

TB234 (Rev4) - CNC11 Velocity Mode Drive Tuning

This document is a quick-start visual walk-through of tuning Velocity Mode drives in CNC11 3.03 rev61 and above.

Tuning is done in the PID Config. menu. This menu is located, from the main screen, at **F1-Setup, F3-Config., F4-PID, F1-PID Config.**

Kv1 is fine tuned first, followed by Kp and lastly Ki. In some cases Kd is required as well. This is typical on, for example, very old Fanuc Velocity Control Units. To begin tuning the drives, enter the recommended PID values of Kp = 0.04*, Ki = 0.0005*, Kd = 0*, Limit = 2560000, Kg = 0, Kv1 = 80**, Ka = 0.

*These numbers reflect 10mm-12mm pitch ballscrew and 160000 counts/rev of the motor. To figure out an appropriate Kp and Ki value divide 160000 by your counts/rev of the motor and multiply by Kp and Ki values above to get ballpark values.

**This value assumes that the Max Rate that you want to use is 80%-90% of the 3rd party drive setting for Max. Rate. Otherwise use the ratio of CNC11 Max Rate to 3rd party drive Max. Rate.

If there is a Tech. Bulletin that describes the setup and wiring for the specific drive you are using, refer to it for more accurate PID values. In velocity mode Kp and Ki are for maintaining positional accuracy during and after motor movement, while Kv1 is for Feed-Forward command to the drive and controls most of the movement. The goal of tuning is to find the settings that produce the least error when the motor is moving or holding.

The following Tech. Bulletins already exist, with more on the way.

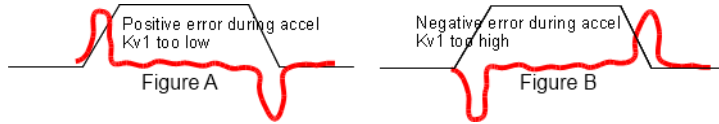
Drive	Tech. Bulletin Number
Delta AB and A2	231
Glentek Alpha	232
Sanyo Denki (forthcoming)	239
Maxsine EP100 (forthcoming)	240
Fanuc Black and Yellow-cap	233

Please note that all machine setup should already be done, specifically limit switches and E-Stop wiring and configuration, before tuning the drives. You should tune the motors un-coupled to the machine, then couple them and fine-tune the settings if required.

Kv1 Tuning:

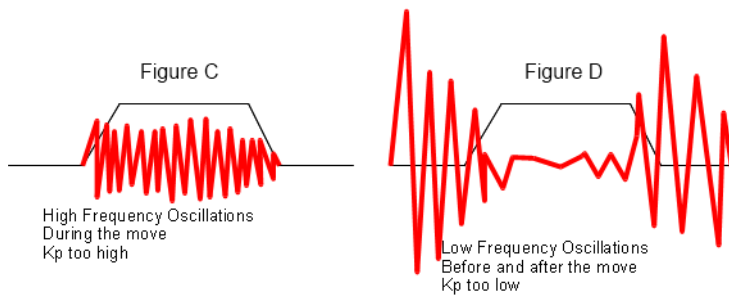
Kv1 is tuned first because it is the main controlling parameter in Velocity Mode. The goal is to get the error at the start and stop of the move as close to zero as possible. Start tuning and compare to Figures A and

B below and Figures 1-5 following the PID Setup Menu. For plots that look like Figure A, increase Kv1 until the error at the start of the move is as close to zero as possible without going across zero to the negative. For plots that look like Figure B decrease Kv1 until the error goes positive then bring it back so it is as close to zero as possible.



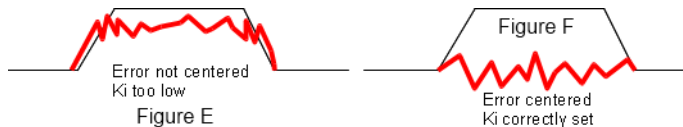
Kp Tuning:

Once Kv1 is tuned, start adjusting Kp. Compare plots to Figures C, D, and 6-10. Increase Kp until oscillations start to look like Figure C. Note this value then decrease Kp until oscillations start to look like Figure D. Note this value. Find the average of the two values by adding them together and dividing by 2, then type that value in for Kp.



