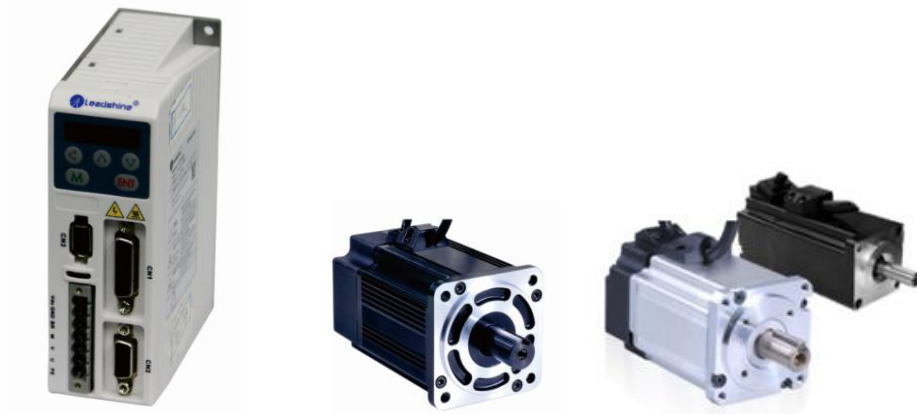# Quick Reference Of ELD5 series Servo Product

◆ **Thanks for supporting Leadshine product.**
◆ **This is only a brief operation guidance, please check servo user manual for more details.**

The main steps to tune the servo product:

A. Check the value of Pr715 and Pr716 in driver if it is suitable for motor ; change it if it is suitable for motor or not
B. Use "run test" to test the motor if motor run normally or not .
C. Choose right control mode and set right value of Pr001, 0 for position mode , 1 for velocity and 2 for torque mode .
D. Connect the wire correctly and use controller to drive the motor if motor run normally or not .
E. Connect the motor with load and tune the inertia ratio
F. Tune inertia ratio for each axis (Pr004).
G. Tune stiffness for each axis(Pr002, Pr003).
H. *Tune Pr000 for more stiffness if needed.*
I. *Tune Pr222 and Pr223 for smoother moving if needed.*

1. *Matching the driver for motor*

Use the Protuner software of ELD5 to check the value if it needed to be changed

The default of driver maybe isn't suitable for your motor, if not, the value of Pr7.15 and Pr7.16 need to be changed to match the motor , check the table below :

Motor type	Pr715	Pr716
ACM602V36-01-1000	1	33
ACM604V60-01-1000	2	33
ACM602V36-01-2500	1	36
ACM604V60-01-2500	2	36
ACM602V36-T-2500	6	36
ACM602V24-T-2500	7	36
ACM604V48-T-2500		
If the motor is with brake , the default setting is the same with motor without brake .		

After changing the value, do need to [Download] firstly , then [Save] it to make the new value working after restart the power .
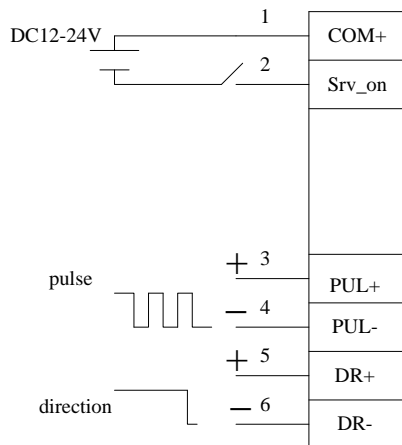
2. *"Run Test "*

Use the "run test " of software protuner to tune the motor , click ""start " to run motor if it is normally .

