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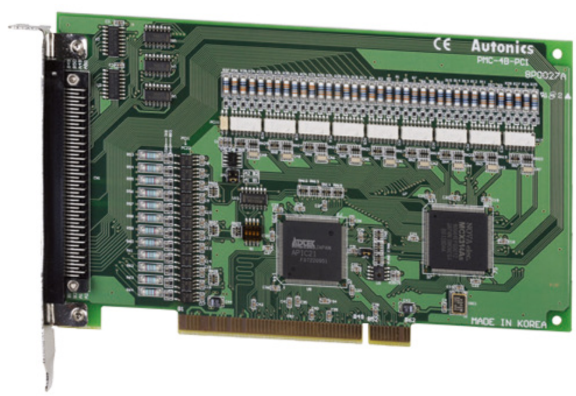
Motion Controller

PMC-4B-PCI

USER MANUAL



PMC-4B-PCI

Thank you very much for selecting Autonics products.

For your safety, please read the following before using.

Preface

Thank you for purchasing Autonics product.

Please familiarize yourself with the information contained in the **Safety Precautions** section before using this product.

This user manual contains information about the product and its proper use, and should be kept in a place where it will be easy to access.

User Manual Guide

Please familiarize yourself with the information in this manual before using the product.

- This manual provides detailed information on the product's features. It does not offer any guarantee concerning matters beyond the scope of this manual.
- This manual may not be edited or reproduced in either part or whole without permission.
- A user manual is not provided as part of the product package. Visit our web site (www.autonics.com) to download a copy.
- The manual's content may vary depending on changes to the product's software and other unforeseen developments within Autonics, and is subject to change without prior notice. Upgrade notice is provided through out homepage.
- We contrived to describe this manual more easily and correctly. However, if there are any corrections or questions, Please notify us these on our homepage.

User Manual Symbols

Symbol	Description
Note	Supplementary information for a particular feature.
Warning	Failure to follow instructions can result in serious injury or death.
Caution	Failure to follow instructions can lead to a minor injury or product damage.
Ex.	An example of the concerned feature's use.
※1	Annotation mark.

Safety Precautions

- Following these safety precautions will ensure the safe and proper use of the product and help prevent accidents and minimize hazards.
- Safety precautions are categorized as Warnings and Cautions, as defined below:

⚠ Warning	Warning	Failure to follow these instructions may result in serious injury or death.

⚠ Caution	Caution	Failure to follow these instructions may result in personal injury or product damage.

⚠ Warning

- Fail-safe device must be installed when using the unit with machinery that may cause serious injury or substantial economic loss. (e.g. nuclear power control, medical equipment, ships, vehicles, railways, aircraft, combustion apparatus, safety equipment, crime/disaster prevention devices, etc.)
  Failure to follow this instruction may result in personal injury, fire, or economic loss.
- Use this unit in the rated environment. Avoid using this unit where flammable or explosive gas or, high temperature and humidity, or vibration exists. It may cause fire, deterioration, malfunction, or damage to the product.
  Failure to follow this instruction may result in personal injury, fire, or economic loss.
- Do not disassemble or modify this unit.
  Failure to follow this instruction may result in personal injury, fire, or economic loss.
- Do not cut off the power during operating.
  Failure to follow this instruction may result in personal injury, economic loss or malfunction.
- Emergency stop should be available during operating.
  Failure to follow this instruction may result in product damage or personal injury.
- Do not remove connector and jumper pin during operating.
  Failure to follow this instruction may result in personal injury, economic loss or malfunction.
- Regard this product as industrial waste when discarding it.

⚠ Caution

- Do not connection, inspect or repair this unit when it is power on.
  Failure to follow this instruction may result in electric shock or malfunction.
- Do not repair this unit. Please contact us if it is required.
  Failure to follow this instruction may result in electric shock or fire.
- Please observe the rated specification.
  Failure to follow this instruction may result in shortening the life cycle of the unit, or fire.
- In cleaning the unit, do not use water or organic solvent. And use dry cloth.
  Failure to follow this instruction may result in electric shock, fire, or product damage.
- Do not inflow dust or wire dregs into the unit.
  Failure to follow this instruction may result in electric shock, fire, or product damage.

(1) Cautions during use

- Caution for before starting motion controller
  ① Before starting motion controller, set the position coordinate and several parameters for the using environment properly.
  ② When using jog or continuous mode, set the proper start speed to increase system speed continuously.
- Caution for ID Select S/W input
  ① When using several this units in one PC, set the switch differently by each other board.
  ② It is available to use up to 16 boards at same time.
- Installation environment
  ① Indoor.
  ② Pollution degree II
  ③ Altitude max. 2000m
  ④ Installation category II

(2) Product storage

Caution

After using this product and for storage, remove the I/O cable from the PC and pack this unit with wrapping paper for preventing stactic electiricity. Keep this unit within the rated temperature and humidity.

(3) Installation to the PC

Insert the Edge connector of the circuit to the PCI bus connector of the PC. Tighten the mounting part with screws.
Before installing this unit, turn off the PC power.

Warning

- You must mount this unit on the PCI bus connector.
  Failure to follow this instruction may result in product damage, fire, electric shock, or personal injury.

Caution

- Power input must be installed the insulated trans.
  Failure to follow this instruction may result in fire, electric shock, or personal injury.

(4) Connect of I/O signal

When connecting external power or I/O singal, do not reverse the polarity or supply over the rated voltage/current. Or it may cause damage to the circuit element or reliablity degradation of the operation. Check the wire and connect it correctly.

Warning

- When connecting this unit, refer to the connection diagram.
  Failure to follow this instruction may result in fire, electric shock, or product damage.
- Install the safety prevention device to the external of controller to safe the whole system even though external power error, or controller malfunction.
  Failure to follow this instruction may result in fire, electric shock, or product damage.
- Install the limit switch.
  Failure to follow this instruction may result in fire, electric shock, or product damage.

- Install the emergency stop switch.
  Failure to follow this instruction may result in personal injury, or economic loss.

Caution

- Turn OFF the power during installing or wiring.
  Failure to follow this instruction may result in electric shock, or product damage.
- Be sure not to short the each other cable during installing and wiring.
  Failure to follow this instruction may result in electric shock, or product damage.
- Do not wire to the unused terminal and be sure that not to short with the other terminals.
  Failure to follow this instruction may result in electric shock, or product damage.

(5) Description of special terms

- active (Active)
  The signal function is valid state.
- drive (Drive)
  For driver start device of servo motor or stepping motor in pulse input, the operation to output pulse to rotate motor
- Fixed pulse drive
  The drive outputs pulses with the fixed amount.
- Continuous pulse drive
  The drive outputs drive pulses until STOP signal is active.
- CW
  Clockwise
- CCW
  Counter clockwise
- Interpolation node
  Each interpolation drive which consists of consecutive interpolation.
- Jerk speed
  Increase/Decrease rate of acceleration and deceleration speed in a given time.
- 2's complement
  Expression of negative value of the binary number.

Ex.

16bit length data is described that -1 is FFFFh and -2 is FFFEh, and -3 is FFFDh, ….

And -32768 is 8000h.

(6) Descriptions of special signs

- n○○○○
  It describes the signal name of the each X, Y, Z, U axis as n○○○○.
  In this case, "n" means X, Y, Z or U.
- ↑
  Rising edge when the signal is changed from low level to high level.
- ↓
  Falling edge when the signal is changed from high level to low level.

- nPP, nPM
  nPP means nP+P, nP+N, and nPM means nP-P, nP-N.
- nECA, nECB, nECZ
  EC means encoders and A, B, C means output phases.
  In register description, nIN2 means nECZ.

(7) Product items

This motion controller, PMC-4B-PCI, consists of following items.

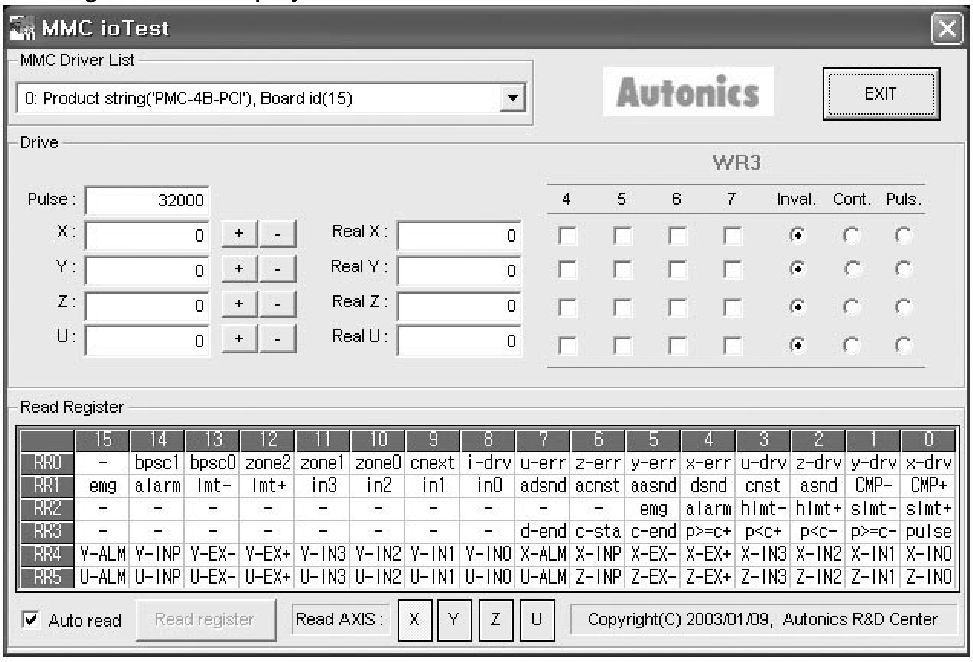
- PMC-4B-PCI Board
- I/O cable
- User CD
- User manual

(8) Software from homepage

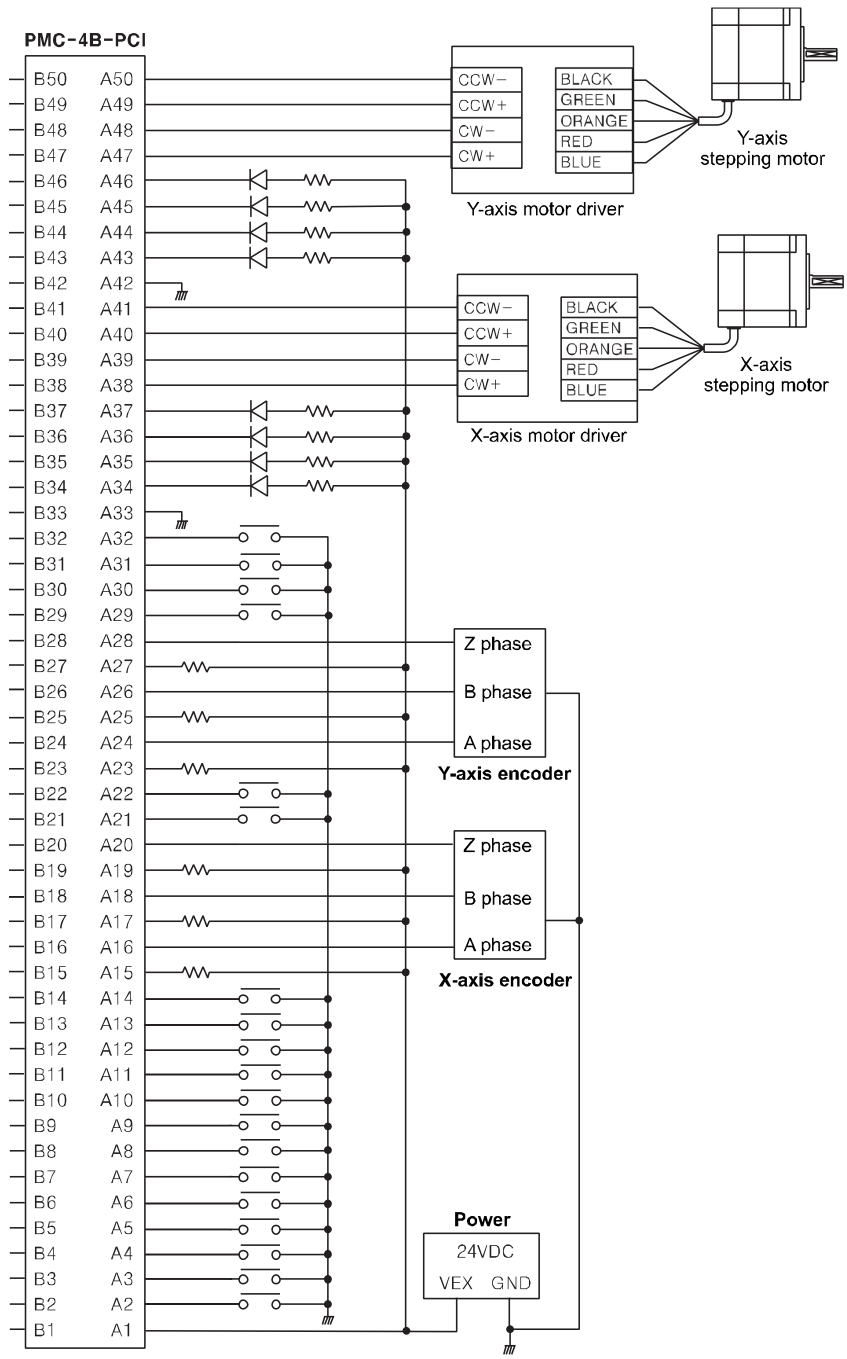
- Window driver (Supports Windows7 32bit, 64bit)
- Labview library and detail information
- C-langauge library and examples (supplies the library manual)

(9) I/O test

This is the test program for input/output of PMC-4B-PCI board. Visit our website (www.autonics.com) to download this program source (C-langauge library and examples). Mount the card in the PC, install win-drive, execute 'ioTest.exe' in 'ioTest' folder, and the following screen is displayed.



Each character represents I/O and status register.
Connect drive pulse and other I/O and supply the signal, and you can check the I/O status by the changed signal character from capital to small or vice versa.
Consist the circuit as the following and you can check the I/O signal and output pulse.



- The resistances connected on the no.15, 17, 19, 23, 25, 27 are 1/2W 220Ω resistance and the others are 1/2W 3.3kΩ resistance.
- Diode specification for general output pin should be over 50V/0.1A.
- Use the open collector type Encoder.
- This circuit describes 50pins of A axis of 100pins connector. Please connect the other 50 pins of B axis as same. However, no.2 terminal of B axis is not used.
- For connection, refer to ‘4 Connections’.

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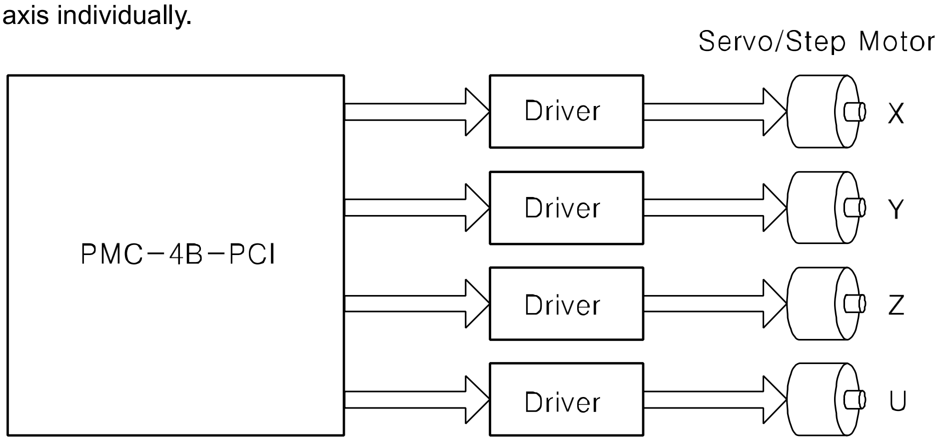
1 Introduction

PMC-4B-PCI is one board available to positioning control of servo motor, step motor by 4-axis's pulse input, interpolation drive, or speed control. This is the circuit board corresponding PC/AT compatible PCI bus. This has the following features.

(1) Individual 4-axis drive

It can control 4-axis individually. Each axis function is same.
Constant speed drive, linear accel/decel drive, S curve drive, etc are available to control 4-axis individually.

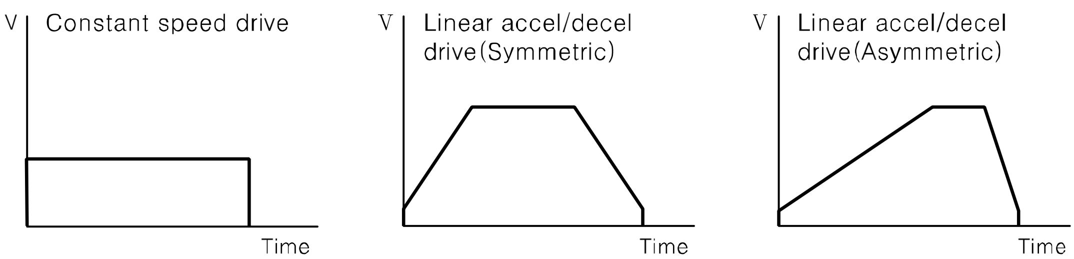


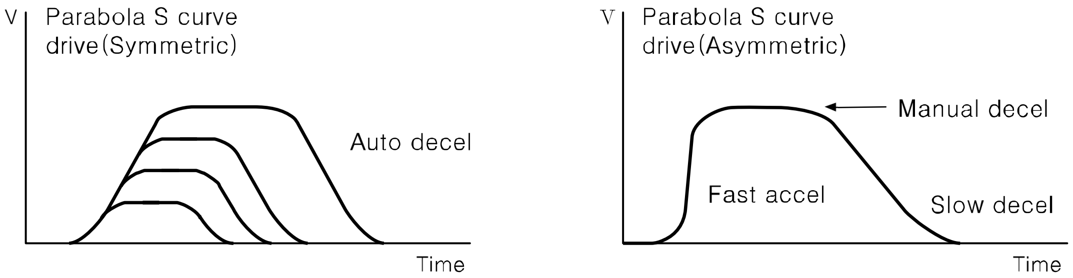
(2) Speed control

Drive speed is from 1pps to max. 4Mpps and constant speed drive, linear accel/decel, S curve drive are available. Speed accuracy of output drive pulse is below $\pm 0.1\%$ of the set value. (CLK=16MHz standard) It is available to change drive speed during drive.

(3) Accel/Decel drive

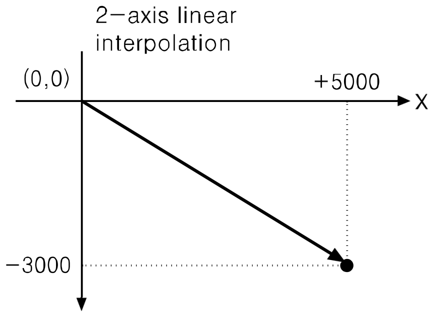
Accel/Decel drive of each axis executes constant speed drive, linear accel/decel drive (symmetric/asymmetric), S curve drive (symmetric/asymmetric). In linear accel/decel fixed pulse drive, symmetric linear accel/decel fixed pulse drive, asymmetric linear accel/decel fixed pulse drive are both available auto deceleration.
S curve is accel/decel with the first linear and speed curve appears as the second parabola accel/decel. In case of S curve fixed pulse drive, only symmetric S is available to auto deceleration. In case of S curve drive, there is triangle form prevention function.

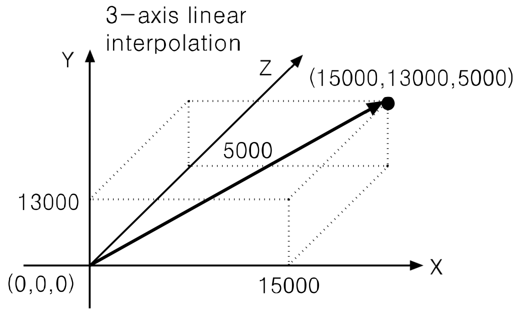




(4) 2-axis/3-axis linearinterpolation

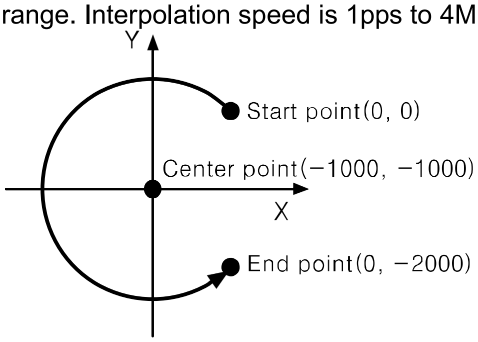
2-axis/3-axis linear interpolation drive is available by selecting the desired 2-axis or 3-axis among 4-axis drivers. The coordinate range of interpolation is -2,147,483,646 to +2,147,483,646 from the current position.
The position error of the designated line is ±0.5 LSB within the whole interpolation range.
Interpolation speed is 1pps to 4Mpps.

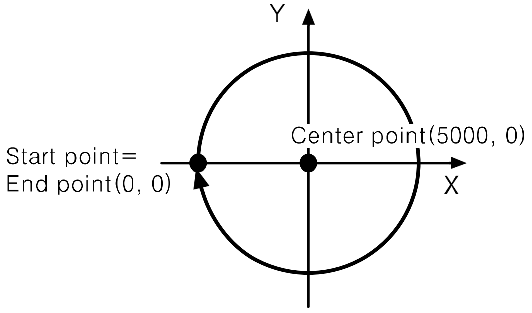




(5) Circular interpolation

Circular interpolation is available by selecting the desired 2-axis among 4-axis drivers.
The coordinate range of interpolation is -2,147,483,646 to +2,147,483,646 from the current position.
The position error of the designated circular curve is ±1 LSB within the whole interpolation range. Interpolation speed is 1pps to 4Mpps.



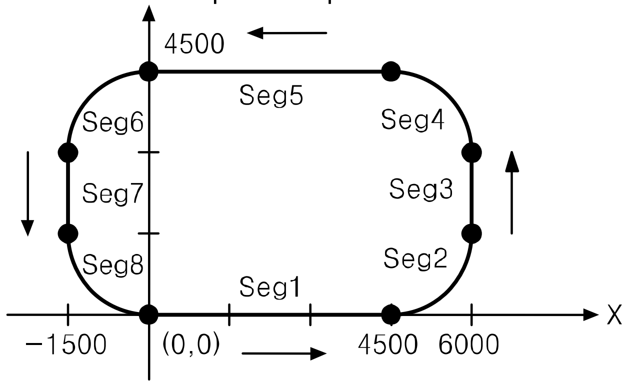


(6) 2-axis/3-axis bit pattern interpolation

This interpolation drive receives Bit patternized interpolation data arithmetic upper CPU by each axis 16bit unit, and outputs the interpolation pulses consecutively with the designated drive speed.
This feature is able to draw the several traces created by upper CPU.

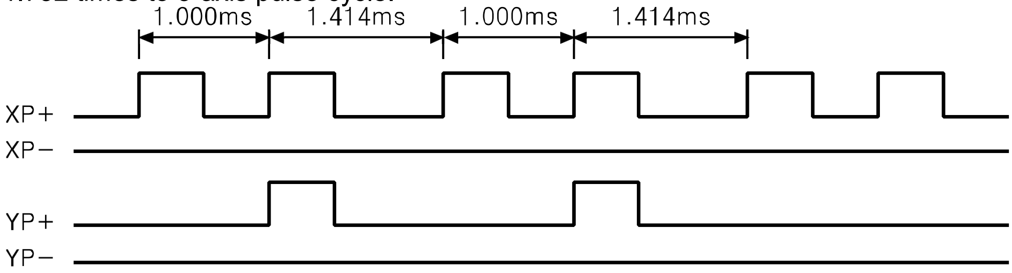
(7) Consecutive interpolation operation

Interpolation drive is able to execute drive continuously without stop at each interpolation instruction such as linear interpolation→circular interpolation→linear interpolation→…
Consecutive interpolation speed is max. 2MHz.



(8) Constant linear velocity control

Constant linear velocity control constants the resultant velocity of interpolation axis. When generating 2-axis drive pulse at the same time, this function multiplies 1.414 times to 2-axis pulse cycle. When generating 3-axis drive pulse at the same time, this function multiplies 1.732 times to 3-axis pulse cycle.



(9) Position management function

All 4-axis have the logic position counter to control drive pulse output in motion control IC and the two actual position counters (32bit) to control pulse from the external encoder.

(10) Compare register and soft limit function

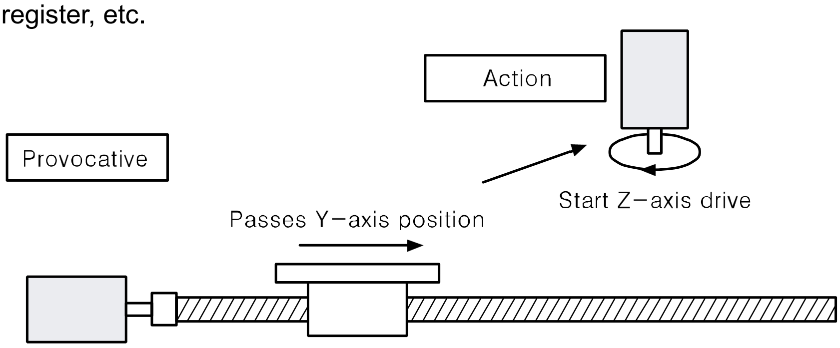
Each axis has two 32bit compare register for comparing between the position of logic position counter and that of actual position counter. It can read size comparison between the compare register and the Logical/Actual position counter during drive in real-time. With the change of size, it can generate interrupt and it can operate two compare registers as soft limit.

(11) Auto home search output

PMC-4B-PCI executes automatically a series of home search output sequence such as high speed near home search → low speed home search → Encoder Z-phase search → Offset movement, etc without special instructions. It reduces CPU load for several phases control.

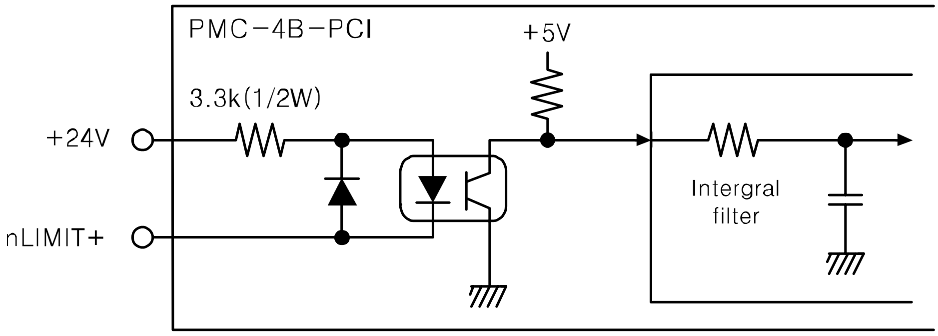
(12) Synchronous operation

Synchronous operation function executes the designated synchronous operation such as start/stop drive when the set operation signal occurs between each axis or between devices besides motion controllers.
Provocative factors for synchronous operation are 10 types; pass the designated position, start/stop drive, rising/falling external input signal, etc. After synchronous operation, there are 14 types operation such as start/stop drive, position counter value saving, drive speed register, etc.



(13) Input signal filter

Each input terminal of input signal has the integral filter. You can set valid/invalid filter function for each input signal and select one filter pass time from 8 types.



(14) External adjustment signal

Each axis executes fixed pulse drive of +/- direction, consecutive pulse drive by external signal.
This function is available as manual pulse output (MANUAL JOG DRIVE) and it reduces upper CPU load.

(15) Several signal for servo motor

It can input servo motor driver output signal such as 2 phase encoder signal, inposition, alarm, etc.

(16) Interrupt occurrence function

Each axis can generate interrupt by several factors such as start constant speed during accel/decel drive, stop constant speed, stop drive, size changing between position counter and compare register, etc. It also can generate interrupt for next data requirement in consecutive interpolation, bit pattern interpolation.

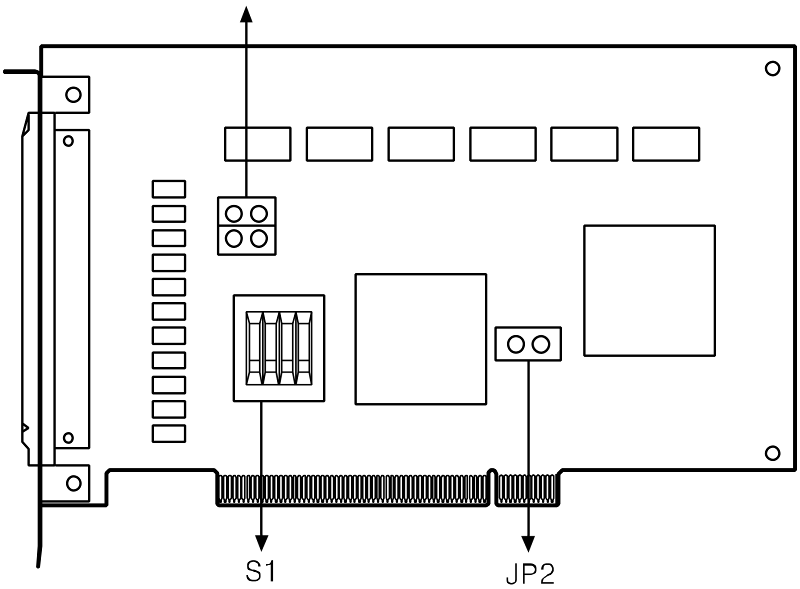
(17) Real-time process monitoring function

It can read current logic position during drive, actual position, drive speed, acceleration, accel/decel status (acceleration, constant speed, deceleration), etc in real-time.

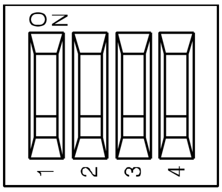
(18) Corresponding 16bit bus

Upper CPU and data bus is available to connect as 16 bit.
The 4-axis(X, Y, Z, U) functions are same exactly and it calculates interpolation at basic pulse start timing of the designated main axis (AX1) during interpolation drive. It is available in consecutive speed drive and accel/decel drive.

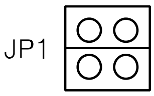
(19) Switch and jumper pin



- Setting and usage of S1 switch
  S1 switch is used for dividing the board ID when using several PMC-4B-PCI boards. There are not any special standard. Set the switch differently than others.
  Total 16 boards are available at once.

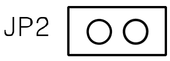


- Setting and usage of JP1 jumper pin
  Select active level of emergency stop (EMG) as high or low.



  For active level setting of emergency stop, refer to '5.9.6 Emergency stop'.

- Setting and usage of JP2 jumper pin



  It is program writing mask for EEPROM. You cannot remove JP2 jumper pin.

(20) I/O specification

I/O connector pin arrangement

Pin No.	Pin name	Pin description	Pin No.	Pin name	Pin description
A1	VEX	12-24 VDC	B1	VEX	12-24 VDC
A2	EMG	Emergency stop(4-axis stop)	B2	-	-
A3	XLMIT+	X-axis + direction limit	B3	ZLMIT+	Z-axis + direction limit
A4	XLMIT-	X-axis – direction limit	B4	ZLMIT-	Z-axis – direction limit
A5	XIN1	X-axis input signal(home signal)	B5	ZIN1	Z-axis input signal(home signal)
A6	XIN0	X-axis input signal(near home signal)	B6	ZIN0	Z-axis input signal(near home signal)
A7	XIN3	X-axis input signal(Encoder Z-phase signal)	B7	ZIN3	Z-axis input signal(Encoder Z-phase signal)
A8	YLMIT+	Y-axis +direction limit	B8	ULMIT+	U-axis +direction limit
A9	YLMIT-	Y-axis –direction limit	B9	ULMIT-	U-axis –direction limit
A10	YIN1	Y-axis input signal(home signal)	B10	UIN1	U-axis input signal(home signal)
A11	YIN0	Y-axis input signal(near home signal)	B11	UIN0	U-axis input signal(near home signal)
A12	YIN3	Y-axis input signal(Encoder Z-phase signal)	B12	UIN3	U-axis input signal(Encoder Z-phase signal)
A13	XINPOS	X-axis inposition input	B13	ZINPOS	Z-axis inposition input
A14	XALRAM	X-axis alarm input	B14	ZALRAM	Z-axis alarm input
A15	XECAP	X-axis Encoder A phase+	B15	ZECAP	Z-axis Encoder A phase+
A16	XECAN	X-axis Encoder A phase-	B16	ZECAN	Z-axis Encoder A phase-
A17	XECBP	X-axis Encoder B phase+	B17	ZECBP	Z-axis Encoder B phase+
A18	XECBN	X-axis Encoder B phase-	B18	ZECBN	Z-axis Encoder B phase-
A19	XECZP	X-axis Encoder Z-phase+	B19	ZECZP	Z-axis Encoder Z-phase+
A20	XECZN	X-axis Encoder Z-phase-	B20	ZECZN	Z-axis Encoder Z-phase-
A21	YINPOS	Y-axis inposition input	B21	UNIPOS	U-axis inposition input
A22	YALARM	Y-axis alarm input	B22	UALARM	U-axis alarm input
A23	YECAP	Y-axis Encoder A phase+	B23	UECAP	U-axis Encoder A phase+
A24	YECAN	Y-axis Encoder A phase-	B24	UECAN	U-axis Encoder A phase-
A25	YECBP	Y-axis Encoder B phase+	B25	UECBP	U-axis Encoder B phase+
A26	YECBN	Y-axis Encoder B phase-	B26	UECBN	U-axis Encoder B phase-
A27	YECZP	Y-axis Encoder Z-phase+	B27	UECZP	U-axis Encoder Z-phase+
A28	YECZN	Y-axis Encoder Z-phase-	B28	UECZN	U-axis Encoder Z-phase-
A29	XEXP+	X-axis manual + drive	B29	ZEXP+	Z-axis manual + drive
A30	XEXP-	X-axis manual – drive	B30	ZEXP-	Z-axis manual – drive
A31	YEXP+	Y-axis manual + drive	B31	UEXP+	U-axis manual + drive
A32	YEXP-	Y-axis manual – drive	B32	UEXP-	U-axis manual – drive
A33	GND	GND	B33	GND	GND
A34	XOUT4/CMPP	X-axis general output	B34	ZOUT4/CMPP	Z-axis general output
A35	XOUT5/CMPM	X-axis general output	B35	ZOUT5/CMPM	Z-axis general output
A36	XOUT6/ASND	X-axis general output	B36	ZOUT6/ASND	Z-axis general output
A37	XOUT7/DSND	X-axis general output	B37	ZOUT7/SND	Z-axis general output
A38	XP+P	X-axis +direction +drive signal output	B38	ZP+P	Z-axis +direction +drive signal output
A39	XP+N	X-axis +direction –drive signal output	B39	ZP+N	Z-axis +direction –drive signal output
A40	XP-P	X-axis -direction +drive signal output	B40	ZP-P	Z-axis -direction +drive signal output
A41	XP-N	X-axis -direction –drive signal output	B41	ZP-N	Z-axis -direction –drive signal output
A42	GND	GND	B42	GND	GND
A43	YOUT4/CMPP	Y-axis general output	B43	UOUT4/CMPP	U-axis general output
A44	YOUT5/CMPM	Y-axis general output	B44	UOUT5/CMPM	U-axis general output
A45	YOUT6/ASND	Y-axis general output	B45	UOUT6/ASND	U-axis general output
A46	YOUT7/DSND	Y-axis general output	B46	UOUT7/DSND	U-axis general output

Pin No.	Pin name	Pin description	Pin No.	Pin name	Pin description
A47	YP+P	Y-axis +direction +drive signal output	B47	UP+P	U-axis +direction +drive signal output
A48	YP+N	Y-axis +direction –drive signal output	B48	UP+N	U-axis +direction –drive signal output
A49	YP-P	Y-axis -direction +drive signal output	B49	UP-P	U-axis -direction +drive signal output
A50	YP-N	Y-axis -direction –drive signal output	B50	UP-N	U-axis -direction –drive signal output

2 Specifications

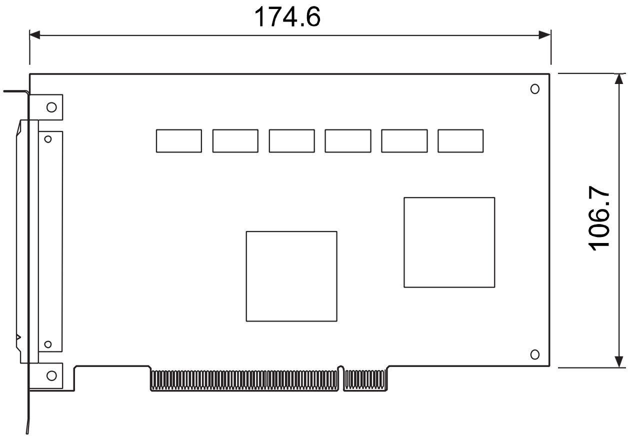
Model		PMC-4B-PCI
Control axis		4-axis
Power supply		5VDC(uses PC inner power)
External power supply		12-24VDC
Allowable voltage range		90 to 110% of rated voltage
CPU data bus length		Selectable 8/16 bit
2/3-axis linear interpolation	Interpolation range	-2,147,483,648 to 2,147,483,647 for each axis
	Interpolation speed	1pps to 4Mpps
	Position accuracy	Max. ±0.5 LBS(within all interpolation range)
Circular interpolation	Interpolation range	Uses PC inner power(5VDC±10%)
	Interpolation speed	1pps to 4Mpps
	Position accuracy	Max.±1 LBS (within all interpolation range)
2/3-axis bit pattern interpolation speed		1pps to 4Mpps(Depends on CPU data setup time)
Other interpolations		Selectable the axis, constant linear velocity, consecutive interpolation, interpolation step transmission (COMMAND, external signal)
Drive pulse output		Output circuit range: 1pps to 4Mpps
(X, Y-axis common specifications)		Output speed accuracy: Max.±0.1%(for SV)
		Speed magnification: 1 to 500
		S jerk speed: 954 to 62.5×106pps/sec(Mag.=1) (Accel/Decel increase rate) 477×103 to 31.25X109pps/sec(Mag.=500)
		Accel/Decel: 125 to 1×106 pps/sec(Mag.=1) 62.5×103 to500×106pps/sec(Mag.=500)
		Initial velocity: 1 to 8,000pps(Mag.=1)/500 to 4×106pps(Mag.=500)
		Drive speed: 1 to 8,000pps(Mag.=1)/500 to 4×106pps(Mag.=500)
		Number of output pulses: 0 to 4,294,967,295(Fixed pulse drive)
		Speed curve: Constant speed/Symmetric, Asymmetric linear accel/decel/Parabola S curve drive
		Fixed pulse drive deceleration mode auto deceleration (asymmetric linear accel/decel function)/Manual deceleration
		Changeable output pulse for driving, drive speed
		Selectable individual 2-pulse/1-pulse direction method
		Selectable drive pulse logic level, changeable output terminal
Encoder input pulse		Inputable 2-phase pulse/Up-Down pulse, Selectable 2-phase pulse 1, 2, 4 multiply
Position counter		Logical position counter (for output pulse) count range: -2,147,483,648 to 2-2,147,483,647

		Actual position counter (for input pulse) count range: -2,147,483,648 to 2-2,147,483,647
Compare register		Comp. +register position comparison range: -2,147,483,648 to 2-2,147,483,647
		Comp. -register position comparison range: -2,147,483,648 to 2-2,147,483,647
		Status output for position counter size, signal output
		Enable to operate as software limit
Auto home search		Step1(High speed near home search) → Step2(Low speed near home search)
Interrupt function (except interpolation)		1 drive pulse output When changes position counter ≥Comp.-, When changes position counter ≤Comp.+ When changes position counter ＜Comp.-, When changes position counter ＞Comp.+, When starting constant speed in accel/decel drive, when ending constant speed in accel/decel drive When ending drive, when ending auto home search, Synchronous operation
Drive adjustment by external signal		Enable to fixed/continuous pulse drive of +/- direction by EXP+/EXP- signal
		Enable to drive 2-phase encoder signal mode (Encoder input)
External deceleration stop/immediate stop signal		IN 0 to 3 each axis 4-point
		Selectable signal valid/invalid and logical level, usable as general input
Input signal for servo motor		Selectable alarm, INPOS(inposition) signal valid/invalid and logic level
General output signal		OUT 4 to 7 each axis 4-point (Uses same terminal with drive status output signal)
Drive status signal output		ASND (Accelerating), DSND (Decelerating)
Overrun limit signal input		Selectable + direction, - direction each 1-point and logic level
		At active, selectable immediate stop/decelerate stop
Emergency stop signal input		EMG 1-point, stops drive pulse of all axes by low level
Integral filter		Built-in integral filter at each input signal input terminal, selectable pass time (8 types)
Others		Selectable the axis, constant linear velocity, consecutive interpolation, interpolation step transmission (COMMAND, external signal)
Environment	Ambient temperature	0 to 45℃, Storage temperature: -10 to 55℃
	Ambient humidity	35 to 85%RH, Storage humidity: 35 to 85%RH
Approval		CE
Unit weight		Approx. 98g

※The temperature or humidity mentioned in Environment indicates a non freezing or condensation environment.

3 Diementions

(Unit: mm)

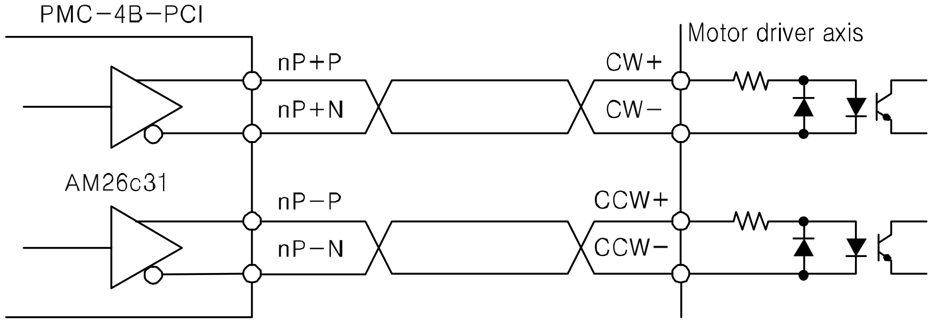


4 Connections

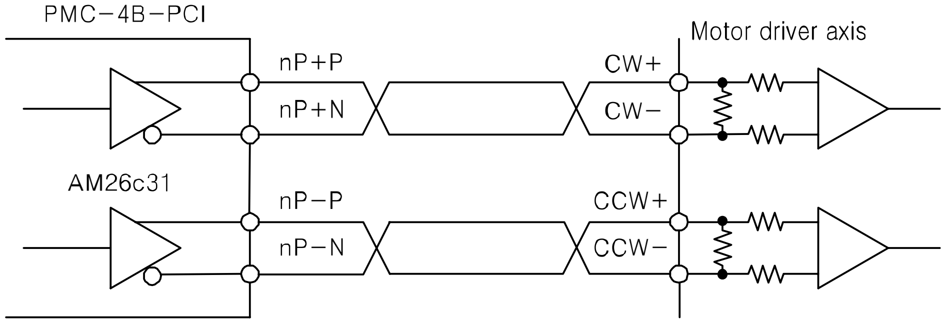
4.1 Drive pulse signal output connection (nP+P/N, nP-P/N)

Driver pulse outputs drive pulse signal of +direction/-direction by line driver(AM26c31) of differential motion output. This is the connection example of motion driver which has photo coupler and line driver input.

