

Programmable Multi-Axis Controller

Startup Guide for DirectPWM Interface

CK3W-AX1313□ CK3W-AX2323□

> Startup Guide

NOTE

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Precautions

- For actual system construction, check the specifications for each device and piece of equipment that makes up the system, use a method with sufficient margin for ratings and performance, and adopt safety circuits and other safety measures to minimize risks even if a breakdown occurs.
- To safely utilize the system, obtain a manual or user's guide for each device and piece of equipment that makes up the system, confirm and understand their content, including "Safety Precautions", "Precautions for Safe Use", and other precautions related to safety, and then proceed with use.
- The customer must check all regulations, laws, and rules that are applicable to the system themselves.
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Precautions for Correct Use

Precautions on what to do and what not to do to ensure correct operation and performance.



Additional Information

Additional information to read as required. This information is provided to increase understanding and make operation easier.

Related Manuals

To safely utilize the system, obtain a manual or user's guide for each device and piece of equipment, confirm their content, including "Safety Precautions", "Precautions for Safe Use", and other precautions related to safety, and then proceed with use.

The manuals for OMRON Corporation (hereafter, "OMRON") and Delta Tau Data Systems Inc. (hereafter "DT") are as shown below.

Manufac- turer	Cat. No.	Model	Manual Name
OMRON	O036	CK5M-□	Programmable Multi-Axis Controller Hardware User's Man-
		CK3M-□	ual
		CK3W-□	
DT	O014		Power PMAC User's Manual
DT	O015		Power PMAC Software Reference Manual
DT	O016		Power PMAC IDE User's Manual

Terms and Definitions

Terms	Descriptions and Definitions
PMAC	This is the acronym for Programmable Multi-Axis Controller.
Power PMAC IDE	This is computer software that is used to configure the Motion Controller, create user programs, and perform monitoring.
DirectPWM	This is a proprietary interface method developed by Delta Tau Data Systems, Inc. for connecting Servo Drives.
Digital Quadrature Encod- er	This is a type of encoder that outputs pulse signals.

Revision History

A manual revision code appears as a suffix to the catalog number on the front and back covers.

- Revision code

Revision code	Revision date	Revised content
01	July 2019	Original production
02	January 2023	Revision due to change of applicable Servo Drives
	January 2023	Corrected mistakes.

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About This Guide

This section lists a summary of these materials.

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1-1 Introduction

This document describes the connecting procedure and confirmation for an OMRON Programmable Multi-Axis Controller CK M-DDD (hereinafter referred to as "Controller") and a Direct PWM interface-capable Servo Drive.

By understanding the setting content and setting procedure points described in *Section 3 DirectPWM Interface Connection Procedure* on page 3-1, you can configure the Controller to send commands to the DirectPWM interface-capable Servo Drive and control Servomotors.

The connection procedure in this document describes an example when a digital quadrature encoder is used to perform position and velocity feedback for CK3W-AX1313^[]. *1

- *1. If CK3W-AX2323□ is used, the same DirectPWM interface as CK3W-AX1313□ is available but the encoder setting needs to be changed because a different type of encoder needs to be connected. Refer to the following documents for encoder settings.
 - Startup Guide Sinusoidal Encoder
 - Startup Guide for SSI/Mitutoyo/EnDat 2.1/2.2 Serial Encoder

1-1-1 Intended Audience

This guide is intended for the following personnel, who must also have knowledge of electrical systems (electrical or the equivalent).

- Personnel in charge of introducing FA systems.
- Personnel in charge of designing FA systems.
- Personnel in charge of installing and maintaining FA systems.
- · Personnel in charge of managing FA systems and facilities.

Also, this guide is intended for personnel who understand the contents described in the DT manual.

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Target Equipment and Device Configuration

This section lists the target equipment and system configurations for connections in these materials.

2-1	Device Configuration	2-2	2
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2-1 Device Configuration

The configuration devices for reproducing the connection procedures in this document are shown below.

This example shows a DirectPWM interface setting using the configuration where the digital quadrature encoder is connected to the output axis of a motor. This configuration is used only to show a setting example and is not a standard configuration.



Precautions for Correct Use

Always secure a Servomotor and encoder. Starting the motor that is not secured leads to a failure.

Manufacturer	Name	Model	Version
OMRON	Programmable Multi-Axis Controller CPU Unit	CK□M-CPU1□1	Version 2.5.2 or later
OMRON	Programmable Multi-Axis Controller Axis Interface Unit	CK3W-AX1313□	
OMRON	Programmable Multi-Axis Controller Power Supply Unit	CK3W-PD048	
OMRON	Programmable Multi-Axis Controller End Cover	CK3W-TER11	
OMRON	DirectPWM Cable	CK3W-CAAD0□□A	
OMRON	Motor Cable	R88A-CAKA0□□S	
OMRON	Encoder Cable	CK3W-CAES03A	
OMRON	Servo Drive	CK3A-G310L	
OMRON	Servomotor	R88M-K05030T	
OMRON	Digital Quadrature Encoder	E6B2-CWZ1X	
OMRON	Coupling	E69-C68B	
OMRON	Switching Power Supply	S8VK-	

Manufacturer	Name	Model	Version
	Windows PC		
DT	Power PMAC Setting Tool	Power PMAC IDE	Version 4.3 or later

3

DirectPWM Interface Connection Procedure

This section describes the procedures for connecting the Controller and Servo Drive, and operating the motion control equipment with the DirectPWM interface. The description assumes that the Controller is set to factory default.

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3-1 Work Flow

The procedures for connecting the Controller and Servo Drive, and operating the motion control equipment with the DirectPWM interface, are shown below.

3-2 Controller Setting Preparations on page 3-3	Perform the Controller setting preparations.
▼	
3-2-1 Creation of a New Project on page 3-3	
▼	
3-2-2 Controller Initial Setting on page 3-4	
∇	
3-3 Connecting Devices on page 3-6	Perform connection and wiring for each de- vice.
∇	
3-4 Various Controller Settings on page 3-8	Perform the Controller settings.
∇	
3-5 Confirmation of Settings on page 3-17	Check that the settings up to here are correct.
∇	
3-6 Motor Tuning on page 3-19	Use Power PMAC IDE tuning tools to tune the motor.
▼	
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3-6-5 Feed-Forward Value Setting on page 3-25	
▼	
3-6-6 Checking of Operation and Creation of Tuning Parameter Project on page 3-27	

3-2 Controller Setting Preparations

Perform the Controller setting preparations. Install the Power PMAC IDE on the PC beforehand.

3-2-1 Creation of a New Project

Follow the procedure below to create a new project.

1	Connect the Controller and computer	
2	Turn ON the power supply to the Con- troller.	
3	 Start up Power PMAC IDE. If a dialog for checking access rights is displayed at the time of startup, se- lect the option for starting up. 	PowerPMAC IDE
4	 The Communication screen is displayed, so specify the IP address of the Controller to be connected to, and click the Connect button. The default IP address for the Controller is "192.168.0.200". If necessary, change the Windows IP address to "192.168.0.X". 	IDE Environment - × Communication - × IP Address 192.168.0.200 - Port 22 - Protocol SSH - User root - Password - - SelectDeviceAtStartup True - IP Address SelectDeviceAtStartup - SelectDeviceAtStartup True - For Address - - Set IP Address - - For detailed setup options go to Tools menu -> Options -> - PowerPMAC - -
5	Power PMAC IDE starts up, and the Controller will come online.	<complex-block> Image: Control of Contr</complex-block>



3-2-2 Controller Initial Setting

Follow the procedure below to perform the initial settings for the Controller.

