QUICK START OF ELP AC SERVO

Only Available for ELP-D*Z/ ELP-RS***Z Version**

Table of Contents

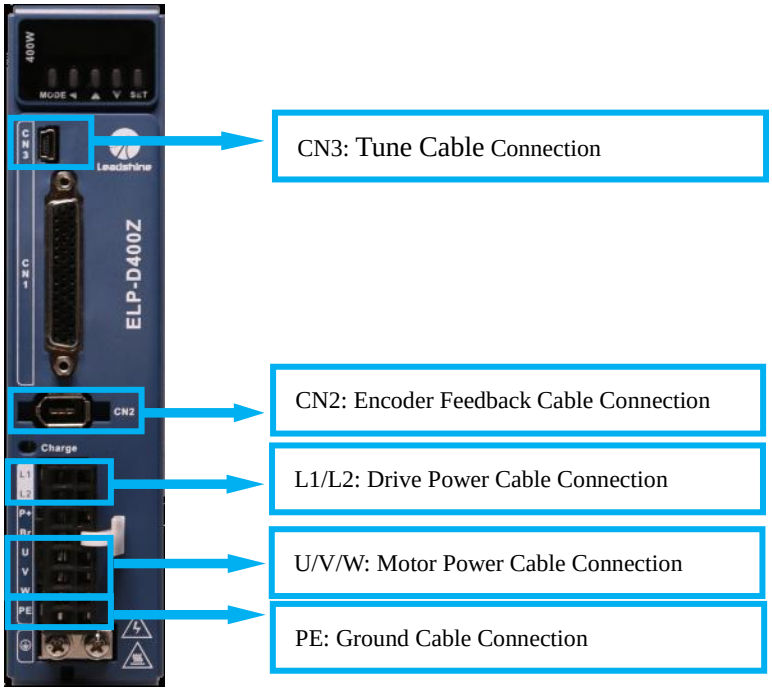
Preparation List

- ELP Series AC drive
- ELM AC Servo Motor
- Cables
  - Motor power cable
  - Encoder feedback cable
  - Tune cable
  - Drive power cable
- Tune software (Motion Studio)
- The driver of tune software (if it is necessary)

Chapter 1 JOG Trail

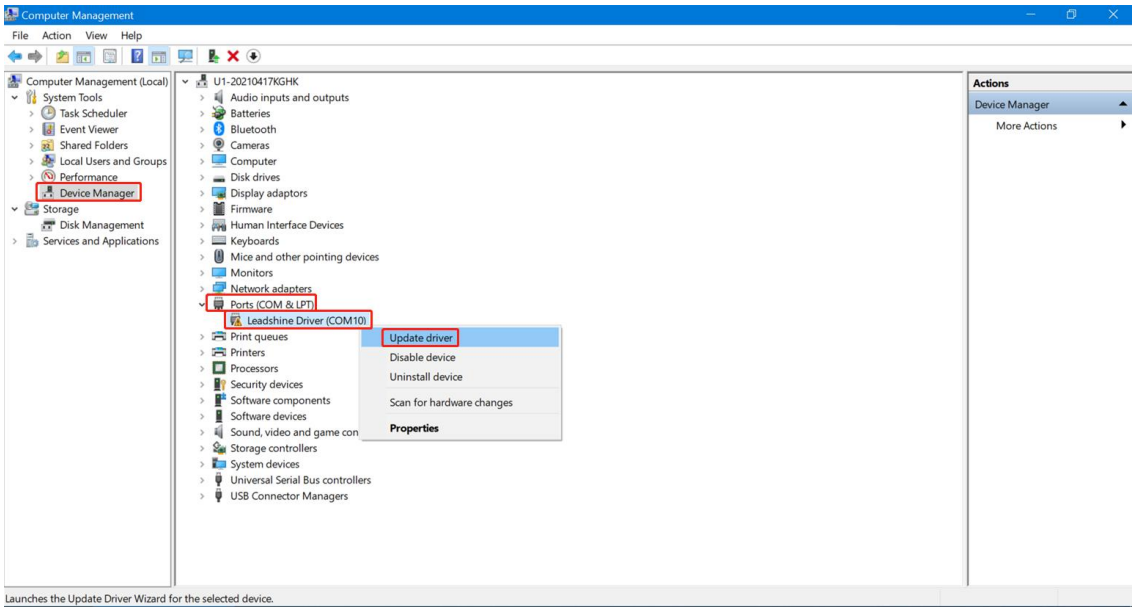
1.1 Connection

1.1.1 Cables connection.

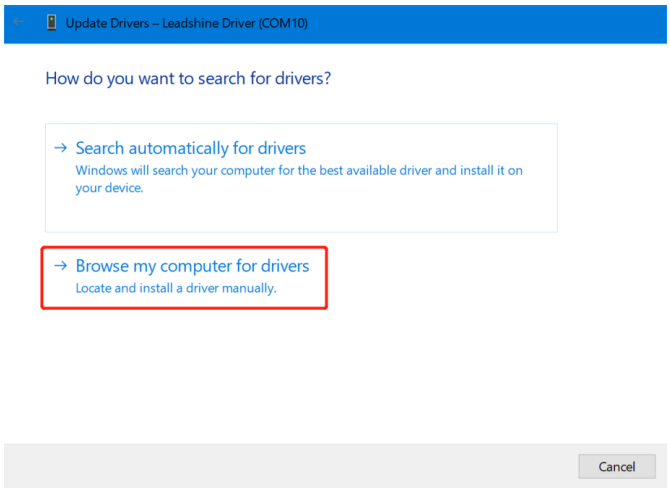


1.1.2 Connect to tune software. (Perform this step if it is necessary to install driver)

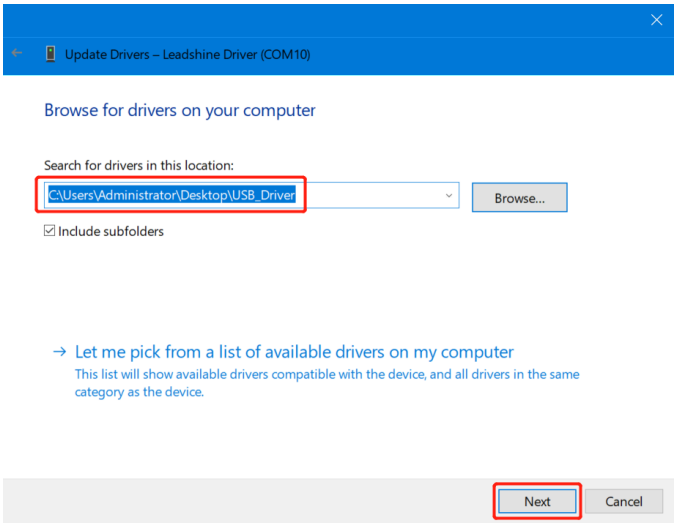
1.1.2.1 Click in turn “Device Manager”, “Ports (COM&LPT)”, “Leadshine Driver”, “Update driver”.