(1) Example of motor driver for photocoupler input connection

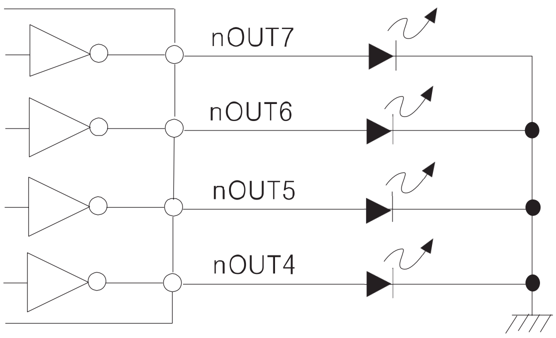


(2) Example of motor driver for line driver connection

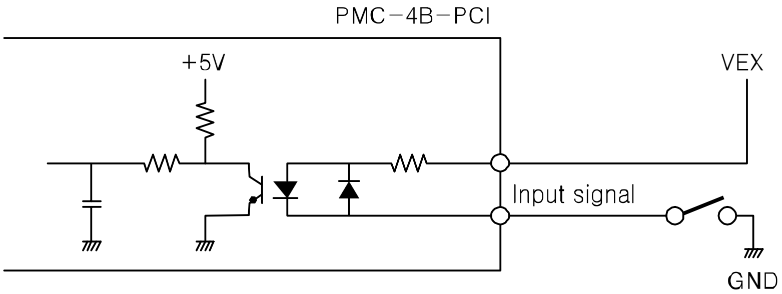


4.2 General output signal connection (nOUT4 to 7)

Output signal outputs as buffer(74LS06). After reset, all outputs are OFF.

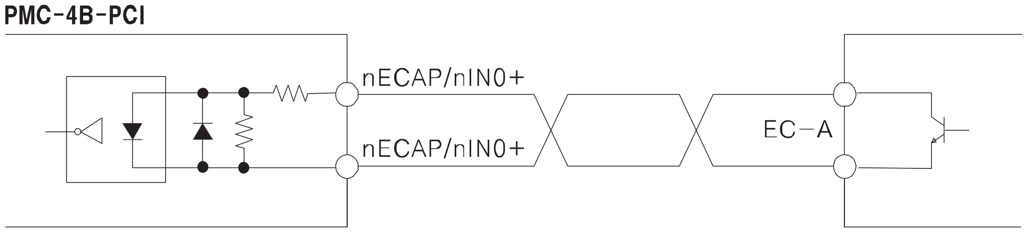


4.3 Input signal connection (nIN1 to 3, nINPOS, nALARM, nEXP+/-, EMG)

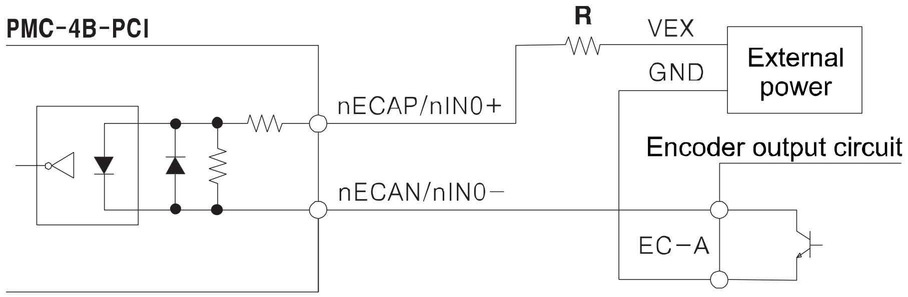


4.4 Encoder input signal (nECAP/N, nECBP/N) and nIN0+/- signal connection

(1) Example of encoder differential motion output line driver connection



(2) Example of encoder NPN open collector output connection

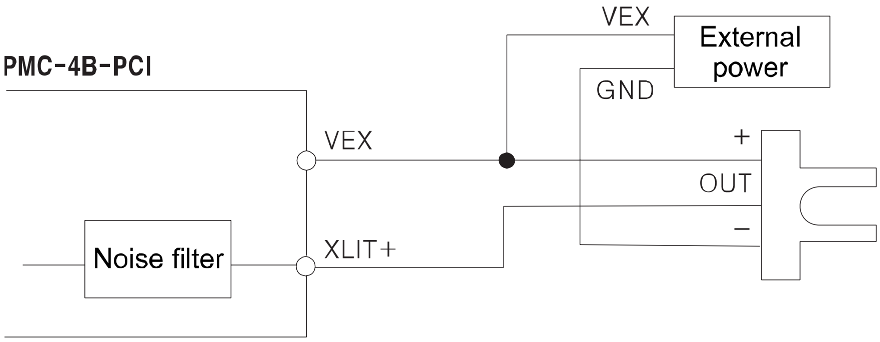


External voltage	Resistance (R)
5V	0
12V	820Ω 1/4W
24V	2kΩ 1W

※ Encoder A, B, Z-phase are same connection.

4.5 Limit input signal connection (nLMIT+/-)

Limit signal is generally unable to exposure wiring externally and it is weak for noise. It is impossible to remove noise only by photo coupler. Use filter function of PMC-4B-PCI as valid and set the proper pass time (FL=2, 3).



5 Features

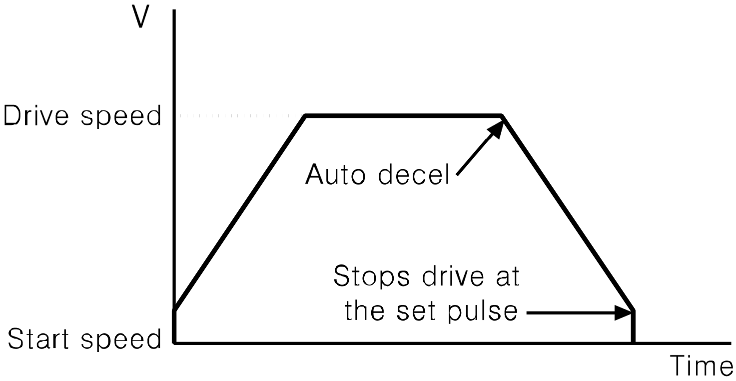
5.1 Fixed pulse drive and Consecutive pulse drive

Drive pulse output of each axis is basically fixed pulse or consecutive pulse drive instructions of + direction/- direction.

5.1.1 Fixed pulse drive

Fixed pulse drive operates constant speed drive or accel/decel drive with the fixed number of output pulses. This is for moving the object to the fixed position and for operating with the number of fixed pulses (the fixed movement distance).

Fixed pulse drive operation when acceleration and deceleration is same accel/decel, auto deceleration starts when the rest of output pulse is smaller than the number of acceleration pulses as <Figure 2.1>. It outputs the designated output pulses and stops drive.



<Figure 2.1 Fixed pulse drive>

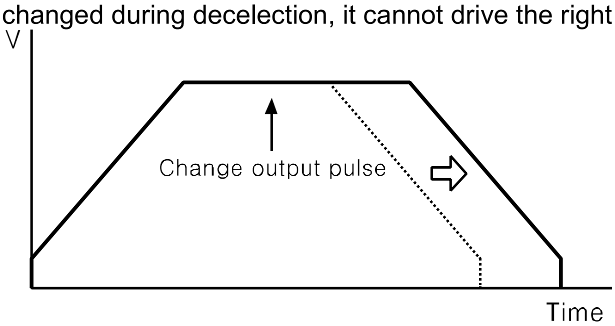
To operate fixed pulse drive as accel/decel drive, you should set the parameters as follow.

Parameter	SV
Range	R
Accel/Decel	A/D
Start speed	SV
Drive speed	V
Number of output pulses	P

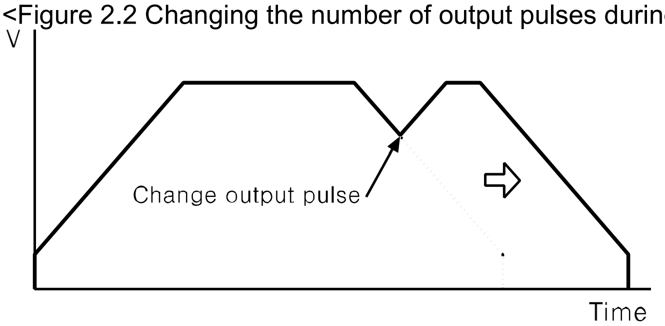
(1) Changing the number of output pulses during driving

You can change the number of output pulses during fixed pulse driving.
During accel/decel driving, the remains of output pulses are smaller than the number of pulses for acceleration. When starting deceleration, if the number of output pulses is changed, it starts acceleration again. <Figure 2.2>

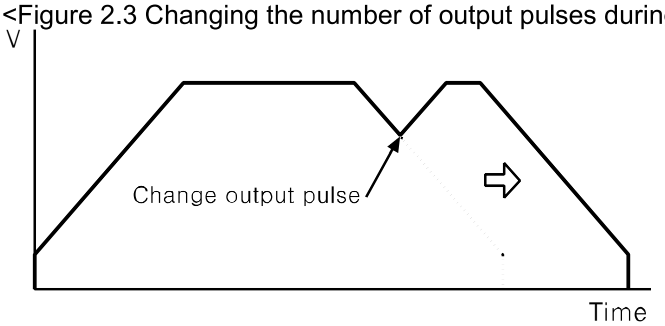
If the changed number of ouput pulses is smaller than the finished number of pulses, it stops instantly. <Figure 2.4> In case of S curve, be sure that if the number of pulses is changed during decelection, it cannot drive the right S curve as following <Figure 2.3>.



<Figure 2.2 Changing the number of output pulses during driving >



<Figure 2.3 Changing the number of output pulses during deceleration >



<Figure 2.4 Changing the number of pulses during driving>

(2) Manual deceleration of accel/decel fixed pulse drive

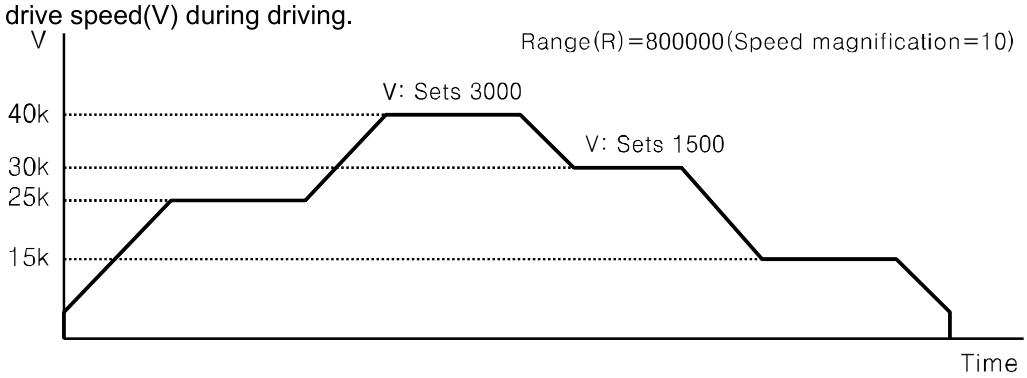
During accel/decel fixed pulse driving, generally it automatically decelerates at the calculated deceleration point as <Figure 2.1>. You can also designate the deceleration point manually. As the following cases, it cannot designate the deceleration point automatically or calculate the right deceleration point. You should set the deceleration point manually.

- Changing speed during driving of linear accel/decel fixed drive
- Setting acceleration, deceleration and increased acceleration rate, increased deceleration rate individually during S curve fixed driving
- Executing accel/decel for circular interpolation, bit pattern interpolation, consecutive interpolation

To set manual deceleration mode, set D0 bit of WR3 register as 1 and the deceleration point is designated by manual deceleration point setting command(07h). The other adjustments are same as general fixed drive’s.

(3) Changing drive speed during driving

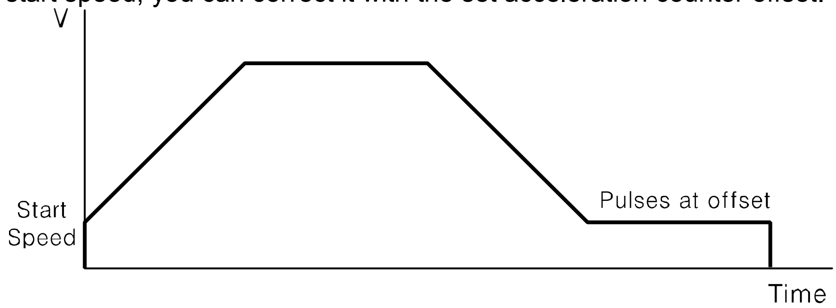
You can change drive speed(V) during driving of linear accel/decel and constant speed fixed drive.
However, in case of linear accel/decel fixed pulse drive, if start speed is low and you change the drive speed, it may cause drive stop. In case of S curve fixed drive, you cannot change drive speed(V) during driving.



<Figure 2.5 Example of changing drive speed during driving >

(4) Acceleration counter offset of accel/decel fixed pulse drive

In case of accel/decel fixed drive, it counts the acceleration pulses by acceleration counter during acceleration. If the remain of set output pulses are smaller than the number of acceleration counter value, it starts deceleration. It ouputs the same number of pulses as the acceleration's during deceleration. Acceleration counter offset adds the designated offset value by acceleration counter as <Figure 2.6>.
After resetting, acceleration counter offset is set as 8. When executing linear accel/decel drive in general, you do not need to reset this parameter. When finishing driving with asymmetric trapezoid accel/decel or S curve fixed drive and the speed is not lower than start speed, you can correct it with the set acceleration counter offset.



<Figure 2.6 Acceleration counter offset>

5.1.2 Consecutive pulse drive

Consecutive drive outputs drive pulses consecutively until stop command or external stop signal is active.

It is for rotating motor by Home search, scanning jog transfer or speed control.

You can change drive speed during consecutive pulse driving.

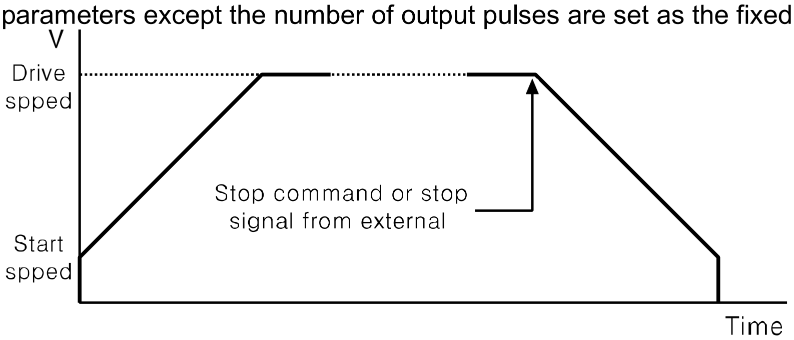
Stop command

There are two stop command; deceleration stop and immediate stop.

External deceleration/immediate stop signal has 4-point of each axis IN3 to IN0 (+/-) and each signal is available to set enable/disable, active level.

(1) Home search operation by consecutive pulse drive

Set Encoder Z-phase signal, home signal, near home signal to nECZ, nIN1, nIN0. Set WR1 register of each axis for each signal's enable/disable, logical level. In case of high speed search, it dirves as accel/decel and executes consecutive pulse drive.
In this case the set signal is active level, it operates deceleration stop.
In case of low speed search, it operates consecutive pulse drive with constant speed. In this case the set signal is active level, it operates immediate stop. When using auto home search function, Z-phase signal is set to nECZP/N, and home signal is set to nIN1, and near home signal is set to nIN0. When executing consecutive drive as accel/decel, the other parameters except the number of output pulses are set as the fixed drive's parameters.



<Figure 2.7 Consecutive pulse drive>

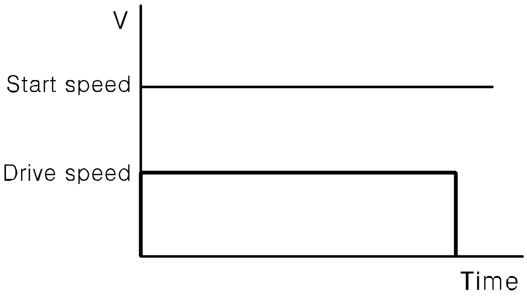
5.2 Speed curve

Drive pulse output of each axis is executed generally by fixed drive command of +direction/-direction or consecutive drive command. You can set this drive as constant speed, linear accel/decel, asymmetriclinear accel/decel, S curve, speed curve of asymmetric S curve by operation parameter values.

5.2.1 Constant speed drive

Constant speed drive outputs drive pulses with constant speed. This product does not execute accel/decel drive when drive speed is lower than start speed and from the start, it drives with constant speed.

When detecting the signal of Home search or Encoder Z-phase search. To stop it immediately, it does not accel/decel drive and from the start it executes constant speed drive with low speed. To execute constant speed drive, you should set the following parameters.



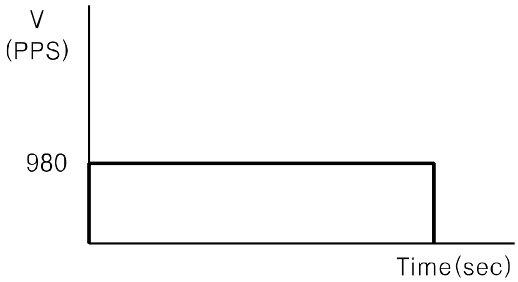
<Figure 2.8 Constant speed drive>

Parameter	Mark	Description
Range	R	
Start speed	SV	Set the higher value than drive speed(V).
Drive speed	V	
Number of output pulses	P	Unnecessory for consecutive pulse drive

(1) Example of parameter setting

It executes constant speed drive with 980pps.

Parameter	Mark	SV	Note
Range	R	8,000,000	Magnification=1
Start speed	SV	980	Set the value as Start speed ≥ Drive speed
Drive speed	V	980	
Number of output pulses	P	2,450	



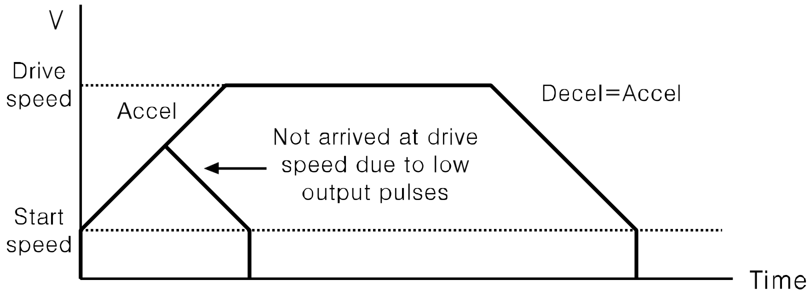
For each parameter information, refer to 9 Data write command.

5.2.2 Linear accel/decel drive

Linear accel/decel drive is the first linear which has the set acceleration gradient at start speed of drive start. It accelerates until drive speed. If acceleration and deceleration of fixed drive are same (symmetric trapezoid) and the pulse for acceleration is smaller than the remains of output pulses, it starts deceleration and decelerates to the first linear same as the gradient of acceleration until start speed. When it outputs all output pulses, it stops. (Auto deceleration)

When executing deceleration stop during acceleration, or in the fixed drive, when the number of output pulses does not meet the required pulses for acceleration to drive speed, it decelerates during acceleration as following <Figure 2.9>. In case of triangle form prevention Mode, even though the number of output pulses are small, it can occur triangle form as trapezoid form. Generally acceleration and deceleration use same value of acceleration, but it is possible to set deceleration value individually.

If setting deceleration individually, auto deceleration of fixed drive is impossible. It should decelerate manually.



<Figure 2.9 Linear accel/decel drive (symmetric trapezoid)>

To set deceleration individually, D2 to D0 bit of WR3 register should be set as following.

Mode set bit	Mark	SV
WR3/D0	MANLD	0
WR3/D1	DSNDE	0
WR3/D2	SACC	0

For WR3 register information, refer to ‘7.6 WR3 mode register 3’.

You should set the following parameters.

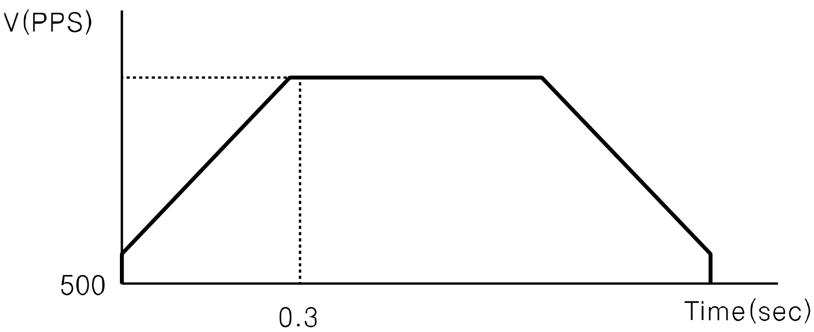
Parameter	Mark	Description
Range	R	
Acceleration	A	It decelerates with this value.
Start speed	SV	
Drive speed	V	
Number of output pulses	P	Unnecessary for consecutive pulse drive

(1) Example of parameter setting

It executes linear accel/decel with Start speed: 500 pps, drive speed: 15,000 pps for 0.3 sec. as following figure.

Parameter	Mark	SV	Note
Range	R	4,000,000	Magnification = 2
Acceleration	A	193	(15,000-500)/0.3 = 488,333 pps/sec, (48333/125)/2 = 193
Start speed	SV	250	500/2 = 250
Drive speed	V	7500	15000/2=7500

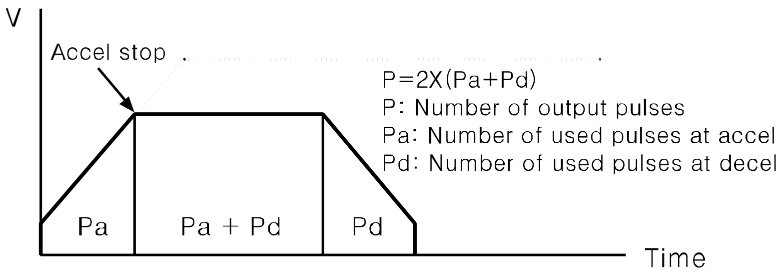
For each parameter information, refer to '9 Data write command'.



(2) Triangle form prevention of fixed pulse drive

Triangle form prevention function prevents triangle form which ocurs in linear accel/decel fixed pulse drive when the number of output pulses is small. If the pulses for acceleration is 1/2 bigger than the number of output pulses for acceleration/deceleration, it stops acceleration and be with constant speed. Even though the number of output pulses are small, 1/2 of the number of output pulses are fixed drive. Triangle form prevention function is not applied after Reset. Set WR6/D3 (AVTRI) bit of extension mode setting command(60h) as 1 and it is valid.

For extension mode setting command information, refer to '9.16 Extension mode setting'.

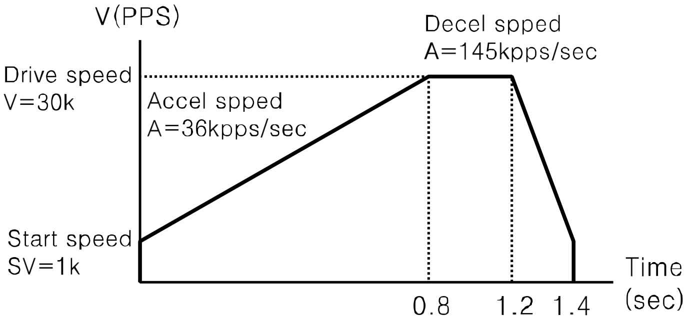


<Figure 2.10 triangle form prevention of linear accel/decel drive >

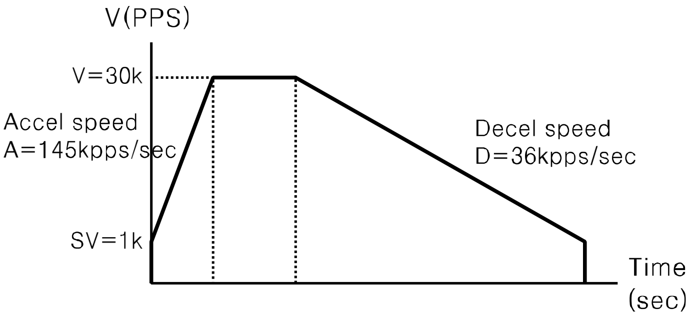
5.2.3 Asymmetric linear accel/decel drive

To transfer the object with vertical direction among the devices executing several operation, acceleration and deceleration for up/down movement should be changed from the gravity accelration. In case of fixed drive of asymmetric linear accel/decel which acceleration and deceleration are not same, auto deceleration is available.
Set the calculated manual deceleration point. <Figure 2.11> is that deceleration is bigger than acceleration. <Figure 2.12> is that acceleration is bigger than deceleration.

Set the number of output pulses(P) and deceleration start point for each speed parameter about this linear accel/decel of asymmetric.



<Figure 2.11 asymmetric linear accel/decel drive (Acceleration<Deceleration)>



<Figure 2.12 asymmetric linear accel/decel drive (Acceleration>Deceleration)>

To auto decelerate fixed pulse drive of asymmetric linear accel/decel, set D2 to D0 bit of WR3 register as following.

Mode set bit	Mark	SV	Description
WR3/D0	MANLD	0	Auto deceleration
WR3/D1	DSNDE	0	It uses deceleration set value when deceleration.
WR3/D2	SACC	0	Linear accel/decel

You should set the following parameters.

Parameter	Mark	Description
Range	R	
Acceleration	A	
Deceleration	D	
Start speed	SV	
Drive speed	V	
Number of output pulses	P	Unnecessary for consecutive pulse drive

Note

- Acceleration>Deceleration
  In case of <Figure 2.12>, there are the following conditions for the rate of acceleration and deceleration.

$$D > A \times \frac{V}{4 \times 10^6}$$

D: Deceleration (pps/sec.)

A: Acceleration (pps/sec.)

V: Drive speed (pps)

CLK=16MHz

Ex.

When drive speed (V)=100 kpps, deceleration (D) shoule be bigger than 1/40 of acceleration (A).

- Acceleration>Deceleration
  In case of <Figure 2.12>, when the ratio of acceleration (A) and deceleration (D) is bigger, pulses are bigger and deceleration pulses occur before drive speed during deceleration.

  In this case, ①set high start speed or ②set minus value for acceleration counter offset.

(1) Example of parameter setting

The parameter settings for asymmetric linear accel/decel (Acceleration<Deceleration) fixed pulse drive as <Figure 2.11> is as following.

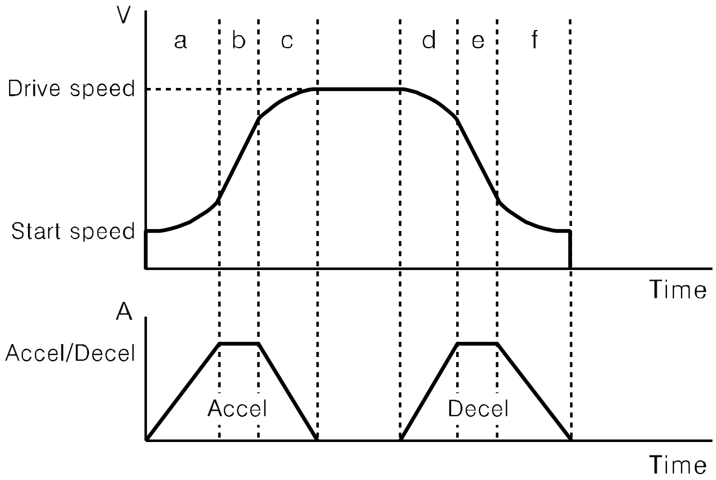
Parameter	Mark	SV	Note
WR3 ← 0002h			WR3 register mode setting
Range	R	800,000	Magnification=10
Acceleration	A	29	(30,000-1,000)/0.8=36,250 pps/sec, (36250/125)/10=29
Deceleration	D	116	(30,000-1,000)/0.2=145,000pps/sec (145,000/125)/10=116
Start speed	SV	100	1,000/10=100
Drive speed	V	3,000	30,000/10=3,000
Number of output pulses	P	275,000	

5.2.4 S curve drive

S curve of speed is available to increase/decrease acceleration/deceleration as the first linear when accel/decel of drive speed.

Symmetric S curve drive for accel/decel is as same operation of <Figure 2.13>.
During acceleration, acceleration increases linearly from 0 to the designated jerk speed(K). Therefore, this speed curve is parabola curve of the second. ('a' section) When Acceleration turns to (A), acceleration maintains as same. This speed curve acclerates linearly. ('b' section)

When the remainder between drive speed(V) and current speed is lower than the number of pulses for increasing acceleration, accleration decrease as 0.
The rate of deecrease is same as increase's. At the designated jerk speed (K), it decreases linearly. This speed curve is parabola of the second. ('c' section) If there are parts that acceleration is constant for acceleration, it is part S curve. Meanwhile, when the remainder between drive speed(V) and current speed increases acceleration before accleration arrives the set value(D) in 'a' section, if it is smaller than the number of used pulses, 'b' section disappeared and 'a' section connects to 'c' section. This is full S curve which does not have 'b' section for constanting acceleration in acceleration.



<Figure 2.13 S curve speed drive>

To execute S curve drive, set D2, D1, D0 bit of nWR3 register as following tables.

Mode set bit	Mark	SV	Description
WR3/D0	MANLD	0	Auto deceleration
WR3/D1	DSNDE	0	Uses acceleration, set value of acceleration increase rate during deceleration.
WR3/D2	SACC	1	S curve

You should set the following parameters.

Parameter	Mark	Description
Range	R	
Acceleration increase rate	K	
Acceleration	A	Must set max. 8,000.※1
Start speed	SV	
Drive speed	V	
Number of output pulses	P	Unnecessary for consecutive pulse drive

※1. If setting low acceleration, accel/decel cannot increase to the set value(A) for acceleration increasement/deceleration increasement of S curve.

(1) Triangle form prevention of fixed pulse drive

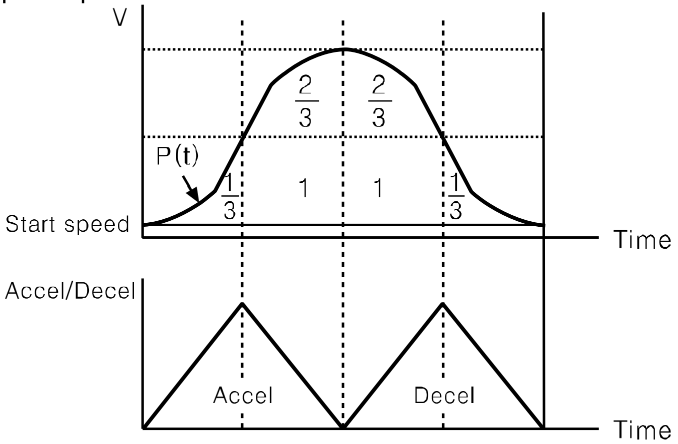
When accleration and deceleration are symmetric S curve in fixed drive, if the number of output pulses for acceleration to drive speed and the number of output pulses for deceleration from drive speed are same, this speed curve is triangle form.
When the start speed is 0, it increases acceleration to time(t) with jerk speed.
In this case, speed is $\mathbf{V(t)=at^2}$ by time(t). The number of pulses from 0 to time(t) is the integral value of speed v(t) from 0 to time(T) and it is $\mathbf{P(t)=1/3 \times at^2}$.
This value is 1/3 of $at^2 \times t$ regardless of the jerk speed value.
In fixed drive, from 0 to time(t) it increases acceleration to the jerk speed and decelerates with the jerk speed same as at time(t)'s.
When acceleration is 0, it decelerates with same jerk speed in deceleration and total number of used pulses is as 1/3 + 2/3 + 1 + 2/3 + 1+ 1/3 = 4.

Note

When setting low acceleration, accel/decel cannot increase over than the set value about S curve acceleration increasement and deceleration increasement in acceleration and speed curve appears as linear part. This value is 1/3 of at2×t (the number of pulses from 1 in the figure) regardless of the value of aceleration increase rate.
In fixed pulse drive, it increases the acceleration increase rate of acceleration from 0 to time(t) and decreases acceleration with the same acceleration increase rate same as time(t)'s.

When acceleration is 0, it decelerates with the same acceleration increase rate and total number of used pulses is the same number of pulses as <Figure 2.14>.
Therefore, the number of pulses from start time 0 to time(t) (1/3) is over than 1/12 of total number of pulses. If S curve fixed pulse drive is over 1/12 of total output pulse when increasing acceleration, it decreases acceleration and the speed curve drives [1/12 rule] as <Figure 2.14>.

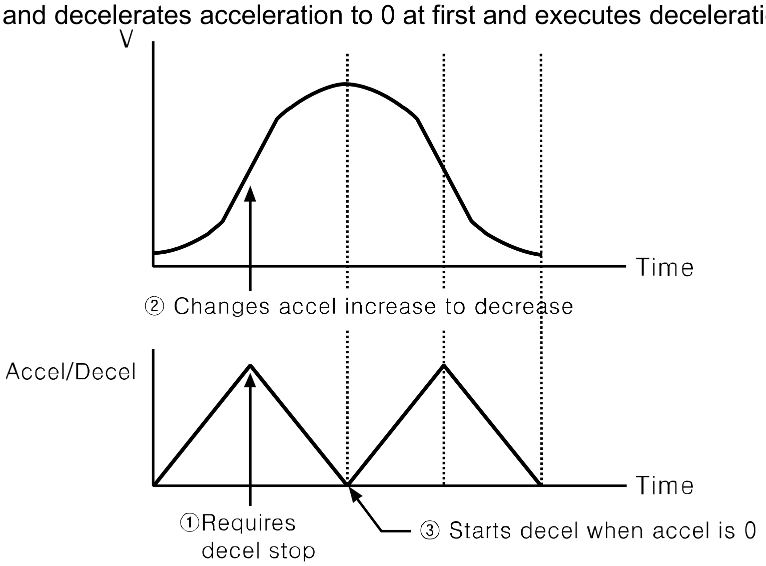
However, this rule should be start speed=0 for the ideal curve. And start speed cannot start as 0 actually.
The pulses from speed 0 to start speed remain as the figure and this part is output during peak speed.



<Figure 2.14 1/12 rule of parabola accel/decel speed >

(2) Triangle form prevention function of deceleration stop

In linear accel/decel drive, when executing deceleration stop, speed curve is triangle form during acceleration. In S curve drive, soft of speed curve is important. If executing deceleration stop during acceleration as <Figure 2.15>, it does not decelerate immediately and decelerates acceleration to 0 at first and executes deceleration.



<Figure 2.15 1/12 rule of parabola accel/decel speed >

(3) Caution for S curve drive

- In the fixed drive for S curve, drive speed cannot change during driving.
- In the fixed drive for S curve, the right S curve cannot drive when changing the number of output pulses during deceleration.
- Circularinterpolation, Bit pattern interpolation, and consecutive interpolation cannot drive in S curve.
- In the fixed drive for S curve, if start speed is too low, it may stops drive pulses before decreasing to start speed during deceleration or it may outputs the remained drive pulses with start speed even though it arrives to start speed.

(4) Example of parameter settings (symmetric S curve)

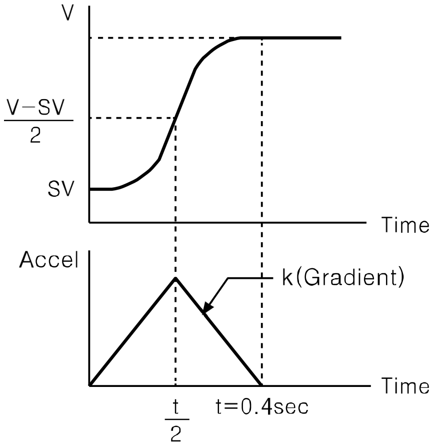
This example is S curve during 0.4 sec. with start speed 100pps to drive speed 40kpps as the following figure.
When increasing acceleration linearly with constant jerk speed (k) during acceleration, this speed type is the increasing integral value (area of oblique line).
As a half of acceleration time (t=0.4 sec), the formula for jerk speed(k) half of drive speed(V) <(V-SV)/2> from start speed(SV) is to same between the left side using k of ablique line and the right side.
The formula for K is as following.

$$\frac{k}{2}\left(\frac{t}{2}\right)^2 = \frac{V-SV}{2}$$

$$k = \frac{4(V-SV)}{t^2}$$

$$k = \frac{4(40{,}000-100)}{0.4^2} = 997{,}500\ \mathrm{pps/sec^2}$$

Acceleration increase rate (k): pps/sec^2
Drive speed (V): pps
Start speed (SV): pps
Acceleration time t: sec

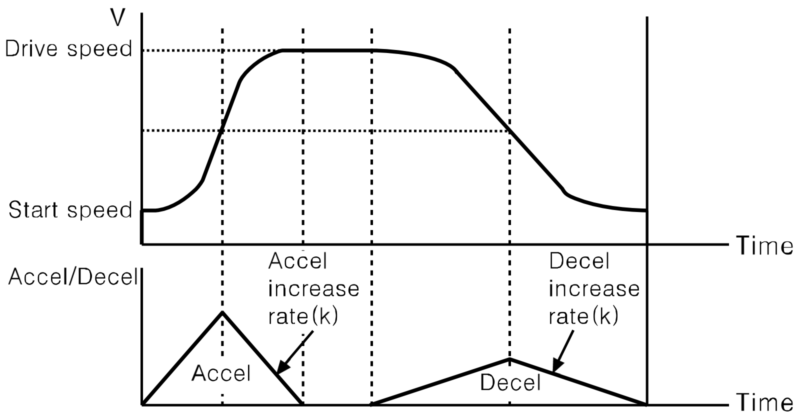


Parameter setting is as followings.

Parameter	Mark	SV	Note
WR3 ← 0004h			Mode setting for WR3 register
Range	R	800,000	Magnification=10
Jerk speed	K	627	(62.5×106/k) ×Magnification=(62.5×10 6/997,500) ×10
Acceleration	A	8,000	Fixed at maximum value.
Start speed	SV	10	100/10=10
Drive speed	V	4,000	40,000/10=4,000
Number of output pulses	P	25,000	Sets in fixed pulse drive
Acceleration counter offset	A0	0	

5.2.5 Asymmetric S curve drive

As <Figure2.16>, there can be asymmetric S curve by setting differently the jerk speed for acceleration and the jerk speed for deceleration in S curve drive. In fixed drive, symmetric S curve cannot decelerate drive automatically. Therefore, you should set deceleration poin manually and drive speed for the number of output pulses for jerk speed in accel/decel.



<Figure 2.16 asymmetric S curve drive>

To drive asymmetric S curve drive, set D2, 1, 0 bit of nWR3 register as following.

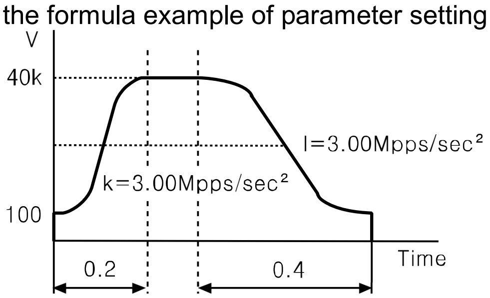
Mode set bit	Mark	SV	Description
WR3/D0	MANLD	1	Manual deceleration
WR3/D1	DSNDE	1	Uses acceleration, the set value of acceleration increase rate during deceleration.
WR3/D2	SACC	1	S curve

Parameter setting is following.

Parameter	Mark	Description
Range	R	
Acceleration increase rate	K	
Deceleration increase rate	L	
Acceleration	A	Must set as maximum value 8,000.
Deceleration	D	Must set as maximum value 8,000.
Start speed	SV	
Drive speed	V	
Number of output pulses	P	Unnecessary for consecutive pulse drive
Manual deceleration point	DP	Sets the calculated number of used pulses during deceleratin in output pulses (P). Unnecessary during consecutive pulse drive

(1) Example of parameter setting (asymmetric S curve)

This example is for asymmetric S curve which accelerates drive speed (V) to 40kpps to 0.2 sec. from start speed (SV) 100pps in acceleration and decelerates start speed (SV) to 100pps to 0.4sec. from drive speed(V) 40kpps.
The followings are the jerk speed for acceleration and the jerk speed for deceleration with the formula example of parameter setting for symmetric S curve. (Magnification: 10)



Increase rate (k) in acceleration $=\frac{4(40{,}000-100)}{0.2^2}$

$=3.99\text{Mpps/sec}^2$

Increase rate (l) in deceleration $=\frac{4(40{,}000-100)}{0.4^2}$

$=0.9975\text{Mpps/sec}^2$

Parameter settings are followings.

Increase rate (k) in acceleration $=\frac{62.5\times10^6}{0.2^2}\times \text{Magnification} = \frac{62.5\times10^6}{3.99\times10^6}\times 10 = 157$

Increase rate (l) in deceleration $=\frac{62.5\times10^6}{I}\times \text{Magnification} = \frac{62.5\times10^6}{0.9975\times10^6}\times 10 = 627$

In asymmetric S curve, auto deceleration is not available. You should set the manual deceleration point (DP).
Manual deceleration point should set the used pulse(Pd) in deceleration from the number of output pulses(P), it calculates used pulse (Pd) in deceleration.

Used pulse (Pd) in deceleration$= (V + SV)\sqrt{\frac{V-SV}{I}} = (40000 + 100)\sqrt{\frac{40000-100}{0.9975\times10^6}} = 8020$

When setting the number of output pulses as 20,000, manual deceleration point (DP) is as following.

Manual deceleration point (DP)=P-Pd=20000-8020=11980

Therefore, parameter settings are as followings.

Parameter	Mark	SV	Note
WR3 ← 0007h			Mode setting for WR3 register
Range	R	800,000	Magnification=10
Jerk speed for acceleration	K	157	(62.5×106/k) ×Magnification =(62.5×106/3.99×106) ×10
Jerk speed for deceleration	L	627	(62.5×106/k) ×Magnification =(62.5×106/0.9975×106) ×10
Acceleration	A	8,000	Fixed at maximum value.
Deceleration	D	8,000	Fixed at maximum value.
Start speed	SV	10	100/10=10
Drive speed	V	4,000	40,000/10=4,000
Number of output pulses	P	20,000	Sets in fixed pulse drive
Manual deceleration point	DP	11,980	
Acceleration counter offset	A0	0	

5.2.6 Drive pulse width and speed precision

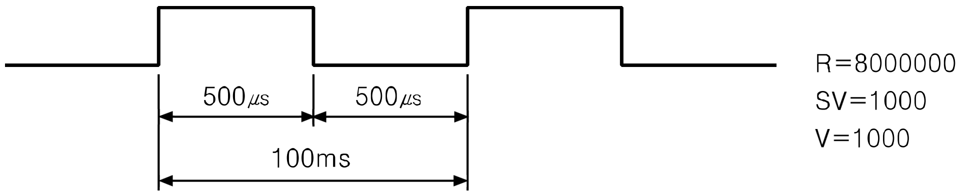
(1) Pulse ratio of drive pulse

The pulse cycle time by drive speed is calculated error ±1SCLK(when CLK=16MHz, ±125 nsec) for drive pulse of each axis +direction/-direction. It is generally divided by 50% for high level and low level.

Ex.

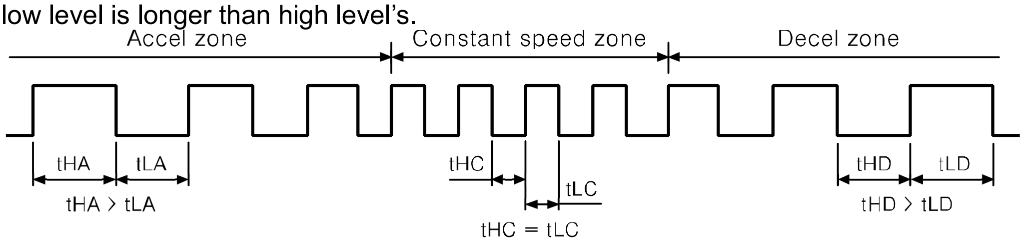
When the settings R=8,000,000, V=1,000 (Magnification=1, Drive speed=1,000pps) as following figure, drive pulse outputs the pulses which high level width=500 ㎲, cycle=1.00ms.

R=8000000
SV=1000
V=1000



<Figure 2.17 High/Low level width of drive pulse output (V=1000pps)>

Pulse width of low level is shorter than that of high level because drive speed increases while one drive pulse outputs in accel/decel drive acceleration. As a reverse, pulse width of low level is longer than high level's.



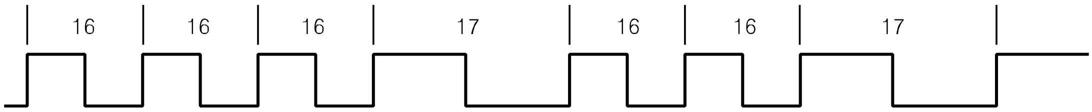
<Figure 2.18 Comparison of drive pulse width in accel/decel drive >

(2) Accuracy of drive speed

The circuit which generates drive pulse operates input clock signal (CLK) as inner 2-divided SCLK. When CLK input is 16MHz standard, SCLK is 8MHz.
To generate the drive pulse of constant frequency without jitter, only the frequency which is the whole number multiple of the SCLK cycle is available.