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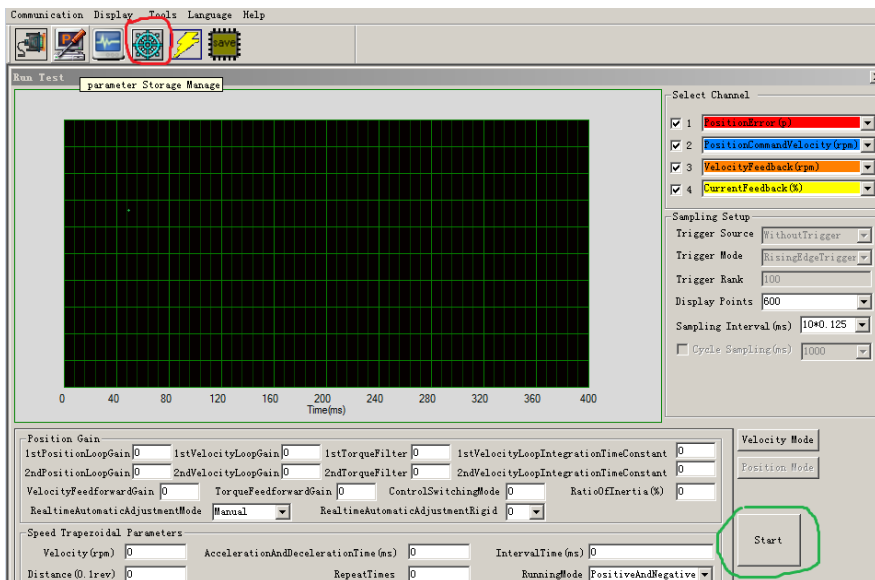
3. *Wiring*

3.1 Wiring in position mode

Notice: com+ is used for input signal, while com- is used for output signal .
 **If the driver is enabled with internal signal, no need to connect pin1 &pin2 .**
 Pr400 is 383 or 8383 or 8383 or 838383 for internal enable.
 Pr400=303 or 030303 for external enable.

The Simple Wiring for CN1 in Position Control Mode

3.2 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.
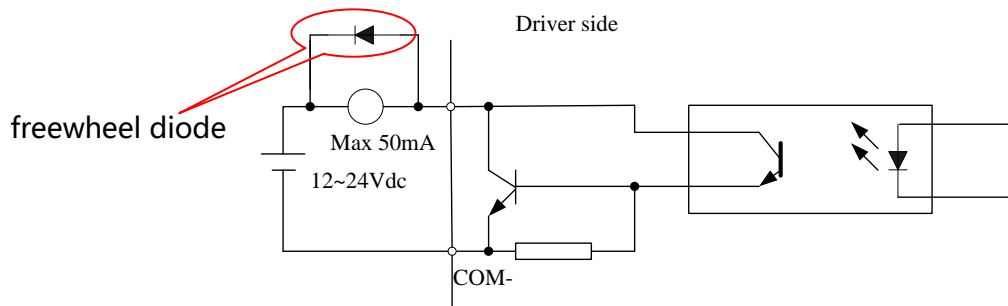
Notice: Don't connect the diode in wrong polarity, otherwise driver will be damaged.

4. *Tuning the inertia ratio*

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) .
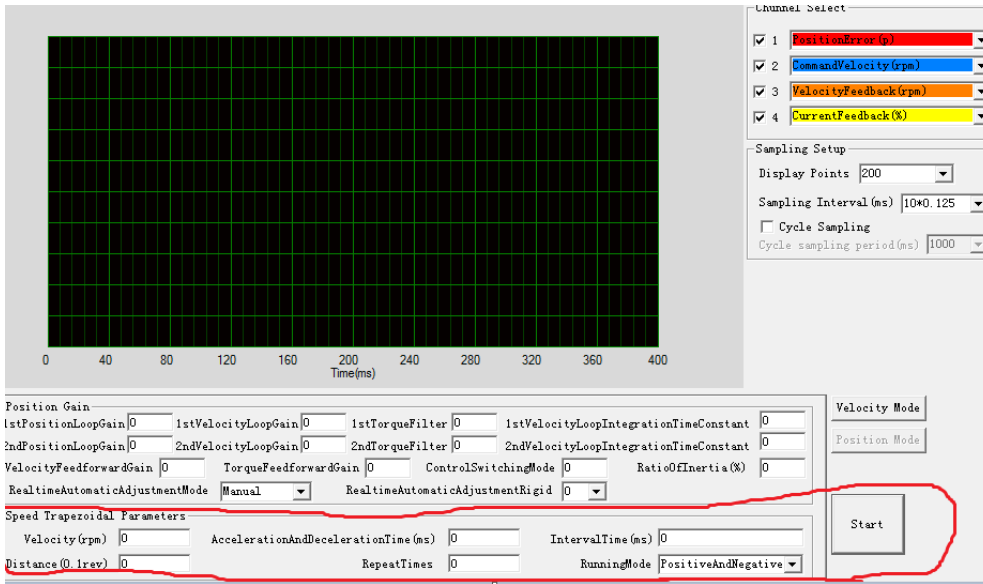
Here is the step to find ratio by user.

