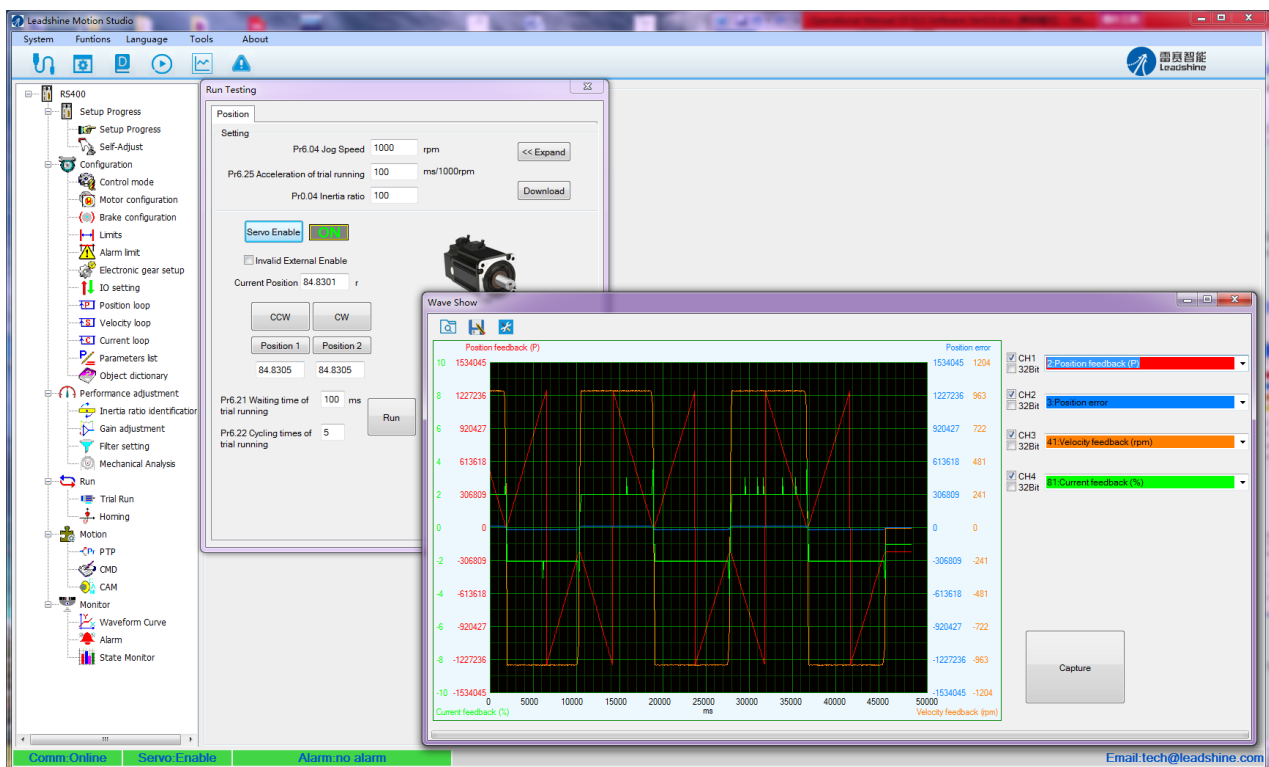
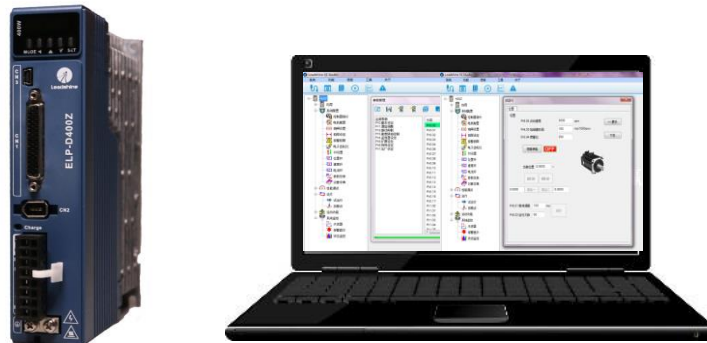


# Quick Reference Of ELP series Servo Product



- ◆ Thanks for supporting Leadshine product.
- ◆ This is only a brief operation guidance, please check servo user manual and Operational Manual Of ELP Software for more details.

## ***The main steps to tune the servo product:***

- A. Use “run testing” to test the motor if motor run normally or not.
- B. Choose right control mode Pr0.01, 0 for position mode , 1 for velocity and 2 for torque mode .
- C. Wring for you application, connect the wire correctly and use controller to drive the motor if motor run normally or not.
- D. Connect the motor with load and Tuning the inertia ratio(Pr004)
- E. Connect the motor with load and Tuning stiffness for each axis(Pr002, Pr003).
- F. Tune Pr000 for more stiffness if needed. ***(only for position mode )***
- G. Tune Pr222 and Pr223 for smoother moving if needed.***(only for position mode )***

### ***A. “Run Testing ”***

Use the “run test ing” of software protuner to tune the motor.

Users need to make sure the shaft of motor is free before running it ,for example , release the brake firstly if motor is with brake.

