ASDA-A2 Series
Electronic Cam (E-CAM)
Function – Advanced Level

About This Presentation

Intended Audience

This is an advanced level presentation designed for the users who have a basic knowledge of Delta‘s servo products, and understand Pr mode and electronic cam (E-CAM) function of ASDA-A series.

Presentation Revision

Revision: 9/8/2009

Revision: those before 8/25/2009 is obsoleted

Firmware & Software Version

Firmware: DSP V1.027 SUB 2, CPLD V0.09

Software: ASDA-A2 Soft V1.04.04 Green Edition

Table of Contents

E-CAM Parameter Settings

Master Axis Input, Clutch, Electronic Gear Ratio, E-CAM Profile

Auto Rotary Knife

Theory, Settings, Usage and Example

Auto Flying Shear

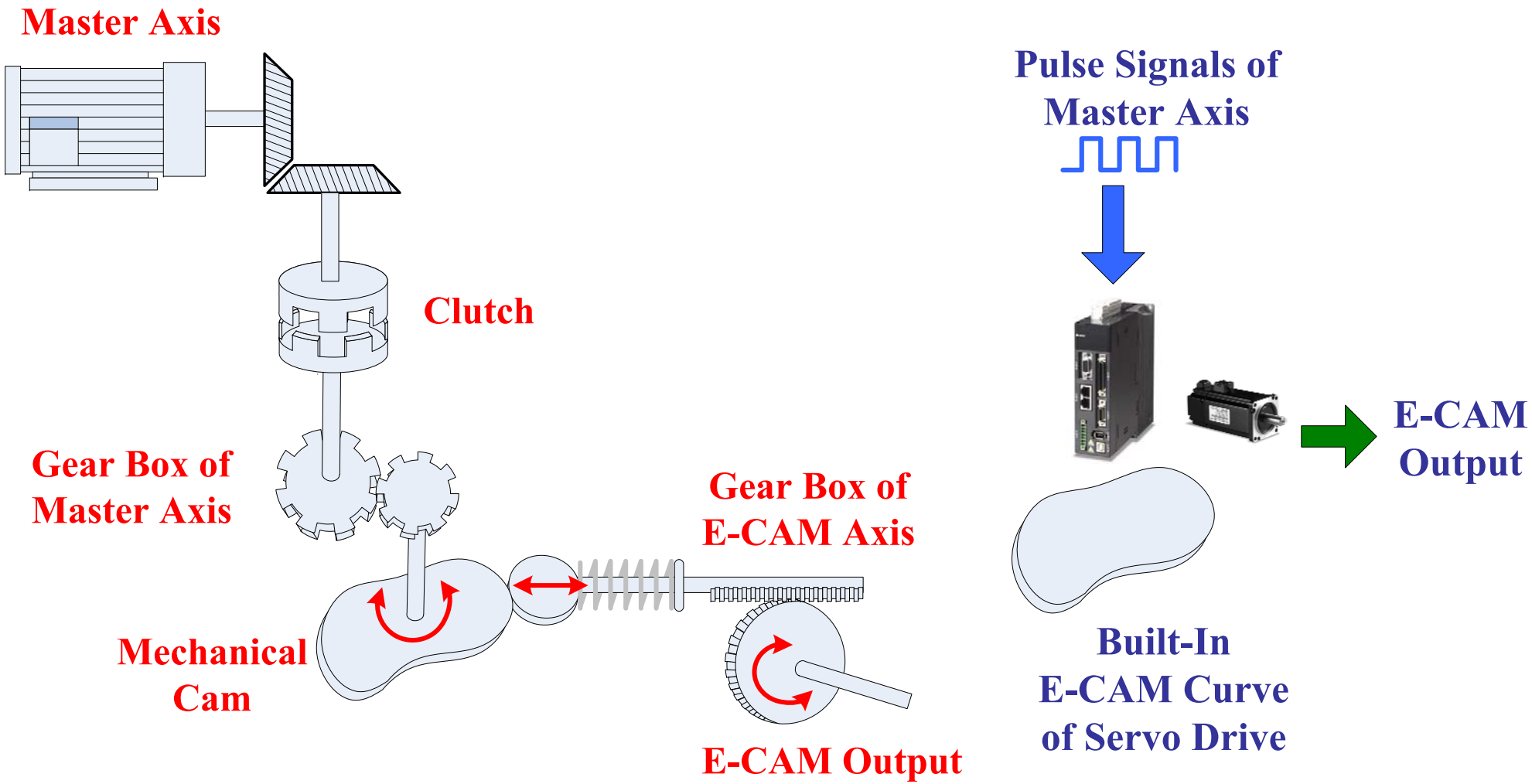
Theory, Applications, Create E-CAM Profie

CAPTURE SYNC AXIS

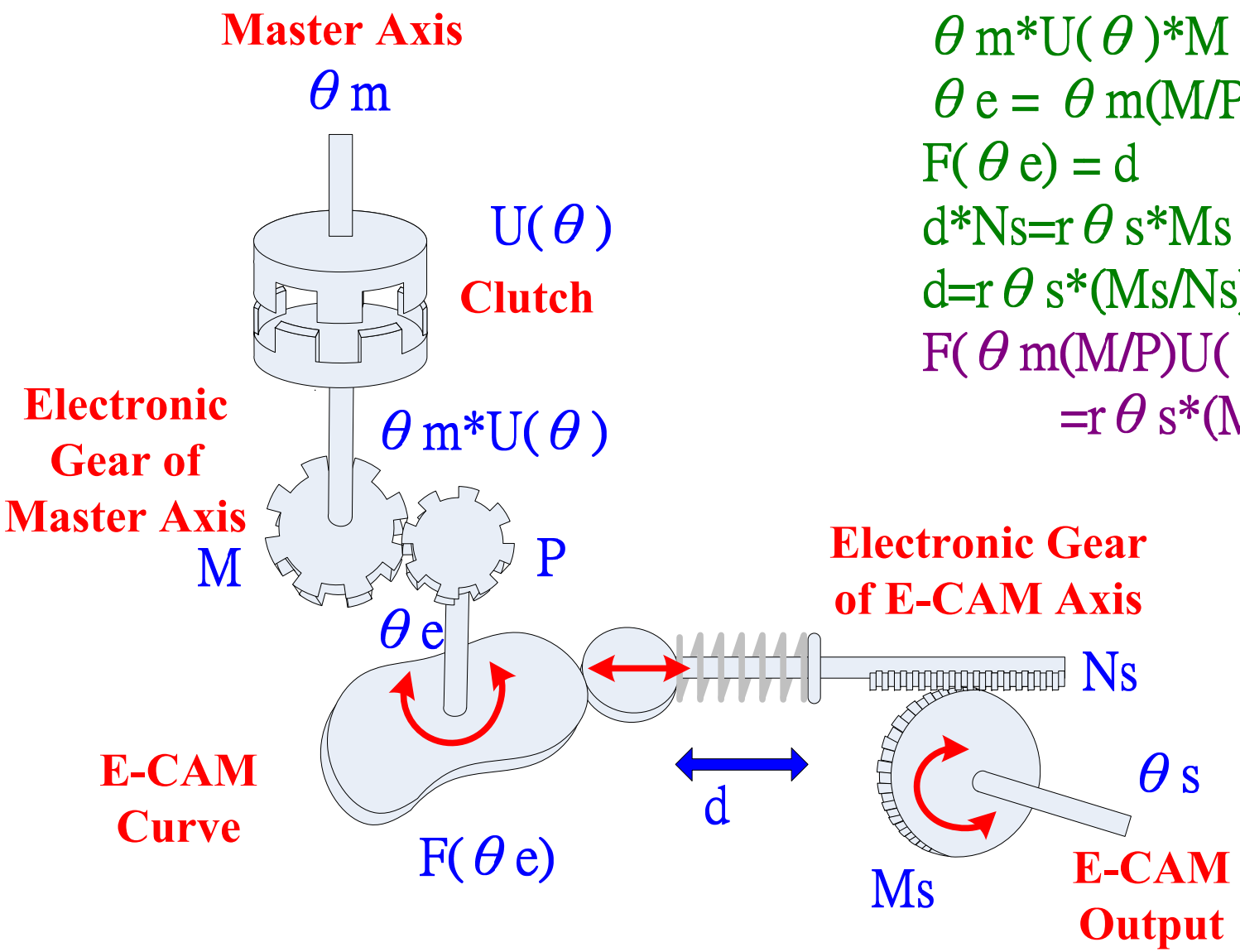
Theory, Settings, Usage and Example

E-CAM Introduction -1

Actual Mechanical Cam and Electronic Cam



E-CAM Introduction -2



$\theta m*U(\theta)*M = \theta e*P$

$\theta e = \theta m(M/P)U(\theta)$

$F(\theta e) = d$

$d*Ns = r\theta s*Ms$

$d = r\theta s*(Ms/Ns)$

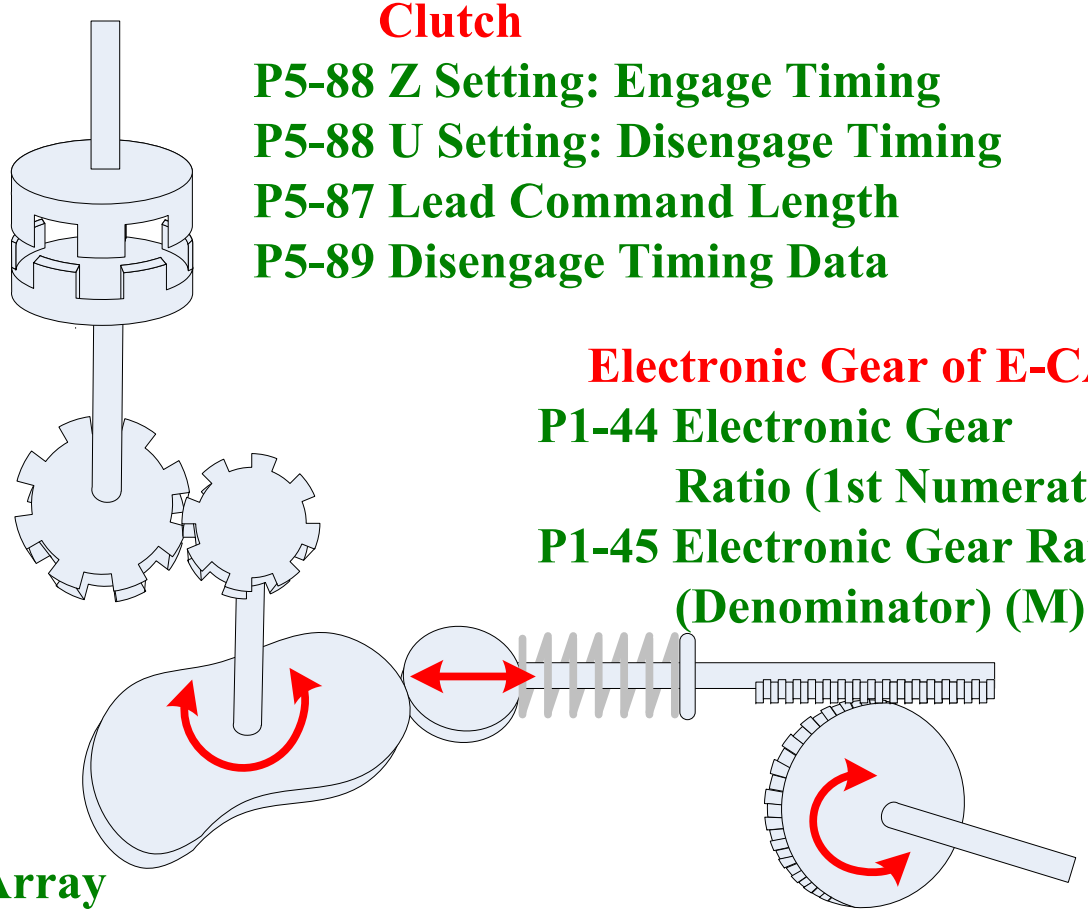
$F(\theta m(M/P)U(\theta)) = r\theta s*(Ms/Ns)$

E-CAM Parameters

Master Axis
P5-88 Y Setting: Command Source Settings

Clutch
P5-88 Z Setting: Engage Timing
P5-88 U Setting: Disengage Timing
P5-87 Lead Command Length
P5-89 Disengage Timing Data

Electronic Gear of Master Axis
P5-83 E-CAM Cycle Number (M)
P5-84 Pulse Number of Master Axis (P)



Electronic Gear of E-CAM Axis
P1-44 Electronic Gear Ratio (1st Numerator)
P1-45 Electronic Gear Ratio (Denominator) (M)

E-CAM Curve
Saved In Data Array
P5-81 Start Address of Data Array
P5-82 E-CAM Area Number N
P5-85 Engage Area Number

E-CAM Output

Master Axis

E-CAM axis which is able to execute E-CAM profile is controlled by the master axis. There are six kinds of command source settings (P5-88 Y Setting) of the master axis:

0: CAPTURE AXIS

1: Auxiliary Encoder (Linear Scale)

2: Pulse Command

3. Pr Command

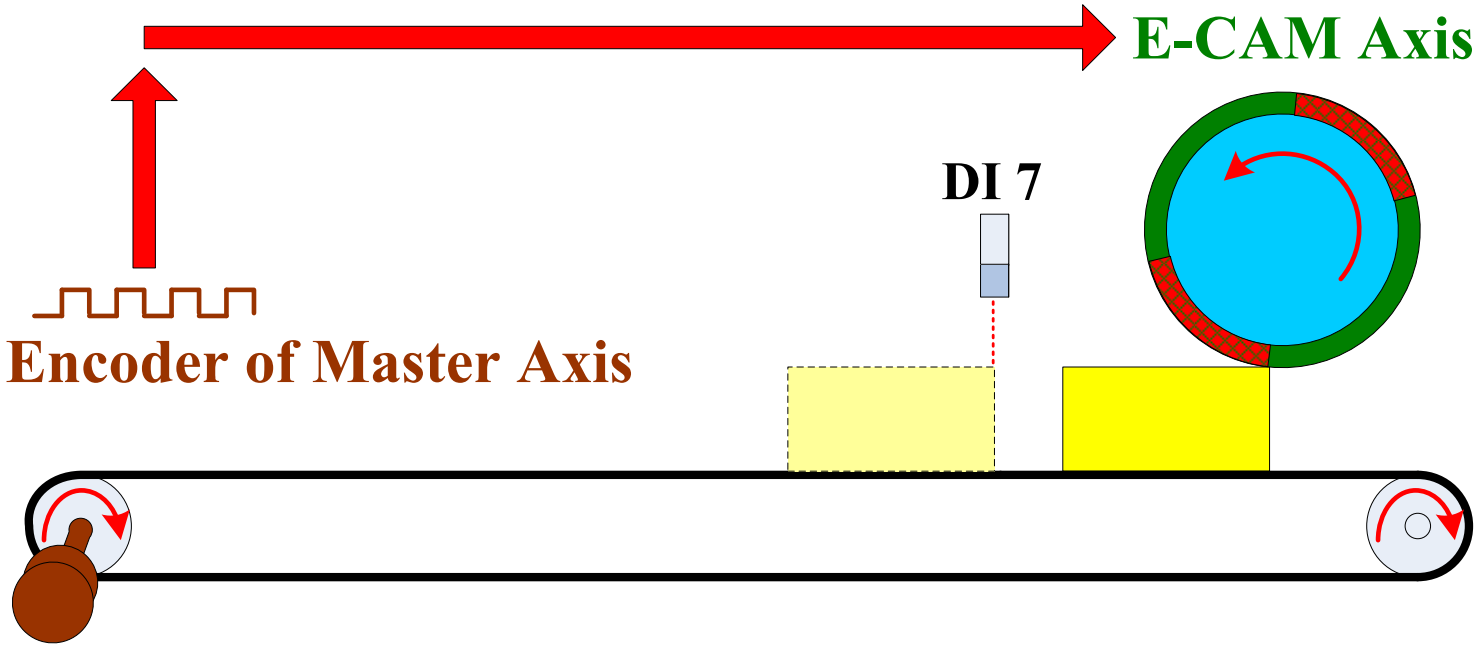
4. Time Axis (1ms)

5: CAPTURE SYNC AXIS (P5-77)

Master Axis -1

0: CAPTURE AXIS

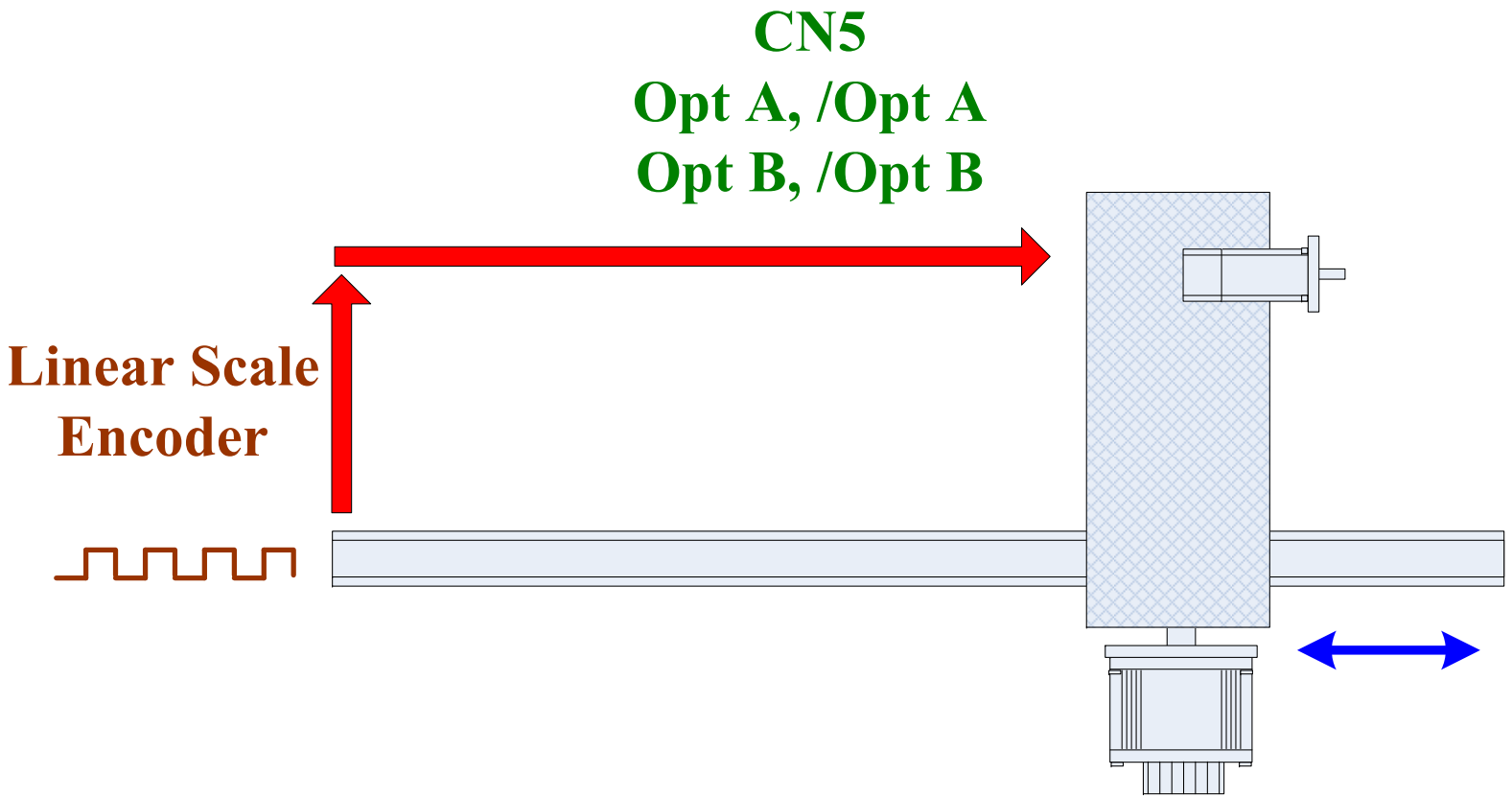
The command of the master axis can be from Capture axis, i.e. B setting (Capture source settings) of P5-39.



Master Axis -2

1: Auxiliary encoder (Linear Scale)

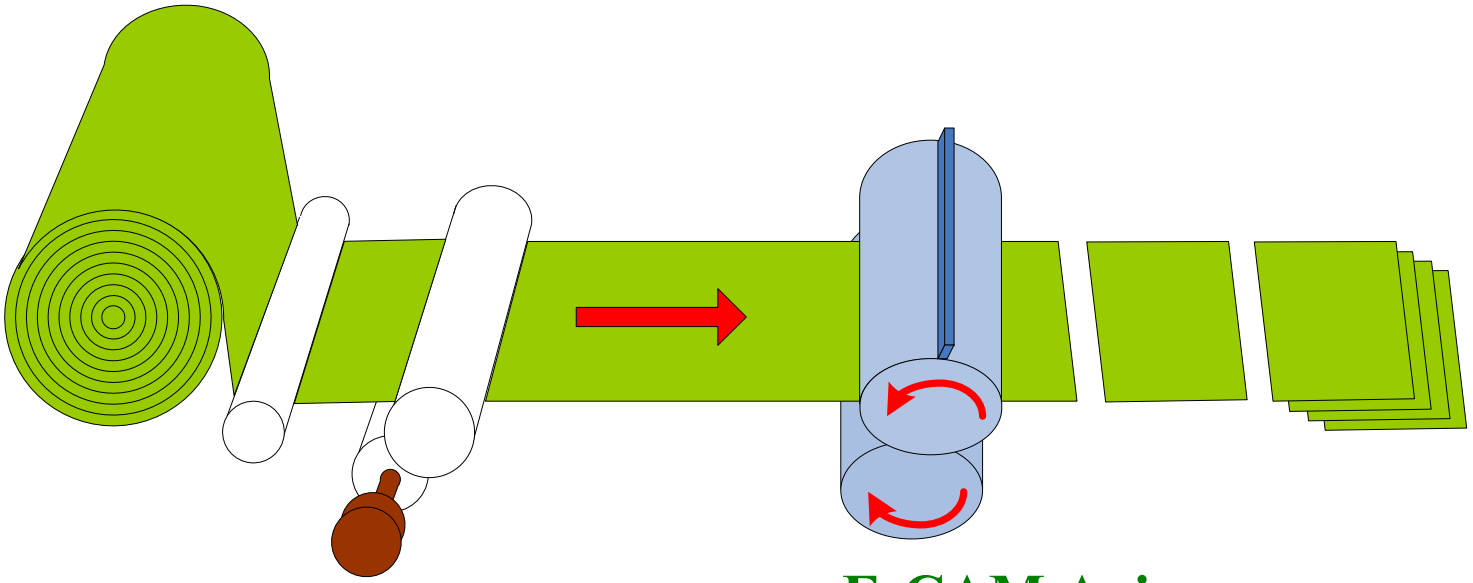
CN5 inputs: Opt A, /Opt A, Opt B, /Opt B



Master Axis -3

2: Pulse Command

CN1 inputs: Pulse, /Pulse, Sign, /Sign



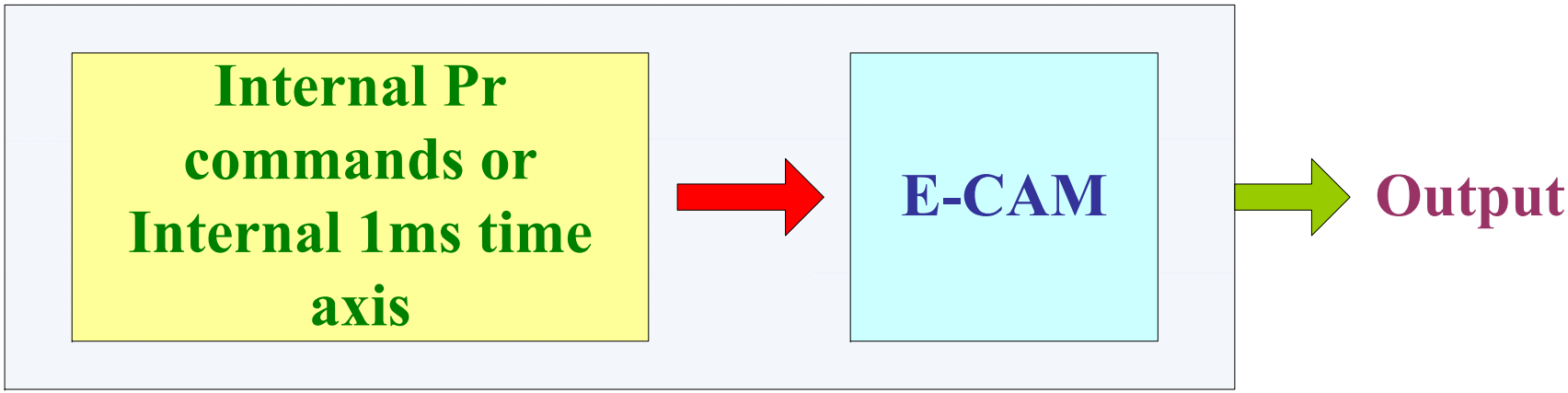
Master Axis -4

3: Pr Command

Internal Pr commands

4: Time Axis

1ms time pulse

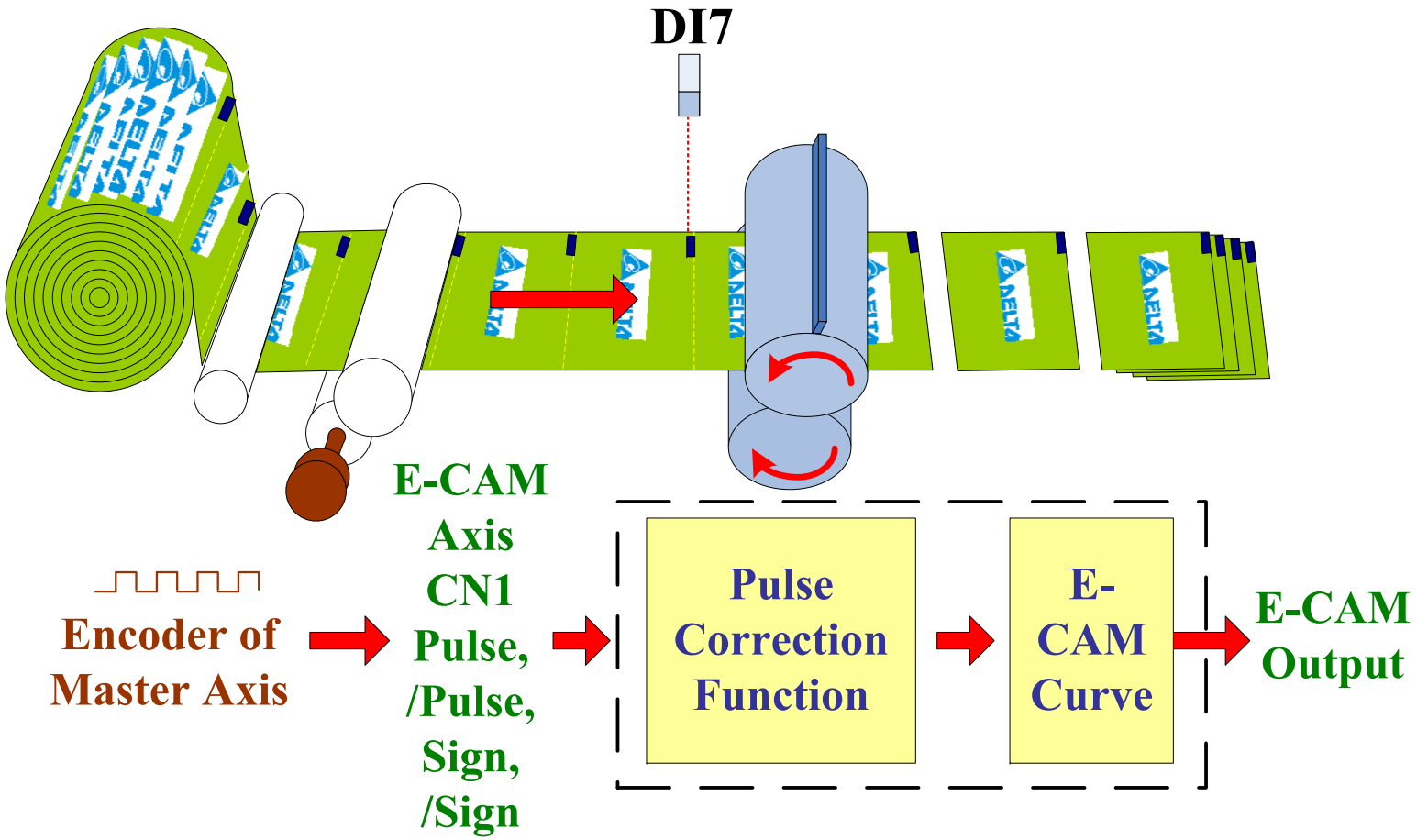


ASDA-A2 Series Servo Drive

Master Axis -5

5: CAPTURE SYNC AXIS

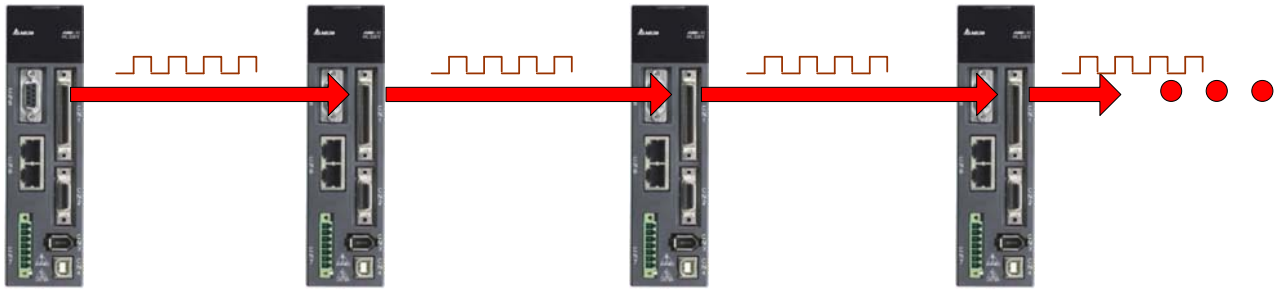
New function which is available in firmware V1.009 or later version (more introduction will be described on page 128~148)



Master Axis -6

One Master Axis to multiple Slave Axes – via CN1 connection

ASDA-A2 provides pulse signal transmission function. One master axis can send the signals to multiple slave axes, i.e. one master axis can control multiple slave axes to move synchronously. The delay for one level is 50ns on slave axis, so the pulse signal is not attenuated.

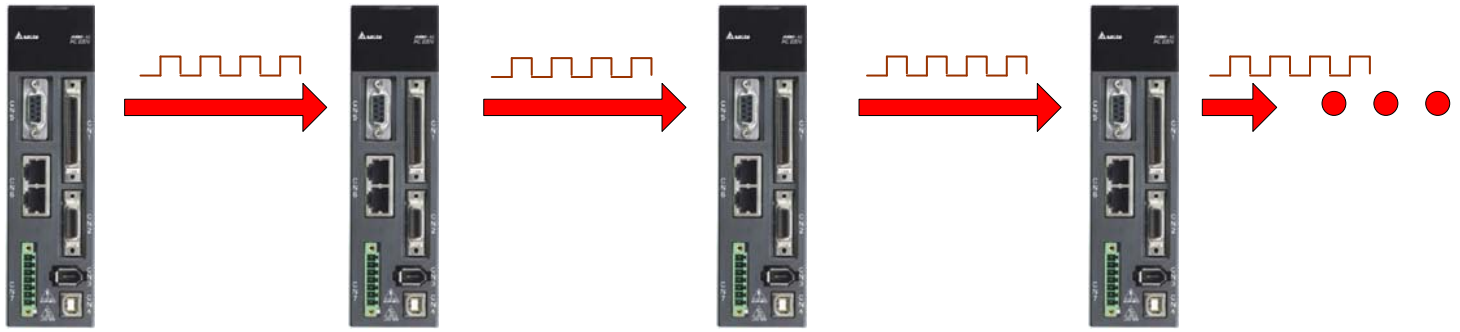


Master Axis CN1 OA, /OA, OB, /OB	E-CAM Axis 1 CN1 Pulse, /Pulse, Sign, /Sign P1-74.Y =2	E-CAM Axis 1 CN1 OA, /OA, OB, /OB	E-CAM Axis 2 CN1 Pulse, /Pulse, Sign, /Sign P1-74.Y =2	E-CAM Axis 2 CN1 OA, /OA, OB, /OB	E-CAM Axis 3 CN1 Pulse, /Pulse, Sign, /Sign P1-74.Y =2	E-CAM Axis 3 CN1 OA, /OA, OB, /OB

Master Axis -7

One Master Axis to multiple Slave Axes – via CN5 By-pass function

The pulse signals of ASDA-A2 can be transmitted via CN5.



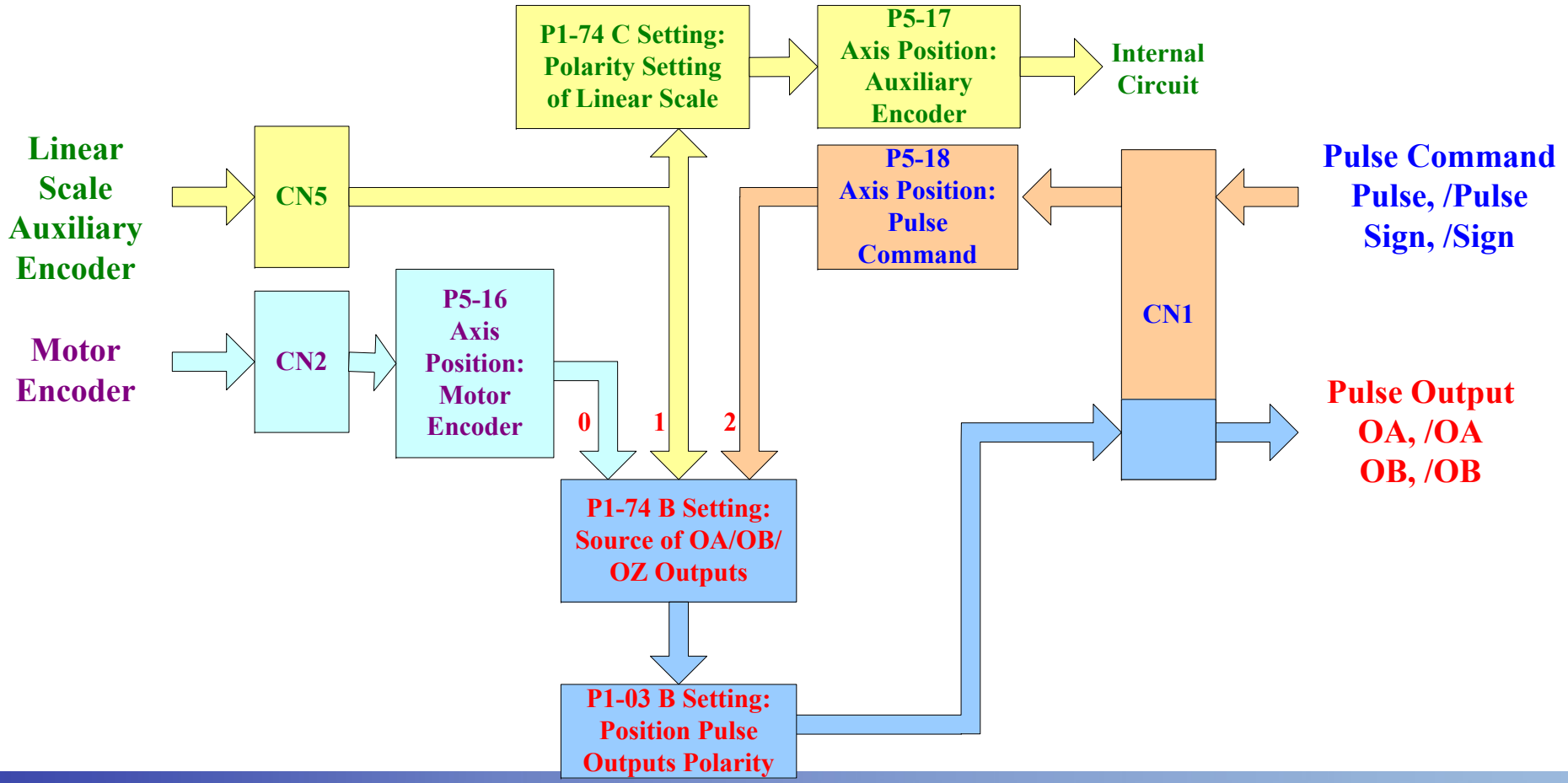
Master Axis CN1 OA, /OA, OB, /OB	E-CAM Axis 1 CN5 Opt A, /Opt A, Opt B, /Opt B P1-74.Y =1	E-CAM Axis 1 CN1 OA, /OA, OB, /OB	E-CAM Axis 2 CN5 Opt A, /Opt A, Opt B, /Opt B P1-74.Y =1	E-CAM Axis 2 CN1 OA, /OA, OB, /OB	E-CAM Axis 3 CN5 Opt A, /Opt A, Opt B, /Opt B P1-74.Y =1	E-CAM Axis 3 CN1 OA, /OA, OB, /OB

Master Axis -8

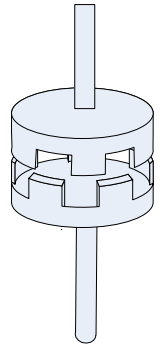
Control and Output of Pulse Command Source

Settings:

0: Motor Encoder, 1: Auxiliary Encoder (Linear Scale), 2: Pulse Command. When sending the signals, it can make the pulse command to be in reverse direction.



Clutch -1

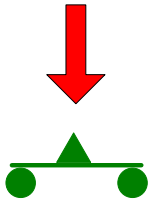


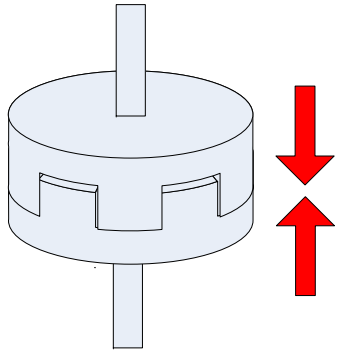
The work of clutch is to control the timing when E-CAM axis accepts the command from master axis. When the clutch is engaged, E-CAM axis will accept the pulse command of master axis and follow E-CAM profile to move synchronously. If the clutch is disengaged, E-CAM will not accept the command of master axis. There are three kinds of settings for engage timing(P5-88 Z Setting):

0: Immediately

1: Digital Input (DI) signal: CAM ON

2. Any point of CAPTURE AXIS



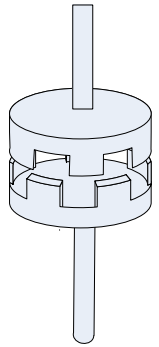


P5-88 Z Setting: Engage Timing

0 : Immediately. Once E-CAM function is enabled, the clutch is engaged.

1 : DI signal: CAM ON(0x36). Triggered by DI signal

Clutch -2

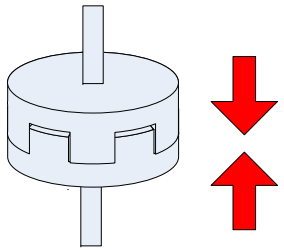


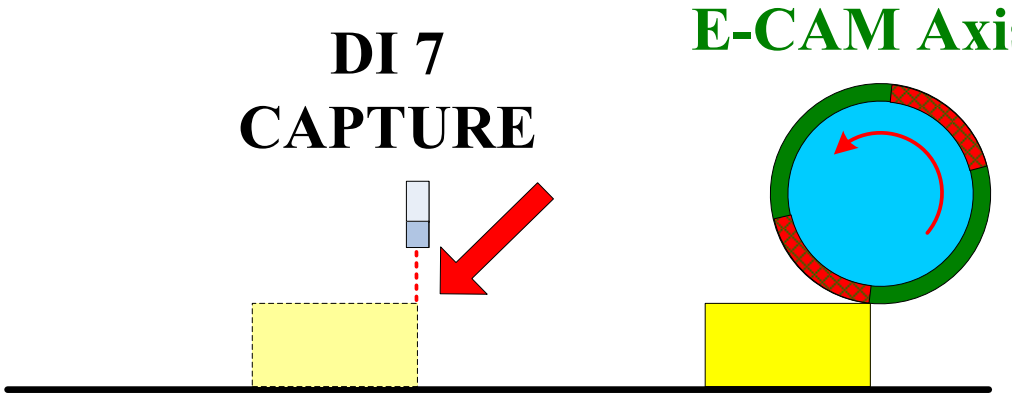
2 : Any point of CAPTURE AXIS

Use Capture function to quickly receive the command via the digital input, DI7.

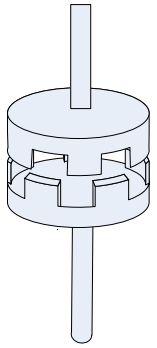
The command comes from the hardware (DI7), so there is almost no time delay.

When Capture function is enabled, ASDA-A2 will activate E-CAM function simultaneously according to this Capture signal.



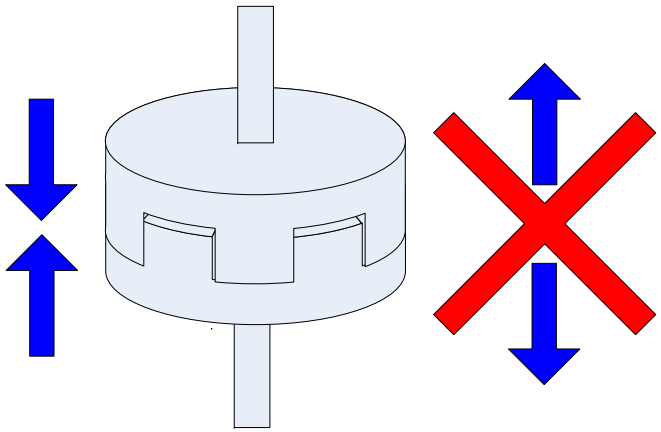


Clutch -3

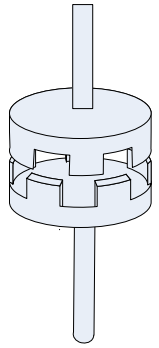


When the clutch is disengaged, E-CAM will disengaged also and E-CAM axis will not follow the master axis to move synchronously.
There are six kinds of settings for disengage timing (P5-88 U Setting):

0: Do not disengage
1: DI signal: CAM OFF
2: Master axis reaches the setting value of P5-89.



Clutch -3

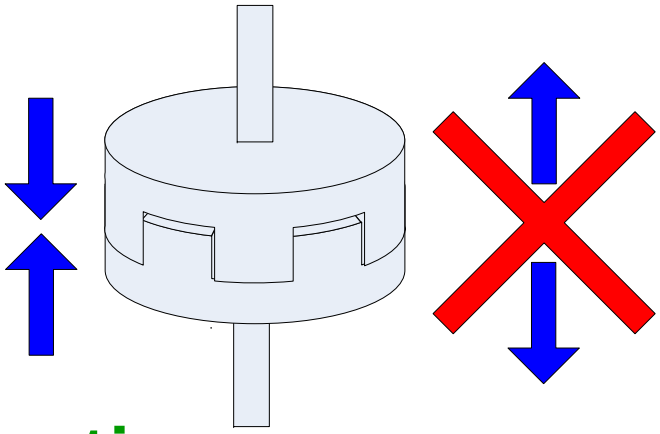


6: This function is the same as the function of P5-88 U=2, but the differences are that the speed will not change when electronic gear is disengaged and the engage length will exceed the setting value of P5-89 a little.

4: After master axis exceeds the setting value of P5-89, the clutch will return to the Lead state.

8: Disable E-CAM function after the clutch is disengaged.

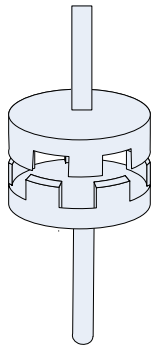
The setting value can be added up, but the setting value 2, 4 and 6 can not be selected simultaneously.



P5-88 U Setting: Disengage Timing

0 : Do not disengage. Once E-CAM function is enabled, the clutch will not disengage.

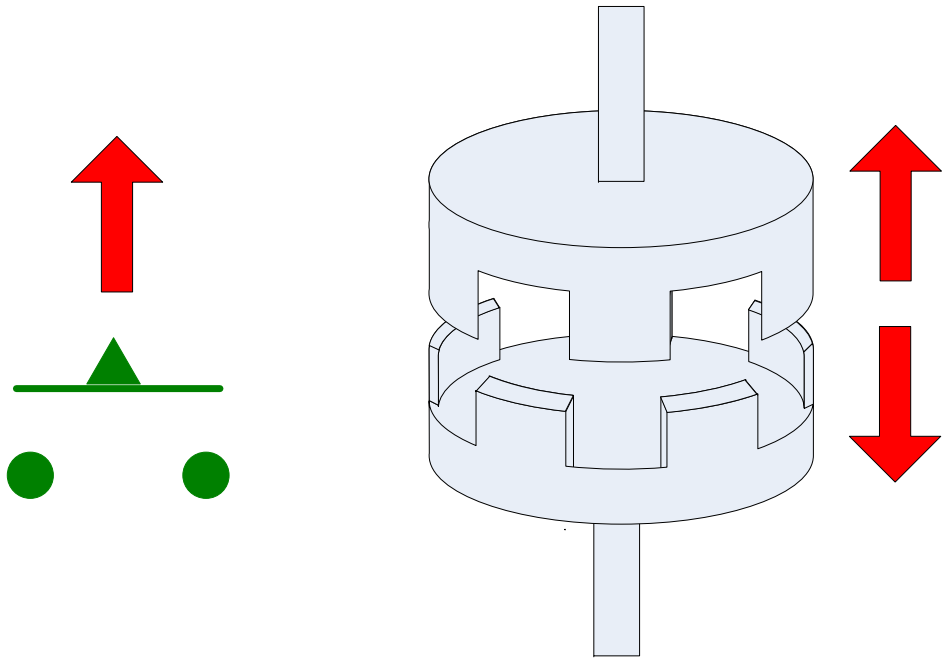
Clutch -4



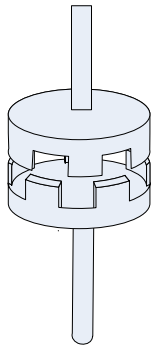
1 : DI signal: CAM ON(0x36).

The disengage timing is controlled by digital input signal (DI signal).

Enter into the state of “Stop” after the clutch is disengaged.

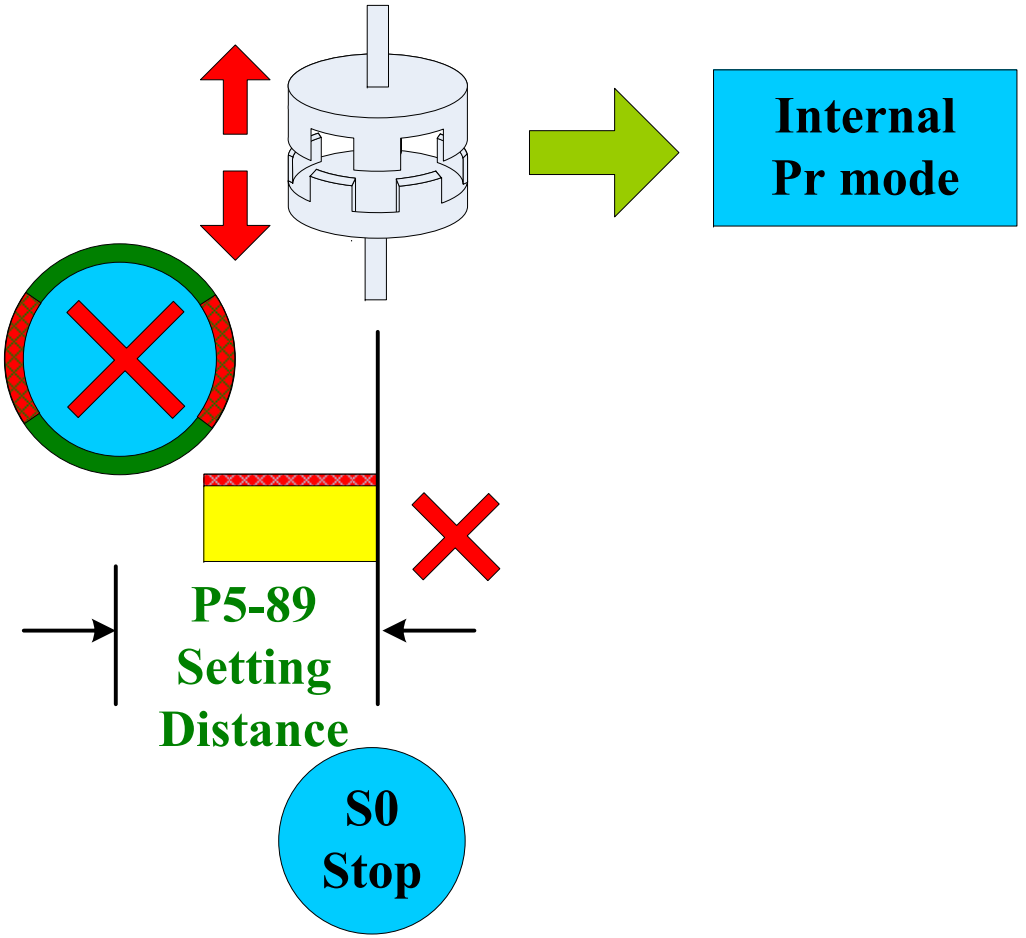


Clutch -5

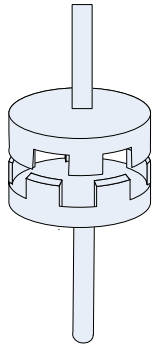


2: Master axis reaches the setting value of P5-89

Enter into the state of “Stop” after the clutch is disengaged. (Able to enter intro Pr mode)

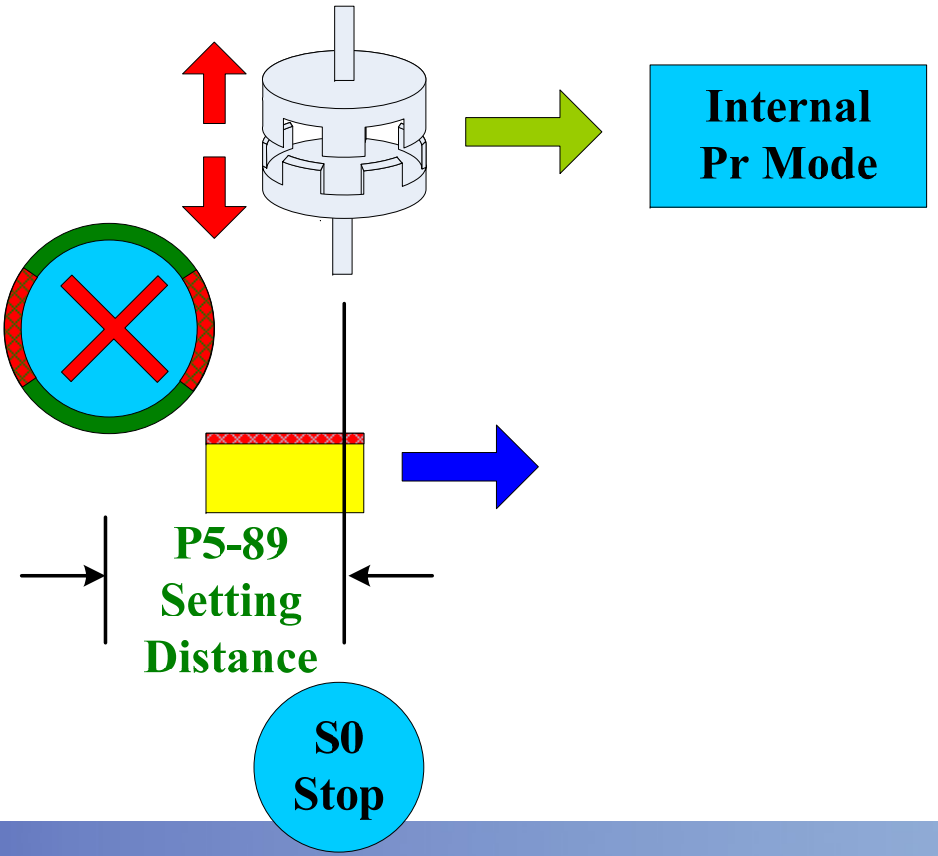


Clutch -6

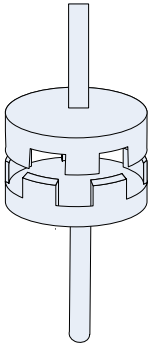


6: Master axis reaches the setting value of P5-89 and the speed will not change when the clutch is disengaged, and the engage length will exceed the setting value of P5-89 a little. (This function is available in firmware V1.009 and later models.)

Enter into the state of "Stop" after the clutch is disengaged. (Able to enter intro Pr mode)

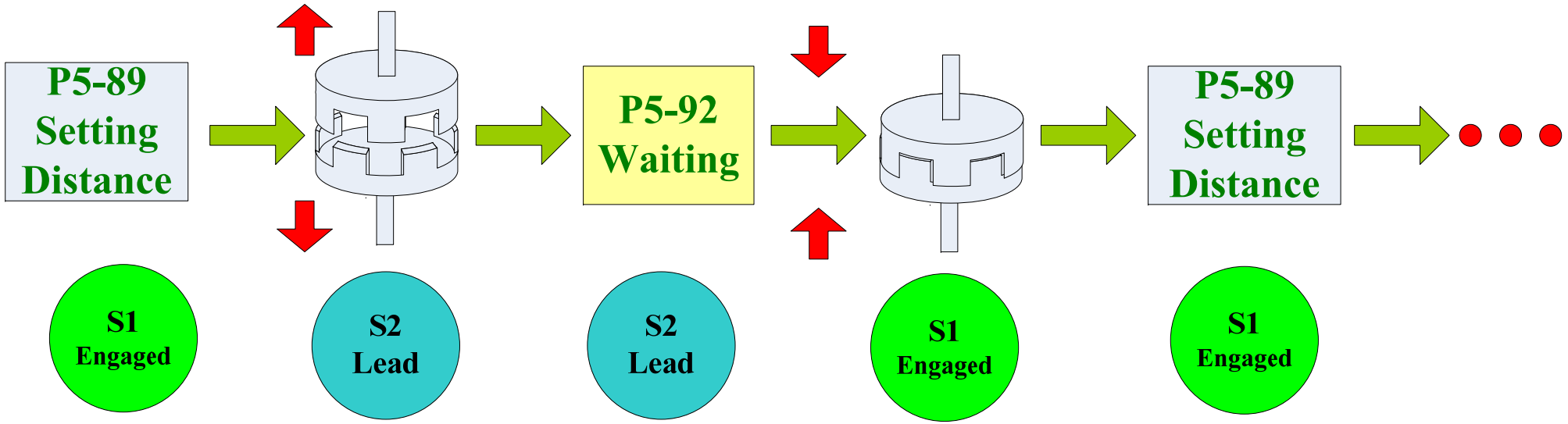


Clutch -7

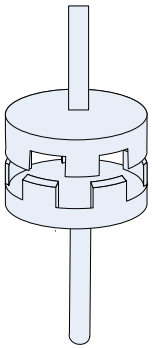


4: Master axis exceeds the setting value of P5-89.

Return to the state of “Lead” after the clutch is disengaged. The Cyclic Lead Command Length is determined by P5-92
(This function is available in firmware V1.009 and later models)

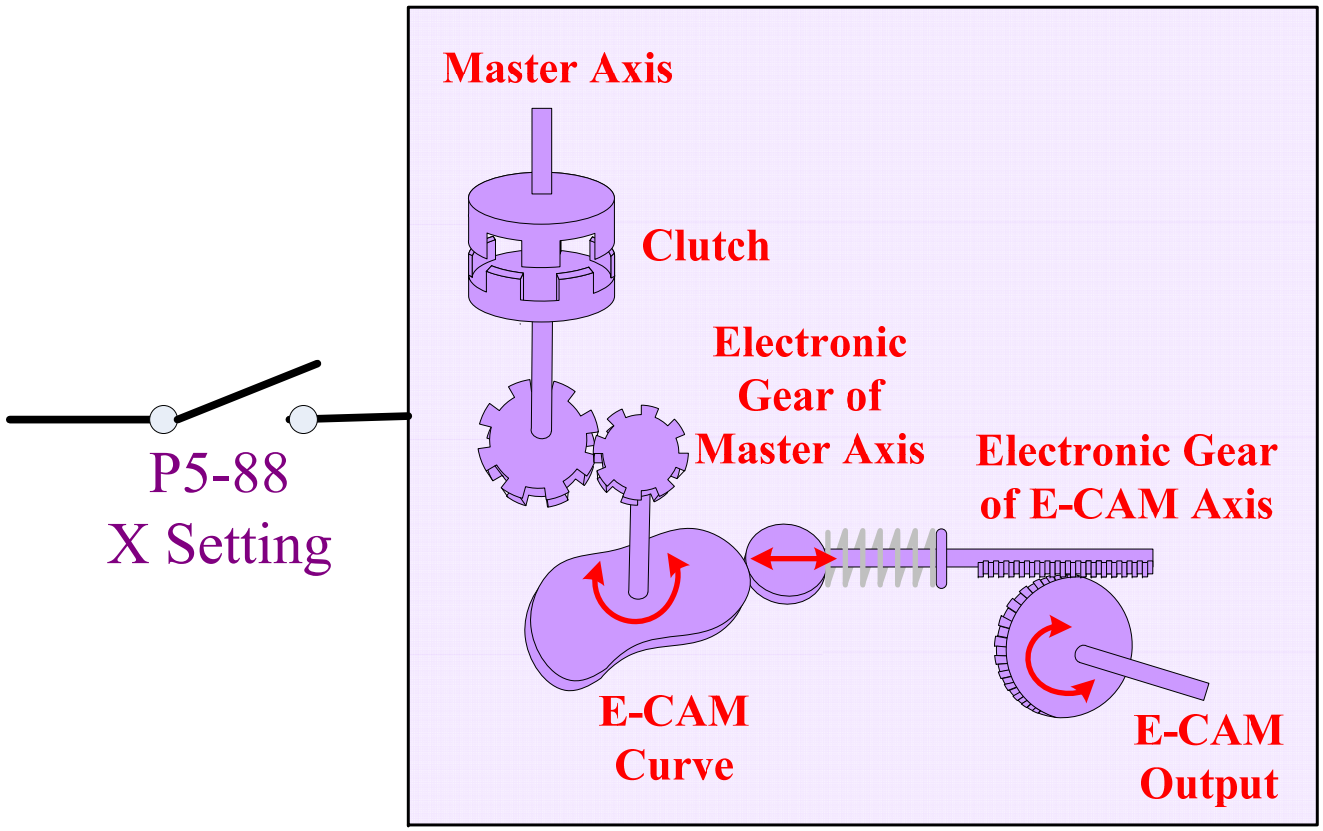


Clutch -8



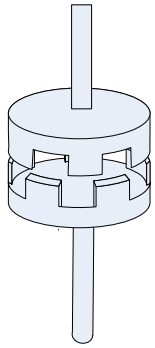
8: Disable E-CAM function after the clutch is disengaged, i.e. X setting of P5-88 is set to 0.