Precautions for Correct Use

Since all memory is cleared by the initial settings, be sure to save any data remaining in the Controller that you may need.

1	Type the \$\$\$ *** command from the Ter- minal, and set the Controller to the fac- tory default state.	Terminal: Online [192.168.0.200 : SSH]

2	 Type the save command in the Power PMAC IDE Terminal. When the save is completed, "Save Completed" is displayed in the Termi- nal. 	Terminal: Online [192.168.0.200 : SSH] ▼ ♀ × Saving To Flash: Finished SAVING to flash Save Completed save
3	 Type the \$\$\$ command in the Power PMAC IDE Terminal. When the reset is completed, "PowerPMAC Reset complete" is displayed in the Terminal. 	Terminal Saving To Flash: Finished SAVING to flash Save Completed SSS PowerPMAC Reset complete SSS

3

3-2 Controller Setting Preparations

3-3 Connecting Devices

The following diagram shows the connection between the axis interface unit and various equipment.



Follow the instructions below to connect a, b, c, and d shown in the diagram above.

a. Connection between the Controller and Servo Drive

Use the following dedicated cables to connect the CK3W-AX1313□ amplifier connector to the Servo Drive C2 connector.

Manufacturer	Name	Model	Length
OMRON	DirectPWM Cable	CK3W-CAAD009A	0.9 m
		CK3W-CAAD018A	1.8 m
		CK3W-CAAD036A	3.6 m

b. Connection between the Servo Drive and Servomotor
 Use the following dedicated cables to connect the Servo Drive P2 connector to the Servomotor connector.

Manufacturer	Name	Model	Length
OMRON	Motor Cable	R88A-CAKA003S	3 m
		R88A-CAKA005S	5 m
		R88A-CAKA010S	10 m
		R88A-CAKA015S	15 m
		R88A-CAKA020S	20 m
		R88A-CAKA030S	30 m
		R88A-CAKA040S	40 m
		R88A-CAKA050S	50 m

c. Connection between the Servomotor and Encoder

Use the following coupling to connect the rotary axes of the Servomotor and digital quadrature encoder.

Coupling: E69-C68B

d. Wiring between the Controller and Encoder

Use the following dedicated cable to connect CK3W-AX1313 to the digital quadrature encoder.

Manufacturer	Name	Model	Length
OMRON	Encoder Cable	CK3W-CAES03A	3 m

Follow the wiring diagram below to connect the dedicated cable (CK3W-CAES03A) to the digital quadrature encoder.

CK3W-CAES03A Encoder Cable				E6B2-CWZ1X Pulse Encoder	
Signal	Pin No.	Cable color	Mark	Color	Signal
Encoder Power Supply (+5VDC)	11	Blue	Black	 Brown	Power supply (+Vcc)
Encoder Power Supply (GND)	13	Blue	Red	Blue	0 V (common)
Encoder A+	1	Pink	Black	 Black	Output phase A
Encoder A-	6	Pink	Red	Black/red stripes	Output phase A-
Encoder B+	2	Green	Black	 White	Output phase B
Encoder B-	7	Green	Red	White/red stripes	Output phase B-
Encoder C+	3	Orange	Black	 Orange	Output phase Z
Encoder C-	8	Orange	Red	Orange/red stripes	Output phase Z-

3

3-4 Various Controller Settings

Perform the settings for the Controller to control the servomotor using the DirectPWM interface and digital guadrature encoder according to the following procedure.



Precautions for Correct Use

- For items to be written in the global definitions.pmh in step 2 in the following procedure, set appropriate values depending on the motor and Servo Drive used. If the set value is not appropriate, an excessive current flows, which may cause the equipment to fail. Refer to Notes *24 through *26 in *3-4-1 List of Notes* on page 3-14 for the settings.
- If Motor[1].IaBias and Motor[1].IbBias are set to other than 0 in the following step 9 and 11, the motor may rotate. Make sure that no problem occurs and the equipment is safe if the motor rotates before the setting.



```
2
    Write the text on the right to the global
                                      Sys.WpKey = $AAAAAAA
    definitions.pmh.
    • Refer to 3-4-1 List of Notes on page
                                      //global setting
                                      Gate3[0].PhaseServoDir = 0;
      3-14 for details on setting items with
      Notes *1 through *30 shown in the
                                      Gate3[0].PhaseFreq = 10000; //10kHz
      text on the right.
                                      Gate3[0].ServoClockDiv = 9; //1kHz
                                      Sys.PhaseOverServoPeriod = 0.1;
                                      Sys.ServoPeriod = 1;
                                      //Encoder Setting
                                      EncTable[1].Type = 1; //*1
                                      EncTable[1].pEnc = Gate3[0].Chan[0].ServoCapt
                                      .a; //*2
                                      EncTable[1].ScaleFactor = 1/exp2(8); //*3
                                      Gate3[0].EncClockDiv = 5; //3.125MHz
                                      Gate3[0].Chan[0].EncCtrl = 7; //*4
                                      //DirectPWM AD Convertor setting
                                      Gate3[0].AdcAmpStrobe = $901001; //*5
                                      Gate3[0].AdcAmpHeaderBits = 4; //*6
                                      Gate3[0].AdcAmpClockDiv = 5; //3.125MHz
                                      //DirectPWM PWM output setting
                                      Gate3[0].Chan[0].PwmFreqMult = 2; //*7
                                      Gate3[0].Chan[0].PwmDeadTime = 3.1 / 0.0533;
                                      //*8
                                      Gate3[0].Chan[0].PackInData = 0; //*9
                                      Gate3[0].Chan[0].PackOutData = 0; //*10
```

3

```
Sys.WpKey=$0
//Motor setting
Motor[1].ServoCtrl = 1; //Enable the Motor[1]
Motor[1].PhaseCtrl = 1; //Enable the commutat
ion task.
Motor[1].pPhaseEnc = Gate3[0].Chan[0].PhaseCa
pt.a; //*11
Motor[1].PhasePosSf = 2048/(256*2000*4/5); //
*12
Motor[1].PwmSf = 13458; //*13
Motor[1].PhaseOffset = 683; //*14
Motor[1].AmpFaultLevel = 1; //*15
Motor[1].pLimits = 0; //Disable the Overtrave
l limit.
Motor[1].WarnFeLimit = 4000; //*16
Motor[1].FatalFeLimit = 8000; //*17
Motor[1].pAmpEnable = Gate3[0].Chan[0].OutCtr
1.a;
Motor[1].pAmpFault = Gate3[0].Chan[0].Status.
a;
Motor[1].pCaptFlag = Gate3[0].Chan[0].Status.
a;
Motor[1].pCaptPos = Gate3[0].Chan[0].HomeCapt
.a;
Motor[1].pEncCtrl = Gate3[0].Chan[0].OutCtrl.
a;
Motor[1].pEncStatus = Gate3[0].Chan[0].Status
.a;
Motor[1].pMasterEnc = EncTable[1].a;
Motor[1].CurrentNullPeriod = 0; //*18
Motor[1].pEnc = EncTable[1].a //*19
Motor[1].pEnc2 = EncTable[1].a //*20
Motor[1].pDac = Gate3[0].Chan[0].Pwm[0].a; //
*21
Motor[1].pAdc = Gate3[0].Chan[0].AdcAmp[0].a;
 //*22
Motor[1].AdcMask = $FFFF0000; //*23
Motor[1].MaxDac = 28377 * 3.33 / 16.25; //*24
Motor[1].I2tSet = 28377 * 1.1 / 16.25; //*25
Motor[1].I2tTrip = (Motor[1].MaxDac * Motor[1
].MaxDac -Motor[1].I2tSet * Motor[1].I2tSet)
* 3; //*26
Motor[1].AbsPhasePosOffset = 400; //*27
Motor[1].PhaseFindingDac = 400; //*28
Motor[1].PhaseFindingTime = 1000; //*29
Motor[1].PowerOnMode=0; //*30
Motor[1].InPosBand = 100;
// Setting Coordinate System
&1
#1->x
&1%100;
```