**Run Testing**

**Position**

**Setting**

Pr6.04 Jog Speed 1000 rpm << Expand

Pr6.25 Acceleration of trial running 200 ms/1000rpm

Pr0.04 Inertia ratio 250 Download

Servo Enable **ON**

☐ Invalid External Enable

Current Position 56.9990 r

CCW CW

Position 1 Position 2

56.9989 56.9989

Pr6.21 Waiting time of trial running 100 ms

Pr6.22 Cycling times of trial running 2

Run

1、Set parameters for run testing:

Specially pay attention to Pr0.03 Stiffness and Pr0.04 Inertia ratio which strongly corresponding to better performance

2、Run testing guidance

Click button "Servo enable"

Click "CCW" to make motor run to CCW direction, click "Position 1" to save the testing position limit 1

Click "CW" to make motor run to CW direction, click "Position 2" to save the testing position limit 2

Click "Run" to start Testing progress

3、During the Run Testing progress, the wave show monitor the performance of the current parameters setting

## B. Wiring

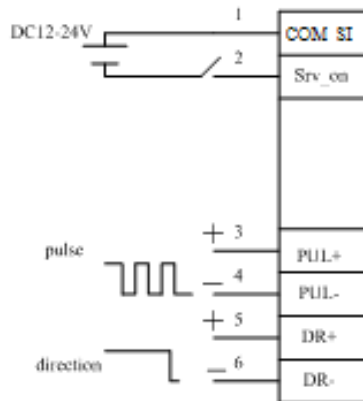
Functions of driver port

Port	Function
CN1	Control Signal Port
CN2	Encoder Input Port
CN3	USB Communication Port
CN4	RS232、RS485 Communication Port
CN5	RS232、RS485 Communication Port
X1	Power Port

Main Power Input Port-X1

Port	Pin	Signal	Detail	
X1	L1	For single phase 220V	For single phase 220V , +15 ~ -15% , 50/60Hz	
	L2	For single phase 220V		
Notes	① Isolation transformer can be used for power supply; ② Do not access the 380VAC power supply, or it will cause serious damage to the drive; ③ In the case of serious interference, it is recommended to use noise filter for power supply; ④ It is recommended to install a non-fusible circuit breaker to cut off external power supply in time when the driver fails.			
Port	Pin	Signal	Detail	
X1	P +	Dc bus + terminal	① Driver Dc bus + terminal ② External regenerative resistor P terminal	
	Br	External regenerative resistor terminal	External regenerative resistor terminal	
Notes	When using external resistors, the values of resistance and power are selected as follows :			
		Driver	Resistor ( Ω )	Power ( W )
		ELP-400	≥ 40	100
Port	Pin	Signal	Detail	
X1	U	U	3 phase motor power input	
	V	V		
	W	W		
	PE	PE	Frame ground	
Notes	① Connect the driver to the ground end (PE) of the motor and connect it to the earth			

### a) Wiring in position mode

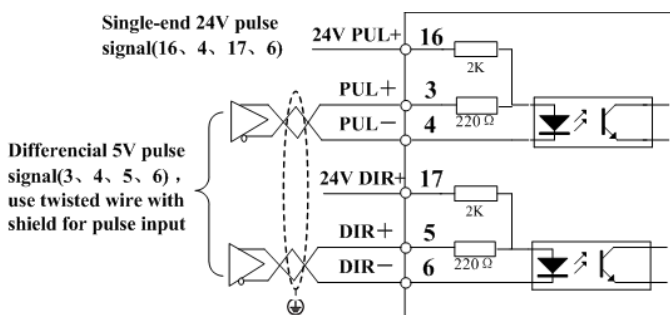


Notice: COM\_S1 is used for input signal, while COM\_SO is used for output signal .

If the driver is enabled with internal signal, no need to connect pin1 & pin2 .

Pr400=83 for internal enable.

Pr400=03 for external enable.



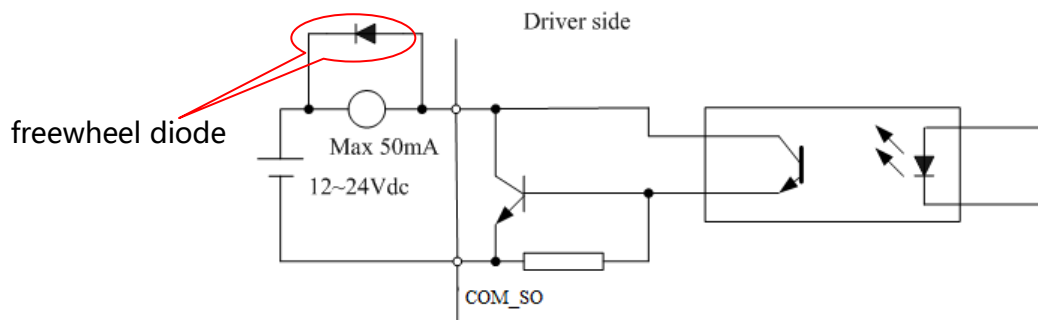
If the voltage of signal is 5V, please connect pin3、 pin4、 pin5、 pin6.

If the voltage of signal is 5V, please connect pin16、 pin4、 pin17、 pin6.

The Simple Wiring for CN1 in Position Control Mode

### b) Using reversed freewheel diode for digital output port *(only for motor with brake)*

The relay is widely used for logic control. Usually it is connected directly to IO port of driver if the motor is with brake. Connect a freewheel diode in anti-parallel to avoid interference of high voltage which comes from the moment of power on or power off.



Notice: Don't connect the diode in wrong polarity, otherwise driver will be damaged.

## C. Set the working mode (Pr0.01)

Pr0.01*	Control Mode Setup		Range	unit	default	Related control mode		
			0-10	-	0	P	S	T

Set using control mode

Setup value	Content	
	1st mode	2nd mode
0	Position	-
1	Velocity	-
2	Torque	-
6	Pr-Mode	

When you set up the combination mode of 3.4.5, you can select either the 1st or the 2nd with control mode switching input(C-MODE).

When C-MODE is open, the 1st mode will be selected.

When C-MODE is shorted, the 2nd mode will be selected.

