TF5200 | TwinCAT 3 CNC

Syntax check
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.

Δ 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.
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1 Overview

Task
With very large, complex or manually created NC programs in particular, it is advisable to check the correctness of the syntax in advance. This is carried out by using the special “Syntax check mode”.

The syntax check can be executed
- either offline on a separate test system
- or directly on the machine controller.

Characteristics
Syntax errors detected in the NC program are displayed or optionally logged to a file so that the operator can then access them at a later date to correct the program.

NC program decoding is not aborted in the event of a syntax error. Instead, the check algorithm attempts to continue working on the next NC line.

To permit rapid processing of the NC program under test,
- the axes/drives are not moved during the syntax check.
- Technology functions (M, H and T functions) are not executed.

Since the entire NC channel (except for the position controller) participates in the syntax check, incorrect programming items are displayed, i.e. axis positions containing violations of software limit switches etc.. In these cases the syntax check is aborted and issues an error message.

Parametrisation
The syntax check can be run in 2 modes:
- Single step mode
- Automatic mode

The associated configuration is carried out in the channel parameter list.

After a syntax error message, a defined restart can be executed and largely avoids any follow-up errors.

The technology commands used in the NC program (M, H and T functions) must be specified for decoding by setting them in the channel parameter list accordingly.

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

Operation

The syntax check is run via the operating mode interface according to real program execution. The following can be evaluated:

- START, STOP, CONTINUE and RESET commands
- ERROR and HOLD display states

Display

In real program execution, the file position (filename and file offset, mc_active_file_offset_r and mc_active_file_name_r) is displayed synchronously with the real axis motion. It no longer has any timing reference to program decoding.

When the syntax check is active, the file position is automatically displayed synchronously to decoding.

Therefore, the operator need not consider any distinction to display the file.

The table below shows the various error scenarios and the possible error responses in syntax check mode:

<table>
<thead>
<tr>
<th>Error type</th>
<th>Error category</th>
<th>Error response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Response to resource errors</td>
<td>e.g. stack overflow</td>
<td>The NC line is discarded</td>
</tr>
<tr>
<td>Response to syntax error</td>
<td>Errors in $ and # commands</td>
<td>The NC line is discarded</td>
</tr>
<tr>
<td></td>
<td>Unexpected character/term after $ and # commands</td>
<td>Use of information pertaining to the current NC line</td>
</tr>
<tr>
<td></td>
<td>Unexpected/invalid characters/terms</td>
<td>Use of information pertaining to the current NC line</td>
</tr>
<tr>
<td>Response to semantic errors</td>
<td>Left-handed error in Allocation</td>
<td>repositioning after allocation</td>
</tr>
<tr>
<td></td>
<td>Selection of NC commands not permitted simultaneously</td>
<td>Continued decoding <strong>without</strong> repositioning</td>
</tr>
<tr>
<td></td>
<td>Overshooting/undershooting a limit</td>
<td>Continued decoding <strong>without</strong> repositioning</td>
</tr>
<tr>
<td></td>
<td>Programmed value impractical</td>
<td>Continued decoding <strong>without</strong> repositioning</td>
</tr>
<tr>
<td></td>
<td>Incomplete information</td>
<td>Continued decoding <strong>without</strong> repositioning</td>
</tr>
</tbody>
</table>
NC program with syntax errors
The example below contains various syntax errors which can be used for continued decoding. The program can be processed in the syntax check and individual errors are signalled.

```plaintext
;Test syntax check of decoder
%check_syntax

;→ overflow error
N40 G01 X10 F1111111111111111

;→ syntax error
N50 #COMMAND UNKNOWN [...]  

;→ syntax error
N60 V.E.not_present = 1

;→ syntax error
N70 #CALL AX [X2, 11, 0]

;→ semantic error
N80 G00 G01 X100 F1000

N130 M30
```

Stop single step mode/decoding
- If configured accordingly (P-CHAN-00028) and during the syntax check, single step mode acts at the decoder level.
- The program stops at the end of every NC line and this is indicated by the HOLD mode state.
- Decoding continues by one NC line when the START transition is commanded to the active mode. In this way, individual NC commands (parameter allocations, branches, loops, etc.) can be decoded to ensure that the program sequence can be viewed during decoding.
- The STOP / RESUME command also acts at the decoder level in the same way as the single step mode.
- In other words, decoding is interrupted by commanding the stop transition to the active mode.
- Decoding can be resumed with the RESUME command.

