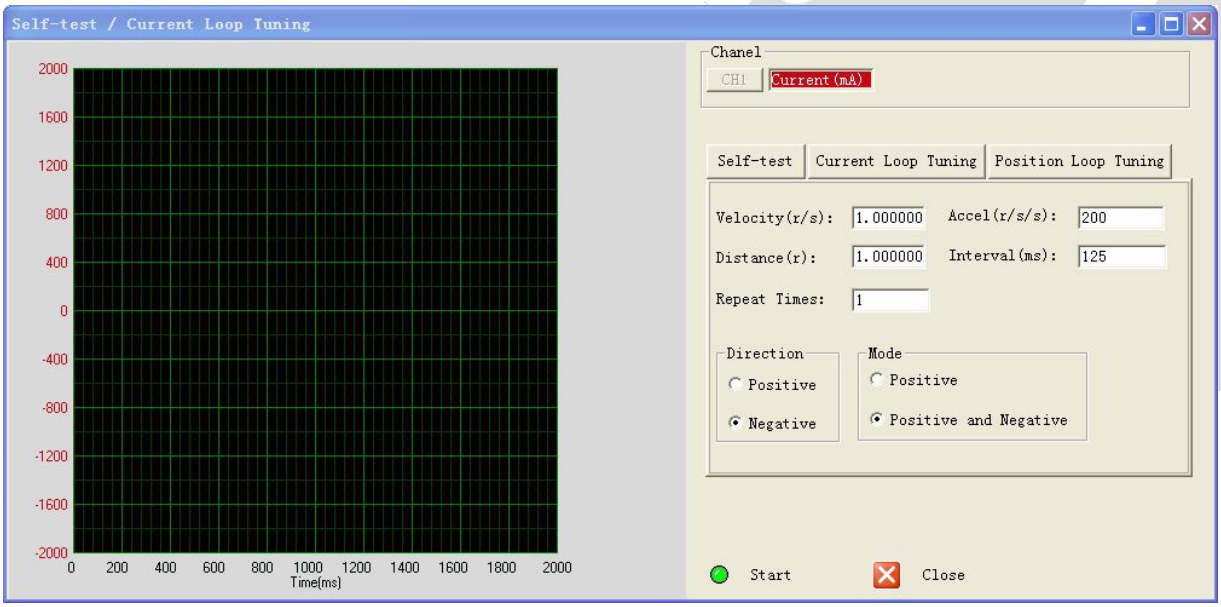
Software Operational Manual

for Hybrid Servo Drive HBS57/86(H)



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Change Log

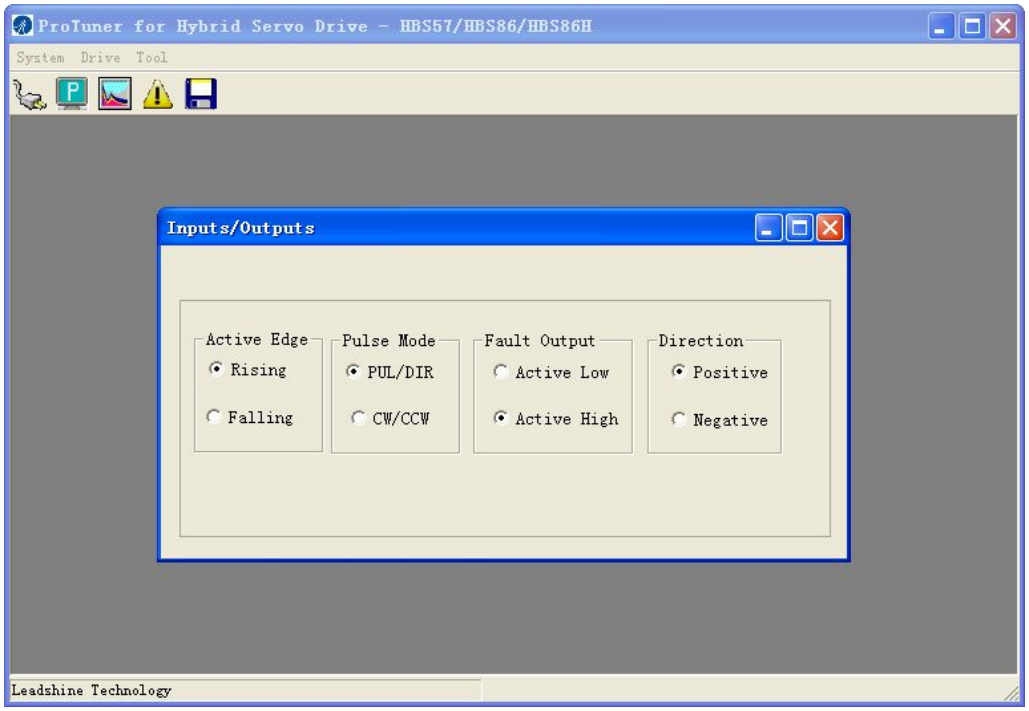
Revision Date	Changes	Version
2012-02-16	Original Create	SM-HBS-R20120216

Table of Contents

Introduction

The ProTuner is a software tool designed to configure and tune the Leadshine HBS series hybrid series drives include HBS57, HBS86 and HBS86H. 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

Properties Window

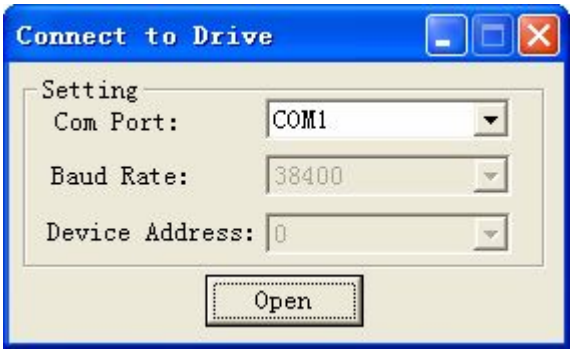
Menus and Toolbar

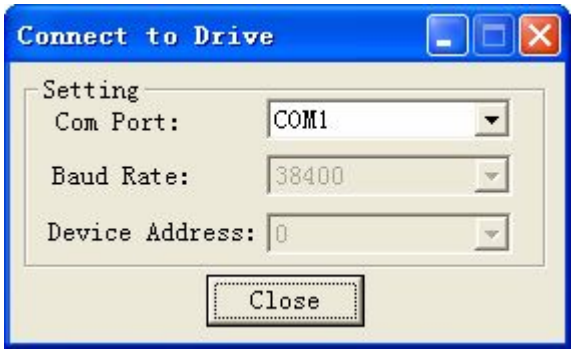
Menus and toolbars are at the top of the workspace. You can click menu bar to view pull-down menu. The toolbar below offers the most frequency used commands.

Menu	Pull Down	Toolbar	Function
System ->	Connect to Drive		Open the serial port and connect to 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.
Drive ->	Inputs / Outputs	-	Set the command type, active level of the I/O signal.
	Motor Setting	-	Set micro step resolution, position following limit and encoder resolution.
	Current Loop / Self-test		Tune the current loop, adjust the position loop parameter and perform self-test.
Tool->	Error		Check drive error
			Save to drive

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.

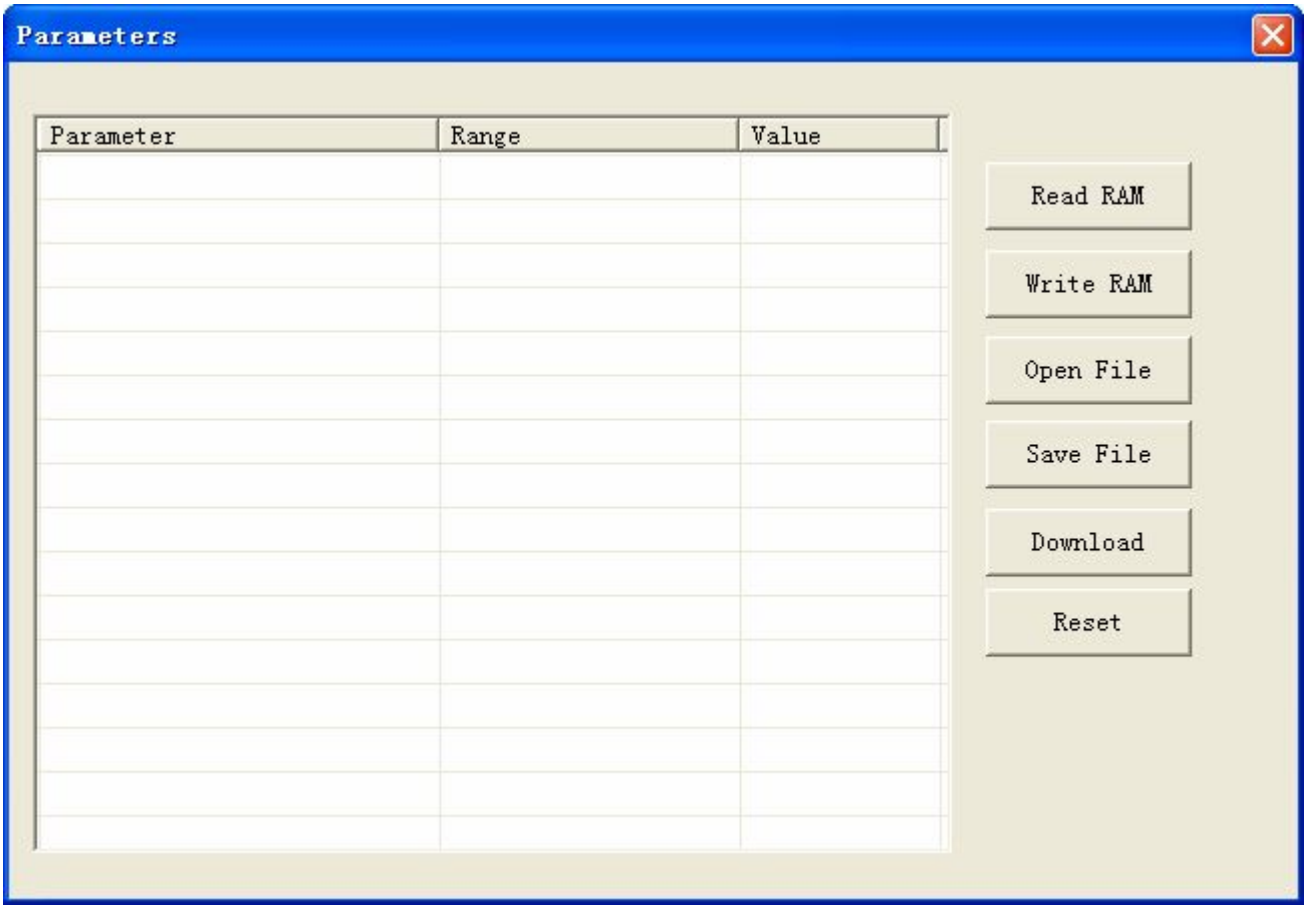
The motor is no need to connect to the drive if you just want to change the parameters but not tuning.

