TRANSMISSION PARTS tooling

AUTOMATIC TRANSMISSION (AT)
MITSUBISHI AUTOMOTIVE TOOLING
Transmission cases

Main machining
①Mounting face
②Various locating holes
③Various locating faces
④Various bores

Machining methods
Milling
Drilling
Boring
Reaming

Work material : ADC12

OP.1 (Reference face)

For machining centres

Tool features
Standard BXD type cutter with TF15 inserts. Specially designed G-class inserts for excellent wall accuracy.

Cutting conditions
vc=1,000m/min  n=7,962min⁻¹  fz=0.1mm/tooth
vf=2,389mm/min Wet

BXD4000R403SA42SA
XDGT1550PDFR-G04 TF15

Tooling Sheet 1
OP.2 (Pre-drilling of the locating holes) For machining centres

Tool features
Special MZE / MZS drill with through coolant holes in HT10 grade. Step drill consolidates processes and reduces machining costs. (Non-coated MZE / MZS offers a sharp cutting edge geometry)

Cutting conditions
vc=150m/min  n=4,154min⁻¹  fr=0.1mm/rev
vf=415mm/min  Wet

OP.3 (Finishing of locating holes) For machining centres

Tool features
Boring bar with a diameter adjustment function. Use of an adjustable unit makes it possible to adjust the cutting edge diameter to a desired value.

Cutting conditions
vc=300m/min  fz=0.06mm/tooth  vf=500mm/min  Wet
**OP.4** (Rough machining of the mounting faces)  
For machining centres

**Tool features**
Special AF5000 type cutter with MD220 inserts. Possible to finely adjust the axial run-out of the inserts.

**Cutting conditions**
- \( vc = 1,760 \text{m/min} \)
- \( fz = 0.1 \text{mm/tooth} \)
- \( vf = 4,000 \text{mm/min} \)

**OP.5** (Roughing of shaft hole)  
For machining centres

**Tool features**
Combination boring cutter with special MD220 inserts. Boring, facing and chamfering are carried out in one plunge process. Cartridge type for high precision machining.

**Cutting conditions**
- \( vc = 350 \text{m/min} \)
- \( fz = 0.1 \text{mm/tooth} \)
- \( vf = 200 \text{mm/min} \)
**OP.6 (Conveyor seat face)**

For machining centres

**Tool features**

Standard BXD type cutter with TF15 inserts. Specially designed G-class inserts for excellent wall accuracy.

**Cutting conditions**

\[\begin{align*}
\text{vc} &= 1,000 \text{m/min} \\
\text{n} &= 7,962 \text{min}^{-1} \\
\text{fz} &= 0.3 \text{mm/tooth} \\
\text{vf} &= 7,166 \text{mm/min} \\
\text{Wet}
\end{align*} \]

**Tooling Sheet 6**

**OP.7 (Pre-drilling of assembly locating holes)**

For machining centres

**Tool features**

Special MZE / MZS drill with through coolant holes in HTi10 grade. Step drill consolidates processes and reduces machining costs. (Non-coated MZE / MZS offers a sharp cutting edge geometry)

**Cutting conditions**

\[\begin{align*}
\text{vc} &= 150 \text{m/min} \\
\text{n} &= 4,154 \text{min}^{-1} \\
\text{fr} &= 0.1 \text{mm/rev} \\
\text{vf} &= 415 \text{mm/min} \\
\text{Wet}
\end{align*} \]

**Tooling Sheet 7**
OP.8 (Finishing of assembly locating holes)  For machining centres

Tool features
Boring bar with a diameter adjustment function. Use of an adjustable unit makes it possible to adjust the cutting edge diameter to a desired value.

Tooling Sheet 8

OP.9 (Side cover dowel location holes)  For machining centres

Tool features
Special MZE / MZS drill with through coolant holes in HTi10 grade. Step drill consolidates processes and reduces machining costs. (Non-coated MZE / MZS offers a sharp cutting edge geometry)

Tooling Sheet 9
OP.10 (Side cover mounting holes)  For machining centres

Tool features
Special MZE / MZS drill with through coolant holes in HTi10 grade. Step drill consolidates processes and reduces machining costs. (Non-coated MZE / MZS offers a sharp cutting edge geometry)

Cutting conditions
vc=160m/min  n=5,995min⁻¹  fz=0.13mm/tooth  vf=779mm/min  Wet

OP.11 (Rough machining of mounting faces)  For machining centres

Tool features
Special AF5000 type cutter with MD220 inserts. Possible to finely adjust the axial run-out of the inserts.

Cutting conditions
vc=1,540m/min  fz=0.13mm/tooth  vf=500mm/min  Wet
**OP.12  (Roughing of shaft hole)  For machining centres**

**Tool features**
Special combination boring cutter with special MD220 inserts. Combination cutter for facing and chamfering. Cartridge type for high precision machining. Use of an ABS clamping system on the head enables high installation repeatability accuracy and convenient head exchange.

**Cutting conditions**
\[ \text{vc} = 405 \text{m/min} \quad \text{fr} = 0.05 \text{mm/rev} \quad \text{vf} = 50 \text{mm/min} \quad \text{Wet} \]

**Tooling Sheet 12**

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**OP.13  (Housing dowel location holes)  For machining centres**

**Tool features**
Special MZE / MZS drill with through coolant holes in HT10 grade. Step drill consolidates processes and reduces machining costs. (Non-coated MZE / MZS offers a sharp cutting edge geometry)

**Cutting conditions**
\[ \text{vc} = 100 \text{m/min} \quad n = 3,352 \text{min}^{-1} \quad \text{fr} = 0.1 \text{mm/rev} \quad \text{vf} = 335 \text{mm/min} \quad \text{Wet} \]

**Tooling Sheet 13**
**OP.14 (Roughing of shaft hole)  For machining centres**

**Tool features**

Special combination boring cutter with HTi10 inserts. Facing and chamfering can be performed in one process, allowing drastic process consolidation and higher production efficiency. Cartridge type for high precision machining.

**Cutting conditions**

vc=600m/min  fr=0.2mm/rev  vf=382mm/min  Wet

**Tooling Sheet 14**

**OP.15 (Roughing of reduction hole)  For machining centres**

**Tool features**

Special combination boring cutter with HTi10 inserts. Combination cutter for facing and chamfering.

**Cutting conditions**

vc=580m/min  fr=0.03mm/rev  vf=80mm/min  Wet

**Tooling Sheet 15**
OP.16  (Roughing of differential hole)  For machining centres

Tool features
Special combination boring cutter with HTi10 inserts. Combination cutter for facing and chamfering.

Cutting conditions
vc=580m/min  fr=0.1mm/rev  vf=264mm/min  Wet

OP.17  (Grooving of shaft hole)  For machining centres

Tool features
Special grooving cutter with special HTi10 inserts. Simultaneous grooving is possible. Insert position can be adjusted by adjusting the machine's drawbar.

Cutting conditions
vc=400m/min  fr=0.1mm/rev  ap=1.2mm  W=2mm  Wet
OP.18 (Mounting holes) For machining centres

**Tool features**

Special MZE / MZS drill with through coolant holes in HTi10 grade. Step drill consolidates processes and reduces machining costs. (Non-coated MZE / MZS offers a sharp cutting edge geometry)

**Cutting conditions**

\[ v_c = 125 \text{ m/min} \quad n = 7,962 \text{ min}^{-1} \quad f_R = 0.13 \text{ mm/rev} \]
\[ v_f = 1,035 \text{ mm/min} \quad \text{Wet} \]

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OP.19 (Oil pan mounting face) For machining centres

**Tool features**

Special NF10000 type cutter with MD220 inserts. Finish milling cutter with high wear and weld resistant MD220 inserts for high speed machining. Radius minor edge for high surface finishes.

**Cutting conditions**

\[ v_c = 1,759 \text{ m/min} \quad f_z = 0.1 \text{ mm/tooth} \quad v_f = 4,000 \text{ mm/min} \quad \text{Wet} \]
OP.20  (Roughing of harness hole)  For machining centres

Tool features
Special combination boring cutter with special HT10 inserts. For the boring operation, inserts with the same geometry as the standard TAF drill can be used. Economical 4 corner use.

Cutting conditions
vc=446m/min  fr=0.15mm/rev  vf=676mm/min  Wet

OP.21  (Finishing of harness hole)  For machining centres

Tool features
Special boring bar with MD220 inserts. To prevent return marks, back boring is performed. The clamping face is tapered to increase overall rigidity for high machining accuracy.

