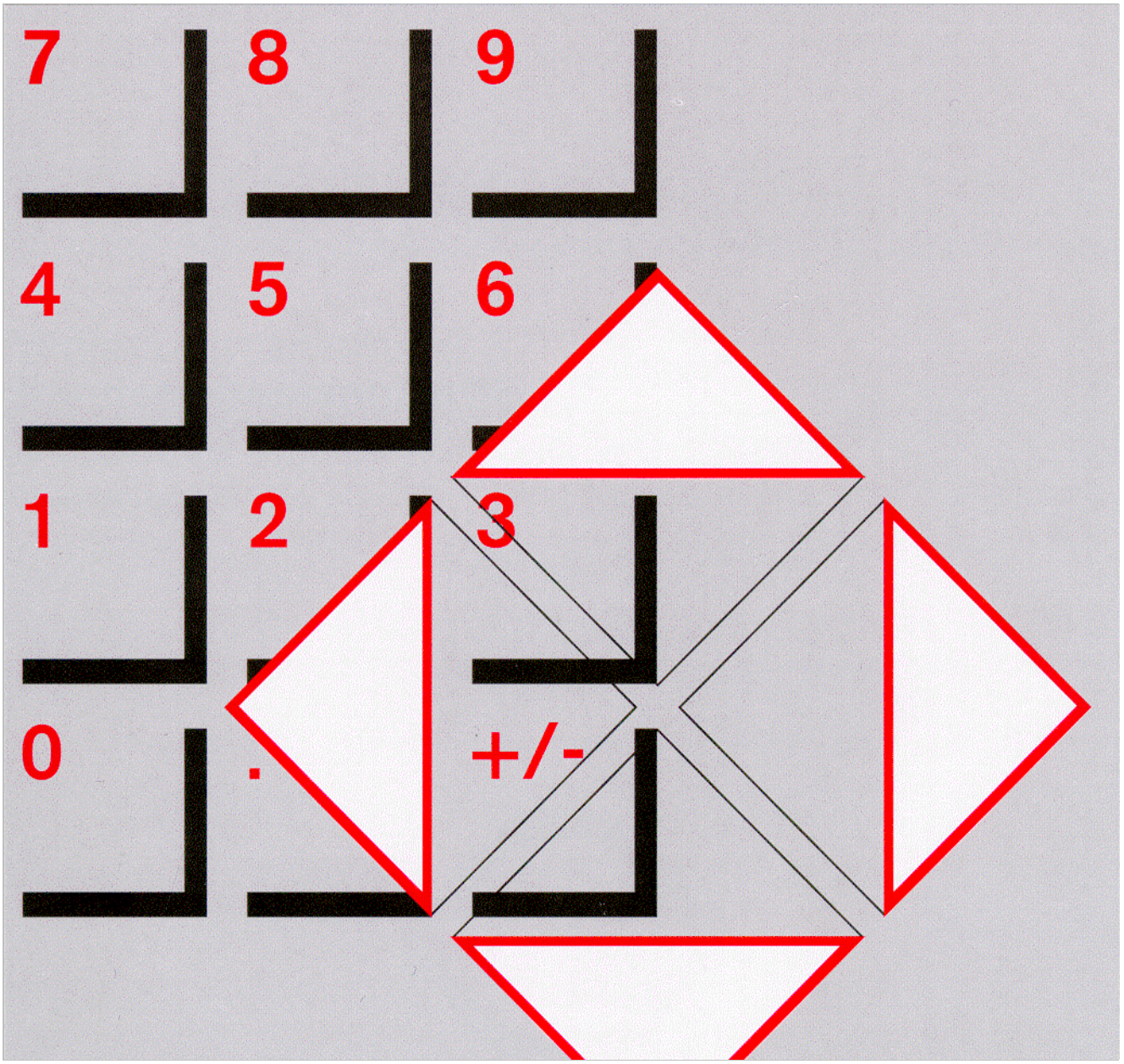
Typ3 osa / PNC

CPL Programming Manual



Edition

111

Rexroth
Bosch Group

Typ3 osa / PNC

CPL Programming Manual

1070 073 740-111 (02.11) GB

Software release: V7.3

Contents

1 Safety Instructions

Please read this manual before using the **CPL** programming language. Store this manual in a place to which all users have access at all times.

1.1 Intended use

This manual contains information required for the proper use of the control unit. For reasons of clarity, however, it cannot contain all details about all possible combinations of functions. Likewise, it is impossible to consider every conceivable case of integration, programming or operation.

The Typ3 osa and PNC controls are used to

- activate feed drives, spindles and auxiliary axes of a machine tool via SERCOS interface for the purpose of guiding a processing tool along a programmed path to process a workpiece (CNC). Furthermore, I/O components are required for the integrated PLC which – in communication with the actual CNC – controls the machine processing cycles holistically and acts as a technical safety monitor.
- program contours and the processing technology (path feedrate, spindle speed, tool change) of a workpiece.

Any other application is deemed improper use!

The products described hereunder

- have been developed, manufactured, tested and documented in compliance with the safety standards. These products pose no danger to persons or property if they are used in accordance with the handling stipulations and safety notes prescribed for their configuration, mounting, and proper operation.
- comply with the requirements of
  - the EMC Directives (89/336/EEC, 93/68/EEC and 93/44/EEC)
  - the Low-Voltage Directive (73/23/EEC)
  - the harmonized standards EN 50081-2 and EN 50082-2
- are designed for operation in industrial environments, i.e.
  - no direct connection to public low-voltage power supply,
  - connection to the medium- or high-voltage system via a transformer.

  In residential environments, in trade and commerce as well as small enterprises class A equipment may only be used if the following warning is attached:

☞ **This is a Class A device. In a residential area, this device may cause radio interference. In such case, the user may be required to introduce suitable countermeasures, and to bear the cost of the same.**

The faultless, safe functioning of the product requires proper transport, storage, erection and installation as well as careful operation.

1.2 Qualified personnel

The requirements as to qualified personnel depend on the qualification profiles described by ZVEI (central association of the electrical industry) and VDMA (association of German machine and plant builders) in:
Weiterbildung in der Automatisierungstechnik
edited by: ZVEI and VDMA
MaschinenbauVerlag
Postfach 71 08 64
D-60498 Frankfurt.

The present manual is designed for

- NC programming personnel and NC project engineers.

These persons need special knowledge of

- the operation, syntax and commands of the CPL and the DIN programming languages.

Programming, start and operation as well as the modification of programs or program parameters may only be performed by properly trained personnel! This personnel must be able to judge potential hazards arising from programming, program changes and in general from the mechanical, electrical, or electronic equipment.

Interventions in the hardware and software of our products, unless described otherwise in this manual, are reserved to our specialized personnel.

Tampering with the hardware or software, ignoring warning signs attached to the components, or non-compliance with the warning notes given in this manual may result in serious bodily injury or material damage.

Only electrotechnicians as recognized under IEV 826-09-01 (modified) who are familiar with the contents of this manual may install and service the products described.

Such personnel are

- those who, being well trained and experienced in their field and familiar with the relevant norms, are able to analyze the jobs being carried out and recognize any hazards which may have arisen.
- those who have acquired the same amount of expert knowledge through years of experience that would normally be acquired through formal technical training.

With regard to the foregoing, please note our comprehensive range of training courses. Please visit our website at http://www.boschrexroth.de for the latest information concerning training courses, teachware and training systems. Personal information is available from our Didactic Center Erbach, Telephone: (+49) (0) 60 62 78-600.

1.3 Safety markings on products

Warning of dangerous electrical voltage!

Warning of danger caused by batteries!

Components sensitive to electrostatic discharge!

Warning of hazardous light emissions (optical fiber cable emitters)

Disconnect mains power before opening!

Pin for connecting PE conductor only!

Connection of shield conductor only

1.4 Safety instructions in this manual

DANGEROUS ELECTRICAL VOLTAGE
This symbol is used to warn of a **dangerous electrical voltage.** The failure to observe the instructions in this manual in whole or in part may result in **personal injury**.

DANGER
This symbol is used wherever insufficient or lacking compliance with instructions may result in **personal injury**.

CAUTION
This symbol is used wherever insufficient or lacking compliance with instructions may result in **damage to equipment or data files**.

☞ This symbol is used to draw the user's attention to special circumstances.

★ This symbol is used if user activities are required.

1.5 Safety instructions for the described product

DANGER
Danger of life through inadequate EMERGENCY-STOP devices!
EMERGENCY-STOP devices must be active and within reach in all system modes. Releasing an EMERGENCY-STOP device must not result in an uncontrolled restart of the system!
First check the EMERGENCY-STOP circuit, then switch the system on!

DANGER
Risk of personal injury and equipment damage!
Always subject new programmes to initial tests while inhibiting axis movements. For this purpose, as a function of the AUTOMATIC mode, the controller provides the option to block axis movements or auxiliary functions by means of special softkey commands.

DANGER
Incorrect or undesired control unit response!
Rexroth accepts no liability for damage resulting from the execution of an NC program, an individual NC block or the manual movement of axes!

Furthermore, Rexroth accepts no liability for consequential damage which could have been avoided by programming the PLC appropriately!

DANGER
Retrofits or modifications may adversely affect the safety of the products described!
The consequences may include severe injury, damage to equipment, or environmental hazards. Possible retrofits or modifications to the system using third-party equipment therefore have to be approved by Rexroth.

DANGEROUS ELECTRICAL VOLTAGE
Unless described otherwise, maintenance works must be performed on inactive systems! The system must be protected against unauthorized or accidental reclosing.

Measuring or test activities on the live system are reserved to qualified electrical personnel!

DANGER
Tool or axis movements!
Feed and spindle motors generate very powerful mechanical forces and can accelerate very quickly due to their high dynamics.

- **Always stay outside the danger area of an active machine tool!**
- **Never deactivate safety-relevant functions!**
- **Report any malfunction of the unit to your servicing and repairs department immediately!**

CAUTION
Use only spare parts approved by Rexroth!

CAUTION
Danger to the module!
All ESD protection measures must be observed when using the module! Prevent electrostatic discharges!

The following protective measures must be observed for modules and components sensitive to electrostatic discharge (ESD)!

- Personnel responsible for storage, transport, and handling must have training in ESD protection.
- ESD-sensitive components must be stored and transported in the prescribed protective packaging.
- ESD-sensitive components may only be handled at special ESD-workplaces.
- Personnel, working surfaces, as well as all equipment and tools which may come into contact with ESD-sensitive components must have the same potential (e.g. by grounding).
- Wear an approved grounding bracelet. The grounding bracelet must be connected with the working surface through a cable with an integrated 1 MΩ resistor.
- ESD-sensitive components may by no means come into contact with chargeable objects, including most plastic materials.
- When ESD-sensitive components are installed in or removed from equipment, the equipment must be de-energized.

1.6 Documentation, software release and trademarks

Documentation

The present manual provides information on the operation, syntax and commands of the CPL programming language.

☞ **The present manual applies only to CPL programming of the CNC. Subjects related to DIN programming are covered in a separate manual.**
For programming of manufacturer-specific (MTB) cycles, please refer to the applicable documentation of the machine-tool builder.

Overview of available documentation	Part no.		
	German	English	French
Typ3 osa – Connectivity Manual for project engineering and maintenance	1070 073 704	1070 073 736	–
Typ3 osa – Software installation	1070 073 796	1070 073 797	–
PNC – Connectivity Manual	1070 073 880	1070 073 881	–
PNC – BF2xxT/BF3xxT Control Panel Connectivity Manual	1070 073 814	1070 073 824	–
PNC – Software installation	1070 073 882	1070 073 883	–
Description of functions	1070 073 870	1070 073 871	–
MACODA Operation and configuration of the machine parameters	1070 073 705	1070 073 742	–
Operating instructions – Standard operator interface	1070 073 726	1070 073 739	1070 073 876
Operating instructions – Diagnostics Tools	1070 073 779	1070 073 780	–
Error Messages	1070 073 798	1070 073 799	–
PLC project planning manual, Software interfaces of the integrated PLC	1070 073 728	1070 073 741	–
iPCL system description and programming manual	1070 073 874	1070 073 875	–
ICL700 system description (Typ3 osa only), Program structure of the integrated PLC ICL700	1070 073 706	1070 073 737	–
DIN programming manual for programming to DIN 66025	1070 073 725	1070 073 738	–
CPL programming manual	1070 073 727	1070 073 740	–
CPL Debugger Operating Instructions	1070 073 872	–	–
Tool Management – Parameterization	1070 073 782	1070 073 793	–
Software PLC Development environment for Windows NT	1070 073 783	1070 073 792	–
Measuring cycles for touch-trigger switching probes	1070 073 788	1070 073 789	–
Universal Milling Cycles	–	1070 073 795	–

☞ **In this manual the floppy disk drive always uses drive letter A:, and the hard disk drive always uses drive letter C:.**

Special keys or key combinations are shown enclosed in pointed brackets:

- Named keys: e.g., <Enter>, <PgUp>, <Del>
- Key combinations (pressed simultaneously): e.g., <Ctrl> + <PgUp>

Release

☞ **This manual refers to the following version:**
Software: V7.3

The current release number of the individual software modules can be viewed by selecting the 'Control-Diagnostics' softkey in the 'Diagnostics' operating mode.

The software version of Windows 95 or Windows NT may be displayed as follows:

1. Click with right mouse key on the 'My Computer' icon on your desktop.
2. Select menu item 'Properties'.

Trademarks

All trademarks of software installed on Rexroth products upon delivery are the property of the respective manufacturer.

Upon delivery, all installed software is copyright-protected. The software may only be reproduced with the approval of Rexroth or in accordance with the license agreement of the respective manufacturer.

MS-DOS® and Windows™ are registered trademarks of Microsoft Corporation.

PROFIBUS® is a registered trademark of the PROFIBUS Nutzerorganisation e.V. (user organization).

SERCOS interface™ is a registered trademark of the Interessengemeinschaft SERCOS interface e.V. (SERCOS interface Joint VDW/ZVEI Working Committee).

2 CPL – Basic Elements

The objective in the development of the **C**ustomer **P**rogramming **L**anguage (**CPL**) was to provide the user with extended options for DIN programming. CPL makes it possible to write and store any machining operation in the form of sub-programs in a variety of formats.

With regard to its handling procedures and the available selection of its language elements, CPL adheres to the BASIC high-level language standard. As a consequence, in addition to an appropriate degree of language comprehensiveness, CPL is also easy to learn. For advanced applications, structural elements similar to PASCAL are provided.

The application of CPL will facilitate:

- shortening of repeat procedures in NC programs and similar program segments, and
- status-dependent program variants as a result of access to NC system data.

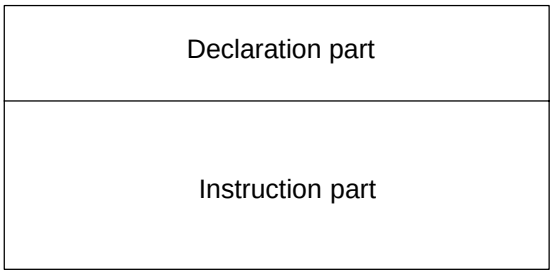
CPL functions can be utilized in the processing sequences of main and sub-programs.

2.1 Program structure

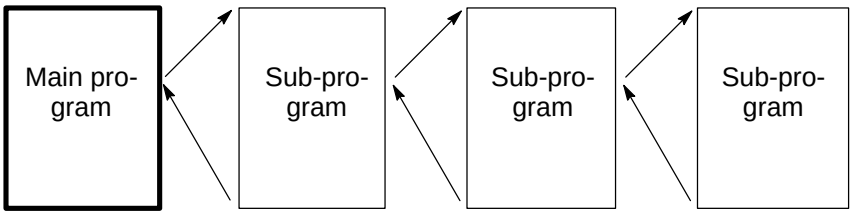
A program generally consists of a declaration part and an instruction part, the latter of which, although not being a mandatory requirement for CPL, may still serve to provide an improved overview of the program.

For example, the declaration part may be used to comment names of variables, to dimension field variables or to assign variables. Also, fixed values can be listed in a list of constants, thus reducing the effort required in the event of modifications. Detailed information on this subject appears further on in this manual.
The instruction part provides the symbolic description of program execution. This is accomplished by means of instructions linking data with the aid of symbol names and operators.

Program



From within a particular program (main program), other programs can be executed by invoking sub-program calls. Once the execution of a sub-program call has been concluded, the main program will continue to run from that point onward. Sub-programs, in turn, can accommodate further sub-program calls. CPL permits a maximum 7-fold nesting depth.



In accordance with existing formal input stipulations, CPL instructions are usually written in capital letters. A formal input comprises the correct syntax of reserved instruction words, thus preventing possible confusion with names of variables.

A consequence of increasing program size is the increased demand for clean programming. Besides comprehensible constants and designations of variables, clean programming mainly includes

- structured programming,
- fault tolerance, and
- software ergonomics.

Generally speaking, structured programs tend to be clearer in their overall architecture. A practice providing several advantages is that of bundling program segments serving related purposes or containing frequently used functions into (parameterized) sub-programs or under a single jump destination. With the added identification by a comprehensible designation (label), and because the respective functions are very often utilized by other programs, this practice, besides resulting in improved readability of the referred programs, also provides the benefit of preventing duplication of effort. Although it should be noted that this approach to programming cannot fully exclude the occasional requirement for programming tricks; it stands to reason that any programmer would best serve his own interest by annotating such tricks with the appropriate comments.

Error-tolerant (fault-forgiving) programs present a significant challenge because experience indicates that the creativity and imagination evidenced by users during the input dialog by far exceeds the capabilities of the most creative and imaginative programmers. The foregoing observation notwithstanding, unfailing attempts on the part of the programmer must be directed toward making his program creation as failure-proof and error-tolerant as possible.

The number of input errors can also be reduced through the observation of software ergonomics. For example, menu options can be visually highlighted without great effort. In doing so, and while making full use of the pertinent capacities inherent in the computer, good judgement should be used in order not to use an excessive variety of colors. The stipulations of the DIN 66 234 standard provide excellent guidelines in this regard.

2.1.1 NC block

In accordance with programming guidelines as stipulated in the DIN standard, a complete CPL instruction is also referred to as a CPL block. Because parts programming may utilize a combination of NC blocks and CPL blocks, a brief discussion of NC blocks appears in order.

NC blocks conform to DIN 66 025 and contain standard information, such as preparatory functions, axis positioning and auxiliary functions. These are programmed with the use of either N-block number or by omitting the block number.

Example:

```
N100 G1 X150 Y100.525
or
G1 X150 Y100.525
```

For further details, please refer to the DIN programming manual.

With the use of CPL it is also possible to write the word contents within a particular NC block (with the exception of N-addresses) in a syntax that includes variables. This makes it possible to effect parameterization of processing operations. It is instructive to note, however, that this practice must not be employed in order to exert, during runtime, an influence on the program flow that could not have been already considered during the linking process. The following example shows the application of variables in a sub-program with the three parameters named P1, P2 and P3.

Example:

```
.
5    XVALUE=P1 : FEED=P2 : COMPTAB=P3 : M3=3
N10 G1 X[XVALUE]F[ FEED*2+1000]M[M3]
N20 G22   K[COMPTAB]
M30
.
```

The parameter values are transferred in the sub-program call of the main program. The **square brackets [ ]** depict the use of variables. Block N10 indicates that not only the names of variables but also entire CPL expressions may be used while enclosed in square brackets.

☞ **None of the addresses invoking a sub-program are intended for variable syntax.**

2.1.2 CPL block

A CPL block consists of an instruction or declaration that is preceded by a line number.
If a CPL block concludes with a colon ":" or a <LINE FEED> character, it must be followed by another CPL block without a line number.

Example:

```
.
.
30  IF X%=3  THEN GOTO 150 ENDIF:
 REM JUMP DESTINATION1
40 IF X%=4 THEN GOTO 200 ENDIF : REM JUMP DESTINATION2
50 WAIT
60 XPOS=MPOS(1) : YPOS=MPOS(2) : ZPOS=MPOS(3)
N100 G90
N110 G1 X[XPOS] Y[YPOS] Z[ZPOS]
 115 REM Travel at G1
N120 G0 X0 Y0 Z0
.
```

☞ **The colon can also be interpreted as marking a comment within an REM instruction. In this case the colon does not separate two CPL blocks.**

A <LINE FEED> identifies the programmed line end. It is automatically inserted into the program text by pressing the ENTER key. However, the <LINE FEED> character is neither visible on the screen nor on the hardcopy. In the event that a CPL block does not conclude with a colon, only a CPL block with a line number or an NC block may follow.

2.2 Start of program

A CPL program is normally selected in the  operating mode, and started by means of CYCLE START. These programs must either be composed exclusively of CPL blocks, or they may comprise combinations of both NC and CPL blocks.

2.3 Linking

Subsequent to program selection via ”CPL Prog” status (toggle softkey), the program is first checked for proper syntax, and for possible jump destinations and sub-program calls. This process is termed ”linking” or ”preparing”. It results in the creation of a so-called link table.

☞ **Only a CPL program that has been linked can be started.**

The control unit stores all link tables in a special directory defined by the MACODA parameter 3080 00004. In this process, the filenames identifying link tables are formed from the name of the selected program and the filename extension ”.l” (l = Link).

While it is starting up, the control unit tries to find the relevant program for all the existing link tables. To do this the search path from MACODA parameter 3080 00001 is used.
Link tables for which no program exists are erased.

If a program is selected again, the Typ3 osa uses an existing link table, provided that the program has not been modified in the interim. If the program has been changed, it will be linked again.

In the event that sub-programs are called in the program to be linked, the control unit will check whether updated link tables exist for the respective programs.
If this is the case, such sub-programs will not be linked again. This may significantly accelerate the linking process for a main program incorporating numerous sub-program calls.

2.4 Symbol names

A typical feature of programming languages such as CPL is symbolic programming. Symbol names represent variable or permanently preset numerical values, and link instructions for this data. The following tables list those keywords that are reserved exclusively for use in instruction words.

2.4.1 Reserved instruction words

The key terms listed below must be used in stand-alone fashion or delimited by special characters, immediately identifying them as instruction words. The selection of names for variables must not encompass any reserved instruction words!

Example:

`GOTO 10` → Jump to line 10

`GOTO10` → Definable symbol name (variable); on its own it will lead to error message RUNTIME ERROR 2167 = MISSING, because a value assignment is expected for the GOTO10 variable.

Key terms:

A:	ABS	AXP	**B:**	BCD	**C:**	CASE	CLS	**D:**	DATE		
	ACOS			BIN		CALL	COF		DIM		
	AND			BMP		CHR$	COL		DLG		
	APOS					CIR	*) COM		DLF		
	ASC					CLG	COS		DO		
	ASIN					CLOCK	CPROBE		DSP		
	ATAN					CLOSE	CPOS		DPC		
	AXO					CLR	CSF				
E:	ELSE		**F:**	FALSE	*) FIXB	**G:**	GETERR		**I:**	IC	
	END			FIL	*) FIXE		GMD			IF	
	ENDDLG			FILEACCESS	FOR		GOTO			INKEY	
	ENDIF			FILEDATE	FXC		GPR			INP	
	ENDCASE			FILEPOS	FXCR		GWD			INP#	
	EOF			FILESIZE	FXDEL					INSTR	
	ERASE			*) FIX	FXINS					INT	
L:	LABEL		**M:**	MCA	MID$	**N:**	NCF	NOT	**O:**	OF	OR
	LEN			MCODS	MMC		NEXT	NUL		OPENR	
	LIN			MCOPS	MPOS		NJUST			OPENW	
	LJUST			*) MIC	MWD					OTHERWISE	
P:	PDIM		**R:**	REM		**S:**	SCL	SIN	**T:**	TAN	THEN
	PLC			REPEAT			SCS	SPOS		TC	TIME
	PPOS			REWRITE			SD	SQRT		*) TD	TRIM$
	PRN			RGB			SDR	STEP		TDA	TRUE
	PRN#			ROUND			SEEK	STR$		*) TDR	*) TXT$
	PROBE						SFK			TFO	
U:	UNTIL		**V:**	VAL		**W:**	WAIT		**X:**	XOR	
							WHILE				
							WPOS				

*) reserved keywords currently not in use

CPL uses the following **code characters**:

#	**!**	**?**	**,**	**”**	**[**	**]**	**<**	**–**	**/**	**&**
@	**%**	**$**	**:**	**(**	**)**	**=**	**>**	**+**	*****	

The comma is normally used as a delimiter. It is used as a grammatical punctuation mark only within character strings. The period is used as a decimal point in decimal numbers, and as a label identifier in jump destinations. Within character strings, the period is interpreted as a grammatical punctuation mark.

2.4.2 Constants

If numerical values are declared for program execution and are to remain unchanged (constant) such values may be entered into the instructions as a numerical expression.

Integer constant (INTEGER)

Integers are written without decimal points.

Example:

```
NUMBER% = 4
```

INTEGER constant

Floating-point constant (REAL)

Real numbers (decimal numbers or fractions) are identified by a decimal point (floating point).

Example:

```
PI = 3.141593
```

REAL constant

Double-precision constant and double-precision operations

Constants assigned to, or compared with, a double-precision REAL variable, are represented with double precision, i.e. precise to 15 digits.

Example: Assignment of double-precision REAL constants, and comparing variables with double-precision REAL constants.

```
4  D5! = -1234.123456 + 12345 + 1234.234567
20 D0! = 123456789.123456
22 D1! = 1.12345678901234
24 D2! = -123456789012345
26 D3! = -1234.123456
```

The following queries produce the result E? = TRUE

```
28 IF D0! = 123456789.123456 THEN E? = TRUE ELSE E? = FALSE ENDIF
29 IF D1! = 1.12345678901234 THEN E? = TRUE ELSE E? = FALSE ENDIF
30 IF D2! = -123456789012345 THEN E? = TRUE ELSE E? = FALSE ENDIF
31 IF D3! = -1234.123456 THEN E? = TRUE ELSE E? = FALSE ENDIF
32 IF D0! + 2.1 + 3.1 = 123456789.123456 + 2.1 + 3.1 THEN
33 E? = TRUE
34 ELSE
35 E? = FALSE
36 ENDIF
37 IF (D0! + 2.1) + 3.1 = 123456789.123456 + 2.1 + 3.1 THEN
38 E? = TRUE
39 ELSE
40 E? = FALSE
41 ENDIF
```

Character string constant (STRING)

A character string constant is limited by quotation marks (inverted commas).

Example:

```
EXAMPLE$ = "This is a character string"
```

STRING constant

2.4.3 Variables

If it is deemed desirable that data remains subject to change (i.e. variable) during program execution, this data will be defined by means of expressions containing variables. Variables are definable symbol names for which, in CPL, some declarations must be effected. The most important declaration is the unambiguous choice of a name for the variable.
However, variable names may not include reserved instruction words, also termed keywords.
The name of the variable may consist of any sequence of capital letters and numbers, the only stipulation being that the first character must be a capital letter.
As CPL uses only the first 8 characters of the name of the variable to distinguish variables, these 8 characters are termed significant. However, in order to enhance program documentation, the name of the variable itself may be longer than 8 characters.

Examples of local, global and permanent variables:

```
10 NUMBER1% = 1   local INTEGER variable
20 #NUMBER2% = 2  global INTEGER variable
30 @36% = 3       permanent INTEGER variable
40 @ABCD% = 4     defined permanent INTEGER variable
```

Groups of variables

Declarations with regard to the effective range of variables are required due to the option of using sub-programs, and also due to the possible requirement to commit the values of variables to intermediate storage independent of the respective program being executed. To this end, a distinction is made between the following groups of variables:

Local variables
take effect only within the program for which they have been declared. As the referred program reaches the end of program (EP), the variables are deleted, thus releasing the respective memory addresses. In the case of a sub-program call, the name of a variable that is local with respect to the main program will not be ”visible” to the sub-program. However, the same variable can also be declared as a local variable in the sub-program without consequential interference due to the similarity of their respective names. Upon return to the main program, the original local variable will again be available, bearing the value that was current at the time the sub-program was invoked from within the main program.

Global variables
are identified by a leading ”#” (number sign, gate or hash) character that is followed by the name of the variable. Once a value has been assigned to a global variable, it can be accessed, read and/or modified from within all program parts for the remainder of the entire program. Global variables are again deleted subsequent to end of program (EP).

☞ **In the case of global variables the # symbol counts as part of the name of the variable. For this reason, the symbol ”#” and the following 7 characters form the significant name of the variable!**

Permanent variables
are identified by a leading ”@” (*at* symbol) character followed by the name of the variable. They can be addressed from within any active program. The variable will be permanently retained even subsequent to EP. Deletion is possible only through direct overwriting. As permanent variables are stored in a separate memory range, clearing the entire memory will not affect the permanent variables.

Under the designation @1 through @100, permanent variables of the “INTEGER” type can be addressed (for detailed information on the INTEGER type, see ’Types of variables’ on page 2–12). To improve program readability, the indication of such permanent variables can also be augmented by appending letter characters to the number.
In addition, the permanent one-dimensional field variable @_R can be used with 100 elements of ”Double”. The two permanent variables @_RES_DOUBLE and @_RES_DWORD are reserved for internal applications and should not be used.

Definable permanent variables
are also identified by a leading ”@” character followed by the name of a variable.
The distinguishing characteristics of “permanent variables” are as follows:

1. Definable permanent variables are not automatically declared as a component of the system software but **manually declared** via user entry in the files named wmhperm.dat (for proprietary data supplied by the machine tool manufacturer) and anwperm.dat (for end user-specific data). The declaration syntax is discussed under ”File structure of wmhperm.dat and anwperm.dat,” below.
   During system start-up, the control searches for the files first in the root directory, then in the user FEPROM, and finally in the FEPROM.
   The control system interprets the file identified by the first occurrence of the respective filename, using the entries found therein to create definable permanent variables, provided they do not already exist. Existing definable permanent variables that are not declared in one of the above-named files will be deleted.
   The maximum possible number of definable permanent variables is dictated by the available memory capacity. In the event that no more memory capacity is available for generating variables, the Typ3 osa/PNC will return an appropriate fault message.
2. The names of definable permanent variables always begin with the **”@” character and a character string**. This character string consists of one capital letter character, followed by any combination of capital letter or alphanumeric characters.
   In the case of the definable permanent variables, the first **16 characters** of the name of the variable are significant. If two names of variables exhibit a difference only with the 17th character and following, CPL will interpret them as one single variable!
3. Defined permanent variables may be of the **INTEGER, REAL, DOUBLE, BOOLEAN or CHARACTER** type.
   The type of the variable is specified by appending an identifier to the end of the name of the variable. This specification must be entered into the part program:
   `@ABCD%` defined permanent variable of INTEGER type
   `@EFGH` defined permanent variable of REAL type (without %, !,$ or ?)
   `@IJKL!` defined permanent variable of DOUBLE type
   `@MNOP?` defined permanent variable of BOOLEAN type
   `@QRST$` defined permanent variable of CHARACTER type
4. One- and two-dimensional **fields** may be used.
   The **maximum field index** is **65535** with field variables of the INTEGER, REAL, DOUBLE or BOOLEAN type. With field variables of the CHARACTER type, the maximum field index is **1024**.

Examples:

```
@WZNR%(1)=4          The first variable (with Index 1) of
                     the 1-dimensional field @WZNR of the
                     INTEGER type is assigned the value 4.

@WZKOR(2,2)=0.2      The variable (with the indexes 2.2)
                     within the 2-dimensional field @WZKOR of
                     the REAL type is assigned the value 0.2.
```

5. Estimating the available **number** of newly definable permanent variables:
   - Total memory space for permanent variables:
     100 Kbyte (102400 byte)
   - In versions smaller than V6.0: 15 Kbyte (15360 byte).
     Thus the number of maximum possible variables is reduced.

Pos.	Reserved for	Memory space (as of V6.0) in bytes	Comment
1	all permanent variables	**102400**	Total memory
	of which the following are reserved for		
2	@1 – @99 (permanent variables)	800	
3	administrative information	24	
4	**all definable permanent variables**	**101576**	(4) = (1) – (2) – (3)

Pos.	Reserved for	Memory space in bytes	Comment
4	all definable permanent variables	101576	(4) = (1) – (2) – (3)
	of which the following are reserved for		
5	@_R	823	Permanent field variables with 100 elements of the type DOUBLE
6	@_RES_DOUBLE	40	Permanent variables of the type DOUBLE, reserved for **internal** applications
7	@_RES_DWORD	35	Permanent variables of the INTEGER type, reserved for **internal** applications
8	**newly defined permanent variables**	**100678**	(8) = (4) – (5) – (6) – (7)

Each definable permanent variable occupies the following memory space:

Pos.	Reserved for	Memory space in bytes	Comment
9	the names of the permanent variables	max. 16	1 byte per character
10	the value of the definable permanent variables	1, 4 or 8	Integer: 4 bytes Double: 8 bytes Real: 4 bytes Boolean: 1 byte
11	administrative information	20	
12	a definable permanent variable of the DOUBLE type with a name length of 16 characters	44	e.g.: **maximum** assignment of memory space (9) + (10) + (11)

Number of ”definable permanent variables” of the types DOUBLE and INTEGER:

Variable type	Number of variables	Comment
Type DOUBLE with a name length of max. 16 characters	**2288**	100678/44=2288
Type INTEGER with a name length of max. 16 characters	**2516**	100678/(16+4+20) =2516
Type INTEGER with a name length of max. 8 characters	**3146**	100678/(8+4+20) =3146
Field variables with name lengths of max.16 characters, Type INTEGER	**25160**	(100678–16–20)/4 =25160
Field variables with name lengths of max.16 characters, Type DOUBLE	**12580**	(100678–16–20)/8 =12580

File structure of “wmhperm.dat” and “anwperm.dat” files:

The files may contain only declarations of “definable permanent variables”. Each declaration occupies a separate line, and concludes with a RETURN.

A line of declaration always exhibits the following structure:

DEF *<type of variable>* **@***<name of variable>***;** *[<comment>]*

Examples of ”wmhperm.dat” and ”anwperm.dat”:

```
DEF INT @ABCD         ;simple INTEGER variable
DEF REAL @EFGH        ;simple REAL variable
DEF DOUBLE @IJKL      ;simple DOUBLE variable
DEF BOOL @MNOP        ;simple BOOLEAN variable
DEF CHAR @PSTR1(3)    ;CHARACTER variable with a length of 3
DEF INT @WZNR(9)      ;1-dimensional INTEGER field with 9 variables
DEF INT @WZKOR(9,2)   ;2-dimensional REAL field with 18 variables
DEF CHAR @PSTR2(9,2) ;2-dimensional CHARACTER field with
                       9 partial strings of 2 characters each
```

Application examples of perm. variables in the program:

```
10 @1 = 1
15 @2_COUNTER = 2
20 @ABCD% = 3
25 @EFGH = 4.1
30 @IJKL! = 5.12345
35 @MNOP? = TRUE
40 @PSTR1$ = "ABC"
45 @WZNR%(2) = 6
50 @WZKOR(3,2) = 7.6
55 @PSTR2$(3) = "DE"
```

Types of variables

INTEGER variable

An INTEGER variable occupies 32 bits of memory space. It is identified by a "%" (percentage) character appended to the name of the variable. The value range extends from –2.147.483.648 through +2.147.483.647.

```
10  NUMBER% = 4
```

INTEGER variable

Floating-point variable (REAL)

If no special identification is appended to the name of the variable, the variable will be interpreted as a REAL variable of single precision.
In this case, the variable occupies 32 bits of memory space. The range of values encompasses +/–10^{38}, this being the equivalent to 7 significant digits.

```
10 PI = 3.141593
```

REAL variable with single precision

Floating-point variable (DOUBLE)

If an exclamation mark "!" is appended to the name of the variable, the variable will be interpreted as a REAL variable with **double precision**.
In this case, a variable occupies 64 bits of memory space. The value range encompasses +/– 10^{308}, this being the equivalent of 15 significant digits.

```
10 PI! = 3.141592653589793
```

REAL variable with double precision

Logical variable (BOOLEAN)

Logical variables are identified by a ”?” question mark that is appended to the name of the variable. Logical variables (Boolean variables) can assume only the values **TRUE** or **FALSE**. They are used to store logical statuses or conditions that will be needed throughout the course of program execution.

```
10 START? = FALSE
```

BOOLEAN variable

Field variable (ARRAY)

The use of ARRAY variables makes it possible to reserve, under a single designation, a one or two-dimensional field (array), consisting of one or more variables of the same type, within the memory range.
Field definitions are possible for variables of the INTEGER, REAL, DOUBLE, BOOLEAN and CHARACTER types. To enable access to the individual field elements of an array, the field index and/or indices are specified in addition to the name of the field variable.

Example: Dimensioning an ARRAY variable

```
10 DIM FIELDVAR (2,3)
```

INTEGER constant for field sizes (index)
Name of variable (REAL variable)
DIM instruction word

Example: Access to Array variable

```
100  FIELDVAR(1,1)   = MPOS(1)
110  FIELDVAR(2,1)   = CPOS(1)
120  FIELDVAR(1,2)   = MPOS(2)
130  FIELDVAR(2,2)   = CPOS(2)
140  FIELDVAR(1,3)   = MPOS(3)
150  FIELDVAR(2,3)   = CPOS(3)
```

Prior to the initial access to the field variables, the index range and/or the field size must be dimensioned with INTEGER constants:

- Field size of the field variable of the types INTEGER and REAL: max. 65536
- Field size of the field variables of the type CHARACTER: max. 1024

DIM *<name of variable>*(*<fieldsize1>*[,*<fieldsize2>*])

☞ **Dimensioning with DIM may not be applied to ”definable permanent variables”. Instead, the dimensioning of these variables occurs in the file wmhperm.dat or anwpwerm.dat.**

CHARACTER and STRING variables

A CHARACTER variable is identified by a trailing ”$” (dollar) sign. This type of variable can accommodate a single character as well as a complete character string.
However, character string instructions (see section “Processing Character Strings”) are possible only if a character string is stored in a one-dimensional or a two-dimensional field (array) of CHARACTER variables. For this the field must be declared by means of a DIM instruction.
Each CHARACTER variable in this field then contains only one character of the character string.
A one-dimensional field comprised of variables of the CHARACTER type is termed STRING variable. No index is entered when accessing a one-dimensional CHARACTER variable. However, when accessing a two-dimensional CHARACTER variable, an index must be entered

Example:

```
1 REM String variable AB (length 10)
2 DIM AB$(10)
3 REM 3 String variables CD (each at a length of 5)
4 DIM CD$(3,5)
5 AB$ = ”Z”
6 CD$(2) = ”ABC”
```

Overview of variables

Group of variables	Name of variable	Type of variable	Arrays possible? (x=YES)
Local	max. 8 significant characters	% INTEGER REAL ! DOUBLE ? BOOLEAN $ CHARACTER	x x x x x
Global #	incl. ”#” symbol max. 8 significant characters	% INTEGER REAL ! DOUBLE ? BOOLEAN $ CHARACTER	x x x x x
Permanent @	1 – 100		
Definable permanent @	max. 16 significant characters	% INTEGER REAL ! DOUBLE ? BOOLEAN $ CHARACTER	x x x x x

2.5 Instructions

Local as well as global variables can be assigned values. This is accomplished with the use of the ”=” (equals) sign.

Example: Value assignment, BOOLEAN variable

```
1 START?   =   FALSE
```

Value
Assignment symbol (equals sign)
(logical) variable

Example: Value assignment, REAL variable

```
1 X1MIN!   =  2097.876
```

Value (max. 7 digits)
Assignment symbol (equals sign)
double-precision REAL variable

Example: Value assignment between variables

```
1  XSET = XMIN!
```

Value (double-precision REAL variable)
Assignment symbol (equals sign)
single-precision REAL variable

The variable to be assigned a value must be positioned to the left of the assignment symbol, and the respective value to the right. This declaration must be used with special caution especially in cases where the value of one variable is to be assigned to another variable.

NUL

If a value has not been assigned to a variable, it will have the value of NUL. As a consequence, the statement <VARIABLE>= NUL is true. This signifies that the equals sign can also be used in expressions representing comparisons or conditional operations.

If the direct deletion of a local or global variable is desired, this can be accomplished by assigning the NUL value. In contrast, a permanent variable cannot be deleted but requires overwriting.

Example: Deleting a variable

```
1 XSET = NUL
2 IF XSET = NUL THEN
3       PRN#(0,”Variable not assigned.”)
4 ENDIF
```

2.5.1 Arithmetical operations

Besides the assignment of a value in the form of a constant expression (numerical) or a variable, it is also possible to assign the value of a CPL expression to a variable. A CPL expression may contain functions using both constants and variables.

