DOCUMENTATION ISG-kernel

Functional description
Estimation of future data

Short Description:
FCT-C34

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Preface

Legal information

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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

Links below (DE)

https://www.isg-stuttgart.de/produkte/softwareprodukte/isg-kernel/dokumente-und-downloads

or (EN)

https://www.isg-stuttgart.de/en/products/softwareproducts/isg-kernel/documents-and-downloads

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.

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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

When it is used in particular in additive manufacturing, a predictive control of the applying unit may help to compensate for dead times within the system and so improve the machining result.

Release Note

This function is available as of CNC Build V3.1.3074.0.

Properties

Starting from the momentary point in time, the state at a specified future time is determined by a pre-calculation and then provided for use.

Notice

This function is an additional option requiring a license.

Parameterisation

The function must be activated by P-STUP-00070.
P-CHAN-00324 defines the point in time for the future state.

Programming

The points in time can also be defined by the NC command
#CHANNEL SET[ESA_TIME<i>=…] [▷ 9].

Mandatory note on references 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

The precalculation of future data elements function provides users with a prediction of future date elements at a configurable future point in time starting from the present point in time.

This function is activated by P-STUP-00070:

configuration.channel[0].interpolator.function FCT_DEFAULT | **FCT_CALC_STATE_AT_T**

Depending on the mode setting (P-CHAN-00325), the function permits the precalculation.

Mode 1: Precalculation of path velocities at up to 10 future points in time

Mode 2: In addition to the path velocities of Mode 1, the axis positions, velocities and accelerations of all axes located in the channel are precalculated in the first time entry.

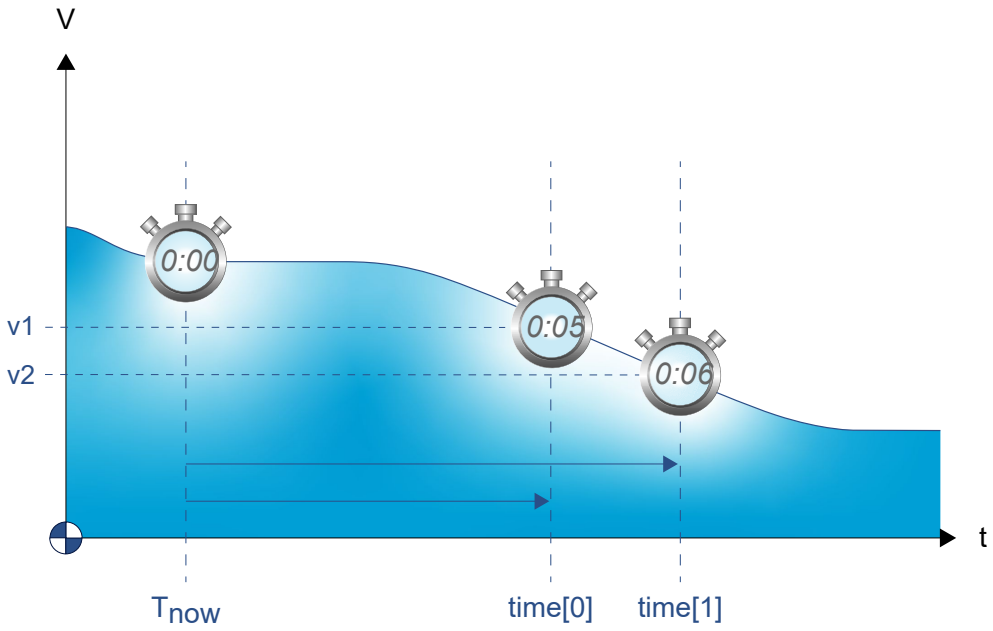

Fig. 1: Chronological sequence

Precalculation of path velocity

The results for future path velocities can be read by CNC objects [▷ 13] (ESA path-feed).

Precalculation is limited to the look-ahead function. If no prediction is possible for path velocity planning (time offset too great), the value -1.0 is output.

Notice

If the result -1 is output for future path velocity, no value could be calculated.

Adapt the look-ahead buffer by P-STUP-00071

As of CNC Build V3.3104.08 future path velocities [▶ 23] can also be read over the HLI interface [▶ 21]. The data element esa_data_valid [▶ 22] indicates whether the future data element is valid.

Precalculation of an axis state

The results of these calculations are also contained in corresponding CHC objects to precalculate the axis position [▶ 20], velocity [▶ 20] or acceleration [▶ 20] of axes. Only the value of the first time entry is used to precalculate at axis level.

