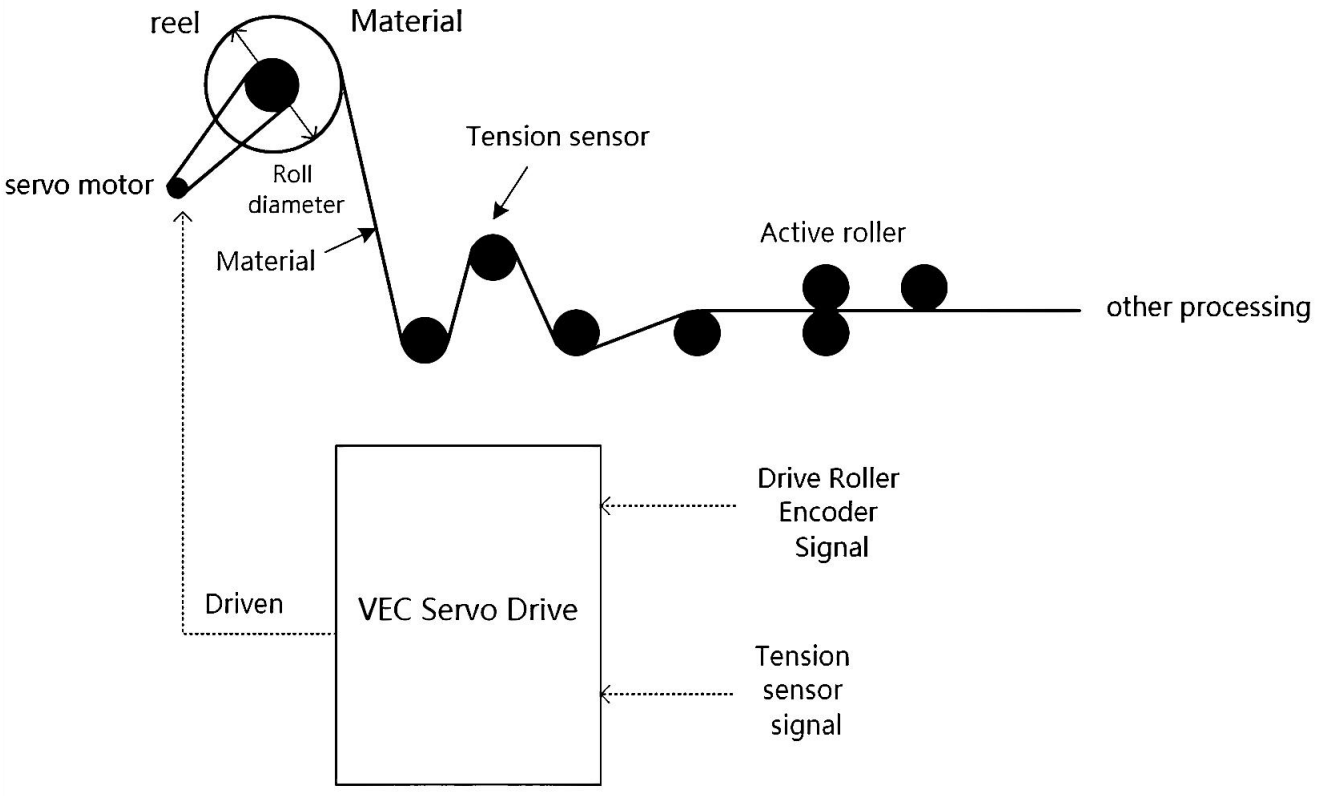
Directory

Tension Control Mode

1 Introduction to Tension Control Mode

Tension control mode is a kind of tension control and process tension control mode specially used for VEC servo. Generally used in printing machinery, film processing machinery, metal material cutting, coating equipment. The schematic diagram of its mechanical structure is as follows. The driving roller is driven by ordinary servo, its function is to drive the material to move, as shown in the figure, if the driving roller drives the material to the right, the reel plays the role of unwinding, if the driving roller drives the material to the left, the reel function as a roll. The driving roller generally rotates at a constant speed, which controls the processing speed of the entire material. The rotation speed of the reel is gradual, and its rotation speed is affected by the reel diameter of the material. The larger the reel diameter, the lower the reel speed, and the smaller the reel diameter, the higher the reel speed. The tensile tension of the material is detected by the tension sensor. During normal operation, it is necessary to control the rotation of the servo motor to control the rewinding/unwinding of the material, and adjust the speed or output torque of the reel servo motor in real time during the rewinding and unwinding process to stabilize the tension of the material.



VEC servo integrates 4 tension control modes, namely closed-loop speed mode, closed-loop torque mode, closed-loop speed/torque automatic switching mode, and

open-loop torque control mode. The specific mode can be set through P14.01.

The closed-loop speed mode is to adjust the material tension by adjusting the motor speed in real time. The advantage of this mode is that the tension fluctuation can be greatly reduced during the acceleration and deceleration of the driving roller, and the material tension can be well controlled at low tension and low rotation speed. Its disadvantage is that it must be strictly ensured that there is no relative slip between the tension roller and the material, and there is no relative slip between the reel and the servo motor.

The closed-loop torque mode is to adjust the tension of the material by controlling the output torque of the motor. The advantage of this mode is that it can allow the relative sliding between the tension roller and the material. The disadvantage is that the tension fluctuates greatly during the acceleration and deceleration process, and it cannot be used below 10% of the rated torque of the motor.

Open-loop torque control mode is a control mode used when there is no tension sensor. In this mode, the tension control accuracy is not high, and the material tension is greatly affected by the acceleration and deceleration of the driving roller, and it cannot be used below 10% of the rated torque of the motor.

2 basic concept

（1）The number of pulses per meter of feeding refers to the number of pulses output by the active roller encoder when feeding one meter, which is generally 4 times the frequency of AB pulses. For example, assuming that the diameter of the driving roller is 0.1m, the reduction ratio between the encoder and the driving roller is 3:1 (that is, the driving roller rotates once, the encoder rotates 3 axes), and the number of lines of the encoder is 2500. Then the number of pulses per meter is

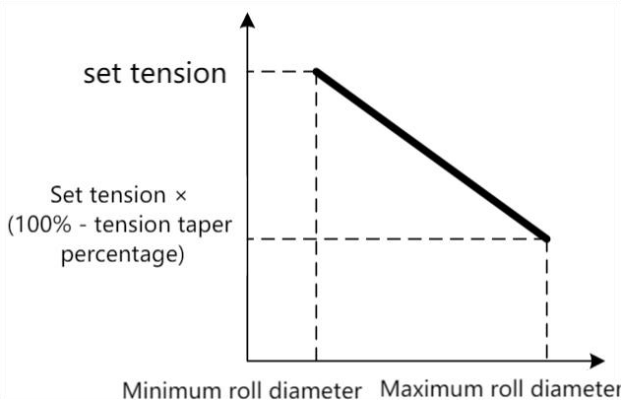
$$\frac{1}{0.1\pi} \times 2500 \times 4 \times 3 = 95493$$

（2）The number of pulses per revolution of the reel refers to the number of pulses output by the motor encoder when the reel makes one revolution. This value is related to the number of lines of the motor encoder and the reduction ratio between the reel and the motor shaft. For example, assuming that the number of motor encoder lines is 2500 lines, and the reduction ratio between the motor shaft and the reel is 3:1 (that is, the reel rotates once, the motor shaft rotates 3 axes), then the number of pulses per revolution of the reel is 2500 × 4 ×3=30000.

（3）Tension taper, when winding, if the material is smooth, the material in the center of the reel is easily squeezed and deformed by the material on the outside of the reel, so it is necessary to set the tension of the material in the center of the reel to be higher, and the material on the outside of the reel. The tension is smaller. That is, the smaller the winding diameter, the higher the tension; the larger the winding diameter, the lower the tension. Make the final collected roll "tight inside and loose outside". The larger the tension taper, the tighter the roll in the center of the reel and the looser

the roll on the outside of the reel, that is, the greater the difference between the tension in the center of the reel and the tension on the outside of the reel. And the smaller the tension taper, the closer the tension between the center of the reel and the outside of the reel.

When the tension taper is valid, the corresponding relationship between the actual roll diameter and the tension is shown in the figure below.