The simplest functions include the four basic arithmetical operations:

Addition	» + «	(plus sign)
Subtraction	» – «	(minus sign)
Multiplication	» * «	(asterisk)
Division	» / «	(slash character)

As a rule, multiplication and division take priority over addition and subtraction. It is also possible to use parentheses, the nesting of which to a depth of seven can be used with simple expressions (containing no function calls).

Example:

```
1 I% = 25: XACTUAL = 10
2 XSET = 150/(100-I%)+XACTUAL    → XSET has the value 12
```

It is also possible to invoke arithmetical functions that act upon variables, constants or CPL expressions which must be placed in rounded brackets immediately behind the respective instruction word. The function always refers to the internal numerical representation of the input value. This representation can be verified during program execution with the use of ”program check.” In the case of nested expressions, and particularly when these contain function calls, the maximum possible nesting depth must be considered. It is dependent upon the memory capacity required by the bracketed expressions during their respective execution.

ABS

Returns the absolute value of the input value, i.e. negative values become positive and positive values remain positive.

Example:

```
1 I% = -125
2 XVALUE = 2*SQRT(ABS(100+I%))   → XVALUE has the value 10
```

INT

Converts the input value (REAL) by cutting of the decimal places (rounding) to a whole number (INTEGER). The input value may be a constant or a variable.

Example:

```
1 XVALUE% = INT(10.9)   → XVALUE has the value 10
```

ROUND

Converts the input value into an INTEGER by rounding it off or up to a whole number (INTEGER). The input value can be a REAL expression.

Example:

```
1 XVALUE% = Round(10.9)    →  XVALUE has the value 11
2 XVALUE% = Round(5.5)     →  XVALUE has the value 6
3 XVALUE% = Round(5.49)    →  XVALUE has the value 5
```

SQRT

This command forms the square root of an input value. Because this is not defined, the input value must not be a negative value.

Example:

```
1 I% = 44
2 XSET = 4*SQRT(100+I%)   → XSET has the value 48
```

SIN, COS, TAN, ASIN, ACOS, ATAN

In the case of trigonometric functions that process angles in terms of conventional degrees of arc, it is useful to identify the angles as double-precision REAL variables. The following trigonometrical functions can be used:

SIN	–	Sine function	ASIN	–	Antisine function
COS	–	Cosine function	ACOS	–	Anticosine function
TAN	–	Tangent function	ATAN	–	Arc tangent function

Example:

```
1 ANGLE = 30
2 XVALUE = SIN(ANGLE)      →  XVALUE has the value 0.5
3 YVALUE = ASIN(XVALUE)    →  YVALUE has the value 30
```

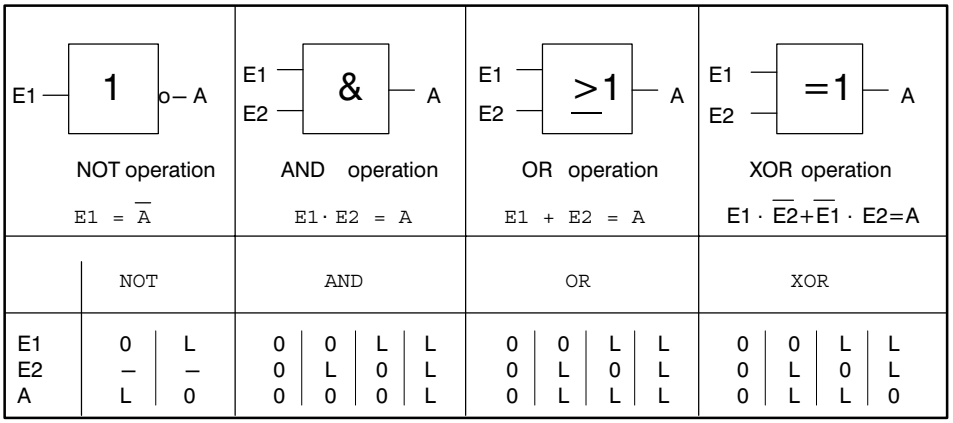
2.5.2 Logical operations

Binary logical operations can be effected by means of logical variables, and decimal logical operations with the use of INTEGER variables. As depicted in the diagram below, logical operations can be represented with the usual operating symbols, i.e. the "·" and the "+" symbol (**not in CPL, however**). Here, too, the governing rule is that of priority of multiplication and division over addition and subtraction. As a consequence, the AND operation takes priority over the OR operation. Bracket nesting up to a depth of seven is possible.

NOT, AND, OR, XOR

CPL provides four types of logical operation:

- the NOT function **NOT**
- the AND function **AND**
- the OR function **OR**
- the EXCLUSIVE OR function **XOR**



	NOT		AND				OR				XOR			
E1	0	L	0	0	L	L	0	0	L	L	0	0	L	L
E2	–	–	0	L	0	L	0	L	0	L	0	L	0	L
A	L	0	0	0	0	L	0	L	L	L	0	L	L	0

Logical operations can be utilized for bit masking.

Example: Is bit 0 set in @20?

```
.
20 IF @20 AND 1 <> 0 THEN GOTO . SET
30 ELSE GOTO .UNSET ENDIF
.
```

2.5.3 Conversion between numeric systems

BCD

Converts binary value into BCD format:

<BCD value>=**BCD(***<binary value>***)**

Example:

```
1 BCD_VALUE = BCD(49)      → BCD_VALUE has the value 73
```

BIN

Converts BCD-coded numbers into binary value:

<binary value>=**BIN(***<BCD value>***)**

Example:

```
1 BIN_VALUE = BCD(49)      → BIN_VALUE has the value 31
```

2.5.4 Relational operations

=, >=, >, <>, <=, <

The following comparison operations are permitted:

» = «	equal
» >= «	greater than/equal
» > «	greater than
» <> «	not equal
» <= «	less than/equal
» < «	smaller than

Comparison operations are used to describe the **relation** (”fulfilled” or “not fulfilled”) of a **condition** (e.g. for the commands REPEAT – UNTIL, WHILE – DO – END, IF – THEN – ELSE – ENDIF).

2.5.5 Repeat instructions

In the event that one or more instructions must be repeatedly processed in accordance with specific conditions, which is to be indicated here as a ”routine”, the option exists to accomplish this routine by means of repeat instructions. The multiple repetition of the program is known as a “**loop**”.

FOR – STEP – TO – NEXT

If the abort condition is to be a direct consequence of the processing of the routine a tracking counter would be required. This counter requires no specific programming for the FOR NEXT loop. A counting variable (INTEGER) is declared, the start and end count of which must be specified. If the counting increment deviates from 1, the step size (STEP) can be specified. A FOR NEXT loop is structured as follows:

FOR *<numerical variable>=<start value>* [**STEP** *<stepsize>*] **TO** *<end value> <routine>*

NEXT [*<numerical variable>*]

Example:

```
10 FOR I%=0 TO 18
20 XSINUS(I%)=SIN(I%*10)
30 NEXT I%
```

☞ **Proceeding the loop, the numerical variable will have a value which is larger than the end value (max. step size).**

In this example, the sine values for 0 through 180 degrees are written into the XSINUS field. The “I%” that was appended to the “NEXT” in line 30 serves clarification purposes only, and may be omitted.

It is also possible to program FOR NEXT loops with **variable step size**. In this case, the step size variable should possess the same type of variable as the numeric variable.

Example:

```
10 OPENW(1,”P222”,130)
20 STEP%=1 : START%=1 : END%=3500 : NJUST
30 FOR COUNTER%=START% STEP STEP% TO END%
40    STEP%=ROUND(STEP%*SORT(STEP%))
50    PRN#(1,”COUNTER: ”,COUNTER%,”  STEP SIZE: ”,STEP%)
60 NEXT
70 CLOSE(1)
```

Subsequent to program execution, the following appears in the ”P222” file:

```
COUNTER:         1  STEP SIZE:             3
COUNTER:         4  STEP SIZE:             5
COUNTER:         9  STEP SIZE:            11
COUNTER:        20  STEP SIZE:            36
COUNTER:        56  STEP SIZE:           216
COUNTER:       272  STEP SIZE:          3175
COUNTER:      3447  STEP SIZE         178902
```

REPEAT – UNTIL

If the loop abort condition is to be queried only subsequent to the first processing of the routine the program can be instructed to ”REPEAT this routine UNTIL the condition has been met.” Accordingly, the REPEAT loop is structured as follows:

REPEAT <*routine*> **UNTIL** <*condition*>

Example:

```
 .
30 REPEAT                          Loop until X = 100
40 X=X+1
50 UNTIL X=100
 .
```

WHILE – DO – END

If the loop abort condition is to be queried prior to the first processing of the routine, the program can be instructed thus: ”WHILE the condition is satisfied, DO the routine.” Accordingly, the WHILE loop is structured as follows:

WHILE <*condition*> **DO** <*routine*> **END**

Example:

```
 .
30 WHILE SD(9)=0                   Wait loop until until SD(9) assumed
40 I=I+1                           the value of 0
50 END
 .
```

2.5.6 Unconditional jump instruction

GOTO

Example:

```
10 GOTO N20          Jump to block N20
N20 X100
30 GOTO 120          Jump to CPL block 120
.
.
120 GOTO .TARG1      Jump to label .TARG1
.
.
150 .TARG1
```

Unconditional program jumps are programmed by means of the GOTO instruction. Specified jump destinations can be CPL block numbers, NC block numbers or “labels” (jump markers).

Label

A label that is to serve as a jump destination can be written only within a CPL block. A label identifier consists of a decimal point followed by ASCII characters, the first one of which must be a capital letter.

A label may not be a variable.

2.5.7 Branch instructions (conditional jump instructions)

IF – THEN – ELSE – ENDIF

A branch instruction can be formulated as follows:

“IF a specific condition is fulfilled, THEN perform the routine, or ELSE perform the other routine.”

Accordingly, the instruction is structured as follows:

IF <*condition*> **THEN** <*routine*> [**ELSE** <*alternative routine*>] **ENDIF**

If the ELSE component is omitted, the program, provided that the condition is not fulfilled, will continue to run immediately after processing the ENDIF instruction. Because any possible variant of this command comprises a division of program flow, this is also termed a *branch*. Both the THEN and the ELSE routine comprise program branches that do not have to be processed in every case.
The condition shares its line with the IF and is concluded by the THEN in that line.

Similar to the abort conditions for loop instructions, the condition for the IF instruction may contain arithmetical, trigonometrical and logical links. Here, too, nesting is possible. Although the IF instruction can also be written without the ELSE instruction, it must always be concluded with an ENDIF instruction, because otherwise the end of the routine or that of the alternative routine will not be recognized. As the placement of the ENDIF instruction depends upon the program processing logic, the computer sometimes fails to reliably detect and interpret a missing ENDIF instruction. The result will be confusing or misleading fault messages. It is therefore good practice for the programmer to verify the completeness of the IF instruction.

Example:

```
 .
10 X = 1
20 .START
30 IF X>=100 THEN
40         GOTO .END
50    ELSE X=X+2.75
60         GOTO .START
70 ENDIF
 .
90 .END
 .
```

CASE–LABEL...LABEL–OTHERWISE–ENDCASE

Within a program it is often necessary to query **more than two statuses** of an integer expression or an integer variable. In such cases, a query by means of an IF instruction is possible only with the use of several nested IF instructions. Such constructs are not only costly in terms of additional computing time, but also lead to an impairment of program readability and maintainability.

The attendant disadvantages can be overcome through the use of the CASE structure:

```
CASE  <integer expression> OF
   LABEL <integer constant>[,<additional integer constant>]
      [: <instruction>] <instruction>
                  :
   LABEL ...
      :
   [OTHERWISE <instruction>
      <instruction>
            :]
ENDCASE
```

Subsequent to the CASE instruction, the program branches to the LABEL instruction in which one of the *<integer constants>* is identical to the value of *<integer expression>*. Now, all instructions up to the next occurrence of the LABEL or OTHERWISE instruction will be carried out. The program then branches directly to the ENDCASE instruction.
If a LABEL instruction in which one of the *<integer constants>* is identical to the value of *<integer expression>* does not exist, the program jumps to the OTHERWISE instruction or (in the event that OTHERWISE was not programmed) directly to the ENDCASE instruction.

The *<instruction>* of a CASE construct can include all CPL instructions. A maximum of 10 CASE constructs can be nested.

Examples:

```
10 CASE A% OF
20 LABEL 0 : Y=1
30 LABEL 2
40           Y=Y*Y
50 LABEL 4 : Z=Y*Y
60           Y=Z*Z
70 OTHERWISE Y=0
80 ENDCASE
```

```
10 CASE INTFIELD%(1,2) OF
20 LABEL 1,2,3 : GOTO .MARK1
30 LABEL 4,5,6 : GOTO .MARK2
40 OTHERWISE GOTO .END
50 ENDCASE
```

```
10 CASE (INT(X/Y)+C%) OF
20 LABEL 1,2 : X=1 : Y=2
30 LABEL 4,8
40           X=2 : Y=4
50 LABEL 0
60           X=0 : Y=1
70 OTHERWISE X=0 : Y=0
80 ENDCASE
```

2.5.8 Program remark

REM

For giving remarks on programs.
Characters after the REM instruction until the next end of a line are ignored in the program's execution of commands.

REM *<remark text>*

Example:

```
.
10   REM *** SP TO DEMASK THE STATUS WORD ***
.
```

☞ **The colon within a remark is not regarded as an instruction-separating character (also see section 2.1.2).**

Notes:

3 Sub-programs and Cycles

The NC makes no formal distinction between main programs and sub-programs. The following conventions apply:

- Sub-programs can contain CPL and DIN blocks.
- Any part program can be invoked as a sub-program from within another part program.
- A sub-program is incapable of invoking itself as a sub-program (recursive call not possible).
- A sub-program call must always take place within a separate block.
- During a sub-program call, parameters can be transferred to the respective sub-programs.

3.1 Calling sub-programs with G, M or P address

Sub-programs can be called from within a DIN block by means of G, P, and/or M addresses.

For example, the programs for the drilling cycles (99999081 through 99999086) are permanently assigned to the functions G81 through G86.

For further details about sub-programs, please refer to the DIN programming manual.

3.2 Handling modal sub-program calls

Subsequent to their initial call, modal sub-programs will continue to be automatically executed after each traversing movement prescribed by a DIN block. This will continue until they are deselected via a special G function.

3.3 Sub-program call via CALL function

CALL

To execute sub-program calls from within programs that consist exclusively of CPL instructions, the CPL-proprietary CALL instruction is required. The CALL instruction must appear in its own separate CPL block. The CALL keyword is followed by the program name. This, in turn, may be followed by transfer parameters enclosed in square brackets and, to conclude the instruction, the “DIN” identifier (to influence the link process).

Example: Programmed CALL instruction

```
.
50    IF  A% = 1 THEN
51    CALL P999
52    ENDIF
.
```

Using “DIN” identifier to influence the link process (”Preparing”)

If you conclude a sub-program call by means of CALL with the “DIN” identifier, the control unit will exclude the sub-program thus called from the linking process. For example, the linking process of a main program that includes numerous sub-program calls can be significantly accelerated in this manner.

It is strongly recommended to include the “DIN” identifier in the program only if

- the invoked sub-program consists exclusively of DIN block, and
- the invoked sub-program does not call any additional sub-programs.

In the event that a sub-program containing CPL elements was excluded from the linking process due to the presence of the “DIN” identifier, the control will return an appropriate error message at program runtime.

Example: “DIN” identifier in sub-program call

Main program

```
50    IF  A% = 1 THEN
51    CALL P999 DIN          Sub-program “P999” is excluded from linking
52    ENDIF
M30
```

As an alternative, the “DIN” identifier can be inserted **as a remark** into the first line of the sub-program to be called. The control unit will respond by excluding the program from the linking process.

Example: “DIN” identifier in sub-program to be called

Sub-program P999:

```
N10   (DIN)                  Sub-program “P999” is excluded from linking
N20   ...
...
```

3.4 Parameter transfer to sub-programs

Parameters which are to be transferred to the sub-program are to be written in the main program in square brackets and separated by commas when calling the sub-program. The individual parameters may contain numbers, variables or arithmetic expressions.

In the sub-program, the parameters transferred during the sub-program call are always addressed via the variables `P1`, `P2`, `P3`, etc. in accordance with the sequence of the parameter transfer.
The parameters may also be addressed by means of P1TEST, P2XYZ, etc. However, the capital letters following P1, P2, etc., will be ignored (P1 = P1TEST = P1XYZ).

Based on the foregoing, it can be shown that in sub-program P999 in the example below, `P1` has a value of 2.75, `P2` assumes the value of the variable `X%` at the time of parameter transfer, and `P3` has the value 0. In the event that `P2` is to represent an INTEGER value also in the sub-program, this can be accomplished by appending a ”%” character to `P2`. This mode of identifying the type of variable can also be used with the other types of variables.
In the sub-program, the value of the individual parameters can be assigned to additional variables.

Example: Parameter transfer to a sub-program

Main program

```
50    IF  A% = 1 THEN
51    CALL P999 [2.75, X%, 0]        Sub-program call with parameter transfer.
52    ENDIF
M30
```

Sub-program P999

```
1 FACTOR=P1 : XVALUE%=P2% : COMPTAB%=P3%
N1  G1 X[XVALUE%*FACTOR]
N2  G22 K[COMPTAB%]
```

PDIM

If a sub-program

- is to be invoked with a string constant as transfer parameter **and**
- the invoking program is selected without linking

the PDIM command must be used.

PDIM *<parameter name>*(*<field size>*)

If the field size programmed is too small or missing entirely, the control unit reports the part program error ”invalid variable”.

Example:

Main program:

```
N10(DIN)
:
N50 P SP[”TEST”]
:
M30
```

Sub-program:

```
10 PDIM P1$(4)
:
M30
```

The string variable P1$ has the value `TEST`.

Notes:

4 System Functions

CPL is able to access system data of the NC control unit with system functions.

4.1 Standard functions

WAIT

The WAIT function is a mandatory requirement in all situations where **current** machine- or process-related data essential to further program execution (i.e. for program branching or a calculation) is needed within the program.

Viewed in terms of elapsed time, ”block processing”, i.e. the operation by which the individual program lines are analyzed and interpreted, is always carried out in advance of its execution on the machine. For this reason, the period of time by which the execution on the machine tool lags behind the completion of block processing is not constant but dependent upon on a variety of parameters (feedrate, distance traversed, etc.).
Therefore, if the program is required to respond to a machine-specific actual status (e.g. axis position) or to an actual process-related status (e.g. signal at the digital interface), the WAIT instruction must be used to ensure that the aforementioned time lag equals “zero” at the precise “sampling time“. This is the only way to ensure that the program will access **current** data.

WAIT may be programmed alone or together with parameter:

- WAIT **without** parameters:
  block processing will be stopped until all program blocks ahead of WAIT have actually been executed.
- WAIT **with** parameters:
  block processing will be stopped until a certain condition occurs at the digital interface between CNC and PLC and/or until a predefined period of time has lapsed.

WAIT without parameters can be included in programming of both CPL and NC blocks. (CPL example: `“20 WAIT”`; NC example: `“N20 WAIT”`).

☞ **A CPL block that includes the WAIT instruction must not contain a ”:”. Subsequent CPL instructions must be programmed in a new CPL block.**

WAIT with parameters can be included only in programming of CPL blocks (e.g. “`20 WAIT(,1000)`”).

The instruction has the following structure:

WAIT [([<*IC condition*>][,[<*Duration*>][,<*Result var*>]])]

<*IC condition*> Specifies the condition which the digital interface between CNC and PLC is to be checked for. To do so, you must adhere to the following syntax:

[**NOT**][**(**]**IC(**<*parameter*>**)**[**)**][**=**<*State*>]

<*parameter*>: Transfer parameter of the IC function (for a description, please refer to the IC function).

<*State*>: BOOLEan expression which the result of the IC function is compared to. If "=<*State*>" is not programmed, the comparison will be made to TRUE.

If the condition is fulfilled, block processing resumes.

<*Duration*> Waiting time in terms of milliseconds; no decimal places. May also be an integer arithmetic expression.
If <*Duration*> was programmed **without** an <*IC condition*>, block processing will stop exactly for the specified period of time.
If <*Duration*> is programmed **with** an <*IC condition*>, block processing will stop until the <*IC condition*> is met, however, no longer than for the specified duration.

<*Result var*> Integer variable. The parameter must only be written with at least one of the other parameters.
The system will store the specified integer variable in a return value which you can evaluate subsequently. The following return values are possible:
0 : <*IC condition*> was already fulfilled at the call.
1 : <*Duration*> has lapsed completely.
2 : <*IC condition*> has changed.

Example: WAIT (without parameter)

```
.
N10   X0
N100  (MSG still running)
N20   X150
30    WAIT                          → Stop block processing.
40    XPOS = MPOS(1)-150
50    IF XPOS < 0.0001 THEN
N60     (MSG,Position reached)      → "Position reached" message
                                      is returned at X = 150.
70    ENDIF
```

As a suggestion, test run the example **with**, and then **without WAIT**. If no WAIT is programmed, the "Position reached" message will not be returned!

Examples: WAIT (with parameter)

```
10  WAIT(,1000,E%)
```
Block processing is stopped for 1000ms. Subsequently, the E% variable is occupied by the integer value ”1”.

```
10 WAIT(,TIME%)
```
The duration of block-processing hold depends on the contents of the TIME% integer variable. No value is returned.

```
10 WAIT(IC(1,1,1)=TRUE)
```
Wait until the 2nd axis-related input signal of the1st axis is set.

```
10 WAIT(IC(2,0,2)=(E1? OR E2?))
```
Wait until the 3rd channel-related input signal of the 2nd channel has reached the value of the logic expression (E1? OR E2?).

```
10 WAIT(NOT IC(3,2,1),,C%)
20 IF C%=0 THEN
30  DSP(10,10,”COND. ALREADY OK”)
40 ENDIF
```
Wait until the 4th spindle-related input signal of the 1st spindle has reached the value of FALSE. The C% variable supplies either the value ”0”, if the condition was already met when WAIT was called, or the value ”2” if the condition was only met during waiting.

```
10 WAIT(IC(4,4,1)=E7?,250,ERG%)
20 IF ERG%=0 THEN
30   DSP(10,10,”DID NOT WAIT ”)
40 ENDIF
50 IF ERG%=2 THEN
60   DSP(10,10,”WAITED >250ms”)
70 ENDIF
```
Wait until the 5th axis-related output signal of the 1st axis takes on the value the E7? variable or 250ms have lapsed.
The ERG% variable will supply either the value ”0” if the condition was already fulfilled when WAIT was called, or the value ”1” if the duration has lapsed, or the value ”2” if the condition was met during waiting.

4.2 Axis and coordinate positions

CPL offers you various functions for inquiring the current positional values of axes and coordinates.

A distinction between the following functional types is made:

- functions, which are based on physical axes or logical coordinates (CPOS, AXO, WPOS, CPROBE).
- functions, which are based on physical or logical axes (MPOS, PPOS, PROBE).
- functions, which are based on physical axes (SPOS, APOS).

To use these functions, you should know

- how to address an axis: by ”physical” or ”logical” axis index or axis name or coordinate name
- how to interpret the transferred positional value.

☞ **Additional information on the topics ”Coordinates, Axes and Transformations” can be found in the user’s manual “Description of Functions”, refer to section 1.6.**

Definition of physical and logical axis names

The term physical axis includes all axes which are connected to the SERCOS interface
In MACODA parameter 1003 00001 they receive a system-wide unique **axis address** (=physical axis name) e.g.: ”X”, ”Y”, ”X1”, ”A” .

Each physical axis has a **physical axis index** that is valid system-wide according to the index of the MACODA individual parameter (1...64), under which the axis is registered in the MACODA.
If the SERCOS axes with their axis addresses are configured with spaces in the MACODA index (1...64), then the physical axis index corresponding to the space cannot be assigned a physical axis:

☞ **Therefore the number of physical axes is smaller than or equal to the physical axis index of the axis configured in the system last.**

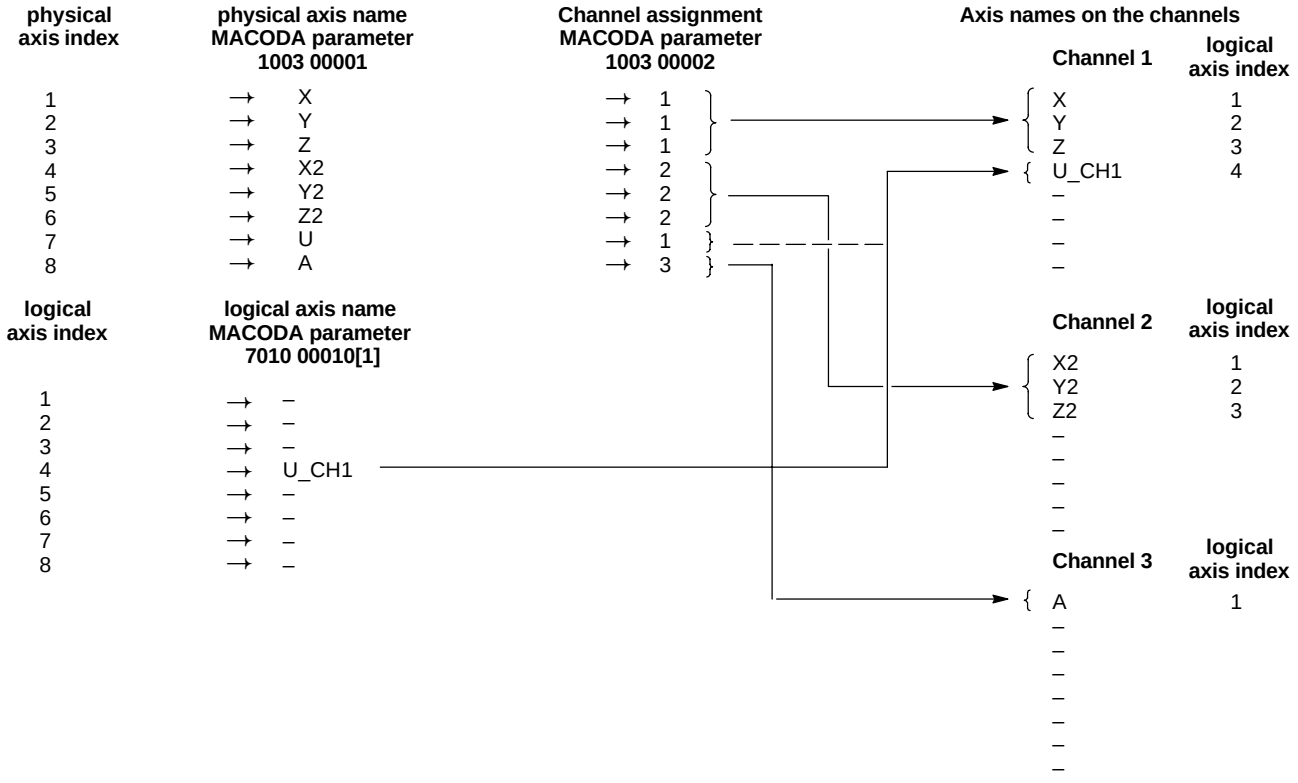
If you assign a physical axis to a machining channel by MACODA parameter 1003 00002, the control unit will automatically assign a ”**logical axis index**” to this axis.
This logical axis index is specific to the respective channel, always starts with the value ”1” for each channel, and is incremented by the value ”1” for each additional axis configured on this channel. In this context the following sequence applies:
The **1st logical axis** is always the axis with the **lowest physical axis index** of all axes configured on the channel.

Furthermore, the logical axes in the MACODA parameter 7010 00010 can be assigned a **logical axis name** for a specific channel.
Channel axes which have not been assigned an explicit logical axis name are implicitly assigned the physical name of the respective axis.

The channel configuration can be changed during run time through the functions of the axis transfer (G510 ff.). When doing so, new logical names can be assigned, which must be previously defined in the MACODA parameter 7010 00020 ”Optional axis designation”.
The logical axis indexes for the respective channel are newly defined after a change has been made to the axis configuration.

☞ **The ”physical axis index” and the ”physical axis name” are fixed and valid within the whole system.**
The ”logical axis index” and the ”logical axis name” are valid related to the channel and can be changed during run time.

1.Example: Configuration and assignment of the axis names to channels



Definition of synchronous and asynchronous axes

Axes that are assigned to **one channel** are called **synchronous axes** (machining axes). The synchronous axes of a channel are related to each other in an interpolated manner.

Axes that are **not assigned to a specific channel** are called **asynchronous axes** (auxiliary axes).

☞ **By using the functions for axes exchange (G510 ff.), synchronous axes can be switched to asynchronous axes and vice versa.**

Definition of coordinates for active axis transformation

In the part program there are always coordinates programmed that are interpolated during program processing. The so-called axis transformation calculates the command values for the respective axes from the current coordinate values.

The advantage of this procedure is that the part programs can be programmed independently from the structure of the machine (kinematics). The prerequisite is, however, that the respective axis transformation which takes the kinematics of the machine into consideration is available.

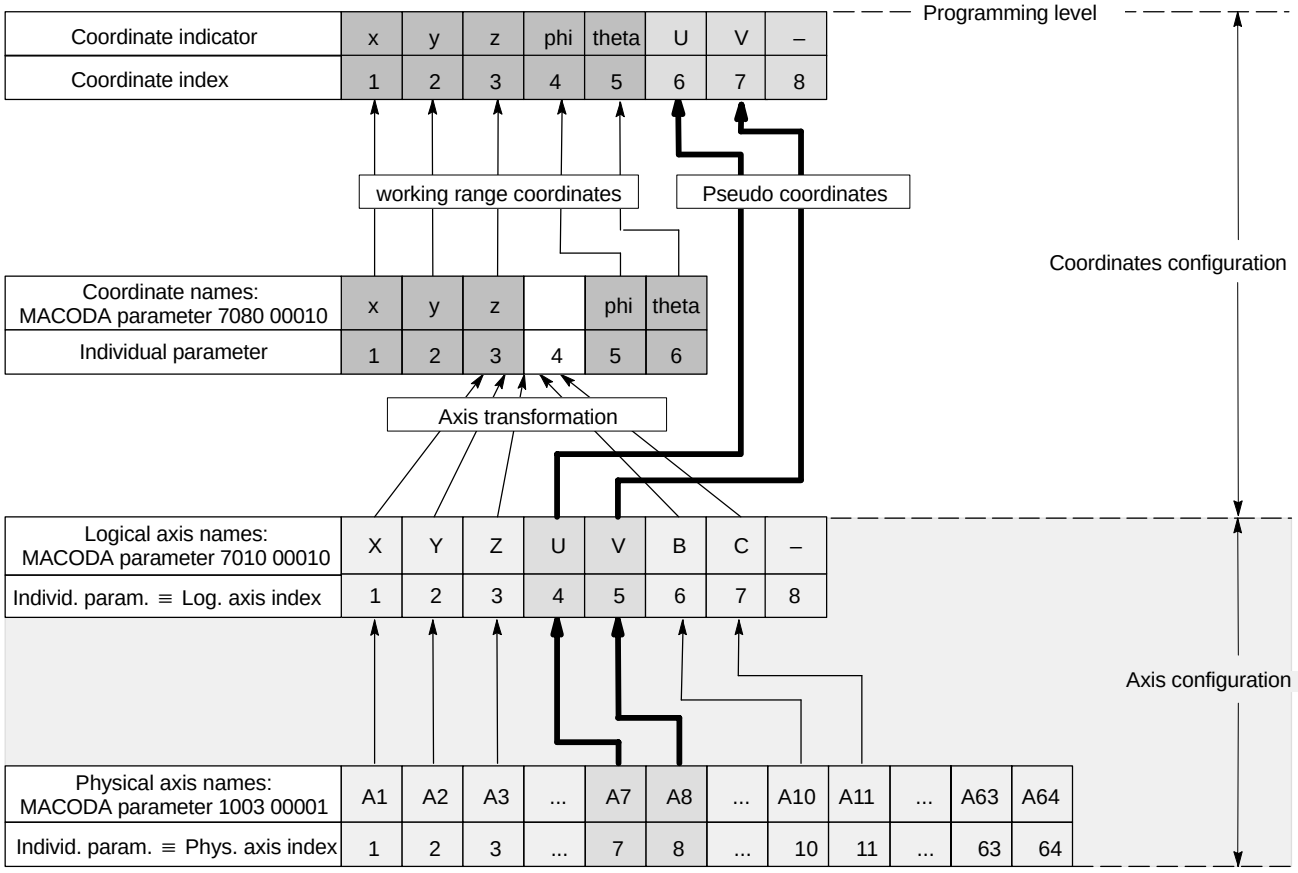
Please differentiate:

- **No axis transformation** active:
  Logical axes and coordinates are identical, i.e. the 1st logical axis is assigned to the 1st coordinate of the channel, etc.
  The coordinates which are directly assigned to a logical axis are also called **pseudo coordinates**.
  The ”name” of a coordinate then takes on the name of the logical axis to which it is assigned.
- **Axis transformation active**:
  There is generally no linear relation between the logical axis and the coordinates. In certain cases a coordinate can influence several axes and several coordinates can affect the same axis simultaneously.
  These kinds of coordinates are called **working range coordinates**.

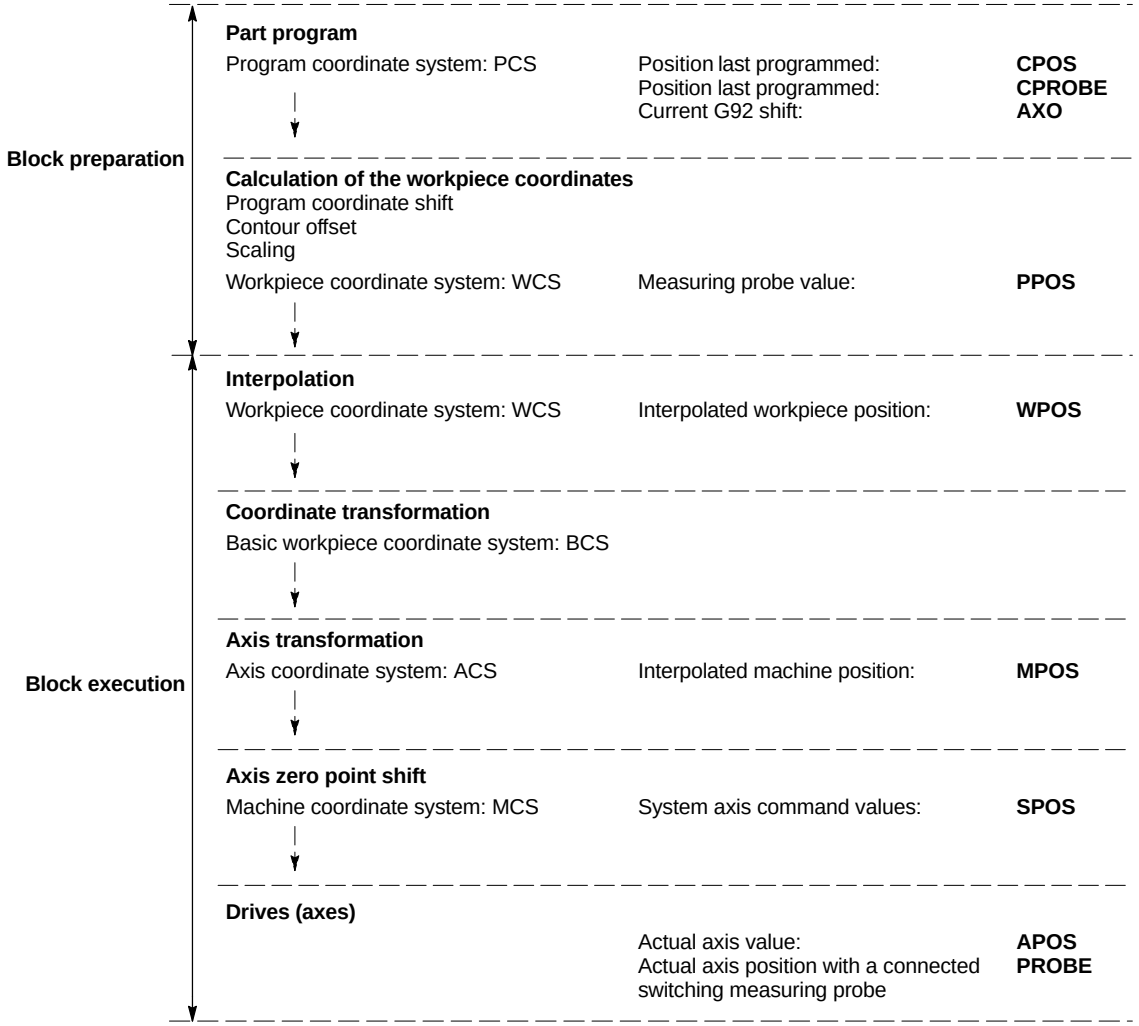
The names of the working range coordinates are set in the MACODA parameter 7080 00010 specific to the channel. The names for the logical axes and the working range coordinates within a channel must be unique.
The **coordinate index** is the successive index in which all the coordinates on the current channel and the working range coordinates defined through active axis transformation as well as any pseudo coordinates that exist are taken into account in the order of their appearance.

During active axis transformation, a channel can be assigned further axes in addition to the logical axis linked to the transformation. These are programmed as pseudo coordinates (see the following figure: e.g. 5-axis transformation).

Axis and coordinate names (Example: active axis transformation + pseudo coordinates)



Overview of all functions for determining the axis and coordinate positions



Measuring units for supplied axis and coordinate positions

Synchronous linear axes and translatory working range coordinates:	”mm” or ”inch”; depending on the momentary active setting (G70, G71) on the invoking channel.
Synchronous rotary axes and rotatory working range coordinates:	”degree”
Asynchronous linear axes:	”mm”
Asynchronous rotary axes:	”degree”

4.2.1 Functions for coordinates or physical axes

The functions AXO, CPOS, CPROBE and WPOS always supply coordinate values.

The coordinates are selected by entering:

- the coordinate indexes or names or
- the physical axis index or axis name (only for pseudo coordinates)

The following is to be noted:

- The coordinate index for working range coordinates on the channel is always fixed.
- Pseudo coordinates, in comparison, can be added or transferred to a channel through the functions of the axis transfer. In this process the coordinate index of other pseudo coordinates on the channel can be changed.
  Through the possibility of specifying the physical axis index, it is also possible with pseudo coordinates to work with fixed indexes.
- When specifying a physical axis that is not assigned to any pseudo coordinate, a run time error is reported.
- If there is no active axis transformation, then all coordinates are pseudo coordinates. Thus access via the physical axis index is possible.

Regarding the functions AXO and CPOS, which supply the data for block preparation, or refer to the condition of the block preparation (CPROBE), only those coordinates that belong to the invoking channel can be queried. If an attempt is made to address a coordinate foreign to the channel, then a run time error occurs.

The function WPOS, which supplies the actual workpiece coordinates, may also be invoked by foreign channels, but only when dealing with pseudo coordinates.

Transfer parameters for the functions AXO, COF, CPOS, CPROBE, and WPOS:

<axis selection> Index or name of the coordinate:
A **name** is interpreted as a coordinate name. Only if no according coordinate name exists, it is interpreted as a physical or a logical axis name.
An **index** is interpreted according to the given *<selection type>*.
Programming an axis/coordinate that is not configured leads to a run time error.

<selection type> **optional**:
Determines how an index programmed under *<axis selection>* is interpreted:
”0”: physical axis index
”1”: coordinate index (default)

The index is interpreted as a coordinate index without <*selection type*>!

<channel> **optional**: channel number (only for WPOS).
If coordinates are to be read from foreign channels, and if they are to be addressed by their index or names, then the number of the channel that the coordinate is currently assigned to is entered in *<channel>*.
If no channel is given, then the coordinates of the current channel will be accessed. If a physical axis is addressed (by name or index) and a channel is entered at the same time, then an error message will be generated.

AXO

AXO supplies the last activated G92 shift for a coordinate at the time of block preparation, i.e. it supplies the last activated shift at the time of program interpretation.

