Software Operational Manual for ACS806

www.leadshine.com

SM-ACS806-R20111215

Change Log

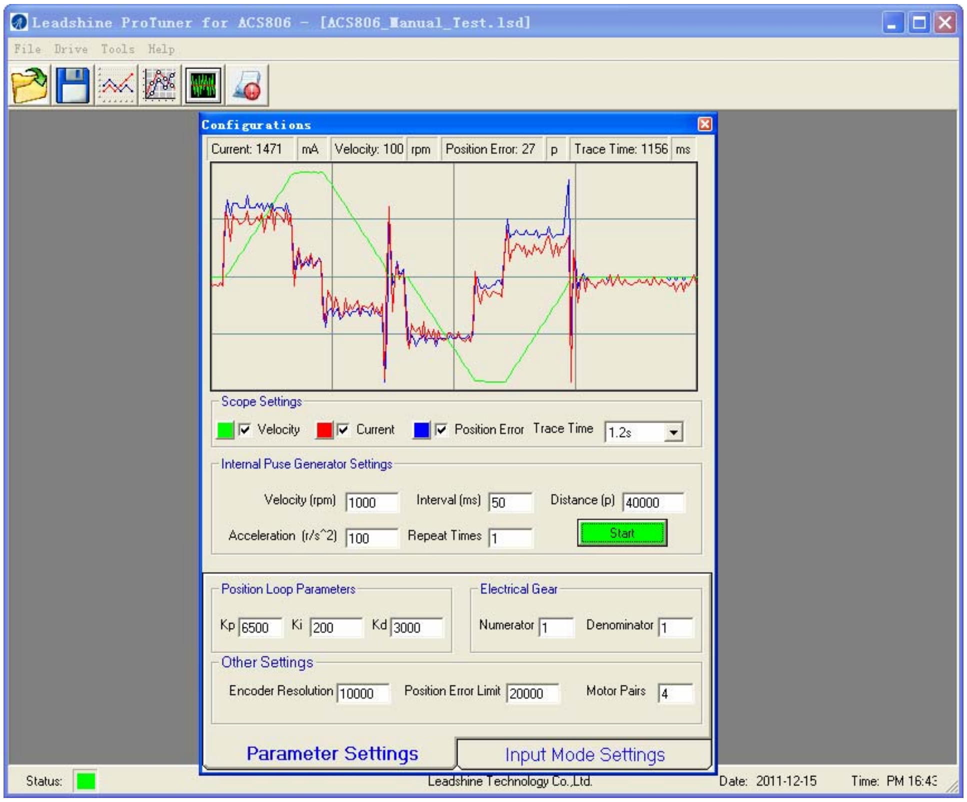
Revision Date	Changes	Version
2011-12-15	Original Create	SM-ACS806-R20111215

Table of Contents

Introduction

ProTuner for ACS806 is a software tool designed to configure and tune the Leadshine digital servo drive ACS806. The user can tune the current loop and adjust the position loop parameters in this software.

Workspace

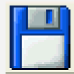
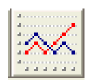
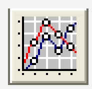
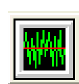


Menu Toolbar

PID Tuning Window

Menus and Toolbar

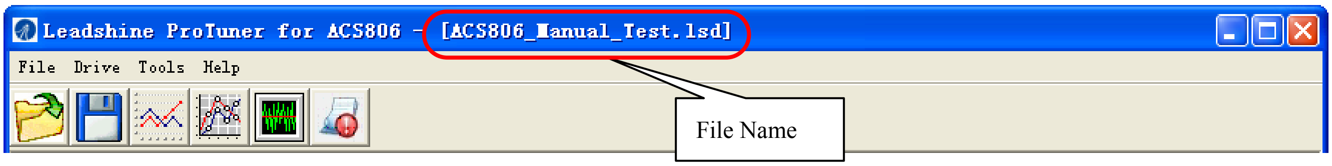
Menus and toolbars are at the top of the workspace. You can click menu bar to view the pull-down menu. The toolbar below the menu offers the most frequency used commands.

Menu	Pull Down	Toolbar	Function	Short cut
File ->	Open		Open a file	Ctrl + O
	Save		Save a file	-
	Save As	-	Save as a file	-
	Close	-	Close the current file	-
	Exit	-	Exit from the software	Ctrl + X
Drive ->	Connect	-	Connect to drive	Ctrl + N
	Current Loop		Set current loop parameters Kp and Ki and test.	-
	Configuration		Set drive properties like I/O logic, motor parameters.	-
	Download to Drive		Download all data to drive	-
	Reset		Restore factory setting	-
Tools->	Scope		Open the scope and check the measured current, position following error and motor velocity.	-
	Error Log		Check the error log.	-
Help->	User Manual on Web		Hardware manual	-
	Software Manual on Web		Software manual	
	About Leadshine ProTuner		Software information	-

Using the Software

Opening a file

If you want to reload the configuration data from a file in the PC, click on **File**->**Open**. The parameters in the software's workspace will be updated. The file name will appear on the up-right of the tile bar.



Save a file

Click **Drive**->**Save** to save data of the current workspace to the file opened. If there is no a file opened, the Save dialog box appears and you can type in the file name.

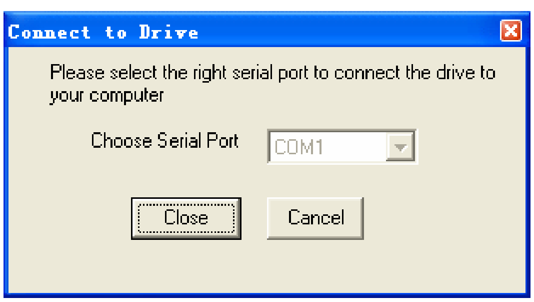
Save as a file

Click **Drive**->**Save** As to save the data in current workspace to a file and rename it.

Close

Click **Drive**->**Close** to close the current file.

Connecting Drive



Connect to Drive window appears at start-up. You can open it by clicking **Drive**->**Connect To Drive** any time. Select the right serial port and click on the Open button. The software will try to connect to the drive and read the settings. It may take several minutes. Please wait.

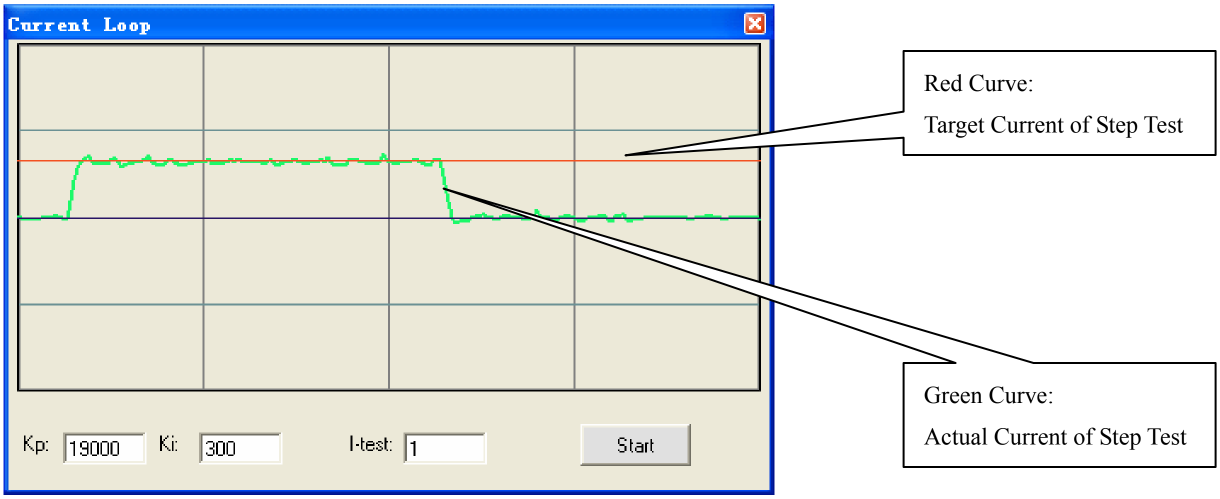
Before clicking on the Open button, please make sure:

1) The RS232 cable .has been connected between the drive and the PC's serial port.
2) The drive has been powered on and the green LED is on.

