4-Axis Motor Control IC

PbFree

MCX304 is 4-axis motion control IC which can independently control either stepper motor driver or pulse type servo motor for position and speed control.

Specification Specification

■Control axis 4 axes ■Data bit bus width 16/8 bit selectable

■Drive output pulse at CLK = 16MHz

1PPS ~ 4MPPS Output speed range

 Output speed accuracy ±0.1%(accrding to the setting value) 954 ~ 31.25 × 10⁹ PPS/SEC 125 ~ 500 × 10⁶ PPS/SEC S-curve jerk Acceleration/deceleration speed

1 ~ 4×10⁶ PPS 1 ~ 4×10⁶ PPS ●Initial speed ●Drive speed

 Number of output pulse 0 ~ 268,435,455 (Fixed drive) or Unlimited(Continuous drive)

Speed curve

Constant, linear acceleration/deceleration or parabola S-curve acceleration/deceleration

Auto(non-symmetry trapezodial drive is allowd)/manual Deceleration mode for fixed pulse drive

The number of output pulse and drive speed during driving are changeable.

●Independent 2 pulse system / 1 pulse 1 direction system is selectable.

● Logical levels of pulse are selectable.

■ Encoder input

2 phase pulse style or Up/down pulse style is selectable.

●Pulse of each single, double and quad count edge evaluation is selectable.(2-phase pulse style).

■ Position counter

● Logical position counter(for output pulse) range -2,147,483,648 ~ +2,147,483,647

• Real position counter (for input pulse) range -2,147,483,648 ~ +2,147,483,647

■Comparison register

-1,073,741,824 ~ +1,073,741,823 -1,073,741,824 ~ +1,073,741,823 ●COMP+ register range ●COMP- register range

Status and signal outputs for the comparisons of position counters.

●To work as software limit.

■Automatic home search

Automatic of execution of Step1(high-speed near home search)

→Step2(low-speed home search)→Step3(low-speed encoder Z-phase search)

→Step4(high-speed offset drive).

Enable/disable of each step and search direction are selectable.

■Interrupt

..the start/finish of a constant-speed drive during the acceleration/deceleration driving

..the end of the driving

..transition to "position counter ≥ the volume of COMP-

..transition to "position counter < the volume of COMP-

..transition to "position counter ≥ the volume of COMP+

..transition to "position counter < the volume of COMP+

■External signal for driving EXPP and EXPM signal for +/- direction fixed/continuous pulse drive.

Driving in manual pulsar mode(Encoder input).

■External decelrating/instant stop signal

STOP0 ~ 2 3 points for each axis.

Enable/disable and logical levels are selectable.

■Input signal for servo motor

ALARM(Alarm) and INPOS(In position check)

■General input/output signal

7 points for each axis (all the points are pin sharing with

the other functions)

Output OUT 0~3 4 points for each axis(all the points are pin sharing

with the other functions)

■Limit signal input 1 point for each +/-direction

Logical levels and decelerating/instant stop are selectable.

■Emergency stop signal

EMGN 1 point for all axes

Stop the drive pulse of all axes immediately in Low level.

■ Integral filter built-in.

Equipped integral filter in the input column of each input signal.

One time constant can be selected from 8 types.

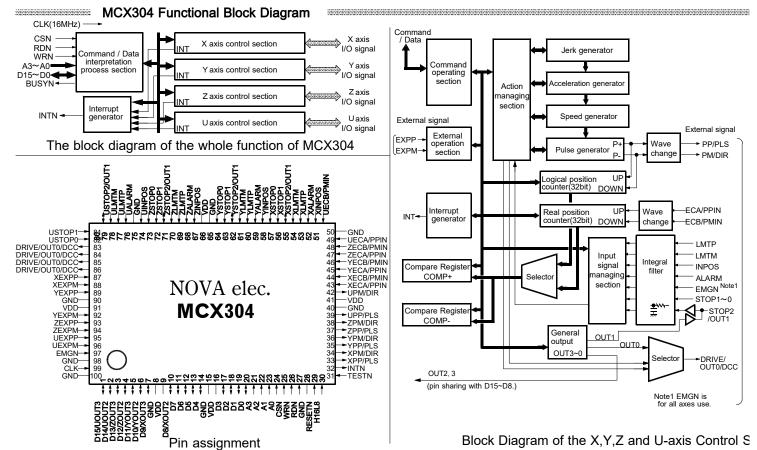
■ Electrical characters

Temperature range for operating 0 ~ + 85°C (32°F ~181°F)