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

Parameters Operation

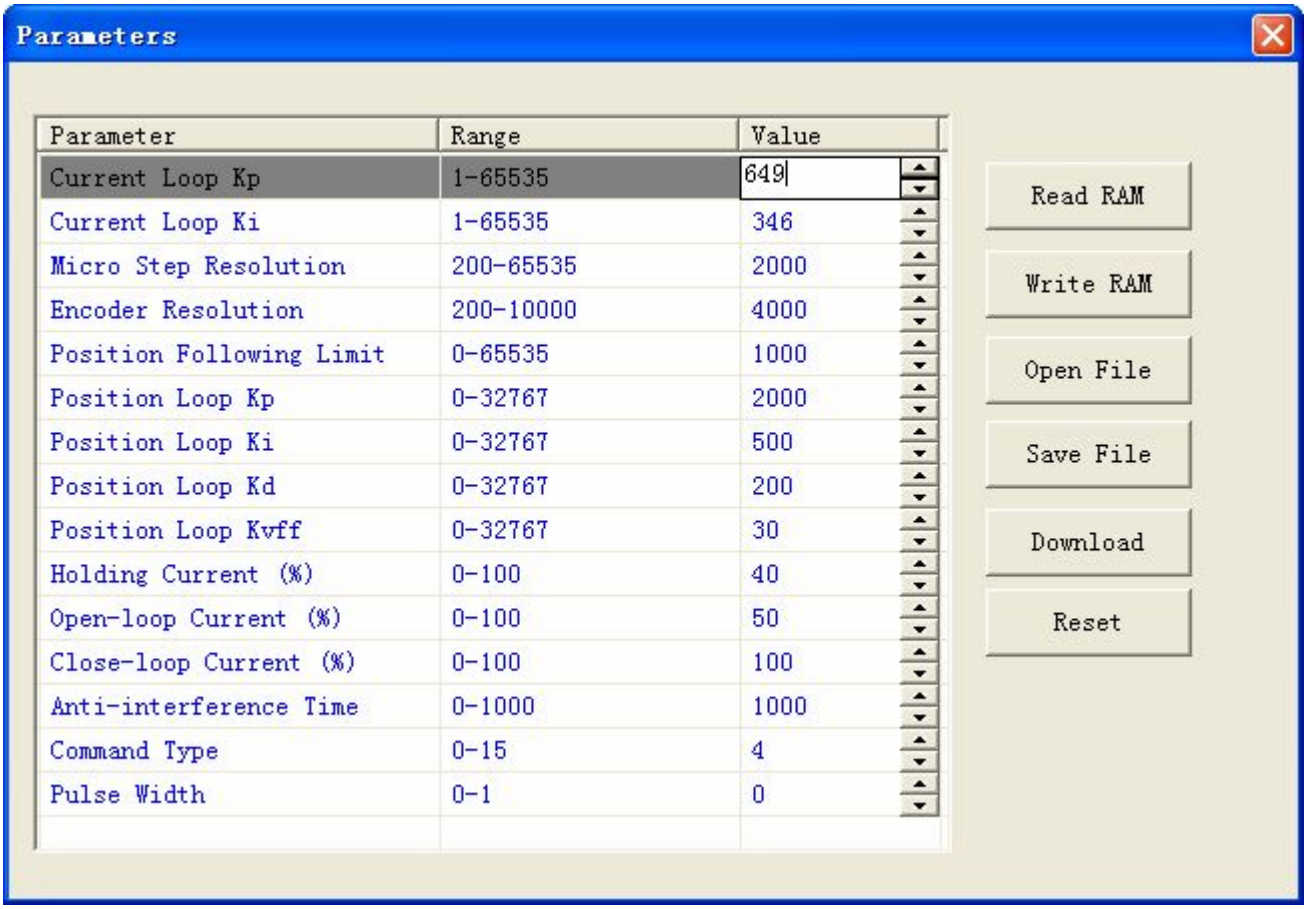
Click **System->Parameters** to open the parameter operation window. You can deal with the drive parameters in this window as follows:

1) **Read RAM**: Read parameters from the drive's RAM (Random-access memory);
2) **Write RAM**: Write parameters to the drive's RAM(Random-access memory);
3) **Open File**: Open a configuration file and restore parameters to ProTuner;
4) **Save File**: Save the parameters to a configuration file;
5) **Download**: Download parameters to the drive's nonvolatile memory;
6) **Reset**: Restore factory settings of the drive.



Read RAM

When you change the parameter, the ProTuner store it to the drive's RAM (Random-access memory). If you wan to check it, click **Read RAM** button and all the parameters will be shown in this window. Double click the value of the parameter, you can change the parameter. Click the other place to confirm the input.



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.	1 – 65535
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.	1 – 65535
Micro Step Resolution	Drive's Micro Step setting for the motor.	200-65535
Encoder Resolution	The encoder lines or resolution. 4 × of the actual resolution	200-10000

Position Following 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	Current when there is no pulse applied to the drive.	0%-100%
Open-loop Current	Current when the drive goes into open loop control.	0%-100%
Close-loop Current	Current when the drive goes into close loop control.	0%-100%
Anti-interference Time	Ignore it.	0-1000 ms
Command Type	Ignore it.	-
Pulse Width	Ignore it.	-

Open File

If you want to load the configuration data from a file in the PC, click **Open File** button in the **Parameters** Window. The parameters in the software's workspace will be updated.

Save File

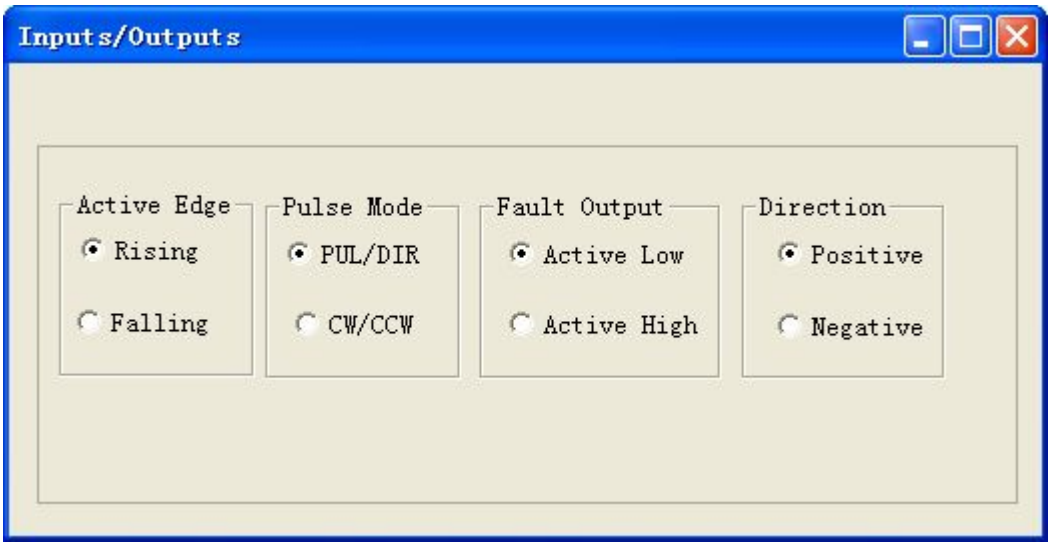
Click **Save File** button to save the data of current workspace to a file. This file can be used for the other drive..

Download

Click **Download button** to download the changes to the drive's nonvolatile memory..