The motor is unnecessary connecting to the drive if you just want to change the parameters but not tuning.

Do not connect or disconnect serial cable when the drive is powered on. The drive's communication circuit may be damaged.

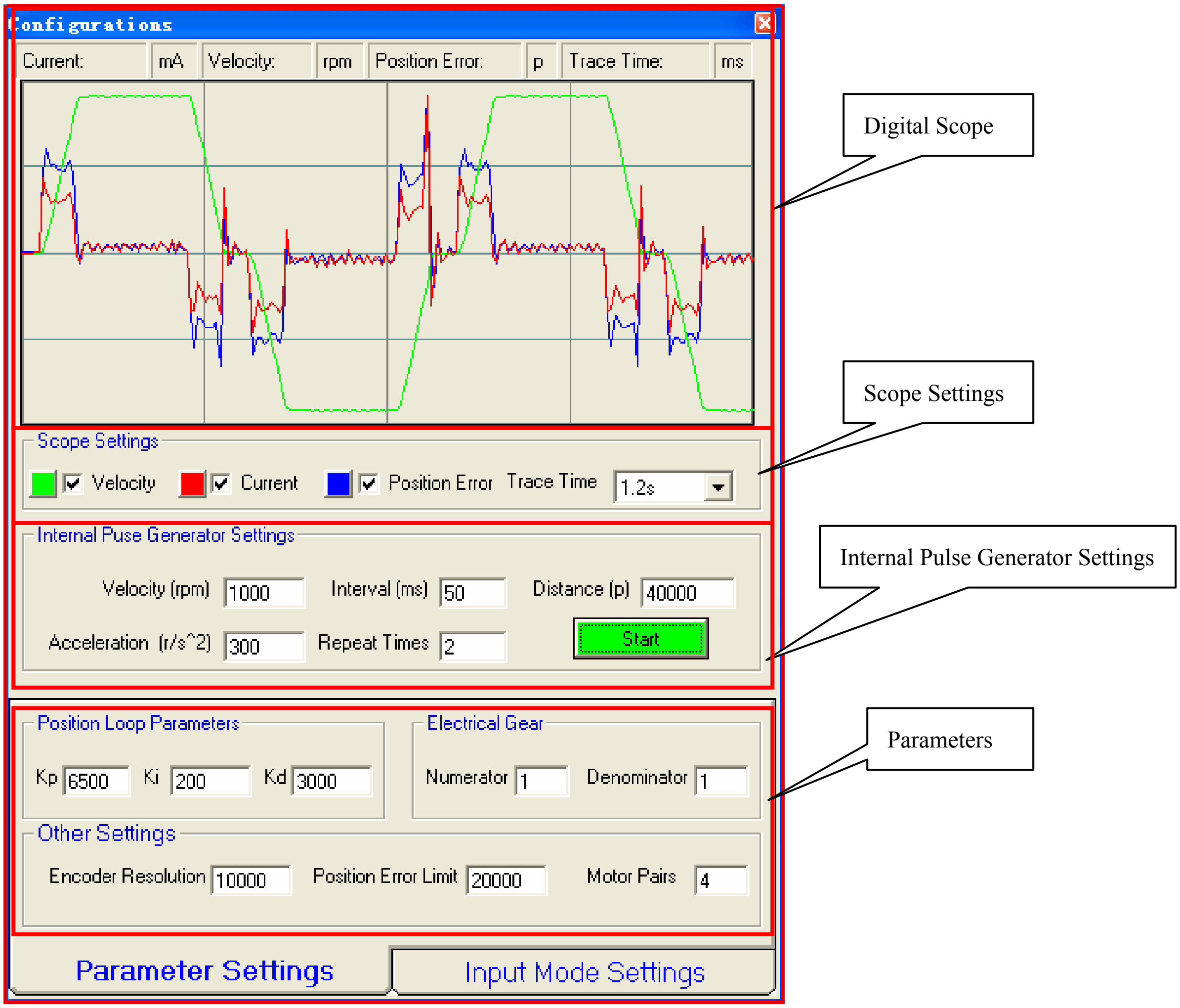
Current Loop Tuning Window



Click **Drive->Current Loop** to open the current loop tuning window. It is used to configure current loop parameters according to different motor. In the tuning window, the user can adjust the proportional gain, integral gain and test Current.

Item	Description	Range
Proportional Gain	Increase this parameter to make current rise fast. Proportional Gain determines the response of the drive to current setting command. Low Proportional Gain provides a stable system (doesn't oscillate), has low stiffness, and large current error, causing poor performances in tracking current setting command in each step. Too large Proportional Gain values will cause oscillations and unstable systems.	1 – 65535
Integral Gain	Adjust this parameter to reduce the steady error. Integral Gain helps the drive to overcome static current errors. A low or zero value for the Integral Gain may have current errors at rest. Increasing the Integral Gain can reduce the error. If the Integral Gain is too large, the systems may "hunt" (oscillate) about the desired position.	1 – 65535
I-Test	The current amplitude for the step response.	0.5 – 6 A
Test Button	Click this button to activate the test. A target curve (red) and an actual curve (green) will be displayed on the screen for user analysis.	-

Configurations Window



Click **Drive**->**Configurations** to open the configurations window. The user can adjust the position loop PID parameters and check the result by clicking the Start button. A build-in Pulse Generator performs trapezoid velocity motion and the Digital Scope displays the motor’s actual velocity, current and position following error. You can also set the electrical Gear, encoder resolution, position error limit and motor pairs in this window.

Digital Scope

Item	Description	Range
Current (A)	Current axis of the digital scope. Unit: Amp.	-
Velocity (rpm)	Velocity axis of the digital scope. Unit: rpm	-
Position Error (p)	Axis of Position following error in digital scope. Unit: Pulse	-

Scope Settings

Item	Description	Range
Velocity	Actual measured velocity measured by the encoder. Ideally, this value should be as close as possible to the commanded velocity.	-
Current	Actual measured current. Click to display it in the scope.	-
Position Error	Position following error. The difference between commanded position and the actual measured position.	-
Trace Time	Trace time of the digital scope.	100 – 3000ms

Internal Pulse Generator Settings

Item	Description	Range
Velocity (rpm)	Target velocity of Pulse Generator.	1– 65535 rpm
Acceleration (r/s^2)	Acceleration of Pulse Generator.	1 – 65536 r/s^2
Interval	Interval between the positive and negative move.	1 – 65535 ms
Distance (s)	Move distance of Pulse Generator.	1 – 65536 pulses
Repeat Times	Repeat times.	1– 65535

Position Loop Parameters

Item	Description	Range
Kp	**Position Proportional Gain**. Proportional Gain determines the response of the system to position errors. Low Proportional Gain provides a stable system (doesn't oscillate), has low stiffness, and large position errors under load. Too large Proportional Gain values will cause oscillations and unstable systems.	0 – 65536
Ki	**Integral Gain**. Integral Gain helps the control system overcome static position errors caused by friction or loading. The integrator increases the output value as a function of the position error summation over time. A low or zero value for the Integral Gain may have position errors at rest (that depend on the static or frictional loads and the Proportional Gain). Increasing the Integral Gain can reduce these errors. If the Integral Gain is too large, the systems may "hunt" (oscillate at low frequency) about the desired position.	0 – 65536
Kd	**Position Derivative Gain**. Derivative Gain provides damping by adjusting the output value as a function of the rate of change of error. A low value provides very little damping, which may cause overshoot after a step change in position. Large values have slower step response but may allow higher Proportional Gain to be used without oscillation.	0 – 65536

