Functional description | EN

TF5200 | TwinCAT 3 CNC

Manual mode offset limits
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.

Disclaimer

The documentation has been prepared with care. The products described are, however, constantly under development.
We reserve the right to revise and change the documentation at any time and without prior announcement.
No claims for the modification of products that have already been supplied may be made on the basis of the data, diagrams and descriptions in this documentation.

Trademarks

Beckhoff®, TwinCAT®, EtherCAT®, EtherCAT G®, EtherCAT G10®, EtherCAT P®, Safety over EtherCAT®, TwinSAFE®, XFC®, XTS® and XPlanar® are registered trademarks of and licensed by Beckhoff Automation GmbH.
Other designations used in this publication may be trademarks whose use by third parties for their own purposes could violate the rights of the owners.

Patent Pending

The EtherCAT technology is patent protected, in particular by the following applications and patents: EP1590927, EP1789857, EP1456722, EP2137893, DE102015105702 with corresponding applications or registrations in various other countries.

EtherCAT® is registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany

Copyright

© Beckhoff Automation GmbH & Co. KG, Germany.
The reproduction, distribution and utilisation of this document as well as the communication of its contents to others without express authorisation are prohibited.
Offenders will be held liable for the payment of damages. All rights reserved in the event of the grant of a patent, utility model or design.
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.
Table of contents

Notes on the documentation ................................................................................................. 3
General and safety instructions ............................................................................................. 4
1 Overview ............................................................................................................................. 8
2 Description .......................................................................................................................... 9
   2.1 Relative offset limits ........................................................................................................ 9
   2.2 Absolute offset limits ...................................................................................................... 12
3 Program relative offset limits ........................................................................................... 14
4 Parameter ........................................................................................................................... 16
   4.1 Overview of parameters .................................................................................................. 16
   4.2 Axis parameters .............................................................................................................. 16
   4.3 Channel parameters ........................................................................................................ 17
   4.4 Manual mode parameters ............................................................................................... 17
   4.5 CNC objects .................................................................................................................. 17
   4.6 ISG parameters ............................................................................................................. 20
5 Support and Service .......................................................................................................... 21
Index ..................................................................................................................................... 22
List of figures

Figure 1  Definition ranges of relative offset limits ................................................................. 9
Figure 2  Definition range of absolute offset limits ................................................................. 12
Figure 3  Access to absolute offset limits in the ISG object browser ....................................... 19
1 Overview

- This description of functions is valid as of CNC Build V2.2800.

Task

Manual mode (HB) permits the external control of individual axes with physical manual mode elements (handwheel, inching keys, joy stick). The operator can move axes in manual mode either

- in a user-defined operating mode (i.e. exclusive) or
- during a running NC program

i.e. apply additional command values.

The motion range of axes is limited by ‘Offset limits in manual mode’ (referred to below as: offset limits).

Properties

Offset limits can be monitored in manual modes with parallel interpolation (G201) and without parallel interpolation (G200). This is applicable to all axis types.

Parametrisation

Offset limit values can be configured for each axis.

- relative offset limits (P-AXIS-00137 and P-AXIS-00138)
- absolute offset limits (P-AXIS-00492 and P-AXIS-00493)

Programming

Relative offset limits can also be set by #MANUAL LIMITS[...].

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

Task
Monitor offset limits and limit the possible motion paths for:
- all axis types and
- every axis direction

Command values are added to their motion direction while manual mode G200 or G201 is active and up to the point of deselection as programmed by G202.

Offset limit types
A distinction is made between:
- relative and
- absolute offset limits

They apply to G200 and G201. With G200, relative offset limits only act if P-CHAN-00114 is configured accordingly.

If both relative and absolute offset limits are active, the innermost limits are always active.

2.1 Relative offset limits

Definition
After HB is selected, offset limits act relative to the current axis position (start position) and are defined by:
- P-AXIS-00137 and P-AXIS-00138 or
- #MANUAL LIMITS[

<table>
<thead>
<tr>
<th>Configured relative manual mode limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>#MANUAL LIMITS [...]</td>
</tr>
<tr>
<td>Start position on manual mode selection</td>
</tr>
<tr>
<td>300</td>
</tr>
<tr>
<td>Negative relative limit</td>
</tr>
<tr>
<td>-80</td>
</tr>
<tr>
<td>Positive relative limit</td>
</tr>
<tr>
<td>+50</td>
</tr>
</tbody>
</table>

Figure 1: Definition ranges of relative offset limits

Activate the monitor
To activate the relative offset limit monitor, at least one of the limits P-AXIS-00137 or P-AXIS-00138 must be configured with the value ≠ 0.

