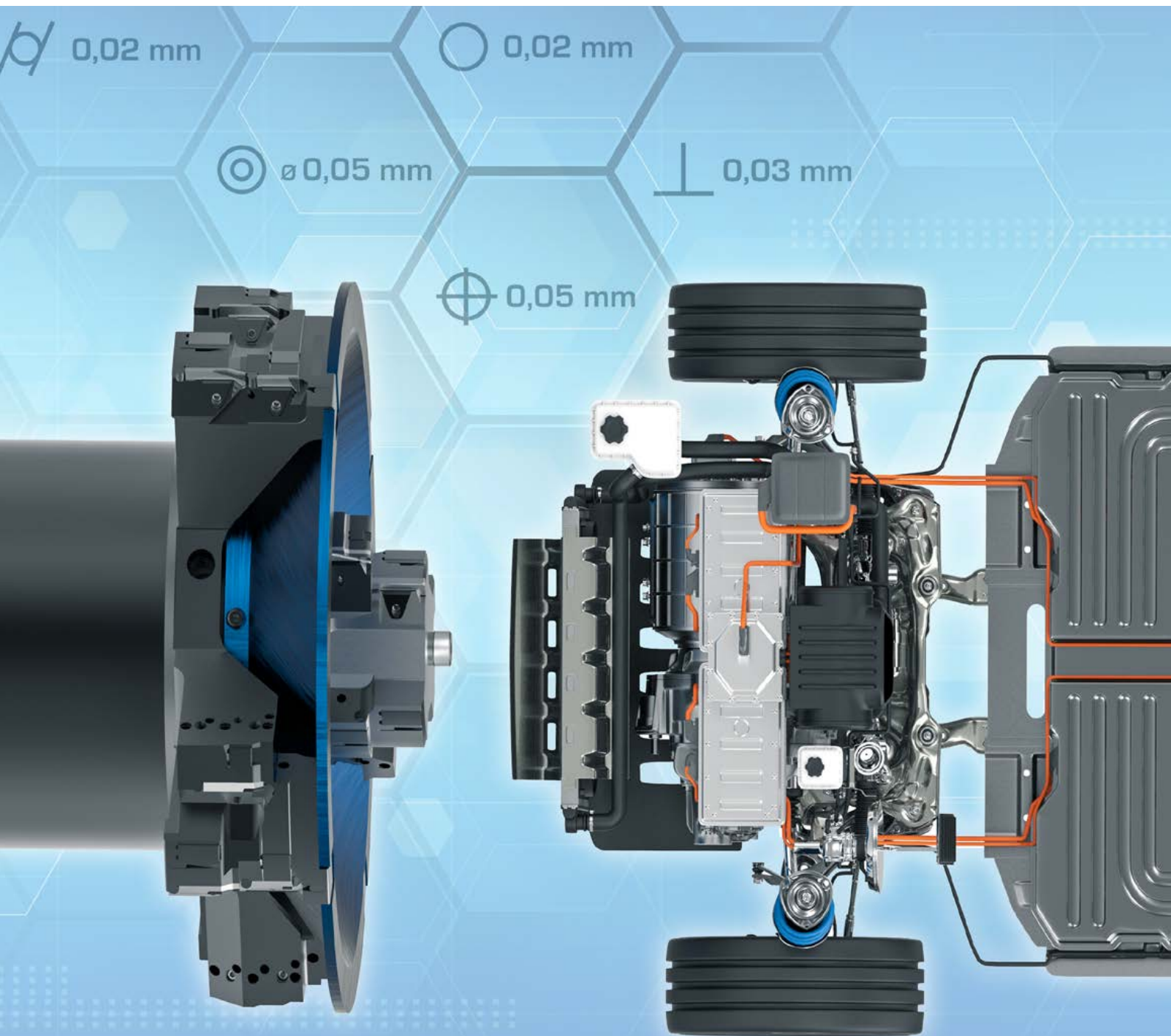




Your technology partner for cost-effective machining  
**ELECTRIFIED MOBILITY**



# Markets and sectors

After many years of close cooperation with customers, MAPAL has acquired a profound understanding of almost all processes and applications in machining production. The fields of application in which machining solutions from MAPAL are used are found in a wide variety of industries.

To overcome the challenges of the automotive industry and the large series production that goes with it, MAPAL has always been developing innovations that are successfully used by all well-known manufacturers and their suppliers in the chassis as well as in the powertrain area and in electric mobility. With process reliable solutions, MAPAL is also an accredited partner to the aerospace industry and sets trends and standards in manufacturing and machining technology. A comprehensive product range is also available for its latest area of expertise, the die & mould sector.





**Germany**  
Headquarters of the group of companies

**Close to the customer – globally**

The close dialogue with customers and thus the early recognition of technological requirements and approaches for innovations are essential pillars of the MAPAL company policy. As a result, MAPAL is directly represented with production and sales branches in 25 countries. This ensures close proximity, personal contacts and long-term partnerships.

In addition to the main production facilities in Germany, local production facilities in strategically important markets worldwide guarantee short delivery times. They are responsible for the manufacture of selected products as well as for reconditioning, repairs and repeat orders for the local market.

In addition to its own branches, MAPAL products are available through sales agencies in a further 19 countries.



**No. 1**

Technology leader for the machining of cubic parts.

Subsidiaries offering production, sales and service in

**25** countries.

Yearly investment in research and development amounting to

**6%** of turnover.

Over

**450**

technical consultants in the field.

More than

**300**

apprentices worldwide.

**Our biggest asset: More than**

**5,000**

staff worldwide.

MAPAL sectors

- 1 Electric mobility
- 2 Automotive
- 3 Aerospace
- 4 Machine engineering
- 5 Energy production
- 6 Medical technology
- 7 Die & mould sector
- 8 Shipbuilding
- 9 Rail transport

# Electrified mobility – tool solutions for every concept

## Mobility is changing – the goal is a CO<sub>2</sub>-neutral future

For the vehicle industry, this means developing alternative drive concepts. One approach is to move away from the combustion engine and towards the electric drive. But this change will not happen overnight. The components of the conventional drive are being further developed and the use of vehicles with hybrid systems is increasing. Nevertheless – sooner or later, fully electrified vehicles will be the main users of roads.

As a supplier of cutting tools for the automotive industry, MAPAL incorporated this topic into the company's strategic orientation at an early stage. And transferred its expertise in machining the conventional power train to the components to be machined in electrically powered vehicles.



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## Electrified drives

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## Electrified micromobility

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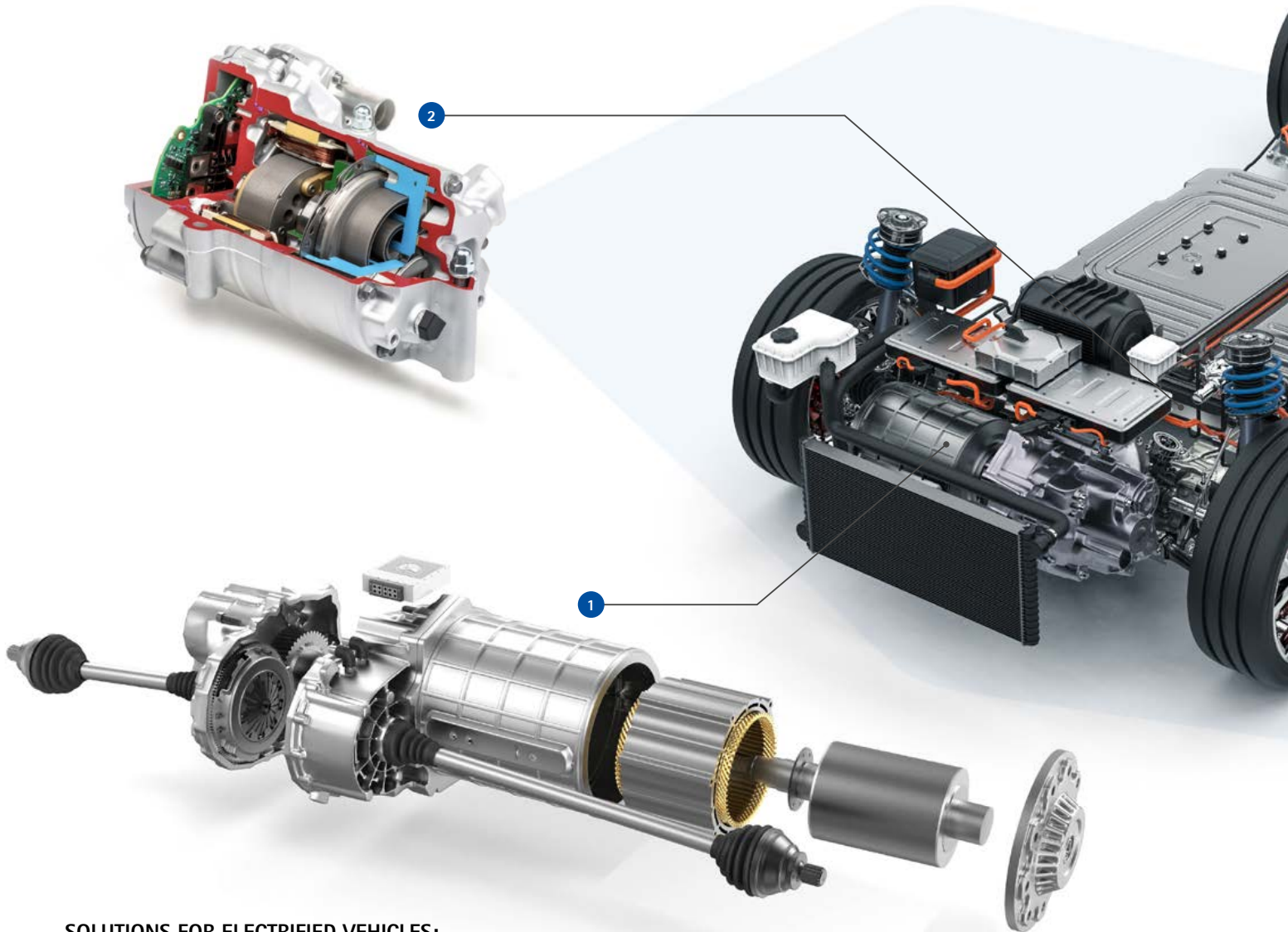
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# New systems and parts for electrified mobility