Inputs/Outputs Window

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

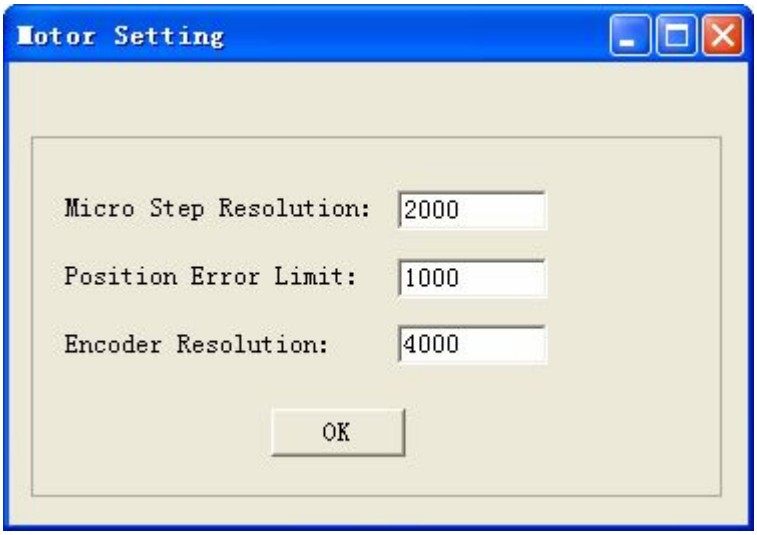


Item	Description	Range
Active Edge	Pulse active edge. The motor shaft moves one micro step every active edge.	Rising /Following
Pulse Mode	Pulse mode of control signal. Select PUL/DIR or CW/CCW according to command type of motion controller. PUL/DIR means pulse and direction mode; CW/CCW means double 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

Direction	Change the motor direction. It is only active in PUL/DIR command mode. Please note that the actual direction is also related to the motor coil connection.	Positive /Negative

Motor Setting Window

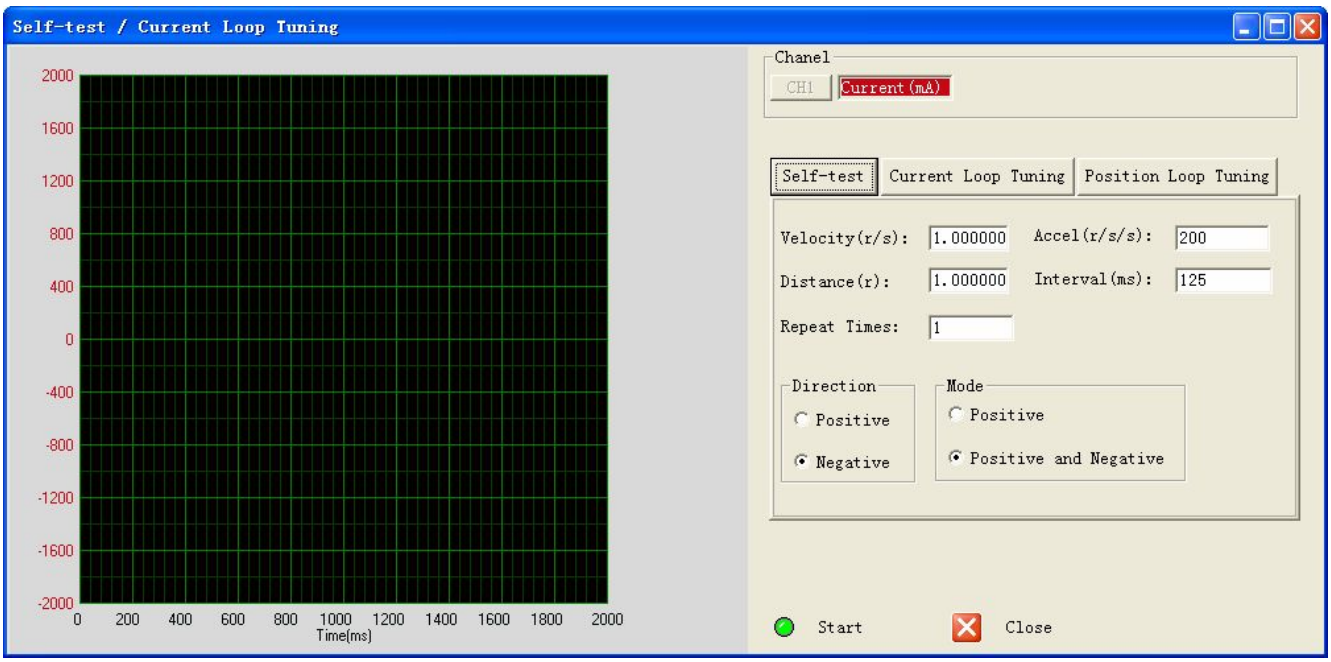
Click Drive->Motor Setting to open this window. You can set the micro step resolution, position following error limit and encoder resolution in this window.



Item	Description	Range
Micro Step Resolution	Drive's Micro Step setting for the motor.	200-65535
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
Encoder Resolution	The encoder lines or resolution. 4 × of the actual resolution. For example, if the encoder resolution is 1000, it is 4000.	200-10000

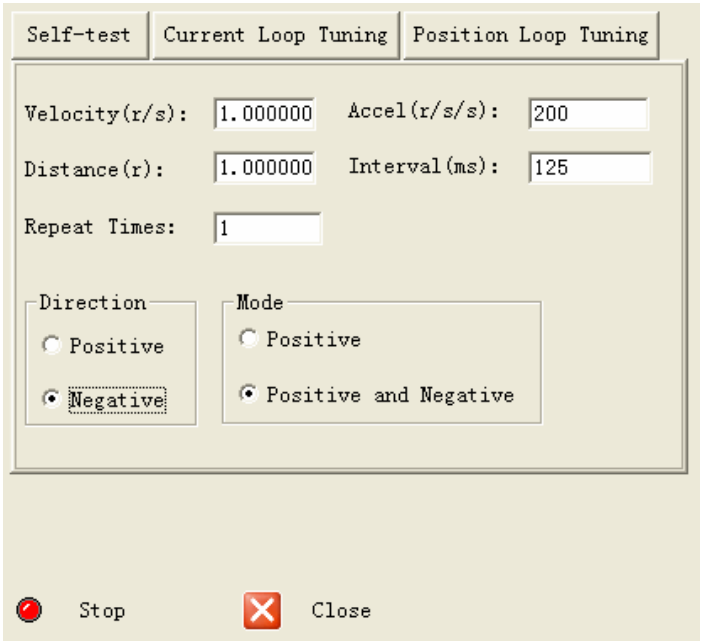
Self-test / Current Loop Tuning Window

Click **Drive->Self-test / Current Loop 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 self-test and adjust the position loop control parameters.



Self-test Tab

In the self-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.

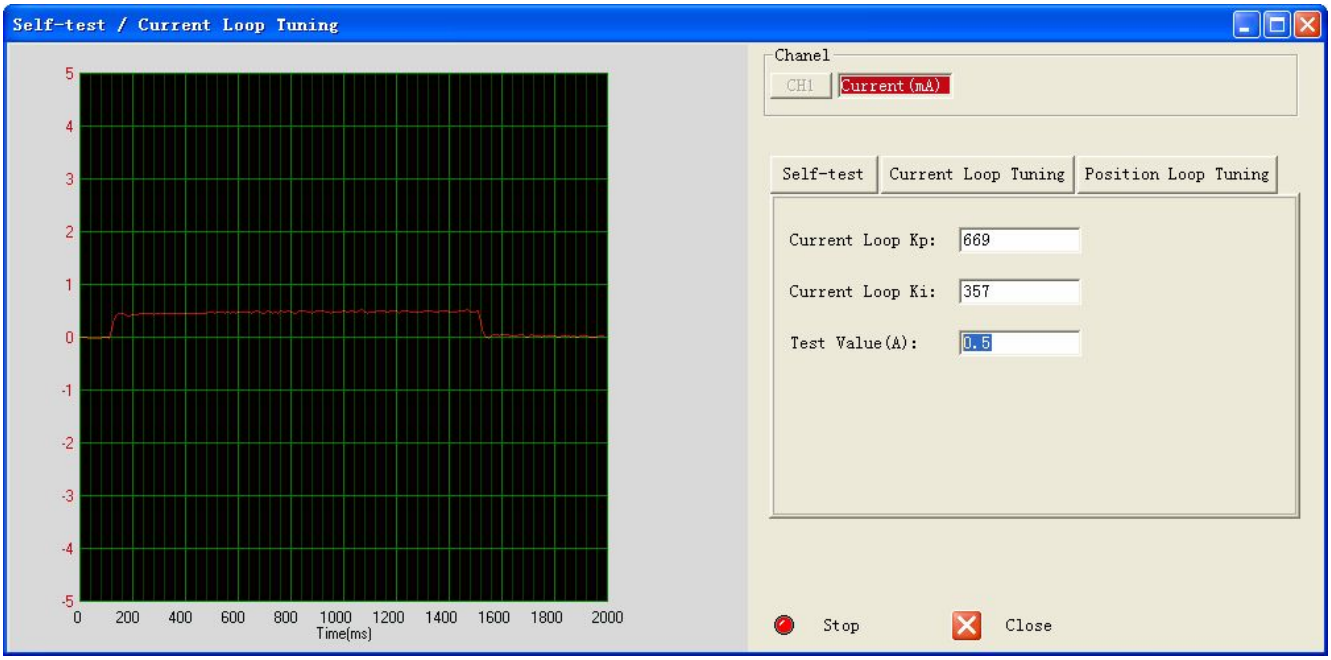


Item	Description	Range
Velocity (r/s)	Target velocity of Self-test.	1– 65535 rpm
Accel (r/r/s)	Acceleration of Self-test.	1 – 65536 r/s^2

Distance (r)	Move distance of Self-test.	1 – 65536 r
Interval (ms)	Interval between moves.	1 – 65535 ms
Repeat Times	Repeat times.	1– 65535
Direction	Move direction.	Positive/ Negative
Mode	Self-test mode includes single direction move or two direction move.	-
Start	Click to start the Self-test.	-
Stop	Stop the move immediately.	

Current Loop Tuning Window

Click **Current Loop Tuning** tab to open this window. The current loop parameter is related to the motor resistance and inductance.

