DOCUMENTATION ISG-kernel

McCOM - Interface to external compensation

Short Description:
McCOM-ExtComp

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Preface

Legal information

This documentation was produced with utmost care. The products and scope of functions described are under continuous development. We reserve the right to revise and amend the documentation at any time and without prior notice.

No claims may be made for products which have already been delivered if such claims are based on the specifications, figures and descriptions contained in this documentation.

Personnel qualifications

This description is solely intended for skilled technicians who were trained in control, automation and drive systems and who are familiar with the applicable standards, the relevant documentation and the machining application.

It is absolutely vital to refer to this documentation, the instructions below and the explanations to carry out installation and commissioning work. Skilled technicians are under the obligation to use the documentation duly published for every installation and commissioning operation.

Skilled technicians must ensure that the application or use of the products described fulfil all safety requirements including all applicable laws, regulations, provisions and standards.

Further information

This link

https://www.isg-stuttgart.de/de/isg-kernel/kernel-downloads.html

contains further information on messages generated in the NC kernel, online help, PLC libraries, tools, etc. in addition to the current documentation.

Disclaimer

It is forbidden to make any changes to the software configuration which are not contained in the options described in this documentation.

Trade marks and patents

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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

➢ 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.

Attention

Restriction or error

This icon describes restrictions or warns of errors.

Notice

Tips and other notes

This icon indicates information to assist in general understanding or to provide additional information.

Example

General example

Example that clarifies the text.

Programing Example

NC programming example

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

Release Note

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

List of figures

1 Overview

Task

The function description explains how to create and integrated a TcCOM object. The TcCOM object is called from the CNC context as a compensation.

Notice

This function is an additional option requiring a license.

Release Note

This function is only available for TwinCAT3 as of CNC Build V3.1.3074.

Parameterisation

The interface for adding a compensation must be activated in the start-up list:

- Activating the external compensation interface (P-STUP-00110 [▶ 10])

Limit values can be configured for each axis:

- Offset limits P-AXIS-00743 [▶ 11] and P-AXIS-00744 [▶ 11]
- Maximum acceleration (P-AXIS-00745 [▶ 11])

Programming

An externally defined compensation can be used with the command #EXTCOMP ON/OFF[...], provided the CNC supplied a compensation object.

2 Description

Point of action

The compensation is added to the axes in the position controller. The dynamics of the movement were already pre-calculated there. Therefore, the compensation should not produce any large position jumps since they are not dynamically adapted.

Limit values for acceleration and maximum offset value must be set for individual axes to prevent overloading the motors with excessive offsets or to avoid violating dynamic limits. The CNC then checks the offsets calculated by the compensation before passing them on to the motors.

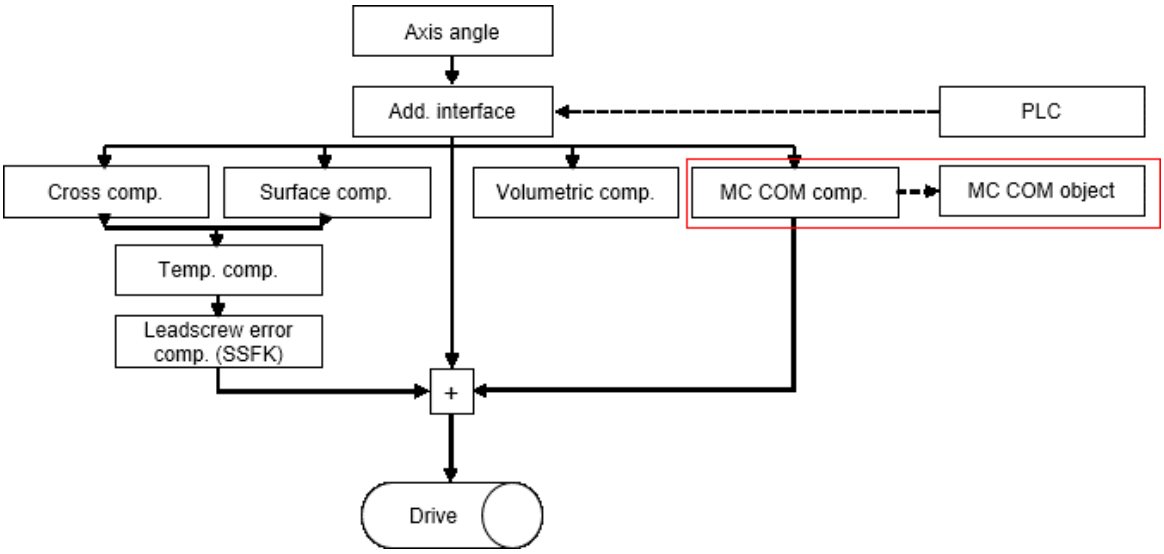


Fig. 1: Placing the external compensation

Application

More complex models may be required to compensate machines with highly complex kinematics. However, the NC kernel does not currently support this.