## SOLUTIONS FOR ELECTRIFIED VEHICLES:

1

### Electrified drives

(Hybrid and fully electric)

#### High-precision with large diameters

Different electric motor housings are used in vehicles with electric drives. You can differentiate between three basic types of construction. MAPAL offers innovative tool solutions for machining tasks with the housing types.

>> More from page 8

2

### Electrified auxiliary units

(Thermal management)

#### Spiral shapes with tolerances in the $\mu\text{m}$ range

Not only the drive and energy storage systems are affected by the electrification of vehicles, but also some auxiliary units. An example of this is the electric refrigerant compressor (scroll compressor).

>> More from page 20

3

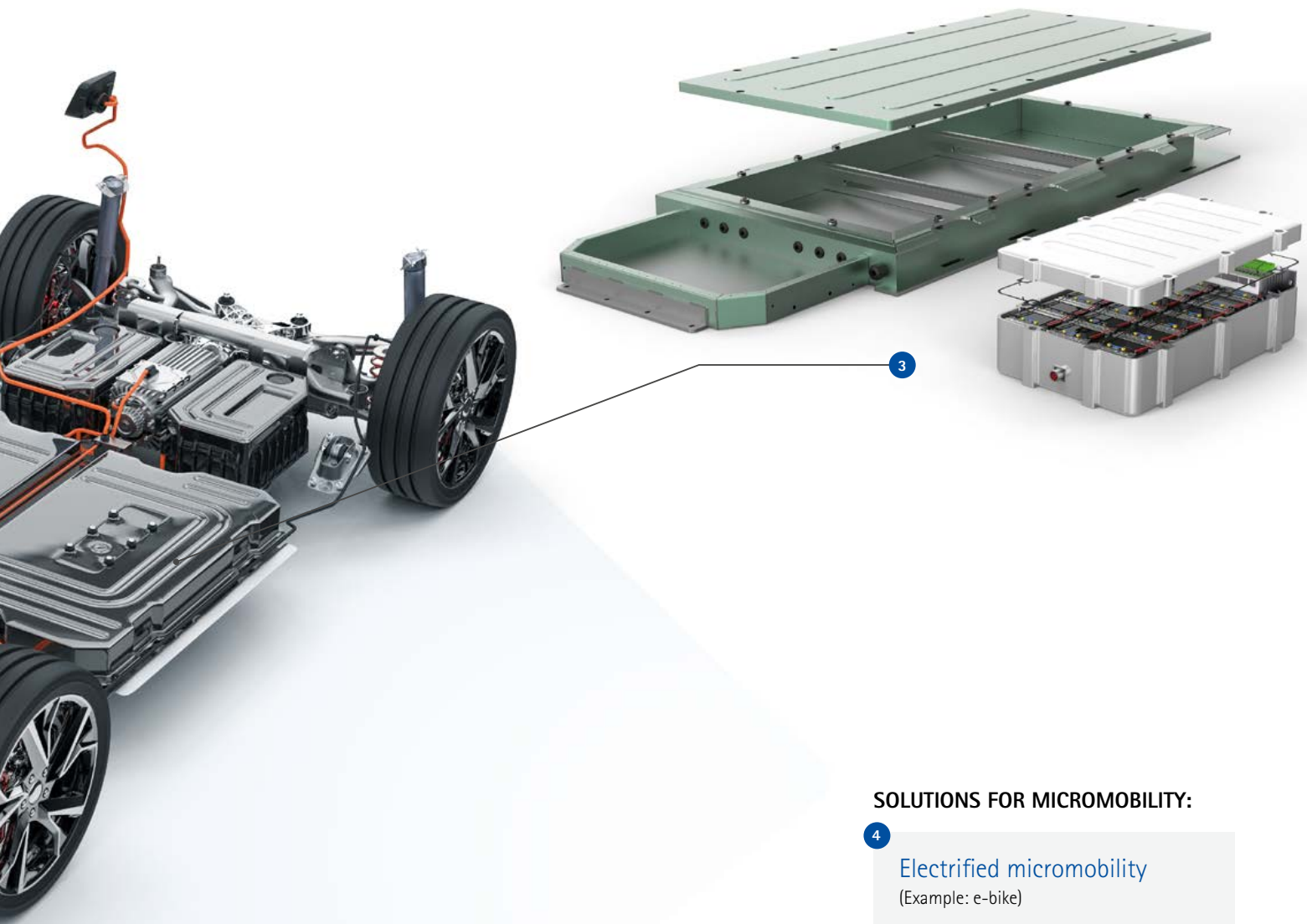
### Energy supply

(Storage, control, charging)

#### Machining complex, thin-walled housings vibration-free

MAPAL offers the appropriate tools with the optimal machining strategy for the various housing variants for batteries and power electronics. The powerful tool portfolio includes PCD and solid carbide tools.

>> More from page 22



**SOLUTIONS FOR MICROMOBILITY:**

4

**Electrified micromobility**  
(Example: e-bike)

**High-precision even on a small scale**  
The very thin-walled housings made of aluminium or magnesium must be manufactured with tight shape, running and position tolerances. The high precision guarantees the tangible comfort of the drives for e-bikes.

**>> More from page 24**




# Electrified drives

Automobile manufacturers and suppliers are facing new challenges when it comes to components for electric motors. The example of the housing of an electric motor shows how big these challenges are: Compared to a transmission housing, this has to be manufactured within significantly tighter tolerances, since the accuracy has a decisive influence on the efficiency of the motor.

In addition, due to the special structure, such as integrated cooling channels, the electric motor housing is usually significantly thinner than a transmission housing. In addition, bearing bushes made of steel materials are pressed into some of these housings. Special protection shields in the tool ensure that steel chips do not come into contact with the aluminium surfaces during processing and damage them.

