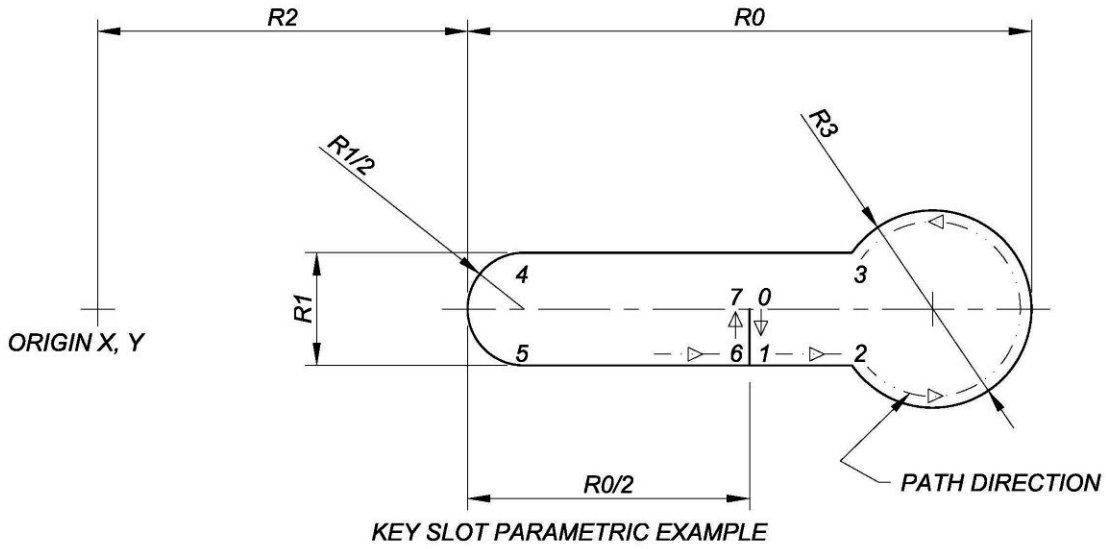
Siemens 840D Training Course
Macro Programming Examples

This document is made available as a preliminary version (draft).
Questions and feedback should be sent to support@cimco.com

Macro Programming Examples using Siemens Arithmetic Variables & Programming Aids and Cimco Editor, NC-Assistant, and Backplot

Example 1

There is a requirement to produce a range of plates with radial Keyhole Slots for a family of motor products. The larger range require more slots in the radial array and the slot sizes vary dependent on the plate size. See below the diagram of the keyhole slots and the variable sizes.

