

GDtool 2.0 position mode tuning tutorial

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Table of Contents

Introduction	. 2
Connecting to drive	. 3
Configuring motor settings	. 4
Testing motor settings (AC and BLDC only)	. 5
Configuring torgue control mode	. 6
Tuning torgue mode	. 7
Configuring trajectory planner settings	11
Tuning position control mode	12
Advanced position tuning: feedforwards	16
Advanced position tuning: anti-dither	17
Advanced motor settings	18
Testing position mode by using GDtool 2.0 shell	19
Troubleshooting	20



Introduction

This tutorial introduces to you how to tune position mode settings with GDtool v**2.0** tuning software. Requirements:

- A Granite Devices servo drive
- USB data cable or parallel cable with breakout board
- GDtool version 2.0.0 software installed
- Microsoft Windows NT4/2000/XP or Vista





Connecting to drive

- 1. Choose connection page
- 2. Select connection type to USB or parallel. If using parallel port, set pins to match you cable.
- 3. Press Connect button
- 4. If you get a dialog about old firmware version, jump to chapter Upgrading firmware
- 5. To load saved configuration from drive, choose **Device->Import settings**

GDtool Eile Device View Help		
	Connection settings	
Motor settings	USB Parallel port	
General settings	Parallel port settings	
Torque tuning	Data in pin 10 V	
Position tuning	Clock pin 1	
Velocity tuning	Enable pin 1 V	
391 Trajectory planner		
Homing controller		
Device status		
Event log		
Firmware flasher		
		3
Not connected		Connect

Connection status should change to Connected state





Configuring motor settings

- 1. Choose motor settings page
- Set proper values, check you motor specification from motor data sheet or contact motor supplier if unsure. Read **Advanced motor settings section** if unsure about purpose of parameters or read a **tool tip** by holding mouse over option for a while
- 3. After peak/cont current levels are set, set **Current fault limit** to 1000 to 2000 mA higher than peak current

Note: there is 50% change that encoder counting direction doesn't match to motor polarity at the first wiring. So if you are getting weird behavior or total instability, try setting **Invert encoder direction** check box. It is **absolutely necessary** to set encoder direction correctly to get proper servo operation.

4. Press Set values button

🖓 GDtool				
<u>Fi</u> le Device V <u>i</u> ew Help				
	Motor configuration Test motor config			
	Motor type	AC	•	
Motor setting	Motor pole count	4	💌 Qty	
<u>R</u>	AC phasing current		1000 🚔 mA	
General settings	Maximum peak current		2000 🚖 mA 🧑	
	Maximum continuous current		1500 🚖 mA 📿	
Torque tuning	Current fault limit		3000 🚖 mA 🔦	
Decition human	Encoder resolution		8000 🖨 CPR	
	Invert encoder direction			
Velocity tuning	Disable high frequency deadtime correction			
	Disable low frequency deadtime correction			
391 Trajectory planner				
Homing controller				
Device status				
Event log				
Firmware flasher				
Connected				Se 4
				_

- 5. Save active settings to drive
- 6. Reset drive to activate new motor settings
- 7. Connect or power up HV power supply now





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Testing motor settings (AC and BLDC only)

Note: if you are using other than AC/BLDC motor, you please skip this chapter

- 1. Choose motor settings page
- 2. Choose test motor config tab
- 3. Press test
- 4. Check that results matches to you configuration or check configuration and wiring if problems are found

🖓 GDtool	
<u>Fi</u> le Device V <u>i</u> ew Help	
	Motor configuration Test motor config
Motor settir	Description:
General settings	If youselected 4 pole motor, the correct CPR value should be near 8000 and for 2 pole motor near 4000. However, use exactly correct CPR and not these measured values which probably have some inaccuracy.
Torque tuning	It appears that stored setting in drive could be correct. However, if you have any troubles of locking rotor, check that you have exact CPR value and there is
Position tuning	no interference in encoder lines.
Velocity tuning	
391 Trajectory planner	
Homing controller	
Device status	
Event log	
Firmware flasher	
	Test 3
Connected	Set



Configuring torque control mode

Torque mode **must** be tuned before proceeding to position mode tuning since all other modes utilize torque control in cascade with other modes

- 1. Choose General settings page
- 2. Select torque mode
- 3. You can set your preferred pulse input mode now, or after configuration
- 4. Press Set values button