1. The monitor is activated.

- If both limits = 0, the monitor is not active.
Warnings, errors and reactions

- Warning P-ERR-50720: When the monitor is active, the relative offset limits are reached. The warning is output only if P-MANU-00014 is configured accordingly.

2. Interpolation is stopped.
   → Move back within the valid range.

- Warning P-ERR-150008: When the monitor is active, the relative offset limits are exceeded in jog mode by additional command values.

1. The additional command values are deleted.
   → Move back within the valid range.

- Error message P-ERR-50041 or P-ERR-50042: With G201, software limits switches are exceeded.

1. Interpolation is stopped.
   → Reset the controller.
   → Move back within the valid range. The valid range is defined by the software limit switches.

Modulo axis

For modulo axes, relative offset limits can include several modulo revolutions. The specified relative offset limits refer to the axis position that was valid when it was activated by G200 or G201.

This reference position can be determined by the CNC object with (index group 0x21301 and index offset 0x2000C) or directly on the HLI.

For example, the second axis in the first channel can be read via the GEO port with index group 0x21301 and offset 0x20007.

Change reference position

If the reference position is changed, a path motion and re-activation of the manual mode axis are required.
Offset limits with modulo axes

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Offset limits lie within one modulo revolution</td>
<td>-60°</td>
<td>120°</td>
<td>-40°</td>
<td>220°</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Offset limits comprise several modulo revolutions</td>
<td>-850°</td>
<td>-670°</td>
<td>380°</td>
<td>560°</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.1 Offset limits lie within another modulo range</td>
<td>800°</td>
<td></td>
<td>920°</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.2 Motion path about +740°</td>
<td>-40°</td>
<td>800°</td>
<td>80°</td>
<td>920°</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Legend:**
- **Rel. neg.:** Relative negative offset limit
- **Abs. neg.:** Absolute negative offset limit
- **Rel. pos.:** Relative positive offset limit
- **Abs. pos.:** Absolute positive offset limit

Based on the current position of 100°, offset limits should be within the range of 800° to 920°.
2.2 Absolute offset limits

**definition**

Absolute offset limits are defined by P-AXIS-00492 and P-AXIS-00493.

1. The monitor is activated.

The adjustable minimum/maximum values are limited by software limit switches.

![Diagram showing software limit switch and configured absolute manual mode selection](image)

Figure 2: Definition range of absolute offset limits

**Activate the monitor**

To activate the relative offset limit monitor, at least one of the limits P-AXIS-00492 or P-AXIS-00493 must be configured with a value ≠ 0.

2. The monitor is activated.

- If both limits = 0, the monitor is not active.

**Warnings, errors and reactions**

- Warning P-ERR-50721: When the monitor is active, the absolute offset limits are reached. The warning is output only if P-MANU-00014 is configured accordingly.

3. Interpolation is stopped.

  - Move back within the valid range.

- Error message P-ERR-50041 or P-ERR-50042: With G201, software limits switches are exceeded.

2. Interpolation is stopped.

  - Reset the controller.

  - Move back within the valid range. The valid range is defined by the software limit switches.

  - The current axis position is outside the absolute offset limits (analogous to warning P-ERR-50721).

1. Interpolation is not stopped.

  - Move back within the valid range.

**Also see about this**
Manual mode parameters [17]
3 Program relative offset limits

As of Build V2.11.2010.02 replaces the command #MANUAL LIMITS […] the command #SET OFFSET [...]. For compatibility reasons, this command is still available but it recommended not to use it in new NC programs.

