Functional description | EN

TF5200 | TwinCAT 3 CNC

Single step mode
Notes on the documentation

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It is essential that the documentation and the following notes and explanations are followed when installing and commissioning the components.

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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.

### DANGER

**Acute danger to life!**
If you fail to comply with the safety instruction next to this icon, there is immediate danger to human life and health.

### CAUTION

**Personal injury and damage to machines!**
If you fail to comply with the safety instruction next to this icon, it may result in personal injury or damage to machines.

### NOTE

**Restriction or error**
This icon describes restrictions or warns of errors.

- **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.
List of figures

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1 Overview

Task
When single step mode is active, the machine operator has the option to execute an NC program step by step. The operator enables every NC line one by one. Comment lines or comment blocks and skipped blocks are skipped.

Characteristics
The NC program sequence is interrupted at block boundaries in the interpolator. The sequence during decoding or in look-ahead mode is not affected. As a result, path-correcting functions such as spline or tool radius compensation can also be active in single step mode.

However, path-changing functions can also shift block boundaries. For single step mode, the shifted block boundaries are active, if applicable, but not the programmed block boundaries.

Parameterisation
Single step mode is activated by the channel parameter @@P-CHAN-00015. When single step mode is activated, a stop is executed at the end of NC blocks depending on this parameter \[ \text{\texttt{15}} \] and depending on a number of criteria.

Programming
The NC command \#SINGLE STEP [DISABLE | ENABLE] \[ \text{\texttt{10}} \] can block whole program areas to single step mode. This program area is then skipped in a complete single step.

The NC command \#SINGLE STEP [RESOLUTION.] \[ \text{\texttt{12}} \] defines a block number related resolution for a single step.

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.
2 Description of the various operation modes

Select

Single step and its operation modes can be set at any time by operator action or the PLC.
The following operation modes are available:

0 : Step into

The "Step into" single step mode is active by default. This means that program execution is again interrupted when subroutines are invoked at the first block in the subroutine.

Single step acts on every programmed NC line which is processed during the program sequence.

1 : Step over

The "Step over" mode can be set if the NC lines contained in a subroutine are not to be executed in single steps. This means that any subroutine invocation which may exist in the next step does not result in a stop.

Program execution is continued without stopping until the subroutine is terminated.

This characteristic also applies to nested subroutines.

2 : Return from function

All subsequent instructions do not result in a stop. Only a return from the current program level again results in a stop of the NC program.

If the current interrupt point is already at the topmost level, i.e. the main program, this mode acts in the same way as "Step into".
3 Disable program areas for single step

Selection

Individual program areas can be disabled in single step mode by the command #SINGLE STEP [ DISABLE / ENABLE ]. This continues the complete area using single step. No stop is executed within the grey area.

#SINGLE STEP [ DISABLE | ENABLE ] (modal)

The program area N40–N100 written in *italics* and the subroutine invocation are not executed in single step mode.

<table>
<thead>
<tr>
<th>N10</th>
<th>X0 Y0 Z0</th>
</tr>
</thead>
<tbody>
<tr>
<td>N20</td>
<td>X10</td>
</tr>
<tr>
<td>N30</td>
<td>Y10</td>
</tr>
<tr>
<td><strong>N40 #SINGLE STEP [DISABLE]</strong></td>
<td></td>
</tr>
<tr>
<td>N50</td>
<td>X20</td>
</tr>
<tr>
<td>N60</td>
<td>Y20</td>
</tr>
<tr>
<td>N65</td>
<td>L GSP.nc</td>
</tr>
<tr>
<td>N70</td>
<td>Z20</td>
</tr>
<tr>
<td>N80</td>
<td>X30</td>
</tr>
<tr>
<td>N90</td>
<td>Z30</td>
</tr>
<tr>
<td><strong>N100 #SINGLE STEP [ENABLE]</strong></td>
<td></td>
</tr>
<tr>
<td>N110</td>
<td>Y30</td>
</tr>
<tr>
<td>N120</td>
<td>X40</td>
</tr>
<tr>
<td>N130</td>
<td>Z40</td>
</tr>
<tr>
<td>N999</td>
<td>M30</td>
</tr>
</tbody>
</table>

Nested disable/enable

When disable/enable commands are nested, the single step disable includes the area beginning from the first disable to the first enable (see example below)
In the following nested areas, single step mode in the area displayed in *italics* is disabled between N40-N75.

```plaintext
%SINGLE_STEP
N10 X0 Y0 Z0
N20 X10
N30 Y10
N40 %SINGLE_STEP [DISABLE]
   N50 X20
N55 %SINGLE_STEP [DISABLE]
   N60 Y20
   N65 L GSP.nc
   N70 Z20
N75 %SINGLE_STEP [ENABLE]
   N80 X30
   N90 Z30
N100 %SINGLE_STEP [ENABLE]
   N110 Y30
   N120 X40
   N130 Z40
N999 M30
```
4 Single step mode on block numbers

Block number

When single step mode is enabled, the CNC stops **before** each new motion block (see P-CHAN-00015 [15]) and waits for an acknowledgement from the PLC.

