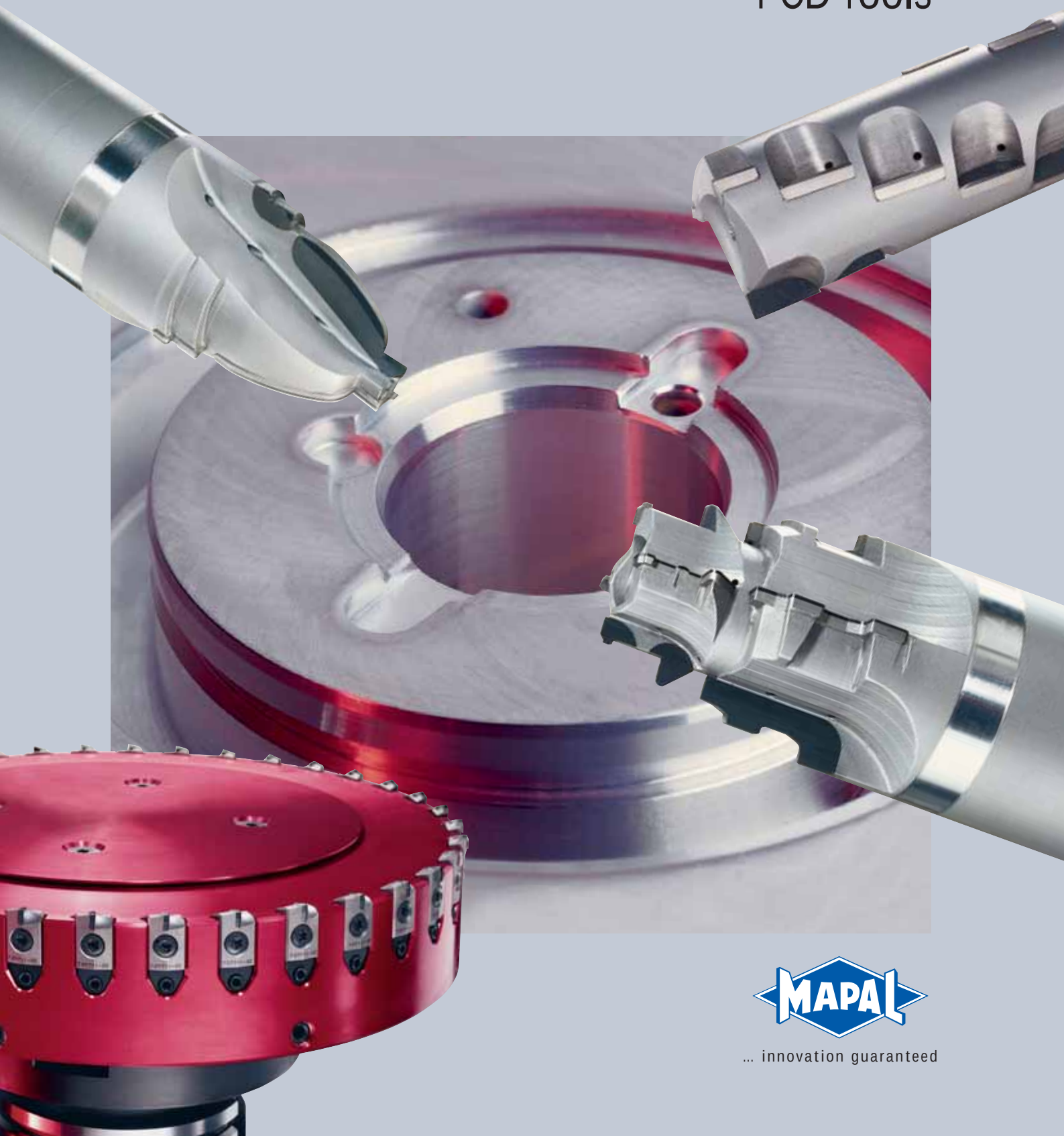
MAPAL WWS Competence – PCD Tools



... innovation guaranteed

Brilliant –

two partners who complement each other perfectly

It was the cutting material PCD which brought the MAPAL and WWS companies together. As a specialist in precision machining, MAPAL saw the enormous opportunities of the new cutting material on the one hand but also the extremely high demands on production technology and on the capabilities of the workforce when manufacturing tools with PCD (polycrystalline diamond) blades which cannot not be adjusted. An organisation operating in the jewellery town of Pforzheim in Germany seemed to be the right partner for the challenge.
Werner Stief had first had contact with this completely new cutting material as far back as 1978. As he had already had a great deal of experience in machining diamonds, PCD aroused his curiosity and he recognised the extent of the task. When WWS was first established in 1980 it could scarcely have been imagined how PCD tool manufacturing would develop. This artificially made cutting material came onto the market at exactly the right time. The amount of aluminium components - particularly in the automobile industry - was increasing to a disproportionate extent at that time and provided the right environment for using PCD blades. The further development of the machining technology for this cutting material was mainly improved and optimised as a result of WWS's activities.

The pioneering work by WWS was to enable the eroding method to be used for manufacturing PCD blades.
MAPAL's takeover of WWS in 1994 provided the initial spark for further turbulent development. The increasing acceptance of the HSK connection system was also helpful and extremely important in the years that followed. The changeover accuracy of within 3 µm which resulted from this has significant effects on concentricity and the use of multiple blades and as a consequence on the life of PCD tools. These are just some of the reasons which have contributed to the huge success story of PCD tools.

Dr. Dieter Kress Werner Stief

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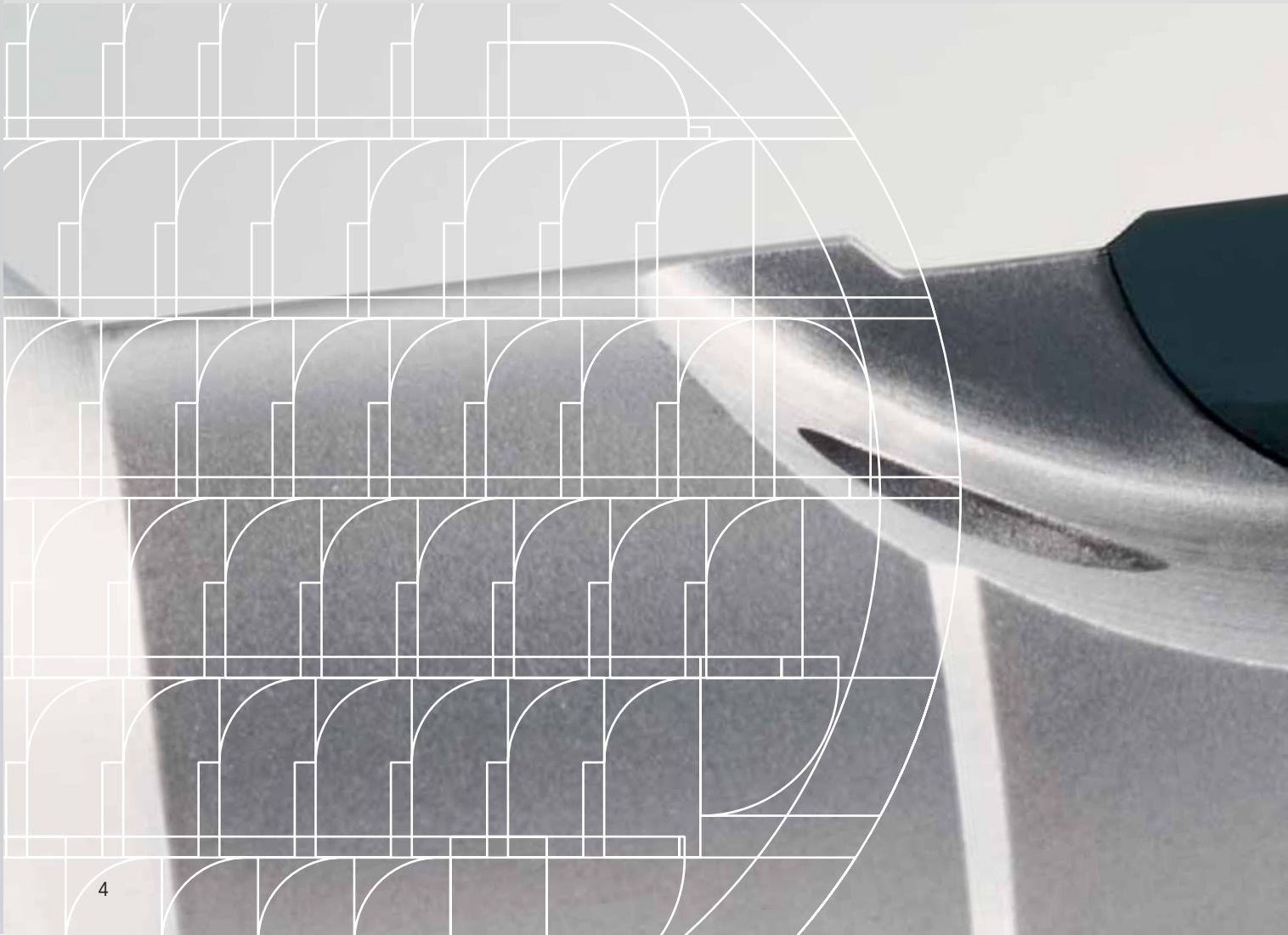
PCD –

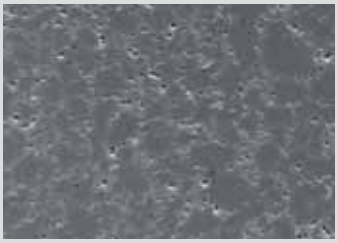
Diamond as a high-tech product

When the first polycristalline diamond (PCD) was introduced at the beginning of the 1980s it brought a revolution in the development of cutting material but also a revolution in tool manufacturing.
How did this come about?
At approximately 1,500°C and at a pressure of approximately 60 kbar an exceptional quality of synthetic diamond, together with a carbide substrate, was subjected to a sintering programme. An extremely complicated chemical process then followed.
Cobalt, a chemical component of carbide, acted as a catalyst and caused an intensive structural change in the individual diamond particles. This intensive structural change a sensation, providing a cutting material with the hardness and wear resistance of diamond, the hardest material on earth. The carbide substrate gave the cutting material the necessary strength and under day-to-day machining conditions offered the best possible conditions for brazing the blades onto suitable carriers. At the beginning the blade size for these so-called PCD blanks was limited but sizes are now available up to a diameter of 75 mm.

A cutting material of this hardness was a tough nut to machine, in the truest sense of the word. The familiar grinding methods were not suitable so new ones were developed and refined to perfection. Wire erosion and laser technology are now state of the art. The originally limitations to cutting forms and geometries no longer exist.

In just 30 years PCD has developed into the super cutting material for machining non-ferrous metals and non-metallic component materials and it would be impossible to imagine modern production technology without it.





Just as with conventional cutting materials, such as carbide, there are considerable variations in quality in the cutting edge. Various machining tasks and the variable abrasiveness of the material require variations in cutting materials. The results of our many years of experience in diamond blades have been an amazing range of modifications using different PCD grades. Different grain sizes in the microstructure of the diamonds can be varied with a selection of coating thicknesses combined with a number of blank sizes. Irrespective of the machining task for which you require a PCD blade, this allows us, to select the right diamond quality.

Taking the lead –

ideas, products and services

Constantly increasing demands on modern cutting operations require a modern, highly flexible approach from the tool manufacturer. Our competence in dealing with PCD cutting material is reflected in day-to-day tool design.
The ongoing objective is to combine several machining tasks with one tool. For the user this means that unproductive ancillary time for tool change is dispensed with.
Not infrequently tool concepts occur as a result of this motivation which are unique in design. We are becoming more competent in this way thinking and acting as a result of high production reliability when manufacturing the tools. However, constant developments in machining PCD are not sufficient in themselves. Any parameters which are required for tool manufacturing need to be constantly driven forward. Examples are modern brazing methods and filigree balancing systems. The high potential performance by our products, enhanced by the enormous technical competence of our application specialists, are guarantees for success in solving the tasks which are faced.


MAPAL WWS

Precision –

the perfect geometry for every tool

This principle is a thread running through all areas of the organisation like the symmetry line through the technical drawing of a tool. With the same precision as that required in the detailed design of every blade, the implementation of these details is effected in all the production areas. Manual work stations are thus in harmony even in the most modern operations with fully automatic production units. An intelligent computer system for controlling production routines and constant quality assurance – all building blocks which fit perfectly together. The highest priority for all the work stations is precision and quality. Complete documentation of all the processes and inspection procedures to accompany the process are the basis for the constantly high quality level of all tools. The result of all these endeavours is rational and reliable production at the customers' works.

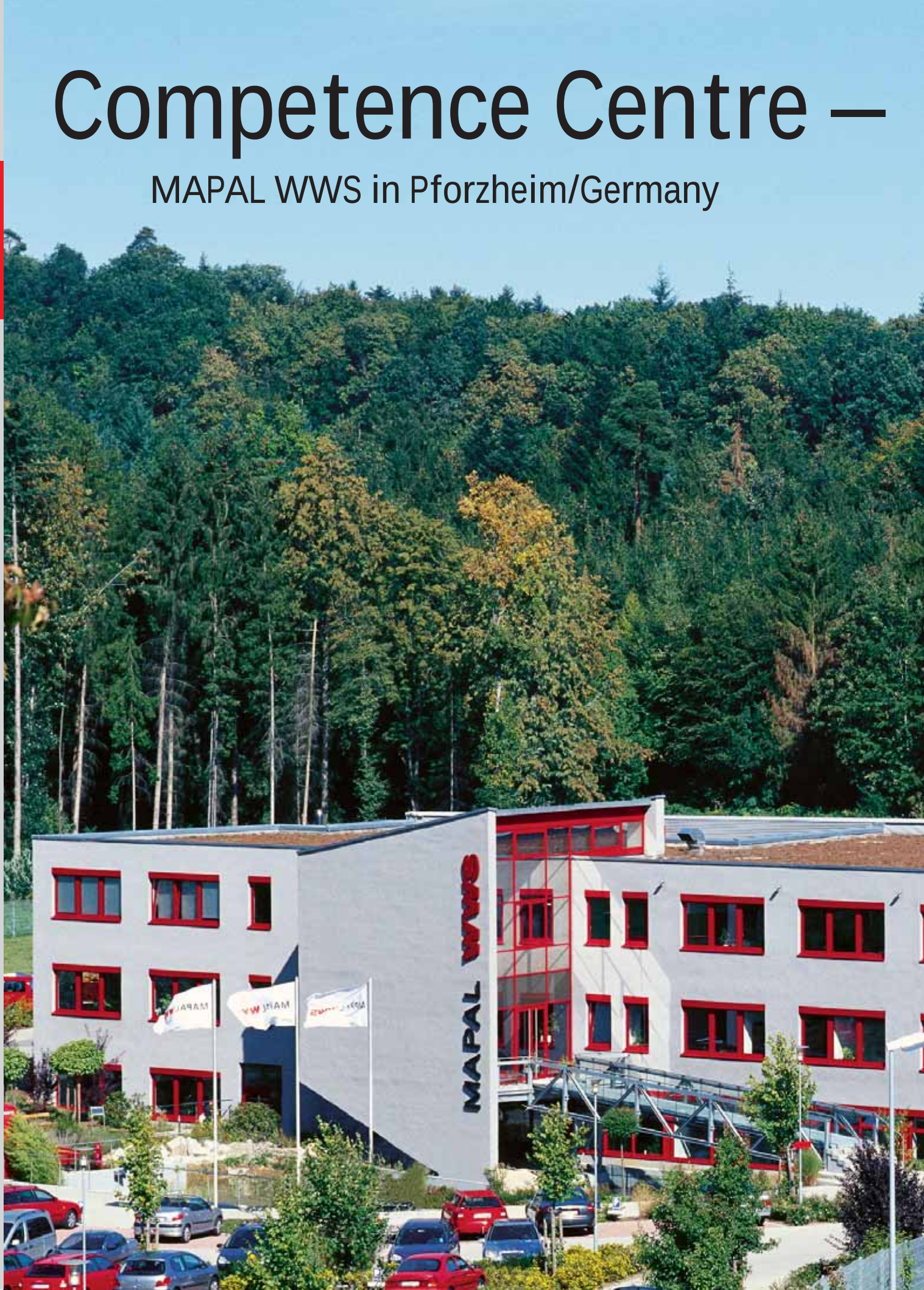




The precision on the tool cannot be tried out but simply produced. It is therefore essential that even during the preliminary sequences, such as when separating PCD sections from the blank or brazing, work is carried out extremely carefully. Only tools which have been perfectly produced right from their basic assembly on the tool carrier can achieve a tolerance range of a few microns with high precision operations such as electrical discharge machining or PCD grinding.

Competence Centre –

MAPAL WWS in Pforzheim/Germany



Consistent quality at all sites is ensured by MAPAL WWS which has been the competence centre for the MAPAL Group for all fixed, brazed PCD tools since 1994. This means that the customer can rely on the same high MAPAL quality throughout the world in engineering, product programme and customer service.

PCD tools –

worldwide competence and global network

With a workforce of more than 500 people worldwide, the PCD tool product group is one of the most important of the MAPAL divisions. A sales and service network with branches in more than 40 countries on every continent guarantees the best possible consultation and customer care at their production sites.

One important element of this network is engineering on site, with which MAPAL can react swiftly and flexibly to customer requirements. By constant training and further training for personnel and worldwide exchange of experience, MAPAL ensures the same high technical standards are provided everywhere. This means the customer receives the best solution for him, whether in Europe, America or Asia.

The production of MAPAL PCD tools in numerous countries also guarantees flexibility, rational delivery times and high tool availability. The network for production and repair of PCD tools is constantly being expanded.

Worldwide – MAPAL Group sites

The MAPAL Group in figures
- More than 2,500 employees
- 21 branches
- 18 production sites
- 30 service and consultation offices

Europe	
Germany	MAPAL Dr. Kress KG in Aalen
	MAPAL WWS GmbH in Pforzheim
	MAPAL ISOTOOL GmbH in Sinsheim
	MILLER GmbH in Altenstadt
	Rudolf Strom GmbH in Vaihingen/Enz
England	MAPAL Ltd. in Rugby
France	MAPAL SARL in St-Denis Cedex
	MAPAL Stockoutil SAS
	in Le Chambon Feugerolles
Italy	MAPAL Italia S.R.L. in Gessate/MI
Poland	MAPAL Narzedzia Precyzyjne
	Spólka z.o.o. in Posen
Czech Republic	MAPAL CZ s.r.o. in Dlouhá Lhota

N. America	
USA	MAPAL Inc. in Port Huron/MI
Central America	
Mexico	MAPAL FRHENOSA S.A. de C.V.
	in Garza Garcia
S. America	
Brazil	MAPAL BILZ Precision Tools Ltda. in Ibirité
Asia	
China	MAPAL China Production Ltd. in Shanghai
Taiwan	MAPAL Precision Tool Systems Co. Ltd.
	in Tainan
Korea	MAPAL HITECO Co. Ltd. in Kyunggi-Do
	MAPAL TET Office Asia in Ulsan
Japan	MAPAL KK in Tokyo
India	MAPAL INDIA Private Ltd. in Bangalore
Singapore	MAPAL ASIA TET Office in Singapur

Production sites for fixed, brazed PCD tools

Germany – MAPAL WWS GmbH
in Pforzheim

USA – MAPAL Inc.
in Port Huron/MI

England – MAPAL Ltd.
in Rugby

Brazil – MAPAL BILZ Precision Tools Ltda. in Ibirité

France – MAPAL Stockoutil SAS
in Le Chambon Feugerolles

China – MAPAL China Production Ltd.
in Shanghai

Italy – MAPAL Italia S.R.L.
in Gessate/MI

Korea – MAPAL HITECO Co. Ltd.
in Kyunggi-Do

Service centres

Czech Republic	MAPAL CZ s.r.o. in Dlouhá Lhota
Mexico	MAPAL FRHENOSA S.A. de C.V. in Garza Garcia
Taiwan	MAPAL Precision Tool Systems Co. Ltd. in Tainan
Japan	MAPAL KK in Tokyo
India	MAPAL INDIA Private Ltd. in Bangalore

PCD tools – from precision gun boring to circular milling

Gun boring – the challenge

The bore defines the function. In almost all cases the quality of a product depends on the precision of the bores within it. Both static and dynamic tasks and functions are effected by the bores.
For tools for manufacturing bores of this kind the name MAPAL WWS is a mark of quality and economics. The almost unlimited design options for the PCD blade for the relevant tools present unimaginable opportunities. Several machining tasks can be easily combined with one tool. The saving of tools and elimination of unproductive ancillary times improve the production economics at the customers' works.
The manufacture of a stepped bore for which all the chamfers and radii have to be machined is solved with one tool. The concentricity of the individual steps is guaranteed. Even machining axial grooves or spot facing mounting faces can be economically resolved with one boring tool. As no radial forces affect the component, requirements for flatness or angular precision can be met many times more easily than with conventional turning or circular operations. Machining of a complex external contour, for example on a dome, is another application for efficient drilling operations. By designing the tool in the form of a bell, the complete machining operation can be carried out in the axial direction. Even the large allowance which is frequently present with applications of this sort, can be safely dealt with. Cutting depths of more than 4 mm per side are not infrequently achieved. Irrespective of the product – whether this is an efficient combustion engine for a sports car or a set of mixer taps for the bathroom – the bore defines the function.