Cutting conditions
vc=351m/min  fr=0.08mm/rev  vf=280mm/min  Wet
**OP.22 (Oil pan mounting holes)**  For machining centres

**Tool features**
Special MZE / MZS drill with through coolant holes in HT110 grade. Step drill consolidates processes and reduces machining costs. (Non-coated MZE / MZS drill cutting edge geometry, sharp edge)

**Cutting conditions**
- \( vc=125 \text{m/min} \)
- \( n=7,962 \text{min}^{-1} \)
- \( f_r=0.08 \text{mm/rev} \)
- \( v_f=637 \text{mm/min} \) Wet

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**OP.23 (Conveyor seat face)**  For machining centres

**Tool features**
Special MZE / MZS drill with through coolant holes in HT110 grade. Step drill consolidates processes and reduces machining costs. (Non-coated MZE / MZS offers a sharp cutting edge geometry)

**Cutting conditions**
- \( vc=150 \text{m/min} \)
- \( n=4,154 \text{min}^{-1} \)
- \( f_r=0.1 \text{mm/rev} \)
- \( v_f=415 \text{mm/min} \) Wet
### OP.24 (Conveyor seat face)

**Tool features**
Special boring bar with a diameter adjustment function with MD220 inserts. Use of an adjustable unit makes it possible to change the adjustment amount to the desired value. Easy diameter adjustment.

**Cutting conditions**
\[ \begin{align*}
  \text{vc} &= 301 \text{m/min} \\
  \text{fr} &= 0.06 \text{mm/rev} \\
  \text{vf} &= 500 \text{mm/min} \\
  \text{Wet}
\end{align*} \]

### OP.25 (Dowel location holes)

**Tool features**
Special MZE / MZS drill with through coolant holes in HTi10 grade. Step drill consolidates processes and reduces machining costs. (Non-coated MZE / MZS offers a sharp cutting edge geometry)

**Cutting conditions**
\[ \begin{align*}
  \text{vc} &= 100 \text{m/min} \\
  \text{n} &= 7,077 \text{min}^{-1} \\
  \text{fr} &= 0.08 \text{mm/rev} \\
  \text{vf} &= 566 \text{mm/min} \\
  \text{Wet}
\end{align*} \]
OP.26 (Dowel location holes)  For machining centres

**Tool features**
Special PCD reamer. Use of MD220 cutting edge with high welding resistance. Straight flute for high precision machining.

**Cutting conditions**
vc=78m/min  fr=0.04mm/rev  vf=400mm/min Wet

Diamond reamer MD220

**Tooling Sheet 26**

OP.27 (Finishing oil pan mounting surface)  For machining centres

**Tool features**
Special NF10000 type cutter with MD220 inserts. Finish milling cutter with high wear and weld resistant MD220 inserts for high speed machining. Radius minor edge for high surface finishes.

**Cutting conditions**
vc=1,539m/min  fz=0.11mm/tooth  vf=4,000mm/min Wet

NF10000 (Special) GDCN2004PDFR3 MD220

**Tooling Sheet 27**
OP.28  (Pre-drilling valve mounting holes)  For machining centres

Tool features
Special MZE / MZS drill with through coolant holes in HT10 grade. Step drill consolidates processes and reduces machining costs. (Non-coated MZE / MZS offers a sharp cutting edge geometry)

Cutting conditions

\[ \begin{align*}
vc &= 125 \text{m/min} \\
n &= 7,962 \text{min}^{-1} \\
fr &= 0.08 \text{mm/rev} \\
vf &= 637 \text{mm/min} \\
\text{Wet}
\end{align*} \]

Tooling Sheet 28

OP.29  (Oil pan inlet holes)  For machining centres

Tool features
Special burnish drill in HT10 grade. Straight flute for easy re-grinding. (Solid carbide, straigh flute)

Cutting conditions

\[ \begin{align*}
vc &= 337 \text{m/min} \\
fr &= 0.1 \text{mm/rev} \\
vf &= 1,000 \text{mm/min} \\
\text{Wet}
\end{align*} \]

Tooling Sheet 29
OP.30 (Oil pan outlet holes)  

For machining centres

![Image of OP.30 tooling](image1)

**Tool features**
Special MZE / MZS drill with through coolant holes in HT10 grade. Step drill consolidates processes and reduces machining costs. (Non-coated MZE / MZS offers a sharp cutting edge geometry)

**Cutting conditions**
- $v_c = 170 \text{ m/min}$
- $n = 3185 \text{ min}^{-1}$
- $f_r = 0.2 \text{ mm/rev}$
- $v_f = 637 \text{ mm/min}$
- Wet

Tooling Sheet 30

OP.31 (Lubrication circuit face)  

For machining centres

![Image of OP.31 tooling](image2)

**Tool features**
Special boring cutter with special HT10 and MD220 inserts. Combined machining of facing and chamfering. Use of ABS clamping system on the head enables high installation repeatability accuracy and convenient head exchange.

**Cutting conditions**
- $v_c = 188 \text{ m/min}$
- $f_r = 0.1 \text{ mm/rev}$
- $v_f = 300 \text{ mm/min}$
- Wet

Tooling Sheet 31
OP.32 (Various mounting faces)  For machining centres

**Tool features**
Special NF10000 type cutter with MD220 inserts. Finish milling cutter with high wear and weld resistant MD220 inserts for high speed machining. Radius minor edge for high surface finishes.

**Cutting conditions**

vc=1,539m/min  fz=0.11mm/rev  vf=4,000mm/min  Wet

**Tooling Sheet 32**

OP.33 (Circuit holes)  For machining centres

**Tool features**
Special boring bar with a diameter adjustment function with MD220 inserts. Use of an adjustable unit makes it possible to change an adjustment amount to the desired value. Easy diameter adjustment.

**Cutting conditions**

vc=195m/min  fr=0.1mm/rev  vf=300mm/min  Wet

**Tooling Sheet 33**
OP.34 (End face of differential oil seal)  
For machining centres

**Tool features**
Special milling cutter with HT10 grade. Combination cutter for facing and chamfering.

**Cutting conditions**
- vc=659m/min  
- fz=0.2mm/rev  
- vf=300mm/min  
- Wet

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OP.35 (Housing dowel location holes)  
For machining centres

**Tool features**
Special boring bar with a diameter adjustment function with MD220 inserts. Use of an adjustable unit makes it possible to change the amount of adjustment to the desired value. Easy diameter adjustment.

**Cutting conditions**
- vc=125m/min  
- fr=0.05mm/rev  
- vf=200mm/min  
- Wet
OP.36 (Shaft hole)  For machining centres

Tool features
Special boring cutter with MD220 inserts. Numerous cartridges are used to perform facing and chamfering in one process. Enables drastic process consolidation and higher production efficiency.

Cutting conditions
vc=130m/min  fr=0.2mm/rev  vf=51mm/min  Wet

OP.37 (Finishing of reduction holes)  For machining centres

Tool features
Special boring cutter with special MD220 inserts. Use of a finishing type, high precision boring unit. Fine adjustment of inserts can be carried out with ease.

Cutting conditions
vc=600m/min  fr=0.08mm/rev  vf=247mm/min  Wet
**OP.38 (Finishing of differential gear holes) For machining centres**

![Image of differential gear holes]

**Tool features**
- Special combination boring cutter with MD220 inserts.
- Combination cutter for facing and chamfering.
- Use of cartridge enables high precision machining.

**Cutting conditions**
- $v_c=650 \text{ m/min}$,
- $f_r=0.05 \text{ mm/rev}$,
- $v_f=148 \text{ mm/min}$

Wet

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**OP.39 (Side cover dowel location holes) For machining centres**

![Image of side cover dowels]

**Tool features**
- Special boring bar with a diameter adjustment function with MD220 inserts.
- Use of an adjustable unit makes it possible to change an adjustment amount to the desired value.
- Easy diameter adjustment.

**Cutting conditions**
- $v_c=125 \text{ m/min}$,
- $f_r=0.04 \text{ mm/rev}$,
- $v_f=150 \text{ mm/min}$

Wet
Clutch housings

Main machining
① Mounting face
② Various locating holes
③ Various locating faces
④ Various bores

Machining methods
Milling
Drilling
Boring
Reaming

Work material : ADC10

OP.1 (Machining of mounting face) For machining centres

Tool features
Special NF10000 type cutter with MD220 inserts.
Finish milling cutter with high wear and weld resistant MD220 inserts for high speed machining.
Radius minor edge for high surface finishes.

