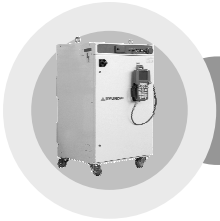
WARNING

THE INSTALLATION SHALL BE MADE BY QUALIFIED INSTALLATION PERSONNEL AND SHOULD CONFORM TO ALL NATIONAL AND LOCAL CODES

Hyundai Robot

Hi4aAA071001FMEN3



Hi4a Controller Function Manual

Additional Axis

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

HYUNDAI
HEAVY INDUSTRIES CO.,LTD.

Printed in Korea – Oct. 2007. 3rd Edition

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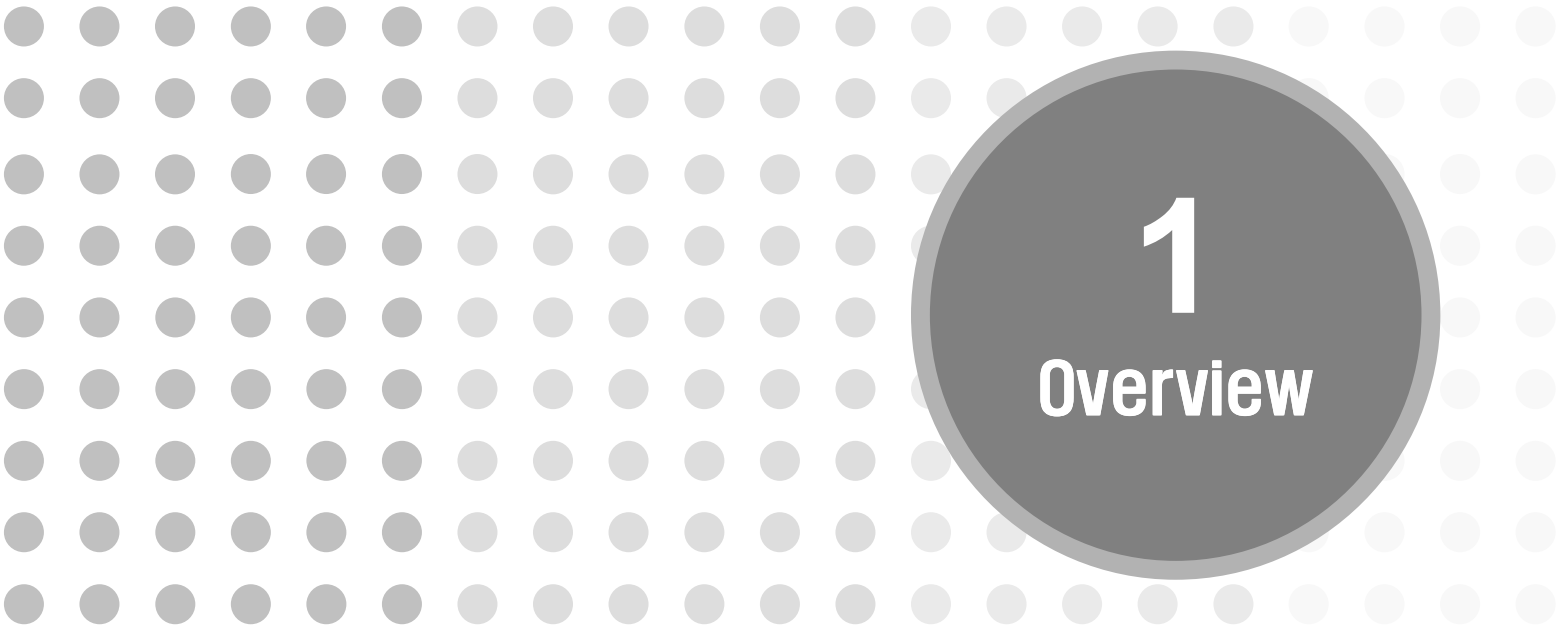

1
Overview

This explains the registration method of the servo controlled additional axis added to the robot.

【Registration procedure】

- Preparation work

  (1) Prepare the manipulators (Robot + Additional axis) and the wire harnesses
  (2) Prepare the controller, a set of servo DSP board (when more than 3 additional axes applied), and various signal cables.
  (3) Additional axis constant
  Prepare the input information in additional axis constants registration format (Article 3.2) such as axis specification and composition of additional axis, bit constant etc.
  (4) Additional axis servo parameter
  Prepare the input information in additional axis servo parameter registration format (Article 3.3) referencing the motor and encoder specification.
  (5) Additional axis Accel & Decel time
  Prepare the input data for additional axis command Accel & Decel time.
  ([PF2]: System』 → 『3: Machine parameter』 → 『6: Accel & Decel parameters』)

- Robot type and additional axis constant parameter registration

  After connecting the wire harnesses between the manipulator and the controller, initialize the system and enter the robot type and number of additional axis = [ ]. Then enter the mechanical constants and the servo parameters of the additional axis. (Maximum number of additional axis is 6.)
  - If the unit has already been registered for the robot type and additional axis constant parameter before delivery, this process is not needed.

- Connection and check
  Turn off the controller → Connect necessary wire to the manipulators and the controller → Turn on the controller → Set the encoder offset and the reference position of robot (Axis constant) if needed.

- Completion
  After setting the operating environment of the additional axis, save the ROBOT.C01 file to an external memory device (HRView, PC card)

2
Preparation Work

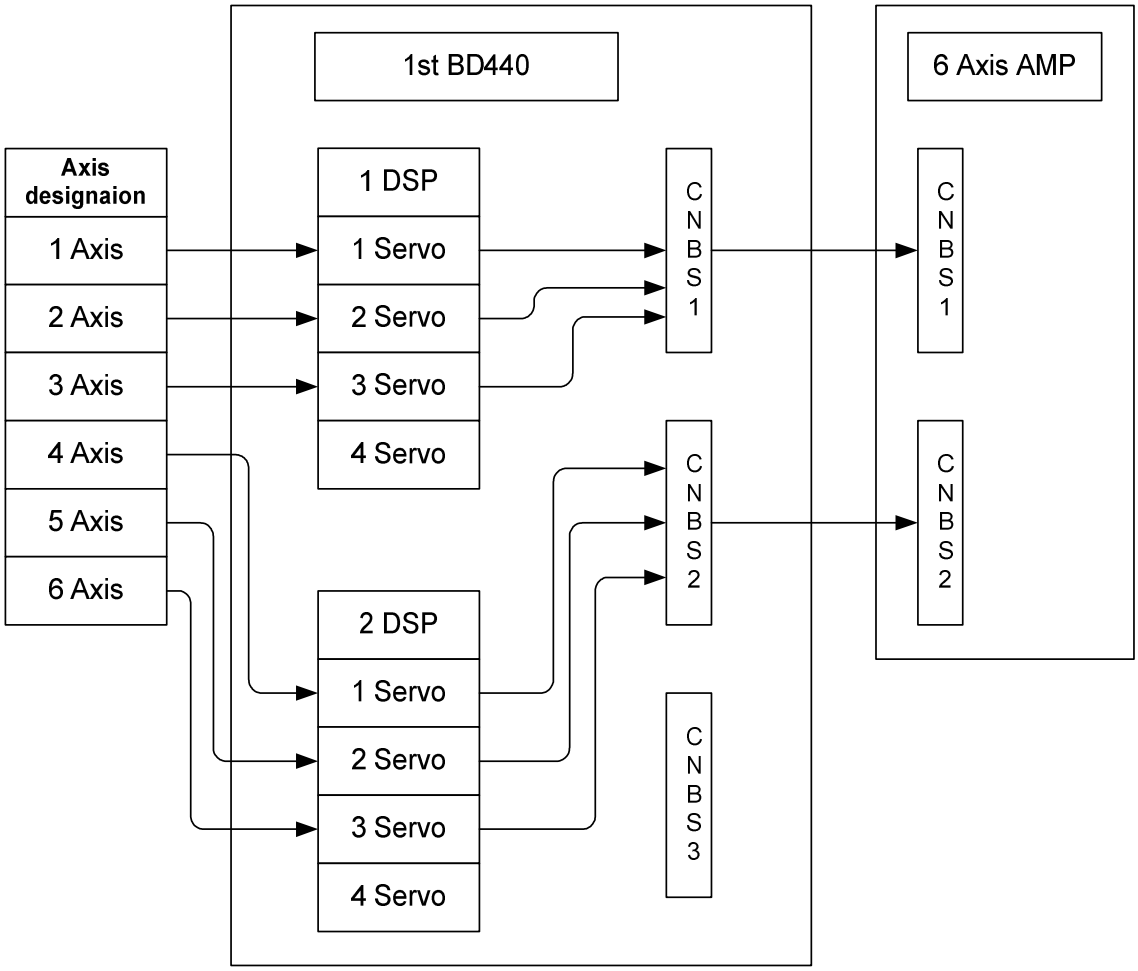
- Check the parts and material to connect.
- Check if the prepared data or additional axis information is ready.

