

kernel

läuft 16:45:50

NC-Programm my1.nc
Nullp.-Liste nullp_d1.lis
Werkz.-Liste werkz_d1.lis
Platzv.-Liste pzv_d1.lis

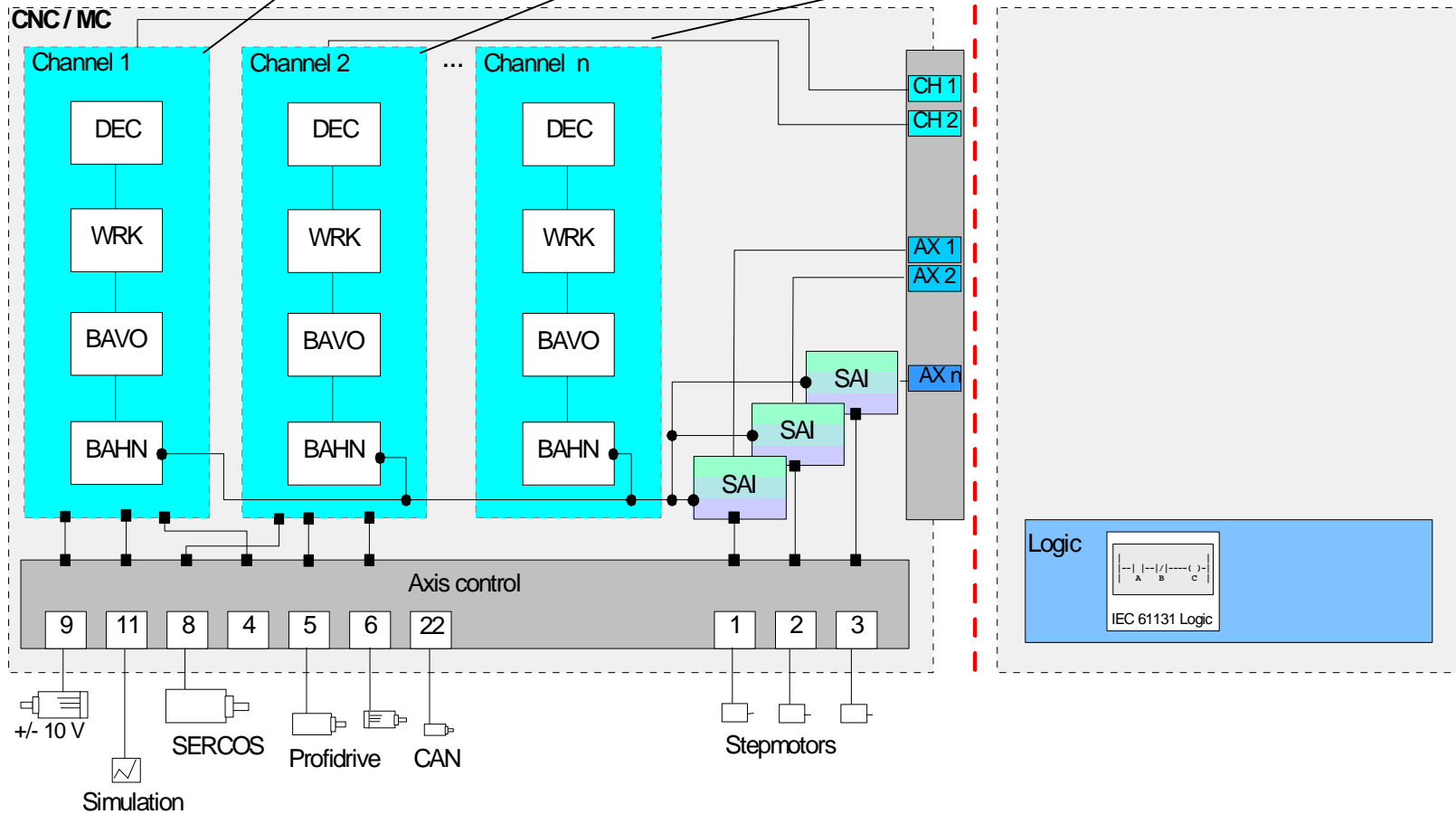
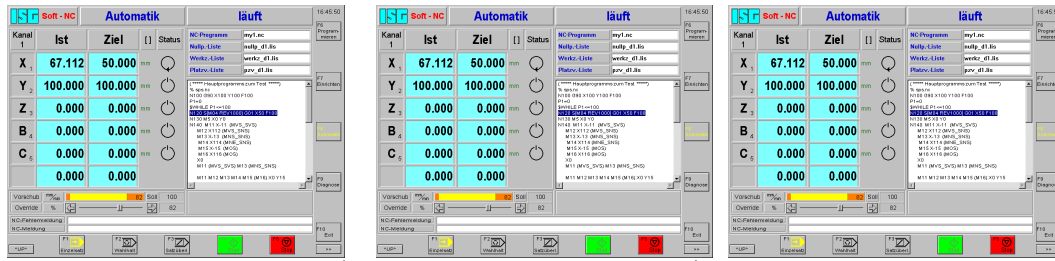
```
( ***** Hauptprogramms zum Test ***** )  
% sps.nc  
N100 G90 X100 Y100 F100  
P1=0  
$WHILE P1 <= 100  
N120 S[M04 REV1000] G01 X50 F100  
N130 M5 X0 Y0  
N140 M11 X-11 (MVS_SVS)  
M12 X112 (MVS_SNS)  
M13 X-13 (MNS_SNS)  
M14 X114 (MNE_SNS)  
M15 X-15 (MOS)  
M16 X116 (MOS)  
X0  
M11 (MVS_SVS) M13 (MNS_SNS)  
  
M11 M12 M13 M14 M15 (M16) X0 Y15
```

Vorschub mm/min
Override %
NC-Fehlermeldung
NC-Meldung

F1 Einzelsatz F2 Wahlhalt F3 Satzüberl. F4 Start F5 Stop F6 Programmieren F7 Einrichten F8 Automatik F9 Diagnose F10 Exit

CNC Functions





1	Machining Technologies	ISG
1.1	Turning	√
1.2	Milling	√
1.3	Drilling	√
1.4	Grinding	√
1.5	Handling	√
1.6	Special machines	√

The tables show the system limits respectively the values currently permitted by ISG. If there are general statements as CPU or memory, the settings can be altered based upon application specific demand or product definitions.

2	Axes Control	
2.1	Max. number of axes	CPU, memory
2.2	Standard number of axes	32
2.3	Max. number of axes / spindles per channel	32
2.4	Number of independent channels	CPU, memory
2.5	Max. number of interpolated axes per channel	32
2.6	Max. number of controlled spindles per channel	CPU, memory
2.7	Maximum number of independent axes in channel	32
2.8	SPS controlled spindles per channel	CPU, memory
2.9	Axes designations in channel	String beginning with X,Y,Z,U,V,W,Q,A,B,C
2.10	Max. number of synchronous spindles per channel	
2.11	Number of axis coupling groups	Memory
2.12	No. of progr. axes pairs inside coupling group	Memory
2.13	Maximum number of Gantry-couplings	Memory
2.14	Maximum number of axes inside a Gantry-coupling	Memory
2.15	Progr. movement area limit (Software limit switch)	Yes
2.16	Axes exchanges between channels	CPU, memory

2.17	Programming precision	0,0001 mm
2.18	Resolution of measurement signals	0,0001 mm
2.19	Smallest programmable Increment	0,0001 mm
2.20	Multi positioning systems	
2.21	Switch of programming unit: inch / metric	G70/G71
2.22	Backlash compensation	√
2.23	Axis compensation, direction dependent (double sided)	Memory
2.24	Cross compensation, Overhang compensation	1 axis, memory
2.25	Axis homing with limit switch and zero impulse	√
2.26	Velocity feed forward	√
2.27	Acceleration feed forward	√
2.28	Measurement	√
2.29	Axes positions to PLC	√
2.30	Axis filters with parameters	√

3	Interpolator Functions	
3.1	Smallest interpolation value	0,0001 mm
3.2	Rapid traverse	G0
3.3	Linear interpolation	G1
3.4	Exact stop	G60
3.5	Circular interpolation	G2/G3
3.6	Center point programming absolute / incremental	G161/G162
3.7	Radius programming	√
3.8	Helical interpolation	G2/G3
3.9	Feed forward / position lag free movement	G135/G137
3.10	Percentage weighting of feed forward	G136
3.11	Dwell time	G4
3.12	Face surface machining	#FACE ON/OFF
3.13	Cylinder surface machining	#CYL ON/OFF
3.14	Thread cutting	G33
3.15	Multiple threads	G33
3.16	Tapping	G63
3.17	Tapping without compensation chuck	G63
3.18	Axis clamping	√
3.19	NC-blocks in Look Ahead	70
3.20	Interpolation cycle time configurable	1 to 20 ms
3.21	Spline interpolation	AKIMA/BSPLINE
3.22	NC block specific parameters of acceleration profile	#SLOPE PROFIL

4	Feed Functions	ISG
4.1	Rapid traverse velocity	0,000001 - 3000 m/min
4.2	Rapid traverse override	0
4.3	Feed	0,000001 - 3000 m/min
4.4	Revs	0,00017 – 715828 U/min
4.5	Manual mode rapid traverse	0 - 3000 m/min
4.6	Manual mode feed	0 - 3000 m/min
4.7	Axis specific override	√
4.8	Feed rate per minute	G94
4.9	Rotational feed	G95
4.10	Programming of machining time	G93
4.11	Block transition behaviour	G8/G9
4.12	Feed hold	√
4.13	Acceleration ramp for rapid traverse	√
4.14	Weighting factors for acceleration ramp	G132/G133
4.15	Constant cutting speed	G96
4.16	Feed adaptation with active tool radius compensation	G10/G11
4.17	Active federate by plc	√
4.18	Reduced speed by plc-signal	√

5	5-Axis Functions	ISG
5.1	RTCP (rotation tool center point)	#RTCP ON/OFF
5.2	TLC (tool length compensation)	#TLC ON/OFF
5.3	Tool orientation to (A)CS	#TOOL ORI CS
5.4	Selection of kinematics	#KIN ID
5.5	Definition of work piece coordinate system	#CS ON/OFF
5.6	Definition of fixture adaptive coordinate system	#ACS ON/OFF
5.7	Chaining of coordinate systems	Memory
5.8	Effector coordinate system	#ECS ON/OFF
5.9	Temporary transition to machine axes coordinate system	#MCS ON/OFF
5.10	Kinematics library	√
5.11	Manual mode in work piece coordinate system	√

6.1	Skip block	/
6.2	Number of NC-programs	Load from von HD / network
6.3	Arbitrary block numbering	√
6.4	Radius/diameter programming	G51/G52
6.5	Interpolation planes	G17/G18/G19
6.6	Free plane selection	G20
6.7	Rotary axis mode	√
6.8	Endless moving rotary axis	√
6.9	Free definable machine coordinate system	G53
6.10	Work piece coordinate system per channel	#CS ON
6.11	Work piece origins per channel	G54 – G59
6.12	Extended work piece origins	Memory
6.13	Rotation of coordinate system	√
6.14	Clamp position offset	√
6.15	Preset	#PSET/#PRESET
6.16	Additional offset	G92
6.17	Number of additive coordinate systems	5
6.18	Insertion of chamfer and radii	G301/G302
6.19	Number of P-parameters per channel	Memory
6.20	Dimensions of parameter arrays	Memory

6.21	Global variables V.P (program local)	Memory
6.22	Global variables V.S (static)	Memory
6.23	Local variables V.L (sub program local)	Memory
6.24	Number of subprogram levels	Memory
6.25	Number of user macros per channel	Memory
6.26	Mirroring	G21/G22/G23/G24
6.27	Absolute / incremental	G90/G91
6.28	Process time calculation	√
6.29	Mathematical functions	+, -, *, /, **, MOD, ABS, SQR, SQRT, EXP, LN, DEXP, &, , ^, INV, LN, ==, !=, >=, <=, <, TRUE, FALSE, SIN, COS, TAN, ASIN, ACOS, ATAN, LOG, INT, FRACT, ROUND
6.30	Time measurement	#TIMER
6.31	Control blocks	BREAK, CONTINUE, DO, FOR, GOTO, IF; ELSE; ENDIF, SWITCH, CASE, DEFAULT, ENDSWITCH, WHILE, ENDWHILE
6.32	Programming of axis designations	√
6.33	Messages from the NC program	#MSG
6.34	Inter-channel synchronization with parameter passing	#SIGNAL/WAIT
6.35	Fixture adaptive CS	#ACS ON/OFF

6.36	Definition and activation of a work piece coordinate system	#CS ON/OFF
6.37	User macros: Max. string length of macro name	30
6.38	User macros: Max. string length of NC-code	70
6.39	Overwrite of user macros	√
6.40	Nesting levels of user macros	14
6.41	Number of expression labels	20
6.42	Number of string labels	20
6.43	Max. length of string labels	15
6.44	Only „P“ for parameters	√
6.45	Max. number of signal parameters during inter channel synchronization	10

7	Operate	ISG
7.1	MDI-mode per channel	√
7.2	Block search	√
7.3	Axis homing	√
7.4	Single step mode	√
7.5	Manual mode	√
7.6	Absolute position detection	√
7.7	Reference point offset	√
7.8	Hand wheel superimposition per channel	√
7.9	Hand wheel superimposition per axis	√
7.10	Hand wheel sensitivity	√
7.11	Hand wheel interruption	√
7.12	Jog mode	√
7.13	Tipp mode	√
7.14	Programmable stop	M0
7.15	Optional stop	M1

8	Spindle and Auxiliary Functions	ISG
8.1	Configurable M-functions per channel	Memory
8.2	Configurable H-functions per channel	Memory
8.3	Maximum number of M-/H-functions per NC-block	15
8.4	Constant cutting speed per channel	√
8.5	Tool specific rev limit per spindle	√
8.6	Tool specific acceleration limit per spindle	√
8.7	Spindle synchronization	√
8.8	Multi spindle control	Memory
8.9	Spindle interpolation (C-axis)	√
8.10	Block global synchronization of M-H-functions on NC-command	√
8.11	Block global synchronization of M-H-functions on G1	√
8.12	Automatic determination of gear step	√

9	Tool Functions	ISG
9.1	Number of internal tool places per channel	Memory
9.2	Connection to external tool management	√
9.3	Tool number	T0 to T2000000000
9.4	Sister tool and variants	√
9.5	Service live calculation	√
9.6	Programmable tool data	√
9.7	Fee tool specific parameters	Memory
9.8	Tool specific minimal- and maximum revs	√
9.9	Tool specific acceleration	√
9.10	Tool specific kinematics	√
9.11	Tool offsets in all axes	√
9.12	Tool specific kinematics parameters	√
9.13	Tool length correction	D
9.14	Tool radius correction	G40/G41/G42
9.15	Transition elements chamfer / radius	√
9.16	Direct and indirect tool select	√
9.17	Cutting edge radius compensation	√
9.18	Number of sister tools and variants	3

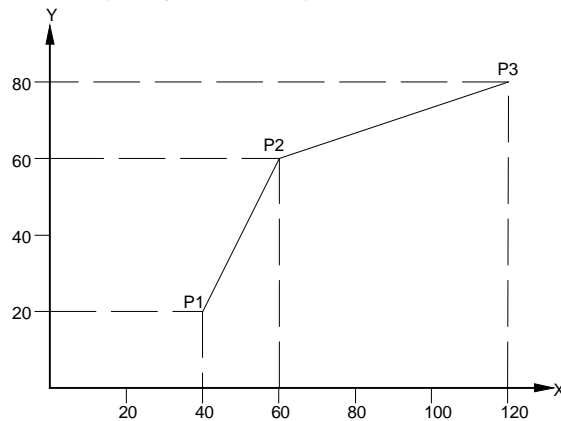
- Language elements according to DIN 66025 syntax and extensions
(G-functions, very comprehensive parameter calculations, M/H/T-functions, local und global subroutines, control structures und loops ...)
- Special #-functions, s.c. clear text commands
(e.g. axes exchange, messages, spline interpolation, slope, channel synchronization ...)