Cutting conditions
vc=1,507m/min  fz=0.15mm/tooth  vf=5,400mm/min
ap=2mm  Wet

Tooling Sheet 1
**OP.2 (Pre-drilling of φ10 reference hole) For machining centres**

**Tool features**
Special MZE / MZS drill with through coolant holes in HTi10 grade. Step drill consolidates processes and reduces machining costs. (Non-coated MZE / MZS offers a sharp cutting edge geometry)

**Cutting conditions**
vc=150m/min  fr=0.20mm/rev  vf=1,005mm/min  Wet

**MZE/MZS drill (Special) TF15**

**OP.3 (Pre-drilling of φ13.5 x φ15) For machining centres**

**Tool features**
Special drill with through coolant holes in HTi10 grade. Multi-step drill consolidates processes and reduces machining costs. Straight flute for easy re-grinding.

**Cutting conditions**
vc=200m/min  fr=0.20mm/rev  vf=944mm/min  Wet

**Special drill HTi10**
**OP.4 (∅11 reference hole)**

**For machining centres**

![Machining component image](image1)

**Tool features**

Special MZE / MZS drill with through coolant holes in HT10 grade. Step drill consolidates processes and reduces machining costs. (Non-coated MZE / MZS offers a sharp cutting edge geometry)

**Cutting conditions**

vc=150m/min  fr=0.10mm/rev  vf=434mm/min  Wet

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**OP.5 (Machining of mounting face)**

**For machining centres**

![Machining component image](image2)

**Tool features**

Special NF10000 type cutter with MD220 inserts. Finish milling cutter with high wear and weld resistant MD220 inserts for high speed machining. Radius minor edge for high surface finishes.

**Cutting conditions**

vc=1,507m/min  fz=0.15mm/tooth  vf=5,400mm/min  ap=2mm  Wet
**OP.6 (Pre-drilling of φ14 dowel location holes)**

*For machining centres*

**Tool features**
Special MZE / MZS drill with through coolant holes in HT110 grade. Step drill consolidates processes and reduces machining costs. (Non-coated MZE / MZS offers a sharp cutting edge geometry)

**Cutting conditions**

- \(v_c=150\) m/min
- \(f_r=0.2\) mm/rev
- \(v_f=707\) mm/min
- Wet

**Tooling Sheet 6**

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**OP.7 (Pre-drilling of M6 tap hole)**

*For machining centres*

**Tool features**
Special MZE / MZS drill with through coolant holes in HT110 grade. Step drill consolidates processes and reduces machining costs. (Non-coated MZE / MZS offers a sharp cutting edge geometry)

**Cutting conditions**

- \(v_c=120\) m/min
- \(f_r=0.2\) mm/rev
- \(v_f=1,529\) mm/min
- Wet
OP.8  (Back boring the main shaft hole_1) For machining centres

Tool features
Special combination boring cutter with HTi10 inserts. Possible to perform 6 processes (boring, facing and chamfering) in one process for drastic process consolidation and higher production efficiency.

Cutting conditions
vc=700m/min  fr=0.2mm/rev  vf=620mm/min  Wet

OP.9  (Back boring the output shaft hole_1) For machining centres

Tool features
Special combination boring cutter with HTi10 inserts. Possible to perform facing and chamfering in one process for drastic process consolidation and higher production efficiency. Cartridge type for high precision machining.

Cutting conditions
vc=700m/min  fr=0.2mm/rev  vf=620mm/min  Wet
OP.10 (Pre-drilling φ13)  
For machining centres

**Tool features**

Special burnish drill with through coolant holes. Straight flute for easy re-grinding.

**Cutting conditions**

- vc=200m/min
- fr=0.2mm/rev
- vf=1,019mm/min
- Wet

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OP.11 (Pre-drilling of M10 tap hole)  
For machining centres

**Tool features**

Special MWE / MWS drill with through coolant holes. Step drill consolidates processes and reduces machining costs. Wave cutting edge gives a balance of edge strength and sharpness. High precision, stable machining.

**Cutting conditions**

- vc=150m/min
- fr=0.2mm/rev
- vf=1,086mm/min
- Wet
OP.12  (Boring the main shaft hole)  For machining centres

Tool features
Special combination boring cutter with HTi10 inserts. For facing, boring and chamfering. Cartridge type for high precision machining.

Cutting conditions
vc=600m/min  fr=0.1mm/rev  vf=420mm/min  Wet

OP.13  (Boring the output shaft hole)  For machining centres

Tool features
Special combination boring cutter with HTi10 inserts. For boring and chamfering. Cartridge type for high precision machining.

Cutting conditions
vc=600m/min  fr=0.2mm/rev  vf=688mm/min  Wet
**OP.14 (Boring of ϕ10 datum hole)**

For machining centres

**Tool features**
Special boring bar with a diameter adjustment function with MD220 inserts. Use of an adjustable unit makes it possible to change an adjustment amount to the desired value. Easy diameter adjustment.

**Cutting conditions**
vc=226~427m/min  fr=0.06mm/rev  vf=120mm/min  Wet

**OP.15 (Back boring the main shaft hole _2)**

For machining centres

**Tool features**
Special combination boring cutter with special MD220 inserts. Use of a finishing type, high precision boring unit. Fine adjustment of inserts can be carried out with ease, enabling high precision machining.

**Cutting conditions**
vc=251m/min  fr=0.06mm/rev  vf=480mm/min  Wet
**OP.16** (Back boring the output shaft hole_2)  
For machining centres

**Tool features**
Special combination boring cutter with special MD220 inserts. Use of a finishing type, high precision boring unit. Fine adjustment of inserts can be carried out with ease, enabling high precision machining.

**Cutting conditions**
vc=345~452m/min  fr=0.06mm/rev  vf=120mm/min Wet

**Tooling Sheet 16**

**OP.17** (Boring circuit holes A)  
For machining centres

**Tool features**
Special boring bar with a diameter adjustment function with MD220 inserts. Use of an adjustable unit makes it possible to change an adjustment amount to the desired value. Easy diameter adjustment.

**Cutting conditions**
vc=327m/min  fr=0.06mm/rev  vf=480mm/min Wet

**Tooling Sheet 17**
**OP.18 (Boring circuit hole B)**

**Tool features**
Special boring bar with a diameter adjustment function with MD220 inserts. Use of an adjustable unit makes it possible to change an adjustment amount to the desired value. Easy diameter adjustment.

**Cutting conditions**
vc=327m/min  fr=0.06mm/rev  vf=480mm/min  Wet

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**OP.19 (Boring circuit hole C)**

**Tool features**
Special boring bar with a diameter adjustment function with MD220 inserts. Use of an adjustable unit makes it possible to change an adjustment amount to the desired value. Easy diameter adjustment.

**Cutting conditions**
vc=402m/min  fr=0.06mm/rev  vf=480mm/min  Wet
OP.20  (Pre-drilling & spot facing of φ22)  For machining centres

Tool features
Special burnish drill with through coolant holes in HTi10 grade. Process consolidation by performing pre-drilling and spot facing in one process. Straight flute for easy re-grinding.

Cutting conditions
vc=252m/min  fr=0.2mm/rev  vf=840mm/min  Wet

OP.21  (Pre-drilling of φ20)  For machining centres

Tool features
Special burnish drill with through coolant holes in HTi10 grade. Straight flute for easy re-grinding.

Cutting conditions
vc=252m/min  fr=0.2mm/rev  vf=840mm/min  Wet
**OP.22 (Semi-finishing of φ20 x φ22)**  
For machining centres

**Tool features**  
Carbide reamer with guide pads in HTi10 grade.  
Self-guiding ensures high precision machining.

**Cutting conditions**  
vc=269 / 297m/min  
fr=0.2mm/rev  
vf=880mm/min  
Wet

**Tooling Sheet 22**

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**OP.23 (Finishing of φ20 x φ22)**  
For machining centres

**Tool features**  
PCD reamer with guide pads.  
Self-guiding ensures high precision machining.

**Cutting conditions**  
vc=200m/min  
fr=0.1mm/rev  
vf=320mm/min  
Wet

**Tooling Sheet 23**
Torque converter cover

Main machining
1. Mounting face
2. Various holes

Machining methods
Milling
Drilling

Work material: ADC12

OP.1 (Engine mounting face) For machining centres

Tool features
Special NF10000 type cutter with MD220 inserts. Finish milling cutter with high wear and weld resistant MD220 inserts for high speed machining. Radius minor edge for high surface finishes.