The instruction has the following structure:

AXO(<axis *selection*>[,<*selection type*>]**)**

☞ **AXO only allows access to shift values of its own channel. Asynchronous axes have no G92-shift, thus AXO does not apply to asynchronous axes!**

Example:

Channel 1 as in the example configuration from page 4–5.
No axis transformation is active, i.e. logical coordinates correspond to logical axes:

```
N10 G1 G90 X100 Y200 F1000
N20 G92 X75 Y125
30 XD = AXO("X")        →  XD is assigned the last activated G92
                           shift of the X coordinate on the cur-
                           rent channel (XD=100-75=25)

40 YD = AXO(2,0)        →  YD is assigned the last activated G92
                           shift of the 2nd physical axis
                           (YD=200-125=75)

50 X2D = AXO(4,0)       →  Run time error, since the 4th physical
                           axis is assigned to channel 2
```

CPOS

CPOS supplies the position of the last programmed (in absolute units) coordinate in connection with the program coordinate system PCS at the time of block preparation. In other words, the position last programmed at the time of the program interpretation is supplied.

Please regard the following condition:

- If switched over to a workpiece coordinate system between programming the coordinate and the inquiry of the position, then the supplied value already takes the new workpiece coordinate system into consideration.

The instruction has the following structure:

CPOS (<*axis selection*>[,<*selection type*>]**)**

☞ **CPOS only allows access to coordinates of its own channel. Thus it is not possible to inquire about positions of asynchronous axes via CPOS!**

Example:

Channel 2 as in the example configuration from page 4–5.
No axis transformation is active, i.e. logical coordinates correspond to logical axes.

```
N1 G0 G90 X2=150 Y2=100
02 X2VALUE=CPOS(1)          → X2VALUE is assigned the programmed abso-
                              lute position of the 1st coordinate on the
                              current channel (X2VALUE = 150)

N3 G91 X2=10                → X2VALUE is assigned the programmed abso-
04 X2VALUE=CPOS(1,1)          lute position of the 1st coordinate on the
                              current channel (X2VALUE = 160)

N5 X2=5 Y2=10               → Y2VALUE is assigned the programmed abso-
06 Y2VALUE=CPOS("Y2",1)       lute position of the coordinate that the
                              physical Y2 axis is assigned to
                              (Y2VALUE = 110)

07 X2VALUE=CPOS("X2")       → X2VALUE is assigned the programmed abso-
                              lute position of the X2-coordinate on the
                              current channel (X2VALUE = 165)

08 XVALUE=CPOS(1,0)         → Run time error: Access to the 1st system
                              axis of channel 2 is not allowed (axis is
                              assigned to channel 1)
```

CPROBE

If a switching measuring probe is connected to the axes of a channel and a measurement is launched, CPROBE can read the measured value for any one coordinate.

Please regard the following conditions:

- CPROBE only allows access to coordinates of its own channel. Therefore you cannot inquire about the positions of asynchronous axes!
- The measurement is activated with the function "Probe input" G75.
- Since all the measured values are axis values based on the axis zero point coordinates of the machine coordinate system MCS, a conversion to the coordinate level takes place when reading the values. In this process all transformations and shifts last programmed at the time of block preparation are taken into consideration, including the lead-screw error and cross-compensation.
  The supplied value is based on the last activated program coordinate system PCS.
- Because all axes/coordinates can be linked to each other within the transformation chain – especially in the case of active axis transformations – the measuring probe in the MACODA parameter 1003 00012 must be entered as "can be activated" for all axes of the channel. Otherwise a run time error will occur when invoking CPROBE.
- You can test launching the measuring probe on the channel with the function SD(9).

The instruction has the following structure:

CPROBE (<*axis selection*>[,<*selection type*>])

☞ **CPROBE cannot be used together with the function ”On-the-fly measurement” G275, since only one single axis is ever measured with ”On-the-fly measurement”.**

Example:

Channel 1 as in the example configuration from page 4–5.
No axis transformation is active, i.e. logical coordinates correspond to logical axes:

```
N10 G75 X100 Y100 Z50
20 IF SD(9) = 1 THEN
N30     (MSG, Measuring probe was not deflected!)
40      GOTO .ERROR
50      ELSE
60      ZMEAS = CPROBE(3)          → The variable ZMEAS is as-
                                     signed the value of the
70 ENDIF                             3rd coordinate of the mea-
..                                   sured position.
```

WPOS

WPOS supplies the current interpolated command position at the time of program interpretation referring to the current workpiece coordinate system WCS for a coordinate.

Please regard the following conditions:

- With WPOS it is possible to inquire about coordinates from **foreign channels**. The current workpiece coordinate system is always that of the channel to which the coordinate is currently assigned.
- For asynchronous axes WPOS always acts like SPOS (p. 4–18).
- In most cases of application, the command position should not be determined at the time of block preparation, but rather at the time of block execution. In this case, WPOS should be programmed in its own block ”WAIT” (see Section 4.1, standard functions WAIT).

☞ **Using WPOS without WAIT does not supply clearly predictable values, as it is not exactly known how far the block execution ”lags behind” the block processing.**

☞ **When accessing axis values of a foreign channel it may be necessary to meet synchronization measures in order to measure a defined position!**

The instruction has the following structure:

WPOS(<*axis selection*>[,<*selection type*>[,<*channel*>]]**)**

Example:

Channel 2 as in the example configuration from page 4–5.
No axis transformation is active, i.e. logical coordinates correspond to logical axes:

```
10 WAIT
20 Z2POS = WPOS(3,1,2)
```
→ Z2POS is assigned the current interpolated workpiece position of the 3rd logical coordinate of the 2nd channel (Z2 axis)

```
100 WAIT
110 YPOS = WPOS(”Y”)
```
→ YPOS is assigned the current interpolated workpiece position of the logical Y coordinate on the current channel

```
120 XPOS = WPOS(1)
```
→ XPOS is assigned the current interpolated workpiece position of the 1st logical coordinate on the current channel

4.2.2 Functions for physical or logical axes

The functions MPOS, PPOS and PROBE always supply axis values.

Access via physical index or axis names is intended for axes where the logical axis index on the channel has changed because an axis has been exchanged.

☞ **Pseudo coordinates are always linked to certain logical axes, but in the case of an active axis transformation the logical axis index and the logical coordinate index can be different!**

Transfer parameters of the functions MPOS, PPOS, PROBE:

<*axis selection*> Index or name of a physical or logical axis:
Name: is initially interpreted as a logical axis name. In none exists, the physical axis name is taken.
Index: is interpreted according to the given <*axis type*>.
Programming an axis that is not configured leads to a run time error.

<*axis type*> **optional**:
Determines how an index programmed under <*axis selection*> is interpreted:
”0”: physical axis index
”1”: logical axis index

The index is interpreted as a logical axis index without <*axis type*>!

<*channel*> **optional**: channel number (only for MPOS).
If the axis value of a foreign channel is read and the axis is to be addressed by its logical index or name, then the channel number of the axis must be entered.
If <*channel*> is not given, then the axes of the current channel are accessed.
Programming a physical axis and a channel number lead to an error message.

MPOS

The MPOS function supplies the currently interpolated command position of an axis referred to the machine zero point of the machine coordinate system MCS at the time of program interpretation.

Please regard the following conditions:

- The result of MPOS always corresponds to the SPOS function.
- With MPOS it is also possible to inquire about axis values from foreign channels.
- If there are no axis zero point shifts or axis transformations, MPOS and WPOS always supply identical values.
- In most cases of application the command position should not be determined at the time of the block preparation, but rather at the time of block execution. In this case, **WAIT** should be programmed in its own block before MPOS (also see Section 4.1 standard functions WAIT).

☞ **Using MPOS without WAIT does not supply clearly predictable values, as it is not exactly known how far the block execution ”lags behind” the block processing.**

☞ **When accessing axis values of a foreign channel, it may be necessary to meet synchronization measures in order to measure a defined position!**

The instruction has the following structure:

MPOS (<*axis selection*> [,<*axis type*> [,<*channel*>]])

Example:

Channel 2 as in the example configuration from page 4–5.
No axis transformation is active, i.e. logical coordinates correspond to logical axes:

```
N10 G0 G90 X2=150 Y2=100
20 WAIT
30 X2VALUE = MPOS(”X2”)      →  X2VALUE is assigned the currently
                                interpolated axis position of the
N40 G91 X2=10 Y2=10             X2 axis
50 WAIT
60 X2VALUE = MPOS(1,1)       →  X2VALUE is assigned the currently
                                interpolated axis position of the
                                1st logical axis on the current
                                channel (X2 axis)

70 Y2VALUE = MPOS(”Y2”,1,2)  →  Y2VALUE is assigned the currently
                                interpolated axis position of the
                                logical Y2 axis on the 2nd channel

80 XVALUE = MPOS(1,0)        →  XVALUE is assigned the currently
                                interpolated axis position of the
                                1st physical axis
```

PPOS

If switching measuring probes are connected, then the current axis actual position of a synchronous axis is queried in the switch point of the measuring probe.

PPOS considers the following compensations:

- axis zero shifts
  (G54...G59, G154...G159, G254...G259, G160...G360)
- tool compensations (Hx, G145...G845, G147...G847)
- program coordinate shift (G168, G268)
- lead-screw error compensation and cross-compensation

The following are not considered

- axis transformation (COORD(n))
- coordinate transformations (G138, G352, G354...G359)
- scaling (G37, G38)
- programmed contour shift (G60)

Please regard the following conditions:

- PPOS may only be used for axes of its own channel.
- If there is no axis transformation or coordinate transformation, the supplied value is based on the last programmed workpiece coordinate system WCS.
- You can enter which axes are to be considered during a measurement in the MACODA parameter 1003 00012. The measurement can be activated with the function ”Probe input” G75, as well as with ”On-the-fly measurement” G275.
  With G75, those axes of the channel are taken into consideration for which the MACODA parameter has the value ”1” . With G275, only the specified axis is measured.
- The measured values are read with functions PPOS and PROBE with the function ”Measuring fixed stop” G375.
- You can test launching the measuring probe on the channel with the function SD(9).

The instruction has the following structure:

PPOS (<*axis selection*>[,<*axis type*>])

☞ **It is not possible to inquire about positions of asynchronous axes!**

Example:

Channel 3 as in the example configuration from page 4–5.
No axis transformation is active, i.e. logical coordinates correspond to logical axes:

```
N10 G1 G75 A250 F500
20 IF SD(9) = 1 THEN
N30     (MSG, Measuring probe was not deflected!)
40      GOTO .ERROR
50      ELSE
60      AMEAS = PPOS(1,1)   → The measured position of the 1st logical axis on
70 ENDIF                      the channel is assigned to the AMEAS variable.
..
```

PROBE

In contrast to the function PPOS, the function PROBE supplies the axis values which are based on the axis zero point coordinates of the machine coordinate system MSC.

Please regard the following conditions:

- PROBE may only be used for axes of its own channel.
- Only lead-screw error compensation and cross-compensation are taken into consideration.
- You can test launching the measuring probe on the channel with the function SD(9).
- The measured values are read with functions PPOS and PROBE with the function ”Measuring fixed stop” G375.

☞ **It is not possible to inquire about positions of asynchronous axes!**

The instruction has the following structure:

PROBE(<*axis selection*>[,<*axis type*>])

Example:

Channel 2 as in the example configuration from page 4–5.
No axis transformation is active, i.e. logical coordinates correspond to logical axes:

```
N70 G75 Y2 250
80 IF SD(9)=1 THEN
N90     (MSG, Measuring probe was not deflected!)
100     GOTO .ERROR
110     ELSE
120     Y2MEAS=PROBE(2)    → The measured actual position of the 2nd logical axis
130 ENDIF                    on the channel (here: Y2-axis on channel 2) is as-
.                            signed to the Y2MEAS variable.
.
```

4.2.3 Functions for use with physical axes only

The functions SPOS and APOS always supply axis values.

They can be accessed via the physical axis index or the physical axis names. It is possible to access axes on the same channel as well as on foreign channels.

Transfer parameter for the functions APOS, SPOS:

<*axis selection*> Index or name of a physical axis.
Programming an axis that does not exist will cause a run time error.

APOS

APOS supplies the actual axis value of a physical axis that is currently issued at the time of block preparation of the CPL block in which APOS is programmed.

Please regard the following conditions:

- The supplied value refers to the machine zero point (not identical with the reference point, which also refers to the machine zero point).
- In most cases of application the actual position should not be determined at the time of block preparation, but rather at the time of block execution. In this case, WAIT should be programmed in its own block before APOS (also see Section 4.1, standard functions WAIT).

☞ **Using APOS without WAIT does not supply clearly predictable values, as it is not exactly known how far the block execution "lags behind" the block processing.**

☞ **When accessing axis values of a foreign channel it may be necessary to meet synchronization measures in order to measure a defined position!**

The instruction has the following structure:

APOS(<*axis selection*>**)**

<*axis selection*>: physical axis index or
physical axis name

Example:

Channels as in the example configuration from page 4–5.

```
30  ACT4=APOS(4)
.
.
```
→ The current actual axis value of the 4th physical axis in the system (X2 axis on channel 2) is assigned to the ACT4 variable.

```
50  ACT8=APOS("A")
.
.
```
→ The current actual axis value of the 8th physical axis in the system (A axis on channel 3) is assigned to the ACT8 variable.

SPOS

SPOS supplies the axis command value of a physical axis that is currently issued at the time of block preparation of the CPL block in which SPOS is programmed.

Please regard the following conditions:

- The supplied value refers to the machine zero point (not identical with the reference point, which also refers to the machine zero point).
- SPOS and MPOS always supply identical values, as MPOS is based on the machine zero point (axis zero point coordinates of the machine coordinate system MCS).
- If there are no axis zero point shifts, axis transformations or coordinate transformations, SPOS and WPOS always supply identical values.
- For asynchronous axes SPOS always acts like WPOS (p. 4–11).
- In most cases of application the command position should not be determined at the time of block preparation, but rather at the time of block execution. In this case, WAIT should be programmed in its own block before SPOS (also see Section 4.1, standard functions WAIT).

☞ **Using SPOS without WAIT does not supply clearly predictable values, as it is not exactly known how far the block execution "lags behind" the block processing.**

☞ **When accessing axis values of a foreign channel it may be necessary to meet synchronization measures in order to measure a defined position!**

The instruction has the following structure:

SPOS(<*axis selection*>**)**

<*axis selection*>: physical axis index or
physical axis name

Example:

Channels as in the example configuration from page 4–5.

```
30  POS1=SPOS(1)        → The current axis command value of the 1st physical
..                        axis in the system (X axis on channel 1) is assigned
                          to the POS1 variable.

50  POS5=SPOS("Y2")     → The current axis command value of the 5th physical
..                        axis in the system (Y2 axis on channel 2) is assigned
                          to the POS5 variable.
```

4.3 Axis zero shift operations

To set up and modify an axis ZS table the following CPL instructions are necessary:

- FXC: access to the axis zero point shift values
- FXCR: setting up a new axis ZS table
- FXDEL: deleting a column in the axis ZS table
- FXINS: inserting a column to the axis ZS table

FXC

Provides direct access to the axis zero shift values (axis ZS values) in the NC.

Both read- and write-access is possible for

- ASCII tables with definable names for axis ZS values
- external axis ZS values.
- the database tables V1, V2 and V3 (compatible with older versions)

Furthermore, the sum of **all effective (last programmed) axis ZS values** of an axis can be requested.

☞ **In the case of external axis ZS values, the function supplies a CPL error message for axes foreign to the channel.**

The instruction has the following structure:

```
FXC(<axis selection>[,<G address>[,<axis ZS table>
                                    [,<unit>]]])
```

<axis selection>:

Axis ZS tables: column index (1..64) or logical axis name.
External axis ZS: logical axis index (1..8) or logical axis name.
The logical axis index can also be programmed with negative sign (incremental specification).
The addressed table can be read or overwritten.
When overwriting it is possible to:
<*axis selection*> **positive**: the programmed value is incorporated into the axis ZS table and replaces the old value.
<*axis selection*> **negative**: the programmed value is added to the old table value (incremental specification).
Program **only** <*axis selection*>: queries all active axis ZS values.
An **axis name** can alternately be given instead of a column index. This determines the corresponding column in the table. A ”–” sign can be put in front of names for an incremental specification. If the syntax of an axis name begins with ”–”, then FXC may not be programmed with axis names.

<G address>:	axis ZS table:	54..59 (G54..G59) 154..159 (G154..G159) 254..259 (G254..G259)
	external axis ZS:	160 (G160) 260 (G260) 360 (G360)
<axis ZS table>:	axis ZS table:	File name with path 1=V1 (database table) 2=V2 (database table) 3=V3 (database table)
	external axis ZS:	0
<unit>:	axis ZS table:	0: mm 2: inch
	external axis ZS:	Non-programmable! G70 active: inch G71 active: mm

Each table has got a table unit. This is specified only once when setting up a new table according to the MACODA parameter 9020 00010.
During read-access the value is converted from the table unit into the programmed <*unit*>. If no <*unit*> is programmed, the value read determines the table unit.
During write-access the value is interpreted i.a.w. the programmed <*unit*> and standardized to the table unit, then added to the table. If no <*unit*> is programmed, the value is written directly into the table without conversion.

Examples:

```
0 TAB$="/usr/user/NPV1.npv"
1 FXC(2,54,1)=80
```
→ For the 2nd logical axis the value 80 is stored in the database axis ZS table V1 under G54.

```
2 FXC(1,54,TAB$)=20
```
→ For the 1st logical axis the value 20 is stored in the ASCII table "/usr/user/NPV1.npv" under G54.

```
3 FXC(-1,54,TAB$)=2
```
→ The value 2 is added to the 1st logical axis under G54.

```
4 FXC("Z",54,TAB$,2)=10/25.4
```
→ The result of 10/25.4 is recorded in inches for the Z axis under G54.

```
5 FXC("Z",160,0)=40
```
→ The external shift G160 is assigned the value 40 for the Z axis.

```
6 FXC("-Z",254,TAB$)=3
```
→ The value 3 is added to the Z axis under G254.

```
7 FXC("-U_CH1",54,TAB$)=20
```
→ The value 20 is added for the U_CH1 axis under G54.

```
8 FXC("Z",255)=40
```
→ The value 40 is filed for the Z axis in the active axis ZS table under G255.

```
9 X_SUM=FXC("X")
```
→ The sum of all active zero point shifts for X axis is assigned the variable X_SUM.

FXCR

Sets up **a new axis ZS table**.

The instruction has the following structure:

FXCR(<*channel or layout*>,<*TabName*>[,<*classification*>]**)**

<*channel or layout*>: Channel number or name of table layout.
According to the channel number the number of columns, the names of the axes and the type of axis are determined, setting up the table accordingly.
The following applies for channel number > 0: a column is set up for each channel axis in the axis ZS table.
For channel number = 0, the following applies: a column is set up for each system axis.
Alternately a table layout including a path can be used as a sample.

<*TabName*>: Axis ZS table name

<*classification*>: Defining the table feature:
0: no strict classification
1: strict classification
If <*classification*> is not programmed, it is occupied by ”0” (default value).

☞ **In order to edit the axis ZS table with the table editor, the file name extension according to the settings in MACODA parameter 3080 00200 should be programmed.**

FXDEL

Deletes a **column** in an axis ZS table.
The instruction has the following structure:

FXDEL(<*TabName*>,<*axis desig*>**)**

<*TabName*>: Axis ZS table name

<*axis desig*>: Logical or physical axis name or column index of the table column that is to be deleted.

Example: FXCR, FXDEL and FXINS

```
10 NPV_BASIS$="/usr/user/NPV_TAB_K2.npv"
11 IF FILEACCESS(NPV_BASIS$)=-1 THEN
12    FXCR(2,NPV_BASIS$)                          → Create axis ZS
                                                    table
                                                    "NPV_TAB_K2.npv"
                                                    for channel 2.
13    FXDEL("NPV_TAB_K2.npv",2                    → Delete column 2
                                                    from axis ZS table
                                                    "NPV_TAB_K2.npv".
14    FXINS("NPV_TAB_K2.npv",3,"U",0)             → Insert column 3 for
15 ELSE                                             rotary axis (U) in
16    IF FILEACCESS("NPV2_TAB_K2.npv")=-1 THEN      axis ZS table
                                                    "NPV_TAB_K2.npv".
17       FXCR(NPV_BASIS$,"NPV2_TAB_K2.npv")       → Create axis ZS
18    ENDIF                                         table
19 ENDIF                                            "NPV2_TAB_K2.npv"
                                                    according to the
                                                    given "/usr/user/
                                                    NPV_TAB_K2.npv"
                                                    layout.
```

FXINS

Sets up a **new column** in front of an existing column of an axis ZS table.

The instruction has the following structure:

FXINS(<*TabName*>,<*position*>,<*axis name*>[,<*axis type*>]**)**

<*TabName*>:	Axis ZS table name
<*position*>:	Logical or physical axis name or column index of the table column at the insert position. The new column is inserted in **front of** the insert position.
<*axis name*>:	Logical or physical axis name of the new table column.
<*axis type*>:	**optional:** axis type of the new axis: 0: rotary axis 1: linear axis (default value)

4.4 Tool compensations

TC

Access tool compensation data.
Both read- and write-access is possible for

- ASCII geometry tables with definable names
- external geometry compensation values.
- the database tables K4 and K5

The instruction has the following structure:

TC(<*selection*>[,<group>[,<table>[,<*unit*>]]]**)**

<*selection*>	– standard compensation	1:	Length compensation H
		2:	Radius compensation D
	– external compensation (1st external compensation)	1:	Length compensation $L_{(1)3}$ or H_{ext}
		2:	Radius compensation R_{ext}
	– general compensation (2nd external compensation)	1:	Length compensation $L_{(2)3}$
		2:	Radius compensation R
		3:	Length compensation $L_{(2)1}$
		4:	Length compensation $L_{(2)2}$
		5:	Tool orientation TO
		6:	Compensation type (read access only)
		7:	Euler angle φ (only absolute)
		8:	Euler angle ϑ (only absolute)
		9:	Euler angle ψ (only absolute)

<*group*>	– standard compensation	1..48:	for compensation group
	– external compensation (1st external compensation)	145..845:	for G145..G845
	– general compensation (2nd external compensation)	147..847:	for G147..G847

<*table*>	– standard compensation	file name with path:	name of table
		4:	K4
		5:	K5
	– external compensation (1st external compensation)	0:	no name
	– general compensation (2nd external compensation)	0:	no name

<*unit*>	– standard compensation	0:	mm
		2:	inch
	– external compensation (1st external compensation)	not programmable	G70 active: inch G71 active: mm
	– general compensation (2nd external compensation)	not programmable	G70 active: inch G71 active: mm

The addressed table can be read and overwritten. During overwriting, the old value can be replaced by the new value or the new value added to superimpose the old value. This can be determined by means of <*selection*>:
If <*selection*> is positive, the programmed value is incorporated into the table. If <*selection*> is negative, the programmed value is added to the table value.
If the sum of the active tool compensation values is requested, only the parameter <*selection*> needs to be programmed.

Each table has a table unit. Each table has a table unit. This is determined when creating a new table according to MACODA parameter 9020 00010.
During read-access the value is converted from the table unit into the programmed <*unit*>. If no <*unit*> is programmed the value read determined the table unit.
During write-access the value is interpreted i.a.w. the programmed <*unit*> and standardized to the table unit, then added to the table. If no <*unit*> is programmed, the value is written directly into the table without conversion.

Examples:

```
10  TC(1,10,5)=A
20  TC(2,10,5)=B
```
→ In the tool compensation table K5 the values of the variables A and B are assigned in the compensation group 10 for H and D.

```
25  TC(1,10,5,0)=25.4
26  TC(1,11,5,2)=1
```
→ In the tool compensation table K5, the same values for H, 25.4 mm and 1 inch, are recorded in the compensation groups 10 and 11.

```
30  TC(-1,10,4)=A
40  TC(-2,10,4)=B
```
→ In the tool compensation table K4 the values of the variables A or B are added in the compensation group 10 for H and D.

```
50  A=TC(1,8,4)
60  B=TC(2,8,4)
```
→ From the tool compensation table K4 the values of compensation group 8 for H and D are copied into the variables A and B.

```
70  TC(1,17)=A
```
→ The length compensation value standing in variable A is transferred to compensation group 17 of the compensation table last selected.

```
80  B=TC(2)
```
→ The radius compensation value valid at the time of the block processing is assigned to variable B in the unit of the active measuring system.

```
N85 G71
90  TC(1,745,0)=A
```
→ The value of variable A in mm is assigned to the external length compensation G745.

```
N90 G70
N91 WAIT
95  TC(3,347,0)=A
```
→ The general geometry compensation G347 is assigned the variable value A for length compensation $L_{(2)1}$ in inch.

```
100  B=TC(2,345,0)
```
→ The radius compensation value valid for the external compensation G345 is stored in variable B.

```
110  A=TC(2,39,"/usr/user/GK33")
```
→ From the ASCII table GK33 in the directory "/usr/user" the radius compensation value of the compensation group 39 is assigned to variable A.

4.5 Access to the tool database

TDA

If the internal tool database is configured, read- or write-access to individual fields is possible by TDA.

The instruction has the following structure:

```
TDA(<sector no.>,<place no.>,<field no.>
[,<Tool tab no.>])
```

<sector no.>:	Sector number (configuration-specific)
<place no.>:	Place number in the given sector (configuration-specific)
<field no.>:	Field number within the data set (1...49)
<Tool tab no.>:	Number of the tool table, where the value 1 is allowed only.

CAUTION
Inconsistency of data types possible!
A data set contains both fields of the ”integer” type and fields of the ”string” type. Data which are to be assigned to a field must be of the appropriate data type!
Make sure that variables used in instructions are of the same type as the field (please refer to table below)!

The table shows how the data are always stored in the 49 individual fields of a data set within the tool database.
This information is independent of the configuration of the tool database and cannot be influenced by the projector of a tool management system!

Field number	Designation	Data type	Remark
1	Sector	Integer	No access
2	Place	Integer	No access
3	query_int1	Integer	
4	query_int2	Integer	
5	query_int3	Integer	
6	query_int4	Integer	
7	query_bitfield	Integer	
8	query_string	String	max. 31 characters
9 ... 48	data_int	Integer	
49	data_string	String	max. 31 characters

CAUTION
Misinterpretation of field data possible!
During the configuration of the tool database it is defined how the data in the individual fields are to be identified by the control unit with respect to
– type (string, integer, real, digits before, digits after decimal point, etc.) and
– purpose (tool name, tool identification, radius, length, etc.).
Make sure that field data are correctly interpreted and, if applicable, converted in accordance with the current configuration of the database. Please refer to the following example!

Example:

Tool length; value in database: 312000 (integer).
The value is interpreted by the control unit in accordance with the current configuration, e.g. as a real number with 4 digits before and 3 digits after the decimal point: 312.000.
If you process the value by CPL or write it into the database you must ensure that the CPL program

- interprets the transferred value correctly and
- writes it into the database as an appropriate integer!

Examples:

```
.
70  TDA(1,1,9,1)=20000
.
```
→ In tool table 1 the value 20000 is entered in sector 1 / place 1 in the 9th database field (integer).

```
70  TDA(2,3,8,1)=NAME$
.
```
→ In tool table 1 the content of the string variable NAME$ is entered in sector 2 / place 3 in the 8th database field (string).

```
70  A%=TDA(2,1,3)
.
```
→ The value of the 3rd database field from the data set of sector 2 / place 1 is entered in integer variable A. Tool table 1 is used for this.

4.6 Contour shift

COF

Supplies the last programmed contour shift (G60) of a coordinate for the channel in which the program with the COF command is running.
Since the programmed contour shift only affects coordinates on the current channel, an error message is issued if a coordinate not existing on this channel is selected.
Compensation values are supplied in the active measuring unit of the current channel, i.e. with G70 in inches and with G71 in mm. When working with rotary axes or rotatory working range coordinates, the unit is always in degrees.

The instruction has the following structure:

COF(<*axis selection*>[,<*selection type*>]**)**

<*axis selection*> See page 4–8, functions for coordinates or physical axes.

<*selection type*> See page 4–8, functions for coordinates or physical axes.

Examples:

```
.
10  A=COF(3)
.
20  B=COF("X")
.
30  C=COF(2,0)
.
100  C=COF(0)
.
```

→ Supplies the last programmed G60 shift of the coordinate with the 3rd coordinate index on the active channel.

→ Supplies the last programmed G60 shift of the X axis/ coordinate on the active channel.

→ Supplies the last programmed G60 shift of the 2nd physical axis on the active channel.

→ Runtime error, since 0 is not a valid coordinate index.

4.7 Compensation of workpiece position

DPC

Supplies the parameters last programmed of the compensation of workpiece position G138 of a coordinate (shift value and angle of rotation) for the channel in which the program with the DPC command is running.

Since the compensation of workpiece position only affects coordinates on the current channel, an error message is issued if a coordinate not existing on the current channel is selected.
Compensation values are supplied in the active measuring unit of the current channel, i.e. with G70 in inches and with G71 in mm. When working with rotary axes or rotatory working range coordinates, the unit is always in degrees.

The instruction has the following structure:

DPC(<*axis selection*>[,<*selection type*>]**)**

<*axis selection*> See page 4–8, functions for coordinates or physical axes.
"1"..."n" or "name": supplies shift value
"0": supplies angle of rotation

<*selection type*> See page 4–8, functions for coordinates or physical axes.

Examples:

```
.
10  A=DPC(1)
.
15  B=DPC("X")
.
20  B=DPC(2)
.
25  B=DPC(2,0)
.
30  ANGLE=DPC(0)
.
100  C=DPC(9)
.
```

→ Supplies the last programmed G138 shift of the coordinate with the 1st coordinate index on the channel.

→ Supplies the last programmed G138 shift of the X axis/ coordinate on the channel.

→ Supplies the last programmed G138 shift of the coordinate with the 2nd coordinate index on the channel.

→ Supplies the last programmed G138 shift of the axis with the 2nd physical axis index on the channel.

→ Supplies the last programmed G138 angle of rotation.

→ Runtime error since 9 is not a valid coordinate index, if there are only 8 axes in the system.

4.8 Scaling

SCL

Supplies the parameters last programmed of the functions G37 and G38 (pole coordinates, scaling factors and angle of rotations) for the current channel (here: channel in which the program with the SCL command is running).
Since G37, G38 only affect coordinates on the current channel, an error message is issued if a coordinate not existing on the current channel is selected.
Compensation values are supplied in the active measuring unit of the current channel, i.e. with G70 in inches and with G71 in mm. When working with rotary axes or with rotatory working range coordinates, the unit is always in degrees.

The instruction has the following structure:

SCL(<*selection*>[,<axis selection>[,<selection type>]]**)**

<*selection*>: 0: Last progr. angle of rotation of the main plane
1: Last programmed pole of a channel axis
2: Last progr. scaling factor of a channel axis

<*axis selection*> See page 4–8, functions for coordinates or physical axes.

<*selection type*> See page 4–8, functions for coordinates or physical axes.

Examples:

```
10  W=SCL(0)
.
20  P=SCL(1,2)
30  F=SCL(2,2,1)
.
40  D=SCL(2,"X")
.
```

→ Writes the last programmed G38 angle into variable W.

→ Writes the pole of the coordinate with the 2nd coordinate index on the channel into variable P.

→ Writes the scaling factor of the coordinate with the 2nd coordinate index on the channel into variable F.

→ Writes the scaling factor of the X coordinate on the active channel into variable D.

4.9 Active system data

MCA

☞ **Notice that different MACODA numbers have been changed in the new version (V5.1.x and on).**
Please check existing part programs according to the list of changes in the annex A.4 to determine which MACODA numbers need to be changed.

Transfers the contents of a MACODA individual parameter. Depending on the type of data, this value can be of the ”integer”, ”float”, ”double” or even ”string” type. The variable in which the transferred value is to be stored must be of the same type!
Type conflicts between the value transferred and the destination variable are detected during the program’s runtime and acknowledged in the form of an error message.

MCA(*<block>,<index>[,<channel>]***)**

<block> Number of a MACODA parameter. Within one MACODA parameter, more than one MACODA individual parameter (parameter list) can be contained.
If a nonexistent parameter number is programmed, a runtime error will appear.

<index> Index of the MACODA individual parameter, beginning with ”0”.
If a nonexistent index number is programmed, a runtime error will appear.

<channel> Channel number. If not programmed, the function will supply the MACODA individual parameter of the channel in which the CPL program is presently being executed.
If a nonexistent channel number is programmed, a runtime error will appear.
”–1” supplies the values of the basic setting for channel dependent-parameters.

Example: MCA instruction with an older software version

Old MACODA No.

```
10 BLOCKNR%=100100004
20 ERG%=MCA(BLOCKNR%,0)
```

→ The contents of the first individual parameter of MACODA parameter 100100004 of the active channel (= type of axis movement) is assigned to the ERG% integer variable.

Example: MCA instruction with a new software version (V5.1.x and on)

New MACODA No.

```
10 BLOCKNR%=100300004
20 ERG%=MCA(BLOCKNR%,0)
```

→ The contents of the first individual parameter of MACODA parameter 100300004 of the active channel (= type of axis movement) is assigned to the ERG% integer variable.

NCF

Supplies the syntax of the NC function last programmed within the modal group of <*NC function*>.
The variable in which the result is to be stored has to be of the ”dimensioned character field” type.
Type conflicts between the value transferred and the destination variable are detected during the program’s runtime and acknowledged in the form of an error message.

The NCF function supplies values for **all** modal groups of the control unit and therefore supersedes the function SD(1).

NCF(<*NC function*>**)**

<*NC function*> Syntax of any NC function.
If a nonexistent syntax is programmed, a runtime error will appear.

Example:

```
10 DIM A$(4)
.
.
20 A$=NCF(”G1”)
.
.
N80 [A$]
```

→ Dimensioning a character field for a string with a length of max. 4 characters.

→ The A$ string variable is assigned the syntax of the last programmed NC function of the group containing ”G1” as syntax.

→ The previously requested NC function is programmed again.

SCS

Enables read-access to SERCOS drive parameters of the active parameter set.

The instruction has the following structure:

SCS(<*axis selection*>,<*ID type*>,<*ID no.*>
[,<*Result var*>]**)**

<*axis selection*>: physical axis index or
physical axis name

<*ID type*>: String expression.
”S”: S parameter
”P”: P parameter

<*ID no.*>: Number of the SERCOS parameter

<*Result var*>: if <Result var> is entered, then no runtime error will be generated when an access error occurs:
the following return value is possible:
0: access ok
1: access presently not possible

If <Result var> is not entered, then a runtime error will be generated when an access error occurs.

<Result var> is an integer variable.

The content of the parameter is supplied without unit and weighting.

☞ **Parameters containing a list (several values separated by commas) cannot be read. The control unit generates an error message in such cases.**

If the drive data can be found in the SERCOS drive telegram, they will be read from here (see Servodyn–D Parameter Manual). Otherwise the drive data are read directly in the drive.
If **other** applications access to drive data, the access to the drive data is not possible at **this** time. In this case of error, the parameter <Result var> leads to a response in the part program. Renewed access can supply the desired drive date.

☞ **Continuous access to the drive data can prevent access for other applications!**

Access to drive data	POSITION%	ERROR%	Error message
yes	New actual position value of the "ith" axis	0	none
no	Old actual position value of the "ith" axis remains	1	SERCOS SERVICE CHANNEL IS LOCKED

By evaluating the integer variables ERROR% the part program can respond to the error.

Example:

```
10 POSITION% = SCS(1,"S",51,ERROR%)   The integer variable POSITION% is
                                      assigned to the actual position value of
                                      the 1st axis.
12 IF ERROR% = 0 THEN                 Error evaluation
13   REM *** actual position value could be read correctly ***
14 ELSE
15   REM *** actual position value could not be read ***
16 ENDIF
```

SCSL

Several of the SERCOS parameter are stored as lists in the drive. These can be read with the command SCSL. Since the length of a list is unknown (and the necessary storage space), the list elements read are stored in ASCII files. Afterwards the data read can be processed with the help of CPL file commands.

The SCSL command causes the given file to be newly set up, if no file already exists. The contents of an already existing file are re-written.

The instruction has the following structure:

SCSL(*<axis index>,<ID type>,<ID no.>,<file name>*[,*<Result var>*]**)**

<*axis index*>: physical axis index or
physical axis name

<*ID type*>: String expression.
"S": S parameter
"P": P parameter

<*ID no.*>: Number of the SERCOS parameter.

<*file name*>: name of the ASCII file in which the list read is to be stored.

<*Result var*>: Integer variable
If <Result var> is put in, no runtime error will be generated when an access error occurs.

The following return value is possible:
0: access ok
1: access to SERCOS is presently not possible
2: access to file is erroneous.

If no <*Result var*> is put in, then a runtime error will be generated when an access error occurs.

Access to drive data is not possible at certain times, i.e. when other applications are accessing drive data. The parameter <*Result var*> reacts to this error in the part program. Renewed access can supply the desired drive date.

☞ **Continuous access to drive data can prevent access for other applications.**

SD

Reads system data of the control unit.

The instruction uses the following syntax:

SD(<*group*>[,<index*1*>[,<index*2*>[,<index*3*>]]])

The SD instruction returns INTEGER values.

☞ **The function SD(1) consists only of compatibility reasons for the Bosch CC series.**
SD(1) will not be supplemented by new functions!
The group index of SD(1) corresponds to that of the CC series and is not compatible for the group classification of the Typ3 osa/PNC (described in DIN programming manual)!
For writing new part programs use the NCF function instead of SD(1)!

Group	Index1	Index2	Index3	Concerns the function	Explanation
1	2...48	1			Active G functions for respective group (see separate table)
1	2...48	2			Last programmed G function
1	1	2			Last programmed G function with index1 = 1 can only be recognized directly in the next block. Otherwise the value 0 will be returned. For non-applied G groups, the SD function returns the value –1.
1*	1...48	3			G functions at Power ON
2	1				Active override position in percent for the respective potentiometer. Feedrate
2*	2				Rapid traverse
2	3				Spindle (SD(2,3)=0, if no spindle is applied)
2	4				2nd spindle (SD(2,4)=0, if no 2nd spindle is applied)
3	1				Currently not in use
3	2				
4	1				Currently not in use
4	2				
5	1	1			Active speeds, rounded up to integer value Feedrate in input unit per minute; evaluated with potentiometer. When G63 is active, SD returns 100% value
5	2	1			Rapid traverse in mm/min or inch/min (100% value)
5	3	1			Spindle speed in rpm; evaluated with potentiometer. (SD(5,3,1)=0, if no spindle applied)
5	4	1			Spindle speed in rpm; evaluated with potentiometer (2nd spindle). (SD(5,4,1)=0, if no 2nd spindle is applied)
5	1	2			Last programmed speeds Feedrate in input unit per minute
5	3	2			Spindle speed in rpm (SD(5,3,2)=0, if no spindle applied)
5	4	2			Spindle speed in rpm (2nd spindle) (SD(5,4,2)=0, if no 2nd spindle is applied)
5	3	3			Actual speed
5	4	3			Actual speed 2nd spindle
6*	1...6				Currently not in use
7*	1				Currently not in use
7*	2				
7*	3				
8					Supplies the channel number of the invoking channel.
9				G75	Probe switched: SD(9)=0 (G75 not active) Probe not switched: SD(9)=1 (G75 active)
				G375	Measuring fixed stop executed SD(9)=0 (G375 not active) Measuring fixed stop not yet executed SD(9)=1 (G375 active)
10	1,2	1,2			Index 1: 1= Number of last programmed drilling axis 2= Number of active drilling axis Index 2: 1= Axis, on which length compensation “H” has an effect 2= Axis, on which the L3 compensation of the general tool compensation has an effect
11	1	1			Main axis of last programmed plane switchover
11	2	1			Secondary axis of last programmed plane switchover
11	1	2			Main axis of active plane
11	2	2			Secondary axis of active plane
12	1				Active sense of spindle rotation SD(12,1)= 3 clockwise spindle rotation SD(12,1)= 4 counter-clockwise spindle rotation SD(12,1)= 0 spindle stop SD(12,1)= –1 spindle not applied SD(12,1)= 19 spindle orientation
12	2				Last programmed sense of spindle rotation (functions as with ”Active sense of spindle rotation”) An active reversal of the sense of rotation via interface signal is not taken into account!
12	3				Active sense of spindle rotation (2nd spindle) (functions as with ”Active sense of spindle rotation”)
12	4				Last programmed sense of spindle rotation (2nd spindle) (functions as with ”Active sense of spindle rotation”)

*: Currently not available

Group	Index1	Index2	Index3	Concerns the function	Explanation
13					Machining mode when executing at the point of interpretation SD(13)= 0 single block, single step SD(13)= 1 automatic SD(13)= 2 program block SD(13)=10 block search with single block or single step, selected block not yet interpreted. SD(13)=11 block search with automatic, selected block not yet interpreted.
14					Number of active national language (MACODA parameter 6010 00010)
15					Test without motion SD(15)=0 : no SD(15)=1; yes
16*	0..1				Currently not in use
17*	1...32				Currently not in use
20	1, 2				Supplies the number of synchronous axes of the invoking channel: SD(20,1)= value (default value) at the moment of block processing SD(20,2)= value when active
21	1..n **	1, 2			Supplies the number of synchronous axes of a channel: SD(21, <1..n> ,1) = value (default value) at the moment of block processing SD(21, <1..n> ,2) = value when active. 1...n = channel number, n = max. number of channels
22	1...m or physical axis designation	1, 2			Supplies the logical axis number of a physical axis, if this is an axis of the invoking channel: SD(22, <1..m>|String ,1) = value (default value) at the moment of block processing SD(22, <m>|String ,2) = value when active. 1..m = physical axis number, m = max. number of physical axes String = physical axis name
23	1..m or logical axis designation	1, 2			Supplies the physical axis number of a logical axis of the invoking channel: SD(23, <1..m>|String ,1) = value (default value) at the moment of block processing SD(23, <1..m>|String ,2) = value when active. 1..m = logical axis number, m = max. number of logical axes String = logical axis name
24	1..m or logical axis designation	1..n **	1, 2		Supplies the physical axis number of a logical axis: SD(24, <1..m>|String ,<1..n>,1) = value (default value) at the moment of block processing SD(24, <1..m>|String ,<1..n>,2) = value when active 1...n = channel number, n = max. number of channels 1..m = logical axis number, m = max. number of logical axes String = logical axis name
25	1...m or physical axis designation				Supplies the channel of a physical axis: SD(25, <1..m>|String) = value when active. 1..m = physical axis number, m = max. number of physical axes String = physical axis name

* : Currently not available
** : Number of a channel:
If the given channel is inactive it could be that axes on this channel have already been lent out, i.e. they are presently active on another channel. Despite this fact, the **axes which are lent out** still belong to the given channel.

