INVT Technical Guide

SV-DA200 Series AC Servo Drive

ECAM System

INVT INDUSTRIAL TECHNOLOGY (SHANGHAI) CO.,LTD.

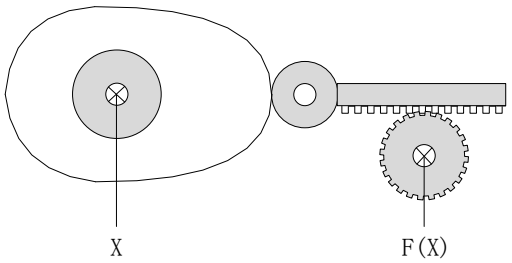
Contents

1 ECAM system

1.1 ECAM description

An electronic cam (ECAM) curve is a function curve that uses the master axis pulse (that is, spindle pulse) input as X and uses the servo motor (that is, cam axis) output as Y= F(X).

The ECAM is mainly used in scenarios in which following the master axis position is required. With the advantages such as easy to use and maintenance, the ECAM can replace the traditional mechanical cam.



1.2 ECAM curve mode

P7.00: Select cam curve. [0] Manually created table; [1] Vector table; [2] Rotary shearing curve; [3] Flying shearing curve

Data size	Modbus address	Canopen address	Setting range	Default	Unit
16bit	2400, 2401	0x2700 00	0–3	0	-

1.3 ECAM switch

P7.01: Enable ECAM parameters. [0] Disable; [1] Enable

Data size	Modbus address	Canopen address	Setting range	Default	Unit
16bit	2402, 2403	0x2701 00	0–1	0	-

P7.02: Select ECAM enabling source. [0] Parameter; [1] Terminal

Data size	Modbus address	Canopen address	Setting range	Default	Unit
16bit	2404, 2405	0x2702 00	0–1	0	-

1.4 Master axis

P7.03: Master axis source. [0] Pulse input; [1] 2nd encoder; [2] Virtual master axis

Data size	Modbus address	Canopen address	Setting range	Default	Unit
16bit	2406, 2407	0x2703 00	0–2	0	-

P7.04: Cam axis resolutions *N*

Data size	Modbus address	Canopen address	Setting range	Default	Unit
32bit	2408, 2409	0x2704 00	1–(2^{31}-1)	1	rev

P7.05: Master axis pulse input corresponding to cam axis resolutions *N*.

Data size	Modbus address	Canopen address	Setting range	Default	Unit
32bit	2410, 2411	0x2705 00	10–(2^{31}-1)	10000	spulse

P7.06: Master axis pulse input speed filter class.

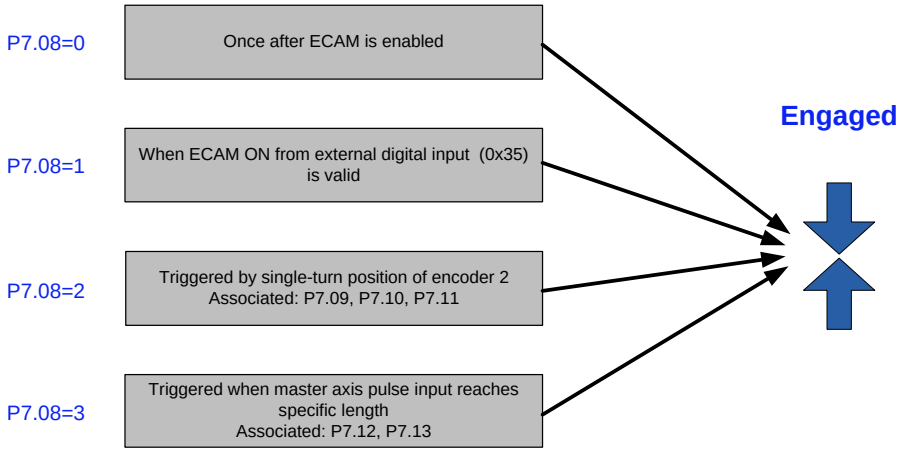
Data size	Modbus address	Canopen address	Setting range	Default	Unit
16bit	2412, 2413	0x2706 00	0–6	5	-

P7.07: Virtual master axis pulse speed setting.

Data size	Modbus address	Canopen address	Setting range	Default	Unit
32bit	2414, 2415	0x2707 00	-(2^{31}-1)–(2^{31}-1)	1000	Spulse/s

1.5 Clutch

1.5.1 Engaging condition



P7.08: ECAM engaging condition.

Data size	Modbus address	Canopen address	Setting range	Default	Unit
16bit	2416, 2417	0x2708 00	0–3	0	-

P7.09: 2nd-encoder position triggering ECAM engaging.

Data size	Modbus address	Canopen address	Setting range	Default	Unit
32bit	2418, 2419	0x2709 00	0–(2^{20}-1)	0	Spulse

P7.10: 2nd-encoder position compensation coefficient at ECAM engaging.

Data size	Modbus address	Canopen address	Setting range	Default	Unit
32bit	2420, 2421	0x270A 00	-(2^{31}-1)–(2^{31}-1)	0	Spulse/100rpm

P7.11: ECAM engaging direction triggered by 2nd-encoder. [0] Forward; [1] Reverse; [2] Bidirectional

Data size	Modbus address	Canopen address	Setting range	Default	Unit
16bit	2422, 2423	0x270B 00	0–2	0	-

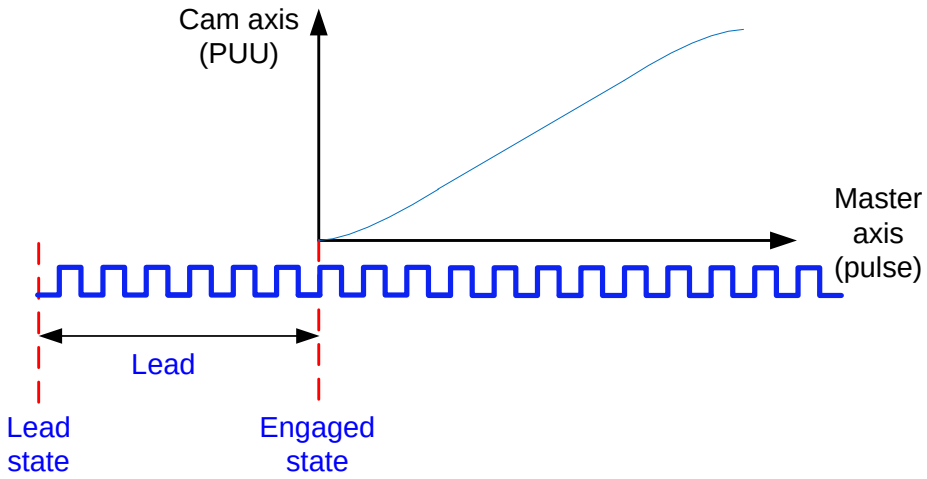
P7.12: Source of ECAM fixed-length count. [0] Pulse input; [1] 2nd encoder; [2] Virtual master axis

Data size	Modbus address	Canopen address	Setting range	Default	Unit
16bit	2424, 2425	0x270C 00	0–2	0	-

P7.13: Length of ECAM fixed-length count.

Data size	Modbus address	Canopen address	Setting range	Default	Unit
32bit	2426, 2427	0x270D 00	1–(2^{31}-1)	100000	Spulse

1.5.2 Lead



Lead: indicates the pulses that are generated for the delay after the engaging conditions are met but before the cam engaging.

