Your technology partner for cost-effective machining

TOOLS FOR AEROSPACE INDUSTRY

Tool and process solutions combined with comprehensive services

We see ourselves as a technology partner ready to support you in the development of efficient and resource-saving manufacturing processes with standard tools, individual tool concepts and tool detail optimisation. Our tools meet the requirements for process reliability, offer high levels of precision and are easy to handle. How do we achieve this? Through advanced development and construction methods and production at state-of-the-art manufacturing facilities.

You're looking for the perfect tool for your task but also want to find a partner who can take over and manage the entire planning stage of your process? If that sounds familiar, we're here for you. We support you during all phases of production and keep your manufacturing processes at the highest level – by being highly productive, economical and process-reliable. We also offer you complete networked solutions for all peripheral tasks related to the actual machining process.

Sectors

1 Automotive
2 Aerospace
3 Fluid power
4 Power generation
5 Electric mobility
6 Medical technology
7 Die & Mould
8 Shipbuilding
9 Rail transport

Subsidiaries offering production, sales and service in 25 countries

Representatives in over 19 countries

Over
5,000
employees worldwide

No. 1
technology leader for the machining of cubic parts

Product lines

1 Reaming and fine boring
2 Drilling from solid, boring and countersinking
3 Milling
4 Turning
5 Actuating
6 Clamping
7 Setting, measuring and dispensing
8 Services

LIGHTWEIGHT DESIGN COMPETENCE

Lightweight materials are finding more and more applications

Modern lightweight materials offer many different advantages. They make it possible to work in a more energy-efficient manner, save materials and, at the same time, to increase performance and productivity, particularly in mechanical and plant engineering.

Customers

Parts can be made significantly lighter by making use of lightweight materials. They are used by the automobile and aircraft industry, among others, to create more efficient designs for their vehicles. In spite of their lightness and the fact that less materials are required in their production, these modern materials make it possible to manufacture parts that are stable and safe. Therefore, lightweight design meets the demand for increased safety as well as that for reduced fuel-consumption.

In close collaboration with our customers, such as those in the aerospace sector, MAPAL has created a comprehensive range of tools for reliably machining modern materials. The range of tools includes both tools for part manufacturing and those for final assembly.

Part manufacturing
In part manufacturing, the machining of parts is stationary, i.e. parts are cut in a machine in several clamping positions. While small to medium cubic parts can be machined on a machining centre, large parts require special gantry machines.

Final assembly
Even today, handheld machines are still used in the final assembly of aircraft, due to their size. For example, in final assembly lines (FAL), rivet holes are made in the outer skin of the aircraft's fuselage. The tools are equipped with special guiding elements.

INNOVATIVE TOOL SOLUTIONS FOR A WIDE RANGE OF SECTORS:

AEROSPACE

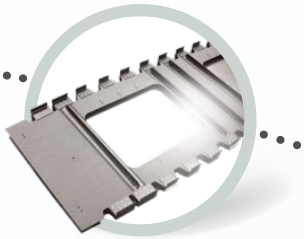
ENERGY

MEDICINE

Innovative and reliable tool solutions require a comprehensive understanding of processes.

Sectors

Requirements for parts and, in turn, the requirements in relation to their machining vary from sector to sector. For example, tools for the aerospace industry must meet "fail safe" requirements



Material

Different materials have different requirements in relation to tool and process parameters. The machining of lightweight materials requires particular machining strategies.

Machine concept

The machine concept has a significant effect on the tool geometry. As a result, tools for handheld machines require additional stabilisers so that they are able to reliably produce constant diameters.

Application

Lightweight materials are machined by milling, drilling or reaming them. Different materials and applications result in different types of wear, which must be taken into account when tools are being designed.

Innovative tool solutions

AUTOMOTIVE

MACHINES AND PLANTS

SPORT AND LEISURE

Scan for more information

Machining centres / gantry machines with moveable gantry

C Fibre composite materials

1 OptiMill-Composite -Speed-Plus

Roughing and finishing CFRP in one machining step

Ideally suited for manufacturing breakthroughs and pockets, trimming the outer contour and milling functional surfaces. Optimised cutting geometry helps prevent delamination or other damage to the part.

