Drilling Handbook

ISCAR's Reference Guide

Member IMC Group

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Quality Standard

ISCAR has been certified by the prestigious Standards Institution, as being in full compliance to ensure delivery of the finest quality goods. Quality control facilities include the metallurgical laboratory, raw metal testing, an online testing procedure and a machining center for tool performance testing and final product inspection. Only the finest products are packaged for entry into ISCAR's inventory.

Dear Machinist, Customer and Colleague,

As a manufacturer of cutting tools, our main objective is to ensure optimal production with the most advanced and high-performance tools that meet the requirements of modern technology. Machining the holes faster and more accurately reduces processing time and cost, and lowers the possibility of defective parts. Although the cutting tool is often considered to be of minor value, it is key to increasing productivity and quality. At **ISCAR**, we understand this fact well, and our ongoing research and design activities are aimed at creating cutting tools that will improve overall performance and make the machining process more effective.

Intensive research and development have resulted in innovative and effective solutions for our customers' diverse range of requirements. As the variety of **ISCAR** tools is vast, it can be a challenge to make the right tooling decision for specific manufacturing needs. We hope that this guide will help you with the right tool selection and that it will be a useful supplement to the other **ISCAR** catalogs and leaflets. This handbook is divided into eight main chapters, considering specific features of holemaking and highlighting the latest holemaking solutions.

The first chapter introduces general formulations such as the definition of types of holes and their designations, drill terminology, drill classifications, hole accuracy and surface roughness by drilling, tool holders, the optimal ways to machine holes, the role of coolant in drilling, as well as general information about **ISCAR**'s holemaking lines, a comparison of exchangeable head drills vs solid drills, and highlights for a quick and easy way to select the correct solution.

The second, third, fourth, fifth, and sixth chapters introduce which **ISCAR** products can be used for machining hole types according to the intended purpose, along with recommendations for cutting conditions, the correct use of the tool, as well as troubleshooting. The seventh chapter introduces general formulas and definitions for drilling. The eighth chapter introduces various types of **ISCAR** grades and their recommended range of use, as well as the material groups based on the VDI 3323 standard.

We hope that this handbook will be a useful tool and a helpful guide for holemaking.

Contents

General Drilling Handbook

Types of Holes and Their Definition

Holes are fundamental in various engineering and manufacturing processes, playing a critical role in the functionality and assembly of countless devices and structures. Whether in metalworking, construction, electronics, or even everyday items, holes are essential for connecting components, allowing for movement, or securing parts in place. Each hole is often tailored to its specific function, whether it's designed for the insertion of fasteners like bolts and screws, creating passageways for fluids or gases, or reducing weight without compromising strength. The precision in drilling or forming these holes is crucial, as the exact dimensions, alignment, and finish can directly impact the performance and reliability of the final product.

Hole Types

(Figure 1.1.1)

- Cylindrical (simple) hole - the most basic and widely used type of hole. Typically used in the general industry.
- Tapered hole - a hole where the surface around the central axis of the hole is at an angle. Used for centering parts, ensuring alignment, and in applications where a tight fit is necessary, such as mounting tapered pins.
- Stepped hole – a hole that has two (or more) diameters along its depth, creating a step at the transition point where the diameter changes.

Stepped holes can also include combinations of different types of holes. The most common subtypes of stepped holes are:

- Countersink holes - the top of the hole is conical, allowing fasteners like countersunk screws or rivets to sit flush with the surface. They are also used to remove burrs from drilling, improving finish and safety. Common angles for countersinks are 120° or 90°.
- Counterbored holes - the top of the hole is enlarged with a flat-bottomed area, allowing fasteners like socket head cap screws to sit flush or below the level of a workpiece's surface. A spot face is usually a very shallow counterbore, often used to ensure a flat surface for the fastener.

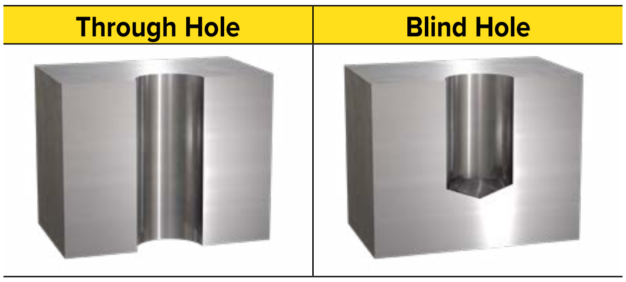
Figure 1.1.1

End Condition

(Figure 1.1.2)

- Through hole (also called a thru-hole or clearance hole) - this type of hole extends completely through the entire thickness of the workpiece.
- Blind hole – this type of hole has a specific depth and does not extend completely through the workpiece.

Figure 1.1.2



Passability of Hole

(Figure 1.1.3)

- Interrupted hole – is characterized by one or more interruptions or recesses along the surface surrounding the central axis of the hole. These interruptions could be the result of intersecting features, such as grooves, slots, or cross-holes.
- Solid/ Whole hole - has a continuous, uninterrupted surface around the central axis of the hole.

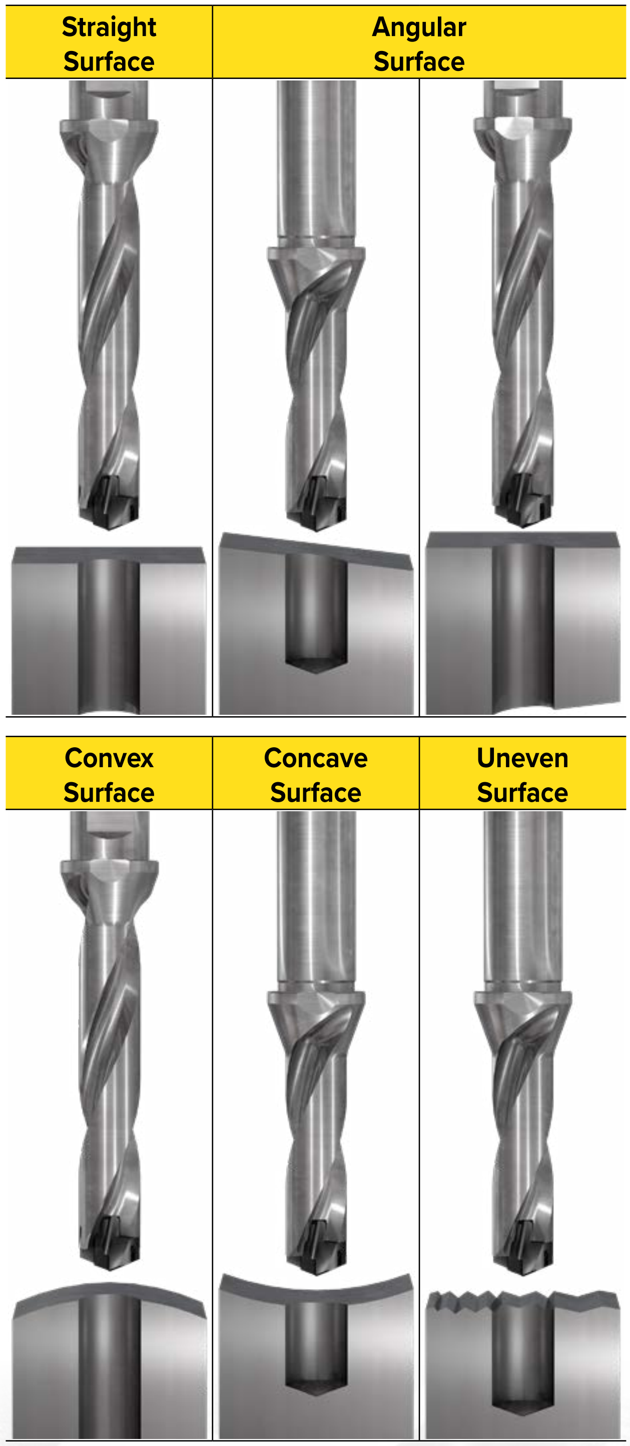
Figure 1.1.3

Hole Location

(Figure 1.1.4)

- Straight surface - the surface on which the hole is located is flat and perpendicular to the central axis of the hole. This is the most common type of hole location.
- Angular surface - the surface on which the hole is located is at an angle relative to the central axis of the hole. Drilling into an angular surface requires careful consideration to ensure the hole is positioned correctly and functions as intended.
- Convex surface - the surface on which the hole is located curves outward, creating a dome-like shape. Drilling into a convex surface can be challenging due to the curved nature of the surface, which can affect the drill's entry point and angle.
- Concave surface - the surface on which the hole is located curves inward, forming a bowl-like shape. Similar to convex surfaces, drilling into a concave surface requires special attention to ensure accurate positioning and alignment.
- Uneven surface - the surface on which the hole is located is irregular or undulating relative to the central axis of the hole. Drilling into an uneven surface is complex and may require advanced techniques or equipment to achieve the desired hole characteristics.

Figure 1.1.4



Drill Terminology

Drilling is one of the most common methods for machining holes in various materials. The process involves using a rotating cutting tool, known as a drill, to remove material and produce a hole. Drilling can create various types of holes with different end conditions and degrees of passability on different surface locations.

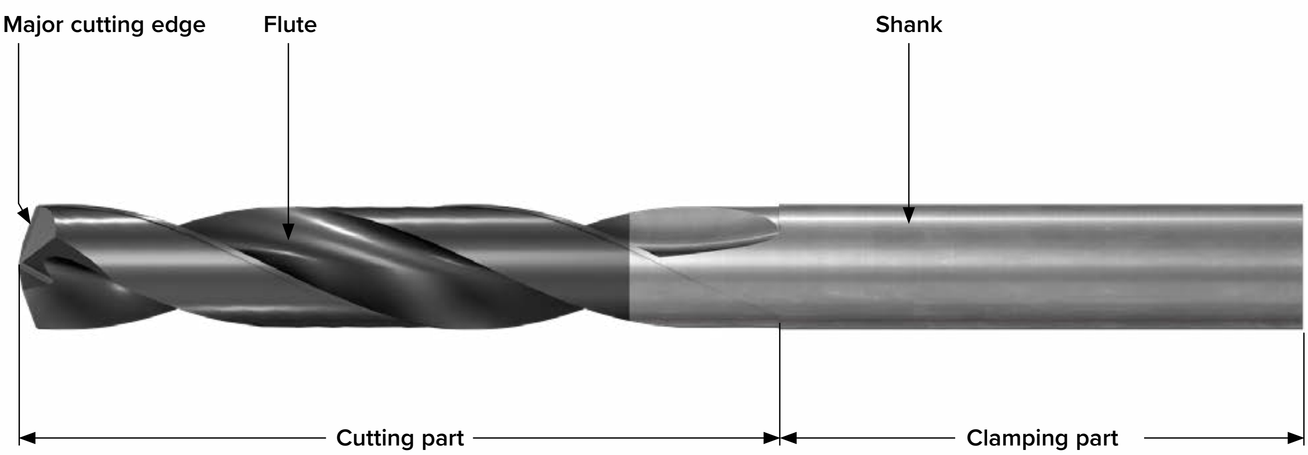
In addition to drilling, some drills can sometimes be used for enlarging the diameter of existing holes in certain cases.

The design of a drill is critical for ensuring the accuracy and efficiency of drilling operations.

A drill is primarily composed of two main sections: the cutting part (also known as the body) and the clamping part. The design of a drill consists of three main elements (Figure 1.2.1):

- Major cutting edges – intended for cutting the material by removing chips.
- Flutes – designed to channel away chips from the cutting area.
- Shank - intended to clamp the drill in the tool holder.

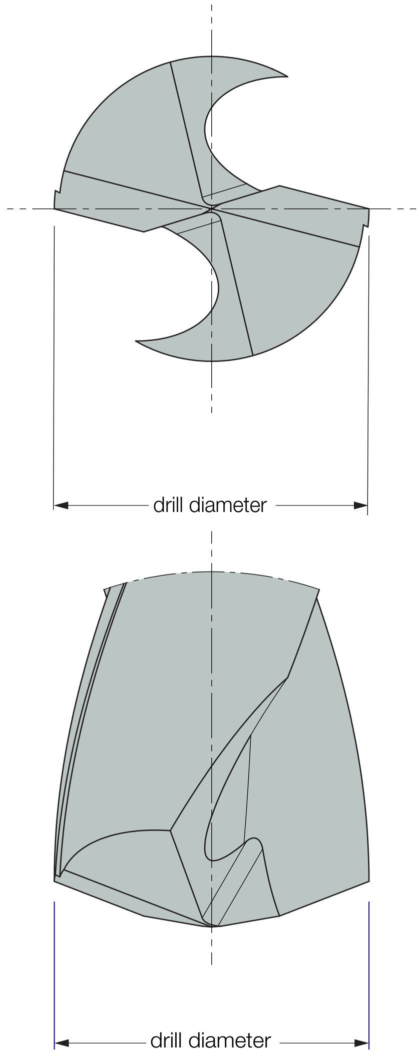
Figure 1.2.1



The Main Parameters of the Drill That Defines Its Functionality Are:

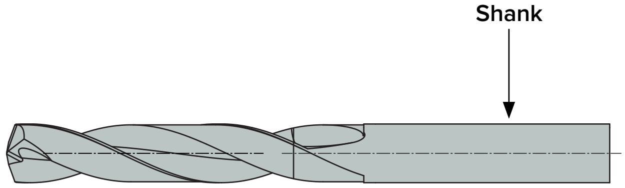
Drill Diameter – The largest diameter of cutting zone, measured between intersection points of cutting edges and drill body. The drill diameter determines the diameter of the hole (Figure 1.2.2).

Figure 1.2.2



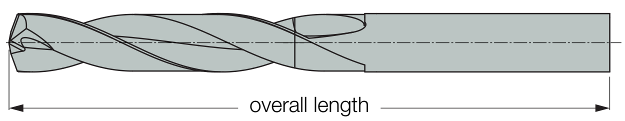
Shank Size – The type and size of the drill shank depends on the chuck in which the drill will be clamped. Various shank and chuck combinations can provide improved performance such as higher torque and more centering accuracy. (Figure 1.2.3).

Figure 1.2.3



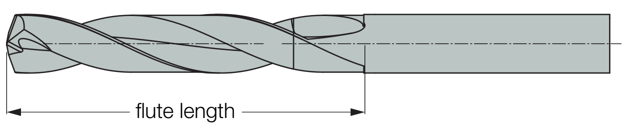
Overall Length – The total length of the drill which includes the length of the cutting zone and the length of the clamping zone, i.e. distance between two extreme planes of the tools which are perpendicular to the central axis of the drill (Figure 1.2.4).

Figure 1.2.4



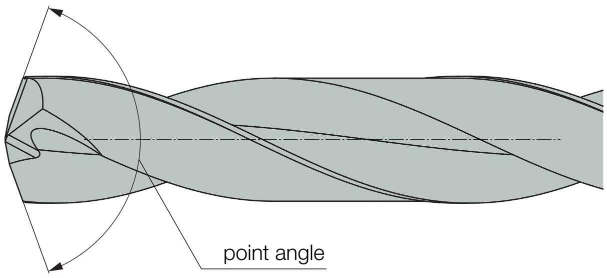
Flute Length – The effective length of the drill which determines the maximum depth of the machined hole. The flute length defined as the distance between two perpendicular planes to the central axis of the drill that are placed on the chisel point and the end of the flute (Figure 1.2.5).

Figure 1.2.5



Point Angle – The angle between cutting edges. The point angle of a drill affects the cutting performance and the tool's thermal conductivity. A sharper point angle will result in a longer cutting edge, thus allowing better thermal conductivity and consequently longer tool life but on the other hand, it weakens the tool rigidity. Therefore, the point angle of a drill depends on the workpiece material it aims to machine. Commonly, for soft material the angle lays between 80 -90 degrees, for steels and cast iron this angle will be between 116 - 118 degrees, for hard steels this angle will be between 130 - 140 degrees (Figure 1.2.6).

Figure 1.2.6

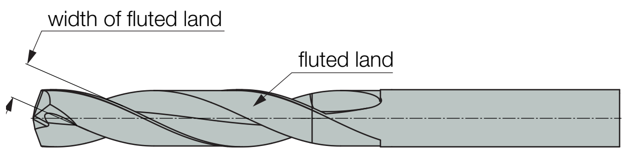


Additional Drill Parameters According to ISO 5419: 1982 Standard

Fluted Land - The helical portion of the body, including both the land and the body clearance (Figure 1.2.7).

Width of Fluted Land - The distance between the leading edge of the land and the heel, measured at right angles to the leading edge of the land (Figure 1.2.7).

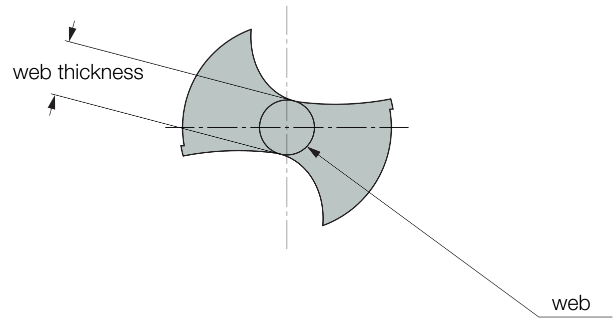
Figure 1.2.7



Web - The central portion of the drill situated between the roots of the flutes over the flute length (Figure 1.2.8). Note 1 to entry: The point end of the web forms the chisel edge (Figure 1.2.14).

Web Thickness - The minimum dimension of the web measured in a plane normal to the axis. The web thickness is usually measured at the point end (Figure 1.2.8).

Figure 1.2.8

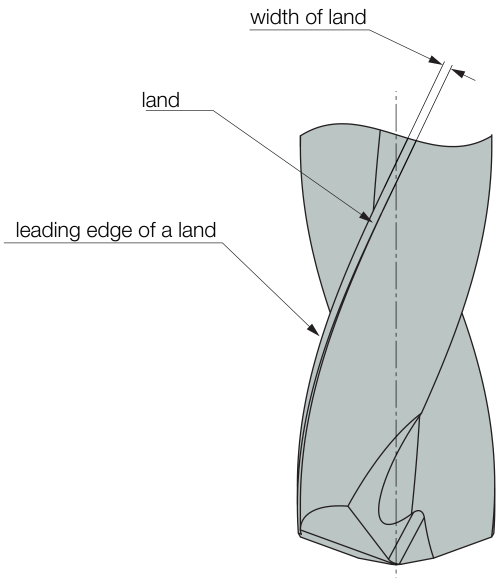


Land - The cylindrical or conical leading surface of the drill (Figure 1.2.9).

Width of Land - The dimension measured at right angles to the leading edge of the land across a land (Figure 1.2.9)

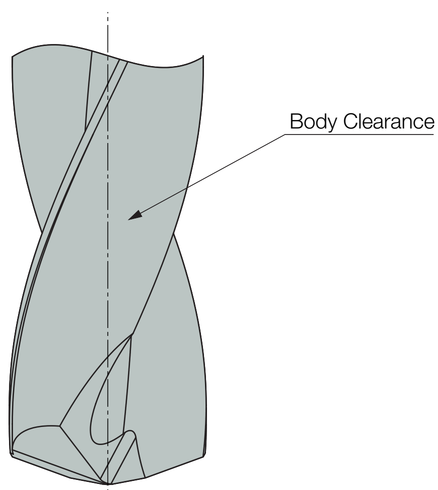
Leading Edge of a Land (minor cutting edge) - The edge formed by the intersection of a land and a flute (Figure 1.2.9).

Figure 1.2.9



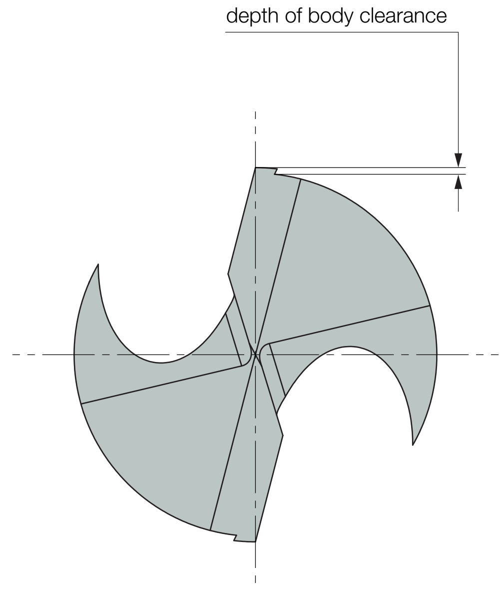
Body Clearance - The portion of a fluted land reduced in diameter to provide diametral clearance (Figure 1.2.10).

Figure 1.2.10



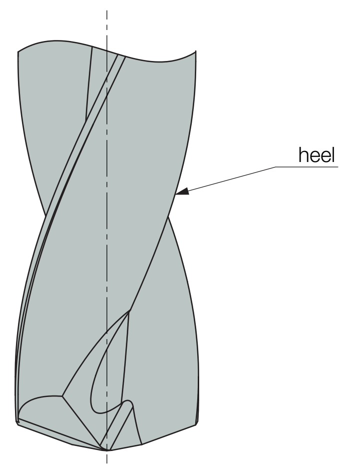
Depth of Body Clearance - The radial distance between the land and the corresponding body clearance. It is generally measured at the outer corners (Figure 1.2.11).

Figure 1.2.11



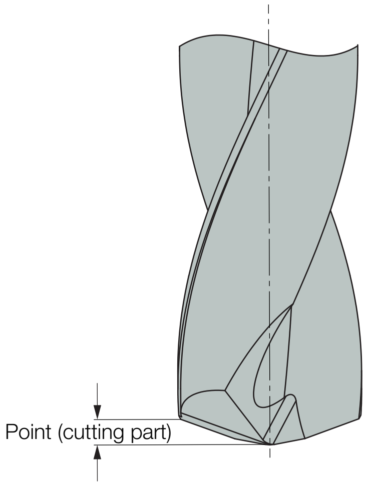
Heel - The edge formed by the intersection of a flute and the body clearance (Figure 1.2.12).

Figure 1.2.12



Point (cutting part) - The functional part of the drill comprised of chip-producing elements. The major cutting edges, chisel edge, faces and flanks are therefore elements of the point (cutting part) (Figure 1.2.13).

Figure 1.2.12



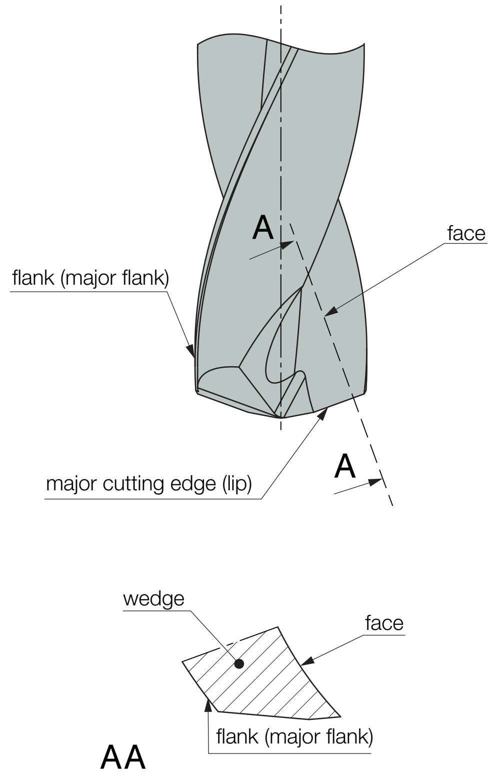
Flank (major flank) - The surface on the drill point bounded by the major cutting edge, the fluted land, the following flute, and the chisel edge (Figure 1.2.13).

Face - The portion of the surface of a flute adjacent to the major cutting edge and on which the chip when formed during the cutting operation. (Figure 1.2.13).

Major Cutting Edge (lip) -
The edge formed by the Intersection of a flank and face (Figure 1.2.13).

Wedge - The portion of the point enclosed between a face and a flank associated with the major cutting edge (Figure 1.2.13).

Figure 1.2.13



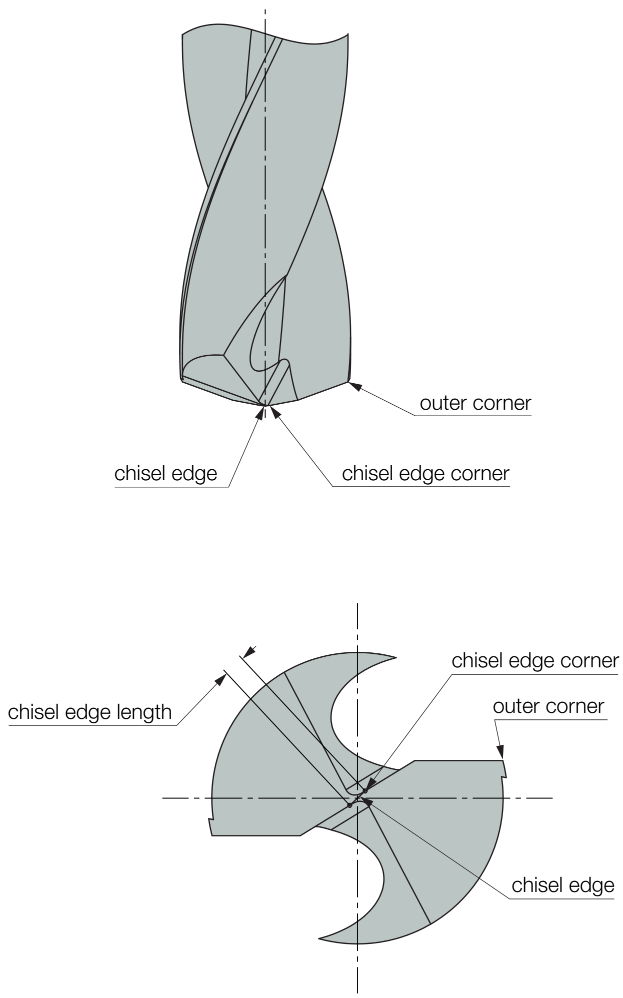
Outer Corner - The corner formed by the Intersection of a major cutting edge and the leading edge of the land (Figure 1.2.14).

Chisel Edge - The edge formed by the intersection of the flanks (Figure 1.2.14).

Chisel Edge Corner - The corner formed by the Intersection of a major cutting edge and the chisel edge (Figure 1.2.14).

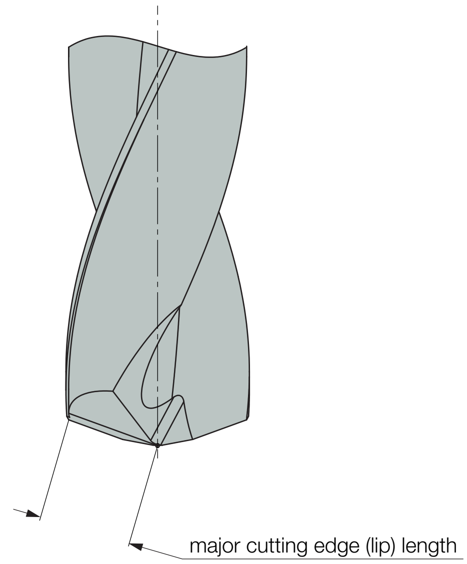
Chisel Edge Length - The distance between the chisel edge corners (Figure 1.2.14).

Figure 1.2.14



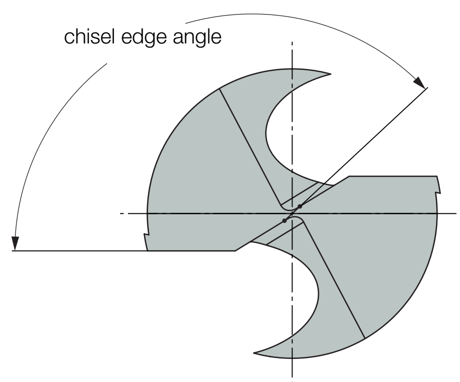
Major Cutting Edge (lip) Length - The minimum distance between the outer corner and the corresponding chisel edge corner of the major cutting edge (Figure 1.2.15).

Figure 1.2.15



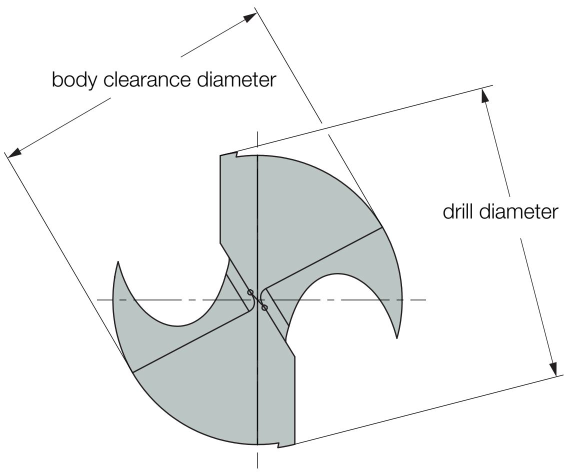
Chisel Edge Angle - The obtuse angle between the chisel edge and a line from the outer corner to the corresponding chisel edge corner. The angle is measured by projection in a plane perpendicular to the drill axis (Figure 1.2.16).

Figure 1.2.16



Body Clearance Diameter - The diameter of the body clearance behind the lands (Figure 1.2.17).

Figure 1.2.17



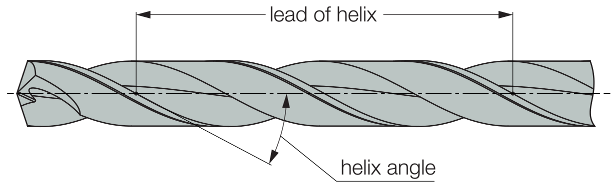
Back Taper - The reduction in diameter from the outer corners towards the shank. It is expressed by the ratio of the reduction in diameter and the length of measurement.

Web Taper - The increase in web thickness from the point of the drill to the shank end of the flutes. It is expressed by the ratio of the increase in thickness and the length of measurement.

Lead of Helix - The distance measured parallel to the drill axis between corresponding points on the leading edge of a land in one complete revolution of the land (Figure 1.2.18).

Helix Angle - The acute angle between the tangent to the helical leading edge and a plane containing the axis and the point in question. This angle lies in a plane normal to the radius at the point on the edge (Figure 1.2.18). Note 1 to entry: Helix angles may be classified as normal, slow and quick.

Figure 1.2.18

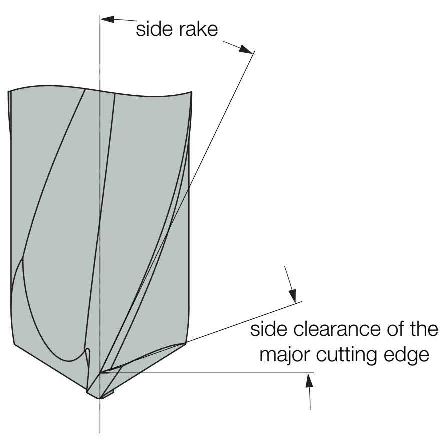


Side Rake - The angle between a face and a plane passing through the selected point on the cutting edge and the drill axis, measured in the plane perpendicular to the radius at the selected point (Figure 1.2.19).

Note 1 to entry: When the selected point is at the outer corner, this angle is equivalent to the helix angle (Figure 1.2.18).

Side Clearance of The Major Cutting Edge - The angle between a flank and a plane containing the cutting edge and the assumed direction of primary motion at the selected point on the cutting edge, measured in the plane perpendicular to the radius at the selected point (Figure 1.2.19). This angle is usually specified and measured at the outer corner.

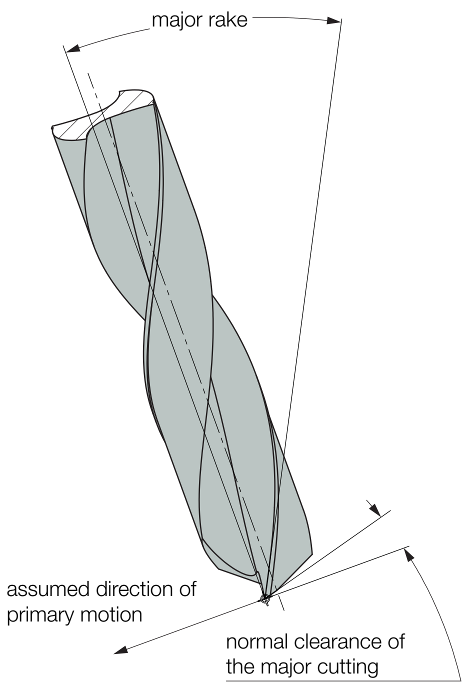
Figure 1.2.19

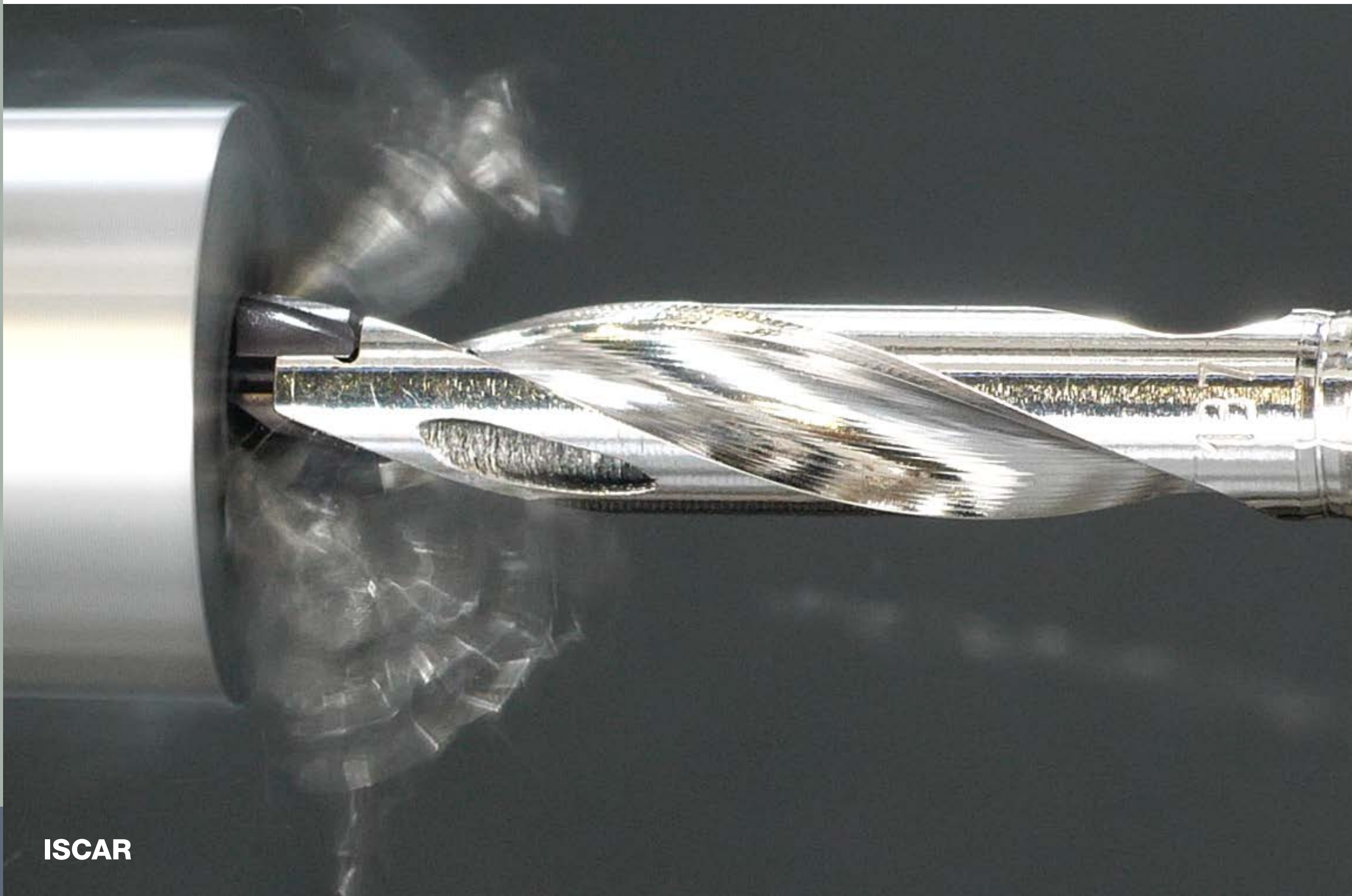


Normal Rake - The angle between a face and a plane passing through the selected point on the cutting edge and the drill axis, measured in the plane perpendicular to the cutting edge (Figure 1.2.20).

Normal Clearance of the Major Cutting Edge - The angle between a flank and a plane containing the cutting edge and the assumed direction of primary motion at the selected point on the cutting edge measured in the plane perpendicular to the cutting edge at the selected point (Figure 1.2.19).

Figure 1.2.20





Drill Classifications

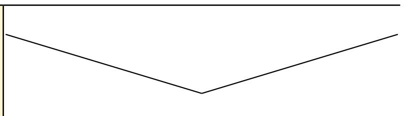
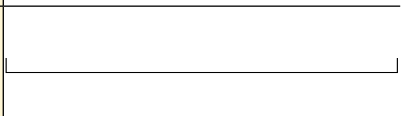
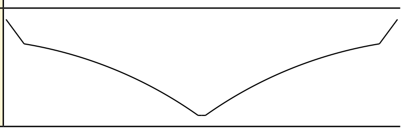
Drills can be classified based on the following criteria:

Cutting Part

The cutting part of a drill consists of two main components: the major cutting edge and the flute.

Major Cutting Edge:

- **V Bottom** – Most common type, used for general applications.
- **Flat Bottom** – Typically used for specific applications such as creating pilot holes, drilling shoulders, or for screw heads, or for spring, etc. It's also employed when the surface of the drill exit is not perpendicular to the central axis of the drill.
- **Self-Centering** – Ideal for situations requiring drilling with an overhang or creating a self-lead for deep drilling in standard turning/milling centers.

V Bottom	
Flat Bottom	
Self-Centering	

Flute Type:

- **Spiral Flute** – Typically used for vertical drilling and provides effective chip evacuation. This is the most common flute type.
- **Straight Flute** - Suited for horizontal drilling, such as in lathes or turning centers, and for deep drilling. It is also used for step drills.

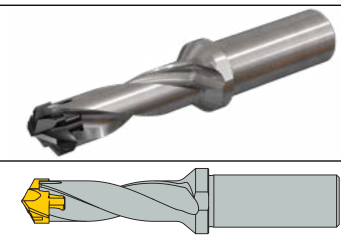
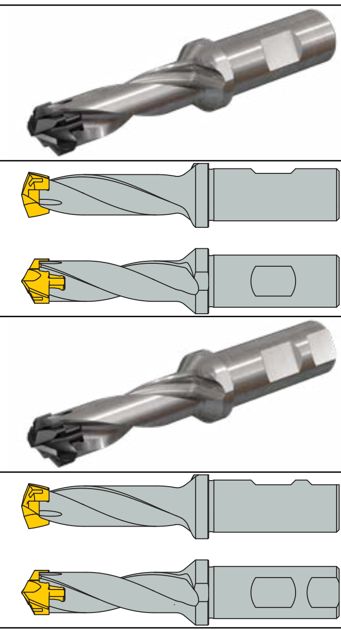
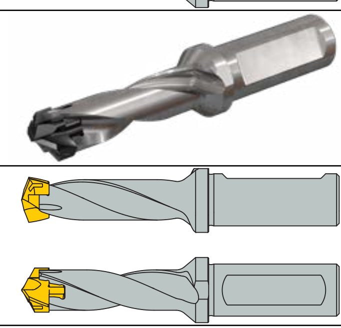
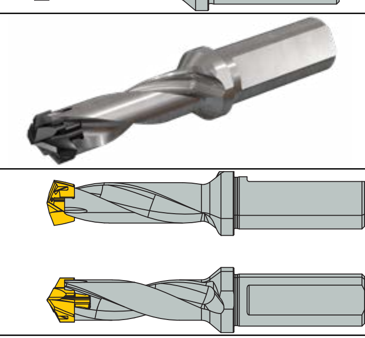
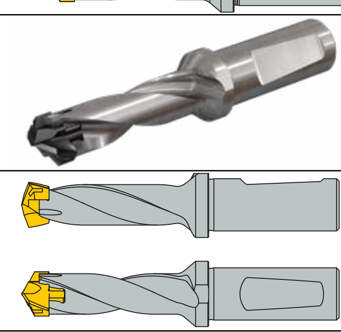
Spiral Flute

Straight Flute

Clamping Part

Intended for clamping the drill into the tool holder. The type and size of a drill shank depends on the chuck in which the drill will be clamped. Various shank and chuck combinations can enhance performance, such as increasing torque and improving centering accuracy. The most common types of shanks are the round shank, side lock shank, and whistle notch shank.

- **Plain Cylindrical Shank / Round Shank** - Compatible with hydraulic and collet chucks, it reduces the runout of the cutting edge, which is crucial for drill lengths over 5xD.
- **Side Lock Shank** – Features a cylindrical shank with one or two parallel flats for side clamping systems. This design provides a secure and rigid clamp in the tool holder, preventing the drill from being pulled outward. It offers high torque transmission, making it suitable for heavy machining operations.
- **Cylindrical Shank with Inclined Clamping Surface / Whistle Notch Shank** – An analog of side lock shanks with the main difference of the notch angled at 2° relative to the central axis of the drill.

Plain Cylindrical Shank / Round Shank (DIN 1835-A and DIN 6535-HA)		
Side Lock Shank	Flatted Cylindrical Shank / Weldon (DIN 1835-B and DIN 6535-HB)	
Side Lock Shank	One Flat Shank (ISO 9266)	
Side Lock Shank	One Parallel Flat Shank (ISO 9266)	
Cylindrical Shank with Inclined Clamping Surface / Whistle Notch Shank (DIN 1835-E and DIN 6535-HE)		

Design Configuration

Drills may differ in their design configuration as follows:

- **Solid Drill** - Primarily used for drilling holes up to 12 mm (0.472 inches) in diameter and up to 12D in depth (drill depth = 12 x drill diameter).
- **Drill With Indexable Inserts** - Mainly used for drilling holes with a diameter of 12 mm and larger, this drill design is also successfully used for deep drilling.
- **Drill With Exchangeable Heads** - An alternative to drills with indexable inserts, used for precise drilling in finish operations.

ISCAR is currently the only company in the world that produces drills with exchangeable heads starting from a 4 mm diameter.

SOLID-DRILL

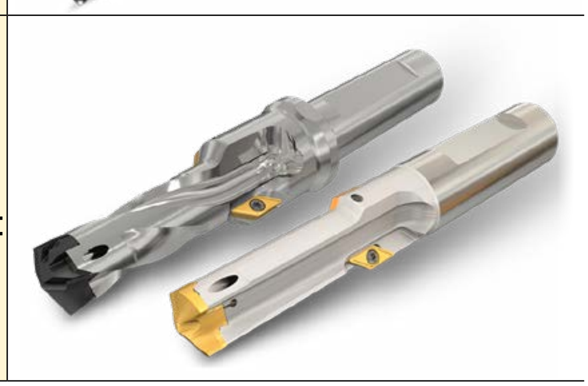
Drill with Indexable Inserts

Drill with Exchangeable Heads

Application

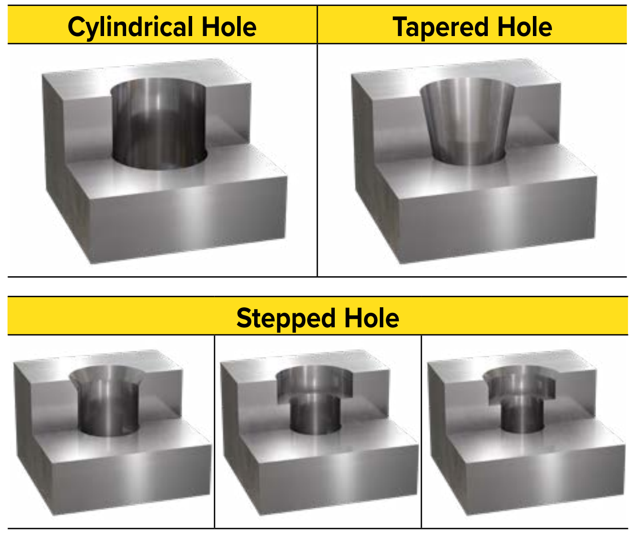
Drills are categorized based on their intended application:

- **General Purpose Drill** – Designed for thought and blind holes in various materials.
- **Centering Drill** - Creates holes for holding parts between centers or with tailstocks in turning and grinding machines.
- **Spot Drill** – Provides pre-location accuracy and a lead for stable drilling.
- **Deep Drill** – Drilling holes on dedicated drilling machines with specialized drilling tools. Commonly used for drilling holes with a depth of 20D (hole depth = 20 x drill diameter) and more, but also can be used for drilling a shallower depth.
- **Stepped Drill** – Drilling stepped holes by one drill.

General-Use Drill	
Central Drill	
Spot Drill	
Deep Drill	
Stepped Drill	

Hole Shape

Drills can be classified by the shape of the holes they create such as cylindrical, tapered, or stepped.

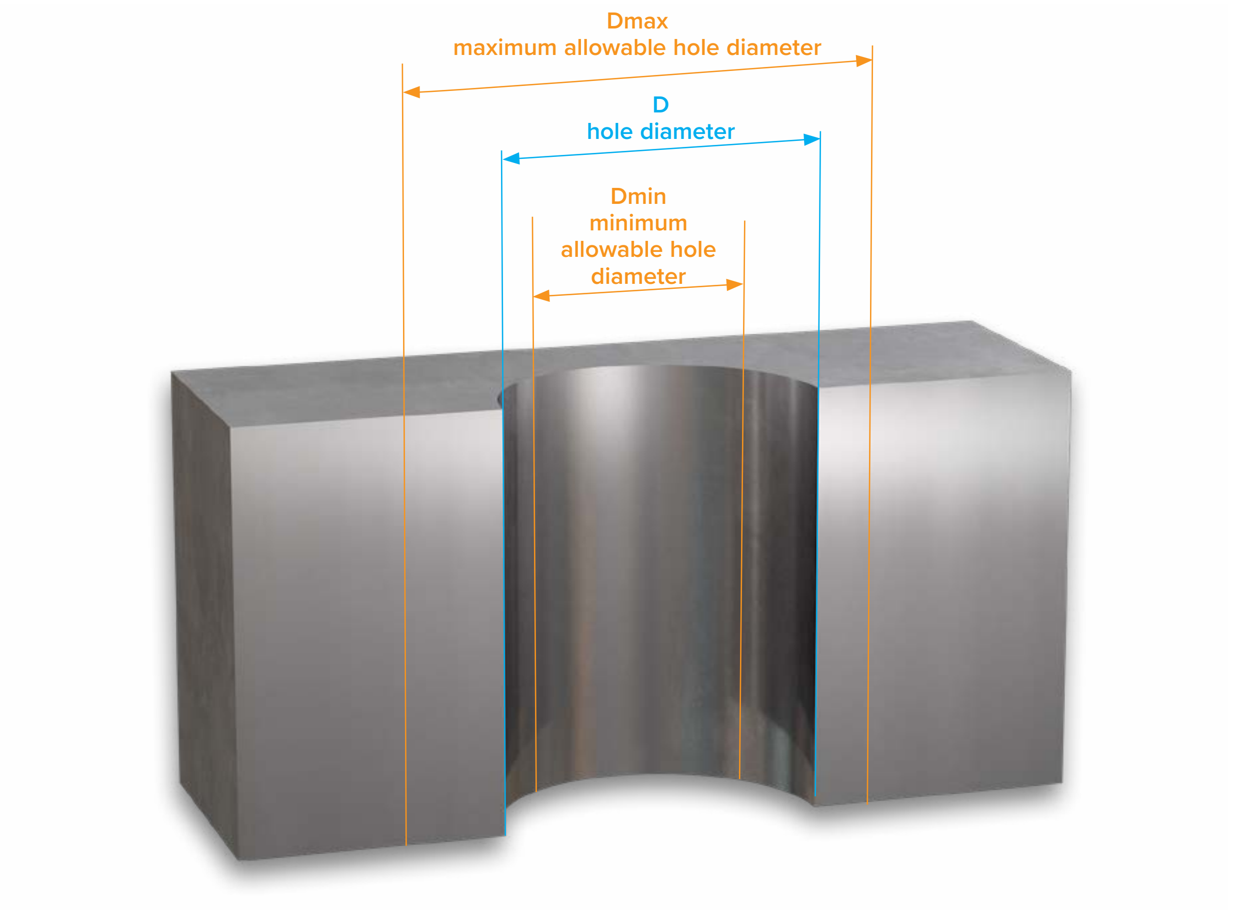


Drill Classifications

- **Drill**
  - Cutting Part
    - Major Cutting Edge
      - V Bottom
      - Flat Bottom
      - Self Centering
    - Flute
      - Spiral Flute
      - Straight Flute
  - Clamping Part
    - Round Shank
    - Side Lock Shank
    - Whistle Notch Shank
    - Other Shank Types
  - Design Configuration
    - Solid Drill
    - Drill with Indexable Inserts
    - Drills with Exchangeable Heads
  - Application
    - General Purpose Drill
    - Centering Drill
    - Spot Drill
    - Deep Drill
    - Stepped Drill
  - Hole Shape
    - Cylindrical Hole
    - Tapered Hole
    - Stepped Hole

Hole Accuracy and Surface Roughness by Drilling

Hole Accuracy



Hole accuracy is determined by the width of the tolerance field, that is, the permissible deviation from the nominal dimensions.

The nominal dimensions - the dimension that is a starting point for deviations and relative to which the limited dimensions are determined, that is, the dimensions that defined in the drawing.