The first time entry is defined by P-CHAN-00324 [▶ 11] (esa.time[0]) or by #CHANNEL SET [ESA_TIME0=…] [▶ 9].

As of CNC Build V3.3104.08 future axis states can also be read over the HLI interface [▶ 21]. The data element esa_data_valid [▶ 21] indicates whether the future data element is valid.

Recommendation for look-ahead buffer

Setting for the available look-ahead buffer (P-STUP-00071):

configuration.channel[0].interpolator.number_blocks_lah 500

3 Programming

The offset time can also be defined in the NC program by the following command as an alternative to configuration in the channel parameter list with P-CHAN-00324 [▶ 11]:

#CHANNEL SET [ESA_TIME<i>=..]

ESA_TIME<i>=<*expr*> Offset time i in [s] where i = 0 ... 9. 10 ESA times (Estimated State of Arrival) can be defined. Only time values greater than 0 are considered.

Programing Example

Setting 3 ESA times

```
#CHANNEL SET [ESA_TIME0=0.3 ESA_TIME1=0.5 ESA_TIME2= 0.8]
```

4 Parameter

4.1 Overview

4.1.1 Start-up parameters

ID	Parameter	Description
P-STUP-00070	configuration.channel[i].interpolator.function	Define interpolator functionality
P-STUP-00071/	configuration.channel[i].interpolator.number_blocks_lah	User-specific size of look-ahead buffer

4.1.2 Channel parameter

ID	Parameter	Description
P-CHAN-00324	esa.time[i]	Precalculation - time offset
P-CHAN-00325/	esa.mode	Precalculation - mode

4.2 Description

4.2.1 Start-up parameters

P-STUP-00070	**Definition of interpolator functionalities**
Description	This parameter defines individual functionalities and the size of the look-ahead buffer in the interpolator, i.e. it defines the number of blocks to calculate deceleration distance and dynamic planning.
Parameter	configuration.channel[i].interpolator.function
Data type	STRING
Data range	See Interpolation function table.
Dimension	----
Default value	FCT_IPO_DEFAULT
Remarks	

P-STUP-00071	User-specific size of look-ahead buffer
Description	This parameter permits the user-defined definition of the number of NC blocks in the look-ahead buffer. The parameter is only evaluated if P-STUP-00070 is set with FCT_LOOK_AHEAD_CUSTOM.
Parameter	configuration.channel[i].interpolator.number_blocks_lah *
Data type	UNS32
Data range	0 ... 10000
Dimension	----
Default value	120
Remarks	As of Build V2.11.20 and higher, the default size of the look-ahead buffer is 70 blocks. As of Build V2.11.28 and higher, the default size is 120 blocks. As the size increases, the additional calculations make greater demands on the controller hardware. As of Build V3.1.3067.07 the upper limit of the data range is 500 blocks. If #SLOPE[TYPE=STEP] is used, the upper limit is 10000 blocks as of Build V3.1.3060.0. * P-STUP-00071 in V2.11.20 and higher : configuration.channel[i].interpolator.parameter

4.2.2 Channel parameter

P-CHAN-00324	Default offset time to calculate future states
Description	At a set time greater than 0, the • path velocity • attempts to calculate axis position, velocity and acceleration at the parameterised point in the future.
Parameter	esa.time[i] where i = 0 ... 9
Data type	REAL64
Data range	0 ≤ time[i] ≤ MAX_REAL64
Dimension	s
Default value	0.0
Remarks	The maximum possible number of entries is limited to 10. Axis position, velocity and acceleration only estimated with the entry esa.time[0].

P-CHAN-00325	Precalculation mode
Description	This parameter sets the precalculation mode. • Mode 1: Precalculation of path velocity • Mode 2: Precalculation of – path velocity – Axis position, velocity and acceleration
Parameter	esa.mode
Data type	UNS32
Data range	1 / 2
Dimension	----
Default value	1
Remarks	

4.3 CNC objects

4.3.1 Channel-specific CNC objects

Name	ESA: Active time [0]		
Description	First configured time at which feedrate is detected.		
Task	GEO (Port 551)		
Index group	0x12130<C_{ID}>	**Index offset**	0x112/
Data type	REAL64	**length**	8
Attributes	read	**Unit**	[s]
Remarks			

