# OPERATING MANUAL
# FORM KNURLING TOOL RD1
# 130 / 131 / 132

Please read this operating manual carefully. Correct assembly and handling of the tool will save you set-up time and allow you to achieve optimal results.

KNURLING PROFILES AND PRODUCTION PROCESS

| Series 130 / 131 / 132 | |
|---|---|
| Machining direction | Knurling profiles on the workpiece: RAA \| RBL \| RBR \| RGE \| RGV \| RKE \| RKV |
| radial | Selection of knurling wheels: AA \| BR \| BL \| GV \| GE \| KV \| KE |
| radial and axial | Selection of knurling wheels: AA \| BR \| BL \| – \| – \| – \| – |

Table 1: Knurling profiles

**Ordering spare parts:**

Please specify the tool number and the corresponding position number (see Fig. 1 – 3).

Series 130

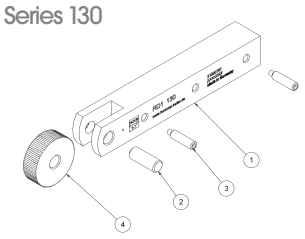


Fig. 1: Series 130 exploded drawing

Series 131

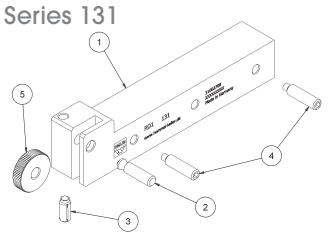


Fig. 2: Series 131 exploded drawing

Series 132

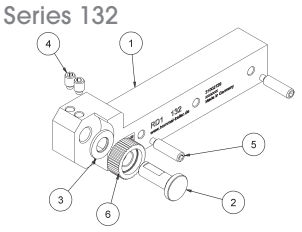


Fig. 3: Series 132 exploded drawing

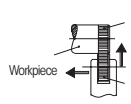
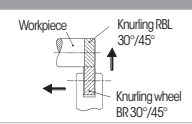
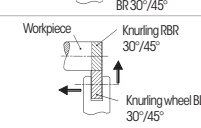
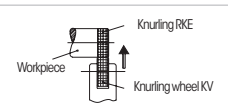
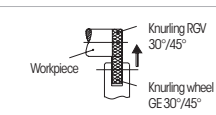
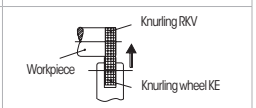
| Knurling profile | Manufacturing process | Knurling profile | Manufacturing process |
|---|---|---|---|
| RAA knurl with straight pattern |   | RBL left-hand knurl 30°/45° |   |
| | | RBR right-hand knurl 30°/45° |   |
| RGE left-hand/ right-hand knurling, Raised points, 30°/45° |   | RKE cross knurl, raised points, 90 ° |   |
| RGV left-hand/ right-hand knurling, lowered points, 30°/45° |   | RKV cross knurl, lowered points, 90° |   |

Table 2: Manufacturing process

## 1. Setting the centre height

Tool series 130: The centre height corresponds to the shaft centre of the tool holder (Fig. 1, Pos. 1)
Tool series 131 / 132: The centre height corresponds to the upper edge of the shank of the tool holder (Fig. 2, Fig. 3, Pos. 1)

## 2. Assembly of the knurling wheel with ClickPin system

TOOL SETTING

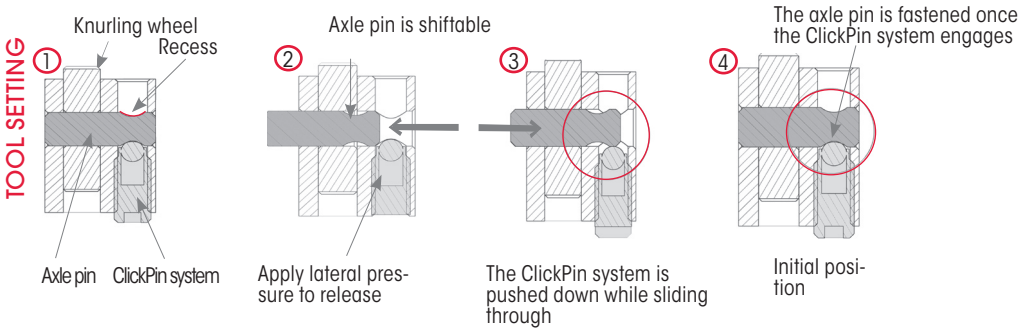



Fig. 4: ClickPin system

Please note: It is not necessary to release the ClickPin system when changing the axle pin!