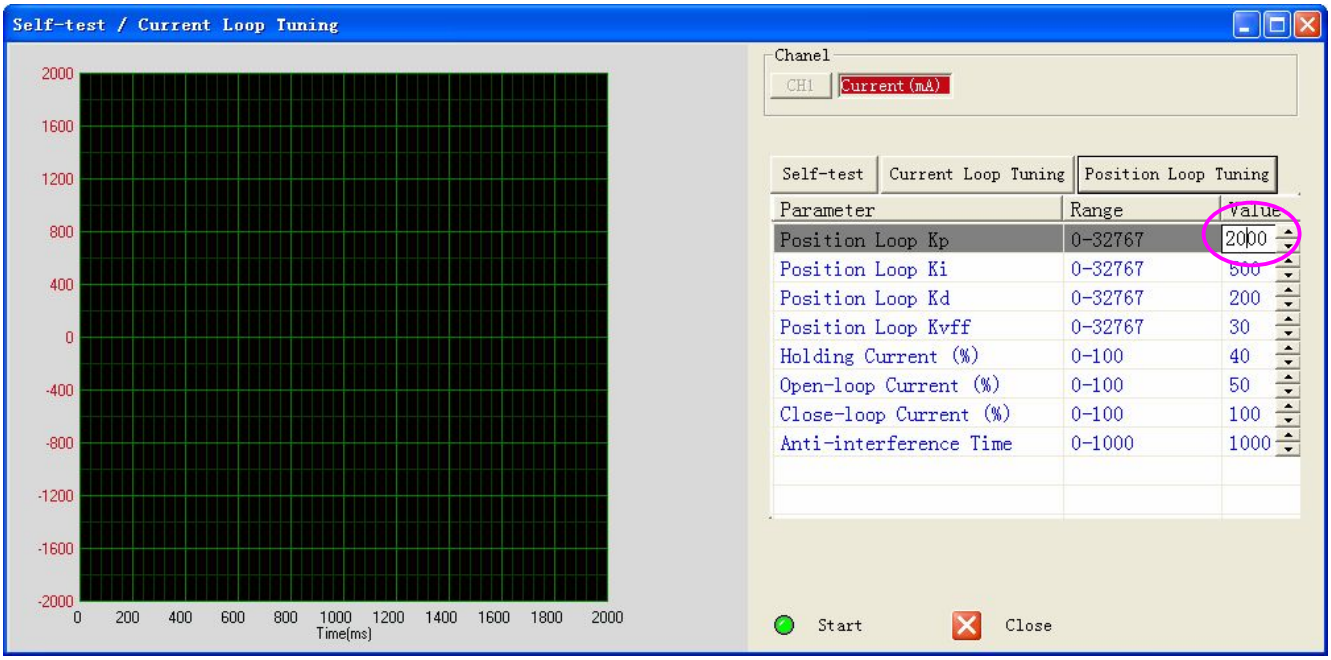


Item	Description	Range
Current Loop Kp (Proportional Gain)	Increase Kp to make current rise fast. Proportional Gain determines the response of the drive to current setting command. Low Proportional Gain provides a stable system (doesn't oscillate), has low stiffness, and large current error, causing poor performances in tracking current setting command in each step. Too large Proportional Gain values will cause oscillations and unstable systems.	1 – 65535

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.	1 – 65535
Test Value (A)	The current amplitude for the step response. Let this value not exceed the maximum output current of the drive.	0.5-2A
Start	Enter Kp and Ki and 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.	-

Current Loop Tuning Window

Click **Position Loop Tuning** tab to open this window. You can adjust the position loop parameter to get lower noise or fast response of the motor. Double click the value to change the parameters.



Item	Description	Range
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	0 – 32767

	position errors under load. Too large Proportional Gain values will cause oscillations and unstable systems.	
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
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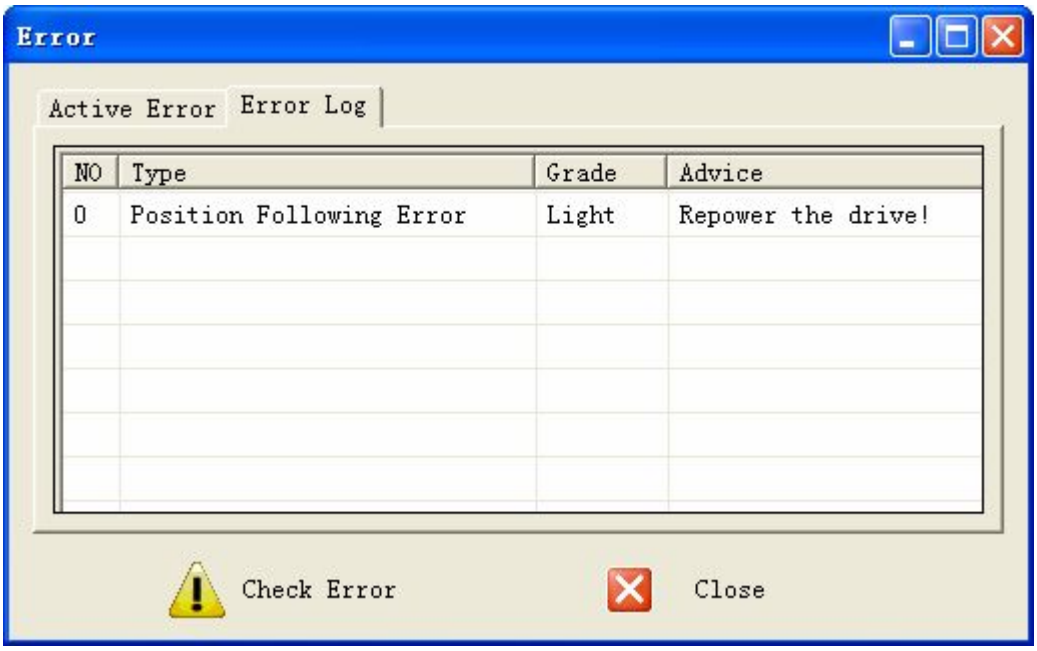
Position Loop Kvff (Feed-forward Gain)	**Feed-forward gain**. It speeds up the system response.	0 – 32767
Holding Current	Current when there is no pulse applied to the drive.	0%-100%
Open-loop Current	Current when the drive goes into open loop control.	0%-100%
Close-loop Current	Current when the drive goes into close loop control.	0%-100%
Anti-interference Time	Ignore it.	0-1000 ms

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 the most of the applications, the HBS series drive does not need to tune and can be used to control the motor. However, if the use has special requirement or the actual performance is not good, the ProTuner can be used to configure the drive. Usually, you can follow the steps below to configure the drive.

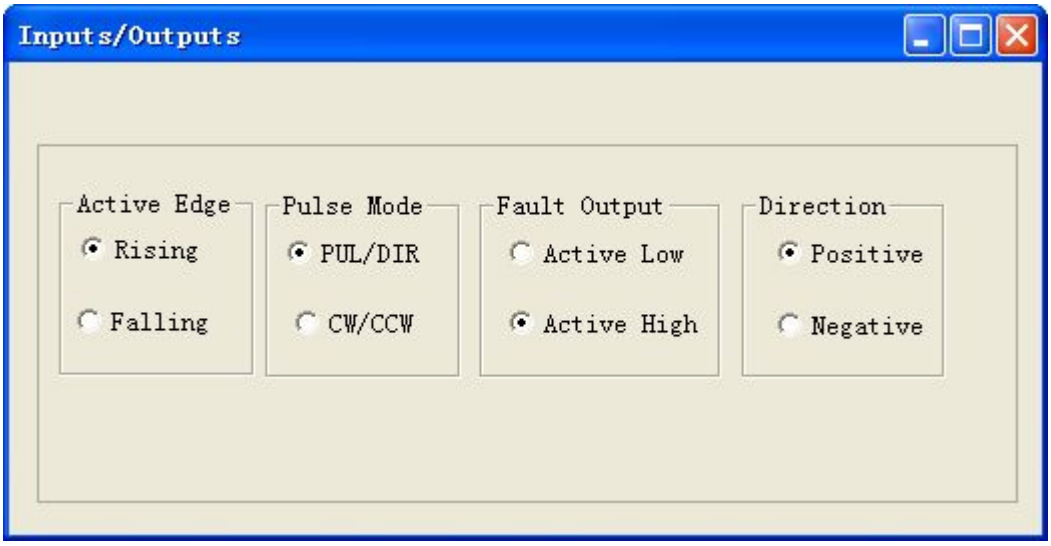
1) Set Input/Output parameters like command type(pulse mode), pulse active edge, active level of fault output, motor direction, encoder resolution, position following limit and micro step resolution according to the motor or application.
2) Tune the current loop parameters with the connected motor.
3) Adjust the position loop parameters when lower noise or fast speed is required.

