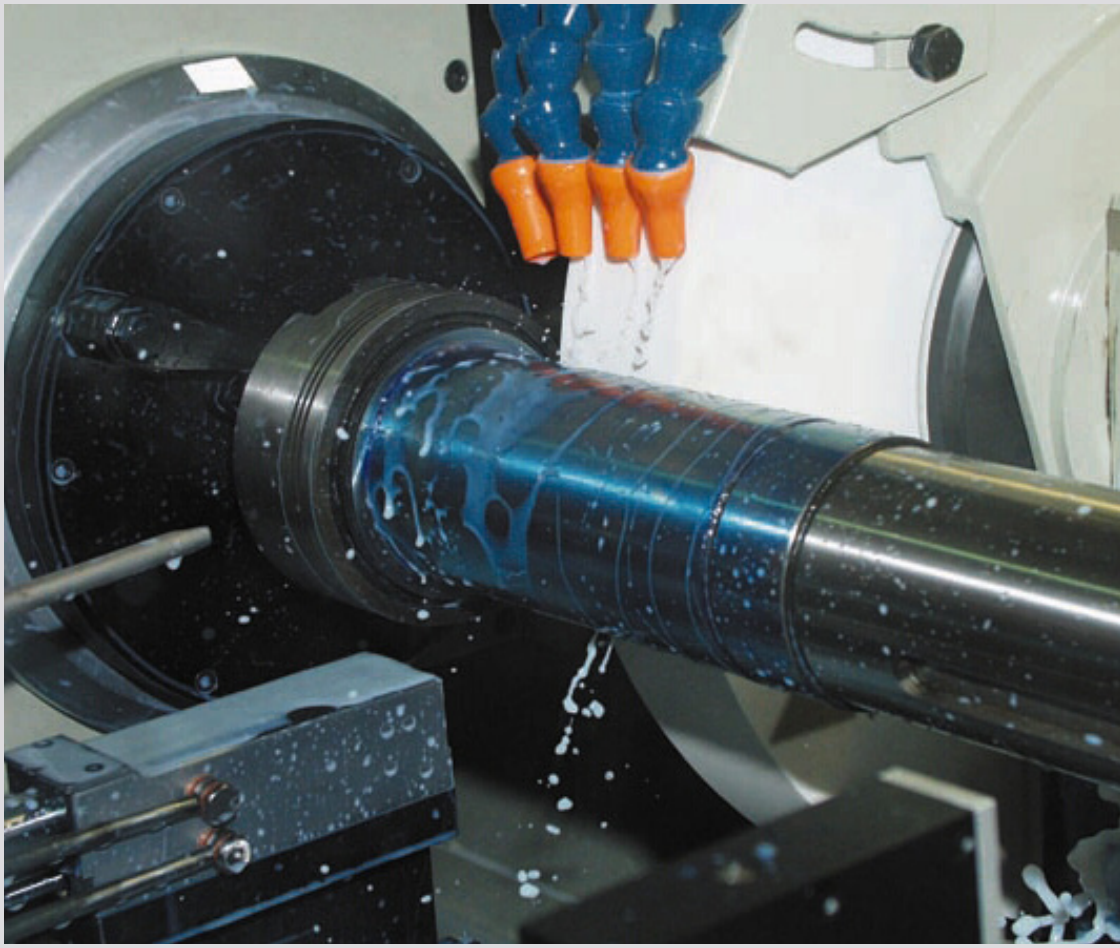
Flexium+ Cylindrical Grinding

Programming manual

(for software release 4.1.10.0)

M00049EN-01

Edition 01.2020



flexium+

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The programming examples described in this manual are intended for guidance only. They must be specially adapted before they can be used in programs with an industrial application, according to the automated system used and the safety levels required.

Summary + Appendix

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Summary

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1 Foreword

1.1 Use of the manual

This manual is for use by qualified personnel only.

To reduce the risk due to an improper use of the product, do not perform any servicing other than that contained in this manual unless you are qualified to do so.

To ensure proper use of these products, please always read this User's manual carefully and retain for future reference. Should the unit require maintenance, please contact a NUM authorized service center only.

1.2 Use of symbols in the manual

Symbol	Meaning of the symbol
	Important notes on product use.
	You may find this symbol whenever a wrong operation may damage the product.

1.3 Document revisions

Date	Index	Reason for revision	See chapter
02 - 2017	00	Document creation	-
01 - 2020	01	Manual compliance with Software Version 4.1.10.00	-

1.4 How to read the manual

This manual gives information about the Flexium+ Cylindrical Grinding Programming manual and its customization to a particular machine.

Chapter	Description
1	**Foreword** This chapter introduces: - The use of the manual. - Use of symbols in the manual. - Document revisions. - How to read the manual. - Using the Programming Manual. - NUM Agencies
2	**General** This chapter introduces: - Description of the grinding axes. - Setting Origins and Shifts. - Wheel Profiles. - Cylindrical Grinding Capabilities. - Preliminary Operations before Starting a Cycle.
3	**Grinding functions and cycles** This chapter introduces: - G Functions - Main summary table. - M Functions - Main summary table. - Setting the dresser origins ► M140 - Wheel Dressing Options. - Selecting the wheel and setting up the working environment ► M06 - Defining the wheel rotation speed from the surface speed ► G230 - Part setup ► M145 - Periodic dressing test counter ► M160 - Passive positioning (axial correction) cycle ► G231 - Intermediate measurement. - Intermediate measurement cycle ► G232 - External grinding cycles. - Internal grinding cycles.
4	**External / Internal Grinding Arguments** - This chapter introduces: - Cycle call arguments table. - In-Cycle arguments table. - Pre-Cycle arguments descriptions. - In-Cycle arguments descriptions.
A	**Appendix** This chapter introduces: - Table of external grinding cycle Syntax. - Table of internal grinding cycle Syntax. - Argument formats at cycle call - External grinding cycles. - In-Cycle argument formats - External grinding cycles. - Argument formats at cycle call - Internal grinding cycles. - In-Cycle argument formats - Internal grinding cycles. - Error messages.

1.5 Using the Programming Manual

This manual is intended for programming CNCs integrated on external/internal cylindrical grinding machines.

It defines the special grinding functions and cycles to be programmed. The other functions that may be used comply with standard use for turning applications; for further information refer to the Flexium+ Programming manual M00040.

Variables L900 to L951 are reserved for NUM programmes. They must not be used in user programmes. It should a/so be noted that programming of functions M200 to M255 is prohibited in G2XX grinding cycle blocks. These functions can however be programmed between two blocks.

Except for the dedicated grinding functions described in this chapter 3, other programming functions used comply with the standard use for turning applications.

The word formats specific to function and cycle programming are defined in Appendix B.

STOP

Variables L900 to L950 are reserved for NUM. Functions M200 to M255 are prohibited in the cycle blocks (but they can be placed between blocks).

1.5.1 Function syntax writing conventions

Grinding programme lines (blocks) include functions and/or arguments.

A special syntax is used with each of the functions described herein. The syntax rules determine how the programme blocks are written.

The following conventions are used in writing the syntax:

- the related function is highlighted in boldface characters,
- the arguments between square brackets [...],

  «/» offers a choice between several terms (equivalent to «OP>),

  ".." after a letter replaces a numerica! value,

  « ...» replaces a character string.

Example

Syntax for cycle G206

The syntax for cycle G206 includes two blocks. The first block contains the cycle call arguments, and the second contains the in-cycle arguments.

Function G206 must not appear in the second block.

Syntax

G206 X.. D.. EZ.. EP.. [ER..] F.. [EE..] [EF..] [EA..] [P..] [EC..] [EH..]
X.. EI.. EJ.. F.. [EG..] [EM..] [EK..] [ED..] [EV..] [ET..] / [EN..] EB..

1.5.2 CNC Operating Modes

Some of the CNC operating modes are mentioned in this manual when they are directly associated with the use of the ISO code function.

Refer to the Flexium+ Programming manual M00040 for further information on these modes.

1.6 NUM Agencies

The list of NUM agencies is given click here http://www.num.com

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Summary

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2 General

2.1 Description of the grinding axes

2.1.1 Axes and Spindles

The axes and spindles are defined as follows:

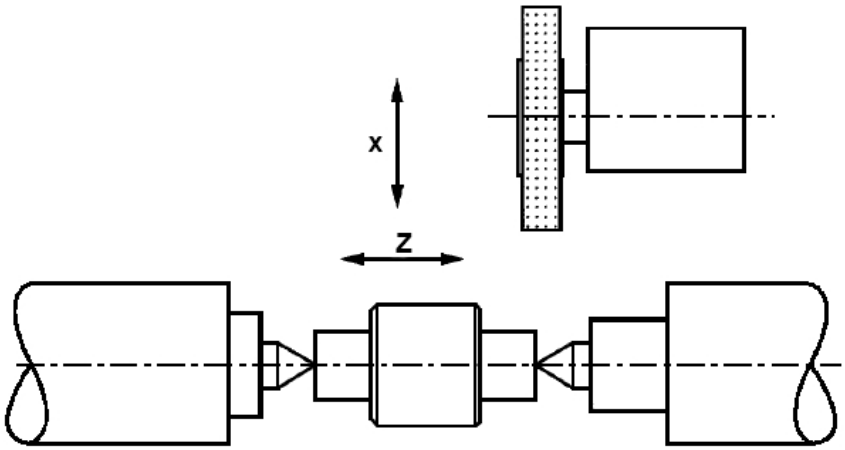
- X: primary radial grinding axis,
- Z: primary axial grinding axis.
- One workpiece-holder spindle.
- One or more wheelhead spindles.

The machine can be defined with B and C axes as well if necessary:

- B: rotary wheelhead axis for grinding with wheel on inclined axis,
- C: measured rotary workpiece holder axis which replaces a spindle.

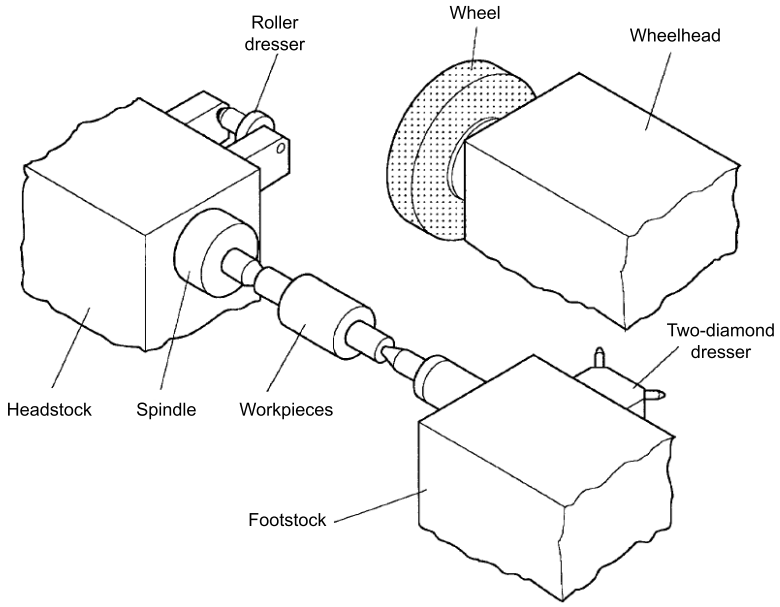
X and Z axes

There can be many grinding machine configurations, but the movements of the X and Z axes are generally defined using the convention shown in the diagram below.



2.1.2 Schematic illustration of a Grinding Machine

External cylindrical grinding machine



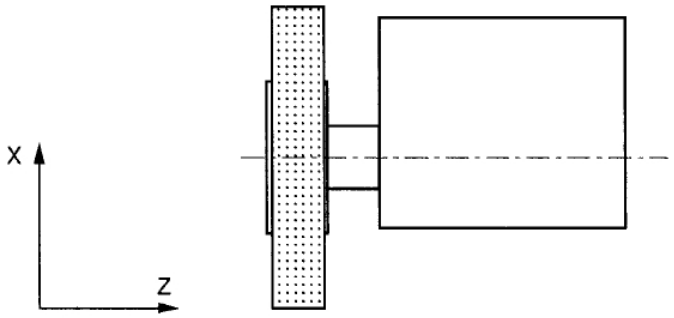
2.1.3 Wheelhead Configurations

Depending on the type of grinding machine and the grinding technique used, the wheelhead can be configured:

- straight,
- on inclined axis.

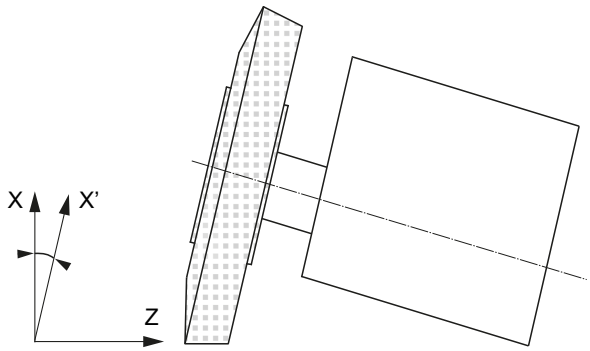
2.1.3.1 Wheelhead (X axis) Straight

The wheel axis is parallel with the Z axis.



2.1.3.2 Wheelhead (X axis) on Inclined Axis

The wheelhead X axis is tilted at the angle specified in machine parameter E69001 (or variable [WD(31)]).



2.1.4 Wheel Dressing Tools

Two types of dresser are generally used on grinding wheels:

- fixed two-diamond dresser,
- roller dresser.

2.1.4.1 Fixed Two-Diamond Dresser

This type of dresser can be used to dress:

- the wheel left and right sides and its peripheral cutting tace (with a radius or chamfer if necessary),
- a complex wheel shape with a special profile.

Limitations associated with the geometry of the fixed two-diamond dresser

All the shaping and dressing cycles performed with the fixed two-diamond dresser are based on the following principle:

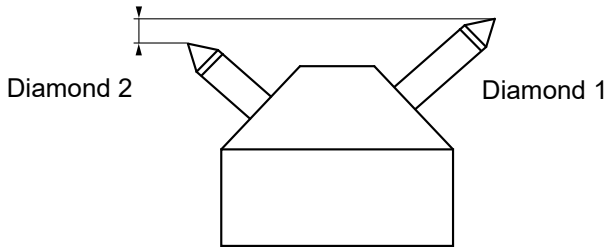
- diamond 1 (right) is used for dressing the wheel peripheral face and its left side,
- diamond 2 (left) is used for dressing the right side of the wheel.

Two-diamond dresser

Since diamond 1 dresses the wheel peripheral face, diamond 2 must be lower than diamond 1.

In this case the difference between the two diamonds is negative. Only this case is considered.

Diamonds 1 and 2 are offset with respect to one another.

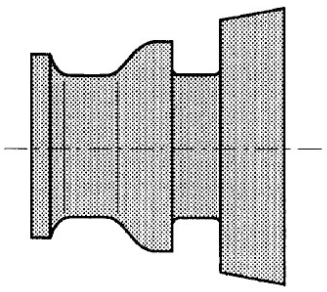


2.1.4.2 Roller Dresser

A roller dresser is a profiled tool used to dress a wheel to the complementary profile.

The roller dresser is rotated by an auxiliary spindle.

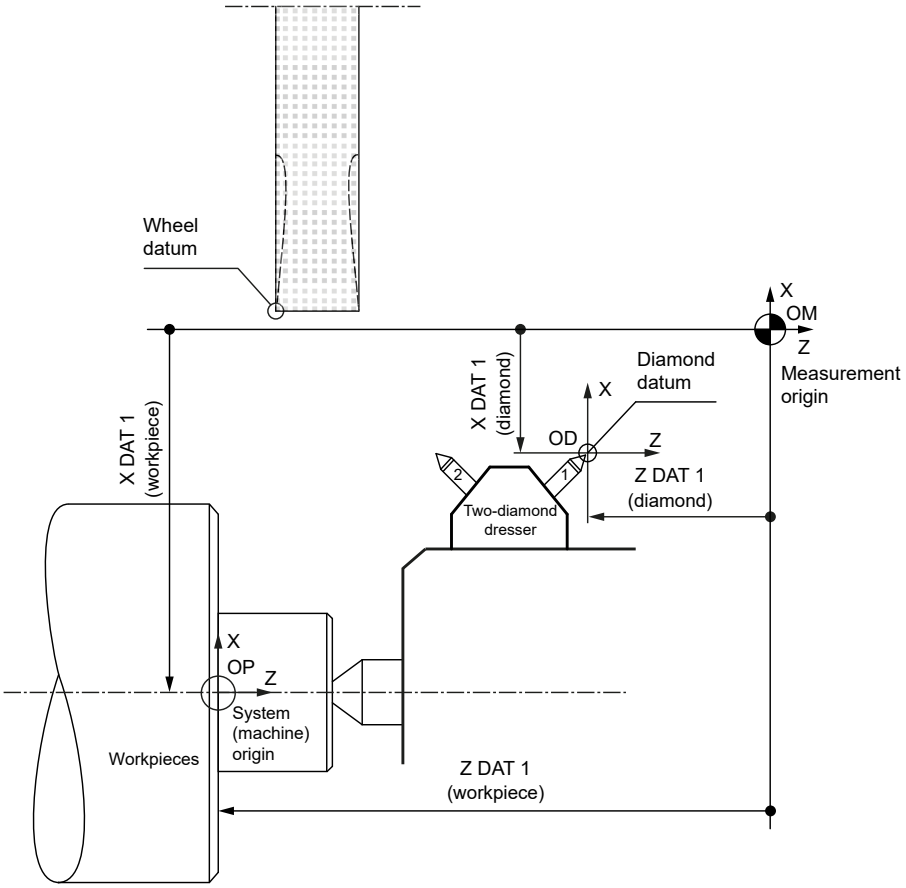
Example of roller dresser



2.2 Setting Origins and Shifts

2.2.1 Machine Origins and Shifts

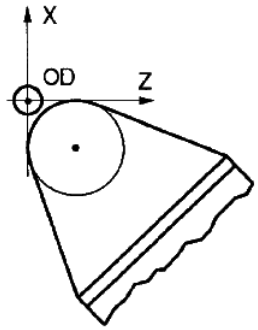
External grinding reference system



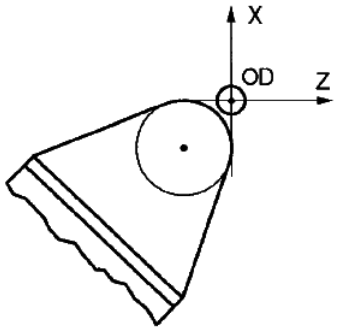
2.2.2 Dresser Origins

2.2.2.1 Fixed Two-Diamond Dresser (Diamonds 1 and 2) Origins

Diamond 2 origin



Diamond 1 origin



2.2.2.2 Roller Dresser Origin

The roller dresser origin can be positioned with respect to the reference side of the wheel (left or right side).

2.3 Wheel Profiles

Flat wheels can be dressed to obtain a number of wheel profiles.

The wheel profiles are:

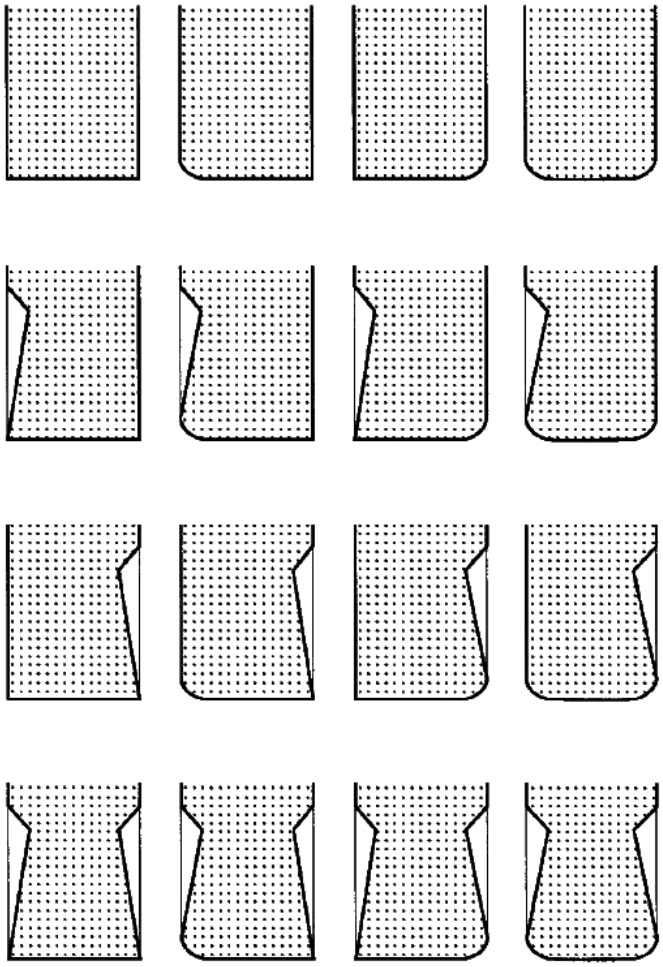
- standard,
- special.

2.3.1 Standard Profiles

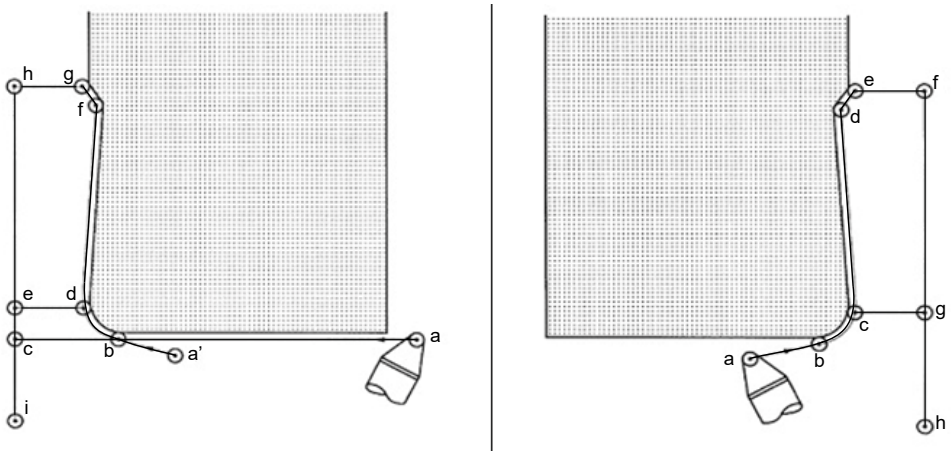
Standard profiles are cut using a shaping function (G245).

2.3.1.1 Obtainable Standard Profiles

The following profiles can be defined with a fillet or chamfer:



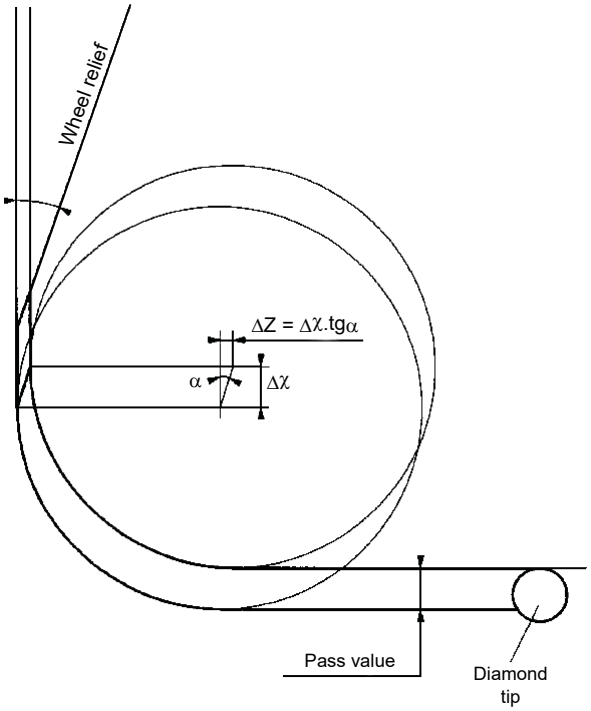
2.3.1.2 Shaping / Dressing Path



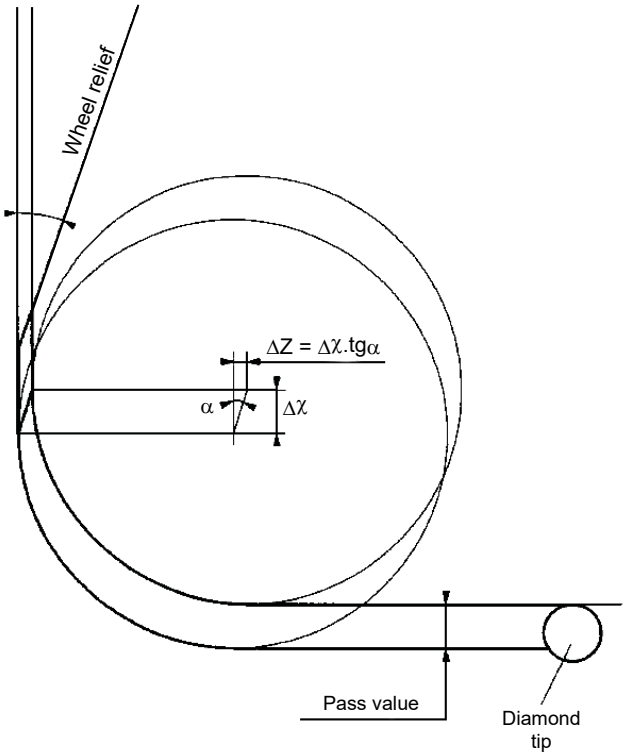
Path of diamond 1			Path of diamond 2		
Side		**Path**	**Side**		**Path**
Face:	**Yes (With radius)**	a, b, d, e, c, i	**Face:**	**Yes (With radius)**	a, b, c, g, h
Face:	**Yes (Without radius)**	a, b, c, i	**Face:**	**Yes (With radius)**	a, b, c, d, e, f, g, h
Face:	**Yes (With radius)**	a, b, d, f, g, h, i	**Side:**	**Right**	
Side:	**Left**				
Face:	**No**	a', b, d, f, g, h, i			
Side:	**Left**				

2.3.1.3 Detail of Radius Dressing

Dressing Wheel Radius and Periphery (with diamond 1)

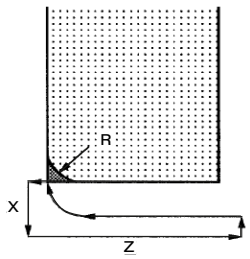
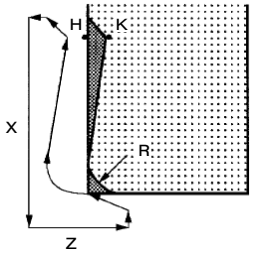
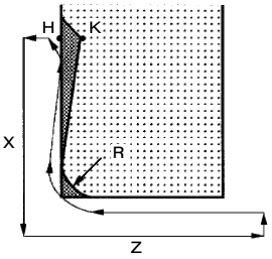
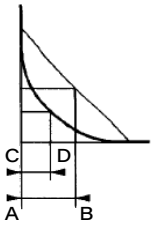
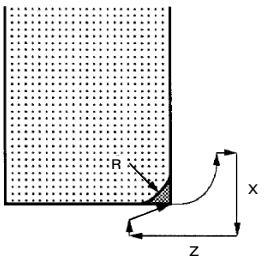
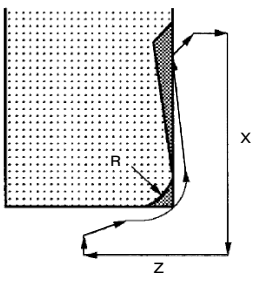


Dressing Wheel Radius, Periphery and Wall (with diamond 1)



2.3.1.4 Axis Movement during Dressing and Shaping

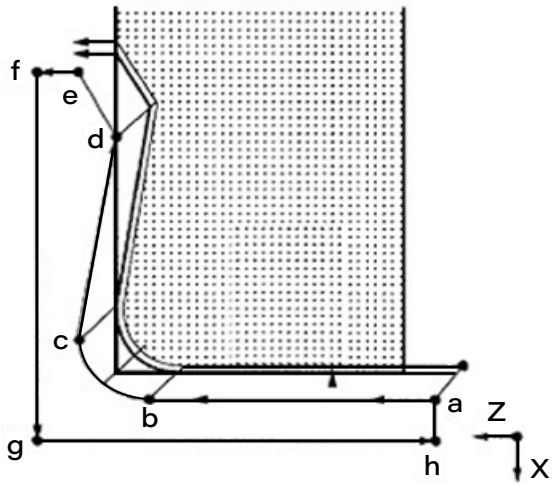
The figures below show the movements executed during the cycles.

