

**Milling of End Face – Course: Techniques for Machining of Material.  
Instruction Examples for Practical Vocational Training**



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# Milling of End Face – Course: Techniques for Machining of Material. Instruction Examples for Practical Vocational Training

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## Introduction

This manual features four selected instruction examples concerning the application and consolidation of the knowledge required for milling end faces.

The necessary materials, tools, measuring, testing and accessory means have been cited for each instruction example in order to facilitate preparations and the actual operations.

In the instruction examples 1 to 4 the steel has been designated in accordance with the tensile strength value in the unit "Megapascal" (MPa).

Basic knowledge requirements which are needed in addition to skills in milling end faces have also been indicated.

We recommend a recapitulation of the said basic knowledge prior to commencing work operations.

Explanations in respect of the working drawings precede the given sequence of operations. The sequence of operations in point incorporates the sequence of steps for yielding a commensurate workpiece. Moreover, this sequence must be adhered to in order to attain sound quality.

Each instruction example is accompanied by a working drawing which indicates the desired shape and dimensions of the work-piece. The admissible deviations for dimensions without tolerance parameters may be taken from the table below:

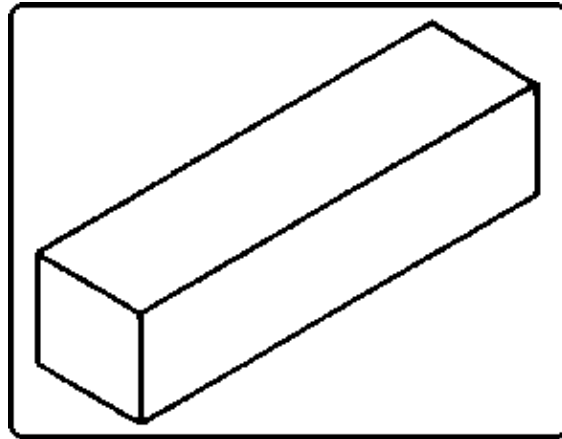
<b>Nominal size</b>	<b>Admissible deviation (in mm)</b>
0.5 – 6	± 0.1
6 – 30	± 0.2
30 – 120	± 0.3
120 – 315	± 0.5

### Instruction example 3.1. Backing material

End face milling is practised on the horizontal milling machine when turning out backing material.

#### Material

Steel 50 (mild steel with 500 MPa tensile strength)



#### Dimensions

280 x 80 x 80

#### Machine tool

Horizontal milling machine

#### Tools

End face mill, stub cutter arbor (short), machine vice, tongues for machine vice, chucking screws, chucking wrench, flat file, try square.

#### Measuring and testing tools

Vernier caliper, thickness gauge

#### Accessories

Stop, chip brush/hand broom, rags. T-slot cleaners

#### Required previous knowledge

Reading of drawings, measuring and testing, setting-up and operating horizontal and vertical milling machines.

#### Explanations to the working drawing

Rz 20: average roughness of the surface machined = 20  $\mu$ m (0.020 mm)