Ki Tuning:

Now that Kv1 and Kp are tuned, start tuning Ki and compare to Figures E, F, and 11-15. Reduce Ki until there is an obvious offset in error away from zero like Figure E. Increase Ki until the offset just goes away and use that value. Compare to Figure F below. Set the Limit value to 50/Ki. This will prevent the Ki term from growing too large in extenuating circumstances.



PID Setup Menu

The PID Setup Menu has changed and now contains an oscilloscope-like tuning screen with the PID parameters. This allows for fast and accurate tuning of PID values. Go to the PID Setup screen by hitting F1 <Setup>, F3 <Config.>, F4 <PID>, F1 <PID Config.>. This is the main screen where the tuning occurs.

Axis X - Looping		Scale	Offset	Value
0.000	0.000	1.00	0.00	0.000
Unused	Visible	1.00	0.00	0.000
Unused	Visible	1.00	0.00	0.000
Unused	Visible	1.00	0.00	0.000
Unused	Hidden	0.01	0.00	0.000



Axis	Kp	Ki	Kd	Limit	Kg	Kv1	Ka	Accel.	Max Rate
X	0.0200	0.000040	0.0000	1250000	0.0000	50.0000	0.0000	0.2000	(300.0)
Y	0.0200	0.000040	0.0000	1250000	0.0000	50.0000	0.0000	0.2000	(330.0)
Z	0.0200	0.000040	0.0000	1250000	0.0000	50.0000	0.0000	0.2000	(300.0)
A	0.0200	0.000040	0.0000	1250000	0.0000	50.0000	0.0000	0.2000	(300.0)
B	0.0200	0.000040	0.0000	1250000	0.0000	50.0000	0.0000	0.2000	(0.0)
N	0.0200	0.000040	0.0000	1250000	0.0000	50.0000	0.0000	0.2000	(0.0)
N	0.0200	0.000040	0.0000	1250000	0.0000	50.0000	0.0000	0.2000	(0.0)
N	0.0200	0.000040	0.0000	1250000	0.0000	50.0000	0.0000	0.2000	(0.0)

Autotune file not found or invalid data. Run Autotune

Edit Program F1	Run Program F2	Ranges F3	Toggles & Pan F4	Zoom In F5	Zoom Out F6	Zoom All F7	Change Axis F8	Save & Apply F9	Save & Exit F10
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Button Overview

- F1 <Edit Program> brings up the program that will be executed. It is called PID_collection_moves.txt. This is a standard G-Code program. The default program moves the X axis 0.5? back and forth at 100 inches/minute.
- F2 <Run Program> goes to a screen that prompts for Cycle Start to be pressed. Once that is done, the program will start running and come back to the view above.
- F3 <Ranges> allows manual changing of the horizontal and vertical axes on the screen. This allows you to refocus what is displayed.
- The Zoom In/Out/All buttons, F5, F6, and F7 respectively, change the viewable range on the screen in both horizontal and vertical directions.
- F8 <Change Axis> changes the axis from which data is gathered. Only one axis can be shown at a time. If you can see that the motor is moving, but nothing shows up on screen push this button to see if the wave-form shows up. Only axes labeled X, Y, Z, U, V, W, A, B, or C can be shown on this screen.
- F9 <Save and Apply> should be used after running a job, if you want to stay on this screen.

- F10 <Save and Exit> goes back a screen to the PID menu.
- Esc. If you wish to discard changes.