Dressing / Shaping of • peripheral face • left radius	
Dressing / Shaping of • wheel left side • left radius	
Dressing / Shaping of • peripheral face • left radius • wheel left side	
Detail of the radius Comparison between HK and: • AB (with chamfer), • CD (with radius)	
Dressing / Shaping of • right radius	
Dressing / Shaping of • right radius • right side	

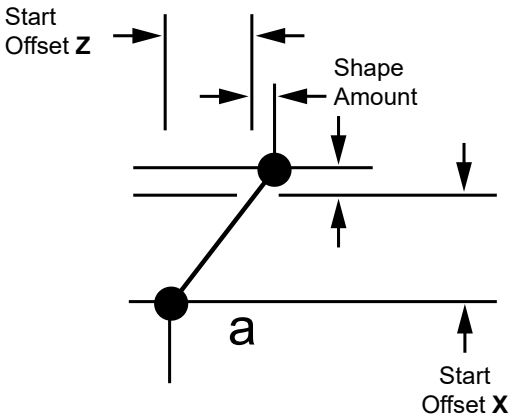
2.3.1.5 Shape Amount & Start Offset

Shape Amount and Calculated Shape Start Offset

- **Rules Applied for Start Offset Calculations**
  - Start offset is calculated, based on the value of the side features in the wheel and the type of shape (Face or Side).
  - When *Side* Shaping: Start offset is in Z direction only.
  - When *Face* Shaping: Start offset is in X direction only.
  - When *Face* + *Side* Shaping: Start offset in X and Z directions.



- **Rules Applied for Shaping**
  - Shape amount is the distance past Diamond Zero.
  - Total Shaping Distance = [Calculated Start Offset + Shape Amount].
  - Number of Shaping Passes = [Total Shaping Distance / Shaping Increment].



Total Shaping Distance =
Calculated Start Offset + Shape Amount

- Calculated Start Offset X/Z

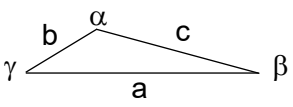
  When we have a combination of Face and Side Shaping the Start Offset X/Z is calculated according to the equation below

  For Radius: Larger of KH or AB.

  For Chamfer: Larger of K'H' or AB.

- K'H' = R/2

- KH = (R.1.41 - R) / 1.41 = $\boxed{R = 0.41 / 1.41}$

- AB = 

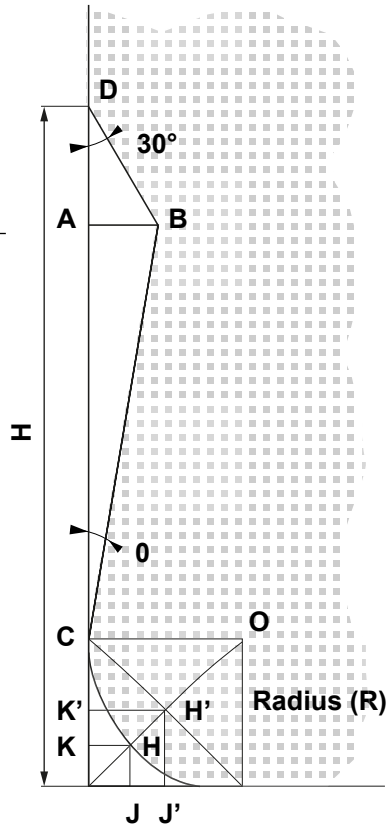
$$\frac{a}{\sin\alpha} = \frac{b}{\sin\beta} = \frac{c}{\sin\gamma}$$

$$\frac{DC}{\sin \overset{\frown}{DBC}} = \frac{DB}{\sin\theta}$$

$$DB = \frac{DC}{\sin \overset{\frown}{DBC}} \bullet \sin\theta$$

$$AB = DB \bullet \sin 30°$$

$$\boxed{AB = \left(\frac{DB}{\sin (150 - \sin\theta)} \bullet \sin\theta \right) \bullet \frac{1}{2}}$$



2.3.2 Special Wheel Profile

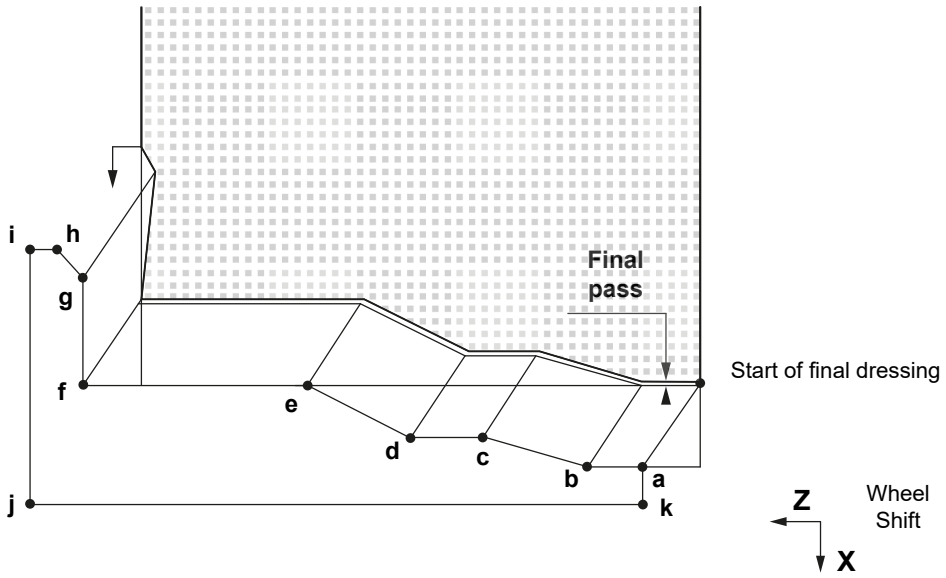
A special wheel profile can be obtained in two ways:

- By defining the special profile in a subroutine, or
- By using a roller dresser whose shape corresponds to the profile.

2.3.2.1 Example of a Special Wheel Profile Cut with a Two-Diamond Dresser

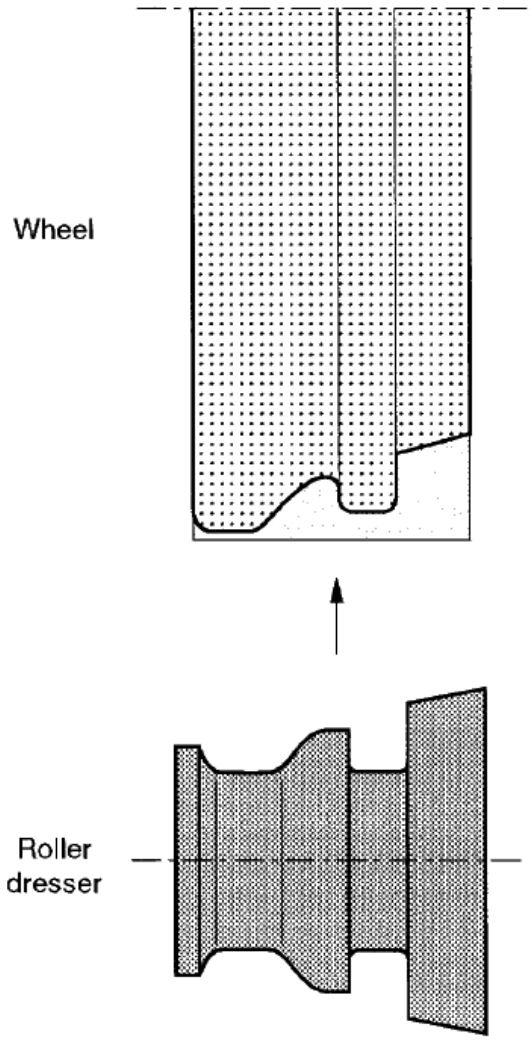
The successive passes are made by shifts on the X and Z axes.

For example:



2.3.2.2 Example of a Special Wheel Profile Cut with a Roller Dresser

The roller is moved on the U axis to cut the profile.



2.4 Cylindrical Grinding Capabilities

The following grinding capabilities are available:

- wheel dressing and shapping,
- grinding cycles,
- Part measurement:
  - programmed in the grinding cycle.
  - manual intermediate measurement.

2.4.1 Wheel Dressing and Shaping

Wheel dressing can be programmed before or during the grinding cycle (see the machine manufacturer's manual for further information).

Types of dressing considered:

- shaping a new wheel,
- periodic dressing during a grinding production run,
- dressing programmed in the grinding cycle,
- dressing requested by the user.

2.4.2 Grinding Cycles

Internal and external grinding cycles are initiated by programming a G2xx function (see Grinding Functions and Cycles on chapter 3).

Grinding cycles considered:

- plunge or multiplunge cycle,
- angular plunge cycle with shoulder,
- plunge or multiplunge cycle with oscillations,
- cylindrical traverse cycle,
- profile grinding cycle,
- taper traverse cycle,
- shoulder plunge cycle with oscillations,
- shoulder traverse cycle,
- shoulder profile grinding.

2.4.3 Part measurement

2.4.3.1 Programmed in the grinding cycle

When measuring the part during the cycle, the part diameter is measured by a gauge and a measurement command:

- Contact outputs,
- BCD outputs - measured value in BCD format (BCD: Binary Coded Decimal).

Gap elimination is the first grinding phase. It is used to measure and adjust the difference in dimensions between parts to be ground.

2.4.3.2 Manual intermediate measurement requested by the user

During an intermediate manual measurement, the part diameter is measured by the operator.

The two measurement possibilities are as follows:

- Programmed manual intermediate measurement,
- Manual intermediate measurement requested by the user from the keyboard.

2.5 Preliminary Operations before Starting a Cycle

The following operations must be carried out before starting a cycle:

- set the measurement origin,
- select the wheel,
- set the dresser origin,
- start rotating the wheel,
- dress and/or shape the wheel,
- clamp the part and set the part origin,
- write the part grinding programme.

Setting the Measurement Origin	The measurement origin is set on the X and Z axes (only at power on) in accordance with the instructions defined by the machine manufacturer.
Selecting the Wheel	The wheel and working environment are selected by programming function M06 Tx (see Grinding Functions and Cycles on chapter 3).
Setting the Dresser Origins	The dresser X and Y origins are set by function M140 (see Grinding Functions and Cycles on chapter 3). This is required only after changing the wheel.
Starting Wheel Rotation	The speed of wheel rotation is programmed by function G230. (see Grinding Functions and Cycles on chapter 3).

<table>
<tr><td>Dressing the Wheel</td><td colspan="2">The wheel is dressed by one of the functions G245 (shaping) or G240 (dressing).
(see Grinding Functions and Cycles on chapter 3).

For wheel dressing, the choice of T1 determines the association with corrections D1, D2, D3 and D4.

For example:
D1 X.. Z.. R.. H1
• X.. X dimension (E50001)
• Z.. Z dimension (E51001)
• R.. Radius (E52001)</td></tr>
<tr><td>Setting the Workpiece Origin</td><td colspan="2">The workpiece origin (OP) is set by function M145.
(see Grinding Functions and Cycles on chapter 3)</td></tr>
<tr><td>Writing the Grinding Program</td><td colspan="2">General program structure</td></tr>
<tr><td></td><td>Example.

%500
M06 T..
G230 S..
M160
M08 (example)
G77 H9911
G2xx ...

...
...
...
...
...

G77 H9912
M02</td><td>

Program number
Choice of wheel and environment
Wheel rotation speed
Periodic dressing or not
Manufacturer's functions
Switch on coolant & spindles
Cycle call with arguments

Cycle phases

Switch off coolant & spindles
End of programme</td></tr>
</table>

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Summary

3 Grinding functions and cycles

3.1 G Functions - Main summary table

Click on **Gxx** to give the detailed information.

Code	Description
G200	External plunge / multiplunge cycle
G201	Internal plunge / multiplunge cycle
G202	External plunge cycle with inclined axis
G203	Internal plunge cycle with inclined axis
G204	External oscillating plunge / multiplunge cycle
G205	Internal oscillating plunge / multiplunge cycle
G206	External cylindrical traverse cycle
G207	Internal cylindrical traverse cycle
G208	External profile grinding cycle
G209	Internal profile grinding cycle
G210	External conical traverse cycle
G211	Internal conical traverse cycle
G212	External oscillating shoulder cycle
G213	Internal oscillating shoulder cycle
G214	External shoulder traverse cycle
G215	Internal shoulder traverse cycle
G216	External shoulder cycle with fillet / chamfer
G217	Internal shoulder cycle with fillet / chamfer
G230	Wheel speed calculation
G231	Passive positioning (axial correction) cycle
G232	Intermediate measurement cycle
G240	Fixed or roller dresser wheel dressing cycle
G245	Fixed dresser wheel shaping cycle

3.2 M Functions - Main summary table

Click on **Mxx** to give the detailed information.

Code	Description
M06	**Selecting the wheel and setting up the working environment**
M140	**Dresser setup**
M145	**Part origin setting**
M160	**Periodic dressing test counter**

3.3 Setting the dresser origins ► M140

M140 Dresser setup

This function is used to set the dresser origin.

The operator is guided through the process by the messages displayed.

Two types of dressers can be used:

- fixed two-diamond dresser,
- roller dresser.

Syntax

[T..] **M140**

T..	Selected wheel number (default T1 if not specified).
M140	Dresser setup.

Notes

The dresser data are saved in file %9910.1

The dressing data will be saved in the %990x.x files (the value x.x is defined according to the active wheel number T).

Dresser origin setting

Two procedures are described:

- for a two-diamond dresser,
- for a roller dresser.

The dresser origin is the "workpiece origin" reterred to during the dressing phase.

3.3.1 Two-Diamond Dresser Setup

Procedure

- Select manual data input mode (MDI).
- Program dresser origin setting function M140 then press Enter.
- Start the cycle by pressing the Cycle Start key on the machine panel twice.
- The following message is displayed:
  "FIXED DRESSER SETUP"
- After two seconds, the following message is displayed:
  "X ORIGIN: MOVE WHEEL ON DIAMOND 1"
- The handwheels and axis jogs become operational (function M12 active).
- Bring the wheel peripheral cutting face in contact with the tip of diamond 1 (see Figure 1).
- Restart the cycle by pressing the Cycle Start key on the machine panel.
  The wheelhead position is stored in the CNC.
- The following message is displayed:
  "Z ORIGIN: MOVE WHEEL ON DIAMOND 1"
- Bring the left side of the wheel in contact with the tip of diamond 1 (see Figure 2).
- Start the cycle again by pressing the Cycle Start key on the machine panel. The position is stored in the CNC.
- The following message is displayed:
  "*** END OF DRESSER SETUP ***"
- If the dressing data only provide for dressing the wheel peripheral face and left side, the CNC stops the procedure.
- If the dressing data provide for dressing the right side ora radius on the right side, the CNC displays the following message:
  "X ORIGIN: MOVE WHEEL ON DIAMOND 2"
- Repeat the procedure described above (see Figures 3 and 4) can be carried out.
- The following message is displayed:
  "Z ORIGIN: MOVE WHEEL ON DIAMOND 2"
- Bring the right side of the wheel in contact with the tip of diamond 2.
- At the end of the procedure, the diamond dresser origin is defined in the left corner of the wheel.

3.3.1.1 Fixed two-diamond dresser origin setting

The origin can be set for diamond 1 or diamond 2.

Origin setting for diamond 1

Figure 1 (on X axis)

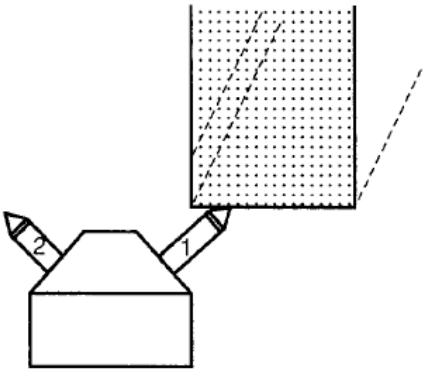
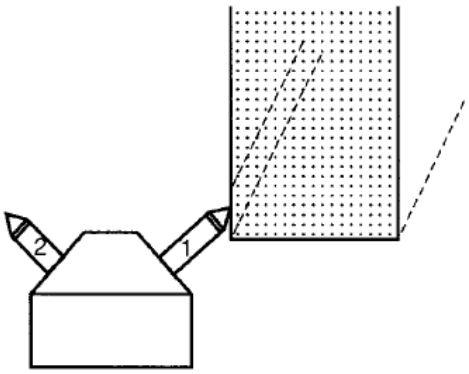


Figure 2 (on Z axis)



Origin setting for diamond 2

Values stored in machine data file:

- shift on X axis (a-b)
- shift on Z axis (c-d)

Figure 3 (on X axis)

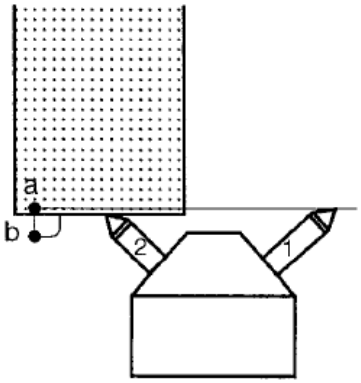
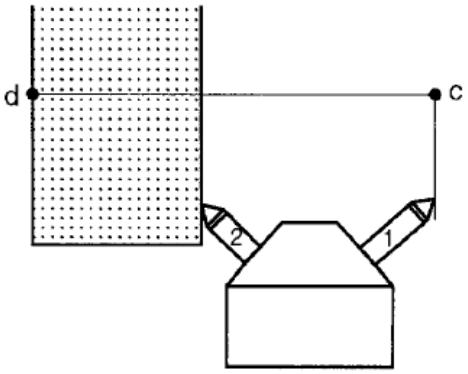


Figure 4 (on Z axis)



3.3.2 Roller Dresser Setup

The procedure is practically the same as for the two-diamond dresser, except that with a roller dresser, contact with the wheel is made by moving the roller dresser towards the wheel (function M12 active).

The roller-wheel contact position is stored in the CNC, which sets the dresser origin to this position.

Example:

Programme the dresser setup for wheel 2.

```
T2 M140
```

Wheel 2 dresser setup. The dressing data are read from file %9900.2 and the dresser data from file %9910.x.

In this case the origins are stored in file %9910.1

3.4 Wheel Dressing Options

There are two possibilities for wheel dressing cycles:

- shaping,
- dressing.

Shaping the wheel

Shaping is performed when a new grinding wheel is fitted. The shaping cycle must always be programmed before a G2xx grinding cycle. This operation gives the wheel the desired profile.

Dressing the wheel

Dressing is performed to freshen the wheel surface after shaping. The dressing cycle can be programmed at the beginning or end of a grinding cycle.

There are three ways of performing dressing:

- periodic dressing for a series of workpieces,
- dressing programmed in the grinding cycle,
- manual dressing requested by the user.

3.4.1 Fixed Dresser Wheel Shaping Cycle ► G245

G245 Fixed dresser wheel shaping cycle

The shaping cycle gives the required shape to a new wheel.

Syntax

G245 X.. EF..

G245	Fixed dresser wheel shaping cycle
X..	X start point. (Safety position before shaping)
EF..	Wheel parts to be shaped defined in [WD(71)] : • EF0: Shaping not programmed • EF1: Wheel periphery • EF2: Left wall • EF3: Periphery and left wall • EF4: Right wall • EF5: Periphery and right wall • EF6: Left wall and right wall • EF7: Periphery and left and right walls • EF8: Periphery with diamond 1 + diamond 2

The call to the G245 ... shaping cycle must be programmed before the call to function Tx M06[1] (see Sec. 3.5, "Selecting the Wheel and Setting Up the Working Environment").

[1] This is backwards, the Tx M06 call needs to come before G245 call to fill in the correct wheel data.

3.4.2 Fixed or Roller Dresser Wheel Dressing Cycle ► G240

G240 Fixed or roller dresser wheel shaping cycle

Dressing is performed to freshen the wheel after shaping.
It can be carried out before, during or after a G2xx cycle.

Syntax

G240 X.. EZ../EX.. ED..

G240	Fixed or roller dresser wheel dressing cycle.
X..	Backoff on X / Safety diameter
EZ..	Return on Z.
EX..	Return on X.
ED..	Wheel surface to be dressed.

Programming possibilities

`G240 ED..` Dress

`G240 X.. ED..`
- Move to X
- Dress

`G240 X.. EZ.. ED..`
- Move to X
- Dress
- Return to work position:
  X = saved position + safety clearance
  Z = EZ..

`G240 X.. EX.. ED..`
- Move to X
- Dress
- Return to work position:
  Z = saved position
  X = EX..

3.4.2.1 Programmed Periodic Dressing

Dressing can be programmed to be carried out every x workpieces during production grinding runs.

Description

The periodic dressing operations are defined by function M160 at the beginning of the grinding cycle (see Sec. 3.8).

At the start of each cycle, function M160 increments a counter and compares its value with the value defined in the wheel data file under the heading "Number of workpieces between dressings".

[WD(59)] : Number of parts between two face dressings.

[WD(60)] : Number of parts between two leftside dressings.

[WD(61)] : Number of parts between two rightside dressings.

When the two values are equal, the wheel dressing cycle is initiated.

Dressing is based on the data from the wheel file, cutting speed, increment, etc.

3.4.2.2 Dressing Programmed in a Cycle

Each grinding phase programmed in a cycle can be interrupted by a programmed dressing phase.

Description

Dressing is defined by argument ED (choice of wheel dressing, peripheral face and/or side) programmed in a block of the cycle.

When argument ED is read in the block, the current cycle phase is stopped and the wheel is retracted. The dressing program is executed.

3.4.2.3 Dressing Requested by the User

Certain programmed grinding phases can be interrupted for dressing requested by the user.

However, the following phases cannot be interrupted for dressing:

- gap elimination (EG1),
- measurement during grinding cycle (G2xx),
- traverse cycle with discontinuous increment in Z and EZ (EC1).

Description

During the grinding phase, the user can request dressing, even if not already programmed.

Dressing is initiated by pressing a button on the operator panel or HMI (depending on the machine manufacturer).

The pushbutton change of state is sent to the PLC program and loaded into parameter E20030.

The current phase is stopped and the wheel is retracted. Dressing can then be performed.

3.5 Selecting the wheel and setting up the working environment ► M06

M06 Selecting the wheel and setting up the working environment

This function is used to select the grinding wheel and set up the working environment.

Syntax

M06T.. [ET..] [ER..] [EX..] [EZ..]

M06	Selecting the wheel and setting up the working environment.
T..	Wheel number selected (T1 to T8, default T1 if not specified).
ET..	Wheel file number (1 to 99).
ER	Wheel retraction to safe machine position (if not specified, no return to safe machine position).
EX..	Shift on X axis (see Notes).
EZ..	Shift on Z axis (see Notes).

Notes

Function M06 calls subroutine %9910.0

If argument ET is present and is assigned a number from 1 to 99, it has priority and the wheel number assigned to T is ignored (ET1 = ET01 => %9900.1).

Shifts EX and EZ

When function M06 is called, two additional shifts can be taken into account if programmed.

In this case their values are added to the existing DAT1s.

Shifts EX and EZ allow the introduction of safety clearances for dummy grinding tests (no material) after dressing, without having to change the settings made when the workpiece origins were defined.

These shifts are corrections assigned to the third corrector of each wheel (see wheel corrections).

The X axis shift (EX) must be smaller than 0.05 mm, and the Z axis shift (EZ) must be between -1 mm and +1 mm.

3.5.1 Wheel correctors

Each wheel uses four tool correctors from the corrector table.

For example:

- wheel 1: correctors D1 to D4
- wheel 2: correctors D5 to D8

and so on, up to wheel 8 (D29 to D32).

Use of correctors for wheel 1:

- D1 defines the wheel left wall wear,
- D2 defines the wheel right wall wear,
- D3 contains shifts EX and EZ defined in the block with M06,
- D4 is reserved.

3.5.2 Files associated with the wheel

Three files are used by the selected wheel during the dressing operations:

- the machine data file,
- the wheel data file,
- the machine limits file.

The machine data file contains the dressing and wheel data:

- datum shifts (DAT1) for the dresser and the workpiece,
- the type of dressing performed,
- the dresser geometry,
- the wheel descriptions (internal or external wheel).

The block numbers concerning the eight possible wheels described are as follows (accessed by the wheel number programmed in block M06 Tx:

- wheel 1: blocks N100 to N118,
- wheel 2: blocks N200 to N218,
- wheel 3: blocks N300 to N318,

and so on, up to wheel 8 (N800 to N818).
The wheel data file contains the general data required for wheel shaping and dressing.
The number of the file used is defined function M06 arguments T and ET.

The number of the file called can be defined by:

- the wheel number assigned to argument T (T1 to T8), or
- the number assigned to argument ET (if specified).

The symbolic variables used in this file are defined by [WD(xx)].
The machine limit files contain the maximum and minimum values of the wheel data (the limit data are defined by the machine manufacturer).
There are eight wheel files %992x, where x is the wheel number (%9921 to %9928).
It should be noted that the content of these files varies with the type of tool selected (wheel or roller dresser):

- straight wheel,
- angular wheel with inclined axis,
- special wheel,
- roller dresser.

