

BECKHOFF

EL2521控制步进电机 (NC篇)

张立文
技术支持部





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步进电机及其驱动器相关参数配置

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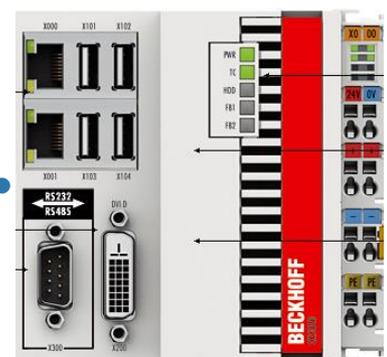
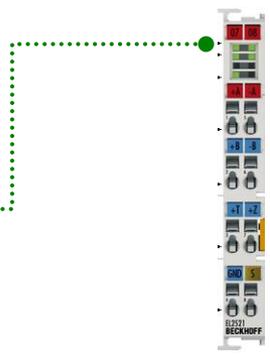
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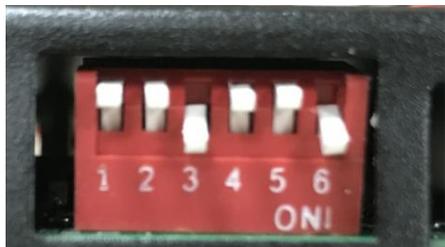


步距角: 1.8°
额定电流: 2.8A

电机转一圈所需步数

$$\frac{360^\circ/r}{1.8^\circ/\text{step}} = 200$$

步进电机驱动器相关参数配置



设置细分倍数为**16**，可计算得出

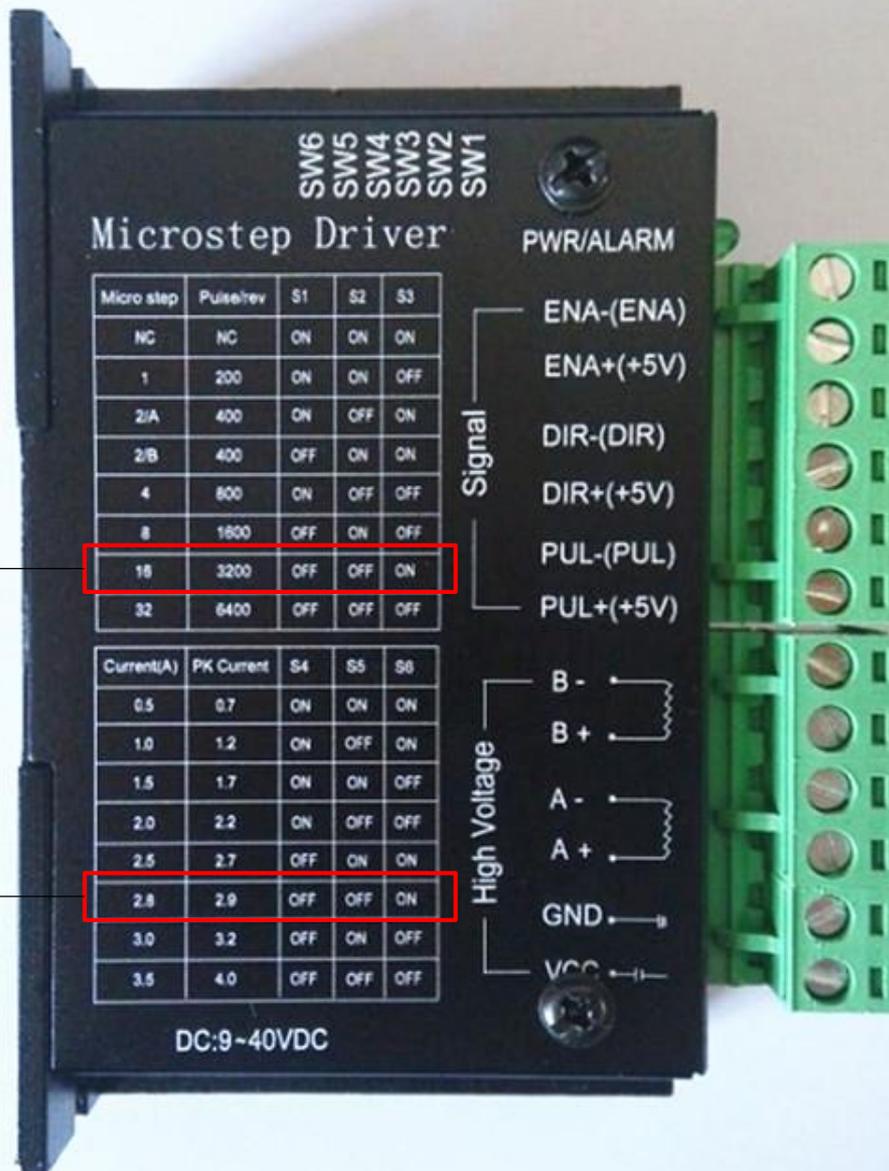
$$\frac{360^\circ/r}{1.8^\circ/step} \times \text{细分倍数} = 200 \times 16 = \mathbf{3200}$$