Notice

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

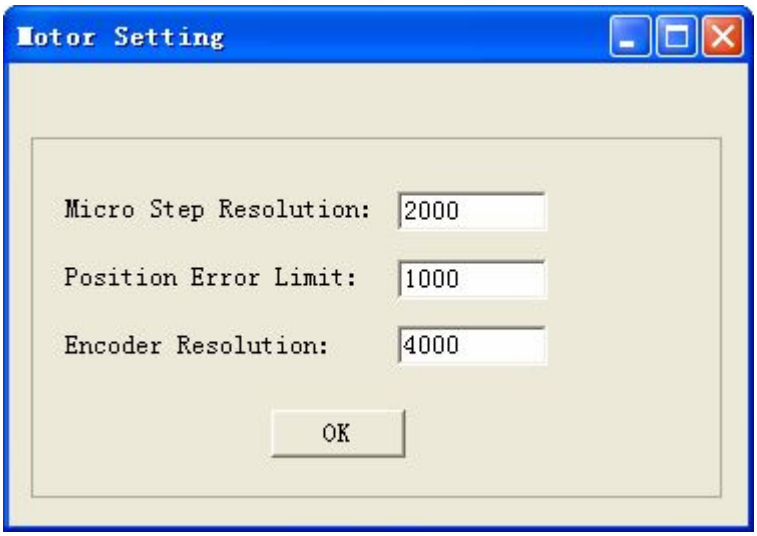
Set Inputs/Outputs

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

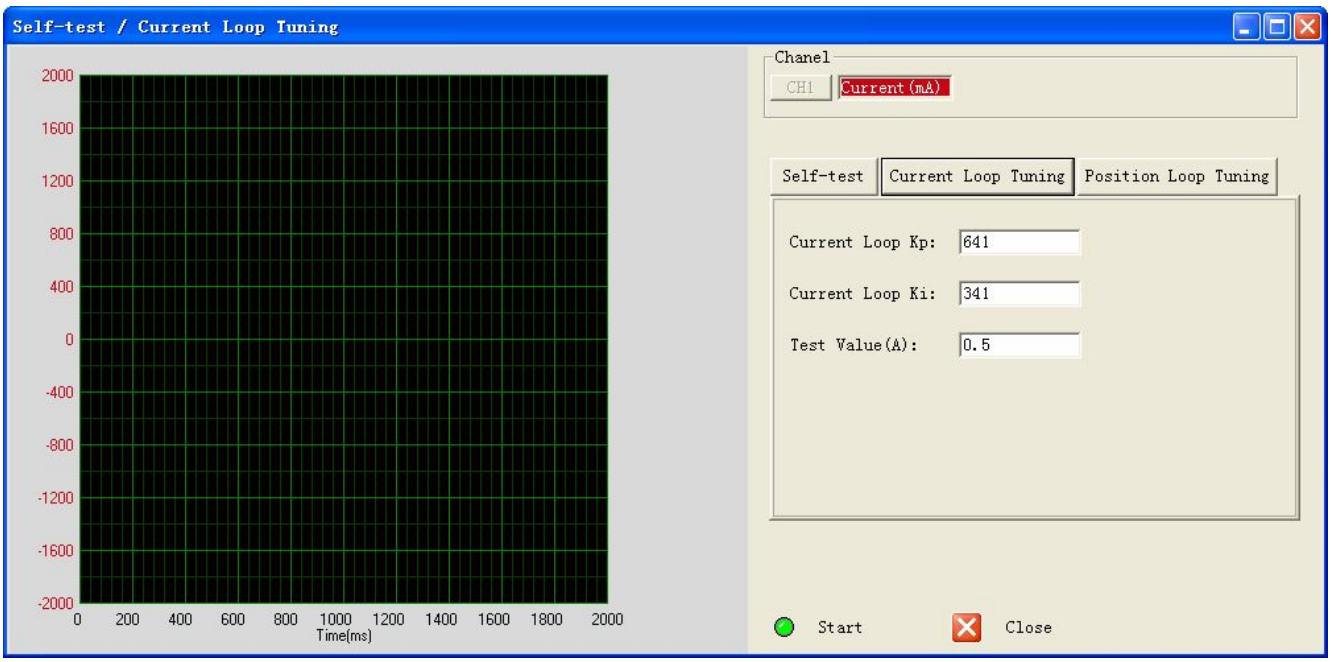
Click **Drive->Motor Settings** to open the motor setting window. You can set the micro step resolution, position error limit and encoder resolution in this window.



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 ×actual encoder resolution.

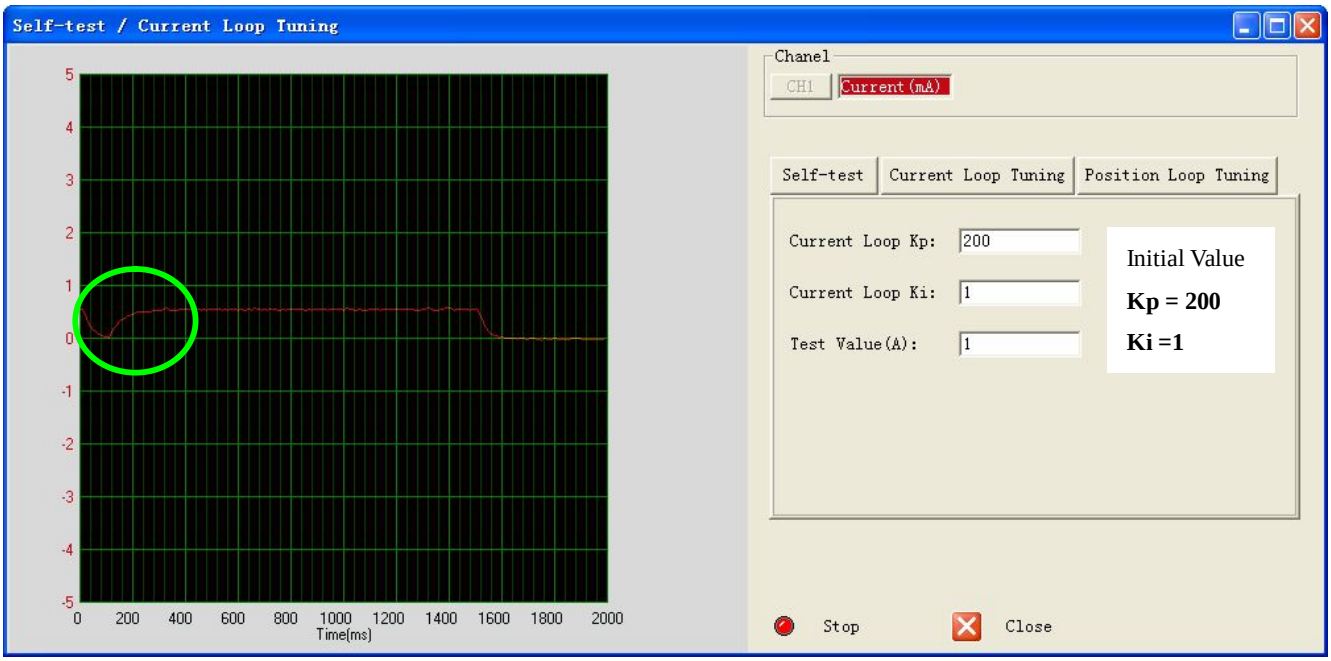
Current Loop Tuning

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

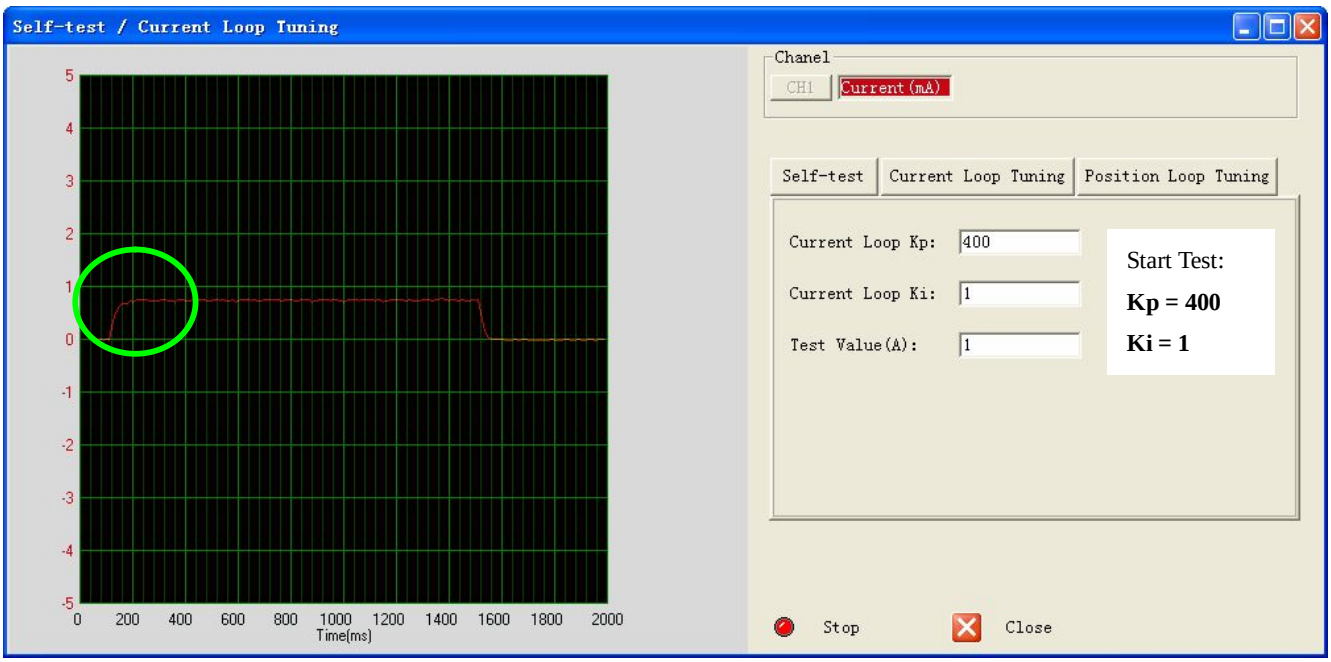


Below is the tuning process of HBS57 plus 57HS3S09-EC-1000 with 24VDC supply voltage.