This function can be used with the function of setting value 1, 2 and 6. If the function of setting value 4 and 8 is used at the same time, the function of setting value 8 will be disabled.

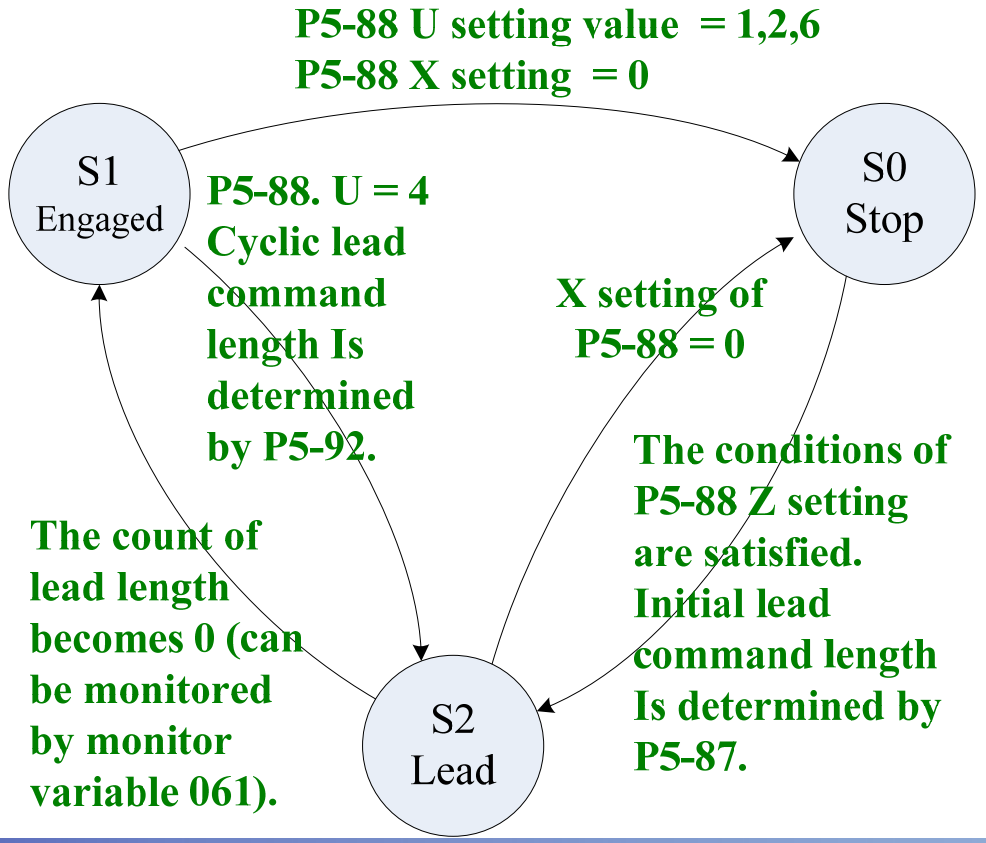


Clutch -9

P5-88 S Setting: Engage Status Display

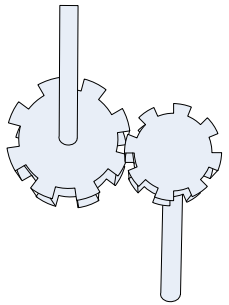


S=0: Stop state (When E-CAM function is disabled, the system will return to this state)
S=1: Engaged state (E-CAM will move with master pulse command according to E-CAM profile.)
S=2: Lead state (E-CAM is waiting and it will not move with master pulse command.) 動



Electronic Gear of Master Axis

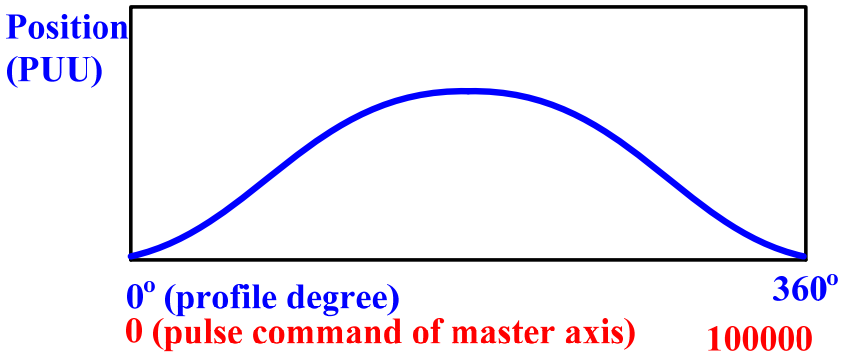
P5-83: E-CAM Cycle Number (M)



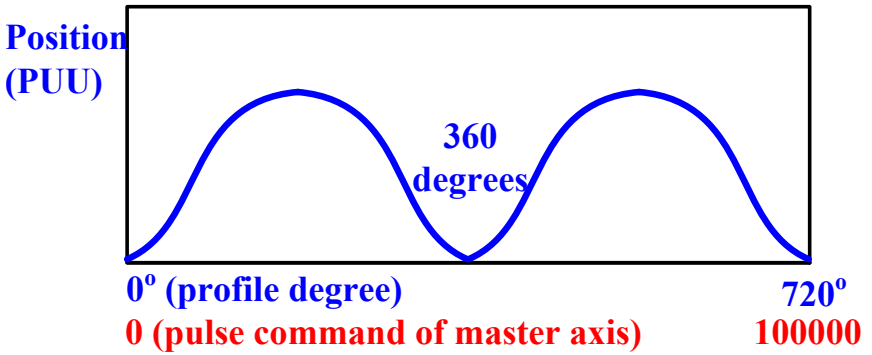
After receiving the pulse number P (P5-84)of master axis, the shaft of E-CAM will rotate M cycles. It indicates that there are M cycles of the E-CAM table. (This parameter can be changed when Servo On)

P5-84: Pulse Number of Master Axis (P)

The pulse number transmitted by master axis. It indicates that there are M cycles (P5-83)of the E-CAM table.

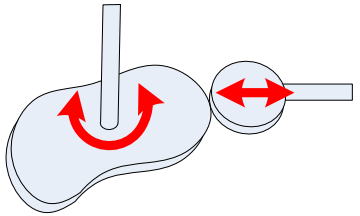


P5-83 =1
P5-84 = 100000



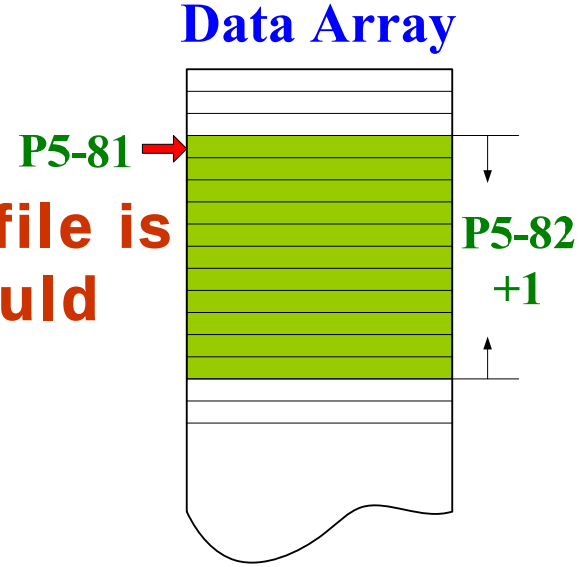
P5-83 =1
P5-84 = 50000 or P5-83 =2
P5-84 = 100000

E-CAM Profile -1



Save E-CAM profile

The E-CAM profile is saved in data array. One E-CAM profile can be divided into max. 720 areas. It means that there are total 721 points in one E-CAM table. After E-CAM profile is downloaded, if it needs to be copied into EEPROM and retained when power is off, the users can use ASDA-A2 Soft software or set P2-08 to 30 and then 35 to complete the copy operation.

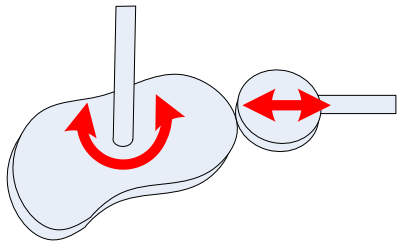


P5-81: Start Address of Data Array

P5-82: E-CAM Area Number N (E-CAM profile is divided into N areas. The E-CAM table should include N(P5-82)+1 data (points).

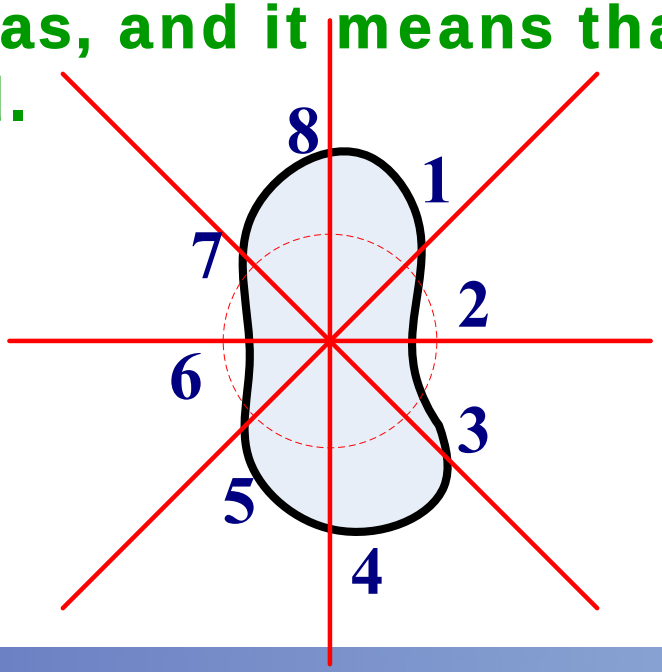
P5-85: Engage Area Number

E-CAM Profile -2

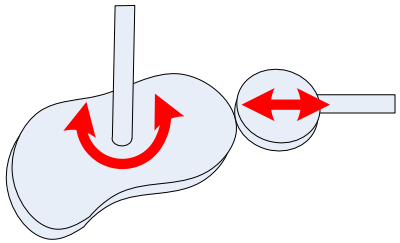


Create E-CAM Profile

Divide the E-CAM profile into equal areas.
The areas are more, the profile is more accurate.
If E-CAM profile is divided into N areas, it indicates that there are (N+1) points. In ASDA-A2 series, E-CAM profile should be divided into 5 areas at least. One E-CAM profile can be divided into max. 720 areas (Set by P5-82). It indicates that ASDA-A2 allows total 721 points in one E-CAM profile table. In the figure below, E-CAM profile is divided into 8 areas, and it means that there are 9 points should be created.

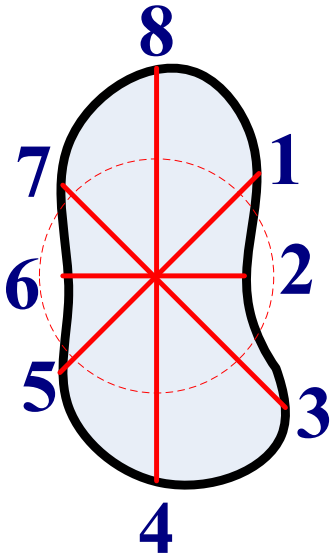


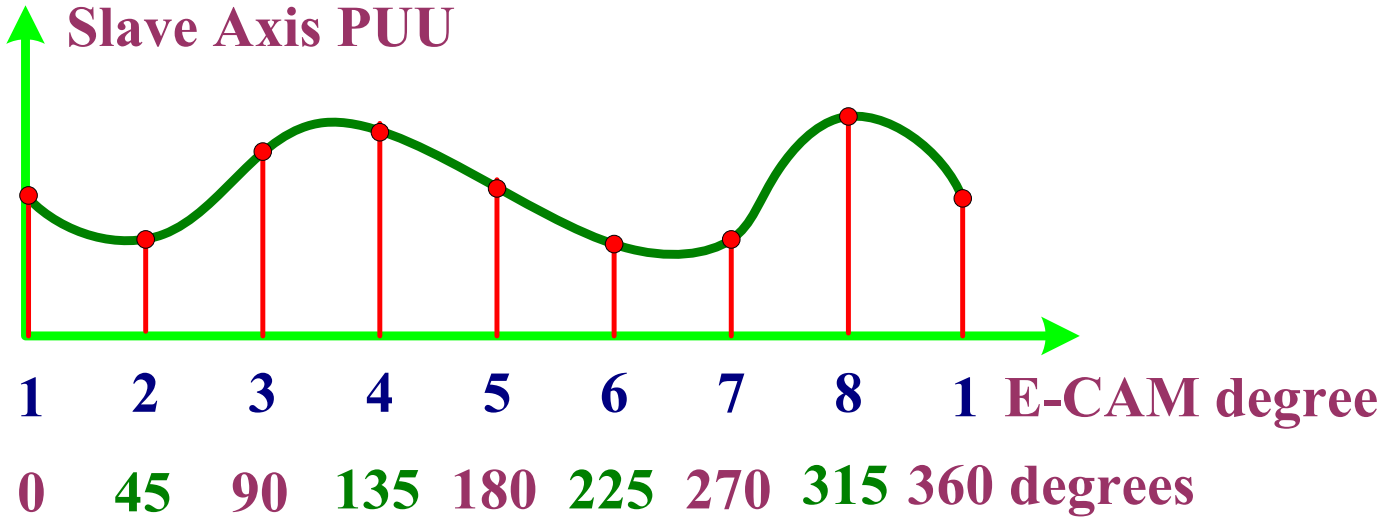
E-CAM Profile -3



Record E-CAM Profile

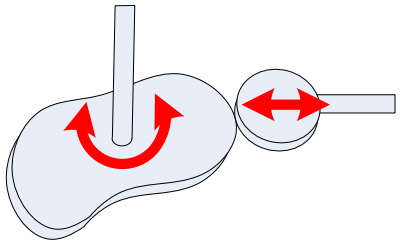
Record the distance from the intersecting line of E-CAM area and E-CAM profile to the center of the circle. Enter the data into E-CAM profile table and the E-CAM profile can be easily created.

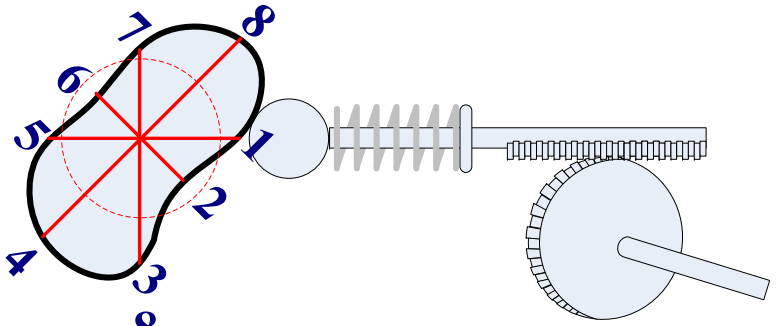


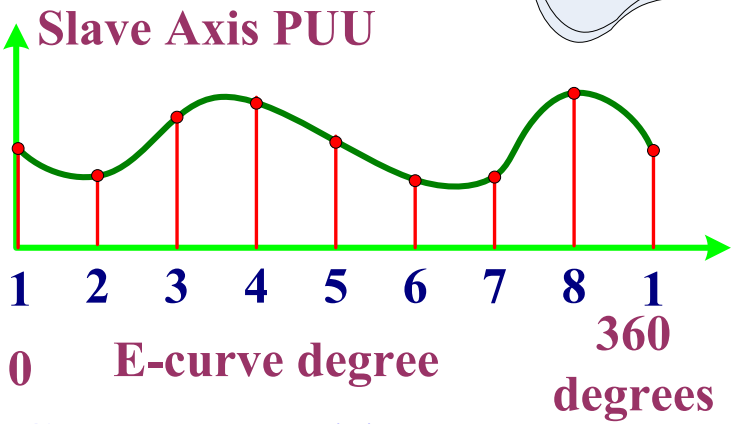


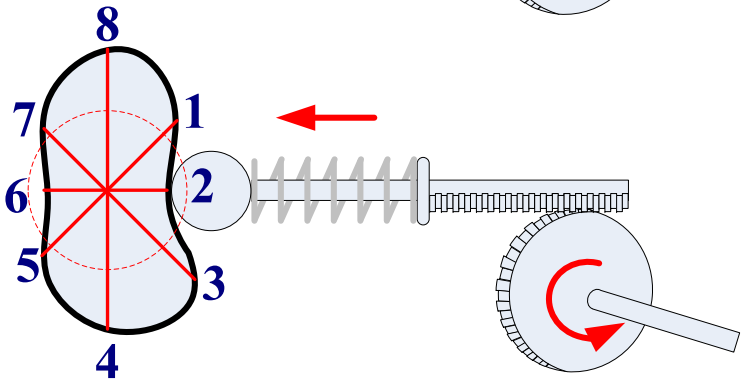
E-CAM Profile -4

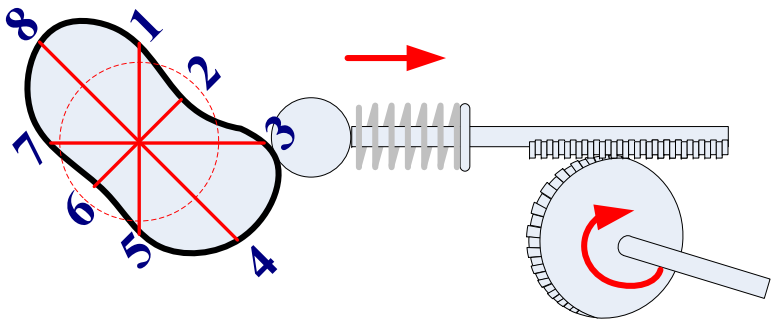
Profile Analysis

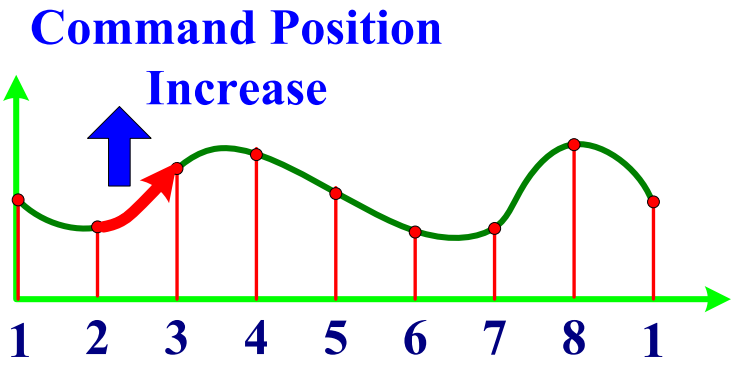




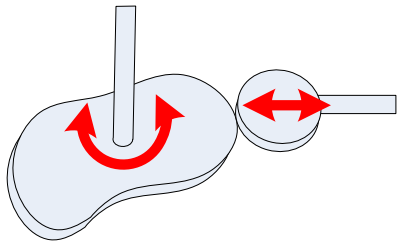






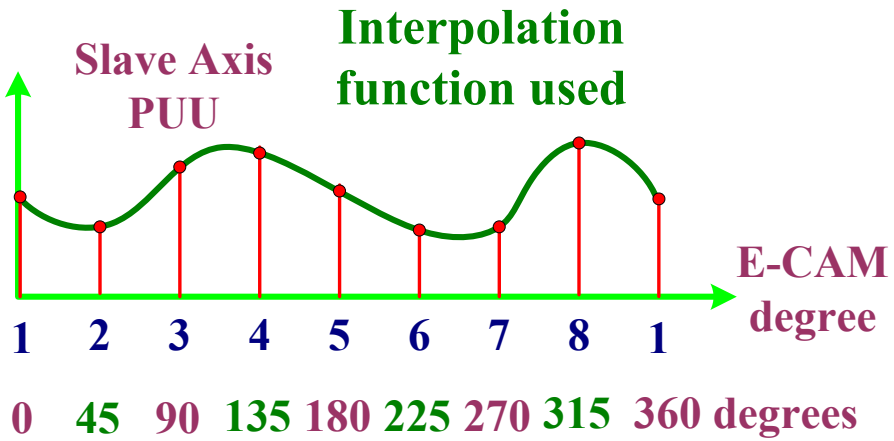


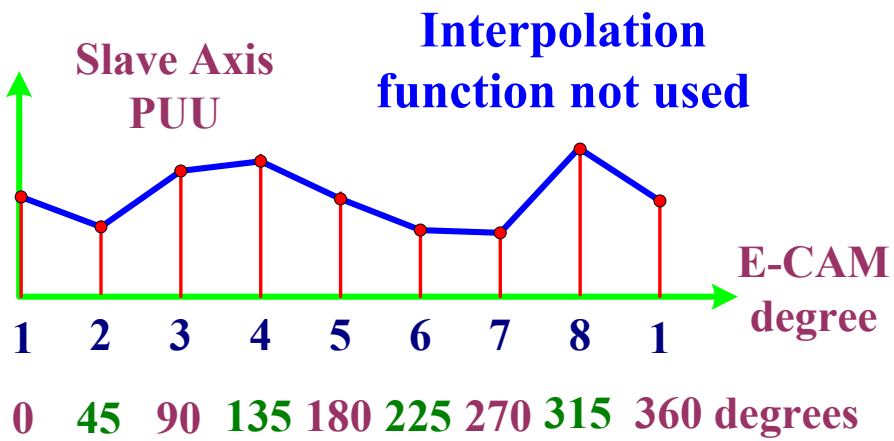
E-CAM Profile -5



Interpolation

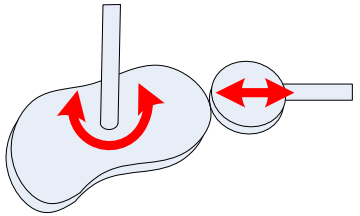
Delta ASDA-A2 series provides interpolation function. Using this function can help the users to use less points but create more smooth E-CAM profile.



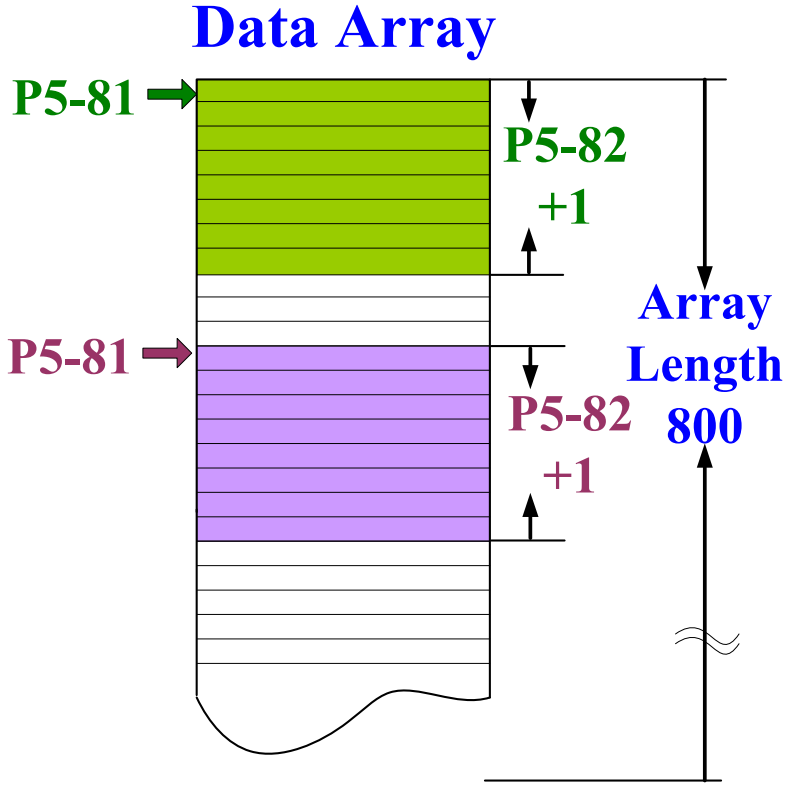


E-CAM Profile -6

Able to Save Multiple groups of E-CAM Profile

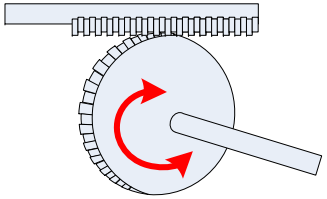


The users can save multiple groups of E-CAM profiles into data array. Up to 800 positions can be saved. Just use three parameters, P5-81(Start Address of Data Array), P5-82(E-CAM Area Number N) and P5-83(E-CAM Cycle Number (M)), changing E-CAM profile is simple.

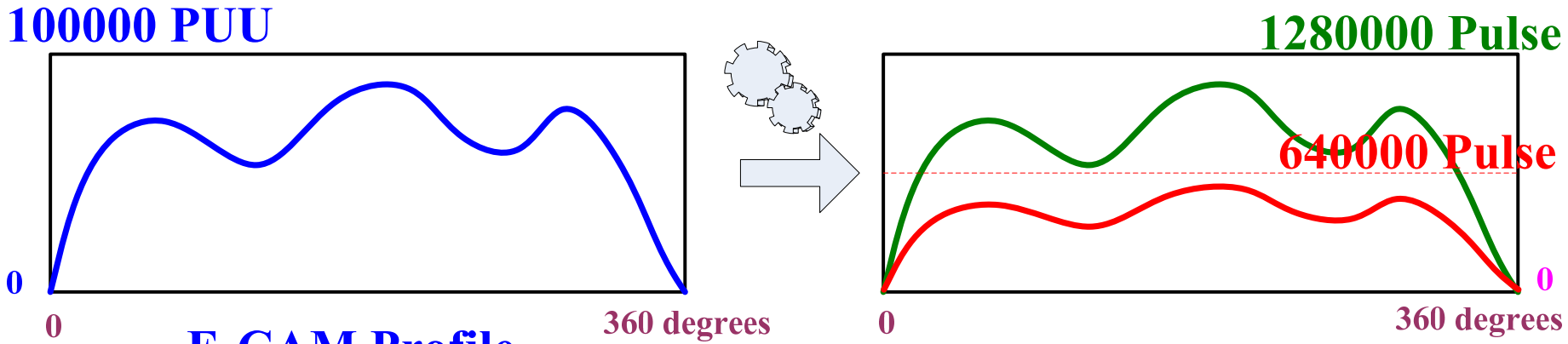


Electronic Gear of E-CAM Axis

P1-44: Electronic Gear Ratio (1st Numerator) (N1)



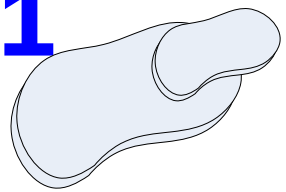
P1-45: Electronic Gear Ratio (Denominator) (M)



P1-44 =128
P1-45 = 10

P1-44 =128
P1-45 = 20

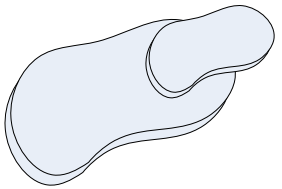
E-CAM Profile Table Magnification -1



P5-19: E-CAM Profile Table Magnification
This parameter is used to magnify or minify the E-CAM profile table.
Min. units: 0.000001 times
Range: -2147.000000 ~ 2147.000000
This parameter can be changed when E-CAM is operating. However, it is effective only when the electronic gear is engaged. This function is available in firmware V1.017 and later models only and it is similar to P1-44 and P1-45. The differences are:

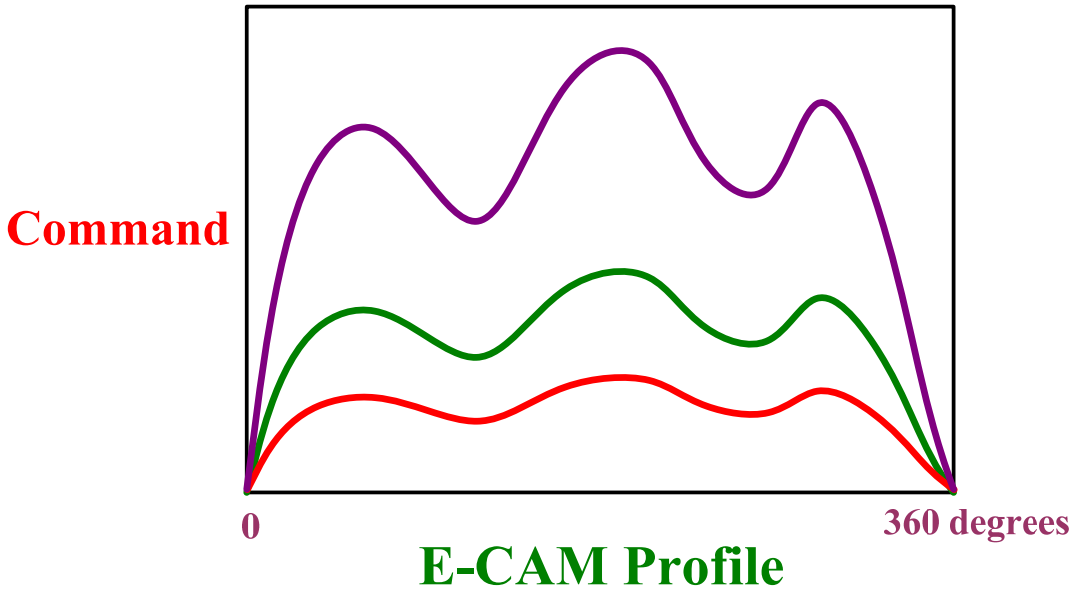
Electronic Gear Ratio	E-CAM Table Magnification
P1-44 / P1-45	P5-19
Servo Off Only	Adjustable during E-CAM operation
Affect whole system. After E-CAM function is disabled, It will becomes the system electronic gear ratio.	Affect the command regarding the E-CAM profile. Only E-CAM command will be changed.

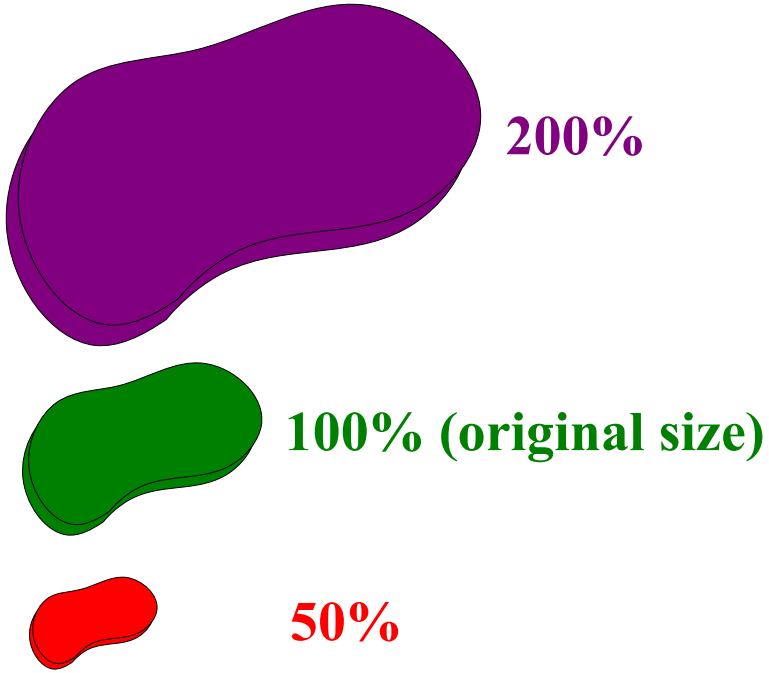
E-CAM Profile Table Magnification -2



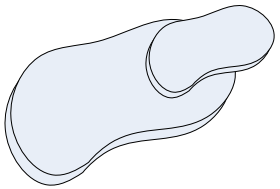
Magnification Ratio

Using P5-19 can easily enlarge and reduce the size of E-CAM profile.



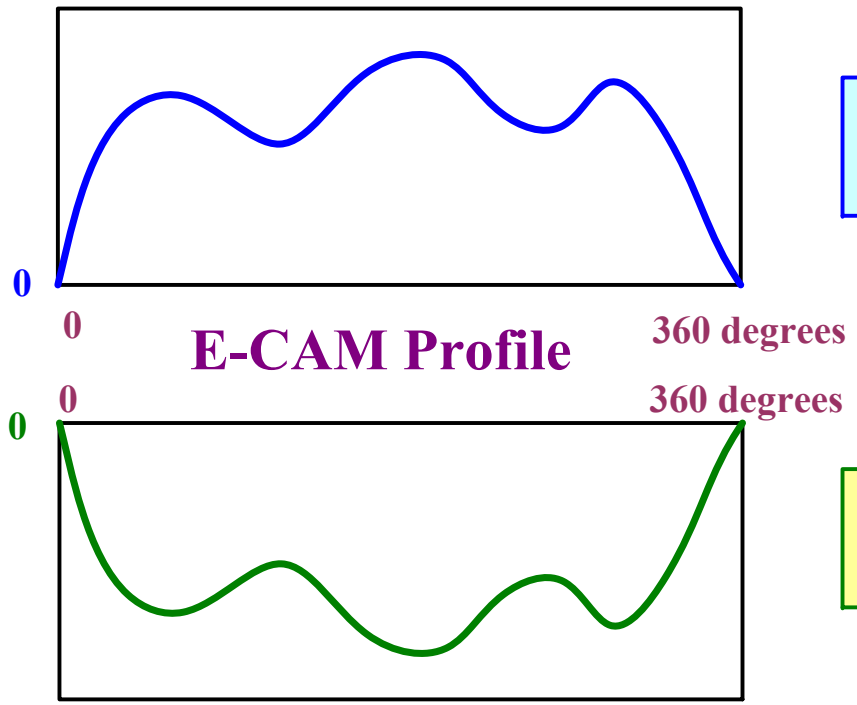


E-CAM Profile Table Magnification -3



Magnification Ratio

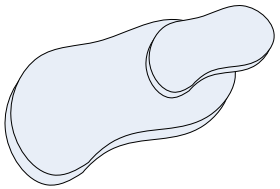
When setting P5-19 from 1 to -1, E-CAM profile will display in mirror image.



P5-19=1

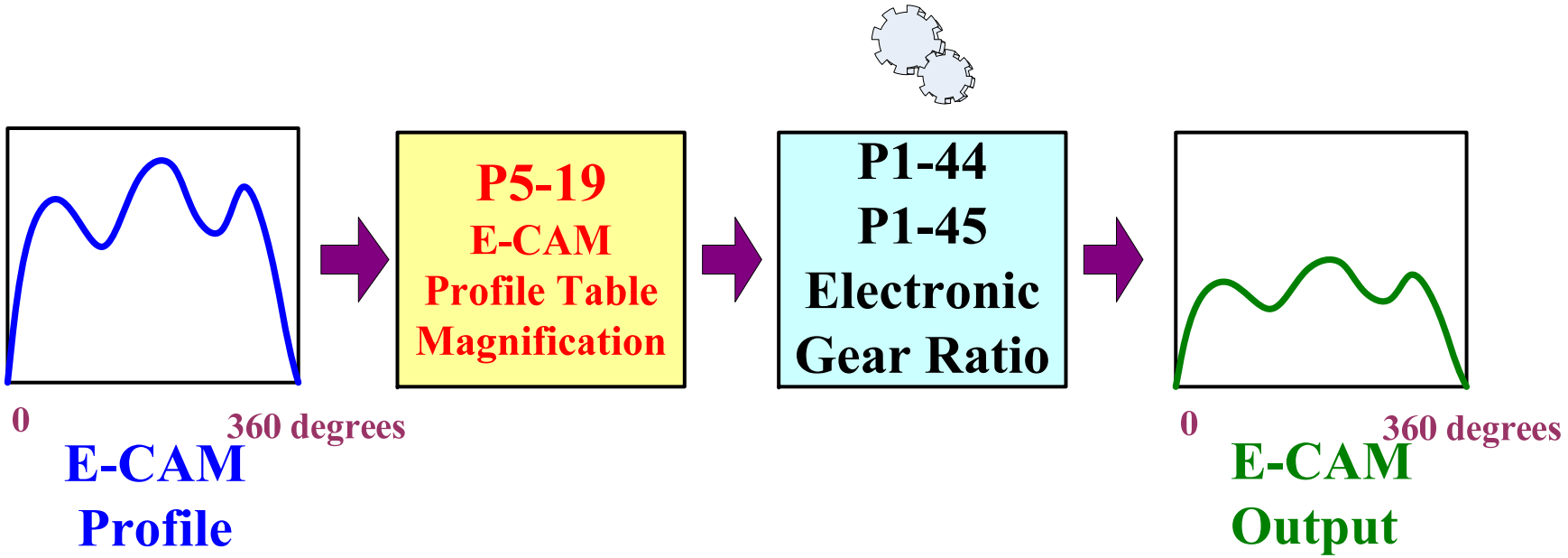
P5-19= -1

E-CAM Profile Table Magnification -4



From Command to Output

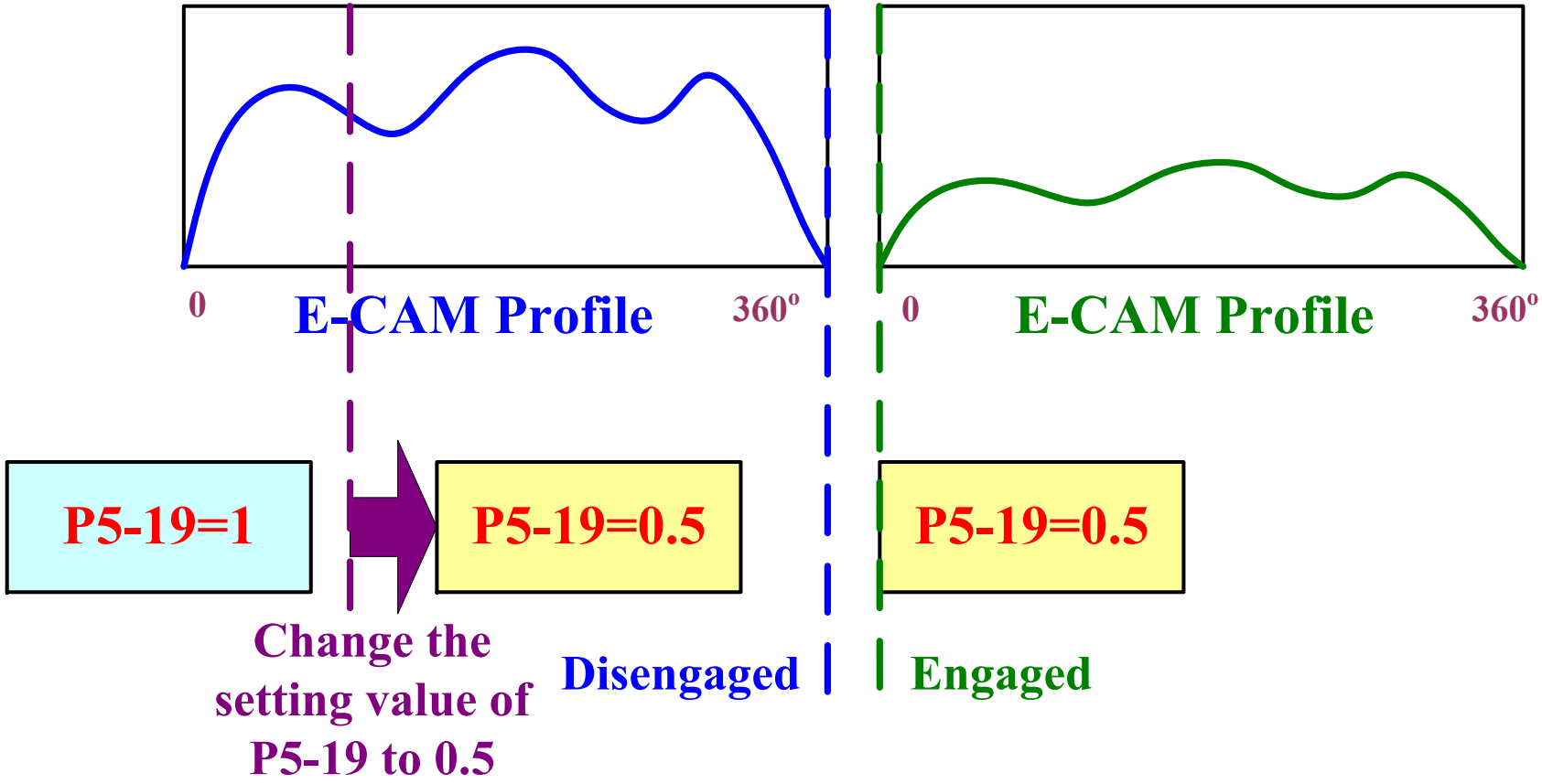
P5-19 can be regarded as another electronic gear ratio and it affect E-CAM profile only.



E-CAM Profile Table Magnification -5

Adjust Magnification during Operation

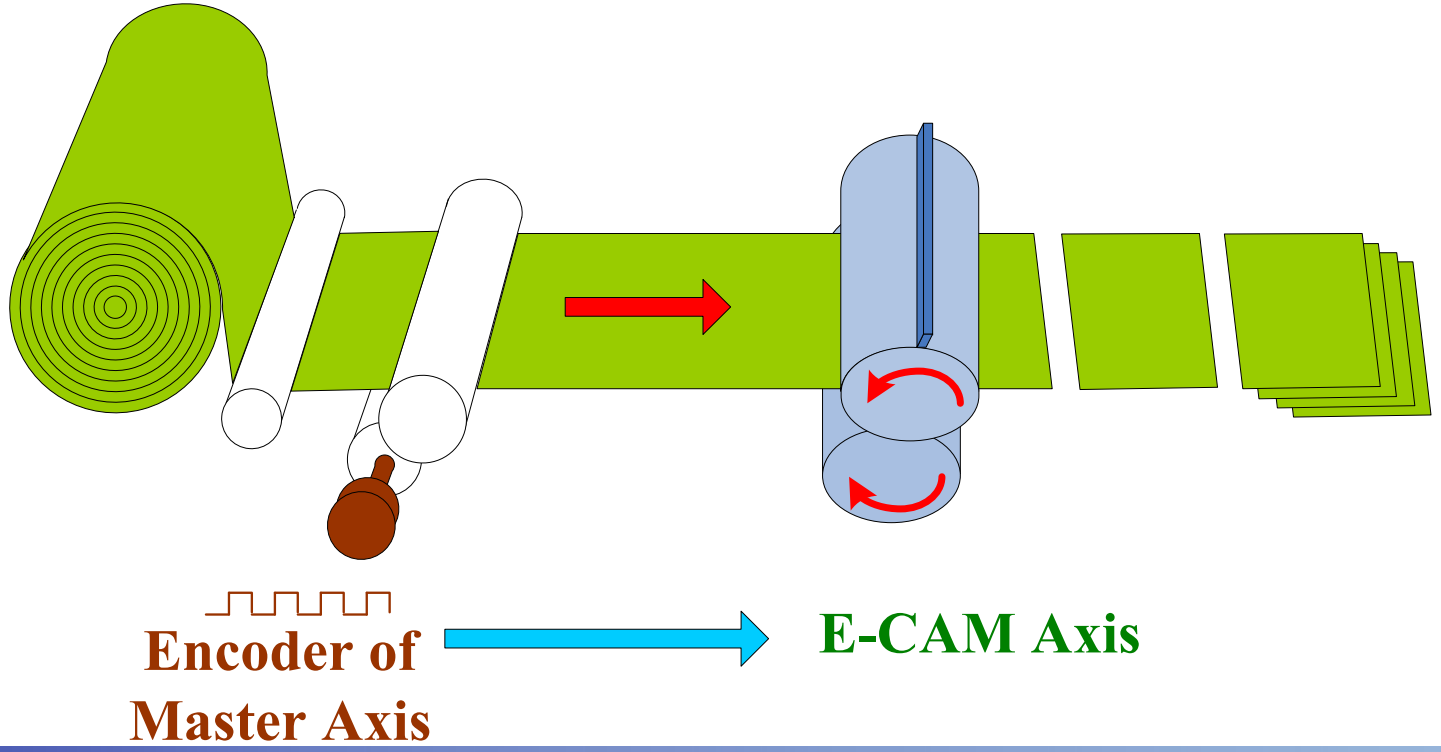
After P5-19 is changed, the setting will be effective only when the electronic gear is engaged next time.



Rotary Knife System -1

Rotary Knife System Introduction

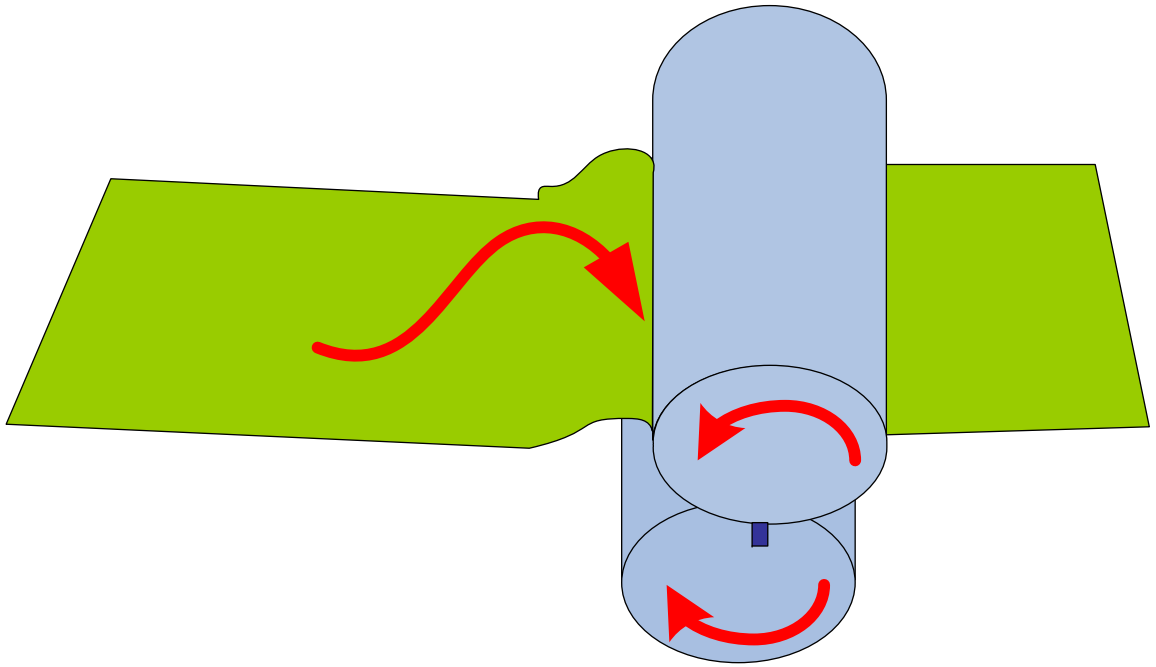
When the rotary knife is cutting, the conveyer which sends the materials will not stop. Therefore, when the rotary knife of the cutting axis touches the cutting materials, the speed of the rotary knife should match the speed of the conveyer.



Rotary Knife System -2

When the speed of the rotary knife is slower than the speed of the material feeding system (Conveyer)

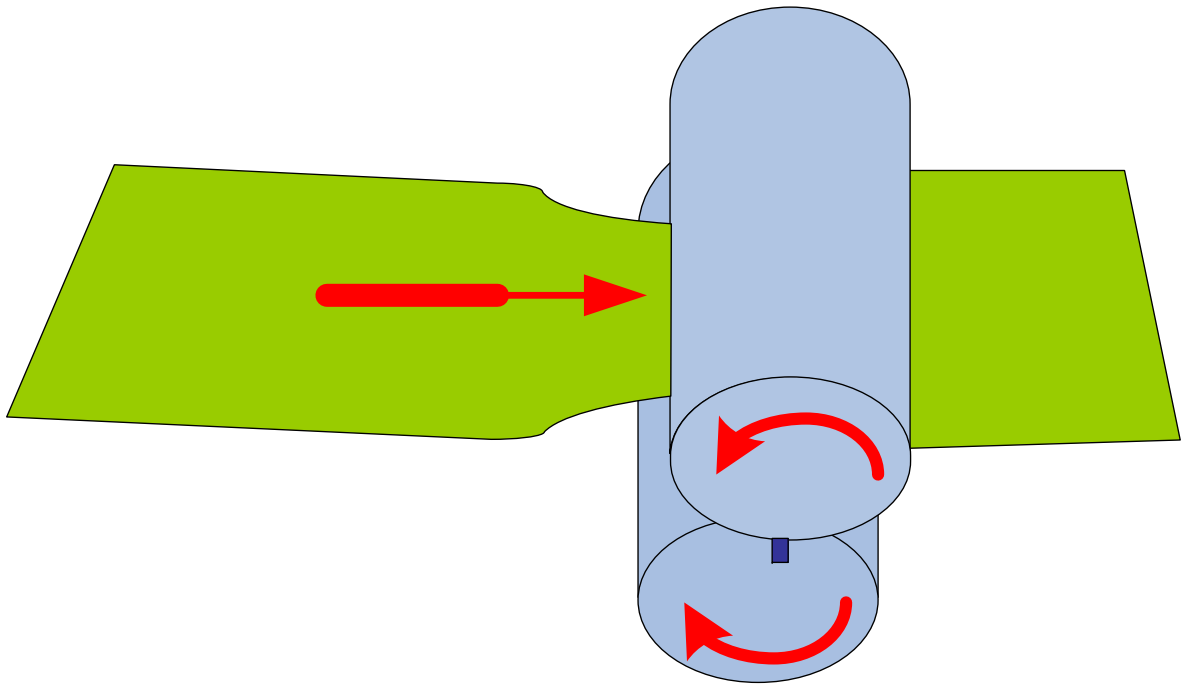
When the cutting operation is executed, if the speed of the rotary knife is slower than the speed of the material feeding system, the materials will be stacked up on the conveyer.



Rotary Knife System -3

When the speed of the rotary knife is faster than the speed of the material feeding system (Conveyer)

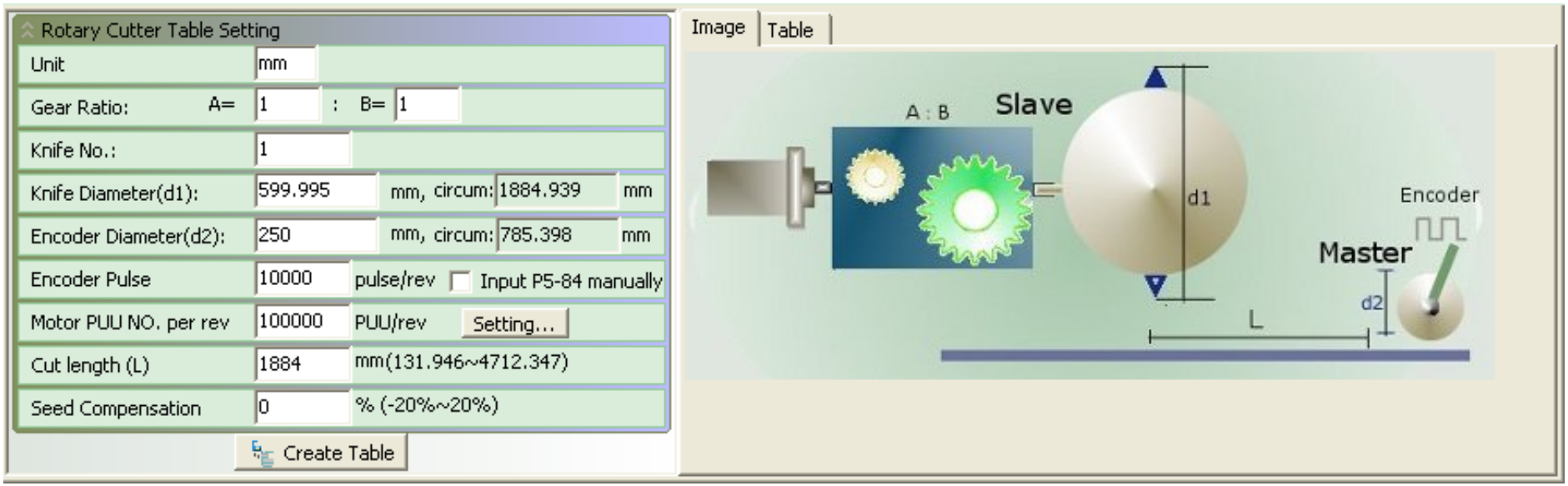
When the cutting operation is executed, if the speed of the rotary knife is faster than the speed of the material feeding system, the materials will be pulled apart and damaged.



Software Settings for Rotary Knife Application -1

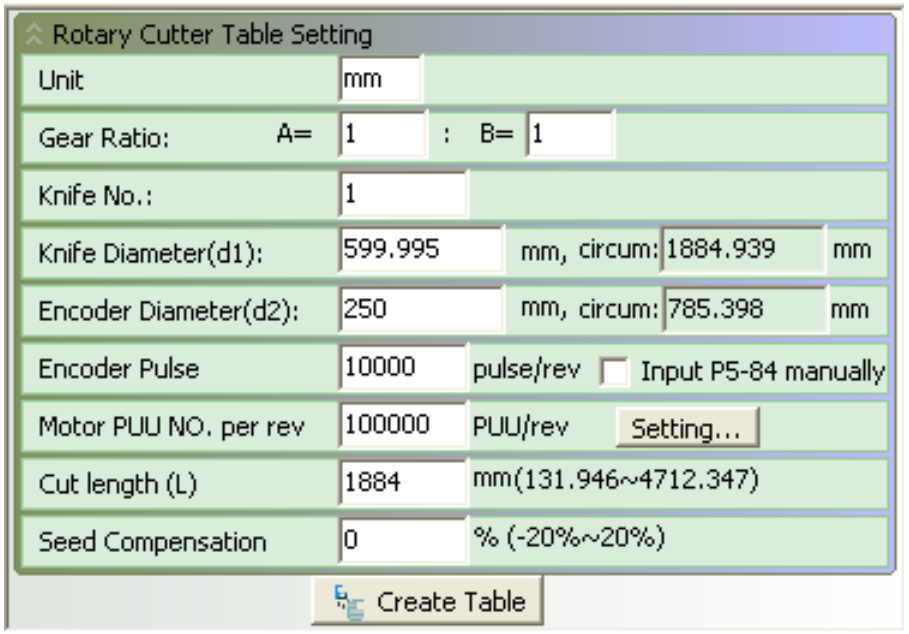
ASDA-A2 Rotary Cutter Table Setting Function

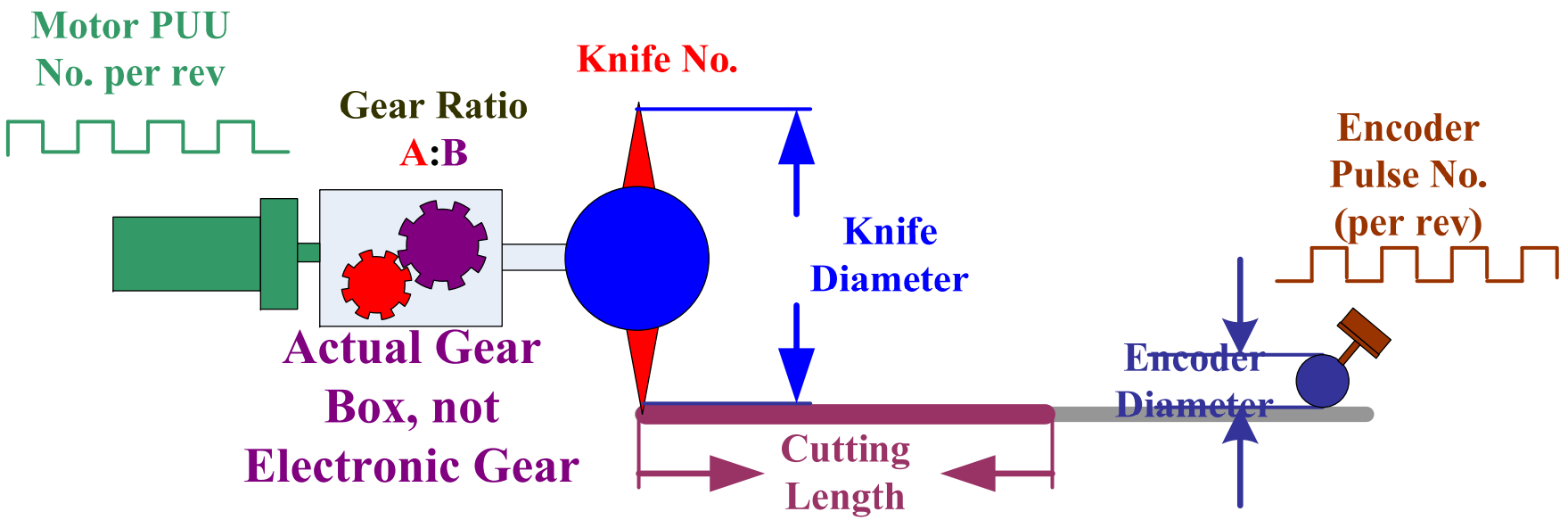
ASDA-A2 provides the user-friendly software settings which assist the users to easily create E-CAM profile for rotary knife application.