  ① Additional axis constants
  ② Additional axis servo parameters
  There are two operating methods for setting up the additional axis servo parameters in Hi4a controller. For the first method, refer to 『3: Robot type and additional axis constant registration』 (Recommended to user).
  For the second method, refer to 『Appendix – Individual setting for additional axis servo parameter』.
  ③ Additional axis accel & decel time

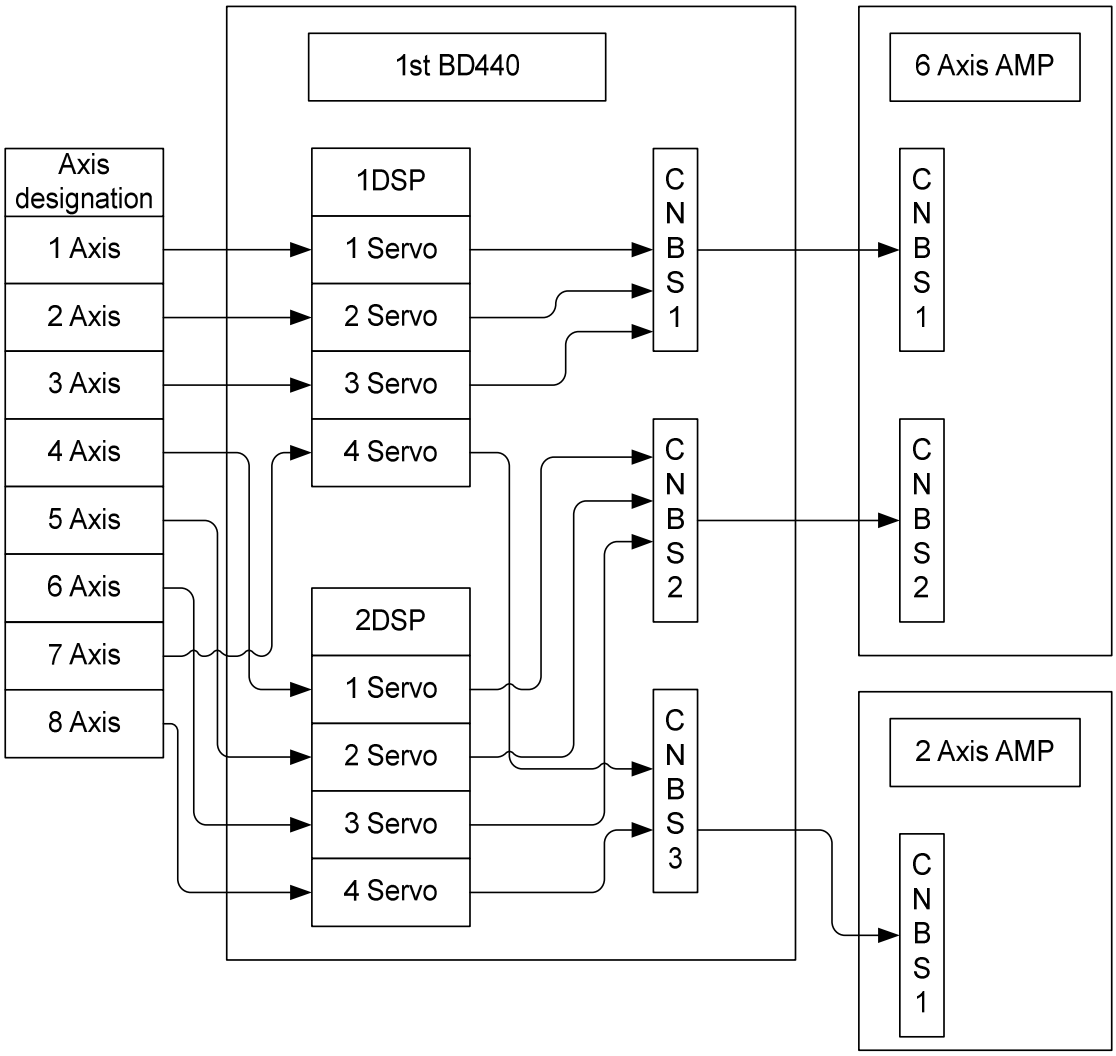
- Combination of servo DSP board (BD440, BD540 or BD541) and AMP according to the number of axis

  ① 1 ~ 6 axis (Basic 6 axis robot) : One DSP board + one 6 axis AMP
  ② 7 ~ 8 axis (Basic 6 axis + additional 2 axis)
  : One DSP board + one 6 axis AMP + one 2 axis AMP
  ③ 9 ~ 12 axis (Basic 6 axis + additional 6 axis)
  : Two DSP boards + two 6 axis AMPs, MSPR I/O common