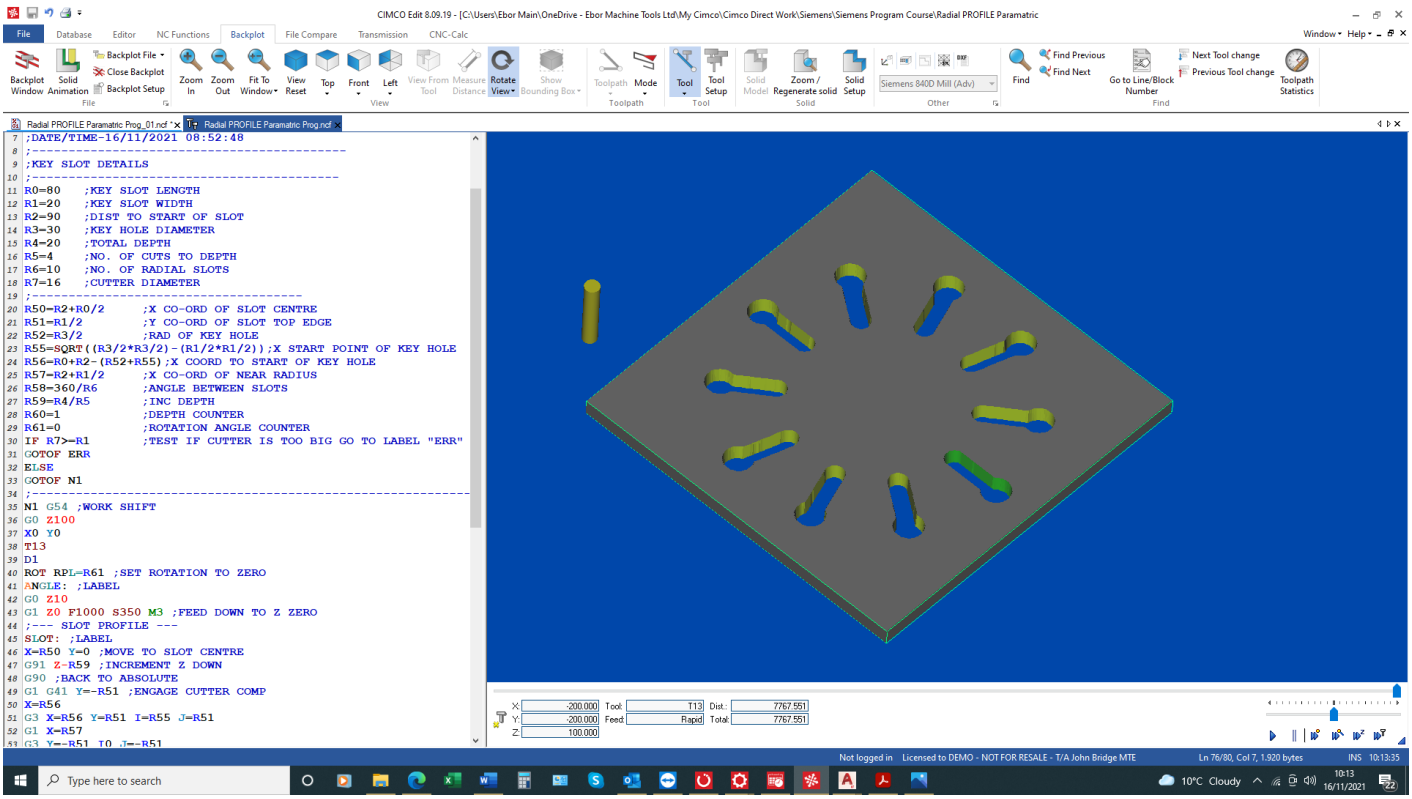


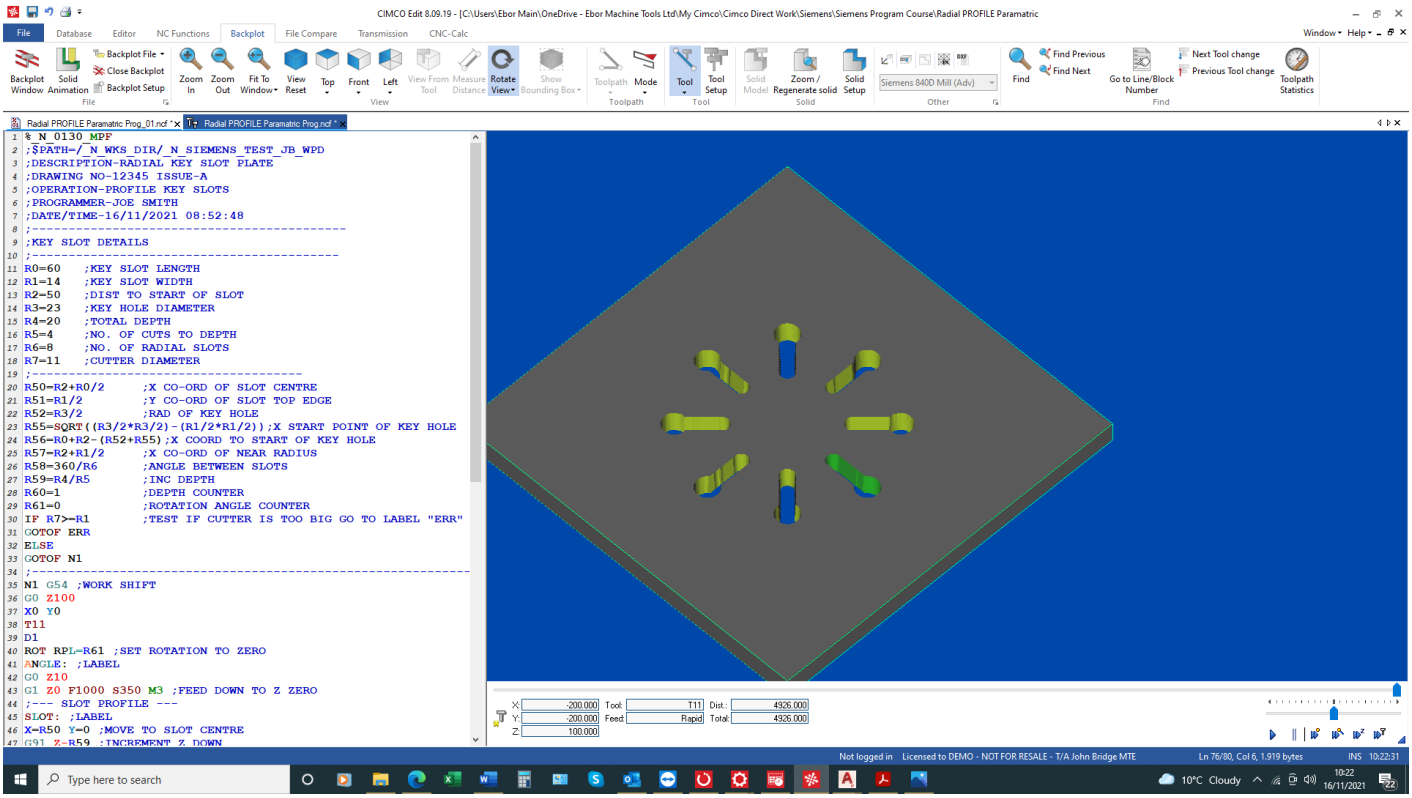
KEY SLOT PARAMETRIC EXAMPLE

See below a section of the Header from the Program with the basic assignment of variables. The arithmetic R variables can be edited to the sizes that are required for the current production run of parts. All sizes here are in mm. The diagram is set at 0 degrees (3PM)

```
; KEY SLOT DETAILS

;-----------------------------------------

R0=80   ;KEY SLOT LENGTH

R1=20   ;KEY SLOT WIDTH

R2=90   ;DIST TO START OF SLOT

R3=30   ;KEY HOLE DIAMETER

R4=20   ;TOTAL DEPTH

R5=4    ;NO. OF CUTS TO DEPTH

R6=10   ;NO. OF RADIAL SLOTS

R7=16   ;CUTTER DIAMETER

;-------------------------------------
```

When we have entered the variable details, we can test the program using the Cimco Editor Backplot facility. Note the two screen shots below with different numbers of slots at different sizes.

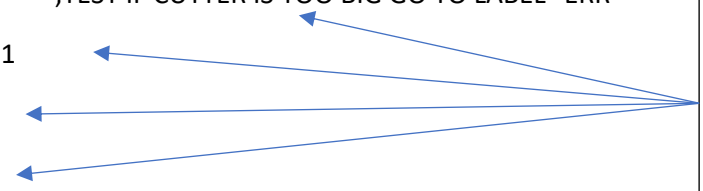




Let's look at the structure of the program that uses the ROT rotation of coordinates to achieve the multiple radial keyhole slots and incremental depth cuts to machine through the plate. We need to have the end point

