“Flying Shears” Technology Template

Technology CPU

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SIMATIC

Technology Template “Fliegende Schere“

Technology CPU

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1 Basic Information

1.1 Requirements

1.1.1 Target group

The technology template is intended for all programmers and users of technology CPUs, who want to implement "Flying Shears" quickly and easily.

1.1.2 Required knowledge

In order to use this technology template, you should be familiar with the STEP 7 program and the application of technology objects and technology function calls within the integrated technology of the technology CPU.

This documentation is not an introduction to these topics and focuses on the specifications for use of this template.

Application Example

The following application example provides an introduction to “flying shears”:

Technology CPU 31xT-2 DP – Flying Shears with Print-Mark Synchronization Based on Gear Synchronism

The application example is available on the Internet at:
http://support.automation.siemens.com/WW/view/en/21063352.

1.1.3 Technical environment

This technology template can be used unaltered only in connection with the Technology CPUs 315T-2 DP and 317T-2 DP.

1.2 Purpose of this technology template

1.2.1 Task

A fed web is to be cut into defined lengths with the Technology CPU.

Flying shears are to be used.

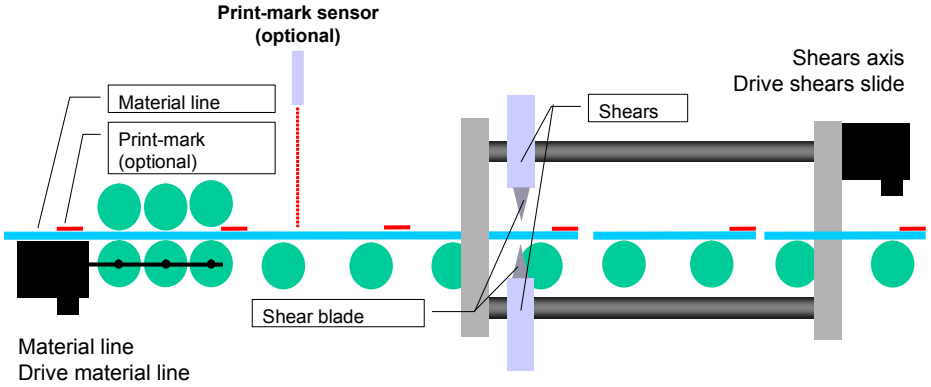
“Flying shears” enable the processing of material without having to interrupt the material line. The available processing time depends on the velocity of the material line and on the length of the distance which can be moved by the shears.

The flying shears consist of the shears attached to a travel range. The shears synchronize to the material line. If the shears are synchronous the cut is performed.

After the cutting process, the shears disable the synchronization and return to the starting position.

The cuts are either performed at definable distances or they are specified by print-marks on the material line.

Figure 1-1 Function principle of flying shears



Further applications

The same problem also occurs in similar forms of processing, primarily in the field of application of packaging machines.

Instead of cutting with shears, the applications can also be sawing, drilling, bonding, labeling, welding, stamping, checking or similar processes.

Definition

In this document, the term “**flying shears**” is used in place of any other possible forms of processing on the fly.

The “**cut**” only designates the processing period required e.g. for sawing, bonding or drilling which may also take some time.

Problem solving using the “Flying Shears” template

The “Flying Shears” template presented in this document helps solve the displayed tasks and develop functional flying shears as quickly as possible.

The template includes an already prepared motion control of the shears axis (axis moving the shears parallel to the material line) which can be adapted to the desired application via parameters. The template takes the complete control of the shears axis.

Via the user program, it is only required to realize the control of the shears and of the material feed and to supply the template with the correct parameters.

1.2.2 Advantages of the “Flying Shears” template

Using the “Flying Shears” template offers the following advantages to the user:

Quick program generation

The “Flying Shears” template enables easy and quick realization of a comprehensive functionality of flying shears during program generation with a technology CPU.

The blocks available in the template can quickly and easily be applied to the application to be created by copying. Additionally required configuration steps are explained in these instructions on the technology template.

Adaptation option

The “Flying Shears” template includes all source codes in commented form. This ensures that the template can be expanded quickly and easily with own functions.

This documentation also includes an explanation of the program flow for expansion of the template.

Test program

The delivery of the “Flying Shears” technology template includes a test program for a CPU 31xT with which you can test the reactions of the “Flying Shears” technology template.

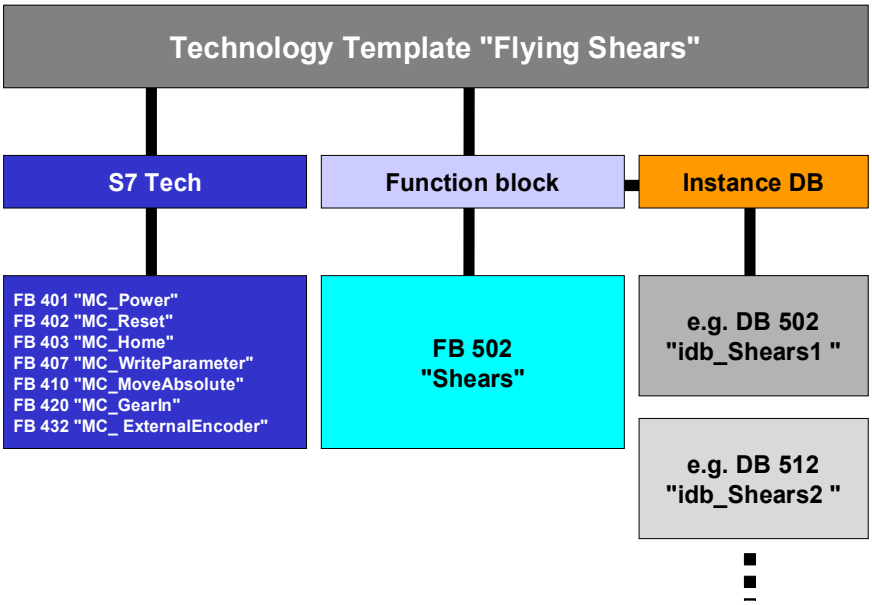
1.3 Components included in the technology template

The technology template as software package

The “Flying Shears” template is a software package which contains all STEP 7 blocks required for the realization of flying shears.

This ensures that the “Flying Shears” template can be integrated quickly and easily into self-created user projects.

Figure 1-2 Components of the “Flying Shears” template



The complete functionality of the flying shears is contained in block FB 502 “Shears” of the “Flying Shears” template.

Some of the technology function blocks in FB 502 “Shears” are used to realize the control of the motion control functions of the technology CPU.

Additionally required objects

In addition to the blocks contained in the template, the user has to create and parameterize the required technology objects (TOs) with S7T Config.

Test program

The delivery of the “Flying Shears” technology template additionally includes a test program with which you can test the reactions of the “Flying Shears” technology template.

Only STEP 7, WinCC flexible and a Technology CPU are required.

The test program is realized as independent STEP 7 project.

2 Possible Applications

2.1 Applications

2.1.1 Authorized controllers

The “Flying Shears” template is only authorized and released for use in the following controller:

- Technology CPU 315T-2 DP
- Technologie-CPU 317T-2 DP

2.1.2 Tasks which can be solved with the template

This technology template is used for the control of plant parts for processing on the fly, such as e.g.

- Cutting
- Bonding
- Stamping
- Drilling
- Labeling
- etc.

The field of application of this template is probably primarily in the field of packaging machines.

- The “Flying Shears” template completely takes the control of the axis moving the shears (shears axis).
- The template outputs a start signal when the cutting process can be started. The end of the cutting process has to be communicated to the template via an additional signal.
- The actual cutting process, like the material feed, has to be realized outside the template in the user program.

2.1.3 Properties of the “Flying Shears” template

The following properties are considered during the realization of the technology template and can be used in the user program when using the template:

- **Selection of the cutting length**
  The cutting length can be set at FB 502 “Shears”. The new cutting length is activated after completion of the current cut.
- **Monitoring the cuts**
  The template monitors the feed of the material line in automatic mode. If a cut cannot be started on time (e.g. if the material line moves more than one cutting length until the shears have moved back to the starting position), an error is output. The material line can be stopped with an error signal at the output of the function block to prevent that larger quantities of the material are moved through the shears uncut.
- **Print-mark detection**
  Instead of specifying a cutting length, the signal of a print-mark detection can also be used for cutting.
  If print-mark detection is used, the following points have to be considered:
  - A new print-mark is only detected when the shears are back in the starting position.
  - There is no check with regard to missed print-marks or cuts.
- **Switching between print-mark detection and selection of the cutting length**
  Switching between print-mark detection and selection of the cutting length at the block is possible at any time. The new setting is activated after completion of the current cut.
- **Limit switches**
  The “Flying Shears” template considers software and optionally hardware limit switches at the travel path of the shears slide.
  Activating a limit switch monitoring causes a stop of the drive. The shears then have to be moved to the permissible travel range in **Manual** mode.

2.2 Restrictions

Properties of the "Flying Shears" technology template

The following properties were not considered during the realization of the template and consequently exclude an unaltered use of the template in a self-created user program:

- **Print-mark compensation**
  The "Flying Shears" technology template can only operate with print-marks which indicate every cut. A print-mark for every second, third or n^{th} cut is not provided for.
- **No print-mark detection with absolute value encoder**
  If an absolute value encoder is used for the material line, a detection of print-marks is not possible This is due to the fact that FB403 "MC_Home" supports passive homing only with incremental encoders. See also chapter **8.2.2**
- **Head-cut**
  This template does not support the head-cut function.
- **Continuation of the cut without gap after error stop**
  If the flying shears go to error during the cut, the "Flying Shears" technology template does not allow to continue the cut. After correcting the cause of the error and after acknowledging, operation can only be continued via returning to initial position.
- **Use of an external encoder requires homing**
  When using print-marks, it has to be possible to home an external encoder. If required, a BERO has to be used.
- **Material line with continuous position detection**
  The axis or the external encoder of the material line are newly homed during every cut, i.e. the current position is set.
  If a continuous position detection is required, e.g. for error tracking, the template can not be used without modifications.
- **Direction of motion of the material line**
  For cutting, the material line has to move in positive direction, i.e. the position value of the material line must increase.
- **Accuracy in large lengths and positions**
  The used REAL format allows, transferred to the decimal system, an accuracy of approximately 8 decimal places. Consequently, rounding errors occur in case of large cutting lengths or positions and the cut becomes less precise.

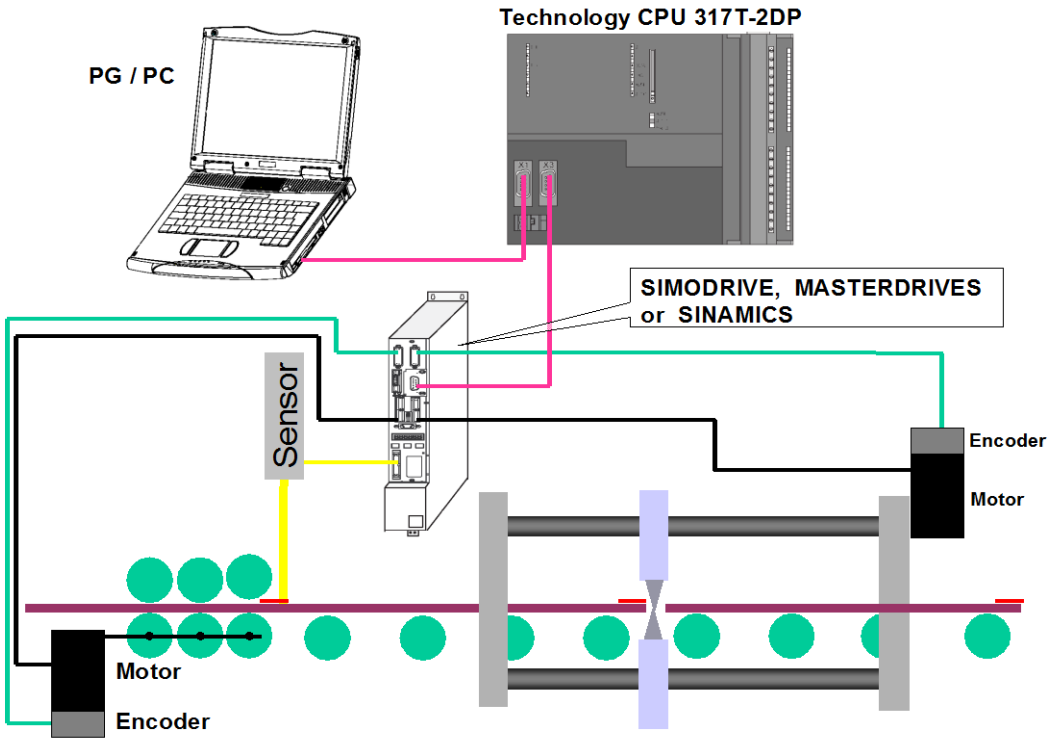
Note If necessary, you can adapt the template to your requirements. See also chapter **8 Information on the Adaptation of the "Flying Shears" Template**

2.3 Environment

2.3.1 Technology CPU controls material line

The “Flying Shears” technology template can be used if the technology template, aside from the axis of the shears, also controls the axis of the material line.

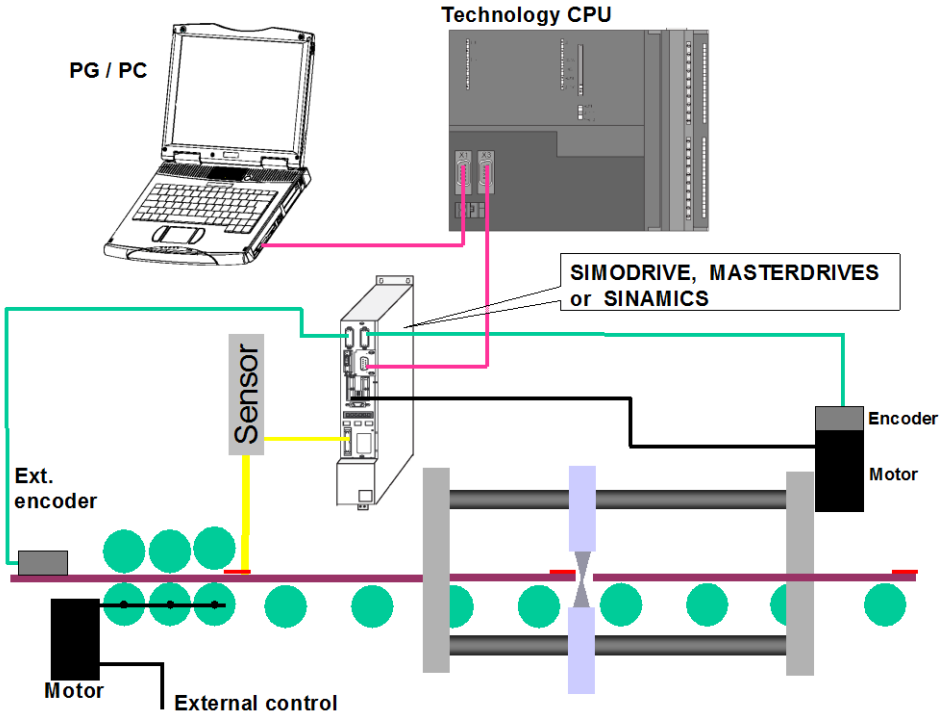
Figure 2-1 Environment for the “Flying Shears” technology template with control of the material line



2.3.2 Material line is controlled externally

The “Flying Shears” technology template can also be used if the axis of the material line is not controlled by the technology CPU but if the velocity and the position are detected with an external encoder.

