

CNC 8055 / CNC 8055i



Programming Manual (M model)

Ref. 0204-ing





AUTOMATION, S.Coop. Ltda.

FAGOR

/A, /B /C

	/A	/B	/C
Block processing time without CPU turbo	12 ms	6 ms	3 ms
Block processing time with CPU turbo	-----	2.5 ms	1.5 ms
RAM Memory	256 Kb expandable to 1Mb	1 Mb	1 Mb
Memkey Card Memory	512 Kb expandable 2Mb	4Mb	4Mb
Minimum Position Loop	4 ms	3 ms	3 ms
Software for 7 axes	-----	Option	Option
Digitizing	-----	Option	Option
Tracing	-----	Option	Option
TCP transformation	-----	Option	Option

가

	GP model	M model
Number of axes with standard software	4	4
Number of axes with optional software	7	7
Solid graphics	-----	Option
Irregular pockets with islands	-----	Option
Rigid tapping	Option	Option
Digitizing	-----	Option
Tool life monitoring	-----	Option
Probing canned cycles	-----	Option
DNC	Option	Option
COCOM version	Option	Option
Tracing	-----	Option
Profile editor	Option	Option
Tool radius compensation	Option	Standard
Tangential control	Option	Option
Retracing	-----	Option
Electronic threading	-----	Standard
Tool magazine management	-----	Standard
Machining canned cycle	-----	Standard
Multiple machining	-----	Standard
TCP transformation	-----	Option
Conversational software (MC and MCO)	-----	Option

INDEX

VERSION HISTORY (M)

INTRODUCTION

Safety conditions	3
Material returning terms	5
Fagor documentation for the CNC	6

1. OVERVIEW

1.1 Part-programs	1
1.1.1 Considerations for the Ethernet connection	4
1.2 DNC connection	6
1.3 Communication protocol via dnc or peripheral device	6

2. CREATING A PROGRAM

2.1 Creating a program in the cnc	1
2.1.1 Block header	2
2.1.2 Program block	3
2.1.2.1 ISO language	3
2.1.2.2 High level language	3
2.1.3 End of block	4

3. AXES AND COORDINATE SYSTEMS

3.1 Nomenclature of the axes	1
3.1.1 Selection of the axes	2
3.2 Plane selection (g16, g17, g18, g19)	3
3.3 Part dimensioning. Millimeters (g71) or inches (g70)	5
3.4 Absolute/incremental programming (g90, g91)	6
3.5 Programming of coordinates	7
3.5.1 Cartesian coordinates	7
3.5.2 Polar coordinates	8
3.5.3 Cylindrical coordinates	10
3.5.4 Angle and one cartesian coordinate	11
3.6 Rotary axes	12
3.7 Work zones	13
3.7.1 Definition of the work zones	13
3.7.2 Using work zones	14

4. REFERENCE SYSTEMS

4.1	Reference points	1
4.2	Machine reference search (G74)	2
4.3	Programming with respect to machine zero (G53)	3
4.4	Presetting of coordinates and zero offsets	4
4.4.1	Coordinate preset and limitation of the s value (g92)	6
4.4.2	Zero offsets (g54..g59)	7
4.5	Polar origin preset (g93)	9

5. PROGRAMMING BY ISO CODE

5.1	Preparatory functions	2
5.2	Feedrate F	4
5.2.1	Feedrate in mm/min or inches/min (g94)	4
5.2.2	Feedrate in mm/rev.or inches/rev (g95)	5
5.2.3	Constant surface speed (g96)	6
5.2.4	Constant tool-center speed (g97)	6
5.3	Spindle speed (s)	7
5.4	Spindle selection (g28, g29)	8
5.5	Synchronized spindles (g30, g77s, g78s)	9
5.6	Tool number (t) and tool offset (d)	10
5.7	Miscellaneous function (m)	12
5.7.1	M00. program stop	13
5.7.2	M01. conditional program stop	13
5.7.3	M02. end of program	13
5.7.4	M30. end of program with return to first block	13
5.7.5	M03. clockwise spindle rotation	13
5.7.6	M04. counter-clockwise spindle rotation	13
5.7.7	M05. spindle stop	13
5.7.8	M06. tool change	14
5.7.9	M19. spindle orientation	14
5.7.10	M41, M42, M43, M44. spindle speed range change	15
5.7.11	M45 auxiliary spindle / live tool	15

6. PATH CONTROL

6.1	Rapid travel (g00)	1
6.2	Linear interpolation (g01)	2
6.3	Circular interpolation (g02, g03)	3
6.4	Circular interpolation by programming the center of the arc in absolute coordinates (g06)	9
6.5	Arc tangent to the previous path (g08)	10
6.6	Arc defined by three points (g09)	11
6.7	Helical interpolation	12
6.8	Tangential entry at beginning of a machining operation (g37)	14
6.9	Tangential exit at the end of a machining operation (g38)	16
6.10	Automatic radius blend (g36)	18
6.11	Automatic chamfer blend (g39)	19
6.12	Threading (g33)	20
6.13	Variable pitch threads (G34)	21
6.14	Move to hardstop (G52)	22
6.15	Feedrate "F" as an inverted function of time (G32)	23
6.16	Tangential control (G45)	24
6.16.1	Considerations about function G45	26

7. ADDITIONAL PREPARATORY FUNCTIONS

7.1	Interruption of block preparation (G04)	1
7.2	Dwell (G04 K)	3
7.3	Working with square (g07) and round (g05,g50) corners	4
7.3.1	Square corner (g07)	4
7.3.2	Round corner (g05)	5
7.3.3	Controlled round corner (g50)	6
7.4	Look-ahead (g51)	7
7.5	Mirror image (g10, g11, g12, g13, g14)	9
7.6	Scaling factor (g72)	11
7.6.1	Scaling factor applied to all axes	12
7.6.2	Scaling factor applied to one or more axes	14
7.7	Pattern rotation (g73)	16
7.8	Slaved axis/cancellation of slaved axis	18
7.8.1	Slaved axis (g77)	19
7.8.2	Slaved axis cancellation (g78)	20
7.9	Axes toggle. G28-G29	21

8. TOOL COMPENSATION

8.1	Tool radius compensation (g40, g41, g42)	2
8.1.1	Activating tool radius compensation	3
8.1.2	Tool radius compensation sections	6
8.1.3	Cancelling tool radius compensation	9
8.2	Tool length compensation (g43, g44, g15)	15
8.3	Collision detection (G41 N, G42 N)	17

9. CANNED CYCLES

9.1	Definition of a canned cycle	1
9.2	Canned cycle area of influence	2
9.2.1	G79. modification of canned cycle parameters	2
9.3	Canned cycle cancellation	4
9.4	General considerations	5
9.5	Machining canned cycles	6
9.5.1	G69. Complex deep hole drilling cycle	9
9.5.2	G81 Drilling canned cycle	13
9.5.3	G82. Drilling canned cycle with dwell	15
9.5.4	G83. Simple deep hole drilling	17
9.5.5	G84. Tapping canned cycle	20
9.5.6	G85. Reaming cycle	23
9.5.7	G86. Boring cycle with withdrawal in rapid (g00)	25
9.5.8	G87. Rectangular pocket canned cycle	27
9.5.9	G88. Circular pocket canned cycle	35
9.5.10	G89. Boring cycle with withdrawal at working feedrate (g01)	42

10. MULTIPLE MACHINING

10.1	G60: Multiple machining in a straight line pattern	2
10.2	G61: Multiple machining in a rectangular pattern	5
10.3	G62: Multiple machining in a grid pattern	8
10.4	G63: Multiple machining in a circular (bolt-hole) pattern	11
10.5	G64: Multiple machining in an arc pattern	14
10.6	G65: Machining programmed by means of an arc chord	17

11. IRREGULAR POCKET CANNED CYCLE (WITH ISLANDS)

11.1	2D pockets	2
11.1.1	Drilling operation	5
11.1.2	Roughing operation	6
11.1.3	Finishing operation	9
11.1.4	Profile programming rules	12
11.1.5	Intersection of profiles	13
11.1.5.1	Basic profile intersection (k=0)	13
11.1.5.2	Advanced profile intersection (k=1)	14
11.1.5.3	Resulting profile	16
11.1.6	Profile programming syntax.....	17
11.1.7	Errors	19
11.1.8	Programming examples	21
11.2	3D pockets	25
11.2.1	Roughing operation	29
11.2.2	Semi-finishing operation	32
11.2.3	Finishing operation	34
11.2.4	Profile or contour geometry	36
11.2.5	Profile programming rules	37
11.2.5.1	Programming examples	39
11.2.6	Composite 3d profiles	42
11.2.6.1	Profile intersecting rules	43
11.2.7	Stacked profiles	45
11.2.8	Profile programming syntax.....	46
11.2.9	Examples	48
11.2.10	Errors	59

12. WORKING WITH A PROBE

12.1	Probing (g75,g76).....	2
12.2	Probing canned cycles	3
12.3	Tool length calibration canned cycle	4
12.4	Probe calibrating canned cycle	7
12.5	Surface measuring canned cycle	11
12.6	Outside corner measuring canned cycle	15
12.7	Inside corner measuring canned cycle	18
12.8	Angle measuring canned cycle	21
12.9	Outside corner and angle measuring canned cycle	24
12.10	Hole measuring canned cycle	28
12.11	Boss measuring canned cycle	32

13. PROGRAMMING IN HIGH-LEVEL LANGUAGE

13.1	Lexical description	1
13.1.1	Reserved words	2
13.1.2	Numerical constants	3
13.1.3	Symbols	3
13.2	Variables	4
13.2.1	General purpose parameters or variables	6
13.2.2	Variables associated with tools	8
13.2.3	Variables associated with zero offsets	10
13.2.4	Variables associated with function g49	11
13.2.5	Variables associated with machine parameters	12
13.2.6	Variables associated with work zones	13
13.2.7	Variables associated with feedrates	14
13.2.8	Variables associated with coordinates	16

13.2.9	Variables associated with the electronic handwheels	18
13.2.10	Variables associated with the main spindle	20
13.2.11	Variables associated with the 2nd spindle	22
13.2.12	Variables associated with the live tool	24
13.2.13	Variables associated with the plc	25
13.2.14	Variables associated with local parameters	26
13.2.15	Sercos variables	27
13.2.16	Software & hardware configuration variables	28
13.2.17	Variables associated with telediagnosis	30
13.2.18	Variables associated with the operating mode	31
13.2.19	Other variables	34
13.3	Constants	39
13.4	Operators	39
13.5	Expressions	41
13.5.1	Arithmetic expressions	41
13.5.2	Relational expressions	42

14. PROGRAM CONTROL STATEMENTS

14.1	Assignment statements	1
14.2	Display statements	2
14.3	Enabling-disabling statements	3
14.4	Flow control statements	4
14.5	Subroutine statements	6
14.5.1	Interruption subroutine statements	12
14.6	Program statements	13
14.7	Screen customizing statements (graphic editor)	16

15. DIGITIZING CYCLES

15.1	digitizing cycle in a grid pattern	2
15.2	digitizing cycle in an arc pattern	5

16. TRACING AND DIGITIZING

16.1	Introduction	1
16.1.1	General considerations	7
16.2	G26. Calibration of the tracing probe	9
16.3	G23. Activate tracing	11
16.3.1	G23. Activate manual tracing	12
16.3.2	G23. Activate one-dimensional tracing	14
16.3.3	G23. Activate two-dimensional tracing	16
16.3.4	G23. Activate three-dimensional tracing	18
16.4	G27. Tracing contour definition	20
16.5	G25. Deactivate tracing	24
16.6	G24. Activate digitizing	25
16.7	Tracing and digitizing canned cycles	28
16.7.1	Grid -pattern tracing canned cycle	29
16.7.2	Arc pattern tracing canned cycle	34
16.7.3	Profile tracing canned cycle along a plane	40
16.7.4	3D profile tracing canned cycle	45
16.7.5	Tracing canned cycle with polygonal sweep	50
16.7.5.1	Profile programming rules	55
16.7.5.2	Profile programming syntax	56

17. COORDINATE TRANSFORMATION

17.1	Movement in the Incline Plane	7
17.1.1	Incline plane definition (G49)	8
17.1.2	G49 on swivel spindle heads	12
17.1.3	G49 on Huron type spindles	12
17.1.4	Considerations for function G49	13
17.1.5	Variables associated with function G49	14
17.1.6	Parameters associated with function G49	14
17.1.7	Programming example	15
17.2	Movement according to the tool coordinate system (G47)	16
17.3	TCP Transformation (G48)	17
17.3.1	Considerations for function G48	21

APPENDIX

Iso code programming	3
Internal cnc variables	5
High level programming	11
Key codes	13
Logic outputs for key status	18
Keys inhibiting codes	23
Programming assistance system pages	28
Maintenance	31

Introduction

<i>Safety conditions</i>	3
<i>Material returning terms</i>	5
<i>Fagor documentation for the CNC</i>	6

SAFETY CONDITIONS

Fagor Automation 가

Fagor Automation

Precautions against personal damage

가

90% 45° C (113° F)

Precautions against product damage

Europe

가

Automation ()

Fagor

가 , CNC , ,

European

- AC (,)

- Etc.

Ambient conditions

+5° C	+45° C	가	. (41° F	113° F)
-25° C	70° C	가	. (-13° F	158° F)



Fagor Automation

AC

(/ ,)

AC



"

"



"

"



가

1.- 15cm (6inches) 170Kg (375 lb.)

2.- Fagor Automation

3.- CRT

4.-

5.-

CNC FAGRO

OEM Manual	CNC			
USER-M Manual	M	CNC		
	2	:		
	Operating Manual		CNC	
	Programming Manual		CNC	
USER-T Manual	T	CNC		
	2	:		
	Operating Manual		CNC	
	Programming Manual		CNC	
MC Manual	MC	CNC		
TC Manual	TC	CNC		
MCO/TCO Manual	MCO/TCO	CNC		
DNC Software Manual	DNC			
DNC Protocol Manual	CNC	DNC		
FLOPPY DISK Manual	Fagor			

1. OVERVIEW

CNC () 가 part program (/ , 가)
 1Mbyte .

CNC :

* CNC

* (DNC) . RS232C RS422

CNC ()

"PROTOCOL"

“PROTOCOL” = 0
 “PROTOCOL” = 1 DNC

1.1 PART-PROGRAMS

Editing

5

CNC RAM

"MemKey Card", 1 2 PC
 (HD) 7

1 2 PC :

- PC "WinWND.exe"
- CNC DNC 8
- 7

: Utility/Directory/Serial L./Change directory.

CNC RAM
"MemKey Card", PC, RAM

Execution

3
CNC RAM
PC 14 GOTO RPT
CNC RAM , "MemKey Card", PC,
CNC RAM
EXEC , RAM , "MemKey Card", PC, 14

Utilities

Ethernet

가 PC 가 : CNC가
• (HD)
• (HD)
• PC
CNC 3.3.4

:

	RAM Memory	CARD A	HD	DNC
Consult the program directory in ...	Yes	Yes	Yes	Yes
Consult the subroutine directory in ...	Yes	No	No	No
Create work directory in ..	No	No	No	No
Change work directory in ..	No	No	No	Yes
Edit a program in ..	Yes	No	No	No
Modify a program in ..	Yes	No	No	No
Delete a program from ..	Yes	Yes	Yes	Yes
Copy from/to RAM memory to/from ...	Yes	Yes	Yes	Yes
Copy from/to CARD A to/from ...	Yes	Yes	Yes	Yes
Copy from/to HD to/from ...	Yes	Yes	Yes	Yes
Copy from/to DNC to/from ...	Yes	Yes	Yes	Yes
Rename a program in ..	Yes	Yes	Yes	No
Change the comment of a program in ..	Yes	Yes	Yes	No
Change protections of a program in ..	Yes	Yes	Yes	No
Execute a part-program in ..	Yes	Yes	Yes	Yes
Execute a user program in ..	Yes	No	No	No
Execute the PLC program in ..	Yes	*	No	No
Execute programs using the GOTO or RPT instructions from ..	Yes	Yes	Yes	No
Execute subroutines stored in ..	Yes	No	No	No
Execute programs stored in RAM, CARD A or HD using the EXEC instruction from ..	Yes	Yes	Yes	Yes
Execute programs via DNC with the EXEC instruction from ..	Yes	Yes	Yes	No
Open programs stored in RAM, CARD A or HD using the OPEN instruction from ..	Yes	Yes	Yes	Yes
Open programs via DNC using the OPEN instruction from ..	Yes	Yes	Yes	No
Consult from a PC and through Ethernet, the program directory in ...	No	No	Yes	No
Consult from a PC and through Ethernet, the subroutine directory in ...	No	No	No	No
Create from a PC and through Ethernet, a directory in...	No	No	No	No

* If it is not in RAM memory, it generates an executable code in RAM and it executes it..

1.1.1 ETHERNET

```

PC
CNC
CNC
:
• << >>
• << >> << >>
• : <<D>>
• : //FAGORCNC/CNCHD (CNC 가 )
• << >> << >> CNC가
CNC
(HD)
6 PIM( ) PIT( )
: 001204.PIM 000100.PIT
: 1204.PIM 100.PIT , CNC
*****!
CNC PC
가 (0) , CNC *****!
CNC PC
% , ( 20 )
(,) 가 : O (OEM), H (hidden), M(modifiable),
X(executable).
% ,MX,
% ,OMX,

```

. , CNC 가 (M) 가 (X)
.
, CNC
'*****'
가 , 가 . CNC, PC
:
20 .
가 (,)가 .
가 .

1.2 DNC

CNC DNC(Distributed Numerical Control) , :
CNC 가

- *
- * CNC PC
- *
- * DNC

1.3 DNC

가, / 가 , CNC CNC
:

- * % 20 .
- ," 가 ,

RETURN(RT) LINE FEED(LF) ;

:
%Fagor Automation, -MX, RT

- * , . RETURN
- (RT) LINE FEED(LF) .

:
N20 G90 G01 X100 Y200 F2000 LF
(RPT N10, N20) N3 LF

가 "EOFCHR" , 'end of file' 가 .

ESC
EOT
SUB
EXT

2. *CREATING A PROGRAM*

CNC (numerical control)

CNC

- .+ -
- 0 1 2 3 4 5 6 7 8 9

, space 가 가 가
가 . 가 가

XP3가
0.003

CNC

P3 X20, X20.567, X-

2.1 *CREATING A PROGRAM IN THE CNC*

가 :

Block header + program block + end of block

2.1.1 BLOCK HEADER

가

CONDITION FOR BLOCK SKIP, /, /1, /2, /3.

"/" "/1"
BLKSKIP3

PLC BLKSKIP1, BLKSKIP2,

"/" "/1" 가 CNC

3

20

20

G4

가

BLOCK LABEL OR NUMBER N(0-9999)

N 4 (0-9999)

가

CNC

CNC

2.1.2 PROGRAM BLOCK

ISO High Level

2.1.2.1 ISO LANGUAGE

ISO

. ISO

:

*

*

*

*

2.1.2.2 HIGH LEVEL LANGUAGE

High Level

IF, GOTO, CALL

, (,) 가 .
" ' 가 ."
가 가 .

2.1.3 END OF BLOCK

가

NUMBER OF REPETITIONS OF THE BLOCK, N(0-9999)

, (canned cycle modal)

N 4 (0-9999)

NO가

BLOCK COMMENT

CNC

","

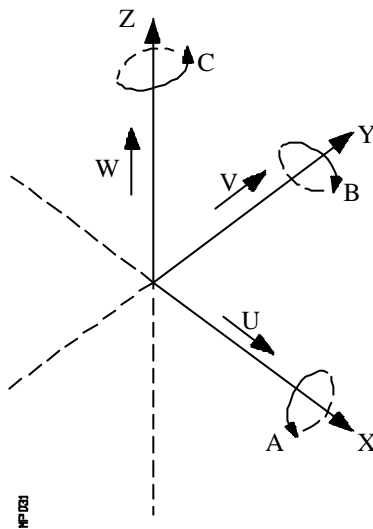
","

3. AXES AND COORDINATE SYSTEMS

CNC , , CNC 가 .

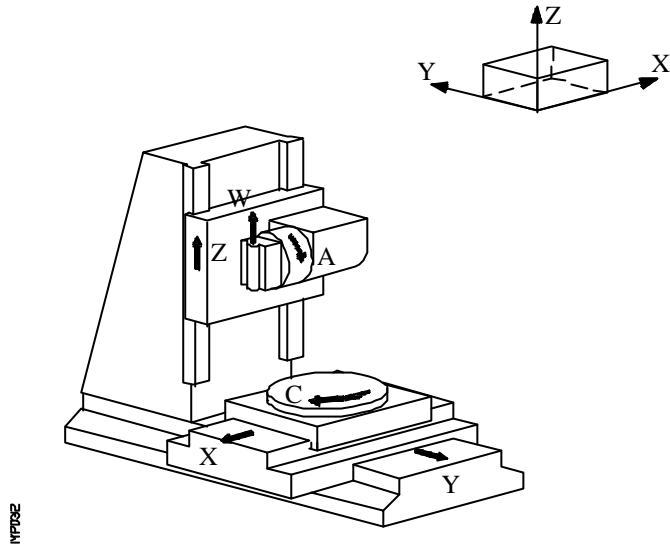
3.1 NOMENCLATURE OF THE AXES

DIN 66217



- * X & Y :
- * Z :
- * U, V, W : X, Y, Z
- * A, B, C : X, Y, Z

가



3.1.1 SELECTION OF THE AXES

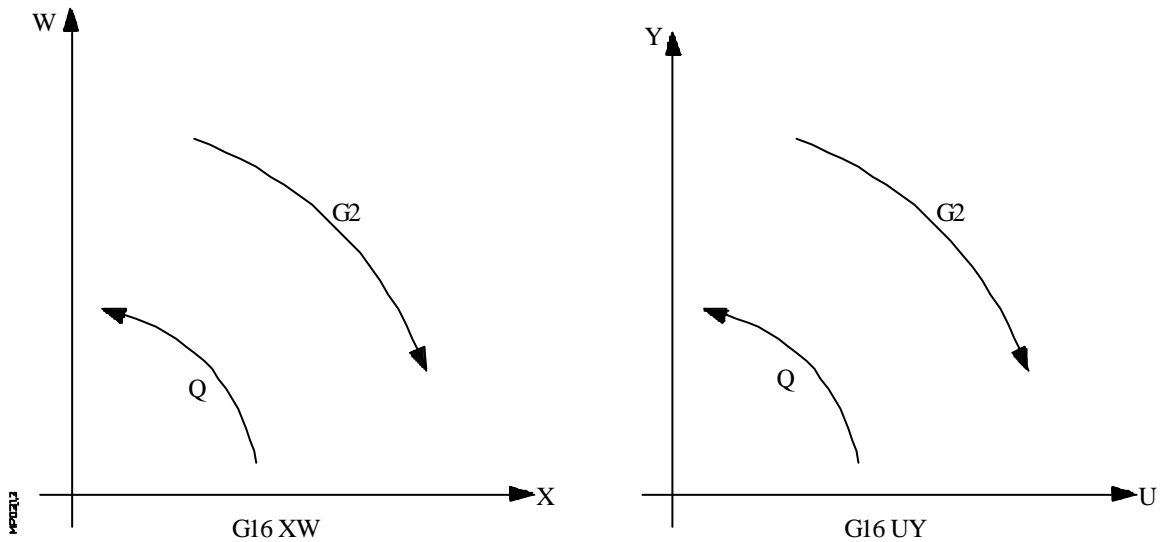
9 , CNC 7 .
 /
 .
 가 . 7 .

3.2 PLANE SELECTION (G16, G17, G18, G19)

:
 -
 -
 -
 -
 - canned cycle
 -
 -
 -

가 "G" :

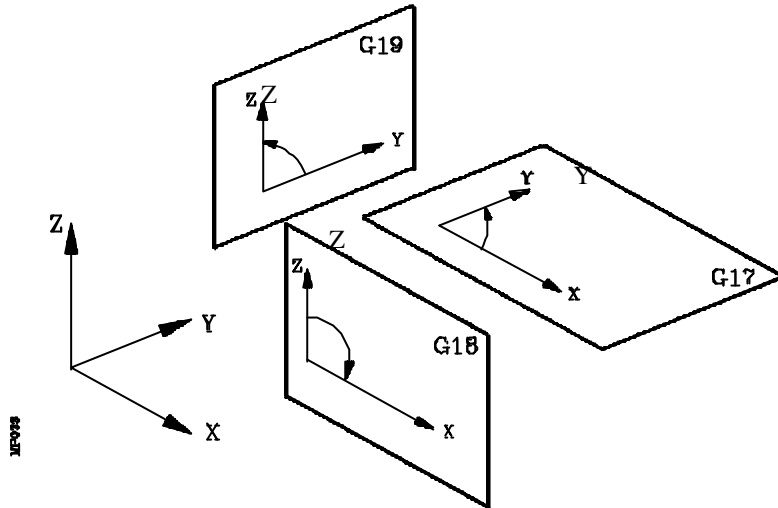
* G16 axis1 axis2.
 axis2 G02 G03 () axis1



- * G17. XY .
- * G18. ZY .
- * G19. YZ .

G16, G17, G18, G19

. G16



G17, G18, G19 (X, Y, Z)

가

Y, Z 가 , CNC G17, G18, G19 , CNC X,

, CNC , M02, M30 "IPLANE" EMERGENCY RESET

: " " G49 . 17

3.4 ABSOLUTE/INCREMENTAL PROGRAMMING (G90, G91)

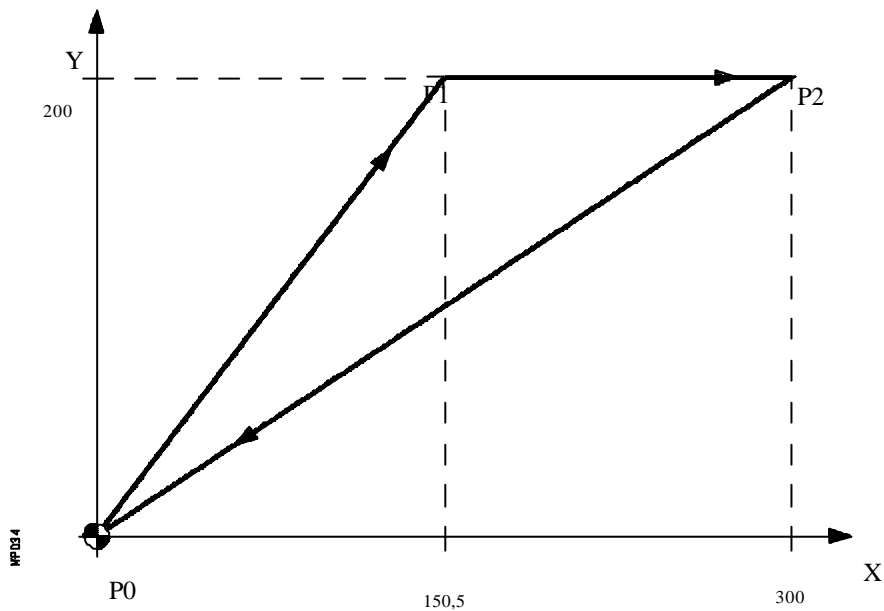
CNC G90 G91

(G90)
part zero () ,

(G91) , 가 가

G90/G91

:



G90 X0 Y0 ; Point P0
 X150.5 Y200 ; Point P1
 X300 ; Point P2
 X0 Y0 ; Point P0

G90 X0 Y0 ; Point P0
G91 X150.5 Y200 ; Point P1
 X149.5 ; Point P2
 X-300 Y-200 ; Point P0

, M02, M30 EMERGENCY RESET CNC
 "ISYSTEM" G90 G91

3.5 PROGRAMMING OF COORDINATES

9 X, Y, Z, U, V, W, A, B, C

7

"AXISTYPE"

가

, CNC

가 :

- *
- *
- *
- *

3.5.1 CARTESIAN COORDINATES

X Y X

2, 3, 4 5 가

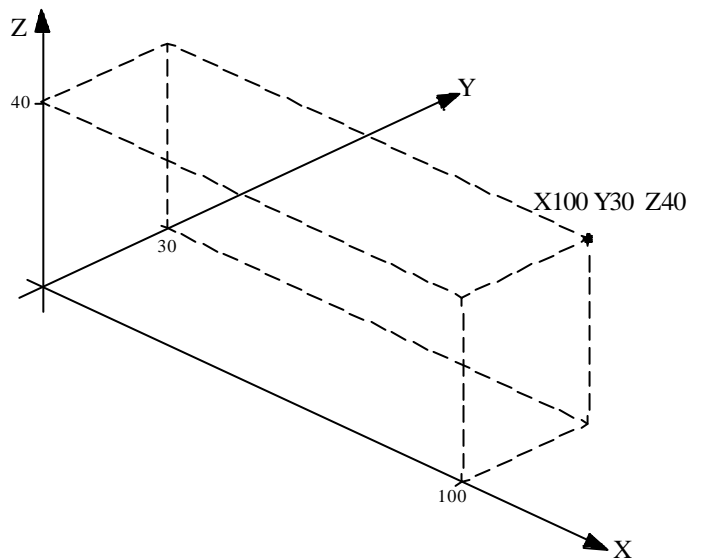
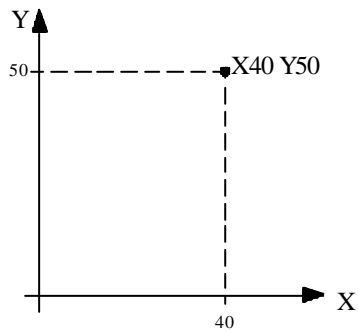
(X, Y, Z, U, V, W, A, B, C,

)

G90 G91

+/- 5.

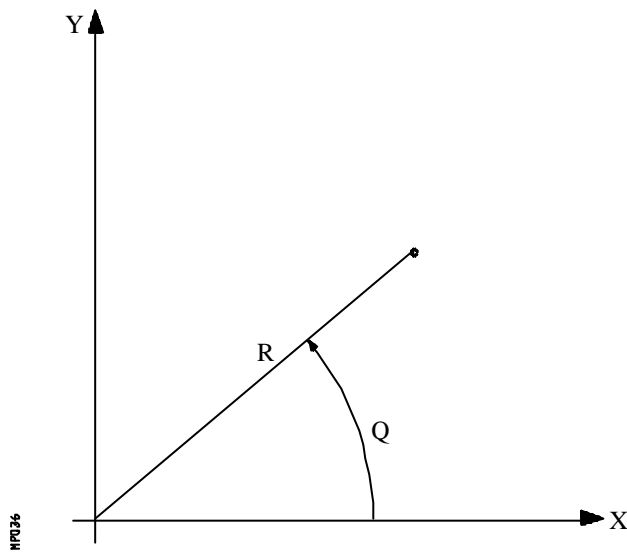
5



MFDS6

3.5.2 POLAR COORDINATES

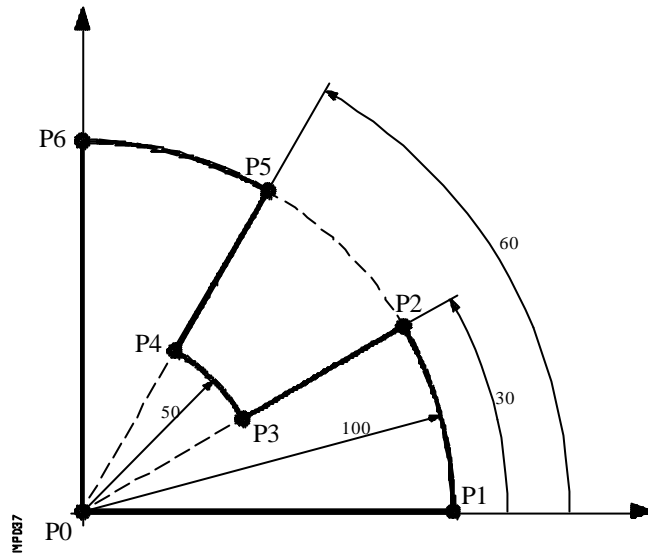
가 , (2)
 (Polar Origin) , (Polar Coordinate System)
 :



- (R),
- (Q), 가 ()

R Q G90 G91 R +/- 5.5 Q +/- 5.5
 (+)
 360 Q , 360
 , Q420 Q60 Q-240 Q-60

가



G90 X0 Y0 ; Point P0
 G01 R100 Q0 ; Point P1, in a straight line (G01)
 G03 Q30 ; Point P2, in an arc (G03)
 G01 R50 Q30 ; Point P3, in a straight line (G01)
 G03 Q60 ; Point P4, in an arc (G03)
 G01 R100 Q60 ; Point P5, in a straight line (G01)
 G03 Q90 ; Point P6, in an arc (G03)
 G01 R0 Q90 ; Point P0, in a straight line (G01)

G90 X0 Y0 ; Point P0
G91 G01 R100 Q0 ; Point P1, in a straight line (G01)
 G03 Q30 ; Point P2, in an arc (G03)
 G01 R-50 Q0 ; Point P3, in a straight line (G01)
 G03 Q30 ; Point P4, in an arc (G03)
 G01 R50 Q0 ; Point P5, in a straight line (G01)
 G03 Q30 ; Point P6, in an arc (G03)
 G01 R-100 Q0 ; Point P0, in a straight line (G01)

G93()

* , M02, M30 EMERGENCY RESET , CNC
 "IPLANE"

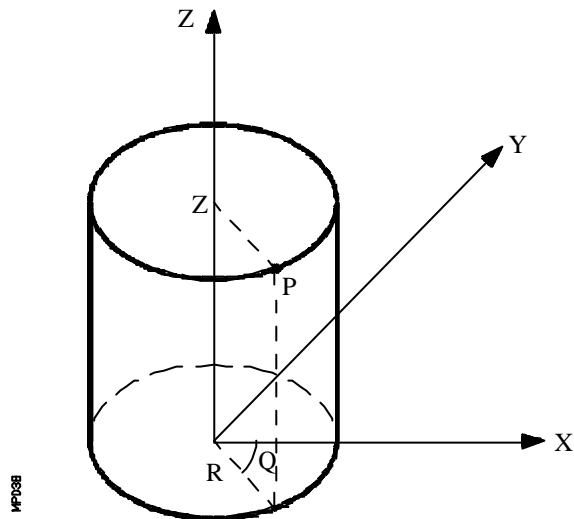
* (G16, G17, G18 G19) , CNC

* (G02 G03) , "PORGMOVE"

가 1

3.5.3 CYLINDRICAL COORDINATES

가



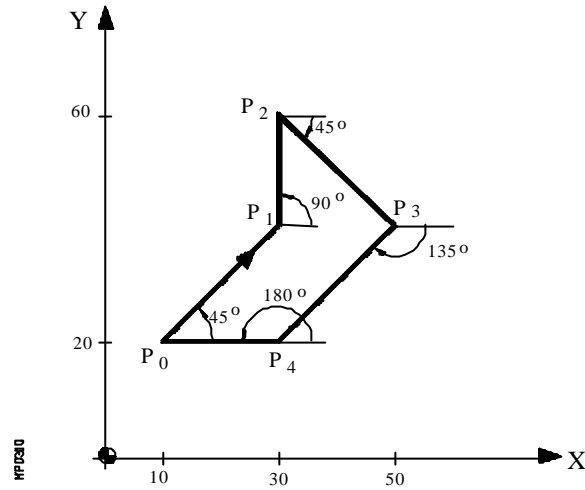
* (R Q) (projection)

*

: R30 Q10 Z100 R20 Q45 Z10 V30 A20

3.5.4 ANGLE AND ONE CARTESIAN COORDINATE

XY :



X10 Y20 ; Point P0,
 Q45 X30 ; Point P1
 Q90 Y60 ; Point P2
 Q-45 X50 ; Point P3
 Q-135 Y20 ; Point P4
 Q180 X10 ; Point P0

3.6 ROTARY AXES

가 :

Normal rotary axis.
Positioning-only rotary axis.
Hirth rotary axis.

Rollover : 가 0° 360°
No rollover : 가 -99999° 99999°
inch/mm

Normal rotary axes

: G00 G01
Rollover : 가 (0 359.9999)
G90 : 360°
G91 :
Non-rollover : G90 G91

Positioning-only Axes

: G00 (G41, G42)
Rollover : 가 . 0 359.9999
G90 : 360°
G91 :
Non-rollover : G90 G91

HIRTH axes

positioning-only axis
hirth

3.7 WORK ZONES

CNC 4

3.7.1 DEFINITION OF THE WORK ZONES

G20:

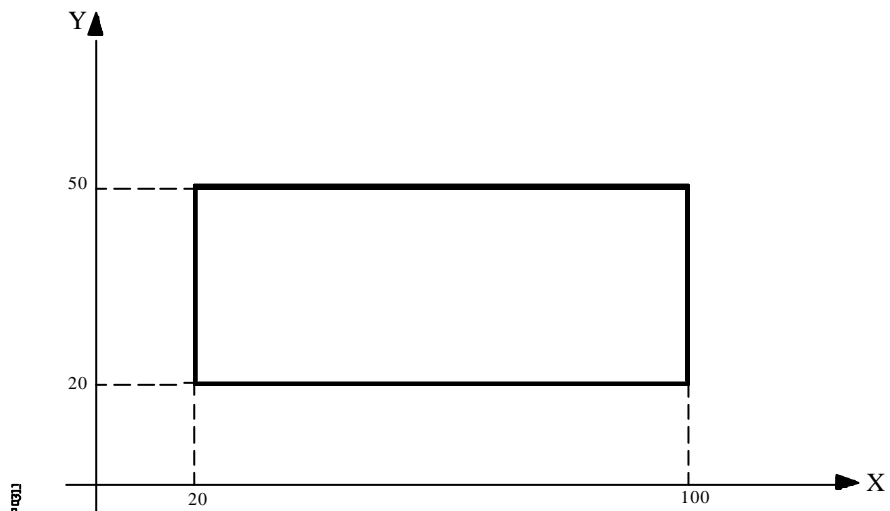
G21:

G20 K X...C +/- 5.5

G20 K X...C +/- 5.5

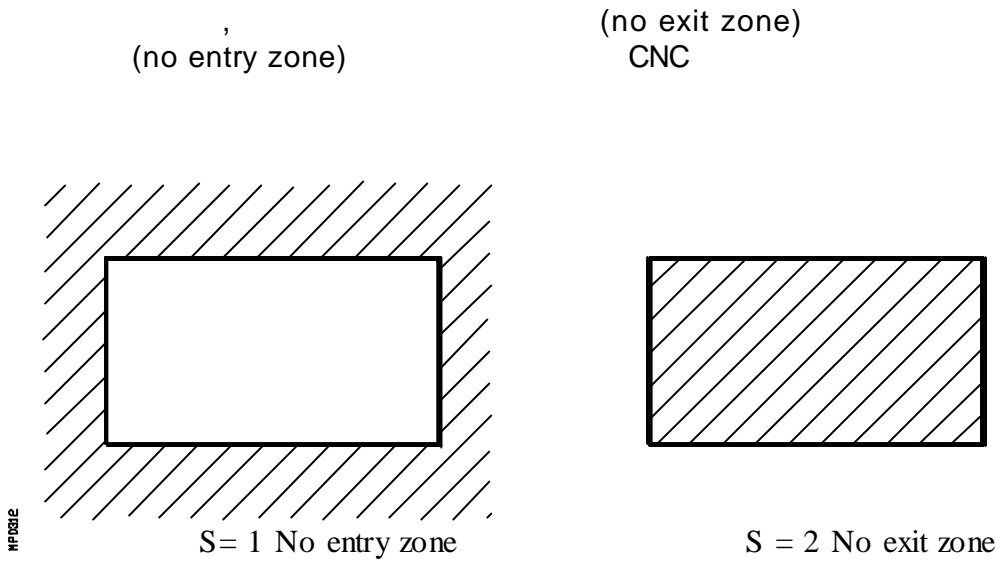
* **K** 가 (1, 2, 3 4)

* **X...C** (home)



G20 K1 X20 Y20
G21 K1 X100 Y50

3.7.2 USING WORK ZONES



CNC

G22 가

G22 K S

* **K** 가 (1, 2, 3 4)

* **S** / :

- S=0
- S=1 no -entry zone
- S=2 no -exit zone

, CNC

G22

4. REFERENCE SYSTEMS

4.1 REFERENCE POINTS

CNC :

* **Machine Reference Zero** or home.

가

* **Part zero** or point of origin of the part.

가

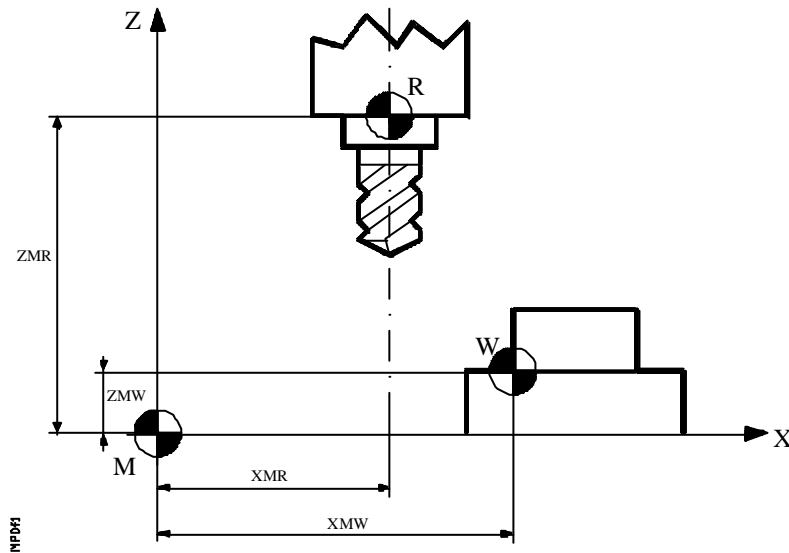
* **Machine Reference point.**

가

가

Machine Reference Zero

REFVALUE"



M

Machine reference zero

W

Part zero

R

Machine reference point

XMW, YMW, ZMW, etc.

Coordinates of part zero

ZMR, YMR, XMR, etc.

Coordinates of machine reference point

("REFVALUE")

4.2 MACHINE REFERENCE SEARCH (G74)

가 :

* MACHINE REFERENCE SEARCH OF ONE OR MORE AXES IN A PARTICULAR ORDER

G74가 :
G74 X Z C Y

CNC ("DECINPUT") 가
"REFDIREC"

가 "REFEED1"

"REFEED2"

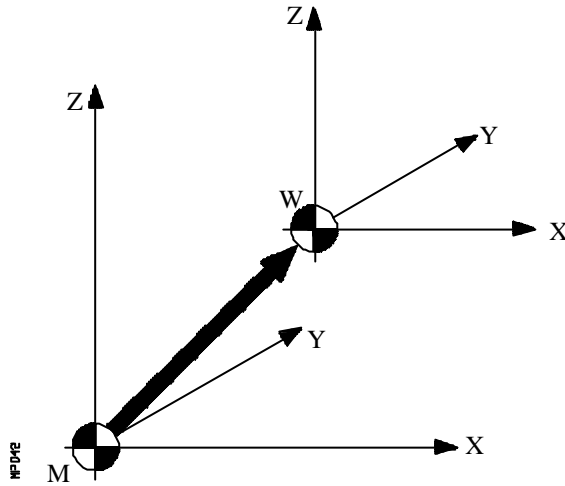
* MACHINE REFERENCE SEARCH USING THE ASSOCIATED SUBROUTINE.

G74 , CNC
"REFPSUB"

G74가 ,
가 JOG
"REFVALUE" , 가 ,

G74 MDI : Jog, Execution
Simulation

4.4 PRESETTING OF COORDINATES AND ZERO OFFSETS



M Machine zero
W Part zero

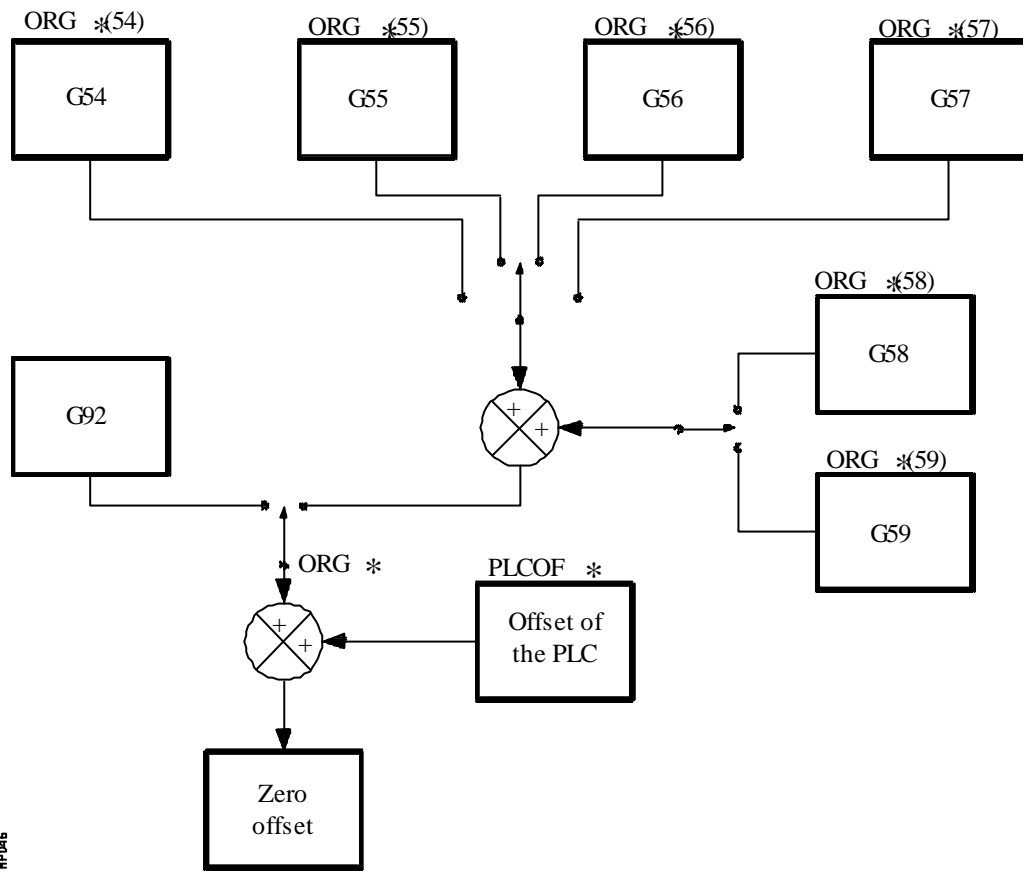
가 가 :

* G92 () . CNC G92

* (G54, G55, G56, G57, G58, G59) . CNC

가

가, PLC
 가



MF046

4.4.1 COORDINATE PRESET AND LIMITATION OF THE S VALUE (G92)

G92 CNC , 가

*

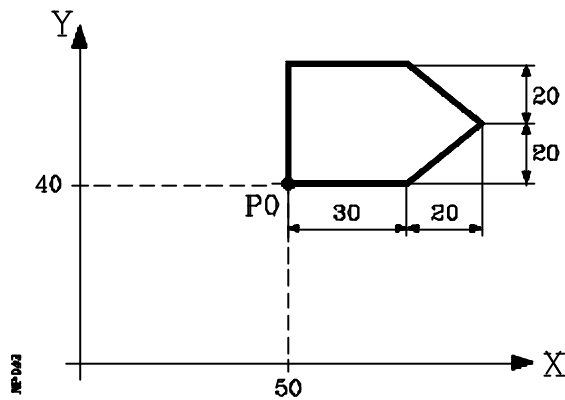
G92 , CNC G92

G92가

:

G92X...C +/- 5.5

:



```
G90 X50 Y40 ; Positioning in P0
G92 X0 Y0 ; Preset P0 as part zero
G91 X30 ; Programming according to part coordinates
X20 Y20
X-20 Y20
X-30 Y-40
```

* Spindle

"G92 S5.4" type , CNC S5.4

,"S" , CNC G92S "S"

4.4.2 ZERO OFFSETS (G54..G59)

CNC 가 .

CNC () high-level

가 :

Absolute zero offsets (G54,G55,G56 & G57).

Additive zero offsets (G58,G59).

G54, G55, G56, G57, G58, G59

:

G54, G55, G56, G57 가 , CNC

가 G58 G59 가 , CNC

가

. ()

G54	G54		-----	>	G54
G58	G58	가	-----	>	G54+G58
G59	G58		G59 가 -----	>	G54+G59
G55			G55 -----	>	G55

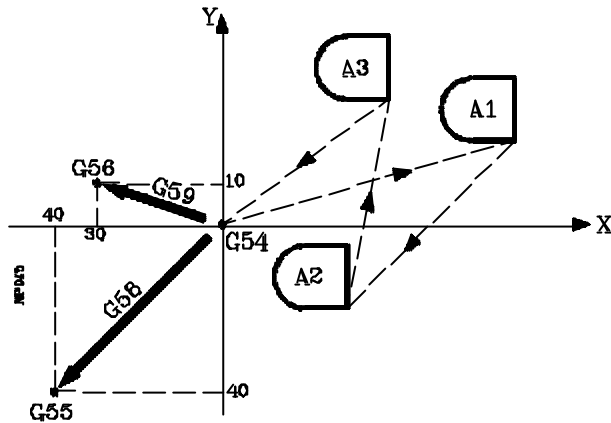
가 , JOG (G74)가
가 CNC

가

:

:

G54: X200 Y100
 G55: X160 Y 60 G58: X-40 Y-40
 G56: X170 Y110 G59: X-30 Y 10



zero offset :

G54 ; Applies G54 offset
 Profile execution ; Executes profile A1
 G55 ; Applies G55 offset
 Profile execution ; Executes profile A2
 G56 ; Applies G56 offset
 Profile execution ; Executes profile A3

zero offset :

G54 ; Applies G54 offset
 Profile execution ; Executes profile A1
 G58 ; Applies offsets G54+G58
 Profile execution ; Executes profile A2
 G59 ; Applies offsets G54+G59
 Profile execution ; Executes profile A3

4.5 POLAR ORIGIN PRESET (G93)

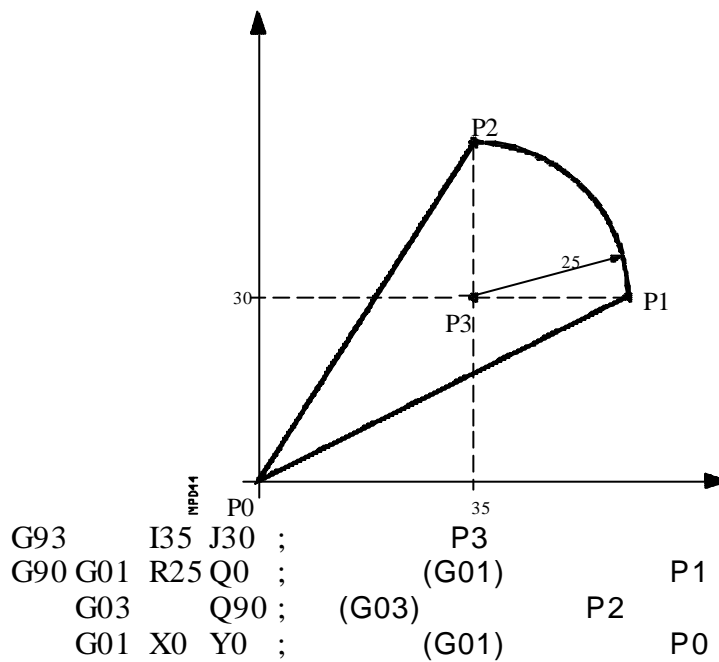
G93

G93 I+/-5.5 J+/-5.5

I & J

가 X0 Y0


가



G93

가

가



: "PORGE" "PORGS"
 "POGEMOVE"가 (G02 G03)
 , CNC
 , M02, M30 EMERGENCY RESET , CNC
 (G16, G17, G18, G19) , CNC

5.1 PREPARATORY FUNCTIONS

G

CNC

CNC G :

Function	M	D	V	Meaning	Section
G00	*	?	*	Rapid travel	6.1
G01	*	?	*	Linear interpolation	6.2
G02	*		*	Clockwise (helical) circular interpolation	6.3
G03	*		*	Counter-clockwise (helical) circular interpolation	6.3
G04				Dwell/block preparation stop	7.1, 7.2
G05	*	?	*	Round corner	7.3.1
G06			*	Absolute arc center coordinates	6.4
G07	*	?		Square corner	7.3.2
G08			*	Arc tangent to previous path	6.5
G09			*	Arc defined by three points	6.6
G10	*	*		Mirror image cancellation	7.5
G11	*		*	Mirror image on X axis	7.5
G12	*		*	Mirror image on Y axis	7.5
G13	*		*	Mirror image on Z axis	7.5
G14	*		*	Mirror image in the programmed directions	7.5
G15	*		*	Longitudinal axis selection	8.2
G16	*		*	Selection of main plane in two directions	3.2
G17	*	?	*	Main plane X-Y and longitudinal Z	3.2
G18	*	?	*	Main plane Z-X and longitudinal Y	3.2
G19	*		*	Main plane Y-Z and longitudinal X	3.2
G20				Definition of lower work zone limits	3.7.1
G21				Definition of upper work zone limits	3.7.1
G22			*	Activate/cancel work zones	3.7.2
G23			*	Activate tracing	16.3
G24			*	Activate digitizing	16.6
G25				Deactivate tracing/digitizing	16.5
G26			*	Tracing probe calibration	16.2
G27			*	Tracing contour definition	16.4
G28	*		*	Second spindle selection	5.4
G29	*	*		Main spindle selection	5.4
G28-G29			*	Axis toggle	7.9
G30	*		*	Spindle synchronization (offset)	5.5
G32	*		*	Feedrate as an inverted function of time	6.15
G33	*		*	Threadcutting	6.12
G34				Variable pitch threading	6.13
G36			*	Automatic radius blend	6.10
G37			*	Tangential entry	6.8
G38			*	Tangential exit	6.9
G39			*	Automatic chamfer blend	6.11
G40	*	*		Cancellation of tool radius compensation	8.1
G41	*		*	Right-hand tool radius compensation	8.1
G41N	*		*	Collision detection	8.3
G42	*		*	Left-hand tool radius compensation	8.1
G42N	*		*	Collision detection	8.3
G43	*	?	*	Tool length compensation	8.2
G44	*	?	*	Cancellation of tool length compensation	8.2
G45	*		*	Tangential control	6.16
G47			*	Tool movement according tool coordinate system	17.2
G48	*		*	TCP transformation	17.3
G49	*		*	Incline plane definition	17.1
G50	*		*	Controlled corner rounding	7.3.3
G51	*		*	Look-Ahead	7.4
G52	*		*	Movement until making contact	6.14
G53			*	Program coordinates with respect to home	4.3

Function	M	D	V	Meaning	Section
G54	*		*	Absolute zero offset 1	4.4.2
G55	*		*	Absolute zero offset 2	4.4.2
G56	*		*	Absolute zero offset 3	4.4.2
G57	*		*	Absolute zero offset 4	4.4.2
G58	*		*	Additive zero offset 1	4.4.2
G59	*		*	Additive zero offset 2	4.4.2
G60			*	Straight line canned cycle	10.1
G61			*	Rectangular pattern canned cycle	10.2
G62			*	Grid pattern canned cycle	10.3
G63			*	Circular pattern canned cycle	10.4
G64			*	Arc pattern canned cycle	10.5
G65			*	Arc-chord pattern canned cycle	10.6
G66			*	Irregular pocket canned cycle	11.1
G67			*	Irregular pocket roughing	11.1.2
G68			*	Irregular pocket finishing	11.1.3
G69	*		*	Complex deep hole drilling	9.5.1
G70	*	?	*	Programming in inches	3.3
G71	*	?	*	programming in millimeters	3.3
G72	*		*	General and specific scaling factor	7.6
G73	*		*	Pattern rotation	7.7
G74			*	Machine reference search	4.2
G75			*	Probing until touching	12.1
G76			*	Probing while touching	12.1
G77	*		*	Slaved axis	7.8.1
G77S	*		*	Spindle synchronization	5.5
G78	*	*	*	Slaved axis cancellation	7.8.2
G78S	*	*	*	Cancellation of spindle synchronization	5.5
G79	*	*	*	Canned cycle parameter modification	9.2.1
G80	*	*	*	Canned cycle cancellation	9.3
G81	*		*	Drilling cycle	9.5.2
G82	*		*	Drilling cycle with dwell	9.5.3
G83	*		*	Simple deep hole drilling	9.5.4
G84	*		*	Tapping cycle	9.5.5
G85	*		*	Reaming cycle	9.5.6
G86	*		*	Boring cycle with withdrawal in G00	9.5.7
G87	*		*	Rectangular pocket milling cycle	9.5.8
G88	*		*	Circular pocket milling cycle	9.5.9
G89	*		*	Boring cycle with withdrawal in G01	9.5.10
G90	*	?	*	Programming in absolute	3.4
G91	*	?	*	Programming in incremental	3.4
G92			*	Coordinate preset/spindle speed limit	4.4.1
G93			*	Polar origin preset	4.5
G94	*	?	*	Feedrate in millimeters(inches) per minute	5.2.1
G95	*	?	*	Feedrate in millimeters(inches) per revolution	5.2.2
G96	*		*	Constant cutting point speed	5.2.3
G97	*	*	*	Constant tool center speed	5.2.4
G98	*	*	*	Withdrawal to the starting plane	9.5
G99	*		*	Withdrawal to the reference plane	9.5

M G , G

D , M02, M30 EMERGENCY
RESET CNC

?가 , G DEFAULT CNC

V , 가 G 가

5.2 FEEDRATE F

가 . 가

F . G94 G95 mm/min (inch/

min) mm/rev (inch/rev) . †

mm 5.4 inch 4.5 .

"MAXFEED" F0

F (G01) (G02, G03) F0 CNC

. F (G00) , F "G00FEED"

F PLC DNC 0% 255% , CNC

0% 120%

, CNC "MAXFOVR"

가 .

(G00) 100%

"RAPIDOVE" 0% 100%

G33(), G34(), G84()

F 100%

5.2.1 FEEDRATE IN MM/MIN OR INCHES/MIN (G94)

G94가 mm/min inch/mm F5.5

CNC degree()/min

() , mm mm/min inch/min

inch

"F"

= $\frac{F \times \text{mm}}{\text{inch}}$

:

X0, Y0, C0

X, Y

C 가

,

:

G1 G90 X100 Y20 C270 F10000

$$\frac{F \Delta x}{\sqrt{(\Delta x)^2 + (\Delta y)^2 + (\Delta c)^2}} = \frac{10000 \times 100}{\sqrt{100^2 + 20^2 + 270^2}} = 3464.7946$$

$$\frac{F \Delta y}{\sqrt{(\Delta x)^2 + (\Delta y)^2 + (\Delta c)^2}} = \frac{10000 \times 20}{\sqrt{100^2 + 20^2 + 270^2}} = 692.9589$$

$$\frac{F \Delta c}{\sqrt{(\Delta x)^2 + (\Delta y)^2 + (\Delta c)^2}} = \frac{10000 \times 270}{\sqrt{100^2 + 20^2 + 270^2}} = 9354.9455$$

G94

가

.

,

G95가

, M02, M30
"IEFFD"가

, EMERGENCY
가

RESET
G95

, CNC
G94

5.2.2 FEEDRATE IN MM/REV.OR INCHES/REV (G95)

G95

가

, mm/rev

inch/rev

F5.5

mm/min
, JOG

inch/min

(G00)

G95

가

.

,

G94가

, M02, M30
"IEFFD"가

, EMERGENCY
가

RESET
G95

, CNC
G94

5.2.3 CONSTANT SURFACE SPEED (G96)

G96 CNC F5.5
(G96)
G96 , G97
, M02, M30, EMERGENCY, RESET CNC G97

5.2.4 CONSTANT TOOL-CENTER SPEED (G97)

G97 가 , F5.5가 CNC
(G97)
G97 , G96
, M02, M30, EMERGENCY, RESET CNC G97

5.3 SPINDLE SPEED (S)

S5.3 rpm

"MAXGEAR1", "MAXGEAR2", "MAXGEAR3", "MAXGEAR4"

G92 S5.4

PLC, DNC CNC "+", "-" SPINDLE S

가 "MINSOVR" "MAXSOVR",

CNC "SOVRSTEP" S "+", "-"

G33 (), G34 (가 S 100%), G84 ()가

5.4 SPINDLE SELECTION (G28, G29)

CNC

가

G28 G29 :

G28:

G29:

M3, M4, M5, M19

S*****

G33, G34, G94, G95, G96, G97

G28 G29

G28 G29

, M02, M30, EMERGENCY, RESET

CNC G29(

)

:

G29

: S1000 M3

1000 rpm

G28

: S1500 M4 ()

1500 rpm

1000 rpm

, G29

: S2000 ()

2000rpm

1500rpm

5.5 SYNCHRONIZED SPINDLES (G30, G77S, G78S)

G77S () .. G78S

G77, G78 G77S G78S

가 ,
 (M3, M4) (M19) () 가

G77S () "SYNSPEED (M5560)' high

G78S 가 , (M3, M4, M5, M19)

S가 , CNC

, G77S angular offset offset , G30

: G30 D ±359.9999 (offset in degrees)

, G30 D90 90

(G30) , (G77S)가

PLCCNTL, SPDLINH, SPDLREV

가 :

G94, G95, G96, G97, M3, M4, M5, M19 S***

DNC, PLC CNC(S)

DNC, PLC, CNC

DNC, PLC CNC (G92S)

가 :

: G28, G29

: M41, M42, M43, M44.

5.6 TOOL NUMBER (T) AND TOOL OFFSET (D)

"T" , "D" T D : T6 D17

"D"가 , "D" " "

" " "D"

" " " "

" T
"GEOMTYPE(P123)" D

6

T D

• "T" "D"

:

T5 D18 5

18

D22 5

22

T3 3

•

, "T" "D"

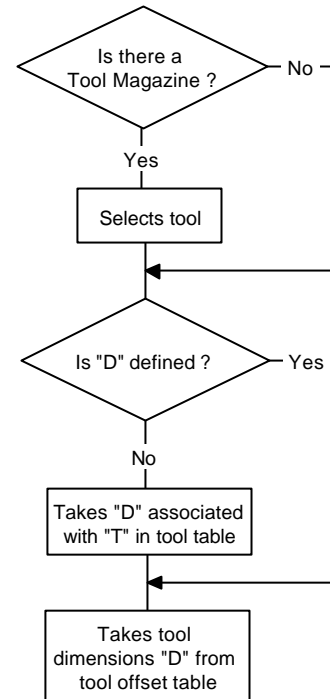
"T"

"D"

, T5 D23

5

23



- 2 가 가 , 가 "T" "D"
"T" (am) "D"

T1 D1 T1 D2가

CNC " " "D"

G40, G41, G42

가 D0 ,

8 " "

5.7 MISCELLANEOUS FUNCTION (M)

M4 7 .
 , CNC
 , "NMISCFUN" () 가 M :
 * M (0-9999)
 *
 * M
 * M 가
 * M
 * CNC가 AUXEND
 M , M , AUX END
 CNC 가
 M , "M"



5.7.1 M00. PROGRAM STOP

CNC가 M400
CYCLE START

M

5.7.2 M01. CONDITIONAL PROGRAM STOP

M01 PLC M01 가 active

M00

5.7.3 M02. END OF PROGRAM

) 가 CNC " " (
M05

M

5.7.4 M30. END OF PROGRAM WITH RETURN TO FIRST BLOCK

CNC가 가 M02

5.7.5 M03. CLOCKWISE SPINDLE ROTATION

CNC canned cycle

M

5.7.6 M04. COUNTER-CLOCKWISE SPINDLE ROTATION

M

가

5.7.7 M05. SPINDLE STOP

가

M

5.7.8 M06. TOOL CHANGE

"TOFFM06" () active , CNC

M

5.7.9 M19. SPINDLE ORIENTATION

CNC 가 (M3, M4) (M19) .
 , 가 .
 , M19 M19 S±5.5 . CNC

* 가 , CNC "REFEED2"
 , S±5.5 .

* 가 , CNC "REFEED1"
 () , S±5.5 "REFEED2"

M19 , "S0"
 , M19 S±5.5 . CNC
 M19가 . (S±5.5)

S±5.5 (S0)
 가 .

5.5

:

S1000 M3
 M19 S100 . 100°
 M19 S-30 0° -30°
 M19 S400 40°

5.7.10 M41, M42, M43, M44. SPINDLE SPEED RANGE CHANGE

CNC "MAXGEAR1", "MAXGEAR2", "MAXGEAR3", "MAXGEAR4" 가 M41, M42, M43, M44 4

"AUTOGEAR"가 , CNC M41 M44

가 , M41 M44 "MAXVOLT" "MAXGEAR1" ("MAXGEAR4") 가

5.7.11 M45 AUXILIARY SPINDLE / LIVE TOOL

live tool (P0 P7)

S rpm live tool , : M45 S5.5

CNC "MAXSPEED"

, M45 M45 S0

(M5548) live tool PLC가 , CNC "DM45"

, "SPDLOVR"

6. PATH CONTROL

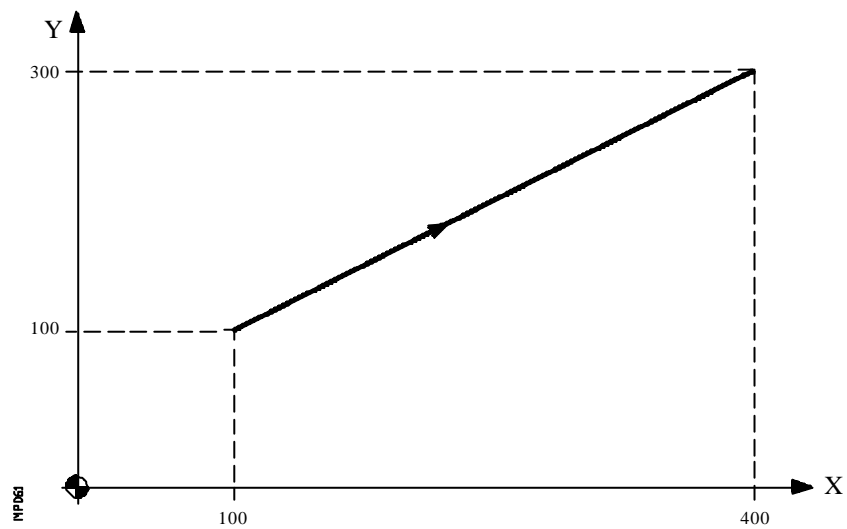
CNC

X, Y, Z, U, V, W, A, B, C

6.1 RAPID TRAVEL (G00)

G00

"G00FEED"



X100 Y100 ; Starting point
G00 G90 X400 Y300 ;

"RAPIDOVR" % 0%

100% (G00) 100%

G00 "F" G01,

G02 G03 "F" . ,

G00 G01, G02, G03, G33, G34 G75 . G00

G G0

, M02, M30 EMERGENCY RESET ,

"IMOVE"가 CNC G00 G01

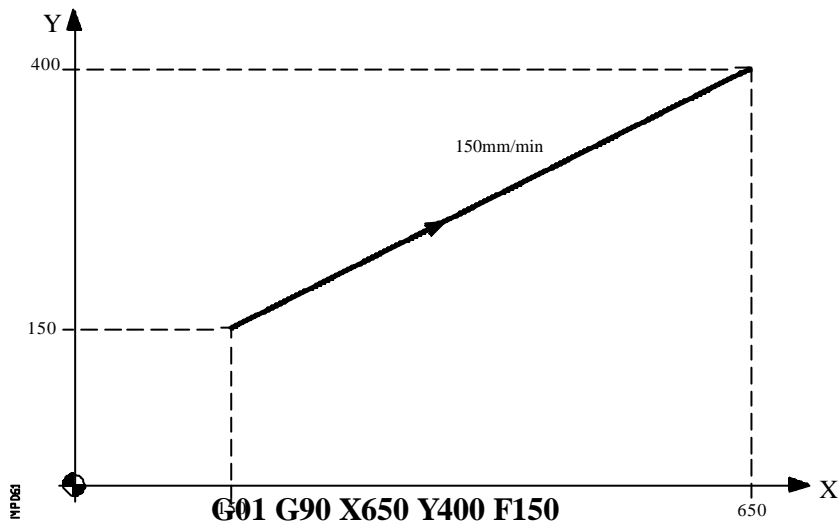
6.2 LINEAR INTERPOLATION (G01)

G01

"F"

CNC "F" 가 "F"

:



, PLC "F" 0% 255% , DNC 0% 120%

가 , CNC "MAXFOVR"

CNC 가 POSITIONING-ONLY . CNC POSITIONING-ONLY

G01 MODAL G00, G02, G03, G33, G34, G75 . G01 G1

, M02, M30 EMERGENCY RESET , "IMOVE"가 CNC G00 G01

6.3 CIRCULAR INTERPOLATION (G02. G03)

G02 :

G03 :

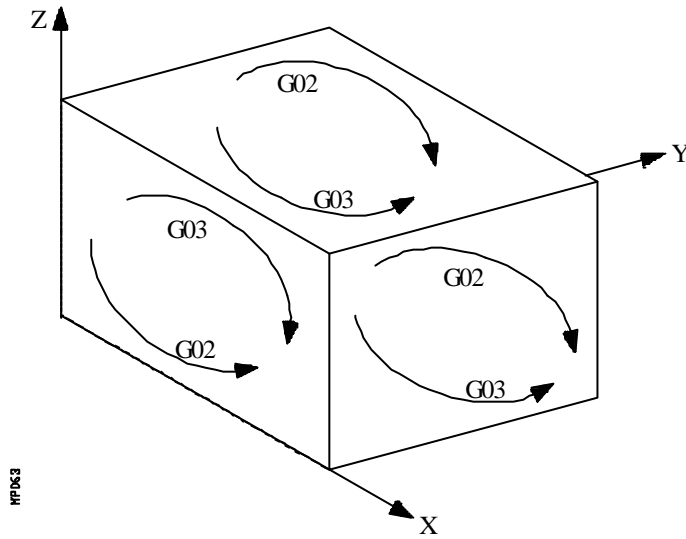
G02

G03

"F"

(G02)

(G03)



c) **CARTESIAN COORDINATES WITH RADIUS PROGRAMMING**

R

:

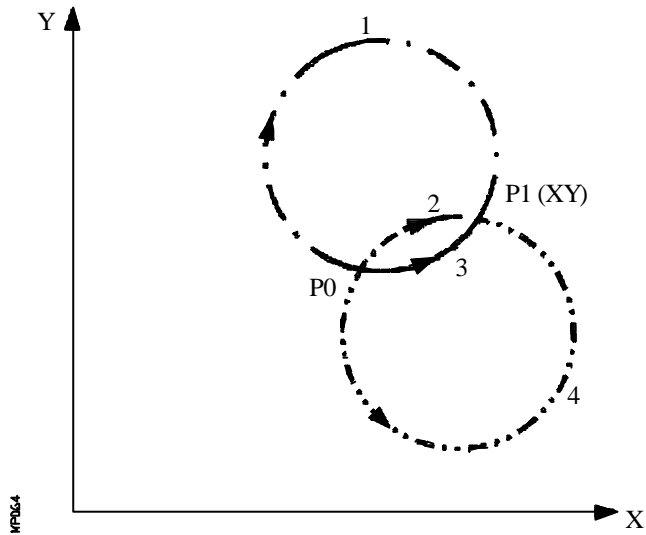
Plane XY: G02(G03) X±5.5 Y±5.5 R±5.5
 Plane ZX: G02(G03) X±5.5 Z±5.5 R±5.5
 Plane YZ: G02(G03) Y±5.5 Y±5.5 R±5.5

, CNC

가 180

(+)

(-)



P0가
4

가

P1

,

가

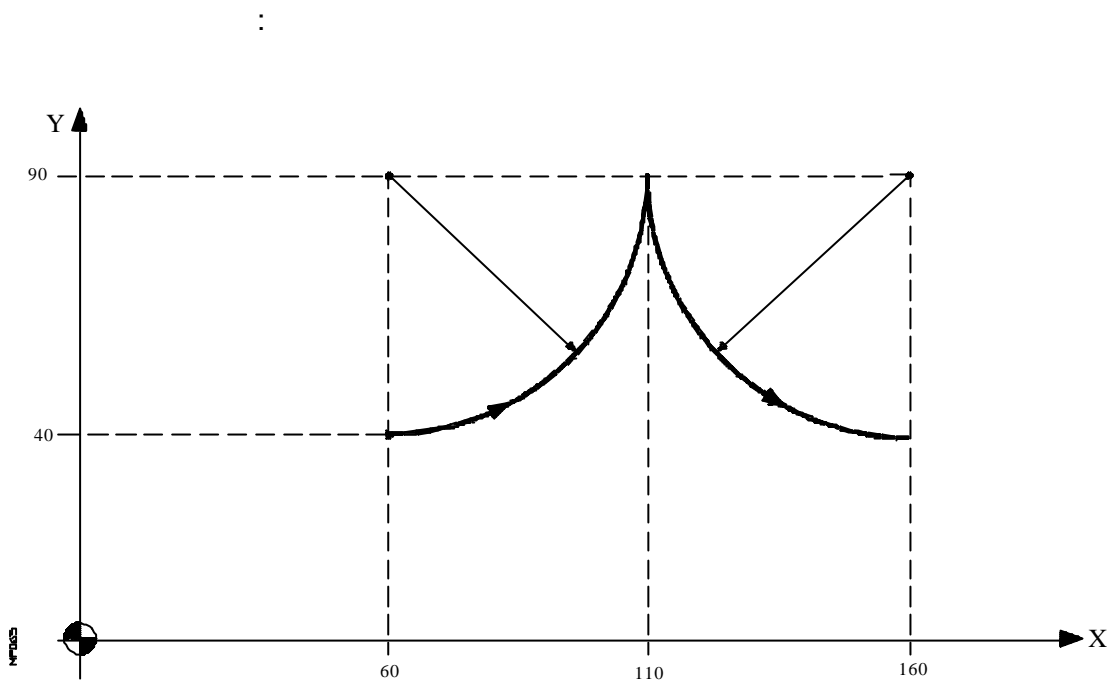
G02

G03

가

:

Arc 1 G02 X.. Y.. R -..
 Arc 2 G02 X.. Y.. R +..
 Arc 3 G03 X.. Y.. R +..
 Arc 4 G03 X.. Y.. R -..



. X60 Y40 .