1.1.2.2 Click "Browse my computer for drivers".

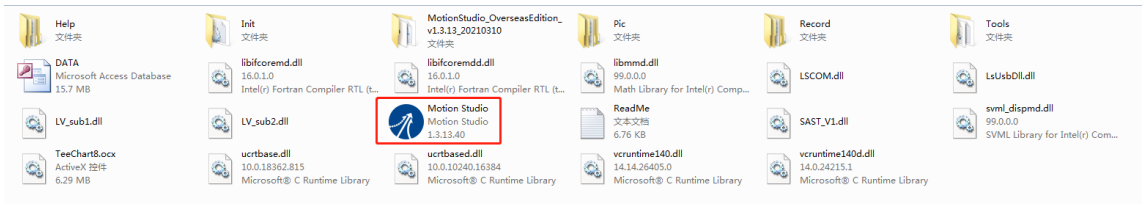


1.1.2.3 Search for drivers in the location from "USB_Driver" folder in which you placed the application that Leadshine provide, and then accomplish updating driver.

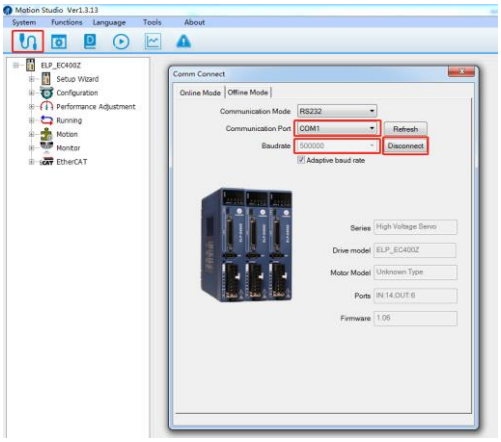


1.2 JOG Trail

1.2.1 Click icon of Motion Studio to enter in.

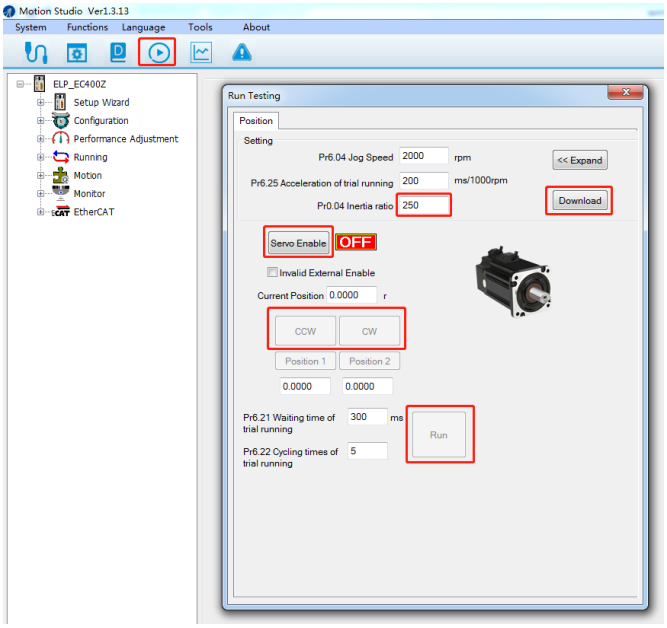


1.2.2 Click "Com Connect  ", and select appropriate communication port and baud rate to start connecting.



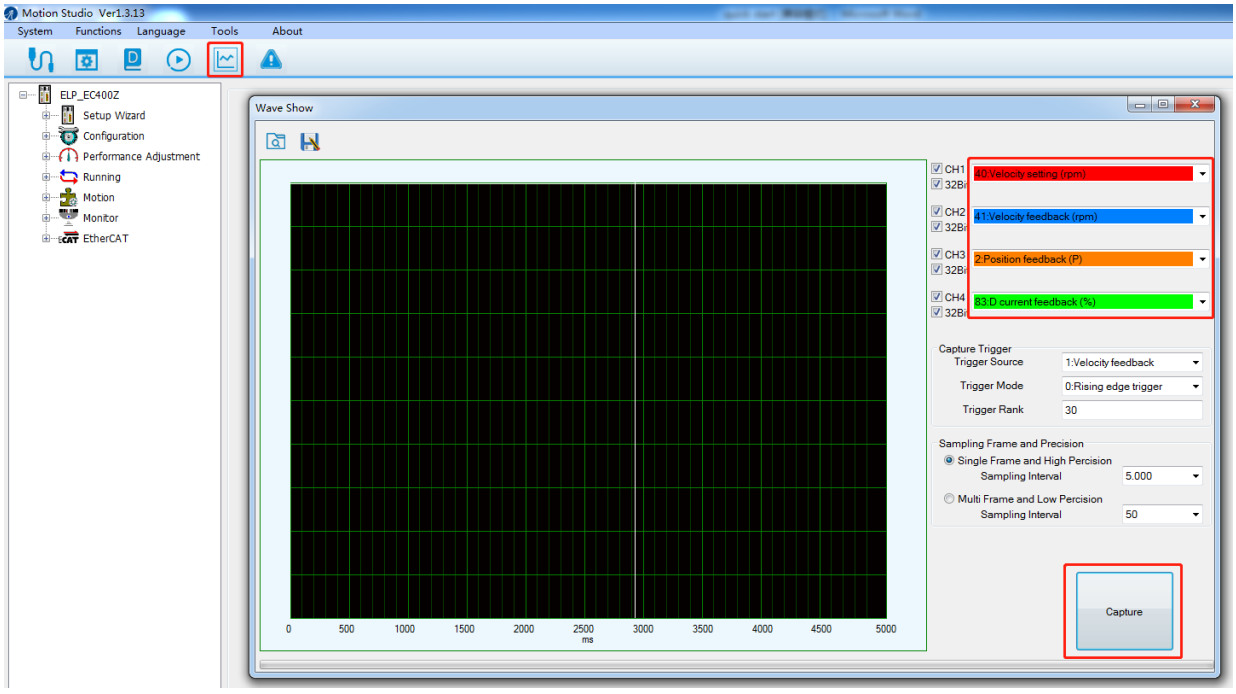
Note: Recommend communication port under COM10.

1.2.3 Click "Run Testing", and tune Pr0.04 inertia ratio and Pr0.03 stiffness, click "download" to save modified parameters, finally click "Servo Enable" to start JOG trail.



Note: All parameters could be modified from "Parameter Manage"; clicking "Download" is necessary to modified parameters under "Run Testing", not necessary under "Parameter Manage".

1.2.4 Click "Wave Show", and select waveform parameters you want to capture, finally click "Capture" to display real-time waveform.

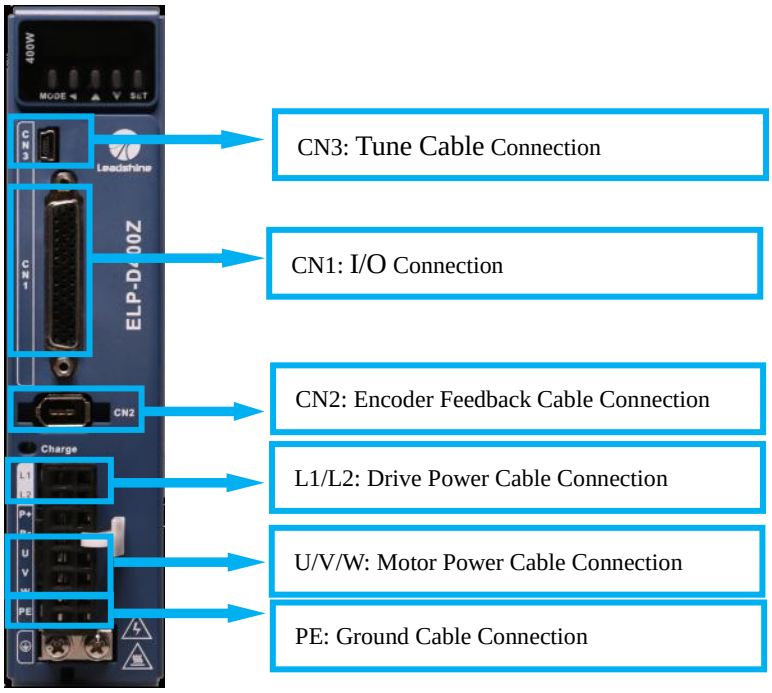


Chapter 2 Position Control (Pul + Dir)