## Required dimensional tolerances

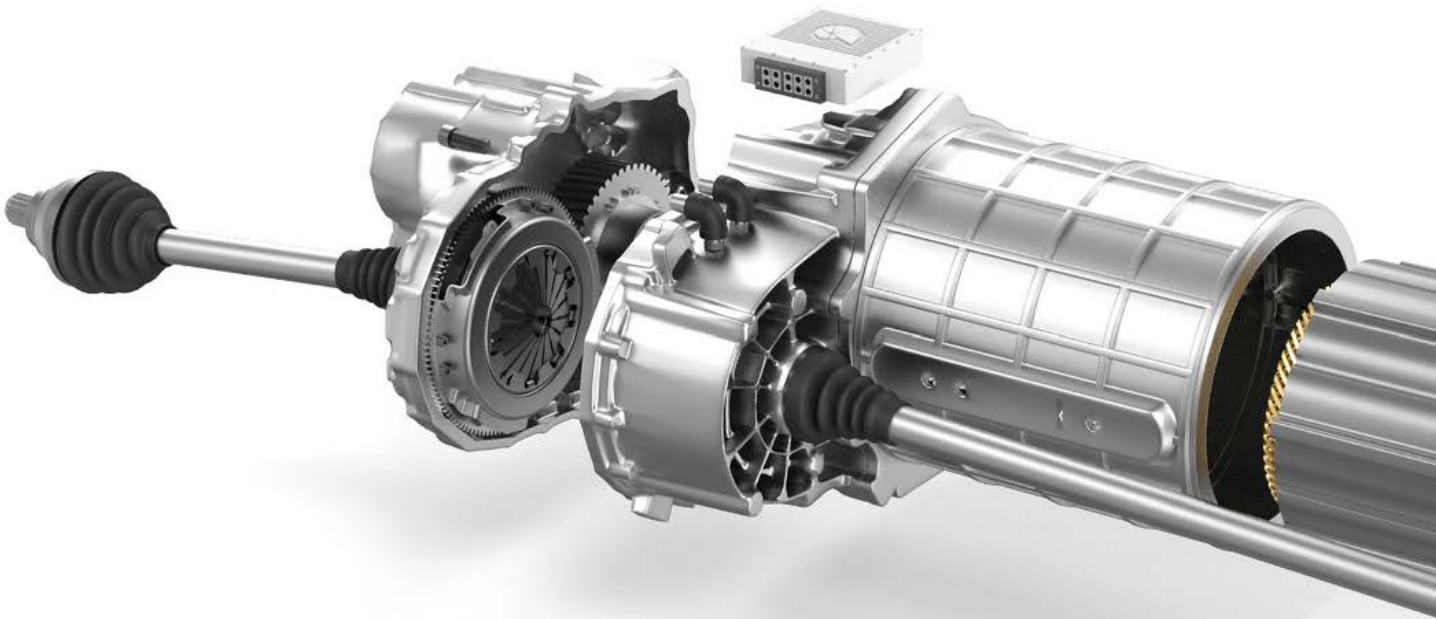
 0,02 mm

  $\varnothing$  0,05 mm

 0,05 mm

 0,02 mm

 0,03 mm



## SOLUTIONS FOR...

### ... highly productive tools for large scale production

MAPAL takes on the planning of complete work-pieces and implements a safe process for large scale production. Customers can concentrate on their core competences – quickly, flexibly and transparently.

### ... weight-optimised tools for series production with hollow shank taper A63

Continuing to use existing machines saves time and money. MAPAL has the necessary know-how to support its customers in the process-reliable conversion for series production – individually customised to their needs.

### ... flexible and cost-effective tool solutions for small series

Adjustable tool solutions enable flexible processing, which is particularly relevant for small series and prototypes due to changing requirements. MAPAL offers simple, flexible and cost-effective tool solutions for this – optimally set up for all requirements



## Basic procedure for machining electric motor housings

The machining process as well as the tools are designed individually depending on the measurement situation, machine park and clamping setup. In this way, the cutting forces applied to the component are kept as low as possible. In addition to the requirements of the component, in most cases the performance of the processing machine is decisive for the design of the tools.

### The machining of the stator bore is divided into 3 steps:

A boring tool is the first choice for pre-machining. This concept enables high cutting speeds and feed rates for fast and economical material removal.

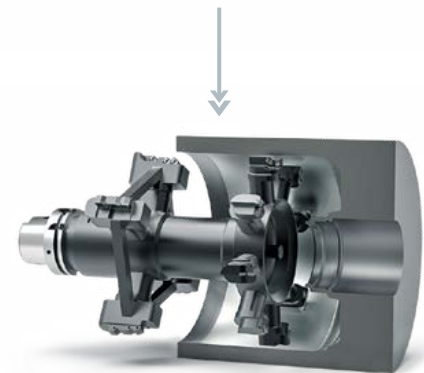
In semi-finish machining, the complex contour of the electric motor housing is pre-machined in such a way that the complete contour with chamfers and radial transitions can be produced in the required quality in the final finishing.

In the last step, the stator bore is machined with a precision of a few  $\mu\text{m}$  using a fine boring tool with finely adjustable indexable inserts and guide pads.

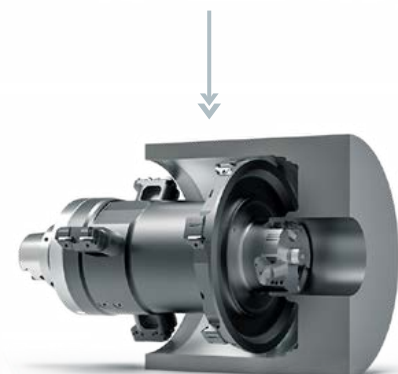
**In comparison to finish-boring, significantly shorter main times can be achieved in this way (see table below).**



1. Pre-machining



2. Semi-finish machining



3. Finish machining

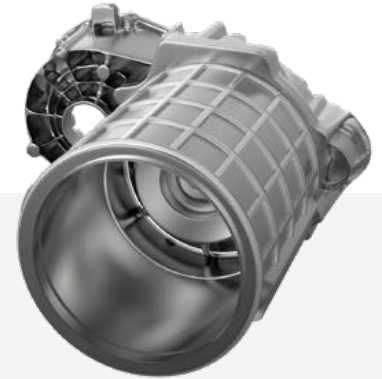


Concepts	Work sequence	Z	$\varnothing$ [mm]	n [1/mm]	$f_z$ [mm/Z]	$v_f$ [mm/min]	$a_p$ [mm]	$t_H$ [mm]	Comparison of main times
Finish-boring	Roughing	1	219.0	600	0.2	120	1.7	1.67	5 min
	Finishing	1	220.0	600	0.1	60	0.5	3.33	
Boring and fine boring	Boring	4	215.7	1476	0.2	1180	max. 7.0	0.17	0.48 min
	Semi-Finish	8	219.7	1083	0.3	2600	2.0	0.08	
	Finish	4	220.0	1083	0.2	866	0.15	0.23	

Values determined using a specific example of a component to compare the processing options

# Machining requirements and features of different housing types

## Highly integrated electric motor housing



### Description:

Highly integrated, complex housing with stator mount, transmission mount and connection for the power electronics. High functional integration saves assembly costs. Compact design. Complex cast housing as a result.

### FEATURES

- Stator incorporated directly in the housing or via a stator carrier / cooling jacket
- Stator bore with stages and flat surfaces as functional surfaces
- A bearing bore of the rotor is integrated coaxially with the stator bore in the housing
- Positioning of the second bearing cover via dowel pins or fitting surfaces; second bearing bore must be coaxial
- Bearing bores of transmission stages integrated in the housing; high concentricity and positional accuracy are required
- Cooling channels partially integrated in the housing
- Complex cast aluminium housing

### MACHINING REQUIREMENTS

- Elaborate contour trains with several diameter levels (→ high cutting forces and large machining volume)
- Mixed processing (→ chip separation / removal)
- Interrupted cuts (→ contacting, cooling circuit)
- 15°-30° flat lead-in chamfers (→ flow chip formation and high radial forces)

## Pot-shaped electric motor housing



### Description:

To reduce the complexity, in particular to implement a simpler construction of the cooling jacket, pot-shaped or bell-shaped housings or stator supports are used.

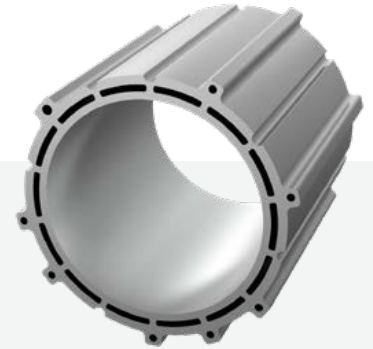
### FEATURES

- As an intermediate housing for integration in the overall system
- Stator bore with stages and flat surfaces as functional surfaces
- A bearing bore of the rotor is integrated coaxially with the stator bore in the housing
- Positioning via fitting surfaces on the outer surface
- Cooling channels as ribs on the outside
- Thin-walled, susceptible to vibration
- Tension problematic

### MACHINING REQUIREMENTS

- Extremely thin-walled parts (→  $a_p$  corresponds to wall strength)
- Outer cooling ribs must be machined
- Pot or bell shape (→ promotes vibrations, special clamping concepts and vibration dampers)
- 15°-30° flat lead-in chamfers (→ flow chip formation and high radial forces)

## Tubular electric motor housing



### Description:

The simplest design of motor housings is tubular. The length of the housing and thus the electrical machine can be varied comparatively easily for different powers. As a result, the installation effort increases due to the low level of functional integration.

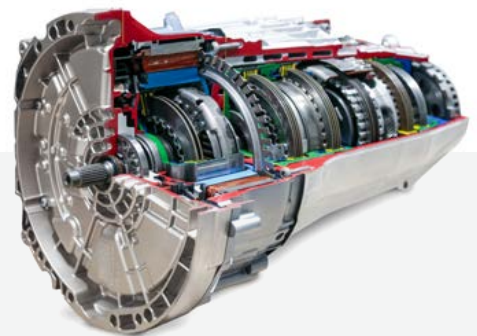
### FEATURES

- No rotor bearing bores integrated in the housing
- Two bearing covers to hold the rotor
- Positioning of the two bearing covers over fitting surfaces for coaxiality of the bearing points
- Minimal complexity
- Practically rotationally symmetrical
- Thin-walled, susceptible to vibration
- Tension problematic

### MACHINING REQUIREMENTS

- More stable components usually with an internal cooling structure
- Extruded profiles also possible (AlSi1 → flow chips)
- Without clamping straps (→ special clamping concepts)
- Partly with fits on both sides in IT6 tolerance

## Hybrid transmission housing and hybrid module/intermediate housing



### Description:

Integration of the electrical machine into the existing transmission architecture using disk-shaped hybrid modules or intermediate housing. Space neutral structures are also implemented with partially pot-shaped housings as slide-in parts.