Example: Axis X2 belongs to channel 2 (inactive) and X2 is synchronously being run on channel 1.
The axis X2 is still regarded in both SD instructions "number of synchronous axes of the channel" of SD(21,2,...) and SD(21,1...).

Group	Index1	Index2	Index3	Concerns the function	Explanation	
				G168, G268		
68	1	1...8			Sum of last programmed coordinate shifts (G168 + G268) for the given axis (Index1).	
68	2	1...8			Total of the active coordinate shifts (G168 + G268) for the given axis (Index2).	
168	1	1...8			Value of last programmed coordinate shift G168 for the given axis (Index1).	
168	2	1...8			Value of the active coordinate shift G168 for the given axis (Index2).	
268	1	1...8			Value of the last programmed additive coordinate shift G268 for the given axis (Index1).	
268	2	1...8			Active value of the additive coordinate shift G268 for the given axis (Index2).	
				G131		
131	1				logical axis number of the axis of rotation	
131	2				symmetry	
				Work area, Dead range		
200	1				Number of active areas on the channel	
200	1	1...10			Shows if an area is active or not. 0: Area i (Index2) is not active	
200	3	1...10			Type of area "i" : 0: type not defined 1: dead range 2: work area	
200	11	1...10			Position of the center of the area "i" (Index2) in programming units (for the 1st axis of the area)	
200	12	1...10			Position of the center of the area "i" (Index2) in programming units (for the 2nd axis of the area)	
200	21	1...10			Extension of the area "i" (Index2) in programming units (for the 1st axis of the area)	
200	22	1...10			Extension of the area "i" (Index2) in programming units (for the 2nd axis of the area)	
				Spindles	1..8 = spindle number	previous, still valid SD functions:
202	1..8				Current potentiometer value	SD(2,3), SD(2,4)
205	1	1..8			Active commanded speed (incl. potentiometer)	SD(5,3,1), SD(5,4,1)
205	2	1..8			Last progr. commanded speed	SD(5,3,2), SD(5,4,2)
205	3	1...8			Actual speed	SD(5,3,3), SD(5,4,3)
212	1	1..8			Active movement function	SD(12,1), SD(12,3)
212	2	1..8			Last programmed movement function	SD(12,2), SD(12,4)
				G328		
328					Last programmed precision barrier of G328	
328	1				Last programmed precision barrier of G328	
328	2				Last programmed distance between corners of G328	

Group	Index1	Index2	Index3	Concerns the function	Explanation
				Axis coupling	m: logical axis number of the master on the current channel s: logical axis number of the slave on the current channel
581	0	1...8 (m)			logical axis number m: if axis m is a master axis 0: if there is no master axis
581	1...8 (s)	0			Number of the master axis to which axis s is a slave 0: if s is not a slave
581	1...8 (s)	1			Programmed slave axis shift in programming units 0: if s is not a slave
581	1...8 (s)	2			Programmed coupling factor 0: if s is not a slave
581	1...8 (s)	3			Programmed master axis shift in programming units 0: if s is not a slave

Examples:

```
.
10 A% = SD(1,2,1)
.
.
20 B% = SD(1,4,1)
.
30 A% = SD(2,1)
.
40 B% = SD(5,1,1)
.
```

→ A% contains the active G function from index range 2, i.e., the value 1 if G1 is active.

→ B% contains the active G function from index range 4.

→ A% contains the active position of the feed potentiometer in percent.

→ Variable B% contains the active feedrate speed.

Supplementary table for querying active G functions of group 1:

Index	G functions	Index	G functions
1	–	25	64, 65
2	0–3, 5, 11–13, 73	26	68, 69
3	70, 71	27	Currently not in use
4	90, 91, 189, 190, 191	28	145..845, 146
5	63, 66	29	114, 115
6	543	30	160, 167
7	93–95	31	Currently not in use
8	40–42	32	Currently not in use
9	6, 7	33	–
10	17–20	34	–
11	8, 9	35	–
12	Currently not in use	36	–
13	14, 15	37	–
14	Currently not in use	38	–
15	78, 79	39	–
16	80–86	40	–
17	Currently not in use	41	–
18	53–59	42	–
19	153–159	43	–
20	253–259	44	–
21	60, 67	45	–
22	37–39	46	–
23	61, 62	47	–
24	–	48	–

Programming example: SD instruction (probe query)

```
.
N4  G75 X120

60  IF SD(9) = 1 THEN
N7    (MSG,PROBE WAS NOT DEFLECTED)
80    GOTO .ERROR
90  ELSE
100  XMEAS = PPOS(1)
110 ENDIF
.
```

In the SD (probe query) example, the x axis is traversed in the direction of the specified position. If the position is reached and the probe is not deflected, a message is returned (line N7), and a jump to the .ERROR label is executed. If the probe is deflected, the current position with reference to the program coordinate system can be stored in XMEAS.

SDR

This instruction reads system data of the NC control unit **in REAL format**. Command syntax and application are similar to the SD instruction.

The syntax is as follows:

SDR (<*group*>[,<*index1*>[,<*index2*>]]**)**

Group	Index1	Index2	Concerns the function	Explanation
1	1...8			Axis positions of all machining axes that were calculated in block search/reentry (index1 = axis number). If there is no block search, 0 will be returned. Addressing a non-applied axis or auxiliary axis will result in a runtime error.
2 2* 2 2	1 2 3 4			Active override position in percent for the respective potentiometer. Feedrate Rapid traverse Spindle (SDR(2,3)=0, if no spindle applied) 2nd spindle (SDR(2,4)=0, if no 2nd spindle is applied)
4*				Currently not in use
5*				Currently not in use
12*				Currently not in use
202	1...8		Spindles	current potentiometer value (older SDR functions which are still valid: SDR(2,3), SDR(2,4))
68	1	1...8	G68 G168 G268	Total of last programmed coordinate shifts (G168 + G268) for the given axis (Index2).
68	2	1...8		Total of the active coordinate shifts (G168 + G268) for the given axis (Index2).
168	1	1...8		Value of last programmed coordinate shift G168 for the given axis (Index2).
168	2	1...8		Value of the active coordinate shift G168 for the given axis (Index2).
268	1	1...8		Value of the last programmed additive coordinate shift G268 for the given axis (Index2).
268	2	1...8		Active value of the additive coordinate shift G268 for the given axis (Index2).
131 131	3 4		Tangential tool guidance	Supplies the offset angle in degrees (Index2) Supplies the adaptation angle in degrees (Index2)
328 328 328	 1 2		G328	Last programmed precision barrier of G328 Last programmed precision barrier of G328 Last programmed distance from corners of G328

*: Currently not available

Group	Index1	Index2	Concerns the function	Explanation
			Axis coupling	m: logical axis number of the master on the current channel s: logical axis number of the slave on the current channel
581	0	1...8 (m)		logical axis number m: If the axis m is a master axis 0: if there is no master axis
581	1...8 (s)	0		Number of the master axis to which axis s is a slave 0: if s is not a slave axis
581	1...8 (s)	1		Programmed slave axis shift in programming units. 0: if s is not a slave axis
581	1...8 (s)	2		Programmed coupling factor 0: if s is not a slave axis
581	1...8 (s)	3		Programmed master axis shift in programming units 0: if s is not a slave axis

*: Currently not available

4.10 Variable axis address

AXP

This function permits the plane-independent programming of part and measuring programs.

AXP(<*axis number*>,<*positional data*>[,<*axis type*>]**)**

To use this function, the instruction must be included in an NC block, enclosed in square brackets "[ ]." It will be programmed in lieu of the address values.

<*axis number*>	logical or physical axis index
<*positional data*>	Variable or value of positional data
<*axis type*>	Determines whether <*axis number*> is interpreted as a physical or as a logical axis index: "0": <*axis number*> is the physical axis index. "1": <*axis number*> is the logical axis index of that channel in which the program is currently being executed. If <*axis type*> is not programmed, it will be occupied with 1 (default value).

Example:

Sub-program:

```
10  A%=P1% : B%=P2%
```
Transferring axis no's from P1% and P2% to A% and B%.

```
20  C=P3:D=P4:RA=P5
30  E=0
```
Transferring command values for G2.
Constant for pole at G20.

```
N40 G20 [AXP(A%,E)] [AXP(B%,E)]
```
Plane switchover with G20; pole at 0,0.

```
N50 G2 [AXP(A%,C)] [AXP(B%,D)] R[RA] F1000
.
```
Radius programming with G2.

Planes are defined by `A%` and `B%`. Subsequent plane switchover via `G20`. The axes conclude by traversing at F1000 in an arc that is defined by the variables `C` and `D` (end point), and `RA` (radius).

4.11 PLC interface

IC

The digital interface between CNC and PLC can be accessed by means of this function. It can be used to query all inputs and outputs of the control unit.

IC(<*bit*>[,<*group*>][,<index>]**)**

<*bit*> The number of the interface signal within the chosen group. Please refer to the PLC Project Planning Manual for the meaning of individual signals.

<*group*> (see table)

<*index*> (see table)

<*bit*>	<*group*> Default = 0	<*index*>
0 ... 111	0 = channel-related input signals	0 ...max. channel Default = active channel
0 ... 111	1 = axis-related input signals	1 ... max. axis Default = 1
0 ... 111	2 = spindle-related input signals	1 ... max. spindle Default = 1
0 ... 95	3 = channel-related output signals	0 ...max. channel Default = active channel
0 ... 63	4 = axis-related output signals	1 ... max. axis Default = 1
0 ... 63	5 = spindle-related output signals	1 ... max. spindle Default = 1
0 ... 31	6 = input signals in the global interface	1
0 ... 31	7 = output signals in the global interface	1
0 ... 7	8 = input signals in the HighSpeed interface	1
0 ...5 with PNC: 0...7	9 = output signals in the HighSpeed interface	1

Example: IC instruction (read-access)

```
.
30 REM Load into variable A? the value of the 6th input signal
35 REM of the 2nd axis (direction of handwheel rotation).
40 A? = IC(5,1,2)
.
```

Write-access is possible only to the channel-related output signals 81 through 96. In this case the value ”0” (and not ”3” !) must be specified for <*group*> parameter.

Example: IC instruction (write-access)

```
.
30 REM Setting the 81st output signal of channel 1.
40 IC(80,0,1) = TRUE
.
```

PLC

This function permits access to the data of the PLC.

PLC(<*type*>,<*DM number*>,<*address*>,<*size*>)

<*type*>	Data type (refer to table below)
<*DM number*>	Data module number (entry is relevant only with <Type> = 4 (data word)). For other types no entry, however, the "," comma must always be written!).
<*address*>	Relative byte address from beginning of range.
<*size*>	Size of data type 1: byte 2: word 4: double word

Possible parameter combinations:

<*type*>	Meaning	<*DM number*>
1	Input (I)	–
2	Output (O)	–
3	Marker (M)	–
4	Data word (D)	number of the data module
5	Data buffer (DB)	–
6	Data field (DF)	–
7	Timer (T)	–
8	Counter (C)	–
9	Special marker (SM)	–
10	System range (S)	–
11	Extended input (EI)	–
12	Extended output (EO)	–

The parameter <address> is checked according to the active PLC.

The parameter <size> has no meaning when reading timers (<type> = 7) and counters (<type> = 8):

- The result (the remaining time until the timer finishes) is supplied in milliseconds when reading timers (<type> = 7).
- The current value of the counter is returned when reading counters.

Read-access is permitted for all types!
MACODA parameter 2060 00100 indicates the **number of the first data module** for which write-access is permitted.
MACODA parameter 2060 00110 indicates the **number of all data modules** for which write-access is permitted.

Examples:

```
.
30 REM Read byte 10 from input image
40 I% = PLC(1,,10,1)
.
80 REM Read one word from byte 2 in data module 98.
90 J% = PLC(4,98,2,2)
.
```

4.12 Time recording

CLOCK

Reads out the internal system time of the control unit in milliseconds.

Example:

```
.
20  WAIT
30 START TIME% = CLOCK
N4 G1X50Y70
40 WAIT
50 ENDTIME% = CLOCK: DIFF% = ENDTIME%-START TIME%
.
```

Before and after the execution of block N4, the current time counter status is transferred to the START TIME% and/or END TIME% variables. The difference in contents of both variables forms the basis for determining the block processing time of N4 in milliseconds.
It is instructive to note that the WAIT instruction is an absolute requirement in time recording!

DATE

Supplies the current value for date.

Example:

```
.
30 A$ = DATE
.
```

The date is assigned to the A$ STRING variable in DD.MM form.

TIME

Supplies the current value for time.

Example:

```
.
40 B$ = TIME
.
```

The time is assigned to the B$ STRING variable in HH.MM.SS form.

4.13 Errors and Error Categories

GETERR

This function calls in the current errors in a CPL program. It includes the elements current error no., channel no. of the error and the error category it belongs to.

Each occurring error is stored in an array with its elements. The maximum number of errors that the array can record is limited by the dimensioning (DIM) of the parameter `<error no.>`.

The GETERR function supplies the following return values:

- –1: Function could not be executed.
- ⩾ 0: Number of present errors on `<channel>`.

GETERR(*<channel>,[<category>],<error no.>[,<number>]***)**

<channel>: Channel no. of the queried channel
–1 : All channels
> 0: Channel no.

<category> 0: All warnings and errors (default)
1: Minor system errors
2: Control or drive errors
3: Interpolator errors
4: Hardware errors
5: PLC errors
6: Part program errors
7: Runtime warnings
8: MSD messages: errors
9: MSD messages: warnings
10: MSD messages: messages

<error no.> Result variable:
Two-dimensional integer array with at least 3 elements in the second dimension (DIM <error no.>% (x.3)), default value: 0.

The function supplies the present error numbers from <channel> in chronological order.
Meaning of the 3 elements of the 2nd dimension:

<error no.>(x,1): error no.
<error no.>(x,2): error channel (–1 = applies to all channels)
<error no.>(x,3): error category (if declared by means of DIM command).
See parameter <category> for values (0 = unknown category).

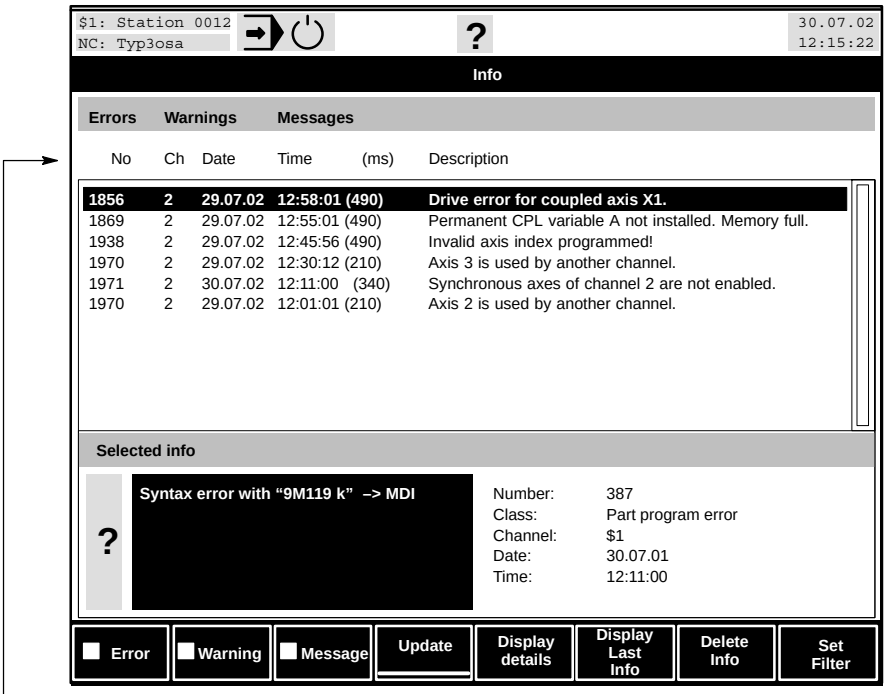
Example: DIM ERRNO% (100,**3**).

☞ **Only the variable name is to be entered without the dimension or index!**

<number> Integer variable (Default value: 1)
Defines the number or the error to be read.
1: Default value
> 0: Parameter values are not tested for validity, i.e. if the number of data to be read is larger than the array dimension, no part program error is generated.

Example:
<number> =120, but DIM ERRNO% (100,**3**).
In this case, 20 errors will not be read.

Example: Display of errors in the information dialog.



Column headers:

No:	Error number
Ch:	Channel on which the event has occurred
Date:	Date on which the event occurred
Time:	Time at which the event occurred
(ms):	Milliseconds. In addition to time
Description:	Information on the event

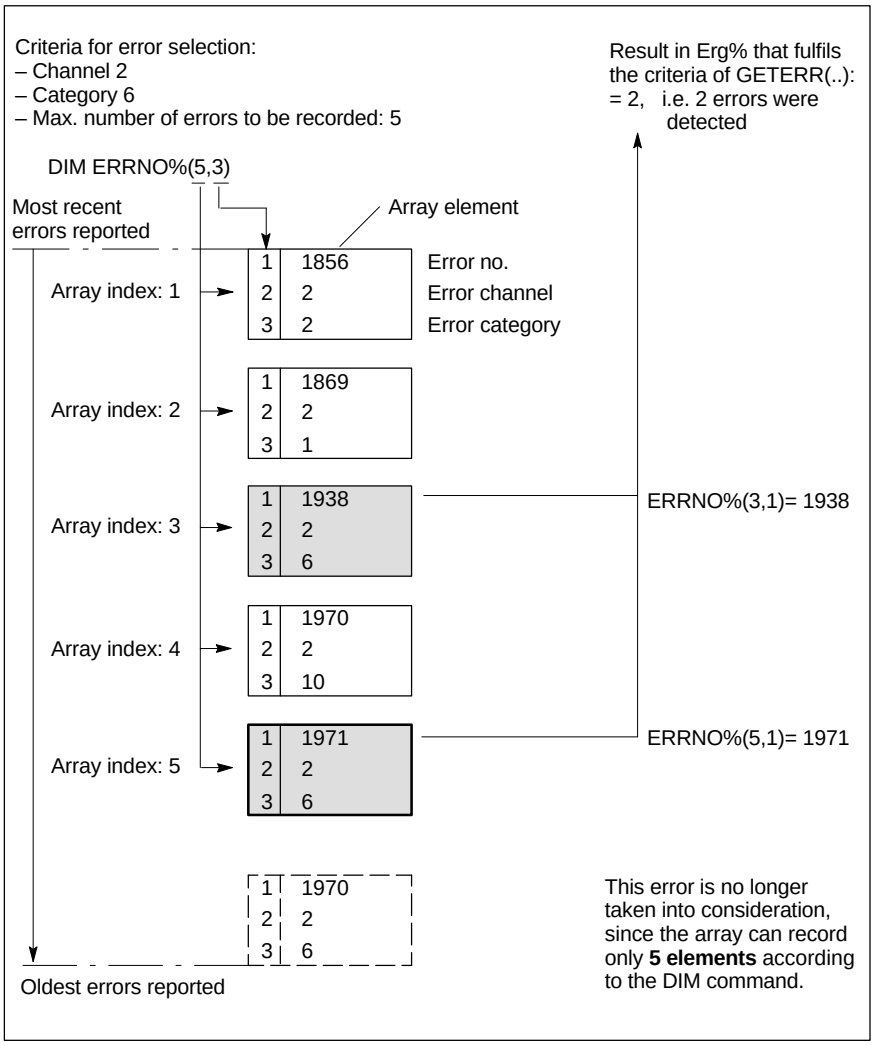
Example:
Query last part program error on channel 2

```
10 DIM ERRNO%(5,3)   :REM Integer array with 5 elements
20 REM REM query last part program error on channel 2
30 CHAN%=2:CATEGORY%=6
40 ERG%=GETERR(CHAN%,CATEGORY%,ERRNO%,1)
```

The error no. 1938 appears in ERRNO% (1,1) (see figure above).

Example:
Result evaluation for 5 array elements (see display page 4–44)

```
10 DIM ERRNO%(5,3):REM Integer array with 5 elements
20 CHAN%=2 : CATEGORY%=0
25 REM query part program error on channel 2
30 ERG%= GETERR(CHAN%, CATEGORY%, ERRNO%, 5)
40 FOR I%= 1 TO ERG%
50       IF ERRNO%(I%,3)=6 THEN
60          PRN#(0, "Part program error: ",ERRNO%(I%,1))
70       ENDIF
80 NEXT I%
```



The part program errors 1938 and 1971 are issued as a result in the MSG window. The variable Erg% has the value 2.

☞ **One of the uses of the GETERR function is to record the chronological appearance of one or several errors in order to research the actual cause of the error.**

4.14 NCS coupling

Process and data services of the internal NCS interface can be accessed by means of the functions for NCS coupling.

4.14.1 Possible error return values of the functions

All function calls supply a return value for verification and remedying errors. This value can be assigned to an integer variable or to a real variable.

Example:

```
ERR_VAR% = MCOPS(...)
ERR_VAR% = MCODS(...)
```

CAUTION
Incorrect program reactions possible!
If invoked functions return an error code, actions which might be important for the continued program sequence were performed incompletely or not at all.
We therefore urgently recommend that after a function call you check the program (e.g. using CASE) to determine whether the function was able to be executed without error.
The further program behaviour will then be based on the type and severity of any error occurring.

The following return values are currently defined:

0: No error occurred.
1: The specified channel does not exist.
2: The function cannot be executed because the specified channel is momentarily occupied (the momentary status does not permit the action).
3: In the specified channel an initiated control reset is not yet completed.
4: The specified program name is too long (currently not in use).
5: The function requires reference points traversed to.
6: The specified program does not exist or cannot be executed.
7: When entering buffered NC blocks, writing into the buffer was interrupted. A second authority had simultaneously attempted to write in the buffer.
8: The function cannot be executed in the current operation mode.
9: The channel cannot be started because its status is not READY.
10: The function cannot be executed because no program is selected.
11: The specified program cannot be selected because the channel status does not permit it (e.g. status of block processing and interpolator is RUNNING).
12: Currently not in use.
13: The operation mode cannot be changed because the channel status does not permit this.
14: The destination of ”Search block” was not found.

15: ”Search block” is not possible because, although the channel status is READY, the processing of the main program has already started (e.g. program at M0).

16: The number of axes in the input of external zero shifts is too large.

17: In the input of external zero shifts the number of axis ZS groups is too large.

18: The specified syntax is unknown.

19: Improper index when entering an external tool compensation.

20: The number of corrections when entering an external tool compensation is too high (may be in connection with the correction index).

21: Improper format when entering an external tool compensation.

22: Improper tool orientation when entering an external tool compensation.

23: Improper compensation group.

24: The axis addressed does not exist.

25: When entering an NC block with automatic start, a runtime error was detected, e.g. a syntax error.

26: When entering buffered NC blocks, the buffer overflowed.

27: The entry for the coordinate filter is incorrect.

100: The magic number of the message is incorrect.

101: The NCS communication is disrupted.

102: The specified function is not available in this software version.

103: An internal error has occurred (currently not in use).

☞ **If the invoking program also contains NC blocks, the block processing is generally ahead of the machining. If at the time of block processing by MCOPS or MCODS function a process service or a machine status is requested the conditions possibly necessary for this at the machine are not yet met.**
This problem, however, applies only to functions which access precisely that channel in which they themselves are executed.
In this case use the WAIT command in the line before the function call. This halts the block processing until all the blocks before WAIT have really been executed.

4.14.2 Available functions

MCODS

Invokes motion control data services of the NCS by CPL. In this way data and statuses can be read from the CNC.

☞ **All returned values refer to that time at which the CPL block is processed by the block processing.**
If the invoking program also contains NC blocks the block processing is generally ahead of the machining. If program sequences are to be influenced by functions which determine current machine data or states you must eliminate the ”time lag” between block processing and the current machine state. This applies, however, only when you use functions which access precisely that channel in which they themselves are executed.
In this case use the WAIT command in the line before the function call. This halts the block processing until all the blocks before WAIT have really been executed.

The functions supply a return value (see section 4.14 from page 4–46).

General syntax:

MCODS(<*type*>,<*channel*>,<*version*>,<*buffer*>,<*size*>,<*axis number*>,<*ID number*>[,<*P1*>])

<*type*>: Integer expression. States the function to be executed. The subsequent table lists all the available functions.

<*channel*>: Integer expression. States the channel which the function is to affect.

<*version*>: Initialized integer or real variable (**not a** constant!). If the content of the variable is at function call = 0 the function defined by <*type*> writes the requested data immediately in <*buffer*>.
In addition, the function returns in <*version*> a version identification of the data supplied. If this version identification is still contained in the variable the next time the function is invoked the function does not write the requested data immediately into <*buffer*> but waits until after the next data change.
In this way for instance a program loop can be run through until a channel has reached a certain state. Here you should, however, include a timeout condition (e.g. counter or expired time period) in the loop in order to avoid endless loops!

<*buffer*>: In <*buffer*> the function returns the requested data values. Depending on the type of data <*buffer*> must be

- a simple variable of the integer, real or double type
- a field variable of the integer, real or double type
- a string variable (one-dimensional character field).

☞ **In the case of field or string variables only the variable name may be given without dimension or index!**

<*size*>: Integer expression. Defines the field size of <*buffer*>. If <*buffer*> is not a field variable but a simple variable of the type integer, real or double, specify the value 1 for <*size*>.

<*axis number*>: Integer expression. Provides the axis number of a physical axis.

<*ID number*>: Integer expression. Supplies the value of an <*ID number*> out of the cyclic axis message for all axes.

☞ **The size of a field variable used must first be defined by DIM command and may not be exceeded in the parameter <*size*>!**

<*P1*>: Optional parameter dependent on <*type*>.

Function overview MCODS(...)

Positions	
Commanded position of axis	see MCODS(1..)
Commanded position of axis	see MCODS(2..)
Actual position of axis	see MCODS(35..)
Actual values of axis (machine coordinate system)	see MCODS(38..)
Lag	see MCODS(4..)
Axis program value (program coordinate system)	see MCODS(37..)
Programmed end positions incl. shifts	see MCODS(16..)
Programmed end positions without shifts	see MCODS(23..)
Speed and spindle speed	
Path feed	see MCODS(3..)
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☞ **In the following tables integer constants are given in some cases as parameters in the syntax. In lieu of these constants you can also program integer variables, but these must be occupied with the stated value at the time of the function call.**

Function supplies / refresh[1)]	<*buffer*> **is of type** [2)]	**Syntax / description**
Commanded position of axis	Double, Array	**MCODS(1,-1,**<*version*>**,**<*buffer*>**,**<*size*>**)**
Z		Supplies in <*buffer*> in ascending, channel-independent order the commanded positions of all **feed and auxiliary axes in the system**: in the case of linear axes in mm in the case of rotary axes in degrees ”Set actual value” (e.g. G92) is included in the calculation of the values.
Commanded position of axis	Integer, Array	**MCODS(2,-1,**<*version*>**,**<*buffer*>**,**<*size*>**)**
Z		Supplies in <*buffer*> in ascending, channel-independent order the commanded positions of all **feed and auxiliary axes in the system**: in the case of linear axes in 0.0001 mm in the case of rotary axes in 0.0001 degrees ”Set actual value” (e.g. G92) is included in the calculation of the values.
Path feed	Real, Array	**MCODS(3,**<*channel*>**,**<*version*>**,**<*buffer*>**,3)**
Z		Supplies in <*buffer*> in ascending order 3 values with current path feeds of <*channel*> (incl. feed potentiometer) in the unit mm/min: 1. The commanded speed which is specified to the interpolator externally. 2. The actual interpolator speed (=momentary path velocity) 3. The interpolator-internal commanded speed. It may have changed vis-à-vis the externally specified speed by an application (e.g. feed-adapt function). In case of feed programming in mm/rev (G95) it supplies the path feed in mm/min.

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Function supplies / refresh[1]	*<buffer>* **is of type** [2]	**Syntax / description**
Lag	Real, Array	**MCODS(4,–1,**<*version*>**,**<*buffer*>**,**<*size*>**)**
Z		Supplies in <*buffer*> in ascending order the lag of all **physical** axes: in the case of linear axes in mm in the case of rotary axes in degrees If the transfer of the lag is not supported by the drives (by SERCOS ID no.) the value 0.0 is returned.
Commanded spindle speed, cutting velocity	Real, Array	**MCODS(5,–1,**<*version*>**,**<*buffer*>**,**<*size*>**)**
Z		Supplies in <*buffer*> in ascending order (S or S1, S2, S3, etc.) the commanded spindle speeds or cutting velocities of all **spindles in the system**: If G196 is active the cutting velocities are supplied in m/min, otherwise the current commanded spindle speeds in rpm. The potentiometer, the speed limits (G192, G292) and the limits by the gear are included in the calculation. If a spindle is not present 0.0 is returned at the relevant location in <*buffer*>.
Status "InPos"	Integer, Array	**MCODS(6,–1,**<*version*>**,**<*buffer*>**,**<*size*>**)**
Z		Supplies in <*buffer*> in ascending, channel-independent order the value 0 or 1 as InPos signal for every **feed and auxiliary axis**: Axis is in position: 1 Axis is not in position: 0 An axis is in position if it is in the parameterized InPos window (MACODA parameter 1015 00100) and no travel command (see also MCODS(47...)) is present.
Value of the feed potentiometer	Real	**MCODS(7,**<*channel*>**,**<*version*>**,**<*buffer*>**,1)**
Z		Supplies in <*buffer*> the current value of the feed potentiometer of <*channel*> in 1/100 percent.
Values of the spindle potentiometers	Real, Array	**MCODS(8,–1,**<*version*>**,**<*buffer*>**,**<*size*>**)**
Z		Supplies in <*buffer*> in ascending order for all **spindles in the system** (S and S1, S2, S3, etc.) the current values of the feed potentiometers in 1/100 percent.
Active length compensation number	Integer	**MCODS(9,**<*channel*>**,**<*version*>**,**<*buffer*>**,1)**
S		Supplies in <*buffer*> the length compensation number active in <*channel*>. If no length compensation is active –1 is returned.
Active length compensation	Real	**MCODS(10,**<*channel*>**,**<*version*>**,**<*buffer*>**,1)**
S		Supplies in <*buffer*> the length compensation active in <*channel*> in mm. If no length compensation is active 0.0 is returned.

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Function supplies / refresh[1]	<*buffer*> **is of type** [2]	**Syntax / description**
Active tool radius compensation number	Integer	**MCODS(11,**<*channel*>**,**<*version*>**,**<*buffer*>**,1)**
S		Supplies in <*buffer*> the tool radius compensation number active in <*channel*>. If no tool radius compensation is active –1 is returned.
Active tool radius compensation	Real	**MCODS(12,**<*channel*>**,**<*version*>**,**<*buffer*>**,1)**
S		Supplies in <*buffer*> the tool radius compensation active in <*channel*> in mm. If no tool radius compensation is active 0.0 is returned.
Name of the active tool compensation table	Character, Array	**MCODS(13,**<*channel*>**,**<*version*>**,**<*buffer*>**,**<*size*>**)**
S		Supplies in <*buffer*> the name of the tool compensation table active in <*channel*>. If none is active 3 blanks are returned as the string.
Name of the active axis zero shift table	Character, Array	**MCODS(14,**<*channel*>**,**<*version*>**,**<*buffer*>**,**<*size*>**)**
S		Supplies in <*buffer*> the name of the axis zero shift table active in <*channel*>. If none is active 3 blanks are returned as the string.
Active axis zero shift values	Real, Array	**MCODS(15,**<*channel*>**,**<*version*>**,**<*buffer*>**,**<*size*>**)**
S		Supplies in <*buffer*> the axis zero shift values of the 3 groups G53...G59, G153...G159 and G253...G259 active in <*channel*> for all feed axes in mm. If no shift is active 0.0 is returned. The following order applies: ● Shift of the 1st axis in group 1 ● Shift of the 2nd axis in group 1 ● Shift of the nth axis in group 1 ● Shift of the 1st axis in group 2 : ● Shift of the nth axis in group 2 : ● Shift of the nth axis in group 3
Programmed end positions incl. shifts	Real, Array	**MCODS(16,0,**<*version*>**,**<*buffer*>**,**<*size*>**)**
S		Supplies in <*buffer*> in ascending, channel-independent order the end positions with reference to the workpiece coordinates of the active blocks of all **feed and auxiliary axes**: ● in the case of linear axes in mm ● in the case of rotary axes in degrees All the shift values are calculated. ”Set actual value” (e.g. G92) is **not** included in the calculation of the values.

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Function supplies / refresh[1]	*<buffer>* **is of type** [2]	**Syntax / description**
Type of programming (inch/metric)	Integer	**MCODS(18,***<channel>***,***<version>***,***<buffer>***,1)**
S		Supplies in *<buffer>* the programming type of the axes present on the *<channel>*: 0: Inch 1: Metric 2: Degree 3: No axis present
Maximum spindle speed	Real, Array	**MCODS(19,0,***<version>***,***<buffer>***,***<size>***)**
S		Supplies in *<buffer>* the maximum permissible spindle speeds in rpm of all **spindles in the system**. Order: S or S1, S2, etc. The speed limits are included in the calculation.
Minimum spindle speed	Real, Array	**MCODS(20,0,***<version>***,***<buffer>***,***<size>***)**
S		Supplies in *<buffer>* the minimum permissible spindle speeds in rpm of all **spindles in the system**. Order: S or S1, S2, etc. The speed limits are included in the calculation.
Programmed end position without shifts	Real, Array	**MCODS(23,0,***<version>***,***<buffer>***,***<size>***)**
S		Like MCODS(16...) but without shifts.
Programmed path feed	Real	**MCODS(24,***<channel>***,***<version>***,***<buffer>***,1)**
S		Supplies in *<buffer>* the programmed path feed of *<channel>* in the unit mm/min.
Programmed spindle speeds	Real, Array	**MCODS(25,0,***<version>***,***<buffer>***,***<size>***)**
S		Supplies in *<buffer>* the programmed speeds of all **spindle axes in the system** in rpm. Order: S or S1, S2, etc.
Status "Axes referenced"	Integer, Array	**MCODS(26,–1,***<version>***,***<buffer>***,***<size>***)**
E		Supplies in *<buffer>* in ascending, channel-independent order the value 0 or 1 as signal "Axes referenced" for each **feed and auxiliary axis**: Axis referenced: 1 Axis not referenced: 0
Jog speeds	Real, Array	**MCODS(27,–1,***<version>***,***<buffer>***,***<size>***)**
E		Supplies in *<buffer>* in ascending, channel-independent order the current jog speeds of all **feed and auxiliary axes in the system**: in the case of linear axes in mm/min in the case of rotary axes in rpm

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Function supplies / refresh[1]	<*buffer*> **is of type** [2]	**Syntax / description**
Messages in the part program	Character, Array	**MCODS(28,**<*channel*>**,**<*version*>**,**<*buffer*>**,80)**
E		Supplies in <*buffer*> the messages programmed in <*channel*> by MSG command.
Status "Test mode"	Integer	**MCODS(29,0,**<*version*>**,**<*buffer*>**,1)**
E		Supplies in <*buffer*> the value 1 if the test mode is activated. Otherwise 0.
Path and name of main program	Character, Array	**MCODS(30,**<*channel*>**,**<*version*>**,**<*buffer*>**,**<*size*>**)**
E		Supplies in <*buffer*> the path incl. the name of the main program selected in <*channel*> as a string. A value existing in <*version*> is ignored in the function call of the function. For files stored in the Typ3-internal file system the value 31 must be given in <*size*> (path incl. file name can contain max. 30 characters here). For files stored in mounted file systems the value in <*size*> depends from the maximum possible number of characters supported by the external file system for path and name of a file.

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Function supplies / refresh[1]	*<buffer>* **is of type** [2]	**Syntax / description**
Channel operation mode	Integer	**MCODS(31,**<*channel*>**,**<*version*>**,**<*buffer*>**,1)**
E		Supplies in <*buffer*> the operation mode active in <*channel*>: 0 No operation mode and therefore no process is active. 1 Jog mode. Axes can be jogged (+/–) 2 Traverse to reference point. Axes can be started with the signals manual+ / manual–. 3 Reserved. 4 Manual data input. Individual NC blocks can be specified for machining. 5 Automatic. Part programs are completely executed. 6 Automatic (program block). Individual blocks of a part program are executed one after the other. Each individual block is prepared and started with cycle start. 7 Automatic (single step). From an individual NC block in the part program the NC may generate and process several blocks. In this operation mode cycle start always passes an individual block on to the interpolator for machining. 8 Reserved. 9 Reserved. 10 Automatic (single block). With cycle start all blocks generated and prepared on the basis of a single NC block in the part program are forwarded to the interpolator for machining. 11 Return to path. Axes can be removed manually from the contour and automatically or manually returned to it. 12: CPL debugger (program block operation): Single blocks are executed as they are specified in the part program. 13: CPL debugger (automatic operation): All blocks up to the next breakpoint are executed.

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If not a simple variable but a field variable is needed the variable type is followed by ”array”.

Function supplies / refresh[1]	<*buffer*> **is of type** [2]	**Syntax / description**
SAV and IPO states	Integer, Array	**MCODS(32,**<*channel*>**,**<*version*>**,**<*buffer*>**,2)**
E		Supplies in <*buffer*> from <*channel*> – the SAV state and – the state of the interpolator. The following values are defined as **SAV state**: 1: The operation mode is not active. A process can be selected. 2: The operation mode is ready. A process can be started. 3: The operation mode is active. A program or NC block is being processed. 4: Reserved. 5: Reserved. 6: An error has occurred in the operation mode which can only be remedied by control reset or deselection of program. 7: Reserved. 8: Control reset momentarily in progress. 9: A program is selected and is momentarily in preparation (e.g. linked). 10: ”Cancel distance to go” has been triggered and is not yet completed. 11: The operation mode is active and is reprocessing existing buffers. 12: The operation mode is ready. The process is at the start of the program and can be started. 13: When entering buffered NC blocks, all blocks have been executed. It is waiting for the next entry. The following values are defined as **IPO state**: 1: Interpolator running 2: Interpolator running down due to feed halt. 3: Interpolator has stopped the axes.
Axis names	Character, Array	**MCODS(33,**<*channel*>**,**<*version*>**,**<*buffer*>**,**<*size*>**)**
R		If you specify the value ”–1” for <*channel*> the names of all **physical axes** will be supplied in <*buffer*> separated by the character ”0” (zero byte) in ascending order of 9 bytes each. If you specify an actually existing channel number for <*channel*> the names of all **axes on the specified channel** separated by the character ”0” (zero byte) will be supplied in <*buffer*> in ascending order. Names which are shorter than 8 characters will be filled with blanks up until the 8th character. The size of the <*buffer*> is specified in <*size*>. It can be a maximum of 144 bytes with 16 axes (9*16). For an example see Chap. 4.14.3 page 4–76.

