Functional description | EN

TF5200 | TwinCAT 3 CNC

Software limit switch
Notes on the documentation

This description is only intended for the use of trained specialists in control and automation engineering who are familiar with the applicable national standards. It is essential that the documentation and the following notes and explanations are followed when installing and commissioning the components. It is the duty of the technical personnel to use the documentation published at the respective time of each installation and commissioning.

The responsible staff must ensure that the application or use of the products described satisfy all the requirements for safety, including all the relevant laws, regulations, guidelines and standards.

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General and safety instructions

Icons used and their meanings
This documentation uses the following icons next to the safety instruction and the associated text. Please read the (safety) instructions carefully and comply with them at all times.

Icons in explanatory text
1. Indicates an action.
   ⇨ Indicates an action statement.

<table>
<thead>
<tr>
<th>DANGER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute danger to life!</td>
</tr>
<tr>
<td>If you fail to comply with the safety instruction next to this icon, there is immediate danger to human life and health.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CAUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal injury and damage to machines!</td>
</tr>
<tr>
<td>If you fail to comply with the safety instruction next to this icon, it may result in personal injury or damage to machines.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NOTE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Restriction or error</td>
</tr>
<tr>
<td>This icon describes restrictions or warns of errors.</td>
</tr>
</tbody>
</table>

• Tips and other notes
  This icon indicates information to assist in general understanding or to provide additional information.

General example
Example that clarifies the text.

NC programming example
Programming example (complete NC program or program sequence) of the described function or NC command.

• Specific version information
  Optional or restricted function. The availability of this function depends on the configuration and the scope of the version.
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1 Overview

Task
Software limit switches (SLS) limit the maximum travel distance of an axis.

Characteristics
The positions of the SLS can be configured for the following axis types:
• Linear axes
• Rotary axes that are not operated as modulo axes
SLS monitoring is only active if the axis
• is referenced or
• used with an absolute position measuring system (P-AXIS-00014).

Parametrisation
The positions of the SLS must be configured for each axis with P-AXIS-00177 and P-AXIS-00178.

Programming
In the NC program, the positions of the SLS can be further limited by NC commands G98 and/or G99. These changes are active up to program end (M30).

Links to other documents
For the sake of clarity, links to other documents and parameters are abbreviated, e.g. [PROG] for the Programming Manual or P-AXIS-00001 for an axis parameter.

For technical reasons, these links only function in the Online Help (HTML5, CHM) but not in pdf files since pdfs do not support cross-linking.

Also see about this
[Overview] 8
2 Description

Task
Software limit switch monitoring (SLS monitoring) is used to monitor the command and actual positions of an axis. A positive SLS (P-AXIS-00178) and a negative SLS (P-AXIS-00177) can be configured for each axis. The positions of the SLS are always referred to the axis coordinate system.

Condition
The monitored axis must be referenced (G74) or P-AXIS-00014 must be configured.

Effectiveness
This is why a distinction is made between SLS monitoring based on the command value or actual value.

- Command positions are checked for exact compliance with the SLS.
- A tolerance of the actual position is configured for monitoring overshoots of SLS using P-AXIS-00179. This prevents the output of an error message in the event of negligible overshoots.

Command position related software limit switch monitoring is executed during path preparation.

In certain applications, the command position of axes is influenced by circumstances (e.g. gear coupling) that are unknown when planning contours. In these cases, the parameters P-AXIS-00520 and P-AXIS-00521 can be used in the position controller to activate the monitoring of command position values.

The actual positions are always monitored in the position controller.

Figure 1: Position and effectiveness of the software limit switch

Activation
SLS monitoring of the command and actual positions of an axis is activated in all the operating modes available as soon as the axis is referenced.

As of Build V3.1.3037.11 the parameter P-AXIS-00705 can be used to switch on/off the SLS monitoring feature irrespective of axis type or axis mode.
SLS monitoring of the command and actual positions is not active for rotary axes that were configured as modulo axes.

**CAUTION**

Incorrectly configured SLS positions may cause personal injury and machine damage

**DANGER**

If axes are operated without software limit switches, the risk of personal injury and machine damage increases to a considerable extent.