Ex.

It outputs only the frequency of twice: 4.000MHz, 3 times: 2.667MHz, 4times: 2.000MHz, 5 times: 1.600MHz, 6 times: 1.333MHz, 7 times: 1.143MHz, 8 times: 1.000MHz, 9 times: 889KHz, 10 times: 800KHz, …. and it cannot set the desired drive speed.
Therefore, it outputs the desired drive speed with following method.
When Set Range Set value(R)=80,000 (Magnification=100), Drive speed set value(V)=4,900, and drive pulse outputs 4900×100=490kpps. But this cycle is not the whole number multiple of SCLK and it cannot outputs 490kpps as constant frequency.
It mixes the frequency of 500kpps from 16 times SCLK and the frequency of 471 kpps from 17 times and outputs them as <Figure 2.19>.
The cycle of 490kpps is 16.326 times of SCLK(8MHz) cycle. It output as 674:326 as 16 times cycle pulse of SCLK and 17 times cycle pulse of SCLK. It makes that average cycle by unit time is 16.326.

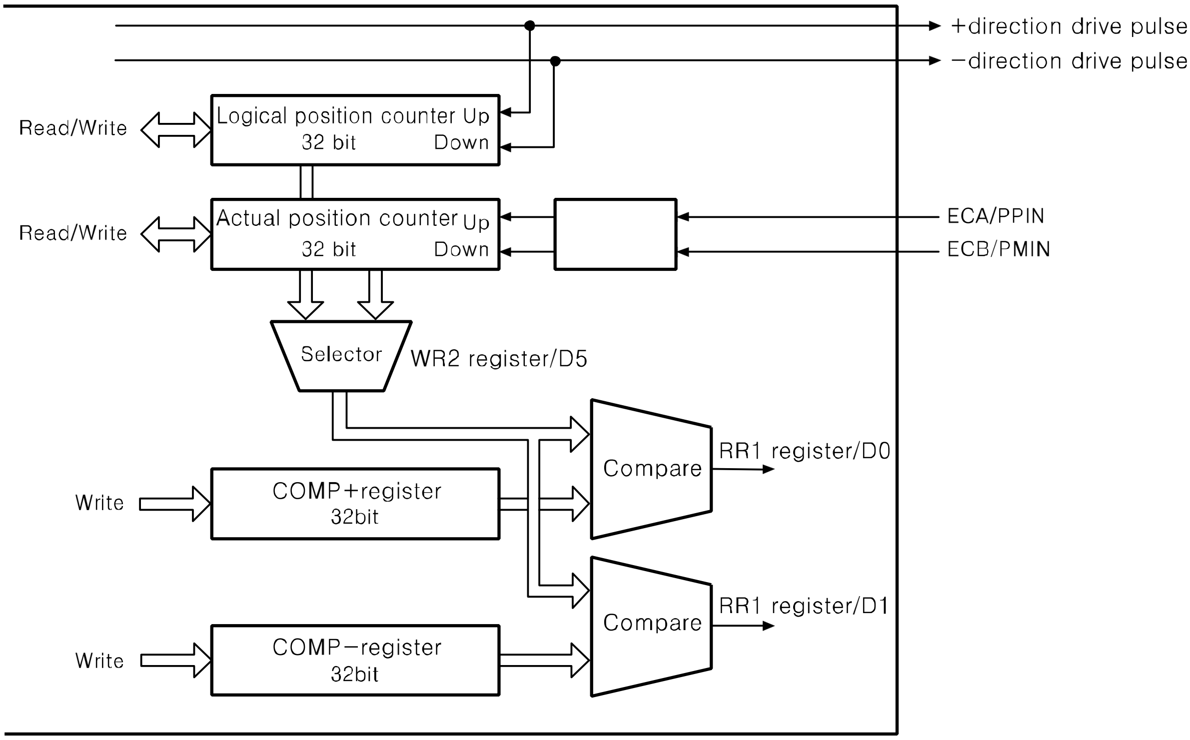


<Figure 2.19 490kpps drive pulse cycle for SCLK cycle>

With this method, it outputs better drive pulse accuracy of the designated speed.
When increasing speed magnification, speed accuracy of actual output drive pulse for the designated speed is constant below ±0.1%.
When measuring drive pulse with oscilloscope, if drive pulse cycle is not the whole number multiple of SCLK cycle, there are time error of 1SCLK (125nsec) for pulse cycle as <Figure 2.19> and it looks like jitter but 1SCLK time error is not big problem with absorbing load inertia when rotating a motor.

5.3 Position management

<Figure 2.20> is position block diagram for 1-axis. Each axis has two 32bit Up/Down counter for current position management and two registers for coparing the size of current position.



<Figure 2.20 Position management block diagram >

5.3.1 Logical position counter and Actual position counter

Logical position counter counts drive output pulses of +direction/-direction as <Figure 2.20>. It counts up by one as +direction 1 pulse and counts down by one as -direction 1 pulse.

Actual position counter counts external input pulse from Encoder, etc. You can select the command whether input pulse is 2-phase pulse input signal or individual 2-pulse(Up/Down) input signal. Refer to the ‘5.9.3 Selection of pulse input method’.

Counter is available to read/write data and count range is -2,147,483,648 to +2,147,483,649.

5.3.2 Comparison register and software limit

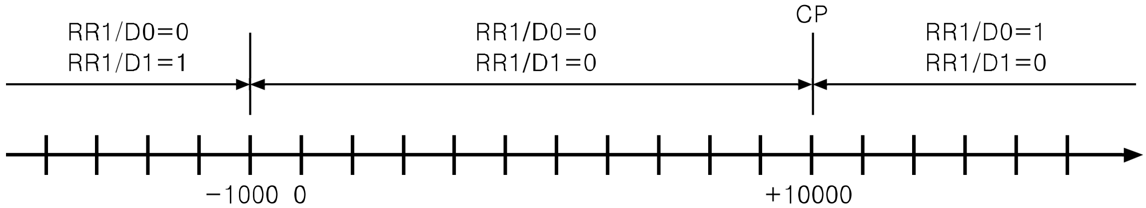
Each axis has logical count or actual position counter and two 32 bit registers (COMP+, COMP-) for comparing size. You can set the comparing subject whether logical position counter or actual position counter of two comparision registers as D5(CMPSL) of WR2 register.

COMP+ register is to detecting the high limit of some range for logical/actual position counter. If the value of logical/actual position counter is bigger than the COMP+ register value, D0 (CMP+) bit of RR1 register becomes 1.

COMP- register is to detecting the low limit of some range for logical/actual position counter. If the value of logical/actual position counter is smaller than the COMP- register value, D1(CMP-) bit of RR1 register becomes 1.

Ex.

COMP + register=10,000, COMP- register= -1,000.



<Figure 2.21 Example setting of COMP+/- register >

Each COMP+ register and COMP- register is usable as software limit of each +direction/-direction. When activating software limit by setting D0, D1 (SLMT+, SLMT-) bit of WR2 register as 1, if logical/actual position counter is bigger than COMP+ register during driving, it executes deceleration stop and D0 (SLMT+) bit of RR2 register becomes 1.

This error is cleared when executing drive command of – direction to make logical/actual position counter is smaller than COMP+ register.

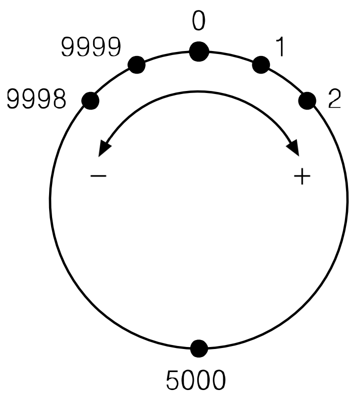
It is same as–direction of COMP- register.

COMP+ register and COMP- register are available to anytime. The contents do not applied after the reset.

5.3.3 Variable ring of position counter

Logical position counter and Actual position counter is Up/Down counter of 32bit.

Therefore, when it counts up from the maximum FFFFFFFFh of 32 bit with + direction and it returns to 0 generally. When it counts down from 0 with – direction and it returns FFFFFFFFh. Variable ring function is to set the maximum value of this ring counter. Inposition-axis is not linear drive, and it is convenient function to the device managing position of rotating axies. When being valid variable ring function, set WR6 register/D4 (VRING)bit of extension mode setting command (60h) as 1 and set the maximum of logical position counter to COMP+ register and set the maximum of actual position counter to COMP- register.



<Figure 2.22 Max. value 9999 operation of position counter ring>

When the rotating axis rotates one time with 10,000 pulses, set as followings.

① To valid valid ring function, set WR6/D4 bit of extension mode setting command (60h) as 1.
② Set 9,999(270Fh) to COMP+ register as the maximum of logical position counter.
③ Set 9,999(270Fh) to COMP- register for using actual position counter.

In this time, count operation is for count up …→9998→9999→0→1→… with +direction, and

for count down …→1→0→9999→9998→… with – direction.

Note

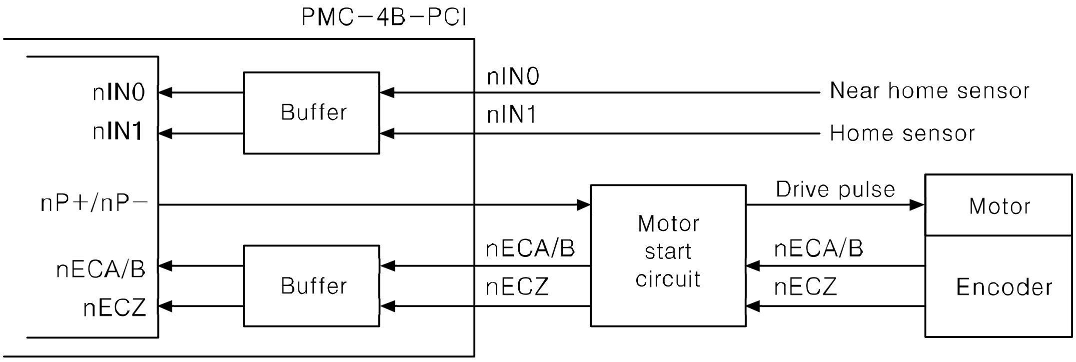
- You can set valid/invalid of variable ring function by each axis. You cannot set valid/invalid of logical position counter and actual position counter individually.
- When being valid variable ring function, soft limit function is not available.

5.3.4 Actual position counter clear by external signal

When executing Z-phase search for home output, actual position counter is cleared at the start level of activated Z-phase signal.

Generally, home search is executed with consecutive driving by connecting near home signal, home signal, Encoder Z-phase signal, etc with nIN0, nIN1, nECZ terminals. It clears logical position/actual position counter because the designated signal is active, drive stops.

Z-phase search is low drive speed and it is useful when there is Z-phase detecting position error from servo or delay of machinery. During Encoder Z-phase search, to clear actual position counter in Z-phase signal, connect Z-phase signal to nECZ signal as <Figure 2.23> and set Z-phase search mode with actual position counter clear and command as followings.



<Figure 2.23 Example of connection actual position counter clear signal by IECZ signal >

① Set range and start speed.

② Set drive speed of Z-phase search. When the drive speed is lower than start speed, accel/decel drive does not operate. When detecting Z-phase, drive pulse stops immediately.

③ Set valid of nECZ signal and active level.

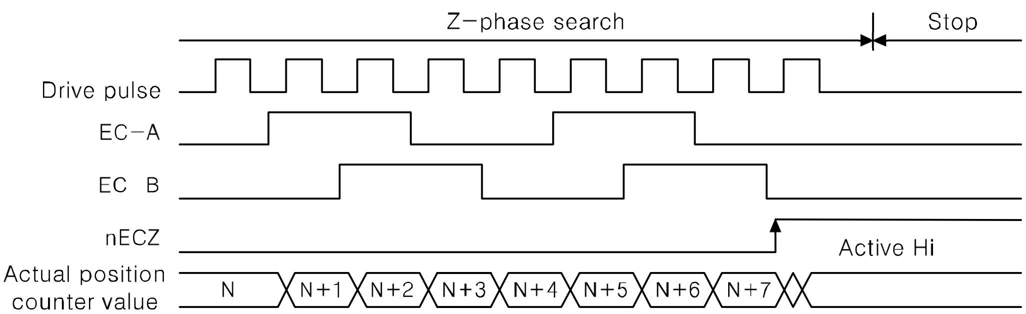
WR1/D5 (IN2-E)	1
D4(IN2-L)	0(Low active), 1(High active)

④ Set actual position counter clear by nECZ signal is valid.
Set WR6/D0 (EPCLR) as 1 and it generates extension Mode setting command (60h).

Note

The other bits of extension mode setting command are also set at the same time.

⑤ It publishes +direction or –direction consecutive pulse drive command.
When executing other adjustments, it starts drive with the set direction and stops drive pulse when Z-phase signal is active level, and actual position counter is cleared at the start of Z-phase signal active level as <Figure 2.24>.



<Figure 2.24 Example of actual position counter clear by IN2 signal >

Note

- The signal for clearing actual position counter is nECZ signal. It cannot clear at nIN3, nIN1, nIN0 signal.
- Active level width of nECZ signal is required over 4 CLK cycle when signal filter is invalid. When input signal filter is valid, the time which multiplies of input signal delay is required.
- It is recommended for Z-phase search to detect only one direction to increase position detecting accuracy.
- To valid actual position counter clear function, set WR6/D0 (EPCLR) as 1. If nECZ signal is active level already, actual position counter is cleared at the command time of extension mode setting.

5.4 Interpolation

Linear interpolation, circular interpolation, or bit pattern interpolation drive is available to select the desired 2-axis or 3-axis among 4-axis.

When designating the axis for interpolation, set axis code to D0, D1(ax1), D2, D3(ax2), D4, D5(ax3) of WR5 register.

Interpolation drive operates interpolation calculation as main-axis(ax1) at the basic pulse timing of the designated-axis. Therefore, before commending interpolation, the parameters such as start speed, drive speed, etc of main-axis(ax1) should be set.

Main-axis is the designated axis as ax1 and set the parameters for interpolation command by each axis and enter interpolation drive command to WR0 Command register to start interpolation drive. During interpolation driving, D8(I-DRV) bit of RR0 (main status register) becomes 1 and when drive is finished it returns to 0.

And during interpolation driving, n-DRV bit of the axis which operating interpolation is set 1. Interpolation calculation such as linear interpolation, circular interpolation, bit pattern interpolation executes up to 4Mpps. However, in case of consecutive interpolation, it is up to 2Mpps.

(1) Over run limit error during interpolation

In interpolation drive, hardware limit, software limit of each driving axis operate always. Therefore, during interpolation drive, the limit of the driving axis is active, interpolation drive stops. When it stops by error, check error bit of the interpolation driving axis of RR0 (main status register) and set 1 to read RR2 (error register) of the axis.

Note

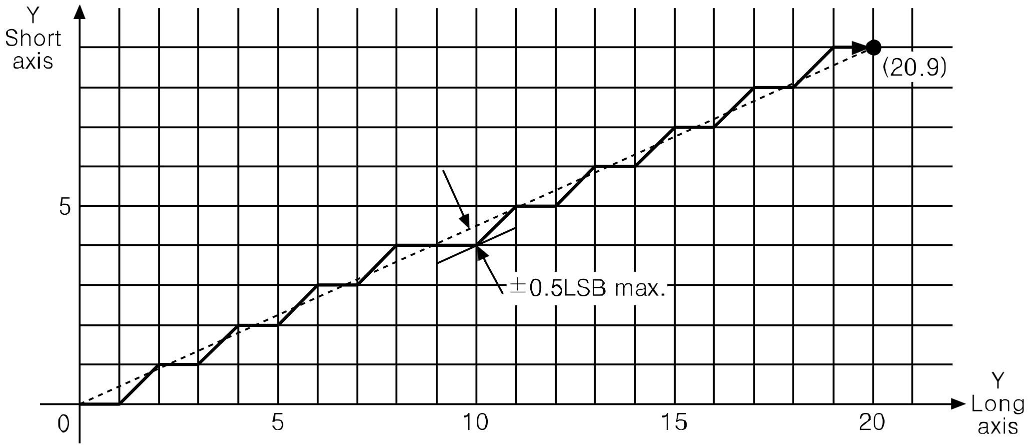
In circular interpolation and bit pattern interpolation, when hardware limit and software limit of any direction between +direction/-direction are active, interpolation may stop. Therefore, it cannot escape at circular interpolation and bit pattern interpolation area.

(2) Correspondence for inposition signal servo motor

In interpolation drive, be valid inposition signal(nINPOS) of the driving each axis and after finishing interpolation drive, check nINPOS signal of all axes is active level. And D8(I-DRV) bit of RR0 register returns to 0.

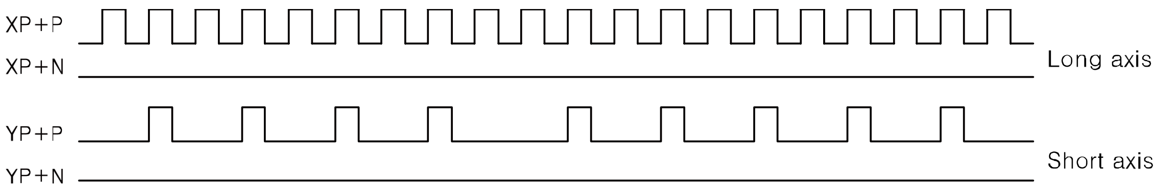
5.4.1 2-axis/3-axis linear interpolation

Select the desired 2-axis or 3-axis among 4-axis and it executes linear interpolation drive. Linear interpolation executes by setting the end coordinate for the current coordinate and by generating 2-axis or 3-axis linear interpolation command. <Figure 2.25> is the example of 2-axis interpolation. Set end coordinate as the relative value of current position with the number of output pulses of each axis. The number of output pulses should be set without sign value when moving each-axis individually. During interpolation driving, be sure that it is set as the relative corrdinate of the current position. The position accuracy for the designated linear is ±0.5 LSB within the whole interpolation range as <Figure 2.25>.



<Figure 2.25 Position precision of linear interpolation >

<Figure 2.26> is the example of drive pulse output for linear interpolation. The long axis which has big absoule value among the set end point values outputs always pulses during interpolation driving.
When the other axes are short axes and generating pulses accoridng to the calculation result of linear interpolation, it may not generate pulses. The coordinate range of linear interpolation is 32bit with sign.
Each axis is available to interpolation from the current position within the range of -2,147,483,646 to +2,147,483,646.



<Figure 2.26 Example of drive pulse output for End point (X: 20, Y:9) >

(1) Example of 2-axis linear interpolation drive

It executes linear interpolation for X, Y-axis from the current position to end coordinate (X: +300, Y: -200). Interpolation drive speed is constant speed drive of 1,000pps.

WR5←0004h write	Sets ax1: X-axis, ax2: Y-axis
WR6←1200h write	Range: 8,000,000 (Magnification:1)
WR7←007Ah write	
WR0←0100h write	
WR6←03E8h write	Start speed: 1,000pps
WR0←0104h write	
WR6←03E8h write	Drive speed: 1,000pps
WR0←0105h write	
WR6←012Ch write	End point X-axis: 300
WR7←0000h write	
WR0←0106h write	
WR6←FF38h write	End point Y-axis: -200
WR7←FFFFh write	
WR0←0206h write	
WR0←0030h write	2-axis linear interpolation drive

(2) Example of 3-axis linear interpolation drive

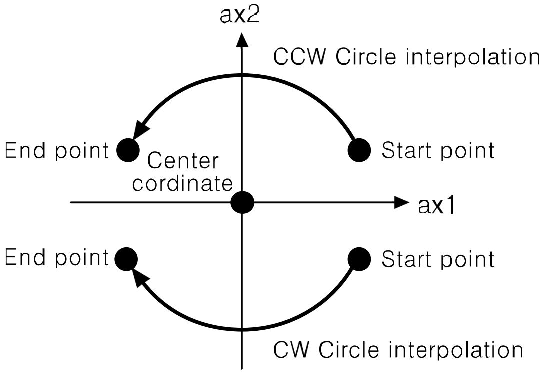
It executes 3-axis linear interpolation for X, Y, Z–axis from the current position to end coordinate(X: 15000, Y: 16000, Z: 20000).
This is linear accel/decel drive as Start speed: 500pps, Accel/Decel: 40,000pps/sec, Drive speed: 5,000pps.

WR5←0024h write	Sets ax1: X-axis, ax2: Y-axis, ax3: Z-axis
WR6←1200h write	Range: 8,000,000 (Magnification:1)
WR7←007Ah write	
WR0←0100h write	
WR6←0140h write	Accel/Decel: 40,000pps/sec
WR0←0102h write	40,000/125/1 =320
WR6←01F4h write	Start speed: 500pps
WR0←0104h write	
WR6←1388h write	Drive speed: 5000pps
WR0←0105h write	
WR6←3A98h write	End point X: 15,000
WR7←0000h write	
WR0←0106h write	
WR6←3E80h write	End point Y: 16,000
WR7←0000h write	
WR0←0206h write	
WR6←4E20h write	End point Z: 20,000
WR7←0000h write	

WR0←0406h write
WR0←003Bh write Valid deceleration
WR0←0031h write 3-axis linear interpolation drive

5.4.2 Circular interpolation

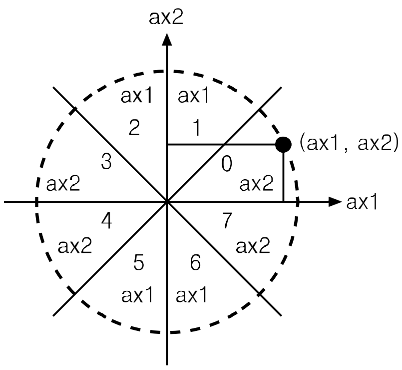
It executes circular interpolation drive by selecting the desired 2-axis among 4-axis.
Circular interpolation executes by setting center coordinate and end coordinate of the circular for the current coordinate and by writing CW circular interpolation command or CCW circular interpolation command.
You should set center coordinate and end pointcoordinate with the relative value for the current coordinate.
CW circular interpolation executes centering the center coordinate with clockwise from the current coordinate to the end coordinate. CCW circular interpolation executes with counter clockwise. When setting end point as (0,0), it can drive as the center circuit. .



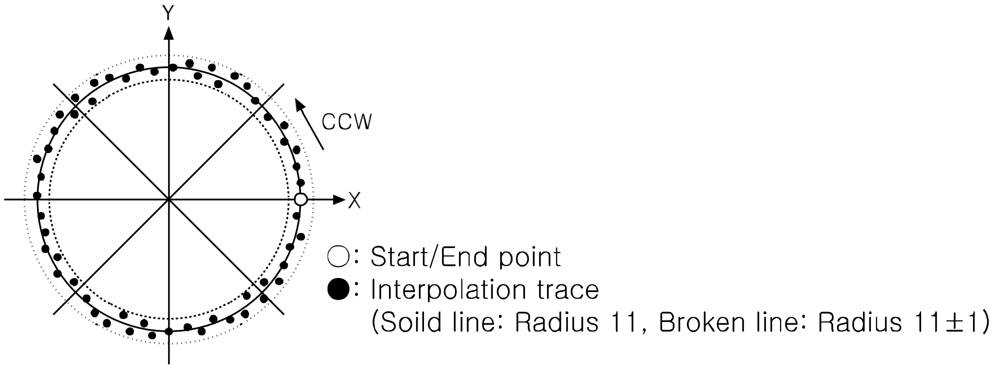
<Figure 2.27 CW/CCW circular interpolation>

The calculation of circular interpolation in PCM-4B-PCI divides total 8 parts (0 to7) as high limit centering the center coordinate of plane by the 1-axis(ax1) and the 2-axis(ax2) as <Figure 2.28>. At 0 high limit, interpolation coordinate (ax1, ax2) moving circular-phase is that the absolute value of ax2 is always smaller tha that of ax1.

The single axis which is small absoulte value is the 1-axis (ax1) in 1, 2, 5, 6 high limit and the 2-axis (ax2) in 0, 3, 4, 7 high limit.



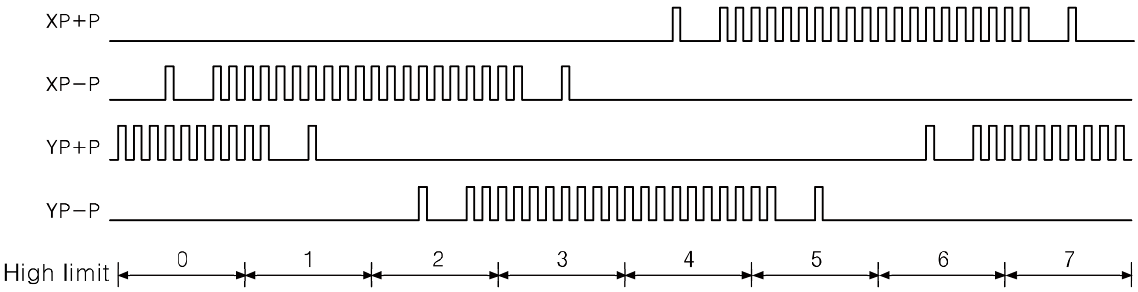
<Figure 2.28 0 to 7 high limit and short-axis of circular interpolation calculation>



<Figure 2.29 Circular interpolation>

<Figure 2.29> is the example of driving the center circuit which radius is 11 by designating the current coordinate center (-11, 0) and end point (0, 0). <Figure 2.30> is drive pulse output for this.

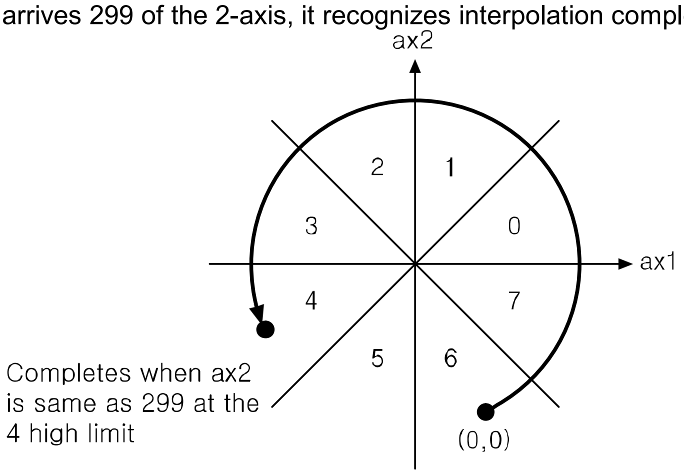
The set range for center coordinate and end point coordinate is -2,147,483,646 to +2,147,483,646 from the current position. Position error for circular is ±1LSB within the whole interpolation. Interpolation speed is 1pps to 4Mpps.



<Figure 2.30 Example of circular interpolation drive pulse output >

(1) End point decision

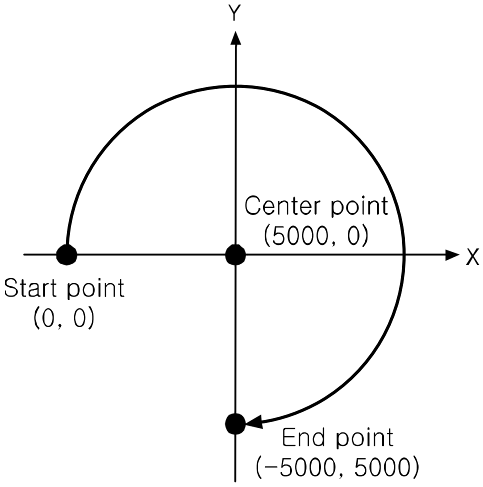
Circular interpolation is set the current coordinate and the center coordinate before starting interpolation drive. When the radius is decided, it drives with the circular trace.
Circular calculation error is ±1LSB within the interpolation coordinate range. Therefore it is not must that the set end point is on the circular trace. At the high limit with end point, it is same with single-axis value of End point, it recognizes as circular interpolation completion.
<Figure 2.31> is the example of CCW circular interpolation with current position(0, 0), from center(-200, 500) to set end point(-702, 299). It executes interpolation by the decided radius from current position(0, 0) and center(-200, 500) as CCWdirection. At the set end point(-702, 299), the 2-axis(ax2) is single-axis as 4 high limit. At end point value (-702, 299), when it arrives 299 of the 2-axis, it recognizes interpolation completion.



<Figure 2.31 Example of circular interpolation completion decision>

(2) Example of CW circular interpolation drive

It executes CW circular interpolation for X, Y –axis from the current position (start point: 0, 0) to center (X: 5000, Y: 0), and end point(X: 5000, Y: -5000). Interpolation drive speed executes constant speed drive with 1000pps and it interpolates constant linear velocity mode.



WR5←0104h write	Sets ax1: X-axis, ax2: Y-axis, constant linear velocity
WR6←0900h write	Range: 4,000,000 (Magnification:2)
WR7←003Dh write	
WR0←0100h write	
WR6←4DC0h write	Range for 2-axis constant linear velocity: 4,000,000×1.414=5,656,000
WR7←0056h write	
WR0←0200h write	
WR6←01F4h write	Start speed: 500×2=1000pps
WR0←0104h write	
WR6←01F4h write	Drive speed: 500×2=1000pps
WR0←0105h write	
WR6←1388h write	Center X: 5000
WR7←0000h write	
WR0←0108h write	
WR6←0000h write	Center Y: 0
WR7←0000h write	
WR0←0208h write	
WR6←1388h write	End point X: 5000
WR7←0000h write	
WR0←0106h write	
WR6←EC78h write	End point Y: -5000
WR7←FFFFh write	
WR0←0206h write	
WR0←0032h write	CW circular interpolation drive

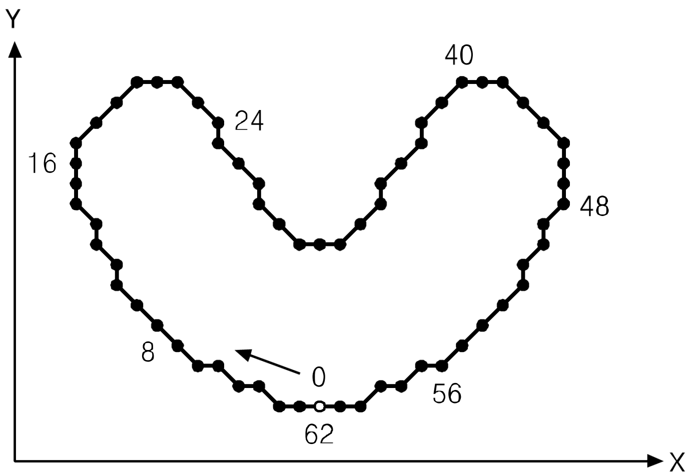
5.4.3 2-axis/3-axis bit pattern interpolation

It receives interpolation data which is bit patterend written from upper CPU by packet (the designated amount data). It is interpolation drive to ouput consecutively interpolation pulses with the set drive speed.

In bit pattern interpolation, Set drive pulse of +direction, -direction from 2-axis or 3-axis as 1bit, 1pulse to each register. When outputing drive pulses, set as '1' or doing not output drive pulses, set as '0'.

Ex.

In case of driving the trace as <Figure 2.32>, when occuring drive pulses of each X+direction, X-direction, Y+direction, Y-direction, set as '1' or when doing not occur drive pulses, set as '0'. Therefore, this bit pattern data is below.



<Figure 2.32 Example of bit pattern>

←	56 ←	48 ←	40 ←	32 ←	24 ←	16 ←	8 ←	0
01000000	00000000	00011111	11011011	11110110	11111110	00000000	00000000	XPP(X+direction)
01111111	11110101	00000000	00000000	00000000	00000000	00101011	11111111	XPP(X-direction)
00000000	00000000	00000000	11111111	00000000	00001111	11111111	11010100	YPP(Y+direction)
00001010	11111111	11111100	00000000	00111111	11000000	00000000	00000000	YPP(Y-direction)

<Figure 2.33> is the 1-axis register organization and bit data movement of bit pattern interpolation. BP1P register, BP1M register is 16 bit register to write bit pattern data from upper CPU. (In case of 8bit bus, write it with dividing L byte, H byte.) Write bit data of 16bit to BP1P register and write the data of –direction to BP1M register. When starting bit pattern interpolation, it outputs drive pulses from D0 by turns.

SC: Stack counter (RR0/D14, 13)

BP1P: ax1 –axis +direction data

register

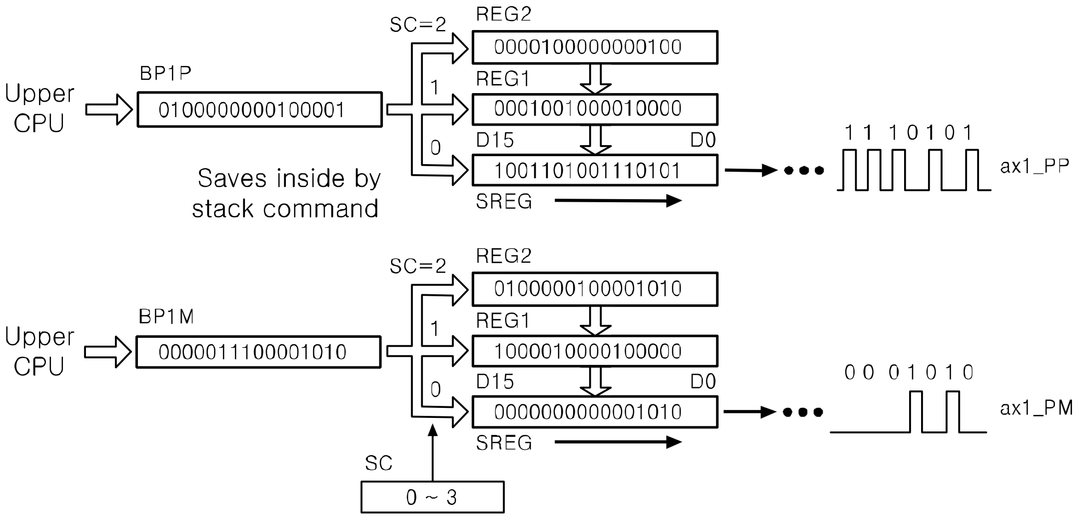
BP1M: ax1 –axis -direction data

register

SREG: 16bit shift register

REG1: 16bit shift register

REG2: 16bit shift register



<Figure 2.33> Register organization and bit data movement of bit pattern interpolation (ax1-axis)>

Stack Counter (SC) is counter to count bit pattern data and it changes from 0 to 3.

D14, D13 bit of RR0 register is the value of stack counter. The data which is written in BP1P, BP1M register is written at whether inner 16bit shift register (SREG) or two16bit registers (REG1, REG2) by BPdata stack command. In this case, if Stack counter SC=0, it is written at SREG, or if SC=1, it is written at REG1, or if SC=2, it is written at REG2. When all data are written, stack counter(SC) increases by 1.

By 2-axis or 3-axis bit pattern interpolation command, when starting bit pattern interpolation, all axes are synchronized with basic pulse of main-axis. It outputs drive pulses by D0 bit value of 16bit shift register (SREG).

When D0 value is ‘1’, it outputs drive pulses. When it is ‘0’, it does not output. When 16bit of shift register finishes all output, data of REG1 register is moved to shift register, and data of REG2 register is moved to REG1 register and Stack Counter (SC) decreased by 1.

Upper CPU cannot stack bit pattern data inside anymore when stack counter(SC) is 3. However, when interpolation drive starts, Stack counter (SC) value decreased as 3→2→1 turn according to drive pulse output and you cannot write data.
Because stack counter(SC)=0 means interpolation drive completion, when executing interpolation bit pattern consecutively, you should set the next data between SC=2 or 1. When SC value is changed from 2 to 1, it generates interrupt for upper CPU and is required to write data.

(1) Limit of interpolation drive speed

Drive speed of bit pattern interpolation is max. 4MHz. When the number of bit is over 48bit, data should be supplied during interpolation driving. Therefore, interpolation drive speed relies to the required time for setup pattern data of CPU.

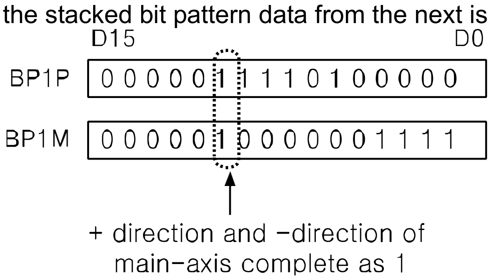
Ex.

When CPU part takes 100 μs by 4×16 bit calculation and data set and BP data stack command occurance as 2-axis bit pattern interpolation, interpolation drive speed is below 1/(100 μs/16)=160kpps.

(2) Completion of bit pattern interpolation

There are two type of completion for bit pattern interpolation.

① Write the completion code to the 1-axis data.
Set bit data of +direction, -direction as '1' at the same time, it is bit pattern interpolation completion. When detecting comletion code, stack counter(SC) becomes 0 forecebly and the stacked bit pattern data from the next is invalid all.



② Stop to write data.
When it stops to write bit pattern data of inner register by BP data stack command, all bit pattern data outputs as drive pulse and it becomes as SC=0 and interpolation drive stops.

(3) Interpolation drive stop by stop command

Set immediate stop command or deceleration stop command to main-axis(ax1) executing bit pattern interpolation drive and drive stops during interpolation. If setting bit pattern interpolation command again, bit pattern interpolation is available continuously. When drive stops by stop command and interpolation stops, you must celar the setting data by BP data clear command.

(4) Stop by hardware limit, software limit

In interpolation drive, hardware limit or software limit of any axes is active, and interpolation drive stops. When interpolation stops, you must clear data written at BP data clear command.
In bit pattern interpolation, hardware limit and software limit of any direction of +direction/-direction is active, and interpolation stops. Be sure that in bit pattern interpolation, it cannot escape from limit over area.

(5) Bit pattern data write register

The below table is for bit pattern data write register address from ax1 axis to ax3 axis by 16 bit bus and 8 bit bus.
Bit pattern data write register address for 16 bit data bus

Address			Register	Description	Response register
A2	A1	A0			
0	0	0			WR0
0	0	1			nWR1
0	0	0	BP1P	ax1 -axis +direction data register	nWR2
0	0	1	BP1M	ax1 -axis -direction data register	nWR3
1	1	0	BP2P	ax2 -axis +direction data register	nWR4
1	1	1	BP2M	ax2 -axis -direction data register	nWR5
1	1	0	BP3P※1	ax3 -axis +direction data register	nWR6
1	1	1	BP3M※1	ax3 -axis -direction data register	nWR7

※1. Each BP3P, BP3M is for WR6, 7 register.

Bit pattern data write register address for 8bit data bus

Address				Register	Address				Register
A3	A2	A1	A0		A3	A2	A1	A0	
0	0	0	0		1	0	0	0	BP2PL
0	0	0	1		1	0	0	1	BP2PH
0	0	1	0		1	0	1	0	BP2ML
0	0	1	1		1	0	1	1	BP2MH
0	1	0	0	BP1PL	1	1	0	0	BP3PL
0	1	0	1	BP1PH	1	1	0	1	BP3PH
0	1	1	0	BP1ML	1	1	1	0	BP3ML
0	1	1	1	BP1PH	1	1	1	1	BP3MH

Each BPmPL, BPmPH, BPmML, BPmMH means the below byte. (‘m’ is 1 to 3.)

BPmPL: Lower byte (D7 to D0) of BPmP
BPmPH: Upper byte (D15 to D8) of BPmP
BPmML: Lower byte (D7 to D0) of BPmM
BPmMH: Upper byte (D15 to D8) of BPmM

Bit pattern data write register has the same address of nWR2 to WR7 register.
After reset, you cannot write data at bit pattern data register. Data write is executed as the following order.

Releasing writable bit register command (36h)

⇩

Writing bit pattern data

⇩

Releasing BP register not writable command(37h)

Note

When finishing bit pattern data writing, if BP register not writable command (37h) is not released, blank of this bit is changed state and nWR2 to WR5 register writing is not available.

(6) Example of bit pattern interpolation drive

Set main-axis(ax1)=X-axis, the 2-axis(ax2)=Y-axis and execute interpolation for bit pattern figure with 1000pps constant speed drive, constant linear velocity mode as <Figure 2.32>.

WR5←0104h write	Sets ax1: X-axis, ax2: Y-axis, constant linear velocity
WR6←0900h write	Sets main-axis speed parameter
WR7←003Dh write	Range: 4,000,000 (Magnification:2)
WR0←0100h write	
WR6←4DC0h write	Range for 2-axis constant linear velocity: 4,000,000×1.414=5,656,000
WR7←0056h write	
WR0←0200h write	
WR6←01F4h write	Start speed: 500×2=1000pps
WR0←0104h write	

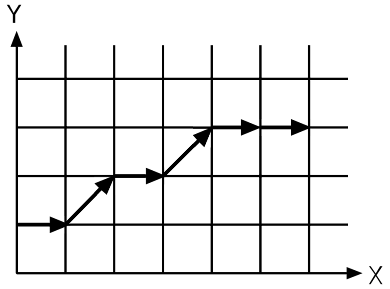
	WR6←01F4h write	Drive speed: 500×2=1000pps	
	WR0←0105h write		
	WR0←0039h write	BPdata clear	
	WR0←0036h write	Writable BP register	
	BP1P←0000h write	Point 0 to 15 X-axis +direction	
	BP1M←2BFFh write	X-axis -direction	
	BP2P←FFD4h write	Y-axis +direction	
	BP2M←0000h write	Y-axis –direction	
	WR0←0038h write	BP data stack	
	BP1P←F6FEh write	Point 16 to 31 X-axis +direction	
	BP1M←0000h write	X-axis –direction	
	BP2P←000Fh write	Y-axis +direction	
	BP2M←3FC0h write	Y-axis –direction	
	WR0←0038h write	BP data stack	
	BP1P←1FDBh write	Point 32 to 47 X-axis +direction	
	BP1M←0000h write	X-axis –direction	
	BP2P←00FFh write	Y-axis +direction	
	BP2M←FC00h write	Y-axis –direction	
	WR0←0038h write	BP data stack	
	WR0←0034h write	2-axis bit pattern interpolation: Drive start	※1
J1	RR0/D14, 13 read	Until stack counter is below 2. If D14=D13=1, it jumps to J1.	※1
	BP1P←4000h write	Point 48 to 61 X-axis +direction	※1
	BP1M←7FF5h write	X-axis –direction	※1
	BP2P←0000h write	Y-axis +direction	※1
	BP2M←0AFFh write	Y-axis –direction	※1
	WR0←0038h write	BP data stack	※1
	WR0←0037h write	BP register not writable	
J2	RR0/D8 read	Waits until interpolation drive completion. If D8=1, it jumps to J2.	

(7) Bit pattern interpolation drive by interrupt

In bit pattern interpolation drive, when stack counter(SC) value is changed from 2 to 1 during driving, interrupt occurs and it is available to write data. When occurring interrupt, set D15 bit of WR5 register as 1.
After this, stack counter(SC) value is changed from 2 to 1 while bit pattern interpolation drive starts, INTN output signal is changed as low level. Bit pattern interpolation data is 16bit or 32bit pattern data. When writing BP data stack command, interrupt is cleared. Interrupt during interpolation driving is available to clear by interpolation interrupt clear command (3Dh). Even though INTN output signal is low status, when interpolation drive is stops, it is cleared and returns to Hi-Z. It is repeated when BP data is contiuous consecutively.

5.4.4 Constant linear velocity

Constant linear velocity control is the function to make resultant velocity of interpolation axis constant. <Figure 2.34> is the trace of 2-axis interpolation. According to the basic pulses of main-axis, each axis outputs drive pulses as the figure. When both X, Y-axis output drive pulses, it moves 1.414 times longer than drive pulse output of only 1-axis. When both axes output drive pulses, speed should be set as 1.414 times than the drive pulse speed of only the 1-axis.



<Figure 2.34 Example of 2-axis interpolation >

(1) 2-axis constant linear velocity

To set 2-axis constant linear velocity, set D9 of WR5 register as 0 and D8bit as 1. When the range parameter of the 2-axis interpolation is set 1.414 times of the range parameter of main-axis and the range parameter of main-axis is used during drive pulse output for only the 1-axis. During drive pulse output for both axes, the range parameter of the 2-axis is used automatically and pulse cycle is multiplied by 1.414 times.

