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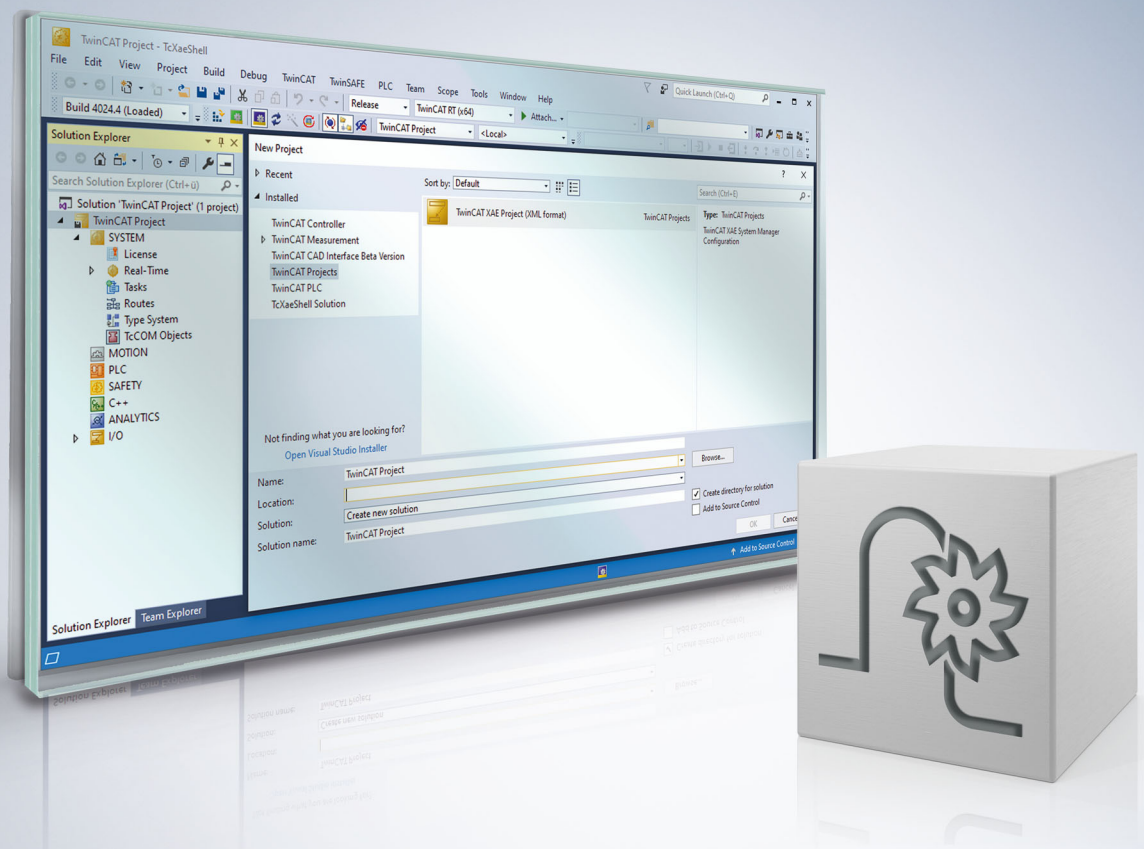
Functional description | EN

TF5200 | TwinCAT 3 CNC

Data streaming



12/18/2023 | Version: 1.06

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.

⇨ 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.

NOTICE

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

NC machining can be commanded by a variety of different interfaces and functions:

1. Automatic program: Start a previously created program
2. Manual block: Specify an NC command possibly consisting of several lines
3. Streaming: Specify sequential subcommands online (not described here)
4. PLC: commanding via PLC interface in compliance with PLCopen

Characteristics

Many user commands or other geometry profiles are only defined online, i.e. when the workpiece is already being machined. The programming environment and the PLC display user actions interactively to send commands to the controllers. Among other things, this affects:

- creating the geometry
- user commands and forward/backward motion
- aborting machining with subsequent resumption

Due to the incremental online specification of program parts, users can define and influence the process in real time.

Parametrisation

Parameterisation is executed using P-CHAN-00158 [▶ 23]. This and other commands are described in detail in the chapter Parameters [▶ 23].

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 of data streaming

NC commanding via various interfaces is depicted in the graphic below:

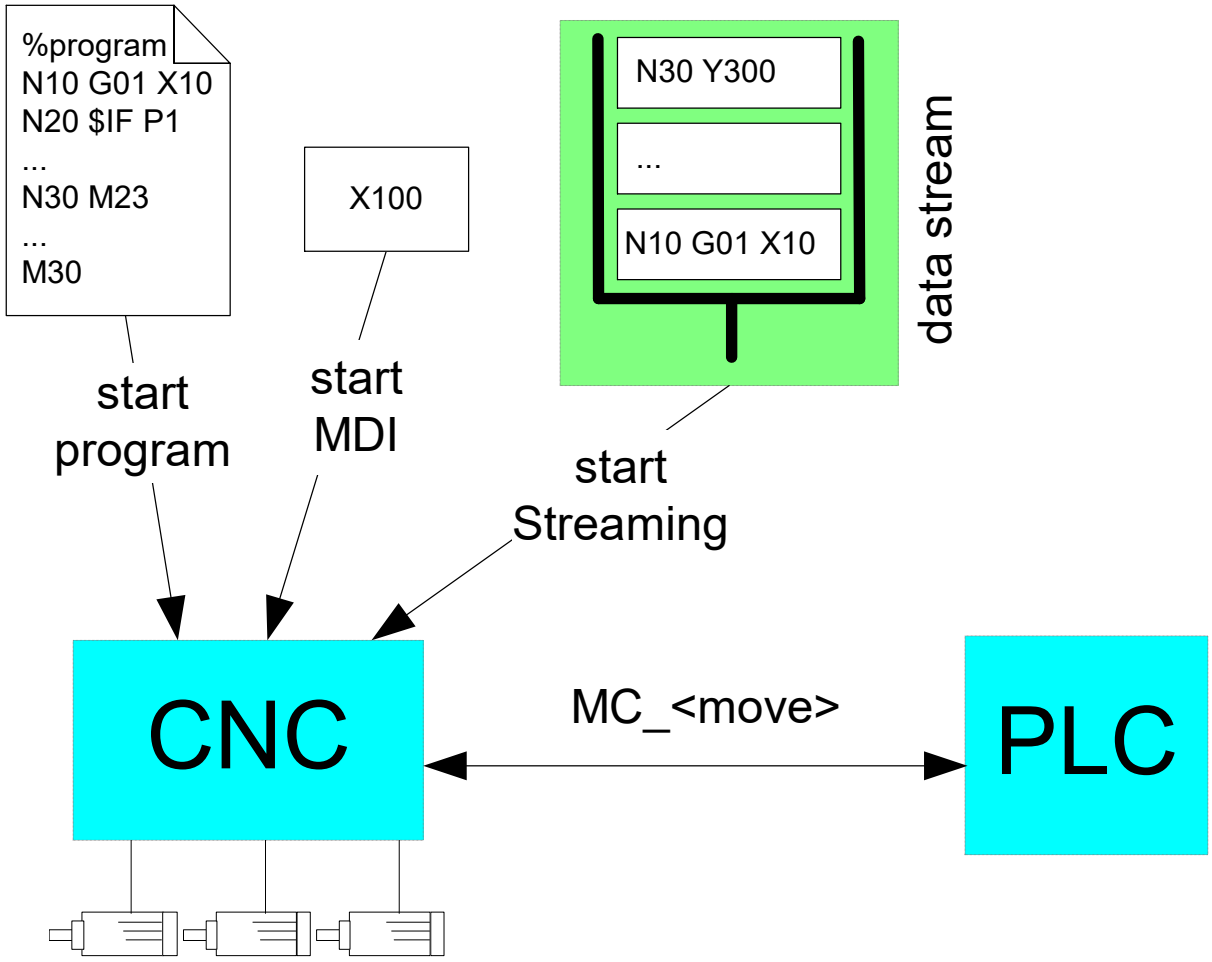


Fig. 1: NC commanding via various interfaces

The effectiveness of data streaming is depicted in the graphic below:

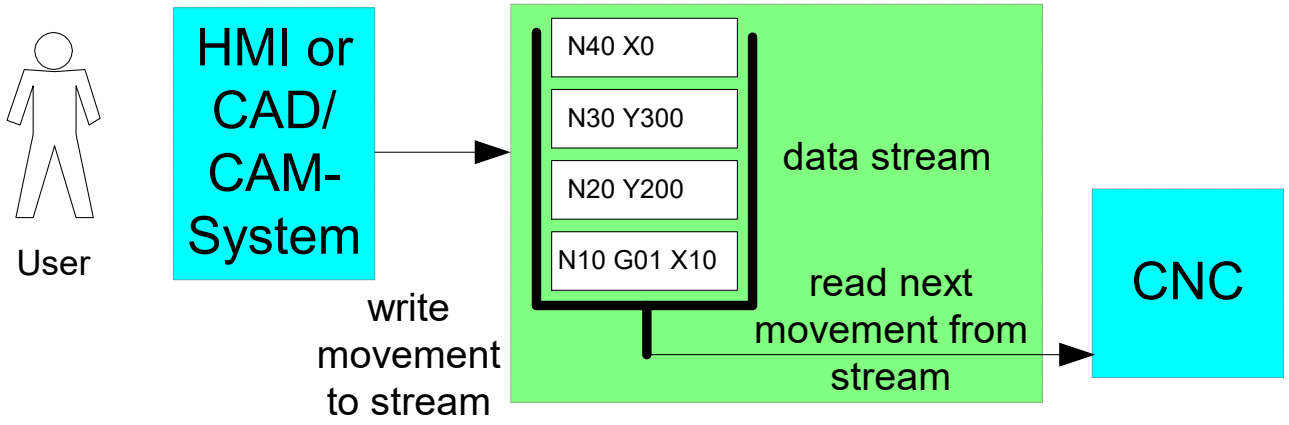


Fig. 2: Effectiveness of data streaming

2.1 General

With the incremental specification of motion commands (streaming), the CAD/CAM system or the PLC stipulates the next path segment to be travelled (or even several segments).

In this way, motion information not previously specified can still be modified until shortly before entering the command.