Name	ESA: Pathfeed [0]		
Description	Calculated pathfeed at first configured point in time. Determining the point of time: P-CHAN-00324 [▶ 11] (esa.time[0]) or #CHANNEL SET[ESA_TIME0 = <value>] [▶ 9]		
Task	GEO (Port 551)		
Index group	0x12130<C_{ID}>	**Index offset**	0x113
Data type	REAL64	**Length**	8
Attributes	read	**Unit**	[µm/s]
Remarks			

Name	ESA: Active time [1]		
Description	Second configured time at which feedrate is detected.		
Task	GEO (Port 551)		
Index group	0x12130<C_{ID}>	**Index offset**	0x114/
Data type	REAL64	**length**	8
Attributes	read	**Unit**	[s]
Remarks			

Name	ESA: Pathfeed [1]		
Description	Calculated pathfeed at second configured point in time. Determining the point of time: P-CHAN-00324 [▶ 11] (esa.time[1]) or #CHANNEL SET[ESA_TIME1 = <value>] [▶ 9]		
Task	GEO (Port 551)		
Index group	0x12130<C_{ID}>	**Index offset**	0x115
Data type	REAL64	**Length**	8
Attributes	read	**Unit**	[µm/s]
Remarks			

Name	ESA: Active time [2]		
Description	Third configured time at which feedrate is detected.		
Task	GEO (Port 551)		
Index group	0x12130<C_{ID}>	**Index offset**	0x116/
Data type	REAL64	**length**	8
Attributes	read	**Unit**	[s]
Remarks			

Name	ESA: Pathfeed [2]		
Description	Calculated pathfeed at third configured point in time. Determining the point of time: P-CHAN-00324 [▶ 11] (esa.time[2]) or #CHANNEL SET[ESA_TIME2 = <value>] [▶ 9]		
Task	GEO (Port 551)		
Index group	0x12130<C_{ID}>	**Index offset**	0x117
Data type	REAL64	**Length**	8
Attributes	read	**Unit**	[µm/s]
Remarks			

Name	ESA: Active time [3]		
Description	Fourth configured time at which feedrate is to be detected.		
Task	GEO (Port 551)		
Index group	0x12130<C_{ID}>	**Index offset**	0x12b
Data type	REAL64	**Length**	8
Attributes	read	**Unit**	[s]
Remarks			

Name	ESA: Pathfeed [3]		
Description	Calculated pathfeed at fourth configured point in time. Determining the point of time: P-CHAN-00324 [▶ 11] (esa.time[3]) or #CHANNEL SET[ESA_TIME3 = <value>] [▶ 9]		
Task	GEO (Port 551)		
Index group	0x12130<C_{ID}>	**Index offset**	0x12c
Data type	REAL64	**Length**	8
Attributes	read	**Unit**	[µm/s]
Remarks			

Name	ESA: Active time [4]		
Description	Fifth configured time at which feedrate is to be detected.		
Task	GEO (Port 551)		
Index group	0x12130<C_{ID}>	**Index offset**	0x12d
Data type	REAL64	**Length**	8
Attributes	read	**Unit**	[s]
Remarks			

Name	ESA: Pathfeed [4]		
Description	Calculated pathfeed at fifth configured point in time. Determining the point of time: P-CHAN-00324 [▶ 11] (esa.time[4]) or #CHANNEL SET[ESA_TIME4 = <value>] [▶ 9]		
Task	GEO (Port 551)		
Index group	0x12130<C_{ID}>	**Index offset**	0x12e
Data type	REAL64	**Length**	8
Attributes	read	**Unit**	[µm/s]
Remarks			

Name	ESA: Active time [5]		
Description	Sixth configured time at which feedrate is to be detected.		
Task	GEO (Port 551)		
Index group	0x12130<C_{ID}>	**Index offset**	0x12f
Data type	REAL64	**Length**	8
Attributes	read	**Unit**	[s]
Remarks			

Name	ESA: Pathfeed [5]		
Description	Calculated pathfeed at sixth configured point in time. Determining the point of time: P-CHAN-00324 [▶ 11] (esa.time[5]) or #CHANNEL SET[ESA_TIME5 = <value>] [▶ 9]		
Task	GEO (Port 551)		
Index group	0x12130<C_{ID}>	**Index offset**	0x130
Data type	REAL64	**Length**	8
Attributes	read	**Unit**	[µm/s]
Remarks			

