Software Operational Manual

Hybrid Servo Drive HBS57/86/86H

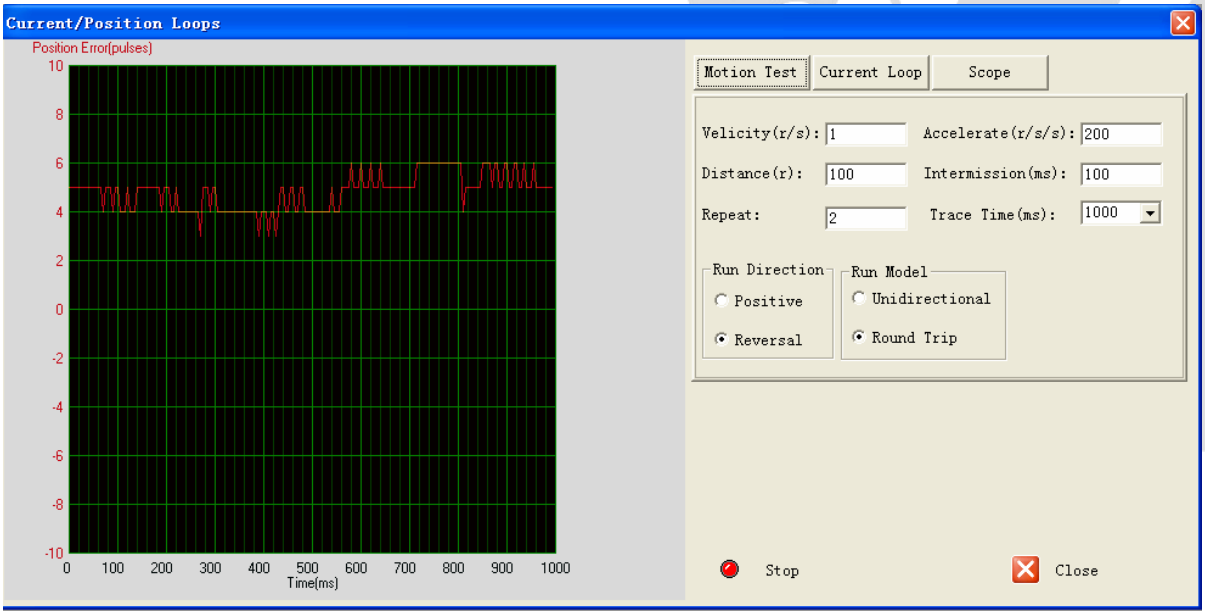
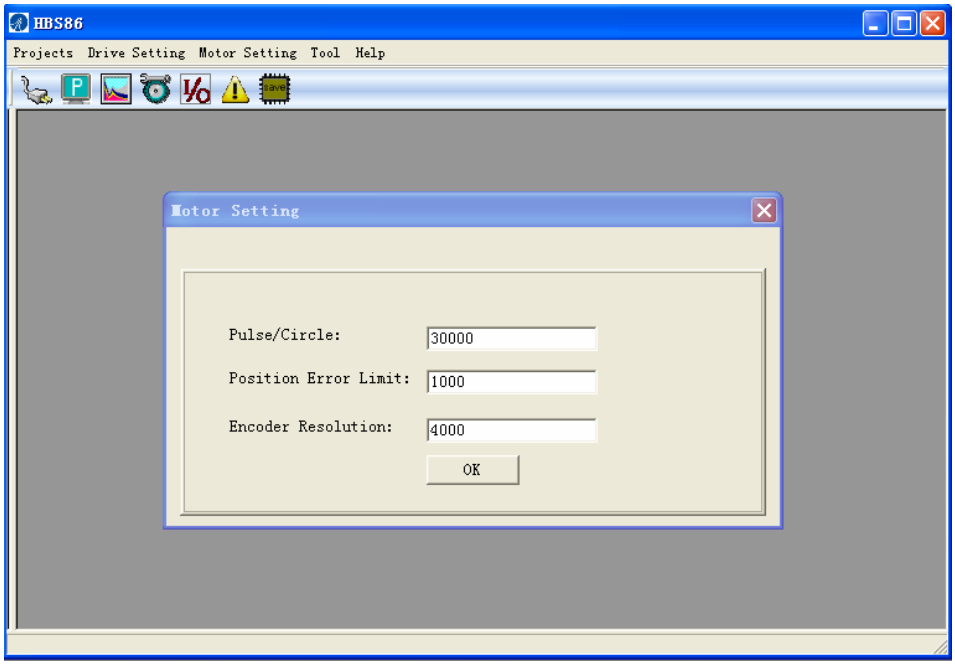


Table of Contents

Introduction

The ProTuner is a software tool designed to configure and tune the Leadshine HBS Drives. The user can configure the drive's output current, micro step, command type, tune the current loop and adjust the position loop parameters in this software.

Workspace



Menu

Toolbar

Motor Settings

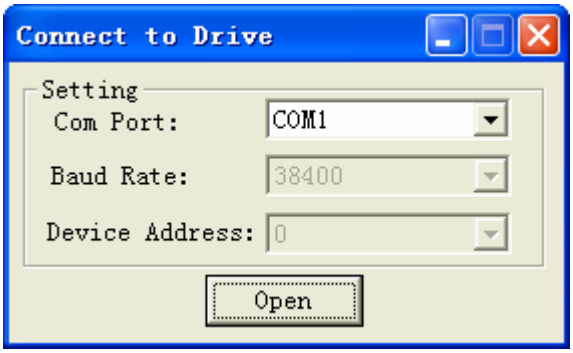
Menus and Toolbar

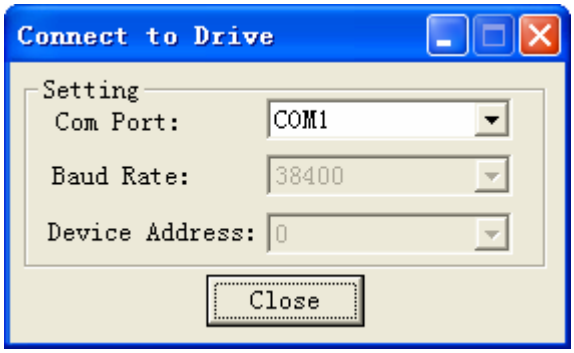
Menus and toolbars are at the top of the workspace. You can click menu bar to view pull-down menu. The toolbar below offers the most frequency used commands.

Menu	Pull Down	Toolbar	Function
Projects ->	Connect to Drive		Open the serial port and connect to drive
	Exit	-	Exit from ProTuner
Drive Setting->	Inputs / Outputs	-	Set the command type, active level of the I/O signal.
	Current Loop / Motion Test		Tune the current loop, perform Motion Test and monitor the position error
	Download to Drive		Store the current setting to drive's non-volatile memory
	Reset		Rest the drive to default setting
Motor Setting->	Motor Setting		Set the encoder resolution(4 multiple), micro step resolution and position following error limit
Tool->	Check Error		Check drive error
	Drive Parameters		Download / upload data between the ProTuner and the drive. Or you can also save parameters to a file and restore parameters from a file.

Using the Software

Connecting Drive





Connect to Drive window appears every time you open ProTuner. You can also open it by clicking **System->Connect To Drive** when the software is open. . Select the serial port number 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 connecting the drive, please make sure:

1) The RS232 cable .has been connected between the drive and PC serial port.
2) Power has been applied to the drive and the green LED is turned on.

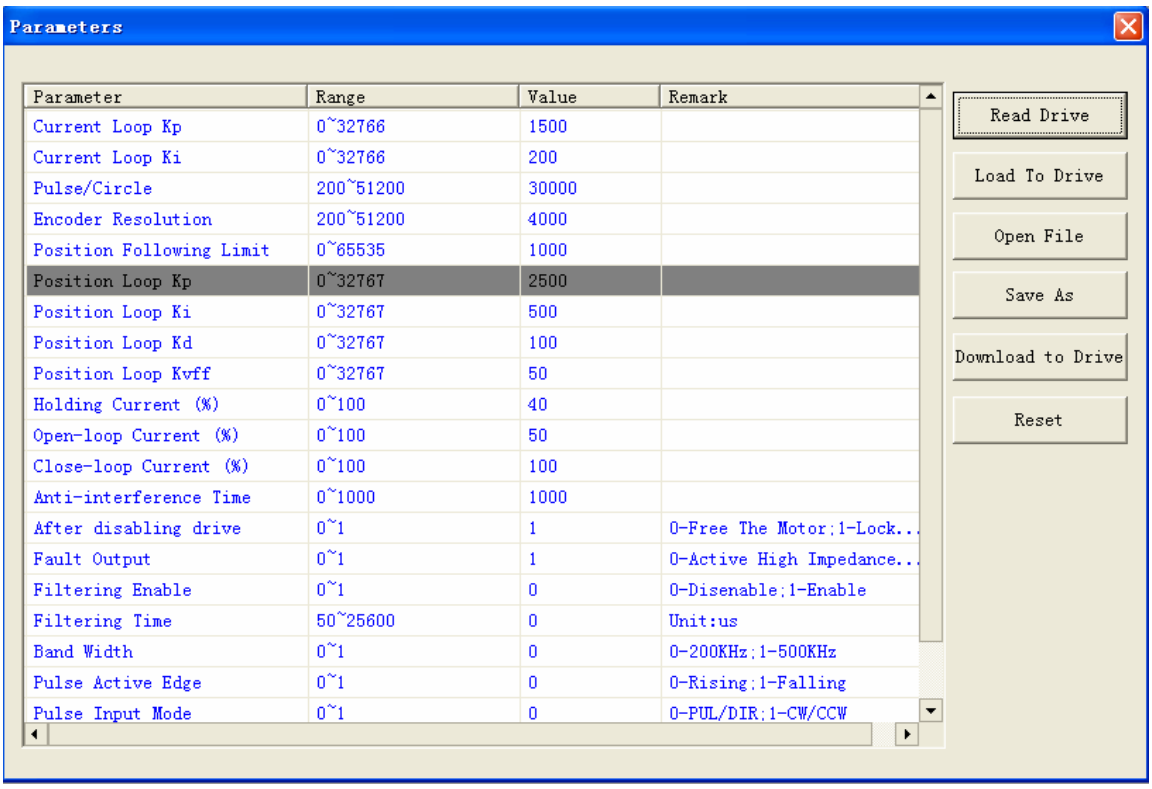
The motor is no need to connect to the drive if you just want to change the parameters but not tuning.