(2) 3-axis constant linear velocity

To set 3-axis constant linear velocity, set D9 of WR5 register as 1 and D8bit as 1. When the range parameter of the 2-axis is the 1.414 times of the range parameter of main-axis and the range parameter of the 3-axis is to set 1.732 times of the main range. When interpolation drive starts and when outputting drive pulse of any one axis among 3-axis, the range parameter of main-axis is used. When outputting drive pulse of the 2-axis, the range parameter of the 2-axis is used. And when outputting drive pulse of the 3-axis, the range parameter of the 3-axis is used. (Refer to <Figure 2.36>.)
In case of 3-axis interpolation, only main-axis and the 2-axis are available for 2-axis constant linear velocity. In this case, set D9, D8 bit of WR5 register as 0, 1.

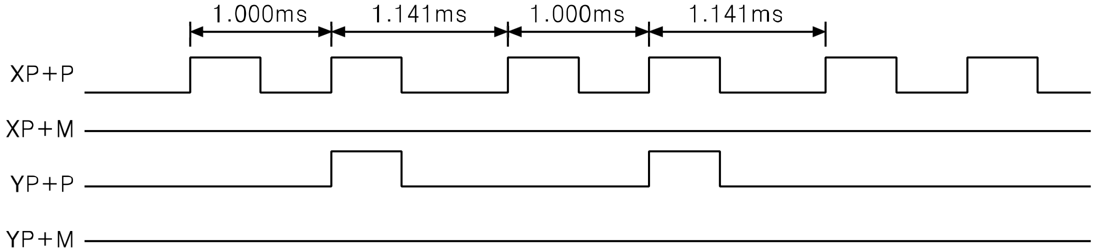
Ex.

- Example of constant linear velocity interpolation drive

Set main-axis(ax1)=X-axis, the 2-axis(ax2)=Y-axis as below and execute linear interpolation with 1000pps constant speed drive, constant linear velocity mode and it outputs drive pulses as <Figure 2.35>.

WR5←0104h write	Sets ax1: X-axis, ax2: Y-axis, constant linear velocity
WR6←0900h write	Sets main-axis speed parameter

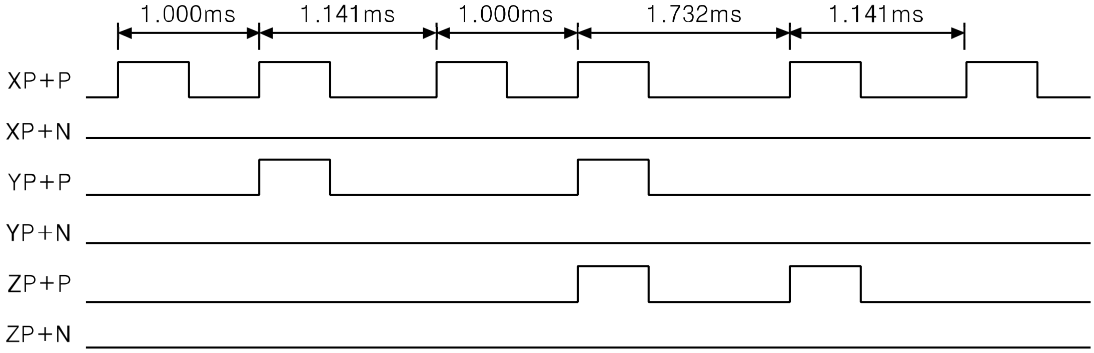
WR7←003Dh write	Range: 4,000,000 (Magnification:2)
WR0←0100h write	
WR6←4DC0h write	Range for 2-axis constant linear velocity: 4,000,000×1.414=5,656,000
WR7←0056h write	
WR0←0200h write	
WR6←01F4h write	Start speed: 500×2=1000pps
WR0←0104h write	
WR6←01F4h write	Drive speed: 500×2=1000pps
WR0←0105h write	
WR6←03E8h write	End point X value
WR7←0000h write	
WR0←0106h write	
WR6←0190h write	End point Y value
WR7←0000h write	
WR0←0206h write	
WR0←0030h write	2-axis linear interpolation start



<Figure 2.35 Example of pulse output for 2-axis interpolation constant linear velocity (start speed: 1000pps)>

Note

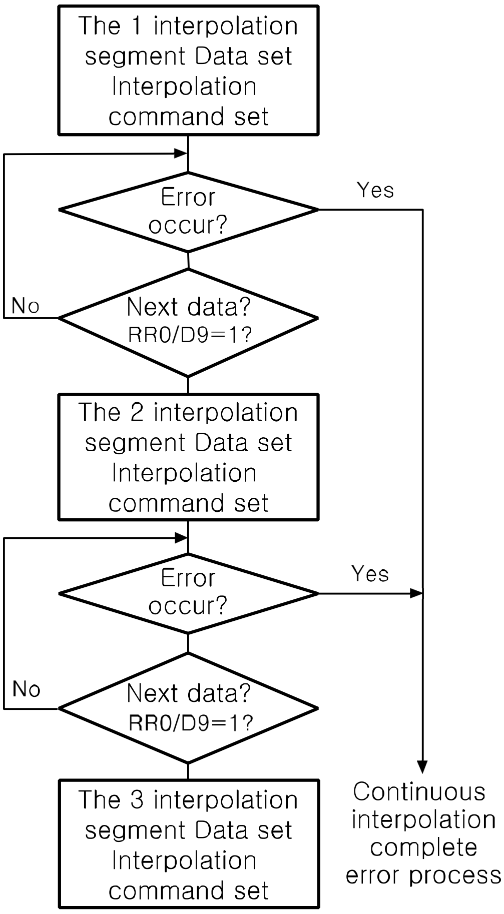
When outputting drive pulse of both axis and pulse cycle is 1.414 times, it extends low level as 1.414 times of pulse 1cycle up to raise part of high level in drive pulse.
In 3-axis constant linear velocity, when 1 cycle is increased by 1.732 times also, only low level is extended.



<Figure 2.36 Example of pulse output for 3-axis interpolation constant linear velocity (start speed: 1000pps)>

5.4.5 Consecutive interpolation

Consecutive interpolation executes interpolation consecutively as linear interpolation→circular interpolation→linear interpolation→… as non-stop driving. Consecutive interpolation drive sets parameter data and interpolation command between the currently driving interpolation and the next interpolation drive and executes interpolation drive consecutively. Therefore, all interpolation nodes need the over set time for data command of the next interpolation node from the drive start to the end time. The below figure is the order of driving consecutive interpolation.



In consecutive interpolation, use D9(CNEXT) bit of RR0 register. This bit is the data of the next interpolation node and it is the whether to set interpolation drive command during interpolation drive during interpolation drive. '1' means set available and '0' means set unavailable.

When drive stops, it becomes '0' and when interpolation drive starts, it becomes '1' and the data of the next interpolation node and the interpolation drive command are set. When interpolation drive command of the next interpolation node is set, it changes as 0(set unavailable). When the next interpolation segment starts drive, it changes as '1' and the data of the next interpolation segmentand interpolation drive command are set available.

(1) Consecutive interpolation by interrupt

When D14 bit of WR5 register drives consecutive interpolation, this bit is to set enable/disable interrupt.
When setting this bit as '1', D9(CNEXT) bit of RR0 register becomes 1(Enables interrupt) and INTN output signal becomes low level. In interrupt process routine, it checks D9(CNEXT) bit of RR0 register. When it is 1(Writable), it writes the data of the next interpolation node and interpolation drive command. In consecutive interpolation interrupt, when writing the next interpolation drive command, INTN signal returns to Hi-Z. Before writing the data of the next interpolation node, it is available to clear interrupt by clear command(3Dh). Interpolation interrupt is cleared forcebly when interpolation drive completes and INTN signal returns to Hi-Z.

(2) Error occurence during consecutive interpolation

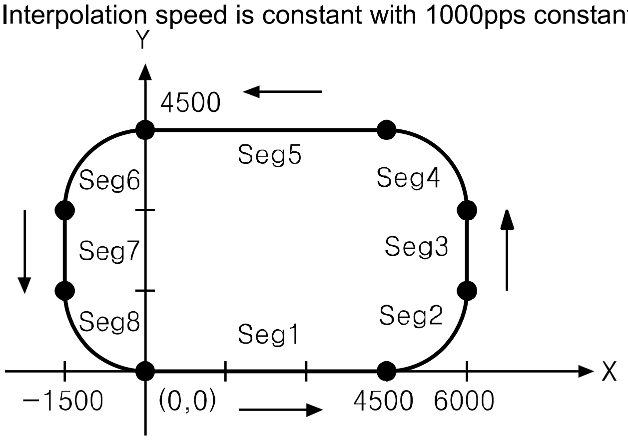
In consecutive interpolation drive, when error such as limit over run, etc occurs, it stops at the current drive node. At the stop interpolation node, it sets the data of the next node and interpolation command during driving. However, interpolation command becomes invalid. Before setting the data of each interpolation node and interpolation command, if error check is not done, it stops as error and two interpolation nodes execute immediately. Therefore, before setting the data of each interpolation node and interpolation command, error check must be done to escape consecutive interpolation loof at error.

(3) Caution for consecutive interpolation

- Each interpolation node sets interpolation command after setting the nedded data. Do not as reverse.
- Drive speed of consecutive interpolation is up to 2MHz.
- When driving all interpolation nodes, time requires to set data of interpolation node and command after error checking of interpolation-axis. If during the set the data of the next interpolation node the current interpolation node completes the drive, D9(CNEXT) bit of RR0 register becomes '0'. However, drive command of the next interpolation node is written, it stops at first and executes consecutive interpolation continuously.
- If there is circular interpolation in consecutive interpolation, single-axis of end point may go wrong ±1LSB than this end point value for circular interpolation. Therefore, you should check each circular interpolation end point not to accumulate error of each node and execute consecutive interpolation.
- It cannot execute the consecutive interpolation starting from 2-axis interpolation and executing 3-axis interpolation, or starting from 3-axis interpolation and executing 2-axis interpolation.
- During consecutive interpolation, it cannot change the axis for interpolation.

Ex.

Example of consecutive interpolation
<Figure 2.37> is the example of consecutive interpolation as the start point node (0, 0) from 1 to 2, 3 … node 8.
Node 1, 3, 5, 7 is linear interpolation and node 2, 4, 6, 8 is the 1/4 circle of 1500 radius.
Interpolation speed is constant with 1000pps constant speed drive.



<Figure 2.37 Example of consecutive interpolation trace>

	WR5←0104h write	Sets ax1: X-axis, ax2: Y-axis, constant linear velocity	
	WR6←0900h write	Sets main-axis speed parameter	
	WR7←003Dh write	Range: 4,000,000 (Magnification:2)	
	WR0←0100h write		
	WR6←4DC0h write	Range for 2-axis constant linear velocity: 4,000,000×1.414=5,656,000	
	WR7←0056h write		
	WR0←0200h write		
	WR6←01F4h write	Start speed: 500×2=1000pps	
	WR0←0104h write		
	WR6←01F4h write	Drive speed: 500×2=1000pps	
	WR0←0105h write		
	WR6←1194h write	End point X value: 4500	Seg1
	WR7←0000h write		
	WR0←0106h write		
	WR6←0000h write	End point Y value: 0	
	WR7←0000h write		
	WR0←0206h write		
	WR0←0030h write	2-axis linearinterpolation	
J1	RR0/ D5, 4	Read; When there is error at X, Y-axis, if D5 or D4=1, it jumps to error and process error.	A process
	RR0/ D9	Read; When the next node data,	

	if D9=0, it jumps to J1;
	ready to writable
WR6←0000h write	Center X value: 0
WR7←0000h write	
WR0←0108h write	
WR6←05DCh write	Center Y value: 1500
WR7←0000h write	
WR0←0208h write	
WR6←05DCh write	End point X value: 1500
WR7←0000h write	
WR0←0106h write	
WR6←05DCh write	End point Y value: 1500
WR7←0000h write	
WR0←0206h write	
WR0←0033h write	CCW circularinterpolation
A process	
WR6←0000h write	End point X value: 0
WR7←0000h write	
WR0←0106h write	
WR6←05DCh write	End point Y value: 1500
WR7←0000h write	
WR0←0206h write	
WR0←0030h write	2-axis linear interpolation
A process	

Seg2

Seg3

The next Seg 4 to 8 process as above.

5.4.6 Interpolation for accel/decel drive

Interpolation operates in constant speed drive generally, but it is available in linear accel/decel drive or S curve drive (only linear interpolation). In interpolation drive, use deceleration valid command (3Bh), deceleration invalid command(3Ch) for consecutive interpolation to accel/decel drive. Deceleration valid command is to be valid auto deceleration or manual deceleration for interpolation drive. Deceleration invalid command is to be invalid deceleration valid command. When executing single interpolation drive as accel/decel, deceleration must be valid state before starting drive. Deceleration valid command during driving is not applied.

(1) Accel/Decel drive for 2-axis/3-axis linear interpolation

In 2-axis/3-axis linear interpolation, linear accel/decel drive and S curve drive are available. In deceleration, both auto deceleration and manual deceleration are available. In manual deceleration, set manual deceleration point of main-axis as the biggest absoulte value from the each axis of end pointcoordinate.

Ex.

When executing 3-axis linear interpolation to the end point (X: -20000, Y: 30000, Z: -50000) with main-axis: X, the 2-axis: Y, the 3-axis: Z-axis, set the needed number of pulses for deceleration as 5000 and the absoule value of Z-axis end point is the biggest. Therefore, it sets 50000-5000=45000 as manual deceleration point of main X-axis.
The example of accel/decel drive in linear interpolation, refer to the example of 3-axis linear interpolation drive in '5.4.1 2-axis/3-axis linear interpolation'.

(2) Accel/Decel drive for circular interpolation, bit pattern interpolation

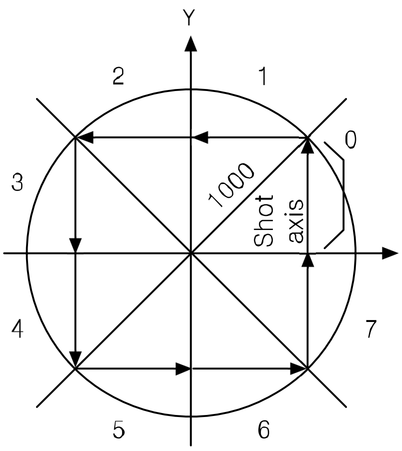
In circular interpolation, bit pattern interpolation, only linear accel/decel drive is available as manual deceleration. S curve drive and auto deceleration are not available. As the figure, driving the the center circuit. Trace of radius 10,000 with linear accel/decel drive, circular interpolation cannot execute auto deceleration, manual deceleration point should be set in advance.
The circle of radius 10,000 passes all from 0 to 7 high limit. Because single-axis outputs pulses always to each high limit, single-axis outputs 10000/2=7071 pulses by 1high limit. The number of output pulses of basic pulse from the main-axis is 7071×8=56568 for the whole circle. When setting start speed as 500pps, making drive speed to linear acceleration up to 20,000pps in 0.3 sec, acceleration becomes (20,000-500)/0.3=65,000pps/sec and in acceleration, the number of used pulses is the area of oblique line as
(500+20,000) ×0.3/2=3075.
Therefore, manual deceleration point sets as 56568-3075= 53493.

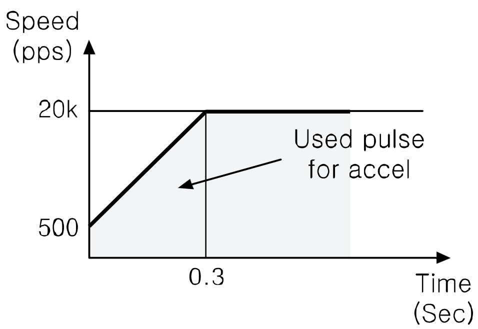
Note

In constant linear velocity mode, this calculation is not available.

WR3←0001h write	Deceleration start point: manual
WR5←0004h write	Sets interpolation ax1: X-axis, ax2: Y-axis
WR6←8480h write	Range: 2,000,000 (Magnification:4)
WR7←001Eh write	
WR0←0100h write	
WR6←0082h write	Acceleration: 130×125×4=65,000pps/sec
WR0←0102h write	
WR6←007Dh write	Start speed: 125×4=500pps

WR0←0104h write	
WR6←1388h write	Drive speed: 5000×4=20,000pps
WR0←0105h write	
WR6←D8F0h write	Center X value: -10,000
WR7←FFFFh write	
WR0←0108h write	
WR6←0000h write	Center Y value: 0
WR7←0000h write	
WR0←0208h write	
WR6←0000h write	End point X value: 0
WR7←0000h write	
WR0←0106h write	
WR6←0000h write	End point Y value: 0
WR7←0000h write	
WR0←0206h write	
WR6←D0F5h write	Manual deceleration point: 53493
WR7←0000h write	
WR0←0107h write	
WR0←003Bh write	Deceleration valid
WR0←0033h write	CCW circular interpolation drive





(3) Accel/Decel drive for consecutive interpolation

In consecutive interpolation, only linear accel/decel drive of manual deceleration is available. S curve drive and auto deceleration are not available. In consecutive interpolation, set manual deceleration point in advance. Manual deceleration point is the last node to executing deceleration, and it sets the value of basic pulse to output from main-axis.
In consecutive interpolation, it sets deceleration as invalid to start interpolation drive. Before the setting interpolation command of the last node to deceleration, set deceleration valid command. When entering drive of the last node, it becomes deceleration valid state and from the start point of the last node, the number of main-axis basic pulses startsto count and when it is over manual deceleration point, deceleration starts.

Ex.

From node 1 to 5 in consecutiveinterpolation, the followings are set when the last node 5 to manual deceleration.

Mode set, main-axis accel/decel parameter set

↓

Manual deceleration point record

↓

Deceleration invalid command(3ch)

↓

Segment 1 data interpolation•command record

↓

Error check, record until the next data set

↓

Segment 2 data interpolation•command record

•

•

Error check, record until the next data set

↓

Deceleration invalid command (3Bh) record

↓

Segment 5 data interpolation•command record

Be sure that manual deceleration point is the value for the number of main axis basic pulses from node 5. For example, deceleration pulse is used 2000, the number of basic pulses which is ouput to node 5 is 5000. Set manual deceleration point as 5000-2000=3000.
From starting deceleration to stopping, it must be set in one node.
In other words, deceleration stop’s last node requires that the total number of used output pulses should be over the number of the pulses for deceleration.

5.4.7 Interpolation step send (Command)

It executes step sending interpolation drive by each 1 pulse. Step sending by the command is set interpolation main-axis as constant speed drive. High level width of output drive pulse at each axis is 1/2 value of the set pulse cycle from drive speed which is interpolation main-axis. Low level width is extended until occuring the next command.

(1) Interpolation step send by command

Interpolation Single step (3Ah) command executes step sending interpolation drive.When D12bit of WR5 register as 1, interpolation step sending by command is available. Interpolation step send by command method is as followings.

① Set D12 bit of WR5 register as ‘1’.
It becomes interpolation step mode by command.

② Set start speed and drive speed of interpolation main-axis as same.
When setting start speed and drive speed as same, it becomes constant speed drive. This speed value should be set faster than the cycle for single step command.

Ex.

When setting single step command as max. 1msec, start speed and drive speed should be faster than 1000pps.

③ Set interpolation data. (end point, center point, etc)

④ Register interpolation command.
When writing interpolation command, it is interpolation step mode by command and drive pulses of each axis are not output.

⑤ Write interpolation single step (3Ah) command.
As the result of interpolation calculation, drive pulses are output by each axis. Until stopping interpolation drive, single step (3Ah) command writes. When stopping interpolation step sending in the middle, it sets immediate stopcommand(27h) for main-axis and gives delay time over 1pulse cycle in drive speed. When setting interpolation single step command again, it stops drive. After completing interpolation drive, written interpolation single step command is not applied.

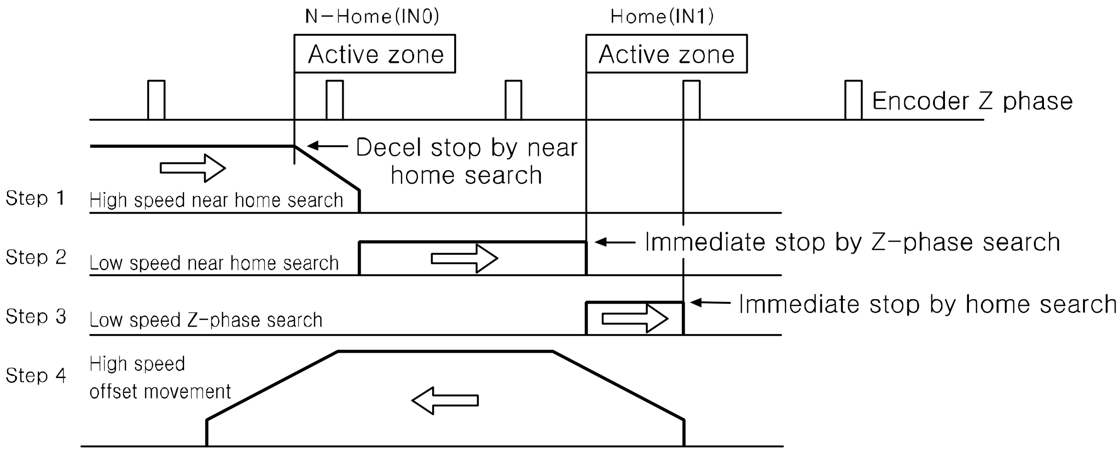
5.5 Auto home search output

Without program setting, it can execute home search order such as high speed near home search→low speed home search→ Encoder Z-phase search→Offset automatically. Auto home search executes from Step 1 to Step 4 as the below table. Select enable/disable for each step and set search direction.

Step 1, 4 operates high speed search with drive speed. And Step 2, 3 operates low speed search with home search speed.

Step No.	Operation	Search speed	Sensing signal
Step 1	High speed near home search	Drive speed (V)	nIN0※1
Step 2	Low speed home search	Home search speed(HV)	nIN1
Step 3	Low speed Z-phase search	Home search speed(HV)	nECZ
Step 4	High speed offset movement	Drive speed(V)	-

※1. It inputs home signal at both nIN0 and nIN1, high speed home search is available by only home signal 1 point. (Refer to the example of home search from '5.5.6 Example of auto home search'.)



<Figure 2.39 auto home search diagram>

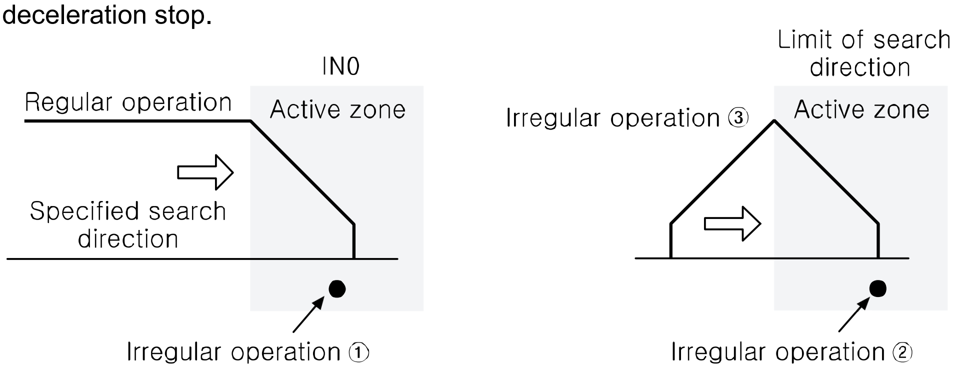
5.5.1 Each step operation

It is available for each step to set enable/disable, search direction(+direction/-direction).

When setting disable, the step is not operated and it processes the next step.

(1) Step 1 high speed near home search

High speed near home search process Step 2 by the set drive speed(V) and direction during drive pulse output when near home signal(nIN0) becomes active. When executing high speed search operation, set drive speed(V) faster than start speed(SV).
When near home signal(nIN0) becomes active during accel/decel driving, it executes deceleration stop.



[Irregular operation]

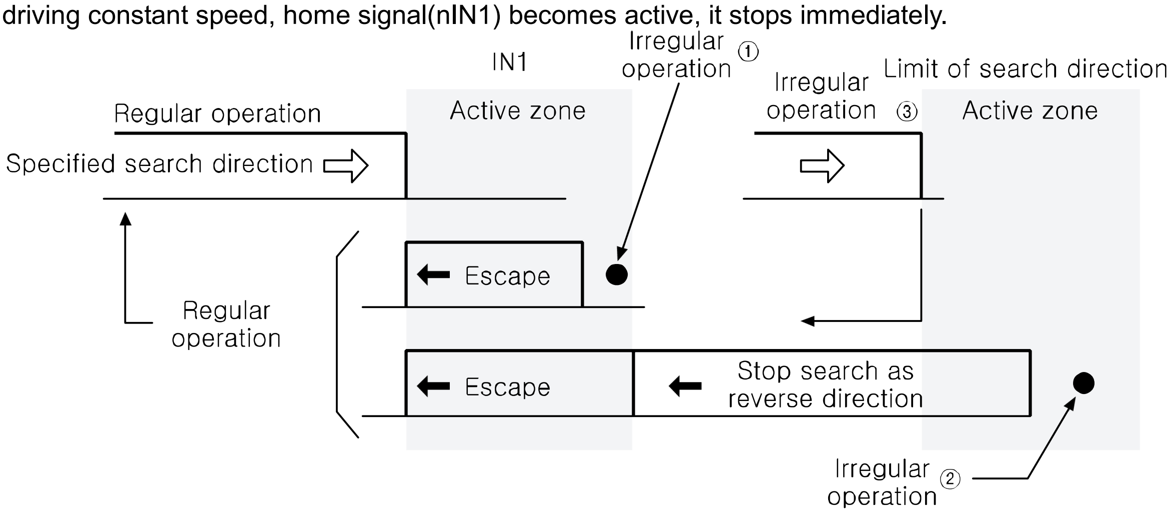
① Before starting Step 1, near home signal(nIN0) is active already → processes to Step 2.

② Before starting Step 1, Limit signal of search direction is active → processes to Step 2.

③ During execution, limit signal of search direction is active → stops driving and processes to Step 2.

(2) Step 2 low speed home search

Low speed home search executes low speed home search speed(HV) when home signal(nIN1) becomes active during drive pulse output the set direction. To execute low speed search operation, set home search speed(HV) lower than start speed(SV). During driving constant speed, home signal(nIN1) becomes active, it stops immediately.



[Irregular operation]

① Before starting Step 2, home signal(nIN1) is active already.
→ until home signal (nIN1) as inactive, it moves home search speed(HV) with the reverse search direction. When home signal (nIN1) is inactive, it starts Step 2.

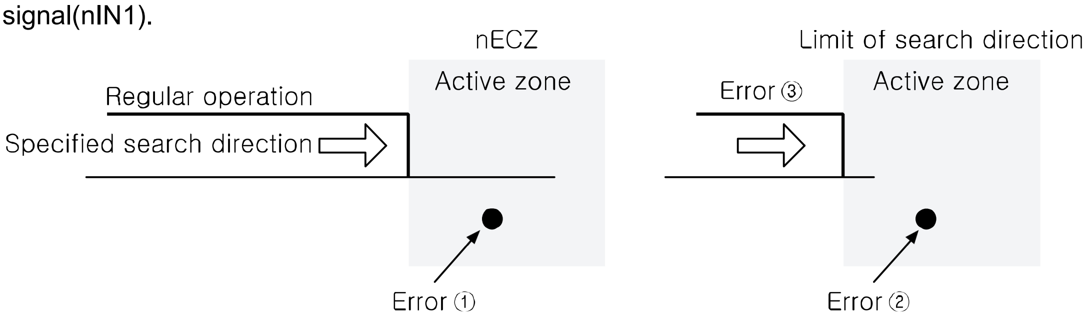
② Before starting Step 2, limit signal of search direction is active.
→ until home signal(nIN1) as active, it moves home search speed(HV) with the reverse search direction. When home signal(nIN1) is active, it moves home search speed(HV)

with the reverse search direction until home signal(nIN1) as inactive. When home signal(nIN1) is inactive, it processes Step 2.

③ During executing, limit signal of search direction is active.
→ Stops driving → it operates same as ②.

(3) Step 3 low speed Z-phase search

When encoder Z-phase signal(nECZ) is active, it outpus drive pulses with home search speed(HV) to the set direction. It operates low speed search, home search speed(HV) shold be lower than start speed(SV).
During constant speed driving, when encoder Z-phase signal(nECZ) is active, it stops immediately.
As the search condition, it stops encoder Z-phase signal(nECZ) as AND condition of home signal(nIN1).



When encoder Z-phase signal(nECZ) is active, it clears actual position counter(EP). Refer to the Actual position counter clear by external signal '5.3.4 Actual position counter clear by external signal'.

Note

① Before starting Step 3, encoder Z-phase signal (nECZ) is active already, it becomes error and D7bit of nRR2 register becomes '1'. Auto home search is complete. Step 3 shold be start when encoder Z-phase signal(nECZ) is inactive status (stable status) by adjusting the machanical system.

② Before starting Step 3, limit signal of search direction is active, it becomes error and search direction imit error bit (D2 or D3) of nRR2 register becomes '1'. Auto home search is complete.

③ During executing, when search direction limit signal is active, search operation stops and search direction limit error bit (D2 or D3) of nRR2 register becomes '1'. Auto home search is complete.

(4) Step 4 high speed offset movement

Step 4 outputs the number of set pulses as Number of output pulses(P) with drive speed(V), and to the set direction. It is available to move from mechanical home to working home. It is available to clear logical position counter and actual position counter by setting mode.
Before starting or running Step 4, when limit signal of movement direction is active, it is error and search direction of nRR2 register limit error bit (D2 or D3) becomes '1' and auto home search ends.

5.5.2 Search speed and mode setting

Speed parameter and mode setting is available to execute auto home search.

(1) Speed parameter setting

Speed parameter	Command code	Description
Drive speed (V)	05	Becomes high speed search speed of Step 1, 4. It is required to set range (R), acceleration(A), start speed(SV) to executing accel/decel drive. Refer to '5.2.2 Linear accel/decel drive'.
Home search speed(HV)	61	Becomes low speed search speed of Step 2, 3. When sensing signal is active, set it lower than start speed(SV) to stop immediately. Refer to '5.2.2 Linear accel/decel drive'.

(2) Auto home search mode setting

Auto home search mode is set by extension mode setting command (60h). Set each bit of WR7 register. When completing auto home search and occuring interrupt, set WR6 register D5 ((HMINT) as '1'. At extension mode setting command (60h), each bit data of WR6 and WR7 is set at inner register at the same time. The other bit of WR6 register should be set properly.

WR7	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
	DCCW2	DCCW1	DCCW0	DCC-L	DCC-E	LIMIT	STAND	PCLR	ST4-D	ST4-E	ST3-D	ST3-E	ST2-D	ST1-E	ST1-D	ST1-E
	Deviation counter clear output								Step 4		Step 3		Step 2		Step 1	

WR6	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
	FL2	FL1	FL0	FE4	FE3	FE2	FE1	FE0	SMODE	0	HMINT	VRING	AVTRI	POINV	EPINV	EPCLR

WR7/D6, 4, 2, 0	STm-E	Set each step operation to enable/disable. 0: Disable, 1: Enable Sets logic setting of searching input signal for each step by WR1 register. Refer to '7.4 WR1 mode register 1'.
WR7/D7, 5, 3, 1	STm-D	Set search/movement direction for each step. 0: + direction, 1: - direction
WR7/D8	PCLR	When setting as '1', logical position counter and actual position counter is cleared after completing Step 4.
WR7/D9	SAND	When setting as '1', Step 3 operation stops when home signal (nIN1) is active and encoder Z-phase signal(nIN2) is active.
WR7/D10	LIMIT	By over run limit signal(nLMT+ or nLMT-), set '1' when executing auto home search.
WR7/D11	DCC-E	Set as '0'. (This board does not support deviation counter clear function.)
WR7/D12	DCC-L	Set as '0'.
WR7/D15 to 13	DCCW2 to 0	Set as '0'.

WR5/D5	HMINT	After completing auto home search, generates interrupt signal(INTN). When this bit is ‘1’, interrupt signal (INTN) becomes low active after completing auto home search and RR3/D8 (HMEND) bit of interrupted axis is set as ‘1’. When reading RR3 register of interrupted axis, RR3 register bit is cleared as ‘0’ and interrupt output signal returns to Hi-Z.

At reset, mode setting bit for each axis is set as ‘0’ all.

5.5.3 Auto home search run and status

(1) Auto home search run

Auto home search is set by auto home search run command(62h). Set auto home search mode and speed parameter of each axis at first, designate the axis at WR0 register and write command code 62h to start. It is available to execute for each axis individually or all axes at the same time.

(2) Auto home search stop

To stop auto home search in the middle, set drive deceleration stop command(26h) or drive immediate stop command(27h) to the operating axis. Currently operating step stops and it finishes auto home search.

(3) Main status register

D3 to D0 of main status register RR0 is the bit for drive operation status for each axis. When operating auto home search, it is able to check status with this bit. When starting auto home search of each axis, this bit is ‘1’ until from Step 1 start to Step 4 completion. When completing Step 4, it returns to ‘0’.

	H								L							
RR0	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
	-	BPSC1	BPSC0	ZONE2	ZONE1	ZONE0	CNEXT	I-DRV	U-ERR	Z-ERR	Y-ERR	X-ERR	U-DRV	Z-DRV	Y-DRV	X-DRV

Deviation counter clear output

Drive of each axis

Be sure that D7 to D4(n-ERR) bit for each axis’ error may indicate ‘1’ even though the normal operation of limit signal due to irregular operation of Step 1, 2. This error bit should be checked when auto home search completes not during auto home search running.

(4) Status register 2

Status register 2(RR2) indicates error information at D7 to D0 and home search run status at D12 to D8.

	H								L							
RR2	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
	-	0	0	HMST4	HMST3	HMST2	HMST1	HMST0	HOME	0	ENG	ALARM				

Auto home output operation state

Signal error for auto home output

At D7(HOME) bit of error information bit during auto home search, encoder Z-phase signal(nIN2) is active already when starting Step 3, it becomes '1'. This bit is cleared when the next drive command or auto home search command is set.
Completion status clear command (25h) is also available to clear. Auto home search run state is for the current run status during auto home search running.

Run state	Run step	Description
0		Waits auto home output run command.
3	Step 1	Waits IN0 signal to be active as specified search direction
8		Waits IN1 signal to be active as specified search reverse direction (Irregular operation)
12	Step 2	Waits IN1 signal to be inactive as specified search reverse direction (Irregular operation)
15		Waits IN1 signal to be active as specified search direction
20	Step 3	Waits ECZ signal to be active as specified search direction
25	Step 4	Offset moving as specified search direction.

5.5.4 Error of auto home output

When running auto home search, error may be occur as the below table.

Error factors	Operation after occurring error	Completion mark
Alarm signal active at Step 1 to 4	Search drive immediately stops, the next step does not run and completes.	RR0-D7 to 4:1, nRR2-D4:1, nRR1-D14:1
EMG signal active at Step 1 to 4	Search drive immediately stops, the next step does not run and completes.	RR0-D7 to 4:1, nRR2-D5:1, nRR1-D15:1
Limit signal (LMT+/-) active of process direction at Step 3	Search drive stops immediate /deceleration, the next step does not run and completes.	RR0-D7 to 4:1, nRR2-D3/2:1, nRR1-D13/12:1
ECZ signal active before starting at Step 3	The next step does not run and completes.	RR0-D7 to 4:1, nRR2-D7:1

After completing auto home search, you must check error Bit (RR0-D7 to D4) of each axis. Error bit set as '1' does not execute the right auto home search. On the other hand, during auto home search running, do not check error bit of each axis. Due to irregular operation of Step 1, 2, error bit may be set as '1'.

(1) Symptoms when sensor failure

It describes about the symptoms when sensor circuit such as home signal or limit signal has fail. It is difficult to translate about the failure due to wiring noise or unstable element operation. In this chapter, it describes only for logic setting and signal connection of signal level during system developemt.

Failure factors		Symptoms
Failure of limit sensor and wiring path	Always ON	The specified direction is not moved, and limit error bit (nRR2-D3/2) becomes '1'.
	Always OFF	Be hit on the mechanical end point of the specified direction and home output operation does not finish.
Failure of near home(nIN0) sensor and wiring path	Always ON	Even though setting Step1 as valid, and starting signal auto home output at OFF position, it does not execute Step1 (high speed near home search) and processes to Step2.
	Always OFF	Stops Step1 (high speed near home search) at limit and processes irregular Step2 operation. The result of home output is right but it is not general operation.
Failure of near home(nIN1) sensor and wiring path	Always ON	Moves as Step2(low speed home search) to reverse direction and stops the reverse direction limit. When it finished, errorbit (nRR2-D3/2) of reverse direction limit becomes '1'.
	Always OFF	Moves as Step2 (low speed home search) at the specified direction limit to the reverse direction, and it stops at the reverse direction limit. When it finished, error bit (nRR2-D3/2) of the revese direction limit becomes '1'.
Failure of Z-phase (nECZ) sensor and wiring path	Always ON	Finishes at Step 3 (low speed Z-phase search). nRR2-D7 becomes '1'.
	Always OFF	Stops as Step3 (low speed Z-phase search) at the specified direction limit. When it finished, error bit (nRR2-D3/2) of the specified direction limit becomes '1'.

5.5.5 Caution for auto home output

(1) Search speed

Home search speed (HV) should be set as low speed to raise position accuracy during home searching. Set it lower than start speed value when input signal is active to stop immediately. When executing encoder Z-phase search of Step3, it is important of Z-phase signal delay and home search speed(HV) relation. When delay time of photo-coupler for Z-phase signal and delay time of integral filter are max. 500 ㎲, you should set home search speed for Z-phase output of encoder to ON for over 1msec.

(2) Step3 (Z-phase search) start position

Z-phase search of Step3 stops search drive when Z-phase (nECZ) signal changes as active from inactive status. Therefore, start position of Step3 (stop position of Step2)should be out of the changed point. Generally, you should adjut start poition of Step3 to the 180° reverse of encoder Z-phase position.

(3) Software limit

When running auto home search, software limit is not applied. When applying software limit, auto home search does not run properly. After completing auto home search normally, you should set logical position counter, actual position counter at first and set software limit.

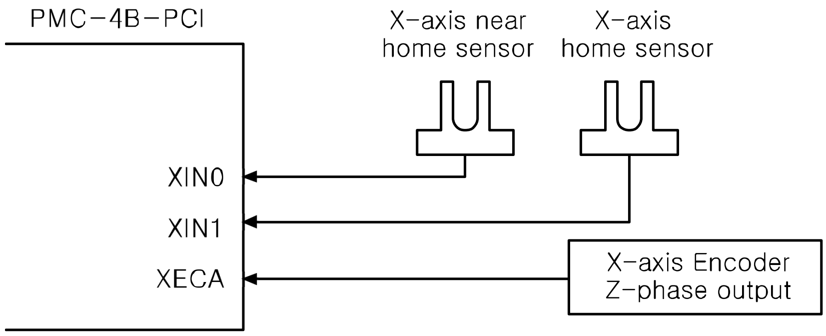
(4) Logic setting of each input signal

Set input signal for auto home search as bit (WR1-D2, D4, D7) of WR1 register.

5.5.6 Example of auto home search

(1) Example of home search by near home, home, Z-phase signal

Step	Input signal and logic level	Search direction	Search speed
Step1	Near home(IN0)signal, low active	-	20,000pps
Step2	Home(IN1)signal, low active	-	500pps
Step3	Z-phase (XECZ)signal, high active	+	500pps
Step4	(Moves 3500 pulses offset to + direction)	+	20,000pps



- High speed search of Step1 and offset movement of Step4 operate as accel/decel drive. It dirives linear accel/decel (accel/decel=19,000/0.2=95,000pps/sec) with Start speed: 1,000pps to 20,000pps for 0.2sec.
- After completing Step4, it clears the value of logical position counter and actual position counter.

[Parameter and mode setting]

WR0←010Fh write	Select X-axis		
WR1←0010h write	Set input signal logic		
	XIN0, XIN1: Low active,		
	XIN2: High active		
	(Refer to '7.4 WR1 mode register 1'/)		
WR6←5D00h write	Set extension mode		
WR7←015Fh write	Record input signal filter mode of WR6		
	(Refer to '5.8 Input signal filter'/)		
	D15 to D13	010	Filter delay: 512 ㎲
	D9	0	XIN2 signal: filter invalid
	D8	1	XIN1, 0signal: filter valid
	Record auto home search mode of WR7		
	D15 to D13	000	
	D12	0	
	D11	0	
	D10	0	Use limit signal as home signal: Invalid
	D9	0	Z-phase signal AND home signal: Invalid
	D8	1	Logical/Actual position counter clear:

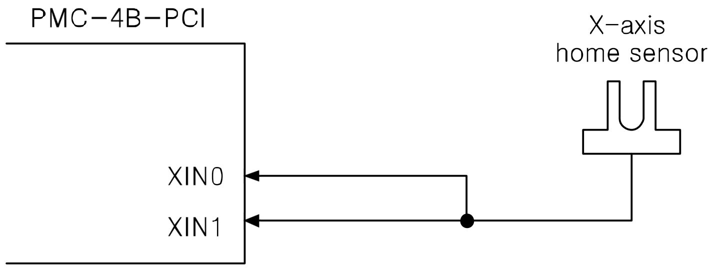
			Valid
	D7	0	Step4 movement direction: +direction
	D6	1	Step4: Valid
	D5	0	Step3 search direction: +direction
	D4	1	Step3: Valid
	D3	1	Step2 search direction: -direction
	D2	1	Step2: Valid
	D1	1	Step1 search direction: -direction
	D0	1	Step1: Valid
WR0←0160h write	Record extension mode setting command as X-axis		
WR6←3500h write	Range: 8,000,000 (Magnification: 10)		
WR7←000Ch write			
WR0←0100h write			
WR6←004Ch write	Accel/Decel: 95,000pps/sec		
WR0←0102h write	95,000/125/10=76		
WR6←0064h write	Start speed: 1000pps		
WR0←0104h write			
WR6←07D0h write	Step 1, 4 speed: 20,000pps		
WR0←0105h write			
WR6←0032h write	Step 2, 3 speed: 500pps		
WR0←0161h write			
WR6←0DACh write	Offset movement pulses: 3500		
WR7←0000h write			
WR0←0106h write			
WR0←0162h write	Auto home search run start		

After running start, when RR0-D0 (X-DRV) bit returns from ‘1’ to ‘0’, auto home search is finished. After finishing, limit at RR0-D4 (X-ERR) is ‘1’, some error during auto home occurs and auto home search does not finish normally. Use XRR2-D7, D5 to D0 bit, XRR1-D15 to D12 bit for interpretation.

(2) Example of home search for home signal

This example is to input home signal at IN0 and IN1 terminal and to operate high speed home search as one home signal.

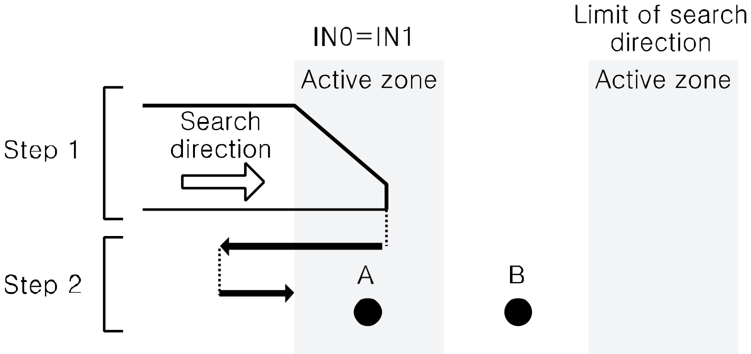
Step	Input signal and logic level	Search direction	Search speed
Step1	Near home (IN0)signal, low active	-	20,000pps
Step2	Home (IN1)signal, low active	-	500pps
Step3	-		
Step4	(3500 pulse offset movement to + direction)	+	20,000pps



As the above table, set signal logic level of Step1 and Step2 as search direction as same. (It is possible to set logic level as reverse.) When home searching at Step1 with high speed and home signal becomes active, it stops by deceleration.