Then connect the wire correctly and use controller to check whether motor run normally or not.

## ***D. Performance adjustment—Tuning the inertia ratio(Pr004)***

It is very important to find the ratio of inertia for one axis, in order to make best performance before setting other parameter (for example, setting PID of position loop or velocity loop).

Connect motor with load if you need to test one axis.

**Make sure the axis can be moved in safe distance, any interference should be avoided to ensure safety and accuracy of testing.**

### **Inertia ratio identification**

Pre-conditions: 1、Servo disable. 2、Positive limit and negative limit invalid

#### **Steps:**

1、Set the Jog speed Pr6.04, and the setting should not be too large(300~1000rpm is recommend)

Set the Acc Pr6.25(50~100 ms/1000rpm is recommend)

Set the Default Inertia Ratio.

**Download** these settings, then **Servo Enable**.

2、Click “CCW” to make motor run to CCW direction, click “Position 1” to save the position limit 1

Click “CW” to make motor run to CW direction, click “Position 2” to save the position limit 2

Click “Run” to start Inertia ratio identification.

**Inertia Ratio Identification**

**STEP-1**

Pr6.04 Jog Speed 400 rpm

Pr6.25 Acceleration of trial running 200 ms/1000rpm

Default Inertia Ratio 250

Download

Servo Enable **ON**

☐ Invalid External Enable

**STEP-2**

Current 62.9497 r

CCW CW

62.9487 Position 1 Position 2 -0.0033

Pr6.21 Waiting time of trial running 50 ms

Pr6.22 Cycling times of trial running 3

Run

**STEP-3**

Inertia Ratio 0

Write

3、After finishing, Click“Write”to save the Inertia ratio identification result into NVM.

## ***E. Performance adjustment—Gain adjustment(Pr0.03)***

To tuning for better performance, users need turning position loop parameters. Users need to open **Run Testing**

window.

Users can select different operation mode in real-time automatic adjustment mode, generally select **Position** mode. If users want to adjust gain parameters by yourself, users can select **Manual** mode, then users can adjust related parameter step by step until meet system requirement.

Users can adjust position loop gain, velocity integration time constant and ratio of inertia for position loop tuning. If users need stronger rigid, users only need adjust ratio of inertia, then adjust gain and integration

The screenshot shows the 'Run Testing' window with the 'Position' tab selected. The 'Setting' section on the left includes parameters like Pr6.04 Jog Speed (400 rpm), Pr6.25 Acceleration of trial running, Pr0.04 Inertia ratio, Servo Enable (OFF), Invalid External Enable, Current Position (0.0000 r), and Pr6.21/22 waiting and cycling times. The right panel lists parameters Pr0.02 through Pr1.15, including real-time auto-gain tuning, rigidity adjustment, command pulse setup, speed command reversal input, and various position/velocity loop gains and time constants. A dropdown menu for Pr0.02 is open, showing '2:Position' as the selected mode, with '0:Manual' and '1:Standard' also visible.

In **Manual** mode(Pr0.02=0), users can setup Kp, Ki and other related parameters. During tuning position loop, users can adjust KI to a very small value in advance and hold it constant, then users can enlarge the value of Kp parameter slowly until system oscillation occurs, at this moment users can enlarge the value of Vi parameter slowly until system oscillation occurs, at this moment the basic adjustment of system finished.

In **Standard** mode(Pr0.02=1), **it is usually for interpolation movement**. It is unavailable to modify the value of Pr1.00- 1.14, we just change the value of Pr0.03 real-time automatic adjustment rigid.

In **Position** mode(Pr0.02=2), **it is usually for point to point movement**. It is unavailable to modify the value of Pr1.00- 1.14, we just change the value of Pr0.03 real-time automatic adjustment rigid.

The definition of Pr0.03

Pr0.03	Selection of machine stiffness at real-time auto-gain tuning	Range	unit	default	Related control mode		
		50 -81	-	70	P	S	T

You can set up response while the real-time auto-gain tuning is valid.