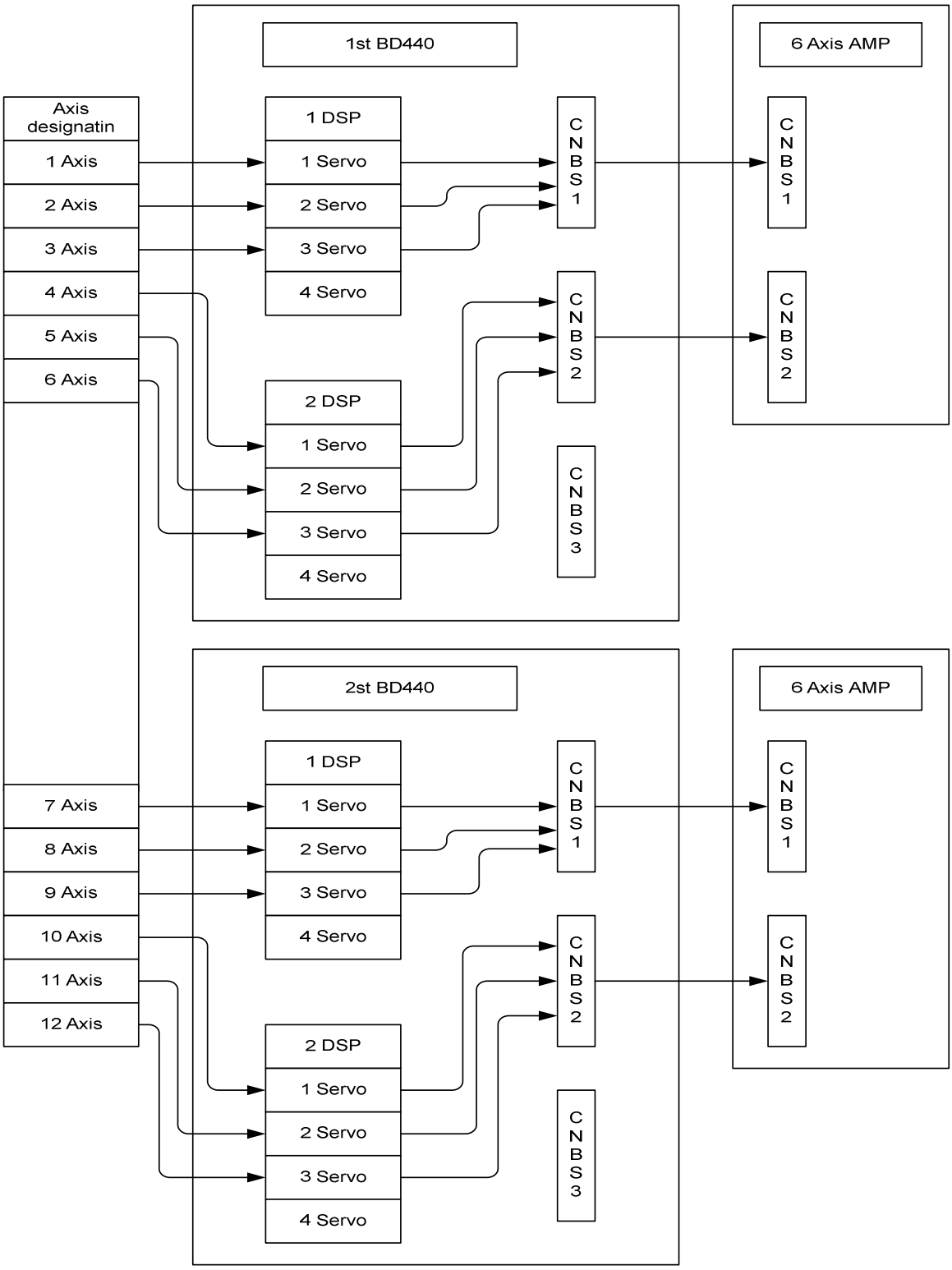
(1) 6 axis combination



(2) 7~8 axis combination



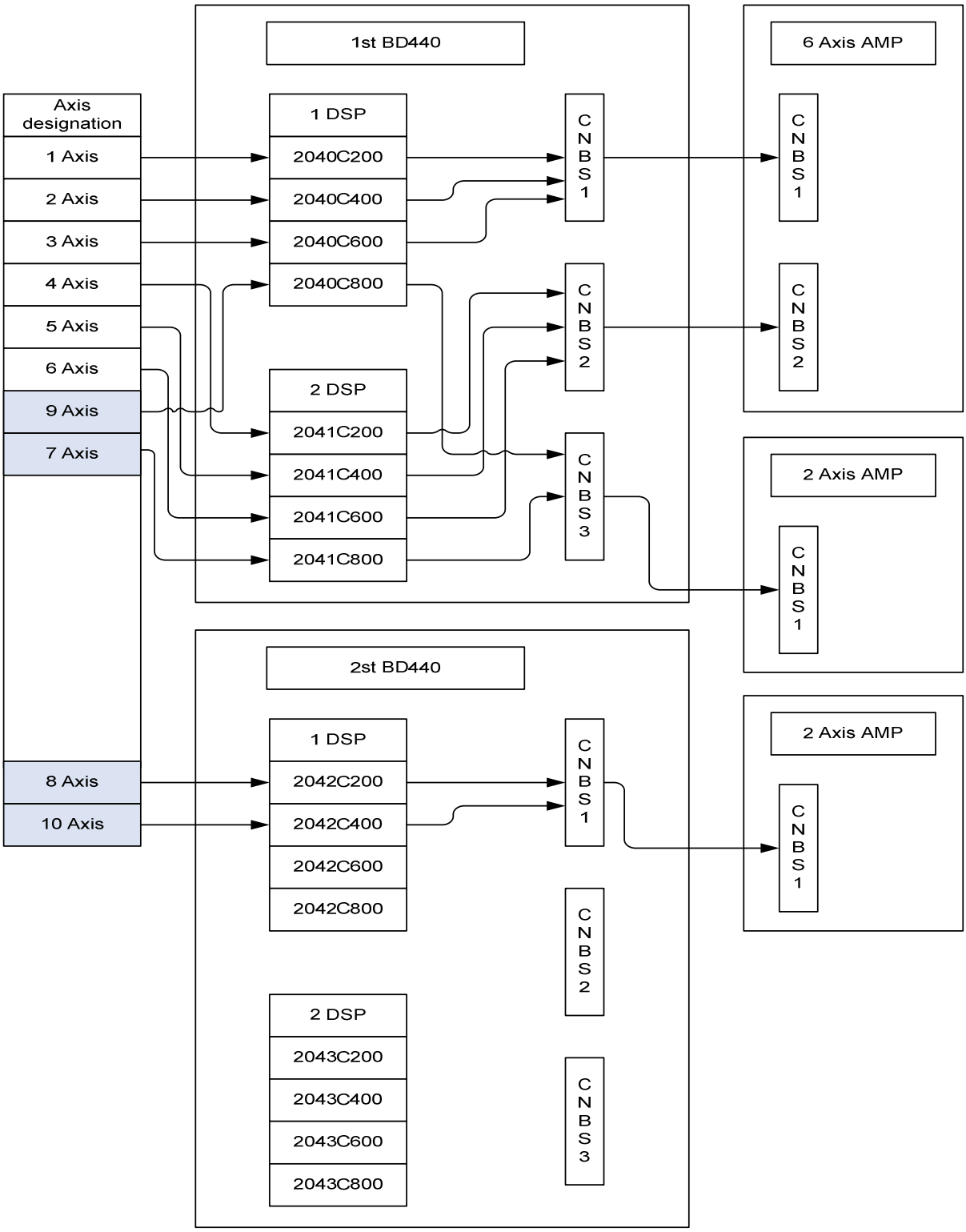
(3) 9~12 axis combination (recommended)



Reference

- For the 2nd 6 axis AMP, share the MSPR relay control (input 1, output 1) with 1st 6 axis AMP.
- The brake control for the Hi4a controller is composed of 6 axis board + 3 axis board and can individually control up to 9 axis. Therefore, for the combination of 10 or more axis, it is recommended to share an additional 3 axis board.
- When using 2 servo DSP boards, to share the clock, you must mutually connect the CNCK connecters between the servo DSP boards.
  The 2nd board is classified as BD440D, BD540D or BD541D and the OSCI1 oscillator is not installed.

(4) Another example of 9~12 axis combination



Reference

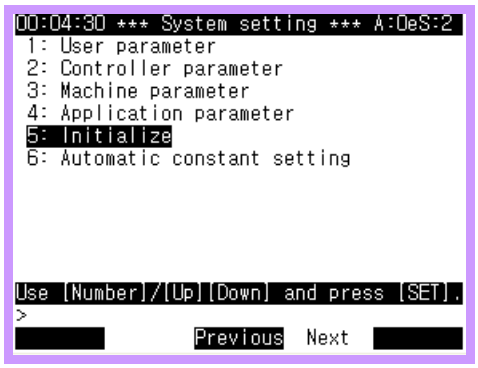
- The robot axis is set by default and the user cannot make changes.
- For up to 3 axis in the robot, use servo 1, 2 and 3 of DSP 1 of 1st board, in order.
- From 4 axis to 6 axis in the robot, use servo 1, 2 and 3 of DSP 2 of 1st board, in order.
- For example, for HR100P, a 4 axis robot, use the servo 1, 2, 3 of DSP 1 and then use servo 1 of DSP 2 of 1st board, in order.

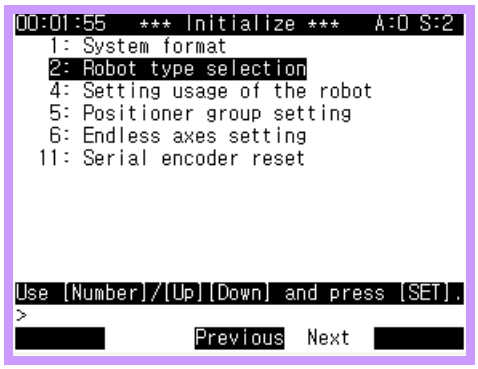
3

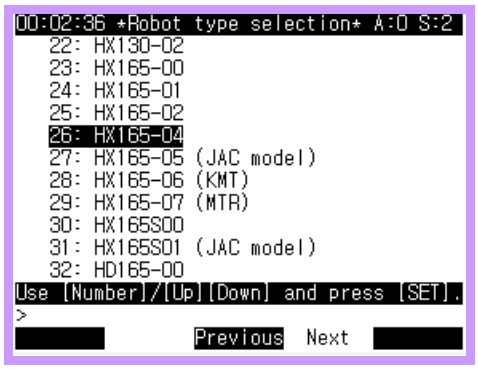
Robot Type and Additional Axis Constant

3.1. Setting robot type and number of additional axis

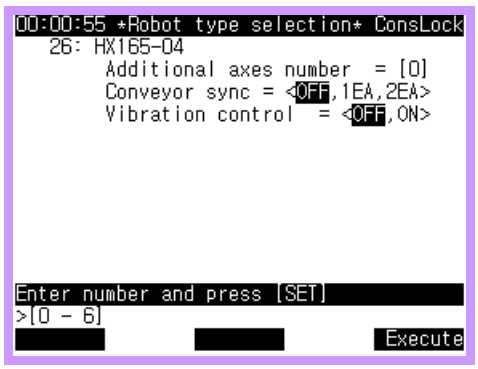
(1) Select the robot type to use from the 『[PF2]: System』 → 『5: Initialize』 → 『2: Robot type selection』 menu in manual mode and press [SET].