When stop position is in active zone of home signal, it escape by the ① irregular operation of Step2 as the reverse direction and enters Step2 operation and searches home. If Step1 stop position is out of active zone of home signal, it is caught at search direction limit as Step2 and it becomes ③ irregular operation.

In case that auto home search start position is the 'A' point as the below figure, Step1 does not run, it runs ① irregular operation of Step2. In case of at 'B' point as the below figure, it caught at search direction limit of Step1, and runs ② irregular operation of Step2.



[Parameter and mode setting]

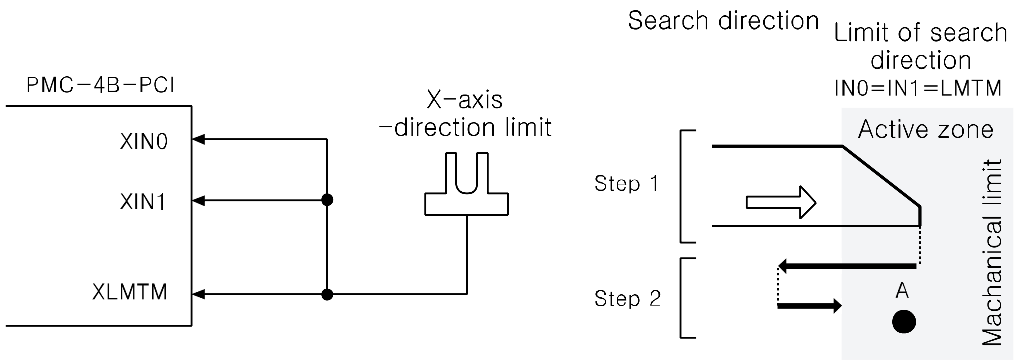
WR0←010Fh write	Select X-axis
WR1←0000h write	Set input signal logic XIN0: Low active, XIN1: High active (Refer to '7.4 WR1 mode register 1.)
WR6←5F00h write	Set extension mode
WR7←014Fh write	Record input signal filter mode of WR6 (Refer to '5.8 Input signal filter'.) D15 to D13 010 Filter delay: 512 ㎲

	D8	1	XIN1, 0signal: filter valid
	Records auto home search mode of WR7		
	D15 to D13	000	
	D12	0	
	D11	0	
	D10	0	Use limit signal as home signal: Invalid
	D9	0	Z-phase signal AND home signal: Invalid
	D8	1	Logical/Actual position counter clear: Valid
	D7	0	Step4 movement direction: +direction
	D6	1	Step4: Valid
	D5	0	Step3 search direction: +direction
	D4	0	Step3: Valid
	D3	1	Step2 movement direction: -direction
	D2	1	Step2: Valid
	D1	1	Step1 movement direction: -direction
	D0	1	Step1: Valid
WR0←0160h write	Record extension mode setting command as X-axis		
WR6←3500h write	Range: 8,000,000 (Magnification: 10)		
WR7←000Ch write			
WR0←0100h write			
WR6←004Ch write	Accel/Decel: 95,000pps/sec		
WR0←0102h write	95,000/125/10=76		
WR6←0064h write	Start speed: 1000pps		
WR0←0104h write			
WR6←07D0h write	Step 1, 4 speed: 20,000pps		
WR0←0105h write			
WR6←0032h write	Step 2, 3 speed: 500pps		
WR0←0161h write			
WR6←0DACh write	Offset movement pulses: 3500		
WR7←0000h write			
WR0←0106h write			
WR0←0162h write	Auto home search run start		

(3) Example of home search by limit signal

This is to use one side limit signal as home signal. It has two conditions.

- When running high speed search, it should stop enough decelerately within up to the mechanical limit distance at the position of limit signal becoming active.
- The start position for auto home search should not out of limit search zone.
  In this example, it is to use –direction limit signal as home signal.
  - Connect XLMT – input to XIN0 (XIN0+, XIN0-) and XIN1 input terminal as the figure.
  - It runs high speed search of Step1, set limit stop mode as deceleration stop. (For WR2/D2 bit, refer to '7.5 WR2 mode register 2')
  - Set logic level of XLMT-, XIN0, XIN1 signal as same. (For WR2/D4, refer to '7.5 WR2 mode register 2'. For WR1/D0, 2 bit, refer to '7.4 WR1 mode register 1')
  - Set WR7/D10 (Limit signal use) bit of extension mode as '1'.



[Operation]
As the figure, Step1 moves to limit with high speed at –direction. When – limit signal becomes active, it stopsby deceleration and processes Step2. By ②irregular operation of Step2, it escape limit at the reverse direction and moves with low speed at the search direction. It searches limit signal active and stops. When auto home search start position is within limit ('A' point of the figure), Step1 operation does not run, it starts from Step2.

[Parameter and mode setting]

WR0←010Fh write	Select X-axis		
WR1←0000h write	Set input signal logic		
	XIN0: Low active,		
	XIN1: Low active		
	(Refer to '7.4 WR1 mode register 1'.)		
WR2←0004h write	D4	0	-Limit signal logic: Low active
			(Refer to '7.5 WR2 mode register 2')
	D2	1	Limit stop mode: Deceleration stop
	Set extension mode		
WR6←5F00h write	Record input signal filter mode of WR6 (Refer to '5.8 Input signal filter'.)		
	D15 to 13	010	Filter delay: 512 ㎲
	D8	1	XLMTM, XIN1, 0 signal: filter valid
WR7←054Fh write	Record auto home search mode of WR7		
	D15 to D13	000	
	D12	0	

	D11	0	
	D10	1	Use limit signal as home signal: Valid
	D9	0	Z-phase signal AND home signal: Invalid
	D8	1	Logical/Actual position counter clear: Valid
	D7	0	Step4 movement direction: +direction
WR0←0160h write	D6	1	Step4: Valid
WR6←3500h write	D5	0	Step3 search direction:
WR7←000Ch write	D4	0	Step3: Invalid
WR0←0100h write	D3	1	Step2 search direction: -direction
WR6←004Ch write	D2	1	Step2: Valid
WR0←0102h write	D1	1	Step1 search direction: -direction
WR6←0064h write	D0	1	Step1: Valid
WR0←0104h write	Record extension mode setting command as X-axis		
WR6←07D0h write	Range: 8,000,000 (Magnification: 10)		
WR0←0105h write	Accel/Decel: 95,000pps/sec		
WR6←0032h write	95,000/125/10=76		
WR0←0161h write	Start speed: 1000pps		
WR6←0DACh write	Step 1, 4 speed: 20,000pps		
WR7←0000h write	Step 2 speed: 500pps		
WR0←0106h write	Offset movement pulses: 3500		
WR0←0162h write	Auto home search run start		

[Caution for using limit signal]

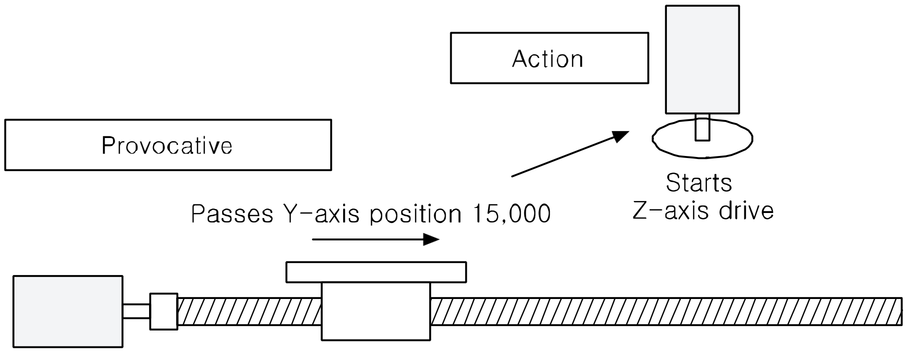
- Search direction of Step1, 2 must be same direction. When operating Step3 (Z-phasesearch), it operates as reverse direction of Step1, 2 direction. Set Step4 (Offset movement) as the reverse of Step1, 2 direction.
  Auto home search must be complete out of limit active zone.
- In case of Step3 operation, AND of Z-phase signal and home signal(IN1) are not applied. WR7/D9 (SAND) bit of extension mode setting must be set ‘0’.

5.6 Synchronous operation

Synchronous operation relates drive start/stop operation (Active) between each axis and the other device.

Ex.

- Ex1: When Y-axis passes 15,000, drive of Z-axis starts.



- Ex2: When X-axis passes -320,000, drive of Y, Z –axis stops.
- Ex3: When input signal input, position data of X, Y, Z –axis is saved.

Generally, this synchronous operation is able to run by writing the program. When software run delay time is not available, this function is convenient. Synchronous operation runs the specified operation when the set provocative facotr occurs. Because this operation runs without the interference of motion control IC, it is useful when synchronous of the precise operation is required.

Synchronous operation sets provocative factors and operation as synchronous operation mode register as the below.

Set provocative factors and the other axis start at WR6 register, and operation(Active) at WR7 register. Designate the axis at WR0 register and set synchronous operation mode setting command 64h.

There are 10 types of provocative factors set by WR6 reigster and 14 types of operation set by WR7 as the below.

	H								L							
WR6	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
	AXIS3	AXIS2	AXIS1	0	0	0	CMD	LPRD	IN3 ↓	IN3 ↑	D-END	D-STA	P≥C-	P<C-	P<C+	P≥C+

Designate axis (D15–D13) Provocative factor (D9–D0)

Set provocative factor, the other axis start bit as '1', it is valid. Set as '0' it is invalid.

D0	P≥C+	Logical/Actual position counter is bigger than COMP+ register.
		(Set Logical/Actual position counter selection by WR2/D5(CMPSL) bit)
D1	P<C+	Logical/Actual position counter is smaller than COMP+ register.
D2	P<C-	Logical/Actual position counter is smaller than COMP- register.
D3	P≥C-	Logical/Actual position counter is bigger than COMP- register.
D4	D-STA	Drive start
D5	D-END	Drive end
D6	IN3 ↑	nIN3 signal changes from low to high level

D7	IN3 ↓	nIN3 signal changes from high to low level
D8	LPRD	Logical position counter command (10h) setting (Set logical position counter(LP) save, actual position counter(EP) save by own/another axis operation(Action) to be able to read at the same time)
D9	CMD	Set synchronous operation start command (65h)
D15 to 13		Designate another axis to operate by start factors of AXIS3 to 1 designated axis 1: Valid

Currently specified-axis (own axis)	D15 (AXIS 3)	D14 (AXIS 2)	D15 (AXIS 3)
X	U-axis start	Z-axis start	Y-axis start
Y	X-axis start	U-axis start	Z-axis start
Z	Y-axis start	X-axis start	U-axis start
U	Z-axis start	Y-axis start	X-axis start

	H								L							
WR7	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
	INT	OUT	0	0	VLSET	OPSET	EPSET	LPSET	EPSAV	LPSAV	ISTOP	SSTOP	CDRV-	CDRV+	FDRV-	FDRV+

Operation (Action)

Set each bit for designating operation(Action) as '1', it is valid. When setting as '0', it is invalid.

D0 FDRV+ +direction fixed drive

D1 FDRV- -direction fixed drive

D2 CDRV+ +direction consecutive drive

D3 CDRV- -direction consecutive drive

D4 SSTOP Drive deceleration stop

D5 ISTOP Drive immediate stop

D6 LPSAV Save current logical position counter(LP) at synchronous buffer register(BP)
LP→BR

D7 EPSAV Save current actual position counter(EP) at synchronous buffer register(BP)
EP→BR

D8 LPSET Save WR6, WR7 register value at logical position counter(LP)
LP←WR6, 7
<Refer to (3) of '5.6.3 Caution for synchronous operation' >

D9 EPSET Save WR6, WR7 register value at actual position counter (EP)
EP←WR6, 7
<Refer to (3) of '5.6.3 Caution for synchronous operation' >

D10 OPSET Set WR6, WR7 register value at number of output pulses(P)
P←WR6, 7
<Refer to (3) of '5.6.3 Caution for synchronous operation' >

D11 VLSET Set WR6 register value at drive speed(V)
V←WR6
<Refer to (3) of '5.6.3 Caution for synchronous operation' >

D14	OUT	Not used (Set as '0')
D15	INT	Interrupt signal(INTN) generates When interrupt signal(INTN) becomes low active, RR3/D9 (SYNC) bit of the axis which generates interrupt is '1'. When reading RR3 register of the axis which generates interrupt by motion control IC, bit of RR3 register is cleared as '0' and interrupt output signal returns to Hi-Z. At reset, all provocative factors and operation become invalid.

5.6.1 Example of synchronous operation

(1) Ex 1. Y-axis passes 15,000 → Z-axis + direction fixed drive start

Set parameters, commands as below.
After starting Y-axis drive, when Y-axis passes 15,000 pulse, +direction fixed drive of Z-axis starts.

WR6←3500h
WR7←000Ch Y, Z-axis range: 800,000 (Magnification: 10)
WR0←0600h

WR6←0190h
WR7←0000h Y, Z-axis acceleration: 400×125×10=500kpps/sec
WR0←0602h

WR6←0032h
WR7←0000h Y, Z-axis start speed: 50×10=500 pps
WR0←0604h

WR6←0BB8h
WR7←0000h Y, Z-axis drive speed: 3000×10=30kpps
WR0←0605h

WR6←C350h
WR7←0000h Y-axis output pulses: 50,000
WR0←0206h

WR6←2710h
WR7←0000h Z-axis output pulses: 10,000
WR0←0406h

WR6←3A98h
WR7←0 Set 15,000 at Y-axis COMP+
WR0←020Bh

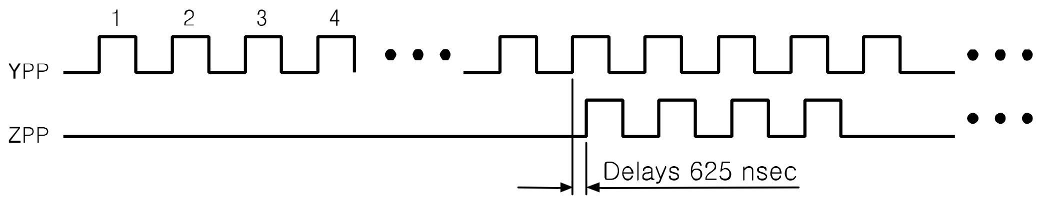
WR6←0		
WR7←0	Y, Z-axis logic Counter (LP) clear	
WR0←0609h		

WR6←2001h	Provocative: P≥C+, the other axis start: Z	Y-axis synchronous operation mode setting
WR7←0000h	Own axis operation: None	
WR0←0264h		

WR6←0000h		
WR7←0001h	Own axis operation: +direction fixed drive	Z-axis synchronous operation mode setting
WR0←0464h		

WR0←0220h	Y-axis +direction fixed drive start

From Y-axis 15,000th pulse start to the 1pulse start of Z-axis, delay time is 5SCLK (625nsec CLK=16MHz).



(2) Ex 2. X-axis passes -320,000 → Y, Z-axis drive stop

WR6←3500h	
WR7←000Ch	X, Y, Z-axis range: 800,000 (Magnification: 10)
WR0←0700h	

WR6←0190h	
WR7←0000h	X, Y, Z-axis acceleration: 400×125×10=500kpps/sec
WR0←0702h	

WR6←0032h	
WR7←0000h	X, Y, Z-axis start speed: 50×10=500 pps
WR0←0704h	

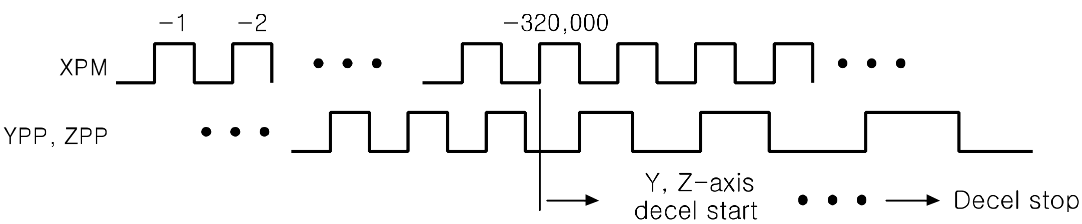
WR6←0BB8h	
WR7←0000h	X, Y, Z-axis drive speed: 3000×10=30kpps
WR0←0705h	

WR6←A120h	
WR7←0007h	X-axis output pulses: 50,000

WR0←0106h		
WR6←1E00h		
WR7←FFFBh	-320,000 at X-axis COMP-	
WR0←010Ch		
WR6←0		
WR7←0	X-axis logic counter (LP) clear	
WR0←0109h		
WR6←6004h	Provocative: P<C-, the other axis start: Y, Z	X-axis synchronous operation mode setting
WR7←0000h	Own axis operation: None	
WR0←0164h		
WR6←0000h		
WR7←0010h	Own axis operation: Deceleration stop	Y, Z-axis synchronous operation mode setting
WR0←0664h		
WR0←0622h	Y, Z-axis + direction consecutive drive start	
WR0←0121h	X-axis –direction fixed drive start	

At the example 2, after starting drive Y, Z-axis consecutively, X-axis starts at –direction with fixed drive. When X-axis passes -320,000 pulse, Y, Z-axis stop decelerately.

If designating synchronous operation of Y, Z-axis as immediate stop, when X-axis passes -320,000 pulse, Y, Z-axis stops immediately.



(3) Ex 3. input signal(XIN3) input → Saves position data of X, Y, Z –axis

After starting drive of X, Y, Z-axis, when XIN3 signal is input, logical position counter value of 3-axis is saved at buffer register (BR) of each-axis. Operation order is to be low active interrupt output signal(INTN) at X-axis and to read buffer of each axis.

WR6←3500h	
WR7←000Ch	X, Y, Z-axis range: 800,000 (Magnification: 10)
WR0←0700h	
WR6←0190h	
WR7←0000h	X, Y, Z-axis acceleration: 400×125×10=500kpps/sec
WR0←0702h	
WR6←0032h	
WR7←0000h	X, Y, Z-axis start speed: 50×10=500 pps WR0←0704h
WR0←0BB8h	
WR7←0000h	X, Y, Z-axis drive speed: 3000×10=30kpps
WR0←0705h	
WR6←0	
WR7←0	X, Y, Z-axis logic counter(LP) clear
WR0←0709h	
WR6←6080h	Provocative: XIN3↓, the other axis start: Y, Z — X-axis synchronous operation mode setting
WR7←8040h	Own axis operation: LP operation, interrupt occurance
WR0←0164h	
WR6←0000h	
WR7←0040h	Own axis operation: LP save — Y, Z-axis synchronous operation node setting
WR0←0664h	
WR0←0722h	X, Y, Z-axis +direction consecutive Drive start

↓

XIN3 input signal input, interrupt occurance

↓

Check interrupt by synchronous operation (Check D9(SYNC)=1 by reading XRR3 register)

WR0←0114h	
RR6→read	X-axis buffer read
RR7→read	

WR0←0214h		
RR6→read	Y-axis buffer read	
RR7→read		
WR0←0414h		
RR6→read	Z-axis buffer read	
RR7→read		

(4) Ex 4. Consecutive operation of fixed pulse drive

When using synchronous operation function, the next drive starts after driving and executes consecutively fixed drive. The below example is it moves to -5,000 immediately after finishing movement +15,000.

WR6←3500h		
WR7←000Ch	X-axis range: 800,000 (Magnification: 10)	
WR0←0100h		
WR6←0190h		
WR7←0000h	X-axis acceleration: 400×125×10=500kpps/sec	
WR0←0102h		
WR6←0032h		
WR7←0000h	X-axis start speed: 50×10=500 pps	
WR0←0104h		
WR6←0BB8h		
WR7←0000h	X-axis drive speed: 3000×10=30kpps	
WR0←0105h		
WR6←0		
WR7←0	X-axis logic counter(LP) clear	
WR0←0109h		
WR6←0020h	Provocative: Drive end	
WR7←8402h	Own axis operation: P←WR6, 7	X-axis synchronous operation mode setting
WR0←0164h	-direction fixed Drive interrupt occurance	
WR6←1388h		
WR7←0000h	Output pulses of next drive: 5,000	
WR0←0120h	X-axis +direction fixed Drive start	
↓		

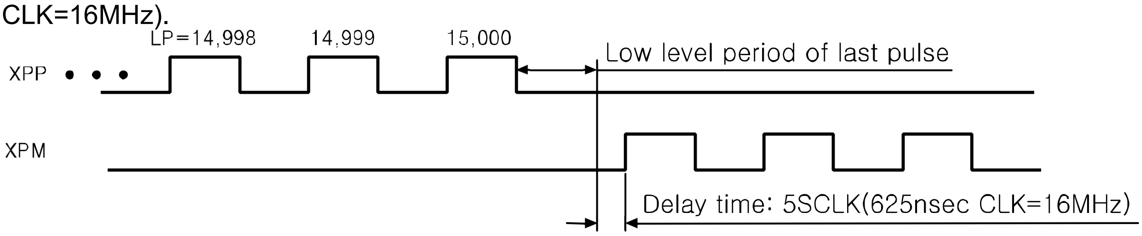
15,000 +direction fixed drive end

↓

-5,000 –direction fixed drive start, interrupt occurance

XRR3→read	Check interrupt occurance by synchronous operation Check D9 (SYNC)=1	
WR6←0000h		
WR7←0000h	Synchronous operation mode clear	Process within interrupt routine
WR0←0164h		

Delay time from +15,000 movement end to -5,000 movement start is 5SCLK (when 625nsec CLK=16MHz).



At Ex4), it clears synchronous operation mode by starting -5,000 drive and generating interrupt at the same time. If it does not clear, it runs only –direction fixed drive.
When drive stops by +direction limit(LMT+) or emergency stop(EMG) during +15,000, the next -5,000 drive runs. If this situation may be the system problem, be careful that synchronous operation use.

5.6.2 Delay time of synchronous operation

Delay time of synchronous operation is the sum of delay from provocative factors generation to operation (Action) as the below table.

(1) Delay from provocative factors generation

1SCLK=125nsec (When CLK=16MHz)

Provocative factor	Definition of delay start		Delay time (SCLK)		
			Min.	Norm	Max.
P≥C+ P<C+ P<C- P≥C-	P=LP	When LP value corresponds of CMP+/- register comparing conditions, until ↑ of drive pulse		1	
	P=EP (A/B phase input)	When EP value corresponds of CMP+/- register comparing conditions, until ↑↓ of nECA/B input signal	3		4
D-STA	When recording drive command, until ↓ of WRN signal		1		2
D-END	Until low level end of the last drive pulse			1	
IN3↑	Until ↑ of nIN3 signal (at inner filter invalid)		0		1
IN3↓	Until ↓ of nIN3 signal (at inner filter invalid)		0		1
LPRD	Records LP read command (10h) and until ↓ of WRN signal		0		1
CMD	Records synchronous operation start command (65h) and until ↓ of WRN signal		0		1

(2) Delay to operation (Action)

1SCLK=125nsec (When CLK=16MHz)

Operation	Definition of delay start	Delay time (SCLK)
FDRV+ FDRV- CDRV+ CDRV-	Until ↑ of the 1 drive pulse	4
SSTOP	Until starting deceleration	※1
ISTOP	Until stopping drive	※1
LPSAV EPSAV	Until LP, EP value saves at BR(buffer)	1
LPSET EPSET OPSET VLSET	Until WR6, 7 value sets at LP, EP, P, V	1
INT		1

※1. The time to finish currently output 1 drive pulse

Ex.

Delay time from ↑ of IN3 input signal to save logical position counter(LP) at synchronous buffer register(BR) is the sum of IN3 ↑ delay time (0 to 1 SCLK) and LP save delay time(1SCLK), min. 1SCLK to max. 2SCLK.
When CLK=16MHz, it becomes from min. 125nsec to max. 250nsec.

5.6.3 Caution for synchronous operation

- After starting the desired synchronous operation such as setting interrupt at operation(Action), set synchronous operation mode setting command 64h again and clear synchronous operation designation. If it is not cleared, it may operate at the unconsidered point.
- To use synchronous operation function, the below unfinished drive is available.

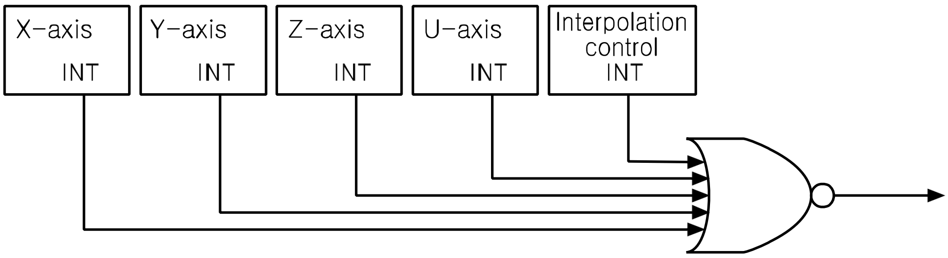
  X-axis drive start → stop → Y-axis drive start → stop

  To stop this loop, set synchronous operation mode setting command 64h again and each bit of start factor and operation as invalid. It is not applied to immediate stop command or deceleration stop command of the driving axis for loop clear.
- For operation (Action) specified D8 (LPSET), D9 (EPSET), D10(OPSET), D11(VLSET), data should be written before starting synchronous operation at WR6, WR7. However, running synchronous operation consecutively, when record timing of WR6, WR7 is late and it is overlap with synchronous operation start, not-data may be accepted.
  Set record of WR6, WR7 at not starting synchronous operation period.
- During current driving, if drive start operation occurs, this operation is ignored. And at the current stop status, the operations of deceleration stop, immediate stop are ignored.

5.7 Interrupt

Interrupt is generated at each X, Y, Z, U-axis, and generated when bit pattern interpolation and consecutive interpolation during interpolation drive. Interrupt signal is one INTN signal.

Therefore, as the below figure, interrupt signal of each axis and bit pattern interpolation, interrupt signal of consecutive interpolation all passes OR gate and generate interrupt.



<Figure 2.42 Interrupt signal path within motion control IC >

Interrupt factors of each axis and interrupt factors during interpolation driving are able to set interrupt enable/disable. At reset, all are disable status.

(1) Interrupt of X, Y, Z, U-axis

The below table is interrupt generating factor of X, Y, Z, U-axis.

	Generation check nRR3 register	Interrupt generation factor
D8 (PULSE)	D0 (PULSE)	One drive pulse output (for positive logic pulse, generates at ↑ of pulse)
D9 (P≥C-)	D1 (P≥C-)	Logical/Actual position counter is bigger than COMP- register(CM).
D10 (P<C-)	D2 (P<C-)	Logical/Actual position counter is smaller than COMP- register(CM).
D11 (P<C+)	D3 (P<C+)	Logical/Actual position counter is smaller than COMP+ register(CM).
D12 (P≥C+)	D4 (P≥C+)	Logical/Actual position counter is bigger than COMP+ register(CM).
D13 (C-END)	D5 (C-END)	Ends pulse output in accel/decel drive at constant speed zone
D14 (C-STA)	D6 (C-STA)	Start pulse output in accel/decel drive at constant speed zone
D15 (D-END)	D7 (D-END)	Ends drive

Each interrupt generation factor is able to set interrupt generate enable(1)/disable(0) by nWR1 register. When starting drive and interrupt is generated, nRR3 register bit becomes ‘1’ and interrupt output signal(INTN) becomes low level. When reading RR3 register of the axis generating interrupt, ‘1’ bit of RR3 register is cleared as ‘0’ and interrupt output signal(INTN) returns to Hi-Z.

Note

In case of 8bit data bus, when reading RR3L register, all cleared. For using auto home search end D8 (HMEND), synchronous operation start D9 (SYNC), read RR3H at first and set RR3L register. The below table is for interrupt of auto home search end, synchronous operation start.

Enable/Disable setting	Generation check nRR3 register	Interrupt generation factor
Extension mode setting command (60h) WR6/D5 (HMINT)	D8 (H-END)	Auto home output end
synchronous operation setting command (64h) WR7/D15 (INT)	D9 (SYNC)	Synchronous operation start by the set start factors

(2) Interrupt of interpolation drive

( ) is interrupt clear method.

Enable/Disable setting WR5 register	Generation check RR0 register	Interrupt generation factor
D14 (CIINT)	D9 (CENEXT)	Enable to record data of the next interpolation segment and interpolation drive command by consecutive interpolation drive (When recording the next interpolation drive command, interrupt is cleared.)
D15 (BPINT)	D14, 13 (BPS1, 0)	In bit pattern interpolation, stack counter (SC) is changed from 2 to 1. Stack for next BP data is available. (When stacking BP data, interrupt is cleared.)

Generated interrupt during interpolation driving is able to clear by interpolation Interrupt clear command(3Dh). When INTN output signal is low, it cleared as interpolation drive and returns to Hi-Z. For interrupt usage of interpolation drive, refer to Bit pattern interpolation, consecutive interpolation.

5.8 Input signal filter

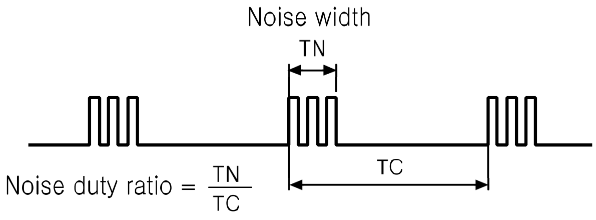
Input terminal of each input signal has the integral filter inside. <Figure 2.43> is filter organization of each input signal for X-axis. (Same as Y, Z, U-axis) Filter pass time is decided by T oscillation circuit as the figure. As WR6 register D15 to 13 (FL2 to 0) bit of extension mode setting command (60h), select one filter pass time of 8 types.

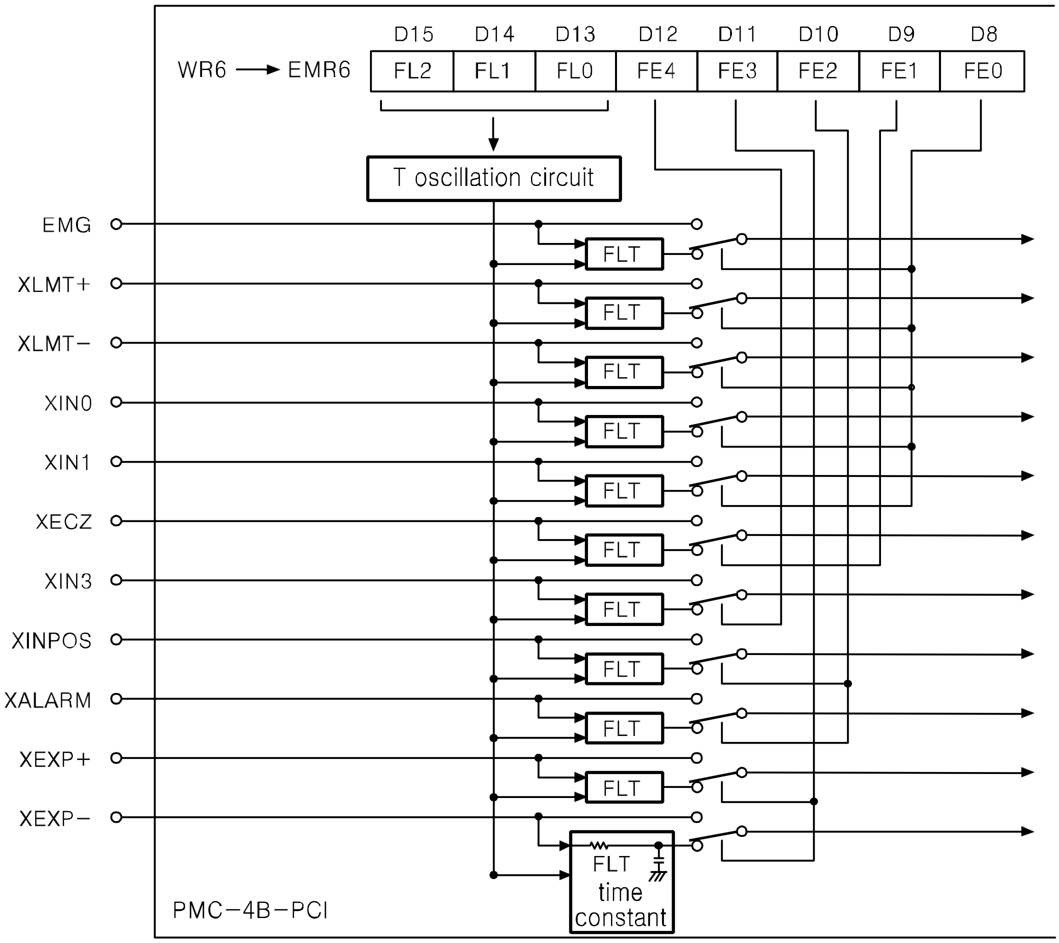
And set input for filter function by D12 to 8 (FE4 to 0) bit of same WR6 register. At reset, all bit of extension mode are cleared and all input signal are not applied to filter function.

For extension mode setting command, refer to '9.16 Extension mode setting'.

There are 8 level of filter pass time as the below table. When increasing pass time, removeable max. noise width increases but signal delay time may be longer. Set the proper value. Generally, it is recommended to set FL2 to 0 as 2 or 3.

FL2 to 0	Removeable max. noise width	Input signal delay time
0	1.75 μs	2 μs
1	224 μs	256 μs
2	448 μs	512 μs
3	896 μs	1.024 ms
4	1.792 ms	2.048 ms
5	3.584 ms	4.096 ms
6	7.168 ms	8.192 ms
7	14.336 ms	16.384 ms





<Figure 2.43 Input signal filter circuit concept diagram >

Noise duty ratio (signal to noise generation time ratio) should be below 1/4 as conditions in any cases. Whether to be valid filter function of each input signal, or to pass input signal not through filter, set WR6 register D12 to 8 (FE4 to 0) bit of extension mode setting command(60h) as the below table. Set ‘1’ at each bit, filter function of this signal is vaild.

Specified bit	Valid signal
WR6/D8 (FE0)	EMG※1, nLMT+, nLMT-, nIN0, nIN1
WR6/D9 (FE1)	nECZ
WR6/D10 (FE2)	INPOS, nALARM
WR6/D11 (FE3)	nEXPM
WR6/D12 (FE4)	nIN3

※1. Set EMG signal by WR6 register D8 bit of X-axis.

(1) Example of input signal filter

Set 512 ㎲ time delay filter at EMG and LMT+, LMT-, IN0, IN1, EXP+, EXP- input signal of X, Y-axis and do not set filter function at the other input signal of X, Y-axis.
Set 2 ㎳ time delay filter at LMT+, LMT-, IN0, IN1, EXP+, EXP- input signal of Z, U –axis and do not set filther function at the other input signal of Z, U-axis.

WR6←4900h write	X, Y -axis extension mode setting		
	Record input signal filter mode at WR6		
	D15 to 13	010	Filter delay: 512 ㎲
	D12	0	IN3 signal: filter invalid
	D11	1	EXP+, EXP-: filter valid
	D10	0	INPOS, ALARM signal: filter invalid
	D9	0	ECZ signal: filter invalid
	D8	1	EMG, LMT+, LMT-, IN1, IN0 signal: filter valid
	Other mode from D7 to D0 inner filter function (Set the proper value. Refer to '9.16 Extension mode setting'.)		
WR7←0000h write	When running auto home search, set the proper value. (Refer to '5.5 Auto home search output'.)		
WR0←0360h write	Record extension mode setting command by X, Y-axis		
	Z, U-axis extension mode setting		
WR6←8900h write	Record input signal filter mode at WR6		
	D15 to D13	100	Filter delay: 2 ㎳
	D12	0	IN3 signal: filter invalid
	D11	1	EXP+, EXP- signal: filter valid
	D10	0	
	D9	0	
	D8	1	
	D7 to D0		Other mode from inner filter function (Set the proper value. Refer to '9.16 Extension mode setting'.)
WR7←0000h write	When running auto home search, set the proper value. (Refer to '5.5 Auto home search output'.)		
WR0←0C60h write	Records extension mode setting command by Z, U-axis		

5.9 Other functions

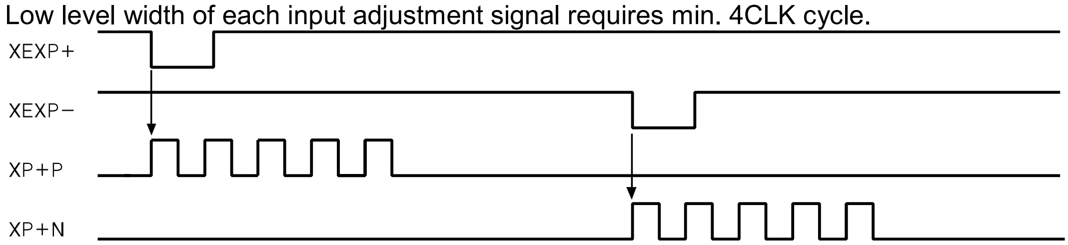
5.9.1 Drive adjustment by external signal

This function is to start fixed drive or consecutive drive by signal input not by setting commands. When there are system and control motor-axis a lot if one motion control IC executes simple jog movement of each axis and manual adjustment all, CPU has too much load and there is possible not to give enough response. By drive adjustment function by external signal, it may reduce this CPU load. And it is able to jog move by inputting 2-phase encoder signal. Each axis has adjustment signal input of nEXP+ and nEXP-.

In fixed drive mode and consecutive drive mode, nEXP+ signal drives at +direction, nEXP- signal drives at –direction. Set whether fixed drive or consecutive drive as D4, D3 bit of WR3 register. Set the required parameter for fixed drive or consecutive drive in advance as the start by command. Set nEXP+ and nEXP- signal as high level generally. In 2-phase encoder signal mode(2-phase pulse input signal), connect A phase signal to nEXP+ input and B phase signal to nEXP- input.

(1) Fixed drive mode

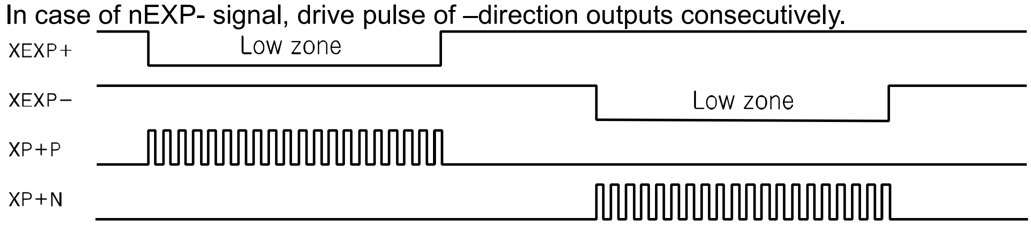
Set D4, 3 bit of WR3 register as ‘1, 0’. Set speed parameter, number of output pulses for driving.
When changing nEXP+ signal from high level to low level, fixed drive of +direction starts.
In case of nEXP- signal, when chaning high level to low level, fixed drive of –direction starts.
Low level width of each input adjustment signal requires min. 4CLK cycle.



<Figure 2.44 Example of output pulse 5 fixed drive by external adjustment signal>

(2) Consecutive pulse drive mode

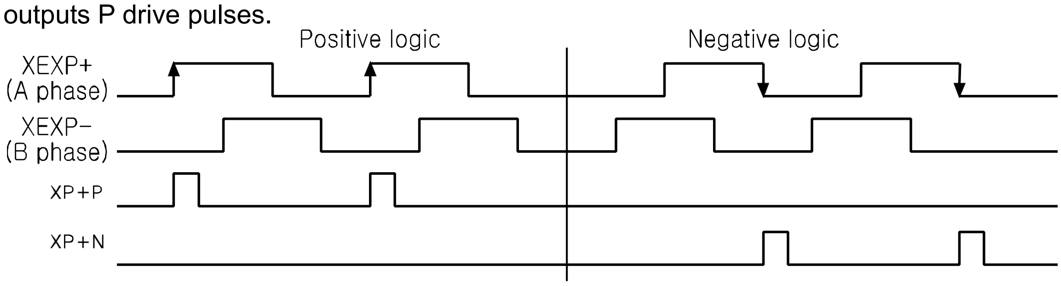
Set D4, D3 bit of WR3 register as ‘0, 1’. Set speed parameter for driving.
When changing nEXP+ signal from high level to low level, drive pulse is output with the set low level width at +direction consecutively. When changing nEXP+ signal from low to high level, accel/decel drive stops by deceleration or constant speed drive stops immediately.
In case of nEXP- signal, drive pulse of –direction outputs consecutively.



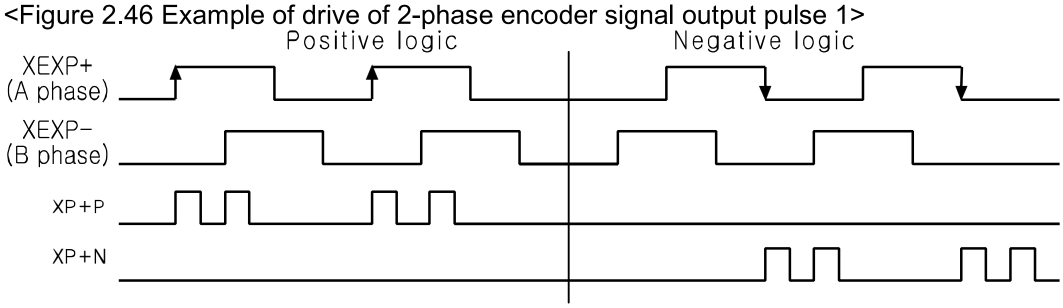
<Figure 2.45 Example of consecutive pulse drive by external adjustment signal >

(3) 2-phase encoder signal mode

Set D4, D3 bit of WR3 register as ‘1,1’. Set speed parameter, the number of output pulses for driving. Connect A phase signal to nEXP+ input, and B phase signal to nEXP- input. When nEXP- signal is low level and nEXP+ signal changes to high level (rising edge), +fixed drive runs. When nEXP- signal is low level and nEXP+ signal changes to low level (falling edge),–fixed drive runs. When setting number of output pulses is 1, each rising of nEXP+ signal, it outputs 1 drive pulse at falling edge. When setting number of output pulses is ‘P’, it outputs P drive pulses.



<Figure 2.46 Example of drive of 2-phase encoder signal output pulse 1>



<Figure 2.47 Example of drive 2-phase encoder signal output pulse 2>

In high, low edge of nEXP+ signal, to output P drive pulses between high, low edge of next signal, set speed parameter as the below condition.
$V \geq F \times P \times 2$

V: Drive speed (pps)
P: output Pulse
F: Frequency for max. high speed of 2-phase encoder signal (Hz)

Ex.

When max. frequency of 2-phase encoder signal is F=500Hz, and output pulse is P=1. Set drive speed V= over1000pps. It does not drive with accel/decel, Start speed SV should set as same value of Drivespeed V. In case of step motor as drive motor, set drive speed not to over the motor start frequency.

5.9.2 Selection of pulse output method

There are two pulse output method as below table for drive output method. Individual 2-pulse method outputs drive pulses in +direction drive at nP+P/nP+N, in -direction drive at nP-P/nP-N.

And 1-pulse method decides drive pulse output by nP+P/nP+N, and direction by nP-P/nP-N.

(Positive logic setting for Pulse/Direction)

Pulse output method	Drive direction	Output signal wave form	
		nP+P/nP+N signal	nP-P/nP-N signal
Individual 2-pulse method	+ direction drive output		Low level
	- direction drive output	Low level	
1-pulse method	+ direction drive output		Low level
	- direction drive output		High level

Set pulse output method by D6(PLSMD) bit of WR2 register. And it is available to set pulse output, direction or logic level.

Note

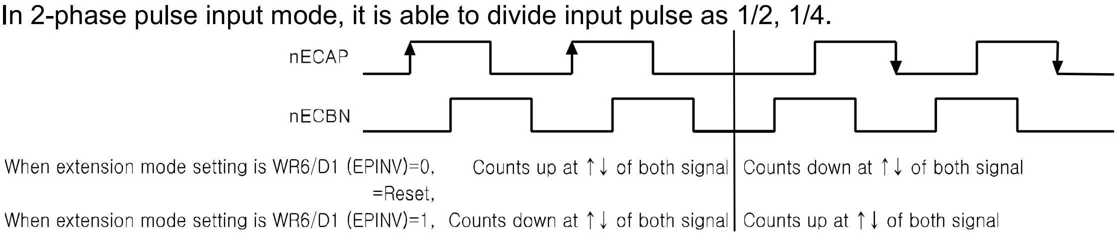
In case of 1-pulse method, check the output timing for pulse signal(nPLS) and direction signal(nDIR). Refer to '15.2 Drive start/end, 15.3 Interpolation drive'.