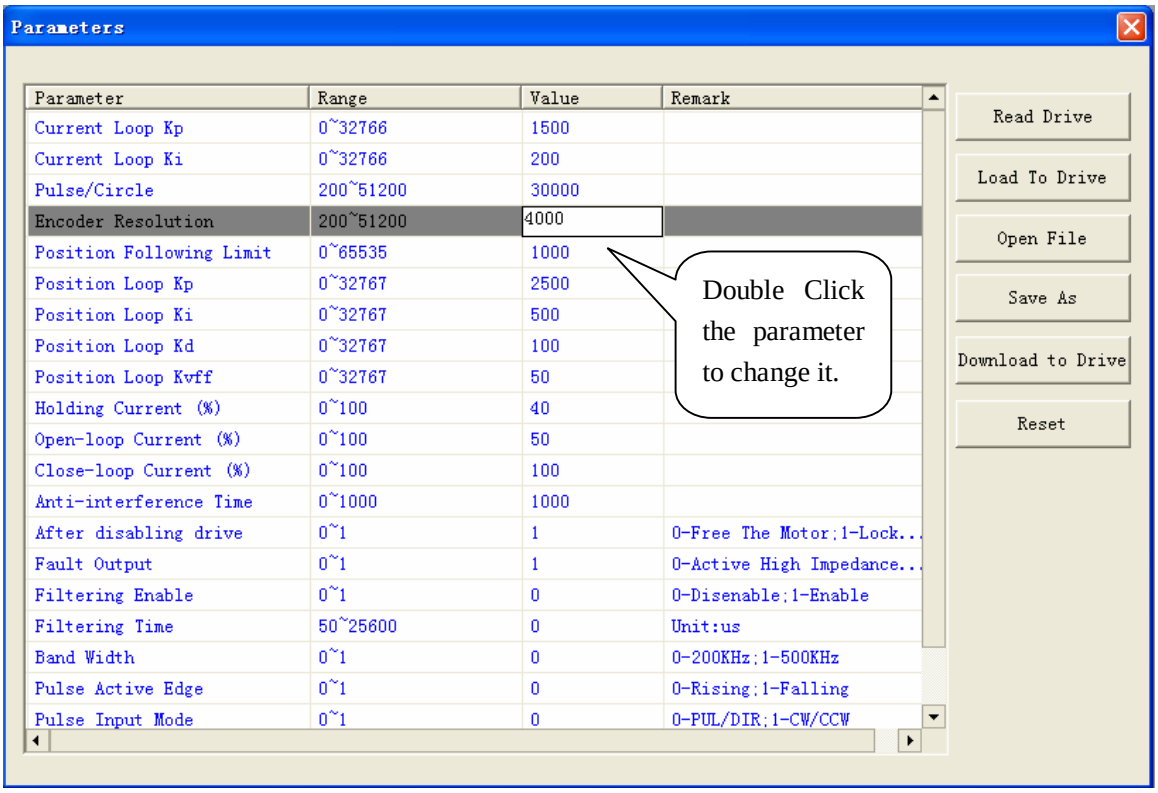
Do not connect or disconnect serial cable when drive is powered on. The drive's communication circuit may be damaged.

Drive Parameters

Click **Tool->Drive Parameters** to open the parameters window. You can deal with the drive parameters in this window as follows:

1) **Read Drive**: Upload parameters from the drive;
2) **Load to Drive**: Apply parameters to the drive;
3) **Open File**: Open a configuration file and restore parameters to ProTuner;
4) **Save As**: Save the parameters to a configuration file;
5) **Download to Drive**: Download parameters to the drive's nonvolatile memory;
6) **Reset**: Restore factory settings of the drive.


Parameters
Parameter | Range | Value | Remark
Current Loop Kp | 0~32766 | 1500 |
Current Loop Ki | 0~32766 | 200 |
Pulse/Circle | 200~51200 | 30000 |
Encoder Resolution | 200~51200 | 4000 |
Position Following Limit | 0~65535 | 1000 |
Position Loop Kp | 0~32767 | 2500 |
Position Loop Ki | 0~32767 | 500 |
Position Loop Kd | 0~32767 | 100 |
Position Loop Kvff | 0~32767 | 50 |
Holding Current (%) | 0~100 | 40 |
Open-loop Current (%) | 0~100 | 50 |
Close-loop Current (%) | 0~100 | 100 |
Anti-interference Time | 0~1000 | 1000 |
After disabling drive | 0~1 | 1 | 0-Free The Motor;1-Lock...
Fault Output | 0~1 | 1 | 0-Active High Impedance...
Filtering Enable | 0~1 | 0 | 0-Disenable;1-Enable
Filtering Time | 50~25600 | 0 | Unit:us
Band Width | 0~1 | 0 | 0-200KHz;1-500KHz
Pulse Active Edge | 0~1 | 0 | 0-Rising;1-Falling
Pulse Input Mode | 0~1 | 0 | 0-PUL/DIR;1-CW/CCW
Read Drive
Load To Drive
Open File
Save As
Download to Drive
Reset

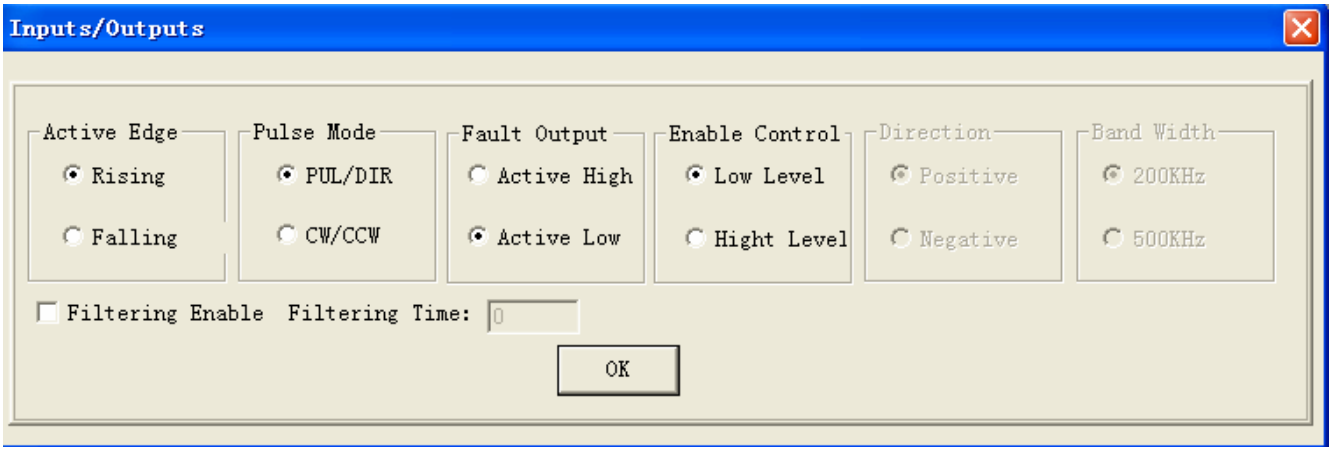

Parameters
Parameter | Range | Value | Remark
Current Loop Kp | 0~32766 | 1500 |
Current Loop Ki | 0~32766 | 200 |
Pulse/Circle | 200~51200 | 30000 |
Encoder Resolution | 200~51200 | 4000 |
Position Following Limit | 0~65535 | 1000 |
Position Loop Kp | 0~32767 | 2500 |
Position Loop Ki | 0~32767 | 500 |
Position Loop Kd | 0~32767 | 100 |
Position Loop Kvff | 0~32767 | 50 |
Holding Current (%) | 0~100 | 40 |
Open-loop Current (%) | 0~100 | 50 |
Close-loop Current (%) | 0~100 | 100 |
Anti-interference Time | 0~1000 | 1000 |
After disabling drive | 0~1 | 1 | 0-Free The Motor;1-Lock...
Fault Output | 0~1 | 1 | 0-Active High Impedance...
Filtering Enable | 0~1 | 0 | 0-Disenable;1-Enable
Filtering Time | 50~25600 | 0 | Unit:us
Band Width | 0~1 | 0 | 0-200KHz;1-500KHz
Pulse Active Edge | 0~1 | 0 | 0-Rising;1-Falling
Pulse Input Mode | 0~1 | 0 | 0-PUL/DIR;1-CW/CCW
Double Click the parameter to change it.
Read Drive
Load To Drive
Open File
Save As
Download to Drive
Reset

Item	Description	Range
Current Loop Kp (Proportional Gain)	Increase Kp 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.	0 – 32766
Current Loop Ki (Integral Gain)	Adjust Ki 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.	0 – 32766
Pulse / Circle (Micro Step Resolution)	Drive's Micro Step Resolution. It can be set from 200-51200 with step 1. It is recommended to download the setting to drive's nonvolatile memory then re-power the drive to apply the change.	200 – 51200
Encoder Resolution	The encoder lines or resolution which is 4 multiple of the actual resolution. For example, if the motor encoder resolution is 1000, the setting here is 4000.	200 – 10000
Position 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
Position Loop Kp (Proportional Gain)	**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 – 32767
Position Loop Ki (Integral Gain)	**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 – 32767