 $+5V \pm 5$ %(Consumption current 67 mA max.) TTL / CMOS level Power voltage Input/output signal level

16.000MHz (Standard.) Input clock ■ Dimension(including pins) 23.8×17.8×3.05mm

100-pin plastic QFP, pin pitch=0.65



■ Input/Output signals ((I): Input (O): Output (B): Bidirectional Each X, Y, Z and U axis has nOOOO signal. "n" means each X, Y, Z and U axis.)

●D15~0(B) Data Bus(D15~8 is pin sharing with nOUT2 and 3) ●A3~0(I) Adress ●CSN(I) Chip select ●WRN(I) Write strobe ●RDN(I) Read strobe ●RESETN(I) Reset

●H16L8(I) 16/8 Data bit bus width selectable ●INTN(O) Interrupt ●nPP/PLS(O) + direction drive pulse/Drive pulse ●nPM/DIR(O) - direction drive pulse/Drive pulse ●nPM/DIR(O) - direction for servo driver alarm ●nLMTP(I) + direction limit ●nLMTM(I) - direction limit ●nSTOP2~0(I) 3points for decelerating/instant stop(nSTOP2 is pin sharing with nOUT1.) ●nDRIVE/OUT0/DCC(O) (DRIVE:Drive pulse outputting status, OUT0:General output, DCC:Sharing pin for Deviation counter clear outputting) ●nEXPP(I) External + direction drive, manual pulsar A-phase ●nEXPM(I) External -direction drive, manual pulsar B-phase ●EMGN(I) Emergency stop ●CLK(I) Clock 16MHz(Standard)

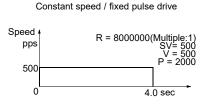
Individual control for 4 Axes

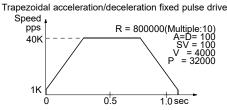
MCX304 has 32 bit position counter for each X,Y,Z and U axis and function to drive constant speed, linear and S-curve acceleration/deceleration to the maximam speed 4MPPS.Drive command is operated by +/- direction fixed pulse drive or continuous drive basically.

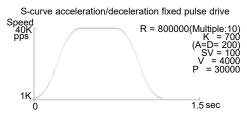
Fixed pulse:Output the specified pulse number.

● Countinuous pulse: Keep outputting the pulse unlimitedly until the stop factor is generated.

Either drive can be operated in constant speed and linear/S-curve acceleration/decelration by operation parameter and mode setting



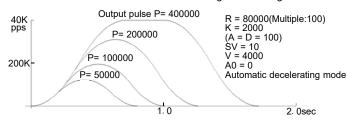


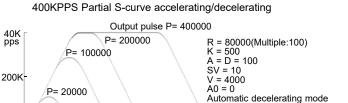


■ S-curve acceleration/deceleration drive

S-curve acceleration/deceleration has a style to increase or decrease acceleration/deceleration speed by linear function. Therefore, its speed curve moves as parabola S-curve. Triangle forms during S-curve acceleration/deceleration are prevented by a special method as the following figure however the number of output pulse is small. Perfect S-curve acceleration/deceleration drives as quadratic curve without linear accelration/deceleration at all during accelerating/decelerating, contrarily, partial S-curve acceleration/deceleration drives as combining liear and curve driving during accelerating/decelerating.