3.6 Defining the wheel rotation speed from the surface speed ► G230

G230 Wheel speed calculation

This function calculates the wheel rotation speed from the wheel diameter.

The wheel speed can be programmed in two ways according to its location:

- before the cycle call,
- in a subroutine.

Syntax

Syntax (before the cycle call)

G230 S..

G230	Calculation of the wheel rotation speed.
S..	Mandatory argument defining the cutting speed (m/s).

Syntax (in a subroutine)

S.. G77 H10230

S..	Mandatory argument defining the cutting speed (m/s).
G77..	Subroutine call function.
H10230	Number of subroutine called (%10230).

Notes

It is mandatory to programme G230 S.. after programming T.. M06 at the beginning of a programme.

The other speed programming possibilities are optional.

They are used to change the speed defined by G230 S..

Examples

Wheel speed calculation before cycle call

```
N.. ...
N.. T.. M06                    Wheel speed calculation
N..  G230 S..
N..
N.. ...
N.. G2xx                       Cycle
N.. ...
```

Speed calculation in a subroutine

```
N.. ...
N.. G2xx ... ..                Cycle call
N.. ...
N.. S.. G77 H10230             Wheel speed calculation
N.. ...
```

3.7 Part setup ► M145

M145 Part origin setting

This function is used to set the part origin.

The user is guided through the process by the messages displayed.

Syntax

[T..] **M145**

T..	Selected wheel number (default T1 if not specified).
M145	Part setup.

3.7.1 Part setup procedure

- Select manual data input mode (MDI).
- Programme part setup function "M145" then press Enter.
- Start the cycle by pressing the Cycle Start key on the machine panel.
- The following message is displayed:
  `"*** PART SETUP -------------- OK"`
- The following message is displayed after 2 seconds:
  `"MOVE WHEEL ON THE REFERENCE DIAMETER"`
- The handwheels and axis jogs become operational (Function M12 active).
- Bring the wheel in contact with the reference diameter (see Figure 1).
- Restart the cycle by pressing the Cycle Start key on the machine panel.
- The following message is displayed:
  `"MEASURE THE PART AND START CYCLE"`
- The wheel is retracted from the workpiece to allow the reference diameter to be measured.
- The following message is displayed:
  `"INPUT DIAMETER MEASURE"`
- Enter the measured diameter on the keyboard then press Enter.
- Start the cycle again by pressing the Cycle Start key on the machine panel.
- The following message is displayed
  `"MOVE WHEEL ON THE REFERENCE SHOULDER"`
- The handwheels and axis jogs become operational (Function M12 active).
- Bring the wheel left side in contact with the reference face of the standard workpiece (see Figure 3).
- The wheel is retracted from the workpiece to allow the standard face measurement to be read.
- The following message is displayed:
  `"REFERENCE SHOULDER POSITION"`
- Enter the measured value on the keyboard then press Enter.
- Start the cycle again by pressing the Cycle Start key on the machine panel.
- The following message is displayed:
  `"END OF PART SETUP"`

Example

Programme wheel 2 origin setting:

```
T02 M145
```

In this case the origins are stored in file N200-N218 section of %9910.1.

3.7.2 Schematic illustration of workpiece origin setting

Workpiece origin on X axis

Wheel in contact with workpiece reference diameter

Figure 1 (X axis straight)

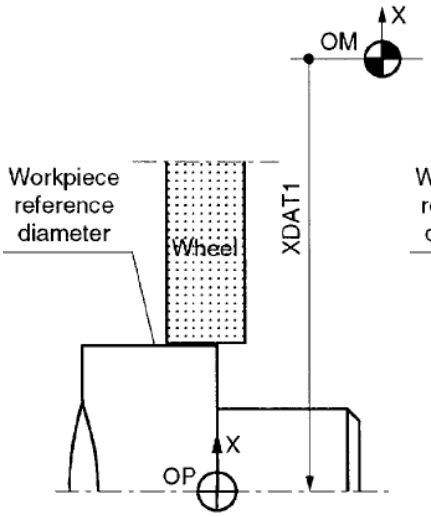
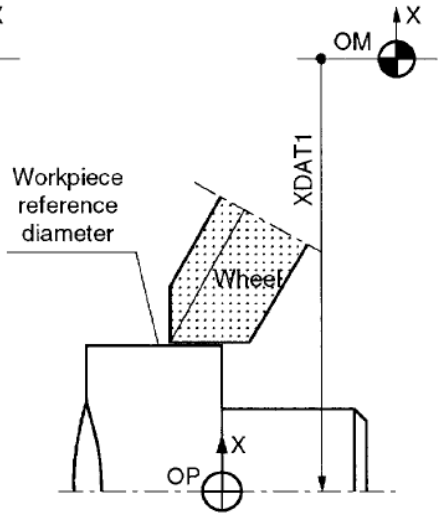


Figure 2 (X axis tilted)



Workpiece origin on Z axis

Wheel in contact with workpiece reference side

Figure 3 (X axis straight)

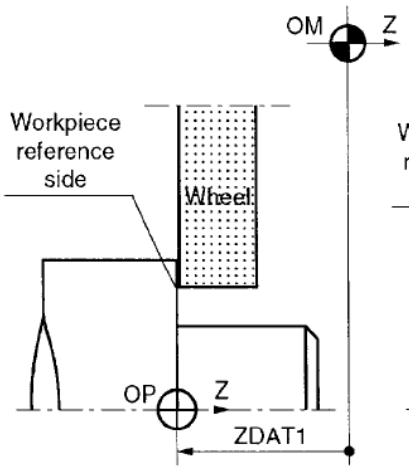
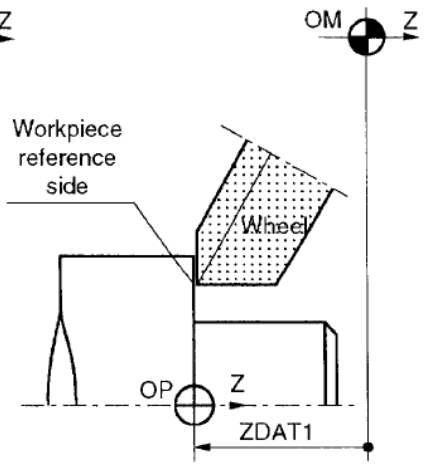


Figure 4 (X axis tilted)



3.8 Periodic dressing test counter ► M160

M160 Periodical dressing test counter

This function programmes wheel dressing every x workpieces in a production run.

Syntax

M160

M160	Periodic dressing test counter.

Notes

Function M160 tests the wheel data indicating the number of workpieces between two dressing operations.

If the value is not zero, the corresponding counter (E560xx) is incremented and compared with the programmed value.

When the counter value exceeds the programmed value, dressing is performed.

The three symbolic variables from the wheel data file:

[WD(59)] : Number of parts between two face dressings

[WD(60)] : Number of parts between two leftside dressings

[WD(61)] : Number of parts between two rightside dressings

3.9 Passive positioning (axial correction) cycle ► G231

G231 Passive positioning (axial correction) cycle

This cycle modifies the origin on the Z axis by adding a workpiece axial offset correction if the machine is equipped with the appropriate gauging system.

The system takes into account the differences in position of each workpiece mounted on the workholder.

Syntax

G231 ES.. EP.. EA..

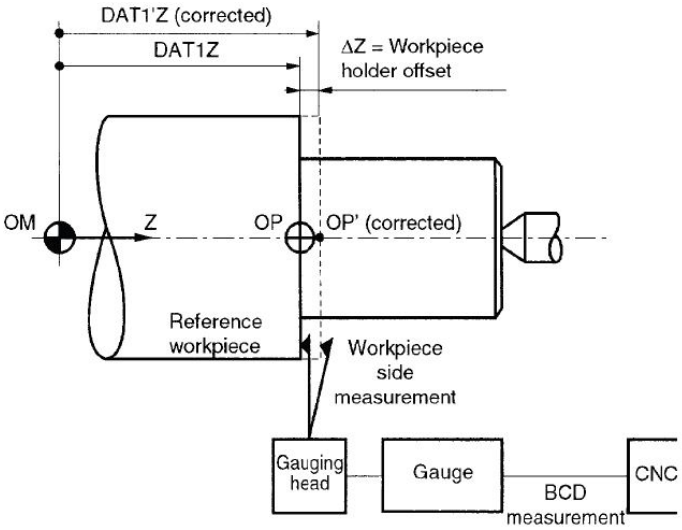
G231	Passive positioning (axial correction) cycle.
ES..	Argument defining the speed of rotation of the part in revolutions per minute (less than 100 rpm). If 0, part doesn't turn during cycle.
EP..	Direction of the gauging head. • EP0: gauging head on the left, • EP1: gauging head on the right (default).
EA..	Z-Flagging Type • EA1: Cond.Manual • EA0: Automatic (default)

Notes

Function G231 must be programmed after calling the block containing the functions.

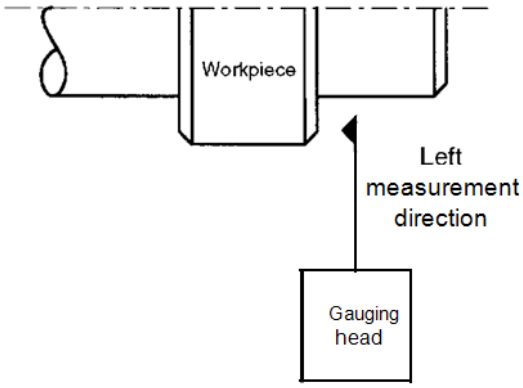
Tx M06 (wheel selection and working environment setup).

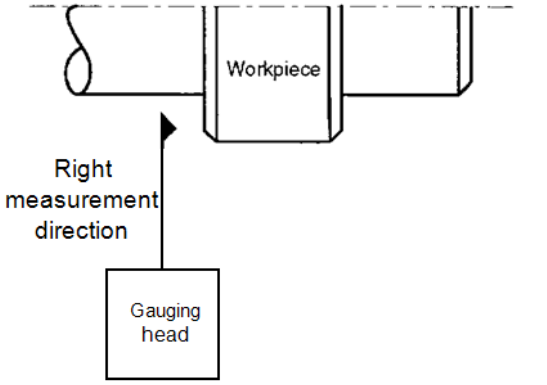
3.9.1 Schematic diagram of workpiece position check



3.9.2 Direction of measurement

The gauging head can be set to measure from the left or the right (see machine manufacturer's manual).





3.10 Intermediate measurement

3.10.1 Manual intermediate measurement programmed in a cycle

Most programmed grinding phases (except gap elimination "EG1", part measurement "EG2/EG9" and discontinuous X-Z traverse cycle "EC1") can end with a manual measurement request.

When arguments EG1 to EG9 are programmed in a G2xx grinding cycle, functions M200 to M255 must not be used in this cycle. However, these functions can be programmed before or after the cycle.

Description

At the end of a programmed grinding phase containing EG99, the wheel retracts from the part and the cycle stops.

The user can make the measurement then, according as EMO, EM1 or EM2 is programmed, new values of DAT1 are loaded (offset limited to +/- 0.05).

Once the new DAT1 values have been loaded, the programmed is resumed.

It should be noted that with:

- EM1: the corrections are added to the existing DAT1 values,
- EM2: the corrections are added to the existing DAT1 values and stored in the machine data file (9910.1).

3.10.2 Intermediate Measurement Requested by the User

Each programmed grinding phase containing EG98 can be interrupted by a measurement requested by the user.

Description

During the grinding phase, the user requests measurement by pressing a pushbutton on the machine panel or HMI (depending on the machine manufacturer).

When the PLC programme receives this input, it sets parameter E20031 to 1.

The current cycle is then stopped and the wheel is retracted. The user can then make the measurement and also enter new DAT1 values if necessary.

The wheel retraction position is defined on X by argument EH (retraction diameter for dressing and manual measurement).

3.11 Intermediate measurement cycle ► G232

G232 Intermediate measurement cycle

The intermediate measurement cycle is used to check the part during G2xx grinding cycles.

Syntax

G232 X.. EZ.. / EX.. EM..

G232	Intermediate measurement cycle.
X..	Backoff on X / Safety diameter.
EZ..	Return on Z.
EX..	Return on X.
EM..	Measurement.

Programming

`G232 EM..`
`G232 X.. EM..`

Measure
- Move to X
- Measure

`G232 X.. EZ.. EM..`

Move to X..
- Return to work position:
  X = saved position + safety clearance
  Z = EZ..

`G232 X.. EX.. EM..`

- Move to X..
- Measure
- Return to work position:
  Z = saved position
  X = EX..

3.12 External grinding cycles

Grinding of the workpiece is achieved by initiating the appropriate grinding cycle.

The cycle chosen is programmed by a G2xx function.

The external grinding cycles have the following numbers:

- G200, G202, G204, G206, G208, G210, G212, G214, G216.

The external grinding cycles have the following numbers:	
G200	**External plunge / multiplunge cycle**
G202	**External plunge cycle with inclined axis**
G204	**External oscillating plunge / multiplunge cycle**
G206	**External cylindrical traverse cycle**
G208	**External profile grinding cycle**
G210	**External conical traverse cycle**
G212	**External oscillating shoulder cycle**
G214	**External shoulder traverse cycle**
G216	**External interpolated shoulder cycle**

The extemal and internal grinding cycles are identical as regards the programming of their arguments. They differ only by their call numbers.

3.12.1 General

Cycles are programmed in two parts:

- the first part includes the G2xx function followed by the cycle call arguments,
- the second part includes the in-cycle arguments.

Cycle call arguments

These programming arguments define the engineering data relating to the final production of the workpiece.

They must always be included in the block containing the G2xx cycle call.

In-cycle arguments

These programming arguments define the characteristics associated with each grinding phase: rough grinding, finishing, sparkout, etc.

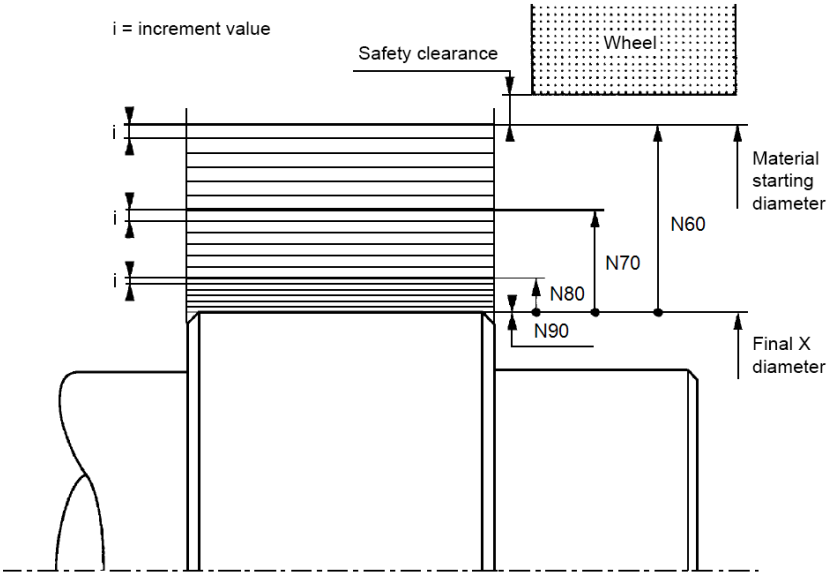
They must be programmed in the successive blocks defined after the cycle call block.

A G2xx cycle must always end with argument EB2 (end of cycle). Otherwise, certain modal arguments are applied during the following cycles.

Example of a cycle

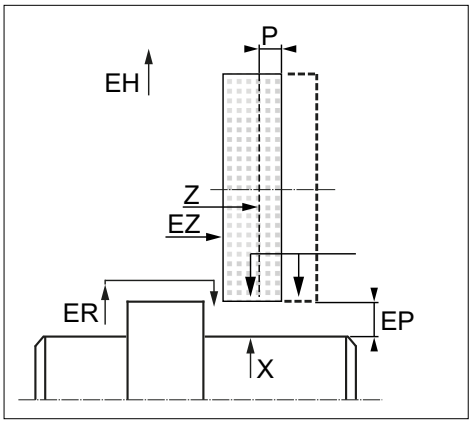
%206	
N10 T01 M06	Selection of the wheel
N20 G230 S...	Wheel speed calculation
N30 M160	Periodic dressing test counter
N40 G77 H9911	Switch on coolant & spindles
N50 G206 ...	External cylindrical traverse cycle and cycle call arguments
N60 ...	Roughing phase
N70 ...	Semi-finishing phase
N80 ...	Finishing phase
N90 ...	Sparkout and end of cycle
N100 G77 H9912	Switch off coolant & spindles
N110 M02	End of program

Schematic representation of the phases of a cylindrical traverse cycle



3.12.2 External plunge / multiplunge cycle ► G200

G200 External plunge / Multiplunge cycle



For single plunge, the cycle includes:

- positioning on Z followed by plunge on X.

For multiplunge, the cycle includes:

- initial positioning on Z followed by a first plunge on X and retraction on X
- a second positioning on Z (wheel width- overlap) followed by a plunge, etc. (until reaching the end point).

Syntax

G200 X.. Z.. D.. [EZ..] EP.. [ER..] [EH..] [P..]
X.. F.. [EG..] [EM..] [EK..] [ED..] [EV..] [ET..] EB..

Cycle call arguments

G200	External plunge / multiplunge cycle.
X..	Final diameter.
Z..	Plunge: plunge position on Z axis. Multiplunge: starting point on Z axis.
D..	Selection of active wheel side. • D1: left side, • D2: right side.
EZ..	Multiplunge: end point on Z.
EP..	Safety clearance on X axis (+ material allowance) / Rapid stop distance
ER..	Skip diameter.
EH..	Backoff diameter for dressing or measuring.
P..	Multiplunge: wheel overlap value.

In-cycle call arguments

X..	Allowance on final diameter or stock remaining relative to final.
F..	Feed rate on X (mm/min).
EG..	Measurement selection (default: no measurement). • EG0: no measurement, • EG1: gap elimination enable, • EG2 to EG9: in-cycle measurement, • EG98: conditional manual measurement call, • EG99: unconditional manual measurement call.
EM..	Offset modification selection (default: no modification). • EM0: no modification, • EM1: modification of DAT1 (actual part), • EM2: modification of DAT1 and machine data (all parts)
EK..	Backoff distance.
ED..	Wheel dressing selection: • ED1: peripheral face, • ED2: left side, • ED3: peripheral face and left side, • ED4: right side, • ED5: peripheral face and right side, • ED6: left side and right side, • ED7: peripheral face and left and right sides. • ED8: face with diamond 1+2.
ET..	Sparkout time (s).
EB..	Cycle sequencing selection. • EB0: sequencing without stopping, • EB1: sequencing with stop, • EB2: end of cycle.
EV..	Dressing type: • EV1: Coarse, • EV2: Fine, • EV3: Coarse+Fine, • EV4: Sparkout, • EV5: Coarse+ Sparkout, • EV6: Fine+Sparkout, • EV7: Coarse +Fine+Sparkout.

Notes

Notes on argument programming

The values of X, EP, X, EK, EZ and ET must be greater than 0.

Multiplunge arguments:

- the value of P must be less than or equal to the wheel width. If P is not programmed its value is forced to 0,
- with D1 or D2 the wheel position does not change. It is the programme origin that is modified,
- movement only takes place when arguments Z and EZ are programmed,
- the difference between Z and EZ must be greater than the wheel width.

Notes associated with arguments ER and EH

If ER and EH are not programmed, program %9970 calculates ER and EH.

In this case: ER and **EH**= X+ EP.

If only ER is programmed (without **EH**), in all cases: EH = ER.

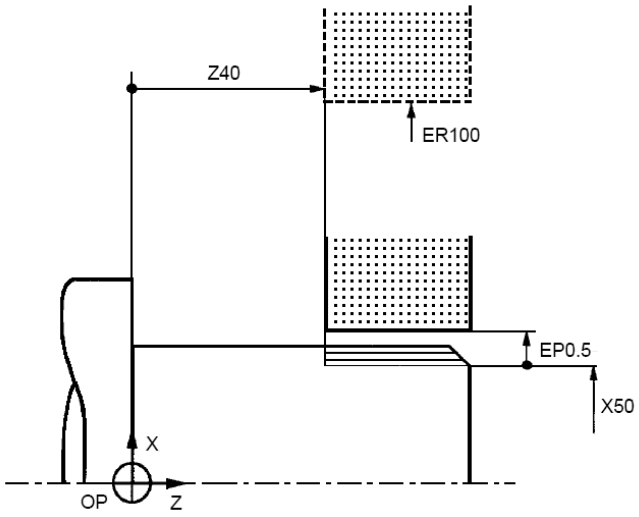
See chapter 4 for further information regarding the arguments present at cycle call or the arguments to be defined during the cycle.

Example

Plunge cycle (external)

```
...
G200 X50 Z40 D1 EP0.5 ER100          Cycle call & Pre-Cycle
X0.2 F2 EB0                          In-Cycle 1
X0.1 F1 EB0                          In-Cycle 2
X0 EK1 ET5 EB2 F0.5                  In-Cycle 3
```

Schematic illustration of cycle

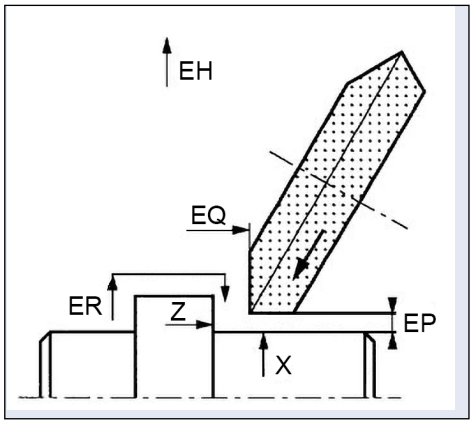


3.12.3 External plunge cycle with inclined axis ► G202

G202 External plunge cycle with inclinated axis

This cycle includes:

- positioning followed by plunge to simultaneously grind the part wall and shoulder.



Syntax

G202 X.. Z.. D.. EP.. EQ.. [ER..] [EH..]
X.. F.. [EG..] [EM..] [EK..] [ED..] [EV..] [ET..] EB..

Cycle call arguments

G202	External plunge cycle with inclinated axis.
X..	Final diameter.
Z..	End point on Z axis.
D..	Selection of active wheel side. • D1: left side.
EP..	Safety clearance on X axis (+ material allowance) / Rapid stop distance.
EQ..	Safety clearance on Z axis (+ material allowance) / Rapid stop distance.
ER..	Skip diameter.
EH..	Backoff diameter for dressing or measuring.

In-cycle call arguments

X..	Allowance on final diameter or stock remaining relative to final.
F..	Plunge feed rate (mm/min) or (in/min).
EG..	Measurement selection: • EG0: no measurement, • EG1: gap elimination enable, • EG2 to EG9: in-cycle measurement, • EG98: conditional manual measurement call, • EG99: unconditional manual measurement call.
EM..	Offset modification selection (default: no modification). • EM0: no modification, • EM1: modification of DAT1 (actual part), • EM2: modification of DAT1 and machine data (all parts)
EK..	Backoff distance.
ED..	Wheel dressing selection: • ED1: peripheral face, • ED2: left side, • ED3: peripheral face and left side,
ET..	Sparkout time (s).
EB..	Cycle sequencing selection. • EB0: sequencing without stopping, • EB1: sequencing with stop, • EB2: end of cycle.
EV..	Dressing type: • EV1: Coarse, • EV2: Fine, • EV3: Coarse+Fine, • EV4: Sparkout, • EV5: Coarse+ Sparkout, • EV6: Fine+Sparkout, • EV7: Coarse +Fine+Sparkout.

Notes

Notes on argument programming

The values of X, EP and EQ must be greater than 0.

Notes associated with arguments ER and EH

If ER and EH are not programmed, program %9970 calculates ER and EH.

In this case:

- in a cycle on X axis: ER and EH =X+ EP.
- in a cycle on Z axis: ER and EH = X.

If only ER is programmed (without EH), in all cases: EH = ER.

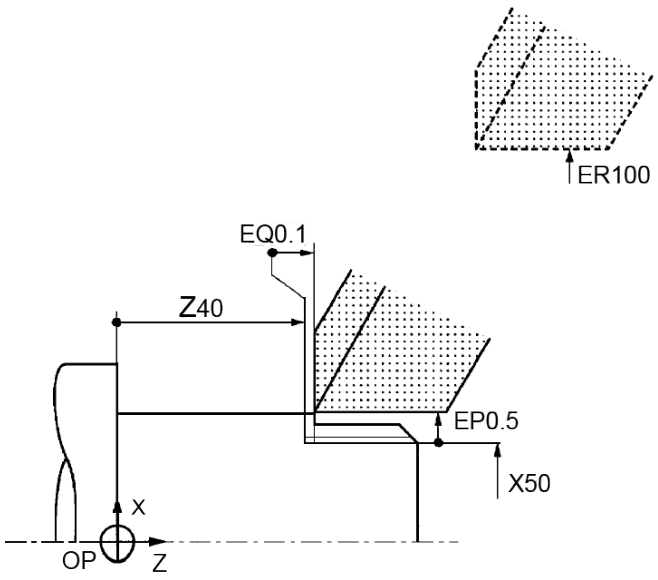
See chapter 4 for further information regarding the arguments present at cycle call or the arguments to be defined during the cycle.

Example

Plunge cycle with inclined axis (external)

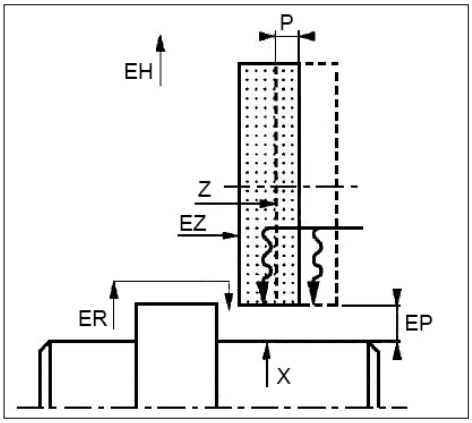
```
...
G202 X50 Z40 D1 EP1 EQ0.1 ER100      Cycle call &  Pre-Cycle
X0.2 F2 EB0                          In-Cycle 1
X0.1 F1 EB0                          In-Cycle 2
X0 EK1 ET5 EB2 F0.5                  In-Cycle 3
```

Schematic illustration of cycle



3.12.4 External oscillating plunge / multiplunge cycle ► G204

G204 External oscillation plunge / multiplunge cycle.



For single plunge the cycle includes:

- Positioning on Z followed by plunge on X with oscillation.

For multi / plunge the cycle includes:

- Initial positioning on Z followed by a first plunge on X with oscillation and retraction on X.
- A second positioning on Z (wheel width-overlap) followed by plunge on X, etc. (until reaching the end point on Z)

Syntax

G204 X.. Z.. D.. [EZ..] EP.. [ER..] [EH..] [P..]
X.. F.. [EZ..] [EO..] [EG..] [EM..] [EK..] [ED..] [EV..] [ET..] EB..