coordinates in X and Y to create the profile, we need to have the angle to rotate the coordinates depending on the number of keyhole slots and we need to have the incremental depth from the number of cuts we have decided on. See below the section of the program that assigns the variable and calculates the points we need to make the program run. We are using the variables in the low digits for the basic assignment, and we are using variables starting at R50 for the profile points and calculations. There are variables Savailable from R0 to R999. See below the basic assignment and the description of the calculation blocks.

```
;KEY SLOT DETAILS

;----------------------------------------

R0=60   ;KEY SLOT LENGTH

R1=14   ;KEY SLOT WIDTH

R2=50   ;DIST TO START OF SLOT

R3=23   ;KEY HOLE DIAMETER

R4=20   ;TOTAL DEPTH

R5=4    ;NO. OF CUTS TO DEPTH

R6=8    ;NO. OF RADIAL SLOTS

R7=11   ;CUTTER DIAMETER

;-------------------------------------

R50=R2+R0/2    ;X CO-ORD OF KEY SLOT CENTRE

R51=R1/2       ;Y CO-ORD KEY OF SLOT EDGE

R52=R3/2       ;RAD OF KEY HOLE

R55=SQRT((R3/2*R3/2)-(R1/2*R1/2))    ;X START POINT OF KEY HOLE (POINT 2 & 3 see diagram)

R56=R0+R2-(R52+R55)  ;X COORD TO START OF KEY HOLE

R57=R2+R1/2    ;X CO-ORD OF NEAR RADIUS

R58=360/R6     ;ANGLE BETWEEN SLOTS

R59=R4/R5      ;INC DEPTH

R60=1          ;DEPTH COUNTER

R61=0          ;ROTATION ANGLE COUNTER (0=3PM)

IF R7>=R1      ;TEST IF CUTTER IS TOO BIG GO TO LABEL "ERR"

GOTOF ERR1

ELSE

GOTOF N1
```



There is a requirement to test for errors in the entry of variables in this type of programming. Here is a simple example of a test to see it the cutter selected is too big for the slot. A fully formed program would have several tests to safeguard the running of the program and the correctness of part geometry, etc.

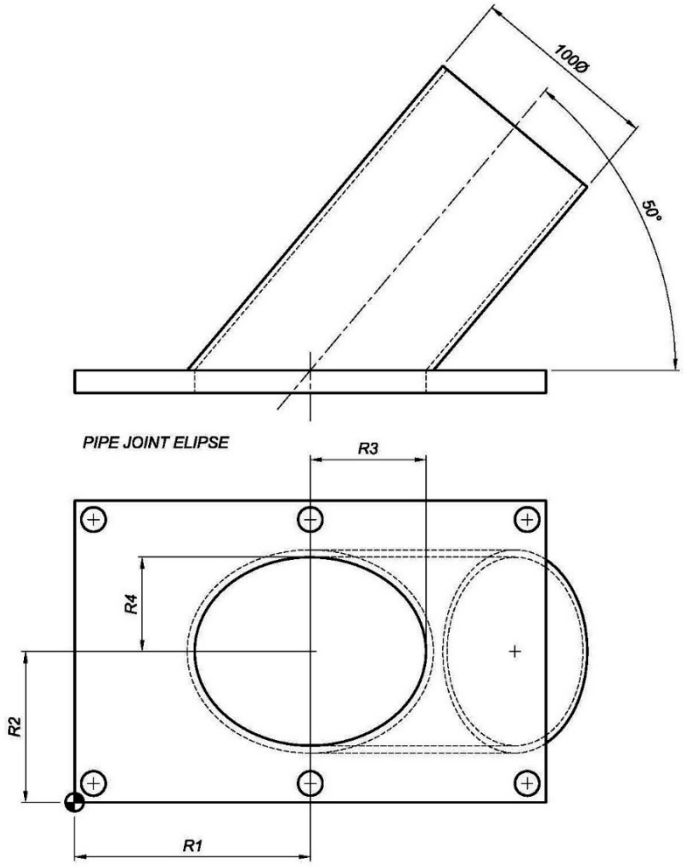
```
N1 G54         ;WORK SHIFT

G0 Z100
```

```
X0 Y0
T11
D1
ROT RPL=R61    ;SET ROTATION TO ZERO
ANGLE:         ;LABEL
G0 Z10
G1 Z0 F1000 S350 M3    ;FEED DOWN TO Z ZERO
;--- SLOT PROFILE & Z MOVES---
SLOT:          ;LABEL
X=R50 Y=0      ;MOVE TO SLOT CENTRE
G91 Z-R59      ;INCREMENT Z DOWN
G90            ;BACK TO ABSOLUTE
G1 G41 Y=-R51  ;ENGAGE CUTTER COMP
X=R56
G3 X=R56 Y=R51 I=R55 J=R51
G1 X=R57
G3 Y=-R51 I0 J=-R51
G1 X=R50
G40 Y0         ;DISENGAGE CUTTER COMP
ENDLABEL:      ;END OF PROFILE
R60=R60+1      ;INCREMENT DEPTH COUNTER
IF R60>R5      ;TEST DEPTH COUNTER
GOTOF N2       ;GOTO FORWARD TO N2 IF R60 GT R5
ELSE
GOTOB SLOT     ;ELSE GO BACK TO LABEL SLOT REPEAT PROFILE
ENDIF
N2 R60=1       ;RESET DEPTH COUNTER
G0 Z10         ;MOVE Z UP CLEAR
R61=R61+R58    ;INCREMENT ANGULAR ROTATION
IF R61>=360    ;TEST ANGULAR ROTATION
GOTOF END      ; GO TO END LABEL
ELSE
ROT RPL=R61    ;SET NEW ROTATION ANGLE
```

```
GOTOB ANGLE   ; GO BACK TO ANGLE LABEL
ENDIF
END:
G0 Z100
ROT                ;CANCEL ANGULAR ROTATION
G0 X-200 Y-200 ;MOVE TO UNLOAD POSITION
M30                ;END OF PROGRAM AND RESET
;***** ERROR SECTION *****
ERR1:    ;LABEL FOR CUTTER DIA TEST
MSG ("CUTTER DIAM GREATER THAN SLOT WIDTH")
M00      ; STOP PROGRAM AND THE MSG ABOVE WILL BE EVIDENT ON THE CNC HMI
```

Example 2

There is a requirement to produce an elliptical hole in a plate to accept a pipe to be welded to the plate that has been cut at an angle. See drawing below.



From the start of the program, you can see the basic R variable assignment that will be used to control the size and shape of the Ellipse.