There are many different methods to compensate industrial robots in order to obtain the most accurate behaviour possible when executing a movement. This is possible by using precise kinematics which can map the exact mechanical properties of a robot. This type of information is generally not available from the manufacturer.

Besides the manufacturers themselves, there are also providers of other measurement techniques that improve the position of the machine. In order to add a compensation to the NC kernel, a special interface was developed to permit the addition of an externally implemented compensation.

Adding a user-defined compensation in TwinCAT 3.1

In TwinCAT 3, a compensation can be added to the CNC via the TcCOM infrastructure.

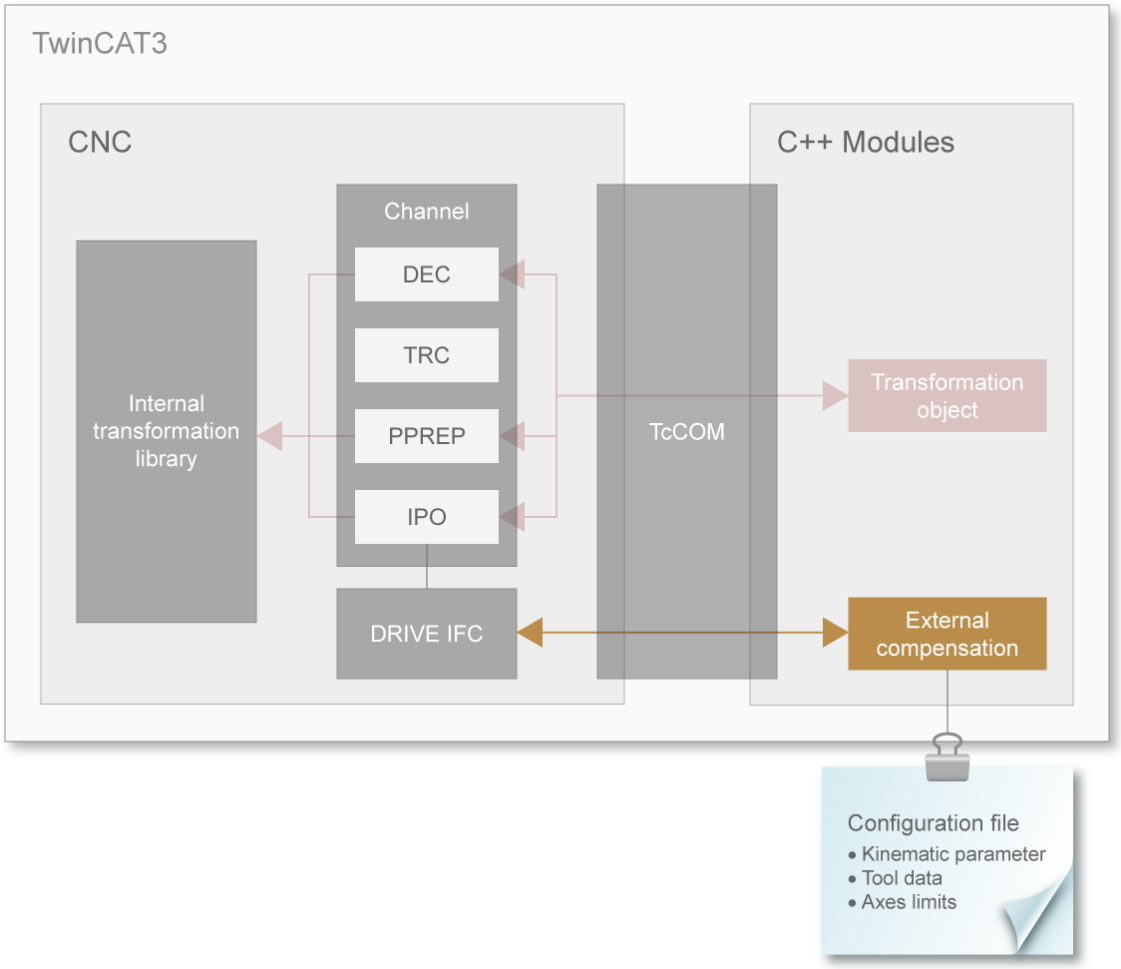


Fig. 2: Diagram of the interaction between PLC, CNC and TcCOM

An external compensation is a user-defined compensation that is implemented outside the CNC environment. The compensation is called from the CNC context. The compensation receives the next axis position and writes the calculated offset back to the CNC:

The compensation always transfers the positions of all axes. This allows axes in different channels to also be compensated by the same compensation. The CNC has little control over the compensation function.

Additional information provided with the axis positions are positive and negative software limit switches.

Notice

The compensation must ensure that the offsets are continuous so that there are no excessive position jumps. In addition, the offsets are not part of the path preparation of the CNC. The dynamics are not adapted for use of the offsets.

3 Programming

Syntax:

#EXTCOMP ON/OFF [ID=.. STRING=.. VALUE=..]

ID=..	Compensation number
STRING=<*string*>	Optional additional information for the compensation as string
VALUE=..	Optional additional information for the compensation as numeric value

The compensation can be switched on or off in the NC program. An additional option is that a message consisting of a string 24 characters long and a REAL value can be sent via the NC program to the compensation.

Programing Example

Sending a message followed by enabling the compensation

```
%Example1
N010 G01 X10 Y10 F1000

N020 #EXTCOMP [ID0 STRING=”OP1” VALUE=41]
N030 #EXTCOMP ON [ID0]

N040 G90 G01 X10 Y10 Z0 F1000
N050 G201 X1 Y1

N060 #EXTCOMP OFF [ID0]
```

Programing Example

Send a message to enable the compensation

```
%Example2
N010 G01 X10 Y10 F1000

N020 #EXTCOMP ON [ID0 STRING=”OP1” VALUE=41]

N030 G90 G01 X10 Y10 Z0 F1000
N040 G201 X1 Y1

N050 #EXTCOMP OFF [ID0]
```

4 Parameter

4.1 Overview of parameters

ID	Parameter	Description
P-STUP-00110	configuration.position_controller.enable_external_compensation_ifc	Enabling the external compensation interface
P-AXIS-00743	lr_param.ext_comp.warn_limit	Maximum position change of the compensation - warning
P-AXIS-00744	lr_param.ext_comp.err_limit	Maximum position change of the compensation - error
P-AXIS-00745	lr_param.ext_comp.max_a	Maximum acceleration of the axes by compensation offset

4.2 Start-up parameters

P-STUP-00110	**Enabling the external compensation**
Description	This parameter enables the function in the NC channel.
Parameter	configuration.position_controller.enable_external_compensation_ifc
Data type	BOOLEAN
Data range	0/1
Dimension	----
Default value	0
Remarks	This parameter can only be used with TwinCAT3. This is because of the use of the McCOM interface that is only available with TwinCAT3. This parameter is available as of CNC Build V3.1.3074

4.3 Axis parameters

P-AXIS-00743	Maximum position change of the compensation - warning limit	
Description	This parameter defines the warning limit for maximum position change of the external compensation. If the warning limit is exceeded, the warning is output with ID 70583. If the compensation value remains above the warning limit, no further warnings are output. A repeat warning is only output when the warning limit is again exceeded.	
Parameter	lr_param.ext_comp.warn_limit	
Data type	UNS32	
Data range	0 ≤ P-AXIS-00743 <= MAX_UNS32	
Dimension	T: 0.1 µm	R: 0.0001°
Default value	0	
Remarks	Parameter available as of CNC Build V3.1.3074.0 and higher	

P-AXIS-00744	Maximum position change of the compensation - error limit	
Description	This parameter defines the error limit for maximum position change of the external compensation. If the maximum position change is exceeded, the error ID 70584 is output and the CNC is stopped.	
Parameter	lr_param.ext_comp.err_limit	
Data type	UNS32	
Data range	0 ≤ P-AXIS-00744 <= MAX_UNS32	
Axis types	T, R	
Dimension	T: 0.1 µm	R: 0.0001°
Default value	0	
Remarks	Parameter available as of CNC Build V3.1.3074.0 and higher	