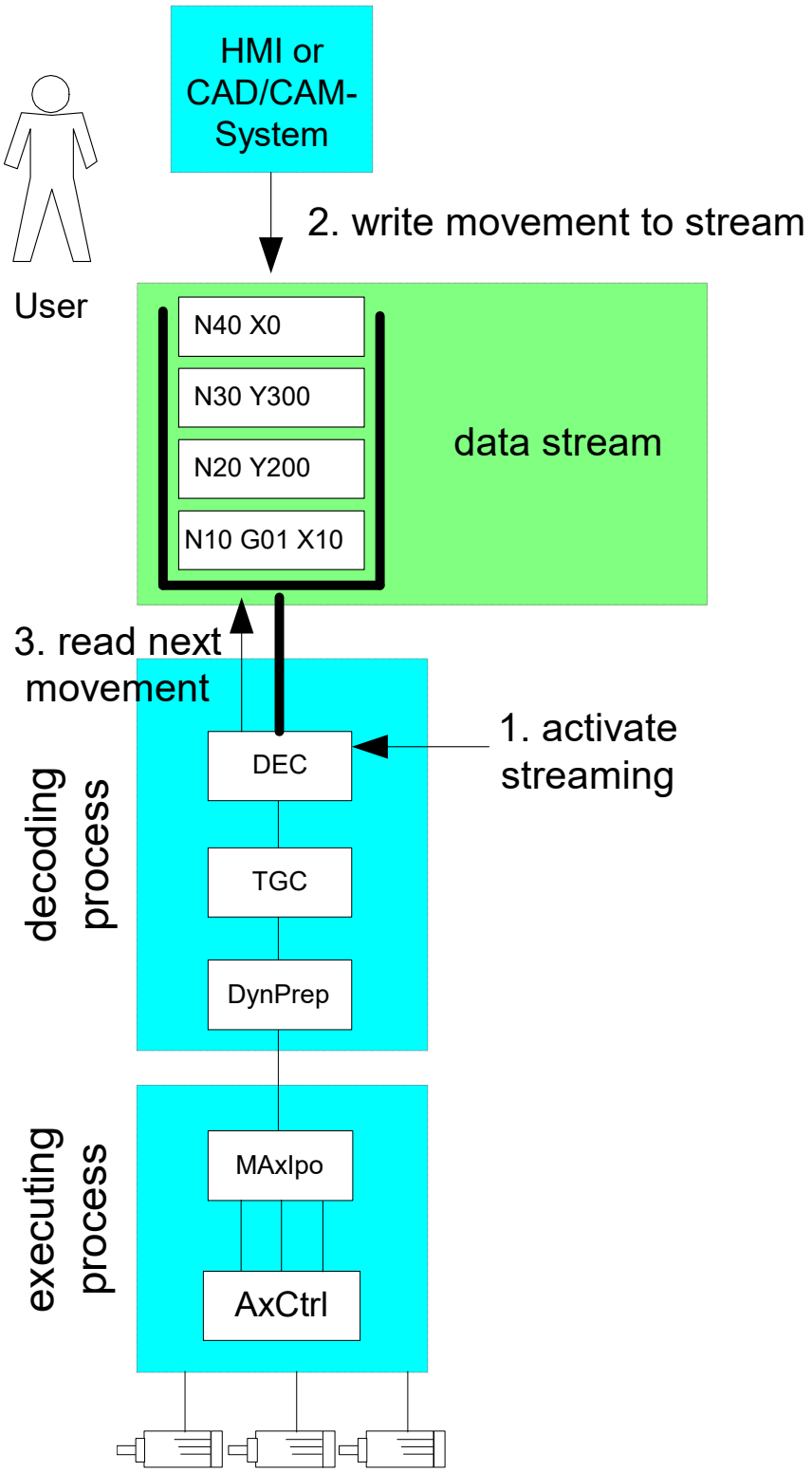


Fig. 3: Graphic showing how data streaming functions

2.2 Basic characteristics

Activation

The name of the streaming program is defined in the channel parameter list: stream_prog_file (see P-CHAN-00158). If this **virtual streaming NC program** is started as the main program (automatic mode) or as a global subroutine, the data is automatically read out from the streaming interface.

Switchover to streaming mode takes place automatically. For users, this program then behaves as if it was available as a real NC program in the file system.

Deactivation/termination

Streaming mode can be terminated normally by:

1. A main program end (M2/M30) or
2. A return at subroutine end (M17/M29)

After normal termination of a streaming program, the remaining contents of the interface are retained but data already read with the program end data packet is discarded. That is to say that, after a program end M2/M30 or M17/M29 is written, he user should first wait until the streaming interface is read completely and empty. Only then can it be ensured that the next streaming program is correctly executed from the very start.

Remarks on the above note

The area marked in red in the figure below showing a program start is not considered since it was already read out with the previous program end M30.