:

**G90 G17 G03 X110 Y90 I0 J50
X160 Y40 I50 J0**

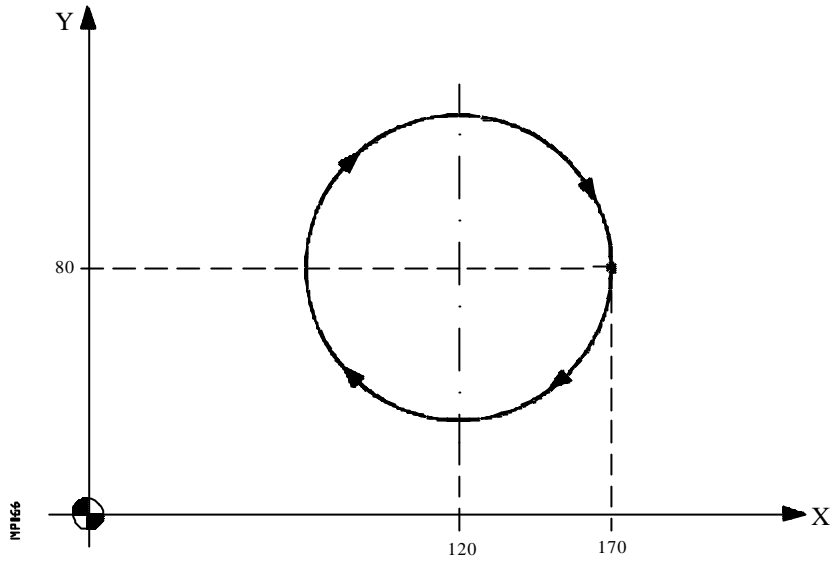
:

**G90 G17 G03 Q0 I0 J50
Q-90 I50 J0**

**G93 I60 J90 ;
G03 Q0
G93 I160 J90 ;
Q-90**

:

**G90 G17 G03 X110 Y90 R50
X160 Y40 R50**



X170 Y8

G90 G17 G02 X170 Y80 I-50 J0

G90 G17 G02 I-50 J0

G90 G17 G02 Q360 I-50 J0

G93 I120 J80 ;
G02 Q360

가

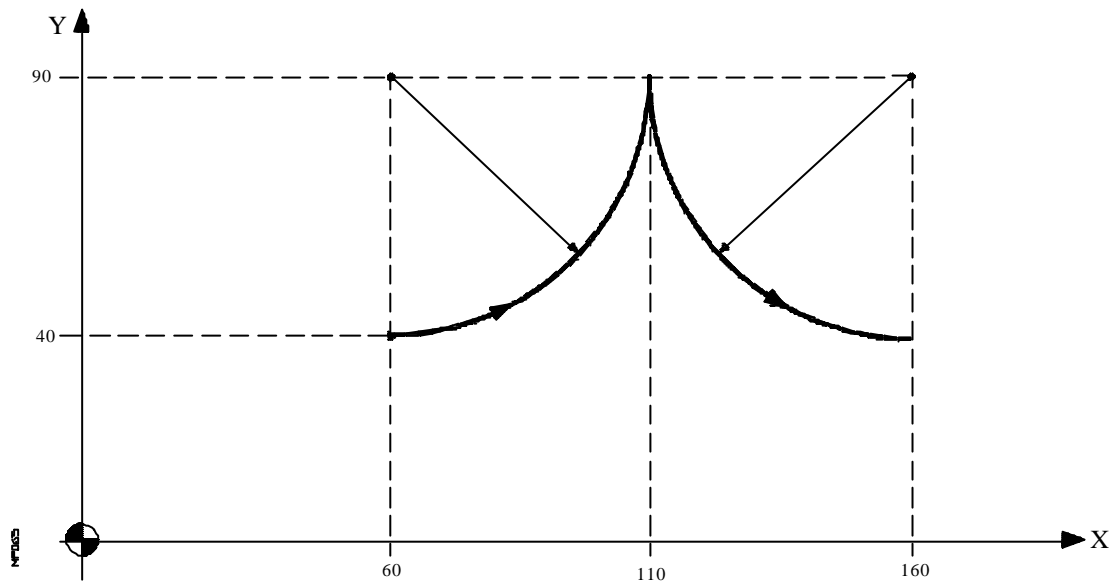
CNC
 , CNC
 "CIRINERR" , 가 , CNC
 "F" 0% 120%
 , PLC 0% 255% , DNC
 가 , CNC "MAXFOVR"
 "PROGMOVE"가 (G02 G03)
 , CNC
 G02, G03 , G00, G01, G33, G34
 . G02 G03 G2, G3
 , M02, M30 EMERGENCY RESET ,
 "IMOVE"가 CNC G00 G01

6.4 CIRCULAR INTERPOLATION BY PROGRAMMING THE CENTER OF THE ARC IN ABSOLUTE COORDINATES (G06)

(I, J K) G06 가

G06
G06 G6

:



X60 Y 40

:

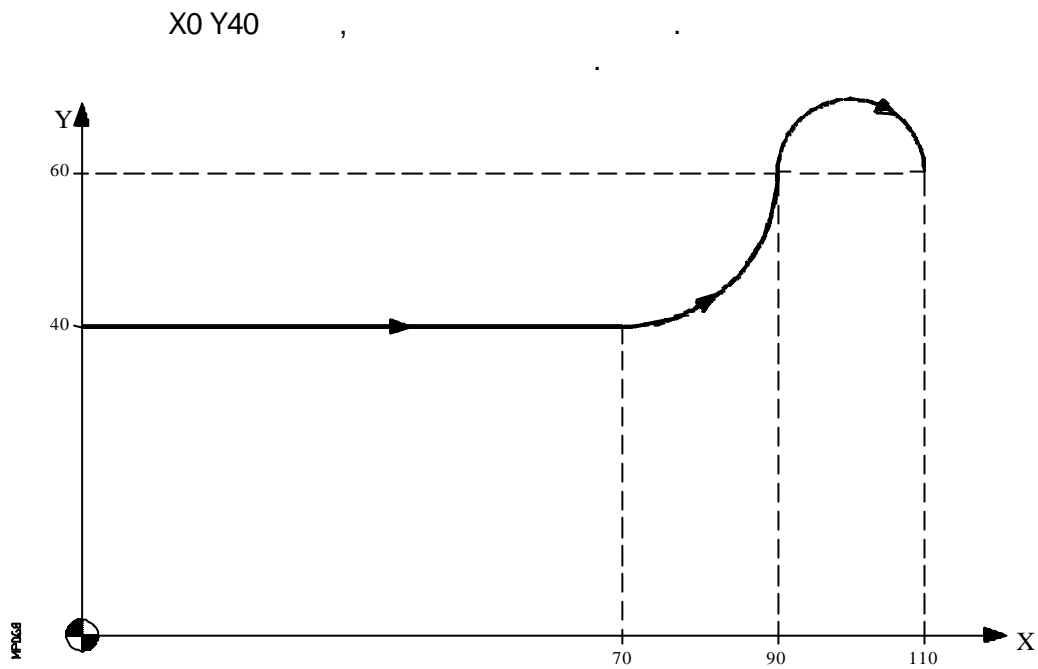
G90 G17 **G06** G03 X110 Y90 **I60 J90**
G06 X160 Y40 **I160 J90**

:

G90 G17 **G06** G03 Q0 **I60 J90**
G06 Q-90 **I160 J90**

6.5 ARC TANGENT TO THE PREVIOUS PATH (G08)

G08 (I, J, K)



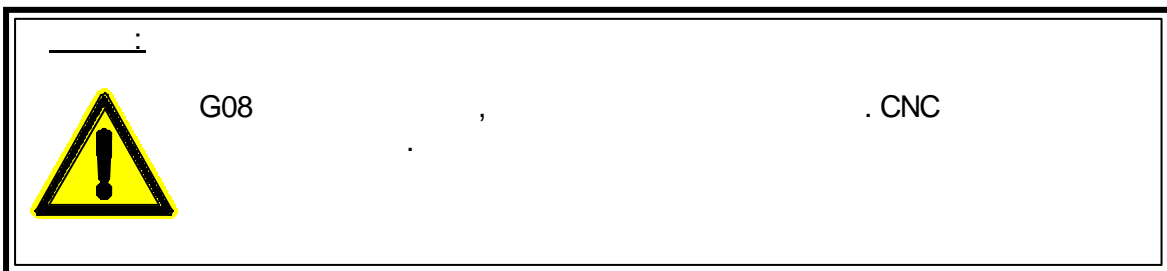
```
G90 G01 X70
G08 X90 Y60 ;
G08 X110 Y60 ;
```

G08

```
G08 G8
```

G08

G01, G02, G03



6.6 ARC DEFINED BY THREE POINTS (G09)

G09 ()

I, J, K :

Axes X,U,A → I

Axes Y,V,B → J

Axes Z,W,C → K

:

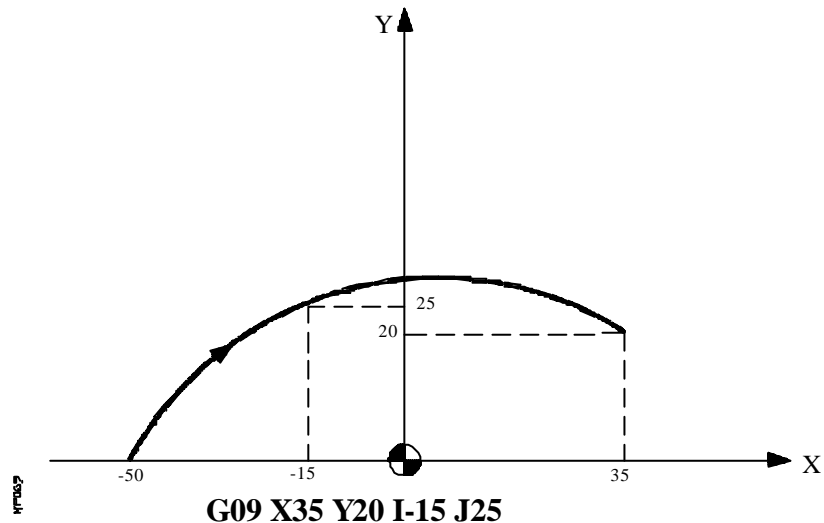
G17 G09 X±5.5 Y±5.5 I±5.5 J±5.5

:

G17 G09 R±5.5 Q±5.5 I±5.5 J±5.5

::

X-50 Y0



G09

G09

G09 G9

G09

(G02 G03)

G09

G01, G02, G03

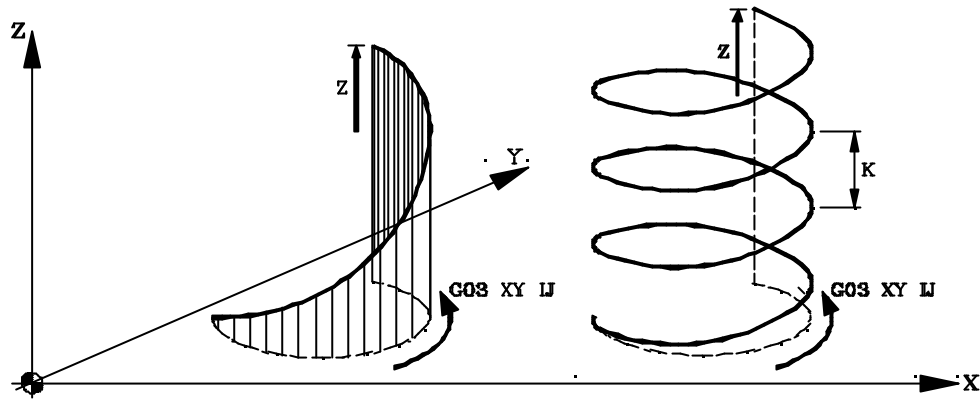


G09

CNC

6.7 HELICAL INTERPOLATION

가



G02, G03, G08

G09

G02 X Y I J
G03 Q I J A
G09 X Y I J

Z G02 X Y R Z A
B G08 X Y Z
Z

()

I, J, K

(5.5)

(I) X, U, Z

(J) Y, V, B

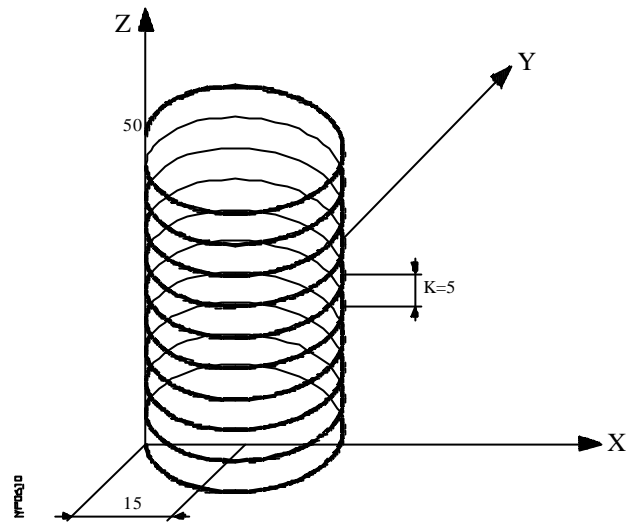
(K) Z, W, C

G02 X Y I J Z
G03 Q I J A I
G09 X Y I J Z

K G02 X Y R Z K
G08 X Y B J
K

:

X0 Y0 Z0



:

G03 X0 Y0 I15 Z50 K5

:

G03 Q180 I15 J0 Z50 K5

6.8 TANGENTIAL ENTRY AT BEGINNING OF A MACHINING OPERATION (G37)

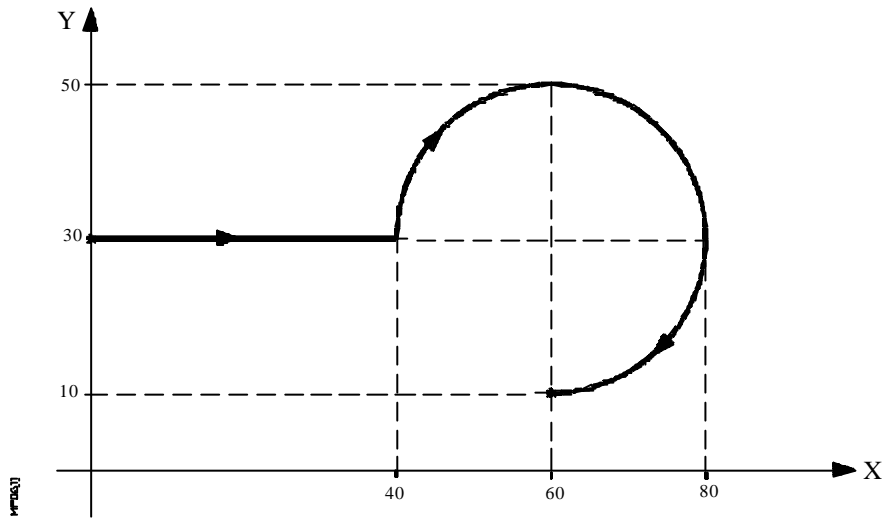
G37

.

G37

G37

:



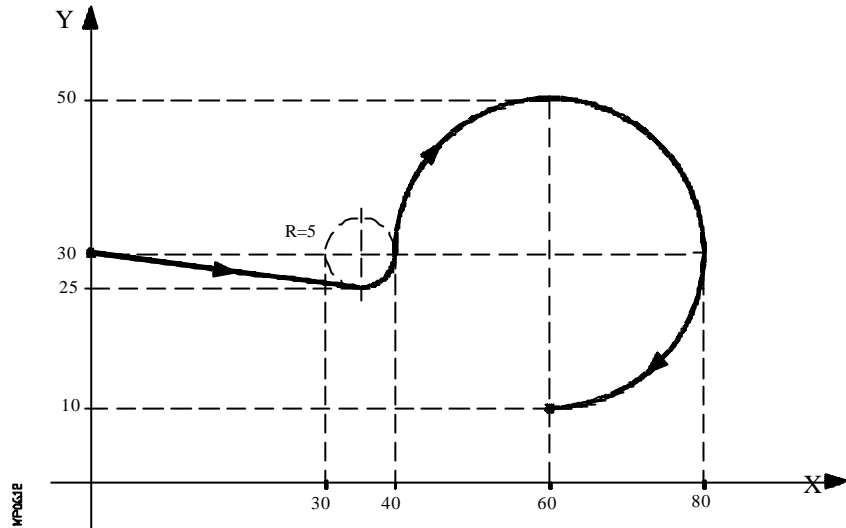
X0 Y30 가 (가) ,

:

G90 G01 X40
G02 X60 Y10 I20 J0

가 : 가 5 MM

G90 G01 G37 R5 X40
G02 X60 Y10 I20 J0



, CNC 가 가 CNC

가 R (+) G37

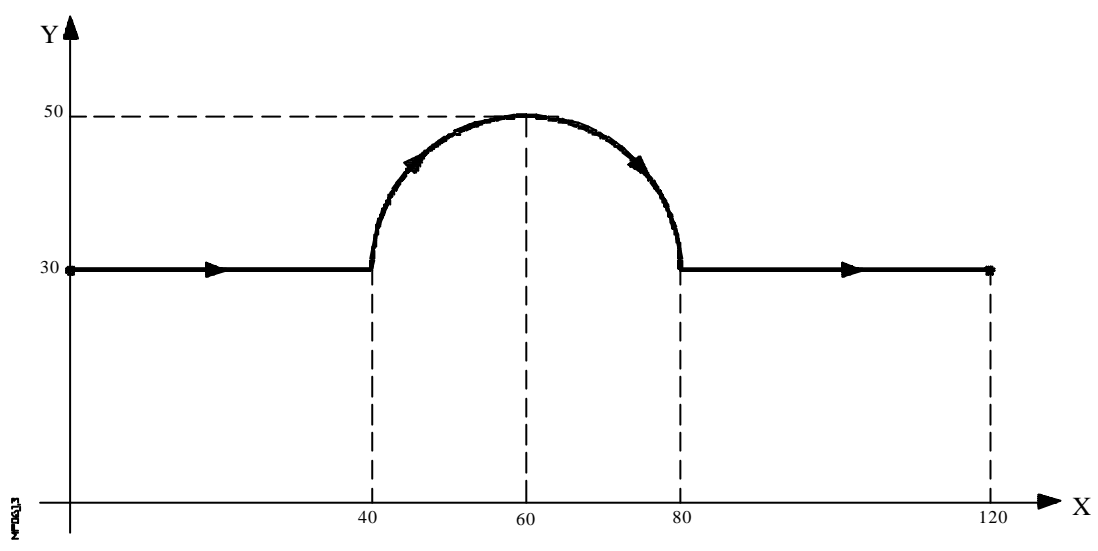
CNC가 가 R5.5 G37

(+)

G37 (G00 G01)
(G02 G03) G37 , CNC

6.9 TANGENTIAL EXIT AT THE END OF A MACHINING OPERATION (G38)

G38 (G00
 G01) 가 가 , CNC
 G38 가 G38
 G38 R5.5 , CNC가
 가 R (+)
 :

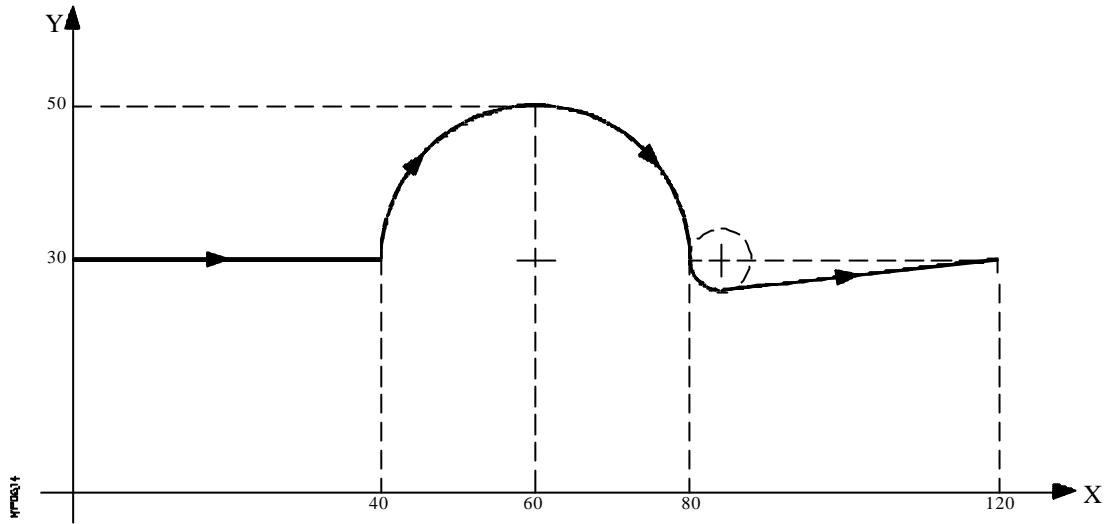


X0 Y30 (, 가) 가 ,
 :

G90 G01 X40
 G02 X80 I20 J0
 G00 X120

가 5 MM

```
G90 G01 X40  
G02 G38 R5 X80 I20 J0  
G00 X120
```



6.10 AUTOMATIC RADIUS BLEND (G36)

G36

가

G36

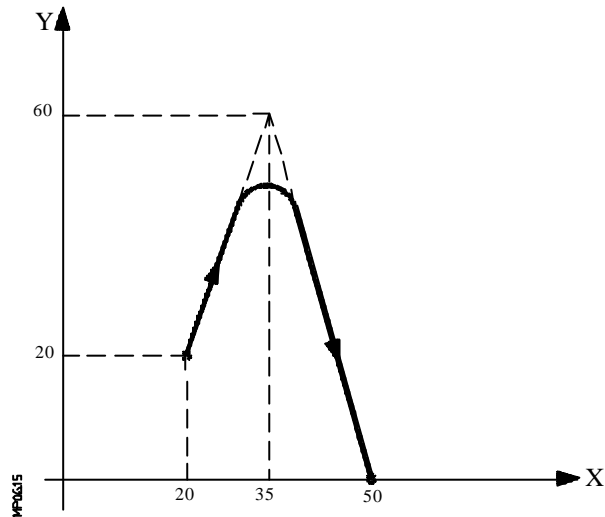
G36

R5.5

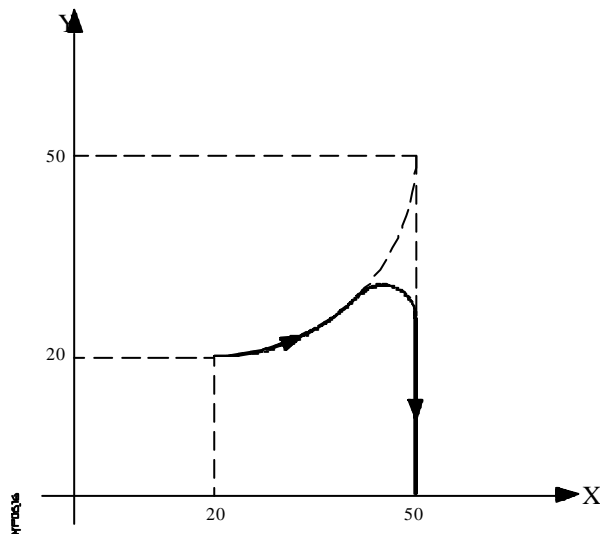
G36

가 R (+)

:



G90 G01 **G36 R5** X35 Y60
X50 Y0



G90 G03 **G36 R5** X50 I0 J30
G01 X50 Y0

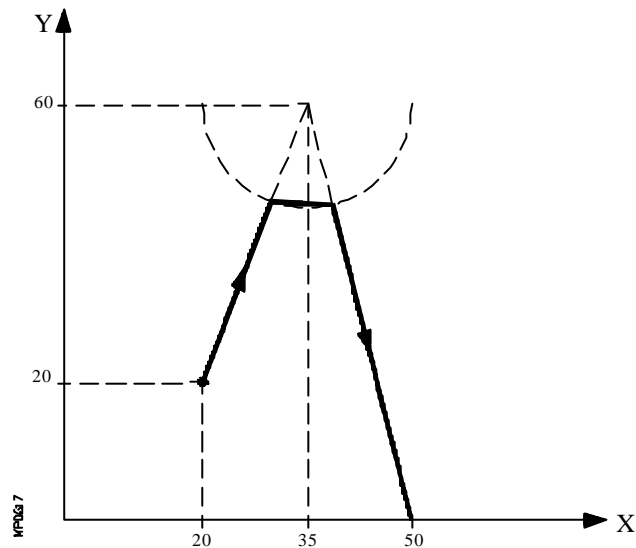
6.11 AUTOMATIC CHAMFER BLEND (G39)

가 G39
(chamfer)

G39 (chamfer) G39
(chamfer)

R5.5 G39 (chamfer)
. R (+)

:



G90 G01 G39 R5 X35 Y60
X50 Y0

6.12 THREADING (G33)

가 , G33 가

, CNC

: G33 X C L Q

X...C ±5.5

L5.5

Q ±3.5

가 .

(±359.9999)

, "0"

_____ :

G33

, CNC

()

Q

"Q"

M19TYPE"가 "1"

(Q) 가 .

G33

100%

"F"

"S"

G33

G00, G01, G02, G03, G34, G75

, M02, M30
"IMOVE"가

EMERGENCY

RESET

CNC

G00

G01

:

Z10

100 mm

5 mm

X0 Y0 Z0

가

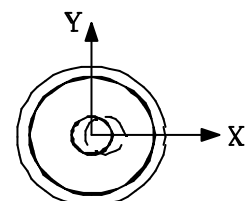
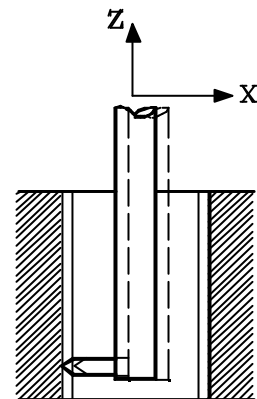
G90 G0 X Y Z ; Positioning

G33 Z-100 L5 ; Threading

M19 ; Spindle orientation

G00 X3 ; Cutter withdrawal

Z30 ; Withdrawal (exit the hole)



6.13 VARIABLE PITCH THREADS (G34)

가 가

CNC 가

: G34 X C L Q K

X...C ±5.5
L 5.5
Q ±3.5 가 ((±359.9999)
; "0" 가
K ±5.5 가

"Q" G34 , CNC
"M19TYPE=1" "Q" 가
(G05) ,
G34 "F" "S"
100%
G34 G00, G01, G02, G03, G34 G75
, M02, M30 EMERGENCY RESET
"IMOVE"가 CNC G00 G01
(G33) 가 (G34)
G34 (L) G33 가 (K/2)
가(K)
가 (G34) 가 가 (G34)
, G34 ... L0 K0 . CNC 가 G33
가 (G34)

6.14 MOVE TO HARDSTOP (G52)

G52
forming machine, live tailstocks, bar feeders

: G52 X..C ±5.5

G52

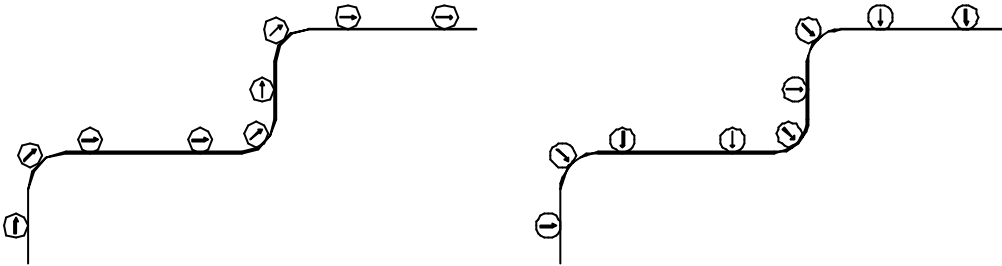
G52

, G01, G40
G03, G34, G41, G75, G76

. G00, G02,

6.16 TANGENTIAL CONTROL (G45)

" " , .



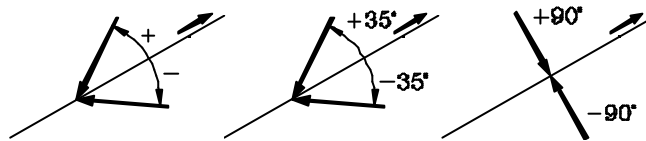
C) (A, B

: G45

(A, B, C)

(±359.9999)

"0"



, G45

. ()

G45 ()

, CNC

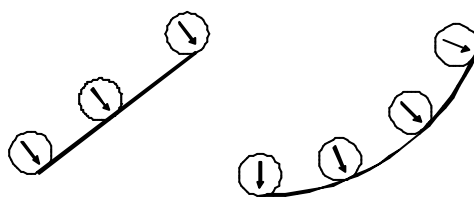
:

1.-



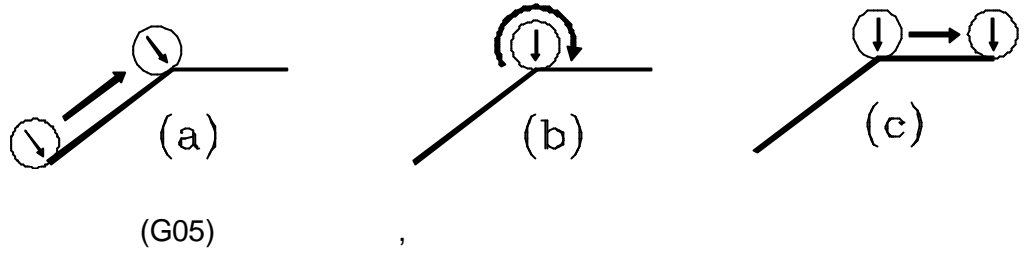
2.-

3.-



4.-

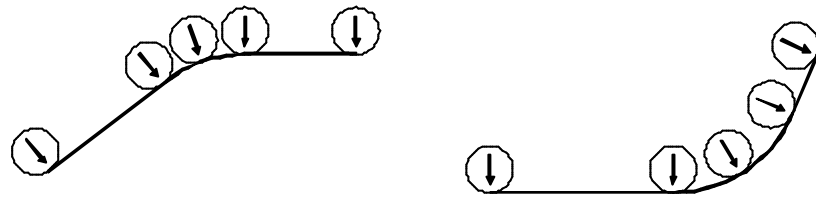
- a)
- b)
- c)



G36

(G07)

(G05)



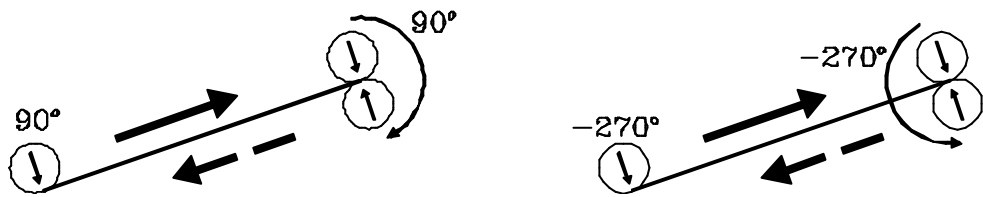
5.-

)

90° ~ 270°

, G45

가



6.16.1 CONSIDERATIONS ABOUT FUNCTION G45

(G45) 가 . 가

- (G40, 41, 42, 43, 44)
- (G10, 11, 12, 13, 14)
-

가 MAXFEED

가 , 가 ,

JOG , MDI MDI

JOG 가 ,

가 :

- 가 가 G
- JOG 가
-

G45 TANGAN CNC, PLC DNC

가 TANGACT (M5558) G45 PLC 가

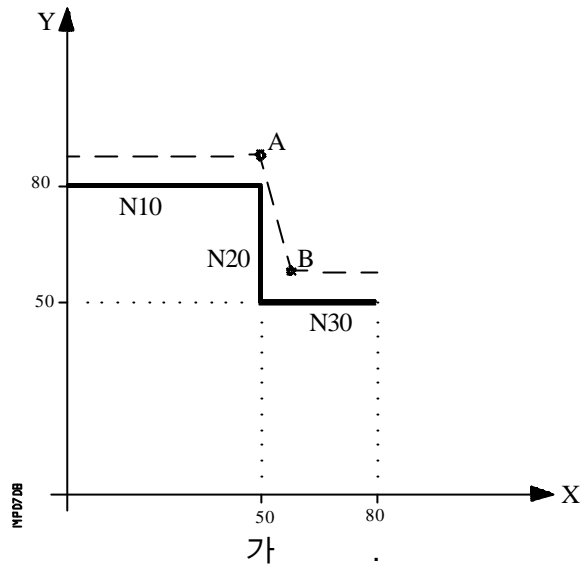
G45 M30 G45가 EMERGENCY RESET , M02

7. ADDITIONAL PREPARATORY FUNCTIONS

7.1 INTERRUPTION OF BLOCK PREPARATION (G04)

CNC 20

, G04 . ,
.
.
.
" - "
:
.
.
.
G04 ;
/1 G01 X10 Y20 ; - "1"
.
.
G04 . ,
.
.
G04 G4
.
G04가 , .
 , 가



G04

7.2 DWELL (G04 K)

G04 K

K5 (0..99999)

1

:

G04 K50 : 50 (0.5)
 G04 K200 : 200 (2)

G04 K

G04 K G4 K

..

7.3 WORKING WITH SQUARE (G07) AND ROUND (G05,G50) CORNERS

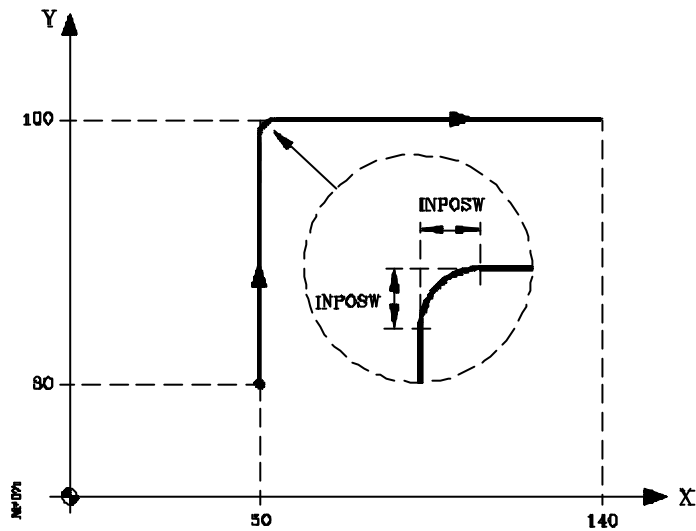
7.3.1 SQUARE CORNER (G07)

G07 ()

CNC

CNC

"INPOSW" (in-position zone dead band)



G91 G01 **G07** Y70 F100
X90

G07

G05 G50

G07 G7

, M02, M30
"ICORNER"

EMERGENCY

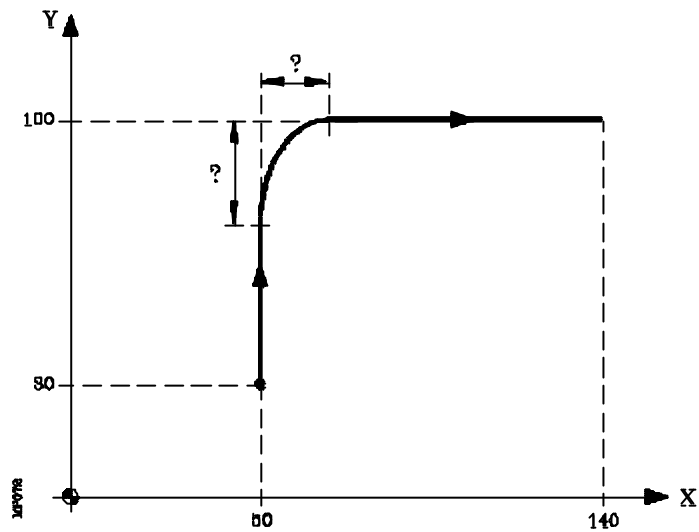
RESET , CNC
G05 G07

7.3.2 ROUND CORNER (G05)

G05 () , CNC

CNC가

:



G91 G01 G05 Y50 F100
X90

"F"

가

G05

G07 G50

G05 G5

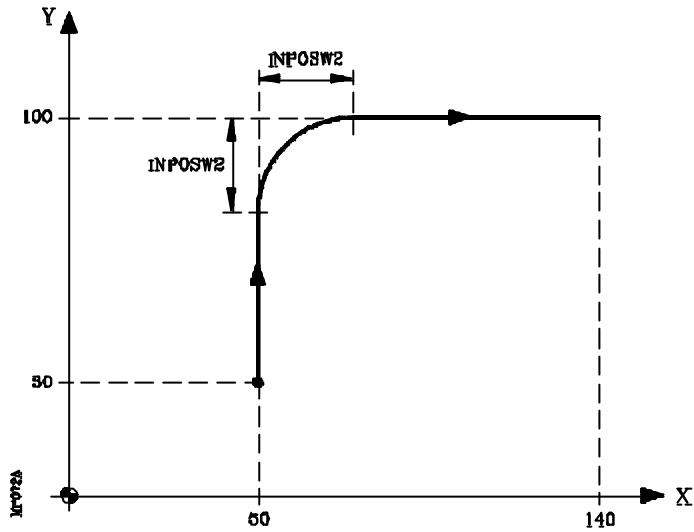
, M02, M30
"ICORNER"

EMERGENCY

RESET , CNC
G05 G07

7.3.3 CONTROLLED ROUND CORNER (G50)

G50 () , 가
 CNC "INPOSW2" 가 .
 :



```
G91 G01 G50 Y50 F100
      X90
```

G50 가 "INPOSW2"
 , G05 , 가 ,
 "F" 가 ,
 G50 . G07, G05 G51 .
 , M02, M30 EMERGENCY RESET , CNC
 "ICORNER" G05 G07

7.4 LOOK-AHEAD (G51)

(CAM, digitizing)

가 가 .

가 LOOK-AHEAD 50 가 CNC
CPU-TURBO

: G51 [A] E

A (0-255) 가 . 가
"0" 가 , CNC

E (5.5) 가

"A" 가 Look-Ahead

"E"가 , 가

"Look-Ahead" following error
contouring error가 following error (lag) 가 .

, CNC :

*
*
*
* 가

Look-Ahead 가 , CNC
"0" Look-Ahead

가

*
* (M, S, T)
*
* MDI
* TOOL INSPECTION

Look-Ahead Cycle stop, Feed-Hold 가 ,

G51 , G51 G05, G07, G50
가 7 (G , G51 가)

- * G23, G26, G27
- * G33
- * G34 가
- * G52
- * G74
- * G75, G76
- * G95

G51

가

, M02, M30
"ICORNER"

EMERGENCY

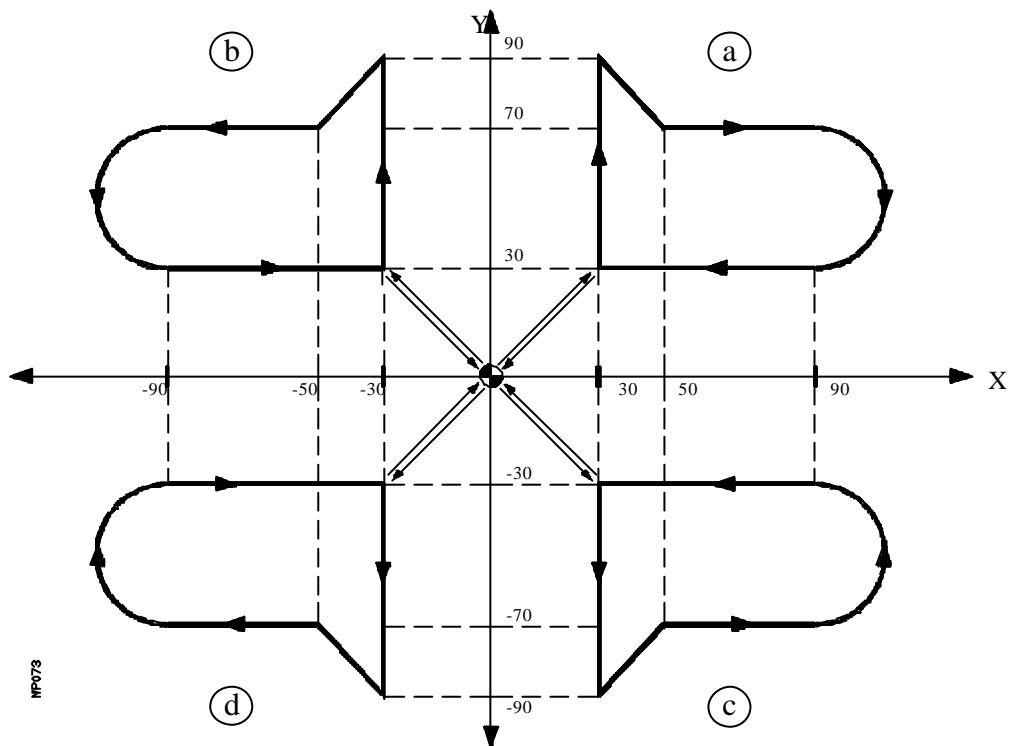
RESET , CNC
G05 G07

7.5 MIRROR IMAGE (G10, G11, G12, G13, G14)

G10 : (mirror)
 G11 : X
 G12 : Y
 G13 : Z
 G14 : : G14 W G14 X Z A B

CNC가

가



"a" 가

```
G91 G01 X30 Y30 F100
      Y60
      X20 Y-20
      X40
G02 X0 Y-40 I0 J-20
G01 X-60
      X-30 Y-30
```

```

:
; "a" 가
G11 ; X
; "b" 가
G10 G12 ; Y
; "c" 가
G11 ; X Y
; "d" 가
M30 ;

```

G11, G12, G13, G14

G10

G11, G12, G13

, G14

G73

, CNC

가 G92 (G11, G12, G13, G14) 가 ,

CNC G10 , M02, M30 , EMERGENCY RESET

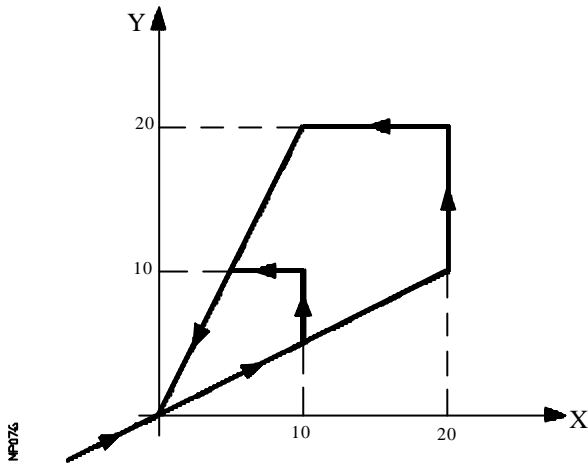
7.6 SCALING FACTOR (G72)

G72

G72

. G72

가

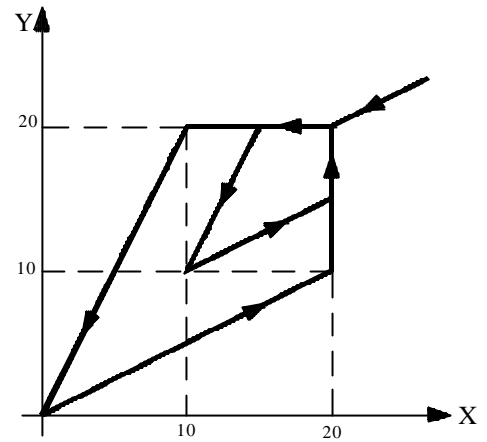


```

G90 G00 X0 Y0
N10 G91 G01 X20 Y10
      X-10 Y10
      X-10 Y-20
N20 G72 S0.5
      (RPT N10,20)

```

M30



```

G90 G00 X20 Y20
N10 G91 G01 X-10
      X-10 Y-20
      X20 Y10
N20 G72 S0.5 ; scaling factor
      (RPT N10,20); repeats from
      ; block 10
      ; to block 20

```

M30

G72 가 S1 가 EMERGENCY RESET , M02, M30

7.6.2 SCALING FACTOR APPLIED TO ONE OR MORE AXES

G72 X ... C 5.5

G72

G72

CNC

CNC

가

가 , CNC

가 ehI , CNC

G72

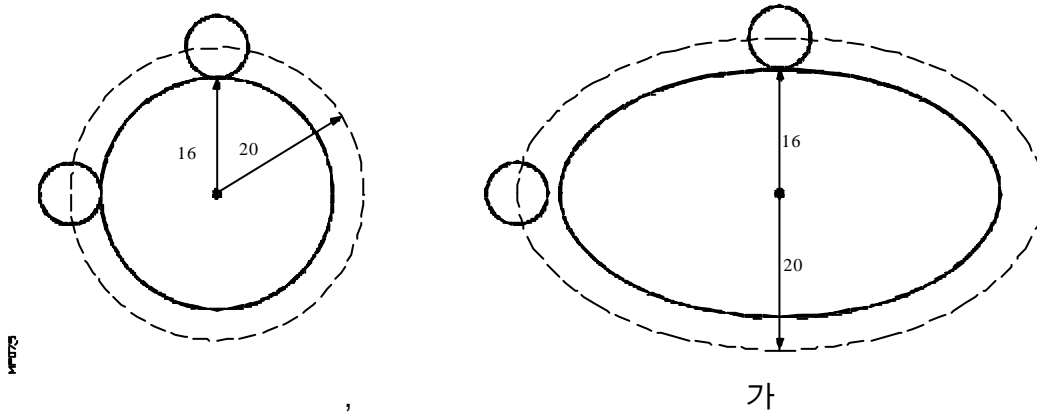
EMERGENCY

RESET

CNC

, M02, M30

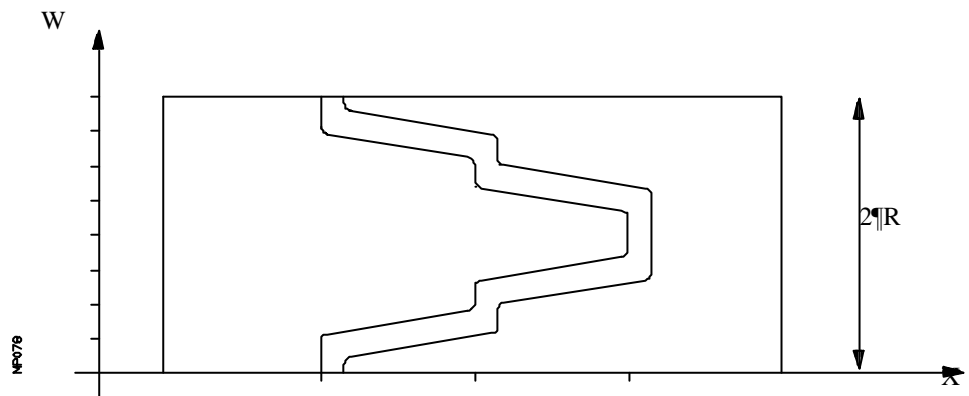
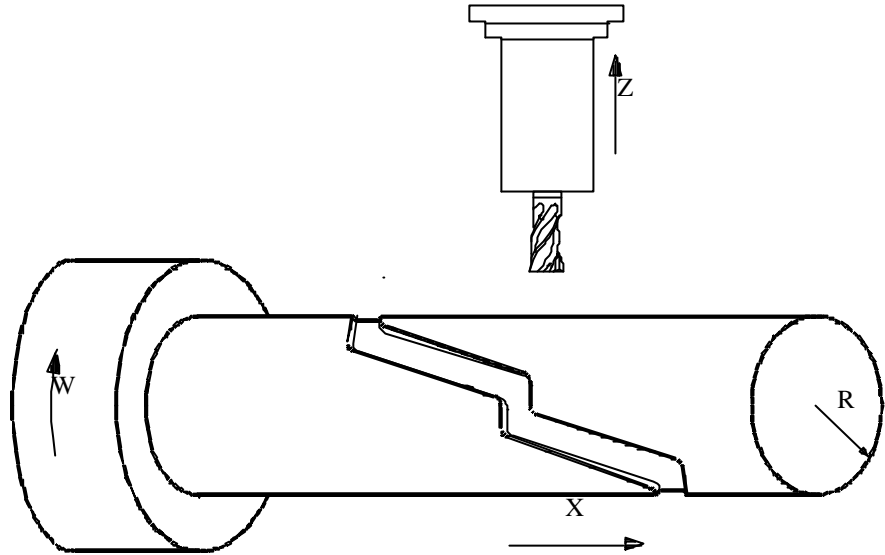
NOTE :



, $360/(2\sqrt{R})$

가 가

R
가



7.7 PATTERN ROTATION (G73)

G73

가

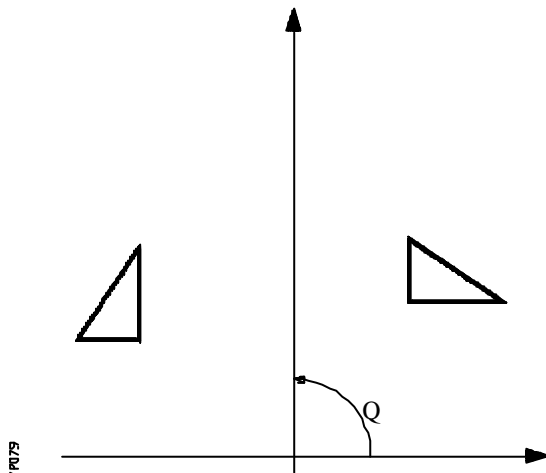
G 73 Q+/-5.5 I±5.5 J±5.5

Q :

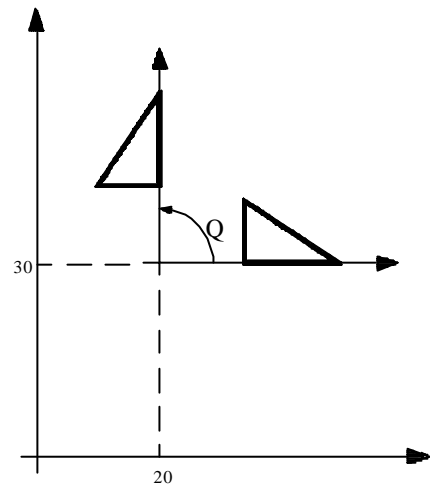
I, J:

가

I J



G73 Q90

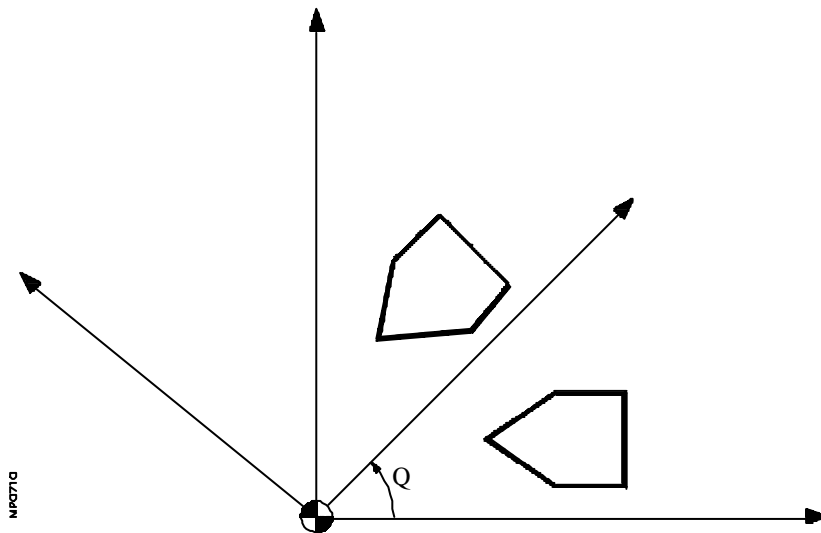


G73 Q90 I20 J30

G73

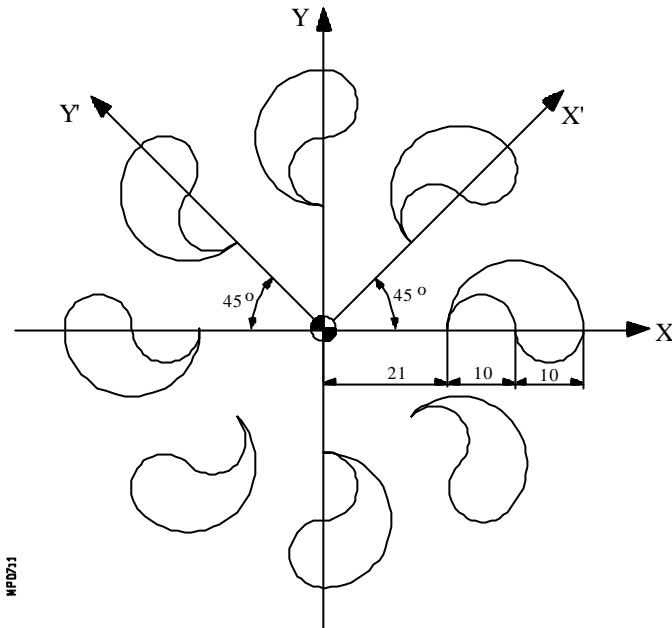
가

Q



G73

:



X0 Y0 :

```

N10 G01 X21 Y0 F300 ;
    G02 Q0 I5 J0
    G03 Q0 I5 J0
        Q180I-10 J0
N20 G73 Q45 ;
    (RPT N10,20) N7 ; 10 20 7
    M30 ;

```

, CNC

G73(,)
M02, M30

G16, G17, G18, G19
EMERGENCY

RESET

7.8 SLAVED AXIS/CANCELLATION OF SLAVED AXIS

CNC

가 :

"GANTRY"

PLC CNC "SYNCHRO1", "SYNCHRO2", "SYNCHRO3",
"SYNCHRO4", "SYNCHRO5"

"SYNCHRO"

G77 G78

7.8.1 SLAVED AXIS (G77)

G77 :

G77 < Axis 1 > < Axis 2 > < Axis 3 > < Axis 4 > < Axis 5 >
 < Axis 2 > < Axis 3 > < Axis 4 > < Axis 5 > < Axis 1 >
 . < Axis 1 > < Axis 2 > .

:

G77 X Y U ; Y U X

:

G77 X Y U ; Y U X
 G77 V Z ; Z V

G77 V Y ; Y V
 G77 X Y ; Y V

G77 X Z ; Z X
 G77 X U ; U X ---> X Z, U
 G77 X Y ; Y X ---> X Y, Z, U

G77 Y U ; U Y
 G77 X Y ; Y U

가

7.8.2 SLAVED AXIS CANCELLATION (G78)

G78

.

G78

G78 <Axis 1><Axis 2><Axis 3><Axis 4>

.

:

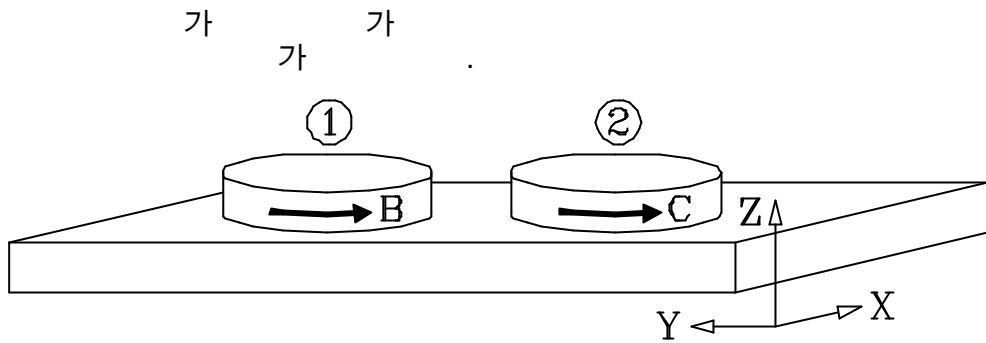
G77 X Y U ; Y U X

G77 V Z ; Z V

G78 Y ; Y . U X Z V

G78 ;

7.9 AXES TOGGLE. G28-G29



G28

. G28

: G28 (axis 1) (axis 2)

G29

"C"

: , G48 G49

G49

, M30

emergency reset

G48

: 1

G28 BC
Zero offset

"B" "C"
2 2 가
1

G29 B
Zero offset

"B" "C"
1 1 가
2

8. *TOOL COMPENSATION*

CNC "NTOFFSET" 가 .
:

* , , $R \pm 5.5$

* , , $L \pm 5.5$

* , (R) , ± 5.5 가 , CNC (R+I)

* , (L) , ± 5.5 가 , CNC (L+K)

(G41 G42) , CNC R+I

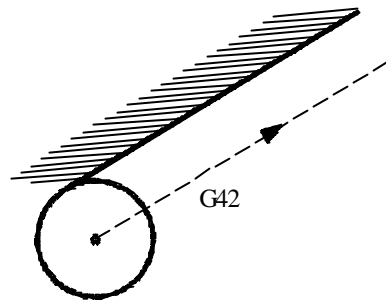
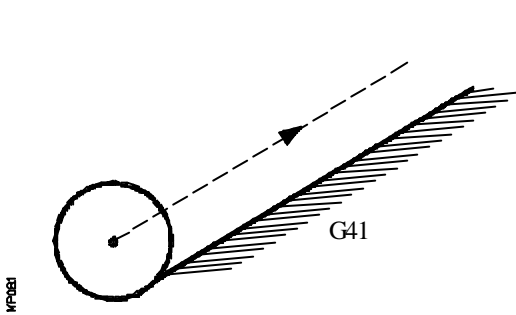
(G43) , CNC L+K

8.1 TOOL RADIUS COMPENSATION (G40, G41, G42)

가 .

CNC

G40
G41
G42



G41. . 가 .

G42. . 가 .

R, L, I, K 가

TOR, TOL, TOI,

TOK

G16, G17, G18, G19

, G41, G42

. D

(T)

G41, G42

. G40, G04 (), G53 (h), canned cycles (G81, G82,

G83, G84, G85, G86, G87, G88, G89)

M02, M30

EMERGENCY RESET

8.1.1 ACTIVATING TOOL RADIUS COMPENSATION

G16, G17, G18, G19 , G41, G42

G41
G42

G41 G42가

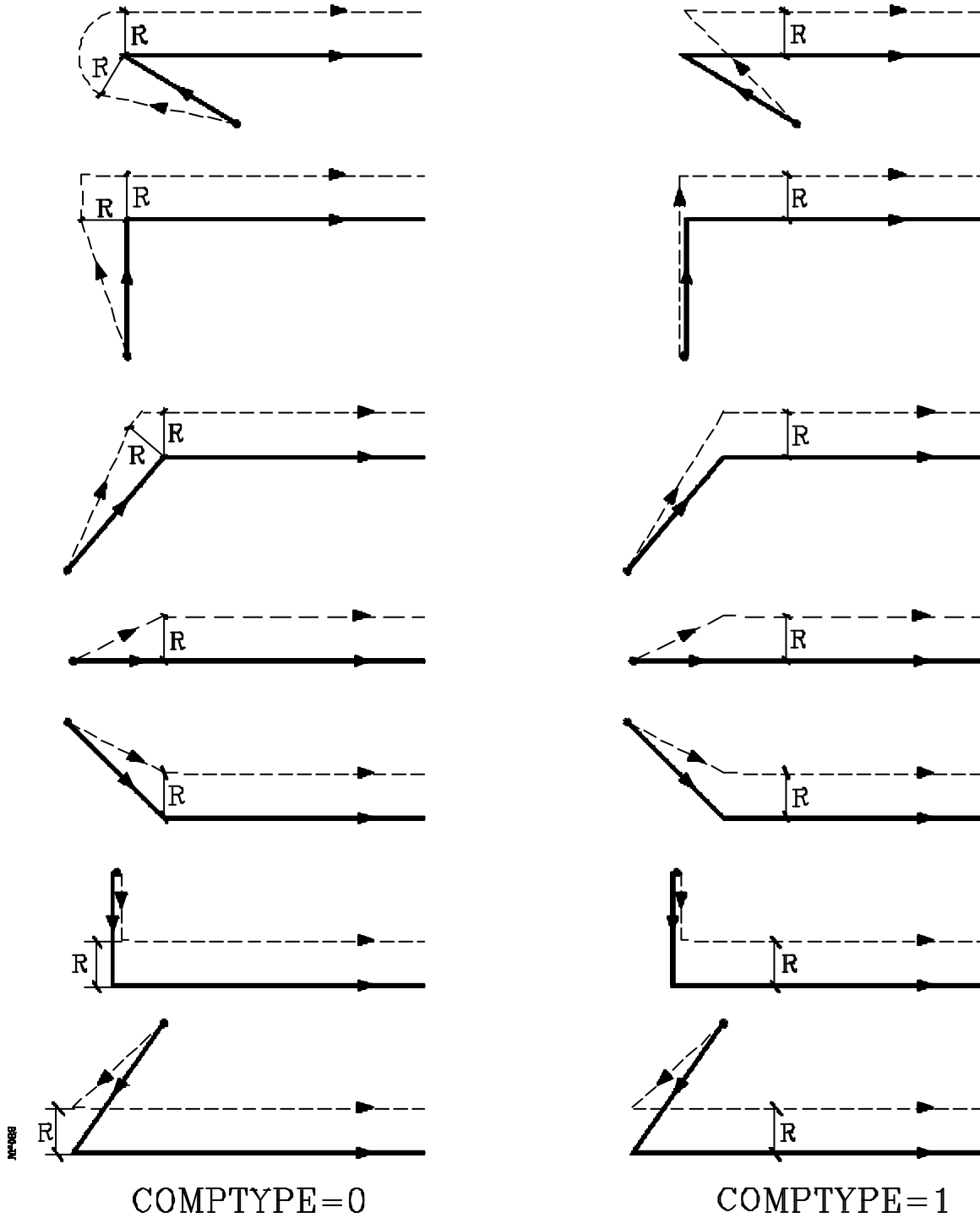
T, D T

가 가 , CNC M06 가 M06

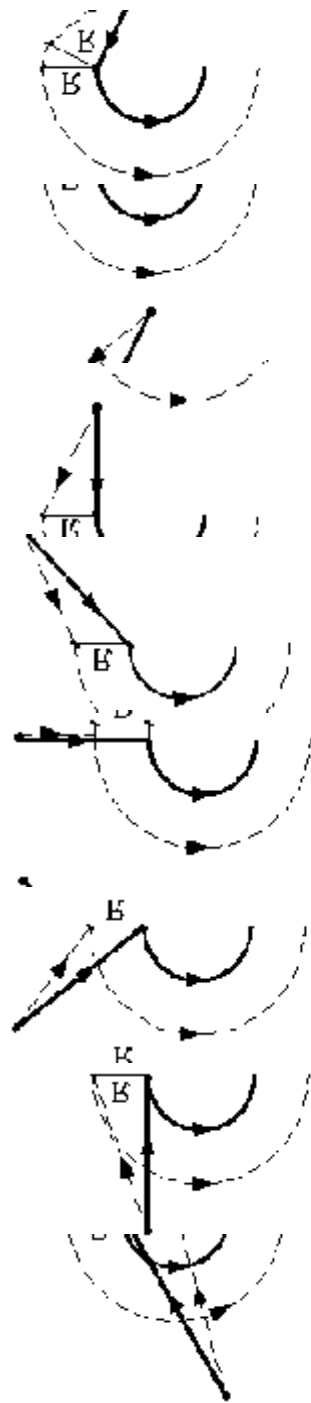
, CNC ((G41 G42)) G53 가
(G41 G42) G00 G01 ()
가

G02 G03 , CNC

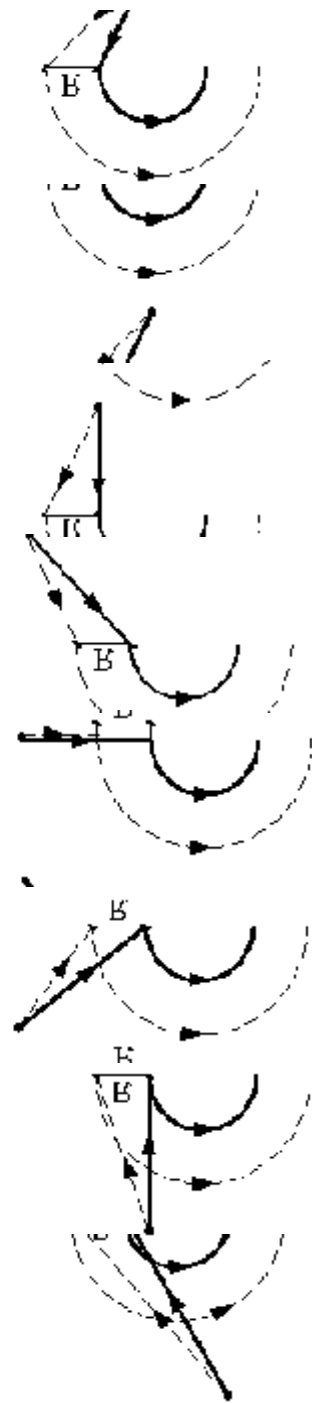
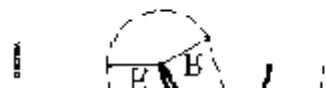
STRAIGHT-STRAIGHT path



STRAIGHT-CURVED path



G01/G02 E=0

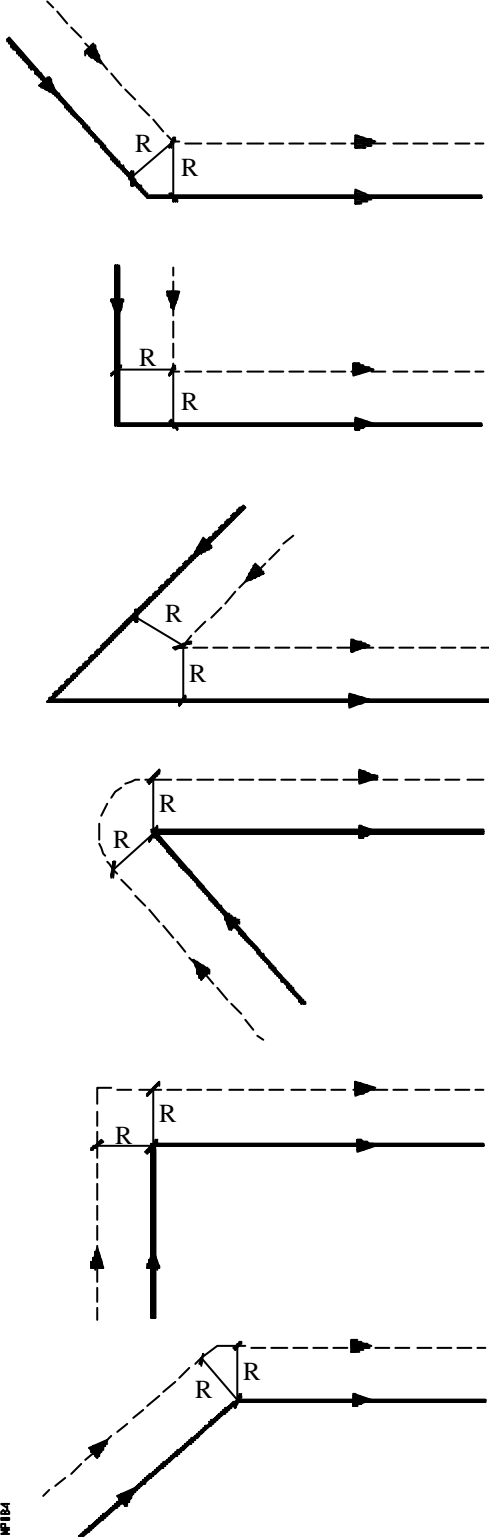


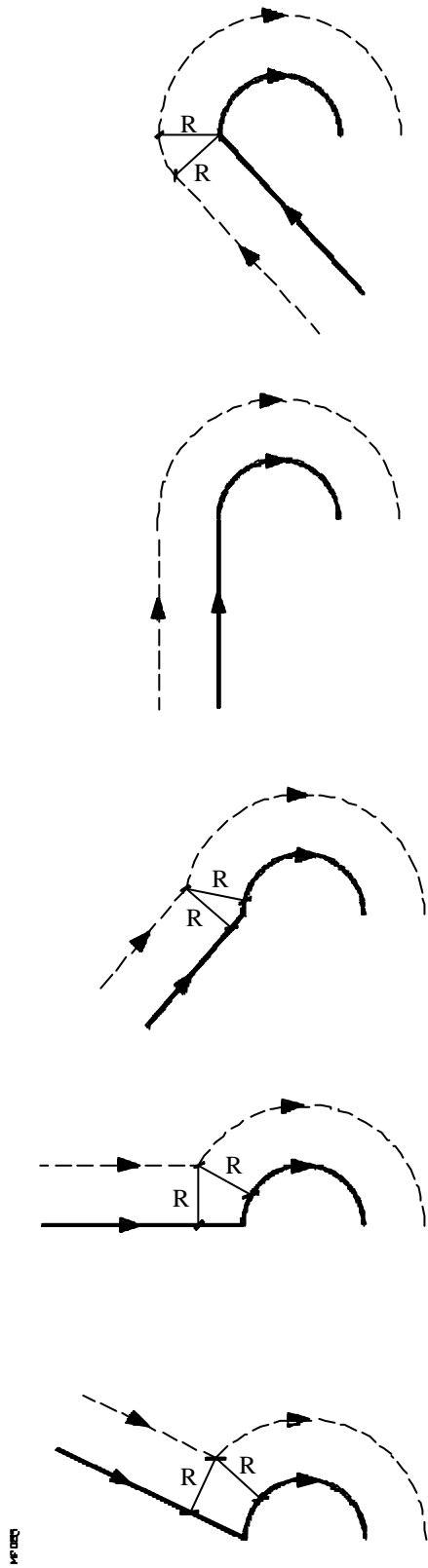
G01/G02 E=1

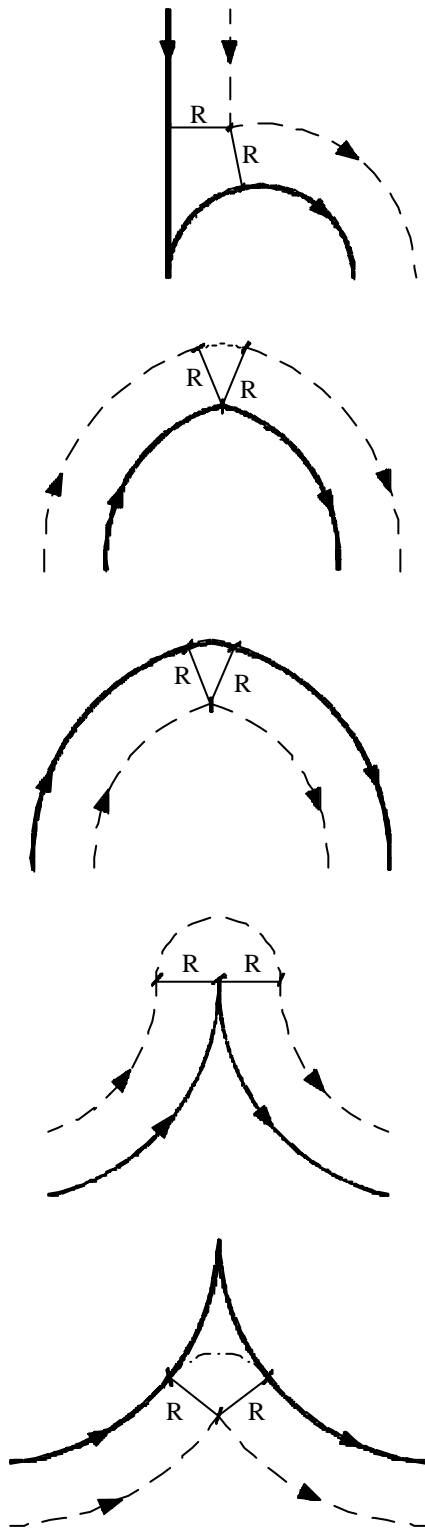


8.1.2 TOOL RADIUS COMPENSATION SECTIONS

CNC







MP066

CNC

20

CNC가

가 . , 17

8.1.3 CANCELLING TOOL RADIUS COMPENSATION

G40

(G40)

(G00

G01)

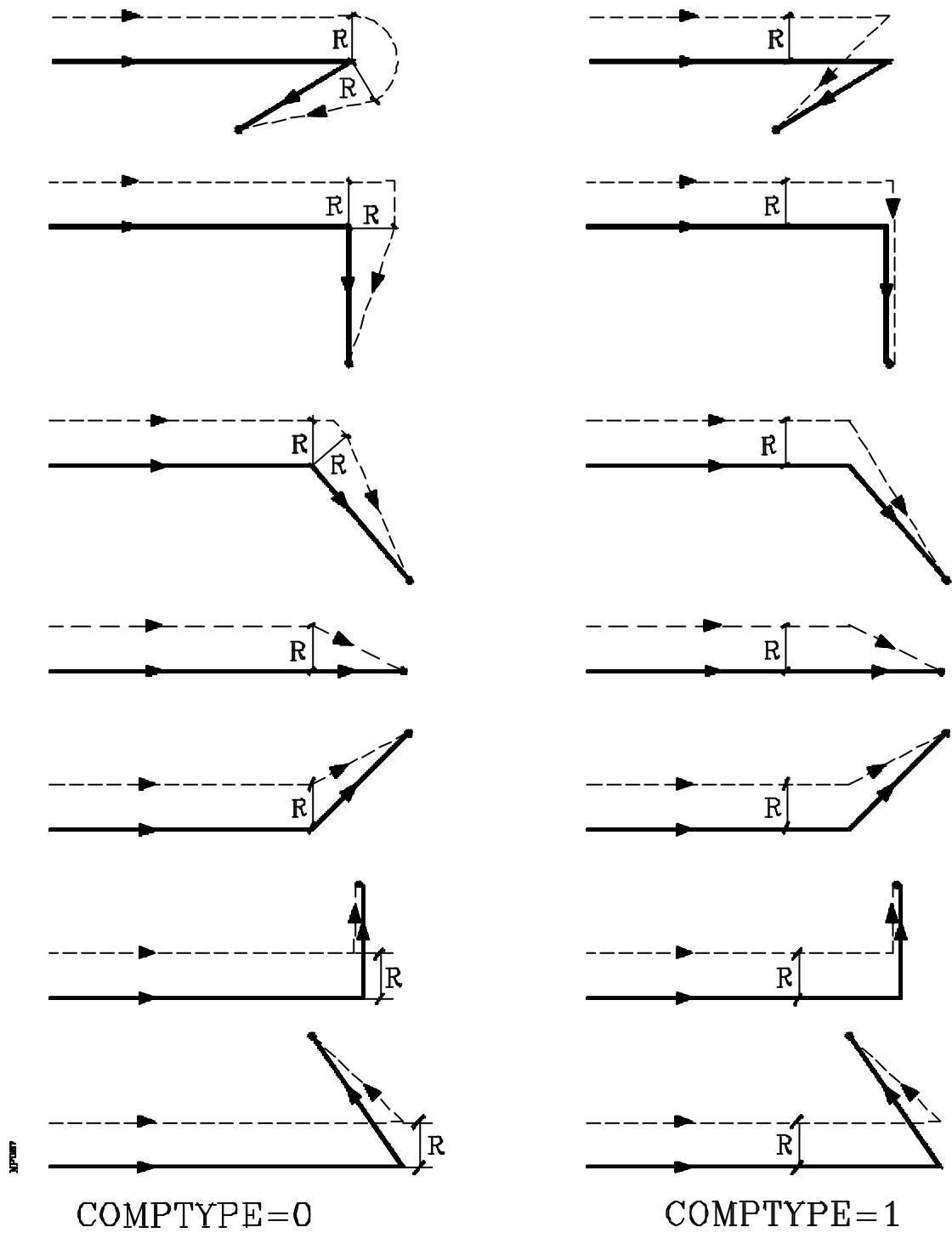
G02

G03

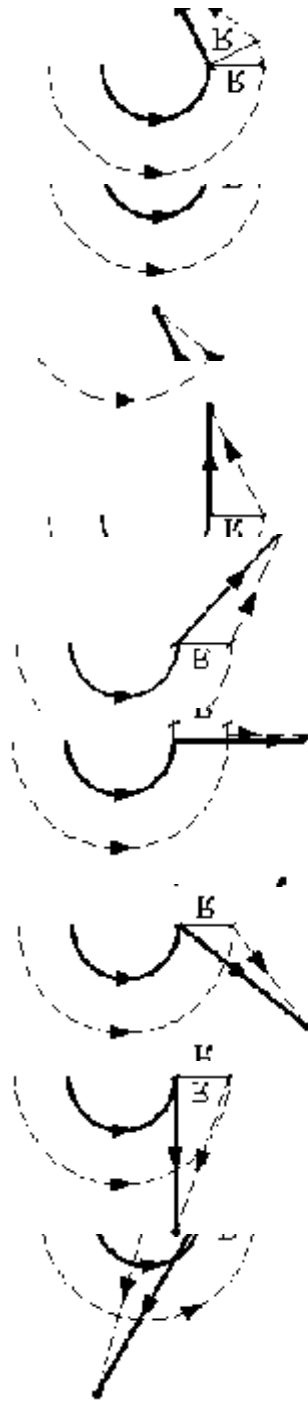
G40

, CNC

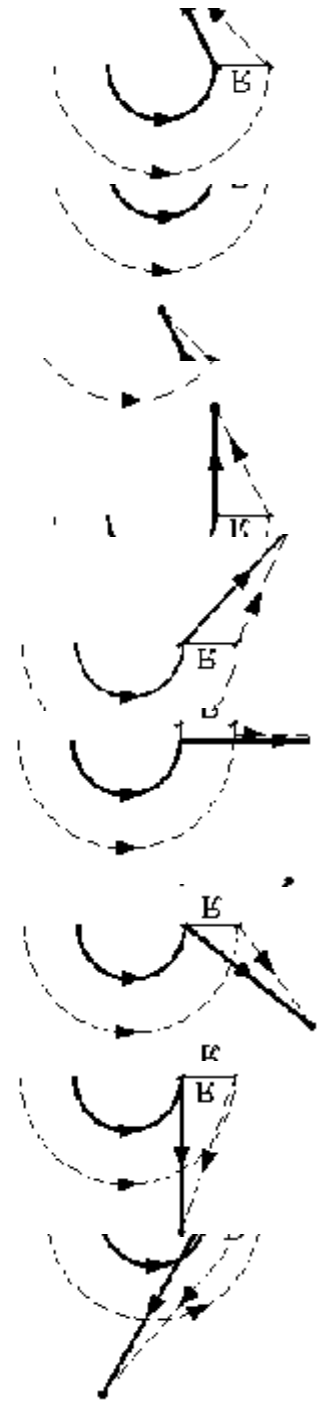
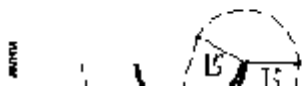
STRAIGHT-STRAIGHT path



