

# Flexium<sup>+</sup> Surface Grinding

## Programming manual

M00050EN-00

Edition 4.2017



**flexium<sup>+</sup>**

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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   | -           |

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## 1.4 How to read the manual

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This manual gives information about the Flexium<sup>+</sup> Surface Grinding Programming manual and its customization to a particular machine.

| Chapter  | Description                                                                                                                                                                                                                                                                                                                                                                                                                        |
|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>1</b> | <b>Foreword</b><br><br>This chapter introduces:<br>- The use of the manual.                                                                                                                                                                                                                                                                                                                                                        |
| <b>2</b> | <b>General description of Surface Grinding</b><br><br>This chapter introduces:<br>- Description of the Grinding Axes and Spindle,<br>- Setting Origins and Shifts,<br>- Wheel profiles,<br>- Surface Grinding Capabilities,<br>- Preliminary Operations before Starting a Cycle.                                                                                                                                                   |
| <b>3</b> | <b>Programming Functions and Cycles</b><br><br>This chapter introduces:<br>- G Functions,<br>- M Functions,<br>- Setting the dresser origins,<br>- Wheel and setting up the working environment,<br>- Wheel Dressing Options,<br>- Selecting the wheel and setting up,<br>- Defining the wheel rotation speed,<br>- Part setup,<br>- Manual Intermediate Measurement,<br>- Surface Grinding Cycles,<br>- External grinding cycles. |
| <b>A</b> | <b>Appendix</b><br><br>This chapter introduces:<br>- Homing Messages,<br>- Cycle Error messages.                                                                                                                                                                                                                                                                                                                                   |

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## 1.5 NUM Agencies

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

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## 2 General description of Surface Grinding

### 2.1 Description of the Grinding Axes

#### 2.1.1 Axes and Spindles

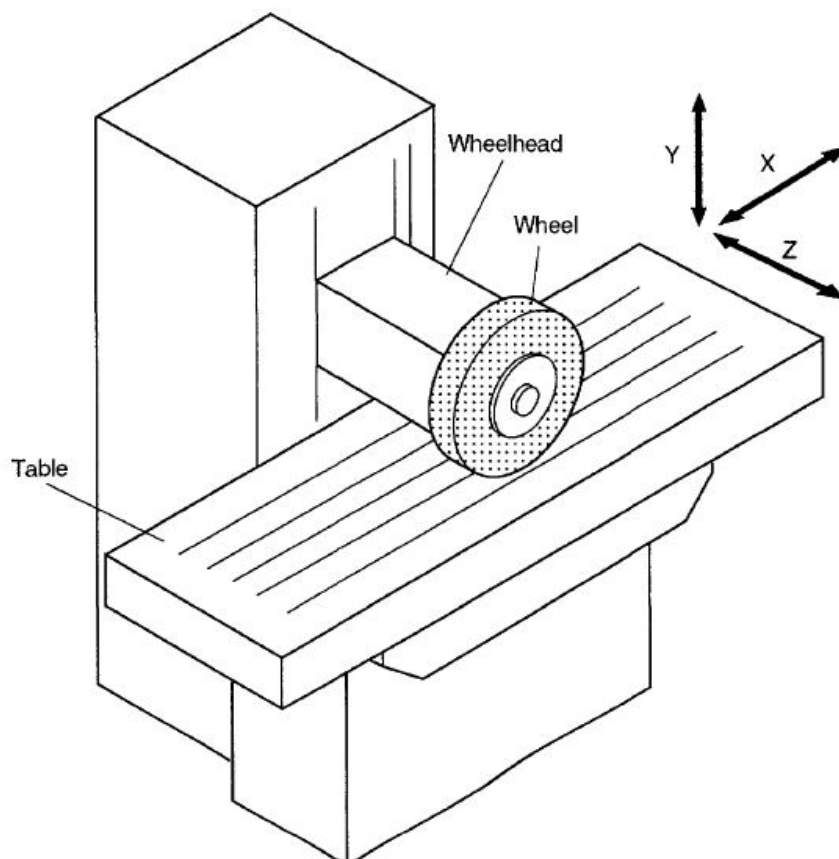
The axes and spindles are defined as follows:

- X: primary longitudinal axis.
- Y: primary vertical axis.
- Z: primary crosswise axis.
- V: secondary axis (when using a roller dresser).

One wheelhead spindle.

#### 2.1.2 Schematic representation of a Machine

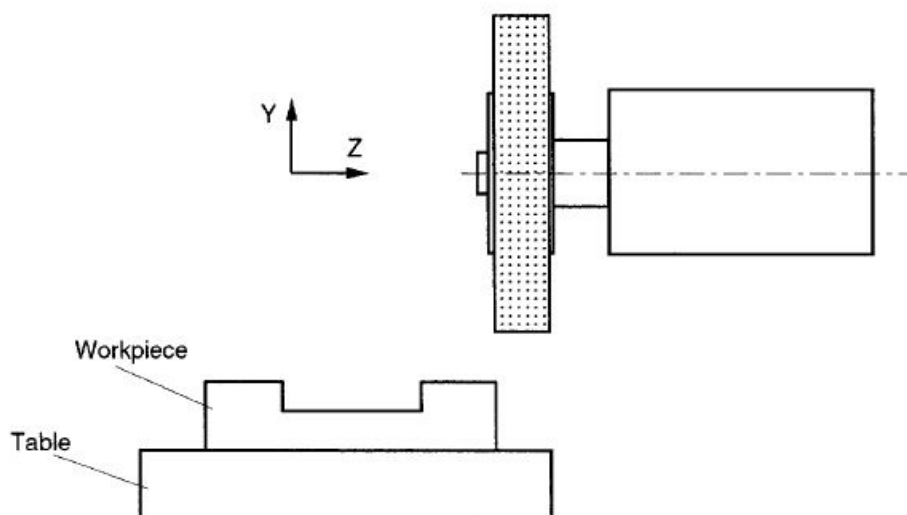
Representation of a surface grinding machine



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### 2.1.3 Wheelhead representation

The wheel axis is parallel to the Z axis



## 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 face (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

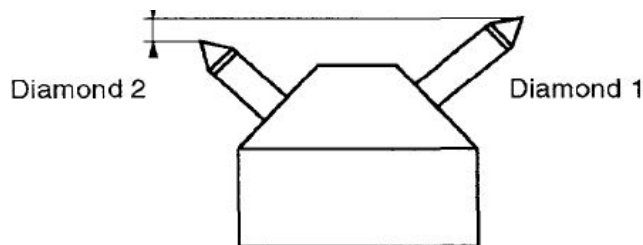
All the shaping and dressing cycles performed with the fixed two-diamond dresser are based on the following principle:

- 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.

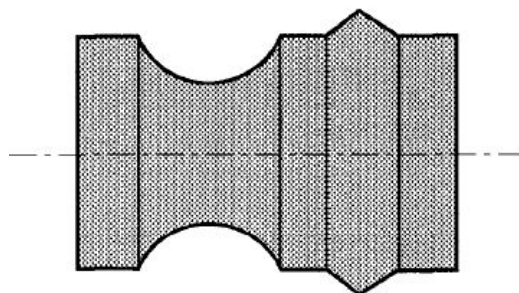
Diamonds 1 and 2 are offset with respect to one another.



### 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.

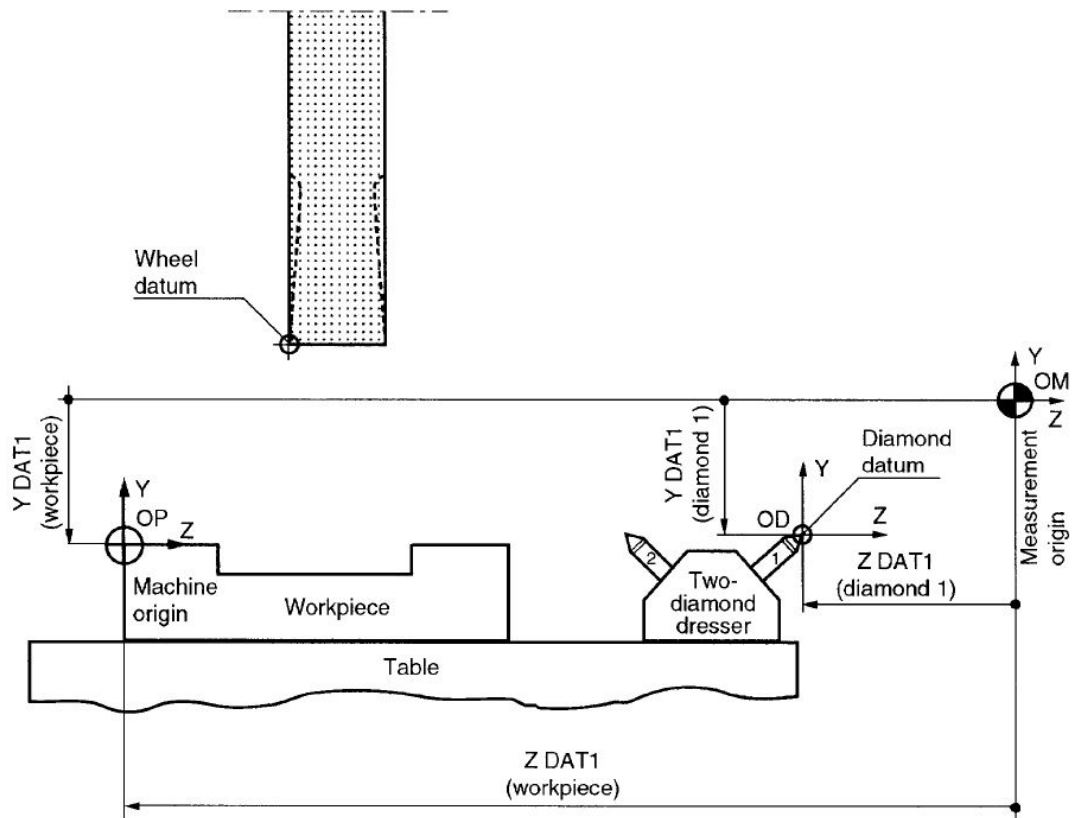
Example of roller dresser



## 2.2 Setting origins and shifts

### 2.2.1 Machine origins and shifts

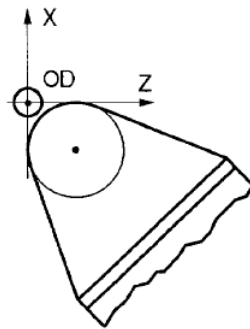
Surface grinding reference system on the Y and Z axes



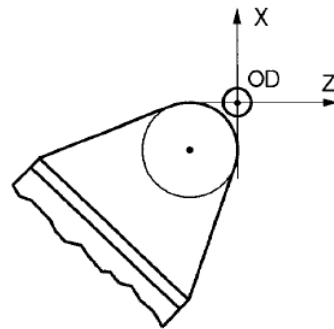
## 2.2.2 Dresser origins

### 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).

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## 2.3 Wheel profiles

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

The wheel profiles are:

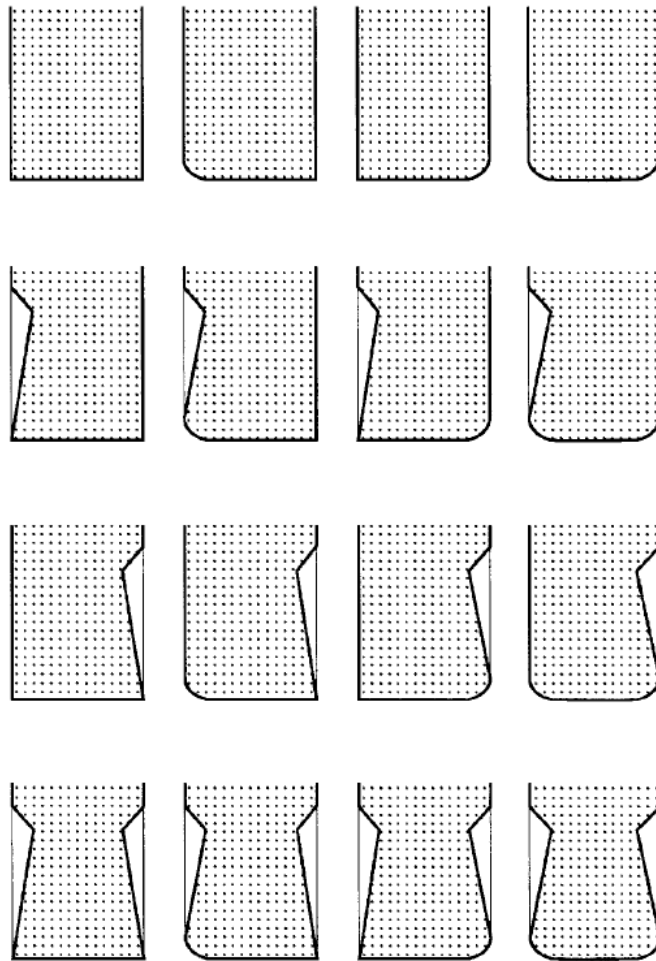
- standard,
- special.

