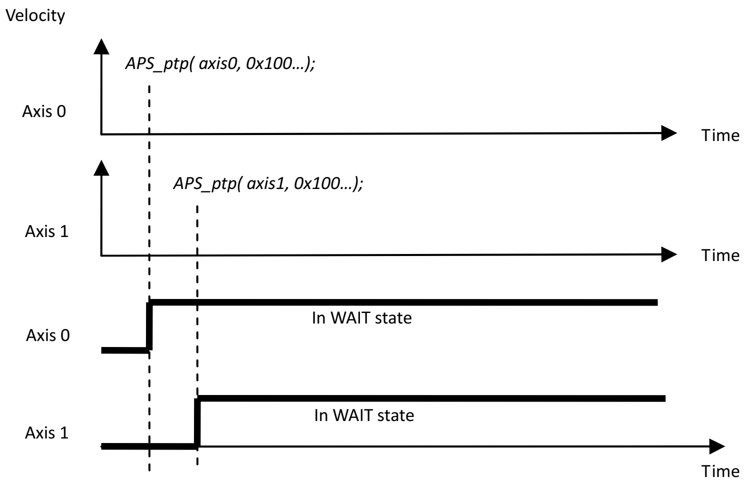
7	6	5	4	3	2	1	Bit:
							Absolute (0) / Relative (1)
15	14	13	12	11	10	9	8
Buffer mode							Wait trigger

After an axis movement is set to startup-by-trigger mode it enters the trigger waiting status, i.e. the WAIT signal of Bit 10 in table below is ON. . You may display its signal status with function library, the motion status monitoring function is

I32 APS_motion_status ();

Motion status definition table							
7	6	5	4	3	2	1	Bit:
--	HMV	MDN	DIR	DEC	ACC	VM	CSTP
15	14	13	12	11	10	9	8
JOG	--	--	--	PTB	WAIT	--	--

See figure below for an illustration of motion set to trigger waiting



Relevant APS API described below

I32 APS_ptp ();I32 APS_ptp_v ();I32 APS_ptp_all ();I32 APS_line ();I32 APS_line_v ();

I32APS_line_all ();I32 APS_vel ();I32 APS_vel_all ();I32 APS_arc2_ca ();I32 APS_arc2_ca_v ();

I32 APS_arc2_ca_all ();I32 APS_arc2_ce ();I32 APS_arc2_ce_v ();I32 APS_arc2_ce_all ();

I32 APS_arc3_ca ();I32 APS_arc3_ca_v ();I32 APS_arc3_ca_all ();I32 APS_arc3_ce ();

I32 APS_arc3_ce_v ();I32 APS_arc3_ce_all ();I32 APS_arc3_ca ();I32 APS_arc3_ca_v ();

I32 APS_arc3_ca_all ();I32 APS_sprial_ca ();I32 APS_sprial_ca_v ();I32 APS_sprial_ca_all ();

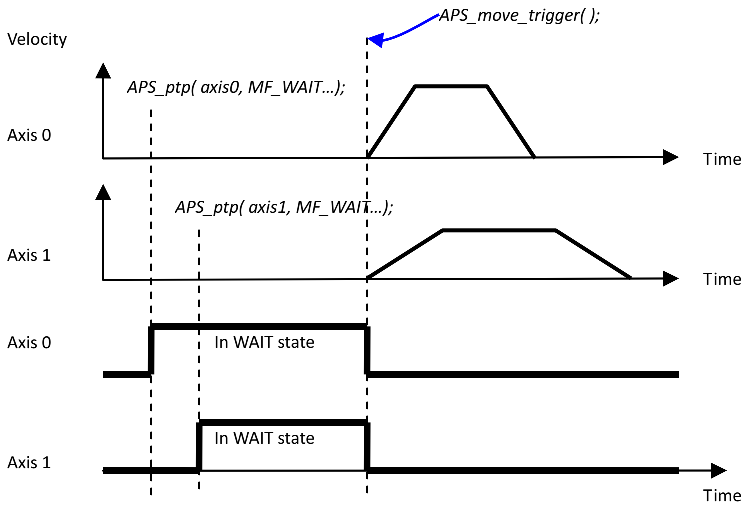
I32 APS_sprial_ce ();I32 APS_sprial_ce_v ();I32 APS_sprial_ce_all ();

b. Send the trigger signal to run synchronized start

You may enable multiple axes at the same time by sending trigger with function in form of:

I32 APS_move_trigger ();

See figure below for multiple axes' concurrent startup by trigger:



Relevant APS API described below:

I32 APS_move_trigger (); // trigger issued

I32 APS_stop_move (); // synchronized deceleration stoppped

I32 APS_stop_move (); // synchronized Emg stoppped

4.9.6 Point Table Movement

The controller features two point table which contains 50 buffer points respectively. You may enjoy point table functions of large amount of points and free from any practical limits by monitoring the usages status of buffer point space and reloading these 50 buffer point space repetitively.

With the controller's point table movement function you may get continuous movement in multi-sections with relevant function. Available commands in point table movements are straight line, arc, and spiral interpolation and dwell. The instruction command covers digital output and VAO table switch which can be used to program application relevant requirements.

4.9.6.1 Point Table Parameter Setup

There are three groups of point table parameters:

a Movement parameter setup

b Instruction command setup

c Set movement command to point table

a. Movement Parameter Setup

Please set up movement parameters before executing movement commands including absolute and relative movement, maximum, ending velocity, acceleration and deceleration, S-factor and speed blending method between adjacent paths, for speed and path planning applicable to applications. Please note that these parameter settings are kept by the program memory once being set up. Existing settings may be applied to other movement commands automatically. Repetitive setups are not required for each movement command unless you want to change parameter settings.

Movement parameter setup	Paired APS function
Absolute / relative movement	APS_pt_set_absolute / APS_pt_set_relative
Maximum speed	APS_pt_set_vm
Ending speed	APS_pt_set_ve
Acceleration	APS_pt_set_acc
Deceleration	APS_pt_set_dec
Acceleration and deceleration	APS_pt_set_acc_dec
S-factor	APS_pt_set_s
Speed blending between adjacent paths Please refer to Section 4.7.3.	APS_pt_set_trans_buffered (**buffer)** APS_pt_set_trans_inp (**buffered in-place**) APS_pt_set_trans_blend_dec (**blend - deceleration**) APS_pt_set_trans_blend_dist (**blend - residue-distance**) APS_pt_set_trans_blend_pcnt (**blend - residue-distance ratio**)

b. Instruction command setup

The instruction command is executed simultaneously with the point table's movement one. That is, it may control digital outputs concurrently at different movement section during motion execution.

Instruction command (executed along with the movement command)	Paired APS function
Digital output (DO)	APS_pt_ext_set_do_ch
VAO table switch	APS_pt_ext_set_table_no

c. Set movement command to point table

The point table offers movement commands of straight line, arc and spiral interpolation which can set movement commands in point table with the paired APS function.

Movement commands	Paired APS function
Straight line interpolation	APS_pt_line
Arc interpolation	APS_pt_arc2_ca / APS_pt_arc2_ce APS_pt_arc2_ca / APS_pt_arc2_ce
Spiral interpolation	APS_pt_sprial_ca / APS_pt_sprial_ce
Dwell	APS_pt_dwell

You may set up relevant movement parameter and required synchronous instruction command as well as save them in the point table with these three steps. Follow the same steps to save all graphic sections in point table.

4.9.6.2 Execute Point Table Movement

The controller features two point table which contains 50 buffer points respectively. You may enjoy point table functions of large amount of points and free from any practical limits by monitoring the usages status of buffer point space and reloading these 50 buffer point space repetitively.