?	0.10/100	: maximum positional deviation from squareness = 0.10 mm over 100 mm length
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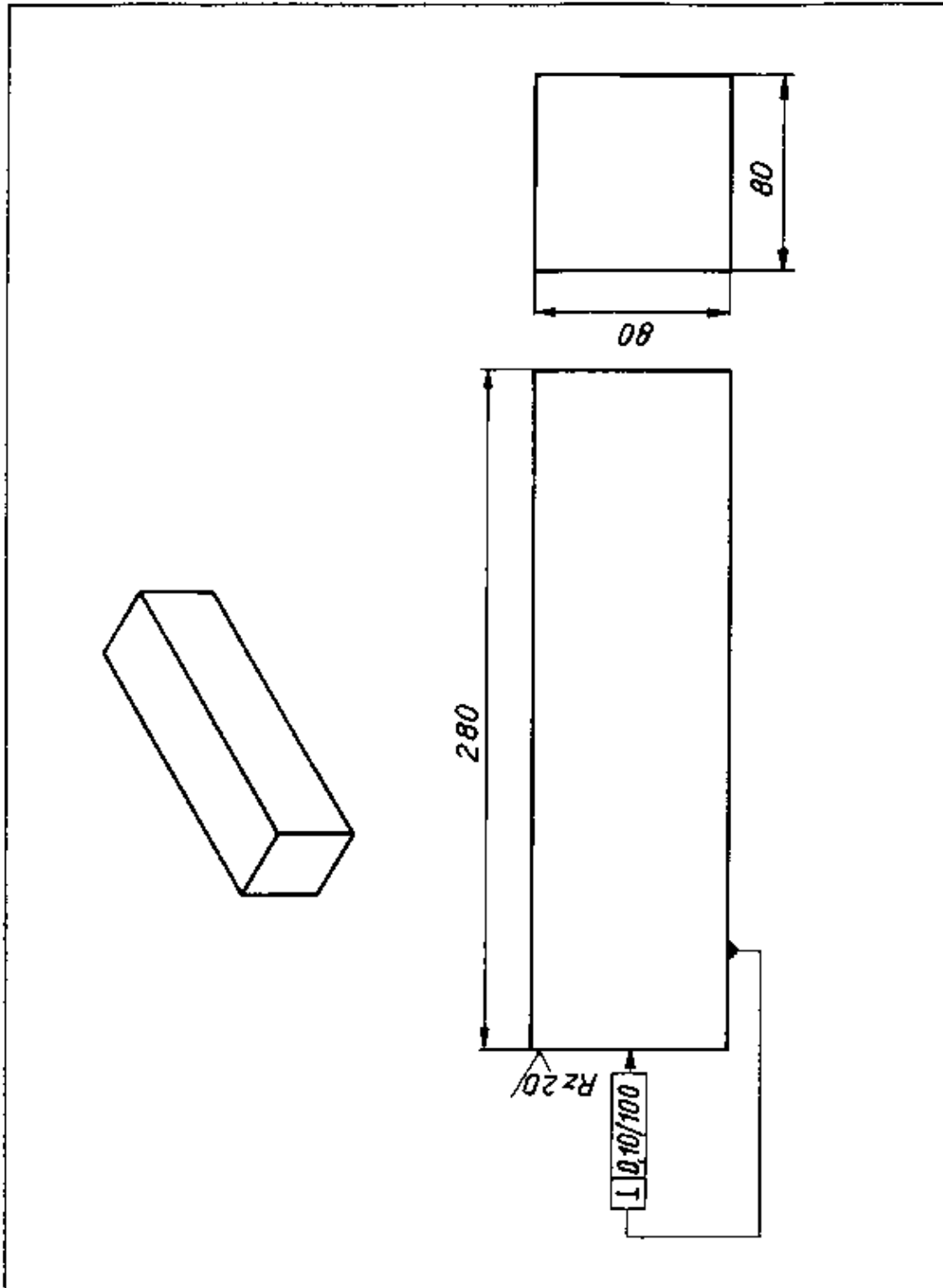
#### **Sequence of operations**

1. Batch-quantity control and rough dimensions.
2. Functional test and milling machine lubrication.

#### **Remarks**

Comparison with work accompanying data sheets.  
Lubrication, oil level control according to lubrication plan.

