

Tuningless Features for Kinetix 5500 and Kinetix 5700 Servo Drives

Kinetix 5500 and Kinetix 5700 Servo Drives

Торіс	Page
Summary of Changes	1
Additional Resources	2
Load Observer	2
Adaptive Tuning with the Tracking Notch Filter	5
Additional Considerations	7

Closed-loop servo systems require settings for the control loop gain and filter values to make sure that the load accurately follows the desired input-command signal. The process of adjusting and refining the gain and filter configuration is called tuning.

Appropriate tuning settings depend heavily upon the system characteristics. Each machine behaves differently due to variables such as compliance, backlash, changing inertias, manufacturing tolerances, and machine degradation, so the tuning configuration can vary greatly from one machine to the next.

With the tuning features of the Kinetix[®] 5500 and Kinetix 5700 servo drives, tuningless operation can now be achieved without compromising on performance. By using both the load observer and the tracking notch filter in Kinetix 5500 and Kinetix 5700 servo drives, most applications no longer require tuning procedures and tests during the commissioning process to achieve an effective level of machine performance.

Summary of Changes

This publication contains new and updated information as indicated in the following table.

Торіс	Page
Added information about the Load Observer with Velocity Estimate option.	4
Added note about selecting additional parameters.	6





Additional Resources

These documents contain additional information concerning related products from Rockwell Automation.

Resource	Description
Industrial Automation Wiring and Grounding Guidelines, publication <u>1770-4.1</u>	Provides general guidelines for installing a Rockwell Automation® industrial system.
Product Certifications website, <u>http://www.rockwellautomation.com/global/</u> certification/overview.page	Provides declarations of conformity, certificates, and other certification details.
Motion System Tuning Application Techniques, publication MOTION-AT005	Provides information and tips for motion system tuning.
Kinetix 5500 Servo Drives User Manual, publication 2198-UM001	Provides information on installing, configuring, starting, and troubleshooting your Kinetix 5500 servo drive system.
Kinetix 5700 Servo Drives User Manual, publication 2198-UM002	Provides information on installing, configuring, starting, and troubleshooting your Kinetix 5700 servo drive system.

You can view or download publications at <u>http://www.rockwellautomation.com/global/literature-library/</u> <u>overview.page</u>. To order paper copies of technical documentation, contact your local Allen-Bradley distributor or Rockwell Automation sales representative.

Load Observer

The load observer feature operates in real time while the machine is running. During machine operation, the load observer estimates the mechanical load inertia on the motor and compensates for it. The result is that the drive controls the motor as if it is unloaded, which provides a relatively high level of drive performance. In addition, the drive automatically compensates for mechanical variations in the system such as changing loads, compliance, and machine wear over time.

Configuration

The following steps describe how to configure an axis with the recommended load observer settings for most applications.

IMPORTANT	Use the load observer with the tracking notch filter to achieve effective tuningless operation.
IMPORTANT	To ensure stable operation, do not perform the autotune test when applying the load observer feature.
TIP	It is recommended that Position Loop control is used for velocity applications unless application requirements dictate Velocity

- 1. In the Controller Organizer, right-click an axis and choose Properties.
- 2. Select the Autotune category.

Loop control.

General	une Control Lo	op by Mea	suring Load Characteristic	3				
Motor Model Analyzer Motor Feedback Scaling Hookup Tests	Application Type: Loop Response: Load	Basic Medium Rigid	•	Perform Tune Start Tune Status: Loop Parameters Tune	itop			
Polarity	couping.			Name	Current	Tuned	Units	
Autotune	Customize (Gains to Tu	ine	PositionLoopBand	width		Hz	
- Load	Positio	n Integrator	Bandwidth	PositionIntegrator	Band		Hz	
Backlash	Vehor	v Internator	Randwidth	VelocityLoopBand	lwidth		Hz	-
Compliance		y mogrator	Dunumuun	E Advanced Compen	sation			
Friction	Velocit	y Feedforwa	rd	Load Parameters Tupe	d			
Observer	Accele	ration Feed	orward	Name	Current	Tuned	llože	
Position Loop	Torque	Low Page	Filter	Maximum A applace	Guirein	Tuned	De	
Velocity Loop	(E) ronque		incol	MaximumPeccelera	tion	_	Po	H
- Acceleration Loop	✓ Measure Ir	nertia using	Tune Profile	Systeminertia	loon	_	%	
Planner	(@) Motor	with Load		Annual Translation				
Homing	0			Accept Turied Va	iues 🔹			
Actions	Travel	0.0	 Position Units 					
Drive Parameters	Limit:		_					
Parameter List	Speed:	0.0	 Position Units/s 					
Status	Torque:	100.0	 % Rated 					
Faults & Alarms	Direction	(r. 11						
See Tag	Directori.	Forward	ni-directional V					