Name	ESA: Active time [6]		
Description	Seventh configured time at which feedrate is to be detected.		
Task	GEO (Port 551)		
Index group	0x12130<C_{ID}>	**Index offset**	0x131
Data type	REAL64	**Length**	8
Attributes	read	**Unit**	[s]
Remarks			

Name	ESA: Pathfeed [6]		
Description	Calculated pathfeed at seventh configured point in time. Determining the point of time: P-CHAN-00324 [▶ 11] (esa.time[6]) or #CHANNEL SET[ESA_TIME6 = <value>] [▶ 9]		
Task	GEO (Port 551)		
Index group	0x12130<C_{ID}>	**Index offset**	0x132
Data type	REAL64	**Length**	8
Attributes	read	**Unit**	[µm/s]
Remarks			

Name	ESA: Active time [7]		
Description	Eighth configured time at which feedrate is to be detected.		
Task	GEO (Port 551)		
Index group	0x12130<C_{ID}>	**Index offset**	0x133
Data type	REAL64	**Length**	8
Attributes	read	**Unit**	[s]
Remarks			

Name	ESA: Pathfeed [7]		
Description	Calculated pathfeed at eighth configured point in time. Determining the point of time: P-CHAN-00324 [▶ 11] (esa.time[7]) or #CHANNEL SET[ESA_TIME7 = <value>] [▶ 9]		
Task	GEO (Port 551)		
Index group	0x12130<C_{ID}>	**Index offset**	0x134
Data type	REAL64	**Length**	8
Attributes	read	**Unit**	[µm/s]
Remarks			

Name	ESA: Active time [8]		
Description	Ninth configured time at which feedrate is to be detected.		
Task	GEO (Port 551)		
Index group	0x12130<C_{ID}>	**Index offset**	0x135
Data type	REAL64	**Length**	8
Attributes	read	**Unit**	[s]
Remarks			

Name	ESA: Pathfeed [8]		
Description	Calculated pathfeed at ninth configured point in time. Determining the point of time: P-CHAN-00324 [▶ 11] (esa.time[8]) or #CHANNEL SET[ESA_TIME8 = <value>] [▶ 9]		
Task	GEO (Port 551)		
Index group	0x12130<C_{ID}>	**Index offset**	0x136
Data type	REAL64	**Length**	8
Attributes	read	**Unit**	[µm/s]
Remarks			

Name	ESA: Active time [9]		
Description	Tenth configured time at which feedrate is to be detected.		
Task	GEO (Port 551)		
Index group	0x12130<C_{ID}>	**Index offset**	0x137
Data type	REAL64	**Length**	8
Attributes	read	**Unit**	[s]
Remarks			

Name	ESA: Pathfeed [9]		
Description	Calculated pathfeed at tenth configured point in time. Determining the point of time: P-CHAN-00324 [▶ 11] (esa.time[9]) or #CHANNEL SET[ESA_TIME9 = <value>] [▶ 9]		
Task	GEO (Port 551)		
Index group	0x12130<C_{ID}>	**Index offset**	0x138
Data type	REAL64	**Length**	8
Attributes	read	**Unit**	[µm/s]
Remarks			

4.3.2 Axis-specific CNC objects

Name	ESA: position in future		
Description	Predicted axis position at defined point in time. The point in time is defined by P-CHAN-00324 [▶ 11] (esa.time[0]) or by #CHANNEL SET [ESA_TIME0=<value>) [▶ 9]		
Task	GEO (Port 551)		
Index group	0x12130<C_{ID}>	**Index offset**	0x<A_{ID}>0087
Data type	REAL64	**Length**	8
Attributes	read	**Unit**	[0.1 µm or 0.0001°]
Remarks			

Name	ESA: velocity in future		
Description	Predicted axis velocity at defined point in time. The point in time is defined by P-CHAN-00324 [▶ 11] (esa.time[0]) or by #CHANNEL SET [ESA_TIME0=<value>) [▶ 9]		
Task	GEO (Port 551)		
Index group	0x12130<C_{ID}>	**Index offset**	0x<A_{ID}>0088
Data type	REAL64	**Length**	8
Attributes	read	**Unit**	[1µm/s or 0.001°/s]
Remarks			

Name	ESA: acceleration in future		
Description	Predicted axis acceleration at defined point in time. The point in time is defined by P-CHAN-00324 [▶ 11] (esa.time[0]) or by #CHANNEL SET [ESA_TIME0=<value>) [▶ 9]		
Task	GEO (Port 551)		
Index group	0x12130<C_{ID}>	**Index offset**	0x<A_{ID}>0089
Data type	REAL64	**Length**	8
Attributes	read	**Unit**	[mm/s^2 bzw. °/s^2]
Remarks			

4.4 HLI parameters

Release Note

Connection to the HLI interface is available as of CNC Build V3.3104.08.