Software Settings for Rotary Knife Application -2

Rotary Cutter Table Setting for Rotary Knife Application



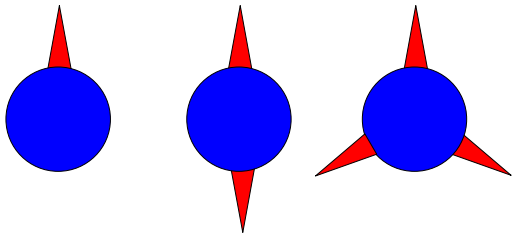


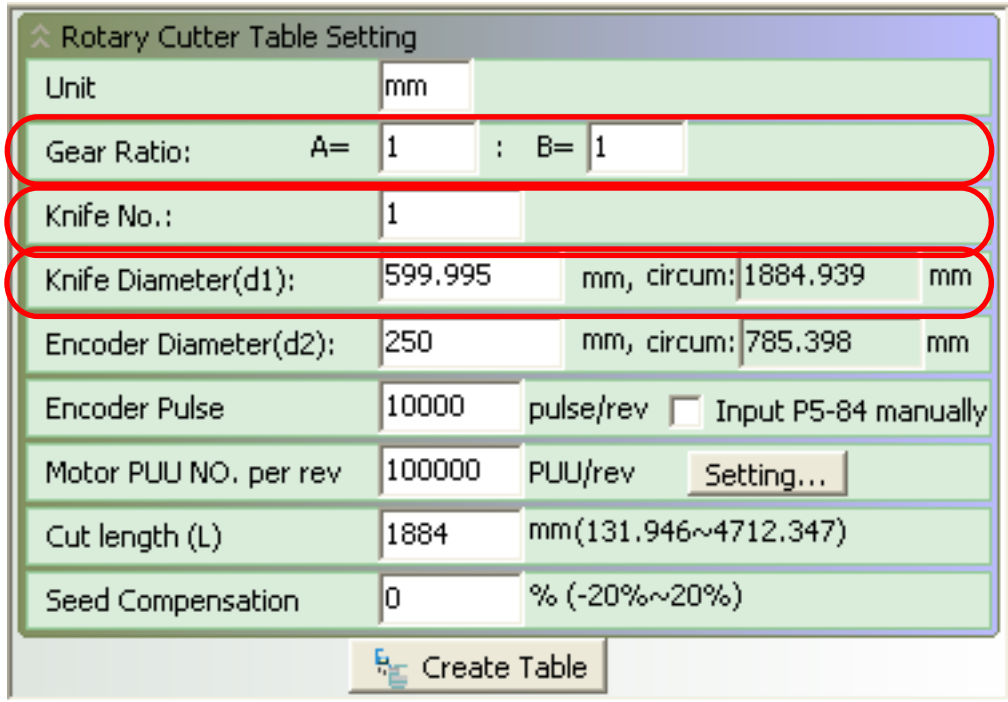
Software Settings for Rotary Knife Application -3

Gear Ratio and Rotary Knife Settings

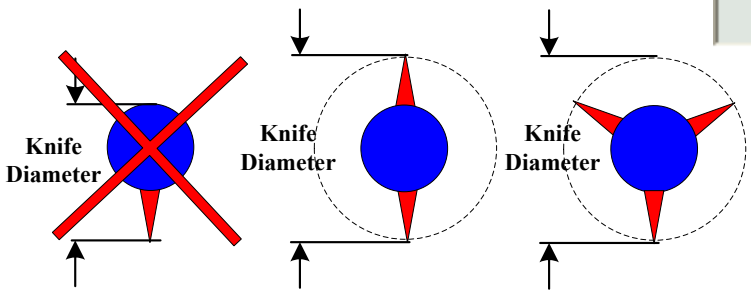
Gear Ratio: Actual gear box, not electronic gear ratio
If there is no actual gear box, please set A:B to

Knife No. :





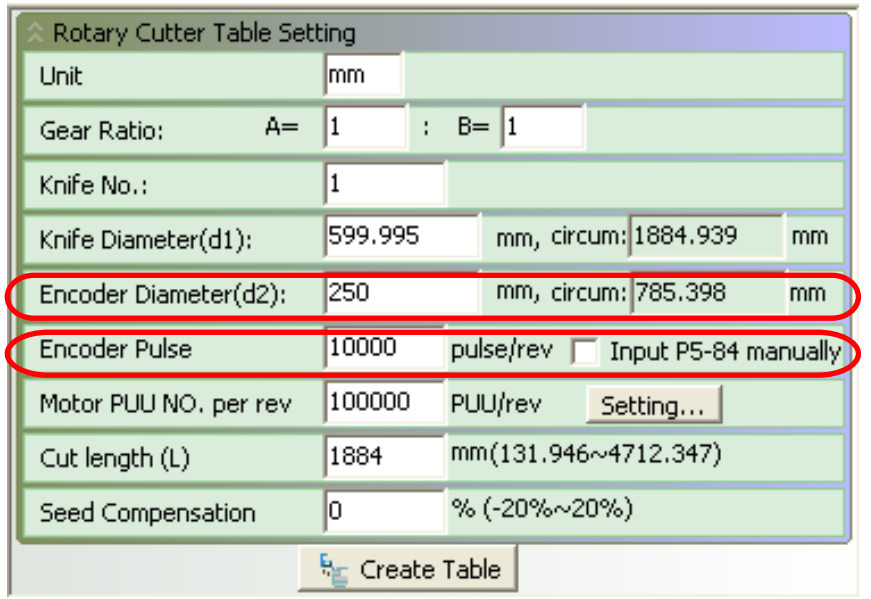
Knife Diameter:
No matter how many knifes are used, the knife diameters are all the same.



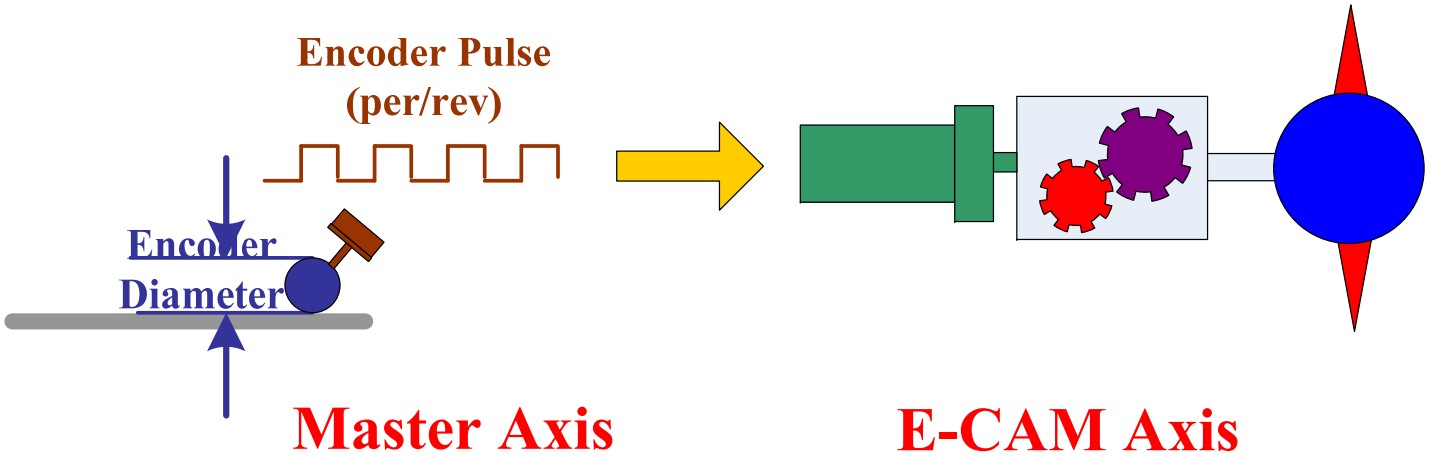
Software Settings for Rotary Knife Application -4

Master Axis Settings:

Encoder Diameter:
Used to calculate the material feeding length. There should be slippage or drift between encoder wheel and materials.



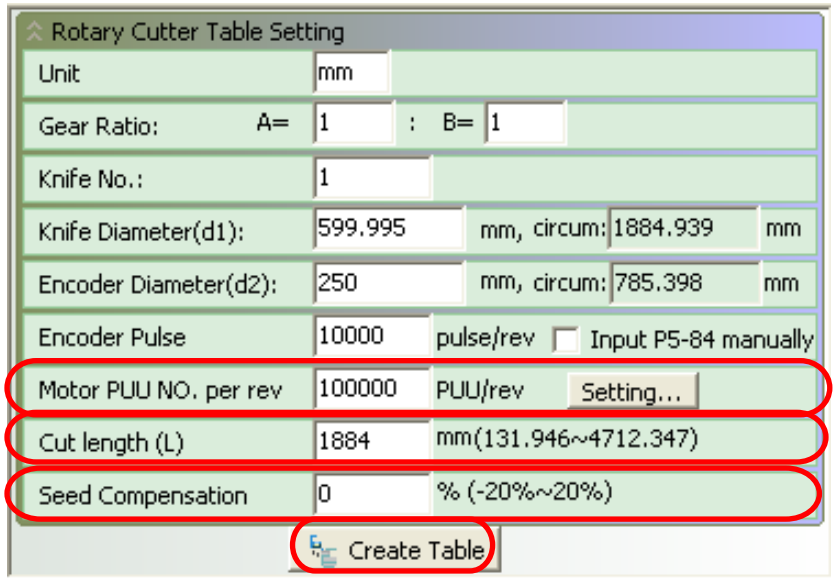
Encoder Pulse:
Pulse number of master axis.
Used to command the E-CAM axis belong to the cutter.



Software Settings for Rotary Knife Application -5

E-CAM and other Settings:

Motor PUU Number (per / rev):
The system will set the electronic gear ratio (P1-44,P1-45) of E-CAM axis by referring this setting value.



Cut Length: Desired cut length

Speed Compensation:
Used to adjust the cut length

Create Table:
When all settings are completed, click “Create Table” button, the system will automatically create the E-CAM profile and profile table needed for rotary knife application.

Software Settings for Rotary Knife Application -6

E-CAM Profile Table for Rotary Knife System

When “Create Table” button is clicked, the system will automatically create the E-CAM profile and profile table which is needed for rotary knife application.

Image | Table

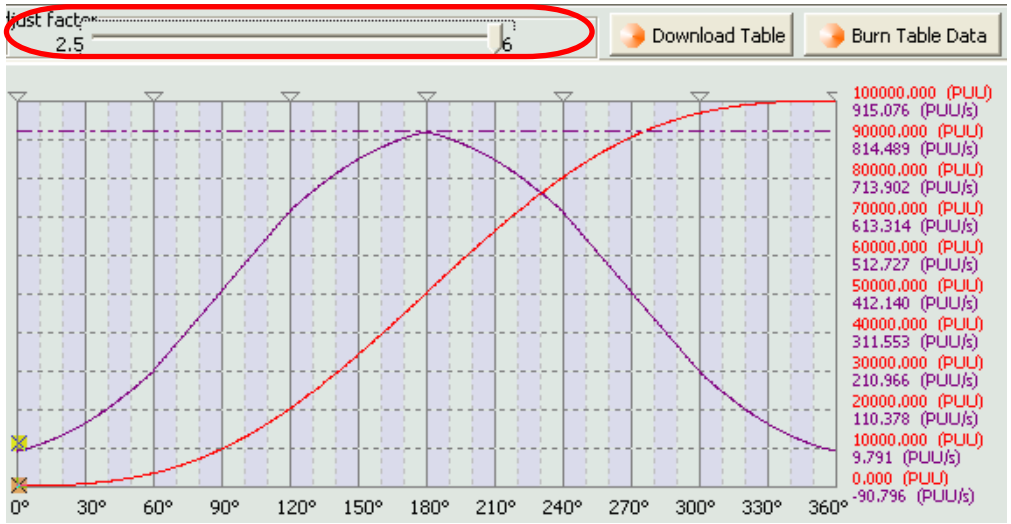
P5-81 : Data Array start position	100
P5-82: E-CAM Points: N(5~720)	7
P5-83: E-CAM Cycle Number: M	1
P5-84: E-CAM Pulse Number of Master-axis: P	23987 (Pulse Number of Master-axis P,

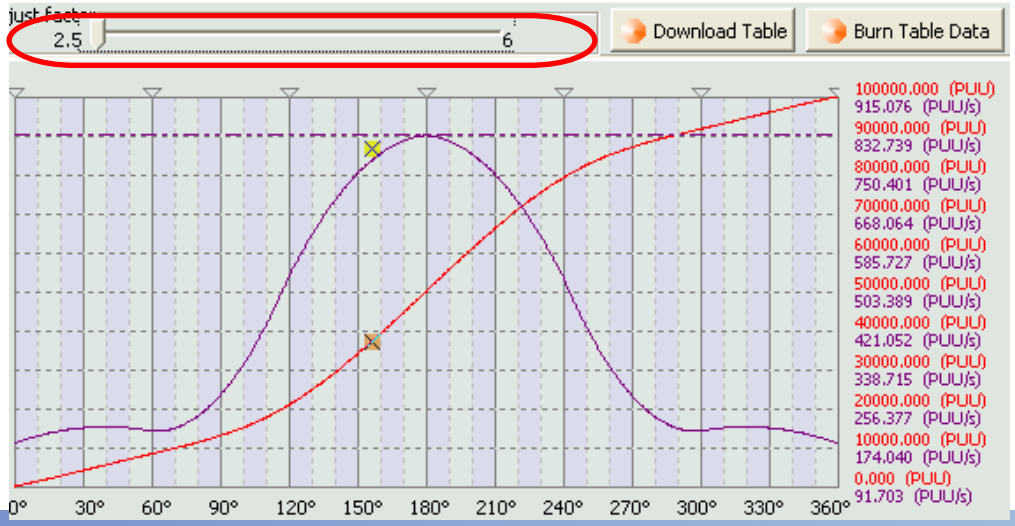
	0	1	2	3	4	5	6	7
θ[°]	0	51.4285714	102.857142	154.285714	205.714285	257.142857	308.571428	36
Postion Y	0	14292	28579	42860	57139	71420	85707	10

Software Settings for Rotary Knife Application -7

Adjust E-CAM Profile

The users can use “Adjustment Bar” to adjust the E-CAM profile.

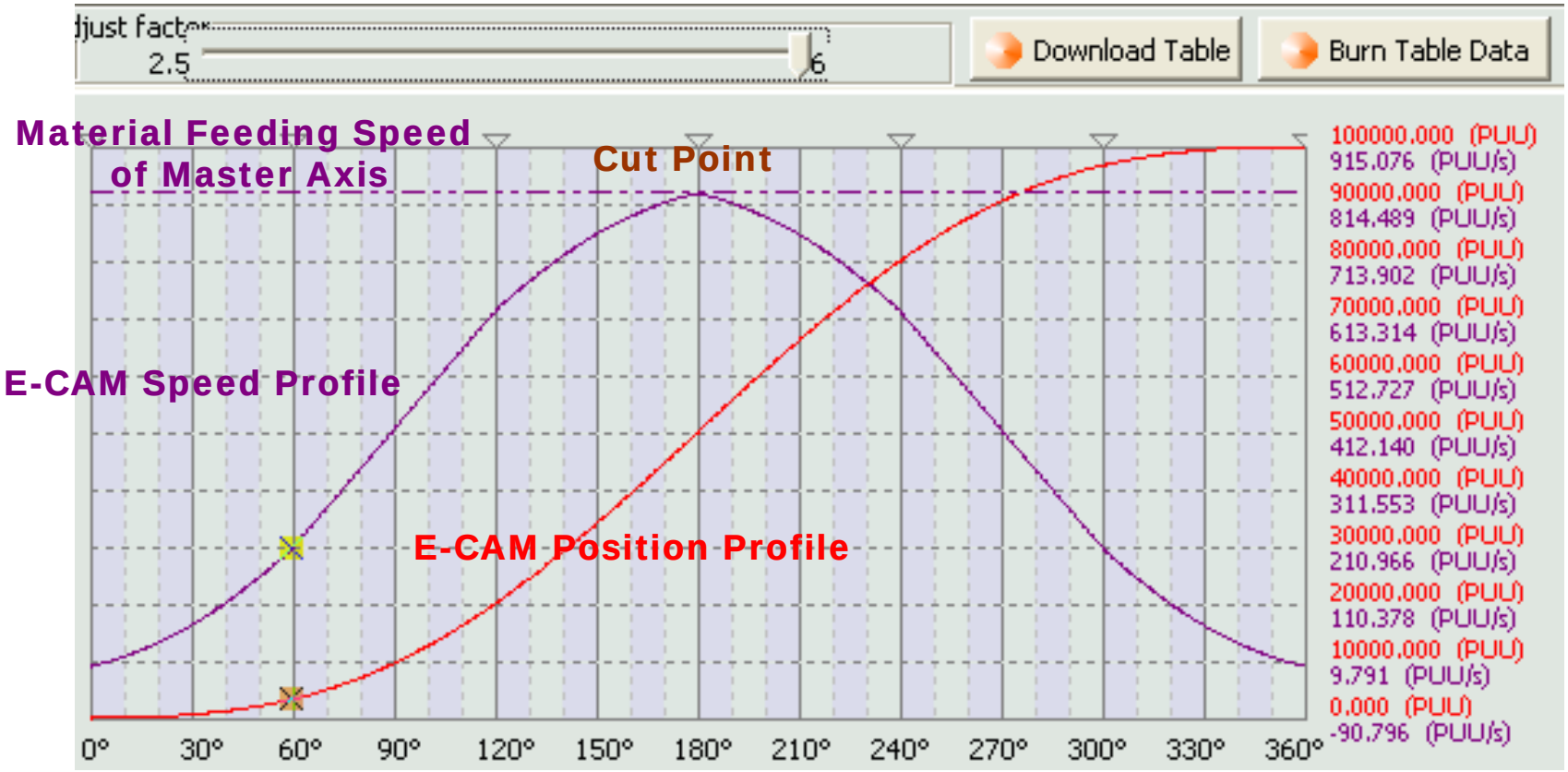




Software Settings for Rotary Knife Application -8

Download Table / Burn Table Data (Record Table Data)

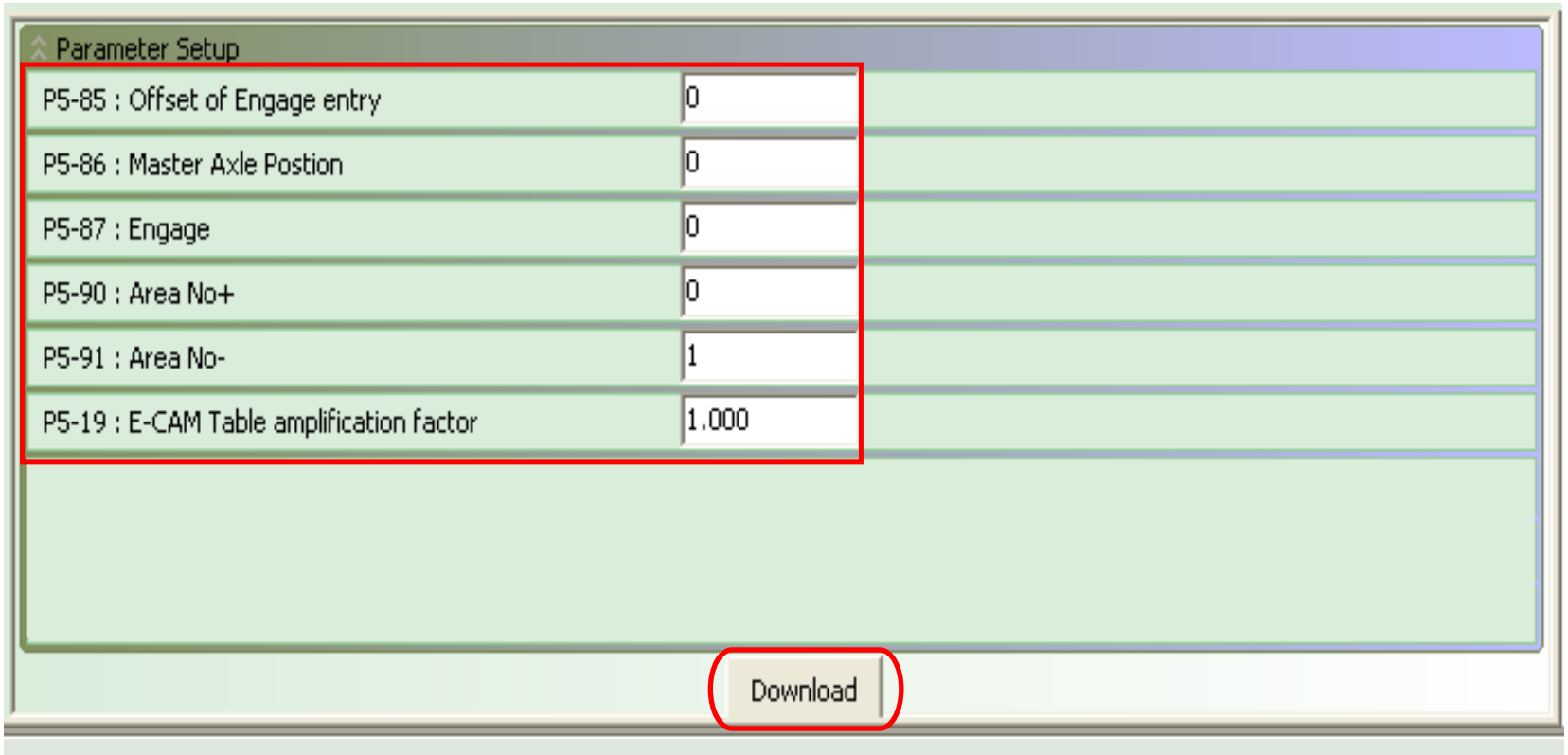
After profile adjustment is completed, please download E-CAM profile table first and then record the data into EEPROM of the servo drive. Please note that the operation of recording data into EEPROM is allowed only when the servo drive is under the status of Servo Off.



Software Settings for Rotary Knife Application -9

Parameters of E-CAM Table

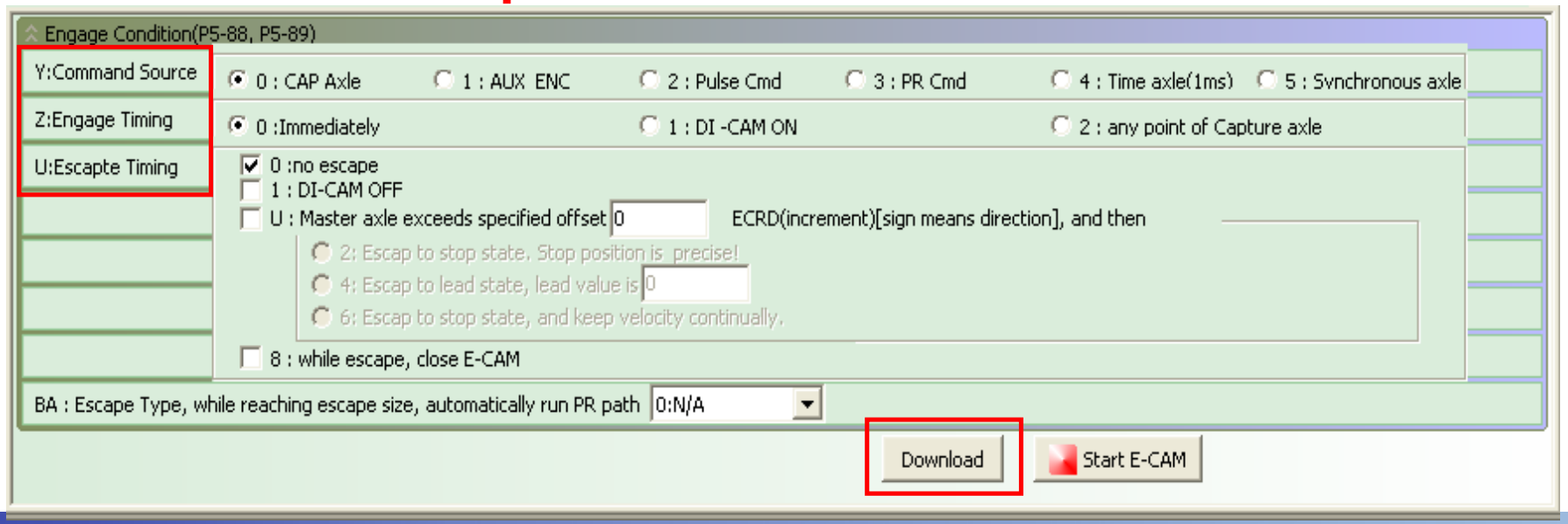
ASDA-A2 Soft configuration software will not fill these parameters automatically. Therefore, the users need to download them from the servo drive and set them manually.



Software Settings for Rotary Knife Application -10

E-CAM Parameters

As ASDA-A2 Soft configuration software will not set P5-88 and P5-89 automatically, please set the settings of these two parameters and download them from the servo drive according to actual conditions. After the above actions are made, it indicates that the settings of rotary knife system are completed as well. This option is designed for the users to perform trial run easily. After trial run is finished, when the system is initialized, please use Pr mode to complete the settings of P5-88 as this parameter setting value will not retained when power is off.



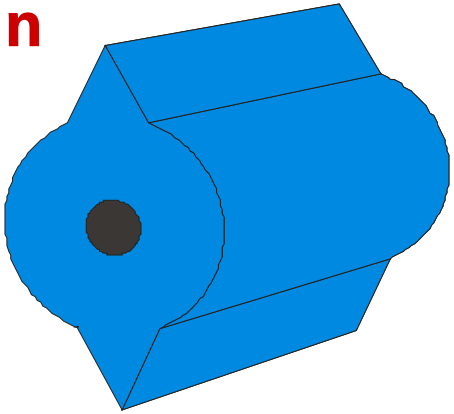
Software Settings for Rotary Knife Application -11

E-CAM Profile without Synchronization Function

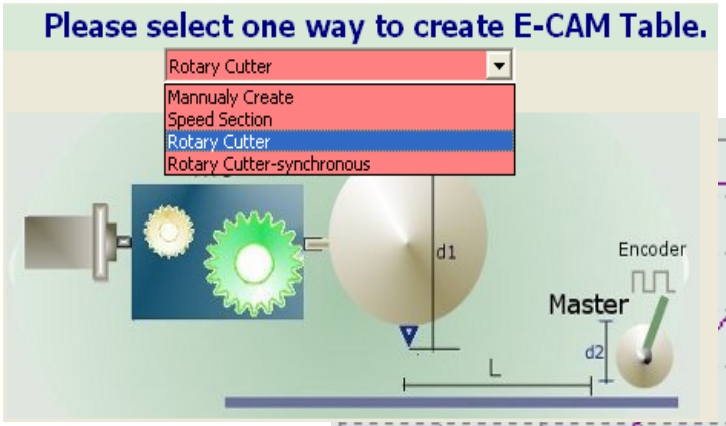
The profile range created by this function is:

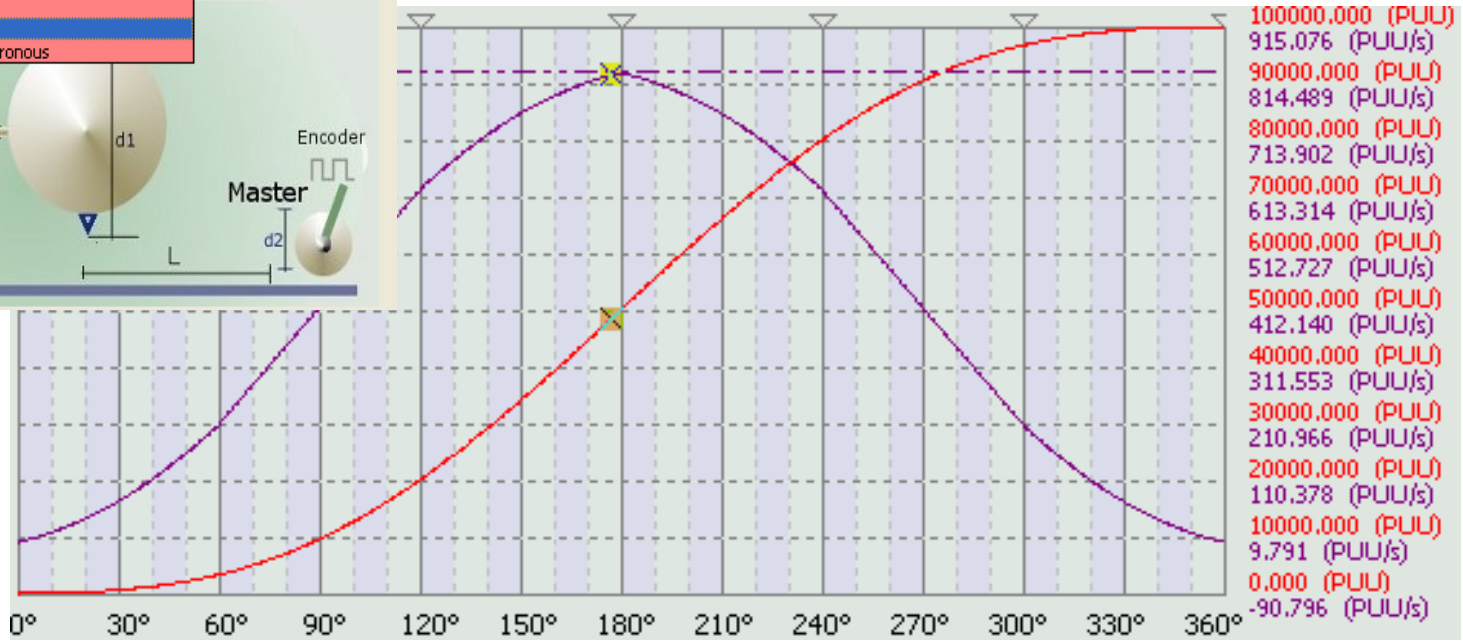
"0.3a ≦ A ≦ 3a" **A: Cut Length**

a: Knife Interval Distance



The head of the rotary knife is a sharp knife.





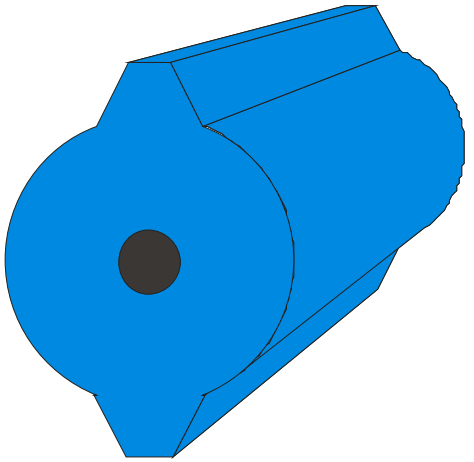
Software Settings for Rotary Knife Application -12

E-CAM Profile with Synchronization Function

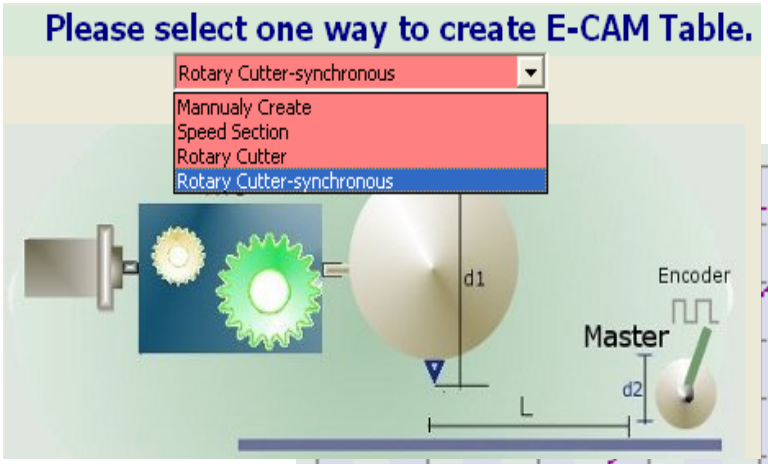
The profile range created by this function is:

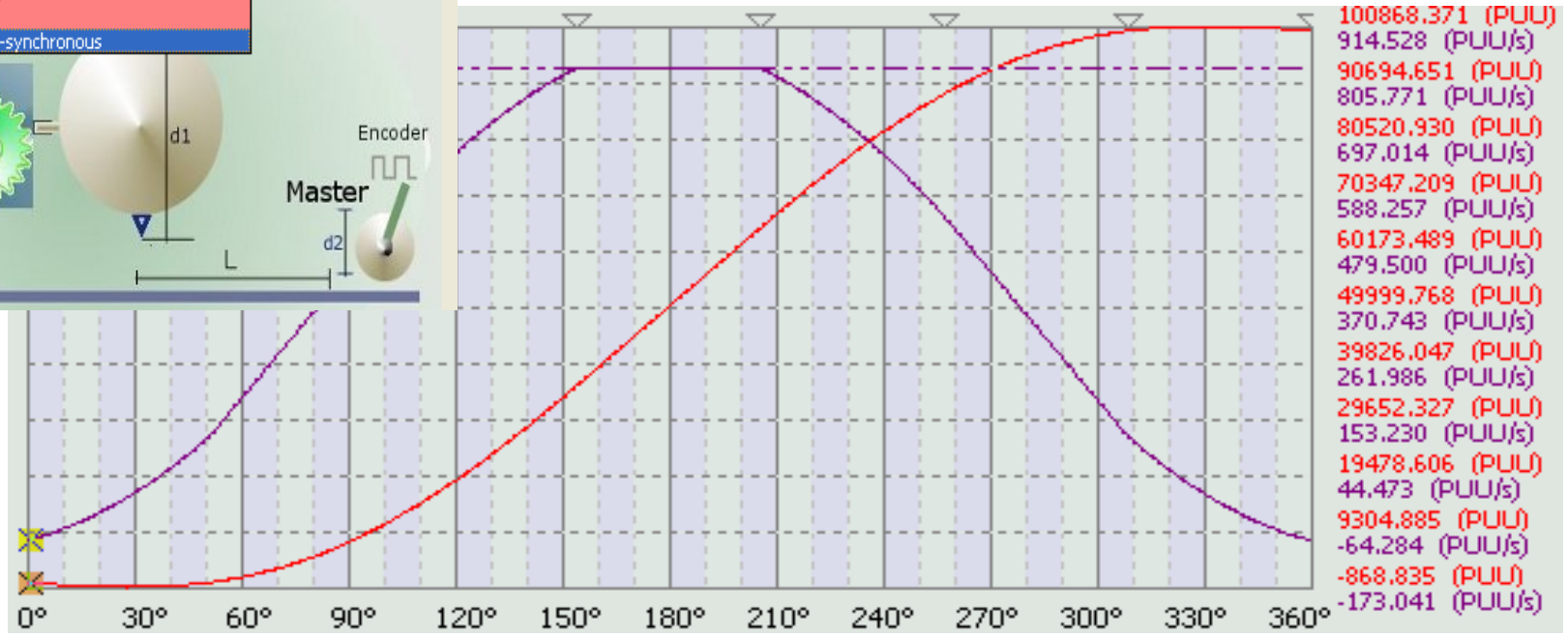
"0.07a ≦ A ≦2.5a" **A: Cut Length**

a: Knife Interval Distance



The head of the rotary knife is a flat knife.

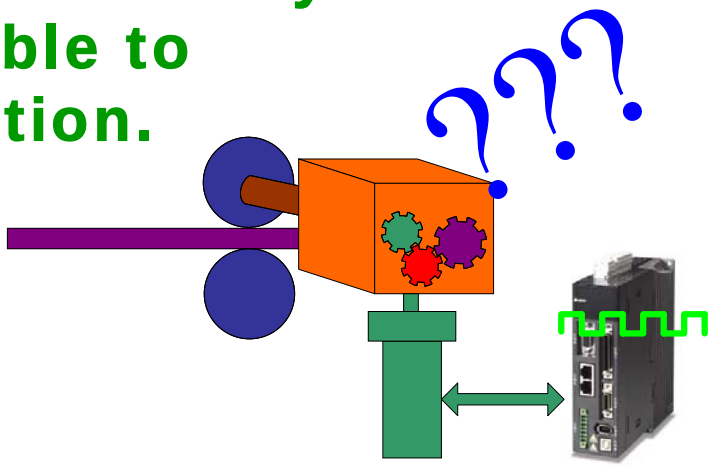


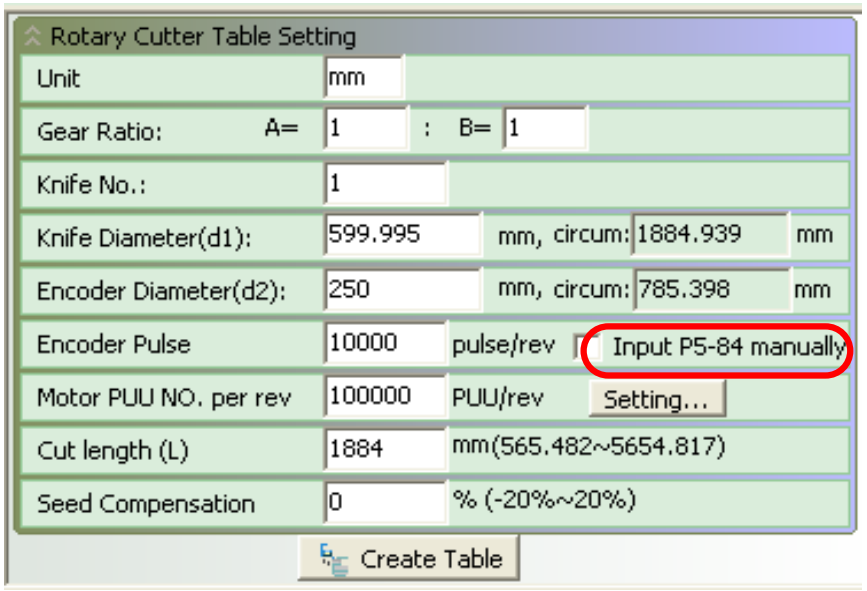


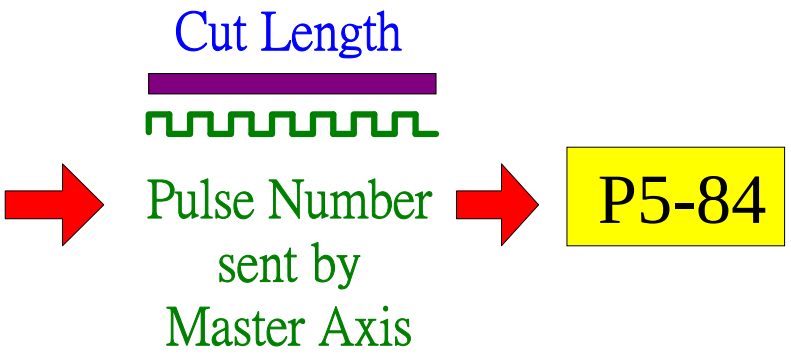
Software Settings for Rotary Knife Application -13

When the encoder diameter of master axis could not be measured:

When the master axis is changed to AC drive or another servo drive, or when the mechanical system is complicated, the system may not be able to measure the encoder pulse per revolution. At this time, the users can choose to input the setting value of P5-84 directly to solve this problem.



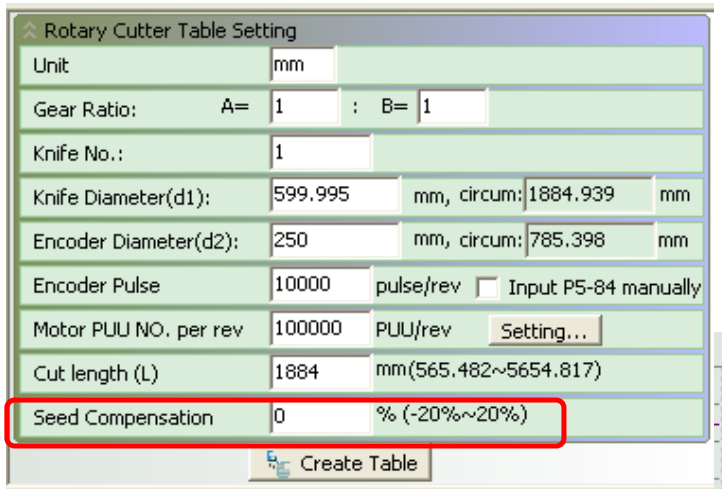


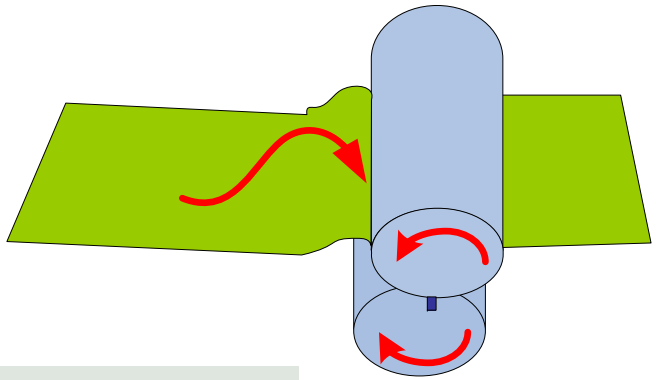


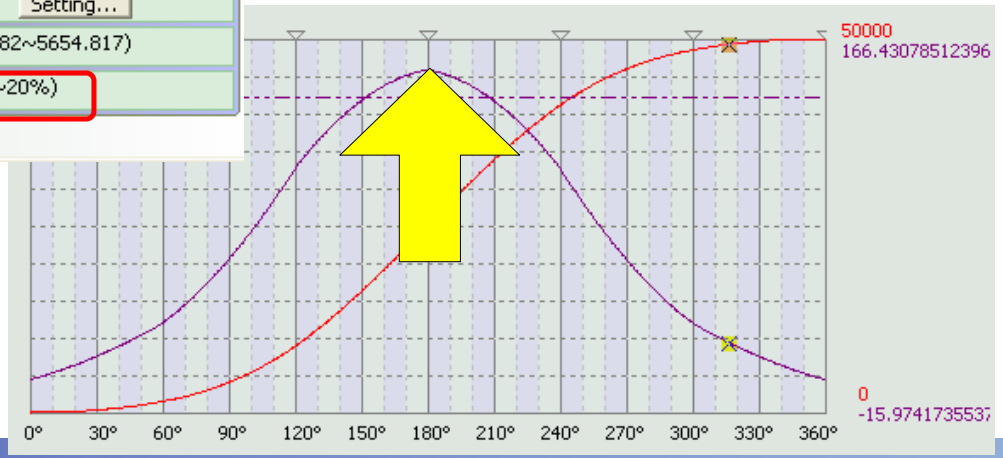
Speed Compensation for Rotary Knife Application -1

When the speed of the rotary knife is slower than the speed of the material feeding system (conveyer)

After completing all rotary knife settings, if the speed of the rotary knife is slower than the speed of the material feeding system, the users can use ”Speed Compensation” function to adjust the speed of the rotary knife or examine all rotary knife settings again to check if all of the settings are correct.



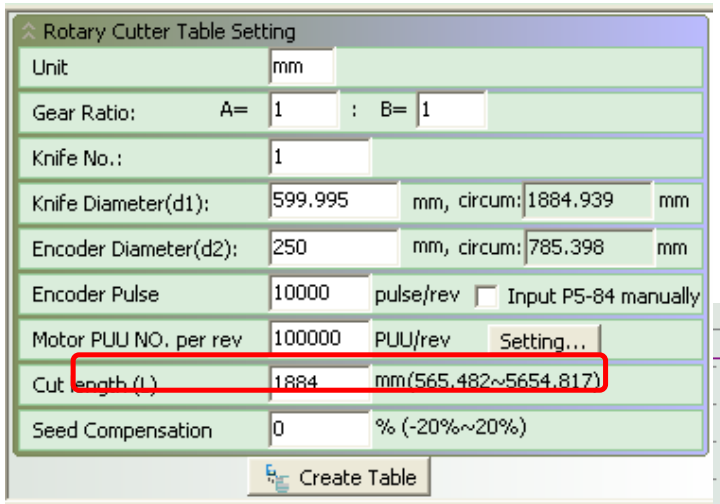


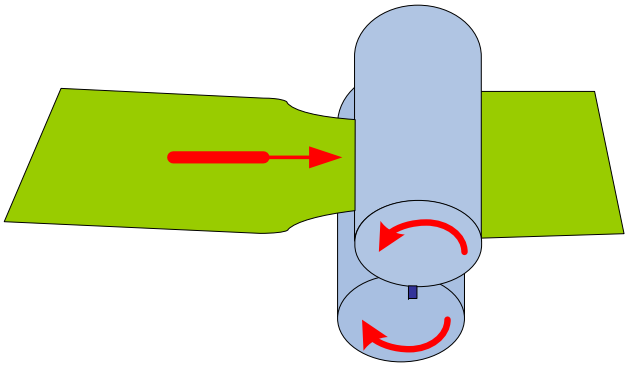


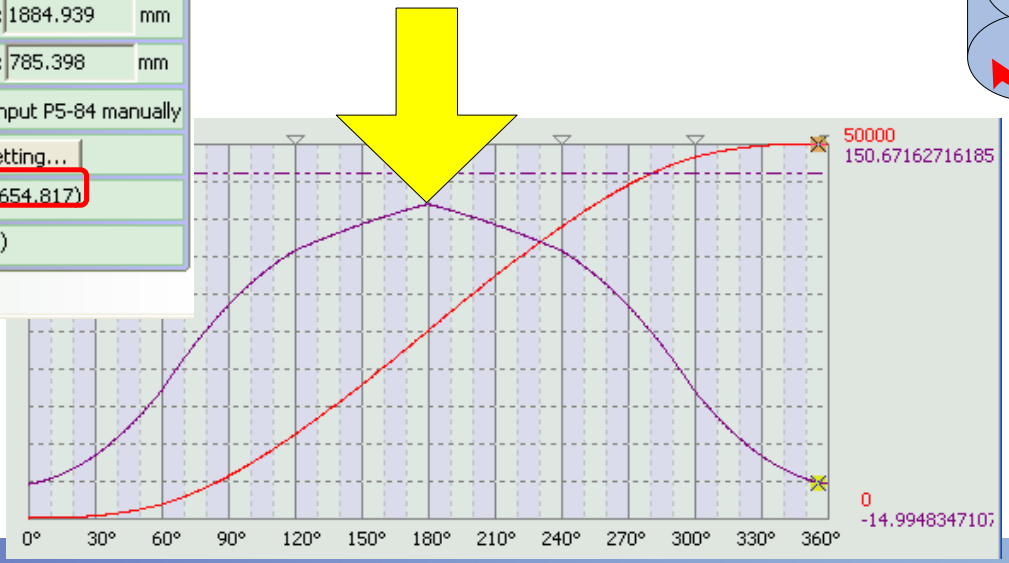
Speed Compensation for Rotary Knife Application -2

When the speed of the rotary knife is faster than the speed of the material feeding system (conveyer)

After completing all rotary knife settings, if the speed of the rotary knife is faster than the speed of the material feeding system, the users can use ”Speed Compensation” function to adjust the speed of the rotary knife or examine all rotary knife settings again to check if all of the settings are correct.







Auto Create E-CAM Profile for Rotary Knife Application -1

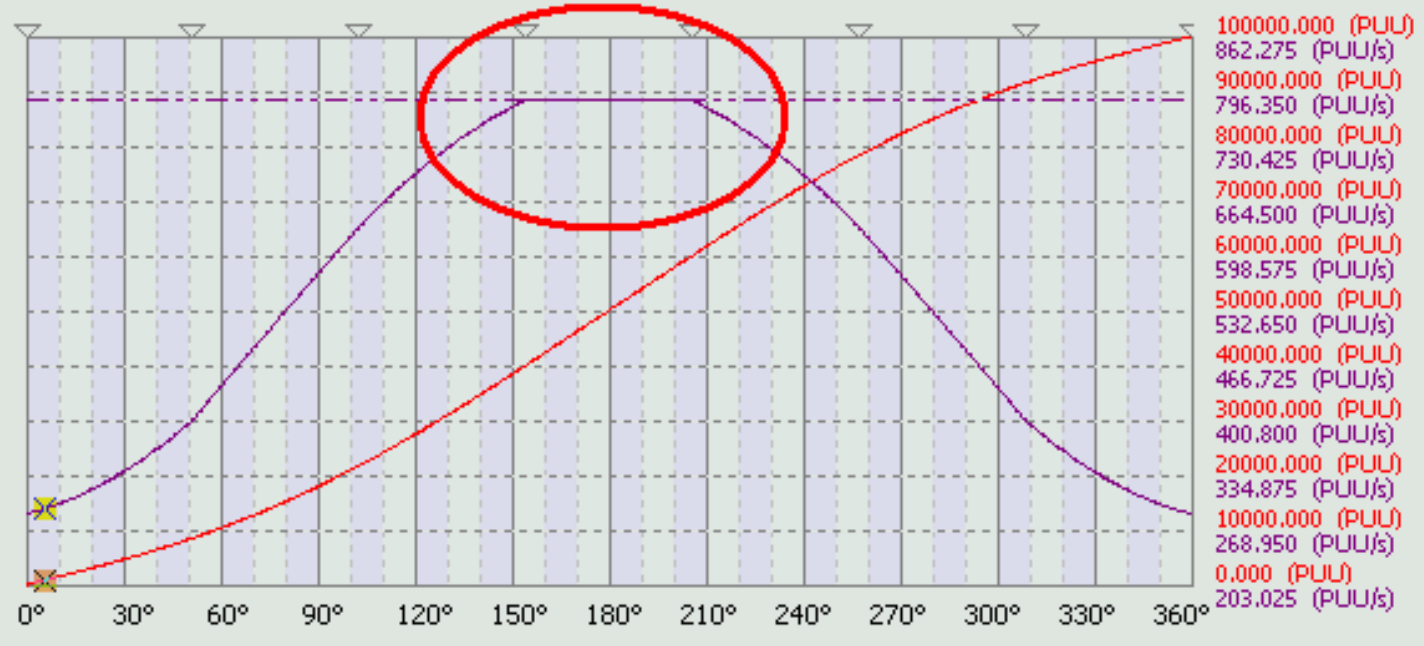
Create E-CAM Profile with Synchronization Function for Rotary Knife Application

The profile range created by this function is:

”0.05 a ≦ A ≦2.5a” A: Cut Length

a: Knife Interval Distance

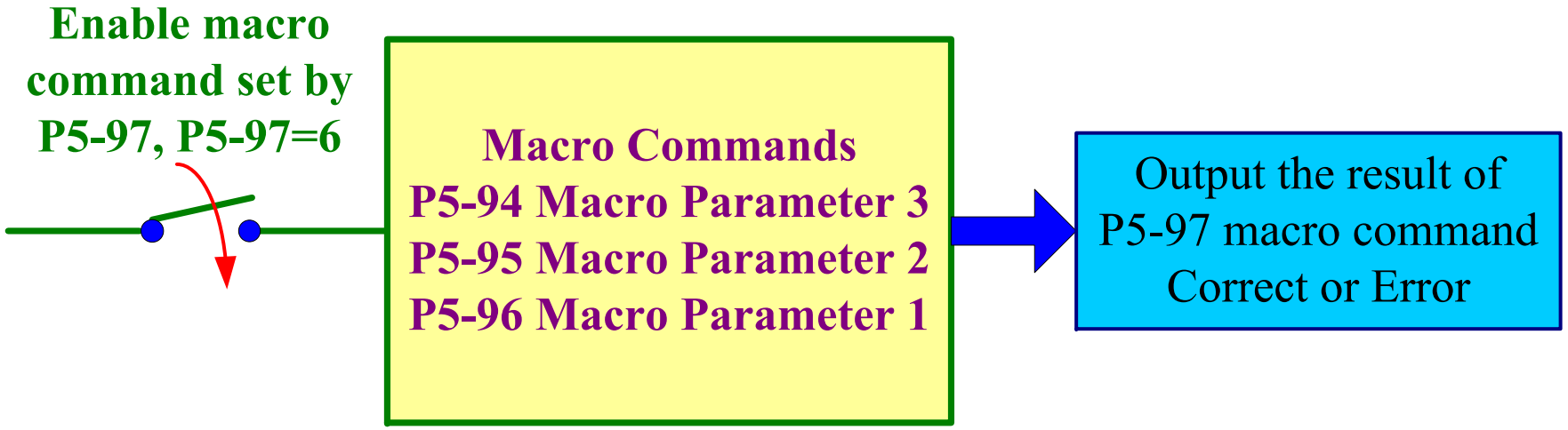
This function is available in firmware V1.024 and later models only.



Auto Create E-CAM Profile for Rotary Knife Application -2

Create E-CAM Profile by using Macro Command

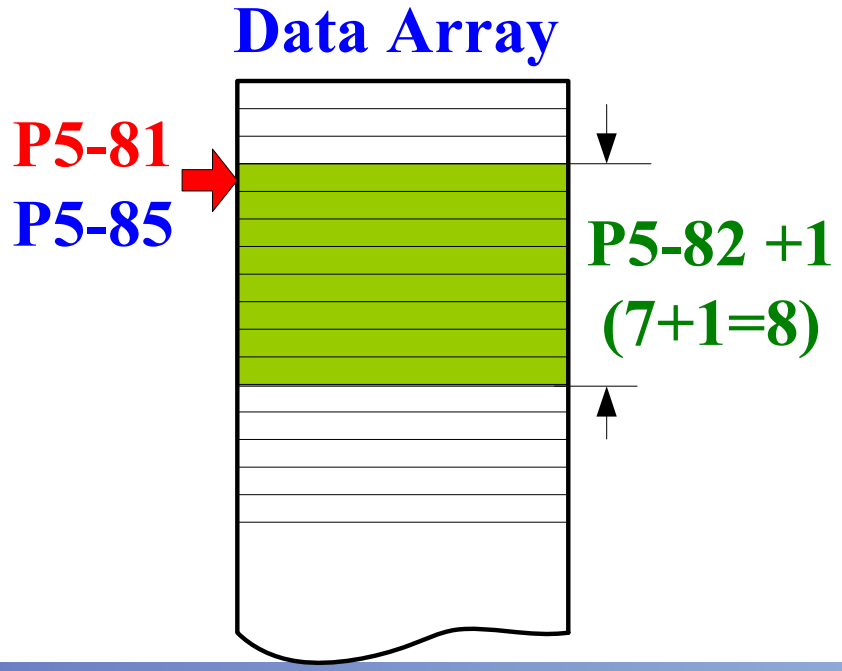
This method is to use new “Macro Command” parameters to create E-CAM profile within the servo drive. The advantage of using this method is to help the host (external) controller be able to change E-CAM profile quickly. It can be applied for the applications which need to change the cut length very often.



Auto Create E-CAM Profile for Rotary Knife Application -3

Steps – Setting System Parameter 1

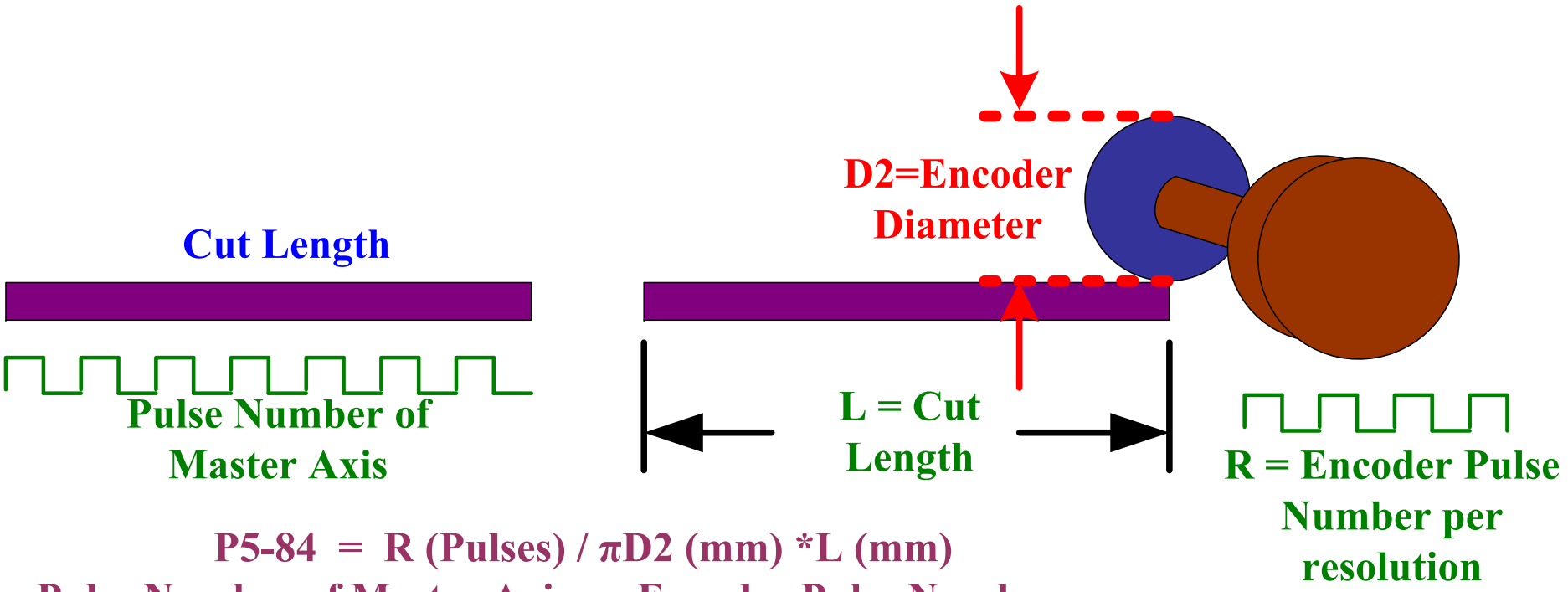
1. P5-81 = Start Address of Data Array. Set the start point of E-CAM table.
2. P5-82 = E-CAM Area Number N. Set the divided parts of E-CAM table. The number is fixed as 7 (total 8 points)
3. P5-85 = 0(Engage Area Number) Set the E-CAM area number when the electronic gear is engaged.