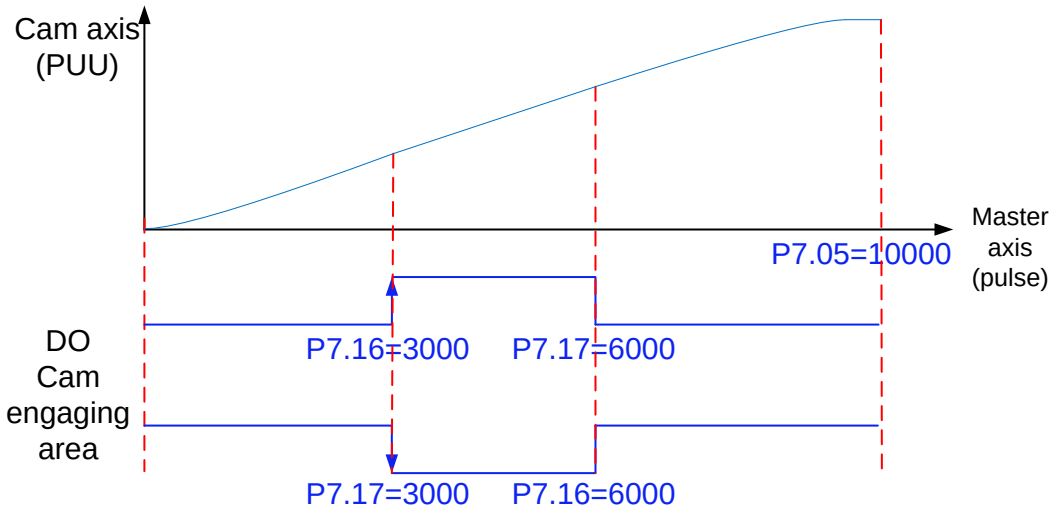
P7.14: Single-engaging advance, that is, advance required for the first engaging.

Data size	Modbus address	Canopen address	Setting range	Default	Unit
32bit	2428, 2429	0x270E 00	-(2^{31}-1)–(2^{31}-1)	0	Spulse

P7.15: Periodic-engaging lead, that is, the lead required for the re-engaging after the ECAM enters the lead state since the disengaging condition is met.

Data size	Modbus address	Canopen address	Setting range	Default	Unit
32bit	2430, 2431	0x270F 00	-(2^{31}-1)–(2^{31}-1)	0	Spulse

1.5.3 Terminal output



P7.16: Positive-direction digital output in engaging zone.

Data size	Modbus address	Canopen address	Setting range	Default	Unit
32bit	2432, 2433	0x2710 00	0–(2^{31}-1)	0	Spulse

P7.17: Negative-direction digital output in engaging zone.

Data size	Modbus address	Canopen address	Setting range	Default	Unit
32bit	2434, 2435	0x2711 00	0–(2^{31}-1)	0	Spulse

P7.18: Delay compensation for digital output in engaging zone.

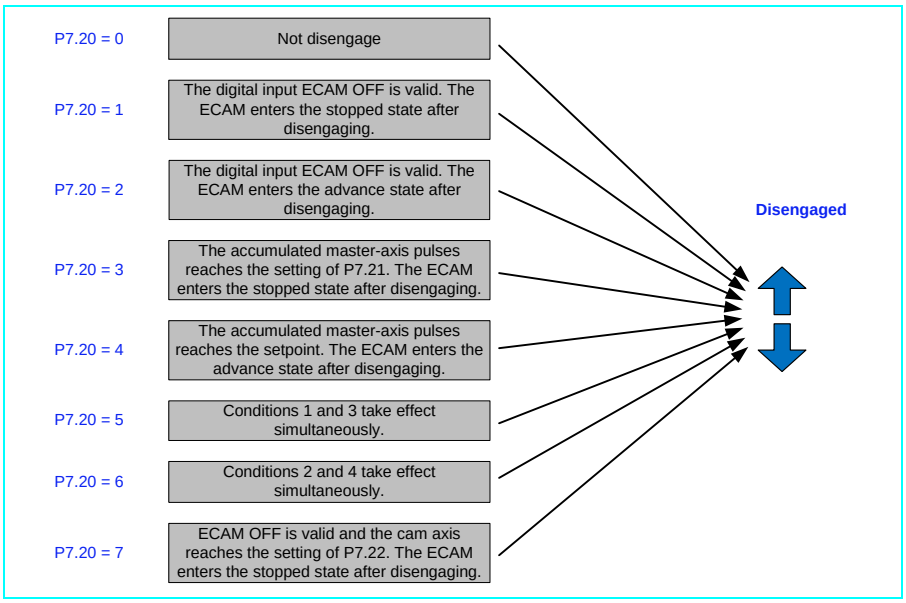
Data size	Modbus address	Canopen address	Setting range	Default	Unit
32bit	2436, 2437	0x2712 00	-(2^{31}-1)–(2^{31}-1)	0.0	ms

1.5.4 Clearing periodic accumulated values

P7.19: Clear the accumulated cam axis running cycles in geared state.

Data size	Modbus address	Canopen address	Setting range	Default	Unit
16bit	2438, 2439	0x2713 00	0–1	0	-

1.5.5 Disengaging conditions



P7.20: Disengaging conditions.

Data size	Modbus address	Canopen address	Setting range	Default	Unit
16bit	2440, 2441	0x2714 00	0–7	0	-

P7.21: Master axis position at disengaging.

Data size	Modbus address	Canopen address	Setting range	Default	Unit
32bit	2442, 2443	0x2715 00	-(2^{31}-1)–(2^{31}-1)	10000	spulse

P7.22: Cam axis position at disengaging.

Data size	Modbus address	Canopen address	Setting range	Default	Unit
32bit	2444, 2445	0x2716 00	-(2^{31}-1)–(2^{31}-1)	0	pulse

1.5.6 Condition for re-engaging from disengaging

P7.23: ECAM re-engaging mode. [0] Re-engaging from the start engaging point; [1] Re-engaging from the last disengaging position

Data size	Modbus address	Canopen address	Setting range	Default	Unit
16bit	2446, 2447	0x2717 00	0–1	0	-

P7.24: Start engaging point.

Data size	Modbus address	Canopen address	Setting range	Default	Unit
32bit	2448, 2449	0x2718 00	0–(2^{31}-1)	0	spulse

P7.27: Start engaging angle.

Data size	Modbus address	Canopen address	Setting range	Default	Unit
32bit	2454, 2455	0x271B 00	0–3600	0.0	°

1.5.7 Adjusting curves

P7.25: Cam curve phase position compensation time, namely, lateral moving of curve.

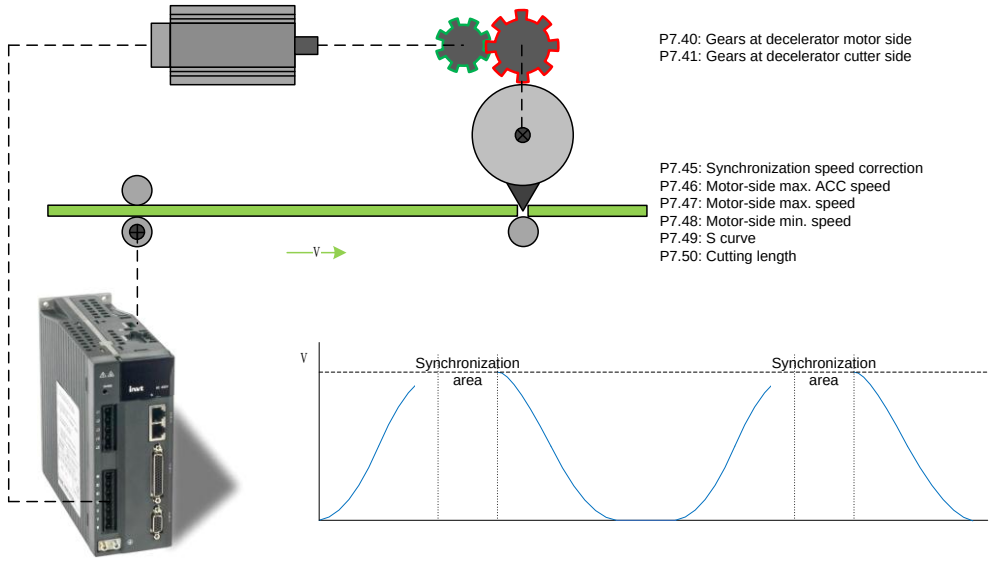
Data size	Modbus address	Canopen address	Setting range	Default	Unit
32bit	2450, 2451	0x2719 00	-(2^{31}-1)–(2^{31}-1)	0.0	ms

P7.26: ECAM table data multiplication, that is, zooming in or out at the Y axis of curve.

