



Electronic CAM

User manual

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Electronic CAM

This manual introduces the electronic CAM function of CAM series PLC. The contents include the instructions and related coils, registers for fly cutting and follow cutting. Electronic CAM is widely used in package printing, continuous production. Fly cutting and follow cutting is mostly used electronic CAM. The professional instruction for fly cutting and follow cutting can quickly build the project.

1. Function summarization

It needs multi-axis control and real-time phase synchronization in package printing industry. CAM series PLC can quickly build the fly cutting and follow cutting project through setting the related registers and calling electronic CAM function.

1-1. Follow cutting summarization

The traditional technology of stop cutting, stop shearing used in C-type steel, color steel tile, paper tube industry has low production efficiency. It is not acceptable for the material forming production which cannot stop.

The follow cutting system can follow and synchronize the main axis speed when cutting, then return and recycle the process. The system can improve the material feeding speed in the situation of uninterrupted feeding. It has vast range of prospects in similar industry.

The follow cutting system contains feeding material drive, main axis speed position feedback, cutting module and cutting linear drive. The feeding material drive is VFD or servo system, the roller encoder detects the feeding speed and position. The cutting module is hydraulic, pneumatic or servo system. The cutting linear drive is performed by servo driving the lead screw.

There are two kinds of follow cutting system. One of them puts the follow cutting system inside the servo drive, the encoder feedbacks to the servo directly, the servo performs follow cutting through fixed-program. Different applications have different standards and requirements. This method is not flexible enough to control the whole system.

The other method puts the electronic CAM inside the controller which can change the action and technology easily. The follow cutting system is shown as figure 1.1.

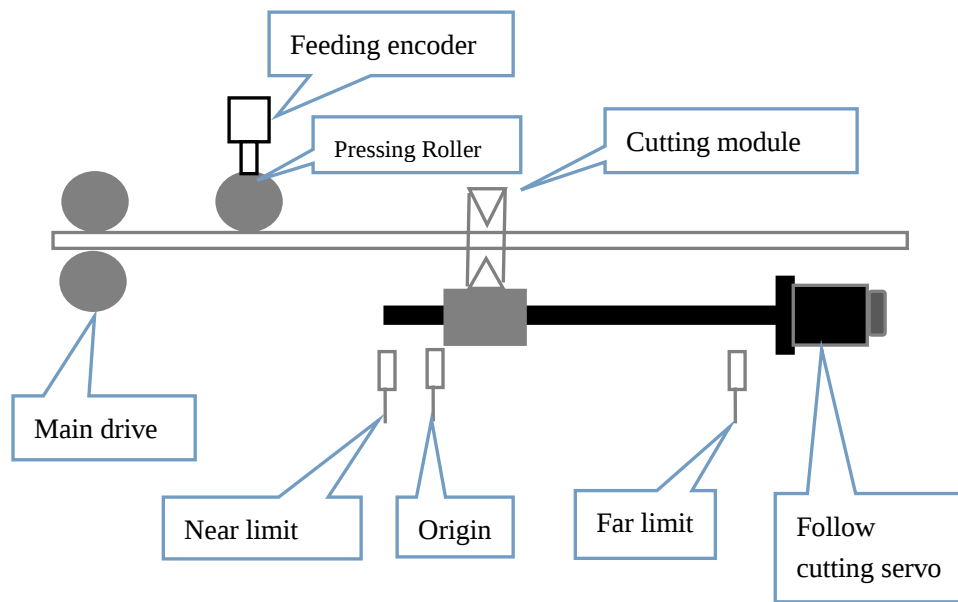


Figure 1.1 follow cutting system

The main drive supplies the power to feeding and molding, the pressing roller presses the material and feedbacks the position and speed through encoder. The servo synchronizes the follow cutting according to the encoder feedback. The cutting module will cut the material according to the synchronous area mark. The origin is the base position of follow cutting sliding table resetting. Near limit and far limit is for travel protection.

CAM instructions can auto-generate the follow cutting curve by setting the cutting length, cutting curve parameters and mechanical electrical parameters. The acceleration and deceleration of CAM follow cutting curve is smooth which can prolong the service life of the machine. The curve is composed of acceleration area, synchronization area, deceleration area, direction switching area, returning area, waiting area. Please see figure 1.2.

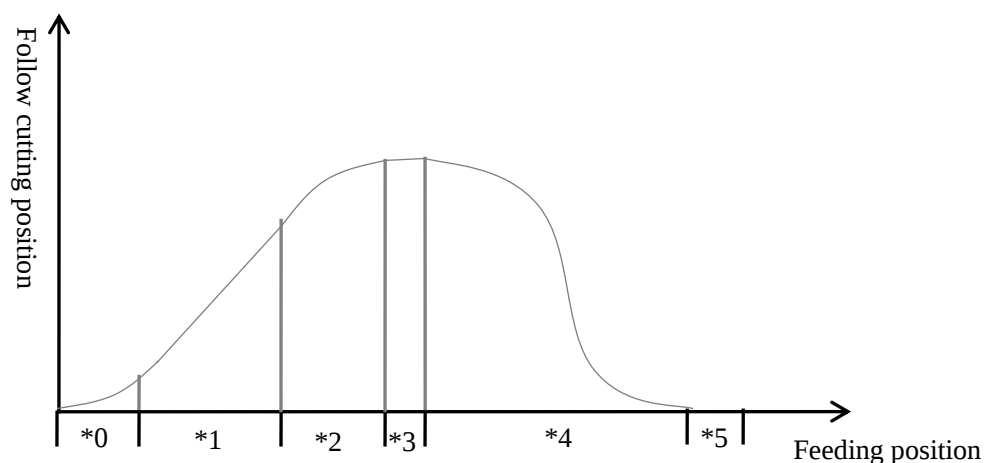


Figure 1.2 follow cutting curve

Curve distance (mm)	Concept
Acceleration distance (*0)	The acceleration distance before feeding synchronization
Synchronization distance (*1)	Feeding synchronization distance
Deceleration distance (*2)	Deceleration distance after synchronization
Direction switching distance (*3)	Direction switching waiting distance
Return distance (*4)	Returning distance (auto-calculation)
Waiting distance (*5)	Waiting distance after returning origin

Table 1.1 The follow cutting concept

The distance of the above table is relative to the feeding axis. The calculating formula is shown as below. The acceleration distance and deceleration distance will affect the stop and start stability of servo. The larger the distance, the more stable the stop and start.

Material length = acceleration + synchronization + deceleration + direction switching + returning + waiting

The synchronization distance is the distance required to cut the material. The calculating formula is shown as below. When the material length is short, as the above formula, set longer acceleration and deceleration distance will shorten the synchronization and returning distance. Because the cutting time is fixed. Finally, the follow cutting machine speed will decrease.

Synchronization distance = follow cutting max speed * cutting time

The direction switching distance provides time to direction switching and decreases the impact of directly direction switching. The returning distance is servo returning distance. The formula is shown as below:

Returning distance = material length - acceleration - synchronization - deceleration - direction switching - returning - waiting

1-2. Mechanical environment of follow cutting

CAM follow cutting function has requirements for mechanical environment.

1. It needs to install main axis position speed detection structure (include pressing roller and encoder). The encoder ppr depends on the follow cutting precision and cannot over CAM high speed counter max value 50KHz.
2. The slave axis needs to install origin and position limit. The origin is used to reset and back to zero. The position limit is used to protect the electric travel.
3. The encoder installation position cannot has vibration in feeding and cutting process (include slipping and mechanical vibration). If the mechanical vibration causes encoder vibration, the follow cutting and pressing roller will vibrate. This will produce serious resonance. This situation will occur when the encoder is installed near the cutting position. The vibration of feeding will affect the encoder especially in the process of follow cutting

direction switching and returning. The solution please refer to application and debug chapters.

1-3. Fly cutting summary

For pillow-style packing, wet wipes and fixed length cutting, the cutting axis needs to follow and synchronize the feeding axis, then smooth change the speed as the material length and enter the synchronization area again. The traditional mechanical cam synchronized the phase by adjusting the speed difference and mechanical phase. The mechanical cam structure is complex and hard to maintenance. If the cutting dimension is large, it needs to change the mechanical cam.

Flying cutting electronic cam real-time follows the main axis encoder feedback speed and position. When the material length is short, the main axis accelerates and decelerates then synchronizes again after fly cutting axis synchronization is completed. When the material length is long, the main axis decelerates and waits then accelerates to synchronization speed to follow the feeding. This has obvious advantage in adjusting material length, phase and maintenance. It has low requirments for mechanical structure.

Figure 1.3 is packing mechanical structure. The main axis is feeding film axis which connects encoder or servo encoder feedback directly. The slave axis is horizontal seal cutter which has a origin to confirm the cutter mechanical position.

The origin installation position must detect the signal when the cutter cuts the material.

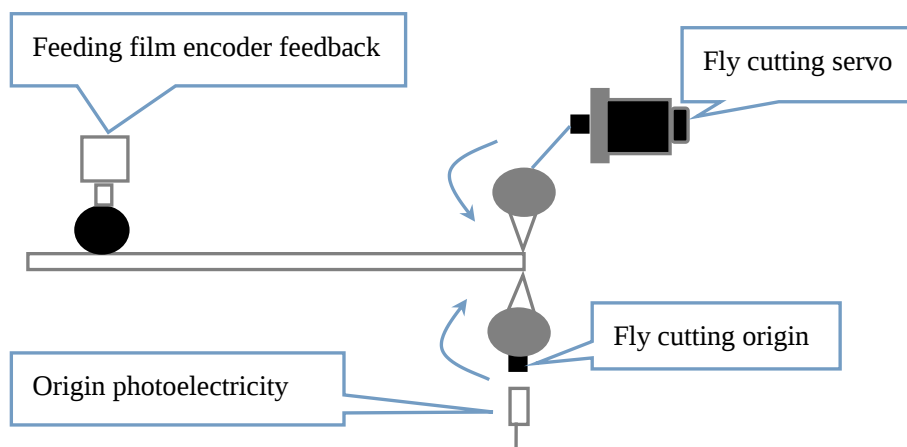


Fig 1.3 fly cutting structure

The fly cutting electronic cam will auto-produce fly cutting curve by setting the parameters including cutting length, cutter numbers, synchronization angle, etc. The fly cutting position curve is shown as below.