（4）User tension units

User unit tension is a user-defined tension unit, which can be kg, N, %, etc., and the number of decimal points can also be defined. All user tension units are consistent with the tension range unit set by the user. For example, when we set the tension range, if the weight of the tension correction is 50kg, P14.08 can be set to 500, the unit of kg can be set to 1 decimal place; P14.08 can be set to 5000, the unit of kg can be set to 2 decimal places; P14.08 can be set to 5000, unit N, one decimal place;

3 All parameters of tension control mode

parameter no.	Parameter Description	Setting range	Defaults	Effective way
P14.01	Tension Control Mode 0- Closed loop speed mode; 1- Closed-loop torque mode; 2- Automatic switching of closed-loop speed/torque mode; 3- Open loop tension control mode 4- IO switches between closed-loop speed mode and closed-loop torque mode 5- Reserve 6- Speed mode torque limit mode	0~6	0	Power-on valid
P14.02	tension given source 0- Sourced from P14.04; 1- From AI1; 2- From AI2;	0~2	0	Immediately

P14.03	source of tension feedback 0- zoom in internally; 1- From AI1; 2- From AI2;	0~2	0	Immediately
P14.04	Tension given value, (unit: user tension unit)	0~32767	0	Immediately
P14.05	Display value of tension, (unit: user tension unit)	RO	0	Immediately
P14.06	Real-time tension display, (unit: user tension unit)	RO	0	Immediately
P14.07	Taper percentage (unit: %) 0% and 100% are invalid, when the minimum roll diameter is the given tension, when the maximum roll diameter, the tension is the given tension multiplied by (100.0 - taper percentage)%	0~100.0	0	Immediately
P14.08	Tension range (unit: user tension unit)	0~32767	500	Immediately
P14.09	Tension maintaining range (unit: user tension unit), when at rest, the tension is within (tension given ± tension maintaining range), no tension adjustment is performed	0~32767	20	Immediately
P14.10	Tension display filter time constant (unit: ms)	0~32767	100	Immediately
P14.11	Zero tension threshold, (unit: user tension units)	0~32767	10	Immediately
P14.12	Excessive tension value, (unit: user tension unit)	0~32767	300	Immediately
P14.16	Material break protection motor speed threshold (unit: rpm) If the material is loose and (the feed speed or the motor speed exceeds Pn14.16) and lasts for the time set by Pn14.17, it will report a material failure fault	0~32767	300	Immediately
P14.17	Material break protection time threshold (unit: ms)	0~32767	1000	Immediately
P14.18	Feed pulses per meter, (double word parameter)	0~2147483647	10000	Power-on valid
P14.20	Number of pulses per revolution of the reel, (double word parameter)	0~2147483647	10000	Power-on valid
P14.22	Arrival length (unit: mm)	0~2147483647	0	Immediately
P14.24	Minimum feeding speed (unit: m/min)	0~3276.	0.3	Immediately

		7		
P14.25	Feeding speed (unit: m/min)	RO	0	Immediately
P14.28	Quick tightening function and pre-drive function selection in closed loop speed mode 0- Neither quick tightening nor pre-driving; 1- Select the function of automatic and fast tightening of loose material; 2- Automatically enter pre-drive mode after changing rolls, until P14.84 is greater than 3 3- Control into fast tightening mode according to INFN.54 4- Enter pre-drive mode according to INFN.54 control	0~4	0	Immediately
P14.29	Pre-driving speed (unit: rpm)	0~32767	0	Immediately
P14.30	Torque limit value in pre-drive mode (unit: %)	0~100.0 %	0	Immediately
P14.31	Fast tightening speed (unit: rpm)	0~32767	0	Immediately
P14.33	Closed loop speed mode motor rotation direction change	0-1	0	Immediately
P14.34	Tension compensation direction in closed loop speed mode 0- positive compensation; 1- reverse compensation; 2- According to IO	0~2	0	Immediately
P14.35	Tension tracking direction in closed-loop speed mode 0- positive tracking; 1- reverse tracking; 2- According to IO	0~2	0	Immediately
P14.36	Tension proportional gain in closed loop speed mode	0~32767	100	Immediately
P14.37	Tension integral gain in closed-loop speed mode	0~32767	0	Immediately
P14.38	Tension integral action range in closed-loop speed mode When (tension given-tension feedback)/(tension range)×100% is less than this range, the integration is valid	0~3276.7%	0	Immediately
P14.39	Minimum compensation speed limit in closed-loop speed mode (unit: rpm)	0~32767	60	Immediately
P14.40	Maximum compensation speed limit in	0~32767	100	Immediately

	closed-loop speed mode (unit: rpm)			
P14.41	Variable gain factor in closed loop speed mode: The larger the error, the greater the superimposed proportional gain, the superimposed proportional gain = the error percentage * P14.41 * the gain set, when the error is 100%, the superposed proportional gain is the proportional gain set by P14.41, set the set error is 10%, and the superimposed proportional gain is 0.1*P14.41*The set proportional gain	0~32767	0	Immediately
P14.42	Source of velocity superposition in closed-loop velocity mode 0- From P14.43 1- From AI1 2- From AI2	0~2	0	Immediately
P14.43	Speed superimposed internal setpoint in closed-loop speed mode	0~32767	100	Immediately
P14.44	Roll diameter KP Error percentage*P14.44*0.1=superimposed roll diameter um; When unwinding, it needs to be set to a positive value; When tightening, it needs to be set to a negative value.	-32767~32767	0	Immediately
P14.45	Positive proportional gain increase In the closed-loop speed mode, when the given value is greater than the feedback value, the material is easy to loosen, so increase the proportional gain in the closed-loop speed mode, and the multiplier is P14.45. When P14.45=0, this function is invalid. When P14.45 is equal to 2.0, the proportional gain increases to 2 times when the forward error occurs. When P14.45=1.0, the proportional gain increases to 1.0 times the original value in forward error, that is, there is no increase.	0~3276.7	0	Immediately
P14.47	Reach roll diameter 2 (unit: mm)	0~3276.7	0	Immediately
P14.48	Roll diameter calculation method 0- Calculated according to the command pulse and motor pulse; this	0-2	0	Immediately

	method needs to connect the motor pulse output of the spindle rotation to the command pulse input terminal 1- Increase layer thickness at each Z point 2- It is derived from the ratio of the spindle speed setting P14.63 and the reel speed; this method needs to set the spindle encoder resolution P14.64, and at the same time write the spindle position to 0x607A through PDO			
P14.49	Roll diameter filter buffer, the larger the roll diameter filter buffer, the more stable the roll diameter output. Max 64, Min 1	1~64	20	Immediately
P14.50	The interval value of the number of motor pulses in each roll diameter calculation; that is to say, at least P14.50 motor pulses are required to calculate the roll diameter once	0~32767	1000	Immediately
P14.51	The layer thickness added at each Z point (unit: um)	-32767-32767	0	Immediately
P14.52	Display of motor pulse increment	RO	0	Immediately
P14.53	Display of feed pulse increment	RO	0	Immediately
P14.54	Current roll diameter (unit: mm)	RO	0	Immediately
P14.55	Instantaneous roll diameter (unit: mm)	RO	0	Immediately
P14.56	Reaching roll diameter (unit: mm)	0~3276.7	90.0	Immediately
P14.57	The range that the roll diameter can reach (unit: mm) When the current roll diameter is within (reach roll diameter ± roll diameter reach range), output roll diameter arrival signal	0~3276.7	1.0	Immediately
P14.58	Minimum roll diameter (mm)	0~3276.7	90.0	Immediately
P14.59	Maximum roll diameter (mm)	0~3276.7	400.0	Immediately
P14.60	The source of the initial roll diameter after roll change 0- Manually pull material to automatically calculate the roll diameter; 1- Derived from initial roll diameter 1; 2- Derived from initial roll diameter 2; 3- Switch initial roll diameter 1 and initial	0~3	1	Immediately

	roll diameter 2 through IO;			
P14.61	Initial Roll Diameter 1(mm)	0~3276.7	90.0	Immediately
P14.62	Initial Roll Diameter 2(mm)	0~3276.7	90.0	Immediately
P14.63	Spindle speed setting RPM	-32767~32767	0	Immediately
P14.64	Spindle encoder resolution ppr	0~65535	10000	Immediately
P14.66	Tension control multi-function enable bit to protect 16 binary bits. Bit 0 enables material break protection Bit 1 has no feed speed clear integral function Bit 2 zero tension does not count as roll diameter function Bit 3 enables the clear torque output function when the material is loosened	0~32767	0	Immediately
P14.67	Proportional gain in closed-loop torque mode	0~32767	100	Immediately
P14.68	Integral gain in closed-loop torque mode	0~32767	10	Immediately
P14.69	The direction of tension control in torque mode 0- Positive 1- Reverse;	0~1	0	Immediately
P14.70	Positive speed limit value in torque mode	0~32767	1000	Immediately
P14.71	Reverse speed limit value in torque mode	0~32767	1000	Immediately
P14.72	Open-loop tension torque output coefficient, when the open-loop tension torque output coefficient is set to 100.0%, the maximum tension is given, and when the maximum coil diameter is given, the rated torque is output	0~3276.7	100.0	Immediately
P14.73	Torque mode acceleration compensation coefficient	-32767~32767	0	Immediately
P14.74	Feed acceleration filter time constant	0~32767	100	Immediately
P14.75	The mode automatically switches the acceleration threshold. When the motor speed exceeds 3% of the rated speed and the feed acceleration is less than this threshold, the closed-loop torque mode is adopted; otherwise, the closed-loop speed mode is adopted.	0~3276.7	10	Immediately