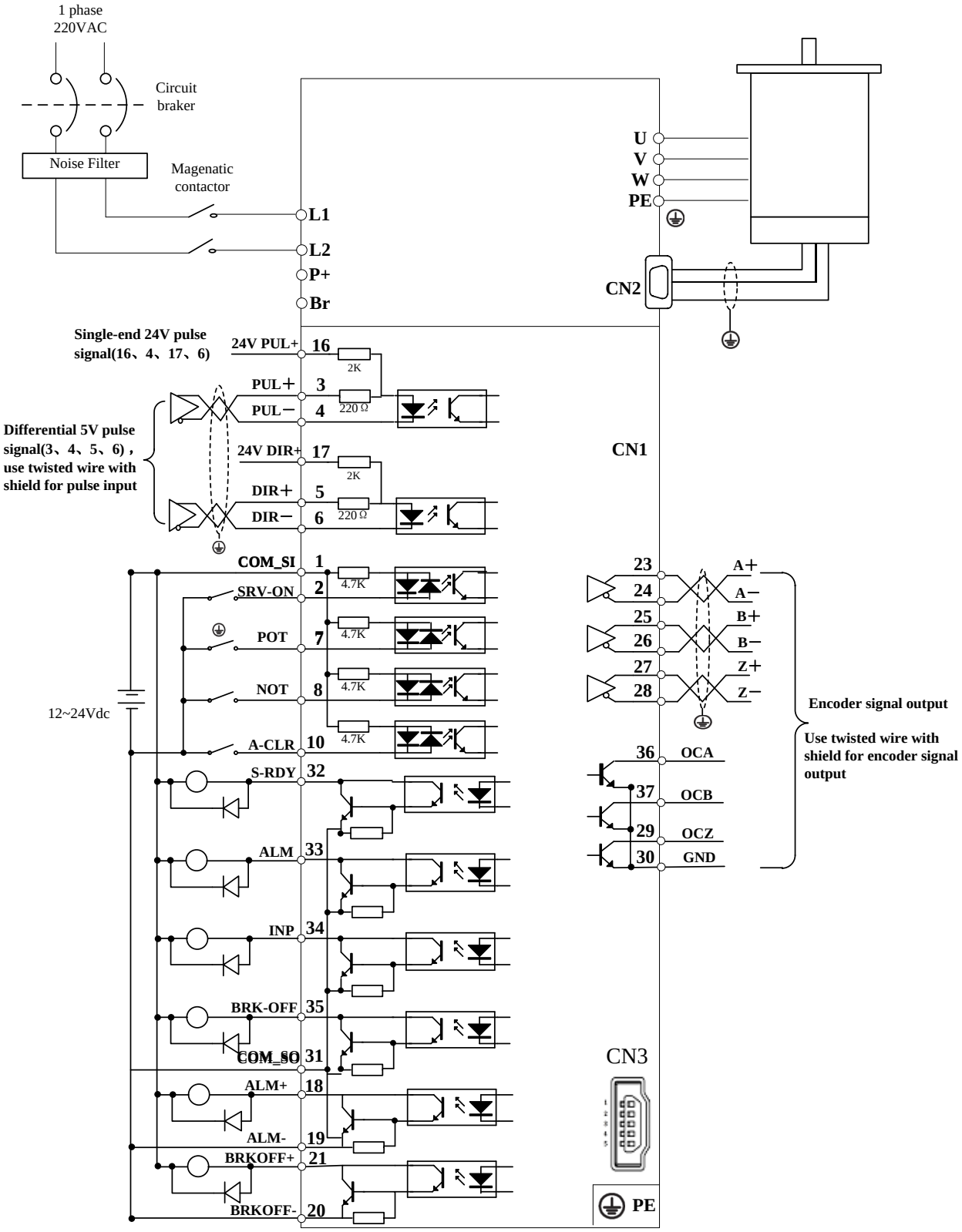
2.1 Connection

2.1.1 Cables connection

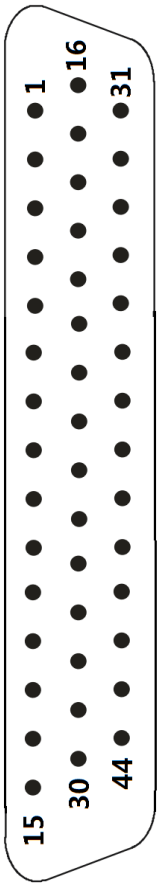
2.1.1.1 Cover display.



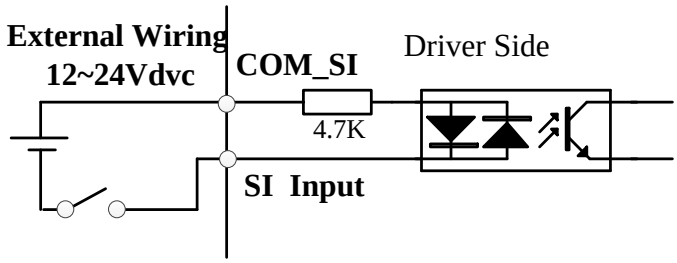
2.1.1.2 Wiring sketch map.



2.1.1.3 I/O terminal definition.

Port	Chart	Pin	Signal	I/O	Name	Explanation
CN1		1	COM_SI	input	Digital input common terminal Com+/Com-, 12VDC~24VDC	Two-way digital input with common terminal, function can be configured. 12VDC ~ 24VDC
		2	SI1	input	Digital input 1	
		7	SI2	input	Digital input 2	
		8	SI3	input	Digital input 3	
		9	SI4	input	Digital input 4	
		10	SI5	input	Digital input 5	
		11	SI6	input	Digital input 6	
		12	SI7	input	Digital input 7	
		13	SI8	input	Digital input 8	
		14	SI9	input	Digital input 9	
		31	COM_SO	output	Digital output common- terminal	Low resistor output in default. OC, the maximum voltage/current is no more than 30V, 50mA. Recommend the voltage: 12 V-24V. Current :10mA
		33	SO1 +	output	Digital output 1	
		32	SO2 +	output	Digital output 2	
		34	SO3 +	output	Digital output 3	
		35	SO4 +	output	Digital output 4	
		18	SO5 +	output	Differential Digital output 5	Differential Digital output，the maximum voltage/current is no more than 30V/50mA . Recommended voltage: 12 -24V. Current :10mA
		19	SO5-	output		
		20	SO6-	output	Differential Digital output 6	
		21	SO6 +	output		
		23	A +	output	Differential output terminal of motor encoder A phase	Differential output, High >= 2.5vdc, low <= 0.5vdc, maximum current ±20mA
		24	A -	output		
		25	B +	output	Differential output terminal of motor encoder B phase	
		26	B -	output		
		27	Z +	output	Differential output terminal of motor encoder Z phase	
		28	Z -	output		
		36	OCA	output	OC output terminal of motor encoder A phase	
		37	OCB	output	OC output terminal of motor encoder B phase	
		29	OCZ	output	OC output terminal of motor encoder Z phase	
		30	GND	output	OC output GND terminal of motor encoder	
		3	PUL +	input	Pulse input，	
		4	PUL -	input	PUL+ and PUL-：5V differential input	
		16	PUL + _24	input	PUL+_24 and PUL-：24V differential input	
		5	DIR +	input	Direction input，	
		6	DIR -	input	DIR+ and DIR-：5V differential input	
		17	DIR + _24	input	DIR+_24 and DIR-：24V differential input	
		39	AI1+	input	Analog input 1, voltage input range: -10VDC~+10VDC, input resistor 20KΩ. for velocity mode (Analog input)	
		40	AI1-	input		
		41	AGND	input		
		43	AI3 +	input	Analog input 3, voltage input range: -10VDC~+10VDC, input resistor 20KΩ. for torque mode (Analog input)	
		44	AI3 -	input		
		15.22.38.40.42	NC	/	No connection	
		Shell	FG		Shield ground	