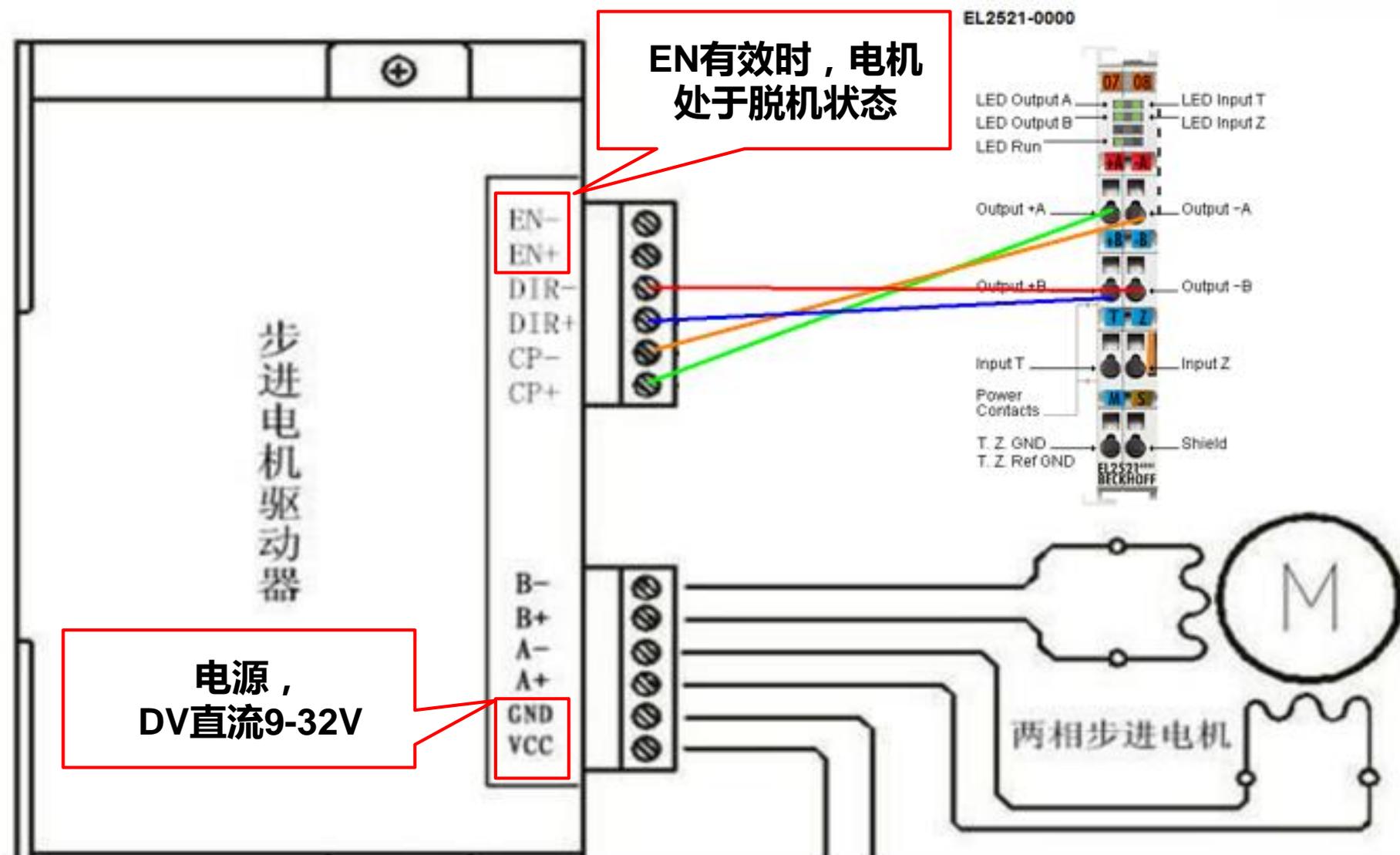
则脉冲数为**3200**，根据上述数据设置**S1~S3**

S1	S2	S3
off	off	on

根据电机的额定电流**2.8A**，设置**S4~S6**

S4	S5	S6
off	off	on







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step1

step2

step 3

确定步进电机采用的驱动方式——脉冲+方向 8000:0E为1

8000:0	Feature bits	RW	> 15
8000:02	Emergency ramp active	RW	FALSE
8000:03	Watchdog timer deactive	RW	TRUE
8000:04	Sign/amount representation	RW	FALSE
8000:05	Rising edge clears/sets counter	RW	TRUE
8000:06	Ramp function active	RW	FALSE
8000:07	Ramp base frequency	RW	10
8000:08	Direct input mode	RW	FALSE
8000:09	Users switch-on-value on wdt	RW	FALSE
8000:0A	Travel distance control active	RW	FALSE
8000:0B	Rising edge sets counter	RW	FALSE
8000:0E	Operating mode	RW	Pulse-dir. ctrl (1)
8000:0F	Negative logic	RW	FALSE

Set Value Dialog

Dec:

Hex:

Enum:

- Pulse-dir. ctrl
- Frequency mod.
- Pulse-dir. ctrl
- Incremental enc.

Bool:

Binary:

Bit Size: 1 8 16 32 64 ?

step1

step2

step 3

确定采用**NC**方式控制步进电机驱动器，关闭原有的斜坡功能**8000:06** 为**0(false)**