Width of the tolerance – the difference between the maximum allowable size and the minimum allowable size. Width of the tolerance is unsigned absolute value, for which it is generally accepted to use the IT Grade (International Tolerance Grade) according to the ISO 286 standard. The width of tolerance according IT Grade tables defined by number that placed after IT letters and depended on nominal dimensions, i.e., the same accuracy value according IT Grade table for different nominal dimensions will define a different range of tolerance. With an increase in the IT Grade number, the tolerance range increases, that is, the accuracy decreases.

For example:

For size range between 6 mm and 10 mm according to IT10 grade the width of the tolerance will be 0.058 mm.

For size ranges between 6 mm and 10 mm according to IT12 grade, the width of the tolerance will be 0.15 mm.

For size ranges between 10 mm and 18 mm according to IT10 grade, the width of the tolerance will be 0.07 mm.

For size ranges between 10 mm and 18 mm according to IT12 grade, the width of the tolerance will be 0.18 mm.

IT Grade Table (ISO 286 Standard)

Basic Size mm		Standard Tolerance Grades																	
Above	up to and Including	IT1	IT2	IT3	IT4	IT5	IT6	IT7	IT8	IT9	IT10	T11	T12	T13	IT14	IT15	IT16	IT17	IT18
		Tolerances µm											mm						
	3[3]	0.8	1.2	2	3	4	4	10	14	25	40	60	0.1	0.14	0.25	0.4	0.6	1	1.4
3	6	1	1.5	2.5	4	5	5	12	18	30	48	75	0.12	0.18	0.3	0.48	0.75	1.2	1.8
6	10	1	1.5	2.5	4	6	6	15	22	36	58	90	0.15	0.22	0.36	0.58	0.9	1.5	2.2
10	18	1.2	2	3	5	8	8	18	27	43	70	110	0.18	0.27	0.43	0.7	1.1	1.8	2.7
18	30	1.5	2.5	4	6	9	9	21	33	52	84	130	0.21	0.33	0.52	0.84	1.3	2.1	3.3
30	50	1.5	2.5	4	7	11	11	25	39	62	100	160	0.25	0.39	0.62	1	1.6	2.5	3.9
50	80	2	3	5	8	13	13	30	46	74	120	190	0.3	0.46	0.74	1.2	1.9	3	4.6
80	120	2.5	4	6	10	15	15	35	54	87	140	220	0.35	0.54	0.87	1.4	2.2	3.5	5.4
120	180	3.5	5	8	12	18	18	40	63	100	160	250	0.4	0.63	1	1.6	2.5	4	6.3
180	250	4.5	7	10	14	20	20	46	72	115	185	290	0.46	0.72	1.15	1.85	2.9	4.6	7.2
250	315	6	8	12	16	23	23	52	81	130	210	320	0.52	0.81	1.3	2.1	3.2	5.2	8.1
315	400	7	9	13	18	25	25	57	89	140	230	360	0.57	0.89	1.4	2.3	3.6	5.7	8.9
400	500	8	10	15	20	27	27	63	97	155	250	400	0.63	0.97	1.55	2.5	4	6.3	9.7
500	630[2]	9	11	16	22	32	32	70	110	175	280	440	0.7	1.1	1.75	2.8	4.4	7	11
630	800[2]	10	13	18	25	36	36	80	125	200	320	500	0.8	1.25	2	3.2	5	8	12.5
800	1000[2]	11	15	21	28	40	40	90	140	230	360	560	0.9	1.4	2.3	3.6	5.6	9	14
1000	1250[2]	13	18	24	33	47	47	105	165	260	420	660	1.05	1.65	2.6	4.2	6.6	10.5	16.5
1250	1600[2]	15	21	29	39	55	55	125	195	310	500	780	1.25	1.95	3.1	5	7.8	12.5	19.5
1600	2000[2]	18	25	35	46	65	65	150	23	370	600	920	1.5	2.3	3.7	6	9.2	15	23
2000	2500[2]	22	30	41	55	78	78	175	280	440	700	1100	1.75	2.8	4.4	7	11	17.5	28
2500	3150[2]	26	36	50	68	96	96	210	330	540	860	1350	2.1	3.3	5.4	8.6	13.5	21	33

The distribution of the tolerance range relative to the nominal size is labelled by letters, the capital letters for holes and lowercase letters for shafts.

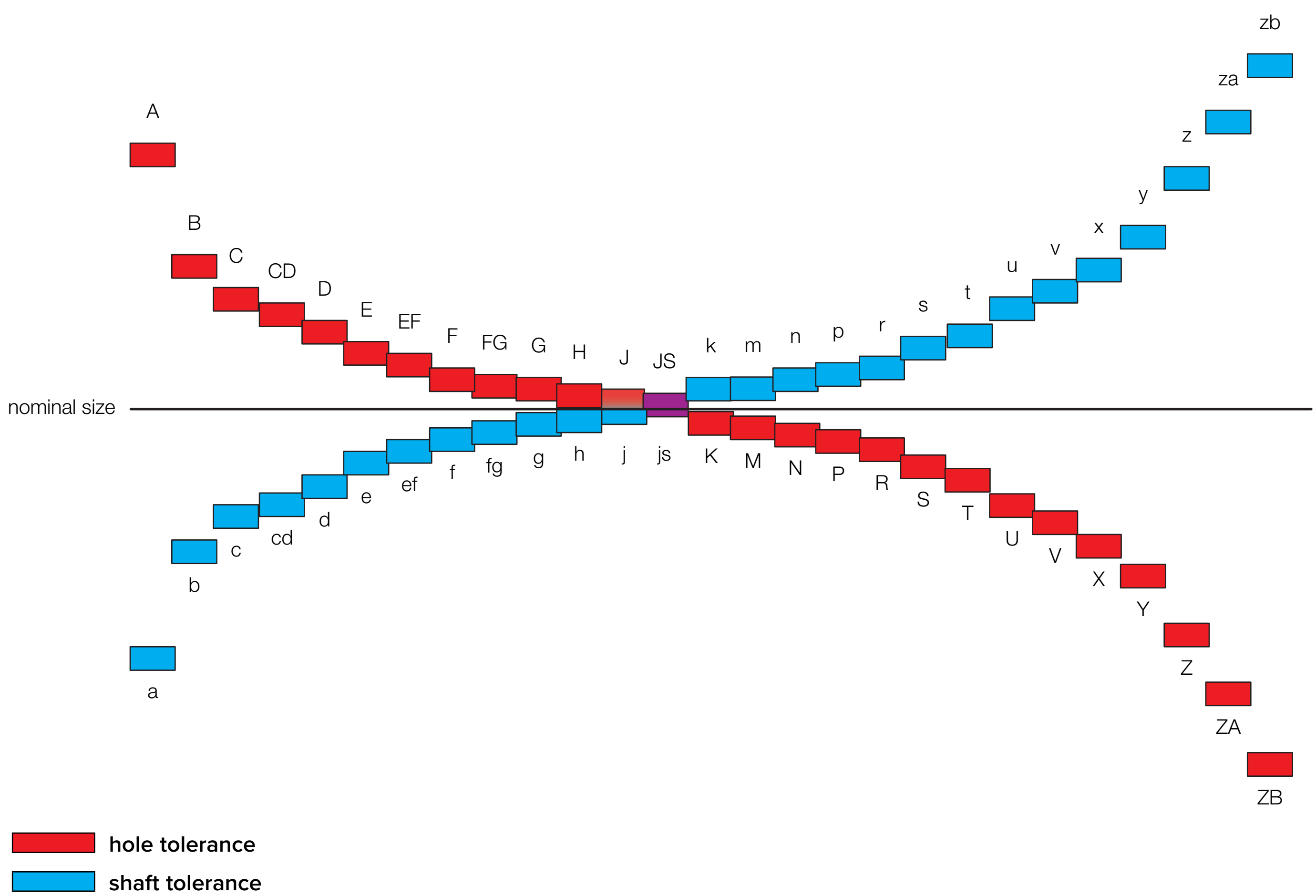
The value for the hole from "A" to "H" are positive (+), for the shaft from "a" to "h" negative (-). The value of the hole from "J" to "K" either positive (+) or negative (-), for shaft form "j" to "k" either positive (+) or negative (-).

For example:

For hole Ø8H10 the tolerance will be +0.058 i.e., the minimum possible hole diameter is 8 mm while the maximum possible hole diameter is 8.058 mm.

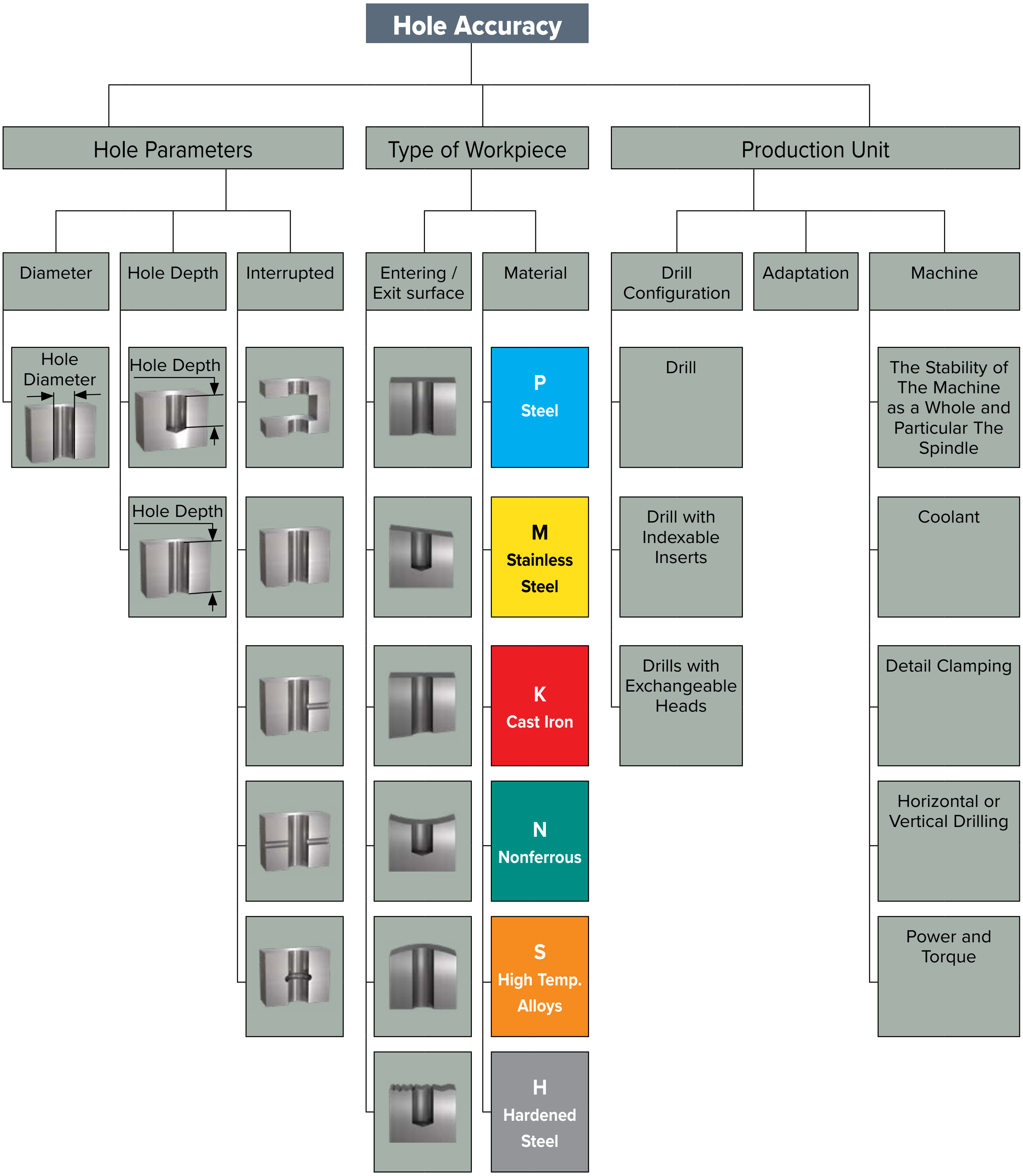
For hole Ø8JS10 the tolerance will be ±0.029 i.e., the minimum possible hole diameter is 7.971 mm while the maximum possible hole diameter is 8.029 mm.

Note: In both examples the width of the tolerance is the same (0.058 mm) with a difference only in the range relative to the nominal size.

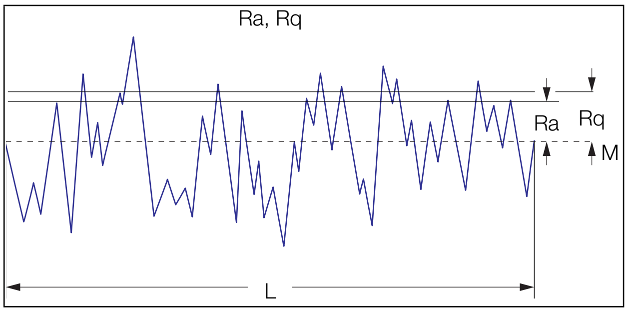


The hole diameter when drilling may be slightly different from the drill diameter. This is because the drill moves away from the hole axis even with minor irregularities.

However, at the same time, hole accuracy by drilling depends on many factors related to both the hole parameters and the type of workpiece, as well as production unit.



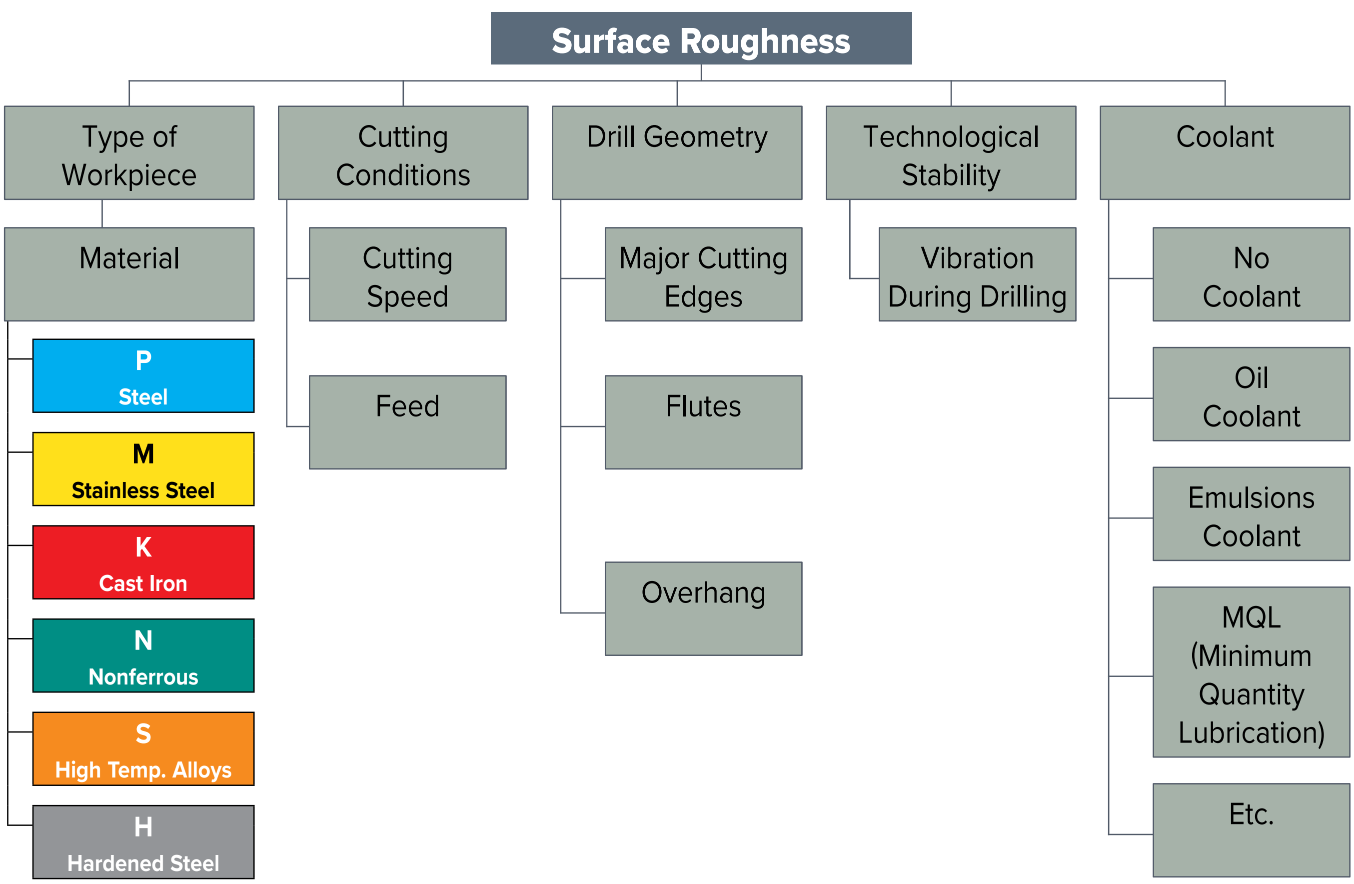
Surface Roughness in Drilling



The surface roughness is a measure of the technological quality of a product. When machining parts by use of material removing processes such as turning, drilling, milling and miscellaneous operations always remain as irregularities on the machined surface. These irregularities occur with all types of processing, even with the most careful surface finishing. The size of irregularities determines the surface roughness.

Surface roughness plays an important role on interaction with other part or environment. Rough surfaces usually wear more quickly and have higher friction coefficients than smooth surfaces. The less roughness of the treated surface of the part, the better it resists corrosion, i.e., damage under the influence of various chemicals - gases, liquids, etc. Significant roughness remaining on the treated surface also reduces the strength of machine parts, especially under alternating loads. It follows from this that the roughness of the processed surface significantly affects the performance characteristics of the part.

In drilling, the main factors affecting surface roughness are type of workpiece, cutting conditions (speed, feed), drill geometry (major cutting edges, flutes, overhang), technological stability (vibration), coolant.



Type of Workpiece

One of the main factors affecting the chip shape and the possibility of effectively removing chips from the drilled hole is the type of material. With poor chip evacuation the machined surface can be damaged, thus achieving the same surface roughness value in different materials requires different efforts.

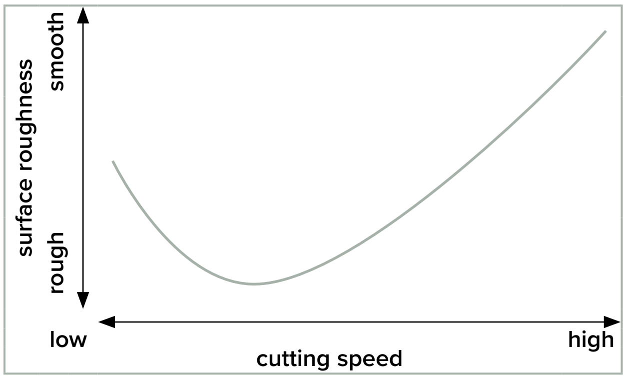
Material	Features of Chip Formation
P - Steel	Low carbon steels tend to form long chips.
M – Stainless Steel	Difficult chip control.
K – Cast Iron	Fragile and quickly breaking chips.
N - Nonferrous	There is a risk of buildup and chip evacuation.
S – High Temp. Alloys	Resistance to cutting causes difficult chip formation.
H – Hardened Steel	Short chips, no problem with chip evacuation.

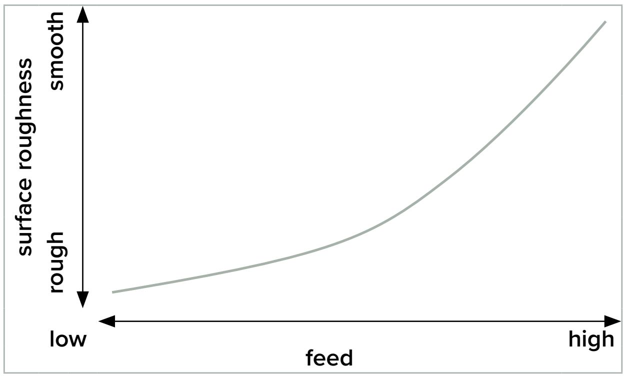
Cutting Conditions

Feed and cutting speed have a significant impact on the surface roughness.

With an increase in feed, the roughness increases. This is explained by the fact that a large layer of metal is removed in one revolution of drill, related to the phenomenon of detachment and breaking of metal particles increases.

Changing the cutting speed affects the roughness in different ways. For example, in a certain range of speeds, a build-up forms on the cutting edge of the tool, which contributes to an increase in roughness and the formation of work hardening on the machined surface, then, with an increase in the speed, the build-up phenomenon stops, the temperature in the cutting zone rises and the chips are removed more smoothly, without breaking off the crystals, therefore, the magnitude of the microroughness decreases.





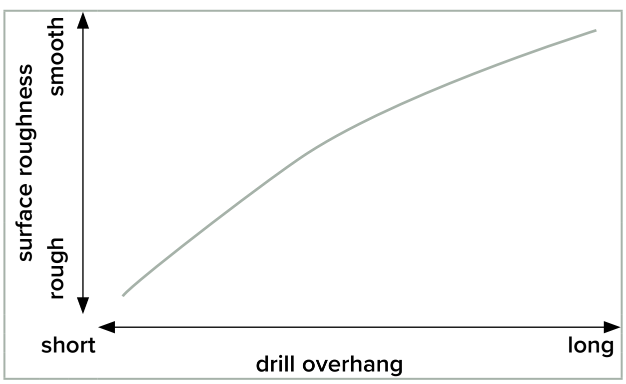
Drill Geometry

Drills, namely such components as major cutting edges geometry, flutes, and drill overhang (length of cutting part) have a direct influence on the surface roughness of the hole.

The right selection of major cutting edges geometry will reduce the load created on the drill while drilling and will also ensure optimal distribution of cutting forces, thereby making the drill work more stable which will be reflected in the surface roughness.

Flutes geometry ensures efficient chip evacuation preventing damage by chips to the machined hole surface.

Minimal tool runout is essential for successful hole drilling. The longer the drill overhangs, the more difficult it is to control its runout, which directly affects the roughness of the drilled hole.



Technological Stability

The loads arising during machining are transmitted by the tool and tool holder, as well as by the part and device in which it is clamped. The resulting loads are transferred by devices to the assembly units and mechanisms of the machine, due to which a closed technological system machine-tool-part is formed. The rigidity of this technological system is one of the main criteria for the performance and accuracy of the machine under load, thereby ensuring technological stability. Poor technological stability leads to vibrations of the cutting tool and machined part, which affects the roughness of machined surface.

Coolant

Coolant has a significant effect on the drilling process and the quality of the machined surface, since it facilitates the process of chip formation and evacuation, removes heat from the cutting zone and lubricates the friction surfaces.

Tool Holders

The fastening of the cutting tool has a significant effect on productivity of metalworking operations. Therefore, it is important to choose the right tooling. The toolholder consists of two parts: machine side and tool side.

The machine side is connected to a machine spindle. In most cases the type of machine side is chosen depending on the spindle type which exists in the machine. In some cases, when the machining required adapters (for example, machining with long overhang) or when purchasing a new machine, the type of machining side of tool holder is selected depending on the main type of operations, the required accuracy, and the type of workpiece.

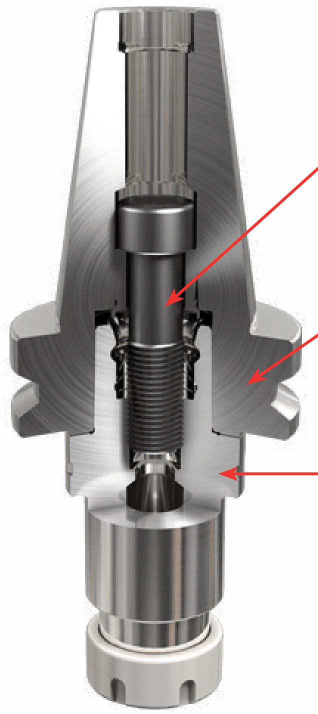
The most common spindle types or machine side tool holders:

CAMFIX (ISO 26623-1)	HSK (DIN 69893) Type A
	 exist: Type A / B / C / D / E / F / T

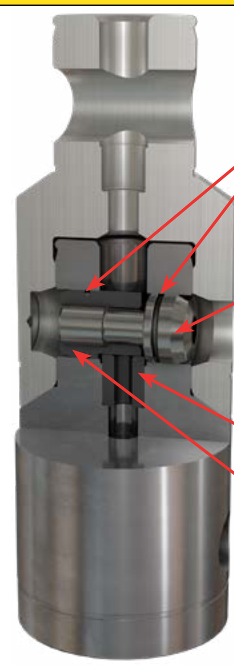
7/24 Taper Shank		
BT	DIN 69871	CAT
		

The most common modular system to increase overhangs

CAMFIX

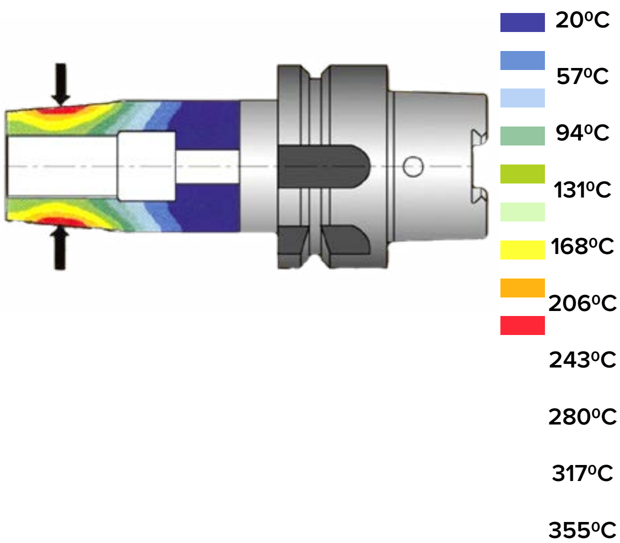


MB Connection



The **CAMFIX** and MB connection adapters enable the use of modular systems on machines with different spindle connection types. The tool side is designed for fixing and clamping the drill. The most common types of tool sides are ER collet chuck, thermal shrink chuck, power (**MAXIN**) chuck, hydraulic chuck, hydraulic heavy-duty chuck, and EM side clamp chuck. Each tool side type has its own purpose, characteristics, and advantages.

Thermal Shrink Chuck



The Thermal Shrink Chuck Is the Most Advanced Type of Machining Side of a Tool Holder (For end Cutting Tools with a Cylindrical Shank), Combining the Highest Accuracy of the Cutting Tool Positioning with an Extremely High Rigidity of the "cutting Tool - Machine Spindle" System.
The Principle of Operation of Shrink Fit Chucks Is Based on the Property of Materials to Expand when Heated. The Chuck Is Heated in a Special Device, and Its Hole Is Enlarged Due to Thermal Expansion. Then a Tool Is Inserted Into It, and the Cartridge Is Cooled (In Air Or in a Special Device). The Unclamping Process Is Similar.

The advantage of the shrink chuck is the high clamping force, high accuracy, and symmetrical design. However, when using a shrink chuck, it should be noted that each chuck is adapted to a specific shank diameter, and constant heating and cooling cycles can lead to severe wear of the chuck. Additionally, special equipment is required for tool changing.

Hydraulic Chuck

Hydraulic Expansion Technology

1 **The Oil Chamber System** Then the oil chamber system filled with hydraulic fluid, it has a damping effect on the clamped tool.

2 **The Expansion Sleeve** The expansion sleeve expands against the tool shank. This clamping process first centers the tool shank before fully clamping it over the whole surface.

3 **The Base Body** The machine side interface is located on the base body.

4 **The length adjustment screw** for fast and easy presetting.

5 **The dirt groove** The enormous clamping pressure of the **HYDRO-FIT** SF chuck creates a displacement of oil, grease, or lubricant residues into the groove, causing surfaces to remain dry.

In the hydraulic chuck, the tool is clamped by fluid pressure. To clamp / unclamp the chuck, simply turn the clamping screw.

When tightening the clamping screw, the force is transferred to the piston, which in turn generates hydraulic fluid pressure. The hydraulic fluid pressure is transmitted to the wall-mounted sliding sleeve. This pressure causes the sleeve to compress around the tool shank creating a concentrated clamping force.

vibration damping

The advantages of the hydraulic chuck include high accuracy, user simplicity, and quick tool changes. Using this type of chuck can reduce vibration and significantly extend tool life.

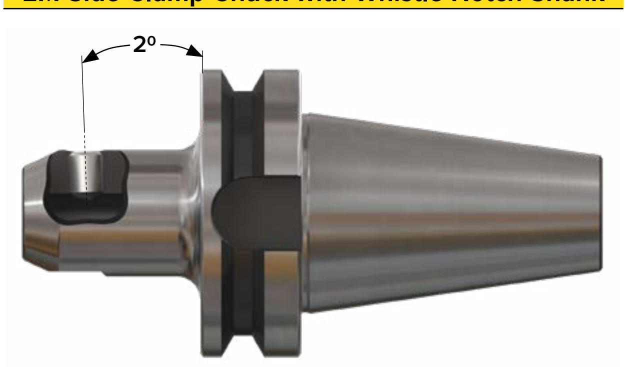
EM Side Clamp Chuck

EM side clamp chuck suitable for cutting tools with Weldon and Whistle-notch shanks. The principle of operation is simple: the tool shank has a flat area, clamping is carried out by tightening the screw, the screw rests on the flat area, reliably fixing the tool.

The difference between chucks for the Whistle-Notch shank and Weldon shanks is the orientation of the clamping screw.

EM Side Clamp Chuck with Weldon Shank

EM Side Clamp Chuck with Whistle Notch Shank



The clamping screw in the chuck for the Weldon shank is perpendicular to the central axis of the cutting tool, while the clamping screw in the chuck for the Whistle-Notch shank is at an angle in accordance with the flattened part on the shank. This allows the screw not only to push the cutting tool against the wall of the chuck but also to pull it inward. The primary advantages of the EM side clamp chuck are its relatively low cost and the absence of torque transfer limitations.

Tool Side Selection Considerations

When selecting the tool side, factors such as the drill shank type and the following parameters should be considered:

- Run Out (OD/ID)
- Gripping/ Torque Transmission (Nm/lbs*ft)
- Vibration Damping
- Balancing Quality (Grade/RPM)
- Rigidity/Stiffness
- Handling and Operability
- Shape limitations
- Maintenance and Tool Life
- Flexibility / Versatility
- Weight Limitation

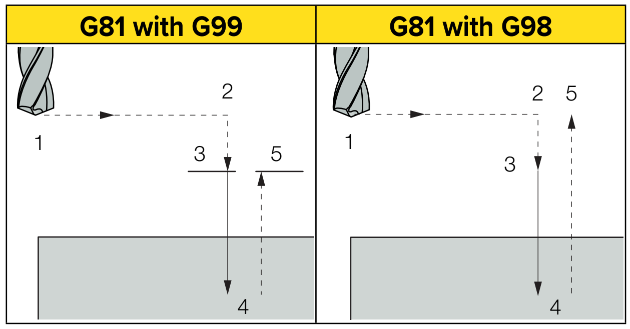
Technological Drilling Method

Technological drilling methods or drilling cycles are defined motion processes (G-codes) for drilling in accordance with ISO 6983-1: 2009 standard. There are several drilling cycles differing in the technological process and thus in their parameterization. The most used drilling cycles are G81, G73, G83. The placement of the drill at the end of drilling cycle is defined by G98 or G99 code. When G98 is active, the drill will return to the initial point at completion of a single operation. When G99 is active, the drill will be returned to the drilling cycle start point when the canned cycle completes a single hole. Generally, using G98 is provided in case there are obstacles between the holes such as clamps or other features of the part.

G81 - Basic Drilling Cycle (without Pecking)

This cycle assumes continuous movement of the drill throughout the cycle.

The drill starts moving from the initial point to cycle start point with rapid feed and then continues moving to the defined depth at the set feed, the drill retracts with rapid feed.



— **rapid feed**
— **set feed**

1-2 — Rapid traverse to the X, Y coordinates of the drilling hole center

2-3 — Rapid traverse to the drilling cycle start point

3-4 — Drilling process to the defined depth at the set feed

4-5 — Drill retracts with rapid feed

Syntax:

G81 X... Y... Z... R... F...

Parameter	Description
X	hole position in X-axis
Y	hole position in Y-axis
Z	drill hole depth
R	cycle start point
F	feed rate

Example:

G98 G81 X15.5 Y20.5 Z-10.0 R0.5 F150

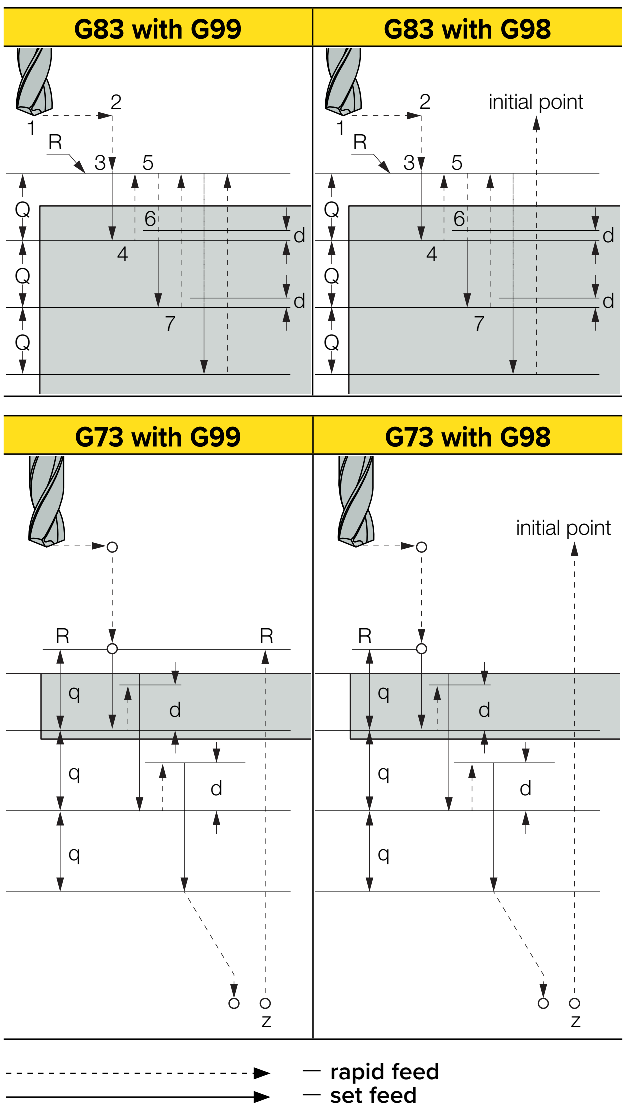
or

G99 G81 X15.5 Y20.5 Z-10.0 R0.5 F150

G73 and G83 – Peck Drilling Cycle

The G73 is a canned peck drilling cycle with a short retract, whereas G83 is a canned peck drilling cycle with a full retract.

The drill starts moving from the initial point to cycle start point with rapid feed and then continue moving by pecking to the defined depth at the set feed, at the end of each peck the drill retracts with rapid feed to distance is set within the machine (short retract) in case G73 is activated or to cycle start point (full retract) in case G83 is activated.



1-2 — Rapid traverse to the X, Y coordinates of the drilling hole center
2-3 — Rapid traverse to the drilling cycle start point
3-4 — Drilling process to the Q depth at the set feed
4-5 — Drill retracts with rapid feed
5-6 — Rapid traverse to the start point of next step drilling process
6-7 — Drilling process to the Q depth at the set feed
...-... — This entire procedure is repeated until the drill reaches the defined depth position. Then, the drill is retracted with rapid feed to either the cycle start point or the initial point, depending on whether G99 or G98 is specified in the program.

Syntax:

G73 X... Y... Z... R... Q... F...

G83 X... Y... Z... R... Q... F...

Parameter	Description
X	hole position in X-axis
Y	hole position in Y-axis
Z	drill hole depth
R	cycle start point
Q	depth of cut for each peck
F	feed rate

Example:

G98 G73 X15.5 Y20.5 Z-10.0 R0.5 Q F150

or

G99 G83 X15.5 Y20.5 Z-10.0 R0.5 F150

The Quick and Easy Way to Select Correct Drilling Cycle

The most recommended and productive drilling method is to use the canned drilling cycle without pecking, i.e. G81 code.

Efficient chip evacuation during drilling can often be very problematic and the deeper the hole, the more problematic the chip evacuation process. The solution to chip evacuation is to use a peck drilling cycle.

In the case of using the peck drilling cycle with a short retract, denoted by the G73 code, the drill does not fully exit the hole. Instead, the tool retracts a specified distance inside the hole. The purpose of G73 is to break stringy chips and pull them out of the holes.

By keeping the drill inside the hole, the impact of drill vibration on hole quality is significantly reduced, especially for long drills.

In the case of using the peck drilling cycle with a full retract, denoted by the G83 code, the drill retracts completely out of the drilled hole at regular intervals to evacuate chips. This method, compared to the previously described methods, is the least productive and may result in lower tool life and potentially worse hole quality. Therefore, the peck drilling cycle with a full retract is recommended only when it is not feasible to effectively remove the chips using the methods described above.

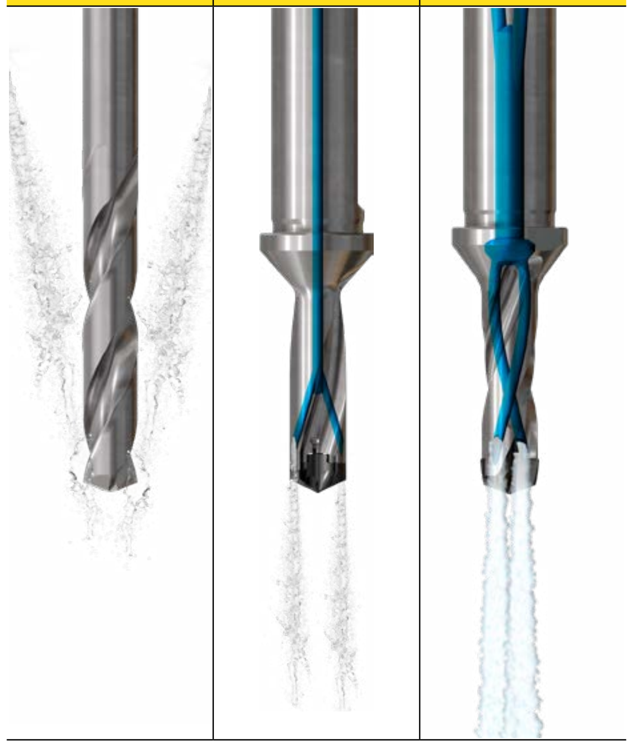
Coolant in Drilling

One major issue encountered during drilling is the overheating of both the drill and the workpiece due to plastic deformation and friction. The temperature at the cutting area can reach several hundred degrees Celsius, which leads to various problems, including accelerated tool wear, workpiece deformations, changes in material properties, and impacts on the quality and geometry of the hole.

To dissipate heat and reduce heat generation from friction, coolant flow is supplied to the cutting region. The velocity of the coolant flow increases as the coolant holes become smaller. When the coolant emerges from the tool through the nozzle, it exerts a high velocity, effectively cooling the chips, lowering their temperature, and protecting the cutting edge from overheating.

In the industry, various types of coolant fluids are used to prevent overheating, such as emulsion, oil, MQL (Minimum Quantity Lubrication), etc. The choice of coolant fluid depends on factors such as cutting parameters, material removal rate (MRR), hole depth, and properties of the machined material. Internal coolant supply is generally preferred over external coolant supply. Internal coolant is delivered through channels within the drill. There are two options for internal coolant channels in the drill: a central coolant hole or twisted coolant holes.

External Coolant	Internal Coolant	
	Central Coolant Hole	Twisted Coolant Holes



In addition to solving the heating problem, coolant also aids in chip evacuation during the drilling process. The pressure of the coolant helps push the chips out of the hole and prevents them from accumulating in the flutes of the drill. The deeper the hole, the more significant the effect of cooling on chip evacuation. Therefore, it is always necessary to strive to supply the maximum coolant flow that the machine can provide in the drill. As the material removal rate (MRR) increases, the required flow rate for chip evacuation also increases. Coolant also has a lubricating effect, reducing friction between the workpiece and the tool, between the chips and the tool, and between the chips and the workpiece. As a result, less force is required for chip evacuation, and reduced friction generates less heat. This leads to longer tool life and a more reliable process.

Pressure Vs. Flow

The main heat formation is around the cutting edge of the drill. To remove heat efficiently it is necessary to flow coolant at high speed as close as possible to the cutting area.

The flow velocity in a channel can be defined by:

$$v = \frac{Q}{A}$$

Where:

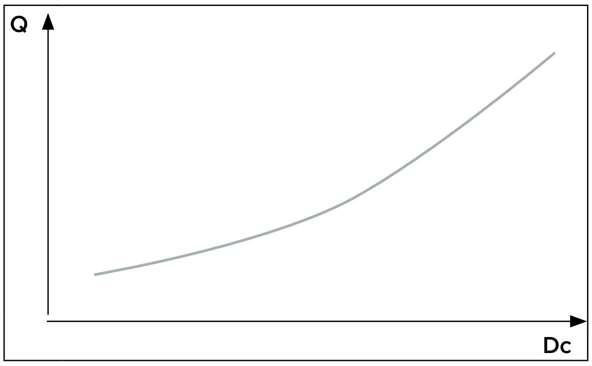
v = Flow velocity

Q = Volumetric flow rate

A = Cross section of coolant channel

Based on the formula it can be concluded that there is a direct relationship between volumetric flow rate and flow velocity and the higher the volumetric flow rate, the higher the flow speed.

Another conclusion that can be drawn is that the larger the diameter of the drill used, the higher the heat generation (and MRR) and we will need a higher coolant volumetric flow rate.



Where:

Q = Volumetric flow rate

Dc = Drill diameter

For a certain tool, there is a relationship between volumetric flow rate and pressure that can be defined by:

$$P=k\times Q^2$$

Where:

P = Pressure

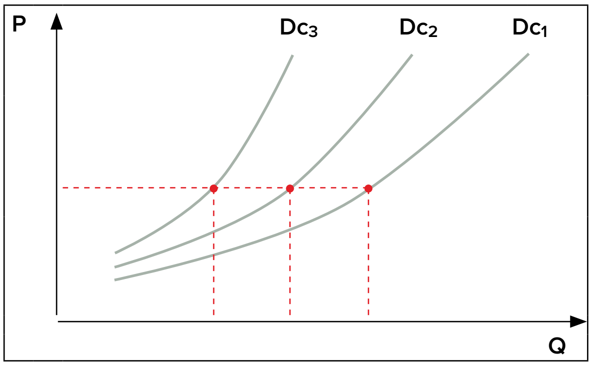
k = Hydraulic resistance of the tool

Q = Volumetric flow rate

The higher the coolant pressure provided at the inlet of the drill, the higher the coolant flow through the drill and vice versa to transfer higher flow through the drill, it is necessary to increase the pressure at the inlet to the drill.

In cooling systems there is a limit to the pressure that can be generated in the system, as soon as the pressure of the liquid is higher than what the system defines a pressure discharge valve will open, and this will be reflected in a limitation of the flow rate. The aim is to supply liquid with maximum flow and for this purpose it is necessary that the pressure in the system will not exceed the upper limit defined in the cooling system.

The larger the diameter of the drill, the greater the flow can be provided for the same inlet pressure due to wider coolant channels, and this can be seen in the diagram below:



$Dc_1 > Dc_2 > Dc_3$ hence $k_3 > k_2 > k_1$

Where:

Q = Volumetric flow rate

P = Pressure

Dc = Drill diameter

k = Hydraulic resistance of each tool

Pressure Ranges

Up to 20 bar – Low pressure (LP)

20 - 70 bar – Medium pressure (MP)

70 – 200 bar – High pressure (HP)

Above 200 bar – Ultra high pressure (UHP)

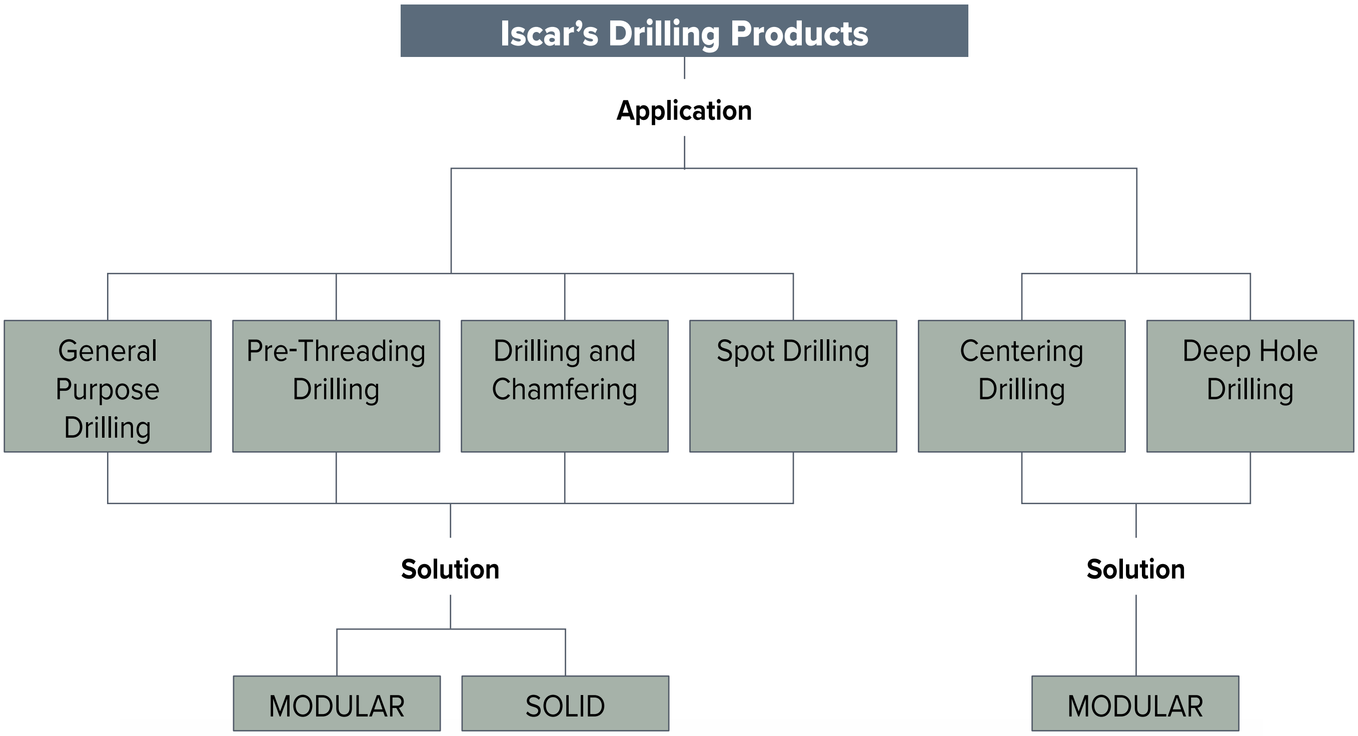
ISCAR Knows How To Adapt Its Tools To All Possibsle Types Of coolant

ISCAR Drilling Products

ISCAR offers a wide range of drilling tools for most industries and applications, such as: general-use drill, central drill, spot drill, pre-threading drill, deep drill, stepped drill.

ISCAR drilling products to produce different hole shapes on various surfaces.

Whatever the method of processing, **ISCAR** will identify a suitable tool according to the hole requirements.



ISCAR's Drilling Lines Depend on the Type of Operation

General Purpose Drilling

- MODULAR
  - Exchangeable Head Drills
    - QUICK-3-CHAM
    - SUMO-CHAM
    - SUMO-L-DRILL
    - SUMO-GUN
    - SPADE-CHAM
    - CHAM-DRILL
  - Indexable Insert Drills
    - DR-TWIST
    - MULTI-FUNCTION TOOLS
  - Combo Drills, Exchangeable Head and Indexable Insert Drills
    - COMBI-CHAM
  - Modular Exchangeable Drilling Heads
    - MODU-DRILL
- SOLID
  - SOLID-DRILL

Pre-Threading Drilling | **Drilling and Chamfering**

- MODULAR
  - Combo Drills, Exchangeable Head and Indexable Insert Drills
    - Pre-Thread
    - CHAM-DRILL
    - CHAMRING
- SOLID
  - SOLID-DRILL

Spot Drilling

- MODULAR
  - Interchangeable Drilling Heads
    - MULTI-MASTER
- SOLID
  - SOLIDMILL

Centering Drilling

- Modular
  - Interchangeable Drilling Heads
    - MULTI-MASTER

Deep Hole Drilling

- Modular
  - Single and Double Tube System
    - Indexable Insert Drills
      - ISCAR-DEEP-DRILL
      - TRI-DEEP
      - FINE-BEAM
    - Brazed Tips Drilling Head
      - ISCAR-DEEP-DRILL
  - GUNDRILLS
    - Indexable Insert Drills
      - TRI-DEEP
    - Brazed Tip Drills
      - ISCAR-GUNDRILLS
    - SOLID-DRILLS
      - ISCAR-GUNDRILLS

Exchangeable Head Drills vs Solid Drills

Often, the question arises regarding which tool to choose for holemaking: a drill with exchangeable drilling heads or a solid drill, especially when it comes to small diameter holes. The answer to this question is not always the same, and each case should be considered individually. Each type of drill has its own characteristics, advantages, and limitations. However, it is clear that a drill with exchangeable drilling heads can be a viable and competitive alternative to solid drills, as indicated by the following facts.

