Inovance

Tension Control Inverter

MD330
User Manual

VER:0.0

Contents

Chapter 1 Overview

This manual shall be used together with the MD320 User Manual. This manual only describes the parts related to curling tension. Other basic functions are described in MD320 User Manual.

When the tension control mode is set as inactive, the inverter has the same functions are the MD320.

MD330 is used for curling control. It can automatically calculate the curling radius and is able to realize constant tension when the curling radius changes. To realize constant torque control in the applications without curling radius change, MD320 inverter is recommended.

When the tension control mode is selected, the output frequency and torque of the inverter will be automatically generated by the tension control function, and the frequency source selection in group F0 will be inactive.

Chapter 2 Tension Control Principles

2.1 Schematic diagram for typical curling tension control

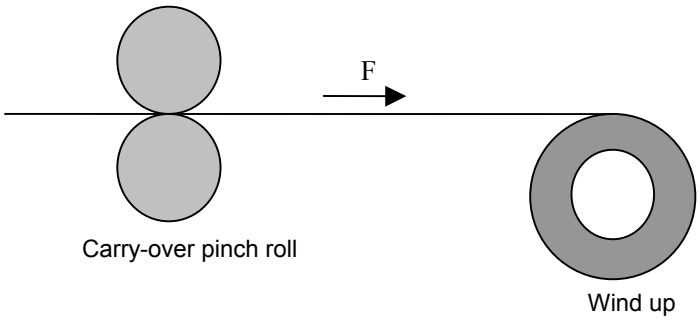

Fig.1 without tension feedback

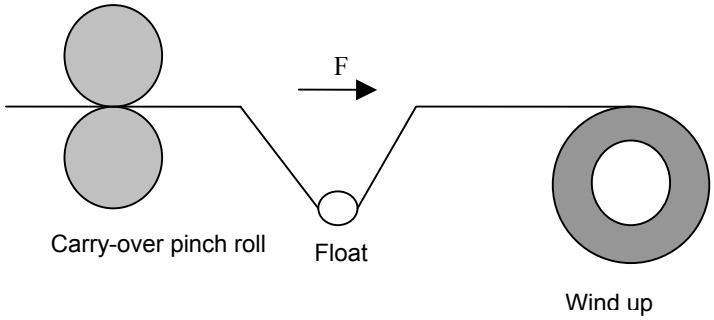

Fig.2 With float roll tension feedback

2.2 Tension control scheme

There are two ways for tension control: to control the output torque of the motor and to control the rotation speed of the motor. MD330 is designed with two tension control modes for the two methods.

1. Open-loop torque control mode

Open loop means that there is no tension feedback signal, and the inverter can realize the control through the output frequency or torque only, which will not be affected if the inverter is in open loop vector mode or close loop vector mode. The torque control mode means that the inverter controls the motor's torque rather than its frequency, and the output frequency changes automatically following the speed of the materials.

According to the formula F=T/R (where: F is the material tension, T is the torque of the wind-up roll, R is the curling radius), if the torque of the wind-up roll can be adjusted based on the change of the curling radius, the tension of the materials can be controlled. This is the principle for tension control in open loop torque mode. The reason for its feasibility is that the tension of the material is from the torque of the wind-up roll only, and the torque of the wind-up roll is mainly imposed on the materials.

The MD series inverter can correctly control the output torque of the motor in closed loop vector mode (with speed sensor vector control). However, to use this control mode, encoder must be installed (the inverter shall be equipped with PG card).

2. Function modules related to open loop torque mode

1) Tension setting part: It is used to the set the tension. In practice, the set value of the tension shall correspond to the actual situations, such as the materials used and the curling requirements. The relevant value shall be set by the user. The tension taper can control the tension to decrease with the increase of the curling radius, so as to improve the curling effect.

2) Curling radius calculation part: It is used to calculate or acquire the curling radius information. If line speed is used to calculate the curling radius, the line speed input function part is needed. If thickness accumulation is used to calculate the curling radius, the relevant function part for calculating curling radius with thickness accumulation shall be used.

3) Torque compensation part: Part of the output torque of the motor will be used to overcome the rotation inertia of the wind-up/roll-down roll during the acceleration/deceleration. The inertia compensation part of the inverter can be automatically compensated automatically according to the acceleration/deceleration rate through proper parameter setting, so that the system can still have stable tension during the acceleration/deceleration. The friction compensation can eliminate the influence of the system resisting force over the tension.

3. Close-loop speed control mode

Close loop means that the tension (position) detection feedback signal forms a close loop for adjustment. Speed control mode means that the inverter realizes the control by adjusting the output frequency according to the feedback signal. The inverter under speed mode can operate in

any of the following three modes: speed sensorless vector control, speed sensor vector control, and V/F control.

The principle for the control mode is as follows: calculate a set value for the matching frequency, f1, according to the material line speed and the actual curling radius, conduct PID operation through the tension (position) detection signal to generate a frequency adjustment value f2, and then output the final frequency f=f1+f2. f1 can basically match the line speed of the wind-up/roll-down roll with the material line speed, and then the control requirement can be met with the slight adjustment of f2. In this way, the problem between the response quickness and the control stability in close-loop control can be well solved.