CURVED-STRAIGHT path



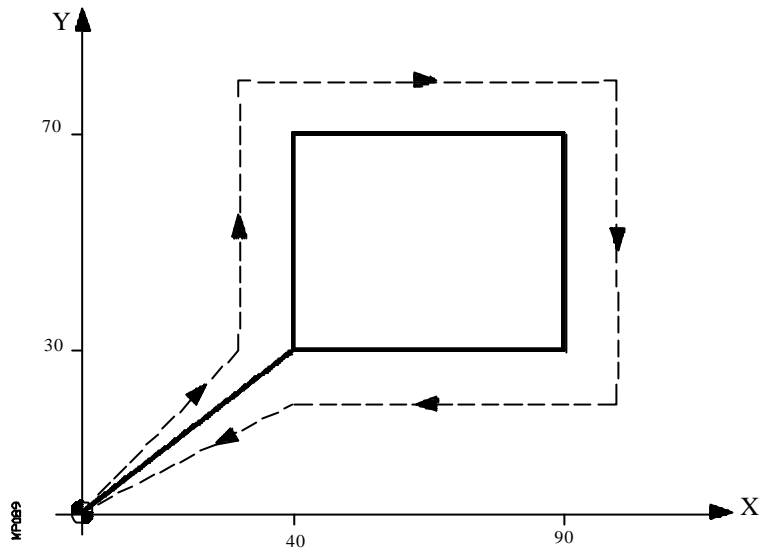
COMPENSATION = 0



COMPENSATION = 1



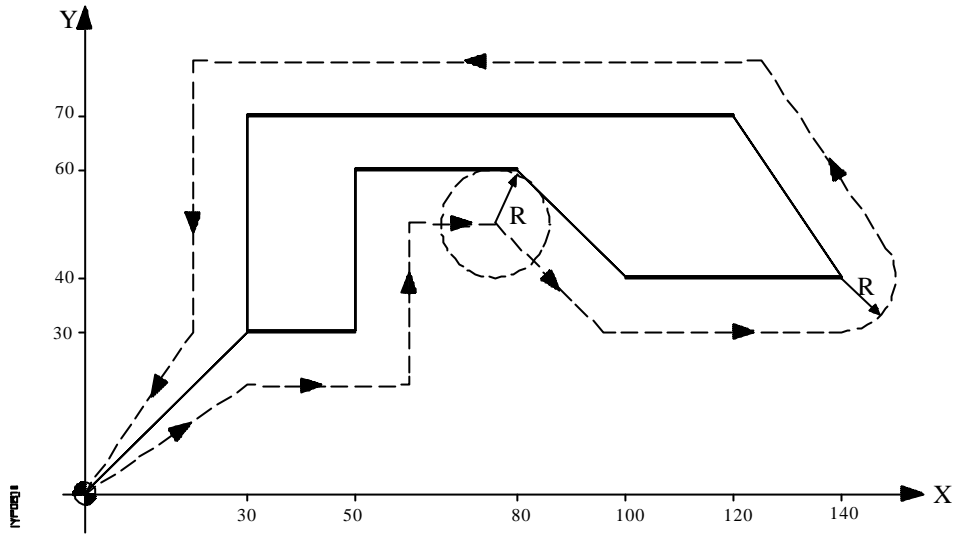
가 :



: 10 mm
 : T1
 : D1

```
G92 X0 Y0 Z0 ;
G90 G17 S0.5 T1 D1 M03 ; , , S100
G41 G01 X40 Y30 F125 ;
      Y70
      X90
      Y30
      X40
G40 G01 X0 Y0 ;
M30
```

가 :



: 10 mm

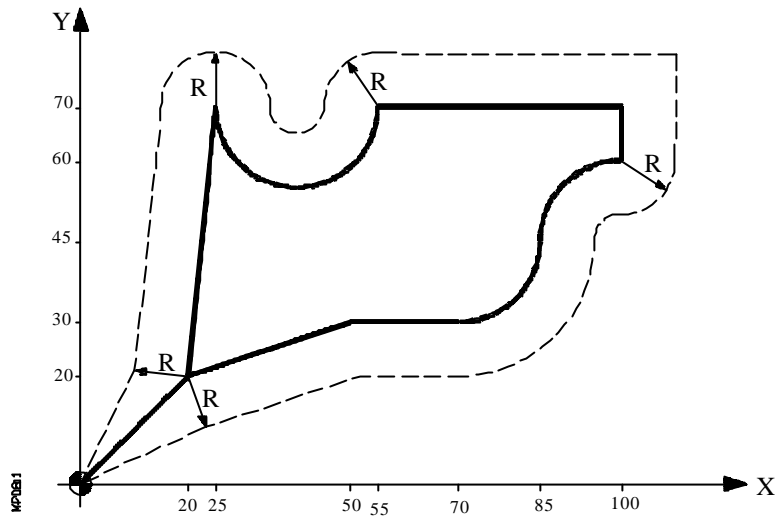
: T1

: D1

```

G92 X0 Y0 Z0 ;
G90 G17 G01 F150 S100 T1 D1 M03 ; , , ...
G42 X30 Y30 ;
X50 ;
Y60 ;
X80 ;
X100 Y40 ;
X140 ;
X120 Y70 ;
X30 ;
Y30 ;
G40 G00 X0 Y0 ;
M30
    
```

가 :



: 10 mm

: T1

: D1

```

G92 X0 Y0 Z0 ;
G90 G17 G01 F150 S100 T1 D1 M03 ; , , ...
G42 X20 Y20 ;
      X50 Y30 ;
      X70 ;
G03 X85 Y45 I0 J15 ;
G02 X100 Y60 I15 J0 ;
G01 Y70 ;
      X55 ;
G02 X25 Y70 I-15 J0 ;
G01 X20 Y20 ;
G40 G00 X0 Y0 M5 ;
M30
    
```

8.2 TOOL LENGTH COMPENSATION (G43, G44, G15)

가

G15

G17 , Z
 G18 , Y
 G19 , X

G17, G18, G19 , CNC

, G15 G17, G18 G19 ,
 (G15)

:

G43
 G44

G43 가 . CNC

: G92 X0 Y0 Z250 ; Preset
 G90 G17 G01 F150 S100 T1 D1 M03 ; Tool, Tool offset, etc.
 G43 X20 Y20 ;
 X70 ;
 Z30 ;

G43 , CNC D tool offset
 (T)

R, L, I, K 가 tool offset
 TOR, TOL, TOI, TOK

tool offset가 , CNC R0 L0 I0 K0 D0

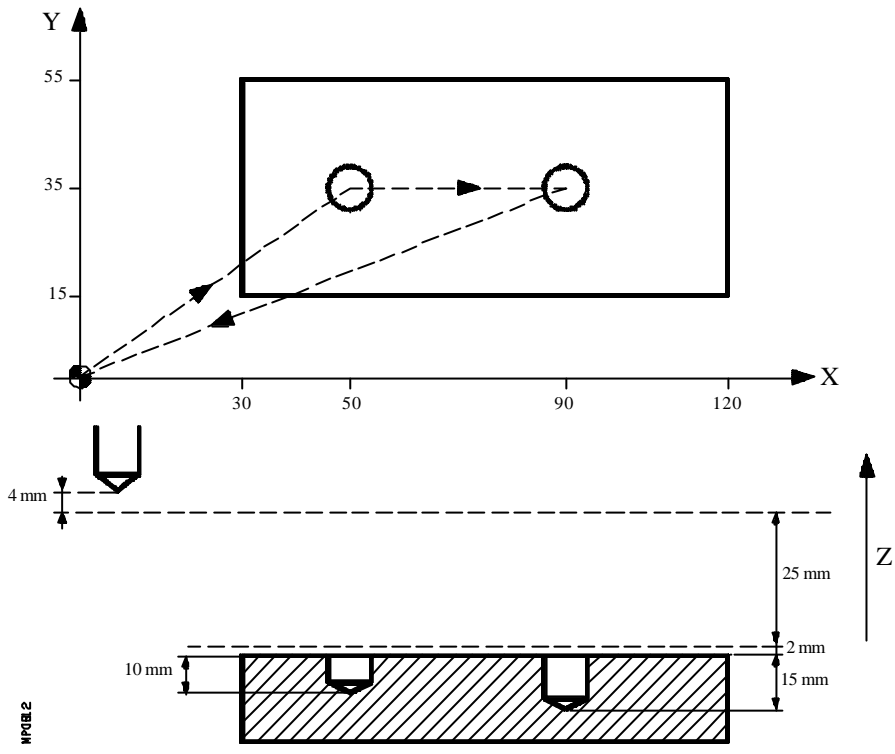
G43 modal . G44 G74(home search)
 "ILCOMP=0" , 가 , M02, M30 EMERGENCY
 RESET

G53 () G53
 G43

canned cycle

가

가 :



4mm

: -4 mm

: T1

: D1

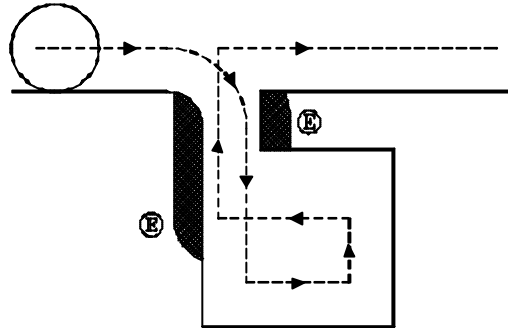
```

G92 X0 Y0 Z0 ;
G91 G00 G05 X50 Y35 S500 M03
G43 Z-25 T1 D1 ;
G01 G07 Z-12 F100
G00 Z12
X40
G01 Z-17
G00 G05 G44 Z42 M05 ;
G90 G07 X0 Y0
M30
    
```


8.3 COLLISION DETECTION (G41 N, G42 N)

(50)

(E)



가

:

)

(

: N

(G41 N G42 N) G41 G42

가

N3 N50

가

."N"

N0, N1, N2

가

,

CAD

N

. (5)

G

: G41 N

G42

N

9. CANNED CYCLES

canned cycle G15

CNC canned cycle :

G69

G81

G82 (dwell) 가

G83

G84

G85

G86 G00

G87

G88

G89 G01

가 canned cycle :

G79 canned cycle

G98 canned cycle

G99 canned cycle reference

9.1 DEFINITION OF A CANNED CYCLE

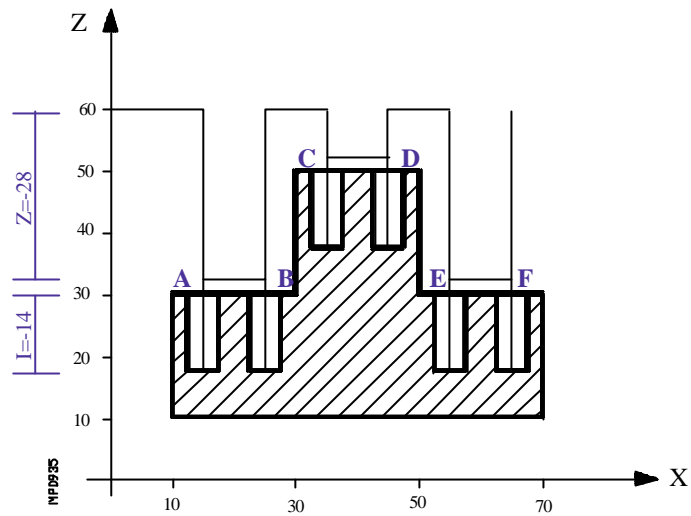
canned cycle 가 G canned cycle
(G02, G03, G08, G09 G34) 가 canned cycle
, G02, G03, G33, G34 canned cycle
. CNC
, canned cycle , G02, G03, G08, G09

9.2 CANNED CYCLE AREA OF INFLUENCE

canned cycle , canned cycle ,
 , CNC
 canned cycle 가
 canned cycle 가 ()
 "N" , canned cycle
 가
 ()가 "N0" , canned cycle 가
 CNC
 canned cycle 가 ,
 canned cycle
 G81 canned cycle ()
 G90 G1 x100 X100
 G91 X10 N3 CNC 3
 * X10 가
 *
 G91 X20 N10 X20 가 ()

9.2.1. G79. MODIFICATION OF CANNED CYCLE PARAMETERS

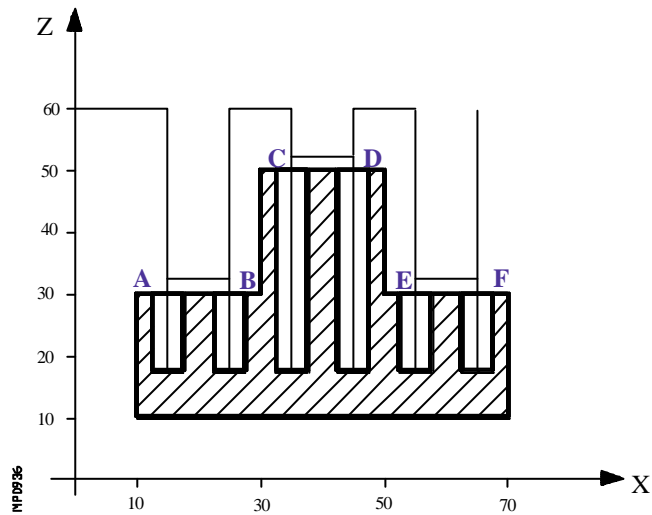
G79 canned cycle
 , canned cycle
 canned cycle canned cycle
 가
 G79 가
 X Y , Z 2 가
 :



```

T1
M6
G00 G90 X0 Y0 Z60 ;
G81 G99 G91 X15 Y25 Z-28 I-14 ; , A
G98 G90 X25 ; B
G79 Z52 ; 가 reference
G99 X35 ; C
G98 X45 ; D
G79 Z32 ; 가 reference
G99 X55 ; E
G98 X65 ; F
M30

```



```

T1
M6
G00 G90 X0 Y0 Z60 ;
G81 G99 G90 X15 Y25 Z32 I18 ; . A
G98 X25 ; B
G79 Z52 ; reference
G99 X35 ; C
G98 X45 ; D
G79 Z32 ; reference
G99 X55 ; E
G98 X65 ; F
M30

```

9.3 CANNED CYCLE CANCELLATION

- canned cycle :
- G80
 - canned cycle . canned cycle
 - M02, M30 , EMERGENCY RESET
 - G74
 - G16, G17, G18 G19

9.4 GENERAL CONSIDERATIONS

1. canned cycle . . . , . . . , . . .
2. canned cycle canned cycle
3. canned cycle "G" . . .
4. canned cycle (M03 M04)
canned cycle , (M03)
5. canned cycle 가 , . . .
6. canned cycle (G41 G42) . G40 가 . . .
7. (G43) , canned cycle
CNC G43 canned cycle . , canned cycle
8. canned cycle P299 . . .

9.5 MACHINING CANNED CYCLES

가
:
.
.
Reference
가
.
가 . reference
.
가 가
G98 가 ,
G99 가 ,
canned cycle
가 가
:

G**			F S T D M	N****
-----	--	--	-----------	-------

canned cycle
.()
canned cycle () 가 가 , canned cycle
F S T D M
가 , CNC
canned cycle 가
"N"
canned cycle 가 , CNC
"N0"가 , canned cycle 가 . CNC

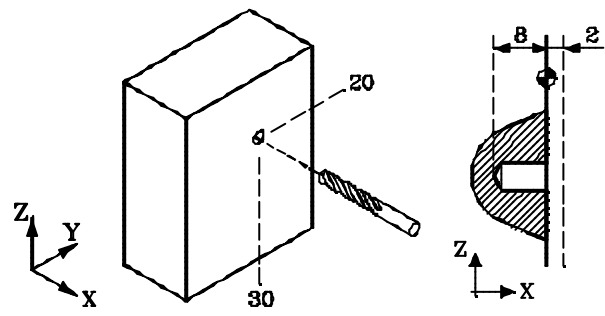
* (M03) , . , ,
 * positioning ()
 * reference
 * 가
 * reference G98 G99
 Y 가 canned cycle X
 Z 가 .

, Y :) 가 . XY (X :
 가 .
 X Y .

G81 canned cycle :
 X
 Y
 I
 K

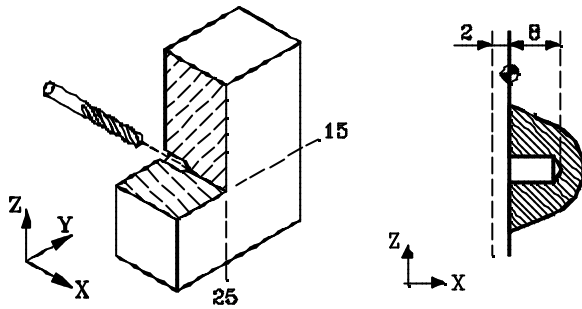
, "0" . 8mm reference
 2mm .

1 :



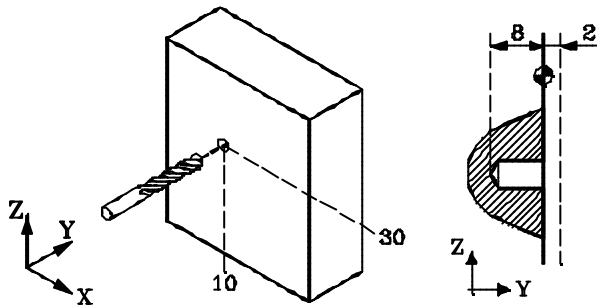
G19
 G1 X25 F1000 S1000 M3
 G81 X30 Y20 Z2 I-8 K1

2 :



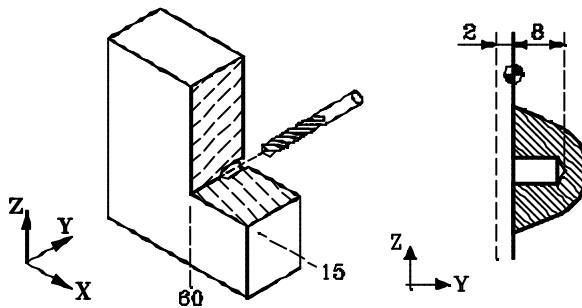
G19
G1 X-25 F1000 S1000 M3
G81 X25 Y15 Z-2 I8 K1

3 :



G18
G1 Y25 F1000 S1000 M3
G81 X30 Y10 Z2 I-8 K1

4 :



G18
G1 Y-25 F1000 S1000 M3
G81 X15 Y60 Z-2 I8 K1

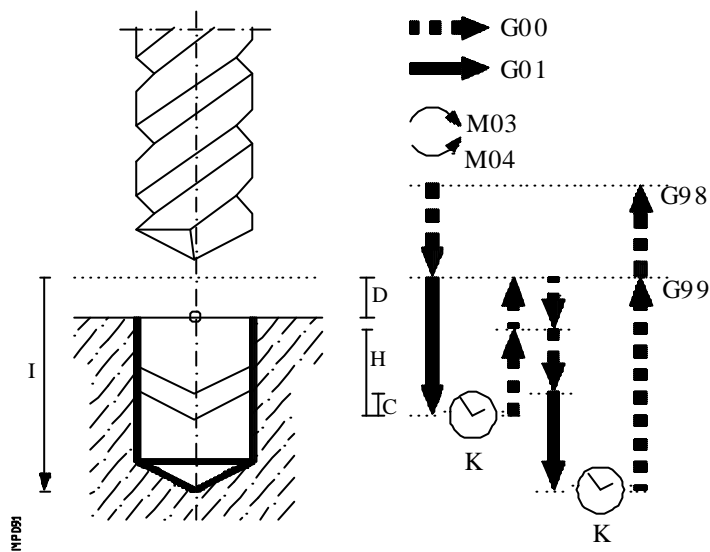
9.5.1 G69. COMPLEX DEEP HOLE DRILLING CYCLE

reference

J

(dwell)

G69 G98/G99 X Y Z I B C D H J K L R



G98 가 ,

G99 reference

XY±5.5 가 가

G90 G91

Z±5.5 reference

, CNC

reference

±5.5

reference

B5.5

C5.5

(G00)

, 1 mm

.0

, CNC

D5.5 reference

"B"

가

0

H±5.5

(peak)

(G00)

가

"0"

"J"
가

"J=0"

relief position

reference

J4

(peak)

가

(G00)

reference

가

.0

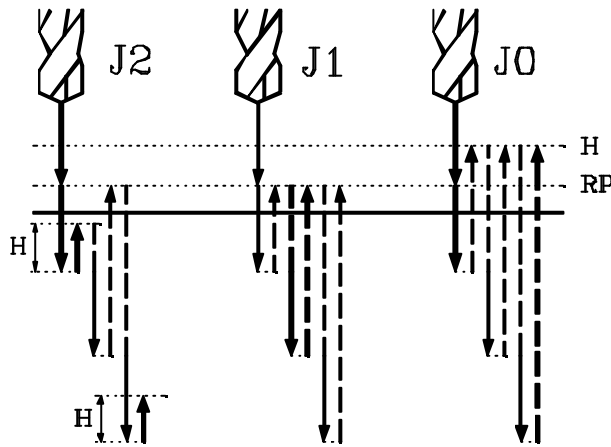
9999

"0"

(relief position)

(peak)

H



"J>1"
(RP)

, "H"

"J" reference

J1

(peal)

reference

J0

, H

relief position

K5

1/100

, CNC K0

L5.5

R

1mm(0.040 inch)가

0

, 1

R 1

"B"

R 1
"R (RB)",

"B"

"R B",

R

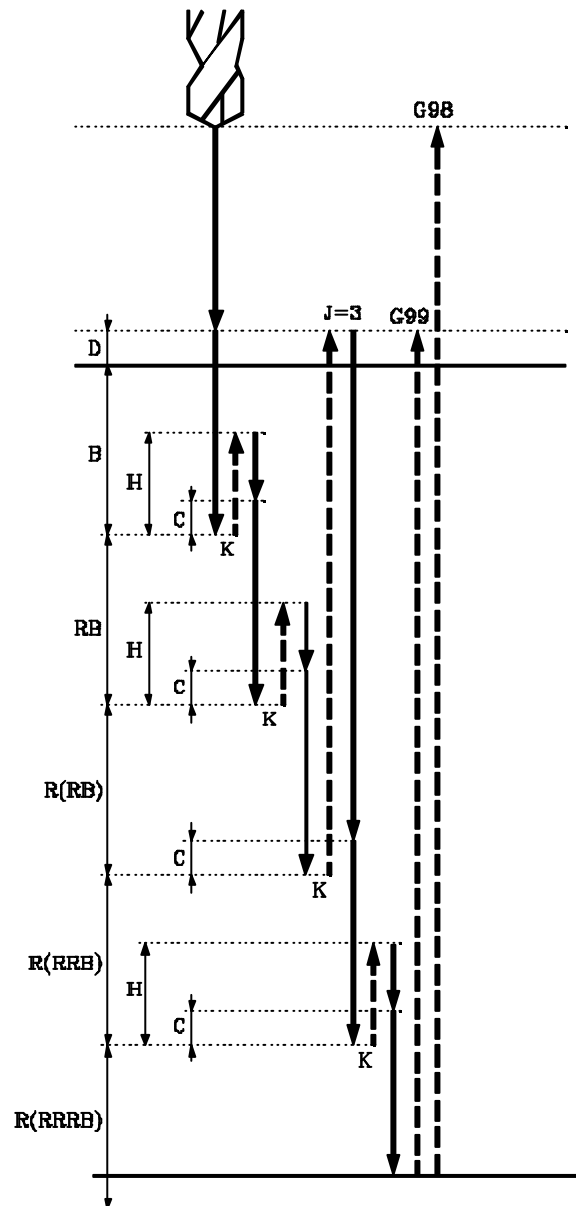
1 R , CNC L

1.

(M03)

2.

reference



3. "B+D"

"INPOSW2(P51)" G07 G50

P51=0 , G7 () P51=1 , G50 ()

4. 가 가I

4.1. 1/100 (dwell) K

4.2. J reference 가 , "H" (G00)

4.3. "C" (G00)

4.4. (G01) "B R" 가

G50 가 "INPOSW2(P51)" G07

P51=0 , G7 () P51=1 , G50 ()

5. 1/100 K

6. G98 G99 (G00) reference

가 , reference

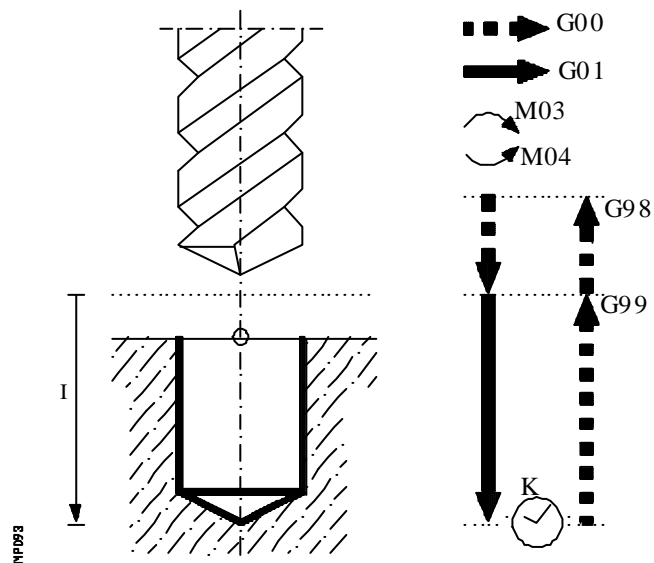
, "D"가 가 ,

X Y , Z XO YO ZO
가 :

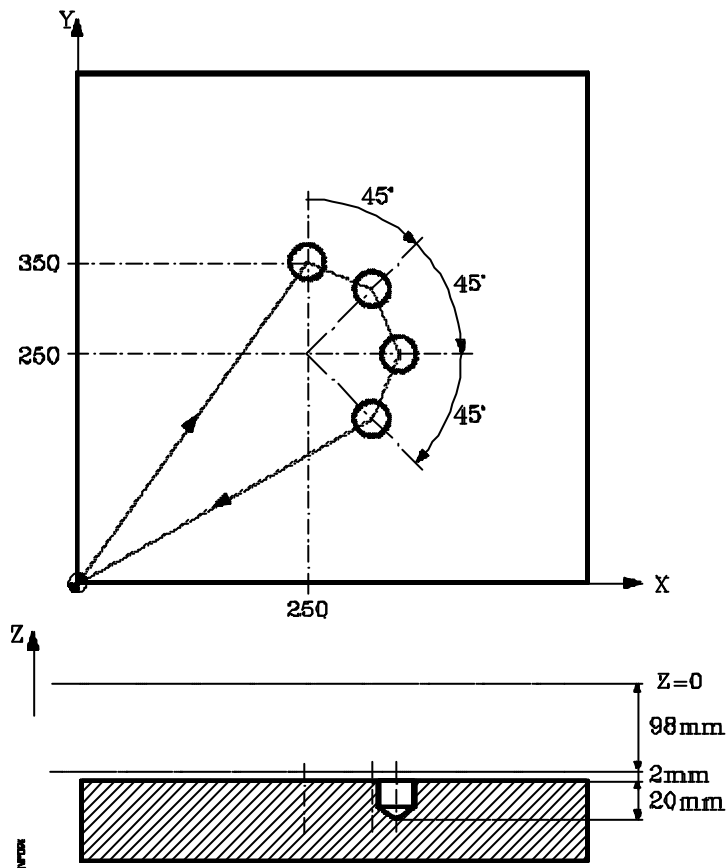
T1
M6
G0 G90 X0 Y0 Z0 ;
G69 G98 G91 X100 Y25 Z-98 I-52 B12 C2 D2
H5 J2 K150 L3 R0.8 F100 S500 M8 ; Canned cycle
G80 ; Canned cycle
G90 X0 Y0 ; Positioning
M30 ;

9.5.2. G81 DRILLING CANNED CYCLE

	G81 G98/G99 X Y Z I K			
G98	가		가	
G99	가	reference	가	
XY±5.5	가	가		
				가
	G90	G91		
Z±5.5	reference			
				reference
				, CNC
I±5.5				reference
K5			(dwell)	1/100
			K0	



1. (M03)
 2. reference
 3. 가 I
 4. , 1/100 K
 5. G98 G99 reference
- (G00)
- X Y , Z X0 Y0 Z0
가 :



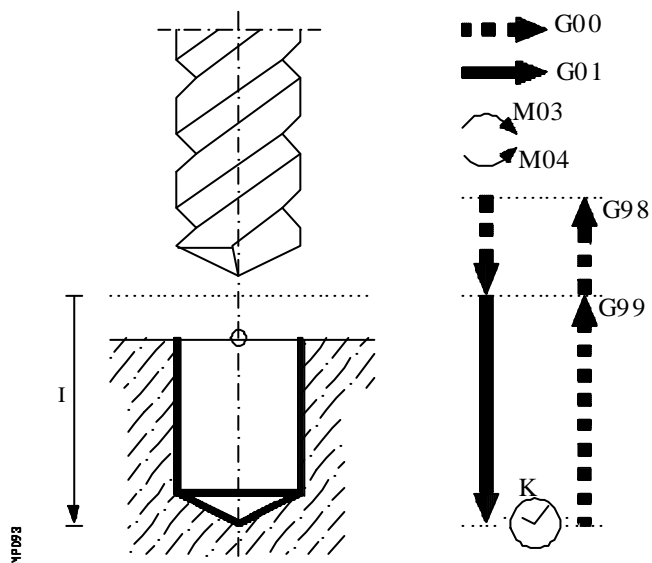
T1
M6
G0 G90 X0 Y0 Z0
G81 G98 G00 G91 X250 Y350 Z-98 I-22 F100 S500 : positioning and definition of canned cycle
G93 I250 J250 : rmrwhkvy dnjswjadml tjfwjd
Q-45 N3 : canned cycle, 3
G80 : canned cycle
G90 X0 Y0 : Positioning
M30 :

9.5.3. G82. DRILLING CANNED CYCLE WITH DWELL

G82 G98/G99 X Y Z I K

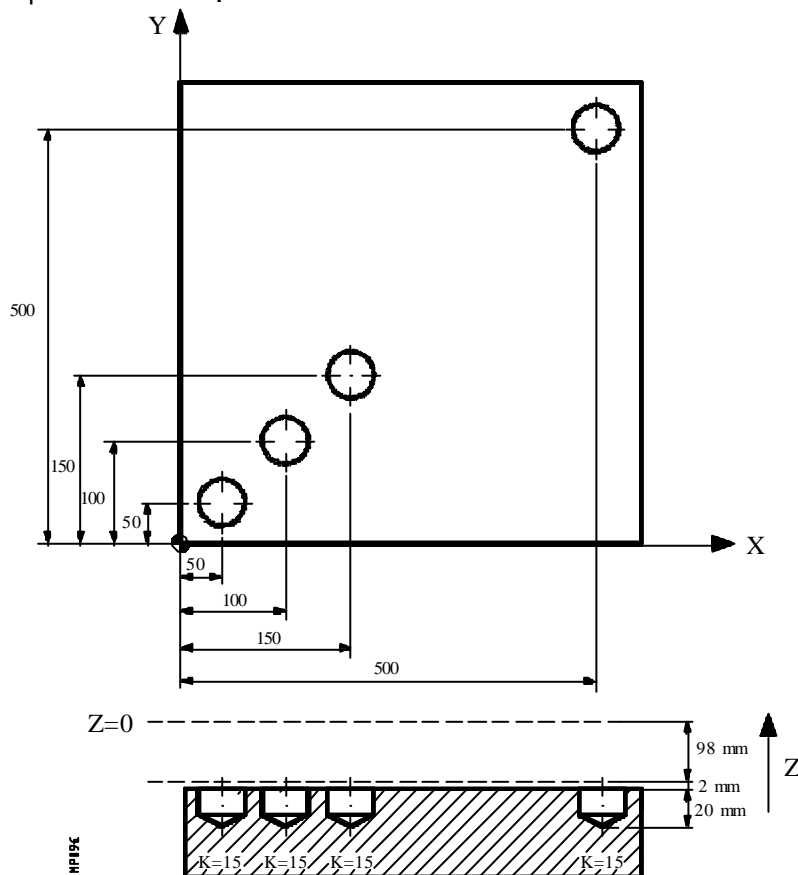
G98	가		가
G99	가	reference	가
XY±5.5	가	가	
	가	G90	G91
Z±5.5	reference		
			, CNC
			reference
I±5.5			. reference
K5			(dwell) CNC K0

1/100



1. (M03)
 2. reference
 3. 가 I
 4. , 1/100 K
 5. G98 G99 reference
- (G00)

X Y , Z X0 Y0 Z0
가 :



```

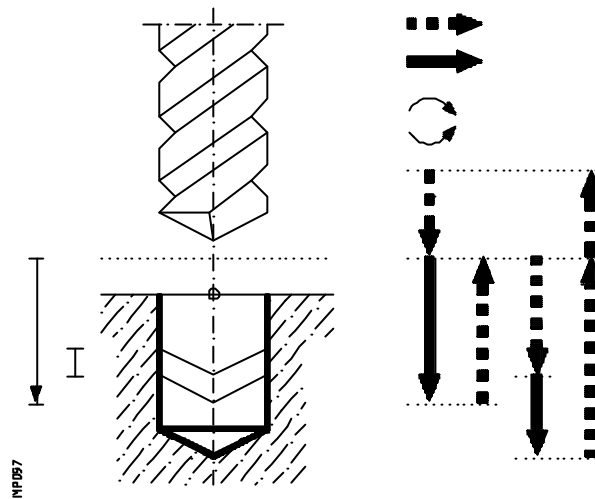
T1
M6
G0 G90 X0 Y0 Z0 ..... ;
G82 G99 G00 G91 X50 Y50 Z-98 I-22 K150 F100 S500 N3 ..... ; 3 가
G98 G90 G00 X500 Y500 ..... ; Positioning and canned cycle
G80 ..... ; canned cycle
G90 X0 Y0 ..... ; Positioning
M30 ..... ;

```

9.5.4. G83. SIMPLE DEEP HOLE DRILLING

reference

G83 G98/G99 X Y Z I J



G98

가

가

G99

가

reference

가

XY±5.5

가

가

G90

G91

가

Z±5.5

reference

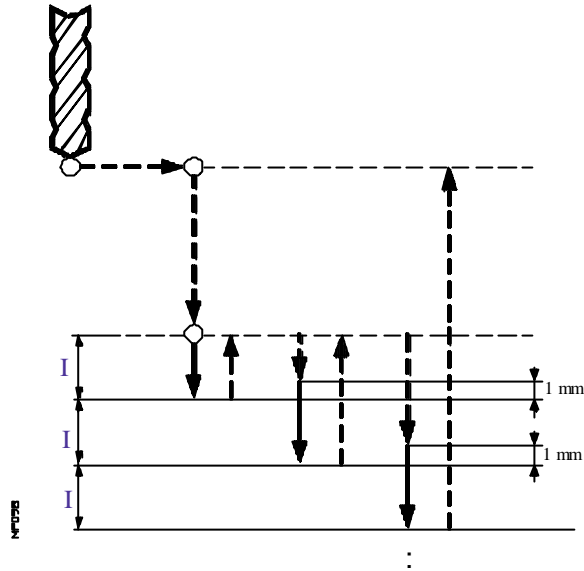
, CNC

reference

I±5.5

J4

. 1 9999



1.

(M03)

2.

reference

3.

"I"

"INPOSW2(P51)"

G07 G50

가

P51=0 , G7 () P51=1 , G50 ()

4.

1"

"J-

4.1. reference (G00)

4.2. (G00) :

INPOSW2=0 , (peak) 1mm
(peak) "INPOSW2+0.02"

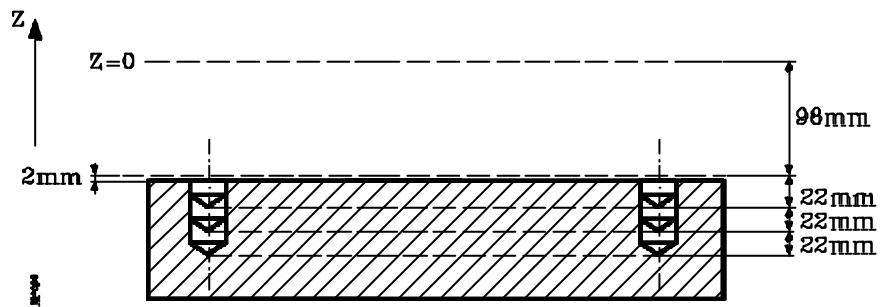
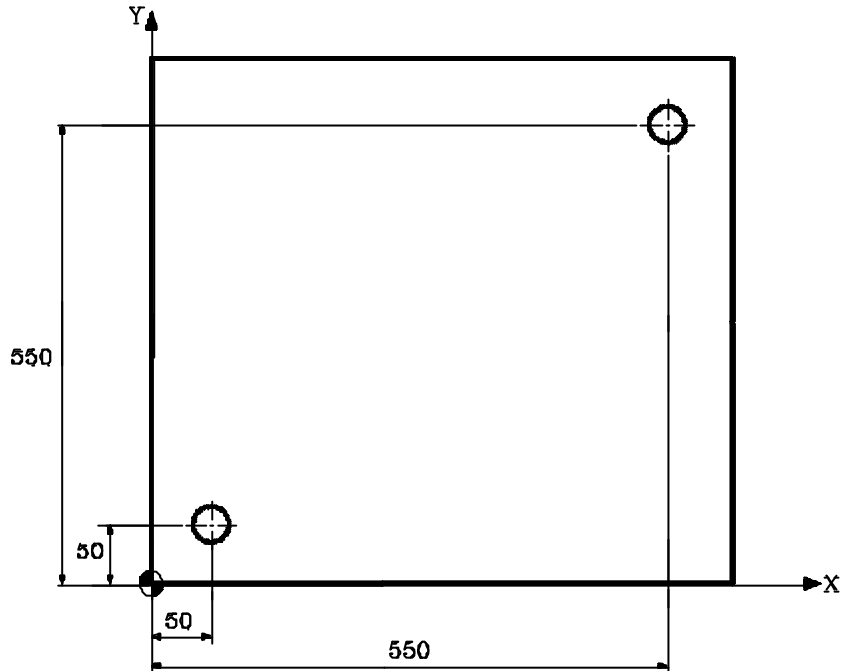
4.3. (G01) "I"

INPOSW2=0 , G7 G50

5. G98 G99 reference

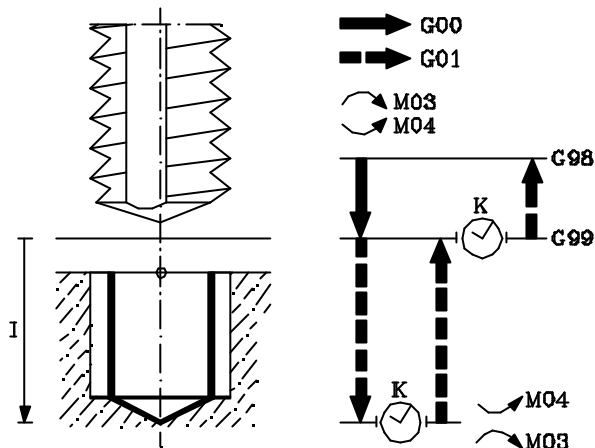
(G00)

가 , "J" 가 "I" 가
 . , "J" 가 .
 X Y Z X0 Y0 Z0
 가 :



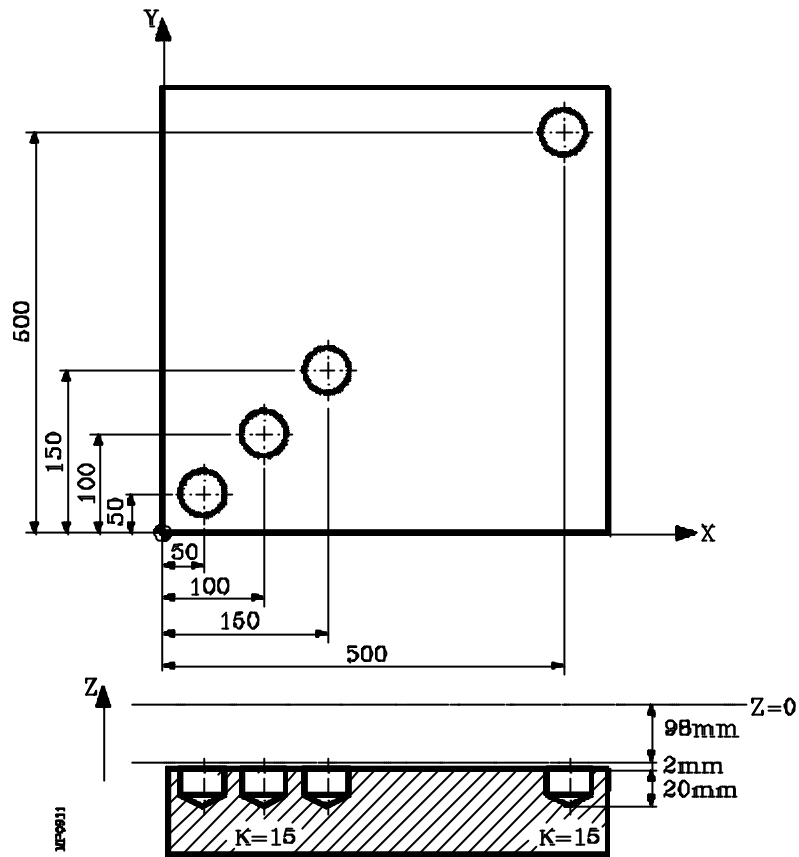
```

T1
M6
G0 G90 X0 Y0 Z0 ..... ;
G83 G99 G00 G90 X50 Y50 Z-98 I-22 J3 F100 S500 M4..... ; Positioning and canned cycle
G98 G00 G91 X500 Y500 ..... ; Positioning and canned cycle
G80 ..... ; canned cycle
G90 X0 Y0 ..... ; Positioning
M30 ..... ; program
    
```

1. (M03)
2. reference
3. 가
canned cycle S F 100%
- rigid (R=1) , CNC "RIGID" (M5521) rigid
PLC
4. (M05). "SREVM05"가 "K"가
"0" 가
5. "K"가 , (dwell)
- 6.
7. J reference , canned
cycle FEEDRATE OVERRIDE SPINDLE OVERRIDE 가
rigid (R=1) , CNC rigid PLC
"RIGID" (M5521)
8. (M05). "SREVM05"가
9. "K"가 , (dwell)
- 10.
11. G98 (G00)

X Y , Z X0 Y0 Z0
 가 : :



T1
 M6
 G0 G90 X0 Y0 Z0
 G84 G99 G00 G91 X50 Y50 Z-98 I-22 K150 F350 S500 N3..... ; 3 machining positions
 G98 G00 G90 X500 Y500 ; Positioning and canned cycle
 G80 ; canned cycle
 G90 X0 Y0 ; Positioning
 M30

9.5.6. G85. REAMING CYCLE

가 (dwell)

G85 G98/G99 X Y Z I K

G98 가

G99 가 reference

XY±5.5 가 가

G90 G91 가

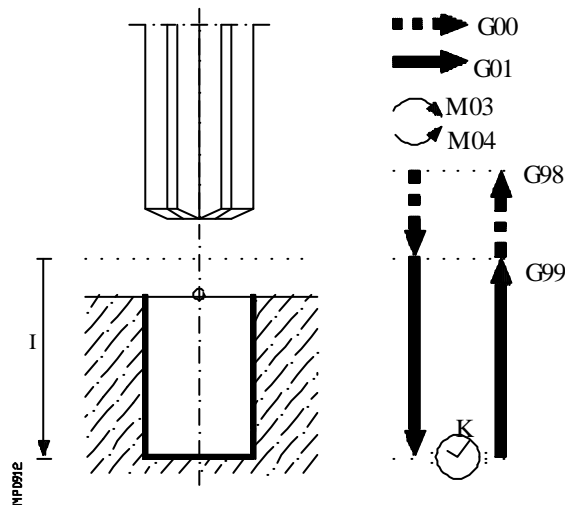
Z±5.5 reference

, CNC reference

±5.5 reference

K5 (dwell) 1/1000

, CNC K0



1. (M03)
2. reference
3. 가 (G01)
4. "K"가 (dwell)
5. reference
6. G98 (G00)

X Y , Z X0 Y0 Z0
 가 :

T1
 M6
 G0 G90 X0 Y0 Z0;
 G85 G98 G91 X250 Y350 Z-98 I-22 F100 S500; Canned cycle
 G80; Canned cycle
 G90 X0 Y0; Positioning
 M30

9.5.7. G86. BORING CYCLE WITH WITHDRAWAL IN RAPID (G00)

가 (dwell)

G86 G98/G99 X Y Z I K

G98

G99 reference

XY±5.5 가 가

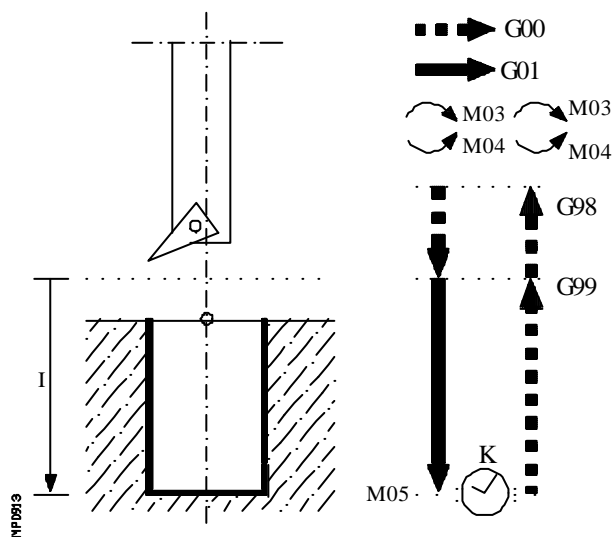
G90 G91 가

Z±5.5 reference

I±5.5 reference

K5 (dwell) 1/1000

, CNC K0



1. (M03) , . ,
2. reference
3. 가 (G01)
4. "K"가 (dwell)
5. (M05)
6. G98 G99 reference
(G00) .
7. 가 , .
X Y Z X0 Y0 Z0
가 :

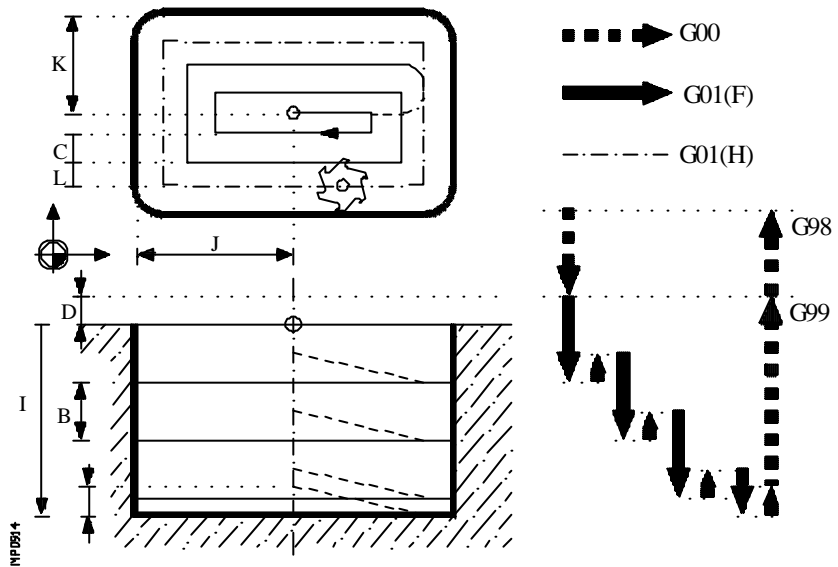
T1
 M6
 G0 G90 X0 Y0 Z0 ;
 G86 G98 G91 X250 Y350 Z-98 I-22 K20 F100 S500 .. ; Canned cycle
 G80 ; Canned cycle
 G90 X0 Y0 ; Positioning
 M30 ;

9.5.8. G87. RECTANGULAR POCKET CANNED CYCLE

(pocket)

가 , CNC

G87 G98/G99 X Y Z I J K B C D H L V



G98

G99

reference

$XY \pm 5.5$

가 가

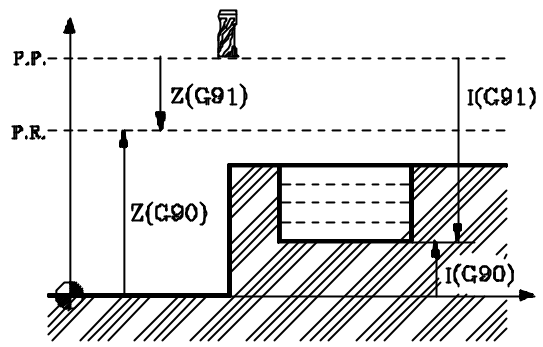
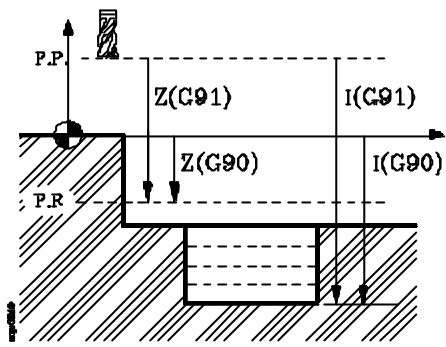
G90

G91

가

$Z \pm 5.5$ reference

(P.P).



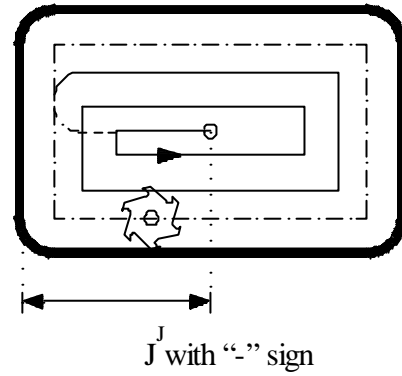
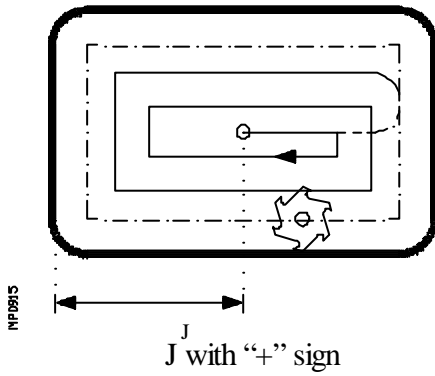
, CNC reference
(P.P.) reference(P.R.)

I±5.5 가

(P.P.)

J±5.5

가



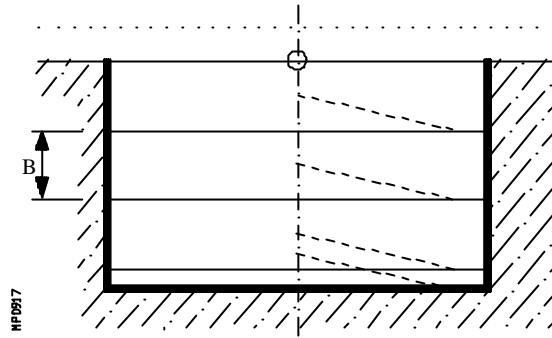
K5.5

K

B±5.5

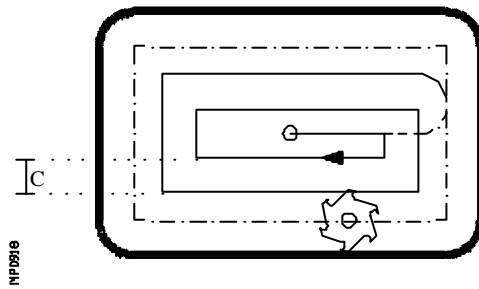
가

가



C±5.5

가



, CNC

3/4

가

0

가

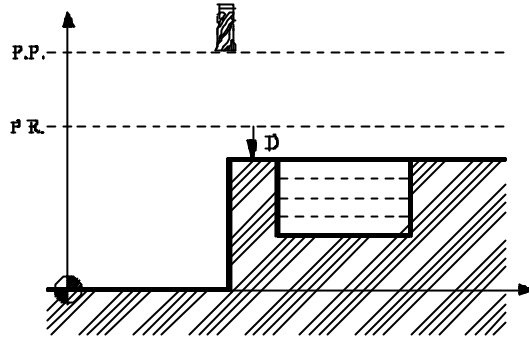
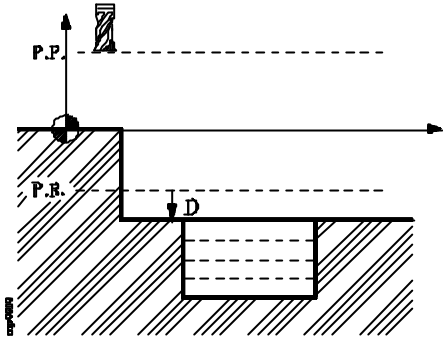
D5.5

(pocket)

reference

deepen
, 0

가 "B" 가



H5.5

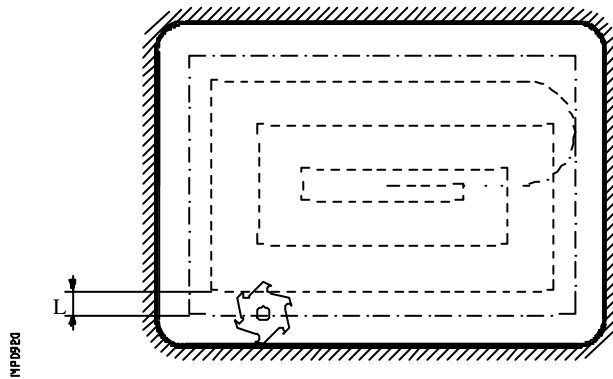
0

, 가

L±5.5

- , 가 (G07)

- , 가 (G05)



0

V5.5

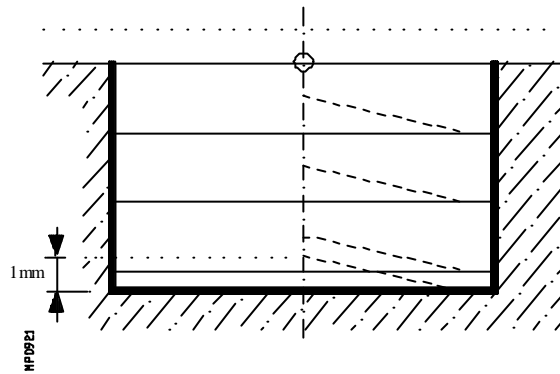
0

, CNC

(F)

50%

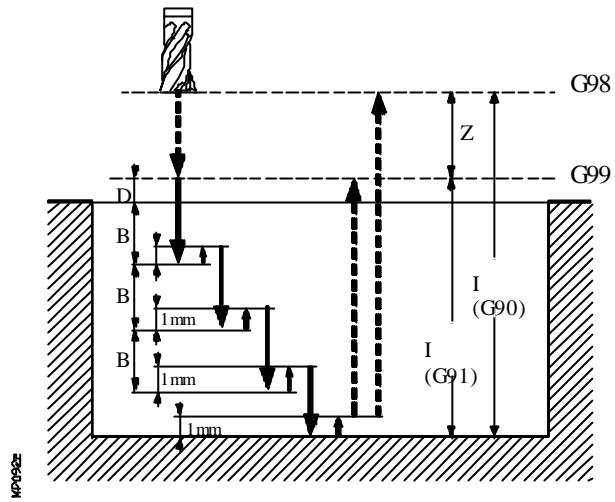
1. (M03)
2. reference
3. deepen "B+D" 가 "V"
4. "L" () "C"
5. "H" "L"
6. 가 , (G00) 가 1 mm (0.040 inch)



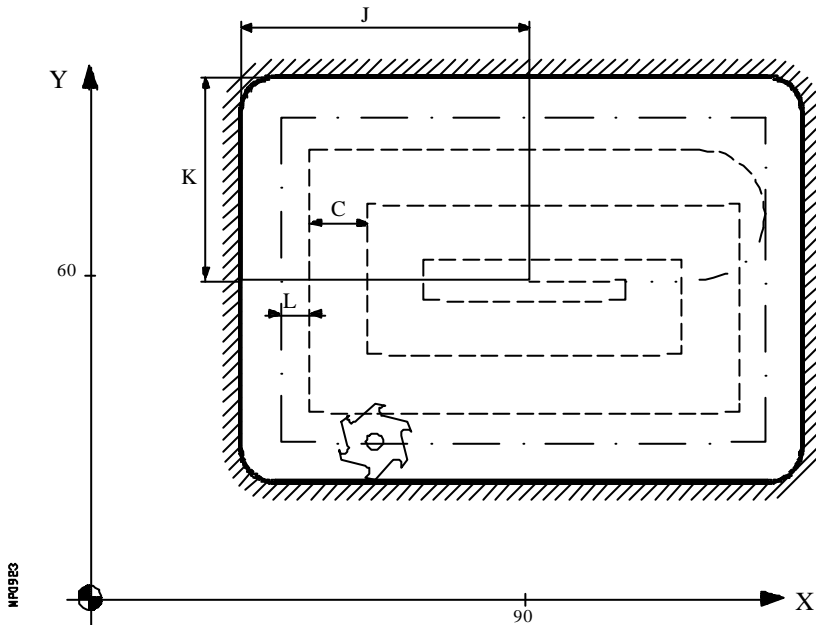
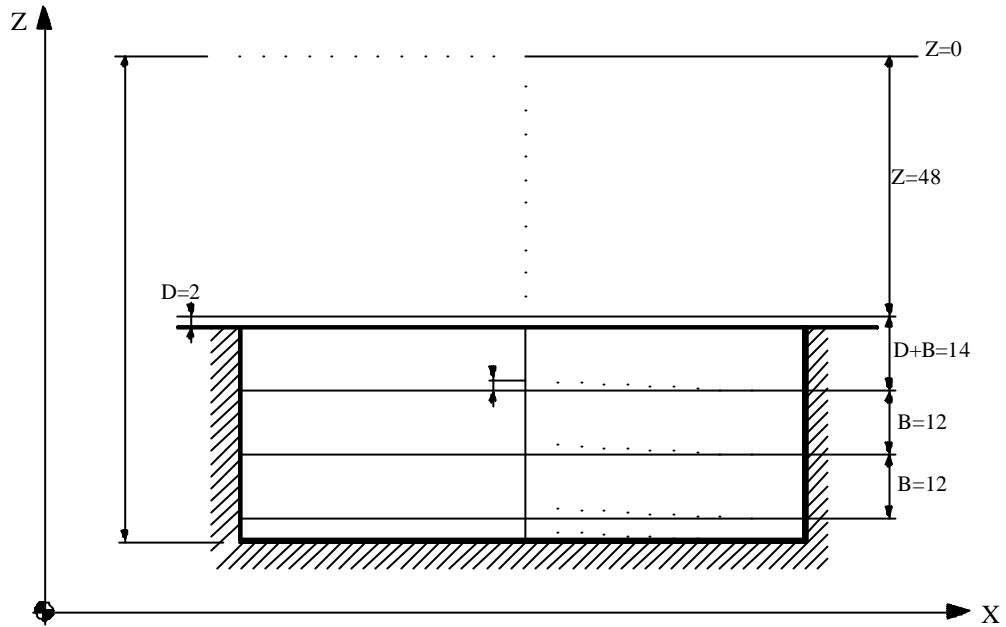
7.
 - "B" , "V"
 - 4, 5, 6

8. G98 G99가
(G00)

reference

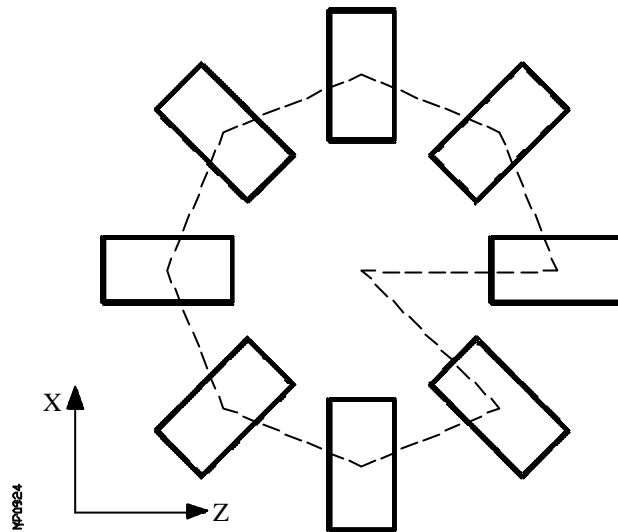


X Y , Z X0 Y0 Z0
 가 : :



```
(TOR1=6, TOT1=0)
T1 D1
M6
G0 G90 X0 Y0 Z0 .....;
G87 G98 G00 G90 X90 Y60 Z-48 I-90 J52.5 K37.5 B12
      C10 D2 H100 L5 V100 F300 S1000 T1 D1 M03 .....; canned cycle
G80 .....; canned cycle
G90 X0 Y0 .....;
M30 .....;
```

X0 Y0 Z0



```

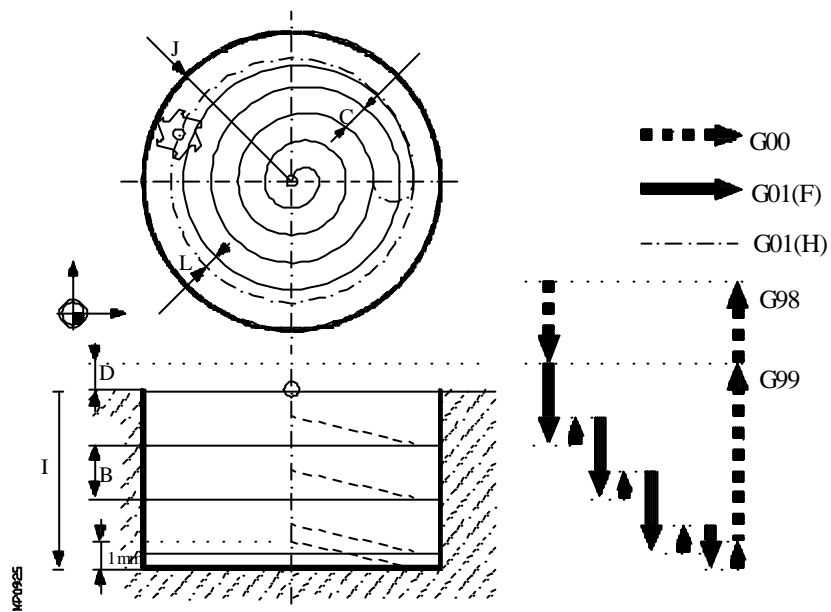
(TOR1=6, TOT1=0)
T1 D1
M6
G0 G90 X0 Y0 Z0 .....;
G18 .....;
N10 G87 G98 G00 G90 X200 Y-48 Z0 I-90 J52.5 K37.5 B12
C10 D2 H100 L5 V50 F300 .....; canned cycle
N20 G73 Q45 .....;
(RPT N10 N20) N7 .....; 7
G80 .....; canned cycle
G90 X0 Y0 .....;
M30 .....;

```

9.5.9. G88. CIRCULAR POCKET CANNED CYCLE

(pocket)

G88 G98/G99 X Y Z I J B C D H L V



G98

G99

reference

XY±5.5

가 가

G90

G91

가

Z±5.5 reference

(P.P).