Multiple Geometries On One Body

A wide range of exchangeable drilling heads with different cutting geometries that can be assembled on one tool significantly improves the capabilities of the drill. This includes drilling in various surface types, such as flat surfaces, angular surfaces, convex surfaces, and concave surfaces, as well as whether there is a pre-hole or not. The availability of multiple exchangeable drilling head geometries allows for machining different hole types with a single tool, whether it be a straight hole, center hole, spot hole, or combined (stepped) hole. This flexibility ensures that a suitable geometry can always be selected to drill the requested hole with one tool.

Multiple Grades On One Body

A wide range of grades together with the ability to mount different drill heads on the same tool, as well as their easy and quick change functionality, opens the possibility of drilling holes in various materials with one tool.

Sustainability

If the cutting edge is damaged or worn, it is not necessary to replace the whole tool, and only the exchangeable drill head needs to be replaced.

No Set-Up Time

There is no need for an additional adjustment after replacing the drilling head - no setup time – and an operator can change the drilling head without removing the shank from a machine tool spindle.

No Need for Regrinding

Using exchangeable drilling heads, there is possible to safely forget about tool regrinding; when the cutting edge wears out, the drilling head is quickly and most importantly easily replaced with a new one.

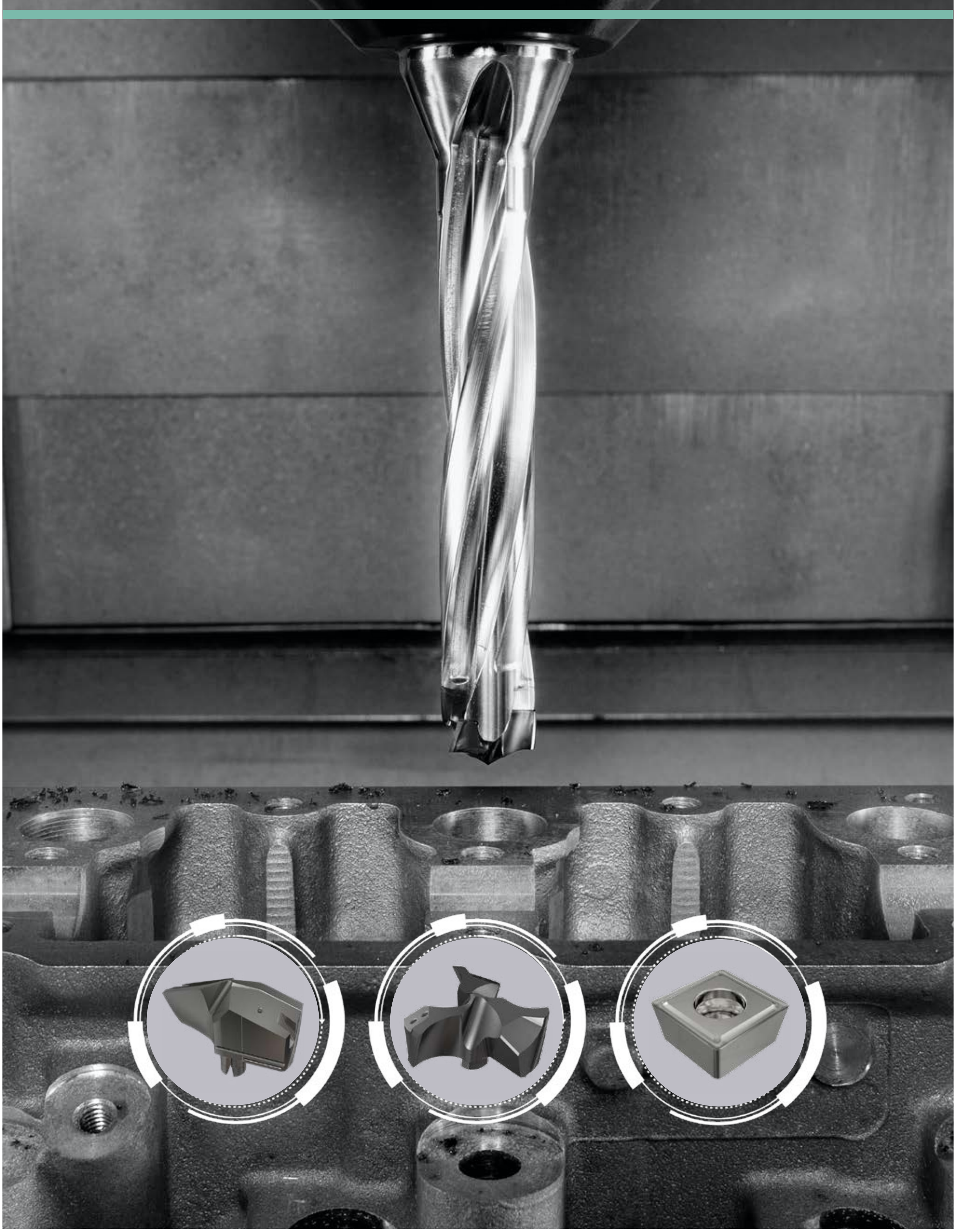
Stock Management

The modular concept of the drills makes it quick and easy to assemble the right tool from the available exchangeable drilling heads and shanks. Hence, customers don't have to order costly, specialized tools and wait months for delivery. If a drill is urgently needed for immediate production, a suitable solution is close at hand. Using exchangeable drilling heads can significantly reduce the amount of stock end users typically keep on hand, thereby reducing manufacturing costs.

Low Cost

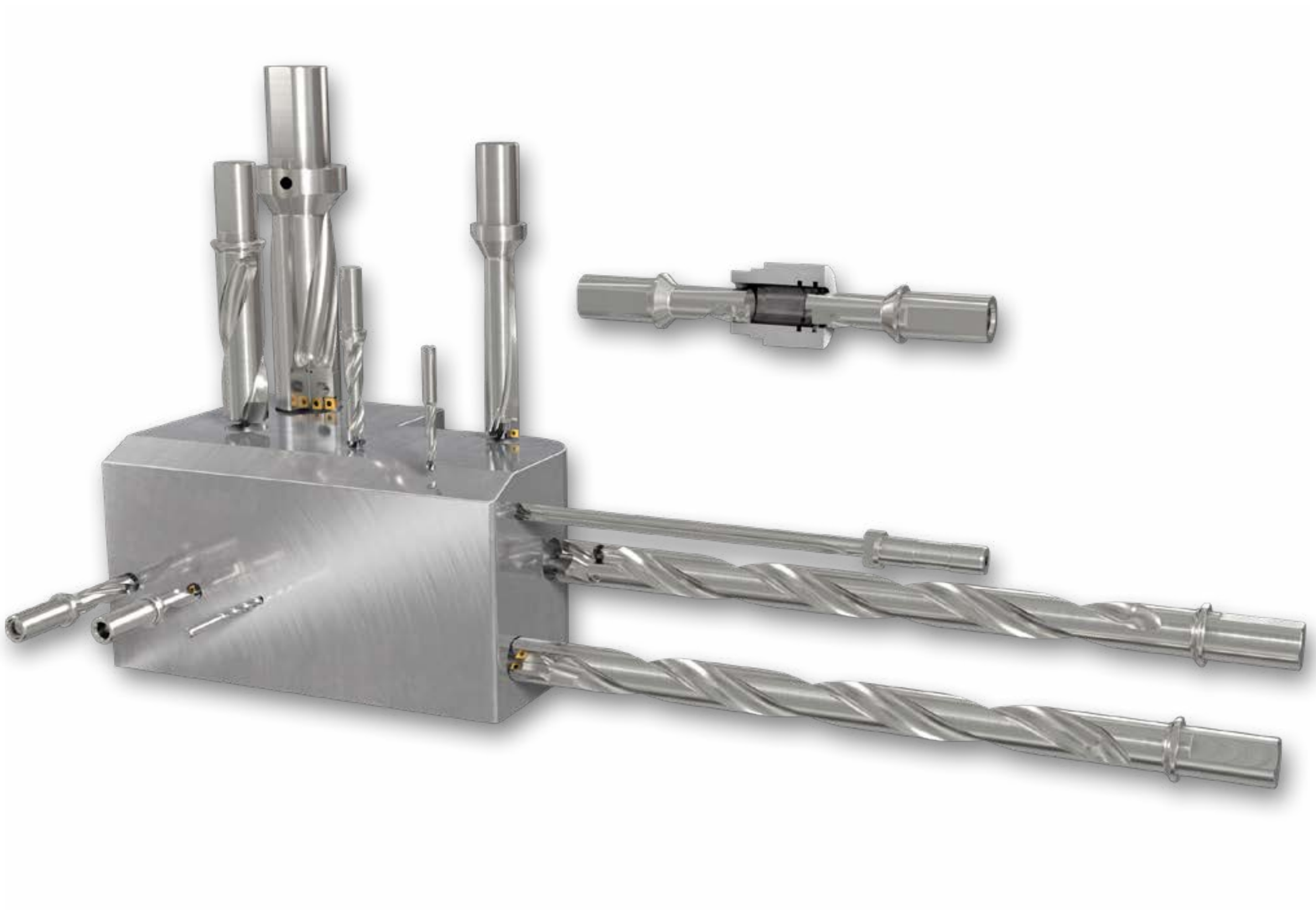
Using drilling heads can significantly reduce cost since the drilling heads are cheaper than a solid drill.

General Purpose Drilling



General purpose drills are the most common tool for machining holes.
The drills in this category are designed for drilling holes in various materials with different accuracy. Drills of these types are widely used in almost any industry whether for single production or mass production. Depending on the tasks in the production of work and materials that need to be machined, drills differ in their design and coating type.

ISCAR offers a wide range of drills with various diameters and lengths



ISCAR Product Families for General Purpose Drilling

ISCAR provides a full solution package for drilling a variety of applications

ISCAR's range of products for general-purpose drilling is categorized into two primary groups: modular tools and solid tools, each encompassing various families or lines of products.

The distinction between drilling tools and the selection of the appropriate one's hinges on a range of factors, including hole size, hole type, precision prerequisites, surface finish demands, and more. These variables play a critical role in determining the most suitable tools for your specific drilling needs.

General Purpose Drilling

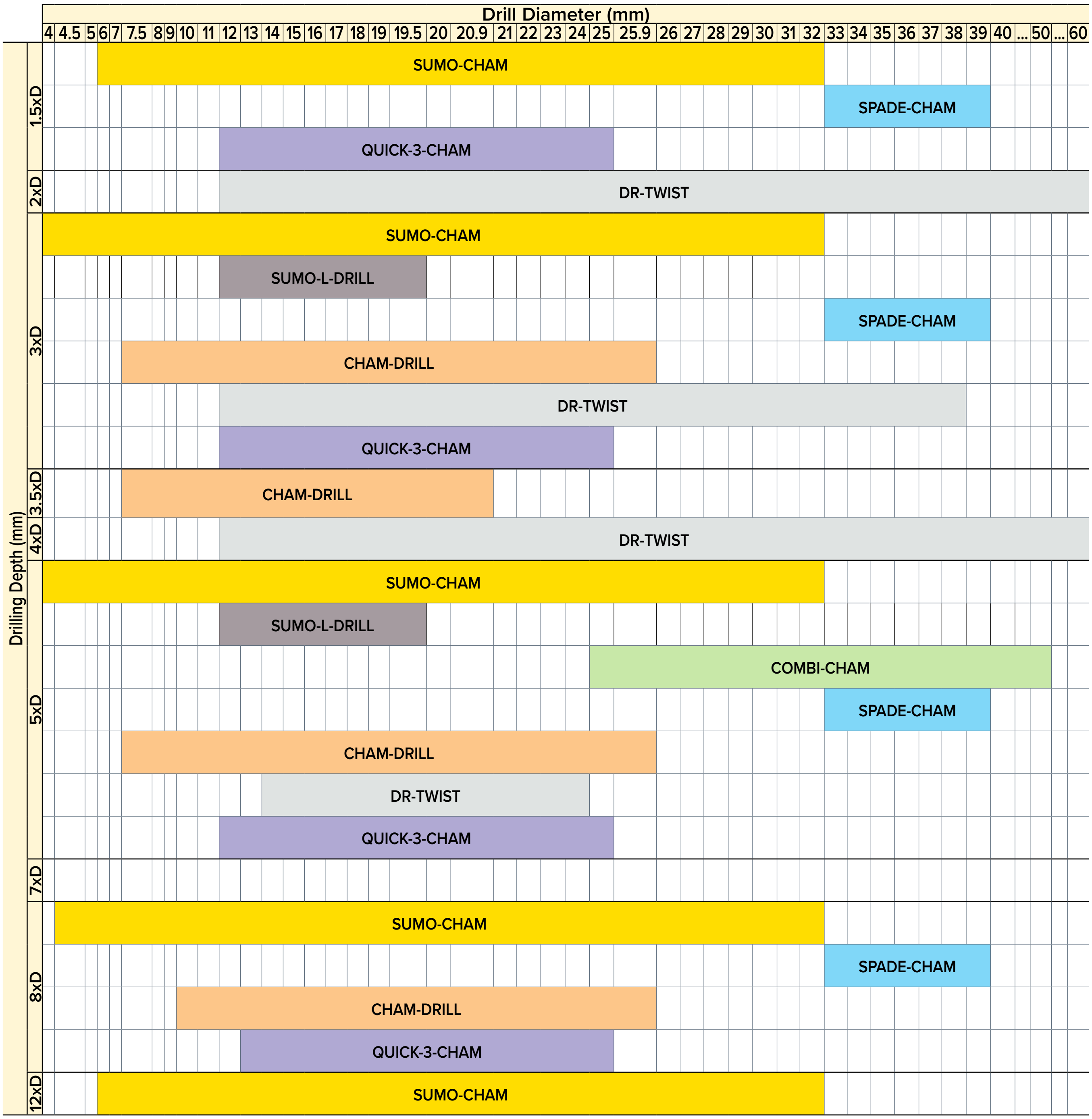
- MODULAR
  - Exchangeable Head Drills
    - SUMO-CHAM
    - SPADE-CHAM
    - CHAM-DRILL
    - QUICK-3-CHAM
    - SUMO-GUN
  - Indexable Insert Drills
    - DR-TWIST
    - MULTI-FUNCTION TOOLS
  - Combo Drills, Exchangeable Head and Indexable Insert Drills
    - COMBI-CHAM
  - Modular Exchangeable Drilling Heads
    - MODU-DRILL
- SOLID
  - SOLID-DRILL

ISCAR Drill Lines Range for General Purpose Drilling

One of the main criteria for holemaking tool selection is the is the relationship between the drill diameter and the possible drilling depth.

The tables shown below describe the working range of drills in each family and line for modular and solid **ISCAR** drill groups, offering valuable insights to assist in the tool selection process.

Modular Drills



Solid Drills

<table>
<tr><th></th><th></th><th colspan="23">Drill Diameter (mm)</th></tr>
<tr><th></th><th></th><th>0.8</th><th>1</th><th>2</th><th>2.9</th><th>3</th><th>4</th><th>5</th><th>5.1</th><th>6</th><th>7</th><th>8</th><th>8.4</th><th>9</th><th>9.6</th><th>9.8</th><th>10</th><th>10.5</th><th>12</th><th>12.1</th><th>14</th><th>16</th><th>18</th><th>20</th></tr>
<tr><th rowspan="20">Drilling Depth (mm)</th><th rowspan="3">3xD</th><td></td><td></td><td></td><td></td><td colspan="14">SCD-AP3N</td><td colspan="5">SCD-AP3</td></tr>
<tr><td></td><td></td><td></td><td></td><td colspan="14">SCD-ACP3N</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td colspan="13">SCCD-ACP3</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><th>4xD</th><td colspan="4">SCD-AP4</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><th rowspan="4">5xD</th><td></td><td></td><td></td><td></td><td colspan="14">SCD-AP5N</td><td colspan="5">SCD-AP5</td></tr>
<tr><td></td><td></td><td></td><td></td><td colspan="14">SCD-ACP5N</td><td colspan="5">SCD-ACP5</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td colspan="13">SCCD-ACP5</td><td></td><td></td><td></td><td></td><td></td></tr>
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<tr><th>6xD</th><td colspan="4">SCD-AP6</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><th rowspan="3">8xD</th><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="3">SCD-ACCG8</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="7">SCD-ACP8</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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<tr><th rowspan="2">20xD</th><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="10">SCD-ACP20</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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<tr><th>30xD</th><td></td><td></td><td></td><td></td><td colspan="12">SCD-SXC30</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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<tr><th>50xD</th><td></td><td></td><td></td><td></td><td></td><td colspan="4">SCD-SXC50</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

Solid Drills for Composite Materials

<table>
<tr><th></th><th></th><th colspan="7">Drill Diameter (mm)</th></tr>
<tr><th></th><th></th><th>3.3</th><th>4.19</th><th>4.85</th><th>6.37</th><th>7.94</th><th>10</th><th>12</th></tr>
<tr><th rowspan="10">Drilling Depth (mm)</th><th rowspan="2">25</th><td>SCD-FNPCD</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>SCD-CVD</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><th rowspan="3">28</th><td></td><td colspan="2">SCD-FNPCD</td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td colspan="2">SCD-WPCD</td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td colspan="2">SCD-CVD</td><td></td><td></td><td></td><td></td></tr>
<tr><th rowspan="3">32</th><td></td><td></td><td></td><td>SCD-FNPCD</td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td colspan="2">SCD-WPCD</td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td colspan="2">SCD-CVD</td><td></td><td></td></tr>
<tr><th>40</th><td></td><td></td><td></td><td></td><td></td><td>SCD-WPCD</td><td></td></tr>
<tr><th>45</th><td></td><td></td><td></td><td></td><td></td><td></td><td>SCD-WPCD</td></tr>
</table>

<table>
<tr><th></th><th></th><th colspan="11">Drill Diameter (mm)</th></tr>
<tr><th rowspan="6">Drilling Depth (mm)</th><th></th><th>10</th><th>13</th><th>14.9</th><th>15</th><th>20</th><th>25</th><th>25.9</th><th>30</th><th>33</th><th>35</th><th>40</th></tr>
<tr><th>200</th><td colspan="2">SUMO-GUN</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><th>250</th><td></td><td colspan="2">SUMO-GUN</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><th rowspan="2">400</th><td colspan="7">SUMO-GUN</td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="3">MODU-DRILL</td></tr>
<tr><th>600</th><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="3">MODU-DRILL</td></tr>
</table>

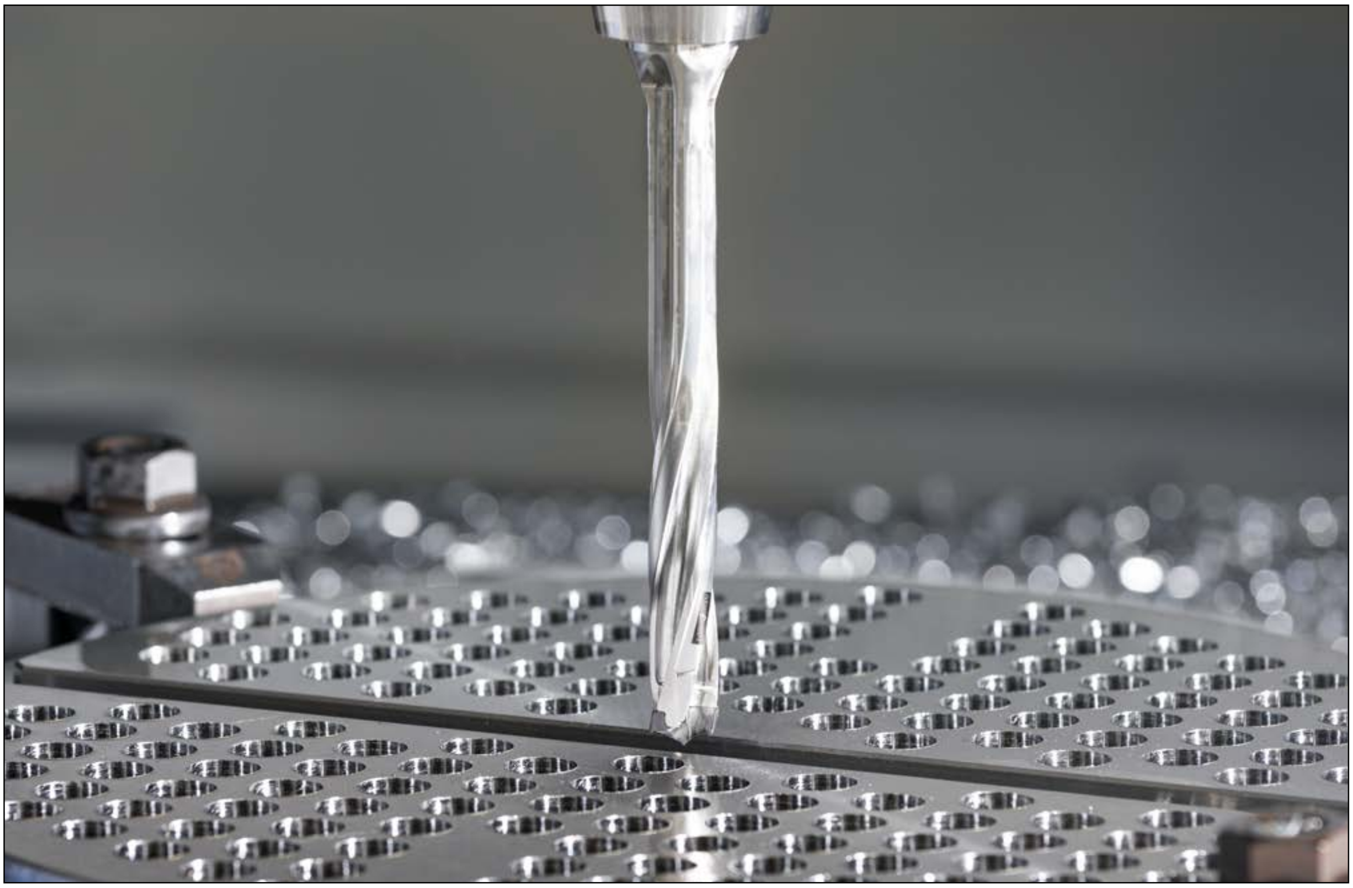
Exchangeable Head Drills

Modular drill systems have become an indispensable part of modern manufacturing. After all, increasing raw material prices, streamlining of warehouses, and consideration of life cycle costs are reason enough. Exchangeable drill heads are an exceptionally productive, precise, and an economical drilling solution.
A variety of head geometries and sizes can be accommodated in the same body, increasing flexibility and providing optimum performance in various materials and drilling applications. The fundamental structure of exchangeable head drills is elegantly simple, comprising two key components: the drill body and the exchangeable drill head.

The drill body is made of steel and all drill bodies are equipped with internal coolant channels designed to perform two main functions such as cooling the cutting zone and improving chip removal. The drill body can carry exchangeable drilling heads of various diameters and geometries. Exchangeable drilling heads are made of tungsten carbide. The diameter dimension is produced with k7 accuracy according to the ISO 286-2 standard.
All drilling heads are coated with an additional coating optimized for their intended use. The combination of all these factors results in a significant increase in cutting performance and tool life compared to conventional drilling tools.

The exchangeable drill head features a unique self-locking interface that interlocks between the drill head and shank body, enabling a simple and quick tool exchange. Operators can replace the drill head without having to remove the drill body from the adapter or re-measure tool offset values, thus saving time.
The drill head can be easily assembled while remaining on the machine.

QUICK-3-CHAM



The most advanced level of maximized productivity and cost efficiency come true in the **QUICK-3-CHAM** line, which includes three flute drills with exchangeable drilling heads and is designed to significantly increase productivity and reduce machining cycle time by up to 50% compared to conventional two-flute drills.

QUICK-3-CHAM applies its user-friendly drilling system for easy handling in accordance with the motto “no-setup time”.

QUICK-3-CHAM drills are available in the range of 12 to 25.9 millimeters (0.472 to 1.020 inch) diameters with 0.1 millimeter (0.004 inch) increments and are suitable for machining holes up to 8D deep.

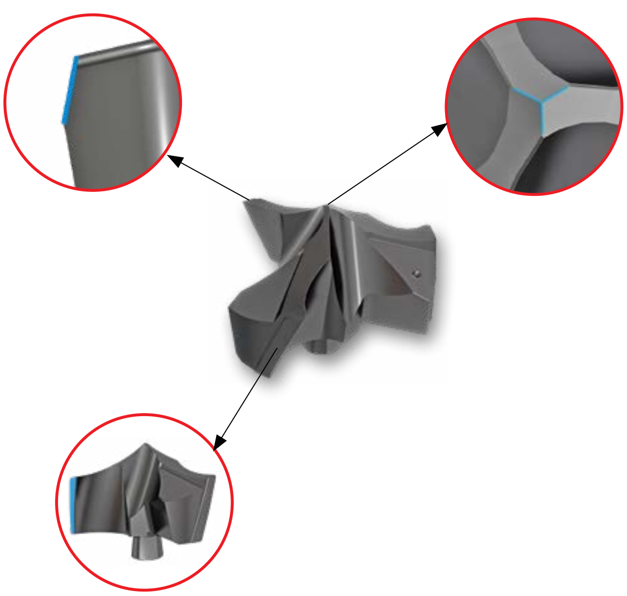
The **QUICK-3-CHAM** drill body designated D3N ... can carry 2 types of exchangeable drilling heads, H3P ... and F3P ..., while F3P ... drilling heads provide flat bottom holes.

Exchangeable Drilling Heads

The H3P ... and F3P ... exchangeable drilling heads are made of IC908 TiAlN PVD nano layer coating grade for prolonged and predictable tool life.

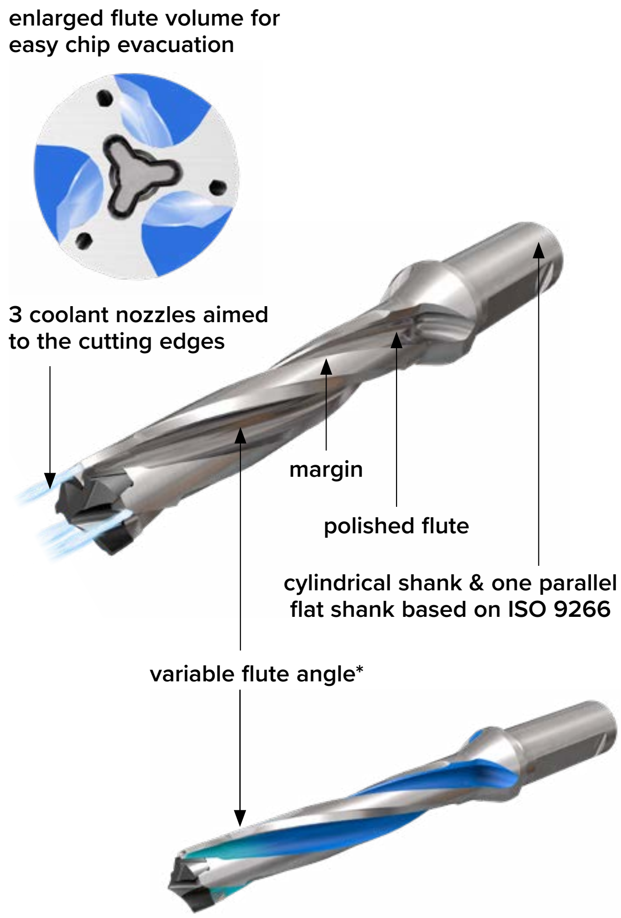
The geometry is suitable for machining both ISO P and ISO K materials - steel, ferritic and martensitic stainless steel, and cast iron. The **QUICK-3-CHAM** exchangeable drilling heads are designed with self-centering point geometry to guarantee drilling process stability, good centering, and smooth penetration into the material capabilities. The patented, durable, and precise chisel point combined with an appropriate gash angle successfully stands against a heavy cutting load. Patented concave cutting edges result in smooth and stable drilling together with a wavy edge shape that significantly contributes to generating optimal chip form and simplifying the chip evacuation process.

The corner chamfer improves wear resistance and strengthens the cutting edge.



Drill Body

The **QUICK-3-CHAM** drill body is based on a variable flute helix angle principle. This provides a durable body structure to resist high axial load and improve the dynamic rigidity of the body. The body is made from a high-grade steel tool with superior hardness for high wear resistance. A helical margin prevents chip adhesion between the body and the drilled hole. **QUICK-3-CHAM** tools are designed with internal coolant channels that supply efficient cooling and lubrication during the drilling process.



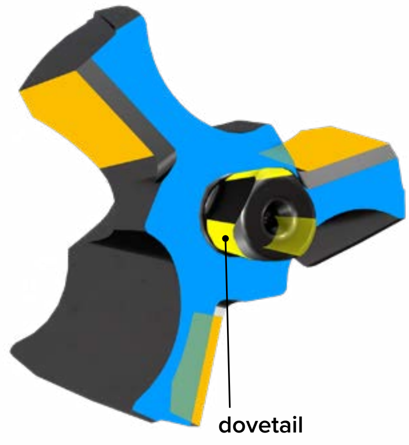
* optimized chip evacuation
* strengthens the tool
(especially during exit with high feed)

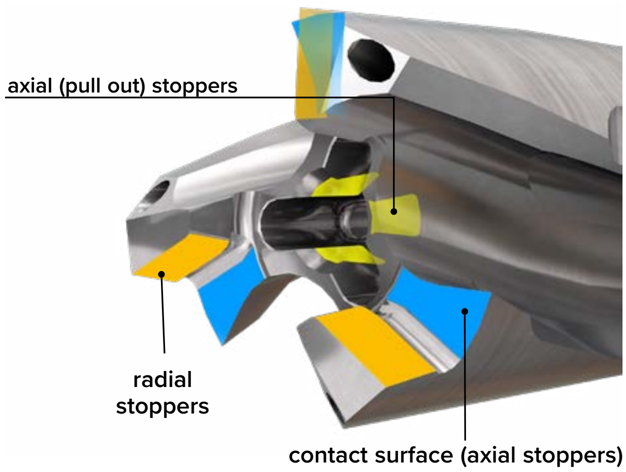
Clamping Pocket

The clamping pocket has a durable structure to avoid plastic deformation and ensures high numbers of drilling head indexing. Radial stoppers secure the drilling head and ensure a reliable drilling process in a high feed machining environment. The head pocket has a large face contact surface that spreads the pressure during machining. 3 conical contact surfaces clamp the head inside the pocket to provide a precise and stable drilling process. Dovetail clamping prevents the head from being extracted from its drill body pocket during retraction. A close structure pocket was designed to increase heat resistance, which prolongs pocket tool life even in difficult conditions.

QUICK-3-CHAM, three flute CHAM-DRILL intelligent design supports performance for high efficiency drilling

Patented Pocket Design





Explanation of QUICK-3-CHAM Drilling Heads Description

Example:

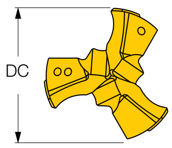
H3P	120	-	IQ	IC908
1	2			3

1 Designation of the Drilling Head

H3P — exchangeable 3 flute drilling head with concave cutting edges

F3P — exchangeable 3 flute drilling head with flat bottom holes

2 Cutting Diameter (DC)

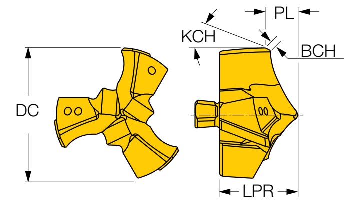


3 Grade

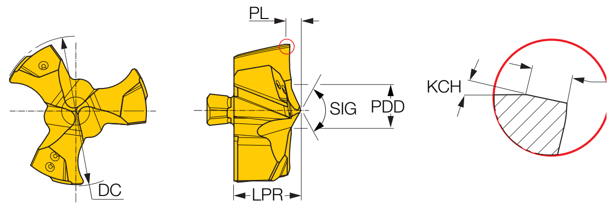
IC908

Basic Dimensions of QUICK-3-CHAM Drilling Heads

H3P ...



F3P ...



DC — cutting diameter

LPR — protruding length

PL — point length

BCH — corner chamfer length

KCH — corner chamfer angle

PDD — pilot drill diameter

SIG — point angle

Explanation of QUICK-3-CHAM Drilling Bodies Description

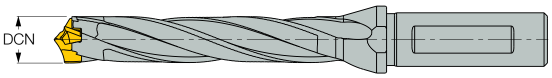
Example:

D3N	120 -	060	16	A	5D
1	2	3	4	5	6

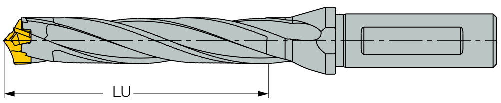
1 Designation of the Drilling Body

D3N — 3 flute drill body

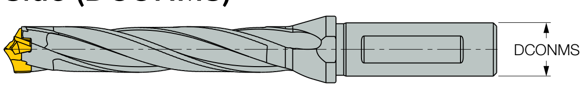
2 Cutting Diameter minimum (DCN)



3 Usable Length (LU)



4 Connection Diameter Machine Side (DCONMS)



5 Shank Type

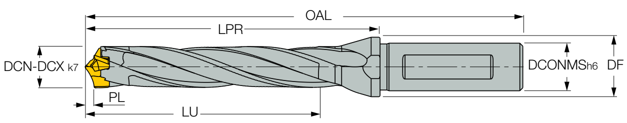
A—one flat shank

R—round shank

6 Drilling Depth

5D = 5 x cutting diameter

Basic Dimensions of QUICK-3-CHAM Drilling Bodies



DCN — cutting diameter minimum

DCX — cutting diameter maximum

DCONMS — connection diameter machine side

DF — flange diameter

LU — usable length

LPR — protruding length

PL — point length

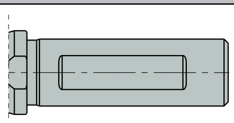
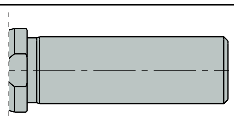
OAL — overall length

SUMO-CHAM

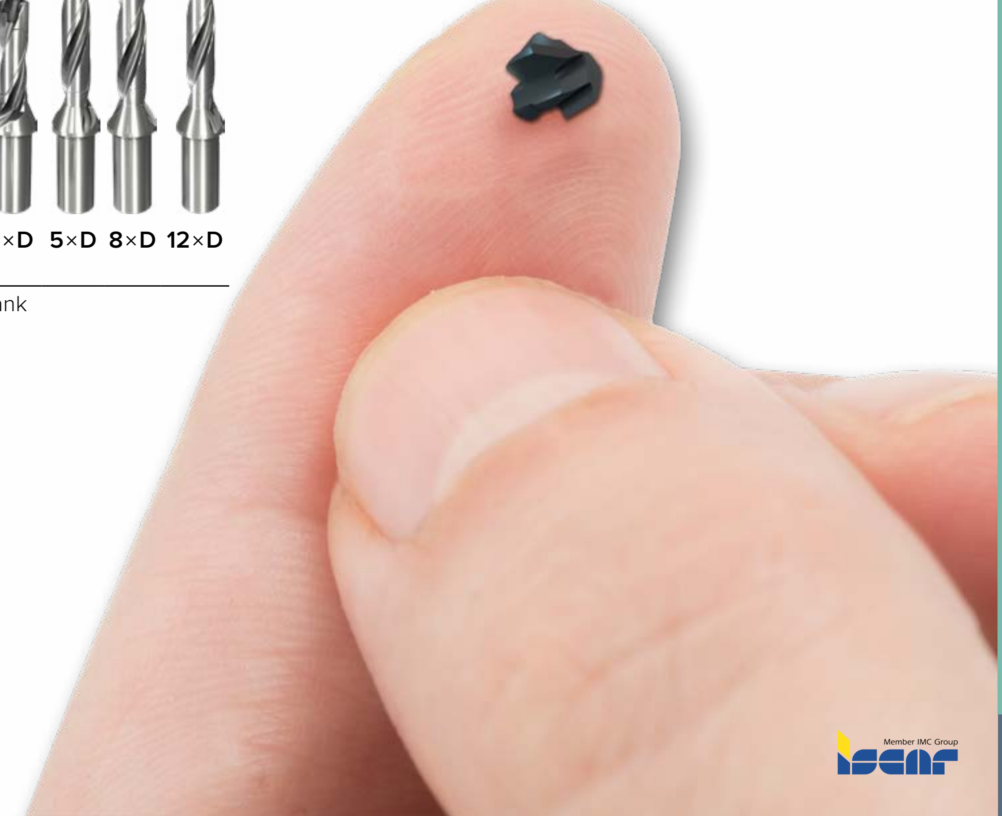
One of the leading drilling lines that undoubtedly deserves attention is the **SUMO-CHAM**.

These interchangeable drill heads are user-friendly, which means the **SUMO-CHAM** line ensures quick and easy replacement of an exchangeable drilling head with emphasis on **ISCAR**'s "no-setup time" principle. The line includes the smallest exchangeable drilling head in the market with a diameter of 4 mm (0.157 inches). These inserts are supplied with a specifically developed user-friendly key enabling easy mounting with no set-up time.

ISCAR SUMO-CHAM exchangeable drilling heads are available in a diameter range of 4 mm up to 32.9 mm (0.157 to 1.295 inch) diameters with 0.1 millimeter (0.004 inches) increments and are suitable for machining holes up to 12D deep.

Diameter Range Ø4-32 mm (0.157″-1.260″)	L/D Ratio
DCN...1.5D - Ø6-32 mm	
DCN...3D - Ø4-32 mm	
DCN...5D - Ø4-32 mm	
DCN...8D - Ø4.5-32 mm	
DCN...12D - Ø6-32 mm	
	
	

* Avaliable with cylidrical or one flat shank

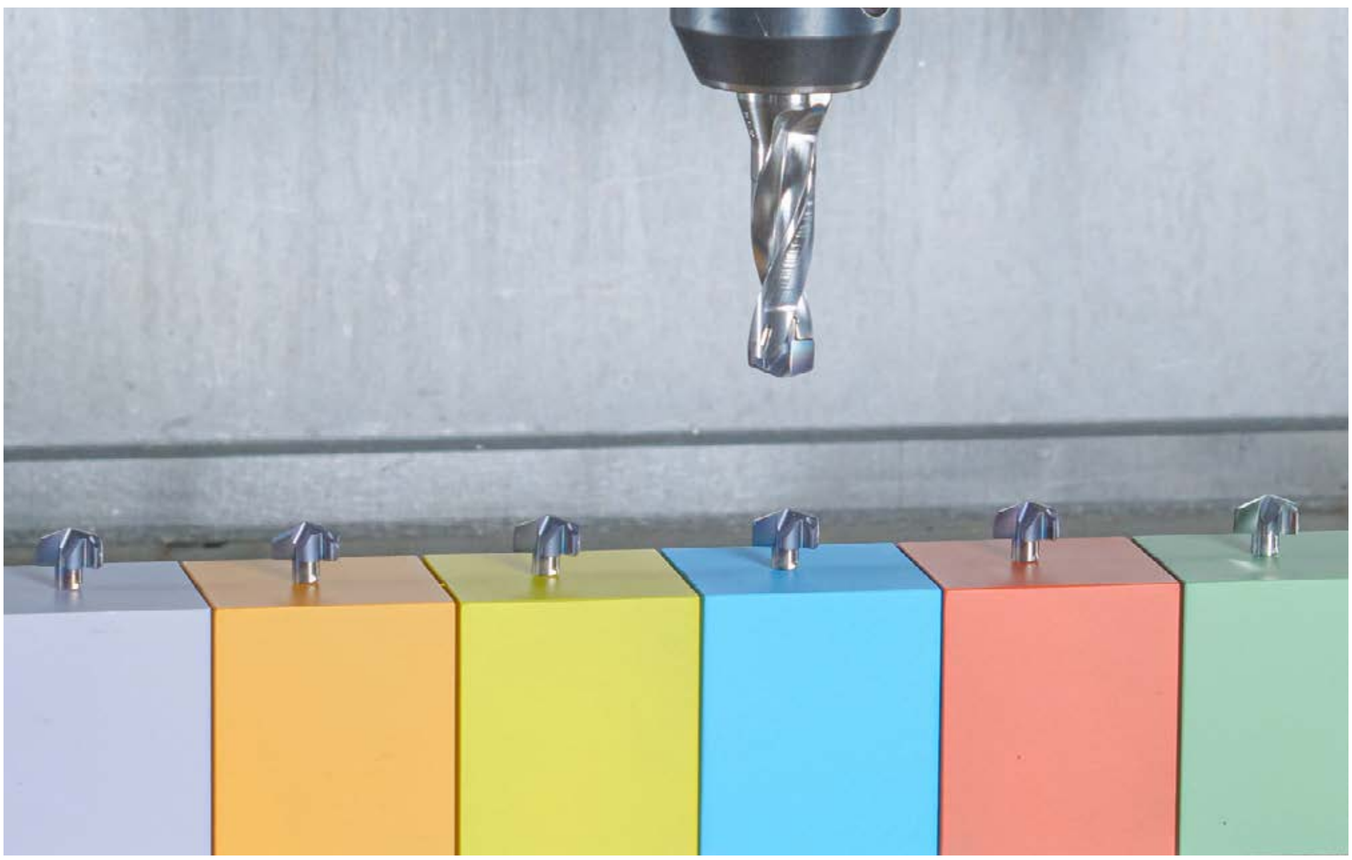


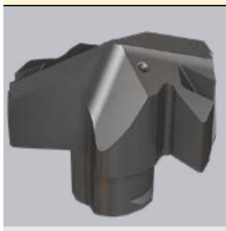
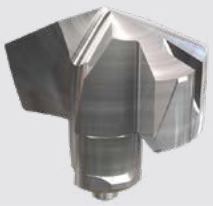
Exchangeable Drilling Heads

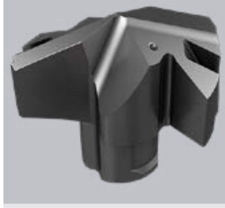
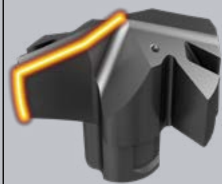
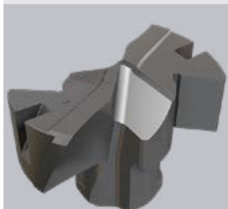
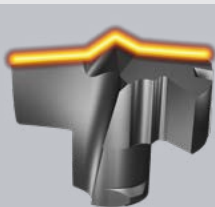
ISCAR SUMO-CHAM exchangeable drilling heads include 12 standard geometries that are suitable for the most popular and common material groups and applications commonly encountered in different industries.

These 12 standard geometries can be categorized into two main groups: standard geometries for general use and standard geometries dedicated for different applications.

All **SUMO-CHAM** exchangeable drilling heads designed with unique multifaceted chisel geometry provide self-centering ability. No pre-centering operation is needed for up to 5-times diameter tools.



Standard Geometries for General Use	
	**ICP geometry:** Designed for ISO P materials and ideally shaped for high productivity and excellent chip control in alloy steel.
	**ICP-2M geometry:** Designed for ISO P materials providing high surface finish results of up to 1.6 µm or 63 µin Ra, better hole cylindricity and straightness of up to 0.05 mm (0.002 inches) for 100 mm (3.937 inches) length.
	**ICK geometry:** Designed to machine ISO K materials at very high feed rates.
	**ICK-2M geometry:** Designed for ISO K materials providing high surface finish results of up to 1.6 µm or 63 µin Ra, better hole cylindricity and straightness of up to 0.05 mm (0.002 inch) for 100 mm (3.937 inch) length.
	**ICM geometry:** Designed to maximize productivity when machining austenitic stainless steel and other ISO M materials.
	**ICN geometry:** Designed with sharp edges and polished chip flutes for ISO N materials. The ICN drilling heads ensure hole tolerance of IT8-9.

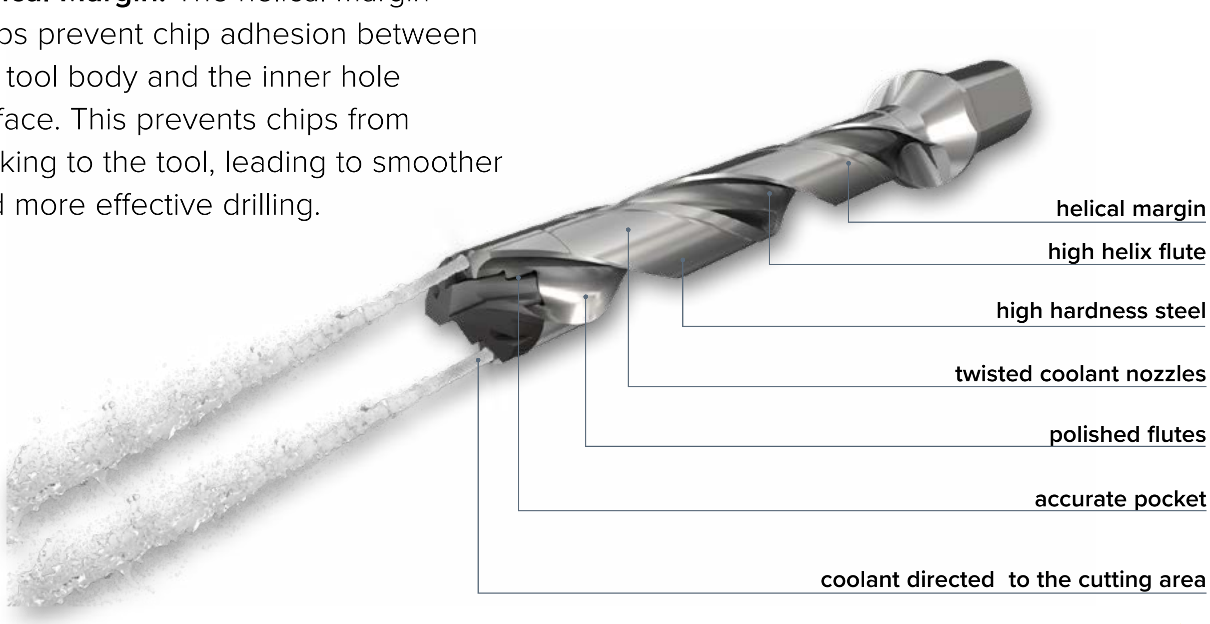
Standard Geometries Dedicated for Different Applications		
		**IHP geometry:** Specially designed for machining non-alloy / carbon steels. Dedicated edge preparation and honing size strengthens the cutting edge and extends tool life when working with non-alloy / carbon steels.
		**ICG geometry:** Designed with grooves on the cutting edge for breaking chips into small segments and unimpeded removal from the cutting area. ICG drilling heads ensure hole tolerance of IT9-10. The ICG geometry should be regarded as a general machining option and is mostly recommended for drilling austenitic stainless steel, titanium, titanium-based alloys, where it can solve chip evacuation problems in deep drilling applications.
		**FCP geometry:** Designed to provide a practical flat bottom hole, which is often required in various operations. The FCP **SUMO-CHAM** flat heads were designed for drilling steel and cast iron components (ISO P and ISO K material groups).
		**QCP-2M geometry:** Designed with a double margin which provides additional support for greater hole straightness and ensures a hole tolerance of IT8-IT9, used for drilling with high surface quality. Due to its self-centering capabilities, a pre hole is no longer needed. Much preferred for high depth drilling operations.
		**HCP geometry:** Special concave design (patent pending) provides smooth distribution of cutting forces when penetration to the material ensures best centering and smooth cutting process, thus eliminating the need for a pre-hole operation at depths of up to 12xD. HCP geometry is designed for machining steel and cast iron (ISO P and ISO K material groups).
		**IHP-BD geometry:** Designed for smooth and quiet drilling process for the beams industry. The sharp cutting corner helps to dedicated grade IC954 minimize the burr size for high deformation resistance when almost dry machining.

By offering both general-use and application-specific geometries, **ISCAR**'s **SUMO-CHAM** exchangeable drill heads provide flexibility and efficiency for a broad spectrum of drilling needs in various industries. Users can select the appropriate geometry based on the materials and applications they work with, optimizing their drilling processes and achieving better results.