Position Loop Kd (Derivative Gain)	**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 – 32767
Position Loop Kvff (Feed-forward Gain)	**Feed-forward gain**. It speeds up the system response.	0 – 32767
Holding Current (%)	Motor coil current setting when there is no pulse applied to the drive and the motor is at standstill state.	0% – 100%
Open-loop Current (%)	Motor coil current limit for open-loop control mode.	0% – 100%
Close-loop Current (%)	Motor coil current limit for close-loop control mode.	0% – 100%
After Disabling Drive	Specify the action after drive is disabled. Use 0 to free the motor shaft and 1 to lock the motor shaft. It is useful for the vertical axis.	0– 1
Fault Output	Specify the active impedance between ALM+ and ALM-. Use 0 to select high impedance and 1 for low impedance.	0– 1
Filtering Enable	Enable or disable the pulse filter. Use 0 to disable and 1 to enable.	0– 1
Filtering Time	Specify the filtering time the built-in digital filter. It will be used when there is much electronic noise coupled into the pulse signal.	200 – 25600
Pulse Active Edge	Select active edge for pulse input. The motor moves one micro step as per each active edge.	–
Band Width	Ignore it.	–
Pulse Input Mode	Select Pulse/Direction or CW/CCW command mode.	0– 1
Direction	Ignore it.	–

Inputs/Outputs Window

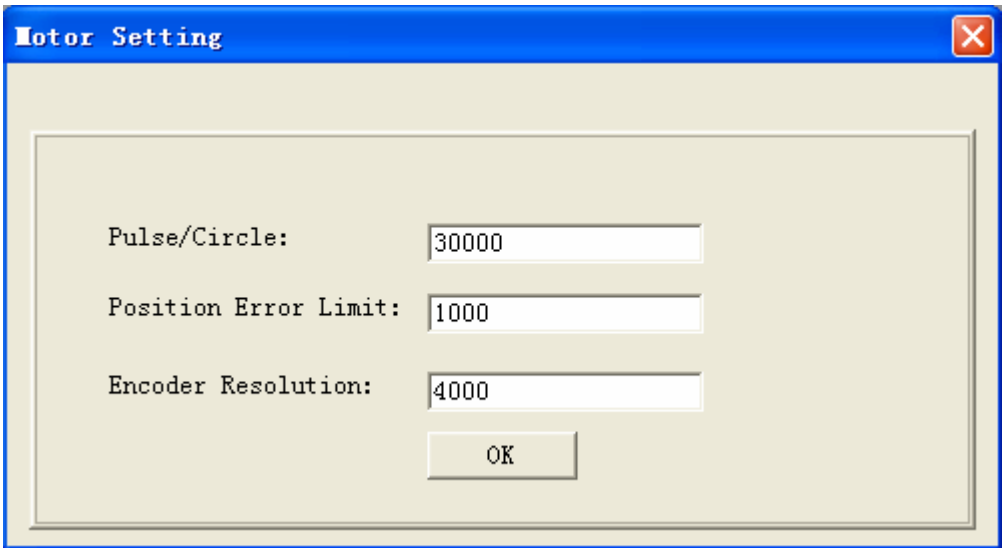
Click **Drive->Inputs/Outputs** to open the I/O configuration window. The user can set the Pulse Active Edge, Pulse Mode and active level of fault output



Item	Description	Range
Active Edge	Pulse active edge. The motor shaft moves one micro step every active edge.	Rising /Following
Pulse Mode	Pulse mode of control signal. Select PUL/DIR or CW/CCW according to command type of motion controller. PUL/DIR means pulse and direction mode; CW/CCW means double pulses mode.	PUL/DIR CW/CCW
Fault Output	Set active impedance for the fault output signal. Active High means high output impedance for drive error and Active Low means low output impedance for driver error.	Active Low /Active High
Enable Control	Change active level for the ENABLE input.	Active Low Level /Active High Level

Motor Setting Window

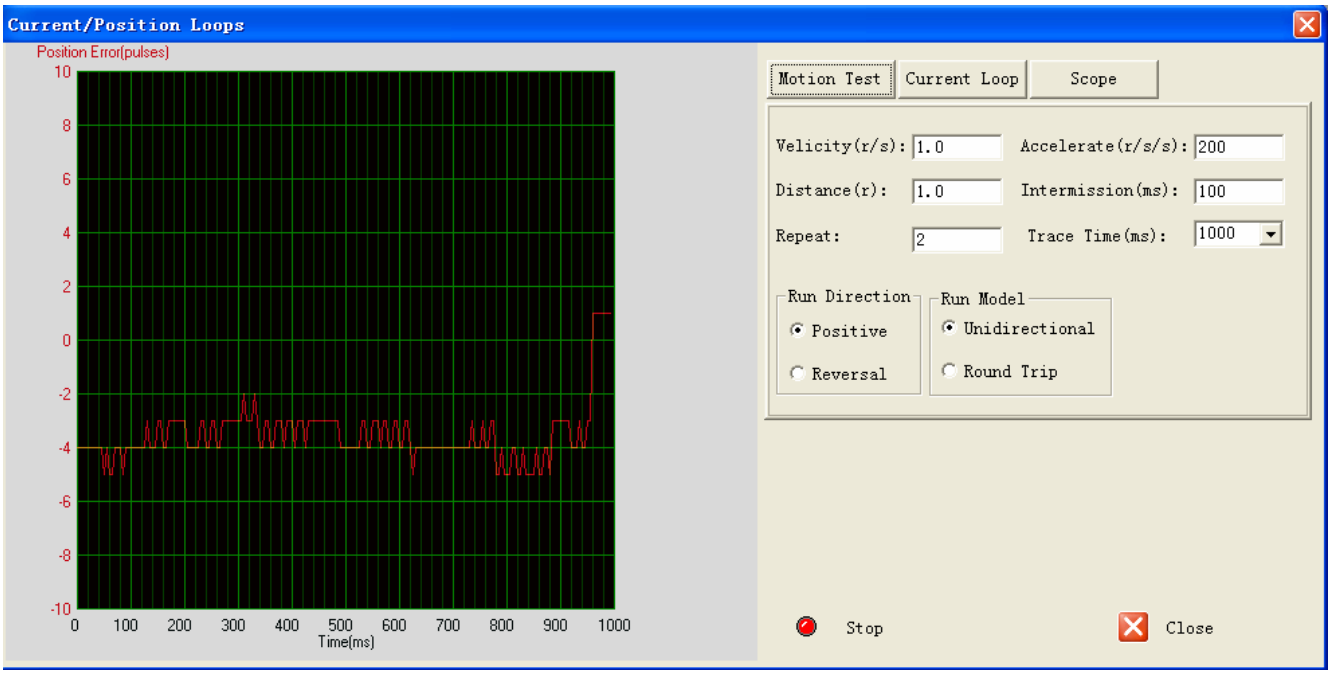
Click **Motor Setting->Motor Setting** to open this window. You can set the micro step resolution, position following error limit and encoder resolution in this window.



Item	Description	Range
Pulse / Circle (Micro Step Resolution)	Drive's Micro Step Resolution. It can be set from 200-51200 with step 1. It is recommended to download the setting to drive's nonvolatile memory then re-power the drive to apply the change.	200 – 51200
Encoder Resolution	The encoder lines or resolution which is 4 multiple of the actual resolution. For example, if the motor encoder resolution is 1000, the setting here is 4000.	200-10000
Position 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

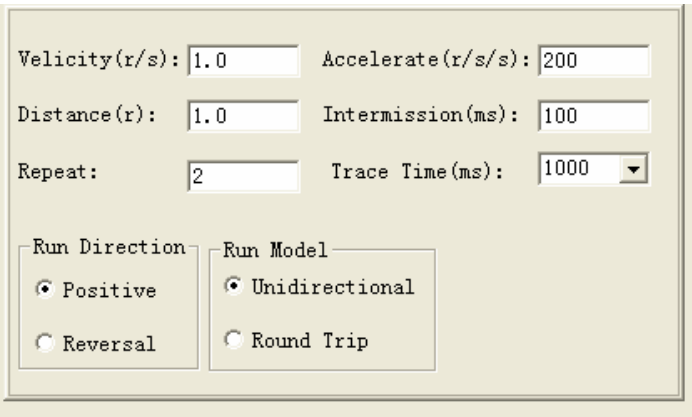
Current Loop / Motion Test Tuning Window

Click **Drive-> Current Loop / Motion Test Tuning** to open this window. You can adjust the current loop Kp (proportional gain) and Ki (integral gain) in this window. The user can also perform the Motion Test and adjust the position loop control parameters.



