

3.5 Slots on a circle - SLOT1



Programming

SLOT1 (RTP, RFP, SDIS, DP, DPR, NUM, LENG, WID, CPA, CPO, RAD, STA1, INDA, FFD, FFP1, MID, CDIR, FAL, VARI, MIDF, FFP2, SSF, _FALD, _STA2)



Parameters

| | | |
|------|------|--|
| RTP | real | Retraction plane (absolute) |
| RFP | real | Reference plane (absolute) |
| SDIS | real | Safety clearance (enter without sign) |
| DP | real | Slot depth (absolute) |
| DPR | real | Slot depth relative to the reference plane (enter without sign) |
| NUM | int | Number of slots |
| LENG | real | Slot length (enter without sign) |
| WID | real | Slot width (enter without sign) |
| CPA | real | Center point of circle, abscissa (absolute) |
| CPO | real | Center point of circle, ordinate (absolute) |
| RAD | real | Radius of circle (enter without sign) |
| STA1 | real | Initial angle |
| INDA | real | Indexing angle |
| FFD | real | Feedrate for depth infeed |
| FFP1 | real | Feedrate for surface machining |
| MID | real | Maximum infeed depth for infeed (enter without sign) |
| CDIR | int | Milling direction for machining the slot Value: 0...Climb milling (as spindle rotation) 1...Opposed milling 2...with G2 (independent of spindle direction) 3...with G3 |
| FAL | real | Final machining allowance on slot edge (enter without sign) |
| VARI | int | Machining type (enter without sign) UNITS DIGIT: Value: 0...Complete machining 1...Roughing 2...Finishing TENS DIGIT: Value: 0...Perpendicular with G0 1...Perpendicular with G1 3...Oscillation with G1 |
| MIDF | real | Maximum infeed depth for finishing |
| FFP2 | real | Feedrate for finishing |

| | | |
|-------|------|--|
| SSF | real | Speed for finishing |
| _FALD | real | Final machining allowance on the base of slot |
| _STA2 | real | Maximum insertion angle for oscillation movement |



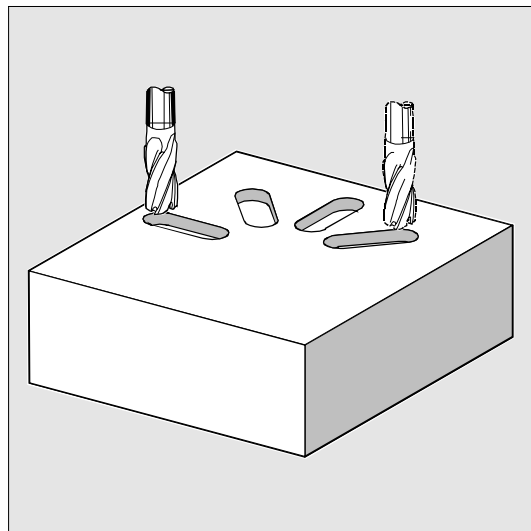
The cycle requires a milling cutter with an "end tooth cutting over center" (DIN 844).



Function

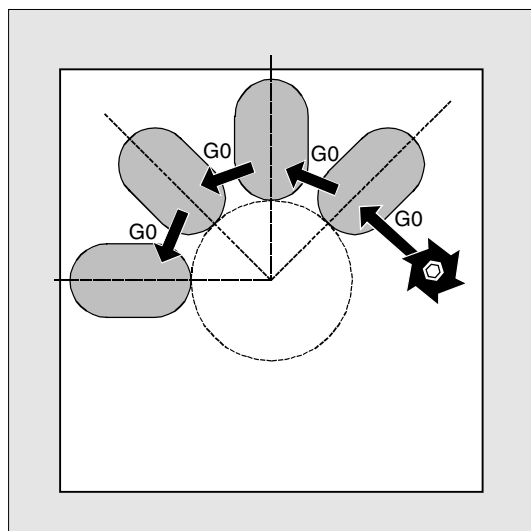
Cycle SLOT1 is a combined roughing-finishing cycle.