Arithmetical standard operations (close to “C” programming language):

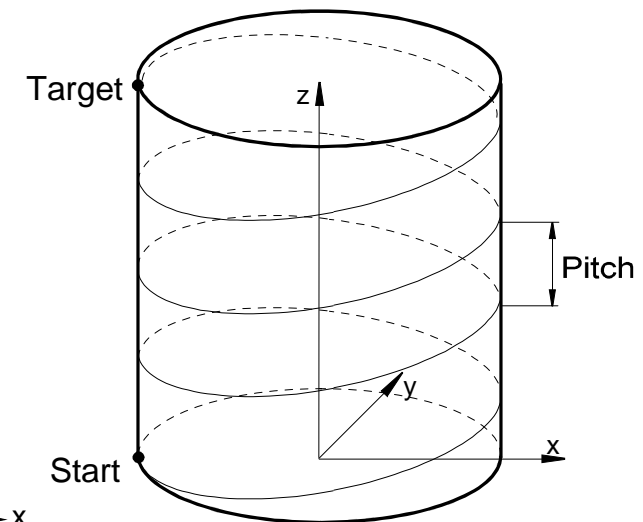
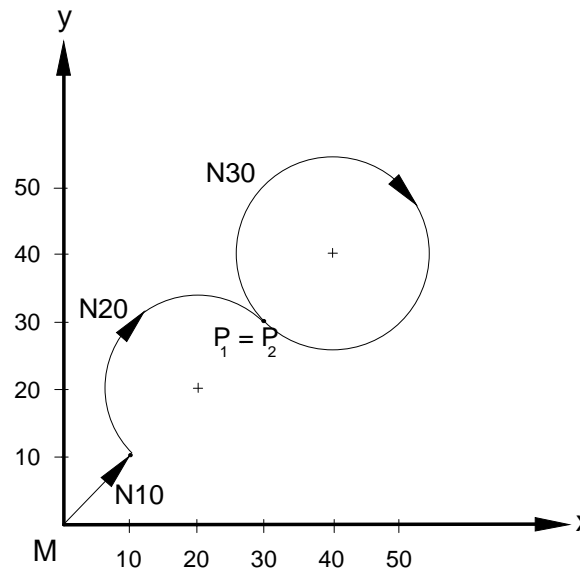
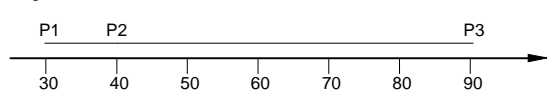
- + , - , * , / , ** , MOD ,
- ABS, SQR, SQRT, EXP, LN, DEXP, LOG,
- &, |, ^, INV[...], AND resp. &&, OR resp. ||
- ==, !=, >=, <=, >, <
- SIN, COS, TAN, ASIN, ACOS, ATAN
- INT, FRACT, ROUND

- **G00** Linear interpolation in rapid traverse
- **G01** Linear interpolation with programmed feed rate
- **G02/G03** Circular interpolation
- **G02/G03-K** Helical interpolation

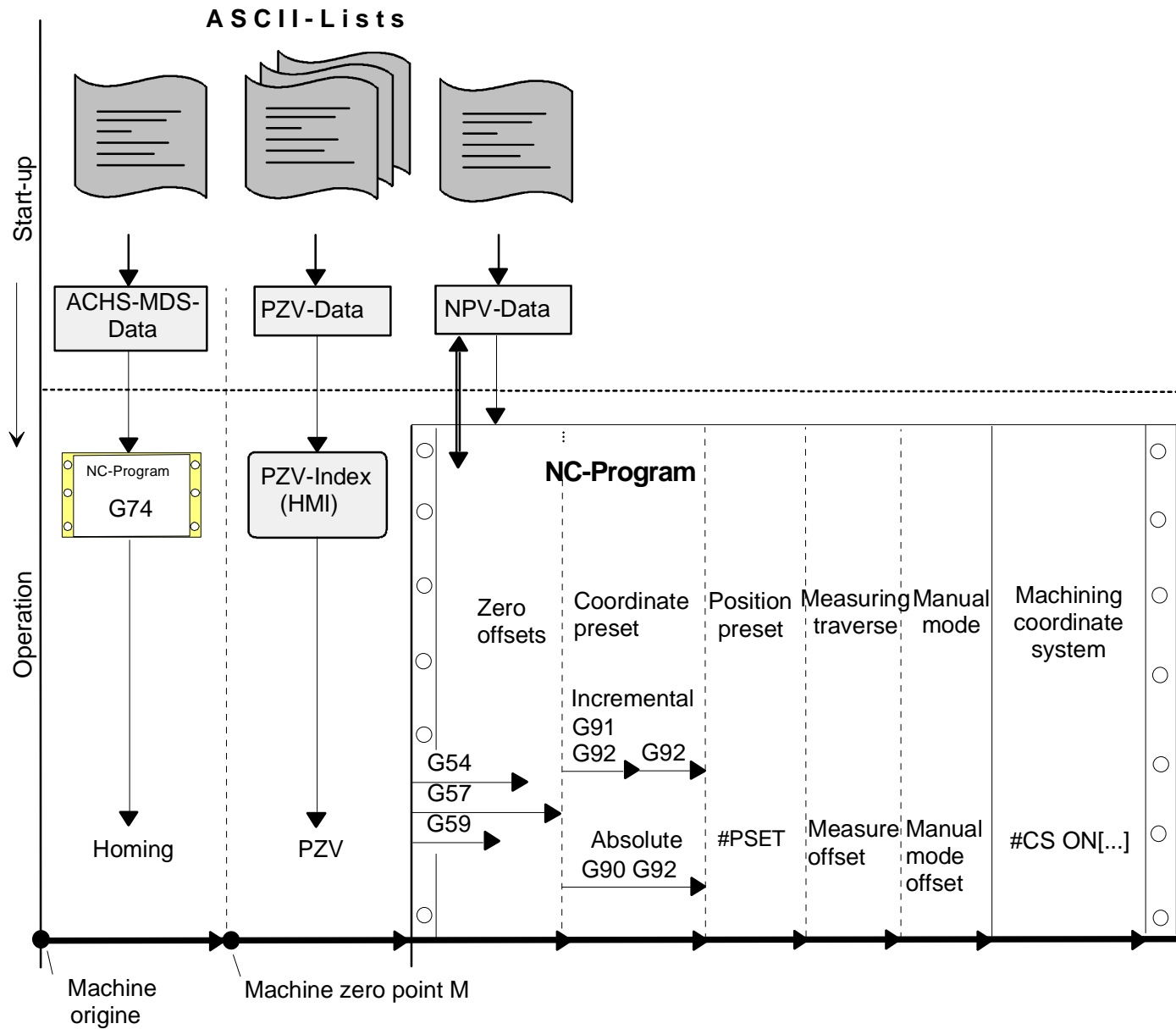
Main axes: (here only X and Y are shown)



Drag axis U:



V2 © ISG 2009



- **G70/G71 Units**
 - G70 Inch data input
 - G71 Metric data input (Default)

- **G90/G91 Dimensions**
 - G90 Absolute dimensioning
 - G91 Relative dimensioning

- **G74** Execute homing

- **Sequential**

- N10 G74 X3 Z1 Y4

- Sequence of homing procedure: Z-X-Y

- **Parallel**

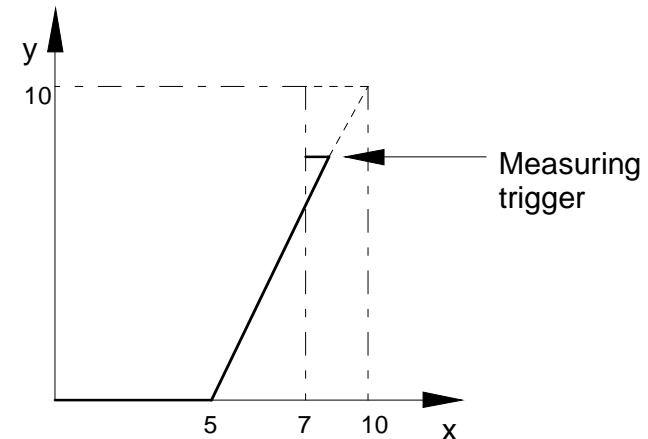
- N10 G74 X3 Z3 Y3

- Homing of all axes starts at the same time

- **G100** Measuring with multiple axes (Type 1)

```

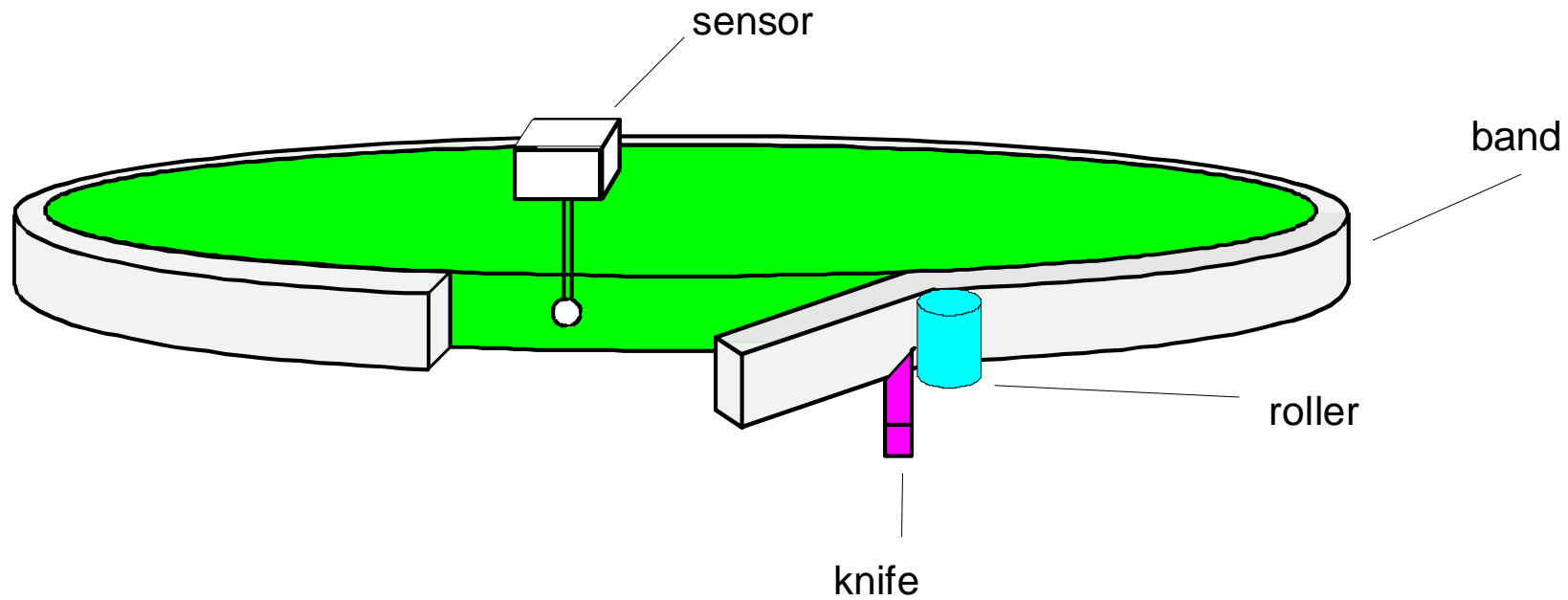
%Measuring
N10 G00    X0    Y0    Z0
N20 X5
N30 G100  X10    Y10    F500
N40 G01    X7
N50 M30
  
```



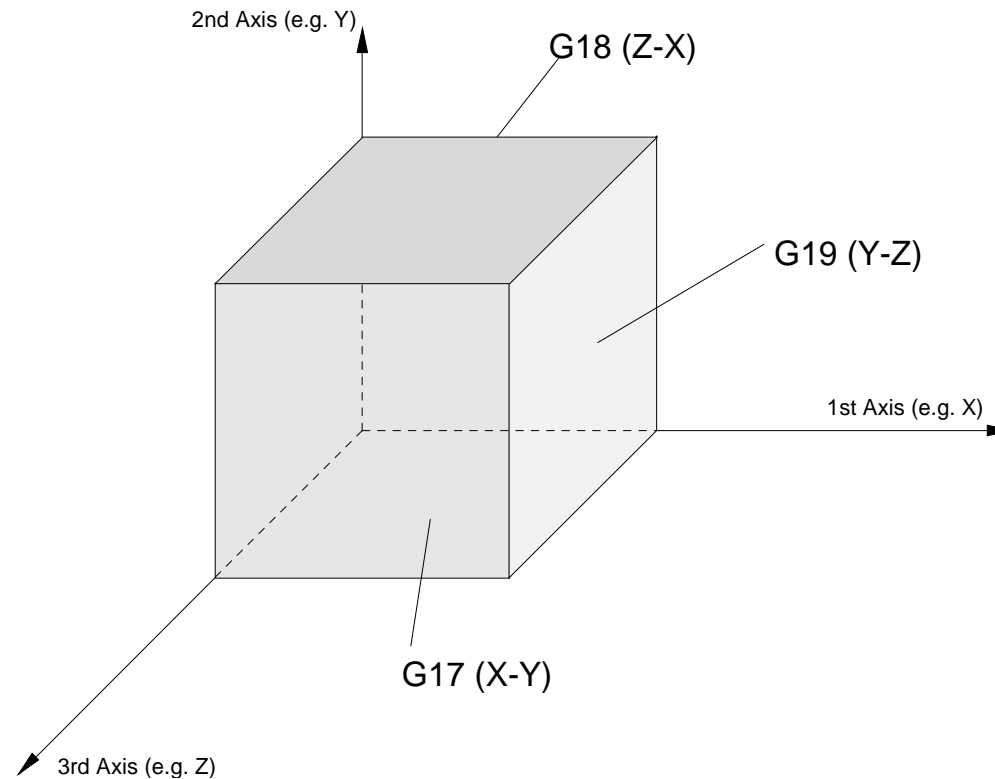
Additional measuring types:

- Measurement with a single axis (Type 2)
 - Measurement with movement to target point (G106, Type 3)
 - Measurement with main axis (Type 4)
 - Measurement with interruption and jump (G310, Type 5,6)
- Computation of measuring offsets (G101/G102)

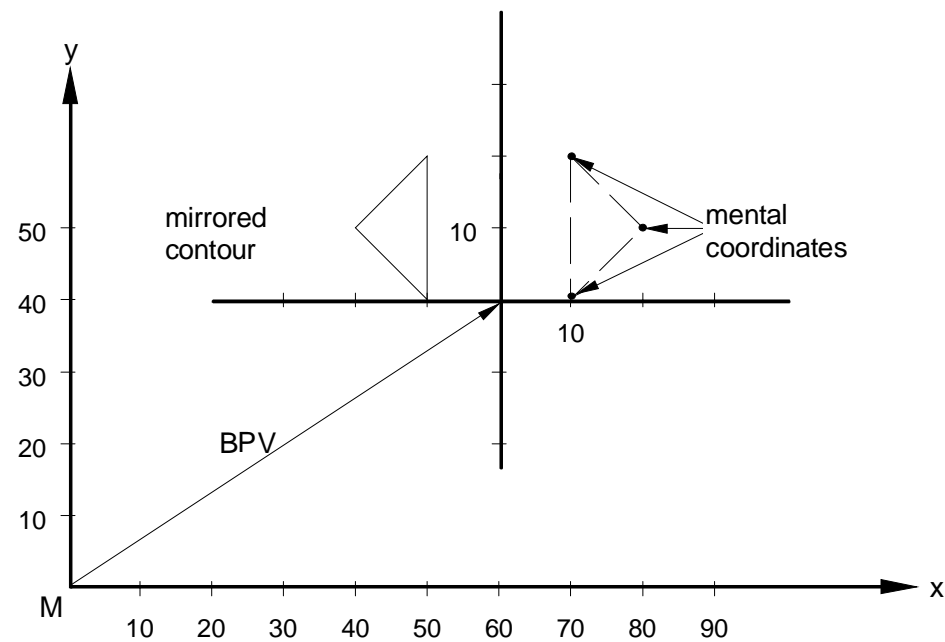
- Edge bending
 - **G108** in one motion block
 - **G108/G107** over multiple motion blocks



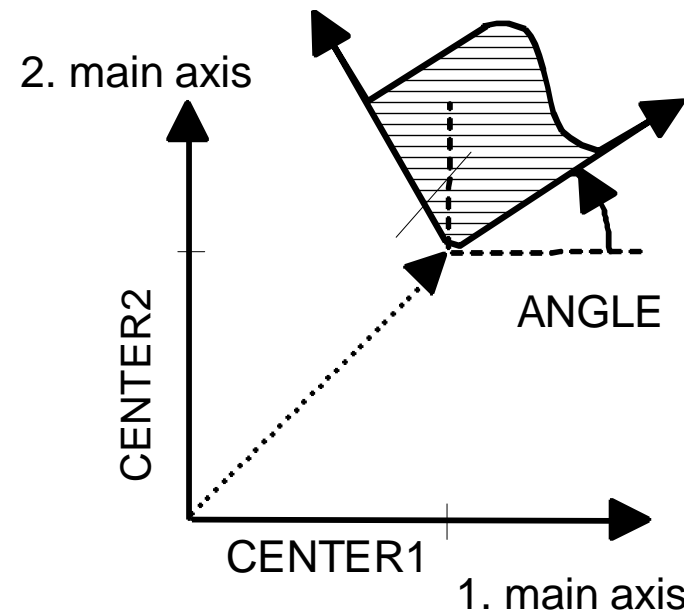
- **G17** X-Y-plane (modal, default)
- **G18** Z-X-plane
- **G19** Y-Z-plane
- **G20** Free plane selection



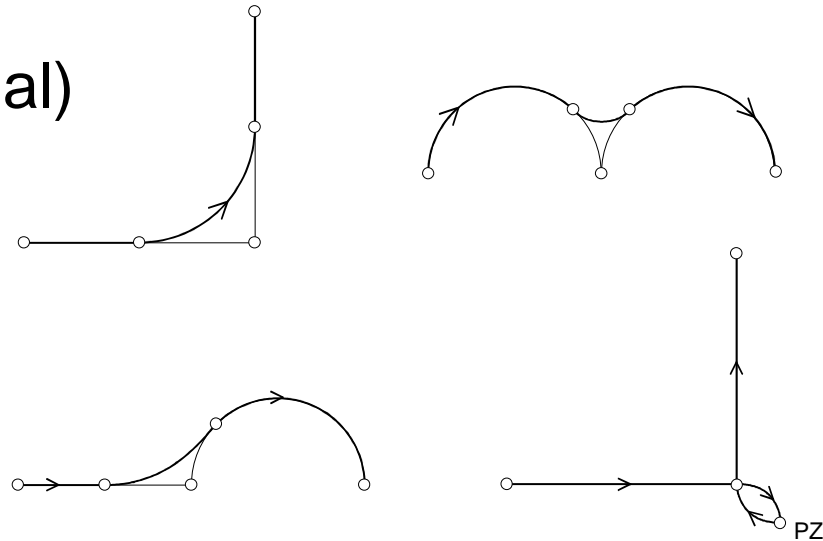
- Mirroring functions (e.g. X-Y-plane)
 - **G21** Mirroring on Y-Axis
 - **G22** Mirroring on X-Axis
 - **G23** Super-imposing G21/G22
 - **G24** De-selection of mirroring



- Contour rotation
 - **#ROTATION ON [ANGLE CENTER1 CENTER2]**
 - **#ROTATION OFF**
- Works in main plane before all other contour manipulation functions



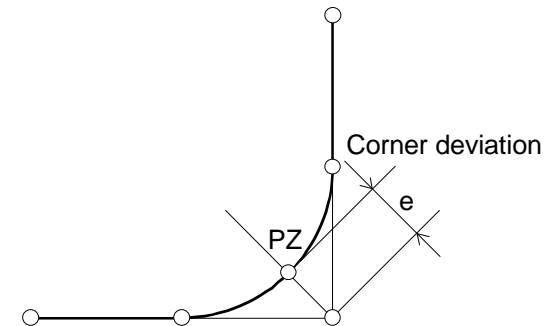
- Polynomial contouring
 - **G61** Selection (non-modal)
 - **G261** Selection (modal)
 - **G260** De-selection (modal)



- Different modes

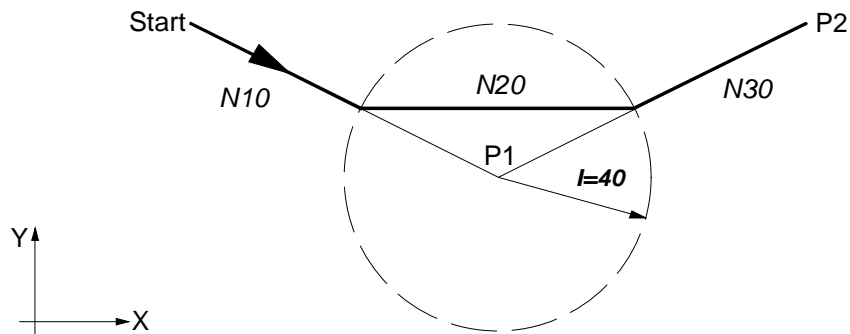
#SET UEBERSCH PARAM [...]