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Function supplies / refresh[1]	*<buffer>* **is of type** [2]	**Syntax / description**
Number of feed axes, auxiliary axes, spindles; movement types, drive types	Integer, Array	**MCODS(34,–1,***<version>***,***<buffer>***,***<size>***)**
R		Reserved. Use MCODS(45...) instead.
Actual axis position	Real, Array	**MCODS(35,–1,***<version>***,***<buffer>***,***<size>***)**
Z		Supplies in *<buffer>* in ascending, channel-independent order the actual positions of all **feed and auxiliary axes** transmitted to the CNC from the drives by SERCOS ID no.: in the case of linear axes in mm in the case of rotary axes in degrees ”Set actual value” (e.g. G92) is **not** included in the calculation of the values.
Actual spindle speed	Real, Array	**MCODS(36,–1,***<version>***,***<buffer>***,***<size>***)**
Z		Supplies in *<buffer>* in ascending order (S and S1, S2, S3, etc.) the actual spindle speeds of all **spindles in the system**. Included in the calculation are the potentiometer, the speed limits (G192, G292) and the limits by the gear. If a spindle is not present 0.0 is returned at the relevant location in *<buffer>*.
Axis program value (program coordinate system)	Double, Array	**MCODS(37,–1,***<version>***,***<buffer>***,***<size>***)**
Z		Supplies in *<buffer>* in ascending, channel-independent order the commanded workpiece-related positions of the interpolator for all **feed axes in the system**: in the case of linear axes in mm in the case of rotary axes in degrees ”Set actual value” (e.g. G92) and axis zero shift (G54...G59, G154...G159, G254...G259) are **not** included in the calculation of the values.
Actual axis values (machine coordinate system)	Double, Array	**MCODS(38,–1,***<version>***,***<buffer>***,***<size>***)**
Z		Supplies in *<buffer>* in ascending, channel-independent order “actual values” referring to the machine coordinates system (Cartesian) currently used. The values are calculated from the axis actual positions by applying the machine-specific kinematic forward transformation (axis transformation), specified for each channel. If no kinematic axis transformation is active, MCODS(38) will supply identical values like MCODS(35). The prerequisite for the application of MCODS(38) is a corresponding setting of the MACODA parameter 9030 00002, which is being used to configure, whether and how frequently actual values of the machine coordinate system are being calculated.

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Function supplies / refresh[1]	<*buffer*> **is of type** [2]	**Syntax / description**
Status ”Dwell active”	Integer	**MCODS(39,**<*channel*>**,**<*version*>**,**<*buffer*>**,1)**
E		Supplies in <*buffer*> the value 1 if a dwell is active in <*channel*>. Otherwise 0.
Status ”Acknowledgement-compulsory auxiliary function active”	Integer	**MCODS(40,**<*channel*>**,**<*version*>**,**<*buffer*>**,1)**
E		Supplies in <*buffer*> the value 1 if an auxiliary function is waiting for acknowledgement in <*channel*>. Otherwise 0.
Status ”Load release”	Integer	**MCODS(41,**<*channel*>**,**<*version*>**,**<*buffer*>**,1)**
E		Supplies in <*buffer*> the value 1 if the NC input signal ”Block transfer inhibit” is set in <*channel*>. Otherwise 0.
Customer-specific data		**MCODS(42,**<*channel*>**,**<*version*>**,**<*buffer*>**,**<*size*>**,** <P1>**)**
E		Supplies in <*buffer*> customer-specific data from <*channel*>. In <*P1*> an integer value in the range from 0 to 65535 can be transferred during the function call to the customer server for the selection of certain data. The function is intended for customer’s own developments in the area ”NC core”.
Assignment of axis to channel	Integer, Array	**MCODS(43,–1,**<*version*>**,**<*buffer*>**,**<*size*>**)**
E		Supplies the following information in <*buffer*> for each physical axis in the system: >=0: Channel number of the axis (=> axis is synchronous) –1: Axis is asynchronous –2: Axis is a spindle –3: Axis is not defined
Number of channels	Integer, Array	**MCODS(44,–1,**<*version*>**,**<*buffer*>**,3)**
R		Supplies in <*buffer*> in ascending order ● the number of usable user channels ● the number of channels at the interface ● the number of all internal and external channels
Number of axes	Integer, Array	**MCODS(45,–1,**<*version*>**,**<*buffer*>**,3)**
R		Supplies in <*buffer*> in ascending order ● the number of the drives existing in the system ● the number of existing axes ● the number of existing spindles

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Function supplies / refresh[1]	*<buffer>* **is of type** [2]	**Syntax / description**
Return to path strategy and recording of jog movements	Integer, Array	**MCODS(46,**<*channel*>**,**<*version*>**,**<*buffer*>**,3)**
E		Supplies in <*buffer*> in ascending order for the specified <*channel*> ● the return to path operation mode ● the return-to-path point ● the recording status of the jog movements. As **return to path operation mode** the following values are possible: 1 Automatic return to path 2 Return to path with single block 3 Manual return to path For the **return-to-path point**: 1 Return to path to the startpoint 2 Return to path to the endpoint 3 Return to path to the breakpoint For the **recording status:** 0 Recording not active 1 Recording active
Status "Travel command"	Integer, Array	**MCODS(47,**<*channel*>**,**<*version*>**,**<*buffer*>**,**<*size*>**)**
Z		If you specify the value "–1" for <*channel*> the travel command signals of all **physical axes** will be supplied in ascending order in <*buffer*>. If you specify an actually existing channel number for <*channel*> the travel command signals of all **axes on the specified channel and behind it those of the asynchronous axes** will be supplied in ascending order in <*buffer*>. Travel command is present: 1 Travel command is not present: 0 A travel command is always set as soon as an axis is to execute a traversing movement by manual input or by input in the part program.

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Function supplies / refresh[1]	<*buffer*> **is of type** [2]	**Syntax / description**
Axis mode	Integer, Array	**MCODS(48,**<*channel*>**,**<*version*>**,**<*buffer*>**,**<*size*>**)**
E		If you specify the value ”–1” for <*channel*> the operation modes of all **physical axes** will be supplied in ascending order in <*buffer*>. If you specify an actually existing channel number for <*channel*> the operation modes of all **axes on the specified channel and behind it those of the asynchronous axes** will be supplied in ascending order in <*buffer*>. Possible return values for the operation values: 0: No operation mode and therefore no process is active. 1: Jog mode. Axes can be jogged (+/–) 2: Traverse to reference point. Axes can be started with the signals manual+ / manual–. 3: Reserved. 4: Manual data input. Individual NC blocks can be specified for machining. 5: Automatic. Part programs are completely executed. 6: Automatic (program block). Individual blocks of a part program are executed one after the other. Each individual block is prepared and started with cycle start. 7: Automatic (single step). From an individual NC block in the part program the NC may generate and prepare several blocks. In this operation mode cycle start always passes an individual block on to the interpolator for machining. 8: Reserved. 9: Reserved. 10: Automatic (single block). With cycle start all blocks generated and prepared on the basis of a single NC block in the part program are forwarded to the interpolator for machining. 11: Return to path. Axes can be removed manually from the contour and automatically or manually returned to it.
Status ”Feed inhibit”	Integer, Array	**MCODS(49,**<*channel*>**,**<*version*>**,**<*buffer*>**,**<*size*>**)**
E		If you specify the value ”–1” for <*channel*> the signals of the feed inhibit of all **physical axes** will be supplied in ascending order in <*buffer*>. If you specify an actually existing channel number for <*channel*> the feed inhibit of all **axes on the specified channel and behind it those of the asynchronous axes** will be supplied in ascending order in <*buffer*>. 1: Feed inhibit is present 0: Feed inhibit is not present

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Data which appear **immediately** when called for are identified with an ”I”.
Data which **never** change (they only need to be called for once) are identified with ”R”.

2) Gives the variable type (integer, real, double, character) needed for <*buffer*>.
If not a simple variable but a field variable is needed the variable type is followed by ”array”.

Function supplies / refresh[1]	*<buffer>* **is of type** [2]	**Syntax / description**
Value of the axis potentiometers	Real, Array	**MCODS(50,**<*channel*>**,**<*version*>**,**<*buffer*>**,**<*size*>**)**
E		If you specify the value ”–1” for <*channel*> the values of the axis potentiometers of all **physical axes** will be supplied in ascending order in <*buffer*> (in 0.01 percent). If you specify an actually existing channel number for <*channel*> for each **axis on the specified channel** the value of the channel potentiometer **and then the values of the axis potentiometers of all asynchronous axes** will be supplied in ascending order in <*buffer*> (in 0.01 percent).
Active external tool compensation values	Real, Array	**MCODS(51,**<*channel*>**,**<*version*>**,**<*buffer*>**,**<*size*>**)**
S		Supplies in <*buffer*> the external tool compensation values active in <*channel*>. Order: radius, length compensation If no external tool compensation is active 0.0 will be returned in each case.
Active external axis zero shift values	Real, Array	**MCODS(52,**<*channel*>**,**<*version*>**,**<*buffer*>**,**<*size*>**)**
S		Supplies in <*buffer*> the external axis zero shift values active in <*channel*>. Order: 1st logical axis, ... 8th logical axis If no external shift is active 0.0 will be returned in each case.
Unit of measurement of the axes	Integer, Array	**MCODS(53,**<*channel*>**,**<*version*>**,**<*buffer*>**,**<*size*>**)**
E		If you specify the value ”–1” for <*channel*> the units of measurement (metric, inch, degree) of all **physical axes** will be supplied in ascending order in <*buffer*>. If you specify an actually existing channel number for <*channel*> the unit of measurement for each **axis on the specified channel and then the unit of measurement of all asynchronous axes** will be supplied in ascending order in <*buffer*>. In the case of asynchronous linear axes in the axis modes ”Jog” and ”Traverse to reference point” the axis interface determines the unit of measurement. If no axis mode is specified ”metric” is supplied. In the case of synchronous linear axes in the channel modes ”Jog” and ”Traverse to reference point” the axis interface determines the unit of measurement. In the other operation modes it depends on the channel unit of measurement metric/inch (G70, G71). With rotary axes and spindles the measuring unit ”degrees” is used, with Hirth axes with position programming a corresponding measuring unit will be supplied. Possible return values for the units of measurement: 0: Inch 1: Metric 2: Degree 3: Axis not present 4: position-programmable Hirth axis

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2) Gives the variable type (integer, real, double, character) needed for <*buffer*>.
If not a simple variable but a field variable is needed the variable type is followed by ”array”.

Function supplies / refresh[1]	*<buffer>* **is of type** [2]	**Syntax / description**
Active general tool compensation	Real, Array	**MCODS(54,**<*channel*>**,**<*version*>**,**<*buffer*>**,**<*size*>**)**
S		Supplies in <*buffer*> the actual values of general tool compensation in <*channel*>. Order: ● Radius compensation ● L3 length compensation ● L1 length compensation ● L2 length compensation ● Tool orientation ● Compensation type The following compensation types are defined: 0: no compensation 1: drill tool 2: milling tool 3: lathe tool 4: anglehead tool If no general tool compensation is active 0.0 will be returned in each case.
Manufacturer's version	Character, Array	**MCODS(55,–1,**<*version*>**,**<*buffer*>**,**<*size*>**,** <*axis number*>**)**
R		Provides the manufacturer's version of the drive. The axis selection occurs in the parameter <*axis number*> by putting in the physical axis (No. 0 also supplies the 1st axis). The manufacturer's version corresponds to the SERCOS ID No. S-0-0030. An array with a maximum of 40 characters is delivered by the parameter <*buffer*>.
Control device type	Character, Array	**MCODS(56,–1,**<*version*>**,**<*buffer*>**,**<*size*>**,** <*axis number*>**)**
R		Provides the Control device type of the drive. The axis selection occurs in the parameter <*axis number*> by putting in the physical axis (No. 0 also supplies the 1st axis). The Control device type corresponds to the SERCOS ID No. S-0-0140. An array with a maximum of 40 characters is delivered by the parameter <*buffer*>.
Motor type	Character, Array	**MCODS(57,–1,**<*version*>**,**<*buffer*>**,**<*size*>**,** <*axis number*>**)**
R		Provides the motor type of the drive. The axis selection occurs in the parameter <*axis number*> by putting in the physical axis. (No. 0 also supplies the 1st axis).The motor type corresponds to the SERCOS SERCOS ID No. S-0-0141. An array with a maximum of 40 characters is delivered by the parameter <*buffer*>.

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Data which appear **immediately** when called for are identified with an "I".
Data which **never** change (they only need to be called for once) are identified with "R".

2) Gives the variable type (integer, real, double, character) needed for <*buffer*>.
If not a simple variable but a field variable is needed the variable type is followed by "array".

Function supplies / refresh[1]	*<buffer>* **is of type** [2]	**Syntax / description**
Default assignment of axis to channel	Integer	**MCODS(58,–1,**<*version*>**,**<*buffer*>**,**<*size*>**)**
R		Supplies in <*buffer*> the following default assignment for each physical axes in the system: >=0: channel number of the axis (=>axis is synchronous) –1: Axis is asynchronous –2: Axis is a spindle –3: Axis is not defined In the case of 16 axes the <*buffer*> must have <*size*> 16 (integer)
Active logical axis names	Character, Array	**MCODS(59,**<*channel*>**,**<*version*>**,**<*buffer*>**,**<*size*>**)**
E		If the value ”–1” is entered for the <*channel*> then the names of **all active logical axes** will appear in <*buffer*>, separated by the character ”0” (zero byte) in increasing order at 9 bytes each. If an already existing channel number is entered for <*channel*> then all the names of **all axes on the given channel** will appear in <*buffer*>, separated by the character ”0” (zero byte) in increasing order. Names which are shorter than 8 characters will be completed with blanks up until the 8th character. The size of the <*buffer*> appears in <*size*>. It can be a maximum of 144 bytes with 16 axes (9*16). Example see chapter 4.14.3 page 4–76.
Logical Axis Names Default Setting	Character, Array	**MCODS(60,**<*channel*>**,**<*version*>**,**<*buffer*>**,**<*size*>**)**
R		If the value ”–1” is entered for the <*channel*> then the names of **all logical axes (in the default setting)** appear in <*buffer*>, separated by the character ”0” (zero byte) in increasing order at 9 bytes each. If an already existing channel number is entered for <*channel*> then **all the names of all axes on the given channel** will appear in <*buffer*>, separated by the character ”0” (zero byte) in increasing order. Names which are shorter than 8 characters will be completed with blanks up until the 8th character. The size of the <*buffer*> appears in <*size*>. It can be a maximum of 144 bytes with 16 axes (9*16). Example see chapter 4.14.3 page 4–76.

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2) Gives the variable type (integer, real, double, character) needed for <*buffer*>.
If not a simple variable but a field variable is needed the variable type is followed by ”array”.

Function supplies / refresh[1]	<*buffer*> **is of type** [2]	**Syntax / description**
Measuring units of axes Default setting	Integer, Array	**MCODS(61,**<*channel*>**,**<*version*>**,**<*buffer*>**,**<*size*>**)**
R		If the value ”–1” is entered for the <*channel*> then the measuring units (metric, inch, degrees) of **all physical axes (in the default setting)** will appear in <*buffer*>, separated by the character ”0” (zero byte) in increasing order at 9 bytes each. If an already existing channel number is entered for <*channel*> then **all the names of all axes on the given channel** will appear in <*buffer*>, separated by the character ”0” (zero byte) in increasing order. • **Asynchronous** linear axes are given in “metric”. • With **synchronous** axes the measuring unit depends on the power-up condition after the start (MACODA parameter 7060 00010): ”metric/inch” (G70/G71) • With rotary axes and spindles the measuring unit ”degrees” is used, with Hirth axes with position programming a corresponding measuring unit will be supplied. Possible return values for the measuring units: 0: inch 1: metric 2: degree 3: axis not available 4: position-programmable Hirth axis In the case of 16 axes the <*buffer*> must have <*size*> 16 (integer).
ID number of the cyclical axis message	Integer, Array	**MCODS(62,–1,**<*channel*>**,**<*version*>**,**<*buffer*>**,**<*size*>**,**<*ID number*>**)**
Z		Supplies the value of an <*ID number*> from the cyclic axis telegram for all axes. If the <ID number> is not in the cyclic telegram the value NCS_MCO_NOT_IN_CYCL_AT_C (–2147483648) is given. The value is “integer” in SERCOS weighting. In the case of 16 axes the <*buffer*> must have <*size*> 16 (integer).
Movement function of the spindles	Integer, Array	**MCODS(63,–1,**<*version*>**,**<*buffer*>**,**<*size*>**)**
E		Supplies the movement function of all spindles. Movement function codes: 0: Spindle is not defined 1: Turn right (clockwise) without coolant 2: Turn right (clockwise) with coolant 3: Turn left (counter-clockwise) without coolant 4: Turn left (counter-clockwise) with coolant 5: Spindel stop 6: Spindle orientation In the case of 8 spindles the <*buffer*> must have the <*size*> 8 (integer).

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2) Gives the variable type (integer, real, double, character) needed for <*buffer*>.
If not a simple variable but a field variable is needed the variable type is followed by ”array”.

Function supplies / refresh[1]	*<buffer>* **is of type** [2]	**Syntax / description**
Gear range of the spindles	Integer, Array	**MCODS(64,–1,**<*version*>**,**<*buffer*>**,**<*size*>**)**
E		Supplies the gear range of the spindles. Gear range codes: 40: automatic gear range selection 41: gear 1 42: gear 2 43: gear 3 44: gear 4 48: neutral gear In the case of 8 spindles the <*buffer*> must have the <*size*> 8 (integer).
Group assignment of the spindles	Integer, Array	**MCODS(65,–1,**<*version*>**,**<*buffer*>**,**<*size*>**)**
E		Supplies the group assignment of the spindles. Group classification: 0: no group, 1 .. 4: group number In the case of 8 spindles the <*buffer*> must have the <*size*> 8 (integer).
Automatic or manual gear selection	Integer, Array	**MCODS(66,–1,**<*version*>**,**<*buffer*>**,**<*size*>**)**
E		Supplies the automatic or manual selection of gears. Gear selection: 0: manual 1: automatic In the case of 8 spindles the <*buffer*> must have the <*size*> 8 (integer).
Information as to whether gear switching is active	Integer, Array	**MCODS(67,–1,**<*version*>**,**<*buffer*>**,**<*size*>**)**
E		Supplies information whether or not gear switching is active. Gear switching: 0: gear switching is not active. 1: gear switching is active. In the case of 8 spindles the <*buffer*> must have the <*size*> 8 (integer).
Skip block (activate)	Integer, Array	**MCODS(68,**<*channel*>**,**<*version*>**,**<*buffer*>**,2)**
E		Shows the condition of the NC output signal **skip block activate** and the input signal **skip block** of <*channel*> in <*buffer*>.
Optional stop (activated)	Integer, Array	**MCODS(69,**<*channel*>**,**<*version*>**,**<*buffer*>**,2)**
E		Shows the condition of the NC output signal **Optional stop activated** and the input signal **Optional stop** of the <*channel*> in <*buffer*>.

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Function supplies / refresh[1]	*<buffer>* **is of type** [2]	**Syntax / description**
Automatic program re-selection acitve	Integer	**MCODS(70,**<*channel*>**,**<*version*>**,**<*buffer*>**,1)**
I		*<buffer>* shows whether the **automatic program re-selection** has been applied on the given channel: 0: function has not been applied 1: function has been applied
Workpiece coordinates	Real, Array	**MCODS(71,**<*channel*>**,**<*version*>**,**<*buffer*>**,**<*size*>**)**
Z		Supplies the values of the **workpiece coordinates** (WCS) of the given channel to <buffer>: first all working range coordinates, then the pseudo coordinates of the channel.
Basis coordinates of the setpoints	Real, Array	**MCODS(72,**<*channel*>**,**<*version*>**,**<*buffer*>**,**<*size*>**)**
Z		Supplies the **setpoint values of the basis coordinates** (BCS) of the given channel to <buffer>: first all working range coordinates, then the pseudo coordinates of the channel.
Axis coordinates	Real, Array	**MCODS(73,**<*channel*>**,**<*version*>**,**<*buffer*>**,**<*size*>**)**
Z		Supplies the **values of the axis coordinates** (ACS) of the given channel to <buffer>. Channel = –1: all axis coordinates 0< channel ⩽ max. channel: data of the specified channel
Machine coordinates	Real, Array	**MCODS(74,**<*channel*>**,**<*version*>**,**<*buffer*>**,**<*size*>**)**
Z		Supplies the values of the **machine coordinates** (MCS) of the given channel to <buffer>. Channel = –1: all axis coordinates 0< Channel ⩽ max. channel: Data of the specified channel
Basis coordinates actual values	Real, Array	**MCODS(75,**<*channel*>**,**<*version*>**,**<*buffer*>**,**<*size*>**)**
Z		Supplies the **actual values of the basis coordinates** (BCS) of the given channel to <buffer>: first all working range coordinates, then the pseudo coordinates of the channel.
Programmed coordinate end points	Real, Array	**MCODS(76,**<*channel*>**,**<*version*>**,**<*buffer*>**,**<*size*>**)**
S		Supplies the **programmed coordinate end points** of the given channel to <buffer>: first all working range coordinates, then the pseudo coordinates of the channels.
Coordinate end points	Real, Array	**MCODS(77,**<*channel*>**,**<*version*>**,**<*buffer*>**,**<*size*>**)**
S		Supplies the **end points of the coordinates** of the given channel to <buffer> including the shifts: first all working range coordinates, then the pseudo coordinates of the channel.

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2) Gives the variable type (integer, real, double, character) needed for <*buffer*>.
If not a simple variable but a field variable is needed the variable type is followed by ”array”.

Function supplies / refresh[1]	*<buffer>* **is of type** [2]	**Syntax / description**
Coordinate names	Character, Array	**MCODS(78,**<*channel*>**,**<*version*>**,**<*buffer*>**,**<*size*>**)**
E		Supplies the **names of the active coordinates** of the given channel to <buffer>: first all working range coordinates, then the pseudo coordinates of the channel.
INPOS status coordinates	Integer, Array	**MCODS(79,**<*channel*>**,**<*version*>**,**<*buffer*>**,**<*size*>**)**
Z		Supplies the **INPOS status of the coordinates** of the given channel to <buffer>: first all working range coordinates, then the pseudo coordinates of the channel. The status for a working range coordinate is derived from the logical AND operation of the axis signals.
Reference status of the coordinates	Integer, Array	**MCODS(80,**<*channel*>**,**<*version*>**,**<*buffer*>**,**<*size*>**)**
E		Supplies the **reference point status of the coordinates** of the given channel to <buffer>: first all working range coordinates, then the pseudo coordinates of the channel. The status for a working range coordinate is derived from the logical AND operation of the axis signals.
Measuring units of the coordinates	Integer, Array	**MCODS(81,**<*channel*>**,**<*version*>**,**<*buffer*>**,**<*size*>**)**
E		Supplies the **measuring units of the coordinates** of the given channel to <buffer>: first all working range coordinates, then the pseudo coordinates of the channel. Possible return values for the measuring units: 0: inches 1: metric 2: degrees 3: coordinate is not available
Number of coordinates	Integer, Array	**MCODS(82,**<*channel*>**,**<*version*>**,**<*buffer*>**,**<*size*>**)**
E		Supplies the **number of coordinates/axes** in 3 elements of the given channel to <buffer>: 1st value: the total number of axes of the channel 2nd value: number of working range coordinates + number of pseudo coordinates of the channel. 3rd value: the number of pseudo coordinates of the channel.
Distance to go of the workpiece coordinates	Real, Array	**MCODS(83,**<*channel*>**,**<*version*>**,**<*buffer*>**,**<*size*>**)**
Z		Supplies the **distances to go of the workpiece coordinates** (WCS) of the given channel to <buffer>: first all working range coordinates, then the pseudo coordinates of the channel.

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2) Gives the variable type (integer, real, double, character) needed for *<buffer>*.
If not a simple variable but a field variable is needed the variable type is followed by ”array”.

Function supplies / refresh[1)]	<*buffer*> is of type [2)]	Syntax / description
Channel waiting states	Integer	**MCODS(87,**<*channel*>**,**<*version*>**,**<*buffer*>**,1)**
E		Supplies the **waiting states** of a **channel** to <buffer>. If a channel goes into a waiting state, this function reports the reasons for doing so. The active waiting statesare bit-coded. The following constant terms define the respective bits of the first integer value, beginning with the lowest value: 0: Dwell time 1: Acknowledgement-compulsory auxiliary function 2: Block transfer inhibit 3: Feed in channel equals 0 4: Program stop with M0/M1 5: Feed hold on the channel 6: Feed inhibit on the channel or of a channel axis 7: Block transfer inhibit entered by customer 8: Synchronized movement stop between channels (ASTOP, ...) 9: Waiting for axis in the case of an axis exchange (G511) 10: Waiting for a permanent variable (WPV) 11: Waiting for an interface signal at an active time (WAITA, ...) 12: Waiting for an interface signal (WAIT(IC...)) or for a set period of time (WAIT(,TIME%)) during block preparation 13: Motion Control Data Services (MCODS(...)) See example under 4.14.3
Online correction values (WCS)	Real, Array	**MCODS(89,** <channel>, <version>, <buffer>, <size>**)**
E		Supplies the **values of the online correction** (WCS) of the given channel to <buffer>. First all working range coordinates, then the pseudo coordinates of the channel.
Status of the online correction (WCS)	Integer, Array	**MCODS(90,** <channel>, <version>, <buffer>, <size>**)**
E		Supplies the **current status of the online correction** (WCS) of the given channel to <buffer>. First all working range coordinates, then the pseudo coordinates of the channel. 0: inactive 1: active

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MCOPS

Invokes motion control process services of NCS by CPL. This enables controlling of channels in the CNC.

General syntax:

MCOPS(<*fct*>,<*channel*>[[,[<*P1*>][,[<*P2*>],[<*P3*>]]],<*P4*>])

<*fct*>: Integer expression. States the function to be executed. All the available functions are described in the following table.

<*channel*>: Integer expression. States the channel which the function is to affect.

<*P1*>.<*P4*>: Optional parameters dependent on <*fct*>. Comma sequences are permissible but no comma before a closing bracket.

☞ **In the following table integer constants are sometimes given as parameters in the syntax. You may also program integer variables in lieu of these constants, but they must be occupied with the specified value at the time of the function call.**

Effect	Syntax / description
Cancel distance to go	**MCOPS**(**1,**<*channel*>)
	Triggers ”Cancel distance to go” on the programmed <*channel*>: • After triggering distance to go, all prepared NC blocks including the rest of the current block are discarded and newly processed. ☞**CPL blocks or CPL parts are not taken into consideration:** Example: The CPL variable POS had the value 10 for preparation. The NC word X[POS] is interpreted as X10, after ”cancel distance to go”, although POS may have a completely different value at this moment. Any corrective values that may have changed are taken into consideration. • The indicated end point is set on the current position in the display, whereby the indicated distance to go is simultaneously canceled. The <channel> subsequently returns to the condition NC ready (**NC-O 16.0 NC ready**). • After “Cycle start” (**NC-I 1.0 Cycle start**), the program continues at the break point, taking the new corrective values into consideration. Example for application of MCOPS(1, <*channel*>): after alteration of compensation tables if the new values are also to apply to blocks already prepared.

Effect	Syntax / description
Control reset	**MCOPS(2,**<*channel*>**[,**<*Control reset type*>**])**
	Triggers ”Control reset” on the programmed <*channel*>. To trigger system control reset: <*channel*> = –2 ● The channel initially accepts no further jobs such as program selection or operation mode switch. ● The interpolator is stopped. ● Jobs assigned to the channel but not yet executed are discarded. ● The main program is exited. ● Altered MACODA parameters not requiring startup are adopted, e.g. MACODA parameter 1020 00001 (software limit). ● Errors and warnings triggered by this channel are deleted. ● The interpolator is restarted. ● The power-up condition at control reset (MACODA parameter 7060 00020) is adopted, i.e. the corresponding modal states become active. ● The channel returns the interface signal 0.2 ”Control reset executed” and is ready again for new jobs. ● <Control reset type>: Integer expression. Sets the behavior of the functions. The following list includes all defined behavior patterns. A code number precedes each pattern. In order to set a certain pattern, the corresponding code number must be transferred into <Control reset type>. If several patterns are to be combined then the total of all the corresponding code numbers in <Control reset type> must be transferred to the function. Up to now the list contains only one element: Code number: 2: If the automatic program re-selection is active, then it can be suppressed with the value ”2” in this control reset. **Example**: `ERR_VAR=MCOPS(2,2,2)` control reset in 2nd channel without automatic program re-selection
Search block	**MCOPS(3,**<*channel*>**[,[**<*Start block*>**][,**<*End block*>**]])**

	Triggers ”Search block” in the selected but not yet started main program of the programmed <*channel*>:
	● <*Start Block*> and <*End Block*> are transferred as string expressions. In the search for <*Start Block*> and <*End Block*> the following conventions apply:
	  ● Blank, <Tab>, <LF> at the beginning of an NC block are ignored.
	  ● If <*Start Block*> and <*End Block*> begin with a number and the expression is not found in the program searched, the system searches for the expression again, but this time with the symbol ”N” prefixed. In this way e.g. ”50” also finds the NC block ”N50X100”.
	  ● If <*Start Block*> and <*End Block*> end with a number the expression is only found in the program searched if no further number follows directly. E.g. ”G1X10” **does not** find the NC block ”G1X100”.
	  ● If <*Start Block*> and <*End Block*> end with a letter the expression is only found in the program searched if a blank follows directly. E.g. ”50A” finds the NC block ”50A =1”, but not ”50A=1”.
	● The machining begins with <*Start Block*> and ends with <*End Block*>. If <*Start Block*> is missing or if the block is not found, the machining begins at the beginning of the program. If <*End Block*> is missing or if the block is not found, the machining stops at the end of the program.
	● The NC status changes to READY.
	Example: `ERR_VAR=MCOPS(3,2,”N50”,”N100”)`
	Triggers ”Search block” on channel 2. The main program is to be executed beginning at N50 up to and including N100.

Effect	Syntax / description
Select program or select string for manual data input	**MCOPS(4,**<*channel*>**[[,[**<*string*>**][,[**<*Start block*>**],[**<*End block*>**]]], <***selection type***>**])**

	Selects on the programmed <*channel*> a program for machining or a string for machining under the manual data input operation mode.
	● <*string*>: string expression. Depending on the <*selection type*> the system interprets the parameter as
	  ● path name (incl. part program name) of a part program (max. 100 characters) to be selected, or
	  ● If 32 is specified in<*selection type*>: as an NC block (size max. 512 bytes incl. final 0 byte), to be executed under the manual data input operation mode, or
	  ● If 32+4096 are specified in <*selection type*>: as several NC blocks, which are to be executed under operation manual data input.
	Several NC blocks are separated by NewLine (”\n”, Hex 0x0A). The max. size of all NC blocks may not exceed 4096 bytes including a final 0 byte.
	● <*Start Block*> and <*End Block*> define the start and end block in the part program for machining. Handling as with MCOPS(3,..).
	If the system interprets <*string*> as manual data input <*Start Block*> and <*End Block*> are ignored.

Effect	Syntax / description

	• <*selection type*>: Integer expression. Defines the behavior of the function. The subsequent list contains all the defined behavior patterns. Each pattern is preceded by a code number.
	If a certain behavior is set this code number must be transferred in <*selection type*>.
	If several behavior patterns are to be combined, the sum of all the corresponding code numbers is to be transferred to the function in <*selection type*>.
	1 During selection the system executes a link run. If there is no link table, one will be generated for the selected main program. Link tables are necessary if sub-program calls or CPL instructions exist in the programs.
	2 The system acknowledges the permissibility of a selection only if the NC status changes to READY.
	Normally the selection is acknowledged without waiting for the NC status READY.
	32 The system interprets <*string*> as manual data input. See also code number 128.
	64 Before the function selects the specified program or the specified MDI block an active program or an active manual data input is first exited.
	128 An MDI block is started immediately. We differentiate between 2 cases:
	<*channel*> is not active: the block is executed immediately as a normal MDI block.
	<*channel*> is already active: the block is executed immediately as a machine function. For restrictions see code number 1024.
	256 Prerequisite for traversing axes in operation mode ”jog”.
	or
	when movements are to take place in operation mode ”jog in workpiece coordinates”.
	512 Prerequisite for starting axes in operation mode ”Traverse to reference point”.
	1024 Machine function. Acts in connection with code number 128.
	An MDI block is executed parallel to the specified <*channel*>. In the MDI block, however, only auxiliary functions and asynchronous axis moves are permissible.
	2048 A program which is already active is replaced by the newly selected one. As a result, all the modal states are retained.
	In the case of manual data input the old character sequence is replaced by the new one.
	4096 Entering buffered NC blocks acts in connection with code number 32. While preceding blocks are being executed, others can already be specified.
	Attention!:
	If <*selection type*> 2 (waiting until the NC condition has changed to READY) is specified and the selected program does not exist or is not able to be executed, then the error message 6 will be returned. In all other cases it will not be examined whether the program can be executed. The function supplies 0 (no error occurred). A corresponding run time error will be generated only during the proceeding link.
	Examples:
	`ERR_VAR=MCOPS(4,1,”sect.cnc”,”N50”,”N100”,1)`
	Program selection of ”sect.cnc” on channel 1 incl. block search and link.
	`ERR_VAR=MCOPS(4,1,”/usr/user/p1.cnc”)`
	Program selection of ”p1.cnc” on channel 1 without block search and link.
	`ERR_VAR=MCOPS(4,1,”F1000G1X500”,,,32)`
	Selects on channel 1 the block ”F1000G1X500” under manual data input.

Effect	Syntax / description
Exit program	**MCOPS(5,**<*channel*>**,**<*deselection type*>**)**
	Exits a selected program or a selected MDI block in programmed <*channel*>. ● < deselection type> integer expression. It sets the behavior of the functions. The following list includes all defined behavior patterns. Each pattern is preceded by a code number. In order to set a certain pattern, the corresponding code number must be transferred to <deselection type>. If several patterns are to be combined, the total of all corresponding code numbers must be transferred to <deselection type>. Up to now the list includes only one element: Code number: 2: If the automatic program re-selection is active, then it can be suppressed in <deselection type> with the value ”2”. **Example**: `ERR_VAR=MCOPS(5,2,2)` Deselection on channel 2 without automatic program re-selection.
Start program	**MCOPS(6,**<*channel*>**)**
	Starts a selected program or a selected MDI block on the programmed <*channel*>.
Specify operation mode	**MCOPS(7,**<*channel*>**,**<*operation mode*>**)**
	Specifies an operation mode on the programmed <*channel*>. ● <*operation mode*> : Integer expression. Defines the operation mode to be switched to. 1 Jog mode. Axes can be jogged (+/–). See also MCOPS(4..) under <*selection type*>: code number 256. 2 Traverse to reference point. Axes can be started with the signals manual+ / manual–. See also MCOPS(4..) under <*selection type*>: code number 512. 4 Manual data input. Individual NC blocks can be specified for machining. 5 Automatic. Part programs are completely executed. 6 Automatic (program block). Individual blocks of a part program are executed one after the other. Each individual block is prepared and started with cycle start. 7 Automatic (single step). From an individual NC block in the part program the NC may generate and prepare several blocks. In this operation mode cycle start always passes an individual block on to the interpolator for machining. 10 Automatic (single block). With cycle start all blocks generated and prepared on the basis of a single NC block in the part program are forwarded to the interpolator for machining. 11 Return to path. Axes can be removed manually from the contour and automatically or manually returned to it. 12 CPL debugger: Single blocks are processed as they appear in the part program. 13 CPL debugger: All blocks are processed until the next break point. 14 Jog mode: movement in workpiece coordinates

Effect	Syntax / description
	A change of operation mode is only possible under the following conditions: ● The IF input signal NC-I 3.0 (operation mode specification by PLC) may not be set. ● No program or block is selected at the NC – or – switching is to take place exclusively between the automatic operation modes automatic, program block, single step or single block. **Example**: `ERR_VAR=MCOPS(7,2,5)` Change of operation mode on the 2nd channel after automatic.
Change return to path strategy	**`MCOPS(8,`***`<channel>`***`,`***`<how>`***`,`***`<where to>`***`)`**
	Sets return to path strategy in the programmed <*channel*>. ● <*how*> : Integer expression. States whether 1 automatic return to path 2 return to path with single block, or 3 manual return to path is desired. ● <*where to*> : Integer expression. States whether return to path takes place 1 to the startpoint 2 to the endpoint, or 3 to the breakpoint.
Stop return to path recording	**`MCOPS(9,`***`<channel>`***`)`**
	Stops the return to path recording on the programmed <*channel*>. Jog movements are now no longer recorded.

4.14.3 Programming examples

Example 1: Immediately request SAV and interpolator state of channel 2

```
10 DIM BUF%(2)                                  Make field
20 VERSION = 0                                  Supply data immediately
30 ERR_VAR% = MCODS(32,2,VERSION,BUF%,2)        Function call
```

–> The SAV condition is shown in BUF%(1), the IPO condition is shown in BUF%(2).
–> The current version number of the data is shown in `VERSION` (important for example 2).

Example 2: Wait until SAV state of channel 2 changes to ”inactive”

<Code of Example 1>

```
:
10 INACTIVE = 1
20 WHILE BUF%(1) <> INACTIVE DO
30   ERR_VAR% = MCODS(32,2,version,BUF%,2)
40 END
```

–> After the call the function does not return to the invoking program until the SAV state changes (VERSION contains another value <> 0; please refer to Example 1 for the version number). The loop will not be exited until BUF%(1) contains the value 1.

Example 3: Version of axis names in MSG window

```
:
30  VERSION=0
40  DIM AXNAME$(512)
50  REM Request all axis names
60  ERR=MCODS(33,-1,VERSION,AXNAME$,512)
70  IF ERR=0 THEN
80    REM Determine number of axes
90    DIM AXNMB%(3)
100   VERSION=0
110   ERR=MCODS(45,-1,VERSION,AXNMB%,3)
120   ANZ=AXNMB%(2)
130 ENDIF
140 IF ERR<>0 THEN
150   PRN#(0,”Error occurred: ”,ERR)
160  ELSE
170   REM Display of axis names
180   FOR I%=0 TO (ANZ-1)
190     NAME$=MID$(AXNAME$,I%*9+1,8)
200     IF ASC(NAME$)<>0 THEN
210       REM Axis name defined
220       PRN#(0,I%+1,”. Axis name: ”,NAME$)
230     ENDIF
240   NEXT
250 ENDIF
N260 M30
```

Example 4: Channel / Waiting state

```
10  CHAN%=1
20  VERSION%=0
30  STATES%=0
40  ERR=MCODS(87,CHAN%,VERSION%,STATES%,1)
50  IF ERR=0 THEN
60    MASK%=1
70    WHILE MASK% <= STATES% DO
80      CASE (STATES% AND MASK%) OF
90        LABEL    1:PRN#(0,"dwell time")
100       LABEL    2:PRN#(0,"acknowledgement-compulsory auxiliary
                       function")
110       LABEL    4:PRN#(0,"block transfer inhibit")
120       LABEL    8:PRN#(0,"feed in channel equals 0")
130       LABEL   16:PRN#(0,"Program stop with M0/M1")
140       LABEL   32:PRN#(0,"feed halt in the channel")
150       LABEL   64:PRN#(0,"feed inhibit or a channel axis")
160       LABEL  128:PRN#(0,"block transfer inhibit entered by
                       customer")
170       LABEL  256:PRN#(0,"Synchronized movement stop
                       between channels (ASTOP, ...)")
180       LABEL  512:PRN#(0,"Waiting for axis in case of axis
                       exchange (G511)")
190       LABEL 1024:PRN#(0,"Waiting for permanent variable (WPV)")
200       LABEL 2048:PRN#(0,"Waiting for interface signal at
                       an active time (WAITA, ...)")
210       LABEL 4096:PRN#(0,"Waiting for interface signal
                       (WAIT(IC(...)))
                       or")
220                  PRN#(0,"  (WAIT(,TIME%)) during block
                       preparation")
230       LABEL 8192:PRN#(0,"Motion Control Data Services
                      (MCODS(...))")
240     ENDCASE
250     MASK%=MASK%*2
260   END
270 ENDIF
M30
```

Example 5: Axis-channel assignment

```
10 REM Program queries number of axes in the system and the
15 REM axis numbers of the channel axes. Based on this information
20 REM the channel axes are traversed first to position 0 and then
40 REM to position <channel number>
50 CHAN=SD(8): REM Own channel number
60 IDCHAX=43: REM Ncs_MCoEvGetChanAxis_Id
70 IDMAXAX=45: REM Ncs_MCoEvGetMaxAxisNumber_Id
80 DIM BUF(16): REM Buffer axis-channel assignment
90 SIZE=16
100 ANZ=0: REM Maximum index of the physical axes
120 REM ChanAxis
130 VERSION=0
140 A=MCODS(IDCHAX,CHAN,VERSION,BUF,SIZE)
150 VERSION=0
160 A=MCODS(IDMAXAX,CHAN,VERSION,ANZ,1)
170 FOR I%=1 TO ANZ
180     IF BUF(I%) = CHAN THEN
N190       F1000 [AXP(I%,0,0)]: REM Traverse channel axes to 0
200     ENDIF
210 NEXT
220 FOR I%=1 TO ANZ
230     IF BUF(I%) = CHAN THEN
N24         M0
N250        WAIT
N260        F1000 [AXP(I%,CHAN,0)]:REM Traverse channel axes
                                       to CHAN
270     ENDIF
280 NEXT
N290 M30
```

5 Processing Character Strings

In order to process strings in CPL they must be filed in a one-dimensional field (field: array) of identified character variables. Each character variable in this field is addressed via an index and may contain exactly 1 character.