With this cycle you can machine slots arranged on a circle. The longitudinal axis of the slots is arranged radially. Unlike the elongated hole, a value is defined for the slot width.



Sequence of operations

Position reached before the beginning of the cycle:
The starting position can be any position from which each of the slots can be approached without collision.

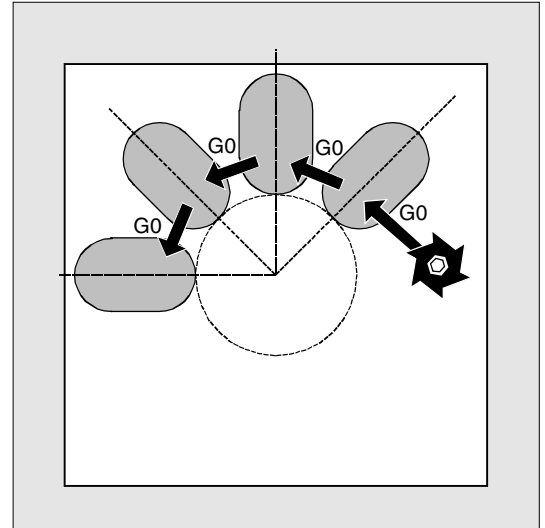


The cycle implements the following motion sequence:

- Travel to the position marked in the figure on the right at the beginning of the cycle with G0
- Complete machining of a slot is performed in the following stages:
 - Approach to reference plane brought forward by the safety clearance with G0.
 - Infeed to the next machining depth as programmed under VAR1 and at feed value FFD.
 - Solid machining of the slot to the final machining allowance on slot base and slot edge at feed value FFP1.

Subsequent finishing at feed value FFP2 and spindle speed SSF along the contour according to the machining direction programmed under CDIR.

- The vertical depth infeed with G0/G1 is always performed at the same position in the machining plane down to the final depth of the slot.
- Retract tool to retraction plane and move to next slot with G0.
- When the last slot has been machined, the tool is moved with G0 to the final position specified in the display in the machining plane until the retraction plane is reached and the cycle ended.





Description of parameters



See Section 2.1.2. (Drilling, Centering – CYCLE81) for a description of parameters RTP, RFP, SDIS.
See Section 3.2 for cycle setting data _ZSD[1].

DP and DPR (slot depth)

The slot depth can be defined as either absolute (DP) or relative (DPR) to the reference plane.

If it is entered as a relative value, the cycle automatically calculates the correct depth on the basis of the positions of the reference and retraction planes.

NUM (number)

The number of slots is determined with the parameter NUM.

LENG and WID (slot length and slot width)

The shape of a slot in the plane is determined with parameters LENG and WID. The milling cutter diameter must be smaller than the slot width. Otherwise alarm 61105 "Cutter radius too large" will be activated and the cycle aborted.

The milling cutter diameter must not be smaller than half of the slot width. This is not checked.

CPA, CPO and RAD (center point and radius)

The position of the circle of holes in the machining plane is defined by the center point (parameters CPA and CPO) and the radius (parameter RAD). Only positive values may be entered for the radius.

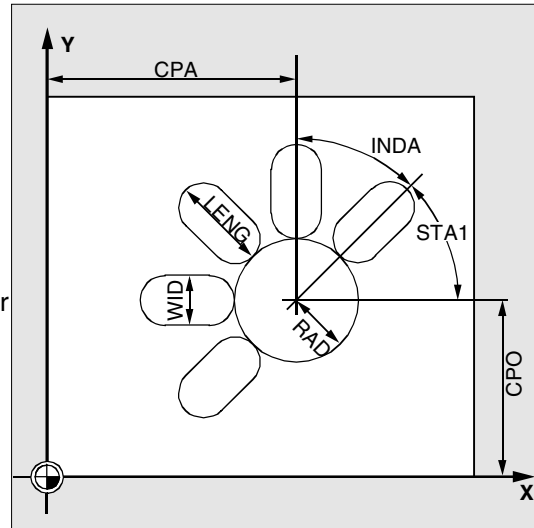
STA1 and INDA (start angle and indexing angle)

The arrangement of the slot on the circle is defined by these parameters.