Motion Test Tab

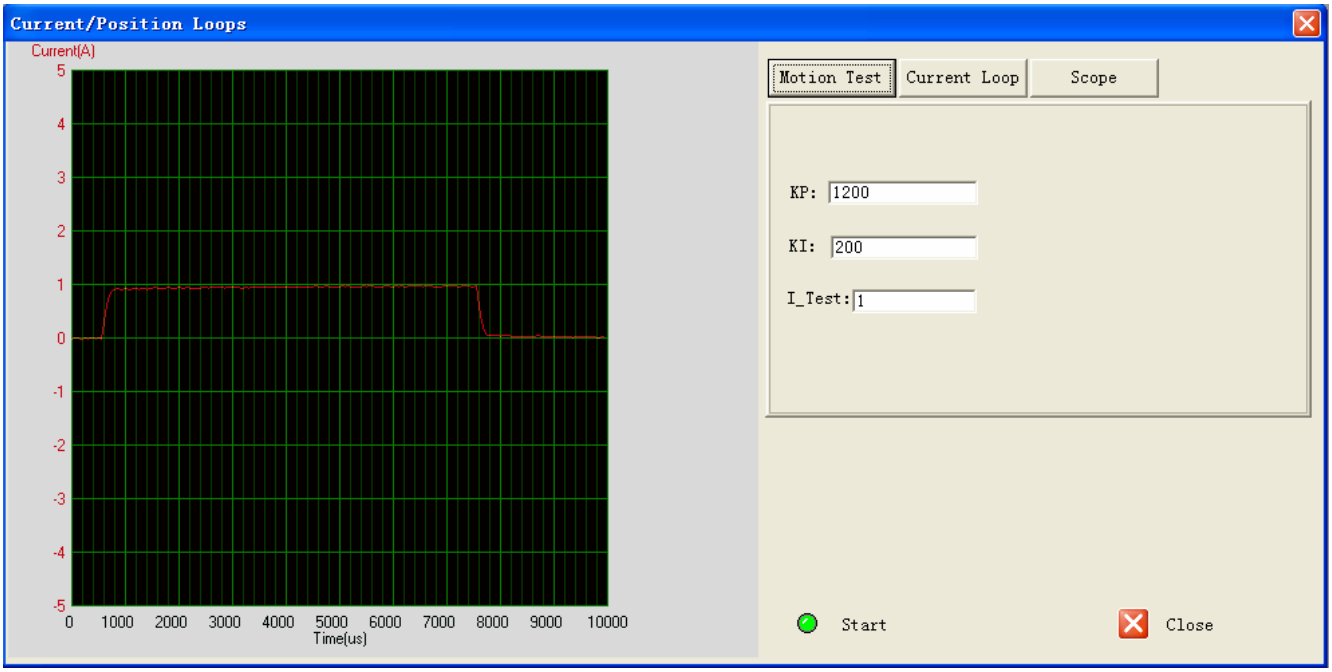
In the Motion Test tab, you can make the motor move without pulse generator or motion controller. Firstly configure the trapezoid velocity file and then click the **Start** button.



Item	Description	Range
Velocity (r/s)	Target velocity of Motion Test.	1- 50rps
Accel (r/r/s)	Acceleration of Motion Test.	1 –3000 r/s^2
Distance (r)	Move distance of Motion Test.	1 – 655 r
Intermission (ms)	Intermission between moves.	1 – 65535 ms
Repeat Times	Repeat times.	1– 65535
Run Direction	Initial direction.	Positive/ Reversal
Run Mode	Specify whether the motion is one direction or two directions.	Unidirectional /Round Trip
Trace Time	The sampling to acquire the position error.	100-3000 ms
Start	Click to start the Motion Test.	-
Stop	Stop the move immediately.	-

Current Loop Tab

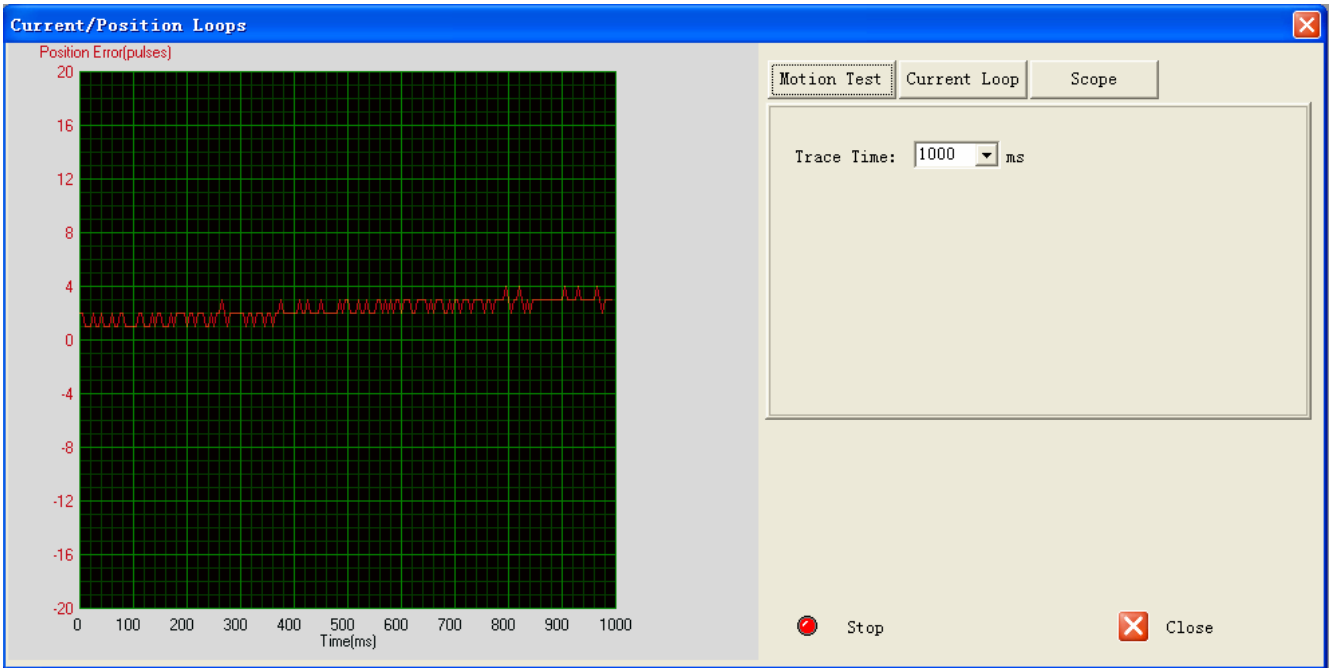
Click **Current Loop Tuning** tab to open this window. The current loop parameter is determined by the motor.



Item	Description	Range
Current Loop Kp (Proportional Gain)	Increase Kp 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.	0 – 32766
Current Loop Ki (Integral Gain)	Adjust Ki 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.	0 – 32766
I-Test	The current amplitude for the step response. Let this value not exceed the maximum output current of the drive.	0.5 – 2A
Start	Type in Kp and Ki and click this button to activate the test.	–

Scope Tab

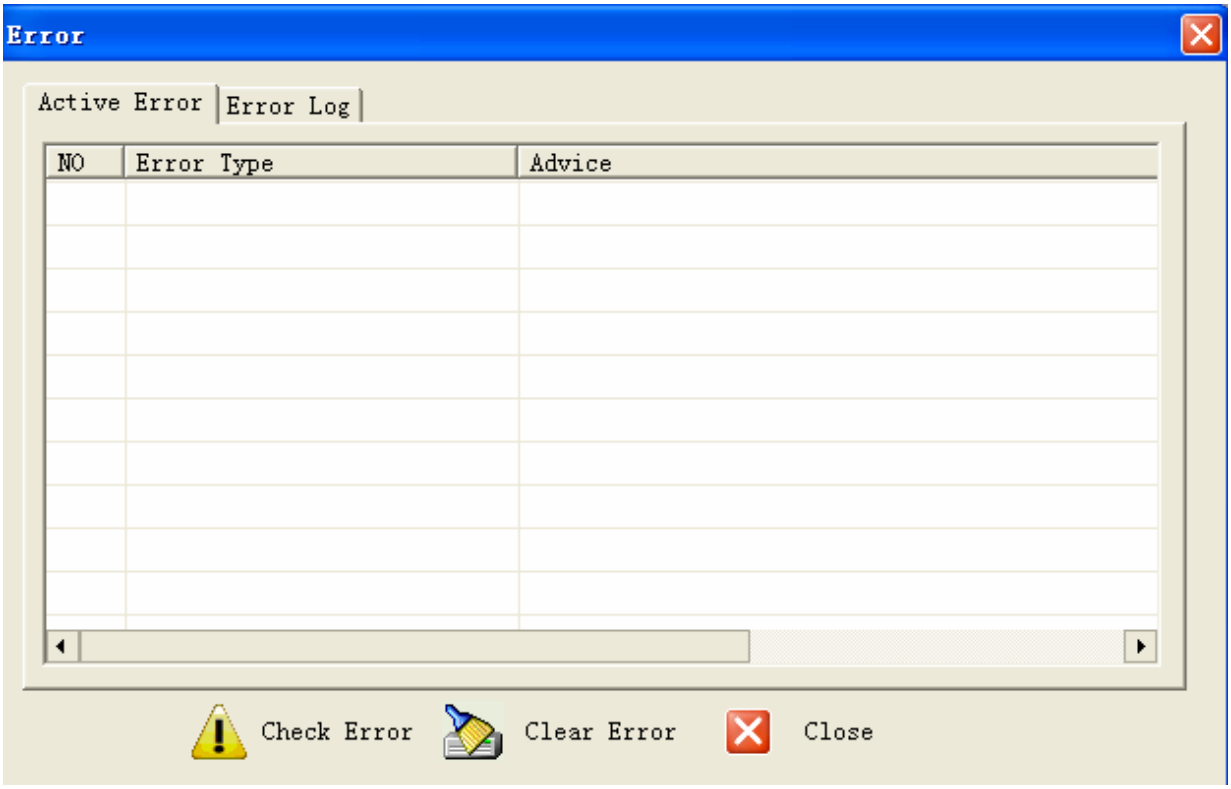
In this tab, you can monitor the dynamic position error. The trace time is the time that samples the data.



Check Errors

You can check the active error or the error log of the drive in this window. Type of error is shown as follows:

Item	Description
Over Current Error	Error occurs when the motor coil current exceeds the drive's current limit.
Over Voltage Error	Error occurs when the input voltage exceeds the drive's voltage limit
Position Following Error	Error occurs when the actual position following error exceeds the limit which is set in Position Error Limit.