- |  |  |
|--|--|
| 3. Clamping and alignment of the machine vice on the machine table.  | Chuck the machine vice longitudinally on the machine table with tongues (align).   |
| 4. Clamping the end face mill on the stub collar arbor and clamping in the milling spindle of the milling machine,                 | A hard metal-tipped milling head is also possible.   |
| 5. Setting-up the coolant unit and the milling protective device.  | When using milling tools of super high-speed steel (SHSS) cooling must ensue during milling (if workpieces are of steel).  |
| 6. Clamping the workpiece in the machine vice and clamping a stop to positionally fix the workpiece in its longitudinal direction. | Ensure cleanliness and burr-freeness of the workpiece. Stop ensures the uniform positioning of the workpiece .   |
| 7. Setting the cutting values (rotational speed and rate of feed) on the milling machine.  | Derive values from the nomogram or calculate them.   |
| 8. Position the workpiece for processing.  | Knee, saddle and machine table should be set in the X-Y-Z rapid traverse in the processing position.   |
| 9. Scratching with the rotating miller on the workpiece surface (end face) and adjusting the milling depth (about 2 – 2.5 mm).     | Scratching ensues by means of the manual adjustment of the saddle.   |
| 10. Rough milling of the end face utilising the coolant.   | The coolant jet shall be aimed directly at the chip removal point,   |
| 11. Dimensional control (longitudinal dimension 280 mm), setting the final value and final end face milling.                       | After final milling – prior to rapid traverse reverse –set the scale to zero to mill the other workpieces according to "position".   |
| 12. Unclamping, deburring and cleaning the workpiece.  | Risk of accident if damaged file handles are used.   |
| 13. Controlling the dimensions and surface condition (roughness) of the end face.  | Careful handling of measuring and testing means is necessary, Correction in case of deviations of the required dimensions and angularity to be undertaken on the workpiece clamping means, |
| 14. Continue milling the end face alongside constant control of the processed workpieces.  | In case of deviation from the given surface quality the rate of feed shall be reduced or the miller exchanged.   |
| 15. Terminate the work assignment and move the workpiece on to the next processing stage, clean the workplace.                     | Only move the workpieces on in a controlled and clean condition.   |



				3.1.
	Backing material			3303

Backing material

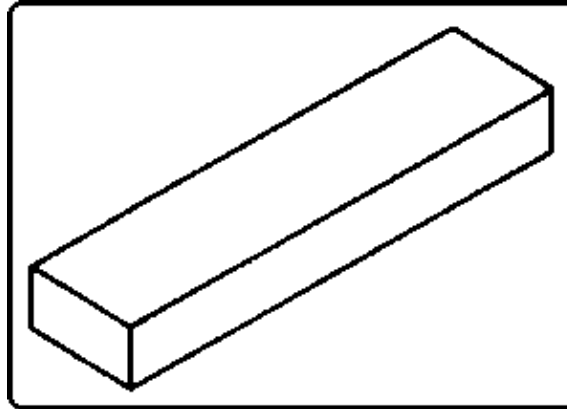
### Instruction example 3.2. Strip

The trainees practise the milling of two end faces (one after the other) whilst turning out a strip on a horizontal milling machine.



## Material

C 35 (high temperature-resistant steel with a tensile strength of 500 to 650 MPa)



## Dimensions

540 x 80 x 22

## Machine tool

Horizontal milling machine

## Tools

Milling bed, stop strip, chucking screws, clamp, chucking supports, chucking wrench, flat file

## Measuring and testing tools

Vernier caliper, bevelled edge square, thickness gauge, dial gauge with stand

## Accessories

Chip brush, hand broom, rags, chip catch. T-slot cleaners, stop for longitudinal measure

## Required previous knowledge

Reading of drawings, measuring and testing, setting-up and operating horizontal and vertical milling machines

## Explanations to the working drawing

Rz 20: average roughness of end faces = 20  $\mu$ m (0.020 mm)