CNC (P.P.) reference(P.R.)

reference

I±5.5 가

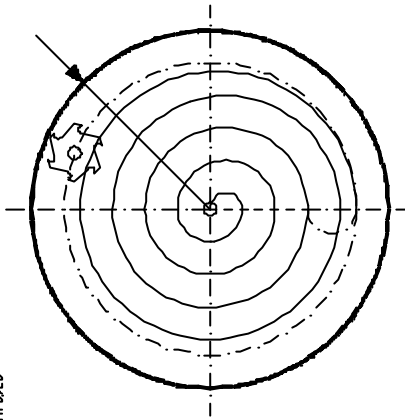
reference

J±5.5

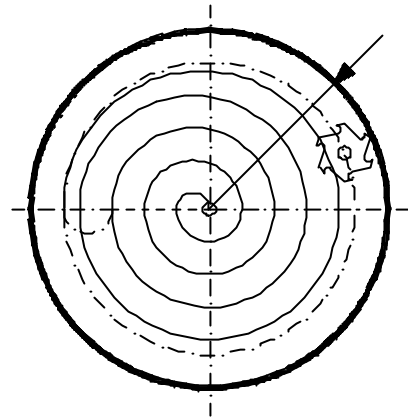
J

가

J



J with "+" sign



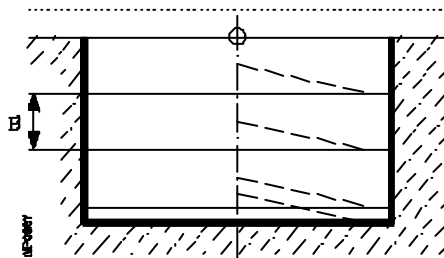
J with "-" sign

B±5.5

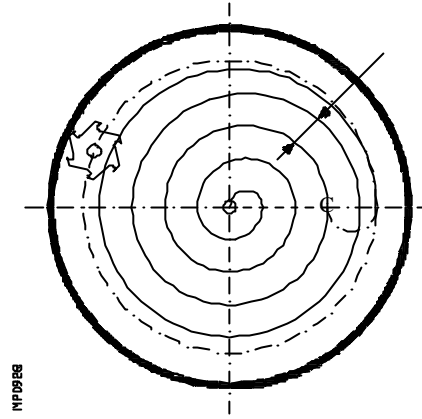
가

가

C±5.5



가



, CNC

3/4

가

0

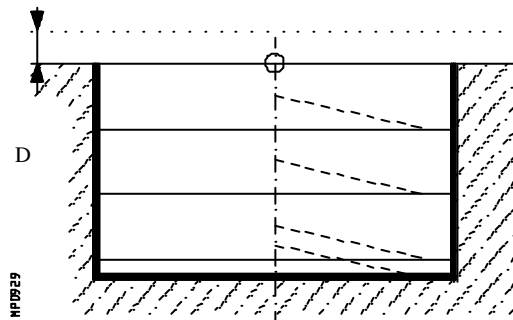
가

D5.5 pocket

reference

deepen
0

가 "B" 가

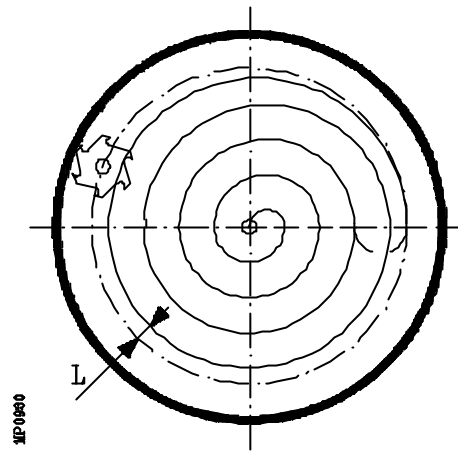


H5.5

0

가

L5.5



0

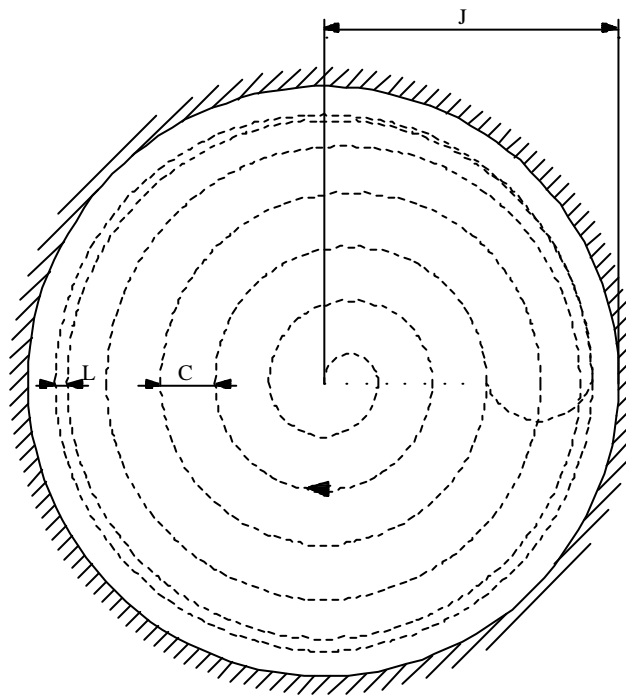
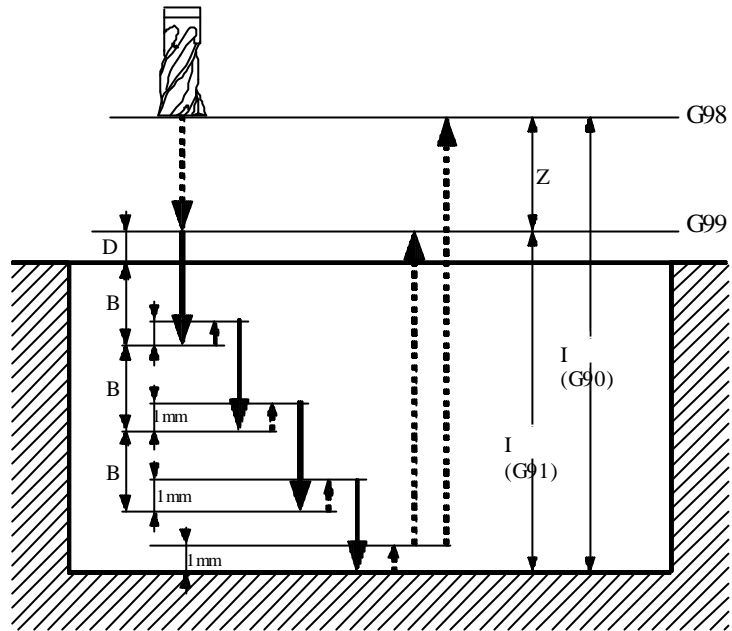
V5.5

0

CNC

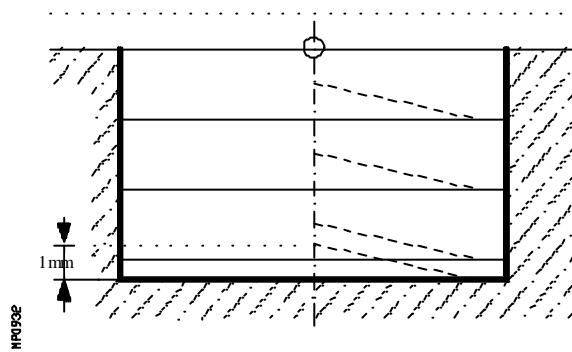
(F)

50%



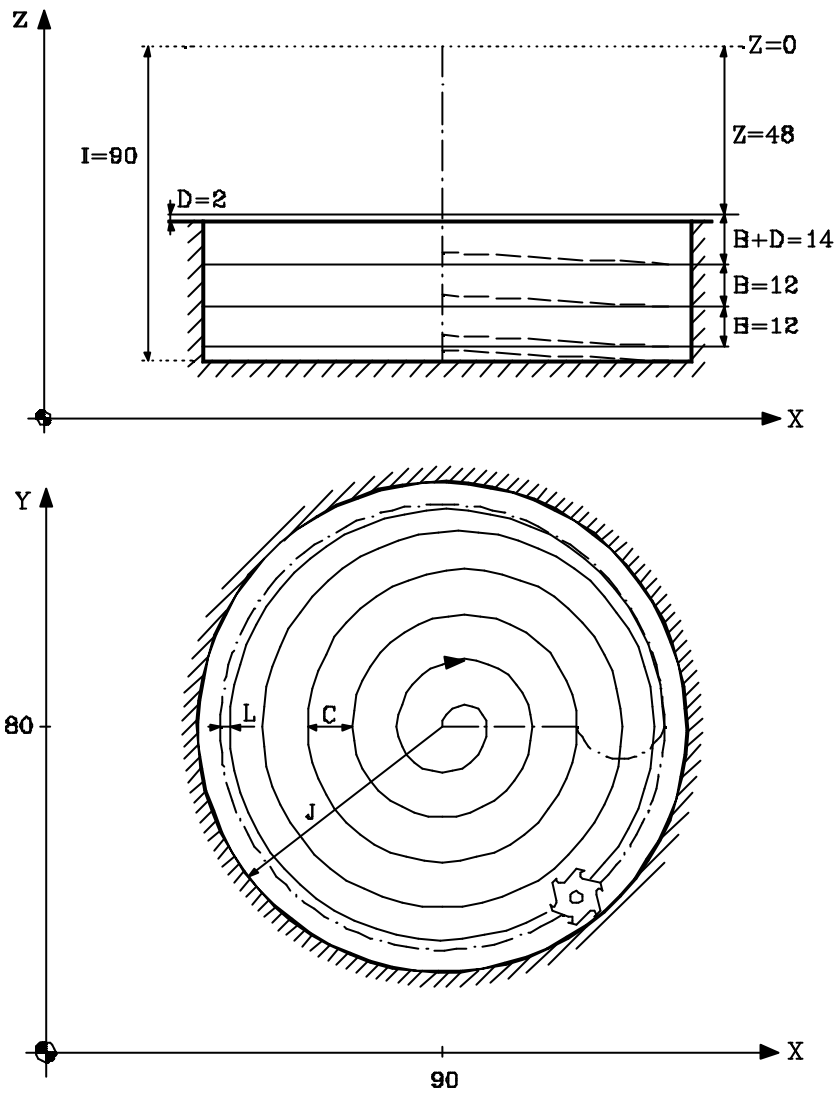
153014A

1. (M03)
2. reference
3. deepen "B+D" 가 "V"
4. "L" () "C"
5. "H" "L"
6. 가 , (G00) 가 1 mm (0.040 inch)



7.
 - "B" , "V"
 - 4, 5, 6
8. G98 G99가 , reference
(G00)

X Y , Z X0 Y0 Z0
가 :



```
(TOR1=6, TOT1=0)
T1 D1
M6
G0 G90 X0 Y0 Z0 .....;
G88 G98 G00 G90 X90 Y80 Z-48 I-90 J70 B12 C10
    D2 H100 L5 V100 F300 S1000 T1 D1 M03 .....; canned cycle
G80 .....; canned cycle
G90 X0 Y0 .....;
M30 .....;
```

9.5.10. G89. BORING CYCLE WITH WITHDRAWAL AT WORKING FEEDRATE (G01)

가 (dwell)

G89 G98/G99 X Y Z I K

G98

G99 reference

XY±5.5 가 가

G90 G91

가

Z±5.5 reference

, CNC

reference

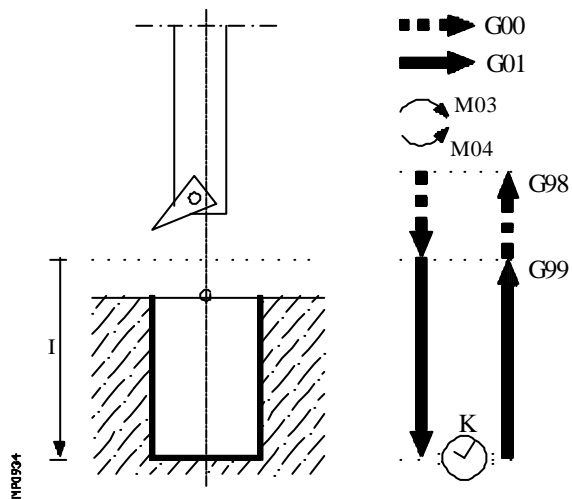
I±5.5 reference

K5

(dwell)

1/100

K0



1. (M03) .
2. reference
3. 가 (G01)
4. (M05)
5. reference
6. G98 (G00) .
X Y , Z XO YO ZO
가 :

T1
M6
G0 G90 X0 Y0 Z0;
G89 G98 G91 X250 Y350 Z-98 I-22 K20 F100 S500; canned cycle
G80; canned cycle
G90 X0 Y0;
M30;

10. MULTIPLE MACHINING

가

canned cycle () 가

가 :

- G60 : 가
- G61 : 가
- G62 : grid 가
- G63 : 가
- G64 : (arc) 가
- G65 : arc-chord 가

가 가

canned cycle

가 :

- 1.- 가
- 2.- canned cycle
- 3.-

가 canned cycle

(T, D, F, S)

가 , canned cycle

가 canned cycle F

가 , 가

가 () ,

가 X Y

P,Q,R,S,T,U,V

가 가
가

, P7 7 가 가
Q10.013 10 13 가 가
, 10, 11, 12, 13 가 가

(Q10.013) 가 ,
. Q10.13 , 가 Q10.130

가 P Q R S T U V
가 , Q
P R

:

P5.006 Q12.015 R20.022
P5.006 Q20.022 R12.015

CNC 가

1. 가 가

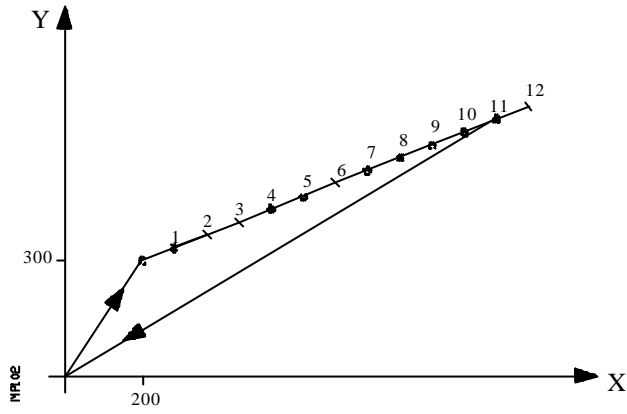
2. (G00)

3. 가 canned cycle

4. CNC 1-2-3

가 , 가

X0 Y0 Z0 X Y , Z



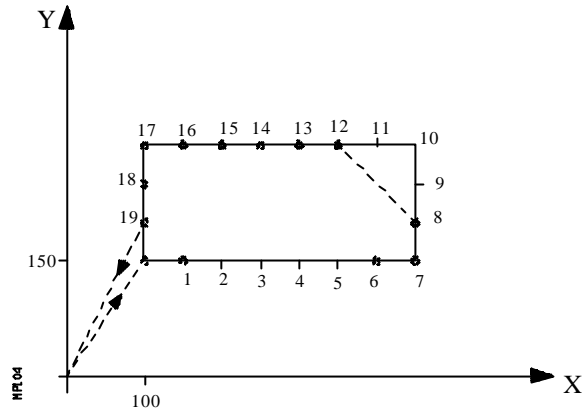
```
G81 G98 G00 G91 X200 Y300 Z-8 I-22 F100 S500 ; canned cycle
G60 A30 X1200 I100 P2.003 Q6 R12 ; 가
G80 ; canned cycle
G90 X0 Y0 ;
M30 ;
```

가 :

G60 A30 X1200 K13 P2.003 Q6 R12

G60 A30 I100 K13 P2.003 R6 R12

X0 Y0 Z0 X Y , Z



```
G81 G98 G00 G91 X100 Y150 Z-8 I-22 F100 S500 ; canned cycle
G61 X700 I100 Y180 J60 P2.005 Q9.011 ; 가
G80 ; canned cycle
G90 X0 Y0 ;
M30 ;
```

가 :

G61 X700 K8 J60 D4 P2.005 Q9.001

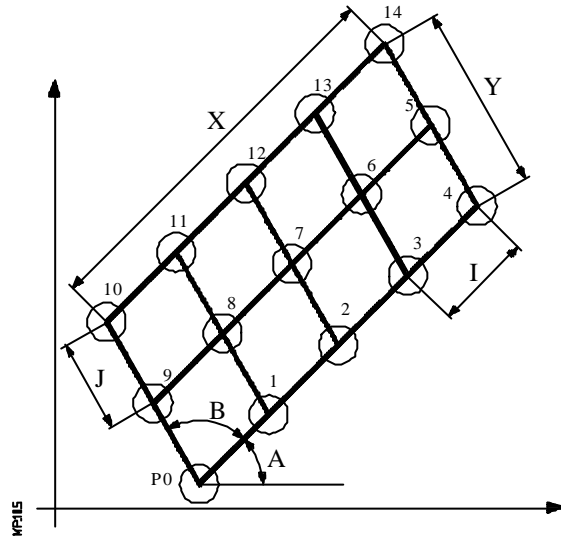
G61 I100 K8 Y180 D4 P2.005 Q9.011

10.3 G62: MULTIPLE MACHINING IN A GRID PATTERN

:

G62 A B | X I | Y J | P Q R S T U V

X I	Y J
X K	Y D
I K	J D



A(+/- 5.5)

가
, A = 0

B(+/- 5.5)

가
B = 90

X(5.5)

가

I(5.5)

가

K(5)

가

가

X I K

가

, CNC

: XI, XK, IK

, CNC

, XI

가

, 가

가

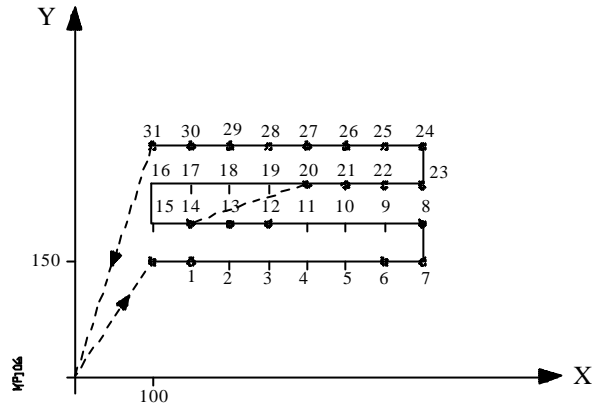
Y(5.5)

가

J(5.5)

가

X0 Y0 Z0 X Y , Z



```
G81 G98 G00 G91 X100 Y150 Z-8 I-22 F100 S500 ; canned cycle
G62 X700 I100 Y180 J60 P2.005 Q9.011 R15.019 ; 가
G80 ; canned cycle
G90 X0 Y0 ;
M30 ;
```

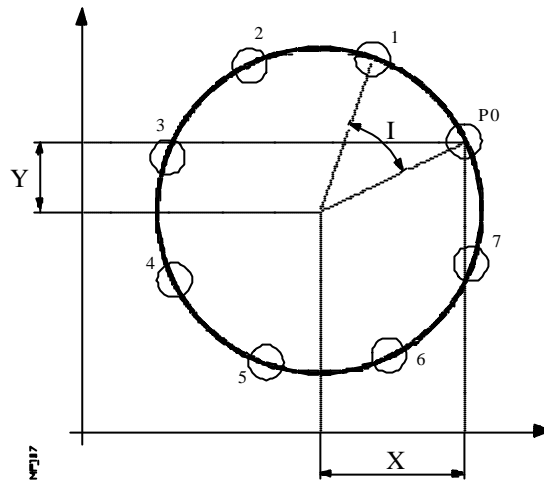
가 :

```
G61 X700 K8 J60 D4 P2.005 Q9.001 R15.019
```

```
G61 I100 K8 Y180 D4 P2.005 Q9.011 R15.019
```

10.4 G63: MULTIPLE MACHINING IN A CIRCULAR (BOLT-HOLE) PATTERN

G63 X Y | I | C F P Q R S T U V
K



X(+/- 5.5)

가

Y(+/- 5.5)

(G02, G03)
가

I J

X Y

I(+/- 5.5) 가
"

. G00

G01

, "+"

, "-"

K(5)

가

가

G00 가

G01

가

I K

가

K

C 가 .
, C = 0 .
C=0 : (G00)
C=1 : (G01)
C=2 : (G02)
C=3 : (G03)

F(5.5) 0 "C"
. , "MAXFEED"
F0 .

P,Q,R,S,T,U,V 가 가
가 . 가
, P7 7 가 가 .
Q10.013 10 13 가 가 .
, 10, 11, 12, 13 가 가
. (Q10.013) 가 ,
. Q10.13 , 가 Q10.130

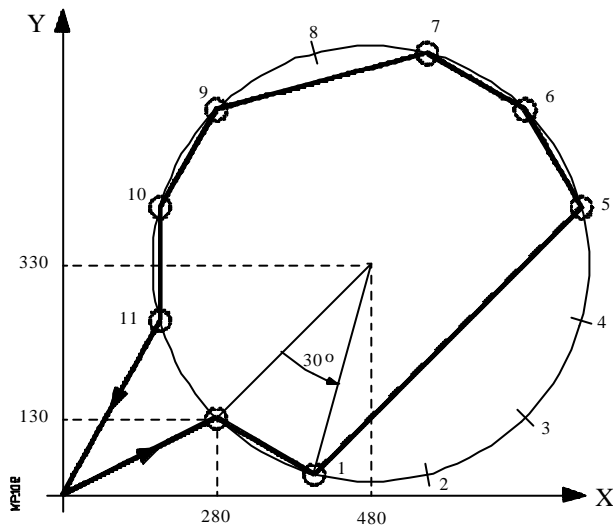
가 P Q R S T U V .
가 , Q
R

:
P5.006 Q12.015 R20.022
P5.006 Q20.022 R12.015

, CNC 가

1. 가 가 .
2. "C" (G00, G01, G02, G03)
3. 가 canned cycle
4. CNC 1-2-3 .

가 , 가
 .
 X0 Y0 Z0 X Y , Z



G81 G98 G01 G91 X280 Y130 Z-8 I-22 F100 S500 ; canned cycle
G63 X200 Y200 I30 C1 F200 P2.004 Q8 ; 가
 G80 ; canned cycle
 G90 X0 Y0 ;
 M30 ;

가 :

G63 X200 Y200 K12 C1 F200 P2.004 Q8

C 가 .
 , C = 0 .
 C=0 : (G00)
 C=1 : (G01)
 C=2 : (G02)
 C=3 : (G03)

F(5.5) 0 "C"
 , "MAXFEED"
 F0 .

P,Q,R,S,T,U,V 가 가 가
 가
 , P7 7 가 가
 Q10.013 10 13 가
 , 10, 11, 12, 13 가 가
 (Q10.013) 가 ,
 Q10.13 , 가 Q10.130

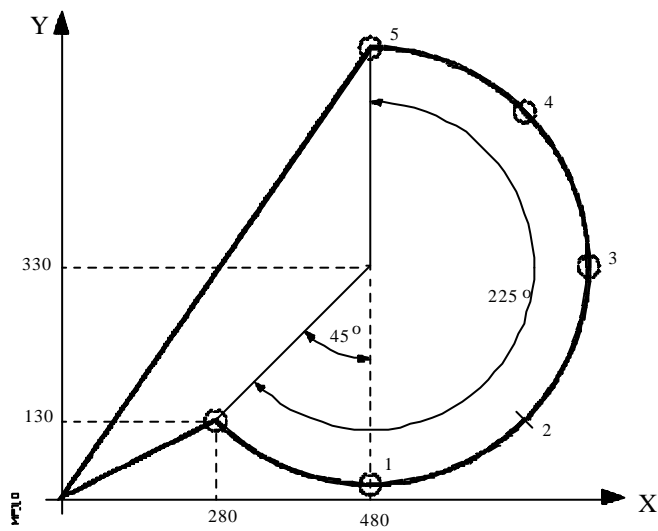
가 P Q R S T U V
 가 , Q
 R

:

P5.006 Q12.015 R20.022
 P5.006 Q20.022 R12.015

, CNC 가

1. 가 가 .
 2. "C" (G00, G01, G02, G03)
 3. 가 canned cycle .
 4. CNC 1-2-3 .
- 가 , 가
- X0 Y0 Z0 X Y , Z



```
G81 G98 G01 G91 X280 Y130 Z-8 I-22 F100 S500 ; canned cycle
G64 X200 Y200 B225 K6 C3 F200 P2 ; 가
G80 ; canned cycle
G90 X0 Y0 ;
M30 ;
```

가 :

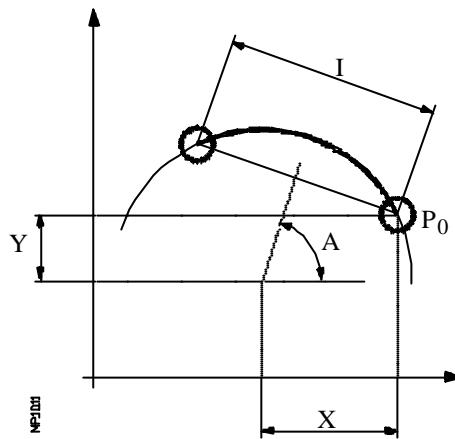
```
G64 X200 Y200 B225 K6 C3 F200 P2
```

10.6 G65: MACHINING PROGRAMMED BY MEANS OF AN ARC CHORD

arc chord

가

G65 X Y | A | C F



X(+/- 5.5)

Y(+/- 5.5)

(G02, G03)

I J

X Y

가

A(+/- 5.5)

chord

I(+/- 5.5)

chord

G00

G01

, "+"

, "-"

C

가

, C = 0

C=0 : (G00)

C=1 : (G01)

C=2 : (G02)

C=3 : (G03)

F(5.5)

0

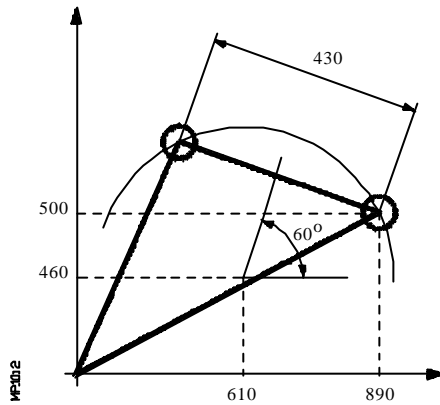
"C"

, "MAXFEED"

F0

1. 가 가 .
2. "C" (G00, G01, G02, G03)
3. 가 canned cycle .
가 , 가

X0 Y0 Z0 X Y , Z

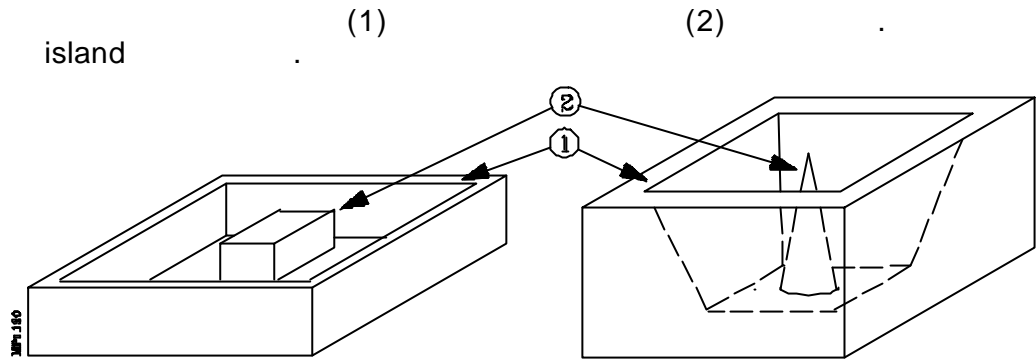


```
G81 G98 G01 G91 X890 Y500 Z-8 I-22 F100 S500 ; canned cycle
G65 X280 Y-40 A60 C1 F200 ; 가
G80 ; canned cycle
G90 X0 Y0 ;
M30 ;
```

가 :

```
G65 X-280 Y40 I430 C1 F200
```

11. IRREGULAR POCKET CANNED CYCLE (WITH ISLANDS)



island (1) (2)

canned cycle 2D 3D 가

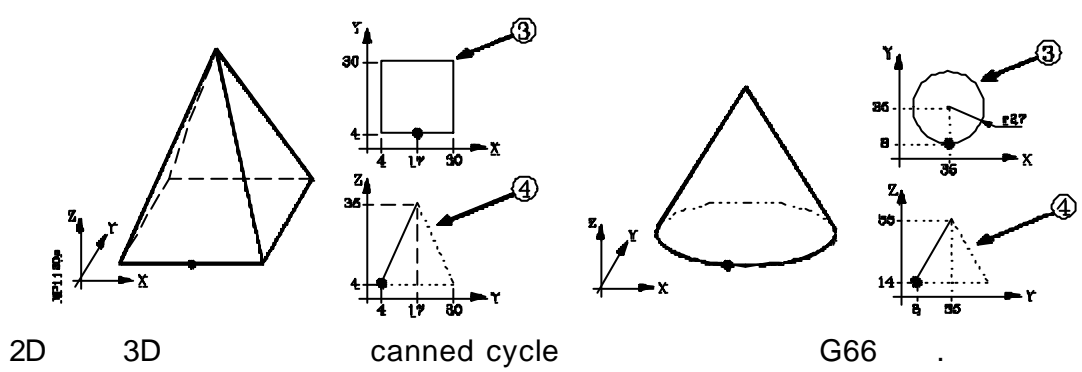
2D ()

2D

3D ()

3D

3D () (3) (4)



2D 3D

가 :

가

..... Only on 2D pockets

..... 2D and 3D pockets

..... Only on 3D pockets

..... 2D and 3D pockets

11.1 2D POCKETS

```

G66                .      2D                .
                canned cycle
                :
                G66 D H R I F K S E Q
D (0-9999) & H (0-9999)                (D)
(H)
  "H"                "D"
  "D"                ,
R (0-9999) & I (0-9999)                (R)
(I)
  "I"                , "R"
  "R"                ,
F (0-9999) & K (0-9999)                (F)                (K)
  "K"                , "F"
  "F"                ,
S (0-9999) & E (0-9999)                (S)
(E)
Q (0-9999)                , "Q"                , S E
                :

```

```

G00 G90 X100 Y200 Z50 F5000 T1 D2 ;
M06
G66 D100 R200 I210 F300 S400 E500 ; canned cycle
M30 ;
N100 G81 ..... ;
N200 ..... ;
G67 ..... ;
N210 ..... ;
N300 G68 ..... ;
N400 G0 G90 X300 Y50 Z3 ; 가
..... ;
..... ;
N500 G2 G6 X300 Y50 I150 J0 ; 가

```

1.-

CNC

, island 가

2.-

Case A:

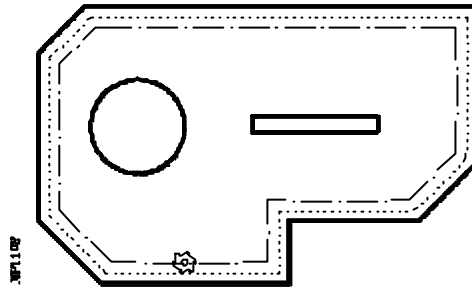
가

가

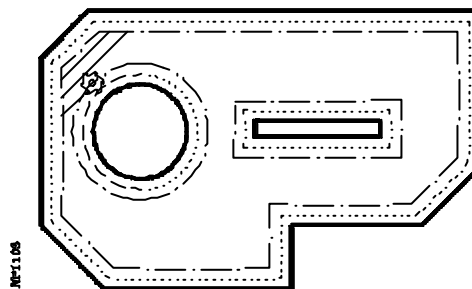
가

*

cycle call
stock

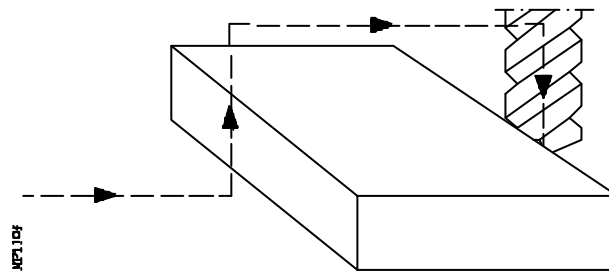


*



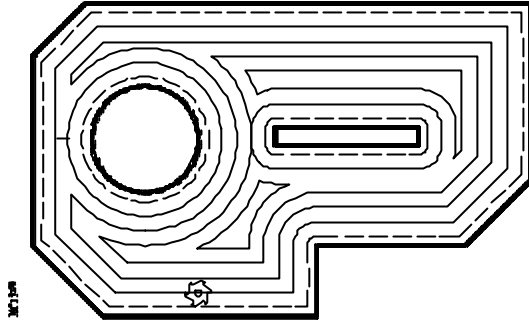
island
island가 가

reference



Case B: 가 가

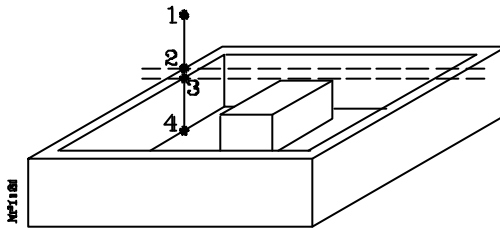
* 가 island



3.-

island 가

island 가 canned cycle , 4 (G15)가



1.- cycle

2.- Reference

3.-

4.- 가

Cycle 가

canned cycle , 가 , CNC G00, G07, G40, G90 가

11.1.1 DRILLING OPERATION

가

canned cycle

가

```

:   G66 D100 R200 F300 S400 E500 ;   cycle
   N100 G81 ..... ;
  
```

canned cycle

:

- G69 canned cycle
- G81 canned cycle
- G82 (dwell) canned cycle
- G83 canned cycle

canned cycle

XY

cycle

F S T D M

가

M

가

M06

M06

가

"T"

:

```

N100 G69 G98 G91 Z-4 I-90 B1.5 C0.5 D2 H2 J4 K100 F500 S3000 M3
N120 G81 G99 G91 Z-5 I-30 F400 S2000 T3 D3 M3
N220 G82 G99 G91 Z-5 I-30 K100 F400 S2000 T2 D2 M6
N200 G83 G98 G91 Z-4 I-5 J6 T2 D4
  
```

11.1.2 ROUGHING OPERATION

가

(G07) (G05)
 , canned cycle G07

canned cycle 가

가

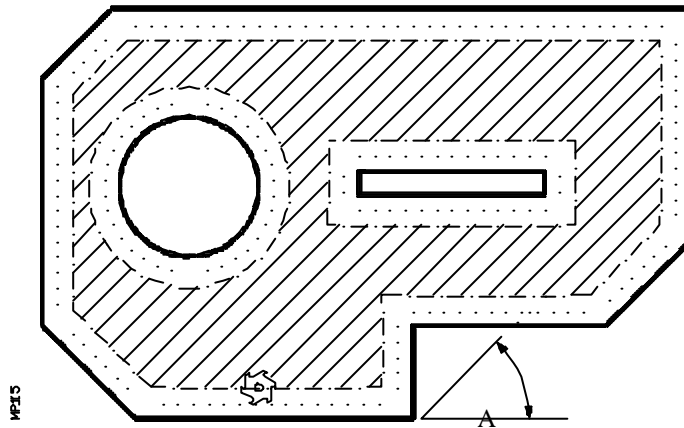
: G66 D100 R200 F300 S400 E500 ; cycle
 N200 G67

G67 :

G67 A B C I R K V Q F S T D M

A(+/- 5.5)

가

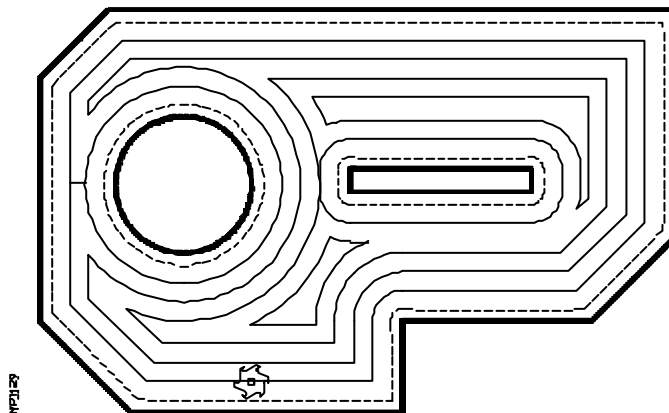


"A"

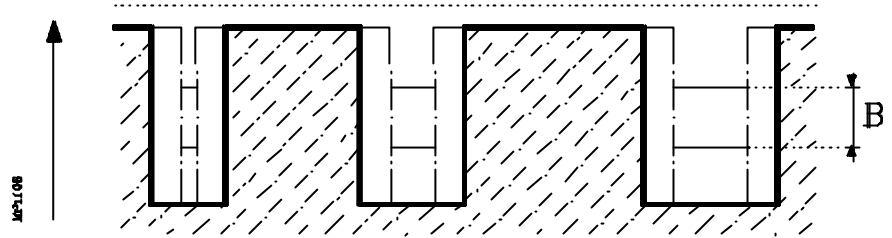
island

가

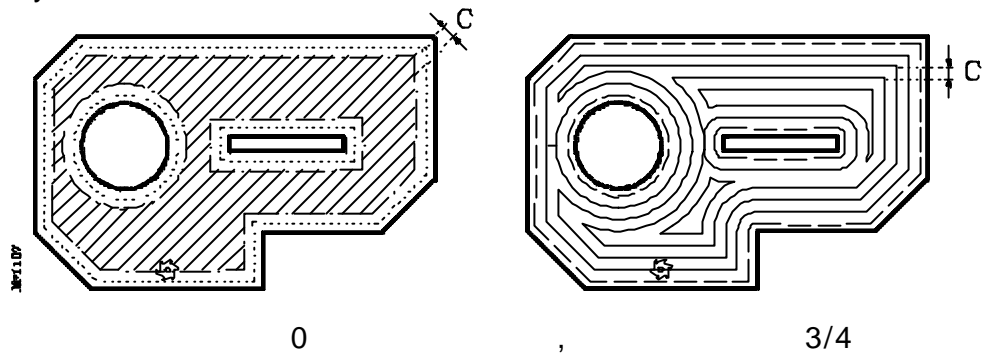
가



B(+/- 5.5) 가 . ()
 1 ; .
 + canned cycle , 가 .
 - cycle , 가 canned



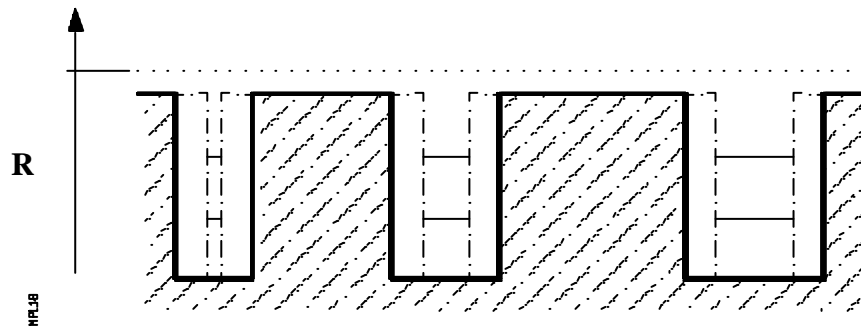
C(+/- 5.5) cycle canned



I(+/- 5.5)

R(+/- 5.5)

reference



K(1)

0 =
1 =

0

C

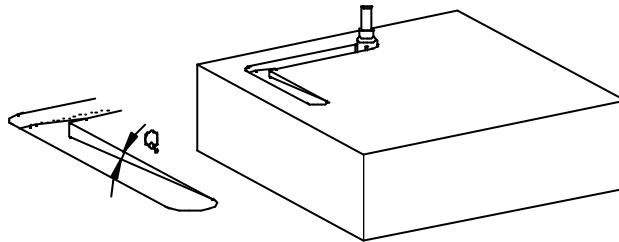
V(5.5)

"0"

, CNC (F)

50%

Q(5.5)



"90"

0

90
"

"canned cycle

F(5.5)

가

S(5.5)

T(4)

D(4)

M

7

M

M06

11.1.3 FINISHING OPERATION

가

가

(finishing) canned cycle 가
가

```
: G66 D100 R200 F300 S400 E500;
  N300 G68 ..... ;
```

(finishing) G68 :

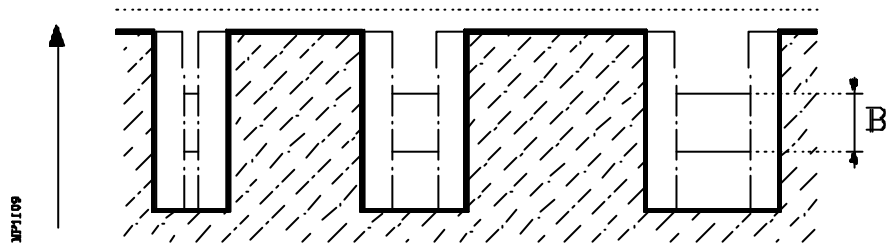
G68 B L Q I R K V F S T D M

B(±5.5) 가 . ()

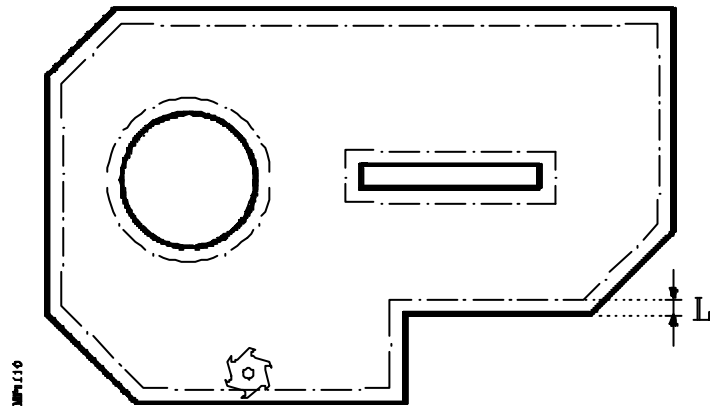
- 0 , CNC 가

- (+) 가 ,
canned cycle

- (-) 가 ,
canned cycle

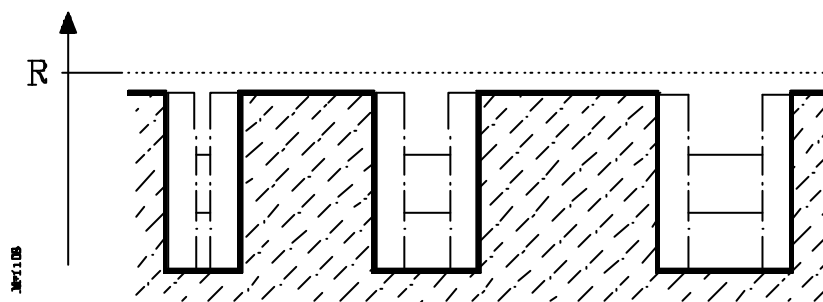


L(±5.5) 가 가 finishing stock



- (+) , (G07)

- (-) , (G05)
 - 0
 Q 가 가 island 가
 Q = 0
 Q = 1
 Q = 2
 0 가 "Q"
 I(±5.5) island
 - island 가 , canned
 cycle
 - island
 R(±5.5) reference
 - island , canned cycle
 - island 가 가 ,



K(1)
 0 =
 1 =

island 가 가 ,
cycle 가 . , , canned
K 0 . , canned cycle

V(5.5)

50% "0" , CNC (F)

F(5.5)

가

S(5.5)

T(4)

D(4)

M

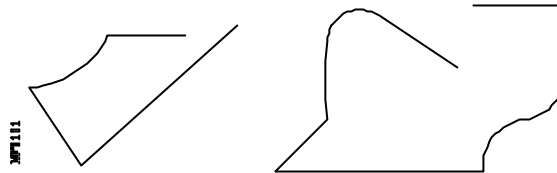
7

M

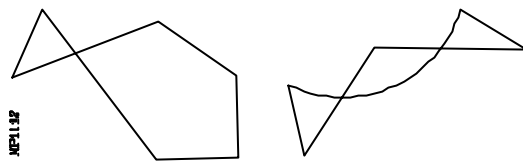
M06

11.1.4 PROFILE PROGRAMMING RULES

1.-

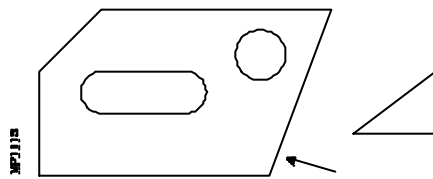


2.-

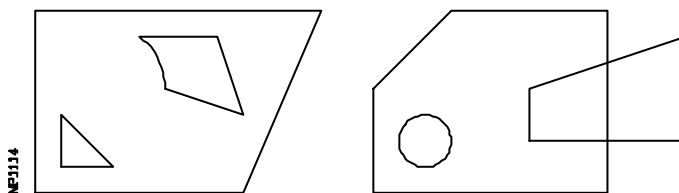


3.-

가 , canned cycle 가

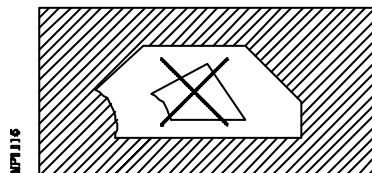


4.-



5.-

가



canned cycle

11.1.5 INTERSECTION OF PROFILES

, canned cycle

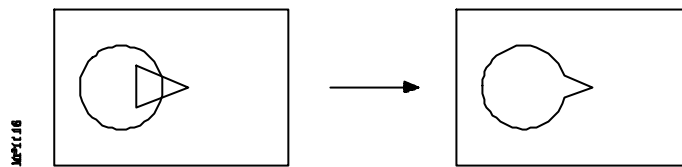
가

가

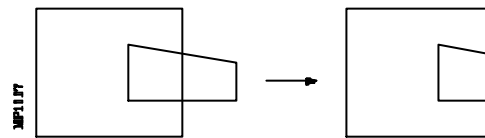
"K"

11.1.5.1 BASIC PROFILE INTERSECTION (K=0)

1.- island



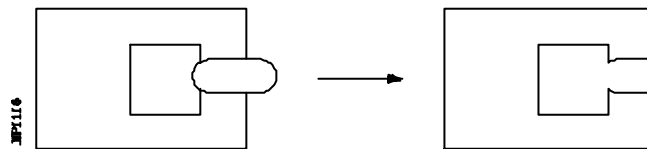
2.-



3.-

가

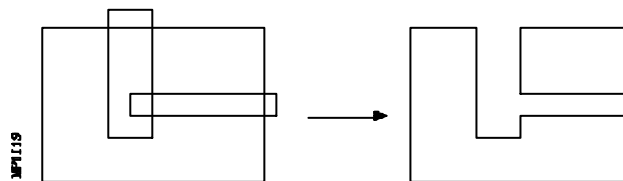
, canned cycle



4.-

가

가



5.-

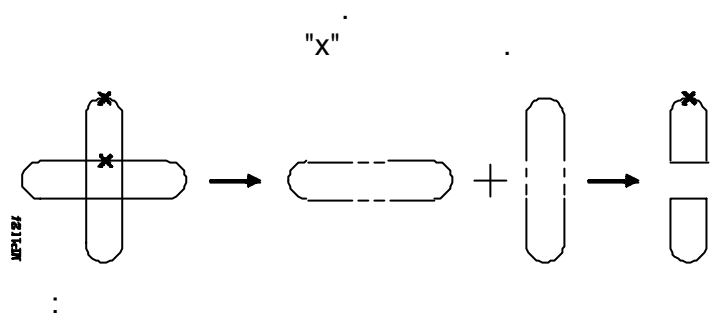
가

가

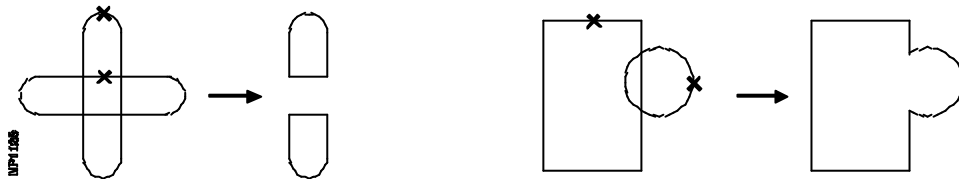
, CNC

11.1.5.2 ADVANCED PROFILE INTERSECTION (K=1)

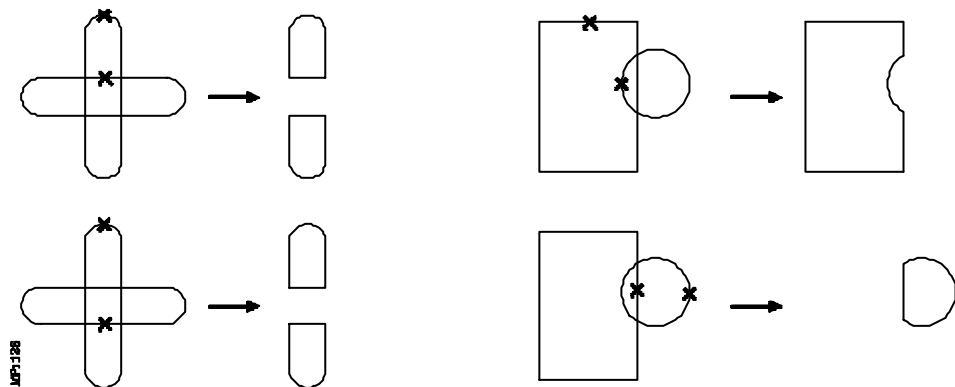
1.-



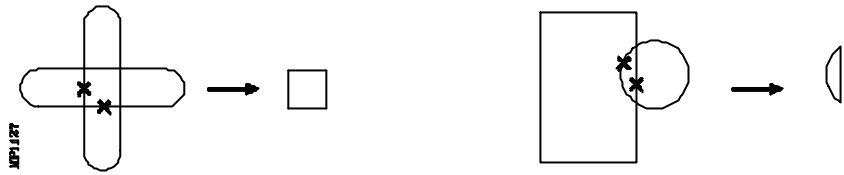
Boolean Addition:



Boolean Subtraction:



Boolean Intersection:



2.-

가

.1, 2

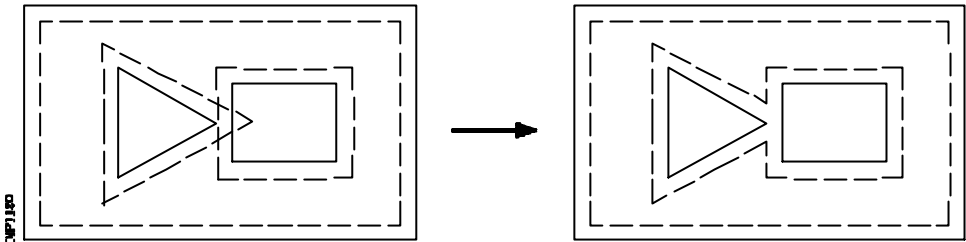
3

:

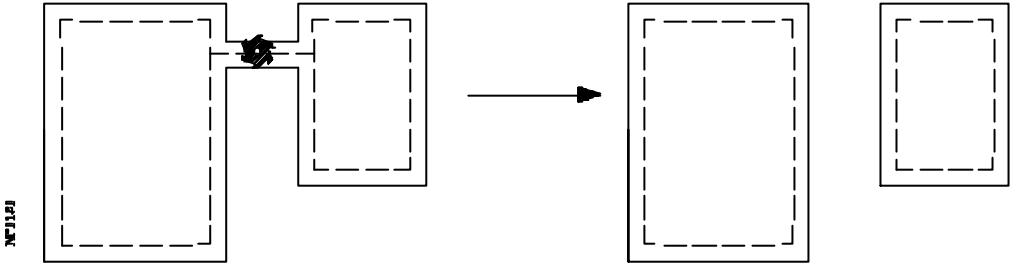
11.1.5.3 RESULTING PROFILE

island , canned cycle stock

:



가 :



11.1.6 PROFILE PROGRAMMING SYNTAX


island

() ()
canned cycle 가

Example: G66 D100 R200 F300 **S400 E500** ;
N400 G0 G90 X300 Y50 Z3 ;

N500 G2 G6 X300 Y50 I150 J0 ;

- 1.- canned cycle G66 가
- 2.-
- 3.- 가) G00 가 (

	<p>G01, G02 , G03</p> <p>G00 CNC</p>
---	--

- 4.- 가 , canned cycle G66 가

```
G0 G17 G90 X-350 Y0 Z50
G66 D100 R200 F300 S400 E500 ..... ; cycle
G0 G90 X0 Y0 Z50
M30
```

```
N400 G0 G90 X-260 Y-190 Z4.5 ..... ;
.....
.....
G0 X230 Y170 ..... ;
G1.....
.....
G0 X-120 Y90 ..... ;
G2.....
.....
N500 G1 X-120 Y90 ..... ;
```


5.-

6.-

7.-

8.-

canned cycle

high level

가

G00

canned cycle

G01
G02
G03
G06
G08
G09
G36
G39
G53
G70
G71
G90
G91
G93

inch
mm

(home)

11.1.7 ERRORS

CNC 가 :

ERROR 1023 : G67.

ERROR 1024 : G68.

ERROR 1025 :
가 "0"

ERROR 1026 :
"C"가

ERROR 1041 : canned cycle 가
error 가
- "I" "R"
- "I" "R"

ERROR 1042 : canned cycle
error 가
- "Q"가
- "B"가 "0"
- "J"가

ERROR 1044 : island 가

ERROR 1046 : canned cycle
reference G66
가

ERROR 1047 : island 가
G0 G1

ERROR 1048 : island 가 (top)
가 top 가

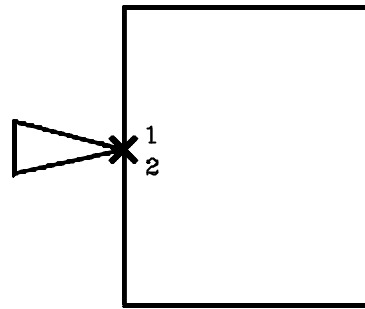
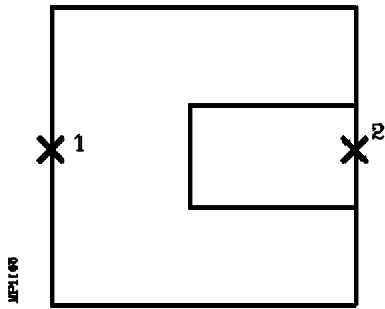
ERROR 1049 : canned cycle reference 가
reference 가 "top" "bottom"

ERROR 1084 :

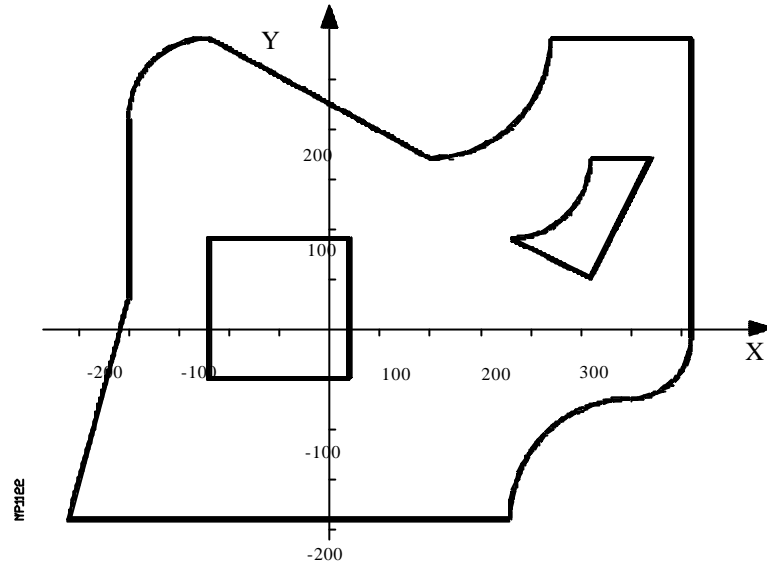
가 가 .

ERROR 1227 : island 가
가

: 가 ()
가 ()



11.1.8 PROGRAMMING EXAMPLES



```

(TOR1=5, TOI1=0, TOL1=25,TOK1=0) ; 1
(TOR2=3, TOI2=0, TOL2=20,TOK2=0) ; 2
(TOR3=5, TOI3=0, TOL3=25,TOK3=0) ; 3
G0 G17 G43 G90 X0 Y0 Z25 S800 ;
G66 D100 R200 F300 S400 E500 ;
M30 ;

```

```

N100 G81 Z5 I-40 T3 D3 M6 ;
N200 G67 B20 C8 I-40 R5 K0 V100 F500 T1 D1 M6 ;
N300 G68 B0 L0.5 Q0 V100 F300 T2 D2 M6 ;

```

```

N400 G0 G90 X-260 Y-190 Z0 ;
      G1 X-200 Y30 ; ( )
      X-200 Y210
      G2 G6 X-120 Y290 I-120 J210
      G1 X100 Y170
      G3 G6 X220 Y290 I100 J290
      G1 X360 Y290
      X360 Y-10
      G2 G6 X300 Y-70 I300 J-10
      G3 G6 X180 Y-190 I300 J-190
      G1 X-260 Y-190

```

```

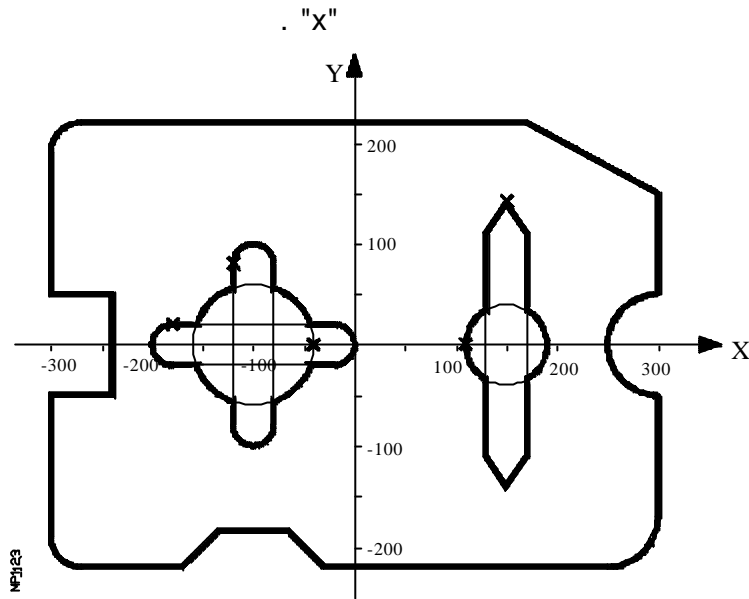
G0 X230 Y170 ; island
G1 X290 Y170
X230 Y50
X150 Y90
G3 G6 X230 Y170 I150 J170

```

```

G0 X-120 Y90 ; island
G1 X20 Y90
X20 Y-50
X-120 Y-50
N500 X-120 Y90 ;

```



```

(TOR1=9, TOI1=0, TOL1=25,TOK1=0) ; 1
(TOR2=3.6, TOI2=0, TOL2=20,TOK2=0) ; 2
(TOR3=9, TOI3=0, TOL3=25,TOK3=0) ; 3
G0 G17 G43 G90 X0 Y0 Z25 S800 ;
G66 D100 R200 F300 S400 E500 ;
M30 ;

```

```

N100 G81 Z5 I-40 T3 D3 M6 ;
N200 G67 B10 C5 I-40 R5 K1 V100 F500 T1 D1 M6 ;
N300 G68 B0 L0.5 Q1 V100 F300 T2 D2 M6 ;

```

```

N400 G0 G90 X-300 Y50 Z3 ;
G1 Y190 ; ( )
G2 G6 X-270 Y220 I-270 J190
G1 X170
X300 Y150
Y50
G3 G6 X300 Y-50 I300 J0
G1 G36 R50 Y-220
X-30
G39 R50 X-100 Y-150
X-170 Y-220
X-270
G2 G6 X-300 Y-190 I-270 J-190
G1 Y-50
X-240
Y50
X-300

```

```

G0 X-120 Y80 ; island
G2 G6 X-80 Y80 I-100 J80 ; ( a)
G1 Y-80
G2 G6 X-120 Y-80 I-100 J-80
G1 Y80

```

G0 X-40 Y0	;	(	b)
G2 G6 X-40 Y0 I-100 J0			
G0 X-180 Y20	;	(	c)
G1 X-20			
G2 G6 X-20 Y-20 I-20 J0			
G1 X-180			
G2 G6 X-180 Y20 I-180 J0			
G0 X150 Y140	;		island
G1 X170 Y110	;	(	d)
Y-110			
X150 Y-140			
X130 Y-110			
Y110			
X150 Y140			
G0 X110 Y0	;	(	e)
N500 G2 G6 X110 Y0 I150 J0	;		

11.2 3D POCKETS

G66 cycle 3D

G66 :

G66 R I C J F K S E

R (0-9999) & I (0-9999) (R) (I)

"I" , "R"
"R" ,

C (0-9999) & J (0-9999) (C) (J)

"J" , "C"
"C" ,

F (0-9999) & K (0-9999) (F) (K)

"K" , "F"
"F" ,

S (0-9999) & E (0-9999) (S)

(E)

:

G00 G90 X100 Y200 Z50 F5000 T1 D2 ;
M06

G66 R100 C200 J210 F300 S400 E500 ; canned cycle

M30 ;

N100 G67 ;

N200 ;

G67 ;

N210 ;

N300 G68 ;

N400 G0 G90 X300 Y50 Z3 ;

..... ;

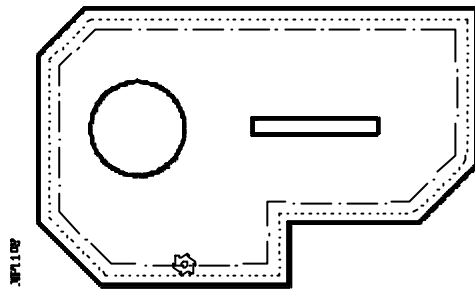
..... ;

N500 G2 G6 X300 Y50 I150 J0 ;

1.-

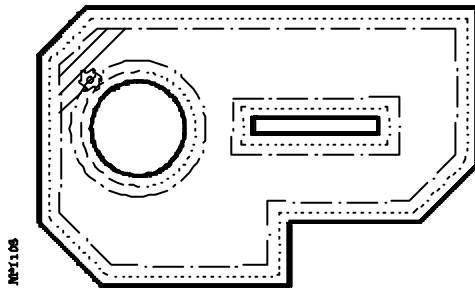
가
Case A : 가 가

* ,
stock



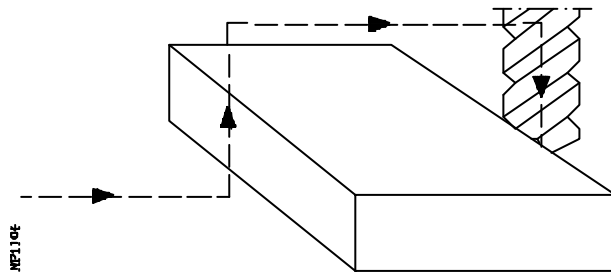
* 가

island



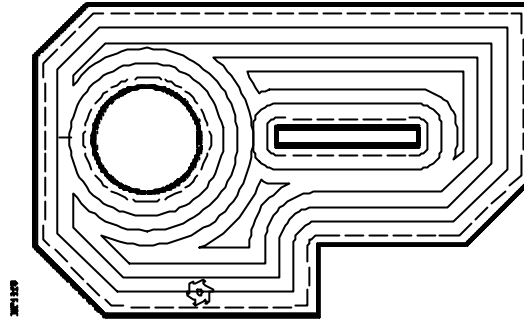
island

reference



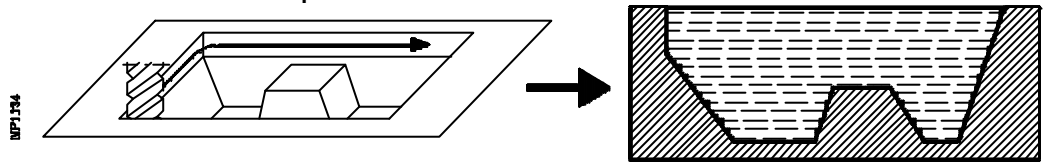
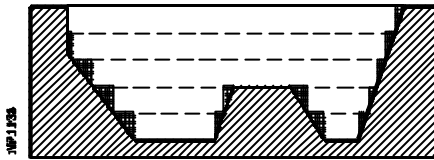
Case B : 가

* . 가 island 가



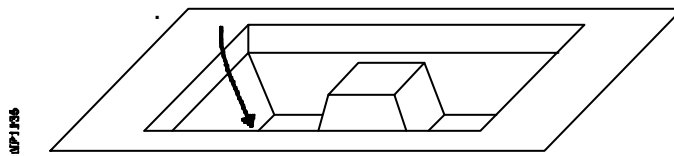
2.-

가 island



3.-

3D 가



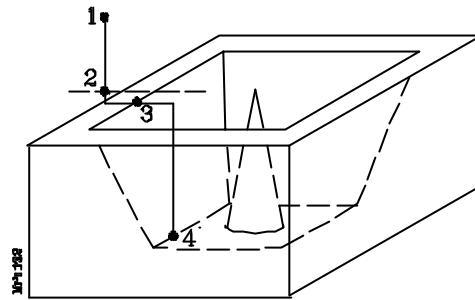
CNC island 가

canned cycle

CNC G00, G40, G90

(reference coordinates)

) canned cycle 가 (G51



- 1.- 가 .
- 2.- .
- 3.- ().
- 4.- 가 ().

11.2.1 ROUGHING OPERATION

가

canned cycle

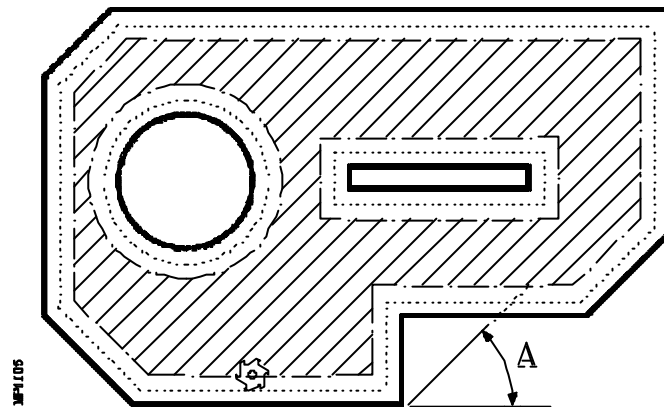
가

가

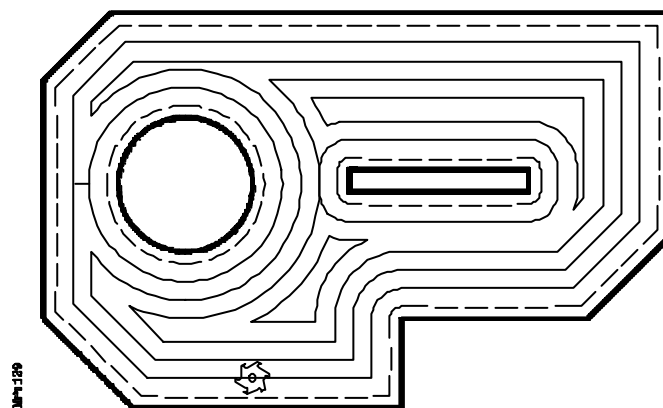
Example: G66 R100 C200 F300 S400 E500 ;
 N100 G67

G67 G66
 : G67 A B C I R V F S T D M

A(+/-5.5)



"A"
 island 가 가

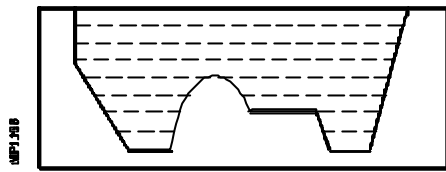


B(+/-5.5)

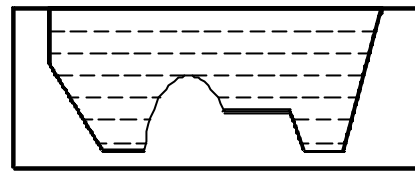
()

가

0



B(+)



B(-)

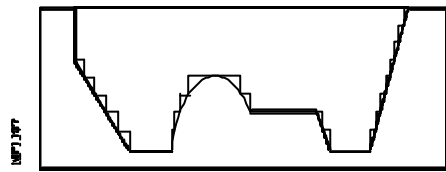
- (+) canned cycle
- (-) canned cycle

가

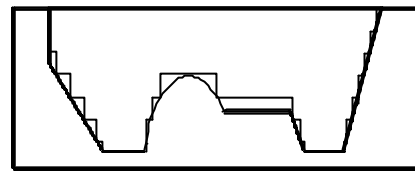
- B(+)

B(-)

island



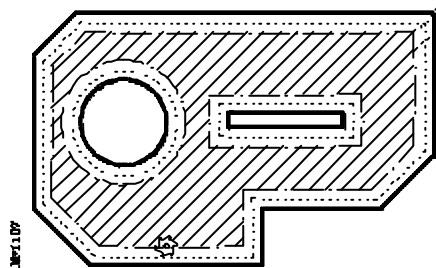
B(+)



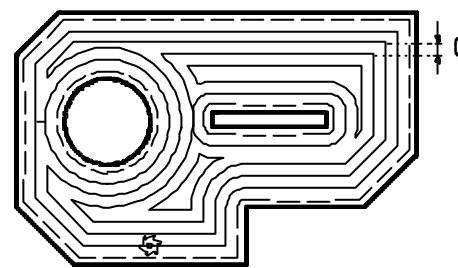
B(-)

C(+/-5.5)

canned cycle



0

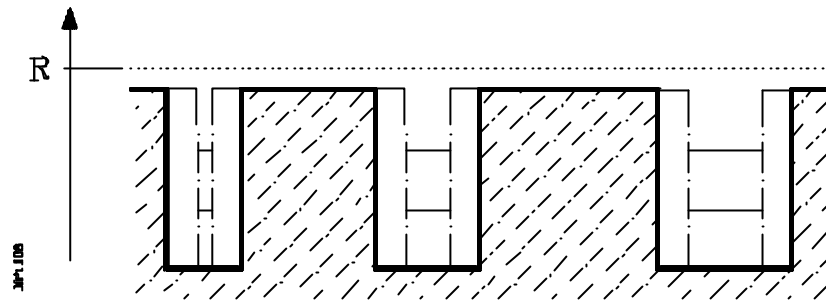


3/4

가

I(+/-5.5)

R(+/-5.5)



V (5.5)

50% "0" , CNC (F)

F (5.5) 가 . 가 .

S (5.5) 가 .

T (4)

D (4) 가 .

M 가 . 7 M

M06

11.2.2 SEMI-FINISHING OPERATION

canned cycle 가 가

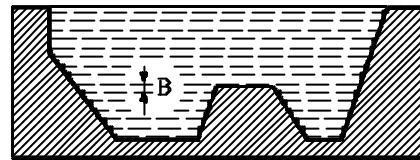
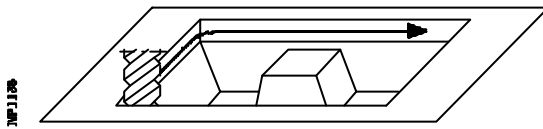
Example: G66 R100 C200 F300 S400 E500 ;
 N200 G67 ;

G67 G66

G67

: G67 B I R V F S T D M

B (±5.5) () 가 "0"



- (+) cycle
- (-) canned cycle

가 canned

I (±5.5)

, CNC

R (±5.5)

, CNC

V (5.5)

"0"

, CNC

50%

F (5.5)

가 .

가

S (5.5)

가 .

T (4)

D (4)

가 .

M

가 .

7

M

M06

11.2.3 FINISHING OPERATION

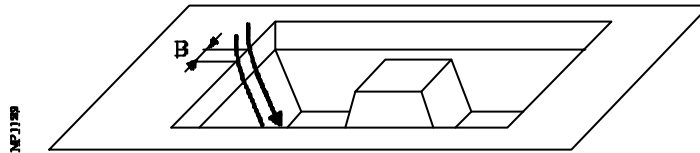
canned cycle 가 가

Example: G66 R100 C200 **F300** S400 E500 ;
N300 G67

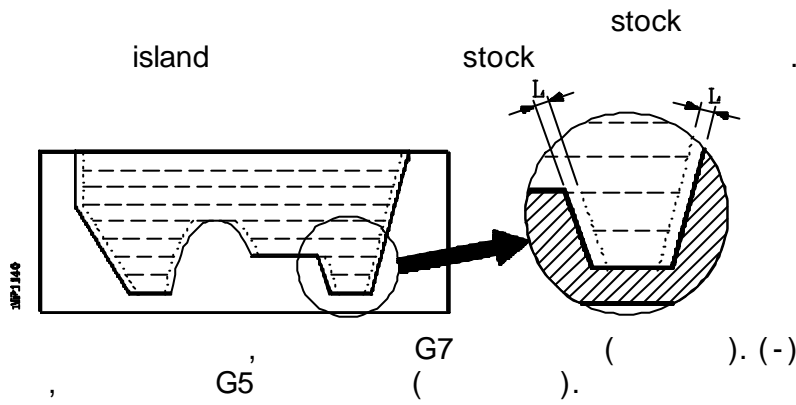
G68 G66

: G68 B L Q J I R V F S T D M

B (5.5) B 3D
 "0"



L (±5.5)



Q

가

Q = 1

가

Q = 2

가

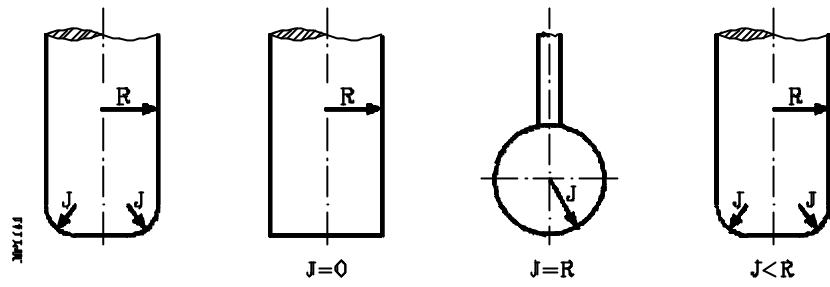
Q = 0

"Q0"

"Q"

J (5.5) (tip)

(CNC : "TOR" + "TOI")
 가



FLAT J
 BALL-END J = R
 TORIC (Corner rounding) J < > 0 J < R J = 0

I (±5.5)

-
-
-
-
-

R (±5.5)

(reference)

-
-
-
-

V (5.5)

"0"

, CNC

50%

F (5.5)

가 . 가

S (5.5)

가 .

T (4)

D (4)

가 .