Configuring the Drive

For most of applications, the position loop parameter of the HBS drive does not need to be tuned. You use the software when the following items are required:

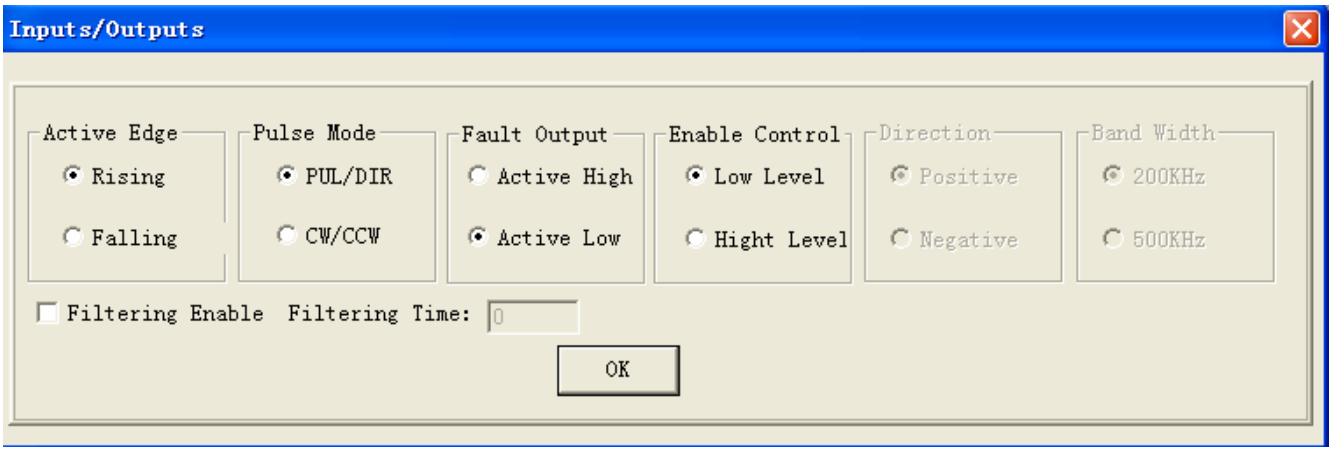
1) Set Input/Output parameters like command type (pulse mode), pulse active edge, active level of fault output.
2) Set encoder resolution, position following limit and micro step resolution according to the motor or application.
3) Set holding current (%) according to the motor's maximum current.
4) Tune the current loop parameter.

Notice

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

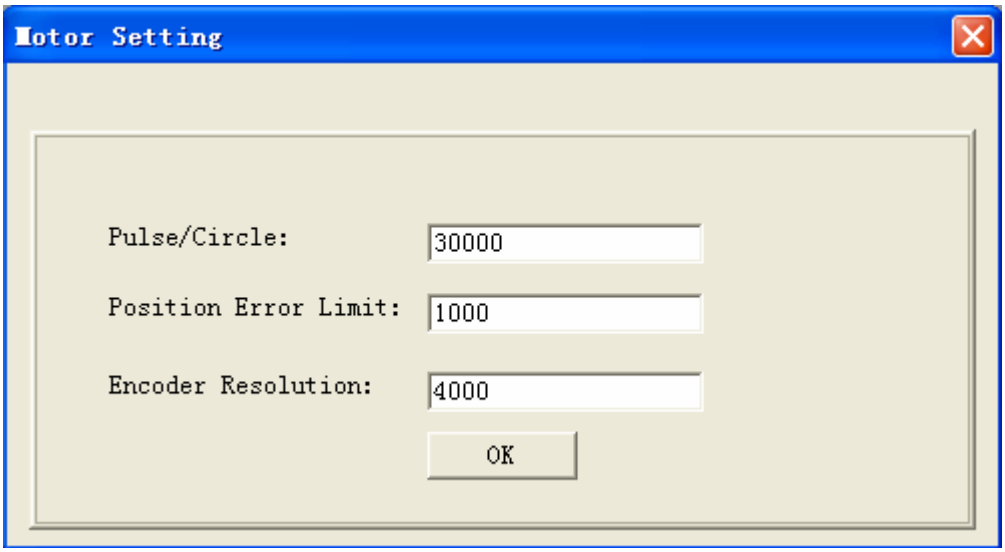
Set Inputs/Outputs

Click **Drive->Inputs / Outputs** to open the setting window. You can set pulse mode, pulse active edge, active level of fault output and motor direction in this window.



Set Motor Parameters

Click **Drive->Motor Settings** to open the motor setting window. You can set the micro step resolution, position error limit and encoder resolution in this window.



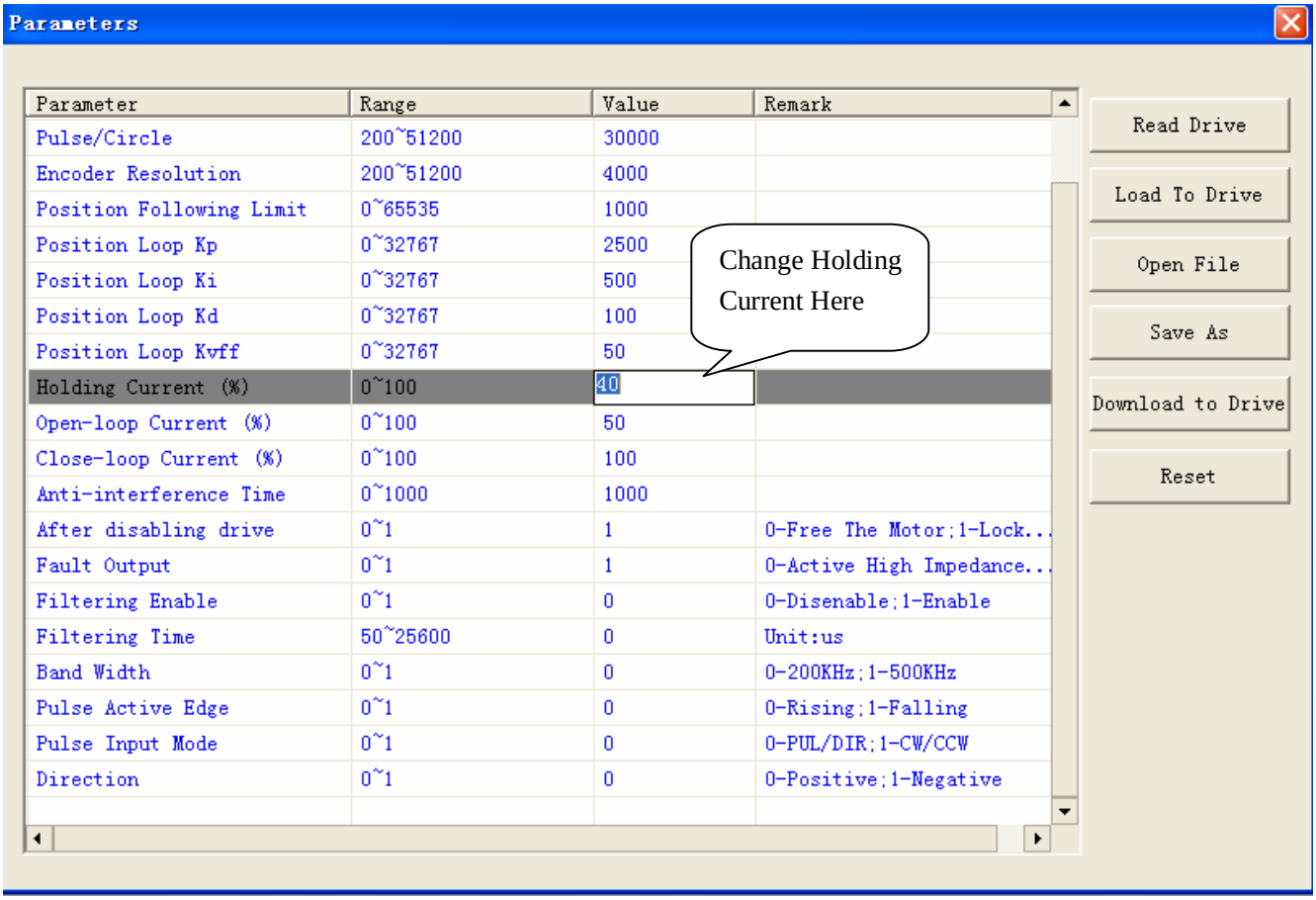
High resolution Micro Step makes the motor move more smoothly. Low Micro Step resolution reduces the high frequency requirement to the controller. If the application requires small position following error, reduce the **Position Error Limit**. The encoder resolution is 4 multiple of the actual encoder resolution.

Set Holding Current

The holding current affects the holding torque at standstill. However, high holding current brings much heating to the motor and this may not be accepted for some application. Please refer to the hardware manual for more information for the setting of the holding current.