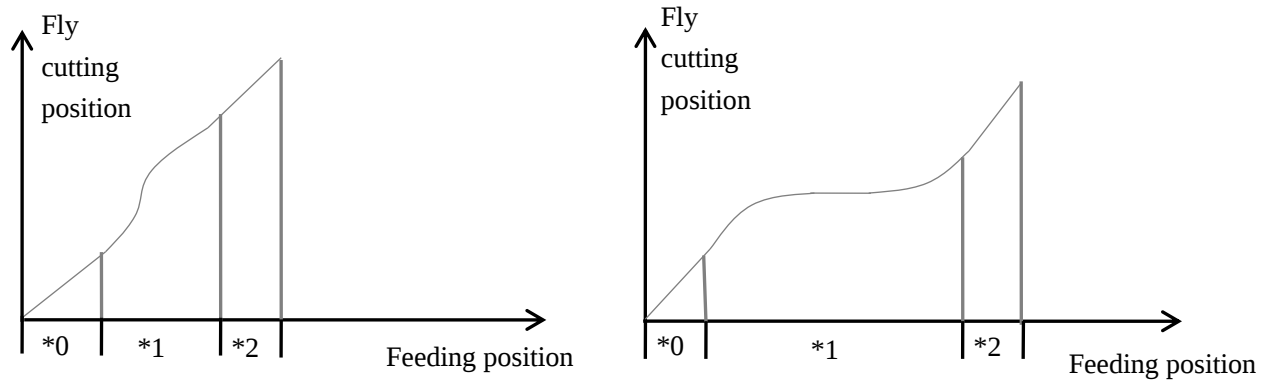


Fig 1.4 fly cutting cam curve

Fly cutting curve three segments concepts

Table 1.2 fly cutting curve concepts

Curve distance (mm)	Concepts
Synchronization area 1 (*0)	The synchronization distance when the cutter leaving the origin
Speed changing area (*1)	The transition curve from synchronization area 1 to 2. When the material length is short, the curve is like left one, the fly cutting axis acclerates then decelerates. When the material length is long, the curve is like right one, the fly cutting axis decelerates to stop then wait, at last accelerates.
Synchronization 2 (*2)	The synchronization distance near the origin

Cutter origin installation location is the position the cutter cut down. Both sides of origin are synchronization area 1 and 2.

The cutter passes the origin and enter synchronization area 1. It adjusts the speed according to the material length after the synchronization is completed. When the material length is long, the fly cutting axis decelerates to stop then wait, at last accelerates to synchronization speed. When the material length is short, the fly cutting axis acclerates then decelerates to synchronization speed. The axis will enter synchronization area 2 to cut the material after the speed adjusting, then return to synchronization area 1 to repeat the process.

1-4. Fly cutting mechanical environemnt

CAM fly cutting mechanical environment requirements:

1. The main axis feedbacks the feeding position and speed through the encoder structure.
2. The position that the origin can detect when the cutter cut the material is the main axis origin photoelectricity installtion location. Refer to figure 1.3.
3. The fly cutting origin can confirm the electric zero point, correct error and compensate.
If the resistance is too large when the cutter is cutting, the cutter force will be not

enough and blocked. There will be an instant overshoot cutting when the servo torque improves enough to cut off the material. This will cause an actual position deviation detected when passing through the origin. It can adjust the origin before the max resistance point to detect the deviation. But the synchronization area will have deviation following the origin position. It needs to enlarge the synchronization angle to ensure the cutting process.

1-5. User-defined CAM

Fly cutting and follow cutting are commonly used CAM, besides, there are many kinds of CAM. User-defined CAM can set the point position and curve parameters.

User-defined CAM needs to set the total point numbers, main axis pulse position of point, related slave axis pulse position, transition curve types.

For example, set the total point numbers to 3, the three-segment curves are (the format is [main axis position, slave axis position, curve type]) [1000,1000,3], [2000,1000,2], [3000,0,3].

When the main axis is from 0 to 1000, the slave axis accelerates to 1000 according to curve No.3. (sine S curve). When the main axis is from 1000 to 2000, the slave axis keeps still. When the main axis is from 2000 to 3000, the slave axis is from 1000 to 0 according to sine S curve. When the main axis keeps increasing, it starts next cycle. The position curve is shown as figure 1.5.

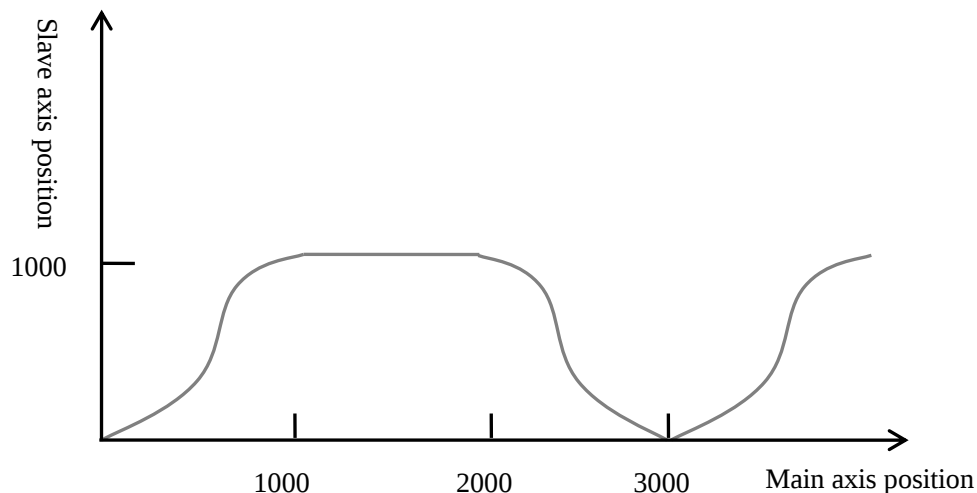


Figure 1.5 User-defined CAM

If the last point of slave axis is not 0, the main axis will make the the last point as starting zero position and restart the next cycle. For example, the total point numbers are 2, the two curves are [1000,1000,3], [2000,1000,2], when the main axis is over 2000, the slave axis will cycle the CAM curve based on 1000. The position curve is shown in figure 1.6.

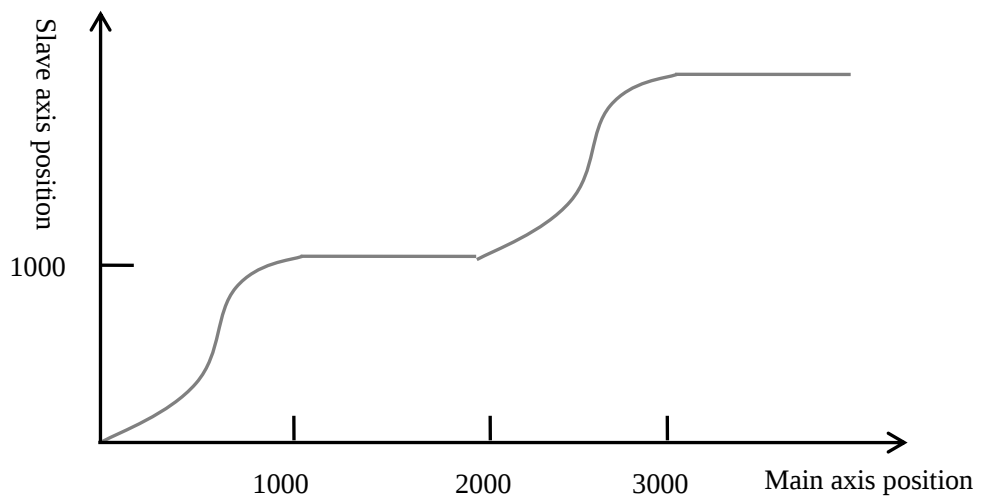


Figure 1.6 Incremental CAM curve

2. Instructions

2-1. Software introduction

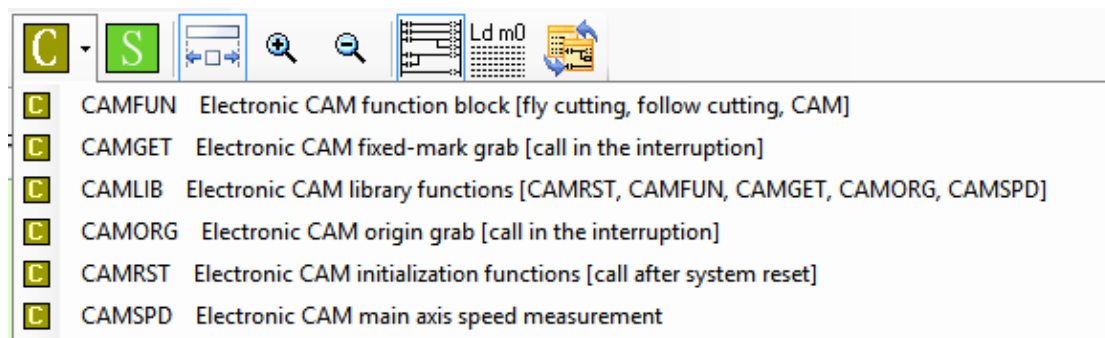
CAM instructions start with CAM, please see the following instruction list:

Instruction	Function	Instruction format	Chapter
CAMFUN	CAM binding	CAMFUN Addr_Para Addr_Flag	2-1
CAMRST	CAM initialization	CAMRST Addr_Para Addr_Flag	2-2
CAMORG	CAM origin grab	CAMORG Addr_Para Addr_Flag	2-3
CAMGET	CAM color mark capture	CAMGET Addr_Para Addr_Flag	2-4
CAMSPD	CAM speed measurement	CAMSPD Addr_Para Addr_Flag	2-5
CAMLIB	CAM motion control library	The motion control library needs to be added when calling the CAM function	2-6

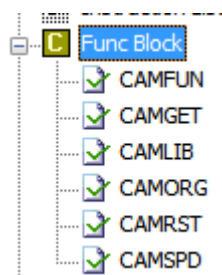
Note: Addr_Para and Addr_Flag parameters must be same for the same axis CAM instruction.

Software:

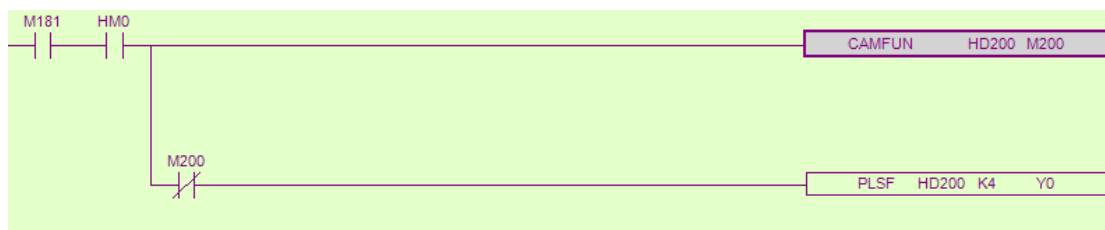
Install the latest XDPPRO software, click the C functions:



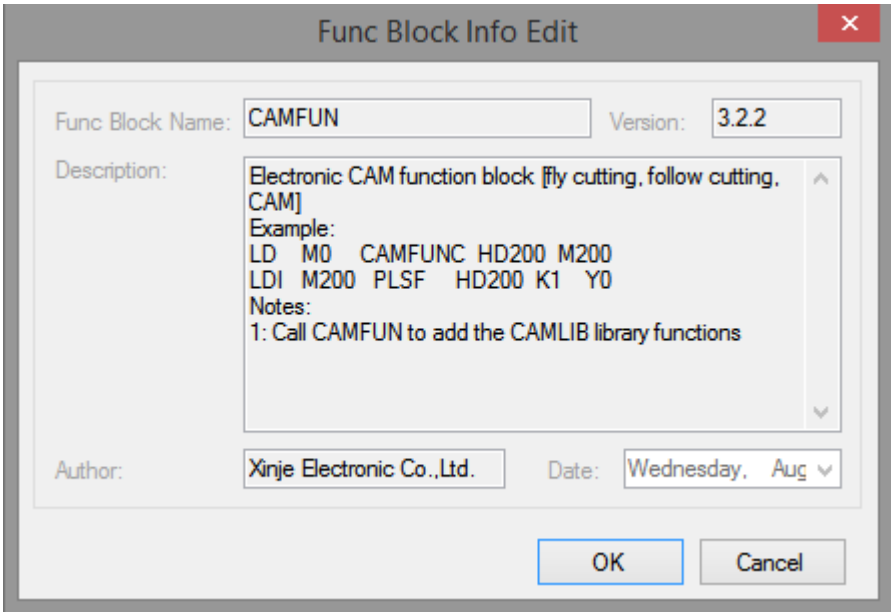
Add the CAM instruction to the function block:



It can call the CAM instruction after configuration.