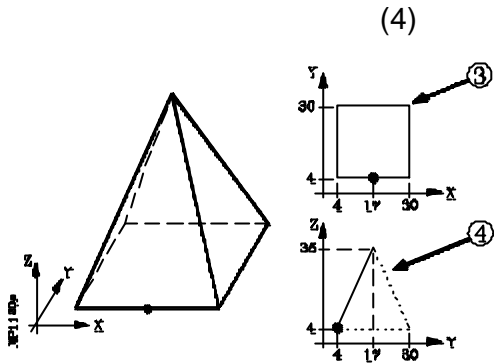
M

가 . 7 M

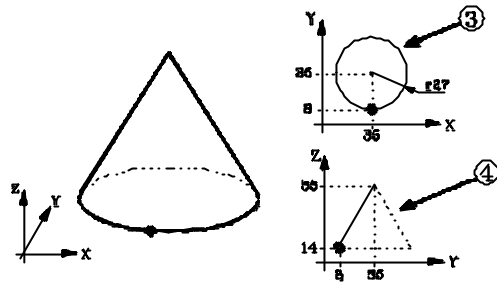
M06

11.2.4 PROFILE OR CONTOUR GEOMETRY

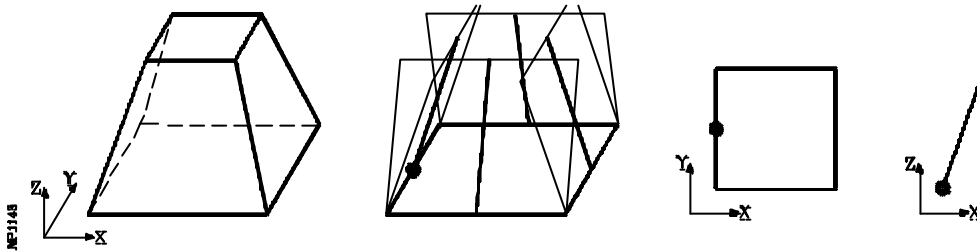
3D



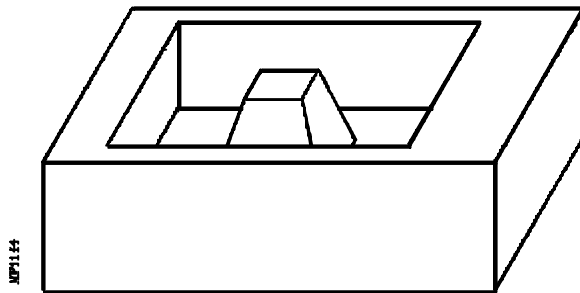
(3)



canned cycle



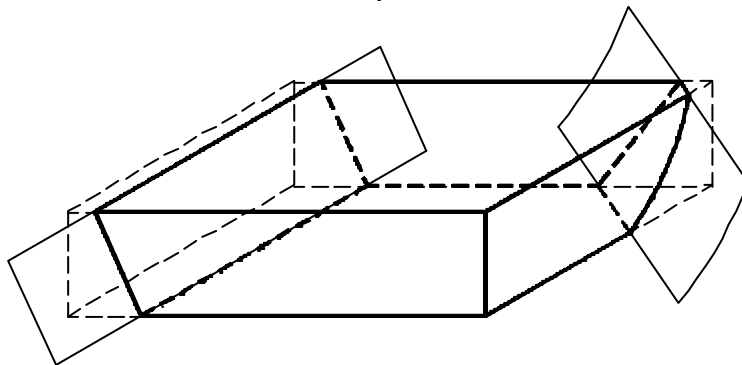
3D



가 3D

가

" 3D



11.2.5 PROFILE PROGRAMMING RULES

(island 가) 3D

1.-

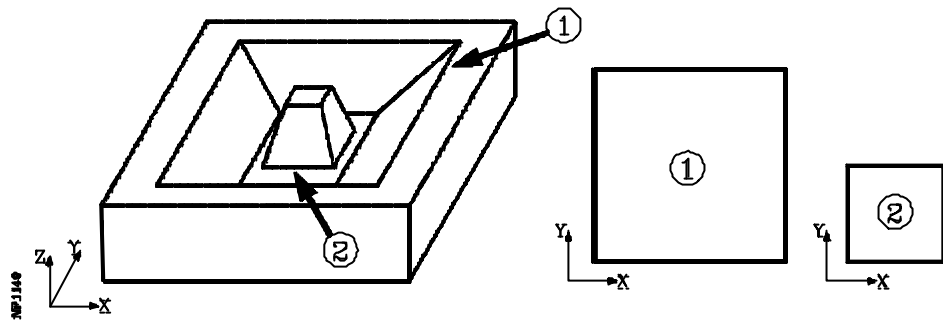
3D

가

*
*

(1)

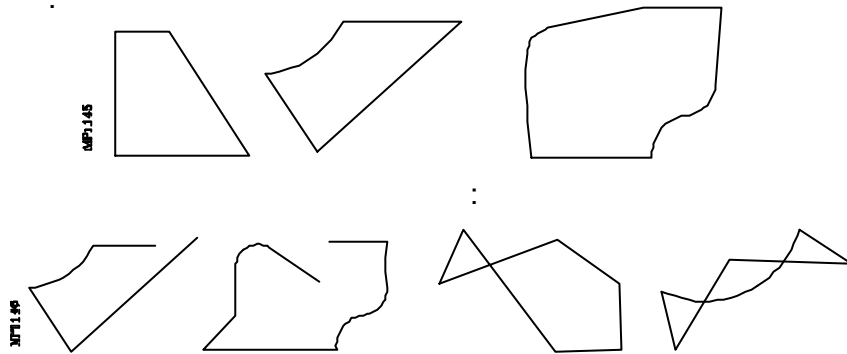
(2)



2.-

(

)



3.-

(XY)

Z

, G16 XZ

G16 YZ

Example:

G16 XY

G16 XZ

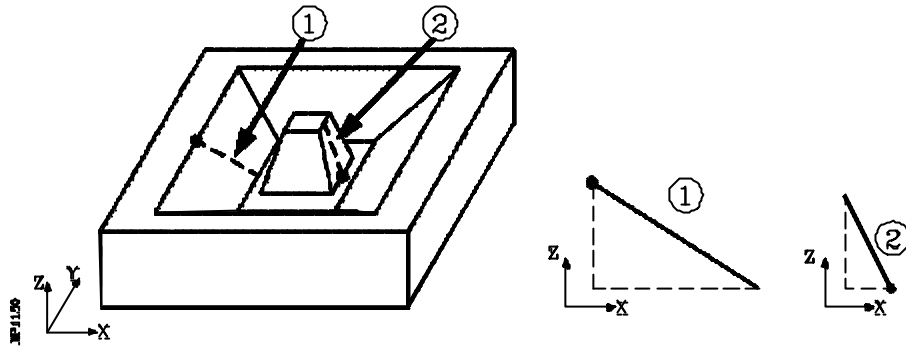
G16 XY island

G16 XZ

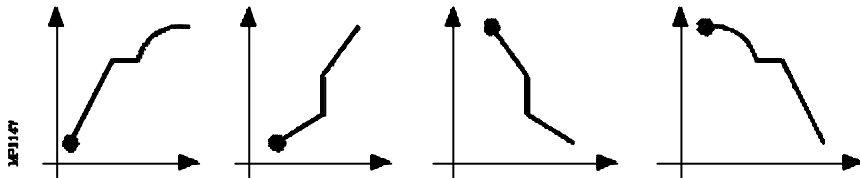
4.-

*
*

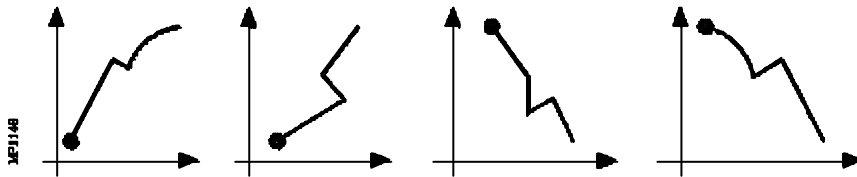
, island (1)
(2)



5.-

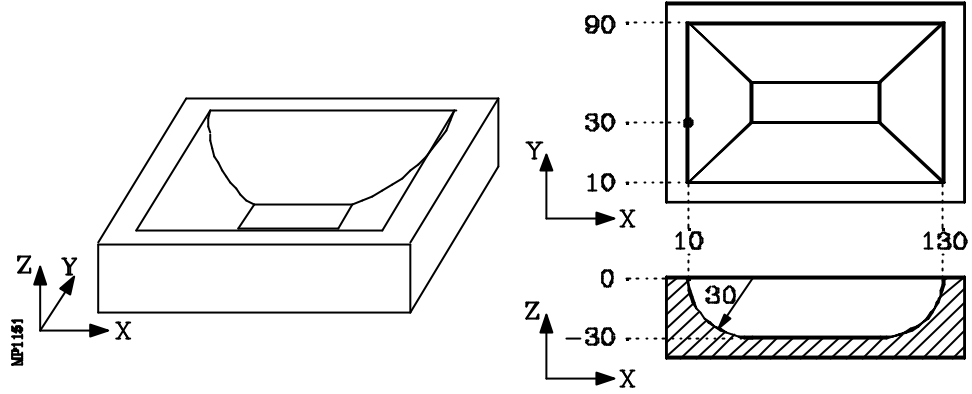


가



11.2.5.1 PROGRAMMING EXAMPLES

island ∇ _____ :



```
(TOR1=2.5,TOL1=20,TOI1=0,TOK1=0)
G17 G0 G43 G90 Z50 S1000 M4
G5
G66 R200 C250 F300 S400 E500 .....; 3D
M30
```

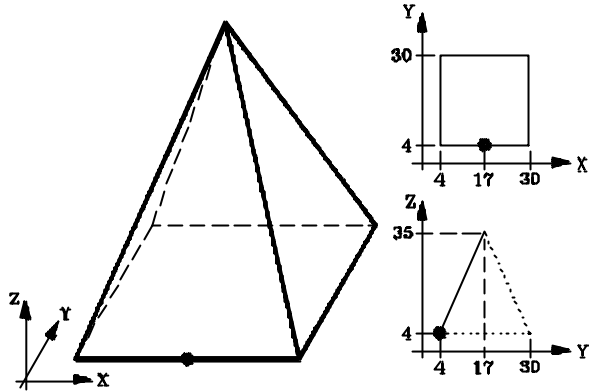
```
N200 G67 B5 C4 I-30 R5 V100 F400 T1D1 M6 .....;
N250 G67 B2 I-30 R5 V100 F550 T2D1 M6 .....;
N300 G68 B1.5 L0.75 Q0 I-30 R5 V80 F275 T3D1 M6 .....;
```

```
N400 G17 .....;
      G90 G0 X10 Y30 Z0 .....;           (      )
      G1  Y90
          X130
          Y10
          X10
          Y30
      G16 XZ .....;           (      )
      G0  X10 Z0
N500 G3  X40 Z-30 I30 K0 .....;
```

Profile definition examples:

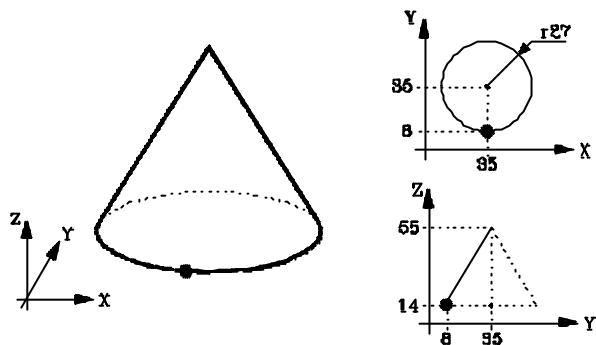
Pyramid Island

Plane profile
 G17
 G0 G90 X17 Y4
 G1 X30
 G1 Y30
 G1 X4
 G1 Y4
 G1 X17
 Depth profile
 G16 YZ
 G0 G90 Y4 Z4
 G1 Y17 Z35



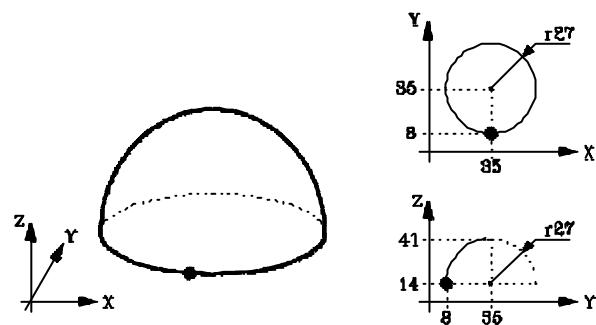
Conic Island

Plane profile
 G17
 G0 G90 X35 Y8
 G2 X35 Y8 I0 J27
 Depth profile
 G16 YZ
 G0 G90 Y8 Z14
 G1 Y35 Z55

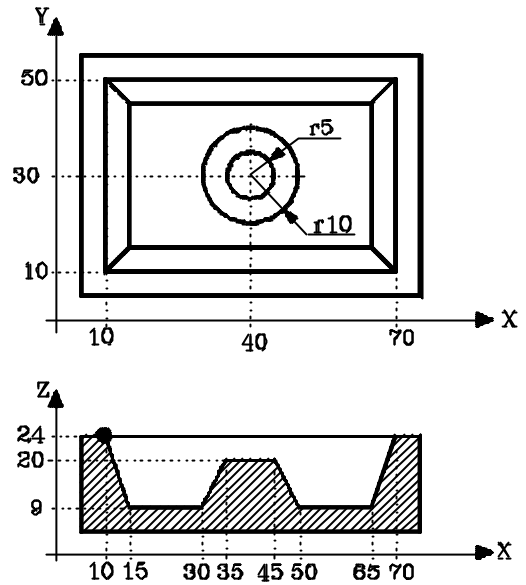
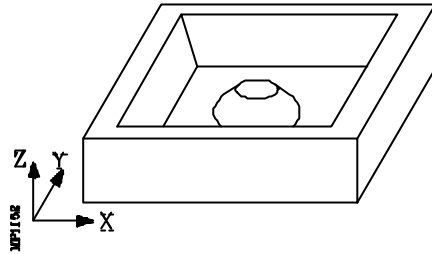


Semi-spherical Island

Plane profile
 G17
 G0 G90 X35 Y8
 G2 X35 Y8 I0 J27
 Depth profile
 G16 YZ
 G0 G90 Y8 Z14
 G2 Y35 Z41 R27



Example of a 3D pocket with islands:



```

(TOR1=2.5,TOL1=20,TOI1=0,TOK1=0)
G17 G0 G43 G90 Z50 S1000 M4
G5
G66 R200 C250 F300 S400 E500 .....;3D pocket definition
M30

N200 G67 B5 C4 I9 R25 V100 F400 T1D1 M6 .....;Roughing operation
N250 G67 B2 I9 R25 V100 F550 T2D1 M6 .....;Semi-finishing operation
N300 G68 B1.5 L0.75 Q0 I9 R25 V50 F275 T3D1 M6 .....;Finishing operation

N400 G17 .....;Beginning of the pocket geometry definition
G90 G0 X10 Y30 Z24 .....;Outside contour (plane profile)
G1 Y50
X70
Y10
X10
Y30
G16 XZ .....;Depth profile
G0 X10 Z24
G1 X15 Z9

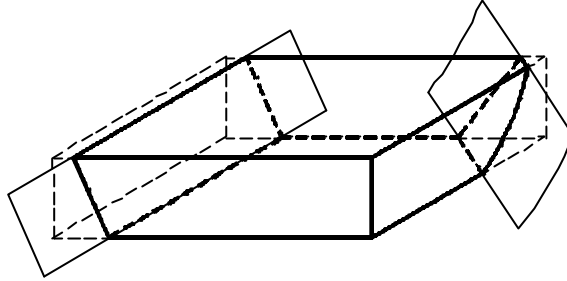
G17 .....;Island definition
G90 G0 X30 Y30 .....;Plane profile
G2 X30 Y30 I10 K0
G16 XZ .....;Depth profile
G90 G0 X30 Z9
N500 G1 X35 Z20 .....;End of the pocket geometry definition

```


11.2.6 COMPOSITE 3D PROFILES

3D

가 3D

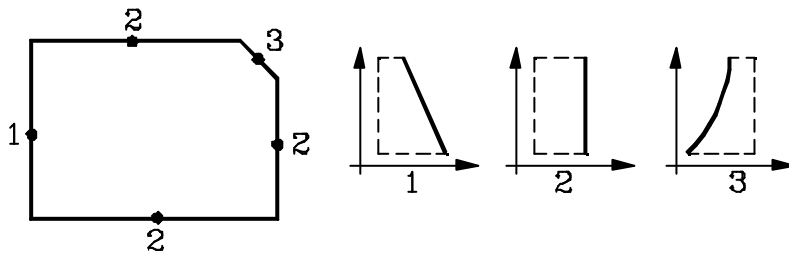
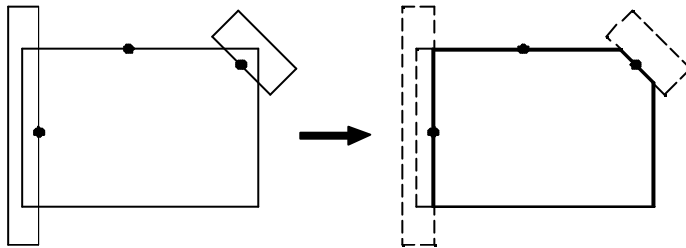


가

:

-
-
-

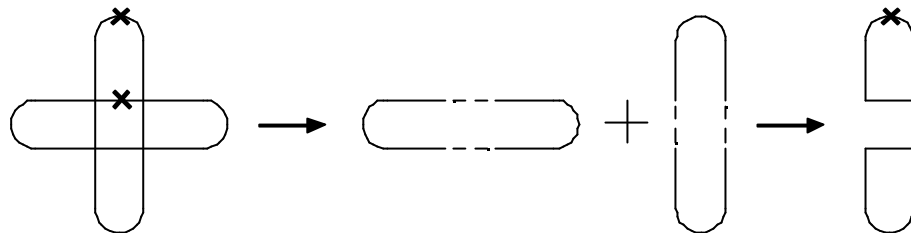
가



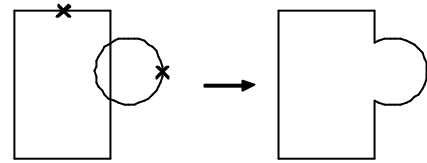
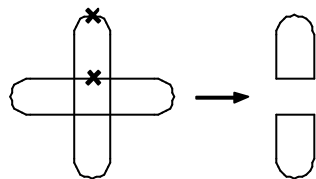
11.2.6.1 PROFILE INTERSECTING RULES

1.-

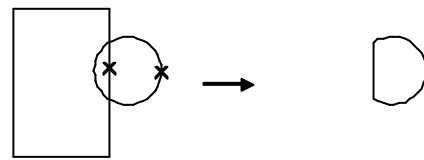
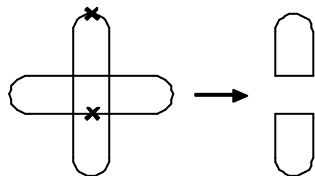
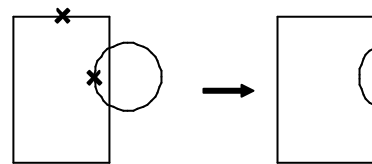
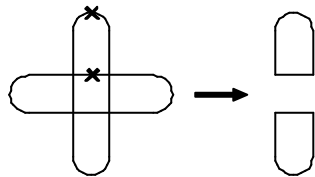
(x)



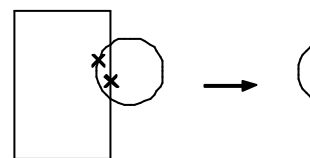
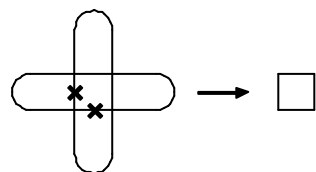
Boolean addition



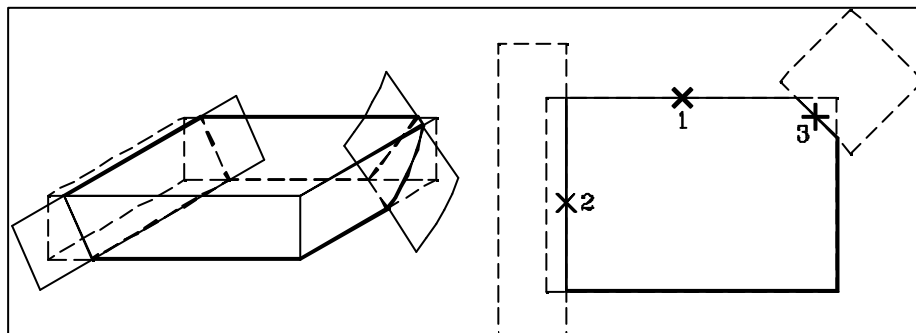
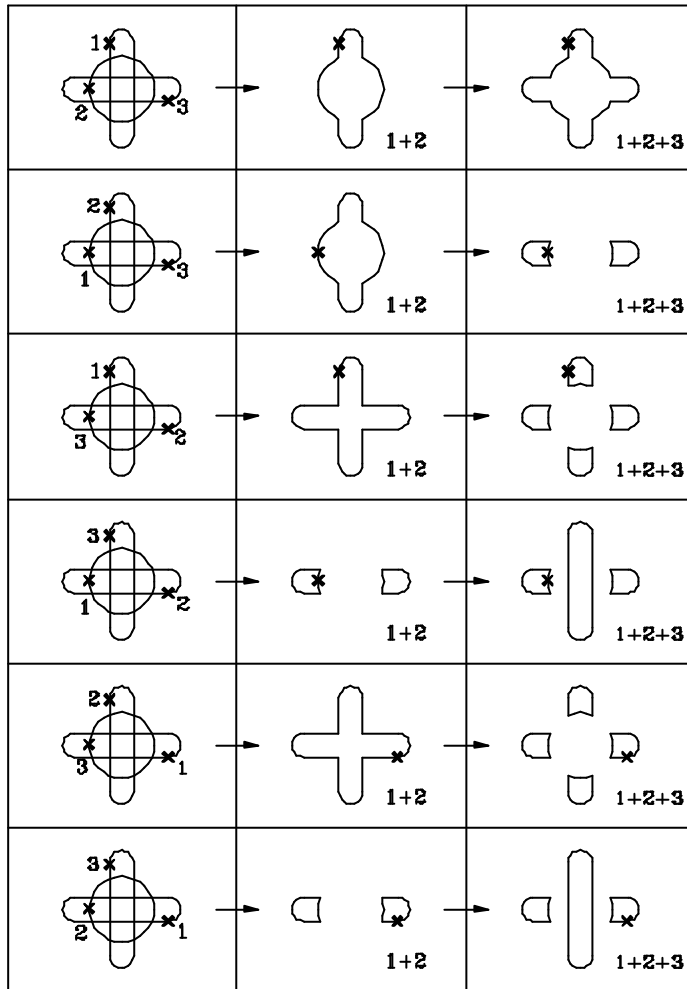
Boolean subtraction



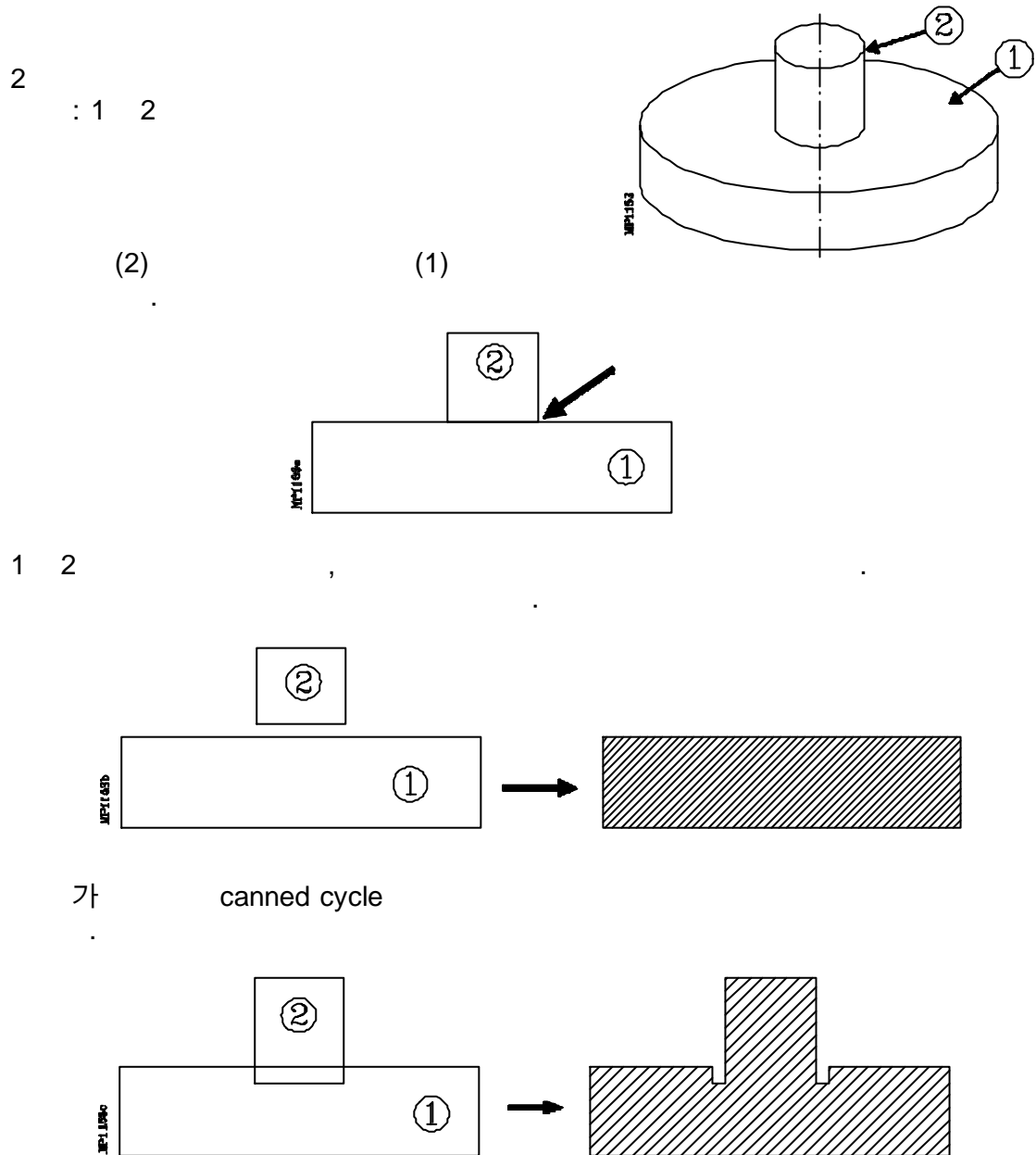
Boolean intersection



2.- 3



11.2.7 STACKED PROFILES



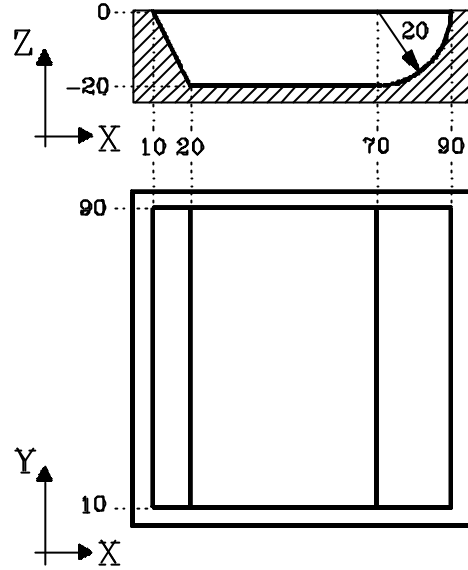
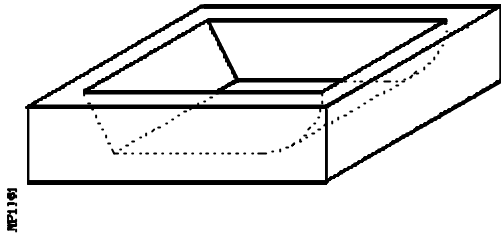
- 6.- , .
- 7.- , , , .
- 8.- , , high level .
- 9.- canned cycle .

가 G00 , canned cycle

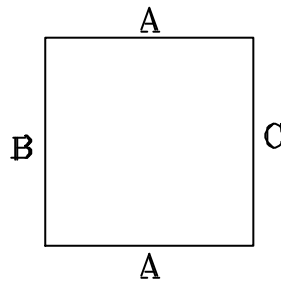
- G01
- G02
- G03
- G06
- G08
- G09
- G16
- G17 X-Y Z ()
- G18 Z-X Y ()
- G19 Y-Z X ()
- G36 ()
- G39
- G53 (home)
- G70 inch
- G71 mm
- G90
- G91
- G93

11.2.9 EXAMPLES

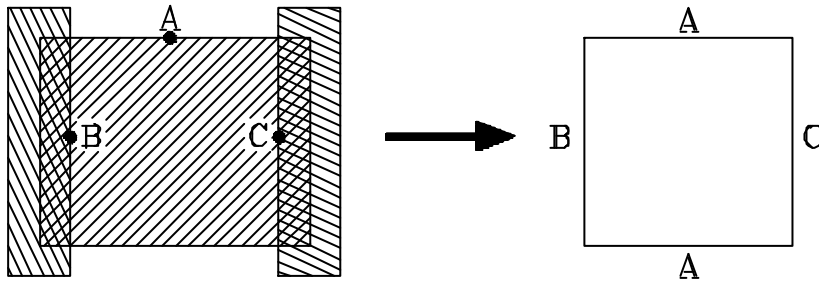
Example 1, island 가 :



, island 가 : A, B, C



island 3 : A- , B- , C-



(TOR1=2.5,TOL1=20,TOI1=0,TOK1=0)

G17 G0 G43 G90 Z50 S1000 M4

G5

G66 R200 C250 F300 S400 E500 ; 3D
M30

N200 G67 B5 C4 I-20 R5 V100 F400 T1D1 M6

N250 G67 B2 I-20 R5 V100 F550 T2D1 M6

N300 G68 B1.5 L0.75 Q0 I-20 R5 V80 F275 T3D1 M6.....

N400 G17

G0 G90 X50 Y90 Z0 ; A ()

G1 X0

Y10

X100

Y90

X50

G16 YZ

G0 G90 Y90 Z0

G1 Z-20

G17 ; B

G0 G90 X10 Y50

G1 Y100

X-10

Y0

X10

Y50

G16 XZ

G0 G90 X10 Z0

G1 X20 Z-20

G17 ; C

G0 G90 X90 Y50

G1 Y100

X110

Y0

X90

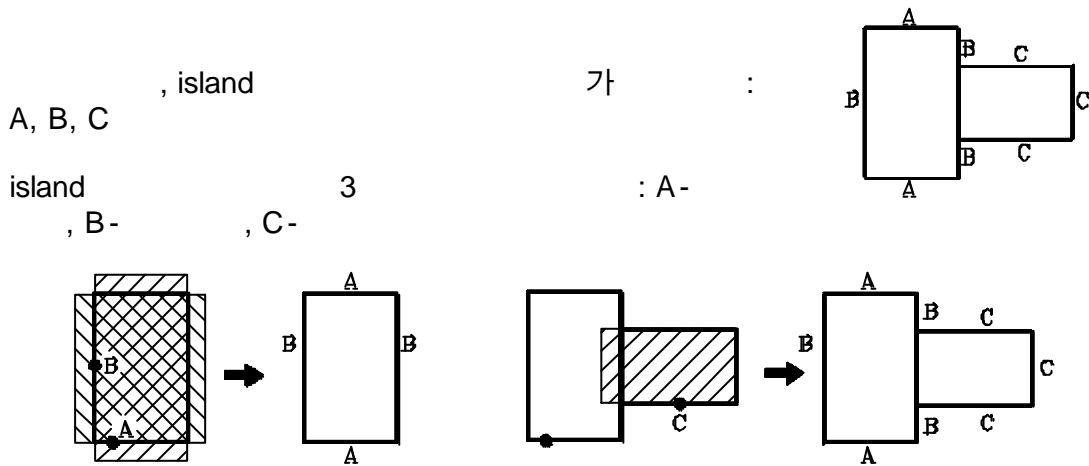
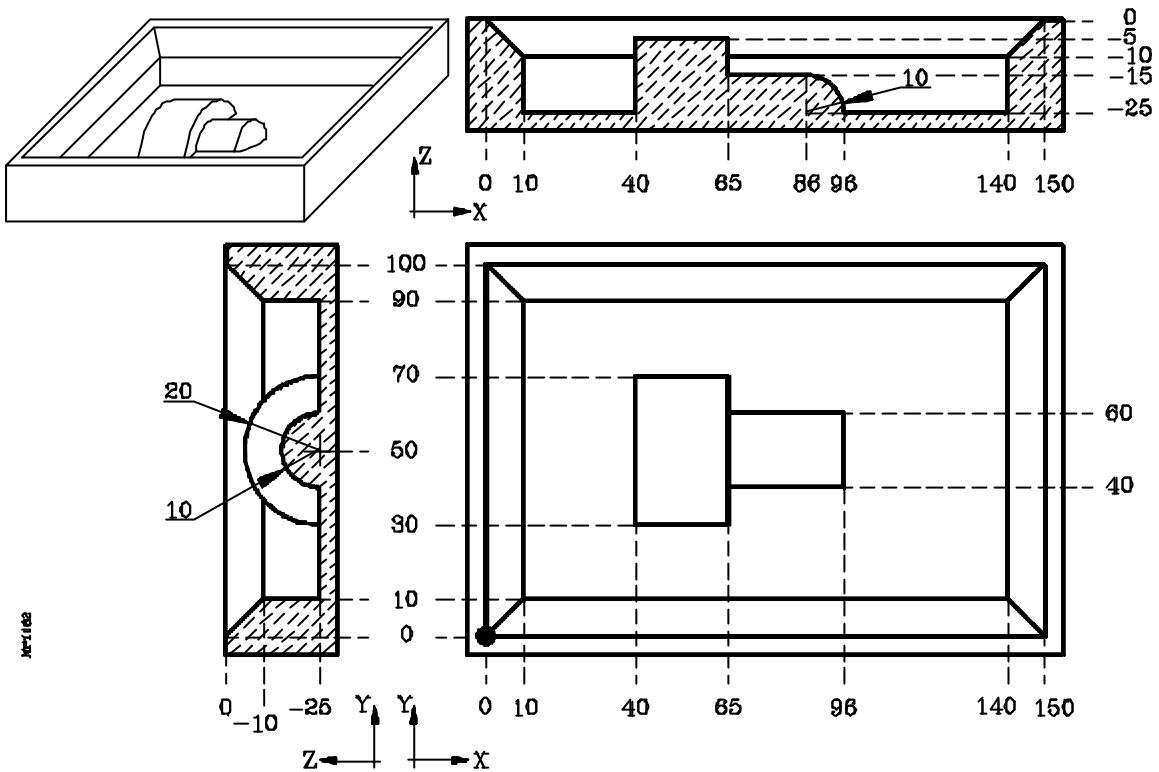
Y50

G16 XZ

G0 G90 X90 Z0

N500 G2 X70 Z-20 I-20 K0

Example 2 :



```
(TOR1=7.5,TOI1=0,TOR2=5,TOI2=0,TOR3=2.5,TOI3=0)
G17 G0 G43 G90 Z50 S1000 M4
G5
G66 R200 C250 F300 S400 E500 .....;3D pocket definition
M30
```

```
N200 G67 B7 C14 I-25 R3 V100 F500 T1D1 M6 .....;Roughing operation
N250 G67 B3 I-25 R3 V100 F625 T2D2 M6 .....;Semi-finishing operation
N300 G68 B1 L1 Q0 J0 I-25 R3 V100 F350 T3D3 M6 .....;Finishing operation
```

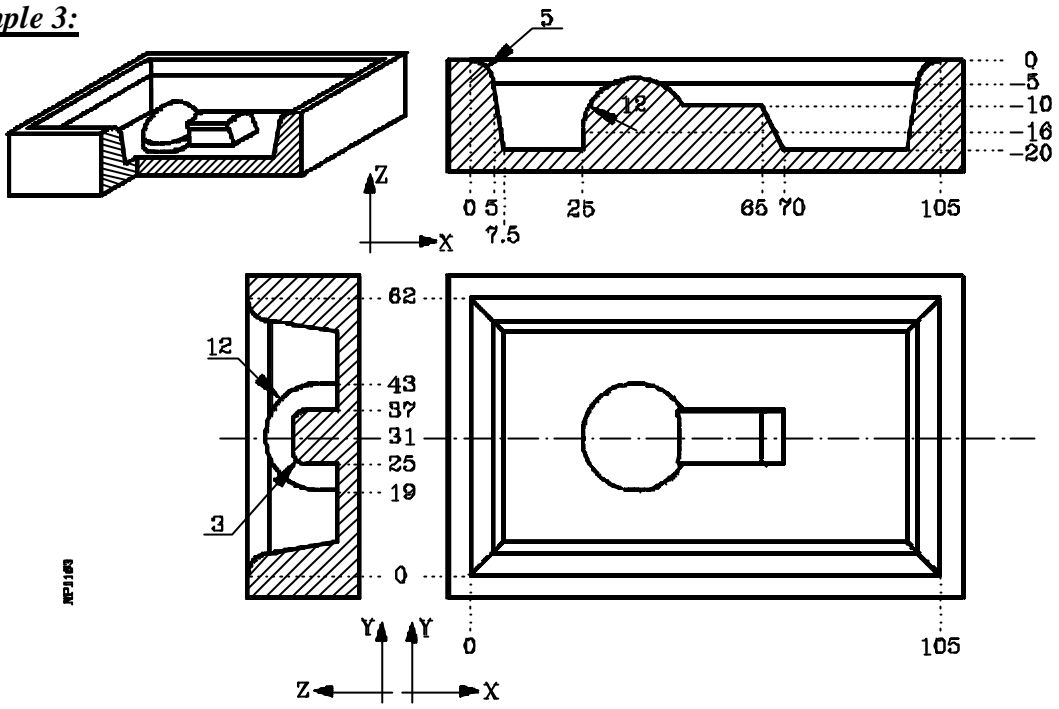
N400 G17 ;Beginning of pocket geometry definition
 G0 G90 X0 Y0 Z0 ;Outside contour (plane profile)
 G1 X150
 Y100
 X0
 Y0
 G16 XZ ;Depth profile
 G0 G90 X0 Z0
 G1 X10 Z-10
 Z-25

G17 ;A-type profile
 G0 G90 X50 Y30 ;Plane profile
 G1 X70
 Y70
 X35
 Y30
 X50
 G16 YZ ;Depth profile
 G0 G90 Y30 Z-25
 G2 Y50 Z-5 J20 K0

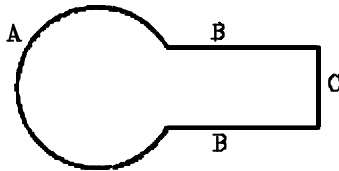
G17 ;B-type profile
 G0 G90 X40 Y50 ;Plane profile
 G1 Y25
 X65
 Y75
 X40
 Y50
 G16 XZ ;Depth profile
 G0 G90 X40 Z-25
 G1 Z-5

G17 ;C-type profile
 G0 G90 X80 Y40 ;Plane profile
 G1 X96
 Y60
 X60
 Y40
 X80
 G16 YZ ;Depth profile
 G0 G90 Y40 Z-25
 N500 G2 Y50 Z-15 J10 K0 ;End of pocket geometry definition

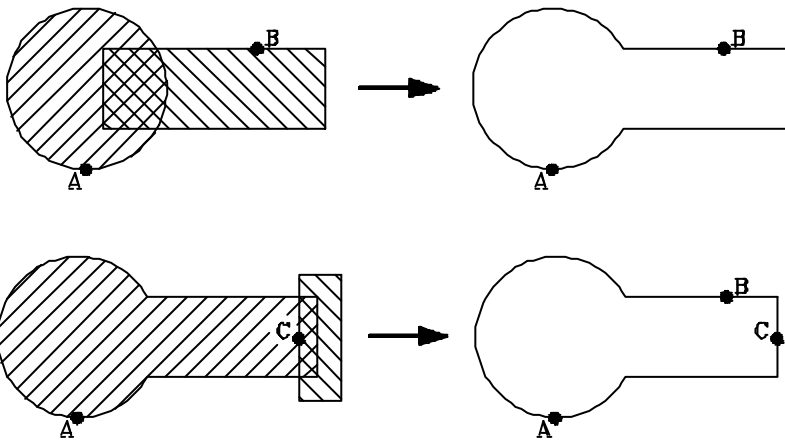
Example 3:



, island 가 : A, B, C



island 3 : A- , B- , C-



```

(TOR1=4,TOI1=0,TOR2=2.5,TOI2=0)
G17 G0 G43 G90 Z25 S1000 M3
G66 R200 C250 F300 S400 E500 ..... ;3D pocket definition
M30

N200 G67 B5 C4 I-20 R5 V100 F700 T1D1 M6 .....;Roughing operation
N250 G67 B2 I-20 R5 V100 F850 T1D1 M6 .....;Semi-finishing operation
N300 G68 B1.5 L0.25 Q0 I-20 R5 V100 F500 T2D2 M6 .....;Finishing operation
;

N400 G17 ..... ;Beginning of pocket geometry definition
G0 G90 X0 Y0 Z0 ..... ;Outside contour (plane profile)
G1 X105
    Y62
    X0
    Y0
G16 XZ ..... ;Depth profile
G0 X0 Z0
G2 X5 Z-5 I0 K-5
G1 X7.5 Z-20

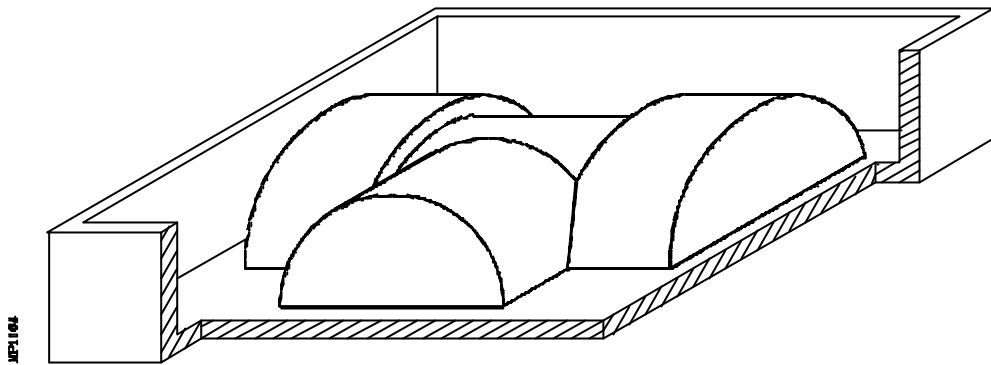
G17 ..... ;A-type contour
G90 G0 X37 Y19 ..... ;Plane profile
G2 I0 J12
G16 YZ ..... ;Depth profile
G0 Y19 Z-20
G1 Z-16
G2 Y31 Z-4 R12 ..... ;End of pocket geometry definition

G17 ..... ;B-type contour
G90 G0 X60 Y37 ..... ;Plane profile
G1 X75
    Y25
    X40
    Y37
    X60
G16 YZ ..... ;Depth profile
G0 Y37 Z-20
G1 Z-13
G3 Y34 Z-10 J-3 K0

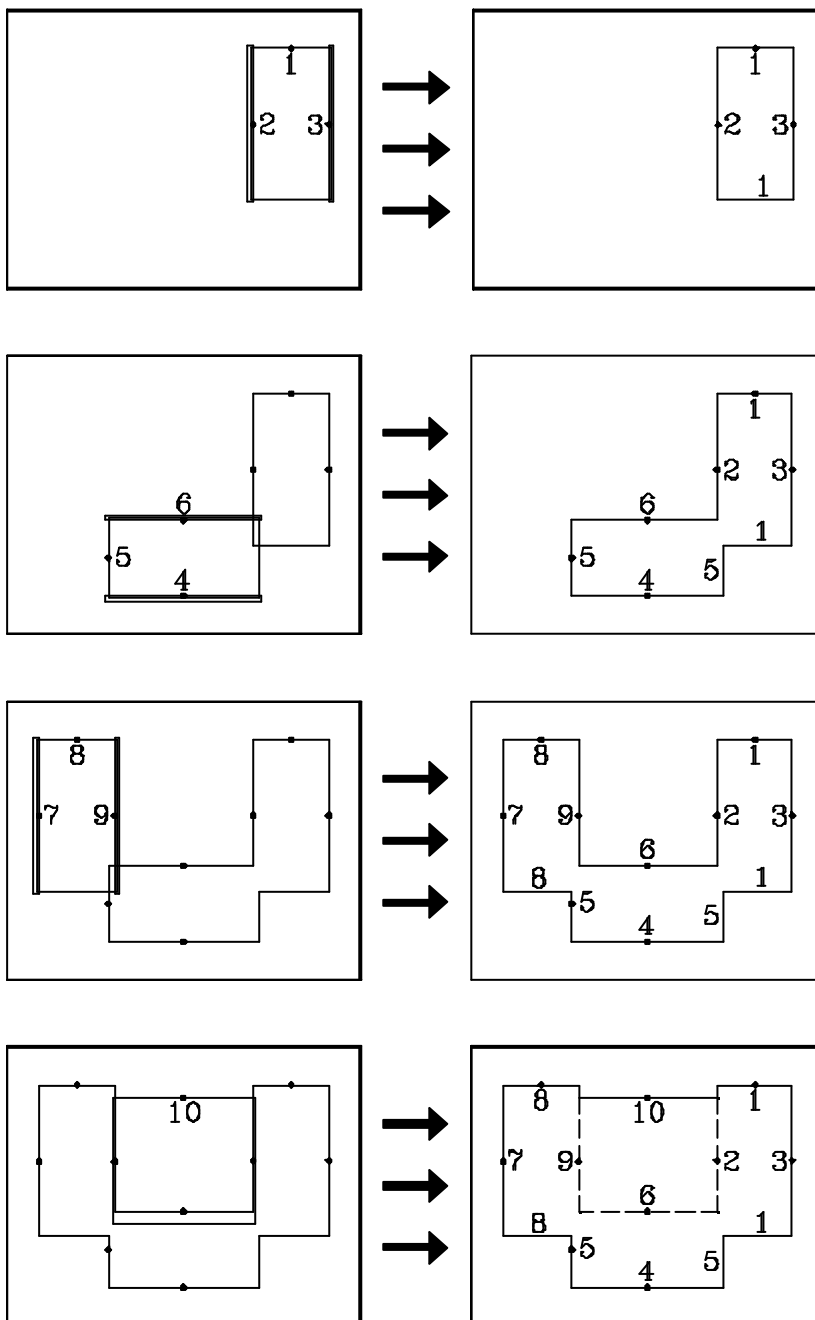
G17 ..... ;C-type contour
G0 X70 Y31 ..... ;Plane profile
G1 Y40
    X80
    Y20
    X70
    Y31
G16 XZ ..... ;Depth profile
G0 X70 Z-20
N500 G1 X65 Z-10 ..... ;End of pocket geometry definition

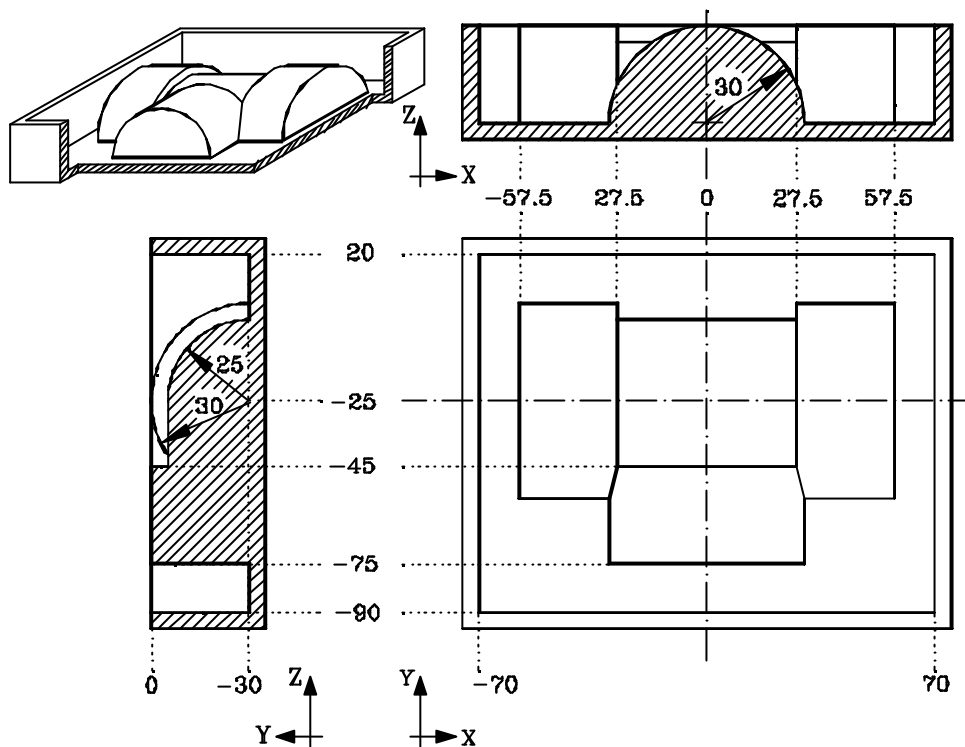
```

Example 4:



island 10





(TOR1=4,TOI1=0,TOR2=2.5,TOI2=0)

G17 G0 G43 G90 Z25 S1000 M3

G66 R200 C250 F300 S400 E500;Definition of the 3D pocket

M30

N200 G67 B5 C0 I-30 R5 V100 F700 T1D1 M6;Roughing Operation

N250 G67 B1.15 I-29 R5 V100 F850 T1D1 M6;Semi-finishing Operation

N300 G68 B1.5 L0.25 Q0 I-30 R5 V100 F500 T2D2 M6;Finishing Operation

N400 G17;Beginning of the pocket geometry definition

G90 G0 X-70 Y20 Z0;Outside contour (plane profile)

G1 X70
Y-90
X-70
Y20

G17;Contour number 1

G90 G0 X42.5 Y5;Plane profile

G1 G91 X-16
Y-60
X32
Y60
X-16

G16YZ;Depth profile

G0 G90 Y5 Z-30

G3 Y-25 Z0 J-30 K0

G17;Contour number 2

G0 X27.5 Y-25

G1 G91 Y31

G1 X-2
Y-62
X2
Y31

G16XZ;Depth profile

G0 G90 X27.5 Z-30

G1 Z0

G17 ;Contour number 3
 G0 X57.5 Y-25
 G1 G91 Y-31
 X2
 Y62
 X-2
 Y-31
 G16XZ ;Depth profile
 G0 G90 X57.5 Z-30
 G1 Z0

G17 ;Contour number 4
 G0 X0 Y-75
 G1 G91 X-31
 Y-2
 X62
 Y2
 X-31
 G16YZ ;Depth profile
 G0 G90 Y-75 Z-30
 G1 Z0

G17 ;Contour number 5
 G0 X-30 Y-60
 G1 G91 Y-16
 X60
 Y32
 X-60
 Y-16
 G16XZ ;Depth profile
 G0 G90 X-30 Z-30
 G2 X0 Z0 I30 K0

G17 ;Contour number 6
 G0 X0 Y-45
 G1 G91 X31
 Y2
 X-62
 Y-2
 X31
 G16YZ ;Depth profile
 G0 G90 Y-45 Z-30
 G1 Z0

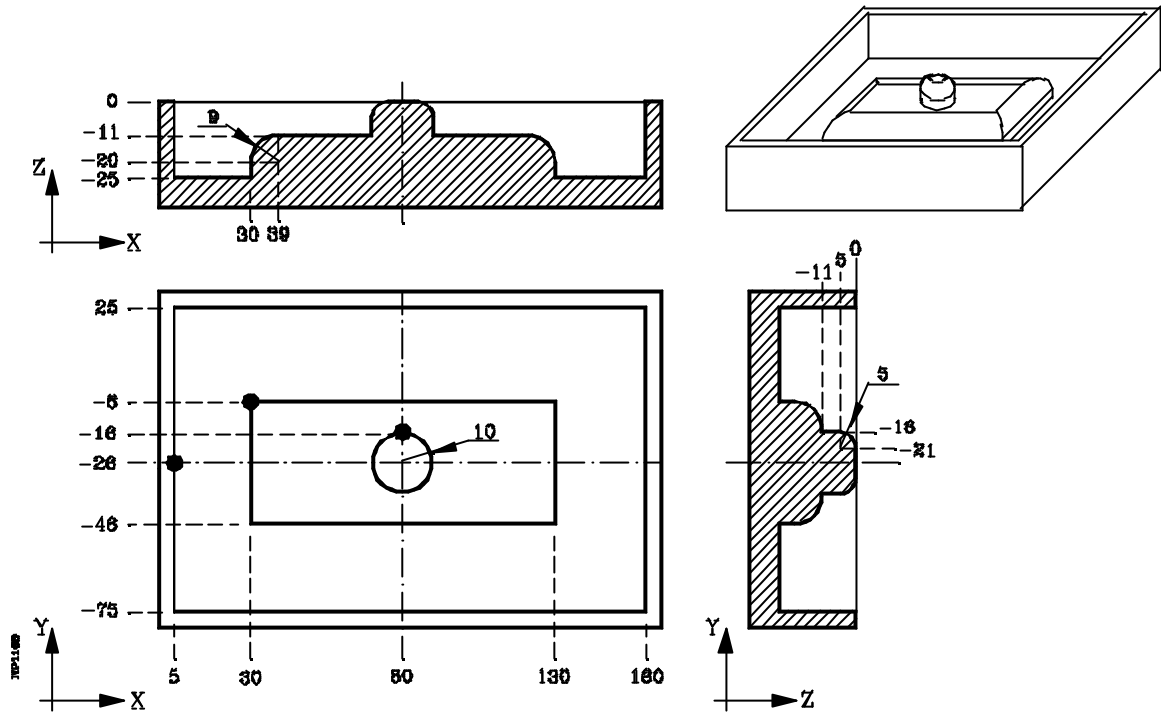
G17 ;Contour number 7
 G0 X-57.5 Y-25
 G1 G91 Y31
 X-2
 Y-62
 X2
 Y31
 G16XZ ;Depth profile
 G0 G90 X-57.5 Z-30
 G1 Z0

G17 ;Contour number 8
 G0 X-42.5 Y5
 G1 G91 X-16
 Y-60
 X32
 Y60
 X-16
 G16YZ
 G0 G90 Y5 Z-30
 G3 Y-25 Z0 J-30 K0

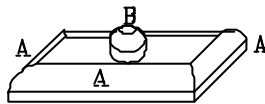
G17 ;Contour number 9
 G0 X-27.5 Y-25
 G1 G91 Y-31
 X2
 Y62
 X-2
 Y-31
 G16XZ ;Depth profile
 G0 G90 X27.5 Z-30
 G1 Z0

G17 ;Contour number 10
 G0 X0 Y0
 G1 X-28
 Y-50
 X28
 Y0
 X0
 G16YZ ;Depth profile
 G0 Y0 Z-30
 N500 G3 Y-25 Z-5 J-25 K0

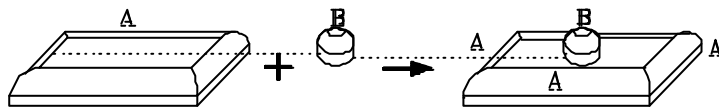
Example 5:



, island 가 : A B



island 2 : (A-) (B-)



(TOR1=2.5,TOL1=20,TOI1=0,TOK1=0)

G17 G0 G43 G90 Z50 S1000 M4

G5

G66 R200 C250 F300 S400 E500 ;3D pocket definition

M30

N200 G67 B5 C4 I-25 R5 V100 F400 T1D1 M6;Roughing operation

N250 G67 B2 I-25 R5 V100 F550 T2D1 M6;Semi-finishing operation

N300 G68 B1.5 L0.75 Q0 I-25 R5 V100 F275 T3D1 M6;Finishing operation

N400 G17 ;Beginning of pocket geometry definition
 G90 G0 X5 Y-26 Z0 ;Outside contour (plane profile)
 G1 Y25
 X160
 Y-75
 X5
 Y-26

 G17 ;Low contour (A type)
 G90 G0 X30 Y-6 ;Plane profile
 G1 Y-46
 X130
 Y-6
 X30
 G16 XZ ;Depth profile
 G0 X30 Z-25
 G1 Z-20
 G2 X39 Z-11 I9 K0

 G17 ;High contour (B-type)
 G90 G0 X80 Y-16 ;Plane profile
 G2 I0 J-10
 G16 YZ ;Depth profile
 G0 Y-16 Z-11
 G1 Y-16 Z-5
 N500 G3 Y-21 Z0 J-5 K0 ;End of pocket geometry definition

11.2.10 ERRORS

CNC 가 :

ERROR 1025 : 가 "0"

ERROR 1026 : "C"가 가

ERROR 1041 : canned cycle 가
 가 :
 - "I" "R"
 - "I" "R"
 - "I" "R"
 - "B"

ERROR 1042 : canned cycle 가
 - "Q"가
 - "B"가 "0"
 - "J"가

ERROR 1043 : island 가
 가
 - 2
 - 가 가 . ("J"
)

ERROR 1044 : island 가

ERROR 1046 : canned cycle reference G66
 가 .

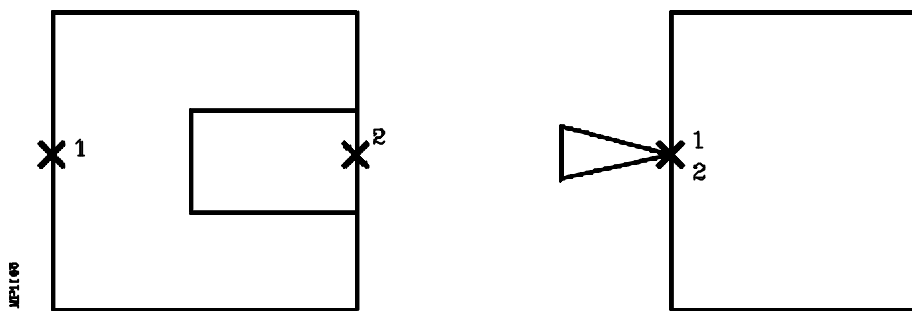
ERROR 1047 : island 가
 G0 G1 .

ERROR 1048 : island 가 (top)
 가 top 가 .

ERROR 1049 : canned cycle reference 가 .
 reference 가 .

ERROR 1084 : 가 가 .

ERROR 1227 : island 가 가
 : 가 ()
 - ()
 - ()



12.1 PROBING (G75,G76)

G75 CNC가

G76 CNC가

G75 X..C # 5.5
G76 X..C # 5.5

G75 G76 ,

(G76) (G75) CNC

, CNC (G75) (G76)

가

G75 G76

G75 G76 . 100%

G75 G76 가 G00, G02, G03, G33, G34, G41, G42
. 가 , CNC G01 G40 .

12.2 PROBING CANNED CYCLES

CNC canned cycle 가 :

1 canned cycle

2 canned cycle

3 canned cycle

4 canned cycle

5 canned cycle

6 canned cycle

7 canned cycle

8 canned cycle

9 canned cycle

canned cycle X, Y, Z
(XY, XZ, YZ, YX, ZX, ZY)

Canned cycle high level

:

(PROBE(expression),(assignment statement),...)

가

canned cycle

:

*

*

canned cycle

G41 G42

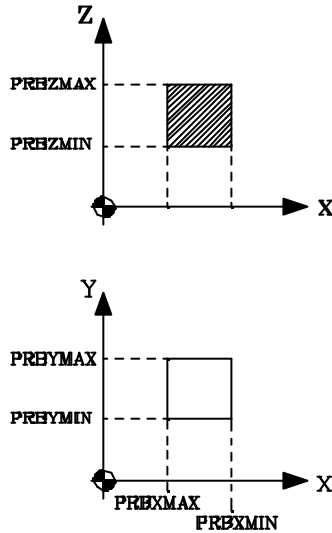
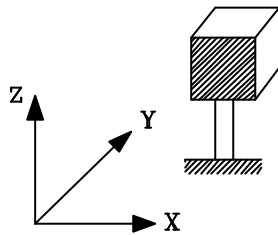
"G"

12.3 TOOL LENGTH CALIBRATION CANNED CYCLE

(L)

가

PRBXMIN X
 PRBXMAX X
 PRBYMIN Y
 PRBYMAX Y
 PRBZMIN Z
 PRBZMAX Z



가

(L)

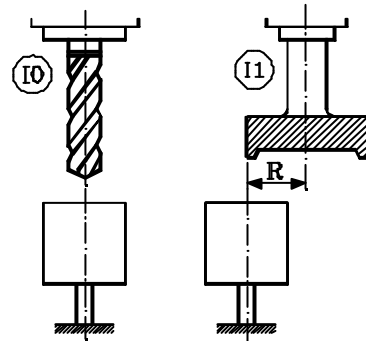
(PROBE 1, B, I, F, X, U, Y, V, Z, W)

B5.5 .0 (+)

I canned cycle

0 =
 1 =

I = 0



F5.5 mm/min inch/min

X, U, Y, V Z, W

PRBZMIN PRBXMIN, PRBXMAX, PRBYMIN, PRBYMAX, PRBZMAX , X,
U, Y, V, Z, W

CNC X, U, Y, V, Z

X, U, Y, V, Z, W CNC

:

1.- (Approch)

(G00)

가

(B)

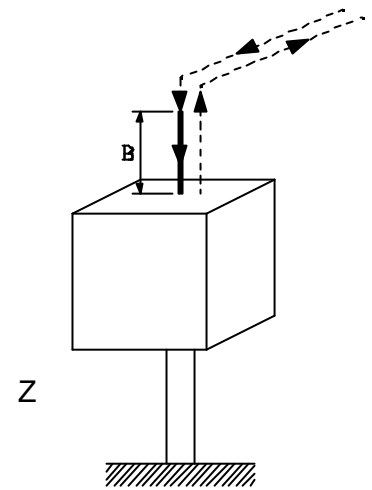
:

XY

Z

Z

XY



2.-

(F)

2B CNC가
가

3.-

(G00)

가

:

1st

2nd

(L) 0 , CNC (K) , ,
.

P299 Error detected 가 .

:

(PROBE 2,X,Y,Z,B,J,E,H, F)

X+/-5.5 X

Y+/-5.5 Y

Z+/-5.5 Z

B5.5 . 0 (+)

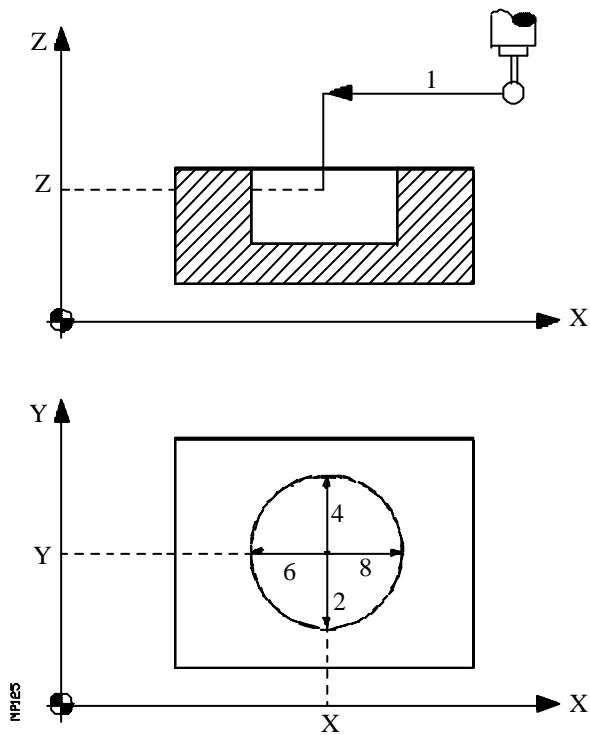
J5.5 . 0 (+)

E.5.5 가 . 0 (+)

H5.5 . mm/min inch/min

F5.5 . mm/min inch/min

:



1.- (Approch)

(G00)

가 :

1st

2nd

2.-

:

* (H)

CNC가 , "B+(J/2)" 가

* (G00)

* (F)

3.-

(G00)

4.-

5.-

(G00)

6.-

7.-

(G00)

8.-

9.-

:

*

(G00)

*

(G00)

*

CNC "I" "K"

P299

PRODEL

12.5 SURFACE MEASURING CANNED CYCLE

canned cycle

:

canned cycle
canned cycle

가
가

:

(PROBE 3,X,Y,Z,B,K,F,C,D,L)

X+/-5.5 X

Y+/-5.5 Y

Z+/-5.5 Z

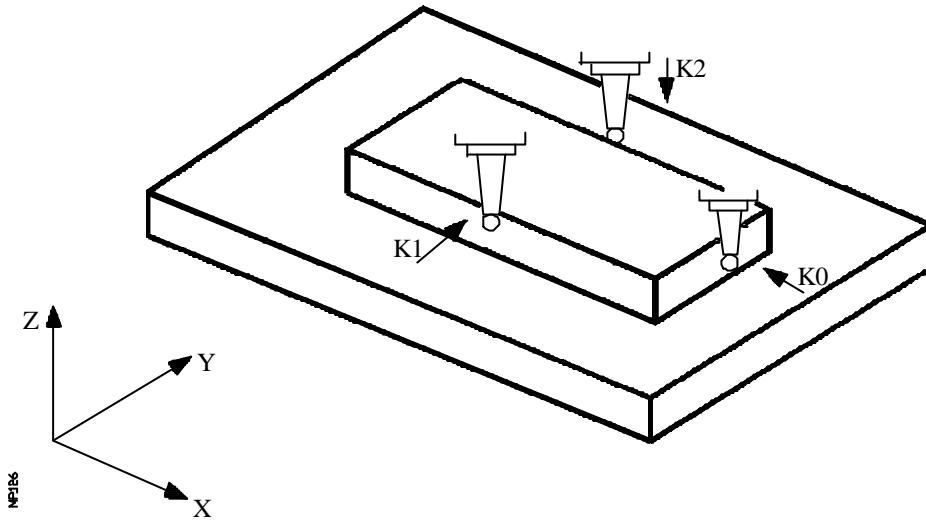
B5.5 .0 (+)

가

K

- 0 =
- 1 =
- 2 =

, canned cycle K = 0



F5.5

mm/min inch/min

C

가

- 0 =
- 1 =

, canned cycle K = 0

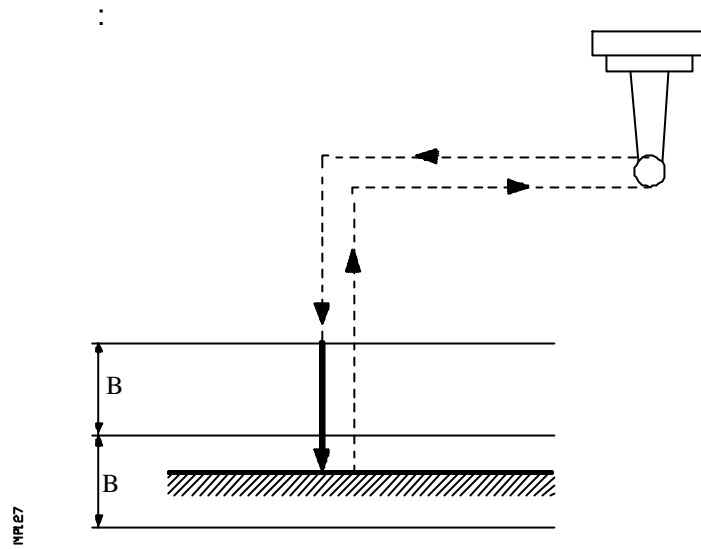
D4

0 , CNC 가

L5.5

가
가

, canned cycle 0



1.- (Approch)

(G00)

(K)

(B)

가

:

1st
2nd

2.-

(F)

(K)

2B

가

CNC가

, CNC

3.

(G00)

:

1st

2nd

3rd (C0)

, CNC

P298

P299

(D)가 , CNC 가 (L)

(K)

* , (D) (K)

* (D)
(l)

12.6 OUTSIDE CORNER MEASURING CANNED CYCLE

canned cycle

:

canned cycle
canned cycle

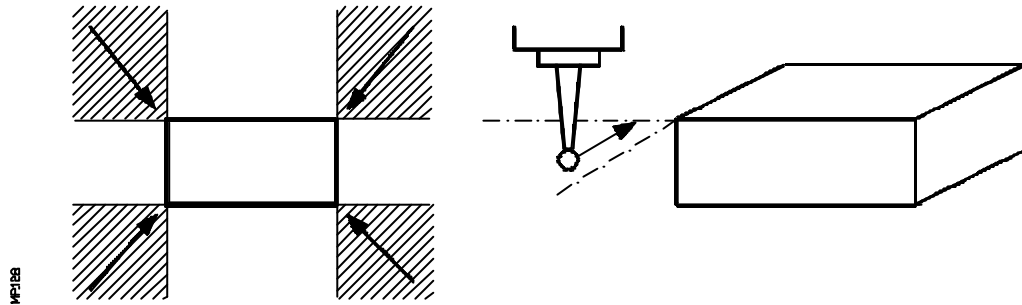
:

(PROBE 4,X,Y,Z,B,F)

X+/-5.5 X

Y+/-5.5 Y

Z+/-5.5 Z



B5.5

.0

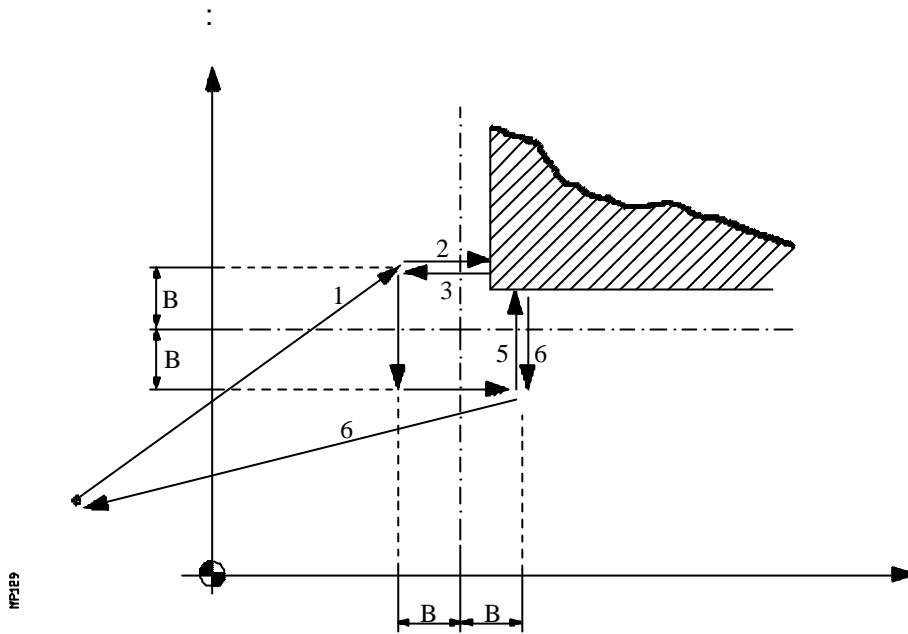
(+)

가

F5.5

mm/min

inch/min



1.-

(G00)

(B)

가 :

1st
2nd

2.-

(F)

(K)

2B

CNC가

가

3.-

(G00)

4.-

(G00)

가 :

1st
2nd

5.-

(F)

(K)

2B

가

CNC가

6.-

(G00)

:

1st

2nd

3rd

, CNC

P296

P297

P298

가

P299

가

12.7 INSIDE CORNER MEASURING CANNED CYCLE

canned cycle

:

canned cycle
canned cycle

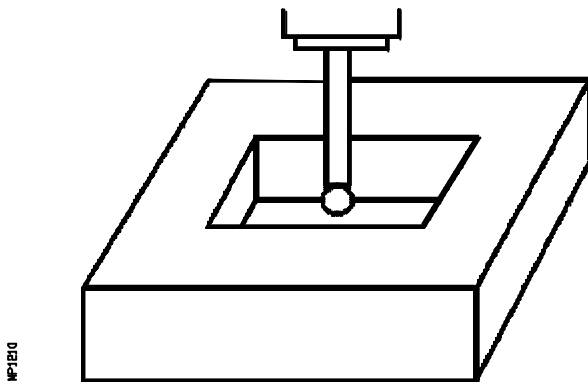
:

(PROBE 5,X,Y,Z,B,F)

X+/-5.5 X

Y+/-5.5 Y

Z+/-5.5 Z



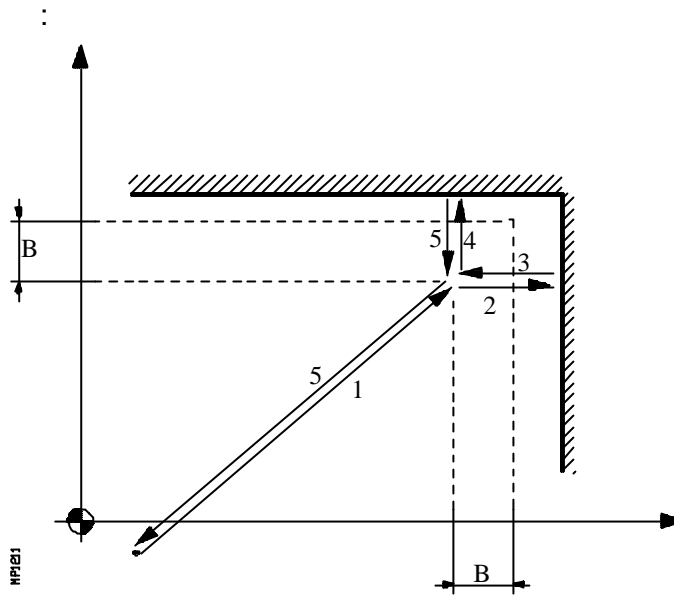
B5.5

. 0 (+)

가

F5.5

mm/min inch/min



1.-

(G00)

(B)

1st
2nd

2.-

(F)

(K)

2B

가

CNC가

3.-

(G00)

4.-

(G00)

2B

가

CNC가

5.-

(G00)

:

1st

2nd

3rd

CNC

P296

P297

P298

가

P299

가

12.8 ANGLE MEASURING CANNED CYCLE

canned cycle :

canned cycle
canned cycle

:

(PROBE 6,X,Y,Z,B,F)

X+/-5.5 X

Y+/-5.5 Y

Z+/-5.5 Z

B5.5 . 0 (+) .

가 .

F5.5 mm/min inch/min .

(F)

2B

가

CNC가

6.-

(G00)

:

1st

2nd

3rd

, CNC

P295

$\pm 45^\circ$

$\pm 45^\circ$

$\geq 45^\circ$, CNC

가

$\leq -45^\circ$, 가

가

12.9 OUTSIDE CORNER AND ANGLE MEASURING CANNED CYCLE

canned cycle :

canned cycle
canned cycle

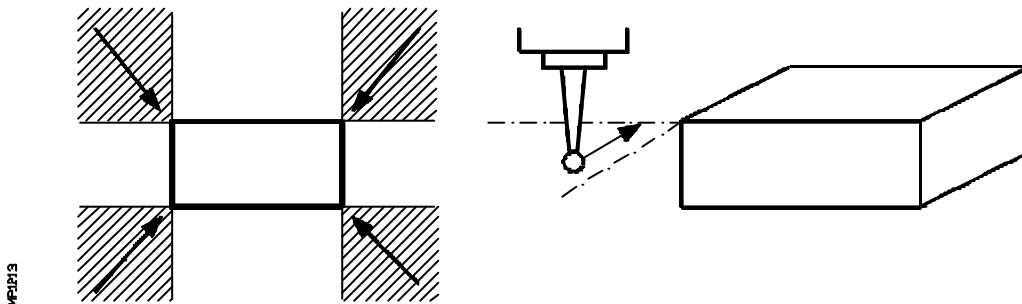
:

(PROBE 7,X,Y,Z,B,F)

X±5.5 X

Y±5.5 Y

Z±5.5 Z



B5.5 . 0 (+)

가

F5.5 mm/min inch/min

4.-

(G00) (2B)

:

1st
2nd

5.-

(F)

3B

.
가

CNC가

6.-

(G00)

7.-

(B)

(G00)

8.-

(F)

4B

.
가

CNC가

9.-

(G00)

가

:

1st
2nd
3rd

, CNC

P295

P296

P297

P298

가

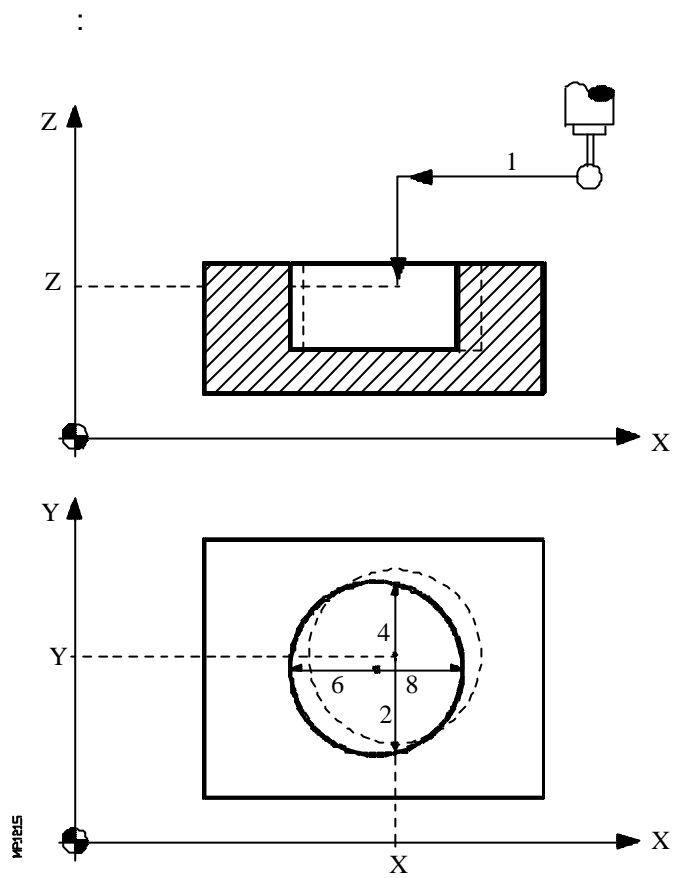
P299

가

$\pm 45^\circ$

$\geq 45^\circ$, CNC 가

$\leq -45^\circ$, 가



1.-

(G00)

:

1st
2nd

2.-

:

* (H)
"B+(J/2)" 가
CNC가 , 가

* (E) (G00)

* (F)

3.-

(G00)

4.-

5.-

(G00) ()

6.-

7.-

(G00)

8.-

9.-

:

* () (G00)

* (C0)

1st

2nd

, CNC

P294

P295

P296

P297

P298

가

P299

가

12.11 BOSS MEASURING CANNED CYCLE

canned cycle 가 :

canned cycle
canned cycle

:

(PROBE 9,X,Y,Z,B,J,E,C,H,F)

X±5.5 X

Y±5.5 Y

Z±5.5 Z

B5.5 . 0 (+) .

J5.5 . 0 (+) .

(J+B) .

E.5.5 가 . 0 (+)

C 가 .

0 =

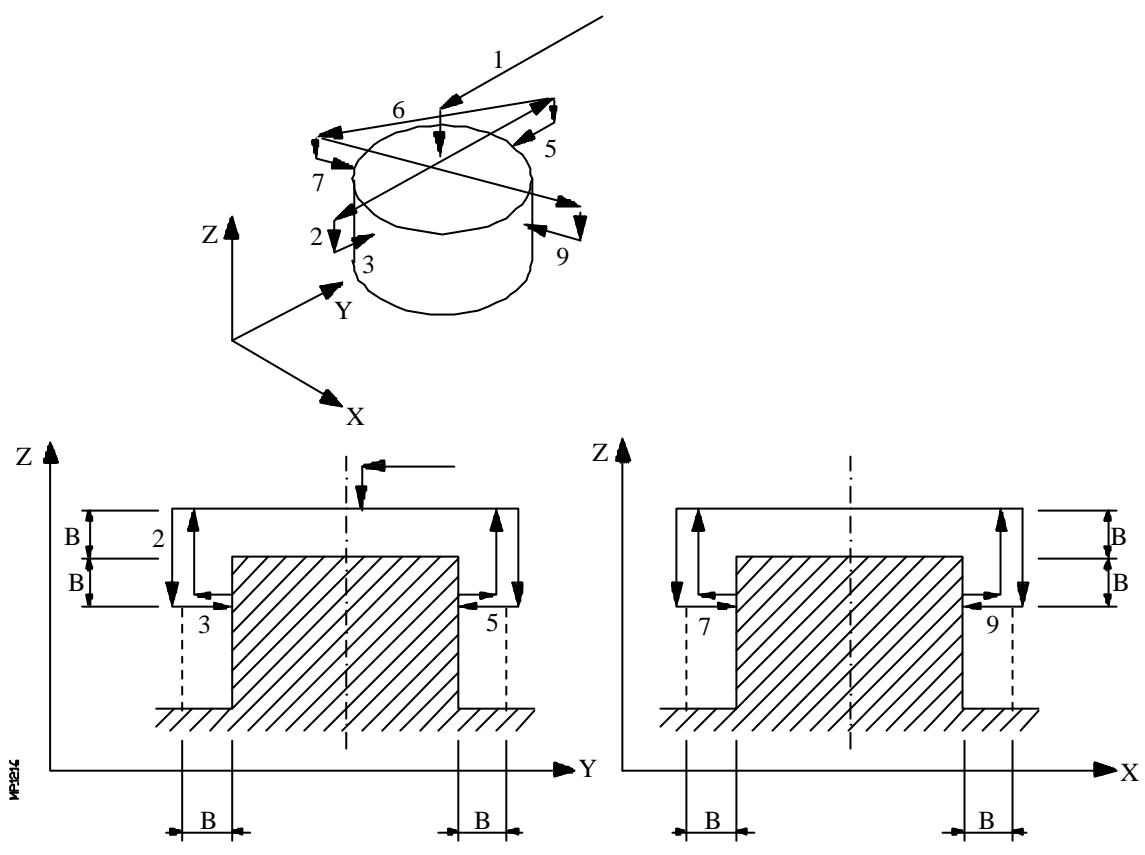
1 =

, canned cycle C = 0 .

H5.5 mm/min inch/min .

F5.5 mm/min inch/min .

:



1.-

(G00)

:

1st
2nd

(B)

2.-

(G00)

:

1st
2nd

(2B)

3.-

:

* (H)

CNC가 , "B+(J/2)" 가

* (E) (G00)

* (F)

4.-

(G00) :

*

* (B)

5.-

6.-

7.-

8.-

9.-

10.-

:

*

*

()

(G00)

* (C0)

1st

2nd

, CNC

P294

P295

P296

P297

P298

가

P299

가

13. PROGRAMMING IN HIGH-LEVEL LANGUAGE

CNC
가 . , PLC , DNC
high-level .
- 가 .

13.1 LEXICAL DESCRIPTION

high-level
.
high-level :
-
-
-

13.1.1 RESERVED WORDS

CNC가			high-level		
ANAI _n	ANAO _n	BLKN	CALL	CALLP	CLOCK
CNCERR	CNCFRO	CNCSSO	CYTIME	DATE	DEFLEX
DEFLEY	DEFLEZ	DFHOLD	DIGIT	DIST(X-C)	DNCERR
DNCF	DNCFPR	DNCFRO	DNCS	DNCSL	DNCSSO
DPOS(X-C)	DSBLK	DSTOP	DW	EFHOLD	ERROR
ESBLK	ESTOP	EXEC	FEED	FIRST	FLWE(X-C)
FLWES	FOZLO(X-C)	FOZONE	FOZUP(X-C)	FPREV	FRO
FZLO(X-C)	FZONE	FZUP(X-C)	GGSA	GGSB	GGSC
GGSD	GMS	GOTO	GS _n	GTRATY	GUP _n
IB	IF	INPUT	KEY	KEYSRC	LONGAX
LUP (a,b)	MCALL	MDOFF	MIRROR	MP(X-C) _n	MPAS _n
MPG _n	MPLC _n	MPS _n	MPSS _n	MSG	MS _n
NBTOOL	NXTOD	NXTOOL	ODW	OPEN	OPMODA
OPMODB	OPMODC	OPMODE	ORG(X-C)	ORG(X-C) _n	ORGROA
ORGROB	ORGROC	ORGROI	ORGROJ	ORGROK	ORGROQ
ORGROR	ORGROS	ORGROT	ORGROX	ORGROY	ORGROZ
PAGE	PARTC	PCALL	PLANE	PLCC _n	PLCERR
PLCF	PLCFPR	PLCFRO	PLC _{In}	PLCM _n	PLCMMSG
PLCOF(X-C)	PLCO _n	PLCR _n	PLCS	PLCSL	PLCSSO
PLCT _n	PORGF	PORGS	POS(X-C)	POSS	PPOS(X-C)
PRBST	PRGF	PRGFIN	PRGFPR	PRGFRO	PRGN
PRGS	PRGSL	PRGSSO	PROBE	REPOS	RET
ROTPF	ROTPS	RPOSS	RPT	RTPOSS	SCALE
SCALE(X-C)	SCNCSSO	SDNCS	SDNCSL	SDNCSSO	SFLWES
SK	SLIMIT	SPEED	SPLCS	SPLCSL	SPLCSO
SPOSS	SPRGS	SPRGS�	SPRGSO	SREAL	SRPOSS
SRIPOS	SSLIMI	SSO	SSPEED	SSREAL	SSSO
STPOSS	SUB	SYMBOL	SYSTEM	SZLO(X-C)	SZONE
SZUP(X-C)	TIME	TIMER	TLFD _n	TLFF _n	TLFN _n
TLFR _n	TMZP _n	TMZT _n	TOD	TO _{In}	TOK _n
TOL _n	TOOL	TOOROF	TOOROS	TOR _n	TPOS(X-C)
TPOSS	TRACE	TZLO(X-C)	TZONE	TZUP(X-C)	WBUF
WBUF	WKEY	WRITE			

(X-C) 9 X, Y, Z, U, V, W,
A, B, C .