### 2.3.1 Standard profiles

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

#### 2.3.1.1 Obtainable standard profiles

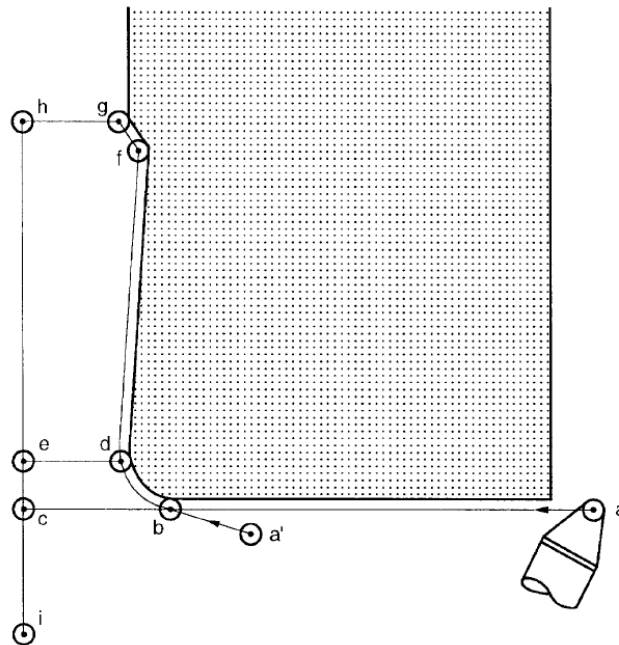
The following profiles can be defined with a fillet or chamfer:



### 2.3.1.2 Standard profiles cut with diamond 1

#### Profile breakdown

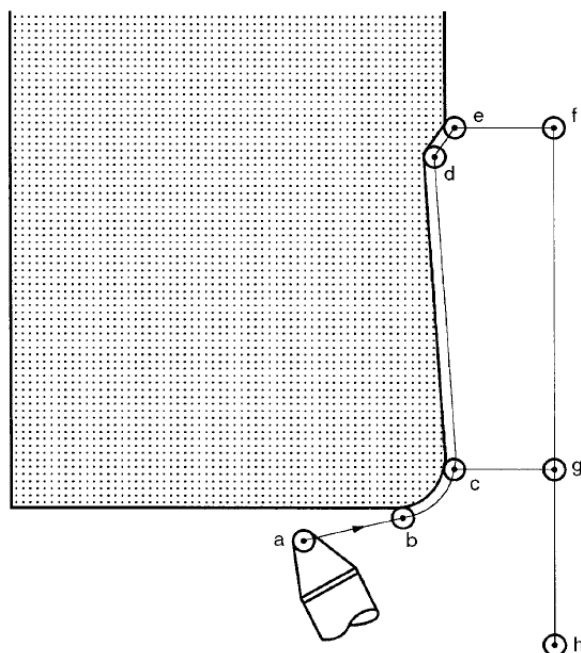
- Dressing of wheel peripheral face without radius: a, b, c, i
- Dressing of wheel peripheral face with radius: a, b, d, e, c, i
- Dressing of wheel peripheral face, left side and radius: a, b, d, f, g, h, i
- Dressing of wheel radius and left side: a', b, d, f, g, h, i



### 2.3.1.3 Standard profiles cut with diamond 2

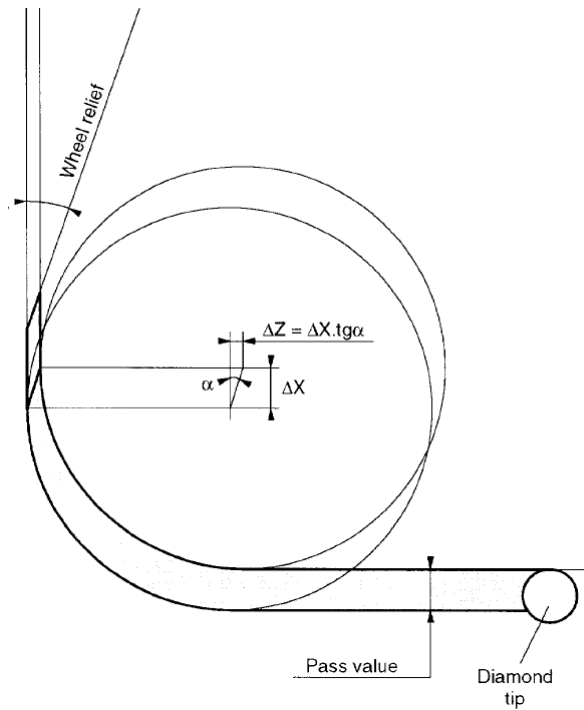
#### Profile breakdown

- Dressing of radius: a, b, c, g, h
- Dressing of wheel radius and right side: a, b, c, d, e, f, g, h

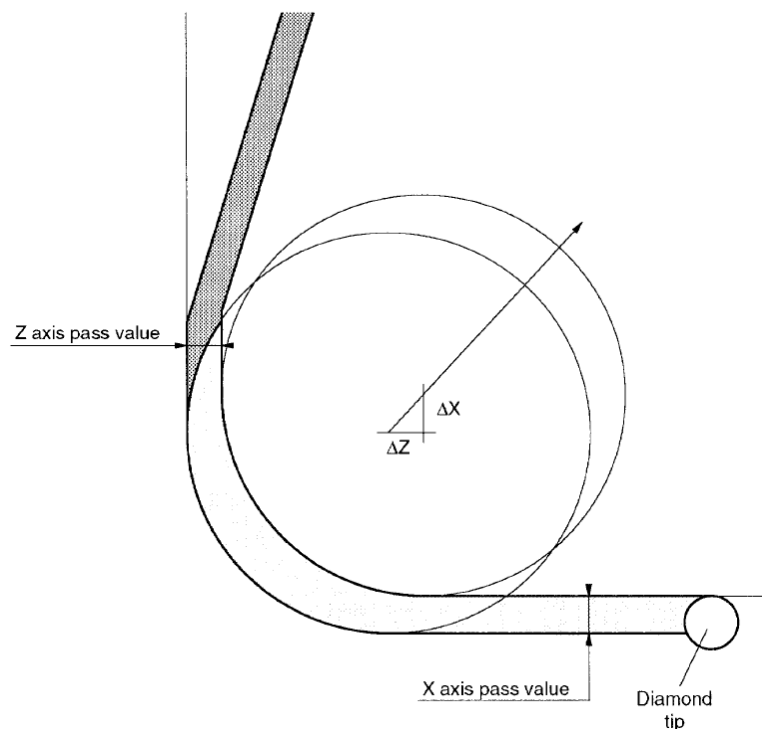


### 2.3.1.4 Detail of radius dressing

Dressing Wheel Radius and Periphery (with diamond 1)

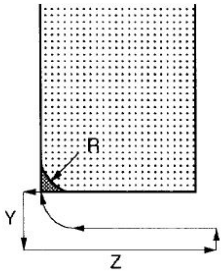
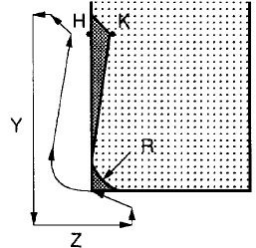
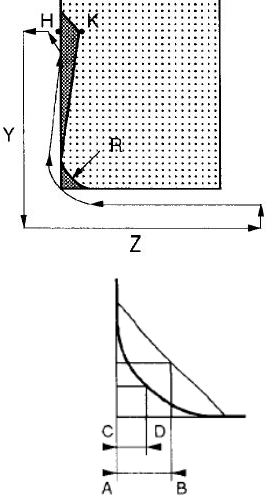
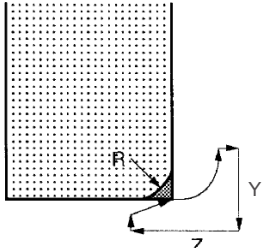
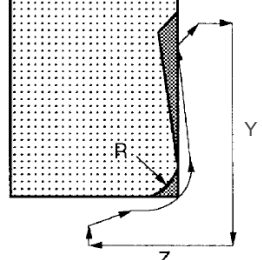


Dressing Wheel Radius, Periphery and Wall (with diamond 1)



**2.3.1.5 Axis movement during dressing**

The figures below show the movements executed during the cycles.

|                                                                                                                                                                                                                                                                                           |                                                                                      |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| <b>Dressing of</b> <ul style="list-style-type: none"> <li>• peripheral face</li> <li>• left radius</li> </ul>                                                                                                                                                                             |    |
| <b>Dressing of</b> <ul style="list-style-type: none"> <li>• wheel left side</li> <li>• left radius</li> </ul>                                                                                                                                                                             |    |
| <b>Dressing of</b> <ul style="list-style-type: none"> <li>• peripheral face</li> <li>• left radius</li> <li>• wheel left side</li> </ul><br><b>Detail of the radius</b><br>Comparison between HK and: <ul style="list-style-type: none"> <li>• AB,</li> <li>• CD (with radius)</li> </ul> |   |
| <b>Dressing of</b> <ul style="list-style-type: none"> <li>• right radius</li> </ul>                                                                                                                                                                                                       |  |
| <b>Dressing of</b> <ul style="list-style-type: none"> <li>• right radius</li> <li>• right side</li> </ul>                                                                                                                                                                                 |  |

### 2.3.1.6 Calculation of shift for dressing the profile

### Shift value

The test is performed on the value AB and:

- K'H' for a chamfer
- KH for a radius.