### Warnings, errors and reactions

#### Automatic mode and manual block, axis referenced

- Error message P-ERR-120002 or P-ERR-120003: A command position that overshoots an SLS is calculated by an NC block.
  1. Interpolation is stopped.
  2. The NC program is aborted at this NC block and the axes participating in the motion are stopped.
  3. The NC block is not executed; the nominal contour is not violated.
     - Reset the controller.
- Error message P-ERR-70021 or P-ERR-70022: The actual value of the axis position overshoots an SLS.
  1. Interpolation is stopped.
  2. The affected axis is decelerated by a linear velocity profile. The nominal contour may be violated if several axes were involved in the motion.
     - Reset the controller.

#### Manual mode (HB) with referenced axis (G200/G201)

- Warning P-ERR-50720: A software limit switch is reached in continuous jog mode. The warning is output only if P-MANU-00014 is configured accordingly.
  1. The motion is stopped.
     - Move back within the valid range.
- Warning P-ERR-150008: In incremental jog mode, the step is no longer executed if it causes an overshoot of an SLS.
  1. The motion is stopped.
     - Move back within the valid range.

The possible motion range in manual mode can be limited by P-AXIS-00137 and P-AXIS-00138.

#### Manual mode (HB) with referenced axis (G200/G201)

Instead of the SLS, the HB offset limits (P-AXIS-00137 and P-AXIS-00138) are used.

- Warning P-ERR-50720: A HB offset limit is reached in continuous jog mode. The warning is output only if P-MANU-00014 is configured accordingly.
  1. The motion is stopped.
     - Move back within the valid range.
- Warning P-ERR-150008: In incremental jog mode, the step is no longer executed if it causes an overshoot of an HB offset limit.
  1. The motion is stopped.
     - Move back within the valid range.
<table>
<thead>
<tr>
<th>CAUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>If offset limit monitoring is inactive, no range monitoring takes place. This may cause machine damage.</td>
</tr>
</tbody>
</table>
3 CNC programming

3.1 Programming a negative software limit switch

Negative software limit switch

The G98 command sets negative SLS in the programmed axes.

- If G90 is active, the negative SLS is set absolute to the programmed value.
- If G91 is active, the programmed value is added relative to P-AXIS-00177.

G98 is active blockwise; the SLS programmed in this way are then active across blocks.

The positions for negative SLS programmed via G98 are stored in the axis-specific variables V.A.-SWE.X, V.A.-SWE.Y, V.A.-SWE.Z, etc. [PROG].

When there is a reset, mode change or axis change, the variables are pre-assigned the value of P-AXIS-00177 of each axis.

Negative software limit switch

(Example 1 – absolute)

```plaintext
%swe_abs.nc
N110  G00  X0  Y0  G90
N120  G00  X20 Y30
```

(Sets neg. SLS in X to -100 and Y to -200)

```plaintext
N130  G98  X-100 Y-200
```

( .... )

(Example 2 – relative)

```plaintext
%swe_rel.nc
N110  G00  X0  Y0  G90
N120  G00  X20 Y30
```

(Offsets neg. SLS in X by 10 and Y by 20)

```plaintext
N130  G98  G91  X10 Y20
```

( .... )
Warnings, errors and reactions

• Warning P-ERR-21648: The controller uses G98 to calculate a position for the negative SLS that is smaller than the position defined by P-AXIS-00177.
  1. The new position is not taken over.
  2. P-AXIS-00177 continues to define the negative SLS.
     • Error message P-ERR-21649: The controller uses G98 to calculate a position for the negative SLS that is equal to or greater than the position defined by P-AXIS-00178.
  3. The new position is not taken over.
     ⇣ Reset the controller.
     • Error message P-ERR-70022: The current actual position of the axis with G98 is smaller than the new negative SLS.
       1. Interpolation is stopped.
       2. The new position of the SLS is taken over.
          ⇣ Reset the controller.
          ⇣ Move within the valid range.
3.2 Position of the positive software limit switch

Positive software limit switch

The command **G99** sets the positive SLS in the programmed axes.

- If G90 is active, the positive SLS is set absolute to the programmed value.
- If G91 is active, the programmed value is added relative to P-AXIS-00178.

**G99** is active blockwise; the programmed SLS programmed in this way are then active across blocks.

> The positions programmed with G99 for the positive SLS are stored in the axis-specific variables V.A.+SWE.X, V.A.+SWE.Y, V.A.+SWE.Z, etc. [PROG].
> When there is a reset, mode change or axis change, the variables are pre-assigned the value of P-AXIS-00178 of each axis.