Cutting conditions
vc=1,260m/min  n=4,012min⁻¹  fz=0.15mm/tooth
vf=4,814mm/min  ap=1.5mm  Wet

Tooling Sheet 1
**OP.2 (Locating holes)**

**Tool features**

Special MZE / MZS drill with through coolant holes in HT10 grade. Step drill consolidates processes and reduces machining costs. (Non-coated MZE / MZS offers a sharp cutting edge geometry)

**Cutting conditions**

vc=100 m/min  n=3,185 min⁻¹  fr=0.12 mm/rev  Wet

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**OP.3 (Engine mounting holes)**

**Tool features**

Standard super burnish drill. Use of a double margin enables high precision drilling.

**Cutting conditions**

vc=123 m/min  n=2,448 min⁻¹  fr=0.12 mm/rev  Wet
**OP.4 (Sensor surface)**

**For machining centres**

![Image](image1.png)

**Tool features**

Standard BXD type cutter with TF15 inserts. Specially designed G-class inserts for excellent wall accuracy.

**Cutting conditions**

\[ \text{vc} = 300 \text{m/min} \quad \text{n} = 2,986 \text{min}^{-1} \quad \text{fz} = 0.2 \text{mm/tooth} \quad \text{vf} = 1,194 \text{mm/min} \]

**Wet**

**Tooling Sheet 4**

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**OP.5 (Sensor holes)**

**For machining centres**

![Image](image2.png)

**Tool features**

Special burnish drill in HT10 grade. The 2-flute cutting edge allows good chip control.

**Cutting conditions**

\[ \text{vc} = 138 \text{m/min} \quad \text{n} = 1,831 \text{min}^{-1} \quad \text{fr} = 0.4 \text{mm/rev} \quad \text{Wet} \]

**Tooling Sheet 5**
OP.6  (Pre-drilling of tap holes for cooler bracket installation)  For machining centres

Tool features
Special MAS drill in HT10 grade.
Use of a double margin enables high precision drilling.

Cutting conditions
vc=150m/min  n=8,717min⁻¹  fr=0.1mm/rev  Wet

OP.7  (Case mounting face)  For machining centres

Tool features
Special NF10000 type cutter with MD220 inserts.
Finish milling cutter with high wear and weld resistant MD220 inserts for high speed machining.
Radius minor edge for high surface finishes.

Cutting conditions
vc=1,000m/min  n=3,184min⁻¹  fz=0.2mm/tooth  vf=5,094mm/min
Wet
OP.8 (Case mounting holes) For machining centres

Special MAS drill in HTi10 grade. Use of a double margin enables high precision drilling.

Cutting conditions:
vc=123m/min  n=3,436min⁻¹  fr=0.12mm/rev  Wet

Tooling Sheet 8
Valve body Upper side

Main machining
① Circuit face
② Back face
③ Various holes

Machining methods
Milling
Drilling
Boring

Work material : ADC12

OP.1 (Roughing of the circuit surface, back face boss) For machining centres

Tool features
Standard NF10000 type cutter with MD220 inserts. Finish milling cutter with high wear and weld resistant MD220 inserts for high speed machining. Chamfer honed main cutting edges increases cutting edge strength.

Cutting conditions
$\text{vc}=3,014 \text{ m/min}$  $n=11,998 \text{ min}^{-1}$  $fz=0.107 \text{ mm/tooth}$  $vf=7,680 \text{ mm/min}$

Wet

For machining centres
OP.2  (Dowel location holes)  For machining centres

Tool features
Special MAS drill in HTi10 grade.
Use of a double margin allows high precision drilling.

Cutting conditions
VC=100m/min  n=5,263/min¹  fr=0.07mm/rev  vf=368mm/min
Wet

OP.3  ( Locating holes) For machining centres

Tool features
Special MAS drill in HTi10 grade.
Use of a double margin allows high precision drilling.

Cutting conditions
VC=100m/min  n=7,768/min¹  fr=0.05mm/rev  vf=388mm/min
Wet

Tooling Sheet 2

Tooling Sheet 3
OP.4  (Rough milling of the case mounting face)  

**For machining centres**

**Tool features**
Standard BXD type cutter with TF15 inserts. Specially designed G-class inserts for excellent wall accuracy.

**Cutting conditions**
- $v_c=79\text{ m/min}$
- $n=2,516\text{ min}^{-1}$
- $f_r=0.06\text{ mm/rev}$
- $v_f=150\text{ mm/min}$
- Wet

OP.5  (Solenoid holes)  

**For machining centres**

**Tool features**
Special PCD reamer in MD220 grade. Use of MD220 cutting edge with high welding resistance.

**Cutting conditions**
- $v_c=1,507\text{ m/min}$
- $n=11,998\text{ min}^{-1}$
- $f_p=0.023\text{ mm/tooth}$
- $v_f=840\text{ mm/min}$
- $a_p=0.3\text{ mm}$
- Wet
OP.6 (Dowel location holes)  For machining centres

**Tool features**
Special MAS drill in HTi10 grade. Use of a double margin allows high precision drilling.

**Cutting conditions**
- vc=100m/min
- n=4753min⁻¹
- fr=0.07mm/rev
- vf=332mm/min
- Wet

---

OP.7 (Roughing of the accumulator bore)  For machining centres

**Tool features**
Special carbide reamer in HTi10 grade. The 6-flute cutting edge enables high performance machining. Straight flute for easy re-grinding.

**Cutting conditions**
- vc=100m/min
- n=1852min⁻¹
- fz=0.05mm/tooth
- vf=555mm/min
- Wet
**OP.8 (Finishing of the accumulator bore)**

*For machining centres*

**Tool features**
Special PCD reamer in MD220 grade. Use of MD220 (PCD) cutting edge with high welding resistance. The single-flute cutting edge improves run-out accuracy leading to better surface finishes and higher hole roundness accuracy.

**Cutting conditions**

\[ \begin{align*}
vc &= 200\text{m/min} \\
n &= 3,640\text{min}^{-1} \\
fr &= 0.07\text{mm/rev} \\
vf &= 255\text{mm/min}
\end{align*} \]

Wet

---

**OP.9 (Pre-drilling of tap holes)**

*For machining centres*

**Tool features**
Special MAS drill in HTi10 grade. Use of a double margin enables high precision stable pre-hole drilling for rolled tap.

**Cutting conditions**

\[ \begin{align*}
vc &= 100\text{m/min} \\
n &= 5,812\text{min}^{-1} \\
fr &= 0.10\text{mm/rev} \\
vf &= 581\text{mm/min}
\end{align*} \]

Wet
**OP.10 (Drain holes)**

**For machining centres**

**Tool features**
Special MAS drill in HTi10 grade. Use of a double margin enables high precision stable pre-hole drilling for rolled tap.

**Cutting conditions**
vc=100m/min  n=5,812min⁻¹  fr=0.10mm/rev  vf=581mm/min

Wet

---

**OP.11 (Pre-drilling of tap holes for the solenoid & oil pressure switch)**

**For machining centres**

**Tool features**
Special PCD reamer in MD220 grade. Use of MD220 cutting edge with high welding resistance.

**Cutting conditions**
vc=113m/min  n=3,788min⁻¹  fr=0.082mm/rev  vf=310mm/min

Wet

---

**Tooling Sheet 10**

**Tooling Sheet 11**
**OP.12 (Finish milling of the case mounting face)**

For machining centres

![Image of OP.12](image1)

**Tool features**
Standard BXD type cutter with TF15 inserts. Specially designed G-class inserts for excellent wall accuracy.

**Cutting conditions**

- $v_c = 1,507 \text{ m/min}$
- $n = 11,998 \text{ min}^{-1}$
- $f_z = 0.02 \text{ mm/tooth}$
- $v_f = 720 \text{ mm/min}$
- $a_p = 0.3 \text{ mm}$
- *Wet*

**Tool features**

Standard AF5000 type cutter with MD220 inserts. 
CBN inserts are available for use instead of PCD inserts to machine other materials than aluminum alloy.