400KPPS Perfect S-curve accelerating/decelerating





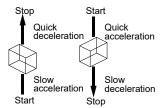
1.0

Automatic deceleration for non-symmetrical trapezoidal drive

40K

In non-symmetrical trapezoidal acceleration/deceleration drive whose accelerating and decelerating speed are different, automatic decelerating is started since the start point of decelerating is calculated inside MCX304. There is no need to set the start point of decelerating from CPU for users.

Non-symmetry trapezoidal acceleration/deceleration



As the above figure shows, when the obejects are moved in up/down direction, gravity acceleration is added. For efective transporting, non-symmetry trapezoidal drive is needed.

R = 800000(Multiple:10) A = 40 D = 400 SV = 50 V = 4000 A0 = 0

P=5000

Output pulse P=30000

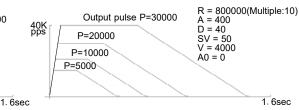
P=20000

P=5000

drive(acceleration deceleration)

Non-symmetry trapezoidal acceleration/deceleration drive(acceleration>deceleration)

2. 0sec



Individual acceleration/deceleraion : WR3/D1 =1, Preventing triangle forms ON : WR3/D5 =1

[Note] In acceleration>deceleration, there is limitation for the rate of acceleration and deceleration which can be operated by automatic deceleration. The limitation depends on the value of driving speed. For example, when the driving speed is 100kpps, its rate is to 1/40.

Automatic home search

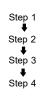
The automatic home search function executes the home search sequence from step1:high-speed near home search to step4:high-speed offset drive as the right figure. Set execution/non-execution and search direction mode for each step.

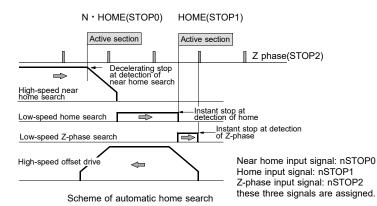
■Search speed

In step 1 and 4, search action is executed by high speed which is set as the drive speed(V). Or, in step 2 and 3, search action is executed by low speed which is set as the home detection speed(HV)

■Irregular operation

In irregular operation
In irregular case, for example, the signal is already active in sensor active part before the searching starts or which is detecting the limit for the direction of movement during searching, the correct home search is executed.

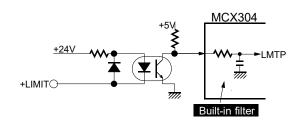




Built-in integral filter

The signal of limit and driving stop for each axis are influenced by external noise.

To cut these noises, photo coupler or CR integral filter is mounted on the circuit normaly. However MCX304 is equipped with integral type filters in the input stage of each input signal. It is possible to set a number of input signals whether the filter function is enabled or the signal is passed through. A filter time constant is selectable from eight stages, min.22µsec ~ max.16msec.



FL2~0	Input delay time
0	2µSEC
1	256µSEC
2	512µSEC
3	1.024mSEC
4	2.048mSEC
5	4.096mSEC
6	8.192mSEC
7	16.384mSEC