R1=125 ;CENTRE IN X

R2=80 ;CENTRE IN Y

R3=61.5 ;RADIUS IN X

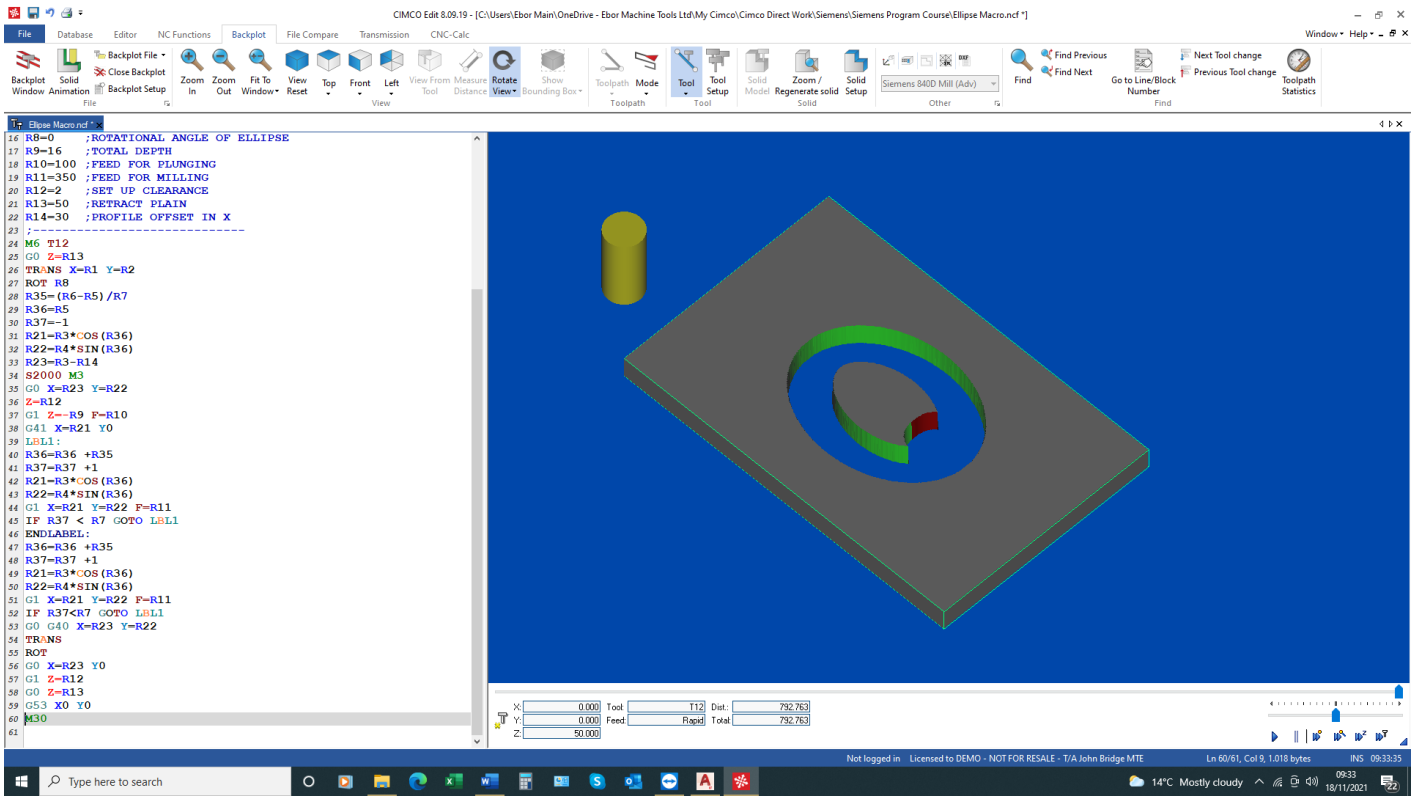
R4=47 ;RADIUS IN Y

R5=0 ;START ANGLE

R6=360 ;END ANGLE

R7=100 ;NO OF STEPS

See below the resulting Solid Animation Backplot. The program to create the ellipse is listed below with comments attached to the blocks with explanations. We have only considered the elliptical shape here and some area clearance or pilot holes may be required for Z axis entry etc.



%_N_0110_MPF

;$PATH=/_N_WKS_DIR/_N_SIEMENS_TEST_JB_WPD

;DESCRIPTION-ELLIPSE PARA SUB

;DRAWING NO-00000 ISSUE-A

;OPERATION-MILL ELLIPSE PROFILE

;PROGRAMMER-JOE SMITH

;DATE/TIME-08/10/2021 10:50:44

;Program Header with comment details

;----------

R1=125 ;CENTRE IN X

R2=80 ;CENTRE IN Y

R3=61.5 ;RADIUS IN X

R4=47 ;RADIUS IN Y

R5=0 ;START ANGLE

R6=360 ;END ANGLE

R7=100 ;NO OF STEPS

Variable Assignment

R8=0 ;ROTATIONAL ANGLE OF ELLIPSE

The Ellipse can be rotated to an angle with this variable. Zero degrees is at 3 O/Clock