**Cutting conditions**

- $v_c = 2,000 \text{ m/min}$
- $n = 2,548 \text{ min}^{-1}$
- $f_z = 0.05 \text{ mm/tooth}$
- $v_f = 1,274 \text{ mm/min}$
- $a_p = 0.4 \text{ mm}$
- *Wet*

---

**OP.13 (Finish milling the circuit surface)**

For machining centres

![Image of OP.13](image2)

**Tool features**

Standard BXD type cutter with TF15 inserts. Specially designed G-class inserts for excellent wall accuracy.

**Cutting conditions**

- $v_c = 1,507 \text{ m/min}$
- $n = 11,998 \text{ min}^{-1}$
- $f_z = 0.02 \text{ mm/tooth}$
- $v_f = 720 \text{ mm/min}$
- $a_p = 0.3 \text{ mm}$
- *Wet*

**Tool features**

Standard AF5000 type cutter with MD220 inserts. CBN inserts are available for use instead of PCD inserts to machine other materials than aluminum alloy.

**Cutting conditions**

- $v_c = 2,000 \text{ m/min}$
- $n = 2,548 \text{ min}^{-1}$
- $f_z = 0.05 \text{ mm/tooth}$
- $v_f = 1,274 \text{ mm/min}$
- $a_p = 0.4 \text{ mm}$
- *Wet*
Valve body lower side

**Main machining**
1. Circuit face
2. Various holes

**Machining methods**
- Milling
- Drilling

**Work material:** ADC12

---

**OP.1 (Roughing of the circuit & oil strainer surface)**

For machining centres

**Tool features**
Standard NR10000 type cutter with MD220 inserts.
Roughing cutter with high wear and weld resistant MD220 (PCD) inserts for high speed machining.
Chamfer honed main cutting edges increases cutting edge strength.

**Cutting conditions**
- $v_c = 3,014 \text{ m/min}$
- $n = 11,998 \text{ min}^{-1}$
- $f_z = 0.067 \text{ mm/tooth}$
- $v_f = 4,800 \text{ mm/min}$
- Wet
OP.2 (Locating holes)  

For machining centres

Tool features
Special MAS drill in HTi10 grade. Use of a double margin enables high precision drilling.

Cutting conditions
\[ \text{vc}=100\text{m/min } n=5,290\text{min}^{-1} \; \text{fr}=0.07\text{mm/rev } \text{vf}=370\text{mm/min} \] Wet

OP.3 (Sensor hole)  

For machining centres

Tool features
Special PCD reamer in MD220 grade. Use of MD220 (PCD) cutting edge with high welding resistance. Shortening the tool length as much as possible achieves high runout accuracy.

Cutting conditions
\[ \text{vc}=113\text{m/min } n=3,788\text{min}^{-1} \; \text{fr}=0.1\text{mm/rev } \text{vf}=380\text{mm/min} \] Wet
**OP.4 T1** (Pre-drilling of the tap holes)  For machining centres

**Tool features**
Special MAS drill in HTi10 grade. Use of a double margin enables high precision stable pre-hole drilling for rolled tap.

**Cutting conditions**
vc=100m/min  n=5,812min\(^{-1}\)  fr=0.10mm/rev  vf=581mm/min  Wet

**Tool features**
Special carbide reamer in HTi10 grade. The 2-flute cutting edge allows good chip disposal. Straight flute for easy re-grinding.

**Cutting conditions**
vc=100m/min  n=3,388min\(^{-1}\)  fz=0.10mm/tooth  vf=678mm/min  Wet

---

**OP.5** (Roughing of the spool holes)  For machining centres

**Tool features**
Mas drill (Special)  HTi10

**Tool features**
Carbide reamer  HTi10

**Tooling Sheet 4**

**Tooling Sheet 5**
OP.6 (①Finishing of the spool holes)  For machining centres

![Image of OP.6 tooling sheet]

**Tool features**
Special PCD reamer in MD220 grade. Use of MD220 (PCD) cutting edge with high welding resistance. The 2-flute cutting edge with good chip disposal properties allows highly efficient machining.

**Cutting conditions**
- $v_c=184 \text{ m/min}$
- $n=5,860 \text{ min}^{-1}$
- $f_r=0.14 \text{ mm/rev}$
- $v_f=820 \text{ mm/min}$
- Wet

---

OP.7 (②Roughing of the spool holes)  For machining centres

![Image of OP.7 tooling sheet]

**Tool features**
Special solid carbide multi-step reamer in HT10 grade. For roughing of 5 stepped holes. The single-flute cutting edge improves run-out accuracy leading to better surface finishes and higher hole roundness accuracy.

**Cutting conditions**
- $v_c=100 \text{ m/min}$
- $n=2,830 \text{ min}^{-1}$
- $f_r=0.05 \text{ mm/rev}$
- $v_f=142 \text{ mm/min}$
- Wet
OP.8 (Finishing of the spool holes)  For machining centres

Tool features
Special PCD multi-step reamer in MD220 grade. Use of MD220 (PCD) cutting edge with high welding resistance. The single-flute cutting edge improves run-out accuracy leading to better surface finishes and higher hole roundness accuracy.

Cutting conditions
vc=113m/min  n=3,005min⁻¹  fr=0.07mm/rev  vf=210mm/min Wet

OP.9 (Finish milling of the circuit surface)  For machining centres

Tool features
Standard AF5000 type cutter with MD220 inserts. CBN inserts are available for use instead of PCD inserts to machine other materials than aluminum alloy.

Cutting conditions
vc=2,512m/min  n=3,200min⁻¹  fz=0.05mm/tooth  vf=1,920mm/min  ap=0.4mm Wet
CVT pulley Primary FIX

Main machining
① External turning
② Sheave surface
③ Boring

Machining methods
Turning
Milling
Drilling
Boring

Work material: SCr420H

OP.1 (Milling of both end faces) For machining centres

Tool features
Standard ASX400 type cutter with VP15TF inserts.
The body is made from a special alloy steel that provides high heat resistance and excellent durability.
Use of screw-on type inserts for easy and high accuracy clamping. Use of a general-purpose JM breaker.

Cutting conditions
vc=150m/min  n=758min⁻¹  fz=0.20mm/tooth
vf=606mm/min  ap=1mm  Wet

Tooling Sheet 1
**OP.2 (Drilling of the FR hole)**

**Tool features**
Standard WSTAR drill.
Use of a wavy cutting edge and special flute geometry with superior chip disposal properties reduces the cutting resistance. High precision, stable machining.

**Cutting conditions**
- vc=120m/min
- n=2,548min⁻¹
- fr=0.13mm/rev
- vf=331m/min
- Id=34mm

Wet Cutting conditions

**Tooling Sheet 2**

**OP.3 (Spot facing of the RR side)**

**Tool features**
Standard CBMPR type cutter with UP20 inserts.
Good chip control and high cutting edge strength.

**Cutting conditions**
- vc=100m/min
- n=1,224min⁻¹
- fr=0.05mm/rev
- vf=122mm/min
- Id=3mm

Wet Cutting conditions

**Tooling Sheet 3**
OP.4  (Rough turning of the outer diameter and sheave surface)  For CNC lathes

Tool features
Standard holder with UE6110 inserts.
The UE6110 steel turning grade with a nano-texture coating provides excellent balance of wear and fracture resistance. The MV breaker gives effective chip control in the light to medium cutting application areas.

Cutting conditions
vc=194~275m/min  n=500~1,000min⁻¹  fr=0.55mm/rev
ap=1.5mm  Wet

OP.5  (Rough external turning of the shaft)  For CNC lathes

Tool features
Standard holder with UE6020 inserts.
The highly reliable UE6020 grade employs Even Coating Technology to deliver higher welding and fracture resistance. The MH breaker with a flat land gives high cutting edge strength, ensuring high stability during interrupted machining.

Cutting conditions
vc=148~240m/min  n=1,450min⁻¹  fr=0.35mm/rev
ap=1.5mm  Wet
OP.6  (Semi-finishing the shaft and finishing the sheave surface)  For CNC lathes

Tool features
Standard holder with UE6020 inserts. The highly reliable UE6020 grade employs Even Coating Technology to deliver higher welding and fracture resistance. The SH breaker featuring the curved edge gives sharp cutting action.

Cutting conditions
vc=250m/min  fr=0.35mm/rev  ap=0.4mm  Wet

OP.7  (Finishing of the shaft outer diameter)  For CNC lathes

Tool features
Standard holder with UE6020 inserts. The highly reliable UE6020 grade employs Even Coating Technology to deliver higher welding and fracture resistance. The SH breaker featuring the curved edge gives sharp cutting action.