If the NC program was automatically generated by a post-processor based on CAD/CAM data, the original geometry information may result in several NC motion blocks. In this case a single step should correlate with the original granularity of CAD/CAM data and only stop at the original geometric resolution.

Another possible application case may be to explicitly disable single step mode for individual blocks.

| SINGLE STEP [ RESOLUTION<value> ] | (modal) |

Figure 1: A single item of geometric information may result in multiple NC motion blocks.
Block number related single step resolution

As an additional option the user can define block number related single step resolution.

0: Off, no single step related to block numbers,
   Stop before each NC line
1: Single step stops before each new programmed NC block number
> 1: A stop is executed before each block which can be divided into an integer
   with no remainder.
   \[
   \text{Integer result} = \frac{\text{Block number}}{\text{Resolution}}
   \]
< 0: Impermissible value for single step resolution, an error message
   is output.

The single step resolution to block numbers was set to 10.

In this case a stop is executed before each block can be divided by 10 into an integer with no remainder.

No stop is executed in the area displayed in italics in single step mode. The black lines show the single-step stop.

```
%single_step

N000 #SINGLE STEP [RESOLUTION = 10]
N000 X0
N010 X1
N011 X1.1
N012 X1.2
N020 X2
N030 X3
... 
N090 X9
N091 Y0
N092 Y1
N093 Y2
N094 Y3
N095 Y4
N100 Y5
N101 Y6
N102 Y7
N110 Y8
... 
```

To ensure effective diagnosis, all NC lines should always be provided with a unique block number.

Block numbering with user resolution (steps of ten) and internal numbering (single step width).

```
%single_step

N010 #SINGLE STEP [RESOLUTION = 10]
N090 Y0
N091 Y1
```
Single step mode on block numbers

N092 Y2
N093 Y3
N094 Y4

N100 Y5
N101 Y6
N102 Y7

N110 Y8
...

Version: 1.01
TF5200 | TwinCAT 3 CNC
Single step mode
# Parameter

## 5.1 Overview

<table>
<thead>
<tr>
<th>ID</th>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>P-CHAN-00015</td>
<td>einzelschrittmodus</td>
<td>Operation mode of single step mode</td>
</tr>
</tbody>
</table>

## 5.2 Description

<table>
<thead>
<tr>
<th>Description</th>
<th>Define single-step operating mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>If the parameter is set to -1 and single-step mode is activated, it is only possible to stop by operator action at the end of NC blocks with axis movements. If the parameter is set to 0 and single-step mode is activated, it is only possible to stop by operator action at the end of NC blocks with axis movements and other NC blocks with relevant control information. If the parameter is set to 1 and single-step mode is activated, it is only possible to stop by operation action at the end of every NC block. Only comment lines are skipped. If motion blocks are inserted by specific NC functionality (TRC, SPLINE, polynomial smoothing over, etc.) and block boundaries are altered, these new block boundaries also determine stopping in the single step mode.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameter</th>
<th>einzelschrittmodus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data type</td>
<td>SGN16</td>
</tr>
<tr>
<td>Data range</td>
<td>-1: Single-step mode only for NC motion blocks 0: Single-step mode for NC motion blocks and relevant control blocks (default) 1: Single-step mode for all NC blocks</td>
</tr>
<tr>
<td>Dimension</td>
<td>----</td>
</tr>
<tr>
<td>Default value</td>
<td>0</td>
</tr>
</tbody>
</table>

Remarks
6 Interfacing

6.1 Selection via HMI interface

The single step operation mode is set by the PLC writing the modifier before the next step.

The operation mode is modal.

<table>
<thead>
<tr>
<th>Single step operation mode</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description</strong></td>
</tr>
<tr>
<td><strong>Type</strong></td>
</tr>
</tbody>
</table>
| **Value range**             | 0: Step into  
                                  1: Step over  
                                  2: Return from function |
| **HMI elements**            | Can currently be used as CNC object only. |
| **Access**                  | Read, write |
| **Address**                 | GEO task  
                                  IndexOffset = 0x1A  
                                  IndexGroup = 0x02130ii<ii> where <ii> = Channel |
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<table>
<thead>
<tr>
<th>P-CHAN-00015</th>
<th>15</th>
</tr>
</thead>
</table>
More information:
www.beckhoff.com/TF5200