3. From the Application Type pull-down menu, choose Custom.

General	Fune Control Los	op by Mea	suring Load Characteristi	CS					
Motor Model Motor Feedback Scaling Hookup Tests	Application Type: Loop Response: Load Coupling:	Basic Custom Basic Tracking Point-to-Po Constant S	vint Speed	Tu	Start Status: op Parameters Tuni	Stop			
Autotupe	Customize G	Sains to Tu	ine	니는	Name	Current	Tuned	Units	1
- Load	Position	n Integrator	Bandwidth		PostionLoopBan	Read		Hz	1
Backlash	- Mala and		Denderstalle		Velocityl oopBan	dwidth		HZ	
Compliance	Velocit;	y integrator	Bandwidth	E	Advanced Comper	reation	_	114	
Friction	Velocity	y Feedforwa	ard		ad Parameters Tup	ad			
Observer	Accele	ration Feedf	onward	Ë	Au raianeters fun	Su Current	Turnet	11-2-	Ē.
Position Loop	Tarra	Law Dave I	Cher	니는	Name	Current	Tuned	Units	1
Velocity Loop		LUW Fdss I	riitei	. H	MaximumAcceler	ation	_	P0	14
Acceleration Loop	Measure In	ontia usino '	Tune Profile	- 1E	Sustembertia	auon		PU	١.,
Disease	includere a	iona dang	Turio Tronic		Systeminertia		-	/0	
Homing	(@) Motor v	with Load	•		Accept Tuned Va	alues 🗧 🗲			
Actions	Travel	0.0	Position Lipite						
Drive Parameters	Limit:	0.0	 Fosition Onits 						
Parameter List	Speed:	0.0	 Position Units/s 						
Status	Torque	100.0	 % Bated 						
Faults & Alarms	Disastian								
Tag	Direction:	Forward U	Ini-directional 👻						

4. Clear the Torque Low Pass Filter checkbox.

General	Tune Control Los	op by Mea	asuring Load Characteristic	3					
Motor Model Motor Analyzer Motor Feedback Scaling Hookup Tests	Application Type: Loop Response: Load Coupling:	Custom Medium Rigid	• •	Pe Tu Lo	erform Tune Start S me Status: op Parameters Tune	top			
Autobarty	Customize G	Sains to Tr	ine		Name	Current	Tuned	Units	Į,
- Load	Position	n Integrator	Bandwidth	- H	PositionLoopBand	width		Hz	ł
Backlash					Velocityl conRead	anu	_	R2	ł
Compliance	Velocity Integrator Bandwidth				VelocityLoopBallu	widin		n2	5
Friction	Velocity	y Feedforwa	ard	(H)	Advanced Compens	sation			
Observer	Accele	ration Feed	forward	Le Le	ad Parameters Tune	0		1	
Position Loop					Name	Current	Tuned	Units	Į,
Velocity Loop	I orque	e Low Pass	Hiter	- 1H	MaximumAccelera	tion		Po	ŀ
Acceleration Loop	D Manager In		Turne Durkle		MaximumDecelerat	tion	_	Po	U
Torque/Current Loop	Measure In	nertia using	Tune Profile		SystemInertia			%	ų
Planner	Motor v	with Load	•		Accept Tuned Val	ues 🔸			
Homing	Toront								
Actions	Limit:	0.0	 Position Units 						
	Speed:	0.0	 Position Units/s 						
Parameter List									
Parameter List	<u>_</u>	100.0	6 8 D 1 1						
	Torque:	100.0	 % Rated 						

5. Select the Load category and verify that the Load Ratio is zero; otherwise, set it to zero.

···· General	Characteristics of Motor Load			
- Motor	Load Inertia/Mass			
Analyzer	Load Coupling:	Rigid	•	
Motor Feedback	Use Load Ratio			
Hookup Tests	Load Ratio:	0.0	Load Inertia/Motor Inertia	
Polarity	Motor Inertia:	0.000011	Kg-m^2	
Autotune	Total Inertia	0.000011	Kam ² 2	
Backlash	r otar m/810a.	0.000011	ingini z	
Compliance Friction	Inertia/Mass Compensati	ion		
Observer	System Inertia:	0.014019278	% Rated/(Rev/s^2)	
Position Loop Velocity Loop	System Acceleration:	7133.035	Rev/s^2 @100 % Rated	
Torque/Current Loop	Active Load Compensatio	n		
Homing	Torque Offset:	0.0	% Rated	
Actions Drive Parameters Parameter List Status Faults & Alarms Tag				