Cutting conditions
vc=204~332m/min  n=2,000min⁻¹  fr=0.35mm/rev  ap=0.4mm  Wet
OP.8 (Snap ring groove) For CNC lathes

![Image of OP.8 tool]

**Tool features**
Standard holder with special VP20MF inserts. The VP20MF grade uses a micro-grain cemented carbide substrate. Superior wear and fracture resistance and long tool life.

**Cutting conditions**
vc=145~130m/min fr=0.1mm/rev ap=2.2mm W=1.73mm Wet

OP.9 (C-ring groove) For CNC lathes

![Image of OP.9 tool]

**Tool features**
Standard holder with special VP20MF inserts. The VP20MF grade uses a micro-grain cemented carbide substrate. Superior wear and fracture resistance and long tool life.

**Cutting conditions**
vc=79~65m/min fr=0.13mm/rev ap=3.7mm W=5.27mm Wet
OP.10  (Roughing of the sensor end face)  For CNC lathes

Tool features
Standard holder with UE6035 inserts. The UE6035 grade ensures higher fracture resistance during interrupted machining. General-purpose MA breaker.

Cutting conditions
\( vc=160 \text{m/min} \quad fr=0.2 \text{mm/rev} \quad ap=1.1 \text{mm} \) Wet

Tooling Sheet 10

OP.11  (Rough external turning and facing of the spline shaft)  For CNC lathes

Tool features
Standard holder with UE6110 inserts. The UE6110 steel turning grade with a nano-texture coating provides excellent balance of wear and fracture resistance. General-purpose MA breaker.

Cutting conditions
\( vc=140 \text{m/min} \quad fr=0.55 \text{mm/rev} \quad ap=0.9 \text{mm} \) Wet

Tooling Sheet 11
**OP.12** (Finish external turning and facing of the spline shaft)  
*For CNC lathes*

![Image of CVT pulley with highlighted areas]

**Tool features**
Standard holder with UE6110 inserts.  
The UE6110 steel turning grade with a nano-texture coating provides excellent balance of wear and fracture resistance.  
The SH breaker featuring the curved edge gives sharp cutting action.

**Cutting conditions**
- n=2,000m/min
- fr=0.2mm/rev
- ap=0.8mm
- Wet

---

**OP.13** (Rough external turning and facing)  
*For CNC lathes*

![Image of CVT pulley with highlighted areas]

**Tool features**
Standard holder with UE6110 inserts.  
The UE6110 steel turning grade with a nano-texture coating provides excellent balance of wear and fracture resistance.  
General-purpose MA breaker.

**Cutting conditions**
- vc=300m/min
- fr=0.26mm/rev
- ap=2.2mm
- Wet

---

**Tooling Sheet 12**

**Tooling Sheet 13**
**OP.14 (Finish external turning and facing)**

For CNC lathes

Tool features
Standard holder with UE6110 inserts. The UE6110 steel turning grade with a nano-texture coating provides excellent balance of wear and fracture resistance. General-purpose MA breaker.

Cutting conditions
n=2,000 min⁻¹ fr=0.2 mm/rev ap=0.25 mm Wet

**OP.15 (Circlip groove)**

For CNC lathes

Tool features
Standard holder with special VP20MF inserts. The VP20MF grade uses a micro-grain cemented carbide substrate. Superior wear and fracture resistance and long tool life.

Cutting conditions
vc=205~191 m/min n=1,000 min⁻¹ fr=0.1 mm/rev ap=1.9 mm Wet
OP.16 (Finish facing of the sensor) For CNC lathes

Tool features
Standard holder with UE6110 inserts.
The UE6110 steel turning grade with a nano-texture coating provides excellent balance of wear and fracture resistance. The MV breaker gives effective chip control in the light to medium cutting application areas.

Cutting conditions
vc=280m/min  fr=0.15mm/rev  ap=0.4mm  Wet

OP.17 (Semi-finishing of the bush press-fit diameter) For CNC lathes

Tool features
Standard boring bar with VP15TF inserts.
The VP15TF uses a micro-grain cemented carbide substrate. Excellent balance of wear and fracture resistance. The MV breaker gives effective chip control in the light to medium cutting application areas.

Cutting conditions
n=2,000min⁻¹  fr=0.24mm/rev  ap=0.6mm  Wet
**OP.18 (Rough boring)**

**Tool features**
Standard TAF drill with US735 inserts. Highly durable body with high insert seat rigidity. Economical 4 cutting edge type inserts.

**Cutting conditions**
- vc=123m/min  
- n=1,350min⁻¹  
- fr=0.15mm/rev  
- ld=19.5mm  
- Wet

**OP.19 (Finishing of the bush press-fit diameter)**

**Tool features**
Standard boring bar with US735 inserts. US735 with high welding resistance helps prevent abnormal wear at medium to low speed, interrupted cutting. Use of the finishing type SV breaker.

**Cutting conditions**
- vc=155m/min  
- fr=0.3mm/rev  
- ap=0.17mm  
- Wet
OP.20 (Finishing of the sensor surface)  For CNC lathes

Tool features
Standard holder with UE6020 inserts.
The highly reliable UE6020 grade employs Even Coating Technology to deliver higher welding and fracture resistance.
Use of the MH breaker with a tougher cutting edge.

Cutting conditions
vc=280m/min  fr=0.15mm/rev  ap=0.4mm  Wet

OP.21 (Slide circuit holes)  For machining centres

Tool features
Standard WSTAR drill.
The use of a wavy cutting edge and special flute geometry with superior chip disposal reduces the cutting resistance.
High precision, stable machining.

Cutting conditions
vc=150m/min  n=6,000min⁻¹  fr=0.24mm/rev  vf=1440mm/min
Wet

DDJNR2525M15
DNMG150412-MH  UE6020

MWE0800SA
VP15TF
OP.22 (Boring)……After heat treating  For CNC lathes

Tool features
Standard boring bar with MBC020 inserts.
MBC020 is a MIRACLE coated CBN grade.
The combination of a high rigidity CBN substrate with a coating for higher wear resistance allows MBC020 to cover a wide range of machining applications.

Cutting conditions
vc=150m/min  fr=0.08mm/rev  ap=0.1mm  Wet

OP.23 (Boring of the bush)……After heat treating  For CNC lathes

Tool features
Standard boring bar with MBC020 inserts.
MBC020 is a MIRACLE coated CBN grade.
The combination of a high rigidity CBN substrate with a coating for higher wear resistance allows MBC020 to cover a wide range of machining applications.
Use of the optimum GA type honing.

Cutting conditions
vc=120m/min  fr=0.06mm/rev  ap=0.25mm  Wet
**OP.24 (Removal of excess material for the thread)……After heat treatment**

**Tool features**
Standard holder with MBC020 inserts. MBC020 is a MIRACLE coated CBN grade. The combination of a high rigidity CBN substrate with a coating for higher wear resistance allows MBC020 to cover a wide range of machining applications. Use of cost effective, double sided, multi-corner type inserts.

**Cutting conditions**
vc=120m/min  f=0.15mm/rev  ap=1.0mm  Wet

**For CNC lathes**

---

**OP.25 (Finishing the press-fit diameter)……After heat treatment**

**Tool features**
Standard holder with MBC020 inserts. MBC020 is a MIRACLE coated CBN grade. The combination of a high rigidity CBN substrate with a coating for higher wear resistance allows MBC020 to cover a wide range of machining applications. Use of wiper inserts balances high machining efficiency and good surface finishes.

**Cutting conditions**
vc=150m/min  f=0.25mm/rev  ap=0.04mm  Wet

---

**For CNC lathes**

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OP.26  (Finishing the press-fit diameter)……After heat treatment  For CNC lathes

Tool features
Standard holder with MBC020 inserts.
MBC020 is a MIRACLE coated CBN grade. The combination of a high rigidity CBN substrate with a coating for higher wear resistance allows MBC020 to cover a wide range of machining applications. Use of cost effective, double sided, multi-corner type inserts.

Cutting conditions
vc=130m/min  f=0.1mm/rev  ap=0.1mm  Wet

OP.27  (Sheave surface)……After heat treatment  For CNC lathes

Tool features
Standard holder with MB810 inserts.
MB810 is a non-coated CBN grade.
High performance grade for high speed continuous machining. Use of the optimum GA type honing.