Low → Machine stiffness → High

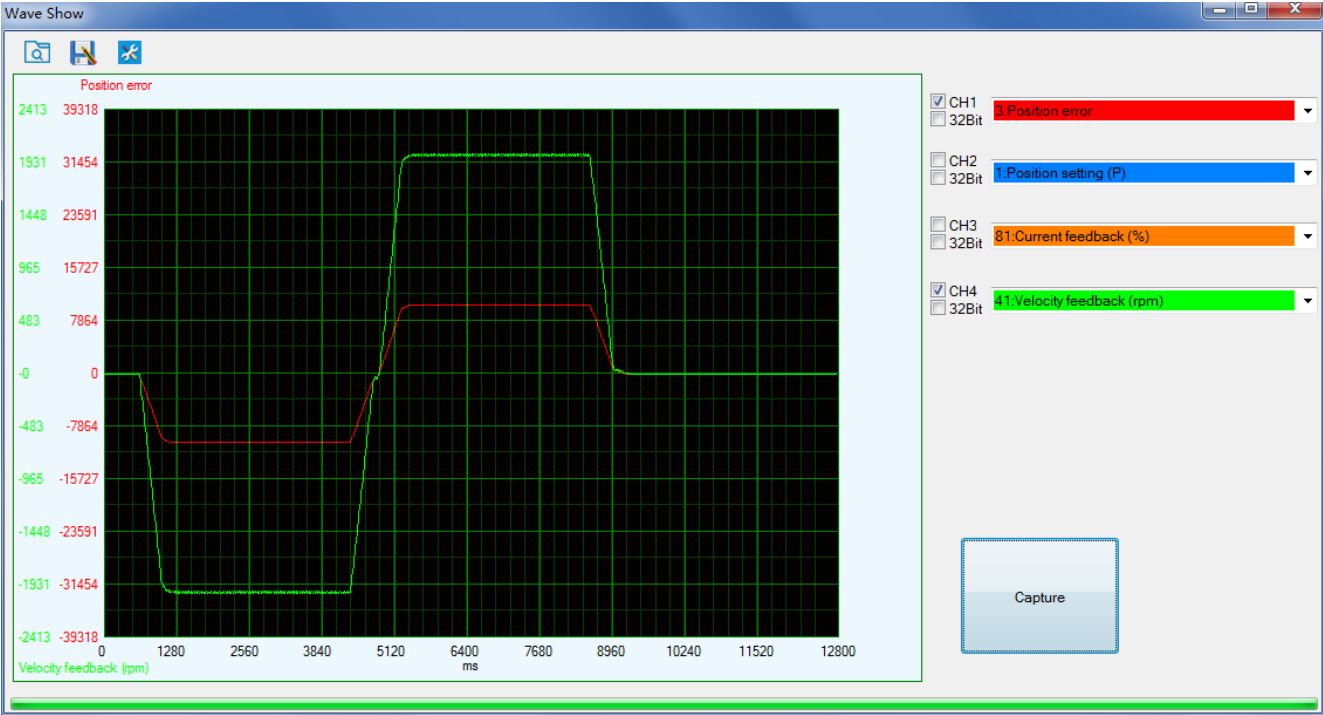
Low → Servo gain → High

81.80.....70.69.68.....51.50

Low → Response → High

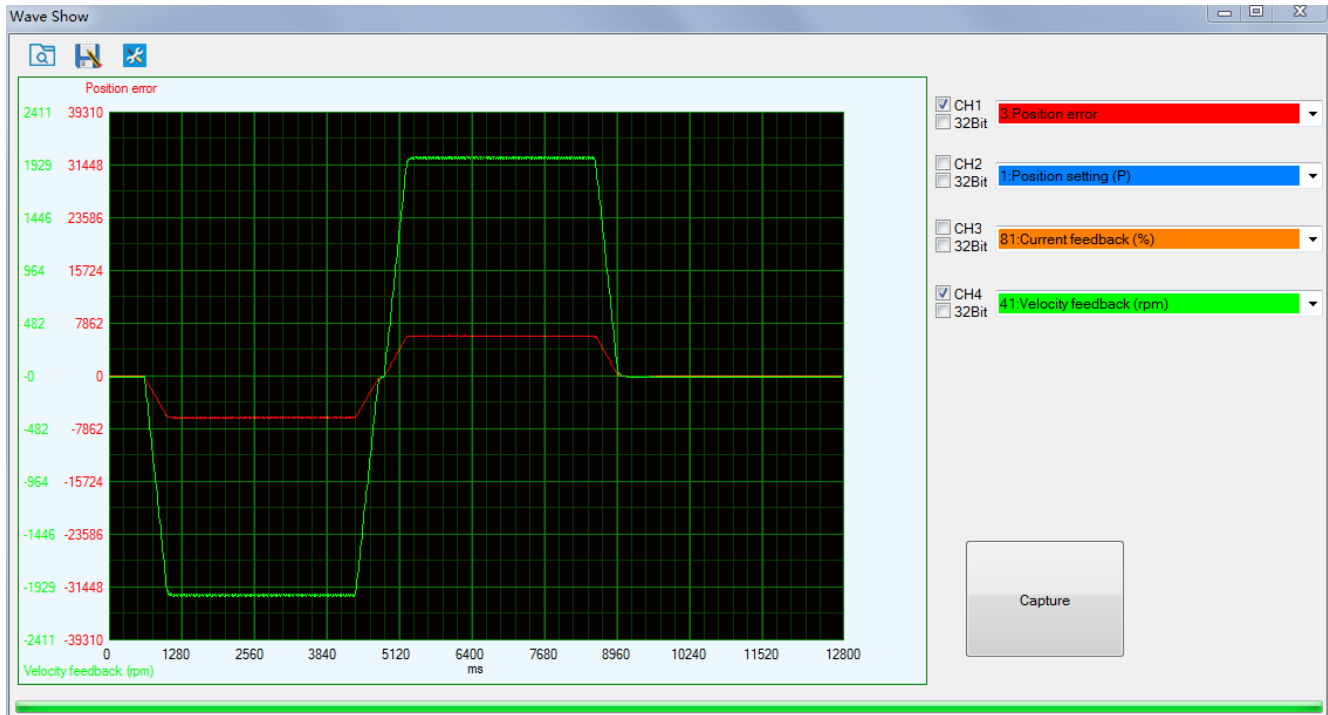
**Notice:** Lower the setup value, higher the velocity response and servo stiffness will be obtained. However, when decreasing the value, check the resulting operation to avoid oscillation or vibration. Control gain is updated while the motor is stopped. If the motor can't be stopped due to excessively low gain or continuous application of one-way direction command ,any change made to Pr0.03 is not used for update. If the changed stiffness setting is made valid after the motor stopped, abnormal sound or oscillation will be generated. To prevent this problem, stop the motor after changing the stiffness setting and check that the changed setting is enabled.

The following figure showing Pr0.02=2, Pr0.03=70, the position error (curve in red) is unacceptable!