P14.79	The current feeding length (unit: mm)	RO	0	Immediately
P14.81	Tension error (unit: user tension)	RO	0	Immediately
P14.82	Display of tension control output compensation speed (unit: 0.1rpm)	RO	0	Immediately
P14.83	Display of feed tracking speed (unit: 0.1rpm)	RO	0	Immediately
P14.84	Roll diameter calculation count display	RO	0	Immediately
P14.85	Roll diameter feedforward coefficient display	RO	0	Immediately
P14.86	Display of the actual tension given	RO	0	Immediately
P14.87	Feeding acceleration (unit: m/min/s)	RO	0	Immediately
P14.88	Output display of PI regulator in torque mode or output of open-loop given torque	RO	0	Immediately
P14.89	Display of acceleration compensation torque in torque mode	RO	0	Immediately
P14.90	Display of the current tension control mode 0- closed loop speed mode; 1- Closed-loop torque mode; 2- Torque speed mode is switching; 3- Open-loop mode;	RO	0	Immediately
P14.91	Roll diameter acceleration display	RO	0	Immediately

4 Tension control mode input function bit

Enter the function number	Parameter Description
INFn.47	Tension compensation direction in closed loop speed mode
INFn.48	Closed loop speed mode tension follow direction
INFn.49	Forced to limit at the maximum compensation speed
INFn.50	When valid, the calculation of the roll diameter is prohibited
INFn.51	Reel change signal input
INFn.52	Switch between initial roll diameter 1 and initial roll diameter 2
INFn.53	Clear feed length
INFn.54	Quick tighten/or pre-drive enable
INFn.55	Tension compensation is prohibited
INFn.66	Speed stacking enabled
INFn.68	Switch between closed-loop speed mode and closed-loop torque mode, when valid, closed-loop torque mode

5 Tension control mode output function bit

output function number	Parameter Description
OUTFn.19	Feeding output; when the feeding speed P14.25 is greater than the minimum feeding speed P14.24, the feeding signal is output
OUTFn.20	Loose material output; the real-time tension P14.06 is less than the zero tension threshold P14.11, and the loose material signal is output
OUTFn.21	The roll diameter calculation is valid; there are two cases: (1)When the roll diameter calculation method P14.48 is set to "0-XY pulse ratio motor pulse".When the motor zero-speed output OUTFn.05 is 0, the feeding OUTFn.19 is 1, and the INFn.50 forbidding curling radius calculation is 0, the curling radius calculation is valid, otherwise the curling radius calculation is invalid. （2）When the roll diameter calculation method P14.48 is set to "1-stack thickness".When INFn.50 forbidding the calculation of curling diameter is 0, the calculation of curling diameter is valid, otherwise the calculation of curling diameter is invalid.
OUTFn.22	The curling diameter reaches the output; when the current curling diameter P14.54 is between (reaching curling diameter P14.56 ± curling diameter reaching range P14.57), output curling diameter reaching signal
OUTFn.23	Length arrival output; when the current feed length P14.79 is greater than the arrival length P14.22, the output length arrival signal.
OUTFn.34	Roll diameter reaches 2 outputs

6 Fault codes and solutions

fault code	Fault description	cause
Err.210	Excessive tension	When the tension display value P14.05 is greater than the excessive tension value P14.12, the excessive tension fault Er.210 will be reported
Err.211	material failure	When the 0th bit of the multi-function enable bit of P14.66 tension control is set to 1, the material break protection function is activated. After activation, when loose material is detected, and the feeding speed or motor speed exceeds Pn14.16, and lasts for the time set by Pn14.17, it will report material failure Er.211.
Err.212	The pulse command type is	Modify P03.02=2, the pulse command is AB pulse

	set incorrectly	

7 other functions

7.1 Tension hold function

When the driving roller is stationary and the tension is basically stable, for some materials that are easy to stretch, when the tension is stable, the tension cannot be adjusted for a long time, otherwise the material will be stretched and deformed. Therefore, when there is no feed speed and the tension is adjusted to a certain range, that is, when the feedback tension is between (Tension given ± Tension maintaining range P14.09), the motor becomes locked and the speed is 0.

7.2 Quick tightening and pre-drive functions

In the closed-loop speed mode, the following selections are made according to P14.28.

When P14.28=0, there is neither fast tightening nor pre-driving function;

When P14.28=1, once loose material is detected, fast tightening is performed;

When P14.28=2, after the roll is changed, when P14.84 is less than or equal to 3, the pre-drive function is executed;

When P14.28=3, whether to tighten quickly is determined according to whether INFN.54 is valid.

When P14.28=4, decide whether to execute pre-driving according to whether INFN.54 is valid.

In the quick tightening mode, the quick tightening speed is P14.31, and the rotation direction is automatically calculated according to the tension error.

In the pre-drive mode, the pre-drive speed is P14.29 and the torque limit is P14.30. The direction of rotation is determined by the direction of tension compensation.

In closed loop torque mode, once loose material is detected, fast tightening is performed without pre-drive function.

In fast tightening mode, the curling diameter must be set correctly.

The pre-drive is used for the initial automatic calculation of the roll diameter.

7.3 Roll diameter reach function

When the current curling diameter P14.54 is between (rolling diameter reaching P14.56 ± curling diameter reaching range P14.57), output curling diameter reaching signal.

When the current curling diameter P14.54 is between (rolling diameter 2 reaches P14.47 ± curling diameter reaching range P14.57), output curling diameter reaching 2 signal.

7.4 length arrival function

When the feed length P14.79 is greater than the arrival length P14.22, the output length arrival signal. When the clear feed length signal is valid, the feed length is 0.

7.5 Tension taper function

When the taper percentage P14.07 is not set to 0% and 100%, the tension taper function is valid. At this time, the actual tension setting decreases with the increase of the roll diameter.

7.6 Material break detection function

When the 0th bit of the multi-function enable bit of P14.66 tension control is set to 1, the material break protection function is activated. After it is activated, when it is detected that the material is cut off, and the feed speed or motor speed exceeds Pn14.16 and lasts for the time set by Pn14.17, it will report the material cut off fault Er.211.

7.7 Excessive tension protection function

When the tension display value P14.05 is greater than the excessive tension value P14.12, the excessive tension fault Er.210 will be reported.

7.8 Closed-loop speed/torque mode automatic switching function

When P14.01 is set to 2, the servo works in the closed-loop speed/torque mode automatic switching mode. In this mode, the automatic switching is performed according to the following rules.

When the motor speed exceeds 3% of the rated speed of the motor and the feed acceleration P14.87 is less than P14.75, the closed-loop torque mode is adopted; otherwise, the closed-loop speed mode is adopted.

7.9 Forward proportional gain increase function

The forward error proportional gain refers to the proportional gain when the

given tension is greater than the feedback tension. In the closed-loop speed mode, when the given value is greater than the feedback value, the material is easy to loosen, so increase the proportional gain in the closed-loop speed mode, and the multiplier is P14.45. When P14.45=0, this function is invalid. When P14.45 is equal to 2.0, the proportional gain increases to 2 times when the forward error occurs. When P14.45=1.0, the proportional gain increases to 1.0 times the original value in forward error, that is, there is no increase.