Auto Create E-CAM Profile for Rotary Knife Application -4

Steps – Setting System Parameter 2

4. P5-83 = 1 (E-CAM Cycle Number (M))
5. P5-84 = Pulse Number of Master Axis (P)



P5-84 = R (Pulses) / πD2 (mm) *L (mm)

Pulse Number of Master Axis = Encoder Pulse Number per resolution / encoder circumference x Cut Length

Auto Create E-CAM Profile for Rotary Knife Application -5-1

Steps – Setting Macro Paramters

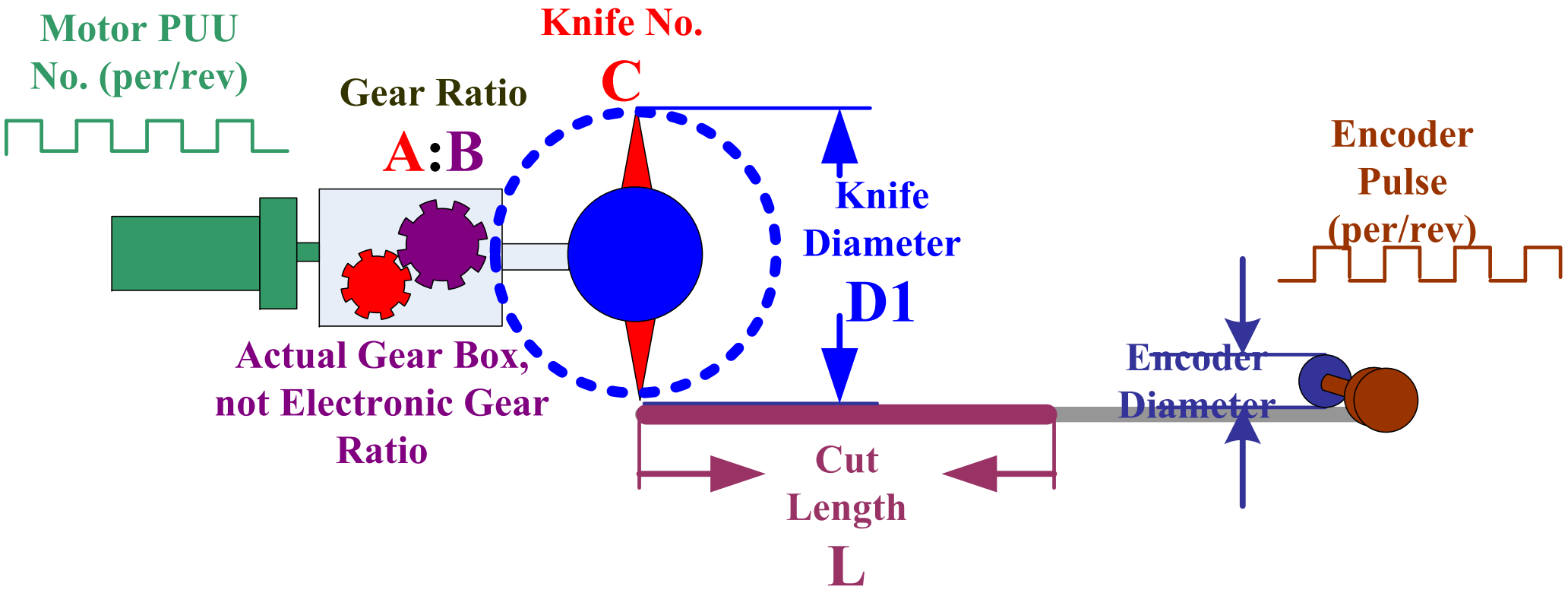
1. P5-94 = Near Motor Electronic Gear Ratio A (Deceleration Ratio: Numerator) x C (Knife Number)
2. P5-95 = Near Rotary Knife Electronic Gear Ratio B (Deceleration Ratio: Denominator)
3. P5-96 = 1000000 x R x V

(R (Cut Ratio) = L (Cut Length) x ℓ (Knife Circumference π *D1) x C (Knife Number)

V (Speed Compensation) = (Cut Speed) / (Product Speed)

Setting Range of V:0.8≦V ≦1.2
V setting is used to adjust the speed of rotary knife and the adjustment ratio is within 20%.

Auto Create E-CAM Profile for Rotary Knife Application -5-2



Auto Create E-CAM Profile for Rotary Knife Application -6-1

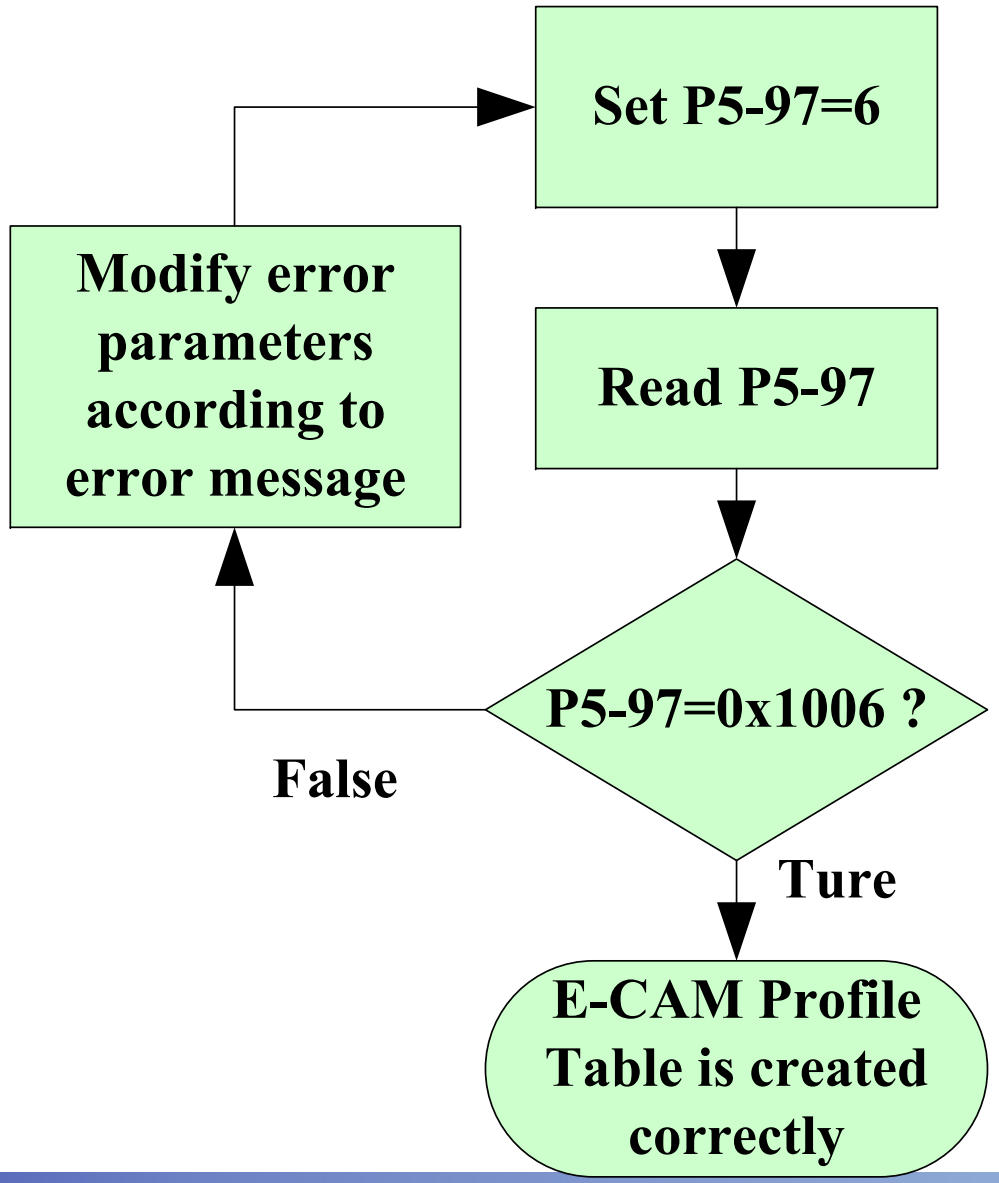
Steps – Use Macro Parameters to Create E-CAM Profile

1. Ensure that the setting values of “System Parameters” and “Macro Parameters” are correct.

2. Command the servo drive to create E-CAM profile by using P5-97. Set the setting value of P5-97 to 6.

3. Read the setting value of P7-96 and check if the setting value is 0x1006 (P5-97=0x1006). This value indicates that E-CAM is created successfully. If the setting value of P5-97 is not 0x1006, please correct the parameter setting value by referring the displayed error message.

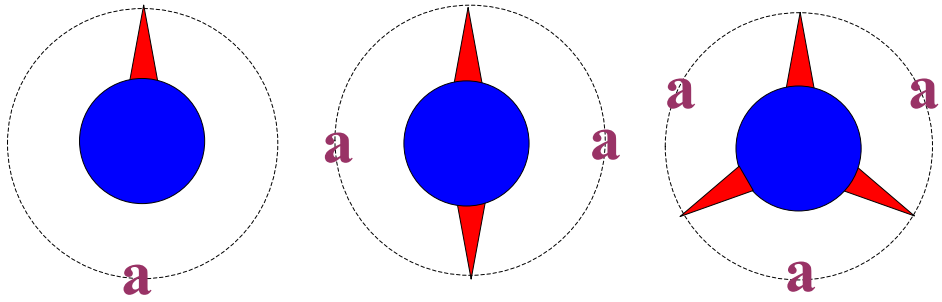
Auto Create E-CAM Profile for Rotary Knife Application -6-2

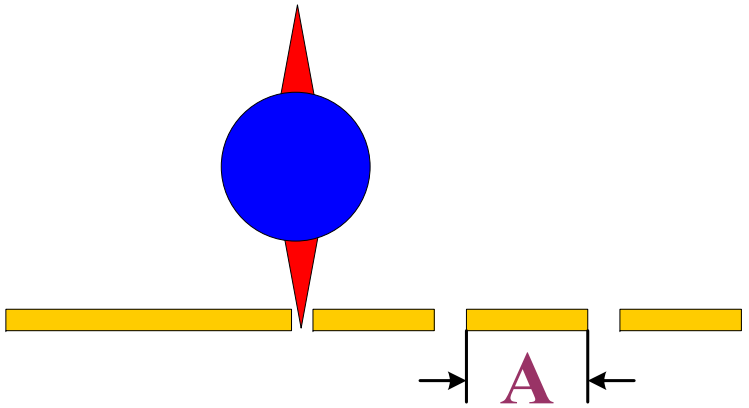


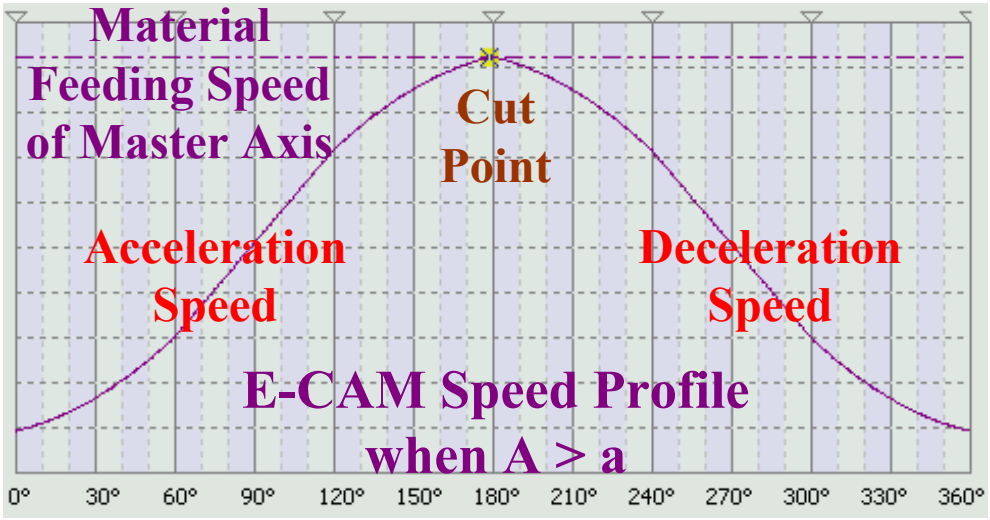
Rotary Knife Parameters -1

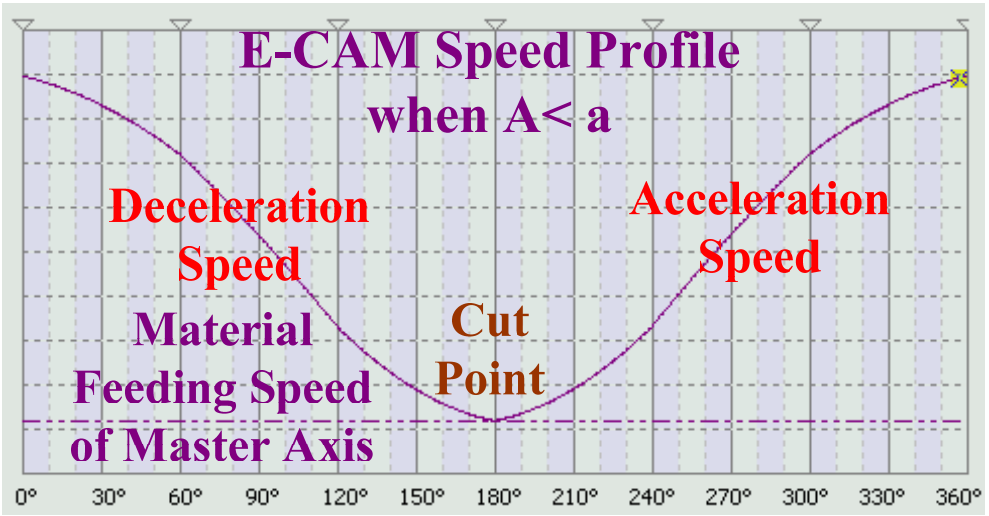
Rotary Knife Interval Distance and Cut Length

Rotary Knife Interval Distance is a and the Cut Length is A.





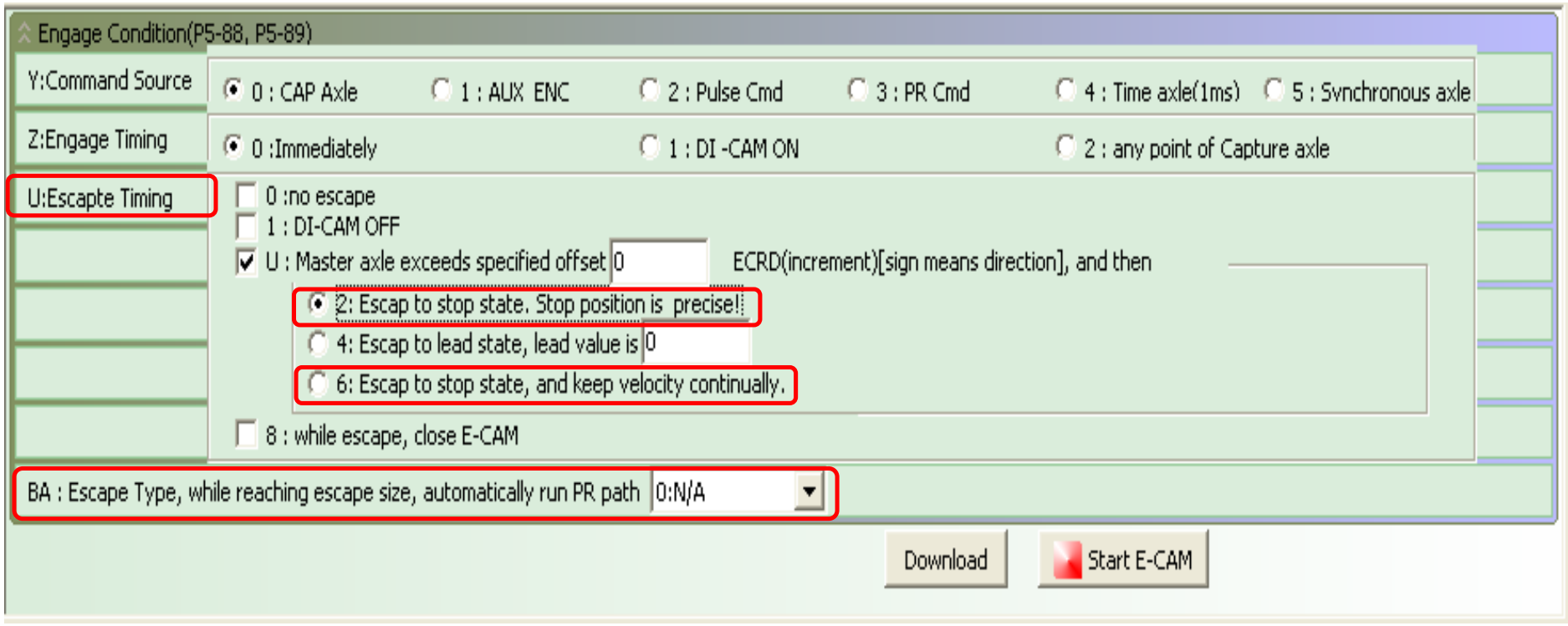




Rotary Knife Parameters -2

The difference between Disengage Timing Setting U=2 and U=6 of P5-88 on rotary knife application

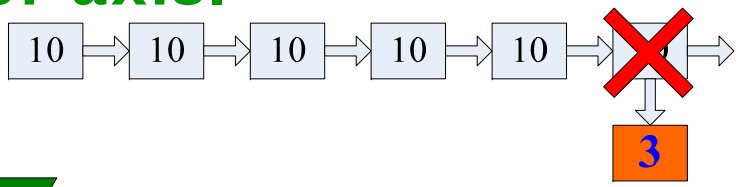
The setting value U=2 and U=6 of P5-88 can not be selected simultaneously. But, when the disengage conditions are satisfied (U=2 and U=6 of P5-88), the users can choose if the system will execute Pr path or not after the electronic gear is disengaged.

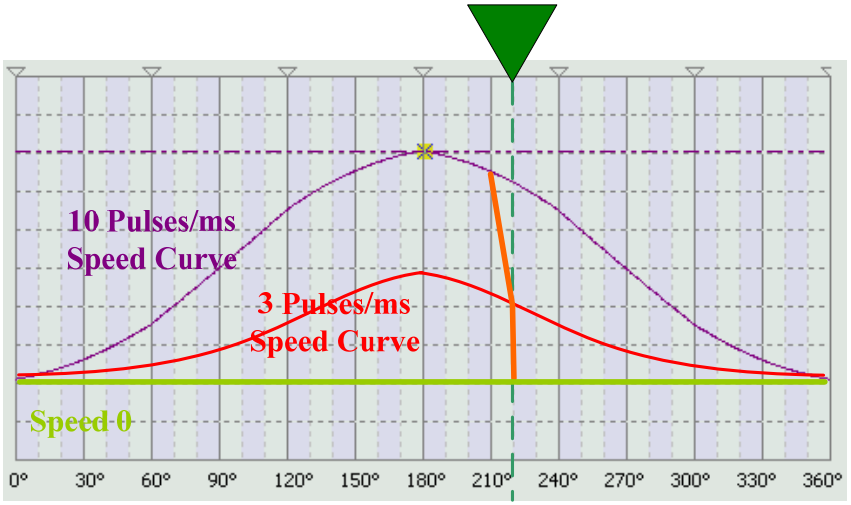


Rotary Knife Parameters -3

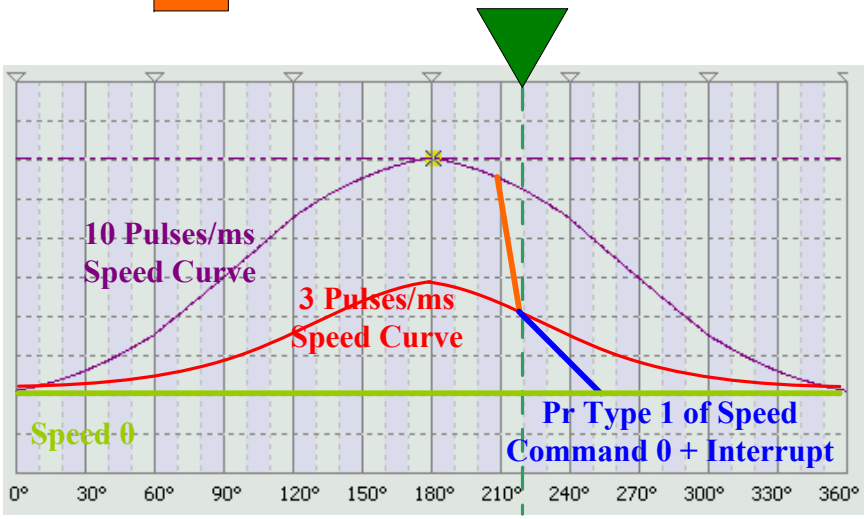
Disengage Timing Setting U=2 of P5-88

Supposes that the master axis sends 10 pulses every 1ms to E-CAM axis and E-CAM axis will disengage when it reaches P5-83 = 53 pulses (assume that it is 220 degrees), after E-CAM is disengaged, E-CAM profiles of Speed 0 command using Pr path and Speed 0 command without using Pr path are shown in the figures below. This disengage command will change the pulse train command of master axis.





E-CAM Disengage Point 220°

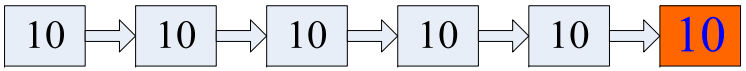


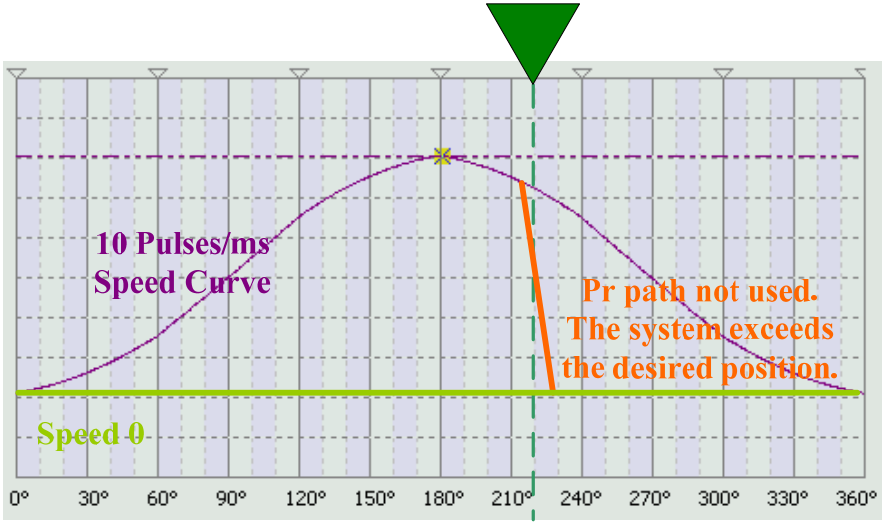
E-CAM Disengage Point 220°

Rotary Knife Parameters -4

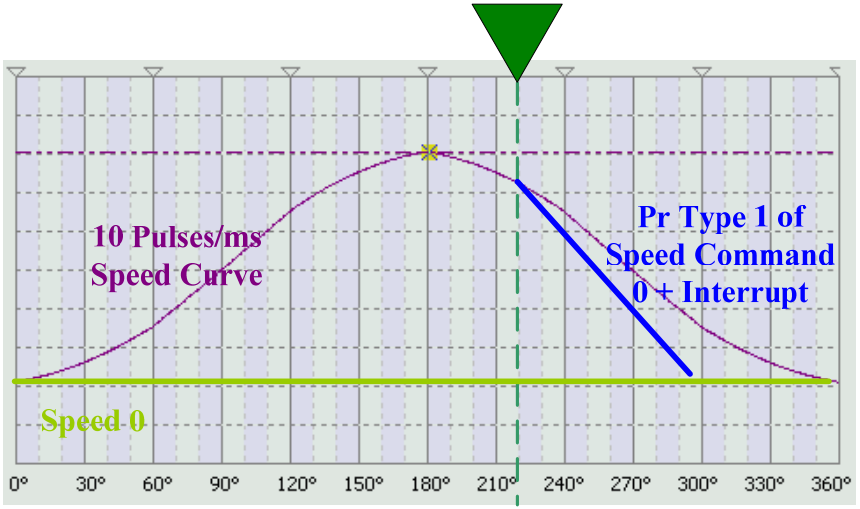
Disengage Timing Setting U=2 of P5-88

Supposes that the master axis sends 10 pulses every 1ms to E-CAM axis and E-CAM axis will disengage when it reaches P5-83 = 53 pulses (assume that it is 220 degrees), after E-CAM is disengaged, E-CAM profiles of Speed 0 command using Pr path and Speed 0 command without using Pr path are shown in the figures below. This disengage command will not change the pulse train command of master axis.





E-CAM Disengage Point 220°



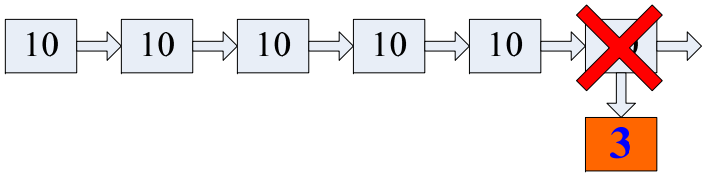
E-CAM Disengage Point 220°

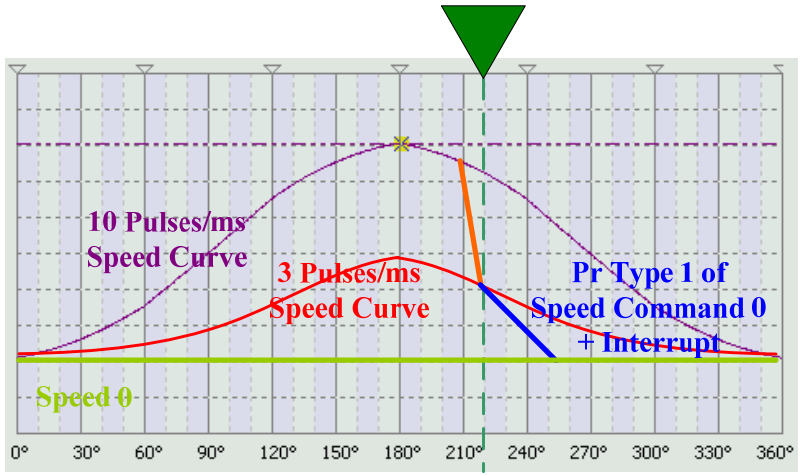
Rotary Knife Parameters -5

Disengage Timing Setting U=6 of P5-88

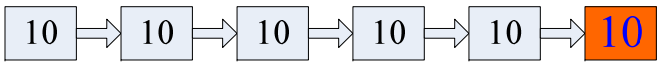
This option is suitable for the application which needs to use Pr command immediately after the electronic gear is disengaged.

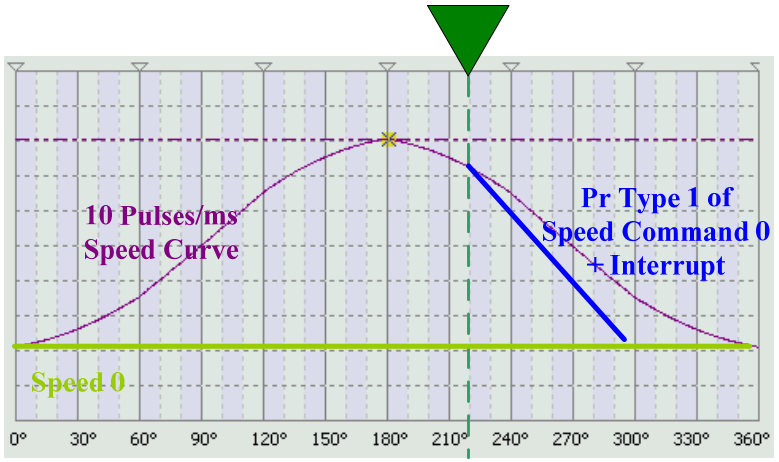
Using this option is to prevent the excessive speed caused when the electronic gear is disengaged suddenly during operation.





E-CAM Disengage
Point 220°





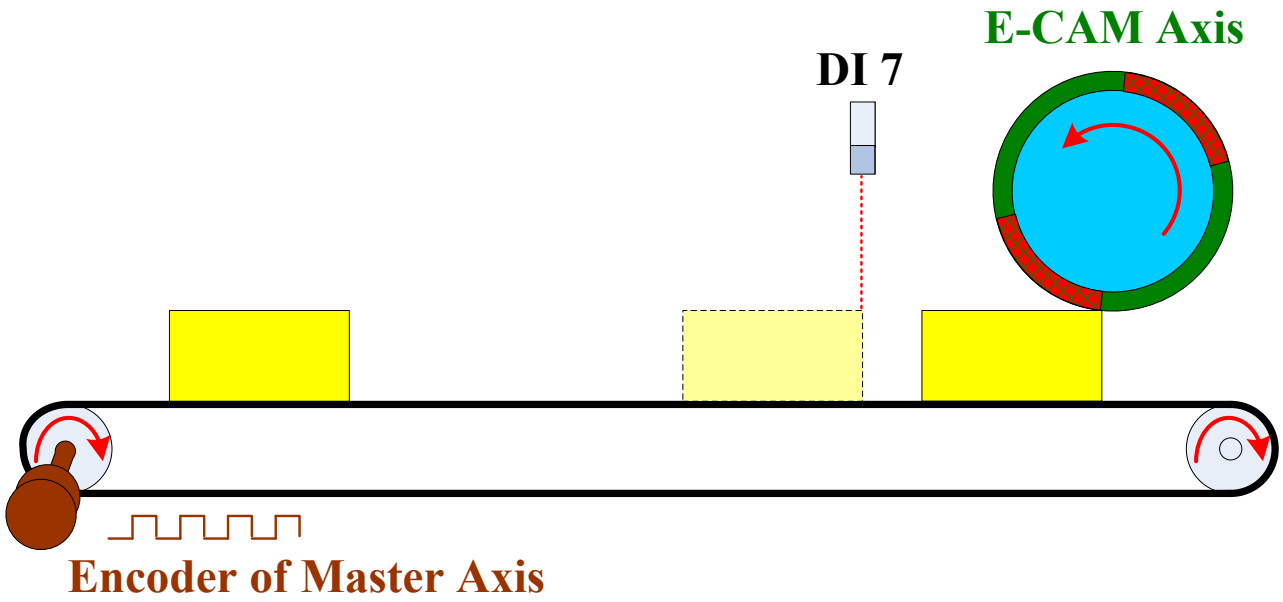
E-CAM Disengage
Point 220°

Rotary Knife Example 1-1

Product on Master Axis appears at random

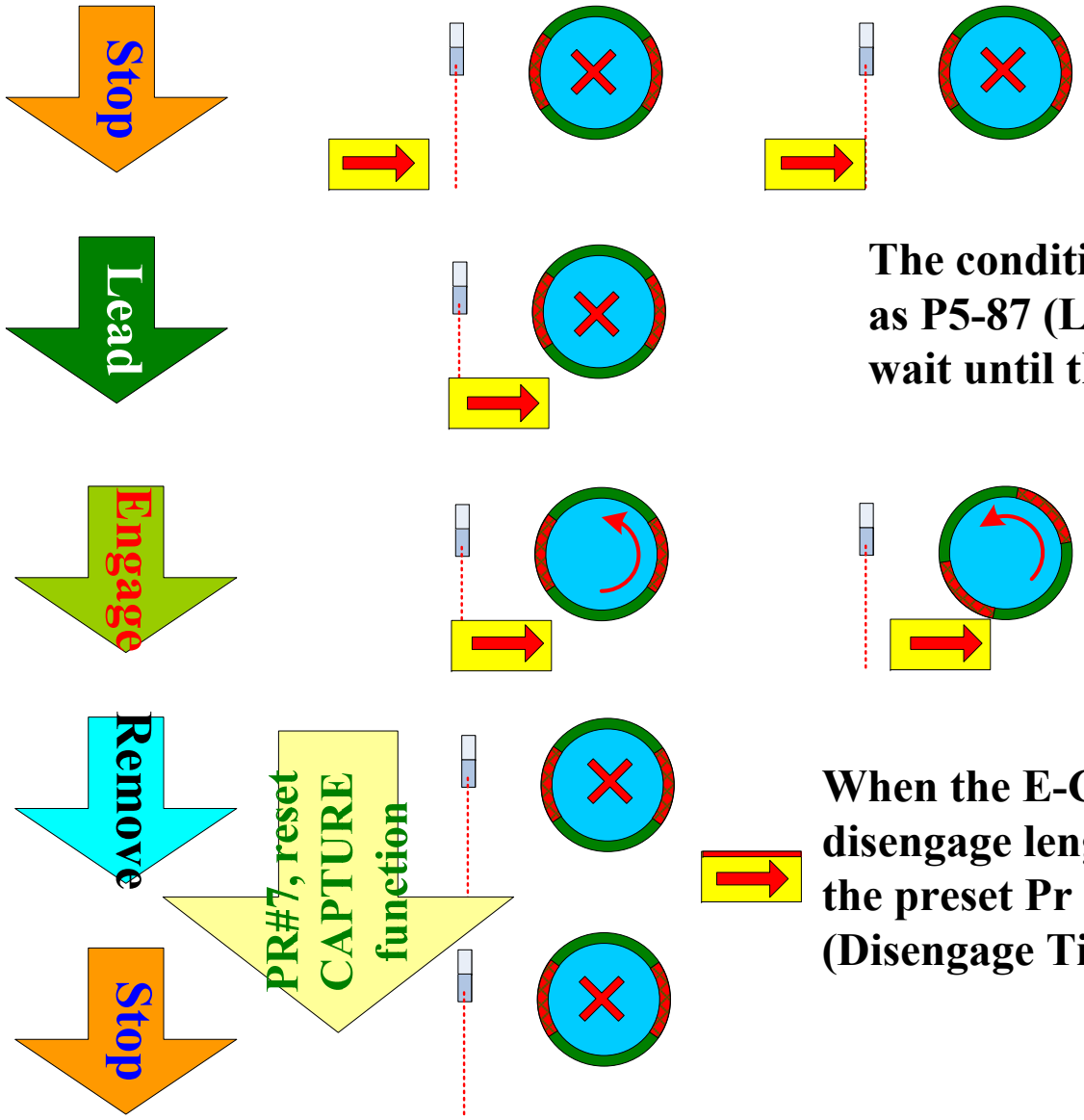
Such as gluing machine or labeling machine.

When CAPTURE signal transmitted through digital input, DI7 is regarded as the condition (P5-88 Z=2) that is used to enable the operation of E-CAM, after E-CAM operates for a certain length of lead command, it will engage. After E-CAM is engaged for a certain length of time, it will disengage and perform preset Pr command, reset CAPTURE function and wait for next trigger.



Rotary Knife Example 1-2

E-CAM Operation Timing



E-CAM stopped and wait for DI7 signal. Enable condition: P5-88 Z=2.

The condition for enabling E-CAM is satisfied. But, as P5-87 (Lead Command Length) is set, it needs to wait until the lead command length is reached.

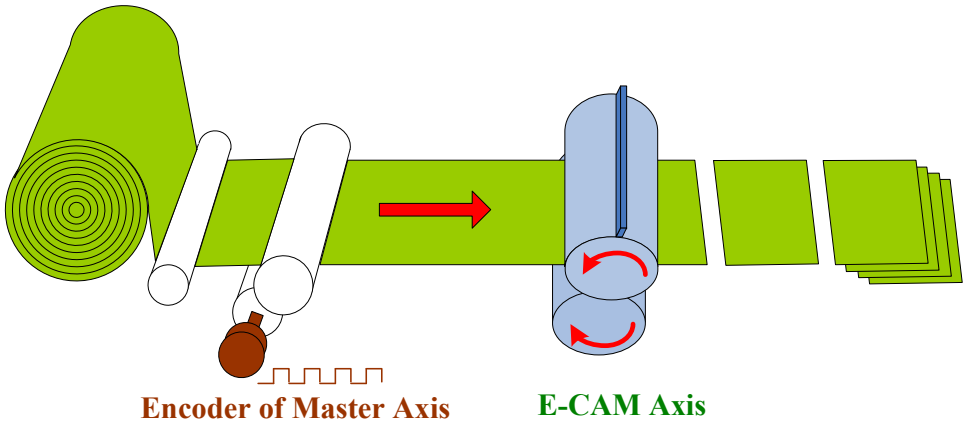
Initial lead command is reached and E-CAM start to operate.

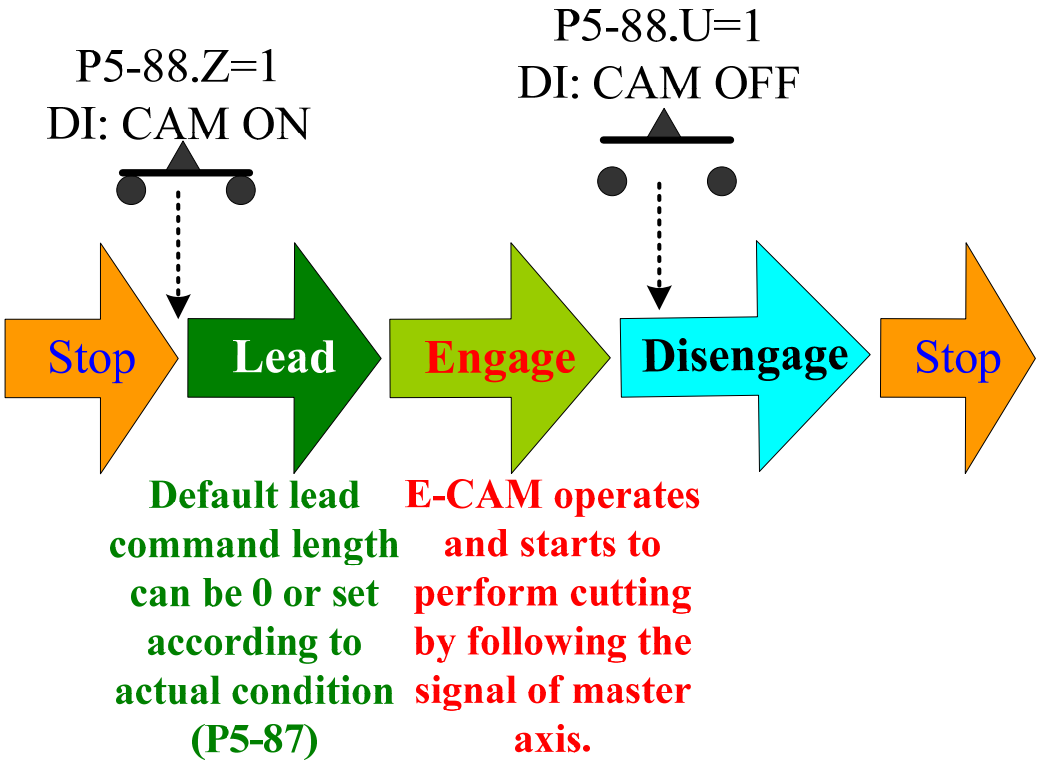
When the E-CAM operating length reaches the disengage length, after E-CAM is disengaged, perform the preset Pr command, set P5-88 U=2, set P5-89 (Disengage Timing Data), and P5-88 BA=PR#7.

Rotary Knife Example 2

Products on Master Axis move continuously without registration marks

Such as cutting machine. DI signal, CAM ON can be used as the enable and disable condition of E-CAM operation. P5-87 is used to set the lead command length.

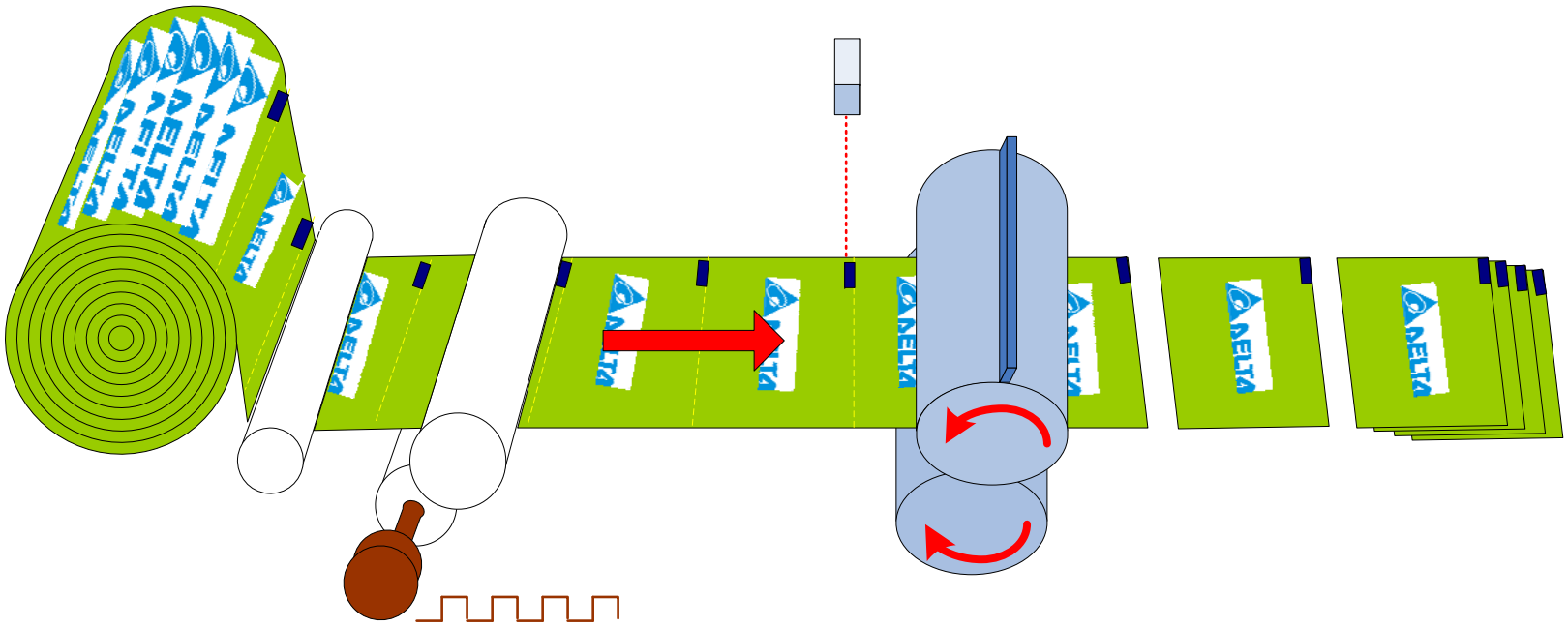




Rotary Knife Example 3-1

Products on Master Axis move continuously with registration marks

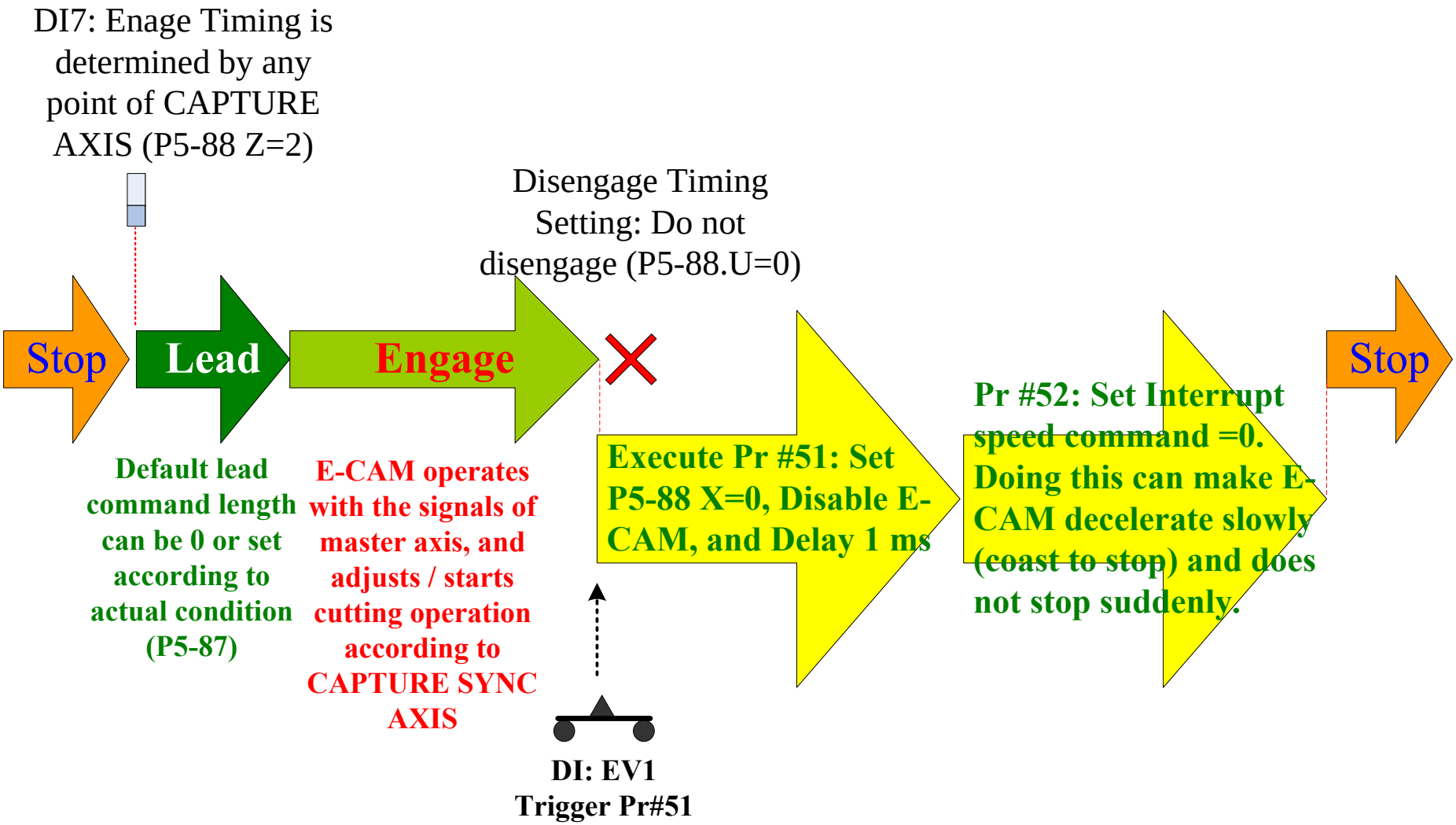
Such as cutting machine. The users can use CAPTURE function (DI7) to detect the registration marks first and use CAPTURE SYNC AXIS function (P5-88 Y=5) to control master axis (more introduction of CAPTURE SYNC AXIS function will be described on page 128~148).



Rotary Knife Example 3-2

Products on Master Axis move continuously with registration marks

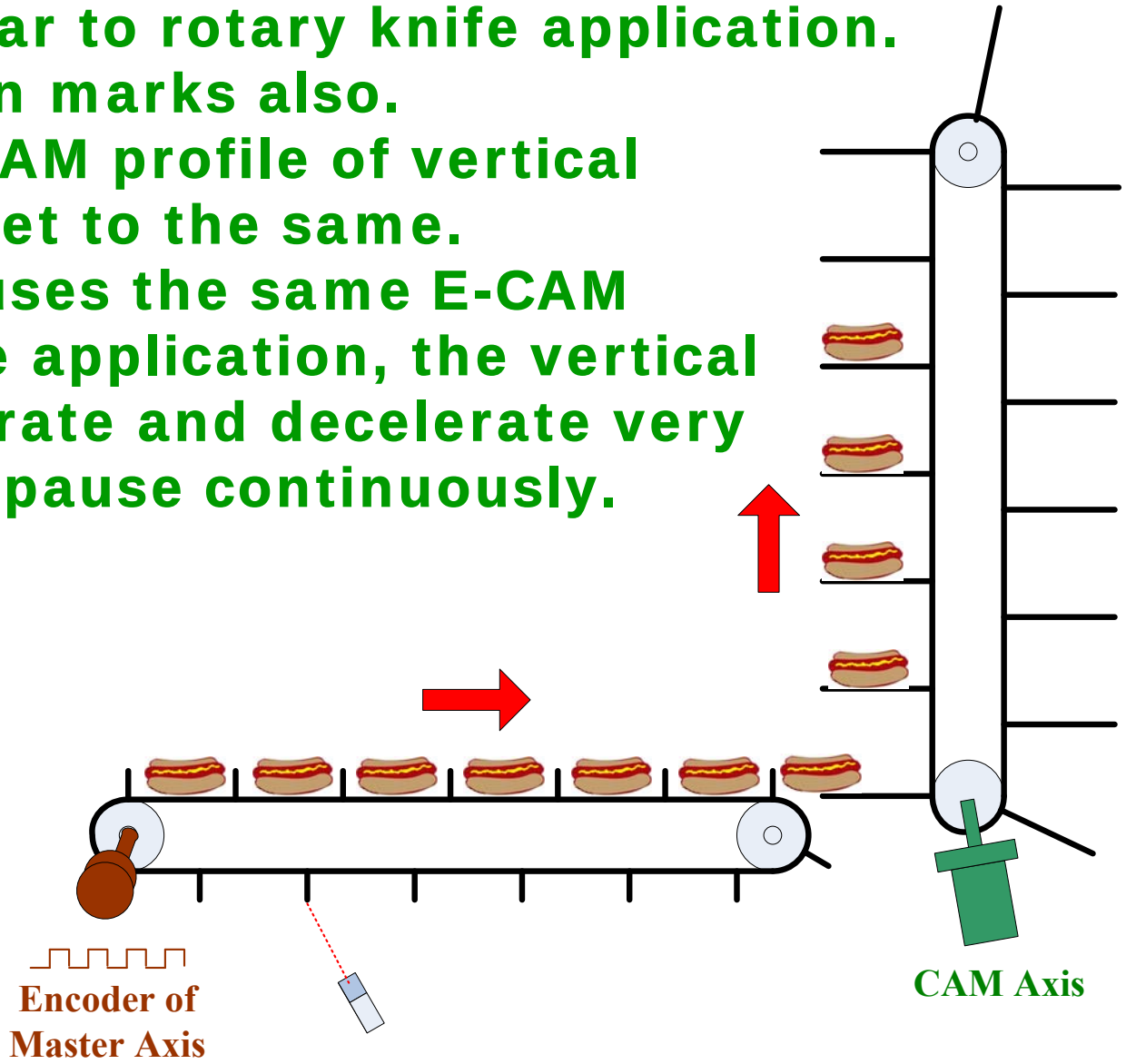
E-CAM Operation



Rotary Knife Example 4

Synchronous Conveyer

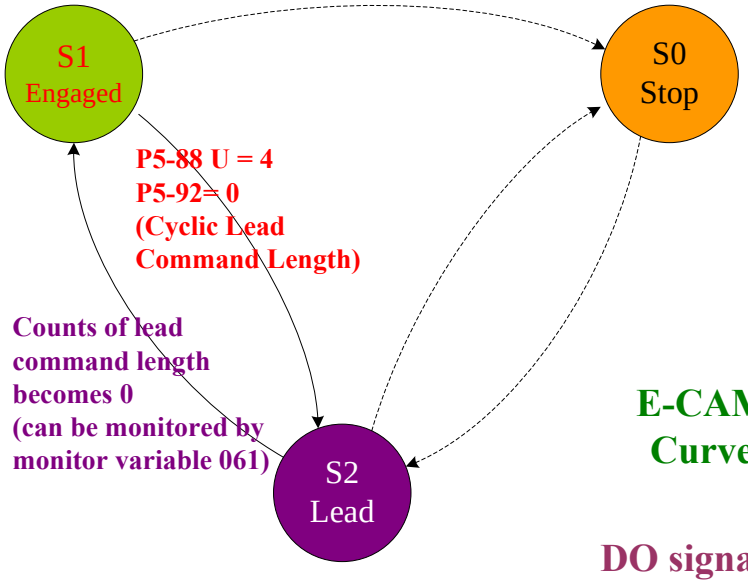
This example is similar to rotary knife application. There are registration marks also. But, the speed of E-CAM profile of vertical conveyer should be set to the same. If vertical conveyer uses the same E-CAM profile of rotary knife application, the vertical conveyer may accelerate and decelerate very often, and move and pause continuously.

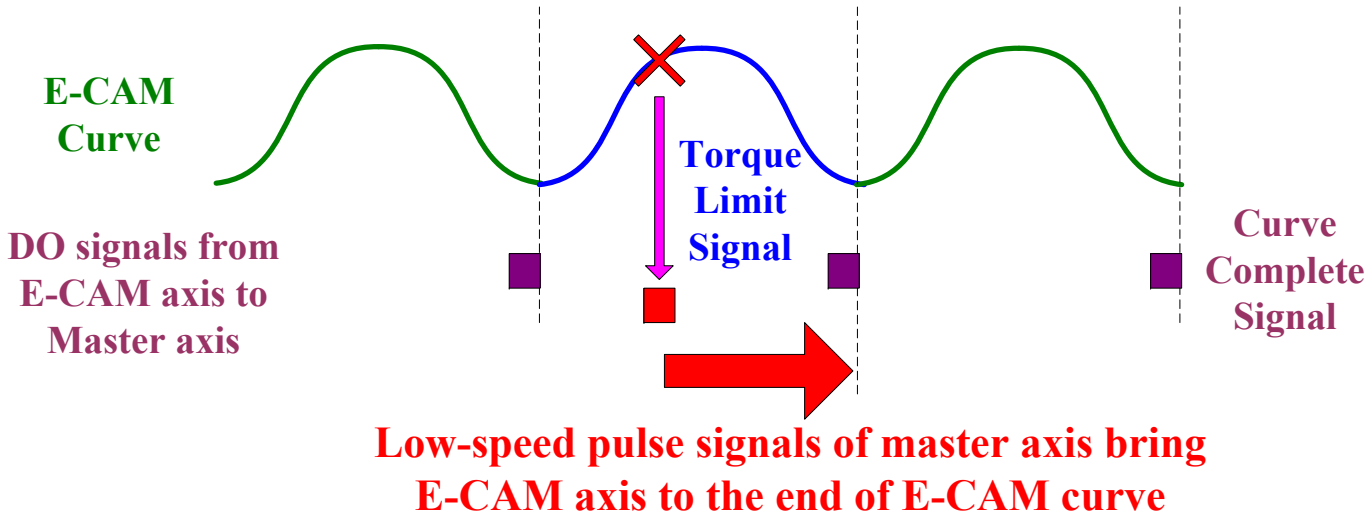


Rotary Knife Example 5

Recover the System

Set disengage timing to “Do not disengage” (P5-88 U=4). When the system error occurs, it is easy to recover the system to normal status.

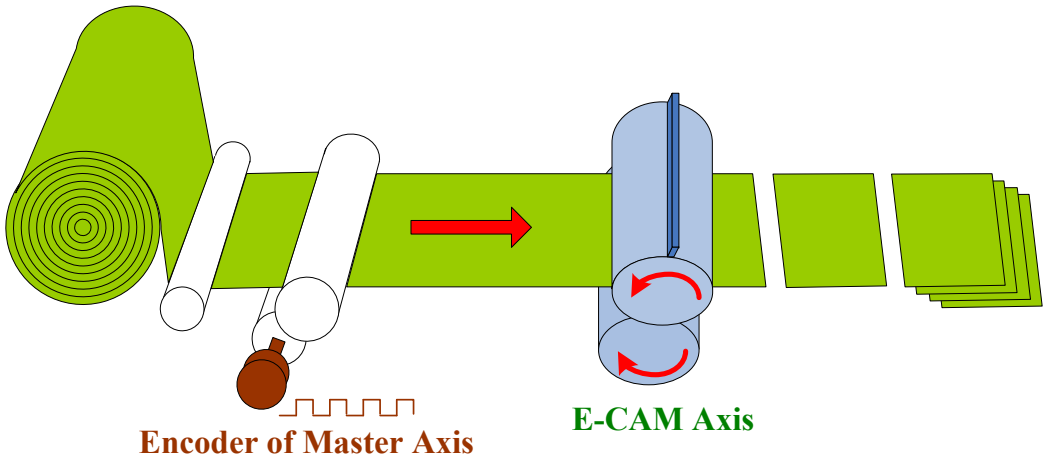


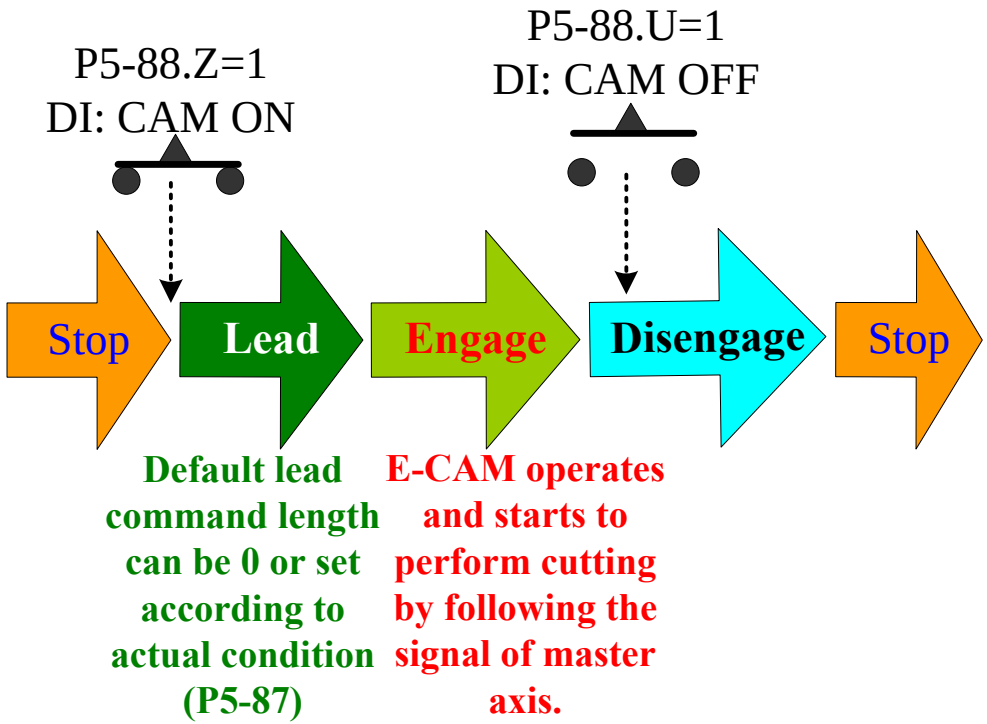


Tips for Rotary Knife Application 1-1

How to make E-CAM disengage at E-CAM profile 360º position

When DI:CAM OFF is activated, if E-CAM disengages immediately, E-CAM operation will not stop at the position of E-CAM profile 360º. This tip is used to solve this problem.