General Tuning Procedure

- Make sure you are in the middle of travel and there are no faults.
 - Open the tuning program by pushing F1 <Edit Program> from the PID Config. screen as seen above. Change the axis labels to match with what axis you are tuning.
 - Change the feedrate to a typical cutting speed for best results. Any speed may be used, however, the speed you are tuning at will be most accurate in positioning.
 - Change the move distance in the program to be something that will allow the motor to get up to speed and be at speed for a few hundred milliseconds. This is observed by noting a flat in the RED ExpV line. The faster the move speed, the longer the distance must be to get up to speed.
 - A bi-directional move is recommended to prevent running out of travel as the program continues to cycle.
 - Save and close the program.
 - Hit F2 <Run Program> and then Cycle Start to begin running the program.
 - Move the cursor over to Kv1 for the axis that is moving and using the PageUp or PageDown for a 1% change and Shift+PageUp or Shift+PageDown key for a 10% change, modify Kv1 according to the Kv1 tuning page.
 - Next, modify Kp according to the Kp tuning page.
 - Lastly, Modify Ki according to the Ki tuning page.
 - Move on to each axis in turn and tune each one as specified above.
 - When tuning is complete save a report and email it to Tech. Support.
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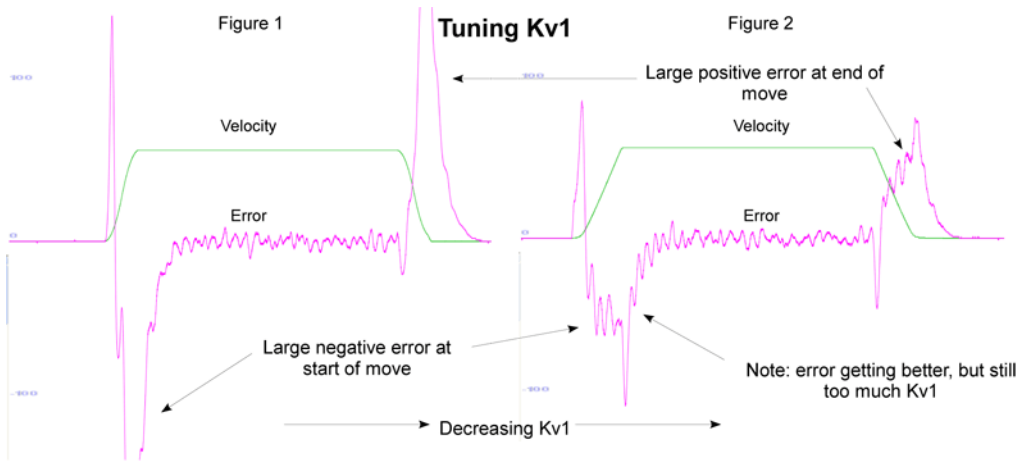


Figure 3

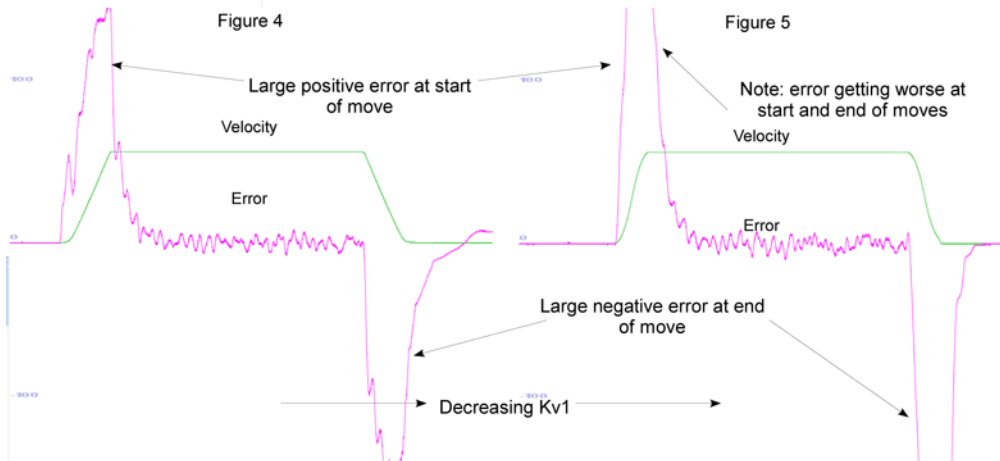
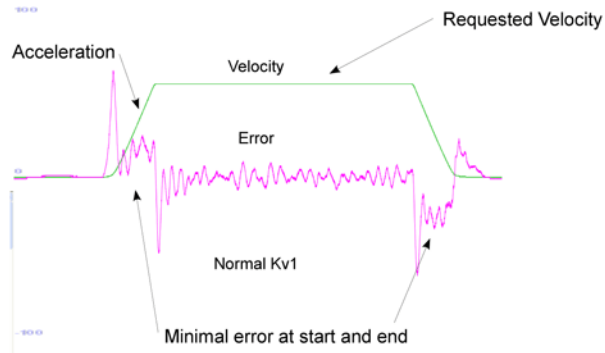