In this mode, the tension setting part is inactive, and the target value of the system control is set in the FA-00PID reference source. The control result is that the tension (position) feedback signal will be the reference value of the PID. It should be noted that when using the position signal (e.g. tension swing, float roll) as the feedback, the actual tension may not be changed by changing the set value (PID reference value). The mechanical configuration, such as the counterweight of the tension swing or float roll, shall be changed to change the tension.

4. Function modules related to close loop speed mode

1) PID part: It is mainly used for setting of group FA. It can also provide auxiliary function for the second group of PID parameters in group FH. After all the other parts are correctly set, the PID parameters shall be adjusted for the final control result.

2) Line speed input part: This part is very important. It has two functions:

to calculate the matching frequency according to the line speed (as described above) and to calculate the curling radius through the line speed.

3) Curling radius calculation part: It is used to calculate the actual curling radius. The inverter can acquire the matching frequency after obtaining the line speed and the actual curling radius. When using the line speed to calculate the curling radius, if the curling radius calculated by the inverter is different from the actual curling radius, it indicates that there is deviation in the line speed input. The line speed input can be corrected through the curling radius calculation result. It should be noted that the matching frequency calculated with the line speed and the curling radius is not the actual output frequency of the inverter, while operating frequency used in calculating the curling radius with the line speed and operating frequency is the actual output frequency of the inverter. There is no contradiction in logic.

4) The second group PID parameter part: Only one group of PID parameters is not sufficient for the whole process control. At this time, the second group of PID parameters can be used. For example, during partial wind-up, the first group of PID parameters can be used to achieve good control result; during full wind-up, the second group of PID parameters can be used to achieve good control result. In this way, good control result can be achieved in the whole process.

Chapter 3 Function Parameter Table

Function code	Name	Set range	Minimum unit	Leave-factory set value	Change
Control mode selection					
FH-00FH-00	Tension control mode	0: inactive 1: Open-loop torque control mode 2: Close-loop speed control mode 3: Close-loop torque control mode 4: Constant line speed control mode	1	0	×
FH-01FH-01	Curling mode	0: wind-up 1: roll-down	1	0	○

Function code	Name	Set range	Minimum unit	Leave-factory set value	Change
FH-02FH-02	Selection of inverse take-up during roll-down	0: Not allowed Active inverse material take-up is not allowed during startup 1: allowed Active inverse material take-up is allowed during startup	1	0	○
FH-03	mechanical transmission ratio	0.01~300.00	0.01	1.00	○
Tension setting part					
FH-04FH-04	Tension setting source	0: FH-05 setting 1: AI1 setting 2: AI2 setting 3: AI3 setting 4: PULSE input setting 5: communication setting	1	0	×
FH-05FH-05	Tension setting	0N~30000N	1	0	×

Function code	Name	Set range	Minimum unit	Leave-factory set value	Change
FH-06	maximum tension	0N~30000N	1	0	×
FH-07	Zero-speed tension increase	0.0%~50.0%	0.1%	0.0%	○
FH-08	zero-speed threshold	0.0~20% (maximum frequency)	1%	0%	○
FH-09FH-09	tension taper	0.0%~100.0%	0.1%	0.0%	×
Curling radius calculat on part					
FH-10FH-10	curling radius calculation method selection	0: calculation through line speed 1: Calculation through thickness accumulation 2: AI1 input 3: AI2 input 4: AI3 input 5: pulse input	1	0	×
FH-11FH-11	maximum curling radius	1mm~10000mm	1	500	×
FH-12	winding shaft diameter	1mm~10000mm	1	100	×

Function code	Name	Set range	Minimum unit	Leave-factory set value	Change
FH-13	initial curling radius source	0: FH-12~FH-15 setting 1: AI1 setting 2: AI2 setting 3: AI3 setting	1	0	×
FH-14FH-14	initial curling radius 1	1mm~10000mm	1mm	100mm	○
FH-15	initial curling radius 2	1mm~10000mm	1mm	100mm	○
FH-16	initial curling radius 3	1mm~10000mm	1mm	100mm	○
FH-17	curling radius filtering time	0.0s~100.0s	0.1s	1.0s	○
FH-18	current value of curling radius	1mm~10000mm	---	---	○
Relevant parameters for curling radius calculation with thickness accumulation					
FH-19FH-19	Number of pulses each turn	1~60000	1	1	○
FH-20	Number of turns each layer	1~10000	1	1	○

Function code	Name	Set range	Minimum unit	Leave-factory set value	Change
FH-21	Material thickness setting source	0: Digital setting 1: AI1 setting 2: AI2 setting 3: AI3 setting	1	0	○
FH-22FH-22	Material thickness 0	0.01mm~100.00 mm	0.01 mm	0.01mm	○
FH-23	Material thickness 1	0.01mm~100.00 mm	0.01 mm	0.01mm	○
FH-24	Material thickness 2	0.01mm~100.00 mm	0.01 mm	0.01mm	○
FH-25	Material thickness 3	0.01mm~100.00 mm	0.01 mm	0.01mm	○
FH-26	maximum thickness	0.01mm~100.00 mm	0.01 mm	1.00mm	○
Line speed input ¡ art					
FH-27FH-27	line speed input source	0: No input 1: AI1 2: AI2 3: AI3 4: pulse input 5: communication setting	1	0	○
FH-28FH-28	maximum line speed	0.10m/Min~6500.0m/Min	0.1m/Min	1000.0m/Min	○