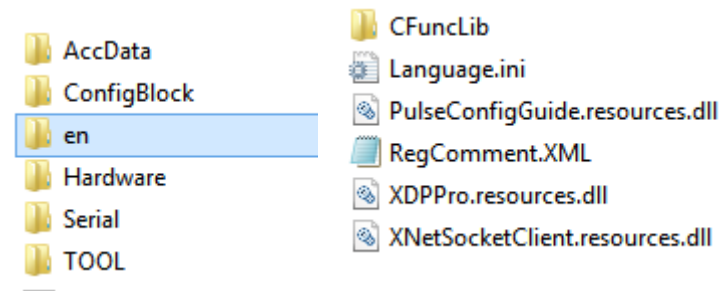


It can check the version of CAM instruction in the function block:



If it needs to update the CAM instruction, please do like this:

Open the XDPpro software installation folder, click en/CFuncLib



Add the CAM file in the CfuncLib folder.

Please note user-defined CAM needs hardware v3.1.0 and up.

2-2. CAM binding [CAMFUN]

1. Instruction summary

CAMFUN instruction can real-time calculate the main axis position, speed feedback, the slave axis following main axis speed.

CAM binding [CAMFUN]			
16-bit instruction		32-bit instruction	CAMFUN
Execution condition	Normally ON/OFF coil	Suitable model	CAM2, CAM4, MCP2, MCG2
Hardware	-	Software	-

2. Operands

Operand	Function	Type
S0	CAM configuration head address	
S1	CAM flag bit head address	

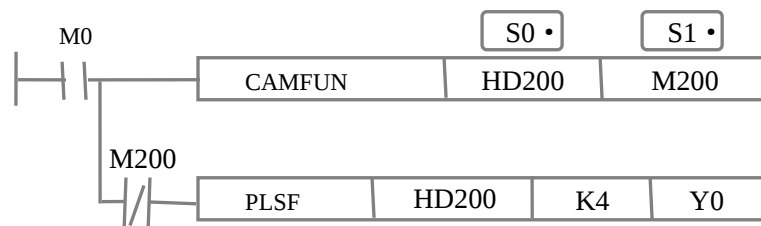
3. Suitable soft component

Word	Operand	System								Constant	Module	
		D*	FD	TD*	CD*	DX	DY	DM*	DS*	K/H	ND	QD
	S0	•										
	S1							•				

*Note: D means D HD; TD means TD HTD; CD means CD HCD HSCD HSD; DM means DM DHM; DS means DS DHS. M means M HM SM; S means S HS; T means T HT; C means C HC.

Function and action

Instruction format:



- When M0 is ON, it calls CAMFUN instruction, S0 is CAM configuration head address, it calculates the CAM frequency according to the configuration values starting from S0, the CAM frequency outputs to HD200. It calls PLSF instruction to control the CAM motion speed according to the CAM frequency. S1 is flag bit head address. If there is alarm, S1 head address M200 will be ON, it stops calling PLSF and CAM following.
-
- It needs to configure the parameters starting from S0 before calling CAM instruction, otherwise it will alarm, the configuration details please refer to chapter 3.
- It needs to call CAMRST to initialize the CAM before calling CAMFUN instruction, otherwise it will cause CAM alarm or CAM following error. The S0, S1 head address of CAMFUN and CAMRST must be same.
- It needs to add CAMLIB motion control library, otherwise the compiling will be error.
- S0+2 (HD202 in the example) is alarm code which can check the CAM error.
- CAM instruction occupies 400 registers starting from S0, and 400 registers starting from S1.
- PLSF instruction please refer to XD series PLC manual. Pulse default speed, acceleration and deceleration time of pulse default speed must be 0 for PLSF, otherwise the CAM motion will be error.

2-3. CAM initialization [CAMRST]

1. Instruction summary

CAMRST instruction can initialize the CAM after CAM reset, the configuration will become default value.

CAM initialization [CAMRST]			
16-bit instruction		32-bit instruction	CAMRST
Execution condition	Rising/falling edge	Suitable model	CAM2, CAM4, MCP2, MCG2
Hardware	-	Software	-

2. Operand

Operand	Function	Type
S0	CAM configuration head address	
S1	CAM flag bit head address	

3. Suitable soft component

Word	Operand	System								Constant	Module	
		D*	FD	TD*	CD*	DX	DY	DM*	DS*	K/H	ND	QD
	S0	•										
	S1							•				

*Note: D means D HD; TD means TD HTD; CD means CD HCD HSCD HSD; DM means DM DHM; DS means DS DHS. M means M HM SM; S means S HS; T means T HT; C means C HC.

Function and action

Instruction format:



- When the rising edge of M0 is coming, it calls CAMRST. It will initialize the CAM according to the configuration parameters starting from S0, delete the alarm state and configure the related registers.
- It needs to configure the parameters starting from S0 before calling CAM instruction,

otherwise it will alarm, the configuration details please refer to chapter 3.

- It needs to add CAMLIB motion control library, otherwise the compiling will be error.

2-4. CAM origin grab [CAMORG]

1. Instruction summary

For fly cutting CAM, CAMORG is called in fly cutting origin interruption program to grab the main axis position and compensate the close-loop.

CAM origin grab [CAMORG]			
16-bit instruction		32-bit instruction	CAMORG
Execution condition	Normally open/close coil in interruption	Suitable model	CAM2, CAM4, MCP2, MCG2
Hardware	-	Software	-

2. Operand

Operand	Function	Type
S0	CAM configuration head address	
S1	CAM flag bit head address	

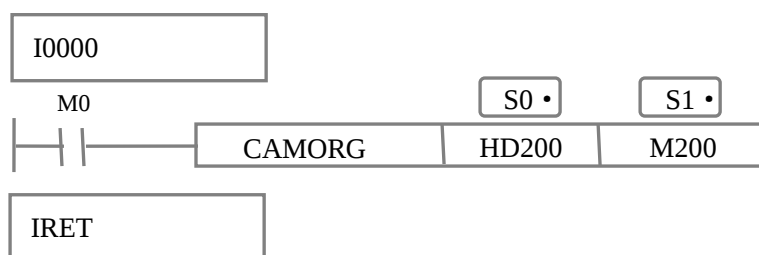
3. Suitable soft component

Word	Operand	System								Constant	Module	
		D*	FD	TD*	CD*	DX	DY	DM*	DS*	K/H	ND	QD
	S0	●										
	S1							●				

*Note: D means D HD; TD means TD HTD; CD means CD HCD HSCD HSD; DM means DM DHM; DS means DS DHS. M means M HM SM; S means S HS; T means T HT; C means C HC.

Function and action

Instruction format:



- CAMORG is fit for fly cutting CAM, it can detect the cut position deviation and compensate it.
- When M0 is ON, it calls CAMFUN, the fly cutting axis follows the main axis to do CAM action. When the fly cutting axis reaches the origin, it enters interruption I0000 to call CAMORG which will grab the origin and main axis position, and compensate the close-loop.
- The CAMORG head address of S0, S1 must be same to CAMFUN.
- It needs to configure the parameters starting from S0 before calling CAM instruction, otherwise it will alarm, the configuration details please refer to chapter 3.
- It needs to add CAMLIB motion control library, otherwise the compiling will be error.

2-5. Color mark grab [CAMGET]

1. Instruction summary

For fixed-mark follow cutting, fly cutting CAM application, CAMGET can grab the color mark position and compensate the position.

Color mark grab [CAMGET]			
16-bit instruction		32-bit instruction	CAMGET
Execution condition	Normally open/close coil in interruption	Suitable model	CAM2, CAM4, MCP2, MCG2
Hardware	-	Software	-

2. Operand

Operand	Function	Type
S0	CAM configuration head address	
S1	CAM flag bit head address	

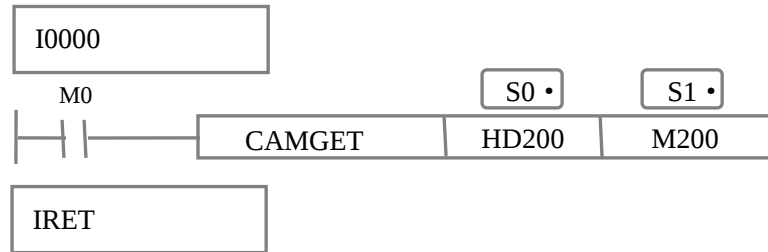
3. Suitable soft component

Word	Operand	System								Constant	Module	
		D*	FD	TD*	CD*	DX	DY	DM*	DS*	K/H	ND	QD
	S0	●										
	S1							●				

*Note: D means D HD; TD means TD HTD; CD means CD HCD HSCD HSD; DM means DM DHM; DS means DS DHS. M means M HM SM; S means S HS; T means T HT; C means C HC.

Function and action

Instruction format:



- CAMGET is fit for fixed-mark follow cutting, fly cutting CAM to grab the color mark position, ensure the cutting position no deviation for long time running, delete the accumulated error.
- When M0 is ON, it calls CAMFUN. It enters I0000 interruption and calls the CAMGET to record and compensate the color mark position when color sensor detects the signal in feeding process.
- The CAMGET head address of S0, S1 must be same to CAMFUN.
- It needs to configure the parameters starting from S0 before calling CAM instruction, otherwise it will alarm, the configuration details please refer to chapter 3.
- It needs to add CAMLIB motion control library, otherwise the compiling will be error.

2-6. CAM speed measurement [CAMSPD]

1. Instruction summary

Measure the main axis linear speed for fly cutting and follow cutting.

CAM speed measurement [CAMSPD]			
16-bit instruction		32-bit instruction	CAMSPD
Execution condition	Normally open/close coil in 50 ms timer interruption	Suitable model	CAM2, CAM4, MCP2, MCG2
Hardware	-	Software	-

2. Operand

Operand	Function	Type
S0	CAM configuration head address	
S1	CAM flag bit head address	

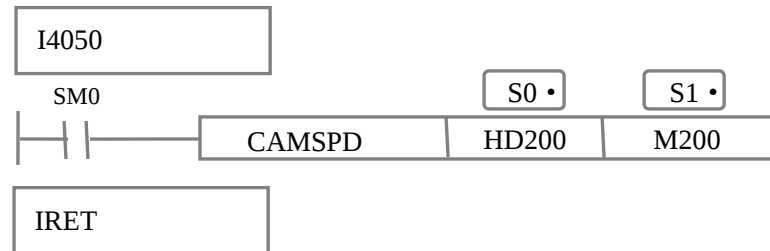
3. Suitable soft component

Word	Operand	System								Constant	Module	
		D*	FD	TD*	CD*	DX	DY	DM*	DS*	K/H	ND	QD
	S0	•										
	S1							•				

*Note: D means D HD; TD means TD HTD; CD means CD HCD HSCD HSD; DM means DM DHM; DS means DS DHS. M means M HM SM; S means S HS; T means T HT; C means C HC.