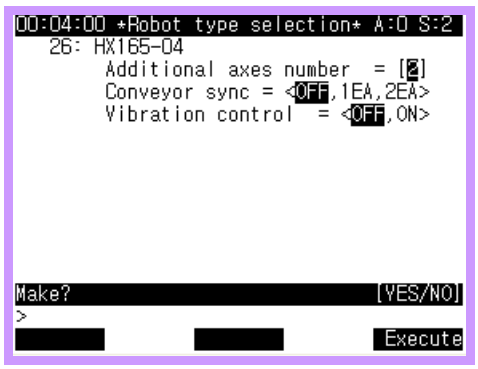






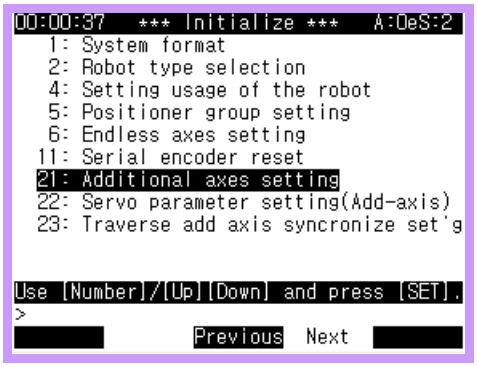
(2) Enter the number of additional axis and press the 『[PF5]: Execute』 key to see the message frame showing 『Make? [Yes]/[No]』.





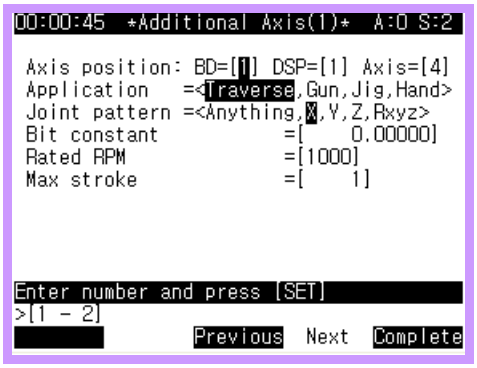
3.2. Additional Axis Setting

(1) Select 『[PF2]: System』 → 『5: Initialize』 → 『21: Additional axis setting』.



※ You can select menu 21 above in the following cases.
- When the engineering code (R314) in manual mode is entered.
- When the state of the motors is off.
- When there is an additional axis.

(2) Set the additional axis constants.(Maximum of 6 axes)



(3) Press『[PF5]: Complete』 to end entry.

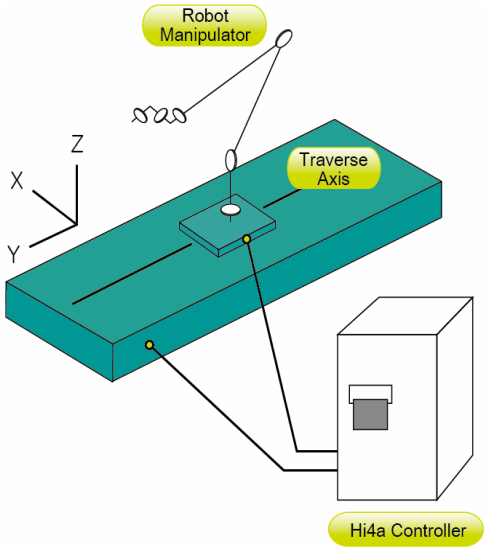
Reference

◆【Additional-Axis Constant Explanation 】◆

(1) Axis position
Users can use it by designating physical configuration of Additional-Axis.
BD =[1](1~2) => Designate the number of servo DSP board.
(2DSP/1Board)
DSP =[1](1~2) => Designate the number of DSP in the servo DSP board.
(4 Axis/1DSP)
Axis =[4](1~4) => Designate Axis No.

Ex) In case of designating it as 1,1,4 to set up 7th Additional-Axis,
Basic 6 axes – Main 3 axis (1st BD440, 1st DSP, 1~3 axis)
Wrist 3 axis (1st BD440, 2nd DSP, 1~3 axis)
Additional 1 axis (1st BD440, 1st DSP, 4th axis)

(2) Application
Select a kind of Additional-Axis between <Traverse, GUN, JIG,Hand>.
When deciding Additional-Axis spec, you should set the sequence Traverse → GUN → JIG → Hand followed by logical Additional-Axis order.



(3) Axis configuration
Select moving direction of axis between <None, X, Y, Z, & Rxyz>.
In case of traverse axis, it is operated as <X> if it is left/right axis running, and it is operated as <Y> if it is forward/backward axis running. Select <Y> if it is parallel to original position of Robot body. Please refer to 『SERVO GUN Function Manual』 to set up the GUN and 『Positioner Synchronization Function Manual』 to setup the JIG.

(4) Bit constant [-9999.99999 ~ 9999.9999] :
Register moving quantity according to Encoder pulse process of 10000bit.
Register rotation axis as deg/10000bit, and transmit axis as mm/10000bit.
Encoder pulse per 1 rotation used in the Hi4a controller is fixed as 8192bit.

Please refer to below example.
The sign is decided as below.
In case forward rotation of motor is correspond with the axis direction , set it as “+” and coordinate value is increased, and reversely fix it as “-“ and coordinate value is decreased.

Ex 1) If it is the rotation axis using 1/100 reducer only,
the axis rotates 360deg by 100 rotations of motor.
Therefore Bit Constant = 360[deg] / (100[rev] X 8192[bit]/[rev]) X 10000[bit] = 4,39453

Ex 2) If it is the transmit axis using 1/20 reducer and rack pinion of PCD 110mm,

110xPhi(=3.14159)[mm] is moved by 20 rotation of motor.
Bit Constant = 110xPhi[mm] / (20[rev] x 8192[bit]/[rev]) X 10000[bit] = 21.09223

Ex 3) If it is the transmit axis using reducer and ball screw of lead 5mm,
The axis moves 5mm by 5 rotation of motor.
Therefore, Bit Constant = 5[mm] / (5[rev] × 8192[bit/rev]) = 1.22070

(5) Rated RPM [1000 - 5000] :
Set the rotation speed of motor used in Additional-Axis. Decide it in the range of not exceeding rated speed of motor. By setting the speed and bit constant, max speed of additional axis is set up automatically in 『[PF2]: System』 → 『3: Machine Parameter』 → 『6: Accel & Decel parameters』.
It is possible to change the speed of axis directly in Accel & Decel Parameters menu.
However, users should tune accelerating time and decelerating rate in the process of system tuning because accel/decelerating time is designated by default value.

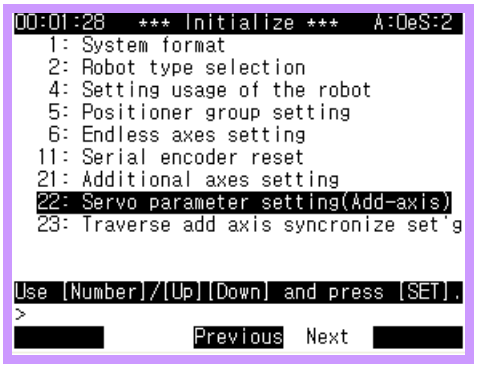
(6) Max. Stroke [1 - 30000] :
This is the information to set up valid moving range of the Robot (Additional-Axis soft limit) in the menu of 『[PF2]: System』 → 『3: Machine Parameter』 → 『3: Softimit』automatically.

3.3. Servo parameter setting(Add-axis)

This sets the servo parameter to accommodate the operating condition of the additional axis (servo loop control).

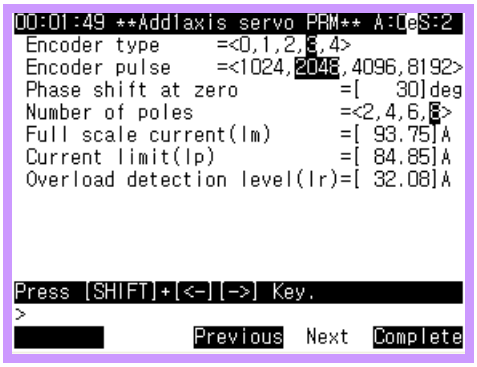
There are two methods for the setting. First method is for the user to collect the raw information without any calculation referring to the motor specification and conveniently enter the parameters into the system. Second method is to enter the calculated results by the user into the servo parameter template (Appendix – Individual setting of additional axis servo parameter). This explains the first method.