## Shift calculation

$$- K'H' = R/2$$

$$- KH = (R \cdot 1.41 - R) / 1.41 = R = 0.41/1.41$$

-  $AB =$

$AB =$ 

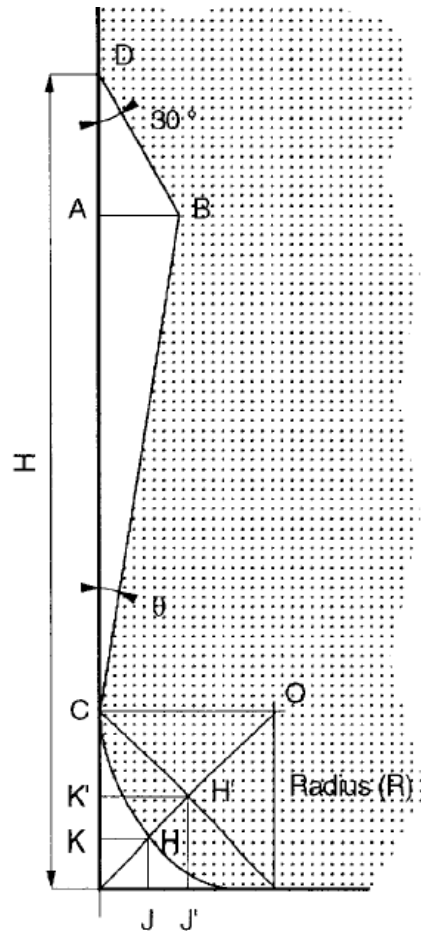
 $\frac{a}{\sin \alpha} = \frac{b}{\sin \beta} = \frac{c}{\sin \gamma}$

$$\frac{DC}{\sin \widehat{DBC}} = \frac{DB}{\sin \theta}$$

$$DB = \frac{DC}{\sin \widehat{DBC}} \cdot \sin \theta$$

$$AB = DB \cdot \sin 30^\circ$$

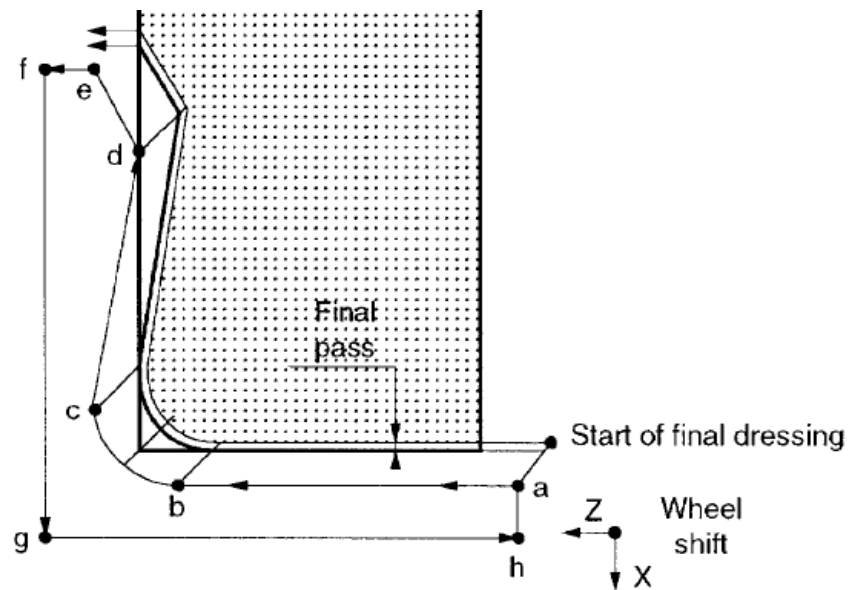
$$AB = \left( \frac{DB}{\sin (150 - \theta)} \cdot \sin \theta \right) \cdot \frac{1}{2}$$



**Illustration of profile**

The profile is dressed following points a, b, c, d, e, f, g, h.

The subsequent passes are made by shifting the wheel on the X and Z axes.



## 2.3.2 Special wheel profile

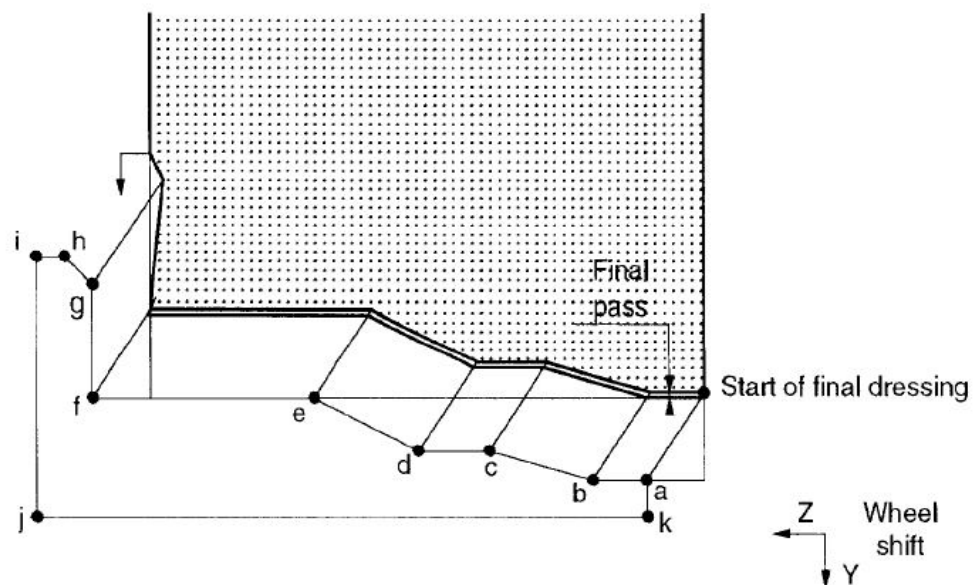
A special wheel profile can be obtained in two ways:

- 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

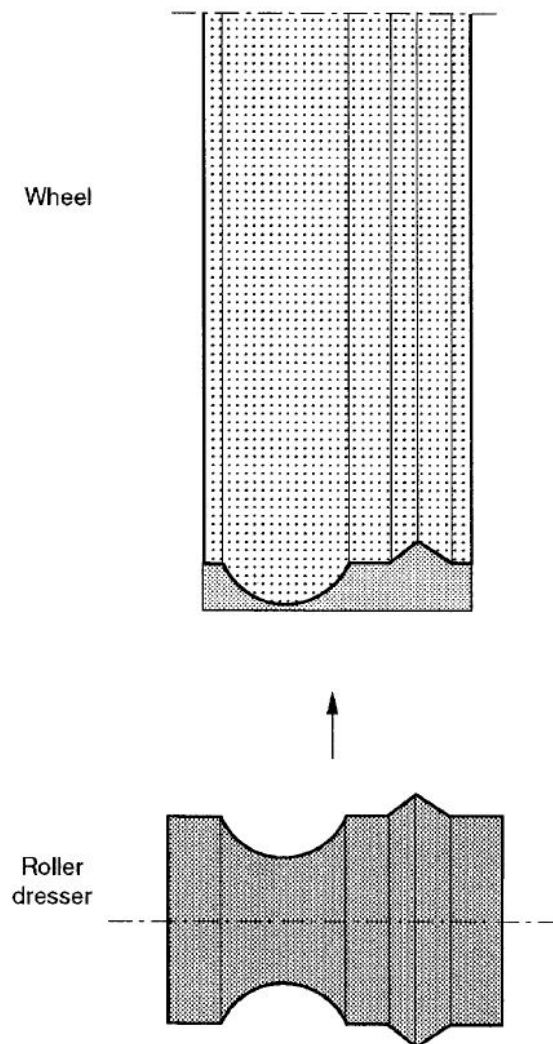
The successive passes are made by shifts on the Y and Z axes.

For example:



### 2.3.2.2 Example of a special wheel profile cut with a roller dresser

For execution, the roller dresser is moved on the secondary V axis.



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## **2.4 Surface grinding capabilities**

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The following grinding capabilities are available:

- wheel dressing,
- grinding cycles,
- intermediate manual measurement.

### **2.4.1 Wheel dressing**

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**

A surface grinding cycle is initiated by programming a G2xx function (see Grinding Functions and Cycles on chapter 3).

Grinding cycles considered:

- G220: flute grinding cycle,
- G222: surface grinding cycle.

### **2.4.3 Manual intermediate measurement**

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

## 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.

|                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|---------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Setting the measurement origin</b> | The measurement origin is set on the X, Y and Z axes (only at power on) in accordance with the instructions defined by the machine manufacturer.                                                                                                                                                                                                                                                                                           |
| <b>Selecting the wheel</b>            | The wheel and working environment are selected by programming function M06 Tx (see Grinding Functions and Cycles chapter 3).                                                                                                                                                                                                                                                                                                               |
| <b>Setting the dresser origins</b>    | The dresser X, Y and Z origins are set by function M140 (see Grinding Functions and Cycles on chapter 3). This is required only after changing the wheel.                                                                                                                                                                                                                                                                                  |
| <b>Starting wheel rotation</b>        | The speed of wheel rotation is programmed by function G230 or by M03 S.. M65 (see Grinding Functions and Cycles on chapter 3).                                                                                                                                                                                                                                                                                                             |
| <b>Dressing the wheel</b>             | <p>The wheel is dressed by one of functions G245 (shaping) or G240 (dressing). (see Grinding Functions and Cycles on chapter 3).</p> <p>For wheel dressing, the choice of T1 determines the association with corrections D1, D2, D3 and D4.</p> <p>For example:</p> <p>D1 L.. R.. @..</p> <ul style="list-style-type: none"> <li>• L.. Length (E52001)</li> <li>• R.. Radius (E50001)</li> <li>• @.. Cutter tip radius (E51001)</li> </ul> |