P-AXIS-00745	Maximum acceleration of the axes by a compensation offset	
Description	This parameter defines the limit value for the maximum permitted acceleration generated by the offsets of the external compensation.	
Parameter	lr_param.ext_comp.max_a	
Data type	UNS32	
Data range	0 ≤ P-AXIS-00745 <= MAX_UNS32	
Axis types	T, R	
Dimension	T: mm/s²	R: °/s²
Default value	P-AXIS-00008	
Remarks	Parameter available as of CNC Build V3.1.3074.0 and higher	

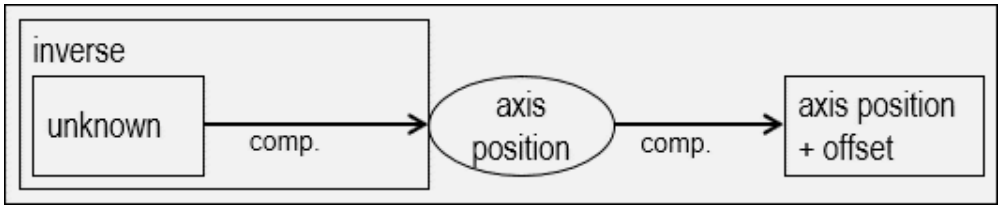
5 Adding a compensation via TcCom

5.1 Interface methods

Methods to be implemented

The following methods must be implemented when creating a compensation (TcNcKinematic-sInter-faces.h):

- `virtual HRESULT TCOMAPI computeStartOffsets(PTcMcComExtCompParameter p) = 0;`
- `virtual HRESULT TCOMAPI computeOffsets(PTcMcComExtCompParameter p) = 0;`
- `virtual HRESULT TCOMAPI writeNcCmd(PTcMcComCmdParameter s) = 0;`
- `virtual HRESULT TCOMAPI initCompensation(PTcMcComExtCompParameter p) = 0;`

computeStartOffset	Calculate the offset of an unknown axis position which reaches the axis positions transferred to the method when it is compensated (axis position + calculated offset).  This method is used to enable the compensated position. This results in no movement when the compensation is enabled.
computeOffsets	Calculate the offset for the transferred axis position.
writeNcCmd	The method of the user-specific commands from the NC program is received and processed.
initCompensation	Function to initialise the compensation.

5.2 Instance data of the compensation

Working data of the compensation

Implementation of the compensation can provide any parameters as working data. The compensation is always invoked cyclically in the position controller as long as the compensation is enabled.

The data provided by the CNC in cyclic operation are the axis positions and the software limit switches of the axes.

TcMcComBase – structure to transfer error information

In the event of an error this structure can be filled to output compensation error information via the CNC.

It forms the basis for the structures

`TcMcComExtCompParameter`

and

`TcMcComCmdParameter:`

The data provided by the CNC in cyclic operation are the axis positions and the software limit switches of the axes.

```
struct TcMcComBase
{
double ret_value1; // out: additional error value
double ret_value2; // out: additional error value
char ret_text[24]; // out: additional error text, max. 24 bytes
};
```

TcMcComExtCompParameter – structure for cyclic exchange

Axis positions are provided in the array cyclic_i of length dim_cyclic_i in unit 10^-8 mm or °. The calculated offset is expected in the array cyclic_o in the same unit.

The array parameter contains the software limit switches of all axes. The order is then [A1 swe pos, A1 swe neg, A2 swe pos, …].

```
struct TcMcComExtCompParameter : public TcMcComBase
{
eMcComExtCompParameter type;
signed __int64* cyclic_i;
long dim_cyclic_i;

signed __int64* cyclic_o;
long dim_cyclic_o;

signed __int64* parameters;
long dim_parameters;
};
```

TcMcComCmdParameter – structure to transfer NC messages

The NC command #EXTCOMP ON/OFF [ID<0> STRING=<string> VALUE= <value>] sends a string consisting of 24 characters and a double value to the compensation.

```
struct TcMcComCmdParameter : public TcMcComBase
{
char para_string[24];
double para_value;
};
```

5.3 Configuring and registering the compensation

Registering the compensation in TwinCAT

The following data is used to register a TcCOM object (TcCncServices.h)

- Type 6 (TCCNC_REGISTEROBJECT_TYPE_COMP) is default
- Group 0 is default
- Index 0 is default

The transformation is registered in the following TcCOM interface, which is defined in the file TcCncInterfaces.h.