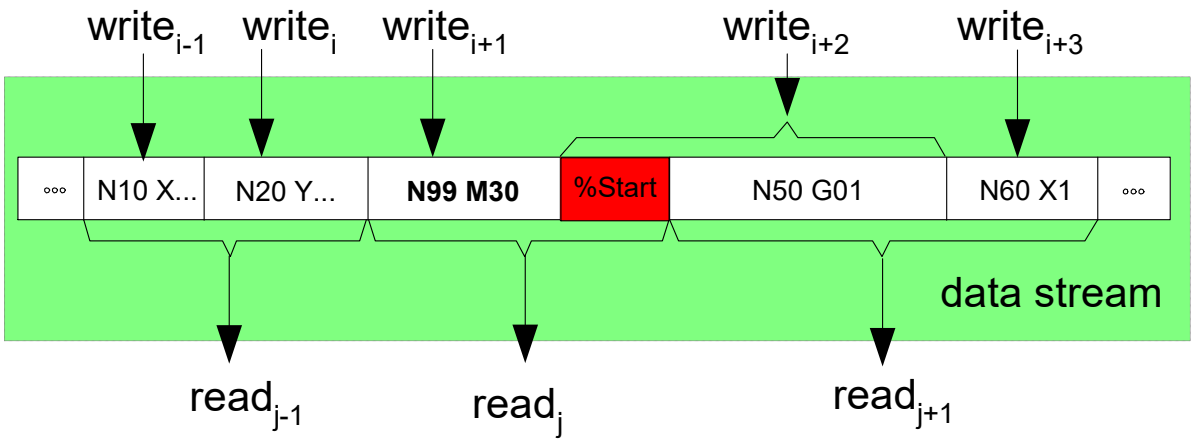


Fig. 4: The area marked in red is no longer considered after M30

Activating streaming when the program is invoked

```
;Channel parameter list
# ***************************************
# TC_CHANNEL_DESC_1: SDA data
# ***************************************
; Activate streaming via a global subroutine
streaming_prog_file streaming.nc
N10 G01 X200 F1000
N20 X240 Y100
N30 X200 Y0
N40 L streaming.nc
```

Description of the chronological sequence

The data stream can be written via a corresponding interface object where one data packet can consist of one or several NC lines.

If there are several read accesses in succession, the individual data packets are sorted according to chronological access and are available to the CNC for read access as a data packet consisting of several lines.

On extraction, the data packets are no longer extracted singly. Instead, all data available at the time of the read access is extracted as a common data packet (program segment).

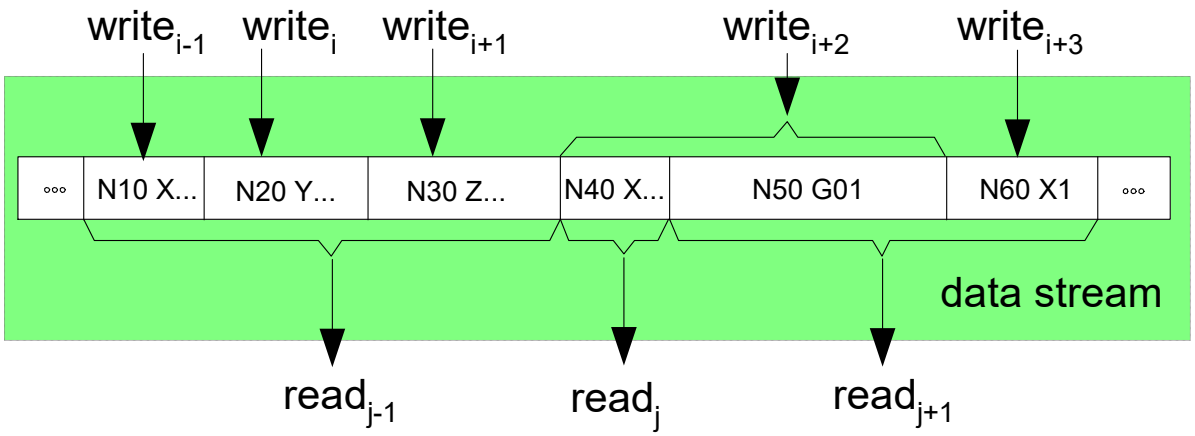


Fig. 5: A data packet may contain one or several NC lines.

Each NC line must be terminated by a carriage return (ASCII value = 13) and line feed (ASCII value = 10).

Interrupt

If the data stream is not written any further, this results in a temporary motion interrupt. The motion can then be resumed by writing the data stream.

Abort/reset/delete

Streaming mode is explicitly disabled in case of an NC reset and the previous contents of the streaming interface are deleted.

2.3 Extended characteristics of data streaming

2.3.1 Flushing the NC channel (#FLUSH CONTINUE)

Cross-block considerations

Planning considers several geometry blocks to include block transitions and special NC functions (e.g. contouring, tool radius compensation, etc.). The blocks are first saved internally and considered jointly, i.e. the blocks are not executed directly after commanding.

Flushing the NC channel (#FLUSH CONTINUE)

The effect of the #FLUSH CONTINUE command is to execute all NC blocks currently saved in the NC channel, i.e. the memory effect of the NC channel is cancelled temporarily. The last motion block programmed before #FLUSH CONTINUE is therefore immediately enabled for output.

Velocity

If the next motion block is presented in good time before an NC block end, motion is resumed without stopping or without reducing the velocity. If no further motion block exists, motion is stopped temporarily.