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

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

4.1   set the driver working in position loop (pr0.01=0).

4.2   click "run test"   ,then set the following value below :

Set RealtimeAutomaticAdjustmentMode as **Manual** ,

And set RealtimeAutomaticAdjustmentRigid as **12 or 13** .

Then set :

Velocity = 1000 rpm ,   acceleration = 100 ,   interval time =1000 ,   distance = 80 (0.1 rev)

Repeat time =3 ,   RunningMode : Positive and negative

Notice : we set the distance as 8 rev , just to make the ratio can be test more precisely , so do make the axis can be moved for 8 rev in safe distance .

4.3 click "start" , then check the D16jrt from the panel of driver after motor stopping moving . you can find the detail of this parameter from chapter 6.2.2 of user manual

6.2.2 Driver Operating Data Monitor

16	d16Jrt	Inertia ratio	ꓱꓱ6ꓱꓭꓭ	%	"J xxx"

Check the value of D16Jrt , then minus 100 , the result means the value of pr004 .

For example ,

Check the value of D16jrt , if the value is 800, then pr004 =700 ,it means the ratio of inertia equals 7 .

Then you need to set pr004=700 , save it and restart the driver to make the new value available .

5. *Tuning the performance of position loop and velocity loop :*

5.1 click "run test" , make the control mode in position loop , just like this :
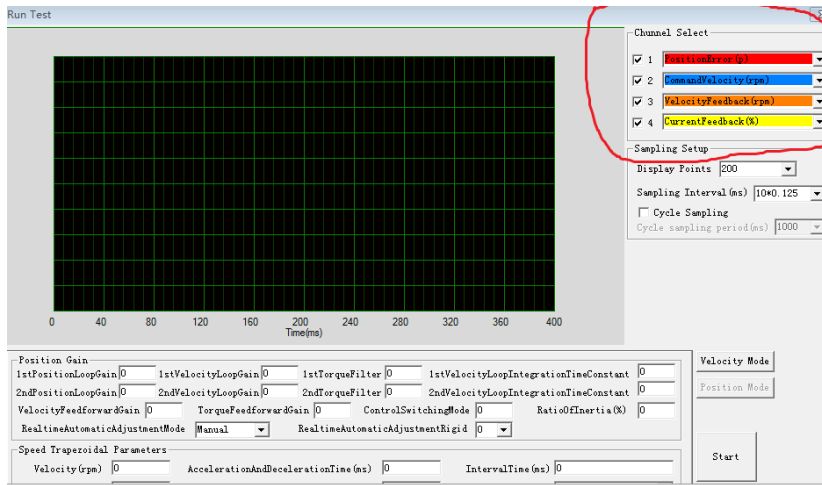
You need to give the driver command (blue curve) and see the feedback of velocity (orange curve) .

Pay attention to the option in red circle above .

5.2   actually , if give the command to driver , the curve of response should be like this ,the following is good for the tuning:
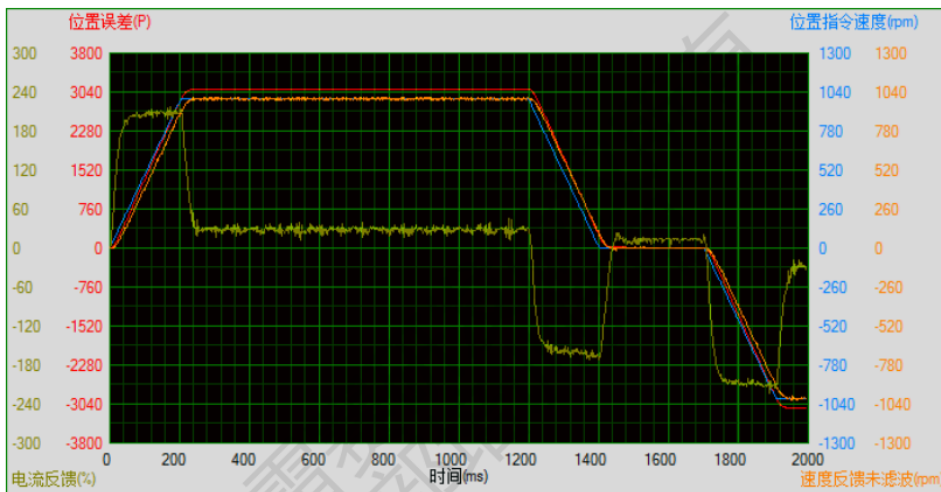
The blue curve means the velocity command , the orange curve means feedback of velocity , the more closer between the two curves , the better response you can get from driver .