## 3. Clamping position of tool

Clamp the tool at an angle of 90° to the workpiece for a radial machining direction (Fig. 5).

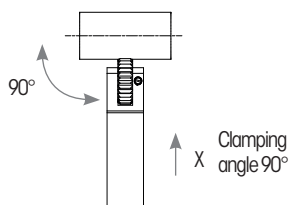



Fig. 5: Radial machining direction

## 4. Setting the clearance angle

In order to guarantee a better material flow during axial machining, correct the clearance angle of the knurling holder with the threaded pin in the shank (Fig. 1, Pos. 3; Fig. 2, Pos. 4; Fig. 3, Pos. 5) by 1-2° (Fig. 6). This depends on the materials to be machined or application problems which may arise.

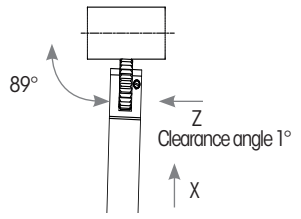



Fig. 6: Radial and axial machining direction

APPLICATION

## 5. Setting the profile depth

The profile depth is set by moving in the X direction and corresponds to approximately the half pitch p (with 90° flank angle), (Fig. 8). After reaching the depth, the dwell time of the tool should be between 3 and 10 revolutions of the workpiece. Then disengage the tool while the spindle is rotating. The profile is completely formed when the tooth tips are closed (Fig. 8, ref. 1). A new setting takes place when the profile is not completely formed (Fig. 8, ref. 2). Running into the profile again is possible, because the knurling wheel catches in the existing profile.

$$\text{Setting the profile depth} = \frac{\text{pitch}}{2} \quad \text{(with 90° flank angle)}$$

Note:
Guidelines for calculation of the material distortion are provided in Tables 5 – 7, chapter 10. This depends on the knurling profile, workpiece diameter and pitch.

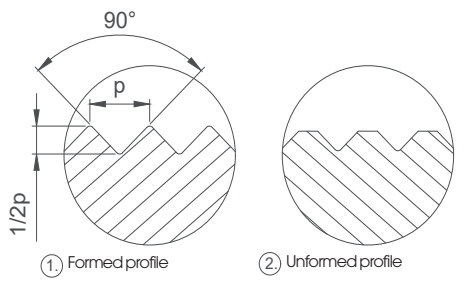



Fig. 8: Different profile pattern

## 6. Feed rate in Z direction

With axial knurling, first set the component in the X-direction (see chapter 5, Setting the profile depth). Then move in the Z-direction until the desired knurl width is achieved. Guideline values for feed rate and cutting speed, please refer to Table 4, chapter 9.

## 7. Manufacturer's recommendation

Replace the axle pin (Fig. 1, pos. 2 / Fig. 2, Pos. 2) or collar stud (Fig. 3, Pos. 2) and race (Fig. 3, pos. 3) and ClickPin system (Fig. 2, Pos. 3) after a reasonable number of cycles, no later than upon appearance of significant wear or deviating process parameters. Inspect the slot of the base holder for wear and widening. An adequate flow of coolant or cutting oil is recommended!