Figure 2-2 Environment for the “Flying Shears” technology template without control of the material line but with external encoder



3 Structure and Function

3.1 Structure of the flying shears

3.1.1 General setup

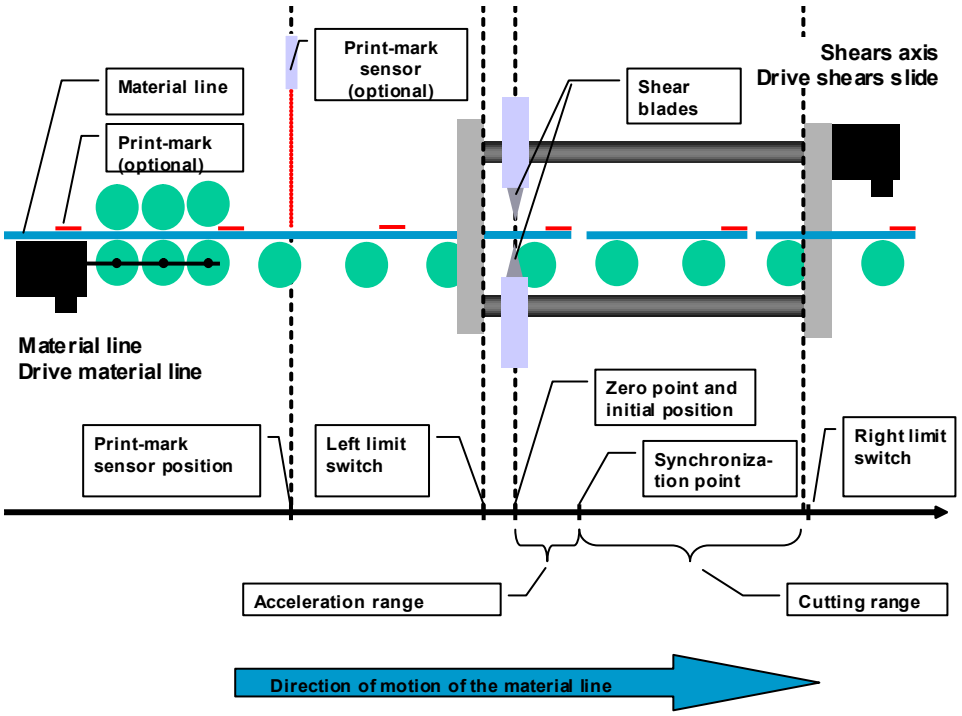
The flying shears on which this technology template is based consist of a slide to which the blade is attached. The template controls the axis moving the shears slide. In the following, this axis is referred to as shears axis.

All positions of the shears axis refer to a zero point, preferably the rest or starting position of the shears. The zero point of the shears axis is located at these positions.

The shears maximally move between the two (software) limit switches. At the starting position, the shears wait for the next cut, subsequently starts accelerating and reaches the synchronism with the material line at the synchronization point so that the cut can be performed from this point. After completing the cut, the shears return to the starting point.

The print-mark sensor and the negative limit switch are usually located in front of the initial position of the shears. For this reason, their position is often negative.

Figure 3-1 Function principle of flying shears



3.1.2 Function Principle

A place on the material line corresponds to the position 0.0 mm (of the material line). Since the material line is moving, this point is also moving. The shears always cut the material line at this point. The sequence is described in the following:

1. The shears synchronize in such a way that the shear blade appears to be located directly above this point of the material line and release the cut.

2. After completing the cut, the shears return to the starting position.
3. Definition of the next cutting position:
   - When cutting to length, the position 0.0 mm of the material line is moved forward by the cutting length so that the position 0.0 mm is at the place of the next cut.
     This is achieved by subtracting the cutting length from the current position of the material line and by assigning this value to the material line as new current position.
   - When cutting to print-mark, the position 0.0mm is assigned to the location at which the print-mark was detected during detection. The cut is then performed at this location.
     If the cut is not to be performed directly at the print-mark, not 0.0 mm but a definable value is assigned to the point. The cut is then performed offset by this value next to the print-mark
4. The next cutting point is now defined and the sequence is repeated.

Details on synchronization

In the Flying Shears template, the following settings are used for the synchronization of the shears to the material line:

- **Master axis-related synchronization**
  The position of the master axis (material line) is decisive for the start and the sequence of the synchronization process.
- **Synchronize before synchronization position**
  The slave axis (shears) synchronizes before the synchronization position and is synchronous after the master axis (material line) has reached the synchronization position. Setting the synchronization length determines the point at which the synchronization starts.

Sequence of the synchronization

The figure below displays the positions of the material line axis and shears axis. It shows that the red material line moves constantly. The blue shears axis is first located at 0.0 mm. It subsequently synchronizes to the material line. In the section of the chart in which the axes move synchronously, the “blue” shears are covered by the “red” material line. After the cut, the synchronous operation is terminated and the “blue” shears return to 0.0 mm.

The beginning and the end of the chart (at approximately 800ms and 16200ms) show that the cutting length (4000.0 mm) is subtracted from the position of the material line to prepare the respective next cut. (Cut to defined length).

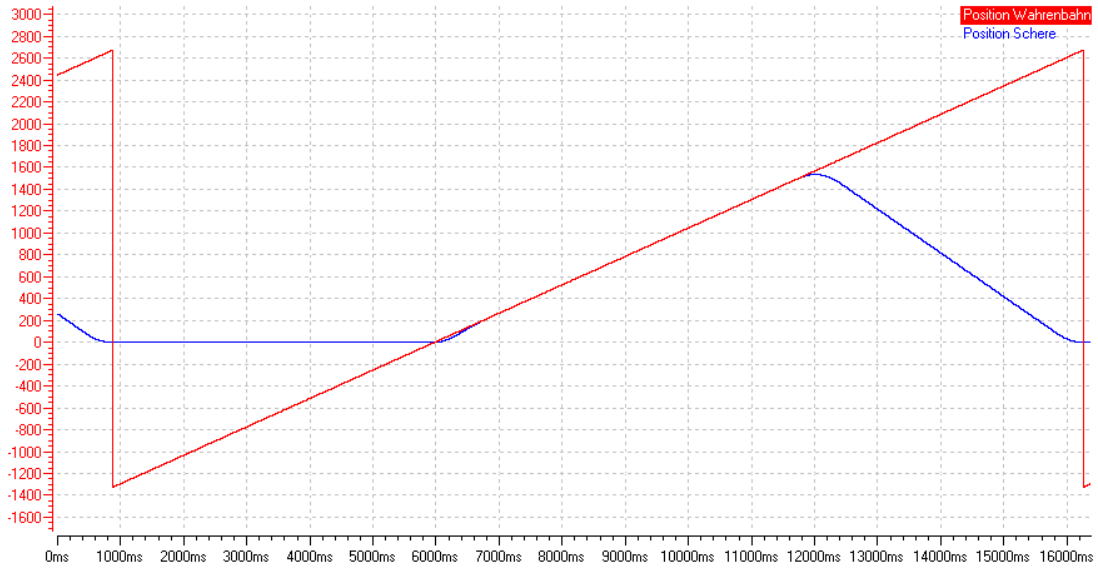
The following values were used for the creation of the chart:

Table 3-1

Parameters	Value
Cutting length	4,000.0 mm
Starting position	0.0 mm
Synchronization point	200.0 mm
Synchronization length	200.0 mm

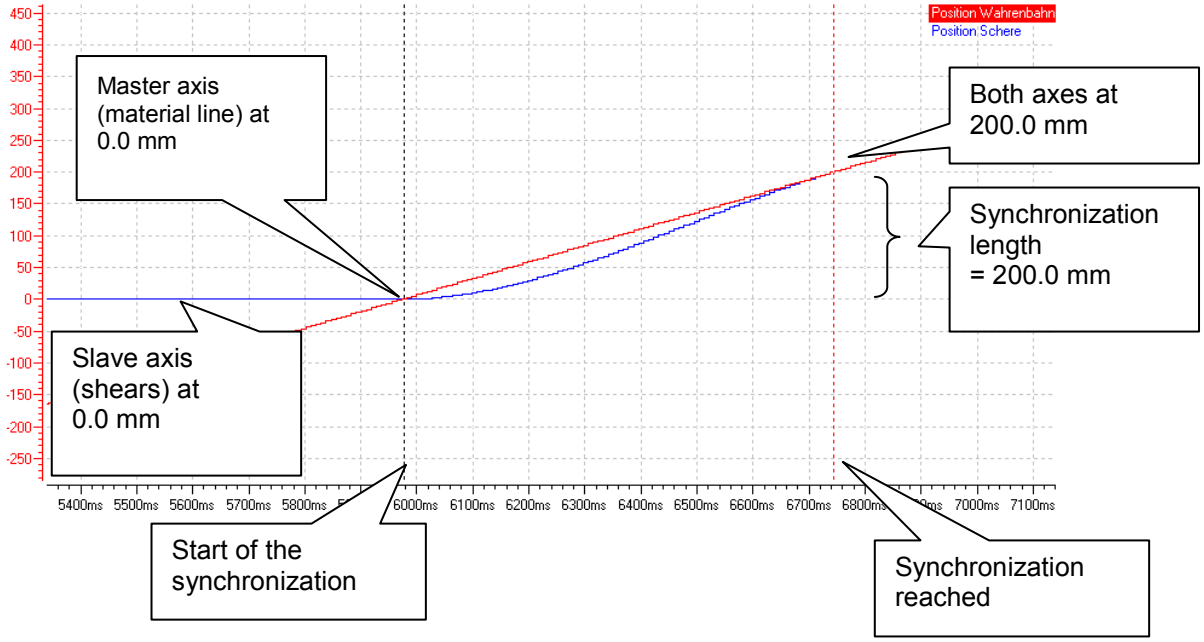
In this parameterization, the shears start accelerating after the material line has reached its starting position. The shears let the material line pass and subsequently catch up with it at the synchronization point.

Figure 3-2 Synchronization overview



The figure below shows an enlarged display of the synchronization section. In addition, the figure shows the synchronization point and the synchronization length.

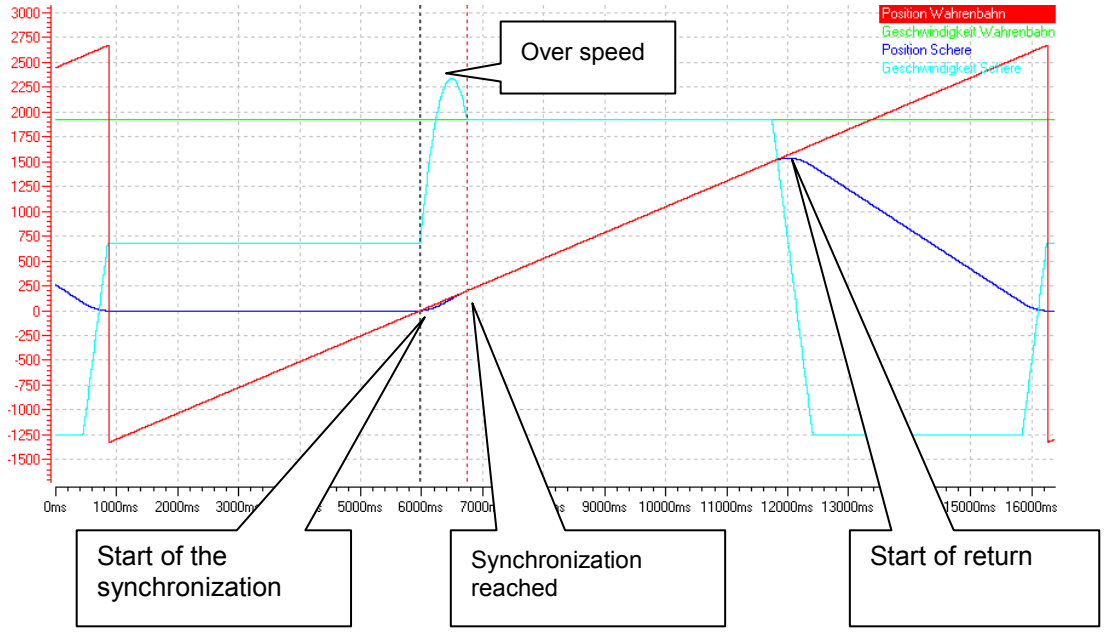
Figure 3-3 Synchronization detail



Below, again the overall chart is displayed, which now also includes the two velocities. During synchronism, the green velocity of the material line disappears behind the light blue / turquoise velocity of the shears.

The figure clearly shows that the shears have to move quicker than the material line to catch up with it.

Figure 3-4 Synchronization Position and velocity of the axes



Improved sequence of the synchronization due to longer synchronization length

The figure below again shows a synchronization process. But this time a longer synchronization length was used:

The following values were used for the creation of the chart:

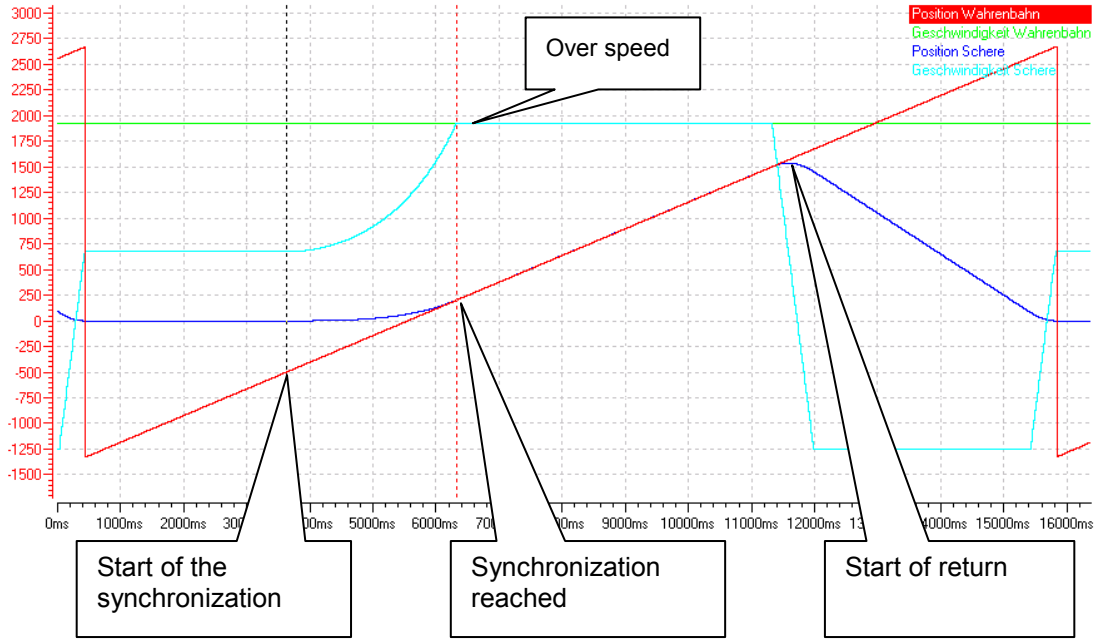
Table 3-2

Parameters	Value
Cutting length	4,000.0 mm
Starting position	0.0 mm
Synchronization point	200.0 mm
Synchronization length	**700.0 mm**

The slave axis (shears) starts moving when the material line is at –500.0 mm.

Since the synchronization starts before the material line has reached the current position of the shears, it is now no longer required that the shears move quicker than the material line to synchronize.

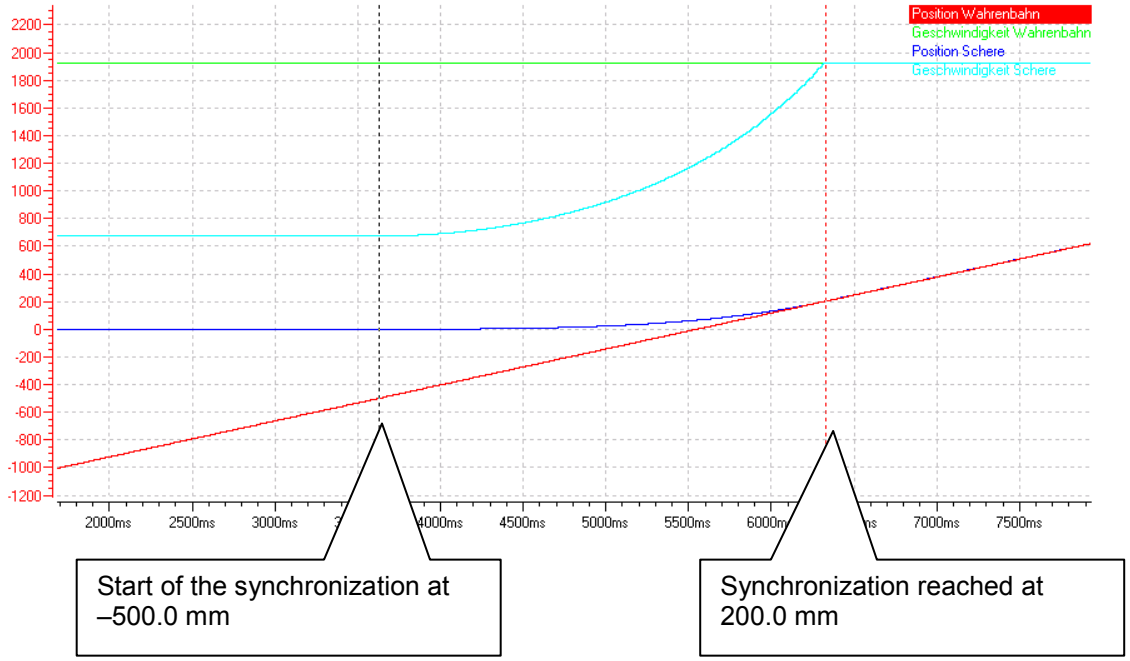
Figure 3-5



3.1 Structure of the flying shears

The figure below also shows an enlarged display of the synchronization section.