STA1 defines the angle between the positive direction of the abscissa of the workpiece coordinate system active before the cycle was called and the first slot.

Parameter INDA contains the angle from one slot to the next.

If INDA=0, the indexing angle is calculated from the number of slots so that they are arranged equally around the circle.



FFD and FFP1 (feedrate depth and plane)

Feedrate FFD is operative for vertical infeed to the machining plane with G1 and for insertion with oscillation motion.

Feedrate FFP1 is active for all movements in the plane traversed at feedrate when roughing.

MID (infeed depth)

The maximum infeed depth is defined with this parameter. The depth infeed is performed by the cycle in equally sized infeed steps.

Using MID and the total depth, the cycle automatically calculates this infeed which lies between 0.5 x maximum infeed depth and the maximum infeed depth. The minimum possible number of infeed steps is used as the basis. MID=0 means that the cut to slot depth is made with one infeed.

The depth infeed commences at the reference plane moved forward by the safety clearance (as a function of _ZSD[1]).

CDIR (milling direction)

You define the slot machining direction in this parameter.

Under parameter _CDIR the mill direction

- direct "2 for G2" and "3 for G3" or
 - alternatively "climb milling" or "opposed milling"
- can be programmed. Climb milling or opposed milling is determined within the cycle via the spindle direction activated prior to the cycle call.

| Climb milling | Opposed milling |
|----------------------|------------------------|
| M3 → G3 | M3 → G2 |
| M4 → G2 | M4 → G3 |

FAL (final machining allowance at slot edge)

With this parameter you can program a final machining allowance on the slot edge. FAL does not affect the depth infeed. If the value of FAL is greater than allowed for the specified width and the milling cutter used, FAL is automatically reduced to the maximum possible value. In the case of rough machining, milling is performed with a reciprocating movement and depth infeed at both end points of the slot.

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VARI, MIDF, FFP2 and SSF (machining type, infeed depth, feedrate and speed)

You can define the type of machining with parameter VARI.

Possible values are:

UNITS DIGIT

- 0=Complete machining in two parts
 - Machining of the slot (SLOT1, SLOT2) or pocket (POCKET1, POCKET2) to the final machining allowance is performed at the spindle speed programmed before the cycle was called and with feedrate FFP1. Depth infeed is defined with MID.
 - Solid machining of the remaining machining allowance is carried out at the spindle speed defined by SSF and feedrate FFP2. The depth infeed is performed via MIDF. If MIDF=0, the infeed is equal to the final depth. If FFP2 is not programmed, feedrate FFP1 is active. The situation is similar if SSF is missing, i.e., the speed programmed before the call is active.
- 1=Roughing

The slot (SLOT1, SLOT2) or pocket (POCKET1, POCKET2) is solid machined up to the finishing allowance at the speed programmed before the cycle call and feedrate FFP1. The depth infeed is programmed in MID.
- 2=Finishing

The cycle requires that the slot (SLOT1, SLOT2) or pocket (POCKET1, POCKET2) is already machined to a remaining final machining allowance and that it is only necessary to machine the final machining allowance. If FFP2 and SSF are not programmed, the feedrate FFP1 or the speed programmed before the cycle call is active. The depth infeed is programmed with MIDF.

TENS DIGIT (infeed)

- 0=Perpendicular with G1
- 1=Perpendicular with G1
- 3=Oscillation with G1

If another value is programmed for the parameter VARI, the cycle aborts after output of the alarm 61102 "Operating mode not defined correctly".

_FALD (final machining allowance on slot base)

A separate final machining allowance on the base is taken into account in roughing operations.

_STA2 (insertion angle)

Parameter _STA1 defines the maximum insertion angle for the oscillation motion.

- **Vertical insertion (VARI=0X, VARI=1X)**

Vertical depth insertion is always performed at the same position on the machining plane down to the final depth of the slot.

