

Product(s): MP3200iec-RBT, MP3300iec-RBT, MotionWorks IEC

Doc. No. AN.MP3300iec.02

Application Overview

This application note provides an overview of steps and an example to tune the three arm motors for a custom delta robot. Before using this application note, it is assumed that the user has properly configured the delta robot in Hardware Configuration, homed the motors, and is able to move the robot in Machine Coordinate System (MCS) properly. The main goal of tuning the motors should be to minimize vibration (hardware vibrations, motor torque ripples) since it is typically the limiting factor in getting higher throughput.

The main strategy has the following steps to tune the three arm axes:

- Use SigmaWin+ to find the inertia ratio
- Use SigmaWin+ autotuning to find tuning gains as starting point.
- Manual tuning of gains after getting initial values from SigmaWin+
- Find a suitable torque feedforward using Torque Passthrough delta parameter.
- The theta axis is much easier, and can typically be tuned like a regular motor.

This is meant to be a general guide of possible steps, and the user may need to slightly deviate from it depending on the needs of their mechanism and application.

Products Used

Component	Product and Model Number
Servopack	Sigma5 or Sigma7
Motor	Sigma5 or Sigma7
Controller	MP3300iec-RBT, MP3200iec-RBT
Firmware	3.3 or higher
Delta Robot	Any simple delta robot with kinematics supported by Hardware Configuration



Product(s): MP3200iec-RBT, MP3300iec-RBT, MotionWorks IEC

Doc. No. AN.MP3300iec.02

Implementation

- When using SigmaWin+ for inertia finding or auto tuning, the motor controlled by SigmaWin+ will move as specified by the inputs to the SigmaWin+ routines. Ensure that the mechanism will have enough space to not crash.
- When doing manual tuning using a defined path, ensure that the application in MotionWorksIEC commands a path that the mechanism can follow without crashing.
- This tuning procedure assumes homing of each axis and is already done and delta mechanism is configured properly in Hardware Configuration in MotionWorksIEC.
- Yaskawa is not responsible for damange to mechanism or damage caused by mechanism during this procedure.

Before starting, make sure the robot motors are in a good position to avoid obstacles or collisions. The inertia ratio finding and auto tuning routine typically require less than two motor revolutions of movement. Typically, motor positions of 0 degrees is a good starting point. Open SigmaWin+, and connect to S L or U motor

□ Suggested Non-Tuning Parameters

The following is a list of parameters not related to tuning, that may help the robot run smoother.

- Pn109 Feed Forward Gain Setting to 100 may help for, especially with 1310 disabled
- Pn10A Feed Forward Filter Constant Setting to mechatrolink rate may help especially with 1310 disabled.
- Pn30C Torque feedforward average moving time Only available for Sigma7 servopacks. Set to Mechatrolink cycle.
- Pn426 Speed feedforward average moving time Only available for Sigma7 servopacks. Set to Mechatrolink cycle



Product(s): MP3200iec-RBT, MP3300iec-RBT, MotionWorks IEC

Doc. No. AN.MP3300iec.02

- Pn506 Brake reference servo OFF delay time When servo off is commanded, keep power on for some time until brake is engaged. Set to 150ms
- Pn600 Regenerative resistor capacity Set to external regenerative resistor if necessary
- **Pn812 Moving average time** Set to Mechatrolink cycle
- **1300 Moving average filter 1 enable** Sets a position moving average filter on axis command positions. Set to TRUE.
- 1301 Moving average filter 1 time constant Time constant of the position moving average filter. This effectively causes a time delay on all move commands, but will smooth out jerk and vibration. Set to 0.05.
- 1310 Velocity feedforward enable/disable Enable for Sigma7, disable for Sigma5
- 1311 Drive motion command option Accfil value Subinterpolation of position commands by drive. Set to 2.



Title: Custom Delta Robot Motor Tuning

Product(s): MP3200iec-RBT, MP3300iec-RBT, MotionWorks IEC Doc. No. AN.MP3300iec.02

□ Find Inertia Ratio

The inertia finding tool in SigmaWin+ can provide an estimate of inertia ratio for Pn103.

 It is sometimes helpful to increase Pn520 to a large value in order for the automatic calculations to complete. Go to the Edit Parameters window from the menu.