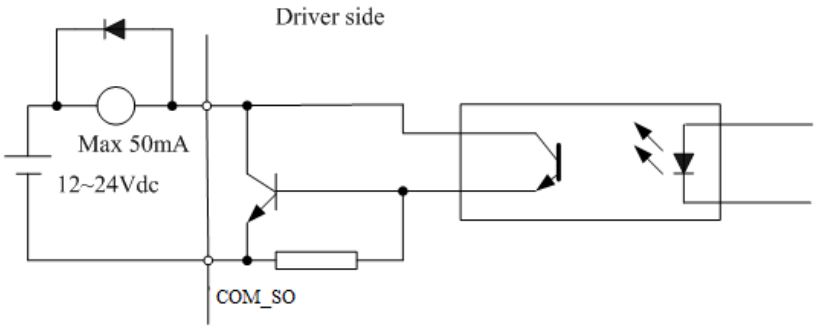
2.1.1.4 I/O input signal circuit.



A. The power supply is provided by user, DC 12-24V, current ≥100mA, if the power polarity connects reversely, the drive won't run.

B. If the drive is enabled by internal signal, then user won't need to connect to Pin1and Pin2.
Pr4.00=83 for internal enable.
Pr4.00=3 for external enable.

2.1.1.5 I/O output signal circuit.



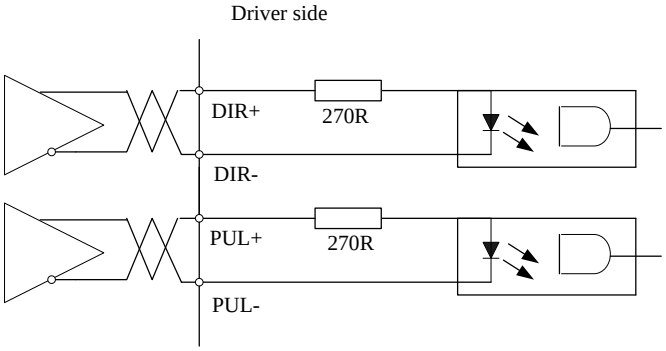
A. The power supply is provided by user, if the power polarity connects reversely, the drive will be damaged.

B. The output circuit adopts open-collector, the maximum voltage is 25V, and maximum current is 50Ma. If user overlooks the requirements or output terminal directly connected to power supply, the drive will be damaged.

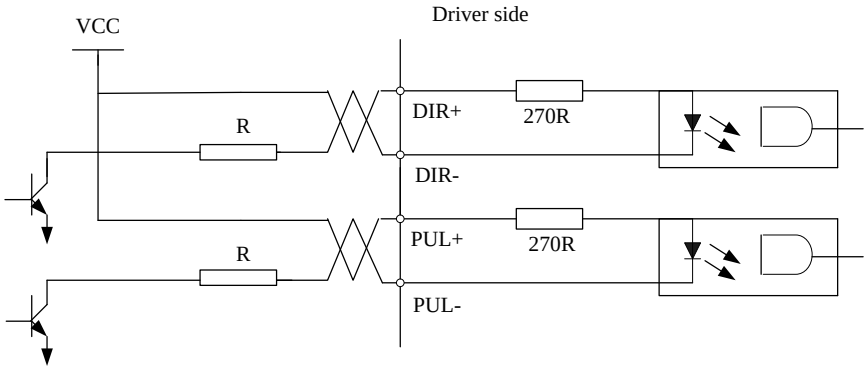
C. If the load is inductive load, etc., anti-parallel freewheeling diode must connect to the load, if the freewheeling diode connects reversely, the drive will be damaged.

D. Pin 31/32/33/34/35 are for single-ended output, pin 18/19, 20/21are for differential output.

2.1.1.6 Pulse input signal circuit.



Wiring method of 5V differential signal (Pin 3/4/5/6)



Wiring method of 24V single-ended signal (Pin 4/6/16/17)

- **A.** The drive support two wiring methods: 5V differential signal and 24V single-ended signal.
- **B.** 5V differential signal are recommended to get more accurate pulse signal data.
- **C.** While 24V single-ended signal are adopted, the power supply is provided by user, if the power polarity connects reversely, the drive will be damaged.
- **D.** Pulse input signal format show as below chart, in addition, 4 times pulse frequency ≤ 500kH while adopting 2 phase input.

2.1.2 Connect to tune software. (Perform this step if it is necessary to install driver)

Refer to section 1.1.2 of chapter 1.

2.2 Main steps to tune ELP Drives in position mode

(1) Connect the wire correctly (motor will be recognized by drive automatically);
(2) Use "run testing" to test the motor if motor run normally or not.
(3) Set the value of Pr400 (Pr400=83 for external servo on signal ; Pr400=3 for internal signal)
(4) Choose right control mode Pr0.01. (0: position mode, 1: velocity mode, 2: torque mode).
(5) Connect the motor with load and Tuning the inertia ratio(Pr0.04)
(6) Connect the motor with load and Tuning stiffness for each axis (Pr0.02, Pr0.03).
(7) Tune Pr2.22 and Pr2.23 for smoother moving if needed.
(8) Set the value of Pr006, 007,008,009,010.
(9) Tune Pr0.00 for more stiffness if needed.

Run Testing

Use “run testing” of software protuner to tune the drive. Make sure the shaft of motor is free before running it, and please release the brake firstly if motor is with brake.