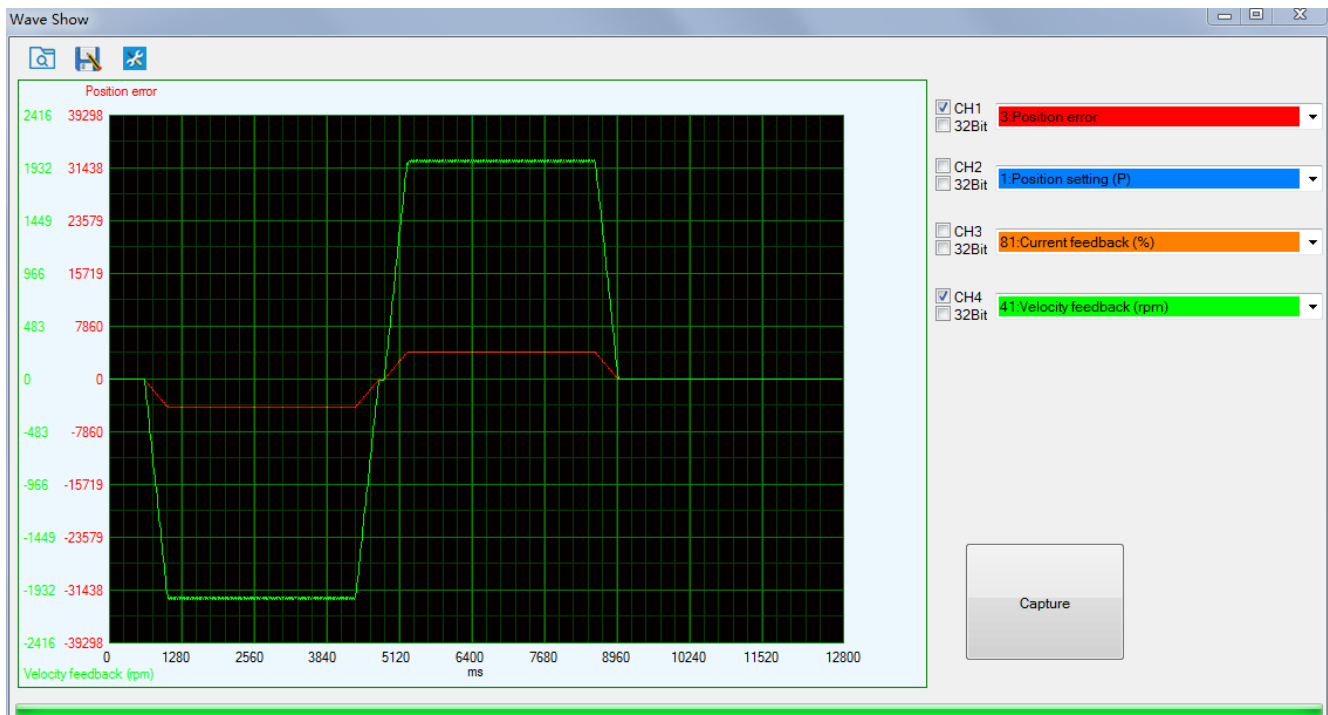


Then we continue decreasing value of Pr0.03, then the position error become smaller and smaller.