Function code	Name	Set range	Minimum unit	Leave-factory set value	Change
FH-29	minimum line speed for curling radius calculation	0.10m/Min~6500.0m/Min	0.1m/Min	200.0m/Min	○
FH-30	Actual line speed	0.10m/Min~6500.0m/Min	———	———	○
Tension compensatic n part					
FH-31FH-31	compensation coefficient self learning torque setting	5.0%~80.0%	0.1%	20.0%	○
FH-32	compensation self learning action	0: no operation 1: Start to identify automatically restore to 0 when the self learning is ended.	1	0	○
FH-33FH-33	mechanical inertia compensation coefficient	1~10000	1	0	○
FH-34	material density	0 Kg/m^3~60000Kg/m^3	1Kg/m^3	0Kg/m^3	○
FH-35	material width	0mm~60000mm	1mm	0mm	○

Function code	Name	Set range	Minimum unit	Leave-factory set value	Change
FH-36	friction compensation coefficient	0.0%~50.0%	0.1%	0.0%	○
material supply interrupt auto detection parameters					
FH-37FH-37	material supply interrupt auto detection function selection	0: inactive 1: active	1	0	×
FH-38FH-38	material supply interrupt auto detection minimum frequency	0.00Hz~50.00Hz	0.01Hz	10.00Hz	○
FH-39	material supply interrupt auto detection error range	0.1%~50.0%	0.1%	10.0%	○
FH-40	material supply interrupt auto detection judgment delay	0.1s~60.0s	0.1s	2.0s	○
the second group of PID parameters					
FH-41FH-41	proportional gain 2	0.0s~100.0s	0.1	20.0	○
FH-42	integral time I2	0.01s~10.00s	0.01s	2.00s	○

Function code	Name	Set range	Minimum unit	Leave-factory set value	Change
FH-43	differential time D2	0.000s~1.000s	0.001s	0.000s	○
FH-44	auto adjustment basis for PID parameters	0: Only the first group of PID parameters are used 1: Adjust according to the curling radius 2: Adjust according to the operating frequency 3: Adjust according to the line speed	1	0	○
Auto roll alternation parameter					
FH-45FH-45	pre-drive speed gain	-50.0%~+50.0%	0.1%	0.0%	○
FH-46	pre-drive torque limit selection	0: F2-09 setting 1: Set the limit according to tension setting	1	0	○
FH-47FH-47	pre-drive torque gain	-50.0%~+50.0%	0.1%	0.0%	○

Function code	Name	Set range	Minimum unit	Leave-factory set value	Change
FH-48	tension taper source selection	0: FH-09 setting 1: AI1 setting 2: AI2 setting 3: AI3 setting	1	0	○
FH-49FH-49	tension close loop control adjustment limit	0.0%~100.0%	0.1%	50.0%	○
FH-50	tension close loop control adjustment limit offset	0.0%~100.0%	0.1%	0.0%	○
FH-51	high-speed torque compensation coefficient	-50.0%~+50.0%	0.1%	0.0%	○
FH-52	compensation basis	0: frequency 1: line speed	1	0	○
FH-53	external taper control maximum output setting source	0: FH-54 setting 1: AI1 setting 2: AI2 setting 3: AI3 setting	1	0	○

Function code	Name	Set range	Minimum unit	Leave-factory set value	Change
FH-54	external taper control maximum output digital setting	0.0%~100.0%	0.1%	100.0%	○
FH-55	pre-drive curling radius calculation selection	0: calculate 1: stop calculation	1	0	○
FH-56FH-56	curling radius calculation stop delay after ending of pre-drive	0.0s~10.0s	0.1s	5.0s	○
FH-57	tension increase ratio	0.0%~200.0%	0.1%	50.0%	○
FH-58	line speed setting source	0: AI1 setting 1: AI2 setting 2: AI3 setting 3: pulse setting 4: communication setting	1	0	○
FH-59	taper compensation correction	1mm~10000mm	1mm	0	○

Function code	Name	Set range	Minimum unit	Leave-factory set value	Change
FH-60	tension taper effectiveness selection for close loop tension control	0: taper effective 1: taper ineffective	1	0	○
input/output selec ion					
F7-04F7-04	operation display selection	BIT13: curling radius BIT14: tension setting			
F7-05F7-05	stop display selection	BIT10: tension setting BIT11: curling radius When switching to display the curling radius during the stop, the curling radius can be changed by the UP/DOWN terminal or relevant button.			