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

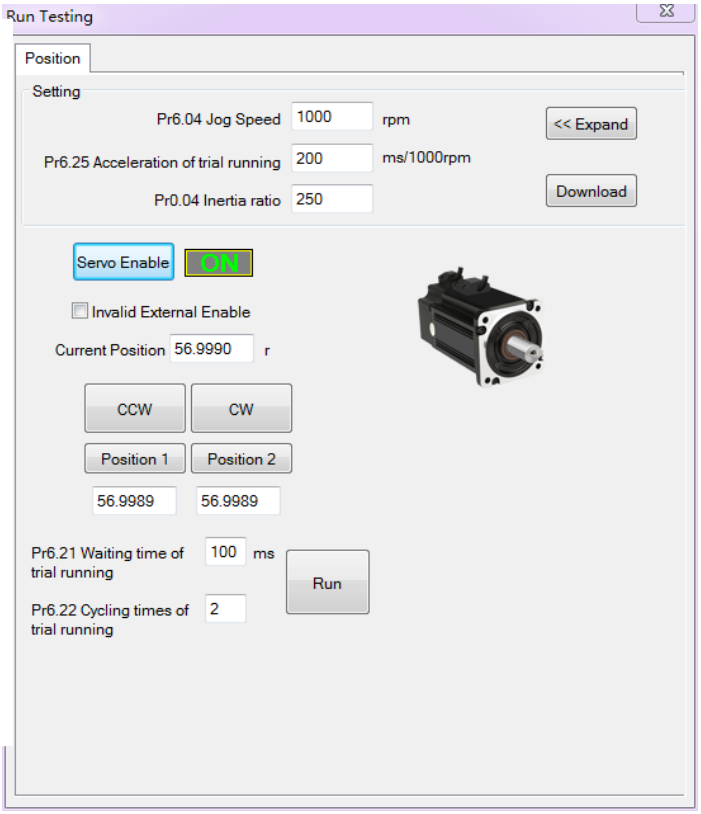
Click button “Servo enable”

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

Click “CW” to make motor run in 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.



Control mode setting (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.

Mode of real-time auto-gain tuning setting (Pr0.02)

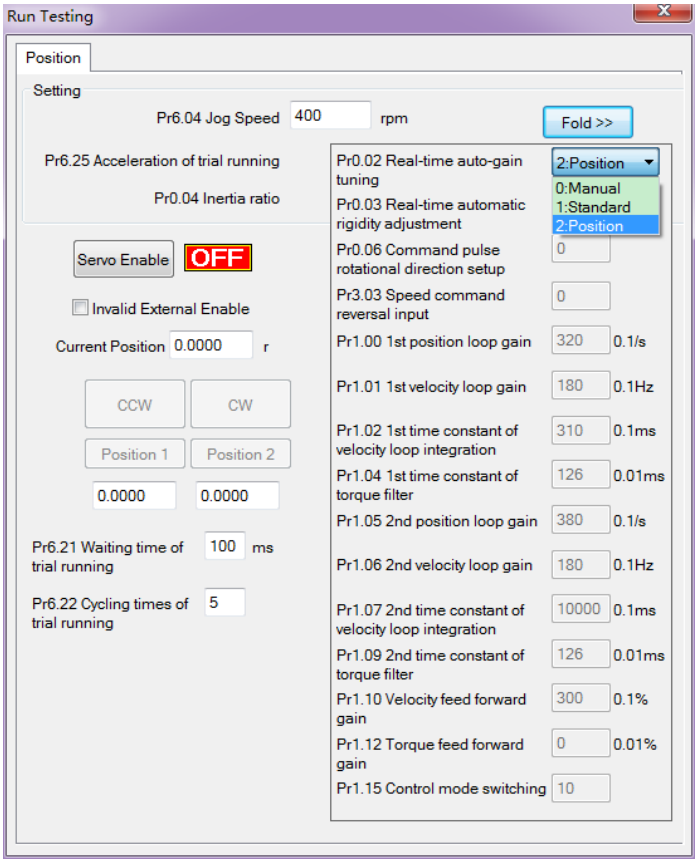
Select different operation mode in real-time automatic adjustment mode,

In **Manual** mode(Pr0.02=0), Kp, Ki and other parameters can be set manually. Pr003 is unavailable now .

About how to tune position loop, Ki can be adjusted to a very small value in advance and hold it constant, then enlarge the value of Kp parameter slowly until system oscillation occurs, at this moment enlarge the value of Vi parameter slowly until system oscillation occurs, at this moment the basic adjustment of system is 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, just change the value of Pr0.03 , then all values of Pr1.00-1.14 will be changed at the same time .

In **Positioning** mode(Pr0.02=2), it is usually for point to point movement. It is unavailable to modify the value of Pr1.00-1.14, just change the value of Pr0.03 ,then all values of Pr1.00-1.14 will be changed at the same time .



Performance adjustment—Tuning the inertia ratio(Pr0.04)

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：

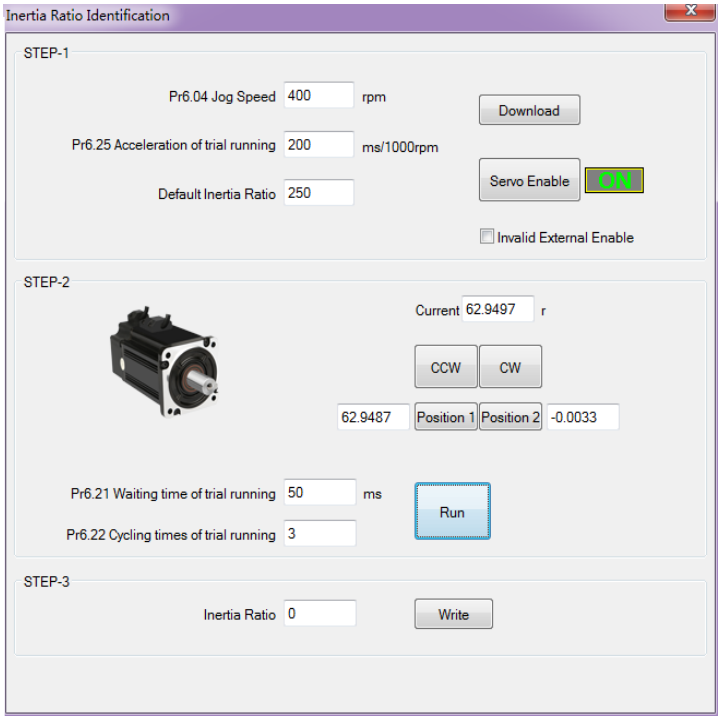
1. Servo disable.
2. Positive limit and negative limit invalid

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 dentification.

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



Performance adjustment—Gain adjustment(Pr0.03)