Recommended **Holding / Close-loop Current** Percentage

	573S09-EC	**573S20-EC**	**57HS10-EC**	**57HS20-EC**	**86HS40-EC**	**86HS80-EC**
Holding Current (%)	60%	60%	40%	60%	60%	60%
Close-loop Current Limit (%)	100%	100%	100%	100%	100%	100%
HBS Drive	HBS57	HBS57	HBS86	HBS86	HBS86	HBS86

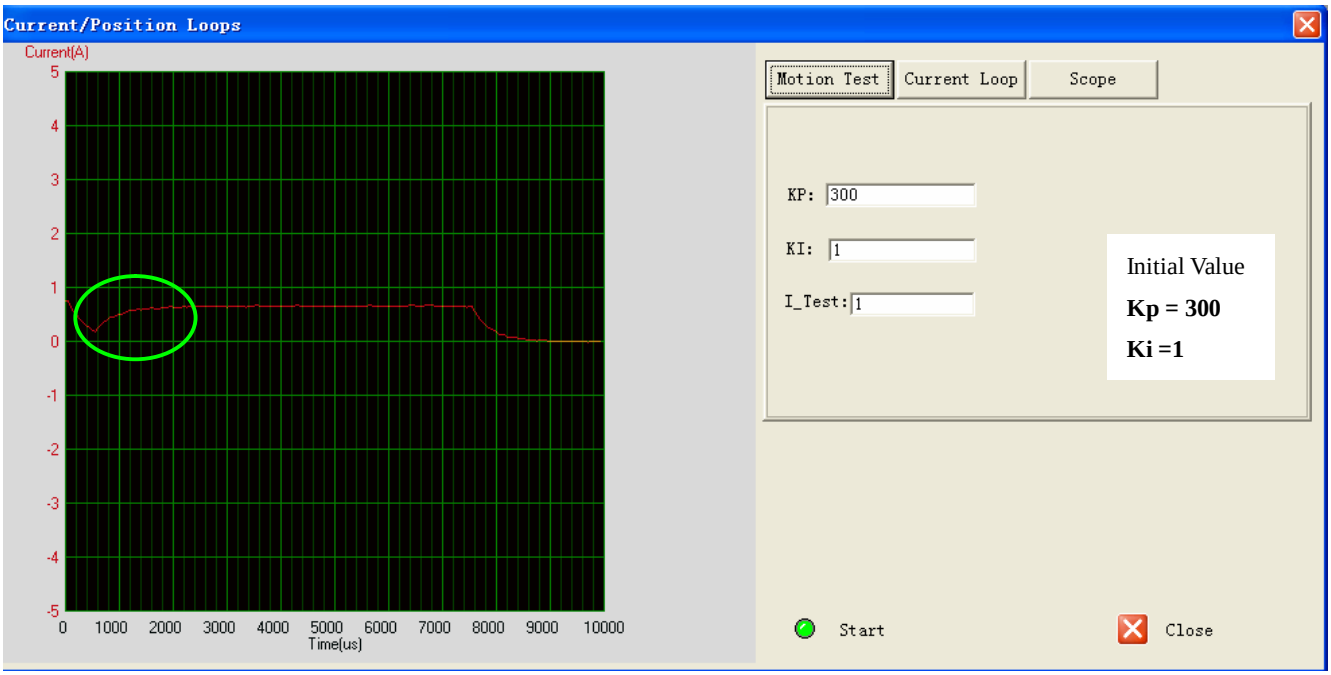


Tune Current Loop

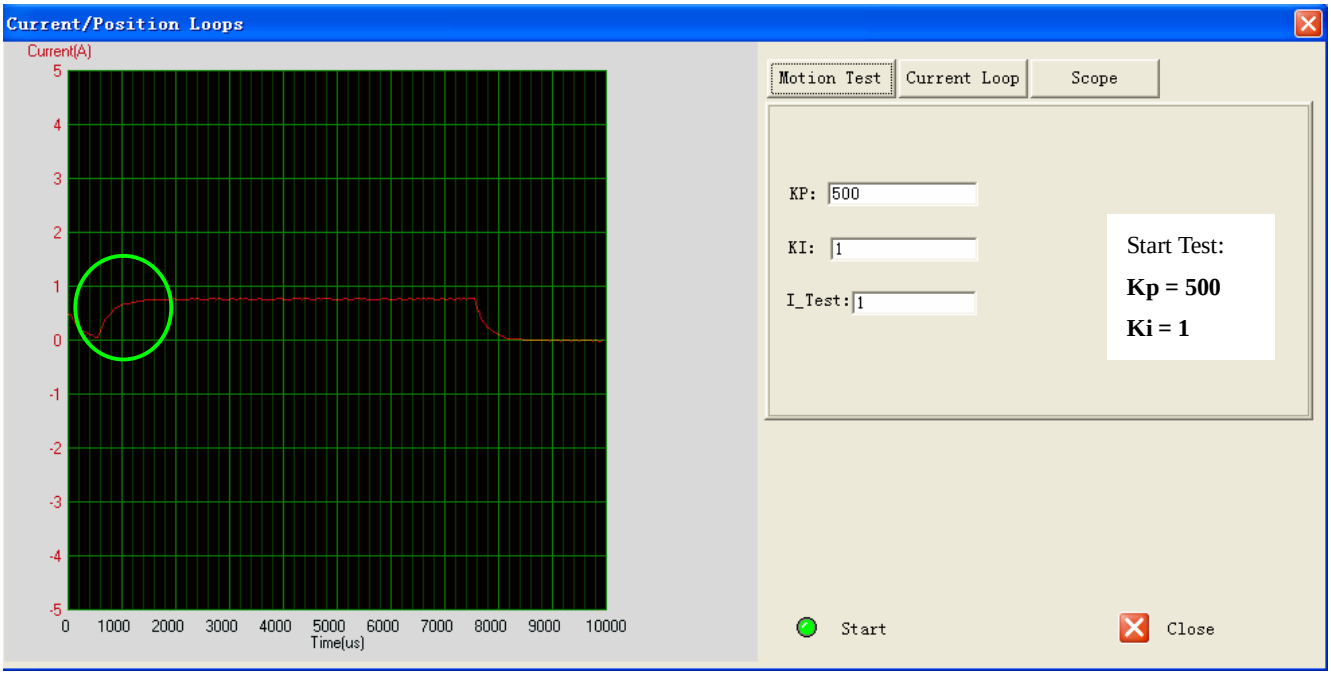
Click the **Drive-> Current Loop / Motion Test Tuning** to start the tuning. In the open window, the default tab is Motion Test. Click the **Current Loop** button and the current loop parameter Kp and Ki appear. See the picture below.

Below is the tuning process of HBS86 plus 57HS10-EC with 24VDC supply voltage.

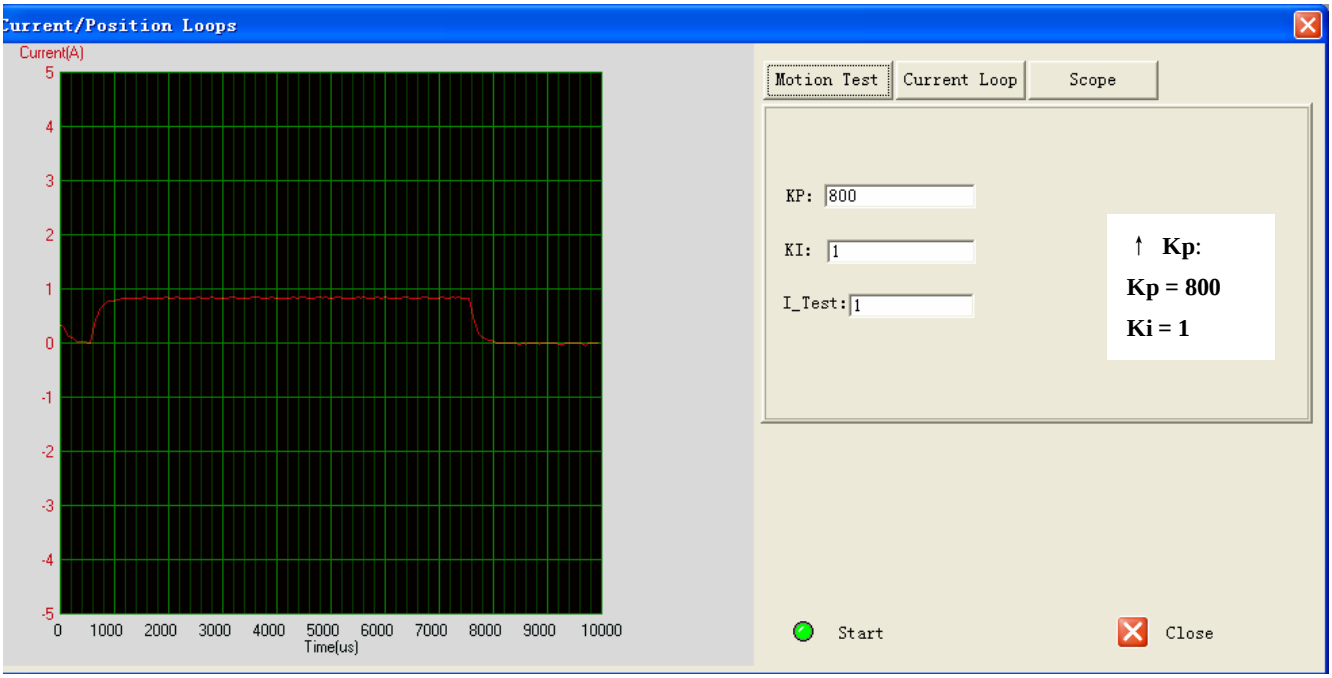
Step 1: Set **I-Test** 1 and start the tuning with small **Kp** and "zero" **Ki**. Here we set **Kp** =300 and **Ki**=1.