### FEATURES

#### Hybrid module/intermediate housing

- Mainly incorporation of the stator
- No rotor bearing with disc shape
- Rotor bearing integrated with pot shape

#### Hybrid transmission housing

- Extreme length-diameter ratios
- Thin-walled, susceptible to vibration
- Elaborate contour trains
- Interrupted cut

### MACHINING REQUIREMENTS

#### Hybrid transmission housing

- IT6 tolerance
- High demands on coaxiality and stage dimensions
- Restricted maximum weight and moment of tilt

# Solutions for electric motor housings

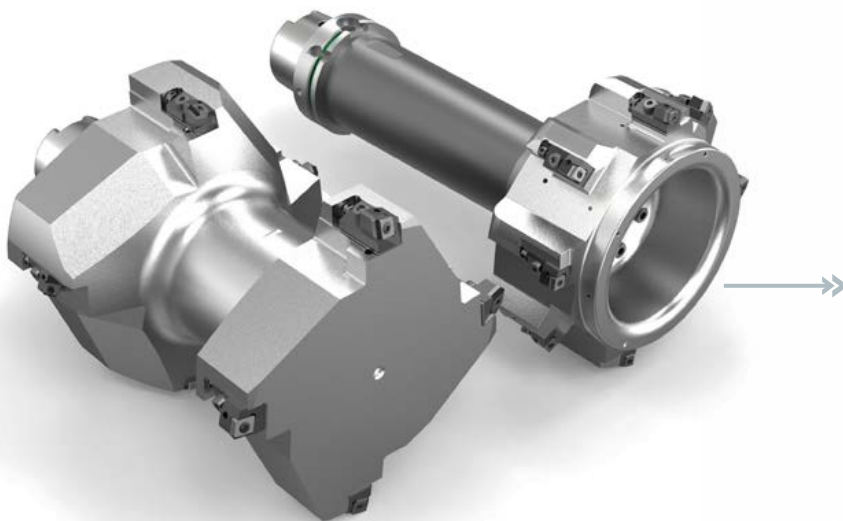
## Series solution with hollow shank taper 100

### Highly productive for large diameters

- Three stage process (pre-, semi-finish and finish machining)
- Large machining diameter > 220 mm
- The highest levels of performance and precision
- Ideal process for large quantities and short cycle times

#### 1. Pre-machining

Efficient roughing with high cutting depth

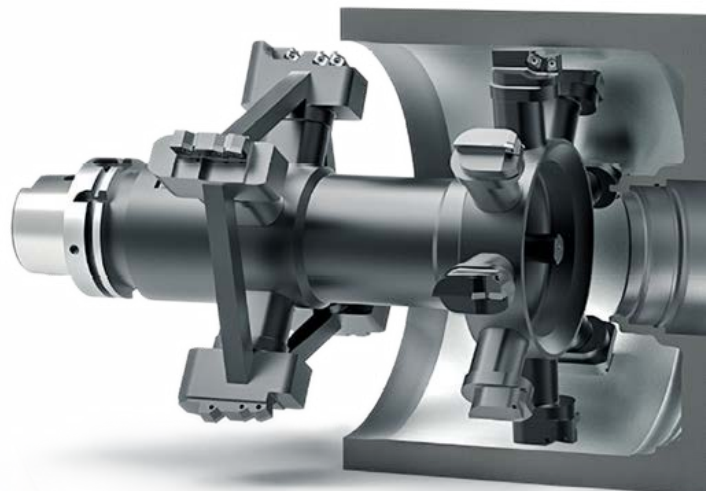


#### ISO-BORING TOOL IN ALUMINIUM DESIGN

- $\varnothing$  250 / 258 mm
- PCD-tipped indexable inserts
- ISO cartridges
- Designed as single or multi-stage
- Weight: max. 21 kg

#### 2. Semi-finish machining

Contour-forming to approximately the final contour

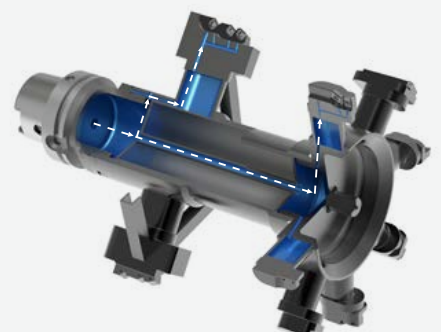
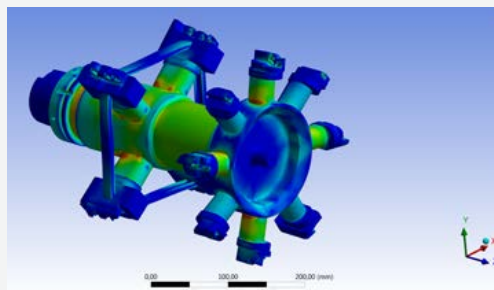


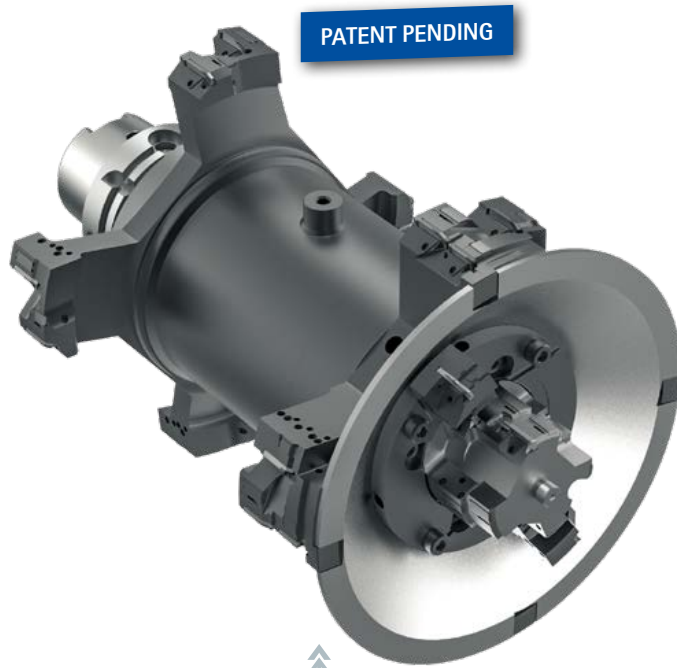
#### PRECISION BORING TOOL

- $\varnothing$  272 / 278 mm
- PCD-tipped indexable inserts
- Design as welded construction or with tool body made of aluminium
- Weight: max. 17.3 kg

#### Individual tool design for specific requirements

- Simulation of the cutting force components
- Calculation of weight and moment of tilt
- FEM calculation of the natural frequencies of the system and the flexibility under axial force / torsional load
- Calculation of coolant distribution and volume flows





### 3.1 Finish machining

#### Innovation for the highest precision

#### FINE BORING TOOL IN LIGHTWEIGHT CONSTRUCTION MADE OF STEEL WITH PROTECTION SHIELD FOR MIXED MACHINING OF THE BEARING BORE

- $\varnothing$  70 / 156 / 250 / 260 mm
- PCD-tipped indexable inserts for aluminium housing
- $A = 362$  mm |  $z = 2+4$
- Cermet indexable inserts for machining of steel bearing bushes
- Finely adjustable and temperature stable
- Guide pad technology
- Weight: max. 21 kg

#### In detail:

With the help of a special chip guiding stage, the appropriate coolant supply and open chip spaces, the steel chips are reliably removed to the front. The aluminium chips, on the other hand, are removed to the rear by a specially designed back-wash. In order to ensure that no steel chips get into the aluminium area, the tool is equipped with a so-called protection shield, which ensures that the steel chips stay in the front area.

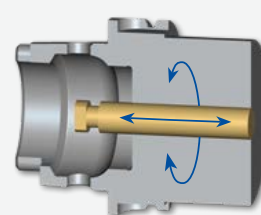
### 3.2 Finish machining

#### Flexible machining of the inner contour

#### ACTUATING TOOL FOR U-AXIS SYSTEMS

- $\varnothing$  80 / 220 mm
- Suitable for machining of housing variants
- To compensate for cutter edge wear
- Weight: max. 23 kg

#### In detail:



#### U-AXIS (rotary / translational)

The movable slides are moved via the U-axis (pull or rotating rod) of the processing machine and controlled via the machine control and set via the machine's NC control. This is a fully integrated NC axis that can be used for contour machining.