Cutting conditions
vc=100m/min  fr=0.22mm/rev  ap=0.05mm  Wet
CVT pulley Primary SLID

Main machining
①External turning
②Sheave surface
③Boring

Machining methods
Turning
Boring

Work material: SCr420H

OP.1 (Rough external turning and facing)  For CNC lathes

Tool features
Standard holder with UE6110 inserts.
The UE6110 grade for steel turning uses a nano-texture coating to provide excellent balance of wear and fracture resistance.
General-purpose MA breaker.

Cutting conditions
vc=190m/min  fr=0.45mm/rev  ap=1mm  Wet

DWLNR2525M08
WNMG080408-MA UE6110
OP.2 (Rough boring)  For CNC lathes

Tool features
Standard holder with UE6020 inserts. The UE6020 grade uses Even Coating Technology to provide exceptional welding and fracture resistance with a highly reliable cutting edge. General-purpose MA breaker.

Cutting conditions
\[ \text{vc} = 180 \text{m/min} \quad \text{fr} = 0.45 \text{mm/rev} \quad \text{ap} = 1.5 \text{mm} \quad \text{Wet} \]

Tooling Sheet 2

OP.3 (Finish external turning and facing)  For CNC lathes

Tool features
Standard holder with NX3035 inserts. NX3035 is a cermet grade with highly improved thermal shock resistance. Offers highly stable cutting edge performance even during wet cutting conditions that usually cause instability in conventional grades. Finishing type FV breaker.

Cutting conditions
\[ \text{vc} = 280 \text{m/min} \quad \text{fr} = 0.45 \text{mm/rev} \quad \text{ap} = 0.5 \text{mm} \quad \text{Wet} \]

Tooling Sheet 3
**OP.4 (Finish boring)**  
For CNC lathes

![Image of tool features](Image)

**Tool features**
Standard holder with NX3035 inserts. NX3035 is a cermet grade with highly improved thermal shock resistance. Offers highly stable cutting edge performance even during wet cutting conditions that usually cause instability in conventional grades. Finishing type FV breaker.

**Cutting conditions**
- $v_c = 220 \text{ m/min}$
- $f_r = 0.35 \text{ mm/rev}$
- $a_p = 0.4 \text{ mm}$
- Wet

---

**OP.5 (Rough external turning and facing)**  
For CNC lathes

![Image of tool features](Image)

**Tool features**
Standard holder with UE6020 inserts. The UE6020 grade uses Even Coating Technology to provide exceptional welding and fracture resistance with a highly reliable cutting edge. General-purpose MA breaker.

**Cutting conditions**
- $v_c = 180 \text{ m/min}$
- $f_r = 0.5 \text{ mm/rev}$
- $a_p = 1 \text{ mm}$
- Wet
OP.6 (Finish external turning and facing)  For CNC lathes

Tool features
Standard holder with UE6110 inserts. The UE6110 steel turning grade with a nano-texture coating provides excellent balance of wear and fracture resistance. The MV breaker gives effective chip control in the light to medium cutting application areas.

Cutting conditions
 vc=320m/min  fr=0.35mm/rev  ap=0.5mm  Wet

OP.7 (Finish boring)  For CNC lathes

Tool features
Standard holder with NX3035 inserts. NX3035 is a cermet grade with highly improved thermal shock resistance. Offers highly stable cutting edge performance even during wet cutting conditions that usually cause instability in conventional grades. Finishing type FV breaker.

Cutting conditions
 vc=250m/min  fr=0.2mm/rev  ap=0.2mm  Wet
OP.8 (Internal grooving)  
For CNC lathes

![Image of internal grooving tool]

**Tool features**
Standard holder with special VP20MF inserts. The VP20MF grade uses a micro-grain cemented carbide substrate. Superior wear and fracture resistance and long tool life.

**Cutting conditions**
- $v_c=150\text{m/min}$
- $f_r=0.1\text{mm/rev}$
- $a_p=1\text{mm}$
- $W=1.75\text{mm}$
- Wet

**Tooling Sheet 8**

OP.9 (Oil holes)  
For machining centres

![Image of oil holes tool]

**Tool features**
Standard holder with special VP20MF inserts. The VP20MF grade uses a micro-grain cemented carbide substrate. Superior wear and fracture resistance and long tool life.

**Cutting conditions**
- $v_c=150\text{m/min}$
- $n=7,960\text{min}^{-1}$
- $f_r=0.2\text{mm/rev}$
- $v_f=1,600\text{mm/min}$
- Wet

**Tooling Sheet 9**
OP.10  (Rough external turning and facing)......After heat treatment  For CNC lathes

**Tool features**
Standard holder with MBC020 inserts. MBC020 is a MIRACLE coated CBN grade. The combination of a high rigidity CBN substrate with a coating for higher wear resistance allows MBC020 to cover a wide range of machining applications. Use of cost effective, double sided, multi-corner type inserts.

**Cutting conditions**
vc=150m/min  f=0.22mm/rev  ap=0.2mm  Wet

---

OP.11  (Finish external turning and facing)......After heat treatment  For CNC lathes

**Tool features**
Standard holder with MBC020 inserts. MBC020 is a MIRACLE coated CBN grade. The combination of a high rigidity CBN substrate with a coating for higher wear resistance allows MBC020 to cover a wide range of machining applications. Use of wiper inserts balances high machining efficiency and good surface finishes.

**Cutting conditions**
vc=140m/min  f=0.2mm/rev  ap=0.2mm  Wet
OP.12  (Sheave surface) ......After heat treatment   For CNC lathes

Tool features
Standard holder with MBC020 inserts. MBC020 is a MIRACLE coated CBN grade. The combination of a high rigidity CBN substrate with a coating for higher wear resistance allows MBC020 to cover a wide range of machining applications. Use of cost effective, double sided, multi-corner type inserts.

Cutting conditions
vc=150m/min  f=0.2mm/rev  ap=0.2mm  Wet

OP.13  (Finishing sensor end face) ......After heat treatment   For CNC lathes

Tool features
Standard holder with MBC020 inserts. MBC020 is a MIRACLE coated CBN grade. The combination of a high rigidity CBN substrate with a coating for higher wear resistance allows MBC020 to cover a wide range of machining applications. Use of wiper inserts balances high machining efficiency and good surface finishes.

Cutting conditions
vc=150m/min  f=0.2mm/rev  ap=0.1mm  Wet
Epicyclic carriers

Main machining
①External turning, facing
②Boring
③Drilling

Machining methods
Turning
Drilling

Work material: S25C

OP.1 (Facing)
For machining centres

Tool features
Standard holder with US735 inserts.
The US735 grade helps prevent welding problems during low speed cutting and abnormal wear problems and fracturing of cutting edges at medium to low speed, interrupted cutting.
General-purpose MA breaker.

Cutting conditions
vc=100m/min  fr=0.2mm/rev  ap=1.2mm  Wet

DCLNR2525M12
CNMG120404-MA US735

Tooling Sheet 1
**Tooling Sheet 2**

**OP.2 (Outer diameter)**

**Tool features**
- Standard holder with US735 inserts.
- The US735 grade helps prevent welding problems during low speed cutting and abnormal wear problems and fracturing of cutting edges at medium to low speed, interrupted cutting.
- General-purpose MA breaker.

**Cutting conditions**
- $v_c = 150\text{ m/min}$
- $f_r = 0.1\text{ mm/rev}$
- $a_p = 1.2\text{ mm}$
- 
- Wet

**Tooling Sheet 3**

**OP.3 (Pre-drilling of holes)**

**Tool features**
- Standard WSTAR drill.
- Wave cutting edge gives a balance of edge strength and sharpness.
- High precision, stable machining.

**Cutting conditions**
- $v_c = 60\text{ m/min}$
- $n = 1706\text{ min}^{-1}$
- $f_r = 0.1\text{ mm/rev}$
- $v_f = 170\text{ mm/min}$
- 
- Wet
**OP.4 (Finishing of holes)**

For machining centres

![Image of carbide reamer HTi10](image)

**Tool features**

Special solid carbide reamer in HTi10 grade. 6-flute cutting edge enables high performance machining. Straight flute for easy re-grinding.