Pr0.03=68

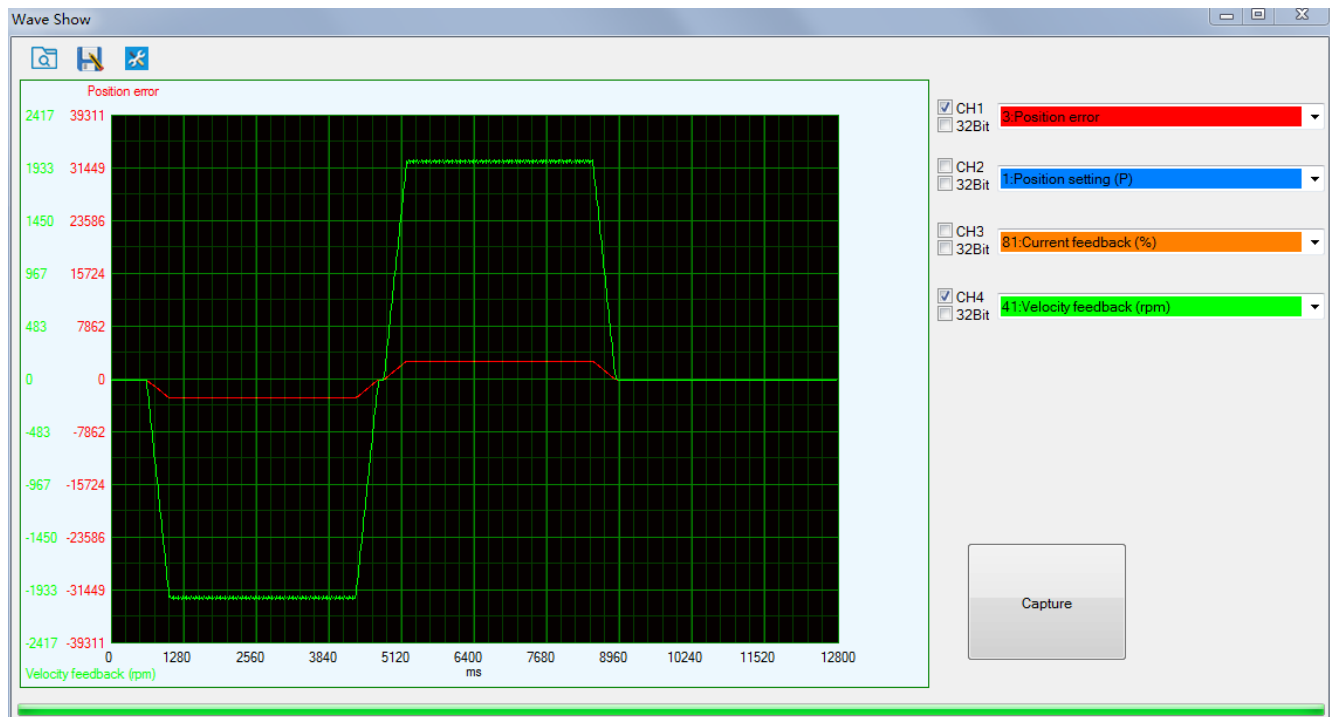


Pr0.03=66

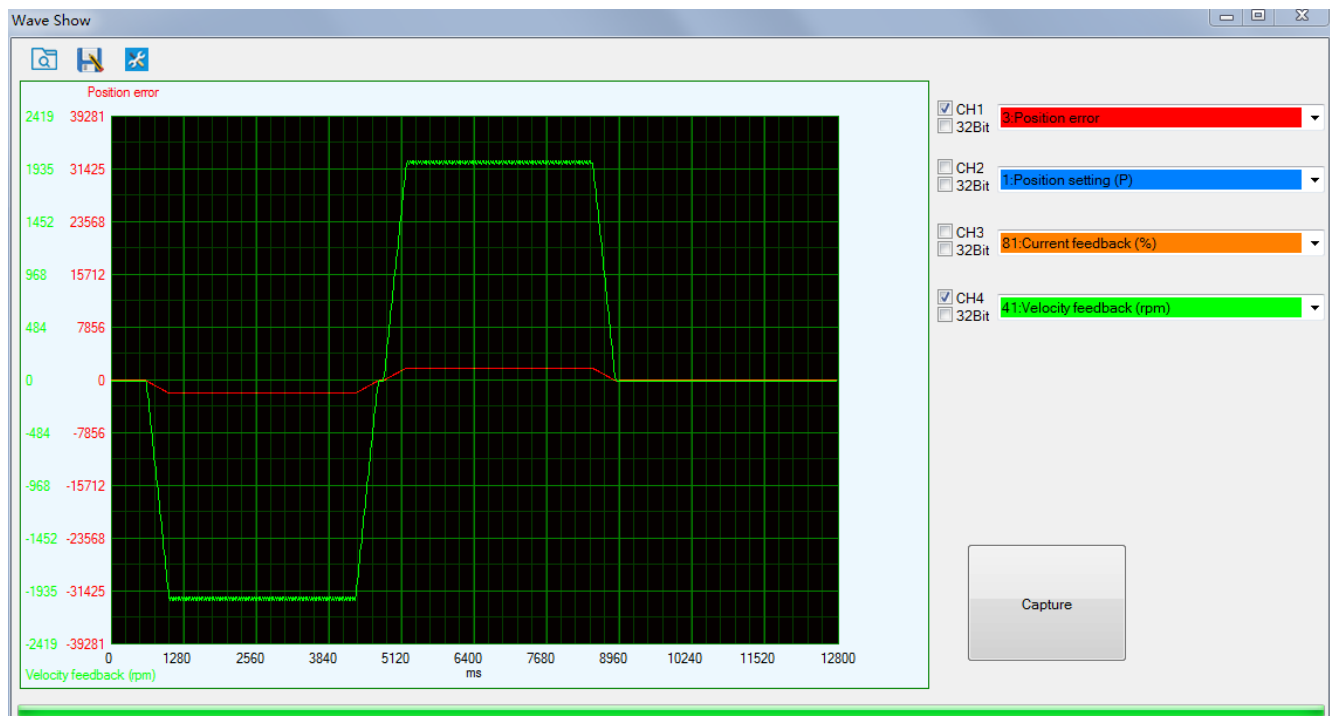




Pr0.03=64

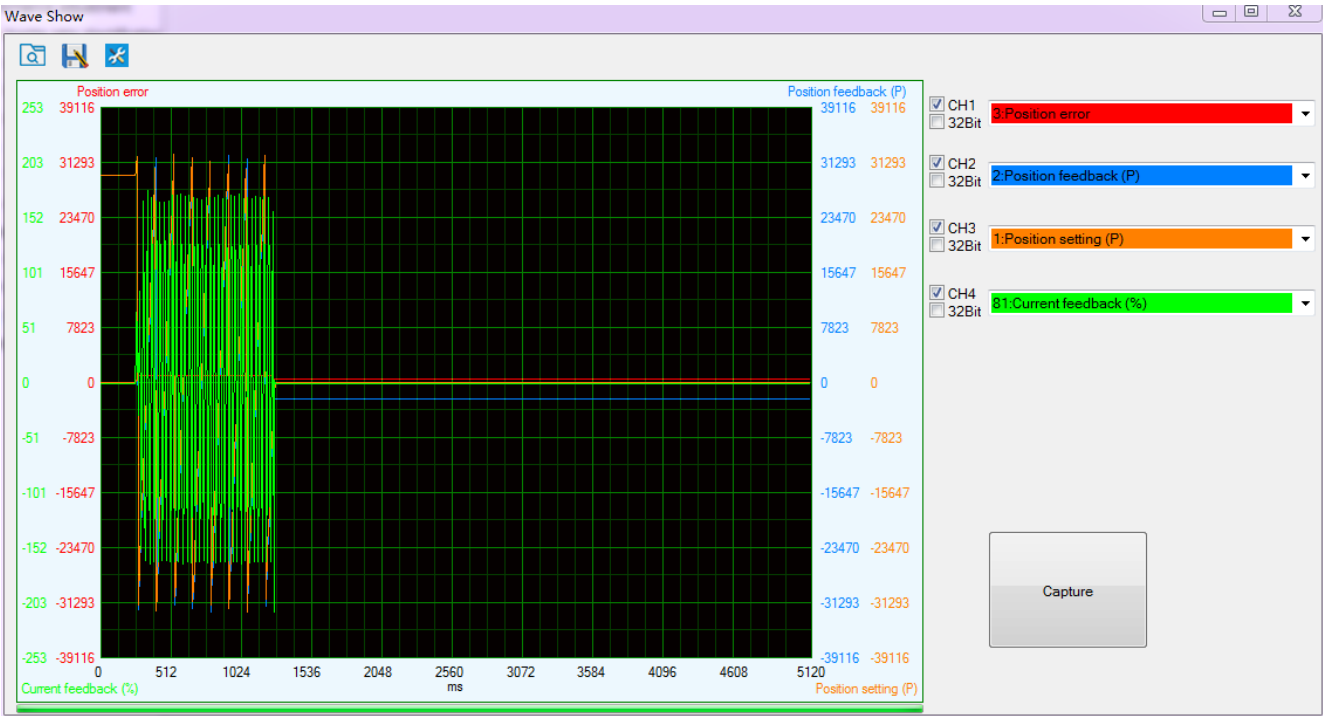


Pr0.03=62



As we continue decreasing the value of Pr0.03, then the position loop gain  $K_p$  become bigger and bigger, the integration time constant  $V_i$  become smaller and smaller, the position error become close to zero.

Pr0.03=61



The noise of motor occurs and alarm occurs if the position loop gain becomes bigger, so just make sure there is no noise.

Finally, we set Pr0.03=62, the basic setting for position loop is finished in **Position mode**.

F. Tuning the dynamic tracking performance

If user need better performance for dynamic tracking control and contouring cutting, it is useful to use function of MFC.

In **Standard** mode(Pr0.02=1), it is usually for interpolation movement.

Model Following Control (MFC)

As a new control technology, MFC is used to enhance the performance of dynamic tracking for input command, make positioning faster, cut down the tracking error, run more smooth and steady .

There are two different way to use it, one is set Pr0.00 =1, the other is set Pr0.00 as another integer which is more than 10 .

It is very useful for multi-axis synchronous movement and interpolation, the performance will be better if the value of each axis is the same.

Pr0.00	Mode loop gain	Range	unit	default	Related control mode		
		0 -32767	0.1Hz	0	P		

Set up the bandwidth of MFC , it is similar to the response bandwidth

Setup value	Meaning
0	Disable the function.
1	Enable the function , set the bandwidth automatically , recommended for most application .
2-10	Forbidden and reserved .