Positive software limit switch

(Example 1 – absolute)

```
%swe_abs.nc
N110  G00  X0  Y0  G90
N120  G00  X20 Y30

(Sets pos. SLS in X to 100 and Y to 200)

N130  G99  X100 Y200
```

( .... )

(Example 2 – relative)

```
%swe_rel.nc
N110  G00  X0  Y0  G90
N120  G00  X20 Y30

(Offsets pos. SLS in X by -10 and Y by -20)

N130  G99  G91 X-10 Y-20
```

( .... )

Warnings, errors and reactions

- Warning P-ERR-21650: The controller uses G99 to calculate a position for the positive SLS that is greater than the position defined by P-AXIS-00178.
  1. The new position is not taken over.
  2. P-AXIS-00178 continues to define the positive SLS.
- Error message P-ERR-21878: The controller uses G99 to calculate a position for the positive SLS that is equal to or smaller than the position defined by P-AXIS-00177.
  3. The new position is not taken over.
- Error message P-ERR-70021: The current actual position of the axis with G99 is greater than the new positive SLS.
  4. Interpolation is stopped.
  5. The new position of the SLS is taken over.
  ⇒ Reset the controller.
  ⇒ Move within the valid range.
4 Parameter

4.1 Overview of parameters

<table>
<thead>
<tr>
<th>ID</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>P-AXIS-00014</td>
<td>Identifier for absolute measuring system.</td>
</tr>
<tr>
<td>P-AXIS-00137</td>
<td>Relative negative offset limit in manual mode.</td>
</tr>
<tr>
<td>P-AXIS-00138</td>
<td>Relative positive offset limit in manual operation mode.</td>
</tr>
<tr>
<td>P-AXIS-00177</td>
<td>Position of the negative software limit switch</td>
</tr>
<tr>
<td>P-AXIS-00178</td>
<td>Position of the positive software limit switch</td>
</tr>
<tr>
<td>P-AXIS-00179</td>
<td>Tolerance range of the software limit switch position for actual positions</td>
</tr>
<tr>
<td>P-AXIS-00520</td>
<td>Activation of limit switch monitoring of the positive limit switch</td>
</tr>
<tr>
<td>P-AXIS-00521</td>
<td>Activation of limit switch monitoring of the negative limit switch</td>
</tr>
<tr>
<td>P-AXIS-00554</td>
<td>Behaviour of software limit switches</td>
</tr>
<tr>
<td>P-AXIS-00705</td>
<td>Switching software limit monitoring off / on</td>
</tr>
<tr>
<td>P-MANU-00014</td>
<td>Output a message at offset limit</td>
</tr>
</tbody>
</table>

4.2 Axis parameters

P-AXIS-00014 Identification code for absolute path measurement system
Description: If an absolute path measurement system is used, then the parameter must be set to 1. So no homing is necessary.
Parameter: kenngr_abs_pos_gueltig
Data type: BOOLEAN
Data range: 0/1
Axis types: T, R, S
Dimension: T: ----
R,S: ----
Default value: 0
Drive types: Simulation, SERCOS,
Remarks:

P-AXIS-00137 Relative negative offset limit in manual mode
Description: The parameter defines the relative negative offset limit.
Parameter: handbetrieb_offsetgrenze_neg
Data type: SGN32
Data range: MIN(SGN32) ≤ offsetgrenze_neg ≤ 0
Axis types: T, R
Dimension: T: 0.1µm
R: 0.0001°
Default value: -1000000
Drive types: ----
Remarks: If both parameters offsetgrenze_neg and offsetgrenze_pos are set to 0 the offset monitoring is inactive!

P-AXIS-00138 Relative positive offset limit in manual mode
Description: The parameter defines the relative positive offset limit.
Parameter: handbetrieb_offsetgrenze_pos
Data type: SGN32
Data range: 0 ≤ offsetgrenze_pos ≤ MAX(SGN32)
Axis types: T, R
### Parameter

<table>
<thead>
<tr>
<th>Dimension</th>
<th>T: 0.1µm</th>
<th>R: 0.0001°</th>
</tr>
</thead>
<tbody>
<tr>
<td>Default value</td>
<td>1000000</td>
<td></td>
</tr>
<tr>
<td>Drive types</td>
<td>----</td>
<td></td>
</tr>
<tr>
<td>Remarks</td>
<td>If both parameters offsetgrenze_neg and offsetgrenze_pos are set to 0 the offset monitoring is inactive!</td>
<td></td>
</tr>
</tbody>
</table>