Precalculated axis-specific states

Precalculated data is valid, axis	
Description	This data element indicates whether precalculated axis data is valid. If the data element is TRUE, the values are valid for the precalculation of position [▶ 21], velocity [▶ 22] and acceleration [▶ 22] at a future point in time. FALSE indicates that no data could be calculated for the future point in time. The point in time is defined by the Index 0 in P-CHAN-00324 [▶ 11] or by #CHANNEL SET[ESA_TIME0=...] [▶ 9].
Signal flow	CNC →PLC
ST Path	gpAx[*axis_idx*]^.ipo_state.**esa_data_valid**
Data type	BOOL
Value range	TRUE/FALSE
Access	PLC is reading
Special feature	**Available as of Build V3.1.3104.08**

Precalculated position, axis	
Description	Axis position at a future point in time. The point in time is defined by the Index 0 in P-CHAN-00324 [▶ 11] or by #CHANNEL SET[ESA_TIME0=...] [▶ 9].
Signal flow	CNC →PLC
ST Path	gpAx[*axis_idx*]^.ipo_state.**esa_pos**
Data type	LREAL
Access	PLC is reading
Special feature	**Available as of Build V3.1.3104.08**

Precalculated velocity, axis	
Description	Axis velocity at a future point in time. The point in time is defined by the Index 0 in P-CHAN-00324 [▶ 11] or by #CHANNEL SET[ESA_TIME0=...] [▶ 9].
Signal flow	CNC →PLC
ST Path	gpAx[*axis_idx*]^.ipo_state.**esa_vel**
Data type	LREAL
Access	PLC is reading
Special feature	**Available as of Build V3.1.3104.08**

Precalculated acceleration, axis	
Description	Axis acceleration at a future point in time. The point in time is defined by the Index 0 in P-CHAN-00324 [▶ 11] or by #CHANNEL SET[ESA_TIME0=...] [▶ 9].
Signal flow	CNC →PLC
ST Path	gpAx[*axis_idx*]^. ipo_state.**esa_acc**
Data type	LREAL
Access	PLC is reading
Special feature	**Available as of Build V3.1.3104.08**

Precalculated axis-specific states

Up to 3 precalculated velocities can be read by the HLI interface.

Precalculated data is valid, path	
Description	If a data element in the field is TRUE, path velocity was precalculated for a future point in time and is therefore valid. This is indicated by the same index as precalculated velocity [▶ 23]. FALSE indicates that no value could be calculated for the future point in time. Several points in time were defined by P-CHAN-00324 [▶ 11]. Times can also be defined by #CHANNEL SET[ESA_TIME<i>=…] [▶ 9].
Signal flow	CNC →PLC
ST path	gpCh[channel_idx]^.bahn_state.**esa_data_valid[ ]**
Data type	ARRAY[0..HLI_ESA_POINTS_MAXIDX] OF BOOL
Value range	TRUE/FALSE
Access	PLC is reading
Special feature	**Available as of Build V3.1.3104.08**

Precalculated velocity, path	
Description	Path velocity at a future point in time. Several points in time were defined by P-CHAN-00324 [▶ 11]. The index of a configured point in time corresponds with the index of the precalculated path velocity. Times can also be defined by #CHANNEL SET[ESA_TIME<i>=…] [▶ 9].
Signal flow	CNC →PLC
ST Path	gpCh[channel_idx]^.bahn_state.**esa_vb[ ]**
Data type	ARRAY[0..HLI_ESA_POINTS_MAXIDX] OF LREAL
Access	PLC is reading
Special feature	**Available as of Build V3.1.3104.08**

Keyword index

5 Appendix

5.1 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

Change options for favourite links in your browser;

Technical changes to the website layout concerning folder paths or a change in the HTML framework and therefore the link structure cannot be excluded.

We recommend you to save the above "QR code link" as your primary favourite link.

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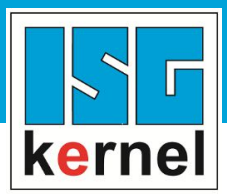

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