A point table movement can be executed in following steps:

a Enable/disable point table function

b Monitor buffer space and fill in the points

c Start /stop point table movement

a. Enable/disable point table function

Please enable the point table function, set up its ID (0~1), movement dimension and axis number before using it. Please disable it after the point table function is ended.

I32 APS_pt_enable (I32 Board_ID, I32 PtbId, I32 Dimension, I32 *AxisArr);

Point table functions	Paired APS function
Enable the point table function	APS_pt_enable
Disable the point table function	APS_pt_disable

b. Monitor buffer space and fill in the points

A point table features 50 buffer points. You may monitor these buffer points and fill in the table with movement commands (see Section 4.9.6.1 for detail) by loading in all the graphic points dynamicall.

Point table functions	Paired APS function
Monitor buffer status	APS_get_pt_status

c. Start /stop point table movement

After enabling the point table and fill in the buffers with movement commands you can then start up the point table function. The motion kernel program starts executing movement commands contained in buffer points in sequence until interrupted or each buffer point has been executed.

Point table functions	Paired APS function
Enable the point table movement	APS_pt_start
End the point table movement	APS_pt_stop

- **Example:**

```
#include "APS168.h"
#include "APS_define.h"
#include "ErrorCodeDef.h"

void pt_move_example ()
{
  //This example shows how pt move operation
  I32 ret;
   I32 Board_ID = 0;
   I32 PtbId = 0; //Point table 0
   I32 Dimension = 2; //2D Dimension
   I32 AxisArr[2] = { 0, 1 }; //Set Axis 0 & Axis 1 to point table 0
   PTLINE Prof;
   PTSTS Status;

   //Enable point table id 0 for 2D dimension with aixs 0 and axis 1.
   APS_pt_enable (Board_ID , PtbId, Dimension, & AxisArr); //Enable point table id 0


   //Get status of point table id 0 to monitor buffer
   APS_get_pt_status (Board_ID , PtbId, &Status);
   if ( !(Status.BitSts & 0x02 ) ) //Point buffer is not full
   {
      //Push move into point buffer
      Prof.Dim = 2;
      Prof.Pos[0] = 10000;
      Prof.Pos[1] = 10000;
      ret = APS_pt_line (Board_ID, PtbId, &Prof, &Status);
   }
   //Start point table move
   APS_pt_start (Board_ID, PtbId, 0);


   }
```

4.10 Safety Protection

During equipment operation there maybe errors or situations where emergency stops are required. In case of this, the usual method is to stop the mechanical equipment from operation. This controller provides some safety mechanism to detect predefined error situations. When these conditions are encountered the controller take proper actions to protect personnel safety and to prevent damage to equipments. Some of these safety mechanism require external hardware signal while others do regular checks with software. These safety mechanism are described below.

4.10.1 Hardware Protection

The controller provides external hardware signal based detective protection mechanism including emergency stop (EMG), servo alarm (ALM) and mechanical plus and minus limit (PEL and MEL). Detailed operation theories are described below.

4.10.1.1 Emergency Stop (EMG)

See table below for EMG hardware input pins:

P1A Pin No	Signal Name
51	IEMG

EMG signal is a hardware input signal. When EMG signal is set to ON status the controller responses with following actions:

1. If the EMG signal is set to ON when the axis is in motion status, the controller stops the axis movement immediately. Error stop code of the axis is set to "1" (STOP_EMG) and motion status of axis is set to abnormal stop (ASTP).
2. If the axis is not in motion status and the EMG signal is ON then user's motion command shall be ignored by the controller while error stop code of the axis is set to STOP_EMG (1) and motion status of axis is set to abnormal stop (ASTP).