7.10 Roll diameter Roll diameter calculation function

There are two kinds of coil diameter calculation functions inside the servo, one is to calculate the coil diameter according to the feed pulse and motor pulse feedback, and the other is to calculate the coil diameter according to the layer thickness superposition. The initial roll diameter is triggered by the INFN51 roll change,

8 Closed loop speed mode debugging

8.1 Set the mechanical parameters

parameter no.	Parameter Description	Setting range	Defaults	Effective way
P14.18	Feed pulses per meter, (double word parameter)	0~2147483647	10000	Power-on valid
P14.20	Number of pulses per revolution of the reel, (double word parameter)	0~2147483647	10000	Power-on valid

8.2 Set the parameters related to the coil diameter

parameter no.	Parameter Description	Setting range	Defaults	Effective way
P14.48	Roll diameter calculation method 0-Calculated according to the command pulse and motor pulse; this method needs to connect the motor pulse output of the spindle rotation to the command pulse input terminal 1-Increase layer thickness at each Z point 2-It is derived from the ratio of the spindle speed setting P14.63 and the reel speed; this method needs to set the	0-2	0	Immediately

	spindle encoder resolution P14.64, and at the same time write the spindle position to 0x607A through PDO			
P14.49	Roll diameter filter buffer, the larger the roll diameter filter buffer, the more stable the roll diameter output. Max 64, Min 1	1~64	20	Immediately
P14.50	The interval value of the number of motor pulses in each roll diameter calculation; that is to say, at least P14.50 motor pulses are required to calculate the roll diameter once, If the value is set to zero, the waiting motor pulse number is related to the feeding speed. When the feeding speed is less than 50m/min, the waiting motor pulse number is 5000. When the feeding speed is greater than 50 and less than 100, the waiting motor The number of pulses is 10000.	0~32767	1000	Immediately
P14.60	The source of the initial roll diameter after roll change 0-Manually pull material to automatically calculate the roll diameter; 1-Derived from initial roll diameter 1; 2- Derived from initial roll diameter 2; 3- Switch initial roll diameter 1 and initial roll diameter 2 through IO;	0~3	1	Immediately
P14.61	Initial Roll Diameter 1(mm)	0~3276.7	90.0	Immediately
P14.62	Initial Roll Diameter 2(mm)	0~3276.7	90.0	Immediately
P14.58	Minimum roll diameter (mm)	0~3276.7	90.0	Immediately
P14.59	Maximum roll diameter (mm)	0~3276.7	400.0	Immediately

8.3 Set the tension related parameters

parameter no.	Parameter Description	Setting range	Defaults	Effective way
P14.01	Tension Control Mode 0-Closed loop speed mode; 1-Closed-loop torque mode; 2-Automatic switching of closed-loop	0~6	0	Power-on valid

	speed/torque mode; 3-Open loop tension control mode 4-IO switches between closed-loop speed mode and closed-loop torque mode 5-Reserve 6-Speed mode torque limit mode			
P14.02	tension given source 0- Sourced from P14.04; 1- From AI1; 2- From AI2;	0~2	0	Immediately
P14.03	source of tension feedback 0- zoom in internally; 1- From AI1; 2- From AI2;	0~2	0	Immediately
P14.04	Tension given value, (unit: user tension unit)	0~32767	0	Immediately
P14.08	Tension range (unit: user tension unit)	0~32767	500	Immediately
P14.09	Tension maintaining range (unit: user tension unit), when at rest, the tension is within (tension given ± tension maintaining range), no tension adjustment is performed	0~32767	20	Immediately

Note that when the tension feedback source is set, it is necessary to set the parameters related to the analog quantity. Take the tension source AI1 as an example. AI1 related parameters are as follows.

parameter no.	Parameter Description	Setting range	Defaults	Effective way
P06.61	AI1 input voltage	RO	0	Immediately
P06.64	AI1 offset	-32767~32767	0	Immediately
P06.65	AI1 Deadband	-32767~32767	0	Immediately
P06.66	AI1 magnification	-32767~32767	100%	Immediately
P06.67	AI1 filter time (ms)	0-32767	10	Immediately
P06.68	AI1 zero drift	-32767~32767	1	Immediately

The parameter setting method is as follows.

At zero tension, record the average value of AI1 input voltage and the variation range of AI1 input voltage, set AI1 zero drift to the average value of AI1 input voltage, and set AI1 dead zone to the variation range of AI1 input voltage. AI1 magnification is directly set to 100%, and the tension range is set to the tension size of AI1=10V.

P06.62	AI2 input voltage	RO	0	Immediately

P06.69	AI2 offset	-32767~32767	0	Immediately
P06.70	AI2 Deadband	-32767~32767	0	Immediately
P06.71	AI2 magnification	-32767~32767	100%	Immediately
P06.72	AI2 filter time (ms)	0-32767	10	Immediately
P06.73	AI2 zero drift	-32767~32767	1	Immediately
P06.86	Internal amplified tension input AD minimum value	0-4095	0	Immediately
P06.87	Internal amplified tension input AD maximum value	0-4095	4095	Immediately
P06.88	Internal amplification tension input filter time (ms)	0-32767	20	Immediately
P06.89	Internal amplified tension input AD value	0-4095	0	Immediately

It should be noted that if the internal amplifier is used, then when calibrating, it is necessary to input the AD conversion value corresponding to zero tension into P06.86, and input the AD conversion value corresponding to full tension into P06.87. The AD conversion value corresponding to zero tension or full tension can be seen through P06.89.

8.4 Set the minimum feed rate

parameter no.	Parameter Description	Setting range	Defaults	Effective way
P14.24	Minimum feeding speed (unit: m/min)	0~3276.7	0.3	Immediately

8.5 Set the tension compensation direction

parameter no.	Parameter Description	Setting range	Defaults	Effective way
P14.34	Tension compensation direction in closed loop speed mode 0- positive compensation; 1- reverse compensation; 2- According to IO	0~2	0	Immediately

In the case of no feeding speed, a certain tension is given, the motor is enabled, and the motor starts to rotate. If the motor rotates in the direction of increasing tension, the setting is correct, otherwise the setting is wrong.

8.6 Set the direction of tension tracking

parameter no.	Parameter Description	Setting range	Defaults	Effective way

P14.35	Tension tracking direction in closed-loop speed mode 0- positive tracking; 1- reverse tracking; 2- According to IO	0~2	0	Immediately

First set the tension proportional gain P14.13 and the integral gain P14.14 to 0 in the closed-loop speed mode, enable the motor, the motor still does not rotate, input the feeding pulse, if the motor follows the feeding motor to rewind or unwind, the specific Whether it is rewinding or unwinding depends on the function required by the customer, that is, if the customer needs to rewind and the motor does turn in the direction of rewinding, the direction is correct, otherwise it is wrong.

8.7 Set tension regulator parameters

parameter no.	Parameter Description	Setting range	Defaults	Effective way
P14.36	Tension proportional gain in closed loop speed mode	0~32767	100	Immediately
P14.37	Tension integral gain in closed-loop speed mode	0~32767	0	Immediately
P14.38	Tension integral action range in closed-loop speed mode When (tension given-tension feedback)/(tension range)×100% is less than this range, the integration is valid	0~3276.7%	0	Immediately
P14.39	Minimum compensation speed limit in closed-loop speed mode (unit: rpm)	0~32767	60	Immediately
P14.40	Maximum compensation speed limit in closed-loop speed mode (unit: rpm)	0~32767	100	Immediately

9 Closed-loop torque mode debugging

9.1 Set the mechanical parameters

parameter no.	Parameter Description	Setting range	Defaults	Effective way
P14.18	Feed pulses per meter, (double word parameter)	0~2147483647	10000	Power-on valid

9.2 Set tension related parameters

Refer to Section 8.3

9.3 Set the minimum feed rate

Refer to Section 8.4

9.4 Set the direction of tension compensation

parameter no.	Parameter Description	Setting range	Defaults	Effective way
P14.69	The direction of tension control in torque mode 0- Positive 1- Reverse;	0~1	0	Immediately

In the case of no feeding speed, a certain tension is given, the motor is enabled, and the motor starts to rotate. If the motor rotates in the direction of increasing tension, the setting is correct, otherwise the setting is wrong.