Data size	Modbus address	Canopen address	Setting range	Default	Unit
32bit	2452, 2453	0x271A 00	-(2^{31}-1)–(2^{31}-1)	1.000000	-

2 Common parameters of the flying/rotary shear system

2.1 Common parameters



P7.40: Gears at decelerator motor side.

Data size	Modbus address	Canopen address	Setting range	Default	Unit
16bit	2480, 2481	0x2728 00	1–32767	1	-

P7.41: Gears at decelerator cutter side.

Data size	Modbus address	Canopen address	Setting range	Default	Unit
16bit	2482, 2483	0x2729 00	1–32767	1	-

P7.42: Length-counting encoder diameter.

Data size	Modbus address	Canopen address	Setting range	Default	Unit
32bit	2484, 2485	0x272A 00	1–(2^{31}-1)	50.0	mm

P7.43: Length-counting encoder PPR.

Data size	Modbus address	Canopen address	Setting range	Default	Unit
32bit	2486, 2487	0x272B 00	1–(2^{31}-1)	10000	spulse

P7.44: Material feeding speed.

Data size	Modbus address	Canopen address	Setting range	Default	Unit
32bit	2488, 2489	0x272C 00	1–(2^{31}-1)	1000	mm/s

P7.45: Synchronization speed correction (for the cam axis).

Data size	Modbus address	Canopen address	Setting range	Default	Unit
16bit	2490, 2491	0x272D 00	1–200	0	%

P7.46: Motor-side max. ACC/DEC speed.

Data size	Modbus address	Canopen address	Setting range	Default	Unit
32bit	2492, 2493	0x272E 00	1–(2^{31}-1)	1000	rad/s^2

P7.47: Motor-side max. speed.

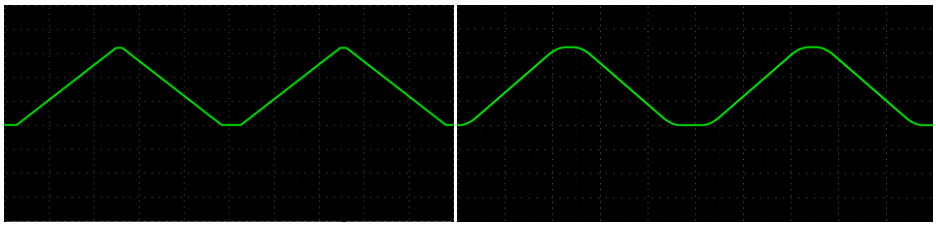
Data size	Modbus address	Canopen address	Setting range	Default	Unit
32bit	2494, 2495	0x272F 00	1–6000	3000	rpm

P7.48: Motor-side min. speed.

Data size	Modbus address	Canopen address	Setting range	Default	Unit
32bit	2496, 2497	0x2730 00	1–6000	0	rpm

P7.49: ACC/DEC S curve.

The following figures show the speed waveforms with P7.49 set to 0.1% and 20% respectively.



Data size	Modbus address	Canopen address	Setting range	Default	Unit
16bit	2498, 2499	0x2731 00	1–1000	0.1	%

P7.50: Cutting length.

Data size	Modbus address	Canopen address	Setting range	Default	Unit
32bit	2500, 2501	0x2732 00	1–(2^{31}-1)	2000.0	mm

2.2 Parameter calculation

If the cutting length parameter is modified in geared state, the modification will take effect after the curve replanning before the synchronization zone is closed.

If a parameter is modified at stopped state and P7.60 is set to "Parameter calculation is valid", the modification takes effect immediately.

R1.40: Parameter calculation status and possible cause.

[0] Initial state

[1] Excessively high synchronization speed: The material feeding speed is greater than the motor maximum speed.

[2] Excessively low synchronization speed: The material feeding speed is less than the motor maximum speed.

[3] Negative non-synchronization zone: The synchronization zone angle is too large.

[4] Negative non-synchronization zone time: The synchronization zone angle is too large.

[5] Excessively-high non-synchronization zone angle difference 1: The material feeding speed is too high or the synchronization zone angle is too large.

[6] Excessively-high non-synchronization zone angle difference 2: The material feeding speed is too high or the synchronization zone angle is too large.

[7] Excessively-low non-synchronization zone angle difference 1: The material feeding speed is too high or the synchronization zone angle is too large.

[8] Excessively-low non-synchronization zone angle difference 2: The material feeding speed is too high or the synchronization zone angle is too large.

[9] P0.22 set to 0: The motor PPR is 0.

[10] Valid parameter calculation.

[11] Negative return zone angle: The distance to the synchronization or ACC zone is too large.

[12] Negative return zone time: The distance to the synchronization or ACC zone is too large.

[13] Excessively small return zone angle: The distance to the synchronization or ACC zone is too large.

[14] Excessively small cutting length: The cutting length is less than R1.33 (Rotary shear min. cutting length).

[15] Cutting mechanism moving overtravel: The distance to the synchronization or ACC zone is too large.

Note: P7.44 must be set correctly for better protection performance. It is recommended that the material feeding speed be set to the maximum one.

3 Flying shear system

3.1 Typical flying shearing and parameters

The master axis is the material feeding axis, responsible for feeding materials in a constant speed and transmitting pulses so as to control the cam axis, featuring continuous actions without stop. The cam axis controls cutter actions and controls cutter rotary speeds based on the synchronization zone width and cutting length.

P7.51: Cutter count.

Data size	Modbus address	Canopen address	Setting range	Default	Unit
16bit	2502, 2503	0x2733 00	1–32767	1	-

P7.52: Cutter diameter.

Data size	Modbus address	Canopen address	Setting range	Default	Unit
32bit	2504, 2505	0x2734 00	$1–(2^{31}-1)$	300.0	mm

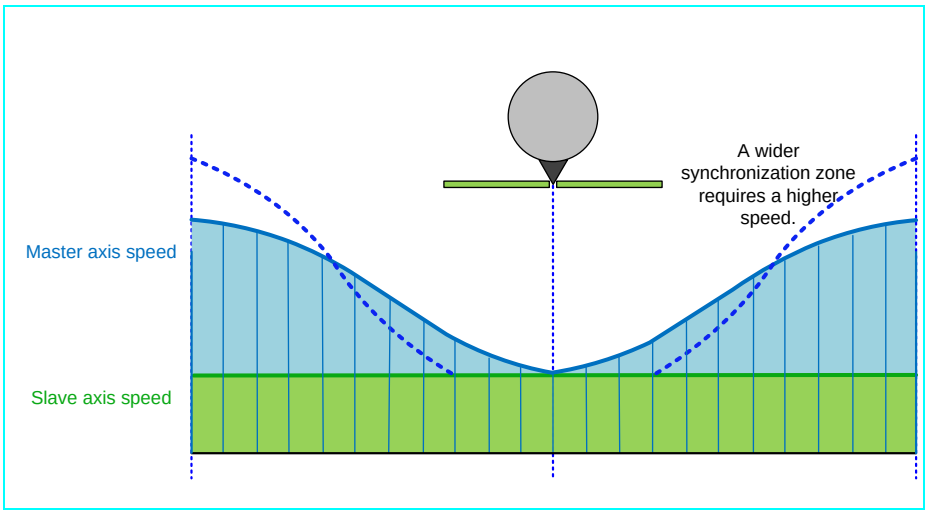
P7.53: Synchronization zone angle.