Figure 6

Tuning Kp

Figure 7

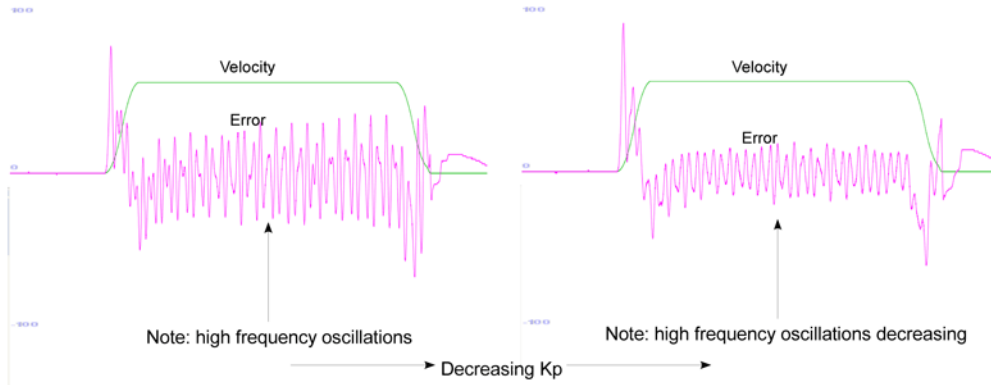


Figure 8

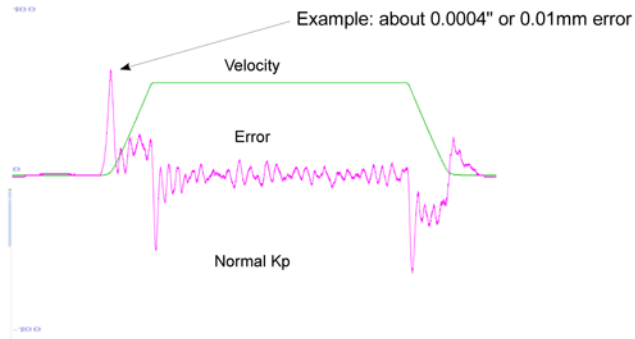


Figure 9

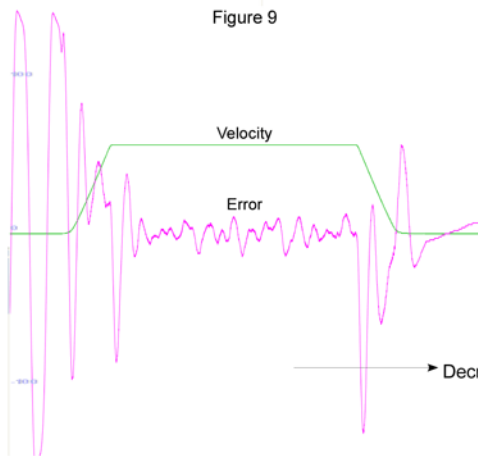
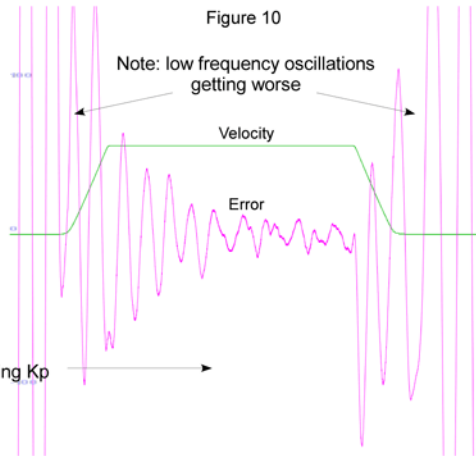