Cycle call argument

G204	External oscillation plunge / multiplunge cycle.
X..	Final diameter.
Z..	Plunge cycle: plunge position on Z axis. Multiplunge cycle: starting from point on Z axis.
D..	Selection of active wheel side. • D1: left side. • D2: rigth side.
EZ..	Multiplunge: end point on Z.
EP..	Safety clearance on X axis (+ material allowance) / Rapid stop distance.
ER..	Skip diameter.
EH..	Backoff diameter for dressing or measuring.
P..	Multiplunge: wheel overlap value.

In-cycle call arguments

X..	Allowance on final diameter or stack remaing relative to final.
F..	Feed rate on X (mm/min) or (inch/min).
EZ..	Oscillation amplitude.
EO..	Oscillation frequency (osc/min).
EG..	Measurement selection: • EG0: no measurement, • EG1: gap elimination enable, • EG2 to EG9: in-cycle measurement, • EG98: conditional manual measurement call, • EG99: unconditional manual measurement call.
EM..	Offset modification selection (default: no modification). • EM0: no modification, • EM1: modification of DAT1 (actual part), • EM2: modification of DAT1 and machine data (all parts).
EK..	Backoff distance.
ED..	Wheel dressing selection: • ED1: peripheral face, • ED2: left side, • ED3: peripheral face and left side, • ED4: right side, • ED5: peripheral face and right side, • ED6: left side and right side, • ED7: peripheral face and left and right sides. • ED8: face with diamond 1+2.
ET..	Sparkout time (s).
EB..	Cycle sequencing selection. • EB0: sequencing without stopping, • EB1: sequencing with stop, • EB2: end of cycle.
EV..	Dressing type: • EV1: Coarse, • EV2: Fine, • EV3: Coarse+Fine, • EV4: Sparkout, • EV5: Coarse+ Sparkout, • EV6: Fine+Sparkout, • EV7: Coarse +Fine+Sparkout.

Notes

Notes on argument programming

The values of X, EP, ET, EK, EO and EZ must be greater than 0.

Multiplunge arguments

- The value of P must be less than or equalto the wheel width. If P is not programmed its value is forced to 0
- With D1 or D2 the wheel position does not change. It is the program origin that is modified.
- Movement only takes place when arguments Z and EZ are programmed.
- The difference between Z and EZ for wheel width must be greater than the wheel width.

Notes associated with arguments ER and EH

If ER and EH are not programmed, program %9970 calculates ER and EH.
In this case: ER and EH =X+ EP.

If only ER is programmed (without EH), in all cases: EH= ER.

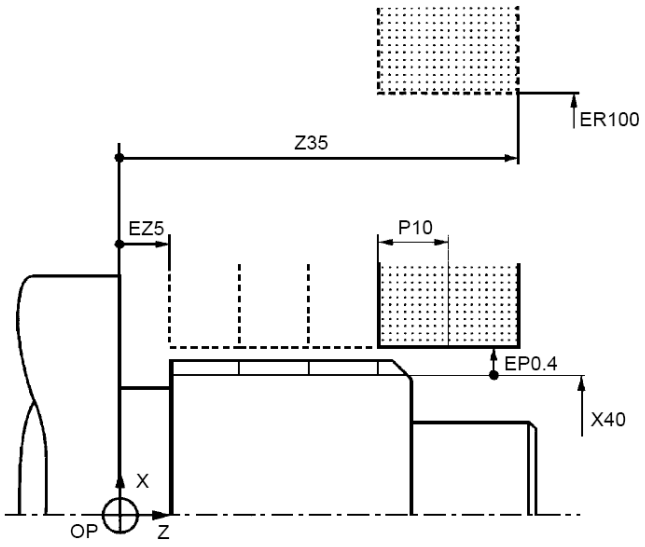
See chapter 4 for further information regarding the arguments present at cycle call or the arguments to be defined during the cycle.

Example

Multiplunge cycle with oscillations (external)

`G204 X40 Z35 EZ5 D1 P10 EP0.4 ER100`	Cycle call & Pre-Cycle
`X0.2 EZ1 EO10 F0.2 EB0`	In-Cycle 1
`X0 ET2 EK1 EB2 F0.1`	In-Cycle 2

Schematic illustration of cycle

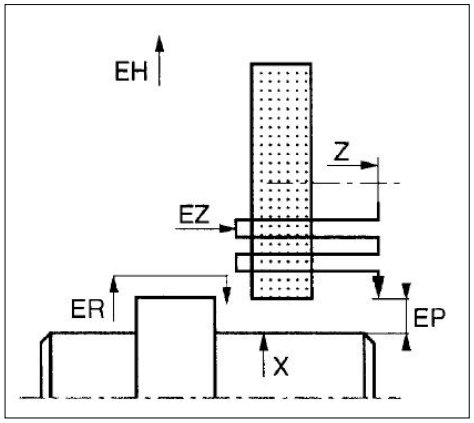


3.12.5 External cylindrical traverse cycle ► G206

G206 External cylindrical traverse cycle.

This cycle includes:

- Initial positioning on Z followed by a first increment on X and traverse up to the end position on Z.
- A second increment on X followed by return traverse, etc.



Syntax

G206 X.. Z.. D.. EZ.. EP.. F.. [ER..] [EH..] [EA..] [P..] [EE..] [EF..] [EC..]
X.. EI.. EJ.. F.. [EG..] [EM..] [EK..] [ED..] [EV..] [ET..] / [EN..] EB..

Cycle call arguments

G206	External cylindrical traverse cycle.
X..	Final diameter.
Z..	Starting point on Z.
D..	Selection of active wheel side. • D1: left side. • D2: rigth side.
EZ..	End point on Z.
EP..	Safety clearance on X axis (+ material allowance) / Rapid stop distance
F..	Traverse feed rate (mm/min or inch/min).
ER..	Skip diameter.
EH..	Backoff diameter for dressing or measuring.
EA..	Overtravel by P, if P is programmed, otherwise by the wheel width, on Z and EZ druing traverse (associated with P). • EA0: wheel within traverse distance, no overtravel, • EA1: Overtravel by one wheel width or P at the starting point (Z). • EA2: Overtravel by one wheel width or P at the end point (EZ). • EA3: Overtravel by one wheel width or P to right and left.
P..	Overtravel (associated with EA).
EE..	Dwell time at start of traverse (s).
EF..	Dwell time at end of traverse (s).
EC..	Type of increment: • EC0: continuous increment, • EC1: discontinuous increment in Z and / or EZ.

In-cycle call arguments

X..	Allowance on final diameter or stock remaining relative to final.
EI..	Increment at start of traverse.
EJ..	Increment at end of traverse.
F..	Feed rate on X (mm/min or inch/min).
EG..	Measurement selection: • EG0: no measurement, • EG1: gap elimination enable, • EG2 to EG9: in-cycle measurement (with continuous increment), • EG98: conditional manual measurement call, • EG99: unconditional manual measurement call.
EM..	Offset modification selection (default: no modification). • EM0: no modification, • EM1: modification of DAT1 (actual part), • EM2: modification of DAT1 and machine data (all parts)
EK..	Backoff distance.
ED..	Wheel dressing selection: • ED1: peripheral face, • ED2: left side, • ED3: peripheral face and left side, • ED4: right side, • ED5: peripheral face and right side, • ED6: left side and right side, • ED7: peripheral face and left and right sides. • ED8: face with diamond 1+2.
ET.. / EN..	• ET: Sparkout time (s). • EN: Number of sparkout passes.
EB..	Cycle sequencing selection: • EB0: sequencing without stopping, • EB1: sequencing with stop, • EB2: end of cycle.
EV..	Dressing type: • EV1: Coarse, • EV2: Fine, • EV3: Coarse+Fine, • EV4: Sparkout, • EV5: Coarse+ Sparkout, • EV6: Fine+Sparkout, • EV7: Coarse +Fine+Sparkout.

Notes

Notes on argument programming

The values of X, EK, EI and EJ must be greater than 0.

If P is not programmed, it is the wheel width that is taken into account.

Notes associated with arguments ER and EH

If ER and EH are not programmed, program %9970 calculates ER and EH.

In this case: ER and EH= X+ EP.

If only ER is programmed (without EH), in all cases: EH = ER.

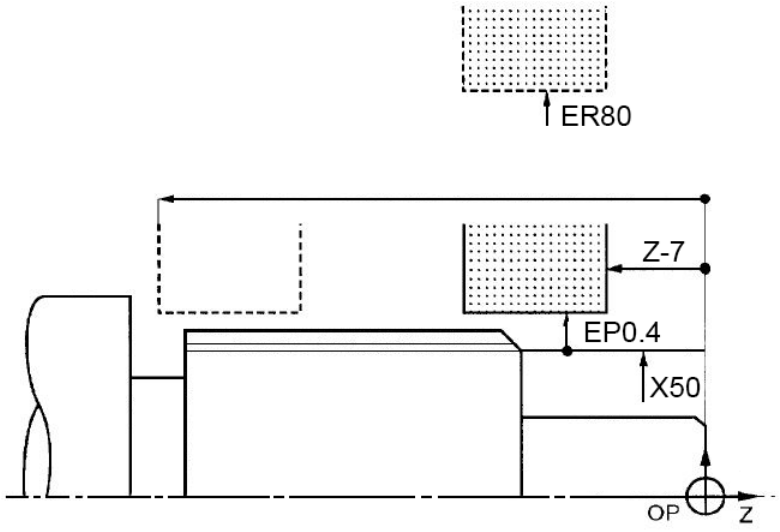
See chapter 4 for further information regarding the arguments present at cycle call or the arguments to be defined during the cycle.

Example

Cylindrical traverse cycle (external)

```
...
G206 X50 Z-7 EZ-65 ER80 EP0.4 F200 EE1 EF1 EA2 EC1 D2      Cycle call & Pre-Cycle
X0.2 EI0.04 EJ0.04 F3 EB0                                  In-Cycle 1
X0 EI0.02 EJ0.02 EN6 EK1 EB2 F2                            In-Cycle 2
```

Schematic illustration of cycle

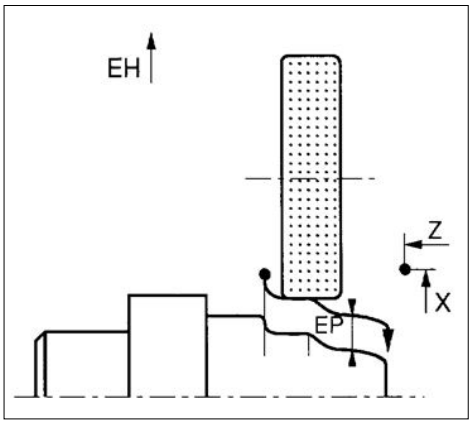


3.12.6 External profile grinding cycle ► G208

G208 External profile grinding cycle.

This cycle includes:

- Initial positioning on Z followed by a grinding of the profile defined in a subroutine.



Syntax

G208 X.. Z.. D.. EP.. ES.. H.. N.. N.. F.. [EH..] [ER..]
I.. EI.. [EN..] [EK..] [ED..] [EV..] EB..

Cycle call arguments

G208	External profile grinding cycle.
X..	Start diameter (X).
Z..	Starting point on Z.
D..	Selection of active wheel side. • D1: left side. • D2: rigth side.
EP..	Safety clearance on X of the profile (+ material allowance).
ES..	Wheel radius correction: • ES1: left radius offset (G41), • ES2: right radius offset (G42).
H..	Number of profile definition subroutine.
N.. N..	Profile start and end blocks.
F..	Feed rate along profile (mm/min or inch/min).
EH..	Backoff diameter for dressing or measuring.
ER..	Skip Diameter.

In-cycle call arguments

I..	Allowance on final diameter or stock remaining relative to final.
EI..	Depth of pass.
EN..	Number of sparkout passes.
EK..	Backoff distance.
ED..	Wheel dressing selection: • ED1: peripheral face, • ED2: left side, • ED3: peripheral face and left side, • ED4: right side, • ED5: peripheral face and right side, • ED6: left side and right side, • ED7: peripheral face and left and right sides. • ED8: face with diamond 1+2.
EB..	Cycle sequencing selection. • EB0: sequencing without stopping, • EB1: sequencing with stop, • EB2: end of cycle.
EV..	Dressing type: • EV1: Coarse, • EV2: Fine, • EV3: Coarse+Fine, • EV4: Sparkout, • EV5: Coarse+ Sparkout, • EV6: Fine+Sparkout, • EV7: Coarse +Fine+Sparkout.

Notes

Notes on argument programming

The values of X must be greater than 0. The value of Z should be selected near the first point of the profile.

The starting point on X and Z must be outside the profile.

The value of X must be greater than the largest X value of the profile.

Notes associated with arguments ER and EH

If ER and EH are not programmed, program %9970 calculates ER and EH.

In this case: ER and EH= X+ EP.

If only ER is programmed (without EH), in all cases: EH = ER.

See chapter 4 for further information regarding the arguments present at cycle cali or the arguments to be defined during the cycle.

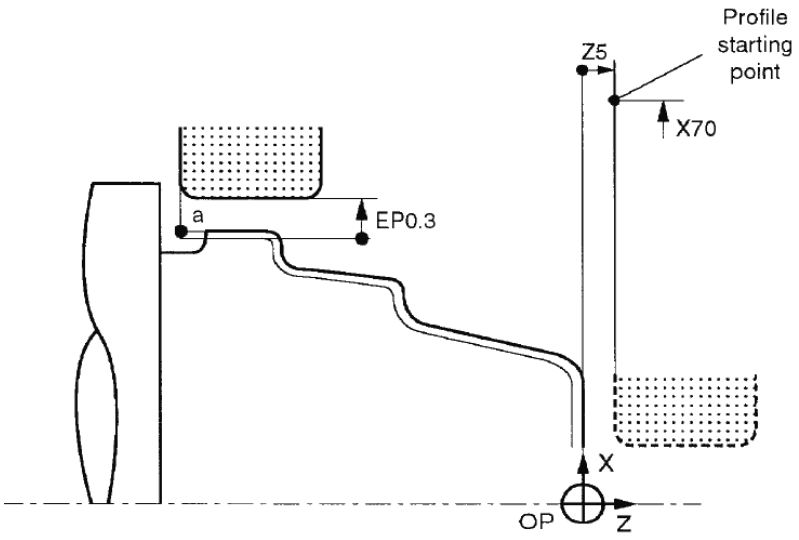
Example

Profile grinding cycle (external)

```
...
G208  X70  Z5  EP0.3 ES1 EH100 H222 N10 N70 F100 D1        Cycle call & Pre-Cycle
I0.2  EI0.1 EN2 F1 EB0                                    In-Cycle 1
I0.02 EI0.01 EN2  EK1 EB2 F0.5                            In-Cycle 2


%222 (PROFILE SUBROUTINE)
N10 Xa Za
N..
N..
N70 X.. Z..
```

Schematic illustration of cycle

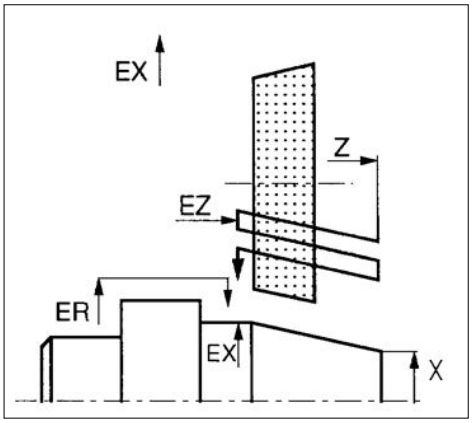


3.12.7 External conical traverse cycle ► G210

G210 External conical traverse cycle.

This cycle includes:

- Initial positioning on Z followed by incrementon X then tapered traverse up to the end position on Z.
- Increment on X and tapered return traverse on Z, etc.



Syntax

G210 X.. EX.. / EU.. Z.. EZ.. D.. EP.. F.. [ER..] [EE..] [EF..] [EA..] [P..] [EC..] [EH..]
X.. EI.. EJ.. F.. [EK..] [EG..] EM.. [ED..] [EV..] [ET..] / [EN..] EB..

Cycle call arguments

G210	External conical traverse cycle.
X..	Final diameter at start of taper.
EX.. / EU..	• EX: Final diameter at end of taper. • EU: Taper angle.
Z..	Starting point on Z.
EZ..	End point on Z.
D..	Selection of active wheel side. • D1: left side. • D2: rigth side.
EP..	Safety clearance on X of the taper (+ material allowance) / Rapid stop distance.
F..	Traverse feed rate (mm/min or in/min).
ER..	Skip diameter.
EE..	Dwell time at start of traverse (s).
EF..	Dwell time at end of traverse (s).
EA..	Overtravel by P, if P is programmed, otherwise by the wheel width, on Z and EZ druing traverse (associated with P). • EA0: wheel within the traverse travel, no overtravel, • EA1: Overtravel by one wheel width or P at the start point (Z), • EA2: Overtravel by one wheel width or P at the end point (EZ), • EA3: Wheel overtravel or P to the right and left.
P..	Overtravel (related to EA).
EC..	Type of increment. • EC0: continuous increment, • EC1: discontinuous increment in Z and/or EZ
EH..	Backoff diameter for dressing and measuring.

In-cycle call arguments

X..	Allowance on final diameter or stock remaining relative to final.
EI..	Increment at start of traverse.
EJ..	Increment at end of traverse.
F..	Feed rate increment (mm/min or in/min).
EK..	Backoff distance
EG..	Measurement selection: • EG0: no measurement, • EG98: conditional manual measurement call, • EG99: unconditional manual measurement call.
EM..	Offset modification selection (default: no modification). • EM0: no modification, • EM1: modification of DAT1 (actual part), • EM2: modification of DAT1 and machine data (all parts).
ED..	Wheel dressing selection: • ED1: peripheral face, • ED2: left side, • ED3: peripheral face and left side, • ED4: right side, • ED5: peripheral face and right side, • ED6: left side and right side, • ED7: peripheral face and left and right sides. • ED8: face with diamond 1+2.
ET.. / EN..	• ET: Sparkout time (s). • EN: Number of sparkout passes.
EB..	Cycle sequencing selection: • EB0: sequencing without stopping, • EB1: sequencing with stop, • EB2: end of cycle.
EV..	Dressing type: • EV1: Coarse, • EV2: Fine, • EV3: Coarse+Fine, • EV4: Sparkout, • EV5: Coarse+ Sparkout, • EV6: Fine+Sparkout, • EV7: Coarse +Fine+Sparkout.

Notes

Notes on argument programming

The values of X, EK, EI and EJ must be greater than 0.

The value of EU must be > -90' and < +90'.

Arguments EX and EU are mutually exclusive.

If P is not programmed, it is the wheel width that is taken into account.

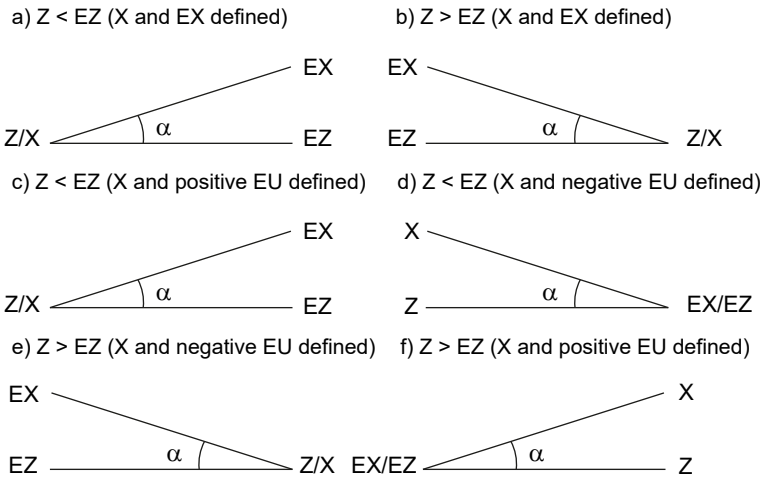
Notes associated with arguments ER and EH

If ER and EH are not programmed, program %9970 calculates ER and EH.

In this case: ER and EH =X+ EP.

If only ER is programmed (without EH), in all cases: EH = ER.

Defining the taper angle



In cases d and f, the value of X is defined as the largest radius of the taper and calculated value EX is the smallest radius.

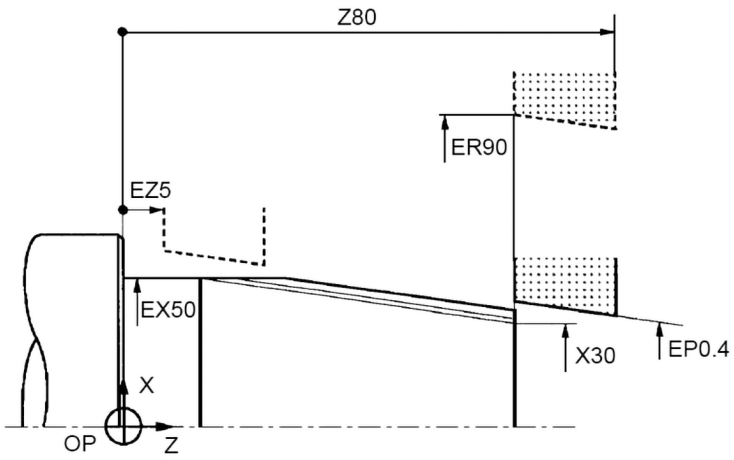
See chapter 4 for further information regarding the arguments present at cycle call or the arguments to be defined during the cycle.

Example

Conical traverse cycle (external)

```
...
G210 X30 EX50 Z80 EZ5 D1 F80 EP0.4 EE1 EF1 EA2 P5 EC1 ER90    Cycle call & Pre-Cycle
X0.2 EI0.05 EJ0.05 F4 EB0                                     In-Cycle 1
X0.1 EI0.02 EJ0.02 F1 EK2 EB0                                 In-Cycle 2
X0 ET5 EI0.01 EJ0.01 F0.05 EK2 EB2                            In-Cycle 3
```

Schematic illustration of cycle

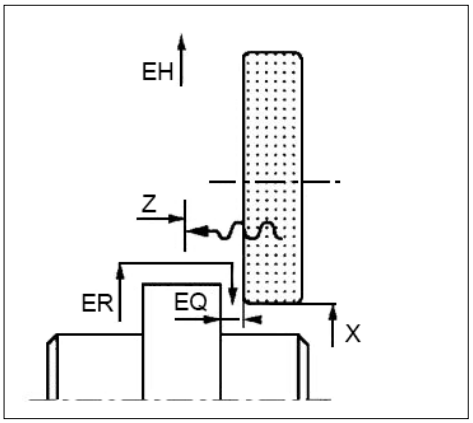


3.12.8 External oscillating shoulder cycle ► G212

G212 External oscillating shoulder cycle.

This cycle includes:

- Initial positioning on X followed by grinding on Z with or without oscillations.



Syntax

G212 Z.. X.. D.. EQ.. [ER..] [EH..]
Z.. F.. [EM..] [EG..] [ET..] [EK..] [ED..] [EV..] [EO..] [EX..] EB..

Cycle call arguments

G212	External oscillating shoulder cycle.
Z..	End point on Z.
X..	Shoulder start diameter.
D..	Selection of active wheel side. • D1: left side. • D2: rigth side.
EQ..	Safety clearance on Z (+ material allowance) / Rapid stop distance.
ER..	Skip diameter.
EH..	Backoff diameter for dressing or measurement.

In-cycle call arguments

Z..	Allowance on Z end point or stock remaining relative to final.
F..	Feed rate on Z (mm/min or in/min).
EM..	Offset modification selection (default: no modification). • EM0: no modification, • EM1: modification of DAT1 (actual part), • EM2: modification of DAT1 and machine data (all parts).
EG..	Measurement selection: • EG0: no measurement, • EG1: gap elimination enable, • EG2 to EG9: in-cycle measurement, • EG98: conditional manual measurement call, • EG99: unconditional manual measurement call.
ET..	Sparkout time (s).
EK..	Backoff distance.
ED..	Wheel dressing selection: • ED1: peripheral face, • ED2: left side, • ED3: peripheral face and left side, • ED4: right side, • ED5: peripheral face and right side, • ED6: left side and right side, • ED7: peripheral face and left and right sides. • ED8: face with diamond 1+2.
EO..	Oscillation frequency (osc/min).
EX..	Oscillation amplitude.
EB..	Cycle sequencing selection. • EB0: sequencing without stopping, • EB1: sequencing with stop, • EB2: end of cycle.
EV..	Dressing type: • EV1: Coarse, • EV2: Fine, • EV3: Coarse+Fine, • EV4: Sparkout, • EV5: Coarse+ Sparkout, • EV6: Fine+Sparkout, • EV7: Coarse +Fine+Sparkout.

Notes

Notes on argument programming

The value of X must be greater than 0.

Arguments EO and EX are prohibited if the cycle is to be performed without oscillations.

Notes associated with arguments ER and EH

If ER and EH are not programmed, program %9970 calculates ER and EH.

In this case: ER and EH = X.

If only ER is programmed (without EH), in all cases: EH = ER.

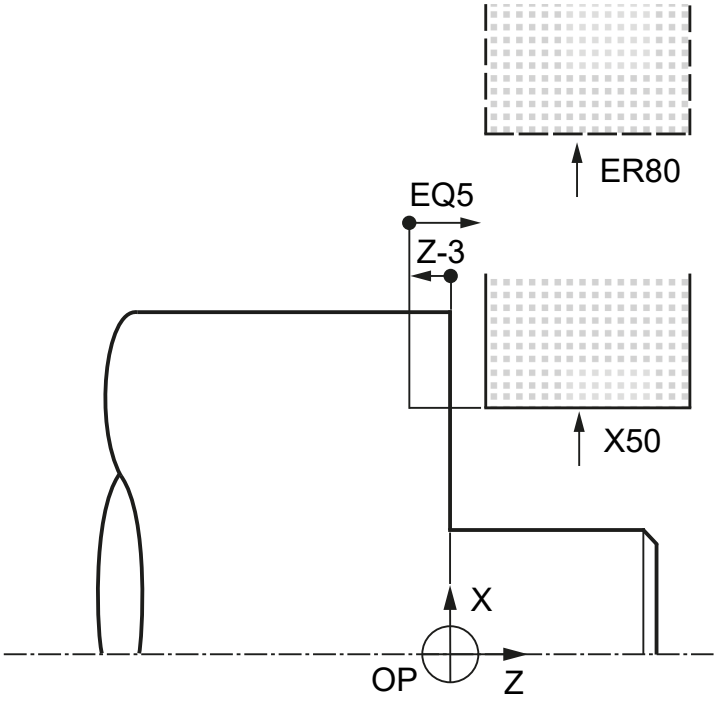
See chapter 4 for further information regarding the arguments present at cycle call or the arguments to be defined during the cycle.