5.3   the normal way to tune :

First ,set value as 11 for rigidity level, then make the value larger until the vibration occurs, then make the rigidity a little smaller .

For example : it isn't a good curve the following below :
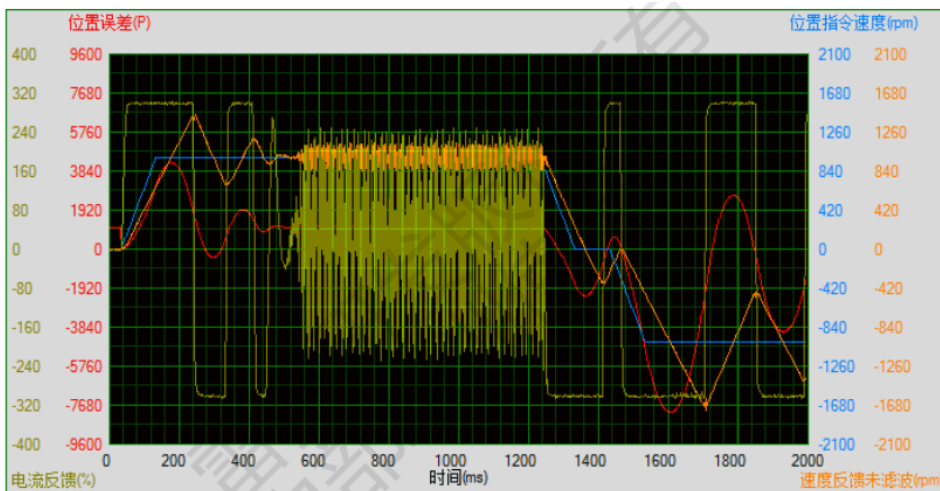
The yellow curve means the current of motor vibrate , the rigidity need to be smaller , maybe from 16 to

15 ,or 13 to 12 , and the acceleration time need to be larger , maybe from 100 to 150 , or 100 to 200 .

then check the performance again .

If the curve look like this below
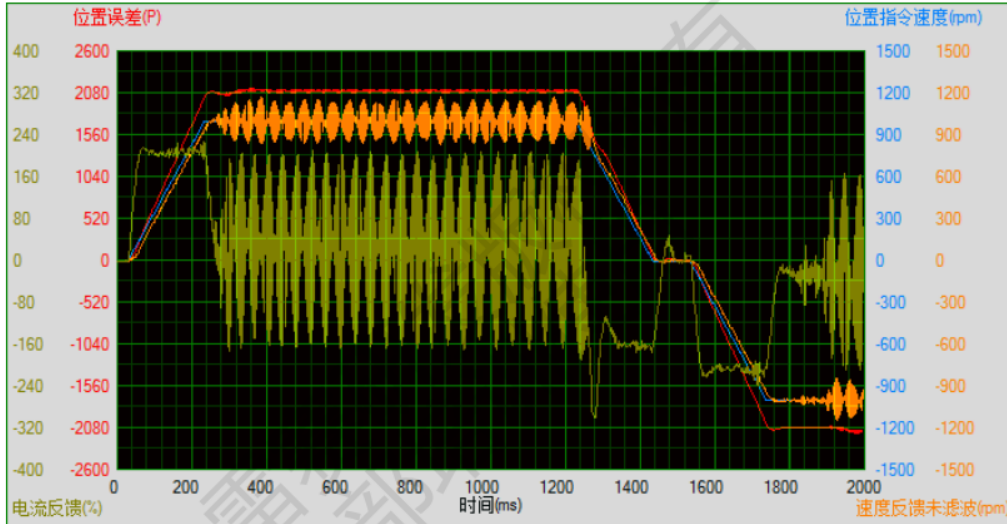
it is still bad , the rigidity need to be smaller ,and the acceleration time need to be larger , maybe from 200 to 250 , or 200 to 300 , change the value and check the performance again .