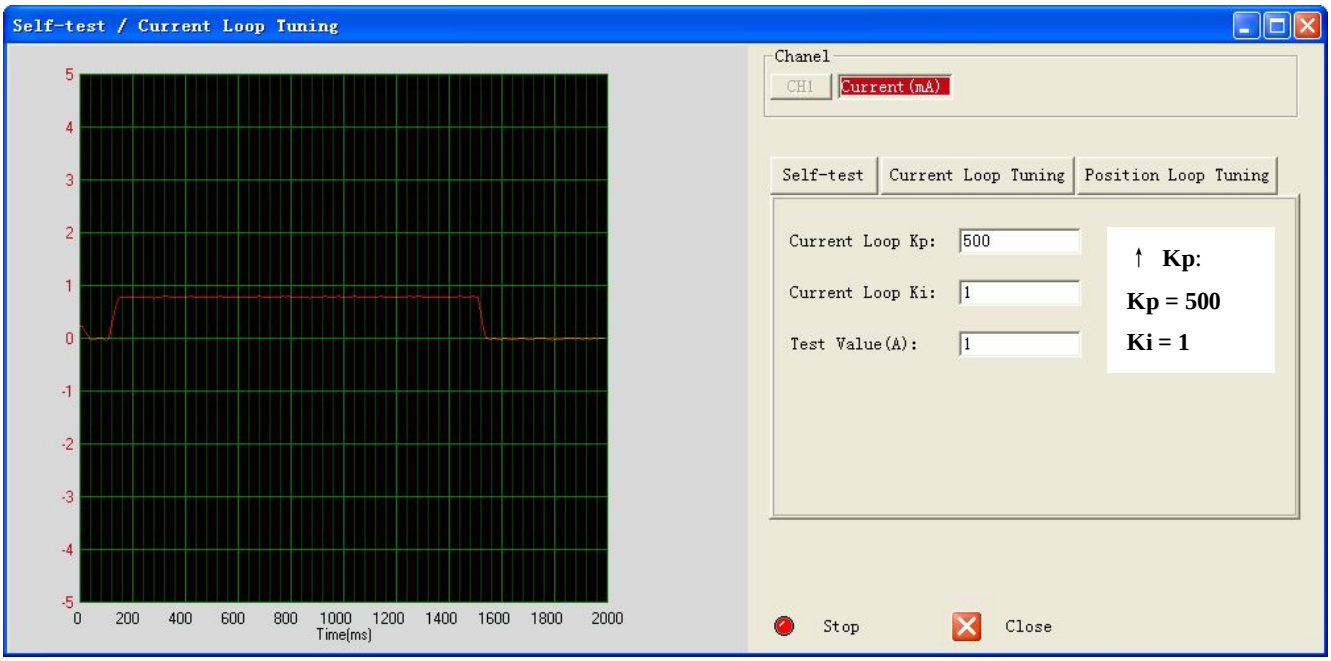
Step 1: Set **Test Current** 1 and start the tuning with small **Kp** and "zero" **Ki**. Here we set **Kp**=300 and **Ki**=1.



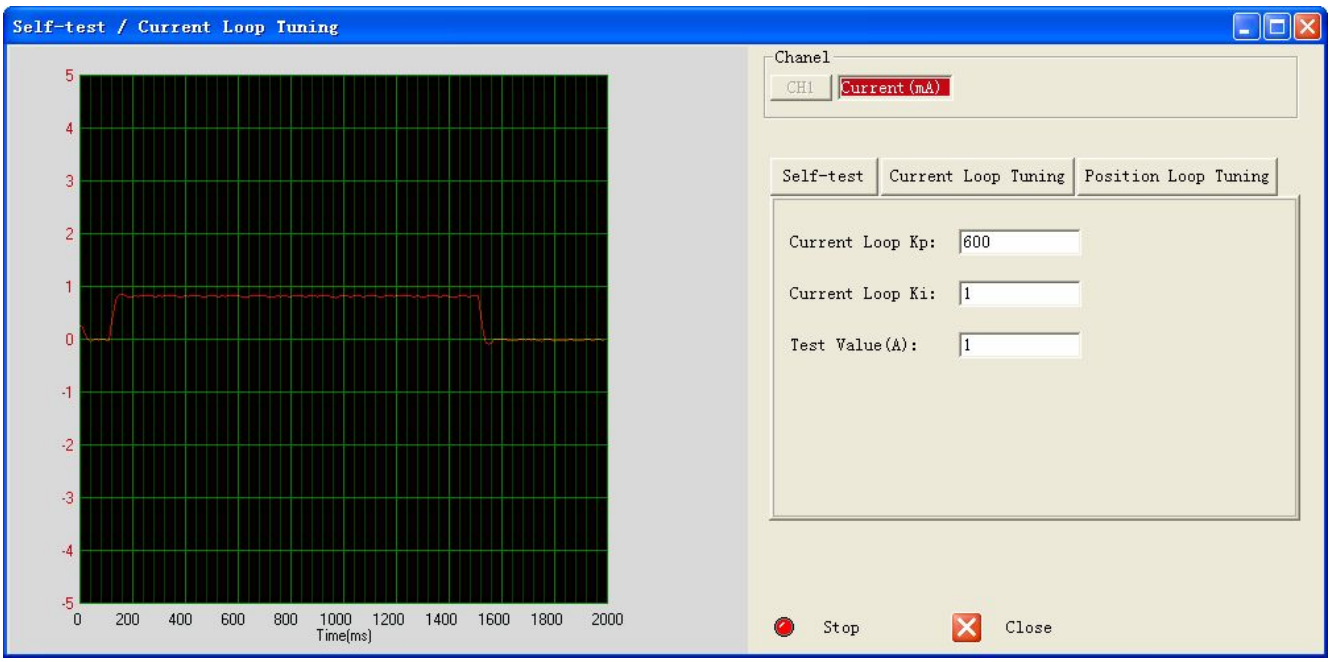
Step 2: Click the **Start** button and the plot window shows the step response of the current test. As the red curve increases from 0 to target slowly, it indicates that a large **Kp** needs to be introduced.

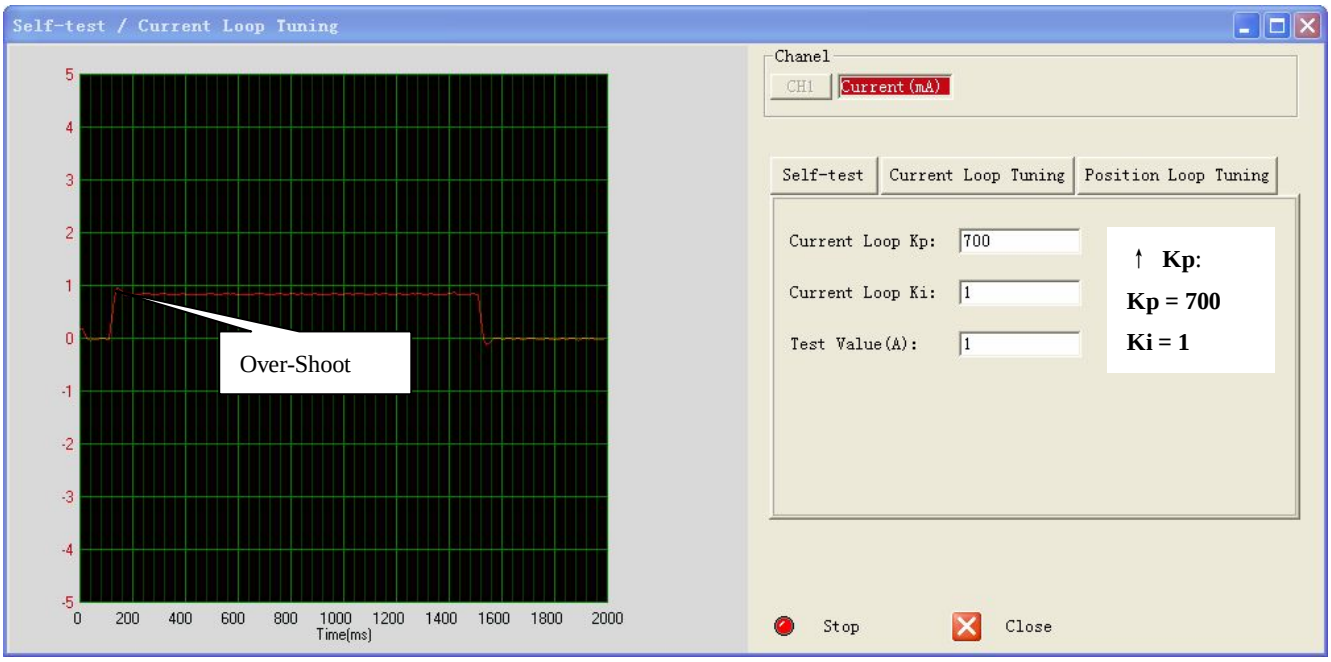


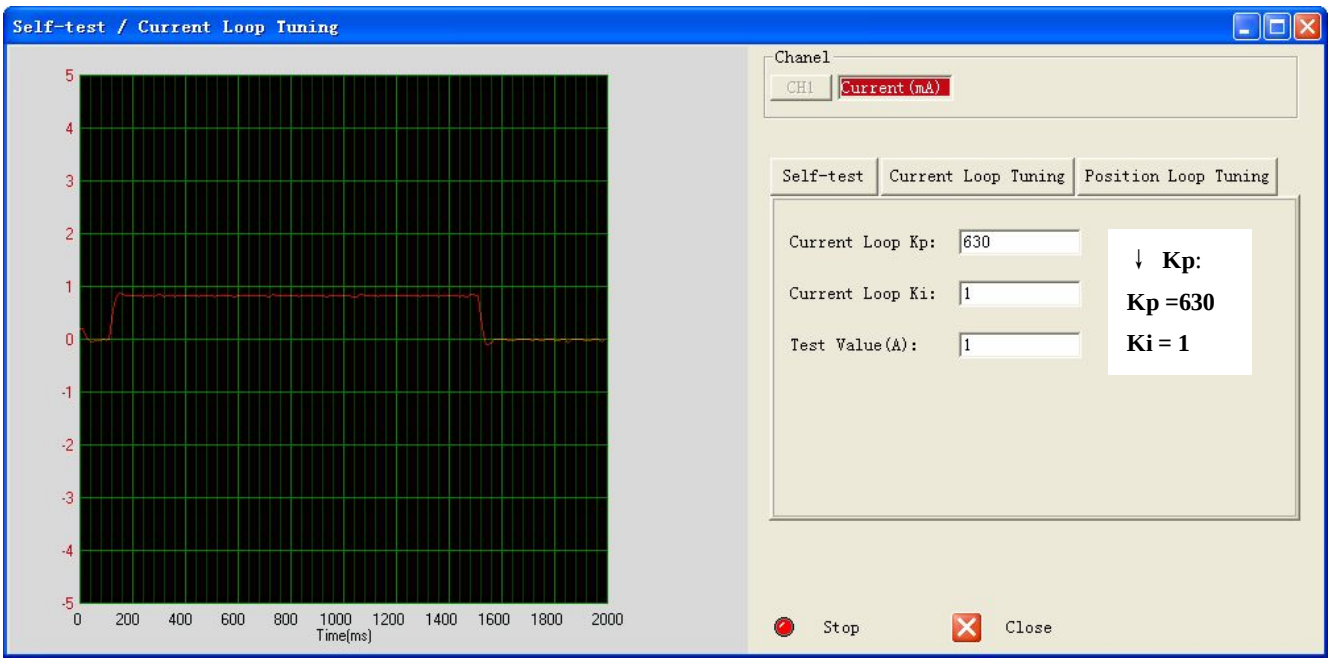
Step 3: Increase **Kp** to 500 and click **Start**. The red curve change faster from 0 to the target..