Relevant APIs:

APS_motion_status (); // read in motion status (ASTP)

APS_get_stop_code (); // read in error stop code

4.10.1.2 Servo Alarm (ALM)

See table below for ALM hardware input pins and corresponding axis number:

P1A Pin No	Signal Name	Axis #	P1B Pin No	Signal Name	Axis #
35	ALM1	0	35	ALM5	4
41	ALM2	1	41	ALM6	5
85	ALM3	2	85	ALM7	6
91	ALM4	3	91	ALM8	7

ALM signal is a hardware input signal where ALM signal is from servo drive to controller through ALM pin. When ALM signal is set to ON status, the controller responses with following actions:

1. If ALM signal is asserted for an axis in motion status, the controller stops motion of the axis immediately and error stop code of the axis is set to "2" (STOP_ALM) and motion status of axis is set to abnormal stop (ASTP = ON).
2. If the axis is not in motion status and the ALM signal is asserted then user's motion command shall be ignored by the controller while error stop code of the axis is set to "2" (STOP_ALM) and motion status of axis is set to abnormal stop (ASTP = ON).

4.10.1.3 Plus and Minus Limit Signal (PEL/MEL)

See table below for EL hardware input pins and corresponding axis number:

P1A Pin No	Signal Name	Axis #	P1B Pin No	Signal Name	Axis #
38	PEL1	0	40	MEL1	0
44	PEL2	1	46	MEL2	1
88	PEL3	2	90	MEL3	2
94	PEL4	3	96	MEL4	3
38	PEL5	4	40	MEL5	4
44	PEL6	5	46	MEL6	5
88	PEL7	6	90	MEL7	6
94	PEL8	7	96	MEL8	7

EL signal is a hardware input signal including PEL and MEL. PEL is the limit signal in positive direction and MEL the negative direction one. An asserted EL signal causes the controller responses with following actions:

1. If PEL signal is asserted for an axis in positive motion status, the controller stops motion of the axis immediately and error stop code of the axis is set to "4" (STOP_PEL) and motion status of axis is set to abnormal stop (ASTP = ON).
2. If MEL signal is asserted for an axis in negative motion status, the controller stops motion of the axis immediately and error stop code of the axis is set to "5" (STOP_MEL) and motion status of axis is set to abnormal stop (ASTP = ON).
3. If the axis is not in motion status and the PEL signal is asserted then user's positive direction motion command shall be ignored by the controller while error stop code of the axis is set to "4" (STOP_PEL) and motion status of axis is set to abnormal stop (ASTP = ON).
4. If the axis is not in motion status and the MEL signal is asserted then user's negative direction motion command shall be ignored by the controller while error stop code of the axis is set to "5" (STOP_MEL) and motion status of axis is set to abnormal stop (ASTP = ON).
5. There are two stop mode options available: decelerating stop and immediate stop. The axis parameter code is PRA_EL_MODE (0x02).

4.10.2 Software Protection

The controller provides software protection mechanism of software limit and postion error protection.

4.10.2.1 Soft-limit Signal

Software limit functions almost the same as that of the hardware limit with the exception that limit signal is generated by checking location of each axis with the software limit function. There are the same plus limit (PEL) and minus limit (MEL) signals. Steps of using the software limit are described below:

1. Set up position of software limit with axis parameters PRA_SPEL_POS and PRA_SMEL_POS shown in table below.
2. Set up stop mode in response to limit signal. You can select decelerating stop or immediate stop with axis parameter PRA_EL_MODE (0x02) and PRA_SD_DEC (0x07).
3. Start up software limit function with axis partameter PRA_SPEL_EN (0x08) and PRA_SMEL_EN (0x09) shown in table below.

Please run homing operation to ensure limit position of the coordiante system before the software limit function can be started.

NO	Define	Description
02h	PRA_EL_MODE	EL signal stop mode See deceleration rate reference parameter, PRA_SD_DEC, for deceleration stop mode:
07h	PRA_SD_DEC	Set up rate for deceleration stop
08h	PRA_SPEL_EN	Soft PEL switch
09h	PRA_SMEL_EN	Soft MEL switch
0Ah	PRA_SPEL_POS	Soft PEL position
0Bh	PRA_SMEL_POS	Soft MEL position

After the software limit function is initiated, you may use the function library provided by the controller to display signal status. This IO monitoing function is described below:

APS_motion_io_status ();