Circular milling – the form is decisive

As always it is an advantage to carry out certain operations by circular milling. When machining hydraulic parts control edges have to be produced in the relevant piston bore. Often several grooves are required which are axially offset to one another. Sometimes all these slots have different forms. These are decisive factors for using PCD tools. Frequently this allows several operations to be combined with one tool. The complete form is then produced in one circular movement on the machine.
This is only possible because of the harmonic cutting behaviour of the PCD blade. Cutting forces are limited to a minimum and the tendency to produce chatter does not arise. Radial grooves on external contours can be economically produced by circular milling. For this the tool is designed as a bell with the blades located on the internal contour of the

tool. With a radial deflection of a few millimeters the groove can be produced with a very slight circular movement.
Because the PCD does not produce burring the manufacture of threads is increasingly significant. Cross holes which occur in thread flanks set extremely high demands for follow-on machining on the parts. By using PCD thread milling cutters subsequent machining is totally unnecessary.

End mills – pure performance

End mills with PCD blades are currently still attracting little attention for use on modern machining equipments. The large range of standard end mills in solid carbide is probably the explanation for this. However, it is in this particular area that there are numerous arguments for using PCD end mills. Costly eroding to produce forms, such as those produced from graphite or large dimensioned integral components for aircraft production, require long tool life and reliability from the milling cutters used. Particularly highly abrasive materials cause wear to be produced unchecked on milling blades for solid carbide milling cutters. The result is that distortions in geometry occur on forms or the required corner radii are not produced. It is in these cases that the enormous potential of PCD end mills can be demonstrated. The recognised advantage of long tool life for PCD cutting material can be directly applied. Time-consuming reworking on formed parts or preparation of sister tools is no longer required. The specifically adapted standard programme of PCD end mills is designed directly for these application areas.

PCD tools – production reliability for pre-machining and finish machining

Face milling – the classic tool

Simple but sturdy construction combined with the facility to change and adjust milling cartridges at extremely low cost makes this product a classic among PCD tools. Numerous application provide daily proof of the reliability of the milling head system. Logically developed, adapted to the needs of modern cutting, the range of uses stretch from conventional milling operations to high speed cutting. The intelligent directing of the coolant through the tool also allows successful use of minimal lubrication. Because of the high diversity of geometry in the standard range of milling cutters, the user is always able to use the prefect blade for different component materials. The milling cartridges, which can be set axially to high precision, along with the appropriate tool holder, achieve surface finishes and tool life which speak for themselves.

Reaming and fine boring – precision to perfection

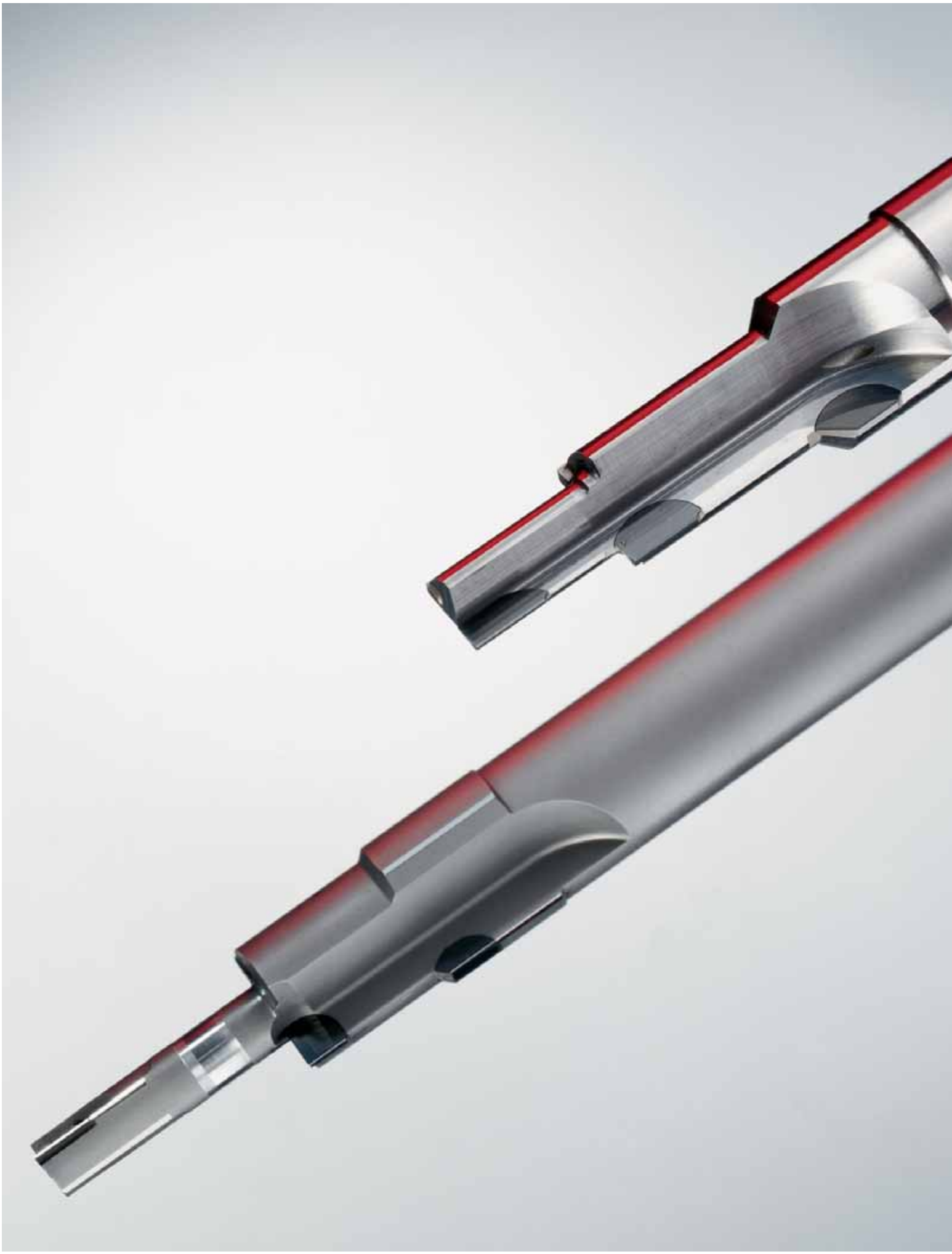
In addition to PCD precision gun boring tools with fixed blades the product programme for reaming and fine boring includes precision tools with replaceable, diamond-tipped blades and guide pads and PCD-tipped multi-bladed reamers. For tools with guide pads, in addition to PCD blades for long tool life and particularly good surface finish, diamond guide pads are also used for their extremely good sliding properties and wear-resistance.

Because of MAPAL's long-established principle, these tools, which can also be used in the HSC area, are particularly impressive in high precision areas.

With HPR high precision reamers MAPAL offers a programme of fixed PCD tipped multi-bladed reamers for fine machining bores. Because the coolant is supplied directly onto the blade, the HPR reamers are also well suited for use with minimal lubrication. In conjunction with the HFS® head fitting system, concentricity and changeover accuracies are achieved to extremely high precision and provide the prerequisite for new dimensions in modern high performance cutting.

But it is not only in aluminium machining that MAPAL tools are tipped with PCD as a cutting material for reaming and fine boring. Innovative tool solutions for use on cast iron materials allow follow-on operations previously required to be dispensed with, such as grinding and honing.
MAPAL tools for reaming and fine boring have become the byword for absolute precision and reliability in modern production throughout the world.

Gun boring and milling – with ISO Inserts
A further product area is special tools with diamond tipped ISO Inserts. Various mounting and adjustment options for the blades ensure exact concentricity and therefore maximum tool life. The extensive experience and numerous innovative ideas provided by the MAPAL specialists produce extremely successful tool concepts.



Competence – Precision gun boring

Gun boring tools produced to high precision guarantee reliable application for every machining task. Various tool designs – with two, four or six blades – ensure perfect dimensional stability and high accuracies of form in the bores to be produced. High tool rigidity is achieved, particularly where tool dimensions are small, by using carbide as the carrier material.

- Who's counting the application opportunities?
- From experience – guidelines and cutting values in practice
- Machining examples

MAPAL WWS Competence – Precision gun boring
Who's counting the applications opportunities?

The extensive experience provided by MAPAL WWS specialists is clearly demonstrated in gun boring tools in the quality of the tools which are produced. The design of the tools, which is perfectly adapted for the application in question, increases productivity and production reliability in use. The high requirements for balance and the guaranteed concentricity of the blades produced are all factors which are perfectly met by these tools. The quality of the precision ground PCD blade is the absolute maximum. 100,000 bores are not unusual. Maximum care in production guarantees total efficiency both from the new tool and even when this has been reconditioned.

Getting to grips with the chip
Laser eroded chip breakers allows optimum clearance from the working area of material which has been removed. This means that stoppages in ongoing production caused by chip jams are avoided.

Modular – the solution
To achieve the required concentricity on the spindle, modular tool holder systems are used. Axial and radial adjustment facilities allow the required concentricity to be obtained, in particular on machines with ISO spindles.

The blade – precision in detail
Production tolerances of ≤ 3 µm for tool diameters, multiple blades and back taper allow demands on the blade to be anticipated. The result is reflected in every bore.

From experience – guidelines and cutting values in practice

Material	Cutting speed v_c (m/min)	Feed/blade f_z (mm)	Cutting depth (mm)
Al < 4%Si	300 – 1.200	0,1 – 0,4	0,1 – 4,0
Al 4–8%Si	200 – 1.000	0,1 – 0,4	0,1 – 4,0
Al 9–13%Si	100 – 800	0,08 – 0,2	0,1 – 4,0
Al > 13% Si	100 – 800	0,05 – 0,2	0,1 – 3,0
Magnesium alloys	200 – 1.000	0,1 – 0,4	0,1 – 4,0
Copper alloys	100 – 500	0,05 – 0,2	0,1 – 4,0
Brass alloys	200 – 1.000	0,05 – 0,15	0,1 – 4,0
Graphite	250 – 1.500	0,01 – 0,1	0,1 – 2,0
Gfk – Cfk	200 – 1.800	0,03 – 0,25	0,1 – 3,0

PCD gun boring tools are individual tool solutions which are specially designed for a specific application. To present recommendations for cutting values which cover all possibilities in a table would be unrealistic. Too many factors have a direct effect on the machining result. Different wall thicknesses, cross bores or interruptions can affect the system. The values shown in the diagram should therefore be regarded as guidelines. MAPAL WWS specialists would be pleased to offer you their knowledge and experience to find the solution to special requirements.

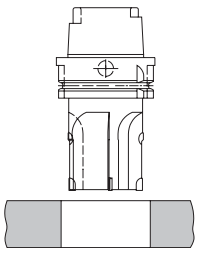
Concentricity

The highest priority for rough boring with PCD tools is the multiple cutting function of the tool. The run-out error measured for the tool on the machine spindle should not exceed 5 µm. For critical bores or fits this should only be a maximum of 3 µm. To monitor this criterion concentricity check points are located on the tool right next to the blades. Here the user can have a direct influence on the tool's concentricity. The accuracy of the cutting track for the blades can be improved by means of axial and radial adjustment screws, for example on modular tool holders, or simply by turning the tool in the hydraulic expanding chuck.

Examples from practice – for use in practice

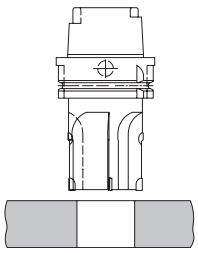
Bore too large

Cause?
- Tool diameter may be too large
- Cutting speed too high
- Feed too high
- Run-out error too high
- Cutting lead uneven
- Coolant unsuitable



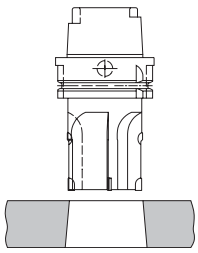
Bore too small

Cause?
- Tool worn
- Cutting speed too low
- Feed too low
- Ductile material – contracts after machining
- Allowance insufficient



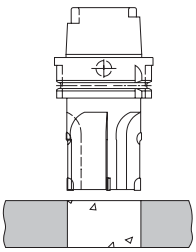
Bore tapered

Cause?
- Run-out error too high
- Cutting lead not correct
- Pre-machining not correct



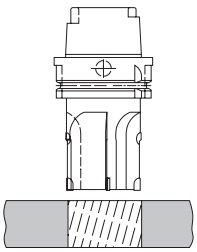
Bad surface in bore

Cause?
- Coolant unsuitable
- Build-up on cutting edge
- Tool blunt – possible fracturing on blade
- Chip removal bad
- Residual imbalance too great



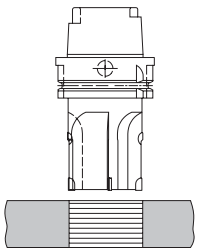
Bore has chatter marks

Cause?
- Build-up on cutting edge
- Tool blunt
- Coolant unsuitable
- Run-out error too high
- Residual imbalance too great
- Clamping set-up not correct



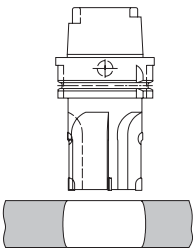
Bore has feed grooves

Cause?
- Tool blunt, possible fracturing on blade
- Build-up on cutting edge
- Coolant unsuitable

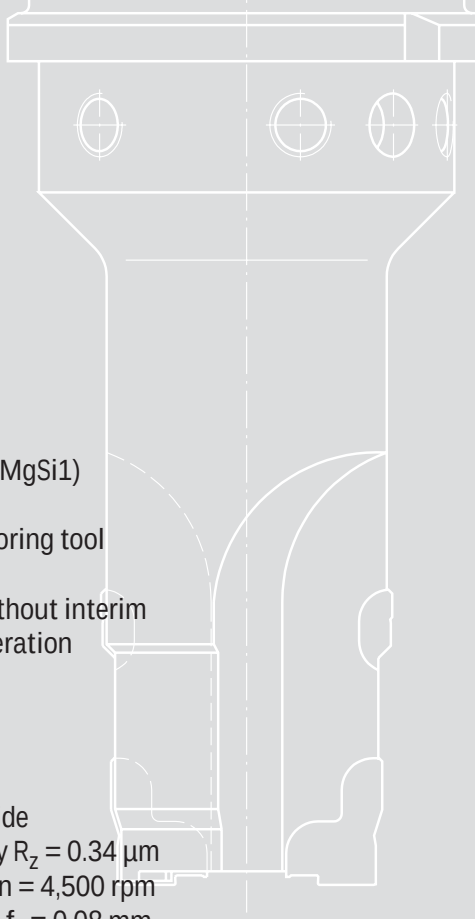


Bore is convex

Cause?
- Workpiece not correctly clamped

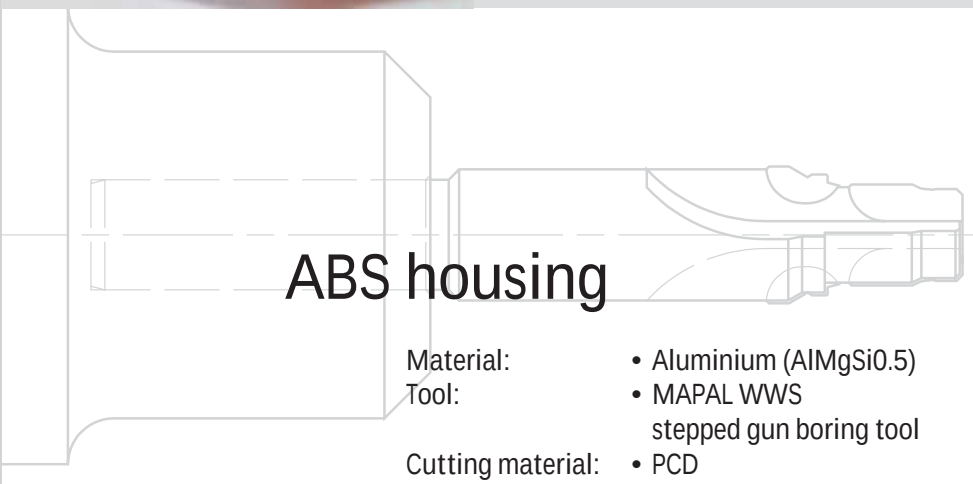


MAPAL WWS Competence - Precision gun boring
Machining examples



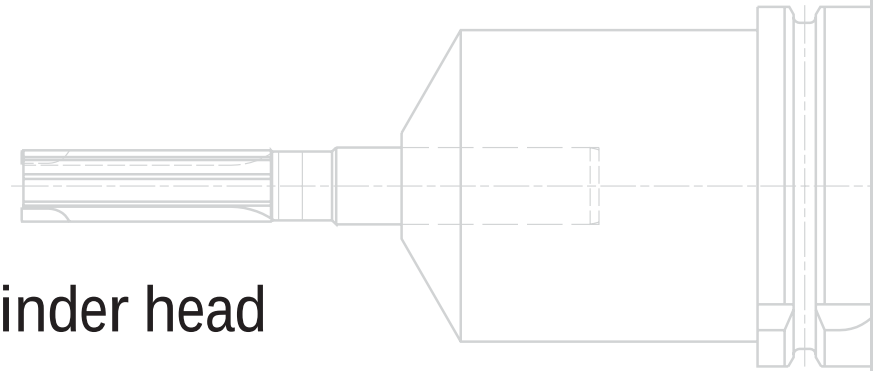
Valve housing

Material:	• Aluminium (AlMgSi1)
Tool:	• MAPAL WWS stepped gun boring tool
Cutting material:	• PCD
Requirement:	• Gun boring without interim machining operation • Bore quality: D 32.5^{D10} mm D 34.2^{F8} mm D 38.0^{A11} mm
Allowance:	• 13.5 mm per side
Result:	• Surface quality R_z = 0.34 µm
Machining values:	• Spindle speed n = 4,500 rpm • Feed per tooth f_z = 0.08 mm



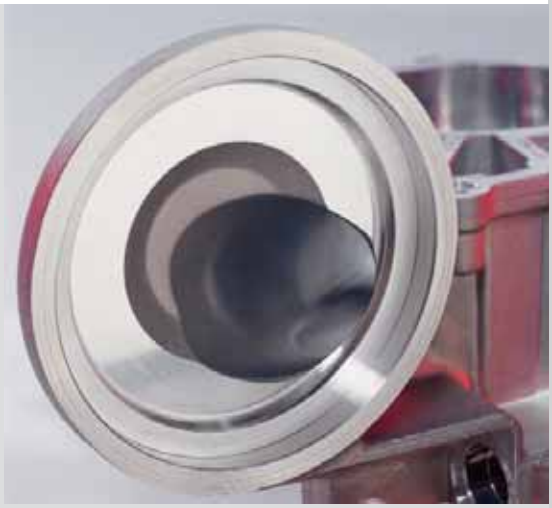
ABS housing

Material:	• Aluminium (AlMgSi0.5)
Tool:	• MAPAL WWS stepped gun boring tool
Cutting material:	• PCD
Requirement:	• Burr-free cross bores • Bore quality: D 4.6^{M7} mm D 10.0^{H9} mm D 13.15^{H8} mm with all chamfers
Allowance:	• 0.4 mm per side
Result:	• Tool life more than 100,000 bores
Machining values:	• Spindle speed n = 5,000 rpm • Feed per tooth f_z = 0.15 mm

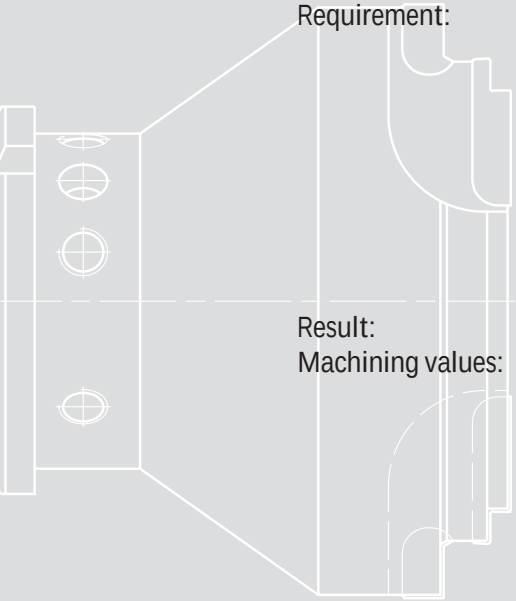


Cylinder head

Material:	• Aluminium (AlSi7MgCu0.5)
Tool:	• MAPAL WWS gun boring tool
Cutting material:	• PCD
Requirement:	• Machining hydraulic lifter bore
	• D 12^{G7} mm; because of statistical production control, however, limited to IT6 quality
	• Problem: blind bore with several interruptions
Result:	• Tool life approx. 75,000 bores
Machining values:	• Spindle speed n = 12,000 rpm
	• Feed per tooth f_z = 0.08 mm

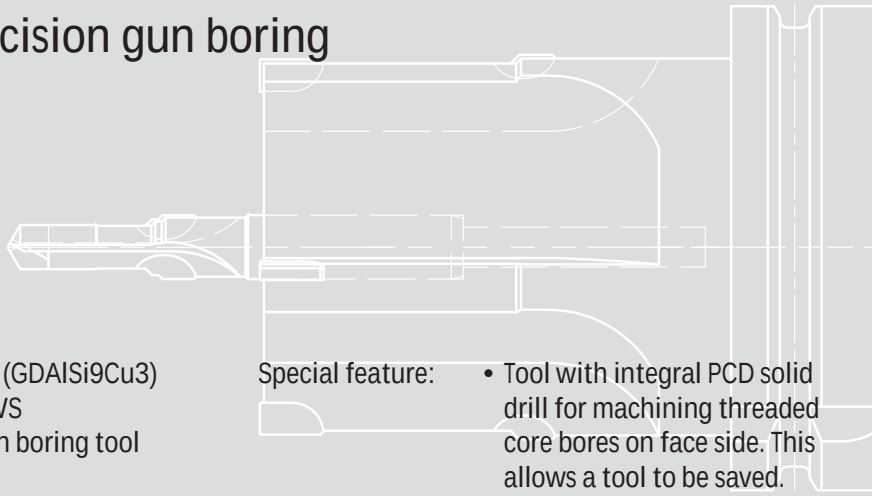


Pump housing



Material:	• Aluminium (GDAlSi9Cu3)
Tool:	• MAPAL WWS stepped gun boring tool
Cutting material:	• PCD
Requirement:	• Gun boring with spot facing
	• Finish machining in precast bore – without pre-machining!
	• Stepped face machining from D 30 to 93 mm with integral hole tolerance D 76^{H8} mm
	• Interrupted cut
	• Different allowances
	• Double spindle used
Result:	• Tool life more than 20,000 bores
Machining values:	• Spindle speed n = 1,100 rpm
	• Feed per tooth f_z = 0.04 mm

MAPAL WWS Competence - Precision gun boring
Machining examples

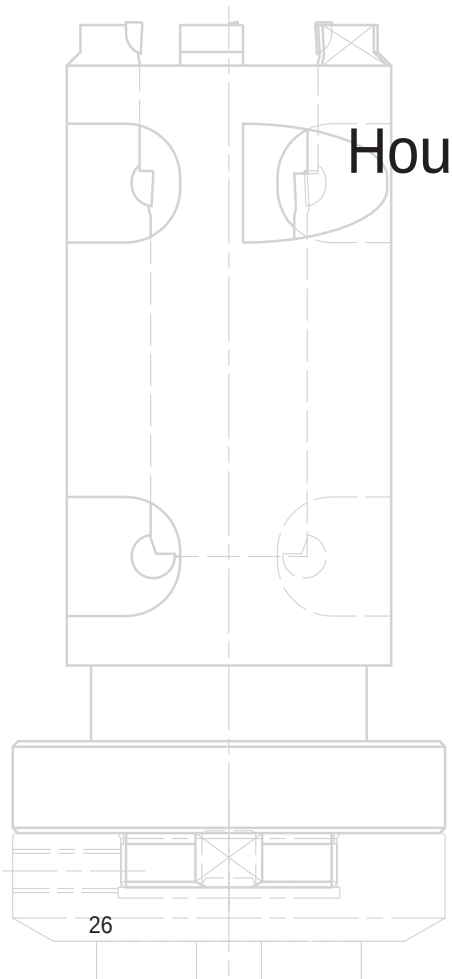


Pump housing

Material:	• Aluminium (GDAlSi9Cu3)
Tool:	• MAPAL WWS stepped gun boring tool
Cutting material:	• PCD
Requirement:	• Finish machining pump chamber • Interrupted cut throughout • Bore diameter D 47^{H8} mm • Double spindle used • Surface quality R_z max = 10 µm
Result:	• Surface quality R_z max = 1–2 µm • Tool life more than 20,000 bores
Machining values:	• Spindle speed n = 5,000 rpm • Feed per tooth f_z = 0.08 mm

Special feature:
- Tool with integral PCD solid drill for machining threaded core bores on face side. This allows a tool to be saved.