Function and action

Instruction format:



- CAMSPD can measure the main axis linear speed (meter/minute) and store the value in S0+12 (double word floating number).
- CAMSPD must be called in 50ms timer interruption, otherwise the measured value will be not reliable.
- The CAMSPD head address of S0, S1 must be same to CAMFUN.
- It needs to configure the parameters starting from S0 before calling CAM instruction, otherwise it will alarm, the configuration details please refer to chapter 3.
- It needs to add CAMLIB motion control library, otherwise the compiling will be error.

2-7. Motion control library [CAMLIB]

1. Instruction summary

The library functions which need to be contained when calling the CAM series instructions.

Motion control library [CAMLIB]			
16-bit instruction		32-bit instruction	CAMLIB
Execution condition	Cannot be called	Suitable model	CAM2, CAM4, MCP2, MCG2
Hardware	-	Software	-

- CAMLIB is system library functions, cannot be called.
- It needs to add CAMLIB library functions when calling CAM series instructions, otherwise the downloading and compiling will be error. The CAM instructions include CAMFUN, CAMRST, CAMORG, CAMGET, CAMSPD.
- CAM series instructions occupy 400 registers starting from S0 and 400 registers starting from S1. Please pay attention to the address assignment.

3. System settings

It needs to configure the registers starting from CAM function block head address S0 before calling the CAM instructions, otherwise there will be error alarm.

CAM instruction uses 400 registers starting from head address S0, and 400 registers starting from head address S1. Please pay attention to the address assignment.

3-1. S0 parameters (CAM parameters)

Type declaration:

- INT32S is 32-bit integer, FP32 is 32-bit floating number
- R is read only, W is write only, RW is read and write

CAM instruction S0 parameter table

Address	Contents	Type	Unit	Notes
S0 + 0	CAM frequency	INT32S / R	HZ	CAM current output frequency, to use with PLSF
S0 + 2	CAM state	INT32S / R		CAM state, please see CAM state table
S0 + 4	CAM current step no.	INT32S / R		CAM current running segment no.
S0 + 6	CAM pulse deviation	INT32S / R	Pulse	When the pulse deviation is over S0+80 (aerodyne pulse limit), it produces aerodyne alarm
S0 + 8	CAM feedforward pulse	INT32S / R	Pulse	the lagging pulse of main axis lead compensation
S0 + 10	CAM slave axis current position	FP32 / R	mm /degree	● Follow cutting CAM is current leading screw position (mm) ● Fly cutting CAM is current rotating angle (it is 0 degree when touching the origin, increase as cutter rotation direction)
S0 + 12	CAM main axis linear speed	FP32 / R	meter/minute	Call CAMSPD in 50ms timer interruption
S0 + 14	CAM main axis theoretical max line speed	FP32 / R	meter/minute	● Call CAMRST or CAMFUN to calculate this value ● It needs to set cutting time and leading screw movable trip to calculate

				the follow cutting CAM
S0 + 20	Main axis no.	INT32S / W	-?~ -1 1 ~ ?	● Negative number means the binding one is high speed counter, positive number means the binding one is pulse axis current position ● -1 means high speed count 0, -2 means high speed count 1, and so on. 1 means Y0 axis, 2 means Y1 axis, 9 means Y10 axis, and so on. ● The value range is based on the high speed counter number of different CAM model
S0 + 22	Slave axis no.	INT32S / W	1-?	● 1 means Y0 axis, 2 means Y1 axis, 9 means Y10 axis ● The value range is based on the pulse axis numbers of different CAM model
S0 + 24	CAM type	INT32S / W	0/1	● 0: follow cutting CAM curve ● 1: fly cutting CAM curve ● 10: user-defined CAM
S0 + 26	CAM mode	INT32S / W	0/1	● 0: fixed length mode (follow/fly cutting) ● 1: fixed mark mode (follow/fly cutting)
S0 + 40	main axis rated speed	INT32S / W	rpm	main axis rated speed
S0 + 42	Main axis pulse numbers per circle	INT32S / W	pulse	Encoder lines needs to mutiply by PLC high speed count frequency times, CAM default is 4 times frequency.
S0 + 44	Main axis reduction ratio	FP32 / W		Final detection device rotates one circle/encoder rotating circles. Please set to 1 if the final detection device connects to encoder. Please

				set to servo reduction ratio if it passes through the servo feedback.
S0 + 46	Main axis moved distance per circle	FP32 / W	mm	The moving distance main axis detection device encoder rotating one circle, the round roller is its perimeter
S0 + 60	Slave axis rated speed	INT32S / W	rpm	See the servo label, for CAM frequency limit
S0 + 62	Slave axis pulse number per circle	INT32S / W	pulse	Servo pulse number per circle, convert through electronic gear ratio
S0 + 64	Slave axis reduction ratio	FP32 / W		The final motion axis rotates one circle, servo rotating circles are slave axis reduction ratio
S0 + 66	Slave axis moving distance per circle	FP32 / W	mm	● The load is leading screw, it is screw pitch ● The load is cutter, it is cutter perimeter
S0 + 80	Aerodyne pulse limit	INT32S / W	pulse (500 ~100000)	● The CAM will stop working and alarm when the difference between slave axis setting position and actual position is larger than aerodyne pulse limit ● Increase this value appropriately if it has aerodyne error when fast running
S0 + 82	Allowable over speed increment	INT32S / W	rpm (0~500)	CAM speed internal limit is rated speed + allowable over speed increment
S0 + 84	Position loop gain	INT32S / W	(100 ~1000)	CAM position corresponding speed, if there is lagging please set it larger, but setting too large will cause overshoot and oscillation.
S0 + 86	Speed loop feedforward gain	INT32S / W	(0 ~10000)	It can increase this value if there is servo response lagging, but setting too large will cause oscillation and instable

S0 + 88	Phase compensation speed		FP32 / W	(0.1~1)	Detection deviation servo compensation speed
S0+24=0 Follow cutting curve	S0 + 100	Cutting length	FP32 / W	mm	● It is setting cutting length for fixed length follow cutting ● It is the shortest material length for fixed mark follow cutting
	S0 + 102	Cutting phase	FP32 / W	mm	● Control the cutting position in fixed mark mode, the larger the phase, the later the cutting position ● Phase adjustment range (-material length, +material length)
	S0 + 104	Color mark protection distance	FP32 / W	mm	● When it detected the color mark again, the color mark is effective when material feeding distance > material length – color mark protection distance, otherwise it is recognized as error signal ● If the distance is less than 5, it will not judge whether it is error signal
	S0 + 120	Acceleration distance	FP32 / W	mm	Follow cutting acceleration area distance, the longer the distance, the more stable the acceleration is. Please set it to about 50mm
	S0 + 122	Synchronization distance	FP32 / W	mm	The synchronization distance that the follow cutting follows the main axis
	S0 + 124	Deceleration distance	FP32 / W	mm	Follow cutting deceleration area distance, the longer the distance, the more stable the deceleration is. Please set it to about 50mm
	S0 + 126	Direction changing distance	FP32 / W	mm	The waiting distance before deceleration completion and

					returning, for direction changing buffer and delay, please set to about 10mm
	S0 + 128	Return distance	FP32 / R	mm	Follow cutting return distance after follow cutting synchronization completion, no need to set
	S0 + 130	Waiting distance	FP32 / W	mm	Waiting distance after follow cutting return, for after returning buffer and follow cutting phase adjustment, please set to about 20mm
	S0 + 132	Leading screw trip	FP32 / W	mm	Follow cutting leading screw moving trip, get it from measurement
	S0 + 134	Cutting time	INT32S / W	mm	The time from cutter falling down, cutting and rising up, get it from measurement, please set to 1000ms for hydraulic pressure cutting
	S0 + 136	Mesh pulse limit	INT32S / W	Pulse numbers	When the color mark reached next cutting position in fixed mark mode, if the follow cutting present position is less than mesh pulse limit, it follows the material feeding mesh, otherwise it wait next mark position to mesh. It no needs to set for fixed length mode
	S0 + 138	Cutter thickness	FP32 /W	mm	Cutter thickness, please set to 0 if the cutting material has no waste
	S0 + 150	Cutter length	FP32 / W	mm	The actual measured cutter length, it will calculate the main axis moving distance per circle as this value and save in S0+152
	S0 + 152	Actual main axis moving distance per circle	FP32 / R	mm	Actual main axis moving distance per circle after corrected. This value can be set in S0+46 (main axis moving distance per circle) to correct the cutting length

	S0 + 154	Color mark interference times	INT32 / R	times	The counting times that CAMGET instruction detects the color mark position outside the color mark protection distance S0+104 in fixed mark mode
	S0 + 180	Optimal synchronization distance	FP32 /R	mm	After setting leading screw moving trip S0+132 and cutting time S0+134, call the instuction CAMRST or CAMFUN to calculate the optimal synchronization distance according to follow cutting theoretical max line speed and cutting time
S0+24=1 Fly cutting curve	S0 + 100	Cutting length	FP32 / W	mm	Set the cutting length
	S0 + 102	Cutting phase	FP32 / W	mm	● Relative color mark cutting position, the larger the phase, the later the cutting position ● Phase adjustment range (-material length, +material length)
	S0 + 104	Color protection distance	FP32 / W	mm	● When it detects the color mark again based on detecting color mark at the first time, only when “material feeding distance>material length-color mark protection distance”, the color mark is effective, otherwise it is a error signal ● It will not judge the signal when the distance is less than 5
	S0 + 120	Synchronization angle	FP32 / W	degree	Cutter synchronization angle
	S0 + 122	Compensate range	FP32 / W	mm	It will compensate when the detected deviation is less than compensate range
	S0 +	Cutter numbers	INT32S	numbers	Fly cutter numbers

	134		/ W		
	S0 + 136	The cutter times to detect once	INT32S / W	times	If it rotates the cutter one times, it detect the origin signal once, please set to 1, if it rotates the cutter two times, it detect the origin signal once, please set to 2
	S0 + 150	Measured cutting length	FP32 / W	mm	After setting the actual measured length, it will calculate the modified main axis moving distance per circle and save in S0+152
	S0 + 152	Actual main axis moving distance per circle	FP32 / R	mm	Modified actual main axis moving distance per circle
	S0 + 154	Color mark interference times	INT32 / R	times	The counting times that the color mark position CAMGET detected is outside the color mark protection distance (S0+104) in fixed mark mode
S0+24=10 User-defined CAM	S0+100	CAM total segment numbers	INT32S / W	Segment numbers	Total CAM segment numbers
	S0+110	CAM phase	INT32S / W	Pulse numbers	Transverse offset of slave axis relative to the main axis position
	S0+120 + N*10 +0	Main axis position	INT32S / W	Pulse numbers	Point N main axis absolute position (N starts from 0)
	S0+120 + N*10 +2	Slave axis position	INT32S / W	Pulse numbers	Point N slave axis absolute position (N starts from 0)
	S0+120 + N*10 +4	Curve types	INT32S / W	0~3	0: smooth curve 0 1: smooth curve 1 2: uniform curve 3: sine S curve
	S0+120 + N*10 +6	Curve parameter 1	FP32 / W		- While the curve type is 0 or 1, it is the starting slope of point N - No need set for curve 2 and 3
	S0+120 + N*10	Curve parameter 2	FP32 / W		While the curve type is 0 or 1, it is the ending

	+8				slope of point N ● No need set for curve 2 and 3
--	----	--	--	--	---

3-2. S1 parameters list (CAM flag bit)

CAM instruction S1 parameters list

Address	Contents	Notes
S1 + 0	CAM alarm	If “S0+2” has alarm, set ON “S1+0”
S1 + 1	CAM synchronization area flag	Follow cutting, fly cutting synchronization area flag, refer to figure 1-2, 1-4
S1 + 2	Main axis static flag	When main axis is static, set on the flag, otherwise it is OFF, this flag can be used to unbundle the slave axis
S1 + 20	Over speed flag	● main axis speed over theory max speed flag for follow cutting, fly cutting ● call the speed measurement instruction CAMSPD in 50ms timer interruption ● it needs to set the leading screw and cutting time for calculating follow cutting theory max speed
S1 + 100	CAM runs to step 0 flag	Set on the flag when “S0+4” is 0
S1 + 101	CAM runs to step 1 flag	Set on the flag when “S0+4” is 1
S1 + 10*	CAM runs to step * flag	● set on the flag when “S0+4” is * ● follow cutting step number range is 0-6 ● fly cutting step number range is 0-2 ● the step number meaning please refer to figure 1.2 and 1.4

4. Application

This chapter includes the debugging steps of follow cutting and fly cutting, CAM instruction applications and field debugging experience.