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

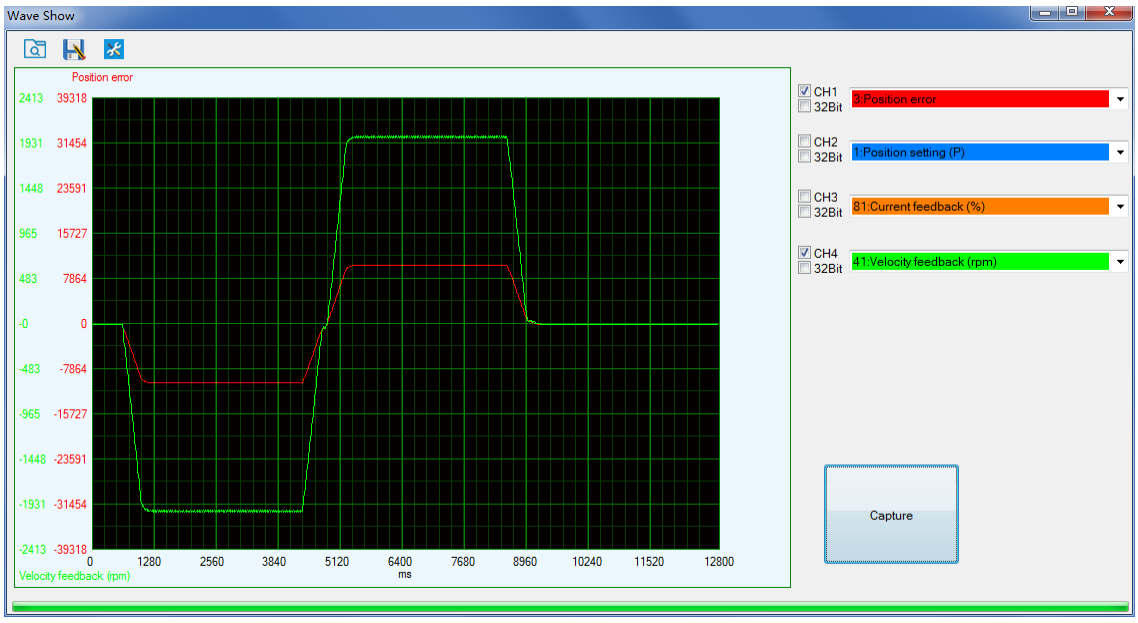
Low ⟶ Servo gain ⟶ High

81.80·····70.69.68·····51.50

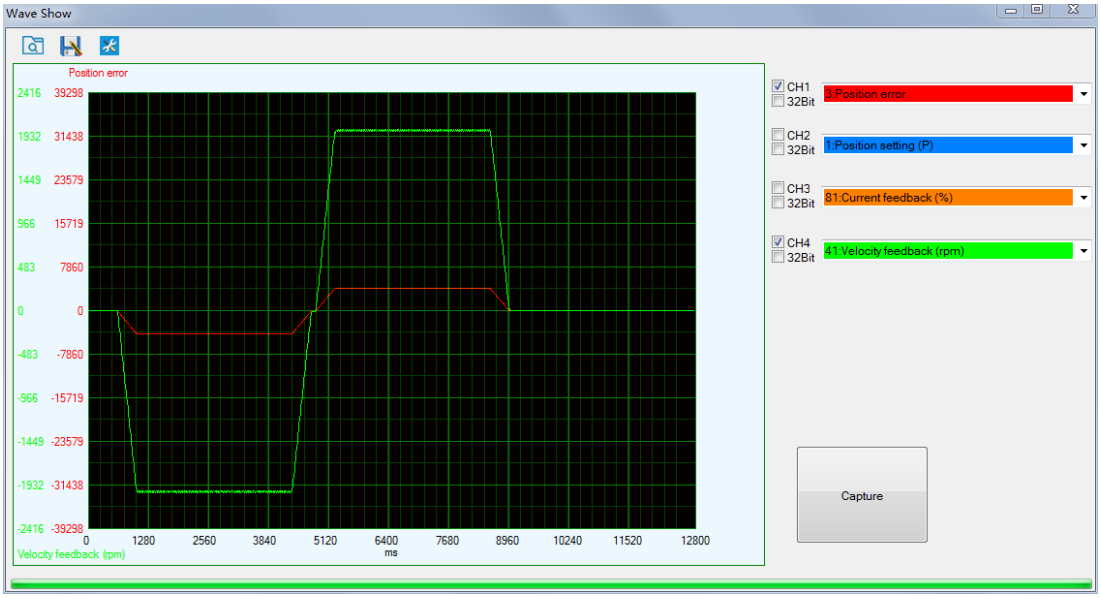
Low ⟶ Response ⟶ High

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.

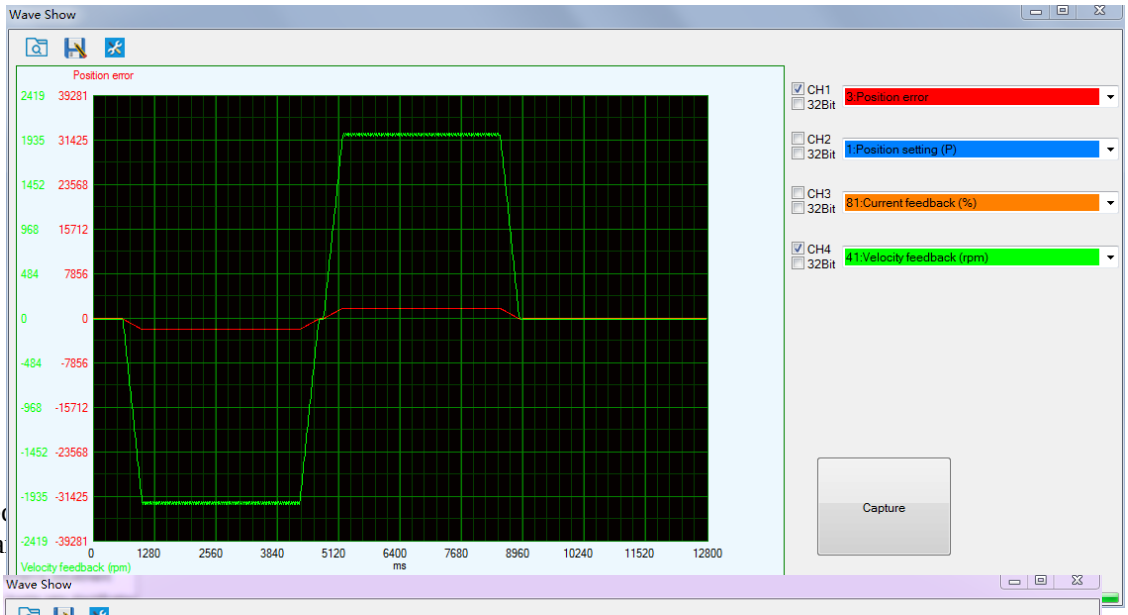
The following figure showing Pr0.02=2, Pr0.03=70, the position error (curve in red) is unacceptable! Keep decreasing value of Pr0.03, then the position error become smaller and smaller.



Pr0.03=66



Pr0.03=62



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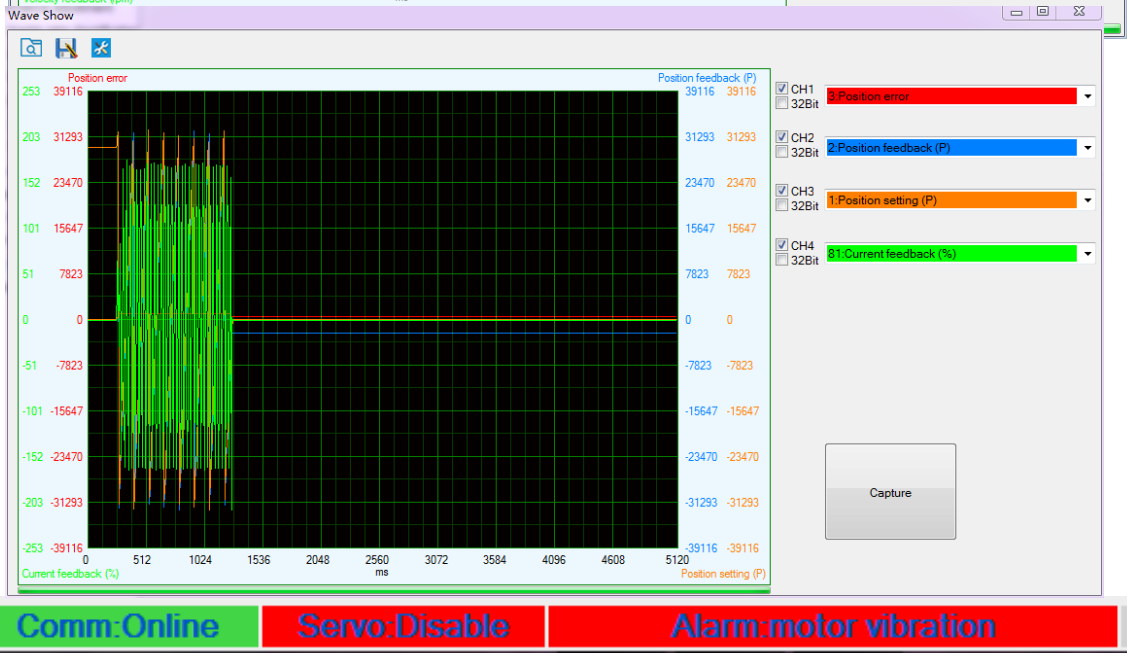
time consta

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

Simple debugging for position control

- **Debugging steps**

(1) Confirm pulse polarity Pr0.06, command input mode Pr0.07

(2) Modify Pr0.08 and set a suitable electronic gear ratio, if intend to set non-integral electronic gear ratio, can use Pr0.09 and Pr0.10.