Data size	Modbus address	Canopen address	Setting range	Default	Unit
32bit	2506, 2507	0x2735 00	1–3599	20.0	°

Synchronization zone angle + Non-synchronization zone angle = 2PI/(Cutter count)

3.2 Synchronization zone setting

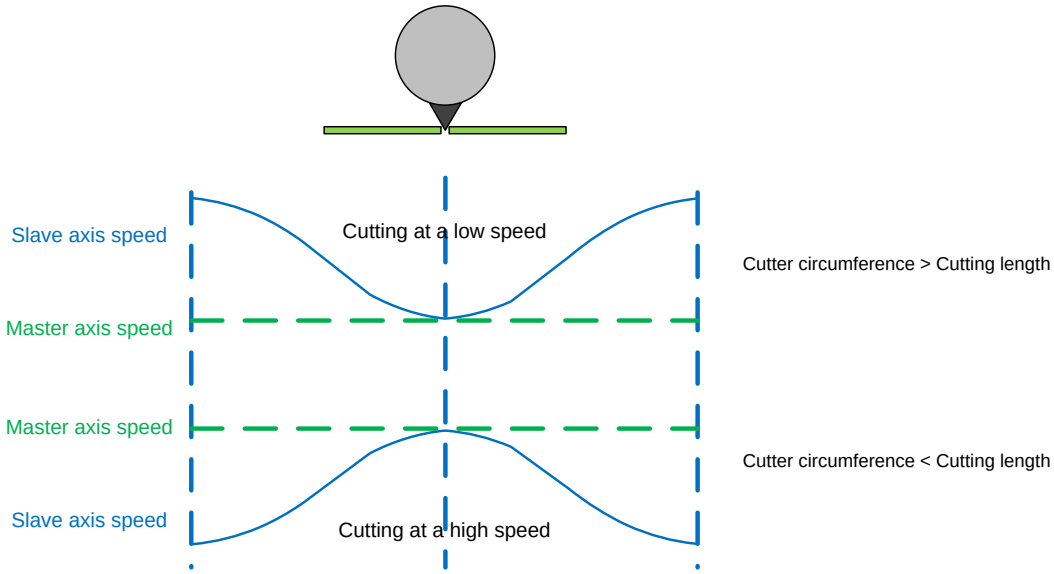
To ensure smooth cutting, the cutters must be fully located in the synchronization zone during cutting. The packages with hot-seal zones require wider cutters, and therefore a larger synchronization zone must be set. Since the cam axis moving distance is fixed, a higher cam axis speed indicates the servo has a greater possibility to reach the saturation state. As a wider synchronization zone requires a higher cam axis speed, the limit on the cuttable minimum length is greater.



3.3 Cutter circumference and cutting length

Cutter circumference > Cutting length: The slave axis has a higher speed than the master axis, but they have the same speed during cutting.

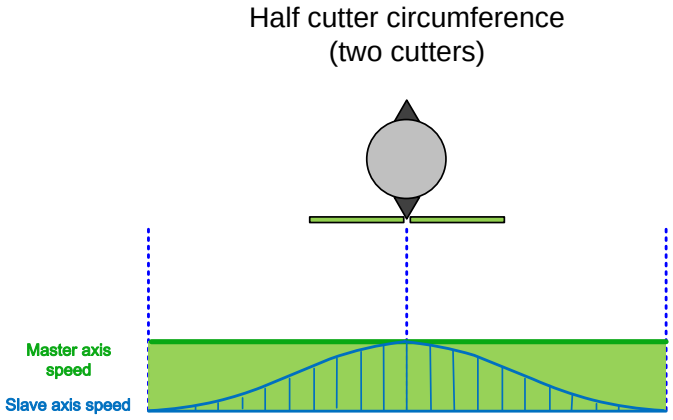
Cutter circumference < Cutting length: The slave axis has a lower speed than the master axis, but they have the same speed during cutting.



Cutting length/Cutter circumference	Cutter max. linear speed /Material feeding linear speed
1.0	100%
0.75	172%
0.50	325%
0.25	870%

3.4 More cutters

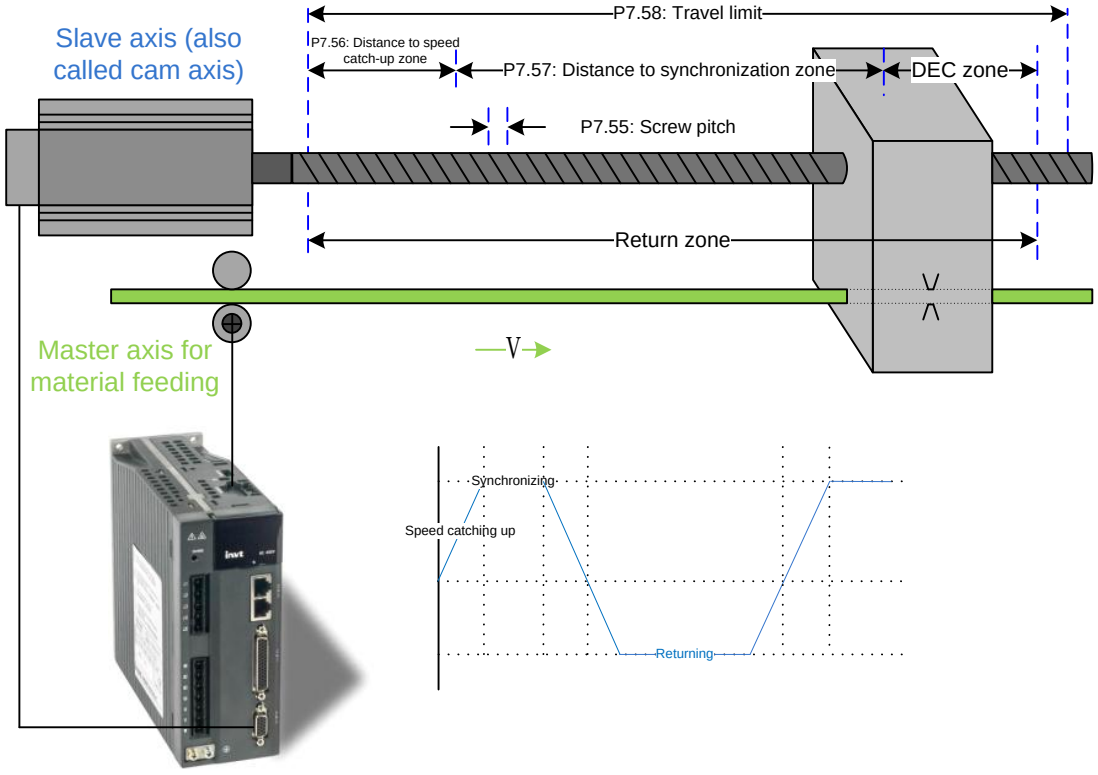
The ratio of the cutter moving distance to the cutting length changes as the number of cutters increases. If other conditions keep unchanged, more cutters indicate shorter cutting length.



4 Rotary shear system

4.1 Typical rotary shearing and parameters

In the rotary shear system, when the master axis for material feeding runs forwards, the slave axis runs forwards and catches up the material feeding speed of the master axis, and keeps synchronization with the master axis during cutting. After the cutting, the cutting mechanism is disengaged. Then the rotary shear system decelerates to zero and runs to the start position reversely to start the next rotary shearing.