Example

Shoulder plunge cycle with oscillations (external)

```
...
G212 Z-3 X50 D1 ER80 EQ5          Cycle call & Pre-Cycle
Z0 E060 EX1 ET10 EB2 F2           In-Cycle 1
```

Schematic illustration of cycle

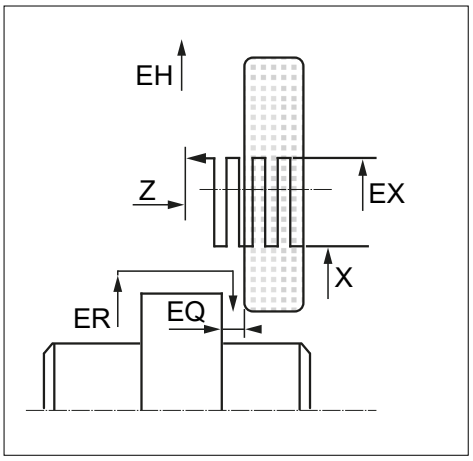


3.12.9 External shoulder traverse cycle ► G214

G214 External shoulder traverse cycle.

This cycle includes:

- Initial positioning on X followed by increment on Z and traverse on X up to the end point on X.
- Increment on Z and return traverse on X, etc.



Syntax

G214 Z.. X.. EX.. D.. EQ.. F.. [ER..] [EH..] [EE..] [EF..] [EC..]
Z.. EI.. EJ.. F.. [EG..] [EM..] [ED..] [EV..] [ET..] / [EN..] [EK..] EB..

Cycle call arguments

G214	External shoulder traverse cycle.
Z..	End point on Z.
X..	Shoulder start diameter.
EX..	End point on X.
D..	Selection of active wheel side. • D1: left side. • D2: rigth side.
EQ..	Safety clearance on Z axis (+ material allowance) / Rapid stop distance.
F..	Traverse feed rate (mm/min or inch/min).
ER..	Skip diameter.
EH..	Backoff diameter for dressing or measurement.
EE..	Dwell time at start of traverse (s).
EF..	Dwell time at end of traverse (s).
EC..	Increment type: • EC0: continuous increment, • EC1: discontinuous increment in X and/or EX.

In-cycle call arguments

Z..	Allowance on final diameter or stock remaining relative to final.
EI..	Increment at start of traverse.
EJ..	Increment at end of traverse.
F..	Feed rate increment (mm/min or in/min).
EG..	Measurement selection: • EG0: no measurement, • EG1: gap elimination enable, • EG2 to EG9: in-cycle measurement measurement (with continuous increment), • EG98: conditional manual measurement call, • EG99: unconditional manual measurement call.
EM..	Offset modification selection (default: no modification). • EM0: no modification, • EM1: modification of DAT1 (actual part), • EM2: modification of DAT1 and machine data (all parts).
ED..	Wheel dressing selection: • ED1: peripheral face, • ED2: left side, • ED3: peripheral face and left side, • ED4: right side, • ED5: peripheral face and right side, • ED6: left side and right side, • ED7: peripheral face and left and right sides. • ED8: face with diamond 1+2.
ET.. / EN..	• ET: Sparkout time (s). • EN: Number of sparkout passes.
EK..	Backoff distance.
EB..	Cycle sequencing selection. • EB0: sequencing without stopping, • EB1: sequencing with stop, • EB2: end of cycle.
EV..	Dressing type: • EV1: Coarse, • EV2: Fine, • EV3: Coarse+Fine, • EV4: Sparkout, • EV5: Coarse+ Sparkout, • EV6: Fine+Sparkout, • EV7: Coarse +Fine+Sparkout.

Notes

Notes on argument programming

The values of Z, EK, EI and EJ must be greater than 0.

Notes associated with arguments ER and EH

If ER and EH are not programmed, program %9970 calculates ER and EH.

In this case: ER and EH = X.

If only ER is programmed (without EH), in all cases: EH = ER.

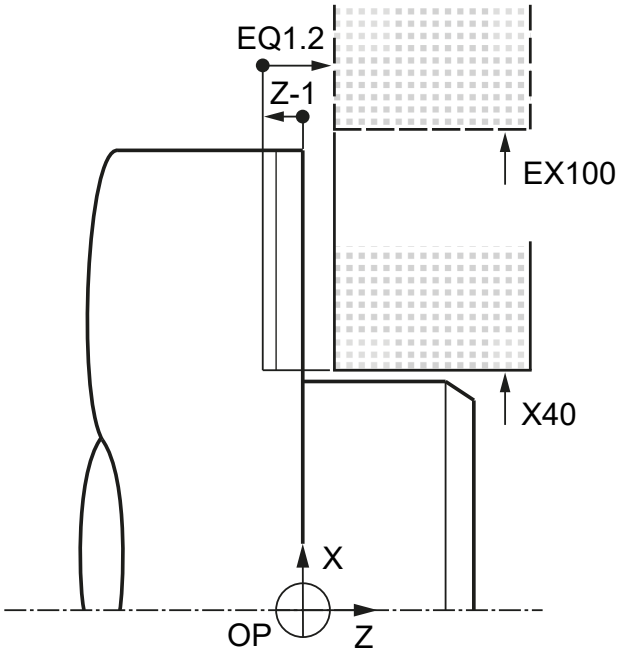
See chaper 4 for further information regarding the arguments present at cycle call or the arguments to be defined during the cycle.

Example

Shoulder traverse cycle (external)

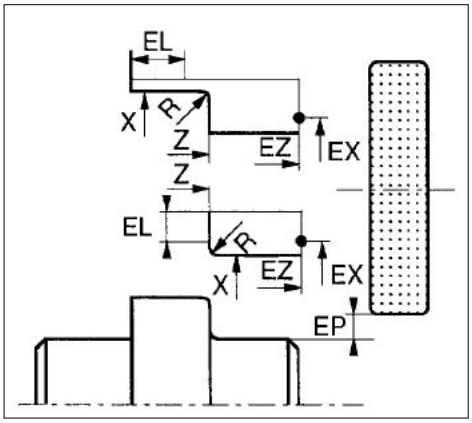
```
...
G214 Z-1  X40 EX100 D1 EQ1.2 ER180 F98 EE1 EF1 EC0      Cycle call & Pre-Cycle
Z0.2  EI0.02   EJ0.02  F2 EB0                          In-Cycle 1
Z0.1 EI0.01 EJ0.01 F0.5 EB0                            In-Cycle 2
Z0 EN6 EK1 EB2 EJ0.05 EI0.05 F0.05                     In-Cycle 3
...
```

Schematic illustration of cycle



3.12.10 External shoulder with fillet cycle ► G216

G216 External shoulder with fillet cycle



This cycle includes grinding of a fillet between a cylindrical surface and a shoulder. It includes several phases:

- Cylindrical grinding phase
- Shoulder grinding phase
- Shoulder/cylinder interface grinding phase.
- Wheel retraction phase with possible repeat of the cycle.

Syntax

G216 X.. Z.. D.. EX.. EZ.. EP.. ES.. EL.. R.. F.. [EH..] [ER..]
I.. EI.. [ED..] [EV..] [EN..] EB..

Cycle call arguments

G216	External shoulder with fillet cycle.
X..	Final diameter.
Z..	End point on Z.
D..	Selection of active wheel side. • D1: left side. • D2: rigth side.
EX..	Cycle starting point on X axis.
EZ..	Cycle starting point on Z axis.
EP..	Safety clearance on X axis (+ material allowance) / Rapid stop distance.
ES..	Radius correction: • ES1: left radius offset (G41), • ES2: right radius offset (G42).
EL..	Retraction on profile / overtravel on profile.
R..	Fillet between two surfaces radius.
F..	Feed rate on cylindrical surface/shoulder (mm/min or inch/min).
EH..	Backoff diameter for dressing or measuring.
ER..	Skip diameter.

In-cycle call arguments

I..	Allowance on final diameter or stock remaining relative to final.
EI..	Depth of pass.
ED..	Wheel dressing selection: • ED1: peripheral face, • ED2: left side, • ED3: peripheral face and left side, • ED4: right side, • ED5: peripheral face and right side, • ED6: left side and right side, • ED7: peripheral face and left and right sides. • ED8: face with diamond 1+2.
EN..	Number of sparkout passes.
EB..	Cycle sequencing selection. • EB0: sequencing without stopping, • EB1: sequencing with stop, • EB2: end of cycle.
EV..	Dressing type: • EV1: Coarse, • EV2: Fine, • EV3: Coarse+Fine, • EV4: Sparkout, • EV5: Coarse+ Sparkout, • EV6: Fine+Sparkout, • EV7: Coarse +Fine+Sparkout.

Notes

Notes on argument programming

The values of EL and R must be greater than 0.

The value of R must be greater than 1.

Case of figures with EX and EZ

Case 1: EX > X
EZ > Z  D1 and G42 active

Case 2: EX > X
EZ < Z  D2 and G41 active

Case 3: EX < X 
EZ > Z D1 and G42 active

Case 4: EX < X 
EZ < Z D2 and G41 active

Notes associated with arguments ER and EH

If ER and EH are not programmed, program %9970 calculates ER and EH.

In this case: ER and EH= X+ EP.

If only ER is programmed (without EH), in all cases: EH = ER.

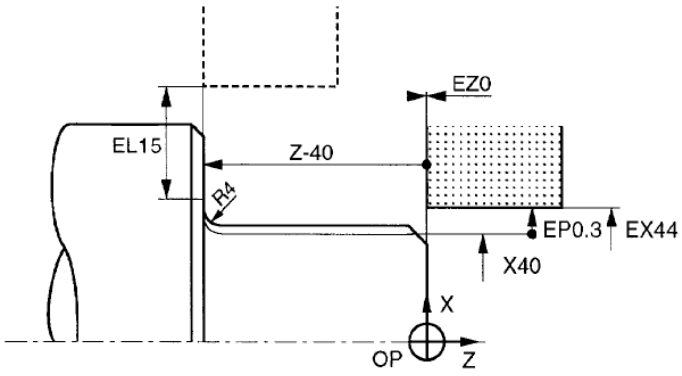
See chapter 4 for further information regarding the arguments present at cycle call or the arguments to be defined during the cycle.

Example

Shoulder profile grinding cycle (external)

```
...
G216 X40 Z-40 EX44 D1 EZ0 EP1 ES2 EL15 R4 F100      Cycle call & Pre-Cycle
I0.2 EI0.04 EB0                                     In-Cycle 1
I0 EI0.02 EN2 EB2                                   In-Cycle 2
...
```

Schematic illustration of cycle



3.13 Internal grinding cycles

Grinding of the workpiece is achieved by initiating the appropriate grinding cycle. The cycle chosen is programmed by a G2xx function.

The internal grinding cycles have the following numbers:

- G201, G203, G205, G207, G209, G211, G213, G215, G217.

The internal grinding cycles have the following numbers:	
G201	**Internal plunge / multiplunge cycle**
G203	**Internal plunge cycle with inclined axis**
G205	**Internal oscillating plunge / multiplunge cycle**
G207	**Internal cylindrical traverse cycle**
G209	**Internal profile grinding cycle**
G211	**Internal conical traverse cycle**
G213	**Internal oscillating shoulder cycle**
G215	**Internal shoulder traverse cycle**
G217	**Internal interpolated shoulder cycle**

The external and internal grinding cycles are identical as regards the programming of their arguments. They differ only by their call numbers.

3.13.1 General

Cycles are programmed in two parts:

- The first part includes the G2xx function followed by the cycle cali arguments.
- The second part includes the in-cycle arguments.

Cycle call arguments

These programming arguments define the engineering data relating to the final production of the workpiece.

They must always be included in the block containing the G2xx cycle call.

In-cycle arguments

These programming arguments define the characteristics associated with each grinding phase:

- Rough grinding.
- Finishing.
- Sparkout, etc.

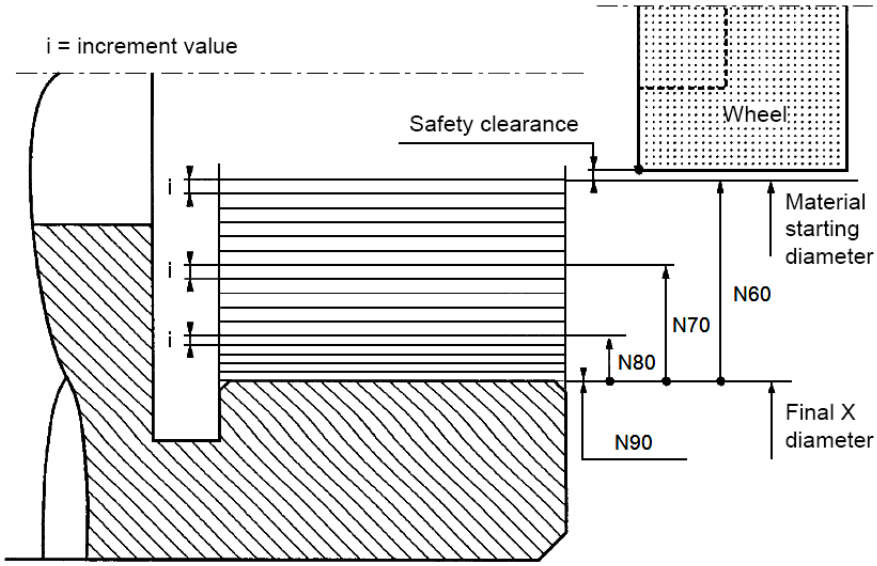
They must be programmed in the successive blocks defined after the cycle call block.

A G2xx cycle must always end with argument EB2 (end of cycle). Otherwise, certain modal arguments are applied during the following cycles.

Example of a cycle

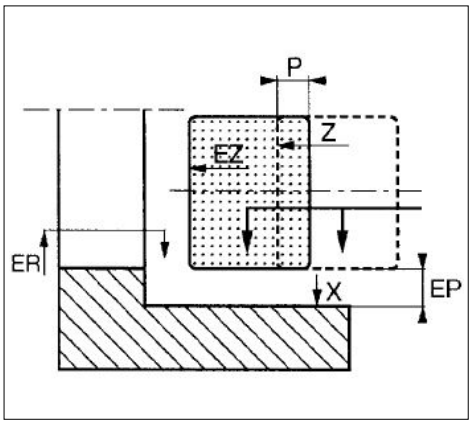
```
%207
N10 T01 M06          Selection of wheel
N20 G230 S...        Wheel speed calculation
N30 M160             Periodic dressing test counter
N40 G77 H9911        Switch on coolant & spindles
N50 G207 ...         Internal cylindrical traverse cycle and cycle call arguments
N60 ...              Roughing phase
N70 ...              Semi-finishing phase
N80 ...              Finishing phase
N90 ...              Sparkout and end of cycle
N100 G77 H9912       Switch off coolant & spindles
N110 M02             End of program
```

Schematic representation of the phases of a cylindrical traverse cycle



3.13.2 Internal plunge / multiplunge cycle ► G201

G201 Internal plunge / multiplunge cycle.



For single plunge the cycle includes:

- Positioning on Z followed by plunge on X.

For multiplunge the cycle includes:

- Initial positioning on Z followed by a first plunge on X and retraction on X.
- A second positioning on Z (wheel width - overlap) followed by plunge, etc. (until reaching the end point).

Syntax

G201 X.. Z.. D.. [EZ..] EP.. [ER..] [EH..] [P..]
X.. F.. [EG..] [EM..] [EK..] [ED..] [EV..] [ET..] EB..

Cycle call arguments

G201	Internal plunge / multiplunge cycle.
X..	Final diameter.
Z..	Plunge: plunge position on Z axis. Multiplunge: starting point on Z axis.
D..	Selection of active wheel side. • D1: left side. • D2: rigth side.
EZ..	Multiplunge: end point on Z.
EP..	Safety clearance on X axis (+ material allowance) / Rapid stop distance.
ER..	Skip diameter.
EH..	Backoff diameter for dressing or measuring.
P..	Multiplunge: wheel overlap value.

In-cycle call arguments

X..	Allowance on final diameter or stock remaining relative to final.
F..	Feed rate on X (mm/min or in/min).
EG..	Measurement selection (default: no measurement). • EG0: no measurement, • EG1: gap elimination enable, • EG2 to EG9: in-cycle measurement, • EG98: conditional manual measurement call, • EG99: unconditional manual measurement call.
EM..	Offset modification selection (default: no modification). • EM0: no modification, • EM1: modification of DAT1 (actual part), • EM2: moditication of DAT1 and machine data (all parts).
EK..	Backoff distance.
ED..	Wheel dressing selection: • ED1: peripheral face, • ED2: left side, • ED3: peripheral face and left side, • ED4: right side, • ED5: peripheral face and right side, • ED6: left side and right side, • ED7: peripheral face and left and right sides. • ED8: face with diamond 1+2.
ET..	Sparkout time (s).
EB..	Cycle sequencing selection. • EB0: sequencing without stopping, • EB1: sequencing with stop, • EB2: end of cycle.
EV..	Dressing type: • EV1: Coarse, • EV2: Fine, • EV3: Coarse+Fine, • EV4: Sparkout, • EV5: Coarse+ Sparkout, • EV6: Fine+Sparkout, • EV7: Coarse +Fine+Sparkout.

Notes

Notes on argument programming

The values of X, EP, X, EK, EZ and ET must be greater than 0.

Multiplunge arguments

- The value ot P must be less than or equal to the wheel width. If P is not programmed its value is torced to 0.
- With D1 or D2 the wheel position does not change. It is the programme origin that is modified.
- Movement only takes place when arguments Z and EZ are programmed.
- The difference between Z and EZ must be greater than the wheel width.

Notes associated with arguments ER and EH

If ER and EH are not programmed, program %9970 calculates ER and EH.
In this case: ER and EH= X+ EP.

If only ER is programmed (without EH), in all cases: EH= ER.

See chapter 4 for further information regarding the arguments present at cycle call or the arguments to be defined during the cycle.

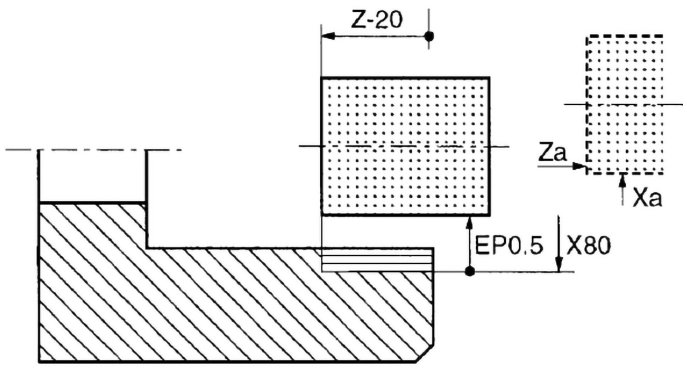
Example

Plunge cycle (internal)

```
...
G0/G1 Za                          Z approach position
Xa                                X approach position
G201 X80 Z-20 D1 EP0.5 ER10       Cycle call & Pre-Cycle
X0.2 F2 EB0                       In-Cycle 1
X0.1 F1 EB0                       In-Cycle 2
X0 EK1 ET5 EB2 F0.5               In-Cycle 3
...
```

Schematic illustration of cycle

Z axis origin on face of workpiece

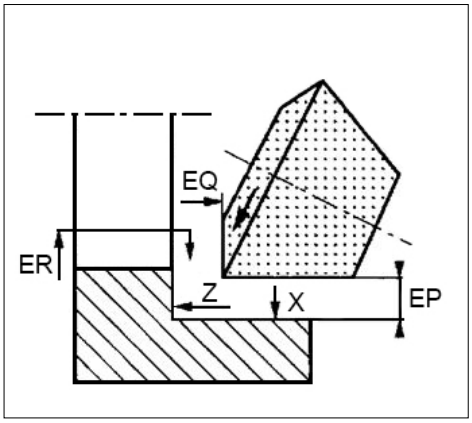


3.13.3 Internal plunge cycle with inclined axis ► G203

G203 Internal plunge cycle with inclined axis.

This cycle includes:

- Positioning followed by plunge to simultaneously grind the part wall and shoulder.



Syntax

G203 X.. Z.. D.. EP.. EQ.. [ER..] [EH..]
X.. F.. [EG..] [EM..] [EK..] [ED..] [EV..] [ET..] EB..

Cycle call arguments

G203	Internal plunge cycle with inclined axis
X..	Final diameter
Z..	End point on Z
D..	Selection of active wheel side • D1: left side.
EP..	Safety clearance on X axis (+ material allowance) / Rapid stop distance
EQ..	Safety clearance on Z axis (+ material allowance) / Rapid stop distance
ER..	Skip diameter
EH..	Backoff diameter for dressing or measuring

In-cycle call arguments

X..	Allowance on final diameter or stock remaining relative to final.
F..	Feed rate on X and Z (mm/min or inch/min).
EG..	Measurement selection (default: no measurement). • EG0: no measurement, • EG1: gap elimination enable, • EG2 to EG9: in-cycle measurement, • EG98: conditional manual measurement call, • EG99: unconditional manual measurement call.
EM..	Offset modification selection (default: no modification). • EM0: no modification, • EM1: modification of DAT1 (actual part), • EM2: moditication of DAT1 and machine data (all parts).
EK..	Backoff distance.
ED..	Wheel dressing selection: • ED1: peripheral face, • ED2: left side, • ED3: peripheral face and left side,
ET..	Sparkout time (s).
EB..	Cycle sequencing selection. • EB0: sequencing with stop, • EB1: sequencing with stop, • EB2: end of cycle.
EV..	Dressing type: • EV1: Coarse, • EV2: Fine, • EV3: Coarse+Fine, • EV4: Sparkout, • EV5: Coarse+ Sparkout, • EV6: Fine+Sparkout, • EV7: Coarse +Fine+Sparkout.

Notes

Notes on argument programming

The values of X, EP and EQ must be greater than 0.

Notes associated with arguments ER and EH

If ER and EH are not programmed, program %9970 calculates ER and EH.

In this case:

- In a cycle on the X axis: ER and EH =X+ EP.
- In a cycle on the Z axis: ER and EH = X.

If only ER is programmed (without EH), in all cases: EH= ER.

See chapter 4 for further information regarding the arguments present at cycle call or the arguments to be defined during the cycle.

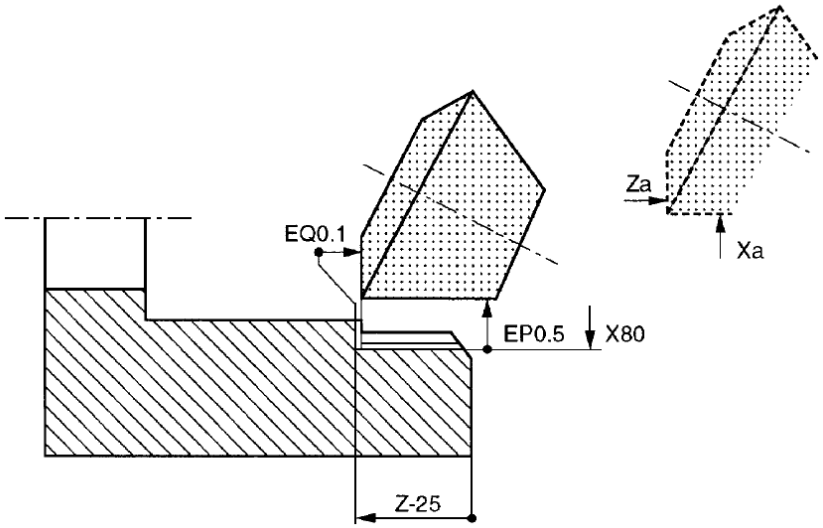
Example

Plunge cycle with inclined axis (internal)

```
...
G0/G1 Za                                  Z approach position
Xa                                        X approach position
G203 X80 Z-25 D1 EP0.4 EQ0.1 ER10         Cycle call & Pre-Cycle
X0.2 F2 EB0                               In-Cycle 1
X0.1 F1 EB0                               In-Cycle 2
X0 EK1 ET5 EB2 F0.5                       In-Cycle 3
...
```

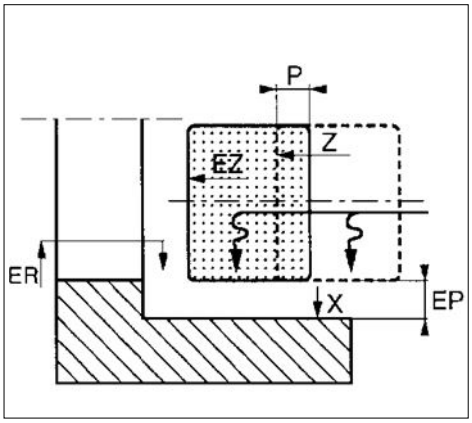
Schematic illustration of cycle

Z axis origin on workpiece face



3.13.4 Internal oscillating plunge / multiplunge cycle ► G205

G205 Internal oscillating plunge / multiplunge cycle.



For single plunge the cycle includes:

- Positioning on Z followed by plunge on X (with oscillation).

For multiplunge the cycle includes:

- Initial positioning on Z followed by a first plunge on X with oscillation and retraction on X.
- A second positioning on Z (wheel width - overlap) followed by plunge on X, etc. (until reaching the end).

Syntax

G205 X.. Z.. D.. [EZ..] EP.. [ER..] [EH..] [P..]
X.. F.. [EZ..] [EO..] [EG..] [EM..] [EK..] [ED..] [EV..] [ET..] EB..

Cycle call arguments

G205	Internal oscillating plunge / multiplunge cycle.
X..	Final diameter.
Z..	Plunge cycle: plunge position on Z axis. Multiplunge cycle: starting point on Z axis.
D..	Selection of active wheel side. • D1: left side. • D2: rigth side.
EZ..	Multiplunge: end point on Z.
EP..	Safety clearance on X axis (+ material allowance) / Rapid stop distance.
ER..	Skip diameter.
EH..	Backoff diameter for dressing or measuring.
P..	Multiplunge: wheel overlap value.

In-cycle call arguments

X..	Allowance on final diameter or stock remaining relative to final.
F..	Plunge feed rate (mm/min or in/min).
EZ..	Oscillation amplitude.
EO..	Oscillation frequency (osc/min).
EG..	Measurement selection (default: no measurement). • EG0: no measurement, • EG1: gap elimination enable, • EG2 to EG9: in-cycle measurement, • EG98: conditional manual measurement call, • EG99: unconditional manual measurement call.
EM..	Offset modification selection (default: no modification). • EM0: no modification, • EM1: modification of DAT1 (actual part), • EM2: moditication of DAT1 and machine data (all parts).
EK..	Backoff distance.
ED..	Wheel dressing selection: • ED1: peripheral face, • ED2: left side, • ED3: peripheral face and left side, • ED4: right side, • ED5: peripheral face and right side, • ED6: left side and right side, • ED7: peripheral face and left and right sides. • ED8: face with diamond 1+2.
ET..	Sparkout time (s).
EB..	Cycle sequencing selection. • EB0: sequencing without stop, • EB1: sequencing with stop, • EB2: end of cycle.
EV..	Dressing type: • EV1: Coarse, • EV2: Fine, • EV3: Coarse+Fine, • EV4: Sparkout, • EV5: Coarse+ Sparkout, • EV6: Fine+Sparkout, • EV7: Coarse +Fine+Sparkout.