Automatic mode
- If configured accordingly (P-CHAN-00028) acts during the syntax check of the automatic mode.
- The NC program runs without stopping.
- Errors detected are displayed.

Syntax check without drives (MACHINE_LOCK)
- The syntax check must always be selected in combination with MACHINE_LOCK. The following properties apply here:
  - The NC program is decoded as normal.
  - To ensure that the syntax check runs faster, axes and drives are not moved (dry run). Interpolation is limited to the output of the target points of the motion blocks.
  - Technology information, spindle commands or waiting times are not executed.
  - Certain real-time influences such as feedhold, override or axis-specific feed enables are not considered.
  - If MACHINE_LOCK is not set, the message P-ERR-21309 is output. In this case MACHINE_LOCK is set implicitly and syntax check is started.
Figure 1: Syntax check without drives
### 3 Interfacing

#### 3.1 Selection via HMI interface

The operator sets the syntax check as an operating mode before starting the program. This setting is forwarded via a so-called control unit to the PLC which can permit or refuse it.

Similarly, the PLC also has a possibility of selecting the syntax check itself without a previous HMI request.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>mc_command_execution_mode_r, mc_command_execution_mode_w</td>
<td>Selecting syntax check</td>
</tr>
<tr>
<td>mc_active_file_offset_r, mc_active_file_name_r</td>
<td>Displays the current file position during the syntax check at the decoder level.</td>
</tr>
<tr>
<td>mc_command_single_block_w</td>
<td>This parameter selects the decoder single step mode in the syntax check.</td>
</tr>
</tbody>
</table>

**Syntax check via HMI**

<table>
<thead>
<tr>
<th>Description</th>
<th>A user interface can select the syntax check via this interface. At the same time, the dry run mode must always be selected together with the syntax check.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>32-bit</td>
</tr>
<tr>
<td>Value range</td>
<td>0x0000 ISG_STANDARD Normal mode 0x0008 SYNCHK Syntax check simulation 0x0040 MACHINE_LOCK Dry run without axis motion</td>
</tr>
<tr>
<td>HMI elements</td>
<td>mc_command_execution_mode_r, mc_command_execution_mode_w</td>
</tr>
<tr>
<td>Access</td>
<td>Read, write</td>
</tr>
<tr>
<td>IndexOffset</td>
<td>0x40, 0x3f (IndexGroup = 0x000201&lt;ii&gt; where &lt;ii&gt; = channel)</td>
</tr>
</tbody>
</table>
3.2 Commands and display via PLC interface

<table>
<thead>
<tr>
<th>Channel mode</th>
<th>Description</th>
<th>Data type</th>
<th>Special features</th>
<th>Access</th>
<th>ST path</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Selecting a special channel mode such as syntax check or production time calculation</td>
<td>MCControlSGN32Unit, see description of Control Unit</td>
<td>-</td>
<td>PLC reads Request + State and writes Command + Enable</td>
<td>pMC[\textit{channel_idx}]^\textit{.addr}^\textit{.MCControlDecoder_Data.MCControlSGN32Unit_ExecutionMode}</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Commanded, requested and return value</th>
</tr>
</thead>
<tbody>
<tr>
<td>ST element</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

| Data type     | DINT         |
| Value range   | 0x0000 - 0x0100 |
| Description   | Normal mode  |

- 0x0000 ISG\_STANDARD | Normal mode |
- 0x0002 SOLLKON     | Nominal contour visualisation simulation |
- 0x0001 SV          | Block search |
- 0x0004 ON\_LINE    | Online visualisation simulation |
- 0x0008 SYNCHK      | Syntax check simulation |
- 0x0010 PROD\_TIME  | Production time computation simulation |
- 0x0020 ONLINE\_PROD\_TIME | Online production time computation simulation |
- 0x0040 MACHINE\_LOCK | Dry run without axis motion |
- 0x0080 TECHNO\_FILTER | Dry Run TECHNO-Filter |
- 0x0100 KIN\_TRAFO\_OFF | Overwrites automatic enable for kinematic transformations by a characteristic parameter defined in the channel parameters (sda\_mds*.lis). |