Figure 3-6

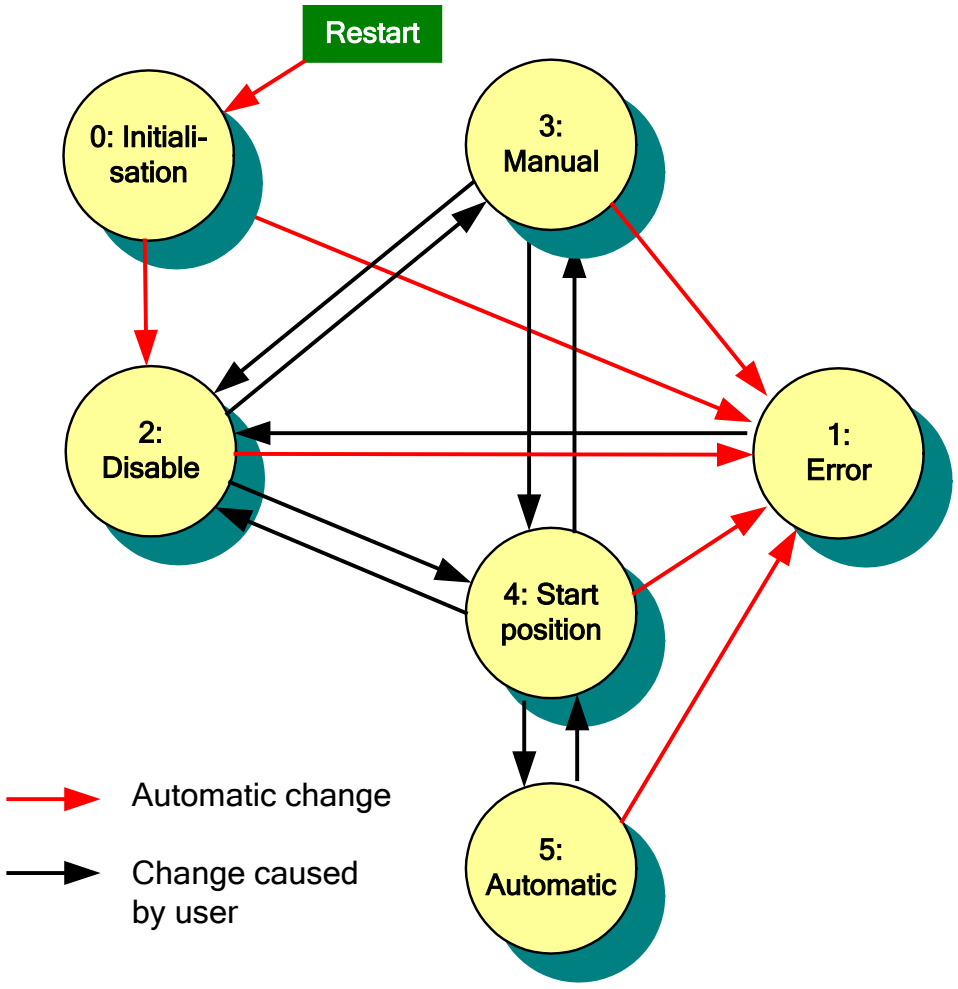


3.2 Modes of the flying shears

The “Flying Shears” technology template takes the automatic control of the shears axis for the realization of the flying shears.

This functionality is divided into five modes in such a way that the sequences of the flying shears can be realized by the modes and by mode transitions. The user influences the flying shears only by selecting the desired mode with the required parameters.

Figure 3-7 Modes



The different modes are listed in the following:

- **Initialization (0)**
  The "flying shears" check the parameterization.
- **Error (1)**
  The “flying shears” have detected an error and the shears axis is disabled. The error is output at the error output of the technology template and can be evaluated by the user.
- **Disable (2)**
  The “flying shears” have acknowledged possibly present errors and are ready for use, but disabled.
- **Manual (3)**
  The flying shears are enabled and in manual mode. The user can manually move the axis by calling technology FBs (or PLCopen FBs[1]) outside FB 502 “Shears”.
- **StartPosition (4)**
  The flying shears axis is enabled and moves to or is located at the starting position and ready for synchronization to the material line.
- **Automatic (5)**
  The shears axis is enabled and cuts the material according to settings.

The above modes are available to the user in the user program for the realization of his shears functionality and can be communicated to FB 502 “Shears” via input parameters.

FB 502 “Shears” displays the currently reached status via an output.

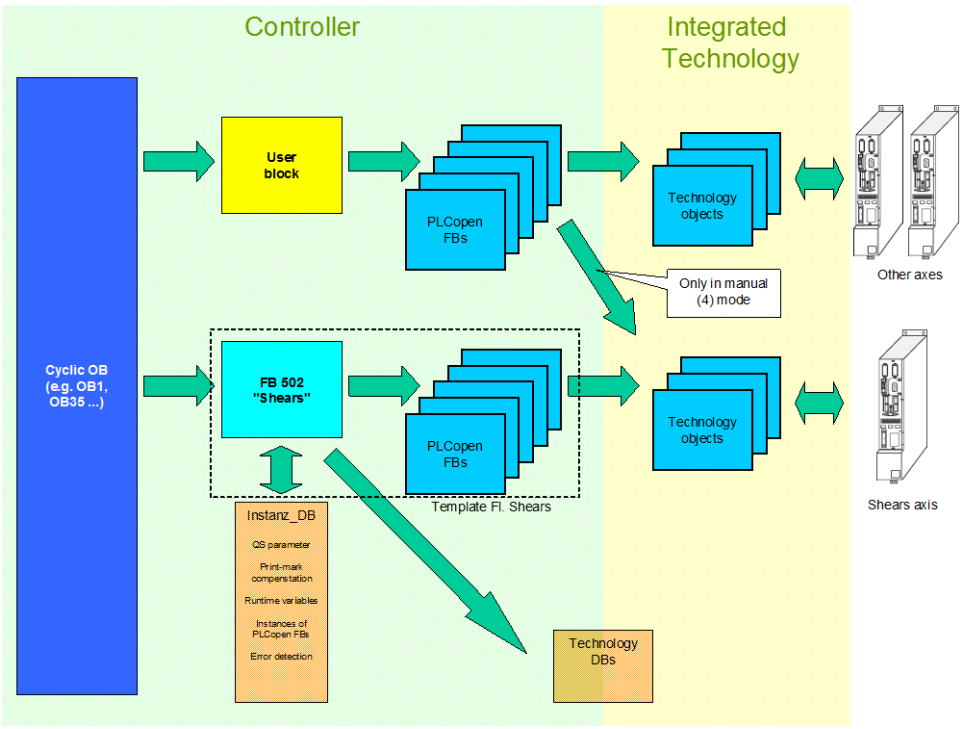
[1] Since the Technoloy FBs comply with the PLCopen standard they are also often referred to as PLCopen blocks.

4 Program Environment and Interfaces

4.1 Call environment

Block FB 502 “Shears” of the template has to be called cyclically in the user program. For this purpose, the call can be performed directly in an OB block or within a cyclically processed FB block.

Figure 4-1 Call environment of FB 502 “Shears”



The technology objects influenced by block FB 502 “Shears” may only be influenced by the user program if the shears axis has previously been set to mode **3:Manual** by the user. In all other modes, influencing the shears axis by the user program is not permissible.

4.2 Interfaces

4.2.1 Structure of the interfaces

Block FB 502 "Shears" can be influenced via several parameters and interfaces which are divided into the following sections:

- Block interfaces
- User interface of the instance data block
- Parameterization of the technology objects

Via the block interface, mode changes are initiated in FB 502 “Shears”. Via the interface, the block reports the current status and possibly occurring errors to the user program.

Via the user interface of the instance data block, primarily the physical variables of the flying shears to be controlled are communicated to FB 502 “Shears”. These variables are not changed during the operation of the flying shears.

4.2.2 Block interface of FB 502 “Shears”

For the control of the flying shears by the function block FB 502 “Shears”, the following interfaces are available at the block:

Figure 4-2 Block interface

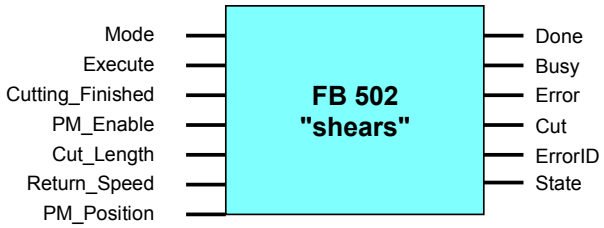


Table 4-1 Interfaces of FB 502 “Shears”

Parameters	Data type	Initial value	Description
Input parameters			
mode	INT	0	Via **Mode**, the mode is preselected that is activated with the next positive edge at the **Execute** input.
Execute	BOOL	False	A pending mode change is activated via this input.
Cutting_Finished	BOOL	False	Signal communicating to FB Shears that the cut is finished and that it can return the shears axis to the initial position. Level evaluation!
PM_Enable	BOOL	False	Switching to print-mark detection
Cut_Length	REAL	1000.0	Cut_Length is the piece length of the cut material in mm. Irrelevant for print-mark detection
Return_Speed	REAL	-1.0	Velocity in mm/s at which the initial position is approached.
PM_Position	REAL	0.0	Position of the print-mark detection in mm (usually a negative value)
Output parameters			
Done	BOOL	False	The mode selected via **Mode** is activated.
Busy	BOOL	False	Mode switching is active.
Error	BOOL	False	Displays errors in the FB and on the shears axis.
Cut	BOOL	False	Signals that the blade is synchronized to the material line and that cutting can be performed.
ErrorID	WORD	0	Warning or error code
State	INT	0	Current mode

4.2.3 Structure of the instance data block

The interconnection to the required technology objects and the physical reference variables and control information are stored in the user interface of the instance data block.

The parameters stored here are usually not changed during correct operation of the flying shears.

Figure 4-3 Structure of the instance DB of FB 502 “Shears”

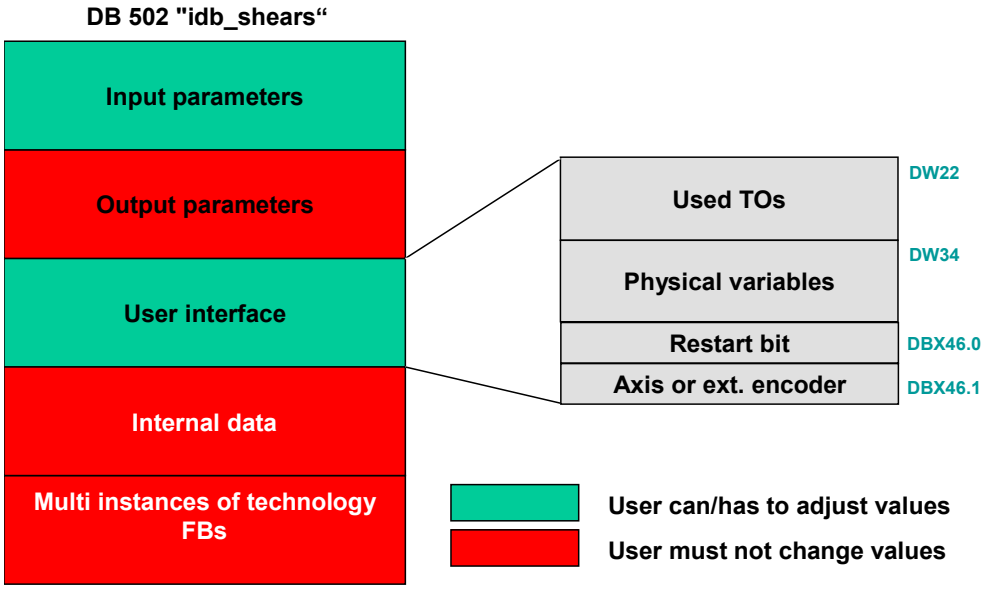


Table 4-2 User parameters in the “idb_Shears” instance data block

Parameters	Data type	Initial value	Description
Used TOs			
Axis_Material	INT	0	TO[2] number of the material axis or of the external encoder
Axis_Shears	INT	0	TO number of the shears axis
Physical variables			
Start_Position [mm]	REAL	0.0	Starting and rest position of the shears
Lower_Limit_Pos [mm]	REAL	0.0	Lower end of the traversing range of the shears (negative limit switch)
Upper_Limit_Pos [mm]	REAL	0.0	Upper end of the traversing range of the shears (positiv limit switch)
Sync_Position [mm]	REAL	0.0	Position from which the shears are to be synchronous to the material line
Sync_Length [mm]	REAL	0.0	Length used by the shears for synchronizing, located before the synchronization point **Sync_Position**
Restart bit			
Restart	BOOL	false	If the bit is set (e.g. in OB100), the template executes a reinitialization and resets the bit. This bit **must** be set each time the CPU is restarted!
axis_material_is_ext_enc	BOOL	false	When set the TO indicated in Axis_Material has to be an external encoder. When not set the TO has to be a positioning (or synchronization axis).

Attention

The restart bit **must** be set each time the CPU is restarted!

[2] TO = technology object of integrated technology, the TO number is the number of the technology data block belonging to the technology object

5 Integration of the “Flying Shears” template

5.1 Requirements

5.1.1 SIMATIC STEP 7

The use of this technology template requires that the STEP 7 programming environment is correctly installed on your computer.

In addition, the “S7-Technology” option package for parameterization and programming of the technology CPUs has to be integrated into the STEP 7 programming environment.

Table 5-1 Software components

Software	Figure	MLFB/Order number and functions	Used version
STEP 7		6ES7810-4CC06-0YX0 Step7 is the basic package for all optional software packages and it is used for programming the SIMATIC S7.	V5.4 SP5
S7-Technologie		6ES7864-1CC30-0YX0 Tool for parameterizing and programming the technology objects of the technology CPU.	V4.1 SP1

5.1.2 Technology CPU

A functional technology CPU is required to operate this technology template.

Note To be able to correctly use the program elements available in this template, you should be familiar with handling, function and programming of this CPU.

Table 5-2 Hardware components

Hardware components	Figure	MLFB/Order number and functions
CPU 31xT-2 DP		6ES7315-6TG10-0AB0 or 6ES7315-6TH13-0AB0 or 6ES7317-6TJ10-0AB0 or 6ES7317-6TK13-0AB0 The CPU 31xT-2 DP processes the user program and the technological functions.
Micro Memory Card 4MB		6ES7953-8LM11-0AA0 The S7 program is stored on the MMC. Communication

5.1.3 Required PLC-Open blocks from the “S7-Tech” library

The following function blocks from the “S7-Tech” library have to be available for operation of the technology template in the controller:

- FB 401 **"MC_Power"** For releasing axes
- FB 402 **"MC_Reset"** For acknowledging errors at axes
- FB 403 **"MC_Home"** For homing axes
- FB 407 **"MC_WriteParameter"** For writing system parameters
- FB 410 **"MC_MoveAbsolute"** For absolute positioning
- FB 420 **"MC_GearIn"** For activating gear synchronization
- **FB 432 "MC_ ExternalEncoder"** For using an external encoder

5.1.4 Required technology objects and synchronism relation

Operation of the “Flying Shears” technology template requires that the technology objects listed below are created and interconnected in the S7T-Config configuration environment as described in the following.

Technology objects

Below, the required technology objects are listed according to their function in the “Flying Shears” technology template:

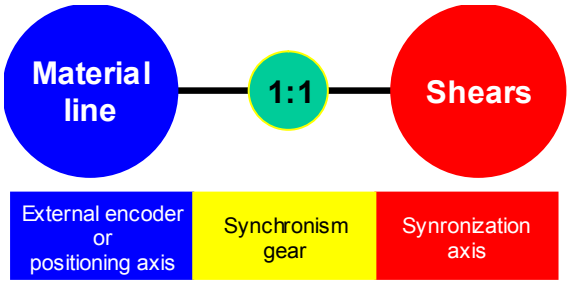
- **TO axis “Axis_Material”** as linear positioning (or synchronization axis) or as external encoder
- **TO axis “Axis_Shears”** as linear synchronization axis

Modulo and/or rotary axes must not be used.