GDtool	
<u>Fi</u> le Device V <u>i</u> ew Help	
	General settings Motor control mode
Motor settings	Position mode Velocity mode
General settin	Torque mode
Torque tuning	Step/Dir 3
Position tuning	Limits
Velocity tuning	Motion fault limit 0
391 Trajectory planner	
Homing controller	
Device status	
Event log	
Firmware flasher	
Connected	Set 4



Tuning torque mode

- 1. Choose torque tuning page
- 2. Adjust P and I gains (note: it's recommended use default gains for the first run)
- 3. Press Set values button

🏹 GDtool Eile Device View Help			
Ele Device View Help Image: Connection Image: Connection Image: Connection Image: Conne	Torque control tuning Step respon Torque mode settings Torque P gain 1000 2 Torque I gain 50 🐑	50	
Connected			Run step response Set



- 4. Click Step response tab
- 5. Choose capture signals you wish to plot or use defaults
- 6. Set step response amplitude value about from 50% to 100% of motor continuous current value (> 500 mA)
- 7. Press Run step response button

GDtool				
<u>Fi</u> le Device V <u>i</u> ew Help				
	Torque control tuning Step resp 4			
Motor settings	Feedback capture signals	Capture settings Buffer length	samples	
General settings	 Feedback value Following error value 	Sample rate 1 Step response amplitude 6	7500 F Hz	
Torque tuning	 Raw position counter value Raw velocity value 			
Position tuning	P controller output I controller output			
Velocity tuning	D controller output			
391 Trajectory planner	Torque control capture signals			
	 Achieved torque value Output voltage amplitude 			
Device status	HV bus voltage			
Event log				
Firmware flasher				
Connected	L		Run step r 7 e	Set



- 8. Captures window should appear after a short while
- 9. Example image 1. Too low gain values. (current not reaching target)
- 10. Example image 2. Too high gain values (oscillation)







- 11. Check signals you have plotted and **adjust PI gains** (jump back to section 2). First increase Pgain to get good (non peaking) response and I-gain after that. **Remember** to press Set values button after each time you change values
- 12. Change PI-gain values and test response until you get good output (see picture below)





Configuring trajectory planner settings

- 1. Choose trajectory planner page
- 2. Set **input scaling ratio** by adjusting **Multiplier**, **Divider** and **Input filter length**. Total input scaling ratio (in the *info* box) displays the real multiplier from drive input to output. **Note:** It is recommended to use **Divider** of at least **50**.
- 3. Set **acceleration** and **velocity limit** values depending your need to limit the motor shaft speed (see *info* box for values in real world units).
- 4. Press Set values button

GDtool File Device View Help				
Connection Connection Motor settings General settings	Trajectory planner settings Limits Acceleration limit Velocity limit Homing acceleration limit Homing acceleration limit		Input scaling Multiplier Divider Input filter length	50 2 50 1
Torque tuning	Error recovery velocity limit	: 200		
Position tuning	Absolute position high limit Absolute position low limit			
Velocity tuning	1			
391 Trajectory planner	Total input scaling ratio Effective velocity limit		50 : 50 (1.0000) 1875.0 rpm	Info
Homing controller	Effective acceleration limit Acceleration time to full spe	ed	156.2 rps² 0.2000 s	Ŭ
Device status				
Event log				
Firmware flasher				
Connected				Set 4



Tuning position control mode

- 1. Select General settings page
- 2. Select position mode
- 3. Press Set values button

GDtool	
File Device View Help	
	General settings
Motor settings	Motor control mode Position mode Velocity mode
General settings	Torque mode
Torque tuning	Drive pulse input mode Step/Dir
Position tuning	PWM offset 0
Velocity tuning	Motion fault limit 0
Trajectory planner	
Homing controller	
Device status	
Event log	
Firmware flasher	
	3
Connected	Set



- 4. Choose position tuning page
- 5. Start by setting **P to 100** and **I to 1** or other very **low** value
- 6. Start with quite high **D gain** value (>500)
- 7. Press Set values button
- 8. Press **Run step response** button

🖗 GDtool							
<u>Fi</u> le Devi	ice V <u>i</u> ew Help						
昂	Connection		Position mode tuning	Anti-dither Step re	sponse		
C	Motor settings		Position P gain	1	(5)		
55	General settings		Position I gain Position D gain	1	6		
	Torque tuning		Velocity feedforward Acceleration feedforward	0 🗘			
	Position tuning	(4)	Follow error fault trip limi	it 500 🚔	Encoder counts		
	Velocity tuning						
391	Trajectory planner						
	Homing controller						
	Device status						
	Event log						
\$	Firmware flasher						
~~	Connected					Run step respons	8 7 Set 7

- 9. **Increase D gain** until you start getting little bit unstable response. **Too high D** causes high frequency oscillation that may be easily heard (see picture). **Remember** to press Set values button after each time you change values
- 10. **Decrease D** gain until you start getting smooth response again.
- 11. Start **increasing P gain** and stop when oscillation or overshoot starts appearing.
- 12. **Reduce P** to get nice response.
- 13. Start **adjusting I** just like you did with D and P

By result of this procedure, you should have nicely behaving and stiff servo operation. If you are getting noisy motor dithering (position hunting) or other undesirable effects, you may reduce all values in PID to get smoother operation.