- Automatic contouring
- Corner distance contouring
- Corner deviation contouring
- Interim point contouring

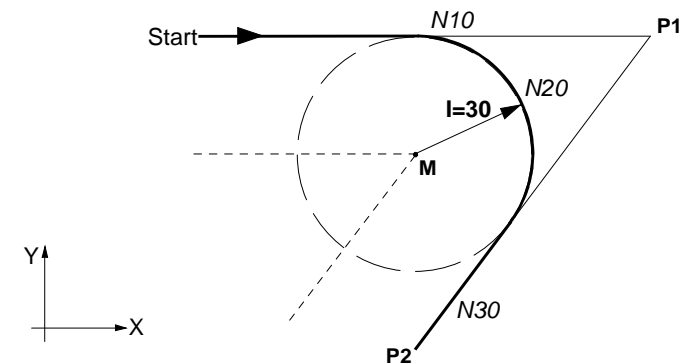


- Both functions work once in between two motion blocks
 - **G301** Inserting of chamfers
 - **G302** Insertion of roundings

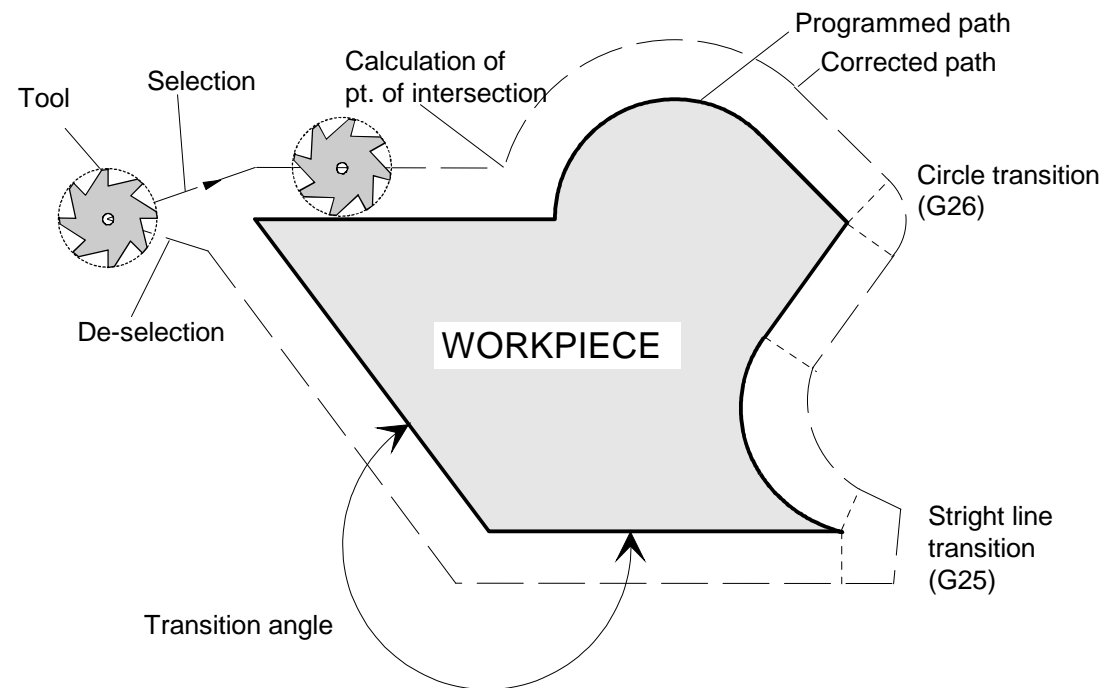
```
N10 G91 G01 X80 Y-40 F100 (P1)
N20 G301 I40
N30 G01 X80 Y40 (P2)
```



```
N10 G91 G01 F100 X60 (P1)
N20 G302 I30
N30 X-40 Y-55 (P2)
```



- Tool radius compensation works on plane selected with **G17**, **G18** or **G19**



Overview of all relevant G-functions for TRC

- **G40** De-selection of TRC (modal, default)
- **G41** Selection of TRC left of contour (modal)
- **G42** Selection of TRC right of contour (modal)

- **G138** Direct Selection/De-selection of TRC (modal)
- **G139** Indirect Selection/De-selection of TRC (modal, default)
- **G05** Tangential Selection/De-selection of TRC (non-modal)

- **G25** Linear transition for TRC (modal, default)
- **G26** Circular transition for TRC (modal)

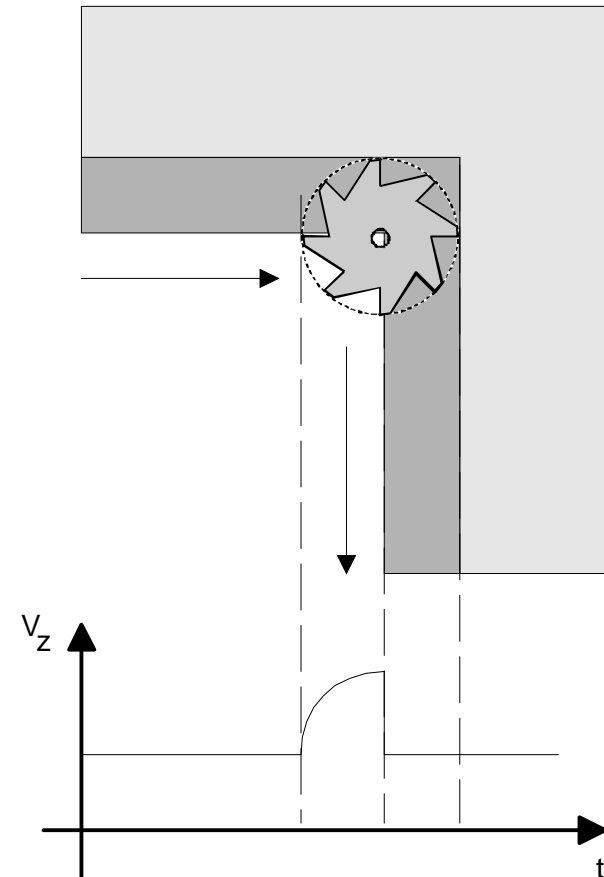
- **G10** Feed rate constant (modal, default)
- **G11** Feed rate adapted (modal)

- **G140** De-selection of contour masking (modal, default)
- **G141** Selection of contour masking (modal)

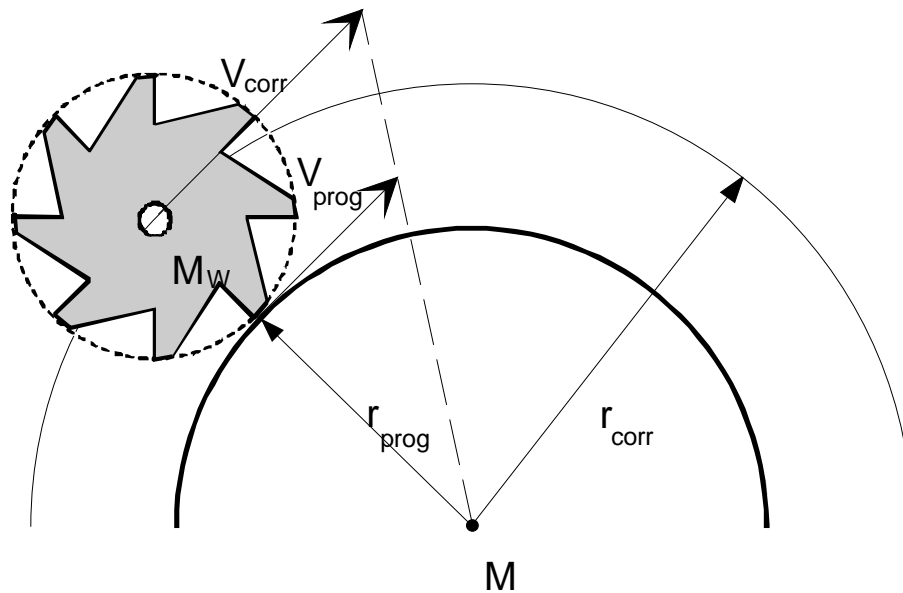
- Corner feed rate reduction

Keeping the performance limit of the spindle by feed rate reduction in the corner area

- **#SET CORNER PARAM**
- **G12/G13**



- TRC feed rate adaptation
– **G10/G11**



$$V_{corr} = \frac{r_{corr}}{r_{prog}} \times V_{prog}$$

M_W : Tool center point

r_{prog} : Programmed radius

r_{corr} : Corrected radius

V_{prog} : Programmed velocity

V_{corr} : Corrected velocity

Change the meaning of the F-word

- **G93** F-word for specifying machining time
- **G94** F-word for specifying the feed rate
mm/min (Linear axes)
°/min (Rotary axes)
- **G95** Feed rate in millimetre per revolution (turning)

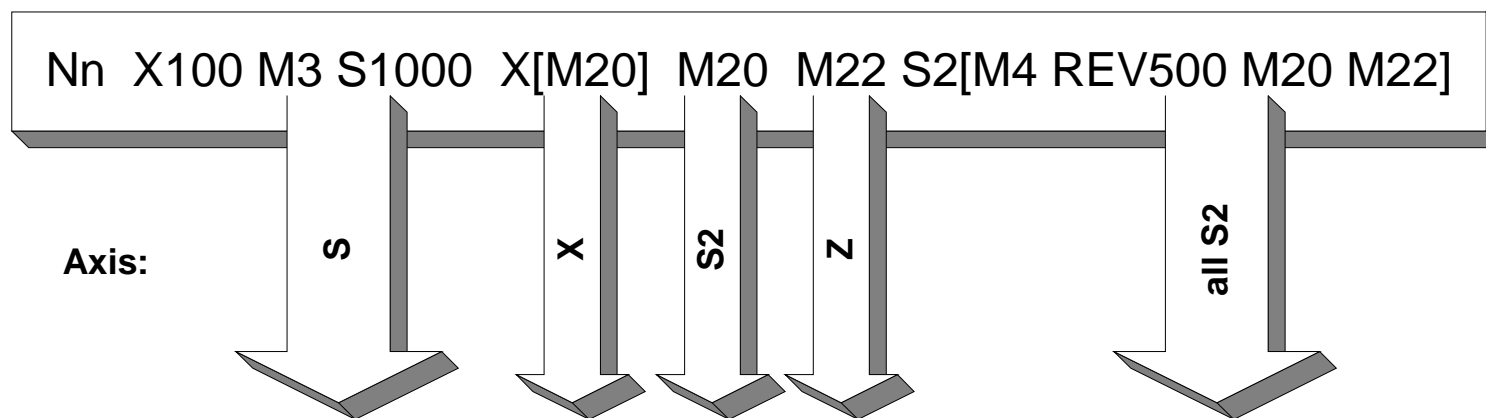
- The following M-functions are carried out by the NC-kernel itself
 - **M00** Programmed stop
 - **M01** Optional stop
 - **M02** End of program, stop machine
 - **M10, M11** Clamping of axes
 - **M17** End of subroutine
 - **M29** End of subroutine
 - **M30** End of program, stop machine

- Defined in machine data list
- Default output is channel specific
- Axis specific execution can be configured ...

m_default_outp_ax_name[<m_expr>] <axis_name>

h_default_outp_ax_name[<h_expr>] <axis_name>

- ... or by axis specific programming in the part program
<achs_name> [M<expr> / H<expr>]



- Types of sub-routines
 - **Local sub-routines** (part of main program file)
 - **Global sub-routines** (external file)
- Nested sub-routines are possible
- Parameter transfer is done via P-Parameter

- P-parameter are place-holder for numerical values
 - **P**<expr.> Standard parameter
e.g. P1 = 1 (definition and initialization)
 - **P**<expr.>[<expr.>] { [<expr.>] } Parameter arrays
e.g. #VAR
$$P10[3][6] = [10,11,12,13,14,15, \backslash$$
$$20,21,22,23,24,25, \backslash$$
$$30,31,32,33,34,35]$$

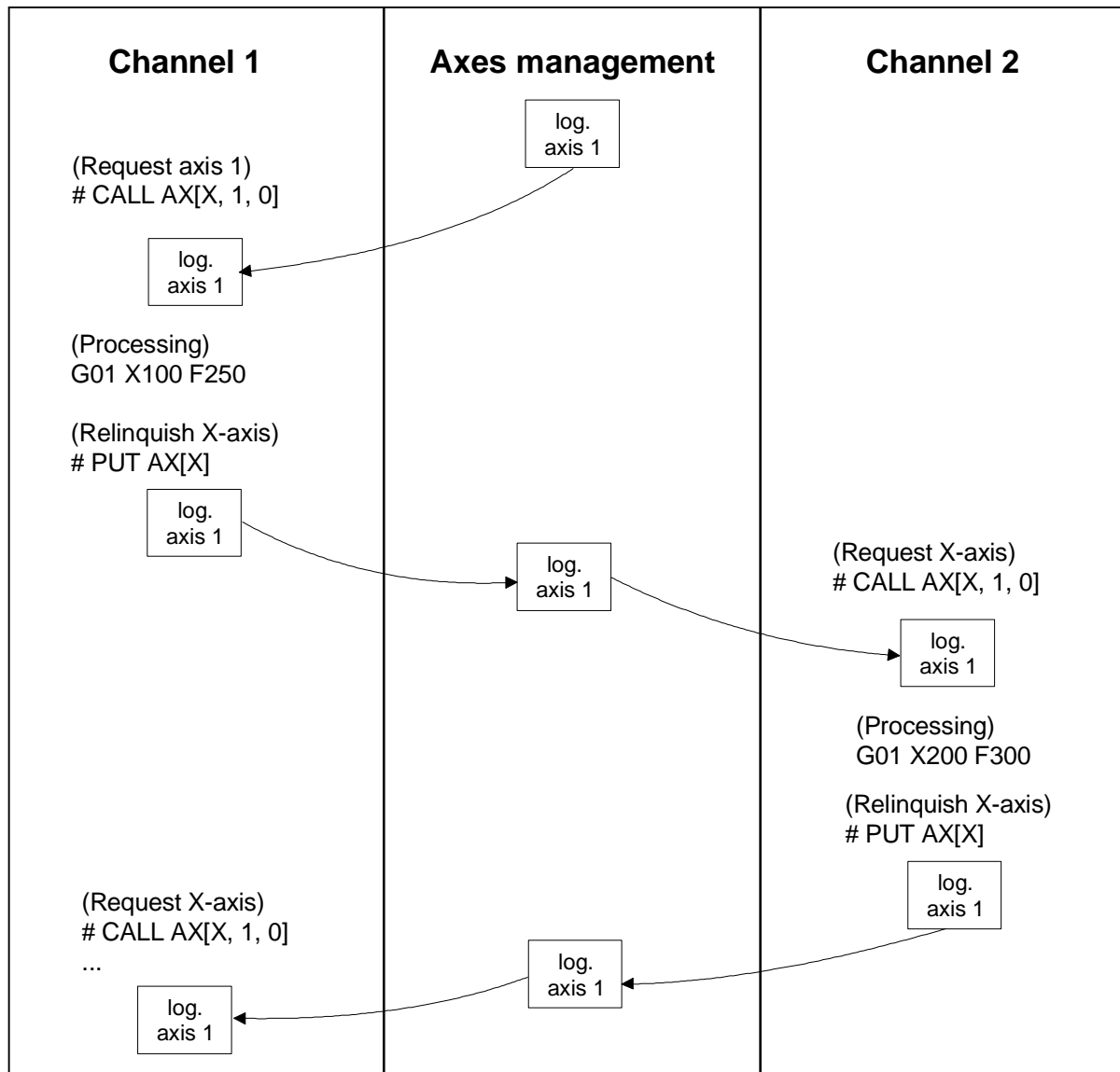
#ENDVAR
 - Validity can be configured (program/main program...)
 - High usability
e.g. N10 XP1 Y[P1+P2] ...