?	0.05/100	: maximum positional deviation from squareness = 0.05 mm over 100 mm length
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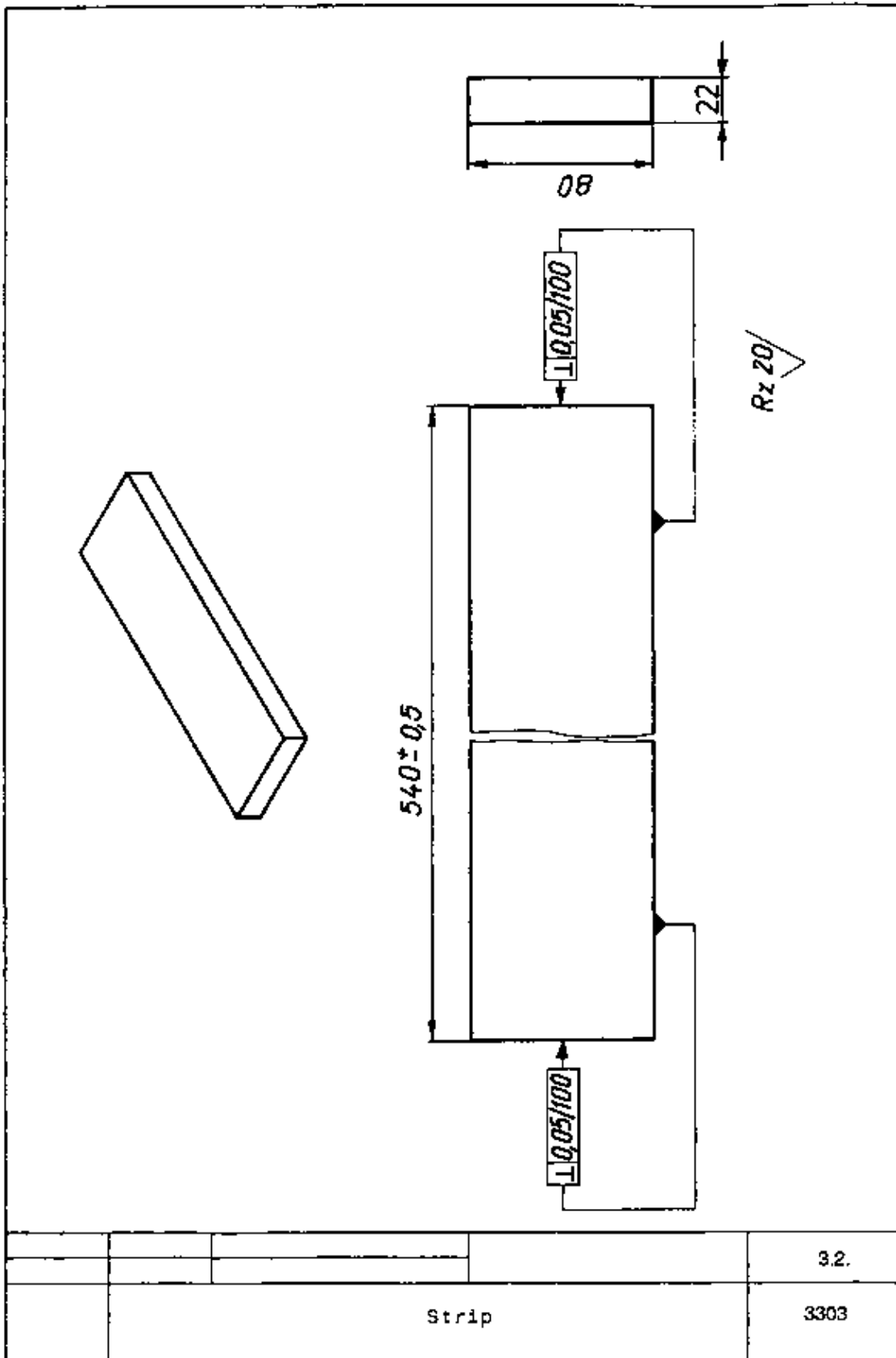
540  $\pm$  0.5: admissible deviation from length (tolerance range 539.5 – 540.5 mm)

## **Sequence of operations**

## **Remarks**

- |  |   |
|--|---|
| 1. Check batch-quantity and rough dimensions.                                  | Comparison with work accompanying data sheets.  |
| 2. Functional test and milling machine lubrication,                            | Lubrication, oil level control according to lubrication plan  |
| 3. Clamping and alignment of the stop strip on the machine table (transverse). | Alignment with a dial gauge (maximum deviation 0.03 mm on the length of the stop strip).<br>Heed cleanliness when clamping. |