P7.55: Screw pitch.

Data size	Modbus address	Canopen address	Setting range	Default	Unit
16bit	2510, 2511	0x2737 00	0–32767	5.0	mm

P7.56: Distance to speed catch-up zone.

Data size	Modbus address	Canopen address	Setting range	Default	Unit
32bit	2512, 2513	0x2738 00	0–100000	200.0	mm

P7.57: Distance to synchronization zone.

Data size	Modbus address	Canopen address	Setting range	Default	Unit
32bit	2514, 2515	0x2739 00	0–100000	200.0	mm

P7.58: Travel limit.

Data size	Modbus address	Canopen address	Setting range	Default	Unit
32bit	2516, 2517	0x273A 00	0–1000000	1000.0	mm

If the distance to the speed catch-up zone is the same as that to the DEC zone, ensure the following:

$$2 * P7.56 + P7.57 < P7.58$$

4.2 Minimum cutting length

The distance to the speed catch-up zone has on impact on both the acceleration speed A and R1.33 (Min. cutting length). Note that cutting can be normally performed only when the cutting length you set is greater than the minimum cutting length.

5 Ordering function

5.1 Function description

The ordering function indicates applying multiple cutting lengths within a processing period. SV-DA200 can plan cam curves based on cutting lengths.

5.2 Function application

P7.61–P7.79 specify 10 groups of ordering. P7.50 indicates the default cutting length, recording the shortest cutting length in the orders. When the ordering function is not needed, you only need to set the cutting count of other groups to 0.

5.3 Parameters

P7.50: Cutting length/Length of order 0.

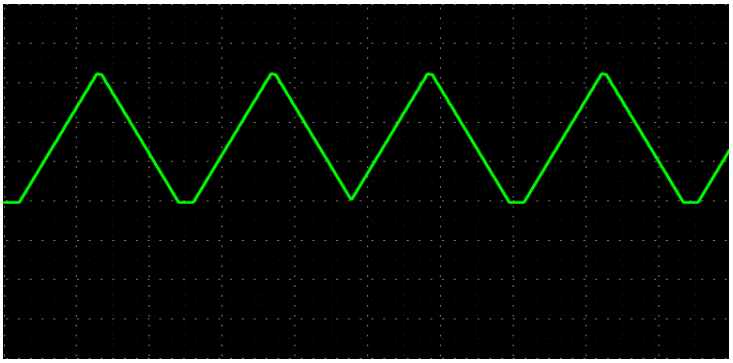
P7.61: Count of order 0.

Data size	Modbus address	Canopen address	Setting range	Default	Unit
32bit	2522, 2523	0x273C 00	1–32767	1	-

P7.62–P7.79: Length and count for orders 1 to 9.

5.4 Speed waveform

P7.61	Number Of Order0	2		-
P7.62	Length of Order1	2,200.0		mm
P7.63	Number Of Order1	0		-
P7.64	Length of Order2	1,800.0		mm
P7.65	Number Of Order2	1		-



6 Cursor capturing function

6.1 Function description

The cursor capturing function indicates curves are adjusted in real time according to cursor signals so that cutting is performed following the cursor.

6.2 Function application

P7.80–P7.84 are cursor-related parameters. P7.80 indicates whether to enable the cursor capturing function. If the function is enabled, the ECAM automatically starts and performs cutting according to cursor signals. If the function is disabled, the ECAM performs fixed-length cutting.

6.3 Parameters

P7.80: Enable cursor capturing.

Data size	Modbus address	Canopen address	Setting range	Default	Unit
16bit	2560, 2561	0x2750 00	0–1	0	-

P7.81: Cursor sensor offset, namely, distance from the cursor sensor to the cutting point. (The distance must be greater than the cutting length.)

Data size	Modbus address	Canopen address	Setting range	Default	Unit
32bit	2562, 2563	0x2751 00	0–100000	0.0	mm

P7.82: Cursor sensor window. A cursor signal takes effect only when the signal is within the window specified by P7.82.

Data size	Modbus address	Canopen address	Setting range	Default	Unit
32bit	2564, 2565	0x2752 00	0–100000	20.0	mm

P7.83: Max. lost cursors. When the number of lost cursors reaches the setting of P7.83, the ECAM turns off. If the setting of P7.83 is 0, the cursor capturing function is invalid.

Data size	Modbus address	Canopen address	Setting range	Default	Unit
32bit	2566, 2567	0x2753 00	0–10000	2	-

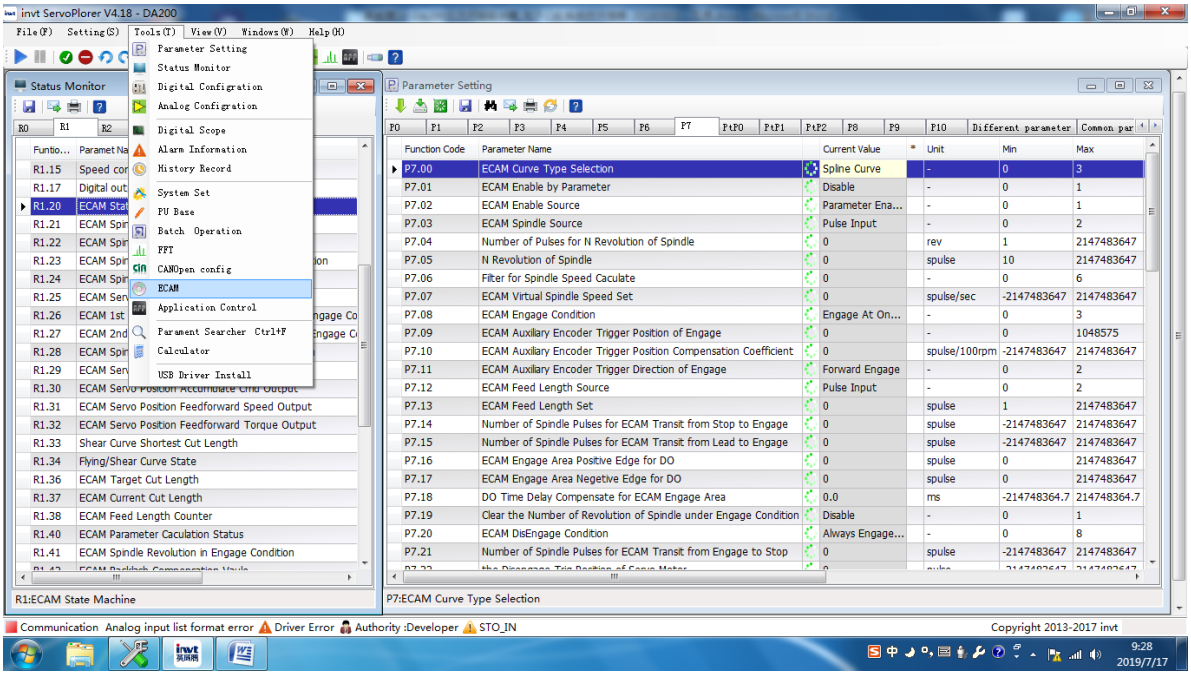
P7.84: Cursor compensation manner. 0: Compensate at next period. 1: Compensate at current period.