9.5 Set tension regulator parameters

parameter no.	Parameter Description	Setting range	Defaults	Effective way
P14.67	Proportional gain in closed-loop torque mode	0~32767	100	Immediately
P14.68	Integral gain in closed-loop torque mode	0~32767	10	Immediately

9.6 Set the forward and reverse speed limit value

parameter no.	Parameter Description	Setting range	Defaults	Effective way
P14.70	Positive speed limit value in torque mode	0~32767	1000	Immediately
P14.71	Reverse speed limit value in torque mode	0~32767	1000	Immediately

9.7 Set the acceleration/deceleration compensation value

If the material is loose during the acceleration and deceleration process, you need to set the acceleration compensation coefficient P14.73, which can be set to a positive

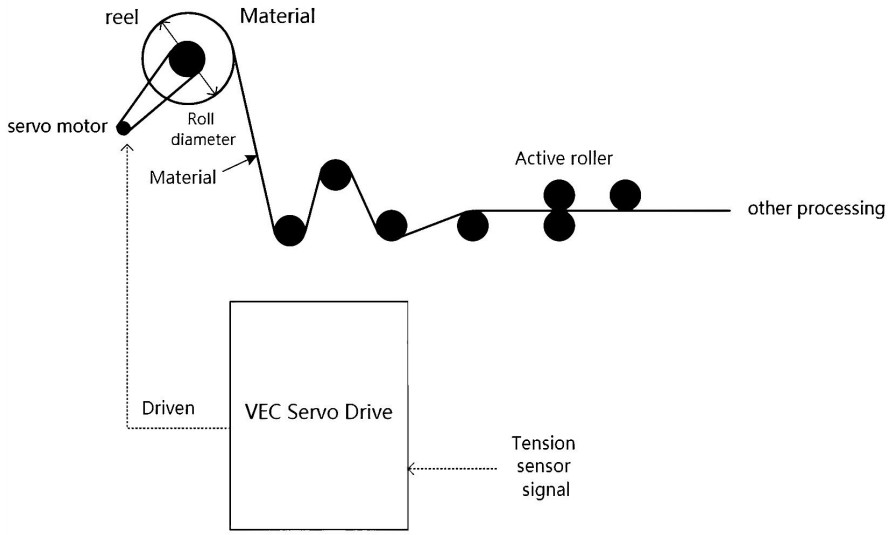
number or a negative number. The specific increase or decrease needs to be adjusted according to the loose material situation.

parameter no.	Parameter Description	Setting range	Defaults	Effective way
P14.73	Torque mode acceleration compensation coefficient	-32767~32767	0	Immediately

10 Open loop torque mode debugging

10.1 Instructions for use of torque limit tension control in open loop speed mode

Open-loop speed mode torque limit mode means that the speed mode is used to control the servo, and the output torque of the servo is limited at the same time. The speed command determines the rotation direction of the motor, and the torque limit determines the final output torque of the motor, thus Determines the tension of the material. The torque control adopts the open-loop control mode, which does not require the participation of the tension sensor. The mechanical structure is generally shown in the figure below.



Before use, it is necessary to set the basic application parameters, including the number of pulses per meter of feed, the number of pulses per revolution of the reel, the given source of tension and other related parameters, and the related parameters of rolling diameter calculation.

Enable this mode by setting P14.01=6.

In this mode, the torque limit command is calculated by the following formula.

Torque limit command = Tension setpoint * Current roll diameter *

Open loop tension torque output coefficient P14.72

There are two sets of speed command parameters and compensation parameters to choose from, which can be switched through INFn81. When INFn81=0, the speed command is controlled by P14.70, the acceleration compensation is controlled by P14.73, and the deceleration compensation is controlled by P13.87. When INFn81=1, the speed command is controlled by P14.71, the acceleration compensation is controlled by P13.82, and the deceleration compensation is set by P13.77. It is explained with INFn81=0.

When 14.70 is within -10000 to -10000, the speed command is P14.70(RPM). This setting is mainly used in the case of unwinding and passively pulling reels.

When P14.70 is greater than 10000, the speed command is automatically calculated, and the calculation formula is:

$$\frac{\text{Feeding speed}}{\text{Roll diameter} * \text{PI}} * \text{Reduction ratio} * 1.5 \text{ times} + (\text{P14.70} - 10000)$$

This setting is mainly used in the case of forward winding.

When P14.70 is less than -10000, the speed command is automatically calculated, and the calculation formula is:

$$\frac{-\text{Feeding speed}}{\text{Roll diameter} * \text{PI}} * \text{Reduction ratio} * 1.5 \text{ times} + (\text{P14.70} + 10000)$$

This setting is mainly used in the case of reverse winding.

The above formula is based on theoretical calculation, and "feeding speed/(roll diameter*PI)" is the theoretical reel speed during feeding. Multiplied by the reduction ratio is the theoretical motor speed. The meaning of multiplying by 1.5 times is that there may be a 50% error in the roll diameter. Within such an error range, the motor can still wind faster than the theoretical winding speed. The meaning of adding (P14.70-10000) means that when the feeding speed is zero, the motor has a basic tightening speed.

The direction of the speed command can also be switched by P14.33. The acceleration and deceleration compensation function is available in this mode. The so-called acceleration refers to the increase in the absolute value of the feed rate, ignoring the direction of the feed rate. The so-called deceleration refers to the increase in the absolute value of the feed speed, ignoring the direction of the feed speed. The acceleration compensation parameter is passed through P14.73/P13.82 is set, and the deceleration compensation parameters are set through P13.87/ P13.77. The acceleration and deceleration compensation parameters can be set to positive or negative values, depending on the direction of motor rotation. for example,

If the motor is unwinding in the direction of the motor's positive rotation, when accelerating, a positive acceleration compensation value should be set. When decelerating, a positive deceleration compensation value should also be set.

If the motor is unwinding in the negative rotation direction of the motor, when accelerating, a negative acceleration compensation value should be set, and when decelerating, a negative deceleration compensation value should also be set.

If the motor rewinds in the direction of the motor's positive rotation, when accelerating, a positive acceleration compensation value should be set. When decelerating, you should also set a positive deceleration compensation value.

If the motor is wound in the negative rotation direction of the motor, when accelerating, a negative acceleration compensation value should be set, and when decelerating, a negative deceleration compensation value should also be set.

10.2 Set the mechanical parameters

Refer to Section 8.1

10.3 Set the parameters related to the coil diameter

Refer to Section 8.2

10.4 Set tension related parameters

Refer to Section 8.3

10.5 Set the minimum feed rate

Refer to Section 8.4

10.6 Set the direction of tension compensation

parameter no.	Parameter Description	Setting range	Defaults	Effective way
P14.69	The direction of tension control in torque mode 0- Positive 1- Reverse;	0~1	0	Immediately

In the case of no feeding speed, a certain tension is given, the motor is enabled, and the motor starts to rotate. If the motor rotates in the direction of increasing tension, the setting is correct, otherwise the setting is wrong.

10.7 Set the open loop tension torque output factor

parameter no.	Parameter Description	Setting range	Defaults	Effective way
P14.72	Open-loop tension torque output coefficient, when the open-loop tension torque output coefficient is set to 100.0%, the maximum tension is given, and when	0~3276.7	100.0	Immediately

	the maximum coil diameter is given, the rated torque is output			

10.8 Set the forward and reverse speed limit value

parameter no.	Parameter Description	Setting range	Defaults	Effective way
P14.70	Positive speed limit value in torque mode	0~32767	1000	Immediately
P14.71	Reverse speed limit value in torque mode	0~32767	1000	Immediately

10.9 Set the acceleration/deceleration compensation value

If the material is loose during the acceleration and deceleration process, the acceleration compensation coefficient P14.46 needs to be set. This value can be set to a positive number or a negative number. The specific increase or decrease needs to be adjusted according to the loose material situation.

parameter no.	Parameter Description	Setting range	Defaults	Effective way
P14.73	Torque mode acceleration compensation coefficient	-32767~32767	0	Immediately

11 Closed-loop speed/torque mode automatic switching mode debugging

Generally speaking, the closed-loop speed mode has high requirements on mechanical stability. If the material slips, it is easy to cause loose material. The closed-loop torque mode is prone to loose material during acceleration and deceleration or low speed. Therefore, combining the advantages of the two, an automatic switching mode is developed. When the motor reaches 3% of the rated speed and the feed acceleration is small, the closed-loop torque mode is adopted, otherwise, the closed-loop speed mode is adopted.