# Solutions for electric motor housings

## Series solution with hollow shank taper 63

### For medium and small diameters

- Specially light tools required
- Diameter of the stator bore < 220 mm recommended
- Tools adapted to less performance and space available
- Also suitable for reconditioning existing machines and systems

#### 1. Pre-machining

Flexible for different diameters



#### HELIX MILLING CUTTER WITH ISO INDEXABLE INSERTS

- Coated ISO indexable inserts made of carbide or PCD-tipped indexable inserts
- Reduced cutting forces
- Standard product
- HSK extension for different machining depths

#### 2. Semi-finish machining

Contour-forming to approximately the final contour

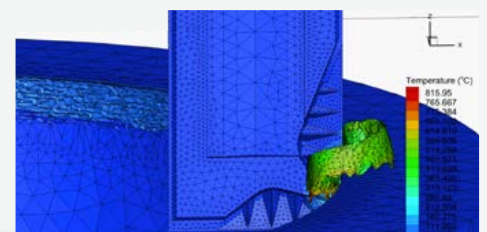
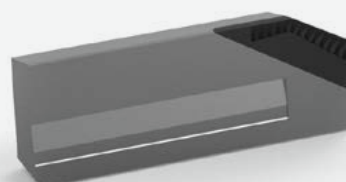


#### PRECISION BORING TOOL

- $\varnothing$  182 / 185 mm
- ISO cartridges
- PCD-tipped ISO indexable inserts
- Tool body made of aluminium
- Weight: max. 9.5 kg

### Process reliability through chip control – chip guiding stage for the fine machining of AISi alloys

MAPAL has developed a new chip breaker to ensure defined chip breaking when boring and reaming with PCD aluminium with a low content of silicon. Its special topology, which was developed with the help of 3D simulations, ensures a defined chip break and thus short chips. Defined chip breakage and a defined chip shape are guaranteed even with low feed rates and low allowances. This ensures the highest performance and process reliability.





### 3.1 Finish machining

#### FINE BORING TOOL IN LIGHTWEIGHT CONSTRUCTION MADE OF STEEL

- $\varnothing$  70 / 176 / 185 mm
- PCD-tipped indexable inserts
- A = 198 mm | z = 2+4+2
- Cermet indexable inserts for machining of steel bearing bushes
- Finely adjustable and temperature stable
- Guide pad technology with EA system
- Weight: max. 11.5 kg



### 3.2 Finish machining

#### ULTRA-LIGHT FINE BORING TOOL MADE OF STEEL

- $\varnothing$  219 / 222 / 225 mm
- PCD-tipped indexable inserts
- A = 257 mm | z = 2+4+2
- Finely adjustable and temperature stable
- Guide pad technology
- Weight: max. 8.5 kg



# Solutions for electric motor housings

## Prototype, pre-series and small series construction

### Simple, flexible and cost-effective tool solutions

- Machining on existing machines
- Standard tools or simple custom tools
- Compromise solutions → small machine – big tool
- Cycle time is not the focus
- High flexibility is what is wanted
- Universal application
- Contour independent

#### 1. Pre-machining

Flexible for different diameters

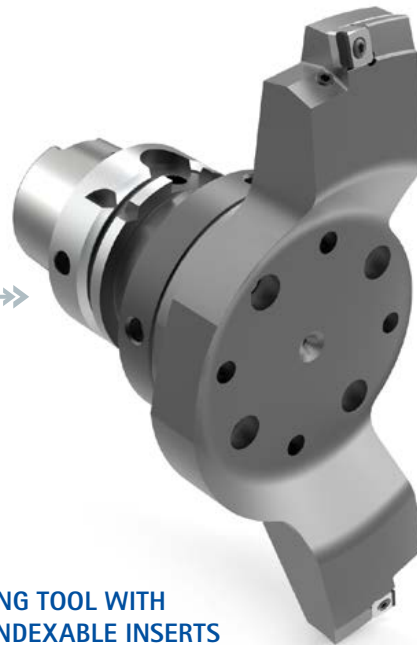


#### HELIX MILLING CUTTER WITH ISO INDEXABLE INSERTS

- Coated ISO indexable inserts made of carbide or PCD-tipped indexable inserts
- Reduced cutting forces
- Standard product
- HSK extension for different machining depths

#### 2. Semi-finish machining

Contour-forming to approximately the final contour



#### BORING TOOL WITH ISO INDEXABLE INSERTS

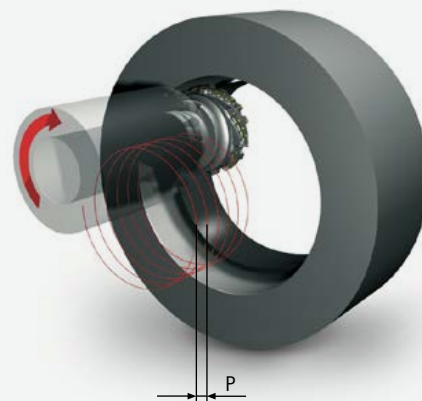
- $\varnothing$  210 mm
- Tool shape adapted to magazine changer
- Coated ISO indexable inserts made of carbide or PCD-tipped indexable inserts
- Weight: max. 3.5 kg

#### Helix milling – helical angled entry

The helical angled entry is an alternative to boring. This involves a circular movement with feed. Due to the larger machining distances compared to boring. However, the cutting forces that occur are significantly lower, which means that the stator bore can also be machined on machines with low torque and low power. In addition, the use of a helix milling cutter enables pre-machining with different diameters.

#### Pitch (P):

The pitch (P) corresponds to the axial simultaneous axial revolution. This depends on the workpiece, tool length, material and machine.







### 3. Finish machining

With simple custom tools

#### FINE BORING TOOL WITH GUIDE PADS

- $\varnothing$  210 mm
- PCD-tipped indexable inserts
- Finely adjustable
- Guide pads made of PCD
- Tool shape adapted to magazine changer
- Weight: max. 5.5 kg

### Pre- and finish machining

Alternative with standard tools

#### MODULE BORE – HIGH FLEXIBILITY DURING BORING UND FINE BORING

- Pre- and finish machining system
- Modular construction
- Standard programme from  $\varnothing$  87 mm – 1000 mm
- Fine boring cartridge adjustable in the  $\mu\text{m}$  range
- Easy handling

Boring heads with bridge module and ISO cartridges



Fine boring heads with bridge module and fine boring cartridge

#### In detail:

Fine boring heads with bridge module and fine boring cartridges enable high flexibility in small series. The bridge modules have slides that are fitted with adjustable fine boring cartridges. An opposite slide is used to compensate for the unbalance.

# Solutions for electric motor housings

## Bearing and position bores

### With maximum concentricity and roundness

A constant air gap between rotor and stator is crucial for the functioning and efficiency of the electric motor. In addition to the coaxiality of the bearing and stator bores, the roundness and cylindrical shape of the bearing seat are decisive for this. In order to meet the high coaxiality demands, it is advantageous to machine the bearing seat in one clamping setup (retraction machining). In the case of tubular or pot-shaped housing, there is at least one bearing point in a separate bearing cover, which is positioned on the electric motor housing via position bores or fitting surfaces.



### 1. Pre-machining

#### Boring of bearing and position holes



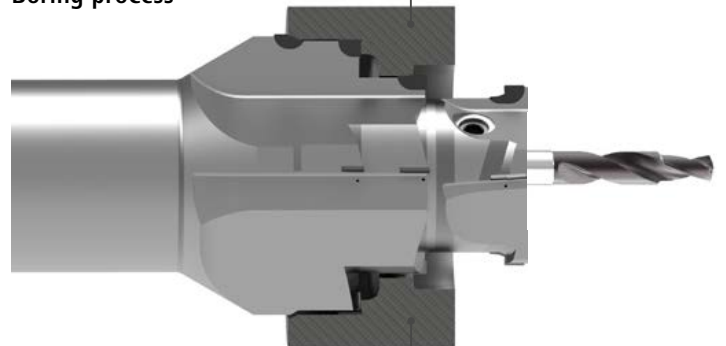
#### ISO BORING TOOL

- Multi-stage boring tool with solid carbide step drill
- PCD-tipped ISO indexable inserts

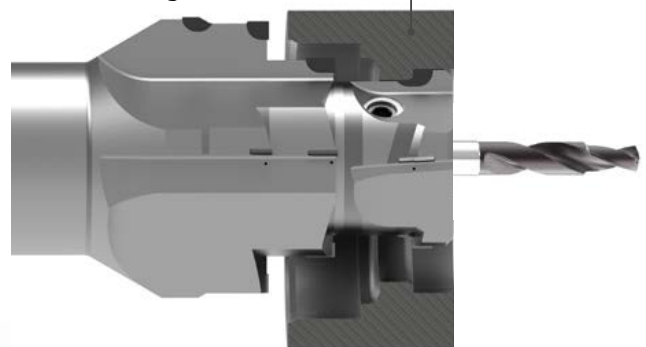
#### PCD BORE MILLING TOOL

- Multi-stage bore milling tool with solid carbide step drill
- Boring and circular milling with a single tool
- Brazed PCD cutting edges