Housing



Material:	• Aluminium (AlSi12Cu1 Fe)
Tool:	• MAPAL WWS stepped gun boring tool
Cutting material:	• PCD
Requirement:	• Bell machining incl. face surface • D $32.0^{\pm 0.075}$ mm / $27.99^{-0.05}$ mm • Length of fit approx. 70 mm
Result:	• Tool life more than 30,000 bores
Machining values:	• Spindle speed n = 6,000 rpm • Feed per tooth f_z = 0.038 mm

Clutch housing

Material:	• Aluminium (GD AlSi9Cu3)
Tool:	• MAPAL WWS stepped gun boring tool
Cutting material:	• PCD
Requirement:	• D 11.8^{R7} mm • D $70.62^{\pm0.025}$ mm • D $80.034^{\pm0.019}$ mm • D $146.885^{\pm0.035}$ mm • D $147.7^{\pm0.1}$ mm • Maximum tool weight 8 kg • Surface quality R_a = 0.8 µm
Result:	• Tool weight 5.8 kg incl. tool holder • Require surface finish achieved
Special feature:	• Tool body in titanium • Combination tool – 4 machining operations combined with one tool

Adaptor

Material:	• Aluminium (AlMgSi0.5)
Tool:	• MAPAL WWS stepped gun boring tool
Cutting material:	• PCD
Requirement:	• Bell machining with variable allowance • Double spindle used • D $17.35^{\pm0.05}$ mm • D $22.6^{\pm0.25}$ mm • Twice $R1^{\pm0.08}$ mm • Surface quality R_a = 1.6 µm
Result:	• Surface quality R_a = 0.7 µm
Machining values:	• Spindle speed n = 6,500 rpm • Feed per tooth f_z = 0.1 mm

Competence – Circular milling and end milling

These tools represent high performance cutting. Extremely high precision when eroding the blades, best balancing quality on the tool and the excellent cutting properties of diamond - the combination reaches new dimensions in milling. Precision and long tool life – the bywords for this product family.

- We manufacture to size
- HP-EndMill – standard programme
- From experience – guidelines and cutting values in practice
- Machining examples

Symbols for quick reference to find the right end mill:

Type


Single and multi-bladed


Blade over centre


Full radius; blade over centre


Spiral blade arrangement

Coolant


External coolant


Internal coolant

Tool holder

Cylindrical shank


HSK-A


ISO

MAPAL WWS Competence – Circular milling and end milling We manufacture to size

Bell machining
The economic solution for machining external contours. The tool makes a small circular movement around the component.

Milling with PCD blades – an even more economic solution
Just as with milling this produces all the advantages of the diamond blade – without compromising the machining result. The extreme hardness of the diamond combined with the toughness of the carbide offers the best combination for effectively milling. These properties are further enhanced as a result of the highly polished chip surface. Low forces when cutting off the chip and the reduced coefficient of friction when the chip moves over the cutting surface are advantages which are directly reflected in the milling performance of the tool in question. The machine's power consumption is noticeably lowered and the process itself becomes more stable. This also has a very positive effect on the life of the tool.

Optimum contour accuracy
Intricate grooves, transition radii or chamfers – almost any contours can be produced on the PCD blade without distortion. It is also not unusual for several features to be on one tool.

The standard end mill programme

It is the intention with this product series to restrict it to the most important elements. Tables which are hard to follow sometimes stretching over several pages of the catalogue, confuse and cause uncertainty in selecting the appropriate tool.

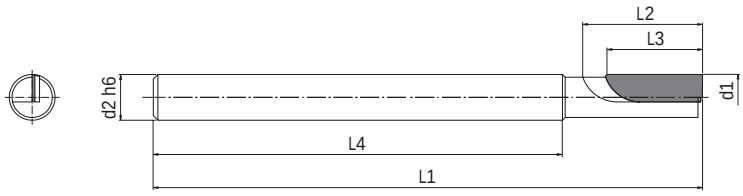
For MAPAL WWS it is quality and not the quantity which takes centre stage. The standard programme HP-EndMill is divided into five sections. Milling cutters designed specifically for an application can also be supplied in the shortest possible time.

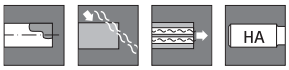
Optimum geometry

The spirally arranged chip space geometry and the division of cut on the blade allows extremely high rates of stock removal when rough milling.

MAPAL WWS
HP-EndMill
Type 50

The smallest PCD milling cutters Ø 4 and 5 mm, designed for intricate milling tasks, e.g. in precision mechanics or for manufacturing printed circuit boards.



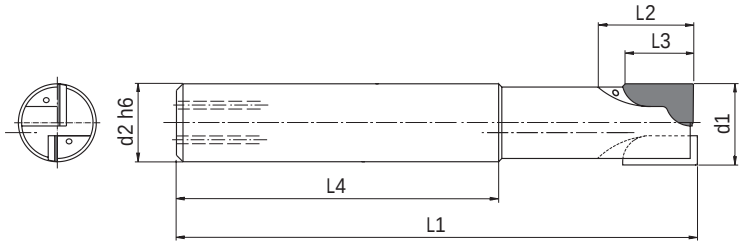


Design:
Milling cutter diameter: 4,0 – 5,0 mm
No. of blades: 1 (cutting over centre)
Shank form: HA (DIN 6536)
Axial angle: neutral
Coolant supply: external (standard), internal (on request)

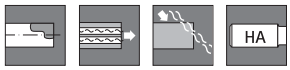
Milling cutter diameter d1±0,05	Shank diameter d2 h6	Overall length L1	Chip groove length L2	Blade length L3	Shank length L4	Cutting lead	Axial angle	Order No.
4,0	4,0	60	12	10	45	0,1x45°	0°	7-50041-10
5,0	5,0	60	13	10	45	0,1x45°	0°	7-50051-10

Dimensions in mm.

MAPAL WWS
HP-EndMill
Type 51



This series from Ø 6 to 12 mm with various cutting edge lengths is the universal genius in the end mill programme. All tools have a blade up to the centre, which means that drilling can also be used. The application range extends from contour milling work on Gfk and Cfk components to slot milling work and deburring on cast aluminium parts.



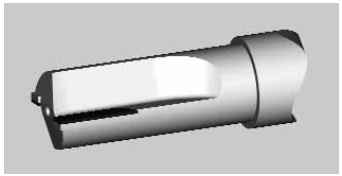
Order example for HP-EndMill
where d1 = 6,0 mm, blade length L3 = 10 mm, axial angle neutral, through blade.
Order No.: 7–51061–10

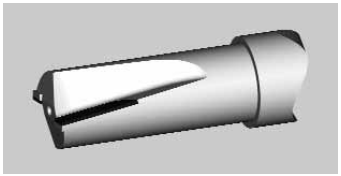
Design:
Milling cutter diameter: 6,0 – 12,0 mm
No. of blades: 2 (cutting over centre)
Shank form: HA (DIN 6535)
Axial angle: neutral, negative or positive
Coolant supply: internal (standard), external (on request)

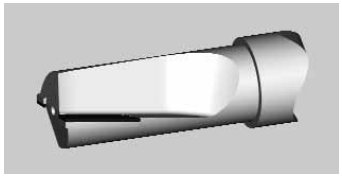
Milling cutter diameter d1±0,05	Shank diameter d2 h6	Overall length L1	Chip groove length L2	Blade length L3	Shank length L4	Cutting lead	Axial angle	Order No.
6,0	6,0	60	12	10	45	0,1x45°	0°/2°	7-51061-__*
6,0	6,0	60	17	15	40	0,1x45°	0°/2°	7-51062-__*
6,0	6,0	80	22	20	55	0,1x45°	0°/2°	7-51063-__*
8,0	8,0	80	12	10	60	0,1x45°	0°/4°	7-51081-__*
8,0	8,0	80	18	15	60	0,1x45°	0°/4°	7-51082-__*
8,0	8,0	80	22	20	50	0,1x45°	0°/4°	7-51083-__*
10,0	10,0	80	12	10	50	0,1x45°	0°/4°	7-51101-__*
10,0	10,0	80	18	15	50	0,1x45°	0°/4°	7-51102-__*
10,0	10,0	80	22	20	50	0,1x45°	0°/4°	7-51103-__*
12,0	12,0	100	15	10	70	0,1x45°	0°/4°	7-51121-__*
12,0	12,0	100	20	15	70	0,1x45°	0°/4°	7-51122-__*
12,0	12,0	100	24	20	70	0,1x45°	0°/4°	7-51123-__*

*Order number plus required blade form (see table below and order example).

Blade form	Through blade
Axial angle neutral	–10
Axial angle negative	–20
Axial angle positive	–30


Axial angle neutral

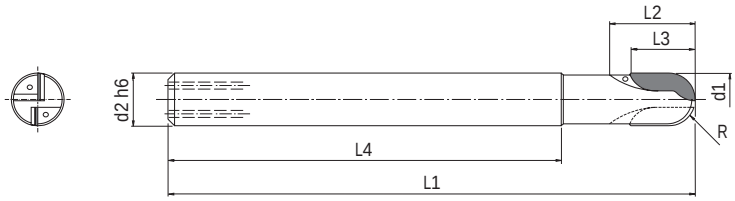

Axial angle negative


Axial angle positive

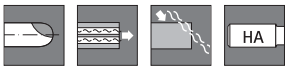
Dimensions in mm.

MAPAL WWS
HP-EndMill

Type 52



Not just of interest to form designers. These ball-head end mills are characterised by the high accuracy of form of the full radius. The tools with numbers of teeth from Z 1 to Z 2, according to diameter range, are notable for their quiet running – not just in the HSC area.

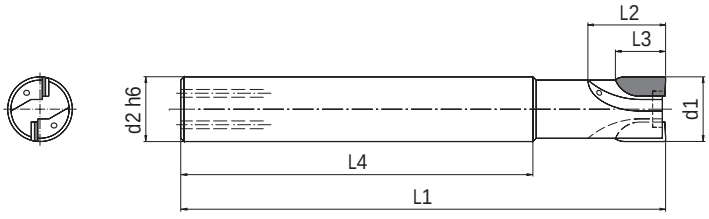


Design:
Milling cutter diameter: 4,0 – 10,0 mm
No. of blades: 1 or 2 (cutting over centre, with full radius)
Shank form: HA (DIN 6535)
Axial angle: neutral
Coolant supply: internal (standard), external (on request)

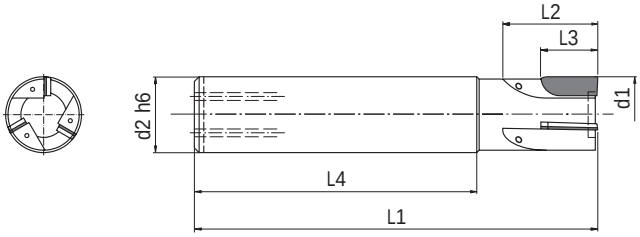
Milling cutter diameter d1±0,05	Shank diameter d2 h6	Overall length L1	Chip groove length L2	Blade length L3	Shank length L4	Radius R	Axial angle	No. of blades Z	Order No.
4,0	4,0	60	12	10	45	2,0	0°	1	7-52041-10
6,0	6,0	80	12	10	65	3,0	0°	1	7-52061-10
8,0	8,0	80	12	10	60	4,0	0°	2	7-52081-10
10,0	10,0	80	12	10	50	5,0	0°	2	7-52101-10

Dimensions in mm.

MAPAL WWS
HP-EndMill
Type 53

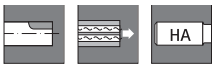


HP-EndMill type 53 – Z 2



HP-EndMill type 53 – Z 3

The high performance product group in the standard range. Specially designed for high settings and tooth feeds. In principle these tools are designed with internal coolant. Machining of closed pockets is carried out with these milling cutters by plunge milling into the workpiece. This is readily achieved without reducing the feed rate even where there is no central blade.



Design:
Milling cutter diameter: 6,0 – 20,0 mm
No. of blades: 2 or 3
Shank form: HA (DIN 6535)
Axial angle: positive
Coolant supply: internal

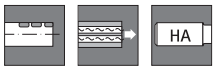
Milling cutter diameter d1±0,05	Shank diameter d2 h6	Overall length L1	Chip groove length L2	Blade length L3	Shank length L4	Cutting lead	Axial angle	No. of blades Z	Order No.
6,0	8,0	55	10	5	40	R 0,2	2°	2	7-53065-30
8,0	8,0	60	12	5	40	R 0,2	4°	2	7-53085-30
10,0	10,0	75	12	5	55	R 0,2	4°	2	7-53105-30
12,0	12,0	85	12	10	60	R 0,2	6°	2	7-53121-30
14,0	16,0	85	12	10	60	R 0,2	6°	3	7-53141-30
16,0	16,0	85	12	10	60	R 0,2	6°	3	7-53161-30
20,0	20,0	100	12	10	50	R 0,2	6°	3	7-53201-30

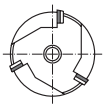
Dimensions in mm.

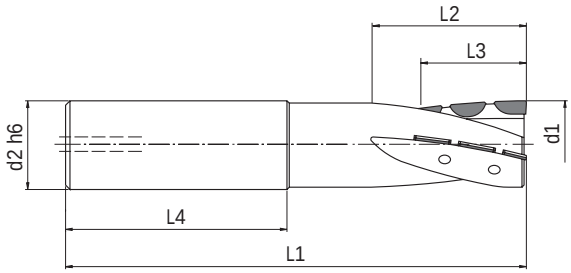
MAPAL WWS
HP-EndMill

Type 57

High removal rates in cutting are easily produced with this type of end mill. The spirally arranged rows of blades are best suited to high volume cutting, for example for integral components. The available drive power can then be perfectly applied for cutting large volumes. Closed pockets can also be accessed with this type of milling cutter by plunge milling. A high performance end mill programme with which long tool life can be expected.





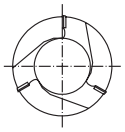


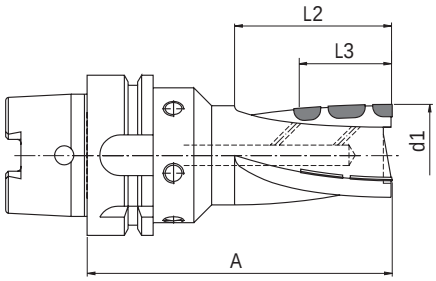
Design:
Milling cutter diameter: 16,0 – 25,0 mm
No. of blades: 3
Shank form: HA (DIN 6535)
Axial angle: positive
Coolant supply: internal

Milling cutter diameter d1±0,05	Shank diameter d2 h6	Overall length L1	Chip groove length L2	Blade length L3	Shank length L4	Cutting lead	Axial angle	No. of blades Z	Order No.
16,0	16,0	100	50	30	50	0,1x45°	15°	3	7-57083-00
20,0	20,0	100	50	30	50	0,1x45°	15°	3	7-57103-00
25,0	25,0	110	50	30	50	0,1x45°	15°	3	7-57123-00

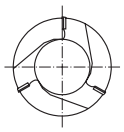
Dimensions in mm.

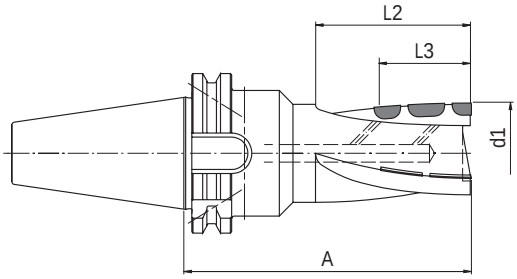
MAPAL WWS
HP-EndMill
Type 57



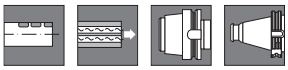


HP-EndMill type 57 – HSK–A 63





HP-EndMill type 57 – ISO 40



Design:
Milling cutter diameter: 32,0 – 63,0 mm
No. of blades: 3 or 4
Shank form: HSK–A 63, ISO 40 (DIN 69871 AD/B)
Axial angle: positive
Coolant supply: internal

Milling cutter diameter d1±0,05	Dimension A	Chip groove length L2	Blade length L3	Shank form	Cutting lead	Axial angle	No. of blades Z	Order No.
32,0	100	50	30	HSK-A 63	0,1x45°	15°	3	7-57163-04
40,0	100	60	40	HSK-A 63	0,1x45°	15°	3	7-57204-04
50,0	100	60	40	HSK-A 63	0,1x45°	15°	4	7-57254-04
63,0	100	60	40	HSK-A 63	0,1x45°	15°	4	7-57314-04
32,0	100	50	30	SK 40	0,1x45°	15°	3	7-57163-01
40,0	100	60	40	SK 40	0,1x45°	15°	3	7-57204-01
50,0	100	60	40	SK 40	0,1x45°	15°	4	7-57254-01
63,0	100	60	40	SK 40	0,1x45°	15°	4	7-57314-01

Dimensions in mm.

From experience – guidelines and cutting values in practice

Material	Cutting speed v_c (m/min)	Feed/blade f_z (mm)	Cutting depth (mm)
Al < 4%Si	500 – 5,000	0.05 – 0.2	0.1 – 5.0
Al 4–8%Si	500 – 4,000	0.05 – 0.2	0.1 – 5.0
Al 9–13%Si	400 – 3,800	0.05 – 0.2	0.1 – 5.0
Al > 13% Si	250 – 3,000	0.03 – 0.15	0.1 – 3.0
Magnesium alloys	300 – 6,000	0.05 – 0.3	0.1 – 4.0
Copper alloys	300 – 6,000	0.05 – 0.4	0.1 – 3.0
Brass alloys	300 – 5,000	0.05 – 0.25	0.1 – 4.0
Graphite	250 – 2,500	0.05 – 0.2	0.1 – 3.0
Gfk – Cfk	250 – 4,000	0.08 – 1.0	0.1 – 5.0

For end milling with high chip volume the cutting values are adjusted to the potential performance of the machine. Because of the significantly lower cutting forces with PCD milling cutters compared to solid carbide tools, settings or teeth feed rates can be increased to reach the limits of the machine's performance. Selection of the appropriate setting should of course be made at a sensible level for the task. Small milling cutter diameters with large feeds would be debatable, just as roughing with a tool diameter of 20 mm in conjunction with a low cutting depth. MAPAL WWS specialists are happy to be of assistance with their knowledge and experience in solving special requirements.

The PCD HP-EndMill is characterised by the high multiple cutting performance of the individual cutting edges. Production tolerances of ≤ 5 µm for radial and axial running ensure the actual multiple cutting performance. Thermal expanding chucks or mechanical pneumatic chucks are the best means of clamping these tools. One further important point for use, particularly under HSC conditions, is balance. Optimum conditions are achieved if the milling cutter and the tool holder are balanced together.