|                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |                |         |                                 |          |                         |      |                            |               |                          |                   |                |          |                           |     |                                                                                   |     |     |     |     |         |                         |     |
|-------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|----------------|---------|---------------------------------|----------|-------------------------|------|----------------------------|---------------|--------------------------|-------------------|----------------|----------|---------------------------|-----|-----------------------------------------------------------------------------------|-----|-----|-----|-----|---------|-------------------------|-----|
| <b>Setting the workpiece origin</b> | The workpiece origin (Op) is set by function M145.<br>(see Grinding Functions and Cycles on chapter 3)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |      |                |         |                                 |          |                         |      |                            |               |                          |                   |                |          |                           |     |                                                                                   |     |     |     |     |         |                         |     |
| <b>Writing the grinding program</b> | <b>General program structure</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |      |                |         |                                 |          |                         |      |                            |               |                          |                   |                |          |                           |     |                                                                                   |     |     |     |     |         |                         |     |
|                                     | <p>Example.</p> <table> <tr> <td>%500</td><td>Program number</td></tr> <tr> <td>M06 T..</td><td>Choice of wheel and environment</td></tr> <tr> <td>G230 S..</td><td>Wheel speed calculation</td></tr> <tr> <td>M160</td><td>Periodic dressing (or not)</td></tr> <tr> <td>M08 (example)</td><td>Manufacturer's functions</td></tr> <tr> <td>M03 S.. M40 (M64)</td><td>Wheel rotation</td></tr> <tr> <td>G2xx ...</td><td>Cycle call with arguments</td></tr> <tr> <td>...</td><td rowspan="5">  </td></tr> <tr> <td>...</td></tr> <tr> <td>...</td></tr> <tr> <td>...</td></tr> <tr> <td>...</td></tr> <tr> <td>M05 M09</td><td>Spindle and coolant off</td></tr> <tr> <td>M02</td><td>End of programme</td></tr> </table> | %500 | Program number | M06 T.. | Choice of wheel and environment | G230 S.. | Wheel speed calculation | M160 | Periodic dressing (or not) | M08 (example) | Manufacturer's functions | M03 S.. M40 (M64) | Wheel rotation | G2xx ... | Cycle call with arguments | ... |  | ... | ... | ... | ... | M05 M09 | Spindle and coolant off | M02 |
| %500                                | Program number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |      |                |         |                                 |          |                         |      |                            |               |                          |                   |                |          |                           |     |                                                                                   |     |     |     |     |         |                         |     |
| M06 T..                             | Choice of wheel and environment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |                |         |                                 |          |                         |      |                            |               |                          |                   |                |          |                           |     |                                                                                   |     |     |     |     |         |                         |     |
| G230 S..                            | Wheel speed calculation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |                |         |                                 |          |                         |      |                            |               |                          |                   |                |          |                           |     |                                                                                   |     |     |     |     |         |                         |     |
| M160                                | Periodic dressing (or not)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |      |                |         |                                 |          |                         |      |                            |               |                          |                   |                |          |                           |     |                                                                                   |     |     |     |     |         |                         |     |
| M08 (example)                       | Manufacturer's functions                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |      |                |         |                                 |          |                         |      |                            |               |                          |                   |                |          |                           |     |                                                                                   |     |     |     |     |         |                         |     |
| M03 S.. M40 (M64)                   | Wheel rotation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |      |                |         |                                 |          |                         |      |                            |               |                          |                   |                |          |                           |     |                                                                                   |     |     |     |     |         |                         |     |
| G2xx ...                            | Cycle call with arguments                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |      |                |         |                                 |          |                         |      |                            |               |                          |                   |                |          |                           |     |                                                                                   |     |     |     |     |         |                         |     |
| ...                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |      |                |         |                                 |          |                         |      |                            |               |                          |                   |                |          |                           |     |                                                                                   |     |     |     |     |         |                         |     |
| ...                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |                |         |                                 |          |                         |      |                            |               |                          |                   |                |          |                           |     |                                                                                   |     |     |     |     |         |                         |     |
| ...                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |                |         |                                 |          |                         |      |                            |               |                          |                   |                |          |                           |     |                                                                                   |     |     |     |     |         |                         |     |
| ...                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |                |         |                                 |          |                         |      |                            |               |                          |                   |                |          |                           |     |                                                                                   |     |     |     |     |         |                         |     |
| ...                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |                |         |                                 |          |                         |      |                            |               |                          |                   |                |          |                           |     |                                                                                   |     |     |     |     |         |                         |     |
| M05 M09                             | Spindle and coolant off                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |                |         |                                 |          |                         |      |                            |               |                          |                   |                |          |                           |     |                                                                                   |     |     |     |     |         |                         |     |
| M02                                 | End of programme                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |      |                |         |                                 |          |                         |      |                            |               |                          |                   |                |          |                           |     |                                                                                   |     |     |     |     |         |                         |     |

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# Summary

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## 3 Programming Functions and Cycles

### 3.1 General

This chapter defines the special functions and grinding cycles that can be programmed. The other programming functions used comply with the standard use of milling applications. For further information, refer to the Flexium+ Programming manual M00040.



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).

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

### 3.2 G Functions - Main summary table

Click on [Gxx](#) to give the detailed information.

| Code                 | Description                                  |
|----------------------|----------------------------------------------|
| <a href="#">G220</a> | Flute grinding cycle                         |
| <a href="#">G222</a> | Surface grinding cycle                       |
| <a href="#">G230</a> | Wheel speed calculation                      |
| <a href="#">G232</a> | Intermediate measurement cycle               |
| <a href="#">G240</a> | Fixed or roller dresser wheel dressing cycle |
| <a href="#">G245</a> | Fixed dresser wheel shaping cycle            |

### 3.3 M Functions - Main summary table

Click on [Mxx](#) to give the detailed information.

| Code                 | Description                                                |
|----------------------|------------------------------------------------------------|
| <a href="#">M06</a>  | Selecting the wheel and setting up the working environment |
| <a href="#">M140</a> | Dresser setup                                              |
| <a href="#">M145</a> | Part origin setting                                        |
| <a href="#">M160</a> | Periodic dressing test counter                             |

---

## 3.4 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.i (i = group number).

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" referred to during the dressing phase.

### 3.4.1 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:  
"Y 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:  
"Y 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.

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### 3.4.1.1 Fixed two-diamond dresser origin setting

The origin can be set for diamond 1 or diamond 2 in Y and Z.

#### Origin setting for diamond 1

Figure 1 (on Y axis)

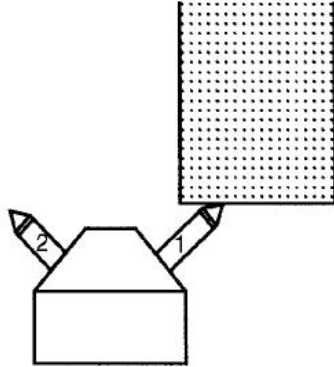
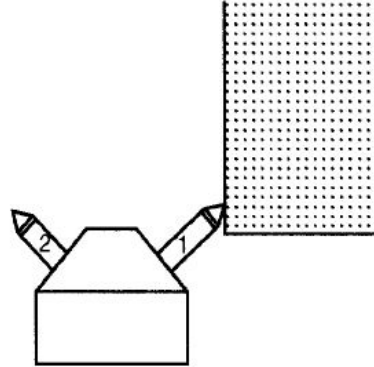


Figure 2 (on Z axis)



#### Origin setting for diamond 2

Values stored in machine data file:

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

Figure 3 (on Y axis)

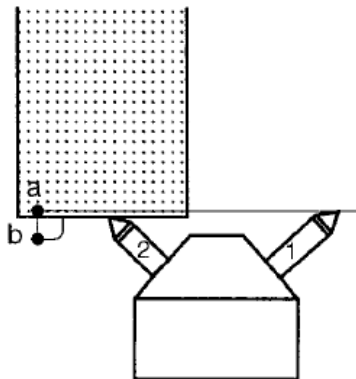
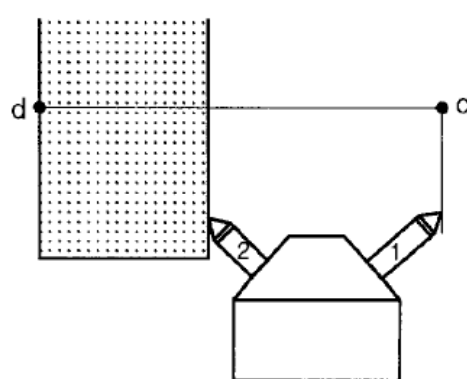


Figure 4 (on Z axis)



### 3.4.1.2 Roller dresser setup

The roller dresser setup 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.i (i= group number).

---

## 3.5 Wheel dressing options

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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.

### 3.5.1 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 Y.. EF..**

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



The call to the G245 ... shaping cycle must be programmed before the call to function Tx M06 (see chapter 3.6, "Selecting the Wheel and Setting Up the Working Environment"). This is backwards, the Tx M06 call needs to come before G245 so the shaping uses the correct wheel data.

### 3.5.2 Fixed or roller dresser wheel dressing cycle ▶ G240

#### G240 Fixed or roller dresser wheel dressing cycle

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

#### Syntax

**G240** Y.. EZ../EX.. ED..

|             |                                                 |
|-------------|-------------------------------------------------|
| <b>G240</b> | Fixed or roller dresser wheel dressing cycle.   |
| <b>Y..</b>  | Backoff on Y. (Safety position before dressing) |
| <b>EZ..</b> | Return on Z.                                    |
| <b>EX..</b> | Return on X.                                    |
| <b>ED..</b> | Wheel surface to be dressed.                    |

#### Programming possibilities

|                         |                                                                                                                                                                                    |
|-------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| G240 ED ..              | Dress                                                                                                                                                                              |
| G240 Y ..ED..           | <ul style="list-style-type: none"><li>- Move to Y</li><li>- Dress</li></ul>                                                                                                        |
| G240 Y. . EZ. . ED. .   | <ul style="list-style-type: none"><li>- Move to Y</li><li>- Dress</li><li>- Return to work position:<br/>Y = saved position + safety clearance<br/>Z = EZ..</li></ul>              |
| G240 Y .. EY .. ED..    | <ul style="list-style-type: none"><li>- Move to Y</li><li>- Dress</li><li>- Return to work position:<br/>Y = saved position + safety clearance<br/>X = EX..</li></ul>              |
| G240 Y EZ.. EY .. ED .. | <ul style="list-style-type: none"><li>- Move to Y</li><li>- Dress</li><li>- Return to work position:<br/>Y = saved position + safety clearance<br/>Z = EZ..<br/>X = EX..</li></ul> |

### 3.5.2.1 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 chapter 3.9).

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".

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.

### 3.5.2.2 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.

### 3.5.2.3 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.

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.

### 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..] [EY..] [EZ..]**

|             |                                                                                   |
|-------------|-----------------------------------------------------------------------------------|
| <b>M06</b>  | Selecting the wheel and setting up the working environment.                       |
| <b>T..</b>  | Wheel number selected (T1 to T8, default T1 if not specified).                    |
| <b>ET..</b> | Wheel file number (1 to 99).                                                      |
| <b>ER1</b>  | Wheel retraction to rest position (if not specified, no return to rest position). |
| <b>EY..</b> | Shift on Y axis (see Notes).                                                      |
| <b>EZ..</b> | 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. (ETxx corresponds to subroutine %990x.x).

Example: ET1 = ET01 => %9900.1

### 3.6.1 Shifts EY 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 EY 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 Y axis shift (EY) must be greater than -0.5 mm, and the Z axis shift (EZ) must be between -1 mm and +1 mm.

### 3.6.2 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 EY and EZ defined in the block with M06,
- D4 is reserved.

### 3.6.3 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.

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 N115,
  - wheel 2: blocks N200 to N215,
  - wheel 3: blocks N300 to N315,
- and so on, up to wheel 8 (N800 to N815).

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)].

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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.

### 3.7 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 three ways according to its location:

- before the cycle call,
- in the cycle call block (G2xx),
- in a subroutine.