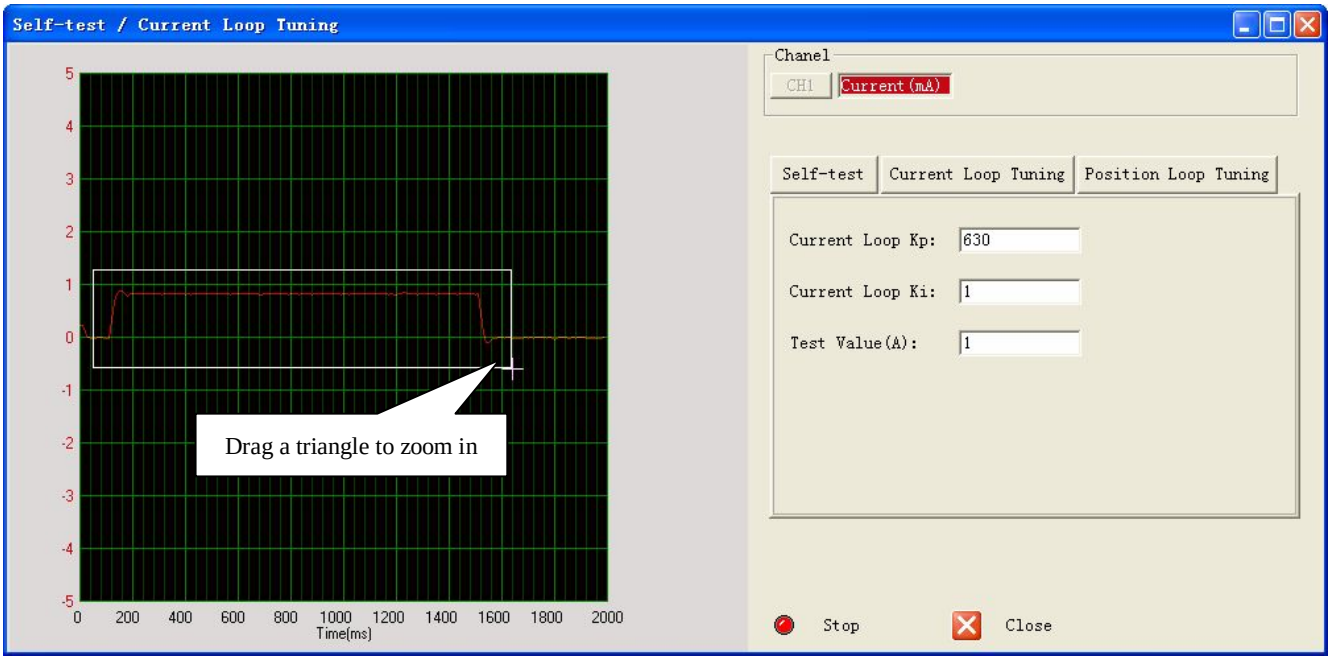
Step 3: Give **Kp** 600, 700 and click **Manual Tuning,** respectively. The red curve is changing faster. Over-shoot is obvious when we increase **Kp** to 700. It indicates that you need to stop increasing Kp and back off. So we decrease Kp to 650 until the actual value is exactly over the target value.

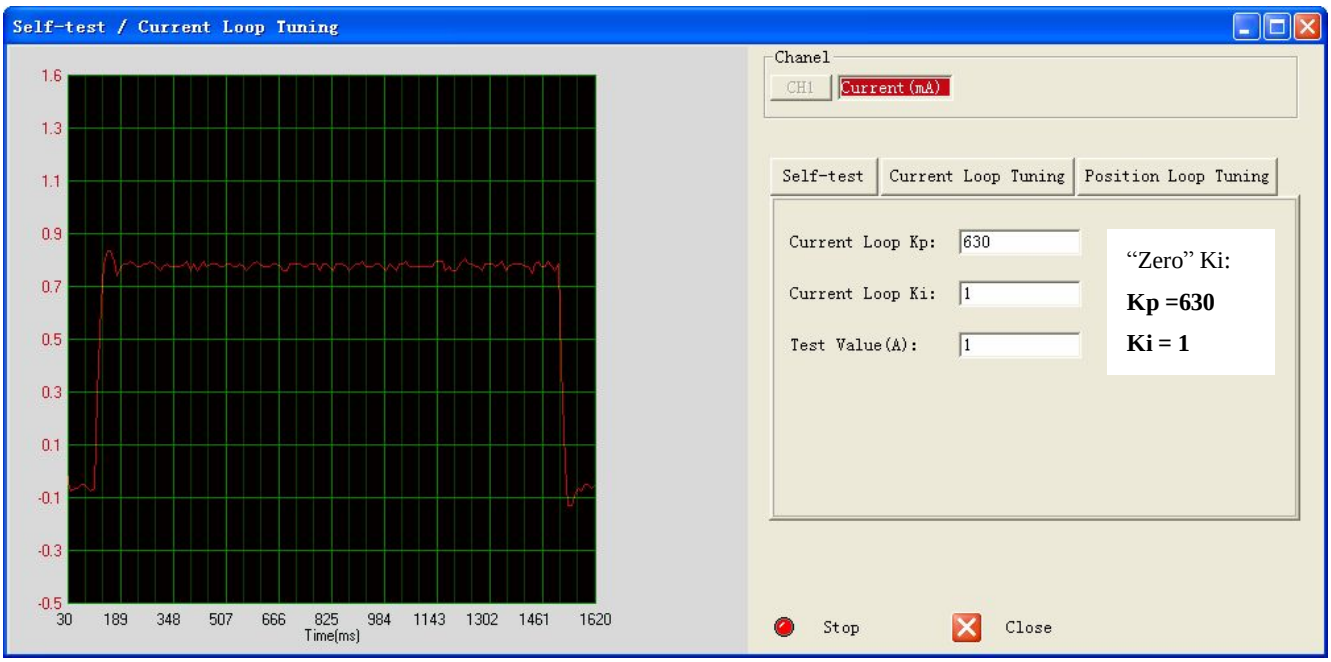

Self-test / Current Loop Tuning
Chanel
CH1
Current (mA)
Self-test
Current Loop Tuning
Position Loop Tuning
Current Loop Kp: 600
Current Loop Ki: 1
Test Value(A): 1
Stop
Close
Time(ms)

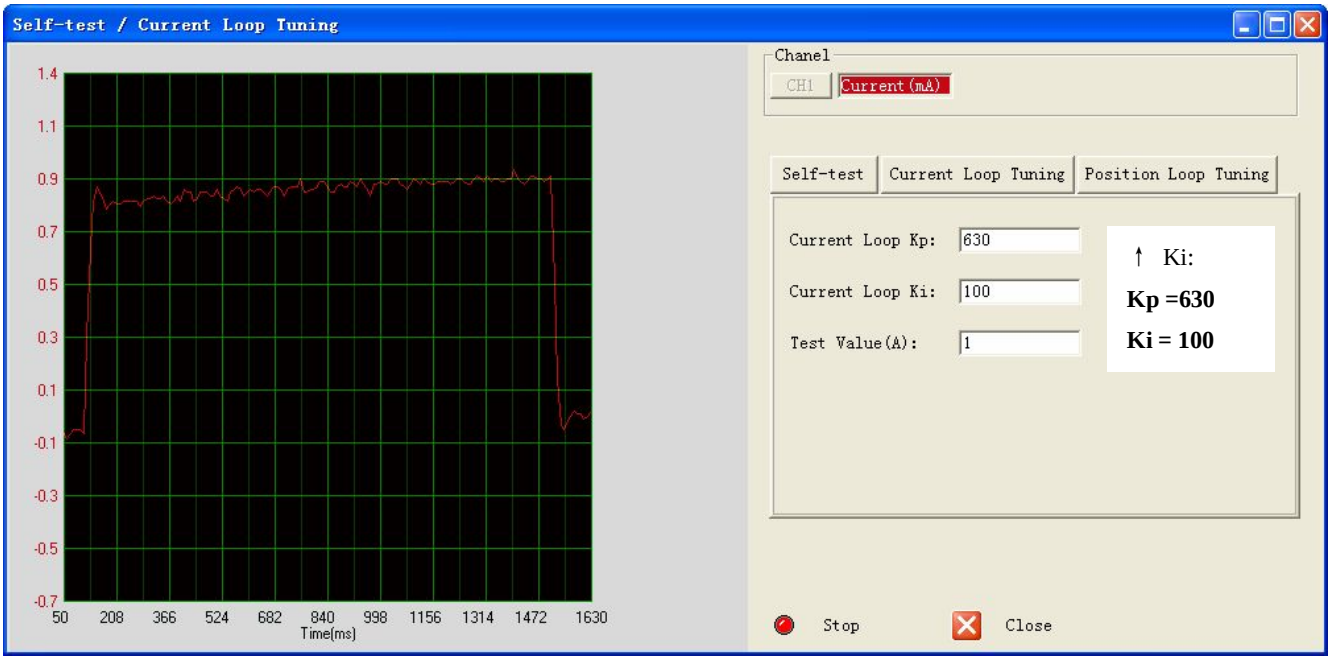

Self-test / Current Loop Tuning
Chanel
CH1
Current (mA)
Self-test
Current Loop Tuning
Position Loop Tuning
Current Loop Kp: 700
Current Loop Ki: 1
Test Value(A): 1
Over-Shoot
↑ Kp:
Kp = 700
Ki = 1
Stop
Close
Time(ms)