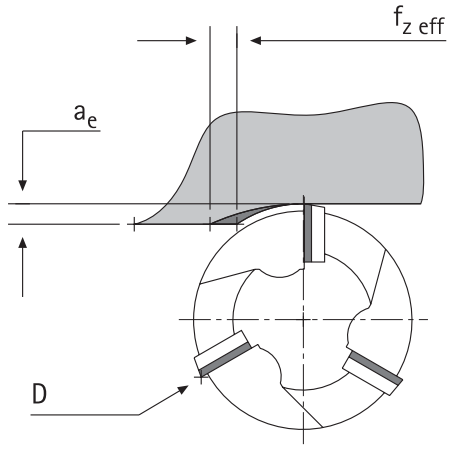
Examples from practice – for use in practice

Machining factor	Mathematical symbol used	Unit	Formula
Spindle speed	n	(min^{-1})	$n = \frac{v_c \cdot 1000}{D \cdot \pi}$
Cutting speed	v_c	(m/min)	$v_c = \frac{D \cdot \pi \cdot n}{1000}$
Feed per blade	f_z	(mm/rev)	$f_z = \frac{v_f}{Z \cdot n} = \frac{f}{Z}$
Feed per revolution	f	(mm)	$f = f_z \cdot Z$
Feed rate	v_f	(mm/min)	$v_f = f_z \cdot Z \cdot n$
Chip-to-chip volume	Q	(cm^3/min)	$Q = \frac{a_e \cdot a_p \cdot v_f}{1000}$

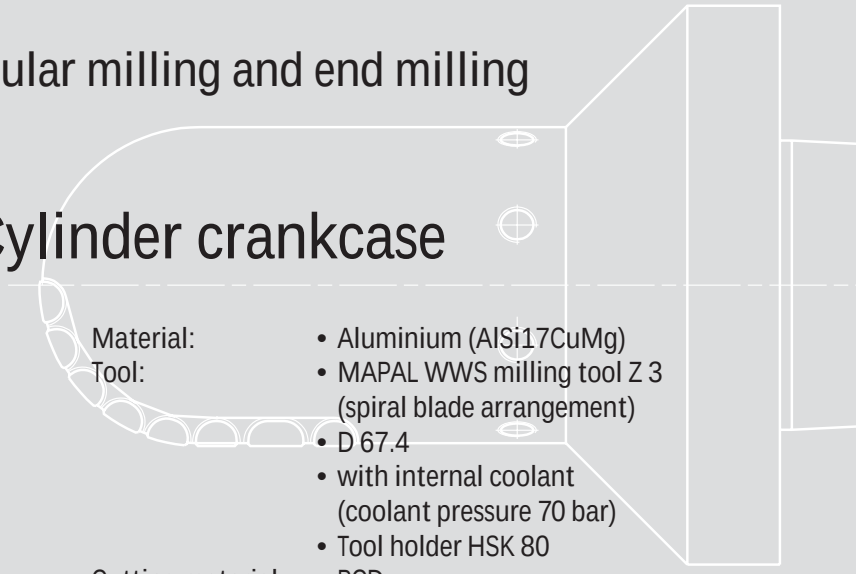
a_e	effective cutting width	(mm)
a_p	cutting depth	(mm)
D	tool diameter	(mm)
π	3.14159...	
Z	number of teeth	

Calculation $f_{z\,eff}$ for peripheral milling with small a_e (up to approx. 0.25 · D)

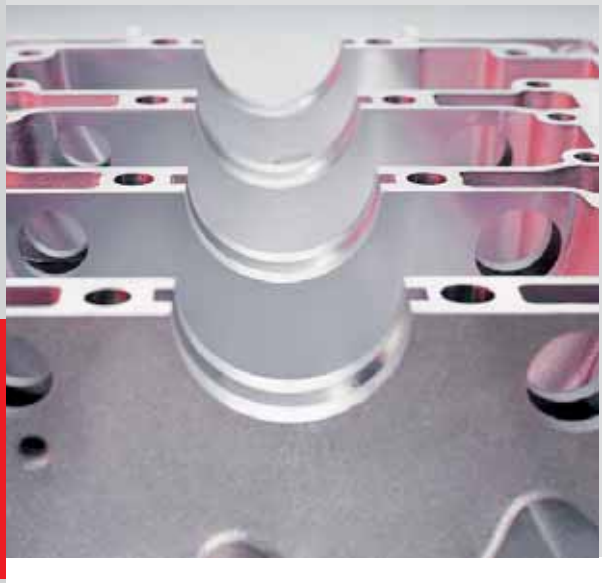
$$f_{z\,eff} = f_z \sqrt{D/a_e}$$



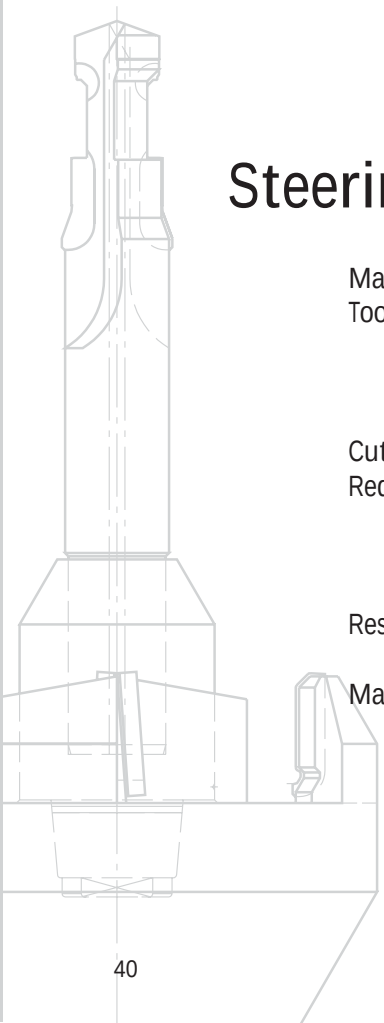
MAPAL WWS Competence – Circular milling and end milling
Machining examples



Cylinder crankcase

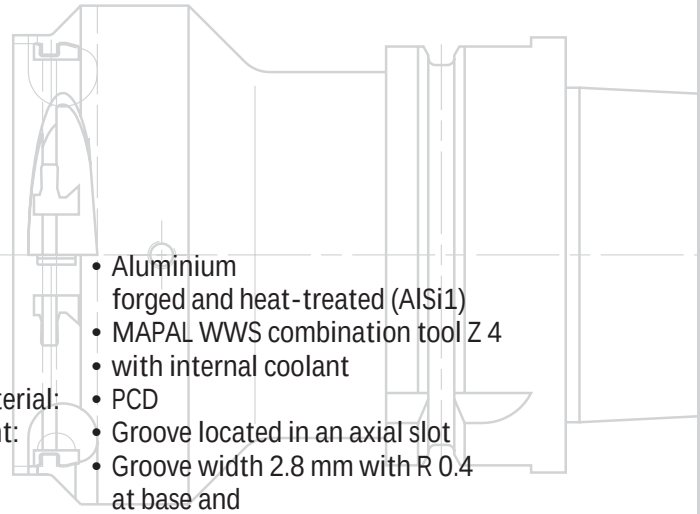


Material:	• Aluminium (AlSi17CuMg)
Tool:	• MAPAL WWS milling tool Z 3 (spiral blade arrangement) • D 67.4 • with internal coolant (coolant pressure 70 bar) • Tool holder HSK 80
Cutting material:	• PCD
Requirement:	• Pre-machining bearing race for crank shaft bearing • Pre-machining into the solid (bearing race is not pre-cast)
Result:	• Tool life 650 m • Machining into the solid possible
Machining values:	• Spindle speed n = 2,600 rpm • Feed per tooth f_z = 0.05 mm



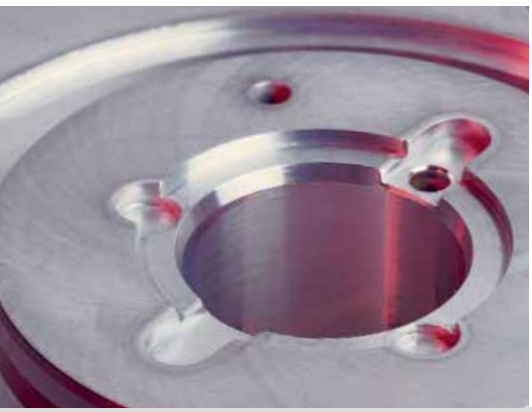
Steering box

Material:	• Aluminium (GDAlSi12Cu1)
Tool:	• MAPAL WWS combination tool • Milling operation Z 4 • Tool operates as bell
Cutting material:	• PCD
Requirement:	• Machining complete external contour with all radii and chamfers • Double spindle used
Result:	• Required accuracy of form fully achieved
Machining values:	• Spindle speed n = 8,000 rpm • Feed per tooth f_z = 0.01 mm



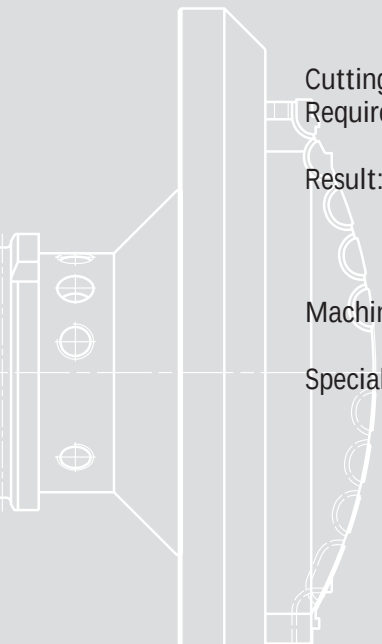
Flange

Material:	• Aluminium forged and heat-treated (AlSi1)
Tool:	• MAPAL WWS combination tool Z 4 • with internal coolant
Cutting material:	• PCD
Requirement:	• Groove located in an axial slot • Groove width 2.8 mm with R 0.4 at base and • Chamfer at entry • Circular form 0.02 mm (statistically checked)
Result:	• cpk value achieved > 2.2
Machining values:	• Spindle speed n = 12,000 rpm • Feed per tooth f_z = 0.1 mm
Special features:	• For safety reasons the tool is designed as a bell with a closed ring in front of the blades

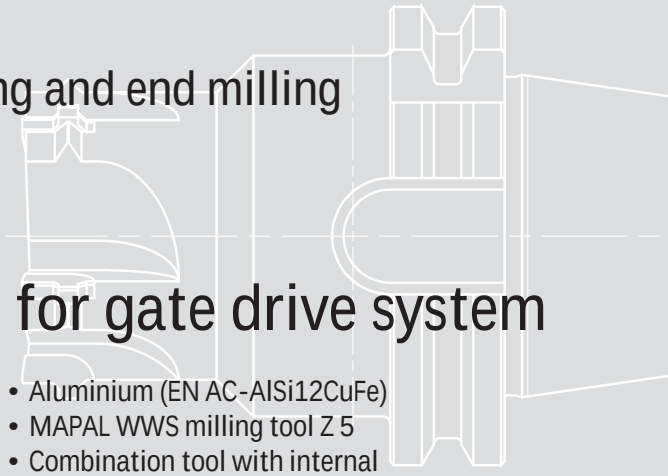


Plastic housing for medical technology

Material:	• Polypropylene (PPH 2250)
Tool:	• MAPAL WWS ball nosed milling cutter Z 1 • Combination tool with internal coolant • D 120 mm with R $109.7^{0.1}$ mm
Cutting material:	• PCD
Requirement:	• Complete contour produced in a single cut
Result:	• Required accuracy of form easily achieved • Reduction in machining time by 30 %
Machining values:	• Spindle speed n = 2,000 rpm • Feed rate v_f = 400 mm/min
Special features:	• Machining into the solid • Aluminium disc as swarf protection plate



MAPAL WWS Competence – Circular milling and end milling
Machining examples

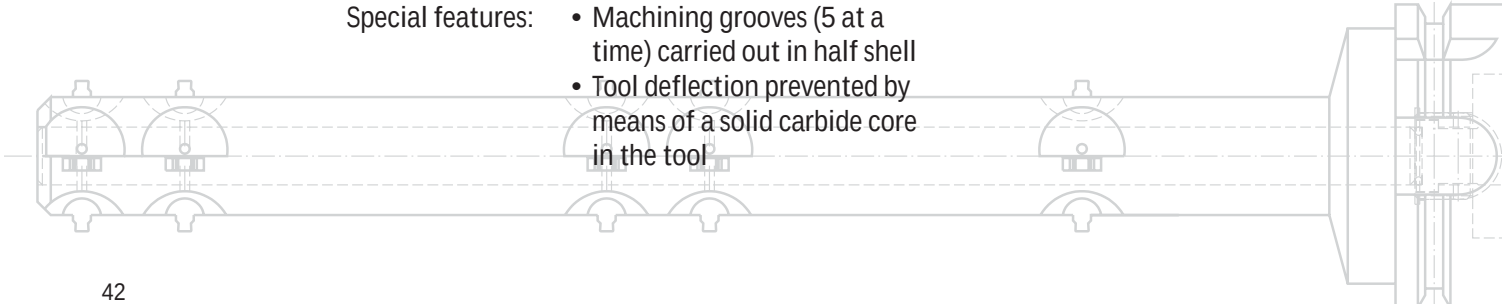


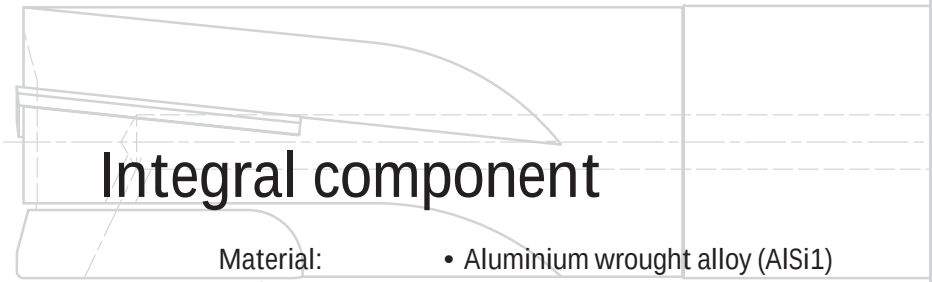
Gear housing for gate drive system

Material:	• Aluminium (EN AC-AlSi12CuFe)
Tool:	• MAPAL WWS milling tool Z 5 • Combination tool with internal coolant • ISO 40 toolholder
Cutting material:	• PCD
Requirement:	• Required surface finish • R_a = 0.8 µm (face surface)
Result:	• Surface finish requirement easily met
Machining values:	• Spindle speed n = 8,000 rpm • Feed per tooth f_z = 0.08 mm
Special features:	• 2 machining operations with one tool on a PCD plate • Groove with D 55^{H12} mm • Face milling on face of bore

Cylinder head
Cam shaft bearing bore

Material:	• Aluminium (GDAlSi9)
Tool:	• MAPAL WWS circular milling tool Z 4 • with internal coolant
Cutting material:	• PCD
Requirement:	• Machining holding slots • Spaces between grooves ± 0.03 mm
Result:	• Machining of all holding slots possible in a single cut
Machining values:	• Spindle speed n = 6,000 rpm • Feed per tooth f_z = 0.08 mm
Special features:	• Machining grooves (5 at a time) carried out in half shell • Tool deflection prevented by means of a solid carbide core in the tool





Integral component

Material:	• Aluminium wrought alloy (AlSi1)
Tool:	• MAPAL WWS HP–EndMill Z 3 • D 20 mm • Blade length 20 mm
Cutting material:	• PCD
Requirement:	• Reduction in machining time • Machining previously with solid carbide tool
Result:	• Increase in cutting results with end mill HP–EndMill by 30 %
Machining values:	• Spindle speed n = 18,000 rpm • Feed per tooth f_z = 0.18 mm • Effective cutting width a_e = 20 mm • Cutting depth a_p = 10 mm
Special features:	• Machining from the solid • 90 % of blank part becomes swarf

Flange

Material:	• Aluminium forged and heat-treated (AlSi1)
Tool:	• MAPAL WWS thread milling tool Z 2 • with internal coolant
Cutting material:	• PCD
Requirement:	• Threaded bore with cross bores
Result:	• Burr–free in cross bore when using PCD thread milling tool
Machining values:	• Spindle speed n = 12,000 rpm • Feed per tooth f_z = 0.1 mm
Special features:	• With a solid carbide thread milling tool a burr is created in the cross bores. This previously required a 100 % inspection and the parts to be re-machined.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Competence – Face milling

High stock removal rates, defined surface uniformity or special requirements for the flat surface of the component – irrespective of what requirements are set for face milling on the tool. MAPAL WWS face milling heads offer the solution.

- Maximum precision as standard
- The optimum solution for every machining operation
- PowerMill and EcoMill series
- Face milling heads – standard programme
- Milling cutter arbors
- Machining examples

Programme summary and help for selection

	PowerMill series		
	PowerFeed	PowerSpeed	PowerFix
Cutting depth max. 4 mm	•	•	•
High feed rates	•		•
Finish machining on unstable parts		•	
Milling cartridges can be reground	•	•	•
Special milling cartridges possible	•	•	•

	EcoMill series		
	EcoFeed	EcoSpeed	EcoFix
Cutting depth max. 2 mm	•	•	•
High feed rates	•		•
Finish machining on unstable parts		•	•
Replaceable milling cartridges	•	•	•

MAPAL WWS Competence – Face milling
The perfect standard tools

With the PowerMill and EcoMill series, this product family, which is designed to suit every imaginable requirement for face milling operations, is impressive in a numerous areas. The components, which are reduced to a sensible minimum, together with the simple but study construction, ensure uncomplicated and extremely fast tool setting. Different numbers of teeth allow the best possible tool to be selected so that maximum economy can be achieved with the milling process.

A low cost 24-hour regrinding service with the PowerMill series or use of replaceable milling cartridges with the EcoMill series offer a choice of two versions.

The perfect solution for every machining task

To complement the standard PowerMill and EcoMill series, MAPAL WWS also constantly provide special solutions for face milling tools which are designed for a specific application.

Controlled chip clearance from the effective working area and brushing processes after the milling operation are probably the most frequently used applications of variations from the standard programme. MAPAL WWS supplies tool designs which also allow these problems to be easily solved.

Complete machining operations, with which faces and spacing can be produced in a single milling pass, are not unusual. For these applications the classic milling head system is then used as a disc milling cutter version.
Face milling operations within housings or milling operations in which the effective working point is at a distance from the spindle nose often lead to vibrations. Here the PowerFix series variation with special vibration damping elements within the milling cutter body are particularly good. By using this tool solution the operation often becomes economic for the first time, even under HSC conditions.

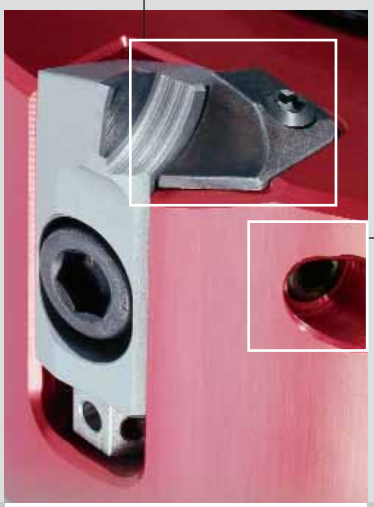
It is not unusual for the user to have the problem that a milling cutter is needed with a large blade cutting track for his machining operation but his machine is restricted by the maximum possible tool diameter. As a special solution MAPAL WWS offers laterally flattened milling heads for this – so-called beam milling cutters. With spindle orientation the machine can then be 'outwitted'.

Special design milling cartridges
In addition to milling heads with special dimensions, milling cartridges which vary from the standard are repeatedly supplied for individual machining tasks. These are designed by MAPAL WWS for use in the PowerMill series.

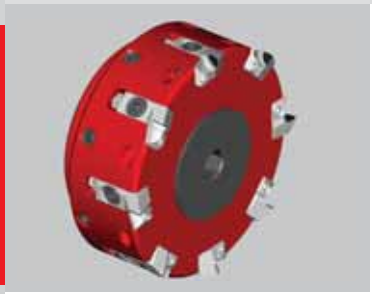
MAPAL WWS Face milling heads in the PowerMill Series – PowerSpeed, PowerFeed and PowerFix

The PowerMill series, the classic amongst all the milling heads, has been constantly adapted to meet the growing demands of cutting operations. The main difference to the EcoMill series lies in the milling cartridge. With the PowerMill series the milling cartridges are designed with larger PCD blades. In addition to the greater cutting depth up to a maximum of 4 mm, this also allows regrinding. Because of accurate production to fit the aluminium body, the high precision milling cartridge guarantees perfect circular movement of the blades.

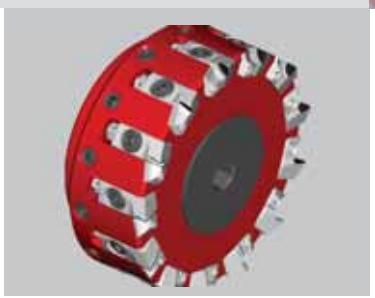
Swarf protection plates
Replaceable swarf protection plates incorporated into the milling head ensure the aluminium body has a long life.



Locking screw
Additional locking screws allow reliable use in HSC operations.



PowerSpeed Face milling head

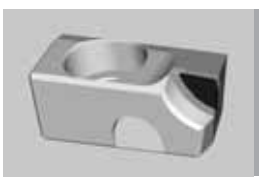


PowerFeed Face milling head

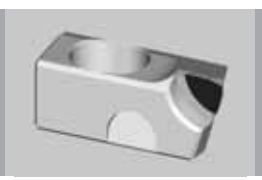
PowerFix Face milling head

Easy setting for the milling cartridge is achieved with an adjustment screw which together with the additional locking screw ensures perfect seating for the blade in the tool body. This means there are no problems when used under HSC conditions. The enormously high balancing quality (G2.5 under ISO 1940/1) is achieved by means of lateral balancing screws. A particularly innovative feature is the coolant screw which, in addition to holding the head on the milling arbor, also enables coolant to be passed from the centre.