ORG(X-C)-> ORGX, ORGY, ORGZ, ORGU, ORGV, ORGW, ORGA, ORGB, ORGC

A-Z high-level

13.1.2 NUMERICAL CONSTANTS

high-level ±6.5 \$

8 16 .

±6.5 , 16

·

: "TIMER" 100000000 ,

·

(TIMER = \$5F5E100)

(TIMER = 10000 * 10000)

(P100 = 10000 * 10000)

(TIMER = P100)

CNC가 (mm) 10 1 (+

-, 5 4) , CNC가 inch

0.00001 , (+ -, 5 4) .

(+ -, 5 5)

·

13.1.3 SYMBOLS

high-level :

() “ = + - * / ,

13.2 VARIABLES

```

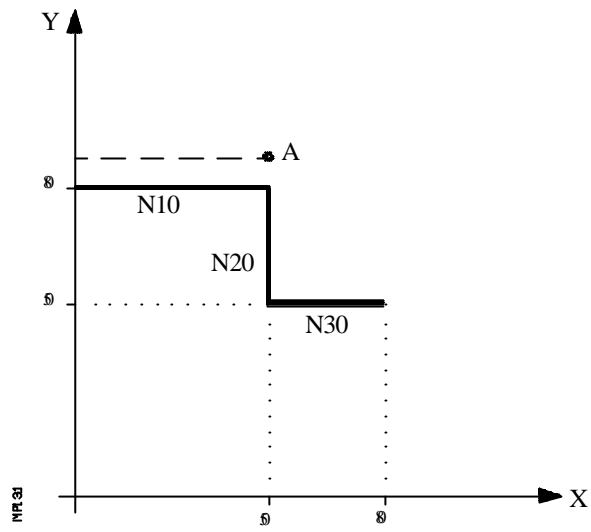
high-level          CNC
-   가              .
                                .
                                가      (TOR3)      .      (
TOR)
CNC   가           :
-
-
-
-
-
-
-   PLC
-
-
CNC                                CNC
                                .
                                가
                                .
                                :
                                G41
                                .
.....
.....
N10 X50 Y80
N15 (P100=POSX);      P100   X
N20 X50 Y590
N30 X80 Y50
.....
.....

```

N15

N10

A



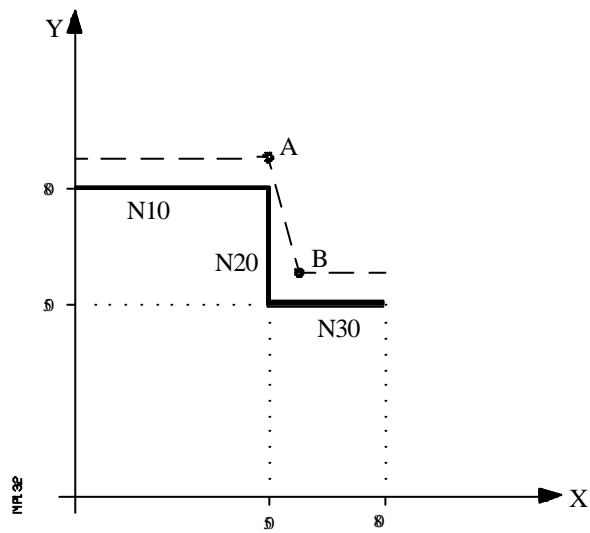
N15

, CNC

N20

"B" , CNC

"A-B"



가

13.2.1 GENERAL PURPOSE PARAMETERS OR VARIABLES

CNC 가 : P0-P25
P100-P299.

CNC

GP0 XP1 Y100 —> G1 X-12.5 Y100
(IF(P100*P101 EQ P102)GOTO N100) —> (IF(2*5 EQ 12)GOTO N100)

가

ISO GX..CFSTDM

high-level 가 ,

CNC

가 CNC

10

(4127.423) scientific notation(=23476 E-3)

CNC

가가 high level

가

26 (P0-P25)

CNC

15

6

가

high-level

N

A-X

A P0 Z P25

가 :

(IF((P0+P1) * P2/P3 EQ P4) GOTO N100)
(IF((A+B) * C/D EQ E) GOTO N100)

(, P0 A),

(P0 = 13.7) → (A = 13.7) → (A13.7)

M30 (M30) . CNC high level
(P12 = 30) (M30) M30 .

(P100-P299) .

가 (G60, G61, G62, G63, G64, G65) 가 canned cycle (G69, G81 ... G89)

가 canned cycle P299 canned
cycle P294 P299 .

13.2.2 VARIABLES ASSOCIATED WITH TOOLS

R,L,I,K

inch G70 , : ±3937.00787
 mm G71 , : ±99999.9999
 : ±99999.9999

Family code 0...NT OFFSET (maximum 255)
 $0 \leq n < 200$
 $200 \leq n \leq 255$
 0...65535
 0.99999.99 99999

1 ...NTOOL
 (255)
 0
 -1

1 ..NPOCKET
 (255)
 0
 -1
 -2

TOOL:

(P100 = TOOL); P100

TOD:

NXTOOL: M06

NXTOD: M06

TMZPn: (n)

TORn:					(n)
	(P100 = TOR3); (TOR3 = P111);	3) 3)	P111	3 R	
TOLn:					(n)
TOIn:	wear(l)				(n)
TOKn:	wear(K)				(n)
TLFDn:					(n)
TLFFn:					(n) family code
TLFNn:					(n)
TLFRn:					(n)
TMZTn:					(n)

13.2.3 VARIABLES ASSOCIATED WITH ZERO OFFSETS

G92 JOG
 PLC 가 가 G54, G55, G56, G57,
 G58, G59
 :
 inch G70 : ±3937.00787
 mm G71 : ±99999.9999
 : ±99999.9999
 가 CNC CNC
 , CNC가 X, Y, Z, U, B ORGX, ORGY, ORGZ
 ORG(X-C) ORGU ORGB

ORG(X-C) PLC ㄸ
 가
 (P100 = ORGX); P100 X X
 G92 "ORG(X-C)n"

PORGF:

PORGS:

ORG(X-C)n: (n)
 (P100 = ORGX55); G55 P100
 X
 (ORGY 54 = P111); G54 Y
 P111
PLCOF(X-C) PLC 가
 PLCOF(X-C) 가
 CNC

13.2.5 VARIABLES ASSOCIATED WITH MACHINE PARAMETERS

YES/NO, +/- ON/OFF

1/0

:

inch G70 : ±3937.00787
 mm G71 : ±99999.9999
 : ±99999.9999

MPGn: (n)

(P100 = MPG 8); mm P11= 0 inch P110 = 1 P100
 "INCHES"

MP(X-C)n (n)

(P110 = MPY 1); 가 Y
 "DFORMAT" P110 P1

MPSn: (n)

MPSSn: (n)

MPASn: (n)

MPLCn: PLC (n)

13.2.6 VARIABLES ASSOCIATED WITH WORK ZONES

inch G70 : ±3937.00787
 mm G71 : ±99999.9999
 : ±99999.9999

0 =
 1 = no - entry zone
 2 = no - exit zone

FZONE:	1		
	(P100 = FZONE);	1	P100
FZLO(X-C)	(X-C)	1	
FZUP(X-C)	(X-C)	1	
SZONE:	2		
SZLO(X-C)	(X-C)	2	
SZUP(X-C)	(X-C)	2	
TZONE:	3		
TZLO(X-C)	(X-C)	3	
TZUP(X-C)	(X-C)	3	
FOZONE:	4		
FOZLO(X-C)	(X-C)	4	
FOZUP(X-C)	(X-C)	4	
FIZONE:	5		
FIZLO(X-C)	(X-C)	5	
FIZUP(X-C)	(X-C)	5	

13.2.7 VARIABLES ASSOCIATED WITH FEEDRATES

FREAL: CNC mm/min inch/min
(P100 = FREAL); P100 CNC

G49

FEED: G94 CNC mm/
min inch/min
, PLC, DNC
DNC 가 가 가 CNC

DNCF: mm/min inch/min DNC
0 ,

PLCF: mm/min inch/min PLC
0 ,

PRGF: mm/min inch/min
0 ,

G95

FPREV: G95 CNC mm/
rev inch/rev
, PLC DNC , CNC
DNC 가 가 가

DNCFPR: mm/min inch/min DNC
0 , ..

PLCFPR: mm/min inch/min PLC
0 ,

G32

PRGFIN: 1/min
, G94 CNC FEED mm/min inch/min

PRGFPR:		mm/rev	inch/rev
FRO:	CNC "MAXFOVR"(255)	(%)	0
	CNC	PLC, DNC , DNC, PLC	
DNCFRO:	DNC	%	0
PLCFRO:	PLC	%	0
CNCFRO:	CNC		%
PLCCFR:	PLC		%

PRGFRO:

0 "MAXFOVR"(255)

0 ,

(P110 = PRGFRO); P110
(%)

(PFRGFRO = P111);
% P111

13.2.8 VARIABLES ASSOCIATED WITH COORDINATES

inch G70 : ±3937.00787
 mm G71 : ±99999.9999
 : ±99999.9999

PPOS(X-C)

(P100 = PPOSX); P100 X

POS(X-C)

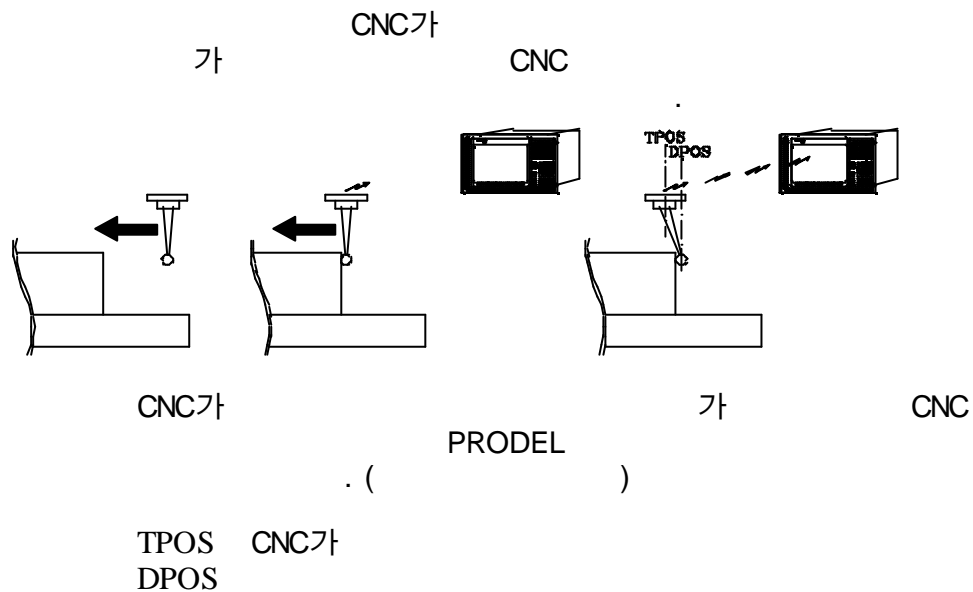
(home)

TPOS(X-C)

(home)
 (+ following error)

DPOS(X-C)

CNC G75, G76 (Probe, Digit) 가



FLWE(X-C)

following error

DEFLEX
DEFLEY
DEFLEZ:

X, Y, Z Renishaw SP2

(POS(X-C), TPOS(X-C), DPOS(X-C), FLWE(X-C), DEFLEX, DEFLEY, DEFLEZ) CNC

DIST(X-C)

(P100 = DISTX); P100 X

(DISTZ = P111); Z 가
P111

DIST(X-C) 가
CNC

LIMPL(X-C):

LIMMI(X-C):

가 , (LIMPL,
LIMMI)

PLC 가 ,
ACTLIM2 (M5052)
M

CNC가 가
G4

LIMIT- (P6) 가 LIMIT+ (P5)


```

(c b a) JOG
      c b a
      0 0 0
      0 0 1 x1
      0 1 0 x10
      1 0 0 x100

```

, CNC X, Y, Z, U, V, W, A, B, C

```

"1"
c b a
1 1 1 x1 factor
1 1 0 x10 factor

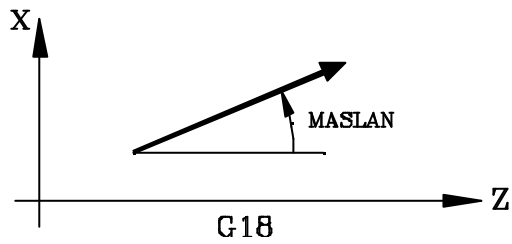
```

HBE 가 CNC JOG, HBEVAR "0"
 , CNC

PLC 가 HBEVAR 가 "0"

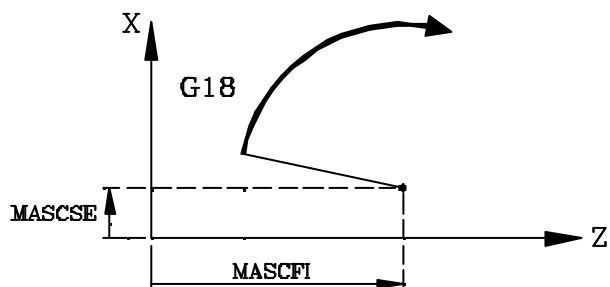
HBE handwheel" 4 "Example of PLC program for Fagor

MASLAN "Path Handwheel"



MASCFI
 MASCSSE

"Path Handwheel"



13.2.10 VARIABLES ASSOCIATED WITH THE MAIN SPINDLE

0 255 (rev/min)
 CNC

SREAL: (rev/min)
 (P100 = SREAL); P100

SPEED: (rev/min) CNC
 , PLC, DNC , CNC
 , DNC 가

DNCS: DNC (rev/min) . 0 ,

PLCS: PLC (rev/min) . 0 ,

PRGS: (rev/min) . 0

SSO: CNC (%)
 0 "MAXSOVR"(255)
 CNC , DNC, PLC, 가

DNCSO: DNC . 0 ,

PLCSO: PLC . 0 ,

CNCSSO: . 0

SLIMIT: CNC
 , PLC, DNC , CNC
 , DNC 가 ,

DNCSL: DNC (rev/min) . 0

PLCSL: PLC (rev/min) . 0

PRGSL: (rev/min)
 0 ,

POSS: ±99999.9999

RPOSS: 0 360°

TPOSS: ±99999.9999

RTPOSS: 0 360°

FLWES: following error

SYNCER 가
 following error

(POSS, RPOSS, TPOSS, RTPOSS FLWES)
 CNC

PRGSSO: 0 "MAXSOVR"(255)
 . 0 ,

(P110 = PRGSSO); P110
 %

(PRGSSO = P111); P111
 %

13.2.11 VARIABLES ASSOCIATED WITH THE 2ND SPINDLE

0 255 (rev/min)

SSREAL: (rev/min)
(P100 = SRSEAL); P100
CNC

SSPEED: (rev/min) CNC
, PLC, DNC , CNC
. DNC 가

SDNCS: DNC (rev/min) . 0 ,

SPLCS: PLC (rev/min) . 0 ,

SPRGS: (rev/min)

SSSO: CNC (%)
0 "MAXSOVR"(255)
CNC , PLC, DNC , DNC, PLC, 가

SDNCSO: DNC . 0 ,

SPLCSO: PLC . 0 ,

SCNCSO: . 0

SSLIMI: CNC

, PLC, DNC , CNC
. DNC 가 ,

SDNCSL: DNC (rev/min)
0 , .

SPLCSL: PLC (rev/min)
0 , .

SPRGSL: (rev/min)
. 0 , .

SPOSS: (M19)
±999999999 0.0001 .

SRPOSS: 0 360°
0.0001 .

TPOSS: ±999999999
0.0001 .

SRTPOS: 0 360°
0.0001 .

SFLWES: (M19) following error .
(SPOSS, SRPOS, STPOSS, SRTPOS SFLWES)
CNC

SPRGSO: 0 "MAXSOVR"(255)
. 0 , .

(P110 = SPRGSO); P110
%

(SPRGSO = P111); P111
%

13.2.12 VARIABLES ASSOCIATED WITH THE LIVE TOOL

```
ASPROG M45  
M45 S      rpm  
M45      ,CNC "0"  
  
M45 ASPROG
```

13.2.13 VARIABLES ASSOCIATED WITH THE PLC

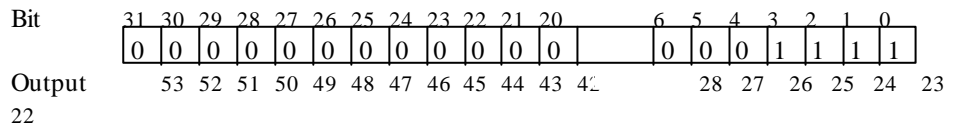
PLC	resource	가	.
Inputs	(I1	I256)	
Outputs	(O1	O256)	
Marks	(M1	M5957)	
Registers	32	(R1	R499)
Timers	32	가	(T1 T256)
Counters	32	가	(C1 C256)

PLC (I, O, M, R, T, C)
CNC

PLCMSG: 가 PLC
(1...128) , 0
(P100 = PLCMSG); P100 가 PLC

PLCIn: (n) 가 32 PLC

PLCOn: (n) 32 PLC



PLCMn: (n) 32 PLC

PLCRn: (n) 32

PLCTn: (n)

PLCCn: (n)

13.2.15 SERCOS VARIABLES

Sercos

CNC

TSVAR(X-C)
TSVARS
TSSVAR

" (identifier)" sercos , Sercos
(P110 = SVARX 40); " ' X 40 sercos
P110

SETGE(X-C)
SETGES
SSETGS

sercos 8 (0 7) 가
218 ,
8 (0 7) 가 . sercos 217
, ()

4 4

SVAR(X-C)
SVARS
SSVAR

sercos
(P110 = SVARX 40); " ' X 40 sercos
P110

13.2.16 SOFTWARE & HARDWARE CONFIGURATION VARIABLES

HARCON CNC "1" .. 가 가

8055 CNC model:

bit		
0	Turbo board	
4,3,2,1	0000	8055 /A model
	0001	8055 /B model
	0010	8055 /C model
5	Sercos integrated into CPU board	
6	Sercos module on manager board	
7	Axes module	
10,9,8	001	One I/O module
	010	Two I/O modules
	011	Three I/O modules
11	Tracing module	
13,12	01	Hard Disk module (without Ethernet)
	10	Module with just Ethernet (without Hard Disk)
	11	Hard Disk module with Ethernet
14	It has analog video	
15	It has CAN integrated into the CPU board	
18,17,16	Keyboard type (technical service department)	
20,19	CPU type (technical service department)	
23,22,21	000	Memkey Card (4M)
	010	Memkey Card (24M)
	110	Memkey Card (512M)
	111	Memkey Card (2M)

8055i CNC model:

bit		
0	Turbo board	
4, 3, 2, 1	0101	8055i /B model
	0110	8055i /C model
5	Sercos (digital model)	
6	Reserved	
9, 8, 7	000	Expansion board missing
	001	"Feedback + I/O" expansion board
	010	Feedback-only expansion board
	011	I/O-only expansion board
10	Axis board with 12-bit (=0) or 16-bit (=1) Digital/Analog converter.	
12, 11	Reserved	
14, 13	Reserved	
15	It has CAN (digital module)	
18,17,16	Keyboard type (technical service department)	
20,19	CPU type (technical service department)	
23,22,21	000	Memkey Card (4M)
	010	Memkey Card (24M)
	110	Memkey Card (512M)
	111	Memkey Card (2M)

13.2.17 VARIABLES ASSOCIATED WITH TELEDIAGNOSIS

HARSWA
HARSWB

(CPU)

4

. (1.2)

HARSWA

<i>bits</i>	31 - 28	27 - 24	23 - 20	19 - 16	15 - 12	11 - 8	7 - 4	3 - 0	
<i>board</i>	Large Sercos	I/O 4	I/O 3	I/O 2	I/O 1	Axes	Turbo	CPU	LSB

HARSWB

<i>bits</i>	31 - 28	27 - 24	23 - 20	19 - 16	15 - 12	11 - 8	7 - 4	3 - 0	
<i>board</i>						Small Sercos	Tracing	HD	LSB

CPU

"0"

, 가 "0"

sercos

CPU

(COM1

1, COM2

2)

(

)

HARTST

"1",

"0"

bit 13	bit 12	bit 11	bit 10	bit 9	bit 8	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0	
Inside temperature	Board voltage					Supply voltages								
	I/O 3	I/O 2	I/O 1	Tracing	Axes	+3.3 V	GND	GND A	-15 V	+15 V	Battery	-5 V	+5 V	LSB

MEMTST

가 OK "1"

가 "1"

4

가

"1"

<i>bits</i>	30	.....	19 - 16	15 - 12	11 - 8	7 - 4	3 - 0	
<i>Test</i>	Test status	.....	Cache	Sdram	HD	Flash	Ram	LSB

NODE

sercos

가 CNC

VCHECK

check sum

13.2.18 VARIABLES ASSOCIATED WITH THE OPERATING MODE

OPMODE:

- 0 = Main menu.
- 10 = Automatic execution.
- 11 = Single block execution.
- 12 = MDI in EXECUTION
- 13 = Tool inspection

- 20 = Theoretical path movement simulation
- 21 = G functions simulation
- 22 = G, M, S and T functions simulation
- 23 = Simulation with movement on main plane
- 24 = Simulation with rapid movement

- 30 = Normal editing
- 31 = User editing
- 32 = TEACH-IN editing
- 33 = Interactive editor
- 34 = Profile editor

- 40 = Movement in continuous JOG
- 41 = Movement in incremental JOG
- 42 = Movement with electronic handwheel
- 43 = HOME search in JOG
- 44 = Position preset in JOG
- 45 = Tool calibration
- 46 = MDI in JOG
- 47 = User JOG operation

- 50 = Zero offset table
- 51 = Tool Offset table
- 52 = Tool table
- 53 = Tool magazine table
- 54 = Global parameter table
- 55 = Local parameter table

- 60 = Utilities

- 70 = DNC status
- 71 = CNC status

- 80 = Editing PLC files
- 81 = Compiling PLC program
- 82 = PLC monitoring
- 83 = Active PLC messages
- 84 = Active PLC pages
- 85 = Save PLC program
- 86 = Restore PLC program
- 87 = "PLC resources in use" mode
- 88 = PLC statistics

- 90 = Graphic Editor
- 100 = General machine parameter table
- 101 = Axis machine parameter tables
- 102 = Spindle machine parameter tables
- 103 = Serial port machine parameter tables
- 104 = PLC machine parameter table
- 105 = M function table
- 106 = Leadscrew and cross compensation table
- 107 = Machine parameter table for Ethernet
- 110 = Diagnosis: configuration
- 111 = Diagnosis: hardware test
- 112 = Diagnosis: RAM memory test
- 113 = Diagnosis: FLASH memory test
- 114 = User diagnosis
- 115 = Hard Disk diagnosis (HD)
- 116 = Circle geometry (ballbar) test

M(SHIFT-ESC) MC, MCO

OPMODE , OPMODA, OPMODB, OPMODC 가 standard

OPMODE

- 0 = CNC starting up
- 10 = In execution mode, it is executing or waiting for the CYCLE START key (cycle start key icon on top)
- 21 = In graphic simulation mode
- 30 = Editing a cycle
- 40 = In jog mode (standard screen).
- 45 = In tool calibration mode
- 60 = Managing parts. PPROG mode

OPMODA

MPMODE (, , PLC)

가 "1"

- bit 0 Program in execution.
- bit 1 Program in simulation.
- bit 2 Block in execution via MDI, JOG
- bit 3 Repositioning in progress.
- bit 4 Program interrupted, by CYCLE STOP
- bit 5 MDI, JOG Block interrupted
- bit 6 Repositioning interrupted
- bit 7 In tool inspection
- bit 8 Block in execution via CNCEX1

- bit 9 Block via CNCEX1 interrupted
- bit 10 CNC ready to accept JOG movements: jog, handwheel, teach-in, inspection.
- bit 11 CNC ready to receive the CYCLE START command: execution, simulation and MDI modes.
- bit 12 The CNC is not ready to execute anything involving axis or spindle movement.

OPMODB

"1"

- bit 0 Theoretical path
- bit 1 G functions
- bit 2 G M S T functions
- bit 3 Main plane
- bit 4 Rapid
- bit 5 Rapid (S=0).

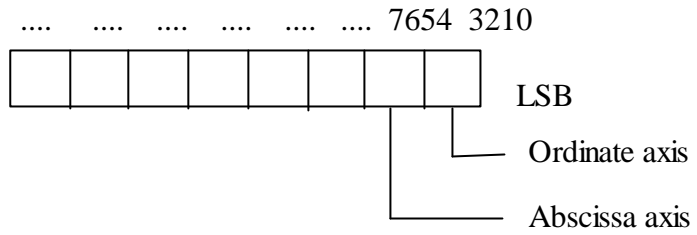
OPMODC

"1"

bit 8	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
		Axis 7	Axis 6	Axis 5	Axis 4	Axis 3	Axis 2	Axis 1

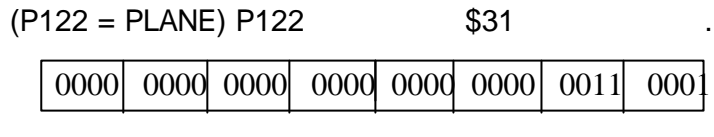
: CNC가 X, Y, Z, U, B, C , 1 X가 ,
 2 = Y, 3 = Z, 4 = U, 5 = B, 6 = C가 .

PLANE: 2 32 (4 7) (0
3)



4 (1
6)

: CNC가 X, Y, Z, U, B, C ZX
(G18)



LONGAX: G15 (1 6)
XY, ZX YZ

: CNC가 X, Y, Z, U, B, C U

(P122 = LONGAX) P122 4

MIRROR 32
1 0

bit 8	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
		Axis 7	Axis 6	Axis 5	Axis 4	Axis 3	Axis 2	Axis 1

: CNC가 X, Y, Z, U, B, C
1 = X, 2 = Y, 3 = Z, 4 = U, 5 = B, 6 = C

SCALE:

SCALE (X-C): (X-C)

ORGROT:G73

±99999.9999°

ROTPF:

inch G70 ±3937.00787
mm G71 ±99999.9999

ROTPS:

inch G70 ±3937.00787
mm G71 ±99999.9999

PRBST:

0 = 가
1 = 가

CLOCK:

0 ... 4294967295

CNC

TIME:

(P150 = TIME); P150 hh-mm-ss
18h 22m 34sec , P150 182234

CNC

DATE:

(P151 = DATE); - - P151
1992 4 25 , P151 920425

CNC

CYTIME: 0 ... 4294967295 1 .가

CNC

FIRST: 0 . 1

CNC
"Shift - Reset"

ANAIN: volt ±1.4 (±Volts) (n)
. 8

CNC

AXICOM 3 G28

		Pair 3		Pair 2		Pair 1	
		Axis 2	Axis 1	Axis 2	Axis 1	Axis 2	Axis 1

4 (1
7)

CNC가 X, Y, Z, B, C G28 BC , AXICOM
:

				Pair 3		Pair 2		Pair 1	
								C	B
0000	0000	0000	0000	0000	0000	0101	0100		

TANGAN (G45) 가 .

TIMER: PLC 가
 . 가 0 ... 4294967295
 , CNC

PARTC: CNC M30 M02가
 가 0
 4294967295
 , CNC

KEY:
 , CNC

KEYSRC: . 가
 :

- 0 = Keyboard
- 1 = PLC
- 2 = DNC

CNC 0 가 .

ANAOn: (n)
 volt ±2.4 (±10 Volts)
 CNC 가 8 (1..8)
 가
 , CNC

13.3 CONSTANTS

- 10
- 16
- PI(π)
-

13.4 OPERATORS

.CNC 가 , , , 2 ,

+	:		P1=3 + 4	—> P1=7
-	:		P2=5 - 2	—> P2=3
	:	(-)	P3=-(2*3)	—> P3=-6
*	:		P4=2*3	—> P4=6
/	:		P5=9/2	—> P5=4.5
MOD :	:	()	P6=7 MOD 4	—> P6=3
EXP :	:		P7=2 EXP 3	—> P7=8

EQ :
NE :
GT : ~
GE :
LT : ~
LE :

2

NOT, OR, AND, XOR: 2

IF (FIRST AND GS1 EQ 1) GOTO N100
P5 = (P1 AND (NOT P2 OR P3))

13.5 EXPRESSIONS

13.5.1 ARITHMETIC EXPRESSIONS

가 , 2 ,

NOT, , -
EXP, MOD
* , /
+ , -

AND, XOR
OR

(P3 = P4/P5 - P6*P7 - P8/P9)
(P3 = (P4/P5)-(P6*P7)-(P8/P9))

가

(SIN 45) (SIN (45))
(SIN 10+5) ((SIN 10)+5)

(P100 = P9)
(P100 = P(P7))
(P100 = P(P8 + SIN (P8 *20)))
(P100 = ORGX 55)
(P100 = ORGX (12+P9))
(PLCM5008 = PLCM5008 OR 1); (M5008 = 1)
(PLCM5010 = PLCM5010 AND \$FFFFFFE); (M5010 =
0)

13.5.2 RELATIONAL EXPRESSIONS

(IF (P8 EQ 12.8) ;P8 12.8
(IF (ABS(SIN(P24)) GT SPEED) ... ;sine
(IF (CLOCK LT(P9*10.99)) ; 가 (P9*10.99)

(IF ((P8EQ12.8) OR (ABS(SIN(P24)) GT SPEED)) AND (CLOCK LT (P9*10.99))

14. PROGRAM CONTROL STATEMENTS

high-level

:

*

:

- Assignment statements
- Display statements
- Enable-disable statements
- Flow control statements
- Subroutine statements
- Statements for generating programs
- Screen customizing statements

*

가

14.1 ASSIGNMENT STATEMENTS

가

:

(target=arithmetic expression)

(P102 = FZLOY)
(ORGY 55 = (ORGY 54 + P100))

가 (P0 A)

(P0=13.7) ==> (A=13.7) ==> (A13.7)

, 26

(P1=P1+P2, P1=P1+P3, P1=P*P4, P1=P1/p5) (P1=(P1+P2+P3)*P4/P5)

","

14.2 DISPLAY STATEMENTS

(ERROR integer, “error text”)

(ERROR integer).

CNC

(ERROR integer “error text”).

(ERROR “error text”).

(A Z P0 P255)

(ERROR 5)
 (ERROR P100)
 (ERROR "Operator error")
 (ERROR 3, "Operator error")
 (ERROR P120, "Operator error")

(MSG “message”)

CNC

DNC

(MSG “Check tool”)

(DGWZ expression 1, expression 2, expression 3, expression 4, expression 5, expression 6)

DGWZ

(.)

mm inch

expression 1 X minimum
 expression 2 X maximum
 expression 3 Y minimum
 expression 4 Y maximum
 expression 5 Z minimum
 expression 6 Z maximum

14.3 ENABLING-DISABLING STATEMENTS

(ESBLK and DSBLK)

ESBLK , CNC
 .
 DSBLK
 .
 , , ESBLK
 DSBLK , .

Example:

```
G01 X10 Y10 F800 T1 D1
(ESBLK) ;
G02 X20 Y20 I20 J-10
G01 X40 Y20
G01 X40 Y40 F10000
G01 X20 Y40 F8000
(DSBLK) ;
G01 X10 Y10
M30
```

(ESTOP and DSTOP)

DSTOP , CNC PLC
 (STOP) .
 ESTOP 가 .

(EFHOLD and DFHOLD)

DFHOLD , CNC PLC Feed-Hold .
 EFHOLD 가 .

14.4 FLOW CONTROL STATEMENTS

GOTO RPT PC

(GOTO N(expression))

GOTO N

:

```
G00 X0 Y0 Z0 T2 D4
      X10
(GOTO N22) ;
      X15 Y20 ;
      Y22 Z50 ;
N22 G01 X30 Y40 Z40 F10000 ;
      G02 X20 Y40 I-5 J-5
      .....
      .....
```

(RPT N(expression), N(expression))

RPT N

가 , RPT가

Example:

```
N10 G00 X10
      Z20
      G01 X5
      G00 Z0
N20 X0
N30 (RPT N10, N20) N3
N40 G01 X20
      M30
```

N30 , N10-N20 ,
N40 .

14.5 SUBROUTINE STATEMENTS

가

CNC

CNC RAM

PC

CNC RAM

RAM

14.6

EXEC

(SUB integer)

SUB 0 9999

CNC

가

가

(RET)

RET

SUB

가

:

(SUB 12)

;

12

G91 G01 XP0 F5000

YP1

X-P0

Y-P1

(RET)

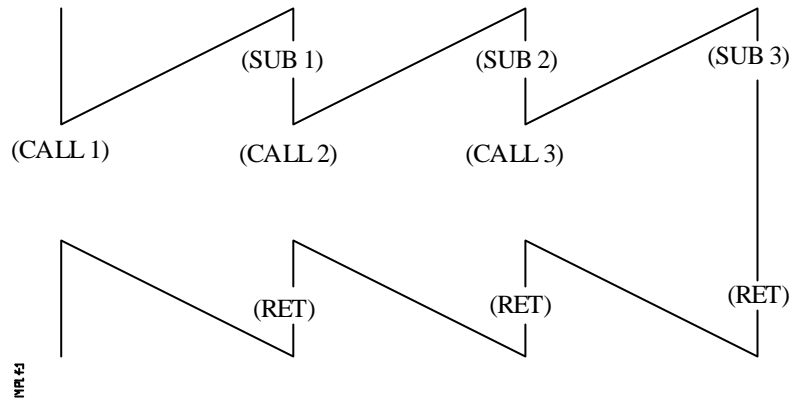
;

(CALL (expression))

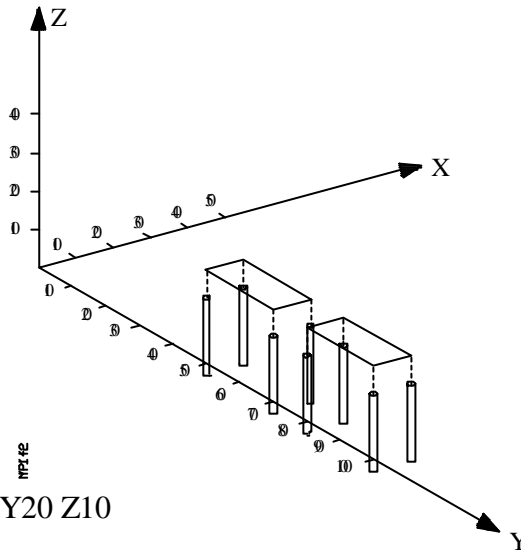
CALL

CNC

15



Example



```

G90 G00 X30 Y20 Z10
(CALL 10)
G90 G00 X60 Y20 Z10
(CALL 10)
M30
  
```

```

(SUB 10)
G91 G01 X20 F5000
(CALL 11) ;
G91 G01 Y10
(CALL 11) ;
G91 G01 X-20
(CALL 11) ;
G91 G01 Y-10
(CALL 11) ;
RET
  
```

```

(SUB 11)
G81 G98 G91 Z-8 I-22 F1000 S5000 T1 D1 ; canned cycle
G84 Z-8 I-22 K15 F500 S2000 T2 D2 ; canned cycle
G80
(RET)
  
```

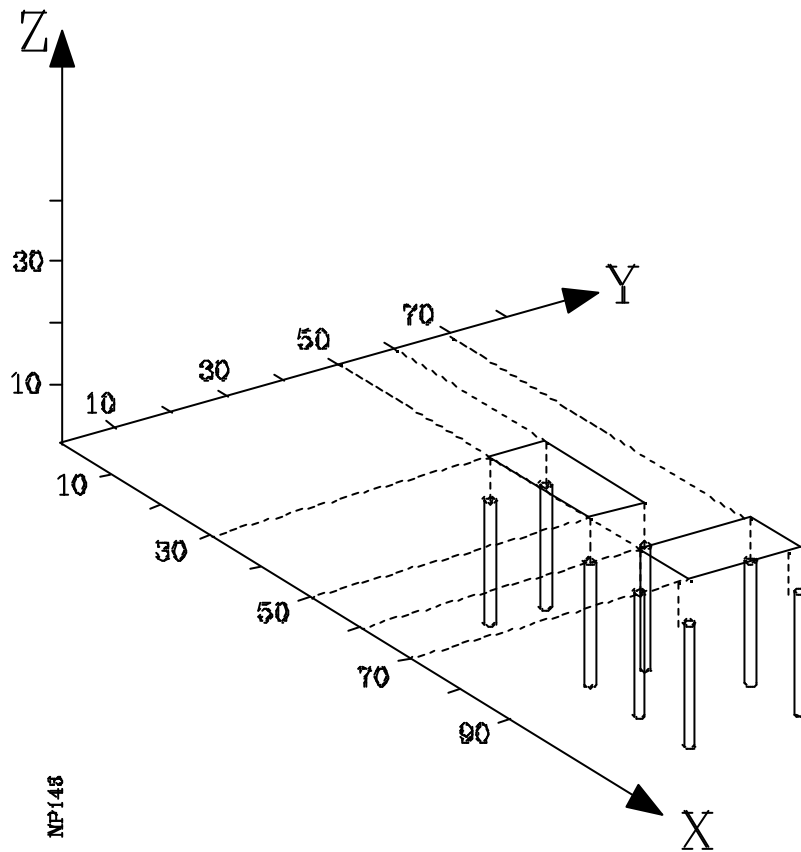
(PCALL (expression), (assignment statement), (assignment statement),...)

PCALL
가, 26

Example: (PCALL 52, A3, B5, C4, P10=20)

15 6 가
26
(P0 - P25) 가

Example:



MP148


```

G90 G00 X30 Y50 Z0
(PCALL 10, P0=20, P1=10) ; (PCALL 10, A20, B10)
G90 G00 X60 Y50 Z0
(PCALL 10, P0=10 P1=20) ; (PCALL 10, A10 B20)
M30

(SUB 10)
G91 G01 XP0 F5000
(CALL 11)
G91 G01 YP1
(CALL 11)
G91 G01 X-P0
(CALL 11)
G91 G01 Y-P1
(CALL 11)
RET

(SUB 11)
G81 G98 G91 Z-8 I-22 F1000 S5000 T1 D1 ; canned cycle
G84 Z-8 I-22 K15 F500 S2000 T2 D2 ; canned cycle
G80
(RET)

```

(MCALL (expression), (assignment statement), (assignment statement),...)

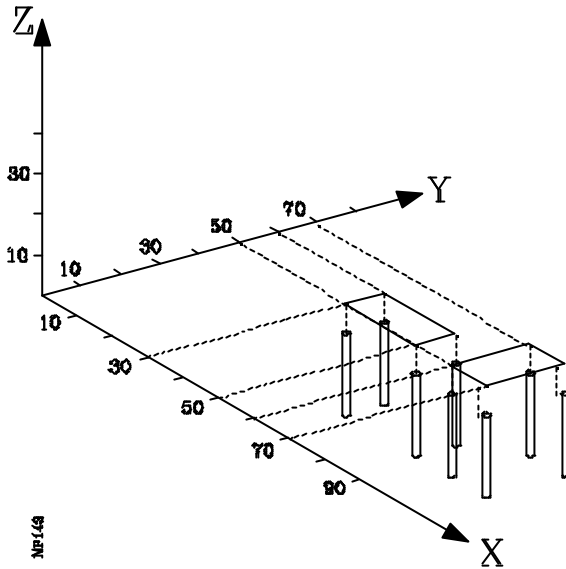
```

MCALL (SUB ) canned cycle
.
PCALL 가
, , 가
, X10 N3 가 (X10)
CNC
.
가가 가
, MCALL
.

```

(MDOFF)

MDOFF 가 MCALL 가



Example:

```
G90 G00 X30 Y50 Z0  
(PCALL 10, P0=20, P1=10)  
G90 G00 X60 Y50 Z0  
(PCALL 10, P0=10 P1=20)  
M30
```

```
(SUB 10)  
G91 G01 XP0 F5000  
(MCALL 11)  
G91 G01 YP1  
G91 G01 X-P0  
G91 G01 Y-P1  
(MDOFF)  
RET)
```

```
(SUB 11)  
G81 G98 G91 Z-8 I-22 F1000 S5000 T1 D1  
G84 Z-8 I-22 K15 F500 S2000 T2 D2  
G80  
(RET)
```

(PROBE (expression), (assignment statement), (assignment statement),...)

PROBE 가,

(DIGIT (expression), (assignment statement), (assignment statement),...)

DIGIT

(OPEN P(expression), (destination directory), A/D, "program comment")

(TRACE (expression), (assignment statement), (assignment statement),...)

TRACE

가

(OPEN P(expression), (destination directory), A/D, "program comment")

14.5.1 INTERRUPTION SUBROUTINE STATEMENTS

```

"INT1" (M5024), "INT2" (M5025), "INT3" (M5026), "INT4" (M5027)
가 , CNC

INT1 INT1SUB(P35)
INT2 INT2SUB(P36)
INT3 INT1SUB(P37)
INT4 INT1SUB(P38)

" (RET)" : "(SUB integer)

;

"(REPOS X, Y, Z ...)"

, CNC

(REPOS X, Y, Z, ...)

REPOS

, CNC

*
*
* CNC가

: C W X, Y C Z X, Y Z

:

(REPOS C, X, Y, Z) (REPOS C, X, Z)(REPOS C, Y, Z)

REPOS

CNC

```

14.6 PROGRAM STATEMENTS

.....Statement (EXEC P.....)
Statement (OPEN P.....)
 가Statement (WRITE.....)

(EXEC P(expression), (directory)

EXEC P

, CNC RAM
 , (directory
 CARDA " "
 HD
 DNC1 1 PC
 DNC2 2 PC

(OPEN P(expression), (destination directory), A/D, “program comment”)

, RAM
 (destination directory)
 CARDA " "
 HD
 DNC1 1 PC
 DNC2 2 PC
 A/D
 A CNC 가
 D CNC

OPEN

, WRITE

Notes:

A/D 가
 OPEN Emergency Reset M30 OPEN
 PC , CNC RAM , CARD A ,

(WRITE <block text>)

WRITE OPEN P <block text> 가

ISO , () 가

(WRITE G1 XP100 YP101 F100) => G1 X10 Y20 F100

high level , 가

"?"

(WRITE (SUB P102)) => (SUB P102)

(WRITE (SUB ?P102)) => (SUB 55)

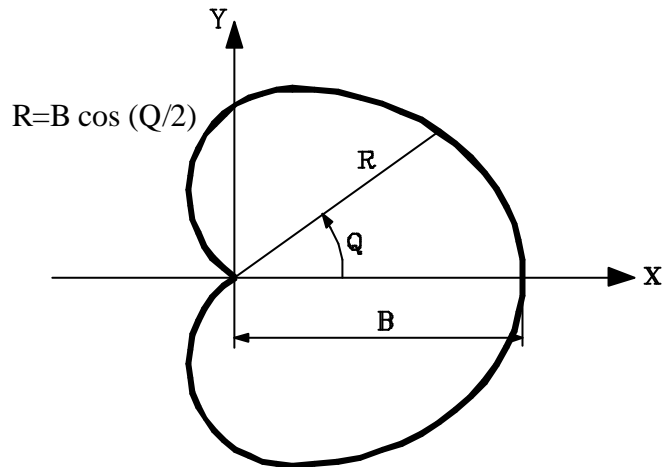
(WRITE (ORGX54=P103)) => (ORGX54=P103)

(WRITE (ORGX54=?P103)) => (ORGX54=222)

(WRITE (PCALL P104)) => (PCALL P104)

(WRITE (PCALL ?P104)) => (PCALL 25)

WRITE OPEN CNC ,



2가 . 가 :

A or P0 Q
 B or P1 B
 C or P2
 D or P3

```

G00 X0 Y0
G93
(PCALL 2, A0, B30, C5, D500)
M30

```

:

```

(SUB 2)
(OPEN P12345) ; P12345
(WRITE FP3) ;
N100 (P10=P1*(ABS(COS(P0/2)))) ; R
(WRITE G01 G05 RP10 QP0) ;
(P0=P0+P2) ;
(IF (P0 LT 365) GOTO N100) ;
(WRITE M30) ;
(RET) ;

```

14.7 SCREEN CUSTOMIZING STATEMENTS (GRAPHIC EDITOR)

```

RAM
"USERDPLY"
"USEREDIT"
"USERMAN" (MODE)
"USERDIAL"
가 5 가

```

(PAGE (expression))

```

PAGE
0 255
CNC
100

```

(SYMBOL (expression 1), (expression 2), (expression 3))

```

SYMBOL 1
(symbol)
2 ( ) 3 ( )
1, 2, 3
CNC CNC
(0-255)
( 2) 0-639, (
2) 0-335

```

(IB (expression) = INPUT "text", format))

```

CNC 26 가 (IBO-1B25)
IB

```


가 .
 "- " , "+ " "- " , 가 , "+ " .
 (0-6) 가 .
 (0-6) 가 .
 (IB1 = INPUT "text") ,

(ODW (expression 1), (expression 2), (expression 3))

ODW 가 . (1
 14)
 1 가 .
 가 , 2() 3() .
 1, 2, 3 .
 CNC 26 (0-25) 21 (0-20)
 80 (0-79) .

(DW(expression 1) = (expression 2), DW (expression 3) = (expression 4),...)

```

      1,      3, ...      DW
      2,      4, ...
1,      2,      3, ...
:
(ODW 1,6,33)      ;      1
(ODW 2,14,33)     ;      2
N10 (DW1=DATE,DW2=TIME) ;      1      2
      (GOTO N10)
CNC      , 16      ,
가      :
      (DW1 = 100)      .      1      "100"
      (DWH2=100) 16      .      2      "64"
      (DWB3=100)      .      3      "01100100"
      , 255      "11111111"
-127      (-)      , 255      "10000000"
8
가, CNC 26
:
(ODW3,4,60)      ;      3
(IB1=INPUT"Axis feed:",5.4) ;
(DW3=IB1)      ;      3

```

(SK(expression 1) = "text1" (expression 2) = "text 2", ...)

SK
가 (1-7)
가
1, 2, 3, ...
10 20 10
, CNC , 10 ,

(SK 1="HELP", SK 2="MAXIMUM COORDINATE")

HELP	MAXIMUM CO ORDINATE
------	------------------------

(SK 1="FEEDRATE", SK 2="_MAXIMUM__COORDINATE")

FEEDRATE	MAXIMUM COORDINATE
----------	-----------------------

Warning:



CNC 가
가 high level "SK" , CNC
level 가 "SK" , CNC 가 high

(WKEY)

WKEY 가

KEY

....
....
(WKEY) ;
8IF KEY EQ \$FC00 GOTO N1000 ; F1 가 , N1000
....
....

(WBUF "text", (expression))

WBUF

가

(WBUF "text", (expression))

가

(Expression)

가

" "

가

Examples for P100=10

(WBUF "X", P100) => X10

(WBUF "XP100") => XP100

(WBUF)

가, (WBUF "text", (expression))

가

"enter"

Example:

(WBUF"(PCALL 25,") ;

(IB1=INPUT "Parameter A:",-5.4) ;

(WBUF "A=",IB1) ;

(IB2=INPUT "Parameter B:",-5.4) ;

(WBUF",B=",IB2 ;

(WBUF")) ;

(WBUF) ;

A "(PCALL25," 가

"A=(value entered)" 가

B "B=(value entered)" 가

)" 가

(PCALL 25, A=23.5, B=-2.25)

(SYSTEM)

SYSTEM

CNC

USER

2

```

;
N0 (PAGE10)
;
(SK 1="CYCLE 1",SK 2="CYCLE 2",SK 7="EXIT")
N5 (WKEY) ;
(IF KEY EQ $FC00 GOTO N10) ; Cycle 1
(IF KEY EQ $FC01 GOTO N20) ; Cycle 2
(IF KEY EQ $FC06 SYSTEM ELSE GOTO N5) ;

```

```

;CYCLE 1
; 11 2
N10 (PAGE11)
(ODW 1,10,60)
(ODW 2,15,60)

```

```

;Editing
(WBUF "(PCALL 1,") ; (PCALL 1 가
(IB 1=INPUT "X:",-6.5) ; X
(DW 1=IB1) ; 1
(WBUF "X",IB1) ; X ( ) 가
(WBUF ",") ; 가
(IB 2=INPUT "Y:",-6.5) ; Y
(DW 2=IB2) ; 2
(WBUF "Y",IB2) ; Y ( ) 가
(WBUF ")") ; ) 가
(WBUF ) ; , : (PCALL 1, X2, Y3)
(GOTO N0)
;( )

```

; CYCLE 2

; 12 3

N20 (PAGE12)
(ODW 1,10,60)
(ODW 2,13,60)
(ODW 3,16,60)

;Editing

(WBUF“(PCALL 2,”) ; (PCALL 2 가

(IB 1=INPUT “A:”,-6.5) ; A

(DW 1=IB1) ; 1

(WBUF “A”,IB1) ; A () 가

(WBUF “,”) ; 가

(IB 2=INPUT “B:”,-6.5) ; B

(DW 2=IB2) ; 2

(WBUF “B”,IB2) ; B () 가

(WBUF “,”) ; 가

(IB 3=INPUT “C:”,-6.5) ; C

(DW 3=IB3) ; 3

(WBUF “C”,IB3) ; C () 가

(WBUF “,”) ;) 가

(WBUF) ; , : (PCALL 2, A3, B1, C3)

(GOTO N0)

15. DIGITIZING CYCLES

CNC

1
2

High level DIGIT

(DIGIT (expression), (assignment statement), ...)

가 가

(XY, XZ, YZ, ZX, ZY) X, Y, Z

가

(OPEN P) ()

CNC

DNC

, (OPEN P)

P)

)

가 (WRITE)

((OPEN

"G"

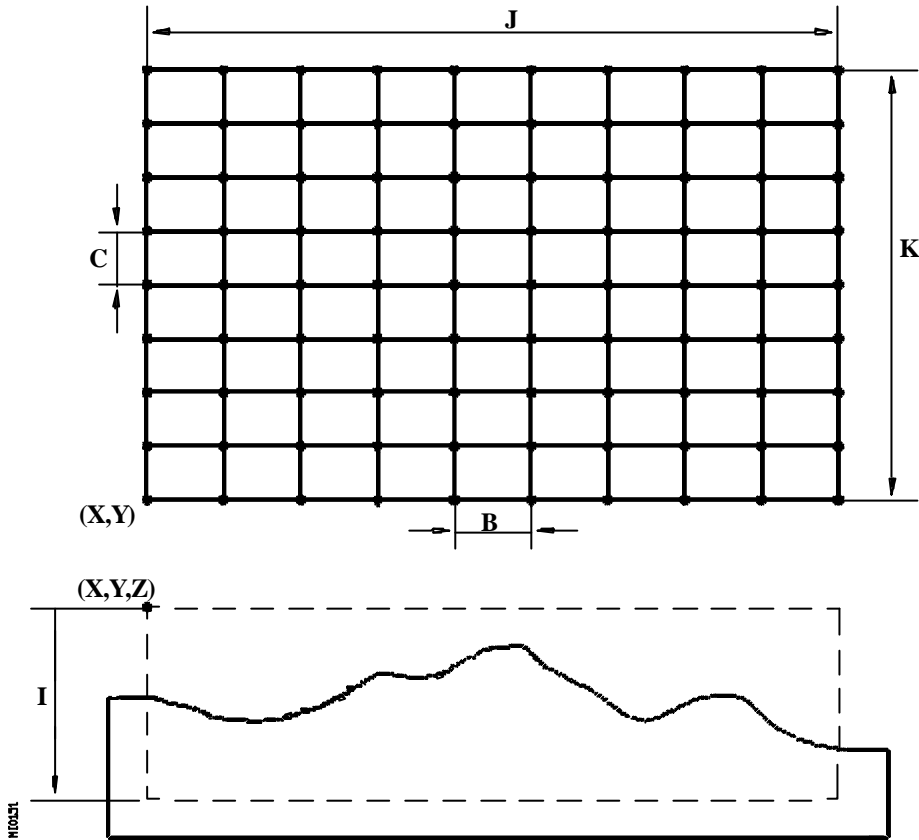
가 ,

M02

M30

15.1 DIGITIZING CYCLE IN A GRID PATTERN

(DIGIT 1, X, Y, Z, I, J, K, B, C, D, F)



$X \pm 5.5$

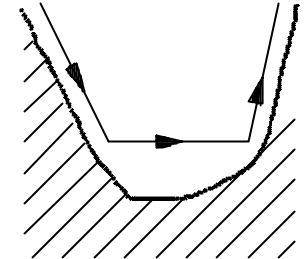
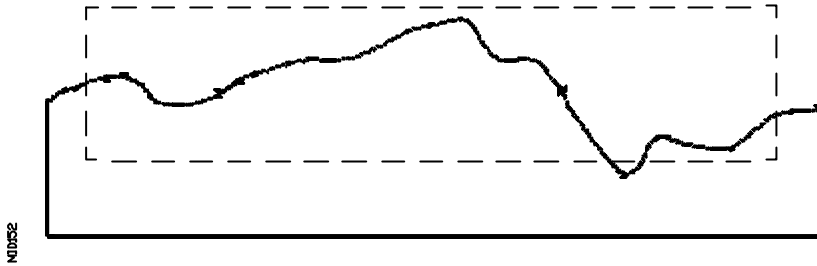
$Y \pm 5.5$

$Z \pm 5.5$

가

I±5.5

Z



0 , CNC

J±5.5

(-)

(+)

(X,Y)가

K±5.5

(-)

(+)

(X,Y)

B 5.5

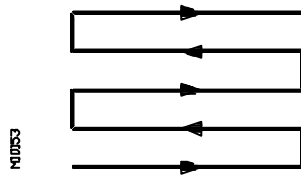
0

(+)

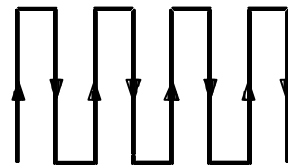
C±5.5

(+)

(-)



C(+)



C(-)

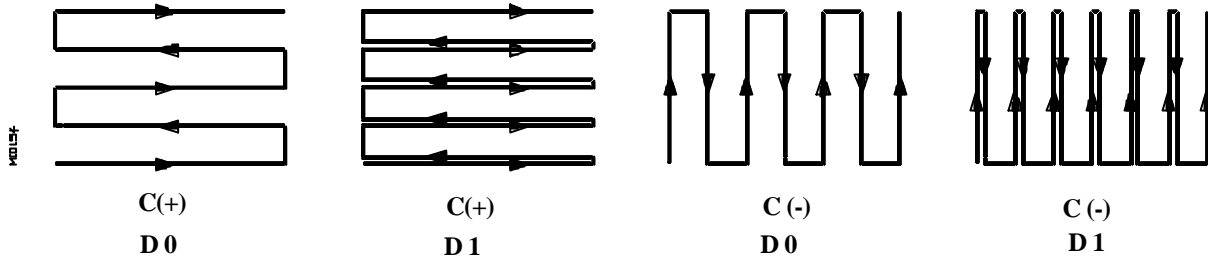
0 , CNC

D

가 "swept"

0 =
1 =

D = 0



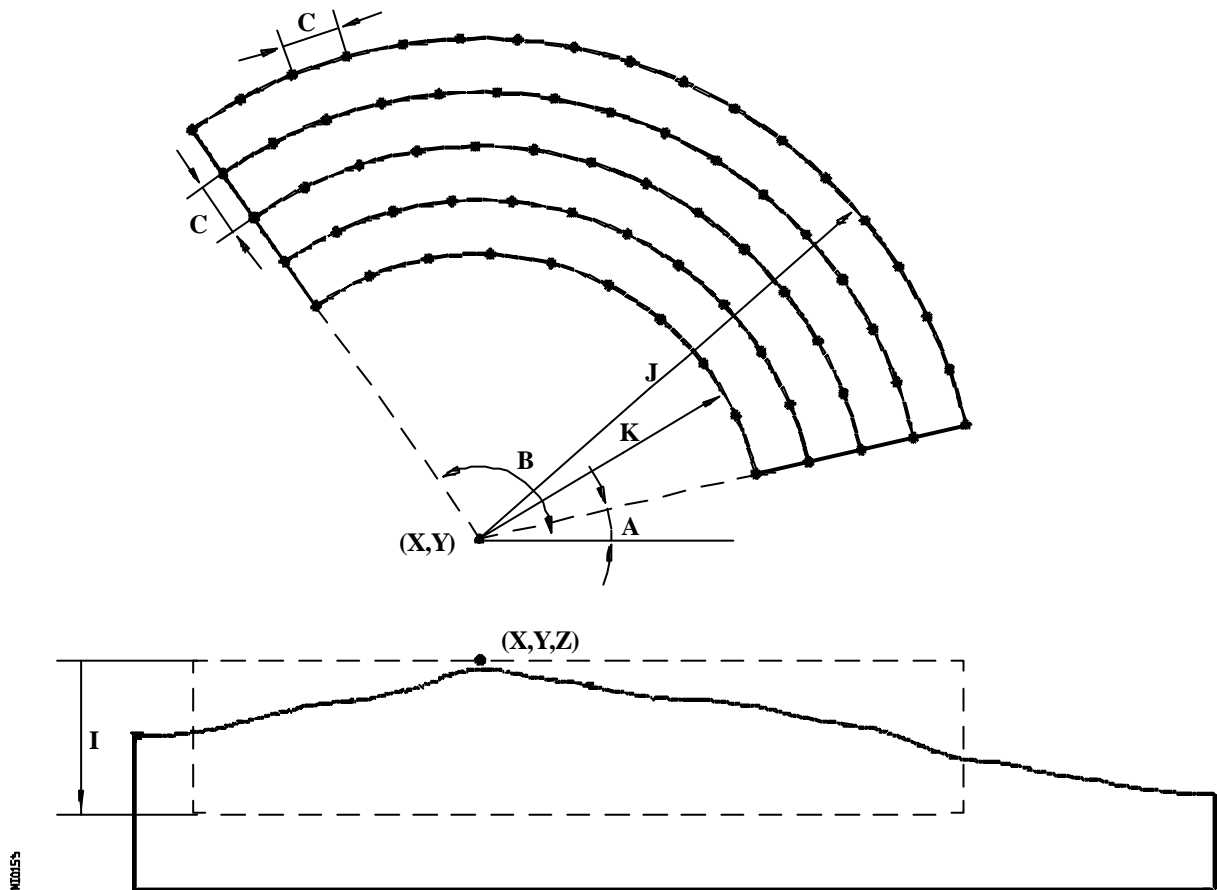
F5.5 mm/min inch/min

- 1.- X, Y, Z
- 2.- 가
- 3.- CNC (OPEN P) X, Y, Z
- 4.- 가
- 5.- canned cycle가
:
*
*

15.2 DIGITIZING CYCLE IN AN ARC PATTERN

:

(DIGIT 2, X, Y, Z, I, J, K, A, B, C, F)



X±5.5

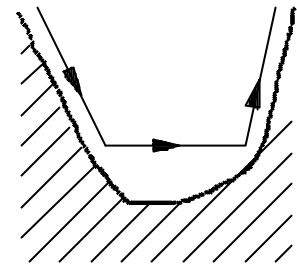
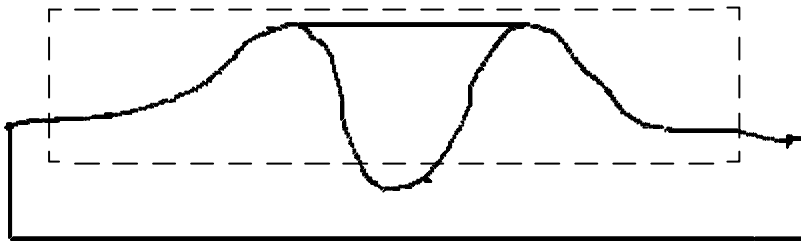
Y±5.5

Z±5.5

가

I±5.5

Z



M0156

0 , CNC

J 5.5 () .0 (+)

K 5.5 () .0 (-)

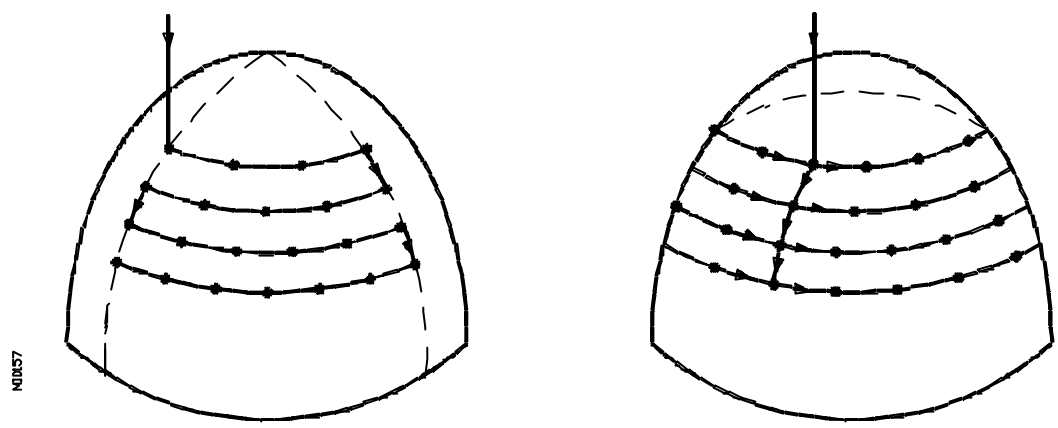
, canned cycle 0

A 5.5

, A = 0

B 5.5 ()

A B ,



NUM57

B = 360

(A0 B360) , A B

C 5.5

F5.5 mm/min inch/min

- 1.- X, Y, Z .
 - 2.- 가 .
 - 3.- CNC (OPEN P) X, Y, Z .
 - 4.- 가 .
 - 5.- canned cycle가 , .
:
- *
*

16. TRACING AND DIGITIZING

16.1 INTRODUCTION

(Tracing) :

(Copying) : 가

(copying arm)

가 가

가

.가

(Digitizing):
"OPEN P"

G23

가 가

가

:

Manually.

Automatically.

canned cycle

:

TRACE 1

/

TRACE 2

/

TRACE 3

/

TRACE 4 3-D

/

(/)

TRACE 5

가

/

(G23)

(G24)

.

가

,
:

1

/

2

/

3

/

/

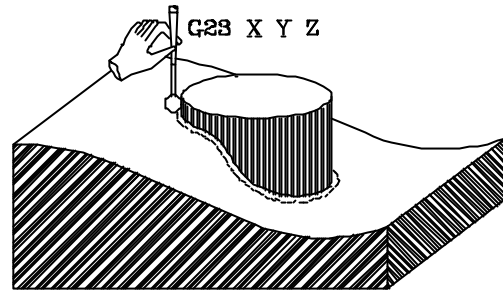
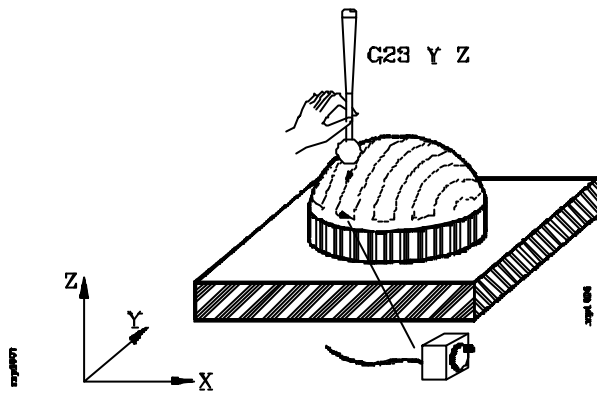
* **Manual Tracing / Digitizing.**

1, 2 3
가

가

, 2

3



가

(digitizing)가
G24

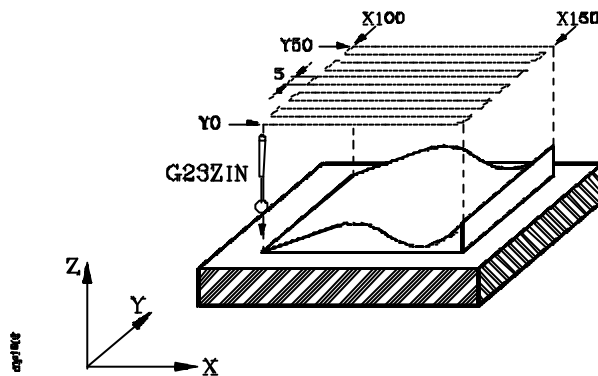
CNC

G24

"READ-BY-POINT"

* One-dimensional Tracing / Digitizing.

1 / 가 .
 G23 , CNC 가
 .
 가 ISO
 JOG
 . (point-by-point)
 CNC . G24
 :
 Z (X100 Y0) (X150 Y50)
 가 .



```

G90 G01 X100 Y0 Z80 F1000
(OPEN P234)
(WRITE G90 G01 G05 F1000)
G23 ZI-10 N1.2          ON
G24 L8 E5 K1           ON
N10 G91 X50            ( )
Y5                      "
X-50                   "
N20 Y5                 "
(RPT N10,N20) N4       "
X50                    "
G25                     OFF
M30
    
```

* Two-dimensional Tracing / Digitizing.

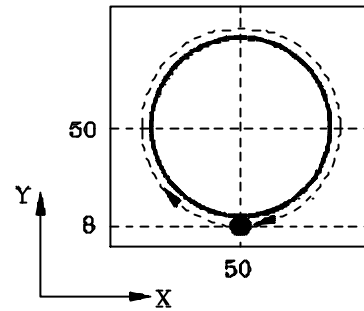
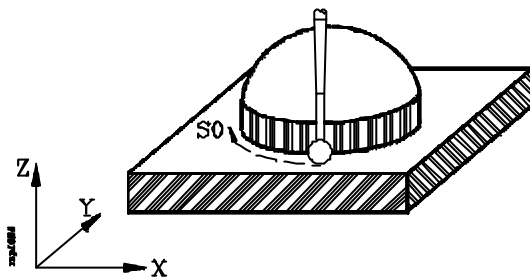
.2 / 가 .

CNC

G27 가) (가) (

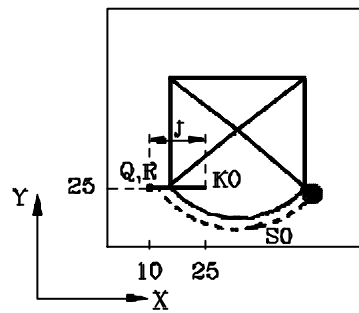
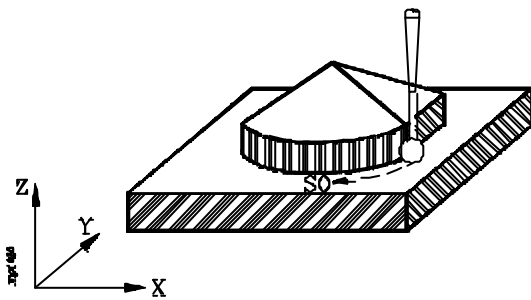
가가 .

CNC



G23 XY I50 J8 N0.8 ; 2
 G24 L8 E5 K1 ;
 G27 S0 ;
 G25 ;

:



G23 XY I60 J20 N0.8 ; 2
 G24 L8 E5 K1 ;
 G27 S0 Q10 R25 J15 K0 ;
 G25 ;

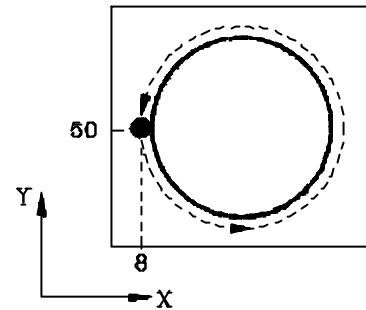
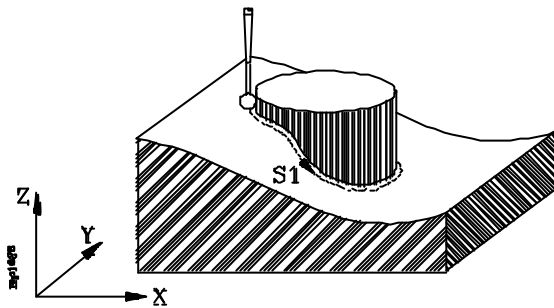
* Three-dimensional Tracing / Digitizing.

CNC

G27 가) (가) (

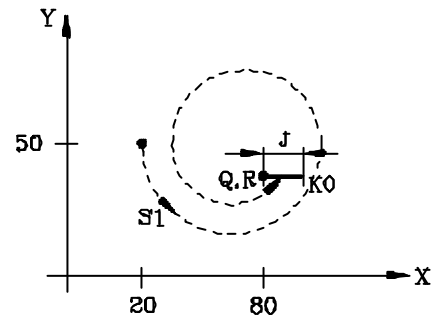
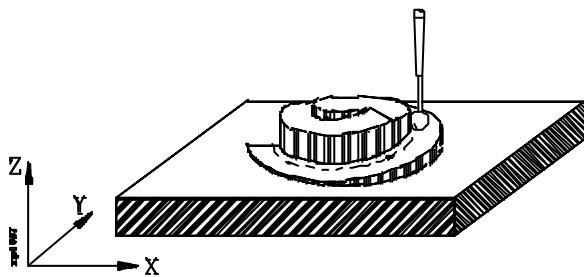
가가

CNC



G23 XYZ I8 J50 K75 N0.8 M0.5 ; 3
 G24 L8 E5 K1 ;
 G27 S1 ;
 G25 ;

:



G23 XYZ I20 J50 K45 N0.8 M0.5 ; 3
 G24 L8 E5 K1 ;
 G27 S1 Q80 R40 J25 K0 ;
 G25 ;

*** Tracing / Digitizing canned cycles**

CNC / canned cycle

TRACE 1 /
 TRACE 2 /
 TRACE 3 /
 TRACE 4 3-D ()
 TRACE 5 가 /)

high level TRACE . (1, 2, 3, 4, 5)

가 .
 "0"

, "OPEN P"
 가 .

16.1.1 GENERAL CONSIDERATIONS

/ CNC :
 G26
 G23
 G24
 G27
 G25 /

canned cycle :

TRACE 1 /
 TRACE 2 /
 TRACE 3 /
 TRACE 4 3-D 가 / ()
 TRACE 5 가 /

() CNC X, Y, Z
 (XY, XZ, YZ, YX, ZX, ZY)

CNC 가
 (G26)
 G23 () , CNC

, ISO JOG 가 가

G23 G25
 / canned cycle , G23, G25
 (가 (-)) 가
 : 가 1mm 10mm (5mm) , 8mm (4mm)

"OPEN P"

/ canned cycle (G23) (G24)
가 가 .
CNC G24 JOG 가
CNC X, Y, Z
(X, Y, Z)
가 CNC

16.2 G26. CALIBRATION OF THE TRACING PROBE

가

CNC

(gage-block)

CNC

가

.