Drill Body

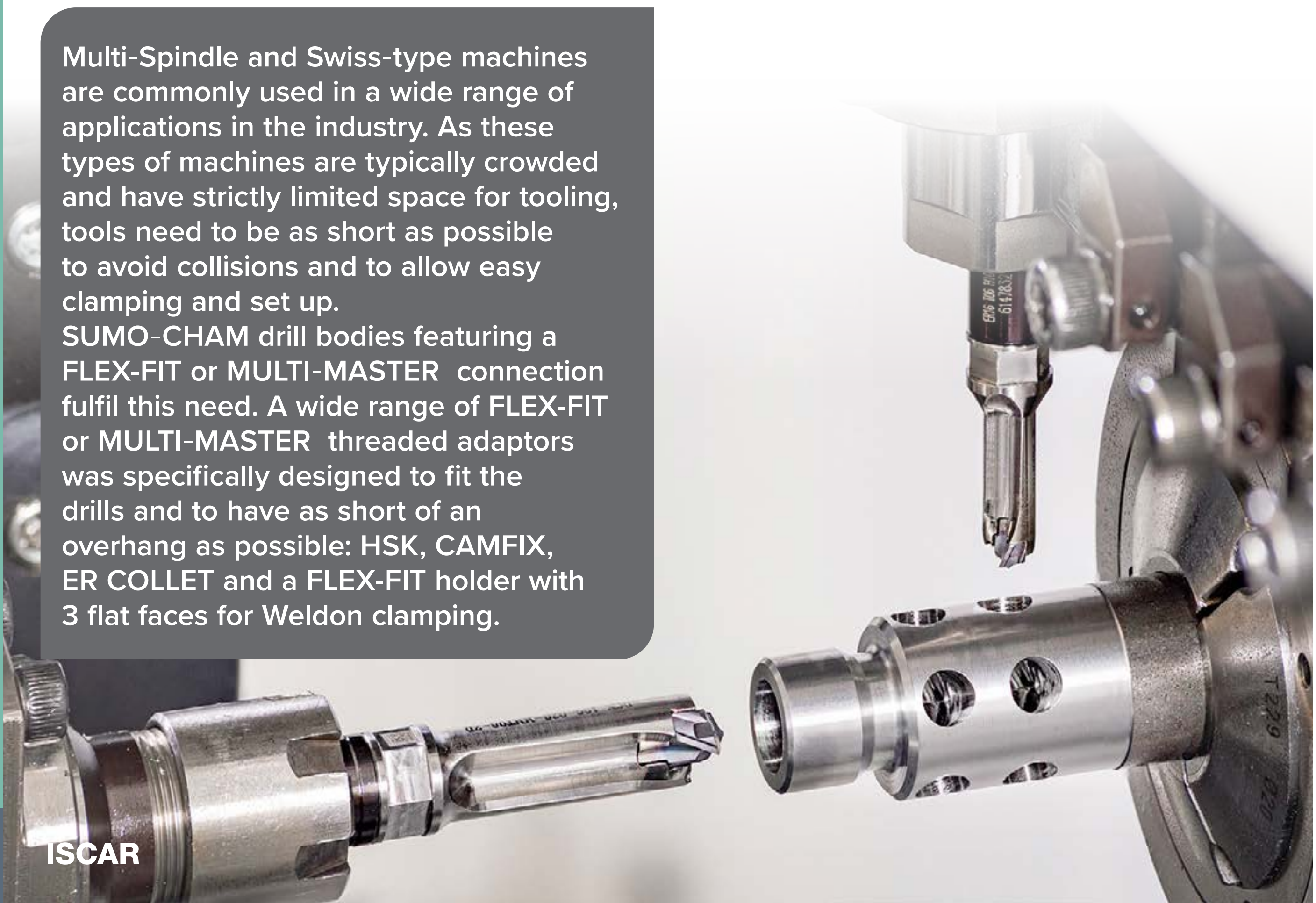
SUMO-CHAM drill bodies are engineered with various features aimed at optimizing hole machining operations. The key features of **SUMO-CHAM** drill bodies are:

- **Depth-to-Diameter Ratios: SUMO-CHAM** drill bodies are designed for machining holes with depth relation to diameter ratios such as: 1.5XD, 3XD, 5XD, 8XD and 12XD.
- **Twisted Coolant Channels:** The tools are embedded with the revolutionary technology of twisted coolant channels. This modified twisted coolant channel design features increased flute volume that greatly contributes to effective chip evacuation.
- **Helical Margin:** The helical margin helps prevent chip adhesion between the tool body and the inner hole surface. This prevents chips from sticking to the tool, leading to smoother and more effective drilling.
- **High Helix Flute:** The high helix flute design is focused on optimizing chip evacuation. It provides an angle that allows chips to be removed more efficiently during the drilling process, contributing to improved drilling performance.
- **High Hardness Steel:** The use of high-hardness steel in the construction of these drill bodies results in enhanced wear resistance. This means the tools are more durable and can withstand the rigors of machining operations.
- **Polished Flutes:** The polished flute surfaces ensure smooth and trouble-free chip evacuation.
- **Interchangeability: SUMO-CHAM** drill bodies offer interchangeability, allowing a single body to accommodate multiple-choice heads and a single head to be used with different bodies. This feature adds versatility to the tooling system, making it adaptable to specific machining requirements while being potentially cost-effective.



SUMO-CHAM drill bodies available with 4 types of shanks enable fast and easy tool change	
	**Plain Cylindrical Shank / Round shank (DIN 1835-A and DIN 6535-HA):** The shank is the most common and straightforward option for replacing existing solid and high-speed Steel (HSS) drills. The overall dimensions of the **SUMO-CHAM** drill body are almost identical to those of traditional drills, making them easy and fast to replace in collet chuck adapters.
	**One Flat Shank (ISO 9266):** This is a specific design that helps with stability and alignment in certain machining applications.
	**MM Type (MULTI-MASTER Connection): SUMO-CHAM** drill bodies with a **MULTI-MASTER** connection enables the use of a wide range of **MULTI-MASTER** standard shanks. High repeatability and fast change will reduce the set-up time.
	**FLEX-FIT type:** Precise and fast method of using **SUMO-CHAM** DCNM drill bodies on **FLEX-FIT** standard adapters. Fast replacement and repeatability are provided.

Multi-Spindle and Swiss-type machines are commonly used in a wide range of applications in the industry. As these types of machines are typically crowded and have strictly limited space for tooling, tools need to be as short as possible to avoid collisions and to allow easy clamping and set up.
SUMO-CHAM drill bodies featuring a FLEX-FIT or MULTI-MASTER connection fulfil this need. A wide range of FLEX-FIT or MULTI-MASTER threaded adaptors was specifically designed to fit the drills and to have as short of an overhang as possible: HSK, CAMFIX, ER COLLET and a FLEX-FIT holder with 3 flat faces for Weldon clamping.



Clamping Pocket

The **SUMO-CHAM** clamping pocket design appears to be a well-thought-out solution for improving the clamping process in drilling applications.

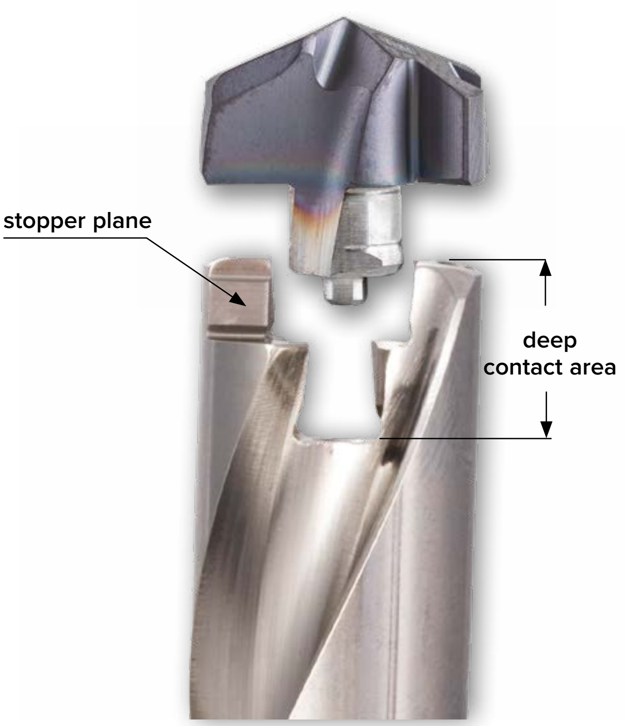
The key factors of the **SUMO-CHAM** clamping pocket are:

Deep contact area:
Provides a significantly high number of clamping indexes due to high precision and a deep contact area for insert mounting.

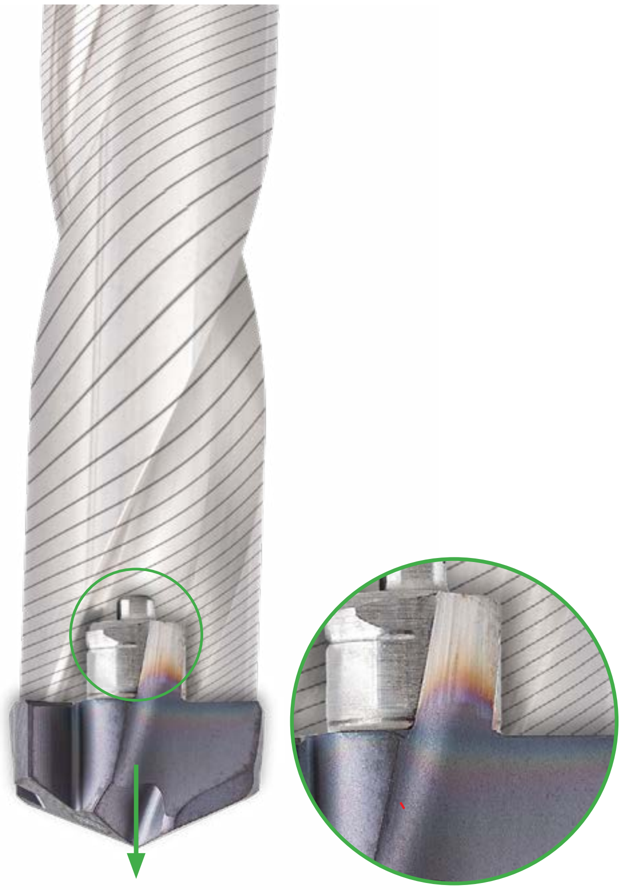
Clamping Rigidity: The design includes a precise cylinder area on the clamping part, which greatly increases rigidity.

Reduction of Internal Stress: The precise cylinder area not only enhances rigidity but also reduces internal stress. Lower internal stress contributes to the overall durability of the clamping pocket system, prolonging tool life.

Rotation Stopper Planes: The rotation stopper planes on the tool are precision made to provide control on the drilling head position and support, which results in better tool performance and tool life.



Axial Stopper: An axial stopper in the pocket prevents the insert from being pulled out during drilling. It is effective even after the clamping force has been lost (may happen when the drill's pocket wears out).



The **SUMO-CHAM** clamping pocket design offers a comprehensive set of features aimed at improving the precision, rigidity, and tool life in drilling applications. It focuses on both initial clamping and long-term retention of inserts, ensuring consistent and high-quality machining results.

Explanation of SUMO-CHAM Drilling Heads Description

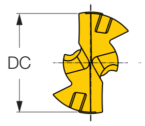
Example:

ICP	225	IC908
1	2	3

1 **Designation of the Drilling Head**

ICP — geometry of exchangeable drilling head

2 **Cutting Diameter (DC)**

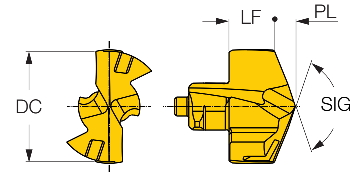


3 **Grade**

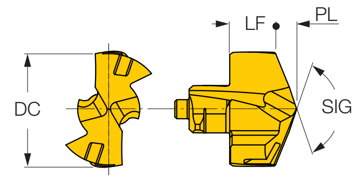
IC908

Basic Dimensions of SUMO-CHAM Drilling Heads

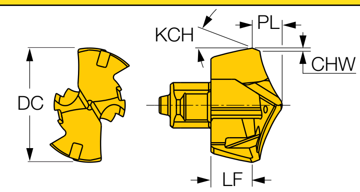
ICP ...



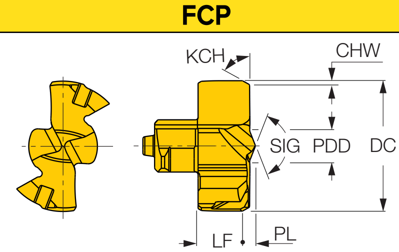
ICP-2M



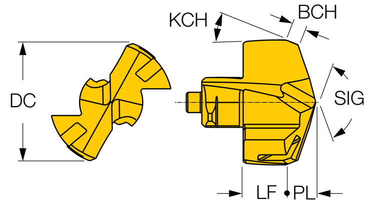
HCP ...



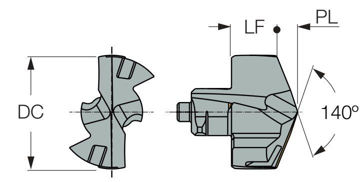
FCP



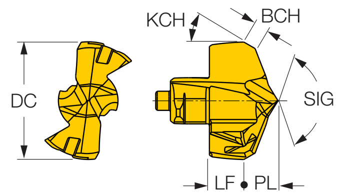
ICK



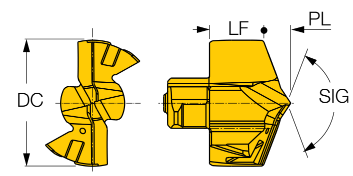
ICN



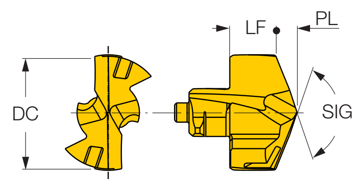
ICK-2M



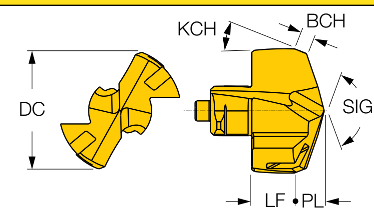
QCP



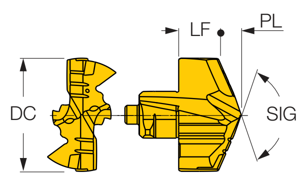
ICM



HCP



ICG



DC — cutting diameter
LF — functional length
PL — point length
BCH — corner chamfer length
KCH — corner chamfer angle
PDD — pilot drill diameter
CHW — corner chamfer width
SIG — point angle

Explanation of SUMO-CHAM Drilling Bodies Description

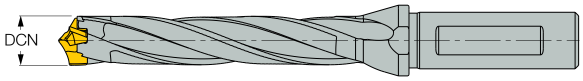
Example:

DCN	100	-	050	16	A	5D
1	2		3	4	5	6

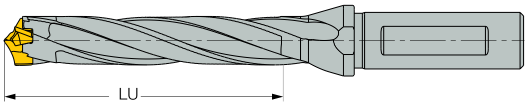
1 Designation of the Drilling Body

DCN — **SUMO-CHAM** drill body

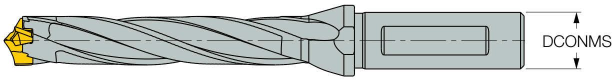
2 Cutting Diameter minimum (DCN)



3 Usable Length (LU)



4 Connection Diameter Machine Side (DCONMS)



5 Shank Type

A — one flat shank

R — round shank

C — round shank without flange

M — **FLEX-FIT** connection

6 Drilling Depth

5D = 5 x cutting diameter

Basic Dimensions of SUMO-CHAM Drilling Bodies

DCN — cutting diameter minimum

DCX — cutting diameter maximum

DCONMS — connection diameter machine side

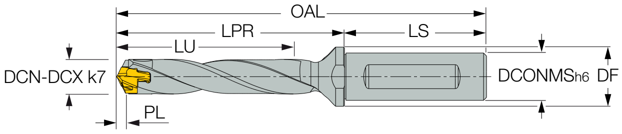
DF — flange diameter

LU — usable length

LPR — protruding length

PL — point length

OAL — overall length

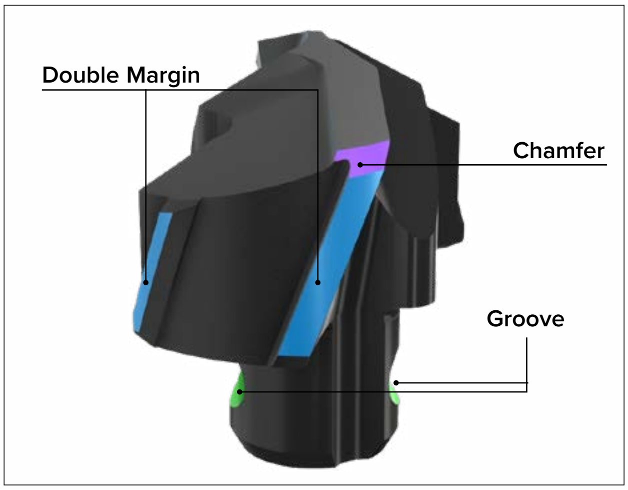


SUMO-L-DRILL

The **SUMO-L-DRILL** is a drill with a unique concept of a side screw locking mechanism designed to withstand unstable machining environments. It performs well in unstable applications, such as interrupted cuts and asymmetrical holes. Additionally, it is suitable for cross-holes, inclined penetrations, chamfers, and other types of interrupted cutting operations. The starting diameter range is 12 to 19.5mm or 0.472 to 0.768-inch diameters, with 0.5-millimeter or 0.02-inch increments. The **SUMO-L-DRILL** drills are available with machining depth-to-diameter ratios of 3xD and 5xD. The **SUMO-L-DRILL** can be easily mounted on machining centers, milling machines, and lathes.

Exchangeable Drilling Heads

The ILP ...-2M drilling head features optimized geometry specially designed to withstand unfavorable conditions. The exchangeable drilling heads are made of IC908 TiAIN PVD nano-layer-coated grade, ensuring prolonged and predictable tool life.



The drill head is designed with two special symmetrical grooves on the shank for easy mounting and to provide a tight contact when fixing the screw. This design minimizes head chattering in the pocket under unfavorable drilling conditions and increases the number of head replacements on a single tool body.

Double Sided Groove for Screw Lock

Double margin system provides additional support, which ensures high-quality holes with a diameter accuracy of IT8-IT9 even under unfavorable conditions.

Double Margin

Chamfered cutting corners guarantee reliable and prolonged tool life even in difficult machining applications.

Chamfer

Drill Body

The drill body is produced with internal coolant nozzles using advanced

3D printing technology.

The **SUMO-L-DRILL** drill body has a robust construction and is made from a high-grade tool steel with superior hardness for high wear resistance.

Clamping Pocket

The unique clamping mechanism enables convenient and fast head replacement without the need to remove the drill from the machine. The screw clamping is designed to withstand tough conditions and prevents the pull-out phenomenon.

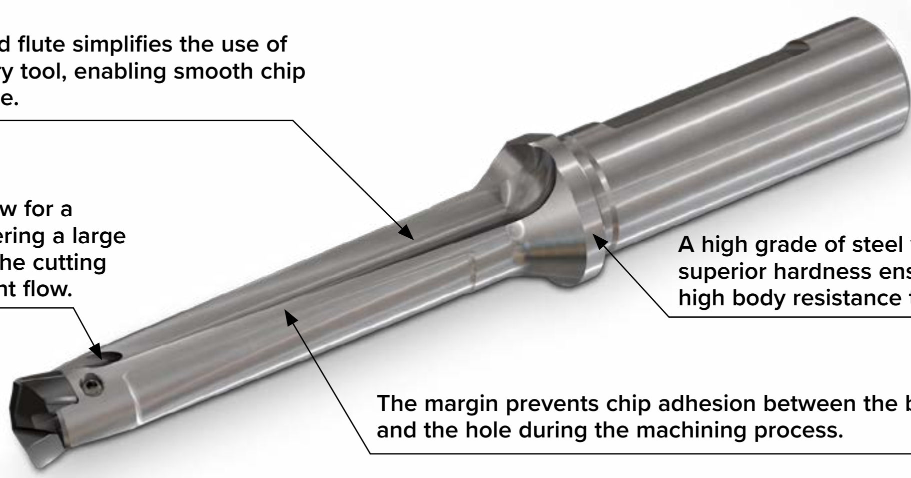
Additional Screw Support Avoids Retraction

The pocket has been designed with an extremely robust structure. The cutting forces are distributed from the insert to the tool through the axial and radial surfaces (marked in blue), ensuring that the screw itself is not affected.

This design allows for an exceptionally high number of head replacements on a single body, even when drilling under unfavorable conditions and maintains high performance and repeatability results.

The almost straight and polished flute simplifies the use of this tool on lathes as a stationary tool, enabling smooth chip evacuation from the cutting zone.

The double coolant nozzles allow for a rigid body structure while delivering a large volume of coolant directly into the cutting zone without interrupting coolant flow.



A high grade of steel with superior hardness ensures high body resistance to wear.

The margin prevents chip adhesion between the body and the hole during the machining process.

SUMO-L-DRILL Drilling Heads Description Legend

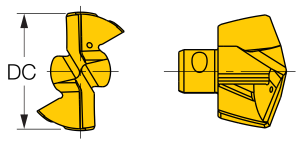
Example:

ILP	120	-	2M	IC908
1	2			3

1 Designation of the Drilling Head

ILP — exchangeable drilling head

2 Cutting Diameter (DC)

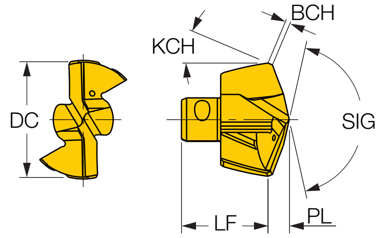


3 Grade

IC908

Basic Dimensions of QUICK-3-CHAM Drilling Heads

ICP ...-2M



DC — cutting diameter
LF — functional length
PL — point length
BCH — corner chamfer length
KCH — corner chamfer angle
SIG — point angle

SUMO-L-DRILL Drilling Bodies Description Legend

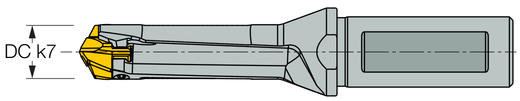
Example:

DLN	120	-	036	-	16	A	-	3D
1	2		3		4	5		6

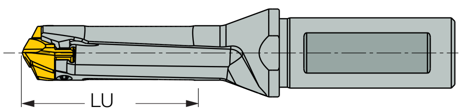
1 **Designation of the Drilling Body**

DLN — drill body with side screw locking mechanism

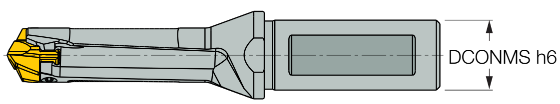
2 **Cutting Diameter Minimum (DCN)**



3 **Usable Length (LU)**



4 **Connection Diameter Machine Side (DCONMS)**



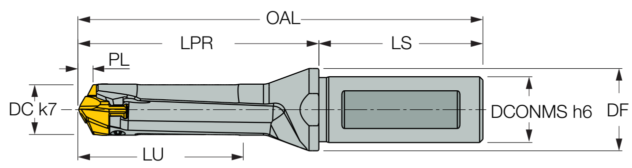
5 **Shank Type**

A — one flat shank

6 **Drilling Depth**

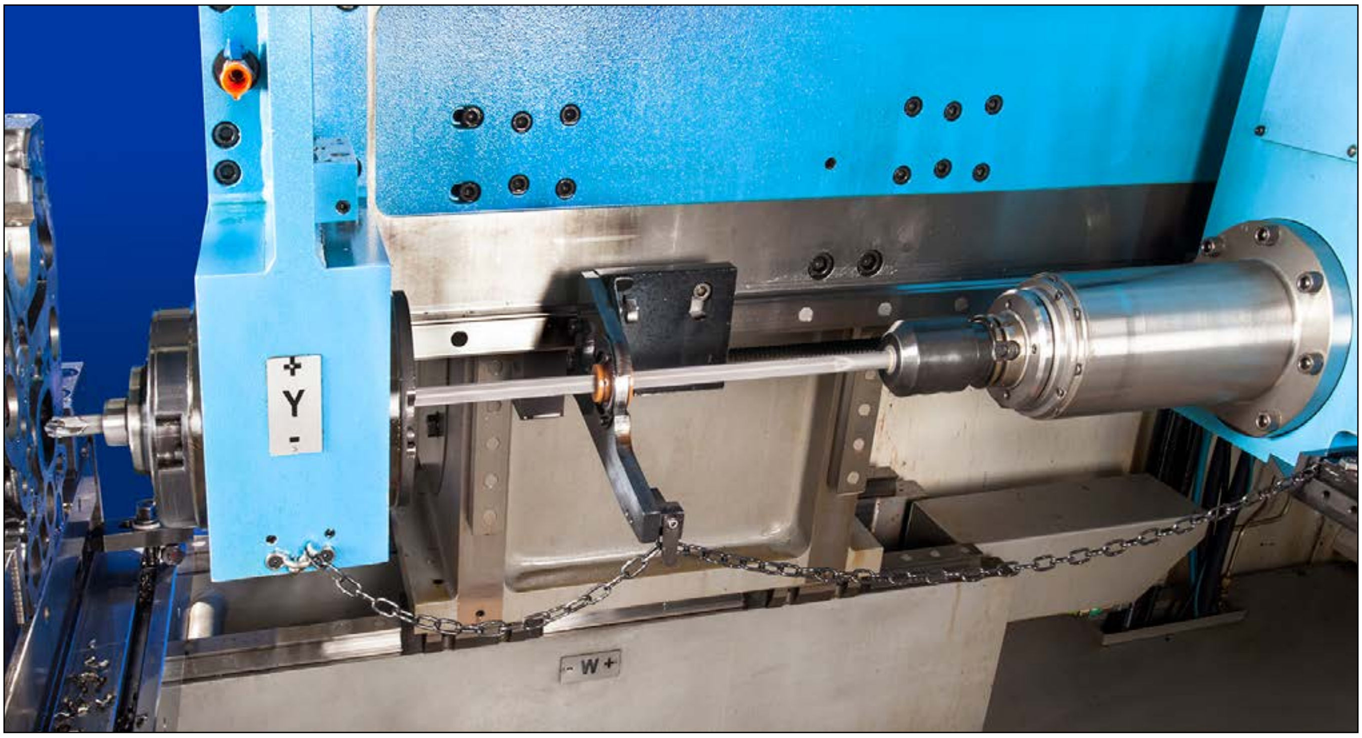
3D = 3 x cutting diameter

Basic Dimensions of SUMO-L-DRILL Drilling Bodies



DCN — minimum cutting diameter
DCX — maximum cutting diameter
DCONMS — machine side connection diameter
DF — flange diameter
LS — shank length
LU — usable length
LPR — protruding length
PL — point length
OAL — overall length

SUMO-GUN



The **ISCAR SUMO-GUN** line was developed for drilling deep holes in a diameter range of 10 to 25.9 mm (0.394 to 1.020 inches). The drill length is above 12XD with a maximum total length of 1000 mm (39.37 inches). **SUMO-GUN** enables replacement of the drilling head inside the machine – there is no need to remove the drill for head indexing.

A polyamide plastic key is available for clamping and removing the **SUMO-GUN** head. The **SUMO-GUN** features two straight flutes carrying the standard **SUMO-CHAM** drilling heads. **SUMO-CHAM** drilling heads are fully effective, which enables drilling at much higher table feed rates when compared to most other gundrills available in the market. One of the advantages of the **SUMO-GUN** line is its versatility. It allows end users to clamp different head geometries according to the specific material and application requirements.

This flexibility makes the **SUMO-GUN** suitable for a wide range of drilling tasks. **ISCAR SUMO-GUN** drills can be used on standard horizontal milling centers, lathes, multi-task machines and gundrill machines. This adaptability allows manufacturers to employ the **SUMO-GUN** line in different machining setups, enhancing their drilling capabilities.

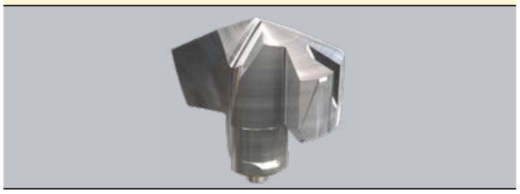
Exchangeable Drilling Heads

ISCAR SUMO-GUN drills can carry any **SUMO-CHAM** interchangeable head with 12 standard geometries (described in chapter 2.3.2) making them extensively used in the metal cutting industries, including aerospace, automotive, dies and molds, power generation, etc.

Standard Geometries for General Use

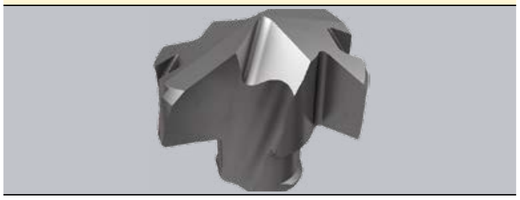
ICP

ICP-2M



ICK

ICK-2M

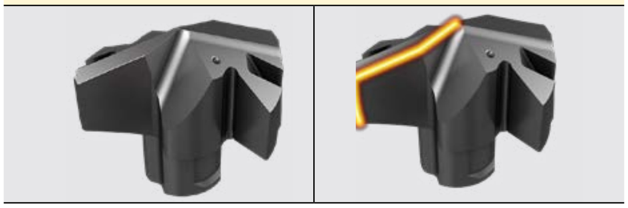


ICM

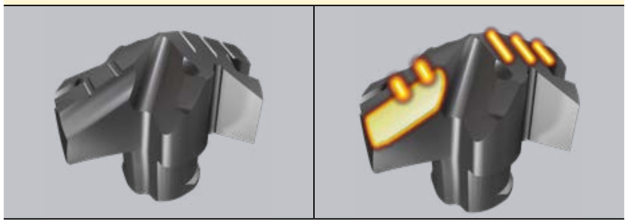
ICN

Standard Geometries Dedicated for Different Applications

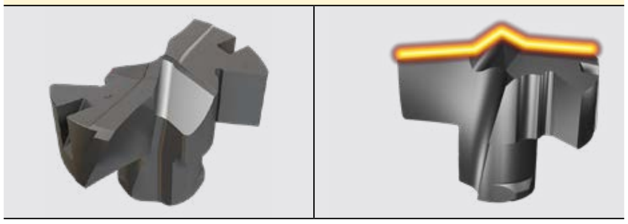
IHP



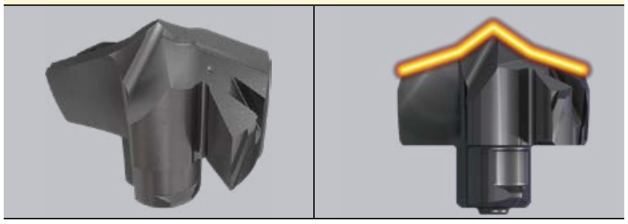
ICG



FCP

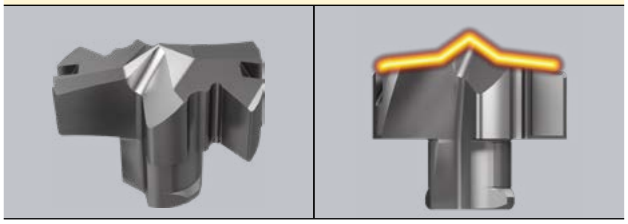


QCP-2M



HCP

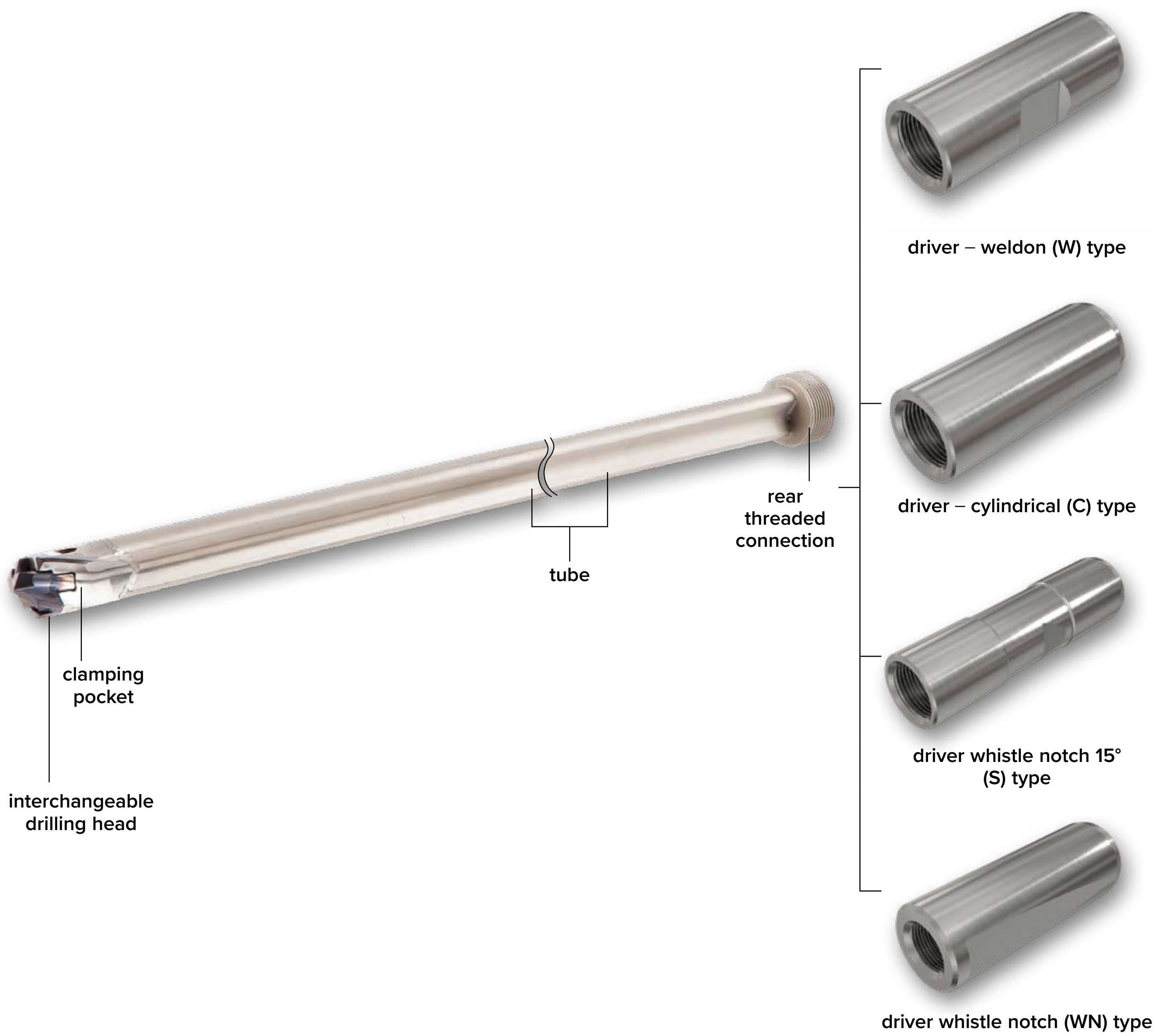
IHP-BD



Drill Body

The **SUMO-GUN** drill body has a modular structure consisting of a tube, clamping pocket, and driver. The drill body features an innovative unique insert clamping pocket that can undergo at least 25 head replacements. The connection between the clamping pocket and tube is done by an advanced welding process.

This welding method is chosen for its ability to provide high torque resistance, ensuring that the components remain securely connected during drilling, even under high stress conditions. The tube also features a rear threaded connection which enables attaching different standard driver types. The **SUMO-GUN** drill body is nickel coated for easy and uninterrupted chip flow and includes straight coolant channels.



Explanation of SUMO-GUN Drilling Tube Description

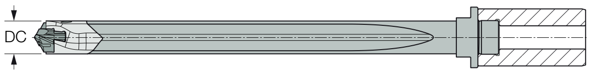
Example:

MNSNT	100	-	400	MF16X1
1	2		3	4

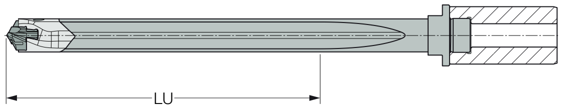
1 Designation of the Drilling Tube

MNSNT — **SUMO-GUN** drill tube

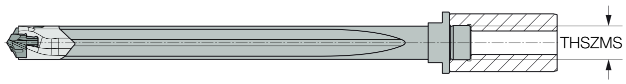
2 Minimum Cutting Diameter (DCN)



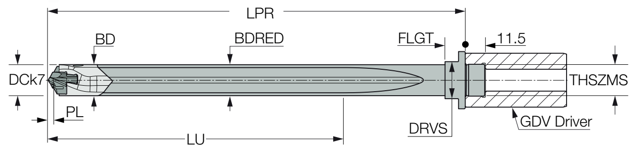
3 Usable Length (LU)



4 Connection Thread (THSZMS)



Basic Dimensions of SUMO-GUN Drilling Tube



DCN — minimum cutting diameter

DCXN — maximum cutting diameter

LU — usable length

PL — point length

THSZMS — connection thread

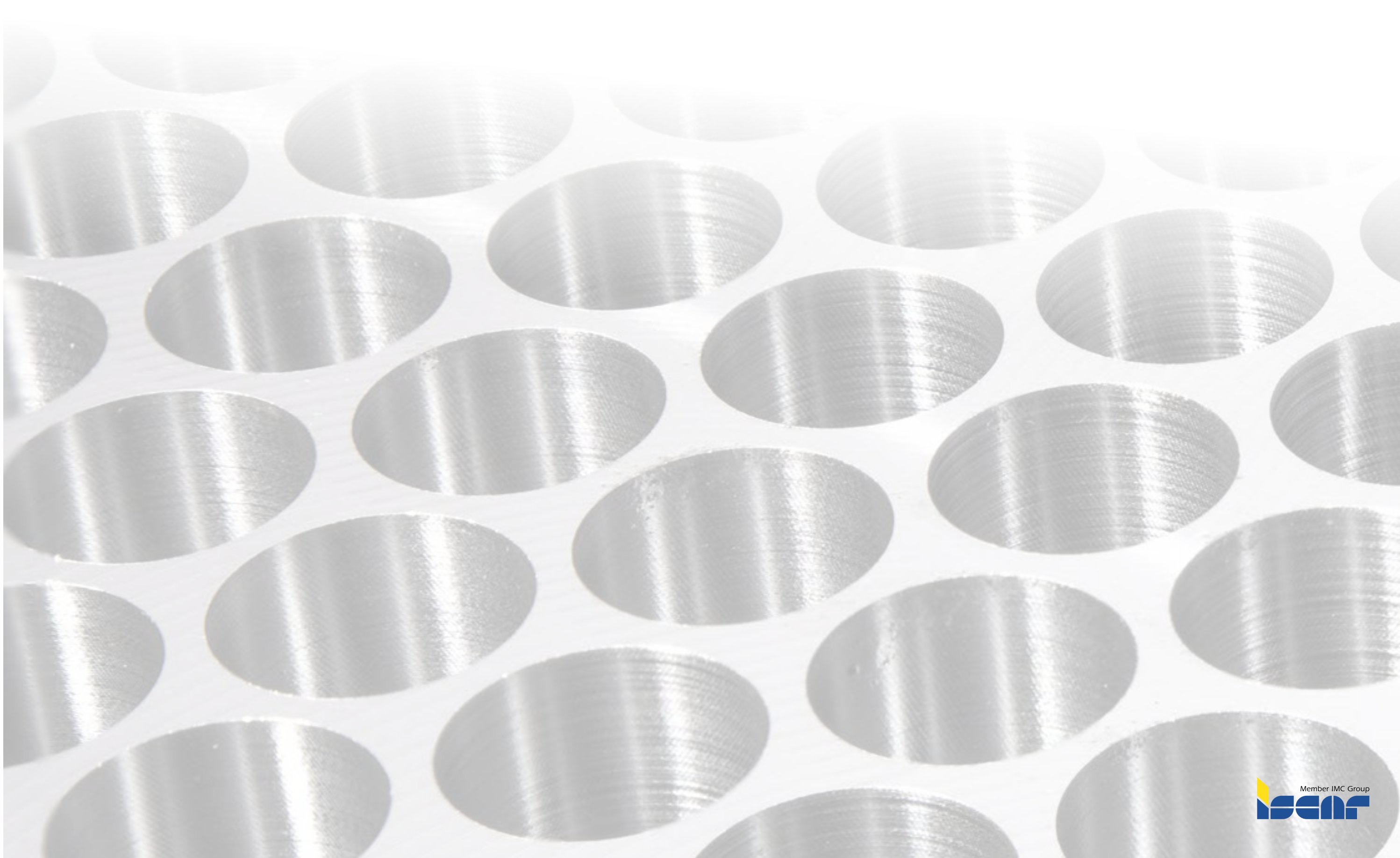
BD — body diameter

BDRED — body diameter reduced

LPR — protruding length

FLGT — flange thickness

DRVS — driver size



Explanation of the Driver for the SUMO-GUN Drilling Tube Description

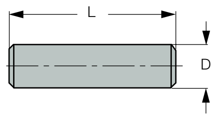
Example:

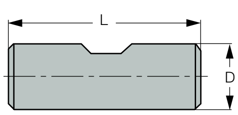
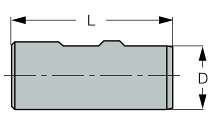
GDV	22	-	MF16X1	M	W	20
1	2		3	4	5	6

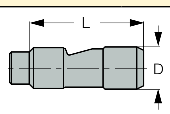
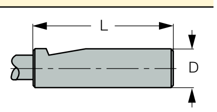
1 Designation of the Driver

GDV — driver for **SUMO-CHAM** drilling tube

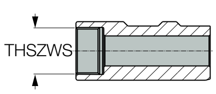
2 Driver Code

Driver Type	Weldon DIN1835B DIN6535HB				
Drawing					
øD x L	20x50	25x56	1.25x2.28"	32x60	40x70
Driver Code	10	11	97	12	13

Driver Type	Central Clamping Surface 15°				
Drawing					
øD x L	.75x2.03"	20x50	25x56	32x60	40x70
Driver Code	99	22	23	24	25

Driver Type	Frontal Clamping Surface 2°			
Drawing				
øD x L	.750x2.75"	25x70	1.00x2.75"	1.00x2.75"
Driver Code	56	57	58	80

3 Connection Thread (THSZMS)



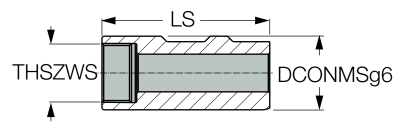
4 System of Measurement

M — metric system

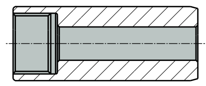
I — imperial system

5 Shank Type

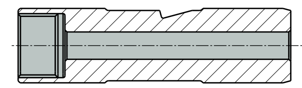
Weldon (W) Type



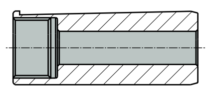
Cylindrical (C) Type



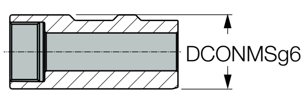
Whistle Notch 15° (S) Type



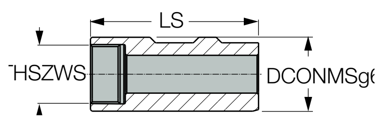
Whistle Notch (WN) Type



6 Connection Diameter Machine Side (DCONMS)



Basic Dimensions of the Driver for the SUMO-GUN Drilling Tube

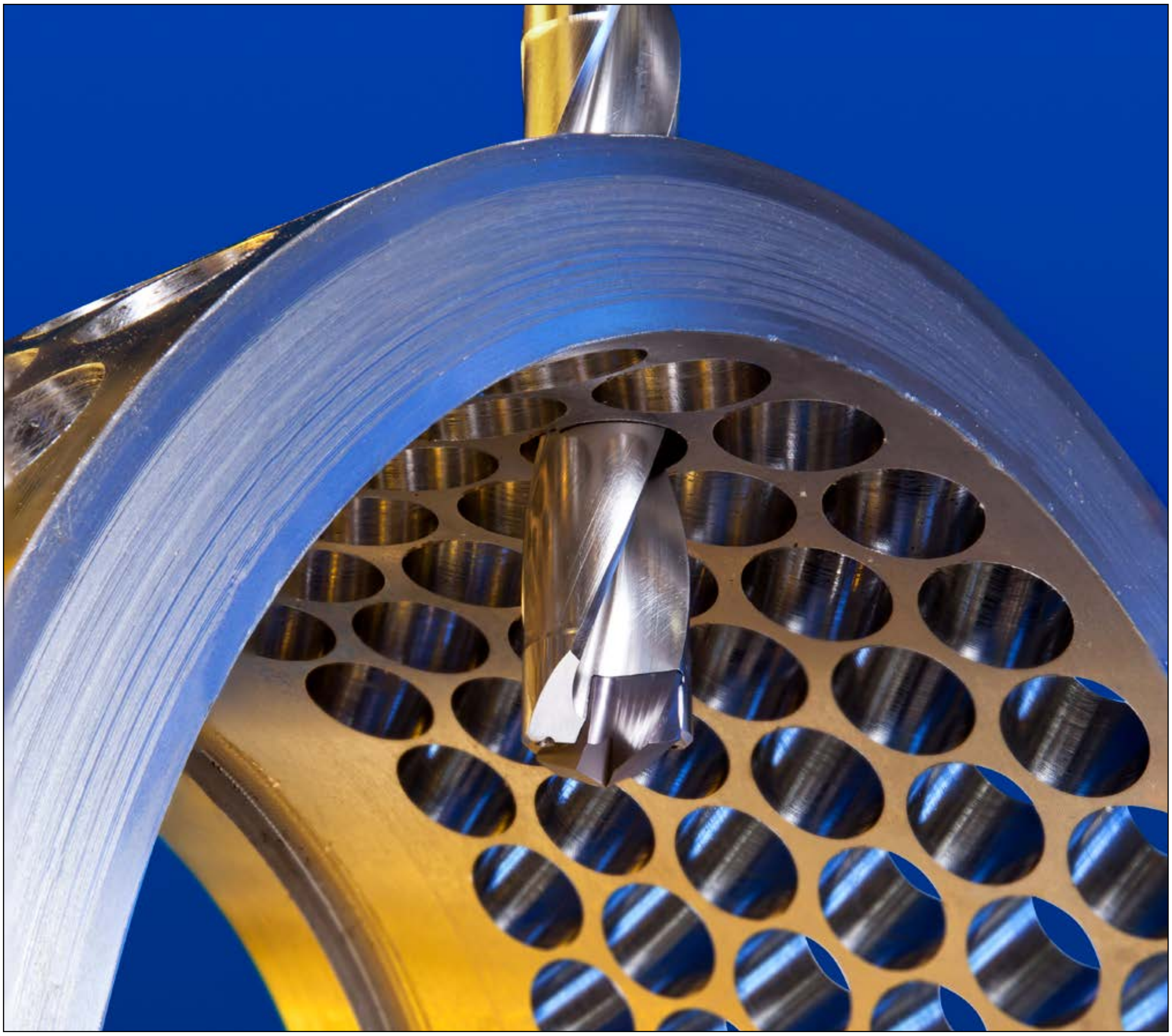


THSZWS — connection thread

DCONMS — connection diameter machine side

LS — shank length

SPADE-CHAM



The **ISCAR SPADE-CHAM** line includes large diameter drills carrying innovative indexable heads designed for machining holes with a diameter range of 33 to 40 mm (1.299 to 1.575 inches) in 0.5 mm (0.02 inch) increments and a 1.5, 3, 5, 8 drill length to diameter ratios.

The **SPADE-CHAM** features a unique design, utilizing carbide flexibility for self-locking, eliminating the need for clamping accessories.

The robust structure of the drill with the concave cutting edge design enables drilling at a high feed rate, providing very accurate IT8 – IT9 hole tolerance.

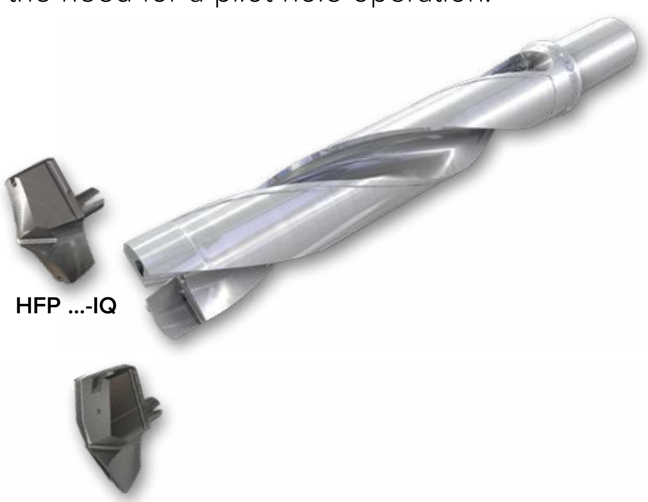
The **SPADE-CHAM** line is suitable for interrupted cuts, unique cutting-edge inserts that provide excellent performance and increased productivity when drilling on inclined and round surfaces.

The **SPADE-CHAM** drill body is designated DFN ...-IQ and can carry 2 types of exchangeable drilling heads, HFP ...-IQ and IFP ...-IQ.

Exchangeable Drilling Heads

HFP ...-IQ and IFP ...-IQ exchangeable drilling heads are made of IC908 TiAlN PVD nano layer coating grade for prolonged and predictable tool life. The cutting-edge geometry of **SPADE-CHAM** indexable heads provides a mechanically efficient cutting action, reducing power consumption and noise, and increasing material-removal rates.

The HFP ...-IQ drilling heads have a unique self-centering geometry that enables using up to 8xD long overhang without the need for a pilot hole operation, which is mainly intended for machining ISO P and ISO K materials. The IFP ...-IQ drilling head is designed for machining ISO P, ISO M and ISO S materials and enables using up to 5xD long overhang without the need for a pilot hole operation.

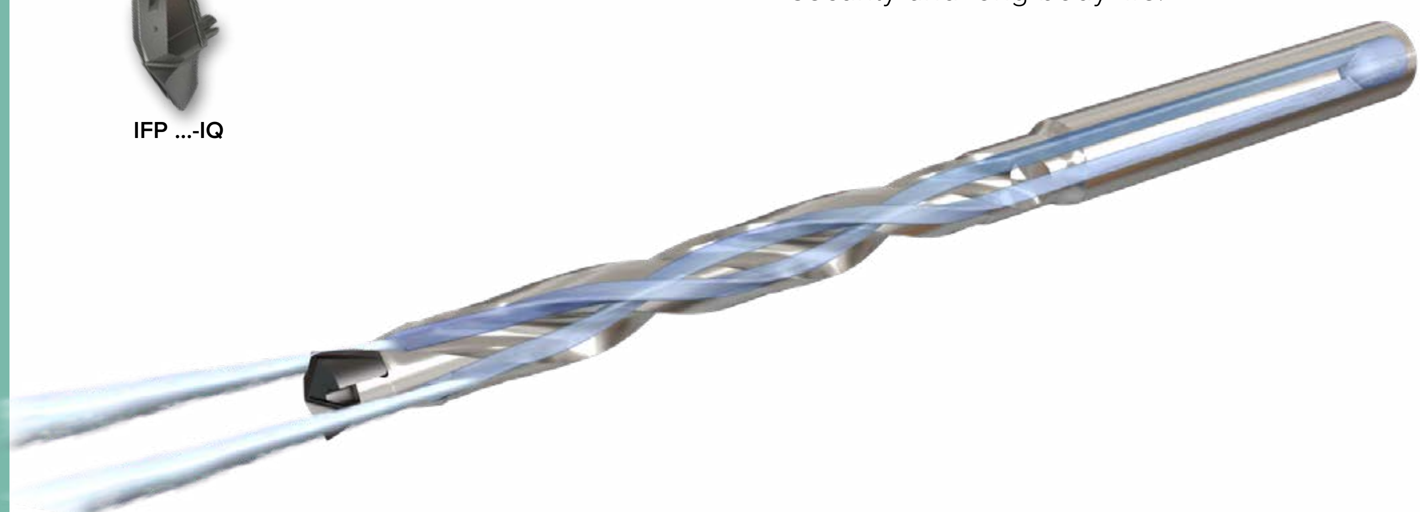


Drill Body

The design of the **SPADE-CHAM** body is made from special steel for high durability. High flute helix and polished flute surfaces provide a smooth and easy chip evacuation process. The internal coolant supply provides efficient cooling and lubrication during the drilling process.