- |   |  |
|---|--|
| 4. Clamping the milling head on the stub cutter arbor and clamping in the milling spindle of the milling machine.                     |  |
| 5. Clamping the workpiece to the machine table.   | Workpiece must nudge directly to the stop strip. Heed clean bearing and supporting surfaces.   |
| 6. Clamp the workpiece longitudinal stop.   | Stop is fixed to the opposite end face.  |
| 7. Set the cutting values (rotational speed and rate of feed).  |  |
| 8. Position the milling protective device and set up the chip catch.  | Danger of eye injuries through flying chips.   |
| 9. Position the workpiece for processing, scratch the workpiece surface and set the cutting depth for rough milling.                  | Proceed in X–Y–Z directions in rapid traverse (scratching ensues through manual setting).  |
| 10. Rough milling of the first end face, dimensional inspection, adjust the remainder (size 542) and complete first end face milling. | Heed admeasure for the second end face.  |
| 11. Chuck, deburr the cutting edges and clean the workpiece.  | Wear protective gloves to avoid accidents when handling sharp–edged workpieces.  |
| 12. Check the size accuracy, angularity and surface properties (roughness) of the first end face.                                     | Check the angle deviation (light slit) with the bevelled edge square and the thickness gauge. If the admissible deviation is exceeded stop strip realignment becomes necessary. The plane surface of the work–piece must be milled again (about 0.3 mm milling depth). |
| 13. Continue milling the first end face.  | Milling according to "position" and constant control of attained quality necessary. Ensure cleanliness of the bearing and supporting surfaces during all workpiece exchanges.  |
| 14. Reset the workpieces and mill the second end face to end size $540 \pm 0.5$ mm.   | Milling to end size also ensues according to "position" (zero position of the saddle scale).   |
| 15. Terminate the work assignment and move the workpiece on to the next processing stage, clean the workplace.                        | Only move the workpieces on in a controlled and clean condition.   |



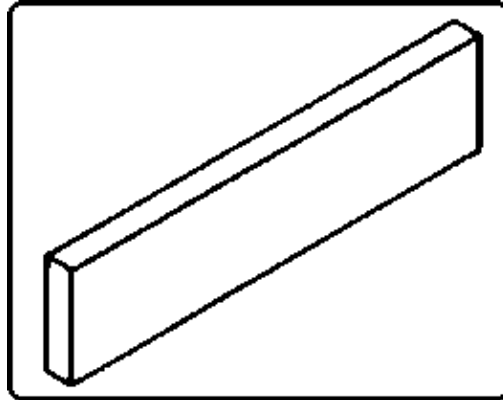
Strip

### Instruction example 3.3. Cover plate

Multi-piece clamping (package clamping) is employed in the machine vice for exercising milling of end faces with the milling head.

Material

19 Mn 3 (mild steel, low–alloyed, tensile strength 470 MPa)



Dimensions

240 x 60 x 14

Machine tool

Horizontal milling machine

Tools

Milling head, machine vice, chucking screws, chucking wrench, tongues, flat file

Measuring and testing tools

Vernier caliper, bevelled edge square, thickness gauge

Accessories

Chip brush, hand broom, rags, chip catch, T–slot cleaners, stop for longitudinal measure

Required previous knowledge

Reading of drawings, measuring and testing, setting–up and operating horizontal and vertical milling machines

Explanations to the working drawing

Rz 10: average roughness of end faces = 10 μm (0.010 mm)

?	0.05/100	: maximum positional deviation from squareness = 0.05 mm over 100 mm length
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$240^{-0.3}$  : admissible deviation from length (tolerance range 239.7 – 240.0 mm)

**Sequence of operations**

**Remarks**

- |   |  |
|---|--|
| <ol style="list-style-type: none"> <li>1. Control batch–quantity and rough dimensions.</li> <li>2. Functional test and milling machine lubrication.</li> <li>3. Clamping and alignment of the machine vice (lengthwise).</li> <li>4. Clamping the milling head on the stub arbor collar and clamping to the milling spindle of the milling</li> </ol> | <p>Comparison with work accompanying data sheets,</p> <p>Lubrication and oil level control according to lubrication plan.</p> <p>Alignment of the machine vice with tongues.</p> |
|---|--|

machine.

5. Clamping of 10 workpieces edgewise in the machine vice (package chucking).

Workpieces must be clean and deburred and aligned to a longitudinal stop (stop must be aligned in a longitudinal direction).

6. Setting the cutting values, position workpieces in processing readiness and align the milling protective device, set up the chip catch.

Derive cutting values from the nomogram, position the workpieces in rapid traverse in X–Y–Z direction.

7. Scratching, rough milling of the first end face, dimensional inspection, adjust and final milling to size 242 mm.

Heed size for the second end face (zero position on the saddle scale).

8. Unclamp, deburr and clean the workpieces of the first package, dimensional inspection, angularity and surface controls.