3	Right click on the Solution Explorer project name at the upper right of the Power PMAC IDE screen, select Build and Download All Programs , and ex- ecute Build and Download.	Solution Explorer Search Solution Explorer (Ctrl+:) PowerPMAC1 PowerPMAC1 Canguage Configuration Configuration Configuration Configuration Configuration Configuration Configuration Clear New Map Add Canguage Configuration Clear New Solution Explorer Clas PowerPMAC1 Project P PowerPMAC1 Project P Properties Properties Properties Properties Properties Cut Unlow	 ب ب × ب ×
4	 Make sure that there are no errors in the Output Window. If the transfer failed, check the content of the error in the Output Window. If there is a program error, fix the program. 	Output Show output from: Build Uploading pp_error.log fi Uploading pp_proj.log fil Uploading pp_error_hist.l Uploading pp_debug.txt fi Uploading and synchronizi Download successful. Total Project download ti Total Project build and co	le from the PowerPMAC. e from the PowerPMAC. og file from the PowerPMAC. le from the PowerPMAC. ng PowerPMAC variables me = 4.453 seconds. download time = 11.365 seconds.
5	 Type the save command in the Power PMAC IDE Terminal. When the save is completed, "Save Completed" is displayed in the Termi- nal. 	Terminal: Online [192.168.0.2 Saving To Flash: Finished S/ Save Completed	00 : SSH]
6	Type the \$\$\$ command in the Terminal.	Terminal: Online [192.168.0.2 Save Completed \$\$\$ Resetting PowerPMAC PowerPMAC Reset complete	00 : SSH]
7	To determine a sign for Motor[1].PhaseOffset, paste Motor[1].PhasePos, Motor[1].IaBias, and Motor[1].IbBias in the Watch win- dow.	Watch Window Command/Query Svs.ServoCount Motor[1].PhasePos Motor[1].IaBias Motor[1].IbBias	☆ ▼ ↓ Response 159954 1.91999999999999999 0 0

3-4 Various Controller Settings

3

8	Type the #1out0 command in the Ter- minal.	Terminal: Online [192.168.0.200 : St Welcome to PowerPMAC terminal Select Device to start communication SSH communication to PowerPMAC \$\$\$ Resetting PowerPMAC PowerPMAC Reset complete #1out0	SH] on C at 192.168.0.200 successful
9	Set Motor[1].laBias=200 and Motor[1].lbBias=0 in the Terminal.	Terminal: Online [192.168.0.200 : SSH communication to PowerPMA \$\$\$ Resetting PowerPMAC PowerPMAC Reset complete #1out0 Motor[1].laBias=200 Motor[1].lbBias=0	SH] AC at 192.168.0.200 successful I
10	Check the Motor[1].PhasePos value in the Watch window	Watch Window	夺 🗕 🕁
	the watch white.	Command/Query	Response
		Sys.ServoCount	230995
		Motor[1].PhasePos	1505.9200000008966
		Motor[1].IaBias	200
		Motor[1].IbBias	0
11	Set Motor[1].IbBias=200 in the Termi-	Terminal: Online [192.168.0.200 : SSH]	
	nal.Motor[1].laBias remains 200.	\$\$\$ Resetting PowerPMAC	
		#1out0 Motor[1].laBias=200	
		Motor[1].lbBias=0 Motor[1].lbBias=200	
		Motor[1].lbBias=200	
12	Check the Motor[1].PhasePos value in the Watch window.	Watch Window	☆ ▼ 巾
		Command/Query	Response
		Sys.ServoCount	320449
		Motor[1].PhasePos	1503.3600000008971
		Motor[1].laBias	200
		Motor[1].IbBias	200



If the **save** command is not successfully completed, the transferred project is not saved in the Controller. If the power to the Controller is switched OFF without the project being saved, the transferred project is destroyed.



Additional Information

To change the counting direction of the digital quadrature encoder (clockwise/counterclockwise), change the sign of the following set values to write in the global definitions.pmh in step 2 to – (subtraction).

- EncTable[1].ScaleFactor
- Motor[1].PhasePosSf

3-4 Various Controller Settings

3

3-4-1 List of Notes

No.	Set item	Set value	Description
*1	EncTable[1].Type	1	Enable EncTable[1] as single-word (32 bits) read.
*2	EncTable[1].pEnc	Gate3[0].Chan[0].S ervoCapt.a	Assign the digital quadrature encoder data to EncTable[1].
*3	EncTable[1].Scale- Factor	1/exp2(8)	Calculate a scale factor set value in accordance with the following for- mula because EncTable[1] is 32 bits and Gate3[0].Chan[0].ServoCapt (digital quadrature encoder data) is 24 bits. Set value : $\frac{1}{2^{(32 \text{ bits } -24 \text{ bits})}}$
*4	Gate3[0].Chan[0].E ncCtrl	7	Set the digital quadrature encoder conversion method to four multipli- cation, counterclockwise.
*5	Gate3[0].Ad- cAmpStrobe	\$fffffc	Specify AMP Strobe Word. If <i>\$fffffc</i> is set, the Controller is compatible with all AD converters.
*6	Gate3[0].AdcAm- pHeaderBits	2	Set the header length of analog to digital conversion data to 2 bits. Set it depending on the Servo Drive specifications.
*7	Gate3[0].Chan[0].P wmFreqMult	2	Set the PWM frequency to 15 kHz. Calculate the PWM frequency in accordance with the formula below. $f_{PWM} = \frac{\text{Gate3[0].Chan[0].PwmFreqMult+1}}{2} \times f_{\text{IntPhase}}$ $f_{\text{IntPhase}} : \text{Internal phase clock frequency}$ Make sure that the value is 40 kHz or less and the same as the Servo Drive maximum input frequency or less.
*8	Gate3[0].Chan[0].P wmDeadTime	3.1/0.0533	Set the dead time of the PWM signal to 3.1 µs. Calculate the dead time with the following formula. Dead time = 0.0533 µs × Gate3[0].Chan[0].PwmDeadTime Set it depending on the Servo Drive specifications.
*9	Gate3[0].Chan[0].P ackInData	0	AdcAmp compression: Disabled If the digital current loop is implemented, enable data compression that improves algorithm efficiency. Disable it this time.
*10	Gate3[0].Chan[0].P ackOutData	0	Disable PWM/DAC compression. If commutation and digital current loops are calculated, data compres- sion improves the efficiency of the algorithm and should be enabled. Disable it this time.
*11	Motor[1].pPha- seEnc	Gate3[0].Chan[0].P haseCapt.a	Use the digital quadrature encoder for commutation position feedback.