Redirection:

| ST element   | .X\_Enable |

Display:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>X_SyntaxCheck</td>
<td>Display: Syntax check active</td>
</tr>
<tr>
<td>X_WaitAfterError</td>
<td>Display: Decoder waits for enable to resume</td>
</tr>
<tr>
<td>X_SyntaxCheckWaitContinueCleared</td>
<td>Display: Decoder waits for cancellation of enable to resume</td>
</tr>
</tbody>
</table>

Syntax check active:

| Description                           | Decoder is currently in the syntax check         |
| Signal flow                           | CNC \rightarrow PLC                             |
| ST path                               | pMC[\textit{channel_idx}]^\textit{.addr}^\textit{.StateDecoder_Data.X\_SyntaxCheck} |
| Data type                             | BOOL                                            |
| Value range                           | [TRUE = decoder operates in the syntax check, FALSE] |
| Access                                | PLC reads                                       |
| Special features                      | -                                               |

Error occurred during syntax check – waiting for external input:

| Description                           | In syntax check mode, the decoder waits after an error for an external input (continue, abort) |
| Signal flow                           | CNC \rightarrow PLC                             |
| ST path                               | pMC[\textit{channel_idx}]^\textit{.addr}^\textit{.StateDecoder_Data.X\_WaitAfterError} |
Interfacing

<table>
<thead>
<tr>
<th>Data type</th>
<th>BOOL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value range</td>
<td>[TRUE = error occurred in the syntax check – decoder waits, FALSE]</td>
</tr>
<tr>
<td>Access</td>
<td>PLC reads</td>
</tr>
<tr>
<td>Special features</td>
<td>-</td>
</tr>
</tbody>
</table>

### Syntax check active

**Description**
Decoder is currently operating in the syntax check and, after an error and enable, waits until enable is cancelled.

**Signal flow**
CNC → PLC

**ST path**
pMC[channel_idx]^.*^.*^.*^.*.StateDecoder_Data.X_SyntaxCheckReleaseNextBlockCleared

<table>
<thead>
<tr>
<th>Data type</th>
<th>BOOL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value range</td>
<td>[TRUE = decoder waits for enable to be cancelled, FALSE]</td>
</tr>
<tr>
<td>Access</td>
<td>PLC reads</td>
</tr>
<tr>
<td>Special features</td>
<td>-</td>
</tr>
</tbody>
</table>

![Diagram showing syntax check active](image)

Figure 2: Implicit handshake during interactive syntax check between decoder and Mcm/PLC

### Decoding interrupted

**Description**
Decoding was interrupted and waits for enable to continue.

**Signal flow**
CNC → PLC

**ST path**
pMC[channel_idx]^.*^.*^.*^.*.StateDecoder_Data.X_WaitContinue

<table>
<thead>
<tr>
<th>Data type</th>
<th>BOOL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value range</td>
<td>[TRUE = decoder interrupted, FALSE]</td>
</tr>
<tr>
<td>Access</td>
<td>PLC reads</td>
</tr>
</tbody>
</table>

![Diagram showing decoding interrupted](image)

Figure 2: Implicit handshake during interactive syntax check between decoder and Mcm/PLC
### Decoding interrupted

<table>
<thead>
<tr>
<th>Description</th>
<th>Decoding was interrupted and the decoder waits until enable is cancelled again resuming.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signal flow</td>
<td>CNC → PLC</td>
</tr>
<tr>
<td>Data type</td>
<td>BOOL</td>
</tr>
<tr>
<td>Value range</td>
<td>[TRUE = decoder waits, FALSE]</td>
</tr>
<tr>
<td>Access</td>
<td>PLC reads</td>
</tr>
<tr>
<td>Special features</td>
<td>-</td>
</tr>
</tbody>
</table>
4 Parameter

Parametrisation

The operator sets the operation mode using P-CHAN-00028:

Single step mode: continues step by step over erroneous commands in the NC program and resumes decoding interactively

Automatic mode: checks the syntax in one run (without further manual intervention)

In addition, abort criteria can be configured for the syntax check using P-CHAN-00019 and P-CHAN-00020 for these two operation modes.

If P-CHAN-00416 is set, all checked NC blocks and reported errors are logged to a file.

The operator can then use the error log to review the NC program and make it executable if required.

The file is created in the controller root directory. The filename consists of the 'dec0' string and the NC channel number in which the syntax check was executed.

The file extension is '.sc'.