When software limit signal is set to ON status the controller responses with following actions:

1. If SPEL signal is asserted for an axis in positive direction motion status, the controller stops motion of the axis immediately and error stop code of the axis is set to "6" (STOP_SPEL) and motion status of axis is set to abnormal stop (ASTP).
2. If SMEL signal is asserted for an axis in negative direction motion status, the controller stops motion of the axis immediately and error stop code of the axis is set to "7" (STOP_SMEL) and motion status of axis is set to abnormal stop (ASTP).
3. If the axis is not in motion status and the SPEL signal is asserted then user's positive direction motion command shall be ignored by the controller while error stop code of the axis is set to STOP_SPEL (6) and motion status of axis is set to abnormal stop (ASTP).
4. If the axis is not in motion status and the SMEL signal is asserted then user's negative direction motion command shall be ignored by the controller while error stop code of the axis is set to STOP_SPEL (7) and motion status of axis is set to abnormal stop (ASTP).

4.10.2.2 Position Error Protection

Position error protection is a software protection mechanism by monitoring difference between command counter and feedback counter. This difference is defined as position error. When position error is too big, the controller sends a Servo off signal which can be set up for use before servo fine tuning.

This function can be set up with axis parameters as shown in table below. You can disable the position error protection by setting position error paramter (PRA_ERR_POS_LEVEL) to value "0". The position error protection is enabled when position error paramter is set to non-zero value.

NO	Define	Description
124h	PRA_ERR_POS_LEVEL	Position error protection setup

Position error protection causes the controller responses with following actions:

If the position error vlaue is greater than setting given by users, the controller run Servo off command directly and error Stop code of the axis is set to STOP_ERROR_LEVEL (6) and motion status of axis is set to abnormal stop (ASTP).

4.10.2.3 Watchdog Timer

The watchdog protection mechanism is a timer inside the controller. Timeout of the timer will enable predefined response actions including Servo off, turning off digital output and turning off PWM output. After the watchdog protection mechanism is enabled, the user program must be in reponsable status. Before timeout of the timer, the watchdog mechanism should be reset continuously to restart timing of the timer. As long as the user program remain in reponsable status relevant events shall not be triggered. In another words, the watchdog protection mechanism is used to detect stagnation (failure) status of the upper control program. If stagnation situation is encountered, the controller triggers a protection mechanism to close signal output.

You may use interrupt function in Windows environment as described below:

1. Set up trigger event of timer timeout
2. Enable watchdog protection mechanism
3. Reset timer within cycle time

See below for relevant APS APIs:

APS_wdt_set_action_event ();

APS_wdt_set_action_event ();

APS_wdt_start ();

APS_wdt_get_timeout_period ();

APS_wdt_reset_counter ();

Detailed operation methods are described below:

1. Set up trigger event of timer timeout:

   Use ***APS_wdt_set_action_event ()*** function to set up trigger event.

   Use ***APS_wdt_get_action_event ()*** function to get trigger event.

2. Enable watchdog protection mechanism:

   Use ***APS_wdt_start ()*** to set up a timeout period and enable the watchdog function then the internal timer starts clicking. Set timeout period to "0" to disable watchdog function.

Use ***APS_wdt_get_timeout_period ()*** to read in the timeout settings.

3. Reset timer continuously

   After the watchdog protection mechanism is enabled, the watchdog mechanism should be reset within timeout period to rest the timer and retiming from beginning. In case of timer timeout relevant events are triggered per setting given by step 1.

   Use ***APS_wdt_reset_counter ()*** to reset watchdog.

4.11 Host Interrupt

An interrupt is a process starting when specified event is encountered, the device (this controller) issue hardware interrupt signal to the operating system, the operating system enable the driver to execute corresponding interrupt service routine. See figure below for illustration to this flow.