Function code	Name	Set range	Minimum unit	Leave-factory set value	Change
F5-07~F5-09F5-07~F5-09	analog output selection	12: external taper control output 13: curling radius output: 0%~100% corresponds to 0~maximum curling radius 14: actual tension (after taper calculation)			
F4-00F4-00	DI1 terminal function selection	31: curling radius reset 32: initial curling radius selection terminal 1 33: initial curling radius selection terminal 2 34: Pre-drive input terminal 35: turn counting signal 36: Torque memory 37: torque			×
F4-01	DI2 terminal function selection				×
F4-02	DI3 terminal function selection				×
F4-03	DI4 terminal function selection				×
F4-04	DI5 terminal function selection				×

Function code	Name	Set range	Minimum unit	Leave-factory set value	Change
F4-05	DI6 terminal function selection				×
F4-06	DI7 terminal function selection				×
F4-07	DI8 terminal function selection				×
F4-08	DI9 terminal function selection				×
F4-09	DI10 terminal function selection				×

Chapter 4 Parameter Description

4.1 Selection of Control Mode

FH-00	**Tension control mode**	0: inactive 1: Open-loop torque control mode 2: Close-loop speed control mode 3: Close-loop torque control mode 4: Constant line speed control mode	0

1. Select the tension control mode with the parameter

1) Don’t choose tension control mode. The tension control is inactive, and the inverter is used as general inverter.

2) Open-loop torque control mode: No tension test and feedback is required. The inverter controls the tension of the material through controlling output torque. The output torque controlled by inverter can realize better control under the speed sensor vector control.

3) Close-loop speed mode: Tension test and feedback are required. The inverter controls output frequency through PID close-loop to enable the set tension is met. The inverter controls output frequency through speed sensorless vector control, V/F control or close-loop vector control.

4) Close-loop speed mode: Tension test and feedback are required.

The inverter controls output torque through PID close-loop to enable the set tension is met. The inverter controls output torque through close-loop vector control mode (with speed sensor vector control).

5) Constant line speed control mode: A special application to realize constant line speed control without PID adjustment, which is more stable than general close-loop control and applicable to the field requiring smooth operation rather than fast line speed adjustment.

It controls inverter output frequency through set line speed and current curling radius. The calculation of curling radius is the same with that of other tension control modes.

Typical application: FH-58 selects line speed set mode to set target line speed. FH-27 adopts actual line speed test, FH-10 calculates line speed through calculating curling radius.

FH-01	**Curling mode**	0: wind-up 1: roll down	0

The curling mode selection can be combined with the switching terminal of wind-up and roll-down. If the switching terminal of wind-up and roll-down is inactive, the set of actual curling mode is the same with the function code; if it is valid, the set of the actual curling mode is opposite to the function code.

The relationship between tension direction and wind-up/roll-down:

The direction of tension is fixed as the direction of wind-up tension, which is consistent with the running direction under non-tension control. For the switching of wind-up/roll-down, it only needs to change FH-01 or use wind-up/roll-down switching terminal rather than change the

forward/reverse running commands.

Note: During the roll-down control, the direction of the force is opposite to the running direction of the system. For the no-load operation, the running direction is also opposite to the direction of normal roll-down.

FH-02	**Selection of inverse take-up during roll-down**	0: Not allowed Active inverse material take-up is not allowed during startup 1: allowed Active inverse material take-up is allowed during startup	0

When selecting roll-down control, whether support active take-up of material through inverse running of motor. If "not allowed" is selected, during the roll-down control, the inverter can only output torque when material is running forward.

During the roll-down, the frequency for inverse take-up can be limited by setting the upper limit frequency.

FH-03	**mechanical transmission ratio**	0.01~300.00	1.00

Mechanical transmission ratio= motor rotation speed/ winding shaft rotation speed

The mechanical transmission ratio must be correctly set during the tension control.

4.2 Tension setting

This part is only related to the open-loop torque mode. The close-loop speed mode is set through PID setting source. Please refer to the description of FA function code in MD320 User Manual.

FH-04	**Tension setting source**	0: FH-05 setting 1: AI1 setting 2: AI2 setting 3: AI3 setting 4: PULSE input setting 5: communication setting	0

The parameter determines the control source of tension:

0: The tension is set with number. The specific number is set in FH-05.

1: AI1, 2: AI2, 3: AI3 The tension is set by analog value which is just like the general potentiometer. If set the tension through analog value, the maximum tension must be set. In general, the maximum value set by analog value corresponds to the maximum tension.

4: The tension is set through pulse input. Pulse input terminal must be DI5 terminal. If set the tension through pulse, the maximum tension must be set. In general, the maximum value set in maximum pulse corresponds to the maximum tension.

5: communication setting. If perform the control with upstream equipment, the tension can be set by communication.

There are two ways to realize communication setting of tension: 1) Change reference value of FH-05, then FH-04 shall be set to 0; 2) Set

the tension through communication address 1000H, FH-04 shall be set to 5 and 1000H shall be set between 0 and 10000, which shows the maximum tension is between 0% and 100%.

FH-05-0	**Tension setting**	0N~30000N	0

When FH-04 is 0, the tension controlled by inverter is determined by the parameter.

FH-06	**maximum tension**	0N~30000N	0

If FH-04 selects analog value control or pulse control as tension source, the parameter determines the corresponding tension for maximum value of analog value or pulse.

FH-07	**Zero-speed tension increase**	0.0%~50.0%	0.0%

Set the tension of the system when it is at zero-speed. It is mainly for overcoming static friction when startup or keep certain tension when the system is at zero-speed. If the control tension is small and it is hard to start, it is allowed to properly increase the setting value of the parameter.