(1) Select『[PF2]: System』 → 『5: Initialize』 → 『22: Servo parameter setting(Add-axis)』 from manual mode.



※ You can select menu 21 above in the following cases.
- When the engineering code (R314) in manual mode is entered.
- When the state of the motors is off.
- When there is an additional axis.

(2) Set the additional axis servo parameter. (Maximum of 6 axis)



(3) Press the 『[PF5]: Complete』 key when you have complete entering.

◆【Additional-Axis Servo Parameter Explanation】◆

- Please use it for reference only because written as Commonly below the explanation can be changed by manufactures.

- After setting up each items, followed by load state 『[PF2]: System』 → 『3: Machine Parameter』 → 『6: Accel & Decel parameters』 → Accel/decelerating information, 『[PF2]: Service』 → 『3. Machine parameter』 → 『12: Servo Parameter Setting』 → 『1: Servo Loop Gain』 → Use it adjusting Position Loop Proportional Gain(Kp) of and Speed Loop Proportional Gain (Kv).

① Encoder Type
0 : Yaskawa, 1 : Tamakawa, 2 : Panasonic, 3 : PanasonicCompact
In Hi4a controller, it corresponds with absolute value encoder only.
Currently the encoder of motor used in our mass production(MP) model robot corresponds to 『3 : PanasonicCompact』.
Motors are supplied by Tamagawa is supplied to our company mounting the encoder of 『3 : PanasonicCompact』 Type.

② Encoder Pulse
< 1024, 2048, 4096, 8192 >
This is the number of Incremental Purse outputted by the encoder per motor 1 rotation.
Setting up the encoder pulse outputted by motor, the inside of Hi4a controller calculates it by converting all encoders to 8192 pulse automatically. Therefore, when calculating Additional-Axis Bit Constant, it is always calculated in the basis of 8192 pulse regardless of encoder pulse setting value.
Commonly Yaskawa 12bit Encoder is 1024, Yaskawa 15bit Encoder is 8192, Panasonic is 2048, and Tamakawa is 4096.
Currently the encoder of motor used by our MP model robot same as encoder type is 2048 pulse, and motors supplied by Tamagawa are supplied by mounting encoder of 2048 pulse.

③ Phase shift at zero
θ [deg]
Input current phase angle at encoder zero point.
Commonly Yaskawa & Tamakawa are 0, and Panasonic is 30.
Current phase angle at encoder zero point of the motors used by our MP model robot currently same as encoder type is 30deg, and motors supplied by Tamagawa are supplied by fitting in the phase angle of 30 deg.

④ Number of poles
< 2, 4, 6, 8 >
Input the number of motor pole.
Currently the number of motor pole used by our MP model robot is 8 pole.

⑤ Full Scale Current
Im [Apeak]
This is the current value corresponded to full scale of current variable(torque command) when calculating S/W Servo Controller. Full Scale Current Value is saved by Formula 1) and it is changed by Shut Resistance and Hall Sensor Output Spec.

$$Fullscale\ Current = Current\ value\ in\ case\ of\ current\ feedback\ Voltage\ 8Volt \times \frac{7.5}{8}$$ Formula 1)

AMP Model	Hall Sensor Signs (Specifications)	Shunt Resistance Sign (Resistance Value)	Full Scale Current(Im)	Usable IPM (rated Current)
Large-sized 6Axis /Additiona l-Axis AMP	0 (4V/75A)		**140.62Apeak**	PM150CSD060 (150A)
	1 (4V/50A)		**93.75Apeak**	PM150CSD060 (150A) PM100CSD060 (100A) PM75CSD060 (75A)
	2 (4V/25A)		**46.87Apeak**	
	3 (4V/15A)		**28.12Apeak**	
	4 (4V/10A)		**18.75Apeak**	
	5 (4V/5A)		**9.37Apeak**	
Medium-sized 6 Axis /Additional -Axis AMP		1 (2mΩ)	**93.75Apeak**	PM100CSD060 (100A) PM75CSD060 (75A)
		2 (4mΩ)	**46.87Apeak**	
		3 (8mΩ)	**23.44Apeak**	
		4 (12mΩ)	**15.58Apeak**	
		5 (16mΩ)	**11.72Apeak**	
Small-sized 6 Axis /Additional -Axis AMP	1 (4V/15A)		**28.12Apeak**	PM30CSJ060 (30A)
	2 (4V/10A)		**18.75Apeak**	PM30CSJ060(30A)
	3 (4V/5A)		**9.37Apeak**	PM30CSJ060(30A) PM10CSJ060(10A)

⑥ Current limit
Ip [Apeak]
This means Motor Output Max. Current. The setting of current limit value sets up necessary current value from motor to satisfy working spec of applied equipment. Available range for setting should satisfy three conditions as below, and for improvement of control performance, set up to use Full Scale Current nearby as possible as it can.

Condition 1) Within Instantaneous Max. Current on Motor Catalog

Condition 2) Within AMP Max. Output Current

Condition 3) Full Scale Current(Im) 97%≥ Current Limit (Ip)≥ Full Scale Current(Im) 40%

※ AMP Max./Continuous Output Current(IPM Max. rated)
AMPMax. Output Current is limited as Formula 2) by the rated of use IPM. Also for the continuously used current, the range of use calculated through the evaluation test with the junction temperature within the permitted range by the heating condition of IPM (Heat sink, forced cooling etc.) and operating condition (Switching loss, on resistance etc.), is about within 60% of the rated current of IPM.
However, instantaneous Max. Output of Large-sized AMP is limited as allowable current of below table related to the structure of AMP regardless of Formula 2).

$$IPM\ Rated\ Current \geq MaxCurrent \times 1.1(10\%\ m\arg in\ of\ Current)$$ ---------- Formula 2)

IPM Type	Rated Current[Sign]	Item	Allowable Current(Apeak)	Use Model
PM150CSD060	150A [L]	**AMP Max. OutputCurrent**	**125**	Large-sized 6 Axis AMP
		AMP Continuous OutputCurrent	**60**	
PM100CSD060	100A [X]	**AMP Max. OutputCurrent**	**90.9**	Large-sized 6 Axis AMP, medium-sized 6 Axis AMP, Large-sized Additional-Axis medium-sized Additional-Axis
		AMP Continuous OutputCurrent	**60**	
PM75CSD060	75A [Y]	**AMP Max. OutputCurrent**	**68.18**	
		AMP Continuous OutputCurrent	**45**	
PM30CSJ060	30A [A]	**AMP Max. OutputCurrent**	**27.27**	Small-sized 6 Axis AMP, Small-sized Additional-Axis
		AMP Continuous OutputCurrent	**18**	
PM10CSJ060	10A [D]	**AMP Max. OutputCurrent**	**9.09**	
		AMP Continuous OutputCurrent	**6**	

■ The case below 40% of Full Scale Current(Im) corresponds with changing Shunt Resistance/ Hall Sensor.

AMP Model	IPM Sign	Hall Sensor/ Shunt Resistance Sign	Available Range for Current Limit Settings (Apeak)
Large-sized 6 Axis/ Additional-Axis AMP	L	0	125 ~ 70.31
	L,X	1	90.90 ~ 37.50
	Y		68.18 ~ 37.50
	L,X,Y	2	45.46 ~ 18.75
	L,X,Y	3	27.27~11.25
	L,X,Y	4	18.19~7.50
	L,X,Y	5	9.08 ~ 3.75
medium-sized 6 Axis / Additional-Axis AMP	X	1	90.90 ~ 37.50
	Y		68.18 ~ 37.50
	X,Y	2	45.46 ~ 18.75
	X,Y	3	22.75 ~9.38
	X,Y	4	15.11~6.23
	X,Y	5	11.37~4.69
Small-sized 6 Axis / Additional-Axis AMP	A	1	27.27~11.25
	A	2	18.19~7.50
	A,D	3	9.08 ~ 3.75

⑦ Overload detection level
Is [Apeak]
This means Motor Output Continuous Current. The setting of overload detecting level sets up current value corresponded by calculating or measuring Trms(Max. Load, Max. Speed, torque mean value of Max. repeat working pattern). Available range for setting should satisfy below two conditions.