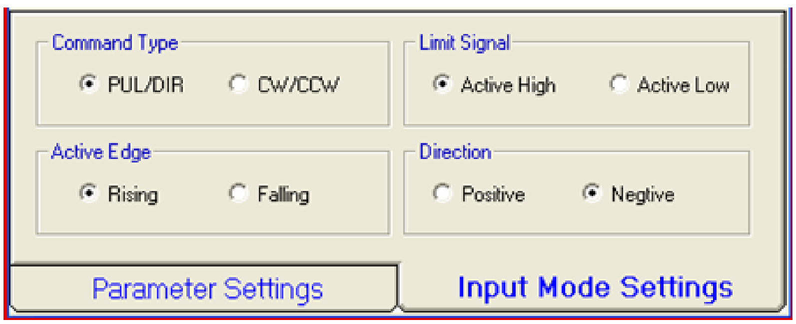
Electrical Gear

Item	Description	Range
Electronic Gear	This parameter includes numerator and denominator. You can scale the pulse frequency and calculate the motor speed as follows: $RPM = \frac{(Pulse \quad Input \quad Frequence) \times 60}{(Encoder \quad Resolution) \times 4} \times \frac{Numerator}{Denominator}$	1/255 – 512/1

Other Settings

Item	Description	Range
Encoder Resolution	Encoder Resolution for the Internal Pulse Generator. Note: This parameter is only used for the Internal Pulse Generator. **It is 4 times of the encoder lines.**	400 – 60000
Position Error Limit	Position Following Error Limit The limit of the difference between commanded position and the actual measured position. When position following error exceeds the Position Following Error Limit in the drive, the following error protection will be activated.	0 – 65535
Motor Paris	Motor poles divided by 2. Please refer to motor datasheet.	1 – 20

Input Mode Settings



The user can set the command's active edge, direction logic, active level of the Enable and Alarm signal, position following error, electrical gear and motor pole pairs according the motor and application.

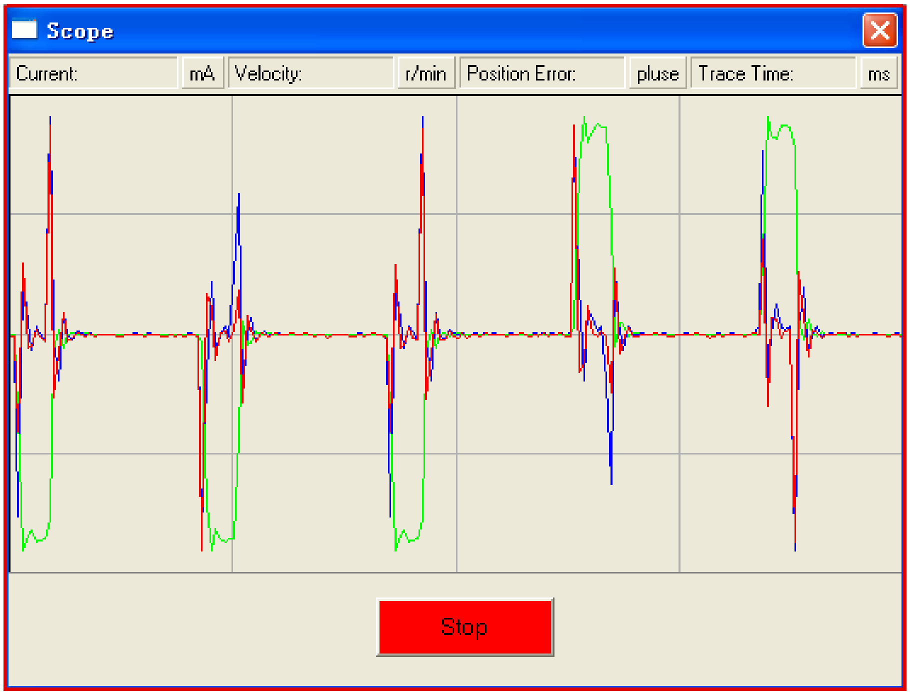
Notice

The Motor Pole Pairs is very important parameter. .It is 2 for Leadshine's BLM series motor and 4 for Leadshine's ACM series motor.

Item	Description	Range
Command Type	Pulse control mode of the drive. PUL/DIR means pulse and direction, CW/CCW means clockwise pulse and counter clockwise pulse mode.	PUL/DIR or CW/CCW
Limit Signal	Active Level of the limit sensor input.	Active High/low
Active Edge	Setting the triggered edge of pulse command signal.	Rising / Falling
Direction	Setting Default motor rotate direction. You can change the direction via this option.	Positive / Negative

Scope

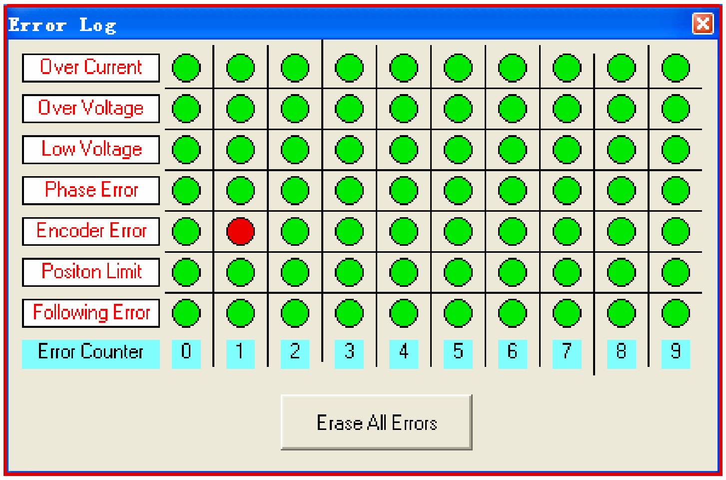
Click **Tool->Scope** to open the scope which is built inside the drive. You can check the actual measured velocity, current and position following error in this window.



Item	Description	Range
Current (mA)	Actual measured current.	-
Velocity (r/min)	Position following error. The difference between commanded position and the actual measured position.	-
Position Error (pulse)	Actual measured velocity measured by the encoder. Ideally, this value should be as close as possible to the commanded velocity.	-
Start/Sop button	Click to turn on/off the scope.	-

Error Log Window

Click **Tool->Error Log** to open the error log window. This window shows both the present status of each error event and their history.



Item	Description
Over Current	Protection will be activated when the motor current is over 20A.
Over Voltage	Protection will be activated when the input voltage is over 40+/-1V.
Low Voltage	Protection will be activated when power supply voltage is lower than 18±1.5 VDC.
Phase Error	Motor power lines wrong & not connected and encoder or hall sensor feedback signals wrong connected will activate this protection.
Encoder Error	Protection will be activated when no encoder feedback signals or wrong encoder/hall sensor feedback signals connected to drive.
Position Limit	Protection will be activated when the positive or negative limit input in FL or RL pin is active.
Following Error	Protection will be activated when position following error exceeds the **Position Following Error Limit**.

Configuring the Drive

If it is the first time setup, you can follow the steps below to configure the drive.

1) Set motor related parameters such as motor pole pairs, encoder resolution and position following error.
2) Tune the current loop parameters according to motor connected.
3) Tune the position loop parameters for the low speed and high speed performance.
4) Save the changes to drive's nonvolatile memory.

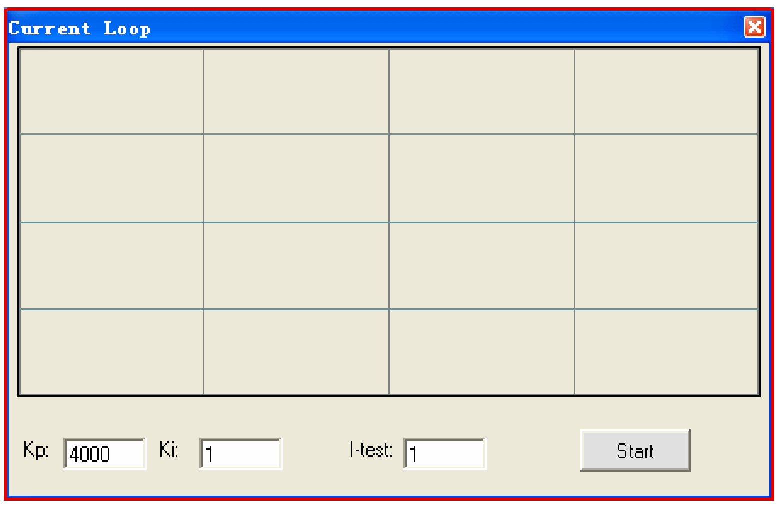
Notice

The motor must be connected to the drive before trying to configure the drive.