FH-08	**zero-speed threshold**	0.0~20% (maximum frequency)	0%

When the running speed of the inverter is below the set speed of the parameter, it is considered that the inverter is under zero-speed operation status.

FH-09	**tension taper**	0.0%~100.0%	0.0%

The parameter is only used for wind-up control. For the wind-up control, sometimes, it is needed to reduce the tension while increasing the curling radius to ensure a good curling of the material. Formula of tension taper:

F=F0*{1-K*[1-(D0+D1)/(D+D1)] }

Wherein, F is the actual tension, F0 is the setting tension, D0 is the diameter of winding shaft, D is the actual curling radius, D1 is the taper compensation correction of FH-59 set tension, and K is the tension taper.

The taper compensation correction of tension can delay the reduction curvature of tension.

4.3 Curling radius calculation

Curling radius is the necessary parameter in the curling control. For the two tension control modes, open-loop torque mode controls the output torque through curling radius; close-loop speed mode obtains the line speed matched output frequency through curling radius.

FH-10	**curling radius calculation method selection**	0: Calculation through line speed 1: Calculation through thickness accumulation 2: AI1 input 3: AI2 input 4: AI3 input 5: Pulse input	0

0: Calculate based on line speed: Refer to the following description of line speed input for the resource of line speed. The inverter can calculate the curling radius based on the line speed and its output frequency, which features that it does not need to consider the thickness of the material while it is able to obtain the accelerated speed of the system.

1: Calculated according to thickness accumulation: It is required to set the thickness of the material. The inverter calculates the total curling radius on the basis of winding-count signal, with increase for wind-up and decrease for roll-down. For the relevant function, refer to the parameter related to curling radius of thickness accumulative calculation.

2: AI1 input4: AI3 input

3: AI2 input 5: PUSLE input

When testing the curling radius with curling radius test sensor, the parameter selects the input channel of curling radius sensor.

FH-11	**maximum curling radius**	1mm~10000mm	1	500

When curling radius source FH-10 selects 2, 3, 4, 5, the parameter must be set. The maximum input corresponds to the maximum curling radius. When the inverter calculates its curling radius, the calculation will be limited by the parameter.

FH-12	**winding shaft diameter**	1mm~10000mm	1	100

Set the diameter of the winding shaft. If the parameter is not properly set and the curling radius of the inverter is lower than the set value, the diameter will be limited by the parameter.

FH-13	**initial curling radius source**	0: FH-14~FH-16 setting 1: AI1 setting 2: AI2 setting 3: AI3 setting	1	0

Select the input channel of initial curling radius.

0: It is allowed to set three initial curling radii with number for FH-14~FH-16.

1:AI1 2:AI2 3:AI3 the initial curling radius is determined by analog value. Select different ports for analog input.

When roll-down, select one terminal as initial curling radius. Select terminal 1, connect to COM, and set initial curling radius in FH-14. Then, when resetting the curling radius, it can be reset to the initial curling radius of roll-down.

Note: The initial value of curling radius can be determined through two multi-function terminals. For example, select DI3,DI4 ports to determine the value of initial curling radius. Set DI3 port parameter F4-02 to

32(select terminal 1 as initial curling radius) and DI4 port parameter to 33(select terminal 2 as initial curling radius). The selection of initial curling radius is as follows:

DI4	DI3	Initial curling radius source
0	0	Determined by FH-12
0	1	Determined by FH-14
1	0	Determined by FH-15
1	1	Determined by FH-16

When the initial curling radius does not count from the hollow curling radius, use the function. The initial curling radius is FH-12 by default, i.e. hollow curling radius.

FH-14	**initial curling radius 1**	1mm~10000mm	100mm
FH-15	**initial curling radius 2**	1mm~10000mm	100mm
FH-16	**initial curling radius 3**	1mm~10000mm	100mm

Set three different initial curling radii, and confirm them through multi-function terminal.

FH-17	**curling radius filtering time**	0.0s~100.0s	1.0s

Lengthen curling radius filtering time to avoid fast change of curling radius calculation (or input) result.

FH-18	**current value of curling radius**	1mm~10000mm	———

Real-time display of current curling radiusIt is able to know the current actual curling radius through the parameter .Also set the start curling

radius by modifying the parameter.

Relevant parameters for curling radius calculation with thickness accumulation

Only when setting curling radius source FH-10 to 1, that is, obtaining through thickness accumulation calculation, it is related to the parameter.

FH-19	**Number of pulses each turn**	1~60000	1

It represents pulse number generated by turn counting signal when winding shaft turns a round.

FH-20	**Number of turns each layer**	1~10000	1

It shows the rounds of winding shaft turning after the material wraps one layer. It is used for wire.

FH-21	**Material thickness setting source**	0: FH-22 setting 1: AI1 setting 2: AI2 setting 3: AI3 setting	0

Set the source of material thickness.

0: Set the material thickness with number in FH-12~FH-25.

1: AI1, 2: AI2, 3: AI3 Confirm the material thickness through input channel set by analog value.