#MANUAL LIMITS [ AX<Axisname> | AXNR<expr> NEGATIVE<expr> POSITIVE<expr> ]

| AX<Axisname> | Name of axis for which the offset limits are valid. |
| AXNR<expr> | Logical number of axis for which the offset limit is to be valid, positive integer |
| NEGATIVE<expr> | Negative relative offset value. Must be programmed as <0 in [mm, inch] |
| POSITIVE<expr> | Positive relative offset value. Must be programmed as <0 in [mm, inch] |

This command defines the positive and negative limits for the permissible relative path motion in G201/G202 manual mode for each path axis. The relative negative and positive offset limits refer here to the starting point when manual mode was selected. Offset limits are also considered in G200 by setting the parameter P-CHAN-00114.

Relative offset limits can be overwritten at any time in the NC program. A sign check is made. Relative offset limits apply to each axis in the programming coordinate system (PCS).
Program relative offset limits

%100
N010 G74 Y1
N015 G01 X10 Y10 F1000
N020 #MANUAL LIMITS[AX=X NEGATIVE=-200 POSITIVE=250]
N030 #MANUAL LIMITS[AX=Y NEGATIVE=-300 POSITIVE=350]
N040 G90 G01 X10 Y10 Z0 F1000
N050 G201 X1 Y1
N060 P1 = 1
N070 $WHILE P1 < 10000
N075 Z[P1/1000]
N080 $IF P1 == 100
N090 #MANUAL LIMITS[AX=X NEGATIVE=-14 POSITIVE=14]
N100 $ENDIF
N080 $IF P1 == 600
N090 G202 X1 Y1
N100 $ENDIF
N080 $IF P1 == 500
N100 $ENDIF
N110 P1 = P1 + 1
N120 #FLUSH WAIT
N120 $ENDWHILE
N1800 M30
4       Parameter

4.1   Overview of parameters

<table>
<thead>
<tr>
<th>ID</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<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 mode</td>
</tr>
<tr>
<td>P-AXIS-00492</td>
<td>Absolute negative ACS movement limit in manual mode</td>
</tr>
<tr>
<td>P-AXIS-00493</td>
<td>Absolute positive ACS movement limit in manual mode</td>
</tr>
<tr>
<td>P-CHAN-00114</td>
<td>Offset limits also apply to G200</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-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
- **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-00492**  Absolute negative ACS movement limit in manual mode

- **Description**: The parameter defines the absolute negative ACS movement limit.
- **Parameter**: handbetrieb.acs_limit_neg
- **Data type**: SGN32
- **Data range**: P-AXIS-00177 ≤ acs_limit_neg ≤ P-AXIS-00178
- **Axis types**: T, R
- **Dimension**: T: 0.1µm  R: 0.0001°
- **Default value**: 0
- **Drive types**: ----
- **Remarks**: If both parameters acs_limit_neg and acs_limit_pos are set to 0 the offset monitoring is inactive!
Table 4.3: Channel parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>handbetrieb.acs_limit_pos</td>
<td>The parameter defines the absolute positive ACS movement limit.</td>
</tr>
<tr>
<td>Data type</td>
<td>SGN32</td>
</tr>
<tr>
<td>Data range</td>
<td>P-AXIS-00177 ≤ acs_limit_pos ≤ P-AXIS-00178</td>
</tr>
<tr>
<td>Axis types</td>
<td>T, R</td>
</tr>
<tr>
<td>Dimensions</td>
<td>T: 0.1µm</td>
</tr>
<tr>
<td></td>
<td>R: 0.0001°</td>
</tr>
<tr>
<td>Default value</td>
<td>0</td>
</tr>
<tr>
<td>Remarks</td>
<td>If both parameters acs_limit_neg and acs_limit_pos are set to 0 the offset monitoring is inactive!</td>
</tr>
</tbody>
</table>

Table 4.4: Manual mode parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>move_limit_warning</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>Data type</td>
<td>BOOLEAN</td>
</tr>
<tr>
<td>Data range</td>
<td>0/1</td>
</tr>
<tr>
<td>Dimensions</td>
<td>----</td>
</tr>
<tr>
<td>Default value</td>
<td>0</td>
</tr>
<tr>
<td>Remarks</td>
<td>This parameter is available as of CNC Build 2.11.2804.12.</td>
</tr>
</tbody>
</table>

Table 4.5: CNC objects

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>manual_act.abs.limit-</td>
<td>Read lower absolute manual mode offset limit.</td>
</tr>
</tbody>
</table>
Read the manual mode offset limits

The active absolute manual mode offset limits are read by CNC objects.
Read the absolute manual mode offset limits.