5.4 then the curve is better and better , just like this :
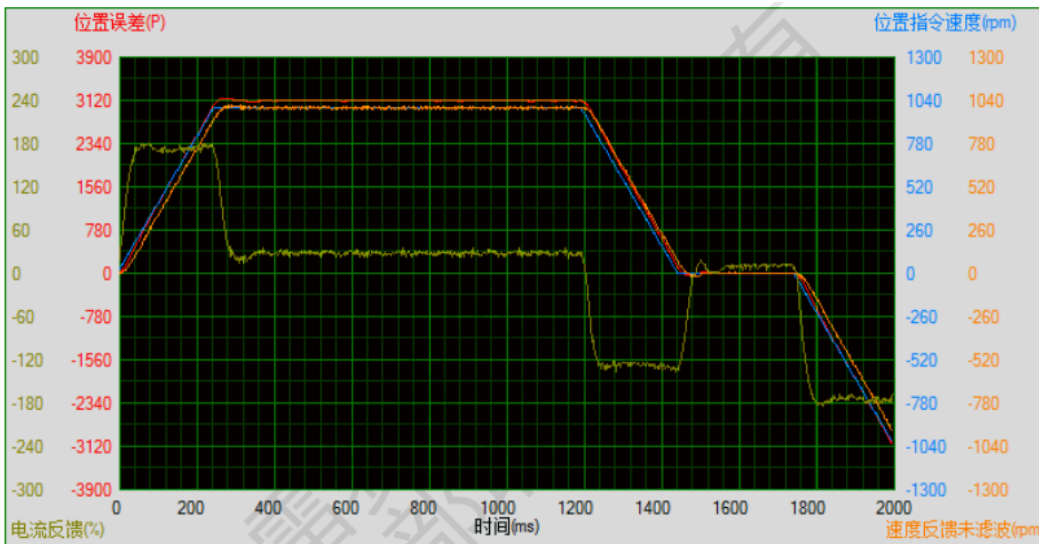
It is better now , this means acceleration time and rigidity are suitable ;

5.5 enlarge part of curve above , just like the curve below :
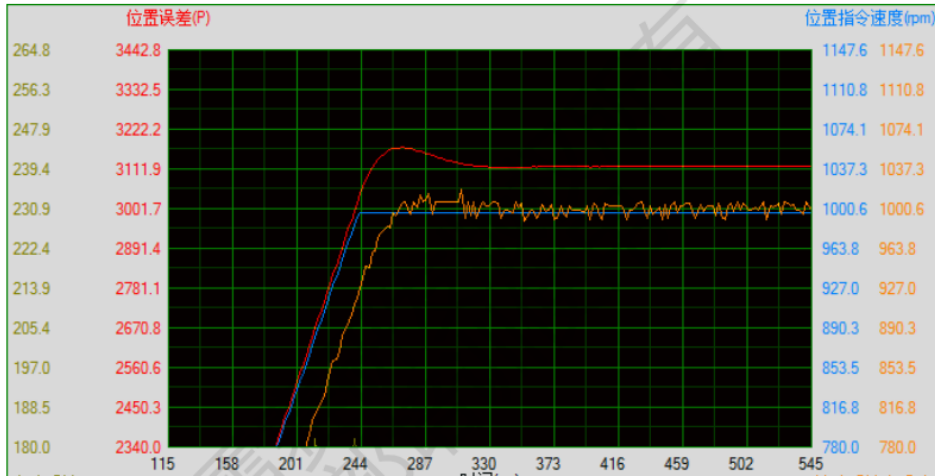
There is a little overshoot , so make the acceleration time a little smaller , maybe from 250 to 220