FH-22	**Material thickness 0**	0.01mm~100.00mm	0.01mm
FH-23	**Material thickness 1**	0.01mm~100.00mm	0.01mm
FH-24	**Material thickness 2**	0.01mm~100.00mm	0.01mm
FH-25	**Material thickness 3**	0.01mm~100.00mm	0.01mm

Set the material thickness with number, and select the terminal code and thickness setting through material thickness.

FH-26	**maximum thickness**	0.01mm~100.00mm	1.00mm

When the material thickness is analog input, the maximum analog input corresponds to the maximum thickness.

4.4 Line speed input

If curling radius source selects line speed calculation or tension control mode as close-loop speed mode, it is required to obtain correct line speed signal. In general, the convenient way for obtaining line speed is through analog output of operation frequency of traction (constant speed) inverter. The operation frequency of traction inverter corresponds with the line speed in linear. It only needs to set the maximum line speed (FH-28) to the corresponding line speed of maximum frequency of operation frequency of traction (constant speed) inverter.

FH-27	**line speed input source**	0: No input 1: AI1 2: AI2 3: AI3 4: pulse input 5: communication setting	0

Line speed input source: Used as the way or channel for obtaining line speed.

0: No input

1: AI1, 2: AI2, 3: AI3: Obtain line speed through analog input port.

4: Obtain line speed through pulse input.

5: Obtain line speed through communication method.

FH-28	**maximum line speed**	0.1 m/Min~6500.0m /Min	0.1m/Min	1000.0m/Min

When obtaining line speed through analog input, the maximum line speed must be correctly set. The maximum value of analog input corresponds with the value.

FH-29	**minimum line speed for curling radius calculation**	0.1 m/Min~6500 m/Min	0.1m/Min	200.0m/Min

Set the minimum speed for starting calculation of curling radius. When the inverter detects that the line speed is lower than the value, inverter will stop curling radius calculation. Correct setting of the value will effectively avoid great deviation of curling radius calculation when the speed is reduced. In general, the value shall be set to over 20% of maximum line speed.

FH-30	**Actual line speed**	0.1 m/Min~6500.0m/Min	———	———

The parameter will display actual line speed on line.

4.5 Tension compensation

It is only relevant to the open loop torque mode.

When the tension control adopts open loop torque mode, during the system acceleration/deceleration, additional torque shall be provided to overcome the rotation inertia of the whole system. Otherwise, too small tension upon wind-up acceleration and too large tension upon deceleration, or too large tension upon roll-down acceleration and too small tension upon deceleration will be caused.

FH-31	**compensation coefficient self learning torque setting**	5.0%~80.0%	0.1%	20.0%

It is used to set the torque used for inertia compensation self learning.

This function is reserved for the current version.

FH-32	**compensation self learning action**	0: no operation 1: Start to identify automatically restore to 0 when the self learning is ended.	1	0

Set the inertia compensation operation method:

0: no operation

1: Start to identify. Press RUN key to start inertia identification.

Note: At this time, the inverter operates in panel control mode.

This function is reserved for the current version.

FH-33	**mechanical inertia compensation coefficient**	1~10000	1	0

It is used to compensate the rotation inertia of the system, including inertia of the motor, rotation system, and the shaft. Such inertias are fixed and independent of the curling radius. This parameter can be obtained automatically by compensation coefficient self learning (this function is reserved for the current version) or manually set. Upon empty roll or small roll, if the material tension reduces during the acceleration, increase the coefficient. Otherwise, the coefficient shall be decreased.

FH-34	**material density**	0Kg/m^3~60000Kg/m^3	1Kg/m^3	0Kg/m^3
FH-35	**material width**	0mm~60000mm	1mm	0mm

The two parameters are relevant to the material inertia compensation. The inverter will automatically calculate the material inertia compensation value according to the parameter and the curling radius.

FH-36	**friction compensation coefficient**	0.0%~50.0%	0.1%	0.0%

Take wind-up as an example. Because of the frictional resistance, the material tension reduces, which is more obvious upon small roll, and the tension will be nonlinear. This situation can be improved by setting the parameter.

Material supply interrupt auto detection parameters

It is an auxiliary function. The material supply interrupt cannot be detected in all the situations. If good result cannot be achieved after proper effort, set FH-37 to 0.

FH-37	**material supply interrupt auto detection function selection**	0: inactive 1: active	1	0
FH-38	**material supply interrupt auto detection minimum line speed**	0.1~10000.0 m/Min	0.1m/Min	200.0m/ Min
FH-39	**material supply interrupt auto detection error range**	0.1%~50.0 %	0.1%	10.0%
FH-40	**material supply interrupt auto detection judgment delay**	0.1~60.0s	0.1s	2.0s

This group of parameters is used for the inverter to automatically detect the material supply interrupt. It is difficult to conduct auto material supply interrupt detection. Only when line speed is used for curling radius calculation can the inverter have the material supply interrupt detection basis. The inverter will detect the material supply interrupt according to the abnormal change of curling radius. By adjusting FH-38, FH-39 and FH-40, mistaken report can be prevented, and adjustment can be made for the detection sensitivity to achieve good result. ERR24

failure will be reported by the inverter after material supply interrupt is detected.

FH-37: When it is set as 0, the material supply interrupt auto detection function is inactive.