#### Syntax

##### Syntax (before the cycle call)

#### G230 S..

|             |                                                      |
|-------------|------------------------------------------------------|
| <b>G230</b> | Calculation of the wheel rotation speed.             |
| <b>S..</b>  | Mandatory argument defining the cutting speed (m/s). |

##### Syntax (in the cycle calling block G2xx)

#### G2xx.. S.. ..

|             |                                                      |
|-------------|------------------------------------------------------|
| <b>G2xx</b> | Grinding cycle.                                      |
| <b>S..</b>  | Mandatory argument defining the cutting speed (m/s). |

##### Syntax (in a subroutine)

#### S.. G77 H10230

|               |                                                      |
|---------------|------------------------------------------------------|
| <b>S..</b>    | Mandatory argument defining the cutting speed (m/s). |
| <b>G77</b>    | Subroutine call function.                            |
| <b>H10230</b> | 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 two 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    |                         |
| N.. G230 S.. | Wheel speed calculation |
| N..          |                         |
| N.....       |                         |
| N.. G2xx     | Cycle                   |
| N.. ...      |                         |

### Wheel speed calculation in the G2xx cycle call block

|                      |            |
|----------------------|------------|
| N .. ...             |            |
| N.. G2xx ... S.. ... | Cycle call |
| N.. ...              |            |
| N.. ...              |            |

### Speed calculation in a subroutine

|                    |            |
|--------------------|------------|
| N .. ...           |            |
| N..G2xx ... S..    | Cycle call |
| N.. ...            |            |
| N.. S.. G77 H10230 |            |
| N.. ...            |            |

## 3.8 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.                                          |

---

### 3.8.1 Part setup procedure

- Select manual data input mode (MDI).
- Programme part setup function "M145".
- 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:  
"X ORIGIN: MOVE WHEEL ON THE REF. SURFACE"
- The handwheels and axis jogs become operational (Function M12 active).
- Move the wheel to the part surface on X.
- Restart the cycle by pressing the Cycle Start key on the machine panel.
- The following message is displayed:  
«INPUT X IN AXIS POSITION»
- The wheel is retracted from the part to allow measurement of the position.
- Enter the value measured and press CNC Enter key.
- Start the cycle again by pressing the Cycle Start key on the machine panel.
- The following message is displayed  
«Y ORIGIN: MOVE WHEEL ON THE REF. SURFACE»
- The handwheels and axis jogs are operational (Function M12 active).
- Touch the part reference surface with the wheel periphery (in Y).
- Retract the wheel from the part to make the measurement on the part surface.
- The following message is displayed:  
«INPUT Y AXIS POSITION=»
- Enter the measured value and press the CNC Enter key.
- The following message is displayed:  
«Z ORIGIN; MOVE WHEEL ON REF. SURFACE»
- The handwheels or axis jogs are operational (Function M12 active).
- Touch the part reference surface with the wheel (in Z).
- Retract the wheel from the part to make the measurement on the part surface.
- The following message is displayed:  
«INPUT Z AXIS POSITION=»
- Enter the value measured on the keyboard than confirm by pressing CNC Enter key.
- 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:

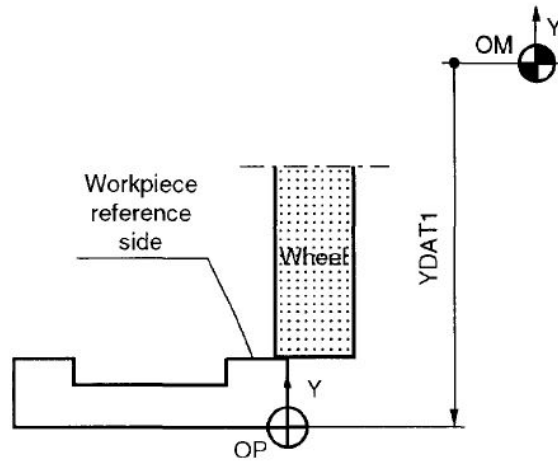
T02 M145

In this case the origins are stored in file N200-N218 section of %9910.1.  
(%9910.2 is used if the %9910 program is running in channel 2)

### 3.8.2 Schematic illustration of workpiece origin setting

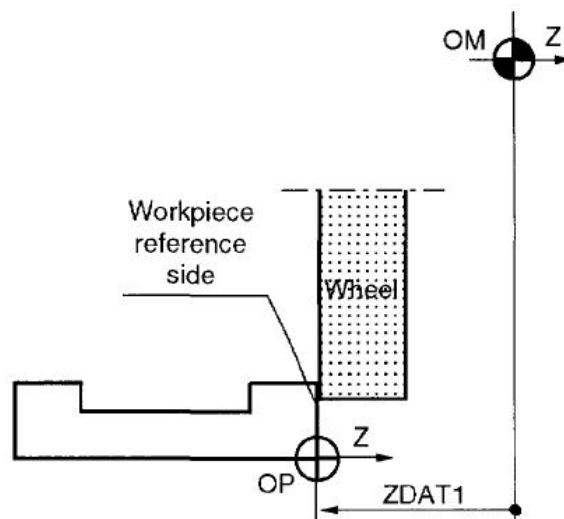
#### Workpiece origin on Y axis

Wheel in contact with the top of the workpiece reference side



#### Workpiece origin on Z axis

Wheel in contact with workpiece reference side



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.

## 3.10 Manual intermediate measurement

The phases of the programmed grinding cycles 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.

### 3.10.1 Manual intermediate measurement programmed in a cycle

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  $\pm 0.05$  ).

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.x).

### 3.10.2 Intermediate manual measurement requested by user

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

During the grinding phase, the user requests measurement by pressing a pushbutton on the machine panel. 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 Y by argument EH (retraction diameter for dressing and manual measurement).

### G232 Intermediate manual measurement cycle

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

#### Syntax

**G232 Y.. EZ.. / EY.. EM..**

|             |                                 |
|-------------|---------------------------------|
| <b>G232</b> | Intermediate measurement cycle. |
| <b>Y..</b>  | Backoff on Y.                   |
| <b>EZ..</b> | Return on Z.                    |
| <b>EX..</b> | Return on X.                    |
| <b>EM..</b> | Measurement.                    |

#### Programming

G232 EM ..

- Measure
- Move to Y..
- Measure

G232 Y .. EM ..

G232 Y .. EZ .. EM ..

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

G232 Y.. EX.. EM..

- Move to Y
- Measure
- Return to work position:  
Y = saved position + safety clearance  
X = EX..

G232 Y.. EZ.. EM..

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

## 3.12 Surface grinding cycles

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

The cycle chosen is programmed by a G2xx function.

The surface grinding cycles are as follows:

- G220: flute grinding cycle,
- G222: surface grinding cycle.



The external 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.

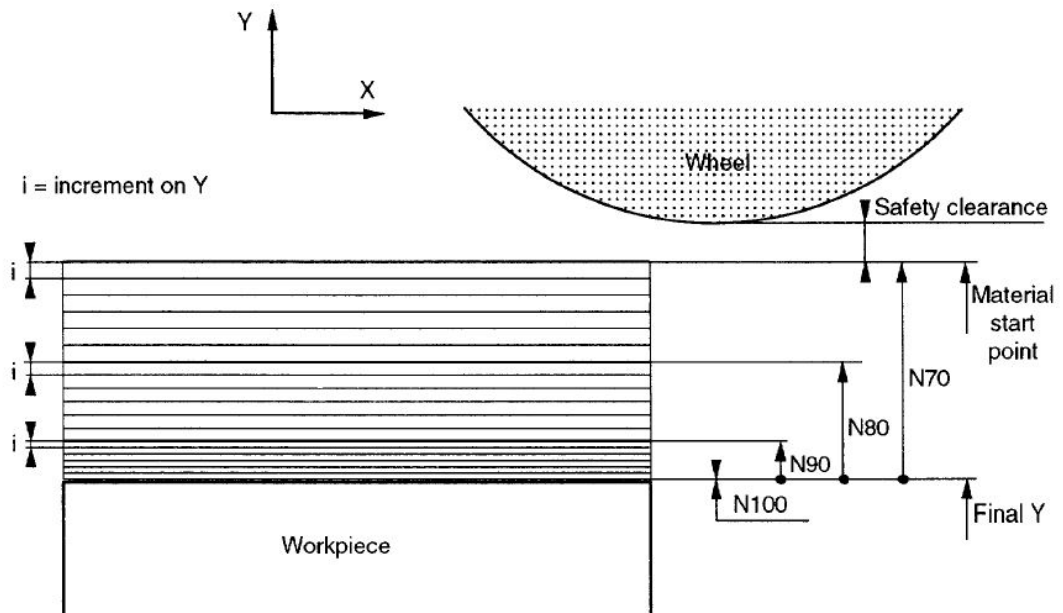


A G2xx cycle must always end with argument EB2 (end of cycle). Otherwise, certain modal arguments are applied during the following cycles.

### 3.12.2 Cycle general example

|                 |                                                 |
|-----------------|-------------------------------------------------|
| %206            |                                                 |
| N10 T01 M06     | Selection of wheel                              |
| N20 G230 S...   | Wheel speed calculation                         |
| N30 M160        | Periodic dressing                               |
| N40 M03 M40 S.. | Wheel rotation                                  |
| N50 M08         | Coolant ON                                      |
| N60 G222...     | Surface grinding cycle and cycle call arguments |
| N70 ...         | Roughing phase                                  |
| N80 ...         | Semi-finishing phase                            |
| N90 ...         | Finishing phase                                 |
| N100 ...        | Sparkout and end cycle                          |
| N110 M05 M09    | Spindle and coolant OFF                         |
| N120 M02        | End program                                     |

**Schematic representation of the phases of a cylindrical traverse cycle**

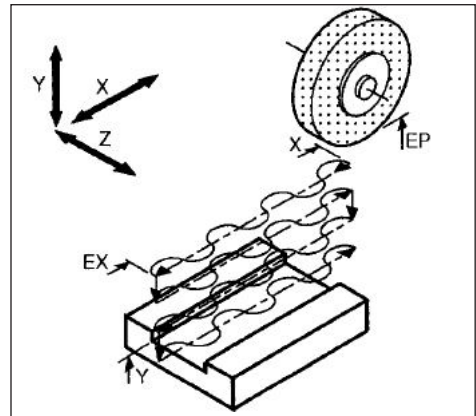


### 3.12.3 Flute grinding cycle ▶ G220

#### G220 Flute grinding cycle

This cycle includes:

- Initial positioning followed by an initial increment on Y, then flute grinding (with or without oscillations) to the end X position.
- A second increment on Y, then return flute grinding, etc.



#### Syntax

**G220** Y.. EP.. X.. EX.. F.. [EC..] [EH..] Z.. EE.. EQ..  
 [Y..] [EI..] [EJ..] [EK..] [ET..] / [EN..] [F..] [ED..] [EG..] [EM..] [EO..] [EX..] [EB..]

#### Cycle call arguments

|             |                                                                                         |
|-------------|-----------------------------------------------------------------------------------------|
| <b>G220</b> | Flute grinding cycle.                                                                   |
| <b>Y..</b>  | Final position on Y.                                                                    |
| <b>EP..</b> | Rapid stop distance on Y.                                                               |
| <b>X..</b>  | Start X position.                                                                       |
| <b>EX..</b> | End X position.                                                                         |
| <b>F..</b>  | Traverse feed on X.                                                                     |
| <b>EC..</b> | Increment type on Y:<br>- EC0: continuous increment.<br>- EC1: discontinuous increment. |
| <b>EH..</b> | Safety distance (retraction) on Y for dressing or manual measurement.                   |
| <b>Z..</b>  | Start Z position.                                                                       |
| <b>E..</b>  | Wheel Rotation:<br>- Start<br>- EE0: Clockwise<br>- EE1: Counter-Clockwise              |
| <b>EQ..</b> | Wheel Rotation:<br>- End<br>- EQ0: Clockwise<br>- EQ1: Counter-Clockwise                |

### In-cycle call arguments

|                    |                                                                                                                                                                                                                                                                                                          |
|--------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Y..</b>         | Stock remaining on Y with respect to the final dimension.                                                                                                                                                                                                                                                |
| <b>EI..</b>        | Increment on Y at the start of traverse (only with EC1).                                                                                                                                                                                                                                                 |
| <b>EJ..</b>        | Increment on Y at the end of traverse.                                                                                                                                                                                                                                                                   |
| <b>EK..</b>        | Backoff on Y.                                                                                                                                                                                                                                                                                            |
| <b>ET.. / EN..</b> | - Sparkout time (s).<br>- Number of sparkout passes.                                                                                                                                                                                                                                                     |
| <b>F..</b>         | Plunge speed on Y.                                                                                                                                                                                                                                                                                       |
| <b>ED..</b>        | Wheel dressing selection:<br>- ED1: periphery,<br>- ED2: left wall,<br>- ED3: periphery and left wall,<br>- ED4: right wall,<br>- ED5: periphery and right wall,<br>- ED6: left wall and right wall,<br>- ED7: periphery and left and right walls.<br>- ED8: periphery face with diamond 1 and diamond 2 |
| <b>EG..</b>        | Measurement type:<br>- EG0: no measurement,<br>- EG98: conditional manual measurement call,<br>- EG99: unconditional manual measurement call.                                                                                                                                                            |
| <b>EM..</b>        | Part origin offset selection (default: no modification).<br>- EM0: no modification,<br>- EM1: modification of DAT1,<br>- EM2: modification of DAT1 and machine data                                                                                                                                      |
| <b>EO..</b>        | Oscillation frequency (osc/min) (only with EC1).                                                                                                                                                                                                                                                         |
| <b>EX..</b>        | Oscillation amplitude on Z.                                                                                                                                                                                                                                                                              |
| <b>EB..</b>        | Cycle sequencing selection:<br>- EB0: sequencing without stopping,<br>- EB2: end of cycle.                                                                                                                                                                                                               |
| <b>ER..</b>        | Start Position Increment:<br>- ER0: Infeed<br>- ER1: Backoff.                                                                                                                                                                                                                                            |
| <b>ES..</b>        | End Position Increment:<br>- ES0: Infeed<br>- ES1: Backoff.                                                                                                                                                                                                                                              |
| <b>EV..</b>        | Dressing Type:<br>- EV1: Coarse<br>- EV2: Fine<br>- EV3: Coarse + Fine<br>- EV4: Sparkout<br>- EV5: Coarse + Sparkout<br>- EV6: Fine + Sparkout<br>- EV7: Coarse + Fine + Sparkout                                                                                                                       |

## Notes

For additional information concerning the cycle call and in-cycle arguments, see chapter 3.15.