Either interrupt or polling mechansim is employed to detect a certain event. The polling mechanism consumes CPU time repetitively and lead to CPU over utilization. The interrupt mechanism alert the CPU of event after it is encountered. This process consumes much less CPU time and so can reduce CPU utilization rate. It also frees up the CPU to process other tasks for multitasks and effective CPU resource utilization when waiting for interrupt signal.

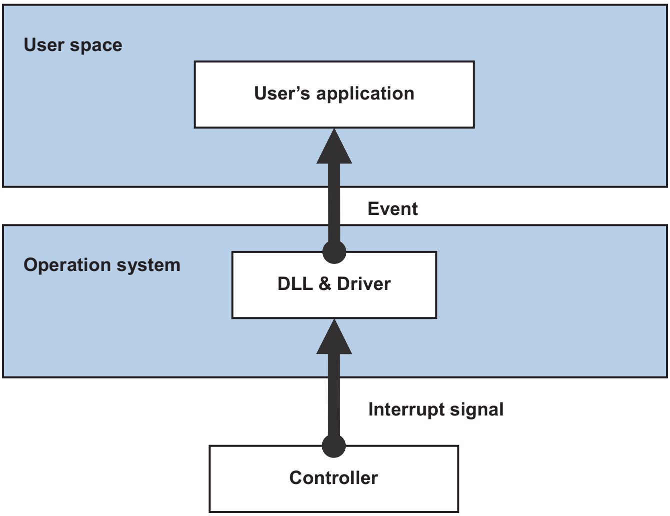


Figure 4-58: Interruption flow chart

Types of interrupt events provided by this controller are described below:

1. Axis interrupt
2. System interrupt
3. Digital input interrupt

Axis interrupt type contains all control axis relevant events. The digital input interrupt contains rising edge interrupt and falling edge interrupt. And other events are contained in system interrupt type.

See table below for all interrupt event types contained in this controller. Here items 0~7 are interrupt relevant to each control axis, item 8 is system relevant interrupt and item 9 and 10 are digital input interrupt. (Note: For AMP-204C items 0~3 and 4~7 are reserved.)

- **Interrupt Item overview:I**

Item	Item type description
0~7	Axis 0~7 interrupt (Item 4~7 of AMP-204C are reserved)
8	System interrupt
9	Digital input rising edge interrupt
10	Digital input falling edge interrupt

Each item can have up to 32 kinds of interrupt events (32 bit). See tables below for detailed defintions.

- **Item = 0~7: Axis interrupt events overview**

Bit No.	7	6	5	4	3	2	1	0
Factor	--	IEMG	IINP	IEZ	IORG	IMEL	IPEL	IALM
Bit No.	**15**	**14**	**13**	**12**	**11**	**10**	**9**	**8**
Factor	ISPEL	--	IASTP	IMDN	IDEC	IACC	IVM	ICSTP
Bit No.	**23**	**22**	**21**	**20**	**19**	**18**	**17**	**16**
Factor	--	--	--	--	IPOSTD	IPRED	--	ISMEL
Bit No.	**31**	**30**	**29**	**28**	**27**	**26**	**25**	**24**
Factor	--	--	--	--	--	--	--	--

- **Axis interrupt events description:**

bit.	Symbol	Interrupt event description
0	IALM	ALM signal occurrence
1	IPEL	PEL signal occurrence
2	IMEL	MEL signal occurrence
3	IORG	ORG signal occurrence
4	IEZ	Motor Z phase signal (EZ) occurrence
5	IINP	Drive in-place (INP) signal occurrence
6	IEMG	Emergency stop signal EMG occurrence (same as system IEMG)
7	--	Reserved, set to "0"
8	ICSTP	CSTP signal occurrence
9	IVM	Maximum velocity
10	IACC	Start acceleration
11	IDEC	Start deceleration
12	IMDN	Motion done
13	IASTP	Abnormal stop
14	--	Reserved, set to "0"
15	ISPEL	Soft PEL occurrence
16	ISMEL	Soft MEL occurrence
17	--	Reserved, set to "0"
18	IPRED	Pre-distance event occurrence
19	IPOSTD	Post-distance event occurrence
20~	--	Reserved, set to "0"