Check angularity with the bevelled edge square and the thickness gauge (light slit method).

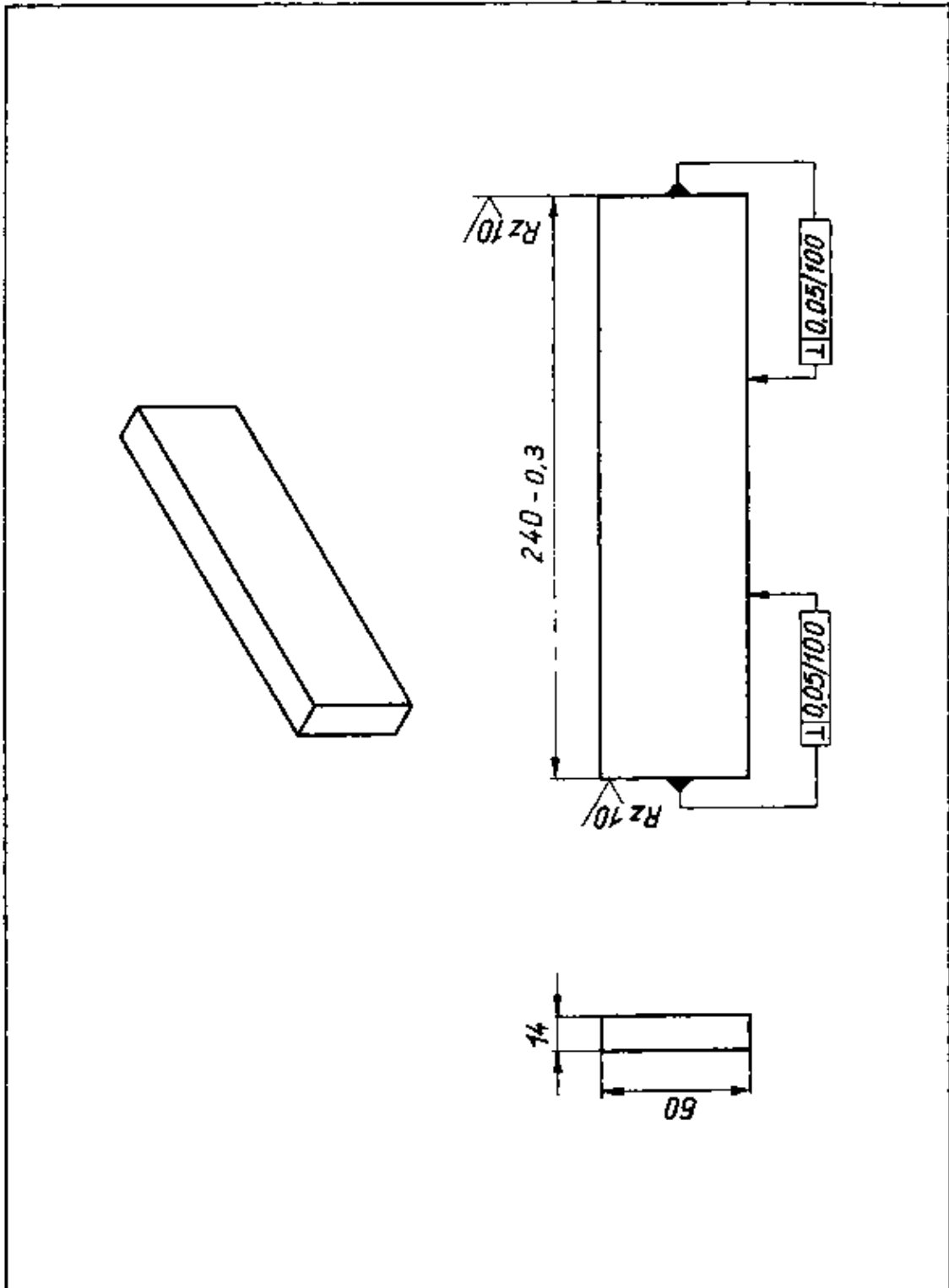
9. Mill the first end face of the remaining workpieces.