Figure 10



Decreasing Kp

Figure 11

Tuning Ki

Figure 12

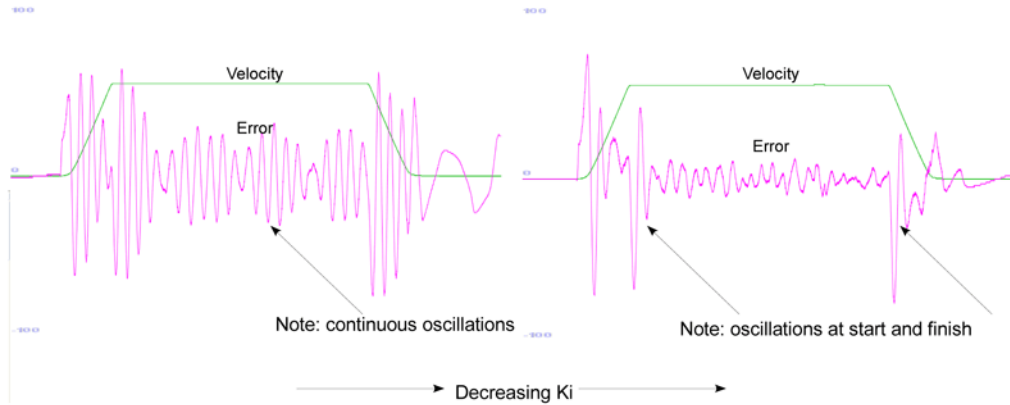


Figure 13

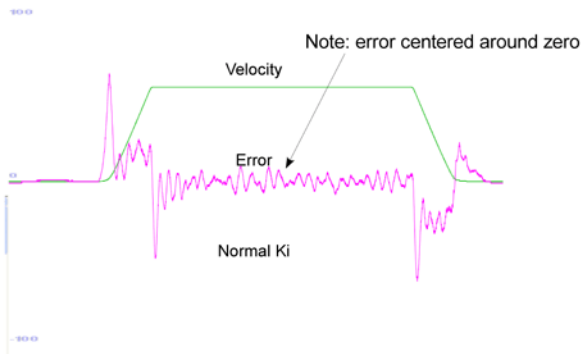


Figure 14

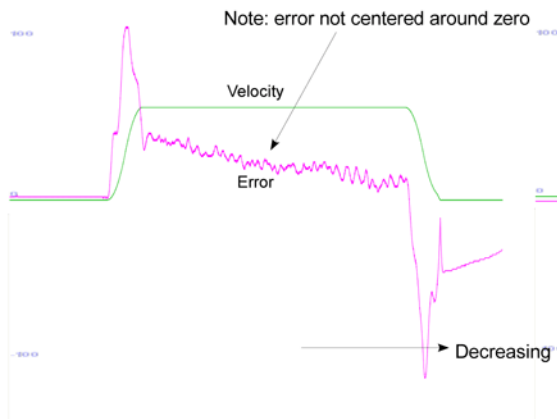
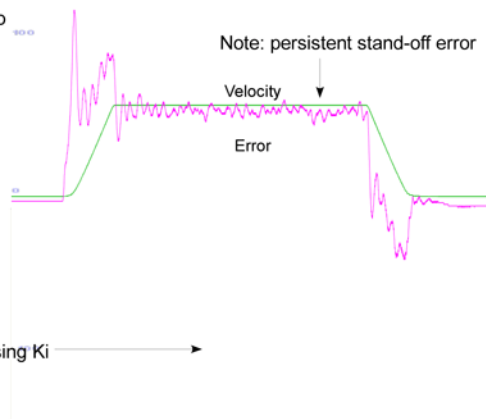


Figure 15



Decreasing Ki

Document History

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