Data size	Modbus address	Canopen address	Setting range	Default	Unit
32bit	2568, 2569	0x2754 00	0–1	1	-

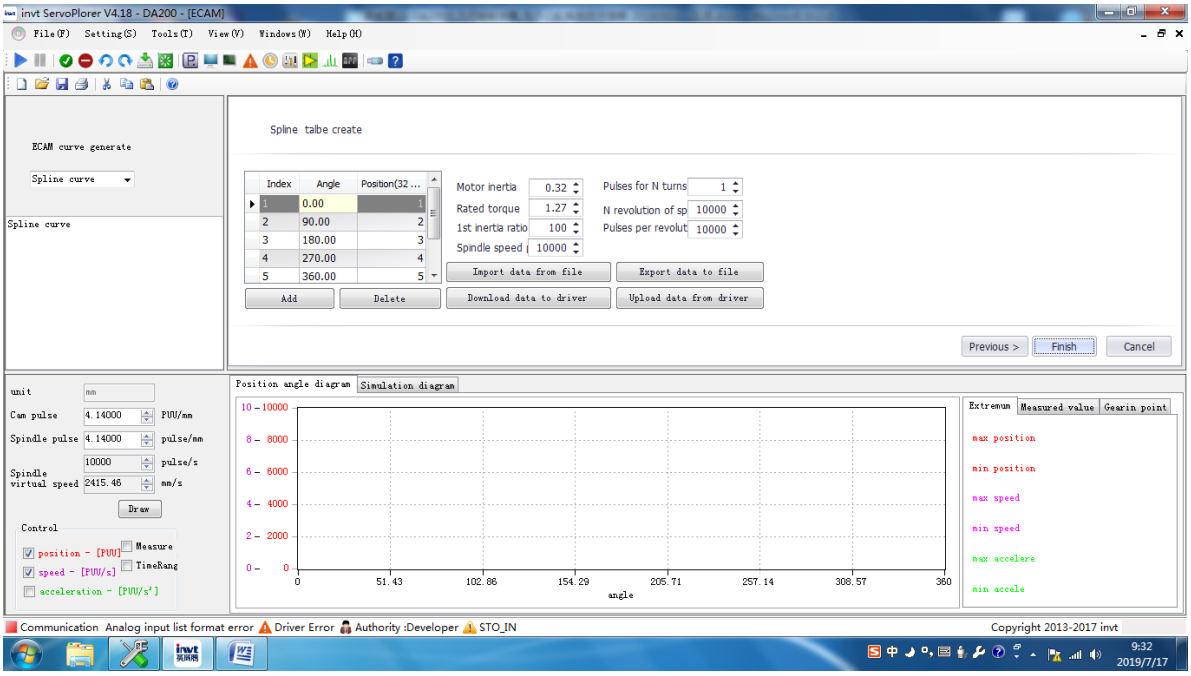
7 Manually creating tables

7.1 Cubic spline

It is recommended that INVT ServoPlorer V4.17 be used. Start the software.



The spline curve display interface is similar to the following:



Based on the actual situation, you can choose to:

- Import data from a file, that is, import the edited data file to the upper computer.
- Export data to a file, that is, export the data in the red rectangle in the figure to a file. Then you can edit the ECAM data in the generated Excel file.
- Download data to the drive, that is, download data from the upper computer to the drive. You can determine whether the downloaded parameters are required by checking the setting of P7.30.

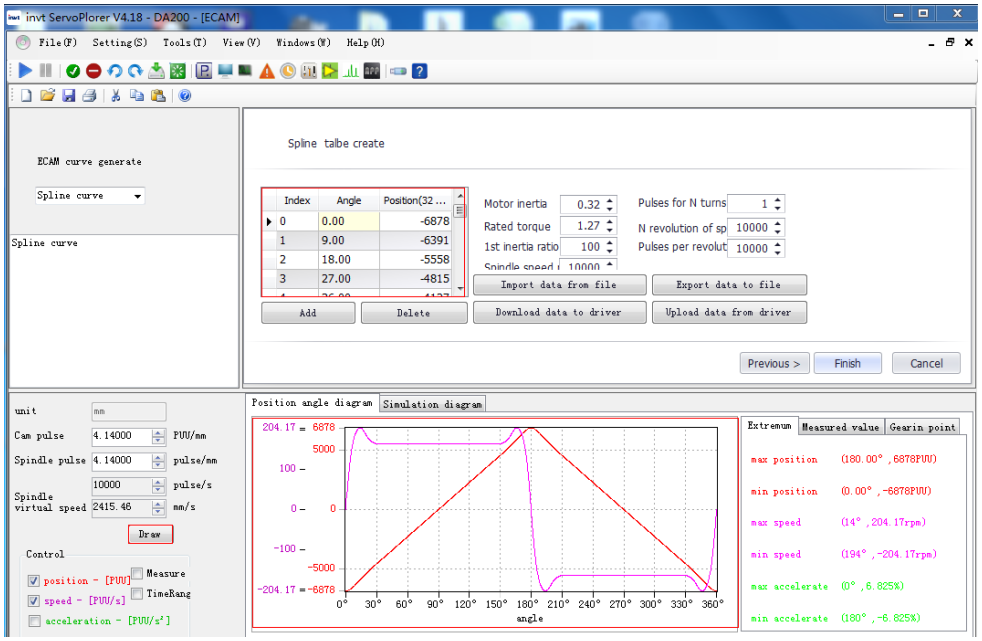
- Upload data from the drive, that is, enable the upper computer to read data from the drive.

Edit the ECAM data file.

	A	B	C
1	No.	Slave axis position (32-bit)	Master axis position
2	0	-6878	
3	1	-6391	
4	2	-5558	
5	3	-4815	
6	4	-4127	
7	5	-3439	
8	6	-2751	
9	7	-2063	
10	8	-1375	
11	9	-687	
12	10	0	
13	11	687	
14	12	1375	
15	13	2063	
16	14	2751	
17	15	3439	
18	16	4127	
19	17	4815	

After importing the data file to the upper computer, click **Draw**.

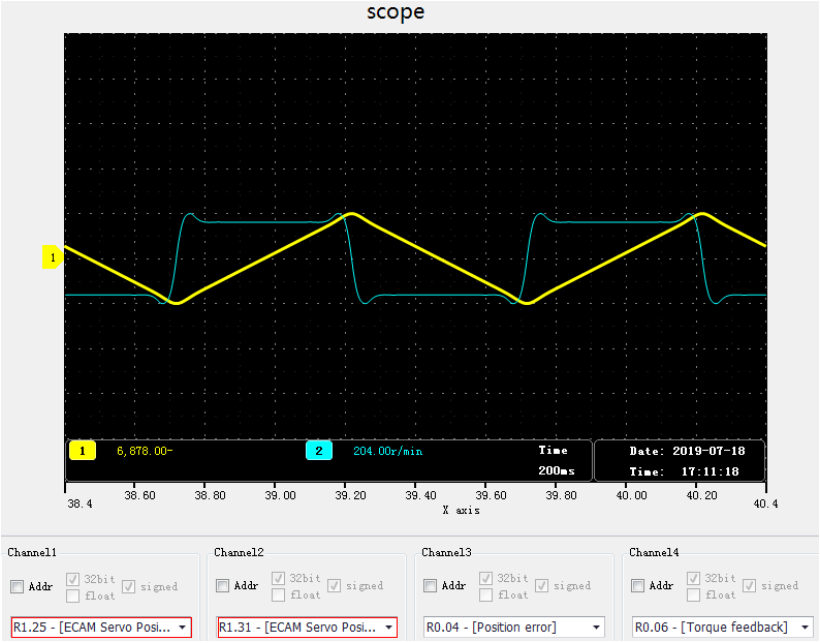
The upper computer automatically draws speed and position curves.



Virtual axis testing curve: Set P7.03 (Master axis source) to the virtual master axis (the setting takes effect only after restart), and set P7.01 (Enable ECAM parameters) to 1.