11-20000	Set the bandwidth manually , 1.1Hz – 2000Hz

#### The main way to use this function :

- Choose the right control mode : Pr0.01 = 0
- Set up the inertia of ratio : Pr0.04
- Set up the rigidity : Pr0.03
- Set up the Pr0.00 :
  - If no multi-axis synchronous movement , set Pr0.00 as 1 or more than 10 ;
  - If multi-axis synchronous movement needed , set Pr0.00 as the same for all the axes .
  - If Pr0.00 is more than 10 , start with 100 , or 150 , 200 , 250 , ....

#### Caution:

- Set up the right control mode , the right inertia of ratio and rigidity firstly .
- Don't change the value of Pr000 when the motor is running , otherwise vibration occurs
- Set up a small value from the beginning if using it in manual mode , smaller value means running more smooth and steady , while bigger one means faster positioning

## G. Position command filter

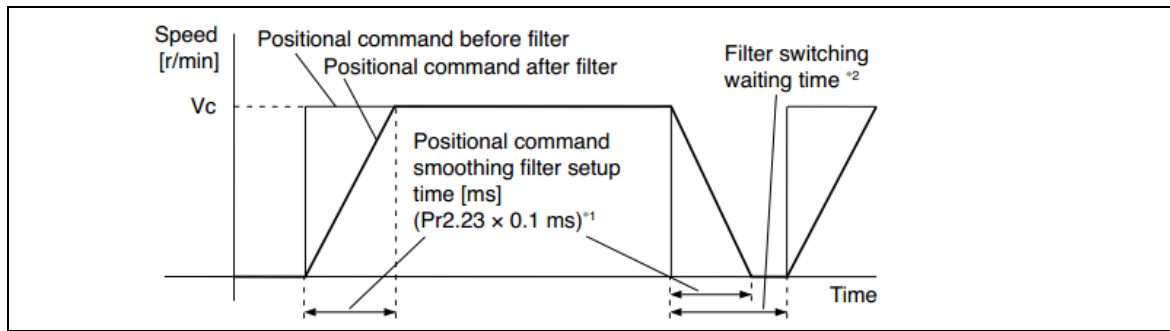
To make the positional command divided or multiplied by the electronic gear smooth, set the command filter.

Pr2.22	positional command smoothing filter	Range	unit	default	Related control mode		
		0 -32767	0.1ms	0	P		

- Set up the time constant of the 1st delay filter in response to the positional command.
- When a square wave command for the target speed  $V_c$  is applied ,set up the time constant of the 1<sup>st</sup> delay filter as shown in the figure below.

Pr2.23	positional command FIR filter	Range	unit	default	Related control mode		
		0 -10000	0.1ms	0	P		

- Set up the time constant of the 1st delay filter in response to the positional command.
- When a square wave command for the target speed  $V_c$  is applied , set up the  $V_c$  arrival time as shown in the figure below.