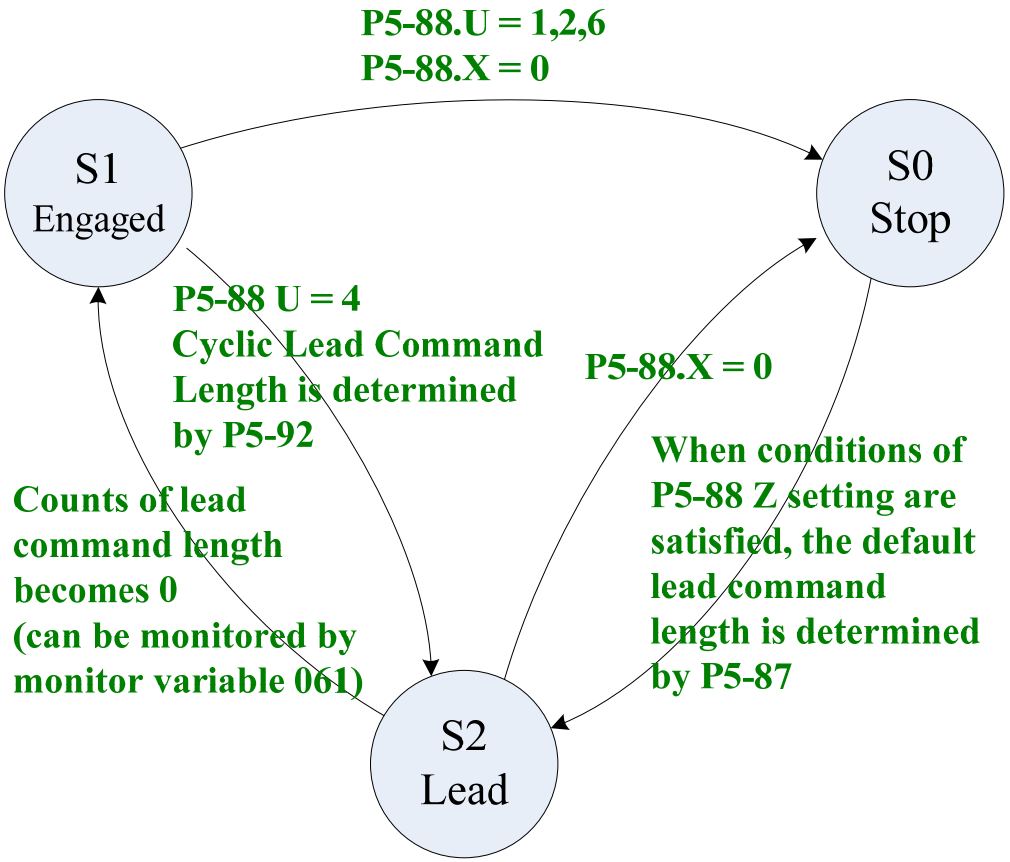




Tips for Rotary Knife Application 1-2

Disengage Timing Setting

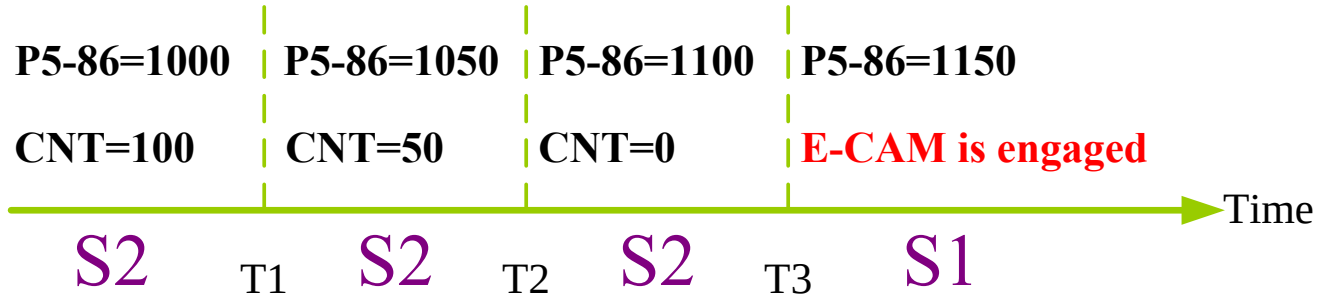
When P5-88 U=4, using the setting value of P5-92 can determine the lead command length. Please refer to the figure below.

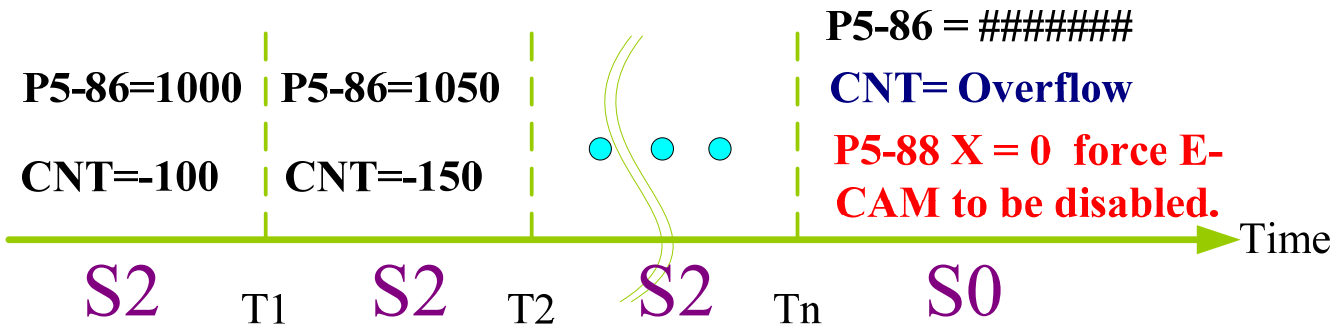


Tips for Rotary Knife Application 1-3

Cyclic Lead Command Length and Master Pulses

P5-86 is used to monitor the accumulated pluses which is sent to E-CAM from master axis. Cyclic Lead Command Length is determined by P5-92. When master pulses is sent, the changes of cyclic lead command length can be monitored via CNT (monitor variable 061h).

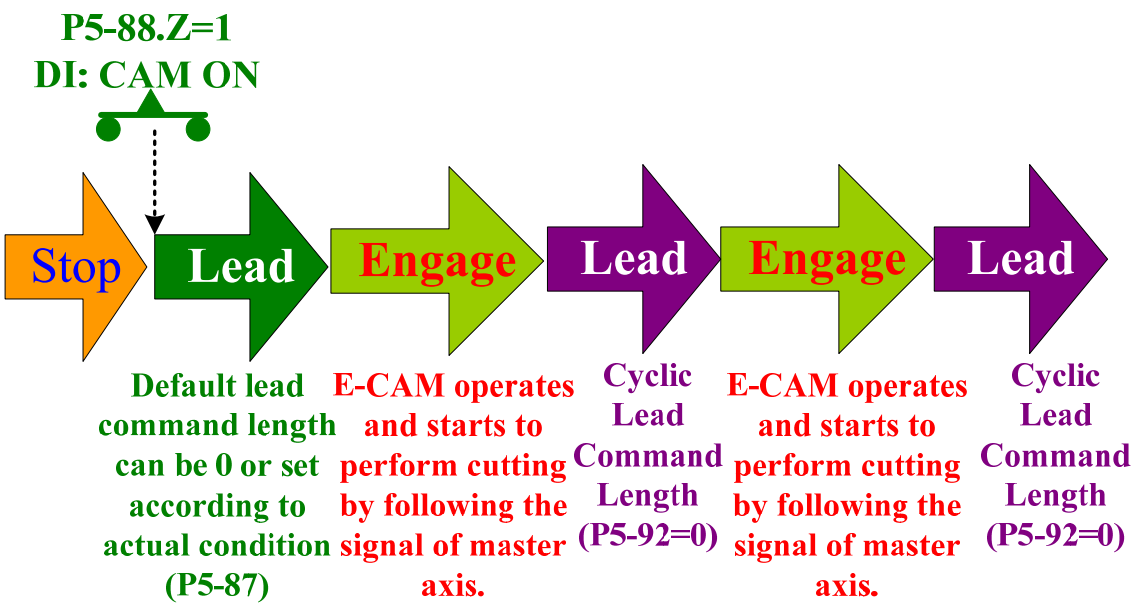


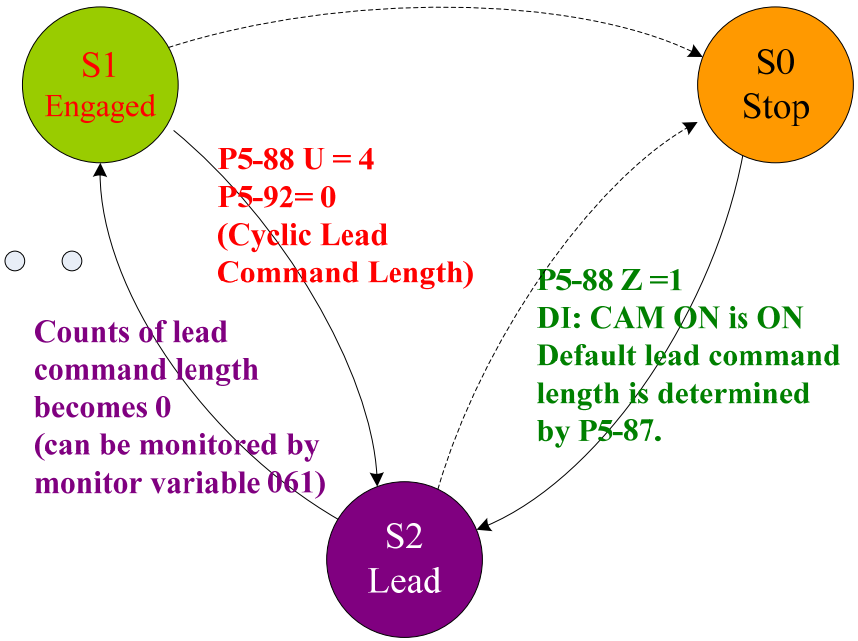


Tips for Rotary Knife Application 1-4

E-CAM Start Operation

Set P5-88 Z=1 and use DI signal: CAM On to enable E-CAM operation. P5-87 is used to set the lead command length of one-time execution before E-CAM operation. P5-92 is used to set cyclic lead command length when P5-88 U=4.

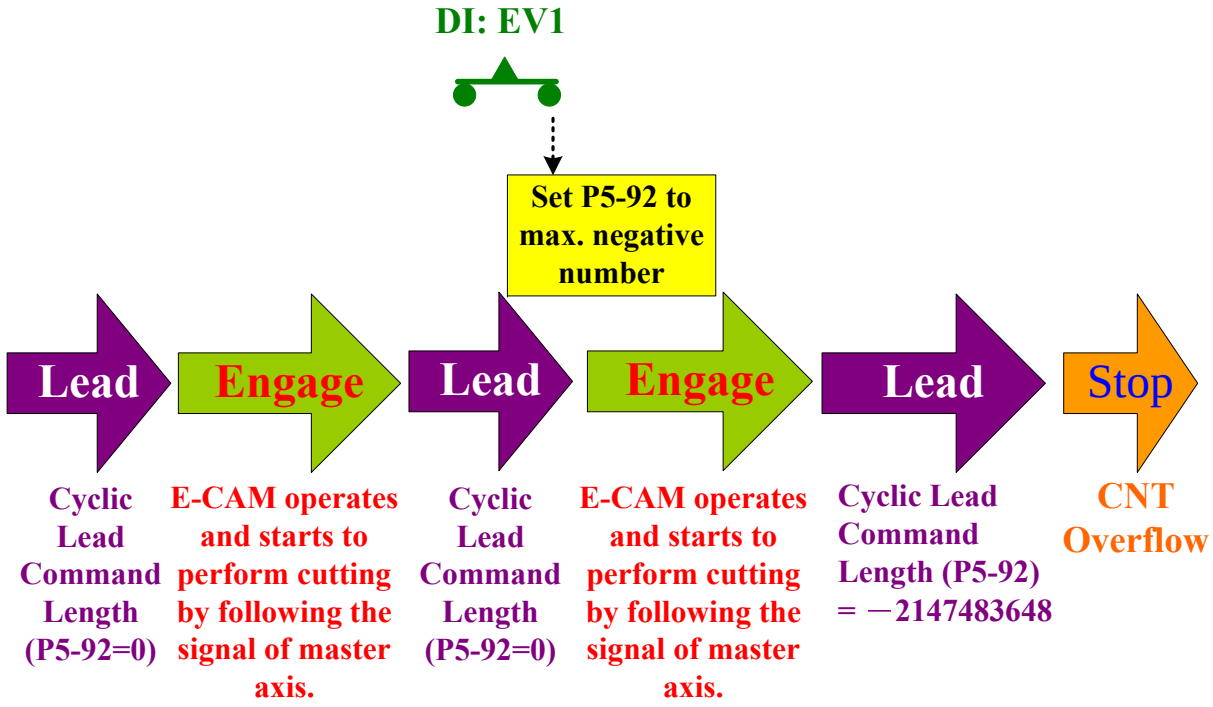


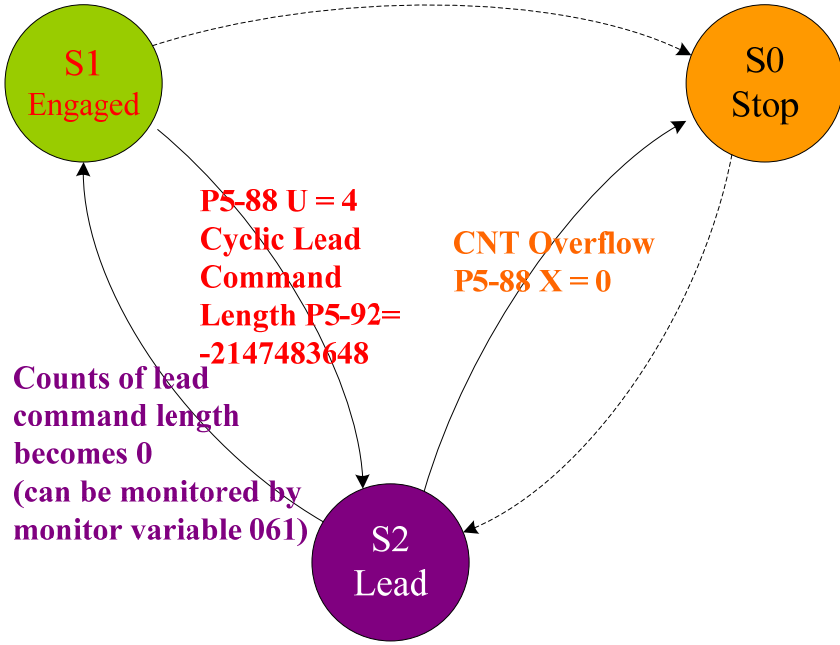


Tips for Rotary Knife Application 1-5

E-CAM Stop Operation

Use Event Trigger Command, EV1 to set parameter P5-92 = -2147483648 (max. negative number). When E-CAM enters into "Lead" state, the count overflow error will occur and E-CAM operation will stop.

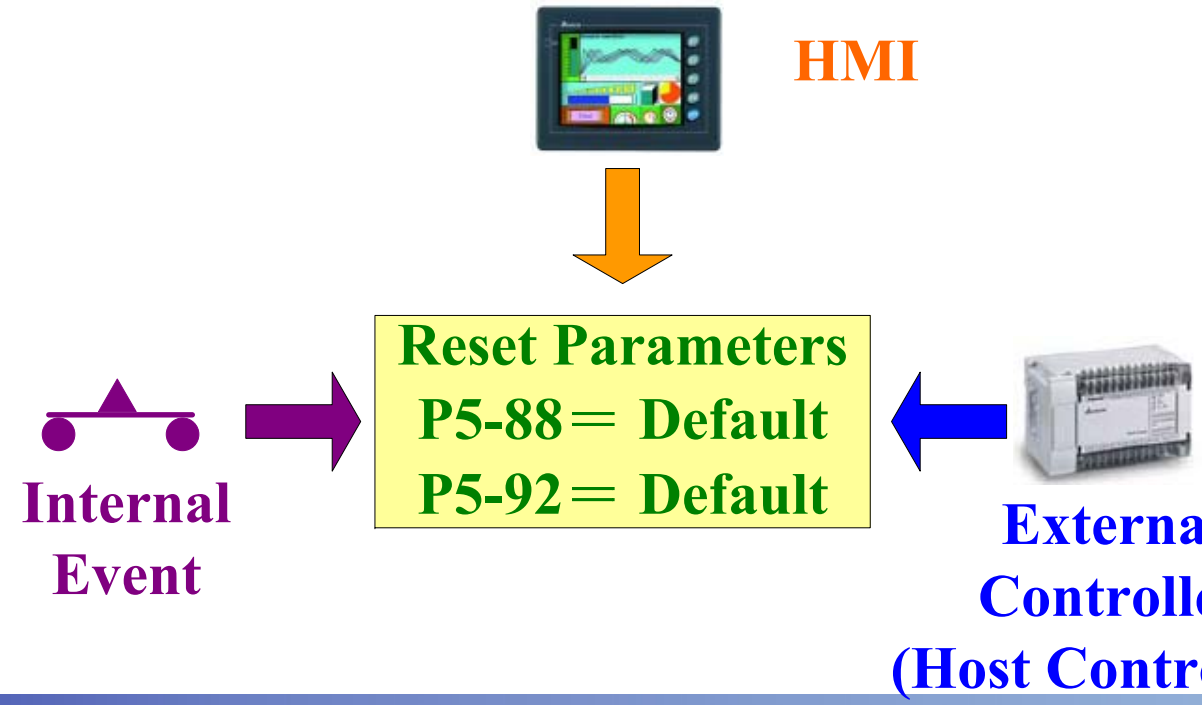




Tips for Rotary Knife Application 1-6

Reset Parameters

When E-CAM returns to Stop state, E-CAM parameters should be reset for next operation. When HMI is not connected (without communication), the users can use Event parameters to reset P5-88 to default value and reset P5-92 to 0. If P5-92 is not reset to 0, when E-CAM enters into “Lead” state (S2), the count overflow error will occur and E-CAM operation will stop.



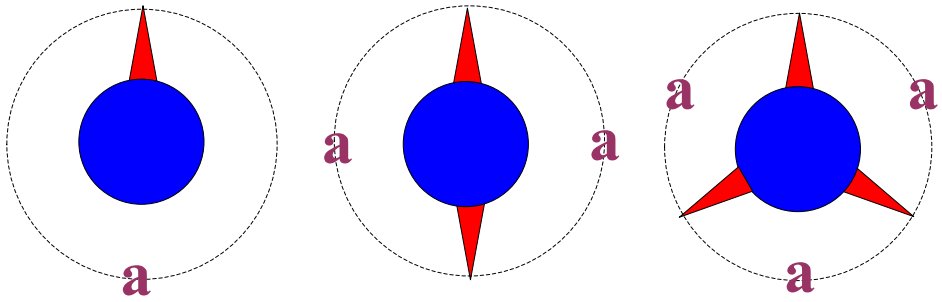
Tips for Rotary Knife Application 2-1

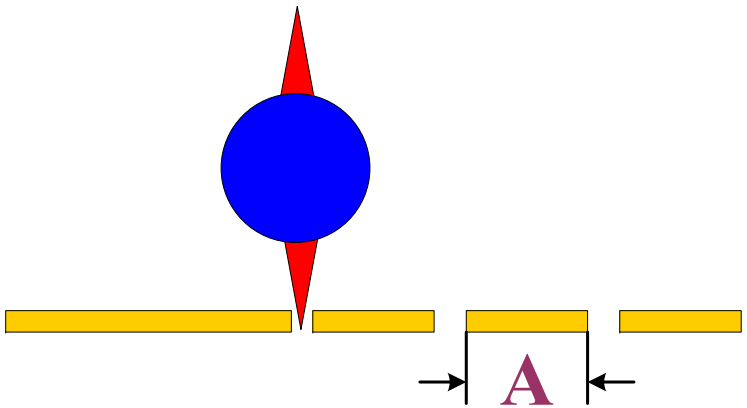
Cut Length

When using auto rotary knife system, the cut length will be limited ”0.3a ≦ A ≦ 3a” due to the algorithm and actual usage of mechanical system. Even if the desired cut length is very long and longer than triple cutter interval distance a, using with the tips described earlier, ASDA-A2 can be stilled applied on the auxiliary system for auto rotary knife application.

A: Cut Length

a: Knife Interval Distance

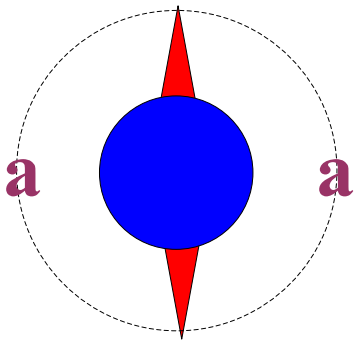


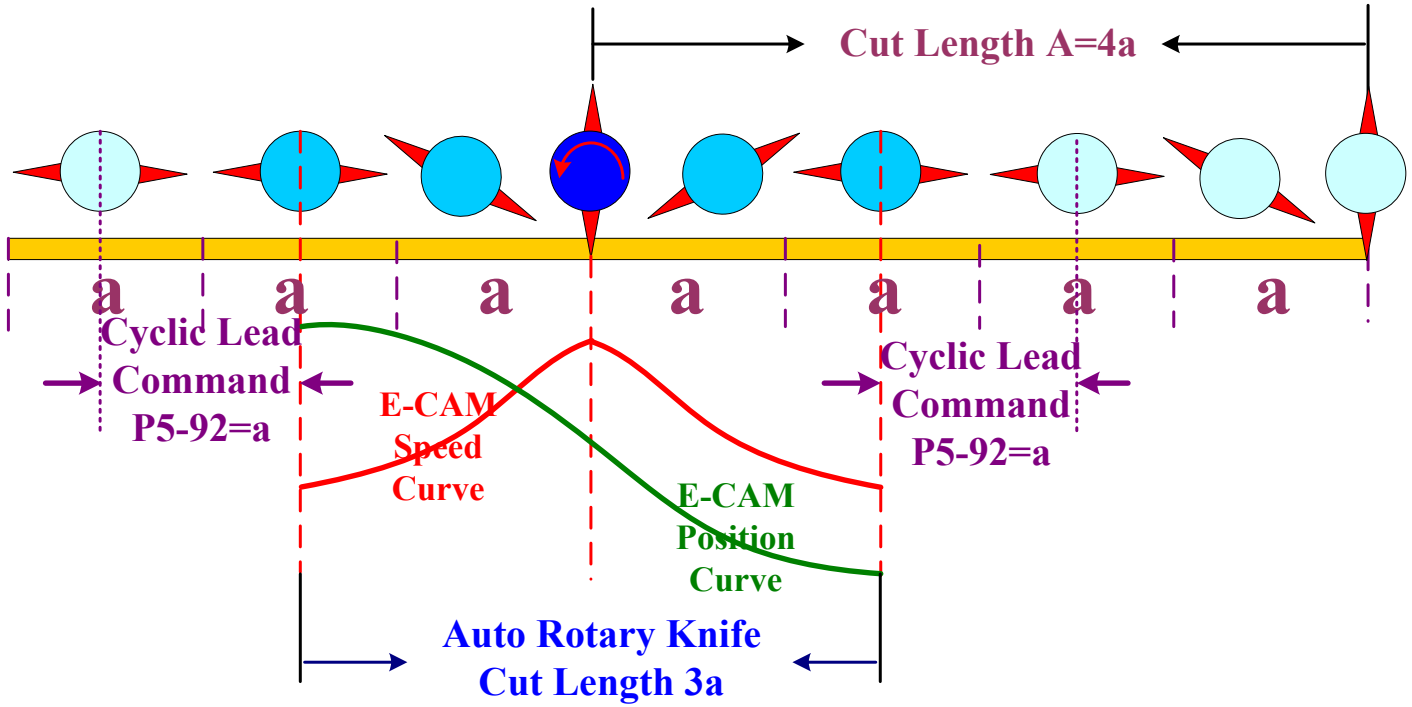


Tips for Rotary Knife Application 2-2

Use Cyclic Lead Command Length P5-92

In this case, cut length is equal to 4a. 3a is the auto rotary knife cut length and the rest 1a is cyclic lead command length. Of course, the users need to set P5-88 U=4. For the other relevant settings, please refer to the tips described in this presentation earlier.

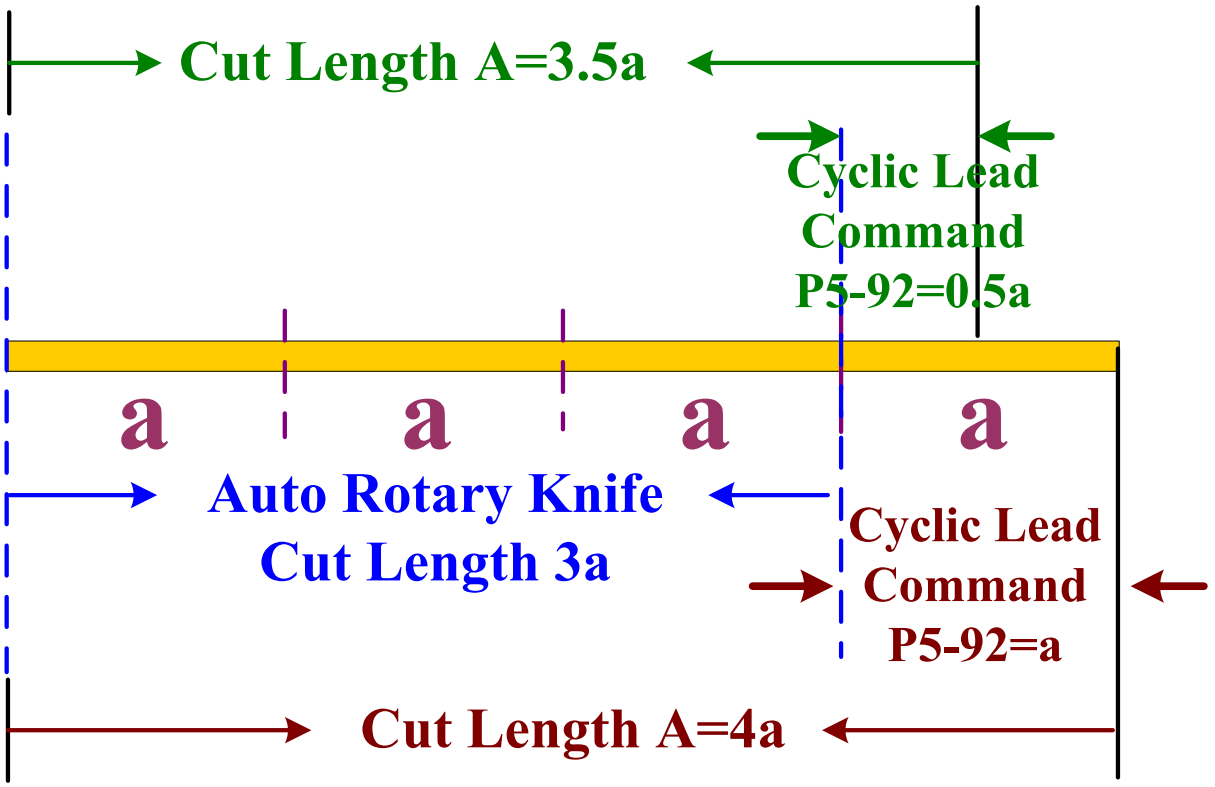




Tips for Rotary Knife Application 2-3

Change Cut Length

When the users want to change cut length from 4a to 3.5a (still longer than auto rotary knife cut length 3a), it only needs to adjust cyclic lead command length and has no need to create E-CAM profile again.



Tips for Rotary Knife Application 2-4

Use CAPTURE SYNC AXIS

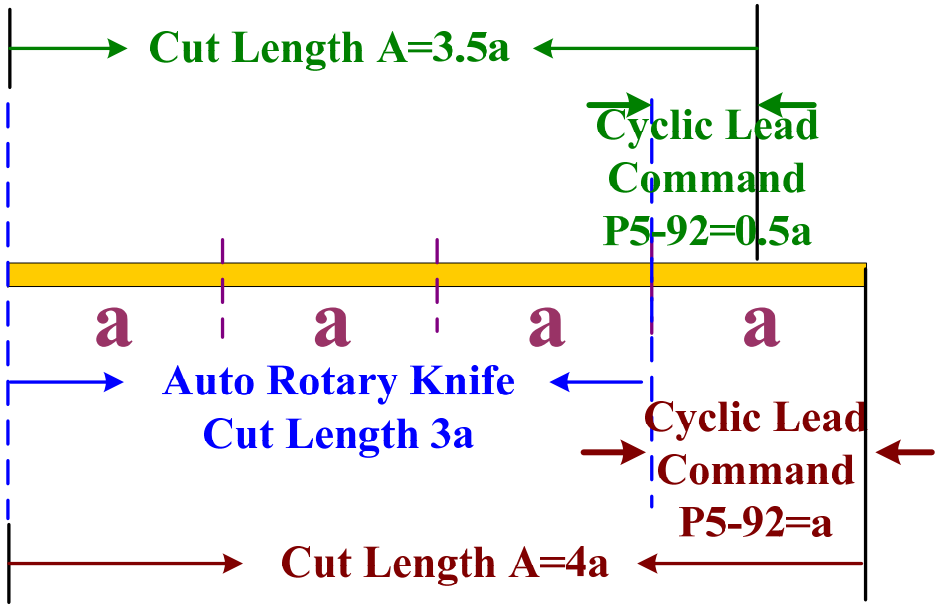
Before using CAPTURE SYNC AXIS, ensure that the following condition is satisfied:

P5-78 = (P5-84 / P5-83) + P5-92 , and (P5-84 / P5-83) = an integer

P5-78: Interval Pulse Number of CAPTURE SYNC AXIS

P5-92: Cyclic Lead Command Length

The usage of CAPTURE SYNC AXIS will be described later.



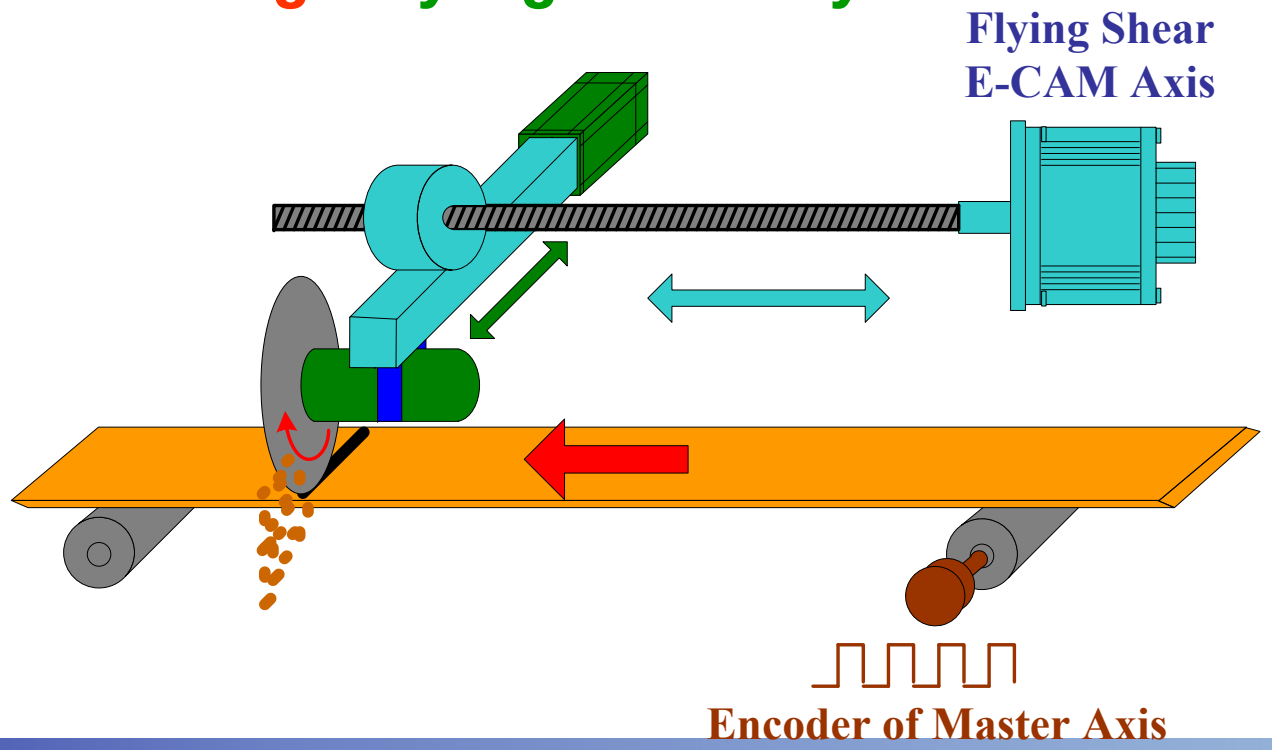
P5-78 = 3.5a

P5-78 = 4a

Flying Shear System

Explanation

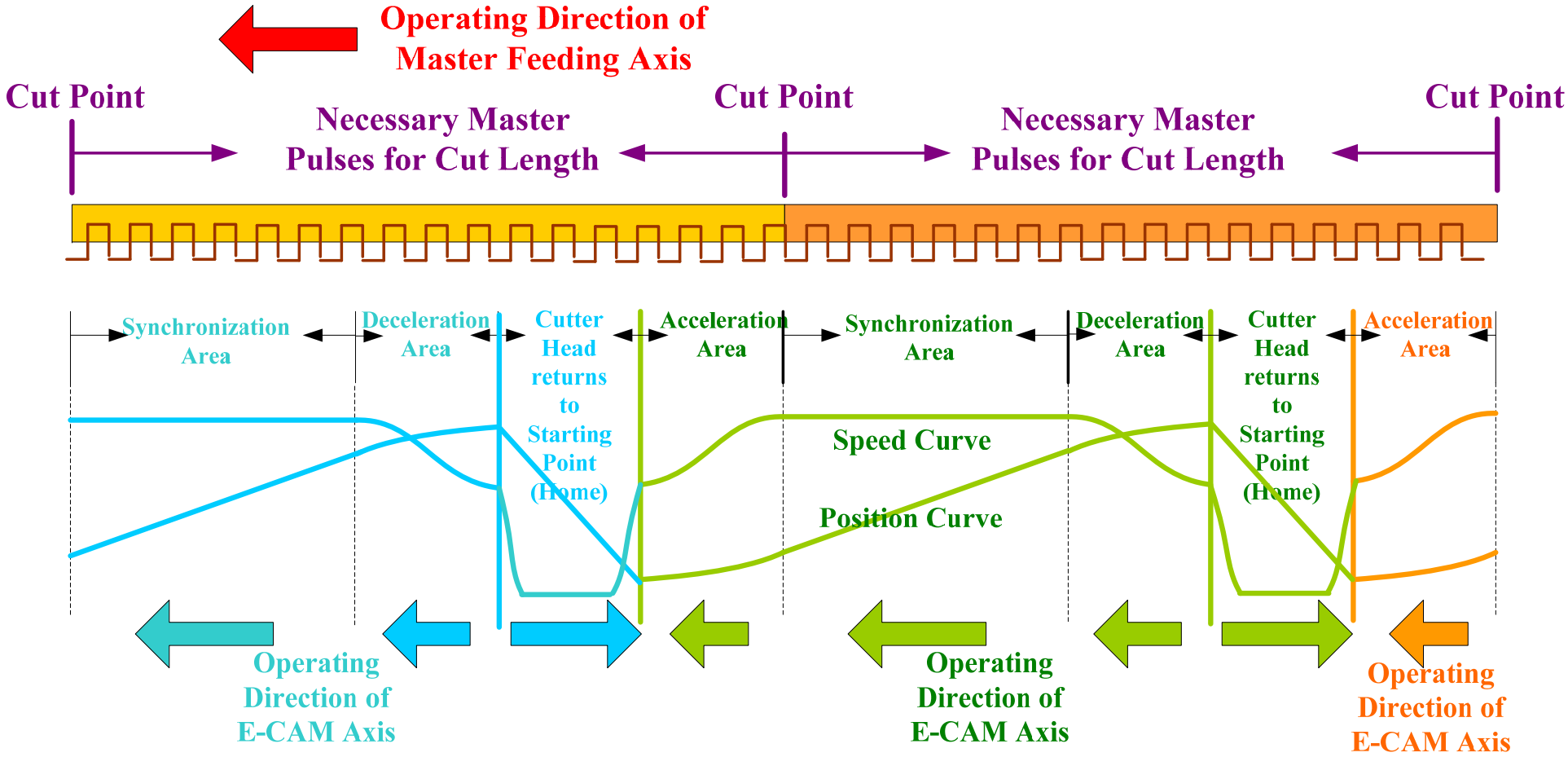
Flying shear system is used for the process that requires cutting operation when the cutting materials are fed on a conveyer (feeding axis will not stop) simultaneously. In this system, the speed of flying shear E-CAM axis and feeding axis must be matched and the cutting time should be long enough to make the cutter complete cutting operation and move to a safe place. Please refer to the following "continuous feeding" flying shear system.



Flying Shear Operation Analysis -1

Detailed Operation of Flying Shear Axis

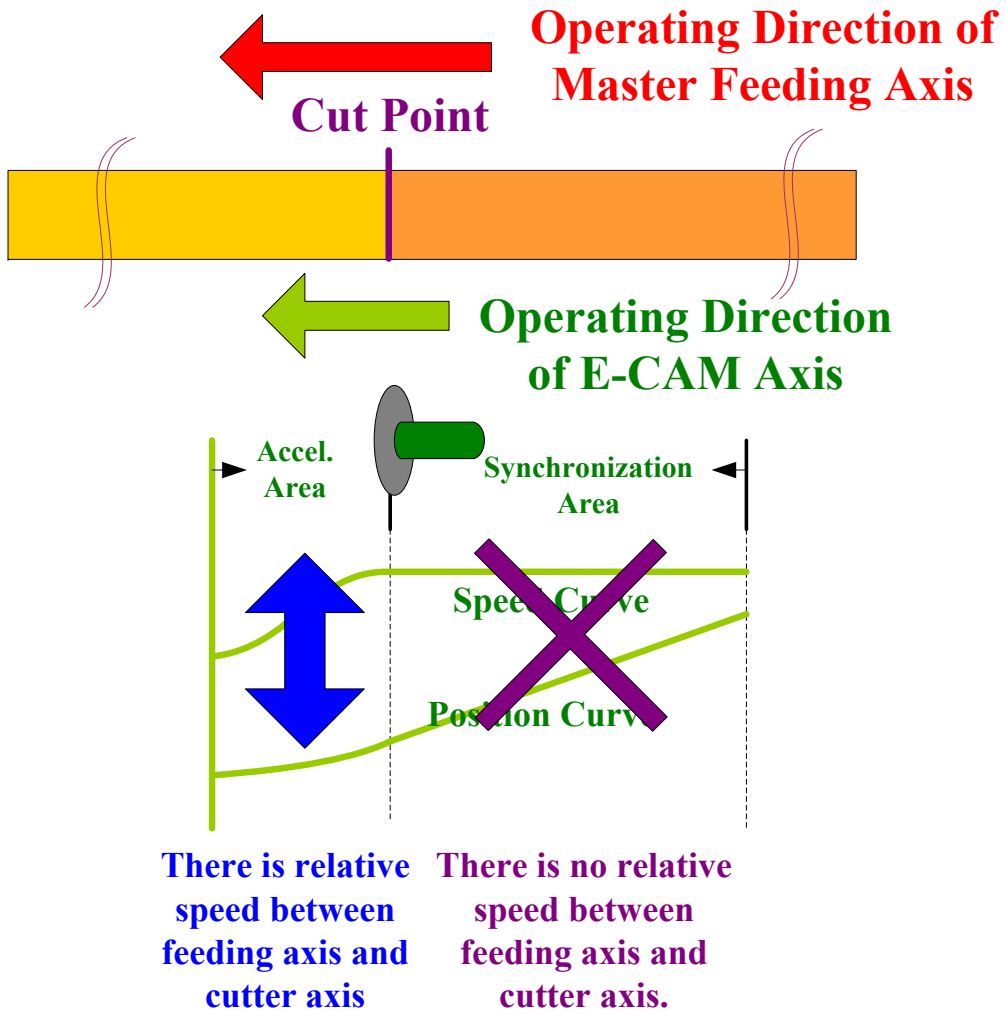
The design of flying shear E-CAM will be described later in this presentation



Flying Shear Operation Analysis -2

Acceleration Area of Flying Shear E-CAM Axis

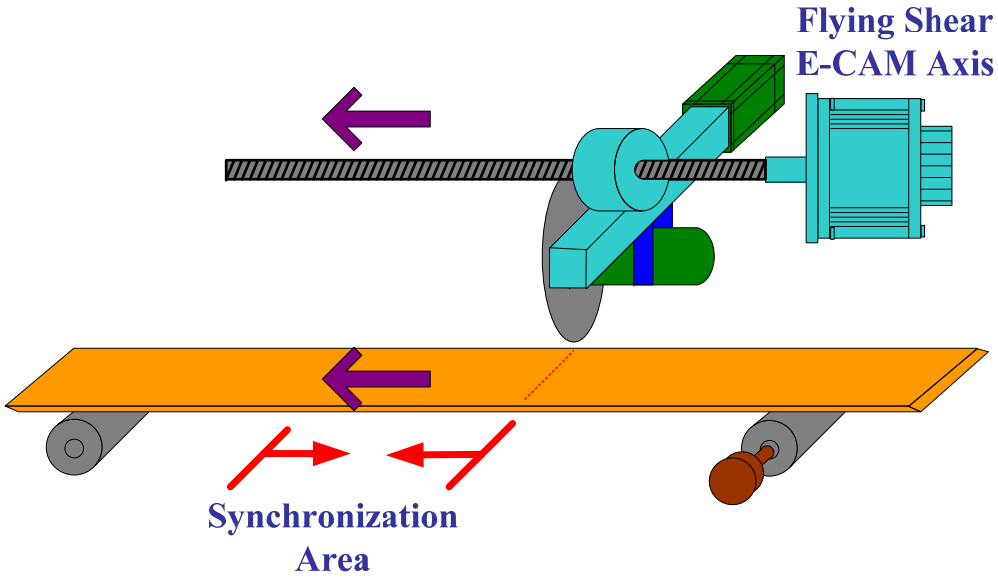
In the end of acceleration area, the cutter of flying shear axis should synchronize to cut point. If not so, after entering synchronization area, as the speed of flying shear and feeding axis are the same and the relative speed is 0, the cutter of flying shear axis could not synchronize to cut point.

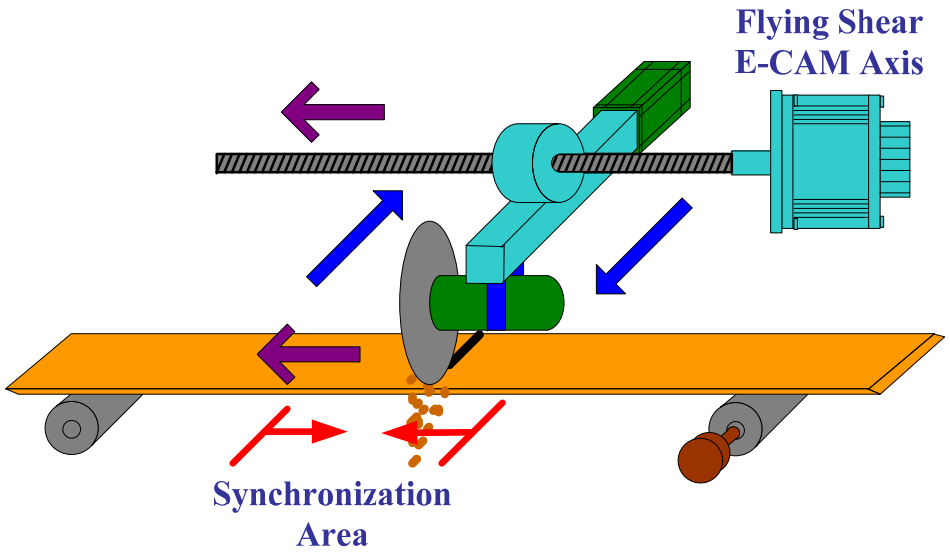


Flying Shear Operation Analysis -3

Same Speed Area of Flying Shear Axis

The cutting time should be long enough to make the cutter complete cutting operation and move to a safe place. Even if the master axis and E-CAM axis operate with the same speed, the cutter will move to the position where the cutter will not hit the moving cutting materials.

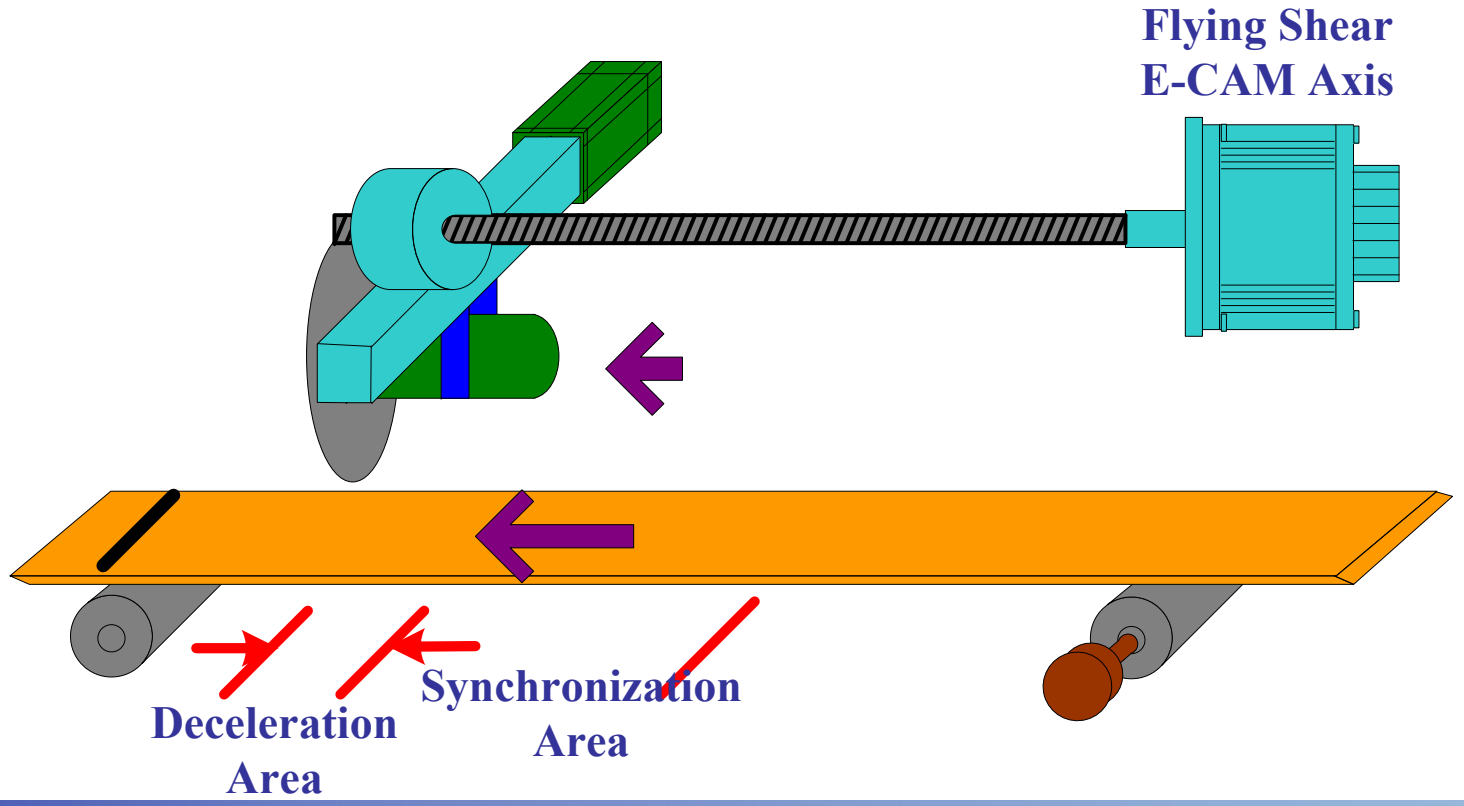




Flying Shear Operation Analysis -4

Deceleration Area of Flying Shear E-CAM Axis

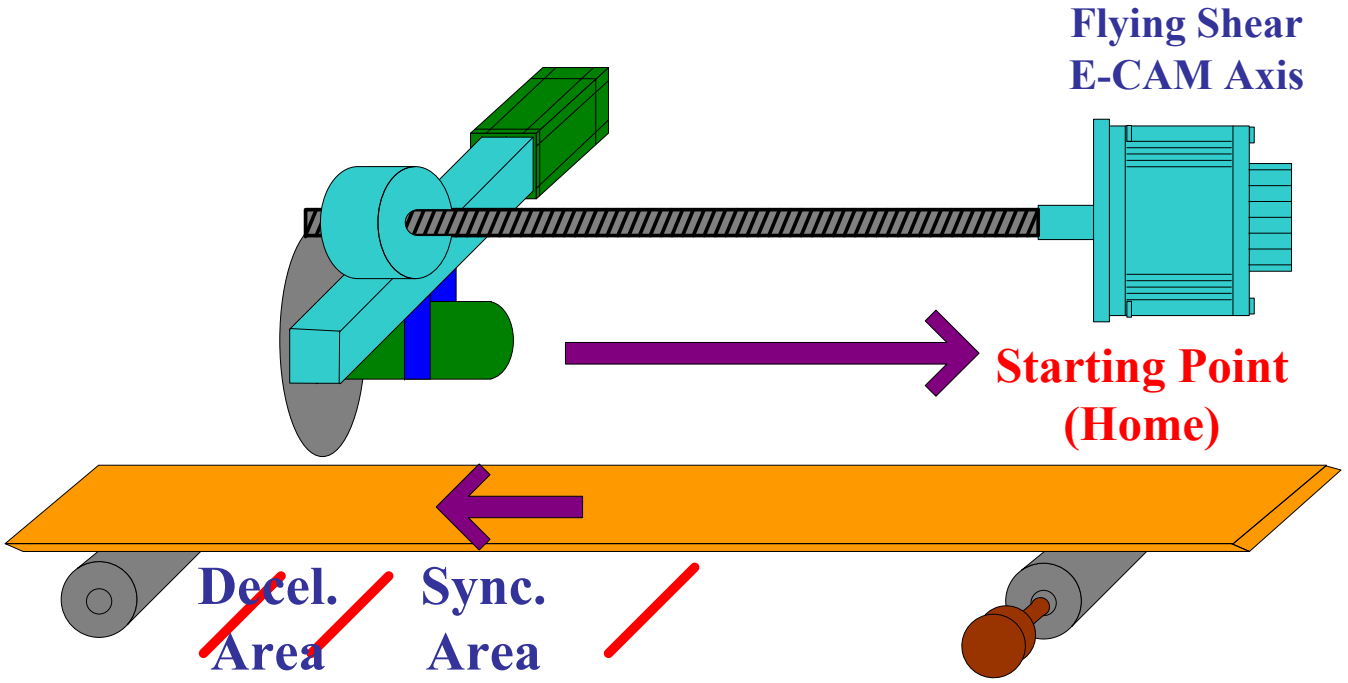
This area is used to decelerate E-CAM axis and prepare to let E-CAM axis operate in reverse direction so as to return to the starting position (home position). This area could be shorter a little in principle. It only needs to keep the distance which is enough for eliminating the lead inertia.



Flying Shear Operation Analysis -5

Flying Shear Axis Returns to Starting Point (Home)

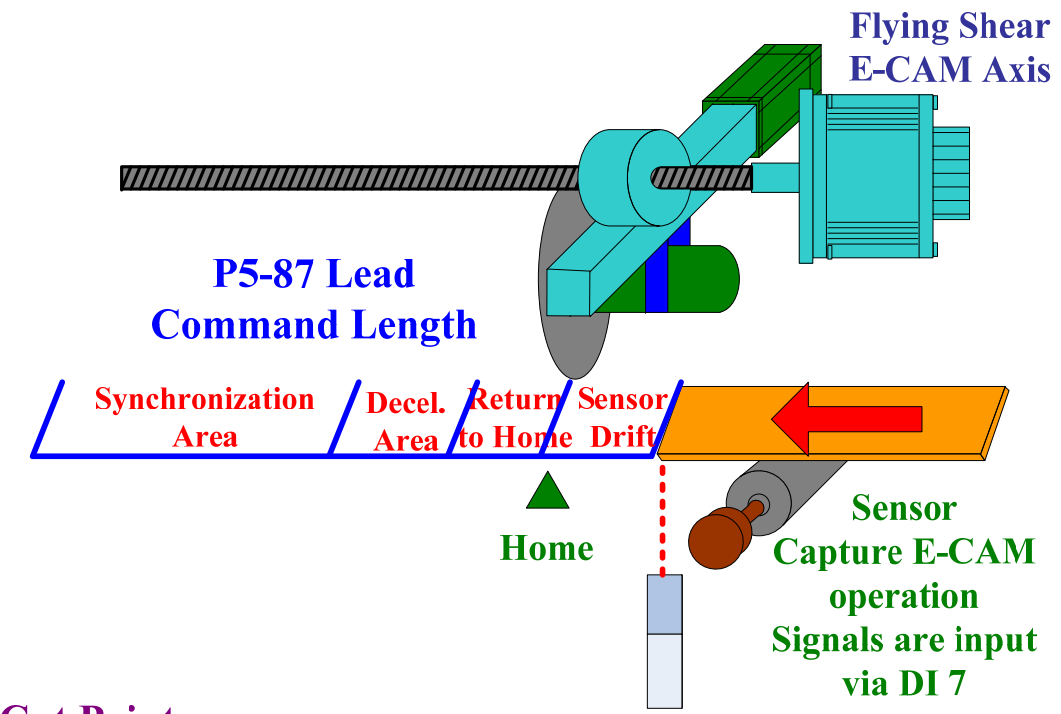
After all the cutting operation is completed, the flying shear should return to the starting point (home position) in the most shortest possible time for the sake of next cycle cutting operation. This is because when the return time is shorter, the time for synchronization area is more and the cutting time will be more enough as well.

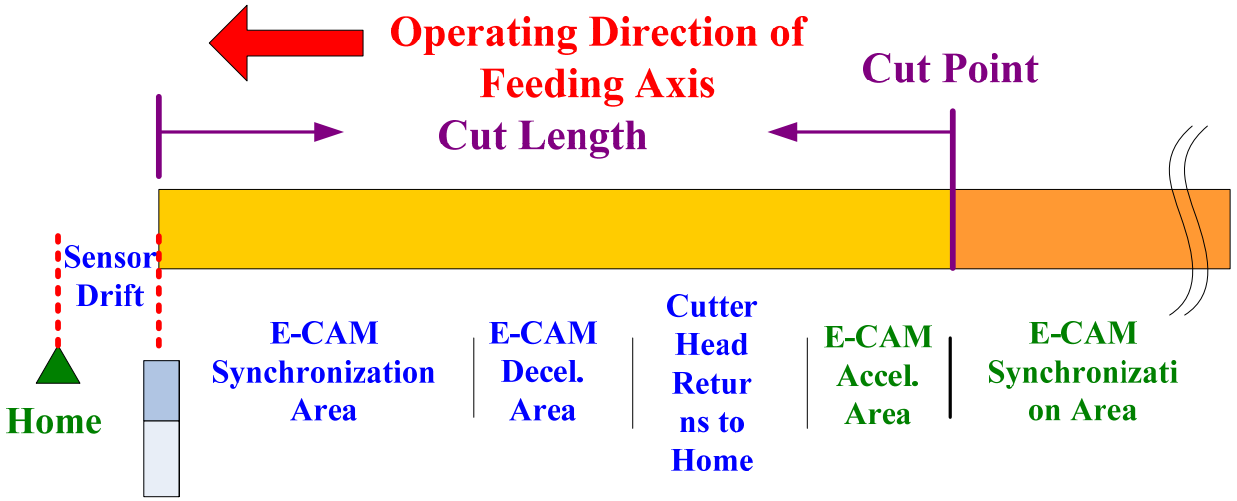


Flying Shear Operation Analysis -6

E-CAM Lead Command Length Setting

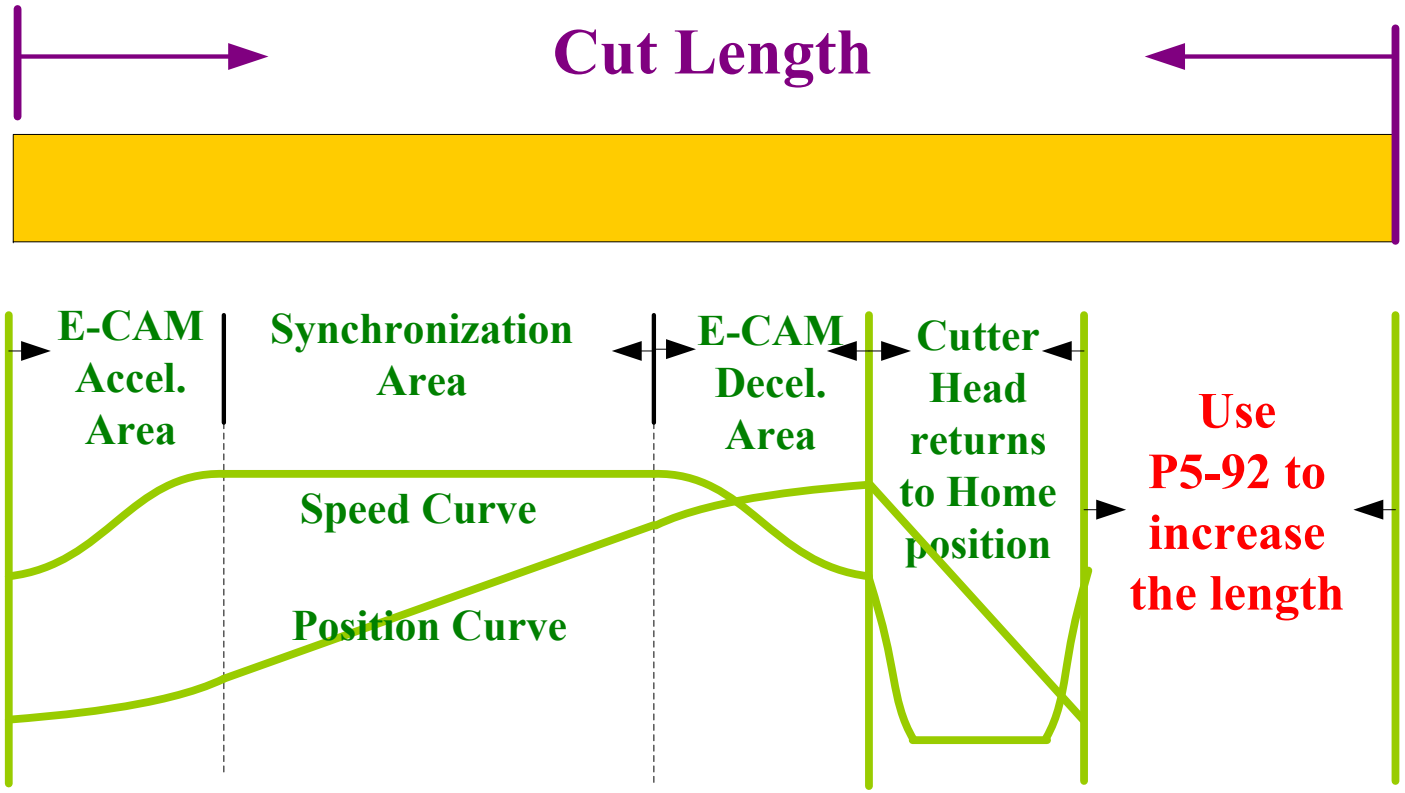
It is set by P5-87 and includes synchronization area, deceleration area, return to home area and sensor drift area.