Current Loop Tuning

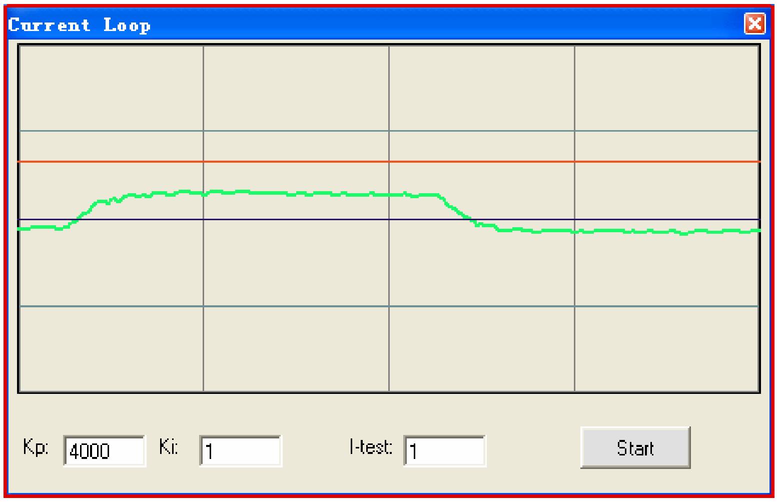
The ACS806's current loop need to be tuned before normal operation in order to get optimize responses with different motors. Otherwise the motor will be easily stall or howls when power-up. Below is the tuning process for a 200 Watt motor with 24VDC supply voltage.

Step 1: Click **Drive->Current** Loop to open the tuning window. Set **I-test** 1 and start the tuning with small **Kp** and "zero" **Ki**. Here we set **Kp** 4000.



Initial Value
Kp = 4000
Ki =1

Step 2: Click the **Start** button， the plot window will show two curves. The red one is target current and the green one is actual current. There is large gap between them in the scope. It indicates that a large **Kp** needs to be introduced.

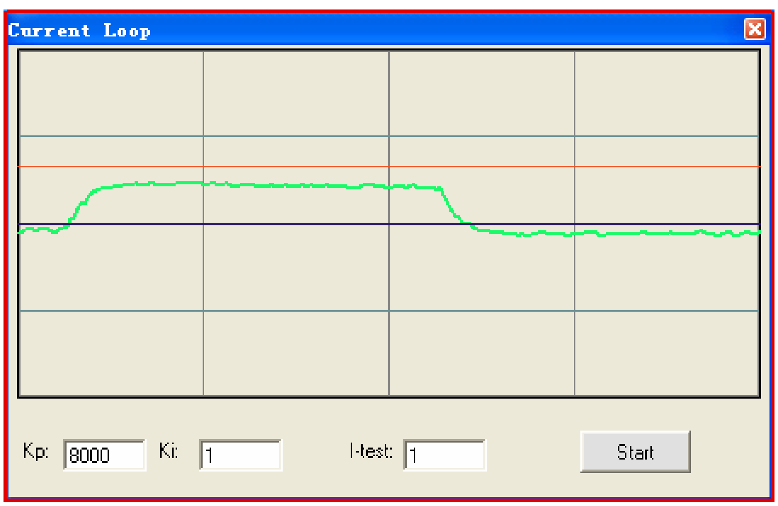


Start Test:

Proportional Gain = 4000

Integral Gain = 1

Step 3: Increase **Kp** to 8000 and click **Test.** The distance between target value and actual value is smaller but a higher **Kp** is still needed.

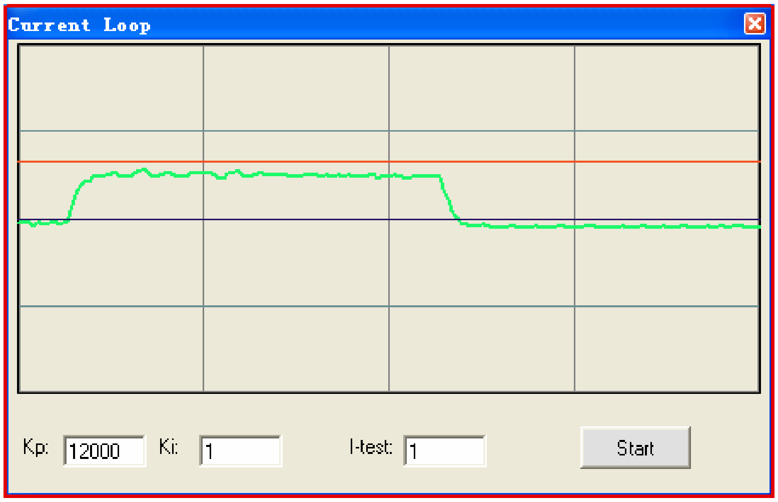


↑ Proportional Gain:

Kp = 8000

Ki = 1

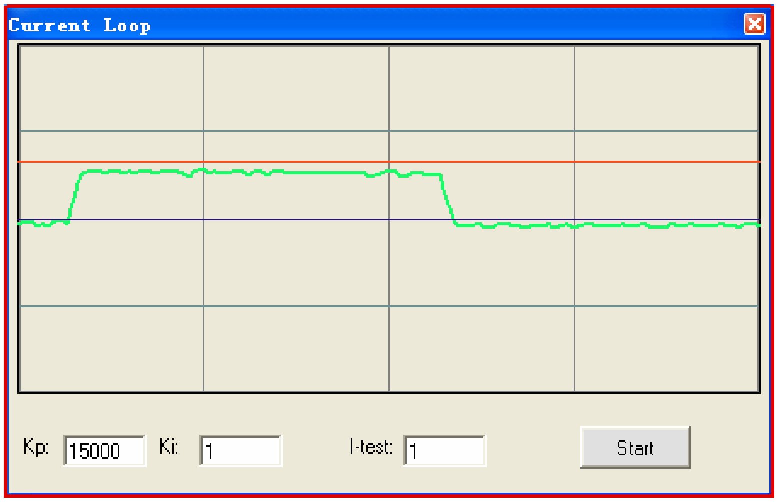
Step 3: Give **Kp** 12000, 15000, 21000 and click the **Test** button**,** respectively. The green curve is getting more and more close to the red curve. Intersection appears when we increase **Kp** to 21000. It indicates that you need to stop increasing Kp and back off. Our purpose is to make the green curve (the actual current) close to the red curve (the target).



↑ Proportional Gain:

Kp =12000

Ki = 1



↑ Proportional Gain:

Kp =15000

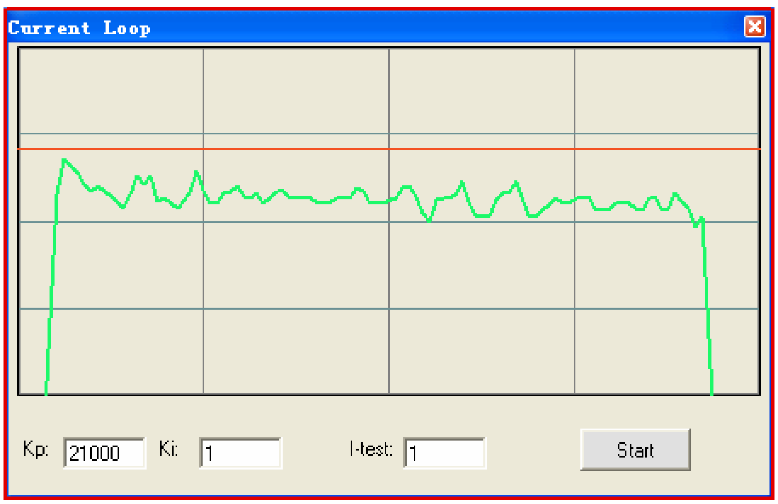
Ki = 1

↑ Proportional Gain:

Kp =21000

Ki = 1

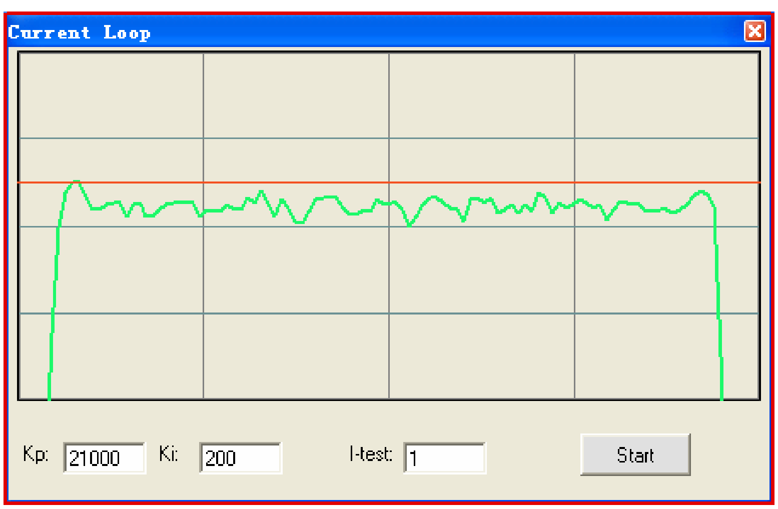
Step 4: Now the **Kp** is relatively good enough. But there is still distance between the green curve and the red curve when we use the mouse to zoom in the green curve. So we need to introduce **Ki** to reduce the distance or steady error at the constant part. It follows the same procedure as **Kp**. High **Ki** causes big vibration, system lag and makes the performance worse. The following figures show how to tune the Ki.



Zero Integral Gain:

Kp =21000

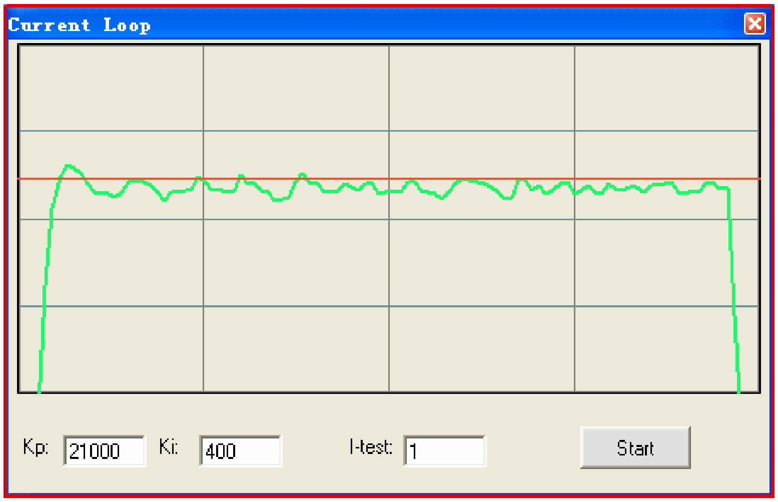
Ki = 1



↑ Integral Gain:

Kp =21000

Ki = 200



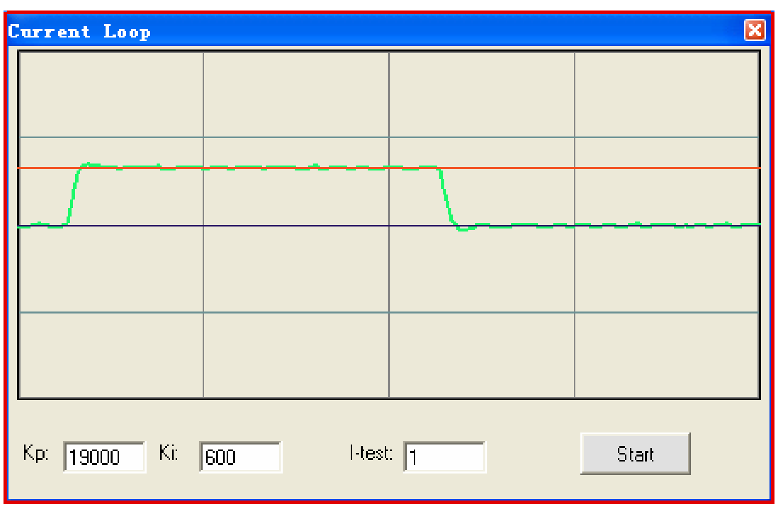
↑ Integral Gain:

Kp =21000

Ki = 400

Step 5: The current loop tuning is basically finished. You can continue to adjust Kp and Ki for better performance. Now the updated Kp and Ki is just stored in the driver's RAM. They will be lost when we power off the driver. **Don't forget to click Drive->Download To Drive to store the changed value to the drive's nonvolatile EEPROM.**

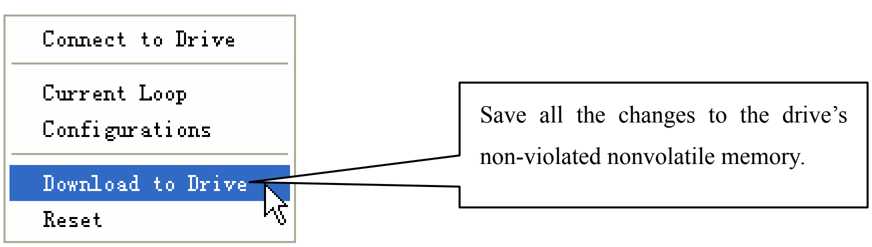
Notice You can reduce the Kp if the motor's noise can not be accepted for the application.



Final Result:

Kp =19000

Ki = 600



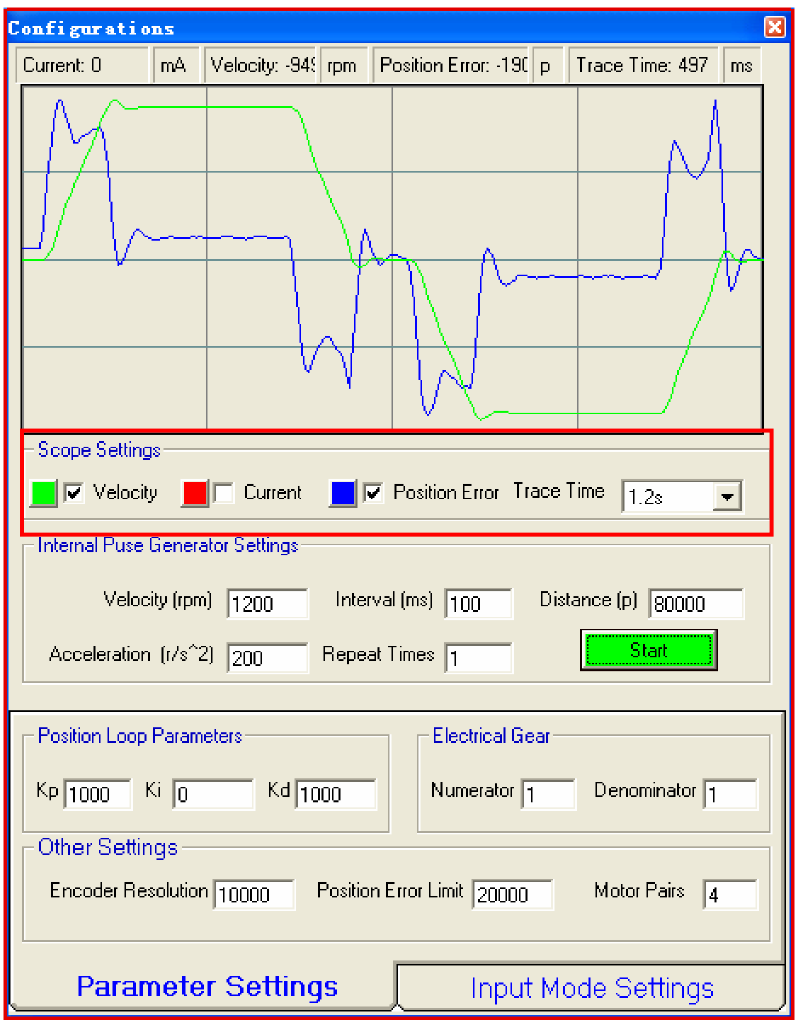
Tuning the Position Loop Parameters

Click **Drive->Configurations** to open the tuning window. The following example demonstrates the tuning of the position loop base on a 400W servo motor with 24VDC input.