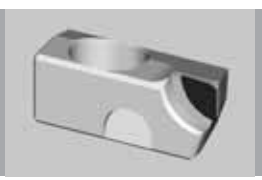
Regrindable milling cartridges
Maximum cutting depth 4 mm.



PCD corner blade



PCD facing blade

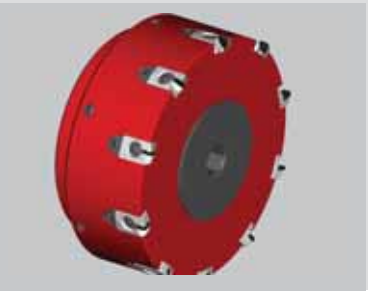


PCD wide face milling blade

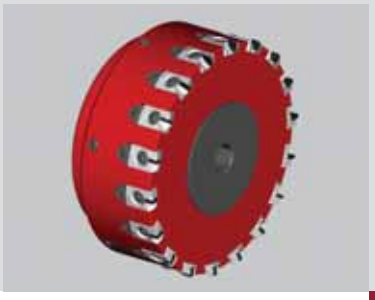
PCD PT blade

MAPAL WWS Face milling heads in the EcoMill Series – EcoSpeed, EcoFeed and EcoFix

The EcoMill series, with the EcoSpeed, EcoFeed and EcoFix systems, represent a new dimension in face milling for HSC operations. The series includes numerous innovations. By using replaceable milling cartridges the reduction in logistics costs from handling is also impressive, likewise the positioning of the milling blade in the aluminium tool body. Centrifugal forces which occur during machining are compensated for by a precision dovetail guide. The new arrangement of the milling blades with integral swarf protection plate clearly increases the life of the milling cutter body. Perfect surface finish is achieved with this milling cutter as a result of the sensitive and effective wedge adjustment on the blades in the Z direction. Initially designed for finishing operations, this milling head is notable for extremely quiet running which it easily achieves despite the high feed rates.

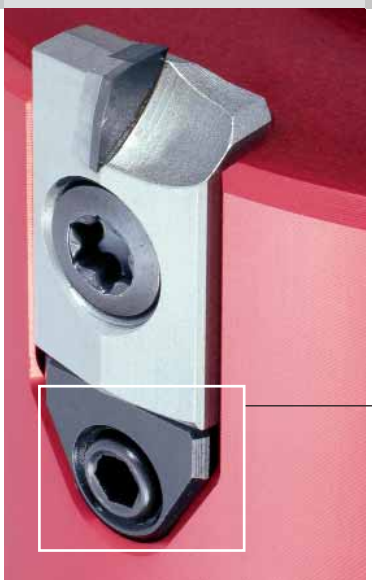


EcoSpeed Face milling head



EcoFeed Face milling head

EcoFix Face milling head



Setting
Sensitive wedge adjustment allows the blades to be set with maximum precision for axial running.

Replaceable milling cartridges
Maximum cutting depth 2 mm.

PCD corner blade

PCD facing blade

PCD wide face milling blade

PCD PT blade

Face milling heads PowerMill and EcoMill – easy handling for high precision results

The efficiency of a milling head system is not just demonstrated by the classic assessment factors. Cutting results, tool life or surface finish achieved and even tool planning are of prime importance. A further important factor for a successful system, however, is handling. A minimum of extremely simple hand movements must be achieved to prepare the milling head at the tool setting stage for use on the machine. It is not unusual, particularly in large cutting organisations, to also recondition the face milling heads at the end of their life within the customer's own tool management system. A decisive factor here is that high precision blade setting can be carried out with the least possible amount of work. It is only in this way that reliable batch production can be obtained even with reground milling cartridges.

PowerMill series – fine adjustment with adjusting screw

- Locate the face milling head in the setting fixture
- Fit the milling cartridge on the basic body using holding screws
- Pre-adjust the milling cartridge with adjusting screws

- Tighten holding screws with 14 Nm

- Finely adjust the milling cartridge with adjusting screw

With the PowerMill series fine adjustment is carried out after the milling cartridge has been finally fitted and the appropriate torque applied. The adjustment screws which have been specially developed for this series allow the blades to be perfectly adjusted. The design of the milling cartridge allows an adjustment range of at least 1 mm.

High precision fine adjustment

The basis for perfect finish machining of a milled surface is the exact axial setting of all the blades to maximum precision. This factor was given particular attention when designing the PowerMill and EcoMill series. While with conventional face milling cutters, whose technology is often based on clamped blades, these have to be positioned in 3 planes in relation to each other, here setting in one direction is quite sufficient.

A decisive factor for this is the precision with which the milling tool body and also the milling cartridges are themselves manufactured. Costly setting devices, time-consuming setting procedures and expensive setting equipment are not required. One setting fixture, whose construction is designed for the primary requirement, plus a precision indicator, is quite sufficient.

EcoMill series – with wedge adjustment

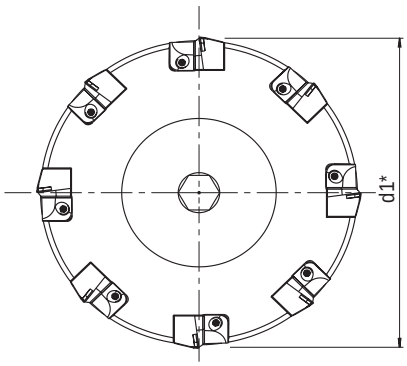
- Position face milling head in setting fixture
- Fit milling cartridge with holding screw onto basic body
- Adjust milling cartridge roughly with adjusting screw

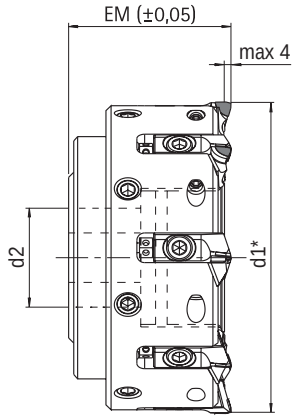
- Tighten holding screw at 8 Nm

- Finely adjust milling cartridge with adjusting wedge

Based on this technology, a new type of wedge adjustment was developed for the EcoMill series. Here the adjusting element has a wedge-shaped surface which lies directly against the milling cartridge. By turning the right-hand and left-hand threaded spindle the axial running can be effortlessly set within the required high-precision range. Combined with the easy handling, the accuracy to be achieved surpasses all the previous results.

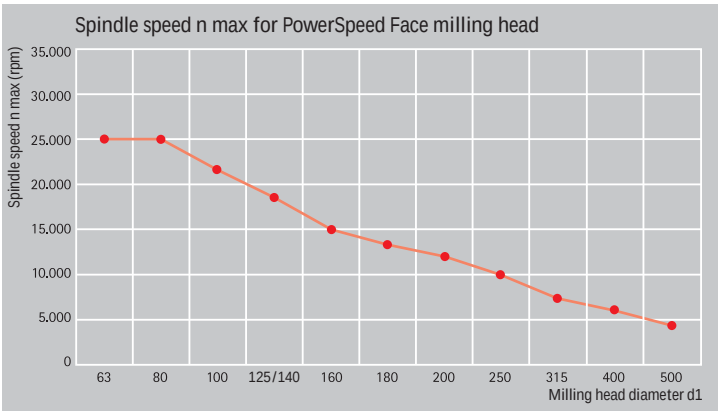
MAPAL WWS
Face milling head – PowerSpeed





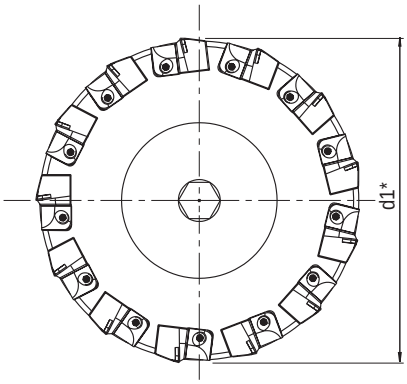
Design:
Milling cutter diameter: 63 – 500 mm
No. of blades: 3 – 30
Coolant supply: internal

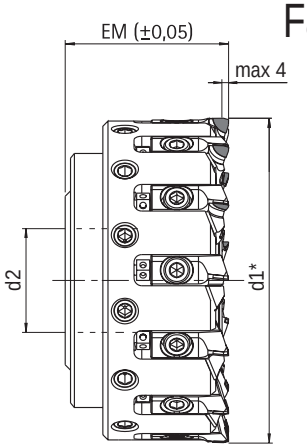
Milling head diameter d1*	No. of blades Z	Setting dimension EM (±0,05)	Tool holder diameter d2	Material basic body	Spindle speed n max (rpm)	Weight incl. milling cartridges kg	Order No. basic body R.H.
63	3	48	22	Steel	25.000	0,85	7-01063-01
63	5	48	22	Steel	25.000	0,80	7-21063-01
80	5	50	27	Aluminium	25.000	0,75	7-01080-01
80	6	50	27	Aluminium	25.000	0,75	7-11080-01
80	7	50	27	Aluminium	25.000	0,80	7-21080-01
100	6	50	32	Aluminium	21.650	1,08	7-01100-01
100	8	50	32	Aluminium	21.650	1,20	7-21100-01
125	8	63	40	Aluminium	18.550	2,20	7-01125-01
125	10	63	40	Aluminium	18.550	2,20	7-11125-01
125	12	63	40	Aluminium	18.550	2,25	7-21125-01
140	10	63	40	Aluminium	18.550	1,95	7-01140-01
160	10	63	40	Aluminium	14.990	2,75	7-01160-01
160	12	63	40	Aluminium	14.990	2,80	7-21160-01
180	10	63	40	Aluminium	13.500	3,40	7-01180-01
200	12	63	60	Aluminium	12.200	4,15	7-01200-01
250	15	63	60	Aluminium	9.760	6,70	7-01250-01
315	18	80	60	Aluminium	7.750	13,35	7-01315-01
400	24	80	60	Aluminium	6.100	21,40	7-01400-01
500	30	80	60	Aluminium	4.880	34,50	7-01500-01



Dimensions given in mm.
*d1 depends on type of milling cartridge, see page 57.
Supplied as follows: Face milling head with all accessory parts.
Milling cartridges and milling cutter arbor not included.
For milling cartridges see page 57.
For accessories and spare parts see page 63.
For milling cutter arbors see page 64 and 65.
L.H. version available on request.

MAPAL WWS
Face milling head – PowerFeed



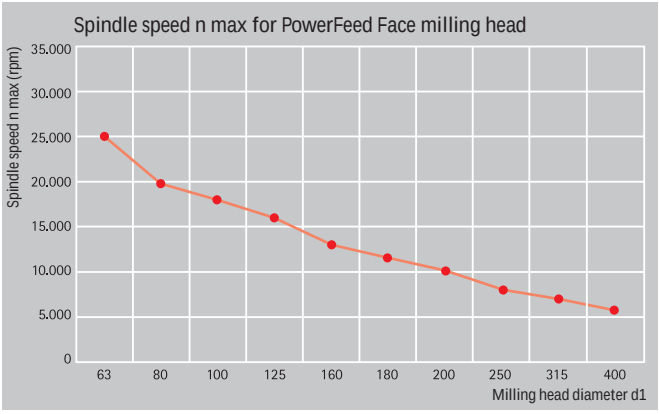


Design:
Milling cutter diameter: 63 – 400 mm
No. of blades: 8 – 50 (standard)
Coolant supply: internal

Milling head diameter d1*	No. of blades Z	Setting dimension EM (±0,05)	Tool holder diameter d2	Material basic body	Spindle speed n max (rpm)	Weight incl. milling cartridges kg	Order No. basic body R.H.
63	8	48	22	Steel	25.000	0,80	7-04063-01
80	8	50	27	Aluminium	20.000	0,75	7-04080-01
100	10	50	32	Aluminium	18.000	1,20	7-04100-01
125	13	63	40	Aluminium	16.000	2,20	7-04125-01
160	18	63	40	Aluminium	13.000	2,15	7-04160-01
180	20	63	40	Aluminium	11.500	2,60	7-04180-01
200	24	63	60	Aluminium	10.000	4,40	7-04200-01
250	30	63	60	Aluminium	8.000	7,00	7-04250-01
315	38	80	60	Aluminium	7.000	14,10	7-04315-01
400	50	80	60	Aluminium	6.100	22,10	7-04400-01

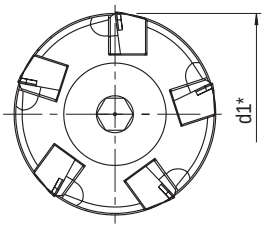
Millling head diameter d1	No. of teeth Standard version Z	No. of teeth Special Z	Material – basic body
63	8	5, 6	Steel
80	8	max. 10	Aluminium or steel
100	10	max. 15	Aluminium or steel
125	13	max. 20	Aluminium or steel
160	18	max. 28	Aluminium

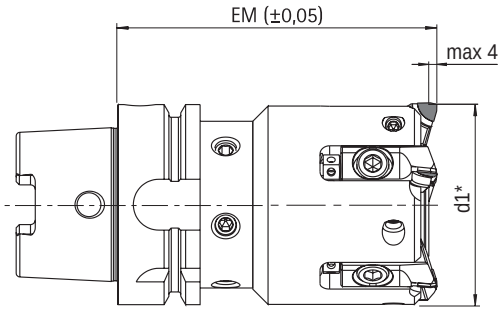
Dimensions given in mm.
*d1 depends on type of milling cartridge, see page 57.
Supplied as follows: Face milling head with all accessory parts
Milling cartridges and milling cutter arbor not included.
For milling cartridges see page 57.
For accessories and spare parts see page 63.
For milling cutter arbors see page 64 and 65.
Special version with greater number of teeth available on request.
L.H. version available on request.



MAPAL WWS
Face milling head – PowerFix

Design:
Milling cutter diameter: 50 – 100 mm
No. of blades: 4 – 6 (standard)
Shank form: HSK-A 63, ISO 40 (DIN 69871 AD/B)
Coolant supply: internal

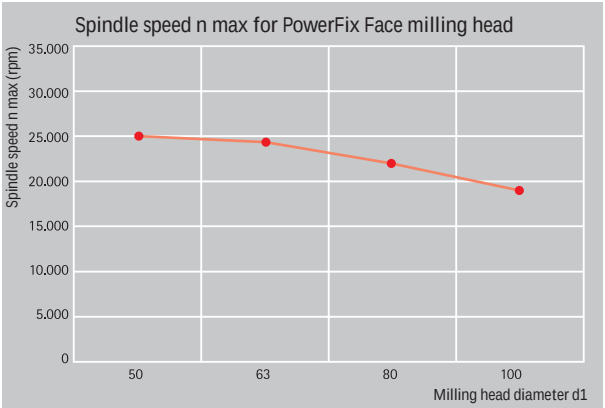




PowerFix Face milling head – HSK-A 63

Milling head diameter d1*	No. of blades Z	Setting dimension EM (±0,05)	Shank form	Material basic body	Spindle speed n max (rpm)	Weight incl. milling cartridges kg	Order No. basic body R.H.
50	4	100	HSK-A 63	Steel	25.000	1,55 kg	7-44050-01
63	5	100	HSK-A 63	Steel	24.360	2,0 kg	7-54063-01
80	5	100	HSK-A 63	Steel	22.000	2,65 kg	7-54080-01
100	6	100	HSK-A 63	Steel	19.000	3,7 kg	7-64100-01
50	4	100	SK 40	Steel	25.000	1,75 kg	7-45050-01
63	5	100	SK 40	Steel	24.360	2,2 kg	7-55063-01

Milling head diameter d1	No. of teeth		Material – basic body
	Standard version Z	Special Z	
50	4	max. 6	Steel
63	5	max. 8	Steel
80	5	max. 10	Steel
100	6	max. 15	Steel



Dimensions given in mm.
*d1 depends on type of milling cartridge, see page 57.
Supplied as follows: Face milling head with all accessory parts.
Milling cartridges not included.
For milling cartridges see page 57.
For accessories and spare parts see page 63.
Special version with greater no. of teeth available on request.
L.H. version available on request.

Milling Cartridges for MAPAL WWS Face milling heads from the PowerMill series

- Max. cutting depth: 4 mm
- Suitable for regrinding

7 - 02 6 1 1 - 0 2

a) Series
b) Type
c) Top rake
d) Blade form
e) Running direction
f) Cutting material

a) Series

No.	Series
02	PowerMill

b) Type

No.	Type
6	Corner blade
7	Facing blade
8	Wide face milling blade
9	PT blade[1)]

c) Top rake

No.	Top rake
1	6°
2	3°
3	0°

d) Blade form

No.	Type No. 6 (corner blade) Type No. 7 (facing blade) Required R_z value (on part)	Type No. 8 (wide face milling blade) Radius	Type No. 9 (PT blade) Required R_z value (on part)
1	≤ 5 µm	•	≤ 5 µm
2	≤ 10 µm		
3	≤ 20 µm		
4	> 20 µm		

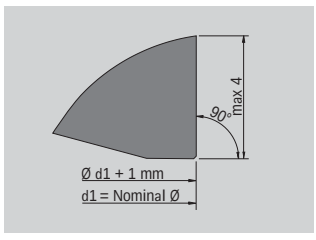
e) Running direction

No.	Running direction
0	R.H.
1	L.H.

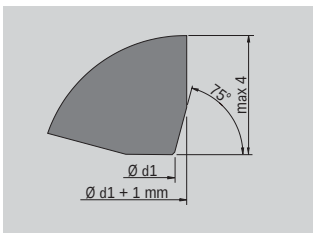
f) Cutting material

No.	Cutting material
2	PCD
3	PCB[2)]
5	carbide

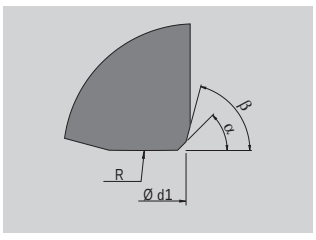
Milling cartridges



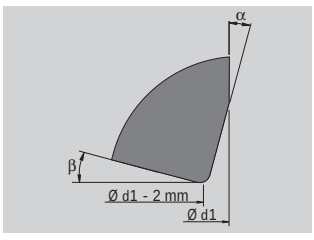
Type No. 6 Corner blade



Type No. 7 Facing blade



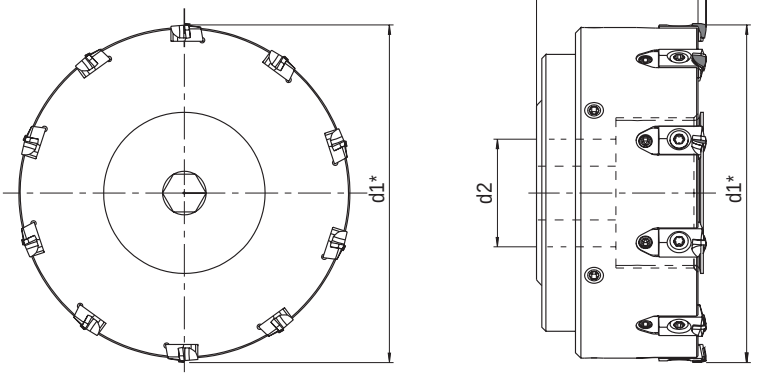
Type No. 8 Wide face milling blade



Type No. 9 PT blade

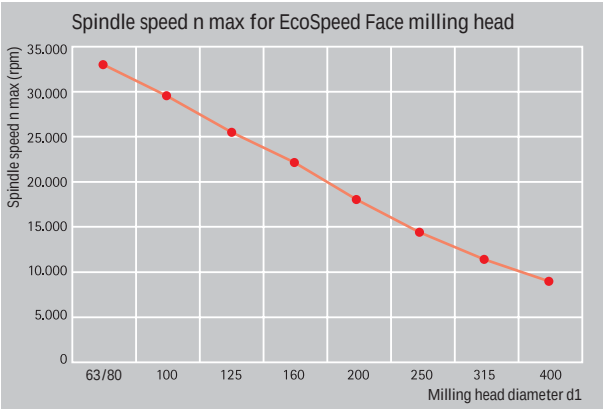
[1)]PT blade: Only top rake No. 3 (0°) can be selected
[2)]In order to be able to select the suitable PCB grade we require details of the machining task.
Weight of milling cartridge = 21 grams.