The command **Flush NC channel** cannot be used for cross-block functions (e.g. active tool radius compensation).

Flushing NC channel

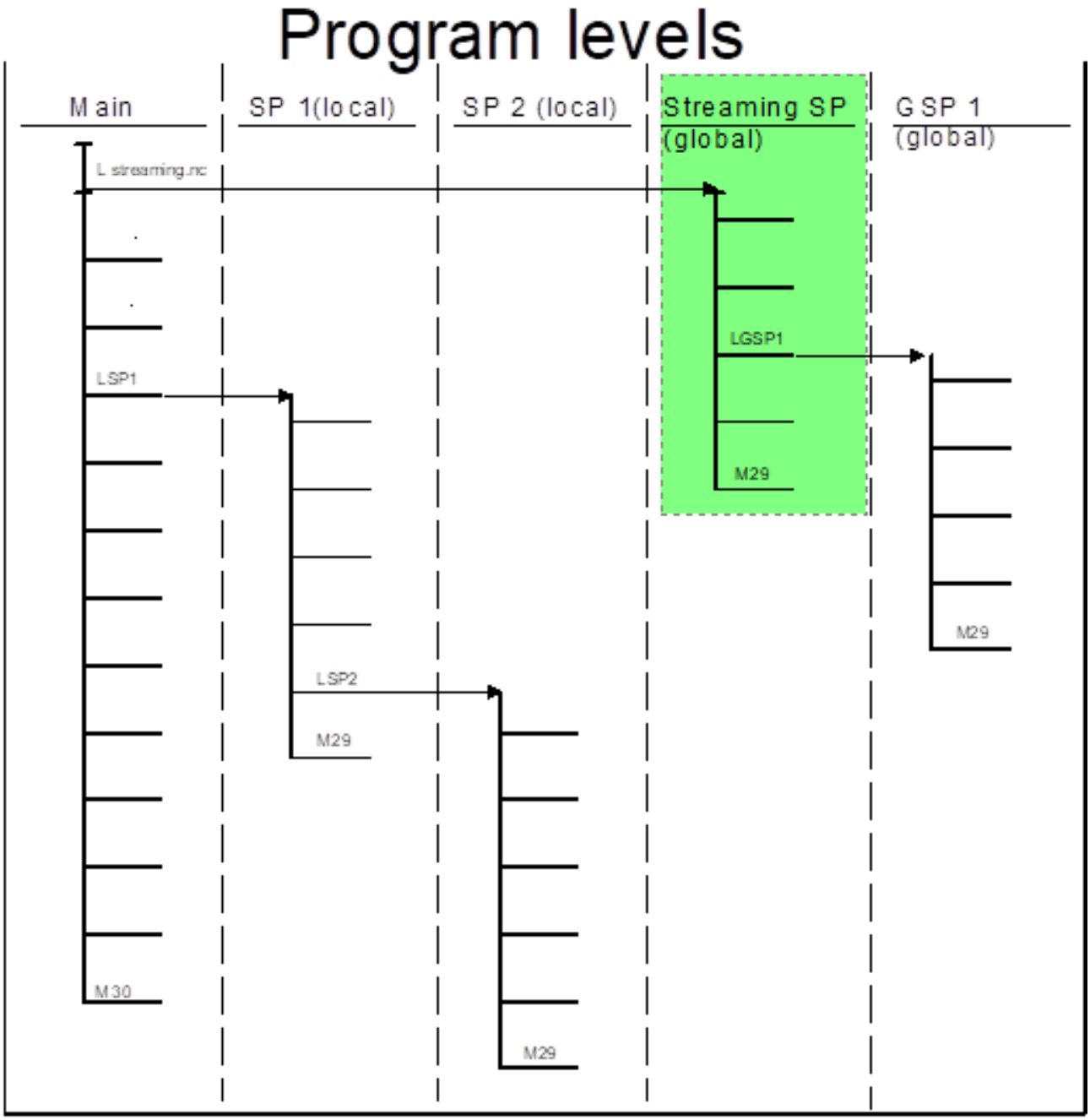
```
N10 G01 X200 F1000
N20 X240 Y100
N30 X200 Y0
N40 #FLUSH CONTINUE
```

2.3.2 Subroutine call

L <subroutine>

It is possible to invoke a global subroutine from the incremental program sequence.

- Subroutine call
- Administration of nesting
- Return to streaming (M17, M29)
- Management of cache elements (streaming, program)



Streaming instructions with subroutine invocation

```
N10 G01 X200 F1000
N20 X240 Y100
N30 X200 Y0
N40 L subprogram.nc
```

2.3.3 Loops and branches

Control structures

Control structures with positioning of the file pointer in backward direction (loops) are not permitted. This type of loop must be resolved in streaming programs and replaced with linearised NC block sequences.

The following control structures result in output of an error message and streaming mode is aborted:

- $FOR - $ENDFOR
- $DO - $ENDDO
- $REPEAT - $UNTIL
- $WHILE - $ENDWHILE

By contrast, control structures that only contain sequential program branches in the forward direction can also be used fully across several data packets.