5.9.3 Selection of pulse input method

There are two encoder pulse input method; 2-phase pulse input, up/down pulse input to up/down count input of actual position counter.

(1) 2-phase pulse input mode

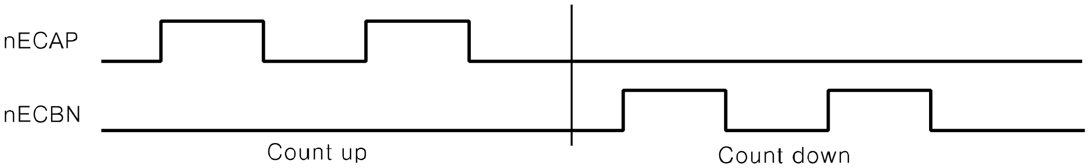
When setting D9(PINMD) bit of WR2 register as '0', it becomes 2-phase pulse input mode. This mode counts up when A phse progresses as positive logic pulse, or counts down when B phase progresses.
It counts up/down at rising/falling edge of both signals. By extension mode setting, set actual position counter increase/decrease reverse bit (WR6/D1) as '1', up/down operation of actual position counter becomes reverse. (Refer to 'Extension mode setting'.)
In 2-phase pulse input mode, it is able to divide input pulse as 1/2, 1/4.



(2) Up/Down pulse input mode

Set D9(PINMD) bit of WR2 register as '1' and it becomes up/down pulse input mode.

nECAP/nECAN counts up inputs, and nECBP/nECBN counts down inputs. It counts at ↑ of each pulse.



Select the pulse input method by D9(PINMD) bit of WR2 register and encoder 2-phase pulse input divided ratio by D11, D10(PIND1, 0) bit.

Note

There are time regulations for pulse width, pulse cycle, etc of input pulse.

5.9.4 Hardware limit signal

Hardware limit signal (nLMT+, nLMT-) is signal input to stop drive pulse of +direction/-direction. When logic level of limit signal and limit signal becomes active, deceleration stop or immediate stop are selectable as command. Set it by D3, D4(HLMT+, HLMT-), D2(LMTMD) bit of WR2 register.

5.9.5 Servo motor driver signal

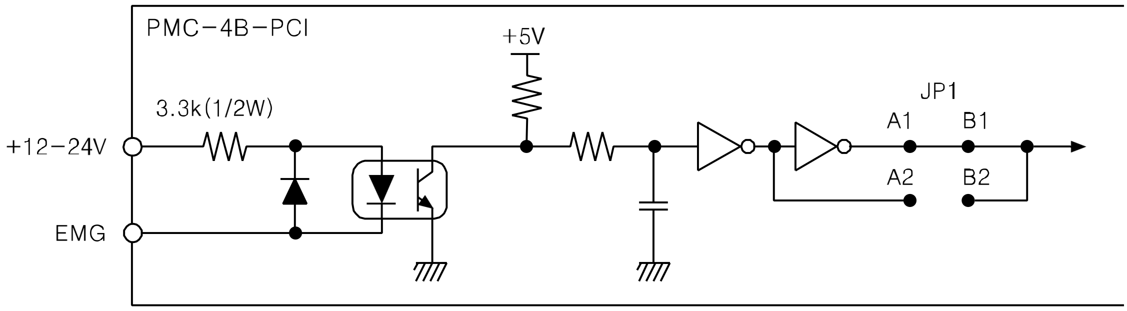
This is input signal for connecting servo motor driver. It has nINPOS to input inposition signal and nALARM to output alarm signal. It is able to set valid/invalid and logic level of each signal.

Set this by D15 to D12 bit of WR2 register. nINPOS input signal corresponds inposition signal of servo motor driver. When setting as valid and nINPOS input signal is active after finishing drive, n-DRV bit of RR0 main status register returns to '0'. nALARM input signal receives alarm signal from servo motor driver. When setting valid, it monitors nALARM input signal always. In case of active status, D4(ALARM) bit of RR2 register becomes '1'. During driving, it stops driving immediate.

This input signal for servo motor driver is able to read the status as RR5, 6 register all the time.

5.9.6 Emergency stop

It is input signal to emergency stop 4-axis all drive. There is ENG signal. EMG signal is generally high level. When it is low level, all driving axes stops immediately and D5(EMG) bit of RR2 register for all axes is '1'. Because EMG signal cannot select logic level, use the jumper pin (JP 1) of PMC-4B-PCI Board to set logic level.

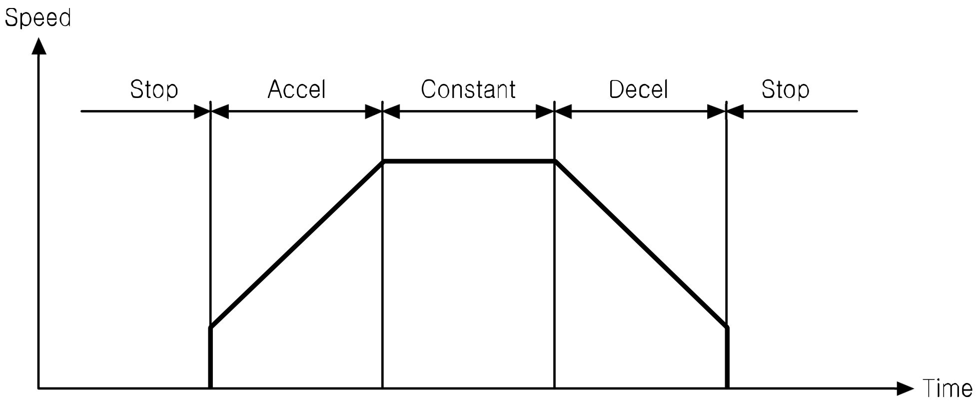


To set emergency stop for a-axis, there are following methods.

- Releasing immediate stop command for 4-axis at the same time.
  Designate all 4-axis to WR0 register and write immediate stop command(27h).
- Set software reset.
  Write 8000h at WR0 register and it resets software.

5.9.7 Drive status output

The drive status driving/stop of each axis outputs at RR0 register D3 to 0(n-DRV) bit.



In each axis drive, the acceleration/constant speed/deceleration status of drive speed outputs at D2(ASND), D3(CNST), D4(DSND) bit of RR1 register for each axis and at nOUT6/ASND, nOUT7/DSND signal. Because signal output is used with general output signal terminal, to output drive status, set D7(OUTSL) bit of WR3 register as '1'.

It cannot use general output signal terminal in PMC-4B-PCI.

The status acceleration/constant speed/deceleration for drive speed during each axis driving outputs at D2(ASND), D3(CNST), D4(DSND) bit of RR1 register for each axis and at nOUT6/ASND, nOUT7/DSND signal. Because signal output is used with general output signal terminal, to output drive status, set D7(OUTSL) bit of WR3 register as '1'.

It cannot use general output signal terminal in PMC-4B-PCI.

Drive status	Register				Output signal	
	RR0/n-DRV	nRR1/ASND	nRR1/CNST	nRR1/DSND	nOUT6/ASND	OUT7/DSND
Stop	0	0	0	0	Low	Low
Acceleration	1	1	0	0	High	Low
Constant speed	1	0	1	0	Low	Low
Deceleration	1	0	0	1	Low	High

At S curve drive, the status increase/constant/decrese of acceleration, deceleration outputs at D5(AASND), D6(ACNST), D7(ADSND) bit of RR1 register.

5.9.8 General output signal

Each axis has 4 general output signals of nOUT7 to 4. Because it is used with position comparisonoutput, drive status output terminal, it cannot use for output. Set nOUT7 to 4 signal at D7(OUTSL) of WR3 register to use general output mode. Set output level value at D11 to 8 (OUT7 to 4) each bit of W3 register to output. General output signal is available to excitation OFF of motor driver, alarm reset, etc.

At reset, each bit of nWR3 register is cleared and all outputs are low level.

6 Description of signal

(1) Description of signal

The signal name, X○○○○, Y○○○○, Z○○○○, U○○○○, is input/output signal of each X-axis, Y-axis, Z-axis, U-axis.

And “n” of n○○○ means X, Y, Z, U. Input signal which has “-F-“ mark has integral filter circuit at input terminal within motion control IC. For filter function, refer to ‘5.8 Input signal filter’.

Signal	Terminal number	Input/Output	Signal description
XP+P / XP+N YP+P / YP+N ZP+P / ZP+N UP+P / UP+N	A38/A39 A78/A48 B38/B39 B47/B48	Output	Pulse+/Pulse: Outputs drive pulse of +direction. At reset, the status is low level. When entering drive operation, positive pulse of duty ratio 50%(in constant speed) outputs. Select positive pulse/negative pulse by mode. When selecting 1-pulse method by mode, this terminal’s drive pulse outputs.
XP-P / XP-N YP-P / YP-N ZP-P / ZP-N UP-P / UP-N	A40/A41 A49/A50 B40/B41 B49/B50	Output	Pulse- / Driection: Outputs drive pulse of –direction. At reset, the staus is low level. When entering drive operation, positive pulse of duty ratio 50%(in constant speed) outputs. Select positive pulse/negative pulse by mode. When selecting 1-pulse method by mode, this terminal becomes direction signal.
XECAP / XECAN YECAP / YECAN ZECAP / ZECAN UECAP / UECAN	A15/A16 A23/A24 B15/B16 B23/B24	Input	Encoder-A / Pulse +in: It is input of encoder A phase signal, it changes Up/Down pulse in motion control IC and becomes count input of actual position counter. When selecting Up/Down pulse input by mode, it is set as Up pulse input and actual position counter counts up at ↑ of input pulse.
XECBP / XECBN YECBP / YECBN ZECBP / ZECBN UECBP / UECBN	A17/A18 A25/A26 B17/B18 B25/B26	Input	Encoder-B / Pulse-in: It is input of encoder B phase signal, it changes Up/Down pulse in motion control IC and becomes count input of actual position counter. When selecting Up/Down pulse input by mode, it is set as Down pulse input and actual position counter counts down at ↑ of input pulse.
XOUT7 / DSND YOUT7 / DSND ZOUT7 / DSND UOUT7 / DSND	A37 A46 B37 B46	Output A	Universal Output 7/ Descend : General output signal. nOut7 to 4 output designates the axis by WR0 register and decides output level of D11 to 8 of WR3 register. At reset, it becomes low. When selecting drive status output mode by mode, it becomes deceleration drive output signal. During

Signal	Terminal number	Input/Output	Signal description
			running drive command and deceleration status, it becomes high level.
XOUT6 / ASND YOUT6 / ASND ZOUT6 / ASND UOUT6 / ASND	A36 A45 B36 B45	Output A	Universal Output 6 / Ascend: General output signal. Setting is same as that of nOUT7. When selecting drive status output mode by mode, it becomes acceleration drive output signal. During running drive command, and acceleration status, it becomes high level.
XOUT5 / CMPM YOUT5 / CMPM ZOUT5 / CMPM UOUT6 / CMPM	A35 A44 B35 B44	Output A	Universal Output 5 / Compare - : General output signal. Setting is same as that of nOUT7. When selecting drive status output mode by mode, and logical/actual position counter is smaller than COMP- register, it becomes high level, as reverse, becomes low level.
XOUT4 / CMPP YOUT4 / CMPP ZOUT4 / CMPP UOUT4 / CMPP	A34 A43 B34 B43	Output	Universal Output 4 / Compare -: General output signal. Setting is same as that of nOUT7. When selecting drive status output mode by mode, and logical/actual position counter is bigger than COMP+ register, it becomes high level, as reverse, becomes low level.
XINPOS YINPOS ZINPOS UINPOS	A13 A21 B13 B21	Input -F-	Inposition: It is input signal corresponding inposition (inposition)output of servo motor driver. Valid/Invalid, logic level are able to set by command. When setting valid, it waits signal becoming active after driving end and n-DRV bit of main status register returns to ‘0’.
XALARM YALARM ZALARM UALARM	A14 A22 B14 B22	Input -F-	Servo Alarm: It is input signal corresponding alarm output for servo motor drive. Valid/Invalid, logic level are able to set by mode. When setting valid and signal becomes active level, ALARM bit of RR2 register becomes ‘1’.
XLMT+ YLMT+ ZLMT+ ULMT+	A3 A8 B3 B8	Input -F-	Over Run Limit +: Over run limit signal of +direction. During drive pulse output of +direction, it becomes active, drive stops by deceleration or stops immediately. When filter function is invalid, active pulse width requires over 2CLK. Deceleration stop/Immediate stop, logic level are able to set by mode. When this signal becomes active level, HLMT+ bit of RR2 register becomes ‘1’.
XLMT- YLMT-	A4 A9	Input -F-	Over Run Limit -: Over run limit signal of –direction. During drive pulse output of -direction, it becomes

Signal	Terminal number	Input/Output	Signal description
ZLMT- ULMT-	B4 B9		active, drive stops by deceleration or stops immediately. When filter function is invalid, active pulse width requires over 2CLK. Deceleration stop/Immediate stop, logic level are able to set by mode. When this signal becomes active level, HLMT+ bit of RR2 register becomes ‘1’.
XIN0 YIN0 ZIN0 UIN0	A6 A11 B6 B11	Input -F-	It is input signal of near home search operation to select active level. When filter function is invalid, active pulse width requires over 2CLK. It is able to read signal status by RR4/RR5 register. It is open collector input. For wiring, refer to ‘4.4 Encoder input signal (nECAP/N, nECBP/N) and nIN0+/- signal connection’.
XECAP/N YECAP/N ZECAP/N UECAP/N	A19 to A20 A27 to A28 B19 to B20 B27 to B28	Input -F-	Encoder-C ECZ is allotted at encoder Z-phase signal.
XIN3, XIN1 to 0 YIN3, YIN1 to 0 ZIN3, ZIN1 to 0 UIN3, XIN1 to 0	A7, A5, A6, A12, A10, A11 B7, B5, B6, B12, B10, B11	Input -F-	Input 3 to 0: The signal for deceleration stop or immediate stop during driving. It is used for input signal of search operation. When filter function is invalid, active pulse width requires over 2CLK. Valid/invalid and logic level for each IN3 to IN1 are able to set. At auto home search, IN1 is allotted at home signal, IN0 is allotted at near home signal. It is able to read signal status by RR4/RR5 register.
XEXP+ YEXP+ ZEXP+ UEXP+	A29 A31 B29 B31	Input -F-	External Operation +: Start signal for +direction externally. In fixed pulse drive mode, +fixed pulse drive starts at ↓ of signal. In external consecutive pulse drive mode, it operates +consecutive pulse drive at low level. In 2-phase encoder signal mode, it inputs encoder A phase signal.
XEXP- YEXP- ZEXP-	A30 A32 B30	Input -F-	External Operation -: Start signal for –direction externally. In external fixed pulse drive mode, -fixed pulse drive starts at ↓ signal. In external consecutive

Signal	Terminal number	Input/Output	Signal description
UEXP-	B32		pulse drive mode, -consecutive pulse drive starts at low level. In 2-phase encoder signal mode, it inputs encoder B phase signal.
EMG	A2	input -F-	Emergency Stop: Emergency stop input signalfor all axes. When this signal is low level and all axes drive including interpolation drive stops immediately, EMG bit of RR2 register for each axis becomes ‘1’. When filter function is invalid, low level pulse width requires over 2CLK. [Caution] This signal is able to select JP1 as logic level.

7 Read/Write register

It describes Read/Write register to control each axis.

For register (BP1P/M, BP2P/M, BP3P/M) of Bit pattern interpolation, refer to '5.4.3 2-axis/3-axis bit pattern interpolation'.

7.1 Register address of 16 bit data bus

As the below table, there are addresses to access read/write register of 16 bit when using 16 bit data bus.

(1) Write register for 16 bit data bus

ADDRESS A2 A1 A0	RESISTER Mark	REGISTER	Description
0 0 0	WR0	Command register	Axis designation, command code setting
0 0 1	XWR1 YWR1 ZWR1 UWR1	X-axis mode register 1 Y-axis mode register 1 Z-axis mode register 1 U-axis mode register 1	External deceleration stop of each axis' valid/invalid of logic level signal setting Interrupt enable/disable of each axis setting
0 1 0	XWR2 YWR2 ZWR2 UWR2	X-axis mode register 2 Y-axis mode register 2 Z-axis mode register 2 U-axis mode register 2	Limit signal mode of each axis setting Drive pulse mode setting Encoder input signal mode setting Valid/invalid of logic level for servo motor signal setting
	BP1P	BP1P register	Bit pattern interpolation the 1-axis +direction bit data settin
0 1 1	XWR3 YWR3 ZWR3 UWR3	X-axis mode register 3 Y-axis mode register 3 Z-axis mode register 3 U-axis mode register 3	Manual deceleration of each axis, Deceleration, S curve mode setting External adjustment mode setting, General output OUT7 to 4 setting
	BP1M	BP1M register	Bit pattern interpolation the 1-axis – direction bit data setting
1 0 0	WR4	Output register	General output OUT3 to 0 setting (Not used)
	BP2P	BP2P register	Bit pattern interpolation the 2-axis +direction bit data setting
1 0 1	WR5	Interpolation mode register	Axis designation, Constant linear velocity mode, step output mode, interrupt setting
	BP2M	BP2M register	Bit pattern interpolation the 2-axis +direction bit data setting
1 1 0	WR6	Write data register 1	General output OUT3 to 0 setting (Not used)

ADDRESS A2 A1 A0	RESISTER Mark	REGISTER	Description
	BP3P	BP3P register	Bit pattern interpolation the 2-axis +direction bit data setting
1 1 1	WR7	Wrtie data register 2	Write data upper 16 bit (D31 to D16) setting
	BP3M	BP3M register	Bit pattern interpolation the 3-axis –direction bit data setting

- As above table, each axis has WR1, WR2, WR3 (Mode register 1, 2, 3). This registers are written in same address and executed. By the last designated axis, it is decided to which axis' mode register to be written.
- Bit data register BP1P to 3P, BP1M to 3M for Bit pattern interpolation cannot be written right after reset. To write this register, it is able to write by BP register writable command (36h). After releasing BP register writable command (36h), it is not available to write nWR2 to 3. After writing bit data by bit pattern interpolation, it is required to release BP register not writable command (37h).
- Be sure that WR6 register and BP3P register, WR7 register and BP3M register use same register as hardware.
- Reset clears all bit of nWR1, nWR2, nWR3, WR4, WR5 register as '0'.
  The other registers are not applied.

(2) Read register for 16 bit data bus

All registers are 16 bit.

ADDRESS A2 A1 A0	RESISTER Mark	REGISTER	Description
0 0 0	RR0	Main status register	Drive, error status of each axis display Drive of interpolation, next data for consecutive interpolation setting High limit of circular interpolation setting Stack counter for BP interpolation display
0 0 1	XRR1 YRR1 ZRR1 URR1	X-axis status register 1 Y-axis status register 1 Z-axis status register 1 U-axis status register 1	Position: COMP register comparision Accelection/Deceleration status, accelection /deceleration incresement/decreasement status display End status display
0 1 0	XRR2 YRR2 ZRR2 URR2	X-axis status register 2 Y-axis status register 2 Z-axis status register 2	Error occurance factor display Auto home search run status display

ADDRESS A2 A1 A0	RESISTER Mark	REGISTER	Description
		U-axis status register 2	
0 1 1	XRR3 YRR3 ZRR3 URR3	X-axis status register 3 Y-axis status register 3 Z-axis status register 3 U-axis status register 3	Interrupt occurance factor display
1 0 0	RR4	Input register 1	X-axis, Y-axis input signal status display
1 0 1	RR5	Input register 2	Z-axis, U-axis input signal status display
1 1 0	RR6	Read data register 1	Read data lower 16bit (D15 to D0) display
1 1 1	RR7	Read data register 2	Read data upper 16bit (D31 to D16) display

As write register, each axis has RR1, RR2, RR3 (each-axis status register 1, 2, 3). This register reads by same address. By the last designated axis, it is decided to which axis' mode register to be read.

7.2 Register address of 8 bit data bus

To access by 8 bit data bus, it divides 16 bit register as upper byte, lower byte.

As below table, ****L is 16 lower byte(D7 to D0) for bit register****, ****H is upper byte(D15 to D8) of 16bit register****. In case that command reigster (WR0L, WR0H) must write upper byte(WR0H) at first, and write lower byte (WR0L) later.

(1) Write register for 8 bit data bus

ADDRESS A3	A2	A1	A0	Writing register
0	0	0	0	WR0L
0	0	0	1	WR0H
0	0	1	0	XWR1L, YWR1L, ZWR1L, UWR1L
0	0	1	1	XWR1H, YWR1H, ZWR1H, UWR1H
0	1	0	0	XWR2L, YWR2L, ZWR2L, UWR2L
0	1	0	1	XWR2H, YWR2H, ZWR2H, UWR2H
0	1	1	0	XWR3L, YWR3L, ZWR3L, UWR3L
0	1	1	1	XWR3H, YWR3H, ZWR3H, UWR3H
1	0	0	0	WR4L, BP2PL
1	0	0	1	WR4H, BP2PH
1	0	1	0	WR5L, BP2ML
1	0	1	1	WR5H, BP2MH
1	1	0	0	WR6L, BP3PL
1	1	0	1	WR6H, BP3PH
1	1	1	0	WR7L, BP3ML
1	1	1	1	WR7H, BP3MH

(2) Read register for 8 bit data bus

ADDRESS A3	A2	A1	A0	Writing register
0	0	0	0	RR0L
0	0	0	1	RR0H
0	0	1	0	XRR1L, YRR1L, ZRR1L, URR1L
0	0	1	1	XRR1H, YRR1H, ZRR1H, URR1H
0	1	0	0	XRR2L, YRR2L, ZRR2L, URR2L
0	1	0	1	XRR2H, YRR2H, ZRR2H, URR2H
0	1	1	0	XRR3L, YRR3L, ZRR3L, URR3L
0	1	1	1	XRR3H, YRR3H, ZRR3H, URR3H
1	0	0	0	RR4L
1	0	0	1	RR4H
1	0	1	0	RR5L
1	0	1	1	RR5H
1	1	0	0	RR6L
1	1	0	1	RR6H
1	1	1	0	RR7L
1	1	1	1	RR7H

7.3 WR0 command register

This register is to write commend by designating axis for each axis. Register consists for bit for designating axis, bit for setting command code, and command reset bit.

When writing axis designation and command code to this register, this command operates promptly. Data write command such as drive speed setting should be written data in WR6, 7 register. When data read command writes command at command register, from the inner circuit, to RR6, 7 register data is set. In case that 8bit data bus must write upper byte(H) at first, and write , lower byte(L) later.

The time for command processing of all command code is max. 250nsec (When CLK=16 MHz).

WR0	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
	RESET	0	0	0	U	Z	Y	X	0							
					Axis designation					command code						

D6 to 0 Sets command code. Refer to each command description for command code.

D11 to 8 Designate axis to execute. When setting the bit of each axis as '1', that axis is designated. It is available to designate several axes at one time and to execute same command or to input same parameter value. In case of data read command, designate only one axis. In command for interpolation relationship , axis designation bit should be set as '0'.

D15 Resets RESET motion control IC. When this bit is '1', motion control IC is reset. After writing command, it cannot access register of motion control IC during max. 875nsec (When CLK=16MHz). For 8bit data bus, it is reset by writing WR0H(80h). RESET bit must be set '0' to write command generally. When setting '1', test command of motion control IC inner circuit starts and unconsidered operation occurs.

7.4 WR1 mode register 1

Each 4-axis has mode register1 individually. By the designation of axis, it is decided to use which axis' mode register. Mode register1 consists of the bit for valid/invalid deceleration stop/immediate stop input signal IN3 to IN0 and logic level for valid during drive and the bit for enable/disable interrupt.

Set IN3 to IN0 as valid and start drive with fixed pulse drive or consecutive pulse drive. When the designated IN signal becomes the set logic level, drive stops by deceleration or immediately. When it is accel/decel drive, it stops by deceleration. When constant speed drive, it stops immediately.

WR1	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
	D-END	C-STA	C-END	P≥C+	P<C+	P>C-	P≥C-	PULSE	IN3-E	IN3-L	IN2-E	IN2-L	IN1-E	IN1-L	IN0-E	IN0-L
	Interrupt enable/disable								Valid/Invalid, logic of drive stop input signal							

D7, 5, 3, 1	INm-E	Valid/Invalid setting bit for drive stop input signal INm(m: 0 to 3) 0: Invalid, 1: Valid
D6, 4, 2, 0	INm-L	When input signal INm is valid, setting bit for logic level. 0: stops at low, 1: stops at high Setting bit for logic level of INm signal using auto home search Valid/Invalid bit (D5, D3, D1) should be invalid.

The below bit is interrupt enable/disable bit. When setting as '1', it becomes interrupt enable, when setting as '0', it becomes interrupt disable.

D8	PULSE	Interrupt occurs at ↑ of pulse by drive pulses (When setting drive pulse positive logic)
D9	P≥C-	Interrupt occurs when logical/actual position counter value is bigger than COMP- register value.
D10	P<C-	Interrupt occurs when logical/actual position counter value is smaller than COMP- register value.
D11	P<C+	Interrupt occurs when logical/actual position counter value is smaller than COMP+ register value.
D12	P≥C+	Interrupt occurs when logical/actual position counter value is bigger than COMP+ register value.
D13	C-END	In accel/decel drive, interrupt occurs when pulse output ends at constant speed zone.
D14	C-STA	In accel/decel drive, interrupt occurs when pulse output starts at constant speed zone.
D15	D-END	Interrupt ends when drive ends.

At reset, D15 to D0 is set as all '0'.

7.5 WR2 mode register 2

WR2	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
	INP-E	INP-L	ALM-E	ALM-L	PIND1	PIND0	PINMD	DIR-L	PLS-L	PLSMD	CMPSL	HLMT-	HLMT+	LMTMD	CLMT-	SLMT+

Each 4-axis has mode register 2 individually. By the designation of axis, it is decided to use which axis' mode register. Mode register 2 is able to set limit input signal mode, drive pulse mode, encoder input signal mode and valid/invalid logic level of servo motor signal.

D0 SLMT+ Set COMP+ register as software limit by +direction. When it sets '1', it is valid. When it sets '0', it is invalid. When it is valid, during driving of +direction, logical/actual position counter is bigger than COMP+ register and it stops by deceleration. And D0(SLMT+) bit of RR2 register is '1'.
In this case, drive command of +direction does not execute.
[Caution] To operate position counter variable ring in extension mode, it cannot use software limit.

D1 SLMT- Set COMP- register as software limit by –direction. When it sets '1', it is valid. When it sets '0', it is invalid. When it is valid, during driving of -direction, and logical/actual position counter value is smaller than COMP- register value, it stops by deceleration. And D1(SLMT-) bit of RR2 register is '1'.
In this case, drive command does not operate.

D2 LMTMD Set drive stop type when hardware limit (nLMTP, nLMTM input signal) is active. When it sets as '0', the type is immediate stop. When it sets as '1', the type is deceleration stop.

D3 HLMT+ Set logic level of +direction limit input signal (nLMTP).
0: Low active, 1: High active

D4 HLMT- Set logic level of –direction limit input signal (nLMTM).
0: Low active, 1: High active

D5 CMPSL Set comparison object of COMP+/- register by logical position/actual position counter.
0: Logical position counter, 1: Actual position counter

D6 PLSMD Set output method of drive pulse.
0: Individual 2-pulse method, 1: 1-pulse method
When setting as individual 2-pulse method, it outputs +direction pulse at output signal nP+P/nP+N, and outputs –direction pulse at output signal nP-P/nP-N.
When setting as 1-pulse method, it outputs drive pulse of +/- both directions at output signal nP+P/nP+N, and outputs pulse direction signal at output signal nP-P/nP-N.
[Caution]
In case 1-pulse method, for output timing of pulse signal and direction signal, refer to '15.2 Drive start/end', '15.3 Interpolation drive'.

D7 PLS-L Set logic level of drive pulse.
0: Positive logic pulse, 1: Negative logic pulse

D8 DIR-L Set logic level of direction output signal for drive pulse.

		By this bit value, voltage level of nP-P/nP-N outputsignal outputs as below table.

D8 (DIR-L)	+ direction pulse output	- direction pulse output
0	Low	High
1	High	Low

D9	PINMD	Select encoder input signal (nECAP/nECAN, nECBP/nECBN) as 2-phase pulse input or Up/Down pulse input. Encoder input signal counts up/down actual position counter. 0: 2-phase pulse input, 1: Up/Donw pulse input In case of 2-pulse input mode, as positive logic pulse, when A phase processes it counts up, or when B phase processes it counts down. At ↑, ↓ of both signals, it counts up/counts down. In case of Up/Down pulse input mode, nECAP/nECAN is count up input and nECBP/nECBN is count down input. It counts at ↑ of each positive pulse.
D11, 10	PIND1, 0	Set divided ratio of encoder 2-phase pulse input.

D11	D10	Divided ratio of 2-phase pulse input
0	0	1/1
0	1	1/2
1	0	1/4
1	1	invalid

D12	ALM-L	Set logic level of nALARM input signal. 0: Low active, 1: High active
D13	ALM-E	Set valid/invalid for input signal nALARM of servo motor alarm. 0: Invalid, 1: Valid In case of valid, when nALARM input signal is active, D14(ALARM) bit of RR2 register is ‘1’. When it is active level during driving, drive stops immediately.
D14	INP-L	Set logic level of nINPOS input signal. 0: Low active, 1: High active
D15	INP-E	Set valid/invalid of input signal nINPOS inposition for servo motor. 0: Invalid, 1: Valid In case of valid, after drive end, when nINPOS signal is active, n-DRV bit of RR0(main status) register returns to ‘0’.

At reset, D15 to D0 are set as all ‘0’.

7.6 WR3 mode register 3

Each 4-axis has mode register 3 individually. By the designation of axis, it is decided to use which axis' mode register. Mode register3 is able to set manual deceleration, deceleration individual, S curve mode, external adjustment mode and general output OUT 7 to 4.

WR3	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
	0	0	0	0	OUT7	OUT6	OUT5	OUT4	OUTSL	0	0	EXOP1	EXOP0	SACC	DSNDE	MANLD

D0 MANLD In case of accel/decel fixed pulse drive, set deceleration as auto deceleration/manual deceleration.
0: Auto deceleration, 1: manual deceleration
When setting manual deceleration mode, manual deceleration point should be set.

D1 DSNDE During linear accel/decel drive deceleration, set whether to use deceleration as acceleration value or the individual deceleration value.
During deceleration of S curve drive, set whether to use deceleration increase rate as acceleration increase rate value or the individual deceleration increase rate value.

D1(DSNDE) Deceleration increase rate accel/decel curve form for deceleration S curve in linear(trapezoid) accel/decel

D1 (DSNDE)	Deceleration in linear(trapezoid) accel/decel	Deceleration increase rate in S curve	Curve form in accel/decel
0	Use acceleration (A) value.	Use acceleration increase rate (K) value.	Symmetric
1	Use deceleration (D) value.	Use deceleration increase rate (L) value.	Asymmetric

When acceleration and deceleration runs symmetric accel/decel drive, set this bit as '0', or runs asymmetric accel/decel drive, set this bit as '1'.
In asymmetric S curve/fixed pulse drive, it cannot auto deceleration. Set D0(MANLD)bit as '1' and set manual deceleration point(DP).

D2 SACC Set linear(trapezoid) accel/decel/S curve.
0: linear(trapezoid) accel/decel, 1: S curve

In case of S curve, acceleration increase rate(K), (Deceleration increase rate(L)) should be set.

D4, 3 EXOP1, 0 Set drive adjustment by external input signal (nEXP+, nEXP-).

D4(EXOP1)	D3(EXOP0)	Description
0	0	Invalid drive adjustment by external input signal
0	1	Consecutive pulse drive mode
1	0	Fixed pulse drive mode
1	1	2-phase encoder signal mode

In consecutive pulse drive mode, during low level period for nEXP+ signal, it outputs drive pulse of +direction consecutively. In nEXP- signal, it also outputs drive pulse of –direction consecutively.
In fixed pulse drive mode, when nEXP+ signal is changed from high level to low level, fixed pulse drive of +direction starts at ↓.

		In nEXP- signal, fixed pulse drive of –direction starts. In 2-phase encoder signal mode, nEXP- signal is low level at ↑ of nEXP+ signal in fixed pulse drive with +direction. And nEXP- signal is low level at ↓ of nEXP+ signal in fixed pulse drive with with –direction.
D7	OUTSL	Select to output signal nOUT7 to 4 as general output/drive state. 0: uses as general output. D11 to D8 state outputs to nOUT7 to 4 terminals. 1: nOUT7 to 4 outputs drive status as below table.

Signal name	Output description
nOUT4/CMPP	When logical/actual position counter is bigger than COMP+ register, it is high level. When it is smaller, it is low level.
nOUT5/CMPM	When logical/actual position counter is smaller than COMP- register, it is high level. When it is bigger, it is low level.
nOUT6/ASND	During executing drive command, in acceleration state, it is high level.
nOUT7/DSND	During executing drive command, in deceleration state, it is high level.

D11 to 8	OUTm	Set output signal nOUT7 to 4 as general output. 0: Low level output, 1: High level output At reset, D15 to D0 are set as all ‘0’. D15 to 12, 6, 5 bit are set as all ‘0’.

7.7 WR5 interpolation mode register

It is able to designate asix to execute interpolation drive, constant linear velocity mode, interpolation step output mode, interrupt setting for interpolation.

WR5	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
	BPINT	CIINT	0	CMPLS	EXPLS	0	SPD1	SPD0	0	0	AX31	AX30	AX21	AX20	AX11	AX10

Enable interrupt (D15, D14); Pulse output (D12, D11); Constant linear velocity (D9, D8); The 3-axis (D5, D4); The 2-axis (D3, D2); The 1-axis (main-axis) (D1, D0)

D1, 0 AX11, 10 Designate the 1-axis (main-axis) to execute interpolation drive. Refer to below table for axis code.

Axis	Code(Binary)
X	0 0
Y	0 1
Z	1 0
U	1 1

The designated axis for the 1-axis(main-axis) generates basic pulse to start interpolation calculation. Set speed parameter for constant speed/accel/decele drive.

D3, 2 AX21, 20 Designate the 2-axis to execute interpolation drive.

D5, 4 AX31, 30 Designate the 3-axis to execute 3-axis interpolation drive.
In 2-axis interpolation drive, designate the proper value.

D9, 8 LSPD1, 0 Set constant linear velocity mode of interpolation drive.

D9	D8	Operation mode
0	0	Constant linear velocity invalid
0	1	2-axis constant linear velocity
1	0	(Unable to set)
1	1	3-axis constant linear velocity

In 2-axis constant linear velocity mode, set range(R) of the 2-axis as 1.414 times value of main-axis R. In 3-axis constant linear velocity mode, set range(R) of the 2-axis as 1.414 times value of main-axisR and set the 3-axis range(R) as 1.732 times of main-axisR.

D11 EXPLS Set as ‘0’. (Not used)

D12 CMPLS Set as ‘1’ and this mode step outputs interpolation drive by command.

D14 CIINT In consecutive interpolation, set enable/disable for interrupt occurance.
0: Disable, 1: Enable

D15 BPINT In bit pattern interpolation, set enable/disable for interrupt occurance.
0: Disable, 1: Enable

At reset, D15 to D0 are set as all ‘0’.

7.8 WR6, 7 Write data register 1, 2

It is register to set data write command. In WR6 register, set write data lower 16 bit(WD15 to WD0). In WR7 register, set write data upper 16 bit(WD31 to WD16).

	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
WR6	WD15	WD14	WD13	WD12	WD11	WD10	WD9	WD8	WD7	WD6	WD5	WD4	WD3	WD2	WD1	WD0

	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
WR5	WD31	WD30	WD29	WD28	WD27	WD26	WD25	WD24	WD23	WD22	WD21	WD20	WD19	WD18	WD17	WD16

Data write command writes data legnths which are designated as each command at this write data registers. After writing write data register WR6, 7(In case of 8bit data bus, WR6L, WR6H, WR7L, WR7H), write command code at command register and write data register contents are placed in each inner register. Number data to write is all binary. Negative value is complement of 2.

Command data must set the designated data length.

At reset, WR6, WR7 register contents are negative.

7.9 RR0 status register

It displays drive, error status of each axis. It also displays the next data during interpolation drive, consecutive interpolation, high limit of circular interpolation, stack counter if BP interpolation.

RR0	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
	-	BPSC1	BPSC0	ZONE2	ZONE1	ZONE0	CNEXT	I-DRV	U-ERR	Z-ERR	Y-ERR	X-ERR	U-DRV	Z-DRV	Y-DRV	X-DRV

Displays each axis error

Displays each axis drive

D3 to 0 n-DRV Displays drive status of each axis. When this bit is '1', it displays the axis is outputting drive pulses. When this bit is '0', it displays the axis is ending drive.
When running auto home search, this bit is '1' during running.
Set valid as nINPOS of input signal for servo motor position and after outputting drive pulse, nINPOS signal becomes active and it returns to '0'.

D7 to 4 n-ERR Displays error releasing state of each axis. Any one of error bit (D7 to D0) of RR2 register for each axis or error end bit (D15 to D12) of RR1 register is '1', this bit is '1'.

D8 I-DRV Displays interpolation drive state. When this bit is '1', it displays outputting interpolation drive pulse.

D9 CNEXT In consecutive interpolation, displays next data writable. As consecutive interpolation drive, when this bit is '1', it is able to write parameter data for the next segment(Segment) and interpolation command.

D1 to D10 ZONEm In circular interpolation drive, displays current driving high limit.

D12	D11	D10	Current driving high limit
0	0	0	0
0	0	1	1
0	1	0	2
0	1	1	3
1	0	0	4
1	0	1	5
1	1	0	6
1	1	1	7

D14, 13 BPSC1, 0 In bit pattern interpolation drive, it displays stack counter(SC) value.

D14	D13	Stack Counter(SC) value
0	0	0
0	1	1
1	0	2
1	1	3

During bit pattern interpolation driving, when SC=3, displays that bit data stack is full. When SC=2, 16bit is empty by each axis and when SC=1, 16bit×2 is empty by each axis. It displays SC=0 outputs all bit data and it ends drive.

7.10 RR1 status register 1

Each 4-axis has status register1. By the designation of axis, it is decided to read any axis' status register. Status register1 displays logical/actual position counter and COMP± register size comparision, acceleration state of accel/decel drive, S curve jerk status. And it displays drive end status.

	H								L							
RR1	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
	EMG	ALARM	LMT-	LMT+	IN3	IN2	IN1	IN0	ADSND	ACNST	AASND	DSND	CMST	ASND	CMP-	CMP+

Drive end status (D15 to D8)

D0	CMP+	Displays size relationship of logical/actual position counter and COMP+ register. 1: Logical/Actual position counter≥COMP+ register 0: Logical/Actual position counter<COMP+ register
D1	CMP-	Displays size relationship of logical/actual position counter and COMP- register. 1: Logical/Actual position counter<COMP- register 0: Logical/Actual position counter≥COMP- register
D2	ASND	In accel/decel drive, it is '1' at acceleration.
D3	CNST	In accel/decel drive, it is '1' at constant speed.
D4	DSND	In accel/decel drive, it is '1' at deceleration.
D5	AASND	It is '1' when acceleration/deceleration increases as S curve drive.
D6	ACNST	It is '1' when acceleration/deceleration is constant as S curve drive.
D7	ADSND	It is '1' when acceleration/deceleration decreases as S curve drive.
D11 to 8	IN3 to 0	It is '1' when drive stops by external deceleration stop signal (nIN3 to 0).
D12	LMT+	It is '1' when drive stops by +direction limit signal (nLIMT+).
D13	LMT-	It is '1' when drive stops by -direction limit signal (nLIMT-).
D14	ALARM	It is '1' when drive stops by alarm signal (nALARM) for servo motor.
D15	EMG	It is '1' when drive stops by emergency stop signal (EMG).

(1) Drive stip status bit

Drive stop status bit is to save and maintain the information of the drive end factors. Fixed pulse drive, consecutive pulse drive end by the following factors.

① When output pulses outputs all by fixed pulse drive.
② When writing deceleration stop or immediate stop command.
③ When software limit is set valid and it is active.
④ When external signal(nIN3, 2, 1, 0) for deceleration stop is active by fixed/consecutive pulse drive.
⑤ When limit input signal(nLIMT+P, nLMT-) is active.
⑥ When nALARM signal is valid and it is active.
⑦ When EMG signal is low level.

In case of ①, ② factors, it is able to control by upper CPU. In case of ③ factor, after driving, it is able to check by RR2 register. However, in case of ④ to ⑦ factors, it maintains bit information even though signal is non active after drive end factor bit is 1.

D15 to D12 bit, drive end status bit error factor, are ‘1’, n-ERR bit of RR0 main-status register is ‘1’. Drive end status bit is cleared automatically by the writing of next drive command, also by end status clear command(25h).

7.11 RR2 status register 2

Each 4-axis has status register 2. By the designation of axis, it is decided to read any axis’ status register.Status register 2 displays error information and auto home search running status. Each bit of error information(D7 to D0) is ‘1’, it displays the bit for error occurance. When this several bit for D7 to D0 of RR2 register is ‘1’, n-ERR bit of RR0 main status register is ‘1’.

	H								L							
RR2	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
	-	0	0	HMST4	HMST3	HMST2	HMST1	HMST0	HOME	0	EMG	ALARM	HLMT-	HLMT+	SLMT-	SLMT+
					Auto home output run state				Error information							

D0	SLMT+	Sets valid to COMP+ register as software limit, when logical/actual position count is bigger than COMP+ register value during +direction drive
D1	SLMT-	Sets valid to COMP- register as software limit, when logical/actual position count is bigger than COMP- register value during -direction drive
D2	HLMT+	When +direction limit signal (nLIMT+) is active level
D3	HLMT-	When -direction limit signal (nLIMT-) is active level
D4	ALARM	Set valid to alarm signal(nALARM) of servo motor and it is active level
D5	EMG	When emergency stop signal(EMG) is low level
D7	HOME	auto home search run error It is ‘1’ when starting Step3 and encoder Z-phase signal (nIN2) is active.
D12 to 8	HMST4 to 0	Auto home search run status displays current operation contents during auto home search running. Refer to ‘5.5.4 Error of auto home output’.

When hard/soft limit of processing direction operates during driving, drive stops by deceleration or immediately.

After stop, drive command which is same as before direction does not execute.

SLMT+/- bit is not ‘1’ even in conditions during reverse direction drive.

7.12 RR3 status register 3

Each 4-axis has status register 3. By the designation of axis, it is decided to read any axis' status register.Status register3 is display interrupt occurance factors. When interrupt occurs, this interrupt occurance factor's bit is '1'.

When generating D7 interrupt at D0, set interrupt enable to each occurance factors of WR1 register.

	H								L							
RR3	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
							SYNC	HMEND	D-END	C-STA	C-END	P≥C+	P<C+	P≥C-	P<C-	PULSE
					Auto home output occurance state				Error information							

D0	PULSE	Drive pulse occurs (When setting drive pulse positive logic)
D1	P≥C-	Logical/Actual position counter is bigger than COMP- register.
D2	P<C-	Logical/Actual position counter is smaller than COMP- register.
D3	P<C+	Logical/Actual position counter is smaller than COMP+ register.
D4	P≥C+	Logical/Actual position counter is bigger than COMP+ register.
D5	C-END	In accel/decel drive, ends constant speed zone pulse output
D6	C-STA	In accel/decel drive, starts constant speed zone pulse output
D7	D-END	Drive ends
D8	HMEND	Auto home search ends Refer to '5.5 Auto home search output'.
D9	SYNC	synchronous operation starts Refer to '5.6 Synchronous operation'.

When occuring interrupt of any interrupt factors, this register bit is '1' and interrupt output signal is low level. When CPU read RR3 register of occuring interrupt axis, RR3 register bit returns '0' and interrupt output signal returns to non-active level.