R9=16 ;TOTAL DEPTH

R10=100 ;FEED FOR PLUNGING

R11=350 ;FEED FOR MILLING

Variable Assignment

8

```
R12=2           ;SET UP CLEARANCE
R13=50          ;RETRACT PLAIN
R14=30          ;PROFILE OFFSET INSIDE IN X
;-----------------------------
M6 T12                  ;CALL THE TOOL INTO THE SPINDLE
D1                      ;ACTIVATE TOOL OFFSET
G0 Z=R13                ; RAPID TO  Z RETRACT PLANE
TRANS X=R1 Y=R2         ; TEMP WORK SHIFT TO CENTRE OF ELLIPSE
ROT RPL=R8                      ; ROTATION ANGLE OF ELLIPSE (0=3PM)
R35=(R6-R5)/R7          ;CALC INCREMENTAL ANGLE
R36=R5                  ;START ANGLE
R37=-1                  ;SET ANGLE COUNTER
R21=R3*COS(R36)         ;CALC X END POINT OF CURRENT ANGLE
R22=R4*SIN(R36)         ;CALC Y END POINT OF CURRENT ANGLE
R23=R3-R14              ;CALC SAFE START POSITION
S2000 M3                ;START SPINDLE
G0 X=R23 Y=R22          ;MOVE TO ELLIPSE SAFE START POSITION
Z=R12                   ;RAPID DOWN TO SAFE START POSITION IN Z
G1 Z=-R9 F=R10          ;FEED DOWN TO DEPTH
G41 X=R21 Y0            ; MOVE ONTO ELLIPSE PROFILE
LBL1:                   ;LABLE
R36=R36 +R35            ;CALC NEW ANGLE
R37=R37 +1              ;INCREMENT COUNTER +1
R21=R3*COS(R36)         ;CALC X END POINT OF CURRENT ANGLE
R22=R4*SIN(R36)          ;CALC Y END POINT OF CURRENT ANGLE
G1 X=R21 Y=R22 F=R11    ;MACHINE CURRENT ELLIPSE INCREMENT
IF R37 < R7 GOTO LBL1   ;TEST INCREMENT COUNT
ENDLABEL:               ;END LABEL
G0 G40 X=R23 Y=R22      ;MOVE BACK TO START POSITION
TRANS                   ;CANCEL TEMP WORK SHIFT TO ELLIPSE CENTRE
ROT             ;CANCEL ROTATION OF ELLIPSE
G1 Z=R12        ; FEED UP TO  Z SAFE POSITION
G0 Z=R13        ; RAPID UP TO  Z RETRACT PLANE
```

Variable Assignment

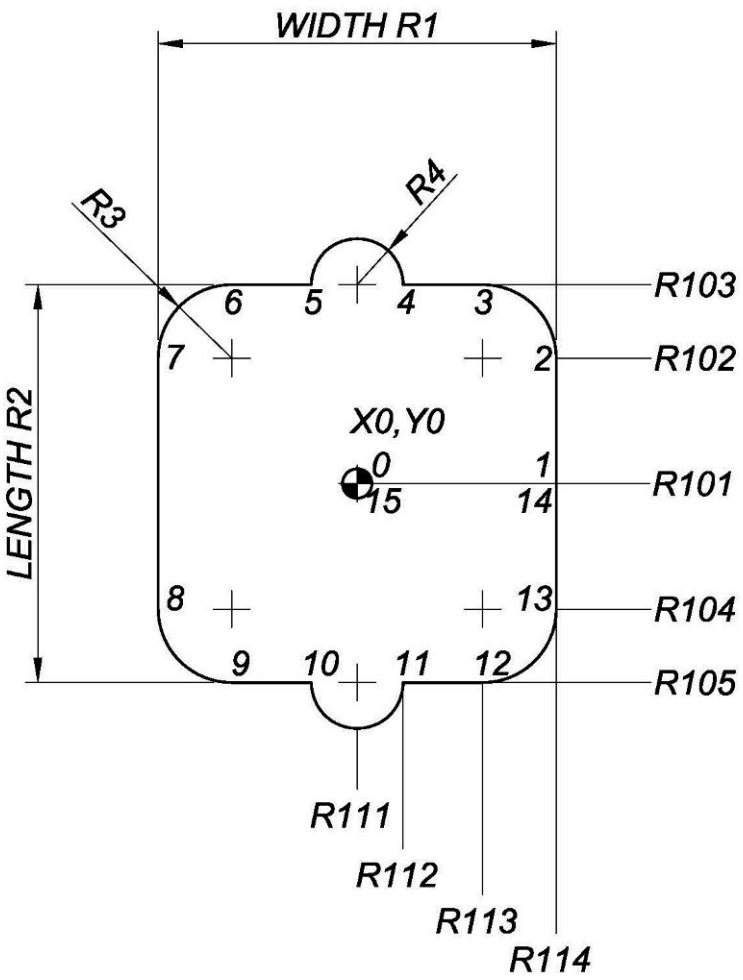
Angle count set to -1 to get a one-step blend overlap

```
G53 X0 Y0        ;MOVE TO MACHINE ZERO X & y TO UNLOAD
M30              ;END OF PROGRAM RESET
```

Example 3

There is a requirement to produce multiple profiled parts from a sheet on material in rows and columns. See below the profile programmed here that can be found within the body of the program. A sub program machining a more complex part could be called from this program instead of the profile here. From the diagram below see the points as indicated 0-14 used to create the program blocks that will change family shape dependent on the variables entered. A program that can be seen below further down the will facilitate the simple editing of these variables to create multiple parts form a given sheet of material.

0=X0 Y=0
1 - X=R114 Y=0
2 - X=R114 Y=R102
3 - X=R113 Y=R103
4 - X=R112 Y=R103
5 - X=-R112 Y=R103
6 - X=-R113 Y=R103
7 - X=-R114 Y=R102
8 - X=-R114 Y=-R104
9 - X=-R113 Y=-R105
10 - X=-R112 Y=-R105
11 - X=R112 Y=-R105
12 - X=R113 Y=-R105
13 - X=R114 Y=-R104
14 - X=R114 Y0
15 - X0 Y0



See the basic variable entries below:

;---NOTCHED PROFILE DETAILS ---

R1=80 ;WIDTH

R2=80 ;DEPTH

R3=20 ;CORNER RAD

R4=16 ;NOTCH RAD

R5=20 ;TOTAL DEPTH

R6=3 ;NO. OF CUTS TO DEPTH

;--- ROW, COLUMN, Z DETAILS ---

R7=50 ;RETRACT HEIGHT

R8=2 ;R PLANE Z POSITION

R9=4 ;NO OF ROWS Y

R10=3 ;NO OF COLUMNS X

R11=60 ;POSN OF 1ST PROFILE X

R12=86 ;POSN OF 1ST PROFILE Y

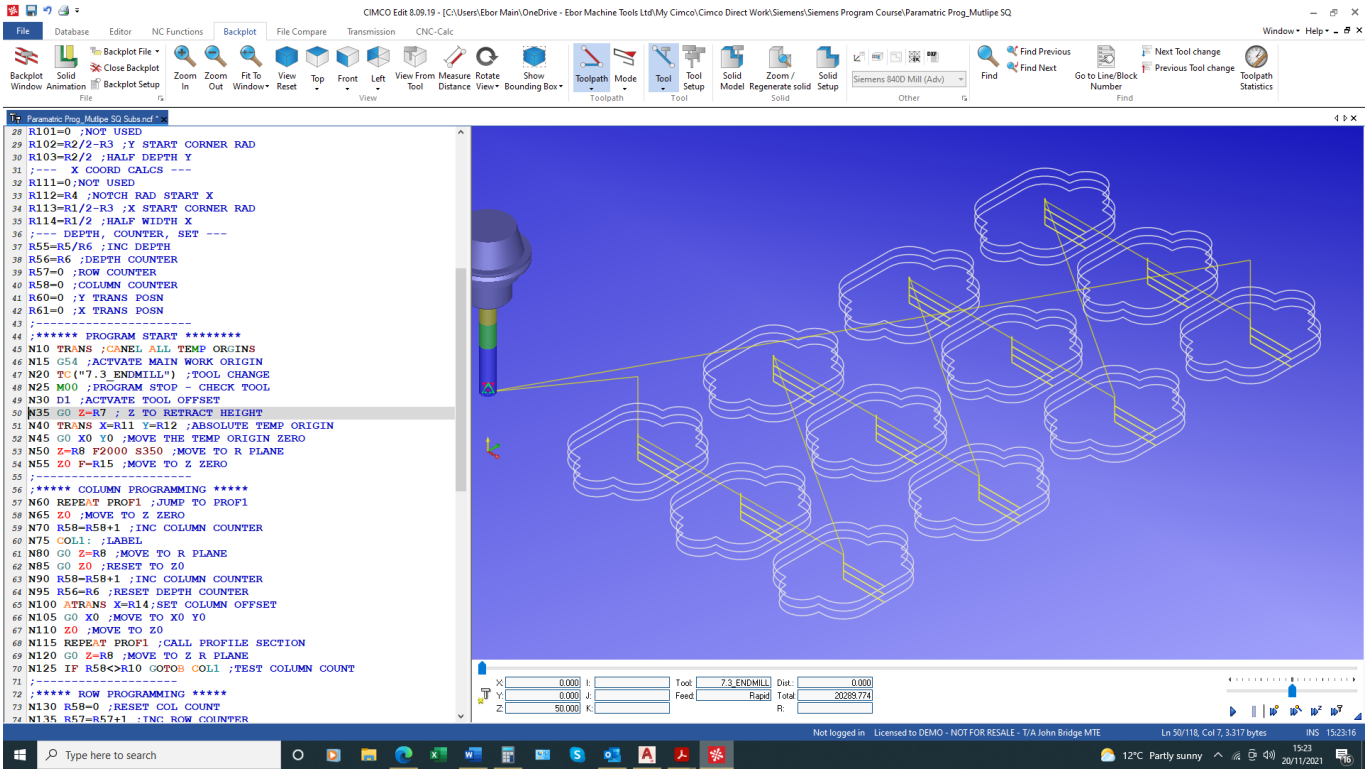
R13=132 ;DIST BETWEEN ROWS Y

R14=100 ;DIST BETWEEN COLUMNS X

R15=1500 ;Z PLUNGE FEED RATE

R16=2000 ;PROFILING FEED RATE

From the entries above the program can be tested. See the Tool path Backplot below showing the correct number of depth cuts and regular spacing as per the entries …..



If we now wish to test the program in Solid Animation the Solid Setup must be set to depict the sheet size to test the nesting of the multiple parts. To do this we need to fix the first part using variables R11 and R12 and then set the Solid Setup X, Y, Z, plus and minus to represent the area of sheet material that our Rows and Columns will fit.

To set R11 and R12 see the guide below: The simple formula below will fix the first part on the sheet and other parts will be spaced as per the other variables.

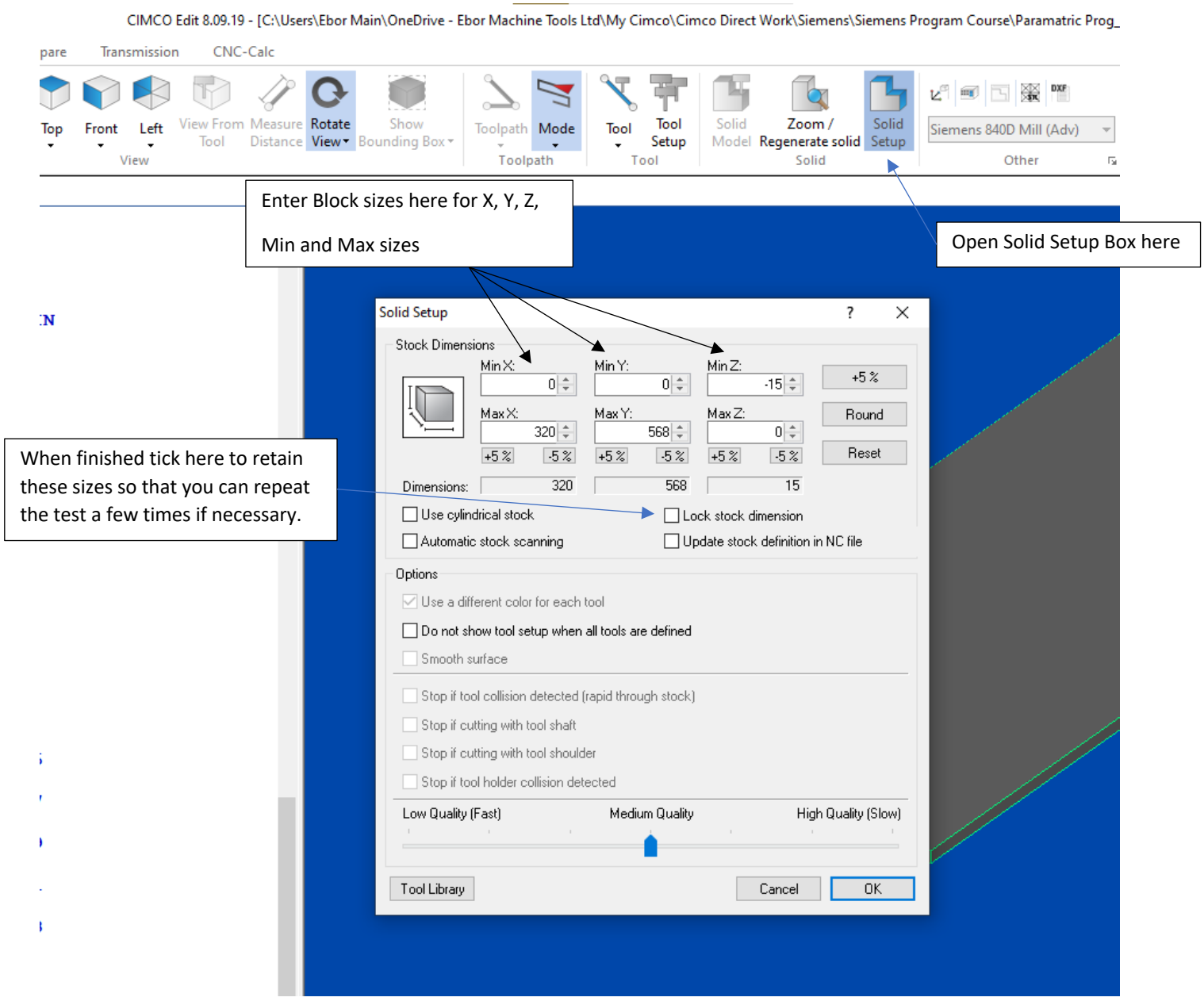
R11=R1/2+20 (Position of 1st part in X)