)

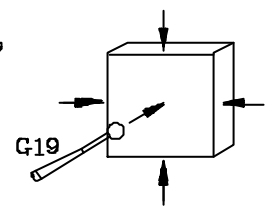
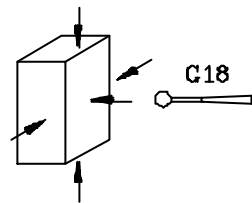
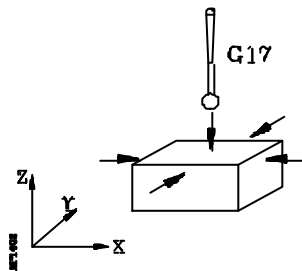
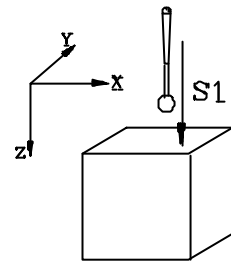
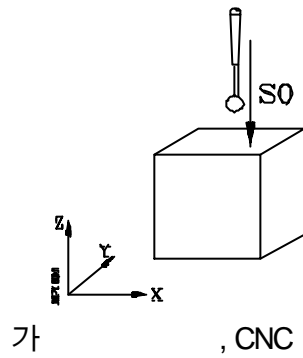
()

G26 S

S

가

0 = (-)
1 = (+)



Warning:



G26

X, Y, Z

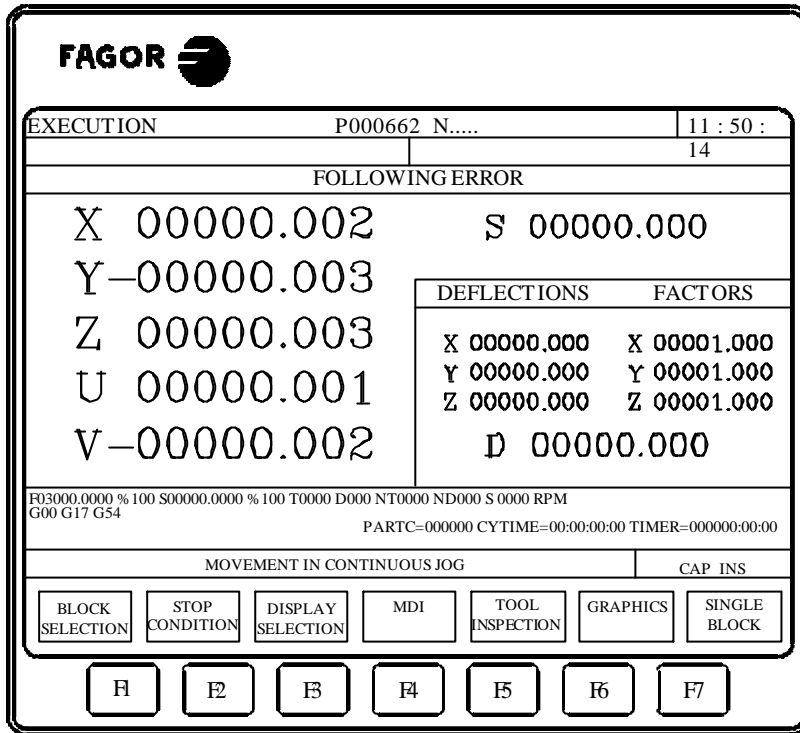
(TRACE)

(G23)

JOG

"Following Error"

, CRT



G26

G26

16.3 G23. ACTIVATE TRACING

(G23) , CNC G25

G23

G23 :

*

가

* 1

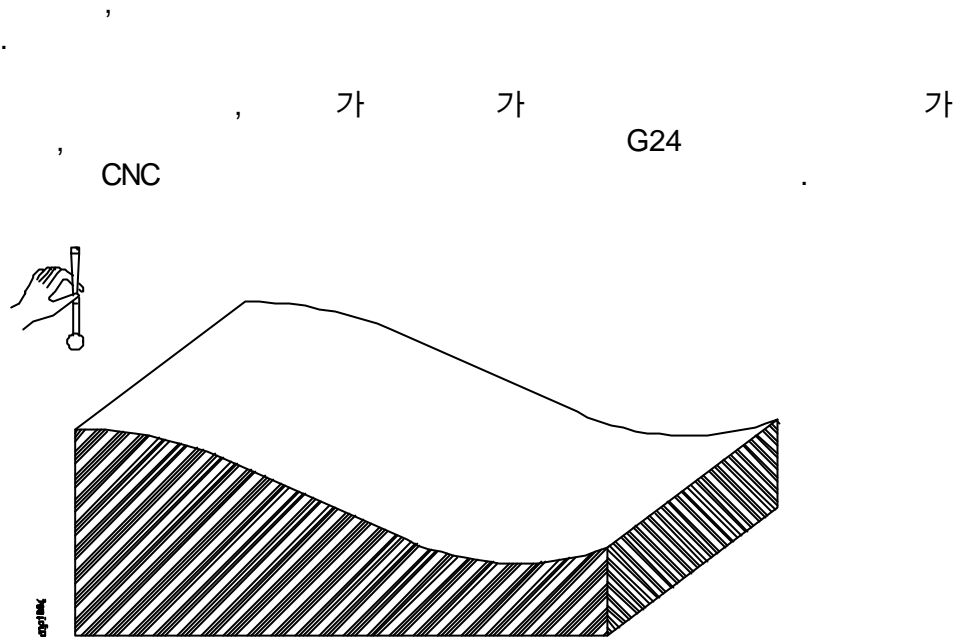
가

* 2

* 3

X, Y, Z

16.3.1 G23. ACTIVATE MANUAL TRACING



JOG MDI
G23 [X] [Y] [Z]

X, Y, Z

X, Y, Z

, CNC ()

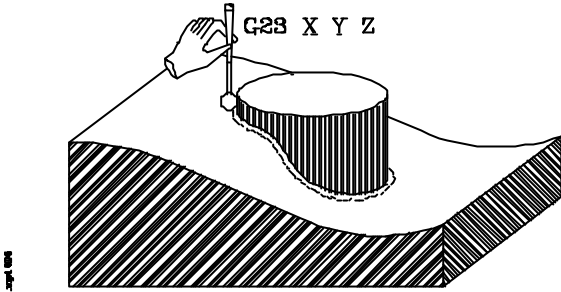
JOG

MDI

G23 Y Z , Y Z , JOG
 . X MDI

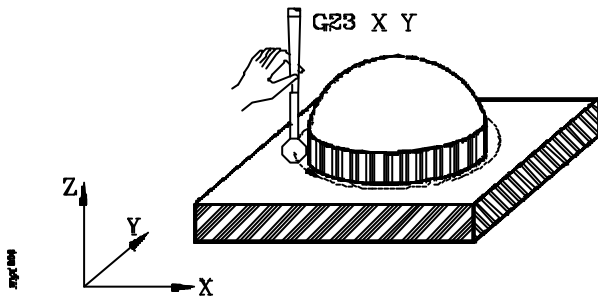
CNC (sweeping)

Examples:



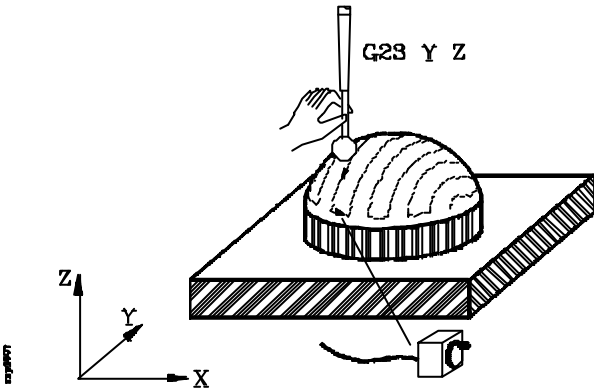
G23 X Y Z

- * 3-D
- * X, Y, Z



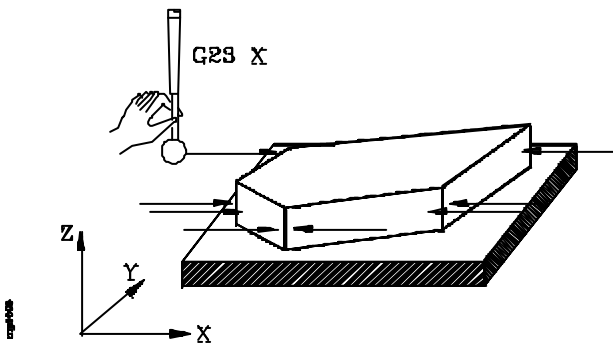
G23 X Y, G23 X Z, G23 Y Z

- * 2
- * (X Y)
- * JOG



- * JOG

G23 X, G23 Y, G23 Z



- * JOG

16.3.2 G23. ACTIVATE ONE-DIMENSIONAL TRACING

MDI JOG AUTOMATIC

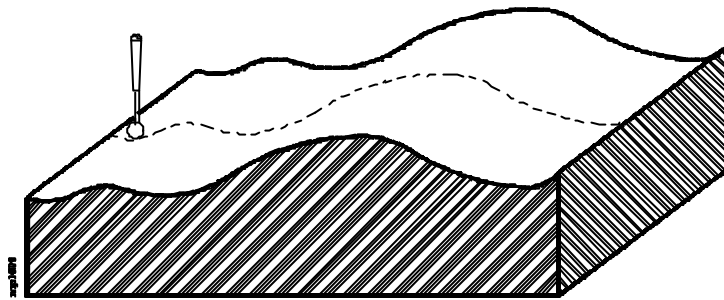
, CNC

ISO

JOG

가

가



G23 [axis] I±5.5 N5.5

[axis]

X, Y

Z

()

, CNC

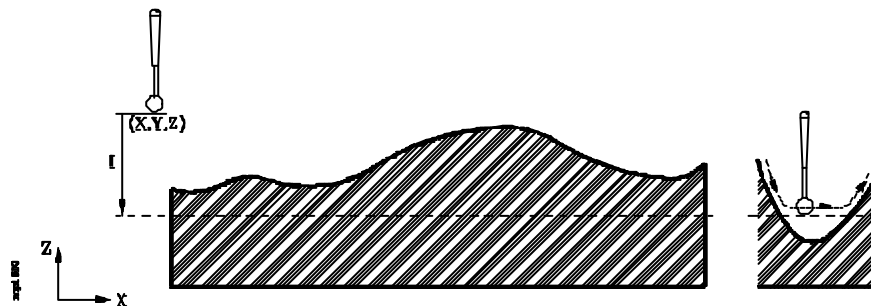
가

ISO

JOG

I±5.5

가



가

N 5.5

가

(mm inch)

1.5mm

0.3mm

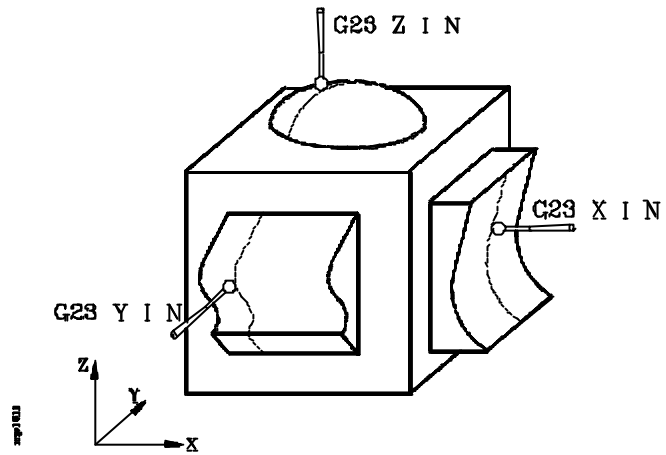
가
1000

1m/min

: 1mm

X, Y, Z

:



:

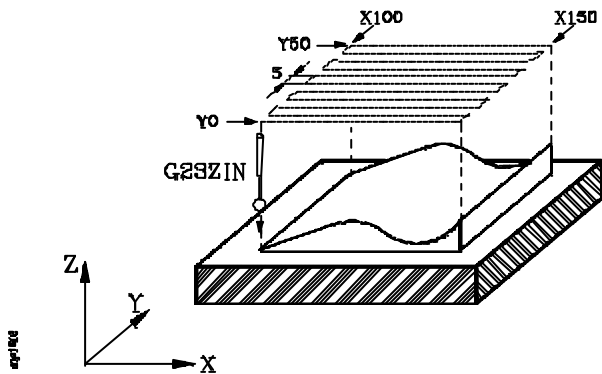
가

Z

가

(X100 Y0)

(X150 Y50)



```

G90 G01 X100 Y0 Z80 F1000
G23 ZI-10 N1.2          ON
N10 G91 X50            sweep
Y5                      "
X-50                   "
N20 Y5                 "
(RPT N10,N20) N4      "
X50                    "
G25                    OFF
M30

```

16.3.3 G23. ACTIVATE TWO-DIMENSIONAL TRACING

2

MDI

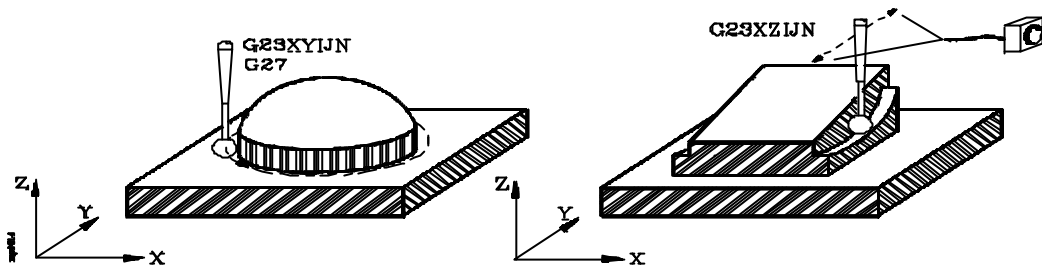
JOG

AUTOMATIC

G23

CNC

(I, J)



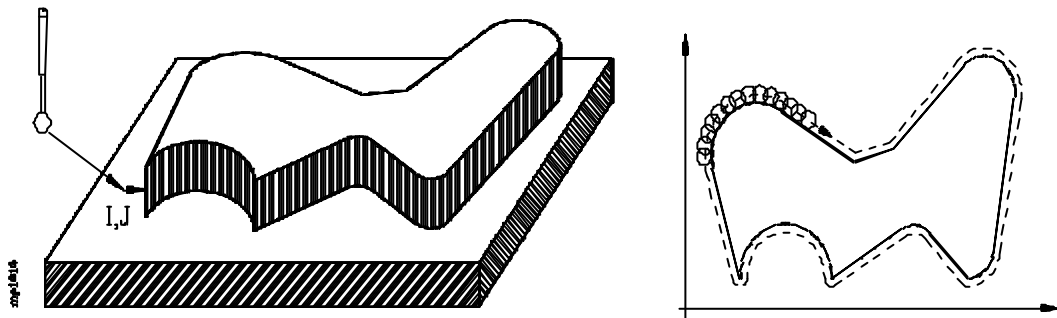
가

가

G27(

)

JOG



G23 [axis1] [axis2] I±5.5 J±5.5 N5.5

axis1 axis2

가

X, Y, Z

I±5.5

J±5.5

Page 16	Chapter: 16 TRACING AND DIGITIZING	Section: ACTIVATE TWO-DIMENSIONAL TRACING (G23)
------------	---------------------------------------	---

N 5.5

가

(mm inch)

0.3mm

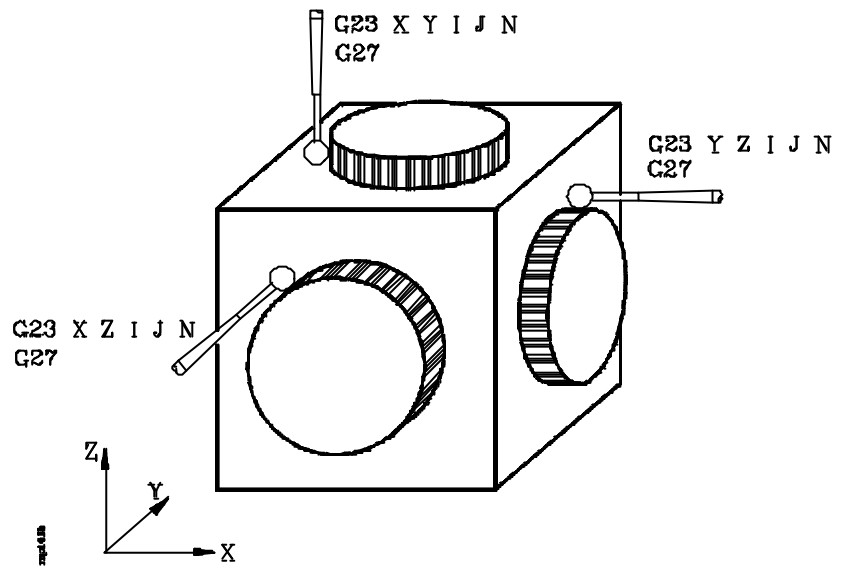
1.5mm

가

1000

1m/min

: 1mm



16.3.4 G23. ACTIVATE THREE-DIMENSIONAL TRACING

3

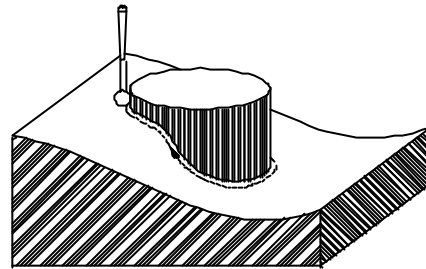
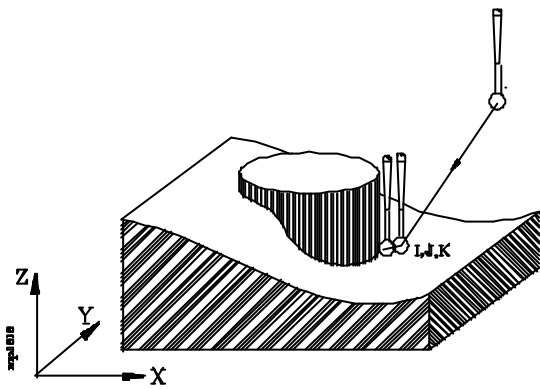
가 가 가 가

MDI JOG AUTOMATIC

G23

CNC

(I, J)

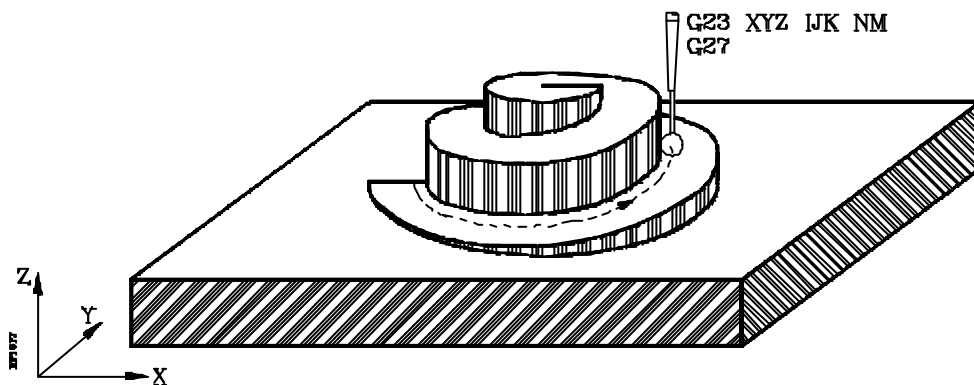


가

가

G27()

JOG



:

G23 X Y Z I±5.5 J±5.5 K±5.5 N5.5 M5.5

X, Y, Z

가

(X, Y, Z)

I±5.5 X

J±5.5 Y

K±5.5 Z

N5.5

M 5.5 ()

N M

가

(mm inch)

0.3mm

1.5mm

가

1000

1m/min

: 1mm

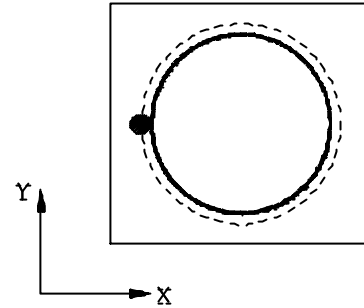
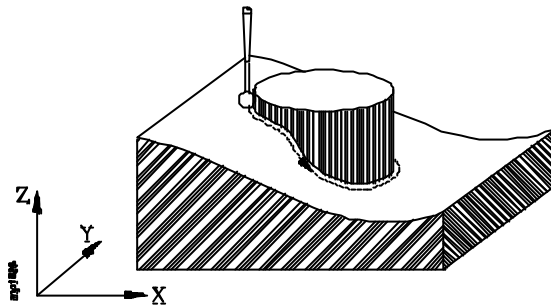
16.4 G27. TRACING CONTOUR DEFINITION

2

3
가 .

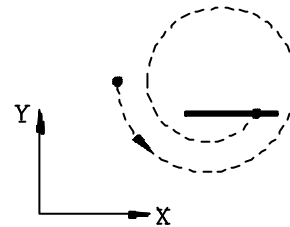
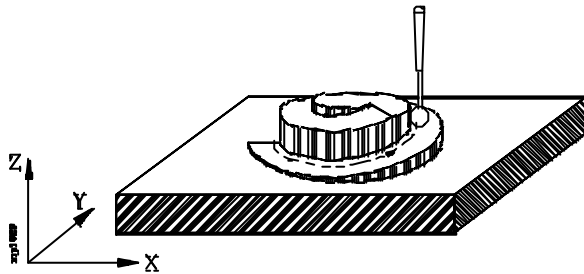
G27

() () .
:



가 ,

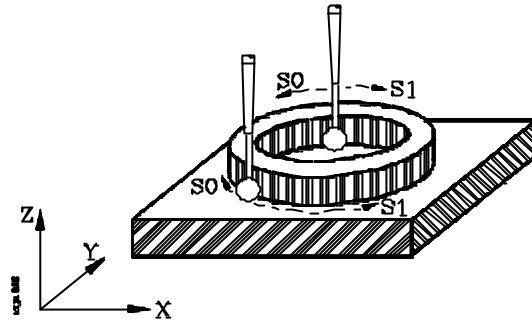
가 .



G27 S Q±5.5 R±5.5 J5.5 K

S

0 =
1 =



, CNC S 0

Q, R±5.5

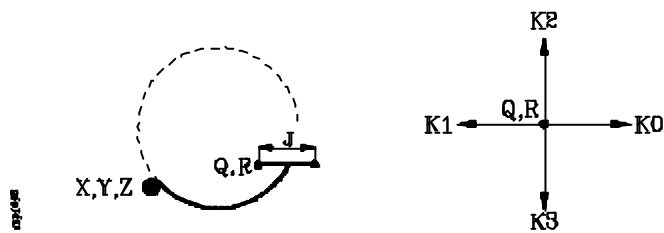
()

. Q 가 R

, G27 S

J 5.5

: Q R



K

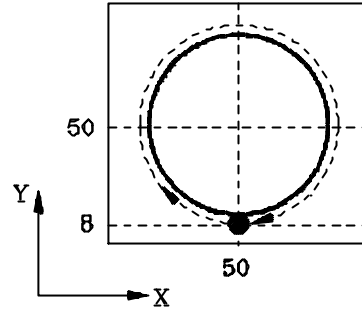
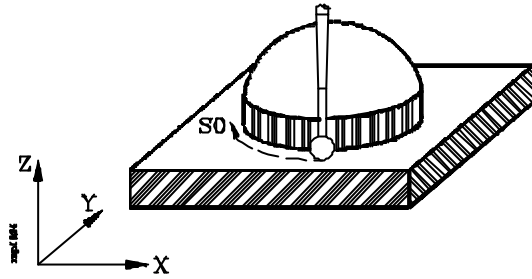
: Q R

0 = (+)
1 = (-)
2 = (+)
3 = (-)

, CNC K 0

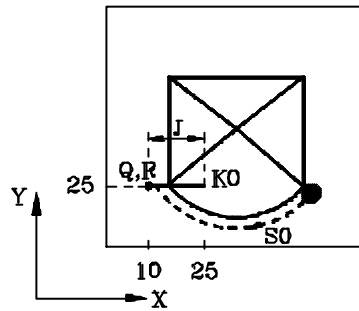
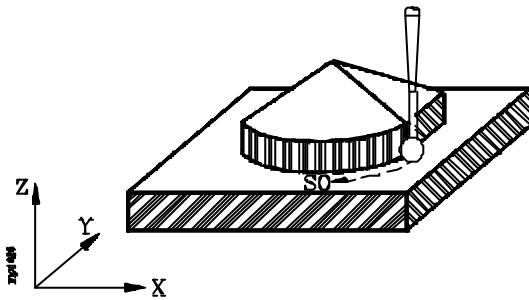
2 _____ :

2 :



```
G23 XY I50 J8 N0.8 ; 2
G24 L8 E5 K1 ;
G27 S0 ;
G25 ;
```

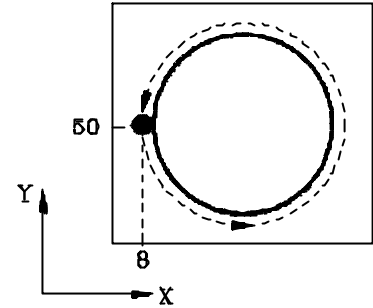
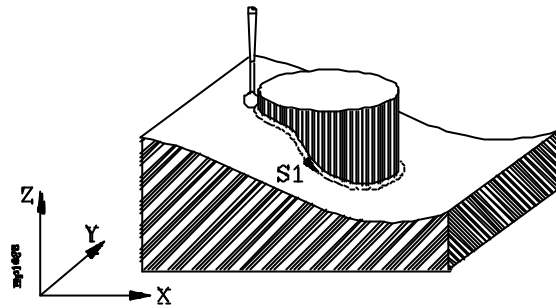
2 :



```
G23 XY I60 J20 N0.8 ; 2
G24 L8 E5 K1 ;
G27 S0 Q10 R25 J15 K0 ;
G25 ;
```

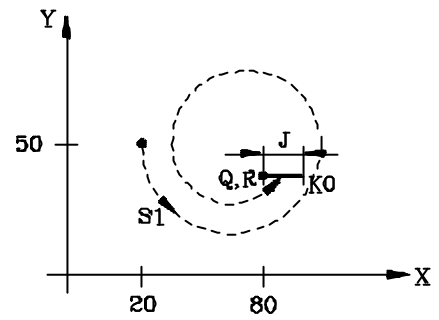
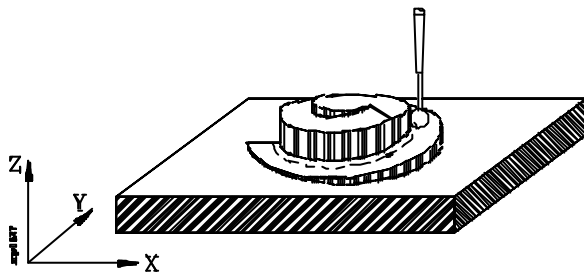
3 _____ :

3 :



```
G23 XYZ I8 J50 K75 N0.8 ;3
G24 L8 E5 K1 ;
G27 S1 ;
G25 ;
```

3 :



```
G23 XYZ I20 J50 K45 N0.8 M0.5 ;3
G24 L8 E5 K1 ;
G27 S1 Q80 R40 J25 K0 ;
G25 ;
```

16.5 G25. DEACTIVATE TRACING

:

- G25
 - (G16, G17, G18, G19)
 - () (G25)
 - (M02, M30)
 - EMERGENCY RESET
- (G23) (G24)

16.6 G24. ACTIVATE DIGITIZING

"OPEN P"

X, Y, Z (, 1 , 2 3)

가 : point-by-point

K : G24 L E

CNC "L" "E" "L"
 , CNC point-by-point

Point-by-Point

가

: G24 K

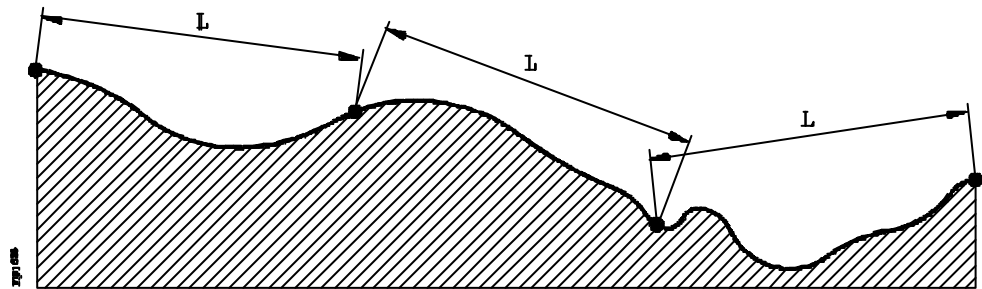
CNC 가 "READ POINT BY POINT" PLC가 CNC
 "POINT" up-flank 가

G24 L5.5 E5.5 K

L 5.5

가

가



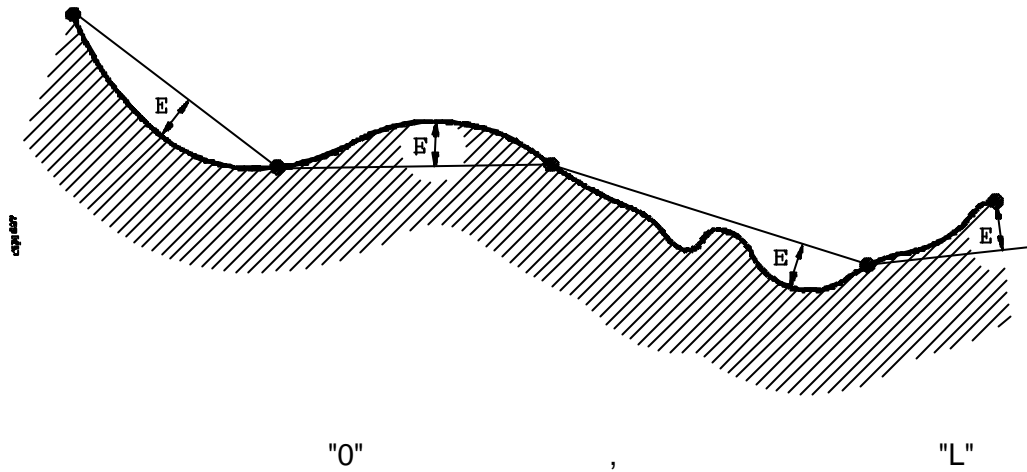
CNC

"L"

, CNC point-by-point

E 5.5

(mm inch)



K "OPEN P"

K=0 Absolute format.

X, Y, Z (G90)

K=1 Absolute filtered format.

(G90) 가

K=2 Incremental filtered format.

(G91) 가

, canned cycle K 0

:

* G24

* (G24) , "OPEN P"

, "OPEN P" CNC , PC
 DNC , 가 ,
 * , CNC X, Y, Z ,
 * 가
 * CNC
 * , G25
 (G23)
 - (G16, G17, G18, G19)
 - () (G25)
 - (M02, M30)
 - EMERGENCY RESET

Programming example:

G17	Selects the Z axis as longitudinal (perpendicular)
G90 G01 X65 Y0 F1000	Positioning
(OPEN P12345)	Program receiving (storing) digitized data
(WRITE G01 G05 F1000)	
G23 Z I-10 N1	Tracing ON
G24 L8 E5 K1	Digitizing ON
G1 X100 Y35	Define tracing path
"	"
"	"
G25	Cancel tracing and digitizing
M30	

16.7 TRACING AND DIGITIZING CANNED CYCLES

CNC / canned cycle
:

TRACE 1 /
TRACE 2 /
TRACE 3 /
TRACE 4 3-D / ()
TRACE 5 가 /

high level TRACE (1, 2, 3, 4, 5)
가
"0"

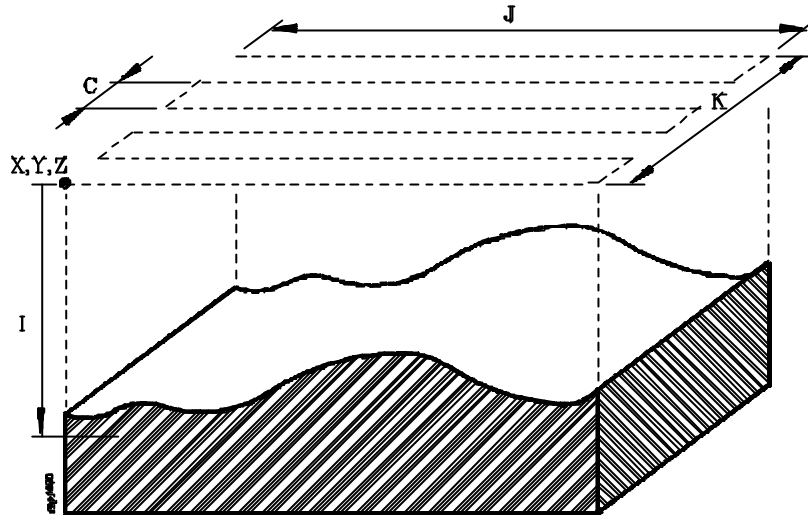
:

- * canned cycle "OPEN P"
- * 가 CNC - DNC
, "OPEN P"
- * (G01 X Y Z)
"WRITE" 가
- * end-of-program (M02 M30) "WRITE"

canned cycle "G"

16.7.1 GRID-PATTERN TRACING CANNED CYCLE

(TRACE 1, X, Y, Z, I, J, K, A, C, Q, D, N, L, E, G, H, F)



X±5.5

Y±5.5

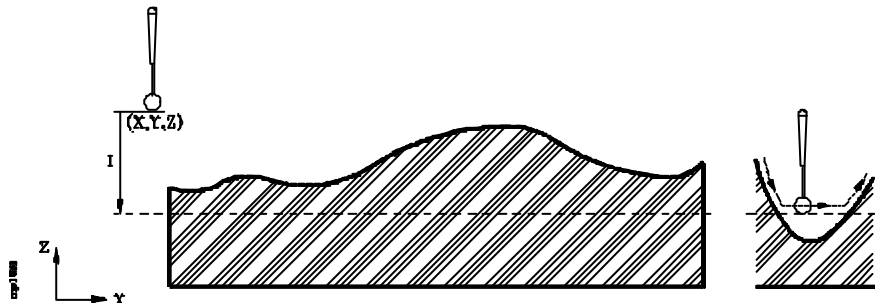
Z±5.5

가 (/)

가

I±5.5

Z



가

"0"

가

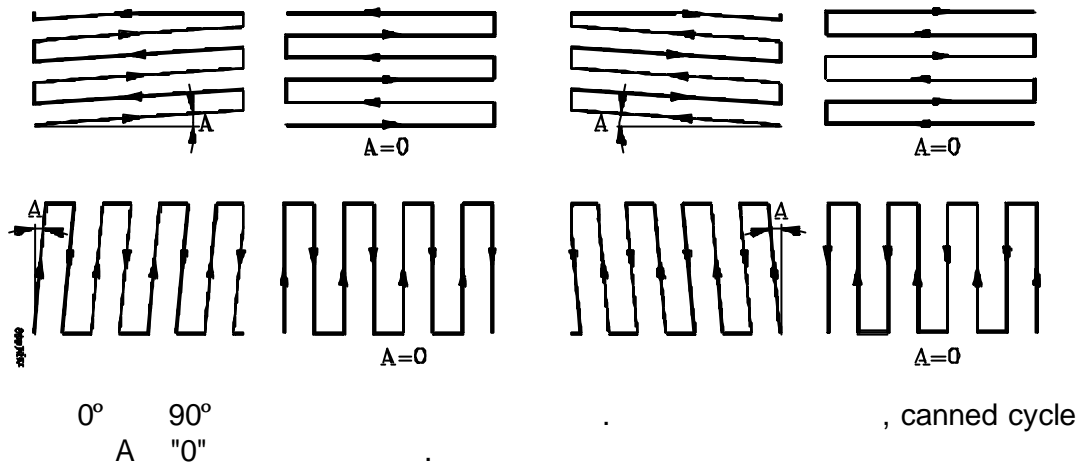
J±5.5

(-) (+) 가 (X, Y)

K±5.5

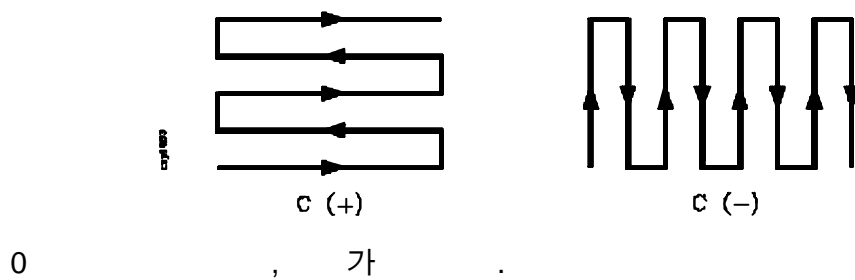
(-) (+) 가 (X, Y)

A 5.5

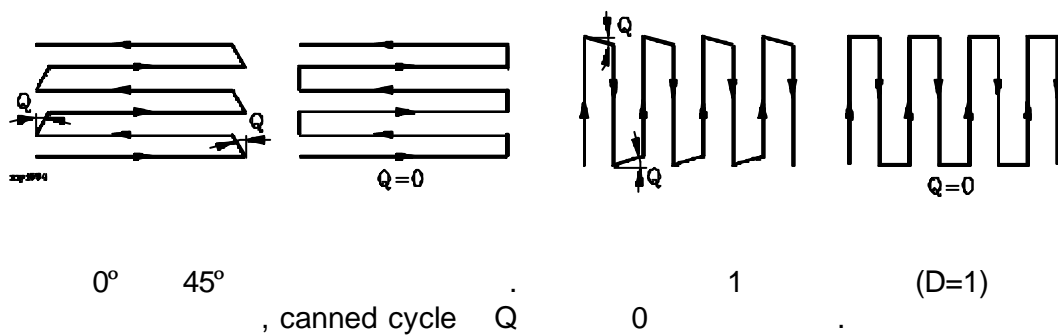


C±5.5

(+) , (-)

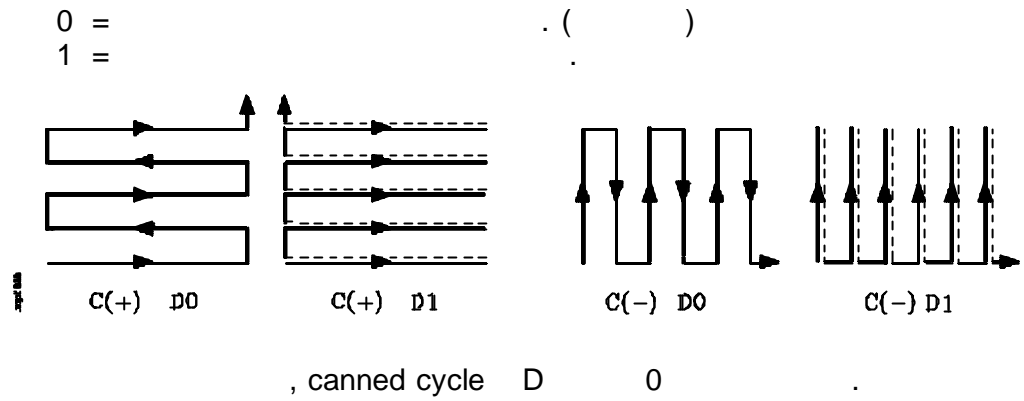


Q 5.5



D

가



N 5.5

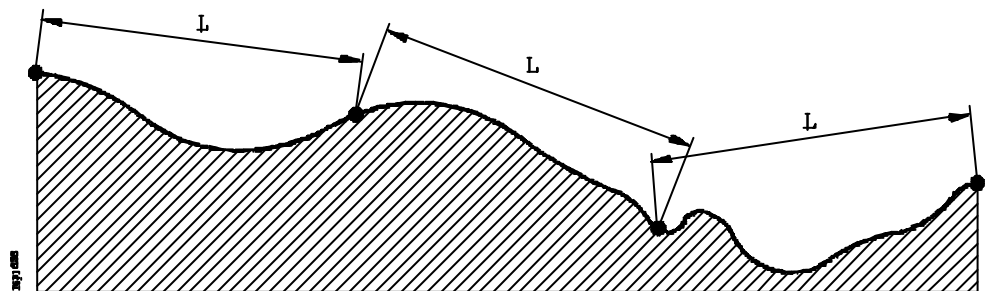
가

1.5mm (mm inch) 0.3mm

가
1000 1m/min : 1mm

, canned cycle 1mm(0.03937")

L 5.5



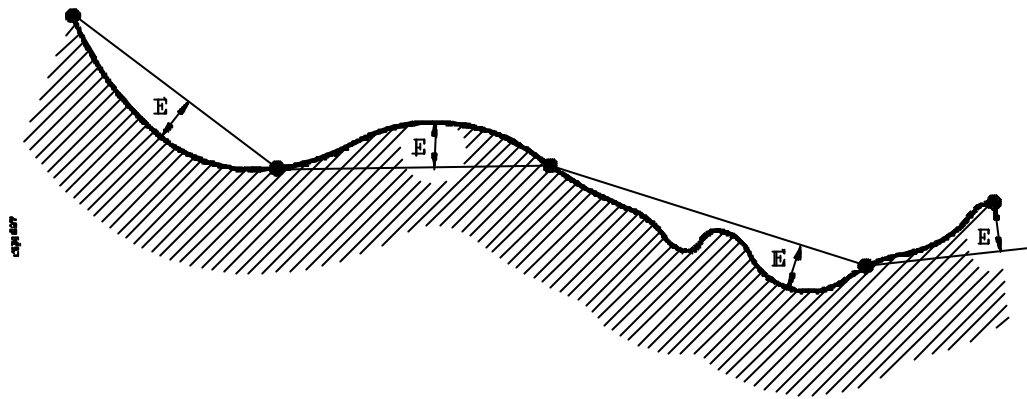
CNC

"L"

"O" , canned cycle

E 5.5

(mm inch)



"O"

"L"

G

"OPEN P"

G=0 Absolute format.

X, Y, Z

(G90)

G=1 Absolute filtered format.

(G90)

가

G=2 Incremental filtered format.

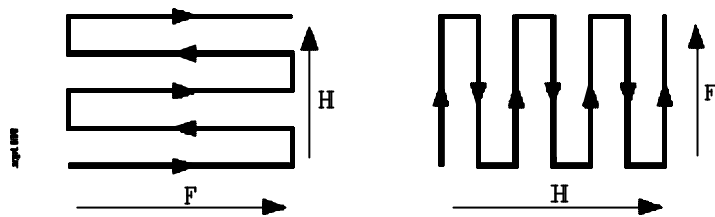
(G91)

가

, canned cycle G 0

H5.5

. mm/min inch/min



, canned cycle "F" ()

F5.5

. mm/min inch/min

_____ :

1.- X, Y, Z 가

2.-

3.-

, "OPEN P"

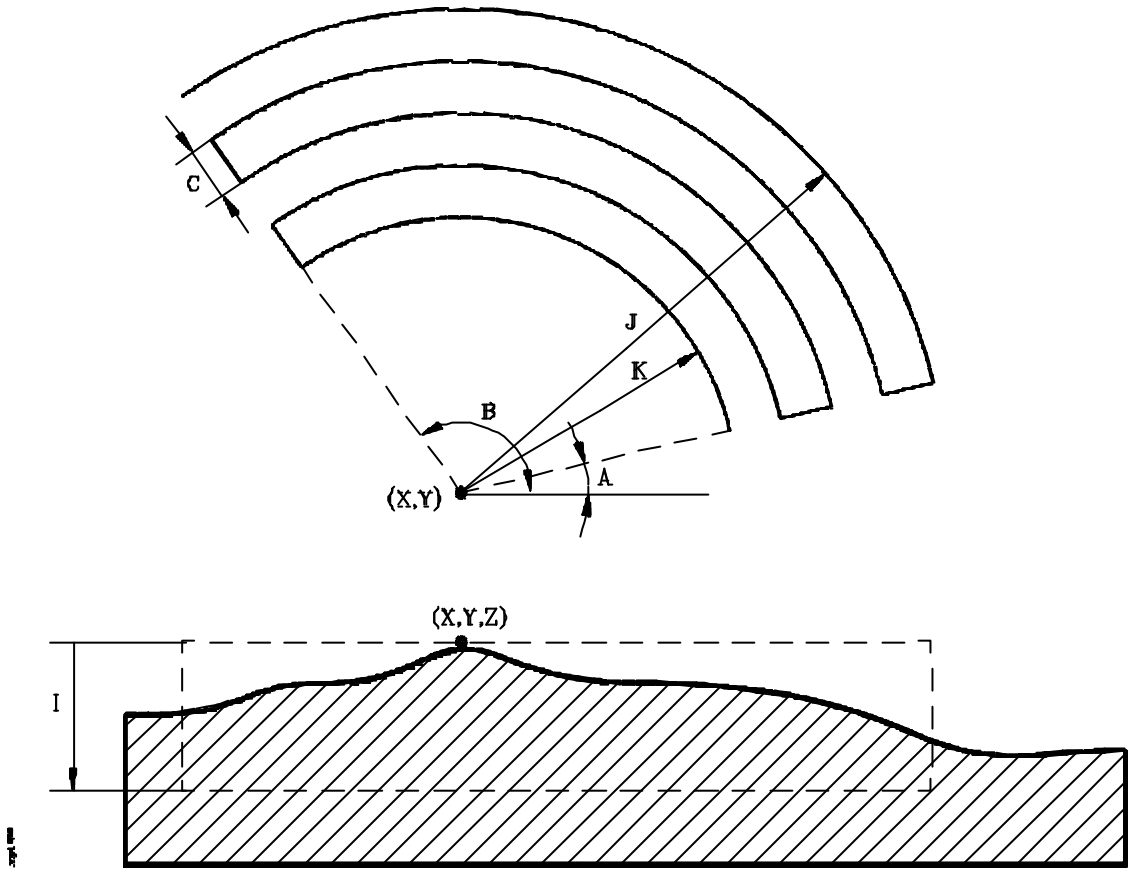
4.- canned cycle 가

:

*
*

16.7.2 ARC PATTERN TRACING CANNED CYCLE

(TRACE 2, X, Y, Z, I, J, K, A, B, C, D, R, N, L, E, G, H, F)



X±5.5

Y±5.5

Z±5.5

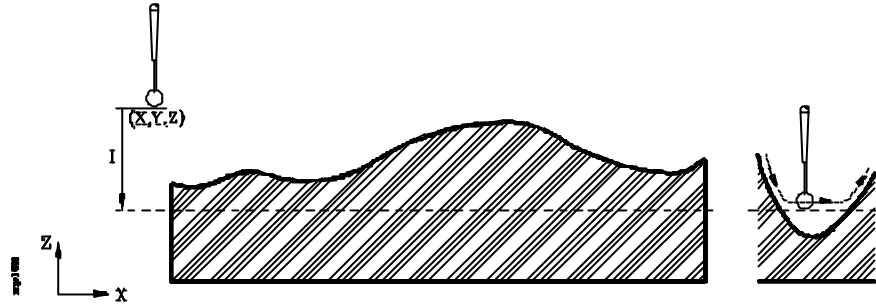
가 (/)

가

I±5.5

Z

가

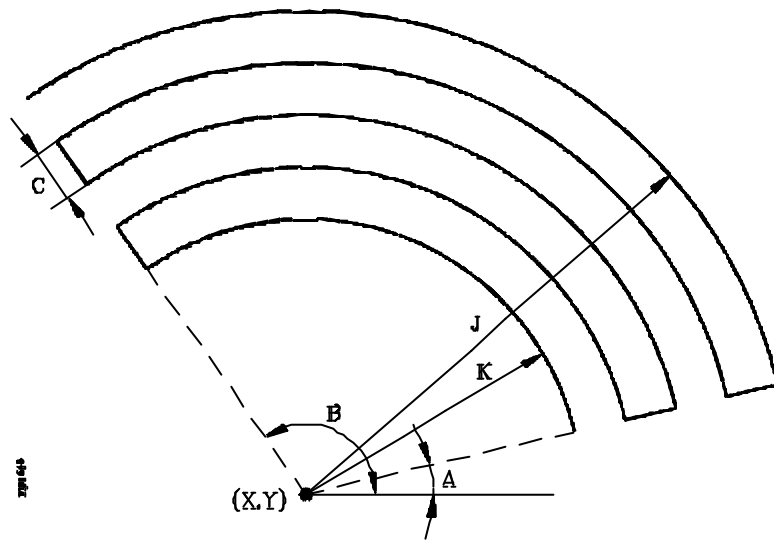


"0" 가

J 5.5 가 "0" (+)

K 5.5 가 (+)

canned cycle K 0



A 5.5

, canned cycle A "0"

B 5.5

, canned cycle "B360"

, A B
canned cycle A0 B360

C 5.5

(R1) "0" (+) (R0) inch mm

D

가

0 =
1 =

()

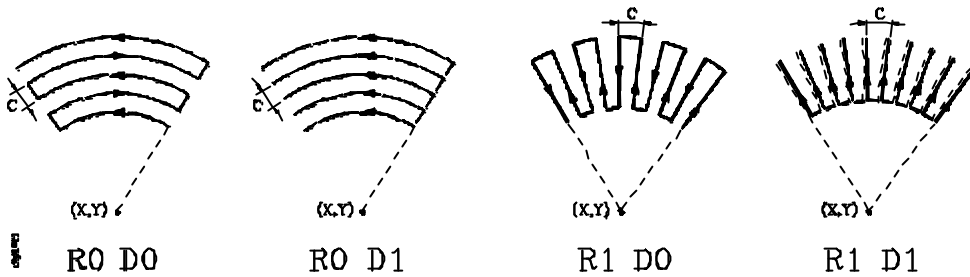
, canned cycle D 0

R

가 :

0 =
1 =

, canned cycle "0"



R0 () :

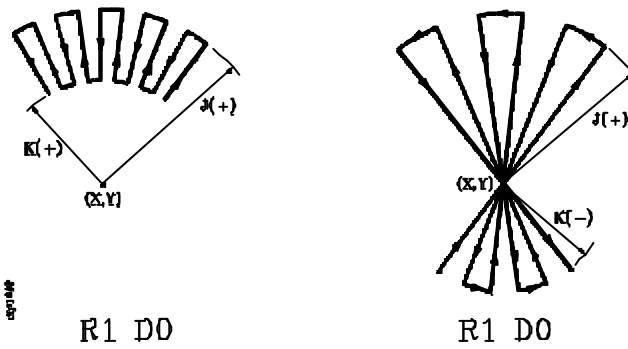
* A B ,

* C 가 .mm inch

R1 () :

* C 가 .

* 가 , K (+) (-)



* R1 D1 , 가 (K) 가 (J)

N 5.5

가

1.5mm

(mm inch)

0.3mm

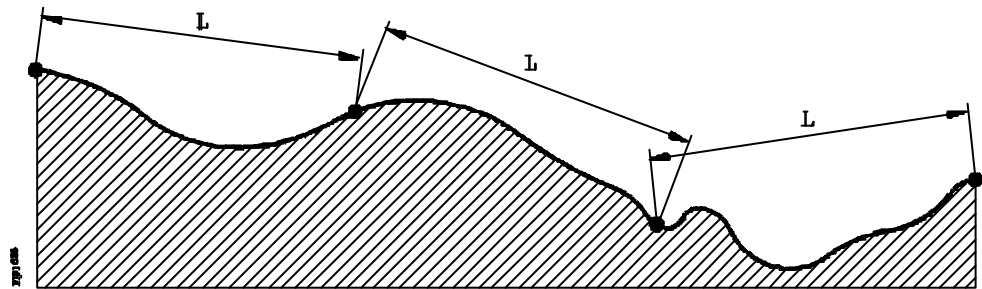
가
1000

1m/min

: 1mm

, canned cycle 1mm(0.03937")

L 5.5



CNC

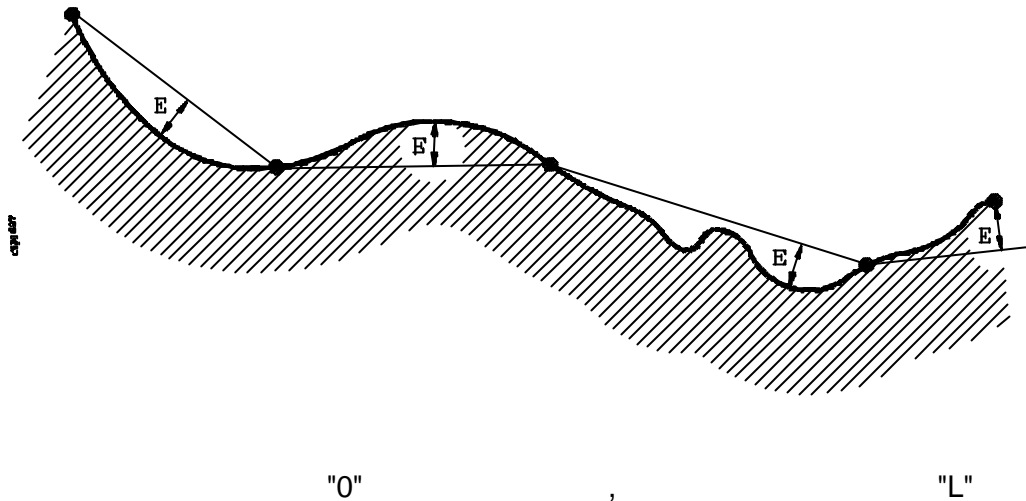
"L"

"0"

, canned cycle

E 5.5

(mm inch)



G

"OPEN P"

G=0 Absolute format.

X, Y, Z (G90)

G=1 Absolute filtered format..

(G90)

가

G=2 Incremental filtered format..

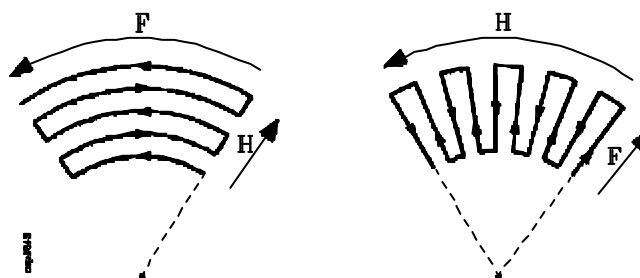
(G91)

가

, canned cycle G 0

H5.5

. mm/min inch/min



, canned cycle "F" ()

F5.5 . mm/min inch/min .

_____ :

- 1.- X, Y, Z 가 .
- 2.- .
- 3.- .

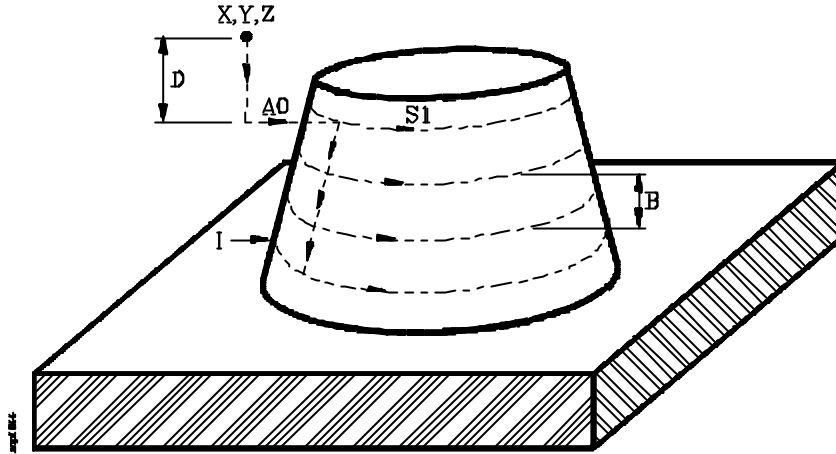
, "OPEN P"

- 4.- canned cycle 가 , .
:

*
*

16.7.3 PROFILE TRACING CANNED CYCLE ALONG A PLANE

(TRACE 3, X, Y, Z, I, D, B, A, C, S, Q, R, J, K, N, L, E, G, H, F)



X±5.5

Y±5.5

Z±5.5

가 (/)

가

I±5.5

가 (/)

D 5.5

() "Z" 가

CNC "I"

B 5.5

"D"

"0" , 가

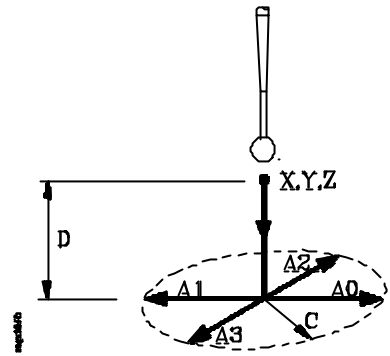
A

가

X Y Z

- 0 = (+)
- 1 = (-)
- 2 = (+)
- 3 = (-)

, canned cycle A "0"



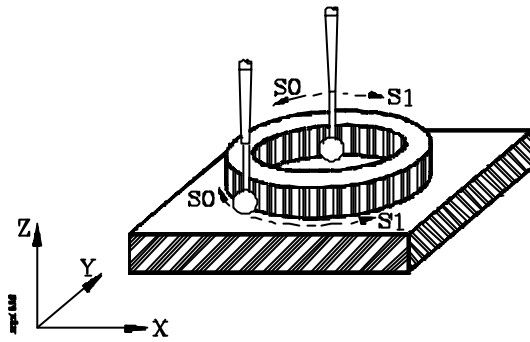
C

A

가

S

- 0 = 가
- 1 = 가



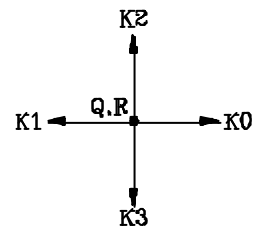
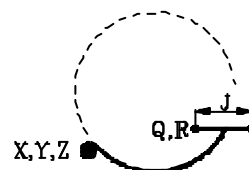
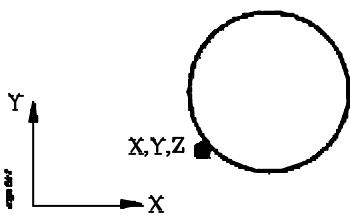
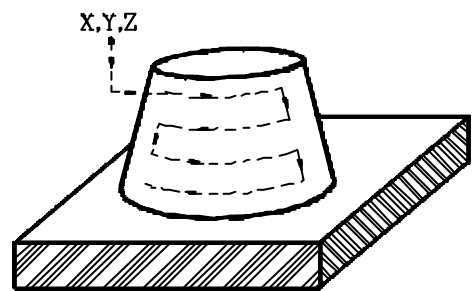
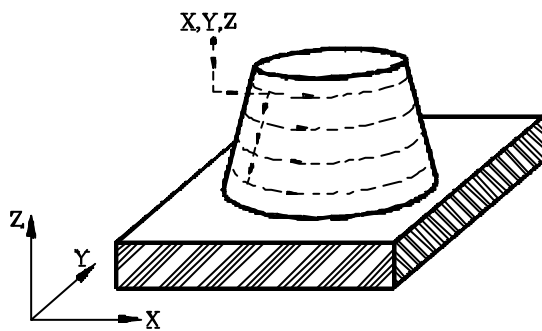
, CNC "S0"

Q, R±5.5

가

"R"

"Q"

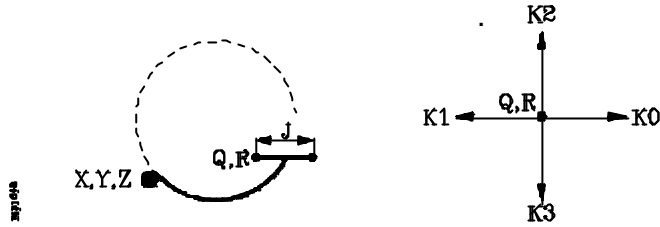


, CNC

()

J 5.5

"R" 가 , "Q"



, CNC

K

"R" 가 , "Q"

- 0 = (+)
- 1 = (-)
- 2 = (+)
- 3 = (-)

, CNC K0

N 5.5

가
 (mm inch) 0.3mm
 1.5mm

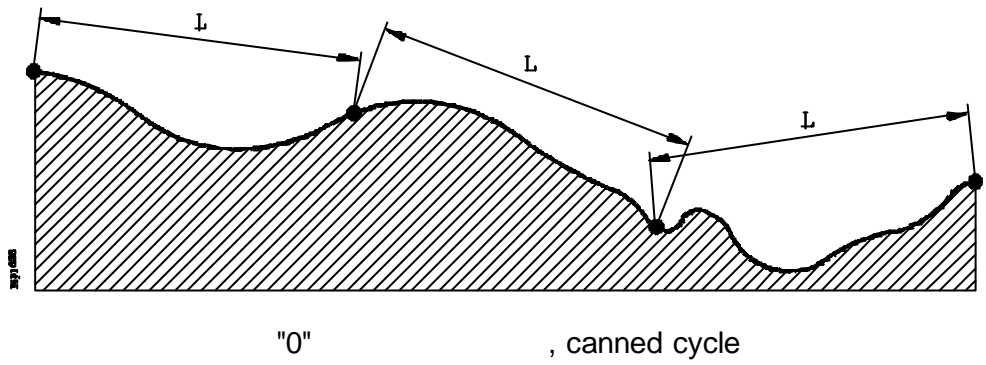
가
 1000 : 1mm
 1m/min

, canned cycle 1mm(0.03937")

L 5.5

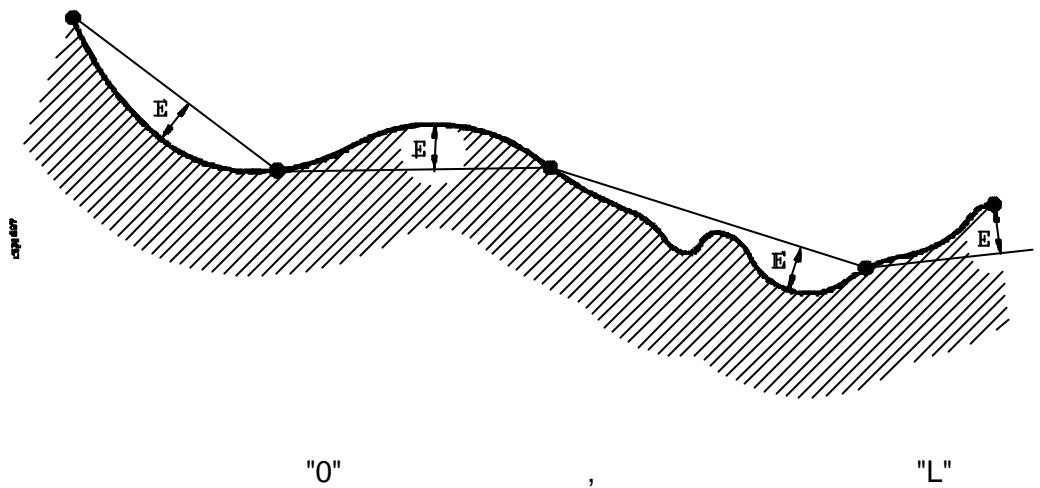
CNC

"L"



E 5.5

(mm inch)



G

"OPEN P"

G=0 Absolute format.

X, Y, Z (G90)

G=1 Absolute filtered format..

(G90)

가

G=2 Incremental filtered format..

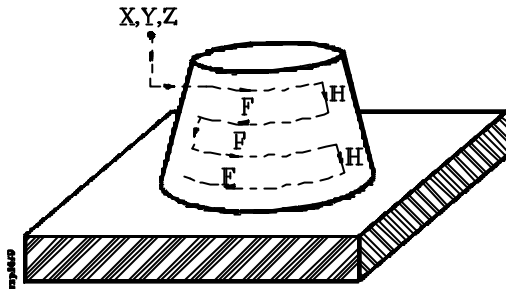
(G91)

가

, canned cycle G 0

H5.5

. mm/min inch/min



, canned cycle F ()

F5.5

. mm/min inch/min

_____ :

- 1.- X, Y, Z 가
- 2.-
- 3.-

, "OPEN P"

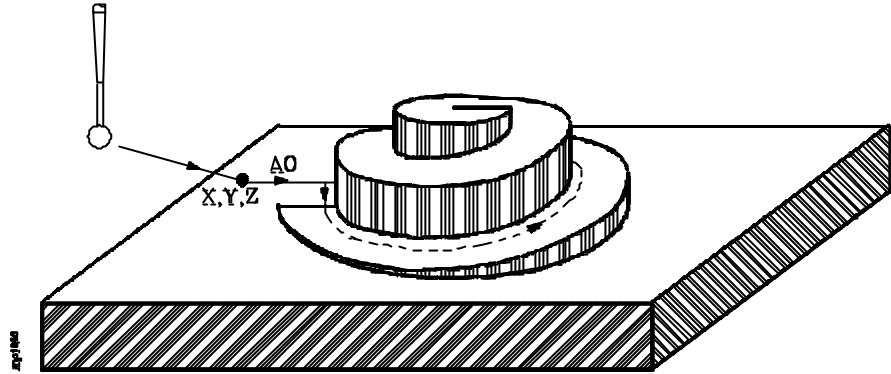
- 4.- canned cycle 가

*
*

16.7.4 3-D PROFILE TRACING CANNED CYCLE

:

(TRACE 4, X, Y, Z, I, A, C, S, Q, R, J, K, M, N, L, E, G, F)



$X \pm 5.5$

$Y \pm 5.5$

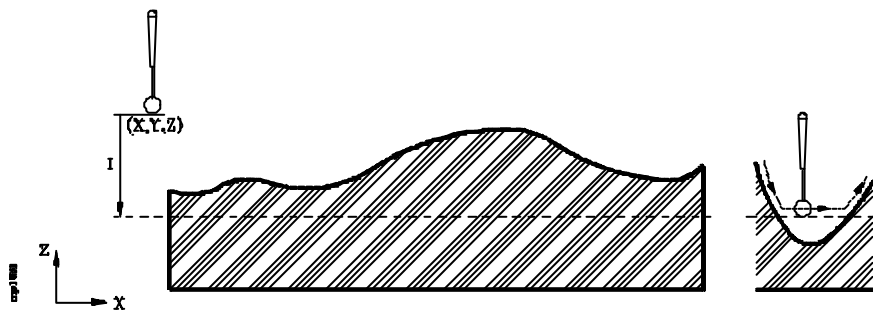
$Z \pm 5.5$

가 (/)

가

$I \pm 5.5$

Z



가

"0"

가

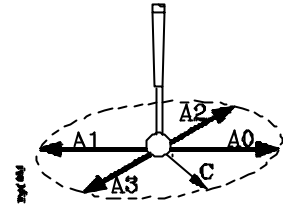
A

가

X Y Z

- 0 = (+)
- 1 = (-)
- 2 = (+)
- 3 = (-)

, canned cycle A "0"



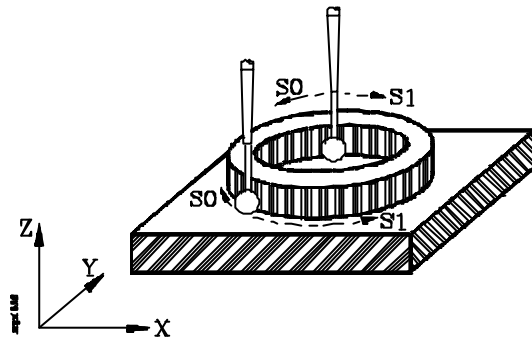
C

A

가

S

- 0 = 가
- 1 = 가



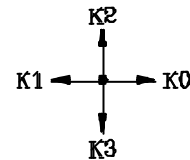
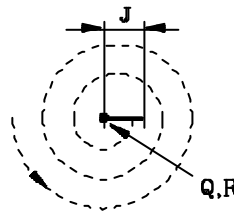
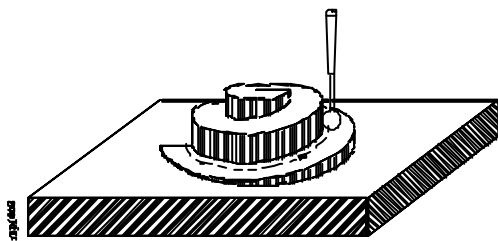
, CNC "S0"

Q, R±5.5

가

"R"

"Q"



J 5.5

가

"R"

, "Q"

, CNC

K

가

"R"

, "Q"

- 0 = (+)
- 1 = (-)
- 2 = (+)
- 3 = (-)

, CNC K = 0

M5.5 (/)

, canned cycle 1mm(0.03937")

N 5.5

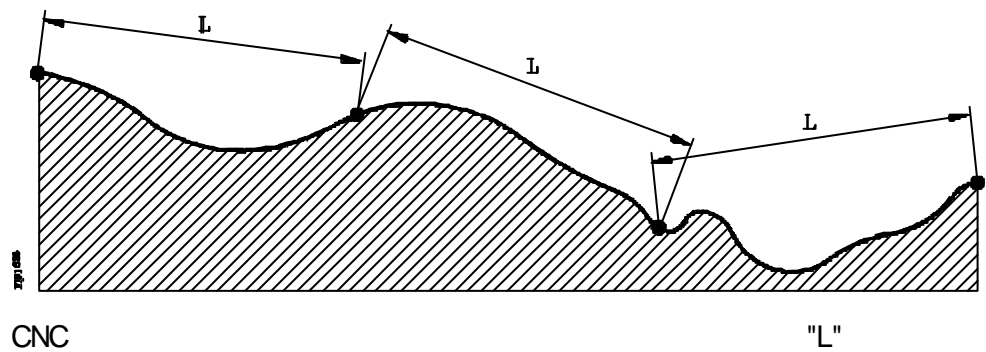
"M" "N" 가

(mm inch) 0.3mm
1.5mm

가
1000 : 1mm
1m/min

, canned cycle 1mm(0.03937")

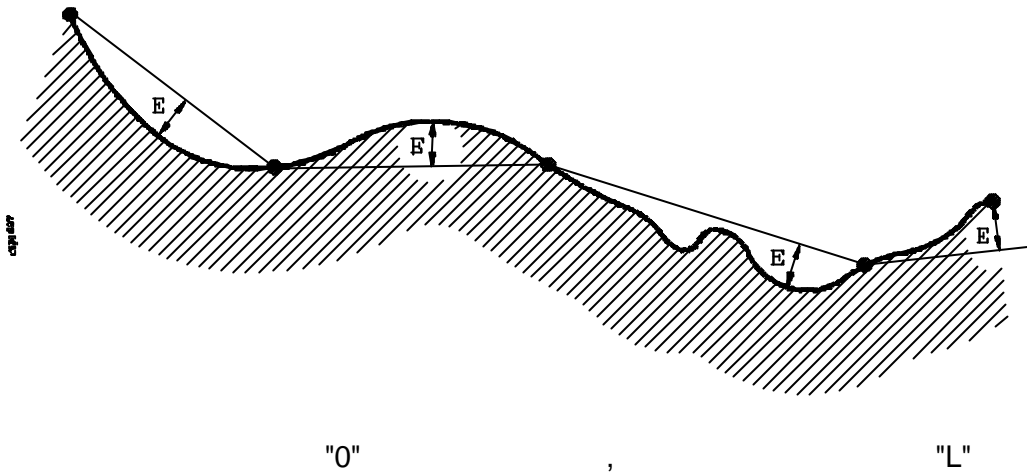
L 5.5



"0" , canned cycle

E 5.5

(mm inch)



G

"OPEN P"

G=0 Absolute format.

X, Y, Z (G90)

G=1 Absolute filtered format..

(G90)

가

G=2 Incremental filtered format..

(G91)

가

, canned cycle G 0

F5.5

. mm/min inch/min

_____ :

1.- X, Y, Z 가 .

2.- .

3.-

.

, "OPEN P"

4.- canned cycle 가 , .

:

*

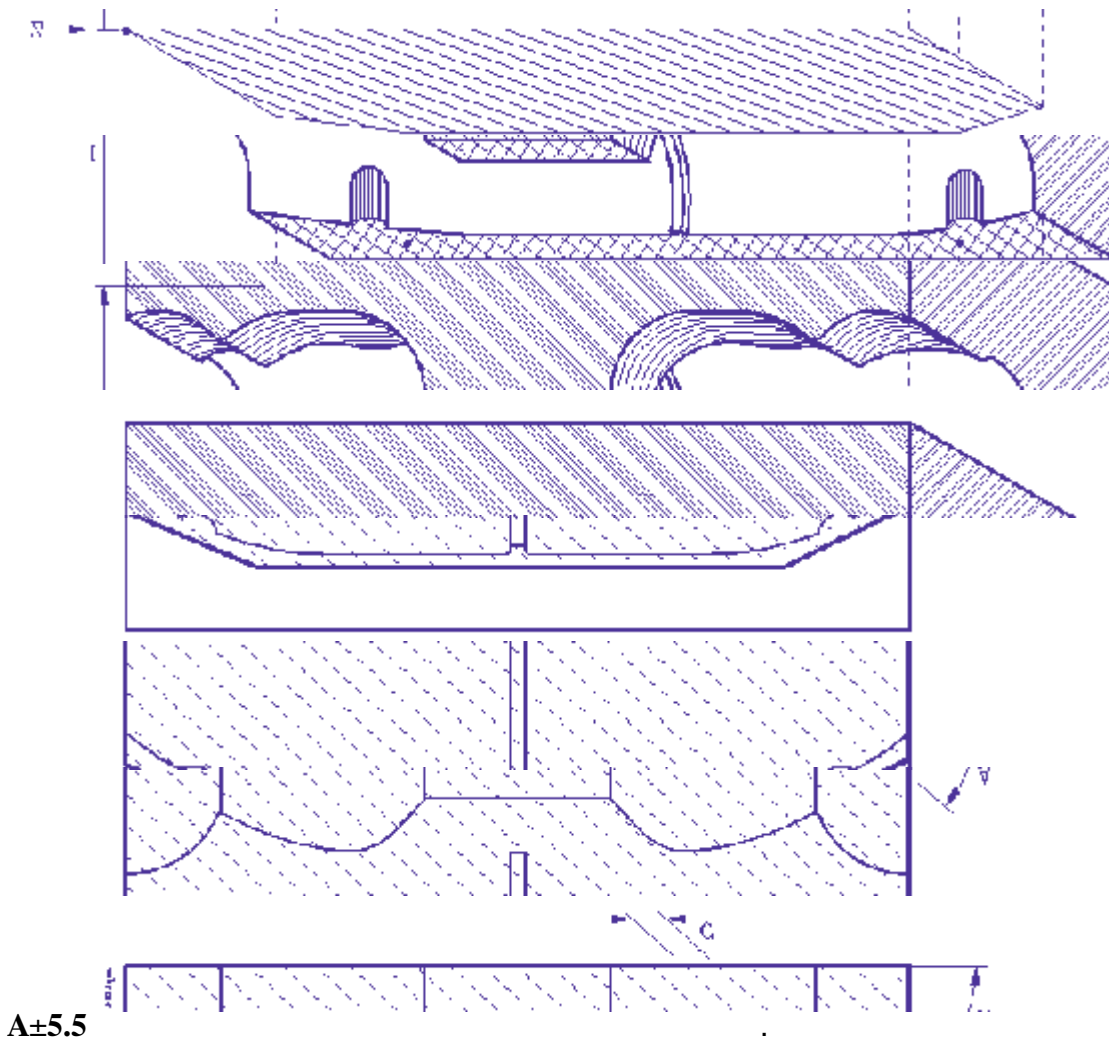
*

16.7.5 TRACING CANNED CYCLE WITH POLYGONAL SWEEP

()

island

(TRACE 5, A, Z, I, C, D, N, L, E, G, H, F, P, U)



A±5.5

, CNC "A0"

Z±5.5

가

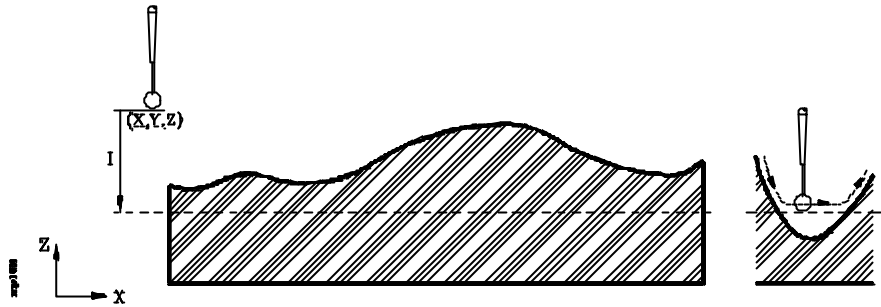
(/)

가

I±5.5

Z

가



"0" , 가

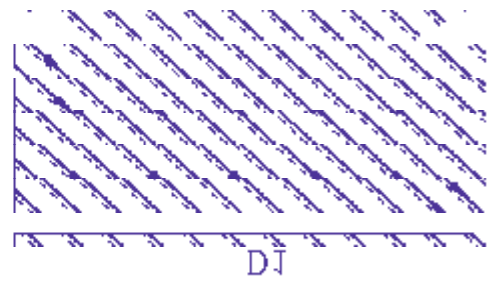
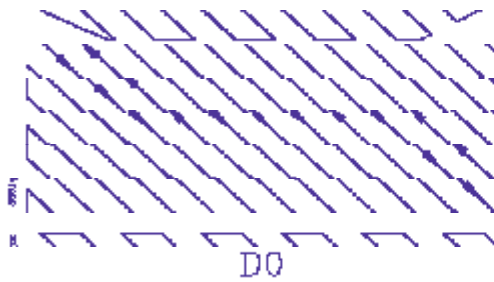
C

"0" , 가

D

가

0 = ()
1 =



, canned cycle D 0

N 5.5

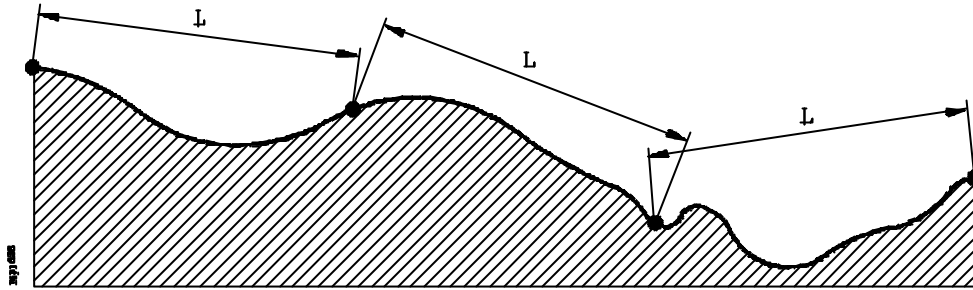
가

1.5mm (mm inch) 0.3mm

가
1000 : 1mm
1m/min

, canned cycle 1mm(0.03937")

L 5.5



CNC

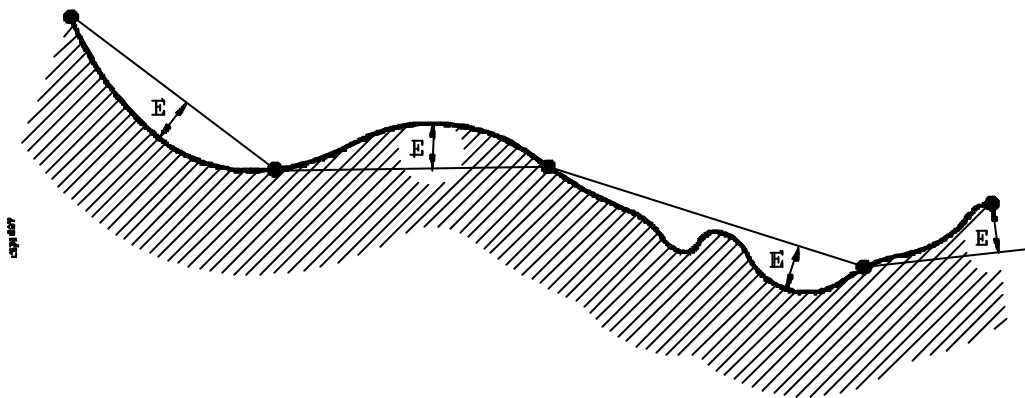
"L"

"0"

, canned cycle

E 5.5

(mm inch)



"0"

"L"

G

"OPEN P"

G=0 Absolute format.