Clamping Pocket

The **SPADE-CHAM** line employs an innovative insert positioning and locking mechanism that eliminates the need for clamps or screws commonly found on drills for larger diameters. This design allows for easy indexing on the machine to reduce setup. A special stopper prevents the drilling head from being extracted upwards from the pocket. Long stoppers provide high resistance to cutting forces, enabling applications under very high cutting conditions. The pocket design eliminates the need for an open or flexible construction, which may weaken the tool, thus enabling a high number of drilling head indexes on each tool. The **SPADE-CHAM** clamping mechanism ensures insert security and long body life.



Explanation of SPADE-CHAM Drilling Heads Description

Example:

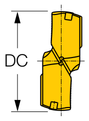
HFP	400	- SPADE IQ	IC908
1	2	3	4

1 Designation of the Drilling Head

HFP — exchangeable drill heads for ISO P and ISO K materials

IFP — exchangeable drill heads for machining ISO P, ISO M and ISO S materials

2 Cutting Diameter (DC)

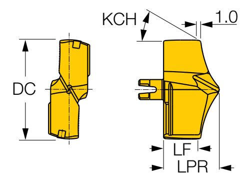


3 Grade

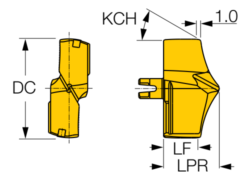
IC908

Basic Dimensions of SPADE-CHAM Drilling Heads

HFP ...-IQ



IFP ...-IQ



DC — cutting diameter

LPR — protruding length

LF — functional length

KCH — corner chamfer angle

SIG — point angle

Explanation of SPADE-CHAM Drilling Bodies Description

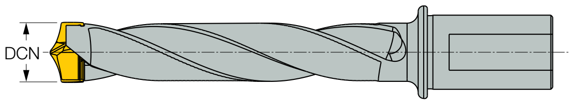
Example:

FDN	390	-	117	-	32	A	-	3D	-	IQ
1	2		3		4	5		6		

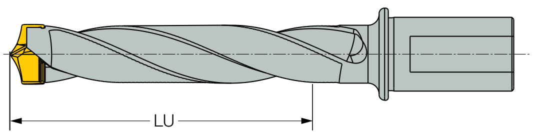
1 **Designation of the Drilling Body**

DFN — **SPADE-CHAM** drill body

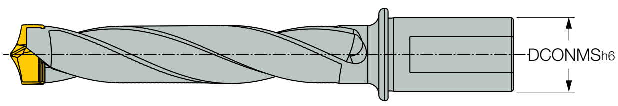
2 **Cutting Diameter minimum (DCN)**



3 **Usable Length (LU)**



4 **Connection Diameter Machine Side (DCONMS)**



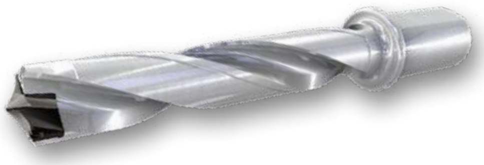
5 **Shank Type**

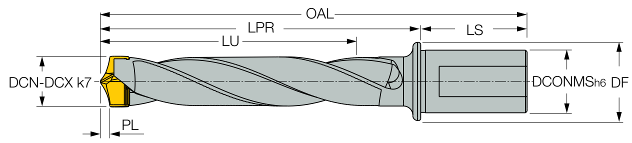
A — one flat shank

6 **Drilling Depth**

3D = 3 x cutting diameter

Basic Dimensions of the SPADE-CHAM Drilling Body





DCN — cutting diameter minimum

DCX — cutting diameter maximum

DCONMS — connection diameter machine side

DF — flange diameter

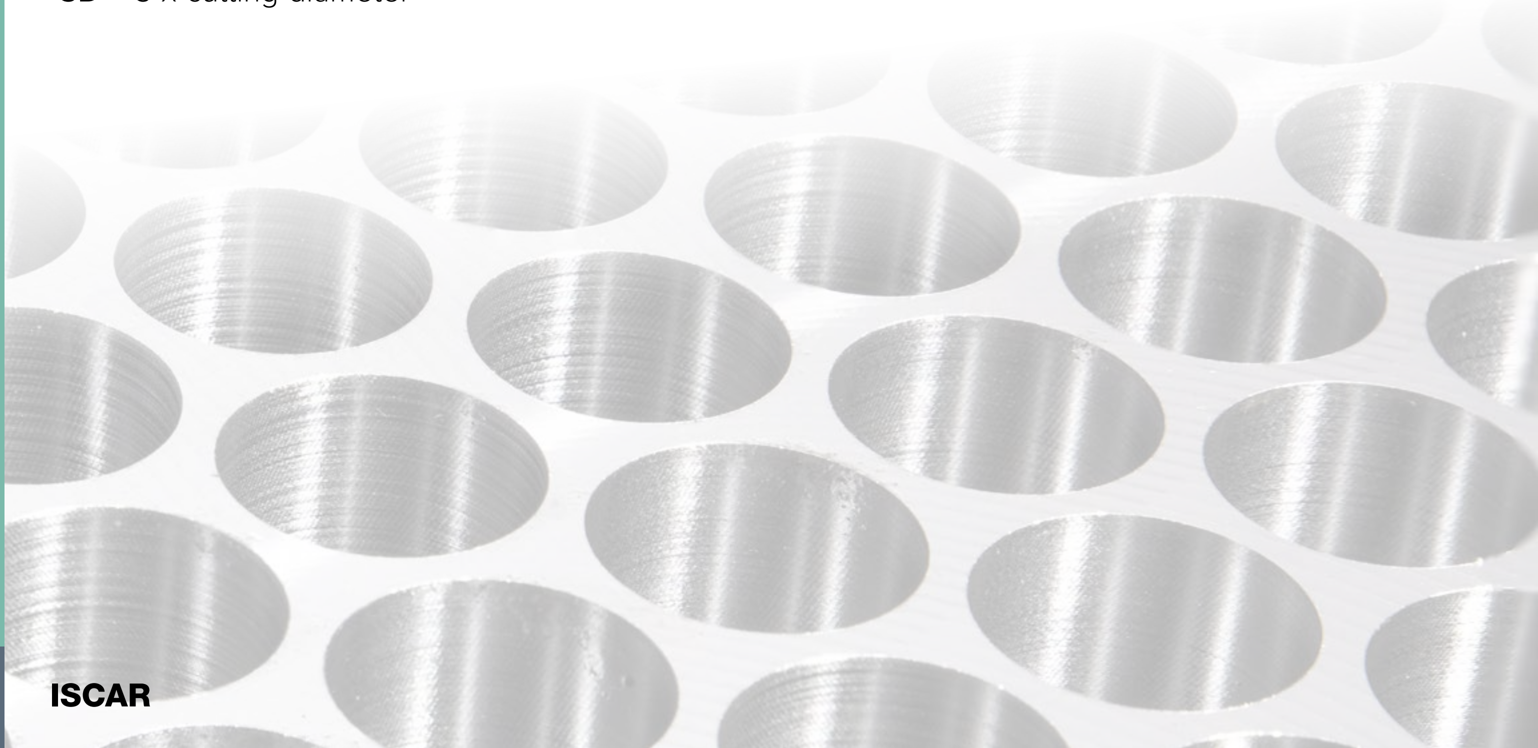
LU — usable length

LPR — protruding length

PL — point length

LS — shank length

OAL — overall length



CHAM-DRILL

ISCAR's **CHAM-DRILL** is a long-standing product drilling line with indexable heads that has been proven over the years and remains popular today.

The **CHAM-DRILL** line is designed for machining holes with a diameter range of 7.5 to 25.9 mm (0.295 to 1.02 inches) in 0.1 mm (0.004 inches) increments and 3, 5, and 8 drill length to diameter ratios.

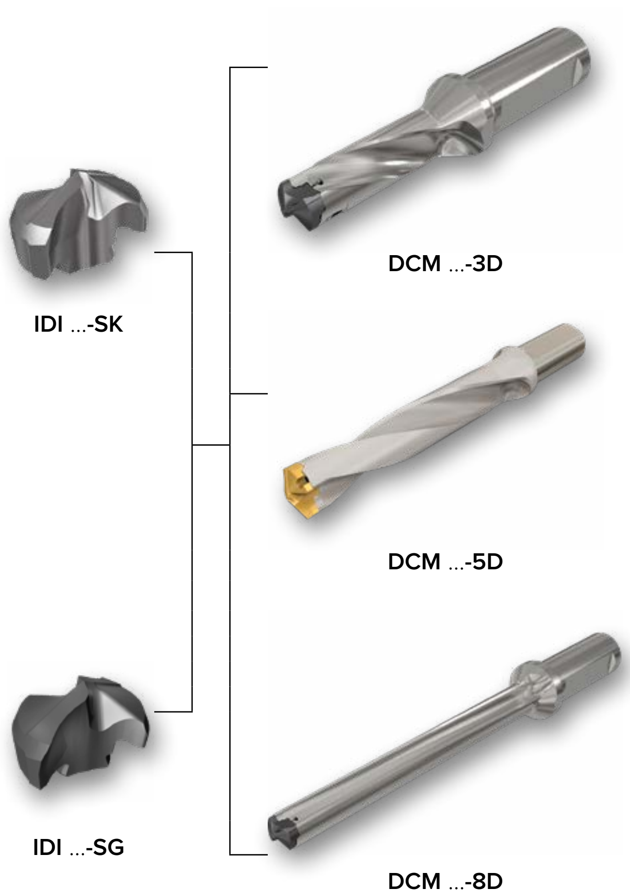
The **CHAM-DRILL** line was the first drilling line in the world designed with the principle of replaceable drill heads without use of screws or other locking devices and the adaptation of its diameter to different industrial uses.

The **CHAM-DRILL** drill body designated DCM ... and can carry 2 types of exchangeable drilling heads: IDI ...-SG and IDI ...-SK.

Exchangeable Drilling Heads

The IDI ...-SG and IDI ...-SK exchangeable drill heads have two ducts on the peripheral for providing coolant directly to the cutting zone. The indexable **SPADE-CHAM** drill heads are made of IC908 TiAlN PVD nano layer coating grade for prolonged and predictable tool life. The IDI ...-SK drill heads have special geometric features for drilling cast iron.

The IDI ...-SG drill heads are designed for general use and are suitable for machining a large variety of workpiece materials.



Drill Body

The **CHAM-DRILL** drills body were designed and produced with an optimal helix flute angle in terms of hole accuracy, roundness, and straightness. The hole straightness of the **CHAM-DRILL** drills, under recommended cutting conditions, can be within 0.06 mm.

The **CHAM-DRILL** drills are equipped with internal coolant channels and in combination with the helix flute angle provide effective chip evacuation while maintaining high rigidity.

The drills are hard touch coated with a hard (up to 60 HRc) layer to resist wear and corrosion. This improves the flute's surface finish, reduces friction, and provides excellent chip evacuation.

DCM ...-3D

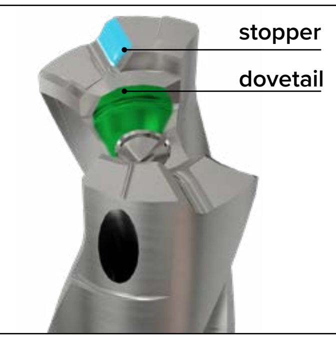
DCM ...-5D

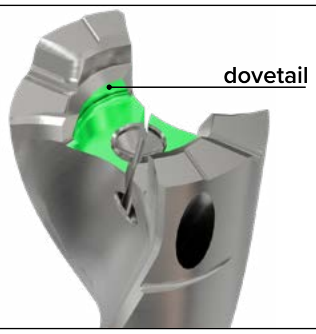
DCM ...-8D

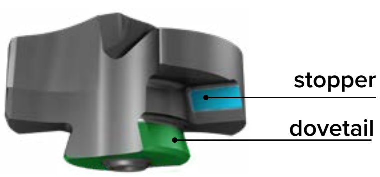
Clamping Pocket

The **CHAM-DRILL** clamping pocket is based on a principle of self-locking, controlled elasticity of the sides of the pocket in the tool. Positioning (centering) and mounting of the insert in the clamping pocket is designed according to the dovetail method. The dovetail joint is very strong because of the way the 'tails' and 'pins' are shaped, thus preventing the drilling head from being pulled out while removing the drill at the end of a drilling operation.

Transmitting radial torque until the drilling head is locked in the clamping pocket is carried out by stoppers in the drilling head and in the clamping pocket of the drill body.





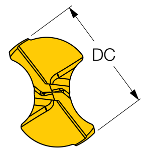


Explanation of CHAM-DRILL Drilling Heads Description

Example:

IDI	150	-	SG	IC908
	1		2	3

1 Cutting Diameter (DC)



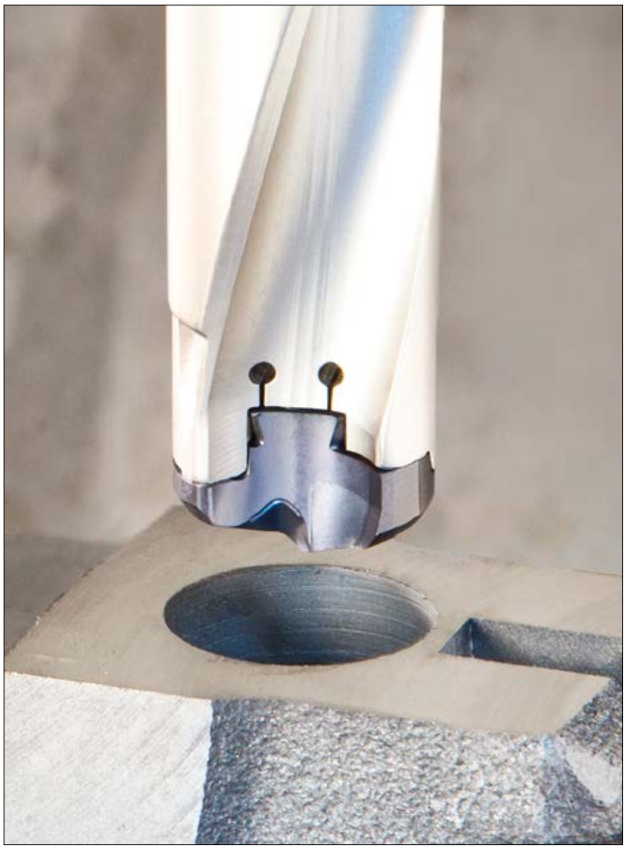
2 Designation of the Drilling Head

SG — exchangeable drilling heads for general use

SK — exchangeable drilling heads for drilling cast iron

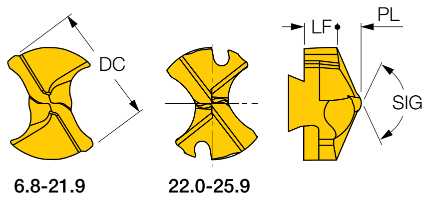
3 Grade

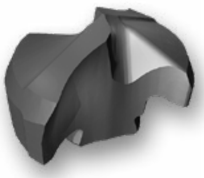
IC908



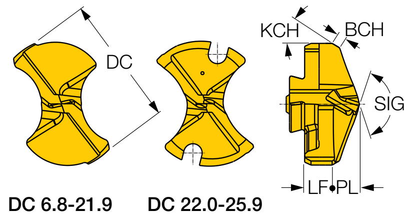
Basic Dimensions of CHAM-DRILL Drilling Heads

IDI ...-SG





IDI ...-SK



DC — cutting diameter
LF — functional length
PL — point length
SIG — point angle
KCH — corner chamfer angle
BCH — corner chamfer angle

Explanation of CHAM-DRILL Drilling Bodies Description

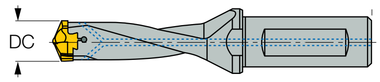
Example:

DCM	150	-	045	-	20	A	-	3D
1	2		3		4	5		6

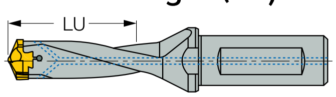
1 Designation of the Drilling Body

DCM — **CHAM-DRILL** drill body

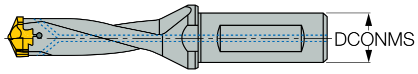
2 Cutting Diameter minimum (DC)



3 Usable Length (LU)



4 Connection Diameter Machine Side (DCONMS)

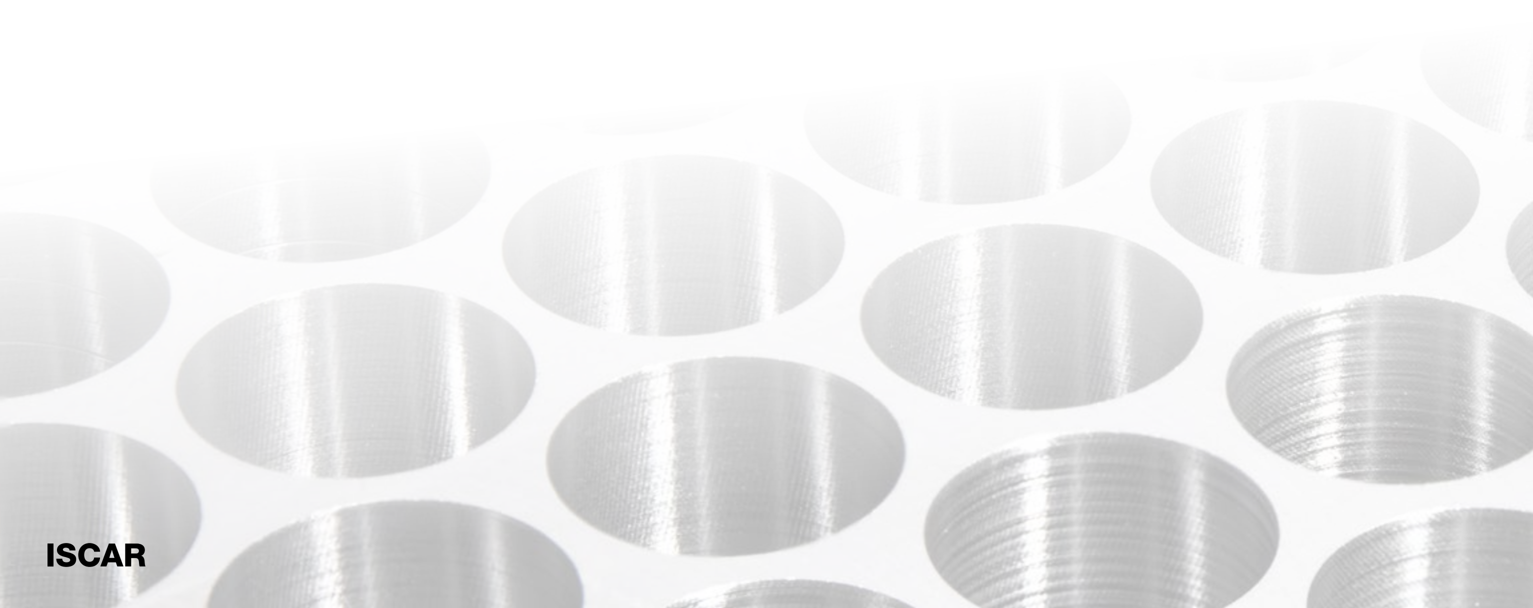


5 Shank Type

A — one flat shank

6 Drilling Depth

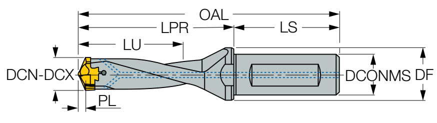
3D = 3 x cutting diameter



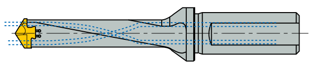
Basic Dimensions of the CHAM-DRILL Drilling Body

DCM ...-3D

D = 7.5 - 21.9

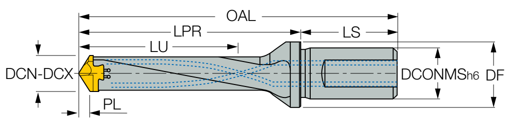


D = 22 - 25.9

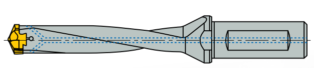


DCM ...-5D

DC = 22-25.9

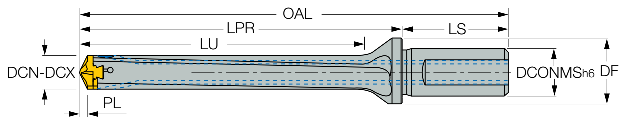


DC = 7.5-21.9

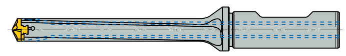


DCM ...-8D

DC= 21-25.9



DC= 10-20.9



DCN — cutting diameter minimum
DCX — cutting diameter maximum
DCONMS — connection diameter machine side
DF — flange diameter
LU — usable length
LPR — protruding length
PL — point length
LS — shank length
OAL — overall length

Exchangeable Head Drills Cutting Conditions and Machine Power

Following these recommended conditions that are organized per drilling lines will help optimize the performance of holemaking applications.

QUICK-3-CHAM

Material No.	V m/min	D=12-13.9				D=14-15.9				D=16-17.9				D=18-19.9			
		mm/rev	Net Power (KW)	Mean torque (Nm)	Axial Force (kN)	mm/rev	Net Power (KW)	Mean torque (Nm)	Axial Force (kN)	mm/rev	Net Power (KW)	Mean torque (Nm)	Axial Force (kN)	mm/rev	Net Power (KW)	Mean torque (Nm)	Axial Force (kN)
1			3.76	14.66	3.11		5.35	24.06	6.009		6.69	34.12	7.52		8.16	46.53	9.17
2	80-100-120		4.34	16.92	3.59		6.16	27.72	6.922		7.7	39.25	8.65		9.38	53.48	10.54
3		0.30 0.39 0.45	4.97	19.38	4.11	0.36 0.45 0.51	7.04	31.66	7.907	0.45 0.51 0.57	8.77	44.72	9.86	0.48 0.57 0.63	10.67	60.79	11.99
4	70-85-100		4.22	19.38	4.11		5.98	31.66	7.907		7.45	44.72	9.86		9.07	60.79	11.99
5	50-65-80		3.66	21.98	4.66		5.19	35.91	8.969		6.47	50.73	11.18		7.86	68.96	13.60
6	70-90-110		4.74	20.54	4.34		6.37	31.84	7.951		7.99	45.26	9.97		9.35	59.2	11.67
7	70-85-100	0.33 0.39 0.42	4.48	20.54	4.34	0.36 0.42 0.48	6.01	31.84	7.951	0.39 0.48 0.54	7.54	45.26	9.97	0.42 0.51 0.60	8.83	59.2	11.67
8	50-65-80		3.33	19.96	4.23		4.47	30.94	7.727		5.61	43.99	9.69		6.56	57.53	11.34
9	40-50-60		2.67	20.83	4.42		3.59	32.28	8.063		4.5	45.9	10.11		5.27	60.04	11.84
10	50-70-90	0.27 0.33 0.36	4.38	24.41	5.18	0.30 0.36 0.39	5.95	38.24	9.55	0.33 0.39 0.42	7.17	52.24	11.51	0.36 0.42 0.45	8.48	69.09	13.62
11	40-60-80		3.83	24.9	5.28		5.2	39.02	9.745		6.27	53.31	11.75		7.42	70.5	13.90
15	90-125-160		5.53	17.27	3.66		7.58	27.3	6.819		9.22	37.6	8.29		10.98	50.07	9.87
16	80-110-140		6.53	23.17	4.91		8.89	272.25	9.08		10.72	49.72	10.96		12.7	65.79	12.97
17	90-135-180	0.40 0.60 0.78	6.92	19.9	4.24	0.45 0.66 0.84	9.44	31.47	7.859	0.54 0.72 0.90	11.42	43.15	9.51	0.60 0.78 0.96	13.55	57.23	11.28
18	80-110-140		6.53	23.17	4.91		8.89	36.36	9.08		10.72	49.72	10.96		12.7	65.79	12.97
19	90-125-160		6.41	19.9	4.24		8.74	31.47	7.859		10.58	43.15	9.51		12.55	57.23	11.28
20	80-110-140		7.11	25.2	5.34		9.65	39.47	9.857		11.62	53.88	11.87		13.74	71.18	14.04

Material No.	V m/min	D=20-21.9 mm/rev	Net Power (KW)	Mean torque (Nm)	Axial Force (kN)	D=22-23.9 mm/rev	Net Power (KW)	Mean torque (Nm)	Axial Force (kN)	D=25-25.9 mm/rev	Net Power (KW)	Mean torque (Nm)	Axial Force (kN)
1	80-100-120	0.51 0.60 0.66	9.4	59.19	10.56	0.54 0.63 0.69	10.69	73.79	12.02	0.57 0.66 0.72	12.06	90.45	13.55
2			10.79	67.99	12.13		12.28	84.72	13.80		13.84	103.8	15.55
3			12.26	77.22	13.78		13.93	96.13	15.66		15.69	117.66	17.63
4	70-85-100		10.42	77.22	13.78		11.84	96.13	15.66		13.33	117.66	17.63
5	50-65-80		9.04	87.59	15.63		10.27	109.04	17.76		11.57	133.46	20.00
6	70-90-110	0.45 0.54 0.63	10.79	75.53	13.47	0.48 0.57 0.66	12.31	94.4	15.38	0.51 0.60 0.69	13.92	115.97	17.38
7	70-85-100		10.19	75.53	13.47		11.63	94.4	15.38		13.14	115.97	17.38
8	50-65-80		7.57	73.4	13.09		8.64	91.75	14.94		9.77	112.7	16.89
9	40-50-60		6.08	76.6	13.66		6.94	95.73	15.59		7.84	117.6	17.62
10	50-70-90	0.39 0.45 0.48	9.89	89	15.88	0.42 0.48 0.51	11.38	112.2	18.28	0.45 0.51 0.54	12.96	138.9	20.81
11	40-60-80		8.65	90.82	16.20		9.96	114.49	18.65		11.34	141.74	21.24
15	90-125-160	0.66 0.84 1.02	12.88	64.9	11.58	0.72 0.90 1.08	14.9	82.27	13.40	0.78 0.96 1.14	17.06	102.35	15.34
16	80-110-140		14.8	84.78	15.12		17.04	106.88	17.41		19.4	132.28	19.82
17	90-135-180		15.84	73.91	13.18		18.27	93.37	15.21		20.84	115.78	17.35
18	80-110-140		14.8	84.78	15.12		17.04	106.88	17.41		19.4	132.28	19.82
19	90-125-160		14.66	73.91	13.18		16.91	93.37	15.21		19.3	115.78	17.35
20	80-110-140		15.99	9159	16.34		18.38	115.3	18.78		20.9	142.52	21.36

* The calculation of power, torue and axial force were done for the largest diameter in each range
(for example, range of 12-13.9 were calculate with dia. 13.90)

For machine power calculation, use below link:

https://mpwr.iscar.com

The above table shows calculated machine power, torque, and axial force using recommended cutting conditions depending on the work material and drill diameter.

It is highly recommended to pay attention to the axial force generated and to make sure the machine being used is capable of withstanding these loads.

SUMO-CHAM

Material Groups				Recommended Machining Conditions													
								SUMO-CHAM									
								Feed vs. Drill Diameter									
ISO	Material		Condition	Tensile Strength $[N/mm^2]$	Hardness HB	Material No.(1)	V m/min	D=4-4.9	D=5-5.9	D=6-7.9	D=8-9.9	D=10-11.9	D=12-13.9	D=14-15.9	D=16-19.9	D=20-25.9	D=26-32.9
								mm/rev									
P	non-alloy steel and cast steel, free cutting steel	<0.25% C	annealed	420	125	1	80-110-140	0.04 0.06 0.08	0.07 0.09 0.11	0.09 0.11 0.13	0.12 0.17 0.22	0.15 0.21 0.28	0.18 0.24 0.30	0.20 0.27 0.35	0.25 0.35 0.45	0.25 0.35 0.45	0.30 0.40 0.50
		≥0.25% C	annealed	650	190	2	80-105-130										
		<0.55% C	quenched and tempered	850	250	3	80-100-120										
		≥0.55% C	annealed	750	220	4	70-90-110										
			quenched and tempered	1000	300	5	50-70-90										
	low alloy and cast steel (less than 5% of alloying elements)		annealed	600	200	6	80-100-120	0.04 0.06 0.08	0.07 0.10 0.13	0.09 0.12 0.15	0.12 0.18 0.25	0.14 0.21 0.28	0.16 0.24 0.32	0.18 0.26 0.35	0.23 0.31 0.40	0.25 0.35 0.45	0.30 0.40 0.50
			quenched and tempered	930	275	7	70-90-110										
				1000	300	8	50-70-90										
				1200	350	9	40-55-70										
	high alloyed steel, cast steel and tool steel		annealed	680	200	10	50-70-90	0.06 0.07 0.08	0.07 0.09 0.10	0.09 0.11 0.12	0.12 0.16 0.20	0.12 0.17 0.22	0.15 0.20 0.25	0.18 0.23 0.28	0.20 0.25 0.30	0.22 0.27 0.33	0.25 0.30 0.35
			quenched and tempered	1100	325	11	40-60-80										
	stainless steel and cast steel		ferritic / martensitic	680	200	12	40-55-70	0.05 0.06 0.07	0.06 0.07 0.08	0.08 0.09 0.10	0.10 0.12 0.15	0.12 0.15 0.18	0.14 0.17 0.20	0.16 0.20 0.24	0.16 0.21 0.26	0.18 0.24 0.30	0.20 0.27 0.35
			martensitic	820	240	13	40-55-70										
M	stainless steel and cast steel		austenitic, duplex	600	180	14	30-50-70	0.05 0.06 0.07	0.06 0.07 0.08	0.08 0.09 0.10	0.10 0.12 0.15	0.12 0.15 0.18	0.14 0.17 0.20	0.16 0.20 0.24	0.16 0.21 0.26	0.18 0.24 0.30	0.20 0.27 0.35
K	gray cast iron (GG)		ferritic / pearlitic		180	15	90-125-160	0.04 0.06 0.08	0.10 0.13 0.15	0.12 0.15 0.18	0.15 0.22 0.30	0.20 0.27 0.35	0.25 0.32 0.40	0.30 0.37 0.45	0.35 0.45 0.55	0.35 0.47 0.60	0.40 0.50 0.60
			pearlitic / martensitic		260	16	80-110-140										
	nodular cast iron (GGG)		ferritic		160	17	90-135-180										
			pearlitic		250	18	80-110-140										
	malleable cast iron		ferritic		130	19	90-125-160										
			pearlitic		230	20	80-110-140										
N	aluminum-wrought alloys		not hardenable		60	21	90-155-220				0.20 0.27 0.35	0.25 0.32 0.40	0.30 0.37 0.45	0.35 0.42 0.50	0.40 0.50 0.60	0.45 0.57 0.70	0.50 0.67 0.75
			hardenable		100	22											
	aluminum-cast alloys	≤12% Si	not hardenable		75	23											
			hardenable		90	24											
		>12% Si	high temperature		130	25	80-120-160										
	copper alloys	>1% Pb	free cutting		110	26	90-155-220										
			brass		90	27											
			electrolytic copper		100	28											
	non metallic		duroplastics, fiber plastics			29											
			hard rubber			30											
S	high temperature alloys	Fe based	annealed		200	31	30-45-60			0.05 0.06 0.07	0.06 0.08 0.11	0.08 0.10 0.13	0.10 0.12 0.15	0.12 0.15 0.18	0.12 0.16 0.20	0.14 0.18 0.22	0.16 0.20 0.25
			hardened		280	32	20-35-50										
		Ni or Co based	annealed		250	33											
			hardened		350	34											
			cast		320	35											
	titanium alloys		pure	400		36	20-35-50			0.05 0.06 0.07	0.06 0.09 0.12	0.08 0.11 0.15	0.10 0.14 0.18	0.12 0.16 0.20	0.14 0.18 0.22	0.16 0.20 0.25	0.18 0.22 0.27
			alpha+beta alloys, hardened	1050		37											
H	hardened steel		hardened		55 HRC	38	20-35-50			0.05 0.06 0.07	0.06 0.09 0.12	0.08 0.11 0.15	0.10 0.14 0.18	0.12 0.16 0.20	0.14 0.18 0.22	0.16 0.20 0.25	0.18 0.22 0.27
			hardened		60 HRC	39											

Recommended cutting data

As a starting value, the middle of the recommended machining range should be used.
Then, according to the wear results, conditions can be changed to optimize performance. The data refers to IC908

- When using external coolant supply only, reduce cutting speed by 10%
- Use internal coolant supply when machining austenitic stainless steel
- When using more than 5XD drill ratio, reduce cutting parameters by 10%

SUMO-GUN

Machining Conditions for MNSNT							SUMO-GUN Feed vs. Drill Diameter (mm/rev)				
ISO	Material	Condition	Tensile Strength [N/mm^2]	Hardness HB	Material Group No.	V (m/min)	D=10-11.9	D=12-13.9	D=14-15.9	D=16-19.9	D=20-25.9
P	non-alloy steel and cast steel, free cutting steel <0.25% C	annealed	420	125	1	80-110-140	0.15 0.18 0.21	0.18 0.21 0.24	0.20 0.23 0.27	0.25 0.30 0.35	0.25 0.30 0.35
P	non-alloy steel and cast steel, free cutting steel ≥0.25% C	annealed	650	190	2	80-105-130					
P	non-alloy steel and cast steel, free cutting steel <0.55% C	quenched and tempered	850	250	3	80-100-120					
P	non-alloy steel and cast steel, free cutting steel ≥0.55% C	annealed	750	220	4	70-90-110					
P	non-alloy steel and cast steel, free cutting steel ≥0.55% C	quenched and tempered	1000	300	5	50-70-90					
P	low alloy and cast steel (less than 5% of alloying elements)	annealed	600	200	6	80-100-120	0.14 0.17 0.21	0.16 0.20 0.24	0.18 0.22 0.26	0.23 0.27 0.31	0.25 0.30 0.35
P	low alloy and cast steel (less than 5% of alloying elements)	quenched and tempered	930	275	7	70-90-110					
P	low alloy and cast steel (less than 5% of alloying elements)	quenched and tempered	1000	300	8	50-70-90					
P	low alloy and cast steel (less than 5% of alloying elements)	quenched and tempered	1200	350	9	40-55-70					
P	high alloyed steel, cast steel and tool steel	annealed	680	200	10	50-70-90	0.12 0.14 0.17	0.15 0.17 0.20	0.18 0.20 0.23	0.20 0.22 0.25	0.22 0.24 0.27
P	high alloyed steel, cast steel and tool steel	quenched and tempered	1100	325	11	40-60-80					
P	stainless steel and cast steel	ferritic / martensitic	680	200	12	40-55-70	0.12 0.13 0.15	0.14 0.15 0.17	0.16 0.18 0.20	0.16 0.19 0.21	0.18 0.21 0.24
P	stainless steel and cast steel	martensitic	820	240	13	40-55-70					
K	gray cast iron (GG)	ferritic / pearlitic		180	15	90-125-160	0.20 0.23 0.27	0.25 0.28 0.32	0.30 0.33 0.37	0.35 0.40 0.45	0.35 0.42 0.47
K	gray cast iron (GG)	pearlitic / martensitic		260	16	80-110-140					
K	nodular cast iron (GGG)	ferritic		160	17	90-135-180					
K	nodular cast iron (GGG)	pearlitic		250	18	80-110-140					
K	malleable cast iron	ferritic		130	19	90-125-160					
K	malleable cast iron	pearlitic		230	20	80-110-140					
N	aluminum-wrought alloys	not hardenable		60	21	90-155-220	0.25 0.28 0.32	0.30 0.33 0.37	0.35 0.38 0.42	0.40 0.45 0.50	0.45 0.50 0.57
N	aluminum-wrought alloys	hardenable		100	22	90-155-220					
N	aluminum-cast alloys ≤12% Si	not hardenable		75	23	90-155-220					
N	aluminum-cast alloys ≤12% Si	hardenable		90	24	90-155-220					
N	aluminum-cast alloys >12% Si	high temperature		130	25	80-120-160					

Recommended cutting data

Mandatory use of emulsion or oil when drilling

For the 400mm long tools please reduce the cutting speed by 20%.

SPADE-CHAM

ISO	Material		Condition	Mtl. No.	V SFM	IFP SPADE-CHAM Feed vs. Drill Diameter D=1.299-1.575 IPR
P	non-alloy steel and cast steel, free cutting steel	<0.25% C	annealed	1	260-360-460	.012- .016 -.020
		≥0.25% C	annealed	2	260-340-430	
		<0.55% C	quenched and tempered	3	260-330-390	
		≥0.55% C	annealed	4	230-300-360	
			quenched and tempered	5	160-230-300	
	low alloy and cast steel (less than 5% of alloying elements)		annealed	6	260-330-390	.012- .016 -.020
			quenched and tempered	7	230-300-360	
				8	160-230-300	
				9	130-180-230	
	high alloyed steel, cast steel and tool steel		annealed	10	160-230-295	.010- .012 -.014
			quenched and tempered	11	130-200-260	
	stainless steel and cast steel		ferritic / martensitic	12	130-200-260	.008-.011-.014
			martensitic	13		
M	stainless steel and cast steel		austenitic, duplex	14	100-160-230	.008- .011 -.014
S	high temperature alloys	Fe based	annealed	31	100-150-190	.006- .008 -.010
			hardened	32	65-115-155	
		Ni or Co based	annealed	33		
			hardened	34		
			cast	35		
	titanium alloys		pure	36	65-115-155	.007- .009 -.011
			alpha+beta alloys, hardened	37		

- Recommended cutting data

CHAM-DRILL

Material Groups								Recommended Machining Conditions					
									Feed vs. Drill Diameter mm/rev				
ISO	Material		Condition	Tensile Strength [N/mm²]	Hardness HB	Material No.	Cutting Speed V_c m/min	D=6.8-10.9	D=11-12.9	D=13-14.9	D=15-16.9	D=17-20.9	D=21-25.9
P	non-alloy steel and cast steel, free cutting steel	<0.25% C	annealed	420	125	1	50-130	0.12-0.2	0.15-0.25	0.2-0.3	0.25-0.35	0.25-0.45	0.25-0.45
		≥0.25% C	annealed	650	190	2	100-120						
		<0.55% C	quenched and tempered	850	250	3	90-110						
		≥0.55% C	annealed	750	220	4	90-120						
			quenched and tempered	1000	300	5	70-90						
	low alloy and cast steel (less than 5% of alloying elements)		annealed	600	200	6	80-130	0.12-0.2	0.15-0.25	0.2-0.3	0.25-0.35	0.3-0.4	0.3-0.45
			quenched and tempered	930	275	7	70-110						
				1000	300	8	60-90						
				1200	350	9	40-70						
	high alloyed steel, cast steel and tool steel		annealed	680	200	10	50-80	0.12-0.2	0.12-0.22	0.15-0.25	0.2-0.28	0.25-0.33	0.25-0.35
			quenched and tempered	1100	325	11	40-70						
	stainless steel and cast steel		ferritic / martensitic	680	200	12	20-50	0.08-0.14	0.12-0.22	0.12-0.15	0.14-0.20	0.16-0.24	0.15-0.28
			martensitic	820	240	13							
M	stainless steel and cast steel		austenitic, duplex	600	180	14	20-50	0.08-0.14	0.12-0.22	0.12-0.15	0.14-0.20	0.16-0.24	0.15-0.28
K	gray cast iron (GG)		ferritic / pearlitic		180	15	90-140	0.2-0.3	0.25-0.35	0.3-0.4	0.35-0.45	0.4-0.5	0.4-0.6
			pearlitic / martensitic		260	16	80-130						
	nodular cast iron (GGG)		ferritic		160	17	100-180						
			pearlitic		250	18	90-160						
	malleable cast iron		ferritic		130	19							
			pearlitic		230	20							
N	aluminum-wrought alloys		not hardenable		60	21	90-160	0.2-0.35	0.25-0.4	0.3-0.45	0.35-0.5	0.4-0.6	0.4-0.65
			hardenable		100	22	80-120						
	aluminum-cast alloys	≤12% Si	not hardenable		75	23	90-160						
			hardenable		90	24							
		>12% Si	high temperature		130	25							
	copper alloys	>1% Pb	free cutting		110	26							
			brass		90	27							
			electrolytic copper		100	28							
	non metallic		duroplastics, fiber plastics			29							
			hard rubber			30							
S	high temperature alloys	Fe based	annealed		200	31	30-50	0.05-0.1	0.08-0.13	0.1-0.15	0.12-0.18	0.12-0.2	0.12-0.22
			hardened		280	32	20-40						
		Ni or Co based	annealed		250	33	20-50	0.06-0.12	0.09-0.15	0.12-0.18	0.15-0.2	0.15-0.23	0.15-0.25
			hardened		350	34							
			cast		320	35							
	titanium alloys		pure	400		36							
			alpha+beta alloys, hardened	1050		37							
H	hardened steel		hardened		55 HRC	38	20-50	0.06-0.12	0.09-0.15	0.12-0.18	0.15-0.2	0.15-0.23	0.15-0.25
			hardened		60 HRC	39							
	chilled cast iron		cast		400	40	20-50	0.06-0.12	0.09-0.15	0.12-0.18	0.15-0.2	0.15-0.23	0.15-0.25
	cast iron		hardened		55 HRC	41							

- When using external coolant supply only, reduce cutting speed by 10%
- When using more than 5XD drill ratio, reduce cutting parameters by 10% As a starting value, the middle of the recommended machining range should be used. Then, according to the wear results, conditions can be changed to optimize performance.

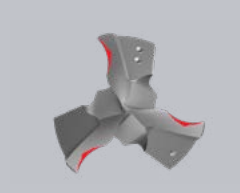
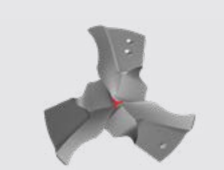
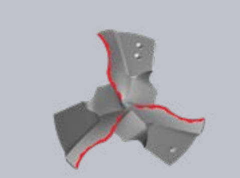
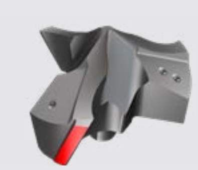
The data refers to IC908. For IC1008, cutting speed should be increased by 15%.

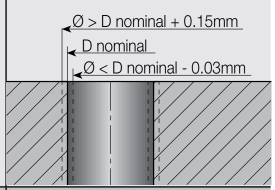
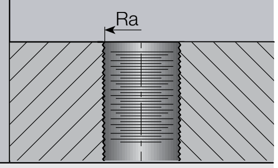
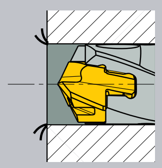
Exchangeable Head Drills Troubleshooting

Uncover insights for seamless drilling with **ISCAR**'s Exchangeable Drill Head Troubleshooting Table.

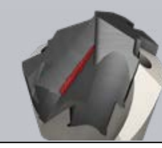
This resource is tailored to guide and support users in resolving common challenges encountered during drilling operations using exchangeable drill heads.

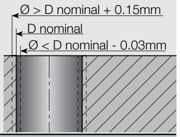
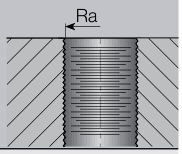
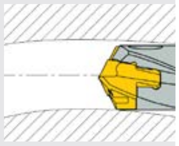
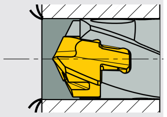
QUICK-3-CHAM

	Troubleshooting	
Cutting Edge Chipping	1 Check the stability of the machine spindle, tool and workpiece clamping rigidity. 2 Reduce feed rate, increase speed. 3 If the drill vibrates, reduce cutting speed and increase feed rate. 4 When drilling rough, hard or angled (up to 12° angular surface), reduce the feed rate by 30-50%. 5 Check cooling lubricant. increase coolant pressure. in case of external coolant supply, improve jet direction and add cooling jets.	
Chisel Area Chipping	1 Reduce feed rate. 2 Increase coolant pressure. 3 Increase workpiece chucking force.	
Excessive Flank Wear	1 Reduce cutting speed. 2 Increase internal coolant pressure.	
Excessive Land Wear	1 Check the runout and make sure it is within 0.02 mm T.I.R. (radial and axial). 2 Reduce cutting speed. 3 When drilling rough, hard or angled (up to 12° angular surface), reduce the feed rate by 30-50%. 4 Increase coolant pressure. 5 Check the chisel point runout and make sure it is within 0.02 mm T.I.R. 6 Increase workpiece chucking force stability and rigidity.	

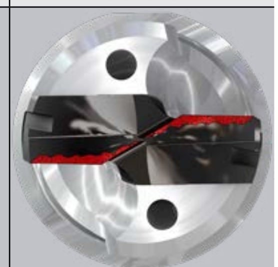
Troubleshooting		
Built-Up Edge	1 Check the runout and make sure it is within 0.02 mm T.I.R. (radial and axial cutting points). 2 Reduce feed rate. 3 Check the chisel point runout and make sure it is within 0.02 mm T.I.R. 4 Worn cutting edge. replace head. 5 Increase workpiece chucking force. 6 Increase internal coolant pressure.	
Deviation of Hole Tolerance	1 Check the runout and make sure it is within 0.02 mm T.I.R. (radial and axial cutting points). 2 Reduce feed rate. 3 Check the chisel point runout and make sure it is within 0.02 mm T.I.R. 4 Worn cutting edge. replace head. 5 Increase workpiece chucking force. 6 Increase internal coolant pressure.	
Surface Finish Too Rough	1 Check the runout and make sure it is within 0.02 mm T.I.R. (radial and axial). 2 Adjust the feed for improved chip formation. 3 In case of chip jamming - increase the coolant flow and/or reduce the cutting speed. 4 Increase the coolant pressure. 5 Check the chisel point runout and make sure it is within 0.02 mm T.I.R. 6 Use pecking cycle. 7 Replace the drilling head	
Inaccurate Hole Position	1 Check the runout and make sure it is within 0.02 mm T.I.R. (radial and axial). 2 Check the stability of the machine spindle, tool and workpiece clamping rigidity. 3 When drilling rough, hard or sloped surfaces (up to 12°), reduce the feed rate by 30-50% 4 Drill a pre-hole for centering. 5 Check the chisel point runout and make sure it is within 0.02 mm T.I.R.	
Burrs on Exit	1 Reduce the feed rate by 50%-70% during exit. 2 Replace the worn head.	

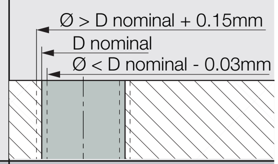
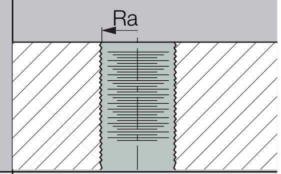
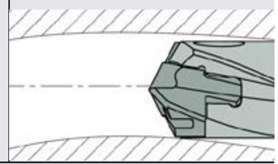
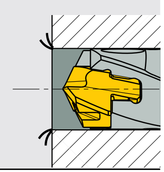
SUMO-CHAM

Troubleshooting		
Cutting Edge Chipping	1 Check the stability of the machine spindle, tool and workpiece clamping rigidity. 2 Reduce feed rate, increase speed. 3 If the drill vibrates, reduce cutting speed and increase feed rate. 4 When drilling rough, hard or sloped surfaces (up to 7°), reduce the feed rate by 30-50% when entering and exiting. 5 Check cooling lubricant and increase coolant pressure. in case of external coolant supply, improve jet direction and add cooling jets.	
Chisel Area Chipping	1 Reduce feed rate. 2 Increase coolant pressure. 3 Check the adaptation. use hydraulic clamping chuck, **MAXIN** power chuck or side lock systems. 4 Increase workpiece chucking force.	
Excessive Flank Wear	1 Check that the correct geometry is used. 2 Reduce cutting speed. 3 Increase internal coolant pressure.	
Excessive Flute Land Wear	1 Check that the correct geometry is used. 2 Check the runout and make sure it is within 0.02 mm T.I.R. (radial and axial). 3 Reduce cutting speed. 4 When drilling rough, hard or sloped surfaces (up to 7°), reduce the feed rate by 30-50% when entering and exiting. 5 Increase coolant pressure. 6 Check the chisel point runout and make sure it is within 0.02 mm T.I.R. 7 Increase workpiece chucking force stability and rigidity. 8 If there is low pocket gripping force - replace drill body.	
Built-Up Edge	1 Increase cutting speed/feed. 2 Increase coolant pressure.	