6. Under the Load category, select Observer.

General	Load Observer					
- Motor	-	(
Model	Configuration:	Disabled		•	Parameters	
Analyzer	Bandwidth:	0.0	Hertz			
Motor Feedback	Interruter Danal middle	0.0				
Scaling	integrator bandwidint	0.0				
Hookup Tests						
Polarity						
Autotune						
🖶 - Load						
Backlash						
Compliance						
Friction						
Observer						
Position Loop						
Velocity Loop						
Acceleration Loop						
Torque/Current Loop						
Planner						
Homing						
Actions						
Drive Parameters						
Parameter List						
Status						
Faults & Alarms						
Tag						
-						

7. From the Configuration pull-down menu, choose 'Load Observer with Velocity Estimate' if the axis is configured for Position Loop control or 'Load Observer Only' if the axis is configured for Velocity Loop control. Load Observer is not available for Torque Loop control.

Categories:					
Central Motor Scaling Hookup Tests Polarty Adotune Load Load Load Load Comblance Friction Motion Comblance Friction Comblance Monitor Noticerver Position Loop Velocity Loop Acceleration Loop Planner Homing Actions Drive Parameters Parameter List Status	Load Observer Configuration: Bendwidth: Integrator Bendwidth:	Deabled Deabled Load Observer Only Load Observer Webcyt Estimate Velocity Estimate Only		Parametera	
Axis State:	Safety State:		ОК	Cancel Apply	Help

8. Click Apply.

Adaptive Tuning with the Tracking Notch Filter

The tracking notch filter operates in real time while the machine runs. During machine operation, the drive measures the mechanical resonances in the system and dynamically sets the notch filter frequency to mitigate the resonances.

Configuration

The following steps describe how to configure an axis with the recommended adaptive-tuning settings for most applications.

IMPORTANT The load observer and the tracking notch filter should be used in conjunction to achieve effective tuningless operation.

- 1. In the Controller Organizer, right-click an axis and then choose Properties.
- 2. Under the Load category, select Compliance.

🏷 Axis Properties - DA11							- • •
Categories:							
General	Compliance Compensation						
🖨 - Motor		0.0					
Model	Forque Low Pass Filter Bandwidth:	0.0		tertz			
Analyzer	Torque Notch Filter Frequency:	0.0	ŀ	lertz			
Motor Feedback	Torque Lag Filter Gain:	1.0					
Scaling							
Hookup Lests	Forque Lag Filter Bandwidth:	0.0		tertz			
Polarity							
Autotune	Adaptive Tuning						
Backlash	Adaptive Tuning Configuration:		Disabled				
Complance	Adaptive Failing Conligated in	Torque Notch Filter High Frequency Limit:					
Friction	l orque Notch hiter High Frequen			2000.0			
Observer	Torque Notch Filter Low Frequence	sy Limit:	296.33984		Hertz % Motor Bated		
Position Loop	Torque Notch Filter Tuning Threst	-bloc	5.0				
Velocity Loop	i orque riecerri ner rannig rinee						
Acceleration Loop							
Torque/Current Loop							
Planner							
Homing							
Actions							
Parameter List							
Status							
- Faults & Alarms							
Tag							
Axis State:	Safety State:						
Manual Tune				OK	Cance	Apply	Help

3. From the Adaptive Tuning Configuration pull-down menu, choose Tracking Notch.

ecories:				
General	Compliance Compensation			
detend detend detend detend detende detendee detende detende detende detende dete	Torque Low Pass Filter Bandwidh: Torque Notch Filter Frequency: Torque Lag Filter Gan: Torque Lag Filter Bandwidh: Adaptive Tuning Adaptive Tuning Configuration: Torque Notch Filter High Freque Torque Notch Filter Low Frequer Torque Notch Filter Tuning Thre	0.0 0.0 1.0 0.0 ncy Limit: ncy Limit: shold:	Hertz Hertz Hertz Tracking Notch V Dasided Gan Stabitzation Tracking Notch and Gan Stabilization 90 v	letz Ietz Motor Rated
· ·				
State:	Safety State:			