- `virtual HRESULT TCOMAPI RegisterObject (TcCncRegis-terObject& id, ITcUnknown* ipUnk)=0;`
- `virtual HRESULT TCOMAPI UnregisterObject (TcCncRegis-terObject& id)=0;`

Registering the compensation in the CNC

The first time the NC command of the external compensation is executed, the TcCOM object is loaded for the first time and the method “initializeCompensation” is invoked. The command is then executed.

5.4 Using the example project/template

Example projects are also supplied.

ExtComp0.h

Header file of the compensation object. The interfaces that the object inherits are declared here. The following are particularly important for the compensation object: ITcCncBase for the version check and IITcMcComExtComp for the methods.

ExtComp0.cpp

Source file of the compensation object. This is where the compensation methods are implemented.

Configurations can be loaded here in the previous status until the object is loaded in the RT context.

ExterneKompensation.tmc

This specifies which interfaces provided by the TwinCAT3 are to be loaded and it also defines the types.

5.5 Loading the compensation object

After the object is successfully generated, the object can be added to the XAE project.

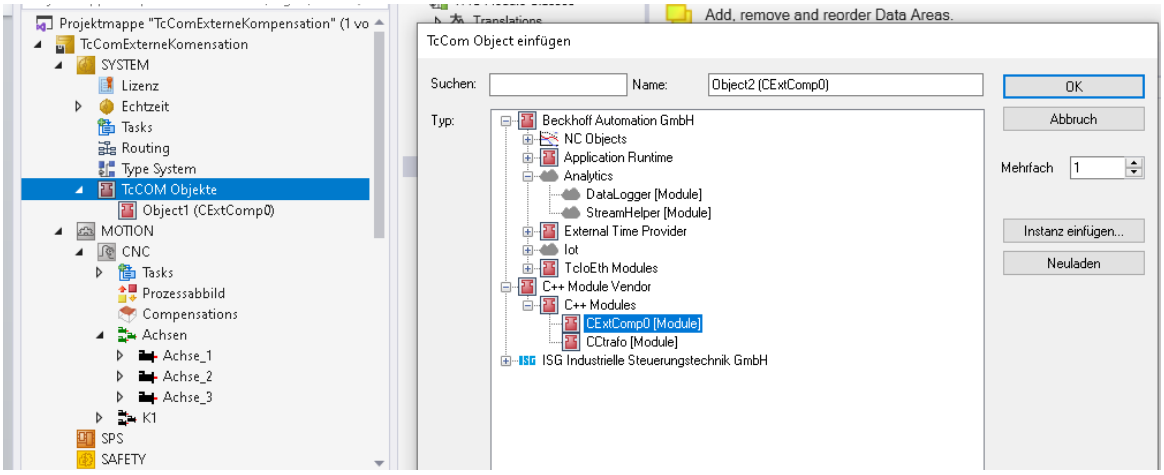


Fig. 3: Adding a TcCom object in TwinCAT

Then the type, index and group of the object must be configured.

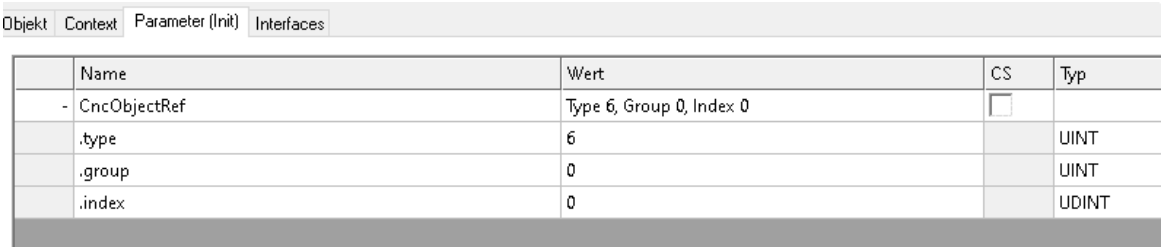


Fig. 4: Configuring the parameters

Notice

The TcCOM object must be signed, otherwise it is not loaded. For more information on TcCOM objects and how to sign an object, go to Beckhoff Information System.