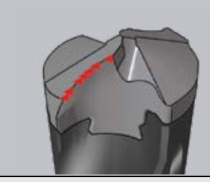
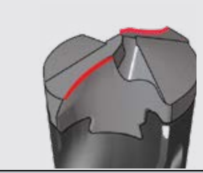
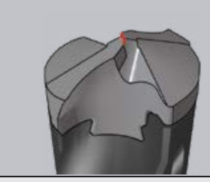
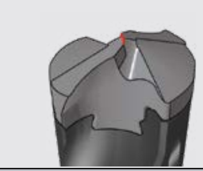
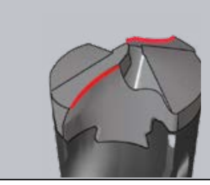
Troubleshooting		
Deviation of Hole Tolerance	1 Check the runout and make sure it is within 0.02 mm T.I.R. (radial and axial cutting points). 2 Reduce feed rate. 3 Check the chisel point runout and make sure that it is within 0.02 mm T.I.R. 4 Wrong cutting edge. replace head. 5 Increase workpiece chucking force. 6 Check the adaptation. use hydraulic clamping chuck, **MAXIN** power chuck or side clamping systems. 7 Increase internal coolant pressure.	
Surface Finish Too Rough	1 Check the runout and make sure it is within 0.02 mm T.I.R. (radial and axial). 2 Adjust the feed for improved chip formation. 3 In case of chip jamming - Increase the coolant flow and/or reduce the cutting speed. 4 Increase the coolant pressure. 5 Check the chisel point runout and make sure it is within 0.02 mm T.I.R. 6 Use pecking cycle. 7 Use double margin geometry.	
Hole Not Straight:	1 Use 2M geometry. 2 Drill a pre-hole for centering (check recommendations for pre-hole operation). 3 Increase coolant pressure, improve jet direction in case of external coolant supply. 4 Increase the feed.	
Inaccurate Hole Position	1 Check the runout and make sure it is within 0.02 mm T.I.R. (radial and axial). 2 Check the stability of the machine spindle, tool and workpiece clamping rigidity. 3 When drilling rough, hard or sloped surfaces (up to 7°), reduce the feed rate by 30%-50% when entering. 4 Drill a pre-hole with a 140° point angle for centering. 5 Check the chisel point runout and make sure it is within 0.02 mm T.I.R.	
Burrs on Exit	1 Reduce the feed rate by 30%-50% when exiting. 2 Replace the worn head. 3 Check the adaptation. use hydraulic clamping chuck, **MAXIN** power chuck or side clamping systems.	

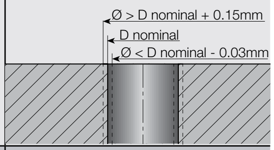
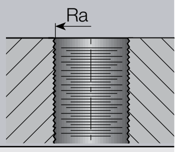
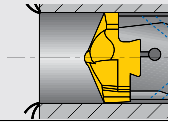
SPADE-CHAM

Troubleshooting		
Cutting Edge Chipping	1 Check the stability of the machine spindle, tool and workpiece clamping rigidity. 2 Reduce feed rate, increase speed. 3 If the drill vibrates, reduce cutting speed and increase feed rate. 4 When drilling rough, hard or sloped surfaces (up to 7°), reduce the feed rate by 50%-70% during entrance and exit. 5 Check cooling lubricant. increase coolant pressure. in case of external coolant supply, improve jet direction and add cooling jets.	
Chisel Area Chipping	1 Reduce feed rate. 2 Increase coolant pressure. 3 Increase workpiece chucking force.	
Excessive Flank Wear	1 Reduce cutting speed. 2 Increase internal coolant pressure.	
Excessive Land Wear	1 Check the runout and make sure it is within 0.03 mm T.I.R. (radial and axial). 2 Reduce cutting speed. 3 When drilling rough, hard or sloped surfaces (up to 7°), reduce the feed rate by 50%-70% during entrance and exit. 4 Increase coolant pressure. 5 Check the chisel point runout and make sure it is within 0.03 mm T.I.R. 6 Increase workpiece chucking force stability and rigidity.	
Built-Up Edge	1 Increase cutting speed/feed. 2 Increase coolant pressure.	

Troubleshooting		
Deviation of Hole Tolerance	1 Check the runout and make sure it is within 0.03 mm T.I.R. (radial and axial cutting points). 2 Reduce feed rate. 3 Check the chisel point runout and make sure it is within 0.03 mm T.I.R. 4 Worn cutting edge. replace head. 5 Increase workpiece chucking force. 6 Increase internal coolant pressure.	
Surface Finish Too Rough	1 Check the runout and make sure it is within 0.03 mm T.I.R. (radial and axial). 2 Adjust the feed for improved chip formation. 3 In case of chip jamming - increase the coolant flow and/or reduce the cutting speed. 4 Increase the coolant pressure. 5 Check the chisel point runout and make sure it is within 0.03 mm T.I.R. 6 Use pecking cycle. 7 Replace the drilling head	
Hole Not Straight	• Drill a pre-hole for centering (check recommendations for pre-hole operation). • Increase coolant pressure; improve jet direction in case of external coolant supply. • Increase the feed.	
Inaccurate Hole Position	1 Check the runout and make sure it is within 0.03 mm T.I.R. (radial and axial). 2 Check the stability of the machine spindle, tool and workpiece clamping rigidity. 3 When drilling rough, hard or sloped surfaces (up to 7°), reduce the feed rate by 50%-70% during entrance. 4 Drill a pre-hole with a 140° point angle for centering. 5 Check the chisel point runout and make sure it is within 0.03 mm T.I.R.	
Burrs on Exit	1 Reduce the feed rate by 50%-70% during exit. 2 Replace the worn head.	

CHAM-DRILL

Troubleshooting		
Cutting Edge Chipping	1 Check the stability of the machine spindle, tool and workpiece clamping rigidity. 2 Reduce feed rate, increase speed. 3 If the drill vibrates, reduce cutting speed and increase feed rate. 4 When drilling rough, hard or sloped surfaces (up to 6°), reduce the feed rate by 30-50% when entering and exiting. 5 Check cooling lubricant and increase coolant pressure. in case of external coolant supply, improve jet direction and add cooling jets.	
Excessive Flank Wear	1 Check that the correct geometry is used. 2 Reduce cutting speed. 3 Increase internal coolant pressure.	
Chisel Area Chipping	1 Reduce feed rate. 2 Increase coolant pressure. 3 Check the adaptation. use hydraulic clamping chuck, **MAXIN** power chuck or side lock systems. 4 Increase workpiece chucking force.	
Excessive Flute Land Wear	1 Check that the correct geometry is used. 2 Check the runout and make sure it is within 0.02 mm T.I.R. (radial and axial). 3 Reduce cutting speed. 4 When drilling rough, hard or sloped surfaces (up to 6°), reduce the feed rate by 30-50% when entering and exiting. 5 Increase coolant pressure. 6 Check the chisel point runout and make sure it is within 0.02 mm T.I.R. 7 Increase workpiece chucking force stability and rigidity. 8 If there is low pocket gripping force - replace drill body.	
Built-Up Edge	1 Increase cutting speed. 2 Increase coolant pressure.	

Troubleshooting		
Deviation of Hole Tolerance	1 Check the runout and make sure it is within 0.02 mm T.I.R. (radial and axial cutting points). 2 Reduce feed rate. 3 Check the chisel point runout and make sure that it is within 0.02 mm T.I.R. 4 Wrong cutting edge. replace head. 5 Increase workpiece chucking force. 6 Check the adaptation. use hydraulic clamping chuck, **MAXIN** power chuck or side clamping systems. 7 Increase internal coolant pressure.	
Surface Finish Too Rough	1 Check the runout and make sure it is within 0.02 mm T.I.R. (radial and axial). 2 Adjust the feed for improved chip formation. 3 In case of chip jamming - increase the coolant flow and/or reduce the cutting speed. 4 Increase the coolant pressure. 5 Check the chisel point runout and make sure it is within 0.02 mm T.I.R. 6 Use pecking cycle.	
Insufficient Pocket Gripping Torque	1 Check unlocking gripping torque with tk dcm torque key. if there is no click indication - replace drill head. 2 Increase coolant pressure.	
Inaccurate Hole Position	1 Check the runout and make sure it is within 0.02 mm T.I.R. (radial and axial). 2 Check the stability of the machine spindle, tool and workpiece clamping rigidity. 3 When drilling rough, hard or sloped surfaces (up to 6°), reduce the feed rate by 30-50% when entering. 4 Drill a pre-hole with a 140° point angle for centering. 5 Check the chisel point runout and make sure it is within 0.02 mm T.I.R.	
Burrs on Exit	1 Reduce the feed rate by 30-50% when exiting. 2 Replace the worn head. 3 Check the adaptation. use hydraulic clamping chuck, **MAXIN** power chuck or side clamping systems.	

Indexable Insert Drills

If the main goal is economical production, then the ideal solution for the machining holes is a drill with indexable inserts. Drills with indexable inserts are reliable and versatile.

A characteristic feature of indexable insert drills is the ability to drill holes with a diameter that is larger than the diameter of the drill itself. To do this, on a lathe, the drill can be shifted relative to the axis of the part by 0.8 - 3.5 mm, depending on the design of the tool (diameter, insert size, etc.).

At the machining center, eccentric bushings or adjustable drill chucks are used for this. Also, drills with indexable inserts have the ability to drill a concave or inclined surface without using preliminary preparation. For such operations, it is only necessary to reduce the feed. The drills with indexable inserts show excellent performance in the processing of interrupted holes and are also capable of boring operations.

Indexable insert drills do a good job with the above tasks. The drills with indexable inserts are mainly used for processing large and medium diameter holes with shallow depth, usually up to 4D.

This type of drill is considered not very productive due to the inability to use high feed per tooth when drilling because of the insufficient rigidity of the drill.

The drill body with a replaceable carbide insert was patented in the 80's, and throughout time this tool has not ceased to be modified.

Let's go back to the 80's, and to the prerequisites for such an important invention, which became widely popular. The main principle was the convenience of operation - namely, the quick replacement of the cutting carbide insert.

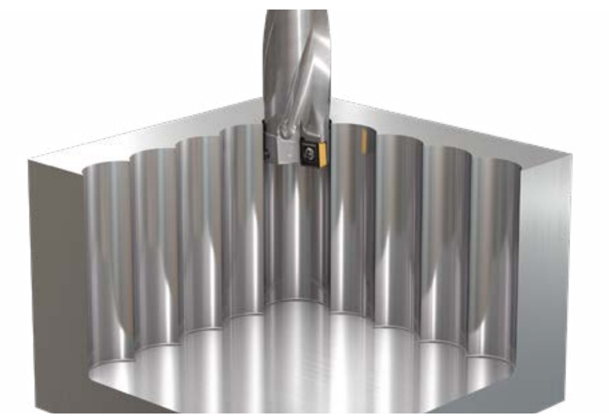
This principle has been preserved in our time, but the structure of the drill body and replaceable inserts has changed based on the realities of the manufacturing industry, the materials from which parts and mechanisms are made, and the equipment on which the drilling process will be carried out.

DR-TWIST

The DR line of holemaking tools is designed to provide an economical solution, suitable for all types of materials. These tools are designed primarily for semi-finishing operations and exhibit a high level of accuracy, even when subjected to interrupted cut machining conditions, or while drilling stacks or sloped surfaces. Furthermore, with the right edge geometry these tools can easily perform an angular penetration holemaking operation, drilling into the material and exiting with flat burr-free exit.

These tools are known to be less susceptible to unstable machining conditions, making them ideal for unbalanced holemaking operations associated with vibration. An optional use of DR drills is for removing material from deep cavities – similar to the plunger's function. The material removal rate is lower than that of the plunger, but the tooling cost is also lower. In interrupted cutting, it is recommended to reduce the machining conditions by 50%.

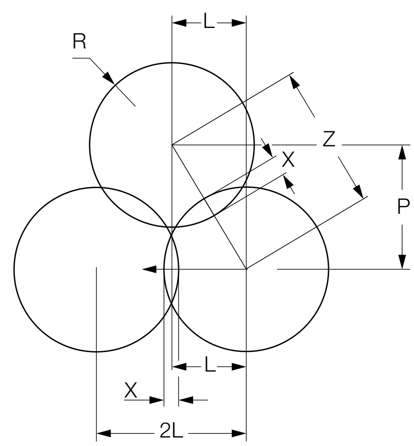
Attached is a sketch and the calculations required for the correct overlapping sidestep pattern which must be employed so the drill will function properly and fully cover the surface to be removed.



$$P = \sqrt{Z^2 - L^2}$$

$$Z = 2R - X$$

$$L = R - X/2$$

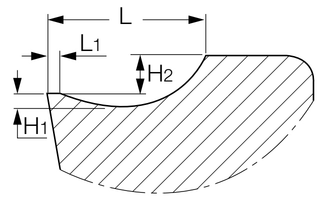


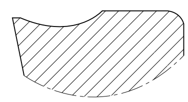
Indexable Drilling Inserts

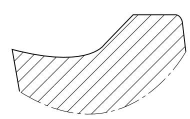
DR drills carry square inserts with a variety of chipformers and grades for machining a wide range of materials. The **DR-TWIST** line includes 6 types of inserts depending on the purpose and tool diameter.

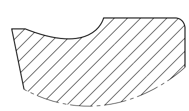
Insert Designation	No. of Cutting Edges	Drill Diameter	Chipformer
AOMT	2	Ø12-13.5	DT HD
AOGT Precise Insert	2	Ø12-13.5	AL
SOGX Precise Insert	4	Ø14-24	AL
SOMX	4	Ø14-24	DT GF HD
SOMT	4	Ø25-80	DT GF HD
SOGT Precise Insert	4	Ø35-44 Ø74-80	AL

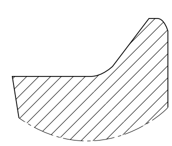
Chip control is one of the most important factors for tool performance to facilitate chip evacuation and prevent tool damage. Chipformer, grade, and cutting conditions must be adjusted to achieve an optimal chip shape. **ISCAR** designed 4 types of chipformers: DT, GF, HD, AL.



DT	
	**general use for ISO – P/M/K/H/S materials for medium up to high feed rates** **L** — open **H_2** — low **L_1** — medium **H_1** — shallow

AL	
	**for medium up to high feed rates for ISO – N material** **L** — open **H_2** — high **L_1** — non **H_1** — deep

GF	
	**for low up to medium feed rates for ISO – P material** **L** — close **H_2** — high **L_1** — small **H_1** — deep

HD	
	**for low up to medium feed rates for ISO – P material** **L** — open **H_2** — high **L_1** — non **H_1** — non

The geometry of the chipformer is designed according to its main purpose and directly depends on the machined material.

- **DT** - is a chipformer designed for general use with an emphasis on machining steels. Chipformer geometry consists of land whose function is to strengthen the cutting edge, rake angle for chip shaping and deflector used for chip breaking. The combination of an open and shallow chipformer design with a wide land and a low deflector provides a special advantage when drilling at medium and high feeds.
- **GF** - is a chipformer designed for machining soft materials such as steel belonging to ISO P groups 1-11. The narrow land and positive angle create a deep and closed design. Narrow land improves cutting edge life but is not a barrier to chips getting into the chipformer pocket. The positive angle gives the chips the correct shape, preparing them for deflector breakage when drilling steel at low to medium feeds.
- **HD** - is a chipformer designed for machining low carbon steel and other soft materials. It features a high deflector that cuts the material into short chips which are easily evacuated along the flutes. The HD chipformer avoids the long and curly chips that may jam the drill's gullets, damage the tool, poorly affect hole quality, and interrupt the drilling process.
- **AL** - is a chipformer designed for machining aluminum and other non-metallic materials. Sharp cutting edges, combined with a positive angle, can provide high quality machining of this ductile material.

Material Groups		Feed (Low ⟷ High)
ISO P	1-11 steel	HD
		GF
		DT
	12-13 stainless steel ferritic and martensitic	HD
		DT
ISO M	14 stainless steel austenitic and duplex (ferritic-austenitic)	DT
ISO K	15-20 cast iron	DT
ISO N	21-28 nonferrous	AL
ISO S	31-37 high temp	DT
ISO H	38-41 hard steel	DT

Drill Body

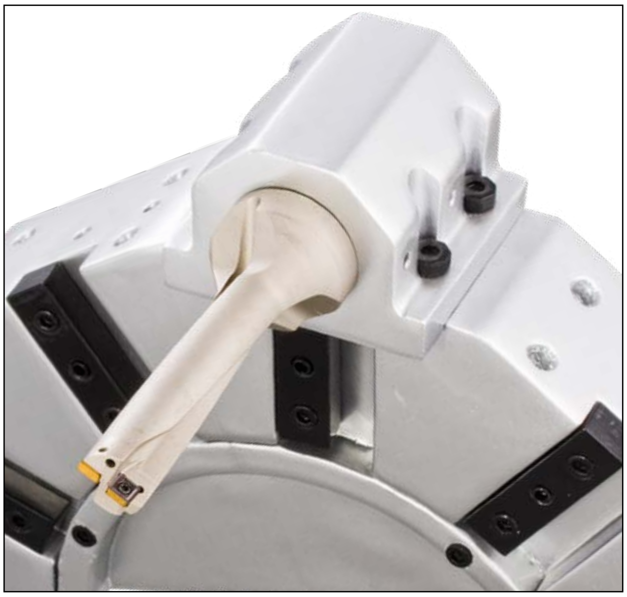
The DR drill body was designed with twisted coolant holes that pass through the drill flutes. This design leaves more room for the chips to flow out of the hole uninterrupted. The coolant holes do not pass through the center core of the drill; therefore, the drill is stronger and more resistant to torsion. A clamping pocket was designed to set inserts at a specific angle giving the right balance to reduce vibration and cutting force.

The DR drill body is made of steel, featuring a body hardness up to 55 HRc and hard touch nickel coating for better wear resistance and smooth chip flow. **DR-TWIST** drill bodies are available in drilling depths to diameter ratios of 2xD, 3xD, 4XD and 5xD and in a diameter range of 12 to 80 mm (for more details please refer to catalog). The drills are available in whole metric sizes as well as half sizes in the above-mentioned range.

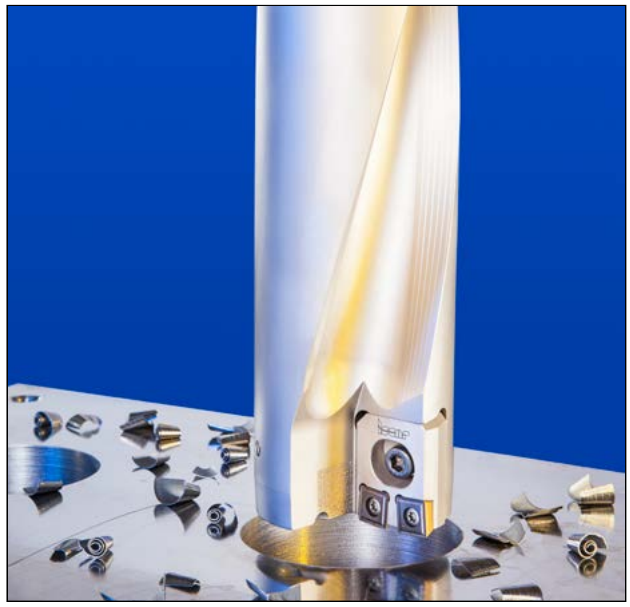
The DR-TWIST Line Contains 3 Types of Tools

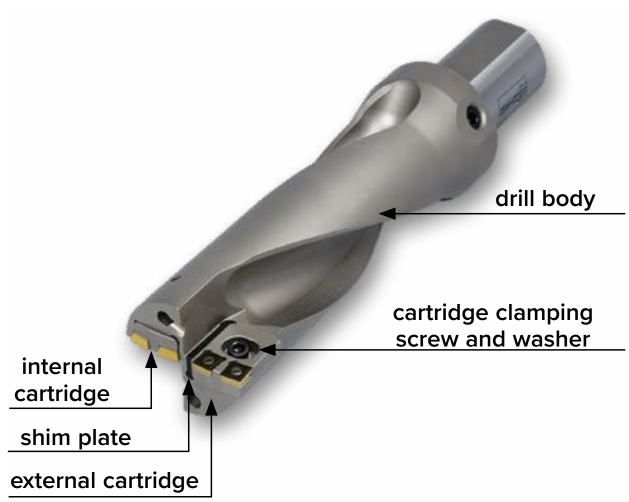
- DR-...-N for general applications, providing phenomenal results.

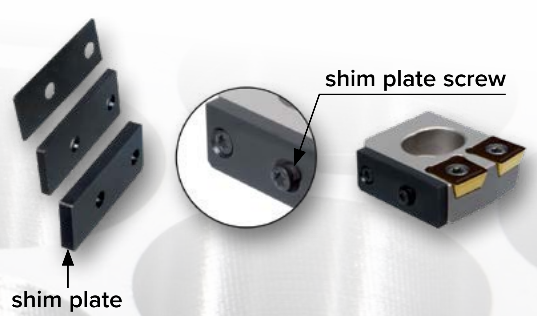
- DR-...-T was designed to bring solutions to typical problems that occur when using turning machines. They feature a shallow helix angle and reinforced body structure, which provides excellent tool performance and easy chip evacuation on lathe applications.



- FDR-...-CA-N allows drilling large diameter holes of 57 to 80 mm (2.24 to 3.15 inches). This drill body carries cartridges with square inserts. Each drill is supplied with a set of shim plates. By mounting these plates, the drill's diameter can be changed. The combination of each drill body's shim plate and cartridge defines a specific drill diameter (hole sizes).







Explanation of DR Indexable Drilling Inserts Description

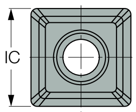
Example:

SOMT	12	04	08	-	DT
1	2	3	4		5

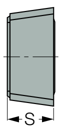
1 Designation of the Drilling Insert

AOMT, AOGT, SOGX, SOMX, SOMT, SOGT

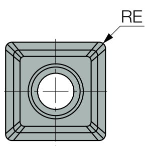
2 Inscribed Circle Diameter (IC)



3 Insert Thickness (S)



4 Corner Radius (RE)

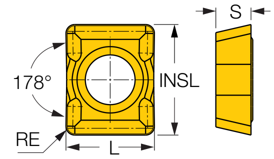


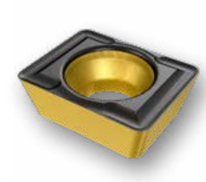
5 Chipformer Type

DT, GF, HD, AL

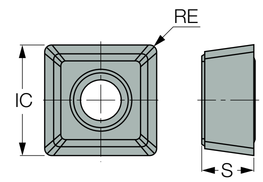
Basic Dimensions of DR Drilling Heads

AOMT /AOGT

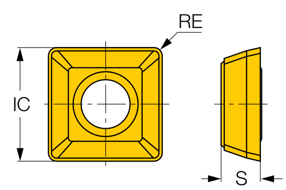




SOGX / SOGT



SOMX / SOMT



IC — inscribed circle diameter

S — insert thickness

RE — corner radius

INSL — insert length

L — cutting edge length

Explanation of DR Drilling Bodies Description

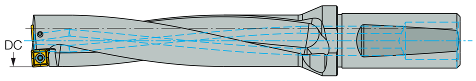
Example:

DR	120	-	036	-	16	-	04	-	3D	-	N
1	2		3		4		5		6		7

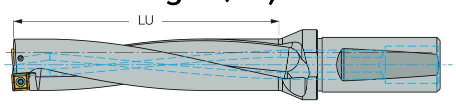
1 Designation of the Drilling Body

DR — **DR-TWIST** line drill body

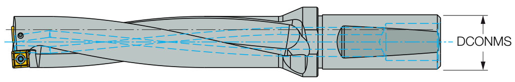
2 Cutting Diameter minimum (DC)



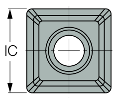
3 Usable Length (LU)



4 Connection Diameter Machine Side (DCONMS)



5 Insert Size (IC)



6 Drilling Depth

3D = 3 x cutting diameter

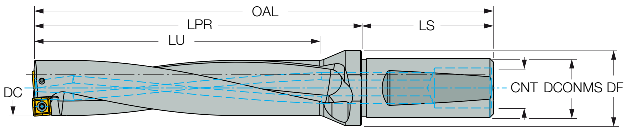
7 Application Designation

N — for general applications

T — for turning machines

CA — for general applications, large diameter, with cartridges

Basic Dimensions of DR Drilling Bodies



DC — cutting diameter minimum

DCX — cutting diameter maximum

DCONMS — connection diameter machine side

DF — flange diameter

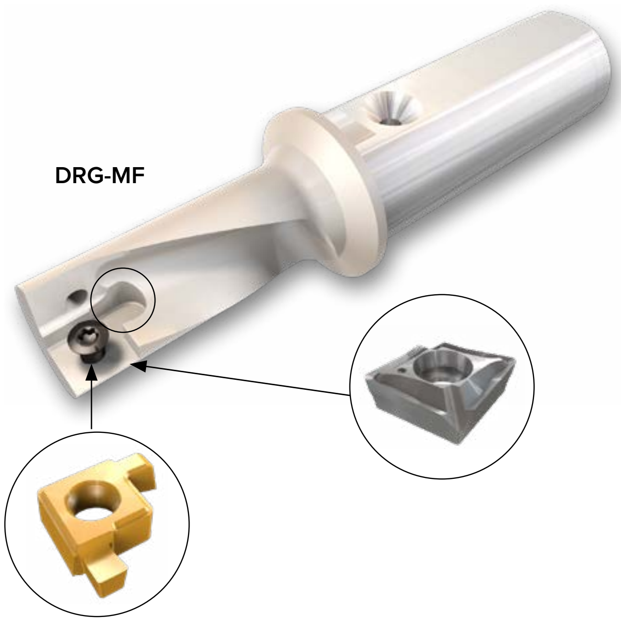
LU — usable length

LPR — protruding length

LS — shank length

OAL — overall length

MULTI-FUNCTION TOOLS



ISCAR MULTI-FUNCTION TOOLS is a line of versatile tools that meet the global trend of “complete machining” in CNC machining centers. This line of **MULTI-FUNCTION TOOLS** consists of tools with the designation DRG-MF carrying indexable inserts for various metal cutting operations. A single multifunction tool can be used for drilling, boring, internal turning, external turning, face turning, and grooving.

By using these tools, the production cycle time and the number of tools being used can be reduced.

Conventional

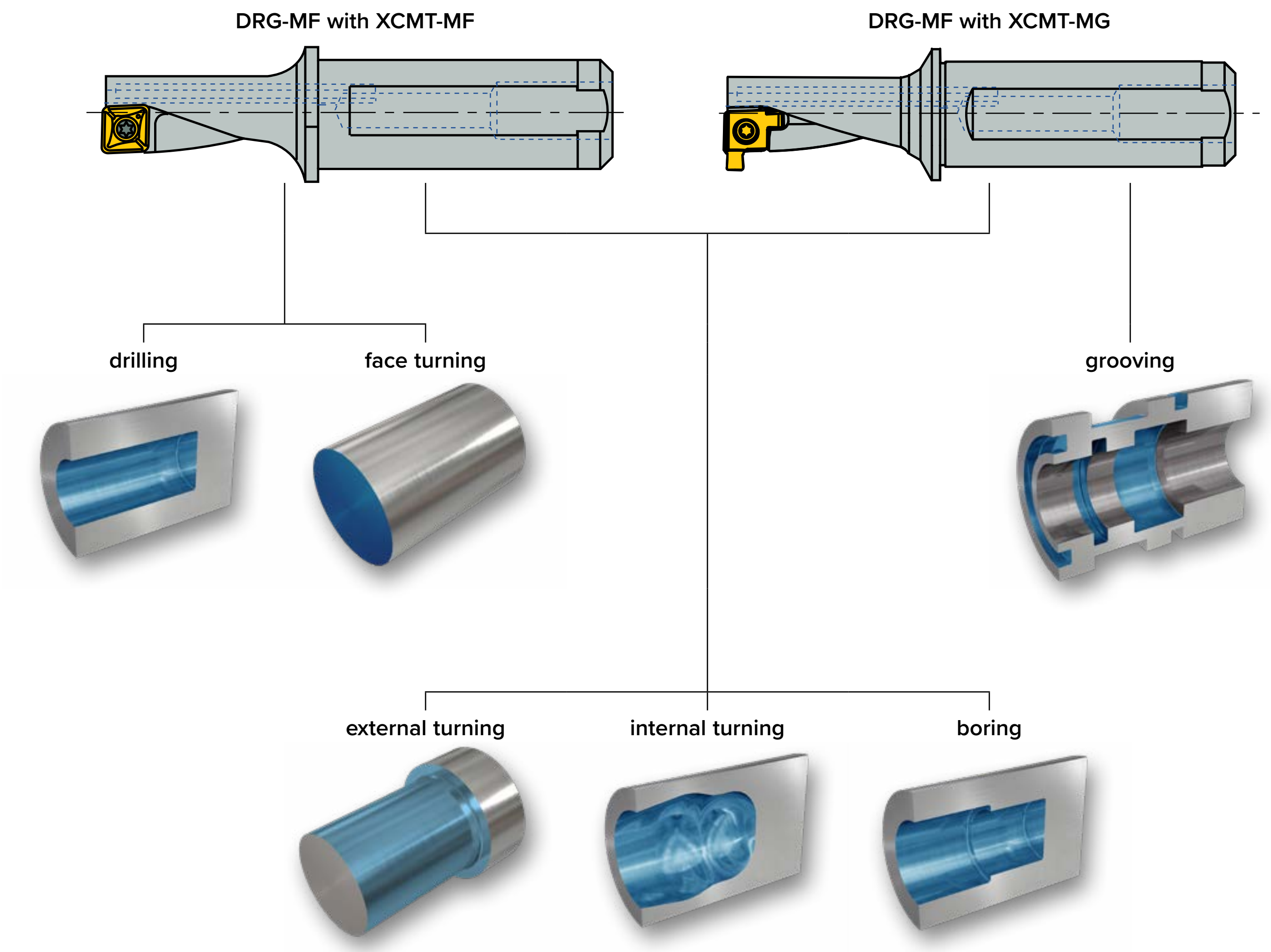
Multifunction tools – DRG-MF

The main use of multifunctional tools is aimed at Swiss-Type machines, miniature parts, automotive parts, dies and molds, aviation and aerospace, medical and general engineering applications.

Indexable Multifunction Inserts

A single DRG-MF tool carries two types of multifunction inserts, XCMT-MF and XCMT-MG for external turning, internal turning, and boring. Both types of indexable inserts have two cutting edges and are made from grade IC908, a submicron substrate TiAlN multilayer coating to optimally cover various machining operations and materials.

The tool with an XCMT-MF insert can also perform drilling and face turning operations. The cutting edge of indexable inserts XCMT-MF is designed with high helix to minimize cutting forces. The tool with an XCMT-MG insert is also intended for grooving operations.



Drill Body

The multifunction tools are designed with diameter ranges of 8 to 32 millimeters (0.315 to 1.26 inch diameters) with usable machining length of 2.25D.

The DRG-MF tools are hard touch coated. This coating provides improved wear resistance due to its 60 HRc hardness and reduces surface friction coefficient on the drill flutes that facilitates chip evacuation. The rear side of the tool shank has a threaded hole to allow f a cooling hose connection directly to the tool by a hose fitting.

DRG-MF with XCMT-MF

DRG-MF with XCMT-MG

Clamping Pocket

The orientation of the insert is determined by the sides of the clamping pocket, while a patented crescent-shaped protrusion near the insert's threaded clamping hole improves clamping rigidity. The protrusion in the pocket enters into a circular cavity around the insert clamping hole. (Indicated in blue).

A high quality torx plus head screw is used to clamp the insert. The Torx Plus head delivers higher clamping torque, providing a more secure clamp, especially on the small screws. In addition, it also extends screwdriver life.

Explanation of Multifunction Indexable Inserts Description

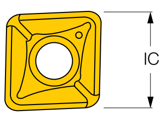
Example:

XCMT	-	05	02	04	-	MF
1		2	3	4		5

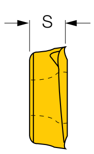
1 Insert Designation

XCMT — designation according to ISO system for indexable inserts (ISO 1832)

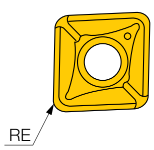
2 Inscribed Circle Diameter (IC)



3 Insert Thickness (S)



4 Corner Radius

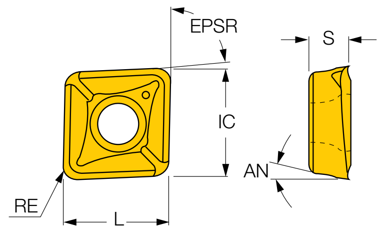


5 Insert Purpose

MF — multifunction indexable insert, designed for external turning, internal turning, boring, drilling and face turning operations

Basic Dimensions of Multifunction Indexable Inserts

XCMT ...-MF



IC — inscribed circle diameter

EPSR — insert included angle

RE — corner radius

L — cutting edge length

S — insert thickness

AN — clearance angle major

Explanation of Multifunction Indexable Inserts Description

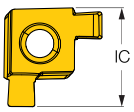
Example:

XCMT	-	05	R	-	20	18	02	-	MG
1		2	3		4	5	6		7

1 Insert Designation

XCMT — designation according to ISO system for indexable inserts (ISO 1832)

2 Inscribed Circle Diameter (IC)

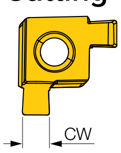


3 Insert Clamp Direction

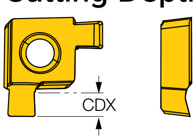
R — right hand

L — left hand

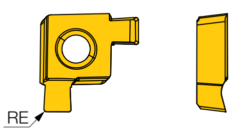
4 Cutting Width



5 Cutting Depth Maximum



6 Corner Radius

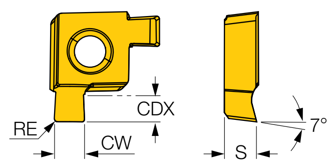


7 Insert Purpose

MG — multifunction indexable insert, designed for external turning, internal turning, boring, grooving operations

Basic Dimensions of Multifunction Indexable Inserts

XCMT ...-MG



CW — cutting width

CDX — cutting depth maximum

RE — corner radius

S — insert thickness

Explanation of Multifunction Tool Bodies Description

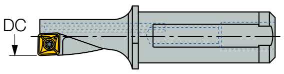
Example:

DRG-MF	-	10		R	-	2.250	-	12		A	-	05
1		2		3		4		5		6		7

1 **Tool Designation**

DRG-MF — **MULTI-FUNCTION TOOLS** body

2 **Cutting Diameter (DC)**

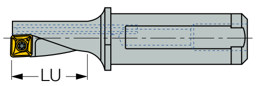


3 **Insert Clamp Direction**

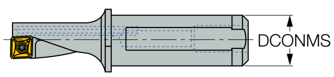
R — right hand

L — left hand

4 **Usable Length**



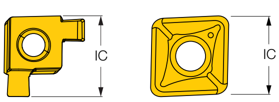
5 **Connection Diameter Machine Side (DCONMS)**



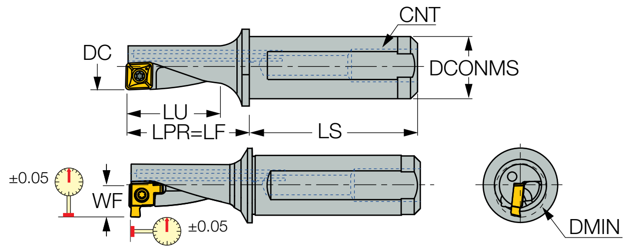
6 **Shank Type**

A — one flat shank

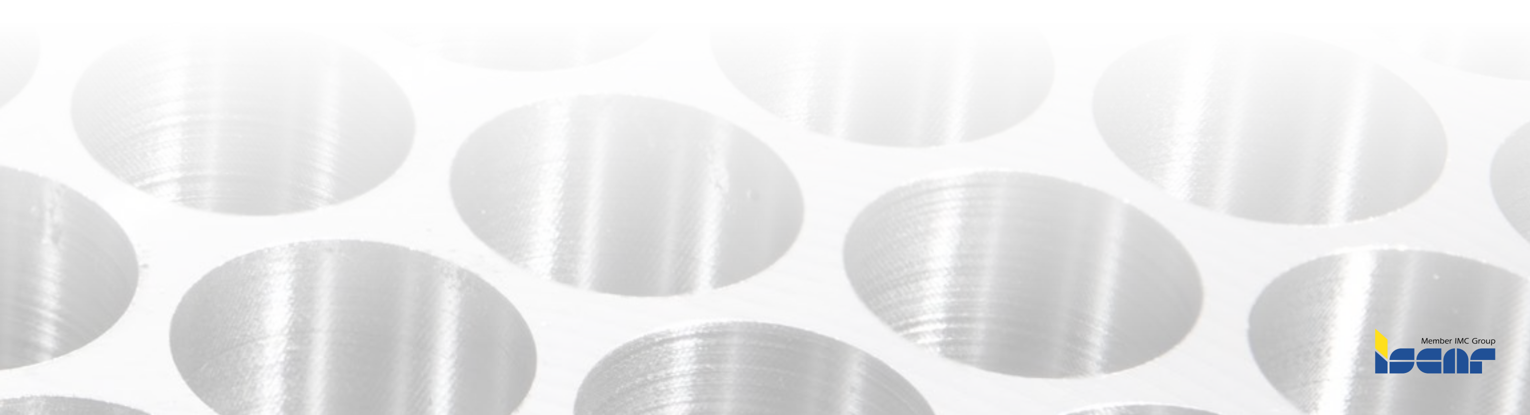
7 **Insert Size (IC)**



Basic Dimensions of Multifunction Tool Bodies



DC	—	cutting diameter
DMIN	—	minimum bore diameter
WF	—	functional length
LU	—	usable length
LPR	—	protruding length
LS	—	shank length
DCONMS	—	connection diameter machine side



Indexable Insert Drills Cutting Conditions

DR-TWIST

ISO	Material		Condition	Tensile Strength [N/mm²]	Hardness HB	Material Group No.	 Cutting Speed (1) Vc m/min IC808/908 external	 Cutting Speed (1) Vc m/min IC8080/9080 external	Feed vs. Drill Diameter mm/rev DR-04 AL/DT/HD	DR-05 GF/DT/AL/HD	DR-06 GF/DT/AL/HD	DR-07 GF/DT/AL/HD	DR-09/10 GF/DT/AL/HD	DR-11/12 GF/DT/AL/HD	DR-14/16 GF/DT/AL/HD
P	non-alloy steel and cast steel, free cutting steel	<0.25% C	annealed	420	125	1	200-300	260-390	0.04-0.08 0.02-0.06	0.06-0.10 0.10-0.15 0.04-0.08	0.07-0.12 0.10-0.16 0.04-0.08	0.08-0.12 0.12-0.18 0.05-0.10	0.10-0.15 0.14-0.22 0.05-0.10	0.12-0.16 0.15-0.25 0.08-0.15	0.14-0.17 0.16-0.26 0.08-0.15
P		≥0.25% C	annealed	650	190	2									
P		<0.55% C	quenched and tempered	850	250	3	150-200	190-260							
P		≥0.55% C	annealed	750	220	4									
P			quenched and tempered	1000	300	5				0.06-0.10 0.10-0.14 0.04-0.08	0.07-0.12 0.10-0.15 0.04-0.08	0.08-0.12 0.10-0.16 0.05-0.10	0.10-0.14 0.14-0.20 0.05-0.10	0.12-0.15 0.14-0.22 0.08-0.15	0.14-0.16 0.15-0.24 0.08-0.15
P	low alloy and cast steel (less than 5% of alloying elements)		annealed	600	200	6	150-220	190-290							
P			quenched and tempered	930	275	7	120-180	160-230							
P				1000	300	8									
P				1200	350	9									
P	high alloyed steel, cast steel and tool steel		annealed	680	200	10	120-190	160-250		0.06-0.10 0.10-0.14 0.08-0.112	0.06-0.10 0.10-0.14 0.08-0.112	0.06-0.10 0.10-0.14 0.08-0.112	0.08-0.12 0.12-0.18 0.096-0.144	0.10-0.15 0.14-0.20 0.112-0.160	0.14-0.17 0.16-0.24 0.128-0.192
P			quenched and tempered	1100	325	11	100-160	210-310							
P	stainless steel and cast steel		ferritic / martensitic	680	200	12	160-240	210-310		0.06-0.10 0.048-0.08	0.06-0.10 0.048-0.08	0.06-0.12 0.048-0.096	0.08-0.12 0.064-0.096	0.10-0.14 0.08-0.112	0.12-0.20 0.096-0.160
P			martensitic	820	240	13									
M	stainless steel and cast steel		austenitic, duplex	600	180	14	160-240	210-310	0.04-0.08	0.06-0.10	0.06-0.10	0.06-0.12	0.08-0.12	0.10-0.14	0.12-0.20
K	gray cast iron (GG)		ferritic / pearlitic		180	15	150-250	190-320	0.08-0.16	0.10-0.22	0.10-0.22	0.10-0.22	0.15-0.25	0.18-0.30	0.20-0.34
K			pearlitic / martensitic		260	16									
K	nodular cast iron (GGG)		ferritic		160	17	120-180	160-230							
K			pearlitic		250	18									
K	malleable cast iron		ferritic		130	19									
K			pearlitic		230	20									
N	aluminum-wrought alloys		not hardenable		60	21	150-300	190-390	0.08-0.24	0.12-0.25	0.12-0.25	0.12-0.25	0.20-0.30	0.2-0.35	0.28-0.45
N			hardenable		100	22									
N	aluminum-cast alloys	≤12% Si	not hardenable		75	23									
N			hardenable		90	24									
N		>12% Si	high temperature		130	25									
N	copper alloys	>1% Pb	free cutting		110	26									
N			brass		90	27									
N			electrolytic copper		100	28									
N	non metallic		duroplastics, fiber plastics		70 Shore D	29									
N			hard rubber		55 Shore D	30									
S	high temperature alloys	Fe based	annealed		200	31	20-50	30-60	0.03-0.07	0.04-0.08	0.04-0.08	0.05-0.09	0.07-0.10	0.08-0.12	0.10-0.14
S			hardened		280	32									
S		Ni or Co based	annealed		250	33									
S			hardened		350	34									
S			cast		320	35									
S	titanium alloys		pure	400	190	36	50-60	60-80							
S			alpha+beta alloys, hardened	1050	310	37									
H	hardened steel		hardened		55 HRC	38	20-50	30-60	0.04-0.08	0.05-0.08	0.05-0.08	0.06-0.09	0.07-0.10	0.08-0.12	0.10-0.14
H			hardened		60 HRC	39									
H	chilled cast iron		cast		400	40									
H	cast iron		hardened		55 HRC	41									

- This table refers to 2/3xD drill ratio usage. • For 4xD ratio decrease cutting data by 15%
- Chipformer should be selected based on our geometry range recommendations
- When using external coolant supply only, reduce cutting speed by 10% • Use internal coolant supply when machining austenitic stainless steel
- This table refers to 2/3xD drill lengths.
- For 4xD and 5XD drills, decrease cutting data by 15%
- When using only external coolant supply, reduce cutting speed by 10% • Use internal coolant supply when machining austenitic stainless steel

(1) Central insert should always be IC808/IC908

DR-DH

ISO	Material		Condition	Tensile Strength Rm [N/mm^2]	Hardness HB	Mtl. No.	Cutting Speed v_c m/min	Feed mm/rev
P	non-alloy steel and cast steel, free cutting steel	<0.25% C	annealed	420	125	1	100-150	0.10-0.25
		≥0.25% C	annealed	650	190	2		0.10-0.25
		<0.55% C	quenched and tempered	850	250	3	80-150	0.15-0.30
		≥0.55% C	annealed	750	220	4		0.15-0.30
			quenched and tempered	1000	300	5		0.15-0.30
	low alloy and cast steel (less than 5% of alloying elements)		annealed	600	200	6		0.15-0.30
			quenched and tempered	930	275	7	70-120	0.15-0.30
				1000	300	8		0.15-0.30
				1200	350	9		0.15-0.30
	high alloyed steel, cast steel and tool steel		annealed	680	200	10	80-150	0.10-0.25
			quenched and tempered	1100	325	11	70-120	0.10-0.25
K	gray cast iron (GG)		ferritic / pearlitic		180	15	180-300	0.18-0.35
			pearlitic / martensitic		260	16		0.18-0.35
	nodular cast iron (GGG)		ferritic		160	17	150-250	0.15-0.30
			pearlitic		250	18		0.15-0.30
	malleable cast iron		ferritic		130	19		0.15-0.35
			pearlitic		230	20		0.15-0.35

MULTI-FUNCTION TOOLS

Cutting speed (V_c)					
				Cutting speed: V_c (m/min) for IC908	
ISO	Workpiece Materials	Material No. VDI 3323	Hardness (BHN)	Drilling	Turning & Boring
P	low carbon steel (<0.25% C)	1	~150	130-240	150-270
P	carbon steel (≥0.25% C)	2	150-250	90-160	100-180
P	low alloy steel	6	~180	120-210	140-230
P	medium alloy steel	7	200-250	70-140	80-160
P	high alloy steel	8, 9	250-350	50-100	60-120
P	martensitic stainless steel	12	200	110-180	130-200
M	austenitic stainless steel	14	200	90-160	100-180
K	grey cast iron	17, 18	180-220	110-180	120-200
K	ductile cast iron	15, 16	200-240	90-160	100-180
N	aluminum alloy	21-24	60-130	100-500	150-600
N	copper alloy	26-28	90-100	100-400	100-500

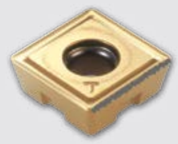
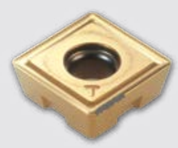
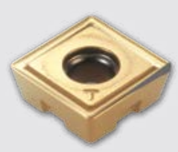
Recommended Cutting Conditions

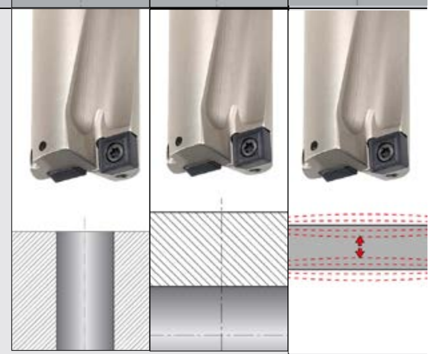
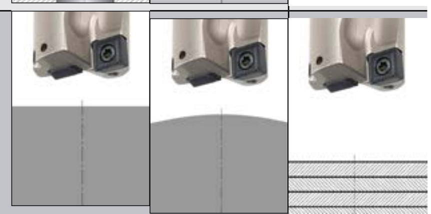
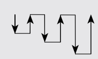
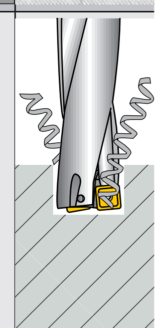
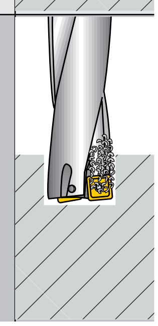
Insert	Machining Type	Cutting Conditions		
		a_p (mm)	a_e (mm)	f (mm/rev)
XCMT 040104R/L -MF	turning and boring	0.6 (0.2-1.8)		0.05 (0.02-0.15)
	drilling	-		0.06 (0.02-0.10)
XCMT 050204-MF	turning and boring	0.8 (0.2-2.5)		0.08 (0.02-0.15)
	face turning	0.6 (0.2-1.7)		0.06 (0.02-0.13)
	drilling	-		0.05 (0.02-0.10)
XCMT 060204-MF	turning and boring	1.0 (0.2-3.0)		0.10 (0.03-0.20)
	face turning	0.8 (0.2-2.5)		0.07 (0.03-0.15)
	drilling	-		0.05 (0.02-0.10)
XCMT 070304-MF	turning and boring	1.3 (0.3-3.5)		0.12 (0.03-0.20)
	face turning	1.0 (0.25-3.0)		0.10 (0.03-0.18)
	drilling	-		0.06 (0.03-0.12)
XCMT 08034-MF	turning and boring	1.2 (0.3-3.5)		0.12 (0.06-0.24)
	face turning	1.5 (0.35-4.0)		0.14 (0.06-0.25)
	drilling	-		0.08 (0.05-0.16)
XCMT 10T304 -MF	turning and boring	1.8 (0.5-3.5)		0.12 (0.06-0.30)
	face turning	1.8 (0.5-3.5)		0.12 (0.06-0.30)
	drilling	-		0.08 (0.03-0.15)
XCMT 10T308 -MF	turning and boring	1.8 (0.5-3.5)		0.20 (0.10-0.40)
	face turning	1.8 (0.5-3.5)		0.20 (0.10-0.40)
	drilling	-		0.08 (0.03-0.15)
XCMT 130404 -MF	turning and boring	2.0 (0.6-4.3)		0.15 (0.07-0.32)
	face turning	2.0 (0.6-4.3)		0.15 (0.07-0.32)
	drilling	-		0.08 (0.03-0.15)
XCMT 130408 -MF	turning and boring	2.0 (0.6-4.3)		0.20 (0.10-0.40)
	face turning	2.0 (0.6-4.3)		0.20 (0.10-0.40)
	drilling	-		0.08 (0.03-0.15)
XCMT 170508 -MF	turning and boring	3.0 (0.7-5.3)		0.22 (0.10-0.40)
	face turning	3.0 (0.7-5.3)		0.22 (0.10-0.40)
	drilling	-		0.08 (0.03-0.15)
XCMT 05R-201802-MG	turning and boring	1.8	2.0	0.05-0.1
	grooving			0.04-0.07
XCMT 06R-202002-MG	turning and boring	2.0	2.0	0.05-0.1
	grooving			0.04-0.07
XCMT 07R-252002-MG	turning and boring	2.0	2.5	0.07-0.12
	grooving			0.05-0.1
XCMT 08R-252502-MG	turning and boring	2.5	2.5	0.07-0.12
	grooving			0.05-0.1
XCMT 10R-303003-MG	turning and boring	3.0	3.0	0.14-0.18
	grooving			0.06-0.12
XCMT 13R-353503-MG	turning and boring	3.5	3.5	0.14-0.2
	grooving			0.07-0.14
XCMT 17R-404004-MG	turning and boring	4.0	4.0	0.15-0.21
	grooving			0.08-0.15

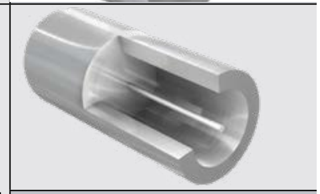
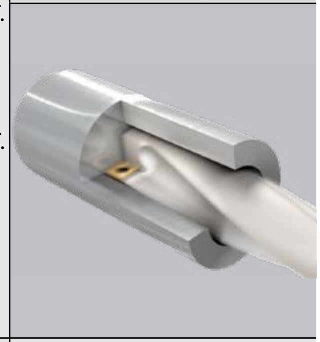
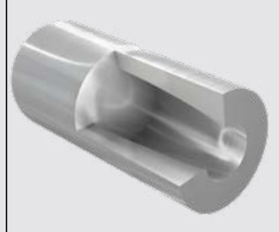
Cutting parameters are for 2.25xD steel shank
Internal coolant supply is recommended

Exchangeable Head Drills Troubleshooting

DR-TWIST

Troubleshooting		
Chipping Along Cutting Edge	1 Reduce entrance feed. 2 Choose a tougher grade. 3 Choose a geometry with open chip breaking for higher feeds. (SOMT, WOLH) 4 Reduce feed.* 5 Reduce cutting speed. 6 Increase coolant pressure.	
Machine Troubleshooting Vibrations	1 Check mounting of drill. 2 Check mounting of workpiece. 3 Increase feed. If drilling a very soft material, reduce feed and increase speed.* 4 Reduce cutting speed.	
Chipping of Center Insert	1 Check mounting of drill. 2 Check mounting of workpiece. 3 Reduce entrance feed. 4 Reduce cutting speed. 5 Check drill runout (should be 0.05 mm maximum).	
Insufficient Torque	1 Reduce feed.* 2 Choose a geometry with a looser chipformer.	
Excessive Flank Wear	1 Reduce cutting speed. 2 Increase coolant pressure/volume. 3 Choose a better wear resistant grade.	
Insufficient Power	1 Reduce cutting speed. 2 Reduce feed.* 3 Choose a geometry with a looser chipformer.	