**Cutting conditions**

\[ v_c = 40 \text{ m/min} \quad n = 1108 \text{ min}^{-1} \quad v_f = 220 \text{ mm/min} \quad \text{Wet} \]

**Tooling Sheet 4**

**OP.5 (Drilling of the pin holes)**

For machining centres

![Image of MZE/MZS drill TF15](image)

**Tool features**

Special MZE / MZS drill with through coolant holes in HTi10 grade. Step drill consolidates processes and reduces machining costs. (Non-coated MZE / MZS offers a sharp cutting edge geometry)

**Cutting conditions**

\[ v_c = 30 \text{ m/min} \quad n = 4700 \text{ min}^{-1} \quad v_f = 235 \text{ mm/min} \quad \text{Wet} \]

**Tooling Sheet 5**
Stators

Main machining
①External turning, facing
②Boring
③Seat face
④Drilling

Machining methods
Turning
Milling
Drilling

Work material: ADC12

OP.1 (Turning of the outer diameter and facing of the RR side) For machining centres

Tool features
Standard holder with MD220 inserts. Use of PCD inserts suitable for ultra high-speed machining of aluminum alloys.

Cutting conditions
vc=1,064m/min fr=0.2mm/rev ap=1.2mm Wet

Tooling Sheet 1
**OP.2** (Boring of the inner diameter of the RR side)  
For machining centres

![Tool Image](image1)

**Tool features**
Standard boring bar with special MD220 inserts.  
Use of PCD inserts suitable for ultra high-speed machining of aluminum alloys.

**Cutting conditions**
vc=405m/min  
fr=0.2mm/rev  
ap=1.0mm  
Wet

---

**OP.3** (Boring of the inner diameter and facing of the FR side)  
For machining centres

![Tool Image](image2)

**Tool features**
Standard boring bar with special MD220 inserts.  
Use of PCD inserts suitable for ultra high-speed machining of aluminum alloys.

**Cutting conditions**
vc=561m/min  
fr=0.17mm/rev  
ap=1.0mm  
Wet

---

**Tooling Sheet 2**

**Tooling Sheet 3**
OP.4  (Pinion seat face)  

**For machining centres**

**Tool features**
Standard 4-flute centre cutting end mill. Suitable for deep slotting and finishing. Centre cutting type allows vertical feed milling.

**Cutting conditions**
- $v_c=45.2\text{m/min}$
- $n=1,200\text{min}^{-1}$
- $v_f=480\text{mm/min}$
- Wet

---

OP.5  (Drilling of the shaft holes)  

**For machining centres**

**Tool features**
Special MZE / MZS drill with through coolant holes in HTi10 grade. Step drill consolidates processes and reduces machining costs. (Non-coated MZE / MZS offers a sharp cutting edge geometry)

**Cutting conditions**
- $v_c=120\text{m/min}$
- $n=1,898\text{min}^{-1}$
- $f_r=0.15\text{mm/rev}$
- Wet
OP.6 (Drilling of the pin holes)  For machining centres

Tool features

Special MZE / MZS drill with through coolant holes in HT10 grade.
Step drill consolidates processes and reduces machining costs.
(Non-coated MZE / MZS offers a sharp cutting edge geometry)

Cutting conditions

$v_c=29.5 \text{ m/min}$  $n=4,628 \text{ min}^{-1}$  $f_r=0.13 \text{ mm/rev}$
$v_f=611 \text{ mm/min}$  Wet

MZE/MZS drill (Special)
TF15
Output shafts

Main machining
1. External turning, facing
2. Oil holes
3. Grooving

Machining methods
- Turning
- Milling
- Drilling

Work material: SCM420H

OP.1 (Facing of the FR/RR faces) For machining centres

Tool features
- Standard ASX445 type cutter with VP15TF inserts.
- The body is made from a special alloy steel that provides high heat resistance and excellent durability. Use of a screw-on type for easy and high accuracy insert clamping.
- General-purpose JM breaker.

Cutting conditions
- $v_c=110\text{ m/min}$, $n=350\text{ min}^{-1}$, $f_z=0.08\text{ mm/tooth}$
- $v_f=190\text{ mm/min}$, $a_p=1.7\text{ mm}$, Wet

ASX445R10007D
SEMT13T3AGSN-JM VP15TF

Tooling Sheet 1
OP.2 (External roughing of the FR side)  For CNC lathes

Tool features
Standard holder with UE6110 inserts. The UE6110 steel turning grade with a nano-texture coating provides excellent balance of wear and fracture resistance. The MV breaker gives effective chip control in the light to medium cutting application areas.

Cutting conditions
vc=270–170m/min  fr=0.35mm/rev  ap=1.7~2.0mm  Wet

Tooling Sheet 2

OP.3 (External roughing of the RR side)  For CNC lathes

Tool features
Standard holder with UE6110 inserts. The UE6110 steel turning grade with a nano-texture coating provides excellent balance of wear and fracture resistance. The MV breaker gives effective chip control in the light to medium cutting application areas.

Cutting conditions
vc=220~140m/min  fr=0.35mm/rev  ap=1.7~2.0mm  Wet

Tooling Sheet 3
OP.4 (Grooving)  
For CNC lathes

Tool features
Standard holder with special VP20MF inserts. The VP20MF grade uses a micro-grain cemented carbide substrate. Excellent wear and fracture resistance and long tool life.

Cutting conditions
vc=150~138m/min fr=0.1mm/rev ap=2.2mm W=2.15mm Wet

OP.5 (Drilling of the oil holes)  
For machining centres

Tool features

Cutting conditions
vc= 50m/min n=8,845min⁻¹ fr=0.08mm/rev Wet
GEAR CUTTING
**STH treated shaving cutter**

### Location
- **Open gear**
  - Spur gears
  - Helical gears

- **Shaft shoulder gear**

### Tool features
Hardening only the serrated parts improves wear resistance without decreasing the toughness of the tool substrate. The surface hardened layer remains unremoved after being reground, allowing stable tool life.

### Cutting conditions
- \( \text{vc}=110 \text{m/min} \)
- \( n=180 \text{min}^{-1} \)
- \( f=0.5 \text{mm/min} \)
- \( T_1=4, T_2=4, T_3=7 \text{(sec)} \)
- \( \text{BM}=0.02 \text{mm} \)
- Wet

---

**Variable land type shaving cutter**

### Location
- **Open gear**
  - Spur gears
  - Helical gears

- **Shaft shoulder gear**

### Tool features
To avoid the tooth profile differences between the upper and lower position caused by irregular tooth engagement, the serration land width is varied in the tooth width direction.

### Cutting conditions
- \( \text{vc}=110 \text{m/min} \)
- \( n=180 \text{min}^{-1} \)
- \( f=0.5 \text{mm/min} \)
- \( T_1=4, T_2=4, T_3=7 \text{(sec)} \)
- \( \text{BM}=0.02 \text{mm} \)
- Wet
Direct 80 dressing gear

Location

Open gear

Spur gears

Helical gears

Shaft shoulder gear

Tool features

Use of the #80 abrasive grain that has double the diameter and 4 times larger surface area than the #170 abrasive grain gives exceptional grain strength and retention force. A high precision electrodeposition technique and semi-truing method are employed for superior tooth profile accuracy.

Cutting conditions (Dressing)

Feed rate=150mm/min  Grinding wheel (N)=40min⁻¹
Feed length=±4mm  Depth of cut/ST=0.003mm
Vertical depth of cut=0.05mm

Super Violet hob

Location

Spur gears

Helical gears

Tool features

Use of a new coating for higher heat and wear resistance. Double tool life compared to conventional types when machining at vc=150m/min. Possible to machine at vc=250m/min, which was previously difficult to perform in actual machining.

Cutting conditions

vc=150m/min  n=530min⁻¹  f=2.0mm/rev  Dry
vc= 200,250m/min  n=700,880rpm  f=2.0mm/rev  Dry
**Miracle hob**

**Location**

**Tool features**

Use of (AlTi)N coating with high hardness and oxidation resistance. Possible to machine at ultra high speeds over $v_c=300\text{m/min}$. Long tool life even during post-quenching finish machining of gears.

**Cutting conditions**

$v_c=6\sim10\text{m/min}$

**Tooling Sheet 5**

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**Large diameter integral type helical broach**

**Location**

**Tool features**

An integral broach type enables reduction of finishing allowance. Longer tool life by reducing the load on each cutting edge.

**Cutting conditions**

$v_c=335\text{m/min}$ $n=1180\text{min}^{-1}$ $f=1.85\text{mm/rev}$ Dry

**Tooling Sheet 6**
Power forming rack

Location

Tool features
Fine particle shot peening is provided to apply residual stress on finish teeth to dramatically increase the fracture resistance of the rack teeth.

Rolling conditions
Rolling speed: 10~20m/min

Tooling Sheet 7