### P-AXIS-00177 Negative software limit switch

**Description**
This parameter defines the possible traverse range in the negative direction (negative software limit switch position). The programmed command positions are always checked on 'kenngr.swe_neg', the actual positions on 'kenngr.swe_neg - kenngr.swe_toleranz'.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>kenngr.swe_neg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data type</td>
<td>SGN32</td>
</tr>
<tr>
<td>Data range</td>
<td>MIN(SGN32) &lt; swe_neg &lt; P-AXIS-00178</td>
</tr>
<tr>
<td>Axis types</td>
<td>T, R</td>
</tr>
<tr>
<td>Dimension</td>
<td>T: 0.1µm</td>
</tr>
<tr>
<td>Default value</td>
<td>-100000000</td>
</tr>
<tr>
<td>Drive types</td>
<td>----</td>
</tr>
<tr>
<td>Remarks</td>
<td>The value of the parameter is adopted on reset, mode change and axis replacement from the axis record.</td>
</tr>
</tbody>
</table>

### P-AXIS-00178 Positive software limit switch

**Description**
This parameter defines the possible traverse range in the positive direction (positive software limit switch position). The programmed command positions are always checked on 'kenngr.swe_pos', the actual positions on 'kenngr.swe_pos + kenngr.swe_toleranz'.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>kenngr.swe_pos</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data type</td>
<td>SGN32</td>
</tr>
<tr>
<td>Data range</td>
<td>P-AXIS-00177 &lt; swe_pos &lt; MAX(SGN32)</td>
</tr>
<tr>
<td>Axis types</td>
<td>T, R</td>
</tr>
<tr>
<td>Dimension</td>
<td>T: 0.1µm</td>
</tr>
<tr>
<td>Default value</td>
<td>100000000</td>
</tr>
<tr>
<td>Drive types</td>
<td>----</td>
</tr>
<tr>
<td>Remarks</td>
<td>The value of the parameter is adopted on reset, mode change and axis replacement from the axis record.</td>
</tr>
</tbody>
</table>

### P-AXIS-00179 Tolerance range for software limit switch

**Description**
In order to prevent the actual value software limit switch monitoring in the position controller from responding when there is a slight oscillation of an axis (e.g. programmed command position = position of positive software limit switch, actual position > position of positive software limit switch), the software limit switch range in the positive and the negative directions is extended respectively by the parameter. The actual positions must lie within this extended range.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>kenngr.swe_toleranz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data type</td>
<td>UNS32</td>
</tr>
<tr>
<td>Data range</td>
<td>0 ≤ swe_toleranz ≤ MAX(UNS32)</td>
</tr>
<tr>
<td>Axis types</td>
<td>T, R</td>
</tr>
<tr>
<td>Dimension</td>
<td>T: 0.1µm</td>
</tr>
<tr>
<td>Default value</td>
<td>1000</td>
</tr>
<tr>
<td>Drive types</td>
<td>Simulation, Conventional, Terminal, Lightbus, Profidrive</td>
</tr>
<tr>
<td>Remarks</td>
<td></td>
</tr>
</tbody>
</table>

### P-AXIS-00520 Activation of limit switch monitoring of the positive limit switch.
Parameter | TF5200 | TwinCAT 3 CNC
---|---|---
**Description** | Command position related software limit switch monitoring is executed during path preparation. This ensures that a programmed movement that crosses a software limit switch is not executed. In certain situations the command position is influenced by circumstances that are not known in the path preparation process and can thus not be detected in the software limit switch operation of the path planning process. Examples for this are the use of the external command position interface of axis coupling via the HLI (see [HLI] or @@[FCT-A9]). With both these parameters, a command side software limit switch monitoring can be activated. When monitoring is active it is checked in every interpolation cycle that the axis can stop from their current velocity before the software limit switch when it is decelerated with P-AXIS-00003. The software limits used are the actual values of the software limit switches without considering the software limit switch tolerance (P-AXIS-00179). If the software limit switch is crossed, error message P-ERR-70195 is output and the axis is stopped.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>lr_param.check_pos_command_limit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Data type</strong></td>
<td>BOOLEAN</td>
</tr>
<tr>
<td><strong>Data range</strong></td>
<td>0/1</td>
</tr>
<tr>
<td><strong>Axis types</strong></td>
<td>T</td>
</tr>
<tr>
<td><strong>Dimension</strong></td>
<td>T: ----</td>
</tr>
<tr>
<td><strong>Default value</strong></td>
<td>0</td>
</tr>
<tr>
<td><strong>Drive types</strong></td>
<td>----</td>
</tr>
<tr>
<td><strong>Remarks</strong></td>
<td></td>
</tr>
</tbody>
</table>