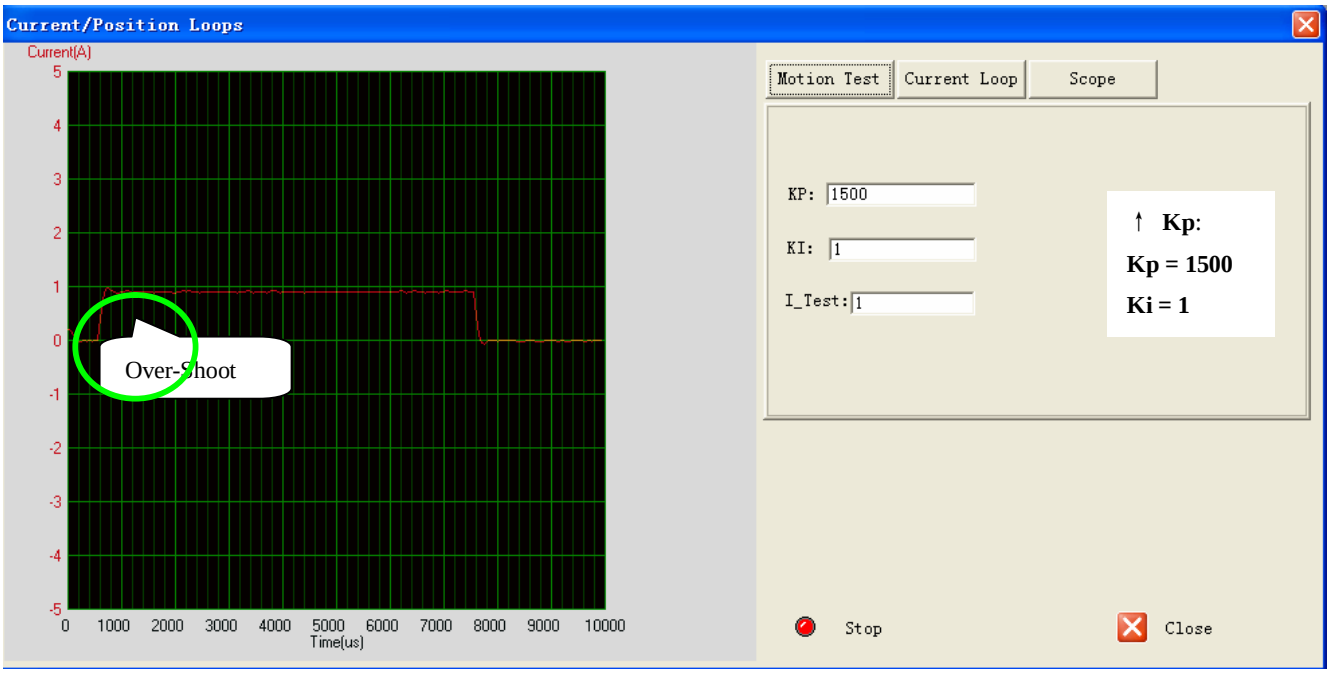
Step 2: Click the **Start** button and the plot window shows the step response of the current test. As the red curve increases from 0 to target slowly, it indicates that a large **Kp** needs to be introduced.

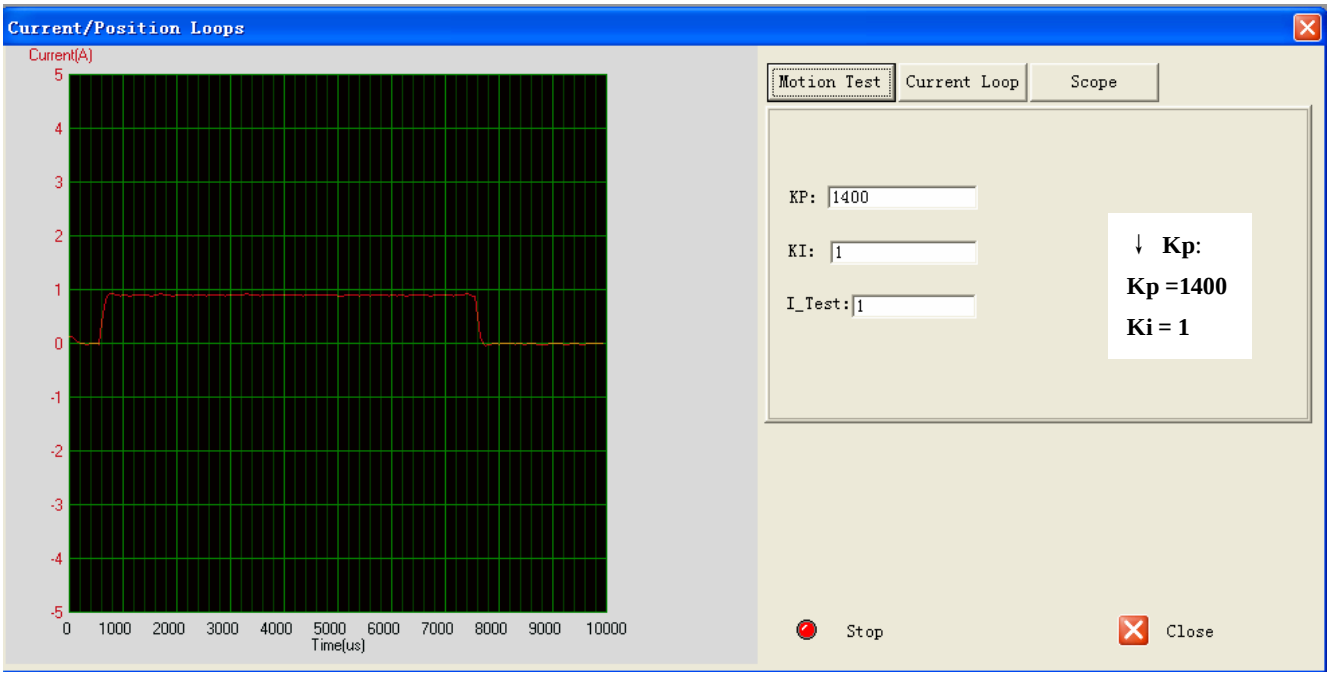


Step 3: Increase **Kp** to 800 and click **Start**. The red curve change faster from 0 to the target.