- **Insertion with oscillation on the center axis of the slot (VARI=3X)**

means that the mill center point oscillates along an oblique linear path until it has reached the next current depth. The maximum insertion angle is programmed under _STA2, the length of the oscillation path is calculated from LENG-WID.

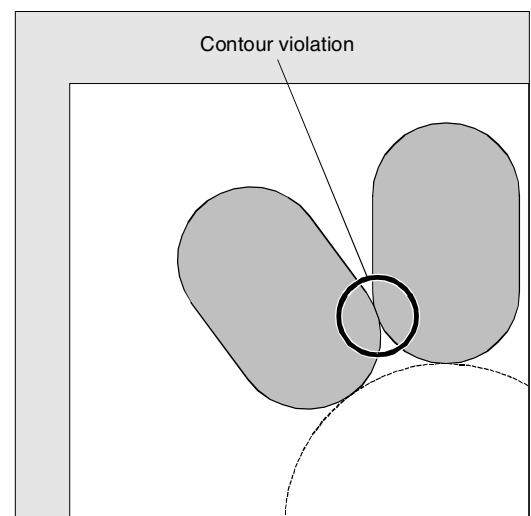
The oscillating depth infeed ends at the same point as with vertical depth infeed motions, the starting point in the plane is calculated accordingly. The roughing operation begins in the plane once the current depth is reached. The feedrate is programmed under _FFD.



Further notes

A tool offset must be activated before the cycle is called. Otherwise the cycle is aborted and alarm 61000 "No tool offset active" is output.

If incorrect values are assigned to the parameters that determine the arrangement and size of the slots and thus cause mutual contour violation of the slots, the cycle is not started. The cycle is aborted after the error message 61104 "Contour violation of slots/elongated holes" is output.



During the cycle, the workpiece coordinate system is shifted and rotated. The values in the workpiece coordinate system displayed on the actual value display are such that the longitudinal axis of the slot that has just been machined corresponds to the first axis of the current machining plane.

When the cycle is completed, the workpiece coordinate system is again in the same position as it was before the cycle was called.

Programming example

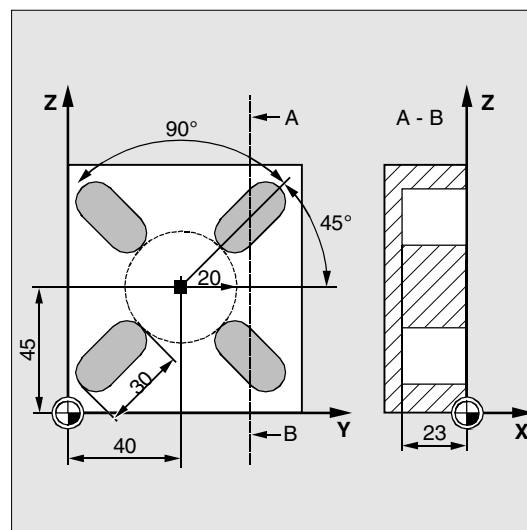
Slots

This program produces the same arrangement of 4 slots on a circle as the program for elongated hole machining (see Section 3.4).

The slots have the following dimensions:

Length 30 mm, width 15 mm and depth 23 mm. The safety clearance is 1 mm, the final machining allowance is 0.5 mm, the milling direction is G2, the maximum infeed in the depth is 10 mm.

The slots must be machined completely with an oscillating insertion motion.



```
N10 G19 G90 D10 T10 S600 M3
```

Specification of technology values

```
N20 G0 Y20 Z50 X5
```

Approach starting position

```
N30 SLOT1 (5, 0, 1, -23, , 4, 30, 15, ->
->40, 45, 20, 45, 90, 100, 320, 10, ->
->2, 0.5, 30, 10, 400, 1200, 0.6, 5)
```

Cycle call, parameters VARI, MIDF, FFP2 and SSF omitted

```
N40 M30
```

End of program

-> Must be programmed in a single block