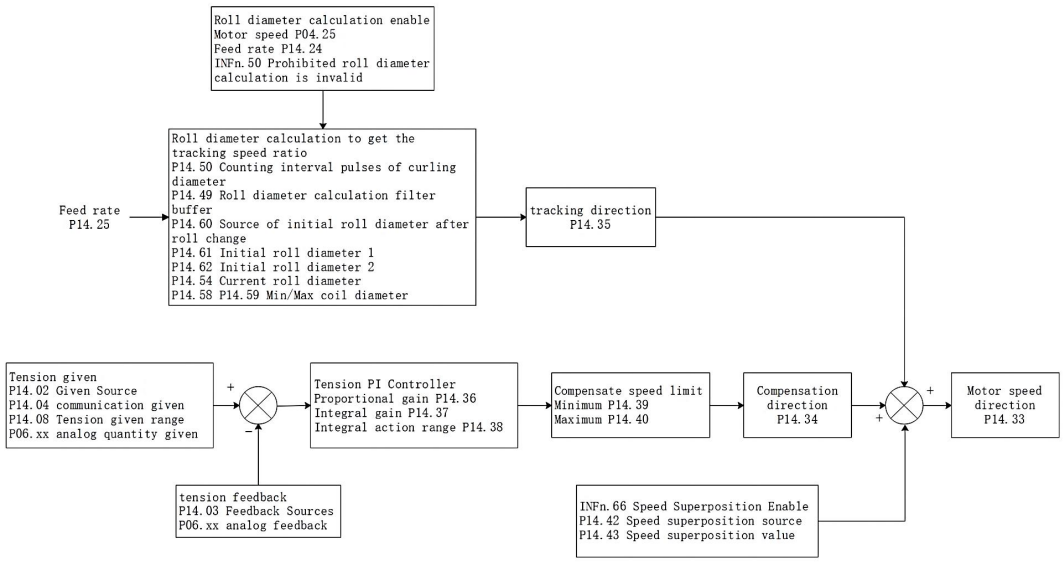
When debugging, first debug the closed-loop speed mode to ensure that it has good stability in the process of low speed or acceleration and deceleration. Then debug the closed-loop torque mode to ensure that it has better stability in the process of high speed and constant speed. Finally, modify the following values.

parameter no.	Parameter Description	Setting range	Defaults	Effective way
P14.01	Tension Control Mode 0- Closed loop speed mode; 1- Closed-loop torque mode;	0~6	0	Power-on valid

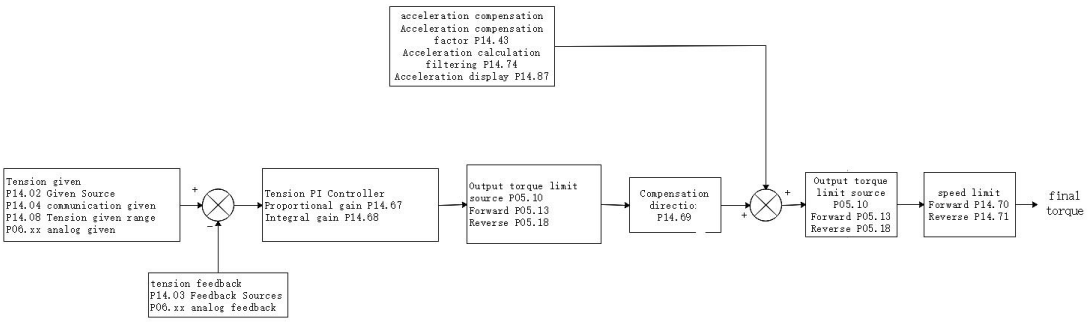
	2- Automatic switching of closed-loop speed/torque mode; 3- Open loop tension control mode 4- IO switches between closed-loop speed mode and closed-loop torque mode 5- Reserve 6- Speed mode torque limit mode			
P14.75	The mode automatically switches the acceleration threshold. When the motor speed exceeds 3% of the rated speed and the feed acceleration is less than this threshold, the closed-loop torque mode is adopted; otherwise, the closed-loop speed mode is adopted.	0~3276.7	10	Immediately

12 Internal implementation block diagram of various modes

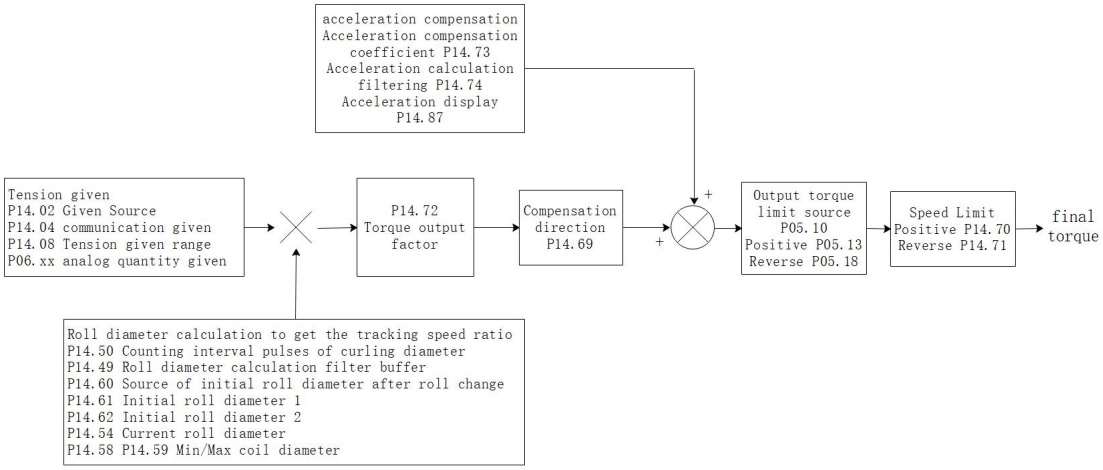
Internal implementation block diagram of closed-loop speed mode



Internal implementation block diagram of closed-loop torque mode



Internal implementation block diagram of open-loop torque mode



13 Description of bus type servo for tension control

When the bus-type servo is used for tension control, the parameters to be set are as follows:

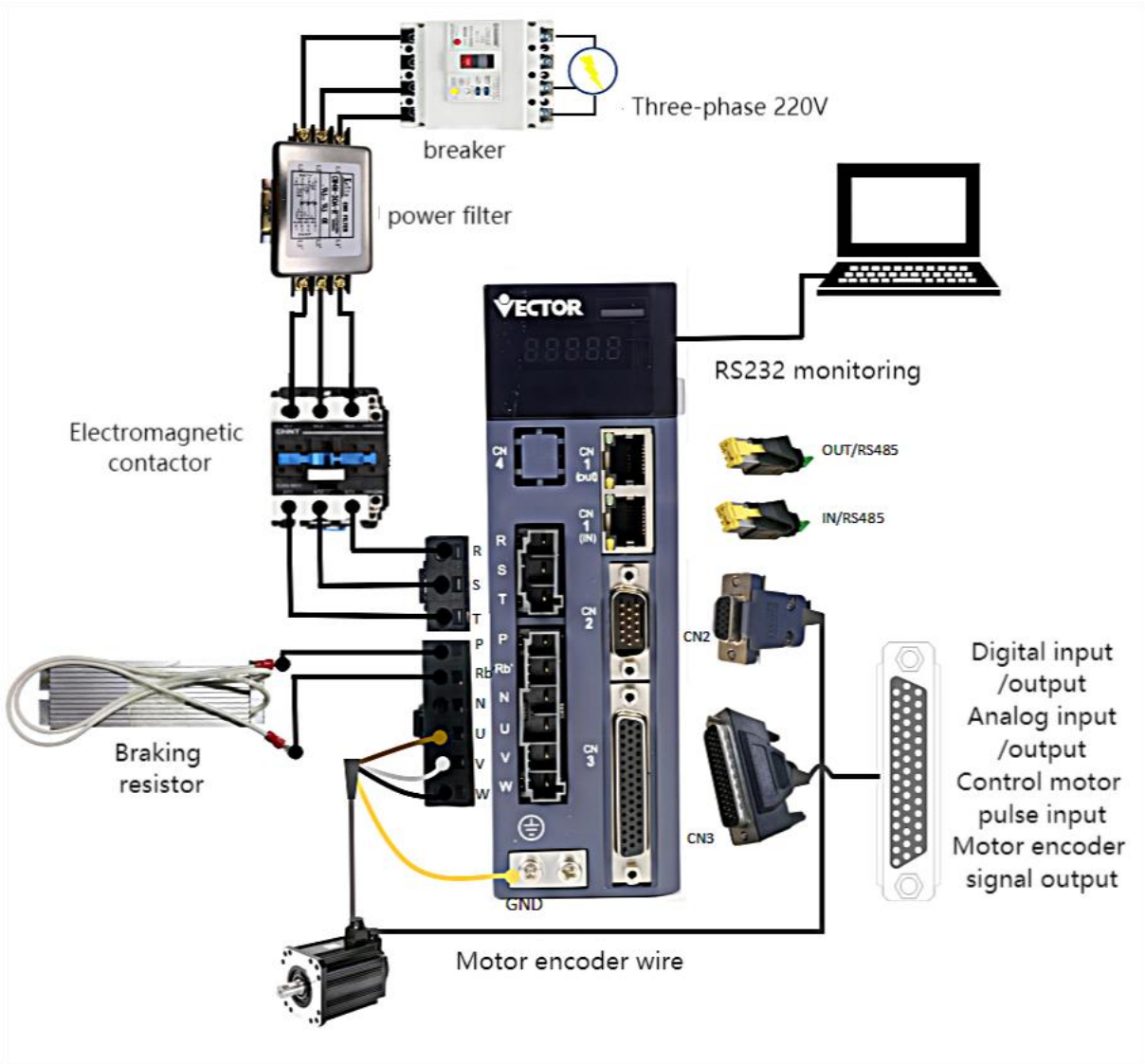
1、 P14.48 is (2-roll through the spindle speed calculation provided by communication);