4-1. Follow cutting applicatoin and debugging

Debugging steps:

1. Check the PLC model, servo model.
2. check the wiring of follow cutting system.
3. configure the pulse parameters including pulse type (configured as pulse numbers), pulse direction terminal and direction delay time, please refer to appendix for details.
4. do the follow cutting servo manual pulse program (PLSF), make sure the follow cutting sliding table direction is feeding material direction when the setting frequency is positive and the direction is reverse when the setting frequency is negative. If the direction is not right, please adjust the servo direction.
5. Do the high speed counting program, manual rotate the feeding roller according to the feeding direction, monitor the high speed counting register HSCD value, if it is increasing, that is ok. If it is decreasing, please switch the AB phase of high speed counter.
6. configure the CAM parameters, set the cutting length and related motion parameters.
7. make the follow cutting reset program. It can call the ZRN instruction to return the origin point, and clear the follow cutting axis current position, call the CAMRST to initialize the CAM. Please refer to the appendix for the pulse axis current position. ZRN instruction please refer to XD series PLC manual.
8. the follow cutting axis binds the feeding axis through CAMFUN instruction after resetting. Start the feeding axis, check whether the follow cutting axis speed following the feeding axis, if they are near each other, test the material in the cutting structure. Do not test the material when the speed is not near each other, it will damage the mechanical structure. It needs to check the parameters, such as the moving distance per circle of main axis.
9. the cutting length and setting length maybe different after material testing. The reason is the measured main axis roller dimension is different from actual dimension. It needs to correct the moving distance per circle of main axis. Store the actual dimension in S0+150 (double words float number), call the CAMFUN or CAMRST to store the corrected moving distance per circle of main axis in S0+152 (double words float number).

Applications:

1. the main axis moving distance per circle, slave axis moving distance per circle, cutting phase, cutting length, aceleration area, synchronization area, deceleration area, waiting area can be modified in binding process. The cutting length cannot set too small, otherwise it will alarm. The modification of these parmaeters will be effective after one follow cutting period.
2. The cutting flag can be triggered by follow cutting synchronization area flag (S1+1), the counting can be triggered by synchronization area falling edge of pulse.

Notes:

1. Please set the parameters starting from S0 before calling CAM instructions, otherwise it will alarm.
2. The S0 and S1 head address of same CAM instruction must be same.
3. The follow cutting sliding table lead screw must be reset before the following cutting system running. The reset is completed when it reached origin position. It needs to clear the present axis pulse counting value after reset and call CAMRST to initialize the CAM. Please refer to appendix for present axis pulse counting.
4. Call CAMRST to initialize before calling CAMFUNC, otherwise it will alarm.
5. If the follow-cutting direction-changing return vibration caused the encoder feedback vibration and effected the follow-cutting following vibration and finally caused the resonance, please set the direction changing area larger, stop CAMFUN and PLSF pulse output by rising edge flag of direction changing area, unbundling the feeding material and follow cutting, then return to origin by PLSR absolute position instruction, binding the CAMFUN again after backing to origin and call PLSF which can avoid the effect of follow-cutting direction changing vibration on the follow cutting. Refer to XD programming manual for PLSR absolute position instruction. It needs 10ms delay for PLSF and PLSR switching.

4-2. Fly cutting application and debugging

Debugging steps:

1. Check the PLC model, servo model.
2. Check the fly cutting system wiring.
3. Configure the pulse parameters, including pulse types, pulse direction terminal and delay time. The acceleration and deceleration time must set to 0 in pulse public parameters. Refer to appendix for configuration register details.
4. Make the fly cutting servo manual pulse program (PLSF), make sure the fly cutting direction is same to feeding material direction when setting the positive frequency, and the fly cutting direction is reverse when setting the negative frequency. Please adjust the servo direction if the direction is error.
5. Make the high speed counting program, rotate the main axis feedback as the feeding material direction by manual, monitor the related high speed counter (HSCD), if the value is decreasing, please switch the AB phase of high speed counter.
6. Configure the CAM parameters according to the CAM system, set the cutting length and running parameters.
7. Make fly cutting reset program which is used to find the fly cutting axis origin. It needs to reset the present position(HSD) when fly cutting reaches origin and call CAMRST to initialize the CAM. Refer to appendix for pulse present position.
8. Binding the fly cutting axis with feeding axis by CAMFUN instruction after resetting, startup the feeding axis, the fly cutting will wait for the suitable feeding position to mesh the CAM, then the fly cutting and feeding axis can synchronized cutting.
9. the cutting length and setting length maybe different after material testing. The reason is

the measured main axis roller dimension is different from actual dimension. It needs to correct the moving distance per circle of main axis. Store the actual dimension in S0+150 (double words float number), call the CAMFUN or CAMRST to store the corrected moving distance per circle of main axis in S0+152 (double words float number).

10. The fly cutting process will have asynchronous problem. The reason is fly cutting axis perimeter is different from actual dimension. It can adjust the two axis's synchronization by changing the slave axis moving distance per circle. Such as packing fly cutting, pull the film to enlarge the moving distance per circle of slave axis, block the film to narrow the moving distance per circle of slave axis.

Application introduction:

1. It can change the moving distance per circle of main axis or slave axis in binding process, and cutting phase, cutting length, synchronization angle, etc. please do not set the cutting length too small, otherwise it will alarm. These changes will be completed when fly cutting passes the origin.
2. It can count according to the fly cutting synchronization area flag (S1+1) falling edge.

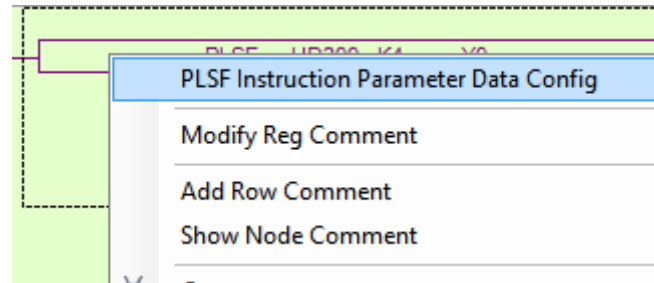
Notes:

1. Please set the parameters starting from S0 before calling CAM instructions, otherwise it will alarm.
2. The S0 and S1 head address of same CAM instruction must be same.
3. It needs to reset the fly cutting axis before running the fly cutting system. The reset position depends on the actual conditions. It needs to clear the present axis pulse counting value (HSD) if it touches the fly cutting axis origin when resetting and call CAMRST to initialize the CAM. Refer to appendix for present axis pulse counting value.
4. Call CAMRST to initialize before calling CAMFUNC, otherwise it will alarm.
5. The moving distance per circle of main axis (roller perimeter) will affect the setting length and actual cutting length. The slave axis perimeter will affect the synchronization.
6. In the condition of several cutters, if the detecting time is 1 for each cutting of cutter which means it will detect the origin condition once when the cutter rotates once, and the cutter detection is realized by equal mechanical block, it needs to care the equal division angle of block, mechanical installation position and whether the block shape will cause position difference when the origin signal is detected everytime. If the signal is different, the fly cutting CAM internal compensation position will produce periodic deviation. The typical condition is while cutting the fixed-length material, one is long and the other is short but the total length is fixed. It is recommended to make the mechanical transmission ratio connected with machine same to cutter numbers, thus can ensure the detected origin position is same everytime.

4-3. Case analysis of fly cutting and follow cutting

It requires basic programming knowledge to use electronic CAM. The following example explains how to use CAM. It needs to configure related registers before calling CAM instructions. Pulse related registers need to be configured at first.

Right click the PLSF instruction to configure the parameters.



Click the config button in the following window:

A screenshot of the "variable frequency output" configuration window. It contains several input fields: "Pulse frequency address" (HD200), "System params" (K4), "Output" (Y0), and "Pulse frequency(HZ)" (0). A "Config" button is circled in red. At the bottom, there are buttons for "Read From PLC", "Write To PLC", "OK", and "Cancel".

Set the pulse unit to pulse number, set the pulse direction terminal, pulse direction delay time.

A screenshot of the "PLC1 - Pulse Set" configuration window. It features a table with parameters and their values. The parameters include pulse direction logic, soft limit, mechanical back to, pulse unit, interpolation coordinate, send mode, pulse number, offset, direction terminal, delayed time, and gear clearance compensation. The "pulse unit" is set to "pulse number". At the bottom, there are buttons for "Read From PLC", "Write To PLC", "OK", and "Cancel".

Param	Value
Y0 axis-Common-Parameters setting-Pulse direction logic	positive logic
Y0 axis-Common-Parameters setting-enable soft limit	disable
Y0 axis-Common-Parameters setting-mechanical back to...	negative
Y0 axis-Common-Parameters setting-Pulse unit	pulse number
Y0 axis-Common-Parameters setting-Interpolation coord...	Cross coordi...
Y0 axis-Common-pulse send mode	complete
Y0 axis-Common-Pulse num (1)	1
Y0 axis-Common-Offset (1)	1
Y0 axis-Common-Pulse direction terminal	Y5
Y0 axis-Common-Delayed time of pulse direction (ms)	1
Y0 axis-Common-Gear clearance positive compensation	0

Set the No. 4 group of parameters, (as here used PLSF HD200 **K4** Y0), set the pulse default speed, acceleration time and deceleration time of pulse default speed to 0.

The screenshot shows the 'PLC1 - Pulse Set' dialog box with the 'Config' tab selected. The 'init axis' button is highlighted. The table below lists the parameters for Y0 axis-group 4.

Param	Value
Y0 axis-group 3-FOLLOW forward compensation(0-100)	0
Y0 axis-group 4-Pulse default speed	0
Y0 axis-group 4-Acceleration time of Pulse default s...	0
Y0 axis-group 4-Deceleration time of pulse default s...	0
Y0 axis-group 4-Acceleration and deceleration time (ms)	0
Y0 axis-group 4-pulse acc/dec mode	linear acc/dec
Y0 axis-group 4-Max speed	0
Y0 axis-group 4-Initial speed	0
Y0 axis-group 4-stop speed	0
Y0 axis-group 4-FOLLOW performance param(1-100)	50
Y0 axis-group 4-FOLLOW forward compensation(0-100)	0

Buttons at the bottom: Read From PLC, Write To PLC, OK, Cancel.