Synchronism relations

The “Flying Shears” technology template expects the following synchronism relation:

Figure 5-1 Required synchronism relation



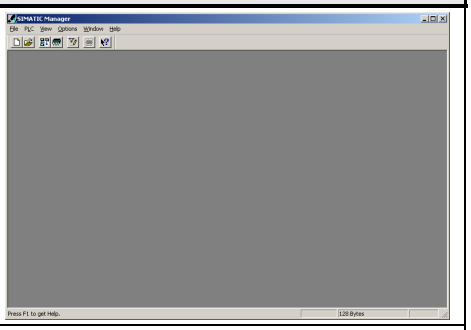
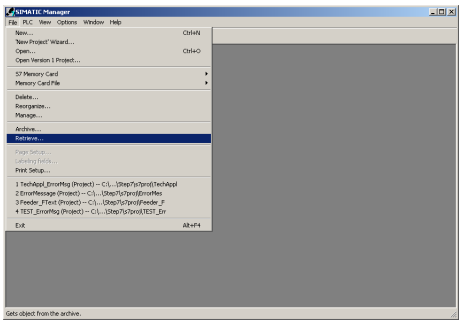
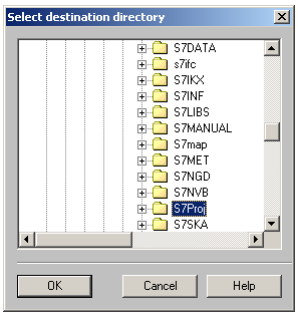
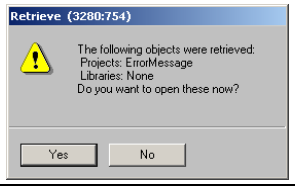
The material line is the reference variable for the flying shears. For this reason, it has to be available to the technology functions as “positioning axis” or as “external encoder”.

5.2 Preparations

5.2.1 Retrieving the “Flying Shears” technology template

The “Flying Shears” technology template is delivered as STEP 7 archive. To use the template, it is required to first retrieve this archive via STEP 7.

Table 5-3 Retrieving the STEP 7 template

No.	Instruction	Comment
1	Start the STEP 7 programming environment	
2	In the **File** section, select the **Retrieve...** function. Select the STEP 7 archive of the template.	
3	Select the destination directory **S7Proj**. Start the retrieving process by clicking **OK**.	
4	After successful retrieving, open the template in STEP 7.	

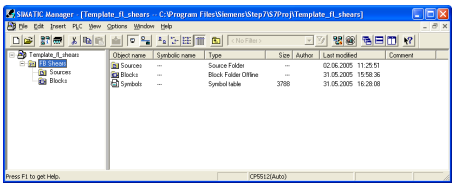
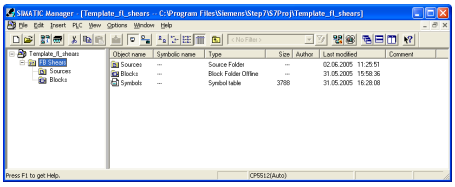
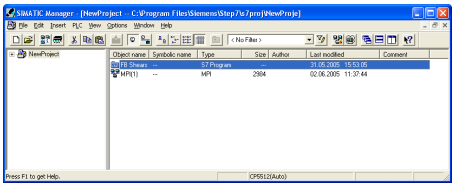
The library of the “Flying Shears” technology template includes an S7 program folder which contains all necessary elements for the use of the template.

5.2.2 Integration of the technology template into your STEP 7 project

For easy and quick transfer of the “Flying Shears” technology template to your STEP 7 project, you should proceed as described below.

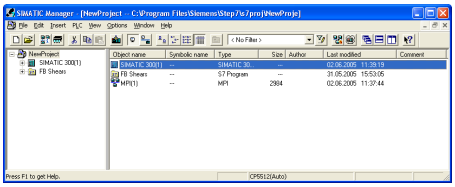
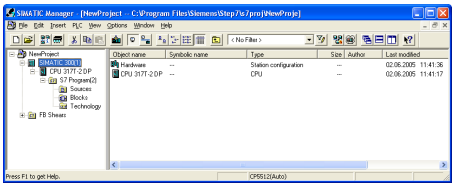
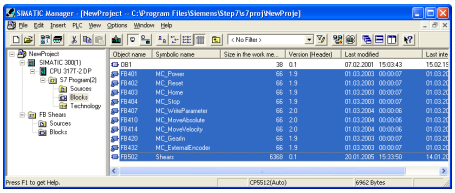
Transfer of the complete S7 program folder

Table 5-4 Transfer of the S7 program folder

No.	Instruction	Comment
1	In STEP 7, select the S7 program folder of the template by clicking it. In the **Edit** section, select the **Copy** function to copy the program folder to the buffer.	
2	Create a new project in STEP 7 by selecting the **New**... function in the **File** section or by opening an already existing STEP 7 project into which you want to integrate the template.	
3	Insert the copied S7 program folder with the elements of the technology template into the project. Select the root node of the S7 project by clicking it (first entry in the project structure overview) and select the **Paste** function in the **Edit** section.	

Integration of the elements of the technology template into your STEP 7 project

Table 5-5 Integration of the STEP 7 program part of the technology template into your project

No.	Instruction	Comment
1	Insert a SIMATIC 300 station as new object.	
2	In the SIMATIC 300 station, configure a Technology CPU with HW Config.	
3	Transferring the function blocks Select all blocks of the technology template available in the “Blocks” folder and copy these blocks into the block folder of your project.	

5.3 Creation of the required technology objects

Requirement

The required drives and possibly encoders have to be connected to the technology CPU via an equidistant PROFIBUS in HW Config. Only then the technology objects can be created and parameterized.

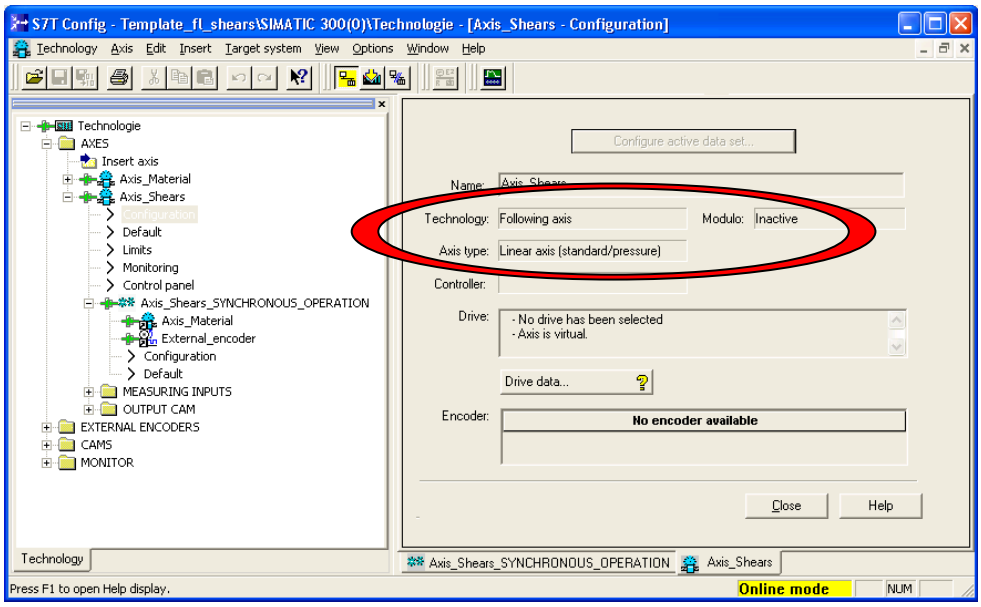
5.3.1 Shears axis

The shears axis has to be configured as synchronization axis:

Configuration

- Parameterization of the axis as **synchronization axis**
- Setting the axis type as **linear**
- No **Modulo**
- All further parameters are to be set according to the drive and encoder data.

Figure 5-2 Configuration shears axis



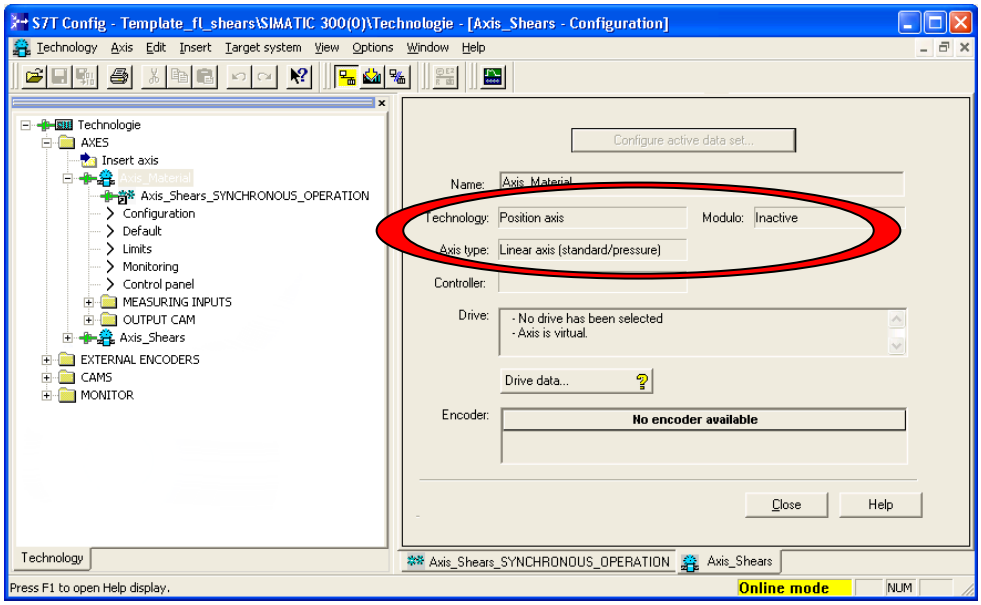
5.3.2 Material line

The material line can be configured as axis or as external encoder.
See chapter **2.3 Environment**.
The type used has to be indicated in parameter "axis_material_is_ext_enc" in the instance DB (see chapter **4.2.3 Structure of the instance data block**).

Configuration (as axis)

- Configuration of axis as **Positioning axis**[3]
  (Checked by template)
- Setting the axis type as **linear**
- No **Modulo**
- All further parameters are to be set according to the drive and encoder data.

Figure 5-3 Configuration material line as positioning axis



Configuration (as external encoder)

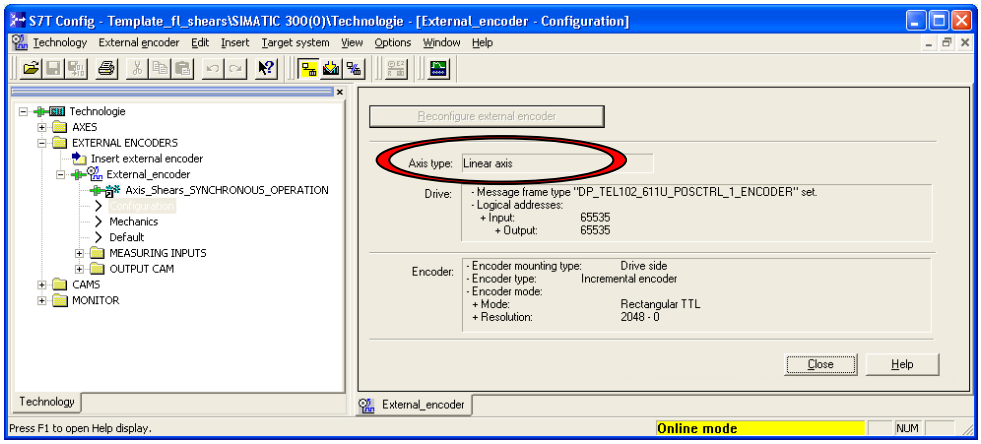
- Setting the axis type as **linear**
- **No Modulo**
- All further parameters are to be set according to the drive and encoder data.

Note

When using an external encoder, the bit "axis_material_is_ext_enc" (Bit 46.1) has to be set to 1 in the instance DB. (see chapter **4.2.3 Structure of the instance data block**)

[3] The material line can also be created as synchronization axis if it is to be operated in synchronism to another axis.

Figure 5-4 Configuration material line as external Encoder



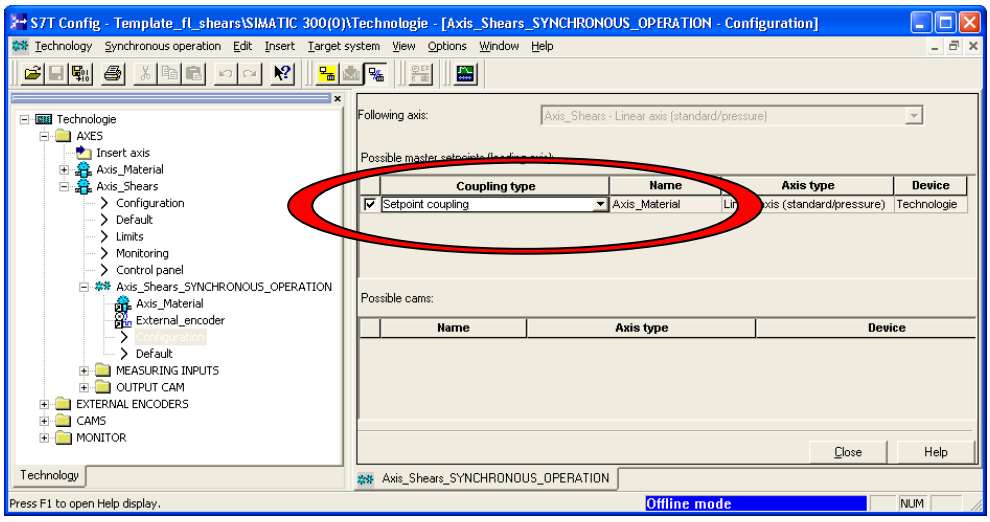
5.3.3 Interconnection of the synchronism relation

The following settings are to be parameterized in the synchronism properties of the shears axis:

Configuration with positioning axis

- Selection of the **Axis_Material** axis as master axis
- Selection of **Setpoint coupling** as coupling type

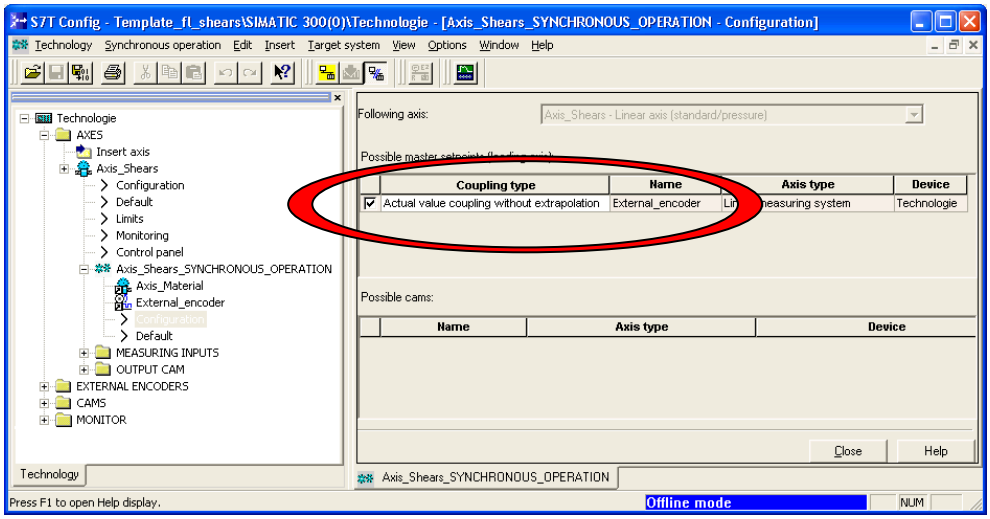
Figure 5-5 Selection of the master axis, material line as positioning axis



Configuration with external encoder

- Selection of **External_encoder** as master axis
- Actual value coupling without extrapolation is to be selected as coupling type.