MAPAL WWS
Face milling head – EcoSpeed



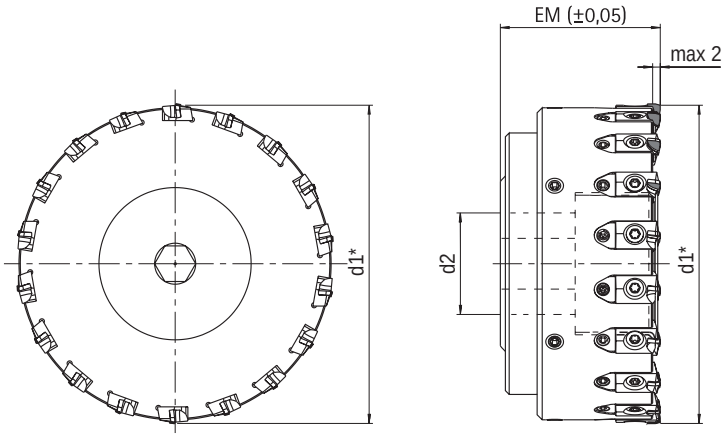
Design:
Milling cutter diameter: 63 – 400 mm
No. of blades: 5 – 28
Coolant supply: internal

Milling head diameter d1*	No. of blades Z	Setting dimension EM (±0,05)	Tool holder diameter d2	Material basic body	Spindle speed n max (rpm)	Weight incl. milling cartridges kg	Order No. basic body R.H.
63	5	48	22	Aluminium	33.000	0,40	7-05063-01
80	6	50	27	Aluminium	33.000	0,70	7-05080-01
100	8	50	32	Aluminium	29.500	1,10	7-05100-01
125	10	63	40	Aluminium	25.500	2,20	7-05125-01
160	12	63	40	Aluminium	22.200	2,80	7-05160-01
200	16	63	60	Aluminium	18.100	4,20	7-05200-01
250	20	63	60	Aluminium	14.500	6,70	7-05250-01
315	24	80	60	Aluminium	11.500	12,90	7-05315-01
400	28	80	60	Aluminium	9.000	21,30	7-05400-01



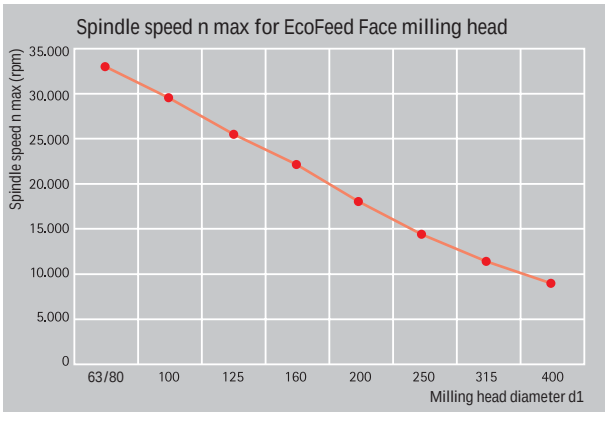
Dimensions given in mm.
*d1 depends on type of milling cartridge, see page 61.
Supplied as follows: Face milling head with all accessory parts.
Milling cartridges and milling cutter arbor not included.
For milling cartridges see page 61.
For accessories and spare parts see page 63.
For milling cutter arbors see page 64 and 65.

MAPAL WWS
Face milling head – EcoFeed



Design:
Milling cutter diameter: 63 – 400 mm
No. of blades: 8 – 58 (standard)
Coolant supply: internal

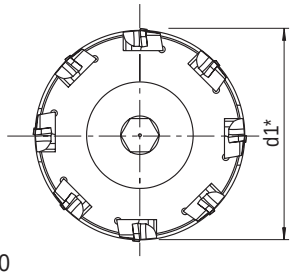
Milling head diameter d1*	No. of blades Z	Setting dimension EM (±0,05)	Tool holder diameter d2	Material basic body	Spindle speed n max (rpm)	Weight incl. milling cartridges kg	Order No. basic body R.H.
63	8	48	22	Aluminium	33.000	0,42	7-06063-01
80	10	50	27	Aluminium	33.000	0,75	7-06080-01
100	14	50	32	Aluminium	29.500	1,20	7-06100-01
125	18	63	40	Aluminium	25.500	2,20	7-06125-01
160	24	63	40	Aluminium	22.200	2,80	7-06160-01
200	28	63	60	Aluminium	18.100	4,30	7-06200-01
250	36	63	60	Aluminium	14.500	6,80	7-06250-01
315	46	80	60	Aluminium	11.500	13,00	7-06315-01
400	58	80	60	Aluminium	9.000	21,60	7-06400-01

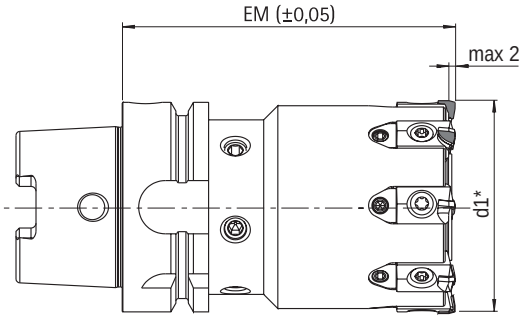


Dimensions given in mm.
*d1 depends on type of milling cartridge, see page 61.
Supplied as follows: Face milling head with all accessory parts.
Milling cartridges and milling cutter arbor not included.
For milling cartridges see page 61.
For accessories and spare parts see page 63.
For milling cutter arbors see page 64 and 65.
Special version with greater number of teeth available on request.

MAPAL WWS
Face milling head – EcoFix

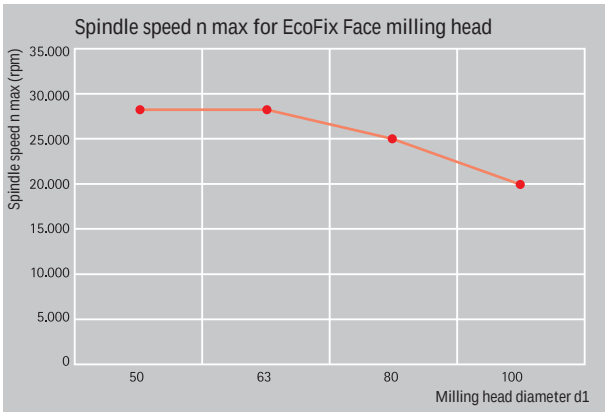
Design:
Milling cutter diameter: 50 – 100 mm
No. of blades: 6 – 14 (standard)
Shank form: HSK-A 63, ISO 40 (DIN 69871 AD/B)
Coolant supply: internal





EcoFix Face milling head – HSK-A 63

Milling head diameter d1*	No. of blades Z	Setting dimension EM (±0,05)	Shank form	Material basic body	Spindle speed n max (rpm)	Weight incl. milling cartridges kg	Order No. basic body R.H.
50	6	100	HSK-A 63	Steel	27.000	1,50	7-08050-04
63	8	100	HSK-A 63	Steel	27.000	1,85	7-08063-04
80	10	100	HSK-A 63	Steel	25.000	2,50	7-08080-04
100	14	100	HSK-A 63	Steel	20.000	3,55	7-08100-04
50	6	100	SK 40	Steel	27.000	1,65	7-08050-05
63	8	100	SK 40	Steel	27.000	2,05	7-08063-05



Dimensions given in mm.
*d1 depends on type of milling cartridge, see page 61.
Supplied as follows: Face milling head with all accessory parts.
Milling cartridges not included.
For milling cartridges see page 61.
For accessories and spare parts see page 63.
Special version with greater number of teeth available on request.

Milling Cartridges for MAPAL WWS Face milling heads from the EcoMill series

- Max. cutting depth: 2 mm
- Unsuitable for regrinding

7 - 07 7 1 2 - 0 2

a) Series
b) Type
c) Top rake
d) Blade form
e) Running direction
f) Cutting material

a) Series

No.	Series
07	EcoMill

b) Type

No.	Type
6	Corner blade
7	Facing blade
8	Wide face milling blade
9	PT blade[1)]

c) Top rake

No.	Top rake
1	6°
2	3°
3	0°

d) Blade form

No.	Type No. 6 (corner blade) Type No. 7 (facing blade) Required R_Z value (on part)	Type No. 8 (wide face milling blade) Radius	Type No. 9 (PT blade) Required R_Z value (on part)
1	≤ 5 µm	•	≤ 5 µm
2	≤ 10 µm		
3	≤ 20 µm		
4	> 20 µm		

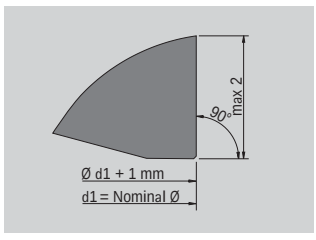
e) Running direction

No.	Running direction
0	R.H.

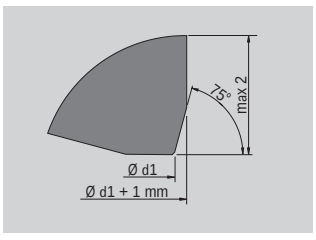
f) Cutting material

No.	Cutting material
2	PCD
3	PCB[2)]
5	carbide

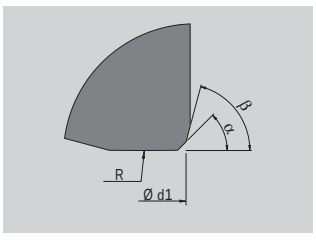
Milling cartridges



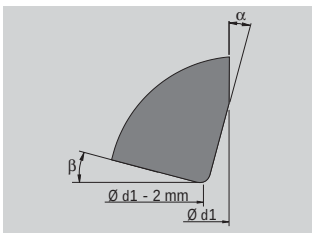
Type No. 6 Corner blade



Type No. 7 Facing blade



Type No. 8 Wide face milling blade

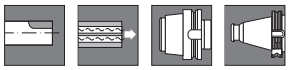


Type No. 9 PT blade

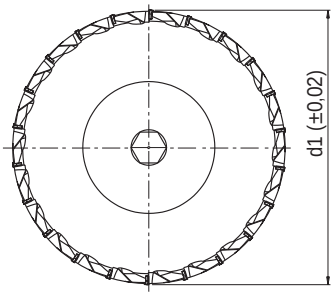
[1)]PT blade: Only top rake No. 3 (0°) can be selected
[2)]In order to be able to select the suitable PCB grade we require details of the machining task.
Weight of milling cartridge = 6.7 grams.

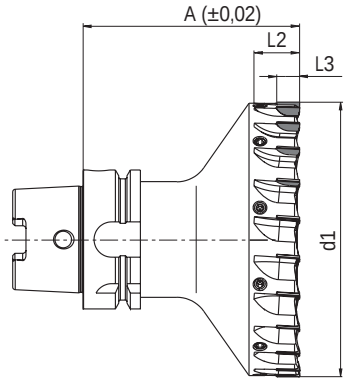
MAPAL WWS
Face milling cutter – HP-FaceMill

This product family is particularly intended for face milling operations with high allowances. Cutting depths are possible up to 10 mm. In addition because of the large number of teeth exceedingly good feed rates are achieved. This is of particular advantage for machines with low spindle speeds. Vibrations which occur during machining, which are also caused by the component, are absorbed by the massive tool body and not passed on to the surface being machined.



Design:
Milling cutter diameter: 40 – 125 mm
No. of blades: 10 – 22
Shank form: HSK-A 63 and 100, ISO 40 (DIN 69871 AD/B)
Axial angle: positive
Coolant supply: internal





Milling cutter diameter d1 (±0,02)	No. of blades Z	Dimension A (±0,02)	Shank form	Chip groove length L2	Blade length L3	Cutting lead	Axial angle	Weight kg	Order No.
40	10	100	HSK-A 63	20	10	0,1x45°	4°	1,43	7-58201-04
50	12	100	HSK-A 63	20	10	0,1x45°	4°	1,71	7-58251-04
63	14	100	HSK-A 63	20	10	0,1x45°	4°	1,98	7-58311-04
80	16	100	HSK-A 63	20	10	0,1x45°	4°	2,39	7-58401-04
100	18	100	HSK-A 63	20	10	0,1x45°	4°	3,01	7-58501-04
125	22	100	HSK-A 63	20	10	0,1x45°	4°	4,21	7-58621-04
80	16	100	HSK-A 100	20	10	0,1x45°	4°	4,68	7-58401-08
100	18	100	HSK-A 100	20	10	0,1x45°	4°	5,36	7-58501-08
125	22	100	HSK-A 100	20	10	0,1x45°	4°	6,34	7-58621-08
40	10	100	SK 40	20	10	0,1x45°	4°	1,63	7-58201-01
50	12	100	SK 40	20	10	0,1x45°	4°	1,96	7-58251-01
63	14	100	SK 40	20	10	0,1x45°	4°	2,17	7-58311-01

Dimensions given in mm.
Special dimensions available on request.

Accessories and spare parts for MAPAL WWS Face milling heads

Designation	for Face milling heads				for milling head diameter d1	Dimensions	Weight	Order No.
	PowerSpeed PowerFeed	PowerFix	EcoSpeed EcoFeed	EcoFix				
Coolant screw		•		•	50		23,6 g	7-03008-00
Coolant screw	•	•	•	•	63		82,3 g	7-03008-01
Coolant screw	•	•	•	•	80		176,2 g	7-03008-02
Coolant screw	•	•	•	•	100		263 g	7-03008-03
Coolant screw	•		•		125 and 140		595 g	7-03008-04
Coolant cover	•		•		160 and 180		0,2 kg	7-03009-01
Coolant cover	•		•		200		0,5 kg	7-03009-02
Coolant cover	•		•		250		0,7 kg	7-03009-03
Coolant cover	•		•		315		1,3 kg	7-03009-04
Coolant cover	•		•		400		2,3 kg	7-03009-05
Coolant cover	•				500		4,6 kg	7-03009-06
Holding screw	•		•		160 to 500	M6x20	4,3 g	7-03001-04
Insert nut	•		•		[1]	M6x8	2,3 g	7-03009-11
Insert nut			•		63 to 400	M5x10	1,9 g	7-03009-12
Shim adjuster	•	•			50 to 500	0,25	0,5 g	7-03004-00
Shim adjuster	•	•			50 to 500	0,5	0,9 g	7-03004-01
Shim adjuster	•	•			50 to 500	1,0	2,0 g	7-03004-02
Shim adjuster	•	•			50 to 500	1,5	3,0 g	7-03004-03
Shim adjuster	•	•			50 to 500	2,0	4,0 g	7-03004-04
Balancing screw	•	•	•	•	80 to 160	M6x10	1,4 g	7-03007-01
Balancing screw	•		•		200 to 500	M10x10	2,7 g	7-03007-02
Balancing screw	•	•	•	•	[2]	M8x10	2,2 g	7-03007-03
For milling cartridges								
Holding screw			•	•	63 to 400	M5x11 (Torx)	1,3 g	7-03002-03
Threaded spindle			•	•	63 to 400	M5x0,5LH/RHx17	1,9 g	7-03002-04
Adjustment wedge			•	•	63 to 400		1,6 g	7-03002-05
Holding screw	•	•			50 to 500	M6x12	5 g	7-03001-01
Holding screw	•	•			50 to 60	M6x12 (flat head)	3,9 g	7-03001-03
Adjusting screw	•	•			50 to 500	M5x8	2,5 g	7-03002-01
Locking screw	•[3]	•			50 to 500	M6x12	1,6 g	7-03003-03
For swarf protection plate								
Swarf protection plate (R.H.)	•				63 to 500		1,4 g	7-03005-01
Swarf protection plate (L.H.)	•				63 to 500		1,4 g	7-03005-02
Torx screw	•				63 to 500	M3x7	0,3 g	7-03006-01
For milling cutter arbor								
Holding screw	•		•		160	M12x40	46 g	7-03001-05
Holding screw	•		•		200 to 500	M16x50	104 g	7-03001-06
Holding screw[4]	•		•		315 to 500	M20x55	150 g	7-03001-07

Dimensions in mm.

[1] 80 to 500 (PowerSpeed and PowerFeed), 160 to 400 (EcoSpeed and EcoFeed)

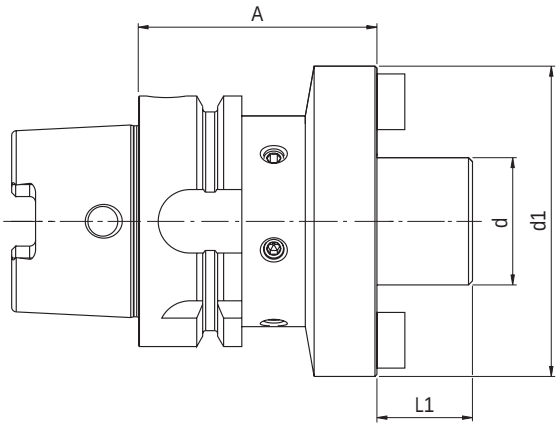
[2] for special milling heads

[3] for PowerSpeed only

[4] on external hole circle only

Milling cutter arbors to DIN 69882-3

Location shank HSK-A to DIN 69893-1

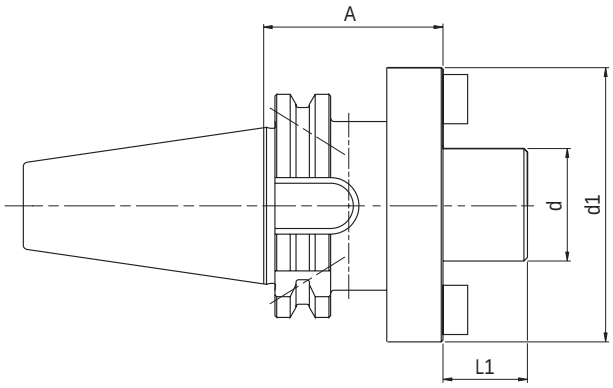


Nominal size	Dimensions				Weight	Code	Order No.
HSK-A	d	d1	A	L1	kg		
63	22	50	50	19	1,1	MN5050-58-K	10066802
63	27	60	60	21	1,3	MN5051-58-K	10066803
63	32	78	60	24	1,4	MN5052-58-K	10066804
63*	40	89	60	27	1,9	MN5053-58-K	10066805
63*	60**	140	70	27	4,2	MN5055-58-K	10067153
80	22	50	50	19	2,3	MN5050-59-K	10066806
80	27	60	50	21	2,5	MN5051-59-K	10066808
80	32	78	60	24	2,6	MN5052-59-K	10066810
80*	40	89	60	27	3,6	MN5053-59-K	10066811
100	22	50	50	19	2,5	MN5050-60-K	10066812
100	27	60	50	21	2,7	MN5051-60-K	10066813
100	32	78	50	24	2,8	MN5052-60-K	10066814
100*	40	89	60	27	3,8	MN5053-60-K	10066815
100*	60	140	70	40	5,5	MN5055-60-K	10066817

Spare parts

Arbor diameter d	Key block		Holding screw ISO 4762 for key block	
	Code	Order No.	Dimensions	Order No.
22	MT1013-01	10005640	M4x10	10003583
27	MT1215-01	10005165	M4x16	10003586
32	MT1422-01	10004063	M5x16	10003601
40	MT1623-01	10004064	M5x16	10003601
60	MT2625-01	10010103	M12x25	10003675

Dimensions in mm.
Supplied as follows: with key blocks screwed on, coolant screw not included (coolant screw is included with supply of face milling head).
Design: permissible concentricity variation of hollow taper shank to arbor d = 0.01 mm.
With 6 balancing bores on periphery.
Note: Sizes marked with * have an additional 4 threaded holes for cutting heads with tool holding to DIN 2079.
**d 60 mm with nominal size HSK-A 63:
– max. milling head diameter D 250 mm
– no balancing holes on periphery.



Milling cutter arbors

ISO location shank to DIN 69871 AD/B

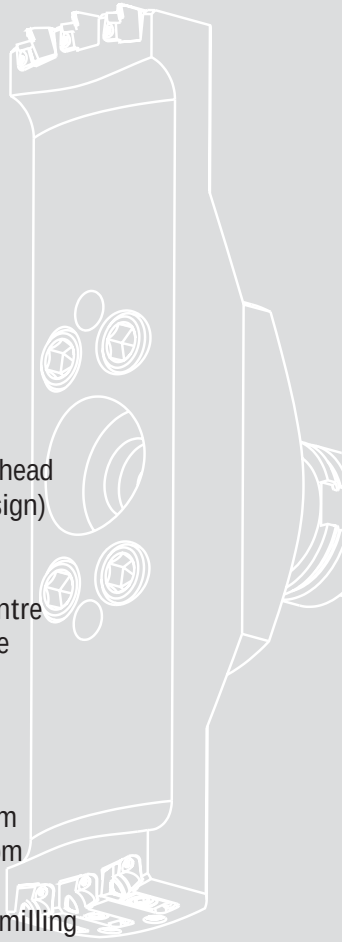
Nominal size	Dimensions				Weight	Code	Order No.
SK	d	d1	A	L1	kg		
40	22	50	35	19	1,05	MN1180-52	10066837
40	27	50	35	19	1,1	MN1181-52	10066838
40	32	78	50	24	1,65	MN1182-52	10066839
40*	40	89	50	27	1,85	MN1183-52	10066840
40*	60**	140	70	27	4,3	MN1185-52	10011328

Spare parts

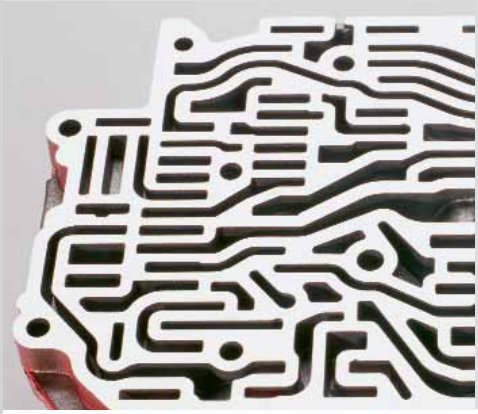
Arbor diameter	Key block		Holding screw ISO 4762 for key block	
d	Code	Order No.	Dimensions	Order No.
22	MT1013-01	10005640	M4x10	10003583
27	MT1215-01	10005165	M4x16	10003586
32	MT1422-01	10004063	M5x16	10003601
40	MT1623-01	10004064	M5x16	10003601
60	MT2625-01	10010103	M12x25	10003675

Dimensions in mm.
Supplied as follows: with key blocks screwed on, coolant screw not included (coolant screw is included with supply of face milling head).
Design: permissible concentricity variation of ISO shank to arbor d = 0.01 mm.
Note: Sizes marked with * have an additional 4 threaded holes for cutting heads with tool holding to DIN 2079.
**d 60 mm: max. milling head diameter D 250 mm.