## 8. Troubleshooting

IMPORTANT

| Problem: | Reason / Cause: | Solution: |
|---|---|---|
| The profile is not completely formed, surface on the tooth tip | The profile depth setting is not correct | Adjust setting (see chapter 5, Setting the profile depth) |
| The profile has a double knurling | – Feed rate incorrect<br>– Profile depth too large<br>– Dwell time in the engagement too long | – Adjust feed rate as specified in chapter 9<br>– Adjust setting as specified in chapter 5<br>– Dwell time should be between 3 and 10 revolutions of the workpiece |
| Irregular profile form | | |
| – On the diameter | – Deficient concentricity of the workpiece<br>– Bending of the workpiece due to excessive projection | – Turn workpiece diameter<br>– Check extension length and clamping pressure<br>– Correct the clearance angle as specified in chapter 4 |
| Spangle collets on the profile | – Dwell time of the tool in the engagement too long<br>– Tooth pitch does not reach the workpiece | – Dwell time should be between 3 and 10 revolutions of the workpiece<br>– Adjust cutting data as specified in chapter 9<br>– Adjust rough turn diameter and / or pitch |
| Excessive material distortion at knurling end (axial) | – Feed rate value incorrect<br>– Profile depth is not correct<br>– Clearance angle is not correct | – Adjust feed rate as specified in chapter 9<br>– Adjust setting as specified in chapter 5<br>– Correct the clearance angle as specified in chapter 5 |
| Spirals are formed in the profile | – Workpiece deflects<br>– Clearance angle is not correct<br>– Feed rate value too high<br>– Incorrect centre height | – Check extension length / support workpiece<br>– Correct the clearance angle as specified in chapter 4<br>– Observe cutting data as specified in chapter 9<br>– Correct centre height |
| – Overpressure on the profile<br>– Diameter reduction at the beginning of the knurling | – Depth adjustment too high<br>– Incorrect approach position / setting outside of the workpiece | – Adjust setting as specified in chapter 5<br>– Setting must take place in the component (observe chapter 5) |
| The finished diameter of the workpiece is too small | – Various material influences<br>– Incorrect rough turn diameter | – Observe guidelines for the material distortion as specified in chapter 10<br>– Adjust rough turn diameter |

Table 3: Troubleshooting

## 9. Guidelines for cutting speed and feed rate

| Material | Workpiece Ø [mm] | Knurling wheel Ø [mm] | Vc [m/min] | | f [mm/U] | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Radial | | Axial | | | |
| | | | | | | | Pitch [mm] | | | |
| | | | from | to | from | to | > 0.3 < 0.5 | > 0.5 < 1.0 | > 1.0 < 1.5 | > 1.5 < 2.0 |
| Free-cutting steel | < 10 | 10/15 | 20 | 50 | 0.04 | 0.08 | 0.14 | 0.09 | 0.06 | 0.05 |
| | 10 – 40 | 15/20 | 25 | 55 | 0.05 | 0.10 | 0.20 | 0.13 | 0.10 | 0.07 |
| | 40 – 100 | 20/25 | 30 | 60 | 0.05 | 0.10 | 0.25 | 0.18 | 0.12 | 0.08 |
| | 100 – 250 | 20/25 | 30 | 60 | 0.05 | 0.10 | 0.30 | 0.20 | 0.13 | 0.09 |
| | > 250 | 25 | 30 | 60 | 0.05 | 0.10 | 0.32 | 0.21 | 0.14 | 0.10 |
| Stainless steel | < 10 | 10/15 | 15 | 40 | 0.04 | 0.08 | 0.12 | 0.08 | 0.05 | 0.04 |
| | 10 – 40 | 15/20 | 20 | 50 | 0.05 | 0.10 | 0.17 | 0.11 | 0.09 | 0.06 |
| | 40 – 100 | 20/25 | 25 | 50 | 0.05 | 0.10 | 0.21 | 0.15 | 0.10 | 0.07 |
| | 100 – 250 | 20/25 | 25 | 50 | 0.05 | 0.10 | 0.26 | 0.17 | 0.11 | 0.08 |
| | > 250 | 25 | 25 | 50 | 0.05 | 0.10 | 0.27 | 0.18 | 0.12 | 0.09 |
| Brass | < 10 | 10/15 | 30 | 75 | 0.04 | 0.08 | 0.15 | 0.09 | 0.06 | 0.05 |
| | 10 – 40 | 15/20 | 40 | 85 | 0.05 | 0.10 | 0.21 | 0.14 | 0.11 | 0.07 |
| | 40 – 100 | 20/25 | 45 | 90 | 0.05 | 0.10 | 0.26 | 0.19 | 0.13 | 0.08 |
| | 100 – 250 | 20/25 | 45 | 90 | 0.05 | 0.10 | 0.32 | 0.21 | 0.14 | 0.09 |
| | > 250 | 25 | 45 | 90 | 0.05 | 0.10 | 0.34 | 0.22 | 0.15 | 0.11 |
| Aluminium | < 10 | 10/15 | 25 | 60 | 0.04 | 0.08 | 0.18 | 0.11 | 0.08 | 0.06 |
| | 10 – 40 | 15/20 | 30 | 65 | 0.05 | 0.10 | 0.25 | 0.16 | 0.13 | 0.09 |
| | 40 – 100 | 20/25 | 35 | 70 | 0.05 | 0.10 | 0.31 | 0.23 | 0.15 | 0.10 |
| | 100 – 250 | 20/25 | 35 | 70 | 0.05 | 0.10 | 0.38 | 0.25 | 0.16 | 0.11 |
| | > 250 | 25 | 35 | 70 | 0.05 | 0.10 | 0.40 | 0.26 | 0.18 | 0.13 |