- $SWITCH - $CASE - $DEFAULT – $ENDSWITCH
- $IF - $ELSE - $ELSEIF - $ENDIF

Jump list in the forward direction

1st data packet

```
%switchstream

N010 G00 X0 Y0 Z0
N020 P1=10
N030
N040 $SWITCH P1
N050 $CASE 1
N060 X10
N070 $BREAK

N080 $CASE 5
N090 X50
N100 $BREAK
N110 $CASE 9
N120 X90
N130 $BREAK
N140 $CASE 10
N150 X100
N160 $ENDSWITCH
:
M30
```

2nd data packet

2.3.4 Comments

Comment lines or blocks in streaming mode are permitted and can be used fully, also across several data packets.

- (<Comment text in parentheses>)
- (<Comment text after open parentheses up to block end>
- ; <Comment text after semicolon up to block end>
- Comment blocks between #COMMENT BEGIN / END

Comments in streaming mode

1st data packet

```
%commentstream

N010 G00 X0 Y0 Z0 (Move to start position)
N17 G53 G90 (Absolute dimension)
N18 G00 X0
N19 G00 Y0
N20 G00 Z0
N21 G54 G90 ;Zero offsets
#COMMENT BEGIN
#HSC ON [OPMODE 2]

N22 ( ================= )
N23 (PROG NAME : Test.nc)
N24 (DATE : 24.02.2010 )
```

2nd data packet

```
N25 (HISTORY :...)
N26 ( ================= )
N27 G00 X17.021 Z-90.0
N28 Y1.036
N29 S30000 M03
N30 G01 X17.021 Y6.036 F300
N31 G01 X17.021 Y8.062 F4000
N32 G01 X14.4 Y9.216
#COMMENT END
N33 G01 X14.4 Y9.216 F30000
N34 G01 X14.174 Y9.313
N35 G01 X13.987 Y9.39
N36 G01 X13.845 Y9.442
N37 G01 X13.755 Y9.468
N38 G01 X13.718 Y9.468
N39 G01 X13.718 Y9.468
N40 G01 X13.718 Y9.464 Z-88.029
N41 G01 X13.718 Y9.456 Z-86.51
N42 G01 X13.718 Y9.443 Z-84.787
N43 G01 X13.718 Y9.425 Z-83.063
N44 G01 X13.718 Y9.403 Z-81.339
N45 G01 X13.718 Y9.379 Z-79.615
N46 G01 X13.718 Y9.354 Z-77.892
N47 G01 X13.718 Y9.329 Z-76.168

N48 G01 X13.718 Y9.306 Z-74.444
N49 G01 X13.718 Y9.286 Z-72.721
N50 G01 X13.718 Y9.271 Z-70.997
N51 G01 X13.718 Y9.262 Z-69.273
N52 G01 X13.718 Y9.261 Z-67.549
N53 G01 X13.718 Y9.261 Z-65.825
N54 G01 X13.718 Y9.261 Z-64.102
:

M30
```

2.3.5 Block search

It is permissible to use block search in streaming to the continuation position by specifying

- block number
- block counter
- file offset

to restore internal states (e.g. coolant on, spindle on, etc.).

Basically, streaming is also possible in combination with block search [FCT-C6]. However, the block search function can also be processed via streaming, i.e. skipped blocks are simply omitted during streaming.

In this case, establishing the internal state after the skipped program sequence and returning to the contour must also be processed in the streaming mode itself.

2.3.6 Jump to label

$GOTO

Using the $GOTO command, it is only possible to jump in the forward direction.

- Jump within data packet
- Jump to next data packet, post-loading

Jumps in the backward direction are not permitted and lead to the output of an **error message** and streaming mode abort.

Jump in the forward direction

1. 1st data package

```
N01 G01 X0 Y0 Z0 F1000
N10 G01 X20
N20 $GOTO N40
N30 G01 Z40
N40: G01 X40
N50 $GOTO N80
```

2. 1st data package

```
N60 G01 Y20
N70 G01 Y40

N80: G01 X-20
N90 G01 X-40
```

3. 1st data package

```
:
M30
```

2.3.7 Tool radius compensation, contouring, splines

Cross-block functions

Cross-block functions are possible if no implicit/explicit *emptying of the channel* (#FLUSH) is commanded when the function is active.

Cross-block functions

```
%streaming-spline

#SPLINE TYPE BSPLINE
G151
G134 50
N36335 X-1.5586 Y-16.3853 (M122
N36336 X-1.5666 Y-16.4702 Z2.9971
N36337 X-1.5749 Y-16.5569 Z2.9881
N36338 X-1.5832 Y-16.6448 Z2.9725
N36339 X-1.5917 Y-16.7332 Z2.9501
N36340 X-1.6    Y-16.8214 Z2.9207
N36341 X-1.6083 Y-16.9086 Z2.8841
N36342 X-1.6164 Y-16.9939 Z2.8403
N36343 X-1.6243 Y-17.0764 Z2.7895
N36344 X-1.6318 Y-17.1553 Z2.732
N36345 X-1.6389 Y-17.2298 Z2.6681
N36346 X-1.6455 Y-17.2992 Z2.5983
N36347 X-1.6515 Y-17.3629 Z2.5235
N36348 X-1.657 Y-17.4202 (Z2.4442
N36349 X-1.6618 Y-17.4707 Z2.3613
N36350 X-1.6659 Y-17.5143 Z2.2757
N36351 X-1.6694 Y-17.5508 Z2.1881
N36352 X-1.6722 Y-17.5801 Z2.0995
N36353 X-1.6743 Y-17.6023 Z2.0107
N36354 X-1.6758 Y-17.6178 Z1.9224
N36355 X-1.6766 Y-17.6268 Z1.8353
…
```

2.4 Automatic program commanding as comparison

Automatic program

In automatic mode the user generates the program in advance. The basic execution of sequences (geometry) is then defined. After the NC program is started, it may/can no longer be modified.