Dimensions:
- ø-area: 4.00 - 20.00 mm
- Design: pulling and pushing cutting edge
- Coating: coated and uncoated
- Shank form: HA | HB

2 MEGA-Drill-Composite MD

Reliable and precise drilling of CFRP

Innovative geometry to prevent delamination, fibre protrusions or the formation of burrs on bore entries and exits. Diamond coating for an excellent service life.

Dimensions:
- ø-area: 0.50 – 12.00 mm
- Design: 5xD

ADVANTAGES

- Low costs per part during mass production thanks to high cutting speeds and large feeds
- No fibre protrusion
- Delamination-free machining
- Very long service life
- Increased process reliability

C Aluminium, CFRP and titanium multilayer composites

1 Replaceable head drill TTD-Stack Drill

Drilling aluminium, CFRP, titanium stacks

These optimally designed tools operate with low process heat in titanium, prevents aluminium from sticking, produce short chips and therefore prevent damage to the adjoining fibre material.

2 HPR replaceable head reamer "Stack-Reamer"

Reaming aluminium, CFRP, titanium stacks

MAPAL multi-bladed reamers (HPR) equipped with PCD blades operate with absolute process reliability and a long tool life in all materials. The required tolerances are achieved in all the different materials, whether it be CFRP, aluminium or titanium.

RESULTS

- Dimensionally stable bores of IT7 quality in all situations
- Minimal burr formation on bore outlets

ADVANTAGES

- Custom tool solutions for the best results in all types of stacks
- Drilling and reaming tools suitable for a wide range of different multilayer composites
- Replaceable head systems for high cost-efficiency
- CFRP-CFRP: Drilling without delamination or fibre protrusion
- CFRP-aluminium drilling with minimal burr formation and without delamination
- CFRP-titanium Low levels of process heat at high process speeds

N Aluminium

1 OptiMill-Alu-Wave

Roughing contours and pockets

A specially developed cutting edge profile with significantly reduced cutting force for high-performance machining. The exceptional plunging properties of the tool significantly reduce the heat input into the part. This helps improve surface finish (conductivity measurement).

Dimensions:

- ø-area: 12.00 - 25.00 mm
- Design: Short, medium and long projection length with neck
- Coating: Available as DLC coating with cutting material HP910
- Shank form: HB | Safe-Lock

ADVANTAGES WHEN ROUGHING

- Machining volume is doubled
- Tool with internal cooling
- Stable corrugated profile for high-performance finishing

2 OptiMill-SPM-Finish

Finishing contours and walls of pockets

The new finishing geometry, which is specially designed for finishing deep pockets and finishing delicate structural parts, also operates without a "pull effect" when there are high levels of wrapping (use of the tool where there is high wrapping, e.g. at the corners of pockets).

Dimensions:

- ø-area: 12.00 - 25.00 mm
- Design: 4xD
- Shank form: HA | HB

ADVANTAGES WHEN FINISHING

- Perfect chip removal thanks to a polished chip flutes
- Strong performance with high levels of wrapping
- Saves time due to the fact it can reach deep cutting depths in one go when finishing
- Low vibration cutting thanks to an optimised cutting edge geometry

NeoMill®-Alu-QBig

Fast material removal rates with low cutting forces and high-quality surface finishes

N **Aluminium**

The new indexable insert cutters NeoMill-Alu-QBig are a highly economical solution for larger diameters. They offer maximum efficiency with a material removal rate of up to 18 litres per minute. Thanks to ultra-strong bolts and a fine-balancing system, this tool boasts a spindle speed of up to 35,000 rpm. The combination of low cutting forces and high-precision indexable inserts enables high-quality surface finishes. Internal cooling and very large chip spaces ensure optimal heat dissipation and chip removal.

Depending on the application, the milling cutter is available with uncoated inserts, PVD-coated indexable inserts and CVD-diamond indexable inserts. The tool bodies are available in a diameter range of 32 to 63 mm for hollow shank taper (HSK) or shank taper (SK) as well as mounting tool variants.