(3) Set suitable inertia with Pr0.04; suggest increase/decrease the value In multiples of 100.

(4) Adjust Pr0.03 to be a suitable stiffiness value. Suggest to set it from big to small until sharp noise appear

(5) Each time you modify parameters, pls execute save steps and restart the power.

- **Basic parameter debugging**

Parameters	Range	Details
Pr0.01(Control mode)	0/1/2	Pr0.01=0 for Position Mode
Pr0.02 (Real-time auto configuration)	0/1/2	Pr0.02=0 for **Manual** mode, Real-time auto-gain tuning function is disabled. Pr0.02=1 for **Standard** mode, it is usually for interpolation movement. It is unavailable to modify the value of Pr1.00- 1.14, just change the value of Pr0.03, then all values of Pr1.00-1.14 will be changed at the same time. Pr0.02=2 for **Positioning** mode, it is usually for point to point movement. It is unavailable to modify the value of Pr1.00- 1.14, just change the value of Pr0.03, then all values of Pr1.00-1.14 will be changed at the same time .
Pr0.03(Machine rigid)	50 -81	Default value is 70, lower the setup value, higher the velocity response and servo stiffness will be obtained.
Pr0.04(inertia ratio)	0—10000	Default value is 250, Pr0.04=(load inertia/rotate inertia)×100%
Pr0.06(Pulse polarity setting)	0/1	Set Pr0.06 to change the rotation direction.
Pr0.07(Pulse input model)	0/1/2/3	Command Pulse Input Mode, set Pr0.07 according to controller signal
Pr0.08(command pulse per motor rotation)	0-8388608	1) If Pr008≠0 , the motor actual turns = pulse number / Pr008 2) If Pr008=0 , Pr0.09 1st numerator of electronic gear and Pr0.10 Denominator of electronic gear become valid.
Pr0.09(numerator of electronic gear)	0-8388608	If Pr008=0 , Pr0.09 1st numerator of electronic gear and Pr0.10 Denominator of electronic gear become valid.
Pr0.10(denominator of electronic gear)	0-8388608	

Remark:

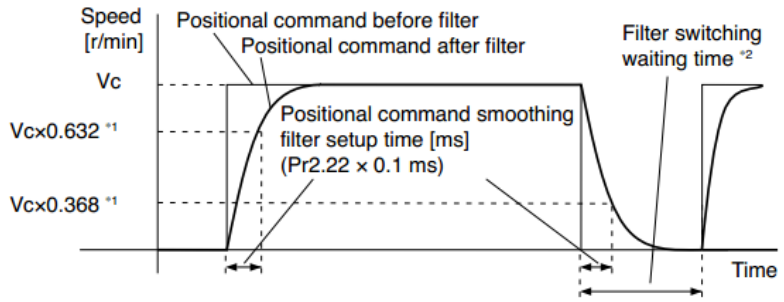
1. Default for Pr0.08 pulse per rev is 10000.
2. Electronic gear ratio can be also set by Pr0.09(numerator) and Pr0.10(denominator), Pr0.08 must be set as 0 before that.
3. Input pulse frequency which is higher than 500K can not be identified by driver. Assuming that 10000 ppr, that means corresponding command bandwidth of 3000rpm can reach to 500k. If motor run above 3000 rpm, the pulse per rev must be lower than 10000.

Position command filter (Pr2.22 and Pr2.23)

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

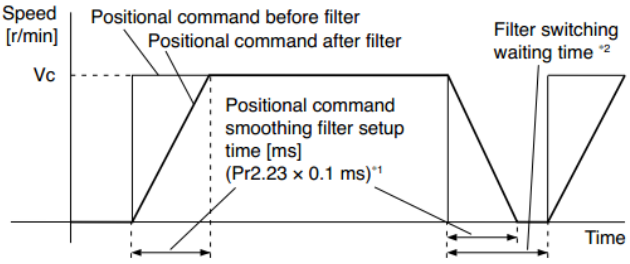
Pr2.22	positional command smoothing filter	Range	unit	default	Related control mode		
		0 -32767	0.1ms	0	P		

- Set up the time constant of the1st delay filter in response to the positional command.
- When a square wave command for the target speed Vc is applied ,set up the time constant of the 1st 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 the1st delay filter in response to the positional command.
- When a square wave command for the target speed Vc is applied, set up the Vc arrival time as shown in the figure below.



Tuning the dynamic tracking performance (Pr0.00) *(optional)*

Notes: set Pr0.02=2 if application is point to point movement, no need to tune the dynamic tracking performance. set Pr0.02=1 if application is interpolation movement, it is very useful to tune the dynamic tracking performance. MFC function is very useful for better dynamic tracking control and contouring cutting.

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 steps to use this function :

a. Choose the right control mode : Pr0.01 = 0
b. Set up Pr0.02=1 for interpolation movement
c. Set up the inertia ratio : Pr0.04
d. Set up the rigidity : Pr0.03
e. Set up the Pr0.00 :
   1) If no multi-axis synchronous movement , set Pr0.00 as 1 or more than 10 ;
   2) If multi-axis synchronous movement needed , set Pr0.00 as the same for all the axes .
   3) If Pr0.00 is more than 10 , start with 100 , or 150 , 200 , 250 , …. .

Caution:

1. Set up the right control mode, the correct inertia of ratio and rigidity firstly .
2. Don't change the value of Pr0.00 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.

Chapter 3 Velocity Control (Analog Input)

Note: Analog control is only available for ELP-RS***Z version

3.1 Connection

3.1.1 Cables connection

3.1.1.1 Cover display.

Refer to section 2.1.1.1 of chapter 2.

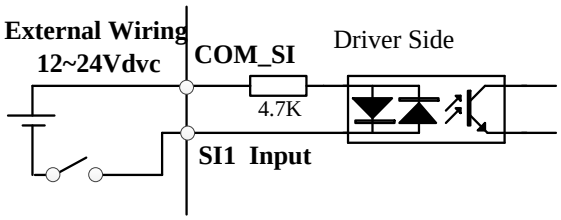
3.1.1.2 Wiring sketch map.

Refer to section 2.1.1.2 of chapter 2.