6 Error handling and diagnosis

6.1 Error messages

Error number	Error text
70582	Function call of external compensation signals an error
70583	Caution: High compensation value of the external compensation
70584	Compensation value of the external compensation exceeded a critical limit
70585	Axis limits must be specified for the external compensation
70586	The external compensation exceeded the maximum acceleration
70587	Interface of external compensation is not enabled.
70588	Axis is already active in another channel when the external compensation was enabled
70589	Axis that is part of the external compensation has no enable
70590	Axis that is part of the external compensation is in error state
293101	Not enough memory to manage the COM interface
293102	The directory of the COM interface objects does not exist.
293103	ISGCtrl is not initialised yet.
293104	Specified ID of COM interface is not configured.
293105	Specified COM interface cannot be stored internally.
293106	The major interface version between CNC and Tc/McCOM is different.
293107	The major interface version between CNC and Tc/McCOM is different.

6.2 Diagnostic data

General diagnostic data of the position controller (PC)

The general diagnostic data of the position controller lists the state of the compensation and the last input and output of the compensation of the first 10 axes.

State of the compensation enabled = 1, disabled = 0

In the event of an error the compensation is deactivated immediately and is then disabled.

Registered: The TcCom object was loaded and initialised. Registration takes place with the first #EXTCOMP command executed.

Initialized: The interface of the external compensation is activated and the objects are initialised for communication.

Input: Axis position in 10^-8 mm or 10^-8°

Output: Compensation offset in 10^-8 mm or 10^-8°

Axis-specific diagnostic data of the PC

Active: The compensation values act on the axis.

Last offset: The previous offset in increments.

Actual offset: The current offset in increments.

Next offset: The next offset.

Diff: The offset acceleration in increments.

Example

Diagnostic data

Axis-specific diagnostic data taken from diagdata.txt:

```
ext_comp.initialized: 1
ext_comp[0].active: 1
ext_comp[0].last_offset: -110901232
ext_comp[0].actual_offset: -110901232
ext_comp[0].next_offset: -110901232
ext_comp[0].offset_delta: 0
ext_comp[0].diff: 0.000000
```

General diagnostic data:

```
ext_comp[0].state 1
ext_comp[0].initialized 1
ext_comp[0].registered 1

ext_comp[0].extcomp_input[0] 897556
ext_comp[0].extcomp_output[0] -1503827
ext_comp[0].extcomp_input[1] -1701406850
ext_comp[0].extcomp_output[1] -4149410
ext_comp[0].extcomp_input[2] -1999519487
ext_comp[0].extcomp_output[2] -4234781
ext_comp[0].extcomp_input[3] 3519482
ext_comp[0].extcomp_output[3] -4374686
ext_comp[0].extcomp_input[4] -171975334
ext_comp[0].extcomp_output[4] -2019399
ext_comp[0].extcomp_input[5] 667959
ext_comp[0].extcomp_output[5] 4246058
ext_comp[0].extcomp_input[6] 0
ext_comp[0].extcomp_output[6] 0
ext_comp[0].extcomp_input[7] 0
ext_comp[0].extcomp_output[7] 0
ext_comp[0].extcomp_input[8] 0
ext_comp[0].extcomp_output[8] 0
ext_comp[0].extcomp_input[9] 0
ext_comp[0].extcomp_output[9] 0
```

6.3 ADS objects

General diagnostic data of the PC

In TwinCAT3 ADS objects are also provided by the external compensation.

GEO platform

Group	index	Name	Type	Unit
0x120300	0x1181	EXTC[0].initialized	BOOLEAN	-
0x120300	0x1182	EXTC[0].registered	BOOLEAN	-
0x120300	0x1183	EXTC[0].state	SGN32	0: disabled 1: enabled 2: Error

GEO axis

Group	index	Name	Type	Unit
0x120300	0x[1,2,..]1180	EXTC[0].last_offset	SGN32 /SGN64	Increment
0x120300	0x[1,2,..]1181	EXTC[0].actual_off-set	SGN32 /SGN64	Increment
0x120300	0x[1,2,..]1182	EXTC[0].next_offset	SGN32 /SGN64	Increment
0x120300	0x[1,2,..]1183	EXTC[0].offset_delta	SGN32 /SGN64	Increment
0x120300	0x[1,2,..]1184	EXTC[0].diff	REAL64	mm/s^2

7 Appendix

7.1 Suggestions, corrections and the latest documentation

Did you find any errors? Do you have any suggestions or constructive criticism? Then please contact us at documentation@isg-stuttgart.de. The latest documentation is posted in our Online Help (DE/EN):

QR code link: https://www.isg-stuttgart.de/documentation-kernel/

The link above forwards you to:

https://www.isg-stuttgart.de/fileadmin/kernel/kernel-html/index.html

Notice

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Keyword index

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