After configuration is complete, save active settings to drive using Device menu.





____**__** 🖗 Captures File Tip 12 💾 🏳 💽 #7 #8 #9 #10 #11 #12 #13 #14 #15 #16 #17 #18 #19 #20 #21 #22 #23 #24 · × VSD-A step response 550 [Steps] / [mA] / [10mV] 300 0.06 Time [ms] 0.02 0.04 0.08 0.1 — Feedback 🛛 — Target

Tip: you may use Zoom tool to check more accurately some parts of response plot



Advanced position tuning: feedforwards

By using **feedforward** (FF) controls, you can further improve servo performance and reduce following error. It is recommended to return in this chapter after you have everything running nicely and tested to work as expected.

Feedforwards are used to compensate system mass or inertia (acceleration FF) and friction (velocty FF) before they start forming any following error that PID compensates.

1. Enable **Feedforward torque** output and **Torque command** scope signals from step response page

GDtool			
<u>Fi</u> le Device V <u>i</u> ew Help			
	Position mode tuning Anti-dither	Step response	
Motor settings	Feedback capture signals	Capture settings Buffer length 1000	samples
General settings	 Feedback value Following error value 	Sample rate 2500 Step response amplitude 500	 ▼ H2 ♥ units
Torque tuning	Raw position counter value Raw velocity value		
Position tuning	P controller output I controller output		
Velocity tuning	D controller D controller D controller D controller D controller		
391 Trajectory planner	Torque control capture signals		
Homing controller	Achieved torque value		
Device status	HV bus voltage		
Event log			
Firmware flasher			
Connected			Run step response Set



2. **Adjust acceleration feedforward gain** (in Position mode tuning page) until you get a plot where torque command (black) is roughly at same level with feedforward output (orange). In the example picture, orange line is crossing the torque output value which represents a correctly configured acceleration FF.



In most cases, acceleration FF has the most significant effect on FF performance. In systems, where significant amount of friction is present, then adjusting also **velocity FF** is recommended. For velocity FF, follow the previous rules (try to adjust it so that FF and torque plots match as well as possible).

After configuration is complete, **save active settings** to drive using the **Device** menu.



Advanced position tuning: anti-dither

Anti-dither settings allow you set different PID-loop parameters when the encoder value reaches target region. Anti-dither PID gains can be tuned as percent values of position loop PID value. Anti-dither region sets the region where anti-dither gains are active. Anti-dither filter strength sets the D-gain low-pass filter strength. Anti-dither PID-loop effective values are shown in info box.

🖓 GDtool File Device View Help	
	Position mode tuning Anti-dither Step response
Motor settings	P gain percentage 20 👻 %
General settings	I gain percentage 20 👻 % D gain percentage 20 👻 %
Torque tuning	Anti-dither region 2 +/- encoder counts Anti-dither filter strength 3
Position tuning	Anti-dither P gain value 200 Anti-dither I gain value 40
Velocity tuning	Anti-dither D gain value 600
391 Trajectory planner	
Homing controller	
Device status	
Event log	
Firmware flasher	
Connected	Run step response Set



Advanced motor settings

Here are available motor setting options explained in same order they exists on motor configuration page

Motor type

Choose motor type. 3 phase brushless motor (AC) or direct current (DC) motor.

Motor pole count (AC only)

This is the number of magnetic poles in AC servo rotor.

AC phasing current (AC only)

This is the current that is driven to AC servo windings at power-up to align rotor. This has

no effect in DC servo mode.

Max peak current

Maximum peak current output value [mA]. This is DC or peak of sine wave value.

Max continuous current

Maximum continuous current value [mA]. This is DC or peak of sine wave value.

Current fault limit

Sets drive fault current limit. If limit is exceeded drive goes to fault state. Should be 1000 to 2000 mA grater than peak current.