FIGURE 1 EDIT PARAMETERS MENU IN SIGMAWIN+

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Title: Custom Delta Robot Motor Tuning

Product(s): MP3200iec-RBT, MP3300iec-RBT, MotionWorks IEC

Doc. No. AN.MP3300iec.02

 Edit Pn520 to some large value. Default is 5242880 units, which should be fine for a SigmaV motor. For a Sigma7 motor, a larger value like 15000000 units may be necessary. Select the Write Edited Parameters From the SERVOPACK to save the new value.

Edit Parameters									
Category	SERVOPACK								
All constant number Function Selection(Pn0xx-) Gain(Pn1xx-) Position(Pn2xx-) Speed(Pn3xx-)	Edited Parameters Pa	All	Edited Parameters	All Parameters	Save to Flash Memory	V Im	port	Export	Si P
Torque(Pn4xx-)	Read from	Servo	V	Vrite to Servo			Fil	e	
Sequence(Pn5xx-) I/O Sign Mechatrolink(Pn8xx-)	No.	Name			Unit		000 🗲 /	01-SGDV-: Axis A	180.
Common Parameters(PnAxx-)	Pn515.1	Reserved	(Do not cha	ange.)	-		8 : Re	served (Do	
Display Settings	Pn515.2	DB Answe	er Signal Ma	pping 1(DBA	N -		8 : Sei	ts signal O	FF
Hierarchy: 0ff	Pn515.3	Reserved	(Do not cha	ange.)	-		8 : Re	served par	a
Descriptions: 0n	Pn517.0	Reserved	(Do not cha	ange.)	-		0 : Re	served (Do	,
	Pn517.1	Reserved	(Do not cha	ange.)	-		0 : Re	served (Do	
	Pn517.2	Reserved	(Do not cha	ange.)	-		0 : Re	served (Do	
	Pn517.3	Reserved	(Do not cha	ange.)	-		0 : Re	served (Do	,
	Pn51B	Excessive	Error Level	Between Ser	v reference	nu e		10	000
	Pn51E	Excessive	Position Er	ror Warning L	e %			1	100
	Pn520	Excessive	Position Er	ror Alarm Lev	e reference	nu e		52428	380
	Pn522	Positionin	ig Complete	d Width	reference	nu e		10	000

FIGURE 2 EDIT PN520



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• Go to the **Tuning** menu.

Menu					×
Connect Disconnect		0001-SGDV-180A21A002000		Display Method Standard	•
Axis A Rotary motor					•
Parameters	2	Setup	7	Test Run	7
Edit Parameters		Servopack Axis Name Setting	*	Jog	
Edit Online Parameters		Reset Absolute Encoder		Program JOG Operation	
Set Up Wizard		Multi-turn Limit Setup			
Parameter Converter		Adjust the Speed and Torque Reference Offset	-		
Alarm	2	Trace	7	Edit Table	7
E Display Alarm		Trace		Edit Program Table	
Alarm Trace		Real Time Trace		Edit Zone Table	
Reset Motor Type Alarm				Edit Jog Speed Table	
Monitor	2	Tuning	2	Solution	7
Read Product Information	<u>~</u>	Tuning		Mechanical Analysis	
	=	••		Ripple Compensation	
B Wiring Check					
Online Vibration Monitor	-				

FIGURE 3 TUNING MENU IN SIGMAWIN+



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Doc. No. AN.MP3300iec.02

• **Execute** the inertia ratio identification routine.

Tuning AXIS#0001A	X
Set the moment of inertia (mass) ratio before executing autotuning.	Precautions
Moment of inertia (mass) ratio identification	
Execute. 100 % Edit	
Reference input from host controller	
Position Reference Input	
C No Reference Input	}
Advanced adjustment	Finish

FIGURE 4 TUNING FUNCTION IN SIGMAWIN+



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Doc. No. AN.MP3300iec.02

 Edit the Condition Settings of the inertia ratio finding routine. Typically a low Acceleration and Speed has a higher chance of completion. A higher than default value (400) of Pn100 may also need to be used. Click Next to go to Reference Transmission.