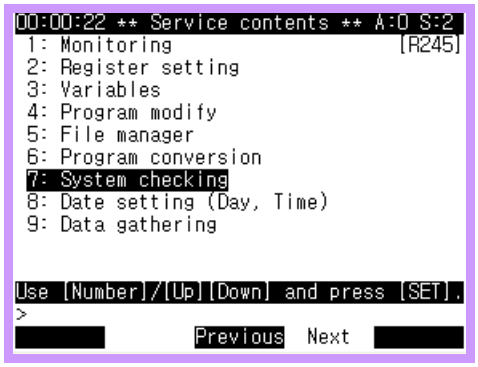
Condition **1)** Within rated Current on **Motor Catalog**
Condition **2)** Within **AMP** Continuous OutputCurrent

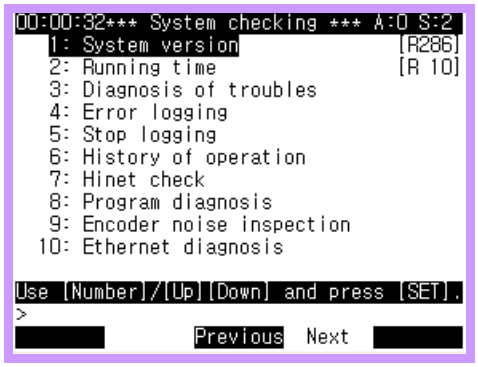
4

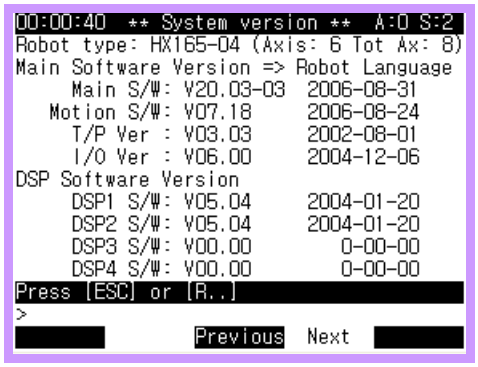
Connection and Check

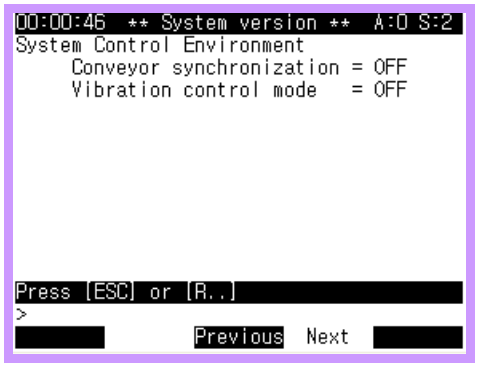
(1) Connect the various signal cables between the manipulator and the controller, and supply power. If a servo error during initial self diagnosis occurs, recheck if the servo parameter is entered as requested. If there is no error in data entry, refer to the Hi4a Controller maintenance manual and signal system diagram to check the encoder line.

(2) First check the number of currently set axis.
Select 『[PF1]: Service』 → 『7: System checking』 → 『1: System version』.



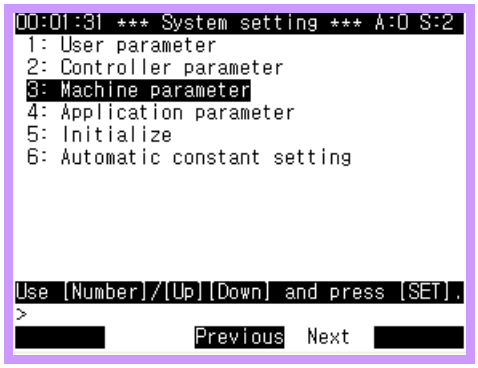


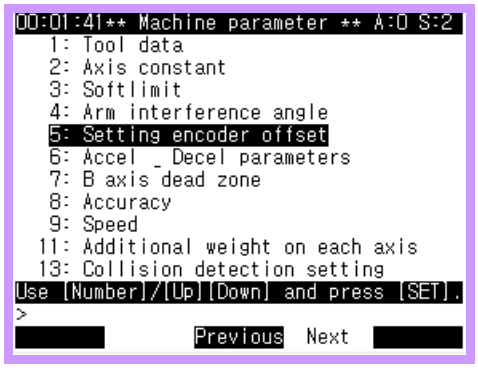




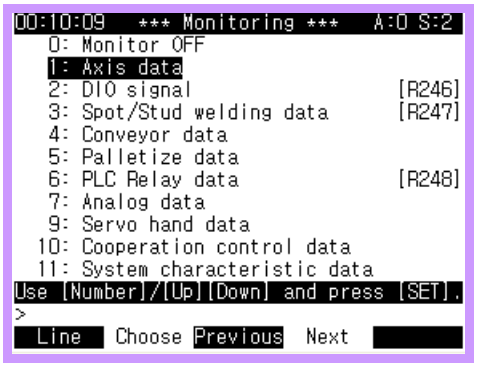
※ Axis : Total number of axis of the robot.
Tot Ax : Total number of robot axis and additional axis.

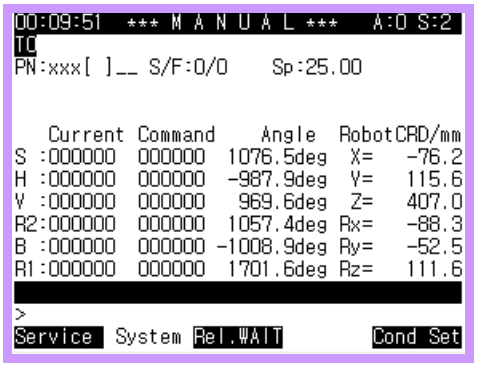
(3) Select 『[PF2]: System』 → 『3: Machine parameter』 → 『5: Setting encoder offset』 and set the reference location of the encoder. Set each axis so that the encoder value of base position is 0x400000.





(4) Use the 『[PF1]: Service』 → 『1: Monitoring』 → 『1: Axis data』, to check whether the data of each axis is set to 0x400000, and then set the motors ON.





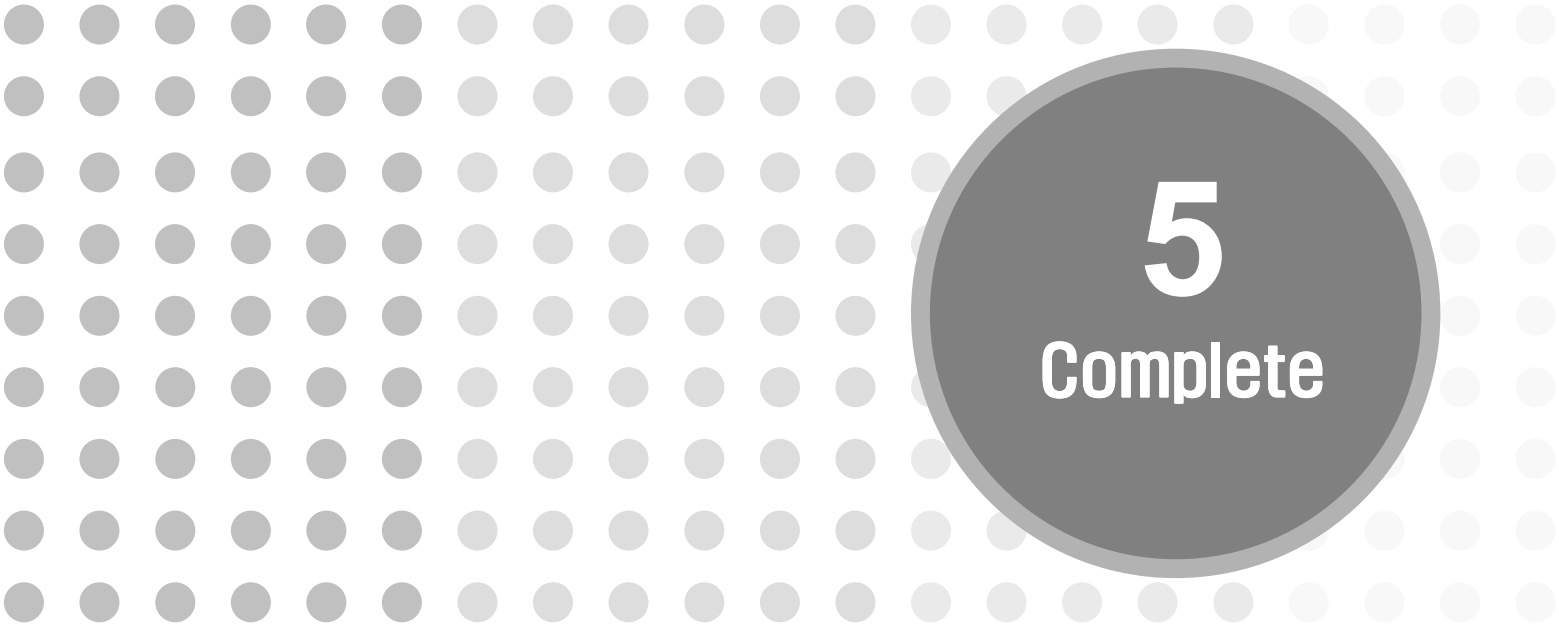
※ The axis data of the monitor, T1 and T2 are the distance from the zero point of the additional axis in the robot coordinate, and the coordinate (X, Y, Z) = Robot coordinate (X_1, Y_1, Z_1) + Main axis coordinate (X_2, Y_2, Z_2).