## Cycle Initiation

When the cycle is initiated, if the wheel is lower than the start position (Y+EP):

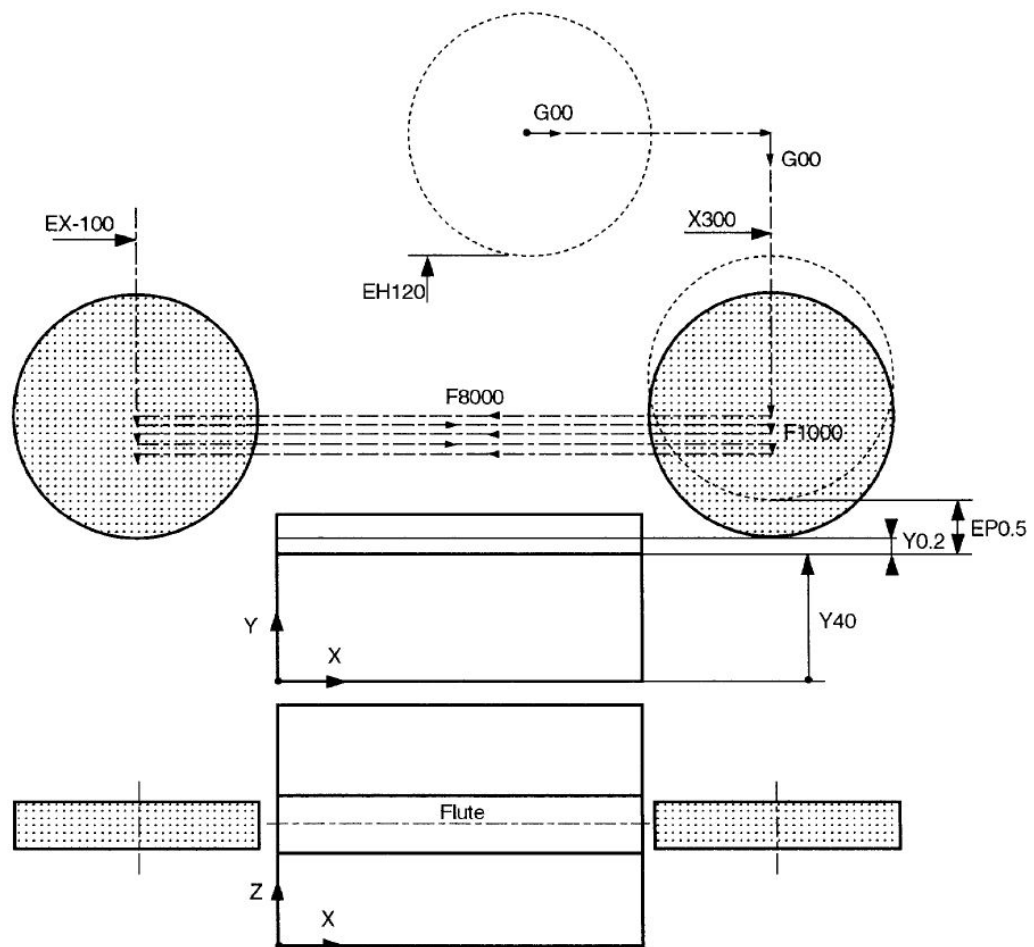
- It first retracts on the Y axis.
- Then goes to the first start X position.
- Then goes to the start Y position (Y+EP).

## Example

### Flute Grinding cycle

|                                            |                                  |
|--------------------------------------------|----------------------------------|
| ...                                        |                                  |
| G220 Y40 EP0.5 X300 EX-100 F8000 EC1 EH120 | Cycle                            |
| Y0.2 EI0.04 EJ0.04 F1000 E050 EX2          | Phase                            |
| Y0 EI0.02 EJ0.02 EN4 EK1 EB2               | Phase, sparkout and end of cycle |
| ...                                        |                                  |

## Schematic representation of cycle

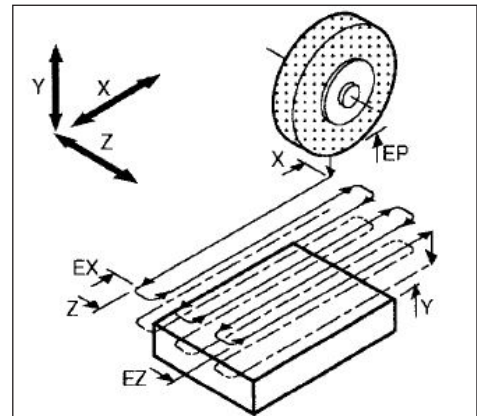


### 3.12.4 Surface grinding cycle ▶ G222

#### G222 Surface grinding cycle

This cycle includes:

- Initial positioning followed by an initial increment on Z then surface grinding to the end X position.
- Increment on Z then backward surface grinding, etc.



#### Syntax

**G222** Y.. EP.. X.. EX.. F.. Z.. EZ.. EE.. EF.. [EC..] [EH..]  
[Y..] [EI..] [EK..] [EN..] [F..] [ED..] [EG..] [EM..] [EB..]

#### Cycle call arguments

|             |                                                                                         |
|-------------|-----------------------------------------------------------------------------------------|
| <b>G220</b> | Surface grinding cycle.                                                                 |
| <b>Y..</b>  | Final position on Y.                                                                    |
| <b>EP..</b> | Rapid stop distance on Y.                                                               |
| <b>X..</b>  | Start X position.                                                                       |
| <b>EX..</b> | End X position.                                                                         |
| <b>F..</b>  | Traverse feed on X.                                                                     |
| <b>Z..</b>  | Start Z position.                                                                       |
| <b>EZ..</b> | End Z position.                                                                         |
| <b>EE..</b> | Z increment (only with EC1).                                                            |
| <b>EF..</b> | Increment feed on Z.                                                                    |
| <b>EC..</b> | Increment type on Z:<br>- EC0: continuous increment.<br>- EC1: discontinuous increment. |
| <b>EH..</b> | Safety distance (retraction) on Y for dressing or manual measurement.                   |

**In-cycle call arguments**

|             |                                                                                                                                                                                                                                                                                                     |
|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Y..</b>  | Stock remaining on Y with respect to the final dimension.                                                                                                                                                                                                                                           |
| <b>EI..</b> | Increment on Y at the start of traverse.                                                                                                                                                                                                                                                            |
| <b>EK..</b> | Backoff on Y.                                                                                                                                                                                                                                                                                       |
| <b>EN..</b> | Number of sparkout passes.                                                                                                                                                                                                                                                                          |
| <b>F..</b>  | Plunge speed on Y.                                                                                                                                                                                                                                                                                  |
| <b>ED..</b> | Wheel dressing type:<br>- ED1: periphery,<br>- ED2: left wall,<br>- ED3: periphery and left wall,<br>- ED4: right wall,<br>- ED5: periphery and right wall,<br>- ED6: left wall and right wall,<br>- ED7: periphery and left and right walls.<br>- ED8: periphery face with diamond 1 and diamond 2 |
| <b>EG..</b> | Measurement selection:<br>- EG0: no measurement,<br>- EG98: conditional manual measurement call,<br>- EG99: unconditional manual measurement call.                                                                                                                                                  |
| <b>EM..</b> | Part origin offset selection (default: no modification).<br>- EM0: no modification,<br>- EM1: modification of DAT1,<br>- EM2: modification of DAT1 and machine data                                                                                                                                 |
| <b>EB..</b> | Cycle sequencing.<br>- EB0: sequencing without stopping,<br>- EB2: End of cycle.                                                                                                                                                                                                                    |
| <b>EV..</b> | Dressing Type:<br>- EV1: Coarse<br>- EV2: Fine<br>- EV3: Coarse + Fine<br>- EV4: Sparkout<br>- EV5: Coarse + Sparkout<br>- EV6: Fine + Sparkout<br>- EV7: Coarse + Fine + Sparkout                                                                                                                  |

**Notes**

For additional information concerning the cycle call and in-cycle arguments, see chapter 3.15.

**Cycle Initiation**

When the cycle is initiated, if the wheel is lower than the start position (Y+EP):