Table 4: Cutting speed and feed rate

## 10. Material distortion

| Pitch [mm] | | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 1.0 | 1.2 | 1.5 | 1.6 | 2.0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Material | Workpiece Ø [mm] | Enlargement of workpiece diameter in mm | | | | | | | | | | |
| Free-cutting steel | 5 | 0.08 | 0.14 | 0.18 | 0.22 | 0.27 | 0.29 | 0.35 | 0.50 | – | – | – |
| | 15 | 0.08 | 0.14 | 0.18 | 0.23 | 0.30 | 0.40 | 0.44 | 0.50 | 0.60 | 0.65 | 0.70 |
| | 25 | 0.08 | 0.15 | 0.23 | 0.24 | 0.28 | 0.35 | 0.44 | 0.53 | 0.62 | 0.70 | 0.98 |
| Stainless steel | 5 | 0.10 | 0.15 | 0.20 | 0.25 | 0.28 | 0.30 | 0.42 | 0.41 | – | – | – |
| | 15 | 0.10 | 0.15 | 0.19 | 0.25 | 0.30 | 0.34 | 0.45 | 0.51 | 0.60 | – | – |
| | 25 | 0.10 | 0.14 | 0.20 | 0.26 | 0.31 | 0.33 | 0.43 | 0.50 | 0.62 | – | – |
| Brass | 5 | 0.08 | 0.12 | 0.18 | 0.20 | 0.21 | 0.22 | 0.25 | 0.28 | – | – | – |
| | 15 | 0.10 | 0.14 | 0.20 | 0.26 | 0.28 | 0.29 | 0.35 | 0.41 | 0.44 | 0.48 | 0.55 |
| | 25 | 0.10 | 0.15 | 0.20 | 0.25 | 0.28 | 0.30 | 0.36 | 0.43 | 0.46 | 0.50 | 0.53 |
| Aluminium | 5 | 0.09 | 0.15 | 0.19 | 0.23 | 0.28 | 0.30 | 0.41 | 0.40 | – | – | – |
| | 15 | 0.10 | 0.15 | 0.19 | 0.26 | 0.29 | 0.33 | 0.45 | 0.51 | 0.57 | 0.65 | – |
| | 25 | 0.09 | 0.15 | 0.19 | 0.26 | 0.29 | 0.32 | 0.45 | 0.52 | 0.59 | 0.65 | 0.75 |