- Branches and loops

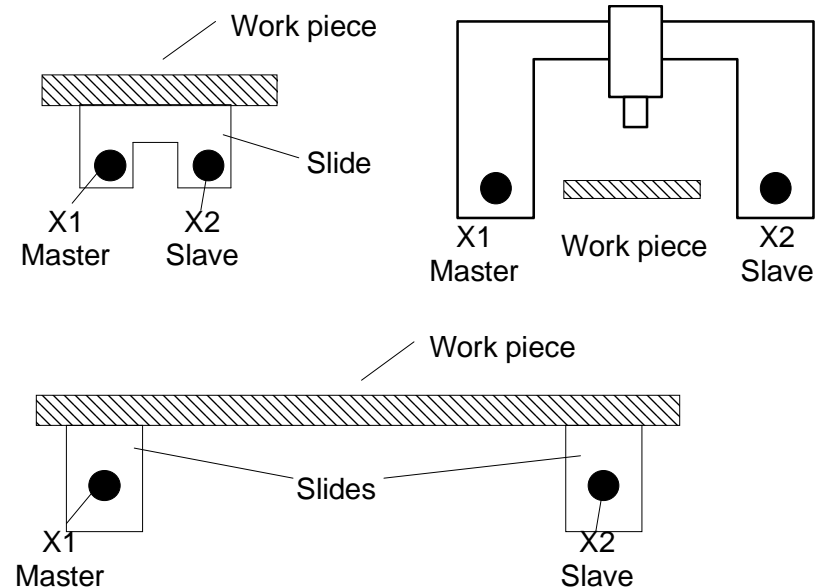
\$<statement>

- \$IF-\$ELSE-\$ELSEIF-\$ENDIF
- \$SWITCH-\$CASE-\$BREAK-\$ENDSWITCH
- \$GOTO <[Label]>
- \$FOR-\$ENDFOR
- \$WHILE-\$ENDWHILE
- \$DO-\$ENDDO

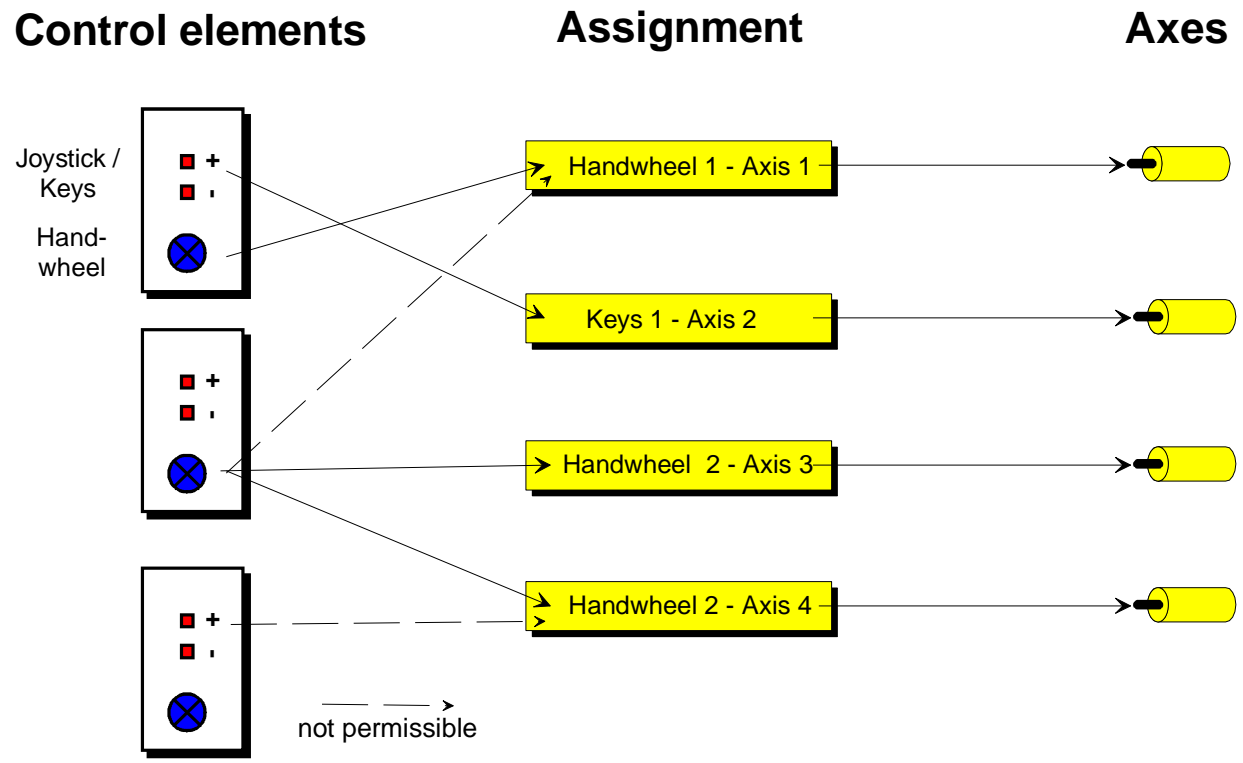
- Useful and necessary especially within multi-channel systems
 - **#CALL AX (FAST)** Request of axis
 - **#PUT AX (ALL)** Release of axis
 - **#SET AX** Definition of axes configuration
- Handling of axis offsets can be controlled



- Definition of axis couplings (Master-Slave)
 - **#SET AX LINK [...]**
 - **#ENABLE AX LINK [..]**
 - **#DISABLE AX LINK**
- Synchronous operation with monitoring of actual position limits
 - Hardware gantry (configurable)
 - Soft-gantry (programmable)



- Hand wheel, Continuous/Incremental Jog
 - **G201/G202** or **G200**
 - With or without parallel interpolation



- User defined message text („printf“):
 - **#MSG (SYN) (Receiver) ["<message_text>"]**
Receiver: ISG_DIAG_BED (AHMI); HMI; PLC

Example:

P1 = 1

V.P.BSP = 2

```
#MSG SYN HMI["Text_%D and Text_%D", P1, V.P.BSP]
```

→ Message text: Text_1 and Text_2

- User defined error message
 - **#ERROR [ID RC MID PV PM PIV]**

Example:

:

```
#ERROR[ID455 RC2 MID2 PV1=5 PV2=4.9 PM1=2 PM2=3]
```

→ Fatal Error 455 (Multiple-ID 2)
with additional Parameter

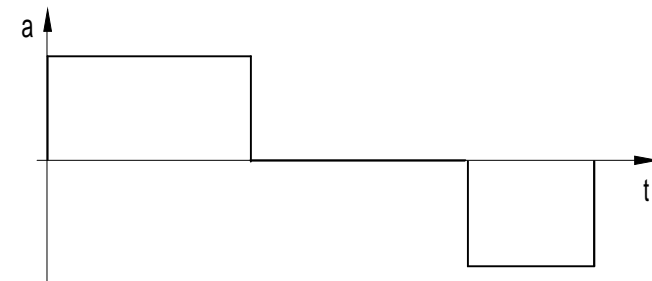
:

```
#ERROR[ID100 RC0 MID10]
```

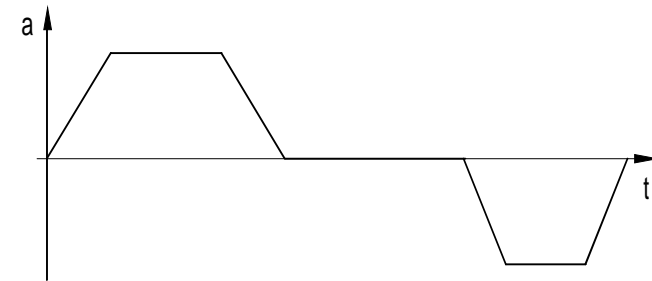
→ Warning 100 (Multiple-ID 10)

:

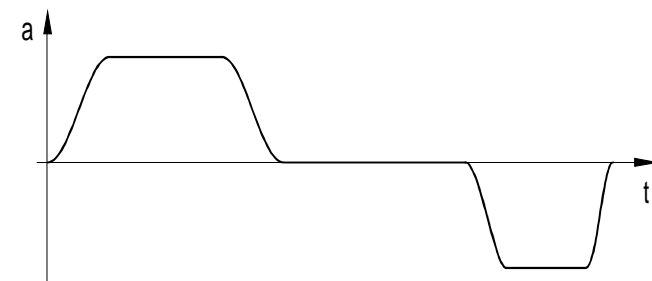
- The slope function determines the velocity on the programmed path while observing the dynamic parameters
- Different modes
 - Step-shaped
 - with restriction of acceleration
 - without monitoring the jerk
 - Trapezoidal
 - with jerk-monitoring
 - Square-sinusoidal
 - with jerk monitoring
- Selection of the operating mode
 - **#SET SLOPE PROFIL [...]**



Step-shaped acceleration profile

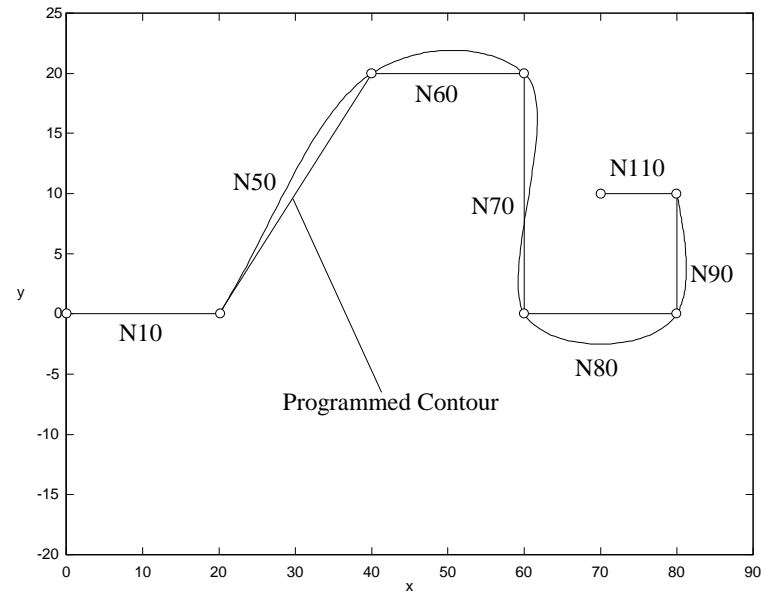
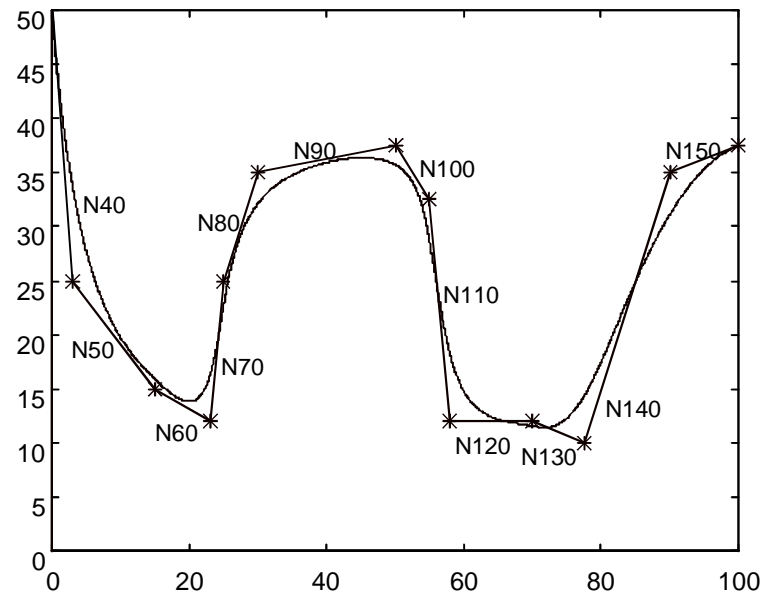


trapezoidal acceleration profile

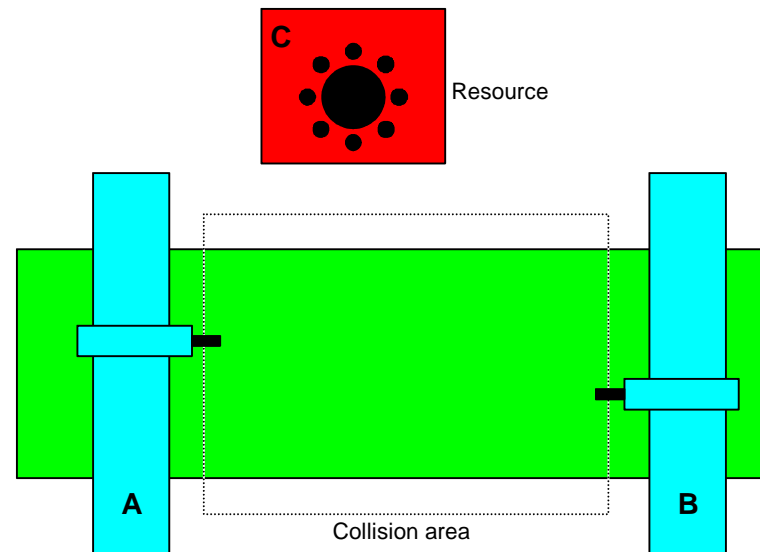


square-sinusoidal acceleration profile

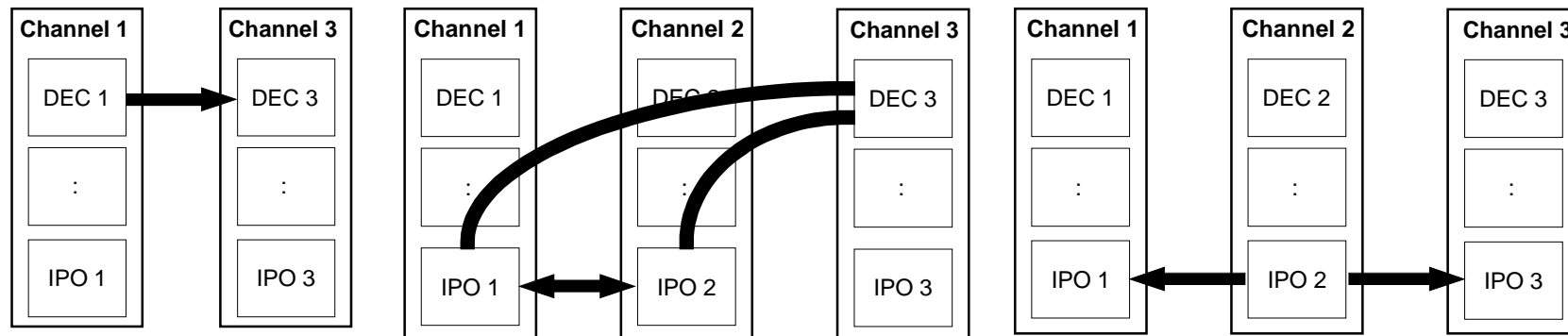
- Two types
 - #SET SPLINETYPE AKIMA**
 - #SET SPLINETYPE BSPLINE**
- Selection/De-selection
 - #SET SPLINE ON**
 - #SET SPLINE OFF**



- When operating a multi-channel control, situations may occur in which specific part program sequences must be synchronized between channels (e.g. to avoid collisions)



- The synchronization is based on sending and waiting for signals
 - Sending signals
#SIGNAL (SYN) [ID COUNT P[..] CH]
 - Waiting for signals
#WAIT (SYN) [ID COUNT P[..] CH AHEAD]



- Time measurement in part program
- Recorded time in milliseconds (ms)
 - **#TIMER <START/STOP/READ/CLEAR> (SYN) [ID]**

Example:

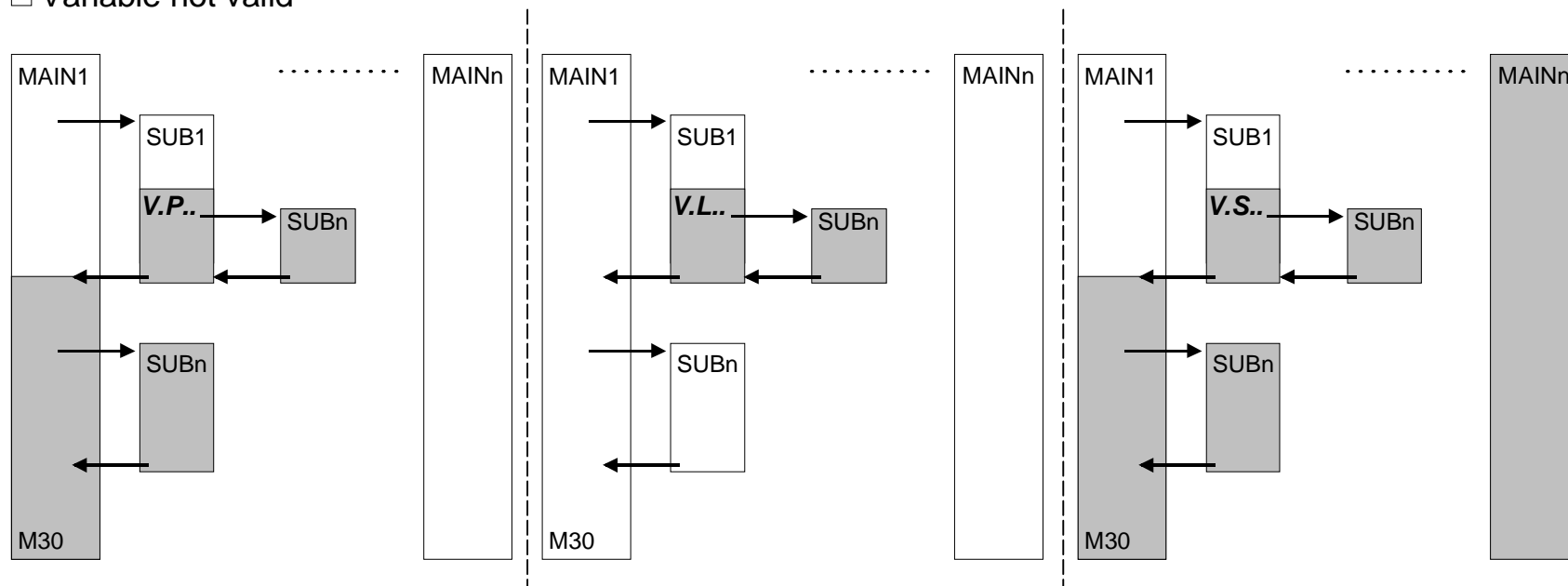
```
:  
#TIMER START [ID10]      Timer 10 is started  
:  
#TIMER READ [ID10]      Timer value is stored in  
                        V.G.TIMER[10]  
#MSG ["Timer10 = %d",V.G.TIMER[10]]  
                        Display timer value  
                        e.g via #MSG  
#TIMER STOP [ID10]      Timer 10 is stopped  
#TIMER CLEAR [ID10]     Timer 10 is reset  
:
```