MAPAL WWS Competence – Face milling
Machining examples



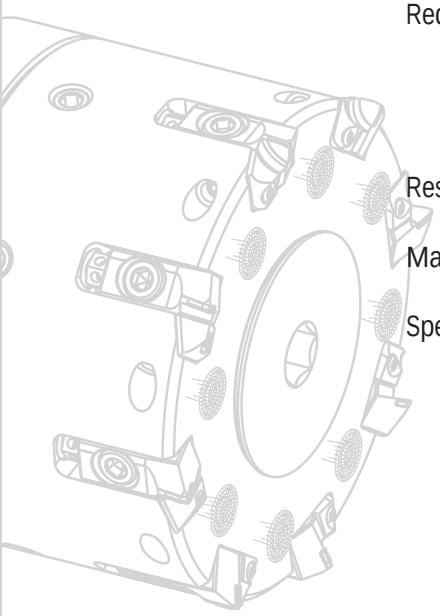
Valve body

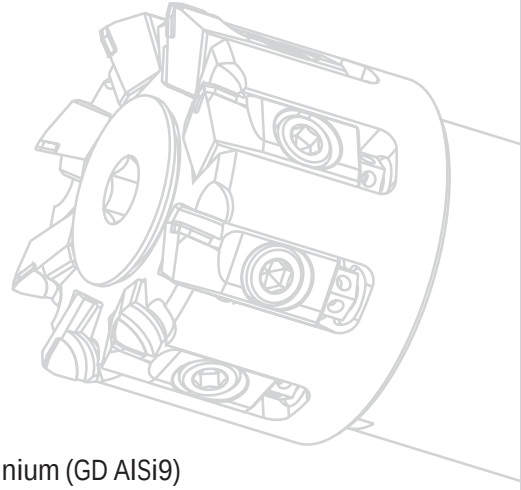


Material:	• Aluminium (GD AlSi9Cu3)
Tool:	• MAPAL WWS face milling head PowerFeed Z 6 (special design) • D 370 mm
Cutting material:	• PCD
Requirement:	• Face mill on machining centre • Machine the whole surface in one cut
Result:	• Flatness = 9 µm • Straightness = 8 to 10 µm • Surface quality R_z = 1.6 µm / R_{max} = 2.2 µm
Machining values:	• Spindle speed n = 3,000 rpm • Feed f = 1,800 mm/min
Special feature:	• Design of a flattened face milling head (beam milling cutter) for use on machining centres

Cylinder head

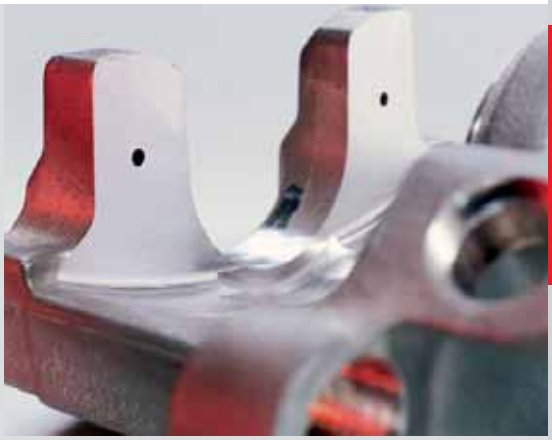
Material:	• Aluminium (GD AlSi8Cu3)
Tool:	• MAPAL WWS face milling head PowerSpeed Z 8 • with integral deburring brushes • D 125 mm
Cutting material:	• PCD
Requirement:	• Milling of combustion chamber side over a total width of 380 mm • Max. possible tool diameter on machine = D 125 mm
Result:	• Flatness = < 10 µm • Surface quality R_z = 4 µm
Machining values:	• Spindle speed n = 6,500 rpm • Feed per tooth f = 6,240 mm
Special feature:	• Machine surface in several tracks by laterally offsetting face milling cutter. • Transitions which are produced are smoothed with integral brushes • Brushes activated by increasing coolant pressure





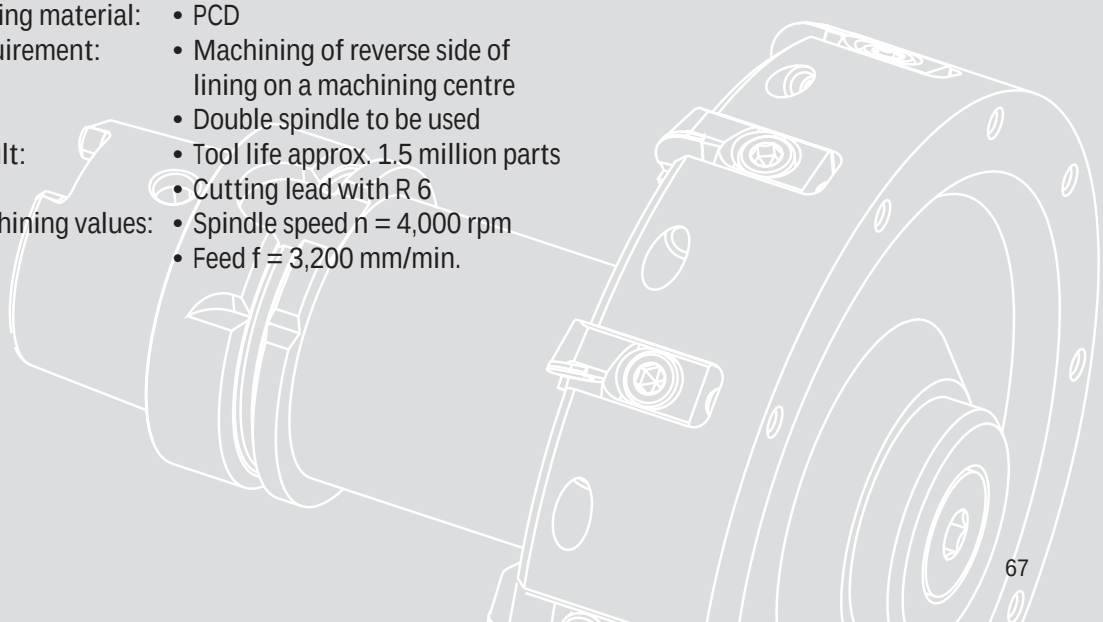
Timing housing

Material:	• Aluminium (GD AlSi9)
Tool:	• MAPAL WWS face milling head PowerFeed Z 8
	• D 63 mm
Cutting material:	• PCD
Requirement:	• Milling over whole component
	• Milling path per component approx. 5 m
Result:	• Tool life approx. 15,000 parts
	• Milling path approx. 75,000 m
Machining values:	• Spindle speed n = 15,000 rpm
	• Feed per tooth f_z = 0.08 mm
Special feature:	• Dimension A for face milling head and milling cutter arbor = 208 mm



Disc brake housing

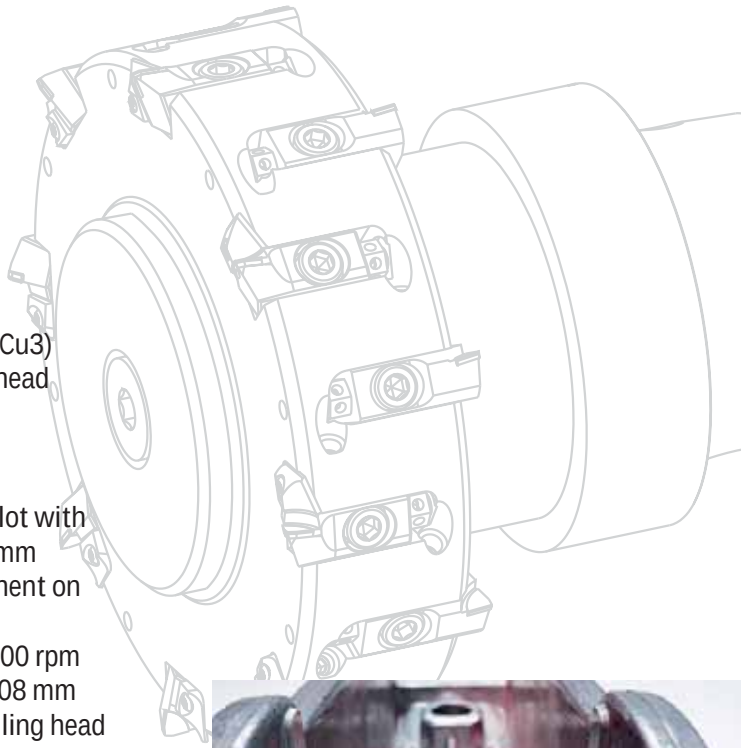
Material:	• Aluminium (GK AlSi7Mg)
Tool:	• MAPAL WWS face milling head PowerSpeed Z 10
	• D 160 mm
Cutting material:	• PCD
Requirement:	• Machining of reverse side of lining on a machining centre
	• Double spindle to be used
Result:	• Tool life approx. 1.5 million parts
	• Cutting lead with R 6
Machining values:	• Spindle speed n = 4,000 rpm
	• Feed f = 3,200 mm/min.



Hydraulic housing

Material:	• Cast iron (GG 25)
Tool:	• MAPAL WWS facing head EcoFeed Z 10 • D 80 mm
Cutting material:	• PCB
Requirement:	• Surface quality for lateral seal surfaces R_a = 0.8 µm
Result:	• Surface quality • R_a = 0.32 – 0.53 µm • Tool life 2,000 parts
Machining values:	• Spindle speed n = 2,800 rpm • Feed per tooth f_z = 0.05 mm
Special feature:	• As much as 13 times longer tool life compared to conventional face milling head

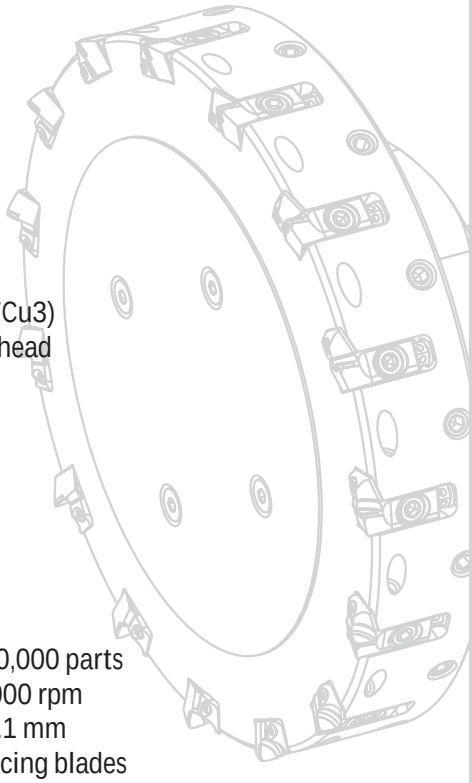
Console



Material:	• Aluminium (GD AlSi9Cu3)
Tool:	• MAPAL WWS facing head PowerSpeed Z 8+8 • D 250 mm
Cutting material:	• PCD
Requirement:	• Milling of a bearing slot with a width of $50.35^{\pm 0.02}$ mm • Machining of component on both edges
Machining values:	• Spindle speed n = 8,000 rpm • Feed per tooth f_z = 0.08 mm
Special feature:	• Double sided face milling head with Z 8+8 allows complete machining in one pass

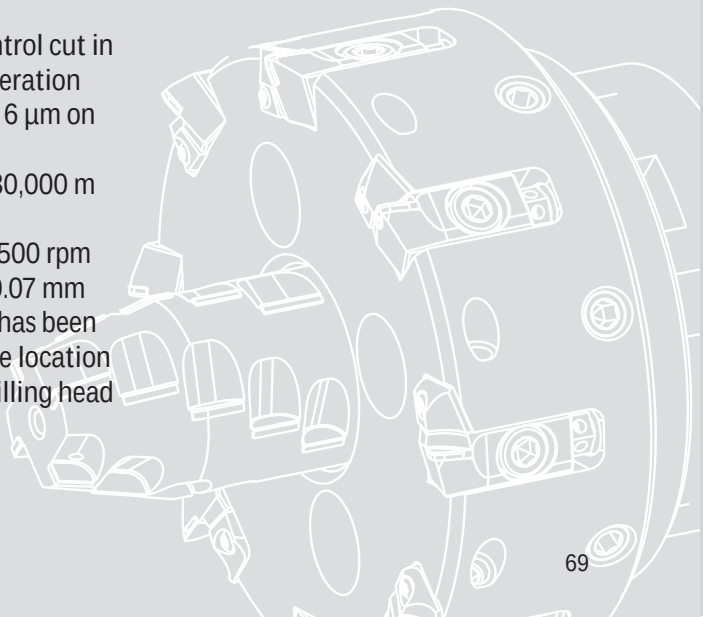
Cylinder head cover

Material:	• Aluminium (GD AlSi7Cu3)
Tool:	• MAPAL WWS facing head PowerSpeed Z 15 • D 250 mm
Cutting material:	• PCD
Requirement:	• Dry machining • Surface quality R_z = max. 15 µm
Result:	• Surface quality R_z = 3.8 µm • Tool life more than 50,000 parts
Machining values:	• Spindle speed n = 3,000 rpm • Feed per tooth fz = 0.1 mm
Special feature:	• Tool fitted with 12 facing blades and 3 wide finishing blades



Clutch housing

Material:	• Aluminium (GD AlSi9Cu5)
Tool:	• MAPAL WWS face milling head PowerSpeed Z 8 • D 125 mm
Cutting material:	• PCD
Requirement:	• Face milling and control cut in clutch bell in one operation
Result:	• Surface quality R_a = 6 µm on face surface • Tool life more than 30,000 m on face surface
Machining values:	• Spindle speed n = 8,500 rpm • Feed per tooth f_z = 0.07 mm
Special feature:	• A spiral milling tool has been incorporated into the location arbor for the face milling head for the control cut.




MAPAL WWS

After Sales and Customer Services

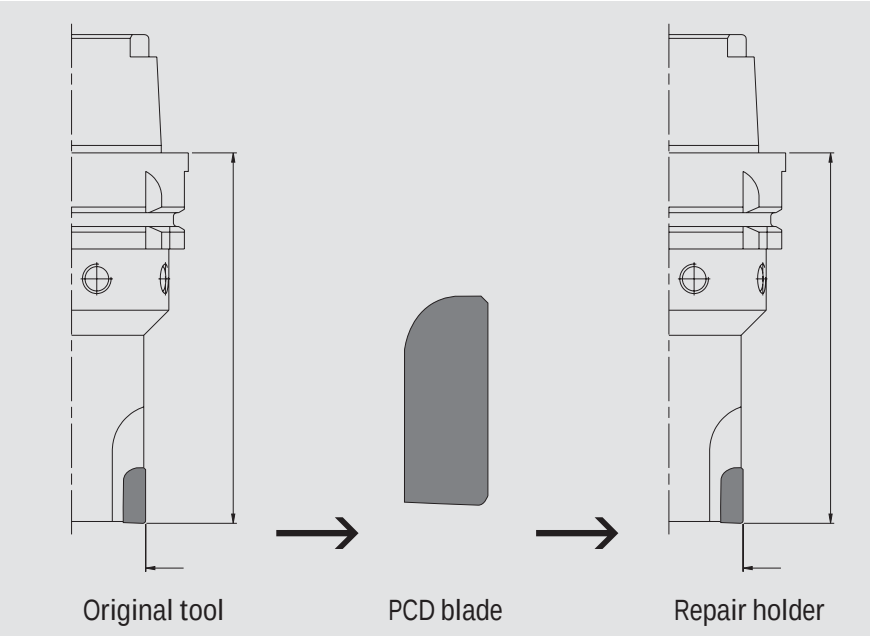
In the modern cutting environment there are numerous elements which need to be observed. Questions on the best possible process or tool layout and the various processing options to maintain batch production – all aspects to which special attention needs to be given. MAPAL's tremendous breadth of experience can be applied to every request in the best possible way.

- Fast Repair – Reconditioning and service
- Milling Head Management – a dependable performance level right from the start
- Pick-up-Service – Direct to the customer

Fast Repair –
Reconditioning and service

Fast and trouble-free

Effective production calculations throughout the whole of the life of the component require maximum reliability in calculation data. It is therefore helpful for the planning department if reconditioning costs which occur for machining tools are already known in advance or have even been specified. The removal of work on the logistics for processing repairs also gives the user the opportunity to concentrate on his own activities. It is exactly these aspects which produced the motivation for a modern repair management system. The preparation of basic tool holders combined with the multiple application properties offered by PCD blades provided the breakthrough for the Fast Repair System. Constant availability of ready-to-use special tools increases production reliability, raises productivity and as a result ensures that each batch producer remains competitive in the market.

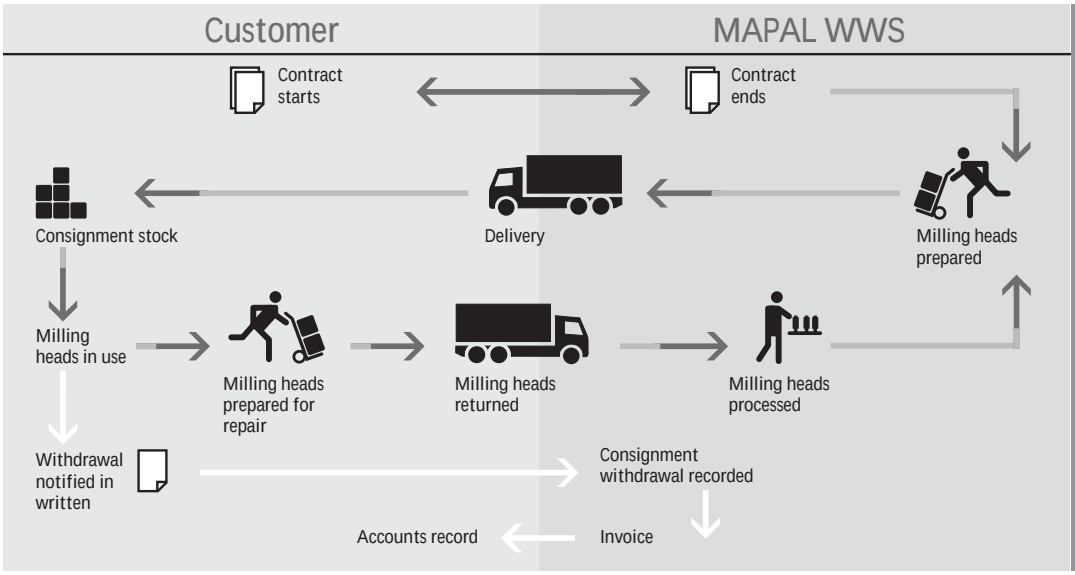


The application of the repair system follows on from the end of the optimisation process in batch production. Subject to the tools which already exist, the need for repair carriers is calculated on the basis of production figures and other parameters. These tool carriers are issued accordingly at the first regeneration stage and are then constantly available. For subsequent reconditioning work the PCD blade from the original tool is changed over onto the new carrier and re-fitted in parallel. This means there are double the number of tools in circulation. The excess is kept in a consignment stock which can be set up on site and is then available to the customer. This results in ongoing availability for all special tools, which also safeguards the continuity of the batch production against unforeseen events (e.g. crash).

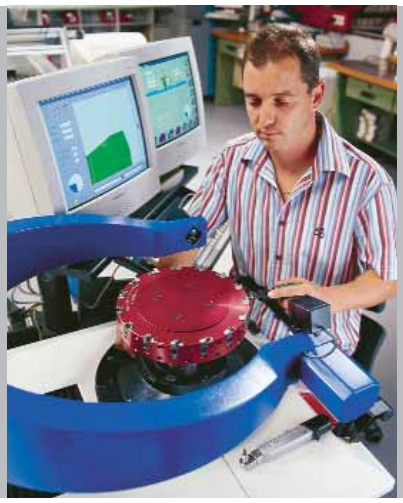
Milling Head Management – A guaranteed performance level right from the start

Milling with a face milling head is frequently the first operation in machining a component. For this reason the operation needs to be approached with extreme caution. Varying allowances, caused by the different loads of blanks, sometimes not yet surface treated, have a direct effect on the face milling tool.

The milling result achieved, however, represents the basis for further bore machining. Production reliability with this process is the basis for trouble-free complete machining of the component. The user must be able to depend on this tool, particularly after regeneration.



Consignment stock administration for MAPAL WWS milling heads



Cleanness, care and precision are the main factors at the forefront of reconditioning milling heads. Once dismantled the tools are basically cleaned, worn parts changed and the system then reconstructed from scratch. Worn parts are passed on for the repair procedure and the tool is refitted with regenerated blades from stock. After assembly with the appropriate milling cutter holder, the milling cartridges are set to the original setting dimension. The customer is then given back a tool which is immediately ready to use.

Length adjustments are not required. The tool will easily achieve the same tool life as before.

If a milling head management agreement is undertaken, we will guarantee this work is carried out within 48 hours.

Pick-up-Service – Direct to the customer

An effective order processing system, both for new orders and for reconditioning, requires all the working practices to run perfectly. As a result the despatch method should also not be overlooked. Prompt deliveries of the products at firmly agreed times make handling easier for the user. This can be achieved by introducing a Pick-up system. The tools are collected or returned directly from the customer by our technical service engineers.

A special advantage is produced for large organisations if difficult despatch routes and unnecessarily long stoppage time can be avoided. This eliminates long-winded processing of deliveries by parcel services and guarantees “Just in Time” despatch.

More information on the countries and regions in which the Pick-up-Service is available can be obtained from your MAPAL representative or from one of the MAPAL branches.

High quality packaging – for safe transport

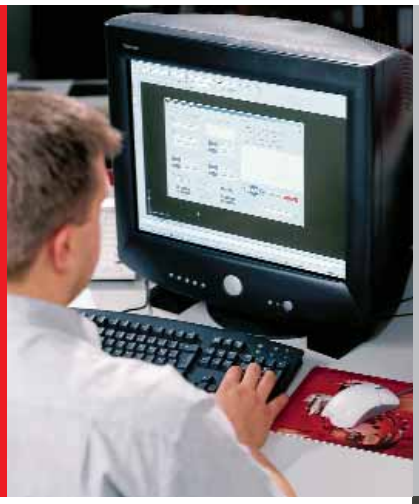
We see it as perfectly natural to prepare our products for transport in the best possible way. For this reason we place great value on using suitable packing methods. Large size tools, such as milling heads, are despatched in special wooden cases whose stability ensures the tools are perfectly contained. Individual special tools are packed in polystyrene foam in high quality boxes. This absorbs any impacts which occur during transport and the tool does not suffer any damage.