Table 5: Knurling profile acc. to DIN82: RAA

| Pitch [mm] | | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 1.0 | 1.2 | 1.5 | 1.6 | 2.0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Material | Workpiece Ø [mm] | Enlargement of workpiece diameter in mm | | | | | | | | | | |
| Free-cutting steel | 5 | 0.11 | 0.15 | 0.20 | 0.24 | 0.28 | 0.34 | 0.45 | 0.55 | – | – | – |
| | 15 | 0.11 | 0.15 | 0.22 | 0.26 | 0.30 | 0.35 | 0.45 | 0.52 | 0.67 | 0.73 | 0.85 |
| | 25 | 0.11 | 0.14 | 0.23 | 0.25 | 0.28 | 0.36 | 0.45 | 0.56 | 0.70 | 0.72 | 0.90 |
| Stainless steel | 5 | 0.09 | 0.14 | 0.19 | 0.25 | 0.31 | 0.34 | 0.45 | 0.52 | – | – | – |
| | 15 | 0.12 | 0.20 | 0.23 | 0.31 | 0.35 | 0.40 | 0.51 | 0.62 | 0.66 | 0.73 | 0.97 |
| | 25 | 0.12 | 0.18 | 0.24 | 0.27 | 0.37 | 0.39 | 0.49 | 0.59 | 0.80 | 0.84 | 0.96 |
| Brass | 5 | 0.10 | 0.14 | 0.20 | 0.23 | 0.24 | 0.28 | 0.33 | 0.37 | – | – | – |
| | 15 | 0.10 | 0.15 | 0.21 | 0.23 | 0.24 | 0.31 | 0.41 | 0.47 | 0.53 | 0.55 | 0.63 |
| | 25 | 0.11 | 0.15 | 0.22 | 0.22 | 0.25 | 0.30 | 0.40 | 0.45 | 0.55 | 0.61 | 0.68 |
| Aluminium | 5 | 0.12 | 0.14 | 0.21 | 0.24 | 0.29 | 0.34 | 0.41 | 0.51 | – | – | – |
| | 15 | 0.12 | 0.18 | 0.23 | 0.26 | 0.36 | 0.40 | 0.50 | 0.56 | 0.56 | 0.61 | 0.75 |
| | 25 | 0.12 | 0.18 | 0.25 | 0.28 | 0.37 | 0.39 | 0.50 | 0.58 | 0.77 | 0.82 | 0.96 |

Table 6: Knurling profile acc. to DIN82: RBL30° / RBR30°

| Pitch [mm] | | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 1.0 | 1.2 | 1.5 | 1.6 | 2.0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Material | Workpiece Ø [mm] | Enlargement of workpiece diameter in mm | | | | | | | | | | |
| Free-cutting steel | 5 | 0.12 | 0.16 | 0.20 | 0.25 | 0.33 | 0.41 | 0.55 | 0.65 | – | – | – |
| | 15 | 0.13 | 0.22 | 0.30 | 0.32 | 0.35 | 0.41 | 0.52 | 0.62 | 0.67 | 0.81 | 0.95 |
| | 25 | 0.12 | 0.18 | 0.28 | 0.32 | 0.35 | 0.38 | 0.55 | 0.67 | 0.77 | 0.87 | 0.98 |
| Stainless steel | 5 | 0.11 | 0.20 | 0.25 | 0.30 | 0.36 | 0.39 | 0.55 | 0.55 | – | – | – |
| | 15 | 0.10 | 0.14 | 0.21 | 0.24 | 0.29 | 0.34 | 0.43 | 0.53 | 0.66 | 0.72 | 0.88 |
| | 25 | 0.11 | 0.13 | 0.20 | 0.25 | 0.28 | 0.32 | 0.44 | 0.52 | 0.67 | 0.70 | 0.83 |
| Brass | 5 | 0.12 | 0.13 | 0.16 | 0.20 | 0.24 | 0.28 | 0.32 | 0.38 | – | – | – |
| | 15 | 0.12 | 0.16 | 0.18 | 0.24 | 0.28 | 0.30 | 0.39 | 0.40 | 0.48 | 0.52 | 0.63 |
| | 25 | 0.12 | 0.17 | 0.22 | 0.23 | 0.27 | 0.30 | 0.38 | 0.41 | 0.48 | 0.50 | 0.63 |
| Aluminium | 5 | 0.10 | 0.15 | 0.21 | 0.25 | 0.33 | 0.36 | 0.50 | 0.57 | – | – | – |
| | 15 | 0.11 | 0.14 | 0.20 | 0.25 | 0.28 | 0.33 | 0.43 | 0.54 | 0.67 | 0.71 | 0.89 |
| | 25 | 0.11 | 0.15 | 0.22 | 0.25 | 0.29 | 0.34 | 0.44 | 0.53 | 0.68 | 0.69 | 0.88 |

Table 7: Knurling profile acc. to DIN82: RGE30°

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