The following table shows details on notes (description of set items) in step 2.

No.	Set item	Set value	Description
*12	Motor[1].Phase- PosSf	2048/ (256*2000*4/5)	Set a scale factor (Sf) of the commutation position (angle). Use the fol- lowing formula to calculate the scale factor if 24 bits digital quadrature encoder (Gate3[0].Chan[0].ServoCapt) is assigned to 32 bits EncTa- ble[1] as this example.
			Sf = $\frac{2048 \times \text{Number of motor pole pairs}}{256 \times \text{Encoder resolution} \times \text{Encoder multiplication setting}}$
			Set it depending on the specifications of equipment used. The following shows parameters for equipment used in this example. $256: 2^{(32 \text{ bits} - 24 \text{ bits})} = 256$ Encoder resolution: 2000 pulses per rotation Encoder multiplication: 4 multiplication Number of motor pole pairs: 5 pairs (10 poles)
*13	Motor[1].PwmSf	13458	Set a scale factor for PWM output. The full range is 16384. The scale factor is normally set to less than 95% of the full range so that PWM waveform cannot reach the duty cycle of 0% or 100%. It is set to approximately 82% in this example. Set it depending on the Servo Drive specifications.
*14	Motor[1].PhaseOff- set	683	For a three-phase motor, set to 683 or −683.
*15	Motor[1].AmpFault- Level	1	Specify a logic of AMP Fault detection. Set it depending on the Servo Drive specifications.0: Negative logic is used to detect AMP Fault.1: Positive logic is used to detect AMP Fault.
*16	Motor[1].WarnFeLi- mit	4000	The status bit Motor[1].AmpWarn is set when the positional deviation exceeds this value. The value for a half-rotation of the motor is set in this example. Set it depending on applications used.
*17	Motor[1].FatalFeLi- mit	8000	The motor is killed and the status bit Motor[1].FeFatal is set when the positional deviation exceeds this value. The value for a half-rotation of the motor is set in this example. Set it depending on applications used.
*18	Motor[1].Current- NullPeriod	0	When the set value is 1, Motor[1].laBias and Motor[1].lbBias are automatically set to Motor[1].PhaseFindingStep=1 during phase search.
*19	Motor[1].pEnc	EncTable[1].a	Specify the digital quadrature encoder as an address used for loop feedback to control the motor position. The digital quadrature encoder is assigned to EncTable[1] in Notes *2 in this example.
*20	Motor[1].pEnc2	EncTable[1].a	Specify the digital quadrature encoder as the address used for loop feedback to control the motor velocity. The digital quadrature encoder is assigned to EncTable[1] in Notes *2 in this example.
*21	Motor[1].pDac	Gate3[0].Chan[0].P wm[0].a	Assign DirectPWM to the motor command output register.
*22	Motor[1].pAdc	Gate3[0].Chan[0].A dcAmp[0].a	Specify the DirectPWM interface AD converter as an AD converter used for digital current feedback.
*23	Motor[1].AdcMask	\$FFFF0000	Specify which bit of 32 bits current feedback word is used as the actual current value. It is set for a 16-bit AD converter this time. Set it according to the spec- ifications of the Servo Drive.

3-4 Various Controller Settings

3

No.	Set item	Set value	Description
*24	Motor[1].MaxDac	28377*3.33/16.25	Set an instantaneous current limit value (root mean square: RMS). Compare those of the Servo Drive and the motor, and use a smaller value. The motor has a smaller value in this example. Use the following formula for calculation. $MaxDac = \frac{Cos (30^{\circ}) \times 32767 \times Maximum instantaneous current}{Servo driver ADC full-range current}$ Determine parameters depending on the equipment used. The following shows parameters for equipment used in this example. Maximum instantaneous current for R88M-K05030T: 4.7 A (p-p)/ $\sqrt{2}$ = 3.33 A (RMS) CK3A-G310L ADC full range current: 16.25 A (RMS)
*25	Motor[1].I2tSet	28377*1.1/16.25	Set a rated current limit value (RMS). Compare those of the Servo Drive and the motor, and use a smaller value. The motor has a smaller value in this example. Use the following formula for calculation. $I2tSet = \frac{Cos (30^{\circ}) \times 32767 \times Rated current}{Servo driver ADC full-range current}$ Determine parameters depending on the equipment used. The following shows parameters for equipment used in this example. Rated current for R88M-K05030T: 1.1 A (RMS) CK3A-G310L ADC full range current: 16.25 A (RMS)
*26	Motor[1].I2tTrip	(Motor[1].Max- Dac*Motor[1].Max- Dac - Mo- tor[1].I2tSet*Mo- tor[1].I2tSet)*3	Set a motor integrated current limit. Use the following formula for cal- culation. I2tTrip = (MaxDAC ² + IdCmd ² – I2tSet ²) × allowable time (second) Allowable time for R88M-K05030T: 3 seconds
*27	Motor[1].AbsPha- sePosOffset	400	Specify the minimum operation that is considered to be an efficient phase search. Although the commutation cycle (2048) 1/4 = 512 (90°) is ideal, it is set to approximately 80% in this example considering that problems such as friction can prevent the operation. If Motor[1].PhaseFindingStep=1 displacement is smaller than this value during phase search, the phase search is considered to be failed by Power PMAC.
*28	Motor[1].PhaseFin- dingDac	400	Set the size of phase-sequence current that is output to each motor phase in phase search. Adjust it depending on the equipment used.
*29	Motor[1].PhaseFin- dingTime	1000	Set duration of each step during phase search. Adjust it depending on the equipment used. The following duration is used in this example. Duration = Servo cycle × Motor[1].PhaseFindingTime = 1 ms × 1000 = 1000 ms
*30	Motor[1].PowerOn- Mode	0	 Enables the motor after phase search. Kills the motor after phase search.

3-5 Confirmation of Settings

Follow the procedure below to check that the settings up to here are correct.

1	Type the Motor[1].PhaseFindingStep=1 command from the Terminal to perform a phase search.	Terminal: Online [192.168.0.200 : SSH] Motor[1].PhaseFindingStep=1 Motor[1].PhaseFindingStep=1	
	• The Motor[1].PhaseFindingStep value changes to 1, 6, 7, and 0.	Watch Window	⇔ - 4
	When the phase search succeeds, the Motor[1].ClosedLoop and Motor[1].PhaseFound values	Command/Query	Response
		Sys.ServoCount	044992
	In addition, the Motor[1].New[0].Pos	Motor[1].PhaseFindingStep	0
	value becomes larger than the Motor[1].AbsPhasePosOffset set	Motor[1].ClosedLoop	1
	value. The AMP ENAB 0 LED is	Motor[1].PhaseFound	1
	turned on at that time. ^T	Motor[1].New[0].Pos	467.19999999999999999
2	Type the #1 out1 command from the Terminal.	Terminal: Online [192.168.0.200 : SSH] SSS Resetting PowerPMAC PowerPMAC Reset complete #1 out1 [#1 out1]	
3	Make sure that the motor is rotating. In addition, check that the Position win-	Position	
	dow Position value is increasing in the positive direction.	Position	
	 If the motor does not rotate even af- ter typing the #1 out1 command. in- 	#1 2,176,411.25 mu	
	crease the value gradually as #1	#2 0.00 mu	
	0012, #1 0013.	#3 0.00 mu	
		#4 0.00 mu	
4	Type the kill command from the Termi- nal to stop the motor.	Terminal: Online [192.168.0.200 : SSH] #1 out3 #1 out4 #1 out5 #1 out6 kill kill	

*1. If **Motor[1].PhaseFound** does not indicate 1, the phase search has failed. Check if the set value is appropriate.