(5) Manually operate (jog) each axis in positive/negative and check if the direction of the encoder (command/current value) changes direction in the monitoring environment. Initial manual operation must start from low speed. If there is no movement in the current value, check the brake Off condition.

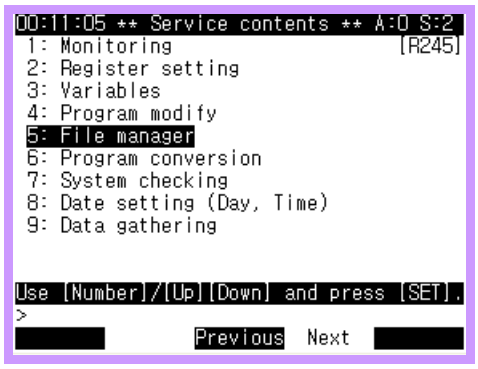
(6) Check the Accel & Decel parameter and bit constant. To protect the main parts of the manipulator, set the Accel & Decel time in accordance with the mechanical design data. Check the bit constant by measuring and checking the movement indicated in the monitor and the movement of the axis.

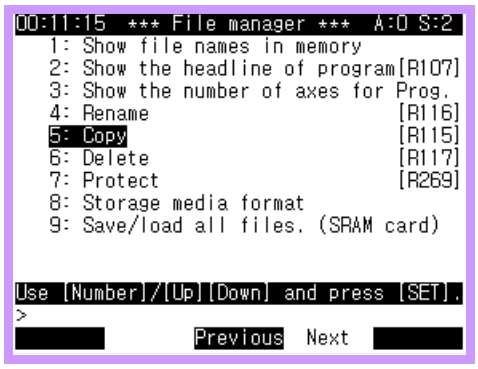
(7) Check the soft limit and resetting it if needed. Also check the input condition of the hardware limit switch.

(8) If you experience vibration and shaking during manual speed and automatic operation, check and tune the mechanical assembly condition.


5
Complete

When the additional axis setting is complete, copy the constants file (ROBOT.C00, ROBOT.C01) in supplementary memory (SRAM) in 『[PF1]: Service』 → 『5: File manager』 → 『5: Copy』 or copy the file to the computer using HRView program.





6 Teaching & Playback

6.1. Manual operation (jog)

(1) Press the [AUX Axis] key on T/P and the auxiliary axis status LED will light up. Press the [left/right] arrow key to do manual operation of the first auxiliary axis.

(2) When the auxiliary axis status LED is on, you can only operate the auxiliary axis.

(3) The operation varies, as shown below, according to the status of the coordinate selection key
- Joint, Lin: Simple operation of additional axis (Move to set axis direction)
- Tool: Operation with tool end (TCP) location fixed (tool end position fixed, robot pose changed)

(4) Tool end (TCP) coordinate (X, Y, Z) = Robot coordinate (X1, Y1, Z1) + Traverse axis coordinate (X2, Y2, Z2)

(5) Manual operation speed (S8 basis) : 25% of additional axis maximum speed (But limited to maximum of 250mm/sec)

(6) When selecting the user coordinate, the direction the additional axis is moving is based on the user coordinate.

6.2. Playback

(1) Interpolation Off
It reaches the target point of each axis at the same time.

(2) Linear Interpolation
Linear Interpolation (maintaining trajectory and orientation) to the target location is Complete.

(3) Circular Interpolation
Circular Interpolation of target position is Complete.

(4) Shift
All the functions for shift (offline, online, search, palletize) applies to the robot, and the additional axis moves only to the recorded location. Especially in the search function, make sure there is no movement for additional axis for the search operation step. If you need to shift traverse axis, it is complete based on the base coordinate.

(5) Coordinate transfer
Because it only changes the movement element of the robot and maintains the same value for the target value of the additional axis, review so that there is no movement in the additional axis in the source program to change.

(6) Applying relative program call function
You must not use the additional axis when preparing an relative program. It only applies the relative position to the robot.

7
Troubleshooting

Code	E0103 (○ AX) Enc Err:Process time over
Cause	Encoder data is not received within communication processing time.
Action	Refer to『Hi4a Controller maintenance manual - 5.Troubleshooting』

Code	E0104 (○ AX) Enc Err:Process time over
Cause	Data is received but it is not a specified form.
Action	Refer to『Hi4a Controller maintenance manual - 5.Troubleshooting』

Code	E0105 (○ AX) Enc Err:Cable not connected
Cause	Communication is impossible because of encoder disconnection.
Action	Refer to『Hi4a Controller maintenance manual - 5.Troubleshooting』

Code	E0106 (○ AX) Enc Err:Bad input data
Cause	Data is received but it is not a specified form.
Action	Refer to『Hi4a Controller maintenance manual - 5.Troubleshooting』

Code	E0107 (○ AX) Enc Err:Bad bit sequence
Cause	Data is received but it is not a specified form.
Action	Refer to『Hi4a Controller maintenance manual - 5.Troubleshooting』

Code	E0108 (○ AX) Enc Err:Encoder reset needed
Cause	Encoder data is out of the offset function application range.
Action	Refer to『Hi4a Controller maintenance manual - 5.Troubleshooting』

8
Appendix

◆ **Individual setting of additional axis servo parameter** ◆

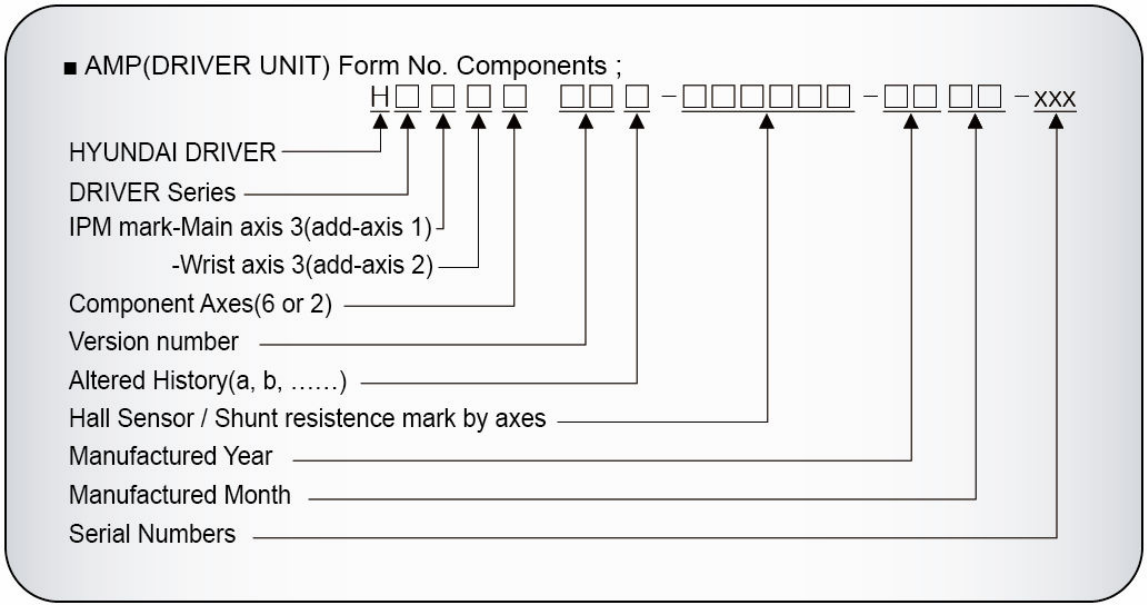
After entering the 'R314' engineering code in the manual mode, enter to 『[PF2]: System』 → 『3: Machine parameter』 → 『12: Servo parameter setting』 and set the servo parameter of the additional axis.