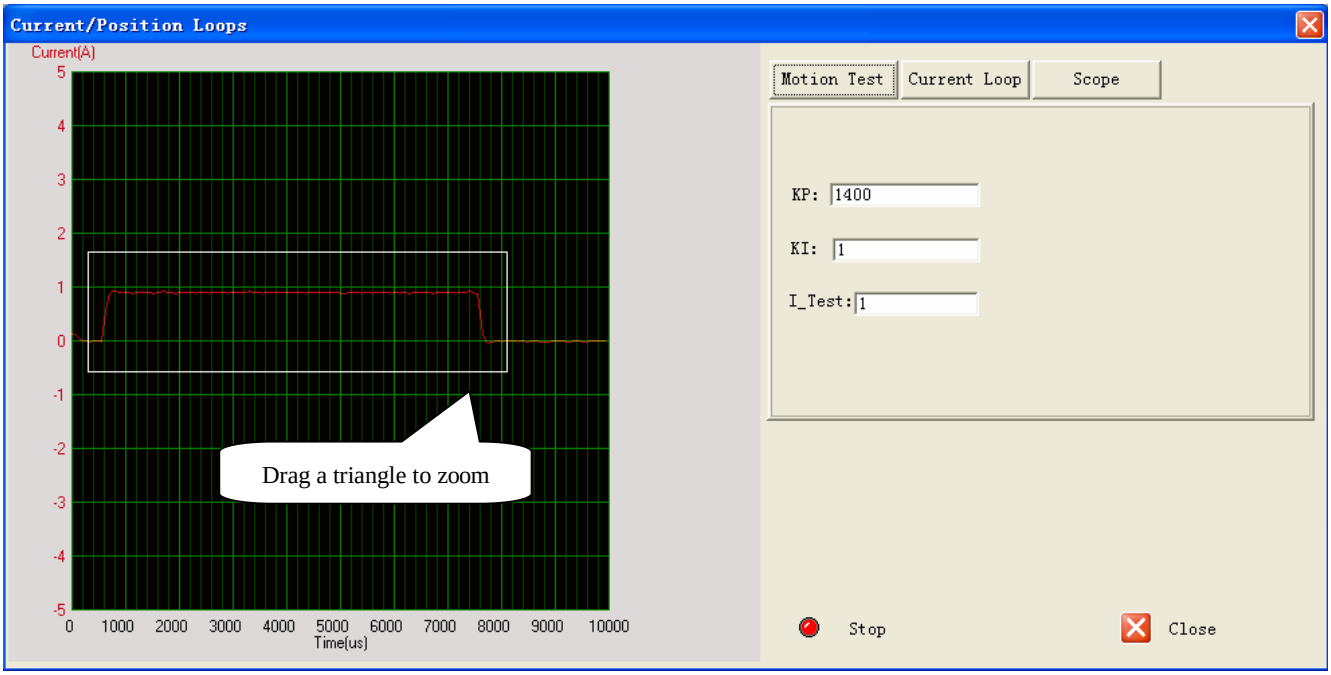


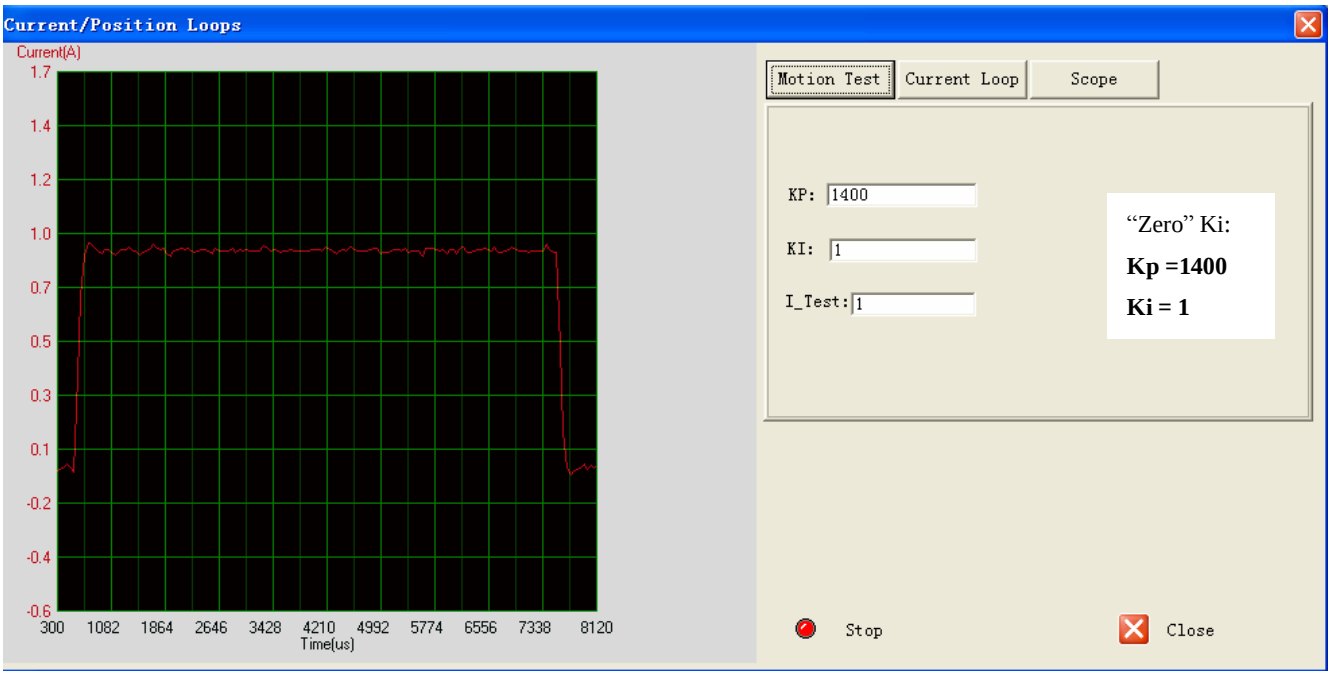
Step 3: Give **Kp** 900, 1200 and click **Manual Tuning,** respectively. The red curve is changing faster. Over-shoot is obvious when we increase **Kp** to 1500. It indicates that you need to stop increasing Kp and back off. So we decrease Kp to 1400 until the actual value is exactly over the target value.

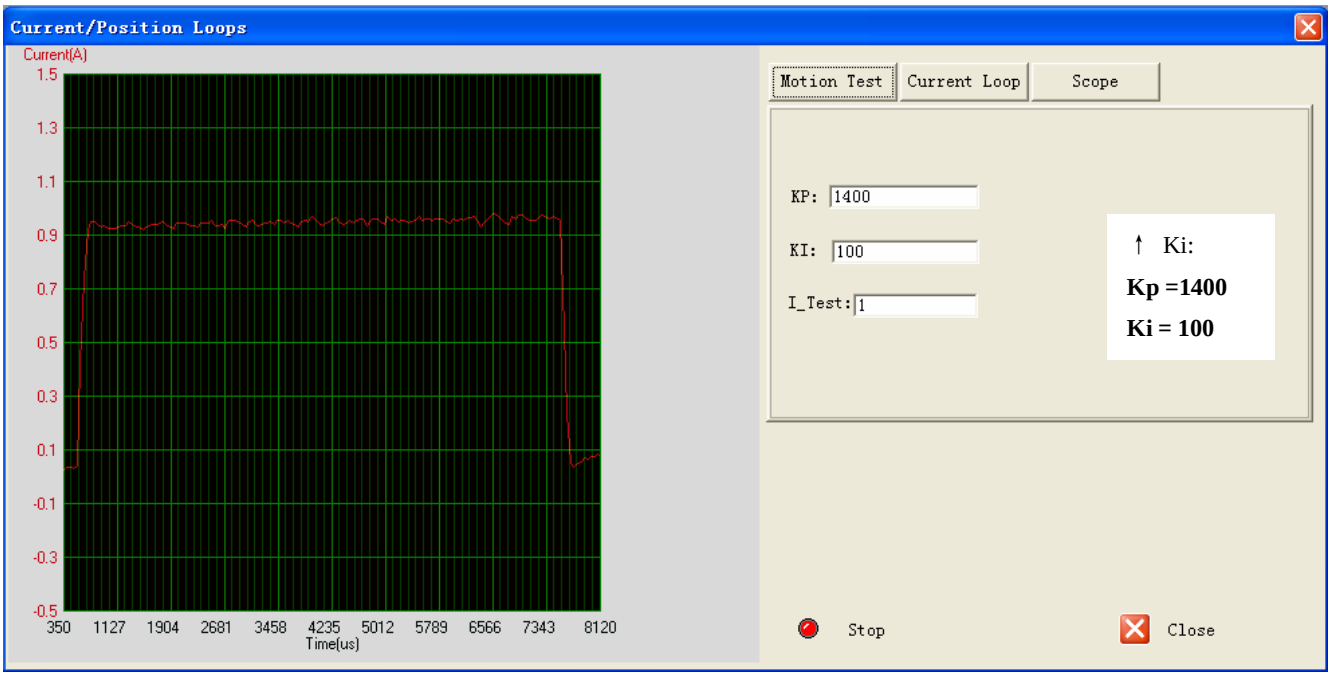


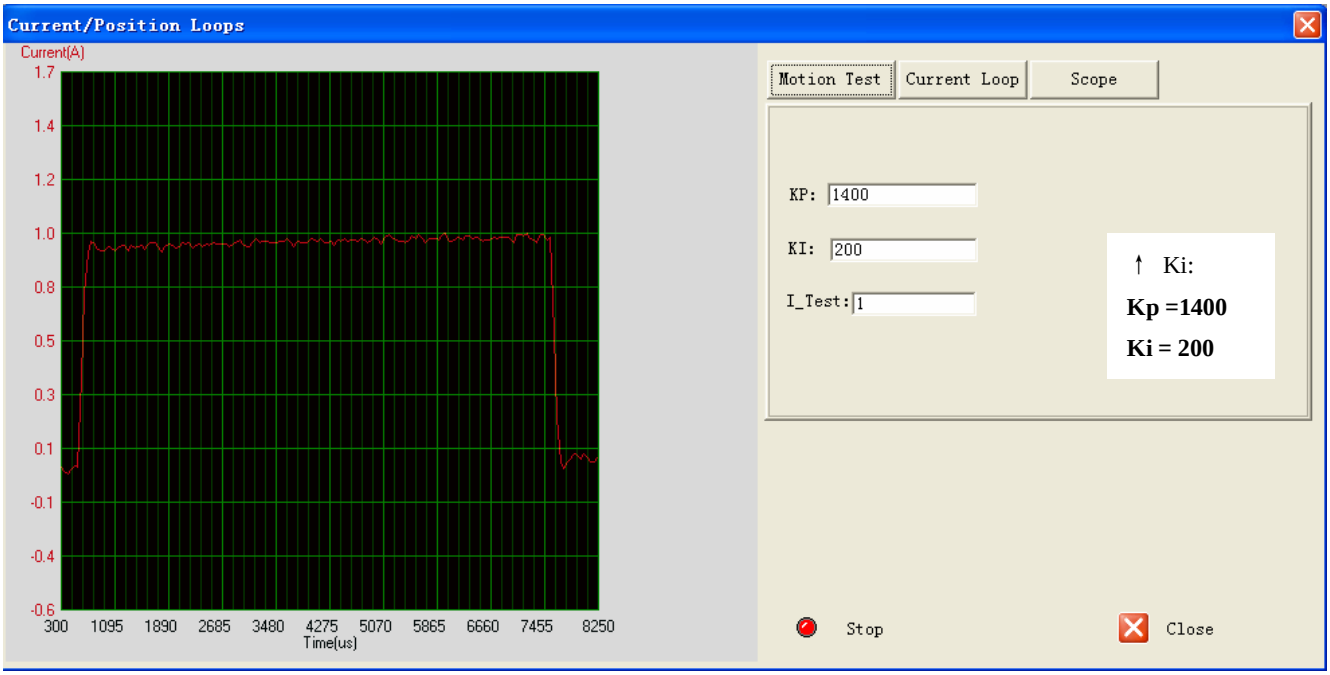


Step 4: Now the **Kp** is relatively good enough. But there is still error between the command current and the target current. So we need to introduce **Ki** to reduce the steady error at the constant part. It follows the same procedure as **Kp**. High **Ki** causes big vibration, system lag and makes the performance worse. The following figures show how to tune the integral gain.

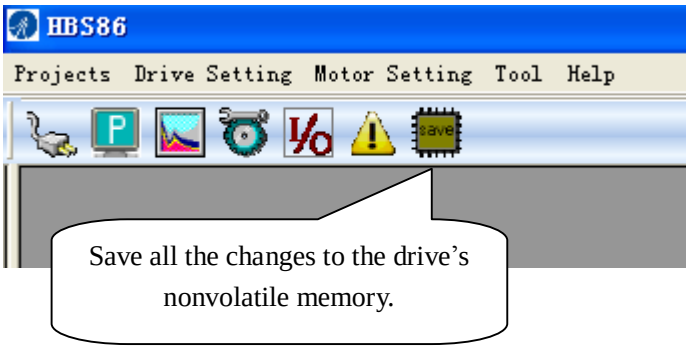





Current/Position Loops
Current(A)
1.5
1.3
1.1
0.9
0.7
0.5
0.3
0.1
-0.1
-0.3
-0.5
350 1127 1904 2681 3458 4235 5012 5789 6566 7343 8120
Time(us)
Motion Test
Current Loop
Scope
KP: 1400
KI: 100
I_Test: 1
↑ Ki:
Kp =1400
Ki = 100
Stop
Close


Current/Position Loops
Current(A)
1.7
1.4
1.2
1.0
0.8
0.5
0.3
0.1
-0.1
-0.4
-0.6
300 1095 1890 2685 3480 4275 5070 5865 6660 7455 8250
Time(us)
Motion Test
Current Loop
Scope
KP: 1400
KI: 200
I_Test: 1
↑ Ki:
Kp =1400
Ki = 200
Stop
Close

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 the **Download to Drive** icon to store the changed value to the drive's non-volatile memory. See below.



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