5.6   then the curve looks like this :
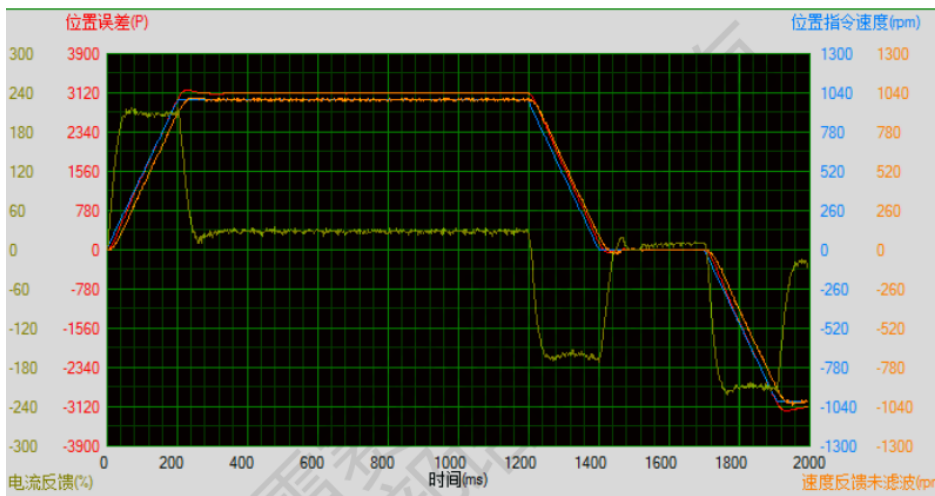
5.7   It looks great for application , however , you may enlarge the ratio of inertia to get better performance . make the ratio of inertia a little larger , maybe from 800 to 1000 , to make the performance better .

change the value of ratio and check the curve again , then the curve goes to :
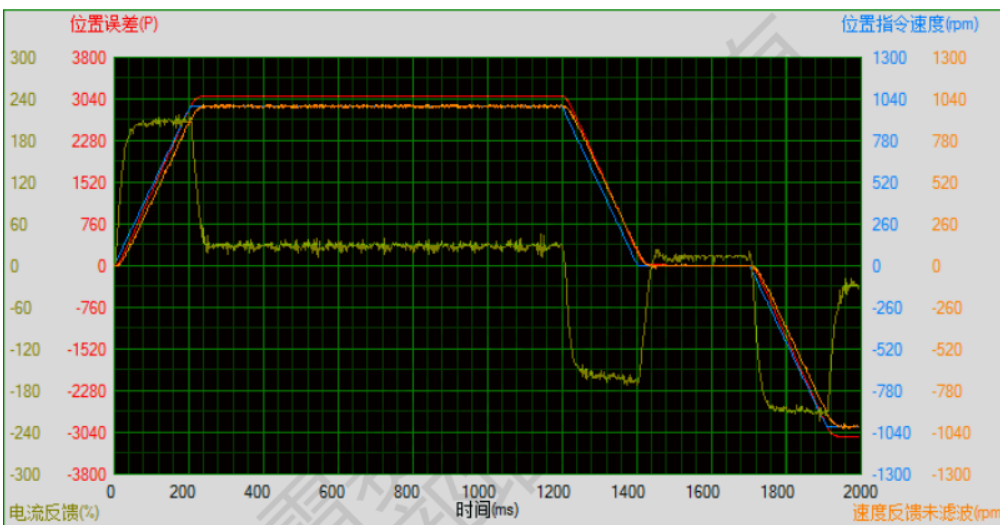
It is better, suitable for most of application .

6. *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.

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 Pr001 as 1 , the other is set Pr001 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 :
a. Choose the right control mode : Pr001 = 0
b. Set up the inertia of ratio : Pr004
c. Set up the rigidity : Pr003
d. Set up the Pr000 :
   1) If no multi-axis synchronous movement , set Pr000 as 1 or more than 10 ;
   2) If multi-axis synchronous movement needed , set Pr000 as the same for all the axes .
   3) If Pr000 is more than 10 , start with 100 , or 150 , 200 , 250 , …. .