Troubleshooting			
Irregular Conditions for DR Drills		If surface slope exceeds 5°, reduce feed by 50% during penetration or when exiting. It is preferred to pre-face the surface to eliminate slope.	
		1 Drilling into a pre-hole reduces feed to eliminate deflection[1] of the drill body. 2 Drilling an interrupted cut reduces feed during crossing to eliminate deflection[1] of the drill body. 3 Insufficient stability of workpiece requires additional support. Reduce feed. [1] Deflection may be observed by a mark on the drill body. Note: For irregular applications, use DR drills with XOMT inserts as a first priority.	
Stacked Plates		Drilling operation is not recommended, but may be done by specially designed drills in 16-60 mm range. Apply standard cutting data. Note: For irregular applications, use DR drills with XOMT inserts as a first priority.	
Indexable Insert Drills - Troubleshooting DR Chips	Chip Jamming due to Long Chips	1 Increase feed. If drilling a very soft material, reduce feed and increase speed. 2 Choose a geometry with a tighter chipbreaker for lower feeds (GF). 3 Long chips that rotate around the drill are problematic. If chip formation can not be improved by changing the machining conditions, use a pecking cycle. 	
	Chip Jamming despite Short Chips	1 Increase coolant pressure/volume. 2 Reduce cutting speed.	

Troubleshooting			
	Rotating drill	**Non-rotating drill**	
Undersized holes / **Oversized holes**	1 Check that overlapping is correct between inner and outer inserts. 2 Check inner insert over center. 3 Increase coolant pressure. 4 Change the insert chipbreaker.	1 Check misalignment. 2 Check that overlapping is correct between inner and outer inserts. 3 Check inner insert over center. 4 Rotate drill 180 degrees. 5 Increase coolant pressure. 6 Change the insert chipbreaker.	 
Pin in hole / **Vibrations**	1 Use shorter drill overhang (if possible). 2 Reduce feed by 30-50%. 3 Check that overlapping is correct between inner and outer inserts. 4 Check inner insert is positioned over center within its limits. 5 Increase coolant pressure. 6 Change the insert chipbreaker.	1 Check misalignment. 2 Check that overlapping is correct between inner and outer inserts. 3 Check inner insert over center. 4 Rotate drill 180 degrees. 5 Increase coolant pressure. 6 Change the insert chipbreaker.	 
Cone Hole	1 Use shorter drill overhang (if possible). 2 Reduce feed by 30-50%. 3 Check that overlapping is correct between inner and outer inserts. 4 Check inner insert is positioned over center within its limits. 5 Increase coolant pressure. 6 Change the insert chipbreaker.	1 Check misalignment. 2 Check that overlapping is correct between inner and outer inserts. 3 Check inner insert is positioned over center within its limits. 4 Rotate drill 180 degrees. 5 Increase coolant pressure. 6 Change the insert chipbreaker.	
Bad Surface Finish	1 Improve chip formation (change chipbreaker type or cutting condition). 2 Increase coolant pressure. 3 Increase speed and reduce feed. 4 Stabilize clamping device.	1 Improve chip formation (change chipbreaker type or cutting condition). 2 Increase coolant pressure. 3 Increase speed and reduce feed. 4 Stabilize clamping device.	

MULTI-FUNCTION TOOLS

Troubleshooting	
Chipping caused by built-up edge	1 Increase cutting speed. 2 Reduce feed. 3 Check tool and workpiece rigidity. 4 Reduce tool and workpiece overhang.
Excessive flank wear	1 Reduce cutting speed. 2 Use a harder grade (special). 3 Increase coolant flow. 4 Check cutting edge height.
Edge deformation	1 Reduce cutting speed. 2 Use a harder grade (special). 3 Increase coolant flow. 4 Reduce feed.
Poor surface quality	1 Reduce feed. 2 Increase coolant flow. 3 Check tool and workpiece rigidity. 4 Increase cutting speed.
Long chips	1 Increase feed. 2 Reduce cutting speed. 3 Increase coolant flow.
Tight chips	Reduce feed
Vibrations	1 Check tool and workpiece rigidity. 2 Reduce tool and workpiece overhang. 3 Reduce cutting speed. 4 Increase feed. 5 Check cutting edge height. 6 Reduce feed and increase cutting speed on very soft materials.

Combo Drills Exchangeable Heads and Indexable Insert Drills

For large diameter drilling applications, the combination of exchangeable drilling heads and indexable drilling inserts is the ideal solution to boost productivity and efficiency, especially in machining deep holes. This truly effective drill enables high accuracy and excellent surface finish.

Combo Drill tools are widely used in various industries, such as wind power, bearing, die mold, heat exchangers, oil and gas, power generation, etc. Especially for the wind power industry, the tools type Combo Drill provide an ultimate solution for drilling the most popular hole diameters in wind turbine parts such as blade bearings, tower flanges, yaw rings and planetary ring gears.

Planetary Ring Gear

Ring gears embrace the gearbox's planetary gears, allowing them to transform low incoming speed to high outgoing speed.

Blade Bearing

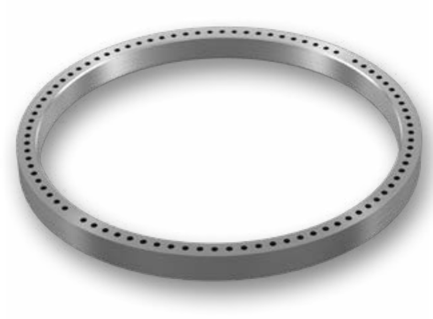
Adjusts the angle of the blades by rotating a bearing at the root of each blade. The blade bearing enables control of the power and slows the rotor. Made of bearing steel.

Yaw Ring

The yaw system of wind turbines is the component responsible for the orientation of the wind turbine rotor towards the wind. This is a mechanism that rotates the nacelle to face the changing wind direction. Made of alloy or bearing steel.

Tower Flange

The vast majority of commercial wind turbines use tubular steel towers. Tower heights depend on rotor diameter and wind speed conditions of the site. Their heights range from 50 meters for a 1 MW turbine to as high as 125 meters and more for very large turbines. The flange comprises a large scale of rolled steel which connects the tower's conical links.

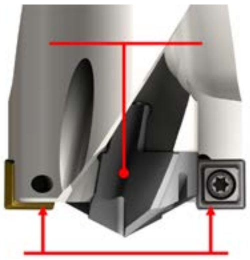


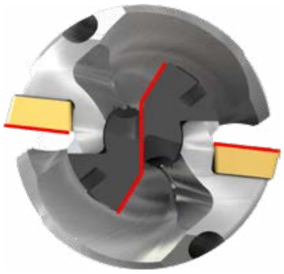
COMBI-CHAM

ISCAR's **COMBI-CHAM** line is intended for semi-finish operations in machining deep holes with large diameters.

The **COMBI-CHAM** line is designed for machining holes with a metric diameter range of 26 to 50 mm in 1 mm increments and the 5, 7, 8 drill length to diameter ratios or with an imperial diameter range of 1.125 to 2 inches in 0.125 inch increments and the 3, 5 drill length to diameter ratios. Market demand has led to the expansion of the **COMBI-CHAM** line and drills have been developed to provide an ultimate solution for drilling the most popular hole diameters in the wind turbine industry. These drills feature an exchangeable pilot drilling head and indexable precision inserts in various sizes.

The design of the drill creates two long cutting edges, i.e., the drill is truly fully effective, it enables high feed drilling, providing high drilling rates, and high accuracy and surface finish.





Exchangeable Pilot Drilling Heads

The **COMBI-CHAM** line drills carry **SUMO-CHAM** line exchangeable pilot drilling heads. These drilling heads have precision self-centering geometry, no need for pre-hole for the 5XD drilling depth to diameter ratio, provides high penetration rates, improves the stability of the tool which influences overall hole quality.

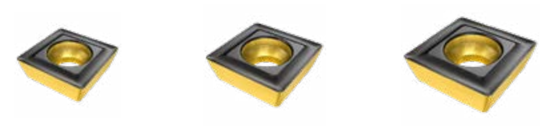
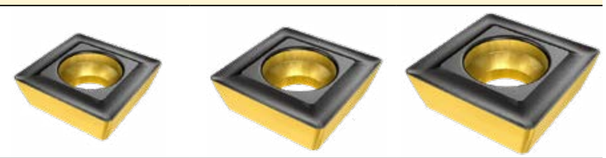
SUMO-CHAM Pilot Drilling Heads
ICP

HCP

ICM


Indexable Peripheral Drilling Inserts

The **COMBI-CHAM** line includes two various drill designs that differ from each other in the type of peripheral indexable inserts. Inserts with designations SOGX ...-W and SOGT ...-W have a square shape with 4 cutting edges. SOGX ...-W and SOGT ...-W peripheral indexable inserts are made of IC808 grade, a tough, submicron substrate with excellent chipping resistance, combined with a "SUMO TEC" PVD coating that provides high wear resistance and is recommended for a very wide range of materials.

ground inserts with a wiper and 4 cutting edges
SOGX ...-W

SOGT ...-W


Inserts with designations WCGX ...-W have a trigon shape with 3 cutting edges.

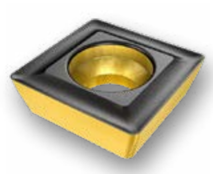
WCGX ...-W peripheral indexable inserts are made of IC918 grade, a tough submicron grain size substrate with a multilayer PVD coating, recommended for general use for diverse operations on materials such as steels, alloy steels, austenitic stainless steel, and high temperature alloys at a wide range of cutting speeds. Features high wear resistance and chipping durability.

ground inserts with a wiper and 3 cutting edges
WCGX ...-W


All peripheral indexable inserts in the **COMBI-CHAM** line are designed with wiper geometry to provide high quality surface finish while DT chipformer ensures good chip control at medium and high feed rates. The drills of the **COMBI-CHAM** line, in combination with SOGX ...-W or SOGT ...-W peripheral indexable inserts, are mainly intended for drilling large-diameter holes at shallow depths and with short tool overhangs on stable machines.

The **COMBI-CHAM** drills in combination with the WCGX ...-W peripheral indexable inserts were designed for a wide range of machining large diameter holes and offer a clear advantage in the following cases:

- large diameter deep hole drilling
- drilling large diameter holes with long tool overhang
- drilling large diameter holes on unstable machines
- stack drilling large diameter holes
- combination of the above cases



ground inserts with a wiper and 4 cutting edges

ground insert with a wiper and 3 cutting edges

SUMOCHAMIQ
CHAMDRILL LINE

Drill Body

The **COMBI-CHAM** drill body designated MNC ... is made of steel, which was specially developed for drilling tools. The drill body features two polished flutes with variable flute geometry for optimal chip evacuation.

Two peripheral coolant nozzles provide high coolant flow directly to cutting zone and are also suitable for MQL coolant types. The shank complies with ISO 9266 standard.

Explanation of SUMO-CHAM Pilot Drilling Heads Description

Example:

ICP	225	IC908
1	2	3

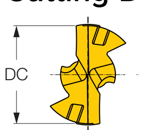
1 Designation of the Drilling Head

ICP — exchangeable drilling heads for ISO P materials

HCP — exchangeable drilling heads for ISO P and ISO K materials

ICM — exchangeable drilling heads for ISO M materials

2 Cutting Diameter (DC)

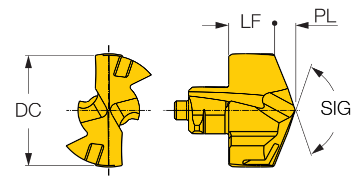


3 Grade

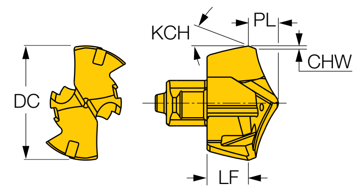
IC908

Basic Dimensions of SUMO-CHAM Pilot Drilling Heads

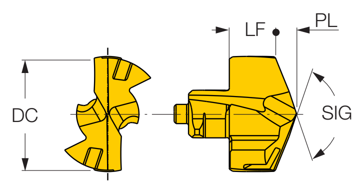
ICP



HCP



ICM



DC — cutting diameter
LF — functional length
PL — point length
KCH — corner chamfer angle
CHW — corner chamfer width
SIG — point angle

Explanation of COMBI-CHAM Indexable Peripheral Drilling Inserts Description

Example:

SOGT	10	04	08	-	W	IC808
1	2	3	4		5	6

WCGX	06	T3	08	-	W	-	DC	IC918
1	2	3	4		5			6

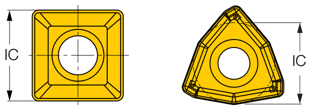
1 Designation of the Drilling Insert

SOGT — indexable peripheral insert for tools over 32 mm diameter

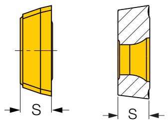
SOGX — indexable peripheral insert for tools up to 32 mm diameter

WCGX — trigon indexable peripheral insert

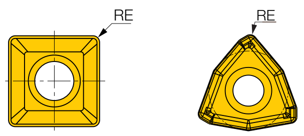
2 Inscribed Circle Diameter (IC)



3 Insert Thickness (S)



4 Corner Radius (RE)



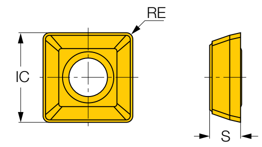
5 W - Wiper

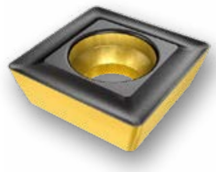
6 Grade

IC808; IC918

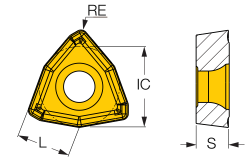
Basic Dimensions of COMBI-CHAM Indexable Peripheral Drilling Inserts

SOGT ...-W / SOGX ...-W





WCGX ...



IC — inscribed circle diameter

RE — corner radius

S — insert thickness

Explanation of COMBI-CHAM Drilling Body Description

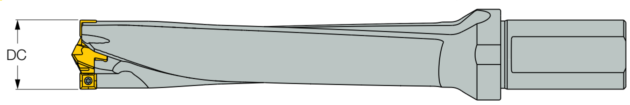
Example:

MNC	400	-	200	A	40	-	225	-	10	-	5D
1	2		3	4	5		6		7		8

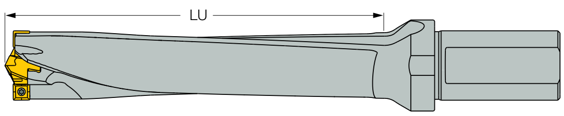
1 **Designation of the Drilling Body**

MNC — **COMBI-CHAM** drill body

2 **Cutting Diameter minimum (DC)**



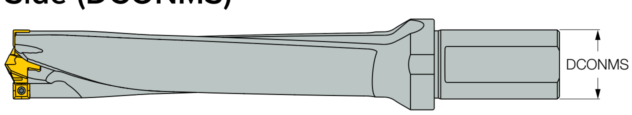
3 **Usable Length (LU)**



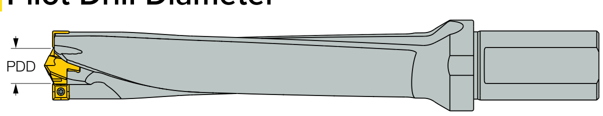
4 **Shank Type**

A — one flat shank

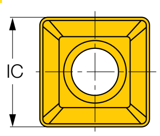
5 **Connection Diameter Machine Side (DCONMS)**



6 **Pilot Drill Diameter**



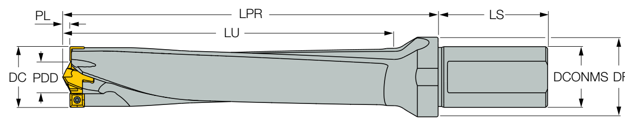
7 **Insert Inscribed Circle Diameter (IC)**



8 **Drilling Depth**

5D = 5 x cutting diameter

Basic Dimensions of the COMBI-CHAM Drilling Body



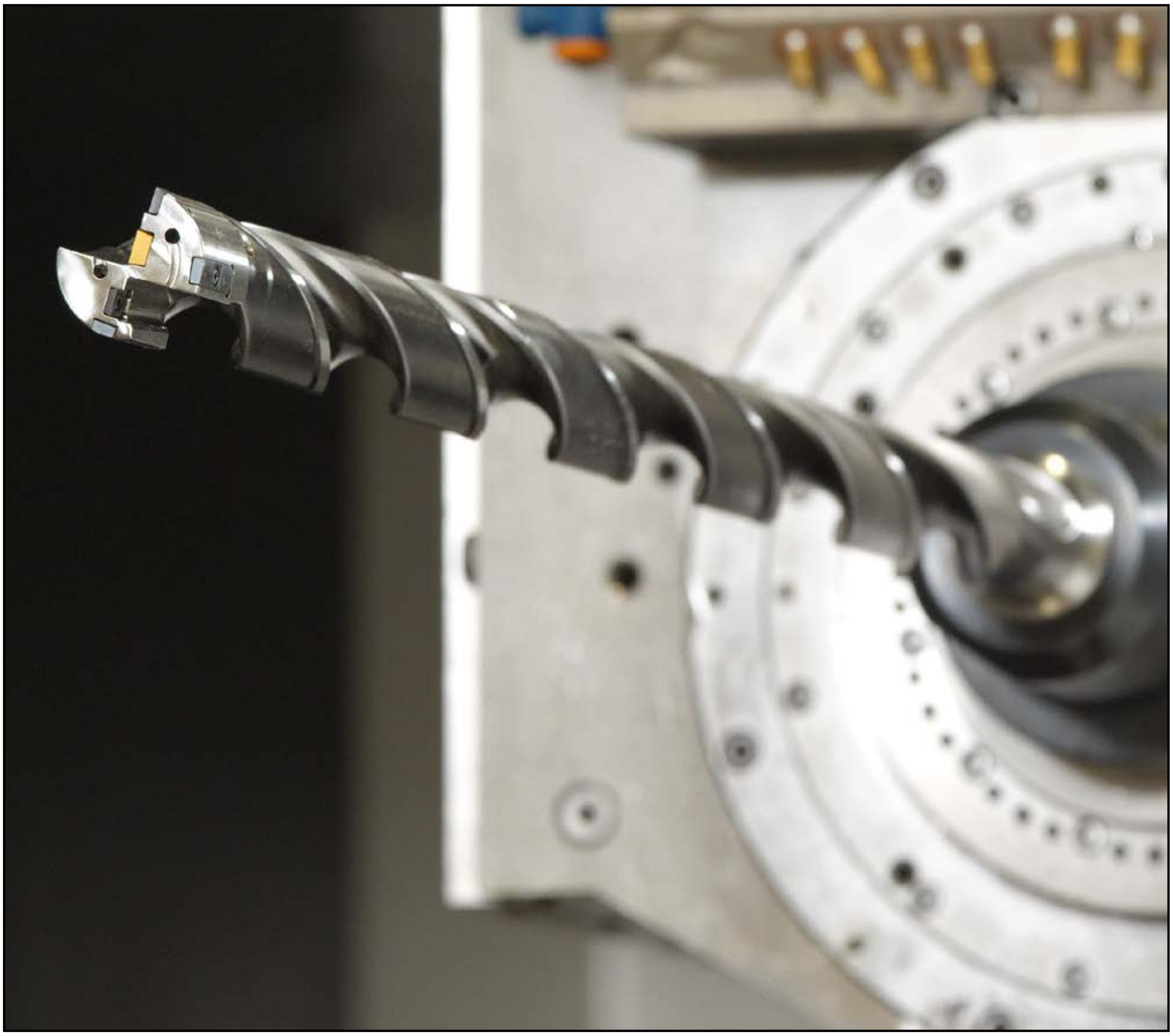
DC — cutting diameter
PDD — pilot drill diameter
DCONMS — connection diameter machine side
DF — flange diameter
LU — usable length
LPR — protruding length
PL — point length
LS — shank length

Combo Drills Exchangeable Heads and Indexable Insert Drills Cutting Conditions

COMBI-CHAM

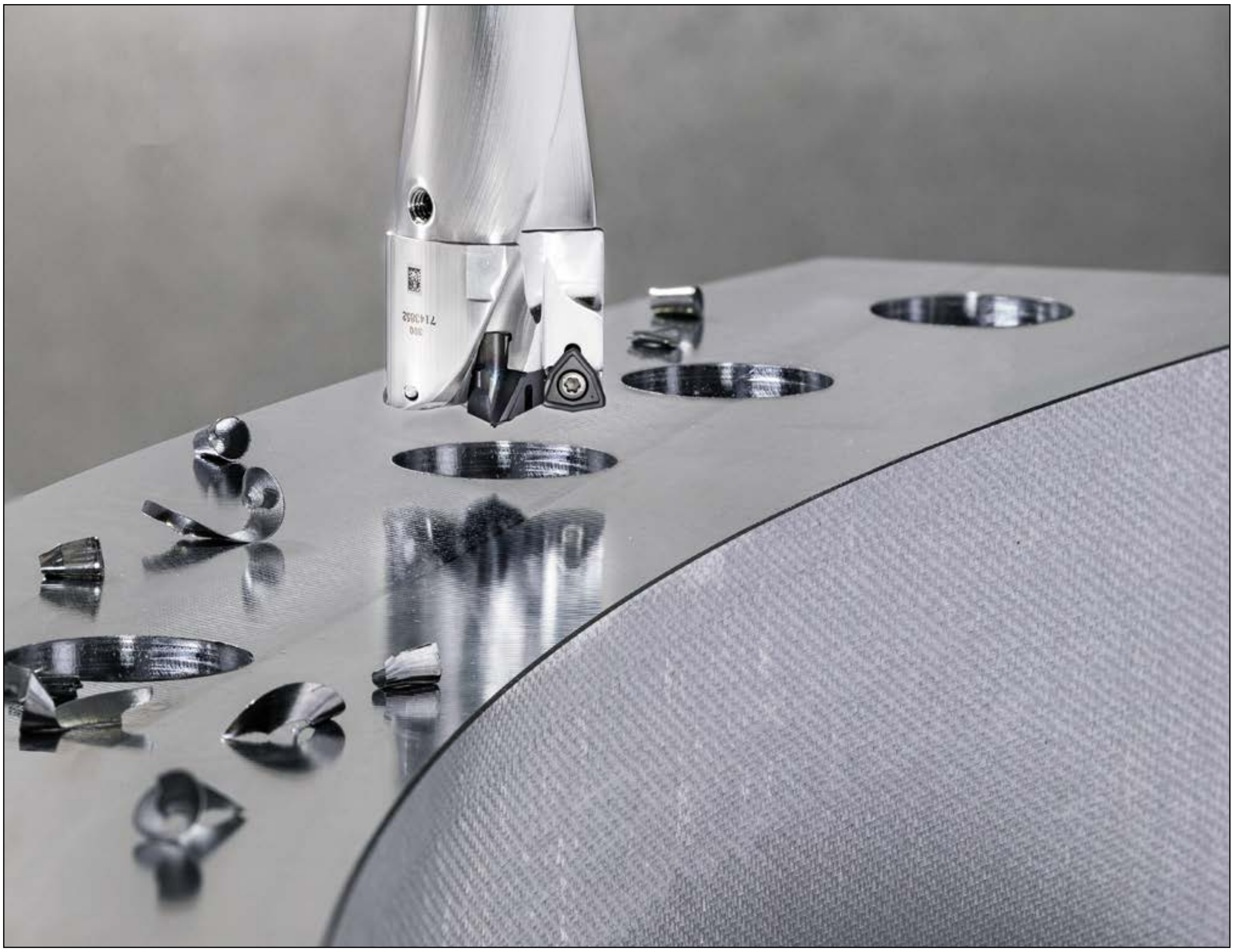
ISO	Material		Condition	Tensile Strength [N/mm²]	Hardness HB	Material Group No.	Cutting Speed V_c [m/min] V_c min	V_c max	Feed vs. Drill Diameter F [mm/rev] 26< ØD <28 f min	f max	29< ØD <32 f min	f max	33< ØD <35 f min	f max	36< ØD <43 f min	f max	44< ØD <50 f min	f max
P	non-alloy steel and cast steel, free cutting steel	<0.25% C	annealed	420	125	1	120	200	0.25	0.35	0.25	0.35	0.25	0.40	0.25	0.40	0.28	0.45
		≥0.25% C	annealed	650	190	2												
		<0.55% C	quenched and tempered	850	250	3	130	190										
		≥0.55% C	annealed	750	220	4												
			quenched and tempered	1000	300	5												
	low alloy and cast steel (less than 5% of alloying elements)		annealed	600	200	6	120	180	0.25	0.33	0.25	0.33	0.25	0.38	0.25	0.38	0.26	0.43
			quenched and tempered	930	275	7												
				1000	300	8												
				1200	350	9												
	high alloyed steel, cast steel and tool steel		annealed	680	200	10	100	160	0.25	0.33	0.25	0.33	0.25	0.36	0.25	0.36	0.26	0.41
			quenched and tempered	1100	325	11												
	stainless steel and cast steel		ferritic / martensitic	680	200	12	90	140	0.12	0.24	0.12	0.24	0.16	0.25	0.18	0.25	0.18	0.30
			martensitic	820	240	13												
M	stainless steel and cast steel		austenitic, duplex	600	180	14	90	140	0.12	0.24	0.12	0.24	0.16	0.25	0.18	0.25	0.18	0.30
K	gray cast iron (GG)		ferritic / pearlitic		180	15	150	250	0.25	0.40	0.25	0.45	0.3	0.50	0.3	0.50	0.35	0.55
			pearlitic / martensitic		260	16												
	nodular cast iron (GGG)		ferritic		160	17												
			pearlitic		250	18												
	malleable cast iron		ferritic		130	19												
			pearlitic		230	20												
N	aluminum-wrought alloys		not hardenable		60	21	160	260	0.3	0.50	0.3	0.50	0.35	0.55	0.35	0.55	0.4	0.60
			hardenable		100	22												
	aluminum-cast alloys	≤12% Si	not hardenable		75	23												
			hardenable		90	24												
		>12% Si	high temperature		130	25												
	copper alloys	>1% Pb	free cutting		110	26												
			brass		90	27												
			electrolytic copper		100	28												
	non metallic		duroplastics, fiber plastics		70 Shore D	29												
			hard rubber		55 Shore D	30												
S	high temperature alloys	Fe based	annealed		200	31	30	60	0.1	0.16	0.1	0.18	0.15	0.20	0.15	0.22	0.16	0.24
			hardened		280	32	20	50										
		Ni or Co based	annealed		250	33												
			hardened		350	34												
			cast		320	35												
	titanium alloys		pure	400	190	36												
			alpha+beta alloys, hardened	1050	310	37												
H	hardened steel		hardened		55 HRC	38	20	50	0.1	0.16	0.12	0.18	0.14	0.2	0.14	0.2	0.16	0.22
			hardened		60 HRC	39												
	chilled cast iron		cast		400	40												
	cast iron		hardened		55 HRC	41												

Modular Exchangeable Drilling Heads



Some good things can be made even better. Much better. This is how the idea of creating a modular drill system was born. The modular drill system expands the possibilities for machining large diameter deep holes or drilling large diameter holes with overhang. The design of the modular drill system is very simple and easy to handle. The drill body can carry a variety of drill heads with indexable inserts or exchangeable drilling heads for different hole requirements, also by using extensions a drill of the required length can be assembled.In other words, the main goal of using modular drill system is versatility in machining large diameter holes. This system significantly reduces costs and simplifies technological processes.

MODU-DRILL



ISCAR's **MODU-DRILL** line expands the possibilities of drilling large diameter holes and features three different types of exchangeable heads that can be mounted on same drilling tool body. In other words, each drill body can carry any one of the three head types. The three available drilling heads covering a metric diameter range of 33 to 40 mm (imperial diameter range of 1.299 to 1.575 inches) but were designed for different applications - cutting conditions, required hole accuracy and surface finish.

ISCAR's **MODU-DRILL** line provides a significant increase in drilling depth. The usable length of the drill body belonging to the MODUDRIL line is 400 mm (15.748 inches). But this is not the limit, with an extension of which the length is 200 mm (7.874 inches), the drill body of the **MODU-DRILL** line can exceed 600 mm (23.622 inches).

When using the MD-EXTENSION, a short pre-hole of at least 1XD deep (minimum) with H8 hole tolerance MUST be prepared to guide the long drill (an endmill can be used) for all drilling head types.

Exchangeable Drilling Heads

The exchangeable drilling heads of **MODU-DRILL** line are designated MD-DFN ... HEAD, MD-DR-DH ... and MD-MNC... .

The MD-DFN ... HEAD carry CHAMIQDRILL line exchangeable solid carbide heads where HFP ... IQ is intended for machining ISO P, ISO K materials while IFP ... IQ is intended for machining ISO P, ISO M, and ISO S materials. Robust structure with concave cutting edge design enables drilling at high feed rates, providing very accurate IT8-IT9 hole tolerance. The unique pocket design enables many drilling head indexes. Special axial stoppers prevent the drilling head from being extracted during retraction. Large radial head stoppers provide high resistance to cutting forces, enabling very high cutting conditions.

HFP ... IQ
for ISO P, ISO K


IFP ... IQ
for ISO P, ISO M, ISO S


The MD-DR-DH ... carry standard SOMX indexable inserts with 4 cutting edges, providing an economical solution. A wide range of grades and chipformers SOMX inserts provide a solution for machining holes in a variety of materials. It is a known and proven design combined with the advantages of a modular system. Double-ended guide pads ensure the straightness of the bore and improve surface quality. When using MD-DR-DH ..., it is necessary to pre-drill flat bottom hole of 1XD minimum depth with a tolerance of H8. Used correctly, this drill head stands out with excellent straightness and surface finish. Recommended for low to medium feed machining.

SOMX ...-DT

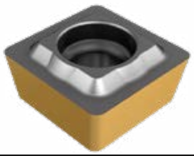
DT chipformer for general use

SOMX ...-GF

GF chipformer for soft materials

SOMX ...-HD

HD chipformer for carbon steel and soft materials



The MD-MNC modular head is designed for machining ISO P and ISO K materials, equipped with a pilot exchangeable **SUMO-CHAM** drilling head (designated as ICP ...-MNC) and peripheral indexable inserts (designated as WCGX ...-W). This modular head allows for drilling without the need for a pre-hole, achieving a depth-to-diameter ratio of up to 8xD. The MD-MNC combines cost efficiency with high precision, ensuring accuracy, cylindricity, roundness, and straightness of the machined hole. Recommended for medium to high feed machining.

Pilot exchangeable drilling head ICP ...-MNC

Peripheral indexable inserts WCGX ...-W

Drill Body and Exchangeable Extension

The **MODU-DRILL** line uses only two drill bodies to cover the full range: one for 33-36 mm (1.299-1.453 inches) and the other for 37-40 mm (1.457-1.575 inches).

These drill bodies have a length of 400 mm (15.748 inches) that can increase an additional 200 mm (7.874 inches) with an exchangeable extension.

The **MODU-DRILL** drill body designated MD-BODY-... and the **MODU-DRILL** extension designate MD-EXTENSION-... are made of high strength steel for high durability. The distinguishing feature of the MD-BODY-... and the MD-EXTENSION-... design is a small core with a central coolant hole, combined with a high flute helix and polished surface that ensures smooth and easy chip evacuation.

The patented connection withstands high torque. The shank complies with ISO 9266 standard.

Explanation of MODU-DRILL Exchangeable Drill Head Description

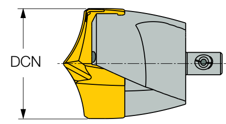
Example:

MD-DFN	350	HEAD
1	2	

1 Designation of the Drilling Head

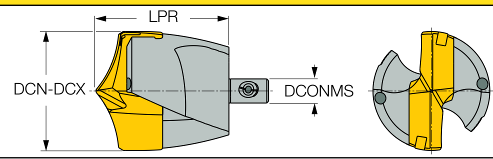
MD-DFN ... HEAD	—	carry **SPADE-CHAM** line exchangeable solid carbide heads
MD-DR-DH ...	—	carry standard SOMX indexable inserts with 4 cutting edges

2 Cutting Diameter minimum (DCN)

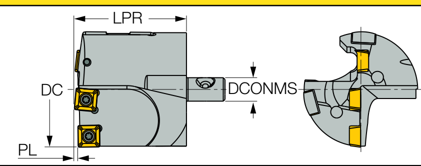


Basic Dimensions of MODU-DRILL Exchangeable Drilling Heads

MD-DFN ... HEAD



MD-DR-DH ...



DC	—	cutting diameter
LPR	—	protruding length
PL	—	point length
DCONMS	—	connection diameter machine side

Explanation of MODU-DRILL Drilling Body Description

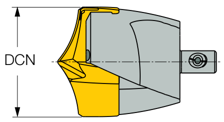
Example:

MD-BODY	33-36	400	32	A
1	2	3	4	5

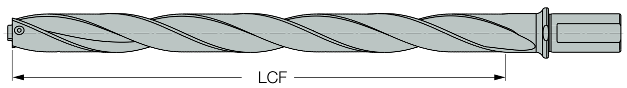
1 Designation of the Drilling Body

MD-BODY — **MODU-DRILL** drill body

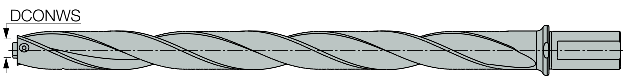
2 Cutting Diameter Drilling Head Range (DC)



3 Usable Length (LCF)



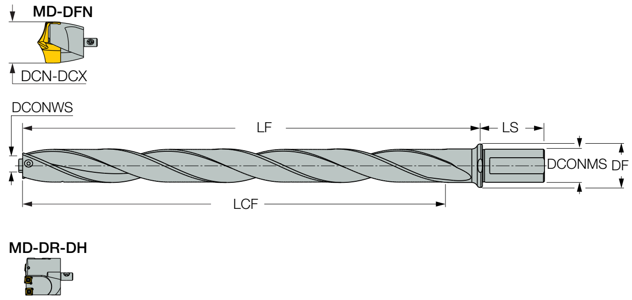
4 Connection Diameter Machine Side (DCONMS)



5 Shank Type

A — one flat shank

Basic Dimensions of MODU-DRILL Drilling Body



DCONWS — cutting diameter workpiece side

DF — flange diameter

LS — shank length

LF — functional length

LCF — length chip flute

DCN-DCX — cutting diameter drilling head range

DCONMS — connection diameter machine side

Explanation of MODU-DRILL Extension Description

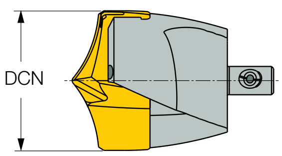
Example:

MD-EXTENSION	33-36	400
1	2	3

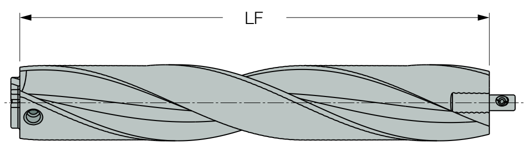
1 Designation of the Drilling Body

MD-EXTENSION — MODU-DRILL extension

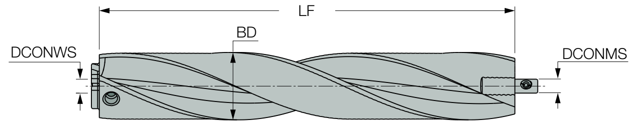
2 Cutting Diameter Drilling Head Range (DC)



3 Functional Length (LF)



Basic Dimensions of MODU-DRILL Extension



DCONWS — cutting diameter workpiece side

LF — functional length

BD — body diameter

DCONMS — connection diameter machine side

Modular Exchangeable Drilling Heads Cutting Conditions

Modudrill – Exchangeable Head MD-DFN ...

ISO	Material		Condition	Tensile Strength Rm [N/mm²]	Hardness HB	Material No.	V_c [m/min]	Feed Vs. Drill Diameter 33<ØD<40 (mm) f [mm/rev]
P	non-alloy steel and cast steel, free cutting steel	<0.25% C	annealed	420	125	1	80-110-140	0.30 0.40 0.50
		≥0.25% C	annealed	650	190	2	90-105-130	
		<0.55% C	quenched and tempered	850	250	3	80-100-120	
		≥0.55% C	annealed	750	220	4	70-90-110	
			quenched and tempered	1000	300	5	50-70-90	
	low alloy and cast steel (less than 5% of alloying elements)		annealed	600	200	6	80-100-120	0.30 0.40 0.50
			quenched and tempered	930	275	7	70-90-110	
				1000	300	8	50-70-90	
				1200	350	9	40-55-70	
	high alloyed steel, cast steel and tool steel		annealed	680	200	10	50-70-90	0.25 0.30 0.35
			quenched and tempered	1100	325	11	40-60-80	
K	gray cast iron (GG)		ferritic / pearlitic		180	15	90-125-160	0.40 0.50 0.60
			pearlitic / martensitic		260	16	80-110-140	
	nodular cast iron (GGG)		ferritic		160	17	90-135-180	
			pearlitic		250	18	80-110-140	
	malleable cast iron		ferritic		130	19	90-125-160	
			pearlitic		230	20	80-110-140	

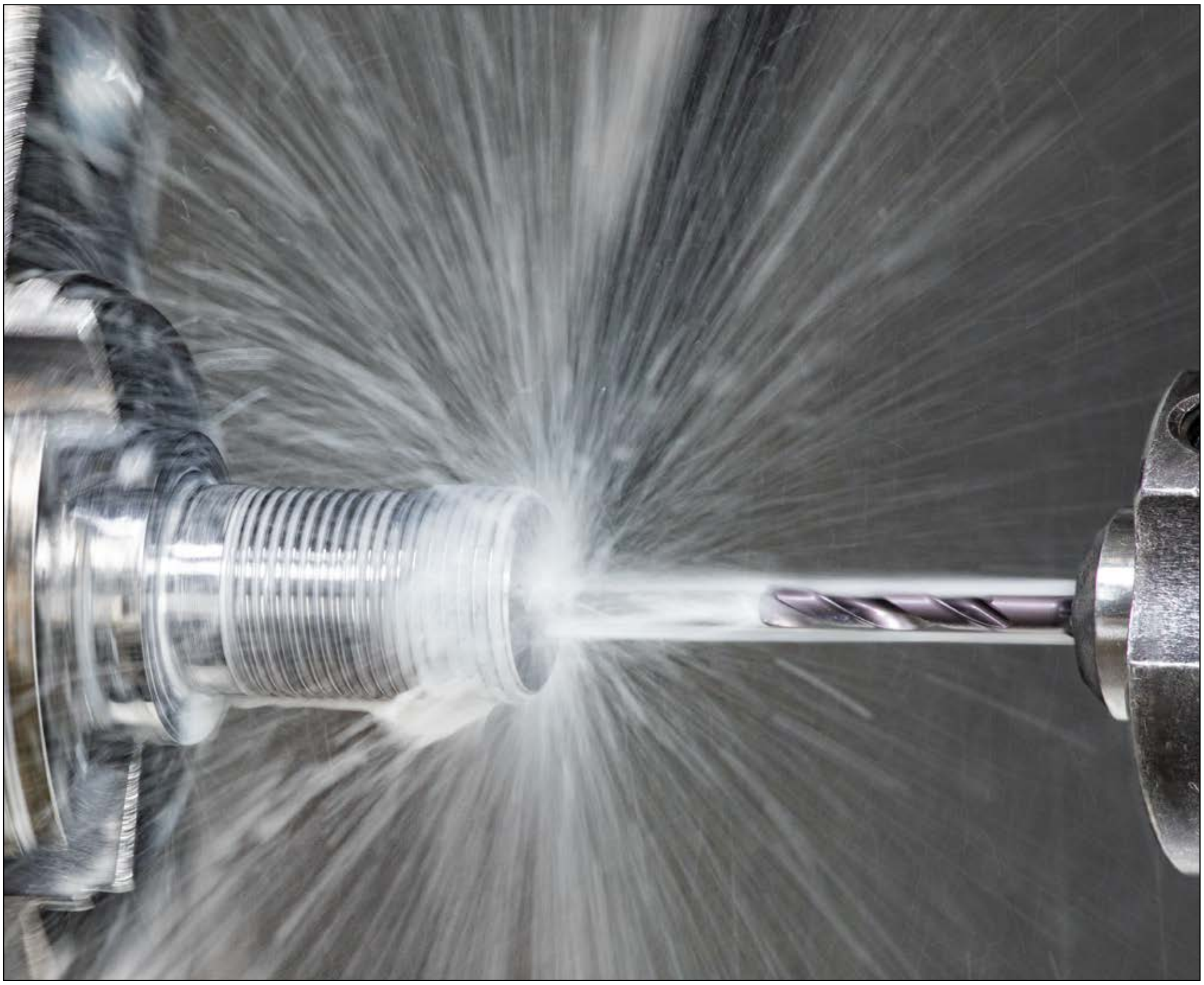
*Reduce speed by 50% when using the MD-Extension
*The MD-Extension is recommended for machining ISO K materials only

Modudrill – Exchangeable Head MD-DR-DH ...

ISO	Material		Condition	Tensile Strength Rm [N/mm²]	Hardness HB	Material No.	V_c [m/min]	Feed Vs. Drill Diameter 33<ØD<40 (mm) f [mm/rev]
P	non-alloy steel and cast steel, free cutting steel	<0.25% C	annealed	420	125	1	100-150	0.10-0.25
		≥0.25% C	annealed	650	190	2		
		<0.55% C	quenched and tempered	850	250	3	80-150	0.15-0.30
		≥0.55% C	annealed	750	220	4		
			quenched and tempered	1000	300	5		
	low alloy and cast steel (less than 5% of alloying elements)		annealed	600	200	6		
			quenched and tempered	930	275	7	70-120	0.15-0.30
				1000	300	8		
				1200	350	9		
	high alloyed steel, cast steel and tool steel		annealed	680	200	10	80-150	0.10-0.25
			quenched and tempered	1100	325	11	70-120	0.10-0.25
K	gray cast iron (GG)		ferritic / pearlitic		180	15	180-300	0.18-0.35
			pearlitic / martensitic		260	16		
	nodular cast iron (GGG)		ferritic		160	17	150-250	0.15-0.30
			pearlitic		250	18		
	malleable cast iron		ferritic		130	19		0.15-0.35
			pearlitic		230	20		

*Reduce speed by 50% when using the MD-Extension

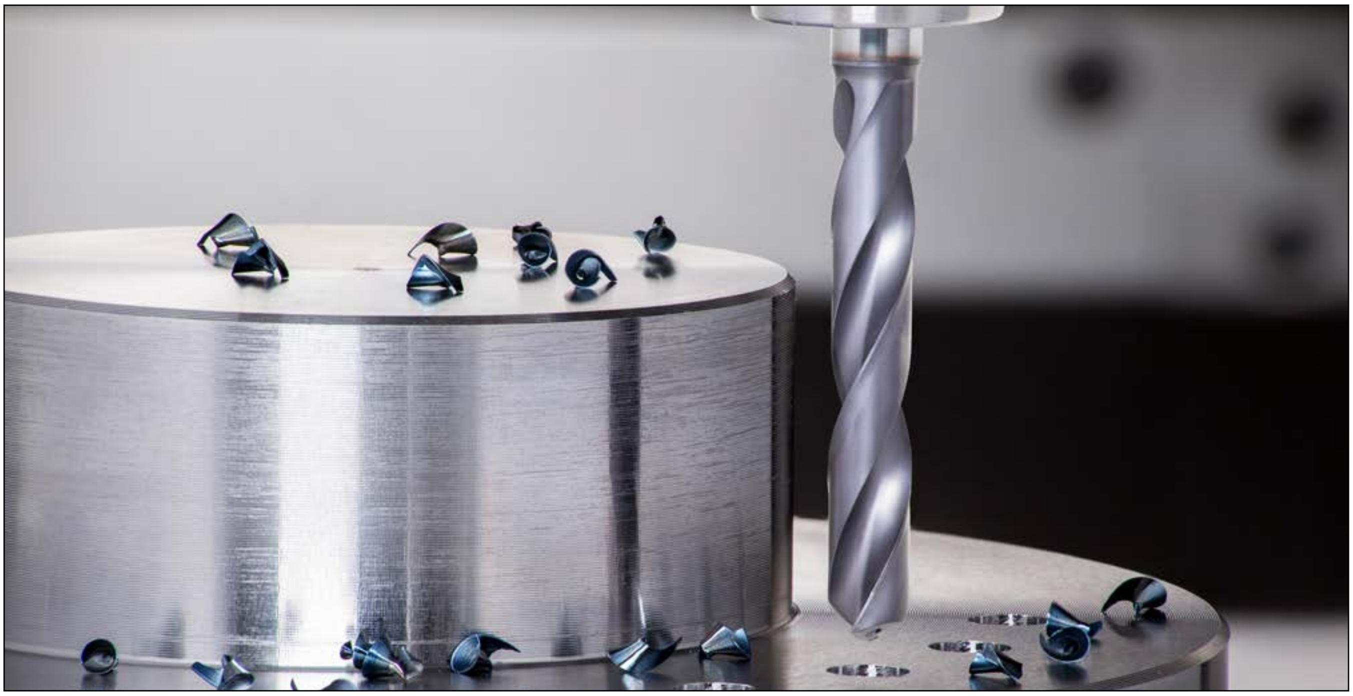
Solid Carbide Drills



Solid carbide drills offer an alternative to indexable drills for machining relatively small diameter holes with tight tolerances and in some cases are the only possible solution. Solid carbide drills are preferable for interrupted applications and machining holes with external coolant above 2XD. The market for solid carbide drills is very diverse and wide, but **ISCAR** tools stand out for their quality and reliability. The design of solid carbide drills can be both with internal coolant supply to the cutting zone, and with external coolant. These drills are coated for increased wear resistance.

At some point, the drill reaches its wear limit and to extend tool life, solid drills can be reground. Regrinding can usually be carried out multiple times. Most of **ISCAR** solid carbide drills comply with the DIN 6537 standard and are available in a diameter range of 0.8 to 20 mm (0.125 to 0.765 inches) with a functional length of up to 50XD depending on the drill diameter. Basically, solid drills are made with a cylindrical shank. Solid carbide drills have high rigidity and are able to work with high feed rates without compromising the quality and durability of the drill.