- Access on internal control specific data
 - Axis specific variables (V.A.)
Example:
V.A.LOG_ACHS_NR.X

 - Global variables (V.G.)
Example:
V.G.CNC_CHANNEL

- Self-defined variables are created in the part program
 - **V.P.**<FREE_DEF> Global, not valid after program end
 - **V.L.**<FREE_DEF> Local, not valid after program end
 - **V.S.**<FREE_DEF> Global, valid after program end

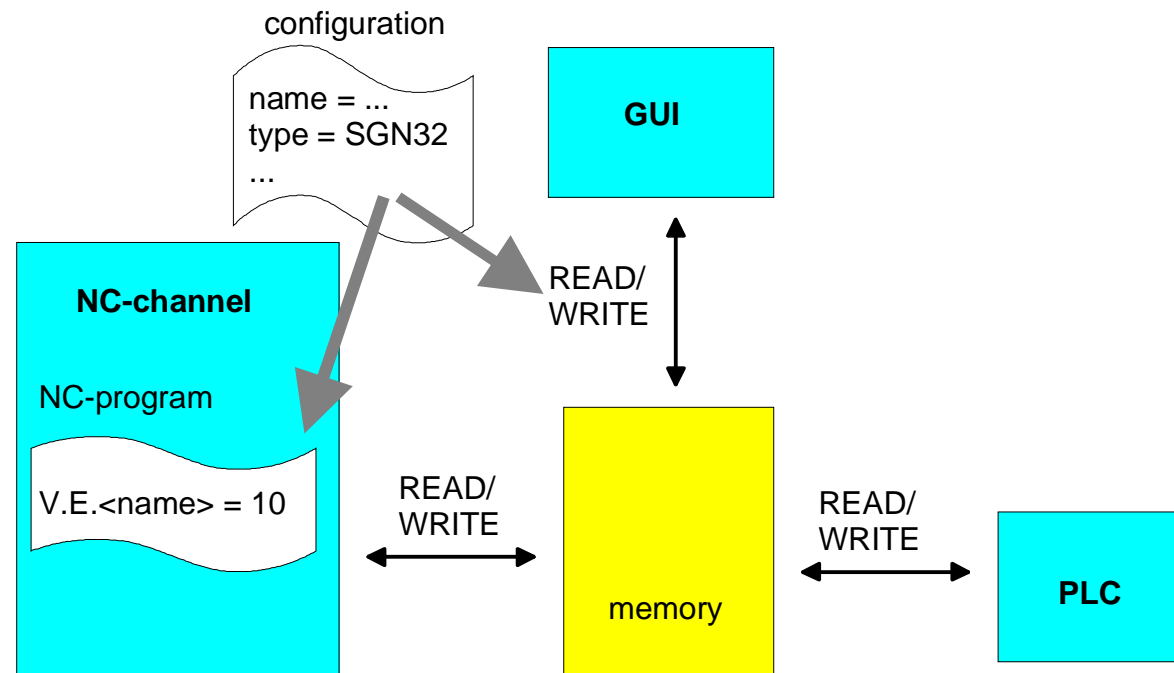
- Variable valid
- Variable not valid



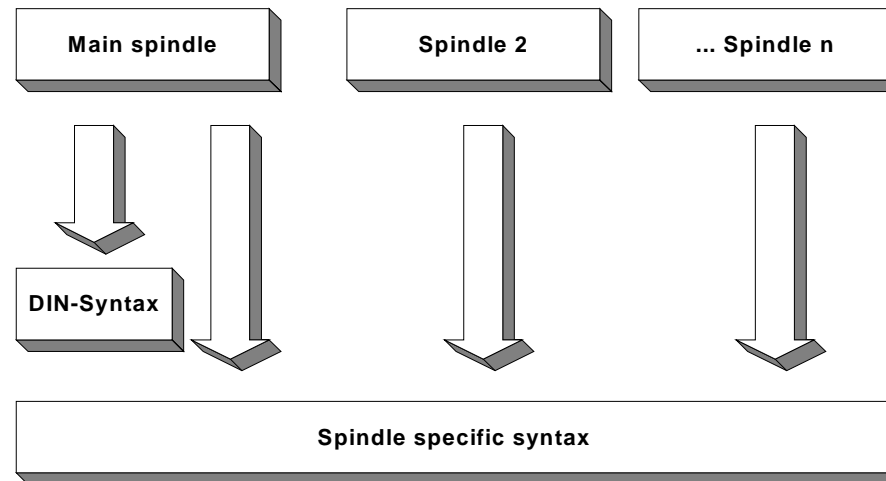
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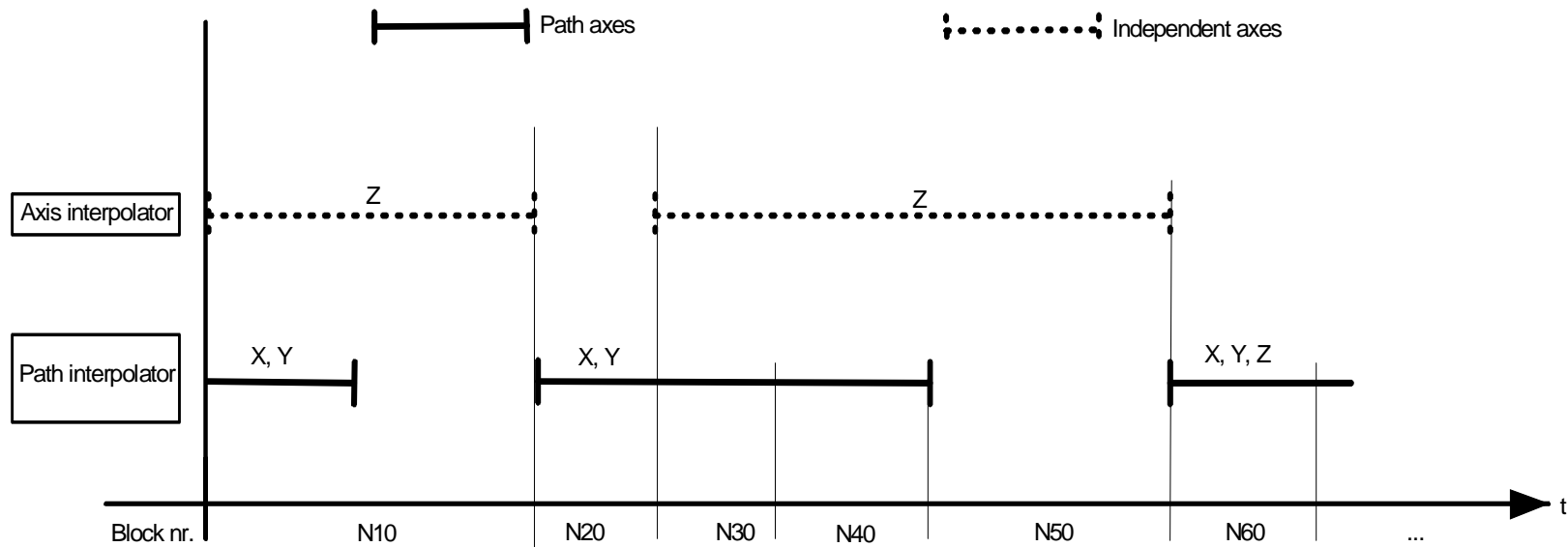


- The external variables (**V.E....**) are configured on the basis of an ASCII list only once during start-up
- Any values can be exchanged via external variables between NC, graphical user interface (GUI) and PLC



- Spindle programming is possible in the conventional syntax (ISO)
Example: **N10 S1000 M3**
- ... and in an axis-specific programming syntax for multi-spindle systems
Example: **N10 S[REV1000 M3] S2[REV2000 M4] ...**
- The so-called “main spindle” can be programmed both in standard syntax and in spindle-specific syntax





```

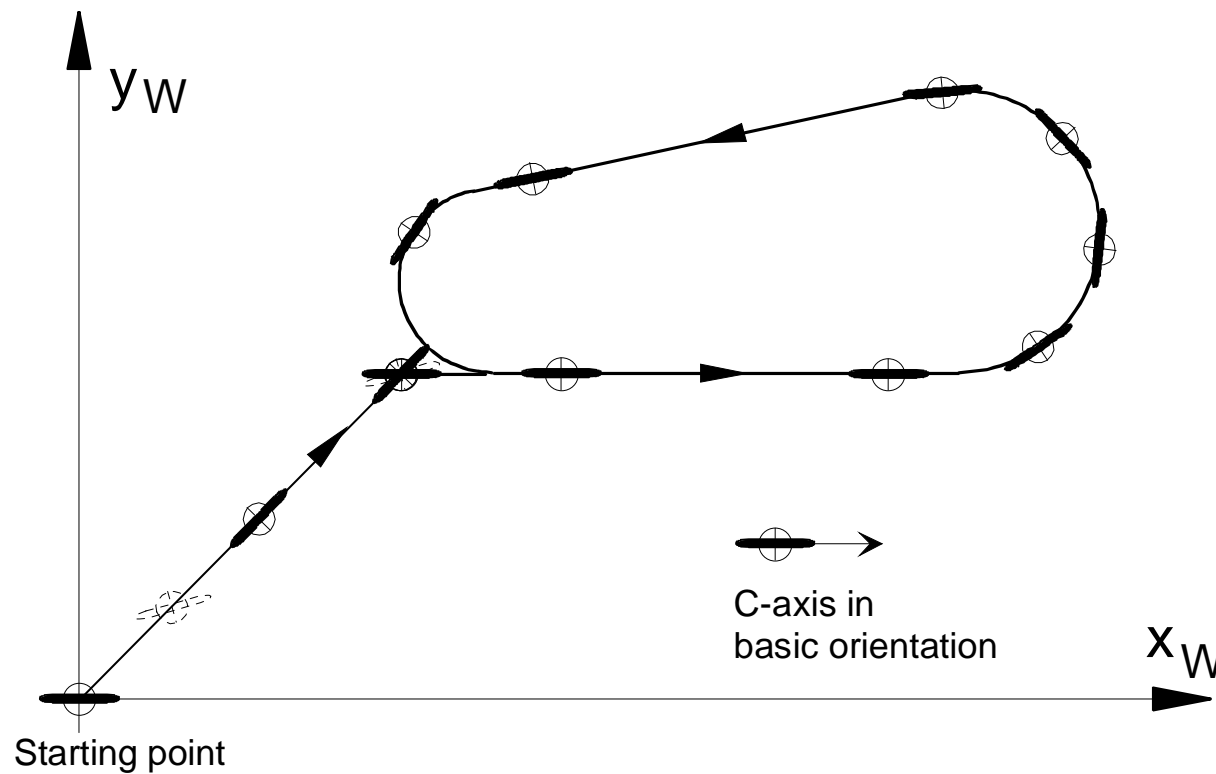
:
N10 X10 Y11 Z[INDP_SYN POS50 G01 F100 G90]
N20 X20 Y22

N30 X5 Y10 Z[INDP_ASYN POS500 G01 F200 G90]
N40 X20 Y30
N50 #WAIT INDP [Z]
N60 X30 Y40 Z60
N70 Z[INDP_SYN M50 ]
:
    
```

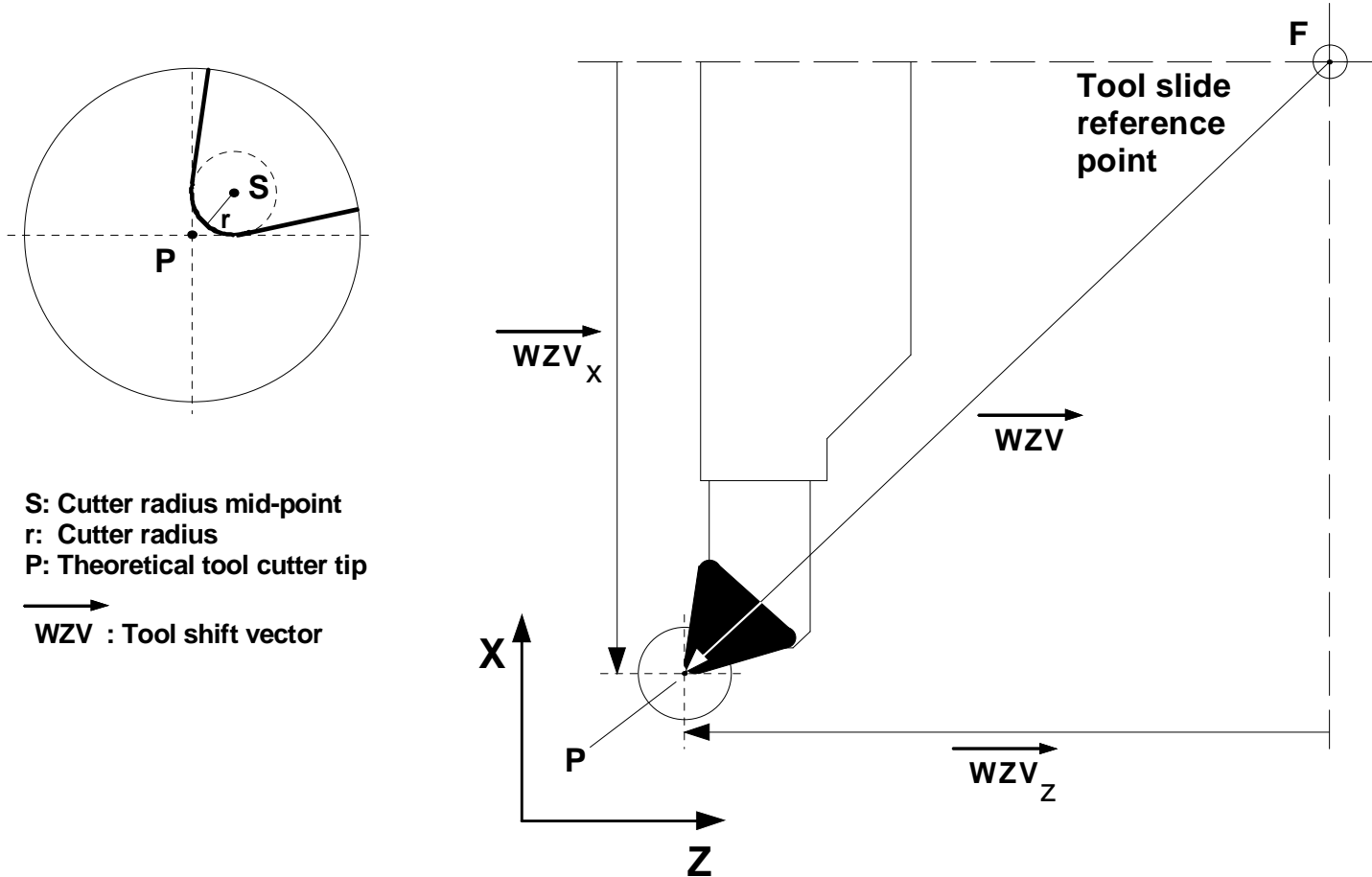
V2 © ISG 2009



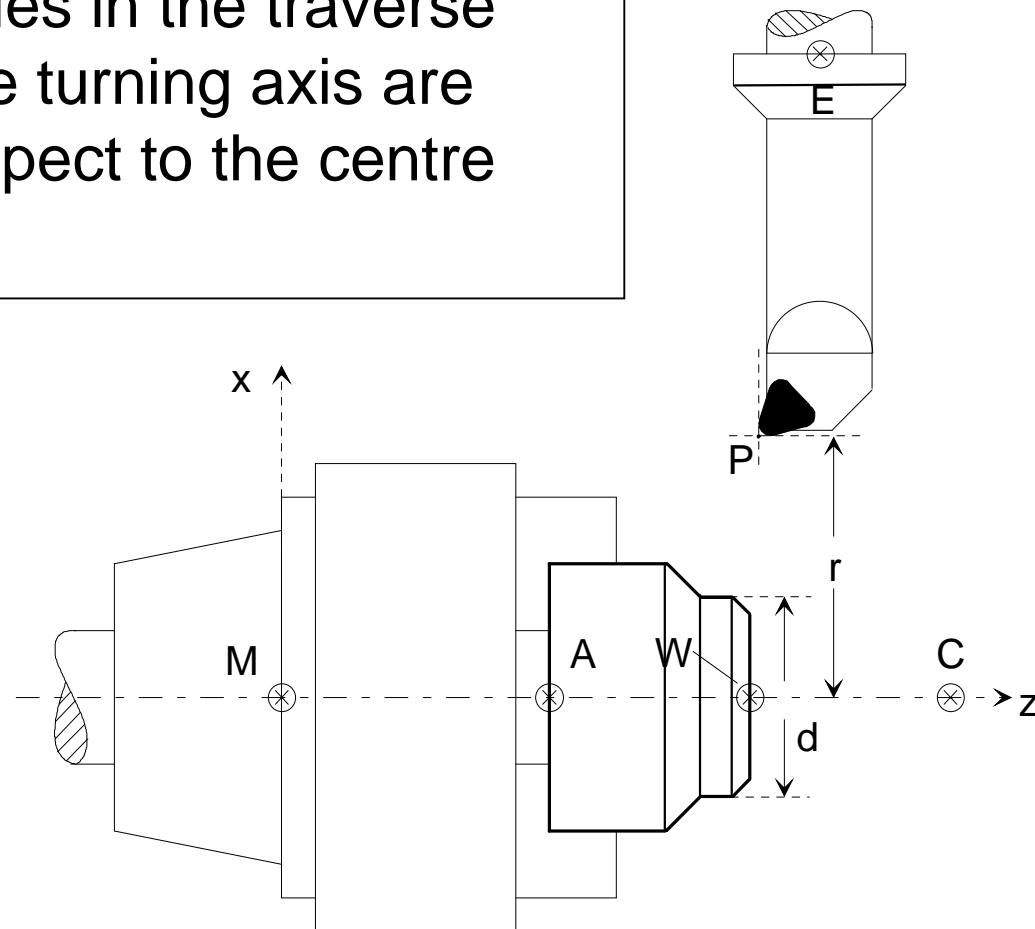
- Tool orientation tangentially with respect to the path
 - **#CAXTRACK ON [ANGLIMIT OFFSET]**
 - **#CAXTRACK OFF**