R12=R2/2+R4+20 (Position of 1st part in Y)

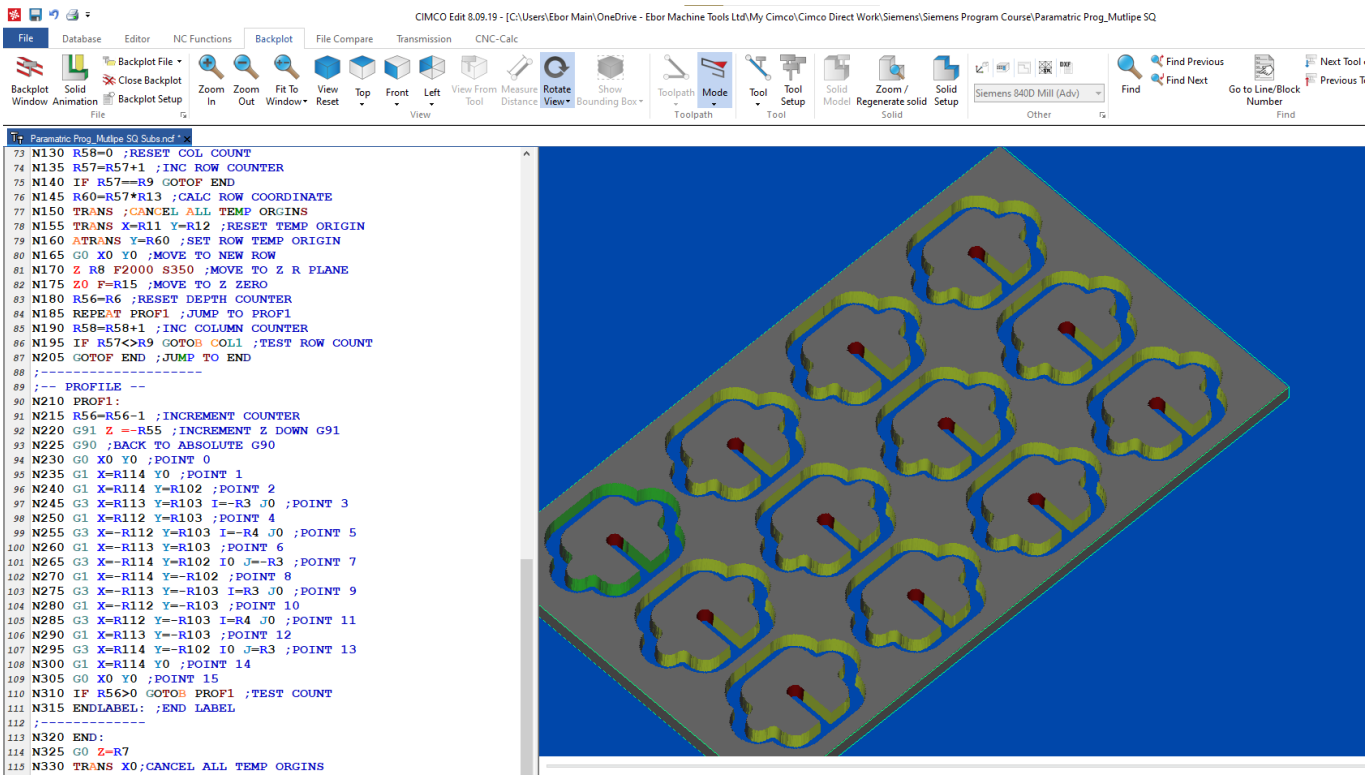
In Solid Animation, Solid Setup needs setting to represent the sheet so that the resultant sheet size shown on the Editor screen, will accommodate all the parts. To achieve a sensible Solid Setup block size, use the formula below and enter the Solid Setup box as indicated below:

X- (Min) = 0 --- X+ (Max)=(R10-1)*R14+R11*2 (EG (3-1)*100+60*2=320)

Y-(Min) = 0 --- Y+ (Max)=(R9-1)*R13+R12*2 (EG (4-1)*132+86*2=568)



See the resulting Solid Animation from the Cimco Editor below.



See the whole program set out below with comment descriptions on each block.