4. Select the Drive Parameters Category.

General Driv	ve Parameters to Controller Mapping	9					
Motor Model	Parameters to be read each cycle:	:		Pa	rameters to be written each cy	cle:	
Analyzer	Name	Value	*		Name	Value	-
Sonling	PositionFineCommand	0.0		E	PositionTrim	0.0	
Hookup Testa	PositionReference	0.0		18	VelocityTrim	0.0	
- Polarity	PositionError	0.0		12	TorqueTrim	0.0	
Autotupe	PositionIntegratorOutput	0.0		1	VelocityFeedforwardGain	100.0	
Land	PositionLoopOutput	0.0		12	AccelerationFeedforwardGain	0.0	
Racklash	VelocityFineCommand	0.0		1	PositionLoopBandwidth	0.92567945	
Complance	VelocityFeedforwardCommand	0.0			PositionIntegratorBandwidth	0.0	
Ediction	VelocityReference	0.0		18	VelocityLoopBandwidth	3.7027178	
Observer	VelocityFeedback	0.0		12	VelocityIntegratorBandwidth	0.0	
Position Loop	VelocityError	0.0		12	LoadObserverBandwidth	14.810871	
Velenity Lean	VelocityIntegratorOutput	0.0		12	LoadObserverIntegratorBandwi	0.0	
Acceleration Loop	VelocityLoopOutput	0.0		12	TorqueLimitPositive	0.0	
Terrue (Current Lean	AccelerationFineCommand	0.0		1	TorqueLimitNegative	0.0	
Planner	AccelerationFeedforwardComm	0.0			VelocityLowPassFilterBandwidth	0.0	
Homing	AccelerationReference	0.0		18	TorqueLowPassFilterBandwidth	0.0	
Actions	AccelerationFeedback	0.0			SystemInertia	0.0	
Drive Parameters	LoadObserverAccelerationEstim	0.0		12	CurrentDisturbance	0.0	
Parameter List	LoadObserverTorqueEstimate	0.0					
Statue	TorqueReference	0.0					
En do 2 Alarma	TorqueReferenceFiltered	0.0					
Tag	TorqueReferenceLimited	0.0	Ŧ				*

- 5. Scroll down and check TorqueNotchFilterFrequencyEstimate and TorqueNotchFilterMagnitudeEstimate.
 - TIP Selecting these parameters is optional. They are available to assist with commissioning and provide diagnostic information.

General	Drive P	arameters to Controller Mapping						
- Motor Model	Parameters to be read each cycle:				Parameters to be written each cycle:			
Analyzer		Name	Value	*		Name	Value	^
Casting		AccelerationReference			100	PositionTrim	0.0	
Healum Tests		AccelerationFeedback			100	VelocityTrim	0.0	
Polosity		LoadObserverAccelerationEstimate			100	TorqueTrim	0.0	
Autotupo		LoadObserverTorqueEstimate			100	VelocityFeedforwardGain	100.0	
Lord		TorqueReference				AccelerationFeedforwardGain	0.0	
Packlash		TorqueReferenceFiltered				PositionLoopBandwidth	0.92567945	
Caracteria		TorqueReferenceLimited			100	PositionIntegratorBandwidth	0.0	
Ediation	V	TorqueNotchFilterFrequencyEstimate			100	VelocityLoopBandwidth	3.7027178	
Observer		TorqueNotchFilterMagnitudeEstimate			101	VelocityIntegratorBandwidth	0.0	
Position Loop		TorqueLowPassFilterBandwidthEstimate			1	LoadObserverBandwidth	14.810871	
Velectr Loop		AdaptiveTuningGainScalingFactor				LoadObserverIntegratorBandwi	0.0	
Acceleration Loop		CurrentCommand			1	TorqueLimtPositive	0.0	
Termus (Current Lann	1	CurrentReference			100	TorqueLimitNegative	0.0	
Planner	10	CurrentFeedback			10	VelocityLowPassFilterBandwidth	0.0	
Haming	1	CurrentError			101	TorqueLowPassFilterBandwidth	0.0	
Actions		FluxCurrentReference			1	SystemInertia	0.0	
Data December		FluxCurrentFeedback				CurrentDisturbance	0.0	
Drive Farenieters		FluxCurrentError						
Clature		OperativeCurrentLimit						
Ende & Alama		CurrentLimitSource		-				
The	4	III						*
Tag	,				'			

6. Click Apply.

Additional Considerations

For more detailed technical information on the operation of the load observer or adaptive tuning features, see Chapter 1 of Motion System Tuning Application Techniques, publication <u>MOTION-AT005</u>.

Notch Filter Initialization

See Knowledgebase article number 1071465 for details on how to retain the notch filter settings when power is removed and reapplied to the system.

Increased Performance

Manual tuning may be used if higher performance is required after applying the default load observer gain values. It is recommended that you incrementally increase the bandwidth values while maintaining the following relationships:

For Position Loop Control

• Load Observer Bandwidth = 4 x Velocity Bandwidth = 16 x Position Bandwidth

For Velocity Loop Control

• Load Observer Bandwidth = Velocity Bandwidth

The bandwidth values can be increased until the desired system performance is achieved.