Condition Setting AXIS#0001A	
Condition Reference → Operation / Setting → Transmission → Measuremer	nt "➡ Write Results
Please set the following conditions for Moment of Inertia Ider	tification.
Speed Loop Setting Pn100:Speed Loop Gain 800 [0.1Hz] Edit	Reference Selection
2000 [0.01ms]	Detailed Setting(limitation in operation)
Identification start level 300 [%]	Acceleration (5000.00 - 12477.74) [min-1/s]
	Speed (6.24 - 275.00) [min-1]
correctly under the following cases: 1. When the torque limit is active Please see the Setting Help in detail.	Moving distance
Execute the software reset function, or turn the power off and then on after completion of execution.	
	< <u>B</u> ack <u>N</u> ext > Cancel

FIGURE 5 SETTINGS FOR INERTIA RATIO ROUTINE



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• On Reference Transmission, click Start, then Next.

Reference Transmis	sion AXIS#0001A	_	
Condition Setting	Reference Transmission	→ Operation / Measurement	Write Results
Transferring I	Reference Conditions	to the Servopack.	Start Cancel
É		100%	
			< Back Next > Cancel

FIGURE 6 BEGIN INERTIA RATIO ROUTINE



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Doc. No. AN.MP3300iec.02

 In Operation/Measurement, click Servo On, then Forward, and Backward until inertia ratio is found, then click Next



FIGURE 7 OPERATION OF INERTIA ROUTINE



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• In Write Results, Select Write Results, then Finish.

Write Results AX	IS#0001A	x
Condition Setting		
Write	s the Identified Moment of Inertia Ratio.	
	Identified Moment of Inertia Ratio 180 [%] ► 103 : Moment of Inertia Ratio [%]	
	Writing Results	
	< Back Finish Cance	el

FIGURE 8 WRITE RESULTS OF INERTIA ROUTINE WHEN FINISHED

• Follow prompts to do a SERVOPACK soft reset.



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When clicking Forward or Backward, an error may be encountered. If this
error comes up, either increase the torque limit of the motor (Pn402/403) or
lower the Acceleration and Speed on the Condition Setting before repeating.



FIGURE 9 POSSIBLE ERROR MESSAGE DURING INERTIA ROUTINE



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Doc. No. AN.MP3300iec.02

□ Autotuning

After finding an inertia ratio, the autotuning function in SigmaWin+ provides a good starting point for motor gains and tuning parameters.

 To go the Tuning menu in SigmaWin+. Select No Reference Input then Autotuning button. Using a reference input is fine too, but it was not used in this example.

Tuning AXIS#0001A		×
Set the moment of inertia (mass) ratio before executing autotuning.	Precautio	ns
Moment of inertia (mass) ratio identification		
Pn103 : Moment of Inertia Ratio		
Execute.		
180 % Edit		
Autotuning Reference input from host controller O Position Reference Input Autotuning No Reference Input	┣→	
Advanced adjustment	Finis	h

FIGURE 10 TUNING FUNCTION FOR AUTOTUNING



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Doc. No. AN.MP3300iec.02

- In the Autotuning Settings Conditions window
 - Select 1: A moment of inertia ratio is not presumed for Switching the load moment of inertia (load mass) identification. This is because inertia was already found in a previous step.
 - Select 1: Standard for Mode Selection.
 - Select 1: Belt mechanism for Mechanism Selection.
 - Set a distance. 20000 was used in this example using a Sigma7 motor. Make sure the distance set will not crash the robot. In this example, there is much more free space than 1.2 rotations of motor.
 - Click Next when done

Autotuning - Setting Conditions AXIS#	0001A	×
Set conditions.		
Switching the load moment of intertia (load	mass) identification -	
1:A moment of inertia is not presumed.		•
- Mode selection		
1:Standard		-
The standard gain adjustment will be exe such as notch filter and anti-resonance of	cuted. In addition, au control can be execut	tomatic adjustments ted.
Mechanism selection		
1:Belt mechanism		•
Executes adjustment suitable for a relative belt mechanism.	vely low-rigidity mech	anism, such as a
Distance		
The moving range from the current value	is specified.	
20000 X 1000 =	2000000	[reference units]
(-99990 - 99990)		
(Setting invalid range : -8388 - 8388)	1.2	[Rotation]
Tuning parameters		
Start tuning using the default settings.		
	<u>N</u> ext >	Cancel

FIGURE 11 AUTOTUNING SETTINGS



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Doc. No. AN.MP3300iec.02

 In the Autotuning – Automatic settings window, click Servo ON, then Start tuning. Click Yes on warning for Please check safety near an operation part to begin autotuning.