3

The following shows some examples of set value adjustment when a phase search fails.

- If the Motor[1].New[0].Pos value is smaller than the Motor[1].AbsPhasePosOffset set value after phase search, increase the Motor[1].PhaseFindingDac value. In addition, check that the Motor[1].PhasePosSf set value is appropriate.
- If an error occurs in I2tFault status during phase search, decrease the value of Motor[1].PhaseFindingDac or Motor[1].PhaseFindingTime.
- If the Motor[1].New[0].Pos value indicates (subtraction) after phase search, change signs of Motor[1].PhasePosSf and EncTable[1].ScaleFactor.

3-6 Motor Tuning

Follow the procedure below to use Power PMAC IDE tuning tools for tuning the motor.

3-6-1 Open Loop Test

Follow the procedure below to operate the motor in an open loop, and check that each setting is correct.



3



3-6-2 Current Loop Gain Setting

Follow the procedure below to perform current loop gain settings and adjust them to achieve desired response characteristics.

1	In the Tune screen, select Current Loop Tuning – Interactive Tune.	Time: Online(192:168.00 Salest Mater Terms)	Adviture Panetaria Adviture Panetaria Heard Gan (Balan) Forward Ref Reportand Gain (L&Gain) Back Path Proportional Gain (L&Gain) Proze A (L&Gain) Proze A (L&Gain)	Ture	Intenctive Turing Intentions State 2 Ourient Loop State 5 Magnitude Deal Time	athe Control Menocine Files Setue: LOS Set hanneter Setue 0000 bits 200 me De A Current Loop Step DD Macer
2	Set the following parameters. IliGain: 0.0099999998 (Default) IpfGain: 0	Simple Auto-tune Au Auto-tune Paramete Integral Gain (JiGain Forward Path Propo Back Path Proportic	to-ture Interactive Tune rs rional Gain (bt/Gain) nal Gain (bt/Gain)	0 0069939395	Current Loop Step Paramete Magnitude Hough Hhasing Magnitude Dwell Time	1000 bits 1000 bits 50 me
	Magnitude: 3000 bits Dwell Time: 50 ms	Phase Current Eles (Phase A (IsBies Phase B (IsBies) fibets)	0	Do A C	ument Loop Step Kill Mator



3-6-3 Bandwidth Automatic Setting

Follow the procedure below to use the auto-tuning function for setting the servo loop bandwidth automatically. 3-6 Motor Tuning

3-6-3 Bandwidth Automatic Setting

1	In the Tune screen, select Position Loop Auto-tune – Advance Auto- tune.	Tune: Online(192:168.0.2005SH) ElDen Loop Test: Plation Loop Autorture ation Loop Autorture Select.Mater Select.Mater Carrent Loop Is Select.Mater Select.Mater Comment Loop Is Select.Mater Select.Mater Comment Loop Is Select.Mater Select.Mater Comment Loop Is Select.Mater Select.Mater Coll Autorture Select.Mater Coll Autorture Coll Autorture Select.Mater Select.Mater Coll Autorture Select.Mater Coll Autorture Coll Autorture Select.Mater Coll Autorture Coll Autorture Select.Mater Coll Autorture Select.Mater Demoing Patio 0.7 Mar. Travel 400 Mar.Travel 400 mu Valorty: FT Coll Autorture Move Only Parater Valorty: FT Coll Autorture Move Only Parater Color Coles Coles Color Autorture Motor Resolution Te Details for Select. Elevalvich Autorture Motor Resolution
2	 Set the following parameters. Amplifier Type: Direct PWM Auto Select Bandwidth: Select the check box. Encoder Resolution: 8000 cts/rev Excitation Magnitude: 8.0%*1 Iteration No.: 2 *1. Select the value rotated in the open loop in step 3 in 3-6-1 Open Loop Test on page 3-19. For Encoder Resolution, set the pulse counts per one motor rotation. In this example, 2000 pulses per rotation of the digital quadrature encoder is set to be multiplied by four, so Encoder Resolution indicates 8000. 	Simple Autortune Secify Autortune Excitation Stattings Ancilifier Type Direct PMM Specify Desired Performance Excitation Magnitude Bandwidth 000 Integral Action 60 Integral Action 60 Mark Travel 000 Integral Action 60 Accoleration FF 000 Auto Select Bandwidth 200 Auto-Tune Move Only 200 No. dsg Back 200 Auto-Tune Move Only 200 No. dsg Back 200
3	Click the Auto-tune Motor button.	Simple Auto-tune Specify Amplifier Type Anchiner Type Specify Desired Performance Bandwidth Damping Patio 0 Set Hand Integral Action Set Hand Auto-tune Excitation Settings Excitation Magnitude Bandwidth 200 Kin Damping Patio 0.7.0 Man Travel Max Travel Auto-tune Move Only Auto-Select Bandwidth Auto-Select Bandwidth Auto-Select Low Pass Filter
4	If the message on the right appears, click the Yes button.	Position AutoTune Message We have chosen a safe and conservative bandwidth of 4.6 Hz You may choose a larger bandwidth of up to 4 times this value and Click Begin Tuning again. Do you wish to go back and change this bandwidth (f you choose No the auto-tuning process will continue?) Ves No