Name of log file after a syntax check run in channel 1: dec01.sc

NOTE

The settings for Program processing in the syntax check are selected before program run. Changes to the settings during the syntax check do not take immediate effect. This only occurs after a program restart.
4.1 Overview

<table>
<thead>
<tr>
<th>ID</th>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>P-CHAN-00019</td>
<td>errors_total</td>
<td>Total number of permissible errors</td>
</tr>
<tr>
<td>P-CHAN-00020</td>
<td>errors_per_block</td>
<td>Errors per NC line</td>
</tr>
<tr>
<td>P-CHAN-00028</td>
<td>interactive</td>
<td>Operating mode</td>
</tr>
<tr>
<td>P-CHAN-00416</td>
<td>record_result</td>
<td>Log detected errors to file</td>
</tr>
</tbody>
</table>

4.2 Description of channel parameters

**P-CHAN-00019** Number of errors in an NC program on syntax check

<table>
<thead>
<tr>
<th>Description</th>
<th>Parameter</th>
<th>Data type</th>
<th>Data range</th>
<th>Default value</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>This parameter defines the number of errors after which NC program decoding is aborted.</td>
<td>syn_chk.errors_total</td>
<td>UNS16</td>
<td>0 ... MAX(UNS16)</td>
<td>0</td>
<td>syn_chk.fehler_gesamt (old syntax up to V2.11.2012.07) Parameterisation example: After a maximum of 20 errors in the NC program the syntax check is aborted. syn_chk.errors_total 20</td>
</tr>
</tbody>
</table>

**P-CHAN-00020** Number of errors per row on syntax check

<table>
<thead>
<tr>
<th>Description</th>
<th>Parameter</th>
<th>Data type</th>
<th>Data range</th>
<th>Default value</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>This parameter defines the number of errors after which the program skips to the next program row.</td>
<td>syn_chk.errors_per_block</td>
<td>UNS16</td>
<td>0 ... MAX(UNS16)</td>
<td>0</td>
<td>syn_chk.fehler_pro_zeile (old syntax up to V2.11.2012.07) Parameterisation example: After a maximum of 2 errors the program skips to the next NC row. syn_chk.errors_per_block 2</td>
</tr>
</tbody>
</table>

**P-CHAN-00028** Specify the operation mode on syntax check

<table>
<thead>
<tr>
<th>Description</th>
<th>Parameter</th>
<th>Data type</th>
<th>Data range</th>
<th>Dimension</th>
</tr>
</thead>
<tbody>
<tr>
<td>This parameter defines the operation mode of the syntax check.</td>
<td>syn_chk.interactive</td>
<td>BOOLEAN</td>
<td>0/1</td>
<td>----</td>
</tr>
</tbody>
</table>

Mode 1 - Automatic operation (0):
After an error, decoding continues automatically. The syntax check is only aborted if the limits described in P-CHAN-00019 and P-CHAN-00020 are exceeded.

Mode 2 - Step (interactive) operation (1):
After each error, decoding is stopped. The operator decides whether the syntax check should continue or decoding should be aborted. If the limits described in P-CHAN-00019 and P-CHAN-00020 are reached, decoding is also aborted automatically.
### Parameter

<table>
<thead>
<tr>
<th>Default value</th>
<th>Remarks</th>
</tr>
</thead>
</table>
| 0             | *interactive (old syntax up to V2.11.2012.07)*  
|               | Parameterisation example: The syntax check runs in automatic mode.  
|               | syn_chk.interactive 0 |

<table>
<thead>
<tr>
<th>P-CHAN-00416</th>
<th>Write results of syntax check to file</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>If this parameter is set to 1, all NC blocks and reported errors checked during the syntax check are logged to a file. The file is created in the controller root directory.</td>
</tr>
<tr>
<td>Parameter</td>
<td>syn_chk.record_result</td>
</tr>
<tr>
<td>Data type</td>
<td>BOOLEAN</td>
</tr>
<tr>
<td>Data range</td>
<td>0/1</td>
</tr>
<tr>
<td>Dimension</td>
<td>----</td>
</tr>
<tr>
<td>Default value</td>
<td>0</td>
</tr>
</tbody>
</table>
| Remarks      | The filename consists of the 'dec0' string and the NC channel number in which the syntax check was executed. The file extension is '.sc'.  
|              | Example:  
|              | Name of log file after a syntax check run in channel 1: dec01.sc |
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