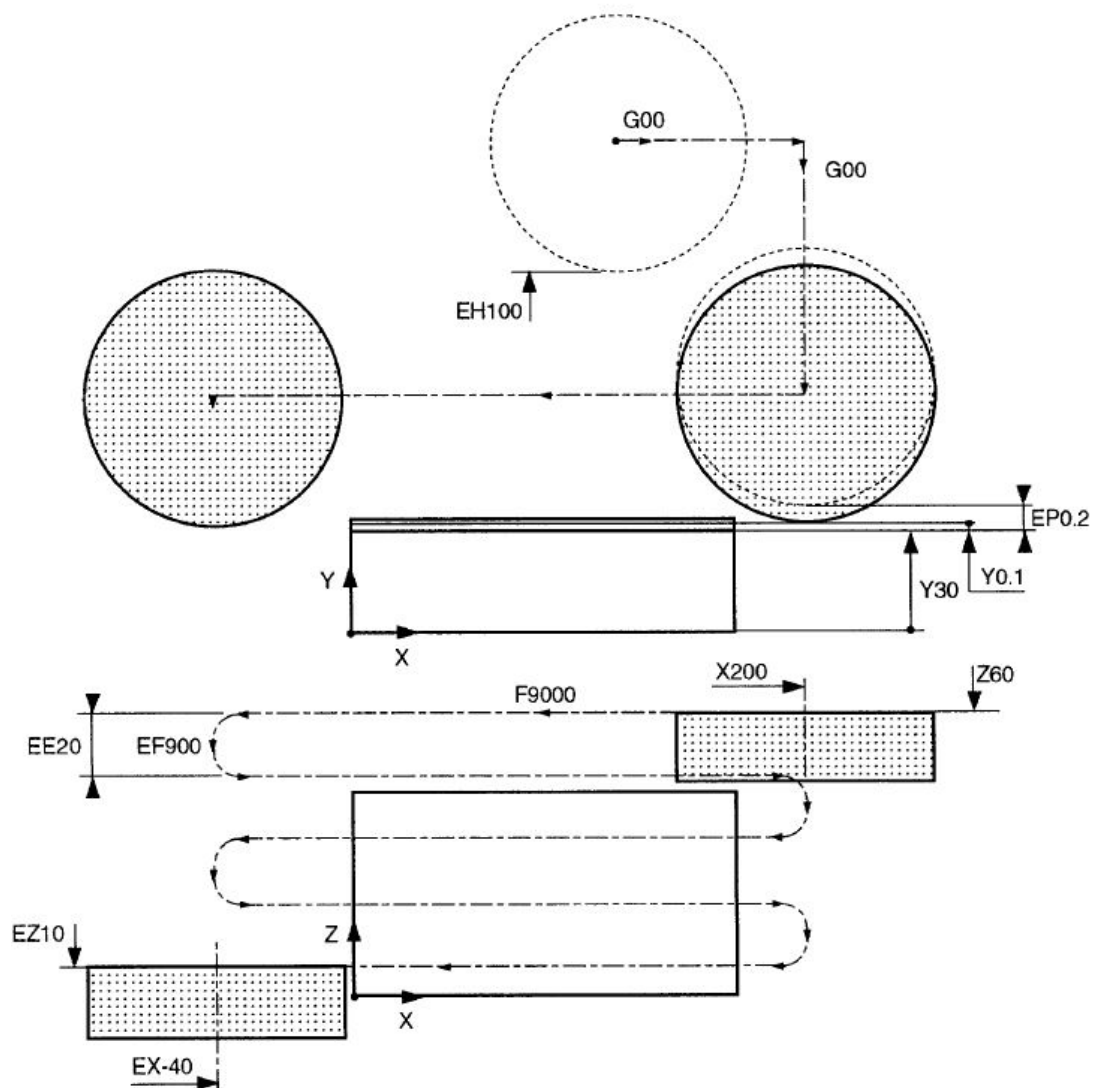
- It first retracts on the Y axis.
- Then goes to the first start X position.
- Then to the start Z position.
- Then to the start Y position (Y+EP).

## Example

### Surface grinding cycle

```
...  
G222 Y30 EP0.2 X200 EX-40 F9000 Z60 EZ10 EE20 EF900 EC1 EH100 Cycle  
Y0.1 EI0.03 F1000 Phase  
Y0 EI0.02 EN6 EK1 EB2 Phase, sparkout and end of cycle  
...
```

### Schematic representation of cycle



### 3.13 Description of the surface grinding arguments

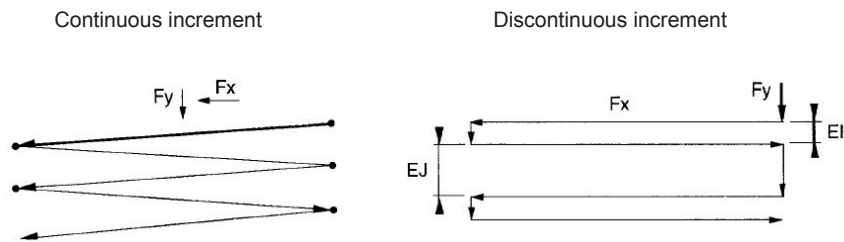
#### 3.13.1 Description of the cycle call arguments

The arguments present when a G220 or G222 cycle is called are described below in alphabetic order.

##### EC.. Type of Increment on Y (G220)

With continuous increment (ECO), traverse on X and plunge on Y are carried out simultaneously.

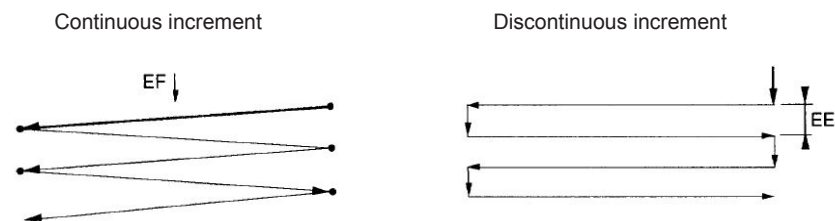
With discontinuous increment (EC1) traverse on X and plunge on Y are carried out alternately.



##### EC.. Type of Increment on Z (G222)

With continuous increment (ECO), traverse on X and plunge on Z are carried out simultaneously.

With discontinuous increment (EC1), traverse on X and plunge on Z are carried out alternately.



##### EE.. Increment on Z (G222)

Movement on Z at the start and end of traverse with discontinuous increment (see G222 and EC1).

##### EF.. Increment feed on Z (G222)

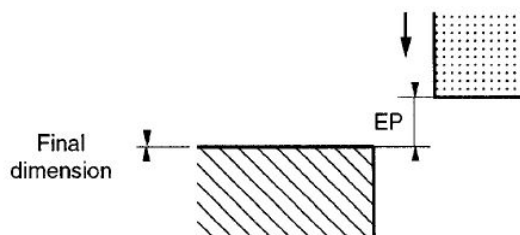
Programmed feed rate (mm/min or in/min) for movement on Z during traversing with continuous increment. (see G222 and ECO)

##### EH.. Backoff on Y for dressing or manual measurement (G220 and G222)

Value by which the wheel is backed off the part for dressing the wheel or making manual measurements. If EH is not programmed, the wheel goes to Y (final dimension) + EP (rapid stop distance on Y).

##### EP.. Rapid stop distance on Y (G220 and G222)

Rapid retraction to the value EP defined with respect to the final dimension plus the stock on Y.



---

**EX.. End X position (G220 and G222)**

Traverse end position on X during a flute or surface grinding cycle.

**EZ.. End Z Position (G222)**

Traverse end position on Z during surface grinding cycle.

**F.. Traverse Feed on X (G220 and G222)**

Traverse feed rate programmed on X during a flute or surface grinding cycle (mm/min).

**X.. Start X Position (G220 and G222)**

Traverse start position on X during a flute or surface grinding cycle.

**Y.. Final Position on Y (G220 and G222)**

Plunge end position on Y during a flute or surface grinding cycle.

**Z.. Start Z Position (G220 and G222)**

Traverse start position on Z during a surface grinding cycle.

**EE.. Wheel Rotation - Start (G220)**

Direction of wheel rotation at start of flute.

**EQ.. Wheel Rotation - End (G220)**

Direction of wheel rotation at end of flute.

### 3.13.2 Description of the In-Cycle arguments

The In-cycle arguments that can be used in a G220 or G222 cycle are described in alphabetical order.

#### EB.. Cycle sequencing selection (G220 and G222)

Argument EB is used to specify the two cycle sequencing possibilities: .

- EBO: sequencing without stopping,
- EB2: end of cycle.

EBO: is set automatically when the cycle is called (in programme %9970)

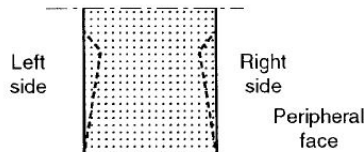
EB2: must always be programmed at the end of each grinding cycle. It means the cycle is finished and forces function G80.

#### ED.. Wheel dressing selection (G220 and G222)

Indicates which parts of 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: peripheral face with diamond 1 and diamond 2



#### EG.. Measurement selection (G220 and G222)

Possible definition of the conditions for a measurement to be made during grinding:

- EGO: no measurement during the cycle,
- EG98: conditional call for manual measurement (by setting parameter E20030 to 1),
- EG99: unconditional call for manual measurement.

#### EI.. Y Increment at Start of Traverse (G220 and G222)

Movement on the Y axis at the beginning of discontinuous traverse (with EC1 ) during a flute and surface grinding cycle. If EI is not programmed, the increment of the last block is used.

The value programmed with EI must be greater than zero.

#### EJ.. Traverse end increment (G220)

Movement on the Y axis at the end of discontinuous traverse (with EC1) during a flute grinding cycle. If EJ is not programmed, the increment of the last block is used.

The value programmed with EJ must be greater than zero.

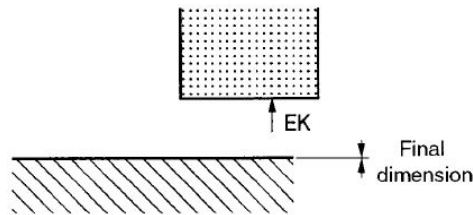
**EV.. Dressing Type (G220 and G222)**

Indicates the type of dressing to be performed upon a dressing request:

- EV1: Coarse,
- EV2: Fine,
- EV3: Coarse + Fine
- EV4: Sparkout
- EV5: Coarse + Sparkout
- EV6: Fine + Sparkout
- EV7: Coarse + Fine + Sparkout

**EK.. Backoff distance (G220 and G222)**

Wheel backoff at the end of the current grinding phase.

**EM.. Offset modification selection (G220 and G222)**

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
- EM2: modification of DAT1 and the machine data.

It should be noted that if one of arguments EM1 or EM2 is programmed, both offsets (X, Y and Z) can be modified (by intermediate measurement).

- EM0: default value in programme %9970, no modification.
- EM1: DAT1 modified.
- EM2: modification of shift E60000 (X), E61000 (Y) or E62000 (Z) depending on the cycle as well as the DAT1 values in the machine data file.

**EN.. Number of sparkout passes (G220 and G222)**

Specifies the number of sparkout passes at the end of the cycle.

**EO.. Oscillation frequency (G220)**

Oscillation frequency on Z (used only with EC1).

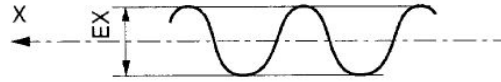
Expressed as a number of oscillations per minute (osc/min).

**ET.. Sparkout dwell time (G220)**

Specifies the sparkout dwell time in seconds.

### EX.. Oscillation amplitude on Z (G220)

Amplitude of the sinusoidal oscillations on Z during traverse on X.



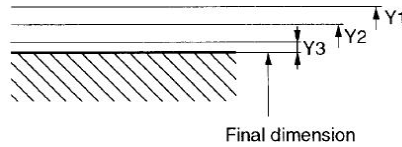
### F.. Plunge speed on Y (G220 and G222)

Programmed plunge speed on Y (mm/min) during a flute or surface grinding cycle.

If F is not programmed, the last programmed value of F is used.