Note

In case of 8 bit data bus, it clears all by RR3L register read. For using D8(HMEND), D9(SYNC) bit, it must read RR3H at first and read RR3L register.

7.13 RR4, 5 input register 1, 2

Input register1, 2 displays inpus signal status of each axis. When input signal is low level, it is ‘0’, when it is high level, it is ‘1’. When not displaying this input signal status, it is available as general input signal.

	H								L							
RR4	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
	Y-ALM	Y-INP	Y-EX-	Y-EX+	Y-IN3	Y-IN2	Y-IN1	Y-IN0	X-ALM	X-INP	X-EX-	X-EX+	X-IN3	X-IN2	X-IN1	X-IN0

	H								L							
RR5	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
	U-ALM	U-INP	U-EX-	U-EX+	U-IN3	U-IN2	U-IN1	U-IN0	Z-ALM	Z-INP	Z-EX-	Z-EX+	Z-IN3	Z-IN2	Z-IN1	Z-IN0

Bit name	Input signal	Bit name	Input signal
n-IN0	n-IN0+/ n-IN-	n-EX+	nEXP+
n-IN1	n-IN1	n-EX-	nEXP-
n-IN2	n-IN2	n-INP	nINPOS
n-IN3	n-IN3	n-ALM	nALARM

7.14 RR6, 7 read data register 1, 2

Inner register data is set at read data register by data read command. Read data lower 16bit (RD15 to RD0) is set at RR6 register and read data upper 16bit (RD31 to RD16) is set at RR7 register.

	H								L							
RR4	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
	Y-ALM	Y-INP	Y-EX-	Y-EX+	Y-IN3	Y-IN2	Y-IN1	Y-IN0	X-ALM	X-INP	X-EX-	X-EX+	X-IN3	X-IN2	X-IN1	X-IN0

	H								L							
RR5	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
	U-ALM	U-INP	U-EX-	U-EX+	U-IN3	U-IN2	U-IN1	U-IN0	Z-ALM	Z-INP	Z-EX-	Z-EX+	Z-IN3	Z-IN2	Z-IN1	Z-IN0

All data are binary. Negative value is complement of 2.

8 Command list

(1) Data write command

Code	Command	Mark	Data range	Data length
00h	Range setting	R	8,000,000(Magnification:1) to 16,000(Magnification:500)	4 byte
01	Acceleration increase rate setting	K	1 to 65,535	2
02	Acceleration setting	A	1 to 8,000	2
03	Deceleration setting	D	1 to 8,000	2
04	Start speed setting	SV	1 to 8,000	2
05	Drive speed setting	V	1 to 8,000	2
06	Number of output pulses/Interpolation end point setting	P	Number of output pulses: 0 to 4,294,967,295 Interpolation end point: -2,147,483,646 to +2,147,483,646	4
07	Manual deceleration point setting	DP	0 to 4,294,967,295	4
08	Circular center point setting	C	-2,147,483,646 to +2,147,483,646	4
09	Logical position counter setting	LP	-2,147,483,648 to +2,147,483,647	4
0A	Actual position counter setting	EP	-2,147,483,648 to +2,147,483,647	4
0B	COMP+ register setting	CP	-2,147,483,648 to +2,147,483,647	4
0C	COMP- register setting	CM	-2,147,483,648 to +2,147,483,647	4
0D	Acceleration counter offset setting	AO	-32,768 to +32,767	2
0E	Deceleration increase rate setting	L	1 to 65,535	2
60	Extension mode setting	EM	(Bit data)	4
61	Home search speed setting	HV	1 to 8,000	2
64	Synchronous operation mode setting	SM	(Bit data)	4

Note

Set the designated data length to set data.

[Parameter]

Magnification = $\frac{8,000,000}{R}$

Accel/decel increase rate (pps/sec^2)

$$= \frac{6.25\times10^6}{K} \times \underbrace{\frac{8,000,000}{R}}_{\text{Magnification}}$$

Deceleration increase rate (pps/sec^2)

$$= \frac{6.25\times10^6}{L} \times \underbrace{\frac{8,000,000}{R}}_{\text{Magnification}}$$

Accel/decel(pps/sec)

$$=A \times 125 \times \frac{8,000,000}{\underbrace{R}_{\text{Magnification}}}$$

Deceleration(pps/sec)

$$=D \times 125 \times \frac{8,000,000}{\underbrace{R}_{\text{Magnification}}}$$

Drive speed(pps)

$$=V \times \frac{8,000,000}{\underbrace{R}_{\text{Magnification}}}$$

Start speed(pps)

$$=SV \times \frac{8,000,000}{\underbrace{R}_{\text{Magnification}}}$$

(2) Data read command

Code	Command	Mark	Data range	Data length
10h	Logical position counter reading	LP	-2,147,483,648 to +2,147,483,647	4 byte
11	Aactual position counter reading	EP	2,147,483,648 to +2,147,483,647	4
12	Current drive speed reading	CV	1 to 8,000	2
13	Current accel/decel reading	CA	1 to 8,000	2
14	Synchronous buffer register reading	SB	-2,147,483,648 to +2,147,483,647	4

(3) Drive command

Code	Command
20h	+direction fixed pulse drive
21	-direction fixed pulse drive
22	+direction consecutive pulse drive
23	-direction consecutive pulse drive
24	Drive start hold
25	Drive start free/stop status clear
26	Drive deceleration stop
27	Drive immediate stop

(4) Interpolation command

Code	Command
30h	2-axis linear interpolation drive
31	3-axis linear interpolation drive
32	CW circular interpolation drive
33	CCW circular interpolation drive
34	2-axis bit pattern interpolation drive
35	3-axis bit pattern interpolation drive
36	Writable BP register※1
37	BP register not writable
38	BP data stack
39	BP data clear
3A	interpolation single step
3B	Valid deceleration
3C	Invalid deceleration
3D	Interpolation nterrupt clear

※1. When writing the other command codes at command regist, test command of motion control IC inner circuit starts. It may cause unconsidered operation.

9 Data write command

Data write command involves write data. It sets operation parameters such as acceleration, drive speed, number of output pulses for drive. When designating severl axes, it is able to set the all axis which is specified the data.

In data write command, when the specified data length is 2byte, it sets at WR6 register. When the data length is 4 byte, it sets at WR6, 7 register. When specifying axis at WR0 register and writing command code, it starts. All number data setting at WR6, 7 write data register is binary. Negative value is complement of 2. Each data must be set within the data range. When setting the value out of the range, proper drive operation does not run.

Note

① The time for command process of data write command is max. 250nsec (In case of CLK=16MHz). After writing command, during command processing time, do not write the next data command.

② Except acceleration counter offset(AO), all operation parameters are not applied after reset. Parameter for drive should be set the proper value before driving.

9.1 Range setting

Command code	Command	Mark	Data range	Data length
00h	Range setting	R	8,000,000(Magnification:1) to 16,000(Magnification:500)	4 byte

Range is the parameter to set magnification of start speed, drive speed, acceleration, deceleration, acceleration increase rate, and deceleration increase rate. When range setting value as R times, magnification is same as below calcuation.

$$\text{Magnification} = \frac{8{,}000{,}000}{R}$$

The parameter for drive speed, start speed, accel/decel, etc setting range is 1 to 8000. When it sets bigger than this, magnification should be raised. When bigger magnification, high speed drive is available but speed resoultion is low.

Set the min. value to cover using speed range.

Ex.

When using up to 40kpps speed, speed setting range is 1 to 8,000, and magnification is five times. R is set as 1,600,00.

When changing range(R) during driving, speed is changed inconsecutively.

9.2 Acceleration increase rate setting

Command code	Command	Mark	Data range	Data length
01h	Acceleration increase rate setting	K	1 to 65,535	2 byte

Acceleration increase rate setting is the parameter to set increase/decrease ration by acceleration time unit in S curve. In symmetric S curve drive(WR3/D1=0) for acceleration and deceleration, even in deceleration, this acceleration increase rate value is used. When setting acceleration increase rate value as ‘K’, acceleration increase rate is below calculation.

$$\text{Accel/Decel increase rate (pps/sec}^2\text{)} = \underbrace{\frac{6.25\times10^6}{K} \times \frac{8{,}000{,}000}{R}}_{\text{Magnification}}$$

Setting range of acceleration increase rate value (K) is 1 to 65,535 and acceleration increase rate range is as below.

When magnification=1, 954pps/sec^2 to 62.5×10^6 pps/sec^2

When magnification=500, 477×10^3 pps/sec^2 to 31.25×10^9 pps/sec^2

9.3 Acceleration setting

Command code	Command	Mark	Data range	Data length
02h	Acceleration setting	A	1 to 8,000	2 byte

This parameter is to set acceleration during linear accel/decel drive(trapezoid) acceleration. In symmetric linear accel/decel drive(WR3/D1=0) for acceleration and deceleration, even in deceleration, this acceleration value is used. In S curve drive, this parameter is always set as max. 8,000. When setting acceleration value as ’A’, acceleration is below calculation.

$$\text{accel/decel(pps/sec)} = A \times 125 \times \underbrace{\frac{8{,}000{,}000}{\boxed{R}}}_{\text{Magnification}}$$

Setting range of acceleration value(A) is 1 to 8,000 and actual acceleration range is as below.

When magnification=1, 125pps/sec^2 to 1×10^6 pps/sec^2

When magnification=500, 62.5×10^3 pps/sec^2 to 500×10^6 pps/sec^2

9.4 Deceleration setting

Command code	Command	Mark	Data range	Data length
03h	Deceleration setting	D	1 to 8,000	2 byte

This parameter is for deceleration during deceleration at asymmetric linear accel/decel drive(WR3/D1=1).

In asymmetric S curve drive, this parameter is always max. 8,000.

When setting deceleration value as ‘D’, deceleration is below calculation.

$$\text{Deceleration(pps/sec)} = D \times 125 \times \underbrace{\frac{8{,}000{,}000}{R}}_{\text{Magnification}}$$

9.5 Start speed setting

Command code	Command	Mark	Data range	Data length
04h	Start speed setting	SV	1 to 8,000	2 byte

It is speed for acceleration start of accel/decel drive and deceleration end speed.

When setting start speed as ‘SV’, start speed is below calculation.

$$\text{Start speed(pps)} = SV \times \underbrace{\frac{8{,}000{,}000}{R}}_{\text{Magnification}}$$

In case of step motor, set within the starting frequency value. In case of servo motor, if setting too low value, when fixed pulse drive deceleration end, drive may maintain outputs with start speed. In that case, follow as below.

- Acceleration/Deceleration symmetric linear accel/decel drive
  - Set acceleration counter offset(A0) as ‘0’
  - Triangle form prevention function valid(extension command 60h WR6/D3 (AVTRI)=1)
- Acceleration/Deceleration asymmetric linear accel/decel drive
  - Set acceleration counter offset(A0) as ‘0’
  - Triangle form prevention function valid(extension command 60h WR6/D3 (AVTRI)=1)

However, when acceleration>deceleration, and ratio of acceleration(A) and deceleration(D) is bigger, constant speed zone disappears.

In this case, raise start speed.

9.6 Drive speed setting

Command code	Command	Mark	Data range	Data length
05h	Drive speed setting	V	1 to 8,000	2 byte

This speed is in constant speed zone of accel/decel drive. In constant speed drive, this speed is applied from the first.

When setting drive speed as 'V', drive speed is below calculation.

$$\text{Drive speed(pps)} = V \times \underbrace{\frac{8,000,000}{R}}_{\text{Magnification}}$$

When setting this drive speed as below start speed, accel/decel drive does not run and from the first constant speed drives. To drive encoder Z-phase search with low speed and to stop immediately, set drive speed as below start speed. Drive speed is able to change during driving. When re-setting drive speed in constant speed zone for accel/decel drive, it starts acceleration or deceleration. When it arrives at the re-setting speed, it drives with constant speed. In auto home search, drive speed is Step1, and Step4 is high speed search speed. It moves high speed.

Note

- In S curve fixed pulse drive, drive speed is not able to change during driving. In S curve consecutive pulse drive, if changing drive speed during acceleration or deceleration, the right S curve is not drived. Change the speed within constant speed zone.
- In linear accel/decel fixed pulse drive, when changing drive speed several times during driving, it is able to drive within deceleration zone with start speed at output pulse end.

9.7 Number of output pulses/Interpolation end point setting

Command code	Command	Mark	Data range	Data length
06h	Number of output pulses/Interpolation end point setting	P	Number of output pulses: 0 to 4,294,967,295 interpolation End point: -2,147,483,646 to +2,147,483,646	4 byte

The number of output pulses is total number of output pulses for pulse drive. Set 32bit without sign.

Linear interpolation, circular interpolation drive sets end point for each axis. End coordinate is 32bit and set the relative value for current position with sign. Number of output pulses is able to change during driving.

9.8 Manual deceleration point setting

Command code	Command	Mark	Data range	Data length
07h	manual deceleration point setting	DP	0 to 4,294,967,295	4 byte

Set deceleration point of accel/decel fixed pulse drive in manual deceleration mode.

Manual deceleration mode is set D0 bit of WR3 register as ‘1’ . Set deceleration point as below.

Manual deceleration point= Number of output pulses – Number of using pulses in deceleration

9.9 Circular center point setting

Command code	Command	Mark	Data range	Data length
08h	Circular center point setting	C	-2,147,483,646 to +2,147,483,646	4 byte

Set center point of circular interpolation drive. Center coordinate is set the relative value for current position with sign.

9.10 Logical position counter setting

Command code	Command	Mark	Data range	Data length
09h	Logical position counter setting	LP	-2,147,483,648 to +2,147,483,647	4 byte

Set logical position counter value. Logical position counter counts up/down drive output pulse of +direction/-direction. The value of logical position counter is always recordable and it is available by data read command.

9.11 Actual position counter setting

Command code	Command	Mark	Data range	Data length
0Ah	Actual position counter setting	EP	-2,147,483,648 to +2,147,483,647	4 byte

Set actual position counter. Actual position counter counts up/down encoder input pulse. Actual position counter value is always recordable and it is available by data read command.

9.12 COMP+ register setting

Command code	Command	Mark	Data range	Data length
0Bh	COMP+ register setting	CP	-2,147,483,648 to +2,147,483,647	4 byte

Set COMP+ register value. COMP+ register is size Comparison register with logical/actual position counter. The comparision result outputs as D0 of RR1 register and nOUT4/CMPP signal. It is available as software limit of +direction. The value of COMP+ register is always recordable.

9.13 COMP- register setting

Command code	Command	Mark	Data range	Data length
0Ch	COMP- register setting	CM	-2,147,483,648 to +2,147,483,647	4 byte

Set COMP- register value. COMP- register is size Comparison register logical/actual position counter. The comparision result outputs as D1 of RR1 register and nOUT5/CMPM signal. It is available as software limit of -direction. The value of COMP- register is always recordable.

9.14 Acceleration counter offset setting

Command code	Command	Mark	Data range	Data length
0Dh	Acceleration counter offset setting	AO	-32,768 to +32,767	2 byte

Set offset value of acceleration counter. Offset value for acceleration counter is set as '8' at reset. When running fixed pulse drive of accel/decel with low setting start speed, set this parametervalue as '0'.

9.15 Deceleration increase rate setting

Command code	Command	Mark	Data range	Data length
0Eh	Deceleration increase rate setting	L	1 to 65,535	2 byte

This parameter for deceleration increase rate value is increse/decrease rate by deceleration time unit for asymmetric S curve drive(WR3/D1=1) in acceleration/deceleration. It is not used for symmetric S curve drive in acceleration/deceleration. When setting deceleration increase rate as 'L', deceleration increase rate is below calculation.

$$\text{Deceleration increase rate (pps/sec2)} = \frac{6.25\times10^6}{L} \times \underbrace{\frac{8{,}000{,}000}{R}}_{\text{Magnification}}$$

The setting range of deceleration increase rate value (L) is 1 to 65,535. Deceleration increase rate range is as below.

When magnification=1, 954pps/sec^2 to 62.5×10^6 pps/sec^2

When magnification=500, 477×10^3 pps/sec^2 to 31.25×10^9 pps/sec^2

9.16 Extension mode setting

Command code	Command	Mark	Data range	Data length
60h	Extension mode setting	EM	(Bit data)	4 byte

Set the proper value at each bit of WR6 and WR7 register for extension mode at first. When writing command code(60h) with axis designation at WR0 register, WR6, 7 register content is set at extension mode register(EM6, 7). At reset, all bit of extension mode register(EM6, 7) is cleared.

	H								L							
WR6	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
	FL2	FL1	FL0	FE4	FE3	FE2	FE1	FE0	SMODE	0	HMINT	VIRING	AVTRI	POINV	EPINV	EPCLR

	H								L							
WR7	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
	DCCW2	DCCW1	DCCW0	DCC-L	DCC-E	LIMIT	SAND	PCLR	ST4-D	ST4-E	ST3-D	ST3-E	ST2-D	ST2-E	ST1-D	ST1-E
	Deviation counter clear output								Step 4		Step3		Step2		Step1	

WR6/D0 EPCLR When drive stops by nIN2 signal, it clears actual position counter. When setting this bit as '1' and nIN2 signal is changed active level during driving, drive stops and actual position counter(EP) is cleared. Set WR1/D5 (IN2-E) bit as '1' and WR1/D4(IN2-L) bit as valid level. Refer to '7.4 WR1 mode register 1'.

WR6/D1 EPINV Reverse increase/decrease of actual position counter.

WR6/D1 (EPINV)	Input pulse mode	Counter (EP) increse/decrease of actual position
0	A/B phase mode	When progressing A phase, counts up When progressing B phase, counts down
	Up/Down pulse mode	When inputting nECA+/- pulse, counts up When inputting nECB+/- pulse, counts down
1	A/B phase mode	When progressing B phase, counts up When progressing A phase, counts down
	Up/Down pulse mode	When inputting nECB+/- pulse, counts up When inputting nECA+/- pulse, counts down

WR6/D2 POINV Changes output signal of drive pulse output, nP+P/nP+N (Drive pulse of +direction) and nP-P/nP-N (Drive pulse of -direction). When setting this bit as '1', drive pulse of nP-P/nP-N signal outputs at +direction drive, and drive pulse of nP+P/nP+N signal outputs at –direction drive.

WR6/D3 AVTRI Prevents triangle form at linear accel/decel (trapezoid) of fixed pulse drive.
0: Invalid, 1: Valid

WR6/D4 VRING Enables to be valid for variable ring function of logical position counter and actual position counter.
0: Invalid, 1: Valid

WR6/D5 HMINT After auto home search end, generates interrupt signal. When setting this bit as '1', interrupt signal is low active and RR3/D8(HMEND) bit of the generating interrupt axis displays '1' after auto home output end. When reading RR3 register of the generating interrupt axis, RR3 register bit is cleared as '0' and interrupt output signal returns to Hi-Z.

WR6/D7	SMODE	In S curve drive, set as '1' to arrive the specify drive speed first of all.
WR6/D12 to 8	FE4 to 0	In input signal, set valid/invalid for motion control IC inner filter function. 0: Invalid, 1: Valid

Specify bit	Filter valid signal
WR6/D8 (FE0)	EMG※1, nLMT+, nLMT-, nIN0, nIN1
WR6/D9 (FE1)	nIN2
WR6/D10 (FE2)	nINPOS, nALARM
WR6/D11 (FE3)	nEXP+, nEXP-
WR6/D12 (FE4)	nIN3

※1. EMG signal is set by WR6 register D8 bit of X-axis.

WR6/D15 to 13	FE2 to 0	Set filter pass time.For input signal filter function information, refer to '5.8 Input signal filter'.

WR6/D15 to 13 (FL2 to 0)	Removeable max. noise width	Input signal delay time
0	1.75 ㎲	2 ㎲
1	224 ㎲	256 ㎲
2	448 ㎲	512 ㎲
3	896 ㎲	1.024 ㎳
4	1.792 ㎳	2.048 ㎳
5	3.584 ㎳	4.096 ㎳
6	7.168 ㎳	8.192 ㎳
7	14.336 ㎳	16.384 ㎳

Each bit of WR7 register sets auto home search mode.

For each bit information, refer to '5.5.2 Search speed and mode setting'.

Note

extension mode setting command is set WR6 and WR7 register's all contents at motion control IC inner extension mode register(EM6, 7). Set the proper value at both WR6 and WR7 register.

9.17 Home search speed setting

Command code	Command	Mark	Data range	Data length
61h	Home search speed setting	HV	1 to 8,000	2 byte

Step2, 3 of auto home search is set low speed search speed.

When setting home search speed set value as 'HV', home search speed is below calculation.

$$\text{Drive speed(pps)} = V \times \frac{8{,}000{,}000}{\underbrace{R}_{\text{Magnification}}}$$

When search signal is active, to stop immediately, set this lower than start speed(SV).

For auto home search, refer to '5.5 Auto home search output'.

9.18 Synchronous operation mode setting

Command code	Command	Mark	Data range	Data length
64h	Synchronous operation mode setting	SM		4 byte

To set synchronous operation mode, set the proper value to each bit of WR6 and WR7 register at first and write command code(64h) with axis designation at WR0 register. WR6, 7 register contents are set at motion control IC inner synchronous operation mode register(SM6, 7) as below. At reset, all bit of motion control IC inner synchronous operation mode register(SM6, 7) are cleared as ‘0’.

	H								L							
WR6	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
	AXIS3	AXIS2	AXIS1	0	0	0	CMD	LPRD	IIN3	IIN3	D-END	D-STA	P≥C-	P<C-	P<C+	P≥C+
	Starts other axis						Provocative									

	H								L							
WR7	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
	INT	OUT	0	0	VLSET	OPSET	EPSET	LPSET	EPSAV	LPSAV	ISTOP	SSTOP	CDRV-	CDRV+	FDRV-	FDRV+
	Operation (Action)															

For each bit information, refer to ‘5.6 Synchronous operation’.

10 Data read command

Data read command is to read register contents of each axis by read data register.

When writng axis designation and data read command code at WR0 register, the specified data is set at RR6, 7 register.

CPU is able to get the specified data by reading RR6, 7 register.

Read data is all binary. Negative value is complement of 2.

Note

- The required time for command process of data read command is max. 250nsec (When CLK=16MHz). After writing command, it should read RR6, 7 register after this time.
- Designate only one axis for axis designation. When designating over two axes, it has priority as X>Y>Z>U and the prior axis data is read.

10.1 Logical position counter reading

Command code	Command	Mark	Data range	Data length
10h	Logical position counter reading	LP	-2,147,483,648 to +2,147,483,647	4 byte

Current value of logical position counter is set at RR6, 7 read data register.

10.2 Actual position counter reading

Command code	Command	Mark	Data range	Data length
11 h	Actual position counter reading	EP	-2,147,483,648 to +2,147,483,647	4 byte

Current value of actual position counter is set at RR6, 7 Read data register.

10.3 Current drive speed reading

Command code	Command	Mark	Data range	Data length
12 h	Current drive speed reading	CV	1 to 8,000	2 byte

During driving, current drive speed value is set at RR6, 7 read data register. When stopping drive, it sets as ‘0’ and data unit is same as that of drive speed set value(V).

10.4 Current accel/decel reading

Command code	Command	Mark	Data range	Data length
13 h	Current accel/decel reading	CA	1 to 8,000	2 byte

During driving, current acceleration or deceleration value is set at RR6, 7 Read data register. Data unit is same as that of acceleration set value(A).

10.5 Synchronous operation buffer register reading

Command code	Command	Mark	Data range	Data length
14 h	Synchronous operation buffer register reading	BR	-2,147,483,648 to +2,147,483,647	4 byte

Synchronous operation buffer register value is set at RR6, 7 data register.

11 Drive command

Drive command is for drive pulse output command of each axis. It is subordinate command. When wrtting axis designation and command code at WR0 command register without write data, it start immediately.

It is available to run same command at the same time by designating several axes.

During driving, when n-DRV bit of each axis for RR0 main status register is ‘1’ and drive stops, n-DRV bit returns to ‘0’.

When setting valid for nINPOsignal for servo motor Drive, nINPOS input signal is active level and n-DRV bit of RR0 main status register returns to ‘0’.

Note

The required time for command process of drive command is max. 250nsec (When CLK=16MHz). To write next command, set it after this time.

11.1 + direction fixed pulse drive

Command code	Command
20h	+ direction fixed pulse drive

It outputs the set number of output pulses at nP+P/nP+N output signal. During driving, whenever outputs 1 drive pulse, logical position counter counts up 1.

You should set the parameter for speed curve to output before writing drive command and the number of output pulses properly.

(○: Requires to set)

Parameter	Speed curve to output				
	Constant speed	Symmetric linear accel/decel	Asymmetric linear accel/decel	Symmetric S curve	Asymmetric S curve
Range (R)	○	○	○	○	○
Acceleration increase rate (K)				○	○
Deceleration increase rate(L)					○
Acceleration(A)		○	○	○ (8000)	○ (8000)
Deceleration(D)			○		○ (8000)
Start speed(SV)	○	○	○	○	○
Drive speed(V)	○	○	○	○	○
Number of output pulses (P)	○	○	○	○	○
Manual deceleration point (DP)					○

11.2 – direction fixed pulse drive

Command code	Command
21h	- direction fixed pulse drive

It outputs the set number of output pulses at nP-P/nP-N output signal. During driving, whenver outputing 1 drive pulse, logical position counter counts down 1.

You should set the parameter for speed curve to output before writing drive command and the number of output pulses properly.

11.3 +direction consecutive pulse drive

Command code	Command
22h	+ direction consecutive pulse drive

It outputs pulses consecutively at nP+P/nP+N output signal until stop command or the specified external signal is active. During driving, whenever outpututting 1 drive pulse, logical position counter counts up 1.

You should set the parameter for speed curve to output before writing drive command.

11.4 – direction consecutive pulse drive

Command code	Command
23h	- direction consecutive pulse drive

It outputs pulses consecutively at nP-P/nP-N output signal until stop command or the specified external signal is active. During driving, whenever outpututting 1 drive pulse, logical position counter counts down 1.

You should set the parameter for speed curve to output before writing drive command.

11.5 Drive start hold

Command code	Command
24h	Drive start hold

It pauses drive start. It is used to start several axes at the same time. Write this command to the axis to start at the same time and all axes start drive by drive startcommand(25h) at the same time.

During driving, drive does not stop even though writing this command.

11.6 Drive start(Free)/end status clear

Command code	Command
25h	Drive start/end status clear

It clears hold status of drive start by drive start hold command (24h).

It clears drive end status bit D15 to 8 of RR1 register.

It clears auto home search IN2 signal error bit D7 (HOME) of RR2 register.

11.7 Drive deceleration stop

Command code	Command
26h	Drive deceleration stop

It stops by deceleration during drive pulse output. When drive speed is lower than start speed, it stops immediately. When writing this command for main-axis during interpolation driving or at the right after drive, interpolation drive stops. The write at drive stop does not operate anything.

11.8 Drive immediate stop

Command code	Command
27h	Drive immediate stop

It stops immediately during drive pulse output. It also stops at accel/decel drive immediately.

The write at drive stop does not operate anything.

12 Interpolation command

Interpolation command is subsidiary for 2-axis/3-axis linear interpolation, CW/CCW circular interpolation, 2-axis/3-axis bit pattern interpolation and interpolation drive. Interpolation command does not need axis designation of D11 to 8 bit for WR0 command register. Set as '0'.

When executing any interpolation, there are two requires before starting interpolation drive.

① Designate the axis for executing interpolation. (sets D5 to D0 of WR5 register)
② Set the speed parameter of the designated main-axis.

During interpolation drive, when D8 (I-DRV) bit of RR0 main status register is '1'. When drive ends, it returns to '0'. During interpolation drive, n-DRV bit which executing interpolation is '1'.

Note

The required time for command process of interpolation command is max. 250nsec(When CLK=16MHz). To write next command, set it after this time.

12.1 2-axis linear interpolation drive

Command code	Command
30h	2-axis linear interpolation drive

It executes 2-axis linear interpolation from current coordinate to end coordinate.

Set each end point of 2 axes which executes interpolation before driving as relative value at output pulse(P).

12.2 3-axis linear interpolation drive

Command code	Command
31h	3-axis linear interpolation drive

It executes 3-axis linear interpolation from current coordinate to end coordinate.

Set each end point of 3 axes which is executes interpolation before driving as relative value at output pulse(P).

12.3 CW circular interpolation drive

Command code	Command
32h	CW circular interpolation drive

It executes circular interpolation for the specified center coordinate to center from current coordinate to end coordinate at CW direction.

Set current position of 2 axes which execute interpolation before drivig at circular center point (C) and end point as relative value at output pulse(P).

When setting end point coordinate as (0, 0), it drives the center circuit. .

12.4 CCW circular interpolation drive

Command code	Command
33h	CCW circular interpolation drive

It executes circular interpolation for the specified center coordinate to center from current coordinate to end coordinate at CCW direction.Set current position of 2 axes which execute interpolation before drivig at circular center point (C) and end point as relative value at output pulse(P).

When setting end point coordinate as (0, 0), it drives the center circuit. .

12.5 2-axis bit pattern interpolation drive

Command code	Command
34h	2-axis bit pattern interpolation drive

It executes 2-axis bit pattern interpolation. Set bit data of +direction/-direction for 2-axis which executes interpolation before driving. Setable bit data size before driving is each-axis 16×3=48 bit. If it is over this, it supplies during driving.

12.6 3-axis bit pattern interpolation drive

Command code	Command
35h	3-axis bit pattern interpolation drive

It executes 3-axis bit pattern interpolation. Set bit data of +direction/-direction for 3-axis which executes interpolation before driving. Setable bit data size before driving is each-axis 16×3=48 bit. It it is over this, it supplies during driving.

12.7 BP register writable

Command code	Command
36h	BP register writable

This command enables to write bit pattern data of bit pattern interpolation at Register (BP1P/M, BP2P/M, BP3P/M).

By generating this command, writing at nWR2 to nWR5 register is not available.

At reset, writing of bit pattern data is not available.

12.8 BP register not writable

Command code	Command
37h	BP register not writable

This command disables to write bit pattern data of bit pattern interpolation at register (BP1P/M, BP2P/M, BP3P/M).

By this command, writing at nWR2 to nWR5 register is available.

12.9 BP data stack

Command code	Command
38h	BP data stack

It moves written bit pattern data at bit pattern data write register (BP1P/M, BP2P/M, BP3P/M) to Register and saves it. When releasing BP data stack command, one stack counter(SC) increases. When stack counter(SC) is '3', this command is not writable.

12.10 BP data clear

Command code	Command
39h	BP data clear

It clears all inner accumulated bit pattern data and becomes stack counter(SC) as '0'.

12.11 Interpolation single step

Command code	Command
3Ah	Interpolation single step

It executes step output interpolation drive by each 1 pulse. Set D12 bit of WR5 register as '1' and interpolation step mode by command. It releases interpolation drive command and executes singel step.

12.12 Deceleration valid

Command code	Command
3Bh	Deceleration valid

When runing interpolation drive in accel/decel, it is valid for auto deceleration or manual deceleration.

When running single interpolation drive in accel/decel, this command must be executed before driving. It is invalid for deceleration by consecutive interpolation and starts interpolation drive. Before writing interpolation command of the last interpolation segment(Segment) to deceleration, write deceleration valid command. At reset, it is invalid deceleration state. When setting valid deceleration status by this command, until writing deceleration invalid command(3C), until reset, it is valid state.

Deceleration valid/invalid is able to set during interpolation driving and when driving each axis individually, auto deceleration or manual deceleration is always valid state.

12.13 Deceleration invalid

Command code	Command
3Ch	Celeration invalid

When running interpolation drive in accel/decel, set invalid for auto deceleration or manual deceleration.

12.14 Interpolation interrupt clear

Command code	Command
3Dh	Interpolation interrupt clear

It clears generated interrupt by bit pattern interpolation or consecutive interpolation.

At bit pattern interpolation, when D15 bit of WR5 register is set as ‘1’, stack counter(SC) is changed from ‘2’ to ‘1’ and interrupt occurs. In consecutive interpolation, when setting D14 bit of WR5 register as ‘1’ and writing the data of next interpolation segment(Segment) and interpolation drive command, interrupt occurs.

13 Other commands

Note

The required time for command process of command is max. 250nsec(When CLK=16MHz). To write next command, set it after this time.

13.1 Auto home search running

Command code	Command
62h	Auto home search running

It runs auto home search. Before running, set auto home search mode and each parameter properly. For more information about auto home search, refer to '5.5 Auto home search output'.

13.2 Synchronous operation start

Command code	Command
65h	Synchronous operation start

This command starts synchronous operation. Set start factor WR6/D9 (CMD) bit as '1' by synchronous operation mode setting command. For more information about synchronous operation, refer to '5.6 Synchronous operation'.

13.3 NOP

Command code	Command
0Fh	NOP

Command does not execute anything.

It selects WR1 to 3 register, RR1 to 3 register of each axis and it is used to change axis.

14 Example of control program

This chapter is example for control program of motion controller by C-language. It is example of 16 bit bus organization.

```
#include <studio.h>
#include <conio.h>
//----- motion control IC register address define-----
#define    adr     0x2a0    // Base address
#define    wr0     0x0      // Command register
#define    wr1     0x2      // Mode register 1
#define    wr2     0x4      // Mode register 2
#define    wr3     0x6      // Mode register 3
#define    wr4     0x8      // Output register
#define    wr5     0xa      // Interpolation mode register
#define    wr6     0xc      // Lower write data register
#define    wr7     0xe      // Upper write data register
#define    rr0     0x0      // Main status register
#define    rr1     0x2      // Status register 1
#define    rr2     0x4      // Status register 2
#define    rr3     0x6      // Status register 3
#define    rr4     0x8      // Input register 1
#define    rr5     0xa      // Input register 2
#define    rr6     0xc      // Lower read data register
#define    rr7     0xe      // Upper read data register
#define    bp1p    0x4      // B P the 1-axis +direction data register
#define    bp1m    0x6      // B P the 1-axis -direction data register
#define    bp2p    0x8      // B P the 2-axis +direction data register
#define    bp2m    0xa      // B P the 2-axis -direction data register
#define    bp3p    0xc      // B P the 3-axis +direction data register
#define    bp3m    0xe      // B P the 3-axis -direction data register
//wreg1 (axis designation, data) ------------------------------------------Write register 1 setting
void wreg 1 (int axis, int wdata)
{
outpw(adr+wr0, (axis << 8) + 0xf); // Axis designation
outpw (adr+wr1, wdata);
}
//wreg2 (axis designation, data) ------------------------------------------Write register 2 setting
void wreg 2 (int axis, int wdata)
{
outpw(adr+wr0, (axis << 8) + 0xf); // Axis designation
outpw (adr+wr2, wdata);
```

```
}
//wreg3 (axis designation, data) ------------------------------------------Write register 3 setting
void wreg 3 (int axis, int wdata)
{
outpw(adr+wr0, (axis << 8) + 0xf); // axis designation
outpw (adr+wr3, wdata);
}
// command (axis designation, commandcode) -------------------------Command writing
void command (int axis, int cmd)
{
outpw(adr+wr0, (axis <<8) + cmd);
}
//range (axis designation, data) --------------------------------------------Range (R) setting
void range (int axis, long wdata)
{
outpw(adr+wr7, (wdata >>16) & 0xffff);
outpw(adr+wr6, wdata & 0xffff);
outpw(adr+wr0, axis<<8) + 0x00;
}
//acac (axis designation, data) -----------------------------------------Acceleration increase rate(K) setting
void acac (int axis, int wdata)
{
outpw (adr+wr6, wdata);
outpw (adr+wr0, (axis << 8) +0x01;
}
// dcac (axis designation, data) ---------------------------------------Deceleration increase rate(L) setting
void dcac (int axis, int wdata)
{
outpw (adr+wr6, wdata);
outpw (adr+wr0, (axis <<8) + 0x0e
}
// acc (axis designation, data) ----------------------------------------Acceleration (A) setting
 void acc (int axis, int wdata)
{
outpw (adr+wr6, wdata);
outpw (adr+wr0, (axis <<8) + 0x02;
}
//dec (axis designation, data) -----------------------------------------Deceleration (D) setting
void dec (int axis, int wdata)
{
outpw (adr+wr6, wdata);
```

```
outpw (adr+wr0, (axis <<8) +0x03);
}
// startv (axis designation, data) ------------------------------------------ Start speed(SV) setting
void startv (int axis, int wdata)
{
outpw (adr+wr6, wdata);
outpw (adr+wr0, (axis << 8) + 0x04;
}
// speed (axis designation, data) ------------------------------------------ Drive speed(V) setting
void speed (int axis, int wdata)
{
outpw (adr+wr6, wdata);
outpw (adr+wr0, (axis << 8) + 0x05);
}
// pulse (axis designation, data) --------------------------- Number of output pulses/end point(P) setting
void pulse (int axis, long wdata)
{
outpw (adr+wr7, (wdata >> 16) & 0xffff);
outpw (adr+wr6, wdata & 0xffff);
outpw (adr+wr0, (axis << 8) + 0x06);
}
//decp (axis designation, data) --------------------------------------- Manual deceleration point(DP) setting
void decp (int axis, long wdata)
{
outpw (adr+wr7, (wdata >> 16) & 0xffff);
outpw (adr+wr6, wdata & 0xffff);
outpw (adr+wr0, (axis << 8) + 0x07);
}
// center (axis designation, data) -------------------------------------- Circular center point(C) setting
void center (int axis, long wdata)
{
outpw (adr+wr7, (wdata >> 16) & 0xffff);
outpw (adr+wr6, wdata & 0xffff);
outpw (adr+wr0, (axis <<8) + 0x08);
}
//lp (axis designation, data) ------------------------------------------- Logical position counter (LP) setting
void lp (int axis, long wdata)
{
outpw (adr+wr7, (wdata >>16) & 0xffff);
outpw (adr+wr6, wdata & 0xffff);
outpw (adr+wr0, (axis <<8) + 0x09);
```

```
}
//ep (axis designation, data) ----------------------------------------- Actual position counter (EP) setting
void ep (int axis, long wdata)
{
outpw (adr+wr7, (wdata >> 16) & 0xffff);
outpw (adr+wr6, wdata & 0xffff);
outpw (adr+wr0, (axis << 8) + 0x0a);
}
// compp (axis designation, data) ------------------------------------- COMP+ (CP) setting
void compp (int axis, long wdata)
{
outpw (adr+wr7, (wdata >> 16) & 0xffff);
outpw (adr+wr6, wdata & 0xffff);
outpw (adr+wr0, (axis << 8) + 0x0b);
}
// compm (axis designation, data) -------------------------------------- COMP- (CP) setting
void compm (int axis, long wdata)
{
outpw (adr+wr7, (wdata >> 16) & 0xffff);
outpw (adr+wr6, wdata & 0xffff);
outpw (adr+wr0, (axis << 8) + 0x0c);
}
//accofst (axis designation, data) ---------------------------------- Acceleration counter offset (AO) setting
void accofst (int axis, long wdata)
{
outpw (adr+wr7, (wdata >> 16) & 0xffff);
outpw (adr+wr6, wdata & 0xffff);
outpw (adr+wr0, (axis << 8) + 0x0d);
}
// hsspeed (axis designation, data) ------------------------------------- Home search speed (HV) setting
void hsspeed (int axis, int wdata)
{
outpw (adr+wr6, wdata);
outpw (adr+wr0, (axis <<8) + 0x61);
}
// expmode (axis designation, data) --------------------------------------- Extension mode (EM) setting
void expmode (int axis, int em6data, int em7data)
{
outpw (adr+wr6, em6data);
outpw (adr+wr7, em7data);
outpw (adr+wr0, (axis << 8) + 0x60);
```

```
}
// syncmode (axis designation, data) ) ---------------------- Synchronous operation mode (SM) setting
void syncmode (int axis, int sm6data, int sm7data)
{
outpw (adr+wr6, sm6data);
outpw (adr+wr7, sm7data);
outpw (adr+wr0, (axis << 8) + 0x64);
}
// readlp (axis designation) --------------------------------- Logical position counter value (LP) reading
long readlp (int axis)
{
long a;long d6;long d7;
outpw (adr+wr0, (axis << 8) + 0x10);
d6 = inpw (adr+rr6) ;d7 = inpw (adr+rr7);
a = d6 + (d7 << 16) ;
return (a);
}
// readep (axis designation) ------------------------------------- Actual position counter value (LP) reading
long readep (int axis)
{
long a;long d6;long d7;
outpw (adr+wr0, (axis << 8) + 0x11);
d6 = inpw (adr+rr6) ;d7 = inpw (adr+rr7);
a = d6 + (d7 << 16) ;
return (a);
}
// wait (axis designation) ---------------------------------------------------- Drive end waiting
void wait (int axis)
{
while (inpw (adr+rr0) & axis);
}
// next_wait( ) ----------------------------------------- Consecutive interpolation next data set waiting
void next_wait (void)
{
while ((inpw (adr+rr0) & 0x0200) = = 0x0);
}
// bp_wait ( ) -------------------------------------------------------- BP interpolation next data set waiting
void bp_wait (void)
{
while ((inpw (adr+rr0) & 0x6000) = = 0x6000);
}
```

```
// homesrch ( ) ---------------------------------------------------- All axes•home search
//
// -----------X-axis home search    ---------------------------------------------------
// Near home(IN0) signal high speed search at Step1 –direction with 20,000 pps
// Home(IN1) signal low speed search at Step2 –direction with 500 pps
// Z-phase(IN2) signal low speed search at Step3 –direction with 500 pps
// When searching Z-phase, deviation counter clear output
// 3,500 pulse offset high speed movement at Step4 +direction with 20,000pps
// -----------Y-axis home search    ---------------------------------------------------
// Near home(IN0) signal high speed search at Step1 –direction with 20,000 pps
// Home(IN1) signal low speed search at Step2 –direction with 500 pps
// Z-phase(IN2) signal low speed search at Step3 –direction with 500 pps
//When searching Z-phase, deviation counter clear output
// 700 pulse offset high speed movement at Step4 +direction with 20,000pps
// -----------Z-axis home search    ---------------------------------------------------
// Step 1 high speed search: None
// Home(IN1) signal low speed search at Step2 + direction with 400pps
// Step3 Z-phase search: None
// 20 pulse offset movement at Step4 –direction with 400pps
// -----------U-axis home search    ---------------------------------------------------
// Step 1 high speed search: None
// Home(IN1) signal low speed search at Step2 –direction at 300pps
// Step3 Z-phase search: None
// Step4 Offset movement: None
void homesrch (void)
{
// X, Y -axis home search parameter setting
// (For mode setting, refer to main initial setting.)
speed (0x3, 2000);              // Step1, 4 high speed speed: 20,000pps
hsspeed (0x3, 50);              // Step2, 3 low speed speed: 500pps
pulse (0x1, 350 0);             // X-axis Offset: 3,500 pulse
pulse (0x2, 700 );              // Y-axis Offset: 700 pulse
// Z-axis home search parameter setting
speed (0x4, 40);            // Step4 movement speed: 400pps
hsspeed (0x4, 40);          // Step2 search speed: 400pps
pulse (0x4, 20) ;           // Offset: 20 pulse
// U-axis home search parameter setting
hsspeed (0x8, 30);          // Step2 search speed: 300pps
command (0xf, 0x62);        // All axes auto home search run
wait (0xf);                 // All axes end waiting
if (inpw(adr+rr0) & 0x0010) // Error display
```



```
{
printf("X-axis Home Search Error \n");
}
if (inpw(adr+rr0) & 0x0020)
{
printf("Y-axis Home Search Error \n");
}
if (inpw(adr+rr0) & 0x0040)
{
printf("Z-axis Home Search Error \n");
}
if (inpw(adr+rr0) & 0x0080)
{
printf("U-axis Home Search Error \n");
}
}
void main (void)
{
int count;
outpw (adr+wr0, 0x8000);        // soft reset
for (count = 0; count <2; ++ count);
command (0x3, 0 xf);            // -----------X, Y -axis mode setting ----------
outpw (adr+wr1, 0x0000);                        // mode register 1
//D15 to 8 : 0 interrupt all prohibition
//D7: 0 IN3 signal: Invalid
//D6: 0 IN3 signal logic: Low active
//D5: 0 IN2 signal: Invalid
//D4: 0 IN2 signal logic: Low active
//D3: 0 IN1 signal: Invalid
//D2: 0 IN1 signal logic: Low active
//D1: 0 IN0 signal: Invalid
//D0: 0 IN0 signal logic: Low active
outpw (adr+wr2, 0xe0000); //mode register 2
//D15:1 INPOS input: Valid
//D14:1 INPOS input logic: High active
//D13:1 ALARM input: Valid
//D12:0 ALARM input logic: Low active
//D11:0
//D10:0 Encoder input divide rate: 1/1
//D9:0 Encoder input method: 2-phase pulse
//D8:0 Drive pulse direction logic
```

```
//D7:0 Drive pulse logic: Positive logic
//D6:0 Drive pulse method: 2 pulse
//D5:0 COMP subject: Logical position counter
//D4:0 – limit logic: Low active
//D3:0 + limit logic: Low active
//D2:0 Limit stop mode: Deceleration stop
//D1:0 Soft limit –: Invalid
//D0:0 Soft limit +: Invalid
outpw (adr+wr3, 0x0000);                    //mode register 3
//D15 to 12:0000
//11:0 General output OUT7: Low
//D10:0 General output OUT6: Low
//D9:0 General output OUT5: Low
//D8:0 General output OUT4: Low
//D7:0 Drive status output: Invalid
//D6: 0
//D5: 0
//D4: 0 External adjustment signal operation: Invalid
//D3: 0
//D2: 0 Accel/Decel speed curve : Linear accel/decel speed (trapezoid)
//D1: 0 Symmetric/asymmetric of accel/decel speed: Symmetric
//D0: 0 Deceleration of fixed pulse drive: Auto deceleration
expmode (0x3, 0 x5d08, 0x497f);             //extension mode
//[others of input signal filter]
//W6/D15 to 13:010 Input signal filter delay: 512 μs
//W6/D12:1 IN3 signal filter : Valid
//W6/D11:1 EXPP, EXPM, EXPLS filter: Valid
//W6/D10:1 INPOS, ALARM signal filter: Valid
//W6/D9:0 IN2 signal filter: Invalid
//W6/D8:1 EMGN, LMTP/M, IN1, 0 filter: Valid
//W6/D7:0
//W6/D6:0
//W6/D5:0 Auto home search end cut in line: Disable
//W6/D4:0 LP/EP variable ring function: Invalid
//W6/D3:1 Triangle form prevention in linear accel/decel speed: Valid
//W6/D2:0 Pulse output replacement: Invalid
//W6/D1:0 EP reverse increase/decrease: Invalid
//W6/D0:0 EP clear by IN2 signal: Invalid
//[auto home search mode]
//W7/D15 to D13 010 Deviation counter clear pulse width: 100 μs
//W7/D12 0 Logic level of deviation counter clear output: High
```

```
//W7/D11 1 Deviation counter clear output: Valid
//W7/D10 0 Uses limit signal as home signal: Invalid
//W7/D9 0 Z-phase signal AND home signal: Invalid
//W7/D8 1 Logical/Actual position counter clear: Valid
//W7/D7 0 Step4 movement direction: + direction
//W7/D6 1 Step4: Valid
//W7/D5 1 Step3 search direction: - direction
//W7/D4 1 Step3: Valid
//W7/D3 1 Step2 search direction: - direction
//W7/D2 1 Step2: Valid
//W7/D1 1 Step1 search direction: - direction
//W7/D0 1 Step1: Valid
//-------------X, Y-axis operation parameter initial setting -----------
accofst (0x3, 0);            //AO = 0
range (0x3, 800000);         // R = 800000 (Magnification= 10)
acac (0x3, 1010);            //K = 1010 (Accel/Decel increase rate = 619kpps/sec2)
dcac (0x3, 1010);            //L = 1010 (Deceleration increase rate = 619kpps/sec2)
acc (0x3, 100);              // A = 100 (Accel/Decel = 125kpps/sec)
dec (0x3, 100);              // D = 100 (Deceleration = 125kpps/sec)
starv (0x3, 100);            //SV = 100 (Start speed= 1000pps)
speed (0x3, 4000);           // V = 4000 (Drive speed = 40000pps)
pulse (0x3, 100000);         // P = 100000 (Number of output pulses = 100000)
lp (0x3, 0);                 // LP= 0 (Logical position counter= 0)
ep (0x3, 0);                 // EP= 0 (Actual position counter= 0)
command (0xc, 0 xf);         //---------Z, U-axis mode setting ----------
outpw (adr+wr1, 0x0000);     //mode register 1
//D15 to 8: 0 interrupt all prohibition
//D7: 0 IN3 signal: Invalid
//D6: 0 IN3 signal logic: Low active
//D5: 0 IN2 signal: Invalid
//D4: 0 IN2 signal logic: Low active
//D3: 0 IN1 signal: Invalid
//D2: 0 IN1 signal logic: Low active
//D1: 0 IN0 signal: Invalid
//D0: 0 IN0 signal logic: Low active
outpw (adr+wr2, 0x0000);     //mode register 2
//D15:0 INPOS input: Invalid
//D14:0 INPOS input logic: Low active
//D13:0 ALARM input: Invalid
//D12:0 ALARM input logic: Low active
//D11:0
```

```
//D10:0 Encoder input divide rate: 1/1
//D9:0 Encoder input method: 2-phase pulse
//D8:0 Drive pusle direction logic:
//D7:0 Drive pulse logic: Positive logic
//D6:0 Drive pulse method: 2 pulse
//D5:0 COMP subject: Logical position counter
//D4:0 –Limit logic: Low active
//D3:0 + Limit logic: Low active
//D2:0 Limit stop mode: Deceleration stop
//D1:0 Soft limit - : Invalid
//D0:0 Soft limit+: Invalid
outpw (adr+wr3, 0x0000);                    // mode register 3
//D15 to 12: 0000
//D11:0 General output OUT7: Low
//D10:0 General output OUT6: Low
//D9:0 General output OUT5: Low
//D8:0 General output OUT4: Low
//D7:0 Drive status output: Invalid
//D6:0
//D5:0
//D4:0 External adjustment signal operation: Invalid
//D3:0
//D2:0 Accel/Decel speed curve : Linear accel/decel speed (trapezoid)
//D1:0 Symmetric/Asymmetric in accel/decel speed: Symmetric
//D0:0 Deceleration in fixed pulse drive: Auto deceleration
// Because auto home search of Z-axis and U-axis are different,
// Set the below extension mode individually.
expmode (0x4, 0 x5d08, 0x01c4);         //Z-axis extension mode
// [others of input signal filter]
//W6/D15 to 13: 010 input signal filter delay: 512 ㎲
//W6/D12:1 IN3 signal filter: Valid
//W6/D11:1 EXPP, EXPM, EXPLS filter: Valid
//W6/D10:1 INPOS, ALARM signal filter: Valid
//W6/D9:0 IN2 signal filter: Invalid
//W6/D8:1 EMGN, LMTP/M, IN1, 0filter: Valid
//W6/D7:0
//W6/D6:0
//W6/D5: 0 Auto home search end cut in line: Disable
//W6/D4: 0 LP/EP variable ring function: Invalid
//W6/D3: 1 Triangle form prevention in linear accel/decel speed: Valid
//W6/D2: 0 Pulse output replacement: Invalid
```