8000:0	Feature bits	RW	> 15 <
8000:02	Emergency ramp active	RW	FALSE
8000:03	Watchdog timer deactive	RW	TRUE
8000:04	Sign/amount representation	RW	FALSE
8000:05	Rising edge clears/sets counter	RW	TRUE
8000:06	Ramp function active	RW	FALSE
8000:07	Ramp base frequency	RW	10 Hz (0)
8000:08	Direct input mode	RW	FALSE
8000:09	Users switch-on-value on wdt	RW	FALSE
8000:0A	Travel distance control active	RW	FALSE
8000:0B	Rising edge sets counter	RW	FALSE
8000:0E	Operating mode	RW	Pulse-dir. ctrl (1)
8000:0F	Negative logic	RW	FALSE

step1

step 2

step3

设置EL2521基频，即电机转过一圈所需要的脉冲数**8001:02**成为**3200**

8001:0	User settings	RW	> 8 <
8001:01	Users switch-on-value	RW	0x0000 (0)
8001:02	Base frequency 1	RW	0x00000C80 (3200)
8001:03	Base frequency 2	RW	0x000186A0 (100000)
8001:04	Ramp time constant (rising)	RW	0x0064 (100)
8001:05	Ramp time constant (falling)	RW	0x0064 (100)
8001:06	Frequency factor (Digit x 10...	RW	0x0064 (100)
8001:07	Slowing down frequency	RW	0x01F4 (500)
8001:08	Ramp time constant (emergency)	RW	