Autotuning - Automatic set	ting AXIS#0001A	×
Waiting for execution Oscillation level measurement Gain search behaviour evaluation	Servo ON/OFF operation	OFF Servo ON LEVE Start tuning
Tuning completed	Mode selection 1:Standard Mechanism selectio 1:Belt mechanism Distance	n
ONotch filter OAnti-res Adj OVib Suppress	2000000	[reference units] [Rotation]
Precautions	< Back	Finish Cancel

FIGURE 12 AUTOTUING OPERATION



Title: Custom Delta Robot Motor Tuning

Product(s): MP3200iec-RBT, MP3300iec-RBT, MotionWorks IEC Doc. No. AN.MP3300iec.02



FIGURE 13 WARNING WHEN STARTING AUTOTUNING

 Autotuning may be aborted due to some possible causes, and there may be an alarm on the drive. Deal with and clear the alarm. It may be necessary to increase the value of Pn520 (Excessive Position Error Alarm Level), Pn522 (Position Completed Width), or Pn402/403 (Torque limits). In this example, Pn520 = 15000000 and Pn522 = 1000 was used for a Sigma7 motor. Pn520 = 5242880 and Pn522 = 70 be used for a Sigma5 motor. Other values may work as well.



FIGURE 14 POSSIBLE ERROR MESSAGE WHEN AUTOTUNING



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Doc. No. AN.MP3300iec.02

 Restart the autotuning routine with the same settings as before. Allow the tuning routine to complete. Click **Finish** to exit. The tuning parameters are now saved.

Autotuning - Automatic sett	ting AXIS#0001A
Waiting for execution	Servo ON/OFF operation Servo ON Servo OFF
Oscillation level measurement	
	Start tuning
Gain search behaviour evaluation	= Q
Tuning completed	Mode selection 1:Standard
	Mechanism selection
	1:Belt mechanism
	Distance
Notch filter	20000000 [reference units]
Vib Suppress	1.2 [Rotation]
Precautions	< Back Finish Cancel

FIGURE 15 AUTOTUNING ROUTINE FINISH SUCCESSFULLY

- Reset Pn520 and Pn522 back to something reasonable. For Sigma7 motors, Pn520=500000 and Pn522=100 can be used. For Sigma5 motors, Pn520=30000 and Pn522=7 can be used. Note that Pn520 may need to be increased later on if accelerations are high.
- Power cycle the controller and drives.



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Doc. No. AN.MP3300iec.02

 Copy the parameters of this arm motor into the other 2 arm motors. Can do it though SigmaWin+ or MotionWorksIEC.



Title: Custom Delta Robot Motor Tuning

Product(s): MP3200iec-RBT, MP3300iec-RBT, MotionWorks IEC

Doc. No. AN.MP3300iec.02

□ Manual Tuning

After finishing autotuning, some manual tuning may be required to get rid of excess vibration or torque ripples.

Create a program in MotionWorksIEC to run a cyclic sample path at a slow speed. It is recommended to have this path be similar to expected operation with some payload attached. This example ran a simple pick and place path through [200 200 950] -> [200 200 1050] -> 100ms Dwell -> [200 200 950] -> [-200 -200 950] -> [-200 -200 1050] -> 100ms Dwell -> [-200 -200 950] -> repeat. All the moves are blended, and with Velocity=1000mm/sec and Acceleration=10000mm/sec^2