The motor should be installed to the machine and connected to load before the position loop tuning.

Move the load to the middle of the axis and make sure 40000/Encoder Resolution turns of motor shaft will not hit anything. Otherwise, please reduce the distance setting in the pulse generator.

Before tuning the position loop parameters, set pulse generator parameter as the following figure. We select the actual velocity and position following error to be displayed in the digital scope. **Trace Time** affects the display length of the curve. Here we select 1200ms.



Pulse Generator and Scope Settings in this Example:
Velocity = 1200rpm,
Acceleration = 200r/s^2,
Distance = 80000Pulse,
Repeat Times = 1
Click the Velocity and Position Error Curve,
Trace Time = 1.2s

The pulse generator will generate the following command trapezoid velocity profile. It takes 100ms to make the motor to accelerate from 0 to 1200 rpm.

Commanded Trapezoid Velocity Curve

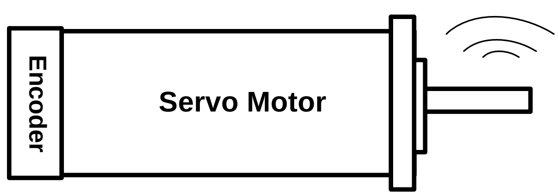
Our purpose is to get the highest system stiffness but lower motor noise. The actual measured velocity should be similar as the commanded velocity curve. However, sometimes we need to trade off between high stiffness and low motor noise because high proportional gain leads to big overshoot and vibration. In this example, we start with small proportional gain then increase it. We will stop increasing when the motor noise can not be accepted. The tuning procedure is shown as follows:

① **Ki** =0, Small **Kp** and **Kd** ②**Kp**↑ , **Kd**↑ ③Small **Ki** ④Adjust **Kp and Kd**

Step 1: Set **Kp** = 1000, **Ki** = 0, **Kp** = 1000. The initial value is depending on supply voltage, motor and reflected load inertia. The above values may not suitable for your system. Please adjust them according to different symptom as follows:

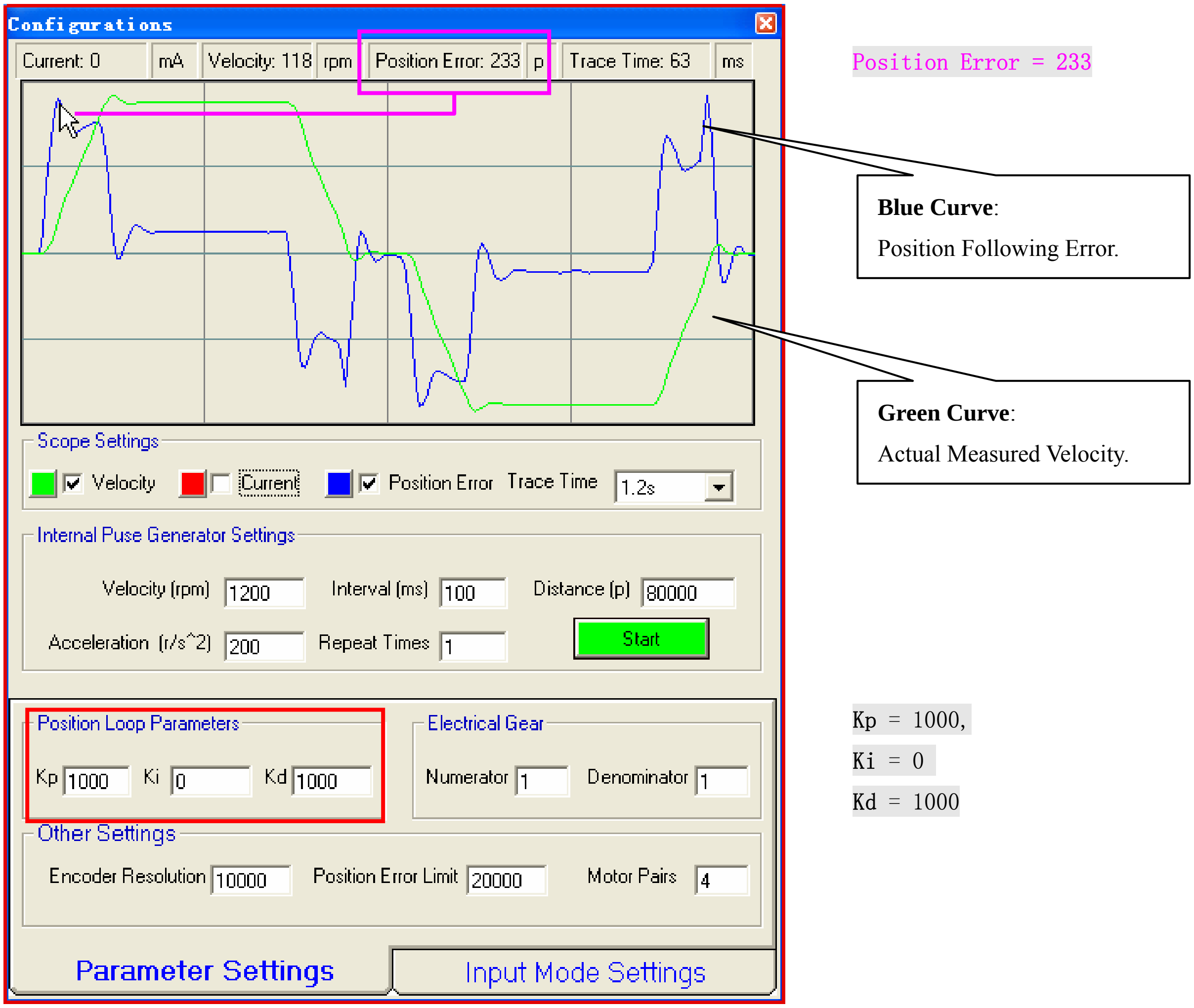
- Decrease **Kp and Kd** if the motor generates big noise. **Kp** and **Kd** can be the same at the beginning.
- Increase **Kp and Kd** if the drive's red LED blinks (Protection mode).

Tip: Giving an external torque by rotating the motor shaft (or moving the load) manually is good way to check whether the **Kp** and **Kd** are suitable or not. If it is hard to rotate/move and the motor generates big noise, you should lower down **Kp** and **Kd**. If it is easy to rotate/move and even the drive goes into protection mode (the red LED blinks), you should increase **Kp**/**Kd**.

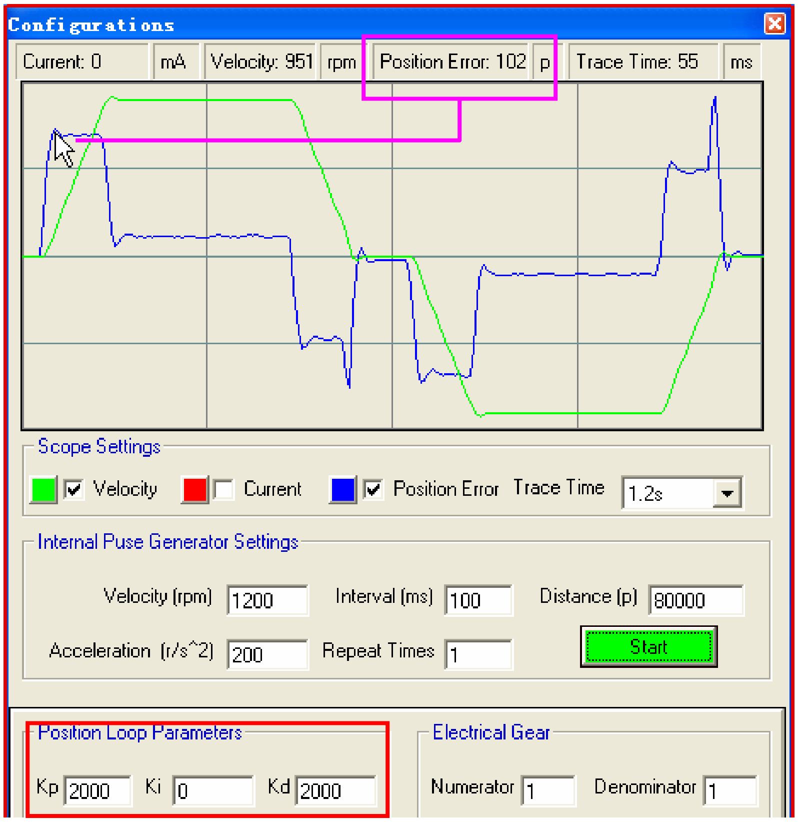


Observe the motor noise/vibration when increasing loop gain

Press the **Start** button to start the test. The motor shaft will move (40000/Encoder Resolution) turns in two directions. Not long later the actual measured velocity and position error curve are displayed in the scope as follows. We see that the position error is large and the velocity curve is not very good when comparing to the commanded one.