FH-38: Only when the line speed is higher than the value can the material supply interrupt be detected.

FH-39: Only when the abnormal change of the curling radius exceeds this range can the material supply interrupt be detected.

FH-40: Only when the lasting time of the abnormal change of the curling radius exceeds this delay can the material supply interrupt be detected.

When the above three conditions are satisfied simultaneously, the inverter reports ERR24 (material supply interrupt failure)

4.6 PID parameters

This group of parameters is only related to the close loop speed mode.

FH-41	**proportional gain 2**	0.0s~100.0s	0.1	20.0
FH-42	**integral time I2**	0.01s~10.00s	0.01s	2.00s
FH-43	**differential time D2**	0.000s~1.000s	0.001s	0.000s

This is the second group of parameters. FA-05, FA-06 and FA-07 belong to the first group of PID parameters. Best result can be achieved in different conditions by setting the two groups of parameters.

FH-44	**auto adjustment basis for PID parameters**	0: Only the first group of PID parameters are used 1: Adjust according to the curling radius 2: Adjust according to the operating frequency 3: Adjust according to the line speed	1	0

Select auto adjustment basis for PID parameters.

0: Only the first group of PID parameters is used, and the second group is inactive.

1: Adjust according to the curling radius. The first group of PID parameters is used for empty roll, while the second group of PID parameters is used for full roll. The PID parameters change continuously during the process.

2. Adjust according to the operating frequency: this first group of PID parameters is used upon zero speed, while the second group of parameters is used upon maximum frequency. The PID parameters change continuously during the process.

3. Adjust according to the line speed: this first group of PID parameters is used upon zero speed, while the second group of parameters is used upon maximum line speed. The PID parameters

change continuously during the process.

4.7 Auto roll alternation parameter

FH-45	**pre-drive speed gain**	-50.0%~+50.0%	0.1%	0.0%

When conducting roll alternation during the operation, to avoid causing too large shock, it is necessary to rotate the wind-up roll (roll-down roll) in advance, and the rotating line speed shall be consistent with the line speed of the materials in operation. This is the pre-drive function.

When the pre-drive terminal is active, the inverter will automatically calculate the output frequency according to the measured line speed and curling radius, so as to match the line speed.

This parameter can adjust the line speed matching relation. When it is set as a negative value, the surface speed of the pre-drive roll will be lower than the line speed of the material in operation.

Upon pre-drive, it is necessary to pause the curling radius calculation (use the curling radius calculation stop terminal) or set the function code FH-55 to 1.

FH-46	**pre-drive torque limit selection**	0: F2-09 setting 1: Set the limit according to tension setting	1	0

It is used to select the torque limit setting mode upon pre-drive. When it is set as 1, the output torque can be limited according to the tension setting and the current curling radius. It is used together with FH-47.

FH-47	**pre-drive torque gain**	-50.0%~+50.0%	0.1%	0.0%

When FH-46 is set as 1, this parameter can be used to adjust the torque limit upon pre-drive, and to get large or small tension according to the system control demand.

4.8 Additional parameters

This section describes the additional parameters for the auxiliary control part according to the actual use demand. The parameters in this section are quite dispersing.

FH-48	**tension taper source selection**	0: FH-09 setting 1: AI1 setting 2: AI2 setting 3: AI3 setting	1	0

Select the setting mode of the tension taper. When analog setting is selected, the settable range is 0%~100%.

FH-49	**tension close loop control adjustment limit**	0.0%~100.0%	0.1%	50.0%

Set the PID regulator output limit in tension close loop control mode. The limit is corresponding to the speed of the whole system.

FH-50	**tension close loop control adjustment limit offset**	0.0%~100.0%	0.1%	0.0%

Set the offset of the PID regulator output limit in tension close loop

control mode. If the value is 0, when the system is at zero speed, the regulator will be inactive. Proper offset value shall be set to avoid this problem.

FH-51	**high-speed torque compensation coefficient**	-50.0%~+50.0%	0.1%	0.0%

It is useful for tension open loop control (torque mode)Some system has different resisting forces at high speed and at low speed. It is impossible to achieve constant tension for the whole process with the constant friction compensation torque only. The influence of the system can be compensated by properly setting this parameter. This parameter is presented as the percentage of the rated torque.

FH-52	**compensation basis**	0: frequency 1: line speed	1	0

It is used together with FH-51 to select the basis of high-speed torque compensation.

FH-53	**external taper control maximum output setting source**	0: FH-54 setting 1: AI1 setting 2: AI2 setting 3: AI3 setting	1	0

This function brings much convenience to the user. The AO output of the inverter can be set as the external taper output, and the inverter can adjust the external taper output according to the current tension proportion to control the external execution parts, such as the control proportion valve, so as to realize the purpose of controlling the tension

taper. When the roll is used as tension feedback, what the inverter controls is the position of the roll rather than the tension of the material. The tension control is decided by the force of the roll.

This function code is used to select the maximum output setting mode.

0: set by FH-54

1, 2, 3: select to be controlled by analog input

FH-54	**external taper control maximum output digital setting**	0.0%~100.0%	0.1%	100.0%

When FH-54 is set as 0, the initial output is set by the function code.