- Cutter radius compensation
 – **G40/G41/G42**

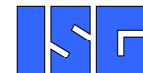


- Diameter programming
 - **G51/G52**
 - The position values in the traverse blocks of the face turning axis are interpreted in respect to the centre point of turning

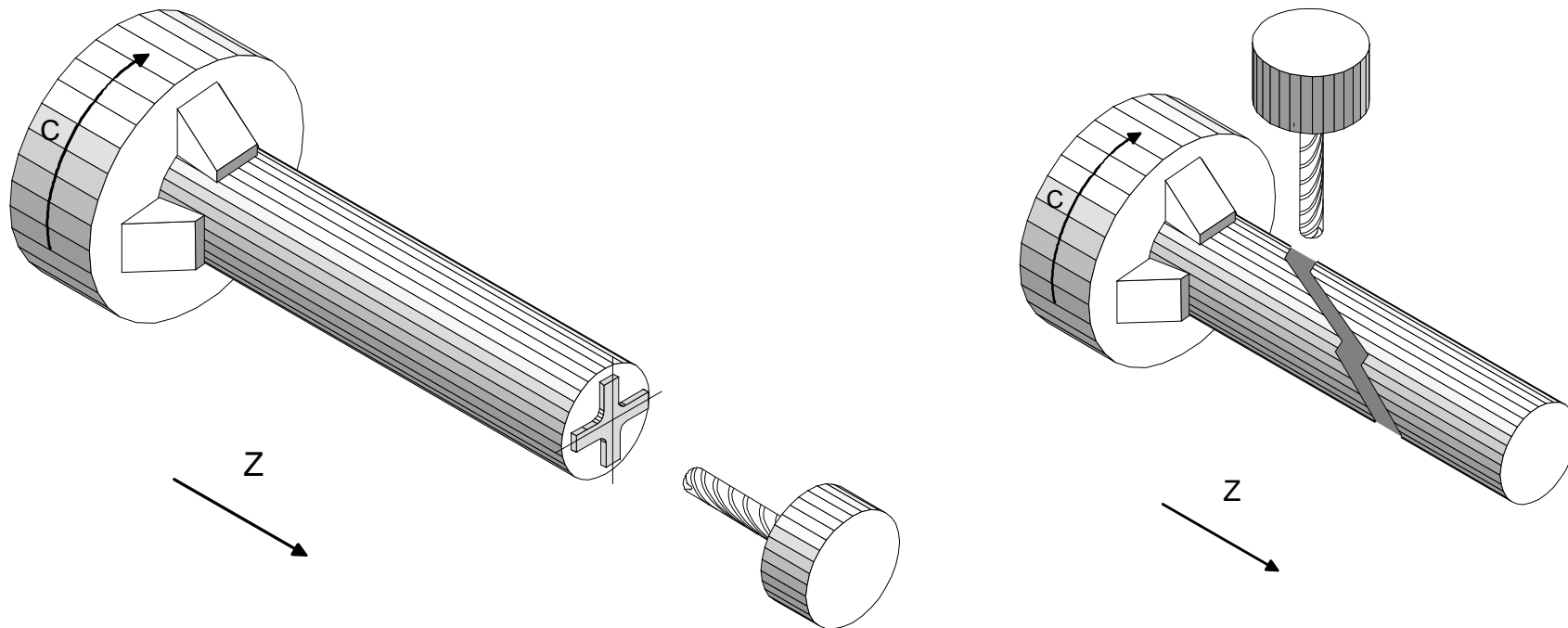


- Feed rate per revolution
 - **G95**
 - A constant chip thickness can be fixed using the F-word in mm/rev, irrespective of the spindle speed (rpm)

- Constant cutting speed
 - **G96/G97/G196**
 - Speed depends on the distance between tool tip and turning centre point
 - Change meaning of the S-word
 - G96 S in m/min (Cutting speed)
 - G97 S in 1/min (Spindle speed)
 - G196 S in 1/min (max. spindle speed during G96)



- Face and lateral surface machining of cylindrical work pieces with C-axis functions
 - **#CAX ON/OFF**
 - **#FACE [...]**
 - **#CYL [...]**

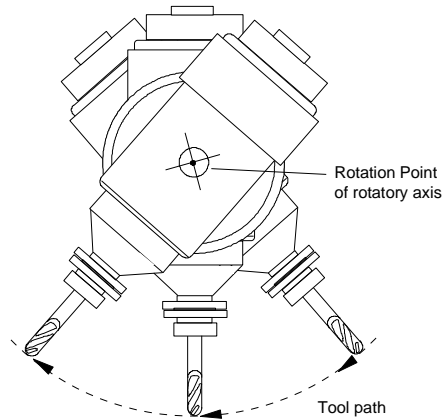


V2 © ISG 2009

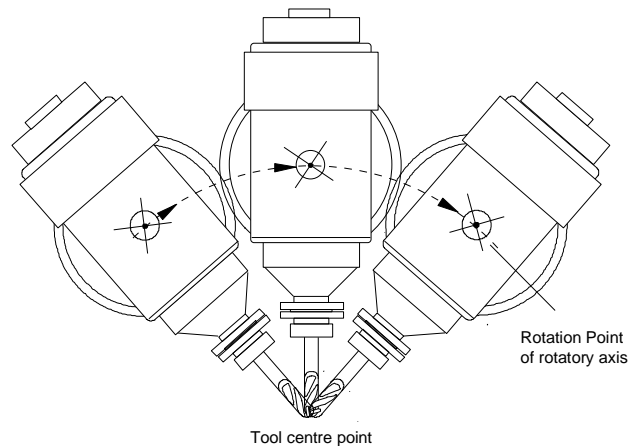
- Rotation Tool Centre Point (RTCP)
- Tool Length Compensation (TLC)
- Tool Orientation (TOOL ORI CS)
- Coordinate systems
 - Machining Coordinate Systems (CS)
 - Fixture Adaptive Coordinate Systems (ACS)
 - Effector Coordinate System (ECS)
 - Temporary switch to the Machine Coordinate System (MCS)

- Machining Coordinate System (CS)
 - Storage of predefined CS
 - Chaining of CS
 - Measurement in CS
 - Manual Mode in CS

- Rotation tool centre point
– **#RTCP ON/OFF**

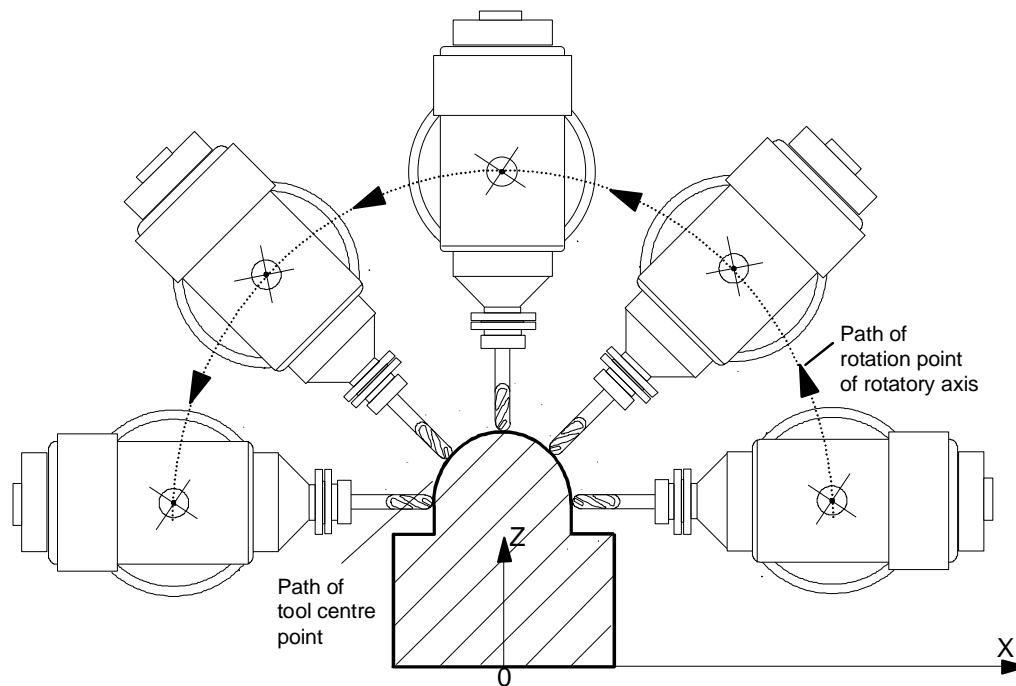


#RTCP OFF



#RTCP ON

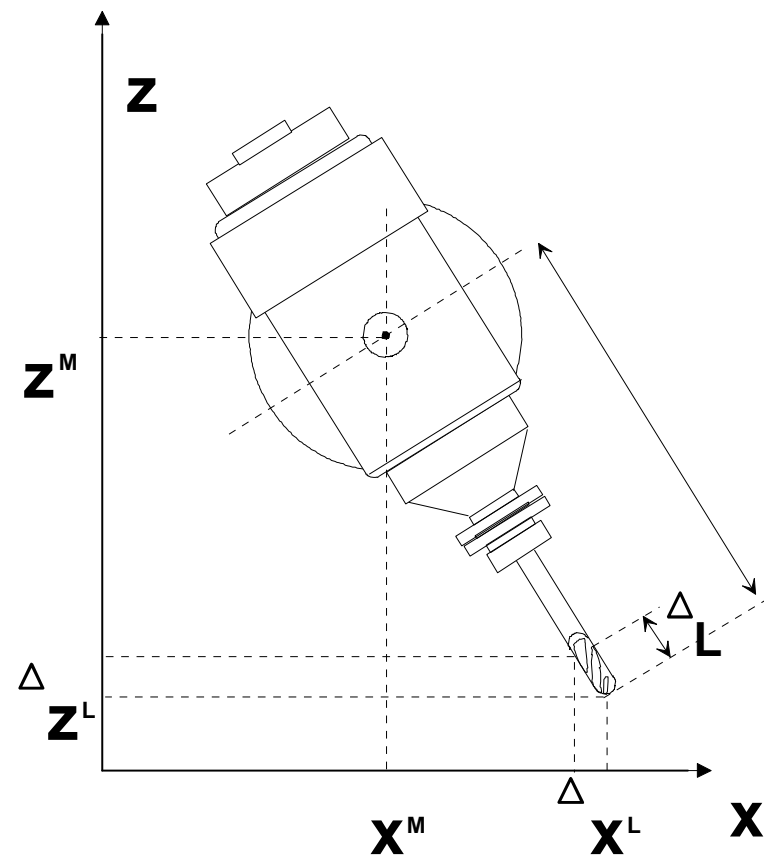
```
N00 #KIN ID [1]  
N10 #RTCP ON  
N20 G01 G18 X0 Y0 Z0 B90 F500  
N30 X-4  
N40 G02 X-20 I-40 B-90 F2000  
N50 .....
```



```
# Definition of cinematic parameter
# =====
kinematik_id                2  Default cinematic
#
#                          in 0.1 µm
kinematik[0].wz_kopf_ersatz[0]    0
kinematik[0].wz_kopf_ersatz[1]   -1
kinematik[0].wz_kopf_ersatz[2]    0
#
kinematik[1].wz_kopf_ersatz[0] 1088000
kinematik[1].wz_kopf_ersatz[1]    0
kinematik[1].wz_kopf_ersatz[2]    0
kinematik[1].wz_kopf_ersatz[3]    0
kinematik[1].wz_kopf_ersatz[4]    0
kinematik[1].wz_kopf_ersatz[5]    0
kinematik[1].wz_kopf_ersatz[6]    0
#
kinematik[2].wz_kopf_ersatz[0]   100000
kinematik[2].wz_kopf_ersatz[1]   200000
kinematik[2].wz_kopf_ersatz[2]   300000
kinematik[2].wz_kopf_ersatz[3]    0
...
```

SDA-MDS

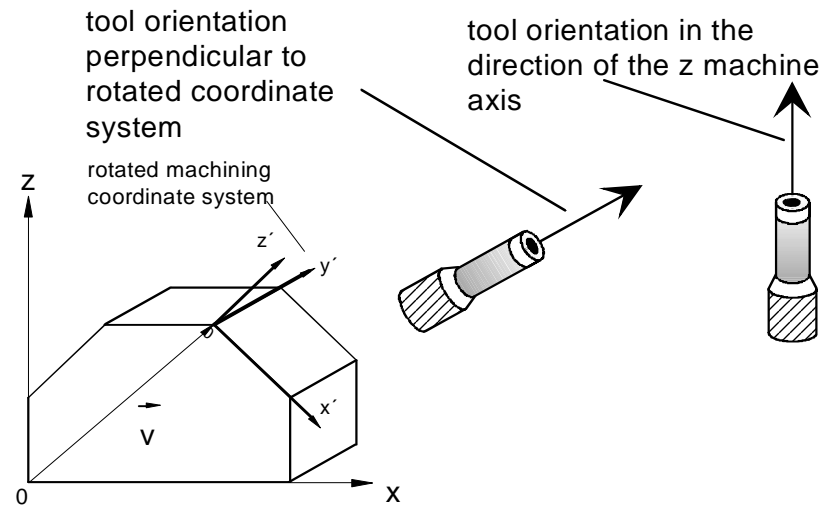
- Online adaptation of generated free form surface programs for modified tool length
 - **#TLC ON [ΔL]**



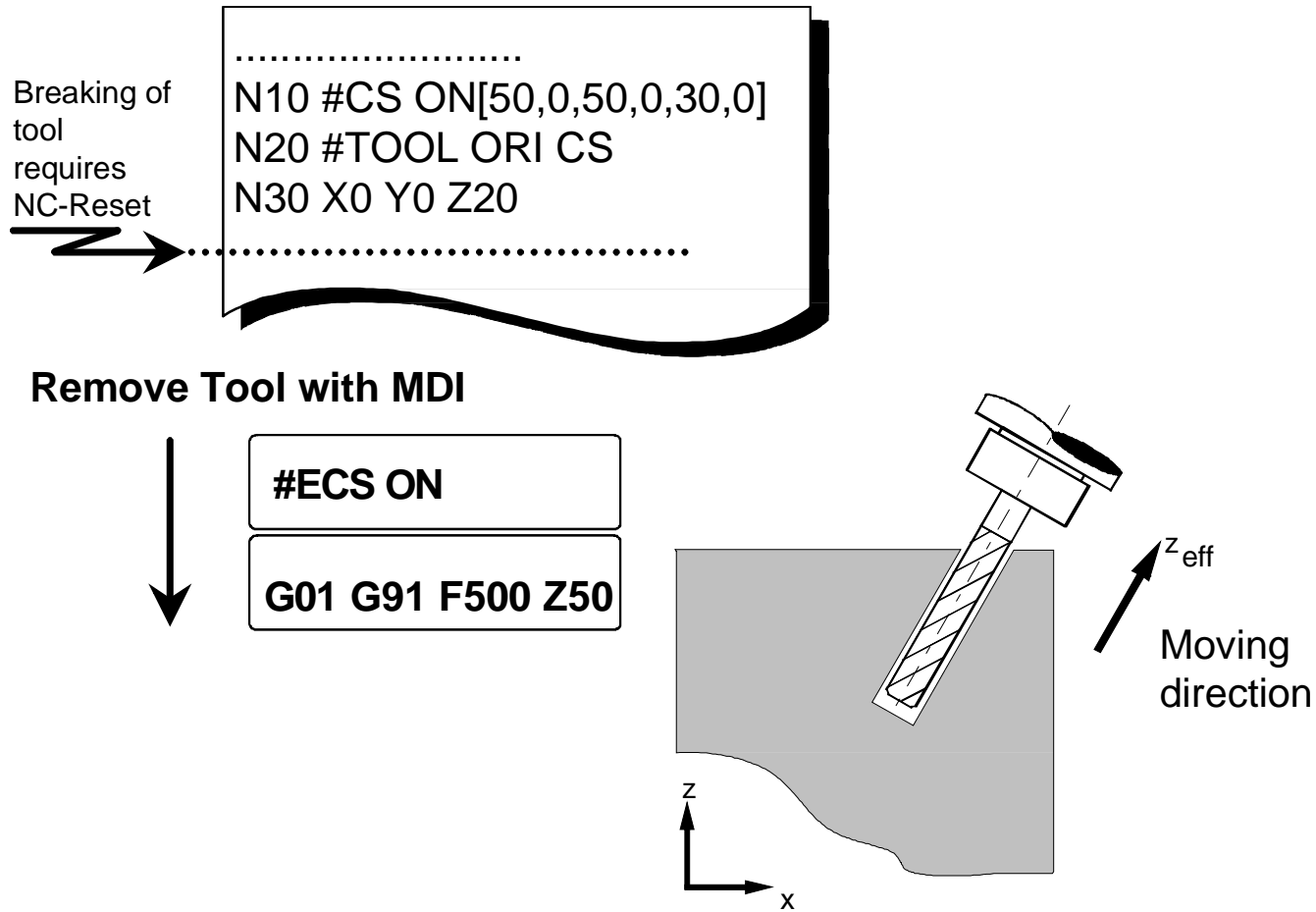
- Tool orientation perpendicular to coordinate system
 – **#TOOL ORI CS**