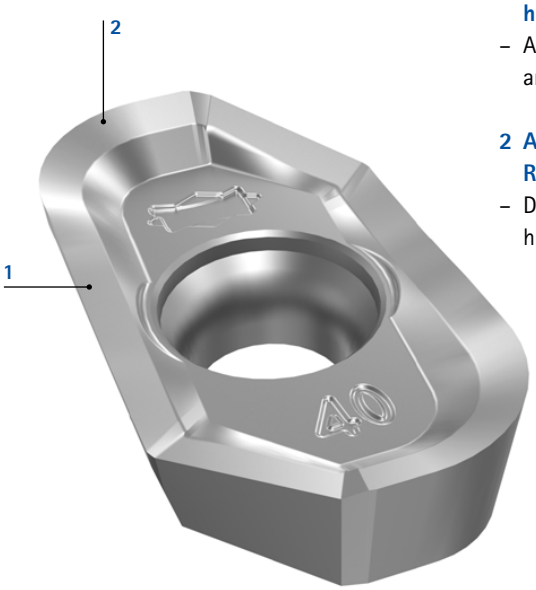
1 New MAPAL system insert
- Cutting edge up to 12.5 mm

2 Polished rake face and highly positive rake angle
- Less friction resistance and heat generation

3 Prismatic insert seat and special clamping screw
- Cutting edge has a firm seat, even at spindle speeds of 35,000 rpm

4 Fine-balancing system
- For quiet running and high-quality surface finish
- Longer tool life

Scan for more information



1 Polished rake surface and high-positive rake angle

– Achieve low frictional resistance and heat generation

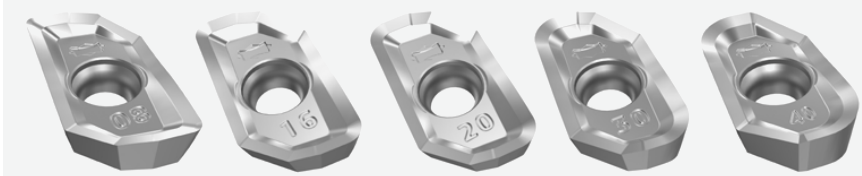
2 Achievable surface qualities R_a 0.8 µm / R_z 4 µm

– Due to low cutting forces, high-precision inserts and coatings

XDHT indexable insert

Corner radii available as standard

0.8 mm | 1.6 mm | 2.0 mm | 3.0 mm | 4.0 mm



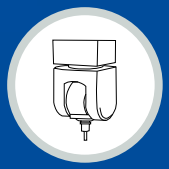
PRODUCT OVERVIEW

MAPAL's highly capable product range ensures excellent and reliable results for all machining tasks in titanium. Cost-effectiveness and product quality are particularly important in meeting customer requirements.

Processing titanium efficiently
The centrepiece of tool design is well thought-out heat removal and heat-resistant cutting material. In this way, relatively high cutting values can be achieved with high process reliability. Machining ductile, high-strength workpiece material becomes more productive and costs are reduced.

Application-oriented
The portfolio includes drills and milling cutters made of solid carbide, milling cutters with indexable inserts, reamers for fine bore machining and indexable inserts for boring. In connection with application-oriented clamping technology, MAPAL offers everything from the spindle to the cutting edge from a single source, thus ensuring the maximum performance of the entire system.

Wide range of available diameters
The range of available diameters is correspondingly broad. Starting with small sizes from 3 mm, as often required in medical technology, through to the large tools for aircraft construction and energy technology.



Tools for titanium machining

S Titanium

Milling cutters with replaceable inserts

NeoMill-Titan-2-Corner
- Shoulder milling cutter with double-edge radial indexable inserts
- Positive basic shape for parts susceptible to vibrations
- Cutting depths from up to 10 mm

NeoMill-Titan-2-Shell
- Shell end face milling cutter with double-edge radial indexable inserts
- Ideal for deep shoulder milling and trimming with high cutting depths of up to 75 mm

NeoMill-4-HiFeed90
- High-feed milling cutter with four-edge radial indexable inserts
- Universal tool system to ensure maximum productivity

ø area: 16.00 - 200.00 mm

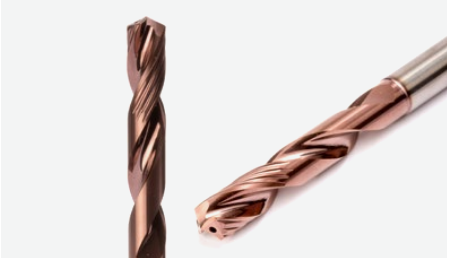
Milling with fixed cutting edges

OptiMill-Titan-HPC
- Four-edge shoulder milling cutter for roughing and finishing titanium
- Special cutting edge finish for the highest degree of resistant to wear
- Highest degree of tool stability through maximum core dimension and core rise at the shank
- Different corner radii available