Caution:
1. Set up the right control mode , the right inertia of ratio and rigidity firstly .
2. Don't change the value of Pr000 when the motor is running , otherwise vibration occurs
3. 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

7. *Setting and saving the value of parameter*
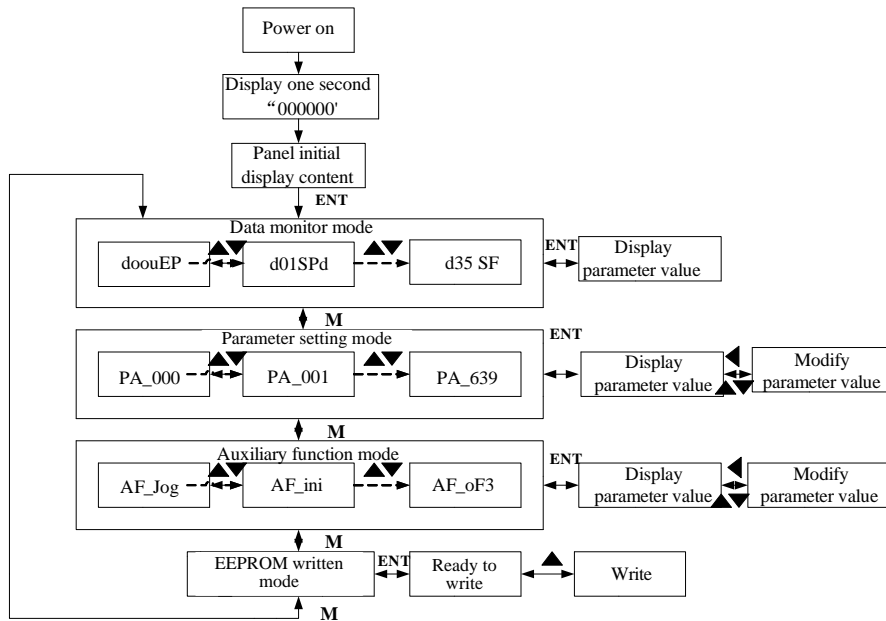
7.1 Panel Operation Flow Figure

Figure 6-2 the flow diagram of panel operation

(1) The front panel display ▨▨▨▨▨▨ 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.

7.2 Saving parameter

Operation procedure:

1. press M to select EEPROM writing mode, display " ▨▨▨▨▨▨ ";

2. Press ENT to enter into writing mode operation:

3. Press and hold ▲, display LED from" ▨▨▨▨▨▨ " to" ▨▨▨▨▨▨ ", then it become" ▨▨▨▨▨▨ ", finally it become" ▨▨▨▨▨▨ ", indicated EEPROM writing operation have been began;

4. ▨▨▨▨▨▨ " means that writing is unsuccessful while ▨▨▨▨▨▨ " 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.*

8. Simple debugging

8.1 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.

8.2 Basic parameter debugging

Parameters	Setting Range	Default	Parameters	Range	Default
PA-001(Control model)	0/1/2	0	PA-006(Pulse polarity setting)	0/1	0
PA-002(Real-time auto configuration)	0/1/2	2	PA-007(Pulse input model)	0/1/2/3	1
PA-003(Machine rigid)	0—31	13	PA-008(Pulse per round)	1—131072	10000
PA-004(inertia ratio)	0—10000	250			

Remark：

1. Default for 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.

9. Alarm

Error code	Main	Extra	Display: " ⊟⊟⊟⊟⊟ "
	⊟⊟	⊟	**Content:** over-current

Cause	Confirmation	Solution
Short of driver output wire	Short of driver output wire, whether short circuit to PG ground or not	Assure driver output wire no short circuit, assure motor no damage
Abnormal wiring of motor	Check motor wiring order	Adjust motor wiring sequence
Short of IGBT module	Cut off driver output wiring, make srv_on available and drive motor, check whether over-current exists	replace the driver with a new one
abnormal setting of control parameter	Modify the parameter	Adjust parameter to proper range
abnormal setting of control command	Check control command whether command changes too violently or not	Adjust control command: open filter function