//W6/D1: 0 EP increase/decrease reverse: Invalid

//W6/D0: 0 EP clear by IN2 signal: Invalid

// [auto home search mode]

//W7/D15 to D13 000 Deviation counter clear pulse width :

//W7/D12 0 Logic level of deviation counter clear output:

//W7/D11 0 Deviation counter clear output: Invalid

//W7/D10 0 Uses limit signal as home signal: Invalid

//W7/D9 0 Z-phase signal AND home signal: Invalid

//W7/D8 1 Logical/actual position counter clear: Valid

//W7/D7 1 Step4 movement direction: -direction

//W7/D6 1 Step4 : Valid

//W7/D5 0 Step3 search direction:

//W7/D4 0 Step3: Invalid

//W7/D3 0 Step2 search direction: + direction

//W7/D2 1 Step2: Valid

//W7/D1 0 Step1 search direction:

//W7/D0 0 Step1: Invalid

expmode (0x8, 0 x5d08x 0x010c);   // U-axis extensionmode

// [the others of input signal filter]

//W6/D15 to 13: 010 Input signal filter delay: 512 ㎲

//W6/D12: 1 IN3 signal filter: Valid

//W6/D11: 1 EXPP, EXPM, EXPLS filter: Valid

//W6/D10: 1 INPOS, ALARM signal filter: Valid

//W6/D9: 0 IN2 signal filter: Invalid

//W6/D8: 1 EMGN, LMTP/M, IN1, 0 filter: Valid

//W6/D7: 0

//W6/D6: 0

//W6/D5: 0 Auto home search end cut in line: Disable

//W6/D4: 0 LP/EP variable ring function: Invalid

//W6/D3: 1 Triangle form prevention in linear accel/decel speed: Valid

//W6/D2: 0 Pulse output replacement: Invalid

//W6/D1: 0 EP increase/decrease reverse: Invalid

//W6/D0: 0 EP clear by IN2 signal: Invalid

// [auto home search mode]

//W7/D15 to D13 0000 deviation counter clear pulse width:

//W7/D12 0 Logic level of deviation counter clear output:

//W7/D11 0 Deviation counter clear output: Invalid

//W7/D10 0 Uses limit signal as home signal: Invalid

//W7/D9 0 Z-phase signal AND home signal: Invalid

//W7/D8 1 Logical/Actual position counter clear: Valid

//W7/D7 0 Step4 movement direction:

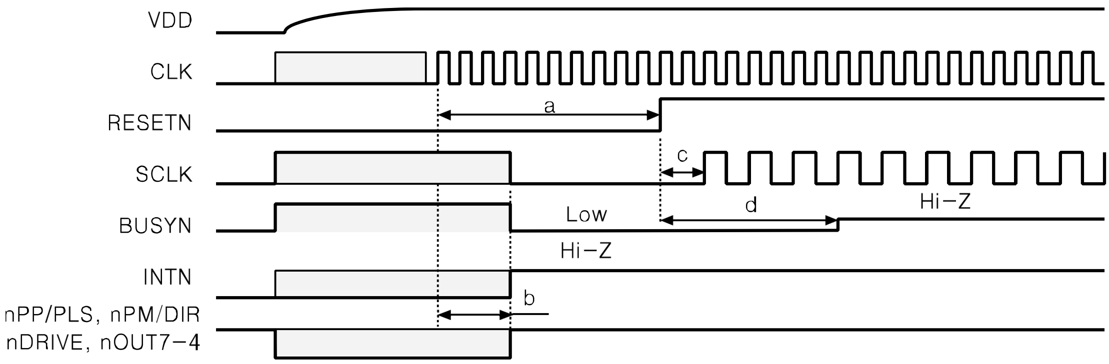
```
//W7/D6 0 Step4: Invalid
//W7/D5 0 Step3 search direction:
//W7/D4 0 Step3: Invalid
//W7/D3 1 Step2 search direction: -direction
//W7/D2 1 Step2: Valid
//W7/D1 0 Step1 search direction:
//W7/D0 0 Step1: Invalid
//--------Z, U-axis operation parameter initial setting ------
accofst (0xc, 0);              //AO = 0
range (0xc, 800000);           // R = 800000 (Magnification = 10)
acac (0xc, 1010);              // K = 1010 (Accel/Decel increase rate=619kpps/sec²)
dcac (0xc, 1010);              // L = 1010 (Deceleration increase rate=619kpps/sec²)
acc (0xc, 100);                // A = 100 (Accel/Decel =125 kpps/sec)
dec (0xc, 100);                // D = 100 (Deceleration =125 kpps/sec)
startv (0xc, 50);              // SV = 50 (Start speed= 500pps)
speed (0xc, 40);               // V = 40 (Drive speed= 400pps)
pulse (0xc, 10);               // P = 10 (Number of output pulses= 10)
lp (0xc, 0);                   // LP = 0 (Logical position counter= 0)
//------------general output register initial setting -------
outpw(adr+wr4, 0x0000);        // 00000000 00000000
//------------interpolation mode register initial setting -------
outpw (adr+wr5, 0x0124);       // 00000001 00100100
ax1=x, ax2=y, ax3=z, constant linear velocity
//---------- drive start ----------------------------------
// homesrch ( ); //---------all axes home search ----------------
//---------X, Y-axis linear accel/decel speed drive--------
acc (0x3, 200);                //A = 200 (Accel/Decel = 250 kpps/sec)
speed (0x3, 4000);             //V = 4000 (Drive speed = 40000 pps)
pulse (0x1, 80000);            //xP = 80000
pulse (0x2, 40000);            //yP = 40000
command (0x3, 0 x20);          //+ fixed pulse drive
wait (0x3);                    // Drive end waiting
//-------------X-axis asymmetric linear accel/decel speed drive ------
wreg3 (0x1, 0x0002);           // acceleration•deceleration individual (asymmetric) mode
acc (0x1, 200);                // xA = 200 (Accel/Decel = 250kpps/sec)
dec (0x1, 50);                 // xD = 50 (Deceleration = 62.5 kpps/sec)
speed (0x1, 4000);             // xV = 4000 (Drive speed = 40000pps)
pulse (0x1, 80000);            // xP = 80000
command (0x1, 0 x20);          // + fixed pulse drive
wait (0x1);                    // Drive end waiting
wreg3 (0x1, 0x0000);           // Acceleration•Deceleration individual mode clear
```

```
//-----------X, Y-axis S curve speed drive ------
wreg3 (0x3, 0x0004);              //S mode
acac (0x3, 1010);                 // K = 1010 (Acceleration increase rate= 619kpps/sec²)
acc (0x3, 200);                   // A = 200 (Accel/Decel = 250kpps/sec)
speed (0x3, 4000);                // V = 4000 (Drive speed = 40000pps)
pulse (0x1, 50000);               // xP = 50000
pulse (0x2, 25000);               // yP = 25000
command (0x3, 0 x21);             // - fixed pulse drive
wait (0x3) ;
wreg3 (0x3, 0x0000);              //S curve speed mode clear
//-----------Z-axis constant speed drive ----------
startv (0x4, 40);                 // SV= 40 (Start speed= 400pps)
speed (0x4, 40);                  // V= 40 (Drive speed = 400pps)
pulse (0x4, 700);                 // P= 700
command (0x4, 0 x20);             // + fixed pulse drive
wait (0x4);                       // (moves to 700 pulse +direction with 400pps)
pulse (0x4, 350);                 // P= 350
command (0x4, 0 x21);             // - fixed pulse drive
wait (0x4);                       // (moves 350 pulse – direction with 400pps)
//-----------X, Y-axis linear interpolationdrive ----------
outpw (adr+wr5, 0x0124);          // ax1=x, ax2=y, ax3=z, constant linear velocity
range (0x1, 800000);              // ax1/R = 800000 (Magnification= 10)
range (0x2, 11311371);            // ax2/R = 800000×1.414
speed (0x1, 100);                 // ax1/V = 100 (Drive speed = 1000pps constant speed)
pulse (0x1, 5000);                // xP = +5000 (End point X= +5000)
pulse (0x2, -2000);               // yP = -2000 (End point Y= -2000)
command (0x0, 0x30);              // 2-axis linear interpolation
wait (0x3);
//-----------------X, Y-axis circular interpolation drive ------
outpw (adr+wr5, 0x0124);          // ax1=x, ax2=y, ax3=z, constant linear velocity
range (0x1, 800000);              // ax1/R = 800000 (Magnification= 10)
next_wait ( );
pulse (0x1, -45 00);        // Seg 5
pulse (0x2, 0);
command (0, 0x3 0);
next_wait ( );
center (0x1, 0);                  // Seg 6
center (0x2, -1 500);
pulse (0x1, -15 00);
pulse (0x2, -15 00);
command (0, 0x3 3);
```

```
next_wait ( );
pulse (0x1, 0);                    // Seg 7
pulse (0x2, -15 00);
command (0, 0x3 0);
next_wait ( );
center (0x1, 15 00);               // Seg 8
center (0x2, 0) ;
pulse (0x1, 150 0);
pulse (0x2, -15 00);
command (0, 0x3 3);
wait (0x3);
//------------synchronous operation ('(1) of 5.6.1 Example of synchronous operation') -----
// When Y-axis passes position 15000 (own),
// +direction fixed pulse of Z-axis drive start
range (0x6, 800000);               // R = 800000 (Magnification= 10)
acc (0x6, 400);                    // A = 400 (Accel/Decel= 500kpps/sec)
startv(0x6, 50);                   //SV= 50 (start speed=50pps)
speed (0x6, 3000);                 // V= 3000 (Drive speed= 30kpps)
pulse (0x2, 50000);                // yP= 50000 (Y-axis Number of output pulses)
pulse (0x4, 10000);                // zP= 10000 (Z-axis Number of output pulses)
compp(0x2, 15000);                 // yCP+ = 15000 (Y-axis CMP+)
lp (0x6, 0);                       // LP= 0 (Logical position counter= 0)
syncmode (0x2, 0x2001, 0x0000);    // Y-axis synchronous operation mode
// Start factor: P≥C+, other axis start: Z
// Own axis operation: None
syncmode (0x4, 0x0000, 0x0001);    // Z-axis synchronous operation mode
// Own axis operation: +direction fixed pulse drive
command (0x2, 0 x20);              // Y-axis + fixed pulse drive start
wait (0x6); // Y, Z -axis end waiting
}
```


15 Input/Output signal timing

15.1 Power-on timing



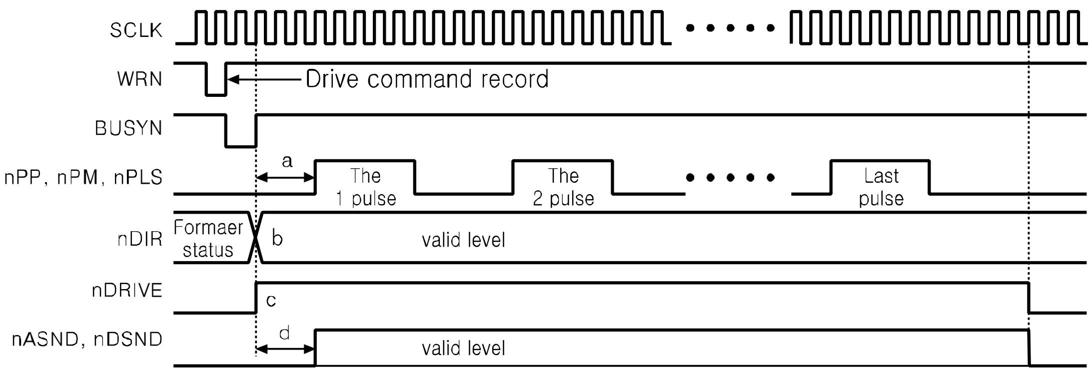
a. Reset input signal RESETN requires low level over CLK×4 cycel after CLK inputing.

b. When supplying power, in output signal, RESETN is low level, CLK input decides level after max. CLK×4 cycel.

c. In SCLK, after RESETN is high level, it outpus after max. CLK×2 cycel.

d. In BUSYN, after RESETN is high level, it decides after max. CLK×8 cycle. In this case, it is disable to read/write motion control IC.

15.2 Drive start/end



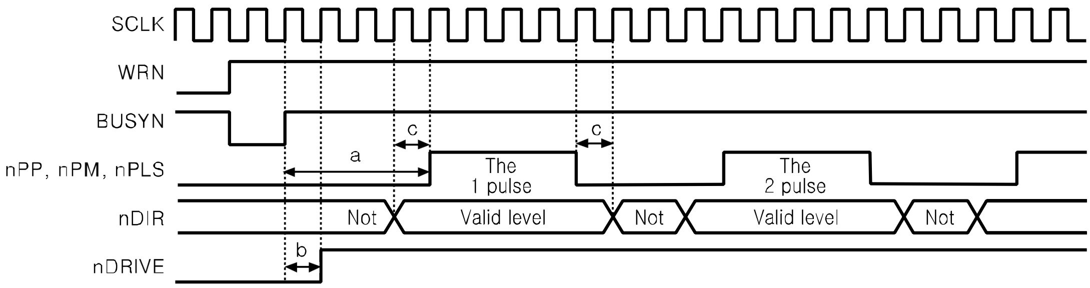
a. The figure drive pulse (nPP, nPM, nPLS) is for positive pulse. The 1pulse is output from ↑ of BUSYN to SCLK3 cycle.

b. When setting 1-pulse method for drive output pulse method, nDIR(direction) signal is changed as valid level at ↑ of BUSYN . After driving, it maintains the level until the next drive command writing. However, it does not applied in interpolation drive.

c. nDRIVE becomes high level at ↑ of BUSYN and returns to low level after pulse low period.

d. nASND, nDSND become valid level at ↑ of BUSYN after SCLK3 cycle and becomes low level when las pulse of nDRIVE starts low.

15.3 Interpolation drive

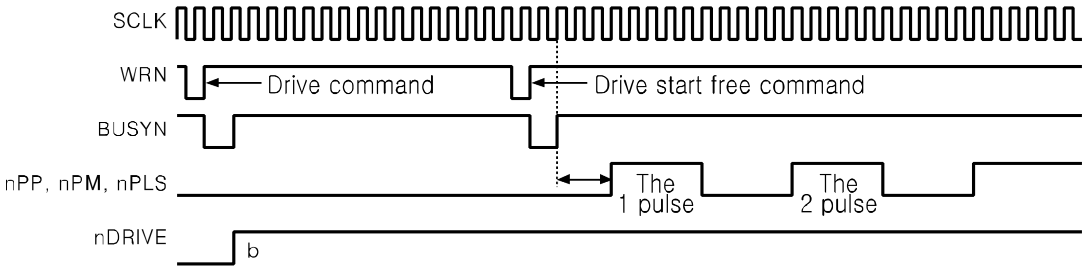


a. In interpolation drive, drive pulse (nPP, nPM, nPLS), it outputs the 1 pulse after SCLK4 cycle at ↑ of BUSYN.

b. nDRIVE becomes high level at ↑ of BUSYN after SCLK1 cycle.

c. When setting 1-pulse method for drive output pulse method, nDIR(direction) signal is in interpolation drive, high level width of drive pulse, before/after between SCLK 1, and valid level. (Drive pulse: for positive logic pulse)

15.4 Drive start free

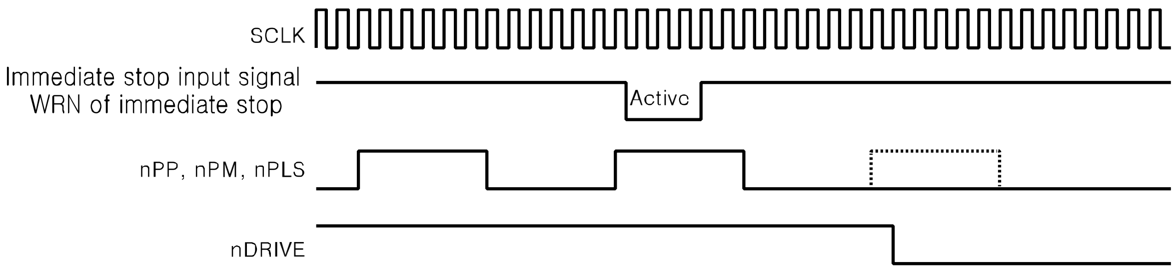


a. After drive pulse(nPP, nPM, nPLS) of each axis cycles to SCLK3 at ↑ of BUSYN for drive start free command write, the 1-pulse is output at the same time.

b. nDRIVE is each high level at ↑ of BUSYN for drive command writing of each axis.

15.5 Drive immediate stop

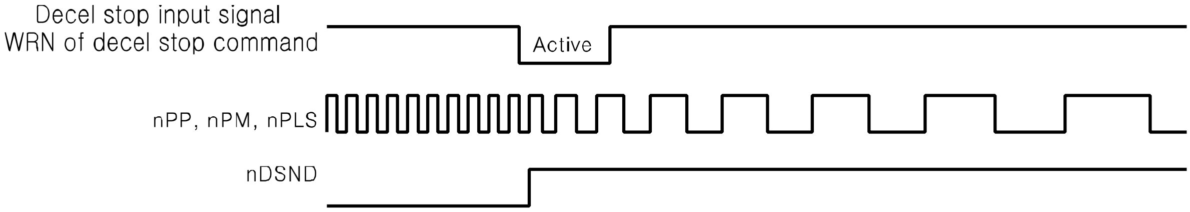
It is operation timing of immediate stop input signal and immediate stop command. Immediate stop input signal is EMG, nLMTP/M (when setting immediate stop mode), nALARM. When immediate stop input signal writes active level or immediate stop command, it outputs drive pulse of current output and stops pulse output.



Immediate stop input signal requires pulse width over than CLK2 cycle even though input signal filter is invalid. When input signal filter is set as valid, input signal is delayed by filter pass time.

15.6 Drive deceleration stop

It is operation timing of deceleration stop input signal and deceleration stop command.
Deceleration stop input signal is nIN3 to 0, nLMT+/- (when setting deceleration stop mode).
When deceleration stop input signal writes active level or deceleration stop command, it outputs drive pulse of current output and stops by deceleration.



When as input signal filter is set as valid, input signal is delayed filter pass time.

16 Specifications

- Control -axis: 4-axis
- CPU Data bus length: Selectable 16/8 bit

(1) Interpolation function

- 2/3-axis linear interpolation
  - Interpolation range: -2,147,483,646 to +2,147,483,646 for each axis
  - Interpolation speed: 1pps to 4Mpps
  - Interpolation position accuracy: Max. $\pm$0.5 LSB (within all interpolation range)
- Circular interpolation
  - Interpolation range: -2,147,483,646 to +2,147,483,646 for each axis
  - Interpolation speed: 1pps to 4Mpps
  - Interpolation position accuracy: Max. $\pm$1 LSB (within all interpolation range)
- 2/3-axis bit pattern interpolation
  - Interpolation speed: 1pps to 4Mpps (Depends on CPU data setup time)
- Other interpolations
  - Selectable the desired axis
  - Constant linear velocity
  - Consecutive interpolation
  - Interpolation step transmission (Command, external signal)

(2) Each axis common specification

- Driver pulse output (When CLK=16MHz)
  - Output circuit range: 1pps to 4Mpps
  - Output speed accuracy: Max. $\pm$0.1% (For set value)
  - Speed magnification: 1 to 500
  - S jerk speed: 954 to 62.5×10^6pps/sec^2 (Magnification=1)
    (Acceleration/Deceleration increase rate): 477×10^3 to 31.25×10^6 pps/sec^2 (Magnification=500)
  - Accel/Decel: 125 to 1×10^6 pps/sec (Magnification=1)
    62.5×10^3 to 500×10^6 pps/sec (Magnification=500)
  - Initial velocity: 1 to 8,000pps (Magnification=1)
    500 to 4×10^6 pps (Magnification=500)
  - Drive speed: 1 to 8,000pps (Magnification=1)
    500 to 4×10^6 pps (Magnification=500)
  - Number of output pulses: 0 to 4,294,967,295 (fixed pulse drive)
  - Speed curve constant speed/symmetric•asymmetric linear accel/decel/symmetric•asymmetric parabola S curve drive
  - Fixed pulse drive deceleration mode auto deceleration (asymmetric linear accel/decel is available) / Manual deceleration
  - Changeable output pulse for driving, drive speed
  - Triangle form prevention of linear accel/decel fixed pulse drive, triangle form prevention function of S curve speed fixed pulse drive
  - Selectable individual 2-pulse/1-pulse direction method
  - Selectable drive pulse logic level, changeable output terminal

- Encoder input pulse
  - Selectable 2-phase pulse/up down pulse input
  - Selectable 2-pulse 1, 2, 4 multiply
- Position counter
  - Logical position counter (for output pulse) count range: -2,147,483,648 to +2,147,483,647
  - Actual position counter (for input pulse) count range: -2,147,483,648 to +2,147,483,647
  - Enable to write, read at all times
  - Variable ring counter function, increase/decrese reverse function of actual position counter, actual position counter clear function by IN2 signal, enable to write, read at all times
- Comparison register
  - COMP+ register position comparison range: -2,147,483,648 to +2,147,483,647
  - COMP- register position comparison range: -2,147,483,648 to +2,147,483,647
  - Status output for position counter size, signal output
  - Enable to operate as software limit
- Auto home search
  - Step1(high speed near home search) → Step2(low speed home search) → Step3(low speed Encoder Z-phase search) → Step4(high speed offset movement), auto run as the order
    Selectable valid/invalid, search direction of each step
- Synchronous operation
  - Start factors
    position counter≥COMP+ changes, position counter<COMP+ changes, position counter<COMP- changes, position≥COMP- changes, drive start, drive end, IN3 signal ↑, IN3signal ↓, LP read command, start command, valid/invalid for each step, selectable search direction
  - Operation
    +/- fixed pulse drive start, +/- consecutive pulse drive start, drive deceleration stop, drive immediate stop, position counter value save, position counter set, number of output pulses set, drive speed set, enables to start the other axis as generating interrupt own axis factor
- Interrupt funcion (except interpolation)
  - Interrupt occurance factors

    1 drive pulse output

    When changing position counter ≥ COMP-

    When changing position counter ≥ COMP+

    When changing position counter < COMP-

    When changing position counter < COMP+

    When starting constant speed in accel/decel drive

    When ending constant speed in accel/decel drive

    When ending drive

When ending auto home search

Synchronous operation

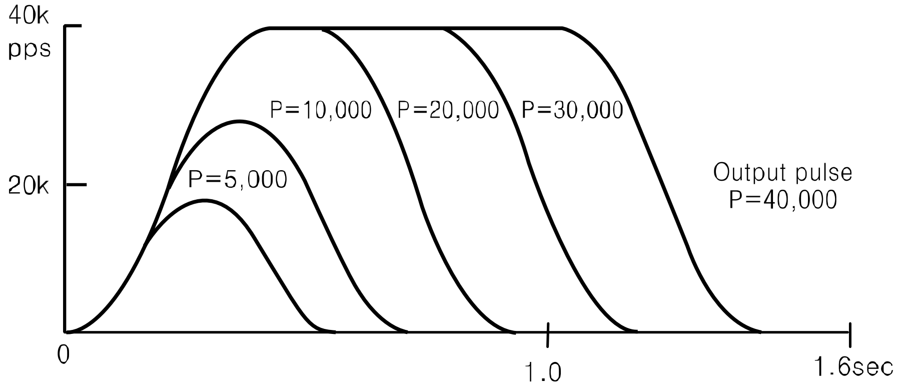
Selectable valid/invalid by any factors.

- Drive adjustment by external signal
  - Enables fixed/consecutive pulse drive of +, -direction by EXP+, EXP- signal
  - Enables 2-phase encoder signal mode (encoder input) drive
- External deceleration stop/immediate stop signal
  - IN0 to 3 each axis 4-point
    Selectable signal valid/invalid and logic level, enables to use general input
- Input signal for servo motor
  - Selectable ALARM (alarm), INPOS (inposition) signal valid/invalid and logic level
- General output signal
  - OUT4 to 7 each axis 4-point (uses same terminal with drive status output signal)
- Drive status signal output
  - ASND(accelerating), DSND(decelerating), CMPP(Position≥COMP+), CMPM(Position<COMP-).
    Drive status is able to read at status register.
- Overrun limit signal input
  - + Selectable + direction, - direction each 1-point and logic level, At active, selectable immediate stop/decelerate stop
- Emergency stop signal input
  - EMG 1-point, stops immediately drive pulse of all axes by low level
- Built-in integral filter
  - Built-in integral filter at each input signal input terminal, selectable pass time (8 types)
- Electric characteristics
  - Power supply: uses PC inner power (5VDC)
  - External power supply: 12-24VDC
  - Operation temperature range: 0 to +45°C
  - Input clock: 16.000 MHz (standard)
- The other interpolation functions
  - Selectable the desired axis
  - Constant linear velocity
  - Consecutive interpolation
  - Interpolation step transmission (Command, external signal)

17 Appendix: speed profile of accel/decel speed drive

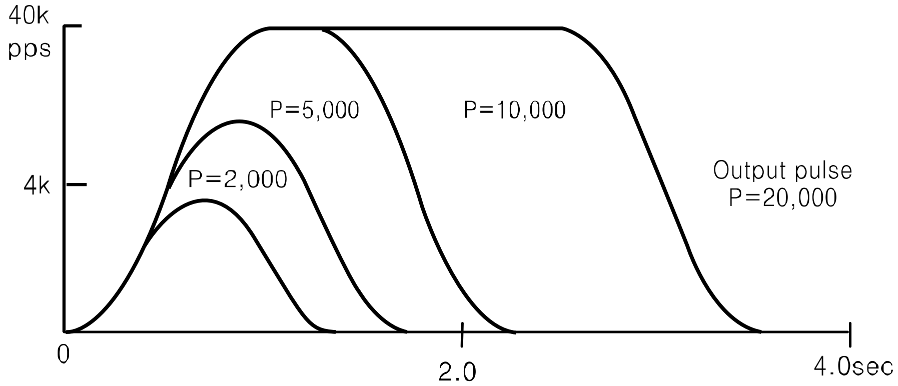
When setting as below parameter, it displays speed curve of drivepulse to output.

(1) 40kpps symmetric S curve



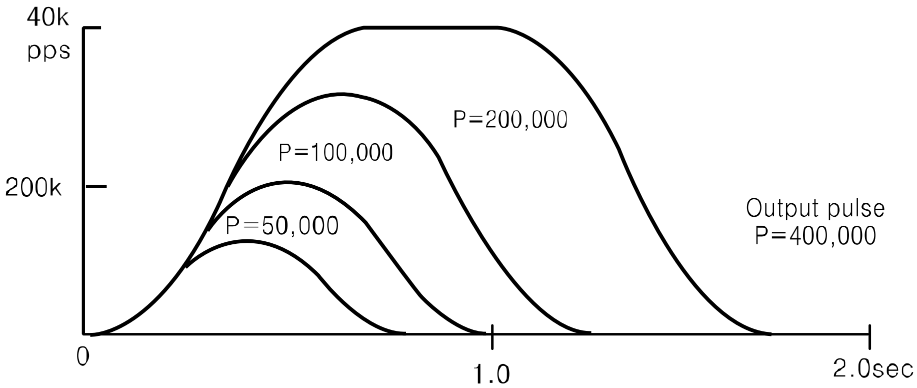
R=800000 (Magnification: 10)
K=700 (A=8000), SV=10, V=4000, A0=0
WR3/D2, 1, 0:1, 0, 0 auto deceleration mode
Acceleration increase rate=893kpps/sec^2
Start speed=100pps
Drive speed=40kpps

(2) 8,000pps symmetric S curve



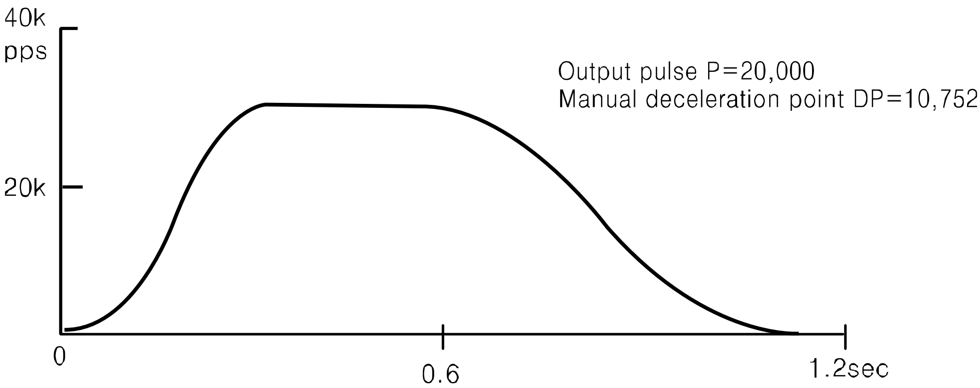
R=8000000 (Magnification: 1)
K=2000 (A=8000), SV=10,
V=8000, A0=0
WR3/D2, 1, 0:1, 0, 0 auto deceleration mode
Acceleration increase rate=31kpps/sec^2
Start speed=10pps
Drive speed=8000kpps

(3) 400pps symmetric S curve



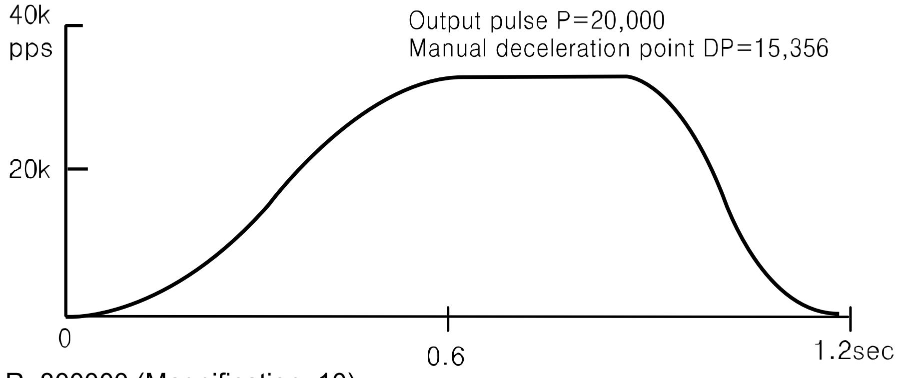
R=80000 (Magnification: 100)
K=2000 (A=8000), SV=10,
V=4000, A0=0
WR3/D2, 1, 0:1, 0, 0 auto deceleration mode
Acceleration increase rate=3.13Mpps/sec^2
Start speed=1000pps
Drive speed=400kpps

(4) 40kpps asymmetric S curve(1)



R=800000 (Magnification: 10)
K=500, L=2000 (A=D=8000),
SV=10, V=3000, A0=0
WR3/D2, 1, 0:1, 1, 1 manual deceleration mode
Acceleration increase rate=1.25Mpps/sec^2
Deceleration increase rate=0.31Mpps/sec^2
Start speed=100pps
Drive speed=30kpps

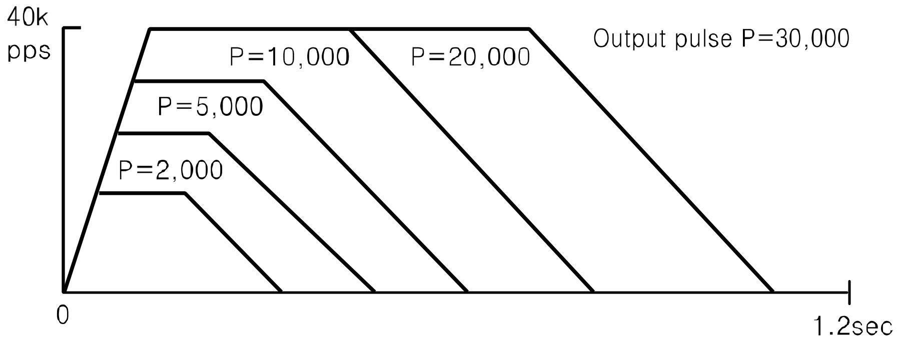
(5) 40kpps asymmetric S curve (2)



R=800000 (Magnification: 10)
K=2000, L=500 (A=D=8000),
SV=10, V=3000, A0=0
WR3/D2, 1, 0:1, 1, 1 manual deceleration mode
Acceleration increase rate=0.31Mpps/sec^2
Deceleration increase rate=1.25Mpps/sec^2
Start speed=100pps
Drive speed=30kpps

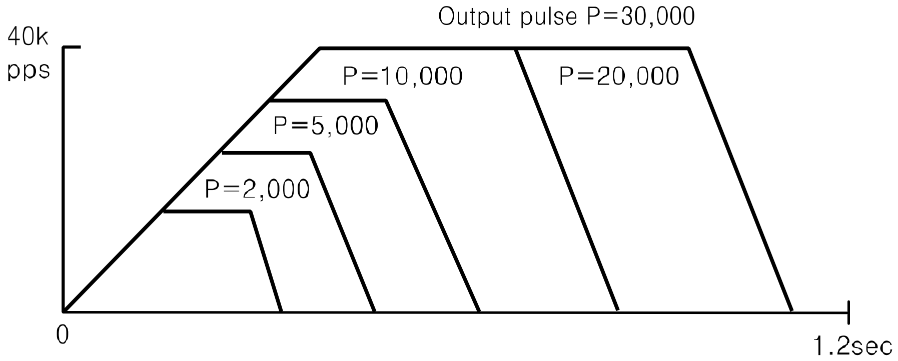
(6) 40kpps asymmetric trapezoid accel/decal

1) Accel/Decel ratio 4:1



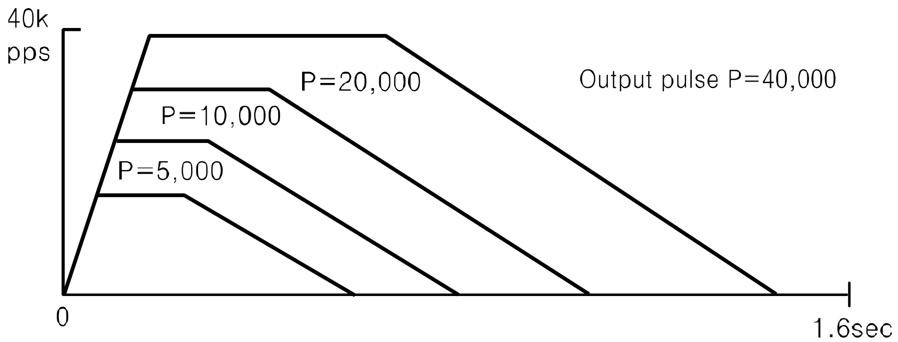
R=800000 (Magnification: 10), A=400
D=100, SV=40, V=4000, A0=0
WR3/D2, 1, 0:0, 1, 0 auto deceleration mode
60H/WR6/D3:1 triangle form prevention ON
Acceleration=500kpps/sec
Deceleration =125kpps/sec
Start speed=400pps
Drive speed=40kpps

2) Accel/Decel ratio 1:4



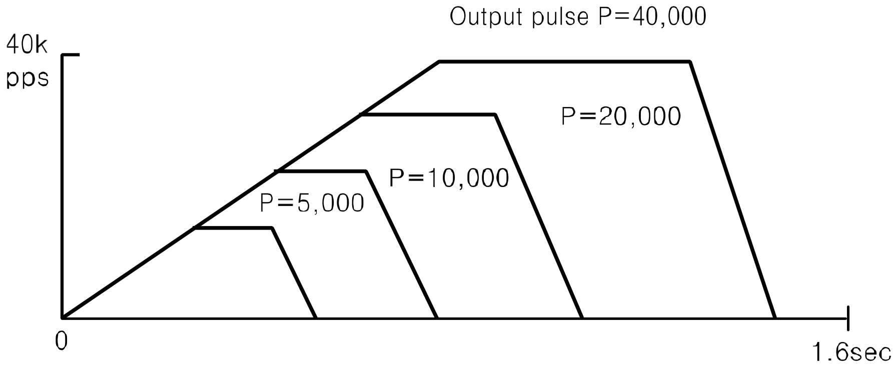
R=800000 (Magnification: 10), A=100
D=400, SV=40, V=4000, A0=0
WR3/D2, 1, 0:0, 1, 0 auto deceleration mode
60H/WR6/D3:1 triangle form prevention ON
Acceleration=125kpps/sec
Deceleration =500kpps/sec
Start speed=400pps
Drive speed=40kpps

3) Accel/Decel ratio 10:1



R=800000 (Magnification: 10), A=400, D=40,
SV=50, V=4000, A0=0
WR3/D2, 1, 0:0, 1, 0 auto deceleration mode
60H/WR6/D3:1 triangle form prevention ON
Acceleration=500kpps/sec
Deceleration =50kpps/sec
Start speed=500pps
Drive speed=40kpps

4) Accel/Decel ratio 1:10



R=800000 (Magnification: 10), A=40, D=400,
SV=50, V=4000, A0=0
WR3/D2, 1, 0:0, 1, 0 auto deceleration Mode
60H/WR6/D3:1 triangle form prevention ON
Acceleration=50kpps/sec
Deceleration =500kpps/sec
Start speed=500pps
Drive speed=40kpps

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