■ Write register

Address A2 A1 A0 Symbol Name		Name	Contents					
/\2		Αυ	-		Axis assignment and writing the command code.			
0	0	0 0 WR0 Command register		Command register	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 Command code Axis assignment Command code			
					● D11~8 Axis assignment 0:non-select/1:select (Mulit-axis are selectable at one time) ● D15 1:Reset			
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	Setting of the logical levels and enable/disable of external decelerating/instant stop, interruption enable/disable and the operatio mode setting for real posiotion counter for each axis D15 D14 D13 D12 D11 D10 D9 D8 D7 D6 D5 D4 D3 D2 D1 D0 D-ENDIC-STAIC-ENDIPEC+IP <c-ipec-ismodiepinviepclr isp2-eisp1-lisp0-eisp1-lisp0-eisp0-eisp0-lisp0-eisp0-eisp0-lisp0-eisp0-lisp0-eisp0-lisp0-eisp0-li<="" td=""></c-ipec-ismodiepinviepclr>			
0	1	0	XWR2 YWR2 ZWR2 UWR2	Y axis mode register 2 Z axis mode register 2	Setting of enable/disable of software limit, the mode of the limit input signal, the mode of drive pulse, the mode of encoder input signal and the logical levels and enable/disable of servo motor signal for each axis. D15 D14 D13 D12 D11 D10 D9 D8 D7 D6 D5 D4 D3 D2 D1 D0 INP-EINP-LIALM-EIALM-LIPIND1 PIND0 PINMD DIR-LIPLS-LIPLSMD CMPSL HLMT-HLMT+ LMTMD SLMT- SLMT+ D1. 0 Software limit 0:disable/1:enable D2 Hardware limit 0:instant/1:decelerating stop D4. 3 Logical level of limit signal 0:Low/1:Hi D5 COMP+/- register comparison 0:logical position counter/1:real position counter D6 Drive pulse outputting type 0:2-pulse system /1:1-pulse 1-direction system D7 Logical level of drive pulse 0:positive logical pulse / 1:negative logical pulse D8 Logical level of the direction signal 0:Low level for + direction/1:Hi level for + direction D9 Encoder input signals 0:2-phase pulse/1:Up/Down pulse D11, 10 Encoder input divide 00:1/1, 01:1/2, 10:1/4 D12 Logical level of ALARM signal 0:Low/1:Hi D13 ALARM signal 0:disable/1:enable D14 Logical level of INPOS signal 0:Low/1:Hi D15 INPOS signal 0:disable/1:enable			
0	1	1	YWR3 ZWR3	X axis mode register 3 Y axis mode register 3 Z axis mode register 3 U axis mode register 3	Setting of the manual deceleration, symmmetry/non-symmmetry of acceleration/deceleration, acceleration/deceleration mode, external operation mode, switching between general purpose output and drive status output and input signal filter. D15 D14 D13 D12 D11 D10 D9 D8 D7 D6 D5 D4 D3 D2 D1 D0 FL2 FL1 FL0 0 FE3 FE2 FE1 FE0 0 VRING AVTRI EXOP1 EXOP0 SACC DSNDE MANLD Filter time constant Input signal filter enable/disable D0 Deceleration of fixed pulse drive 0:automatic/1:manual D1 Decelerating speed 0:using the value of accelerating speed (Symmetry)/1:using the value of decelerating speed(non-symmetry) D2 Acceleration/deceleration mode 0:Trapezoidal/ 1:S-curve D4,3 External driving operation 00:disable/01:continuous drive/10:fixed pulse drive/11:manual pulsar D5 Preve ntion of the triangle forms at linear acceleration/deceleration driving 0:disable/1:enable D6 Enable the variabble ring function of position counter 0:disable/1:enable D8 EMG,LMTP/M,STOP0,1 signal filter 0:disable/1:enable D9 STOP2 signal filter 0:disable/1:enable D10 INPOS and ALARM signal filter 0:disable/1:enable D11 EXPP/M signal filter 0:disable/1:enable D15~D13 Setting of input filter time constant(000:0.002msec/ 001:0.2msec/ 010:0.5msec/ 011:1msec/ 100:2msec/ 101:4msec/ 110:8msec/111:16msec)			
1	0	0	WR4	Output register 1	Setting of the outputting value of general output signal nOUT3~0. 0:Low/ 1:Hi D15 D14 D13 D12 D11 D10 D9 D8 D7 D6 D5 D4 D3 D2 D1 D0 UOUT3 UOUT2 UOUT1 UOUT0 ZOUT3 ZOUT2 ZOUT1 ZOUT0 YOUT3 YOUT2 YOUT1 YOUT0 XOUT3 XOUT2 XOUT1 XOUT0			
1	0	1	WR5	Output register 2	Setting of enable/disable of general output signal nOUT3~0 0:disable/ 1:enable D15 D14 D13 D12 D11 D10 D9 D8 D7 D6 D5 D4 D3 D2 D1 D0 UOT3E UOT2E UOT1E UOT0E ZOT3E ZOT2E ZOT1E ZOT0E YOT3E YOT2E YOT1E YOT0E XOT3E XOT2E XOT1E XOT0E			
1	1	0	WR6	Write data register 1	Setting of the low word 16-bit for data writing. (D15~D0)			
1	1	1	WR7	Write data register 2	Setting of the high word 16-bit for data writing. (D31~D16)			