%_N_0110_MPF

;$PATH=/_N_WKS_DIR/_N_SIEMENS_TEST_JB_WPD

;DESCRIPTION-MULTIPAL PROFILES

;CPN-000

;DRAWING NO-00000 ISSUE-0

;PROGRAMMER-JOHN BRIDGE

;DATE/TIME-21/10/2021 10:47:45

Program Header

;------------------------------

;---NOTCHED PROFILE DETAILS ---

R1=80 ;WIDTH

R2=80 ;DEPTH

R3=20 ;CORNER RAD

R4=16 ;NOTCH RAD

R5=20 ;TOTAL DEPTH

```
R6=3                    ;NO. OF CUTS TO DEPTH
;--- ROW, COLUMN, Z DETAILS ---
R7=50                   ;RETRACT HEIGHT
R8=2                     ;R PLANE
R9=4                    ;NO OF ROWS Y
R10=3                   ;NO OF COLUMNS X
R11=0                   ;POSN OF 1ST PROFILE X
R12=0                   ;POSN OF 1ST PROFILE Y
R13=132                 ;DIST BETWEEN ROWS Y
R14=100                 ;DIST BETWEEN COLUMNS X
R15=1500                ;Z PLUNGE FEED RATE
R16=2000                ;PROFILING FEED RATE
;--- Y COORD CALCS ---
R101=0                  ;NOT USED
R102=R2/2-R3            ;Y START CORNER RAD
R103=R2/2               ;HALF DEPTH Y
;---  X COORD CALCS ---
R111=0                  ;NOT USED
R112=R4                 ;NOTCH RAD START X
R113=R1/2-R3            ;X START CORNER RAD
R114=R1/2               ;HALF WIDTH X
;--- DEPTH, COUNTER, SET ---
R55=R5/R6               ;INC DEPTH
R56=R6                  ;DEPTH COUNTER
R57=0                   ;ROW COUNTER
R58=0                   ;COLUMN COUNTER
R60=0                   ;Y TRANS POSN
R61=0                   ;X TRANS POSN
;----------------------
;****** PROGRAM START ********
TRANS                   ;CANEL ALL TEMP ORGINS
G54                     ;ACTVATE MAIN WORK ORIGIN
TC("7.3_ENDMILL")       ;TOOL CHANGE
```

```
M00                     ;PROGRAM STOP - CHECK TOOL
D1                      ;ACTVATE TOOL OFFSET
G0 Z=R7                 ; MOVE Z TO RETRACT HEIGHT
TRANS X=R11 Y=R12       ;ABSOLUTE TEMP ORIGIN
G0 X0 Y0                ;MOVE THE TEMP ORIGIN ZERO
Z=R8 F2000 S350         ;MOVE TO R PLANE
Z0 F=R15                ;MOVE TO Z ZERO
;----------------------
;***** COLUMN PROGRAMMING *****
REPEAT PROF1            ;JUMP TO PROF1
Z0                      ;MOVE TO Z ZERO
R58=R58+1               ;INC COLUMN COUNTER
COL1:                   ;LABEL
G0 Z=R8                 ;MOVE TO R PLANE
G0 Z0                   ;RESET TO Z0
R58=R58+1               ;INC COLUMN COUNTER
R56=R6                  ;RESET DEPTH COUNTER
ATRANS X=R14            ;SET COLUMN OFFSET
G0 X0                   ;MOVE TO X0 Y0
Z0                      ;MOVE TO Z0
REPEAT PROF1            ;CALL PROFILE SECTION
G0 Z=R8                 ;MOVE TO Z R PLANE
IF R58<>R10 GOTOB COL1 ;TEST COLUMN COUNT
;--------------------
;***** ROW PROGRAMMING *****
R58=0                   ;RESET COL COUNT
R57=R57+1               ;INC ROW COUNTER
IF R57==R9 GOTOF END ;TEST ROW COUNT
R60=R57*R13             ;CALC ROW COORDINATE
TRANS                   ;CANCEL ALL TEMP ORIGINS
TRANS X=R11 Y=R12       ;RESET TEMP ORIGIN
ATRANS Y=R60            ;SET ROW TEMP ORIGIN
G0 X0 Y0                ;MOVE TO NEW ROW
```

```
Z R8 F2000 S350          ;MOVE TO Z R PLANE
Z0 F=R15                 ;MOVE TO Z ZERO
R56=R6                   ;RESET DEPTH COUNTER
REPEAT PROF1             ;JUMP TO PROF1
R58=R58+1                ;INC COLUMN COUNTER
IF R57<>R9 GOTOB COL1 ;TEST ROW COUNT
GOTOF END                ;JUMP TO END
;--------------------
;-- PROFILE --
PROF1:                   ;LABEL
R56=R56-1                ;INCREMENT COUNTER
G91 Z =-R55              ;INCREMENT Z DOWN G91
G90                      ;BACK TO ABSOLUTE G90
G0 G41 X0 Y0                    ;POINT 0
G1 X=R114 Y0                    ;POINT 1
G1 X=R114 Y=R102                ;POINT 2
G3 X=R113 Y=R103 I=-R3 J0       ;POINT 3
G1 X=R112 Y=R103                ;POINT 4
G3 X=-R112 Y=R103 I=-R4 J0      ;POINT 5
G1 X=-R113 Y=R103               ;POINT 6
G3 X=-R114 Y=R102 I0 J=-R3      ;POINT 7
G1 X=-R114 Y=-R102              ;POINT 8
G3 X=-R113 Y=-R103 I=R3 J0      ;POINT 9
G1 X=-R112 Y=-R103              ;POINT 10
G3 X=R112 Y=-R103 I=R4 J0       ;POINT 11
G1 X=R113 Y=-R103               ;POINT 12
G3 X=R114 Y=-R102 I0 J=R3       ;POINT 13
G1 X=R114 Y0                    ;POINT 14
G0 G40 X0 Y0                    ;POINT 15
IF R56>0 GOTOB PROF1  ;TEST COUNT
ENDLABEL:                ;END LABEL
;-------------
END:                     ;LABEL
```

```
G0 Z=R7                 ;GO TO RETRACT HEIGHT
TRANS X0                ;CANCEL ALL TEMP ORIGINS
G0 X-100 Y-100          ;MOVE TO UNLOAD POSITION
M30                     ;END OF PROGRAM RESET
```