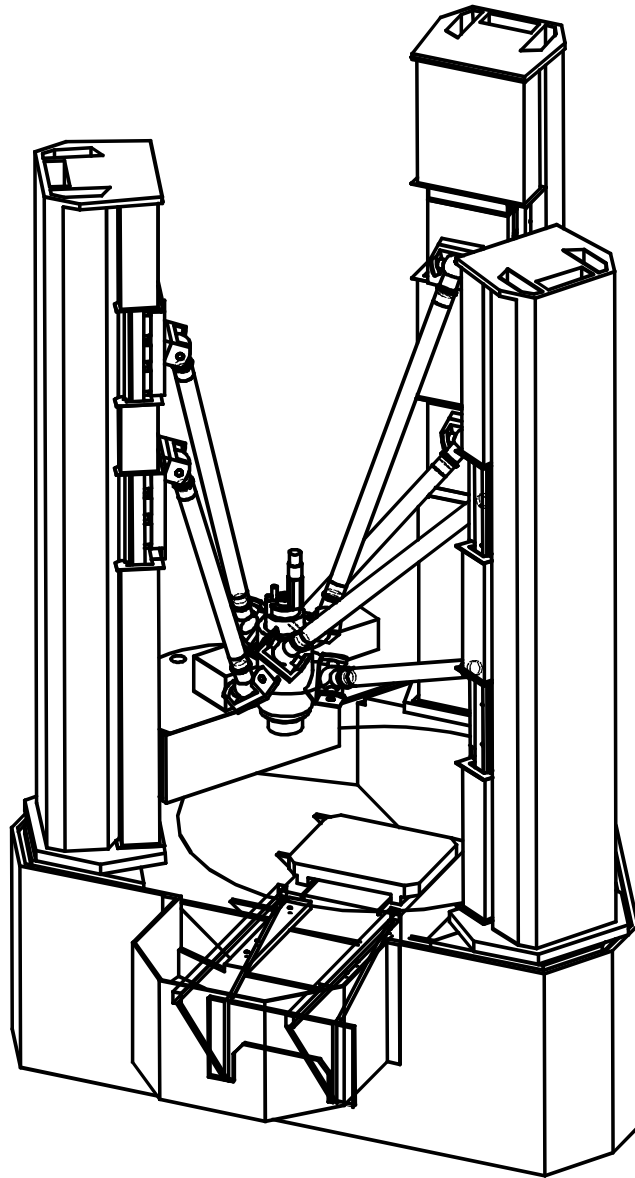
```

N00 #KIN ID[1]
N10 #CS ON[50,0,50,0,45,0]
N20 #TOOL ORI CS
N30 X0 Y0 Z20
            
```

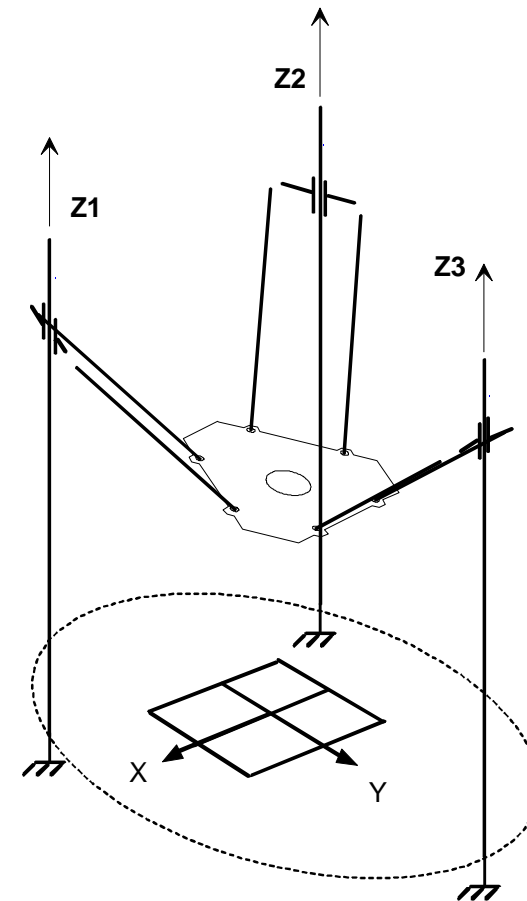
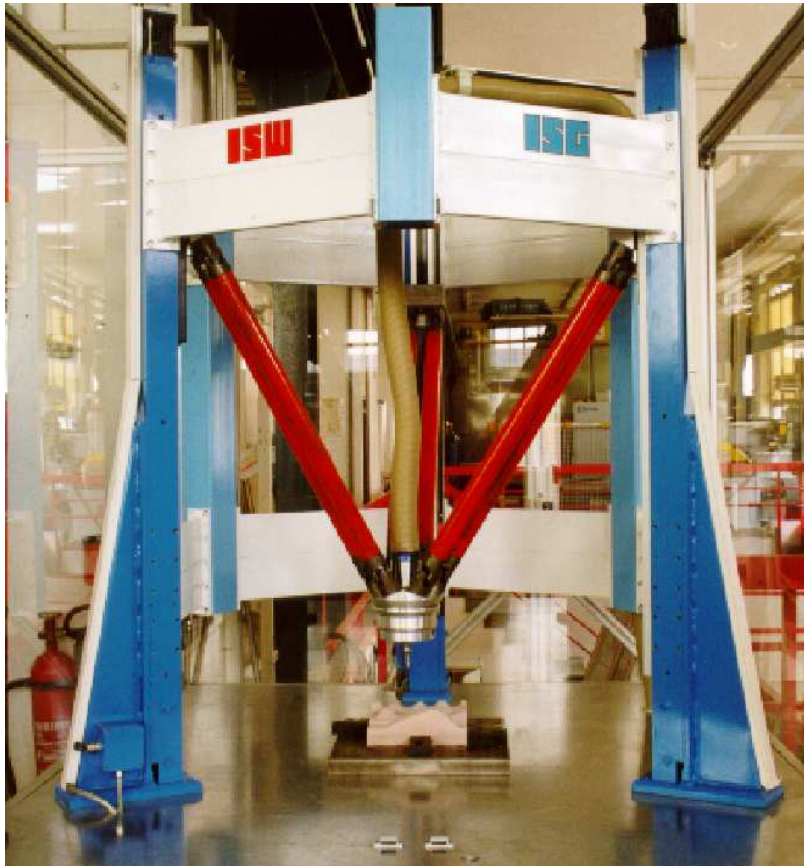


- Set coordinate system according to tool orientation
 - **#ECS**





Transformation for position and
tool orientation programming

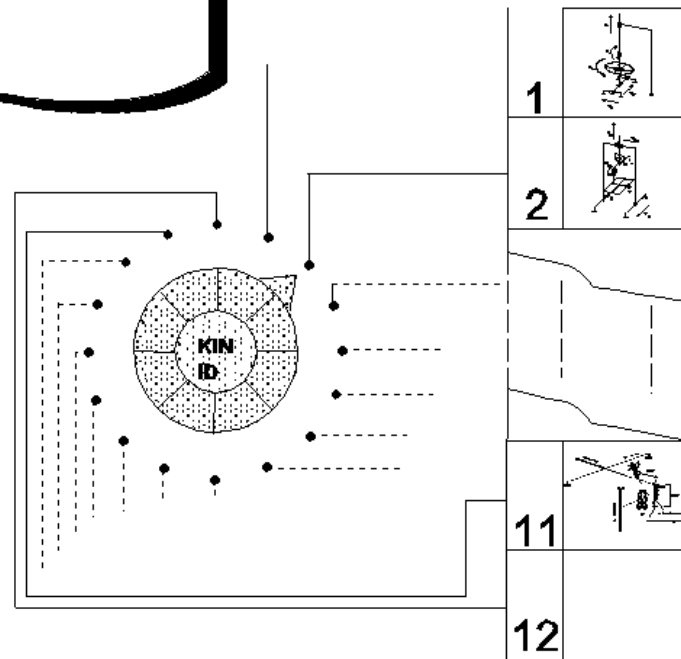


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- Select cinematic in the part program
 - **#KIN ID**

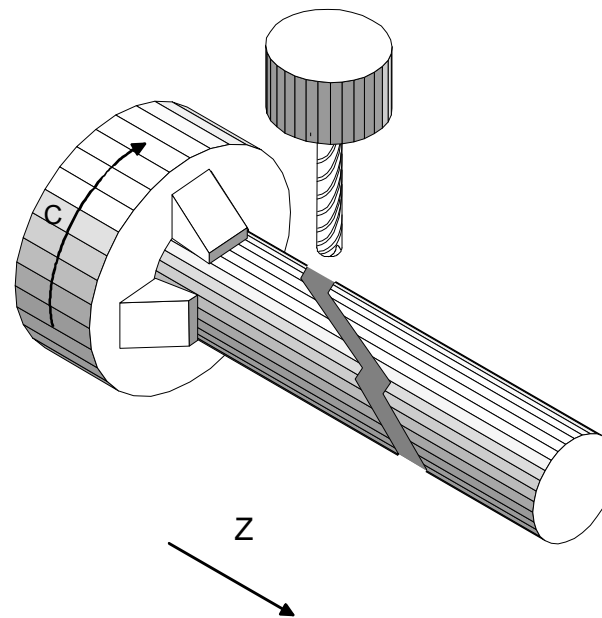
```
N10 #KIN ID[1]
N20 #RTCP ON
N30 LL SUBPRG1
N40 #RTCP OFF
N50 # KIN ID[2]
N60 LL SUBPRG2
```

Machine and
Tool Head Kinematics



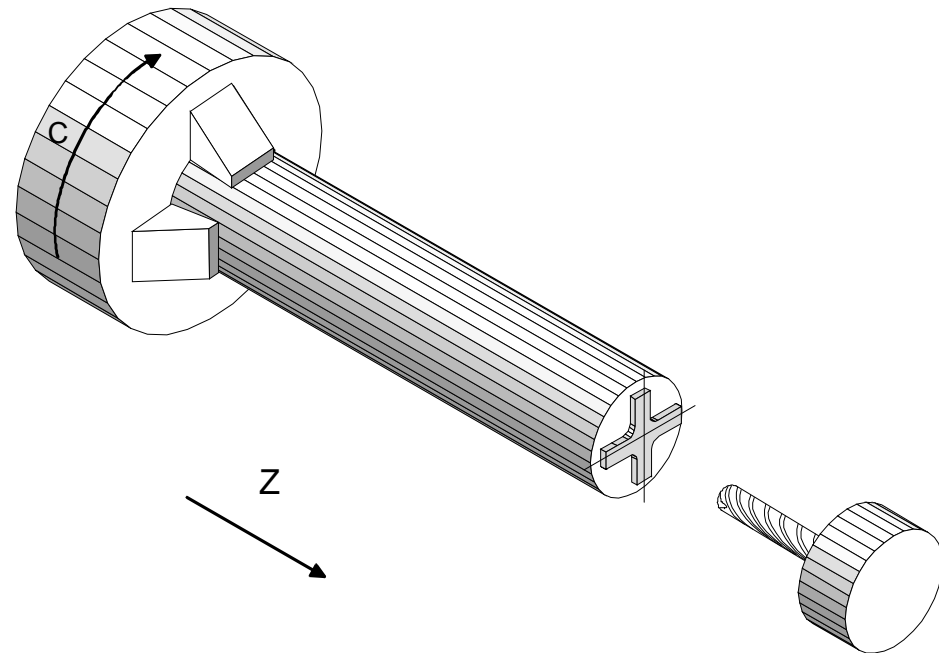
- C-axis function for lateral surface machining
– **#CYL**

```
N00 #CAX  
N10 #CYL  
N20 .....  
.....
```



- C-axis function for face machining
– **#FACE**

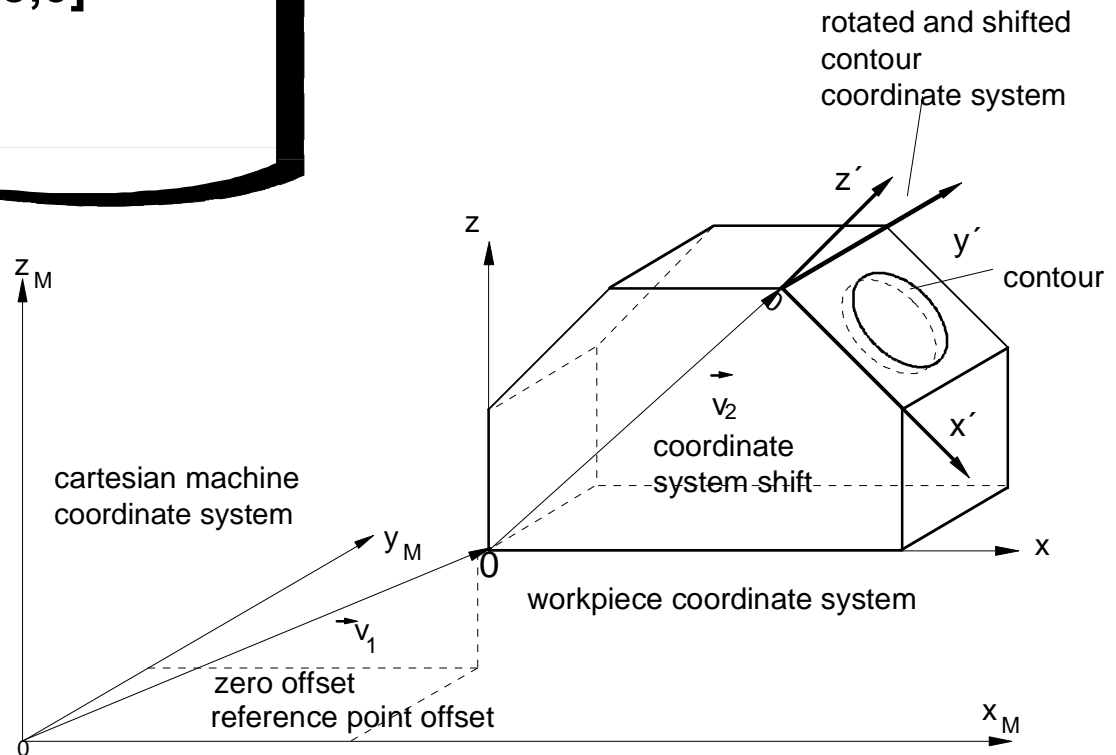
```
N00 #CAX  
N10 #FACE  
N20 .....
```



- Definition of machining coordinate systems
 - #CS

```

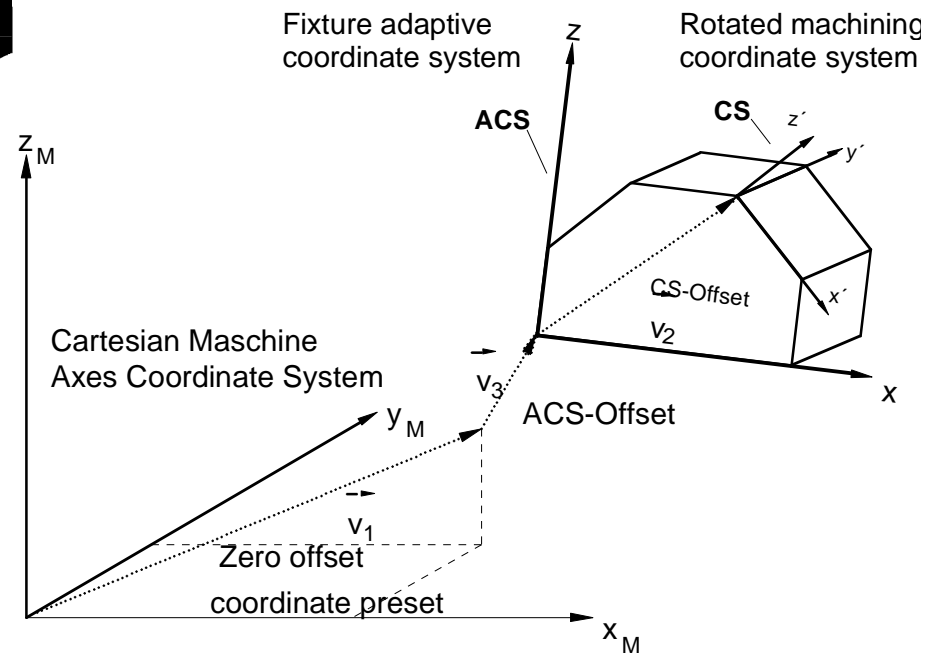
.....
N10 #CS ON[50,0,50,0,45,0]
N20 X0 Y0 Z20
.....
    
```