			^
0001-SGDV-180A21A002000)	Display Method Standard	•
			Þ
Setup	7	Test Run	7
Servopack Axis Name Setting		log	
Reset Absolute Encoder		Program JOG Operation	
Multi-turn Limit Setup			
Adjust the Speed and Torque Reference Offset	-		
Trace	7	Edit Table	7
B <u>Trace</u>		Edit Program Table	
Real Time Trace		Edit Zone Table	
		Edit Jog Speed Table	
Tuning	2	Solution	2
Tuning		Mechanical Analysis	
		Ripple Compensation	
-			
r -			
	O001-SGDV-180A21A002000 Setup Setup Servopack Axis Name Setting Reset Absolute Encoder Multi-turn Limit Setup Adjust the Speed and Torque Reference Offset Trace Encoder Real Time Trace Tuning Tuning	OUDI-SGDV-180A21A002000 Setup Setup Setup Setup Setup Setup Setup Setup Multi-turn Limit Setup Adjust the Speed and Torque Reference Officet Trace Trace Real Time Trace Tuning Tuning	OUD1-SGDV-180A21A002000 Display Method Standard Image: Servopack Axis Name Setting Image: Servopack Axis Name Setting Reset Absolute Encoder Jog Multi-turn Limit Setup Jog Adjust the Speed and Torque Reference Offset Image: Edit Table Edit Table Edit Table Edit Table Edit Zone Table Edit Jog Speed Table Edit Jog Speed Table Image: Im

• Open **SigmaWin+** and connect to an arm motor. Go into the **Trace** menu.

FIGURE 16 TRACE FROM MAIN MENU



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Doc. No. AN.MP3300iec.02

 On the Trace window, click Setup, then configure settings to record Feedback Speed, Torque Reference, and Position Error. Set Sampling Time to something that will capture a cycle of the move, with Highprecision trace checked. Use a Trigger based on rising edge of Feedback Speed. Click OK to continue. On Trace window, Click Start to collect data.

3 8 6	19 M	<u></u>		D History	Ove	rlapping	Setup	
Trigger setting	Data VO	Measuren	nent Axis					
Trigger Conditio	ns	Т	rigger Target	Trigger Level	Trigger Type		→ Single	T
Pre-trigger		Trigger A				-	Start	
		ingger b				•		
								_
0								
5	⁵ T	5	I					
4-	4-	4-						
3-	3-	2-						
5	5	5						
2-	2-	2-						
1-	1 -	1-						
0	0							
0Ŧ	U T	0						
-1-	-1-	-1-						
-2-	-2-	-2-						
		_						
-3-	-3-	-3-						
-4-	-4-	-4-						
-5	-5-	-5						
-	-	-	0.000 50.000	100.000	150.000	200.000	250.000	
CH1	CH2	CH3		Time[ms]			
AUTO	AUTO	AUTO	4				•	
	-			1 O 1/02 O 1/0	3			

FIGURE 17 TRACE WINDOW

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Doc. No. AN.MP3300iec.02

Trace Setting		e Trapi	MEAN.	Tage Tag	X
		- Sampling Setting			
Auto Setting	Monitors positioning completion (Sampling Time	4000	• [us] x 500	= 2000.000 [ms]
Trace Object Set	tting	L			
		🔽 High-pi	recision trace (T	he time required to trace	will be reduced to a half.)
Analog Tr	race - vertical axis (Left)		 10		
Data 1	Feedback Speed 💌	[min-1]	VO 1	/S-ON	- -
Data 2	Torque Reference 🔽	[%]	VO 2	/P-CON	
Data 3	Position Error	[reference units]	10.3	Unsetting	_
Trigger setting					
Trigger Condi	tions Trigger A	Pre	-trigger	0 📩 [%]	
Trigger A —		Tr	igger B		
Trigger Targe	t Feedback Speed	Tr	igger Target	No Trigger	<u></u>
Trigger Type	T Rising Edge ▼	Tr	igger Type	Rising Edge	
Display option	S Settling time			Г	OK Cancel