Set Value Dialog

Dec:	<input type="text" value="3200"/>	<input type="button" value="OK"/>
Hex:	<input type="text" value="0x00000C80"/>	<input type="button" value="Cancel"/>
Float:	<input type="text" value="4.4841551e-042"/>	
Bool:	<input type="button" value="0"/> <input type="button" value="1"/>	<input type="button" value="Hex Edit..."/>
Binary:	<input type="text" value="80 0C 00 00"/> <input type="button" value="4"/>	
Bit Size:	<input type="radio"/> 1 <input type="radio"/> 8 <input type="radio"/> 16 <input checked="" type="radio"/> 32 <input type="radio"/> 64 <input type="radio"/> ?	



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step1

step2

step 3

创建NC轴，同时将该轴关联EL2521模块所带的外部硬件轴

The screenshot shows the TwinCAT software interface. On the left is the Solution Explorer showing a project structure with 'Axis 1' selected. The main window displays the 'Parameter' tab for 'Axis 1'. A dialog box titled 'Select I/O Box/Terminal ('Axis 1')' is open, showing a table with the following data:

Type	Name	Comment
(none)	(none)	
Pulse Train Drive (MDP 253)	Term 4 (EL2521)	EL2521 1Ch. Pulse Train O

At the bottom of the dialog, the 'Unused' radio button is selected, and 'OK' and 'Cancel' buttons are visible.

step1

step2

step 3

设置scaling factor

Scaling factor Numerator = 进给量 = 360°

Scaling factor Denominator = 脉冲数/圈 = $3200/r$

General NC-Encoder Parameter Time Compensation Online

Parameter	Offline Value	Online Value
- Encoder Evaluation:		
Invert Encoder Counting Direction	FALSE	FALSE
Scaling Factor Numerator	360.0	360.0
Scaling Factor Denominator (default: 1.0)	3200.0	3200.0
Position Bias	0.0	0.0

step1

step 2

step3

设置reference velocity、maximum velocity、homing velocity等，使得NC命令与脉冲量相匹配

$reference\ velocity = 进给量 \times 电机额定转速 = 360^\circ/r \times 60r/min = 360^\circ/s$

$maximum\ velocity = reference\ velocity \times 120\% = 360^\circ/s \times 120\% = 432^\circ/s$

其他速度根据实际使用情况进行设置。

Parameter	Offline Value
Maximum Dynamics:	
Reference Velocity	360.0
Maximum Velocity	432.0
Homing Velocity (towards plc cam)	30.0
Homing Velocity (off plc cam)	5.0
Manual Velocity (Fast)	200.0
Manual Velocity (Slow)	50.0

EL2521控制步进电机 (NC)

实例：轴以 $90^\circ / s$ 的速度由 0° 到 360° 转一圈

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The screenshot shows the Beckhoff TwinCAT software interface for configuring an axis. The main window displays the following parameters and controls:

- Setpoint:** 0.0000 [mm]
- Actual Velocity:** 0.0000 [mm/s]
- Setpoint:** 0.0000 [mm/s]
- Override:** 100.0000 %
- Total / Control:** 0.00 / 0.00 %
- Error:** 0 (0x0)
- Status (Log.):** Ready, NOT Moving, Calibrated, Moving Fw, Has Job, Moving Bw
- Status (phys.):** Coupled Mode, In Target Pos., In Pos. Range
- Enabling:** Controlle: [Set], Feed Fw, Feed Bw
- Controller Kv-Factor:** [mm/s/mm]
- Reference Velocity:** 360 [mm/s]
- Target Position:** 360 [mm]
- Target Velocity:** 90 [mm/s]

The interface also includes a Solution Explorer on the left showing the project structure, a Properties window on the right for 'Axis 1 Continuous Axis', and an Error List at the bottom showing 0 errors and 0 warnings.