Flying Shear Operation Analysis -7

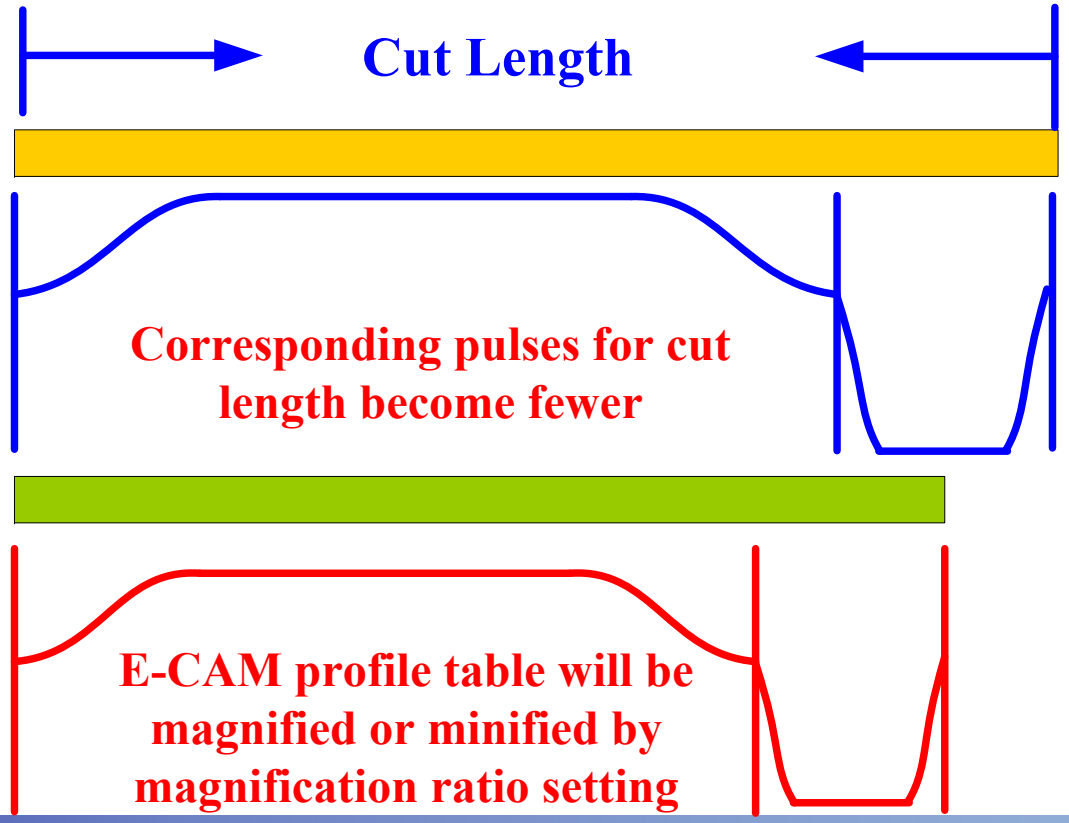
When the cut length is longer than E-CAM profile Set P5-88 U=4 and use P5-92 to determine the lead command length.



Flying Shear Operation Analysis -8

When the cut length is less than E-CAM profile

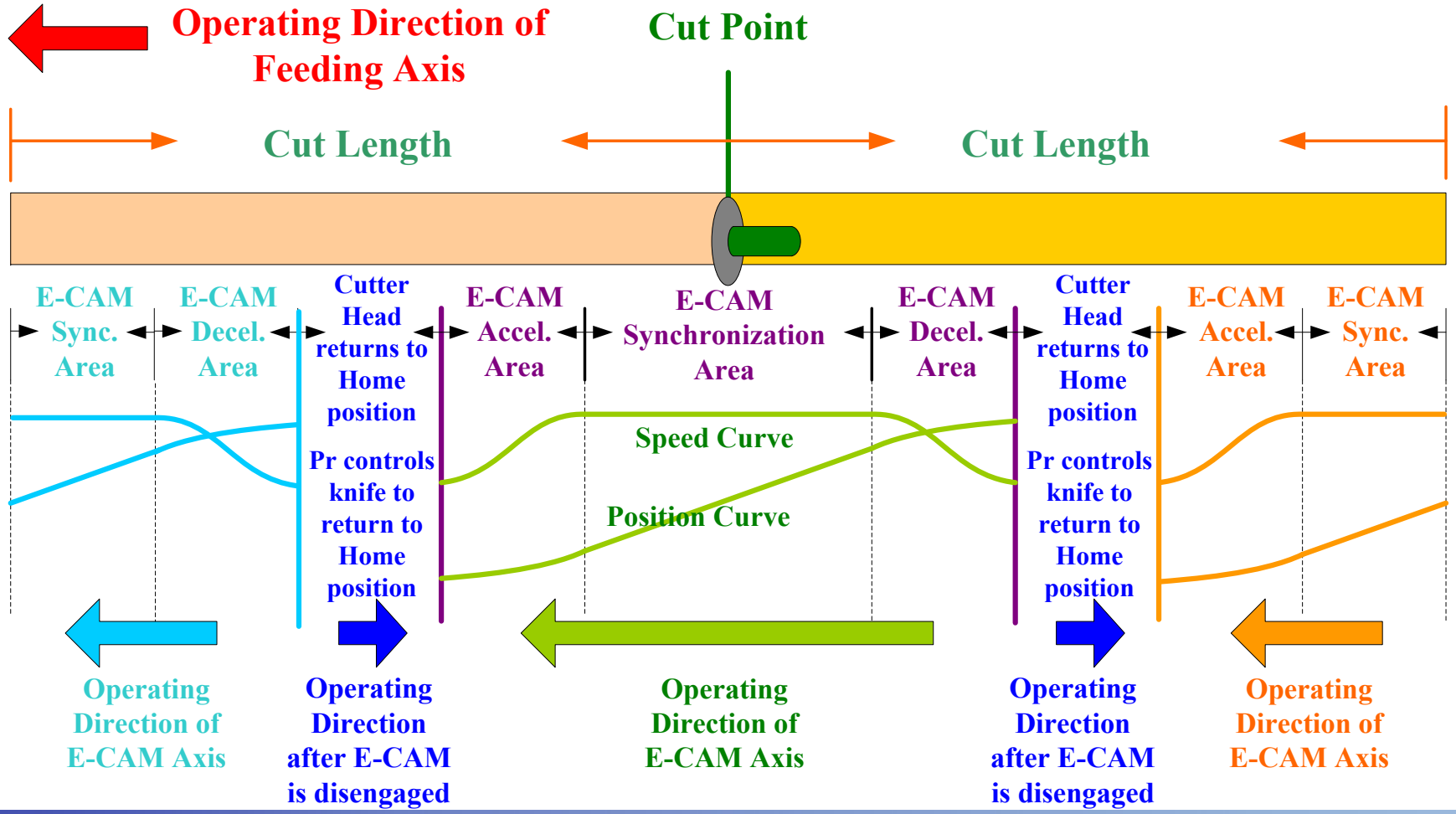
Use P5-19 to adjust E-CAM profile table. The parameters relevant to pulse number of master axis, such as P5-84 should be adjusted as well. Please also notice that the cutting time should be long enough to make the cutter complete cutting operation.



Flying Shear Operation Analysis -9

CAPTURE and COMPARE Functions

If CAPTURE and COMPARE functions are both used, it has no need to create E-CAM profile for return path for "continuous feeding" flying shear application.



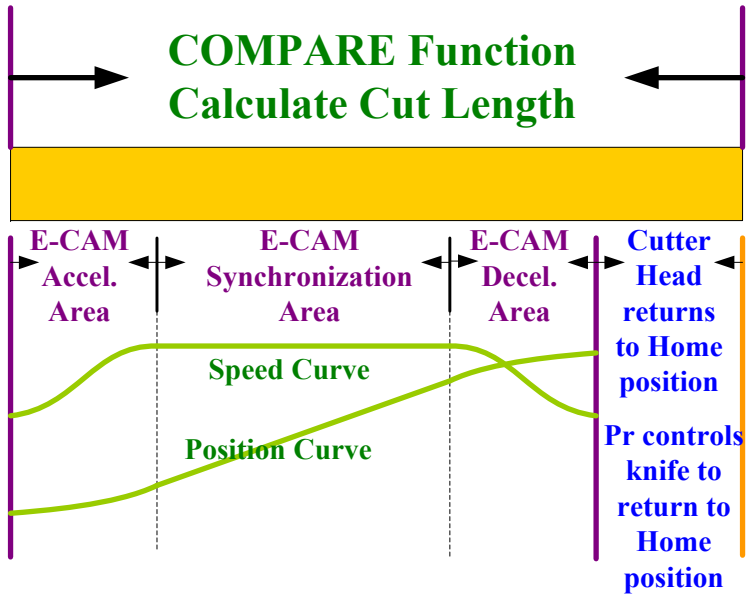
Flying Shear Operation Analysis -10

Use COMPARE function to calculate Cut Length

Incorporating DO4 (Digital Output) and DI7 (Digital Input), the users can use CAMPARE function to calculate the cut length and use CAPTURE function to enable E-CAM operation. The whole motion cycle should return to starting point (home position) before next cutting operation.

DI/DO Signals of E-CAM Axis

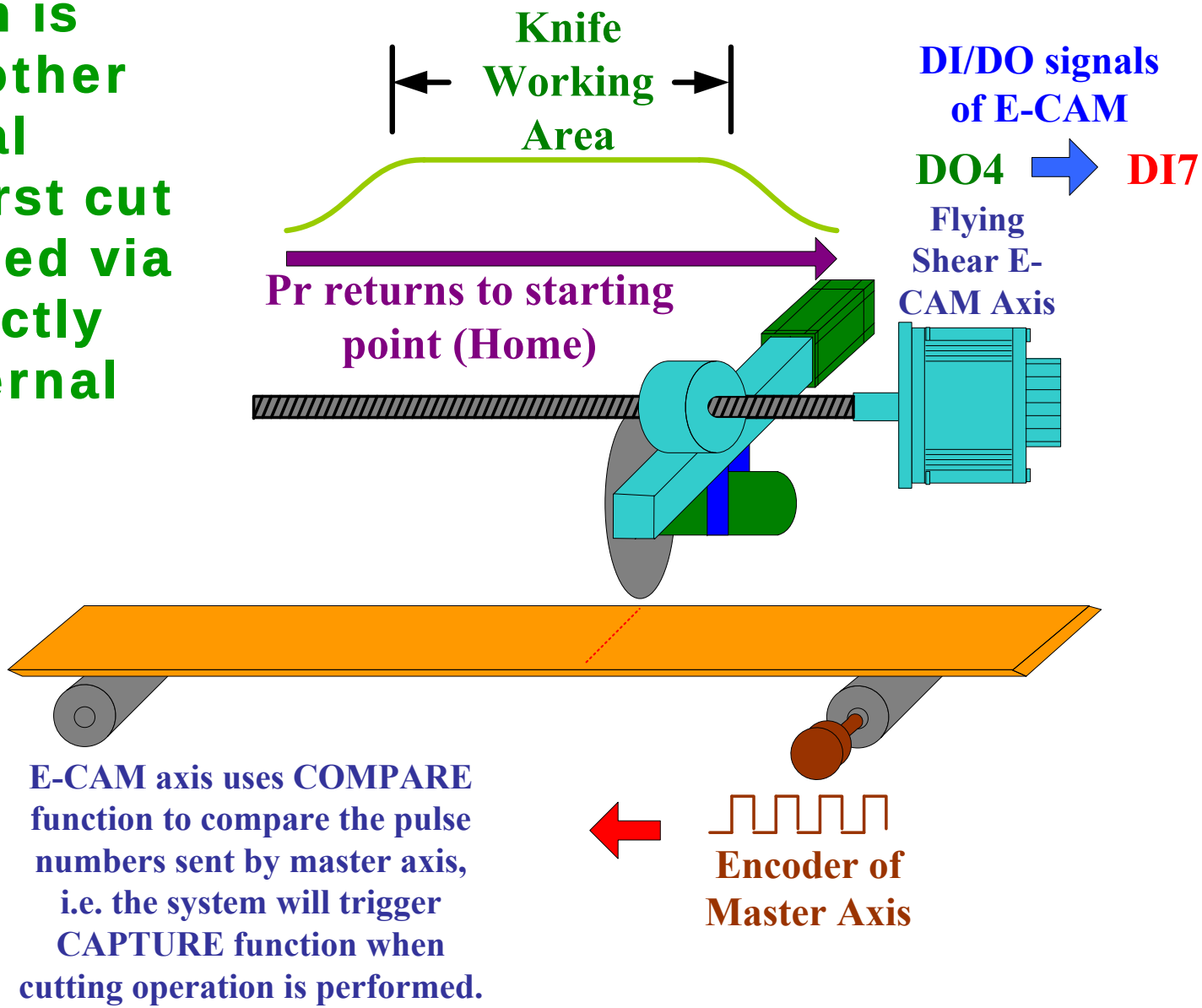
DO4 ➡ DI7



CAPTURE ➡ COMPARE ➡ CAPTURE ➡ • • •

Flying Shear Operation Analysis -11

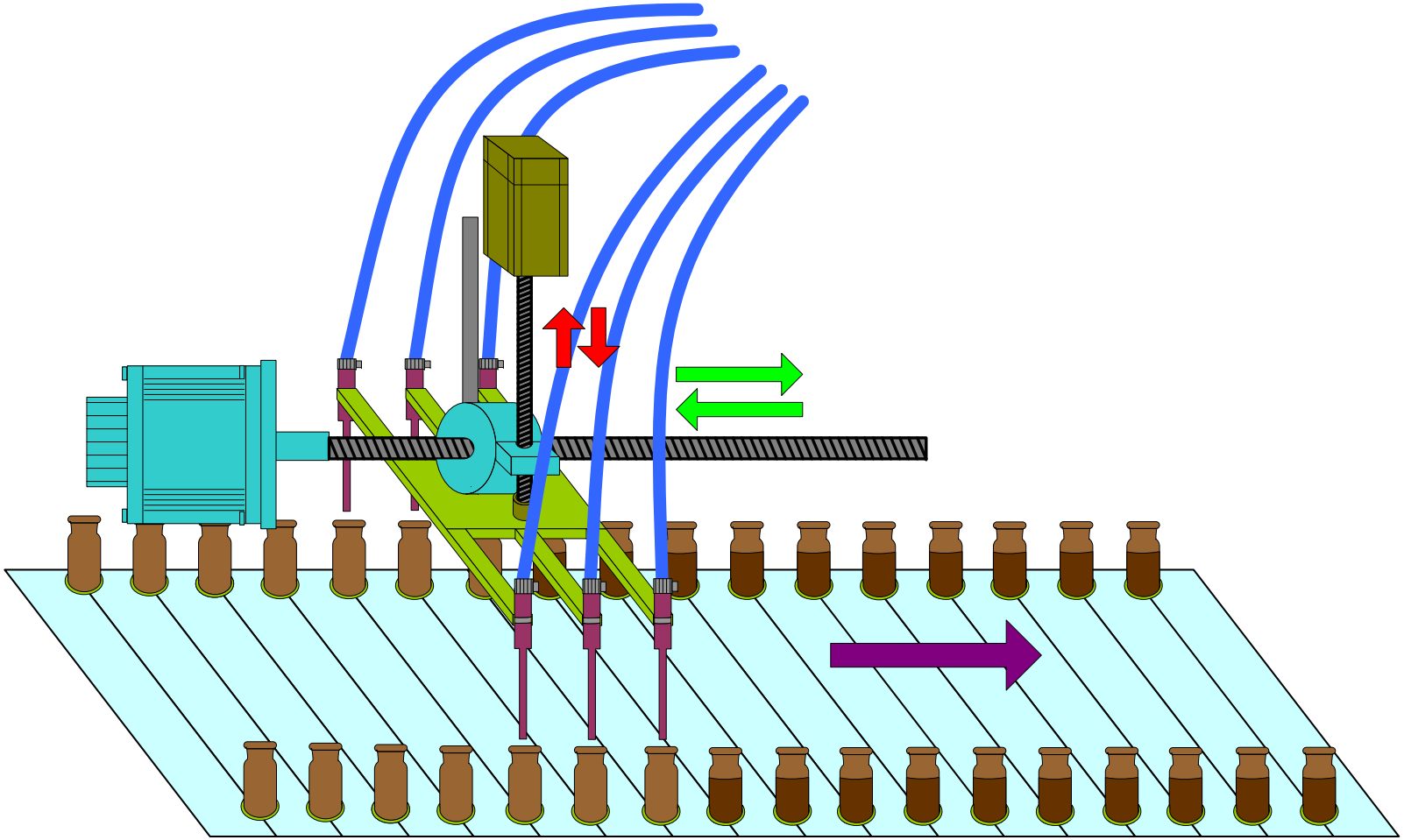
Knife Working Area
Cutting operation is controlled by another E-CAM or external controller. The first cut should be activated via DI7 which is directly triggered by external signal.



Flying Shear Application

Medicine Filling Machine

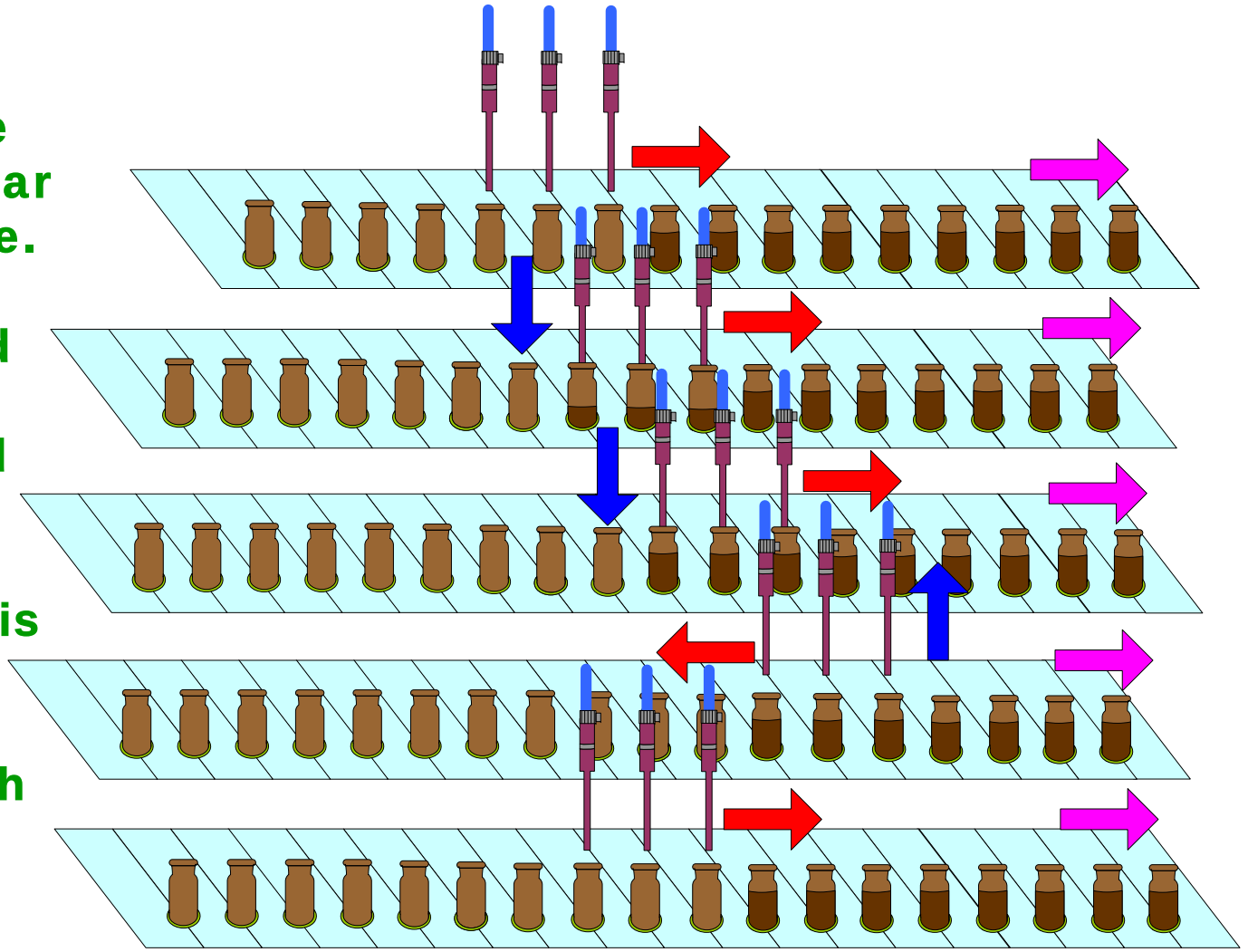
This kind of application is a typical "non-continuous feeding" flying shear system. ASDA-A2 series can easily complete this kind of operation.



Flying Shear Application Theory -1

Moving Load Table

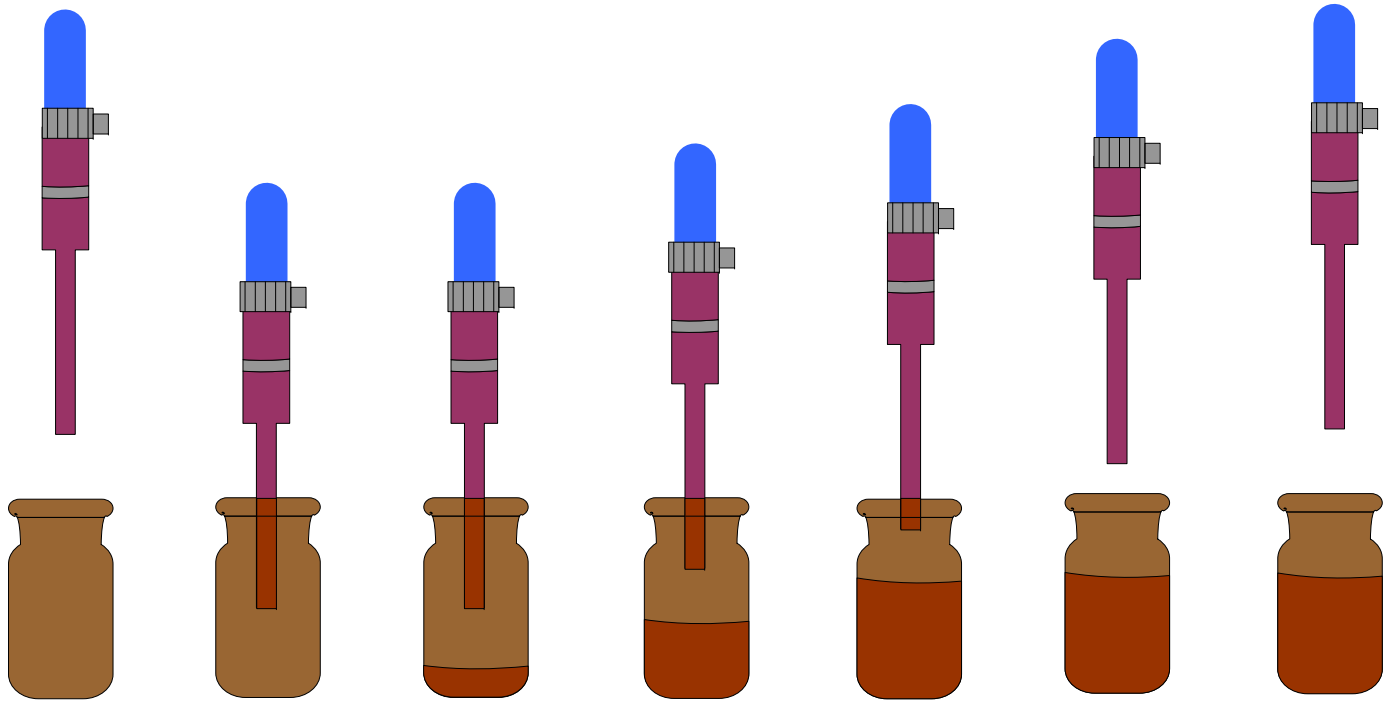
When bottles reach the position, the sensor will sent the signal to enable E-CAM, i.e the flying shear axis of moving load table. When moving load table attain to the same speed of conveyer, the filling axis will move down and start filling operation. After filling operation is completed, the filling axis will move up to original position and E-CAM will be disengaged. If Pr path is set in advance, the system will control the moving load table to return to home position.



Flying Shear Application Theory -2

Filling Axis

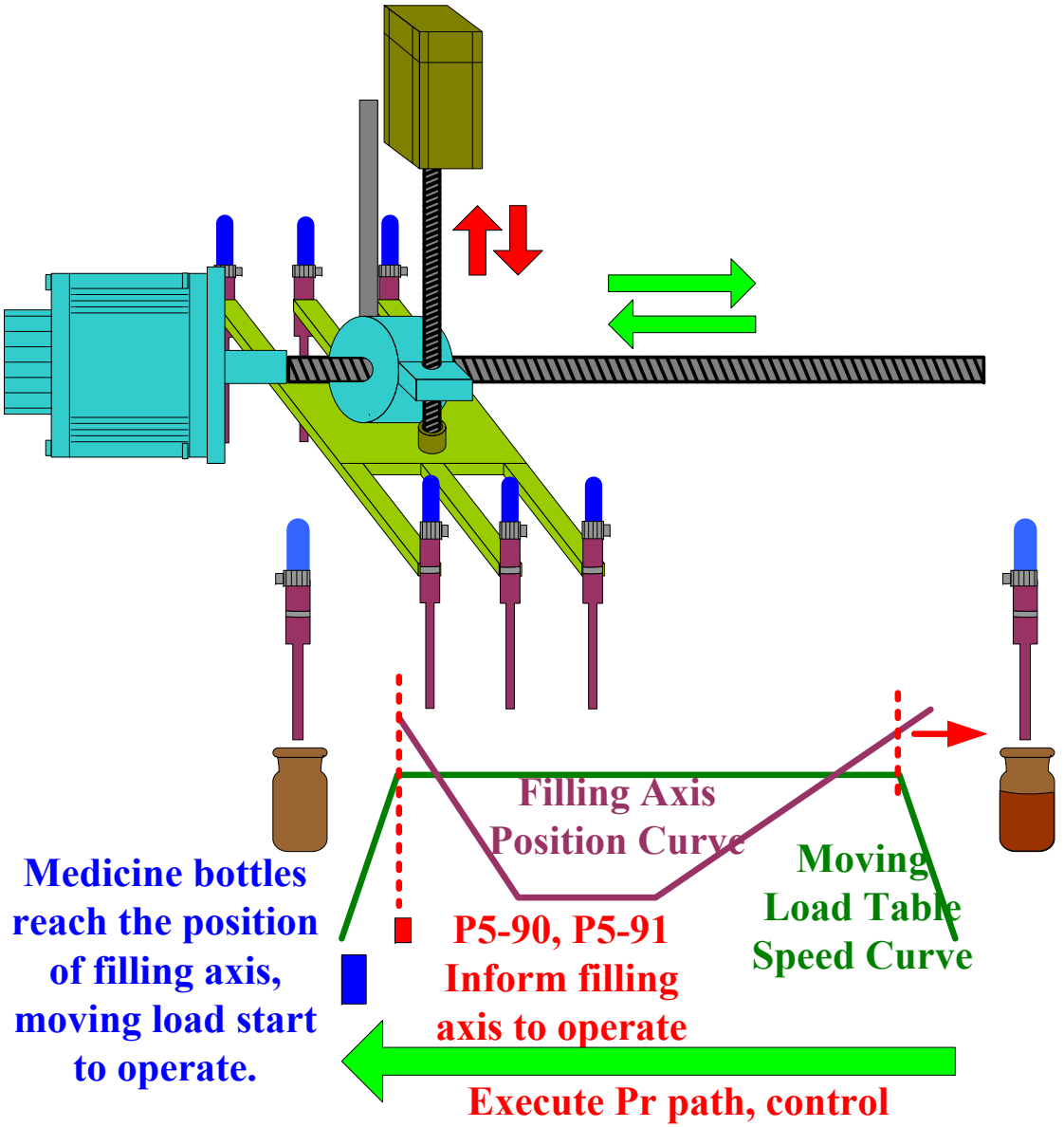
When moving load table synchronizes to the conveyer of medicine bottles, the filling axis will move down and start filling operation. After filling operation is completed, the filling tubes must leave the bottles when moving load table and the conveyer operate in the same speed. Otherwise, the filling tubes will hit the bottles when moving load table start to return to home position.



Flying Shear Application Theory -3

E-CAM Profile Design

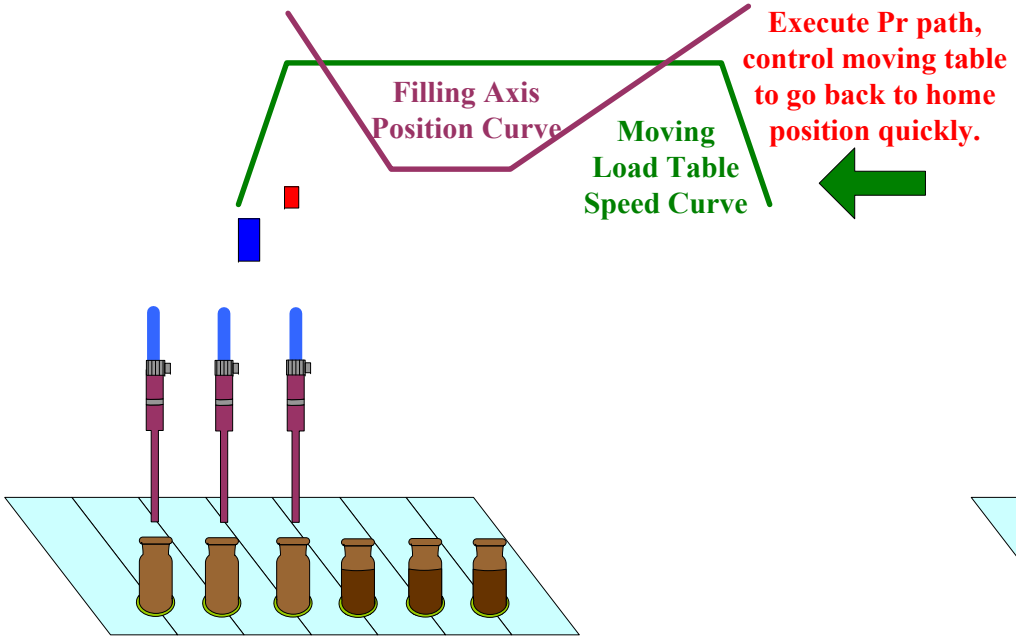
This system needs two groups of E-CAM profile, one is for moving load table (position curve) and the other is for filling axis (speed curve). On the return path, the system will move quickly by using Pr path and send the load table to go back to the home position. All operation should complete before next group of bottles reach the position of the filling axis.

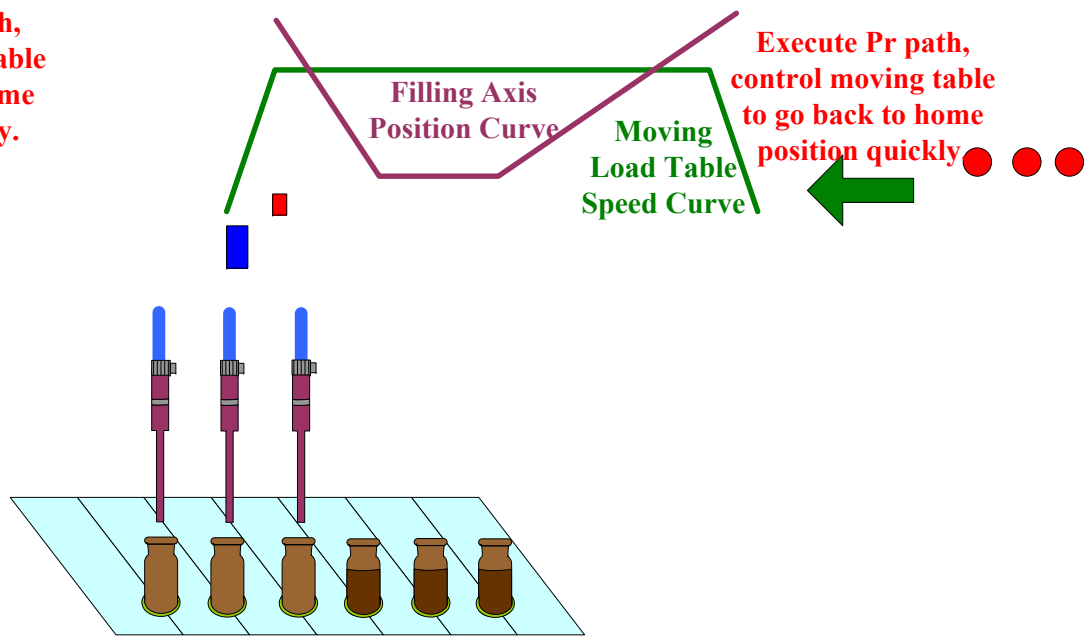


Flying Shear Profile Design -1

Operation Cycle Explanation

One operation cycle is defined as a period from the time the load table completes E-CAM profile to the time the load table executes Pr path after the filling tube leave the bottles.

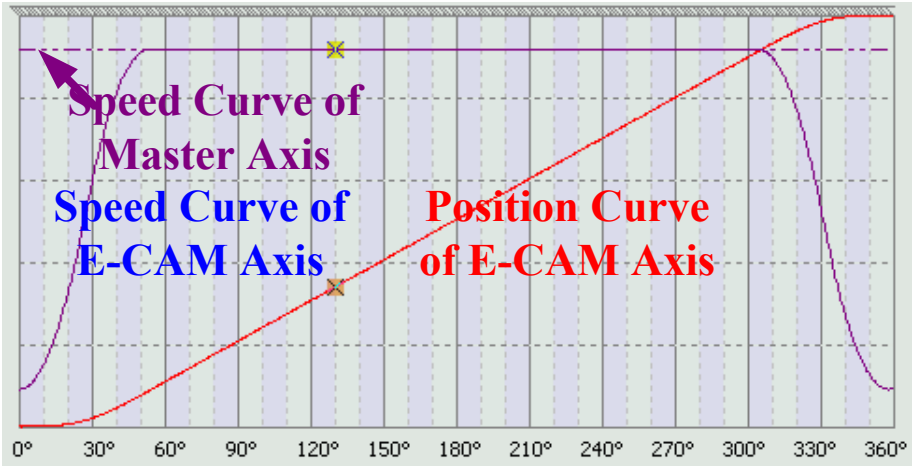


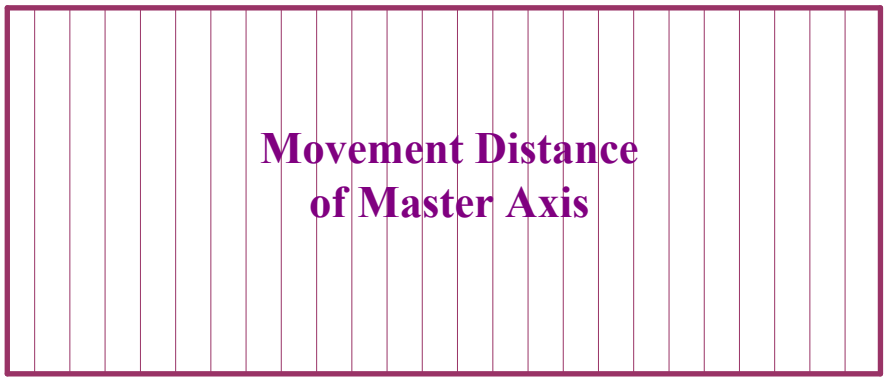


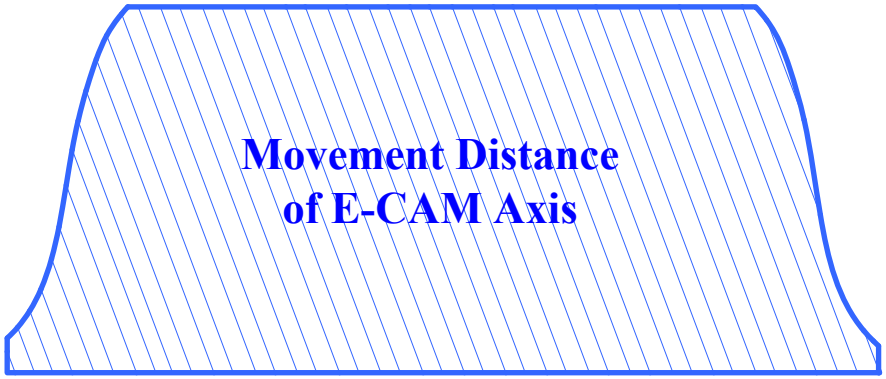
Flying Shear Profile Design -2

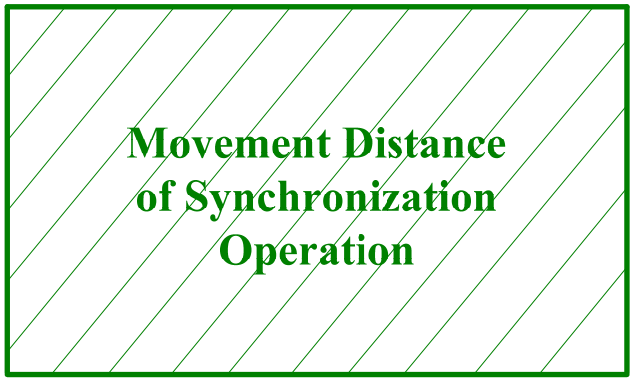
Position Curve and Speed Curve Explanation

Movement Distance of Master Axis > Movement Distance of E-CAM Axis > Movement Distance of Synchronization Operation





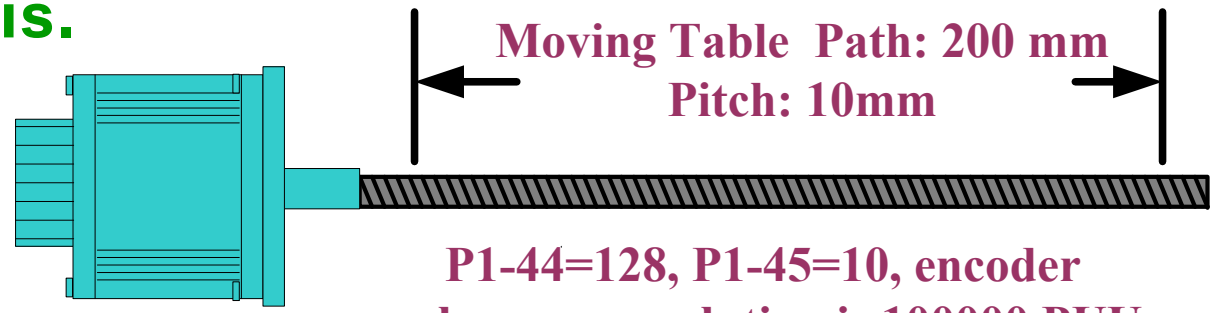




Flying Shear Profile Design -3

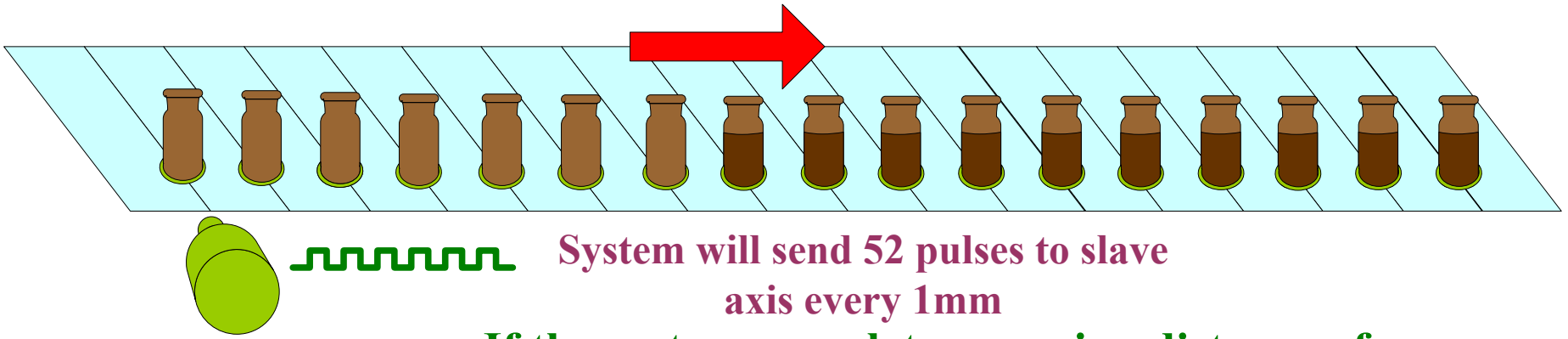
Mechanical System Size Settings

Before creating E-CAM profile, it needs to understand the pulse physical quantity between master axis and slave axis.



P1-44=128, P1-45=10, encoder pulses per revolution is 100000 PUU

2000000 PUU is needed for 200mm path, i.e. 10000PUU is needed for every 1mm



System will send 52 pulses to slave axis every 1mm

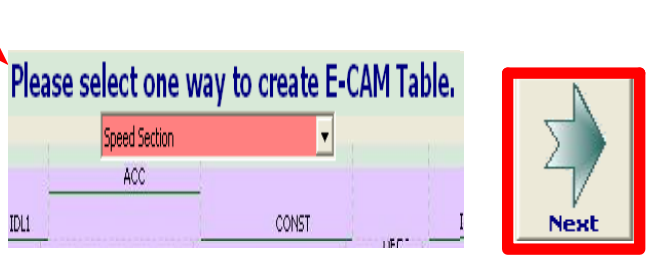
If the system complete a moving distance of 220mm, it will send 11440 pulses to slave axis.

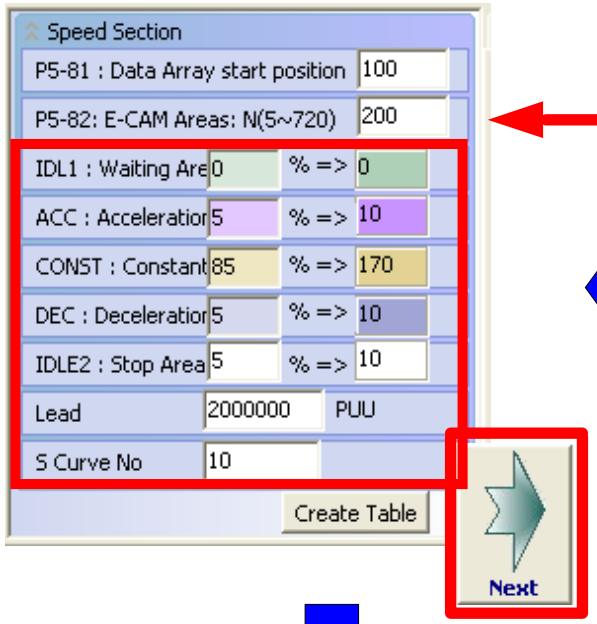
Flying Shear Profile Design -4

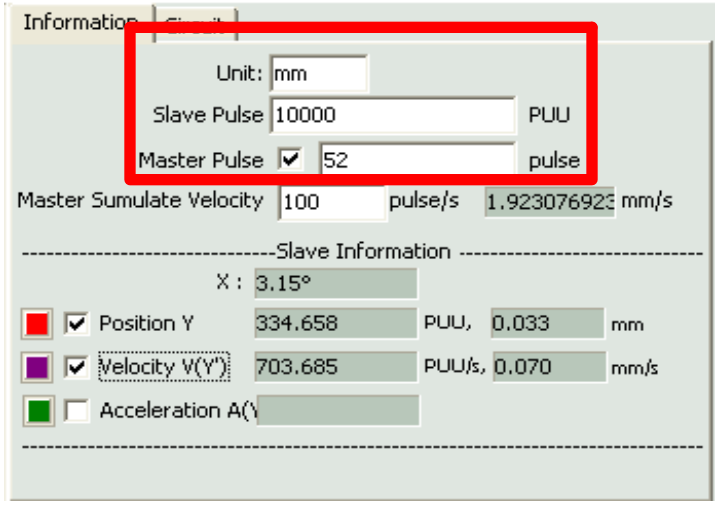
Create E-CAM Profile for Moving Load Table (1) – Enter Setting Value and Simulation Value

Choose ”Speed Section” function to create E-CAM profile for moving load table.

P1-44=12
P1-45=10^8



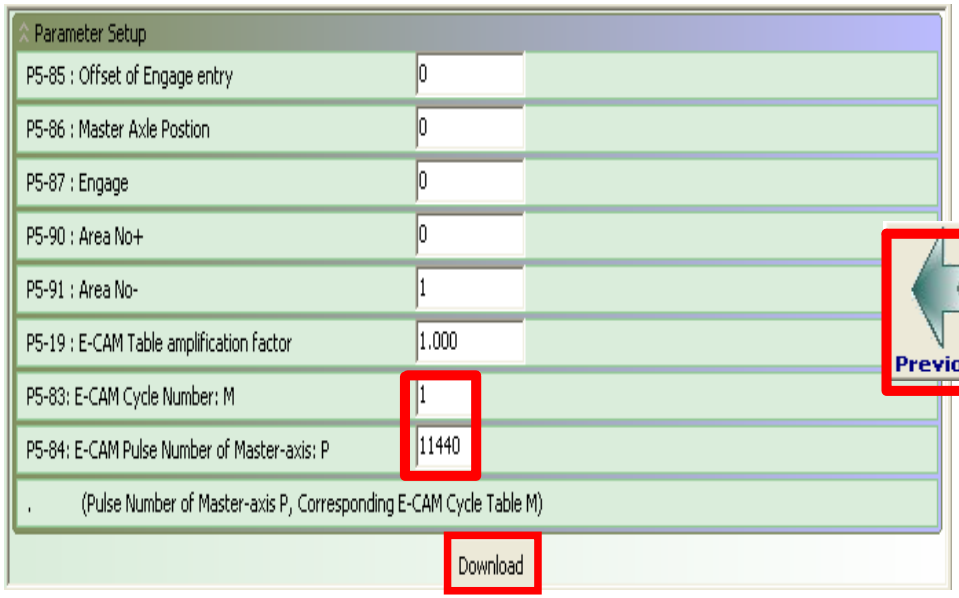


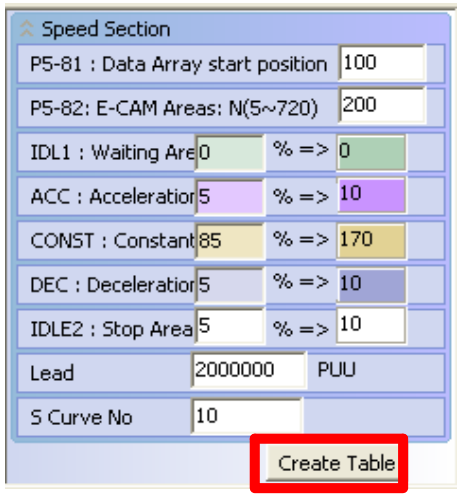


See Next Slide

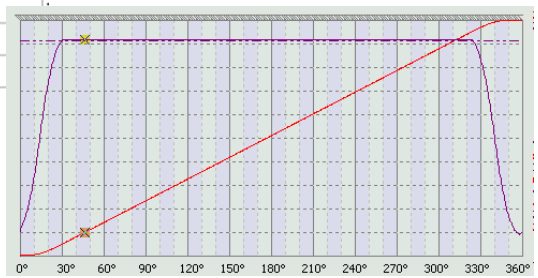
Flying Shear Profile Design -5

Create E-CAM Profile for Moving Load Table (2) – Enter Setting Values for Master Axis and Create E-CAM Profile Table





	0	1	2	3	4
θ[°]	0	1.8	3.6	5.4	7.2
Postion Y	0	111	444	1111	2222

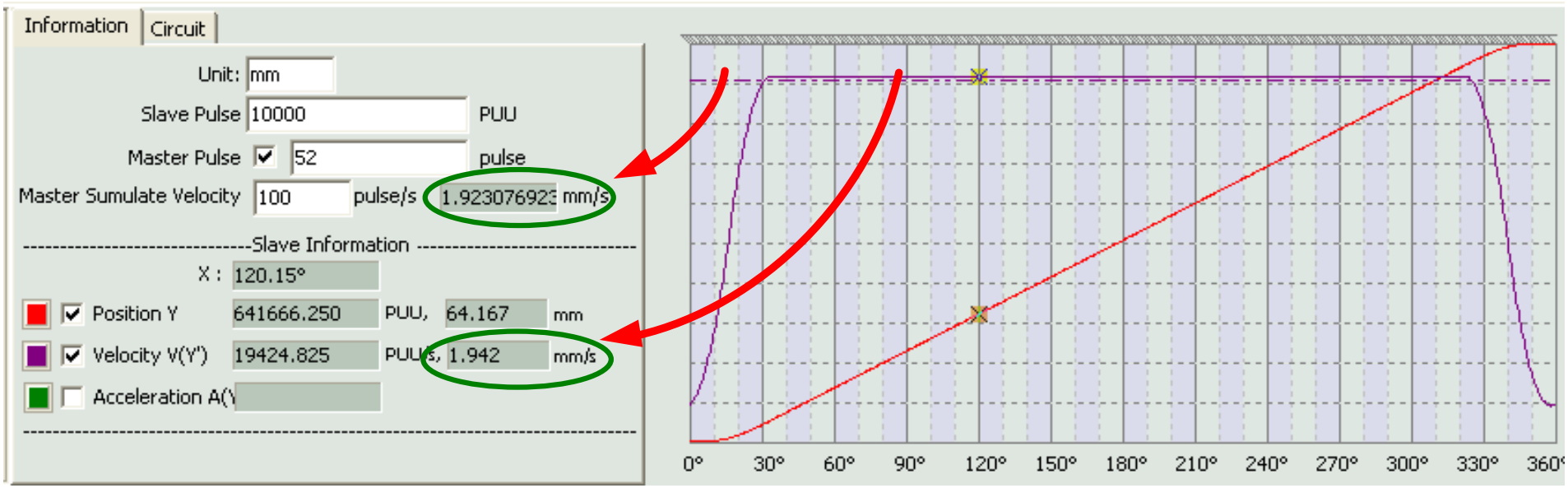


See Next Slide

Flying Shear Profile Design -6

Create E-CAM Profile for Moving Load Table (3) – Examine Operating Speed of Master and Slave

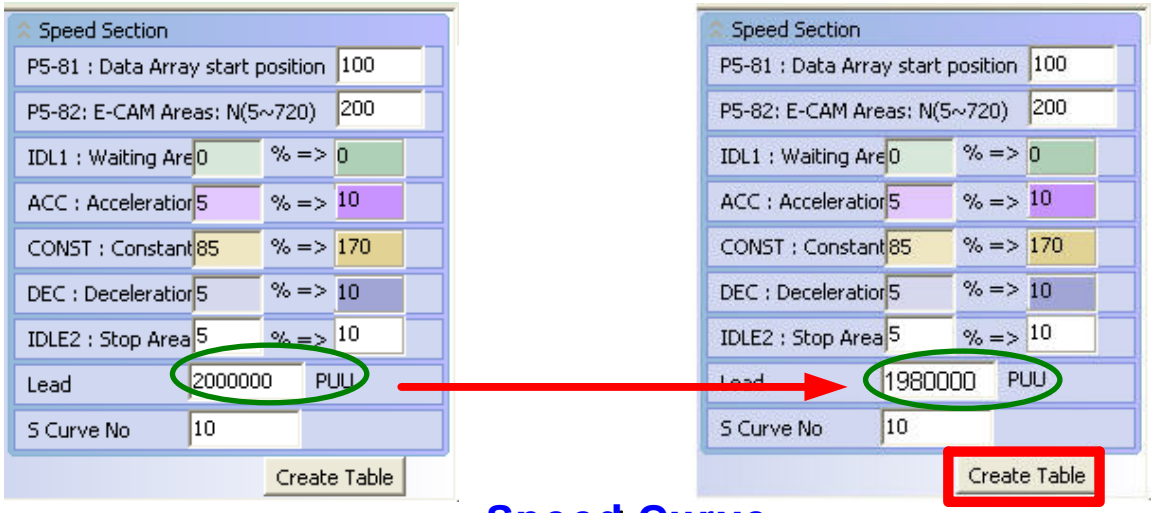
On E-CAM profile, setting "Master Simulate Velocity" to 1.923076923 which is smaller than E-CAM (Slave) speed=1.942 is able to adjust the operating path of master axis and slave axis, and accel. & decel. area of slave axis so as to make the speed of flying shear axis and master axis be the same.

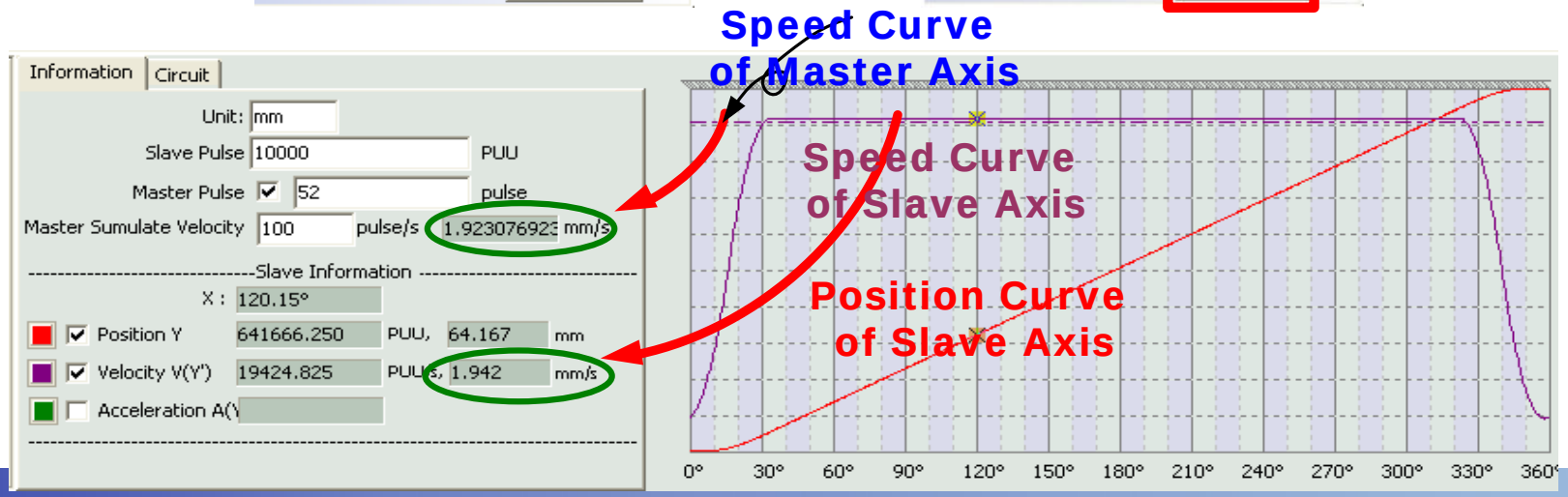


Flying Shear Profile Design -7

Create E-CAM Profile for Moving Load Table (4) – Adjust Speed through Commands of Slave Axis

Use Lead Command Length to make adjustment. Perform testing repeatedly and stop until the speed of flying shear axis and master axis become the same. The Lead Command Length will be adjusted from 2000000PUU to 1980000PUU.