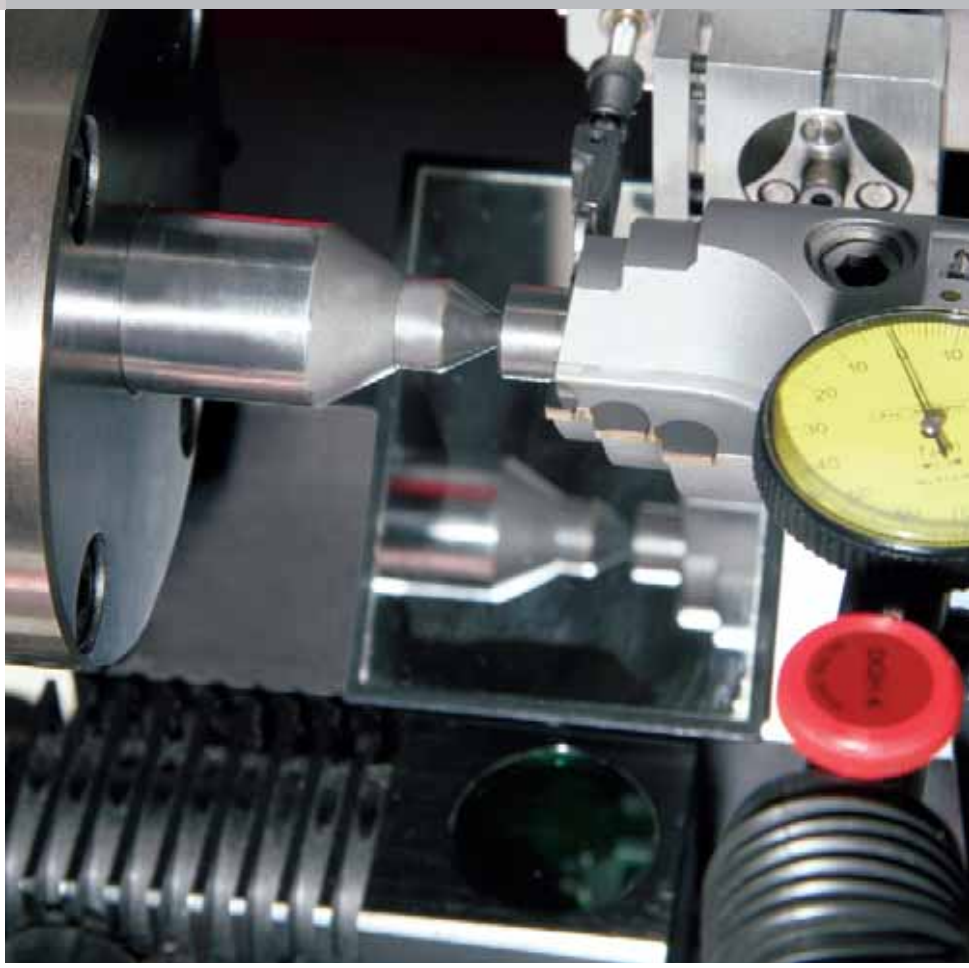
PCD tools made to measure

When designing a suitable tool for the machining operation MAPAL accepts a high degree of responsibility for the production process. MAPAL specialists are constantly aware of this. Consequently the best possible machining solution is always sought. New machining concepts are frequently the result of these efforts. The experience they have gained is passed directly to the customer.

- PCD special tools – quality from quotation to production
- Enquiry form for drilling and gun boring operations
- Enquiry form for milling operations

PCD tools made to measure – quality from quotation to production





PCD special tools need to fit the application in question like a made-to-measure suit. Our team of technicians and engineers in the technical sales department specialises in meeting this high demand for quality. Ongoing training and further training, both in theory and in our trials laboratory, ensure this level of knowledge is maintained. As competent tool specialists your contacts in the internal service department are available for any queries on PCD tools. Once your enquiry has been received, the best possible tool layout will be worked out. With the price proposal you will receive a technical drawing on which the tool layout will be shown.

The processing of an enquiry follows a tried and tested procedure. After the task has been examined, possible critical restrictions – such as cross bores or interrupted cuts – are given special consideration. Our tool technology department is frequently actively involved in the decision-making process. Recurring operations on typical parts, such as cylinder heads, brake or steering components, are listed in an electronic tool catalogue and constantly updated. This tool design system at MAPAL WWS is consistently applied from quotation to design. This means the customer can be certain that the machining proposal is based on the very latest tool technology. As a result he can take direct advantage of the innovation capacity of our organisation.

In designing complete machining operations MAPAL WWS specialists are available as competent contact partners – even on site if required. The highest priority in tool layout is always to achieve maximum productivity because “profit from cutting operations depends on the blade”.

Enquiry form
for drilling and gun boring operations

Please send to:
Address see last page.

Company		Customer number (if available)
Contact partner	Department	
Address		
E-Mail	Tel./Fax	
Technical consultant	Enquiry No.	Date

Component

Description	
Material	
Ø tolerance (mm)	
Drilling depth (mm)	
☐ through hole ☐ blind bore	
Cross bore	☐ Yes ☐ No
Interruptions	☐ Yes ☐ No
Stepped bore	☐ Yes ☐ No
Pre-machining	☐ Yes ☐ No
Cutting depth/allowance (mm/Ø)	
Quality to be achieved	
Surface quality	
Roundness (µm)	
Straightness (µm)	
Cylindricity (µm)	
Concentricity (µm)	
Machining time (min)	

Machine

Manufacturer/type/machining centre/transfer line	
Type	☐ vertical ☐ horizontal ☐ multi-spindle/___ No.
Variable spindle speed	☐ Yes ☐ No
Variable feed	☐ Yes ☐ No
Max. spindle speed (min^{-1})	
Power (kW)	
Spindle accuracy (µm)	
Spindle adaptor	
Guide bush	☐ Yes ☐ No
Coolant	☐ Yes ☐ No
Coolant supply	☐ externally ☐ through spindle
Type	☐ oil ☐ emulsion
Emulsion	☐ mineral oil ___% ☐ mixture ___%
Coolant pressure (bar)	
Coolant quantity (l/min)	

Tool

Type	☐ rotating ☐ stationary	
Tool No.		
Diameter/tolerance (mm)		
Working length (mm)		
Cutting over centre	☐ Yes ☐ No	
Coolant	☐ internal ☐ external	
Shank (HSK, ABS/Weldon, etc.) Size/form		
Adjustable adaptor	☐ Yes ☐ No	☐ radial ☐ angular
other adaptors/holders		

Other notes (Drawing No., workpiece/tool)

Enquiry form
for milling operations

Please send to:
Address see last page.

Company		Customer number (if available)
Contact partner	Department	
Address		
E-Mail	Tel./Fax	
Technical consultant	Enquiry No.	Date

Component

Description	
Material	
Cutting depth/allowance (mm)	
☐ Face milling	
☐ Circular milling	
☐ Climb milling	
☐ Conventional milling	
Quality to be achieved	
Surface quality	
Flatness (µm)	

Machine

Manufacturer/type/machining centre/transfer line	
Type	☐ vertical ☐ horizontal ☐ multi-spindle/___ No.
Variable spindle speed	☐ Yes ☐ No
Variable feed	☐ Yes ☐ No
Max. spindle speed (min^{-1})	
Power (kW)	
Spindle accuracy (µm)	
Spindle location	
Coolant	☐ Yes ☐ No
Coolant supply	☐ external ☐ through spindle
Type	☐ oil ☐ emulsion
Coolant pressure (bar)	

Tool

Type	
Tool No.	
Diameter/tolerance (mm)	
Blade length (mm)	
Cutting over centre	☐ Yes ☐ No
Coolant	☐ internal ☐ external
Shank (HSK, ABS/Weldon, etc.) Size/form	
Other adaptors/holders	

Other notes (Drawing No., workpiece/tool)

Our experience is second to none

For the complete machining of cubic components the MAPAL GROUP holds a leading position amongst tool suppliers. As a result of the variety of products from the different areas of competence, the optimum tool layout is produced for reliable production. The range of products extends from efficient standard tools to complex special tools – both for pre-machining and for finish machining operations.

To plan the whole production process and design and acquire all the tools needed for the operation, a team of cutting specialists – the Tool Expert Team (TET) is available at MAPAL which has successfully product managed complete machining operations for components for many years.

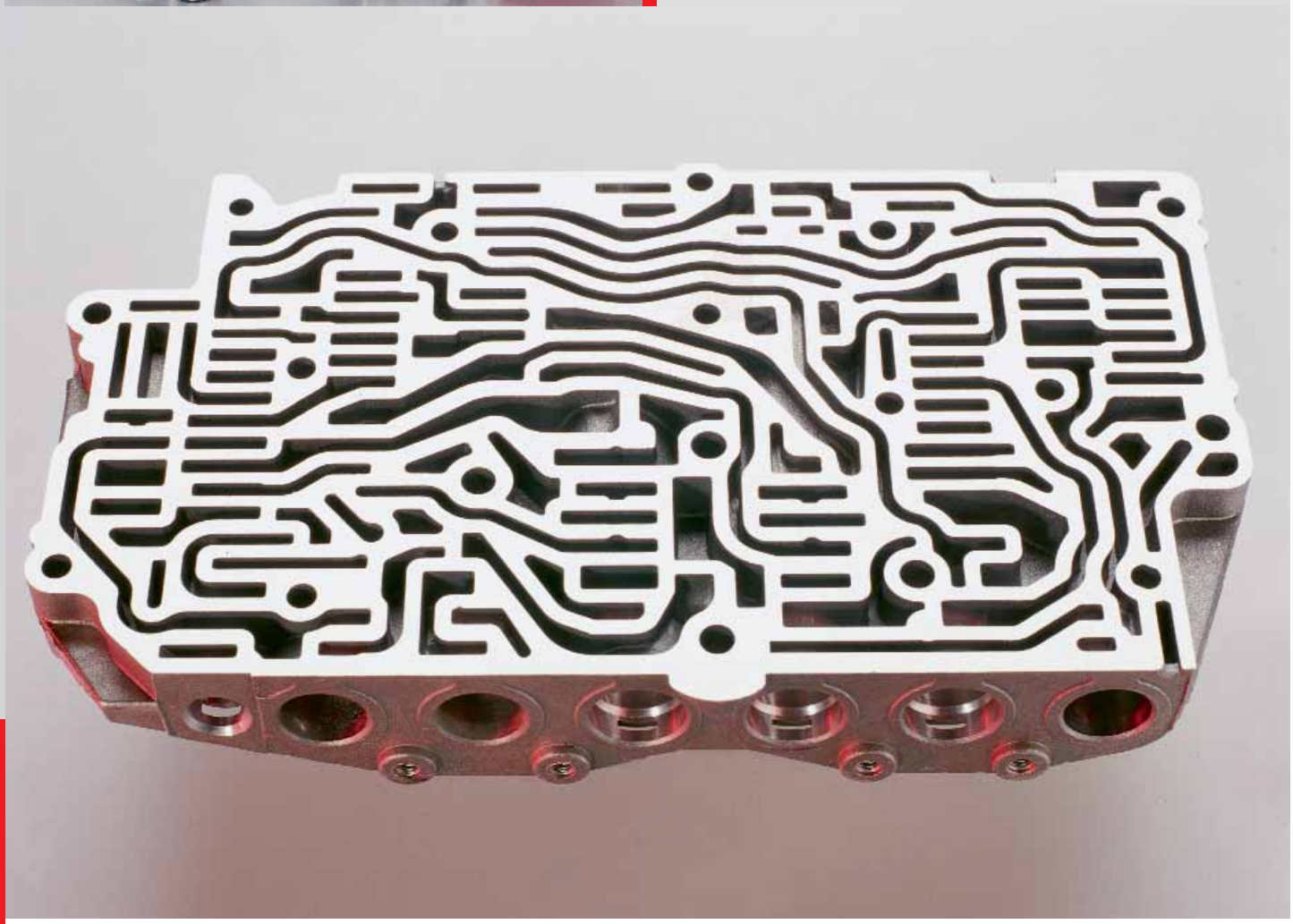
Machining examples

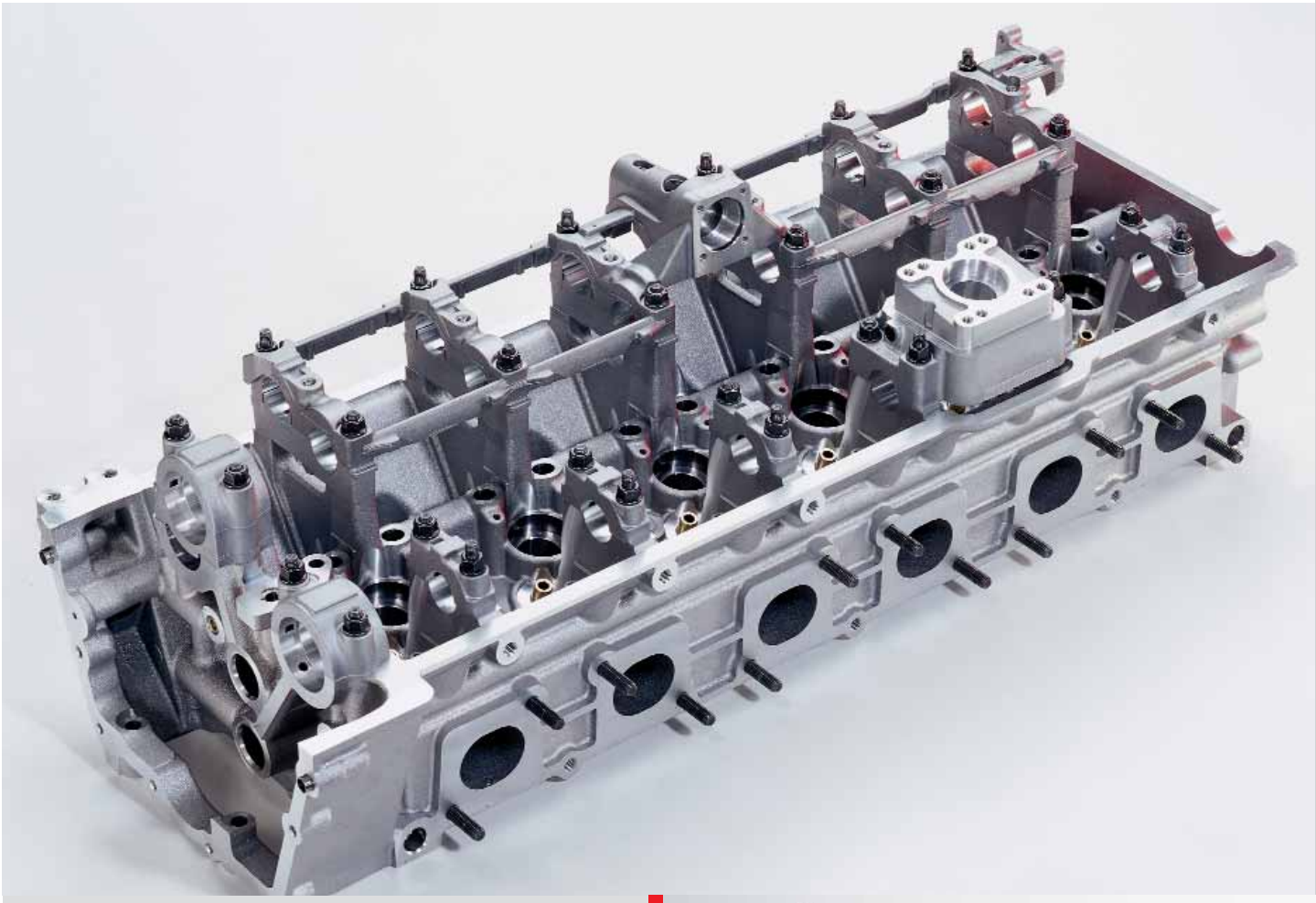
- Valve body
- Cylinder head
- Transmission housing
- Steering box
- Main brake cylinder housing
- ABS housing

Valve body

To machine valve bodies for automatic transmission systems up to 50 tools are used. The position of the bores, the clamping points and the relatively small size of the part compared to other workpieces make machining a challenge. However, absolute precision bores are the prerequisite for the part to function perfectly. The valve body bores on the face side, with up to four steps, and possibly an additional contour, pass for example through ribs just a few millimeters in depth. Sometimes these features have to be produced in solid material.

MAPAL supplies high precision tools for all machining steps, whether for face machining, for pre-machining and gun boring, or for the final finish machining.





Nowadays cylinder heads are produced almost entirely from aluminium. For this reason PCD as a cutting material plays a decisive role in machining these parts. Overall PCD is gaining importance in the automotive industry as a result of the increasing number of light metal components.

In addition to the parent bores and spark plug bores, plus the high precision cam shaft bearing bore, particular requirements are made in the cylinder head on valve seat and valve guide machining. Here concentricity, roundness, accuracy of form and surface quality play the decisive role in trouble-free valve function – a vital requirement for achieving optimum engine performance.

Cylinder head

Transmission housing

MAPAL has supplied precision tools for the wide diversity of types of clutch and transmission housings for more than 30 years and as a result holds a special position in the industry through the knowledge and experience it has gained.

Whether tools with fixed blades for premachining and finish machining or fine boring tools with high precision adjustment, the range of products offers solutions for every task. The principal production tasks on transmission housings include selector shaft bores and bearing bores which are subject to statistical production requirements in form, position, surface finish and bore diameter. These bores are partly interrupted by ventilation or oil slots – something which places a specific demand on the tool. With MAPAL precision tools these machining tasks are reliably and precisely solved within the required tolerances.

The various versions of steering gear boxes can extend to lengths of up to 350 mm and are therefore a special challenge to the tool manufacturer. In particular it is important to ensure the required quality of the reciprocating piston bore with regard to surface finish, concentricity and straightness with reliable production results. Large chip spaces and intensive cooling make sure the numerous chips which are produced are removed. One special feature when finish machining the reciprocating piston is in the simultaneous machining of various diameters with different defined and specified surface finish which lie within a specific range. This means that a surface which is too good does not always corresponds with the production concept.

MAPAL also demonstrates high flexibility and wide experience in project planning for these complex components.

Steering boxes

Main brake cylinder housing

In the brake system area, main brake cylinders in aluminium alloys are important components which are subject to strict safety conditions. When machining the main brake cylinder housing, quality and production reliability therefore have maximum priority.

Machining is mainly carried out in 2 clamping positions on multi-spindle machining centres with high performance MAPAL WWS tools. For flange machining with turning along the external spigot diameter, high performance, multi-bladed PCD bell tools are used. The piston bore is gun bored with PCD stepped tools and finish machined to a high surface quality with PCD reamers with guide pads. Multi-bladed PCD fine boring tools are being increasingly used to achieve higher feed rates. The lateral connection bores are pre-machined and finish machines in one step with PCD combination tools.

Anti-locking brake systems for cars are now an integral part of the automobile industry. Electronically controlled braking systems prevent the wheel from locking.

ABS housings are safety related components which are subject to a cpk analysis. The increasing demands for tolerances, burr-free results and an extremely low Si content in the material make cutting operations a challenge. In particular extremely high stipulations are made for machining bores in engines and pumps. Decisive factors for successful production are surface finish, accuracy, concentricity and interrelating positions. For bores in pumps maximum tolerances of IT 7 with a surface finish of R_a 0.2 µm apply.

Solid carbide tools for pre-machining together with tools with fixed PCD blades and fine boring tools with guide pads are typical tools for these components.

ABS housing

A Review of MAPAL's Competence

Reaming and Fine Boring
From the wide range of single and twin-bladed reamers with guide pads, together with fine boring tools with guide pads and WP or HX blades, to the HPR High Performance Reamers combined with the MAPAL HFS® Head Fitting System for exact concentricity and accurate changeover – to give you a general view of our complete knowledge and experience in precision machining bores.

PCD Tools
For pre-machining and finish machining, MAPAL also offers an extensive programme of precision tools with fixed PCD (polycrystalline diamond) blades. This includes precision gun boring tools plus circular and end milling tools. The programme of face milling heads from the PowerMill and EcoMill series is characterised by simple, sturdy design and rapid, accurate blade setting.

ISO Tools
This aspect of MAPAL competence is made up of special tools with ISO elements for gun boring and milling. This includes precision ground blades in the widest variety of cutting materials and coatings. The use of MAPAL's tried and tested adjustment system ensures that the blades are accurately matched to the task. MAPAL offers particular knowledge and experience in tangential technology.

Generating Slide Tools
Generating slide tools offer a high potential for rationalisation and optimisation on special machines and machining centres. In addition to the conventional facing heads, MAPAL also supplies EAT and LAT performance-enhanced actuating systems for generating slide tools. MAPAL Tooltronic® tools with their extraordinary range of functions are the latest development.

Drilling
Yet another area is the product programme for drilling. MAPAL offers the right tool concept for every task, whether for machining aluminium, steel or cast iron, hard machining or dry machining or for use in HSC areas. Specially developed coatings and PCD blades complete the broad-based drilling programme.

Clamping
MAPAL's modern clamping systems, in conjunction with MAPAL's tried and tested reaming and fine boring tools, guarantee maximum productivity and economy. Whether HSK, ISO or HFS®, these high-precision connections and interfaces provide the concentricity and changeover accuracy essential to modern production.

Customer Services
Project planning, maintenance, management and optimisation – the complete CTS® service package from MAPAL will accompany you from process design to permanent process optimisation and will ensure optimum and cost-saving use of your tools with the best possible results.

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