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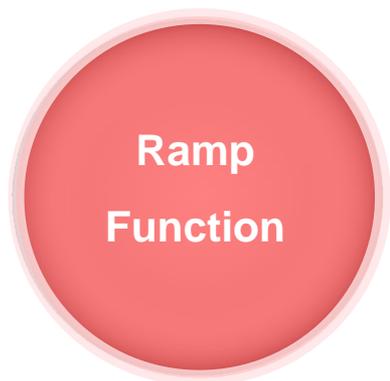
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NC控制的相关参数设置

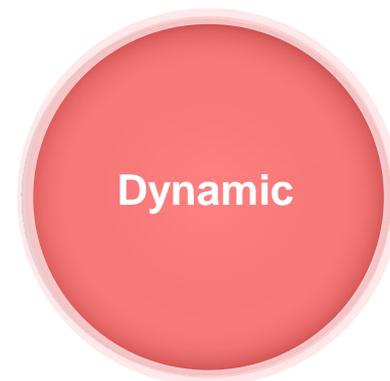
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NC加减速功能

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功能替换



实现加减速

Address	Feature bits	Access	Value
8000:0	Feature bits	RW	> 15 <
8000:02	Emergency ramp active	RW	FALSE
8000:03	Watchdog timer deactive	RW	TRUE
8000:04	Sign/amount representation	RW	FALSE
8000:05	Rising edge clears/sets counter	RW	TRUE
8000:06	Ramp function active	RW	FALSE
8000:07	Ramp base frequency	RW	10 Hz (0)
8000:08	Direct input mode	RW	FALSE
8000:09	Users switch-on-value on wdt	RW	FALSE
8000:0A	Travel distance control active	RW	FALSE
8000:0B	Rising edge sets counter	RW	FALSE
8000:0E	Operating mode	RW	Pulse-dir. ctrl (1)
8000:0F	Negative logic	RW	FALSE

General Settings Parameter Dynamics Online Functions Coupling Compensation

Indirect by Acceleration Time

Maximum Velocity (V max): 432 mm/s

Acceleration Time: 3 s

Deceleration Time: as above 3 s

Acceleration Characteristic: smooth stiff

Deceleration Characteristic: smooth stiff

Direct

Acceleration: 145.44 mm/s²

Deceleration: as above 145.44 mm/s²

Jerk: 4896.48 mm/s³

Download Upload

轴从0走到2000，当设置成下图的动态速度时，

The screenshot shows the 'Dynamics' configuration window for a motor. It has several tabs: General, Settings, Parameter, Dynamics (selected), Online, Functions, Coupling, and Compensation. There are two main sections for dynamic control:

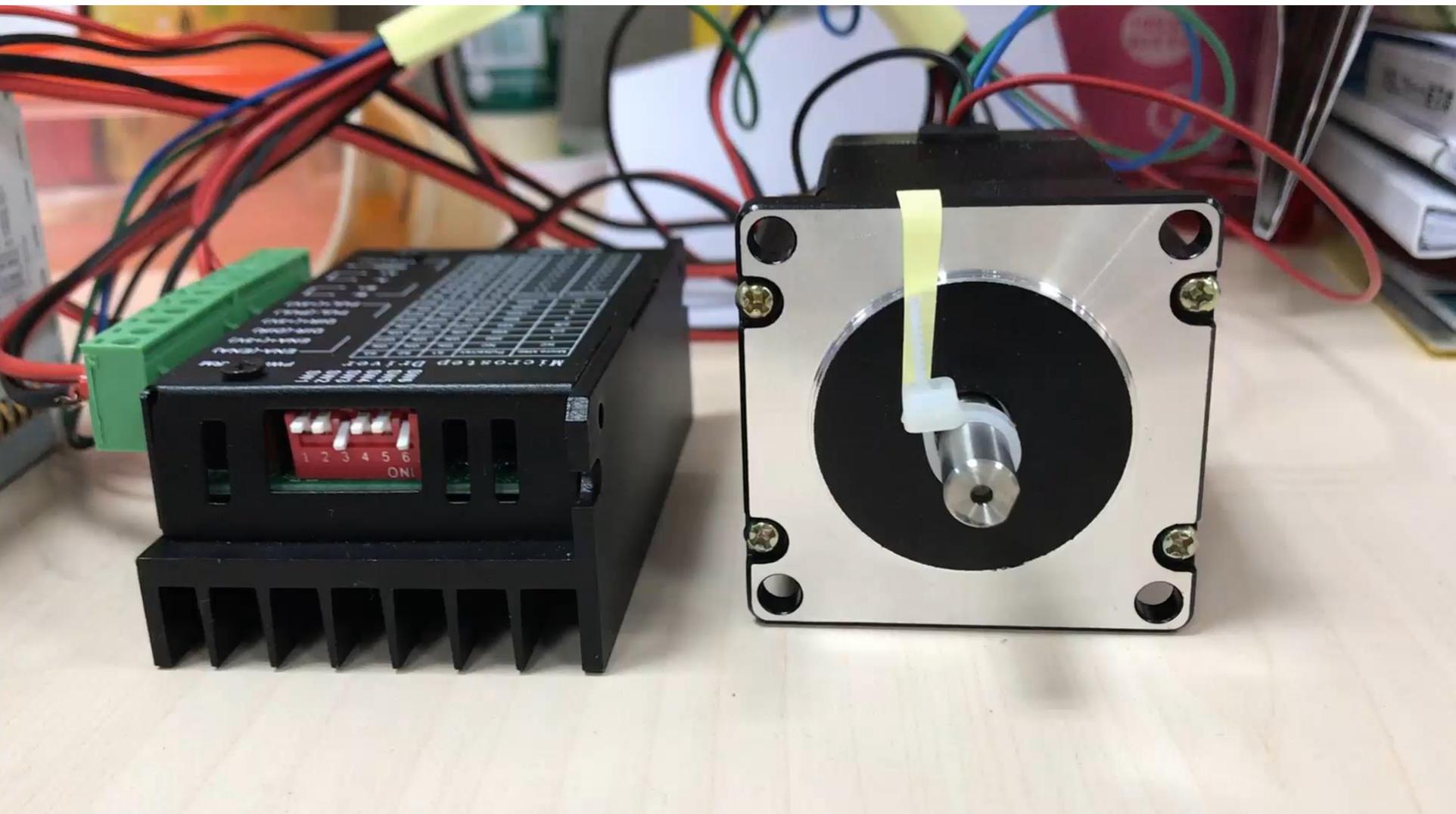
- Indirect by Acceleration Time:** This section is currently unselected. It includes:
 - Maximum Velocity (V_{max}): 432 mm/s
 - Acceleration Time: 10 s
 - Deceleration Time: as above 10 s
 - Acceleration Characteristic: A slider between 'smooth' and 'stiff'.
 - Deceleration Characteristic: A slider between 'smooth' and 'stiff'.
 - Graphs for acceleration $a(t)$ and velocity $v(t)$ are shown below the sliders.
- Direct:** This section is selected and highlighted with a red box. It includes:
 - Acceleration: 43.632 mm/s²
 - Deceleration: as above 43.632 mm/s²
 - Jerk: 440.683 mm/s³

At the bottom of the window, there are 'Download' and 'Upload' buttons.