The process can still be influenced at the time of program decoding by querying variables/parameters over the user interface or the PLC (conditional branches).

At the time of program execution, the axes are moved in accordance with the programmed geometry and information is sent to the PLC or execution is synchronised with the PLC.

The PLC can still influence the process online by using specific NC functions:

- Velocity: feed hold, override, reduced velocity (safety)
- interrupt/resume, abort, move backward

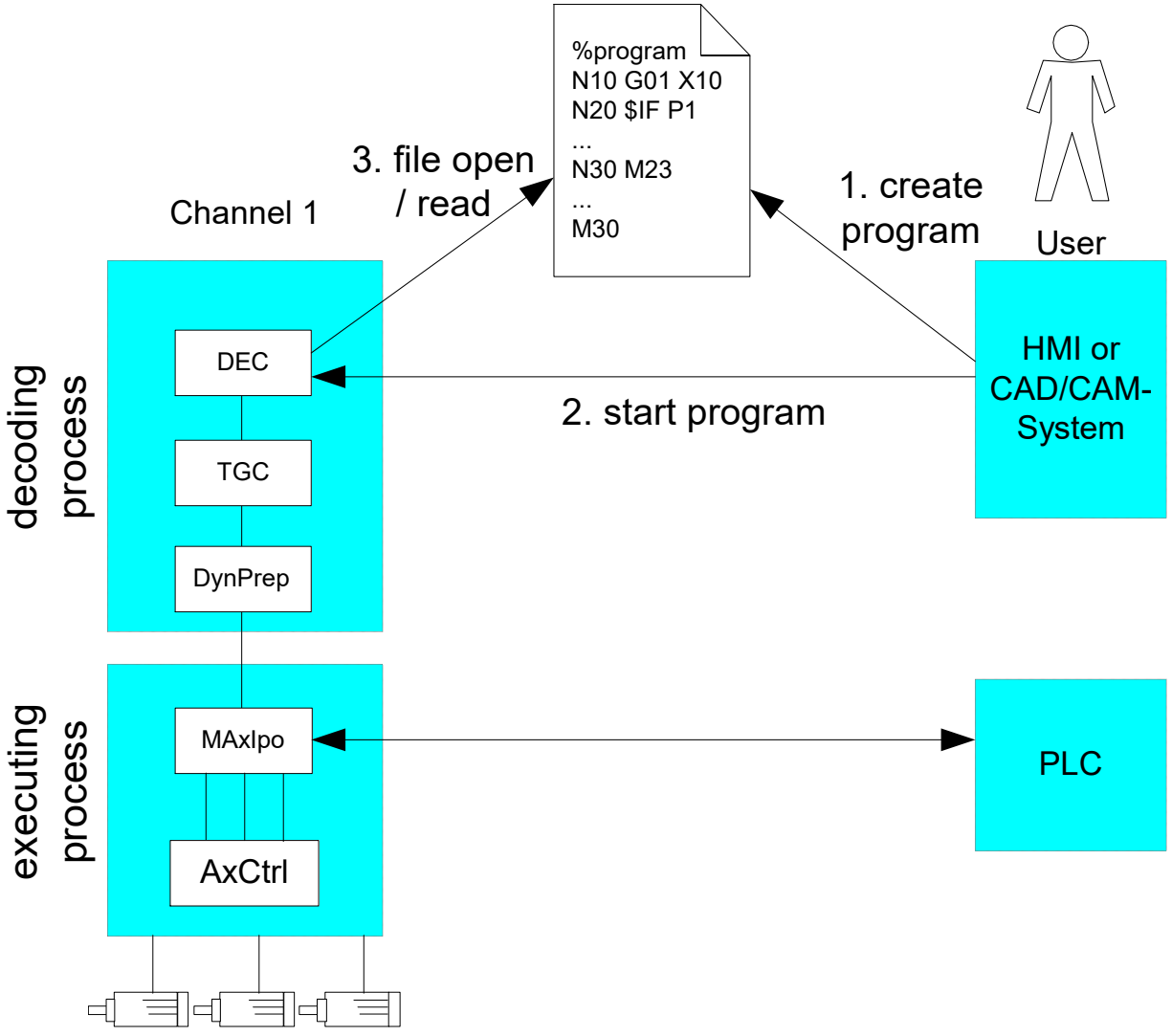


Fig. 6: Online influences by the PLC

Function/action	Automatic program	Data streaming
Start/initialise NC status data	Each time the program is started, the channel's default settings are restored, i.e. programs do not influence each other globally (exception: modal parameters, etc.).	Only at the start of streaming, i.e. status data of the NC remains valid throughout the duration of streaming
Response to errors	NC reset with reset of NC status data	NC reset with reset of NC status data