### Y.. Stock remaining on Y with respect to final dimension (G220 and G222)

Stock, during the different phases of the cycle, with respect to the final dimension on Y.  
(for instance, in the figure below: roughing Y1, semifinishing Y2 and finishing Y3)



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# Summary

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1

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3

A

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## A Appendix

### A.1 Cycle call argument formats

| Format       | Name                                                                      | G2xx cycle  | Unit or value   |
|--------------|---------------------------------------------------------------------------|-------------|-----------------|
| <b>X053</b>  | Start X position                                                          | G220 - G222 | mm or in        |
| <b>Y053</b>  | End Y position                                                            | G220 - G222 | mm or in        |
| <b>Z053</b>  | Start Z position                                                          | G222        | mm or in        |
| <b>EC01</b>  | Y increment type                                                          | G220 - G222 | 0 or 1          |
| <b>EE022</b> | Z increment                                                               | G222        | s               |
| <b>EF022</b> | Z increment feed                                                          | G222        | mm/min or in/mm |
| <b>EH053</b> | Backoff on Y for dressing or measurement                                  | G220 - G222 | mm or in        |
| <b>EP053</b> | Rapid stop distance on Y                                                  | G220 - G222 | mm or in        |
| <b>EX053</b> | End X position                                                            | G220 - G222 | mm or in        |
| <b>EZ053</b> | End Z position                                                            | G222        | mm or in        |
| <b>F..</b>   | Traverse speed on X                                                       | G220 - G222 | mm/min or in/mm |
| <b>EE..</b>  | Wheel Rotation - Start.<br>Direction of wheel rotation at start of flute. | G220        | 0 or 1          |
| <b>EQ..</b>  | Wheel Rotation - End.<br>Direction of wheel rotation at end of flute.     | G220        | 0 or 1          |

---

## A.2 In-Cycle argument formats

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| Format        | Name                                       | G2xx cycle  | Unit or value |
|---------------|--------------------------------------------|-------------|---------------|
| <b>Y053</b>   | Stock on Y with respect to final dimension | G220 - G222 | mm            |
| <b>EB01</b>   | Cycle sequencing selection                 | G220 - G222 | 0 to 2        |
| <b>ED01</b>   | Wheel dressing selection                   | G220 - G222 | 1 to 8        |
| <b>EG01</b>   | Measurement selection                      | G220 - G222 | 0, 98, 99     |
| <b>EI053</b>  | Y increment at start of traverse           | G220 - G222 | mm            |
| <b>EJ053</b>  | Increment at the end of traverse           | G220        | mm            |
| <b>EK053</b>  | Backoff distance on Y                      | G220 - G222 | mm            |
| <b>EM01</b>   | Offset modification selection              | G220 - G222 | 0 to 2        |
| <b>EN..</b>   | Number of sparkout passes                  | G220 - G222 | ENn           |
| <b>EO..</b>   | Oscillation frequency                      | G220        | osc/min       |
| <b>ET022</b>  | Sparkout dwell time                        | G220        | s             |
| <b>EX053</b>  | Oscillation amplitude on Z                 | G220        | mm            |
| <b>F..</b>    | Plunge speed on Y                          | G220 - G222 | mm/min        |
| <b>EV01..</b> | Dressing Pass Type                         | G220 - G222 | 1 to 7        |

## A.3 Homing Messages

The values assigned to the variables defined in the file are given only as an illustration.

| (==== Message file 9960====) |                                      |
|------------------------------|--------------------------------------|
| <b>N100</b>                  | *** FIXED DRESSERS SETUP ----- OK?   |
| <b>N101</b>                  | Y ORIGIN: MOVE WHEEL ON DIAMOND 1    |
| <b>N102</b>                  | Z ORIGIN: MOVE WHEEL ON DIAMOND 1    |
| <b>N103</b>                  | Y ORIGIN: MOVE WHEEL ON DIAMOND 2    |
| <b>N104</b>                  | Z ORIGIN: MOVE WHEEL ON DIAMOND 2    |
| <b>N105</b>                  | X DRESSING POSITION - MOVE X AXIS    |
| <b>N106</b>                  | *** END OF DRESSER SETUP ***         |
| <b>N107</b>                  | *** ROLLER DRESSER SETUP ----- OK?   |
| <b>N108</b>                  | MOVE ROLLER DRESSER ON THE WHEEL     |
| <b>N200</b>                  | *** PART SETUP ----- OK?             |
| <b>N201</b>                  | X ORIGIN: MOVE WHEEL ON REF. SURFACE |
| <b>N202</b>                  | Y ORIGIN: MOVE WHEEL ON REF. SURFACE |
| <b>N203</b>                  | Z ORIGIN: MOVE WHEEL ON REF. SURFACE |
| <b>N204</b>                  | INPUT X AXIS POSITION=               |
| <b>N205</b>                  | INPUT Y AXIS POSITION=               |
| <b>N206</b>                  | INPUT Z AXIS POSITION=               |
| <b>N207</b>                  | *** END OF PART SETUP ***            |
| <b>N208</b>                  |                                      |
| <b>N300</b>                  | *** WHEEL DRESSING ----- OK?         |
| <b>N301</b>                  | *** WHEEL DRESSING IN PROGRESS ***   |
| <b>N302</b>                  | *** WHEEL SHAPING ----- OK?          |
| <b>N303</b>                  | *** WHEEL SHAPING IN PROGRESS ***    |
| <b>N304</b>                  | *** MANUAL WORKING-- OK'?            |
| <b>N305</b>                  | *** MANUAL WORKING ***               |
| <b>N306</b>                  | *** AXES TO HOME POSITION -- OK?     |
| <b>N307</b>                  | *** AXES TO HOME POSITION ***        |
| <b>N308</b>                  | *** MANUAL MEASUREMENT -- OK?        |
| <b>N309</b>                  |                                      |
| <b>N310</b>                  | WARNING! MOVE Y TO SAFETY POSITION   |
| <b>N311</b>                  | COMPENS. ARE NOT NULL - RESET? (Y/N) |

|             |                                        |
|-------------|----------------------------------------|
| <b>N320</b> | >> RAPID RETRACTION <<---              |
| <b>N321</b> |                                        |
| <b>N400</b> | *** MANUAL MEASUREMENT CYCLE ***       |
| <b>N401</b> | DO YOU WANT TO MODIFY Y ORIGIN'? (Y/N) |
| <b>N402</b> | DO YOU WANT TO MODIFY Z ORIGIN'? (Y/N) |
| <b>N403</b> | *** CORRECTION VALUE :                 |
| <b>N404</b> | *** END OF MEASURING CYCLE ***         |
| <b>N405</b> | CORRECTION VALUE OUT OF LIMITS         |
| <b>N406</b> | INPUT EM WITH VALUE 0, NOT CORRECTION! |
| <b>N500</b> | *CORRECTION DIAMOND*                   |
| <b>N501</b> | CORRECTION DIAMOND 1? Y/N              |
| <b>N502</b> | CORRECTION VALUE AXIS Y:               |
| <b>N503</b> | CORRECTION VALUE AXIS Z:               |
| <b>N505</b> | CORRECTION DIAMOND 2? Y/N              |
| <b>N506</b> | CORRECTION AXIS Y? Y/N                 |
| <b>N507</b> | CORRECTION AXIS Z? Y/N                 |
| <b>N508</b> | CORRECTION VALUE TOO BIG!!!            |
| <b>N509</b> | MODIF. DIAMOND RADIUS 1? Y/N           |
| <b>N510</b> | MODIF. DIAMOND RADIUS 2? Y/N           |
| <b>N511</b> | DIAMOND RADIUS:                        |
| <b>N512</b> | ACTIVE DIAMOND RADIUS:                 |
| <b>N513</b> | ACTIVE CORRECTION Y:                   |
| <b>N514</b> | ACTIVE CORRECTION Z:                   |
| <b>N550</b> |                                        |
| <b>N551</b> | GS OPTION NOT ENABLED BIT 241          |

## A.4 Cycle Error messages

The lists below contain the messages returned in case of programming errors.

The messages are defined for:

- Wheel dressing and part measurement,
- Surface grinding cycles.

### A.4.1 Wheel dressing and workpiece measuring errors

|              |                                                                                     |
|--------------|-------------------------------------------------------------------------------------|
| <b>N5301</b> | DRESSER SETUP NOT EXECUTED                                                          |
| <b>N5302</b> | PART SETUP NOT EXECUTED                                                             |
| <b>N5303</b> | WHEEL NUMBER ERROR                                                                  |
| <b>N5304</b> | MACHINE DATA ERROR                                                                  |
| <b>N5305</b> | MACHINE MODE NOT EXECUTED                                                           |
| <b>N5306</b> | PART COMPENSATION ERROR                                                             |
| <b>N5307</b> | PROFILE DESCRIPTION NOT SELECTED, [WD(142) DEFINED 0 or 1"                          |
| <b>N5308</b> | CORRECTION VALUE OUT OF LIMITS                                                      |
| <b>N5309</b> | MEASURE OUT OF RANGE                                                                |
| <b>N5310</b> | WHEEL LEFT SIDE NOT SHAPED                                                          |
| <b>N5311</b> | WHEEL RIGHT SIDE NOT SHAPED                                                         |
| <b>N5312</b> | The Face Shaping Feedrate in the wheel files Shaping block must be greater than 0   |
| <b>N5313</b> | The Side Shaping Feedrate in the wheel files Shaping block must be greater than 0   |
| <b>N5314</b> | The Course Face Feedrate in the wheel files Dressing Block must be greater than 0   |
| <b>N5315</b> | The Course Side Feedrate in the wheel files Dressing Block must be greater than 0   |
| <b>N5316</b> | The Fine Face Feedrate in the wheel files Dressing Block must be greater than 0     |
| <b>N5317</b> | The Fine Side Feedrate in the wheel files Dressing Block must be greater than 0     |
| <b>N5318</b> | The Sparkout Face Feedrate in the wheel files Dressing Block must be greater than 0 |
| <b>N5319</b> | The Sparkout Side Feedrate in the wheel files Dressing Block must be greater than 0 |
| <b>N5320</b> | WORKING WHEEL SIDE CODE NOT PROGRAMMED                                              |
| <b>N5340</b> | WHEEL GEOMETRICAL ERROR                                                             |
| <b>N5341</b> | WHEEL DRESSING ERROR                                                                |
| <b>N5342</b> | WHEEL SHAPING ERROR                                                                 |

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## A.4.2 Grinding cycle errors

|              |                                                                  |
|--------------|------------------------------------------------------------------|
| <b>N5350</b> | Y: final position missing                                        |
| <b>N5351</b> | X: first return position missing                                 |
| <b>N5352</b> | EX: second return position missing                               |
| <b>N5353</b> | EP: start offset not programmed                                  |
| <b>N5354</b> | EH: wrong safety plane $EH < Y$                                  |
| <b>N5356</b> | X and EX have the same value                                     |
| <b>N5357</b> | TxM6: the active tool is not the initialised one                 |
| <b>N5358</b> | Z: first Z position missing                                      |
| <b>N5359</b> | EZ: second Z position missing                                    |
| <b>N5360</b> | EE: Increment in Z not programmed or $\leq 0$                    |
| <b>N5362</b> | EC: plunging mode wrong value [0,1]                              |
| <b>N5363</b> | F: traverse speed not programmed or 0                            |
| <b>N5364</b> | F: plunge feed not programmed                                    |
| <b>N5365</b> | EF: feed rate in Z not programmed                                |
| <b>N5366</b> | Z and EZ have the same value                                     |
| <b>N5372</b> | EI/EJ: increment not programmed or zero                          |
| <b>N5373</b> | ED: invalid part dressing                                        |
| <b>N5374</b> | EG: invalid measurement mode                                     |
| <b>N5375</b> | EB: invalid value                                                |
| <b>N5376</b> | S: cutting speed not programmed                                  |
| <b>N5377</b> | Max rotation speed exceeded                                      |
| <b>N5378</b> | EM: PREF modification has wrong value                            |
| <b>N5380</b> | Part setup not executed                                          |
| <b>N5381</b> | Dressing setup not executed                                      |
| <b>N5390</b> | Error of Cycle, End of Cycle not programmed                      |
| <b>N5392</b> | Modification cutting speed only with cycle G230 Sxx              |
| <b>N5393</b> | GS Option Not Enabled (Bit 242)                                  |
| <b>N5394</b> | SLOT CYCLE: One of either EI or EJ must be Infeed                |
| <b>N5395</b> | SLOT CYCLE: EI and EJ cannot be a negative number                |
| <b>N5396</b> | SLOT CYCLE: Z Index - Distance between slots not programmed or 0 |
| <b>N5397</b> | SLOT CYCLE: Z Index - Number of Slots not programmed or 0        |

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