To reduce following error, it is recommended that Integrator Bandwidth be applied according to the following relationship:

For Position Loop Control

• Position Integrator Bandwidth = Position Bandwidth/100

For Velocity Loop Control

• Velocity Integrator Bandwidth = Velocity Bandwidth/10

The integrator bandwidth value can be adjusted until the desired system performance is achieved. It is not recommended to use the position and velocity integrators simultaneously.

TIP It is recommended that Position Loop control is used for velocity applications unless application requirements dictate Velocity Loop control.

For more detailed technical information on manual tuning, see chapter 4 of Motion System Tuning Application Techniques, publication <u>MOTION-AT005</u>.

Maximum Acceleration and Deceleration

When using the Load Observer feature, it is recommended that the load ratio is set to zero. For applications that utilize 'percent of maximum' for the motion units, the Maximum Acceleration and Maximum Deceleration values for the application should be decreased (as appropriate for the load) to stay within drive limits during operation. The Maximum Acceleration and Deceleration attribute values can be found in the Planner category of the Axis Properties dialog box.

egories:					
- General	Characteristics of Motion Plan	ner			
Motor Model Analyzer	Maximum Speed:	113.333336	rev/s	Parameters	
Motor Feedback Scaling Hookup Tests	Maximum Deceleration:	17446.563	rev/s^2		
Polarity Autotupe	Maximum Acceleration Jerk:	2685728.3	rev/s^3	= 100% of Max Accel Time	Calculate
Load Backlash Compliance Fiction Observer Postion Loop Acceleration Loop Torque/Current Loop Homing Actions Drive Parameters Parameter List Status Faults & Alams Tag	Maximum Deceleration Jerk:	2685728.3	rev/s^3	= 100% of Max Decel Time	Calculate
s State:	Safety State:				

Vertical Load Considerations

Gain stabilization is not recommended for applications that use a vertical load, as detuning may cause load drops. For more detailed information on techniques for managing vertical loads, see the Vertical Load and Holding Brake Management Application Technique, publication <u>MOTION-AT003</u>.

Notes:

Rockwell Automation Support

Use the following resources to access support information.

Technical Support Center	Knowledgebase Articles, How-to Videos, FAQs, Chat, User Forums, and Product Notification Updates.	www.rockwellautomation.com/knowledgebase
Local Technical Support Phone Numbers	Locate the phone number for your country.	www.rockwellautomation.com/global/support/get-support- now.page
Direct Dial Codes	Find the Direct Dial Code for your product. Use the code to route your call directly to a technical support engineer.	www.rockwellautomation.com/global/support/direct- dial.page
Literature Library	Installation Instructions, Manuals, Brochures, and Technical Data.	www.rockwellautomation.com/literature
Product Compatibility and Download Center (PCDC)	Get help determining how products interact, check features and capabilities, and find associated firmware.	www.rockwellautomation.com/global/support/pcdc.page

Documentation Feedback

Your comments will help us serve your documentation needs better. If you have any suggestions on how to improve this document, complete the How Are We Doing? form at <u>http://literature.rockwellautomation.com/idc/groups/literature/documents/du/ra-du002_-en-e.pdf</u>.

Rockwell Automation maintains current product environmental information on its website at http://www.rockwellautomation.com/rockwellautomation/about-us/sustainability-ethics/product-environmental-compliance.page.

Allen-Bradley, Kinetix, LISTEN. THINK. SOLVE., Rockwell Automation, and Rockwell Software are trademarks of Rockwell Automation, Inc. Trademarks not belonging to Rockwell Automation are property of their respective companies.

Rockwell Otomasyon Ticaret A.Ş., Kar Plaza İş Merkezi E Blok Kat:6 34752 İçerenköy, İstanbul, Tel: +90 (216) 5698400

www.rockwellautomation.com

Power, Control and Information Solutions Headquarters

Americas: Rockwell Automation, 1201 South Second Street, Milwaukee, WI 53204-2496 USA, Tel: (1) 414.382.2000, Fax: (1) 414.382.4444 Europe/Middle East/Africa: Rockwell Automation NV, Pegasus Park, De Kleetlaan 12a, 1831 Diegem, Belgium, Tel: (32) 2 663 0600, Fax: (32) 2 663 0640 Asia Pacific: Rockwell Automation, Level 14, Core F, Cyberport 3, 100 Cyberport Road, Hong Kong, Tel: (852) 2887 4788, Fax: (852) 2508 1846

Publication MOTION-QS001C-EN-P - November 2018

Supersedes Publication MOTION-QS001B-EN-P - February 2018