OptiMill-Tro-Titan
- Five-edge trochoidal milling cutter
- Maximum material removal rate while providing an excellent surface finish at the same time
- Unequal spacing for quiet running during machining
- Finely balanced cutting tool for protecting the machine spindle and a longer tool life
- Cutting depth up to 3xD

ø area: 6.00 - 25.00 mm

Drilling from solid with solid carbide



MEGA-Speed-Drill-Titan
- Double-edge high-speed drill
- Four margin lands for precise surface accuracy and cylindricity
- Convex cutting edge with corner chamfer for high stability
- Novel knurled profile to protect the margin lands
- Maximum heat and wear resistance

ø area: 3.00 - 20.00 mm

Scan for more information

Boring with tangential technology

Part-specific custom tools
- Single- or multi-stepped tool with indexable inserts
- Tangential technology for top performance
- Defined chip formers
- Highest productivity
- Stable machining

Tangential indexable inserts
- Ground CTHQ and FTHQ inserts
- Four usable cutting edges
- Wide range of applications due to the three different sizes
- High-performance PVD coating for maximum heat and wear resistance
- Special arc shaped land for optimal machining results at a length-to-diameter ratio > 3.5xD

Fine bore machining

FixReam FXR
- High-performance reamer made from solid carbide
- Ideal for implementing short cycle times
- Variety of cutting materials and coatings available

HPR replaceable head reamer
- High-precision replaceable head system in a fixed design with brazed cutting edges
- Precise radial run-out and changeover accuracy of < 3 µm
- Highest degree of economic efficiency due to modular system
- Suitable for minimum quantity lubrication (MQL)

ø area: 2.80 - 65.00 mm

Hydraulic clamping technology and mechanical tool clamping technology

Hydraulic clamping technology
- UNIQ Mill Chuck, HA for highly dynamic milling applications
- UNIQ DReaM Chuck for reaming and drilling applications as well as for finishing during milling operations
- HydroChuck with an extensive standard range

Mechanical tool clamping technology
- Side lock chuck Mill Chuck, HB
- MFS milling head holder for screw-in milling cutter
- HFS replaceable head holders for HPR replaceable head reamer

Milling cutter arbor
- With enlarged face connection diameter

Adapter
- Alignment adapter for high-precision alignment of all flange modules

SPECIAL SOLUTIONS FOR TITANIUM MACHINING

Features for tools for machining large parts

Application examples for special solutions

1 Shell end face milling cutter in a monolithic design for milling very high shoulder dimensions.
2 Combination tool with tangential technology for boring as well as circular milling of chamfers on both sides on the large bore of a connecting rod.
3 Fine boring tool with minimum quantity lubrication (MQL) with PCD guide pads and module flange for setting radial run-out precisely. The adjustable cutting edge ensures a µm-accurate diameter on the bearing rib.
4 Six-edge special HNC reamer made of solid carbide for MQL machining with a back-flushing function for machining engine holders.
5 Solid carbide form-cutter head (z=2+2) with CFS connection for deburring, chamfering and circular milling of inner contours or relief grooves.
6 Four-edge solid carbide end milling cutter with a neck for machining parts with deep pockets.

7 Fine boring tool with MQL, with insert and PCD guide pads for µm-accurate machining of valve bores.

8 Multi-stepped boring tool with ISO indexable inserts for machining bearing bores on housing parts.

9 HPR replaceable head reamer with brazed cutting edges for economical contour machining of diameter, chamfer and radii on hydraulic housings.

10 Circular milling tool with tangential technology for countersinking and circular milling of chamfers on bores.

11 Coated solid-carbide drill with internal cooling and three margin lands for precise milling of bores on pylons.

12 Boring bar with ISO indexable insert for machining the bearing ribs of hinge lines. These are used as fuselage connection elements for doors, landing gear covers and flaps on aeroplanes.