Error code	Main	Extra	Display: " ⊟⊟⊟⊟⊟ "
	⊟⊟	⊟	**Content**: IPM over-current

Cause	Confirmation	Solution
Short of driver output wire	Short of driver output wire, whether short circuit to PG ground or not	Assure driver output wire no short circuit, assure motor no damage
Abnormal wiring of motor	Check motor wiring order	Adjust motor wiring sequence
Short of IGBT module	Cut off driver output wiring, make srv_on available and drive motor, check whether over-current exists or not	replace the driver with a new one
Short of IGBT module	/	replace the driver with a new one

abnormal setting of control parameter	Modify the parameter	Adjust parameter to proper range
abnormal setting of control command	Check control command whether command changes too violently or not	Adjust control command: open filter function

Error code	Main	Extra	Display: "Er 0F0"
	0F	0	Content: driver over-heat
Cause	**Confirmation**		**Solution**
the temperature of power module have exceeded upper limit	Check driver radiator whether the temperature is too high or not		Strengthen cooling conditions, promote the capacity of driver and motor, enlarge acceleration/deceleration time, reduce load

Error code	Main	Extr	Display: "Er 100"
	10	0	Content: motor over-load
Cause	**Confirmation**		**Solution**
Load is too heavy	Check actual load if the value of parameter exceed maximum or not		Decrease load, adjust limit parameter
Oscillation of machine	Check the machine if oscillation exists or not		Modify the parameter of control loop; enlarge acceleration/deceleration time
wiring error of motor	Check wiring if error occurs or not, if line breaks or not		Adjust wiring or replace encoder/motor for a new one
electromagnetic brake engaged	Check brake terminal voltage		Cut off brake

Error code	Main	Extra	Display: "Er 1A0"
	1A	0	Content: over-speed 1
Cause	**Confirmation**		**Solution**
Motor speed has exceeded the first speed limit (PA_321)	Check speed command if it is too large or not; check the voltage of analog speed command if it is too large or not; check the value of PA_321 if it is too small or not; check input frequency and division frequency coefficient of command pulse if it is proper or not; check encoder if the wiring is correct or not		Adjust the value of input speed command, enlarge the value PA_321 value, modify command pulse input frequency and division frequency coefficient, assure encoder wiring correctly

Error code	Main	Extra	Display: "Er 150"
	15	0	Content: encoder line breaked
Cause	**Confirmation**		**Solution**
Encoder line disconnected	check wiring if it steady or not		Make encoder wiring steady
Encoder wiring error	Check encoder wiring if it is correct or not		Reconnect encoder wiring
Encoder damaged	/		replace the motor with a new one
Encoder measuring circuit damaged	/		replace the driver with a new one

Error code	Main	Extra	Display: "Er 180"
	18	0	Content: position error over-large error
Cause	**Confirmation**		**Solution**
Unreasonable set of	Check parameter PA_014 value if it is too		Enlarge the value of PA_014

position error parameter	small or not	
Gain set is too small	Check parameter PA_100, PA_105 value if it is too small or not	Enlarge the value of PA_100, PA_105
Torque limit is too small	Check parameter PA_013, PA_522 value whether too small or not	Enlarge the value of PA_103, PA_522
Outside load is too large	Check acceleration/ deceleration time if it is too small or not , check motor rotational speed if it is too big or not ; check load if it is too large or not	Increase acceleration/ deceleration time decrease speed, decrease load

Error code	Main	Extra	**Display:** "⊟⊟⊟⊟19⊟"
	19	0	**Content:** motor vibration

Cause	Confirmation	Solution
Current vibration	Current vibration	Cut down the value of Pr003. Pr004
Stiffness is too strong	Stiffness is too strong	

Error code	Main	Extra	**Display:** "⊟⊟⊟24⊟"
	24	0	**Content:** CRC verification error when EEPROM parameter is saved

Cause	Confirmation	Solution
r,t terminal under-voltage	Check r,t terminal voltage	Assure r,t terminal voltage in proper range
Driver is damaged	save the parameters for several times	replace the driver with a new one
The setting of driver maybe default setting which isn't suitable for motor .	Check the setting of driver if it is suitable for your motor	Download the suitable project file to driver for motor