- **Item = 8: System interrupt events overview**

Bit No.	7	6	5	4	3	2	1	0
Factor	--	IHOV	IMOV	IFCF1	IFCF0	ILCF1	ILCF0	IEMG
Bit No.	**15**	**14**	**13**	**12**	**11**	**10**	**9**	**8**
Factor	--	--	--	--	--	--	--	--
Bit No.	**23**	**22**	**21**	**20**	**19**	**18**	**17**	**16**
Factor	--	--	--	--	--	--	--	--
Bit No.	**31**	**30**	**29**	**28**	**27**	**26**	**25**	**24**
Factor	--	--	--	--	--	--	--	--

- **System interrupt events description**

bit.	Symbol	Interrupt event description
0	IEMG	Emergency stop signal (EMG) signal occurrence
1	ILCF0	Linear comparator 0 comparing end
2	ILCF1	Linear comparator 1 comparing end
3	IFCF0	FIFO comparator 0 comparing end
4	IFCF1	FIFO comparator 1 comparing end
5	IMOV	Motion control loop overload
6	IHOV	System job loop overload
7	--	Reserved, set to "0"

- **Item = 9: Digital input rising edge interrupt**

Bit No.	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Factor	IDIR7	IDIR6	IDIR5	IDIR4	IDIR3	IDIR2	IDIR1	IDIR0
Bit No.	**15**	**14**	**13**	**12**	**11**	**10**	**9**	**8**
Factor	IDIR15 (TTL7)	IDIR14 (TTL6)	IDIR13 (TTL5)	IDIR12 (TTL4)	IDIR11 (TTL3)	IDIR10 (TTL2)	IDIR9 (TTL1)	IDIR8 (TTL0)
Bit No.	**23**	**22**	**21**	**20**	**19**	**18**	**17**	**16**
Factor	IDIR23 (TTL15)	IDIR22 (TTL14)	IDIR21 (TTL13)	IDIR20 (TTL12)	IDIR19 (TTL11)	IDIR18 (TTL10)	IDIR17 (TTL9)	IDIR16 (TTL8)
Bit No.	**31**	**30**	**29**	**28**	**27**	**26**	**25**	**24**
Factor	--	--	--	--	--	--	--	--

- **Item = 10: Digital input falling edge interrupt:**

Bit No.	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Factor	IDIF7	IDIF6	IDIF5	IDIF4	IDIF3	IDIF2	IDIF1	IDIF0
Bit No.	**15**	**14**	**13**	**12**	**11**	**10**	**9**	**8**
Factor	IDIF15 (TTL7)	IDIF14 (TTL6)	IDIF13 (TTL5)	IDIF12 (TTL4)	IDIF11 (TTL3)	IDIF10 (TTL2)	IDIF9 (TTL1)	IDIF8 (TTL0)
Bit No.	**23**	**22**	**21**	**20**	**19**	**18**	**17**	**16**
Factor	IDIF23 (TTL15)	IDIF22 (TTL14)	IDIF21 (TTL13)	IDIF20 (TTL12)	IDIF19 (TTL11)	IDIF18 (TTL10)	IDIF17 (TTL9)	IDIF16 (TTL8)
Bit No.	**31**	**30**	**29**	**28**	**27**	**26**	**25**	**24**
Factor	--	--	--	--	--	--	--	--

CAUTION

Digital input signal (DI) status changes are detected by controller in every motion cycle. Interrupt can be generated only when the period of external input signal change cycle is greater than that of motion cycle.