The CPL instructions MID$, LEN, INSTR, ASC, STR$, VAL and TRIM$ are available for string processing.

5.1 Dimensioning character fields

DIM

In order to make a character field you must index a character variable by DIM instruction.
In this way character fields with a max. capacity of 1024 characters can be made (value range of the index: 1 to 1024).

If the value range is not adhered to the error message INVALID FIELD LIMIT appears.

Example:

```
1 DIM VWX$(14)
```

In this example the character field `VWX$`, consisting of 14 individual character variables, is made. In `VWX$` strings with up to 14 characters in length can therefore be stored.

Examples:

`1 DIM ABC$(1)`	Character field for a string with a max. length of 1 character.
`2 DIM BCDE$(10)`	Character field for a string with a max. length of 10 characters.

5.2 Reading characters from a definable point into a character string

MID$

This function takes parts from a string expression.
The result can be transferred to a dimensioned or to a non-dimensioned character variable:

- A **dimensioned** character variable receives the complete partial string defined in the MID$ command.
- A **non-dimensioned** character variable receives only the beginning address and length of the defined partial string. If the string expression from which the partial string was taken changes, then the non-dimensioned character variable changes correspondingly.

If chaining (e.g. `MID$(A$+B$,2,3)`) occurs within the MID command, the result can only be assigned to a character field.

MID$(<*STRING expression*>**,**<*start point*>[**,**<*number of characters*>]**)**

<*STRING expression*>	String expression from which parts are to be taken.
<*start point*>	Determines the position within the <*STRING expression*> character field from which the characters are to be taken.
<*number of characters*>	Determines the number of characters taken. If <*number of characters*> is not programmed, all characters up to the end of the character field length will be taken.

The range of values for the 2nd and 3rd parameter encompasses INTEGER values from 1 to 1024. If the range of values is not adhered to, the fault message INVALID PARAMETER is returned.

“NUL” is returned if a character field part which has not yet been assigned is accessed.

Example:

```
1 DIM A$(10)
2 DIM B$(5)
3 A$=”ABCDEFGHIJ”
4 B$=MID$(A$,2,5)
4 C$=MID$(A$,2,5)
6 REM                 The variables B$ and C$ both
                      have the content: BCDEF
7 A$=”QRSTUVWXYZ”
8 REM                 The variable B$ has the content: BCDEF
                      The variable C$ has the content: RSTUV
```

5.3 Modifying character strings

MID$

The MID$ instruction overwrites parts of a character field.

MID$(<*character field*>**,**<*start point*>[**,**<*number of characters*>]**)**

<*character field*>	Character field in which parts are to be overwritten.
<*start point*>	Determines from which position in the <*character field*> the characters are to be overwritten. The <*start point*> value may exceed the number of previously assigned components (length) by a maximum of 1.
<*number of characters*>	Determines the number of characters which are overwritten. If <*number of characters*> is not programmed, all assigned characters are entered in <*character field*> in so far as the dimensioning of the character field allows.

The range of values for the 2nd and 3rd parameters is between 1 to 1024. If the range of values is not adhered to, the fault message INVALID PARAMETER appears.

Example:

```
1 DIM A$(10)
2 A$= "ABC"
3 MID$(A$,4,3)="DEF"
```

Length of A$ is 3.

The 4th to 6th components of the character field are written. This is permissible because the first three components have already been assigned.

Example:

```
1 DIM A$(10)
2 A$= "ABC"
3 MID$(A$,5,3)="DEF"
```

Length of A$ is 3.

An attempt is made to inscribe the 5th to 7th components of the character field. This, however, results in the error message CHARACTER FIELD NOT ASSIGNED, because the 4th component has not yet been assigned.

If more characters are assigned than permitted by the maximum character field length, these characters will be discarded.

5.4 Character string length

LEN

Returns the number of characters in a <*STRING expression*>. The result is an INTEGER value.
If the <*STRING expression*> is empty, LEN returns the value 0.
If the <*STRING expression*> is not defined, LEN returns the value –1.

LEN(<*STRING expression*>**)**

Example:

```
1 DIM XYZ$(10)
2 XYZ$="ABC"
3 I%=LEN(XYZ$)          The INTEGER variable I% has the value 3
4 XYZ$=""
5 J%=LEN(XYZ$)          The INTEGER variable J% has the value 0
6 XYZ$=NUL
7 K%=LEN(XYZ$)          The INTEGER variable K% has the value –1
```

5.5 Searching for a character string

INSTR

INSTR (<*character string*>**,**<*STRING expression*>**[,**<*start point*>**])**

Beginning at the <*start point*>, INSTR searches for a <*character string*> within a <*STRING expression*> and outputs the position of the first character of the <*character string*> found in the <*STRING expression*> as an INTEGER value.

A value of 0 is returned if the <*character string*> is not found.
The <*character string*> can be programmed as a STRING expression.

The range of values for the 3rd parameter is between 1 to 1024. The following error message appears if the range of values is not adhered to: INVALID PARAMETER.

Example:

```
1 DIM A$(8)
2 DIM B$(16)
3 A$ = "A" : MID$(A$,2) = "UVWXYZ"
4 B$ = "ABCDEF UVWXYZ GH"
5 POS1% = INSTR(MID$(A$,2),B$,4)
6 POS2% = INSTR(MID$(A$,2,4),B$,10)
7 POS3% = INSTR(MID$(A$,2),B$)
```

Content of INTEGER variable `POS1% : 8`
Content of INTEGER variable `POS2% : 0`
Content of INTEGER variable `POS3% : 8`

5.6 Strings and numbers

ASC

ASC(<*character string*>**)**

Outputs the ordinal number of the first character (ASCII code) from the <*character string*> as an INTEGER value.
If the <*character string*> is empty or not defined, ASC returns the value –1.

<*character string*> must be a STRING expression.
ASC is the reversal of CHR$.

Example:

```
10 DIM A$(1)
20 A$ = "ABC"
30 B$ = "BCD"
40 I% = ASC(A$)          Content of INTEGER variable I% : 65
50 J% = ASC(B$)          Content of INTEGER variable J% : 66
60 A$ = ""
70 K% = ASC(A$)          Content of INTEGER variable K% : –1
80 A$ = NUL
90 L% = ASC(A$)          Content of INTEGER variable L% : –1
```

CHR$

CHR$ is the reversal of ASC.

CHR$(<*integer expression*>**)**

Converts an <*integer expression*> into the corresponding ASCII character. All ASCII character decimal significants appear in the “ASCII character set” table in the Annex of this manual.

Example:

```
10 DIM A$(1)
20 I% = 65
30 A$ = CHR$(I%)
```
Content of string variable A$: "A"

STR$

STR$([<*format string*>**,**]<*value*>**)**

Converts the numerical expression <*value*> to a string which can only be assigned to a character field. Assignment to a STRING variable leads to a runtime error.

<*value*> may be an INTEGER or REAL expression of single and double precision.

If <*format string*> is programmed, the string can be output formatted. The symbol "#" indicates digits and "." indicates decimal points. If <*format string*> is not programmed, outputs are in standard format.

Standard formats:

INTEGER number:	9 digits
Single-precision REAL number:	4 digits before, and 3 after the decimal point.
Double-precision REAL number:	9 digits before, and 6 after the decimal point.

Example:

```
10 DIM A$(50)
20 DIM B$(21)
30 A$ = STR$("number = ##.###",(37/3))
40 B$ = STR$(2.5)
```

Content of character field A$: `"number = 12.333"`
Content of character field B$: `"    2.500"`

VAL

VAL(<*STRING expression*>**)**

Returns the numerical value for a <*STRING expression*>. If the string contains a character other than a leading space, the leading “+” or “–” sign, the numbers 0 to 9 or the decimal point “.”, the conversion will be performed up to this (other) character. Leading spaces and leading zeros are ignored for purposes of value formation. If none of the characters above appear, then “NUL” is returned. If the string contains a decimal point, the result may only be assigned to a REAL or double-precision REAL variable. Assignment to an INTEGER variable in this case would lead to an INVALID ASSIGNMENT error message.

Example:

```
1 I% = VAL(”1.23DE”)
2 K% = VAL(”123DE”)
3 J% = VAL(”ABC”)
4 R  = VAL(”-1.23DE”)
5 Z  = VAL(”+ 000001234TEST4365”)
6 X  = VAL(”ABC1.23DE”)
7 D! = VAL(”1234567.234567”)
```

Line 1 leads to an error message because an assignment to an INTEGER variable is to take place.

The value of the INTEGER variable `K%` is 123. The numbers `1,2,3` are converted to an INTEGER number. The “`D`” character aborts the conversion because it cannot belong to an INTEGER number. The characters which follow it are ignored.

The value of the INTEGER variable `J%` is NUL, i.e. the variable is not assigned. The “`A`” character aborts the processing of the <*STRING expression*>.

The value of the REAL variable `R` is -1.23. The “`-`” character is recognized as a sign for the REAL number. The digit `1`, the “`.`” character and the digits 2 and 3 are converted to a REAL number. The “`D`” character aborts the conversion because it cannot belong to a REAL number. The “`E`” character is no longer processed.

The value of the REAL variable `Z` is 1234. The “`+`” character is recognized as a sign for the REAL number. The spaces which follow as well as the leading zeros are ignored for purposes of value formation. The digits `1, 2, 3` and `4` are converted to a REAL number. The “`T`” character aborts the conversion because it cannot belong to a REAL number. The remaining characters are not further processed.

The REAL variable `X` is NUL, i.e. not assigned. The conversion is aborted when the character “`A`” is recognized.

The value of the double-precision REAL variable `D!` is 1234567.234567.

5.7 Removing leading and trailing spaces

TRIM$

TRIM$(<*character string*>**)**

TRIM$(<*character string*>**,"L")**

TRIM$(<*character string*>**,"R")**

When a character field range is assigned to a STRING variable or character field, TRIM$() returns a string without preceding (→ index L) or trailing (→ index R) spaces.
The TRIM function without index masks out both preceding and concluding spaces.
If chaining occurs within the TRIM command (e.g. `TRIM $(A$+B$)`), the result may be assigned only to a character field.

Example:

```
1 A$ = " ABCDEF "
2 B$ = TRIM$(A$,"L")
3 C$ = TRIM$(A$,"R")
4 D$ = TRIM$(A$)
5 PRN#(1,">",A$,"<")
6 PRN#(1,">",B$,"<")
7 PRN#(1,">",C$,"<")
8 PRN#(1,">",D$,"<")
```

Leads to the following lines in the file with the logical number 1 opened for write-access:

```
> ABCDEF <
>ABCDEF <
> ABCDEF<
>ABCDEF<
```

5.8 Programming examples

A STRING expression can be assigned to a STRING variable.

Example: Programming of STRING variables (without previous dimensioning)

```
1 A$="ABCDE"
2 B$=CHR$(10)
```

During read access, parts of the STRING variables can be accessed by means of the MID$ command:

```
1 A$="ABCDEFGHIJKLMN"
2 B$=MID$(A$,2,1)
3 C$=MID$(A$,4,4)
```

The following lines of programming will lead to faults:

```
4 MID$(A$,1,4)="ABCD"
4 A$=MID$(A$,1,3) + MID$(A$,4,1)
4 A$=B$ + A$
```

To continue processing a dimensioned character field, it is necessary to specifically access one or several connected characters. Only then will it be possible to assign a character field or a part of the character field to a STRING variable or to another character field.

Read- and write-access to a part of a character field is performed with the MID$ command. If only the character field name is entered, the entire character field will be addressed.

Reading a character field

If the <n>th character of the character field is to be accessed, proceed as follows (n is less than or equal to the length of the character field and the number of characters in the field):

Example: Reading a character field

```
1 DIM VWX$(13)
2 VWX$="TEST TEST TES"
3 A$ = MID$(VWX$,12,1)
4 I%=12
5 A$=MID$(VWX$,I%,1)
```

The 12th character ("E") of the VWX$ character field is assigned to the A$ string variable.

Writing of a character field

If the content of a STRING variable is to be assigned to the character field or a part of the character field, the assignment must be converted.

Example: Partial writing of the character field

```
1 DIM XYZ$(15)
2 B$="ABCDE"
3 MID$(XYZ$,1,5)=B$
4 MID$(XYZ$,6,5)=B$
```

The 1st through 10th character of the XYZ$ character field are assigned the content of the B$ STRING variable.

The following programming would lead to the error message CHARACTER AREA NOT USED because the 1st to 5th characters of the character field are not yet assigned:

```
1 DIM XYZ$(15)
2 B$="ABCDE"
4 MID$(XYZ$,6,5)=B$
```

Example: Partial writing of the character field

```
1 DIM XYZ$(100)
2 B$= "ABCDE"
3 MID$(XYZ$,1,10)=B$
```

Content of the STRING variable B$: "ABCDE"
Content of the field variable XYZ$: "ABCDE". The field variable has a length of 5. The remaining 95 characters are not assigned.

If the length of the STRING variable is smaller than the character field, the character field `XYZ$` is written only in the length of the STRING variable. When allocating this character field to a STRING variable it is not the entire character field (defined via DIM instruction) which is assigned, but only the range which was written previously (→ length of the character field).

Example:

```
1 DIM XYZ$(100)
3 MID$(XYZ$,1,10)="ABCDE"
4 MID$(XYZ$,6,3)="T"
```

The content of the `XYZ$` field variable after block 3 is: `"ABCDE"`.
The field variable has a length of 5. The remaining 95 characters are not assigned and are therefore not part of the length.
The content of the `XYZ$` field variable after block 4 is: `"ABCDET"`.
The field variable now has a length of 6. The remaining 94 characters are not assigned and are therefore not part of the length.

Example: Overwriting a character field

```
1 DIM XYZ$(100)
3 MID$(XYZ$,1,10)="1234567890"
4 MID$(XYZ$,3,3)="T"
```

The content of the `XYZ$` field variable after block 3 is: `"1234567890"`.
The field variable has a length of 10.
The content of the `XYZ$` field variable after block 4 is `"12T4567890"`.
The field variable has a length of 10. The character `"3"` is overwritten by `"T"`. The characters `"4"` and `"5"` are retained.

Example: Prohibited access to the character field

```
1 DIM XYZ$(100)
3 MID$(XYZ$,1,6)="ABCDEF"
5 MID$(XYZ$,9,5)="TESTE"
```

The XYZ$ field variable after block 3 contains "ABCDEF".
The field variable has a length of 6.
After block 5 an attempt is made to assign a constant to the 9th to 13th components of the character field. This, however, results in the error message CHARACTER AREA NOT USED because the 7th and 8th components are not assigned.
If the whole character field is to be accessed, entering the variable name will suffice.

5.8.1 Assigning a STRING expression to a character field

If the STRING expression contains fewer characters than the selected range of the character field, the remaining range is regarded as not assigned. This remaining range is not included in the character field length.

Example:

```
1 DIM XYZ$(16)
2 XYZ$=" "
Content of character field XYZ$: " "
Length of character field XYZ$ : 1
```

If the length of the STRING expression exceeds the maximum length of the character field during assignment, the surplus characters will be rejected.

Example:

```
1 DIM XYZ$(3)
2 XYZ$="ABCDEF"
Content of character field XYZ$: "ABC"
Length of character field XYZ$: 3  ---> maximum length
```

Example:

```
1 DIM XYZ$(16)
2 A$="DAS "                    (This)
3 B$="IST EIN TEST"            (is a test)
4 C$="EIN EI"                  (an egg)

5 MID$(XYZ$,1,4)=A$
```

CONTENT OF THE CHARACTER FIELD

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
D	A	S													

Length = 4 Range is not assigned

```
6 MID$(XYZ$,5,6)=B$
```

CONTENT OF CHARACTER FIELD

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
D	A	S		I	S	T		E	I						

Length = 10 Range is not assigned

```
7 MID$(XYZ$,5,12)=B$
```

CONTENT OF CHARACTER FIELD

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
D	A	S		I	S	T		E	I	N		T	E	S	T

Length = 16; Range is fully assigned

```
8 MID$(XYZ$,9,8)=C$
```

CONTENT OF CHARACTER FIELD

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
D	A	S		I	S	T		E	I	N		E	I	S	T

Length = 16; Range is fully assigned

```
9 XYZ$=MID$(XYZ$,1,4)
```

CONTENT OF CHARACTER FIELD

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
D	A	S													

Length = 4 Range is not assigned

The character field was cut off.

5.8.2 Comparisons of STRING expressions

It is also possible to compare STRING expressions (STRING constants, STRING variables and character fields) with one another.

Example:

```
1 DIM A$(10)
2 DIM B$(15)
3 A$=”ANTON”
4 B$= ”WILLY”
5 C$=”ABCDE”
6 D$=”VWXYZ”
7 IF A$ < B$ THEN ...
8 IF MID$(A$,2,3) = MID$(B$,1,3) THEN ...
9 Z?=A$ <> ”TEST”
10 IF ”A” <= ”C” THEN ...
11 IF C$ > D$ THEN ...
12 IF A$ = C$ THEN ...
13 IF ”TE” < MID$(D$,2,2) THEN ...
```

The contents of the STRING expressions are checked for alphabetical order in accordance with the ASCII code of the individual characters.

5.8.3 Chaining STRING expressions

Several STRING expressions can be chained with the use of the “+” plus character. The result must be assigned to a character field. The nesting depth for the chaining of STRING expressions is 3. If this depth is exceeded, the following fault message is returned: RUNTIME ERROR 2153 - NESTING TOO DEEP

Example: Chaining also within CPL instructions

```
1 DIM A$(3)
2 DIM B$(3)
3 A$ = ”ABC”
4 B$ = ”DEF”
5 C$ = ”GH”
6 D$ = ”JKL”
7 OPENW(1,”P2”,130,”CHAINING TEST”,10)
8 PRN#(1,A$+B$)
9 PRN#(1,A$+C$)
10 PRN#(1,C$+D$)
11 PRN#(1,A$+C$+”TEST”)
12 PRN#(1,”UVW”+”XYZ”)
13 CLOSE(1)
```

Content of P2 file:

```
ABCDEF <LF>
ABCGH  <LF>
GHJKL  <LF>
ABCGHTEST <LF>
UVWXYZ <LF><ETX><LF>
```

Example: Chaining texts via STRING expressions

```
10 DIM A$(100)
20 DIM B$(100)
30 DIM C$(10)
40 DIM D$(20)
51 DIM E$(30)
52 DIM F$(30)
53 DIM G$(30)
54 DIM H$(30)
55 DIM I$(30)
60 A$=”THIS ”
70 B$=”IS A TEST”
80 MID$(C$,1,6)=A$ + B$
90 MID$(D$,1,10)=MID$(A$,1,1) + MID$(B$,1,2)
92 E$=A$ + MID$(B$,1)
93 X$=”ABC”
94 Y$=”DE”
95 F$=X$ + Y$
96 G$=X$ + A$
97 H$=X$ + A$ + ”TEST”
98 I$=”TES” + ”T1”
```

Content of A$:	”THIS ”	Length 4
Content of B$:	”IS A TEST”	Length 9
Content of C$:	”THIS I”	Length 6
Content of D$:	”TIS”	Length 3
Content of E$:	”THIS IS A TEST”	Length 14
Content of F$:	”ABCDE”	Length 5
Content of G$:	”ABCTHIS ”	Length 8
Content of H$:	”ABCTHIS TEST”	Length 12
Content of I$:	”TEST1”	Length 5

The following lines of code will lead to faults:

```
1 DIM A$(3):A$ = ”ABC”:B$ = ”CD”:C$ = ”EF”
2 D$ = A$ + B$
3 D$ = B$ + C$
4 D$ = A$ + B$ + ”TEST”
5 D$ = ”TEST” + ”TEST1”
```

Inadmissible assignment to an non-dimensioned STRING variable

Example: STR$

```
1 DIM A$(50) : DIM B$(21)
2 A$ = STR$("A$ = ##.###",(37/3)) : B$ = STR$(2.5)
```

Content of character field `A$ : "A$ = 12.333"` ; character field `B$ : " 2.500"`

Example: VAL

```
1 DIM FOLGE$(20) : FOLGE$ = "X VALUE -0001.234 MM"
2 XR = VAL(MID$(FOLGE$,7)) : Z% = VAL(MID$(FOLGE$,7,6))
3 Y% = VAL(MID$(FOLGE$,15,5)) : X% = VAL(MID$(FOLGE$,18))
```

Content of REAL variable XR: –1.234
Content of INTEGER variable Z%: –1
Content of INTEGER variable Y%: 34
Content of INTEGER variable X%: NUL

Example: LEN

```
1 DIM Z$(10)
2 Z$ = "TEST"
3 S$ = "TEST"
4 A% = LEN("TEST")
5 B% = LEN(Z$)
6 C% = LEN(S$)
7 D% = LEN("TEST"+Z$+S$)
```

Content of INTEGER variable A% : 4
Content of INTEGER variable B% : 4
Content of INTEGER variable C% : 4
Content of INTEGER variable D% : 12

Example: MID$ command with read-access

```
10 DIM A$(4)
20 DIM B$(10)
30 DIM C$(10)
40 DIM D$(10)
50 DIM E$(10)
55 DIM F$(10)
60 A$ = "ABCD"

70 B$ = MID$(A$,2,2)     --> B$ = "BC"
80 C$ = MID$(A$,2,5)     --> C$ = "BCD"
95 E$ = MID$(A$,5,1)     --> E$ = NUL
97 F$ = MID$(A$,2)       --> F$ = "BCD"
98 F$ = MID$(F$,1,1)     --> F$ = "B"
```

Example: MID$ command with write-access

```
10 DIM A$(4)
20 DIM B$(10)
30 DIM C$(10)
40 DIM D$(10)
60 A$ = "ABCD"
70 B$ = "1234567890"
80 C$ = "EFGHIJKLMN"
85 D$ = A$                --> D$ = "ABCD"
90 MID$(D$,2,3) = B$      --> D$ = "A123"
95 MID$(D$,5,1) = C$      --> D$ = "A123E"
97 MID$(D$,4) = B$        --> D$ = "A121234567"
```

Example: TRIM$

```
1 DIM XYZ$(16)
2 XYZ$ = "XVALUE =  0.123  "
3 A$ = MID$(XYZ$,8)
4 B$ = TRIM$(MID$(XYZ$,8))
5 C$ = TRIM$(MID$(XYZ$,8),"L")
6 D$ = TRIM$(MID$(XYZ$,8),"R")
```

Content of STRING variable A$: " 0.123 "
Content of STRING variable B$: "0.123"
Content of STRING variable C$: "0.123 "
Content of STRING variable D$: " 0.123"

6 File Handling

Files are containers for data. Data can be read from files or stored in files during a CPL program.
For instance, measured values can first be stored and later displayed or printed out.

In the CNC data files are managed in the file system. They are stored in a file system of hierarchical structure, and accessed by means of directories and pathnames.

Data files can be managed in different operating modes.
For read- or write-access to files the corresponding file must first be opened (see OPENW, OPENR commands); as soon as the access to the data is no longer needed you can close the file again (see CLOSE command).

6.1 Filenames and file structures

6.1.1 File names

Filenames are governed by the following conventions:

- Maximum length 30 characters. No distinction is made between the filename and its possible extension, if one is used. All alphanumeric characters, plus the special characters "." and "_" are permitted.
  During the linking procedure, the CNC generates a file, the name of which consists of the original filename plus 2 added characters. Accordingly, filenames of part programs may not be more than 28 characters in length.

☞ **The "$" symbol may be used only for data files that are internally generated. Names of files received from external sources (via operator interface, or DNC) may not contain a "$" character.**

- A distinction is made between upper- and lower-case letters.
  Examples: Filename variations
  P123456789.PRG
  P12_Data_Dial
  P12_DATA_DIAL

- Filenames comprising "." and ".." are prohibited as they are already used internally.
- Filenames must be unique within the directory in which they are contained.
  However, files with the same name may exist in different directories.

6.1.2 Sequential file structure

A sequential file contains a sequence of **components** (records) which may have a **variable length.** If a particular record is sought in a sequential file, the search for this record must be performed from the start of the file onwards. Direct access is not possible. If the length of a record is changed in a sequential file, all subsequent records must be moved accordingly.

Unlike random files, sequential files contain records of varying length (max. length 1024 characters). The end of a record is identified by an <LF> which does not form part of the length. An <ETX><LF> which denotes an EOF pointer is inserted after the last file record. An EOF pointer indicates the end of the usable data (<ETX>) in a file.

6.1.3 Random file structure

A random file contains **components** (records) with a **fixed**, **definable length.** Direct random access to any desired file component is therefore possible. The classification of random files into records of fixed length facilitates direct access to a particular record. As is the case with sequential files, data is stored in the form of ASCII characters. This enables both the usual access with the editor as well as the reading-in and out of random files.

The advantage of the random file is that the required data can be accessed more quickly. Furthermore, the data of a record can be processed and/or amended without changing the structure of the rest of the file. Records which are not completely filled with data are filled up with blanks up to the defined length.

If an attempt is made to insert a STRING variable into a random file, whose length is greater than the record length, the record will be filled up to the defined length with the first characters of the STRING variable and the remaining characters are discarded.

When reading the file, the file end is recognized by the EOF character.

The REWRITE and CLOSE instructions are used as with sequential files.

Sequential access to a random file is also possible.

6.2 Opening a file

In order to be able to access a file by means of file management commands in a CPL program, this file must first be opened for the CPL program. This is accomplished with the following commands:

OPENW, OPENR

The command used to open a file is dependent on the desired type of access:

- write-access: OPENW
- read-access: OPENR

If the file to be opened does not yet exist, it is created during opening and the predetermined memory area is reserved.

Files which have already been opened can also be opened for read-access by means of the OPENR command. An open file cannot, however, be opened again for writing to it.

To open a random file, an additional parameter is introduced which returns the length of the records in the file in bytes (1 byte = length of a character). In all other respects, the command structure corresponds to that of the sequential file.
After an OPENR command the file pointer is positioned on the first file record, which can then be read-accessed.
After an OPENW command the file pointer is positioned on the EOF pointer, that is after the last record of the file.

The commands have the following structure:

OPENW(<*n*>,<*PGM name*>,<*length*>[,<*PGM remark*>][,<*record length*>])

OPENR(<*n*>,<*PGM name*>[,<*record length*>])

<*n*>: Logical number under which the file can be addressed.
Values from 1 to 9 can be selected. The logical number must be programmed as an INTEGER expression. A logical number may not be assigned for reading and writing a file simultaneously. Therefore, a maximum of nine different files may be opened at the same time.
If the range of values is not adhered to, the following error message appears: INVALID LOGICAL NUMBER.

<*PGM name*>: Must be programmed as a STRING expression. The string must contain at least the filename (maximum of 30 characters including the extension).
The specification of the filename including the complete prefixed path is permitted.

<*length*>: Reserved length when creating the file in bytes.
A minimum length of 130 bytes is necessary since writing in a file causes at least 1 record (= 130 characters) to be created and stored. The following error message appears if this is not observed: ILLEGAL FILE SIZE.

<*PGM remark*>: Only one STRING expression is permitted for the programming of the program remark parameter.

<*record length*>: Number of bytes in a record; range of values: 1..1024. If the range of values is not adhered to, the following error message appears: INVALID COMPONENT LENGTH

Examples:

```
50   OPENW(1, ”P500”,1024,”This is my best progam”

40   A$ = ”P500” : B1$=”This is my best program”
50   OPENW(9,AS,1024,B1$)

50  OPENW(7,”PData_Meas.DAT”,1024,”Store measurement data”)
```

When the file is opened for writing a check is made to ensure that the random structure has been maintained.
If the structure has been damaged by the editor, the following message appears: INVALID COMPONENT LENGTH.

Example:

```
10 OPENW(2,”P200”,1024,10)
20 FOR I% = 1 TO 3
30 PRN#(2,”TEST”)
40 NEXT I%
50 CLOSE(2)

Result: ”P2”
TEST <LF>
TEST <LF>
TEST <LF>
<ETX><LF>
```

When the file is opened for reading, a check is made to ensure that the random structure has been maintained. All components must have the identical length specified in the OPENR command.

Example:

```
1 OPENW(2,”P200”,130,”TEST”,10)
2 PRN#(2,”ABC”)
3 CLOSE(2)
4 OPENR(1,”P2”,5)
5 CLOSE(1)
```

The program verifies whether the record length of file ”P2” is 5. However, the record length of this file is 10.

Example:

P1:

```
N10 G1F10000X1000Y1000Z1000
1 A$=”01234567890123456789”
2 B$=”TEST”
N20 X0
M30
```

P2:

```
1 OPENW(1,”PMeas_PRG”,500,”RANDOM FILE”,10)
2 OPENR(2,”P1”)
3 DIM A$(30)
4 FOR I% = 1 TO 5
5 INP#(2,A$)
6 PRN#(1,A$)
7 NEXT
8 CLOSE(2)
9 CLOSE(1)
```

RESULT: PMeas_PRG:

```
N10 G1F100<LF>
1 A$=”0123<LF>
2 B$=”TEST<LF>
N20 X0 <LF>
M30 <LF>
<ETX><LF><LF>
```

If the structure was damaged by the editor, the following message appears: INVALID COMPONENT LENGTH.

6.3 Inscribing a file

LJUST, NJUST

With LJUST (= Left JUSTify) a change-over to left-justified data output is carried out. It is effective up to the end of the program run for all data outputs. NJUST (No JUSTify) makes it possible to return prematurely to the formatted output.

A maximum of 7 places (4 pre-decimal and three post-decimal places) are available for the REAL data type and a maximum of 9 places are available for the INTEGER data type when data is output to files. Leading and trailing zeros are suppressed. This also applies to left-justified output.

Since blanks between the NC address and the value are suppressed, with LJUST NC programs which can be executed under the AUTOMATIC mode can be created directly with CPL.

PRN#

PRN#(<*n*>,[<*expression*>][,<*expression*>][,<*expression*>][,...][**;**])

<*n*>: 1 to 9: Logical number of the file to be written into.
0: Issuance is diverted to monitor (as in the case of message programming by MSG command). This setting can also be used for the CPL dialog within the editor in order to overwrite a selected block.
For relevant information see Chap. 7.2 page 7–2.

<*expression*>: Any alphanumeric characters (text in inverted commas), format strings or variable, the content of which is to be saved/displayed.

; Suppresses the automatic addition of a <CR><LF>.
If a record is overwritten via the PRN# command, the following applies:
PRN# command with semicolon:
If the length of the new data to be written is shorter than the length of the old data, the new data is inserted and the rest of the old data is retained.
PRN# command without semicolon:
If the length of the new data to be written is shorter than the length of the old data, the new data is inserted and the rest of the old data is overwritten with blanks.

The type of variable is freely selectable. Indexed variables and character fields can also be used. Double-precision REAL expressions can also be programmed as any definable CPL expressions.

If the result of an expression is to be output giving a format, at least one of the expressions must be of the STRING type. The format can be specified by using “#” and “.” in this format string. The results are entered at the place of the format instruction specified with “#”. The first format instruction contained in a STRING expression refers to the first subsequent expression which may be output with a format entry. Boolean expressions cannot be formatted. The number of all programmed format entries must be less than or equal to the number of expressions to be output. If this condition is not fulfilled, the surplus “#” symbols are displayed. An expression is output in standard format if a format entry is not made.

If the output of an expression exceeds 1024 characters, the following error message appears: BLOCK EXCEEDS 1024 BYTES.
If the result cannot be output in the specified format, the warning PRN FORMAT INCORRECT is returned, and ”*” asterisk characters are output instead of the faulty format.

If # characters are to be created in the file itself, no formattable expression may follow after the string within the PRN# instruction.
The output of the # character can also be performed with CHR$(35).

A line feed can be initiated during output with CHR$(13), i.e. the further output of the PRN# command is continued in the next line (i.e. in the next record).
Other control characters to be transferred with the CHR$() function, e.g. when outputting via a serial interface.

Example: PRN# command with semicolon

```
1 OPENW(2,”PProg123.PRG”,200,35)
2 PRN#(2,”TEST1 FOR PRN COMMAND WITH SEMICOLON”)
3 PRN#(2,”TEST2 FOR PRN COMMAND WITH SEMICOLON”)
4 PRN#(2,”TEST3 FOR PRN COMMAND WITH SEMICOLON”)
6 SEEK(2,1)
7 PRN#(2,”OVERWRITE”;)
8 CLOSE(2)
```

RESULT in PProg123.PRG:

```
OVERWRITE PRN COMMAND WITH SEMICOLON<LF>
TEST2 FOR PRN COMMAND WITH SEMICOLON<LF>
TEST3 FOR PRN COMMAND WITH SEMICOLON<LF>
<ETX><LF>
```

Example: PRN# command without semicolon

```
1 OPENW(2,”P2”,1000,36)
1 REWRITE(2)
2 PRN#(2,”TEST1 FOR PRN COMMAND W/O SEMICOLON”)
3 PRN#(2,”TEST2 FOR PRN COMMAND W/O SEMICOLON”)
4 PRN#(2,”TEST3 FOR PRN COMMAND W/O SEMICOLON”)
6 SEEK(2,1)
7 PRN#(2,”OVERWRITE”)
8 CLOSE(2)
```

RESULT in P2:

```
OVERWRITE                              <LF>
TEST2 FOR PRN COMMAND W/O SEMICOLON<LF>
TEST3 FOR PRN COMMAND W/O SEMICOLON<LF>
<ETX><LF>
```

An *<ETX><LF>* is inserted after the last block of the file.

The following error message appears if the length of the block exceeds 1024 characters BLOCK EXCEEDS 1024 BYTES.

If a sequential file is written and the end of the file is reached, the file is copied automatically and the reserved range increased by the occupied length insofar as sufficient memory is available in the part program memory.
Since this very quickly takes up a great deal of memory, it is advisable to reserve a sufficiently large file length when creating the file with OPENW.

Example:

```
1 OPENW(1,"P2",300,"TEST PRN COMMAND")
2 A$="TEST"
3 B$="FOR"
4 C$="PRN COMMAND"
5 PRN#(1,A$)
6 PRN#(1,B$)
7 PRN#(1,C$)
8 PRN#(1,A$;)
9 PRN#(1,B$;)
10 PRN#(1,C$;)
11 CLOSE(1)
```

Result:
P2:
TEST<*LF*>
FOR<*LF*>
PRN COMMAND<*LF*>
TESTFORPRNCOMMAND<*LF*><*ETX*><*LF*>

Example:

```
10 DIM E$(50)
20 OPENW(1,"P2",300,"TEST2")
30 A% = 5000
40 R = 1.231
50 B! = 4/3
60 D$ = "ABCDE"
70 E$ = "CDEFGHI"
80 PRN#(1,"10";)
90 PRN#(1,"#####","###.###","#.#####",A%,R,B!,D$,E$)
95 CLOSE(1)
```

P2 :

```
10 5000 1.2311.33333ABCDECDEFGHI<LF>
    A%    R     B!    D$    E$
```

REWRITE

If data is already present in the opened file, the new data is normally appended to the existing data when writing. An existing file can, however, be overwritten by means of REWRITE without especially having to delete the contents that are no longer required. When overwriting, the range reserved in the OPENW command remains available in the part program memory.

REWRITE(<*n*>**)**

<*n*>: logical file number (range of values 1 ... 9)

To overwrite a file, it must be open.

6.4 Reading a file

INP#

With the INP# instruction the ASCII data in an open file may be read in record form and assigned to one or several variables. This command only has an effect on files that were opened with ”OPENR(...)”.

INP#(<*n*>,<*variable*>[,<*variable*>][,...][**;**]**)**

<*n*>: 1 to 9: Logical file number to be read from.
0: This setting can be used for the CPL dialog within the editor.
For relevant information see Chap. 7.2 page 7–2.

<*variable*>: Variable under which the read data is stored.

; If a semicolon is programmed, the file pointer remains in the record until the end of the record is reached. After that the next record is switched to. Reading does not, however, automatically take place there.
If no semicolon is programmed, the next record is switched to automatically.

The type of variable is freely selectable. Indexed variables and character fields can also be used. If a value other than TRUE or FALSE is assigned to a logical variable, this variable is valued at NUL.

The characters “0” to “9”, leading signs ’–’, ’+’, leading zeros or spaces are converted to INTEGER or REAL values if the variable type is INTEGER or REAL (simple and double precision). If another character is assigned to an INTEGER or REAL variable, the variable is assigned NUL. If a variable is assigned NUL, the position within the file does not change.

If the value is assigned to an INTEGER or a REAL variable is too high, a corresponding error message appears:
INVALID INTEGER VALUE
INVALID FLOAT VALUE

Example: INP# instruction

P2:
```
ABC 123456789 ABC
```

P3:
```
1 OPENR(2,”P2”)
2 DIM C$(3)
3 DIM D$(3)
4 INP#(2,I%,J,L?,C$,K%,D$)
5 CLOSE(2)
```

RESULT:
```
I% = NUL
J = NUL
L? = NUL
C$ = ”ABC”
K% = 123456789
D$ = ”ABC”
```

Example: Reading a record from a file

```
1 OPENW(1,”P2”,200,”TEST”,22)
2 PRN#(1,”-12TEST1.23V12ABCD2.4A”)
3 PRN#(1,”-12TEST1.23V12ABCD2.4A”)
4 PRN#(1,”-12TEST1.23V12ABCD2.4A”)
5 CLOSE(1)
6 DIM A$(3)
7 DIM C$(5)
8 DIM D$(4)
9 DIM E$(4)
10 DIM G$(25)
11 DIM H$(7)
12 DIM I$(7)
13 DIM J$(25)
14 DIM R(1,2)
15 OPENR(2,”P2”,22)
16 INP#(2,B%,D$,R(1,1),MID$(E$,1,1),R(1,2),A$,C$)
17 INP#(2,G$)
18 INP#(2,H$;)
19 INP#(2,I$;)
20 INP#(2,J$)
21 CLOSE(2)
```

Result:

```
B% = -12
D$ = ”TEST” ,since max. length of character field = 4
R(1,1) = 1.230
E$ = ”V”
R(1,2) = 12.000
A$ = ”ABC” ,since max. length of character field = 3
C$ = ”D2.4A”
G$ = ”-12TEST1.23V12ABCD2.4A”
H$ = ”-12TEST” ,since max. length of character field = 7
I$ = ”1.23V12” ,since max. length of character field = 7
J$ = ”ABCD2.4A”
```

6.5 End-of-file recognition

EOF

The EOF function allows a query to be made as to whether the end of a file (EOF ☞ **e**nd **o**f **f**ile) has been reached.
The EOF function returns the logical value TRUE if the end of the file is reached during read-access. Otherwise FALSE is returned.

Example:

```
.
9  DIM A$(10)
10 OPENR(1,"P",444) : I%=0
11 WHILE NOT (EOF(1))DO
12 INP#(1,A$)
13 I%=I%+1


14 END

15 CLOSE(1)
M30
.
```

6.6 Closing a file

CLOSE

Closes a file.

All in all max. 9 files can be open at the same time. If, when 9 files are open, access to a further file is necessary, you must first close a file.
Open files should therefore as a rule be closed immediately upon completion of read or write operations.

CLOSE(<*n*>**)**

<*n*>: 1 to 9: Logical number of the file to be closed.