FIGURE 18 TRACE SETTINGS



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Doc. No. AN.MP3300iec.02

X

mace []						_
<u>3</u>	8 0	<u>N</u> QQ		History	Overlapping	Setup
Trigger sett	ing Data	VO Measu	rement Axis			
Trigger Con	ditions	_	Trigger Target	Trigger Level	Trigger Type 🔺	→ Single
Trigger /	4	Trigger A	AXIS#0001A:Feedback	. 3[min-1]	🛧 Rising Edge 📃	Start
Pre-trigger		Trigger B				
0[%]		•			4	
\bigcirc						
-					·	
1000-	- 20	500000-		. .	.	
1000	20	300000				
800-	15	400000-				
			l An ∃ ⊟			
600		300000	ta an	A BARANA	•••••	
			$=$ $M = \pm$	N 🥂 Và	<u></u>	
400-	- 5	200000	፼ 1/ \\:····	A Martin Martin	M	
200-	0	100000-	S Lucian Ard	. /		
200	-	5	≝ / <u>(</u> A(1/3)/			
0-	Ë -5	- 8 0-	≣ in∦riv.	[$\sim Q \sim \Lambda$	<u></u>
	Dee	lieu	Ę /':\:\:\/		- i <u>N</u> i i	
-200	ທີ່ -10	-100000-	≗ } ⊸/…;…\\;; }	/ ::	····	
	pac	er E			E E E	hatter the
-400	8 -15	200000			E E L EM	NW /
-600-	LL 20	300000	• · · · · · · · · · · · · · · · · · · ·	· · · · · · · · · · · · · · · · · · ·		
-000	-20	-300000	E V			

• The plot may look something like this with some torque ripple.

FIGURE 19 FEEDBACK SPEED, TORQUE REFERENCE, POSITION ERROR WITH AUTOTUNE PARAMETERS

400.000

800.000

€ 1/01 € 1/02 € 1/03

Time[ms]

1200.000

1600.000

FULL

/S-0N

-800

-1000

AUTO

CH1

- 5

AUTO

-400000

СНЗ

- [/div]

AUTO

▼ 100000

0.000

.€

*

2000.000

[ms/div]

/P-CON

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Doc. No. AN.MP3300iec.02

Manually tune parameters in the Edit Parameters menu until satisfied with amount of torque ripple and position error. Typically, editing Pn100, Pn101, and Pn102 will be good enough. Keep in mind that the first priority is minimizing vibration, which may shows up as torque ripples. High speed video of the TCP would also be useful to ensure the payload is not vibrating during moves. For Sigma5 servopacks, controller parameter 1310 may need to be disabled. After tuning, the plots should show a smoother torque profile and TCP vibration should be minimized.



Title: Custom Delta Robot Motor Tuning

Product(s): MP3200iec-RBT, MP3300iec-RBT, MotionWorks IEC

Doc. No. AN.MP3300iec.02

23

🎦 Trace []

_	1	1.	1	- 1	_	1



FIGURE 20 FEEDBACK SPEED, TORQUE REFERENCE, POSITION ERROR AFTER MANUAL TUNING

Stop the move routine, save the parameters, and copy the parameters over to the other two arm axes.



Product(s): MP3200iec-RBT, MP3300iec-RBT, MotionWorks IEC

Doc. No. AN.MP3300iec.02

- Power cycle controller and servopacks.
- Run sample path again and check SigmaWin+ on all arm axes to make sure that the tuning is still satisfactory.
- If it is satisfactory, run the same sample path at higher speed. Check SigmaWin+ again. If tuning is not satisfactory at high speed, do manual tuning of parameters again while running at high speed. For pick and place applications, position error values that correspond to less than 0.5 degrees on the arm is typically good enough depending on accuracy required by application.
- Sample plot of an arm axis when running the sample path at high speed. 7000mm/sec velocity, 120000mm/sec^2 acceleration after manual tuning. In this data set, the max position error after converting to arm angle is about 0.45 degrees. (around 800000 units max position error, 24bit encoder for Sigma7 motor, 38.5 gear ratio)



Title: Custom Delta Robot Motor Tuning

-3.00E+06

-4.00E+06

-5.00E+0

• снз

AUTO

▼ 1.00E+06 ▼ [/div]

▼

CH2

AUTO

0.000

4

▲ **▼**

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IEC	RB1, MP3300iec-RB1, Mo	Do	c. No. AN.MP3300iec.02
Trace []			
E B B M	QQ 🖻 🖀	to History	Overlapping Setup
Trigger setting Data VO Trigger Conditions	Measurement Axis	Trigger Level Trigge	r Type ▲ Single ▼
Pre-trigger	Trigger A AXIS#0001A:Feedback Trigger B	3[min-1] 1 Ris	ing Edge Start
0			
5000 T 250 T	5.00E+06		
4000 - 200 -	4.00E+06-	: 	
3000 - 1 <mark>50</mark> -	3.00E+06-	1	
2000 - 100 -	2.00E+06		
		A	
-1000 - Speed Speed Sterence Sterence	-1.00E+06		