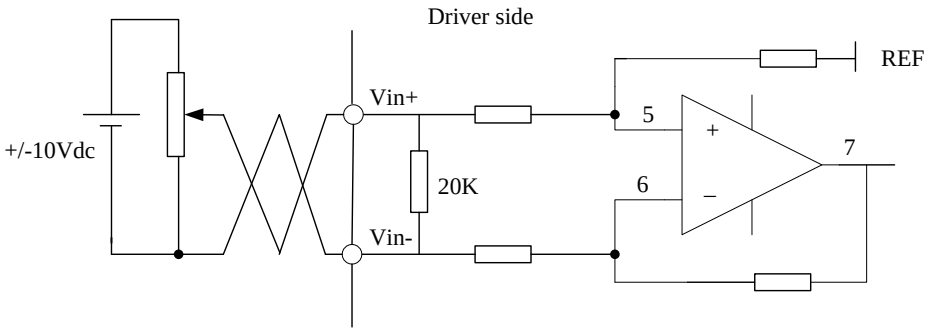
3.1.1.3 I/O terminal definition.

Refer to section 2.1.1.3 of chapter 2.

3.1.1.4 Analog input signal circuit.



Wiring method of servo enable signal (Pin 1/2)



Wiring method of analog input signal

Note: Analog control is only available for ELP-RS***Z version

A. Connect power of 12VDC~24VDC to Pin1 and Pin2 (COM_SI and SI1) to define Srv_on function.

B. Connect analog voltage of -10VDC~+10VDC to Pin39 and Pin40 (AI1+ and AI-).

3.1.2 Connect to tune software. (Perform this step if it is necessary to install driver)

Refer to section 1.1.2 of chapter 1.

3.2 Analog Control

Common functions under I/O control show as below (recommend for velocity control):

Pr0.01*	Name	Control Mode Setup			Mode	P	S	T
	Range	0~10	Unit	—	Default	0		
	Data Type	16bit	Access	R/W	Address	0003H		
	Repower	o						

Set using control mode:

Setup value	Content	
	1st mode	2nd mode
0	Position	-
1	**Velocity**	-
2	Torque	-
3	Position	Velocity
4	Position	Torque
5	Velocity	Torque
6	Pr-Mode	
7~10	Reserved	

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 on, the 1st mode will be selected.
When C-MODE is off, the 2nd mode will be selected.
Note: Pr0.01=1 equal to velocity control mode

Pr0.03	Name	Selection of machine stiffness at real-time auto-gain tuning			Mode	P	S	T
	Range	50 -81	Unit	—	Default	70		
	Data Type	16bit	Access	R/W	Address	0007H		
	Repower	-						

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.

Pr0.04	Name	Inertia ratio			Mode	P	S	T
	Range	0~10000	Unit	%	Default	250		
	Data Type	16bit	Access	R/W	Address	0009H		
	Repower	-						

You can set up the ratio of the load inertia against the rotor(of the motor)inertia.

Pr0.04=(load inertia/rotate inertia)×100%

Notice:

If the inertia ratio is correctly set, the setup unit of Pr1.01 and Pr1.06 becomes (Hz). When the inertia ratio of Pr0.04 is larger than the actual value, the setup unit of the velocity loop gain becomes larger, and when the inertia ratio of Pr0.04 is smaller than the actual value, the setup unit of the velocity loop gain becomes smaller..

Pr3.01	Name	Speed command rotational direction selection			Mode		S
	Range	0~1	Unit	—	Default	0	
	Data Type	16bit	Access	R/W	Address	0303H	
	Repower	-					

Select the Positive /Negative direction specifying method

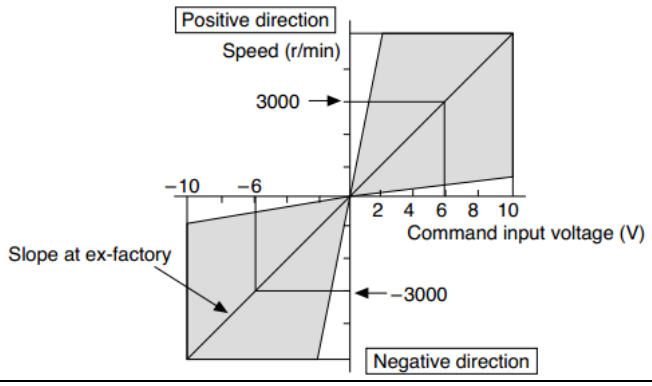
Setup value	Select speed command sign (1st to 8th speed)	Speed command direction (VC-SIGN)	Position command direction
0	+	No effect	Positive direction
	-	No effect	Negative direction
1	Sign has no effect	OFF	Positive direction
	Sign has no effect	ON	Negative direction

Pr3.02	Name	Input gain of speed command			Mode		S
	Range	10~2000	Unit	(r/min)/V	Default	500	
	Data Type	16bit	Access	R/W	Address	0305H	
	Repower	-					

Based on the voltage applied to the analog speed command (SPR), set up the conversion gain to motor command speed.
You can set up “slope” of relation between the command input voltage and motor speed, with Pr3.02. Default is set to Pr3.02=500(r/min)/V, hence input of 6V becomes 3000r/min.

Notice:

1. Do not apply more than ±10V to the speed command input(SPR).
2. When you compose a position loop outside of the drive while you use the drive in velocity control mode, the setup of Pr3.02 gives larger variance to the overall servo system.
3. Pay an extra attention to oscillation caused by larger setup of Pr3.02

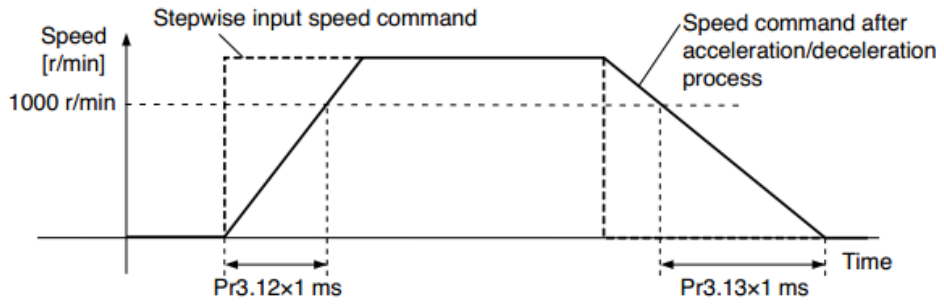


Pr3.12	Name	time setup acceleration			Mode		S
	Range	0~10000	Unit	Ms/ (1000r/min)	Default	100	
	Data Type	16bit	Access	R/W	Address	0319H	

	Repower	-				
Pr3.13	Name	time setup deceleration			Mode	S
	Range	0~10000	Unit	Ms/ (1000r/min)	Default	100
	Data Type	16bit	Access	R/W	Address	031BH
	Repower	-				

Set up acceleration/deceleration processing time in response to the speed command input.
Set the time required for the speed command(stepwise input)to reach 1000r/min to Pr3.12 Acceleration time setup. Also set the time required for the speed command to reach from 1000r/min to 0 r/min, to Pr3.13 Deceleration time setup.
Assuming that the target value of the speed command is Vc(r/min), the time required for acceleration/deceleration can be computed from the formula shown below.

Acceleration time (ms)=Vc/1000 *Pr3.12 *1ms
Deceleration time (ms)=Vc/1000 *Pr3.13 *1ms



Pr3.14	Name	Sigmoid acceleration /deceleration time setup			Mode	S
	Range	0~1000	Unit	ms	Default	0
	Data Type	16bit	Access	R/W	Address	031DH
	Repower	o				

Set S-curve time for acceleration/deceleration process when the speed command is applied. According to Pr3.12 Acceleration time setup and Pr3.13 Deceleration time setup, set up sigmoid time with time width centering the inflection point of acceleration/deceleration.