- ●The above table indicates the address for 16-bit data bus. In 8-bit data bus access, the 16-bit data bus are divided into the high word byte (D15~8) and the low word byte (D7~0) by using address signal A3~A0.
- Each axis has WR1,WR2 and WR3 (mode register 1, 2 and 3). Writing the data in these registers by the same address. It depends on the axis assignment of the last command to write the data in the mode register of which axis. Or, uesr can select the axis by writing the NOP command whichis assigned an axis just before.
- ●At resetting, all the bits of nWR1, nWR2, nWR3, WR4 and WR5 registers are cleared to 0(n=X, Y, Z and U). The other registers are undetermined.

Automatic home search mode setting

Mode setting of automatic home search is executed by the setting command of automatic home search mode (60h), writing the axis assignment and the command code 60h in WR0 register after setting each bit of WR6 register as follows.

A2	Address Symbol Name		Name	Contents		
1	1	0	WR6	Write data register 1	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 Stelling of deviation counter clear outputting Step4 Step3 Step2 Step1 D6,4,2,0 STm-E Stepm execution 0:non-execution/1:execution D7,5,3,1 STm-D Stepm search direction 0:+ direction/1:- direction D8 Logical/real position counter clear after Step4 is executed 0:disable/1:enable D9 AND of Z-phase signal and home signal at Step3 0:disable/1:enable D10 Using limit signal as home signal 0:disable/1:enable D11 Deviation counter clear outputting 0:disable/1:enable D12 Deviation counter clear outputting and logical level 0:active Hi/1:Low D15~13 Deviation counter clear outputting active pulse width(000:0.01msec/ 001:0.02msec/ 010:0.1msec/ 101:2msec/ 110:10msec/ 111:20msec)	

Read register

A2	ddre A1	ss A0	Symbol	Name	Contents		
		7.10			Displaying the drive and error status and automatic home search execution status of each axis .		
0	0	0	RR0	Main status register	D15 D14 D13 D12 D11 D10 D9 D8 D7 D6 D5 D4 D3 D2 D1 D0 - 0 0 0 U-HOM Z-HOM Y-HOM X-HOM U-ERR Z-ERR Y-ERR X-ERR U-DRV Z-DRV Y-DRV X-DRV Automatic home search execution Error Drive		
					●D3~0 1:driving ●D7~4 1:error occuring(become "1" whichever from RR2/D7~0, RR1/D15~12.) ■D11~8 1:automatic home search executing		
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	Displaying the comparison of position counter and COMP± register, status of aceeleration/deceleration during the driving and driving termination status. D15 D14 D13 D12 D11 D10 D9 D8 D7 D6 D5 D4 D3 D2 D1 D0 EMG ALARM LMT- LMT+ - STOP2 STOP1 STOP0 ADSND ACNST AASND DSND CNST ASND CMP- CMP+ Driving termination status D0 1:position counter≥COMP+ D1 1:position counter <comp- 1:accelerating="" 1:constant="" 1:decelerating="" 1:increasing="" accelerating="" d2="" d3="" d4="" d5="" decelerating="" driving="" speed="" speed<="" td=""></comp->		
_					●D7 1 decreasing accelerating/decelerating speed ●D15~8 1:factor of driving termination		
0	1	0	XRR2 YRR2 ZRR2 URR2	X axis status register 2 Y axis status register 2 Z axis status register 2 U axis status register 2	xis status register 2 xis status register 3 xis register		
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	Displaying the factor of interrupt occring. 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- -="" 1:="" bit="" corresponding="" d15~d9="" d7~d0="" each="" interrupt="" is="" occuring="" of="" p≥c-="" register1)<="" td="" to="" wr1(mode="" =""></c->		
1	0	0	RR4	Input register 1	Displaying the input signal status of X and Y axis. 0:Low 1:Hi 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-ST2 Y-ST1 Y-ST0 X-ALM X-INP X-EX- X-EX+ EMG X-ST2 X-ST1 X-ST0		
1	0	1	RR5	Input register 2	Displaying the input signal status of Z and U axis. 0:Low 1:Hi 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-ST2]U-ST1]U-ST0]Z-ALM[Z-INP]Z-EX- Z-EX+ - [Z-ST2]Z-ST1]Z-ST0		
1	1	0	RR6	Read register 1	Displaying the low word 16-bit for the read data.(D15~D0)		
1	1	1	RR7	Read register 2	Displaying the high word 16-bit for the read data.(D31~D16)		