It needs to configure the signal terminal switch state if using ZRN instruction to reset. Refer to XD programming manual ZRN instruction for details of setting.

The screenshot shows the 'PLC1 - Pulse Set' dialog box with the 'Config' tab selected. The 'init axis' button is highlighted. The table below lists the signal terminal switch state settings for Y0 axis-Common.

Param	Value
Y0 axis-Common-signal terminal switch state setting...	normally on
Y0 axis-Common-signal terminal switch state setting...	normally on
Y0 axis-Common-signal terminal switch state setting...	normally on
Y0 axis-Common-signal terminal switch state setting...	normally on
Y0 axis-Common-Far-point signal terminal setting	X5
Y0 axis-Common-Z phase terminal setting	X no terminal
Y0 axis-Common-positive limit terminal setting	X7
Y0 axis-Common-negative limit terminal setting	X6
Y0 axis-Common-Zero clear CLR output setting	Y no terminal
Y0 axis-Common-Return speed VH	10000
Y0 axis-Common-Creeping speed VC	1000

Buttons at the bottom: Read From PLC, Write To PLC, OK, Cancel.

PLC1 - Pulse Set

Config ▾ Delete | init axis | config guide

Param	Value
Y0 axis-Common-Far-point signal terminal setting	X5
Y0 axis-Common-Z phase terminal setting	X no terminal
Y0 axis-Common-positive limit terminal setting	X7
Y0 axis-Common-negative limit terminal setting	X6
Y0 axis-Common-Zero clear CLR output setting	Y no terminal
Y0 axis-Common-Return speed VH	10000
Y0 axis-Common-Creeping speed VC	1000
Y0 axis-Common-Mechanical zero position	0
Y0 axis-Common-Z phase num	0
Y0 axis-Common-CLR signal delayed time (ms)	20
Y0 axis-Common-grinding wheel radius(polar)	0

Read From PLC Write To PLC OK Cancel

Click write to PLC to write the parameters in the PLC registers.

Then it needs to configure the CAM parameters starting from S0.

In the following example, the follow cutting main axis high speed counter is 0, follow cutting axis is Y0, S0 head address is HD200, S1 head address is M200, fly cutting main axis high speed counter is 1, fly cutting axis is Y1, S0 head address is HD600, S1 head address is M600.

Notes: DHD means HD double words integer value, FHD means HD floating numbers.

The configurations of public parameters of follow cutting:

Configuration parameters:

- DHD[220] = -1 ; // main axis no. (high speed counter 0, wiring terminal is X0, X1)
- DHD[222] = 1 ; //slave axis no. (Y0)
- DHD[224] = 0 ; //CAM types (0: follow cutting CAM, 1: fly cutting CAM)
- DHD[226] = 0 ; //CAM mode (0: fixed length 1: fixed mark)

Main axis parameters:

- DHD[240] = 3000 ; //main axis rated speed (no need to set)
- DHD[242] = 4096 ; //main axis pulse number per circle (supposed the main axis encoder is 1024 lines, after AB phase 4 times frequency high speed counting, it is $1024 \times 4 = 4096$)
- FHD[244] = 1 ; //main axis reduction ratio (set to 1 for roller connecting to encoder directly)
- FHD[246] = 314 ; //main axis moving distance per circle (supposed the roller diameter is 100ms, perimeter is 314)

Slave axis parameters:

- DHD[260] = 3000 ; //slave axis rated speed
- DHD[262] = 2500 ; //slave axis pulse number per circle (as the CAM pulse max output frequency is 200KHz, it recommends to set the servo pulse per circle to 2500)
- FHD[264] = 1 ; //slave axis reduction ratio (supposed the servo connecting the lead screw directly)
- FHD[266] = 20 ; //slave axis moving distance per circle (supposed the lead screw pitch is 20)

Performance parameters:

- DHD[280] = 2000 ; //speed pulse (it will alarm when pulse deviation is over 2000)
- DHD[282] = 100 ; //permissible overspeed range (rated speed permissible overspeed 100 rpm)
- DHD[284] = 500 ; //position loop gain (appropriate increase the tracking response while it is slow, the max is 1000, set it too large will cause shock or overshoot)
- DHD[286] = 0 ; //feedforward gain (not use feedforward)
- FHD[688] = 0.5 ; //compensation speed (fly cutting needs to set it, follow cutting no need, the larger the value, the faster the compensation, too large value will cause shocks)

Follow cutting CAM parameters:

- FHD[300] = 1000 ; //cutting material length (1000mm)
- FHD[302] = 0 ; //cutting point phase (set it in fixed mark mode, the larger the value, the later the cutting point)
- FHD[304] = 30 ; //color mark detection range (the color mark is effective while it appears over 1000-30)
- FHD[320] = 50 ; //acceleration distance (50mm)
- FHD[322] = 200 ; //synchronization distance (200mm)
- FHD[324] = 50 ; //deceleration distance (50mm)
- FHD[326] = 20 ; //direction changing distance (20mm)
- FHD[328] = no need to set ; //return (automatically calculated)
- FHD[330] = 20 ; //waiting distance (20mm)
- FHD[332] = 500 ; //screw stroke (500mm, get from local measurement)
- DHD[334] = 1000 ; //cutting time (1000ms, get from actual measurement)
- DHD[336] = 100 ; //meshing pulse (100 pulses, need to set in fixed mark mode)
- FHD[338] = 0 ; //cutter thickness (0 means the cutting has no waste material)

Fly cutting CAM parameters:

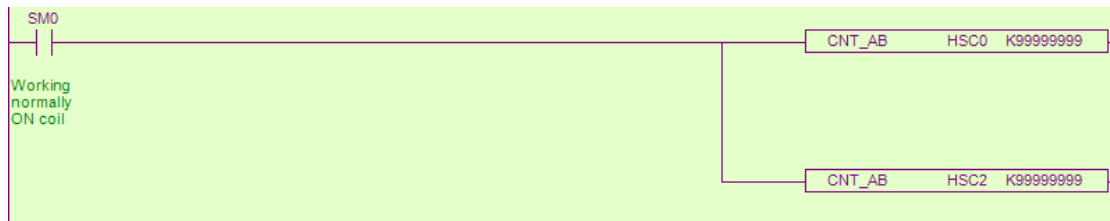
- FHD[700] = 1000 ; //cutting material length (1000mm)
- FHD[702] = 0 ; //cutting point phase (set in fixed mark mode, the larger

the value, the later the cutting point)

- FHD[704] = 30 ; //color detection range (the color mark is effective while it appears after 1000-30)
- FHD[720] = 60 ; //synchronization angle (60 degree)
- FHD[722] = 2; //compensation shortest range (it compensates while the error is over 2mm)
- DHD[734] = 1; //cutter numbers (1 cutter)
- DHD[736] = 1; //how many cutters to detect once (detect origin once every one cutter)

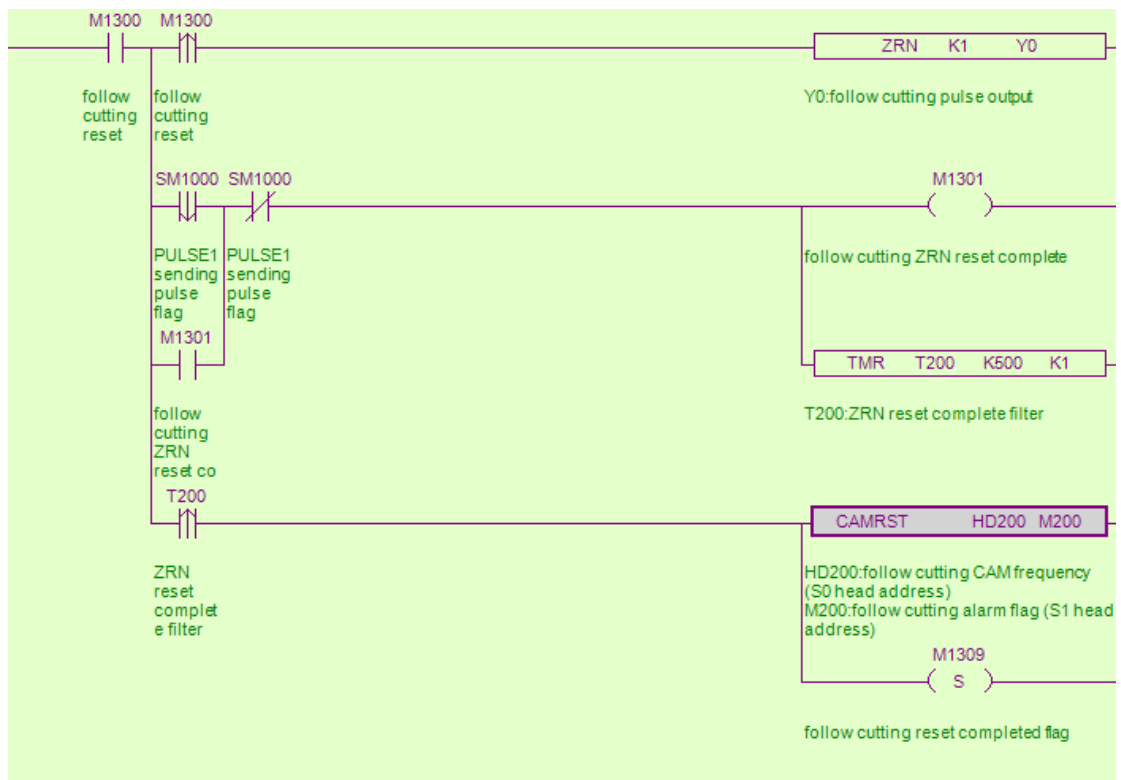
Please use CAM instruction to do CAM operation. The following example will introduce the method of application.

CNT_AB is high speed counting instruction. HSC0 corresponds to X0, X1 terminal, HSC2 corresponds to X3, X4 terminal. Refer to appendix for details.

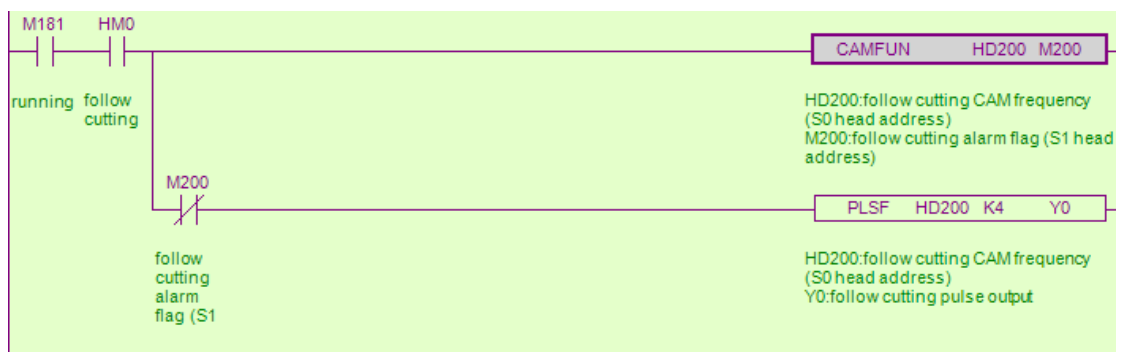


ZRN instruction is used to reset the follow cutting, then CAMRST instructin will initialize the CAM. When setting on M1300, the rising edge of M1300 will trigger ZRN instruction to reset. The pulse sending flag of Y0 SM1000 can judge whether the reset is completed. Then the timer T200 delay 500ms to filter, and CAMRST will initialize the CAM.