Notes

Notes on argument programming

The values of X, EP, ET, EK, EO and EZ must be greater than 0.

Multiplunge arguments

- The value ot P must be less than or equal to the wheel width. If P is not programmed its value is torced to 0.
- With D1 or D2 the wheel position does not change. It is the program origin that is modified.
- Movement only takes place when arguments Z and EZ are programmed.
- The difference between Z and EZ must be greater than the wheel width.

Notes associated with arguments ER and EH

If ER and EH are not programmed, program %9970 calculates ER and EH.
In this case: ER and EH =X + EP.

If only ER is programmed (without EH), in all cases: EH= ER.

See chapter 4 for further information regarding the arguments present at cycle call or the arguments to be defined during the cycle.

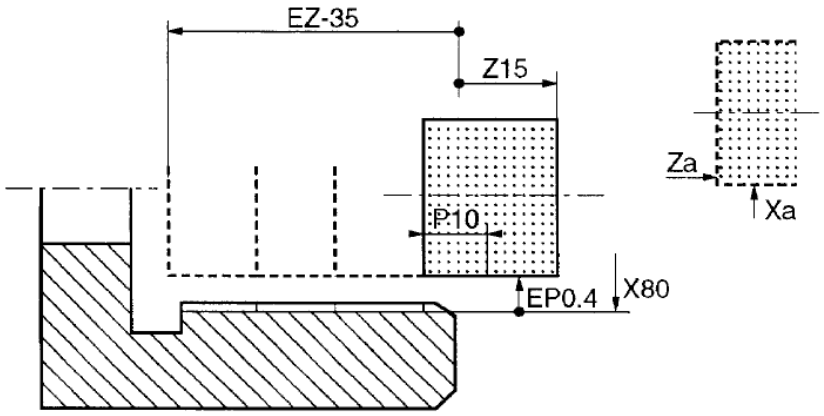
Example

Multiplunge cycle with oscillations (internal)

...	
G0/G1 Za	Z approach position
Xa	X approach position
G205 X80 Z15 EZ-35 D1 EP0.4 ER10 P10	Cycle call & Pre-Cycle
X0.2 EZ1 E010 F0.2 EB0	In-Cycle 1
X0 ET2 EK1 EB2 F0.1	In-Cycle 2
...	

Schematic illustration of cycle

Z axis origin on workpiece face

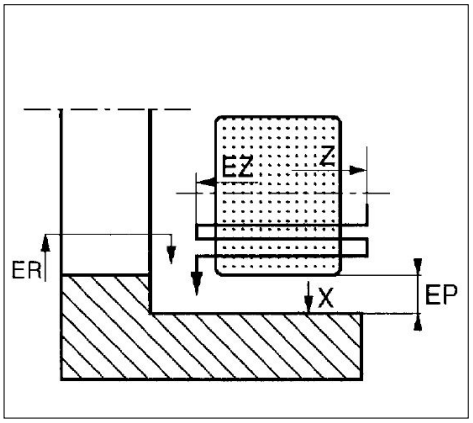


3.13.5 Internal cylindrical traverse cycle ► G207

G207 Internal cylindrical traverse cycle.

This cycle includes:

- Initial positioning on Z followed by a first increment on X and traverse up to the end position on Z.
- A second increment on X followed by return traverse, etc.



Syntax

G207 X.. Z.. D.. EZ.. EP.. F.. [ER..] [EH..] [EA..] [P..] [EE..] [EF..] [EC..]
X.. EI.. EJ.. F.. [EG..] [EM..] [EK..] [ED..] [EV..] [ET..] / [EN..] EB..

Cycle call arguments

G207	Internai cylindrical traverse cycle.
X..	Final diameter.
Z..	Starting point on Z.
D..	Selection of active wheel side. • D1: left side. • D2: rigth side.
EZ..	End position on Z.
EP..	Safety clearance on X axis (+ material allowance) / Rapid stop distance.
F..	Traverse feed rate (mm/min or inch/min).
ER..	Skip diameter.
EH..	Backoff diameter for dressing or measuring.
EA..	Overtravel by P, if P is programmed, otherwise by the wheel width, on Z and EZ druing traverse (associated with P). • EA0: wheel within traverse distance, no overtravel, • EA1: Overtravel by one wheel width or P at the starting point (Z). • EA2: Overtravel by one wheel width or P at the end point (EZ). • EA3: Wheel overtravel or P to right and left.
P..	Overtravel (associated with EA).
EE..	Dwell time at start of traverse (s).
EF..	Dwell time at end of traverse (s).
EC..	Type of increment: • EC0: continuous increment, • EC1: discontinuous increment in Z and/or EZ.

In-cycle call arguments

X..	Allowance on final diameter or stock remaining relative to final.
EI..	Increment at start of traverse.
EJ..	Increment at end of traverse.
F..	Feed rate increment (mm/min or inch/min).
EG..	Measurement selection. • EG0: no measurement, • EG1: gap elimination enable, • EG2 to EG9: in-cycle measurement (with continuous increment), • EG98: conditional manual measurement call, • EG99: unconditional manual measurement call.
EM..	Offset modification selection (default: no modification). • EM0: no modification, • EM1: modification of DAT1 (actual part), • EM2: moditication of DAT1 and machine data (all parts).
EK..	Backoff distance.
ED..	Wheel dressing selection: • ED1: peripheral face, • ED2: left side, • ED3: peripheral face and left side, • ED4: right side, • ED5: peripheral face and right side, • ED6: left side and right side, • ED7: peripheral face and left and right sides. • ED8: face with diamond 1+2.
ET.. / EN	• ET: Sparkout time (s). • EN: Number of sparkout passes
EB..	Cycle sequencing selection: • EB0: sequencing without stop, • EB1: sequencing with stop, • EB2: end of cycle.
EV..	Dressing type: • EV1: Coarse, • EV2: Fine, • EV3: Coarse+Fine, • EV4: Sparkout, • EV5: Coarse+ Sparkout, • EV6: Fine+Sparkout, • EV7: Coarse +Fine+Sparkout.

Notes

Notes on argument programming

The values of X, EK, EI and EJ must be greater than 0.

It P is not programmed, it is the wheel width that is taken into account.

Notes associated with arguments ER and EH

If ER and EH are not programmed, program %9970 calculates ER and EH.
In this case: ER and EH =X + EP.

If only ER is programmed (without EH), in all cases: EH= ER.

See chapter 4 for further information regarding the arguments present at cycle call or the arguments to be defined during the cycle.

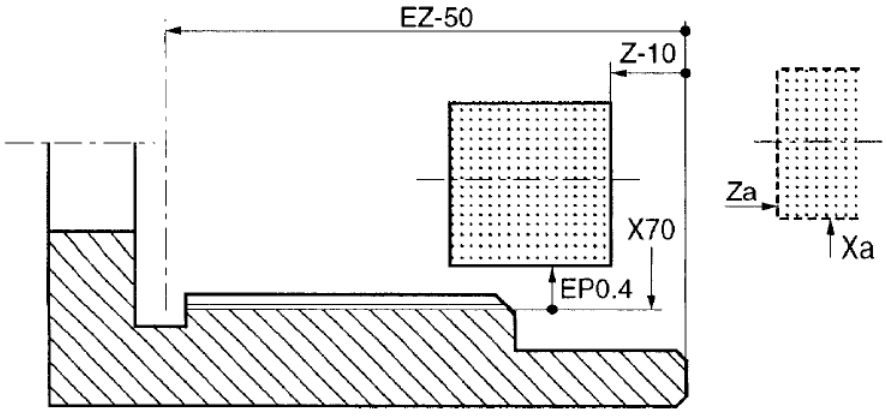
Example

Cylindrical traverse cycle (internal)

```
...
G0/G1 Za                                                    Z approach position
Xa                                                          X approach position
G207 X70 Z-10 EZ-50 EP0.4 ER10 F100 EE1 EF1 EA2 EC1 D2      Cycle call & Pre-Cycle
X0.2 EI0.04 EJ0.04 F3 EB0                                   In-Cycle 1
X0 EI0.02 EJ0.02 EN7 EK1 EB2 F0.2                           In-Cycle 2
...
```

Schematic illustration of cycle

Z axis origin on workpiece face

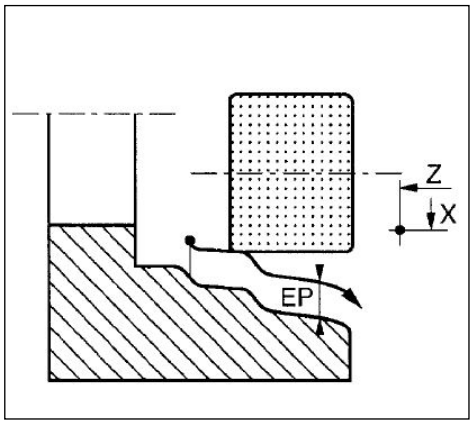


3.13.6 Internal profile grinding cycle ► G209

G209 Internal profile grinding cycle.

This cycle includes:

- Initial positioning on X and Z followed by grinding of the profile defined in a subroutine.



Syntax

G209 X.. Z.. D.. EP.. ES.. H.. N.. N.. F.. [ER..] [EH..]
I.. EI.. [EN..] [EK..] [ED..] [EV..] EB..

Cycle call arguments

G209	Internal profile grinding cycle.
X..	Start diameter (X).
Z..	Starting point on Z.
D..	Selection of active wheel side. • D1: left side. • D2: rigth side.
EP..	Safety clearance on X axis (+ material allowance).
ES..	Wheel radius correction: • ES1: left radius offset (G41), • ES2: right radius offset (G42).
H..	Number of profile definition subroutine.
N.. N..	Profile start and end blocks.
F..	Feed rate on profile (mm/min or in/min).
EH..	Backoff diameter for dressing or measurement.
ER..	Skip diameter.

In-cycle call arguments

I..	Allowance on final diameter or stock remaining relative to final.
EI..	Depth of pass.
EN..	Number of sparkout passes.
EK..	Backoff distance.
ED..	Wheel dressing selection: • ED1: peripheral face, • ED2: left side, • ED3: peripheral face and left side, • ED4: right side, • ED5: peripheral face and right side, • ED6: left side and right side, • ED7: peripheral face and left and right sides. • ED8: face with diamond 1+2.
EB..	Cycle sequencing selection. • EB0: sequencing without stop, • EB1: sequencing with stop, • EB2: end of cycle.
EV..	Dressing type: • EV1: Coarse, • EV2: Fine, • EV3: Coarse+Fine, • EV4: Sparkout, • EV5: Coarse+ Sparkout, • EV6: Fine+Sparkout, • EV7: Coarse +Fine+Sparkout.

Notes on argument programming

In cycle G209, the profile description points must have negative values.

The value of X must be greater than 0.

The starting point on X and Z must be outside the profile.

The points must run from the inside to the outside (in positive Z direction) and the X values must become more and more negative. The profil must always be ground from the inside to the outside.

Notes associated with arguments ER and EH

If ER and EH are not programmed, program %9970 calculates ER and EH.

In this case: ER and EH= X+ EP.

If only ER is programmed (without EH), in all cases: EH = ER.

See chapter 4 for further information regarding the arguments present at cycle call or the arguments to be defined during the cycle.

Example

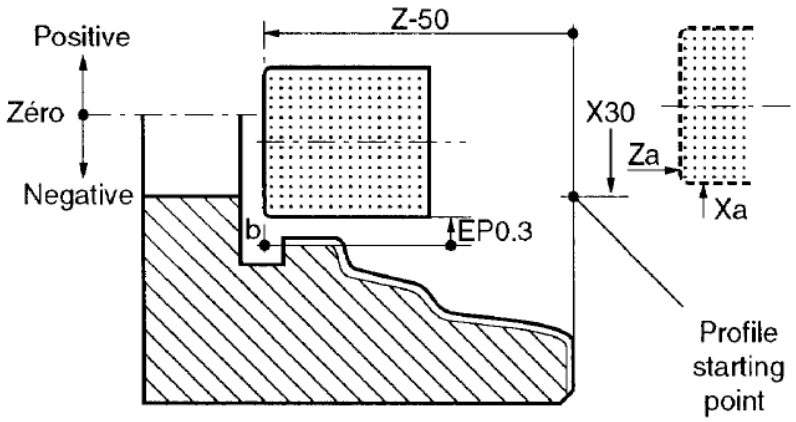
Profile grinding cycle (internal)

```
...
G0/G1 Za                                          Z approach position
Xa                                                X approach position
G209 X30 Z-50 EP0.3 ES1 H333 N10 N80 F100 D1      Cycle call & Pre-Cycle
10.2 EI0.1 EN2 F1 EB0                             In-Cycle 1
I0.02 EI0.01 EN2 EK1 EB2 F0.5                     In-Cycle 2
...

%333(PROFILE SUBROUTINE)
N10 Xb Zb                                         Negative profile description points
N..
N..
N80 X.. Z...
```

Schematic illustration of cycle

Z axis origin on workpiece face

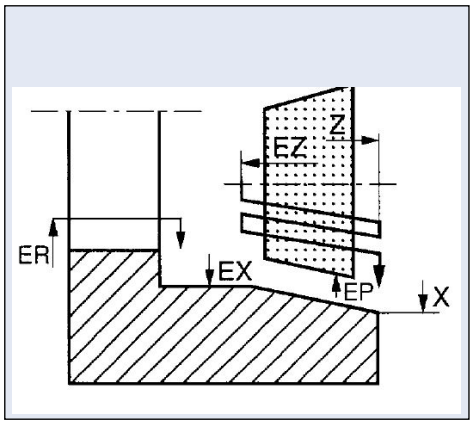


3.13.7 Internal conical traverse cycle ► G211

G211 Internal conical traverse cycle.

This cycle includes:

- Initial positioning on Z followed by increment on X then tapered traverse up to the end position on Z.
- Increment on X and tapered return traverse on Z, etc.



Syntax

G211 X.. EX / EU.. Z.. EZ.. D.. EP.. F.. [ER..] [EH..] [EE..] [EF..] [EA..] [P..] [EC..]
X.. EI.. EJ.. F.. [EK..] [EG..] [EM..] [ED..] [EV..] [ET..] / [EN..] EB..

Cycle call arguments

G211	Internal conical traverse cycle.
X..	Final diameter at start of taper.
EX.. / EU	• EX: Final diameter at end of taper. • EU: Taper angle
Z..	Starting point on Z axis.
EZ..	End point on Z.
D..	Selection of active wheel side. • D1: left side. • D2: rigth side.
EP..	Safety clearance on X axis (+ material allowance) / Rapid stop distance.
F..	Traverse feed rate (mm/min or in/min).
ER..	Skip diameter.
EH..	Backoff diameter for dressing and measuring.
EE..	Dwell time at start of traverse (s).
EF..	Dwell time at end of traverse (s).
EA..	Overtravel by P, if P is programmed, otherwise by the wheel width, on Z and EZ druing traverse (associated with P). • EA0: wheel within the traverse travel, no overtravel, • EA1: Overtravel by one wheel width or P at start point (Z), • EA2: Overtravel by one wheel width or P at end point (EZ), • EA3: Wheel overtravel or P to right and left.
P..	Overtravel (related to EA).
EC..	Type of increment: • ECO: continuous increment, • EC1: discontinuous increment in Z and/or EZ.

In-cycle call arguments

X..	Allowance on final diameter or stock remaining relative to final.
EI..	Increment at start of traverse.
EJ..	Increment at end of traverse.
F..	Feed rate increment (mm/min or in/min).
EK..	Backoff distance.
EG..	Measurement selection. • EG0: no measurement, • EG98: conditional manual measurement call, • EG99: unconditional manual measurement call.
EM..	Offset modification selection (default: no modification). • EM0: no modification, • EM1: modification of DAT1 (actual part), • EM2: moditication of DAT1 and machine data (all parts).
ED..	Wheel dressing selection: • ED1: peripheral face, • ED2: left side, • ED3: peripheral face and left side, • ED4: right side, • ED5: peripheral face and right side, • ED6: left side and right side, • ED7: peripheral face and left and right sides. • ED8: face with diamond 1+2.
ET.. / EN	• ET: Sparkout time (s). • EN: Number of sparkout passes.
EB..	Cycle sequencing selection. • EB0: sequencing without stop, • EB1: sequencing with stop, • EB2: end of cycle.
EV..	Dressing type: • EV1: Coarse, • EV2: Fine, • EV3: Coarse+Fine, • EV4: Sparkout, • EV5: Coarse+ Sparkout, • EV6: Fine+Sparkout, • EV7: Coarse +Fine+Sparkout.

Notes

Notes on argument programming

The values of X, EK, EI and EJ must be greater than 0.

The value of EU must be> -90° and < +90°.

Arguments EX and EU are mutually exclusive.

If P is not programmed, it is the wheel width that is taken into account.

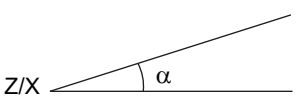
Notes associated with arguments ER and EH

If ER and EH are not programmed, program %9970 calculates ER and EH.
In this case: ER and EH =X + EP.

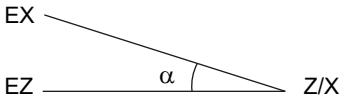
If only ER is programmed (without EH), in all cases: EH= ER.

Defining the taper angle

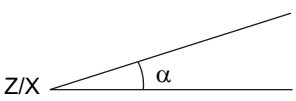
a) Z < EZ (X and EX defined)



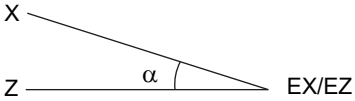
b) Z > EZ (X and EX defined)



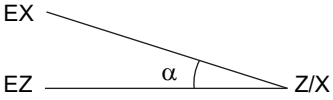
c) Z < EZ (X and positive EU defined)



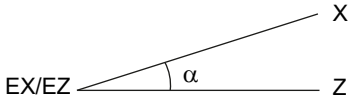
d) Z < EZ (X and negative EU defined)



e) Z > EZ (X and negative EU defined)



f) Z > EZ (X and positive EU defined)



In cases d and f, the value of X is defined as the largest radius of the taper and calculated value EX is the smallest radius.

See chapter 4 for further information regarding the arguments present at cycle call or the arguments to be defined during the cycle.

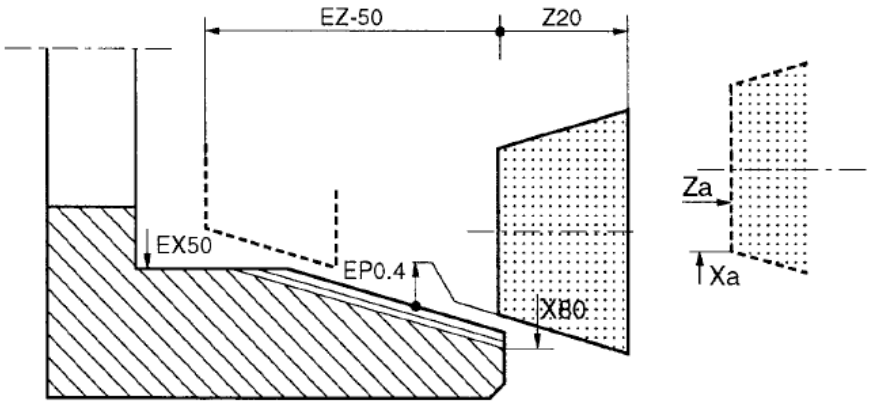
Example

Conical traverse cycle (internal)

```
...
G0/G1 Za                                                    Z approach position
Xa                                                          X approach position
G211 X80 EX50 Z20 EZ-50 ER10 D1 F100 EP0.4 EE1 EF1 EA0 EC1  Cycle call & Pre-Cycle
X0.2 EI0.05 EJ0.05 F4 EB0                                   In-Cycle 1
X0.1 EI0.02 EJ0.02 F1 EK2 EB0                               In-Cycle 2
X0 ET5 EI0.01 EJ0.01 F0.05 EK2 EB2                          In-Cycle 3
...
```

Schematic illustration of cycle

Z axis origin on workpiece face

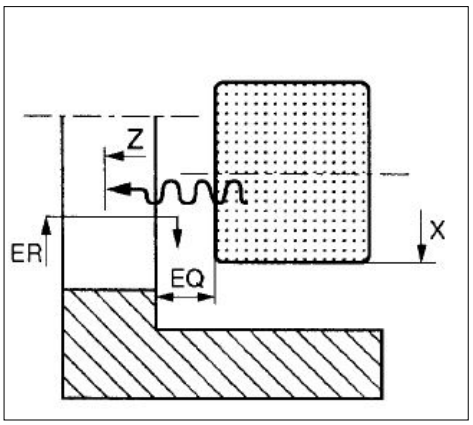


3.13.8 Internal oscillating shoulder cycle ► G213

G213 Internal oscillating shoulder cycle.

This cycle includes:

- Initial positioning on X followed by grinding on Z with or without oscillations.



Syntax

G213 Z.. X.. D.. EQ.. [ER..] [EH..]
Z.. F.. [EM..] [EG..] [ET..] [EK..] [ED..] [EV..] [EO..] [EX..] EB..

Cycle call arguments

G213	Internal oscillating shoulder cycle.
Z..	End point on Z.
X..	Shoulder start diameter.
D..	Selection of active wheel side. • D1: left side. • D2: rigth side.
EQ..	Safety clearance on Z axis (+ material allowance) / Rapid stop distance.
ER..	Skip diameter.
EH..	Backoff diameter for dressing and measuring.

In-cycle call arguments

Z..	Allowance on final diameter or stock remaining relative to final.
F..	Feed rate on Z (mm/min or in/min).
EM..	Offset modification selection (default: no modification). • EM0: no modification, • EM1: modification of DAT1 (actual part), • EM2: moditication of DAT1 and machine data (all parts).
EG..	Measurement selection. • EG0: no measurement, • EG1: gap elimination enable, • EG2 to EG9: in-cycle measurement, • EG98: conditional manual measurement call, • EG99: unconditional manual measurement call.
ET..	Sparkout time (s).
EK..	Backoff distance.
ED..	Wheel dressing selection: • ED1: peripheral face, • ED2: left side, • ED3: peripheral face and left side, • ED4: right side, • ED5: peripheral face and right side, • ED6: left side and right side, • ED7: peripheral face and left and right sides. • ED8: face with diamond 1+2.
EO..	Oscillation frequency (osc/min).
EX..	Oscillation amplitude.
EB..	Cycle sequencing selection. • EB0: sequencing without stop, • EB1: sequencing with stop, • EB2: end of cycle.
EV..	Dressing type: • EV1: Coarse, • EV2: Fine, • EV3: Coarse+Fine, • EV4: Sparkout, • EV5: Coarse+ Sparkout, • EV6: Fine+Sparkout, • EV7: Coarse +Fine+Sparkout.

Notes on argument programming

The values of X must be greater than 0.

Arguments EO and EX are prohibited if the cycle is to be performed without oscillations.

Notes associated with arguments ER and EH

If ER and EH are not programmed, program %9970 calculates ER and EH.
In this case: ER and EH =X + EP.

If only ER is programmed (without EH), in all cases: EH= ER.

See chapter 4 for further information regarding the arguments present at cycle call or the arguments to be defined during the cycle.

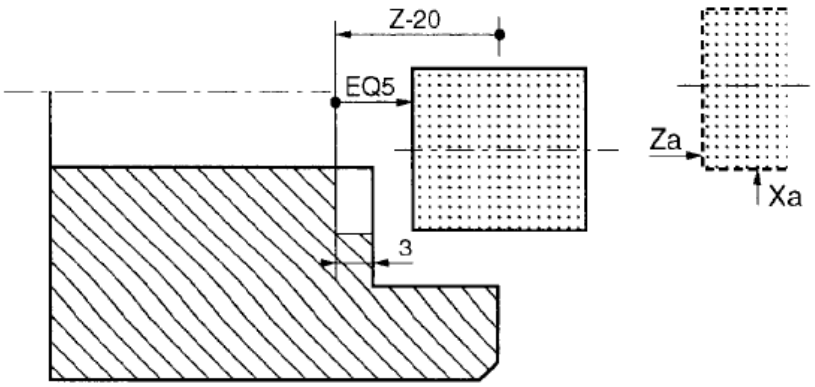
Example

Shoulder plunge cycle with oscillations (internal)

```
...
G0/G1 Za                          Z approach position
Xa                                X approach position
G213 Z-20 X70 D1 ER10 EQ5         Cycle call & Pre-Cycle
Z0 E060 EX1 ET10 EB2 F2           In-Cycle 1
...
```

Schematic illustration of cycle

Z axis origin on workpiece face

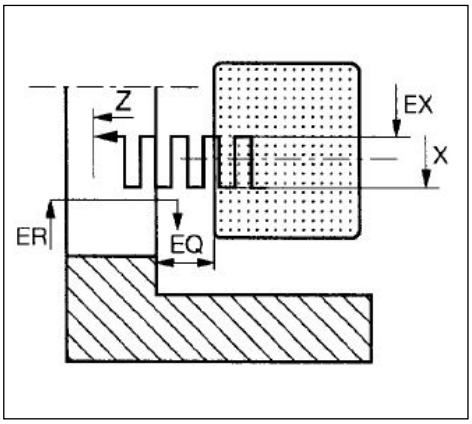


3.13.9 Internal shoulder traverse cycle ► G215

G215 Internal shoulder traverse cycle.

This cycle includes:

- Initial positioning on X followed by increment on Z and traverse on X up to the X end point.
- Increment on Z and return traverse on X, etc.



Syntax

G215 Z.. X.. EX.. D.. EQ.. F.. [ER..] [EH..] [EE..] [EF..] [EC..]
Z.. EI.. EJ.. F.. [EG..] [EM..] [ED..] [EV..] [ET..] / [EN..] [EK..] EB..