Example:

```
.
90   DIM A$(35)
100  XPOS = MPOS(1)
110  YPOS = MPOS(2)
120  OPENW(1,"P5",500,"AXISPOS")
130  REWRITE(1)
140  PRN#(1,"X AXIS",XPOS,"YPOS,"Y AXIS",YPOS)
150  CLOSE(1)
160  OPENR(1,"P5")
170  INP#(1,A$)
180  CLOSE(1)
.
```

In the above example the current positions of the X and Y axis are transferred into variables (lines 90 to 110). File 1 is then opened and stored as part program P5 (line 120).
The file is subsequently written or overwritten and then closed (lines 140 to 150). The file is then opened for reading and assigned the contents of the `A$` variable. It is closed again after read-access (lines 160 to 180).

6.7 Reading file pointer position

FILEPOS

The FILEPOS() function returns the record number of the current record of a random file. This record can be accessed afterwards. It is also possible to determine the record offset within the current record of a random file or the offset from the current byte that can be accessed for a sequential file. The file can therefore be a sequential or a random file.

Offset refers to the number of bytes from the top of the file up to the current byte in a file. The record offset specifies the byte at which positioning takes place within a record. The record offset begins with the value 1 (= 1st byte in a record) and can have the maximum value of the record length + 1 (last byte in this record is <LF>). The value 1 is returned if you are on the EOF pointer.

FILEPOS(<*n*>**[,**<*mode*>**])**

<*n*>: 1 to 9: Logical number of the file in which the position of the file pointer is to be read.
If the range of values is not adhered to, the following error message appears: INVALID FILE NUMBER

<*mode*>: **With random files**: Range of values 1 to 3

<*mode*> = 1:
Supplies the offset to the current byte which can be read or written.

<*mode*> = 2:
Supplies the record number of the current record which can be read or written. The result is as follows if you are on the EOF pointer: number of records + 1.

<*mode*> = 3:
This command supplies the record offset within the current record which can be read or written. The record offset begins with the value 1 (☞ 1st byte in this record) and can have the maximum value of the record length + 1 (☞ last byte in this record is <LF>).
The value 1 is returned if you are on the EOF pointer and reading from the file is not permitted.

<*mode*> not programmed:
Supplies the record number of the current record which can be read or written. The result is as follows if you are on the EOF pointer: number of records + 1.

With sequential files: Range of values 1

<*mode*> = 1 or not programmed:
Supplies the offset to the current byte which can be read or written.

If the range of values of <*mode*> is not adhered to, the following error message appears: INVALID PARAMETER.

Example: FILEPOS and sequential file

```
1 OPENW(1,”P2”,200,”TEST”)
2 FOR I%= 1 TO 10
3 PRN#(1,”TEST FOR FILEPOS”)
4 NEXT
5 CLOSE(1)
6 OPENR(1,”P2”)
7 SEEK(1,3)
8 POS% = FILEPOS(1)
9 POS1% = FILEPOS(1,1)
11 SEEK(1,0)    : REM POSITIONED ON END OF FILE
12 POS2% = FILEPOS(1)
13 POS3% = FILEPOS(1,1)
14 CLOSE(1)
```

Result:
`POS% = 3` –> byte number
`POS1% = 3` –> byte number
`POS2% = 171` –> byte number
`POS3% = 171` –> byte number

Example: FILEPOS and random file

```
1 OPENW(1,”P2”,200,”TEST”,1024)
2 FOR I%= 1 TO 10
3 PRN#(1,”TEST FOR FILEPOS”)
4 NEXT
5 SEEK(1,3,2)
6 POS% = FILEPOS(1)
7 POS1% = FILEPOS(1,1)
8 POS2% = FILEPOS(1,2)
9 POS3% = FILEPOS(1,3)
10 PRN#(1,”OVERWRITING OF 3RD RECORD FROM BYTE 2 WITH THIS TEXT”)
11 SEEK(1,0)    : REM POSITIONED ON END OF FILE
6 POS% = FILEPOS(1)
7 POS1% = FILEPOS(1,1)
8 POS2% = FILEPOS(1,2)
9 POS3% = FILEPOS(1,3)
11 CLOSE(1)
```

Result:
`POS% = 3` –> record number of record of current position
`POS1% = 258` –> byte number
`POS2% = 3` –> record number of record of current position
`POS3% = 2` –> position within 3rd record
`POS% = 11` –> record number of record of current position
`POS1% = 1281` –> byte number
`POS2% = 11` –> record number of record of current position
`POS3% = 1` –> position within 3rd record

6.8 Setting file pointer

SEEK

Positions the file pointer at a certain position of an open file. The file may be a sequential or a random file.
With sequential files, the file must be opened with the command ”OPENR(..)”. For random files, the command ”OPENW(..)” is also permissible.

SEEK(<*n*>,<*k*>[,<*o*>]**)**

<*n*>: Logical number of the file in which the file pointer is to be positioned.
Range of values: 1 to 9
If the range of values is not adhered to, the following error message appears: INVALID FILE NUMBER.

<*k*>: Record number of a random file or byte number of a sequential file. The file pointer is positioned on <*k*>.
Range of values: 0 to last existing record or
0 to last existing byte.
The record with the EOF pointer is taken to be the last existing record. At 0, positioning is on the EOF pointer.
The INVALID COMPONENT error message appears if the range of values is not adhered to or if the specified record does not exist.

<*o*>: Record offset. Specifies at which byte within a record positioning should take place.
Range of values: 1 ... Record length + 1.
If the record offset is not programmed for random files, positioning of the file pointer is at the 1st byte of record <*k*> .
If the range of values is not adhered to, the INVALID PARAMETER error message appears.

This parameter is only permitted for random files. The INVALID PARAMETER error message appears if this parameter is programmed although it is a sequential file (which has been opened for reading).

Example: SEEK and sequential file

```
1DIM A$(1):LJUST:OPENW(1,”P271”,130,”TEST”):FOR I%=1 TO 10:
 PRN#(1,”!/-!/-!/-!/-!/-!/-!/-!/-!/-”):NEXT:
 CLOSE(1):OPENR(2,”P271”):FOR I%=1 TO FILESIZE(2,2)-28:
 IF NOT (EOF(2)) THEN SEEK(2,I%):INP#(2,A$) ENDIF:
 IF (EOF(2)) THEN PRN#(0,”###”,I%,”. BYTE: <EOF>”):
 ELSE PRN#(0,”###”,I%,”. BYTE: <”,A$,”>”) ENDIF:
 NEXT I%:CLOSE(2)
M30
```

Example: SEEK and random file

```
1 OPENW(1,27272,200,”TEST”,1024):LJUST
2 FOR I%= 1 TO 10
3  PRN#(1,I%,”. Record”)
4 NEXT
5 SEEK(1,3,4)  :  REM, positioned at the 4th byte in the 3rd record
6 PRN#(1,”OVERWRITE THE 3RD RECORD FROM BYTE 4 WITH THIS TEXT”)
7 SEEK(1,11):PRN#(1,”11th record”)
8 SEEK(1,11,5):PRN#(1,”@@”)
9 SEEK(1,0):PRN#(1,”<EOF>”)
10 SEEK(1,0,1):PRN#(1,”new <EOF>”)
11 CLOSE(1)
```

6.9 Determining file size

FILESIZE

Supplies the size of a file, or the limit up to which a file has already been written. The file may be a sequential or a random file. This command only has an effect on files that were opened with ”OPENR(...)”.

FILESIZE(<*n*>[,<*k*>]**)**

<*n*>: 1 to 9: Logical number of the file whose size is to be determined.
If the range of values is not adhered to, the INVALID FILE NUMBER error message appears.

<*k*>: **With random files**: Range of values 1 to 4
With sequential files: Range of values 1 to 2

<*k*> = 1:
Total memory area size (in bytes) used by a file.

<*k*> = 2:
Memory area size (in bytes) used from the start of the data area up to the EOF pointer (excluding the size of the EOF pointer).

<*k*> = 3:
Maximum number of records in a file. This result depends on the record length with which the file was opened.

<*k*> = 4:
Number of records from the start of the file up to the EOF pointer. This result depends on the record length with which the file was opened.

<*k*> not programmed:
Like <*k*> = 1.

If the ranges of values for <*k*> is not adhered to, the INVALID PARAMETER error message appears.

Example: FILESIZE and sequential file

```
1 OPENW(1,2,1000)
2 FOR I%= 1 TO 20
3 PRN#(1,”TEST FILESIZE”)
4 NEXT
5 CLOSE(1)
6 OPENR(2,2)
7 A%=FILESIZE(2)
9 B%=FILESIZE(2,1)
10 C%=FILESIZE(2,2)
11 CLOSE(2)
```

```
The INTEGER variable A% has the value: 302
The INTEGER variable B% has the value: 302
The INTEGER variable C% has the value: 300
```

Example: FILESIZE and random file

```
1 OPENW(1,”P2”,1000,10)
2 FOR I%= 1 TO 20
3 PRN#(1,”TEST FILESIZE”)
4 NEXT
5 CLOSE(1)
6 OPENR(2,2,10)
7 A%=FILESIZE(2)
9 B%=FILESIZE(2,1)
10 C%=FILESIZE(2,2)
10 D=FILESIZE(2,3)
10 E%=FILESIZE(2,4)
11 CLOSE(2)
```

The INTEGER variable A% has the value: 222
The INTEGER variable B% has the value: 222
The INTEGER variable C% has the value: 220
The INTEGER variable D% has the value: 20
The INTEGER variable E% has the value: 20

6.10 Erasing a file

ERASE

Erases files in the current directory.

ERASE(<*PGM identifier*>**)**

<*PGM identifier*> STRING expression; max. 30 characters. Otherwise the INVALID FILE NAME error message appears.

The following values can be returned if the ERASE function is assigned to an INTEGER variable or if it is used in loops or queries (WHILE, IF etc.):

0: File erased.
1: File not erased because it does not exist.
2: File not erased because this file is erase-protected.
3: File not erased because this file is active.

If a file cannot be erased a warning to this effect is issued and execution of the program continues.

Examples:

```
10 IF ERASE(”P1”) <> 0 THEN ...

10 I% = ERASE(”P1”)

10 WHILE ERASE(”P1”) <> 0 DO ...
```

Example:

```
10 OPENW(1,”P2”,200)
11 OPENW(2,”P3”,200)
20 PRN#(1,”TEST1 FOR ERASE”)
21 PRN#(2,”TEST2 FOR ERASE”)
31 CLOSE(1)
32 CLOSE(2)
40 ERASE(”P2”)
43 A$=”P3”
44 ERASE(A$)
```

6.11 Determine file access rights

FILEACCESS

With FILEACCESS of the CPL program it is possible to tell whether a file exists and which access rights (privileges) it has.

FILEACCESS(*<file name>*)

<file name> File name with a complete path as a string expression.
If the *<file name>* contains no path, the file is searched for in the current directory. The CPL function supplies the return value as an integer value:

–1	: file does not exist
0	: file without access rights
otherwise	: binary coded access rights:
	Bit1: execution possible (X)
	Bit2: writing allowed (W)
	Bit3: reading allowed (R)
	Bit4: file is a directory (D)
	Bit5: file is an active program (A)

An **active program** is a file which

- is executed as a program
- is executed as a sub-program within a program
- has been opened by a CPL command

on a channel.

If the **access rights** of a zero shift or tool compensation table which are being used in a running part program are queried by the CPL FILEACCESS then the Bit5 is **not** set.

Example:

```
10 I% = FILEACCESS ("/usrfep/test.cnc")
```

6.12 Determine file date

FILEDATE

In the CPL program, the date of a file can be determined with FILEDATE. An access error does not generate a part program error, but instead the function supplies an empty string.

FILEDATE(<*file name*>[,<*mode*>]**)**

<*file name*>: File name with the complete path as a string expression. If no path is entered, the file is searched for in the current directory. The CPL function supplies a string expression as a return value.

<*mode*>: Integer variable for the function mode (default = 1):
1 = Date of the file, format: dd.mm.yy
2 = Time of the file, format: hh.mm.ss

Example:

```
10 DIM DATE$(10)
20 DATE$ = FILEDATE("/usr/user/Test.txt",1)
30 IF LEN(DATE$)>0 THEN
40 PRN#(0,"File date: ",DATE$)
50 ENDIF
```

Notes:

7 Dialog Programming

Dialog programming enables operator-prompted data in- and output.

Newly created CPL graphic programs make full use of the screen. The SFK command always produces 8 softkeys.
Old CPL graphic programs of the CC 200/220 series only use the corresponding pixel range of the CC 220 panel. The SFK command always produces 5 softkeys.

An identifier in the old CPL graphic programs distinguishes them from new ones. In order to enable old graphic programs to produce correct graphic output in the control unit, they have to contain the following DIN remark as first instruction:

```
N10   (TYP2)
....
```

7.1 Calling CPL dialog via softkeys

In the basic level of the ”manual”, ”automatic”, ”manage” and ”diagnostics” group operating modes or in the editor one CPL dialog program can be called via the CPL DIALOG softkey.

All CPL dialog programs run in the channel defined by the MACODA parameter 3080 00005.
If you change the entry in parameter 3080 00005, you must restart the operator interface of the control unit. Only then will the change become effective.

In standard mode, the control unit does not display the CPL DIALOG softkeys.
To have them displayed, proceed as follows:

1. Write the necessary CPL dialog programs.
2. Save them under the following names:
   ”`cpldlg01.dlg`” (CPL dialog program for the ”Manual” GOM)
   ”`cpldlg02.dlg`” (CPL dialog program for the ”Automatic” GOM)
   ”`cpldlg03.dlg`” (CPL dialog program for the ”Manage” GOM)
   ”`cpldlg04.dlg`” (CPL dialog program for the ”Diagnostics” GOM)
   ”`cpldlg05.dlg`” (CPL dialog program for the editor).
   The programs must be stored in
   – the root directory or
   – the user FEPROM or
   – FEPROM
   The control unit will search these directories in the stated sequence.
3. Restart the operator interface of the Typ3 osa.

☞ **The MACODA parameter 6001 00020 controls the behavior of the operator interface during actuation of the softkey ”CPL-dialog” if a CPL program is already active.**

7.2 CPL dialog in the editor

After actuating the CPL-DIALOG softkey in the editor the NC block currently selected in the editor is checked for a sub-program call.
To do this the control unit searches in the machine parameters 3080 00006 and 3080 00007 for a corresponding link between sub-program call (G-, auxiliary function or sub-program name) and CPL dialog program (program name).

If and when the control unit finds a link the NC block is forwarded to the corresponding CPL dialog program. If no link is present the NC block is forwarded to the CPL dialog program ”cpldlg05.dlg” (see Chap. 7.1).

Now the NC block selected in the editor can be read or even overwritten in the CPL dialog program. For this use the CPL commands **INP#** and **PRN#**.

INP#

Transfers call parameters from the selected NC block to the CPL dialog program.
In this way parameter values of the CPL dialog program can be occupied beforehand and displayed without having to input them in the dialog again.

INP#(0,P1[**,P2**][**,P3**][**,...**])

P*x*: Numeric or binary variable(s) into which the call parameters from the selected NC block are entered. A variable type is labelled by adding the corresponding characters to the variable name (INTEGER: %, REAL: no character, BOOLEAN: ?, DOUBLE: !).

PRN#

Overwrites the selected NC block with data defined here in the CPL dialog program.
This behavior can be used as a programming aid for sub-program calls with numerous transfer parameters.

PRN#(0,[<*expression*>][,<*expression*>][,<*expression*>][,...])

<*expression*>: Definable alphanumeric characters (text in quotation marks), format strings or variable(s). The specified expressions overwrite the selected NC block.

7.3 Data input and output

CSF

Deletes the currently depicted softkeys.

DSP

Outputs data in a preset format at a specified line and column position on the graphics screen.

DSP(<*line*>,<*column*>,<*expression1*>,<*expression2*>,...,
<*expressionN*>**)**

<*line*>,<*column*>: Start of output. Constants or variables may be of the REAL or INTEGER type. If <*line*> and <*column*> are of the REAL type, they are rounded off to become INTEGERs.
<*line*> may take on values from **1** to **46**,
<*column*> values from **1** to **79**.
An invalid starting position will lead to the ”Invalid line or column number in CPL command” error message.

<*expression1*>...<*expressionN*>: Any CPL expressions. If the result of an expression is to be output in formatted form, at least one of the expressions has to be a character string.
Using ”#” and ”.” in this character string it is possible to specify the format, with ”#” representing individual digits and “.” separating pre- and post-decimal places.

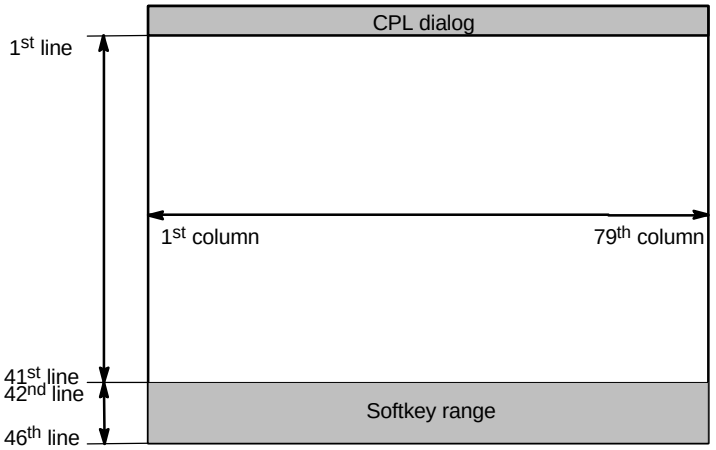
The first format instruction contained in a character string refers to the first expression thereafter to be output in a formatted manner. Expressions of the BOOLEAN or STRING type cannot be output in format. The number of all programmed formatting specifications must be smaller than or equal to the number of expressions to be output. If this condition is not fulfilled, surplus “#” will be displayed.

If no format is specified for an expression, it will be output in the default format. The default output for the REAL data type has a maximum of 7 digits, with leading zeros being suppressed. The max. output for the INTEGER data type is 9 digits. Leading zeros are likewise suppressed.

If the right screen boundary is exceeded during output of an expression, the output will be cut off at the screen boundary without an error message.
In case of string expressions with more than 77 characters the error message ”maximum string length exceeded” is issued.

If the result cannot be depicted in the specified format, the “format not permitted” error message will be displayed.

Line and column grid of the screen



Example:

```
.
10   LIN%=4 : COL%=1
20   FOR I%=1 TO 10
30   DSP(LIN%+I%,COL%,"###.### IS ROOT OF ##",SQRT(I%),I%)
40   NEXT I%
M30
.
```

Screen output:

```
 1.000  IS ROOT OF 1
 1.414  IS ROOT OF 2
 1.732  IS ROOT OF 3
 .
 .
 3.162  IS ROOT OF 10
```

Example:

```
.
10   A=25 : B=SQRT(A) : Z=5 : S=10
20   DSP(Z,S,"A= ",A,"  B= ",B,"  C= ",A+B)
.
```

Screen output:

```
A= 25.000   B= 5.000   C= 30.000
```

Example:

```
.
10   A=25 : B=SQRT(A) : Z%=5 : S%=10
15   FA$="   A= ###.#" : FB$="   B= #.#" : FC$="   C= ##"
20   DSP(Z%,S%,FA$,FB$,FC$,A,B,B+A)
.
```

Screen output:

```
A= 25.0   B=5.0   C=30
```

Example:

```
.
1  1.5:Y=2.5:B?=TRUE:I%=200:T1$="   MEAS.PROBE=":T2$="  NO.="
2  DSP(5"XPOS  ###.### YPOS ###.###,T1$,B?,X,Y,T2$,I$)
.
```

Screen output:

```
XPOS 1.500   YPOS 2.500     MEAS.PROBE=TRUE        NO.=200
```

DLG, ENDDLG

Some dialog instructions may be contained in the program within a range which is enclosed by DLG and ENDDLG. This range offers convenient data input options (cf. PRN and INP below).

Example:

```
.
30   DLG          } Start of dialog
     .            }
     .            } Dialog and other CPL commands
     .            }
90   ENDDLG       } End of dialog
.
.
```

INKEY

Returns as a function value the number of a depressed key which was not yet processed. This gives the user the opportunity to respond to the depression of a certain key.

If the program flow encounters the INKEY function, the execution of the program will not be interrupted.
The INKEY function can provide values between 0 and 255. The value 0 means that no key was pressed. The values from 1-127 correspond to the decimal values of the ASCII characters. The keys of the operating panel have separate numbers assigned. For the ASCII table and the key codes, please refer to the Annex.

The command is only effective when the CPL dialog is in the foreground.

Example:

```
.
1  NEW%=0 : OLD%=0
2  CLS
3  DSP(10,10,"Press any key! ABORT WITH ENTER")
4  WHILE NEW%<>13 DO
5    NEW%=INKEY
6    IF (OLD%<>NEW%) AND (NEW%>0) THEN
7      DSP(12,10,"KEY NUMBER:###",NEW%) : OLD%=NEW%
8    ENDIF
9  END
10 CLG
.
```

Example:

```
.
1     A$ = ”SOFT1” : B$ = ”SOFT2” : C$ = ”SOFT3”
2     D$ = ”SOFT4” : B$ = ”SOFT5” : F$ = ”SOFT6” : G$ = ”SOFT7” : H$ = ”SOFT8”
3     CALL UNTPR [ A$,B$,C$,D$,E$ ]
M30
.
UNTPR:
1   Z%=0 : COL(0,7,0)
2   DSP(41,4,P1$) : DSP(41,13,P2$) : DSP(41,22,P3$)
3   DSP(41,31,P4$) : DSP(41,40,P5$) : DSP(41,49,P6$) : DSP(41,58,P7$) : DSP(41,67,P8$)
4   REPEAT
5     REPEAT
6      K%=INKEY
7     UNTIL ((K%=141) OR (K%=142) OR (K%=143) OR (K%=144) OR (K%=145)
          OR (K%=146) OR (K%=147) OR (K%=148) OR (K%=139))
8   JZ%=Z%-140 : JK%=K%-140
9   IF ((JZ%>0) AND (JZ%<9)) THEN COL(0,7,0)
10    FOR I%=0 to 2
11     DSP(41+I%,(JZ%-1)*8+JZ%+1,”   ”)
12    NEXT I%
13    IF Z%=141 THEN DSP(41,4,P1$) ENDIF
14    IF Z%=142 THEN DSP(41,13,P2$) ENDIF
15    IF Z%=143 THEN DSP(41,22,P3$) ENDIF
16    IF Z%=144 THEN DSP(41,31,P4$) ENDIF
17    IF Z%=145 THEN DSP(41,40,P5$) ENDIF
18    IF Z%=146 THEN DSP(41,49,P6$) ENDIF
19    IF Z%=147 THEN DSP(41,58,P7$) ENDIF
20    IF Z%=148 THEN DSP(41,67,P8$) ENDIF
21  ENDIF
22  IF ((JK%>0) AND (JK%<9)) THEN COL(O,O,7)
23    FOR I%=0 TO 2
24     DSP(41+I%,(JZ%-1)*8+JZ%+1,”   ”)
25    NEXT I%
26    IF K%=141 THEN DSP(41,4,P1$) ENDIF
27    IF K%=142 THEN DSP(41,13,P2$) ENDIF
28    IF K%=143 THEN DSP(41,22,P3$) ENDIF
29    IF K%=144 THEN DSP(41,31,P4$) ENDIF
30    IF K%=145 THEN DSP(41,40,P5$) ENDIF
31    IF K%=146 THEN DSP(41,49,P6$) ENDIF
32    IF K%=147 THEN DSP(41,58,P7$) ENDIF
33    IF K%=148 THEN DSP(41,67,P8$) ENDIF
34  ENDIF
35  Z%=K%
36  UNTIL K%=139 : CLG
M30
.
```

Example:

```
.
10   M=10
20   REPEAT
30     KEY%=INKEY
40     LIN(250,10,M,M)
45     M=M+1
50   UNTIL ((KEY%=66) OR (M>300))
60   CLG
.
```

Example:

```
.
10   M=2
20   WHILE ((INKEY<>66) AND (M<150)) DO
30     CIR(250,160,M) : M=M+1
40   END
50   CLG
60
.
```

INP

Assigns a value to a REAL or INTEGER variable in the dialog.

INP(<*variable name*>**)**

☞ **If an INP instruction is to be executed the CPL processor must have read a corresponding PRN instruction with the same variable within the DLG-ENDDLG range before.**

An attempt to use INP to assign a value to a STRING variable will be ignored but the corresponding PRN instruction will be executed.

The dialog text will be displayed on the screen with the reading of the first INP instruction.
An INP instruction can be skipped using the cursor keys without a value assignment being made. An existing value can be deleted using the delete key.

The validity of the format is checked during value input. It is not possible to enter a value exceeding the valid format length. Upon completion of the input via ENTER, an automatic jump to the next input instruction is made.

Example:

```
.
30   DLG
40   PRN(8,4,"MAX. CUTTING WIDTH: ###.### MM",WI)
50   PRN(10,4,"MAX. CUTTING DEPTH: ###.### MM",DP)
60   INP(WI):INP(DP)
70   ENDDLG
80   PRN# 0,"Q900[",WI,",",DP,"]")
.
```

PRN

Issues a text or displays the content of a variable in the specified format with text preceding or following (e.g. to explain input and display the unit of measurement).

PRN(<*line*>**,**<*column*>**,"**<*text*>**")**
or
PRN(<*line*>**,**<*column*>**,"**[<*text*>]<*format*>[<*text*>]**",**<*variable name*>**)**

<*line*>:	Constant in the value range from **1** to **46** (cf. page 7–4)
<*column*>:	Constant in the value range from **1** to **79** (cf. page 7–4)
<*text*>:	Any alphanumeric text (“#” for format information only)
<*format*>:	Defined input format of the variable; ”#” represents placeholders for digits, ”.” separates pre- from post-decimal places.
<*variable name*>:	If the variable has a value assigned, the value will be displayed in the defined format. If the variable is not yet assigned, the specified format will be displayed.

SFK

Depicts a softkey bar with 8 softkeys and awaits the actuation of a softkey. After actuation of a softkey its number or its text is transferred to a variable.

The programmed softkey bar is displayed until the next SFK command, CLG command or until the end of the program.

SFK(<*variable*>**,**[<*text1*>],[<*text2*>],[<*text3*>],[<*text4*>],
[<*text5*>],[<*text6*>],[<*text7*>],[<*text8*>])

<*variable*>: If the variable is of the INTEGER type, the number of the softkey being depressed will be transferred to it; if it is of the STRING type, it will receive the softkey's text.
Pressing the LEVEL RETURN key exits the SFK command and the value of the parameter <*variable*> remains unchanged.

<*text1*>...<*text8*>: STRING expressions for which 3 lines of text consisting of 9 characters each are available. Within the STRING expressions line breaks within the softkey's text are denoted by a "&" sign.

Example:

```
.
1    .SOFTKEY1
.
.
.
10   .SOFTKEY2
11   KEY%=0
12   SFK (KEY%,,"ABORT",,"ACTION",,,,)
13   IF KEY%=2 THEN GOTO .END ENDIF
14   IF KEY%=4 THEN GOTO .ACTION ENDIF
15   IF KEY%=0 THEN GOTO .SOFTKEY1 ELSE GOTO .SOFTKEY2 ENDIF
.
30   .ACTION
.
40   .END
.
```

TFO

Modifies the font in the CPL dialog.

☞ **The font of the dialog text displayed in the INP command cannot be modified.**

TFO(*<font>,<size>,<cut>,<orientation>***)**

<font>:
0: Lucida console (default) Sample text
1: Arial
2: Verdana
3: Book Antiqua
4: Times New Roman
5: Bosch
6: Impact
7: Haettenschweiler
8: Comic Sans MS
9: Brush Script MT
10: Wingdings

<size>:
0: font height = 9 pixels, font width = 8 pixels (default) (only for Lucida console font setting)
1 to 500: font height in pixels; font width is determined automatically.

Example: Point sizes: 6, 8, 10, 12, 16, 20, 36

If the font width is to be set individually for a certain font height calculate the input value for <*size*> according to the following formula:
<*size*> = font height + (font width * 1000)
with: font height: 1 to 500
font width: 1 to 500

<cut>:
0: normal (default)
1: **boldface**
2: *italics*
3: ***boldface and italics***

<orientation>: 0 to 360 degrees (0 = default).
<*orientation*> does not work for font 5 (Bosch).

If individual parameters are not to be specified at least the corresponding commas must be written in front of the last programmed parameter: e.g. `TFO(,,3)`.
At the end of the program the default setting `TFO(0,0,0,0)` automatically becomes active again.

If you set another font than ”0” the following applies:

- The specification of line and column in CPL dialog commands defines only the starting position for the screen output. An assignment between line/column and the returned character no longer exists because of the differing space requirement of a character.
- Softkey texts are not returned centered.

Notes:

8 Graphic Programming

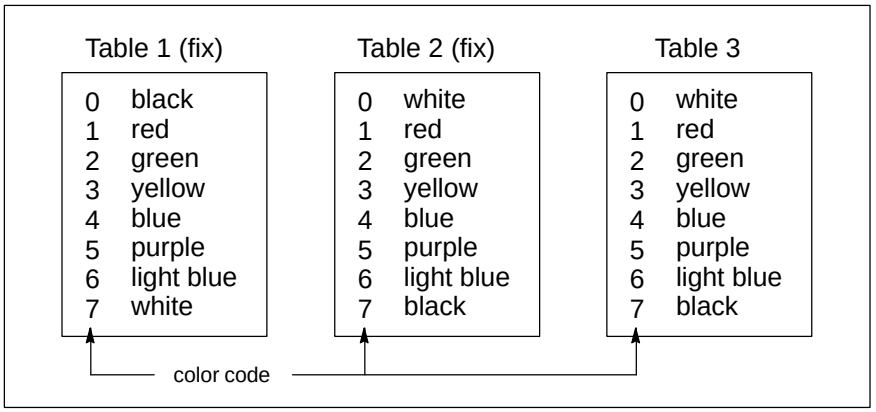
Graphic programming allows the representation of text and drawings on the screen. The following functions are available for this purpose:

- Selection of color
- Selection of line type
- Selection of the graphics area
- Drawing of lines and circles
- Filling of closed contour surfaces
- Selective deletion of screen areas
- Text display in graphics grid
- Representation of bitmap files

8.1 Color selection

In CPL 2 fixed and 1 freely definable color tables are available.
Each color table contains 8 colors and each color is assigned a **color code** (0 to 7; integer).
Table 3 is assigned as Table 2 as a default setting for the time being.

☞ **The colors in Table 3 can be changed by RGB command. Here the individual color codes can also be assigned mixed colors.**



When the program is started the first table is always automatically activated.
The colors for screen objects are preset as follows:

Color of	Lines, circles:	1
	Text:	2
	Text background:	0
	Softkeys:	3
	Softkey background:	4
	Graphics background:	0

To select a color use the COL command.
With this, new screen objects to be displayed can be assigned a different color from the active color table or a specific color table can be activated at any time.

COL

Assigns new screen objects to be displayed a color from the active color table or activates a specific color table.

☞ **When a color table is activated the entire screen is erased.**

COL([<*graphics*>],[<*text*>],[<*textBG*>],[<*tab*>],[<*SK*>],[<*SKBG*>])

<*graphics*>:	Color code for lines and circles.
<*text*>:	Color code for text.
<*textBG*>:	Color code for text background.
<*tab*>:	0: Selection of color table 1. 7: Selection of color table 2. 10: Selection of color table 3.
<*SK*>:	Color code for softkey text.
<*SKBG*>:	Color code for softkey text background.

As color code any INTEGER expression in the value range from 0 to 7 may be used.

If and when individual parameters are not to be specified at least the corresponding commas must be written in front of the last programmed parameter: e.g. `COL(,,,3)`.

Examples:

`10 COL(,,,7)`	Selection of color table 2. Entire screen is erased.
`30 COL(,,,10)`	Selection of color table 3. Entire screen is erased.
`50 COL(,,,,1,4)`	Color for softkey text: 1; color for softkey text background: 4
`70 COL(4)`	Color for lines and circles: 4
`90 COL(,6,5)`	Color for text: 6; color for text background: 5

RGB

Programs colors in the third color table.

☞ **If you want to use mixed colors (mixed colors: color portions except 0 and 255) first set a color resolution of at least 65536 colors (high color; 16 bit) in the PC control panel.**
You will find a table of standardized mixed colors on the PC control panel in the directory ”c:\programme\exceed.95(nt)\user\rgb.txt”.

RGB(<*color code*>,<*R*>,<*G*>,<*B*>)

<*color code*>:	0 to 7. Any INTEGER expression. Determines which color in table 3 is changed.
<*R*>:	0 to 255. Any INTEGER expression. Red portion. (0: no red portion; 255: max. red portion).
<*G*>:	0 to 255. Any INTEGER expression. Green portion. (0: no green portion; 255: max. green portion).
<*B*>:	0 to 255. Any INTEGER expression. Blue portion. (0: no blue portion; 255: max. blue portion).

Examples: Set colors in color table 3 and activate color table 3.

`:`	Assign colors to the individual color codes.
`10 RGB(0,238,130,238)`	Color code 0: violet
`11 RGB(1,255,165,0)`	Color code 1: orange
`12 RGB(3,192,192,192)`	Color code 3: grey
`13 RGB(4,165,42,42)`	Color code 4: brown
`20 COL(1,2,3,10,4,5)`	Activate color table 3.

8.2 Line type

GMD

The GMD function can be used to select the type of representation of lines on the screen.

GMD(<*line type*>)

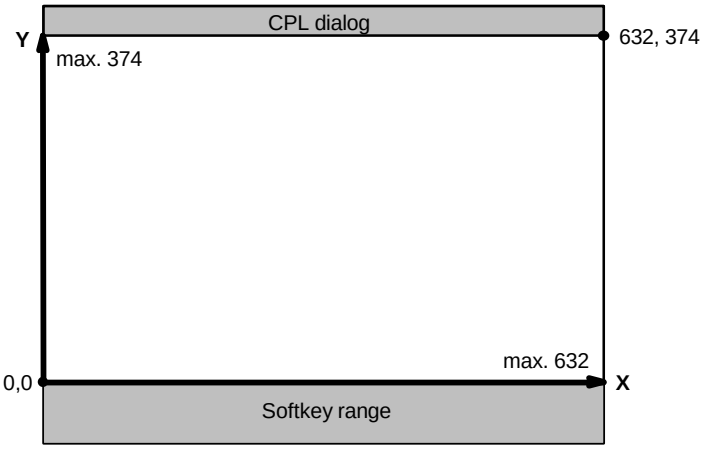
<*line type*>: 0 = unbroken line
1 = line must be erased
2 = erase line or regenerate erased line
3 = dash-dot line
4 = dash-dash line

8.3 Defining the graphics area

GWD

When the control unit is switched on the displayable graphics range is as follows:

- horizontal: **0–632** pixels
- vertical: **0–374** pixels



If only a portion of this graphics range is desired, you can use the GWD command to define a rectangular graphic window.

GWD(<*X left*>,<*X right*>,<*Y bottom*>,<*Y top*>)

<*X left*>: Left window edge. INTEGER expression, with
<*X left*> greater than or equal to 0;
<*X left*> smaller than <*X right*>

<*X right*>: Right window edge. INTEGER expression, with
<*X right*> greater than <*X left*>;
<*X right*> smaller than or equal to 632

<*Y bottom*>: Bottom window edge. INTEGER expression, with
<*Y bottom*> greater than or equal to 0;
<*Y bottom*> smaller than <*Y top*>

<*Y top*>: Top window edge. INTEGER expression, with
<*Y top*> greater than <*Y bottom*>;
<*Y top*> smaller than or equal to 374

Programming example: see Chap. 8.5.

MWD

If the edges of the current graphics window are to take on values of another coordinate system for the next graphics programming, this can be achieved using the MWD command. When doing so, make sure that the parameters of the current graphics window have the same ratio to each other as the parameters of the MWD command. This means that the ”MWD rectangle” must have the same side-side ratio as that of the ”GWD rectangle”. The command format and parameterization correspond to those of the GWD command:

MWD(<*X left*>,<*X right*>,<*Y bottom*>,<*Y top*>)

Programming example: see Chap. 8.5.

8.4 Join (line)

LIN

Draws a line between starting and end point (programming example, see Chap. 8.5).

LIN(<*X start*>,<*Y start*>,<*X end*>,<*Y end*>)

<*X start*>,<*Y start*>: Pixel coordinates of the starting point. Any INTEGER expressions.

<*X end*>,<*Y end*>: Pixel coordinates of the endpoint. Any INTEGER expressions.

If a contour pass is being programmed, the definition of the starting point is no longer required after the 2nd line. The last endpoint is regarded as the new starting point. In this case it is possible to write as follows:

LIN(<*X end*>,<*Y end*>)

If <*X end*> or <*Y end*> remain unchanged compared to the preceding LIN instruction, renewed specification of <*X end*> or <*Y end*> may be omitted.

If no true-to-scale graphics window has been defined using the MWD command (please see there), the coordinate values will be interpreted as pixel values (image spots of the monitor). If REAL values are used instead of INTEGER values, an internal conversion to integer pixel values will take place.

8.5 Circle

CIR

Draws full circles or arcs of circles in clockwise direction.

Full circle:
CIR(<*X center*>,<*Y center*>,<*radius*>)

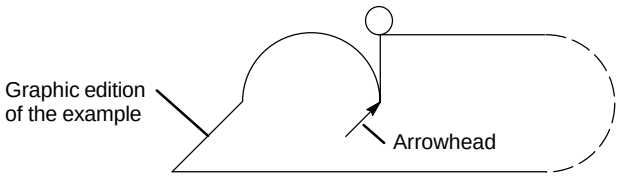
Partial circle (arc) clockwise:
CIR(<*X start*>,<*Y start*>,<*X end*>,<*Y end*>,<*X center*>,<*Y center*>)

<*X center*>,<*Y center*>:	Circle-center coordinates in the form of any INTEGER expression.
<*radius*>:	Radius of the full circle in the form of any INTEGER expression.
<*X start*>,<*Y start*>:	Coordinates of the starting point in the form of any INTEGER expression.
<*X end*>,<*Y end*>:	Coordinates of the end point in the form of any INTEGER expression.

If parameter values are identical with a preceding circle programming, these unchanging parameters may be omitted at the corresponding place of the CIR command.
If REAL values are used instead of INTEGER values, an internal conversion to integer pixel values will take place.

Examples: Graphic commands

```
1  DLF                    :REM Bring CPL dialog window to the foreground
2  COL(7,,,7)             :REM Activate color table 2, set graphic color to 'black'

3  GWD(100,500,100,350) :REM Specify graphic area
4  MWD(0,400,-150,100)  :REM Determine edges of the coordinate system

5  LIN(50,-100,100,-50) :REM Draw line from 50/-100 to 100/-50

6  REM Draw half-circle from 100/-50 to 200/-50 with center 150/-50
7  CIR(100,-50,200,-50,150,-50)

8  LIN(,0)                :REM Draw line from 200/-50 to 200/0

9  REM Draw full circle with center 200/10 (R=10)
10 CIR(200,0,,,200,10)

11 LIN(300,)              :REM Draw line from 200/0 to 300/0

12 REM Draw half-circle from 300/0 to 300/-100 with center 300/-50
13 GMD(3)                 :REM Set line type to 'dash-dot' line
14 CIR(300,0,300,-100,300,-50)
15 GMD(0)                 :REM Set line type to 'unbroken' line

16 LIN(50,-100)           :REM Draw line from 300/-100 to 50/-100

20 REM Draw arrowhead
21 #XX=195 : #YY=-50 : #WI=30
22 LIN(#XX,#YY,#XX+15*COS(#WI+165),#YY+15*SIN(#WI+165))
23 LIN(#XX+15*COS(#WI+195),#YY+15*SIN(#WI+195)):LIN(#XX,#YY)

24 REM Fill the tip of the arrow with the color 'black'

25 FIL(#XX-10*COS(#WI),#YY-10*SIN(#WI),0,7,7)
26 LIN(#XX-15*COS(#WI),#YY-15*SIN(#WI),#XX-30*COS(#WI),#YY-30*SIN(#WI))
```



Lines 21 to 26 draw an arrowhead, with the global variables `#XX` and `#YY` representing the coordinates of the tip of the arrow and `#AN` (`#WI`) the angle of the arrowhead with reference to the X axis of the graphics coordinate system. This also shows clearly that the use of REAL expressions is permitted, since they are converted to INTEGER values internally.

8.6 Filling in closed contour surfaces

FIL

Fills in a closed contour.