Figure 5-6 Selection of the master axis, material line as external encoder

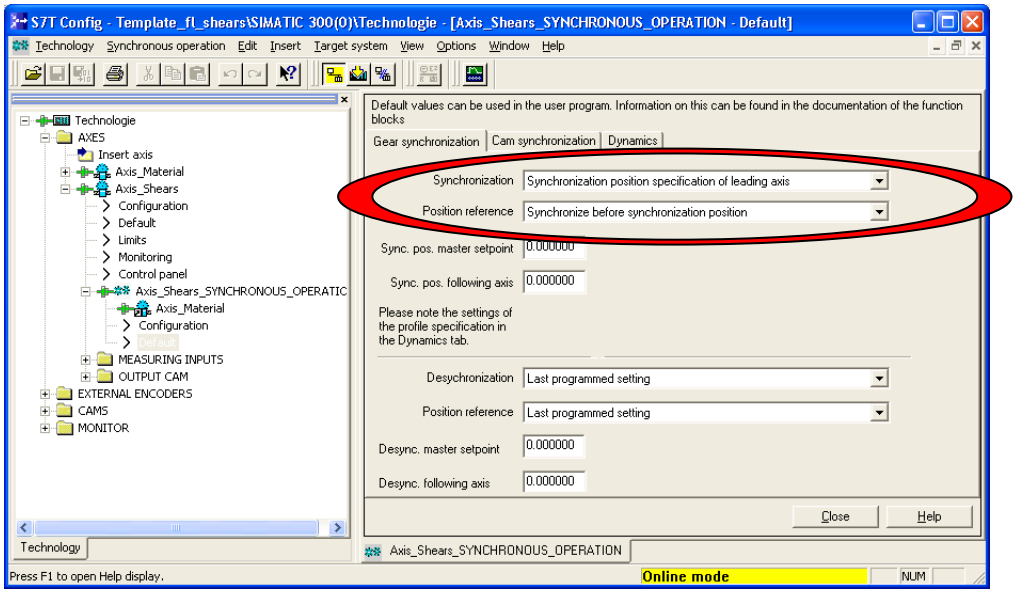


Default selection (tab: Gear synchronization)

You have to set the following points

- Synchronization:
  Synchronization position specification of leading axis
  (the template corrects the settings)
- Position reference:
  Synchronize before synchronization position
  (the template corrects the settings)
- The template enters the synchronization point specified in the instance DB in the values **Sync. pos. master setpoint** and **Sync. pos. following axis**.

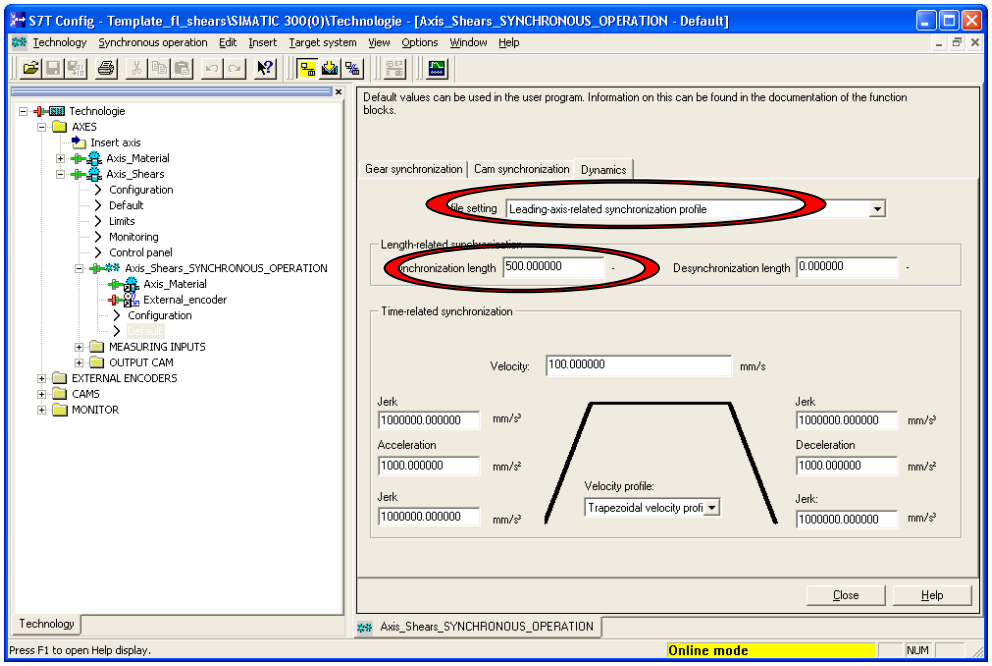
Figure 5-7 Synchronization settings



Default selection (tab: Dynamics)

- Profile setting: **Leading-axis-related synchronization profile** (the template corrects the settings)
- The template overwrites the synchronization length with the value from the instance DB (sync_length parameter).

Figure 5-8 Dynamics



Note

Since the template writes several parameters in the StartPosition mode, inconsistency is possibly displayed in the S7 T Config of the S7 Technology Editor.

This is for instance the case in the figure above at the external encoder (red "coupling").

5.4 Integration into your application

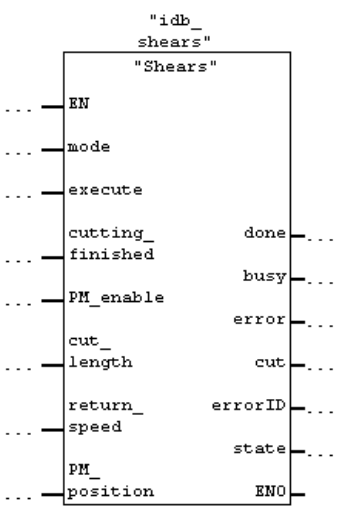
5.4.1 Call of the block FB 502 “Shears” in the user program

The function block of the “Flying Shears” technology template can easily be called in the program after the integration into your STEP 7 project.

Call of the “Shears” function block in STL and FBD

The calls of the “Shears” function block of the “Flying Shears” technology template in the programming languages STL and FBD are shown below as examples:

Table 5-6 Call of the “MC_Shears” function block

	STL	FBD
FB 502 “Shears“	CALL "Shears" , "idb_shears" mode := execute := cutting_finished:= PM_enable := cut_length := return_speed := PM_position := done := busy := error := cut := errorID := state :=	

Assignment of the instance data block

An individual instance data block or area in a multi-instance DB has to be assigned to each shears which are realized with FB 502 “Shears”.

5.4.2 Integrating template blocks into the processing sequence

The function block of the “Flying Shears” technology template is integrated into the processing sequence by a simple block call and the transfer of the required parameters. The call has to be performed in a cyclically starting OB or FB block. A timer interrupt-controlled processing (e.g OB35) is not necessary (but possible).

6 Use of the Template

6.1 General information

Basic information

The most important element of the technology template is the function block FB 502 “Shears”. Via this block, the connected flying shears are parameterized and controlled.

The parameterization of the block and the mode switching of the block are realized in the user program to cause FB 502 „Shears” to execute the desired functions.

The configuration of FB 502 "Shears" is performed as described in chapter **4.2.3 Structure of the instance data block**. During the parameterization, basic values of the flying shears are determined which normally do not change, such as e.g the indication of the number of the shears axis, limit switch positions, etc.
Changing these values is only permitted during stop and requires a reinitialization (restart) of FB 502 “Shears”!The individual modes of block FB 502 "Shears" are described in chapter **3.2 Modes of the flying shears**.The procedure for mode switching will be explained in detail in the following chapters.

6.2 Sequence of the mode switching

Switching mode

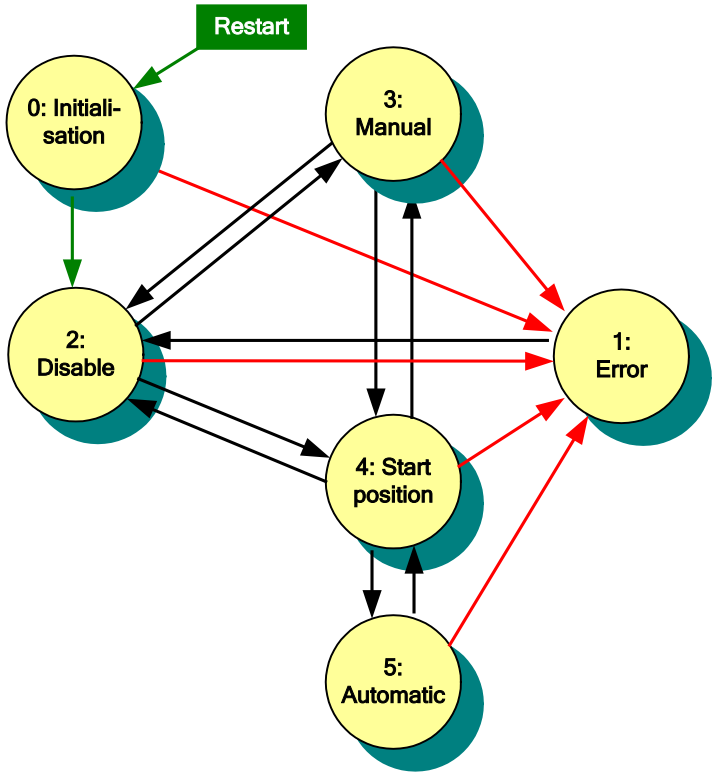
The functions of block FB 502 “Shears” and consequently the functions of the connected flying shears are controlled via the mode switching of the block.

After starting the CPU (restart bit set, see Chapter **6.3**), FB 502 “Shears” is initialized and the parameterization is checked during this process.

If no error occurs, the block goes to mode **2:Disable** and remains in this mode until the user selects a different mode or until an error occurs.

The following modes and mode transitions can be called at the block:

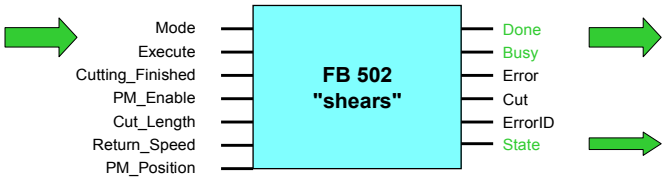
Figure 6-1 Possible mode transitions at the block



The modes **0:Initialisation** and **1:Error** cannot be directly activated by the user via the mode selection.
The user can only activate the mode changes indicated in black via the mode selection.
The mode changes indicated in green are executed automatically during restart.
A mode change indicated in red takes place in case of an error.

The current status of the block is always displayed at the **State** output.

Figure 6-2 Inputs and outputs of the mode switch



To set the block to a new mode, it is required to specify the number of the desired target mode at the **Mode** input. A rising edge at the **Execute** input activates the switching.

The number of the current mode can be read at the **State** output.

Switching to the new mode is active as long as a high signal is output at the **Busy** output. If all actions of the switching have been successfully completed and if the new mode is reached, this is indicated by a high signal at the **Done** output of the block and the **Busy** output is reset.

A mode change has been completed if the **Done** output displays **high**, the **ErrorID** output displays 0000 and the **State** output displays the new mode.

Error

If an error occurs, a high signal is output at the **Error** output and the cause of the error is output at **ErrorID**. The outputs **Busy** and **Done** are cleared and the shears axis is disabled.
The block automatically changes to the error status and the State output displays 1 for mode **1:Error**.

6.3 Use of the restart bit

Setting the restart bit

Each time the CPU is restarted or if the parameterization is changed, the restart bit **must** be set in the instance DB of FB 502 “Shears”. An initialization routine and a parameter check are executed in FB 502 “Shears” and the block is set to a defined status.

During restart, the block checks essential parameters of the technology as well as the existence and the type of the data blocks and technology objects stored in the instance DB.

The restart bit is automatically reset after successful initialization of the block.

The parameters may only be written and the restart bits and "axis_material_is_ext_enc" may only be set when the axis is stopped!

6.4 The "axis_material_is_ext_enc" bit

Function of the "axis_material_is_ext_enc" bit

After a cut the position 0.0 of the material line is pushed forwared by one cutting length or is set via print-mark.
Since this means using different blocks for the technology objects axis and ext. encoder, the FB 501"Shears" has to know what type the technology object is. This is why this information is saved in the "axis_material_is_ext_enc" bit.

This information was read from the technology DB up to and including version V3.0 of the template. However, since this had the effect that the template was dependent on the version, this function was removed and now the user has to set the bit.

Danger

The parameters may only be written and the restart bits and "axis_material_is_ext_enc" may only be set when the axis is stopped!

Note

We recommend performing the complete parameterization of FB 502 “Shears” with load and transfer commands only in OB100 and setting the restart bit in OB100 to set the block to a defined status during starting or restarting the CPU!

We recommend restarting the CPU after parameter changes (and consequently setting parameters and restart bit) instead of setting the restart bit from the cyclic program.

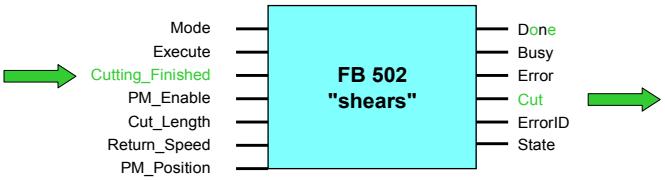
6.5 Shears control

Control signals for the shears

As soon as the shears are synchronous to the material line, FB 502 “Shears ” outputs the **Cut** signal with which the user can start the cut.

The user communicates the end of the cut to FB 502 “Shears” via the **Cutting_finished** signal. Subsequently, the template clears the **Cut** signal and starts the return.

Figure 6-3 Inputs and outputs of the shears control



Note

The **Cutting_finished** signal is level-triggered and must therefore not be present permanently since otherwise the shears would start the return immediately when reaching the synchronism.

If an error occurs during the synchronous motion, the **Error** output is set and an error code is displayed at **ErrorID**. The outputs **Busy** or **Done** and **Cut** are reset and the shears axis is disabled and FB 502 “Shears” goes to mode **1:Error**.

6.6 Operating data

Return speed

The return speed has to be communicated to FB 502 “Shears” during runtime: The following input is used:

- Return_Speed

Cut to length

If the cutting length is to be specified, the following input is used:

- Cut_Length

This input is ignored when using print-marks or an external encoder.

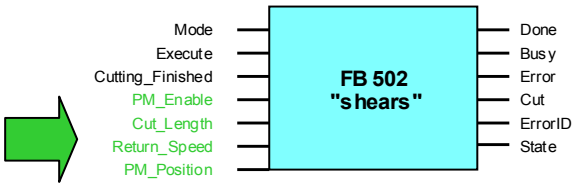
Print-mark detection

When using the print-mark detection, the following connections have to be supplied:

- PM_Enable
- PM_Position

PM_Enable can switch between length selection and print-mark.
The **PM_Position** input is ignored if **PM_Enable**=0 (selection of the cutting length).

Figure 6-4 Inputs for operating data

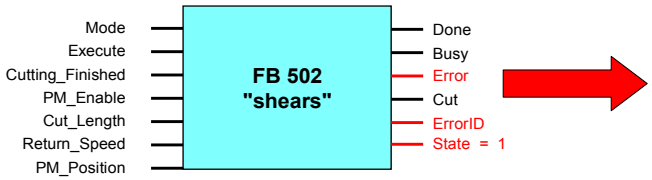


6.7 Warning and Error Messages

Error Messages

If errors occur during the operation of FB 502 “Shears” in the block or at the technology objects and technology functions involved, these errors are reported via the block outputs **Error** and **ErrorID** and FB 502 “Shears” goes to mode **1:Error**.

Figure 6-5 Block outputs for error messages



The **Error** bit signals a present error while an error code is displayed at the **ErrorID** output via which the cause of the error can be analyzed.

As soon as an error is present, the outputs **Busy**, **Done** and **Cut** are reset.

The error has to be acknowledged by selecting the **Disable** mode. Only after this selection, FB 502 “Shears“ is ready for use again.

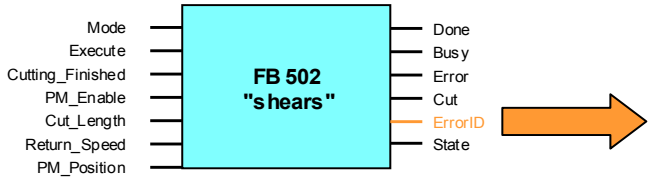
Notes

- If the shears are moved into to/via a limit switch, they have to be moved to the permissible travel range in mode **3:Manual** before the modes **4:StartPosition** and **5:Automatic** can again be used.
- To prevent that material passes the blade uncut in case of an error, the material line should be stopped at FB 502 “Shears” if an error occurs.
  If necessary, this is to be realized in the user program.

Warnings

In case of warnings, the warning code is displayed at the **ErrorID** output. The **Error** output bit is not set.
An acknowledgement of the warnings is not required and also not possible.
If the reason for the warning does no longer exist, the **ErrorID** output is automatically reset to “0000”.

Figure 6-6 Block outputs for warnings



7 Description of important Program Elements

7.1 Program structure

Comments

Several comments exist in the code. They are already prepared expansions or improve the readability of the code or optimize the runtime.

For instance, if a value is already loaded in the accumulator, reloading to the accumulator is included in the code, but commented. This enables to easily recognize what is being compared, e.g. in network 1.