Undertake constant size and angle controls. Mill according to "position".  
Take care when unclamping and deburring – danger of accidents from burrs at the cutting edges.

10. Reset the workpieces and mill the second end face to finished size 240 – 0.3 mm.

Mill according to "position". Ensure a clean workpiece support in the machine vice and proper bearing at the longitudinal stop.

11. Terminate the work assignment and move the workpieces on to the next processing stage, clean the workplace.



				3.3.
			Cover plate	3303

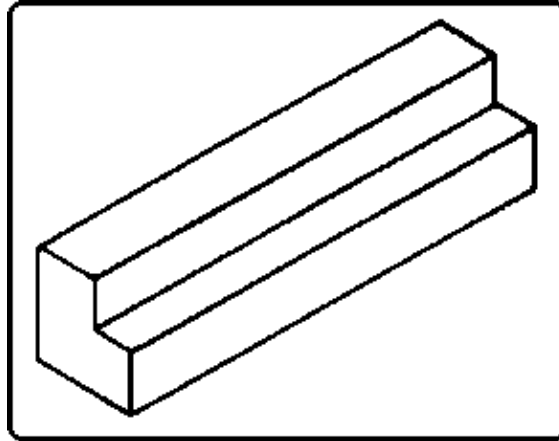
Cover plate

### Instruction example 3.4. Elbow

The milling of end faces is exercised by employing a gang cutter on a horizontal milling machine.

## Material

GGL 25 (250 MPa tensile strength, 1000 MPa compressive strength, unalloyed with lamina graphite)



## Dimensions

225 x 50 x 48

## Machine tool

Horizontal milling machine

## Tools

Two cylindrical cutters (gang cutters, hard metal tipped or of super high-speed steel), machine vice, chucking screws, chucking wrench, tongues, flat file

## Measuring and testing means

Vernier caliper, bevelled edge square, thickness gauge

## Required previous knowledge

Reading of drawings, measuring and testing, setting-up and operating horizontal and vertical milling machines

## Explanations to the working drawing

Rz 10: average roughness of end faces = 10  $\mu$ m (0.010 mm)

?	0.03/50	: maximum positional deviation from squareness = 0.03 mm over 50 mm length
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225  $\pm$  0.2: admissible deviation from length (tolerance range 224.8 – 225.2 mm)