#### Boring process



#### Circular milling



## 2. Finish machining

### MULTI-STAGE ISO CIRCULAR MILLING CUTTER WITH INTEGRATED BORING STAGE

- Boring of the bearing bore
- Finishing of face surfaces and radial recess



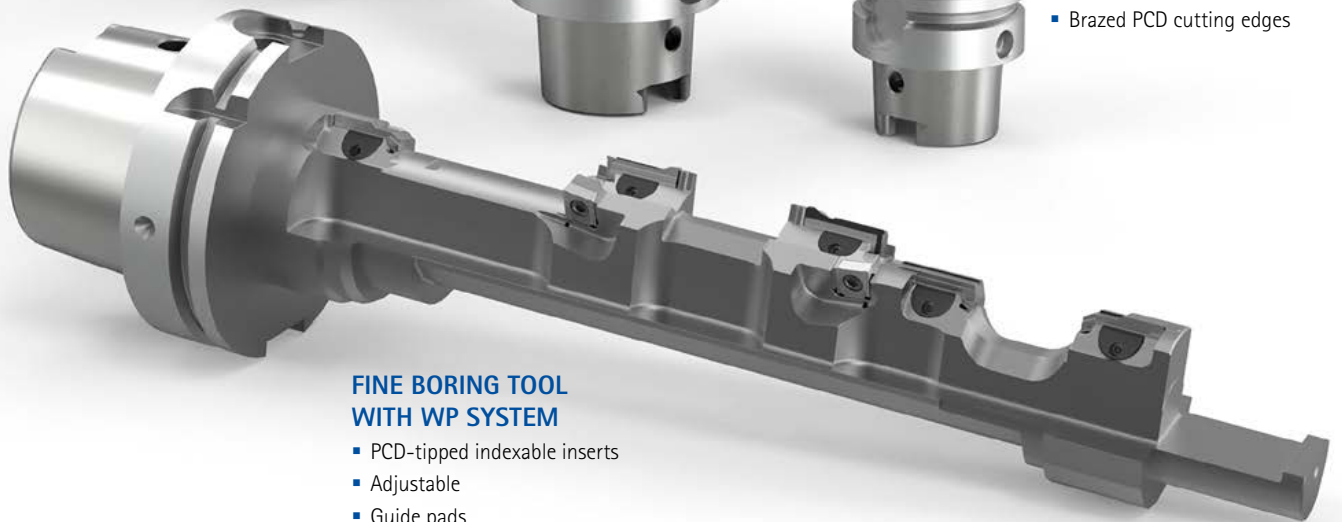
### FINE BORING TOOL WITH WP SYSTEM

- PCD-tipped indexable inserts
- Adjustable
- Guide pads
- Integrated retraction machining



### PRECISION BORING TOOL

- Multi-stage combination tool with brazed step drill
- Finishing of bearing and position holes
- Brazed PCD cutting edges



### FINE BORING TOOL WITH WP SYSTEM

- PCD-tipped indexable inserts
- Adjustable
- Guide pads
- Integrated retraction machining

### Sealing and contact surfaces



### FACE MILLING CUTTER WITH PCD MILLING INSERTS

- Creation of defined surface profiles for sealing and contact surfaces (e.g. cross-cut structures)
- Surface finish  $R_z < 1$



### MONOLITHIC FACE MILLING CUTTER WITH PCD MILLING INSERTS

- Long overhangs make it possible to work on hard-to-reach areas

### External machining of the bearing bore



### EXTERNAL REAMER WITH EA SYSTEM

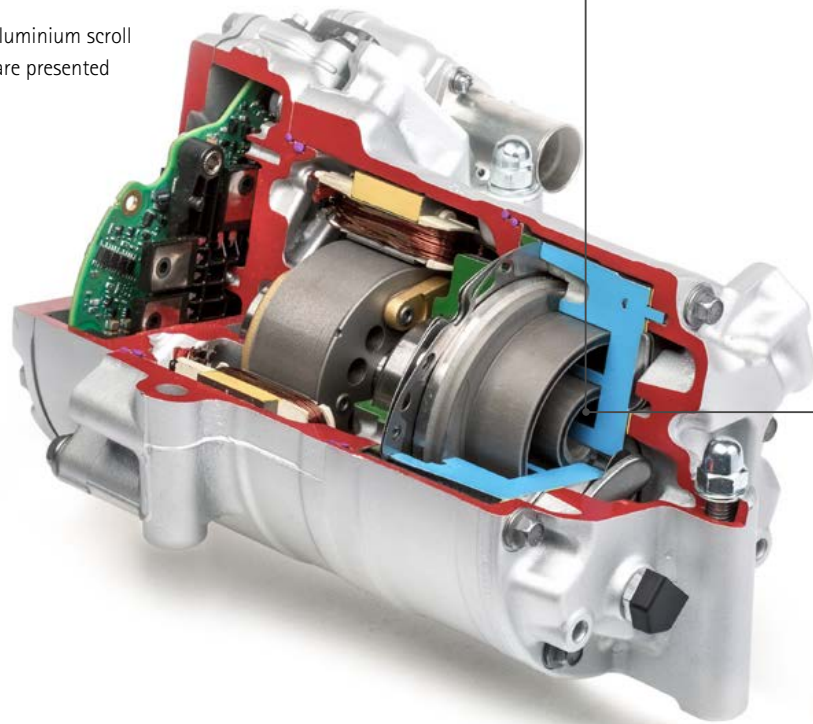
- External machining of the bearing bore

# Electrified auxiliary units

As a result of electrification in the automotive industry, more and more drive tasks of the internal combustion engines are being performed by electrified components. By electrifying the auxiliary units, these components can be used as required and depending on the load, and thus contribute to reduced energy consumption. They stand out thanks to their high reliability and low noise emissions as well as excellent energy efficiency.

An example of this is the scroll compressor, which is used as an electric refrigerant compressor in thermal management.

Three specific machining operations on an aluminium scroll compressor for use in an electrified vehicle are presented as examples.



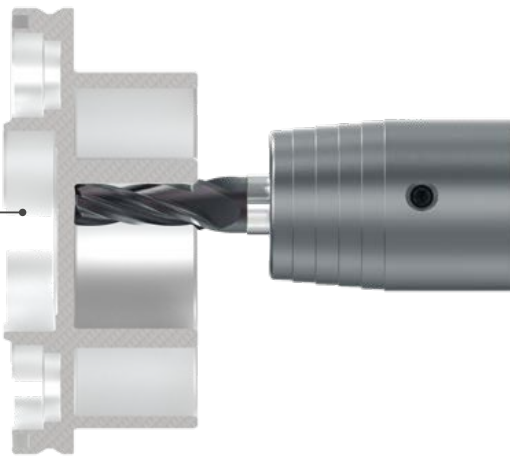
## FEATURES

- Core pieces orbit and fixed scroll
- Geometric accuracy and connection is paramount
- Exact positioning of the spirals to each other

## MACHINING REQUIREMENTS

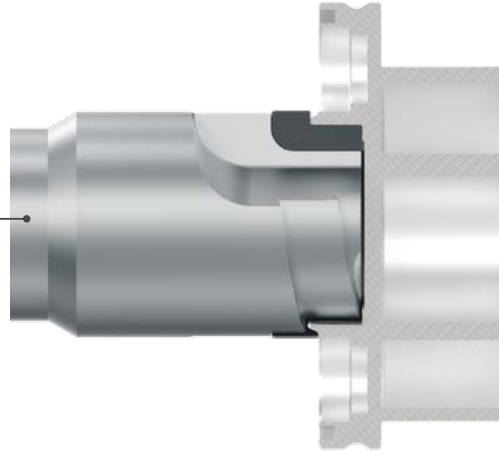
- High degree of shape accuracy of the spirals ( $\leq 20 \mu\text{m}$ )
- High perpendicularity of flanks to base surface ( $\leq 20 \mu\text{m}$ )
- Parallel alignment and flatness of  $\leq 10 \mu\text{m}$
- Surface roughness ( $R_z$ ) in the single-digit range
- Perfect interaction between machine and tool





### 1 HIGH PRECISION SPIRAL SHAPES

- Pre-machining and finish machining with solid carbide milling cutters
- Extremely sharp cutting edges ensure high dimensional accuracy



### 2 PRECISE BEARING BORE

- Pre-machining is carried out by circular milling with a triple-fluted PCD milling cutter
- Finish machining with double edge PCD boring tool with two stages and distribution of the cut to reduce the cutting forces