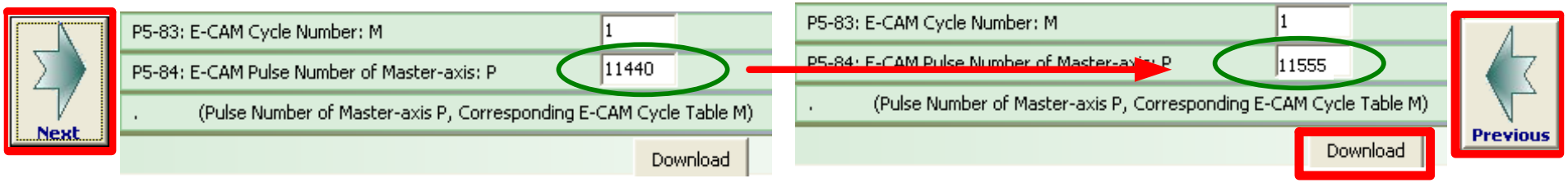


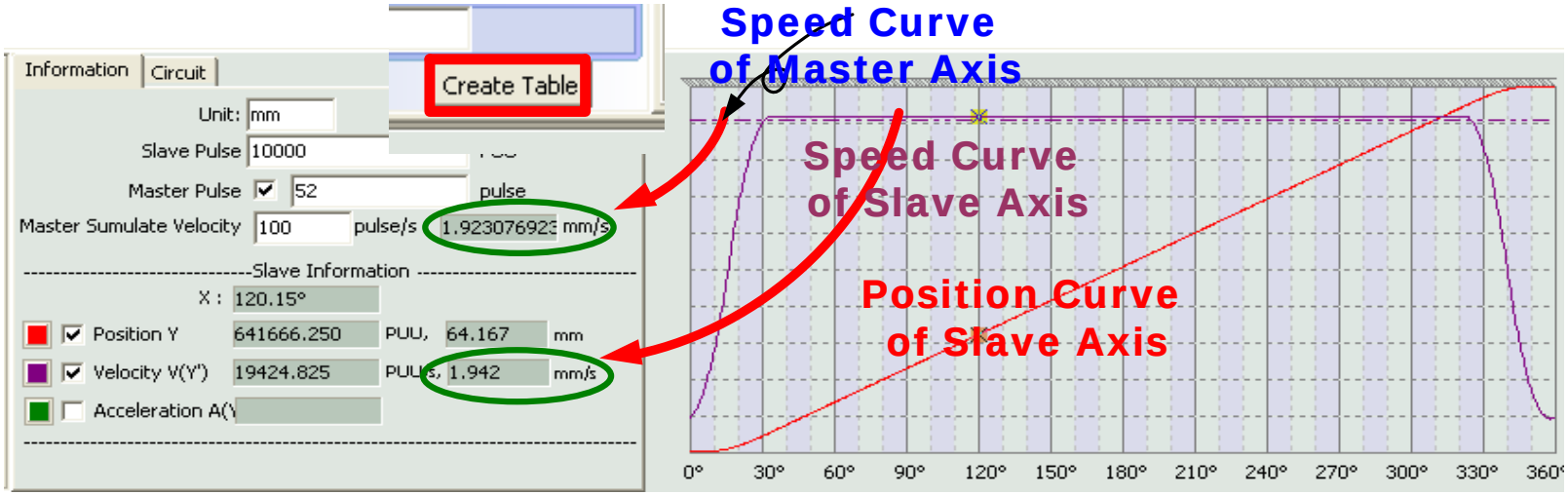


Flying Shear Profile Design -8

Create E-CAM Profile for Moving Load Table (5) – Adjust Speed through Pulse Number of Master Axis

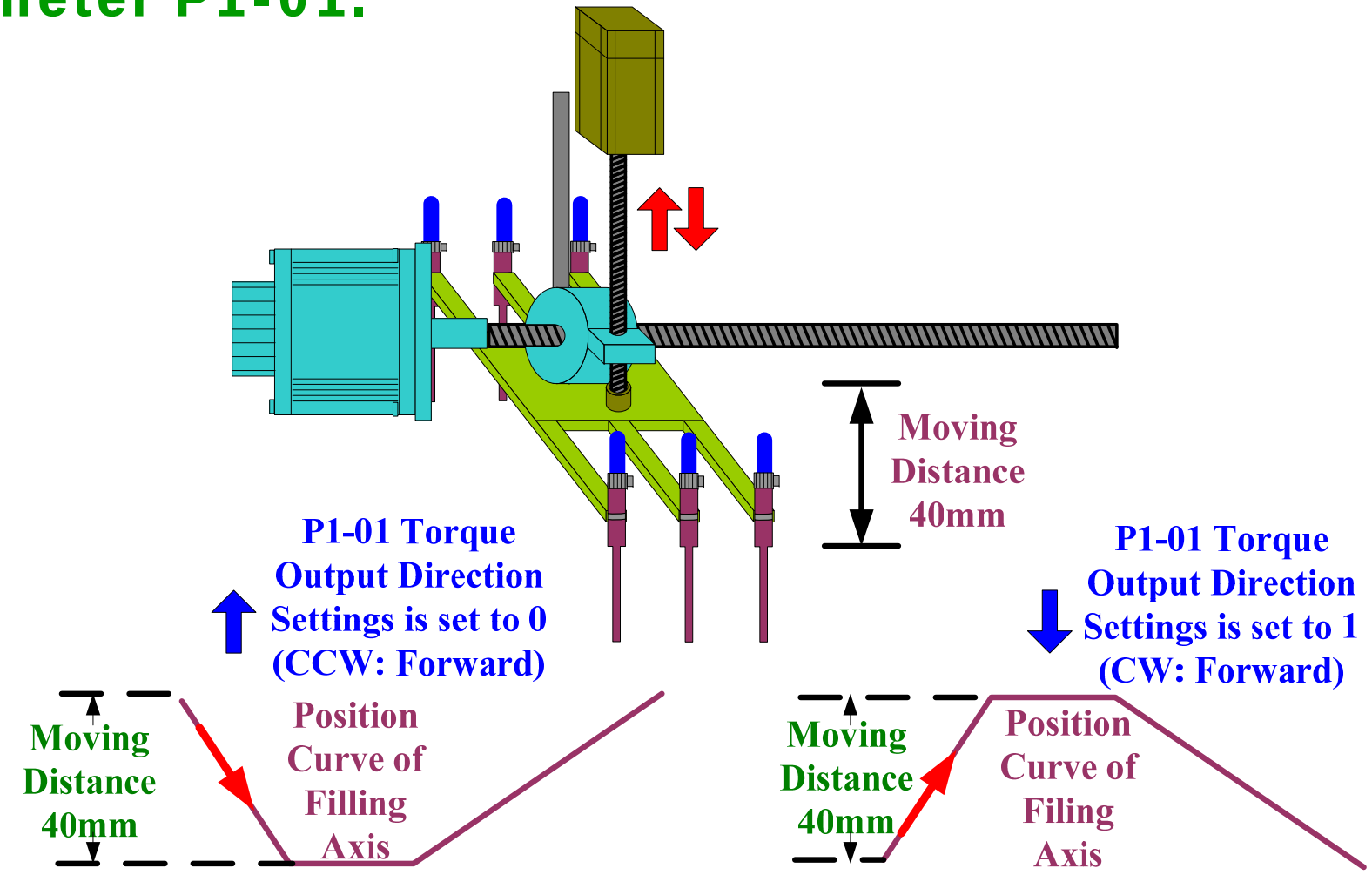
Use Lead Command Length to make adjustment. Perform testing repeatedly and stop until the speed of flying shear axis and master axis become the same. The pulse number of master axis will be adjusted from 11440 to 11555.





Flying Shear Profile Design -9

Create E-CAM Profile for Filling Axis (1) –
E-CAM Profile Direction and Moving Distance
Please refer to the torque output direction settings of parameter P1-01.



Flying Shear Profile Design -10

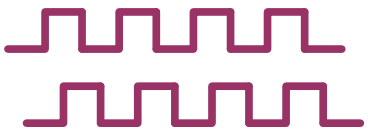
Create E-CAM Profile for Filling Axis (2) –
Motor Operating Direction and E-CAM Profile

Same pulse command corresponds to the same position curve. Using Torque Output Direction Settings is able to change the motor operating direction. In ASDA-A2 series, motor forward direction is defined as the increasing direction of encoder pulse number. The motor operating direction in the figure below is just the reference for explanation, not actual motor operating direction.

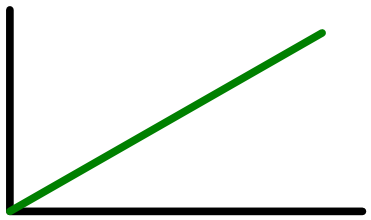
Pulse Command

P5-16 is positive, pulse number is increased in forward direction

P5-86 is positive, pulse number is increased in forward direction

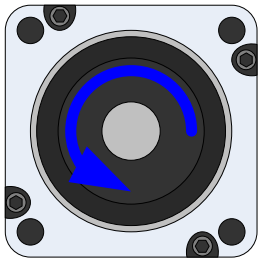


E-CAM Profile Position Curve

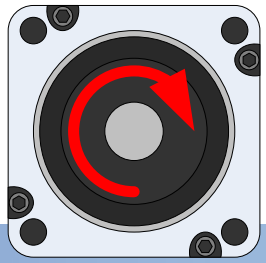


Motor Operating Direction

P1-01 Torque Output Direction Settings = 0



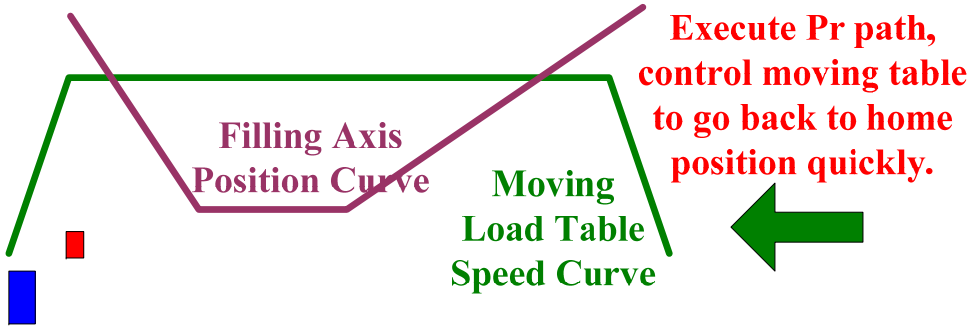
P1-01 Torque Output Direction Settings = 1

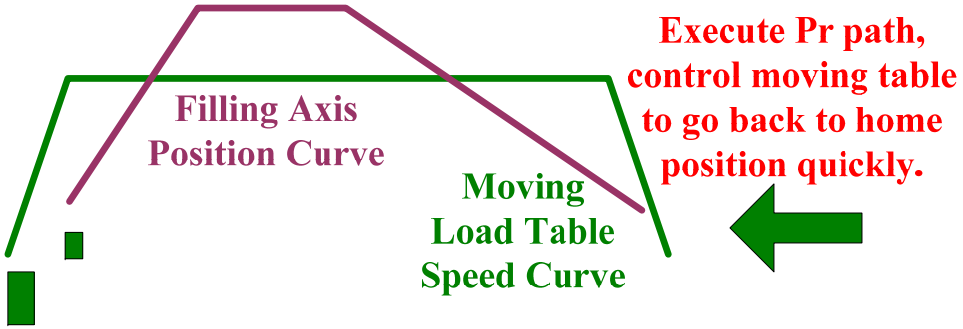


Flying Shear Profile Design -11

Create E-CAM Profile for Filling Axis (3) – E-CAM Profile Selection

The E-CAM profile must be set in accordance with the motor operating direction. The following two E-CAM profile could be both used for flying shear applications.

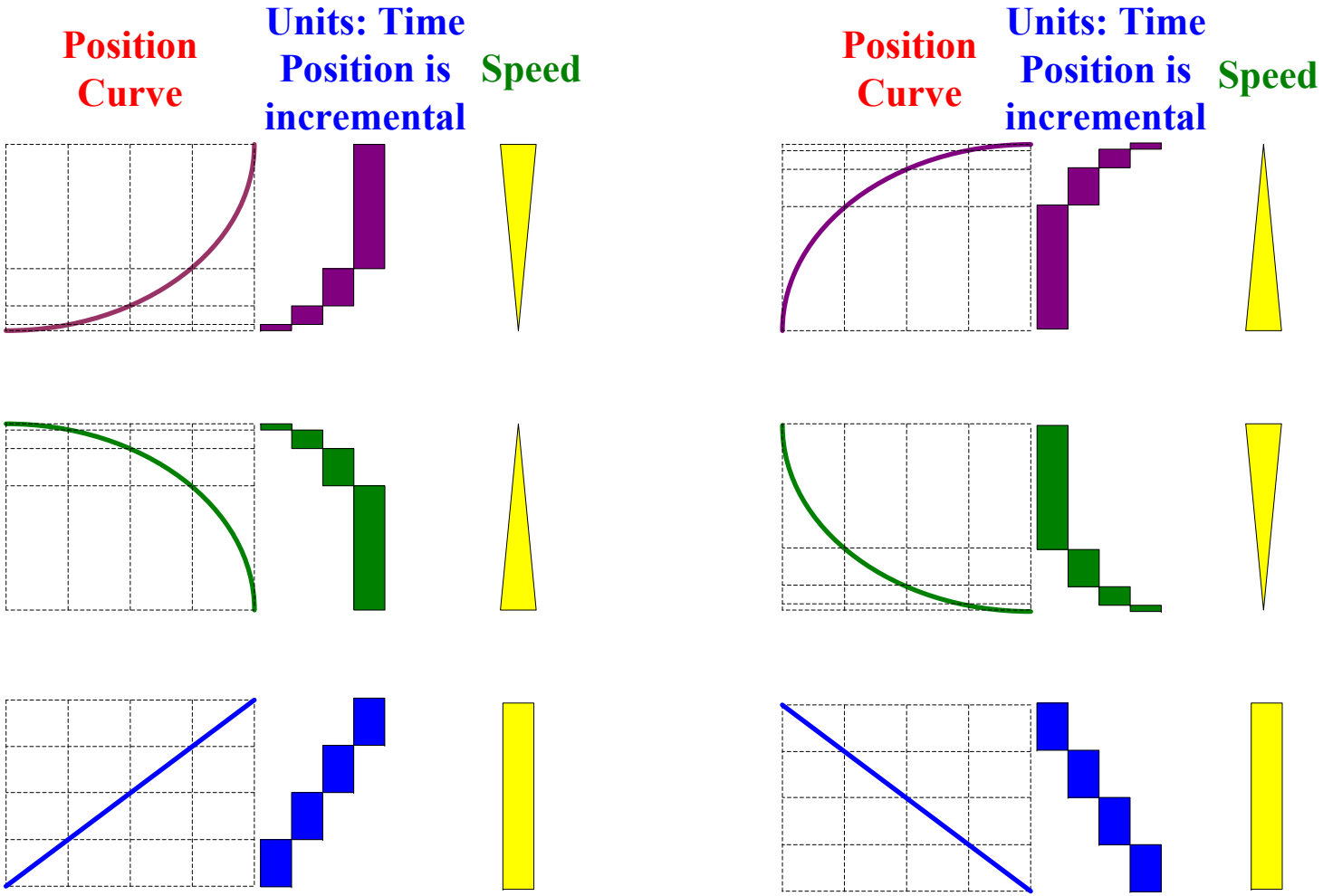




Flying Shear Profile Design -12

Create E-CAM Profile for Filling Axis (4) – Position Curve and Speed Curve

The curvature of E-CAM position curve and concave- convex direction will affect the operating speed of E-CAM Axis.

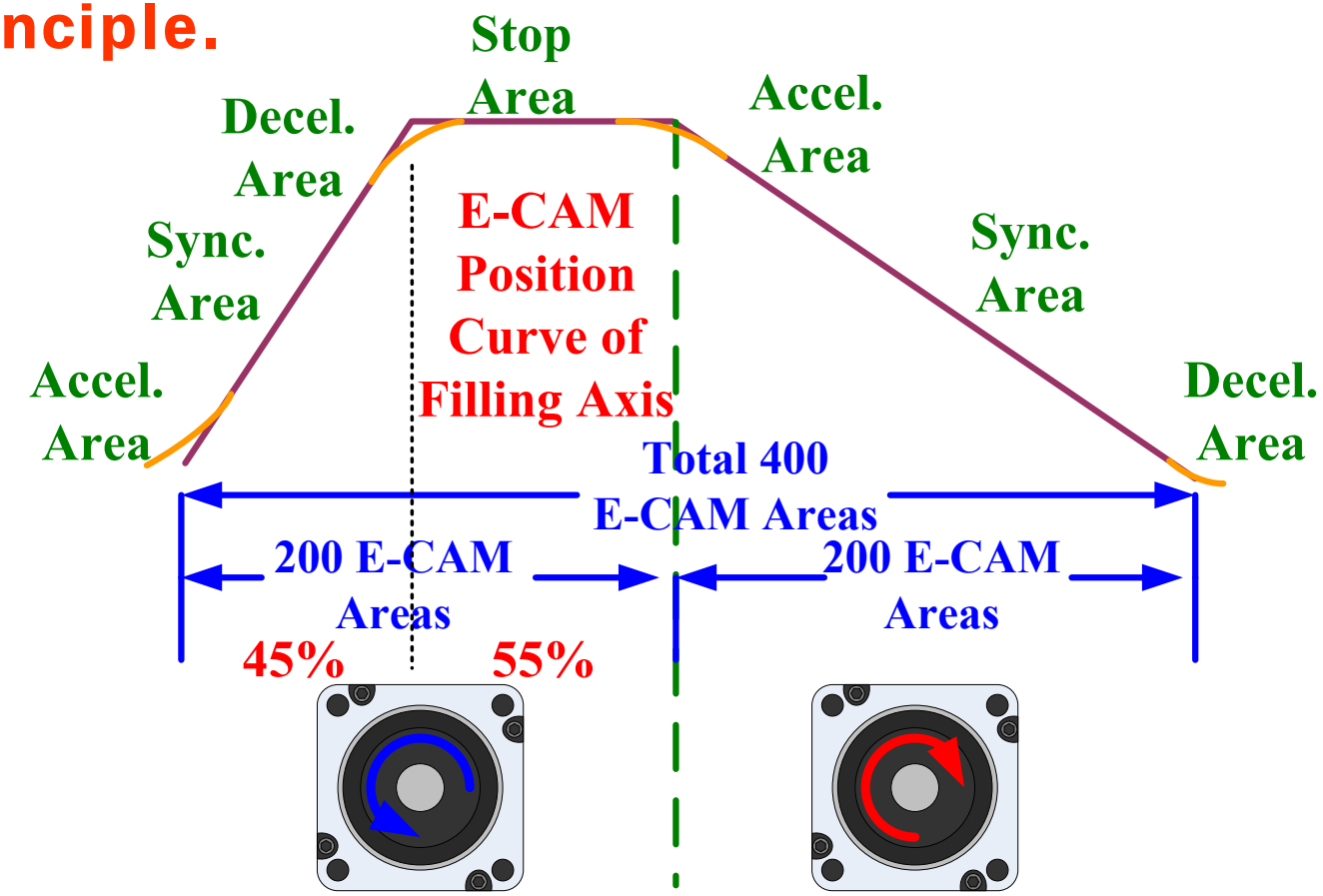


Flying Shear Profile Design -13

Create E-CAM Profile for Filling Axis (5) – E-CAM Curve Areas

Position curve of filling axis could be divided into two parts and these two curves do not need to obtain a 1:1 ratio.

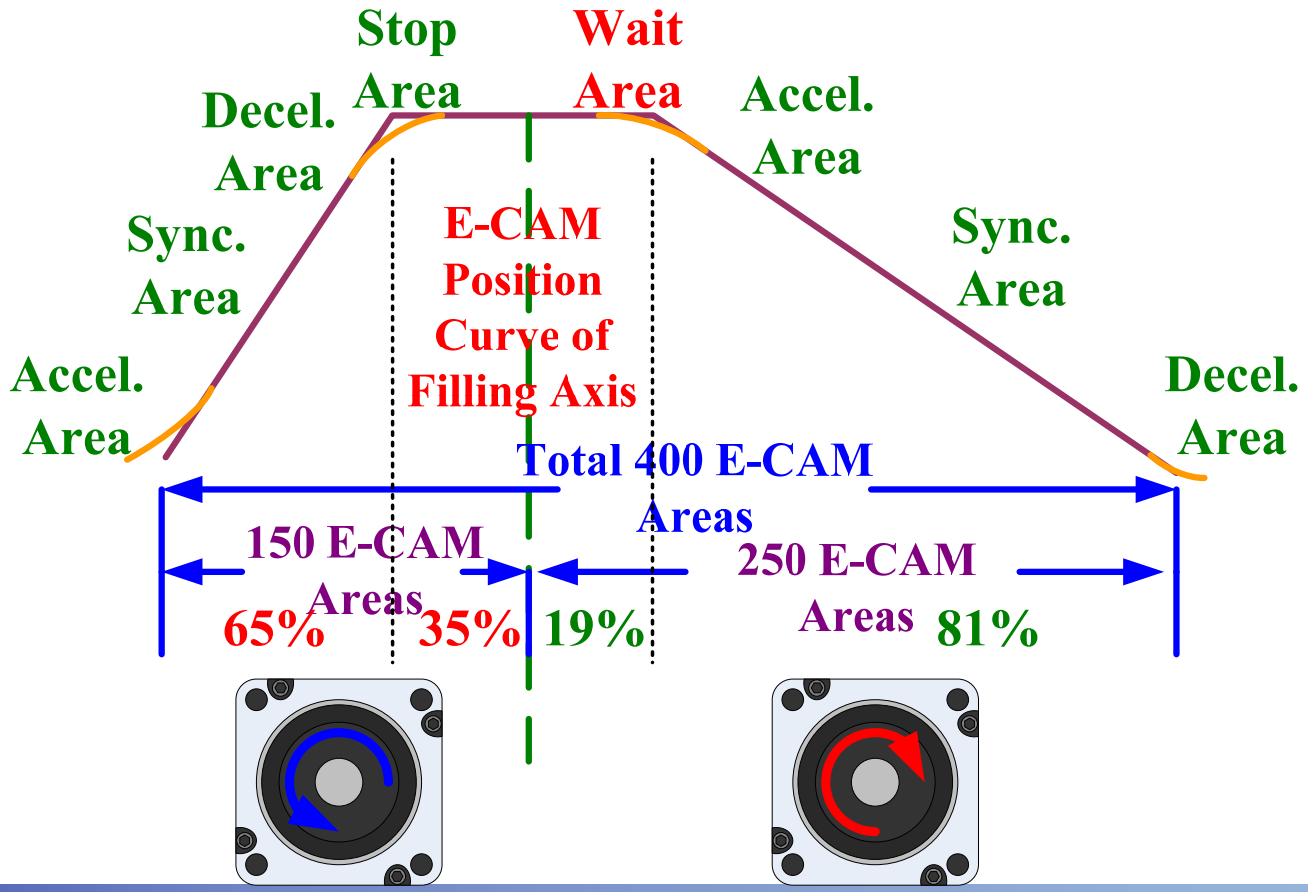
The motor operates in one direction only in each E-CAM area on principle.



Flying Shear Profile Design -14

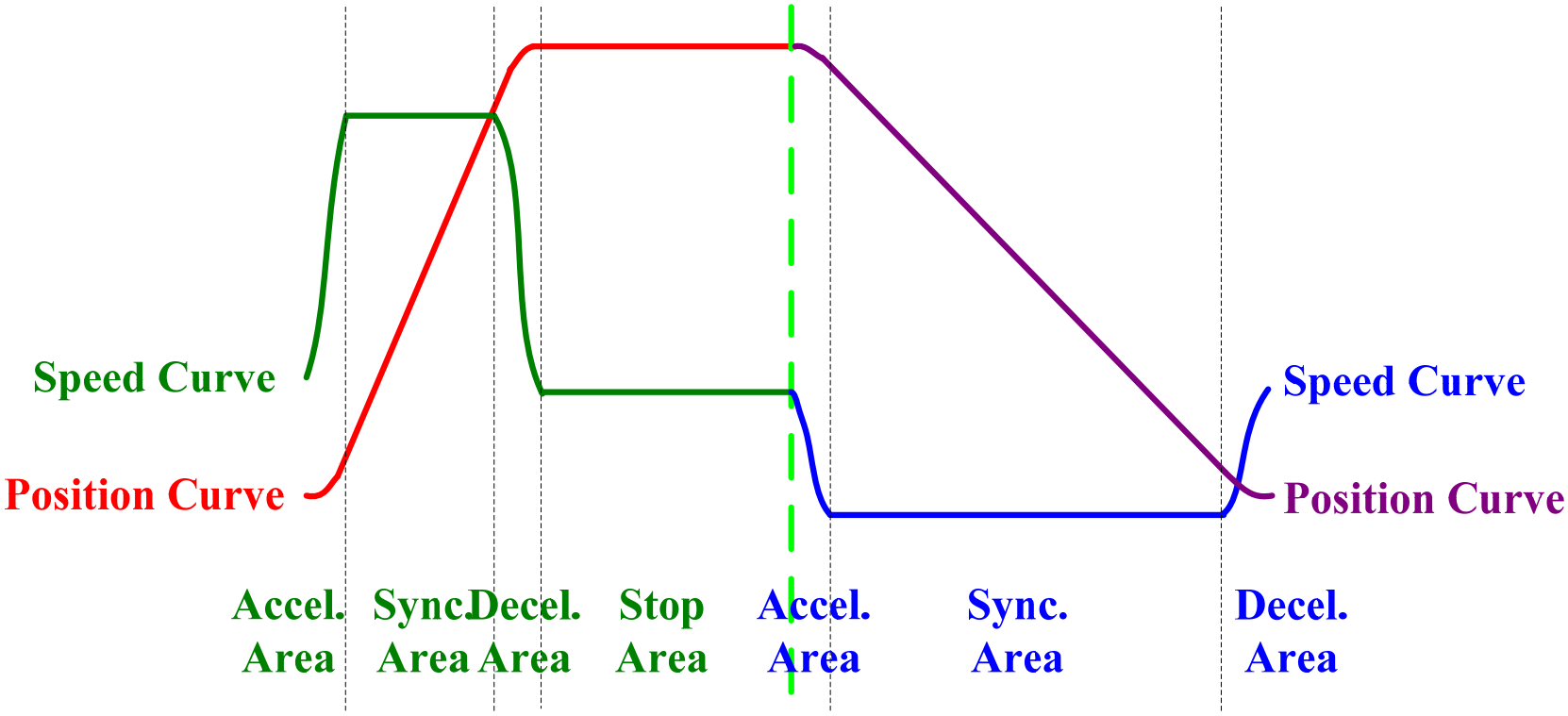
Create E-CAM Profile for Filling Axis (6) – E-CAM Curve Areas

Position curve of filling axis could be designed as the figure shown below as it also comply with "motor operates in one direction only in each E-CAM area" this principle. But this profile is not more easy-to-use than the profile shown on previous page 115, so it is recommended to create E-CAM profile by referring to previous page 115.



Flying Shear Profile Design -15

Create E-CAM Profile for Filling Axis (7) – Speed Curve and E-CAM Profile

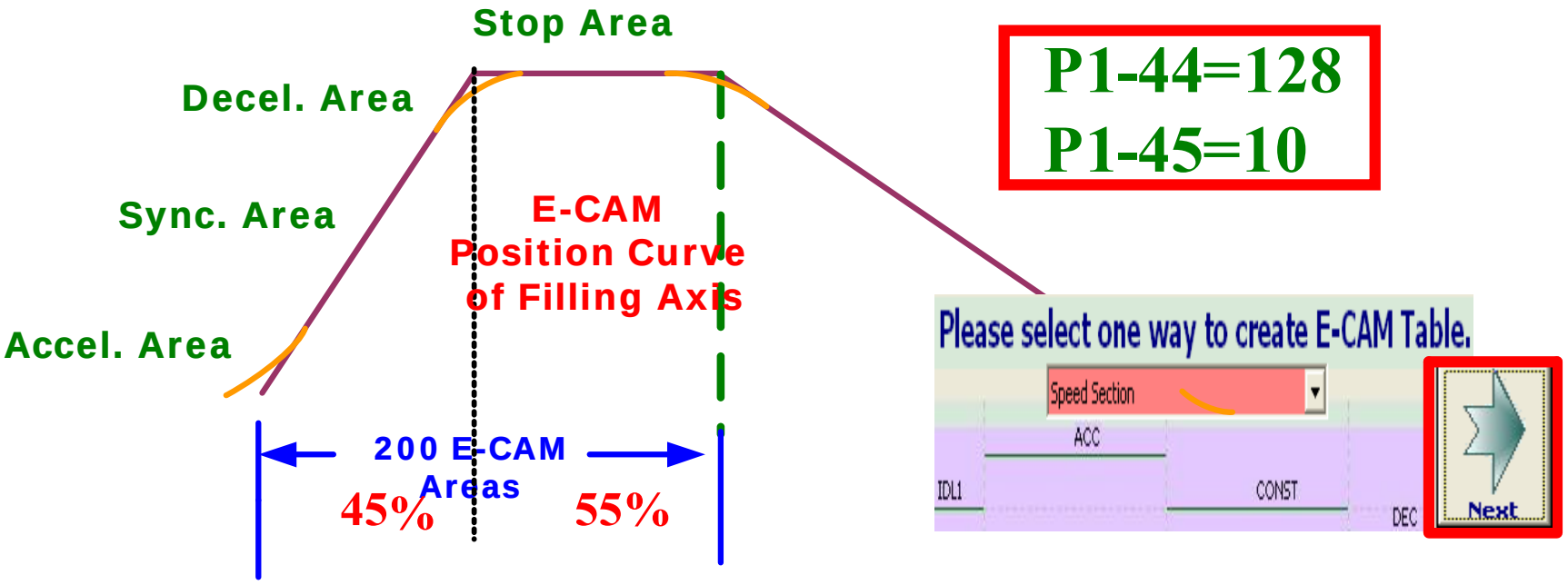


Flying Shear Profile Design -16

Create E-CAM Profile for Filling Axis (8) – 1st E-CAM Profile

Choose ”Speed Section” function to create E-CAM profile.

In this example, if the lead command length is set to 40mm and pitch is set to 10mm, it indicates that the motor has to rotates for 4 revolutions. If P1-44=128 and P1-45=10, the lead command length should be designed to 400000 PUU.

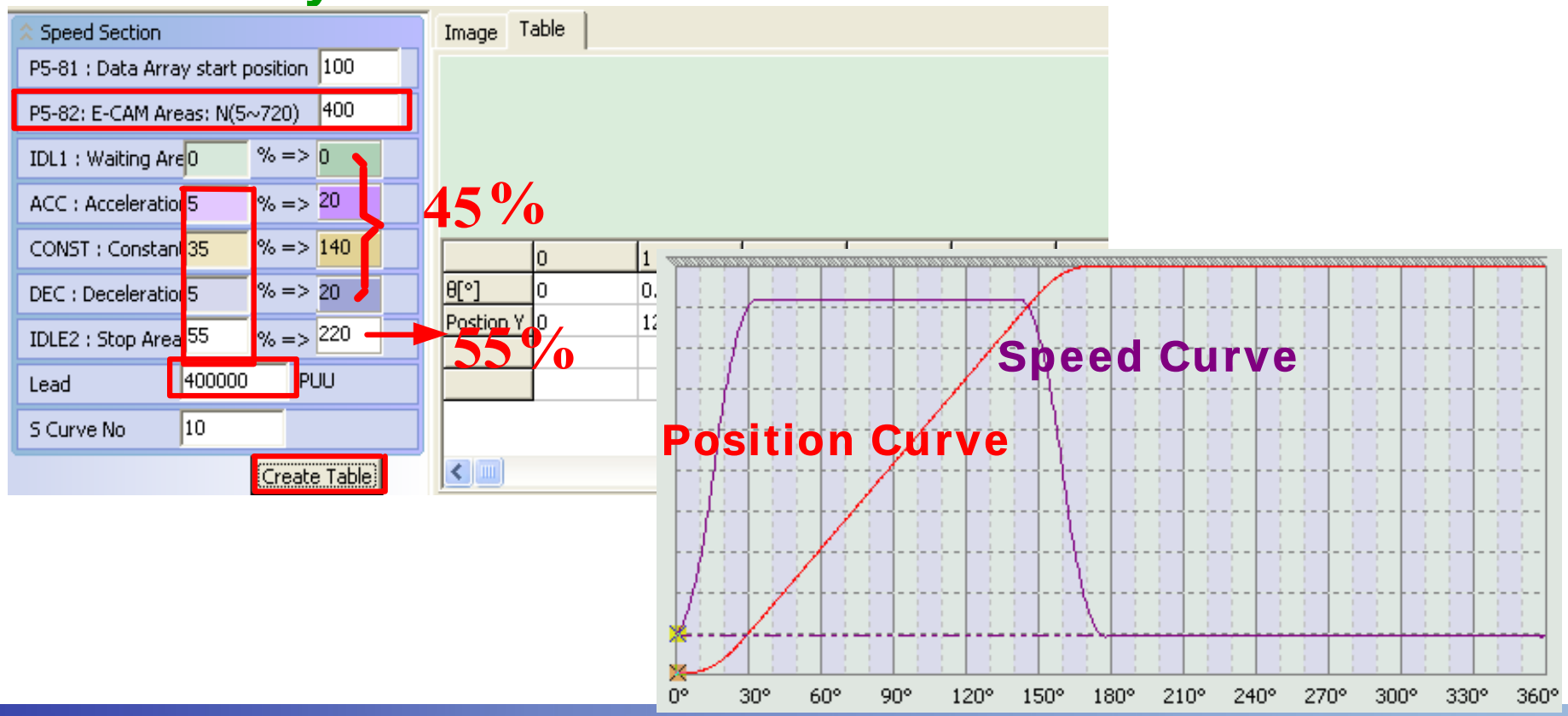


P1-44=128
P1-45=10

Flying Shear Profile Design -17

Create E-CAM Profile for Filling Axis (9) – Acceleration and Deceleration Ratio of 1st E-CAM Profile

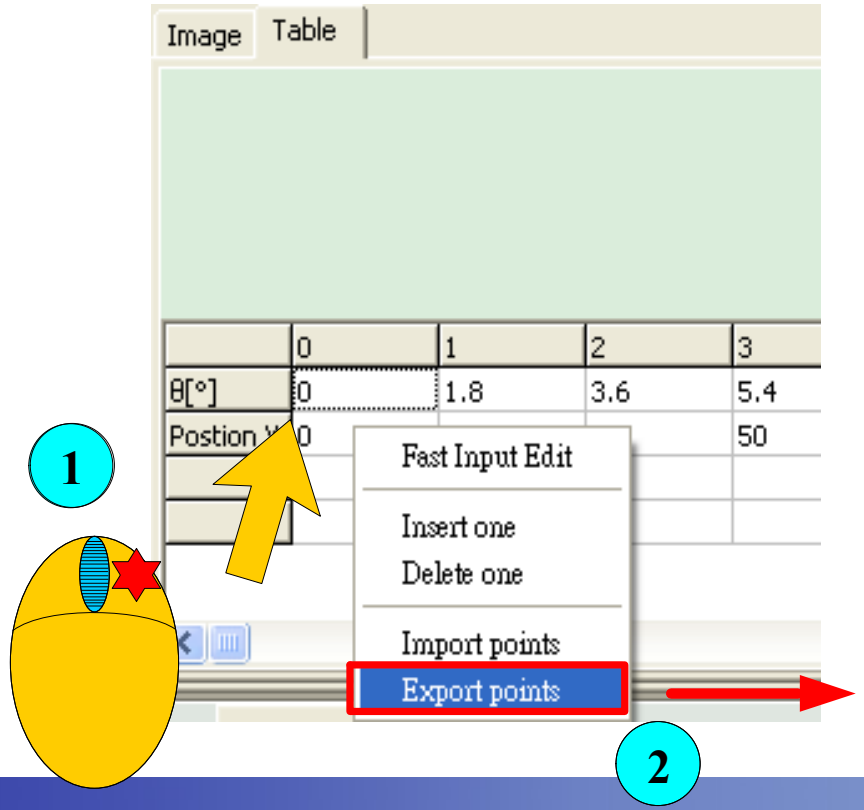
After complete the following settings in “Speed Section” table, only click “Create Table” button, then E-CAM profile and E-CAM profile table will be created and shown immediately.

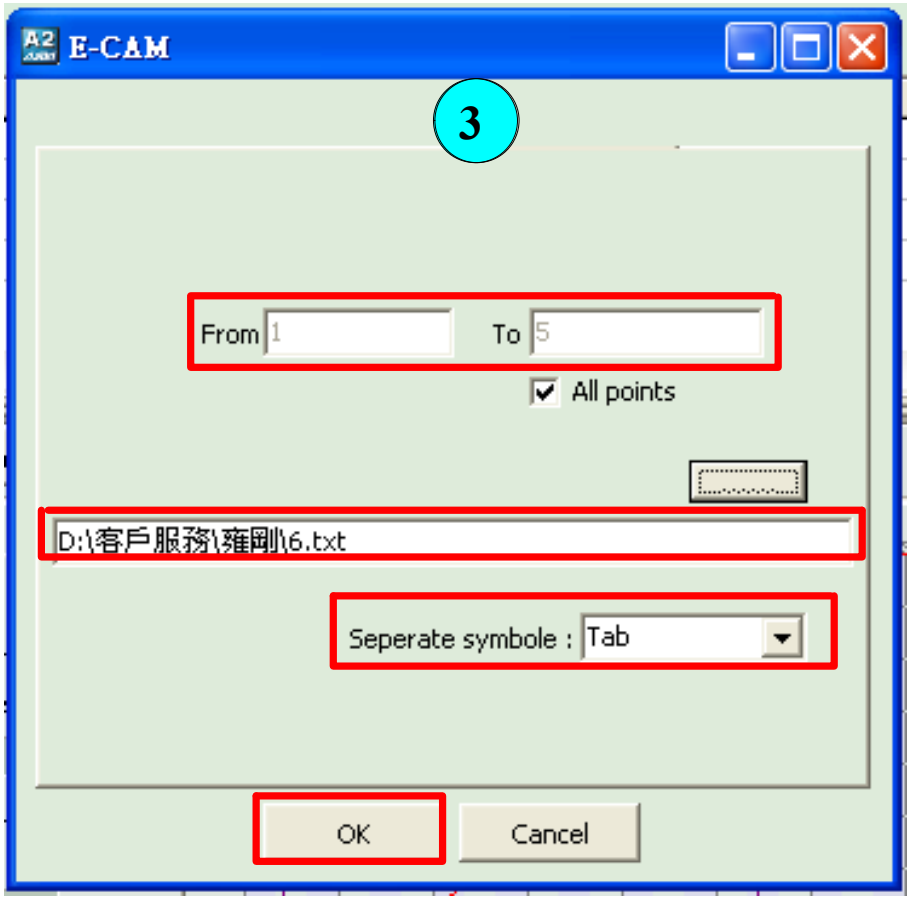


Flying Shear Profile Design -18

Create E-CAM Profile for Filling Axis (10) – Export (Save) 1st E-CAM Profile Table Data

Right-click the mouse on any column of E-CAM profile table and select “Export points” from pop-up menu. After entering correct information and then click OK button, the data of E-CAM profile table could be saved in a file.

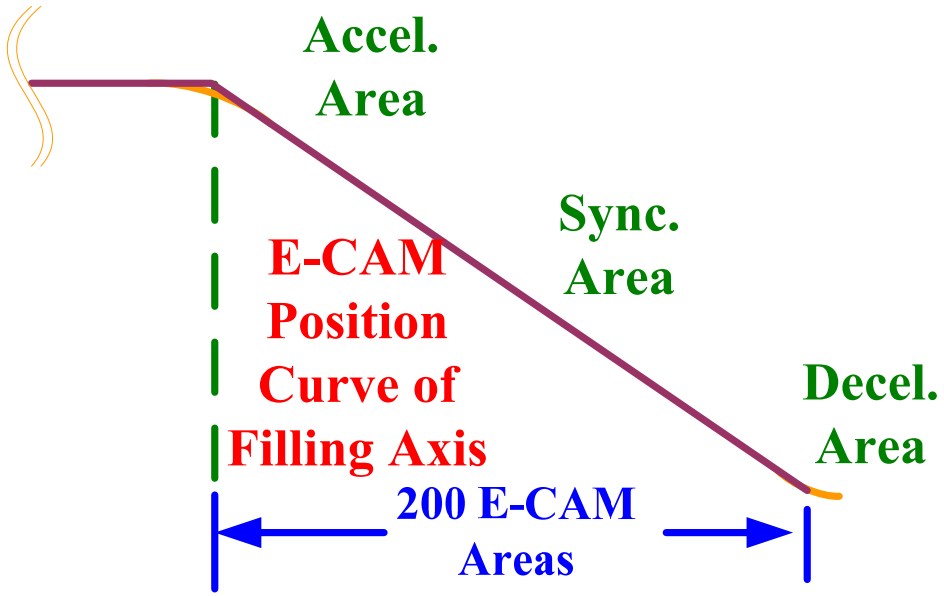


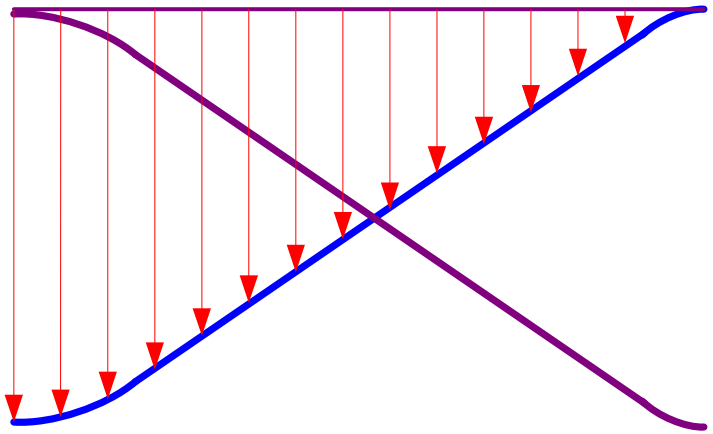


Flying Shear Profile Design -19

Create E-CAM Profile for Filling Axis (11) – 2nd E-CAM Profile

Choose ”Speed Section” function to create the return E-CAM profile. In this example, the lead command length is designed to 400000 PUU and E-CAM area number is set to 200 as well. The system will create the reverse position curve and the users can use it to complete 2nd E-CAM profile.

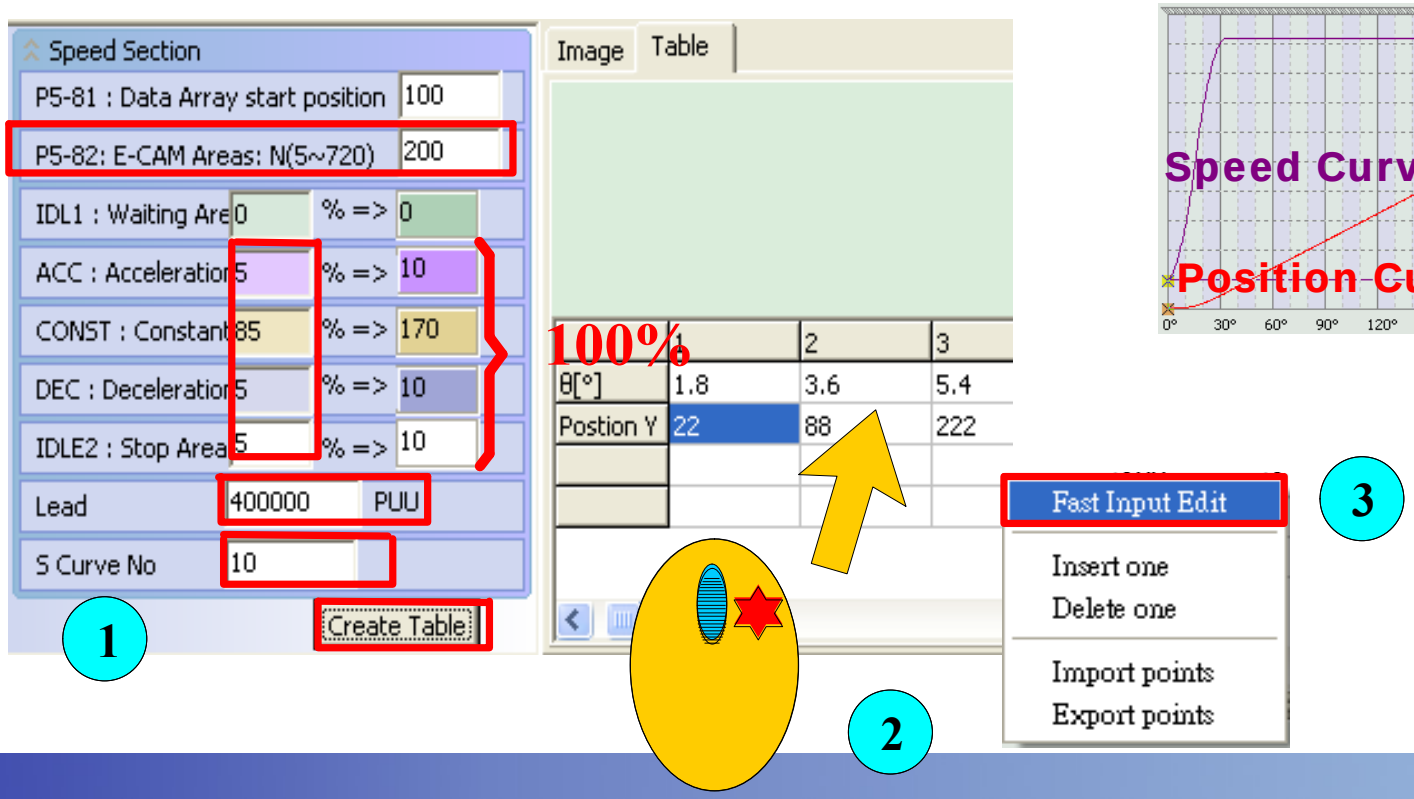


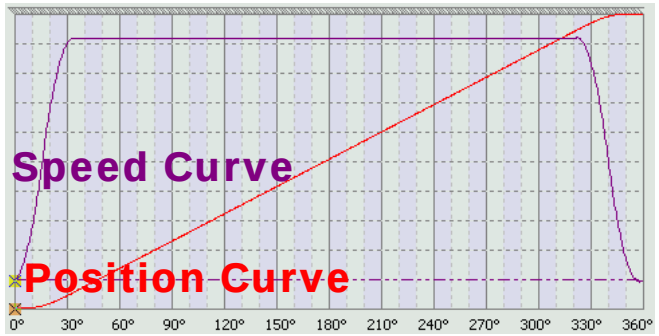


Flying Shear Profile Design -20

Create E-CAM Profile for Filling Axis (12) – Complete Relevant Settings for 2nd E-CAM Profile

Complete the following settings in “Speed Section” table (ensure to use S Curve No) and then click “Create Table” button to create E-CAM profile table. After E-CAM profile table is created, right-click the mouse on any of column of E-CAM profile table and select “Fast Input Edit” from pop-up menu.

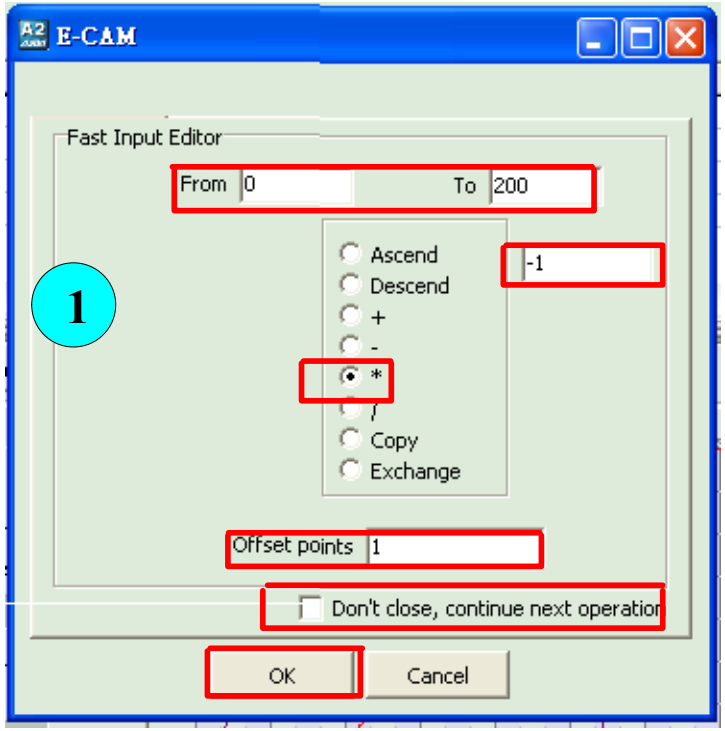


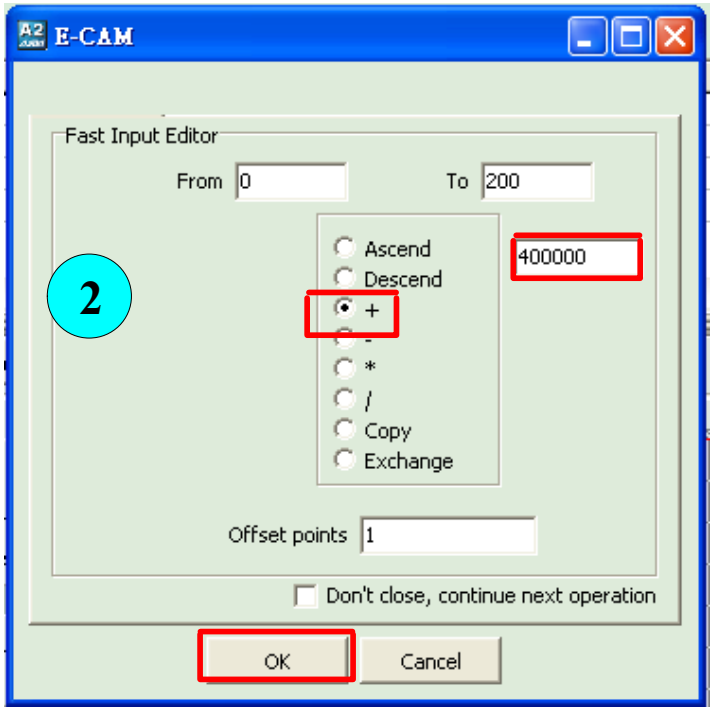


Flying Shear Profile Design -21

Create E-CAM Profile for Filling Axis (13) – Edit Data of E-CAM Profile Table

When E-CAM ”Fast Input Editor” dialog appears, the users can edit the data of E-CAM profile table (see the figures below) to redraw and create new E-CAM profile.

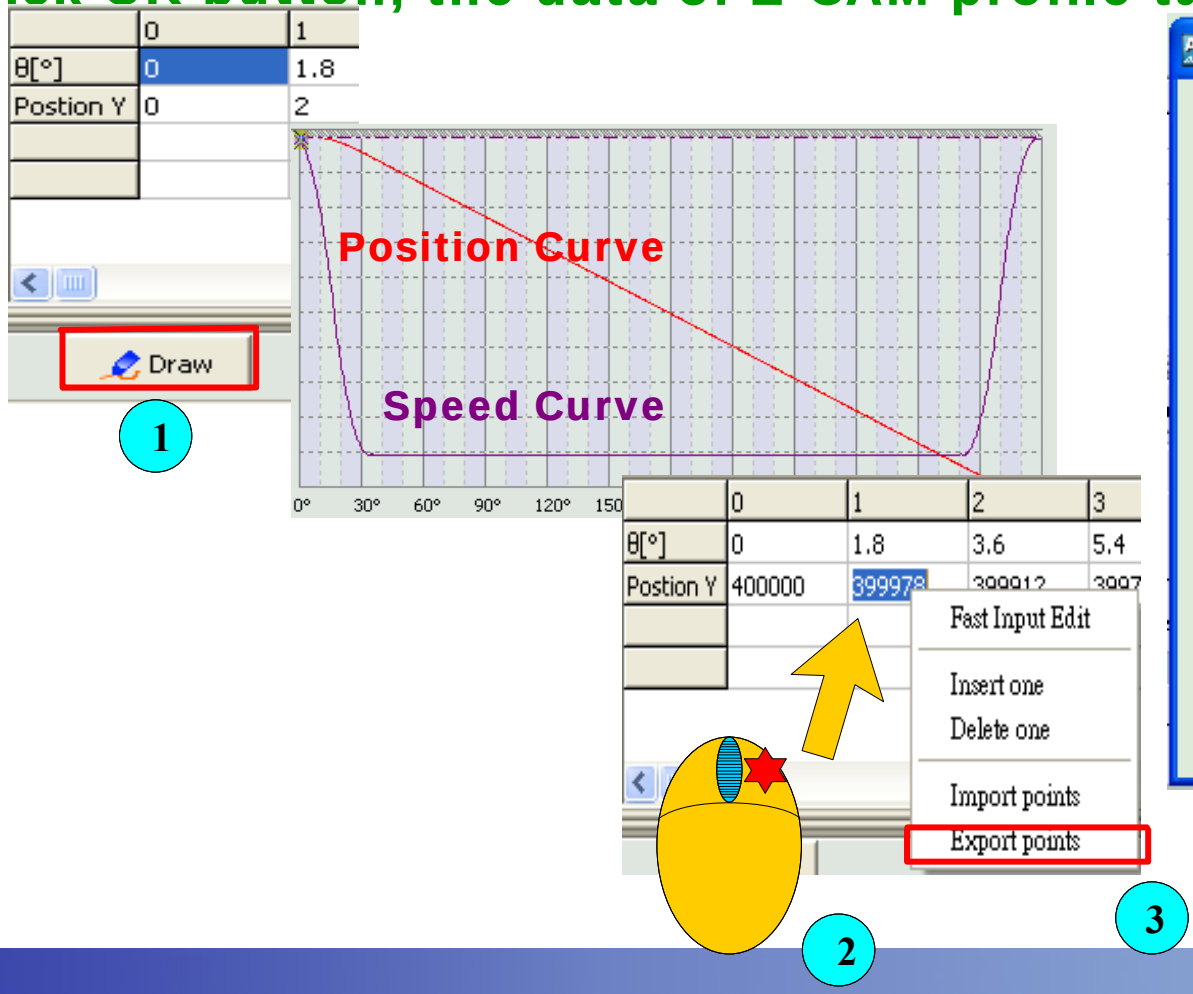


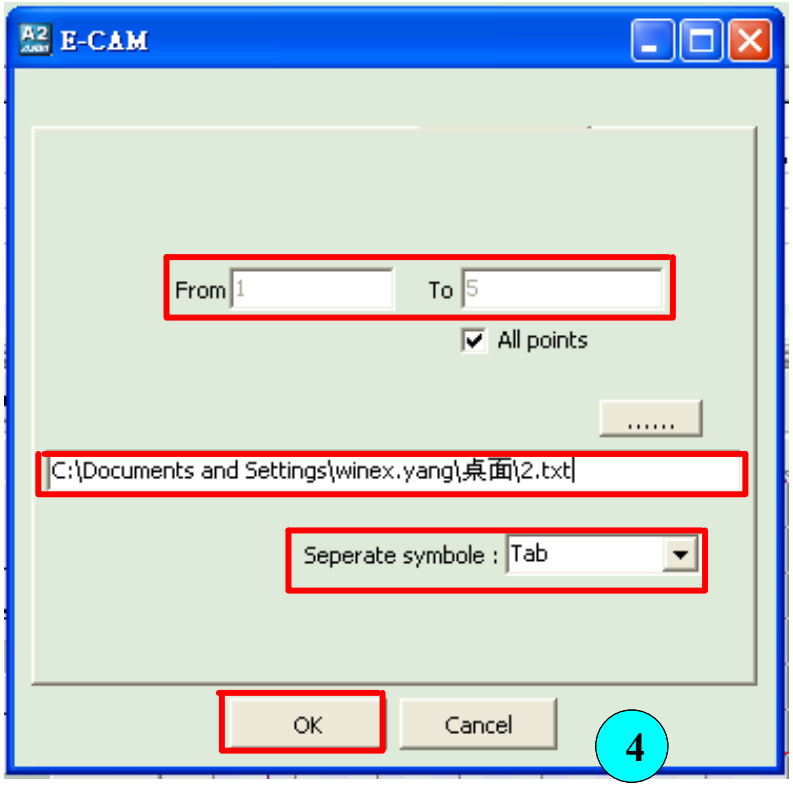


Flying Shear Profile Design -22

Create E-CAM Profile for Filling Axis (14) – Export (Save) 2nd E-CAM Profile Table Data

Click "Draw" button, the E-CAM profile will appear immediately. Right-click the mouse on any column of E-CAM profile table and select "Export points" from pop-up menu. After entering correct information and then click OK button, the data of E-CAM profile table could be saved in a file.

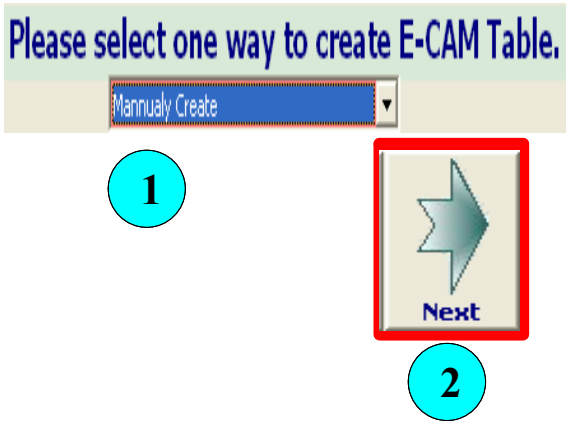


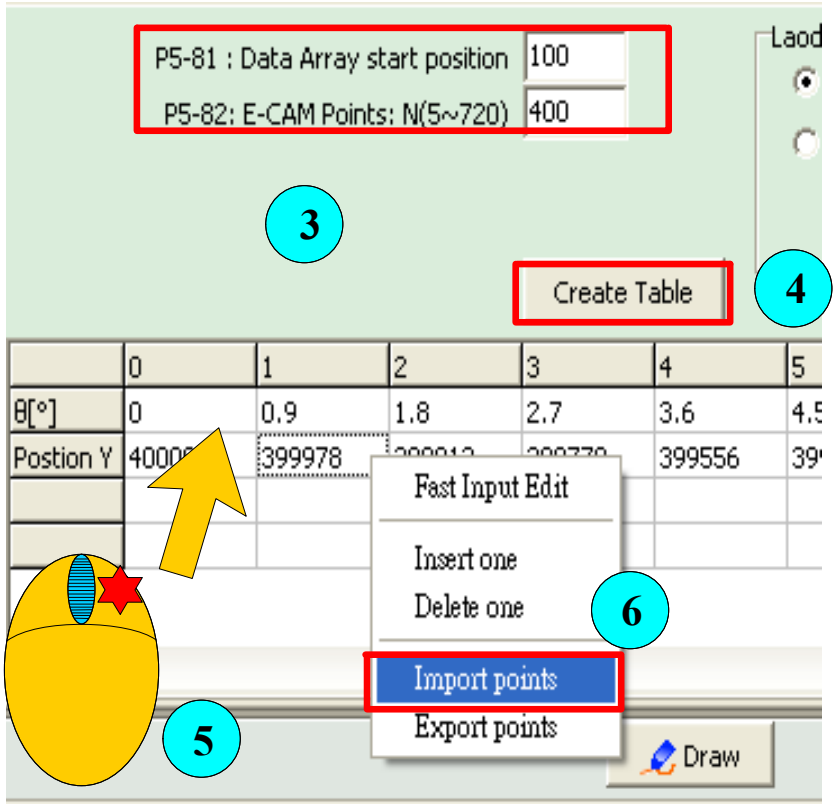


Flying Shear Profile Design -23

Create E-CAM Profile for Filling Axis (15) – Combine E-CAM Profile Table Data

Select “Manual Create” option from drop-down menu, after entering the E-CAM area number and clicking “Create Table” button, E-CAM profile table will be created immediately. Then, right-click the mouse on any column of E-CAM profile table. When the pop-up menu appears, select “Import points”.