You may use interrupt function in Windows environment as described below:

1. Set up interrupt events
2. Enable main interrupt switch
3. Waiting for interrupt trigger
4. Reset interrupt to non-signaled state
5. Close interrupt event and main interrupt switch

See table below for relevant APS APIs:

I32 APS_int_enable (I32 Board_ID, I32 Enable);

I32 APS_set_int_factor (I32 Board_ID, I32 Item_No, I32 Factor_No, Enable);

I32 APS_get_int_factor (I32 Board_ID, I32 Item_No, I32 Factor_No, *Enable);

HANDLE APS_int_no_to_handle (I32 Int_No);

I32 APS_wait_single_int (I32 Int_No, I32 Time_Out);

I32 APS_wait_multiple_int (I32 Int_Count, I32 *Int_No_Array, I32 Wait_All, I32 Time_Out);

I32 APS_reset_int (I32 Int_No);

I32 APS_set_int (I32 Int_No);

Detailed operation methods are described below:

1. Set up interrupt events:

Use ***APS_set_int_factor( )*** to set up interrupt event for waiting. The function returns interrupt event number if setup is successful. You shall store event number in a parameter to be used by later Wait functions.

The ***APS_set_int_factor( )*** function can be used to close opened interrupt event as required by application.

2. Enable main interrupt switch:

Interrupt signal of hardware device can be received only when the main interrupt switch of controller is opened. Open with ***APS_int_enable( )***.

3. Waiting for interrupt trigger

Use ***APS_wait_single_int( )*** to wait for single interrupt event, or ***APS_wait_multiple_int( )*** to wait for multiple interrupt events concurrently.

The program enters sleep mode after entering this function. That is, the program (or thread) consumes no CPU resources until there is interrupt event or timeout ccurred. You may use the returned value from the "Wait" function to ensure the occurrence of event in waiting and execute followed application steps.

4. Reset interrupt to non-signaled state

When there is event triggered and the program left the "Wait" function, the interrupt event is set in signaled state. To wait for the same event's occrurrence again, please reset the interrupt status to non-signaled state manually. Call the "Wait" function before reset will cause the Wait function to return directly. Function for reset: ***APS_reset_int( )***

5. Close interrupt event and main interrupt switch

Finally, use ***APS_set_int_factor( )*** function to close individual interrupt event, use ***APS_int_enable( )*** function to close main interrupt switch to release all interrupt relevant resources.

In addition, you may use Event handle of win32 by using APS_int_no_to_handle() after step 1 to convert Event number into format of win32 Event handle.

Important Safety Instructions

For user safety, please read and follow all **instructions**, **WARNINGS**, **CAUTIONS**, and **NOTES** marked in this manual and on the associated equipment before handling/operating the equipment.

- Read these safety instructions carefully.
- Keep this user's manual for future reference.
- Read the specifications section of this manual for detailed information on the operating environment of this equipment.
- When installing/mounting or uninstalling/removing equipment:
  - Turn off power and unplug any power cords/cables.
- To avoid electrical shock and/or damage to equipment:
  - Keep equipment away from water or liquid sources;
  - Keep equipment away from high heat or high humidity;
  - Keep equipment properly ventilated (do not block or cover ventilation openings);
  - Make sure to use recommended voltage and power source settings;
  - Always install and operate equipment near an easily accessible electrical socket-outlet;
  - Secure the power cord (do not place any object on/over the power cord);
  - Only install/attach and operate equipment on stable surfaces and/or recommended mountings; and,
  - If the equipment will not be used for long periods of time, turn off and unplug the equipment from its power source.

- ▶ Never attempt to fix the equipment. Equipment should only be serviced by qualified personnel.

A Lithium-type battery may be provided for uninterrupted, backup or emergency power.

WARNING

Risk of explosion if battery is replaced with one of an incorrect type. Dispose of used batteries appropriately. Please check local regulations for disposal of batteries.

- ▶ Equipment must be serviced by authorized technicians when:
  - ▷ The power cord or plug is damaged;
  - ▷ Liquid has penetrated the equipment;
  - ▷ It has been exposed to high humidity/moisture;
  - ▷ It is not functioning or does not function according to the user's manual;
  - ▷ It has been dropped and/or damaged; and/or,
  - ▷ It has an obvious sign of breakage.

Getting Service

Contact us should you require any service or assistance.

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