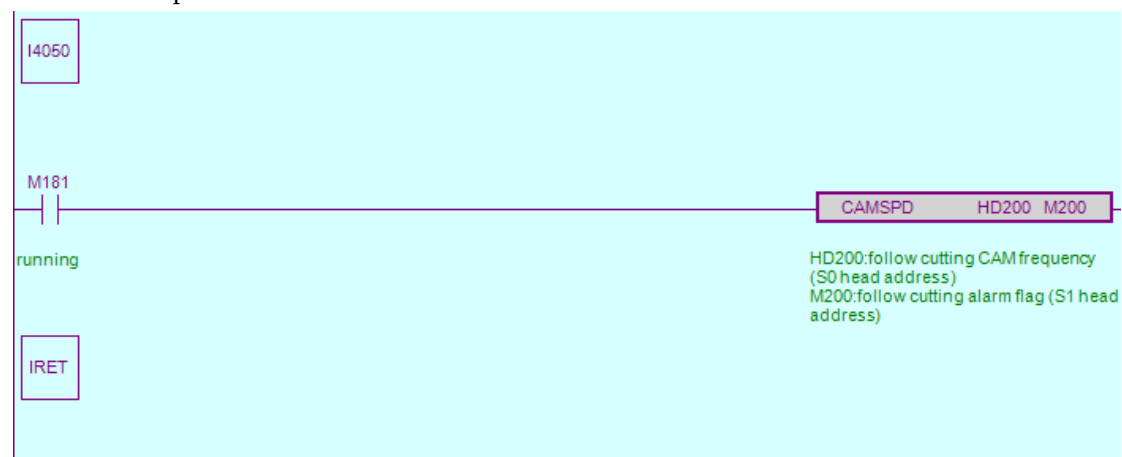
ZRN instruction can clear the present axis position automatically (Y0 is HSD0). If users make the reset program by themselves, it needs to clear the present axis position.



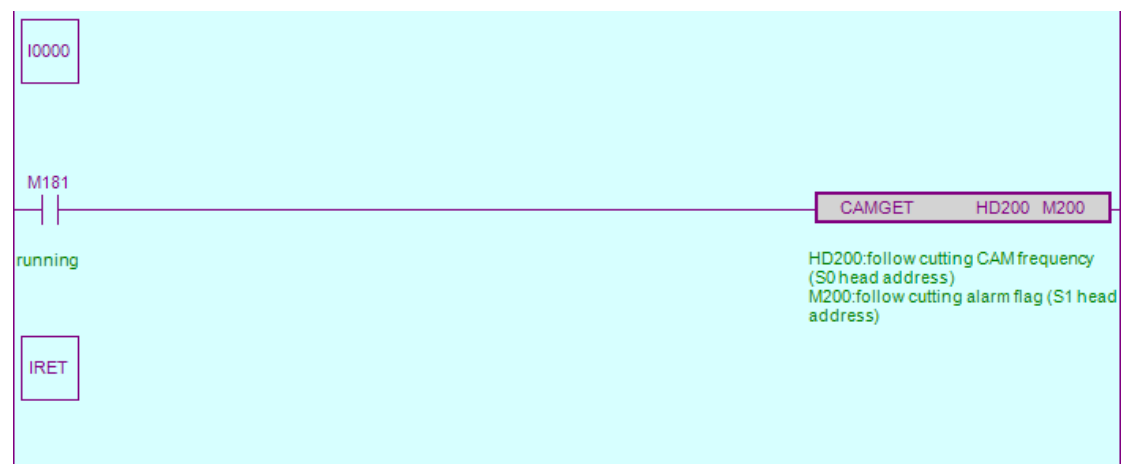
CAMFUN instruction can startup the CAM binding. When the main axis moves forward (HSC0 is increasing), CAMFUN instruction calculates the follow frequency which is stored in HD200 (S0 head address), PLSF instruction can control the pulse speed and perform the synchronization follow cutting. When the follow cutting produces alarming, M200 (S1 head address) is set on by CAMFUN, PLSF stop running, HD200 is cleared automatically. The alarm code please refer to HD202.



It calls CAMSPD in 50ms timer interruption (I4050) to measure the main axis speed, and display the real-time speed.

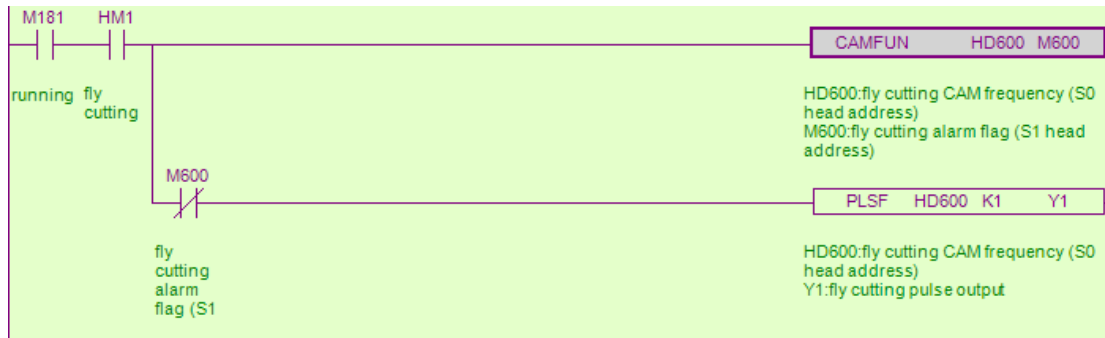


It needs to call CAMGET to high-speed grab the color mark position in color mark interruption in fixed mark mode.

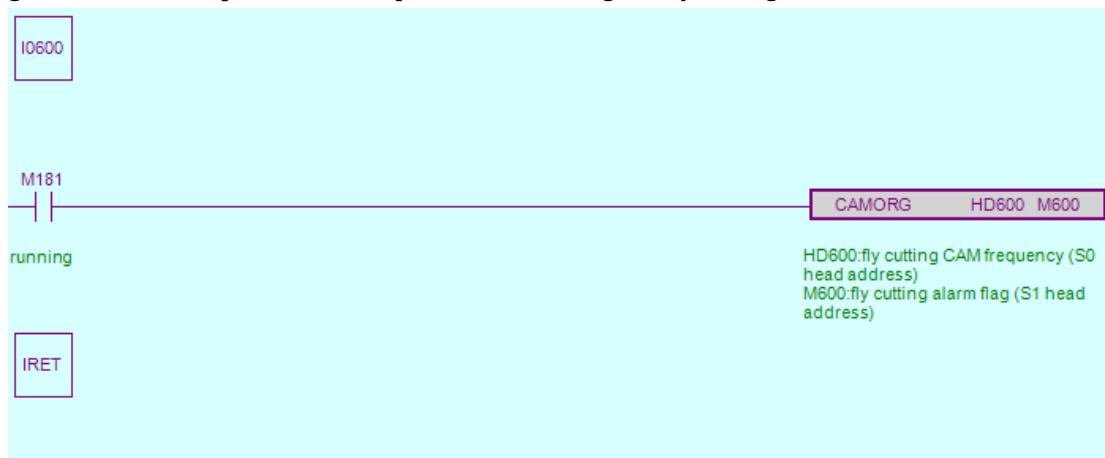


Fly cutting CAM reset is different from follow cutting. As the fly cutting origin installation position is the cutter cutting position, if it calls ZRN to reset, the cutter is just at the bottom which will block the material feeding. The cutter must be at the top position. After the ZRN reset completed, please use PLSR instruction to output certain pulses to make the cutter at the top position. For some occasions such as packing, the film feeding and cutter need to be synchronization reset (separately reset will cause film pulling), it can calculate the frequency when synchronizing and the two axes send the pulse at the same time to reset. When making the reset program separately, it needs to clear the present axis pulse position (HSD[*]) when the cutter touches the origin, and call the CAMRST instruction to initialize the parameters after resetting. Please make the reset program according to the actual conditions.

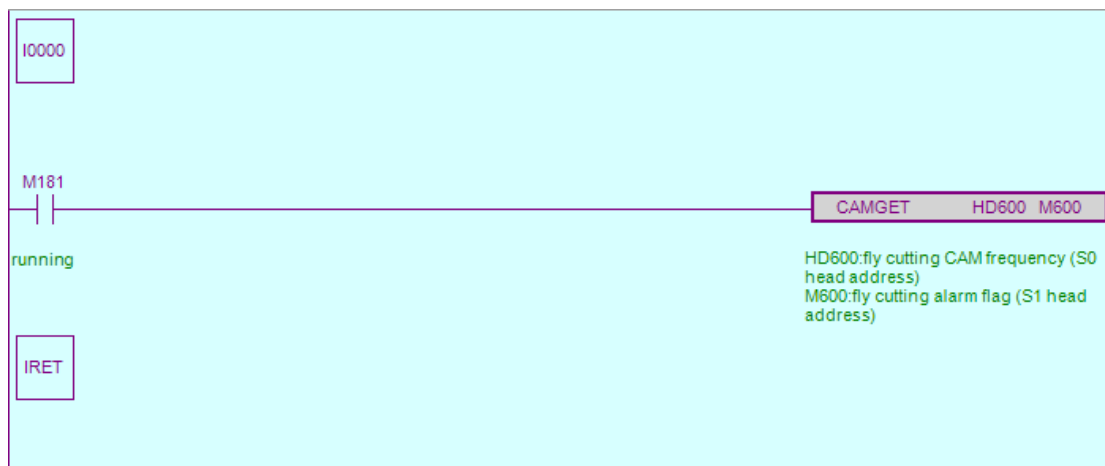
After the fly cutting resetting, it calls CAMFUN to bind the CAM. When the main axis moves forward (HSCD2 is increasing), the slave axis follows the main axis and binds with it. When the CAM alarms, M600 is set ON to stop PLSF outputting pulses. The alarm code please refer to HD602.



It needs to call the CAMORG instruction in the fly cutting origin terminal interruption address to grab the main axis position to compensate when using the fly cutting CAM.



It needs to call the CAMGET instruction in color mark interruption to grab the color mark position in fixed mark mode.



4-4. User-defined CAM application

The user-defined CAM can produce the CAM curve by configuring the point position and transition curve. Next we will introduce the user-defined CAM configuration information.

The pulse configuration please refer to the follow cutting and fly cutting application.

It needs to configure the CAM parameters starting from head address S0 of CAM instruction.

In the following example, the user-defined CAM main axis is high speed counter 0, slave axis is Y0, S0 head address is HD200, S1 head address is M200, the CAM curve is shown in figure 4.1.

Note: DHD means HD double words integer format, FHD means HD floating number register.