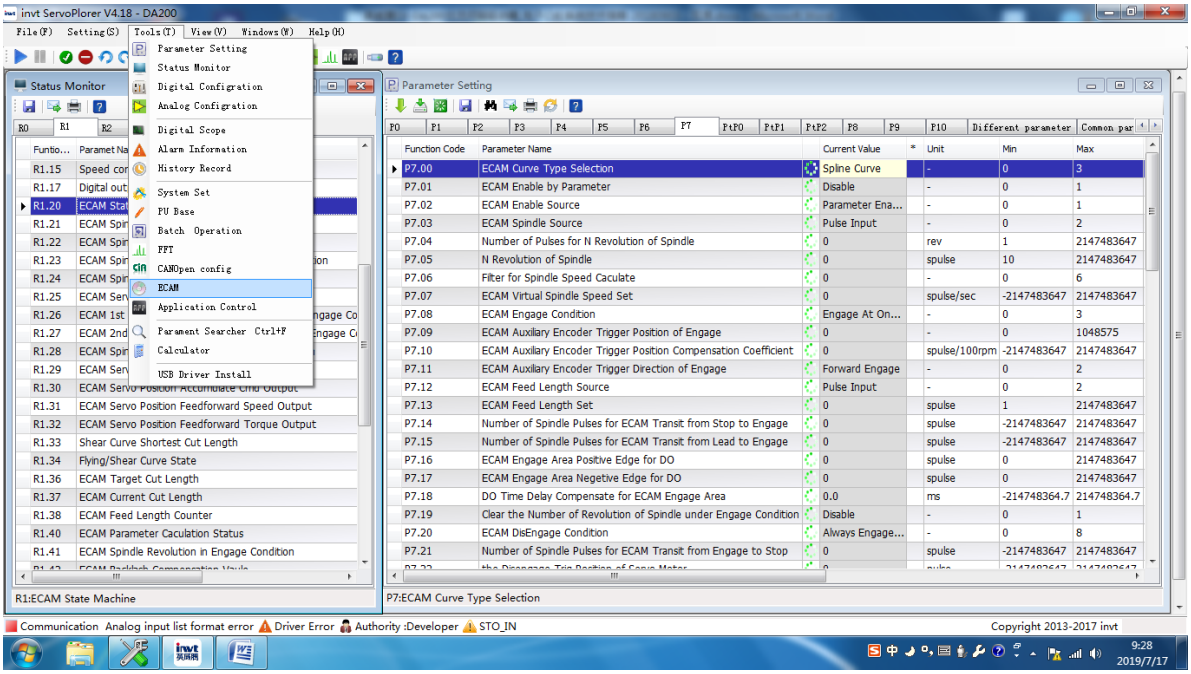
Oscilloscope selection: R1.25, cam axis position at the ECAM engaging point; R1.31: ECAM cam axis speed feedforward output.

After performing the test, you can restore the parameters and enable the servo motor. Then the system can run properly.

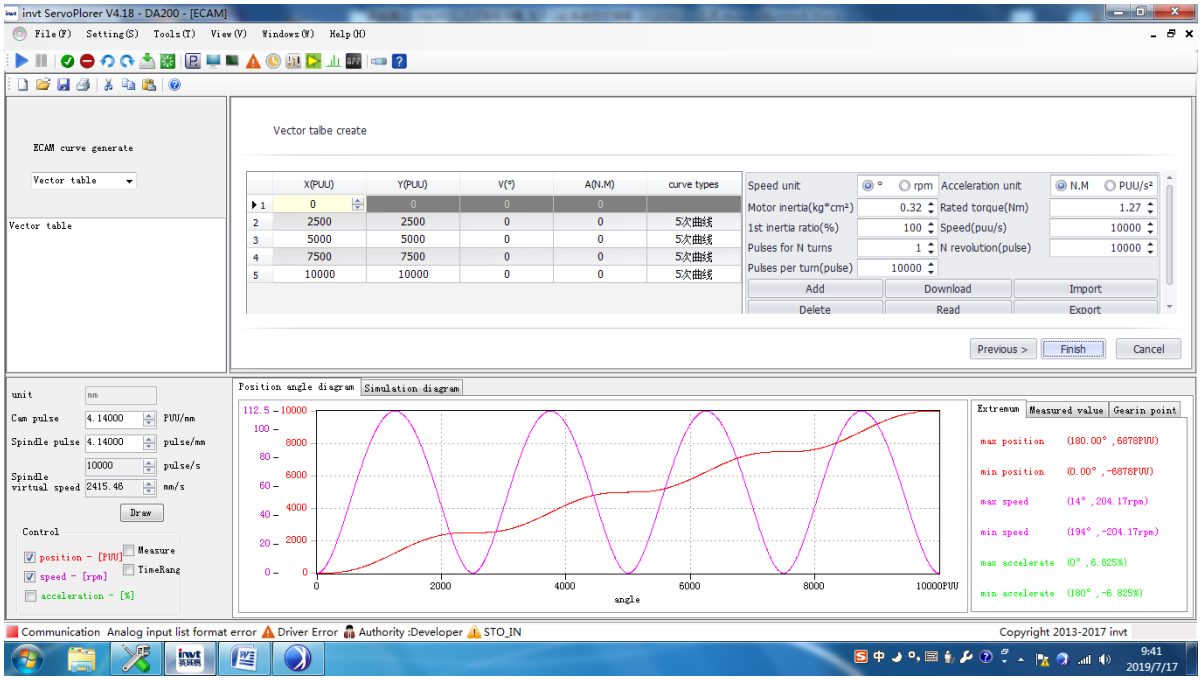


7.2 Vector table

It is recommended that INVT ServoPlorer V4.17 be used. Start the software.



The vector tabulation display interface is as follows:



Based on the actual situation, you can choose to:

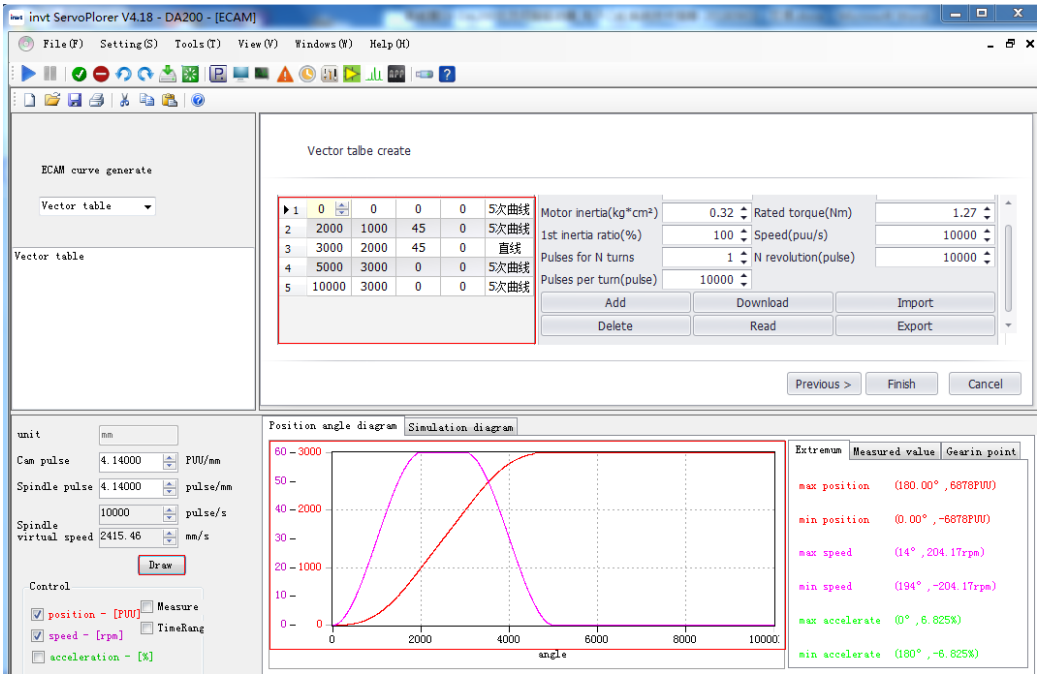
- Add or delete data points.
- Import or export, that is, import a data file to the upper computer or export data from the upper computer to an Excel file.
- Download data from the upper computer to the drive or enable the upper computer to read data from the drive.