Riveter / robots with drilling end effector

The number of aircraft built per year is rising continuously. Final assembly of the aircraft, however, is still far from being a fully automated production line process. As a rule, an aircraft is fully assembled in one place. But here again, the degree of automation is increasing with more and more robots being used. Here robots with end-effectors for drilling and riveting mounted on shuttles are moved from assembly position to assembly position along the aircraft fuselage and position themselves automatically.

Conventional robots frequently do not have the optimum rigidity. This results on the one hand from the constantly changing positions of the main axes and the use of multi-stage planetary gear units, and on the other hand from the high weight of the end-effectors used that necessitate laborious control compensation before commissioning. The tool therefore has the task of carrying out the drilling process reliably and over a long tool life under these difficult boundary conditions.

In addition to this lack of rigidity, the very heterogeneous material combinations used in modern aircraft construction also represent a major challenge for the tool development. Multi-layer machining is state-of-the-art with combinations of aluminium, titanium and CFRP materials often being used. MAPAL has defined various tool features especially for the aerospace industry that can be adapted optimally to the material and the boundary conditions, depending on the machining situation.

The "MicroReamer" micro-cutting stage patented by MAPAL has the ability to cut at the side and to bring the diameters of all the layers to tolerances in the IT8 range. The burr at the bore outlet that has to be less than 0.1 mm can also be reliably achieved with this micro-cutting stage.

Also of great influence is the differential tip angle, i.e. the combination of a small tip angle in the middle of the tool and a large tip angle at the outside diameter. The small tip angle in the middle ensures immediate self-centering, a good radial run-out of the tool on entering the material and hence a high diameter precision. The large tip angle at the outer diameter guarantees a small outlet burr when aluminium or titanium are on the bore exit of the component. In cases where CFRP forms the external material layer, the differential tip angle prevents delamination at the bore exit. The prevention of any burr formation and delamination is of great importance for the compact fitting of the aircraft parts and hence for optimum strength that prevents localised overloading of the structure.

In combination with innovative diamond coatings that prevent the formation of built-up edges, high-performance drills from MAPAL ensure reliable processes and cost-effective results when machining using robots.

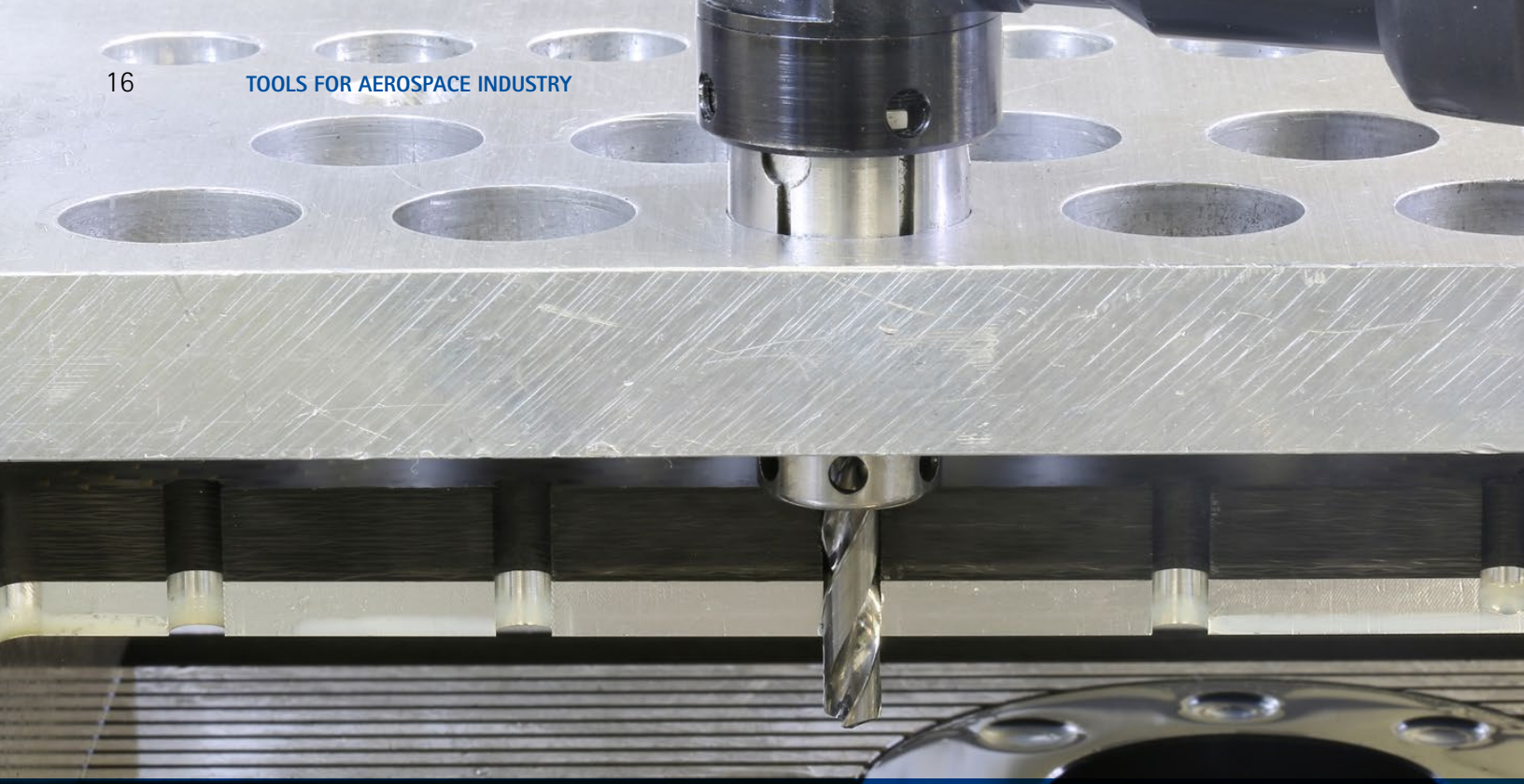
The industry is also reacting with the development of more rigid robot systems that in combination with the optimised tool solutions further enhance the process reliability and flexibility of aircraft assembly.