EL2521控制步进电机（NC）

NC加减速功能

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轴从0走到2000，当设置成下图的动态速度时，

General Settings Parameter **Dynamics** Online Functions Coupling Compensation

Indirect by Acceleration Time

Maximum Velocity (V_{max}): mm/s

Acceleration Time: s

Deceleration Time: as above s

smooth stiff

Acceleration Characteristic:

Deceleration Characteristic:

$a(t)$   

$v(t)$   

Direct

Acceleration: mm/s²

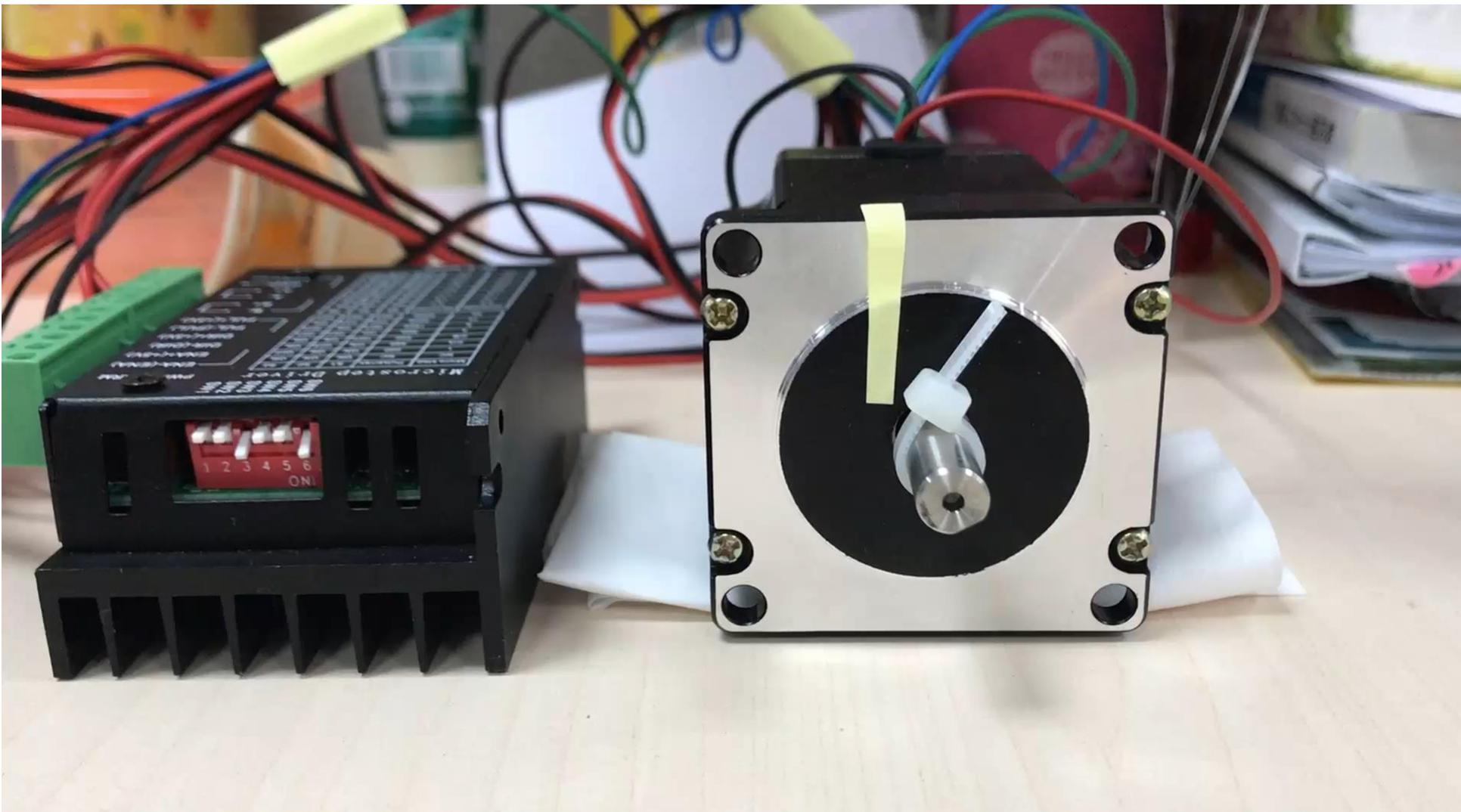
Deceleration: as above mm/s²

Jerk: mm/s³

EL2521控制步进电机（NC）

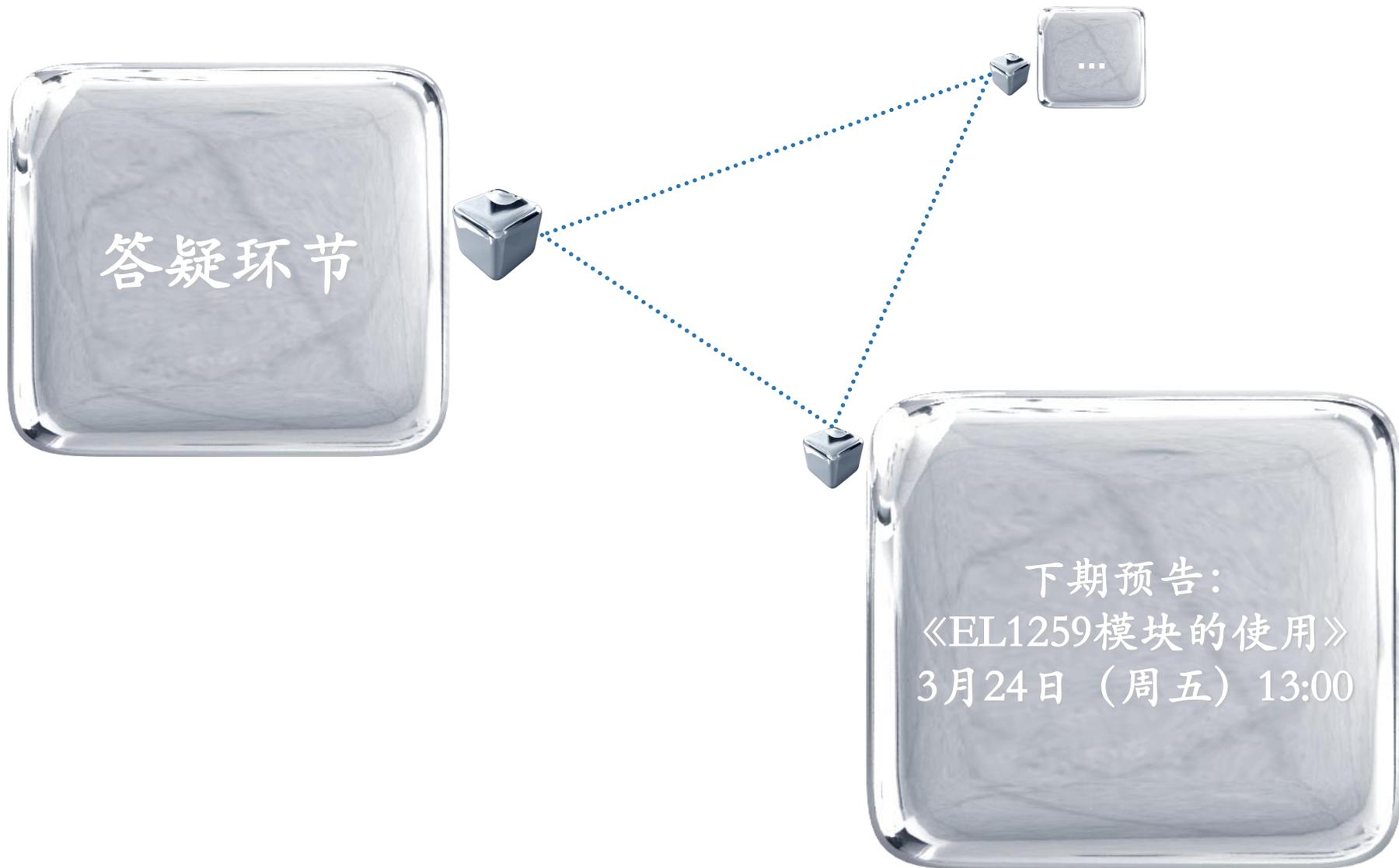
NC加减速功能

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答疑、下期预告



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