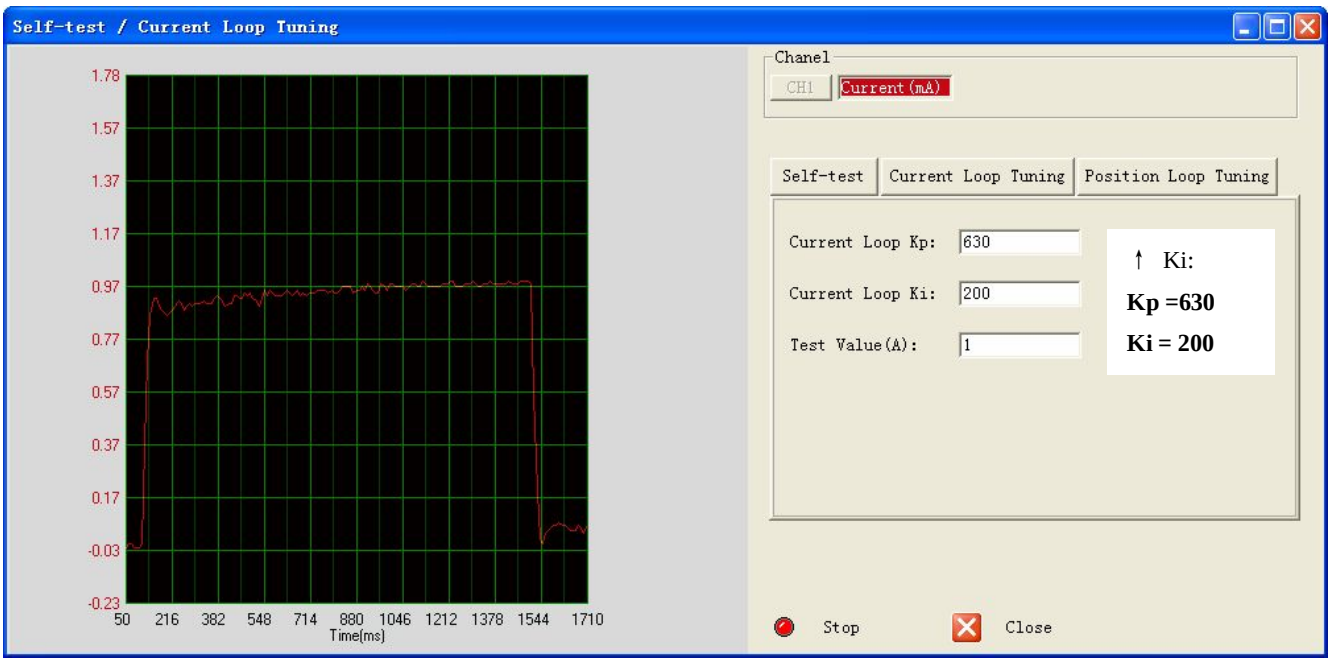


Step 4: Now the **Kp** is relatively good enough. But there is still error between the command current and the target current. So we need to introduce **Ki** to reduce the steady error at the constant part. It follows the same procedure as **Kp**. High **Ki** causes big vibration, system lag and makes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

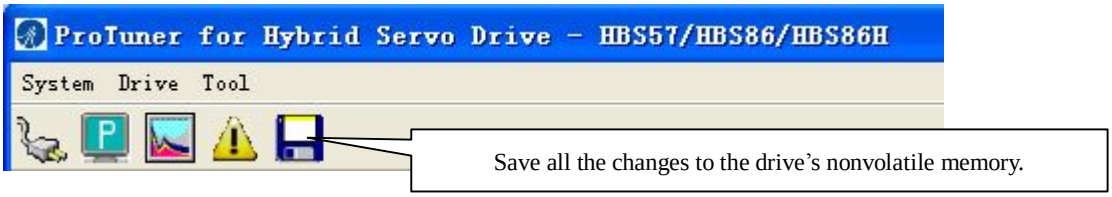



Self-test / Current Loop Tuning
1.6
1.3
1.1
0.9
0.7
0.5
0.3
0.1
-0.1
-0.3
-0.5
30 189 348 507 666 825 984 1143 1302 1461 1620
Time(ms)
Chanel
CH1
Current(mA)
Self-test
Current Loop Tuning
Position Loop Tuning
Current Loop Kp: 630
Current Loop Ki: 1
Test Value(A): 1
"Zero" Ki:
Kp =630
Ki = 1
Stop
Close


Self-test / Current Loop Tuning
1.4
1.1
0.9
0.7
0.5
0.3
0.1
-0.1
-0.3
-0.5
-0.7
50 208 366 524 682 840 998 1156 1314 1472 1630
Time(ms)
Chanel
CH1
Current(mA)
Self-test
Current Loop Tuning
Position Loop Tuning
Current Loop Kp: 630
Current Loop Ki: 100
Test Value(A): 1
↑ Ki:
Kp =630
Ki = 100
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 **Save to Drive** icon to store the changed value to the drive's EEPROM. See below.

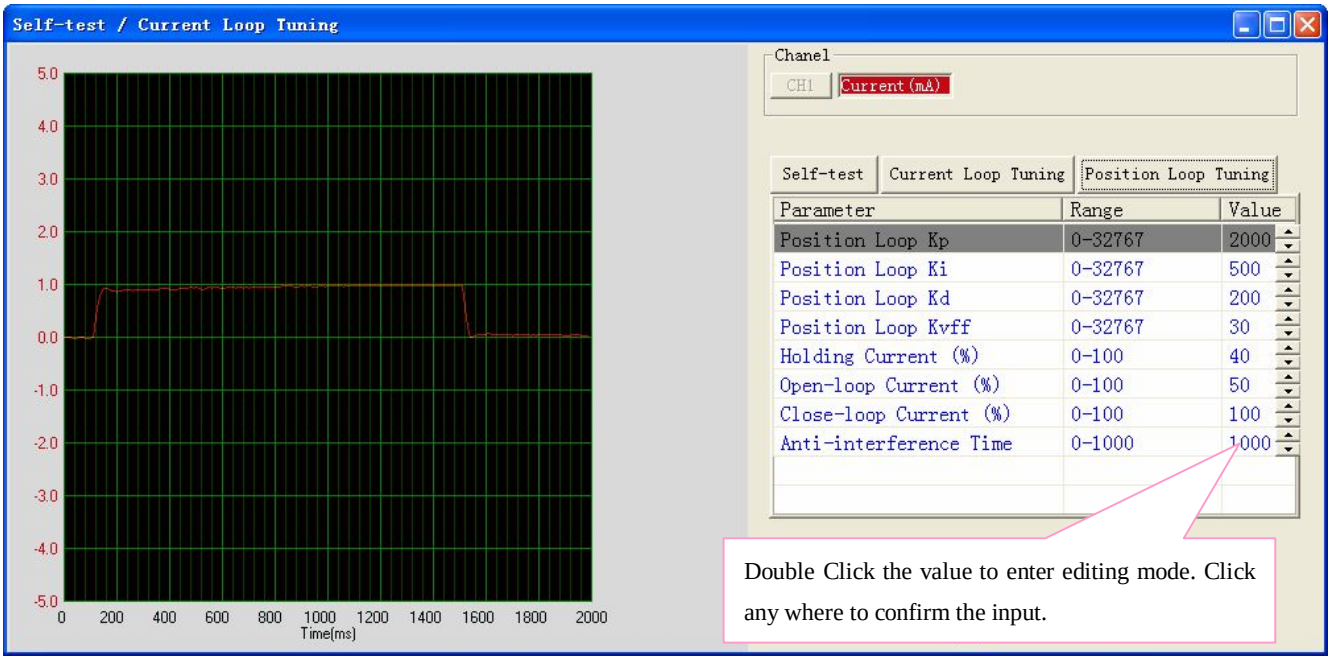


Position Loop Tuning

The hybrid servo drive can work with the matching motor very well. However, sometimes the actual motor noise is big or the speed is not enough. The user can adjust the following parameters to make the drive more suitable for the application.

Item	Description	Range
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	Current when there is no pulse applied to the drive.	0%-100%
Open-loop Current	Current when the drive goes into open loop control.	0%-100%
Close-loop Current	Current when the drive goes into close loop control.	0%-100%
Anti-interference Time	Ignore it.	0-1000 ms

Click **Drive->Self-test / Current Loop** Tuning to open the tuning window. Then click the **Position Loop Tuning** button and the position loop parameters appear.



Position Loop Tuning Suggestion

Faster Response **High Speed** **High Torque** **Smooth Move**	Increase the Kp, Kd, Kvff, Open-Loop Current and Close-loop Current.
Lower Motor Noise **Lower Motor Heating**	Decrease the Kp, Kd, Kvff, Open-Loop Current and Close-loop Current

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