5	If the screen on the right appears, click	Auto-tune Results for Motor			
-	the Implement button		Current Gains	Previous Gains	Recommended Gains
	the implement batton.	Proportional (Kp)	4	4	0.703372719665314
		Derivative (Kvfb)	40	40	17.2223454108807
		Integral (Ki)	9.9999997e-05	9.9999997e-05	0
		Velocity feedforward (Kvff)	40	40	0
		Acceleration feedforward (Kaff)	0	0	0
		Derivative Gain 2 (Kvifb)	0	0	0
		Velocity feedforward into Integrator (Kviff)	0	0	0
				Restore	Implement
6	Check that the Recommended Gains	Active filter will be removed		ОК	Cancel
6	Check that the Recommended Gains	Active filter will be removed		ОК	Cancel
6	Check that the Recommended Gains values are applied to Current Gains ,	Active filter will be removed	Current Gains	OK Previous Geins	Cancel
5	Check that the Recommended Gains values are applied to Current Gains , and then click the OK button	Active filter will be removed Auto-tune Results for Motor Proportional (Kp)	Current Gains 0.703372719665314 17.7033424119997	OK Previous Gains 4	Cancel Peccommended Gains 0.703372719665314 112222464102033
)	Check that the Recommended Gains values are applied to Current Gains , and then click the OK button.	Active filter will be removed Auto-tune Results for Motor Proportional (Kp) Derivative (Kvfb)	Current Gains 0.703372719665314 17.2223454108807 0	OK	Cancel Recommended Gains 0.703372719665314 17.2223454108807 0
5	Check that the Recommended Gains values are applied to Current Gains , and then click the OK button.	Active filter will be removed Auto-tune Results for Motor Proportional (Kp) Derivative (Kvfb) Hitsgar (Ki) Validative for difference (Kr db)	Current Gains 0.70037271 9665314 17.2223454108807 0 0	OK Previous Gains 4 40 99999997e-05 40	Cancel
5	Check that the Recommended Gains values are applied to Current Gains , and then click the OK button.	Active filter will be removed Active filter will be removed Auto-tune Results for Motor Proportional (Kp) Derivative (Kvfb) Integral (Ki) Velocity feedforward (Kvff) Accelerative forkering (Kvff)	Current Gains 0.703372719665314 1.72223454108007 0 0	ОК Реміоць Gains 4 40 9.999997е-05 40 0	Cancel
5	Check that the Recommended Gains values are applied to Current Gains , and then click the OK button.	Active filter will be removed Active filter will be removed Auto-tune Results for Motor Proportional (Kp) Derivative (Kvfb) Integral (Kc) Velocity feedforward (Kvff) Acceleration feedforward (Kaff) Derivative (Kvfb)	Current Gains 0.703372719665314 17.2223454108807 0 0 0 0	ОК Ремчоце Gains 4 40 9999997е-05 40 0 0	Cancel
5	Check that the Recommended Gains values are applied to Current Gains , and then click the OK button.	Active filter will be removed Auto-tune Results for Motor Proportional (Kp) Derivative (Kvfb) Integral (Kc) Velocity feedforward (Kvff) Acceleration feedforward (Ksff) Derivative Grad (Kvff) Velocity feedforward (Ksff) Derivative Grad (Kvff)	Current Gains 0.703372719665314 1.7.2223454108807 0 0 0 0 0 0 0 0	ОК Региона Gaina - 4 40 9 999997е-05 40 0 0 0 0 0	Cancel
5	Check that the Recommended Gains values are applied to Current Gains , and then click the OK button.	Active filter will be removed Auto-tune Results for Motor Proportional (Kp) Derivative (Kvft) Acceleration Reddforward (Kvff) Acceleration Reddforward (Kvff) Derivative Cain 2 (Kvfft) Velocity feedforward into Integrator (Kviff)	Current Gains 0.703372719665314 17.2223454108807 0 0 0 0 0 0 0 0	OK Previous Gains 4 40 0 0 0 Restore Previous Previous Calins 4 Previous Calins 4 Previous Calins 4 Previous Calin	Cancel Flecommended Gains 0703372719665314 172223454108007 0 0 0 0 0 0 0 0 0 0 0 0 0

3-6-4 Manual Setting of Bandwidth

Follow the procedure below to set a more appropriate bandwidth, while monitoring the step response characteristic.

1	Soloot Bogition Loop Interactive				
	Select Position Loop Interactive	Select Motor	Current Loop Tuning Open Loop Test Position Loop Auto-tu	Position Loop Interactive Tuningfilter S	etup Adaptive Control I
	Tuning Stop in the Tune screen		Heedback Gains	0.70026740	Stee
	runnig – Step in the rune screen.		Proportional Gain (ND)	17.107720	Step Mow
			Derivative Gain 1 (KVID)	0	Care Cire
			Intraeni Gain (Ki)	0	Step Size
			Fire Council Online		Step Time
			Velocity Exectfrouwerl Gain 1 (Kuff)	0	
			Valority Feederward Gain 7 (Kviff)	0	
			Acceleration Feedforward Gain (Kaff)	0	
			Friction Feedforward Gain (Kfff)	0	
			Integral Mode (SwZvint)	0	Move Options
			Fatal Following Error Limit (FatalFeLimit)	9000	Kill Motor After the Move
		KII	Servo Output Limit (MaxDec)	8399.5918	Dwell Time After the Move
		Enable Open Loop	Input Deadband Size (BreakPosErr)	0	
			Input Deadband Gain (KBreak)	0	H
		Phase Motor	Output Deadband Inner Size (OutDb0n)	p	Set Gantr
		Export motor 1 settings to the	Output Deadband Outer Size (OutDoOm)	<u>0</u>	Show §
		current project	Output Deadband Seed (OutDoSeed)	<u>v</u>	
2	Set the following parameters.	Current Loop Tuning Open Loop Test FeedBack Gains Proportional Gain (Kp)	Position Loop Auto-tune Position Loop Interactive Tuning Pre-filter	Setup Adaptive Control Interactive Filter Setup Trajectory Selection Step Ramp Parabolic Vel. Trapezoidal	LC Setup Vel. SCurve Sinusoidal S
	Step Size: 2500 mu	Derivative Gain 1 (Kvfb)	16.439548	Adva Ave U - Downson	
	•	Derivative Gain 2 (Kvifb)	0	Step Size 2500	mu
		Integral Gain (Ki)	0		
		FeedForward Gains			
		Velocity Feedforward Gain 1 (Kvff)	0		
		Velocity Feedforward Gain 2 (Kviff)	0		
		Friction Feedforward Gain (Kfff)	0	Step Move	
		Integral Mode (SwZvint)	0	Move Options	
		Fatal Following Error Limit (FatalFeLi	imit) 8000	After the Move	
		Servo Output Limit (MaxDac)	8399.5918	After the Move	500 ms
		Insuit Devaltand Size (BreakPosEm)	0		
		Input Deadband Gain (KBreak)	0	Filter Calculator	Select Hot It
		Output Deadband Inner Size (OutDb0	0 (n	Set Gentry Omse-Openium Gaine	Left Avis
		Output Deadband Outer Size (OutDb	ю т (0	Concision y crister contributing claims	Fight Axis
		Output Deadband Seed (OutDbSeed)	0	Show Servo Block Diagram	Plot to