[●]The above table indicates the address for 16-bit data bus. In 8-bit data bus access, the 16bit data bus are divided into the high word byte (D15~8) and the low word byte (D7~0) by using address signal A3~A0.

Data writing commnads

Code	Setting Command	Symbol	Data range	Data length (byte)
00	Range	R	R8,000,000(multiple=1) ~ 16,000(=500)	` , ,
01	Jerk	K	1 ~ 65,535	ž
02	Acceleration	Α	1 ~ 8,000	2
03	Deceleration	D	1 ~ 8,000	2
04	Initial speed	SV	1 ~ 8,000	2
05	Drive speed	V	1 ~ 8,000	2
06	Output pulse numbers	Р	0 ~ 268,435,455	4
07	Manual deceleration point	DP	0 ~ 268,435,455	4
09	Logical position counter	LP	-2,147,483,648 ~ +2,147,483,647	4
0A	Real position counter	EP	-2,147,483,648 ~ +2,147,483,647	4
0B	COMP+ register	CP	-1,073,741,824 ~ +1,073,741,823	4
0C	COMP- register	CM	-1,073,741,824 ~ +1,073,741,823	4
0D	Acceleration counter offset	AO	-32,768 ~ +32,767	2
0F 60	NOP(for switching) Automatic home search mode	НМ		2
61	Home search speed	HV	1 ~ 8,000	2

Parameter calculation at CLK= 16MHz

 $Multiple(M) = \frac{8,000,000}{R}$ Initial speed(PPS)= SV \times M Drive speed(PPS)= $V \times M$ Accelerating speed(PPS/SEC)= A \times 125 \times M $Jerk(PPS/SEC^{2}) = \frac{62.5 \times 10^{6}}{K} \times M$ Decelerating speed(PPS/SEC)= D \times 125 \times M Decelerating speed increasing (PPS/SEC)= $\frac{62.5 \times 10^{\circ}}{I} \times M$

■ Data reading commands

Code	Reading Command	Symbol	Data range	Data length (byte)
10	Logical position counter	LP	-2,147,483,648~+2,147,483,647	4 bytes
11	Real position counter	EP	-2,147,483,648~+2,147,483,647	4
12	Current drive speed	CV	1 ~ 8,000	2
13	Acceleration / deceleration	CA	1 ~ 8,000	2

■ Driving commands

Cod	Commands
20 21 22 23	+direction fixed pulse drive -direction fixed pulse drive +direction continuous drive -direction continuous drive
24	drive start holding
25	drive start holding release /termination status clear
26 27	decelerating stop instant stop

■Other commnands

Code	Commands
62	Automatic home search execution
63	Deviation counter clear output

The Specifications are subject to change without notice due to the technical development.

Distributor

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Each axis has RR1,RR2 and RR3 (status register 1,2 and 3). It can be read the data in these registers by the same address. It depends on the axis assignment of the la st command to read the data in the mode register of which axis. Or, user can select the axis by writing the NOP command which is assigned an axis just before.