2、 P14.64 is set to the spindle encoder resolution, and VECServo as the spindle is set to 10000;

3、 The operation mode 6060h is set to 14;

14 wiring

14.1 Main circuit wiring



14.2 I/O line

In order to facilitate communication with the upper controller, the VECServo drive provides 10 groups of digital input terminals and 6 groups of digital output terminals that can be arbitrarily configured. In addition, it also provides XY pulse input and encoder differential output signals OA+, OA-, OB+, OB- and analog input and output signals that can be arbitrarily divided.

Depending on the type of the host controller, the DI and DO signals of the VECServo drive are designed to be selected by jumpers.

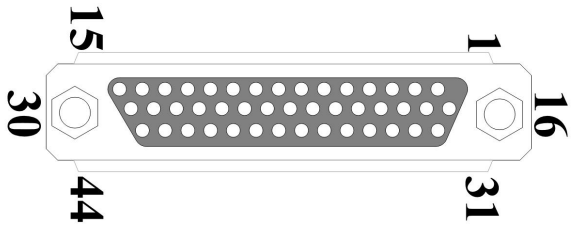
1）DIx jumper selection

SW-DI (pin 27 of CN3) and +24V (pin 26) are short-circuited as NPN, and SW-DI (pin 27 of CN3) and COM (pin 25) are short-circuited as PNP;

2）DOx jumper selection

SW-DO (pin 11 of CN3) and COM (pin 25) are short-circuited as NPN, and SW-DO (pin 11 of CN3) and +24V (pin 26) are short-circuited as PNP;

Remarks: Connect external DC24V power supply to pin 9 (COM) and pin 10 (+24V).

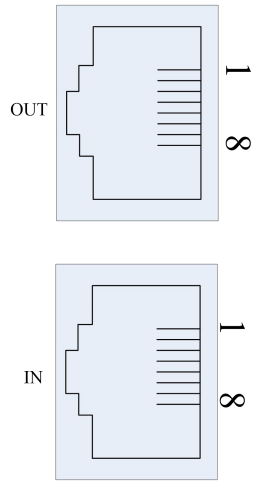


44PIN pin definition					
Pin No.	Define	Functional Description	Pin No.	Define	Functional Description
10、26	+24V	External DC24V power supply, for DI, DO work	21	RST	Reset
9、25	COM		12	AGND	Built-in Analog Ground
3	DO1	Programmable Digital Output	14	AI1	Analog input
18	DO2		15	AI2	
2	DO3		44	AO1	Programmable Analog Output
17	DO4		28	Y2+	High-speed pulse position command input
1	DO5		29	Y2-	
			13	X2+ (SIG+)	(Default high-speed pulse position command input (can be customized as Tension sensor signal input, the tension sensor can be powered through pins 35 and 36 (only for rewinding and unwinding)) Two functions can be selected)
16	DO6		30	X2- (SIG-)	
24	DI1	Programmable digital input	37	OA+	Select the encoder signal frequency division output or the second encoder input through parameter P03.78
8	DI2		38	OA-	
23	DI3		39	OB+	
7	DI4		40	OB-	
22	DI5		41	OZ+	Encoder Z point signal output
6	DI6		42	OZ-	
5	DI7		35	+5V	Built-in +5V power
20	DI8		36	0V	

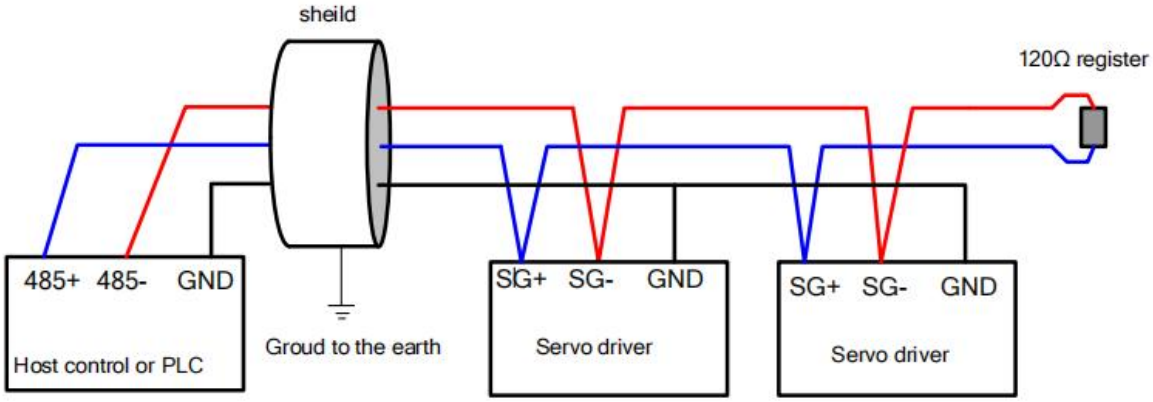
4	DI9		11	SW-DO	DO's NPN/PNP jumper
19	DI10		27	SW-DI	DI's NPN/PNP jumper
31	X+	Position command input, input signal type can choose differential signal or open collector	43	XYPH	XY input pull-up resistor
32	X-				
33	Y+		Case	Shielded network layer	Connect to the ground wire of the driver
34	Y-				

14.3 Communication wiring

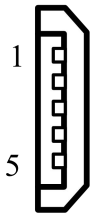
Pin assignment and definition of the E-structure communication port (CN1)

<table>
<tr><th>Location and function</th><th>Terminal shape</th><th>Description</th></tr>
<tr><td>CN1</td><td> 
</td><td>Both interfaces are defined the same.
<table>
<tr><th>Pin.No</th><th>Position</th><th>Description</th></tr>
<tr><td>1</td><td>NC</td><td>dangling</td></tr>
<tr><td>2</td><td>NC</td><td>dangling</td></tr>
<tr><td>3</td><td>GND</td><td>power ground</td></tr>
<tr><td>4</td><td>SG+</td><td>The signal of RS485 is positive</td></tr>
<tr><td>5</td><td>SG-</td><td>The signal of RS485 is negative</td></tr>
<tr><td>6</td><td>NC</td><td>dangling</td></tr>
<tr><td>7</td><td>NC</td><td>dangling</td></tr>
<tr><td>8</td><td>GND</td><td>power ground</td></tr>
</table>
<u>(1)It is necessary to connect the power ground of the controller (PLC) with the power ground of the servo drive</u>
<u>(2)When multiple drives use the RS485 bus in parallel, please add a 120Ω terminal resistor between the SG+ and SG- terminals of the most remote drive</u></td></tr>
</table>

Remarks: VC510/520 servos use RS-485 signal communication.
Note: When wiring, please connect the GND terminal of the host device and the GND terminal of the servo drive together.