Edit the ECAM data file.

	A	B	C	D	E
1	X	Y	V	A	曲线类型
2	0	0	0	0	2
3	2000	1000	1000000	0	2
4	3000	2000	1000000	0	0
5	5000	3000	0	0	2
6	10000	3000	0	0	2

After importing the data file to the upper computer, click **Draw**.

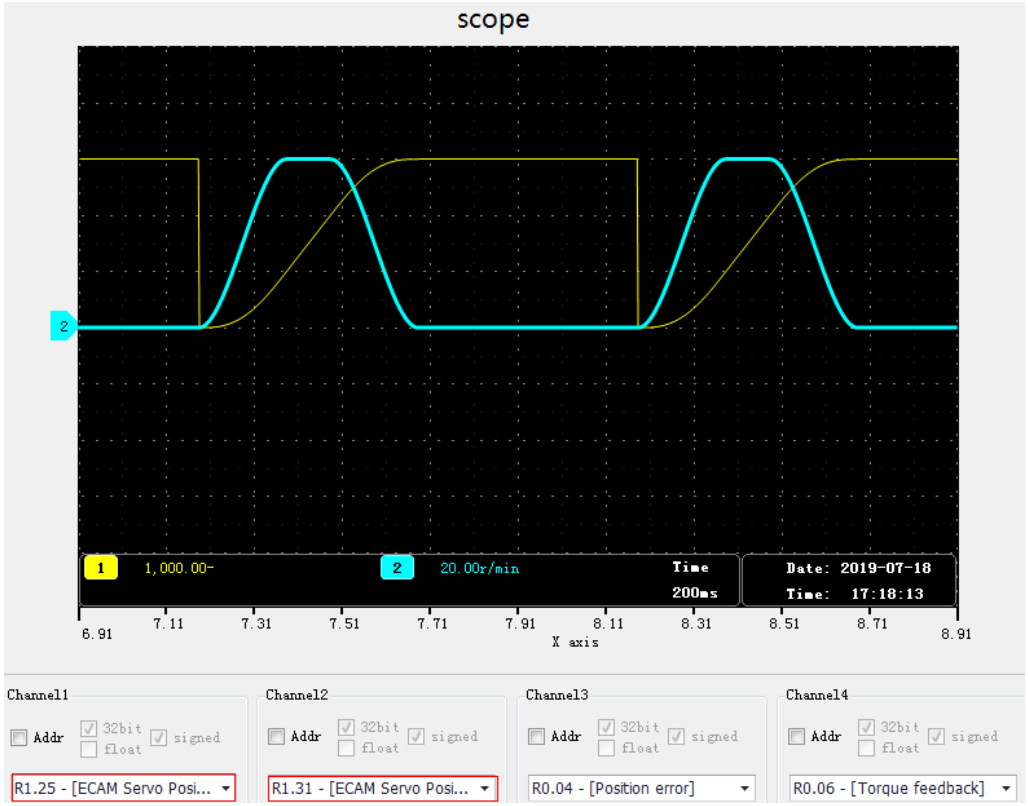
The upper computer automatically draws speed and position curves.



Virtual axis testing curve: Set P7.03 (Master axis source) to the virtual master axis (the setting takes effect only after restart), and set P7.01 (Enable ECAM parameters) to 1.

Oscilloscope selection: R1.25, cam axis position of the ECAM engaging point; R1.31, ECAM cam axis speed feedforward output.

After performing the test, you can restore the parameters and enable the servo motor. Then the system can run properly.



8 Preparing for commissioning

8.1 Checking before power-on

- Ensure the power cables of the servo drive and motor are correct.
- Ensure external wiring is properly performed according to the electrical diagram.
- After the wiring is complete, check whether the 24V power is reversely connected or short circuited by using a multimeter.

You can power on the equipment and perform the test only after all the preceding check items meet requirements.

8.2 Checking after power-on

- Ensure all devices are displayed properly.
- Ensure all sensor signals are normal.

8.3 Startup

You can perform startup only after mechanical positions are determined and there is no personnel safety risk.

9 Commissioning

9.1 Parameter settings

Set cam curves and parameters based on the actual situation. It is recommended that P2.10 (Speed feedforward) be set to 100%.

After the setting, click the button for validating parameter calculation, and ensure R1.40 indicates parameter calculation is valid.

9.2 Virtual master axis testing

You can set P7.03 (Master axis source) to the virtual master axis (the setting takes effect only after restart), and use the upper computer oscilloscope to monitor R1.20–R1.60. In this way, you can check whether curves are correct even if the equipment is not started.

9.3 ECAM function

You can set P7.01 or P7.02 to enable the ECAM function through parameters or terminals. After the ECAM function is enabled, devices work properly.

9.4 Synchronization speed compensation

When thick materials need to be cut or a higher synchronization speed is required, you can increase synchronization speed compensation, but this will impact the material feeding speed. You are recommended to increase the setting by 5% for every adjustment.

9.5 Speed feedforward filter time

Generally, the ECAM adds the speed feedforward of 100%, while the master axis encoder has a low resolution, and therefore it is recommended the speed feedforward filter time be increased by 1ms to 2ms.

9.6 Cutting length and material feeding speed

The cutting length has an impact on the material feeding speed. In principle, changing the cutting length requires changing the material feeding speed. You can set the material feeding speed to the maximum speed allowed by normal cutting. If the cutting length is too short, parameter calculation fails. In this case, you can change the material feeding speed for the parameter calculation to succeed.

9.7 Length-counting encoder diameter resolution

Considering precision, the length-counting encoder diameter resolution can contain only two decimal places.

10 Troubleshooting

10.1 Master axis is running without motor rotating

- Check whether the servo drive reports a fault alarm.
- Check the master axis encoder signal by monitoring the pulse input speed feedback is normal on the touchscreen.
- Check whether the servo drive is enabled through the enabling signal.
- Check servo parameter settings. That is, check whether servo parameters are correctly set according to the parameter table and ensure R1.40 indicates parameter calculation is valid.

10.2 Inaccurate cutting

- Check whether the home position is returned. If not, cutting may be inaccurate.
- Check whether the cutting length is correct. If not, correct the setting.

10.3 Motor does not stop after homing

The possible cause is the homing switch does not detect the homing signal. In this case, you can manually move the mechanism to the homing switch. If the switch is not turned on, the induction chip of the sensor may be too far, the sensor wiring may be incorrect, or the sensor is abnormal.

10.4 Cutting precision problem

- The master axis speed fluctuates sharply. The possible cause is that the material feeding device works unsteadily, the length-counting encoder signal is abnormal, or materials slip.
- The master axis speed is too high, exceeding the maximum material feeding speed.
- There are incorrect parameter settings. Check whether the cutting length is less than the minimum cutting length and parameter calculation succeeds.

Precautions

- **It is recommended that absolute motors be used in ECAM applications and length-counting encoder precision be set as high as possible.**
- **Do not put your hands into rotating cutters if the machine encounters a paper jam problem. Shut down the servo or turn off the power first before performing any operation.**
- **The copyright of this guide belongs to INVT Industrial Technology (Shanghai) Co., Ltd. This guide provides guidance for users and commissioning engineers to use ECAM functions. Do not use it for other purposes.**