3

3	Click the Step Move button.	Oursert Loop Turing Open Loop Test. Peetion Loop Autorstree Peetion Loop Autorstree Presortional Gain (Re) Dirity Dariatova Gain 1 (Koh) [Erd] Dariatova Gain 2 (Koh) Dirity Presortional Gaine Velocity Presortional Gaine Dirity Velocity Peetforward Gain (Koh] Dirity Presortional Gaine Dirity Velocity Peetforward Gain (Koh] Dirity Priston Feedforward Gain (Koh] Dirity Sonro Nortz-Invertise Invol Devetterd Gain (Koh) Dirity Pouto Chardbard Gain (Koha) Dirity Dirity Outout Chardbard Gainer Gainer (Sain (OutDrin) Dirity Dirity Outoutoutoutoutoutoutoutoutoutoutoutoutou	anduka Tuning Pan-Tiker Satus L.D. Satus II. 19079
4	Check the step response characteristic.	1 Step Move:	#1 5/14/2019 4:39:18 PM ctual Poston 324.50 324.00 323.00 323.00 322.50 322.00 321.50 321.50 321.50 321.50 321.00 321.50 321.50 321.00 321.50 321.00 321.50 321.50 321.00 322.50 322.00 321.50 321.50 321.50 322.00 321.50 322.00 321.50 322.50 322.00 321.50 322.50 322.50 322.50 322.50 322.50 322.50 322.50 322.50 322.50 322.50 322.50 322.50 322.50 322.50 322.50 322.50 321.50
5	If the target position has not been reached, return to the Advance Auto- tune screen, and set an even larger value for Bandwidth .	Current Loop Turing Open Loop Test. Position Loop Auto-ture Single Auto-ture Avance Auto-ture Spocify Amplifier Type Direct PVM Direct	Auto-tune Motor Auto-tune Motor Auto-tune Motor
6	Click the Recalculate button.	Current Loop Tuning Open Loop Teet Position Loop Auto-tune Simple Auto-tune Advance Auto-tune Specify Amplifier Type Amplifier Type Direct PWM Specify Desired Performance Bandwidth 18.0 Hz Damping Ratio 0.7 C Negral Action Soft Integral Action Velocity FF Acceleration FF Optione Auto Select Eandwidth Auto Select Low Pass Filter	Auto-tune Motor
7	If the screen on the right appears, click the Implement button.	Auto-tune Results for Motor Proportional (Kp) Derivative (Kvhb) IT Integral (K) Valocity feedforward (Kvff) Orivative Gain 2 (Kvff) Orivative Gain 2 (Kvff) Orivative Gain 2 (Kvff) Other State (Kvff	Numerical Previous Carrent Gains Previous



Feed-Forward Value Setting 3-6-5

Follow the procedure below to set a more appropriate bandwidth, while monitoring the step response characteristic.

1	In the Tune screen, select Position	Current Loop Tuning Open Loop Te Rosition Loop Auto-tu	e position Loop Interactive Tuning	Pre-filter Setup Adaptive Control Inte
	Loop Auto-tune – Advance Auto-	Simple Auto-tune Advance Auto-tune		
	fund and incent sheets into Valacity	Specify Amplifier Type Amelifier Type Dimet DMM	Specify Auto-tune Excitation Settin	125
	tune, and insert checks into velocity	Amplifier Lype Direct Hwini V	Excitation Magnitude	8.0 🗢 %
	FF and Acceleration FF.	Specify Desired Performance	Excitation Time	100 ms
		Bandwidth 18.0 E Hz	Min Traval	400
		Damping Ratio 0.7 🖨	Mill. Horos	mu
		Colt Have	Max. Travel	4000 mu
		Integral Action	Auto-tune Move Options	
			Positive Move Only	Iteration No
			Negative Move Uniy	
		Auto Select Bandwidth		
		Auto Select Sample Period	Auto-tune Motor	Becalculate
		Auto Select Low Pass Filter		
0				
	Click the Recalculate button.	Current Loop Funing Upen Loop Fest Position Loop Auto-tu	Position Loop Interactive Funing F	rhe-filter Setup Adaptive Control Inti
		Simple Auto-rune Autor and and Specify Amplifier Type	Specify Auto=tune Excitation Settin	185
		Amplifier Type Direct PWM ~	Excitation Magnitude	80 🛎 «
		Specify Desired Performance	Evolution Time	
		100	Excitation Line	1.00
		Bandwidth 18.0 V Hz		100 ms
		Damping Ratio 0.7	Min. Travel	100 ms 400 mu
		Bandwidth 180 Hz Demping Ratio 0.7 C	Min. Travel Max. Travel	100 ms 400 mu 4000 mu
		Bandwidth Hz Damping Ratio 0.7 ♥ Integral Action ♥ Hz	Min. Travel Max. Travel Auto-tune Move Options	100 ms 400 mu 4000 mu
		Dendwidth Hz Demping Ratio 07 € Integral Action Soft Hard	Min, Travel Max, Travel Auto-tune Move Options	100 ms 4000 mu 4000 mu heration No
		Demohaidth 120 V Hz Demping Ratio 07 0 Integral Action Soft Hard Velocity FF	Min, Travel Max, Travel Auto-tune Move Options Positive Move Only Negative Move Only	100 ms 4000 mu 4000 mu Iteration No 1 ©
		Demokridith 120 V Hz Demping Ratio 07 V Integral Action Soft Hard Valocity FF Valocity FF Valocity FF	Min, Travel Max, Travel Auto-traine Move Options Control Market Move Only Negative Move Only No Jog Back	100 me 4000 mu 4000 mu Iteration No I
		Demokwidth 120 ¥ Hz Demoing Ratio 07 € Integral Action Soft Hand ✓ Velocity FF ⊘ Acceleration FF Options	Min. Travel Max. Travel Auto-tune Move Options Options Negative Move Only No. Jog Back	100 me 4000 mu 4000 mu Iteration No 1 \$
		Bendwidth team integral Action Soft Hard Integral Action Soft Hard Velocity FF ⊘Acceleration FF Options Auto Select Bandwidth Auto Select Bandwidth	Min. Travel Max Travel Auto-tune Move Options Desitive Move Only Negative Move Only No Jog Back	100 me 4000 mu 4000 mu 1 0
		Bendwidth 120 ¥ Hz Damping Ratio 07 € Integral Action 507 € Velocity FF ⊘ Acceleration FF Options △ Auto Select Bandwidth △ Auto Select Sample Period △ Auto Select Low Pass Filter	Min. Travel Max. Travel — Positive Move Options — Positive Move Only — No Jog Back — Auto-tune Motor	100 me 400 mu 4000 mu Iteration No 1 2 Recalculate
		Bendwidth 120 ¥ Hz Demping Ratio 07 € Integral Action Soft Hard ✓ Velocity FF ✓ Acceleration FF Options Auto Select Bandwidth Auto Select Cample Period Auto Select Low Pass Filter	Min. Travel Max. Travel Auto-tune Move Options Destrive Move Only No Jog Back Auto-tune Motor	100 me 400 mu 4000 mu Iteration No 1 1
		Bendwidth 12 v v Hz Demping Patio 07 € Integral Action 6 + Hard Velocity FF Acceleration FF Options Acceleration FF Options Auto Select Sample Period Auto Select Low Pass Filter	Min. Travel Max. Travel Auto-tune Moxe Options Opsitive Moxe Only No. Jog Back Auto-tune Motor	100 me 4000 mu 4000 mu Iteration No I S Recalculate