Function/action	Automatic program	Data streaming
		An NC reset without reset of the NC is currently not possible.
Data throughput	Implicit by access to the file system	Provided by filling the data stream "in good time", i.e. axis motion can be interrupted by delaying filling.
Velocity planning, look ahead (HSC)	Cross-block velocity planning is possible to the full extent	Planning limited, may be only possible for the specified blocks
Process changes	No longer possible after program start if branches (e.g. via external variables) are not already considered in the program.	Program parts not yet specified can still be modified.
Jumps/loops	Jumps to program flags possible, higher-level language constructs with loops possible	No return jumps possible, no loop programming possible
Fast forward	Via block search (jump to block number, block counter, file position) -> system state at forward position is established automatically	By programming system with corresponding omission of forward areas -> system state at forward position must be established manually.
Backward motion	NC functions, possible at any time by PLC command	Via NC functions or by specifying an inverted data stream
Automatic geometry changes at the block transitions (phases, radii, smoothing, splines, etc.)	Possible via standard NC functions	By CAD/CAM system, no consideration of several path segments in the NC because execution is always enabled immediately. Without implicit #FLUSH, also possible by NC
Tool radius compensation	Standard NC function	To be executed by CAD/CAM system Without implicit #FLUSH, also possible by NC

3 Parameter

3.1 Overview

Constant	Description
MAX_PROGRAM_STREAM_SIZE	4094: Maximum size of the data stream in bytes
MAX_PROGRAM_STREAM_INPUT_SIZE	992: Maximum size of a data packet in bytes that is transferred with each write access.

ID	Parameter	Description
P-CHAN-00158	streaming_prog_file	Name of the file (main program/global subroutine) that automatically triggers a changeover to streaming mode when it is started.
COM interface	mc_program_stream_w	Interface object to describe the data stream.

3.2 Description

P-CHAN-00158	**Program name for automatic streaming**
Description	When this program is opened as a main program or a subroutine, the ASCII data is not read in from the file system, but is requested from the data streaming interface. The data input is therefore diverted transparently to the streaming interface. If the program name is not entered, the streaming function can not be activated
Parameter	streaming_prog_file
Data type	STRING
Data range	<empty_string>: Streaming function deactivated (default). <prog_name>: Name of the file (main program/global subroutine) that automatically triggers a changeover to streaming mode when it is started.
Dimension	----
Default value	*
Remarks	Parameterisation example: *streaming_prog_file streaming.nc (name of streaming program)* * Note: The default value of variables is a blank string.

Data stream for incremental program commanding	
Description	This COM interface object can write the data stream with incremental NC commands. One complete NC line must always be written. Several NC lines may also be written jointly in one write access. Each NC line must be terminated by a carriage return (ASCII value = 13) and line feed (ASCII value = 10).
Type	String; the string length depends on the application
Value range	ASCII characters
HMI elements	mc_program_stream_w
Access	Read, write
IndexOffset	0x90 (IndexGroup = 0x000201<ii> where <ii> = channel)

4 Error handling

4.1 Exceptional situations and error cases

NC line incorrectly terminated

Each NC line must be terminated by a carriage return (ASCII value = 13) and line feed (ASCII value = 10). If this is not the case, processing is aborted with the error message 21476 "Streaming data does not contain a correct line end marker". (P-ERR-21476)

Syntax errors

Miscellaneous syntactical errors in the data stream are reported in the same way as a comparable error in the NC program.

4.2 Data transfer via COM object

Data is transferred via the COM object "mc_program_stream_w" to the CNC.

If the CNC is unable to currently accept new data the CNC message 11012 – “Error writing the object” (warning) is output. At the same time, writing the CNC object causes a negative acknowledgement.

The object must be re-written in one of the next cycles.

Using the streaming interface this message recurs repeatedly if a large volume of data is written at short time intervals.

For correctly implemented clients, the message is non-critical and therefore classified as a warning.

5 Example

Test: driver for file in data stream

```
#define ISGPORT_COMTASK 553
#define IDS_OFFSET_COM_DATA_STREAM 0x90

idx_group = 0x20100 + channel_nr;
idx_offset = IDS_OFFSET_COM_DATA_STREAM;


BOOLEAN write_line_to_stream( char * p_source, unsigned length)
{
int result;
result = AdsSyncWriteReq( p_amsAddr,
idx_group,
idx_offset,
length,
p_source);
if (0 != result)
return FALSE;
return TRUE;
}




while (NULL != fgets( inLine, MAX_LINE_LEN, pInFile))
{
unsigned long length = strlen( inLine);

// Attention : ensure line closed with "carriage return" & "line feed" !
if (inLine[length-1] == '\n')
{
inLine[length-1] = '\r';
inLine[length++] = '\n';
}

f_ret = write_line_to_stream( inLine, length);
while (FALSE == f_ret)
{
Sleep(500);
f_ret = write_line_to_stream( inLine, length);
printf(".");
}
inLine[length] = 0; // just for correct print
printf("%d/%d) %s", length, c_written_sum, inLine);
c_written_sum += length;
}
```

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