FIGURE 21 FEEDBACK SPEED, TORQUE REFERENCE, POSITION ERROR AT HIGH SPEED

200.000

400.000

● VO1 ○ VO2 ○ I/03

Time[ms]

600.000

800.000

FULL

/S-ON

1000.000

[ms/div]

/P-CON

F

-3000

-4000

-5000

AUTO

1000

 \mathbf{T}

▼ 50



Product(s): MP3200iec-RBT, MP3300iec-RBT, MotionWorks IEC

Doc. No. AN.MP3300iec.02

□ Additional Performance Improvements: Torque Passthrough

Torque Passthrough is a kinematic parameter that is used to estimate torque feedforward for the delta mechanism. It may help with lowering vibration and position error.

It is calculated as:

Torque(%Rated) = TorquePassthrough * MotorAcceleration (rad/sec^2).

The full expanded calculation to solve for Torque Passthrough is follows:

Passthrough = RotorInertia(kg - m^2) * InertiaRatio (* 100%) * GearRatio * PI/180 * 100/RatedTorque(N - m)

- Calculate an initial value of Torque Passthrough
- Enable Torque Passthrough in Hardware Configuration for the delta group used. In the Set Kinematics tab of Hardware Configuration, scroll down to the S L U Torque Passthrough parameters. Use the calculated value as a starting point. Click OK when done.







Product(s): MP3200iec-RBT, MP3300iec-RBT, MotionWorks IEC

Doc. No. AN.MP3300iec.02

- Save configuration and power cycle controller and SERVOPACKs.
- Run a sample path at a slow speed. The same path from manual tuning was used.
- Use the Trace function in SigmaWin+ to plot Torque FeedForward, Torque Reference, and Position Error. Check if Torque FeedForward and Torque Reference have a high discrepancy and if Position Error is getting better. In the sample plot, it is shown that the Torque FeedForward is much lower than Torque Reference, but the Position Error has decreased.



Title: Custom Delta Robot Motor Tuning

Product(s): MP3200iec-RBT, MP3300iec-RBT, MotionWorks IEC

Doc. No. AN.MP3300iec.02



FIGURE 23 LOW SPEED WITHOUT TORQUE PASSTHROUGH



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FIGURE 24 TORQUE PASSTHROUGH ENABLED WITH CALCULATED INITIAL VALUE

▲ ▼ 0 VO1 0 VO2 0 VO3

2

▼ 10

▼ 10000

▼ [/div]

[ms/div]

FULL



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- Since Torque Feedforward is much lower than Torque Reference, try increasing the Torque Passthrough parameter again in Hardware Configuration.
- After increasing Torque Passthrough parameter, there was decrease in Position Error. Torque FeedForward and Torque Reference will not match perfectly. It is typically better to have Torque FeedForward be lower in magnitude than Torque Reference.



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Time[ms]

/S-ON

FIGURE 25 INCREASED TORQUE PASSTHROUGH PARAMETER

AUTO

5

CH2

СНЗ

/P-CON



Product(s): MP3200iec-RBT, MP3300iec-RBT, MotionWorks IEC

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Run sample path at high speed, and plot **Torque FeedForward**, **Torque Reference**, and **Position Error**, then compare to the previous plot before **Torque Passthrough** was enabled. From the following plot, it shows that when **Torque Passthrough** was enabled, **Position Error** has dropped significantly, from a maximum of 800,000 (after manual tuning) units to 500,000 units.

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CH1 CH2	CH3	Time[ms]		
			/S-ON -	/P-CON
20 V 50 V	100000 V [/div]	• V01 C V02 C V03	EUL	▼ [ms/div]
			1.000	[mardia]

FIGURE 26 EFFECT OF TORQUE PASSTHROUGH AT HIGH SPEED



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 Plot Torque FeedForward, Torque Reference, and Position error of the other two arm axes to confirm that this is a good setting. Modify Torque Passthrough until satisfied.