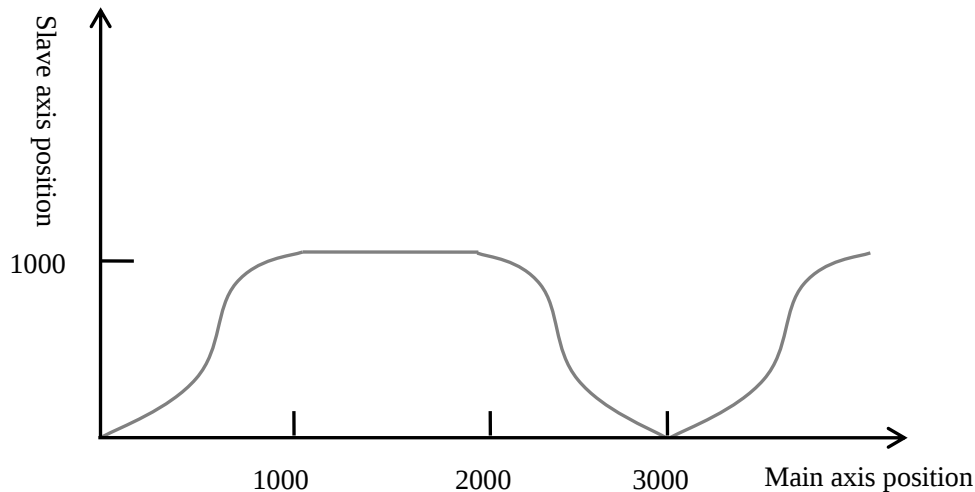


Figure 4.1 user-defined CAM

The public parameters:

Configuration parameters:

```
DHD[220] = -1 ;    // main axis no. (high speed counter 0, the wiring is X0, X1)
DHD[222] = 1 ;     //slave axis no. (Y0 axis)
DHD[224] = 10 ;    //CAM types (10: user-defined CAM)
```

CAM parameters:

```
DHD[300] = 3 ;     //CAM total segments

DHD[320] = 1000    //segment 0 main axis position
DHD[322] = 1000    //segment 0 slave axis position
DHD[324] = 1       //segment 0 curve (smooth curve 1)
FHD[326] = 0       //segment 0 smooth curve start point slope
FHD[328] = 0       //segment 0 smooth curve end point slope

DHD[330] = 2000    //segment 1 main axis position
DHD[332] = 1000    //segment 1 slave axis position
DHD[334] = 2       //segment 1 uniform curve

DHD[340] = 3000    //segment 3 main axis position
DHD[342] = 0       //segment 3 slave axis position
```

DHD[344] = 3 ;//segment 3 curve (sine S curve)

The curve has four types which including smooth curve 0, smooth curve 1, uniform curve and sine s curve.

Smooth curve 0 and 1 need to set the start point and end point slope (float number). The two curves can smooth transit and be applied to complicated connection, such as it needs to accelerate from static to synchronization and keep the state, please set the start point slope to 0 and end point slope to pulse ratio of synchronization state. Smooth curve 1 is smoother than smooth curve 0.

Uniform curve can keep the constant speed according to the target position, it is used in synchronization occasion. There maybe impact to use uniform curve from static state to target position.

Sine S curve will form S type acceleration and deceleration curve according to the target position. It is used to fast positioning occasion. It has small impact and the configuration is simpler than smooth curve.

Notes:

1. It needs to configure the related registers before calling CAM instructions. CAM instruction will occupy 400 registers starting from address S0 and 400 registers starting from address S1. Using the same head address for S0 and S1 makes it easy to check the respective axis.
2. It needs to reset the system for calling CAMFUN to bind the main or slave axis after system alarming or before power on at the first time. It needs to call CAMRST to initialize the CAM after system reset.
3. It needs to return to electrical origin for follow cutting reset and clear the present axis pulse register DHSD (refer to appendix 3), then call CAMRST to initialize the CAM.
4. The cutter can go to appointed position for fly cutting reset, but if the reset touches the origin, it needs to clear the present axis pulse register DHSD (refer to appendix 3), then call CAMRST to initialize the CAM.
5. It needs to add CAMLIB file before calling CAM instructions, otherwise the downloading will be error.
6. After calling the CAMFUN to bind the CAM, it does not allow to do jog operation for the axis. If it needs to do jog operation, it should reset again before CAMFUN binding.
7. Make sure the encoder completely stop before unbinding the CAMFUN. If it unbinds and the encoder has not completely stop, it will chase the main axis position and overshoot for binding again before next time startup, or it will produce speed alarm.
8. The pulse unit should be set to numbers, but not equivalent when using CAM function.
9. It cannot set or clear the pulse numbers of binded main axis and slave axis (HSCD/HSD) when the system is running.
10. Please set the pulse default speed, pulse default speed acceleration/deceleration time to 0 in pulse configuration public parameters when using PLSF instruction. Otherwise the action will be error. If it needs to use acceleration/deceleration time, user can use other public parameters, for example, ZRN instruction uses the first group parameters, PLSF uses fourth group parameters when reset.
11. If the binded main axis is encoder, it needs to use high speed counter CNT_AB. If the binded main axis is pulse position, it cannot ensure the cutting accuracy.
12. Please startup the main axis after CAM binding, and unbind the CAM after the main axis stop completely, otherwise it will have impact or speed alarm.

5. Q&A

Q: it has downloading or compilation error after added the CAM block.

A: check whether the CAMLIB block is added.

Q: the CAM has alarm and cannot startup.

A: the system must be reset normally.

Q: following cutting servo cannot move.

A: check whether the high speed counter worked, the wiring is correct, the high speed counting instruction is used, encoder is increasing, follow cutting is reset normally and CAMRST is called.

Q: it cannot return to origin when the follow cutting speed is fast, the faster the speed, the further the distance, but there is no accumulated error.

A: check whether the position loop gain (S0+84) is too small.

Q: it has speed alarm if the speed is fast (position deviation is too large).

A: check whether the pulse deviation limit (S0+80) is too small, it can monitor the CAM pulse deviation (S0+06) to judge it.

Q: how can perform multi-axis phase synchronization for multi-axis binding the main axis.

A: short connect the high speed counter of main axis to other high speed counter, bind the high speed counter main axis of short connected to make the same position base of main axis. The main axis parameters of CAM axis must be set to consistent.

Q: the cutter offset while the fly cutting CAM has run for long time (cutting position offset).

A: if the deviation changes regularly in short time, check the slave axis parameters (pulse numbers per circle, reduction ratio), if the deviation changes irregularly in long time, check whether there is interference.

Q: how to adjust the cutting point position?

A: please adjust the phase, increase the phase, the cutting position will be later, decrease the phase, the cutting position will be in advance. The phase adjusting range is from negative material length to positive material length. If the phase is negative, the phase will change to "material length + negative phase" automatically to ensure the phase range is from 0 to positive value.

Q: the cutting position is not accurate in fixed mark mode.

A: check whether the cutting length is correct in fixed length mode, if not, please correct the moving distance per circle of main axis. If it is normal, please check whether the color mark signal is stable and has little interference which can be judged by color mark interference times (S0+154).

6. Version update

V3.0.0

1. Main axis can bind the pulse axis as the virtual axis
2. the main axis and slave axis no. have been changed
3. modify the fly cutting CAM parameters address

V3.1.0

1. user-defined CAM is added

Appendix

Appendix1: CAM status and alarm information (S0+2)

Type	Status code	Notes
Normal status	0	No status
	1	CAM mesh is normal
	10	Wait for the CAM mesh
	11	CAM initialization
Parameter configuration error	10000	Model error
	10100	Main axis binding axis no. error
	10101	Slave axis binding axis no. error
	10102	CAM type error
	10103	CAM mode error
	10104	Main axis parameters configuration error
	10105	Slave axis parameters configuration error
	10106	Fly cutting parameters configuration error
Running error	20000	CAM speed/pulse deviation too large
	20001	System not reset
	20002	Main axis encoder connected reversed
Follow cutting CAM error	30000	Follow cutting feeding length too short
Fly cutting CAM error	30100	Fly cutting feeding length too short
User-defined CAM error	31000	User-defined CAM curve error

Appendix 2: high speed counter

Cam main axis no.	Counter terminal	Present pulse numbers	Frequency times	Notes
0	X0, X1	HSCD[0]	SFD[320]	● distribute the terminal as the CAM main axis no. ● the first channel of CAM2, MCP2, MCG2 support AB phase counting max 50KHz ● the first four channels of CAM4-32T-E support AB phase counting max 50KHz ● the first 8 channels of CAM4-60T10-E support AB phase counting max 50KHz ● please repower on after changing the frequency times which only can be set to 2 or 4.
1	X3, X4	HSCD[2]	SFD[321]	
2	X6, X7	HSCD[4]	SFD[322]	
3	X11, X12	HSCD[6]	SFD[323]	
4	X14, X15	HSCD[8]	SFD[324]	
5	X17, X20	HSCD[10]	SFD[325]	
6	X22, X23	HSCD[12]	SFD[326]	
7	X25, X26	HSCD[14]	SFD[327]	

Appendix 3: pulse configuration

Slave axis no.	Pulse terminal	Pulse/ equivalent	Direction terminal	Direction changing delay	Present pulse numbers	Notes
0	Y0	SFD[900]	SFD[906]	SFD[907]	HSD[0]	● distribute the pulse terminal as the CAM slave axis no. ● set the pulse mode to pulse numbers when using the CAM mode which means the related SFD is 0 or 2.
1	Y1	SFD[1030]	SFD[1036]	SFD[1037]	HSD[4]	
2	Y2	SFD[1160]	SFD[1166]	SFD[1167]	HSD[8]	
3	Y3	SFD[1290]	SFD[1296]	SFD[1297]	HSD[12]	
4	Y4	SFD[1420]	SFD[1426]	SFD[1427]	HSD[16]	
5	Y5	SFD[1550]	SFD[1556]	SFD[1557]	HSD[20]	
6	Y6	SFD[1680]	SFD[1686]	SFD[1687]	HSD[24]	
7	Y7	SFD[1810]	SFD[1816]	SFD[1817]	HSD[28]	
8	Y10	SFD[1940]	SFD[1946]	SFD[1947]	HSD[32]	

9	Y11	SFD[2070]	SFD[2070]	SFD[2077]	HSD[36]	● Configure the direction terminal as the actual wiring. ● Direction changing delay time is about 5ms. ● It needs to clear the pulse present position (HSD) when it touched mechanical origin when CAM reset
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Appendix 4: interruption entry address

Interruption no.	Interruption address	Notes
X2	I0000	● CAMORG and CAMGET should be called in interruption to ensure no response delay. ● CAMORG or CAMGET can be called in related interruption entry address according to the distributed origin or color mark terminal.
X3	I0100	
X4	I0200	
X5	I0300	
X6	I0400	
X7	I0500	
X10	I0600	
X11	I0700	
X12	I0800	
X13	I0900	

Appendix 5: register capacity range

Model	Register	Range	Numbers
CAM2 MCP2	M	M[0]-M[7999]	8000
	HM	HM[0]-HM[959]	960

MCG2	D	D[0]-D[7999]	8000
	HD	HD[0]-HD[999]	1000
CAM4	M	M[0]-M[69999]	70000
	HM	HM[0]-HM[11999]	12000
	D	D[0]-D[69999]	70000
	HD	HD[0]-HD[24999]	25000

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