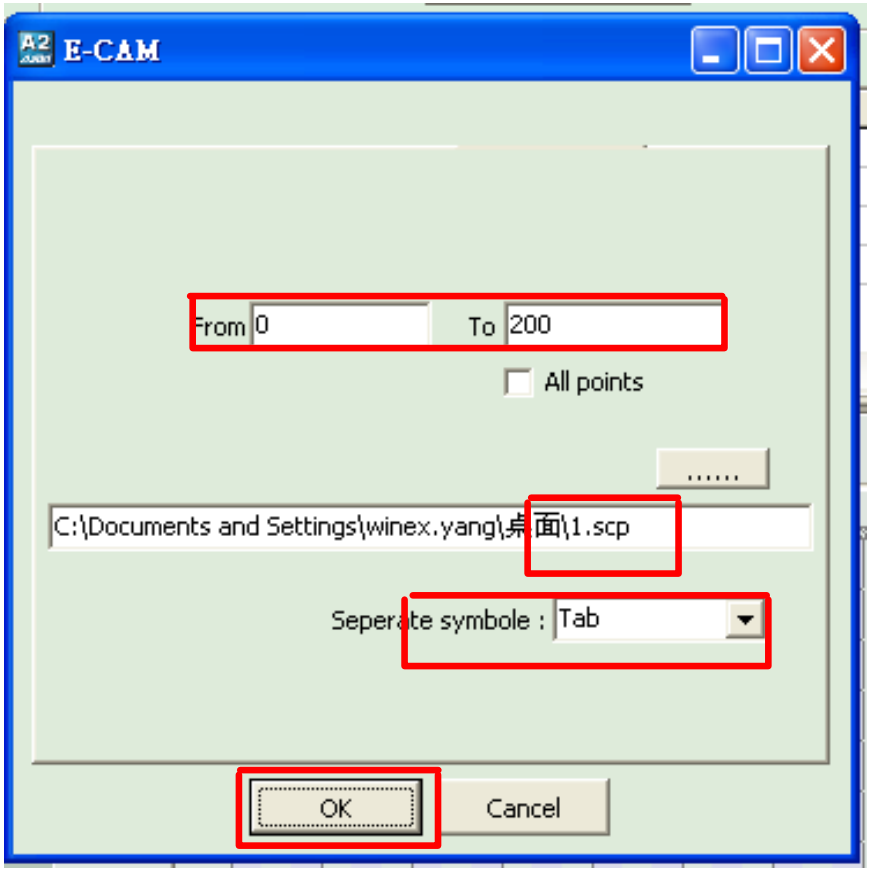


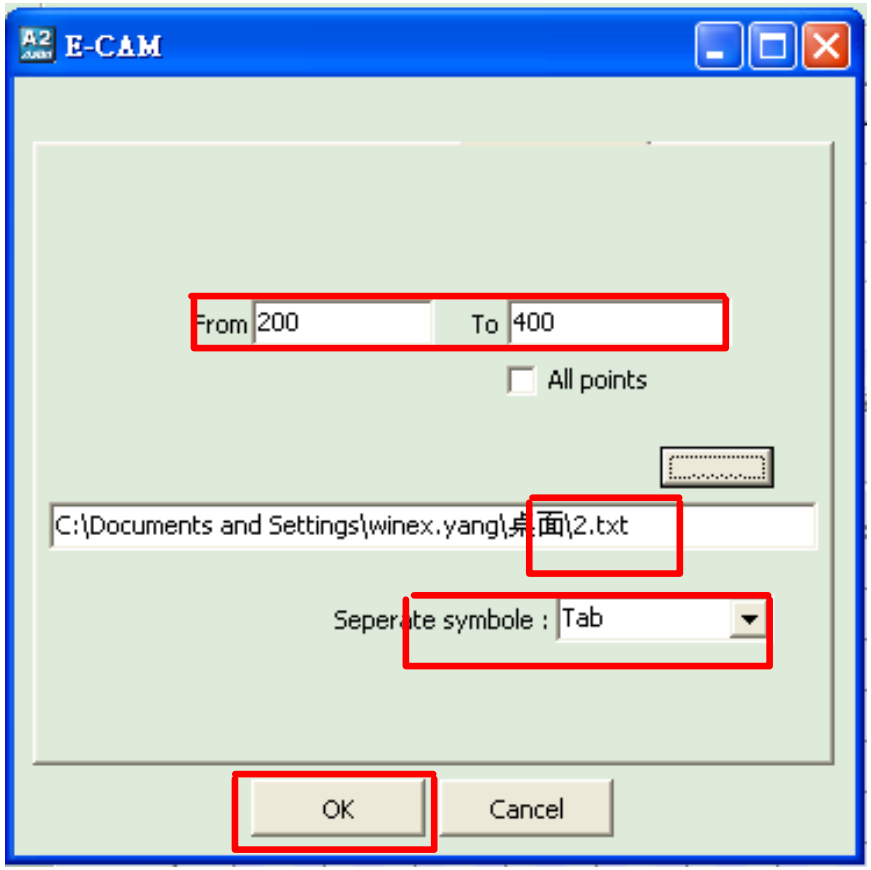


Flying Shear Profile Design -24

Create E-CAM Profile for Filling Axis (16) – Import E-CAM Profile Table Data

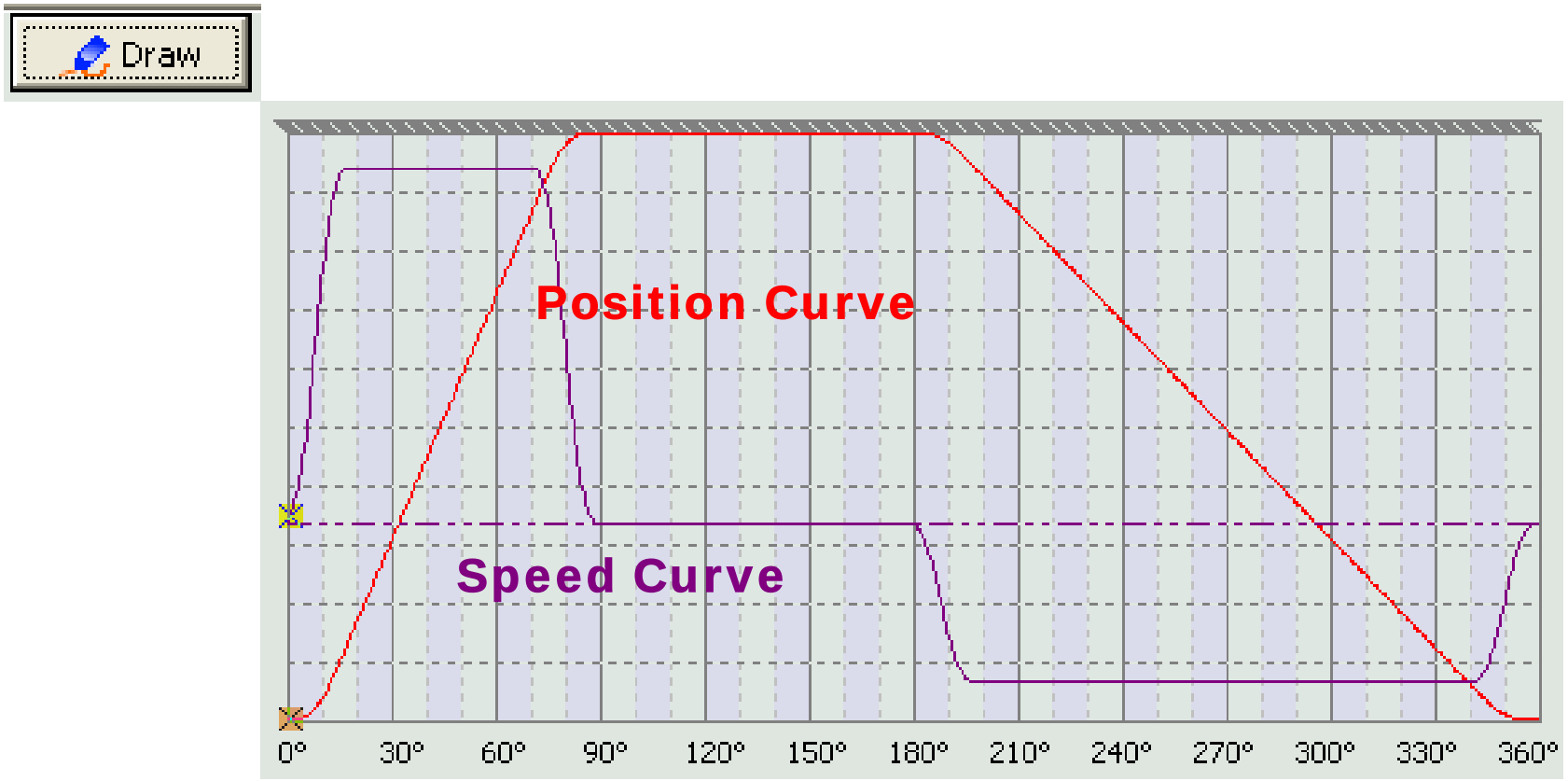
Import the data created previously by using “Speed Section” function. Please note that one E-CAM area number should be repeated and the file location must be entered correctly.





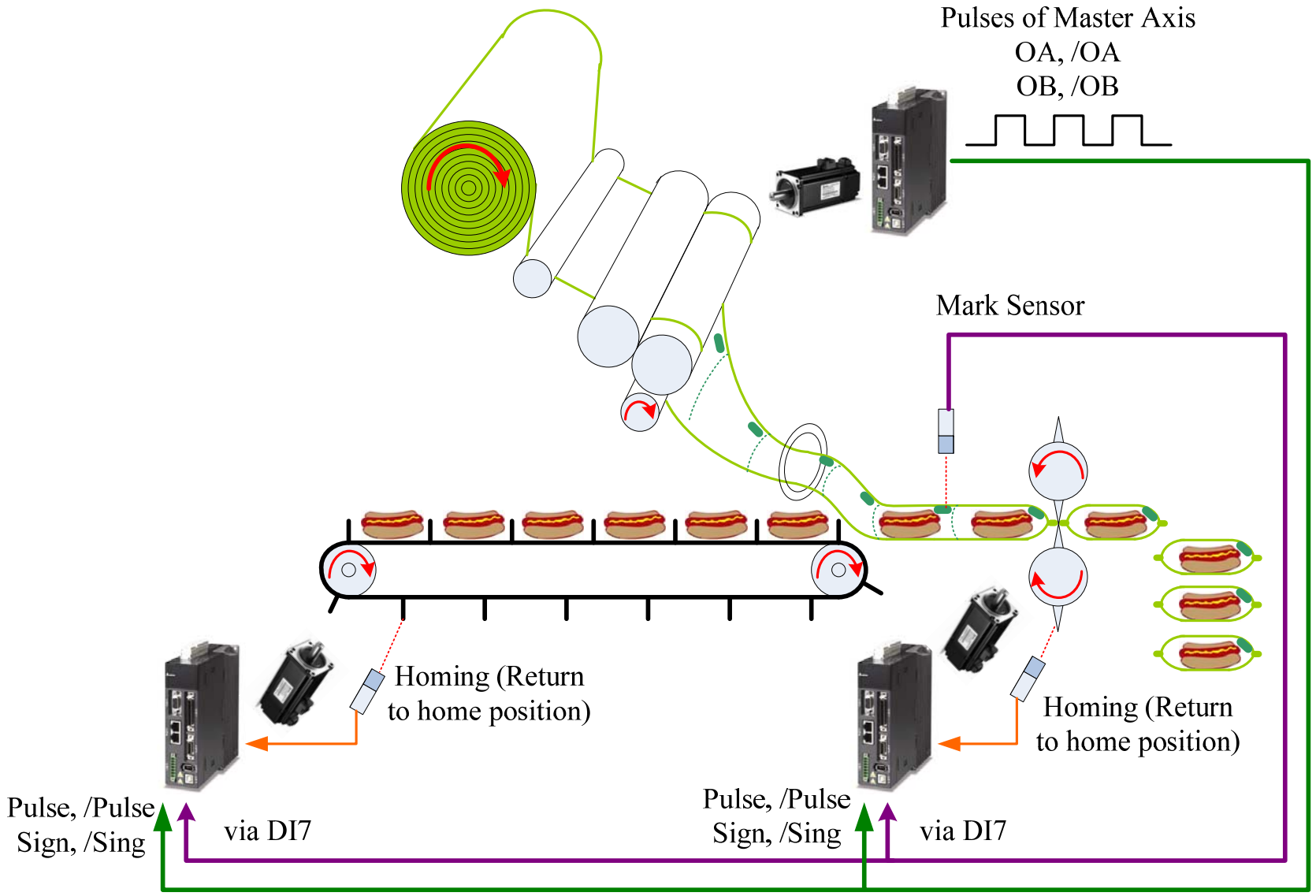
Flying Shear Profile Design -25

Create E-CAM Profile for Filling Axis (17) –
Complete E-CAM Profile and Profile
Click “Draw” button and the final complete E-CAM profile will display immediately.



CAPTURE SYNC AXIS -1

Food Packaging Machine



CAPTURE SYNC AXIS -2

System Configuration Explanation

Packaging Materials Feeding Axis

The job of this axis is to send packaging films to the packaging system. This axis is also the master axis of servo system which is used to send pulse signals to E-CAM axis and control E-CAM axis.

Rotary Knife Control Axis

This axis is built-in with E-CAM profile for controlling the rotary knife to cut the packaging films. As there are print marks on the packaging films, it is needed to use mark sensor and performs cutting operation by referring the mark signals.

Products Feeding Axis (Conveyer)

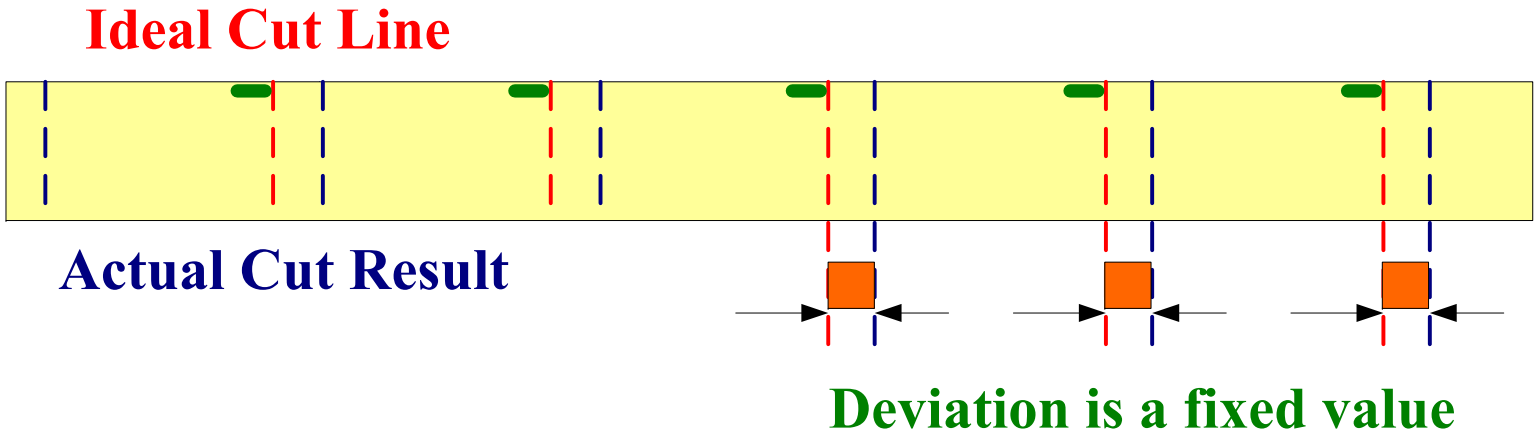
This axis is built-in with E-CAM profile for controlling the feeding speed. Its usage is similar to rotary knife control axis. But, the difference is that the E-CAM profile is not the same as rotary knife control axis and it must operate smoothly (in a smooth speed).

CAPTURE SYNC AXIS -3

Analysis of Inaccurate Cutting Problem

Deviation is fixed

The potential cause may be positioning error. In order to solve this problem, the users can adjust the position of mark sensor or change the setting value of P5-87 to adjust the lead command length before E-CAM is engaged.



CAPTURE SYNC AXIS -4

Analysis of Inaccurate Cutting Problem

Deviation is not fixed

Some of the potential causes are mentioned below:

Ball screw slips

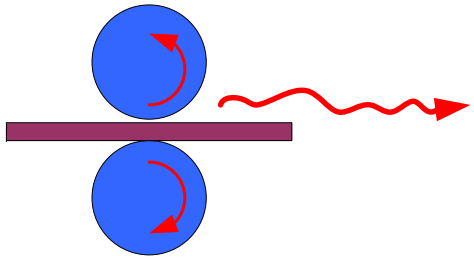
Film tension is change

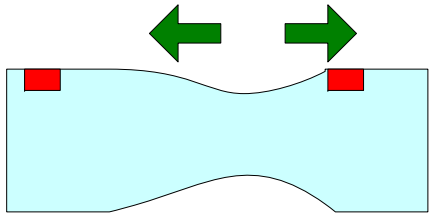
Packaging materials is dirtied

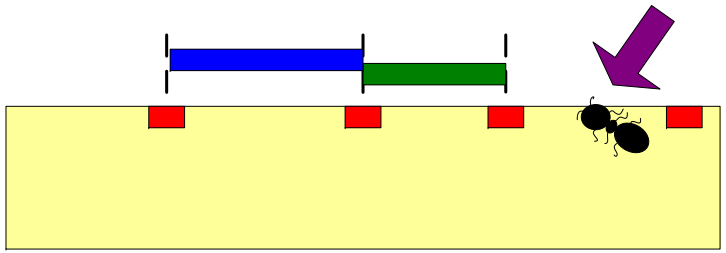
Inaccurate print mark

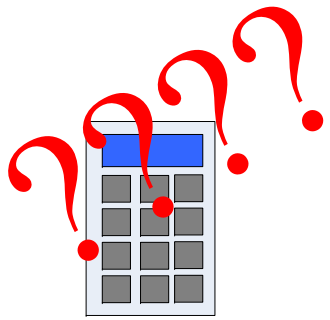
Pulse lost of master axis

Calculation errors caused by calculator







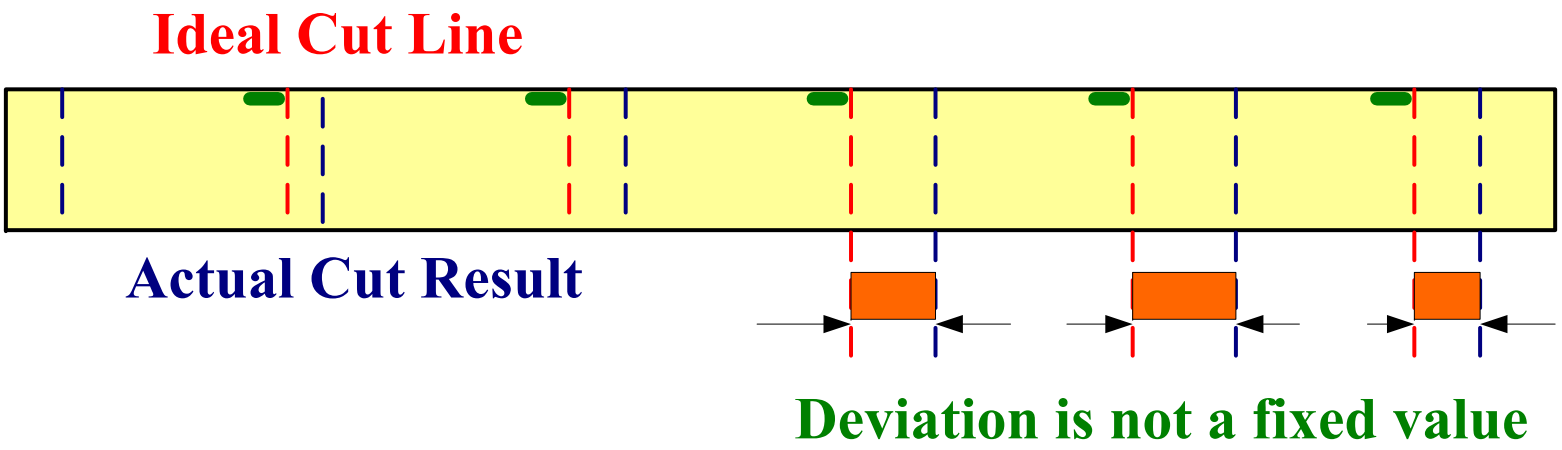


CAPTURE SYNC AXIS -5

Analysis of Inaccurate Cutting Problem

Deviation is not fixed

This problem could be solved by using CAPTURE SYNC AXIS function.

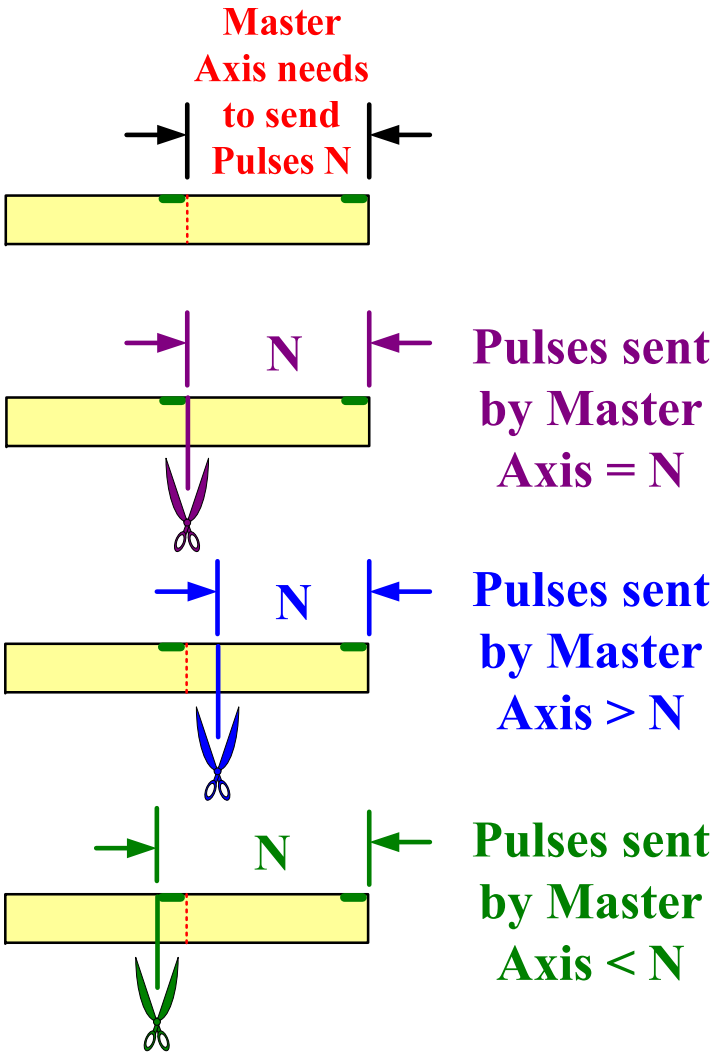


CAPTURE SYNC AXIS -6

Analysis of Inaccurate Cutting Problem

Pulse Command of Master Axis and E-CAM Axis.

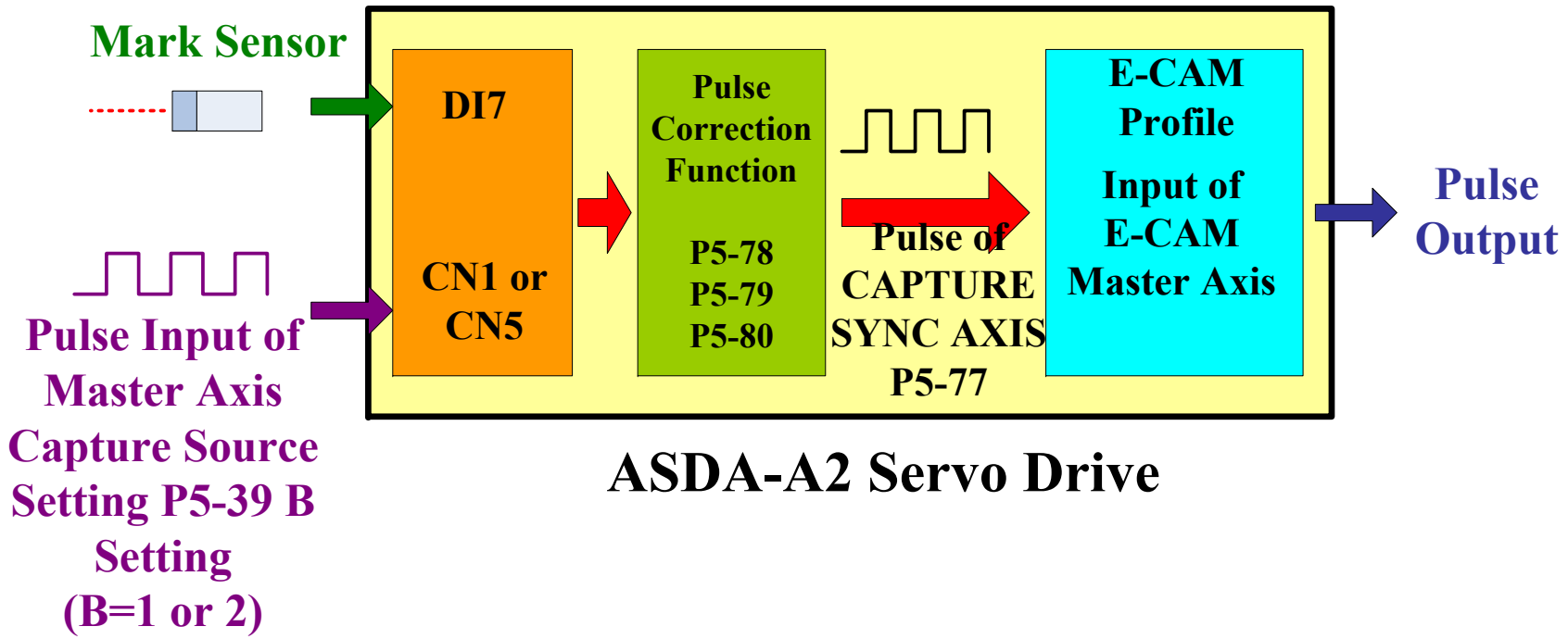
Suppose that the master axis has to send pulses N when setting cut length, if the pulses sent by master axis is more than pulses N, the time of cutting operation will be advanced. When the pulses sent by master axis is less than pulses N, the time of cutting operation will be delayed.



CAPTURE SYNC AXIS -7

Introduction of CAPTURE SYNC AXIS

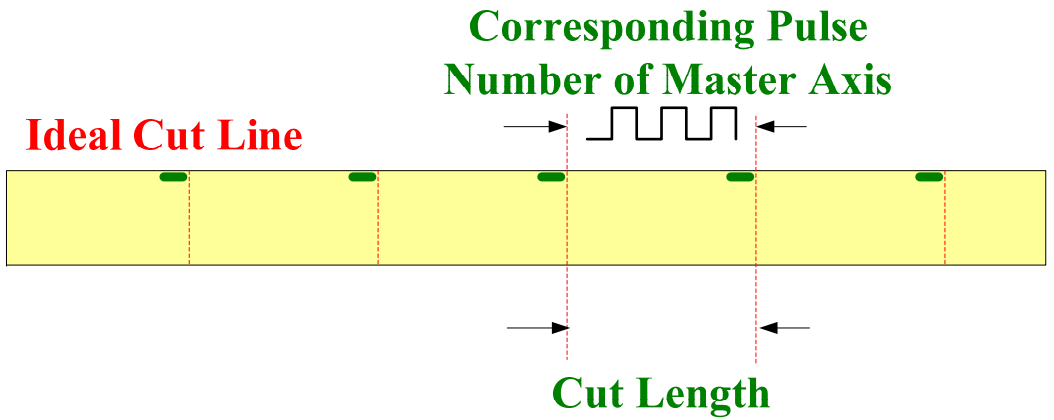
This function is available in firmware V1.009 and later ASDA-A2 models. Setting a fixed cut length is able to reduce the deviation occurred at every cut so as to eliminate the accumulated errors caused between every cut.



CAPTURE SYNC AXIS -8

Relevant Parameters Settings

P5-78 Interval Pulse Number of CAPTURE SYNC AXIS
= Cut Length
P5-83 E-CAM Cycle Number (M) = 1
P5-84 Pulse Number of Master Axis (P)
= Corresponding Pulse Number of Master Axis
i. e. the input pulses input from master axis which control E-CAM profile rotate 1 cycle
i.e. the required pulses for moving “Cut Length” by E-CAM axis
P5-88 Y=5, Command source setting is set to CAPTURE SYNC AXIS (P5-77)
P5-88 Z=2, Engage timing is set to any point of CAPTURE SYNC AXIS



CAPTURE SYNC AXIS -9

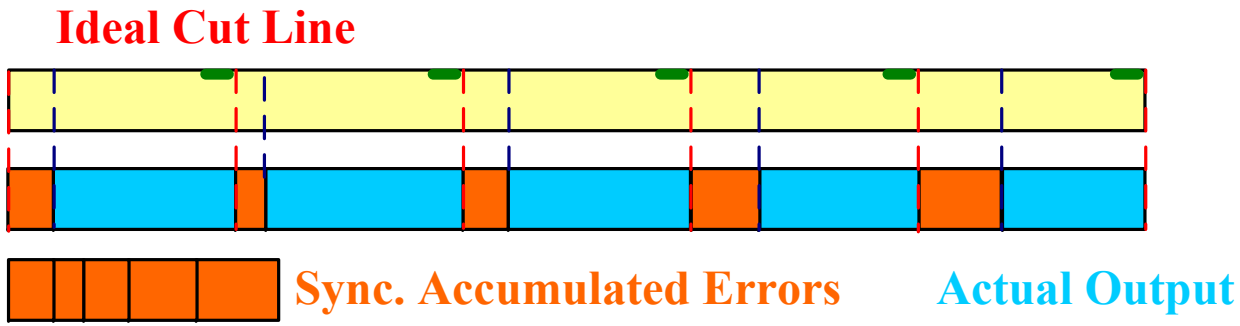
Parameters Settings for CAPTURE SYNC AXIS

P5-77 Position of CAPTURE SYNC AXIS
This parameter is used to set the position that synchronizes with the capture signal so as to monitor the received pulses of CAPTURE SYNC AXIS, i.e. the pulses provided for E-CAM system.

P5-78 Interval Pulse Number of CAPTURE SYNC AXIS
This parameter is used to set the standard length of CAPTURE SYNC AXIS, i.e. required cut length.

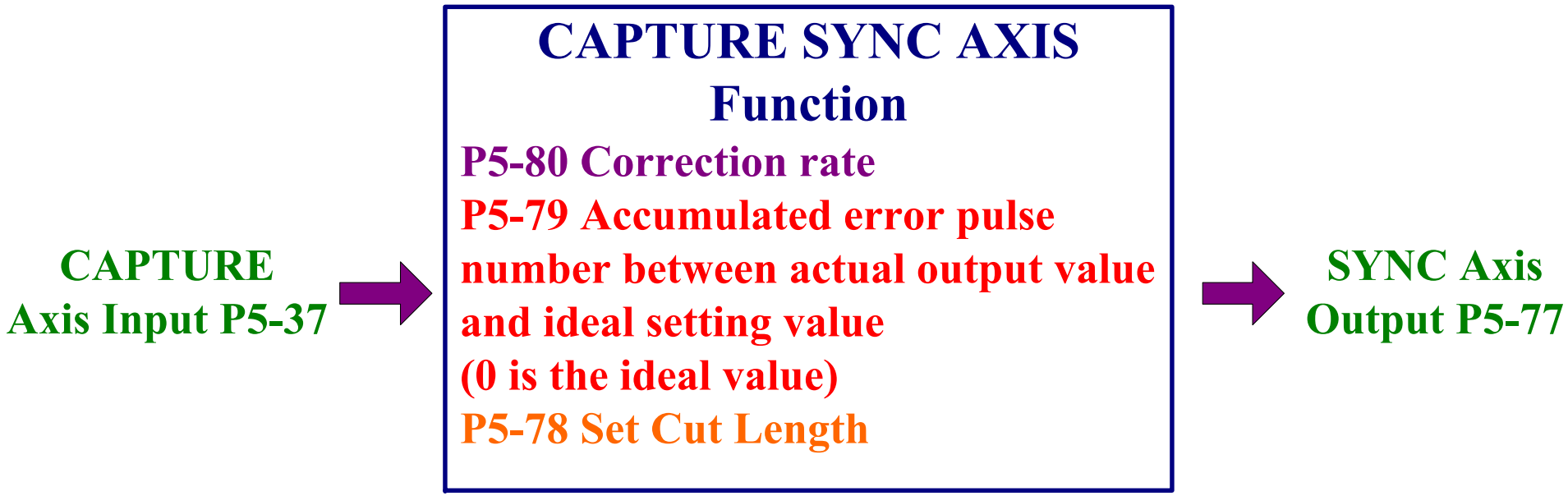
P5-79 Error Pulse Number of CAPTURE SYNC AXIS
This parameter is used to display the accumulated error pulse number between actual output value and ideal setting value.
Error Pulse Number of CAPTURE SYNC AXIS =
Output Value of SYNC AXIS – Ideal Setting Value of SYNC AXIS
= P5-77 Accumulation Amount – (P5-78 x Capture (Output) Times)

P5-80 Max. Correction Rate of CAPTURE SYNC AXIS
This parameter is used to limit the correction rate of CAPTURE SYNC AXIS at every output.



CAPTURE SYNC AXIS -10

CAPTURE SYNC AXIS Correction Function



P5-79 = P5-77 – (P5-78 x CAPTURE times)

Correction Rate = Output Pulses of SYNC Axis - Input Pulses of SYNC Axis

(100 - P5-80)% < Correction Rate < (100 + P5-80)%

CAPTURE SYNC AXIS -11

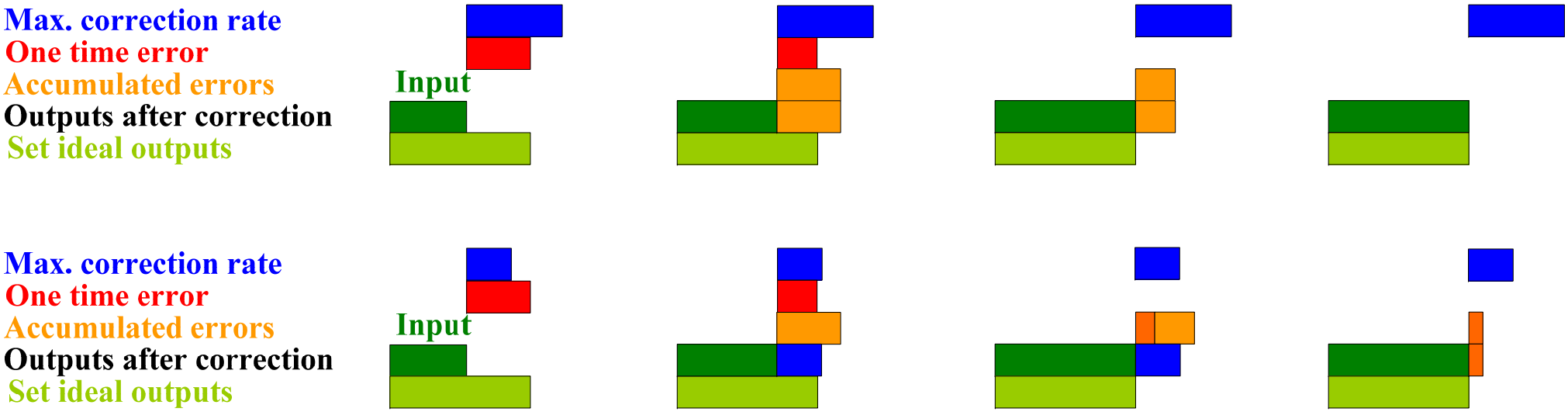
Max. Correction Rate of CAPTURE SYNC AXIS

P5-80 SYNC Correction Rate

When the value of the correction rate is higher, the SYNC error value will go towards 0 quickly, i.e. attain the desired position more easily, but the changes of the speed are very fast.

When the value of the correction rate is lower, the SYNC error value will go towards 0 slowly, i.e. attain the desired position more difficultly, but the changes of the speed are very smooth.

The following figures are for reference only, not actual application result (Delta Confidential Information).

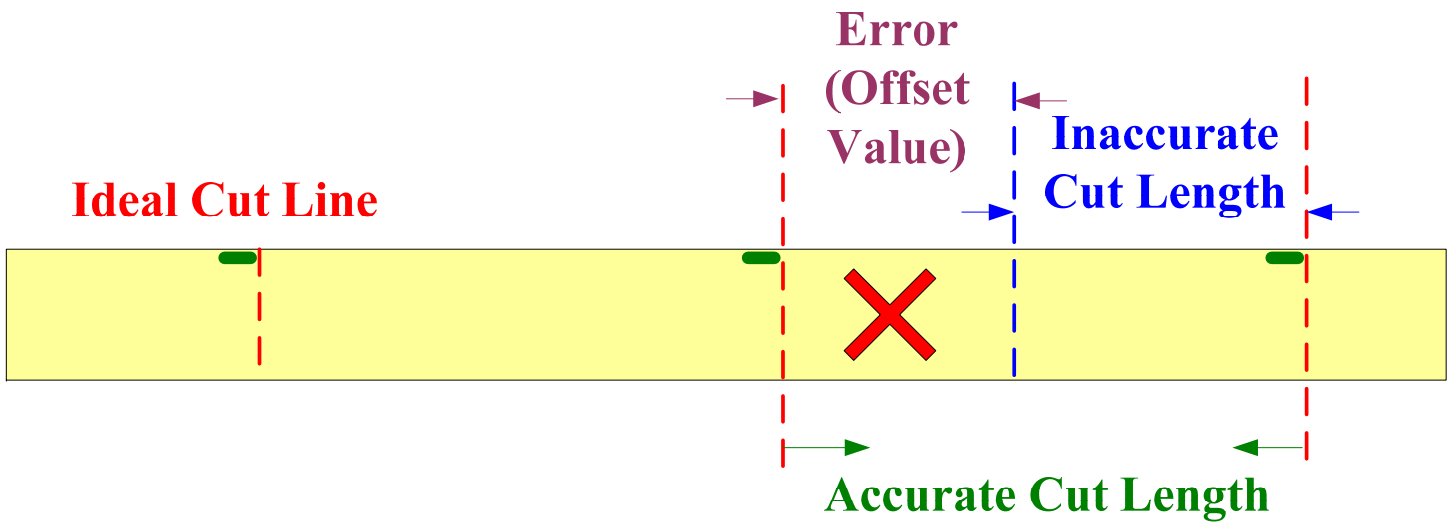


CAPTURE SYNC AXIS -12

Set Cut Length

P5-78 Interval Pulse Number of CAPTURE SYNC AXIS

This parameter is used to set the standard length of CAPTURE SYNC AXIS, i.e. required cut length.
The setting value of this parameter must be correct, otherwise there will be an offset value in the system always. The users can use monitor variable 051h to monitor the actual input pulse value and then set this parameter correctly.

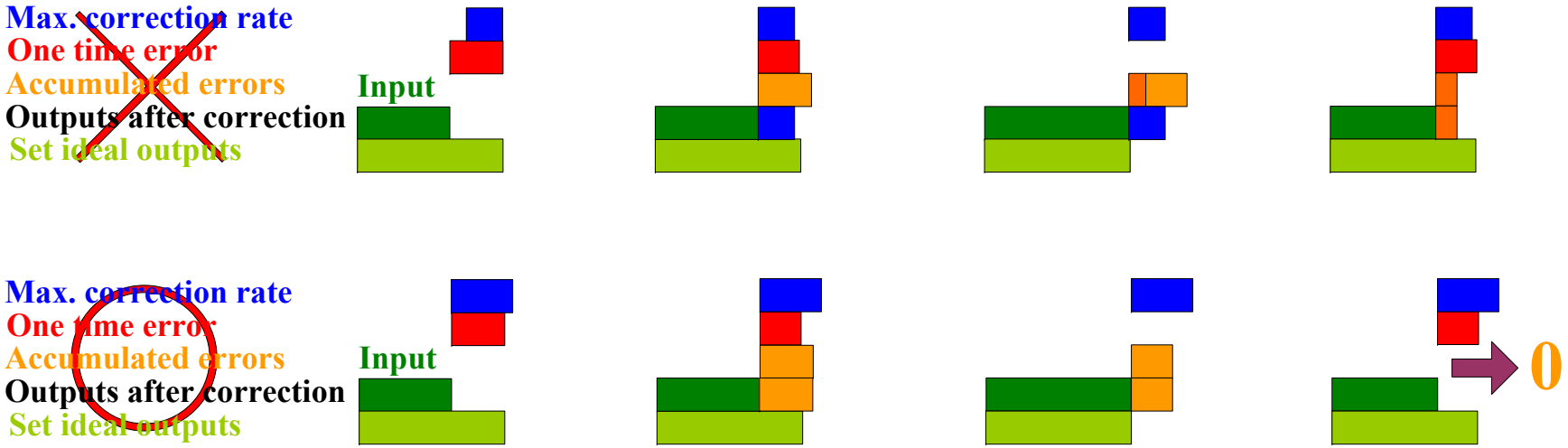


CAPTURE SYNC AXIS -13

Set Error Pulse Number

P5-79 Error Pulse Number of CAPTURE SYNC AXIS

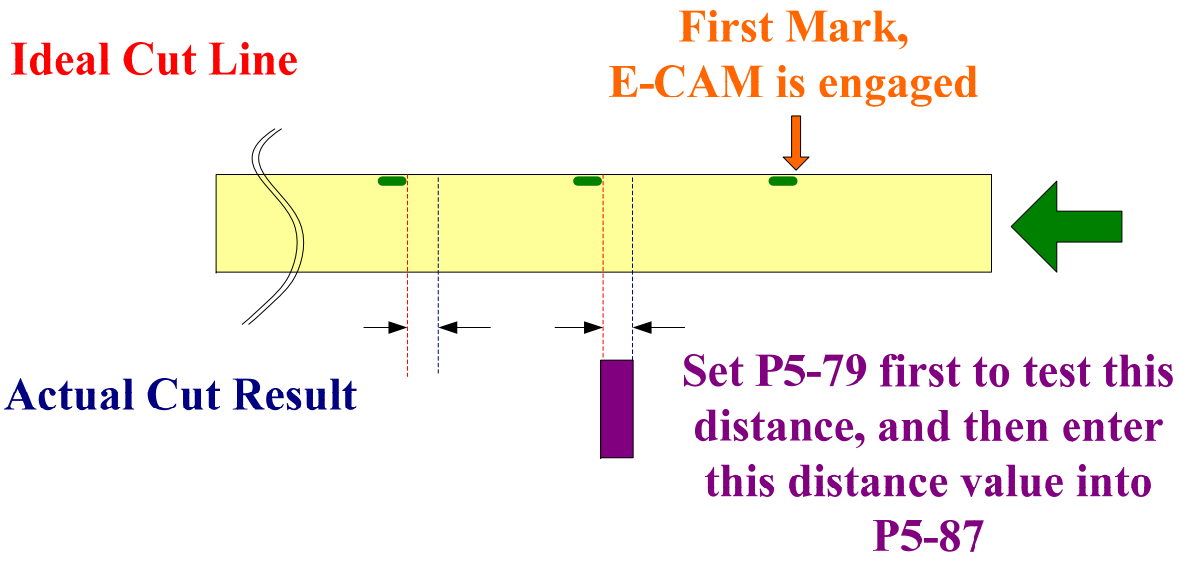
It can be monitored by monitor variable 054h. When the ideal setting value goes towards 0, it indicates that the correction value is set correctly. If the setting value of P5-79 changes excessively or will not go towards 0, it indicates that the correction value is not correct. At this time, please examine the setting values of relevant parameters or adjust the mechanical system. This parameter can also be set when the users want to correct or reset the accumulated errors.



CAPTURE SYNC AXIS -14

Error occurs at the first cut

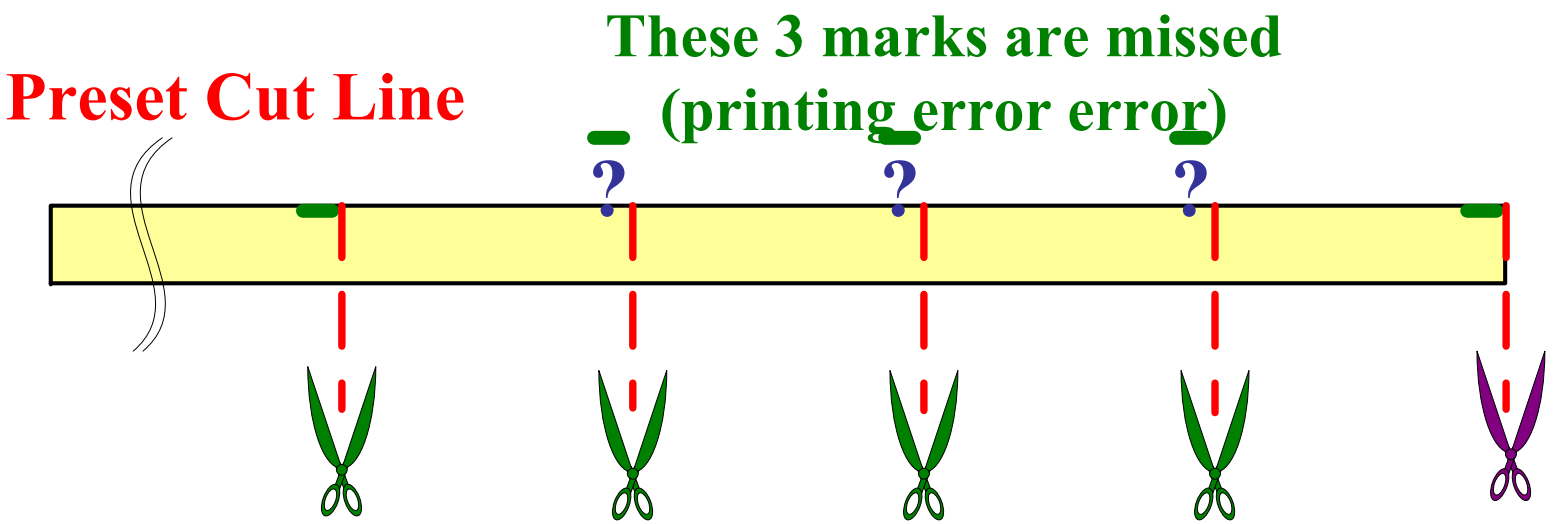
When executing the first cut, there should be no accumulated error (P5-79) in the system. Therefore, if the error occurs at the first cut, CAPTURE SYNC AXIS could not correct the error. At this time, the users need to set P5-79 to let the system move to the correct cut position. After the system moves to the correct cut position, record this setting value and set P5-87 to the setting value of P5-97.



CAPTURE SYNC AXIS -15

When registration marks are missed

When CAPTURE SYNC AXIS function is used, if the registration marks are missed (printing error), CAPTURE SYNC AXIS still can perform cutting operation according to the parameter setting values of the servo drive and continue perform synchronization correction until registration marks appear.



CAPTURE SYNC AXIS -16

Relevant Parameters Settings for CAPTURE SYNC AXIS

CAPTURE and COMPARE functions will be both used.
CAPTURE Function Settings

CAPTURE Enable Setting: (P5-39 X Settings):
0: Enable CAPTURE function

CAPTURE Source Setting: (P5-39 Y Settings):
1: Auxiliary Encoder ; 2: Pulse Command

CAPTURE Activate State settings (P5-39 Z Settings):
0: Normally open (use N.O. contact, rising-edge triggered)
1: Normally closed (use N.C. contact, falling-edge triggered)

CAPTURE Trigger Time Setting (P5-39 U Settings: No need to set it

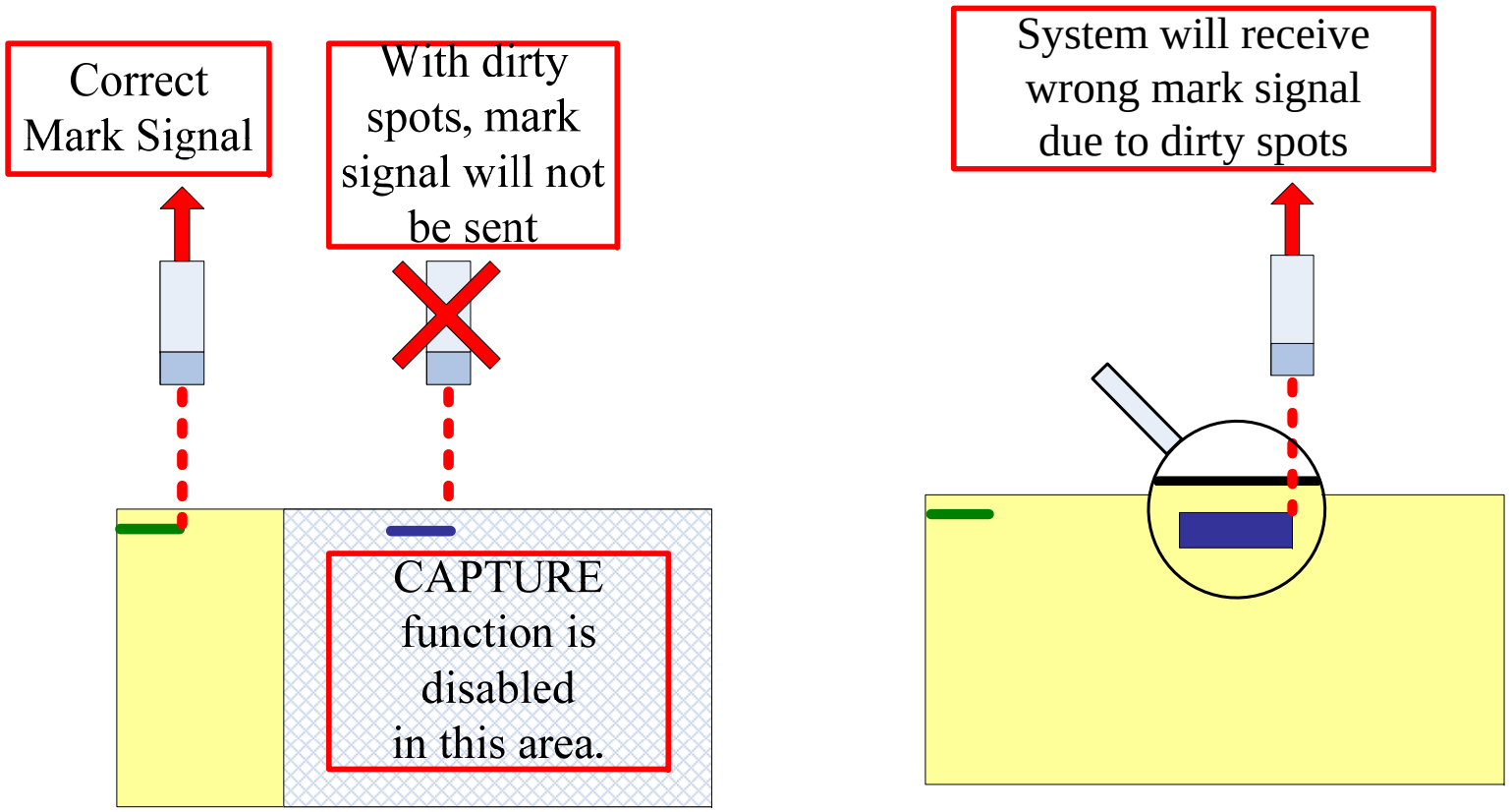
Start Address of Data Array (P5-36): Set to an unused address, in case the other important data is overwritten.

Note: When using CAPTURE SYNC AXIS function, the system will enable COMPARE function automatically after CAPTURE function is completed. The parameters of COMPARE function will be introduced later in this presentation.

CAPTURE SYNC AXIS -17

COMPARE Function

Using COMPARE function to enable the CAPTURE function can prevent interference and enhance the system stability.

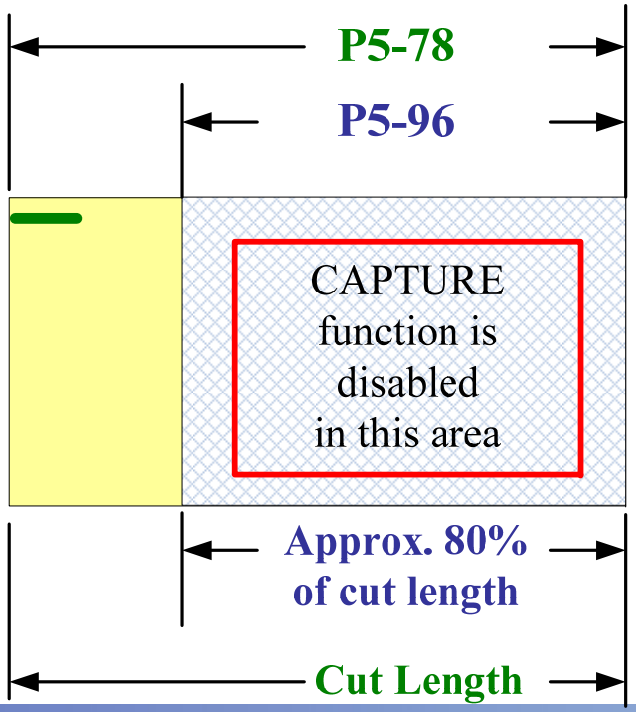


CAPTURE SYNC AXIS -18

CAPTURE / COMPARE Function

When the setting value of P5-78 is higher than the setting value of P5-96, the correct registration mark will be ignored and result in abnormal system operation.

P5-96 is Macro Parameter (Set COMPARE function), available in firmware V1.009 and later ASDA-A2 models



CAPTURE SYNC AXIS -19

Macro Parameters

Macro parameter can execute several macro commands by using one parameter only. If use macro parameters, the users do not need to set and enable each macro command one by one. It can save the setting time and reduce errors.

P5-96 Motion Control: Macro Parameter 1

If this parameter is specified by macro command, ensure to enter the relevant setting values correctly.

P5-97 Motion Control: Macro Command

Execute macro commands and display the execution result

CAPTURE SYNC AXIS -20

Usage of Macro Commands

Write macro commands into the specified parameters.
For example, when the macro command code is set to 0001h, set P5-96 as COMPARE first coordinate, i.e. the position where 80% of cut length for covering dirty spot.

↓

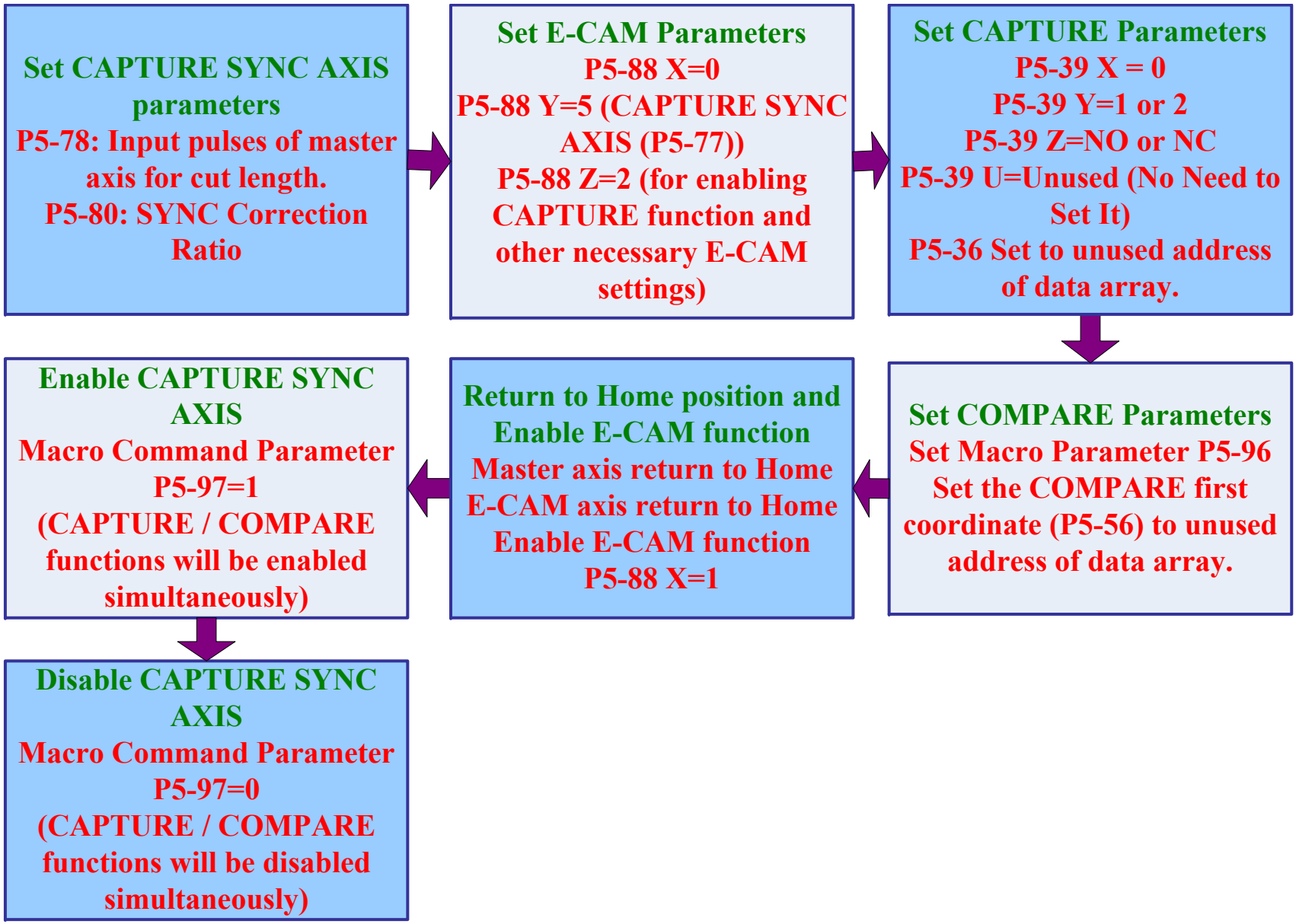
Enter macro command code into P5-97
For example, entering command code 0001h is for enabling CAPTURE SYNC AXIS

↓

The system will display the execution result of macro command via P5-97.
For example, if 1001h displays, it indicates that the CAPTURE SYNC AXIS is enabled successfully.
For example, if F002h displays, it indicates that the CAPTURE function is enabled and the users need to disable it.

CAPTURE SYNC AXIS -21

Parameters Setting Steps



Thank You