Cycle call arguments

G215	Internal shoulder traverse cycle.
Z..	End point on Z.
X..	Shoulder start diameter.
EX..	End point on X.
D..	Selection of active wheel side. • D1: left side. • D2: rigth side.
EQ..	Safety clearance on Z axis (+ material allowance) / Rapid stop distance.
F..	Traverse feed rate (mm/min or in/min).
ER..	Skip diameter.
EH..	Backoff diameter for dressing and measuring.
EE..	Dwell time at start of traverse (s).
EF..	Dwell time at end of traverse (s).
EC..	Increment type: • EC0: continuous increment, • EC1: discontinuous increment in X and/or EX

In-cycle call arguments

Z..	Allowance on final diameter or stock remaining relative to final.
EI..	Increment at start of traverse.
EJ..	Increment at end of traverse.
F..	Feed rate increment (mm/min or in/min).
EG..	Measurement selection. • EG0: no measurement, • EG1: gap elimination enable, • EG2 to EG9: in-cycle measurement, • EG98: conditional manual measurement call, • EG99: unconditional manual measurement call.
EM..	Offset modification selection (default: no modification). • EM0: no modification, • EM1: modification of DAT1 (actual part), • EM2: moditication of DAT1 and machine data (all parts).
ED..	Wheel dressing selection: • ED1: peripheral face, • ED2: left side, • ED3: peripheral face and left side, • ED4: right side, • ED5: peripheral face and right side, • ED6: left side and right side, • ED7: peripheral face and left and right sides. • ED8: face with diamond 1+2.
ET.. / EN..	• ET: Sparkout time (s). • EN: Number of sparkout passes
EK..	Backoff distance.
EB..	Cycle sequencing selection. • EB0: sequencing without stop, • EB1: sequencing with stop, • EB2: end of cycle.
EV..	Dressing type: • EV1: Coarse, • EV2: Fine, • EV3: Coarse+Fine, • EV4: Sparkout, • EV5: Coarse+ Sparkout, • EV6: Fine+Sparkout, • EV7: Coarse +Fine+Sparkout.

Notes

Notes on argument programming

The values of Z, EK, EI and EJ must be greater than 0.

Notes associated with arguments ER and EH

If ER and EH are not programmed, program %9970 calculates ER and EH.
In this case: ER and EH =X + EP.

If only ER is programmed (without EH), in all cases: EH= ER.

See chapter 4 for further information regarding the arguments present at cycle call or the arguments to be defined during the cycle.

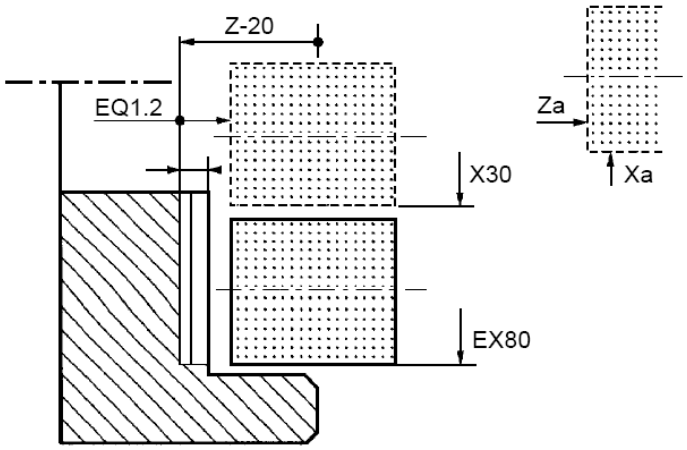
Example

Shoulder traverse cycle (internal)

```
...
G0/G1 Za                                          Z approach position
Xa                                                X approach position
G215 Z-20 X30 EX80 D1 EQ1.2 ER10 F100 EE1 EF1 EC0 Cycle call & Pre-Cycle
Z0.2 EI0.02 EJ0.02 F2 EB0                         In-Cycle 1
Z0.1 EI0.01 EJ0.01 F0.5 EB0                       In-Cycle 2
Z0 EN6 EK1 EB2 EJ0.05 EI0.05 F0.05                In-Cycle 3
...
```

Schematic illustration of cycle

Z axis origin on workpiece face

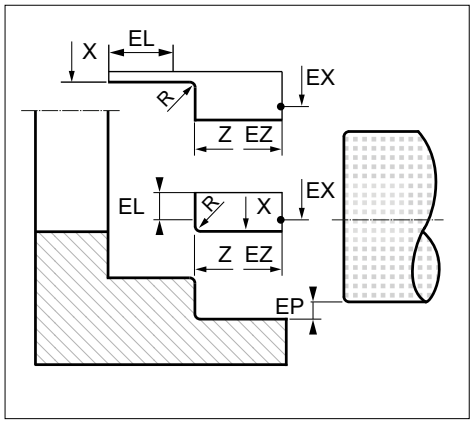


3.13.10 Internal shoulder with fillet cycle ► G217

G217 Internal shoulder with fillet cycle.

This cycle includes grinding of a fillet between a cylindrical surface and a shoulder. It includes several phases:

- Cylindrical grinding phase.
- Shoulder grinding phase.
- Shoulder/cylinder interface cutting phase.
- Wheel retraction and repeat of cycle.



Syntax

G217 X.. Z.. D.. EX.. EZ.. EP.. ES.. EL.. R.. F.. [EH..] [ER..]
I.. EI.. [ED..] [EV..] [EN..] EB..

Cycle call arguments

G217	Internal shoulder with fillet cycle.
X..	Final diameter.
Z..	End point on Z.
D..	Selection of active wheel side. • D1: left side. • D2: rigth side.
EX..	Cycle starting point on X axis.
EZ..	Cycle starting point on Z axis.
EP..	Safety clearance on X axis (+ material allowance / Rapid stop distance.
ES..	Radius correction: • ES1: left radius offset (G41), • ES2: right radius offset (G42).
EL..	Retraction on profile / overtravel on profile.
R..	Fillet or chamfer between two surfaces / radius.
F..	Feed rate on cylindrical surface/shoulder (mm/min or inch/min).
EH..	Backoff diameter for dressing and measuring.
ER..	Skip diameter.

In-cycle call arguments

I..	Allowance on final diameter or stock remaining relative to final.
EI..	Depth of pass.
ED..	Wheel dressing selection: • ED1: peripheral face, • ED2: left side, • ED3: peripheral face and left side, • ED4: right side, • ED5: peripheral face and right side, • ED6: left side and right side, • ED7: peripheral face and left and right sides. • ED8: face with diamond 1+2.
EN..	Number of sparkout passes.
EB..	Cycle sequencing selection. • EB0: sequencing without stop, • EB1: sequencing with stop, • EB2: end of cycle.
EV..	Dressing type: • EV1: Coarse, • EV2: Fine, • EV3: Coarse+Fine, • EV4: Sparkout, • EV5: Coarse+ Sparkout, • EV6: Fine+Sparkout, • EV7: Coarse +Fine+Sparkout.

Notes

Notes on argument programming

The values of EL and R must be greater than 0.

The value of R must be greater than 1.

Case of figures with EX and EZ

Case 1: EX < X
EZ > Z  D1 and G42 active

Case 2: EX < X
EZ < Z  D2 and G41 active

Case 3: EX > X 
EZ > Z D1 and G42 active

Case 4: EX > X 
EZ < Z D2 and G41 active

See chapter 4 for further information regarding the arguments present at cycle call or the arguments to be defined during the cycle.

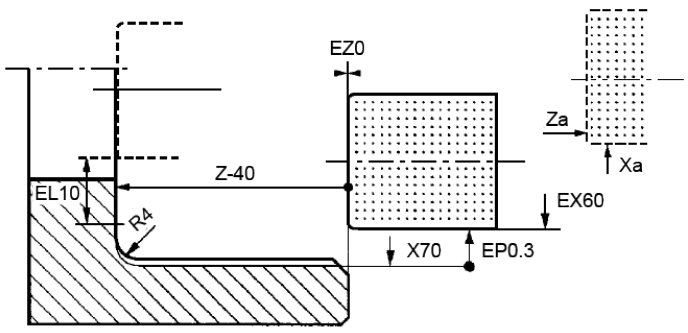
Example

Shoulder profile grinding cycle (internal)

```
...
G0/G1 Za                                          Z approach position
Xa                                                X approach position
G217 X70 Z-40 EX60 D1 EZ0 EP1 ES2 EL10 R4 F100    Cycle call & Pre-Cycle
I0.2 EI0.04 EB0                                   In-Cycle 1
I0 EI0.02 EN2 EB2                                 In-Cycle 2
...
```

Schematic illustration of cycle

Z axis origin on workpiece face



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Summary

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4 External / Internal Grinding Arguments

4.1 Cycle call arguments table

The arguments present when one of the G200 to G217 cycles is called are described in this chapetr-
Click on **xx** to give the detailed information.

D..	**Selection of active wheel side**
EA..	**Overtravel Beyond Z and EZ in Traversing Pass**
EC..	**Type of increment**
EE..	**Dwell time at start of traverse**
EF..	**Dwell time at end of traverse**
EH..	**Backoff diameter for dressing and measurement**
EL..	**Retraction on profile / overtravel on profile**
EP..	**Safety clearance on X**
EQ..	**Safety clearance on Z**
ER..	**Skip diameter**
ES..	**Wheel radius offset**
EU..	**Taper angle**
EX..	**Case 1 .. Case 2 .. Case 3**
EZ..	**Case 1 .. Case 2 .. Case 3 .. Case 4**
F..	**Case 1 .. Case 2 .. Case 3**
H..	**Number of profile definition subroutine**
N.. N..	**Profile start and end blocks**
P..	**Case 1 .. Case 2 ..**
R..	**Radius**
X..	**Case 1 .. Case 2 .. Case 3 .. Case 4**
Z..	**Case 1 .. Case 2 .. Case 3 .. Case 4**

4.2 In-Cycle arguments table

Click on **xx** to give the detailed information.

EB..	**Cycle sequencing selection**
ED..	**Wheel dressing selection**
EG..	**Measurement selection**
EI..	**P.. Case 1 and 2**
EJ..	**Traverse end increment**
EK..	**Backoff distance**
EM..	**Offset modification selection**
EN..	**Number of sparkout passes**
EO..	**Oscillation frequency**
ET..	**Sparkout dwell time**
EX..	**Oscillation amplitude on X**
EZ..	**Oscillation amplitude on Z**
F..	**Case 1 .. Case 2 ..**
I..	**Allowance on final diameter**
X..	**Allowance on final diameter**
Z..	**Allowance on final position on Z**
EV..	**Dressing type**

4.3 Pre-Cycle arguments descriptions

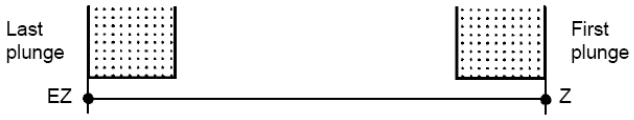
4.3.1 Selection of active wheel side ► D..

D.. Selection of active wheel side

D..	Selects the active wheel wall (D1 = left wall or D2 = right wall) as reference for wheel movements or positioning on the Z axis.
	Notes on programming in plunge and traverse cycles The cases described below concern programming of D1 or D2 with Z and EZ in the following cycles: G200/G201-G204/G205-G206/G207-G210/G211 First possibility: • D1: left side active, • Value of Z < EZ, • Z: first plunge position, • EZ: last plunge position (EZ- wheel width).  Second possibility: • D2: right side active, • Value of Z < EZ, • Z: first plunge position (Z + wheel width), • EZ: last plunge position. 

Third possibility:

- D1: left side active,
- Value of Z > EZ,
- Z: first plunge position (Z - wheel width),
- EZ: last plunge position.

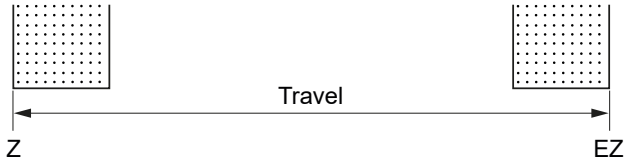


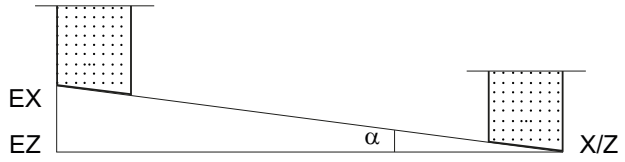
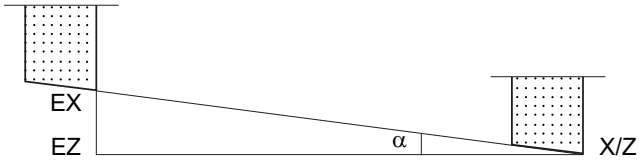
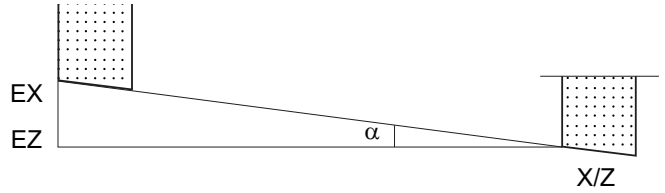
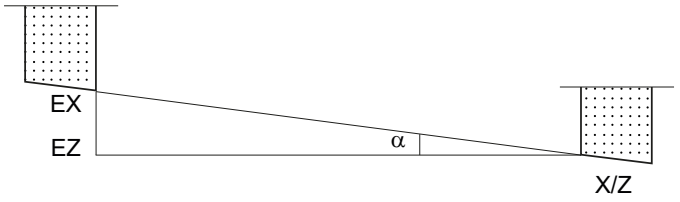
Fourth possibility:

- D2: right side active,
- Value of Z > EZ,
- Z: first plunge position,
- EZ: last plunge position (EZ- wheel width).

4.3.2 Overtravel beyond Z and EZ in traversing pass ► EA..

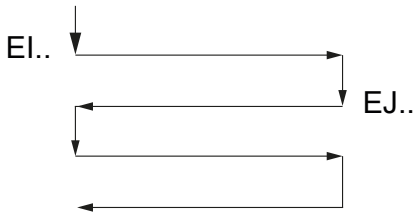
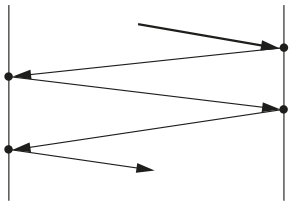
EA.. Overtravel beyond Z and EZ in traversing pass

EA..	The traverse travel can be exceeded by the value of the wheel width if one of arguments EA1, EA2 or EA3 is programmed. The overtravel amount can be limited to the value programmed with argument P if programmed.
	Cylindrical traverse (G206/G207) **Possibilities when P is not programmed: wheel width = 20 mm** • **EA0** (wheel inside travel distance, no overtravel):  • **EA1** (overtravel at the starting point by one wheel width):  • **EA2** (overtravel at the end point by one wheel width):  • **EA3** (overtravel to the left and right by one wheel width): 

EA..	**Possibilities when P is programmed: wheel width = 20 mm and P = 10** • **EA0** (wheel inside travel distance, no overtravel): • **EA1** (overtravel at the starting point by 10 mm):  • **EA2** (overtravel at the end point by 10 mm):  • **EA3** (overtravel to right and left by 10 mm): 
	Taper traverse (G210/G211) **Possibilities when P is not programmed: wheel width 20 mm** • **EA0** (wheel inside travel distance, no overtravel):  • **EA1** (overtravel at the end point by one wheel width):  • **EA2** (overtravel at the starting point by one wheel width):  • **EA3** (overtravel to the left and right by one wheel width): 

4.3.3 Type of increment ► EC..

EC..	Type of increment

EC..	The cases described below concern programming in the following cycles: G206/G207 & G210/G211 & G214/G215. With discontinuous increment, the traverse passes are carried out in alternation. With continuous increment, the traverse passes are carried out simultaneously on theX and Z axes. EC1: Discontinuous increment  EC0: Continuous increment 

4.3.4 Dwell time at start of traverse ► EE..

EE..	Dwell time at start of traverse

EE..	The function described below concern programming in the following cycles: G206/G207 & G210/G211 & G214/G215 Dwell time at start of forward traverse phase.

4.3.5 Dwell time at end of traverse ► EF..

EF..	Dwell time at end of traverse

EF..	The function described below concern programming in the following cycles: G206/G207 & G210/G211 & G214/G215 Dwell time at end of forward traverse phase.

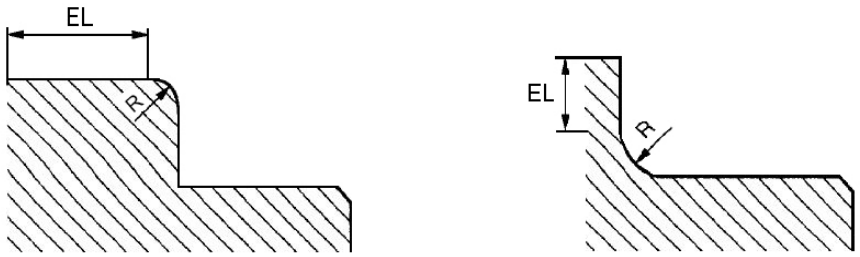
4.3.6 Backoff diameter for dressing and measurement ► EH..

EH.. Backoff diameter for dressing and measurement	

EH..	The function described below concern programming in the following cycles: G200/G201 - G216/G217 Wheel backoff diameter with respect to the workpiece for dressing or taking measurements.

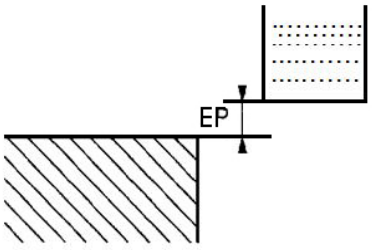
4.3.7 Retraction on profile ► EL..

EL.. Retraction on profile	

EL..	The function described below concern programming in the following cycles: G216/G217 Specifies backoff on the profile (cylindrical or shoulder) at the end of the fillet. 

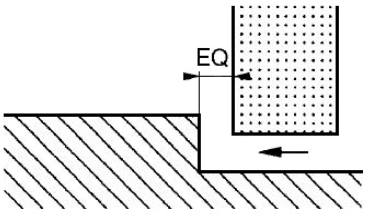
4.3.8 Safety clearance on X ► EP..

EP.. Safety clearance on X

EP..	The function described below concern programming in the following cycles: G200/G201 - G210/G211 & G216/G217 Fast movement to the EP value, defined with respect to the final X diameter plus the material allowance on X axis. 

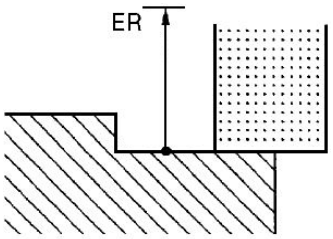
4.3.9 Safety clearance on Z ► EQ..

EQ.. Safety clearance on Z

EQ..	The function described below concern programming in the following cycles: G202/G203 & G212/G213 - G214/G215 Fast movement to the EQ value, defined with respect to the final Z plus the material allowance on the Z axis after each phase of the cycle. 

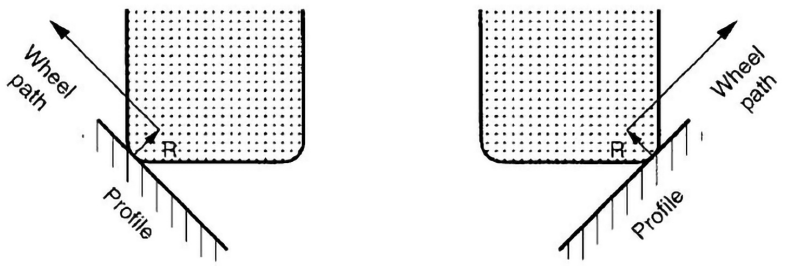
4.3.10 Skip diameter ► ER..

ER..	Skip diameter

ER..	The function described below concern programming in the following cycles: G200/G201 - G216/G217 Diameter to which the grinding wheel must move to allow safe movement along the Z axis. The movement to the "Skip diameter" position is the first movement carried out in a grinding cycle (G200-G217). It is followed by positioning on the Z axis. Therefore, ER must be selected so that the grinding wheel does not collide with any shoulder of the workpiece. 

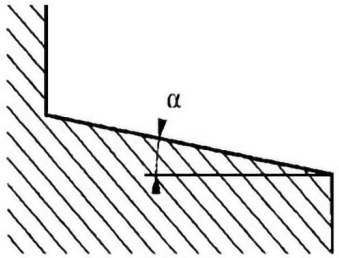
4.3.11 Wheel radius offset ► ES..

ES..	Wheel radius offset

ES..	The function described below concern programming in the following cycles: G208/G209 & G216/G217 Sets the wheel radius on the left or right of the ground profile with respect to the direction of travel. Right radius offset Left radius offset 

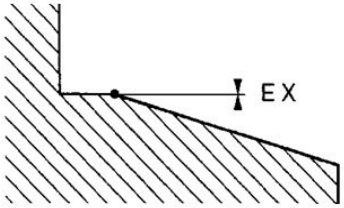
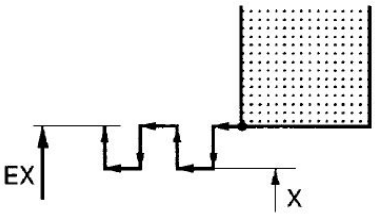
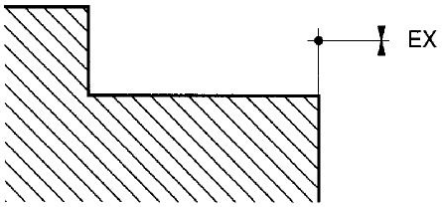
4.3.12 Taper angle (G210/G211) ► EU..

EU..	Taper angle

EU..	The function described below concern programming in the following cycles: G210/G211 Angle of the taper in respect of the cylindrical surface. Specify value in angular degree. 

4.3.13 EX.. Case 1 to 3 ► EX..

EX.. Case 1 to 3

EX.. Case 1	**Final diameter at end of taper (G210/G211).** Value of the final diameter after grinding the taper. 
EX.. Case 2	**End point on X (G214/G215)** Specifies the wheel end point on X for axial traverse. 
EX.. Case 3	**Start point on X (G216/G217)** Start point on the X axis for shoulder with radius. 

4.3.14 EZ.. Case 1 to 4 ► EZ..

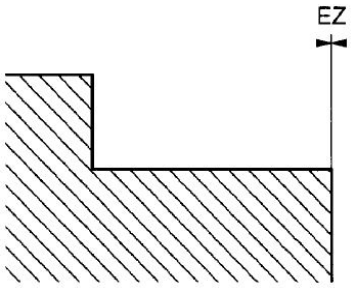
EZ.. Case 1 to 4

EZ.. Case 1	**End point on Z for multiplunge (G200/G201 & G204/G205)**

EZ.. Case 2	**End point on Z for cylindrical traverse (G206/G207)**

EZ.. Case 3	**End point on Z for tapered traverse (G210/G211)**

For cases 1, 2 and 3: The effective end point on Z depends on the grinding wheel reference side (see D..).

EZ.. Case 4	**Cycle start point on Z (G216 and G217)** Start point on the Z axis for a shoulder with radius. 

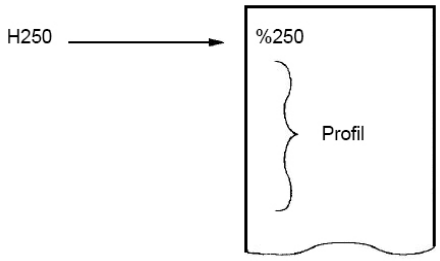
4.3.15 F.. Case 1 to 3 ► F..

F.. Case 1 to 3

F.. Case 1	**Traverse feed rate (G206/G207 & G210/G211& G214/G215)** Feed rate programmed on the traverse axis: Z for radial and X for axial.
F.. Case 2	**Feed rate on profile (G208/G209)** Tangential feed rate on the path ot the profile to be ground.
F.. Case 3	**Feed rate on cylinder/shoulder (G216/G217)** Feed rate during the shoulder grinding cycle.

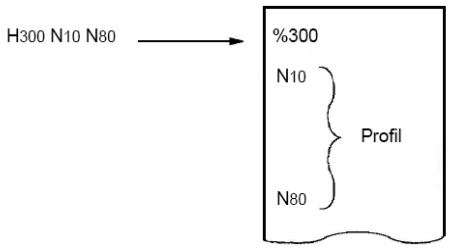
4.3.16 Number of profile definition subroutine ► H..

H.. Number of profile definition subroutine

H..	The function described below concern programming in the following cycles: G208/G209 Indicates the number ot the subroutine containing the definition ot the profile to be ground. 

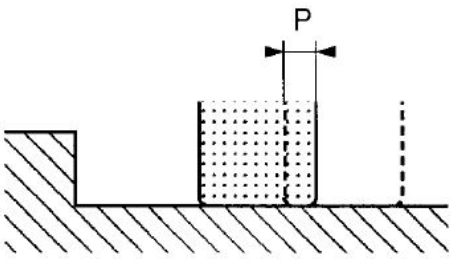
4.3.17 Profile start and end blocks ► N.. N..

N.. N.. Profile start and end blocks

N.. N..	The function described below concern programming in the following cycles: G208/G209 Indicates the numbers of the first and last block defining the profile to be ground. 

4.3.18 P.. Case 1 and 2 ► P..

P.. Case 1 and 2

P.. Case 1	**Wheel overlap value (G200/G201 & G204/G205)** Multiplunge: overlap during consecutive plunges. If P is not programmed, the default value used is the wheel width (see EA..). 

P.. Case 2	**Overtravel (G206/G207 & G210/G211)** The overtravel can be limited to the value programmed in P if P is programmed. Otherwise, the overtravel corresponds to a wheel width (see EA..).

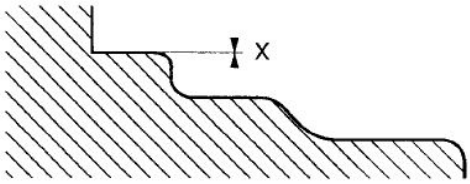
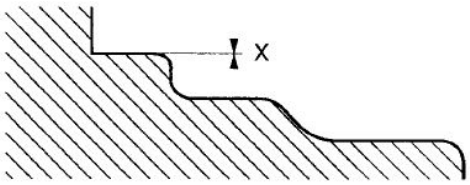
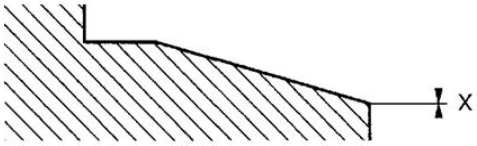
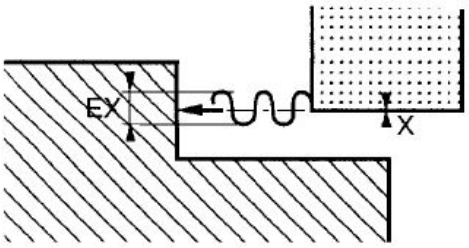
4.3.19 Radius ► R..

R.. Radius

R..	The function described below concern programming in the following cycles: G216/G217 Value of the connection radius (fillet) between the cylindrical surface and the shoulder. 

4.3.20 X.. Case 1 to 4 ► X..

X.. Case 1 to 4

X.. Case 1	**Final diameter (G200/G201 to G206/G207 and G216/G217)** Final part diameter. 
X.. Case 2	**Profile start diameter (G208/G209)** Start diameter of the profile to be ground. The X and Z start point specified must not lie on the profile. 
X.. Case 3	**Final diameter at start of taper (G210/G211)** Value of the diameter at the start of the taper to be ground. 
X.. Case 4	**Shoulder start diameter (G212/G213-G214/G215)** Value of the diameter at the cycle start. 