1. Servo loop gain

Parameter	Content	Method
Kp	Proportional gain of position loop	Set it same as general axis no. 1
Kf	Feed Forward gain	0
Kv	Proportional gain of velocity loop	Set it same as general axis no. 1: Adjust in case of vibration
Kb	Velocity feedback constant	Set it same as general axis no. 1
Ki	Velocity loop integral gain	Set it same as general axis no. 1
F1	1st Filter time constant	Set it same as general axis no. 1
F2	2nd Filter time constant	Set it same as general axis no. 1
Fc	Filter coefficient	Set it same as general axis no. 1
Im	Full Scale current	Full Scale current [Apeak]x100
Ip	Current limit	Current limit [Apeak]x100
Ir	Overload detection level	Overload detection level [Apeak]x100
Ti	MOTOR overload detection time constant	16

Reference) Full Scale current

Set it properly by referring the to the AMP type number for additional axis.



2. Position error level

- Mea. Val :
  The maximum value of the position deviation generated up to now since the controller power was ON.

- Set Val : Deviation value to detect the position deviation error
  The default value is set as 10000 but generally it is calculated and decided by the following formula.

$$Location\_deviation = \frac{Kb}{Kp} \times Motor\_rated\_rotation\_speed[rpm] \times 8.192$$

When there is interference during robot operation, this sets the function to promptly stop the robot using the position deviation error function. This is complete by setting the position error level, which is 1.2 to 1.5 times the above measured value after running the robot operation program several times.

3. Motor and encoder type

This is decided by the motor and encoder specification.
If you change the current loop gain, you must turn off and then on again to apply the changed value.

Parameter	Content	Setting method
MD	Motor rotation direction	Assuming that the direction in which the encoder value increases is the positive direction and according to the rotating direction of the shaft of the motor from the flange side, the value for positive CCW is 0 and positive CW is 1
POLE	Number of Motor Pole	Number of Motor Pole / 2
ABSE	Absolute value encoder type	1- Yaskawa 2-Tamakawa 3-Panasonic 4-Seial Encoder Type 7-Compact Encoder type
ICNT	Incremental Count direction	Based on the positive motor rotation, 0 if the A phase comes first and 1 if B phase comes first.
EE	Encoder expansion	0-Standard 1-Tamakawa Even 2-Tamakawa 21bitEven 3-Tamakawa 21bitOdd
PULS	Number of encoder pulse per 1 motor rotation	1024, 2048, 4096, 8192 All values are converted to 8192 and used within the controller
PHSE	Current phase angle at Zero	0°~ 359°, generallyPanasonic type is 30°
PHVL	Current delay compensation angle according to speed	0°~ 359°, generally 11°~ 30° is used Current delay compensation angle when the motor is rotating at the speed of 2000rpm

4. Current loop gain

(1) Current loop gain is set according to the used motor and AMP.
If you change the current loop gain, you must turn off and then on again to apply the changed value.

(2) Method of setting current loop gain

Parameter	Content	Setting method
INTL	Current interrupt lag after PWM Top/Bottom	[0~1] 0:0%, 1:5%, always 0
LSEL	Current Loop Enable/Disable	[0~1] 0:Disable, 1:Enable, always 1
CLG	Current Loop Gain	[0~31] Decided by motor and AMP
CTL	Current loop time constant	[0~7] Always 5
FDIS	ASIC current calculation part filter enable/disable	[0~1] 0:Enable, 1:Disable, always 0
FSEL	Current Feedback Scale	[0~3] 0-1/8, 1-1/4, 2-1/2, 3-1/1, always 3
PDLY	PWM On Delay (Dead Time) set value	[0~15]Always 9
PFRQ	PWM Carrier frequency	[0~15] Always 13
EMFC	BackEMF compensation constant	[0~32767] Measured by motor
TFC	Torque filter cutoff frequency	[0~511] Always 0
VELS	Actual speed calculation cycle	[0~7] Always 5
GERR	Current loop error compensation	[0~127] Measured by motor and AMP, 0 if unknown

But be careful because it is indicated in PWMF (PDLY) and PWMD (PFRQ) for menus in software version V10.01-04

(3) Motor characteristics table and measured value of back EMF compensation coefficient EMFC
EMFC is decided with the measured value through experiment for motors repectively.

Motor type	Maker	Applied robot	Rated output [kW]	Phase-resistance [Ω]RΦ	Phase-inductance [mH]LΦ	EMFC
TS4293N8030	Tamakawa	HX130-02 main axis HX165-02 main axis	5.5	0.05	1	60
TS4836N8030	Tamakawa	HX130-02 wrist axis HX165-02 wrist axis	3.0	0.083333	0.606666	35
MFM552Q2M	Panasonic	HX130-01 main axis HX165-01 main axis HR100P main axis	5.5	0.028	1.1	60
MFM302Q3V	Panasonic	HX130-01 wrist axis HX165-01 wrist axis HR050-01 main axis	3.0	0.06	1.2	35
MQM082Q5V	Panasonic	HR050-01 wrist axis	0.75	0.49	6.9	30
MQM152Q2H	Panasonic	HR015-01 main axis HR100P wrist axis	1.5	0.17	2.6	30
MSMA022Q2H	Panasonic	HR015-01 wrist axis	0.2	2.3	7.8	30
MQM082Q3V	Panasonic	HR006-03 main axis	0.75	0.49	6.9	30
MQMZ012Q3U	Panasonic	HR006-03 wrist axis	0.1	4.0	11.4	25
MFM452H2D	Panasonic	HR130-2 main axis HR165-2 main axis HR120 main axis HR150 main axis	4.5	0.034	1.4	55
MSM302Q3V	Panasonic	HR130-2 wrist axis HR165-2 wrist axis	3.0	0.06	1.2	35
MFM202H2D	Panasonic	HR120 wrist axis HR150 wrist axis	2.0	0.1	2.1	45
TS4815N8030	Tamakawa	Servo gun	1.5	0.343	1.575	25

Set to 25 for motor not shown in table.

(4) Calculating method of current loop gain CLG
Using the motor characteristics shown in the above table and AMP current feedback constant, calculate CLG with the following formula. Show the result in closest integer.

CLG = (14.5 * - RΦ) * 0.0048 * Iv
LΦ : Top inductance of motor [mH]
RΦ : Top resistance of motor [Ω]
Iv : AMP current feedback constant

Ex) When using TS4293N8030 on HDXY2-11 AMP
CLG = (14.5X1 - 0.05)X0.0048X100 = 0.6936 ☞ CLG = 7

AMP Model	Hall Sensor symbol(spec)	Shunt resistance symbol (resistance value)	Full Scale current(Im)	AMP feedback constant(Iv)
Large 6 axis/additional axis AMP	0 (4V/75A)		140.62Apeak	**150.00**
	1 (4V/50A)		93.75Apeak	**100.00**
	2 (4V/25A)		46.87Apeak	**50.00**
	3 (4V/15A)		28.12Apeak	**30.00**
	4 (4V/10A)		18.75Apeak	**20.00**
	5 (4V/5A)		9.37Apeak	**10.00**
Medium 6 axis/additional axis AMP		1 (2mΩ)	93.75Apeak	**100.00**
		2 (4mΩ)	46.87Apeak	**50.00**
		3 (8mΩ)	23.44Apeak	**25.00**
		4 (12mΩ)	15.58Apeak	**16.67**
		5 (16mΩ)	11.72Apeak	**12.50**
Small 6 axis/additional axis AMP	1 (4V/15A)		28.12Apeak	**30.00**
	2 (4V/10A)		18.75Apeak	**20.00**
	3 (4V/5A)		9.37Apeak	**10.00**

5. Vibration control gain
Auxiliary axis is irrelevant..

6. 2 axis synchronized servo parameter
Set it only for 2 axis synchronization function..

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