X, Y, Z (G90)

G=1 Absolute filtered format..

(G90)

가

G=2 Incremental filtered format..

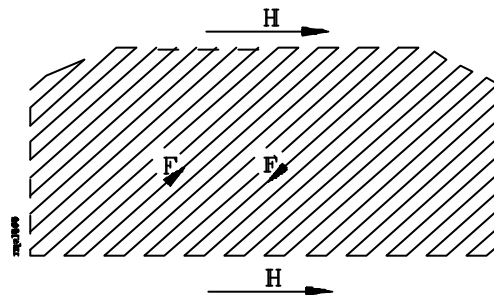
(G91)

가

, canned cycle G 0

H5.5

. mm/min inch/min



, canned cycle F ()

F5.5

. mm/min inch/min

P (0-9999)

U (0-9999)

(island)

_____ :

1.- X, Y, Z 가 .

2.- .

3.- .

, "OPEN P"

4.- canned cycle 가 , .
:

*

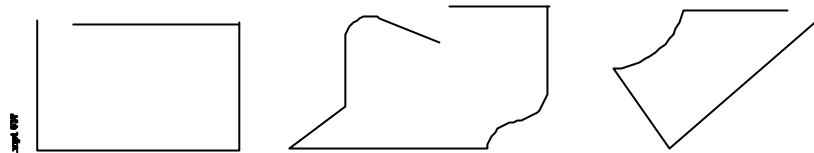
*

16.7.5.1 PROFILE PROGRAMMING RULES

island

1.-

가



2.-

가



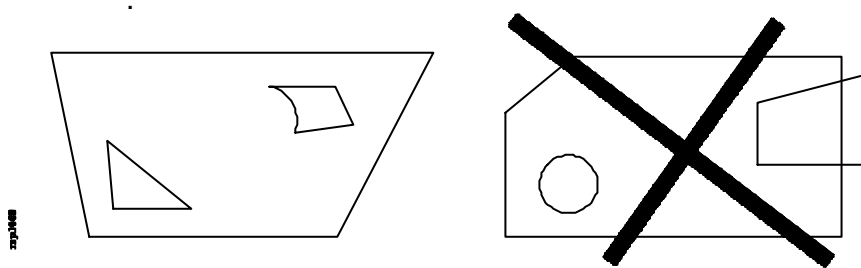
3.-

CNC

island

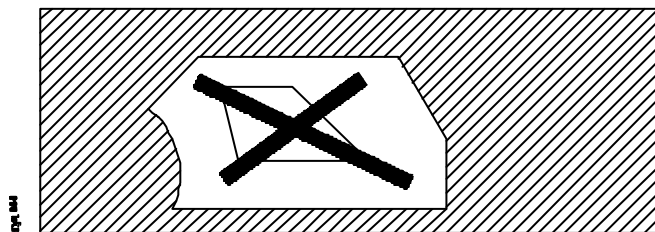
4.-

()



5.-

가



CNC

canned cycle

16.7.5.2 PROFILE PROGRAMMING SYNTAX

island . ()

:

1.- 가 canned cycle
"P"

2.- ()
가 CNC
가 G00

3.- G00 ()

Warning:	
	G00 G03 CNC G01, G02

4.- cycle , "U" . canned

5.-
G01
G02
G03
G06
G08
G09
G36 ()
G39
G53 ()
G70 inch
G71
G90
G91
G93

6.- , , , 가 .

7.- high level

8.- canned cycle .

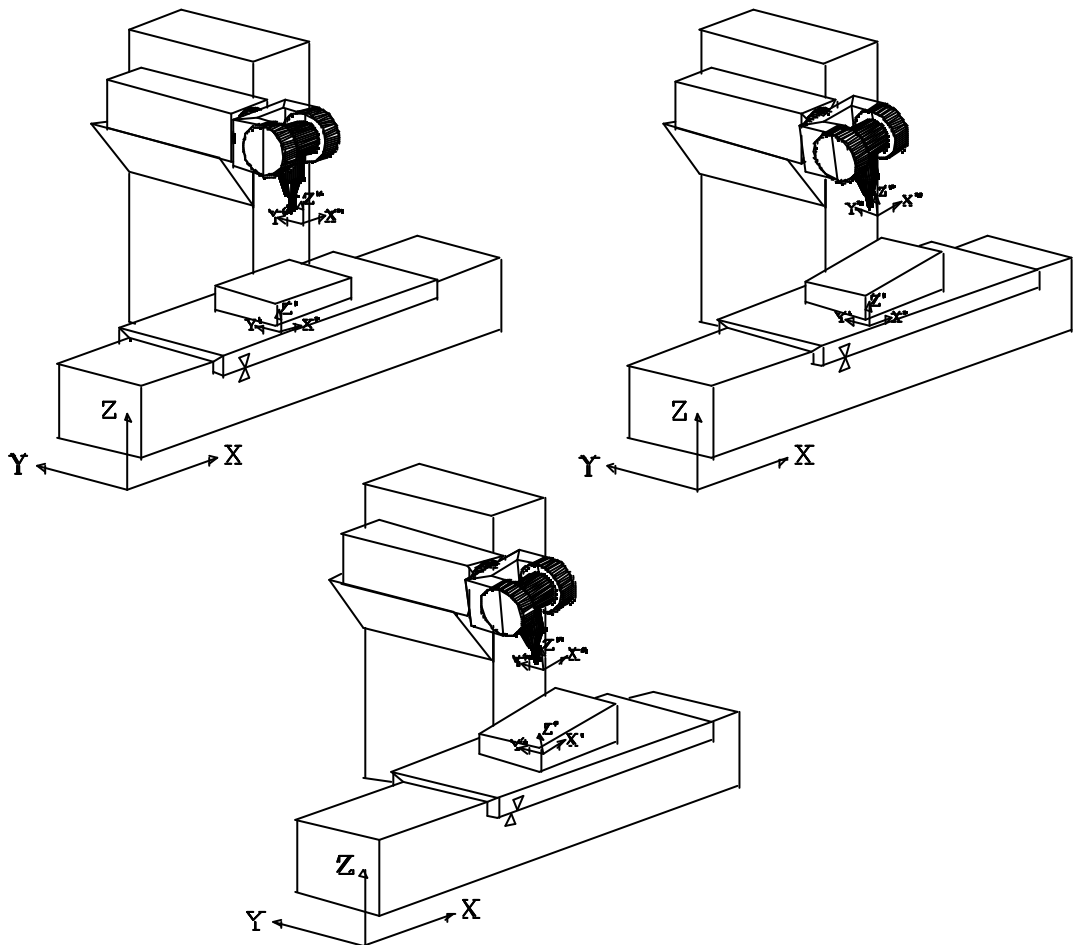
:

(TRACE 5, A, Z, I, C, D, N, L, E, G, H, F, **P400, U500**)

N400 X-260 Y-190 Z4.5 ;
G1.....
.....
G0 X230 Y170 ;
G1.....
.....
G0 X-120 Y90 ;
G2.....
.....
N500 X-120 Y90 ;

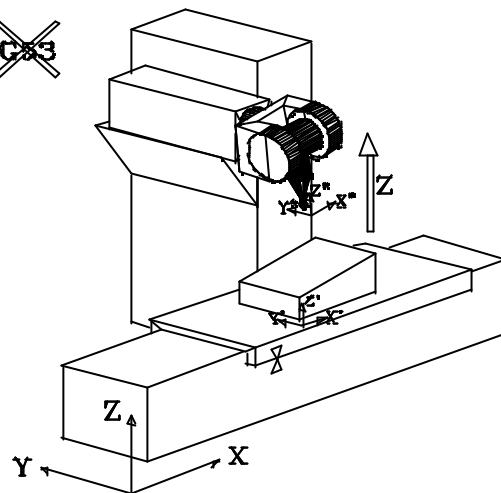
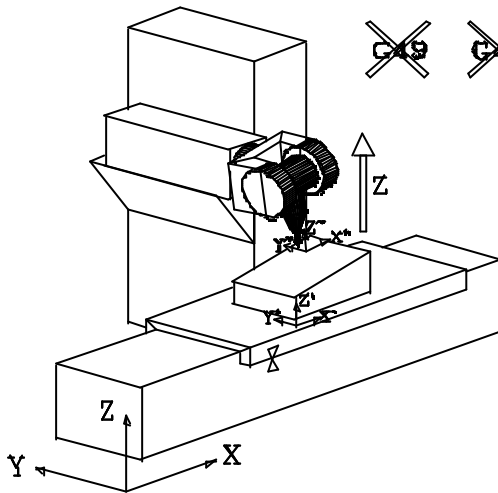
17. COORDINATE TRANSFORMATION

- 가 :
- (G49)
- TCP , (G48)
- (G47)
- X Y Z
- X' Y' Z'
- X'' Y'' Z''
- ,
- , (X'' Y'' Z'')
- , (G49) , (X' Y' Z')



Case a)

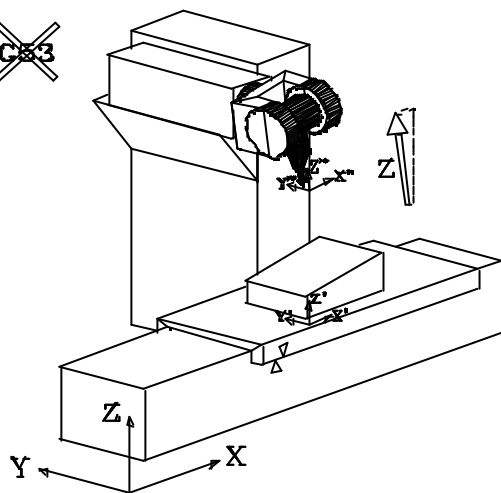
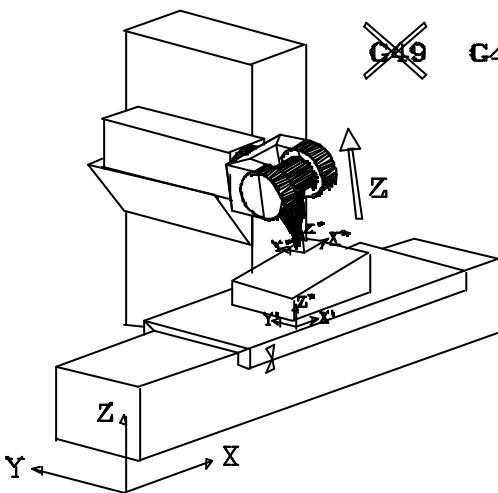
Z (G01 Z)



G47

, Z (G01 G47 Z)

Z



G47

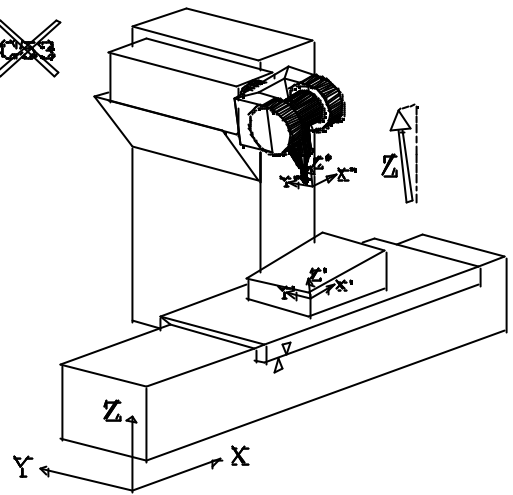
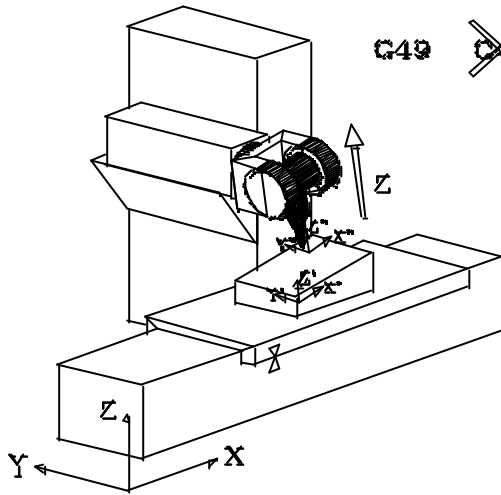
JOG (M5021) PLC

, CNC , X, Y

, CNC "TOOLMOVE

Case b) _____ (G49)

Z (G01 Z) ,



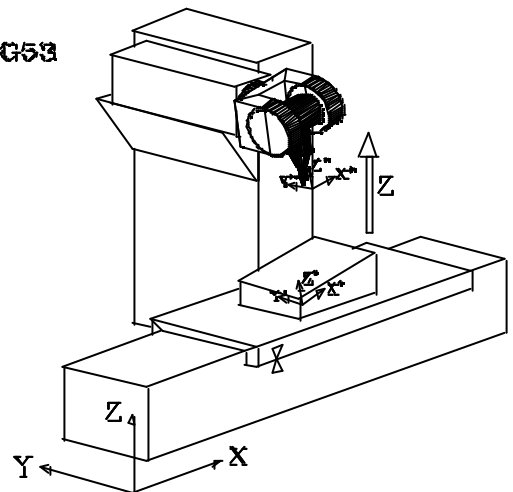
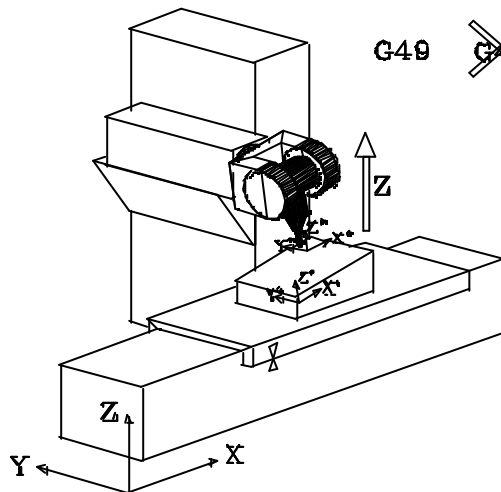
CNC

Y

G53()

Z

Z



G53

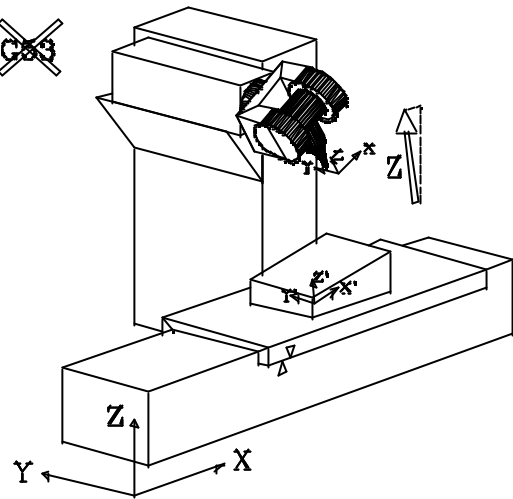
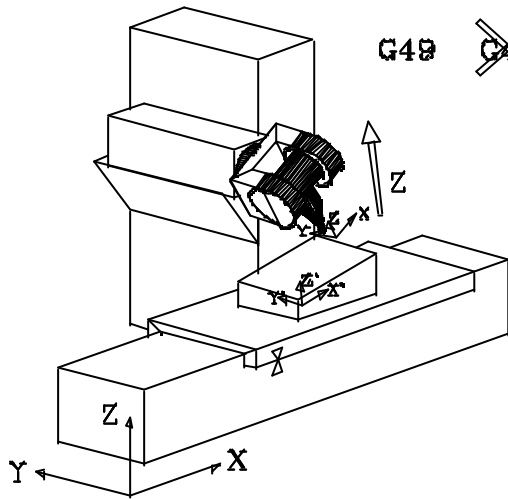
JOG (M5021)" PLC

, CNC

"TOOLMOVE

Case c) _____ (G49) _____

Z (G01 Z) _____

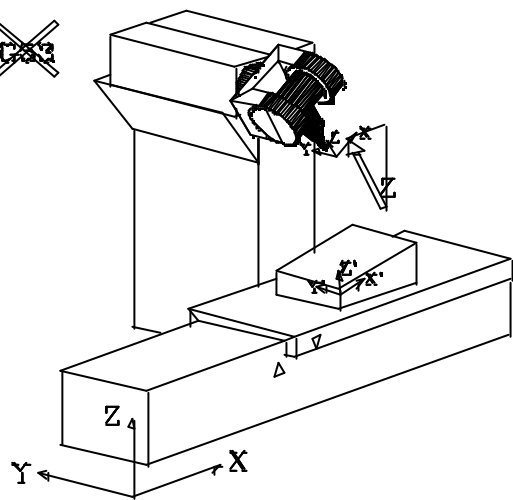
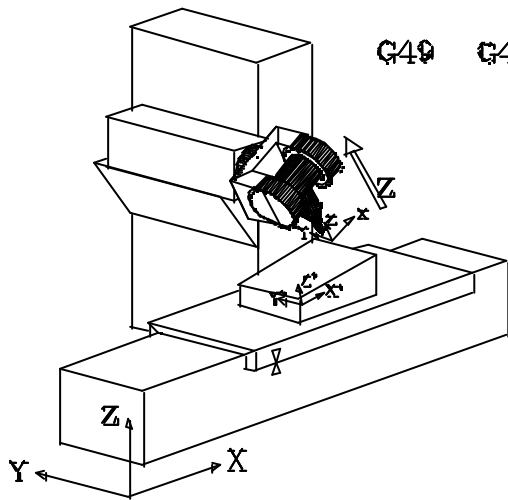


, CNC

X, Z

Z (G01 G47 Z)

G47



, CNC

, X,

Z

G47

JOG (M5021) PLC

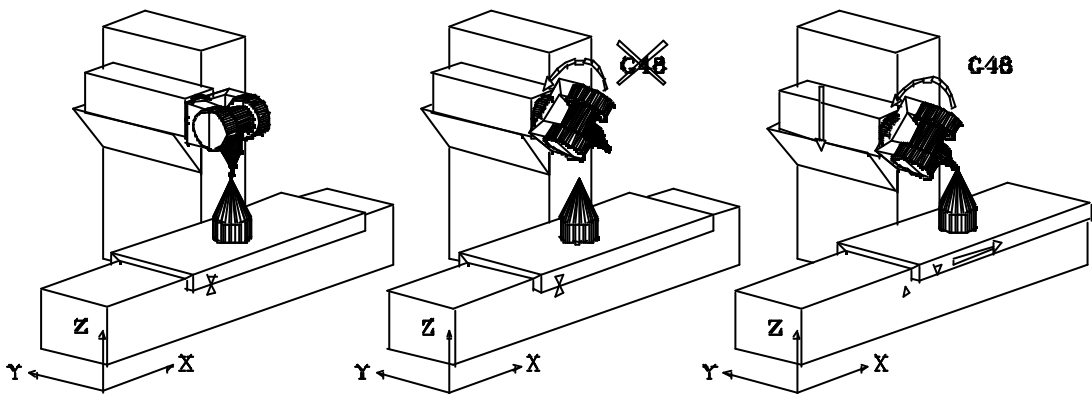
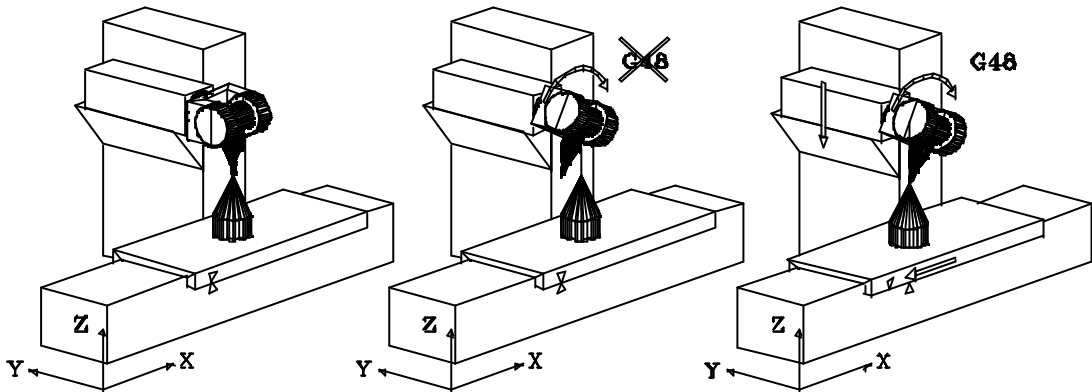
, CNC

"TOOLMOVE

Case d) TCP _____

G48 TCP , CNC
 . ()

, CNC



, G48

TCP

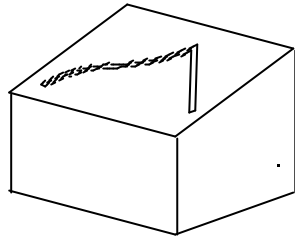
TCP G48 G49 () G47 ()

17.1 MOVEMENT IN THE INCLINE PLANE

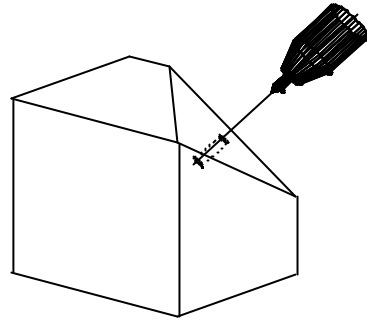
X, Y, Z

CNC

XY



가



:

1.- 가 G49

. G49

2.- CNC TOOROF, TOOROS

p297, p298

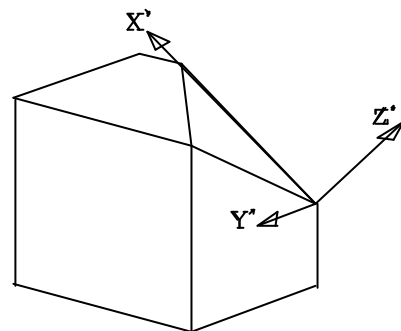
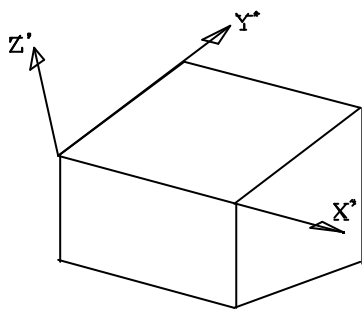
()

3.-

, XY

Z

XY



17.1.1 INCLINE PLANE DEFINITION (G49)

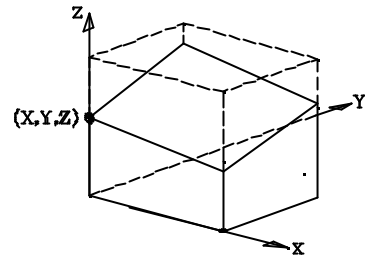
G49

G49 가 :

G49 X Y Z A B C X Z

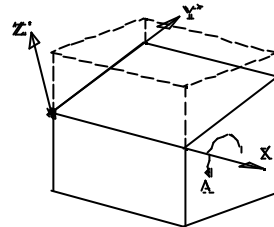
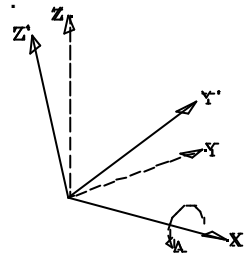
X, Y, Z

X, Y, Z



A, B, C X

A

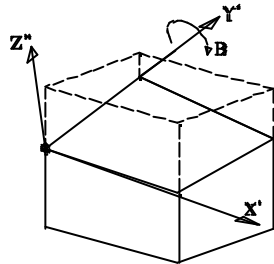
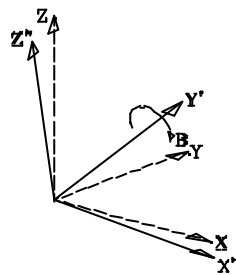


Y Z

XY'Z'

, B

Y'

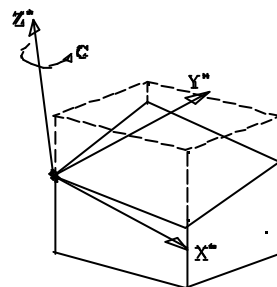
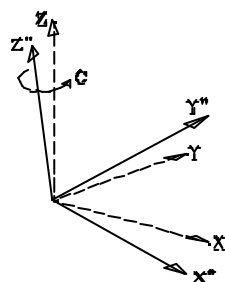


X Z

X'Y'Z''

, C

Z''



G49 XYZQRS
Z

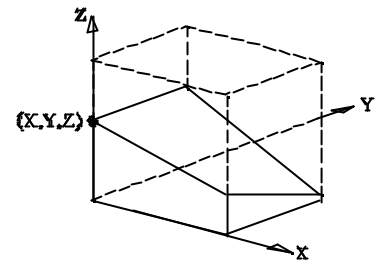
Q, R, S

Z

Y

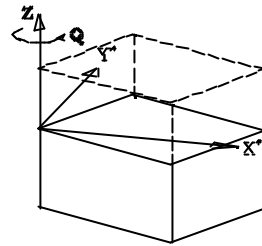
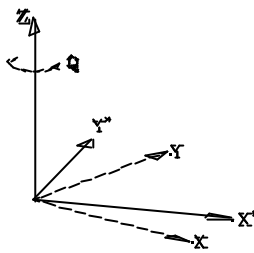
X, Y, Z

X, Y, Z



Q, R, S Z

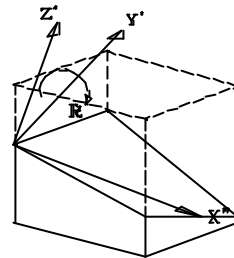
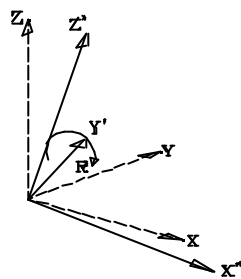
Q



X Y

X'Y'Z'

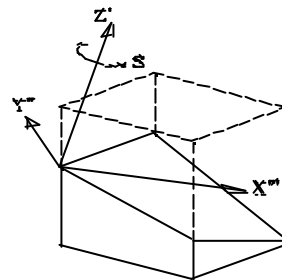
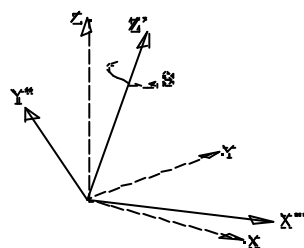
, Y' R



X Z

X''Y'Z'

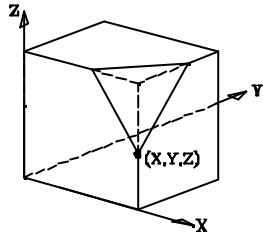
, Z' S



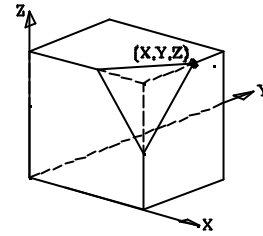
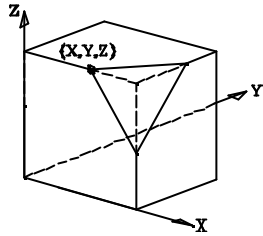
G49 XYZIJKRS

X, Y, Z 가

X, Y, Z

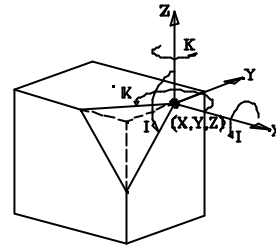
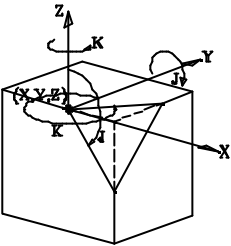
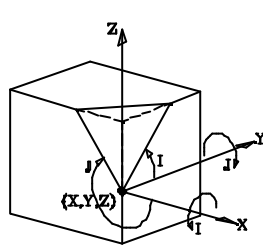


X, Y, Z



IJK

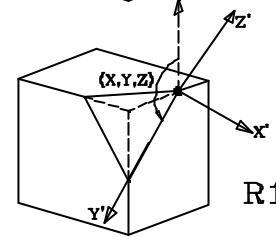
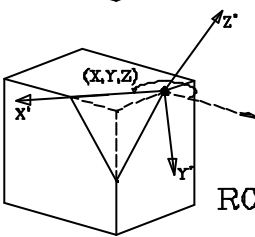
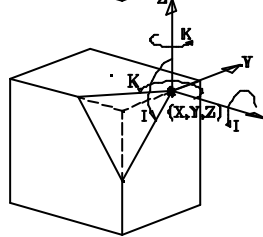
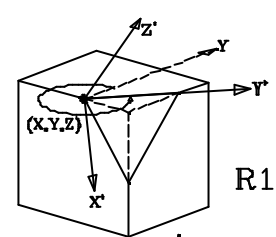
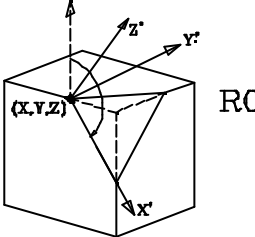
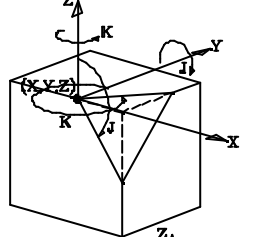
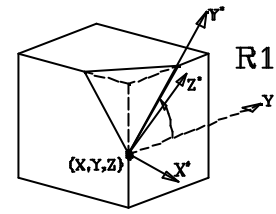
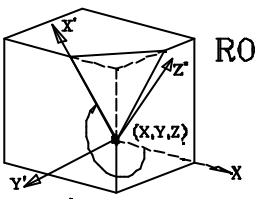
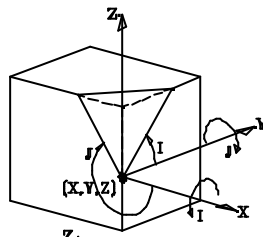
XYZ 가



R

, R1 (X', Y')

, R = 0



S

G49 T X Y Z S

("XFORM(P93)" 2 3)

가

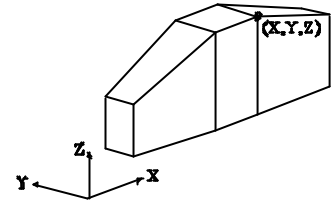
T

X, Y, Z

X, Y, Z

S

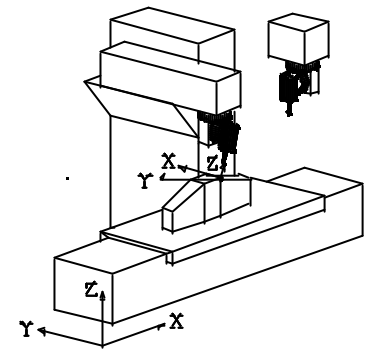
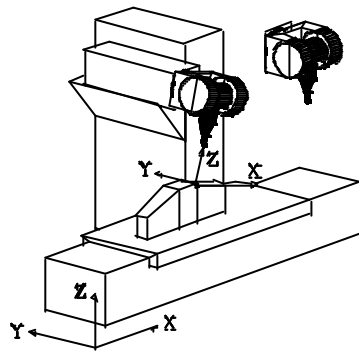
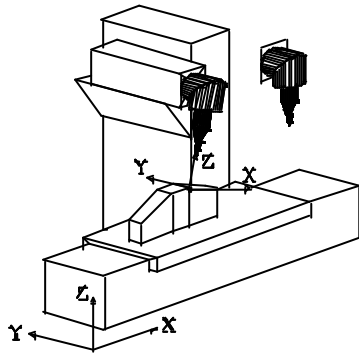
Z'



Z

X, Y

Z



가

X', Y'

G49 T X Y Z S-90

S-90

Z' -90°

17.1.2 G49 ON SWIVEL SPINDLE HEADS

(W) G49 () 가 .
: G49 ***** W.

G49 XYZABCW
G49 XYZIJKRSW

G49 XYZQRSW
G49 TXYZSW

X, Y, W

GRAPHICS(P16)=1

canned cycle

가

:

- (G49 **** W) (G15W) W Z
W
 - (G49 **** W) Z-W (G28 ZW) Z
W
- , G49

17.1.3 G49 ON HURON TYPE SPINDLES

, CNC

TOOROF, TOOROS

P297, P298

(45) 가 가 "L" 가
가 G49 () 가 가
: G49 ***** L.

G49 XYZABCL
G49 XYZIJKRSL

G49 XYZQRS L
G49 TXYZSL

"L" "L0" , 0° 가 가

"L1"

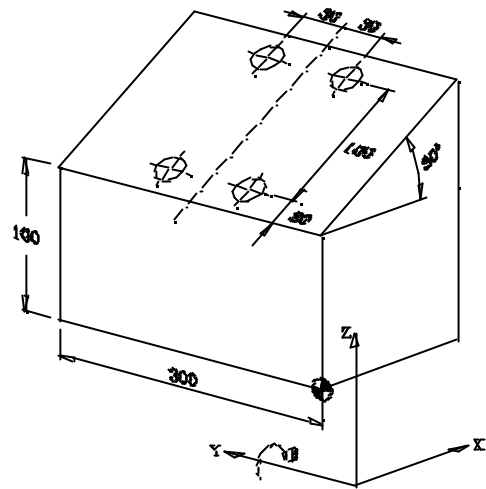
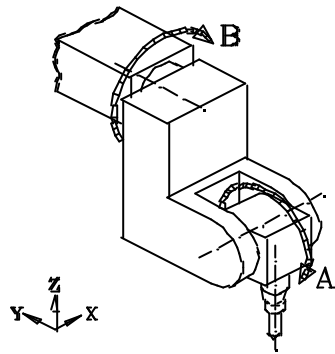
"L" , "Option unavailable" 가

17.1.4 CONSIDERATIONS FOR FUNCTION G49

G49 :
 CNC GP
 PLC ()
 pocket

(G49) , X, Y, Z . X, Y, Z GANTRY
 가) (Z
) ,
 G49 G49 ,
 G49 G
 CNC가
 , :
 G49 E1
 G49 E0 or G49 G49가
 G74 G49가
 , :
 G54-G59, (G73) (G93, G93)
 가
 , :
 (G23 G27)
 (G75)
 hardstop (G52)

17.1.7 PROGRAMMING EXAMPLE



G49 X0 Y0 Z100 B-30
G01 AP298 BP297

(B)

(A)

ABC

G90 G01 Z5
G90 G01 X20 Y120
G??
G91 G01 Y60
G??
G91 G01 X100
G??
G91 G01 Y-60
G??
G90 G01 Z 20
G49

가

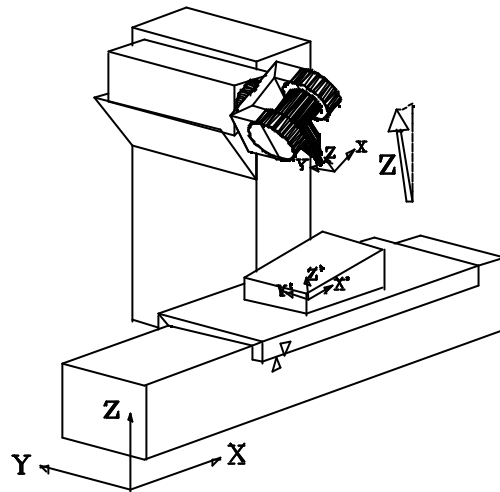
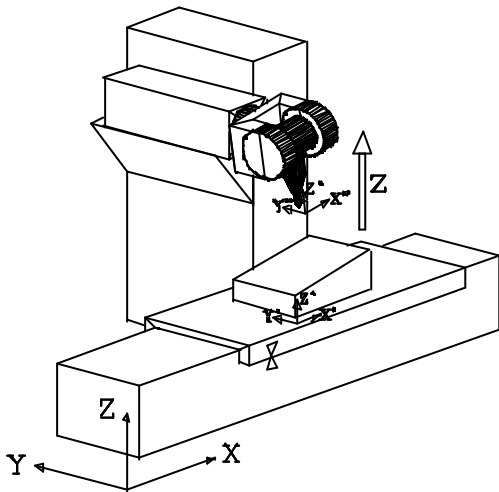
가

가

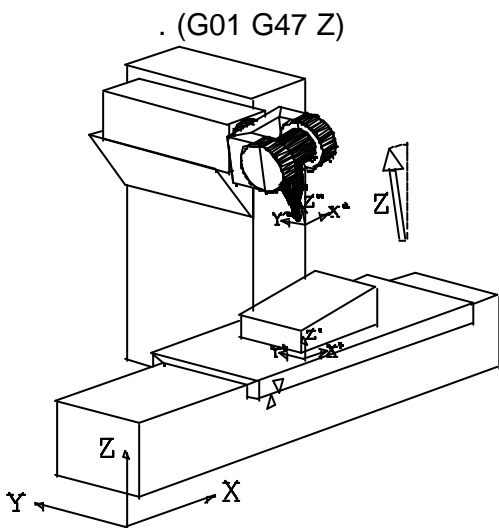
가

17.2 MOVEMENT ACCORDING TO THE TOOL COORDINATE SYSTEM (G47)

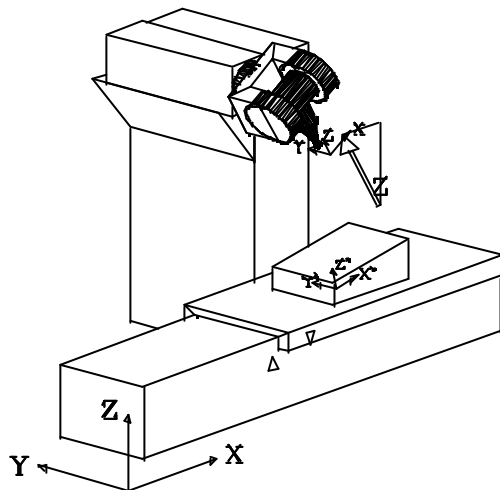
$(G01 \ G47 \ Z)$ Z G47
 $(P93) \ 2 \ 3 \)$ $($ "XFORM



(G49)



Z G47



G47

G47

G47 G48 G49가

17.3 TCP TRANSFORMATION (G48)

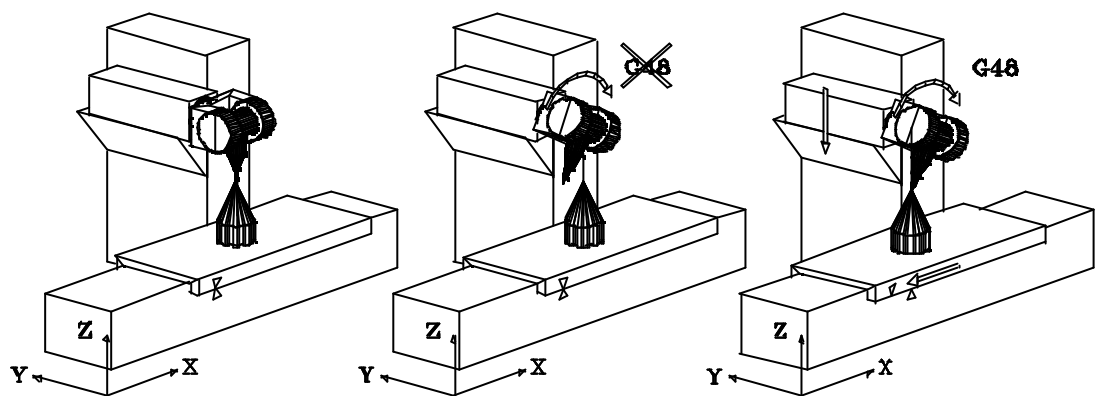
가 CNC

TCP
()

"XFORM

(P93)" "0"

, CNC



TCP G48

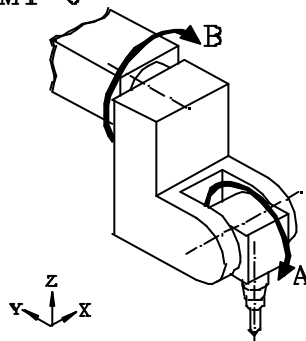
G48 S1 TCP ON
G48 S0 TCP OFF

TCP G48

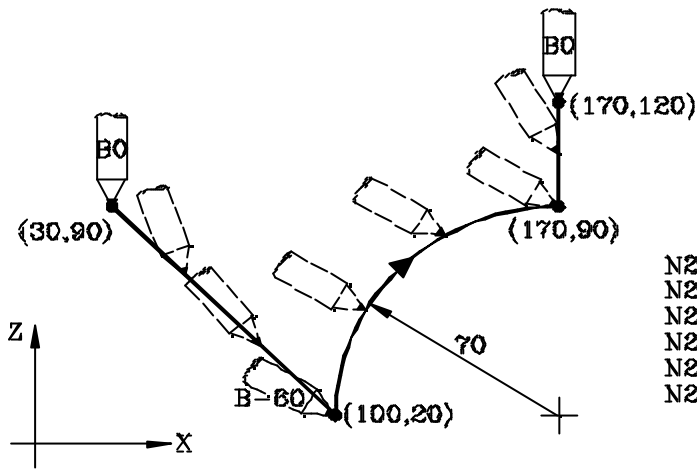
G48

TCP가 ON 가

XFORM=1
XFORM1=0



a)



```

N20 G18 G90 G01 X30 Z90
N21 G48 S1
N22 G01 X100 Z20 B-60
N23 G03 X170 Z90 I70 K0
N23 G01 X170 Z120 B0
N25 G48 S0

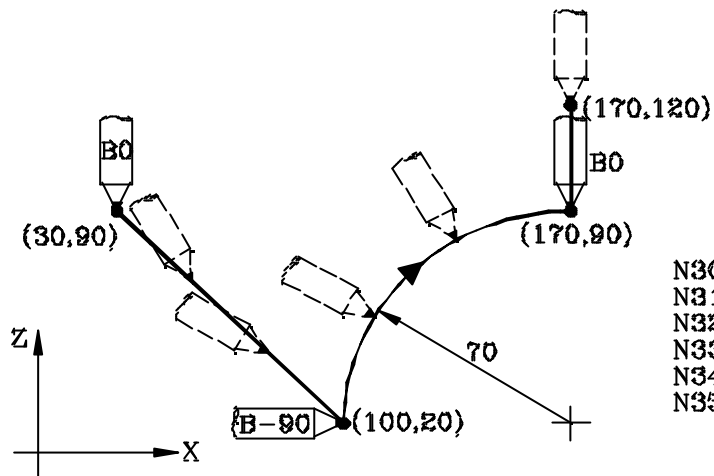
```

```

N20 ZX (G18) (30, 90)
N21 TCP
N22 -60° (100, 20)
CNC XZB (0°) (-60°)
N23 (170, 90)
N24 0° (170, 120)
CNC XZB (-60°) (0°)
N25 TCP

```

b)



```

N30 G18 G90 G01 X30 Z90
N31 G48 S1
N32 G01 X100 Z20 B-90
N33 G03 X170 Z90 I70 K0 B0
N34 G01 X170 Z120
N35 G48 S0

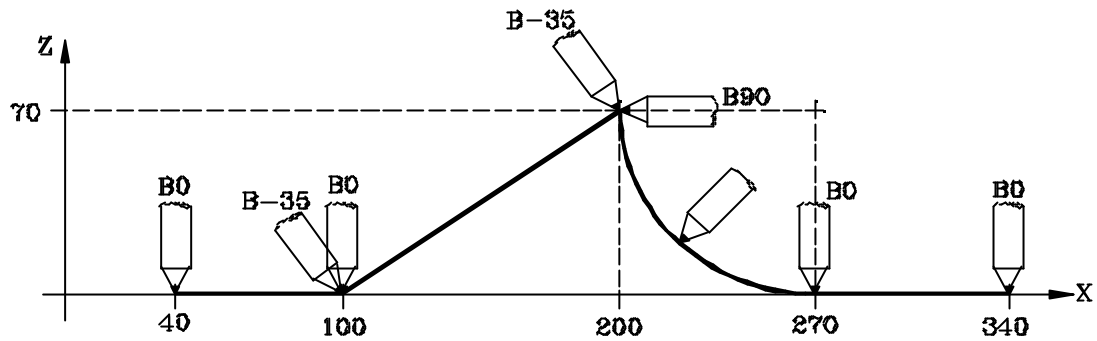
```

```

N30 ZX (G18) (30, 90)
N31 TCP
N32 -90° (100, 20)
CNC XZB (0°) (-90°)
N33 (0°) (170, 90)
CNC XZB (-90°) (0°)
N34 (170, 120)
N25 TCP

```

c) 가

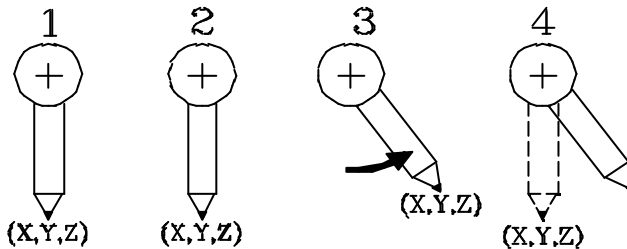


```

G18 G90 ..... ZX          (G18)
G48 S1 ..... TCP on
G01 X40 Z0 B0 ..... (0°) (40,0)
      X100 ..... (0°) (100,0)
      B-35 ..... (-35°)
      X200 Z70 ..... (-35°) (200,70)
      B90 ..... (90°)
G02 X270 Z0 R70 B0 ..          (270,0)
G01 X340 ..... (0°) (340,0)
G48 S0 ..... TCP off
  
```

17.3.1 CONSIDERATIONS FOR FUNCTION G48

GP
 PLC ()
 TCP (G48) , X, Y, Z
 . X, Y, Z GANTRY 가 PLC
 TCP ridig , (Z)
 가
 TCP CNC
 G48 G49
 TCP , "G48 S0" G48 (G74)
 TCP ON , 가 :
 G54-G59
 () (G73)
 (G92, G93)
 JOG
 , :
 (G23 G27)
 (G75)
 TCP가 (G43)
 CAD/CAM
 G48 ON, OFF :
 G48 ON , CNC
 G48 OFF , CNC . ()
)



- 1.- G48 off. CNC
- 2.- G48 on. CNC
- 3.- . G48 ON , CNC
- 4.- . CNC ()

TCP , :

G48 S1 TCP
 G49
 G01 AP298 BP297
 G 가
 가
 G49
 G48 S0TCP
 M30

TCP .

APPENDIX

<i>ISO CODE PROGRAMMING</i>	3
<i>INTERNAL CNC VARIABLES</i>	5
<i>HIGH LEVEL PROGRAMMING</i>	11
<i>KEY CódES</i>	13
<i>LOGIC OUTPUTS FOR KEY STATUS</i>	18
<i>KEYS INHIBITING CODES</i>	23
<i>PROGRAMMING ASSISTANCE SYSTEM PAGES</i>	28
<i>MAINTENANCE</i>	31



ISO CODE PROGRAMMING

Function	M	D	V	Meaning	Section
G00	*	?	*	Rapid travel	6.1
G01	*	?	*	Linear interpolation	6.2
G02	*		*	Clockwise (helical) circular interpolation	6.3
G03	*		*	Counter-clockwise (helical) circular interpolation	6.3
G04				Dwell/block preparation stop	7.1, 7.2
G05	*	?	*	Round corner	7.3.1
G06			*	Absolute arc center coordinates	6.4
G07	*	?		Square corner	7.3.2
G08			*	Arc tangent to previous path	6.5
G09			*	Arc defined by three points	6.6
G10	*	*		Mirror image cancellation	7.5
G11	*		*	Mirror image on X axis	7.5
G12	*		*	Mirror image on Y axis	7.5
G13	*		*	Mirror image on Z axis	7.5
G14	*		*	Mirror image in the programmed directions	7.5
G15	*		*	Longitudinal axis selection	8.2
G16	*		*	Selection of main plane in two directions	3.2
G17	*	?	*	Main plane X-Y and longitudinal Z	3.2
G18	*	?	*	Main plane Z-X and longitudinal Y	3.2
G19	*		*	Main plane Y-Z and longitudinal X	3.2
G20				Definition of lower work zone limits	3.7.1
G21				Definition of upper work zone limits	3.7.1
G22			*	Activate/cancel work zones	3.7.2
G23			*	Activate tracing	16.3
G24			*	Activate digitizing	16.6
G25				Deactivate tracing/digitizing	16.5
G26			*	Tracing probe calibration	16.2
G27			*	Tracing contour definition	16.4
G28	*		*	Second spindle selection	5.4
G29	*	*		Main spindle selection	5.4
G28-G29			*	Axes toggle	7.9
G30	*		*	Spindle synchronization	5.5
G32	*		*	Feedrate as an inverted function of time.	6.15
G33	*		*	Threadcutting	6.12
G34				Variable pitch thread	6.13
G36			*	Automatic radius blend	6.10
G37			*	Tangential entry	6.8
G38			*	Tangential exit	6.9
G39			*	Automatic chamfer blend	6.11
G40	*	*		Cancellation of tool radius compensation	8.1
G41	*		*	Right-hand tool radius compensation	8.1
G41N	*		*	Collision detection	8.3
G42	*		*	Left-hand tool radius compensation	8.1
G42N	*		*	Collision detection	8.3
G43	*	?	*	Tool length compensation	8.2
G44	*	?	*	Cancellation of tool length compensation	8.2
G45	*		*	Tangential control (G45)	6.16
G47			*	Tool movement according to tool coordinate system	17.2
G48	*		*	TCP transformation	17.3
G49	*		*	Incline plane definition	17.1
G50	*		*	Controlled corner rounding	7.3.3
G51	*		*	Look-Ahead	7.4
G52				Movement until making contact (against hardstop)	6.14
G53				Program coordinates with respect to home	4.3
G54	*		*	Absolute zero offset 1	4.4.2
G55	*		*	Absolute zero offset 2	4.4.2
G56	*		*	Absolute zero offset 3	4.4.2
G57	*		*	Absolute zero offset 4	4.4.2
G58	*		*	Additive zero offset 1	4.4.2
G59	*		*	Additive zero offset 2	4.4.2
G60			*	Straight line canned cycle	10.1
G61			*	Rectangular pattern canned cycle	10.2

Function	M	D	V	Meaning	Section
G62			*	Grid pattern canned cycle	10.3
G63			*	Circular pattern canned cycle	10.4
G64			*	Arc pattern canned cycle	10.5
G65			*	Arc-chord pattern canned cycle	10.6
G66			*	Irregular pocket canned cycle	11.1
G67			*	Irregular pocket roughing	11.1.2
G68			*	Irregular pocket finishing	11.1.4
G69	*		*	Complex deep hole drilling	9.5.1
G70	*	?	*	Programming in inches	3.3
G71	*	?	*	programming in millimeters	3.3
G72	*		*	General and specific scaling factor	7.6
G73	*		*	Pattern rotation	7.7
G74			*	Machine reference search	4.2
G75			*	Probing until touching	12.1
G76			*	Probing while touching	12.1
G77	*		*	Slaved axis	7.8.1
G77S	*		*	Spindle synchronization	5.5
G78	*	*		Slaved axis cancellation	7.8.2
G78S	*	*		Cancellation of spindle synchronization	5.5
G79				Canned cycle parameter modification	9.2.1
G80	*	*		Canned cycle cancellation	9.3
G81	*		*	Drilling cycle	9.5.2
G82	*		*	Drilling cycle with dwell	9.5.3
G83	*		*	Simple deep hole drilling	9.5.4
G84	*		*	Tapping cycle	9.5.5
G85	*		*	Reaming cycle	9.5.6
G86	*		*	Boring cycle with withdrawal in G00	9.5.7
G87	*		*	Rectangular pocket milling cycle	9.5.8
G88	*		*	Circular pocket milling cycle	9.5.9
G89	*		*	Boring cycle with withdrawal in G01	9.5.10
G90	*	?		Programming in absolute	3.4
G91	*	?	*	Programming in incremental	3.4
G92				Coordinate preset/spindle speed limit	4.4.1
G93				Polar origin preset	4.5
G94	*	?		Feedrate in millimeters(inches) per minute	5.2.1
G95	*	?	*	Feedrate in millimeters(inches) per revolution	5.2.2
G96	*		*	Constant cutting point speed	5.2.3
G97	*	*		Constant tool center speed	5.2.4
G98	*	*		Withdrawal to the starting plane	9.5
G99	*		*	Withdrawal to the reference plane	9.5

M means MODAL, i.e., that once programmed, the G function remains active as long as another incompatible Gfunction is not programmed, M02, M30, EMERGENCY, RESET are not programmed or the CNC is not turned on or off.

Letter **D** means BY DEFAULT, i.e., that these will be assumed by the CNC when turned on, after executing M02, M30 or after EMERGENCY or RESET.

In cases indicated with ? it must be interpreted that the DEFAULT of these G functions depends on the settings of the general CNC machine parameters.

V means that the G function is displayed next to the machining conditions in the execution and simulation modes.



INTERNAL CNC VARIABLES

Section (13.2.2)

R indicates that the variable can be read.
W indicates that the variable can be modified.

VARIABLES ASSOCIATED WITH TOOLS

Variable	CNC	PLC	DNC	
TOOL	R	R	R	Number of active tool.
TOD	R	R	R	Number of active tool offset.
NXTOOL	R	R	R	Number of the next requested tool waiting for M06.
NXTOD	R	R	R	Number of the next tool's offset.
TMZPn	R	R	-	(n) tool's position in the tool magazine.
TLFDn	R/W	R/W	-	(n) tool's offset number.
TLFFn	R/W	R/W	-	(n) tool's family code.
TLFNn	R/W	R/W	-	Nominal life assigned to tool (n).
TLFRn	R/W	R/W	-	Real life value of tool (n).
TMZTn	R/W	R/W	-	Contents of tool magazine position (n).
TORn	R/W	R/W	-	Tool radius (R) value of offset (n).
TOLn	R/W	R/W	-	Tool length (L) value of offset (n).
TOIn	R/W	R/W	-	Tool radius wear (I) of offset (n).
TOKn	R/W	R/W	-	Tool length wear (K) of offset (n).

VARIABLES ASSOCIATED WITH ZERO OFFSETS

(Section 13.2.3)

Variable	CNC	PLC	DNC	
ORG(X-C)	R	R	-	Zero offset active on the selected axis without including the additive Zero offset activated via PLC.
PORGF	R	-	R	Abscissa coordinate value of polar origin.
PORGS	R	-	R	Ordinate coordinate value of polar origin.
ORG(X-C)n	R/W	R/W	R	Zero offset (n) value of the selected axis.
PLCOF(X-C)	R/W	R/W	R	Value of the additive Zero Offset activated via PLC.

VARIABLES ASSOCIATED WITH FUNCTION G49

(Section 13.2.4)

Variables associated with the definition of function G49:

Variable	CNC	PLC	DNC	
ORGROX	R	R	R	X coordinate of the new part zero with respect to home
ORGROY	R	R	R	Y coordinate of the new part zero with respect to home
ORGROZ	R	R	R	Z coordinate of the new part zero with respect to home
ORGROA	R	R	R	Value assigned to parameter A
ORGROB	R	R	R	Value assigned to parameter B
ORGROC	R	R	R	Value assigned to parameter C
ORGROI	R	R	R	Value assigned to parameter I
ORGROJ	R	R	R	Value assigned to parameter J
ORGROK	R	R	R	Value assigned to parameter K
ORGROQ	R	R	R	Value assigned to parameter Q
ORGROR	R	R	R	Value assigned to parameter R
ORGROS	R	R	R	Value assigned to parameter S
GTRATY	R	R	R	Type of G49 programmed (0) no G49 defined, (1) G49 X Y Z A B C (2) G49 X Y Z Q R S, (3) G49 T X Y Z S, (4) G49 X Y Z I J K R S

Variables updated by the CNC once G49 has been executed:

TOOROF	R/W	R/W	R/W	Position to be occupied by the spindle's main rotary axis.
TOOROS	R/W	R/W	R/W	Position to be occupied by the spindle's secondary rotary axis.

VARIABLES ASSOCIATED WITH MACHINE PARAMETERS

(Section 13.2.5)

Variable	CNC	PLC	DNC	
MPGn	R	R	-	Value assigned to general machine parameter (n).
MP(X-C)n	R	R	-	Value assigned to machine parameter (n) of the axis (X-C)
MPSn	R	R	-	Value assigned to machine parameter (n) of the main spindle.
MPSSn	R	R	-	Value assigned to machine parameter (n) of the second spindle.
MPASn	R	R	-	Value assigned to machine parameter (n) of the auxiliary spindle.
MPLCn	R	R	-	Value assigned to machine parameter (n) of the PLC.

VARIABLES ASSOCIATED WITH THE WORK ZONES

(Section 13.2.6)

Variable	CNC	PLC	DNC	
FZONE	R	R/W	R	Status of work zone 1.
FZLO(X-C)	R	R/W	R	Lower limit of work zone 1 along the selected axis (X/C).
FZUP(X-C)	R	R/W	R	Upper limit of work zone 1 along the selected axis (X/C).
SZONE	R	R/W	R	Status of work zone 2.
SZLO(X-C)	R	R/W	R	Lower limit of work zone 2 along the selected axis (X/C).
SZUP(X-C)	R	R/W	R	Upper limit of work zone 2 along the selected axis (X/C).
TZONE	R	R/W	R	Status of work zone 3.
TZLO(X-C)	R	R/W	R	Lower limit of work zone 3 along the selected axis (X/C).
TZUP(X-C)	R	R/W	R	Upper limit of work zone 3 along the selected axis (X/C).
FOZONE	R	R/W	R	Status of work zone 4.
FOZLO(X-C)	R	R/W	R	Lower limit of work zone 4 along the selected axis (X/C).
FOZUP(X-C)	R	R/W	R	Upper limit of work zone 4 along the selected axis (X/C).
FIZONE	R	R/W	R	Status of work zone 5.
FIOZLO(X-C)	R	R/W	R	Lower limit of work zone 5 along the selected axis (X/C).
FIZUP(X-C)	R	R/W	R	Upper limit of work zone 5 along the selected axis (X/C).

VARIABLES ASSOCIATED WITH FEEDRATES

Section (13.2.7)

Variable	CNC	PLC	DNC	
FREAL	R	R	R	Real feedrate of the CNC in mm/min or inch/min.

Variables associated with function G94

FEED	R	R	R	Active feedrate at the CNC (G94) in mm/min or inch/min.
DNCF	R	R	R/W	Feedrate selected via DNC.
PLCF	R	R/W	R	Feedrate selected via PLC.
PRGF	R	R	R	Feedrate selected by program.

Variables associated with function G95

FPREV	R	R	R	Active feedrate at CNC (G95), in m/rev or inch/rev.
DNCFPR	R	R	R/W	Feedrate selected via DNC.
PLCFPR	R	R/W	R	Feedrate selected via PLC.
PRGFPR	R	R	R	Feedrate selected by program.

Variables associated with function G32

PRGFIN	R	R	R	Feedrate selected by program. In 1/min.
--------	---	---	---	---

Variables associated with Feedrate Override

FRO	R	R	R	Feedrate Override (%) active at the CNC.
PRGFRO	R/W	R	R	Feedrate Override (%) selected by program.
DNCFRO	R	R	R/W	Feedrate Override (%) selected by DNC.
PLCFRO	R	R/W	R	Feedrate Override (%) selected by PLC.
CNCFRO	R	R	R	Feedrate Override (%) selected from the front panel knob.
PLCCFR	R	R/W	R	Feedrate Override (%) of the PLC execution channel.

VARIABLES ASSOCIATED WITH POSITION VALUES

Section (13.2.8)

Variable	CNC	PLC	DNC	
PPOS(X-C)	R	-	-	Theoretical programmed position value (coordinate).
POS(X-C)	R	R	R	Real position value of the indicated axis.
TPOS(X-C)	R	R	R	Theoretical (real + lag) position value of the indicated axis.
FLWE(X-C)	R	R	R	Following error of the indicated axis.
DEFLEX	R	R	R	Probe deflection along the X axis.
DEFLEY	R	R	R	Probe deflection along the Y axis.
DEFLEZ	R	R	R	Probe deflection along the Z axis.
DIST(X-C)	R/W	R/W	R	Distance travelled by the indicated axis.
LIMPL(X-C)	R/W	R/W	R	Upper second travel limit.
LIMMI(X-C)	R/W	R/W	R	Lower second travel limit.

VARIABLES ASSOCIATED WITH HANDWHEELS

(Section 13.2.9)

Variable	CNC	PLC	DNC	
HANPF	R	R	-	1st hand wheel pulses received since CNC power-up.
HANPS	R	R	-	2nd hand wheel pulses received since CNC power-up.
HANPT	R	R	-	3rd hand wheel pulses received since CNC power-up.
HANPFO	R	R	-	4th hand wheel pulses received since CNC power-up.
HANFCT	R	R/W	R	Individual multiplying factor for each handwheel.
HBEVAR	R	R/W	R	HBEhandwheel: counting enabled, jog axis and (x1, x10, x100) factor
MASLAN	R/W	R/W	R/W	Angle of linear path with "Path hand wheel".
MASCFI	R/W	R/W	R/W	Arc center coordinates with "Path handwheel".
MASCSE	R/W	R/W	R/W	Arc center coordinates with "Path handwheel".

VARIABLES ASSOCIATED WITH THE MAIN SPINDLE

(Section 13.2.10)

Variable	CNC	PLC	DNC	
SREAL	R	R	R	Real spindle speed in r.p.m.
SPEED	R	R	R	Active spindle speed at the CNC.
DNCS	R	R	R/W	Spindle speed selected via DNC.
PLCS	R	R/W	R	Spindle speed selected via PLC.
PRGS	R	R	R	Spindle speed selected by program.
SSO	R	R	R	Spindle Speed Override (%) active at the CNC.
PRGSSO	R/W	R	R	Spindle Speed Override (%) selected by program.
DNCSO	R	R	R/W	Spindle Speed Override (%) selected via DNC.
PLCSSO	R	R/W	R	Spindle Speed Override (%) selected via PLC.
CNCSO	R	R	R	Spindle Speed Override (%) selected from front panel.
SLIMIT	R	R	R	Spindle speed limit, in rpm, active at the CNC.
DNCSL	R	R	R/W	Spindle speed limit selected via DNC.
PLCSL	R	R/W	R	Spindle speed limit selected via PLC.
PRGSL	R	R	R	Spindle speed limit selected by program.
POSS	R	R	R	Real Spindle position. Between ± 99999999 ten-thousandths $^{\circ}$
RPOSS	R	R	R	Real Spindle position. Between 0 and 360 $^{\circ}$ (in ten-thousandths $^{\circ}$)
TPOSS	R	R	R	Theoretical Spindle position.
RTPOSS	R	R	R	Theoretical Spindle position. Between ± 99999999 ten-thousandths of a degree Between 0 and 360 $^{\circ}$ (in ten-thousandths of a degree).
FLWES	R	R	R	Spindle following error in degrees.
SYNCER	R	R	R	Second spindle following error when synchronized with the main spindle.

VARIABLES ASSOCIATED WITH THE SECOND SPINDLE

(Section 13.2.11)

Variable	CNC	PLC	DNC	
SSREAL	R	R	R	Real spindle speed in r.p.m.
SSPEED	R	R	R	Active spindle speed at the CNC.
SDNCS	R	R	R/W	Spindle speed selected via DNC.
SPLCS	R	R/W	R	Spindle speed selected via PLC.
SPRGS	R	R	R	Spindle speed selected by program.
SSSO	R	R	R	Spindle Speed Override (%) active at the CNC.
SPRGSO	R/W	R	R	Spindle Speed Override (%) selected by program.
SDNCSO	R	R	R/W	Spindle Speed Override (%) selected via DNC.
SPLCSO	R	R/W	R	Spindle Speed Override (%) selected via PLC.
SCNCSO	R	R	R	Spindle Speed Override (%) selected from front panel.
SSLIMI	R	R	R	Spindle speed limit, in rpm, active at the CNC.
SDNCSL	R	R	R/W	Spindle speed limit selected via DNC.
SPLCSL	R	R/W	R	Spindle speed limit selected via PLC.
SPRGSL	R	R	R	Spindle speed limit selected by program.
SPOSS	R	R	R	Real Spindle position. Between ± 99999999 ten-thousandths $^{\circ}$
SRPOSS	R	R	R	Real Spindle position. Between 0 and 360 $^{\circ}$ (in ten-thousandths $^{\circ}$)
STPOSS	R	R	R	Theoretical Spindle position.
SRTPOS	R	R	R	Theoretical Spindle position. Between ± 99999999 ten-thousandths of a degree. Between 0 and 360 $^{\circ}$ (in ten-thousandths of a degree).
SFLWES	R	R	R	Spindle following error in degrees.

VARIABLES ASSOCIATED WITH THE LIVE TOOL

Section (13.2.12)

Variable	CNC	PLC	DNC	
ASPROG	R	R	-	RPM programmed in M45 S (within the associated subroutine)

VARIABLES ASSOCIATED WITH THE PLC *Section (13.2.13)*

Variable	CNC	PLC	DNC	
PLCMSG	R	-	R	Number of the active PLC message with the highest priority.
PLCIn	R/W	-	-	32 PLC inputs starting from (n).
PLCO n	R/W	-	-	32 PLC outputs starting from (n).
PLCM n	R/W	-	-	32 PLC marks starting from (n).
PLCR n	R/W	-	-	Indicated (n) Register.
PLCT n	R/W	-	-	Indicated (n) Timer's count.
PLCC n	R/W	-	-	Indicated (n) Counter's count.

VARIABLES FOR GLOBAL AND LOCAL PARAMETERS *(Section 13.2.14)*

Variable	CNC	PLC	DNC	
GUP n	-	R/W	-	Global parameter (n) (100-P299).
LUP (a,b)	-	R/W	-	Local parameter (b) and its nesting level (a). (P0-P25).
CALLP	R	-	-	Indicates which local parameters have been defined by means of a PCALL or MCALL instruction (calling a subroutine).

VARIABLES SERCOS *(Section 13.2.15)*

Variable	CNC	PLC	DNC	
SETGE(X-C)	W	W	-	Work gear and parameter set for (X-C) axis drive
SETGES	W	W	-	Work gear and parameter set for main spindle drive
SSETGS	W	W	-	Work gear and parameter set for 2nd spindle drive
SVAR(X-C) id	R/W	-	-	Sercos variable for (X-C) axis identifier "id"
SVARS id	R/W	-	-	Sercos variable for main spindle identifier "id"
SSVAR id	R/W	-	-	Sercos variable for 2nd spindle identifier "id"
TSVAR(X-C) id	R	-	-	Third attribute of the sercos variable of (X-C) axis identifier "id"
TSVARS id	R	-	-	Third attribute of the sercos variable of main spindle identifier "id"
TSSVAR id	R	-	-	Third attribute of the sercos variable of 2nd spindle identifier "id"

SOFTWARE & HARDWARE CONFIGURATION VARIABLES *(Section 13.2.16)*

Variable	CNC	PLC	DNC	
HARCON	R	R	R	Its bits indicate the CNC hardware configuration.
IDHARH	R	R	R	Hardware identifier (8 least significant bits)
IDHARL	R	R	R	Hardware identifier (4 most significant bits)
SOFCON	R	R	R	CNC & HD software versions (bits 15-0) and (31-16) respectively.

VARIABLES ASSOCIATED WITH TELEDIAGNOSIS *(Section 13.2.17)*

Variable	CNC	PLC	DNC	
HARSWA	R	R	R	Hardware configuration
HARSWB	R	R	R	Hardware configuration
HARTST	R	R	R	Hardware test
MEMTST	R	R	R	Memory test
NODE	R	R	R	Node number within the Sercos ring
VCHECK	R	R	R	Checksum of the software version

VARIABLES ASSOCIATED WITH THE OPERATING MODE *(Section 13.2.18)*

Variable	CNC	PLC	DNC	
OPMODE	R	R	R	Operating mode.
OPMODA	R	R	R	Operating mode when working in the main channel.
OPMODB	R	R	R	Type of simulation.
OPMODC	R	R	R	Axes selected by handwheel.

OTHER VARIABLES

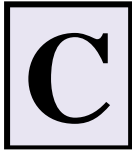
(Section 13.2.19)

Variable	CNC	PLC	DNC	
NBTOOL	R	R	R	Number of the tool being managed
PRGN	R	R	R	Number of the program in execution.
BLKN	R	R	R	Label number of the last executed block.
GS _n	R	-	-	Status of the indicated G function (n).
GGSA	-	R	R	Status of functions G00 thru G24.
GGSB	-	R	R	Status of functions G25 thru G49.
GGSC	-	R	R	Status of functions G50 thru G74.
GGSD	-	R	R	Status of functions G75 thru G99.
MS _n	R	-	-	Status of the indicated M function (n)
GMS	-	-	R	Status of M functions: M (0..6, 8, 9, 19, 30, 41..44)
PLANE	R	R	R	Axes which form the active main plane.
LONGAX	R	R	R	Axis affected by the tool length compensation (G15).
MIRROR	R	R	R	Active mirror images.
SCALE	R	R	R	Active general Scaling factor.
SCALE(X-C)	R	R	R	Scaling Factor applied only to the indicated axis.
ORGROT	R	R	R	Rotation angle (G73) of the coordinate system in degrees.
ROTPF	R	-	-	Abscissa of rotation center.
ROTPS	R	-	-	Ordinate of rotation center.
PRBST	R	R	R	Returns probe status.
CLOCK	R	R	R	System clock in seconds.
TIME	R	R	R/W	Time in Hours, minutes and seconds.
DATE	R	R	R/W	Date in Year-Month-Day format
TIMER	R/W	R/W	R/W	Clock activated by PLC, in seconds.
CYTIME	R	R	R	Time to execute a part in hundredths of a second.
PARTC	R/W	R/W	R/W	Part counter of the CNC.
FIRST	R	R	R	Flag to indicate first time of program execution.
KEY	R/W*	R/W	R/W	keystroke code.
KEYSRC	R/W	R/W	R/W	Keystroke source, 0=keyboard, 1=PLC, 2=DNC
ANAIn	R	R	R	Voltage (in volts) of the indicated analog input (n).
ANAOn	W	W	W	Voltage (in volts) to apply to the indicated output (n).
CNCERR	-	R	R	Active CNC error number.
PLCERR	-	-	R	Active PLC error number.
DNCERR	-	R	-	Number of the error generated during DNC communications.
AXICOM	R	R	R	Pair of axes toggled with function G28
TANGAN	R	R	R	Associated with G45. Angular position, in degrees, with respect to programmed path.

Warning:



The "KEY" variable can be "written" (W) at the CNC only via the user channel.



HIGH LEVEL PROGRAMMING

DISPLAY STATEMENTS

(Section 14.2)

(ERROR whole number, “error text”)	Stops execution of program and displays indicated error.
(MSG “message”)	Displays indicated message.
(DGWZ expression 1, expression 6)	Define the graphics display area

ENABLING/DISABLING STATEMENTS

(Section 14.3)

(ESBLK and DSBLK)	The CNC executes all the blocks which are found between ESBLK and DSBLK as if they were a single block.
(ESTOP and DSTOP)	Enable (ESTOP) and disable (DSTOP) of the Stop key and the external Stop signal (PLC)
(EFHOLD and DFHOLD)	Enable (EFHOLD) and disable (DFHOLD) of the Feed-Hold input (PLC)

FLOW CONTROLLING STATEMENTS

(Section 14.4)

(GOTO N(expression))	Causes a jump within the same program, to the block defined by label N(expression)
(RPT N(expression), N(expression))	Repeats the execution of the part of a program existing between two blocks defined by means of labels N(expression)
(IF condition <action1> ELSE <action2>)	Analyzes the given condition which must be a relational expression. If the condition is true (result equals 1), <action1> will be executed, otherwise (result equals 0) <action2> will be executed.

SUBROUTINE STATEMENTS

(Section 14.5)

(SUB integer)	Definition of subroutine
(RET)	End of subroutine
(CALL (expression))	Call to subroutine
(PCALL (expression, (assignment statement), (assignment statement),...))	Call to a subroutine. Besides, allows the initialization, by means of assignment statements, of up to 26 local parameters of this subroutine.
(MCALL (expression), (assignment statement), (assignment statement),...)	The same as PCALL, but converting the subroutine indicated into a modal subroutine.
(MDOFF)	Cancellation of modal subroutine
(PROBE (expression), (assignment statement), (assignment statement),...)	Executes a probing canned cycle, its parameters being initialized by means of assignment statements.
(DIGIT (expression), (assignment statement), (assignment statement),...)	Executes a digitizing canned cycle, its parameters being initialized by means of assignment statements.
(TRACE (expression), (assignment statement), (assignment statement),...)	Executes a tracing canned cycle, its parameters being initialized by means of assignment statements.
(REPOS X, Y, Z, ...)	It must always be used inside interruption subroutines and it facilitates the repositioning of the machine axes to the interruption point.

PROGRAM STATEMENTS

(Section 14.6)

(EXECP(expression), (directory)	Starts the execution of the program
(OPEN P(expression), (destination directory), A/D, "program comment")	Starts generating a new program and allows it to be associated with a program comment.
(WRITE <block text>)	Adds the information contained in <block text> after the last program block of the program which was being generated with OPEN P, as a new program block.

CUSTOMIZING STATEMENTS

(Section 14.7)

(PAGE(expression))	Displays the user page number (0-255) or system page number (>1000) indicated.
(SYMBOL (expression 1),(expression 2),(expression 3)	Displays the symbol (0-255) indicated by expression 1 Its position on the screen is defined by expression 2 (row,0-639) and by expression 3(column,0-335).
(IB(expression)=INPUT"text",format)	Displays the text indicated in the data input window and stores the data input by the user in the input variable (IBn).
(ODW(expression 1), (expression 2), (expression 3)	Defines and draws a white window on screen (1 row x 14 columns). Its position on screen is defined by expression 2(row) and by expression 3 (column).
(DW (expression 1)=(expression 2), DW(expression 3) = (expression 4),...)	Displays the numerical data indicated by expression 2,4,.. in windows indicated by the value of expression 1,3...
(SK (expression 1)="text 1", (expression 2)="text 2",...)	Defines and displays the new softkey menu indicated.
(WKEY)	Stops the execution of a program until a key is pressed.
(WBUF"text"(expression))	Adds the text and the value of the expression, once this has been evaluated, to the block which is being edited and in the data input window.
(SYSTEM)	Ends the execution of user customized program and returns to standard CNC menu.