4.3.21 Z.. Case 1 to 4 ► Z..

Z.. Case 1 to 4

Z.. Case 1	**Plunge position on Z (G200/G201 & G204/G205)** Single plunge: specifies the plunge Z position. Multiplunge: specifies the Z start point of the first plunge

Z.. Case 2	**End point on Z (G202/G203 & G212/G213 - G216/G217)** Specifies the Z end point.

Z.. Case 3	**Start point on Z (G206/G207 & G210/G211)** Traverse: specifies the Z start point.

Z.. Case 4	**Z Start point (G208/G209)** For profile grinding: specifies the profile Z start point. This point must always lie off the profile.

4.4 In-Cycle arguments descriptions

The in-cycle arguments that can be used in a G200 to G217 cycle are described in alphabetical order.

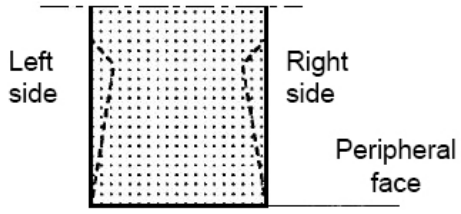
4.4.1 Cycle sequencing selection ► EB..

EB.. Cycle sequencing selection

EB..	The function described below concern programming in the following cycles: G200/G201 - G216/G217 Argument EB is used to specify the three cycle sequencing possibilities: • EB0: sequencing without stopping, • EB1: sequencing with stop, • EB2: end of cycle. **EB0** When G10 is active (e.g. in the case of a measurement during the cycle), EB0 is used to sequence the cycle phases on each interrupt without stopping movement. EB0 is automatically initialised when a cycle is called (in program %9970). **EB1** Must be programmed when stopping of movement is requested by the user (e.g. when the final dimension is reached). **EB2** Must always be programmed at the end of each grinding cycle. It means the cycle is finished and forces function G80.

4.4.2 Wheel dressing selection ► ED..

ED..	Wheel dressing selection

ED..	The function described below concern programming in the following cycles: G200/G201 - G216/G217 Indicates which parts ot the wheel are to be dressed (peripheral face and/or sides). Dressing is performed at the start of the grinding phase in which argument ED is programmed: • ED1: diameter, • ED2: left side, • ED3: peripheral face and left side, • ED4: right side, • ED5: peripheral face and right side, • ED6: left side and right side, • ED7: peripheral face and left and right sides. • ED8: face with diamond 1+2. 

4.4.3 Measurement selection ► EG..

EG..	Measurement selection

EG..	The function described below concern programming in the following cycles: G200/G201 - G206/G207 & G212/G213 - G214/G215 Possible definition of the conditions for a measurement to be made during grinding: • EG0: no measurement during the cycle. • EG1: gap elimination enabled. • EG2-EG9: measurement during the cycle; the current phase is stopped by an interrupt numbered 2 to 9. • EG98: conditional call for manual measurement (by setting parameter E20030 to 1). • EG99: unconditional call for manual measurement..

When arguments EG1 to EG9 are programmed during a G2xx grinding cycle, functions M200 to M255 must not be used during the cycle. However, these functions can be programmed before or after the cycle.

4.4.4 EI.. Case 1 and 2 ► EI..

EI.. Case 1 and 2

EI.. Case 1	**Increment at start of traverse (G206/G207 & G210/G211 & G214/G215)** Movement on the axis (X or Z depending on cycle) at the start of a discontinuous traverse.

EI.. Case 2	**Pass Depth (G208/G209 & G216/G217)** Depth of pass on the X axis.

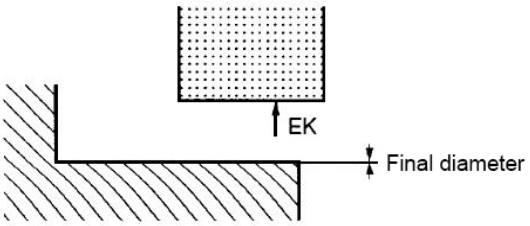
4.4.5 Traverse end increment ► EJ..

EJ.. Traverse end increment

EJ..	The function described below concern programming in the following cycles: G206/G207 & G210/G211 & G214/G215 Movement on the axis (X or Z depending on cycle) at the end of discontinuous traverse.

4.4.6 Backoff distance ► EK..

EK.. Backoff distance

EK..	The function described below concern programming in the following cycles: G200/G201 - G216/G217 Wheel backoff at the end of the current grinding phase. 

4.4.7 Offset modification selection ► EM..

EM.. Offset modification selection

EM..	The function described below concern programming in the following cycles: G200/G201 - G206/G207 & G210/G211 - G214/G215 Argument EM specifies whether or not the origin is to be shifted. It is used for compensating wheel wear. It takes into account the difference between the position of the axes and the measured dimensions. This parameter is meaningless unless the measurement system is active. Argument EM is used to specify the three following possibilities: • EM0: no modification • EM1: modification of DAT1 (actual part) • EM2: modification of DAT1 and the machine data (all parts). It should be noted that if one of arguments EM1 or EM2 is programmed, both offsets (X and Z) can be modified (by intermediate measurement). However, during an in cycle measurement, if only EM1 or EM2 is programmed, only the measured axis is corrected. **EM0** Default value in programme %9970, no modification. **EM1** DAT1 modified. **EM2** Modification of shift E60000 (X) or E62000 (Z) depending on the cycle as well as the DAT1 values in the machine data file.

4.4.8 Number of sparkout passes ► EN..

EN.. Number of sparkout passes

EN..	The function described below concern programming in the following cycles: G206/G207 - G210/G211 & G214/G215 - G216/G217 Specifies the number of sparkout passes.

4.4.9 Oscillation frequency ► EO..

EO.. Oscillation frequency

EO..	The function described below concern programming in the following cycles: G204/G205 & G212/G213 Oscillation frequency on X or Z (depending on the cycle). Expressed as a number of oscillations per minute (osc/min).

4.4.10 Sparkout dwell time ► ET..

ET.. Sparkout dwell time

ET..	The function described below concern programming in the following cycles: G200/G201 - G206/G207 & G210/G211 - G214/G215 Specifies the sparkout dwell time.

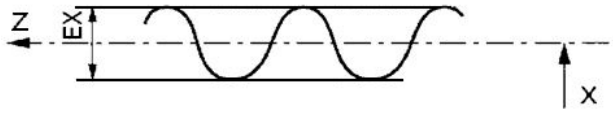
4.4.11 Dressing type ► EV..

EV.. Dressing type

EV..	The function described below concern programming in the following cycles: G200/G201 - G216/G217 Specifies the type of dressing to be applied to the grinding wheel: • EV1: Coarse, • EV2: Fine, • EV3: Coarse + Fine, • EV4: Sparkout, • EV5: Coarse + Sparkout, • EV6: Fine + Sparkout, • EV7: Coarse + Fine + Sparkout

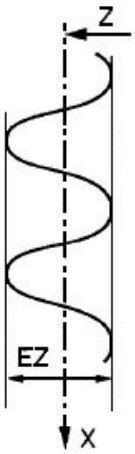
4.4.12 Oscillation amplitude on X ► EX..

EX.. Oscillation amplitude

EX..	The function described below concern programming in the following cycles: G212/G213 Amplitude of the oscillations on X. 

4.4.13 Oscillation amplitude on Z ► EZ..

EZ.. Oscillation amplitude

EZ..	The function described below concern programming in the following cycles: G204/G205 Amplitude of the oscillations on Z. 

4.4.14 F.. Case 1 and 2 ► F..

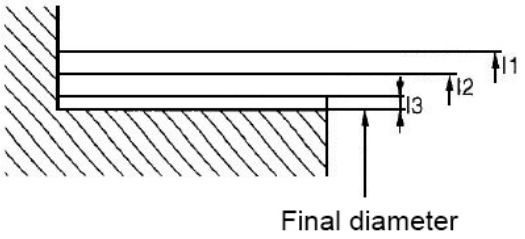
F.. Case 1 and 2

F.. Case 1	**Feed rate on X and/or Z (G200/G201 - G204/G205 & G212/G213)** Wheel feed rate on X and/or Z (depending on the cycle).

F.. Case 2	**Incrementation feed rate (G206/G207 & G210/G211 & G214/G215)** Incrementation feed rate on X and/or Z (depending on cycle).

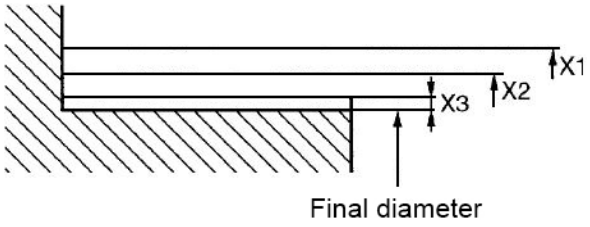
4.4.15 Allowance on final diameter ► I..

I.. Allowance on final diameter

I..	The function described below concern programming in the following cycles: G208/G209 & G216/G217 Allowance during the different phases of the cycle with respect to the final diameter on X (e.g. see figure below: roughing I1, semi-finishing I2 and finishing I3). 

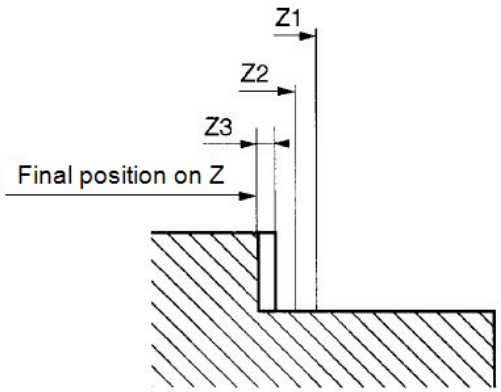
4.4.16 Allowance on final diameter ► X..

X.. Allowance on final diameter

X..	The function described below concern programming in the following cycles: G200/G201 - G206/G207 & G210/G211 Allowance during the different phases of the cycle with respect to the final diameter on X (e.g. see figure below: roughing X1, semi-finishing X2 and finishing X3). 

4.4.17 Allowance on final position on Z ► Z..

Z.. Allowance on final position on Z

Z..	The function described below concern programming in the following cycles: G212/G213 & G214/G215 Allowance during the different phases of the cycle with respect to the final position on Z (e.g. see figure below: roughing Z1, semi-finishing Z2 and finishing Z3).. 

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Summary

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A Appendix

A.1 Table of external grinding cycle Syntax

G200 : External plunge / mulitplunge cycle

Syntax:
G200 X.. Z.. D.. [EZ..] EP.. [ER..] [EH..] [P..]
X.. F.. [EG..] [EM..] [EK..] [ED..] [EV..] [ET..] EB..

G202 : External plunge cycle with inclined axes (angular plunge cycle)

Syntax:
G202 X.. Z.. D.. EP.. EQ.. [ER..] [EH..]
X.. F.. [EG..] [EM..] [EK..] [ED..] [EV..] [ET..] EB..

G204 : External oscillating plunge / multiplunge cycle

Syntax:
G204 X.. Z.. D.. [EZ..] EP.. [ER..] [EH..] [P..]
X.. F.. [EZ..] [EO..] [EG..] [EM..] [EK..] [ED..] [EV..] [ET..] EB..

G206 : External cylindrical traverse cycle

Syntax:
G206 X.. Z.. D.. EZ.. EP.. F.. [ER..] [EH..] [EA..] [P..] [EE..] [EF..] [EC..]
X.. EI.. EJ.. F.. [EG..] [EM..] [EK..] [ED..] [EV..] [ET..] / [EN..] EB..

G208 : External profile grinding cycle

Syntax:
G208 X.. Z.. D.. EP.. ES.. H.. N.. N.. F.. [EH..] [ER..]
I.. EI.. [EN..] [EK..] [ED..] [EV..] EB..

G210 : External conical traverse cycle

Syntax:
G210 X.. EX.. / EU.. Z.. EZ.. D.. EP.. F.. [ER..] [EE..] [EF..] [EA..] [P..] [EC..] [EH..]
X.. EI.. EJ.. F.. [EK..] [EG..] EM.. [ED..] [EV..] [ET..] / [EN..] EB..

G212 : External oscillating shoulder cycle

Syntax:
G212 Z.. X.. D.. EQ.. [ER..] [EH..]
Z.. F.. [EM..] [EG..] [ET..] [EK..] [ED..] [EV..] [EO..] [EX..] EB..

G214 : External shoulder traverse cycle

Syntax:
G214 Z.. X.. EX.. D.. EQ.. F.. [ER..] [EH..] [EE..] [EF..] [EC..]
Z.. EI.. EJ.. F.. [EG..] [EM..] [ED..] [EV..] [ET..] / [EN..] [EK..] EB..

G216 : External shoulder with fillet cycle

Syntax:
G216 X.. Z.. D.. EX.. EZ.. EP.. ES.. EL.. R.. F.. [EH..] [ER..]
I.. EI.. [ED..] [EV..] [EN..] EB..

A.2 Table of internal grinding cycle Syntax

G201 : Internal plunge / mulitplunge cycle

Syntax:
G201 X.. Z.. D.. [EZ..] EP.. [ER..] [EH..] [P..]
X.. F.. [EG..] [EM..] [EK..] [ED..] [EV..] [ET..] EB..

G203 : Internal plunge cycle with inclined axes (angular plunge cycle)

Syntax:
G203 X.. Z.. D.. EP.. EQ.. [ER..] [EH..]
X.. F.. [EG..] [EM..] [EK..] [ED..] [EV..] [ET..] EB..

G205 : Internal oscillating plunge / multiplunge cycle

Syntax:
G205 X.. Z.. D.. [EZ..] EP.. [ER..] [EH..] [P..]
X.. F.. [EZ..] [EO..] [EG..] [EM..] [EK..] [ED..] [EV..] [ET..] EB..

G207 : Internal cylindrical traverse cycle

Syntax:
G207 X.. Z.. D.. EZ.. EP.. F.. [ER..] [EH..] [EA..] [P..] [EE..] [EF..] [EC..]
X.. EI.. EJ.. F.. [EG..] [EM..] [EK..] [ED..] [EV..] [ET..] / [EN..] EB..

G209 : Internal profile grinding cycle

Syntax:
G209 X.. Z.. D.. EP.. ES.. H.. N.. N.. F.. [EH..] [ER..]
I.. EI.. [EN..] [EK..] [ED..] [EV..] EB..

G211 : Internal conical traverse cycle

Syntax:
G211 X.. EX.. / EU.. Z.. EZ.. D.. EP.. F.. [ER..] [EE..] [EF..] [EA..] [P..] [EC..] [EH..]
X.. EI.. EJ.. F.. [EK..] [EG..] EM.. [ED..] [EV..] [ET..] / [EN..] EB..

G213 : Internal oscillating shoulder cycle

Syntax:
G213 Z.. X.. D.. EQ.. [ER..] [EH..]
Z.. F.. [EM..] [EG..] [ET..] [EK..] [ED..] [EV..] [EO..] [EX..] EB..

G215 : Internal shoulder traverse cycle

Syntax:
G215 Z.. X.. EX.. D.. EQ.. F.. [ER..] [EH..] [EE..] [EF..] [EC..]
Z.. EI.. EJ.. F.. [EG..] [EM..] [ED..] [EV..] [ET..] / [EN..] [EK..] EB..

G217 : Internal shoulder with fillet cycle

Syntax:
G217 X.. Z.. D.. EX.. EZ.. EP.. ES.. EL.. R.. F.. [EH..] [ER..]
I.. EI.. [ED..] [EV..] [EN..] EB..

A.3 Argument formats at cycle call - External grinding cycles

Format	Name	G2xx cycle	Unit or value
N05	Number of first and last profile block	G208	0 to 32767
H04	Number of profile subroutine	G208	0 to 9000
X053 X053 X053 X053	Final diameter Start point (X) Final diameter at start of taper Shoulder start diameter	G200 - G206, G216 G208 G210 G214, G216	mm or Inch mm or Inch mm or Inch mm or Inch
Z053 Z053 Z053	Plunge position on Z axis End point on Z axis Starting point on Z axis	G200, G204 G202, G212, G214, G216 G206, G208, G210	mm or Inch mm or Inch mm or Inch
EA01	Z and EZ overtravel during traverse	G206, G208, G210	0 to 3
EC01	Type of increment	G206 - G210, G214	0 or 1
EE022	Dwell time at start of traverse	G206, G210, G214	s
EF022	Dwell time at end of traverse	G206, G210, G214	s
EH053	Backoff diameter for dressing (or measurement)	G200 - G216	mm or Inch
EL053	Retraction on profile	G216	mm or Inch
EP053	Safety clearance on X axis (+ allowance)	G200 - G210, G216	mm or Inch
EQ053	Safety clearance on Z axis (+ allowance)	G202, G212, G214	mm or Inch
ER053	Skip diameter	G200 - G216	mm or Inch
ES01	Radius offset	G208, G216	1 or 2
EU034	Angle	G210	Degrees
EX053 EX053 EX053	Final diameter at end of taper End point on X axis Starting point on X axis	G210 G214 G216	mm or Inch mm or Inch mm or Inch
EZ053 EZ053	End point on Z axis Starting point on Z axis	G200, G204, G206, G210 G216	mm or Inch mm or Inch
P053 P053	Wheel overlap Overtravel	G200, G204 G206, G210	mm or Inch mm or Inch
R053	Radius	G216	mm or Inch
F.. F.. F..	Traverse feed rate Feed rate along profile Feed rate along cylinder/shoulder	G206, G210, G214 G208 G216	mm/min or Inch/min mm/min or Inch/min mm/min or Inch/min
D01	Choice of wheel side	G200 - G216	1 or 2

A.4 In-Cycle argument formats - External grinding cycles

Format	Name	G2xx cycle	Unit or value
X053	Allowance on final diameter	G200 - G206, G210	mm or Inch
Z053	Allowance on end point on Z axis	G212, G214	mm or Inch
I053	Allowance on final diameter	G208, G216	mm or Inch
EB01	Cycle sequencing selection	G200 - G216	0 to 2
ED01	Wheel dressing selection	G200 - G216	1 to 7
EG01	Measurement selection	G200 - G206, G212, G214	0 to 9, 98, 99
EI053 **EI053**	Increment at start of traverse Depth of pass	G206, G210, G214 G208, G216	mm or Inch mm or Inch
EJ053	Increment at end of traverse	G206, G210, G214	mm or Inch
EK053	Backoff distance	G200 - G216	mm or Inch
EM01	Offset modification selection	G200 - G206, G210 - G214	0 to 2
EN..	Number of sparkout passes	G206 - G210, G214, G216	Positive integer
EO..	Oscillation frequency	G204, G212	osc/min
ET022	Sparkout dwell time	G200 - G206, G210 - G214	s
EV01	Dressing type	G200 - G216	1 to 7
EX053	Oscillation amplitude on X axis	G212	mm or Inch
EZ053	Oscillation amplitude on Z axis	G204	mm or Inch
F.. **F..**	Feed rate on X and/or Z Feed rate increment	G200 - G204, G212 G206, G210, G214	mm/min or Inch/min mm/min or Inch/min

A.5 Argument formats at cycle call - Internal grinding cycles

Format	Name	G2xx cycle	Unit or value
N05	Number of first and last profile block	G209	0 to 32767
H04	Number of profile subroutine	G209	0 to 9000
X053 **X053** **X053** **X053**	Final diameter Start point (X) Final diameter at start of taper Shoulder start diameter	G201 - G207, G217 G209 G211 G213, G215	mm or Inch mm or Inch mm or Inch mm or Inch
Z053 **Z053** **Z053**	Plunge position on Z axis End point on Z axis Starting point on Z axis	G201, G205 G203, G213, G215, G217 G207, G209, G211	mm or Inch mm or Inch mm or Inch
EA01	Z and EZ overtravel during traverse	G207, G209, G211	0 to 3
EC01	Type of increment	G207 - G211, G215	0 or 1
EE022	Dwell time at start of traverse	G207, G211, G215	s
EF022	Dwell time at end of traverse	G207, G211, G215	s
EH053	Backoff diameter for dressing (or measurement)	G201 - G217	mm or Inch
EL053	Retraction on profile	G217	mm or Inch
EP053	Safety clearance on X axis (+ allowance)	G201 - G211, G217	mm or Inch
EQ053	Safety clearance on Z axis (+ allowance)	G203, G213, G215	mm or Inch
ER053	Skip diameter	G201 - G217	mm or Inch
ES01	Radius offset	G209, G217	1 or 2
EU034	Angle	G211	Degrees
EX053 **EX053** **EX053**	Final diameter at end of taper End point on X axis Starting point on X axis	G211 G215 G217	mm or Inch mm or Inch mm or Inch
EZ053 **EZ053**	End point on Z axis Starting point on Z axis	G201, G205, G207, G211 G217	mm or Inch mm or Inch
P053 **P053**	Wheel overlap Overtravel	G201, G205 G207, G211	mm or Inch mm or Inch
R053	Radius	G217	mm or Inch
F.. **F..** **F..**	Traverse feed rate Feed rate along profile Feed rate along cylinder/shoulder	G207, G211, G215 G209 G217	mm/min or Inch/min mm/min or Inch/min mm/min or Inch/min
D01	Choice of wheel side	G201 - G217	1 or 2

A.6 In-Cycle argument formats - Internal grinding cycles

Format	Name	G2xx cycle	Unit or value
X053	Allowance on final diameter	G201 - G207, G211	mm or Inch
Z053	Allowance on end point on Z axis	G213, G215	mm or Inch
I053	Allowance on final diameter	G209, G217	mm or Inch
EB01	Cycle sequencing selection	G201 - G217	0 to 2
ED01	Wheel dressing selection	G201 - G217	1 to 7
EG01	Measurement selection	G201 - G207, G213, G215	0 to 9, 98, 99
EI053 **EI053**	Increment at start of traverse Depth of pass	G207, G211, G215 G209, G217	mm or Inch mm or Inch
EJ053	Increment at end of traverse	G207, G211, G215	mm or Inch
EK053	Backoff distance	G201 - G217	mm or Inch
EM01	Offset modification selection	G201 - G207, G211 - G215	0 to 2
EN..	Number of sparkout passes	G207 - G211, G215, G217	Positive integer
EO..	Oscillation frequency	G205, G213	osc/min
ET022	Sparkout dwell time	G201 - G207, G211 - G215	s
EV01	Dressing type	G201 - G217	1 to 7
EX053	Oscillation amplitude on X axis	G213	mm or Inch
EZ053	Oscillation amplitude on Z axis	G205	mm or Inch
F.. **F..**	Feed rate on X and/or Z Feed rate increment	G201 - G205, G213 G207, G211, G215	mm/min or Inch/min mm/min or Inch/min

A.7 Error messages

A.7.1 Error messages in measuring or wheel dressing cycles

Error No.	Description
5301	DRESSER SETUP NOT EXECUTED
5302	PART SETUP NOT EXECUTED
5303	WHEEL NUMBER ERROR
5304	MACHINE DATA ERROR
5305	MACHINE MODE NOT SELECTED
5306	PART COMPENSATION ERROR
5307	POSITIONING CYCLE - WORKHEAD SPEED ERROR
5308	CORRECTION VALUE OUT OF LIMITS
5309	MEASURE OUT OF RANGE
5310	WHEEL LEFT/BOTTOM SIDE NOT SHAPED
5311	WHEEL RIGHT/TOP SIDE NOT SHAPED
5312	Profil description not selected, [WD(142)]defined 0 or 1
5320	WORKING WHEEL SIDE CODE NOT PROGRAMMED
5340	WHEEL GEOMETRICAL ERROR
5341	WHEEL DRESSING ERROR
5342	WHEEL SHAPING ERROR

A.7.2 Error messages in external / internal grinding cycles

Error No.	Description
5350	X: definition of X missing
5351	Z: definition of Z missing
5352	EP: plunge offset not programmed
5353	Wheel width zero
5354	Grinding distance < wheel width
5355	D: invalid tool correction number
5356	ER: invalid skip diameter
5357	EH: invalid safety diameter
5358	EC: invalid value
5359	EC: not programmed
5360	F: traverse feed not programmed
5361	EQ: plunge offset not programmed
5362	EX: second X position not programmed
5363	EZ: second Z position not programmed
5364	EZ: oscillation amplitude not programmed
5365	R: not programmed
5366	EL: not programmed
5367	ES: invalid radius corrector
5368	ES: not programmed
5369	F : Profile feed not programmed
5370	EX: oscillation amplitude not programmed
5371	F: plunge feed not programmed
5372	EI/EJ: increment not programmed
5373	ED: invalid dressing part
5374	EG: invalid measuring mode
5375	EB: invalid value
5376	S: cutting speed not pragrammed
5377	max. rotation speed exceeded
5378	T: toolnr. must be [1..8]
5379	wheel overlapping >= wheel width
5380	part setup not executed
5381	dressing setup not executed
5382	H: profile program number not programmed
5383	N: sequence of profile not programmed
5384	wheel side not correct
5385	actual toolnr. <> initialised toolnr.
5386	EU,EX: taper angle not correct
5387	Shoulder radius < grinding offset
5389	not enough space in dynamic operator table
5390	Error of Cycle,End of Cycle not programmed

5391	Language not defined
5392	Modification cutting speed only with cycle G230 Sxx
5393	Wheel diameter > part diameter
5394	Option bit 242, GC cycles, not enabled.
5395	Z and K must both be programmed in G233
5396	EV: invalid dressing type
5397	Taper comp. out of range.
5398	Enter either sparkout passes or sparkout time not both.
5500	The NUMBER OF POINTS field must be a whole number ranging from 1-20.
5501	The value in the NUMBER OF POINTS field does not match the number of points.
5502	The Z SPACING field must be greater than 0.
5503	Missing Z start point. There must be a value in the Z[01] field.
5504	The SKIP DIAMETER (ER) must be greater than the largest X[ ] value.
5505	The SAFETY DIAMETER must be greater than the largest X[ ] value.
5506	The Face Shaping Feedrate in the wheel files Shaping block must be greater than 0.
5507	The Side Shaping Feedrate in the wheel files Shaping block must be greater than 0.
5508	The COURSE Face Feedrate in the wheel files Dressing Block must be greater than 0.
5509	The COURSE Side Feedrate in the wheel files Dressing Block must be greater than 0.
5510	The FINE Face Feedrate in the wheel files Dressing Block must be greater than 0.
5511	The FINE Side Feedrate in the wheel files Dressing Block must be greater than 0.
5512	The SPARKOUT Face Feedrate in the wheel files Dressing Block must be greater than 0.
5513	The SPARKOUT Side Feedrate in the wheel files Dressing Block must be greater than 0.
5824	Option NUMgrind Cylindrical Grinding Cycles missing

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