The following applies to the negative offset limits of the 2nd axis in Channel 1:

- Task GEO (Port 551)
- Index group 0x12301
- Index offset = 0x2001D

The following applies to the positive offset limits of the 2nd axis in Channel 1:

- Task GEO (Port 551)
- Index group 0x12301
- Index offset = 0x2001E

Write the manual mode offset limits

The absolute manual mode offsets limits are read by CNC objects.

Define the offset limits in manual mode

The following applies to the negative offset limits of the 2nd axis in Channel 1:

- Task GEO (Port 551)
- Index group 0x12301
- Index offset = 0x2001D

The following applies to the positive offset limits of the 2nd axis in Channel 1:

- Task GEO (Port 551)
- Index group 0x12301
- Index offset = 0x2001E

Verify absolute offset limits via the ISG object browser

![ISG Object Browser](image)

Figure 3: Access to absolute offset limits in the ISG object browser
## 4.6 ISG parameters

### Command position (ACS)

<table>
<thead>
<tr>
<th>Description</th>
<th>Command position of current cycle in the axis coordinate system</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signal flow</td>
<td>CNC → PLC</td>
</tr>
<tr>
<td>ST path</td>
<td><code>gpAx[axis_idx]^.lr_state.active_position_acs_r</code></td>
</tr>
<tr>
<td>Data type</td>
<td>DINT</td>
</tr>
<tr>
<td>Unit</td>
<td>0,1 µm</td>
</tr>
<tr>
<td>Access</td>
<td>PLC reads</td>
</tr>
</tbody>
</table>

### Move back manual mode offset

<table>
<thead>
<tr>
<th>Description</th>
<th>If manual mode is active in the channel and if the commanded axis fails to move, the axis is moved by this command so that afterwards manual mode offset is 0.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data type</td>
<td>MC_CONTROL_BOOL_UNIT, see description of Control Unit</td>
</tr>
<tr>
<td>Special features</td>
<td>A rising edge (FALSE → TRUE) at <code>command_w</code> initiates the process. The signal is ignored if a manual mode motion is still active or manual mode offset is already 0.</td>
</tr>
<tr>
<td>Access</td>
<td>PLC reads <code>request_r + state_r</code> and writes <code>command_w + enable_w</code></td>
</tr>
<tr>
<td>ST path</td>
<td><code>gpAx[axis_idx]^.ipo_mc_control.manual_mv_back_to_start</code></td>
</tr>
</tbody>
</table>

#### Commanded, requested and return value

- **ST element**: `.command_w`, `.request_r`, `.state_r`
- **Data type**: BOOL
- **Value range**: rising edge (FALSE → TRUE) triggers backward motion
- **Redirection**: `.enable_w`
5 Support and Service

Beckhoff and their partners around the world offer comprehensive support and service, making available fast and competent assistance with all questions related to Beckhoff products and system solutions.

Beckhoff’s branch offices and representatives

Please contact your Beckhoff branch office or representative for local support and service on Beckhoff products!

The addresses of Beckhoff’s branch offices and representatives round the world can be found on her internet pages: https://www.beckhoff.com

You will also find further documentation for Beckhoff components there.

Beckhoff Support

Support offers you comprehensive technical assistance, helping you not only with the application of individual Beckhoff products, but also with other, wide-ranging services:

- support
- design, programming and commissioning of complex automation systems
- and extensive training program for Beckhoff system components

Hotline: +49 5246 963 157
Fax: +49 5246 963 9157
e-mail: support@beckhoff.com

Beckhoff Service

The Beckhoff Service Center supports you in all matters of after-sales service:

- on-site service
- repair service
- spare parts service
- hotline service

Hotline: +49 5246 963 460
Fax: +49 5246 963 479
e-mail: service@beckhoff.com

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
Index

A
  ACS
    Position: Soll
    20

H
  Handbetrieb
    Offset: zurück fahren
    8
    20

O
  Offset
    Handbetrieb: zurück fahren
    20

P
  P-AXIS-00137
    16
  P-AXIS-00138
    16
  P-AXIS-00492
    16
  P-AXIS-00493
    17
  P-CHAN-00114
    17
  P-MANU-00014
    17
  Position
    Soll: ACS
    20

S
  Sollposition
    ACS
    20