**P-AXIS-00521** Activation of limit switch monitoring of the negative limit switch.

**Description** Command position related software limit switch monitoring is executed during path preparation. This ensures that a programmed movement that crosses a software limit switch is not executed. In certain situations the command position is influenced by circumstances that are not known in the path preparation process and can thus not be detected in the software limit switch operation of the path planning process. Examples for this are the use of the external command position interface of axis coupling via the HLI (see [HLI] or @@[FCT-A9]). With both these parameters, a command side software limit switch monitoring can be activated. When monitoring is active it is checked in every interpolation cycle that the axis can stop from their current velocity before the software limit switch when it is decelerated with P-AXIS-00003. The software limits used are the actual values of the software limit switches without considering the software limit switch tolerance (P-AXIS-00179). If the software limit switch is crossed, error message P-ERR-70195 is output and the axis is stopped.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>lr_param.check_neg_command_limit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Data type</strong></td>
<td>BOOLEAN</td>
</tr>
<tr>
<td><strong>Data range</strong></td>
<td>0/1</td>
</tr>
<tr>
<td><strong>Axis types</strong></td>
<td>T</td>
</tr>
<tr>
<td><strong>Dimension</strong></td>
<td>T: ----</td>
</tr>
<tr>
<td><strong>Default value</strong></td>
<td>0</td>
</tr>
<tr>
<td><strong>Drive types</strong></td>
<td>----</td>
</tr>
<tr>
<td><strong>Remarks</strong></td>
<td></td>
</tr>
</tbody>
</table>

**P-AXIS-00554** Behaviour of software limit switches
### Description

The axis parameter P-AXIS-00554 can influence the error response of the NC kernel if software limit switches are crossed. The software limit switch monitor can output only warnings instead of errors.

### Parameters

- **kenngr.swe_behaviour**
  - **Data type**: STRING
  - **Data range**: ERROR
    - Crossing software limit switches results in an error already in path preparation.
    - ERROR_LR
      - Crossing software limit switches results in a warning during path preparation. An error is output in the position controller when software limit switches are crossed and this triggers the associated error response.
    - WARNING
      - When software limit switches are crossed, only warnings are output in path preparation and in the position controller.

- **kenngr.swe_check**
  - **Data type**: SGN08
  - **Data range**: -1: The effectiveness of the software limit switch monitor is dependent on the axis type and axis mode (default) 0 : Switch off software limit monitoring 1 : Switch on software limit monitoring

- **Move_limit_warning**
  - **Data type**: BOOLEAN
  - **Data range**: 0/1
  - **Default value**: 0
  - **Remarks**: This parameter is available as of CNC Build 2.11.2804.12.

### 4.3 Manual mode parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Output a message at offset limit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description</strong></td>
<td>If this parameter is set to TRUE, the CNC generates a warning if a manual movement stops at a relative offset limit (P-AXIS-00137, P-AXIS-00138) or at an absolute offset limit (P-AXIS-00492, P-AXIS-00493).</td>
</tr>
<tr>
<td><strong>Parameter</strong></td>
<td>move_limit_warning</td>
</tr>
<tr>
<td><strong>Data type</strong></td>
<td>BOOLEAN</td>
</tr>
<tr>
<td><strong>Data range</strong></td>
<td>0/1</td>
</tr>
<tr>
<td><strong>Dimension</strong></td>
<td>----</td>
</tr>
<tr>
<td><strong>Default value</strong></td>
<td>0</td>
</tr>
<tr>
<td><strong>Remarks</strong></td>
<td>This parameter is available as of CNC Build 2.11.2804.12.</td>
</tr>
</tbody>
</table>
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Beckhoff Headquarters

Beckhoff Automation GmbH & Co. KG
Huelshorstweg 20
33415 Verl
Germany

Phone: +49 5246 963 0
Fax: +49 5246 963 198
e-mail: info@beckhoff.com
web: https://www.beckhoff.com
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