Or in network 18, at the end of step 1, the jump to the block end is commented. The end of the step is recognizable, also if it is to be directly continued with the next step.

Network structure of FB 502 “Shears”

The structure of FB 502 “Shears” is divided into two parts. In the networks 1 to 13, basically the mode management is performed. The technological functions are realized in the networks 15 to 19.

Table 7-1 Network structure of FB 502 “Shears”

Net-work	Name	Comment
1.	Restart	Checking the restart bit and, if required, check of the parameterization.
2.	Error check	Checking whether an error has occurred
3.	General mode switching	Checking and starting the mode changes.
4.	Mode switching 1->2	Execution of the mode change
5.	Mode switching 3->2	
6.	Mode switching 4->2	
7.	Mode switching 2->3	
8.	Mode switching 4->3	
9.	Mode switching 2->4	
10.	Mode switching 3->4	
11.	Mode switching 5->4	
12.	Mode switching 4->5	
13.	Jump distributor mode	Jump distributor to jump to active mode
14.	-	Visual separation
15.	Error (1)	**Error** mode
16.	disable (2)	**Disable** mode
17.	manual (3)	**Manual** mode
18.	start position (4)	**Start Position** mode
19.	automatic (5)	**Automatic** mode
20.	MC_Power	Release block of the shears

7.2 Explanation of the program of the block modes

Below you find a brief description of what happens in the individual modes.

0: Initialisation

Mode **0:Initialisation** is realized in network 1 and it is only executed if the restart bit is set.

If a parameterization error is detected, it is displayed and the block is terminated with the BEC instruction (conditional block end) so that no further processing takes place.

If the parameterization is correct, a jump to mode **2:Disable** occurs and the restart bit is reset.

1: Error

If mode **1:Error** is processed for the first time (internal variable: mode_changed= true), the **ErrorID** is saved in a buffer and the axis is disabled.

If the **Execute** bit is cleared, **ErrorID** is also cleared. The template remains in mode **1:Error** until mode **2:Disable** is selected.

2: Disable

If mode **2:Disable** is executed for the first time (mode_changed= true), the shears axis is disabled and the step counter for this mode is initialized.

Subsequently, the 5 steps listed below are executed.

1. Preparing MC_Reset (Execute=0)
2. Acknowledging possible first error with MC_Reset (Execute=1)
3. Again preparing MC_Reset (Execute=0)
4. Acknowledging possible second error with MC_Reset (Execute=1)
5. Clearing **Busy** output signal and setting **Done**.

Since two errors are generated e.g. when exceeding the limit switches, double acknowledgement is necessary to make the shears ready for operation again.

The template remains in mode **2:Disable** until a new mode is selected.

3: Manual

If mode **3:Manual** is executed for the first time (mode_changed= true), the shears axis is enabled and can be moved by external PLCopen blocks.

The template remains in mode **3:Manual** until a new mode is selected.

4: Start Position

If mode **4: Start Position** is executed for the first time (mode_changed= true), it is checked whether the axis is homed. The step counter for this mode is initialized.

Subsequently, the following steps are executed.

1. Preparing MC_WriteParameter (Execute=0) and checking the value at the **Return_Speed** input whether it is >0.0mm/s
2. Writing the synchronization length with MC_WriteParameter
3. Writing the synchronization position with MC_WriteParameter
4. Setting the synchronization mode with MC_WriteParameter
5. Setting the synchronization type with MC_WriteParameter
6. Writing the position of the negative software limit switch with MC_WriteParameter
7. Writing the position of the positive software limit switch with MC_WriteParameter
8. Activating the software limit switches with MC_WriteParameter
9. Preparing enable of the shears and MC_MoveAbsolute (Execute=0)
10. Positioning the shears to **Start_Position** with MC_MoveAbsolute
11. Clearing **Busy** output signal and setting **Done**.

The template remains in mode **4:StartPosition** in step 11 until a new mode is selected.

5: Automatic

In this mode, the value at Cut_Length is first cyclically checked (provided that cut to length is activated).

If mode **5: Automatic** is executed for the first time (mode_changed= true), the step counter for this mode is initialized.

Subsequently, the following steps are executed.

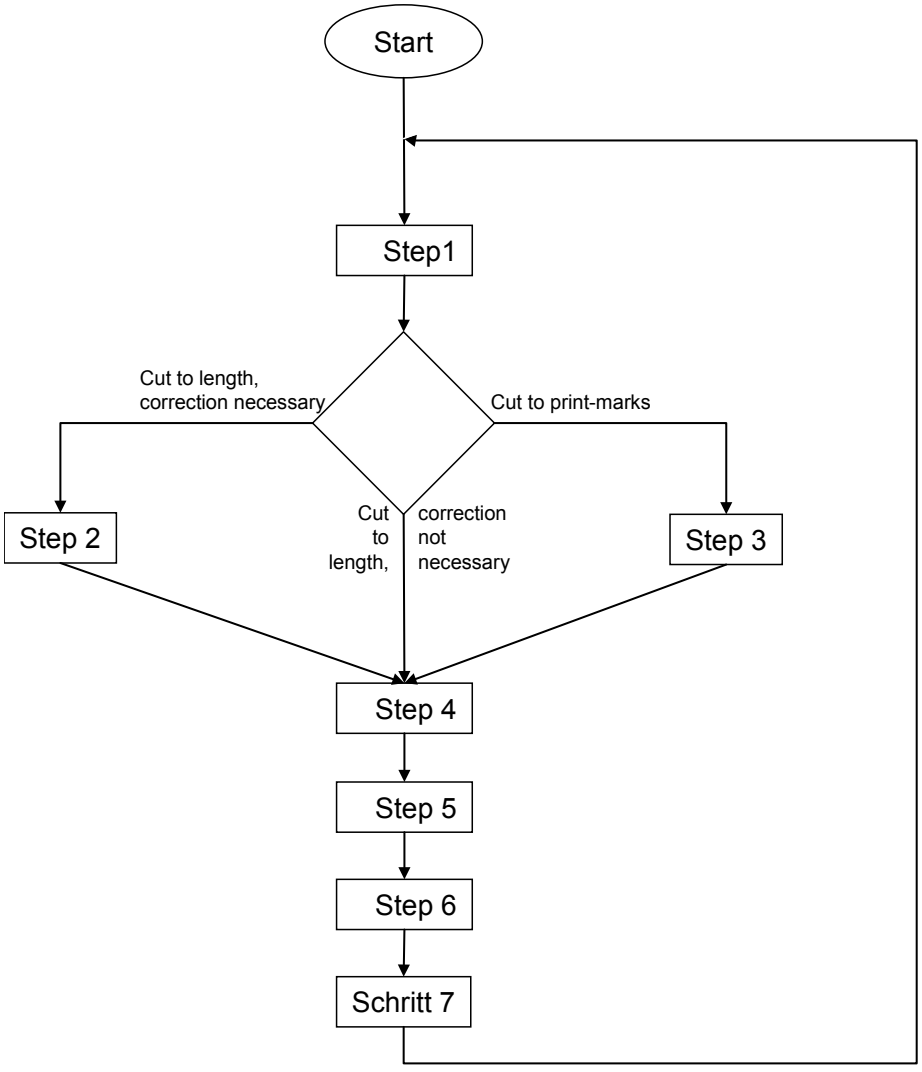
1. Checking the type of the cut:
   - If cut to print-mark is performed, immediate continuation with step 3.
   - If cut to length is performed, the position of the material line is checked and calculation of a offset value if required, see Chapter **7.3**
     If the position is in the permissible range, immediate continuation with step 4, otherwise step 2
     If the position is not in the permissible range and if the cut is not the 1st cut (variable first_run = true), the “Cut missed” error message is output and a jump to the error status occurs.
2. Correction of the position of the material line by the value determined in step 1. Continue with step 4
3. Checking the **PM_Position** value, enable of the print-mark detection and waiting for detection of a print-mark.
4. Activating the synchronism with MC_InGear. Consequently the shears start synchronisation as soon as the material line has reached the synchronization position[4] .
5. Synchronization block (MC_InGear) reports “Synchronization has been performed”, i.e. the shears are now synchronous to the material line and the **Cut** signal is output, the cut can begin.

[4] This position is calculated from synchronization point, synchronization length and synchronization type, e.g.–500.0mm if the synchronization length is 700.0mm and if the synchronization point is at 200.0 mm and if synchronization before synchronization point.

6. The **Cutting_Finished** signal was (e.g. by the test program) transmitted to FB502 “Shears”. The cut is now completed and the shears replaces the synchronism with the positioning to the starting position. MC_MoveAbsolute is used for this process.
7. The used technology FBs are prepared for the next use (Execute=0). Continue with step 1

The template remains in mode **5: Automatic** until an error occurs or until mode **4:StartPosition** is selected.

Figure 7-1 Structure of the step sequence in mode **5:Automatic**



7.3 Calculation of an offset value for the first cut

Background

The shears are only synchronized when the material line is located in the defined synchronisation area[5] or enters the synchronisation area.

When starting mode **5:Automatic**, it consequently has to be ensured that the material line is located before the synchronization range to provide that the shears can synchronize safely. This ensures that the shears can cut also if the position of the material line was changed while the shears were not in mode **5:Automatic**.

7.3.1 Cut to print-marks

When cutting to print-marks, the position is assigned to the material line as soon as the print-mark is detected. The assigned position is determined via the PM_Position connection. By setting the position in print-mark detection it is not required to calculate an offset value.

7.3.2 Cut to length

When cutting to length, a multiple of the cutting length is subtracted from the position of the material line if required. This ensures that the cuts remain “in the grid”.

First, it is checked whether the material line is on the left of the point at which the synchronization is to start. If this is the case, the correction is skipped and (in the next cycle) the process is continued with the call of MC_GearIn (in step 4).

If the material line is on the right of the start of the synchronization range, an correction is required. A multiple of the cutting length is calculated, subtracted from the current position of the material line in step 2 and subsequently MC_GearIn is called (in step 4).

During the first cut (after changing to mode **5:Automatic**), there is no check whether the material line is located more than one cutting length before the synchronization range. In this case no correction occurs. The shears cut only after the material line has reached the shears.

After the first cut, it is checked whether more than one cutting length had to be subtracted from the position of the material line. If this was the case, an abort takes place with the “Cut missed” error.

[5] defined by type, point and length of synchronization

7.4 Diagnostics aids

Diagnostics aids

The error messages of FB 502 “Shears” are basically sufficient for diagnostics. However, two additional variables exist which facilitate error finding.

The information below is also displayed on the HMI.

Number of the last called T-FB

During each active (Execute=1) call of a PLCopen or technology FB within FB 502 “Shears”, a serial number is written into the variable **MC_FB_No** so that it can be determined at any time which technology FB was last used.
This is particularly helpful if this technology FB outputs an error which is copied on the **ErrorID** output of FB 502 “Shears”. That way, it can easily be determined which technology DB output the error.

Number of the last jump to fault mode

All jumps to fault mode are numbered. Prior to a jump to fault mode, this number is entered in the **Er_Jp_No** variable. This ensures that it can be determined at any time which error detection caused the error in the program.

Actual state/step

The current step of the step sequences is always indicated in the **sequencer** variable since it is used for the jumps. Together with the **state** variable, the currently processed part of the program can be identified.

8 Information on the Adaptation of the “Flying Shears” Template

8.1 Notes and warnings

Before you implement changes

Before you change the components included in the technology template, you should have become familiar with the principle of operation of the components using the STEP 7 documentation.

Uncontrolled changes of the technology template can cause danger to life and limb!

Support restrictions when changing the components of the technology template

Support services in the scope of the Customer Support can only be provided for the unaltered technology template.

If the code is changed it is no longer possible to provide support for the technology template.

The same applies to the suggested changes and adaptations described in this chapter.

8.2 Possible adaptations

8.2.1 Already prepared adaptations

Disabling the mode switching (by the user) during the cut

A standard delay of a mode change initiated by the user until the end of the positioning is only performed in mode **4:StartPosition**. This ensures that the shears are in starting position when changing to automatic mode.

If this is also to be performed during a cut in mode **5:Automatic**, the line commented in network 3 (O #cut) is to be activated.

Reduction of the processing time in mode 4:StartPosition

When changing from mode **5:Automatic** to mode **4:StartPosition**, it is not required to write parameter values into the technology as in a change from the other modes to mode **4:StartPosition**. Writing into the technology can thus be skipped:

In network 18, 5 lines are commented which, when changing from mode **5:Automatic** to mode **4:StartPosition**, skip steps 1-7 (writing the technology settings). If these lines are activated, the technology parameters are only set when changing from the modes **2:Disable** or **3:Manual** to mode **4: StartPosition**.

8.2.2 Not prepared expansions

Using a virtual master

If a virtual axis (an axis without drive hardware) is used as Axis_Material, this axis has to be synchronized to the actual material line in gear synchronism.

The virtual axis is the leading or master axis for the shears. This is referred to as virtual master.

This synchronism is to be realized and activated in the user program (we recommend a time-controlled synchronization since this also “couples” the axes at standstill).

The use of the virtual axis as master axis for the shears desynchronizes the material line from the shears, which provides the following advantages:

- The position of the material line is no longer influenced by the template but by the virtual axis. This enables the use of the position of the material line e.g. for error tracking.

However, there are also disadvantages which are listed below:

- Cut to print-mark is less precise without a TM17.
  A TM17 allows the flying homing of a virtual master. If it’s not used the virtual master cannot be homed by print-mark and the precision with which cutting to print-mark can be performed decreases. This is due to the fact that the position of the virtual master has to be corrected in the STEP 7 program (reading measuring sensor and subsequently setting the new position of the axis) so that an inaccuracy develops because of the runtime of the changes between technology and control section and because of the cycle time of the user program.
  In contrast to this, an real axis (or a virtual with TM17) is homed in the integrated technology, in which homing can be performed without runtime influences.

Using an absolute value encoder for the material line

If an absolute value encoder is used for the detection of the material line, a print-mark detection can only be performed externally using a measuring sensor. The determined value is used for the calculation of the required cutting length which is entered under **Cut_length**. When reaching the rest position, the position of the material line is corrected by this value.
Consequently, two different cases exist, which are to be considered during the positioning of the print-mark sensor:

- The print-mark is detected before the shears have reached the rest position. In this case, the value is used for the next cut.
- The print-mark is detected after the shears have reached the rest position. In this case, the value is used for the cut after the next cut since the synchronization has already been activated with the previous value.

Deactivating the software limit switches

The software limit switches are activated in mode **4:StartPosition**. If they are to be deactivated in mode **3:Manual**, mode **3:Manual** is to be expanded in such a way that it once sets the technology parameter 4 to the value 0.

9 Error Messages and Warnings

9.1 Signaling of error events at FB 502 “Shears”

Error

If an error occurs in FB 502 “Shears” of the “Flying Shears” technology template, it is displayed via an error code at the **ErrorID** output of the FB and the **Error** output bit is set. These error messages are listed in the following chapter.

If an error is caused by a PLCopen block (FB4xx MC_xxx) called by the technology template, its **ErrorID** is displayed at the **ErrorID** output of FB 502 “Shears”.

The meaning of the errors is described in the documentation of the technology CPU.

In case of an error, the outputs **Busy**, **Done** and **Cut** are reset.

Warnings

If warnings occur, only the number of the warning is displayed at the **ErrorID** output. The outputs **Busy**, **Done** and **Error** are not influenced.

9.2 Error messages of FB 502 “Shears”

Error Codes

Table 9-1 Error codes of the Flying Shears template

ErrorID error code	Meaning	Explanation
9020	Shears axis is not homed	Call MC_Home
9021[6]	Unpermissible call of a PLCopen FB outside FB “Shears”	Use mode **3:Manual** to use external PLCopen FBs
9022	**axis_shears** parameter is incorrect	Check parameterization in the instance DB
9023	**axis_material** parameter is incorrect	
9024	Positive limit switch is not larger than negative limit switch	
9025	Cutting length <= synchronization length specified	A cutting length shorter than the synchronization length was specified, the shears can no longer synchronize
9026	Synchronization length <=0 mm	Check parameterization in the instance DB
9027	Starting position is below the negative limit switch	
9028	Starting position is above the positive limit switch	
9029	**Return_Speed** parameter <= 1µm/s	Check **Return_Speed** value
902A	Cut missed, material line moved more than the cutting length until the shears were back in starting position	• Extend cutting length • Increase return speed • Reduce material velocity
902B	Print-mark position is larger than (synchronization point – synchronization length), no synchronization and thus no cut possible	• Check **PM_Position** value • Change position of the print-mark • Reduce synchronization length • Increase synchronization point
902C	Error during correcting the position of the material line, job was replaced	• The execution of the shears was disturbed by a job to the material line axis initiated by the user.
902D	Axis error	• The axis is in error stop

[6] External calls of PLCopen FBs are only detected if they abort a job of the template, so that external calls of PLCopen FBs do not always cause error 9021.