### 3 RECESSES FOR SEALING ELEMENTS

- Pre-machining and finish machining of the recesses is carried out with double-edged PCD boring tools
- Combination tool enables the machining of the connection bore
- Distribution of the cut reduces cutting forces and ensures optimal chip formation



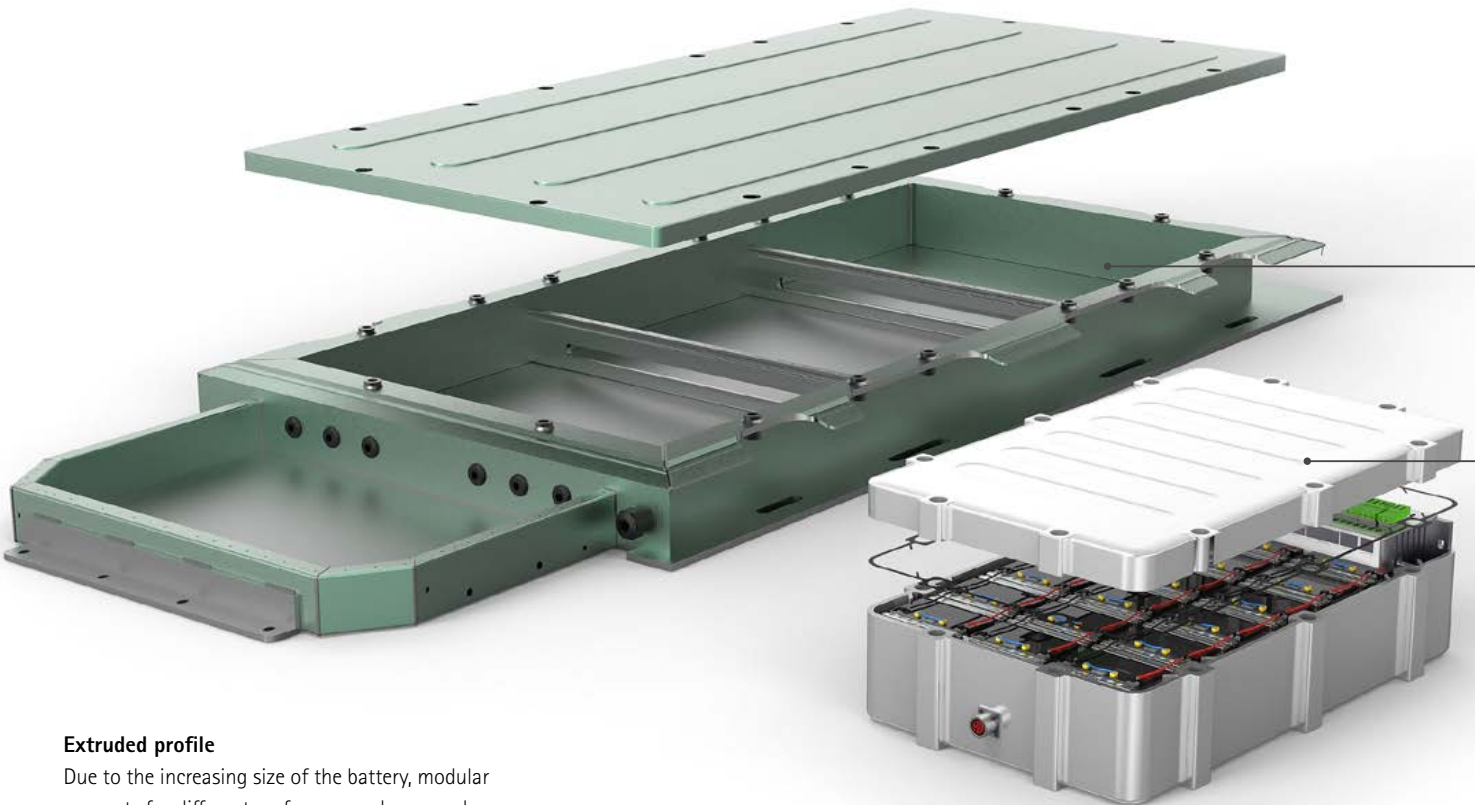
MAPAL offers the complete process for machining scroll compressors from a single source.

# Energy supply housing

Different housings are used to protect electronic components, such as battery systems or power electronics, from external environmental influences and to attach the components to the interior in order to ensure that they function properly during vehicle operation. The requirements for the housing depend on the electronic system and drive concept. Different materials and manufacturing processes are currently used.

## FEATURES

- Unstable, thin-walled components (susceptible to vibration)
- Construction as a cast tub or as a frame construction made of hollow profiles
- Partly low-silicon aluminium
- Large area (2 × 3m)
- Mainly drilling and milling operations and threading
- Accuracy and surface requirements for cable bushing and cooling connections



## Extruded profile

Due to the increasing size of the battery, modular concepts for different performance classes and ranges are used. For this reason, extruded aluminium profiles are welded to form a housing.

### MACHINING REQUIREMENTS

- Thin material with several layers
- **Drilling:** Vibrations and burr formation. Ring formation on the tool
  - Helix milling/orbital drilling prevents burrs and rings
- **Milling:** Thin material tends to vibrate
  - Fewer vibrations through optimised cutting edge geometry

## Die-cast housing

Die-cast aluminium housings are mostly used to accommodate power electronics or smaller battery systems for hybrid vehicles. The complex housing structures are designed with integrated cooling channels.

### MACHINING REQUIREMENTS

- Milling of sealing surfaces (in some cases specific surface requirements)
- Drilling of core holes (> 50 holes per component)
- Milling of mounting surfaces for electronics and battery cells with long tool overhang



1.1

1.2

1.3

2

### OptiMill-SPM

Standard programme for the machining of aluminium structural parts

- Highly positive cutting edge geometry
- Reduced cutting forces
- Low vibration cut

#### 1.1 OptiMill-SPM-Rough

- Low vibration roughing with deep cutting depth

#### 1.2 OptiMill-SPM

- Ideal for making openings or pockets
- Solid carbide design or with brazed PCD cutting edges

#### 1.3 OptiMill-SPM-Finish

- Finishing of great depths in one go
- Strong performance with high wraps

### 2 TRITAN-DRILL-ALU

- Creation of core holes
- Three cutting edges for the highest feed rates
- Highest positioning accuracy through self-centring cross cutting edge