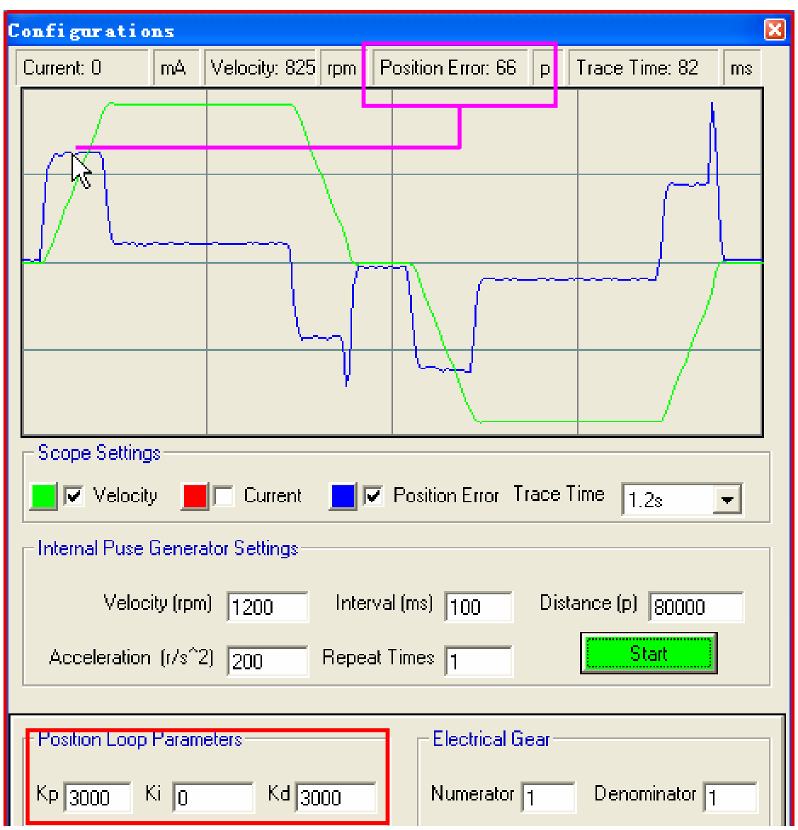


Step 3: Increase **Kp and Kd** to maximize the system stiffness or minimize the position error until the motor noise/vibration can not be accepted. To activate the noise/vibration, sometimes you need to give a disturbance to the load by either clicking the **Start** button or trying to push/pull the load. In this example, we give **Vp** 400, 800, 1000 and find that the noise/vibration at **Vp**=1000 can be accepted. So we stop increasing **Vp**.