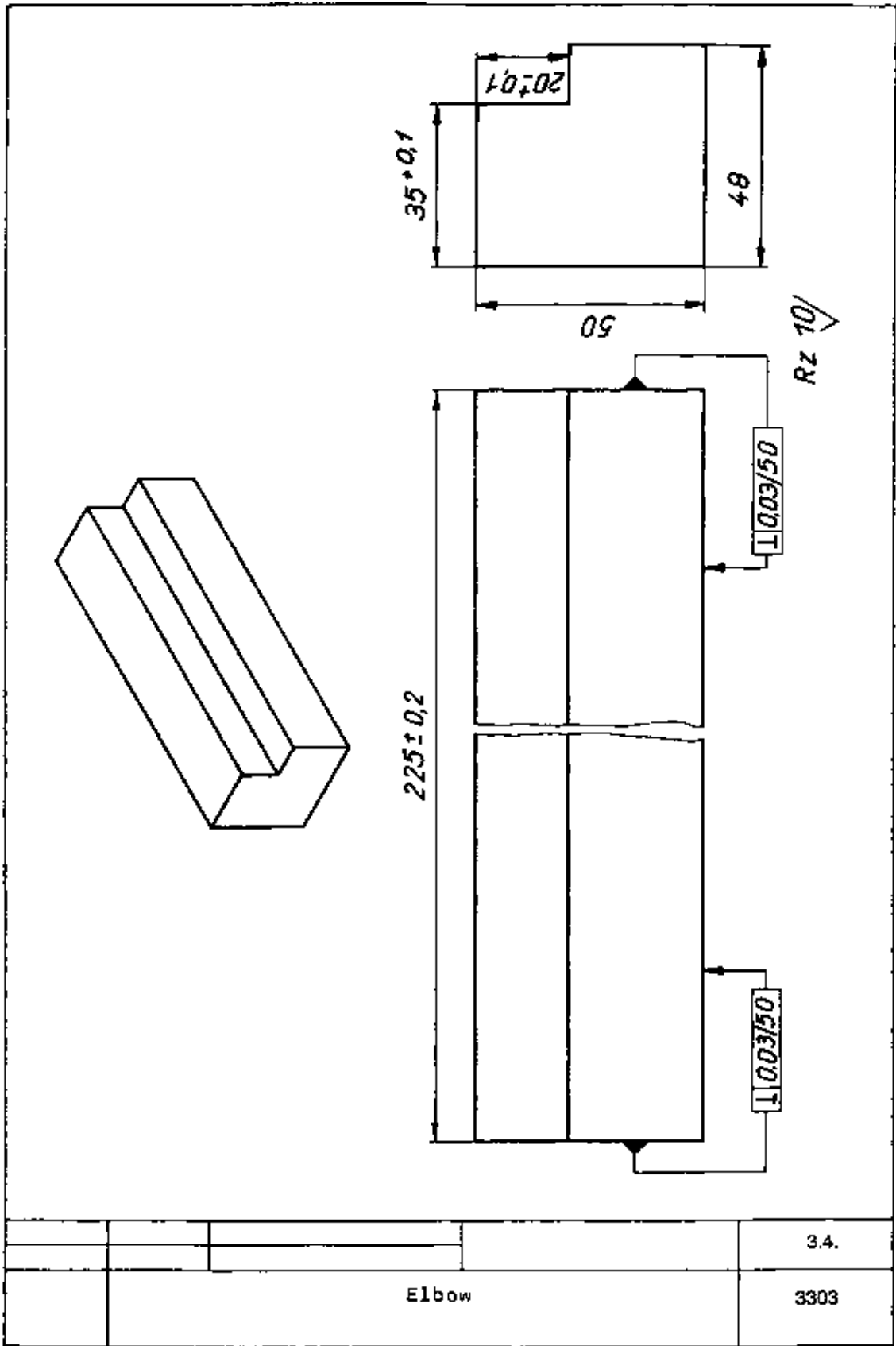
## **Sequence of operations**

## **Remarks**

- |  |   |
|--|---|
| 1. Check batch-quantity and rough dimensions.  | Comparison with work accompanying data sheets.                                  |
| 2. Functional test and milling machine lubrication.  | Lubrication, oil level control according to lubrication plan.                   |
| 3. Clamping and alignment of the machine vice (lengthwise).  | Alignment of the machine vice with tongues and the dial gauge to 0.03 accuracy. |
| 4. Clamping and setting of the cylindrical cutter to the gang cutter (internal distance 225 $\pm$ 2 mm). | Distance 225 $\pm$ 2 is attained by means of the cutter arbor and spacers.      |

- |  |   |
|--|---|
| 5. Setting the cutting values, positioning the workpieces and the milling protective device, control the longitudinal dimension $225 \pm 0.2$ mm and the angularity. | Derive cutting values from the nomogram, position the workpieces in rapid traverse in X–Y–Z direction.  |
| 6. Clamp test piece (left over or waste material) and undertake test cut, control longitudinal dimension $225 \pm 0.2$ mm and the angularity.                        | Given deviations from the final size. correct by removing or adding spacers. Control angularity with the bevelled edge square and the thickness gauge.  |
| 7. Clamp at least two workpieces to mill both end faces to finished size in one operation and end face milling.  | The number of workpieces to be simultaneously clamped depends on the maximum clamping width of the machine vice. Uniform positioning of the workpieces in the machine vice by employing a movable stop piece (i.e. a parallel piece is positioned to the processed side surface of the vice – workpieces are positioned to the parallel piece). |
| 8. Unclamp, clean, control dimensional angle and surface.  | Control angularity of the end faces in respect of all longitudinal sides,   |
| 9. Continue milling of end faces in conjunction with regular quality controls.   | Pay attention to cleanliness when clamping the workpieces. Avoid surface damage through chips between the workpieces.   |
| 10. Terminate the work assignment and move the workpieces on to the next processing stage, clean the workplace.  | Clean both the machine and the workplace but do not use compressed air – danger of eye injuries.  |





Elbow