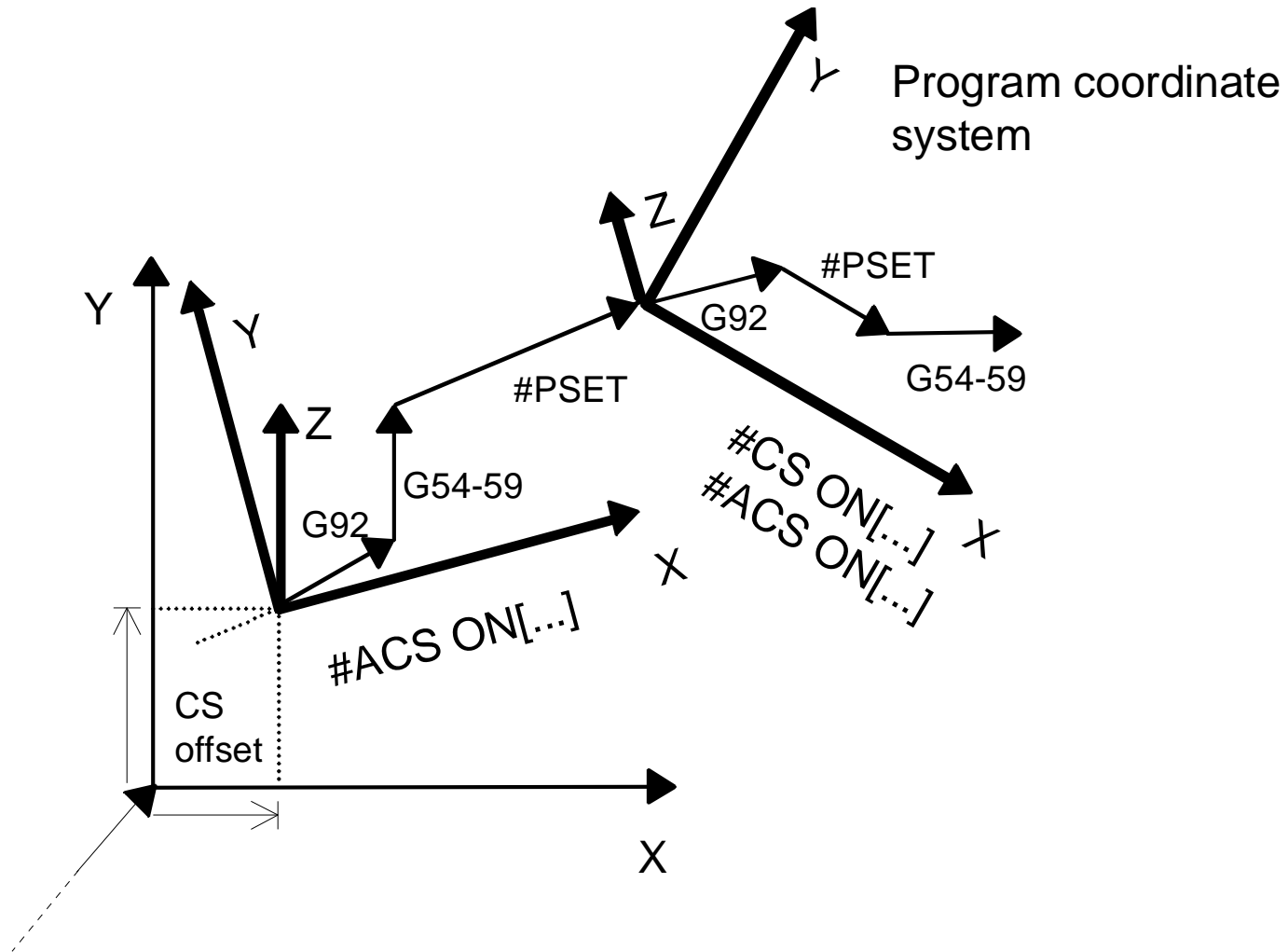
- Definition of fixture adaptive coordinate systems
 - #ACS

```

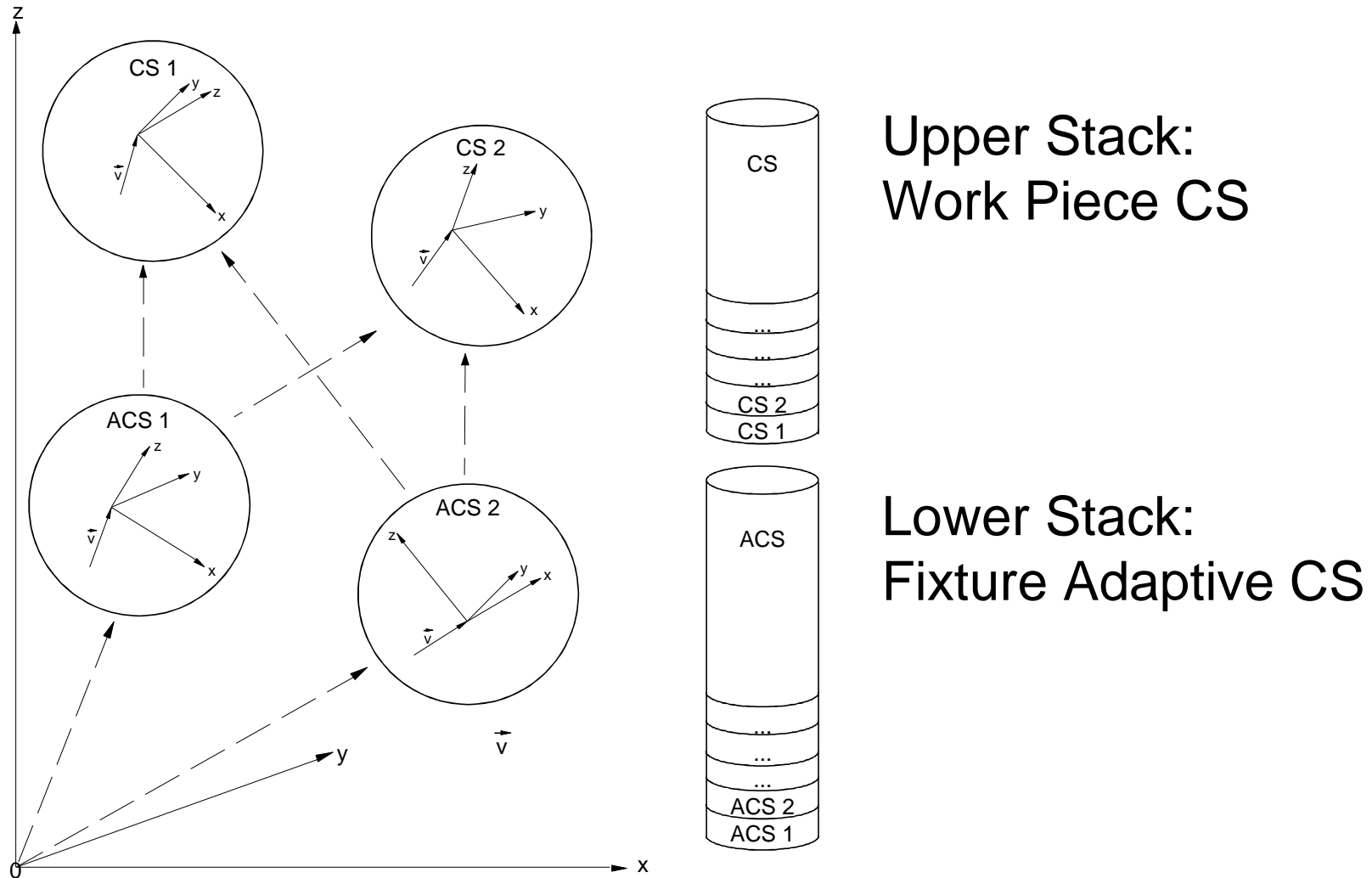
.....
N30 #ACS ON[10,10,20,0,10,0]
N40 X0 Y0 Z20
N50 #CS ON[50,0,50,0,45,0]
.....
    
```



- Local Offsets in chained Coordinate systems



- No restriction to sequence of CS/ACS selection



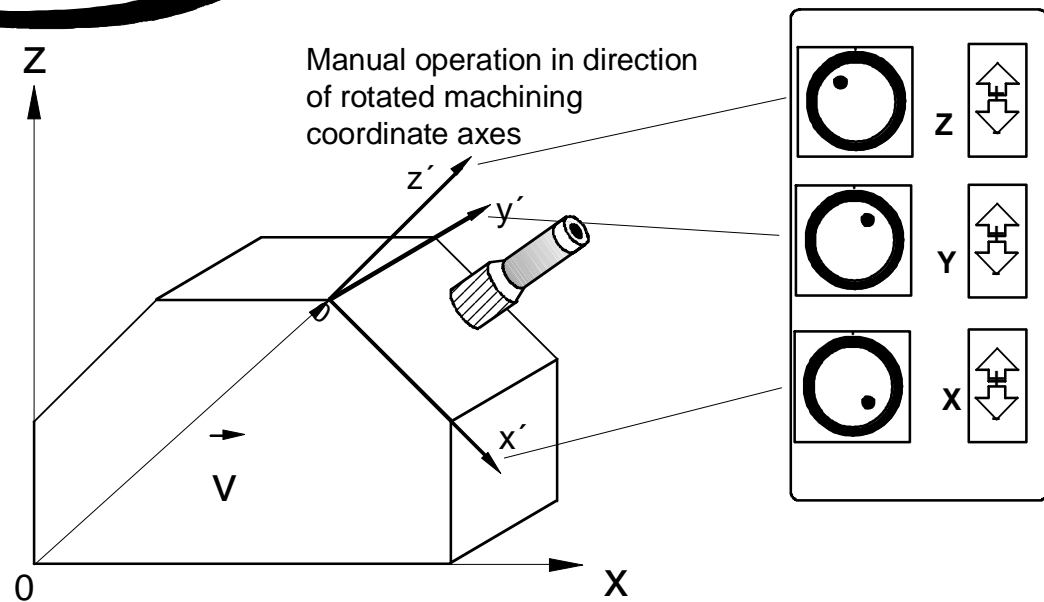
Distinction ACS and CS



- Manual operation in coordinate system

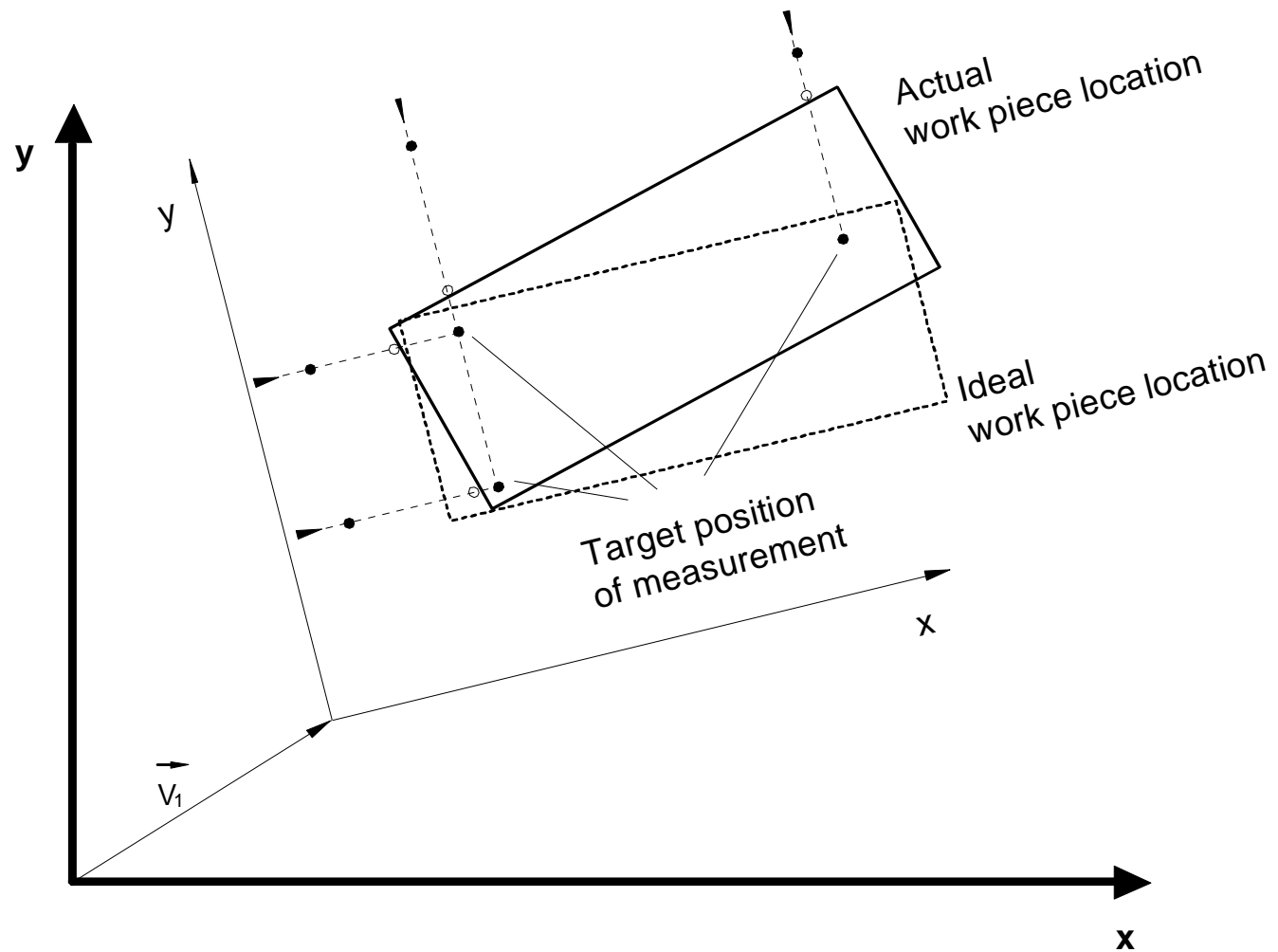
```

.....
N10 #CS ON[50,0,50,0,45,0]
N20 #TOOL ORI CS
N30 X0 Y0 Z20
N40 G200
    
```



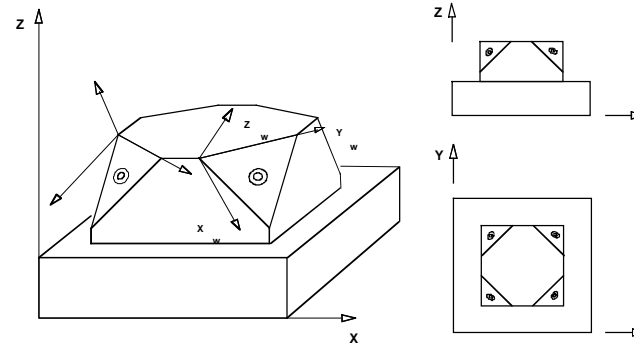
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- Measuring in coordinate system



% Main_Program

N05	#KIN ID[1]	(Machine cinematic 1)
N10	G74 Z1 X2 Y3 B4 C5	(Homing)
N20	T1 D1	(Select Tool)
N40	#RTCP ON	(Select RTCP)
N50	#CS ON[0,-50,51,0,30,-45]	(Select rotated, shifted CS)
N52	G00 X0 Y0 Z5	(Positioning with new origin)
N55	#TOOL ORI CS	(Tool orientation)
N60	LL UNTERPRG1	(Contour machining)
N70	LL UNTERPRG2	(Contour machining)
N80	#CS OFF	(De-select machining CS)
N90	#CS ON[-50,0,51,0,30,-135]	(Select rotated, shifted CS)
N92	G00 X0 Y0 Z5	(Positioning with new origin)
N95	#TOOL ORI CS	(Tool orientation)
N100	LL UNTERPRG1	(Contour machining)
N110	LL UNTERPRG2	(Contour machining)
N120	#CS OFF	(De-select machining CS)
N130	#CS ON[0,50,51,0,30,-225]	(Select rotated, shifted CS)
N132	G00 X0 Y0 Z5	(Positioning with new origin)
N135	#TOOL ORI CS	(Tool orientation)
N140	LL UNTERPRG1	(Contour machining)
N150	LL UNTERPRG2	(Contour machining)
N160	#CS OFF	(De-select machining CS)
N170	#CS ON[50,0,51,0,30,-315]	(Select rotated, shifted CS)
N172	G00 X0 Y0 Z5	(Positioning with new origin)
N175	#TOOL ORI CS	(Tool orientation)
N180	LL UNTERPRG1	(Contour machining)
N190	LL UNTERPRG2	(Contour machining)
N200	#CS OFF	(De-select machining CS)
N210	#RTCP OFF	(De-select RTCP)
N220	Z120	(Retraction motion)
N230	#TOOL ORI CS	(Tool orientation)
N240	X0 Y0	(Movement because of tool orientation)
N250	X0 Y0 Z120 B0 C0	(Movement in machine CS)
N260	M30	(Program end)



For further information please have a look at the

ISG Programming Manual

and at

www.isg-stuttgart.de