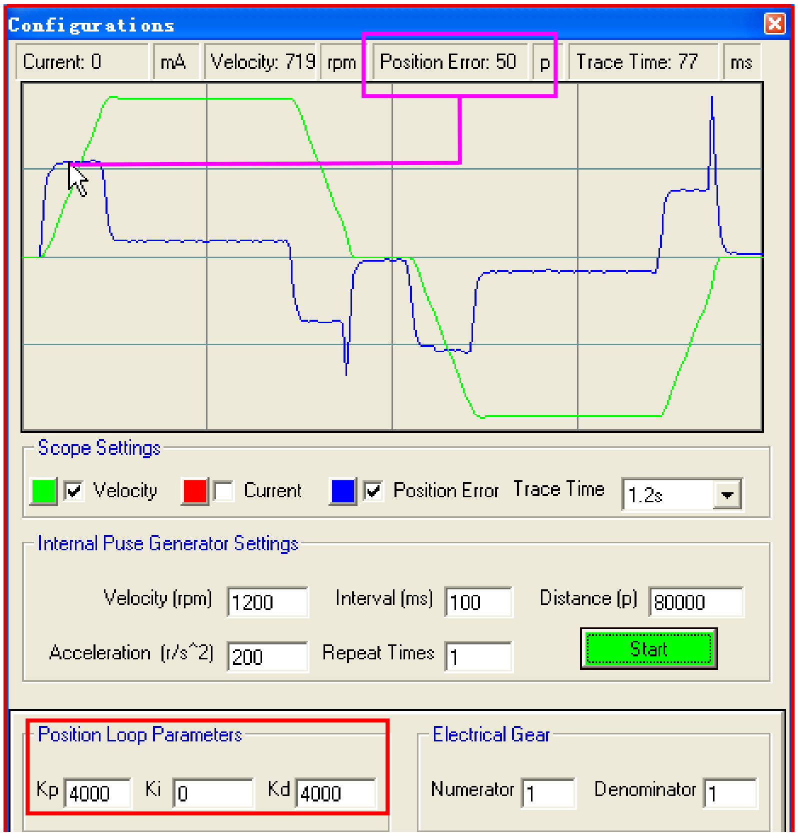
Position Error = 102

- Proportional Gain:
- Kp = 2000,
  Ki = 0
- Kd = 2000



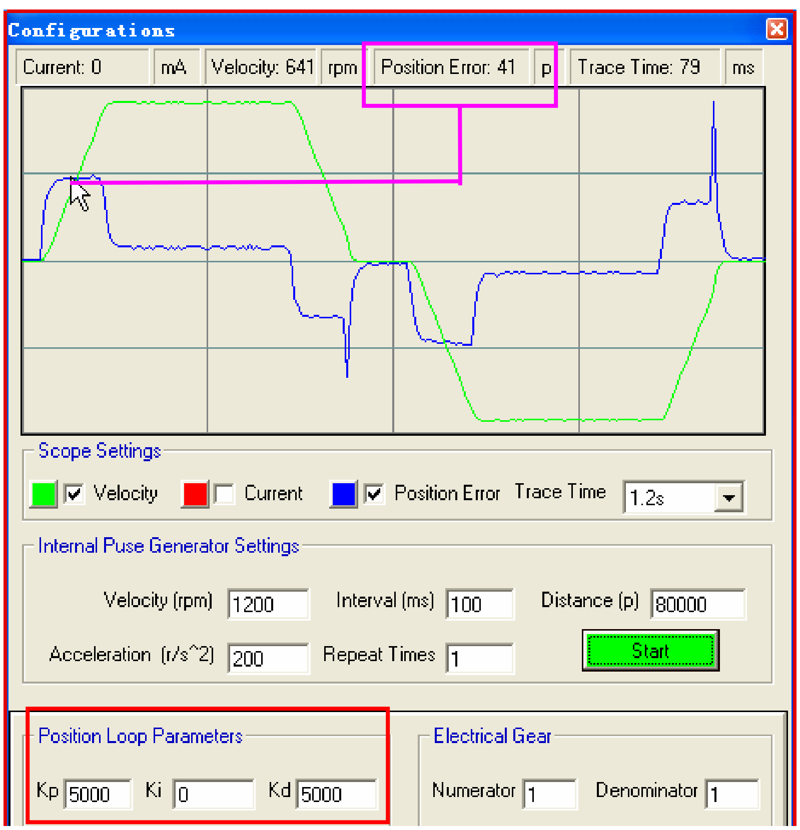
Position Error = 66

- Proportional Gain:
- Kp = 3000,
  Ki = 0
- Kd = 3000



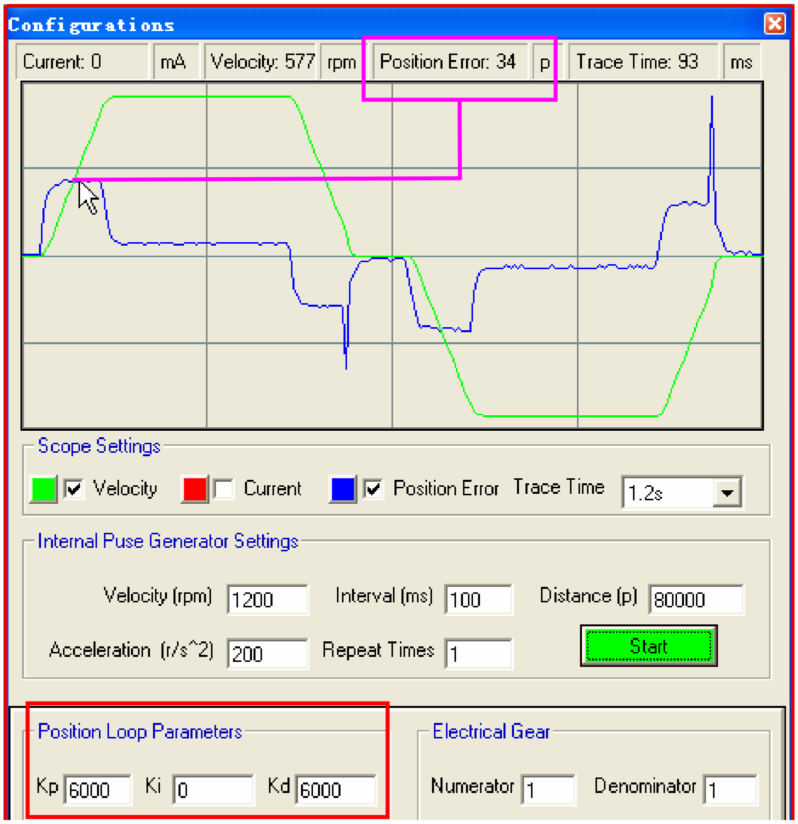
Position Error = 50

- Proportional Gain:
- Kp = 4000,
  Ki = 0
- Kd = 4000



Position Error = 41

- Proportional Gain:
- Kp = 5000,
  Ki = 0
- Kd = 5000



Position Error = 34

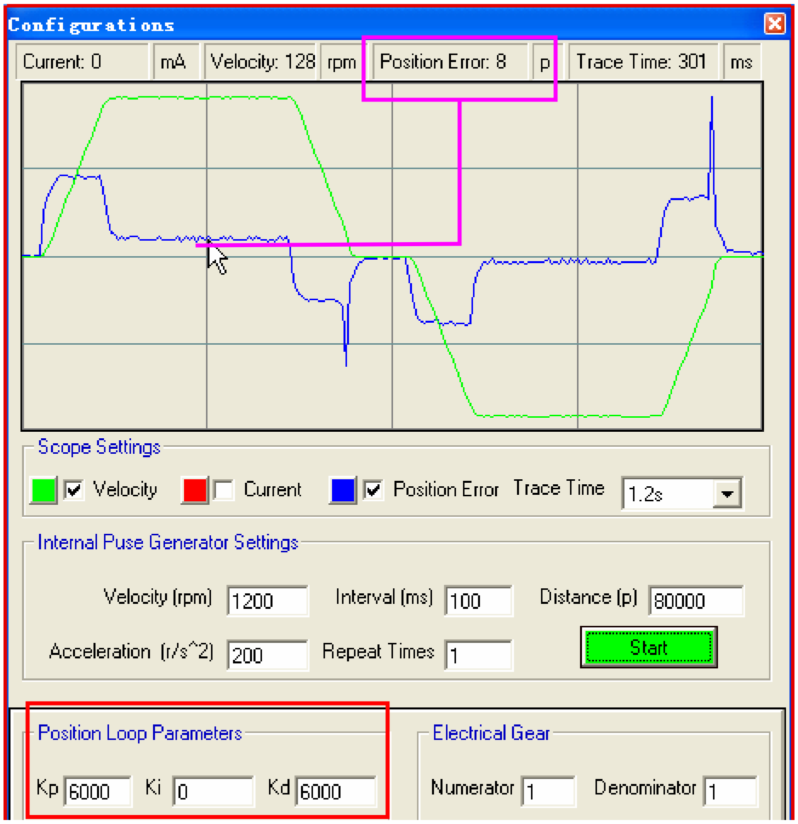
- Proportional Gain:
- Kp = 6000,
  Ki = 0
- Kd = 6000

Now the system has been basically tuned. You can continue to increase the Kp and Kd but the motor noise will also be increased too. We stop here in this example. In the following step, we give small Ki to “Zero” the position error at constant velocity (The velocity curve is straight). However, big noise may be introduced if Ki is too big.

Step 4: Set .Ki = 200 and the position error at constant speed becomes near 0.

Remember that tuning the servo is to get satisfying performances, getting the best performances of the servo is a time consuming work. So if the servo performance can meet your application requirements, then the easier tuning way the better. Just like if the performances of the products can meet your application requirements, then the cheaper the better.

Step 5: Don’t forget to click Drive->**Download To Drive** to store the changed value to the drive’s nonvolatile EEPROM**.**



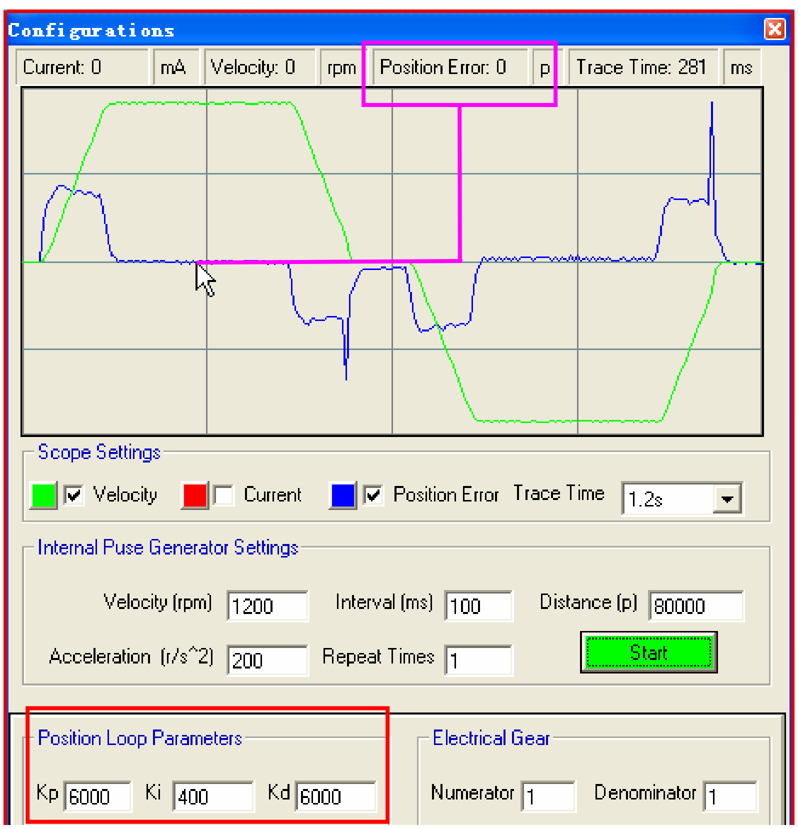
Position Error = 8

When Ki = 0 and the target speed has been archived

Kp = 6000,

Ki = 0

Kd = 6000



Position Error = 0

When Ki = 400 and the target speed has been archived

Kp = 6000,

Ki = 400

Kd = 6000

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