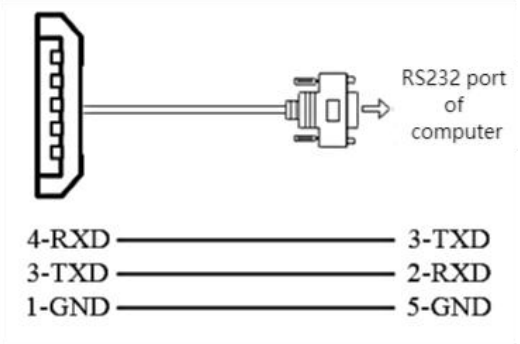


E structure monitoring port pin assignment and definition

Location and function	Terminal shape	Description
CN5		

Pin No.	Define	Description
1	GND	power ground
2	NC	dangling
3	TXD	RS232 send
4	RXD	RS232 receive
5	NC	dangling

The connection to the computer is as shown below:



RS232 baud rate selection parameters are as follows:

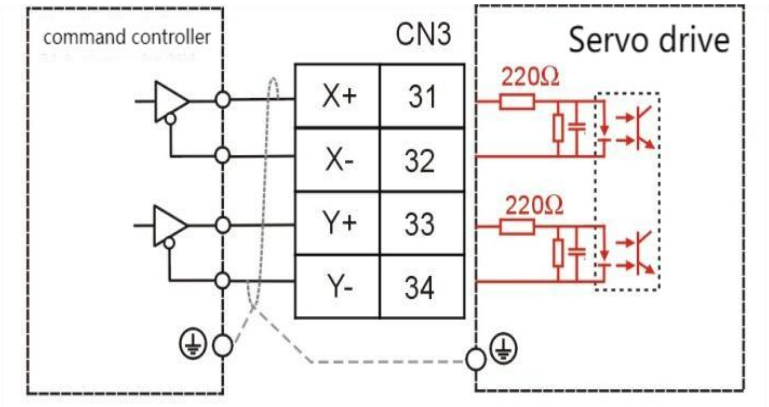
parameter no.	Parameter Description	Setting range	Units	Function	Setting method	Effective way	Defaults	read and write method
P08.26	RS232 monitor port baud rate 0- 9600 1- 38400 2- 115200	0~2	bps	Set the baud rate of the RS232 monitor port.	anytime	Immediately	2	RW

14.4 Position command pulse signal wiring

The following describes the wiring method of the position command input in the CN3 port in detail. There are two options for the input signal type, namely differential signal input and open collector input. Details are as follows:

(1) When differential signal input

Maximum input frequency ≦ 500KHz (before frequency multiplication)



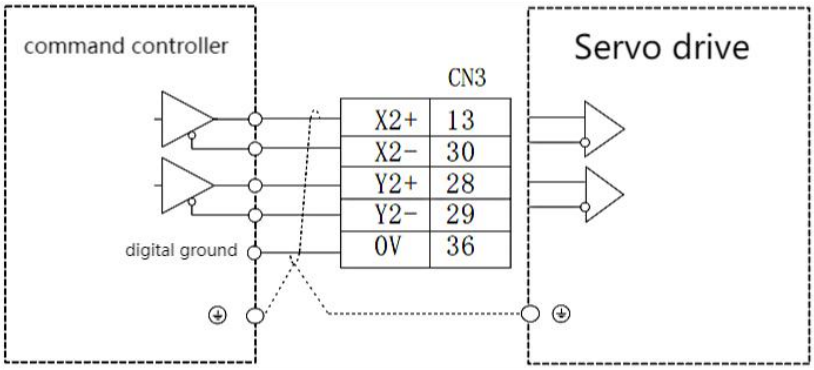
When working, please ensure that:

- 3.2V≤[(high level)-(low level)]≤5.1V

If the above formula cannot be satisfied, the input pulse of the servo drive will be unstable, and the phenomenon of pulse loss or command inversion may occur.

(2) High-speed pulse position command input (differential signal input)

Maximum input frequency ≦ 4MHz (before frequency multiplication)



When working, please ensure that:

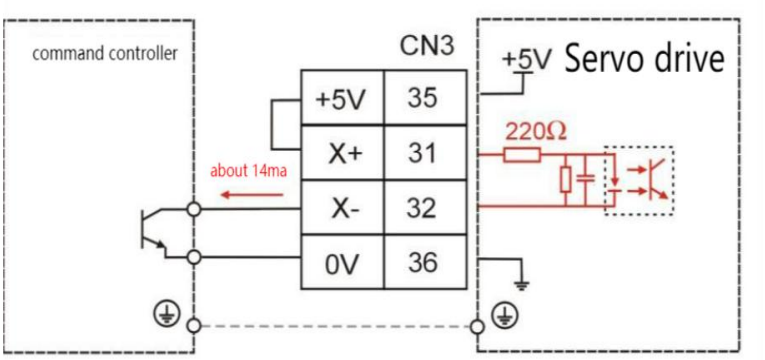
If the above formula cannot be satisfied, the input pulse of the servo drive will be unstable, and the phenomenon of pulse loss or command inversion may occur.

(3) Open collector input

Maximum input frequency ≦ 300KHz (before frequency multiplication)

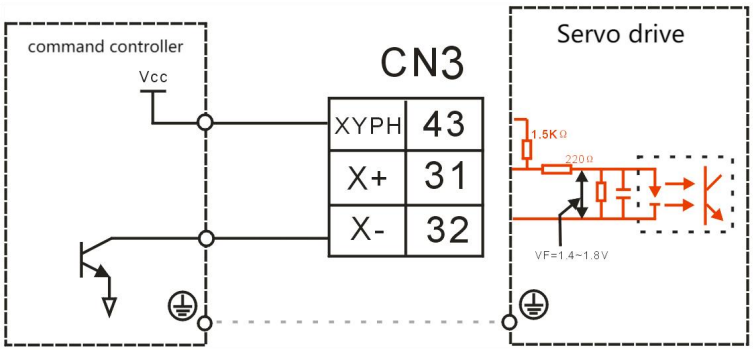
①The upper controller is NPN type (Japanese PLC such as Mitsubishi, Panasonic, Omron, etc.)

a.When using the drive's internal 5V power supply:



- The wiring of Y+ (33 feet) and Y- (34 feet) is the same as that of X+ and X-.

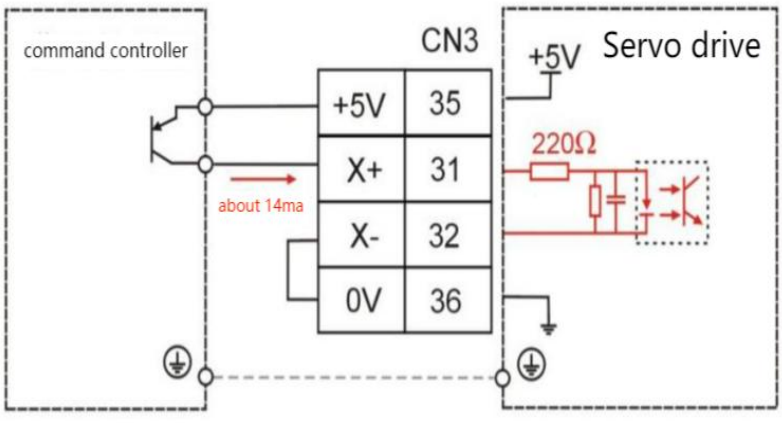
b. When using an external power supply prepared by the user:



- The wiring of Y+ (33 feet) and Y- (34 feet) is the same as that of X+ and X-.
- VCC=24V。

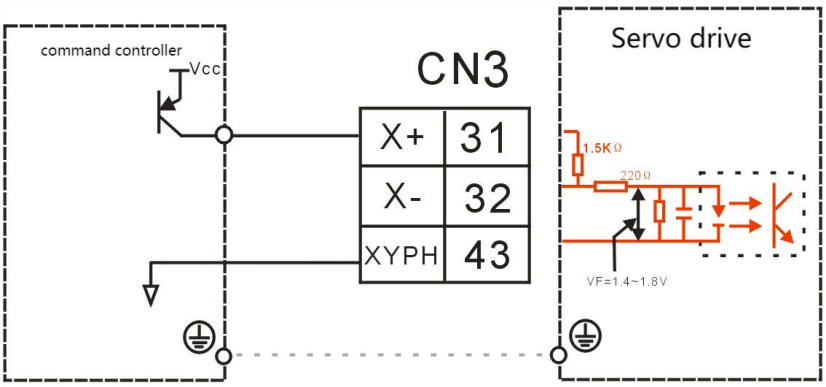
②The upper controller is PNP type (European PLC such as Siemens)

a. When using the drive's internal 5V power supply:



- The wiring of Y+ (33 feet) and Y- (34 feet) is the same as that of X+ and X-.

b. Use a user-prepared external power supply



- The wiring of Y+ (33 feet) and Y- (34 feet) is the same as that of X+ and X-.
- VCC=24V。

Version Update Record

version	release date	Change description
1.01	2022-3-7	The AI3 and AO2 ports are cancelled on the hardware, and AI3 and AO2 are deleted from the manual.