FH-55	**pre-drive curling radius calculation selection**	0: calculate 1: stop calculation	1	0

Select whether the curling radius calculation is stopped upon pre-drive. In general, the curling radius calculation shall be stopped.

FH-56	**curling radius calculation stop delay after ending of pre-drive**	0.0s~10.0s	0.1s	5.0s

If curling radius calculation is stopped upon pre-drive, this function code will decide when the curling radius calculation starts after the pre-drive is ended, so as to prevent the curling radius causing too large fluctuation at the instant of the pre-drive ending.

FH-57	**tension increase ratio**	0.0%~200.0%	0.1%	50.0%

When the tension increase terminal is active, the tension controlled by the inverter will be increased according to the parameter.

FH-58	**line speed setting source**	0: AI1 setting 1: AI2 setting 2: AI3 setting 3: pulse setting 4: communication setting	1	0

It is relevant to the situation when FH-00 is set as 4 (line speed control mode). For details, please refer to the description of FH-00.

FH-59	**taper compensation correction**	1mm~10000mm	1mm	0

It is the auxiliary parameter for tension taper control. For details, please refer to the description of FH-09.

FH-60	**tension taper effectiveness selection for close loop tension control**	0: taper effective 1: taper ineffective	1	0

This function code decides whether the tension taper will be effective upon close loop tension control.

In general, when the control adopts roll feedback, it is unnecessary for the tension taper to have influence over the roll setting position (PID reference). However, it will be effective on the external taper output because it is used for the control proportion valve to adjust the tension.

Input/output selection: when the inverter is the tension control inverter, the following functions are the supplementary for the

functions of the multi-function terminals of the MD320 inverter.

F4-00	**DI1 terminal function selection**	31: curling radius reset 32: initial curling radius selection terminal 1 33: initial curling radius selection terminal 2 34: Pre-drive command terminal 35: turn counting signal 36: Torque memory 37: torque memory enable 38: wind-up roll-down switching 39: curling radius calculation stop 40: thickness selection terminal 1 41: thickness selection terminal 2 42: tension control disable terminal 43: tension increase terminal		
F4-01	**DI2 terminal function selection**			
F4-02	**DI3 terminal function selection**			
F4-03	**DI4 terminal function selection**			
F4-04	**DI5 terminal function selection**			
F4-05	**DI6 terminal function selection**			
F4-06	**DI7 terminal function selection**			
F4-07	**DI8 terminal function selection**			
F4-08	**DI9 terminal function selection**			
F4-09	**DI10 terminal function selection**			

31: curling radius rest when replacing with a new roll, the curling radius shall be reset to initial curling radius.

32, 33: Initial curling radius selection terminal, used to select the initial curling radius value.

34: Pre-drive command terminal. When the terminal is active, the inverter operates in pre-drive mode. When the terminal is inactive, the inverter operates in tension control mode.

35: Turn calculation signal. When calculating the curling radius with the thickness accumulation method, this signal is used to calculate the turns of the shaft rotation.

36, 37: reserved.

38: wind-up/roll-down switching. When the terminal is active, the actual curling mode is the inverted setting of FH-01.

39: Curling radius calculation stop terminal. It is used when it is necessary to pause the calculation of the curling radius.

40, 41: thickness selection terminal, used to select the setting source for digital setting thickness.

42: Tension control disable terminal. When this terminal is active, it is equivalent to the situation that FH-00 is set as 0.

43: Tension increase terminal. When this terminal is active, the control tension will be increased according to the proportion set in FH-57.

F5-07~F5-09	**analog output selection**	12: external taper control output 13: curling radius output: 0%~100% corresponds to 0~maximum curling radius 14: actual tension (after taper calculation)	1	0

Warranty Agreement

1. The warranty period of the product is 18 months (refer to the barcode on the equipment body). During the warranty period, if the product fails or is damaged under the condition of normal use by following the instruction, Our company will be responsible for free maintenance.
2. Within the warranty period, maintenance will be charged for the damages caused by the following reasons:
   A. The damage caused by improper use or repair/modification without prior permission;
   B. The damage caused by fire, flood, abnormal voltage, other disasters and second disaster;
   C. The damage caused by dropping or transportation after the purchase.
   D. The damage caused by the improper operation;
   E. The damage or failure caused by the trouble out of the equipment (e.g. external device)
3. If there is any failure or damage to the product, please correctly fill out the Product Warranty Card in detail.
4. The maintenance fee is charged according to the newly adjusted Maintenance Price List by our company.
5. In general, the warranty card will not be re-issued. Please keep the card and present it to the maintenance personnel when asking for maintenance.
6. If there is any problem during the service, please contact the

agent of our company or our company directly.

7. This agreement shall be interpreted by Shenzhen Invoance Technology Co., Ltd.

Shenzhen Invoance Technology Co., Ltd.

Service Department

Address: Block E, Hongwei Industry Park, Liuxian Road,

Baocheng No. 70 Zone, Bao'an District, Shenzhen

Tel.: 0755-29619910 Postal code: 518101

Product Warranty Card

<table>
<tr><td rowspan="3">Customer information</td><td colspan="2">Add. of unit:</td></tr>
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Maintenance personnel:</td></tr>
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