Encoder resolution (counts per revolution)

Sets encoder resolution value to match your motors encoder. This is number of encoder counts in with 4X decoding, so CPR equals 4 times the encoder line or pulse count.

Invert encoder direction

Inverts encoder counting direction.Use encoder inversion if you are getting follow errors without any stability

Disable high frequency deadtime correction

This disables power stage deadtime distortion compensation at high output frequencies.

May reduce motor heating with some motors. If unsure, leave this unchecked.

Disable low frequency deadtime correction

This disables power stage deadtime distortion compensation at low output frequencies.

Note: checking this may reduce motor position mode stiffness. If unsure, leave this unchecked.



Testing position mode by using GDtool 2.0 shell

- 1. Choose event log page
- 2. Clear log window by using menu View->Log->Clear
- 3. Execute **list** command by pressing **Execute in shell** button. All available commands should be listed into log window.

GDtool File Device View	2			
	Running Comman	LIST ds:		
Motor settin	Igs OPEN SET GET			
General sett	ings CLEARFA CAPTURE STATUS SAVE	ULTS		
Torque tunin	ng RESET MOVEAB MOVEING	5		
Position tuni	Ing PLOT READPAR MOVEHO WRITEPA	RAMS ME IRAMS		
Velocity tuni	ng FLASHFII SLEEP	FOR RMWARE		
391 Trajectory p	lanner LIST >			
Homing cont	roller			
Device statu	JS			
Event log				
Firmware fla	sher			
		1	 	3
right Conne	ected	4		Execute in shell

- 4. Remove list command and type **moveabs 1000** and press Execute in shell button. Motor shaft should turn 1000 encoder counts after button click. If you want to make incremental movement type **moveinc yy** to move incrementally yy encoder counts. Negative values changes the movement direction.
- 5. You should **not** need to use other commands available in log window



Upgrading firmware

Start drive with CLR jumper set (Described in VSD-A data sheet)

- 1. Connect to drive (Described in chapter *Connecting to drive*).
- 2. Select Firmware flasher page
- 3. Select firmware file. Latest firmware can be found from homepage (<u>www.granitedevices.fi</u>)
- 4. Press upload upgrade button to start firmware upgrade

GDtool		
<u>File Device</u> 1 v Help		
	Firmware flasher	
Motor settings		
General settings		
Torque tuning		
Position tuning	Filename:	3
Velocity tuning		Орен пол
Trajectory planner		
Device status		
Event log		
Firmware flasher 2		
Connected	Bootloader mode. Ready to flash	Upload upgrade

Tip: Information on bottom page informs that drive is in bootloader mode



Wait until flashing is finished. Do **NOT** remove power from drive while upgrading or the won't be operating normally.

🚯 GDtool		
File Device View Help		
	Firmware flasher	
Motor settings		
General settings		
Torque tuning		
Position tuning	Filename: C:/Documents and Settings/Default/Desktop/vsda_113.1.gdf	
Velocity tuning	Flasher	Open file
Trajectory planner		
Homing controller	Flach writing in progress	
Device status	17%	
Event log		
Firmware flasher		
Connected	Bootloader mode. Ready to flash	Upload upgrade

After flashing finished press close button, switch power off and remove jumper.

Note that after flashing all drive parameters are reset to firmware defaults. You can save and load settings using file menu.





Troubleshooting

When drive red led start to blink you can check the error reason from device status page.

In this case it is follow error which occurs when encoder value differs too much from target value. **Follow** error limit value needs to be increased or **PID gains** adjusted in **Position tuning page**. This is also typical if **encoder inversion** is incorrectly set in **Motor settings** page.

GDtool						
Elle Device Vijew Help						
	-Drive status					
	Status register	Fault register				
Motor settings	Power On	Invalid command				
General settings	Target reached	Follow error				
•	Follow error recovery	Overcurrent				
Torque tuning	Run	Communication fault				
Position tuning	Enabled	Encoder fault				
Valocity tuning	E Fault stop	Over heat				
torocicy curring	Busy					
Trajectory planner	= Extended in the	Under voltage				
391	Excended input	Over voltage				
Homing controller	Writing flash					
	Rotor aligned	Firmware				
Device status		Hardware				
	Extended event					
Event log	Homing	Memory				
Firmware flasher	Initialized	Initialization				
.4.4.	Voltages good	Motion				
	Permanent stop	Range				
Connected						

To recover from error state to normal state use Clear drive faults or Reset drive from device menu



Questions, troubles? Please, feel free to contact support@granitedevices.fi