3

4

5

6

### 3 PCD MILLING CUTTER WITH ALTERNATELY ARRANGED CUTTING EDGES

- Low cutting forces over the entire machining depth

### 4 SPIRALLED PCD MILLING CUTTER

- Finishing of thin-walled structures

### 5 PCD HELIX MILLING CUTTER

- Trimming with a large cutting depth

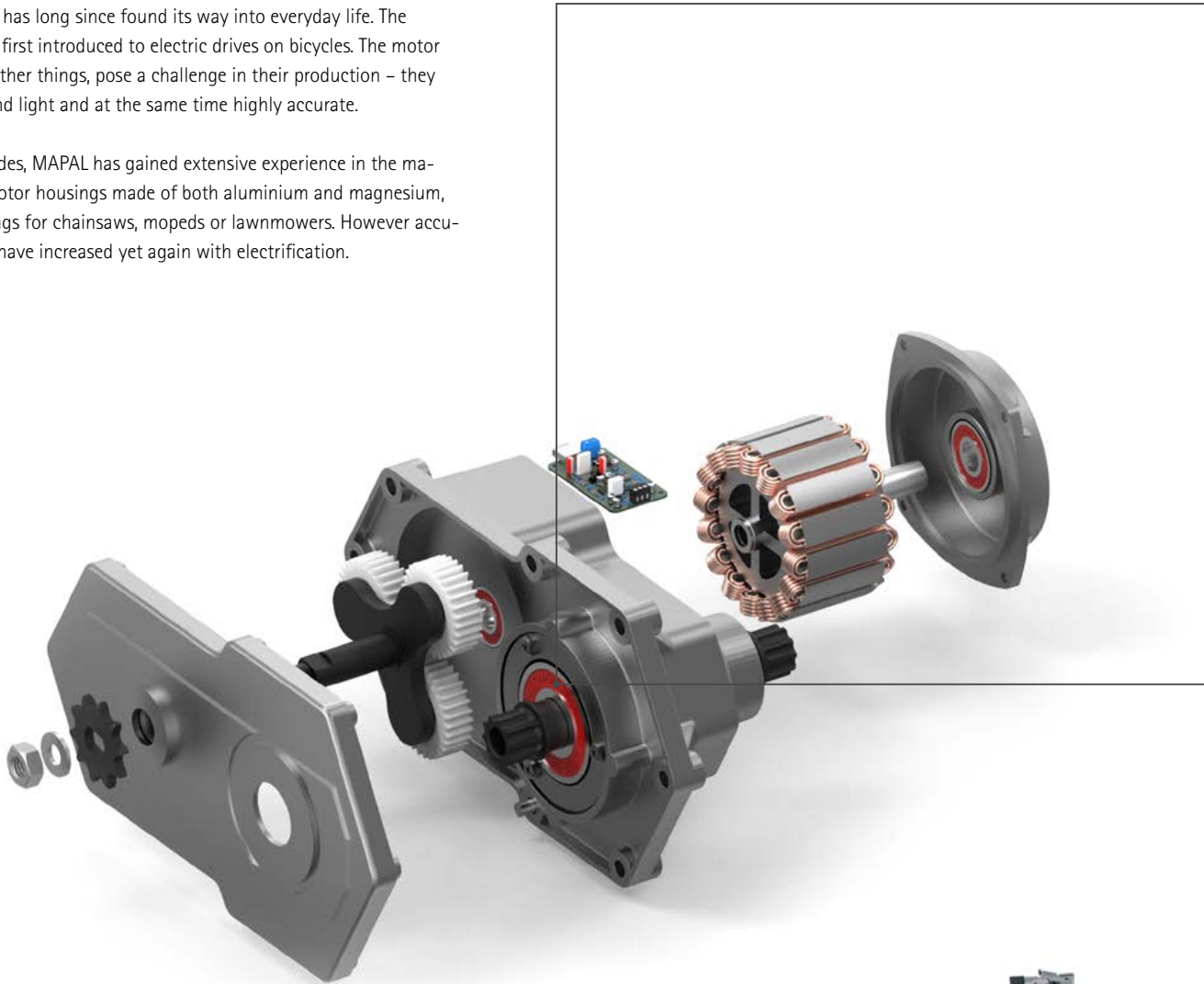
### 6 PCD FACE MILLING CUTTER

- Face milling for a cutting depth of up to 10 mm
- Creation of defined surface profiles for sealing and contact surfaces

# Small motor housings using the example of an e-bike drive

Electrified mobility has long since found its way into everyday life. The general public was first introduced to electric drives on bicycles. The motor housings, among other things, pose a challenge in their production – they have to be small and light and at the same time highly accurate.

Over the past decades, MAPAL has gained extensive experience in the machining of small motor housings made of both aluminium and magnesium, for example housings for chainsaws, mopeds or lawnmowers. However accuracy requirements have increased yet again with electrification.



## FEATURES

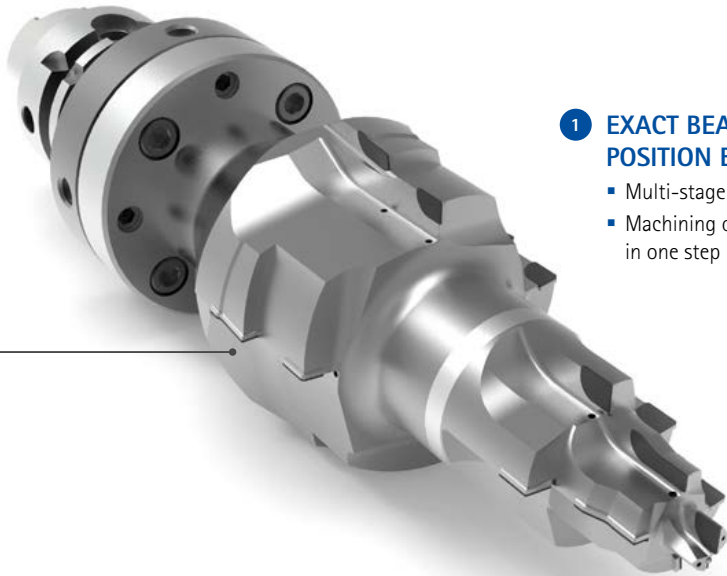
- Two-part or three-part (housing and cover)
- Die-cast housings made of aluminium or magnesium
- Unstable, thin-walled components (susceptible to vibration)
- Multi-stage contour paths
- The geometrical and dimensional requirements are high (shape, running and position tolerances)

## MACHINING REQUIREMENTS

- Roundness < 0.01 mm
- Diameter tolerance IT7
- Average roughness depth  $R_z < 10 \mu\text{m}$







### 1 EXACT BEARING AND POSITION BORES IN ONE GO

- Multi-stage PCD combination tool
- Machining of bearing and position bores in one step



### 2 DRILLING AND MILLING COMBINED IN ONE TOOL

- Multi-stage PCD bore milling tool
- Drilling stage for bearing and position bores
- Milling stage for finishing seal grooves

**MAPAL offers an all-round package for the machining of small housings made of aluminium or magnesium.**

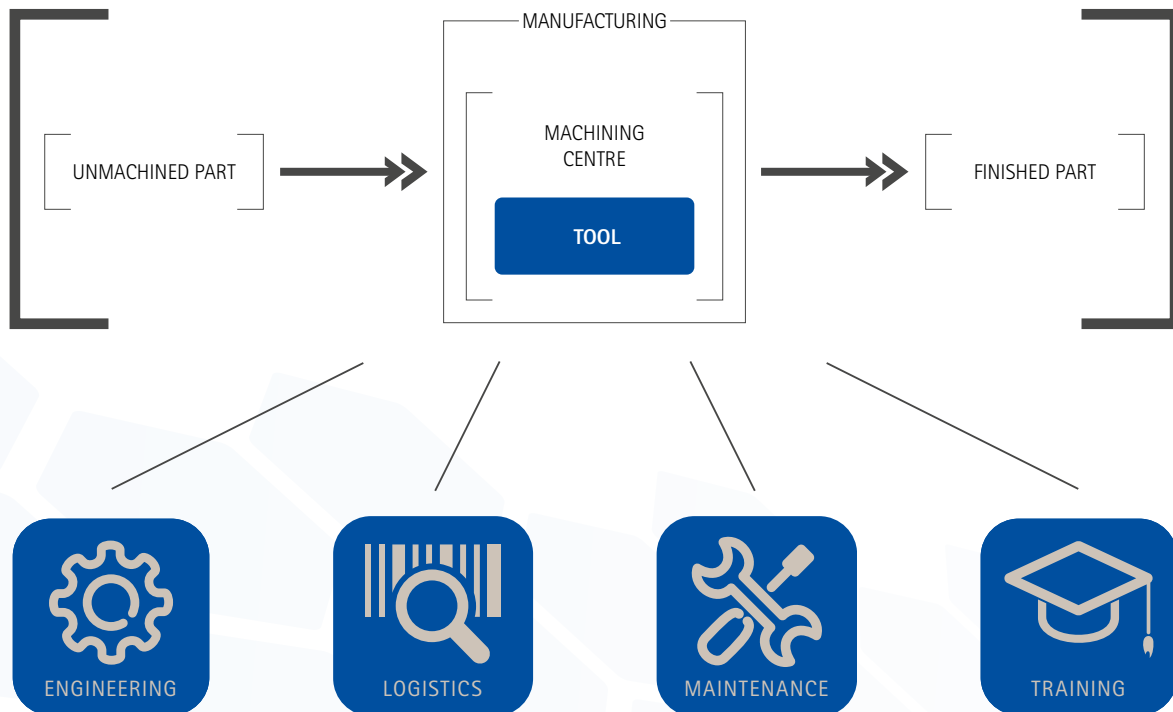
First and foremost, PCD and solid carbide tools are ideal for machining both materials. Depending on the requirements and complexity, MAPAL will design the best concept including all tools and chucks. Combination tools, each covering several work steps, make the process more economical.



# Individual, needs-based service

MAPAL's roots lie in the manufacture of custom tools. The focus is therefore always on holistic advice and support for machining tasks and processes.

MAPAL provides support in all phases and areas of production with an extensive range of services. Regardless of whether a new production facilities is to be set up, processes are to be optimised, new technologies to be introduced, machines to be converted to new components, the tool inventory to be optimised or the know-how of employees to be expanded.



With the engineering service module, MAPAL guarantees fast, precise and safe manufacturing. Further savings potential can be tapped in the area of logistics and maintenance. And in the area of training, MAPAL ensures that the specialist know-how it has gathered is transparently and completely available to the customer – this gives customers a decisive lead over their competitors.

All of the services offered by MAPAL focus on optimal processes and comprehensive support on the way to Industry 4.0. The goal is to always significantly assist the customer in achieving smooth, productive and economical manufacturing.

## ADVANTAGES

- Solutions for complete workpieces including tools, devices, NC programs and commissioning
- Complete process design and implementation from a single source
- Fast and flexible on-site support worldwide
- Efficient and cost-optimised tool technology
- Optimum coordination of tool, workpiece, equipment and machine
- Highest product quality, process reliability and cost-effectiveness right from the start
- Fast throughput from planning to implementation with maximum planning security



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