## H. Setting and saving the value of parameters

### a) Panel Operation Flow Figure

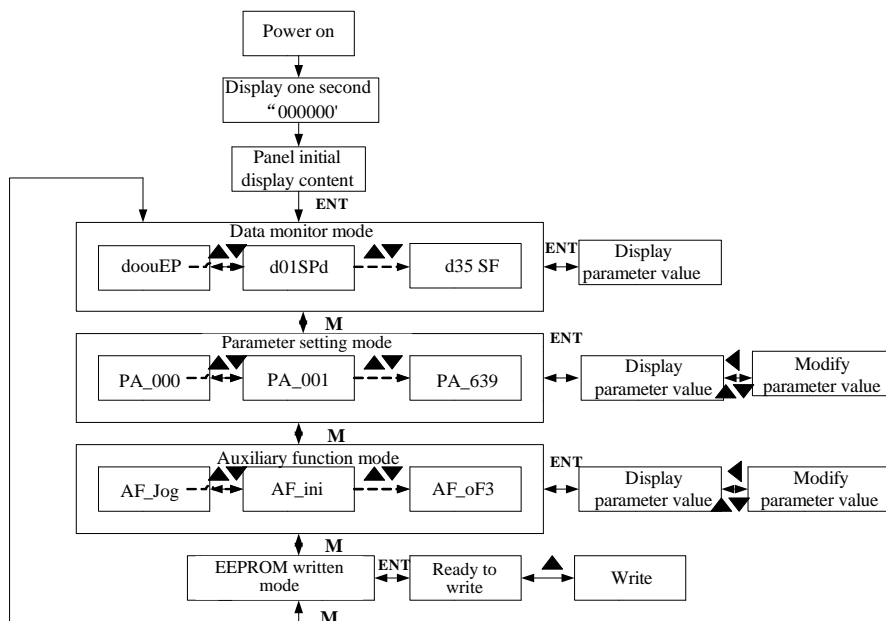


Figure the flow diagram of panel operation

- (1) The front panel display 000000 for about one second firstly after turning on the power of the driver. Then if no abnormal alarm occurs, monitor mode is displayed with the value of initial parameter ; otherwise, abnormal alarm code is displayed.
- (2) Press M key to switch the data monitor mode → parameter setting mode → auxiliary function mode → EEPROM written mode.
- (3) If new abnormal alarm occurs, the abnormal alarm will be displayed immediately in abnormal mode no matter what the current mode is, press M key to switch to the other mode.
- (4) In data monitor mode, press ▲ or ▼ to select the type of monitor parameter; Press ENT to enter the parameter

type , then press ◀ to display the high 4 bits “H” or low 4 bits “L” of some parameter values.

(5) In parameter setting mode, press ◀ to select current editing bit of parameter No, press ▲ or ▼ to change current editing bit of parameters No. Press ENT key to enter the parameter setting mode of corresponding parameters No. Press ◀ to select current bit of parameter value when editing it, press ▲ or ▼ to change the value of the bit. Press ENT to save it and switch to the interface of parameter No.

### b) Saving parameter

Operation procedure:

1. press M to select EEPROM writing mode, display “EESEEE”;
2. Press ENT to enter into writing mode operation:
3. Press and hold ▲, display LED from” EEP--- ” to” EEP--- ”, then it become” EEP--- ”, finally it become” SEEEE ”, indicated EEPROM writing operation have been began;
4. “EEEEE ” means that writing is unsuccessful while “SEEE ” show that the writing is successful; Follow steps 3 and 4 to repeat the operation; the drive may be damaged if repeat of several times still fails. The driver need to repair.
5. The driver need to power off and restart again if writing is successful .

**NOTE:** Don't turn off the power if EEPROM writing operation goes on, otherwise it may cause a writing wrong data; If this happens, please reset all the parameters , then do EEPROM writing operation again.

## I. Simple debugging

### a) Debugging steps

- (1) Confirm pulse polarity 0.06, command input model 0.07
- (2) Modify 0.08 and set a suitable electronic gear ratio, if intend to set non-integral electronic gear ratio, can use 0.09 and 0.10.
- (3) Set suitable inertia with 0.04, suggest to increase/decrease the value In multiples of 100.
- (4) Adjust 0.03 to be a suitable inertia value. Suggest to set it from small to big until sharp noise appear
- (5) Each time you modify parameters, pls execute save steps and restart the power.

### b) Basic parameter debugging

Parameters	Setting Range	Default	Parameters	Range	Default
Pr0.01(Control model)	0/1/2	0	Pr0.06(Pulse polarity setting)	0/1	0
Pr0.02(Real-time auto configuration)	0/1/2	2	Pr0.07(Pulse input model)	0/1/2/3	1
Pr0.03(Machine rigid)	50 -81	70	Pr0.08(Pulse per motor rotation)	1—131072	10000
Pr0.04(inertia ratio)	0—10000	250			

#### Remark:

1. Default for PR0.08 pulse per rev is 10000 .
2. Electronic gear ratio can be also set by PA009(numerator) and PA110(denominator), PA008 must be set as 0 before that.
3. Input pulse frequency which is higher than 500K can be identified by driver. Assuming that 10000 ppr, that means corresponding command bandwidth of 3000rpm can reach to 500k. If motor run above 3000 rpm, the pulse per rev must be lower than 10000.

## J. Alarm

Protection function is activated when an error occurs, the driver will stop the rotation of servo motor, and the front panel will automatically display the corresponding fault error code. The history of the error can be viewed on data monitoring mode. error logging submenu displays like:“d12Er”.

#### For alarm can be cleared:

- 1、 Use auxiliary function “AF\_ACL”
  - a. Press M to select auxiliary function

b. Press SET to enter into “AF\_ACL”

c. Press and hold ◀ to clear the alarm

2、Set IO input function as Alarm clear input “(A-CLR)”, refer to switch input interface connection to clear the alarm

**For alarm can not be cleared:**

1、 Restart the power-supply to clear the alarm.