Notes

If an axis error (902D) occurs, possibly first error 9021 (unpermissible call of a PLCopen FB) is displayed until the technology DB of the shears axis is updated and FB “Shears” is called. Then the **ErrorID** output jumps to 902D.

To prevent this jump, FB 502 "Shears" has to be called in OB65 (update of the technology DBs completed, technology synchronous alarm) to ensure that an axis error is detected immediately.

If error 804D (axis type inadmissible) occurs, you should check the correct settings of the parameters in the instance DB (see **Chap. 4.2.3**)

Notes

- If the shears are moved into to/via a limit switch, they have to be moved to the permissible travel range in mode **3:Manual** before the modes **4:StartPosition** and **5:Automatic** can again be used.
- To prevent that material passes the blade uncut in case of an error, the material line should be stopped at FB 502 “Shears” if an error occurs.
  If necessary, this is to be realized in the user program.

9.3 Warnings of FB 502 “Shears”

Warning codes

Table 9-2 Warning codes of the Flying Shears template

ErrorID warning code	Explanation
B0	Undefined or unpermissible mode selected
B1	Change in **2:Disable** not permitted from the current mode
B2	Change in **3:Manual** not permitted from the current mode
B3	Change in **4:StartPosition** not permitted from the current mode
B4	Change in **5:Automatic** not permitted from the current mode
B5	Mode is only changed after reaching the starting position
B6	Cutting length <= synchronization length specified (shears will stop during the next cut with error **9025**)

Note

If warnings occur, only the number of the warning is displayed at the **ErrorID** output.

The outputs **Busy**, **Done**, **Error** and **State** are not influenced and continue to display the status of the block or the active mode.

10 Test Program for the “Flying Shears” Template

10.1 Functions of the test program

Task of the test program

For the first tests prior to the integration of the “Flying Shears” technology template into a user program, a test program is available which offers the option to supply the interfaces of the block with values and consequently to extensively test the reactions and options of the template via an operator-friendly HMI.
No real machine axes are required for the test program. The test only requires a technology CPU. The machine axes are then simulated on the CPU as virtual axes.

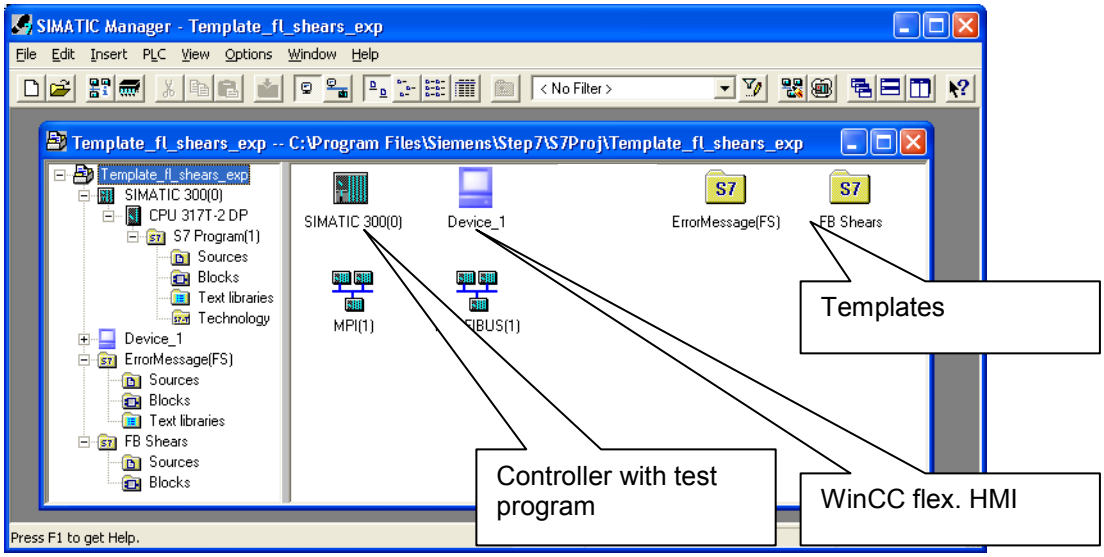
Attention

The test program is used to familiarize with the principle of operation and the reactions of the template.

This program is not intended for use in real machines and consequently not released.

The test program is available as independent STEP 7 archive with all required technology objects and STEP 7 blocks. A WinCC flexible HMI is included.

Figure 10-1 Test program in STEP 7



Apart from the test program the project also contains two other S7 program folders:

- ErrorMessage(FS)
  This is where the blocks and text libraries of the “Error display" template (V3.0) stored. The library of error messages was expanded by the error messages of the “Shears” FB.

- FB Shears
  This is where the blocks of the "Flying Shears" template are stored again.

These program folders can be used as copy source for own projects.

10.2 Requirements for running the test program

Requirements

To start up the test program, the following requirements have to be met:

- The STEP 7 project of the test program was correctly loaded to the technology CPU
- The CPU is in RUN and no error message is present
- CPU and programming device are connected via an MPI connection. (a PROFIBUS line and a transmission rate of 12 Mbaud is recommended)
- WinCC flexible RT 2008 + SP2 + HF2 is installed.

Warning

Before changing the interface speed, check the maximum speed of your used CP or adapter.

If the maximum speed is not 12 Mbit/s and if you load the application to the CPU without prior changes, you can no longer access the CPU!

For this reason, it is required to set the baud rate of all MPI busses in the project to the maximum transmission rate possible before downloading the application.

10.3 HMI of the test program

10.3.1 Overview

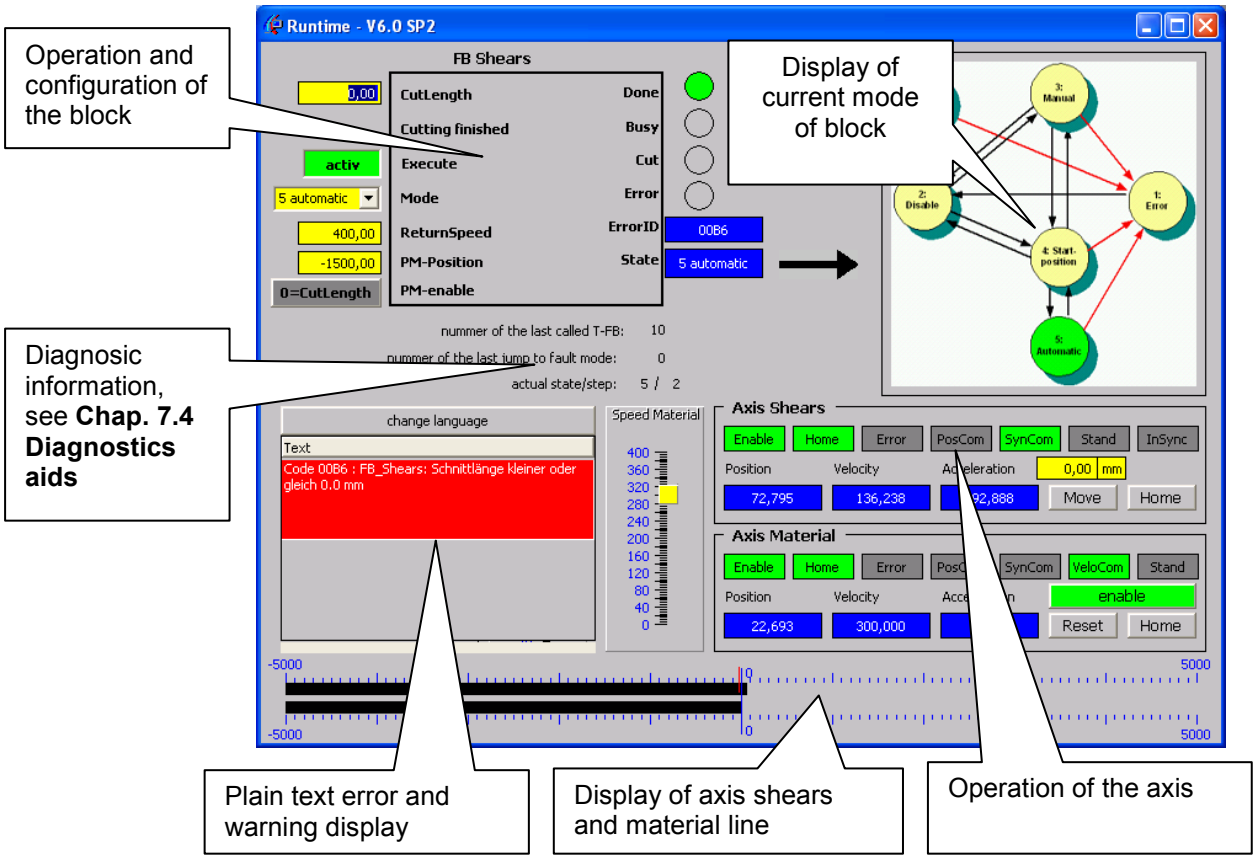
Via the HMI of the “Flying Shears” template, the functions listed below can be executed and tested in a convenient way:

- Presetting the input variables of the template
- Operation of the template via the modes
- Display of the current status and of the output variables
- Switching to print-mark detection
- Operation of the material line axis for simulation of the material line
- Display of the axis status of the shears axis and of the material line axis.

For these functions, different operator displays, in which the respective functions of the template can be activated via input boxes and buttons, are available on the HMI of the test program.

Display elements and output boxes display the current status of the output interface of the block and the mode of the block is additionally visualized via a status display of the block.

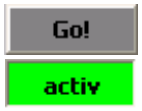
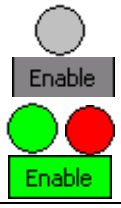
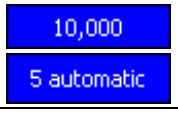
Figure 10-2 Operator displays of the test program for the “Flying Shears” template



10.3.2 General functions of the controls and display elements

The controls and display elements available on the HMI of the test program have the following meaning:

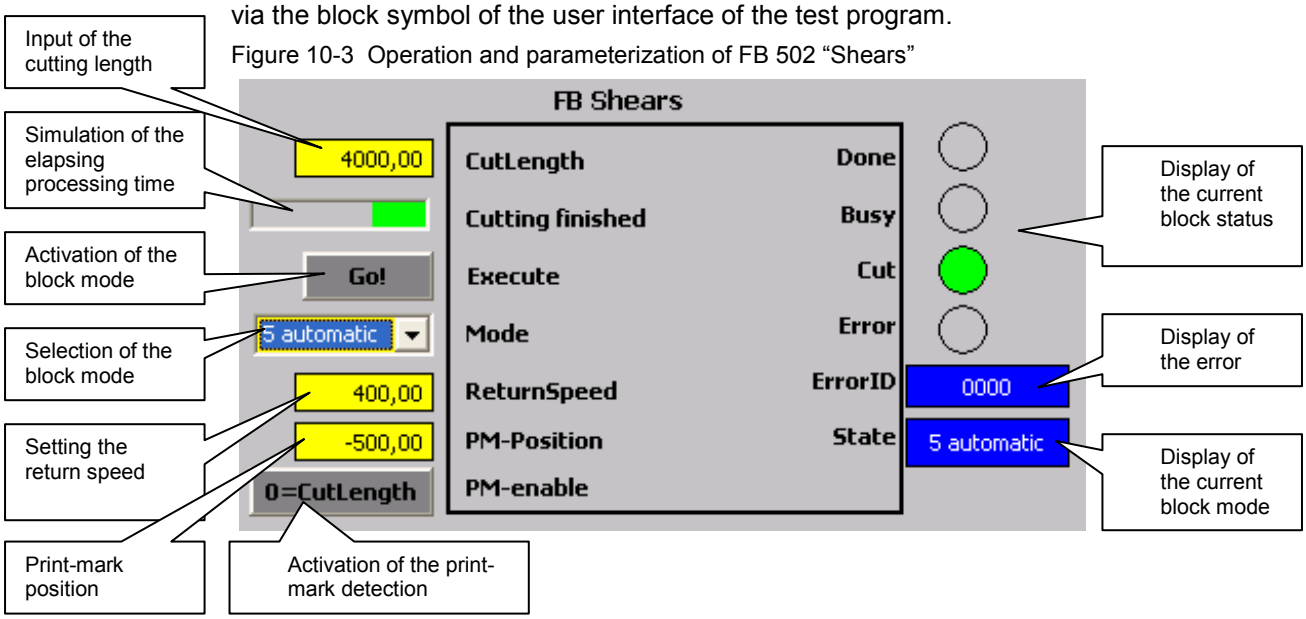
Table 10-1 General function of the controls and display elements

Item	Function	Description
	Setting and resetting boolean inputs.	The status of a boolean input is displayed by the color of the control. If the control is green the input is set. Gray means “not set”
	Status display for boolean outputs.	The status of a boolean output is displayed by the color of the control. Gray signals that the bit is not set. All other colors mean “set”.
	Input boxes	Parameter values can be set in these boxes.
	Output boxes	Output values are displayed in these boxes.

10.3.3 Operation and parameterization of the block

The inputs and outputs of FB 502 “Shears” can be parameterized and monitored via the block symbol of the user interface of the test program.

Figure 10-3 Operation and parameterization of FB 502 “Shears”

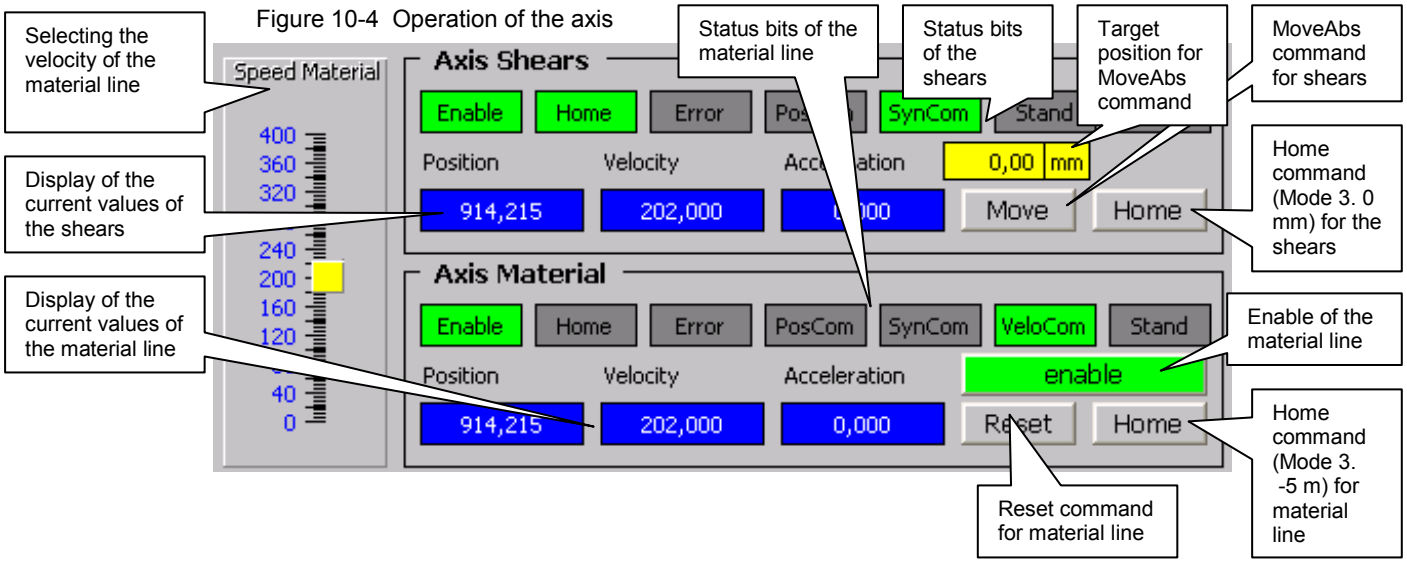


With the **CUT** output signal, a timer is started in the test program which 3 s later activates the **Cutting_finished** signal and thus simulates the processing time of the shears.

10.3.4 Operation of the axes

The axes available in the test program can also be controlled and monitored via individual operator displays of the HMI.