0						
3	If the screen on the right appears, click	Auto-tune Results for Motor				×
	the Implement button.		Current Gains	Previous Gains	Recommended Gains	
		Proportional (Kp)	1.9111081	1.9111081	1.91110810197676	
		Derivative (Kvfb)	28.388481	28.368461	28.3884814465067	
		Integral (Ki)	0		28 3884814465067	
		Acceleration feedforward (Kaff)	0	0	215.150816623052	
		Derivative Gain 2 (Kvifb)	0	0	0	
		Velocity feedforward into Integrator (Kviff)	0	0	0	
		And a Steam II to many ad			anpienenc	
				OK	Cancel	
4	Check that the Recommended Gains	Auto-tune Results for Motor				×
•	Values are explied to Current Caine	-	Current Gains	Previous Gains	Recommended Gains	
	values are applied to current Gains ,	Proportional (Kp)	1.91110810197676	.9111081	1.91110810197676	
	and then click the OK button.	Derivative (Kvfb)	28.3884814465067	8.388481	28.3884814465067	
		Integral (Ki)	0	1	0	
		Velocity feedforward (Kvff)	28.3884814465067	1	28.3884814465067	
		Acceleration feedforward (Kaff)	215.150816623052	1	215.150816623052	
		Derivative Gain 2 (Kvifb)	0	<u> </u>	0	
		Velocity feedforward into integrator (Kviff)	0	<u> </u>	0	
				Restore	Implement	
		Active filter will be removed			0.1	
				UK	Cancel	
5	Select Position Loop	Connect you Turing Organization Turing Logications - Particip Logic Interactive Turing L	Har Satur, Adaption Oceanol. Interaction	a FilerSatury 10 Satury		
•	Interactive Tuning Developie Vel	Freedback Gains Proportional Gain (Kp) 1.9111081	Trajectory S Step Rar Panabolic	Al apezoidal Vel. SCurve Sinusoidal	Sine Sweep User Defined	
	Interactive luning – Parabolic vel.	Derivative Gain 1 (Koltb) (20100401 Derivative Gain 2 (Koltb) (0	Move Size	2000 mu		
	and set the following parameters.	Integral Gain (%) 0	Move Time	500 ma		
	Maya Siza: 2500 mu	Velocity Feedforward Gain 1 (Kvff) (20.001401 Velocity Feedforward Gain 2 (Kvff) (0	_			
	WOVE SIZE. 2500 Mu	Acceleration Feedforward Gain (KeR) 215 15052 Friction Feedforward Gain (KR) 0	Pin	bolic Velocity Move		
	Move Time: 500 ms	integral Mode (SwiZvint)	Move Options			
	Laft Axis: Velocity	Patal Following Error Limit (Fatal PeLinit) [0000 Serve Output Limit (MarDarc) [00002010	After fee Nove	500	Only Bepetitive More	
		Incontractional Basel Postery 0 Incontractional Size (BreakPostery) 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	Filter Cal	ouletor		
	Right Axis: Following Error	Output Deadband Inter Site (OutD60 n) 0 Output Deadband Outer Site (OutD60 R) 0	Set Gentry Cross	Couching Gaine Right A	a vecaty a FollowingError	~
		Output Deachand Seed (OutDitSeed)	ONOW DEFICE D	Concentration		
6	Click the Parabolic Velocity Move but	Current Loop Tuning Open Loop Test (Position Loop Auto-tune) Position Loop Interactive Tuning P	Pre-Riter Setup: Adaptive Control: Interacti	ve Filter Setup LC Setup		
U	Click the Falabolic velocity wove but-	Proportional Gardina (Kp) [1.9111081	Step Ramp Parabolic V Select Parabolic Move Pa	Al. Trapezoidal Vel. SCurve Sinusoidal	Sine Sweep User Defined	
	ton.	Derivative Gain (19940) Derivative Gain (19940) Derivative Gain (19940) D	Move Size	2500 mu		
		Freedforward Calves	Move Time	500 m		
		Vecoldy Feedbraint Cain 1 (VVH) 20.305401 Velocity Feedbravert Cain 2 (VVH) 0 Control Cain				
		Priction Feedbrand Cain (1999)	Para	bolic Velocity Move		
		Interant Mode (SAZVH) 0 Fatal Following Brox Linit (Fatal FeLinit) 8000	Move Options Kill Motor		Move in One Direction Only	
		Servo Nutrut Limit (MeDec) [89997918 Servo Nord_ineerities	Deel Time After the Nove	200 ma	Bepetitue Move	
		Input Deadband Size (BeakPosDin) U Input Deadband Size (Reak)	Filter Cel	culator Left Av	tens s Welocity	~
		Output Decidend Iver's de Output V Output Decidend Outer's de Output V Output Decidend Outer's de Output V O	Set Gentry Cross Show Serve B	Couching Gains Rgint A	is Following Error to New Chart	~
		<u></u>				
7	Check the parabolic response charac-					
		1 Parabolic	Move: #1 5/14/20	019 5:05:48 PM		
	teristic of velocity.	Command Velocity — Act	tual Velocity —	 Following Error 	1	50
						00
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		5 5 1	Na			o in
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		octue	1h		a popular	ving
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				- Martine Mart		ŭ.
					-	100
			400 500 -			150
		0 100 200 300	Time (ms)	 700 80		



3-6-6 Checking of Operation and Creation of Tuning Parameter Project

Follow the procedure below to check operations and create a tuned parameter project.

1	Type the Motor[1].PhaseFindingStep=1 command from the Terminal to perform a phase search.	Termi	nal: Online [192.168.0.200 : SSH] [1].PhaseFindingStep=1	
	• The Motor[1].PhaseFindingStep value changes to 1, 6, 7, and 0.		ch Window	� ~ 다
	• When the phase search succeeds, the Motor[1] ClosedLoop and	Col	mmand/Query	Response
	Motor[1].PhaseFound values	Sys	.ServoCount	4088603
	change from 0 to 1. In addition, the Motor[1].New[0].Pos value be-	Mo	tor[1].PhaseFindingStep	0
	comes larger than the Motor[1].AbsPhasePosOffset set value. The AMP ENAB 0 LED is turned on at that time.	Mo	tor[1].ClosedLoop	1
		Mo	tor[1].New[0].Pos	469.7599999999999999
2	Type the #1 j+ command from the Ter- minal.	Termi Motor #1 j+	inal: Online [192.168.0.200 : SSH] [1].PhaseFindingStep=1	
3	Make sure that the motor is rotating. In	Posit	ion	
	value is around 32 in the Position win-	F	Position	Velocitv
	dow.Velocity depends on	#1	10,608,759.57 mu	31.32 mu/msec
	Motor[1].JogSpeed (32 by default).	#2	0.00 mu	0.00 mu/msec
4	Type the kill command from the Termi- nal to stop the motor.	Term Motor #1 j+	inal: Online [192.168.0.200 : SSH] [1].PhaseFindingStep=1	

5	Open the global definitions.pmh under PMAC Script Language – Global Includes in the Solution Explorer.	Solution Explorer	₽ ·
6	Add the gain values obtained from tun- ing to the global definitions.pmh.	<pre>Motor[1].IiGain = *** Motor[1].IpfGain = *** Motor[1].IpbGain = *** Motor[1].Servo.Kp = *** Motor[1].Servo.Kvfb = *** Motor[1].Servo.Kaff = *** Motor[1].Servo.Kvff = ***</pre>	
7	Open the pp_startup.txt under Configuration in the Solution Explorer.	Solution Explorer	₽ × • •
8	Write the phase search implementation command shown on the right.	<pre>Motor[1].PhaseFindingStep = 1</pre>	

3-6 Motor Tuning

9	Select the project and execute Build
	and Download.
	• Refer to step 3 through 6 in 3-4 Vari-
	ous Controller Settings on page 3-8
	for the Build and Download method.
	• As shown in step 5 and 6, gains can
	be downloaded on PMAC as a pro-
	gram if you write gains in the global
	definitions.pmh.
	 As shown in step 7 and 8, the phase
	search is automatically performed af-
	ter the power is turned ON or reset to

ter the power is turned ON or reset to enable Motor[1] if you write the phase search implementation command in the pp_startup.txt.

CK3M/CK5M Series Startup Guide DirectPWM Interface (O047)

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