AT A GLANCE

- Tool solutions for drilling processes with robots
- Wide range of material combinations can be controlled

ADVANTAGES

- High process reliability
- Optimum tool design for every application
- Many years of experience guarantee the best machining results



Drill feed units

1 Drills with short threaded shank

ADU Drilling

For ADU drilling the adapter at most applications has to be threaded shank. Mapal drills have cylindrical shaft and the threaded adapter is shrink. The advantage is that the adapter can be used nearly unlimited helping to reduce costs.

2 Drill with countersink step

Dry machining the riveted joints of an aircraft fuselage

Extremely positive cutting edges as well as a double angle ensure that few bores are formed and centring is improved The coating prevents material from sticking to the cutting edge. A leading stage ensures optimal bore quality. Specially formed chip flutes ensure optimal chip removal.

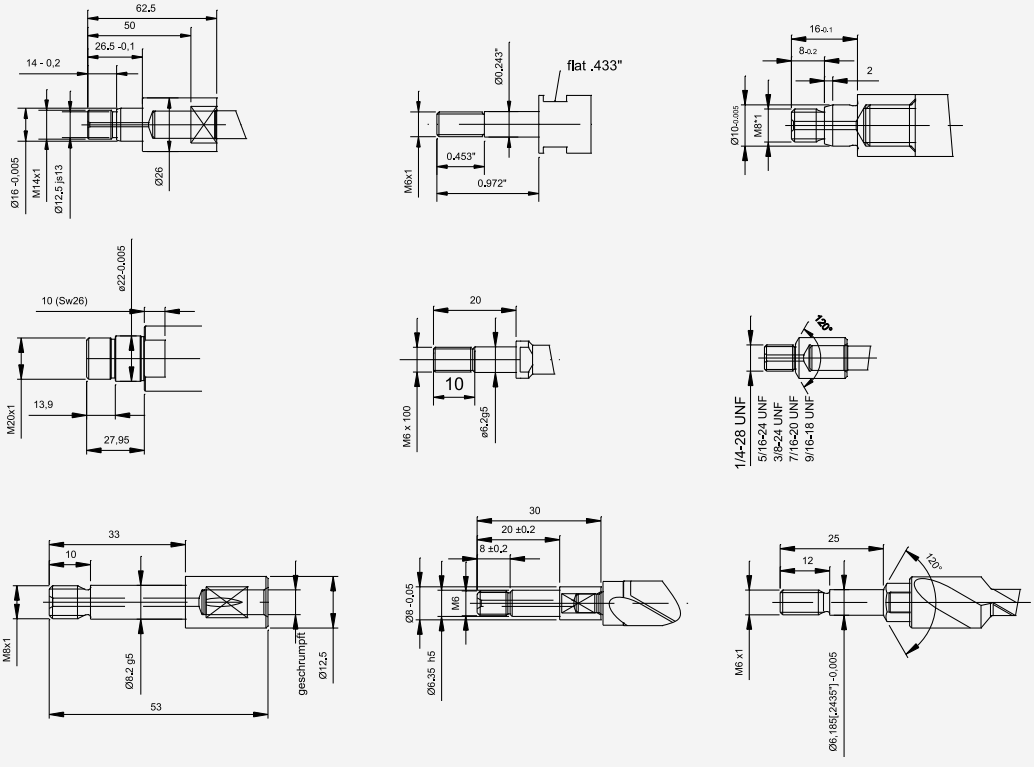
ADVANTAGES

- Minimal burr formation and improved centring
- Optimal bore quality and a long tool life
- Clean parts. No cleaning/disassembly necessary
- Low emissions when machining

Thread adapters for drill feed units

The spindles on drill feed units are equipped with manufacturer-specific thread connections so that tools can be changed quickly and easily. The connection between the adapter and cutting tool is available either in a brazed or shrunk version. Both types of connections offer advantages, the brazed version requires significantly less space whereas the shrunk version can be re-used multiple times. MAPAL manufactures all tools with the specific thread adapters required.

Design samples



Hand drills

Tools for final assembly

Handheld machines are used in the final assembly of aircraft, due to the size of these items. MAPAL has developed a range of high-performance tools specifically for machining with handheld machines and drill feed units.

Application-oriented
The range includes tools for the drilling from solid, boring, reaming and countersinking of multimaterial multilayer composites. Specific guiding elements ensure the reliable production of precise bores with high surface quality and accurate concentricity.

Process reliability in focus
MAPAL offers innovative geometries for the various combinations of materials in order to prevent delamination, fibre protrusions or the formation of burrs on bore entries and exits. Optional accessories such as guide pins and drill brushes also improve machining quality.