Figure 10-4 Operation of the axis



Shears

The shears axis is enabled and acknowledged in FB 502 “Shears”. The Move command is used for the positioning in mode **3:Manual** or for generating an error by a call of an external technology FB if the template is not in mode **3:Manual**.

Material line

Via a slider, the velocity of the material line can be set. Using the buttons **Enable**, **Reset** and **Home**, the respective functions for the material line can be activated.

10.3.5 Plain text error display

In the error monitoring section, warnings and failures are displayed as plain text. The “Error monitoring” template was used in the test program. In the header, English and German are available as display language (of the error monitoring).

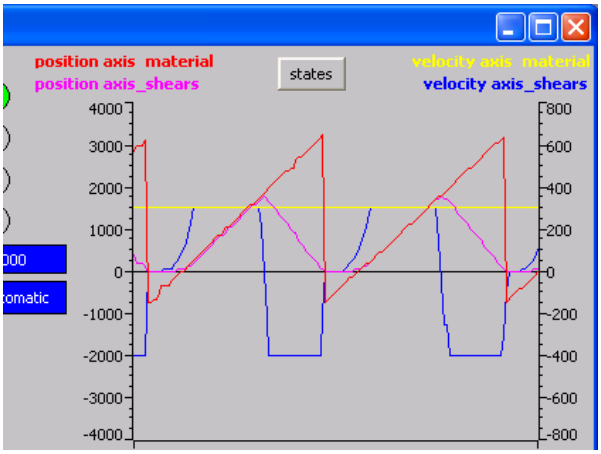
10.3.6 Status display

In the status display section, the status or **State** output of FB 502 “Shears” is displayed graphically. The current mode of FB 502 “Shears” is displayed in this section.

By clicking the state diagram, the graphic can be changed to a recorder display. This display shows the positions and velocities of the two axes.

Clicking the **states** button again displays the status display.

Figure 10-5 Recorder display



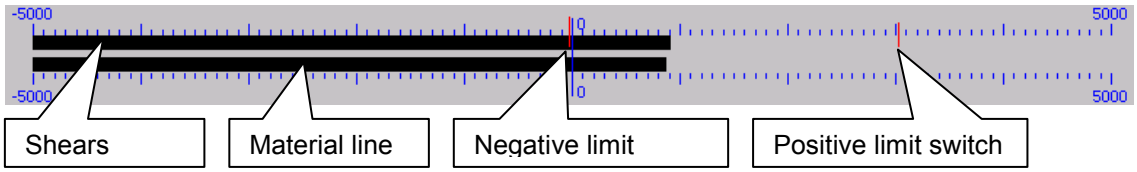
10.3.7 Diagnostics information

The number of the last called PLCopen block and of the current step are displayed on the user interface for diagnostics.See also chapter **7.4 Diagnostics aids**

10.3.8 Display of the axes shears and material line

The position of the two axes is displayed graphically. The upper bar represents the shears, the lower bar represents the material line. For orientation, the display of the shears includes the limit switches.
(The position of the limit switches in the user interface is fixed and it is not automatically adapted when the parameterization in the instance DB is changed)

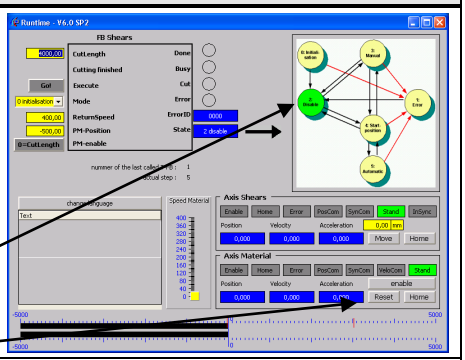
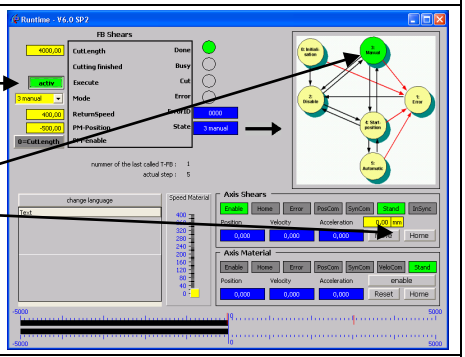
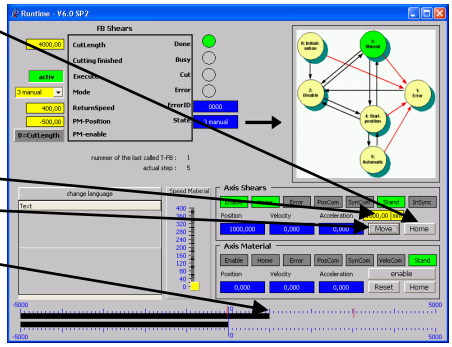
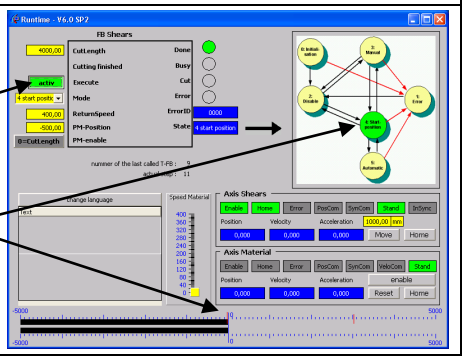
Figure 10-6 Display of the axes shears and material line



10.4 Sequence of the operating steps in the test program

10.4.1 Preparations

Table 10-2 Making “Flying Shears” template ready for operation

No.	Instruction	HMI
1	Load the test program to the controller and set the controller to RUN. Start the HMI configuration FB 502 “Shears” is in mode **2:Disable**	
2	At the **Mode** input, select mode **3:Manual** and activate this mode by clicking **Go!** at the **Execute** input bit. FB 502 “Shears” is in mode **3:Manual** The shears are enabled and can be moved via external blocks.	
3	Click **Home** to home the axis. The corresponding status LED is illuminated. The axis is now to be moved to 1000.0 mm: Enter 1000.0 mm as target position and click **Move**. The shears move to 1000.0 mm	
4	At the **Mode** input, select mode **4:StartPosition** and activate this mode by clearing the signal at the **Execute** input bit and by newly giving it with **Go!**. The shears move to the starting position (0.0 mm) and are in mode **4:StartPosition**.	

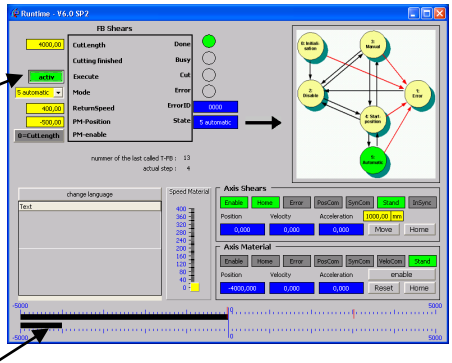
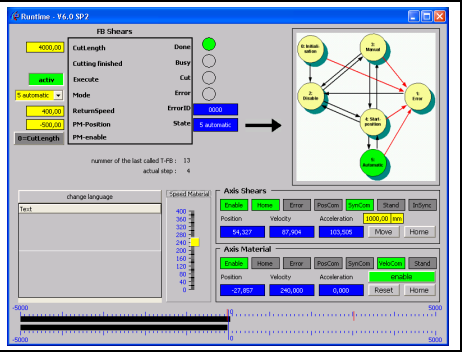
The shears are now ready for operation and start cutting after activating the automatic mode.

10.4.2 Cutting to defined length

Prerequisites

- The shears have to be in mode **4:StartPosition**.
- The **PM_Enable** input must not be activated.
- When cutting to length, the position of the material line is reduced by the cutting length as soon as the shears (again) reach the starting position so that the next cutting point is “marked”. This is clearly displayed by the jump of the lower bar by the cutting length (presetting 4000.0 mm).

Table 10-3 Setting “Flying Shears” template to initial status

No.	Instruction	HMI
1	At the **Mode** input, select mode **5:Automatic** and activate this mode by clearing the signal at the **Execute** input bit and by newly giving it with **Go!**. The shears are now in mode **5:Automatic**, ready for cutting and wait for the material line. The position is set in such a way that cutting has to be performed at its 0.0 mm position. Since the material starts at 0.0 mm, cutting has to be performed at a distance of 4000.0 mm so that the position of the material line is set to –4000.0 mm.	
2	Enable the material line by clicking **Enable**. Use the slider to select a velocity of approximately 240 mm/s. The shears start synchronizing as soon as the material line exceeds the position –500 mm. (Synchronization point at 200.0 mm and synchronization length 700.0 mm)	

Switching between cutting to length and cutting to print-mark is possible at any time. The change is effective from the next cut.

10.4.3 Cutting to print-mark

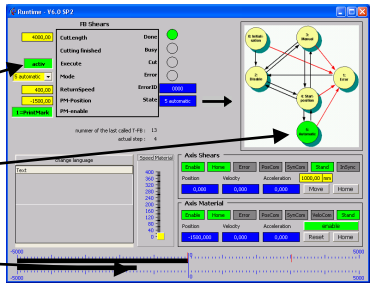
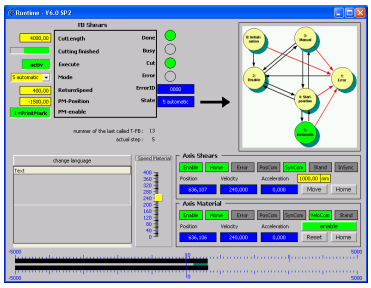
Unfortunately cutting to print-mark cannot be simulated with with virtual axis. An axis error will be displayed: incorrect axis type, when input **PM_Enable** is set, since virtual axis do not support homing on the fly.
To be able to test this function you have to connect a drive and change the project to "real" axis.

Prerequisites

- The shears have to be in mode **4:StartPosition**.
- The **PM_Enable** input must be activated.
- When cutting to print-mark, the print-mark detection (more exactly: The homing on the fly at the **PM_Position** position) is enabled as soon as the shears (again) reach the starting position.

The lower bar jumps to the position specified by the value at the **PM_Position** connection (presetting – 1500.0 mm)

Table 10-4 Setting “Flying Shears” template to initial status

No.	Instruction	HMI
1	At the **Mode** input, select mode **5:Automatic** and activate this mode by clearing the signal at the **Execute** input bit and by newly giving it with **Go!**. The shears are now in mode **5:Automatic**, ready for cutting and wait for the material line. If a print-mark is detected, the position of the material line is set to the **PM_Enable** value.	
2	Enable the material line by clicking **Enable**. Use the slider to select a velocity of approximately 240mm/ min. The shears start synchronizing as soon as the material line exceeds the position –500 mm. (Synchronization point at 200.0 mm and synchronization length 700.0 mm)	

Switching between cutting to length and cutting to print-mark is possible at any time. The change is effective from the next cut.

10.4.4 Warning and error generation

Warnings

The easiest way to generate warnings is to call

- a non existing mode (e.g. **6:undefined**[7]),
- a generally unpermissible mode (e.g. **1:Error**),
- a currently unpermissible mode (e.g. **3: Manual**, if **5: Automatic** active) or
- mode **5:Automatic** already in mode **4:StartPosition** during the positioning of the shears to the starting position.

Error

The following errors can easily be provoked:

- Locating the PM_Position value behind the start of the synchronization (Sync.position – Sync.length).
  Thus using a value larger than –500.0 in the test program.
- Moving the material line with maximum velocity when cutting to length or decelerating the return speed so that the material line move mores than the cutting length while the shears cut and return to starting position.
- Start of a positioning process (**Move** button) of the shears in automatic mode

Normally, the material line is to be stopped in case of an error since the material passes the blade uncut. In the test program this was not donw and this is why the material line has to be stopped manually.

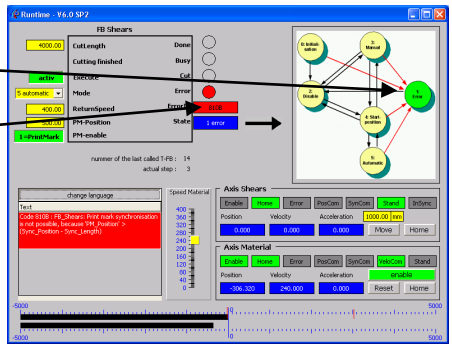
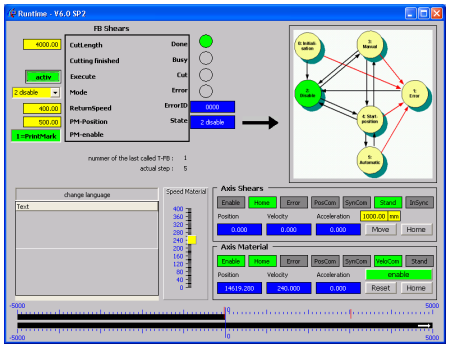
Note If the shears are moved into to/via a limit switch, they have to be moved to the permissible travel range in mode **3:Manual**. In the test program, a position within the limit switches is to be approached using **Move**.

[7] Mode 6 can be selected in the HMI, although the template does not recognize this mode

10.4.5 Error acknowledgement

If there is an error, FB 502 “Shears” is in mode **1:Error**.
To acknowledge the error, you have to activate mode **2:Disable**.
Subsequently, you can select another desired mode.

Table 10-5 Setting “Flying Shears” template to initial status

No.	Instruction	HMI
1	If there is an error, FB 502 “Shears” jumps to mode **1:Error**. The **Error** bit is set. The cause of the error (more exactly the last error) is displayed at **ErrorID**. The error is displayed as long as the **Execute** bit is set.	
2	To acknowledge the error, mode **2:Disable** has to be activated. At the **Mode** input, select mode **2:Disable** and activate this mode by clearing the signal at the **Execute** input bit and by newly giving it with **Go!**. The shears are back in their initial status and can be moved via the other modes.	

11 Bibliography

11.1 Bibliography

This list is not complete and only represents a selection of relevant literature.

Table 11-1

	Topic	Title
/1/	STEP7	Automating with STEP7 in STL and SCL Hans Berger Publicis MCD Verlag - 2004 ISBN-10 3895783412 ISBN-13 9783895783418
/2/	Technology CPU	SIMATIC – S7-300: CPU 31xT Siemens manual Issued 03/2008 Document identification number: A5E01672598-01 http://support.automation.siemens.com/WW/view/en/21362915
/3/	Technology CPU	SIMATIC Engineering Tools S7-Technology Siemens manual Issued 03/2008 Document identification number: A5E00251797-06 http://support.automation.siemens.com/WW/view/en/22640076

11.2 Internet Links

This list is not complete and only represents a selection of relevant literature.

Table 11-2

	Topic	Title
\1\	Reference to the entry	http://support.automation.siemens.com/WW/view/en/21062270
\2\	Siemens Industry Online Support	http://support.automation.siemens.com
\3\	Siemens Industry Online Support **Application & Tools**	http://support.automation.siemens.com/WW/view/en/20208582
\4\	CPU manual 31xT-2 DP	http://support.automation.siemens.com/WW/view/en/21362915
\5\	Manual S7 Technology	http://support.automation.siemens.com/WW/view/en/30119663

	Topic	Title
\6\	FAQ Technology CPU version overview	Which versions of the S7 Technology option package are available and which SINAMICS S120 drive firmware can you use with which of these versions? http://support.automation.siemens.com/WW/view/en/23411204
\7\	WinCC flexible manual:	WinCC flexible manual: http://support.automation.siemens.com/WW/view/en/18796010
\8\	WinCC flexible Getting Started	For beginners: http://support.automation.siemens.com/WW/view/en/18660846 For advanced learners: http://support.automation.siemens.com/WW/view/en/18656980
\9\	Technology Templates for Technology CPU (a selection)	Simple 3D interpolation using cam disks: http://support.automation.siemens.com/WW/view/en/21364022 Measuring a Hydraulics Characteristic: http://support.automation.siemens.com/WW/view/en/27731588 MoveCircle 2D http://support.automation.siemens.com/WW/view/en/26659810 Cross Cutter http://support.automation.siemens.com/WW/view/en/31073433

12 History

Table 12-3 History

Version	Date	Modifications
V1.0	31.05.2005	First version
V3.0	11.09.2007	Adaption to "S7 Technology" Version 3.0 : • External encoder now also enables cutting to length. • Updating of documentation.
V4.1	29.03.2010	Adaption to "S7 Technology" Version 4.1 : • Removal of TO/UDT check to make the template independent of the S7 Technology version used. • Description of new “axis_material_is_ext_enc" parameter (Chap. 6.4) • Updating of documentation.
V4.1a	02/2013	Corrected in documentation: P.25: **3**:Manual P.44: FB5**0**2 P.57: error **8**04D