FIL(<*X value*>**,**<*Y value*>**,**<*fill pattern*>**,**<*fill color*>
[**,**<*contour color*>]**)**

<*X value*>,<*Y value*>:	Coordinates of the fill-in point within the closed contour in the form of any INTEGER expressions.
<*fill pattern*>:	INTEGER expression ≧ 0 and ≦ 5, currently not used for representation. Reserved for later implementation.
<*fill color*>:	Color code (cf. page 8–1).
<*contour color*>:	Color code (cf. page 8–1) of the closed contour pass. This indication is only necessary if the fill color does not correspond to the color of the contour.

8.7 Clear commands

CLG

Clears the entire image area (**CL**ear **G**raphic) permissible for CPL and moves the CPL dialog window into the background of the screen (see also DLF instruction on p. 8–8).

CLR

Clears the graphics range (**CL**ear **R**ange) defined by GWD.

CLS

Clears the entire screen (**CL**ear **S**creen).

8.8 Text output in the graphics grid

GPR

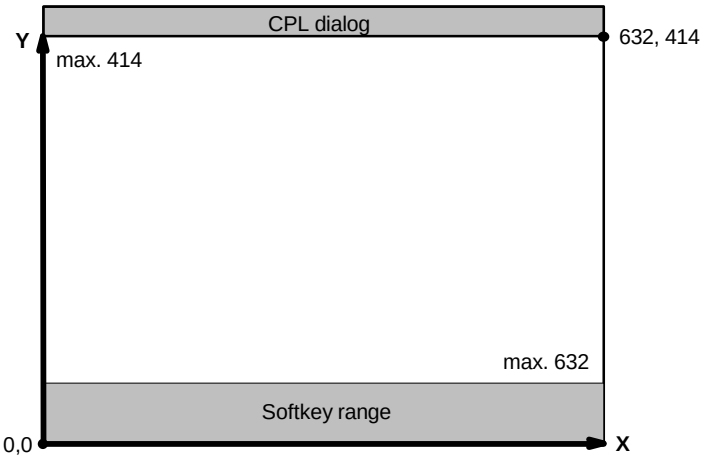
If text is to be written in a form other than in the line/column grid, such as is the case with the PRN and DSP commands, text can be addressed in graphics coordinates using the GPR command.
For this purpose, the bottom left point of the letter matrix at the beginning of a character string is defined by way of specifying the screen pixels in the X and Y direction.
The command format is as follows:

GPR(<*X pixel*>**,**<*Y pixel*>[+<*offset*>]**,**<*text*>**)**

<*X pixel*>,<*Y pixel*>: Coordinates of the first alphanumeric character (bottom left image spot) of the character string in <*Text*>. The coordinates must be within the defined graphics range and may be any INTEGER expressions.

<*offset*>: Owing to the fact that, in contrast to the other graphics commands, the use of the GPR also allows writing in the softkey area, there is a difference of **40** pixels between the Y addressing of the GPR command and that of the other graphics commands.
If, especially in the case of variable addressing, the Y coordinate is supposed to be uniform, this difference has to be taken into account in the form of an addition of **40** pixels.
<*Y pixel*> and <*offset*> together must not exceed the defined graphics range.

<*text*>: Any STRING expression (constant or variable).



Example:

```
.
1   NR%=49 : REM, *** ASCII character 49 → "1" ***
2   FOR W%=0 STEP 45 TO 360
3    X=75+W% : Y=175+100*SIN(W%)
4    N$=CHRS(NR%) : NR%=NR%+1
5    LIN(X,Y+10,X,Y-10) : LIN(X-10,Y,X+10,Y)
6    GPR(X+16,Y+40,"pixel") : GPR(X+64,Y+40,N$)
7   NEXT W%
.
```

8.9 Influencing the entire CPL dialog window

CLG

Clears the entire screen range allowed for CPL, and moves the CPL dialog window to the **background of the screen.**

DLF

Moves the CPL dialog window to the **foreground of the screen.**

8.10 Display bitmap files

BMP

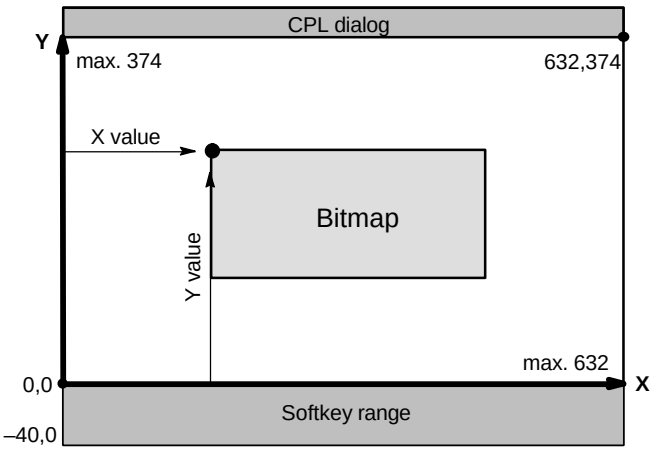
Displays bitmaps (picture files of type ”*.bmp”) in the CPL dialog window.

☞ **If the color intensity of the bitmap to be shown does not comply with the currently set color intensity as displayed on the screen the system automatically performs a bitmap conversion. As a result, the bitmap is displayed after a delay.**

BMP(<*X value*>,<*Y value*>,”<*file*>”,[<*copy type*>])

<*X value*>,<*Y value*>:

Coordinates in the CPL dialog window for the upper left-hand pixel of the bitmap to be displayed.
Value range:
<X value>: 0 ... 632
<Y value>: 0 ... 374
Any INTEGER expressions are possible.
The entire graphics area incl. softkey bar can be used for displaying the bitmap.



<*file*>: File name of the bitmap **without file name extension** (.bmp). Max. 70 characters. Must be programmed as STRING expression.

☞ **Used bitmap files must always be stored in the following directory: "...\typ3pcp\bin\cplbmp".**
If the file cannot be accessed the following error message appears: "cplbmp\<*name*>.bmp is not existing".
After the error message has been acknowledged the program is continued.

<*copy type*>: Value range 0 to 8. Any INTEGER expression.
The parameter defines how the bitmap is copied into the CPL dialog window. In this way the bitmap to be displayed can also linked with the current content of the CPL dialog window.

0: Bitmap is copied over the contents of the CPL dialog window.

1: White surface with the size of the bitmap is copied over the contents of the CPL dialog window.

2: Black surface with the size of the bitmap is copied over the contents of the CPL dialog window.

3: Bitmap is copied into the CPL dialog window. The pixels of the bitmap (source) and those of the CPL dialog window (target) are linked here according to the following formula: target = source **OR** target

4: Like 3, but link formula here: target = source **AND** target

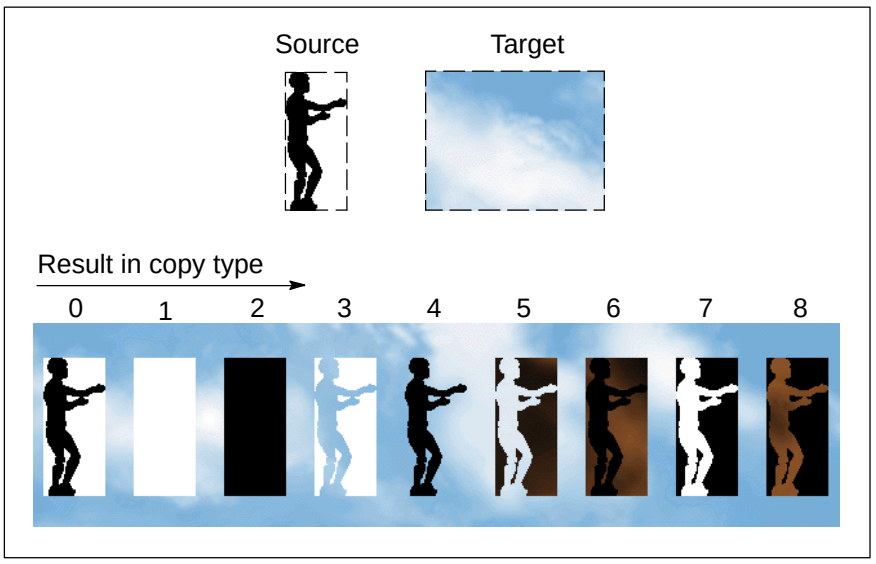
5: Like 3, but but link formula here: target = source **XOR** target

6: Like 3, but link formula here: target = source **AND (NOT** target)

7: Like 3, but link formula here: target = **(NOT** source)

8: Like 3, but link formula here: target = **(NOT** source) **AND (NOT** target)

Example:



Notes:

9 Communication

MMC

Sends information from a part program to a client at program run time and waits for a response from this client.
This is carried out with the aid of CPL variables, which can send values from the part program as well as return values to the part program.

The part program is stopped during run time at the point where the MMC command is received.

The following processing possibilities are possible:

- If no client has reported that it is able to process the MMC command, then the corresponding return value (=1) is assigned and the processing of the part program continues.
- If a suitable client for processing the data of the MMC command is available, then an assignment between the part program and the client occurs. After the client has sent a reply, the corresponding return value is set and the execution of the part program continues.

The MMC command can have a maximum of 20 CPL variables as parameters. The name and the values of these variables are transmitted to the client.

The instruction has the following structure:

MMC(<CPL var1>[,<CPL var2>....[,<CPL varN>]....]**)**

<CPL var1> ... <CPL varN> CPL variables, *N*=max. 20
The client can write new values on the CPL variables stated in the MMC command. The CPL variables stated in the MMC command can be used in the part program.

The MMC command supplies the following return values as a result:
0: o.k.
1: no client available
2: error in the client

Example:

```
10  DIM PROGNAME$ (50)
20  PROGNAME$ = ”WinProg”
30  INTPAR% = 1
40  REALPAR = 1.1
50  I% = MMC (PROGNAME$,INTPAR%,REALPAR)   → The CPL variables
                                              PROGNAME$, INTPAR%
                                              and REALPAR with
                                              their values are made
                                              available to the cli-
                                              ent.

60  IF I% = 0 THEN                         → The block preparation
70      IF INTPAR% = 2 THEN                   of the part program
80       .....                                is not continued in
90      ELSE                                  line 60 until a cor-
100      .....                                responding ’finished’
110     ENDIF                                 message has come.
120 ENDIF
```

Notes:

A Annex

A.1 Abbreviations

Abbreviation	Description
C	Drive name, in this case drive C (hard disk drive)
CPL	Customer Programming Language
ESD	Electro-Static Discharge Abbreviation for all terms relating to electro-static discharge, e.g. ESD protection, ESD hazards, etc.
Fx	Function key with number x
GOM	Group Operating Mode
HP	Main Program (’Hauptprogramm’)
LSEC	Lead Screw Error Compensation
MDI	Mode “Manual Data Input“
MP	MACODA parameter
MSD	Machine-Status Display
MTB	Machine-Tool Builder
NC, CNC	Numeric Control
OI	Operator Interface
OM	Operating Mode
PE	Protective Earth
PLC	Programmable Logic Controller
SK	Softkey
SP	Sub-program

A.2 Overview of commands

Command	Syntax / Short description	see page
ABS	**ABS**(<*input value*>) Returns the absolute value of the input value, i.e. negative values become positive, positive values remain positive.	2–16
ACOS	<*function value*>**=ACOS**(<*input value*>) Application of arc cosine (anticosine) function to the <*input value*>.	2–17
AND	<*expression1*> **AND** <*expression2*> Binary operation of two BOOLEAN or INTEGER expressions with the AND function.	2–18
APOS	**APOS**(<*axis selection*>) Transfers the current actual axis value referred to the machine zero point.	4–17
ASC	**ASC**(<*character string*>) Outputs the ordinal number of the first character (ASCII code) in a <*character string*> as an INTEGER value.	5–5
ASIN	<*function value*>**=ASIN**(<*input value*>) Application of arc sine (antisine) function to the <*input value*>.	2–17
ATAN	<*function value*>**=ATAN**(<*input value*>) Application of arc tangent (antitangent) function to the <*input value*>.	2–17
AXO	**AXO**(<axis selection>[,<*selection type*>]) Transfers an active G92 shift for a coordinate.	4–9
AXP	**AXP**(<*axis number*>,<*positional data*>) The application of this function is carried out in an NC block. It must be in square brackets “[ ]” and is programmed in lieu of the address values.	4–39
BCD	<*BCD value*>=**BCD**(<*binary value*>) Converts a binary format to BCD format.	2–19
BIN	<*binary value*>=**BIN**(<*BCD value*>) Converts a BCD format to binary format.	2–19
BMP	**BMP**(<*X value*>,<*Y value*>,<*file*>,[<*copy type*>]) Displays bitmaps (picture files of the ”*.bmp” type) in the CPL dialog window.	8–8
CALL	**CALL** <*program number*> **[**<*transfer parameter1*>,...**] [DIN]** Sub-program call from a CPL program.	3–2

Command	Syntax / Short description	see page
CASE	**CASE** <*Integer expression*> **OF** **LABEL** <*int. constant*>[,<*additional int. constant*>] [**:** <*instruction*>] <*instruction*> : **LABEL** ... : **OTHERWISE** <*instruction*> <*instruction*> : **ENDCASE** Conditional selection from several alternatives.	2–24
CHR$	**CHR$(**<*Integer expression*>**)** Transmits a character whose ordinal number in the ASCII table is equal to the value transferred via the <*INTEGER expression*> parameter.	5–5
CIR	**CIR(**<*X start*>,<*Y start*>,<*X end*>,<*Y end*>,<*X center*>,<*Y center*>**)** **CIR(**<*X center*>,<*Y center*>,<*radius*>**)** Output of a partial or full circle.	8–5
CLG	Clears the entire image area and moves the CPL dialog window into the background.	8–6, 8–8
CLOCK	<*function value*>**=CLOCK** Time counter query in milliseconds.	4–42
CLOSE	**CLOSE(**<*n*>**)** Closes an open file with logical number <*n*> after concluding read or write operations.	6–10
CLR	Deletion of the graphics range defined via GWD.	8–6
CLS	Deletion of the entire image range.	8–6
COF	**COF(**<*axis selection*>[,<*selection type*>]**)** Supplies for the current channel (here: channel in which the program with the COF command is running) the contour shift last programmed (G60) of a coordinate.	4–26
COL	**COL(**[<*graphics*>],[<*text*>],[<*textBG*>],[<*tab*>],[<*SK*>],[<*SKBG*>]	8–2
	Defines the colors for graphics, text, text background, softkey text and softkey text background. Also switches the color table.	
COS	<*function value*> **= COS(**<*input value*>**)** Application of the cosine function to the <*input value*>.	8–6
CPOS	**CPOS(**<*axis selection*>[,<*selection type*>]**)** Transfers the last programmed absolute position of a coordinate.	4–9
CPROBE	**CPROBE(**<*axis selection*>[,<*selection type*>]**)** Reads the measured value for one coordinate at a time.	4–10
CSF	Deletion of the current softkey bar.	7–3
DATE	<*STRING variable*>**=DATE** DATE assigns the date in DD.MM form to the <*STRING variable*>.	4–42

Command	Syntax / Short description	see page
DIM	**DIM** <*variable name*>(<*field size1*>[,<*field size2*>]) Specifies the field size (dimensioning) of ARRAY variables with INTEGER constants.	2–13, 5–1
DLF	Moves the CPL dialog window to the screen foreground.	8–8
DLG	Start of a dialog input range.	7–5
DPC	**DPC**(<*axis selection*>[,<*selection type*>]) Supplies for the current channel (here: channel in which the program with the DPC command is running) the parameters last programmed of the compensation of workpiece position G138 of a coordinate (shift values and rotation angles).	4–27
DSP	**DSP**(<*line*>,<*column*>,<*expression1*>,..,<*expressionN*>) Formatted output of text on the screen, positioned by line and column number.	7–3
ENDDLG	End of a dialog input range.	7–5
EOF	**EOF**(<*n*>) Checks for end of file.	6–10
ERASE	**ERASE**(<*PGM identifier*>) Erases files.	6–15
FALSE	<*BOOLEAN variable*>**=FALSE** Truth value of a BOOLEAN variable.	2–13
FIL	**FIL**(<*X value*>,<*Y value*>,<*fill pattern*>,<*fill color*>[, <*contour color*>]) Filling of closed contour surfaces.	8–6
FILEACCESS	**FILEACCESS**(<*file name*>) Returns the information whether a file exists and which access rights it has.	6–16
FILEDATE	**FILEDATE**(<*file name*>[,<*mode*>]) Determines the date / time of a file.	6–17
FILEPOS	**FILEPOS**(<*n*>[,<*mode*>]) <*n*> = logical file number. <*mode*> = mode Returns the record number of the current record and the record offset of a random file. Returns in case of sequential files the current byte position of the file pointer.	6–11
FILESIZE	**FILESIZE**(<*n*>[,<*k*>]) <*n*> = logical file number. <*k*> = mode Transmits the size of a file, or the limit up to which a file has already been written. The file can be a sequential or a random file.	6–14
FOR NEXT	**FOR** <*numerical variable*>**=**<*start value*> [**STEP** <*step size*>] **TO** <*end value*><*routine*> **NEXT** [<*numerical variable*>] Loop construction with automatic counter.	2–20
FXC	**FXC**(<*axis selection*>[,<*G address*>[,<*axis ZS table*>[,<*unit*>]]]) Access to axis zero shift values.	4–19

Command	Syntax / Short description	see page
FXCR	**FXCR(**<*channel or layout*>,<*TabName*>[,<*classification*>]**)** Sets up a new ZS table.	4–21
FXDEL	**FXDEL(**<*TabName*>,<*axis desig*>**)** Deletes a column in a ZS table.	4–21
FXINS	**FXINS(**<*TabName*>,<*position*>,<*axis name*>[,<*axis type*>]**)** Sets up a new column in a ZS table.	4–22
GETERR	**GETERR(**<*channel*>,[<*category*>],<*error no.*>[,<*number*>]**)** Supplies the error no., channel no. and the assigned error category for the current errors.	4–43
GMD	**GMD(**<*line type*>**)** Definition of the type of representation of lines.	8–3
GOTO	**GOTO** <*jump destination*> Unconditional program jumps to line numbers, block numbers or labels.	2–22
GPR	**GPR(**<*X pixel*>,<*Y pixel*>[+<*offset*>],<*text*>**)** Text output in pixel graphics grid.	8–7
GWD	**GWD(**<*X left*>,<*X right*>,<*Y bottom*>,<*Y top*>**)** Determination of the graphics range in terms of pixels.	8–3
IC	**IC(**<*bit*>[,<*group*>][,<*index*>]]**)** Access to the digital interface between CNC and PLC.	4–40
IF ENDIF	**IF** <*condition*> **THEN** <*routine*> [**ELSE** <*alternative routine*>] **ENDIF** Conditional jump to a routine or alternative routine.	2–23
INKEY	<*function value*>**=INKEY** Supplies a pressed key as a function value (at time when command is invoked).	7–5
INP	**INP(**<*variable*>**)** Input of a value for the specified variable.	7–7
INP#	**INP#(**<*n*>**,**<*variable*>[**,**<*variable*>][**,...**][**;**]**)** Read-access to data from the file with the logical number <*n*>.	6–8
INSTR	**INSTR(**<*character string*>**,**<*STRING expression*>[**,**<*start point*>]**)** Beginning at the <*start point*>, searches for a <*character string*> within a <*STRING expression*> and outputs its start position as an INTEGER value.	5–4
INT	<*INTEGER number*>**=INT(**<*REAL expression*>**)** Converts a <*REAL expression*> to an <*INTEGER number*> by removing the decimal places.	2–16
LEN	**LEN(**<*STRING expression*>**)** Returns the number of characters in a STRING expression. The result is an INTEGER value.	5–4
LIN	**LIN(**<*X start*>,<*Y start*>,<*X end*>,<*Y end*>**)** Draws a line.	8–4

Command	Syntax / Short description	see page
LJUST	**LJUST** Switches to left-justified data output and is effective for all file outputs up to the end of the program run.	6–5
MCA	**MCA**(<*block*>,<*index*>[,<*channel*>]) Transfers the contents of a MACODA individual parameter.	4–29
MCODS	**MCODS**(<*type*>,<*channel*>,<*version*>,<*buffer*>,<*size*>,[<*P1*>]) Calls Motion Control Data services of the NCS by CPL. Enables data and statuses to be output from the CNC.	4–48
MCOPS	**MCOPS**(<*fct*>,<*channel*>[[,[<*P1*>][,[<*P2*>],[<*P3*>]]],<*P3*>]) Calls Motion Control Process services of the NCS by CPL. Enables controlling of channels in the CNC.	4–70
MID$	**MID$**(<*STRING expression*>,<*start point*>[,<*number of characters*>]) This function takes a part from a <*STRING expression*> and outputs it as text. The result can be transferred to a STRING variable or to an appropriately dimensioned character field. **MID$**(<*character field*>,<*start point*>[,<*number of characters*>]) Overwrites parts of a character field.	5–2
MMC	**MMC**(<CPL var1>[,<CPL var2>....[,<CPL varN>]....]) Sends information on the program run time from a part program to a client and waits for the result from this client.	9–1
MPOS	**MPOS**(<*axis selection*>[,<*axis type*>[,<*channel*>]]) Transfers the currently interpolated command position referred to the machine zero point of the machine coordinate system MCS.	4–14
MWD	**MWD**(<*X left*>,<*X right*>,<*Y bottom*>,<*Y top*>) Definition of a coordinate system for the current graphics window.	8–4
NCF	**NCF**(<*NC function*>) Transfers the syntax of the active NC function within the NC modal group of <*NC function*>.	4–30
NJUST	**NJUST** Premature resetting of left-justified data output to formatted output.	6–5
NOT	**NOT** <*expression*> Negation of a BOOLEAN or bit-by-bit negation of an INTEGER expression.	2–18
NUL	<*variable*>**=NUL** Deleting a variable	2–15
OPENR	**OPENR**(<*n*>,<*PGM name*>[,<*record length*>]) Opens a file for subsequent read-access.	6–3
OPENW	**OPENW**(<*n*>,<*PGM name*>[,<*length*>][,<*PGM remark*>][,<*record length*>]) Opens a file for subsequent write-access.	6–3

Command	Syntax / Short description	see page
OR	*<expression1>* **OR** *<expression2>* Binary operation of two BOOLEAN or INTEGER expressions with the OR function.	2–18
PDIM	**PDIM** *<parameter name>*(*<field size>*) If a sub-program • with a string constant as transfer parameter is to be invoked **and** • the invoking program is selected without linking the PDIM command must be used.	3–3
PLC	**PLC**(*<type>*,*<DM number>*,*<address>*,*<size>*) Access to PLC data.	4–41
PPOS	**PPOS**(*<axis selection>*[,*<axis type>*]) Requests the axis actual position in the switch point of the measuring probe.	4–15
PRN	**PRN**(*<line>*,*<column>*"[*<text>*]*<format>*[*<text>*]") Display of the dialog text and determination of the input format.	7–7
PRN#	**PRN#**(*<n>*,[*<expression>*][,*<expression>*][,*<expression>*][,...][;]) Write-access to a file with the logical number *<n>*.	6–5
PROBE	**PROBE**(*<axis selection>*[,*<axis type>*]) Requests the axis position in the switch point of the measuring probe. The value supplied refers to axis zero point coordinates of the machine coordinate system MSC.	4–16
REM	**REM** *<remark text>* Program commentary	2–25
REPEAT	**REPEAT** *<routine>* **UNTIL** *<condition>* Loop construction with query of abort condition after first execution of the routine.	2–21
REWRITE	**REWRITE**(*<n>*) Overwrites an existing file.	6–7
RGB	**RGB**(*<color code>*,*<R>*,*<G>*,*<B>*,) Programs colors in the third color table.	8–2
Round	*<INTEGER number>*=**ROUND**(*<REAL expression>*) Converts a REAL expression to an INTEGER number by rounding up or down.	2–17
SCL	**SCL**(*<selection>*[,*<axis selection>*[,*<selection type>*]]) Supplies for the current channel (here: channel in which the program with the SCL command is running) the parameters last programmed of the functions G37 and G38 (pole coordinates, scaling factors and rotation angles).	4–28
SCS	**SCS**(*<axis index>*,*<ID type>*,*<ID no.>*[,<Result var>]) Enables read-access to SERCOS drive parameters of the active parameter set.	4–30
SCSL	**SCSL**(*<axis index>*,*<ID type>*,*<ID no.>*,*<filename>*[,*<Result var>*]) Creating a file for SERCOS parameter lists.	4–31

Command	Syntax / Short description	see page
SD	**SD(**<*group*>[,<*index1*>[,<*index2*>[,<*index3*>]]]**)** Reads active system data of the NC control unit.	4–32
SDR	**SDR(**<*group*>[,<*index1*>[,<*index2*>]]**)** Reads active system data of the NC control unit in REAL format.	4–37
SEEK	**SEEK(**<*n*>,<*k*>[,<*o*>]**)** <*n*> = logical file number <*k*> = record <*o*> = record offset Positions the file pointer on the <*k*>th record of a random file or on the <*k*>th byte of a sequential file.	6–13
SFK	**SFK(**<*variable*>,[<*text1*>],..[<*text8*>]**)** Output of a softkey bar, and assignment of the softkey being depressed to the specified variable.	7–8
SIN	<*function value*>**=SIN(**<*input value*>**)** Application of sine function to <*input value*>.	2–17
SPOS	**SPOS(**<*axis selection*>**)** Transfers the current axis command value of a physical axis.	4–18
SQRT	<*function value*>**=SQRT(**<*input value*>**)** Application of square root function to <*input value*>.	2–17
STR$	**STR$(**[<*format string*>,]<*value*>**)** Converts the numerical expression <*value*> to a character string which can only be assigned to a character field. If <*format string*> is programmed, the string can be output formatted. <*value*> can be an INTEGER or REAL expression of simple and double precision.	5–6
TAN	<*function value*>**=TAN(**<*input value*>**)** Application of tangent function to <*input value*>.	2–17
TC	**TC(**<*selection*>[,<*group*>[,<*table*>[,<*unit*>]]]**)** Access to tool compensation data.	4–23
TDA	**TDA(**<*sector no.*>,<*place no.*>,<*field no.*>[,<*Tool tab no.*>]**)** If the internal tool database is configured in the NC read- or write-access to individual fields can be achieved by TDA.	4–25
TFO	**TFO(**<*font*>,<*size*>,<*cut*>,<*orientation*>**)** Modifies the font in the CPL dialog.	7–9
TIME	<*STRING variable*>**=TIME** TIME assigns the time in HH.MM.SS form to the <*STRING variable*>.	4–42
TRIM$	**TRIM$(**<*character string*>**)** **TRIM$(**<*character string*>**,"L")** **TRIM$(**<*character string*>**,"R")** When a character field range is assigned to a STRING variable or character field this command returns a character string without preceding (→ index L) or subsequent (→ index R) spaces. The TRIM$ function without index masks out both preceding and concluding spaces.	5–8

Command	Syntax / Short description	see page
TRUE	*<BOOLEAN variable>*=**TRUE** Truth value of a BOOLEAN variable.	2–13
VAL	**VAL(***<STRING expression>***)** Returns the numerical value for a <*STRING expression*>.	5–7
WAIT	**WAIT** [**(**[*<IC condition>*][,[*<duration>*][,*<Result var>*]])] Stops block processing until all blocks programmed ahead of WAIT are processed, or until a certain state occurs at the digital interface between NC and PLC and/or until a predefined period of time has lapsed.	4–1
WHILE	**WHILE** *<condition>* **DO** *<routine>* **END** Loop construction with query of abort condition before the first loop execution.	2–21
WPOS	**WPOS(***<axis selection>*[,*<selection type>*[,*<channel>*]]**)** Transfers the interpolated command (set) position referred to the workpiece zero point of the current WCS.	4–11
XOR	*<expression1>* **XOR** *<expression2>* Binary operation of two BOOLEAN or INTEGER expressions with EXCLUSIVE-OR function.	2–18

A.3 Differences regarding the CPL commands: Typ3 osa <–> CC200, CC220, CC300, CC320

This list includes the presently existing differences regarding the CPL command set of the Typ3 osa to the previous controls Typ1 osa, CC200, CC220, CC300, CC320.

A.3.A CPL commands and SD functions which are no longer applicable in the Typ3 osa

The following **CPL commands** are no longer applicable in the Typ3 osa in comparison to the above-mentioned previous controls:

Command	Remark
IC	Command is not compatible, as the interface assignment is different (see ICL700 project planning manual) Typ3 osa interface has been divided into the following groups: – channel, – axis and – spindle
TD, TDR	inapplicable, as Typ3 uses no KS tables
FIX, FIXB, FIXE	Complex graphics can be quickly called up in the Typ3 osa with the CPL command ”BMP” (Bit map)
OPENR(”TTY”), OPENW(”TTY”)	CPL access to serial standard interfaces is no longer possible
MIC	In the Typ3 osa the single word access to the NC interface is done with the CPL command ”PLC”
CLX	The CLX command when changing the background color is no longer programmed in the Typ3 osa, instead the COL command is used.
TXT$	No longer applicable, as the Typ3 osa uses no CPL text files.

The following **SD functions** (functions for system data) **are no longer applicable** in the Typ3 osa in comparison to the previous controls:

Command	Remark
SD(1,–,3)	Power-up condition of G functions
SD(2,2)	Setting of rapid traverse potentiometer (Typ3 osa uses no rapid traverse potentiometer)
SD(3)	Number of the last programmed or active tool compensation table*
SD(3)	Number of the last programmed or active zero shift table*
SD(6)	Last programmed help function
SD(7)	Active or programmed tool
SD(16)	Dry run to block with sub-program call: control of runs
SD(17)	Dry run to block with sub-program call: active G functions
SD(20)	Next available program number*
SD(21)	File status and access rights
SD(23)	Panel type: passive/PC control panel color/monochrome
SD(24)	Pointer to the active main and sub-program
SD(30)	Prevents setting G codes back to power-up condition
SD(31)	Direct processing: size, offset and level of utilization
SD(32)	Program selection from the program memory and PC control panel
SD(33)	Read in files from PC control panel
SD(34)	Load files into PC control panel
SD(2,5)	Position of the 5th potentiometer
SD(5,5,1),SD(5,5,2)	Active or programmed feed of the oscillating axis

The following **SD functions** (functions for system data) **are no longer applicable** in the Typ3 osa in comparison to the previous controls ”Typ1 osa/ CC220 Center”:

Command	Remark
SD(101–104)	Compensation of the workpiece position (rotating and mirroring via SD function)
SD(105)	Sub-program call with simple auxiliary functions: number of auxiliary functions
SD(110)	External tool compensations: entering the tool number for the display
SD(111)	Upper speed limit for spindles

The following **SD functions** (functions for system data) **are no longer applicable** in the Typ3 osa in comparison to the previous controls ”Typ1 osa/ CC220 Lathe”:

Command	Remark
SD(140–142)	Piece counter
SD(143,144)	Transmission ratio of the motorized tool
SD(145)	Programmed and rated speed of the motorized tool
SD(146)	Minimum permitted distance to the axis of rotation
SD(147)	Maximum tool length

The following **SDR functions are no longer applicable** in the Typ3 osa in comparison to the previous controls:

Command	Remark
SDR(4)	Active zero shift values
SDR(5)	Active speeds and revolutions
SDR(12)	Spindle position with M19

*) Typ3 osa uses file names instead of file numbers.

A.3.B CPL commands and SD functions which have been changed in the Typ3 osa

The following **CPL commands** have been **changed** in the Typ3 osa in comparison to the previous controls:

Command	Remark
IC	Command is not compatible, as the interface assignment is different (see ICL700 project planning manual) Typ3 osa interface has been divided into the following groups: – channel, – axis and – spindle
COL	The meaning of parameters 3, 4 and 5 of the COL command have been changed. The color setting ”blinking” no longer exists.
SFK	The SFK command has been extended to 8 softkeys.
REM	No further CPL block may follow a ”REM” remark: 10 REM, this is a comment: DSP(z%,S%,FA$,FB$,A,B,C)

The following **SD functions** (functions for system data) **have been changed** in the Typ3 osa in comparison to the previous controls:

Command	Remark
SD(8)	Typ1osa: last main program number called Typ3osa: channel number of the invoking channel
SD(14)	Typ1osa: active foreign language (file order in the customer EPROM) Typ3osa: Active foreign language (corresponds to the country code F=33, GB=44, etc.)
SD(22)	Typ1osa: reading access to the machine parameter for customer software; (P4017) is no longer applicable. Typ3osa: Access via the CPL command ”MCA” to the customer specific MACODA group 50 ”applications”.

A.3.C Other CPL changes in the Typ3 osa

The following **functions** have been changed in the Typ3 osa in comparison to the previous controls:

Command	Remark
Control panel	The graphic window of the Typ3 osa is larger than that of the Typ1 osa: Horizontally: 79 columns (text) or 633 pixels (graphics) Vertically: 46 lines (text) or 415 pixels (graphics) See chapter 8.8 8 softkeys (see page 7–8)
Key codes	By using the CPL command ”INP” the keys can be queried. As the control panel has been changed, so have some keycodes been changed. (See Annex A.6 ”Additional keycodes”
(TYP2)	Those CPL dialog programs marked ”(TYP2)” are executed as “Typ2”-compatible in Typ3 osa. Only the first 5 softkeys are used and the dialog uses only the smaller graphic section of the previous controls. (See chapter 7 ”Dialog programming”)
MP 4017	The machine parameter block P4017 ”Machine parameters for customer software” no longer exists in the Typ3 osa. MP 4017 has been replaced by the MACODA group 50 ”applications” (5010 00001 and 5010 00002) for configuring CPL programs and PLC modules.

A.4 MACODA parameters (list of changes)

Beginning with the software version V5.1.x the MACODA parameters have received **other** numbers. This list shows the change from old to new MACODA numbers:

old MACODA no. (up to and including V4.x.x)	new MACODA no. (V5.1.x and up)
1001 0000 1	1003 0000 1
1001 0000 2	1003 0000 2
1001 0000 3	1001 0000 1
1001 0000 4	1003 0000 4
1001 0000 5	1003 0000 5
1001 0000 6	1050 0000 1
1001 0000 7	7010 0003 0
1001 0000 8	obs.
1001 0000 9	1003 0000 9
1001 0001 0	1003 0001 0
1001 0001 1	1003 0001 1
1001 0001 2	1003 0001 2
1001 0002 0	1003 0002 0
1001 0005 0	1003 0005 0
1001 0005 1	obs.
1001 0005 5	1003 0005 5
1001 0005 6	1003 0005 6
1001 0005 7	1003 0005 7
1001 0006 0	1003 0006 0
1001 0006 1	1003 0000 8
1001 0010 0	1003 0010 0
1001 0100 1	obs.
1001 0100 2	6020 0001 1
1001 0100 3	6020 0001 2
1010 0000 3	1010 0001 1
1010 0000 4	1010 0001 2
1010 0000 6	1010 0000 1
1010 0000 9	1010 0000 2
1015 0000 1	1015 0000 2
1015 0000 6	1015 0010 0
1015 0000 7	1015 0000 1
1030 0000 4	7030 0001 0
1030 0000 5	7030 0031 0
1030 0000 8	7030 0021 0
1030 0000 9	7030 0022 0
1030 0001 0	7030 0011 0
1030 0010 1	7040 0011 0
1030 0030 1	7050 00110
1030 0030 2	7050 0012 0
1030 0030 3	7050 0013 0
1030 0020 1	7020 0001 0
1030 0020 2	7010 0011 0
1040 0001 1	1050 0000 3
1040 0001 2	1050 0000 4

old MACODA no. (up to and including V4.x.x)	new MACODA no. (V5.1.x and up)
1050 0000 1 1050 0000 6 1050 0008 9 1050 0010 0 1050 0010 1 1050 0100 0 1050 0100 1	9030 0000 1 1050 0001 1 1050 0001 2 1050 0003 1 1050 0003 2 1050 0000 2 1050 0002 1
1061 0000 2 1061 0000 3 1061 0000 4 1061 0000 5	1020 0000 1 1020 0000 2 1020 0000 3 1020 0000 4
1070 0000 2 1070 0000 3 1070 0000 4 1070 0000 9 1070 0002 0 1070 0002 1 1070 0001 1 1070 0001 8 1070 0010 1 1070 0090 1	1040 0001 0[1] 1040 0001 1[1] 1040 0001 2[1] 1040 0001 5[1] 1040 0002 0[1] 1040 0002 1[1] 1040 0003 1[1] 1040 0004 1[1] 9020 0011 0 1040 0000 3
1080 0000 2 1080 0000 3 1080 0000 4 1080 0000 9 1080 0002 0 1080 0002 1 1080 0001 1 1080 0001 8	1040 0001 0[2] 1040 0001 1[2] 1040 0001 2[2] 1040 0001 5[2] 1040 0002 0[2] 1040 0002 1[2] 1040 0003 1[2] 1040 0004 1[2]
2060 0000 1 2060 0001 0	obs. obs.
3030 0000 1 3030 0000 2	7060 0002 0 7060 0001 0
3080 0000 3 3080 0010 0 3080 0010 1 3080 0010 2	7070 0001 0 7060 0031 0 7060 0032 0 7060 0033 0
9020 0000 5 9020 0000 6	obs. obs.
9098 0000 1 9098 0000 2 9098 0000 3 9098 0000 4 9098 0000 9 9098 0001 0 9098 0001 1 9098 0001 2 9098 0001 6 9098 0002 0 9098 0002 4 9098 0003 0 9098 0004 0	9050 0000 1 9040 0000 1 7060 0011 0 9040 0010 4 7060 0021 0 7050 0001 0 7050 0002 0 7050 0003 0 7040 0001 0 7040 0002 0 8004 0000 1 9020 0001 0 7050 0031 0

A.5 ASCII character set

Dec.	Hex	ASCII	Dec.	Hex	ASCII	Dec.	Hex	ASCII	Dec.	Hex	ASCII
0	00	NUL	32	20	SP	64	40	@	96	60	‘
1	01	SOH	33	21	!	65	41	A	97	61	a
2	02	STX	34	22	”	66	42	B	98	62	b
3	03	ETX	35	23	#	67	43	C	99	63	c
4	04	EOT	36	24	$	68	44	D	100	64	d
5	05	ENQ	37	25	%	69	45	E	101	65	e
6	06	ACK	38	26	&	70	46	F	102	66	f
7	07	BEL	39	27	’	71	47	G	103	67	g
8	08	BS	40	28	(	72	48	H	104	68	h
9	09	HT	41	29	)	73	49	I	105	69	i
10	0A	LF	42	2A	*	74	4A	J	106	6A	j
11	0B	VT	43	2B	+	75	4B	K	107	6B	k
12	0C	FF	44	2C	,	76	4C	L	108	6C	l
13	0D	CR	45	2D	−	77	4D	M	109	6D	m
14	0E	SO	46	2E	.	78	4E	N	110	6E	n
15	0F	SI	47	2F	/	79	4F	O	111	6F	o
16	10	DLE	48	30	0	80	50	P	112	70	p
17	11	DC1	49	31	1	81	51	Q	113	71	q
18	12	DC2	50	32	2	82	52	R	114	72	r
19	13	DC3	51	33	3	83	53	S	115	73	s
20	14	DC4	52	34	4	84	54	T	116	74	t
21	15	NAK	53	35	5	85	55	U	117	75	u
22	16	SYN	54	36	6	86	56	V	118	76	v
23	17	ETB	55	37	7	87	57	W	119	77	w
24	18	CAN	56	38	8	88	58	X	120	78	x
25	19	EM	57	39	9	89	59	Y	121	79	y
26	1A	SUB	58	3A	:	90	5A	Z	122	7A	z
27	1B	ESC	59	3B	;	91	5B	[	123	7B	{
28	1C	FS	60	3C	<	92	5C	\	124	7C	I
29	1D	GS	61	3D	=	93	5D	]	125	7D	}
30	1E	RS	62	3E	>	94	5E	↑ (^)	126	7E	~
31	1F	US	63	3F	?	95	5F	→(_)	127	7F	DEL

: Characters that are skipped by default when reading-in data

A.6 Additional keycodes

Keycodes (Dec.)	Meaning
134	CURSOR UP
135	CURSOR DOWN
136	CURSOR RIGHT
137	CURSOR LEFT
139	LEVEL RETURN
141	SOFTKEY 1
142	SOFTKEY 2
143	SOFTKEY 3
144	SOFTKEY 4
145	SOFTKEY 5
146	SOFTKEY 6
147	SOFTKEY 7
148	SOFTKEY 8

A.7 Index

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