Always the right choice
MAPAL offers the right tool for every application and provides support for optimising the respective machining task. All tools can be manufactured with the specific thread adapters required.

Drilling from solid (first hole)

Tools for drilling from solid in multilayer composite materials (stacks) made out of CFRP, aluminium, high-alloy steels or titanium with a hand drill.

- Innovative geometries to prevent delamination, fibre protrusions and the formation of burrs on bore entries and exits
- Extremely sharp cutting edges ensure a smooth cut and low cutting force
- Ideal for multilayer stacks in which the top stack has already been mechanically pre-drilled
- Countersink drill for producing bores with a countersink in one machining step Also suitable for use with drill feed units

Boring and reaming (final hole)

Boring and reaming of through bores tools with special cutting leads and guiding elements for the reliable production of precise bores with high surface quality and accurate concentricity.

- Tools with guide spigots for boring pre-drilled bores
- Tools for reaming bores in multilayer composites, ensuring process reliability and consistently high quality - also when hand drills are used
- Tools with an enlarged contact surface and extra long blade (type Paris) for reaming damaged bores

Countersinking

Producing precise, circular countersinks and spot faces on bores that have already been pre-drilled.

- Spot facers for producing contact surfaces for rivet heads
- 100° countersink cutter for producing rivet head seats
- Cost-effective chamfering using a 90° countersink cutter
- Cross-hole countersink cutters for reduced cutting force and controlled chip removal
- Precision countersink cutters with extremely unequal spacing for precise, circular 90° countersinks
- Design with fixed or replaceable guide pin for machining pilot bores of different diameters with only one countersink cutter
- Reverse countersink with drawbars make the machining of hard-to-reach areas possible

Discover tool and service solutions now that give you a lead:

BORE MACHINING

REAMING | FINE BORING

DRILLING FROM SOLID | BORING | COUNTERSINKING

MILLING

CLAMPING

TURNING

ACTUATING

SETTING | MEASURING | DISPENSING

SERVICES

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