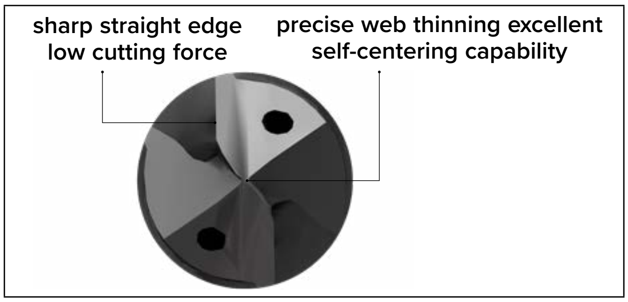
SOLID-DRILL

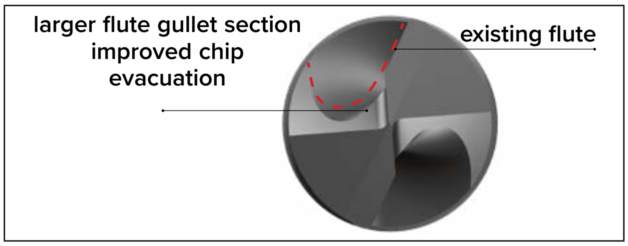


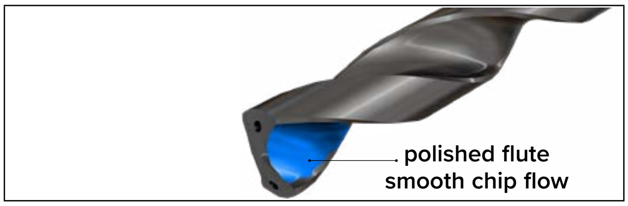
Today, competition in the solid carbide drills market is very tough, but the quality of **ISCAR** solid carbide drills is considered the market leader, mainly when it comes to drills designed for certain materials. All **ISCAR** solid carbide drills are manufactured using a very precise grinding process, which minimizes runout, thereby affecting the stability of the drilling process. Thought out to the smallest detail design, accurate manufacturing, high quality coating - provide the best general proposed drill in the market. The assortment of **ISCAR** solid carbide drills is constantly expanding to cover more and more applications on the market.

The SCD...APN/ACPN (3XD-8XD) drills for general purpose holemaking were designed with the most advanced features to machine the variety materials in the market. An optimized sharp straight cutting edge provide smooth cutting and low cutting forces.

Precise web thinning generates excellent self-centering and penetration capability for higher hole accuracy and drilling stability. The unique gash form creates optimal chip form in all materials. Narrow wiper reduce heat generation.







These drills are available with a diameter range of 3 to 12 mm (0.118 to 0.47 inches) according to tolerance m7 with 0.1 mm equivalent to 0.004 inch increments. SCD ...APN/ACPN drills designed with internal coolant holes for length to diameter ratio of 3XD, 5XD, 8XD and without internal coolant holes for length to diameter ratio of 3XD, 5XD.

All SCD ...APN/ACPN drills are made from grade IC908, which is multi-layered PVD coated and provides maximum toughness and increased wear resistance featuring prolonged tool life and high efficiency machining.

SCD ... APN/ACPN is clearly the key to success in machining holes for general use.

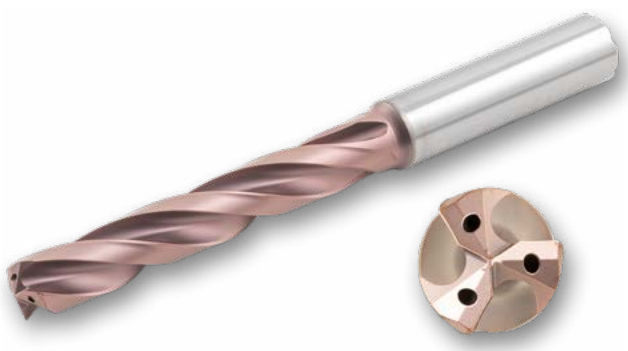
The SCD...SXC (16XD-50XD) are extra-long solid carbide drills. The initial contact between the drill and the material, especially when it comes to long drills, greatly affects the drilling result. Smooth penetration into the material is ensured by a sharper point angle than in short tools. These drills are designed with double margins to improve accuracy, stability, and surface finish.

The combination of polished and enlarged flutes with optimal coolant nozzle size provide proper chip evacuation and the multi-layer coating allows drilling at high speed while achieving maximum tool life. **ISCAR** solid carbide long drills are excellent for drilling small diameters and deep holes in automotive crankshafts, camshafts, connecting rods, cylinder heads, cylinder blocks, hydraulic blocks and for dies and molds. These drills feature high metal removal rates that are at least six times faster than HSS drills. The advantageous metal removal rate saves machine time and man hours for much better overall productivity.

The SCCD...ACP (3XD-5D) are 3 flute solid carbide drills with internal coolant channels. The unique geometry design significantly improves productivity and machining stability under high cutting conditions, especially in cast iron and provides maximum hole quality, performance reliability, and economic output.

These drills are precision holemaking tools and can achieve IT8 hole tolerance. The 3 flute solid carbide drills feature high spiral flute helix and a reinforced web, available with 140° head point angle with a nearly flat bottom required for diverse applications. SCCD drills are made from grade IC608 i.e., IC08 submicron substrate (10% cobalt) and advanced TiAIN coating with the edge resistance silicon “bronze” layer to ensure stable and prolonged edge life.

Their dimensions are according to DIN 6537 standard and are manufactured in m7 diameter tolerance, with cylindrical shanks according to DIN 6535 standard. The 3 flute solid carbide drills can be used on any CNC machining center, lathe machine, or Swiss-type machines. The SCCD drills are available in the range of 4 to 12 millimeter (0.157 to 0.472 inch) diameters with 0.1 millimeter (0.004 inch) increments and are suitable for machining holes up to 5D deep. SCCD drills have been found to be very effective in the automotive, die and mold, oil and gas, power generation, and heavy industries.



The SCD...AP4/AP6 micro drill with no coolant holes is intended for machining very small diameters in the range of 0.8 to 2.9 mm equivalent to 0.031 to 0.114 inches with 0.1 millimeter (0.004 inch) increments and the functional length of 4XD and 6XD. These drills are manufactured according to m6 drill diameter tolerance, cylindrical shanks according to DIN 6535 standard. The design featured a high spiral flute helix, 140° head point angle and a standard flute back taper.

The submicron substrate and reinforced web thickness provide superior rigidity. The multiplayer TiAIN PVD coating and special edge preparation for smoother cuts while ensuring process reliability and increased tool life. The drills can be used for ISO P, ISO M, ISO K and ISO N material groups. SCD...AP4/AP6 are widely used on Swiss-type machines and in the following industries: miniature parts, automotive, die and molds, aviation and aerospace, micro fittings, computer motherboards, medical, and general engineering.

The SCD...AH5 are solid carbide drills for hard materials with a hardness of 50-70HRc. These drills are available with a diameter range of 3 to 10.5 mm equivalent to 0.118 to 0.413 inches with tolerance m7 in length to diameter ratio of 5XD without internal coolant holes. The very rigid design with a thick reinforced web and low helix angle, prevents breakage which may be caused by micro-chipping.

A special edge preparation provides a smooth cut and narrow optimized flute for machining hard materials and provides uninterrupted flow of typical small chips. The SCD...AH5 are made from IC903, which is comprised of IC03 ultra fine substrate and the latest TiAlN PVD coating. They feature excellent performance, superior hole quality, reliability and in addition provide an economical solution. SCD...AH5 are used in die and mold, aviation and aerospace, automotive, power train, power generation, oil and gas, and medical industries.

The SCDT ...-M... are solid carbide step drills with internal coolant holes in the diameter range of 2.5-8.5 mm, which are compatible with ISO M thread standard of M3 to M10 pre-thread hole dimensions and expand the existing DCT... **CHAM-DRILL** Pre-Thread line. The dimensions of the solid carbide pre-thread drills are according to DIN 6537 and the step length are according to DIN 8378.

The outer cutting drill diameter manufacture according to m7 tolerance and round shank according to h6 tolerance.

The drill point angle is 140° and spiral helix flute is 30°. The straight cutting edge and pinpointed chisel geometry is designed for machining ISO P, ISO M, ISO K materials. Submicron IC08 substrate with 10% cobalt content and the latest IC900 TiAlN PVD coated grade increase wear resistance and enable high cutting conditions. These step drills are suitable for machining any blind or through hole applications requiring a top chamfer, thus providing an applicative and cost-effective machining solution.

The SCD...CVD drill design for composite materials features a unique design for optimal performance in all types of composite materials and promise high wear resistance.

Drilling in composite materials places special demands on machining.

The last decades are characterized by an increase in the use of composite materials in various industries. Hole making has become one of the most common machining processes in composites. The processing of composite materials, which combine two or more materials with different physical and chemical properties, involves cutting or breaking the fibrous portion of the material. If this is not done correctly, then the layers of composite material will peel off from their places. Delamination affects hole quality and repeatability.

The amount of heat generated during the processing of composites also becomes significant.

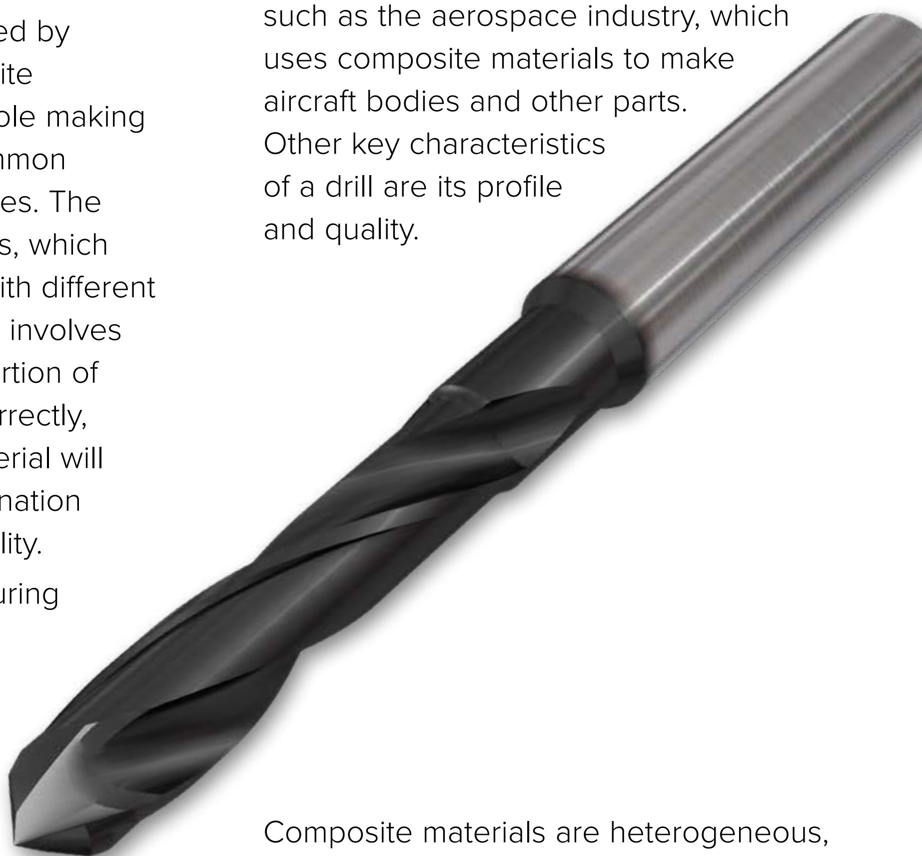
The poor thermal conductivity of the material and the absence of chips pose a danger to the resin that holds the fibers of the material together.

In other words, the processing of composites reveals flaws in the processing that might otherwise go unnoticed.

These shortcomings are underlined by the growing range and unpredictability of composite materials available on the market. This makes competitive processing a challenge.

The SCD...CVD is a high-performance drill for machining composites including carbon fiber (CFRP) and glass fiber reinforced (GFRP) materials. This drill was designed with a focus on industries that use composite materials extensively and require more drillable material per tool, such as the aerospace industry, which uses composite materials to make aircraft bodies and other parts.

Other key characteristics of a drill are its profile and quality.



Composite materials are heterogeneous, and the introduction of any new material into the production cycle creates unique challenges; thickness, composition type, and so on. Carbide drills are well suited for machining aerospace components because the carbide strengthens the tool through its cutting geometry and shank. This optimizes the cutting action and increases material evacuation. However, due to the abrasive nature of composites, carbide also wears quickly.

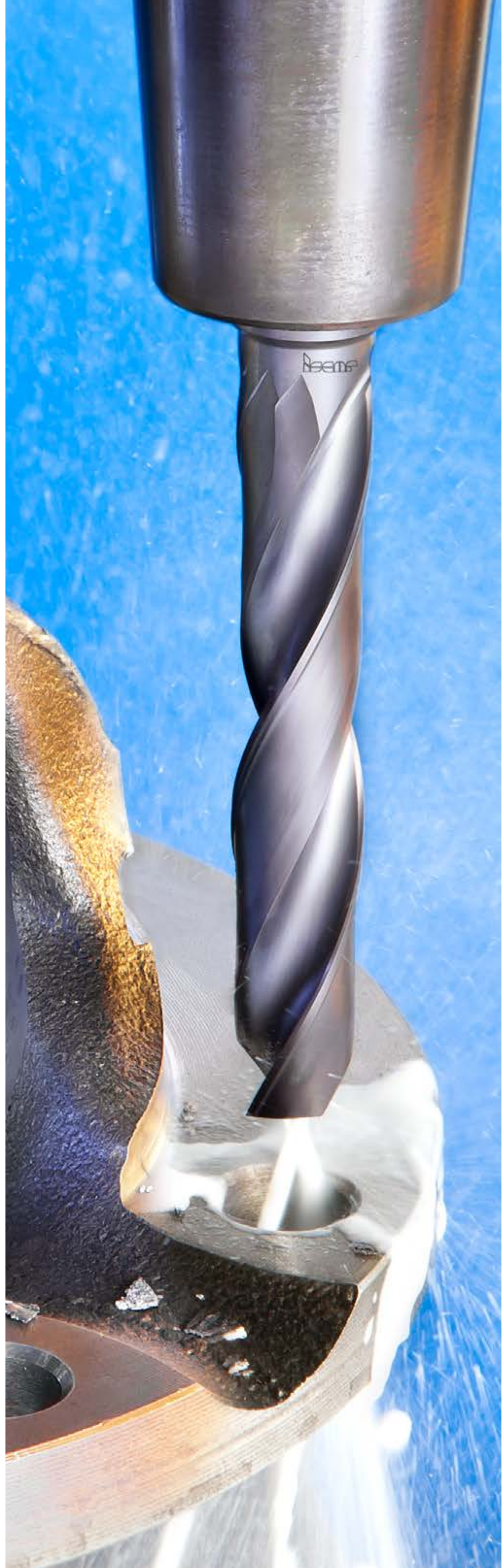
This is problematic, especially in automated production plants. To overcome this, chemical vapor deposition (CVD) diamond coating technology is used.

CVD is a very hard tool material that is ideal for machining composites and multilayer materials. Applying CVD layers across the entire cutting edge can significantly increase tool life, and due to low CVD friction and high thermal conductivity, tool edges are less prone to built-up edge (BUE).

Because the CVD stays sharp, it dissipates heat, has low friction, and minimizes the tendency for bore problems. Thus, CVD grade is preferred where there are a large number of holes and higher productivity is required.

SCD...CVD provides excellent tool life, reduced tool changes, and repeatability and reliability when machining composite materials.

The SCD...CVD is a specialty cutting tool that is critical to successful holemaking, especially in components made from composite or stacked materials. Such a tool can also play a critical role in helping companies fully automate their processes, even when processing rigid composite materials.



Explanation of Solid Carbide Drills Description

Example:

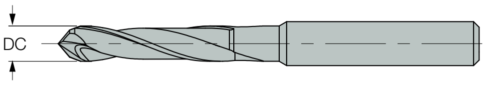
SCCD	040	017	060	A	C	P	3
1	2	3	4	5	6	7	8

1 Designation of Drilling Body

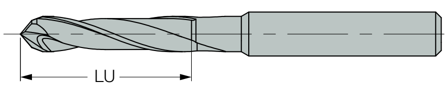
SCD — solid carbide drill with 2 flutes

SCCD — solid carbide drill with 3 flutes

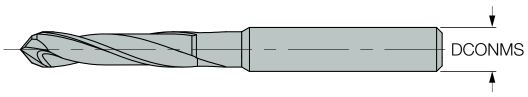
2 Cutting Diameter (DC)



3 Usable Length (LU)



4 Connection Diameter Machine Side (DCONMS)



5 Shank Type

A — cylindrical shank

6 Coolant

If not specified — external coolant

C — internal coolant

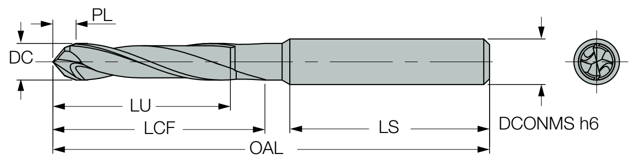
7 Cutting Geometry

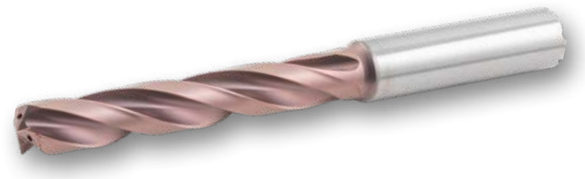
P — cutting geometry for steel

8 Functional Length to Diameter Ratio (LU/DC)

3 — functional length is 3 times the cutting diameter of the drill

Basic Dimensions of Solid Carbide Drill





DC — cutting diameter

DCONMS — connection diameter machine side

LU — usable length

LCF — length chip flute

OAL — overall length

LS — shank length

PL — point length

KCH — corner chamfer angle

CHW — corner chamfer width

SOLID-DRILL Cutting Conditions

Recommended Machining Conditions for Solid Carbide Drills D=0.8-2.9 mm

ISO	Material		Condition	Tensile Strength [N/mm²]	Hardness HB	Material No.(1)	Cutting Speed V_c (m/min)	Feed (mm/rev) vs. Drill Diameter Ø0.8-1.4	Ø1.5-1.9	Ø2-2.4	Ø2.5-2.9
P	non-alloy steel and cast steel, free cutting steel	<0.25% C	annealed	420	125	1	50-100	0.03-0.10	0.05-0.15	0.07-0.17	0.08-0.20
		≥0.25% C	annealed	650	190	2	40-100	0.03-0.10	0.05-0.15	0.07-0.17	0.08-0.20
		<0.55% C	quenched and tempered	850	250	3	40-85	0.03-0.10	0.05-0.15	0.07-0.17	0.08-0.20
		≥0.55% C	annealed	750	220	4	40-85	0.03-0.10	0.05-0.15	0.07-0.17	0.08-0.20
			quenched and tempered	1000	300	5	40-85	0.03-0.10	0.05-0.15	0.07-0.17	0.08-0.20
	low alloy and cast steel (less than 5% of alloying elements)		annealed	600	200	6	40-75	0.03-0.10	0.05-0.15	0.07-0.17	0.08-0.20
			quenched and tempered	930	275	7	40-60	0.03-0.10	0.05-0.15	0.07-0.17	0.08-0.20
				1000	300	8	40-60	0.03-0.10	0.05-0.15	0.07-0.17	0.08-0.20
				1200	350	9	40-60	0.03-0.10	0.05-0.15	0.07-0.17	0.08-0.20
	high alloyed steel, cast steel and tool steel		annealed	680	200	10	30-50	0.03-0.10	0.05-0.15	0.07-0.17	0.08-0.20
			quenched and tempered	1100	325	11	30-50	0.03-0.10	0.05-0.15	0.07-0.17	0.08-0.20
	stainless steel and cast steel		ferritic / martensitic	680	200	12	20-35	0.03-0.06	0.04-0.08	0.05-0.10	0.06-0.10
			martensitic	820	240	13	20-35	0.03-0.06	0.04-0.08	0.05-0.10	0.06-0.10
M	stainless steel and cast steel		austenitic, duplex	600	180	14	20-35	0.03-0.06	0.04-0.08	0.05-0.10	0.06-0.10
K	gray cast iron (GG)		ferritic / pearlitic		180	15	40-80	0.03-0.10	0.05-0.15	0.07-0.17	0.08-0.20
			pearlitic / martensitic		260	16	40-70	0.03-0.10	0.05-0.15	0.07-0.17	0.08-0.20
	nodular cast iron (GGG)		ferritic		160	17	40-95	0.03-0.10	0.05-0.15	0.07-0.17	0.08-0.20
			pearlitic		250	18	50-95	0.03-0.10	0.05-0.15	0.07-0.17	0.08-0.20
	malleable cast iron		ferritic		130	19	40-80	0.03-0.10	0.05-0.15	0.07-0.17	0.08-0.20
			pearlitic		230	20	40-80	0.03-0.10	0.05-0.15	0.07-0.17	0.08-0.20
N	aluminum-wrought alloys		not hardenable		60	21	80-150	0.03-0.10	0.05-0.15	0.07-0.17	0.08-0.20
			hardenable		100	22	80-150	0.03-0.10	0.05-0.15	0.07-0.17	0.08-0.20
	aluminum-cast alloys	≤12% Si	not hardenable		75	23	80-150	0.03-0.10	0.05-0.15	0.07-0.17	0.08-0.20
			hardenable		90	24	80-150	0.03-0.10	0.05-0.15	0.07-0.17	0.08-0.20
		>12% Si	high temperature		130	25	80-150	0.03-0.10	0.05-0.15	0.07-0.17	0.08-0.20
	copper alloys	>1% Pb	free cutting		110	26	80-150	0.03-0.10	0.05-0.15	0.07-0.17	0.08-0.20
			brass		90	27	50-150	0.05-0.12	0.07-0.15	0.08-0.18	0.09-0.18
			electrolytic copper		100	28	60-160	0.05-0.15	0.07-0.18	0.08-0.20	0.09-0.22
	non metallic		duroplastics, fiber plastics		70 Shore D	29					
			hard rubber		55 Shore D	30					
S	high temperature alloys	Fe based	annealed		200	31	10-20	0.02-0.04	0.03-0.06	0.04-0.07	0.04-0.08
			hardened		280	32	10-20	0.02-0.04	0.03-0.06	0.04-0.07	0.04-0.08
		Ni or Co based	annealed		250	33	10-20	0.02-0.04	0.03-0.06	0.04-0.07	0.04-0.08
			hardened		350	34	10-20	0.02-0.04	0.03-0.06	0.04-0.07	0.04-0.08
			cast		320	35	10-20	0.02-0.04	0.03-0.06	0.04-0.07	0.04-0.08
	titanium alloys		pure	400	190	36	10-20	0.02-0.03	0.02-0.03	0.03-0.04	0.03-0.04
			alpha+beta alloys, hardened	1050	310	37	10-20	0.02-0.03	0.02-0.03	0.03-0.04	0.03-0.04
H	hardened steel		hardened		55 HRC	38	10-20	0.01-0.02	0.01-0.02	0.02-0.03	0.02-0.03
			hardened		60 HRC	39	10-20	0.01-0.02	0.01-0.02	0.02-0.03	0.02-0.03
	chilled cast iron		cast		400	40	10-20	0.01-0.02	0.01-0.02	0.02-0.03	0.02-0.03
	cast iron		hardened		55 HRC	41	10-20	0.01-0.02	0.01-0.02	0.02-0.03	0.02-0.03

- For drill with length to diameter ratio larger than 6xD, reduce feed by 20%
- If the RPM exceeds 10,000, a dynamic balance should be done to the system
- Maximal radial and axial runout should not exceed 0.01 mm As a starting value, the middle of the recommended machining range should be used, then (according to wear results), conditions can be changed in order to optimize performance.

Recommended Machining Conditions for Solid Carbide Drills D3.0-20.0 mm

ISO	Material		Condition	Tensile Strength [N/mm²]	Hardness HB	Material No.[1]	Cutting Speed V_c m/min	Feed (mm/rev) vs. Drill Diameter Ø3-5	Ø5.1-8	Ø8.1-12	Ø12.1-16	Ø16.1-20
P	non-alloy steel and cast steel, free cutting steel	<0.25% C	annealed	420	125	1	80-120	0.10-0.18	0.15-0.25	0.2-0.30	0.20-0.35	0.25-0.40
		≥0.25% C	annealed	650	190	2	80-110	0.10-0.18	0.15-0.25	0.2-0.30	0.20-0.35	0.25-0.40
		<0.55% C	quenched and tempered	850	250	3	70-100					
		≥0.55% C	annealed	750	220	4		0.10-0.20	0.15-0.28	0.2-0.35	0.20-0.38	0.25-0.42
			quenched and tempered	1000	300	5						
	low alloy and cast steel (less than 5% of alloying elements)		annealed	600	200	6	70-90	0.10-0.18	0.15-0.25	0.2-0.30	0.20-0.35	0.25-0.40
			quenched and tempered	930	275	7						
				1000	300	8	60-80	0.10-0.18	0.15-0.25	0.2-0.30	0.20-0.35	0.25-0.40
				1200	350	9	50-70	0.10-0.20	0.15-0.28	0.2-0.35	0.20-0.38	0.25-0.42
	high alloyed steel, cast steel and tool steel		annealed	680	200	10	60-80	0.10-0.20	0.15-0.28	0.18-0.35	0.20-0.38	0.25-0.42
			quenched and tempered	1100	325	11	50-70	0.10-0.15	0.12-0.20	0.14-0.25	0.16-0.30	0.18-0.32
	stainless steel and cast steel		ferritic / martensitic	680	200	12	25-75	0.04-0.10	0.05-0.15	0.05-0.18	0.08-0.20	0.10-0.20
			martensitic	820	240	13	25-75	0.04-0.10	0.05-0.15	0.05-0.18	0.08-0.20	0.10-0.20
M	stainless steel and cast steel		austenitic, duplex	600	180	14	25-75	0.04-0.10	0.05-0.15	0.05-0.18	0.08-0.20	0.10-0.20
K	gray cast iron (GG)		ferritic / pearlitic		180	15	85-105	0.15-0.25	0.20-0.35	0.25-0.45	0.30-0.50	0.35-0.55
			pearlitic / martensitic		260	16	75-90	0.15-0.25	0.20-0.35	0.25-0.45	0.30-0.50	0.35-0.55
	nodular cast iron (GGG)		ferritic		160	17	65-80	0.12-0.20	0.15-0.25	0.20-0.35	0.25-0.40	0.30-0.45
			pearlitic		250	18						
	malleable cast iron		ferritic		130	19						
			pearlitic		230	20						
N	aluminum-wrought alloys		not hardenable		60	21	70-300	0.10-0.25	0.15-0.35	0.25-0.45	0.30-0.50	0.35-0.55
			hardenable		100	22	70-200					
	aluminum-cast alloys	≤12% Si	not hardenable		75	23	70-300	0.07-0.18	0.12-0.25	0.20-0.35	0.25-0.45	0.30-0.50
			hardenable		90	24						
		>12% Si	high temperature		130	25						
	copper alloys	>1% Pb	free cutting		110	26						
			brass		90	27						
			electrolytic copper		100	28						
	non metallic		duroplastics, fiber plastics		70 Shore D	29						
			hard rubber		55 Shore D	30						
S	high temperature alloys	Fe based	annealed		200	31						
			hardened		280	32						
		Ni or Co based	annealed		250	33						
			hardened		350	34						
			cast		320	35						
	titanium alloys		pure	400	190	36						
			alpha+beta alloys, hardened	1050	310	37	15-35	0.02-0.07	0.04-0.10	0.06-0.12	0.08-0.15	0.08-0.18
H	hardened steel		hardened		55 HRC	38	40-70	0.06-0.10	0.08-0.12	0.10-0.14	0.12-0.16	0.14-0.18
			hardened		60 HRC	39						
	chilled cast iron		cast		400	40						
	cast iron		hardened		55 HRC	41						

As a starting value, the middle of the recommended machining range should be used, then (according to wear results), conditions can be changed in order to optimize performance.

- When using external coolant supply only, reduce cutting speed by 10%
- Use internal coolant supply when machining austenitic stainless steel

Recommended Machining Conditions for SCD-SXC Solid Carbide Drills

ISO	Material		Condition	Material Group No.	Tensile Strength [N/mm²]	Hardness HB	Cutting Speed V_c (m/min)	Cutting Diameter / Feed (mm/rev) 3.0-5.0	5.1-8.0	8.1-10.0	10.1-16	16.1-20
P	non-alloy steel and cast steel, free cutting steel	<0.25% C	annealed	1	420	125	70-90	0.1-0.18	0.14-0.24	0.16-0.26	0.18-0.3	0.2-0.35
		≥0.25% C	annealed	2	650	190						
		<0.55% C	quenched and tempered	3	850	250						
		≥0.55% C	annealed	4	750	220						
			quenched and tempered	5	1000	300						
	low alloy and cast steel (less than 5% of alloying elements)		annealed	6	600	200						
			quenched and tempered	7	930	275						
				8	1000	300						
				9	1200	350						
	high alloyed steel, cast steel and tool steel		annealed	10	680	200	75-85					
			quenched and tempered	11	1100	325						
	stainless steel and cast steel		ferritic/martensitic	12	680	200	60-70	0.08-0.14	0.1-0.18	0.12-0.2	0.14-0.22	0.16-0.24
			martensitic	13	820	240						
M	stainless steel and cast steel		austenitic, duplex	14	600	180	55-65	0.06-0.14	0.08-0.16	0.1-0.18	0.12-0.2	0.14-0.24
K	gray cast iron (GG)		ferritic / pearlitic	15		180	80-100	0.14-0.24	0.16-0.26	0.18-0.0.3	0.2-0.35	0.25-0.45
			pearlitic / martensitic	16		260						
	nodular cast iron (GGG)		ferritic	17		160						
			pearlitic	18		250						
	malleable cast iron		ferritic	19		130						
			pearlitic	20		230						
S	high temperature alloys	fe based	annealed	31		200	35-45	0.06-0.12	0.08-0.16	0.1-0.18	0.12-0.2	0.12-0.22
			hardened	32		280						
		Ni or Co based	annealed	33		250	30-40	0.06-0.12	0.08-0.16	0.1-0.18	0.12-0.2	0.12-0.22
			hardened	34		350						
			cast	35		320						
	titanium alloys		pure	36	RM 400	190	35-45	0.06-0.12	0.08-0.16	0.1-0.18	0.12-0.2	0.12-0.22
			alpha+beta alloys, hardened	37	RM 1050	310						

Recommended Machining Conditions for SCCD-ACP Solid Carbide Drills

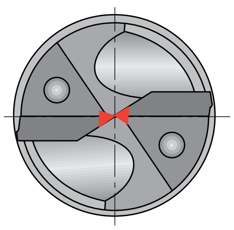
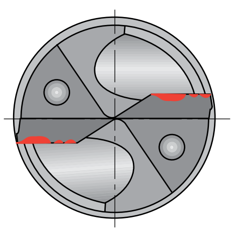
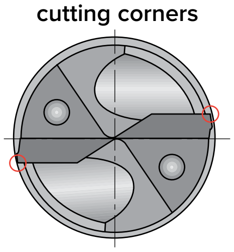
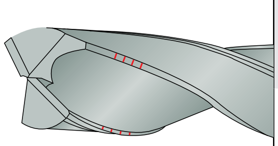
ISO	Material No.	Material		Material Condition	Cutting Speed V_c, m/min	Cutting Diameter / Feed f, mm/rev Ø4-5	Ø5.1-6	Ø6.1-8	Ø8.1-10	Ø10.1-12
P	1	non-alloy steel and cast steel, free cutting steel	<0.25% C	annealed	80-140	0.15-0.25	0.20-0.35	0.25-0.45	0.30-0.55	0.35-0.60
	2		≥0.25% C	annealed	80-130					
	3		<0.55% C	quenched and tempered	80-120					
	4		≥0.55% C	annealed	70-110					
	5			quenched and tempered	50-90					
	6	low alloy steel and cast steel (less than 5% of alloying elements)		annealed	80-120			0.25-0.40	0.30-0.50	0.35-0.55
	7			quenched and tempered	70-110					
	8				50-90					
	9				40-70					
	10	high alloyed steel, cast steel, and tool steel		annealed	50-90	0.15-0.20	0.20-0.30	0.25-0.35	0.30-0.45	0.35-0.50
	11			quenched and tempered	40-80					
K	15	grey cast iron		ferritic/pearlitic	80-140	0.20-0.30	0.25-0.45	0.35-0.55	0.40-0.60	0.45-0.65
	16			pearlitic	70-120					
	17	nodular cast iron		ferritic	80-120		0.20-0.40	0.30-0.50	0.35-0.55	0.40-0.60
	18			pearlitic	70-110					
	19	malleable cast iron		ferritic	80-120					
	20			pearlitic	70-110					

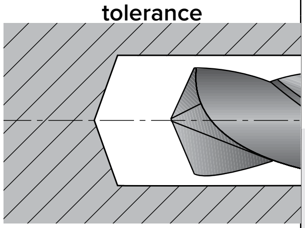
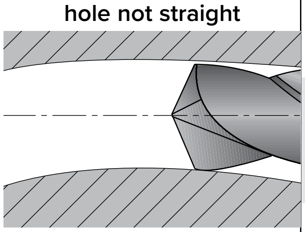
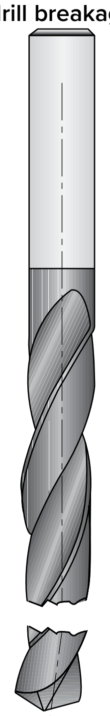
Recommended Machining Conditions for SCD-AH5 Solid Carbide Drills

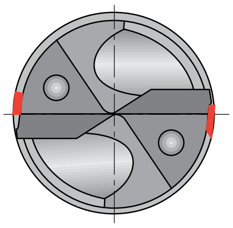
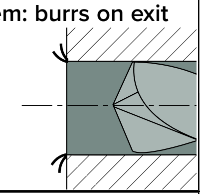
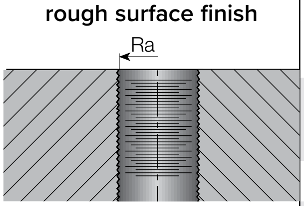
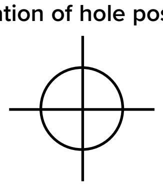
ISO	Material	Hardness	Material No.	Cutting Speed V_c (m/min)	Feed vs. Drill Diameter (mm/rev) Ø3-5	Ø5.1-8	Ø8.1-12
H	hardened steel	50-55 HRC	38	25-40	0.04-0.07	0.05-0.08	0.06-0.10
	hardened steel	56-60 HRC	39	15-25	0.03-0.06	0.04-0.07	0.05-0.08
	hardened steel	61-70 HRC	39	10-15	0.02-0.04	0.03-0.05	0.03-0.05

Materials over 50 HRC must be used with external cooling while machining.
Use of semi-synthetic or emulsion with more than 6% oil concentration is highly recommended to extend tool life and hole quality.

SOLID-DRILL Troubleshooting

Problem	Cause	Solution
chipping on the chisel edge 	• Poor clamping of the chuck.	• Check the clamping. Use hydraulic clamping chuck, **MAXIN** power chuck or a shrink system.
	• Unsuitable cutting conditions.	• Decrease feed, increase coolant pressure.
	• Chisel runout.	• Check or replace the clamping adaptation.
	• Workpiece movement.	• Increase workpiece chucking force.
chipping on the cutting edges / built-up edge 	• Poor clamping of the chuck.	• Check the clamping. Use hydraulic clamping chuck, **MAXIN** power chuck or a shrink system.
	• Unsuitable cutting conditions.	• Increase cutting speed, reduce feed rate.
	• Insufficient coolant.	• Check cooling lubricant. Increase coolant pressure. In the case of external coolant supply, improve jet direction and add cooling jets.
	• Rough application.	• Reduce feed rate by 30-50% during entry and exiting.
excessive wear on the cutting corners 	• Insufficient coolant.	• Check cooling lubricant. Increase coolant pressure. In the case of external coolant supply, improve jet direction and add coolant jets.
	• Large runout.	• Check if the runout is within 0.02 mm T.I.R. (radial & axial)
	• Unsuitable cutting conditions.	• Reduce cutting speed, increase feed.
	• Rough application.	• Reduce feed rate by 30-50% during entry and exit.
	• Poor clamping of the chuck.	• Check the clamping. Use hydraulic clamping chuck, **MAXIN** power chuck or a shrink system.
chipping on the lands 	• Workpiece movement.	• Increase workpiece chucking force.
	• Insufficient coolant.	• Check cooling lubricant. Increase coolant pressure. In the case of external coolant supply, improve jet direction and add coolant jets.
	• Wrong drill.	• Check drill type, drilling depth, cooling system and workpiece material.
	• Unsuitable cutting conditions.	• Increase feed. When spot drilling, reduce feed.

Problem	Cause	Solution
hole diameter out of tolerance 	• Unsuitable cutting conditions.	• If hole size is too large, increase cutting speed or reduce feed. If hole size is too small, reduce cutting speed or increase feed.
	• Poor clamping of the chuck.	• Check the clamping. Use hydraulic clamping chuck, **MAXIN** power chuck or a shrink system.
	• Large runout.	• Make sure that the drill's runout is within 0.02 mm (radial & axial).
	• Worn out center point (chisel).	• Regrind cutting edge or replace the drill.
hole not straight 	• Insufficient chip evacuation.	• Use pecking cycle.
	• Poor clamping of the chuck.	• Check the clamping. Use hydraulic clamping chuck, **MAXIN** power chuck or a shrink system.
	• Workpiece rigidity.	• Increase workpiece chucking force.
	• Worn out drill center point (chisel).	• Regrind cutting edge.
	• Unsuitable cutting conditions.	• Increase feed. When spot drilling, reduce feed.
drill breakage 	• Poor clamping of the chuck.	• Check the clamping. Use hydraulic clamping chuck, **MAXIN** power chuck or a shrink system.
	• Workpiece movement.	• Increase workpiece chucking force.
	• Wrong drill.	• Check drill type and drilling depth, cooling system and workpiece material.
	• Insufficient coolant.	• Check cooling lubricant. Increase coolant pressure. In the case of external coolant supply, improve jet direction and add cooling jets.
	• Unsuitable cutting conditions.	• Reduce feed.
	• Worn out drill center point (chisel).	• Regrind cutting edge.
	• Insufficient chip evacuation.	• Use pecking cycle.

Problem	Cause	Solution
chipping on the cutting corners 	• Poor clamping of the chuck.	• Check the clamping and adaptation. Use hydraulic clamping chuck, **MAXIN** power chuck or a shrink system.
	• Workpiece movement.	• Increase workpiece chucking force.
	• Wrong drill.	• Check drill type and drilling depth, cooling system and workpiece material. Possibly use longer drill.
	• Insufficient coolant.	• Check cooling lubricant. Increase coolant pressure. In the case of external coolant supply, improve jet direction and add cooling jets.
	• Unsuitable cutting conditions.	• Check cutting parameters, and possibly reduce feed.
	• Worn out or broken cutting corner.	• Replace drill or regrind cutting edge.
problem: burrs on exit 	• Unsuitable cutting conditions.	• Reduce feed by 30-50% during exit.
	• Worn out drill.	• Replace drill.
rough surface finish 	• Unsuitable cutting conditions.	• Adjust feed to improve chip flow.
	• Large runout.	• Make sure that the drill's runout is within 0.02 mm (radial & axial).
	• Chip jamming.	• Reduce cutting speed.
	• .	• Increase coolant pressure.
	• .	• Apply pecking procedure.
deviation of hole position 	• Large runout.	• Make sure that the drill runout is within 0.02 mm (radial & axial).
	• Poor stability.	• Check and improve drill and workpiece clamping rigidity.
	• Rough application.	• When drilling hard materials or sloped surfaces, reduce feed by 30-50% during entrance.
	• .	• Use a short pilot drill with 140° point angle.

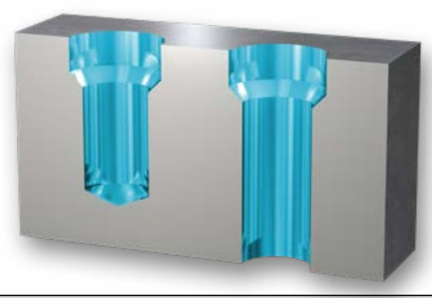
Pre-Thread Drilling with Chamfering

Pre-Thread Drilling / Drilling with Chamfering Drilling Stepped Holes

A large number of drilled holes require chamfering. In some cases, the profile of the required hole is more complex and includes chamfering and counterboring.

A preparatory hole for threading is one of the common uses for these holes. Despite the fact that cutting internal threads is not a complex technological operation, there are some features for the preparation of this procedure. In most cases, before threading, it is necessary to drill a pre-hole with a chamfer. Sometimes counterboring is also required in addition to chamfering.

Therefore, it is recommended to accurately determine the dimensions of the pre-hole for threading and choose the right tool, for which special tables of drill diameters for threading are used. For each type of thread, it is required to use the appropriate tool and calculate the diameter of the preparation hole. Keep in mind that if the diameters of the pre-holes intended for threading are chosen incorrectly, this can lead not only to poor quality threads but also to breakage of the threading tool. An additional example of the use of holes with chamfering, or holes with chamfering and counterboring, are holes for screws, rivets, etc.

	Hole with Chamfering	Hole with Chamfering and Counterboring
Common Use		
Deburring	V	
Preparation for Threading	V	V
Flush Fastening for Bolts, Screws, Nuts, Etc.	V	V
Reduced Stress Concentration	V	
Bushing Placement	V	V
Cosmetic Enhancement	V	V

Combined Drills

The most optimal solution for drilling holes with chamfering, or holes with chamfering and counterboring, is with a combined drill. The combined drill is designed for machining several different drilling operations with one drill.

Using a combined drill greatly simplifies the processing of holes with chamfering and the processing of more complex holes, including chamfering and counterboring.

The most obvious advantages of the combined drill are:

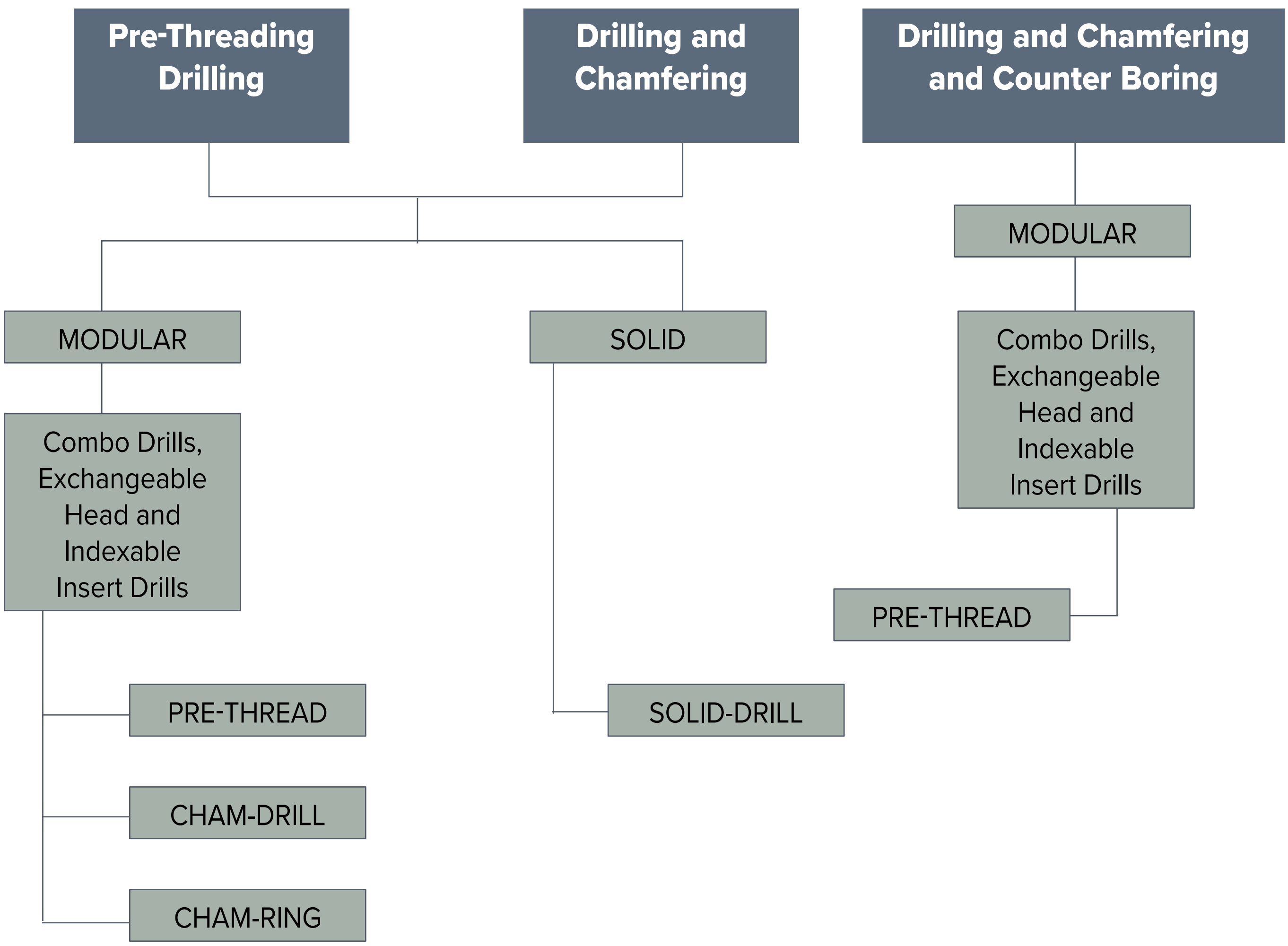
- Increasing productivity - by reducing machine time, i.e., cancelling machine time required to change tools and reducing tool set-up time.
- Reducing required tool stock.
- The ability of drilling a more accurate hole that contains elements such as chamfering or chamfering and counterboring, which is a significant reduction in the coaxial deviations of the various hole elements due to removing axis movements of the table during regular tools exchange inside the machine.

The combined drill is a great option that does not change cutting tools but performs operations such as drilling, chamfering, and counterboring with one tool.

ISCAR Product Family for Pre-Thread Drilling

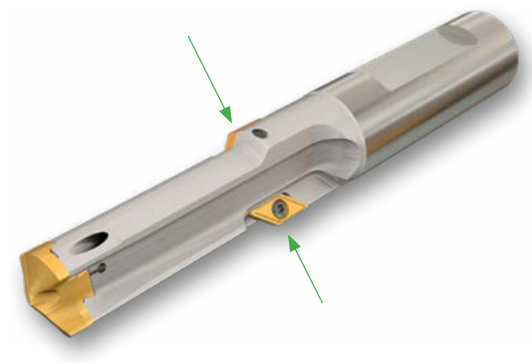
Drilling with Chamfering, and Drilling with Chamfering and Counterboring

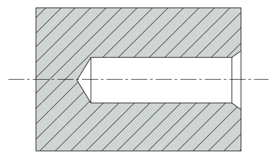
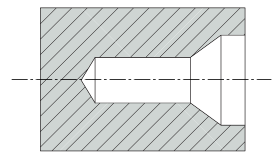
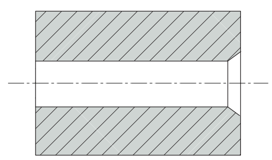
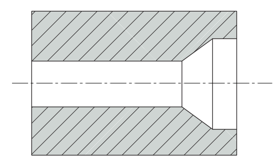
ISCAR offers standard drills and special tools for efficient drilling of pre-threading holes, holes with chamfering, and holes with chamfering and counterboring.



Pre-Thread Assembled Combined Drills

Assembled combined drills belonging to the Pre-Thread line carry two unique indexable chamfering inserts and interchangeable drilling heads.

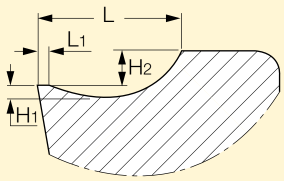


Pre-Thread Drilling	
Blind Hole	
Drilling with Chamfering	Drilling with Chamfering and Counterboring
	
Through Hole	
Drilling with Chamfering	Drilling with Chamfering and Counterboring
	

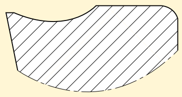
The indexable chamfering inserts designated AOMT ... are available with two types of chipformers DT and HD. The DT chipformer is suitable for machining all kinds of materials, while the HD chipformer is designed for machining low carbon steel and soft materials.

The indexable chamfering inserts placed symmetrically on the drill and cutting forces are balanced for optimal performance. This feature is especially essential in through hole application.

The indexable chamfering inserts were designed for chamfering and counterboring on a wide range of materials with optimal chip formation.



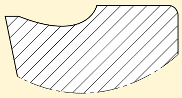
DT Chipformer



general use
for ISO – P/M/K/H/S materials
for medium up to high feed rates

L – open
H2 – low
L1 – medium
H1 – shallow

HD Chipformer



general use
for low up to medium feed rates
for ISO – P material

L – close
h2 – high
L1 – small
h1 – deep

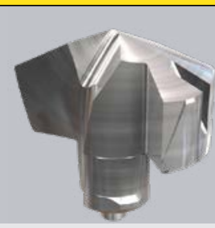
Assembled combined drills belonging to the Pre-Thread line provides geometric versatility by capability of using a range of interchangeable drilling heads on each drill body.

Drilling head replacement performs quickly and easily thanks to self-clamping mechanism, also no set-up is required after drilling head replacement.

The pocket of the drill body can carry various interchangeable drilling heads for pre-threading operation according to the requirements of different thread standards.

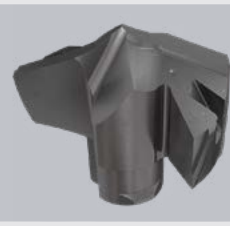
Related Drilling Heads for DCNT ...

ICP
Exchangeable **SUMO-CHAM** drilling heads for machining ISO P materials.

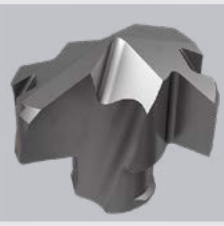


ICP-2M
Exchangeable double margin **SUMO-CHAM** drilling heads, for machining ISO P materials with high surface finish results.

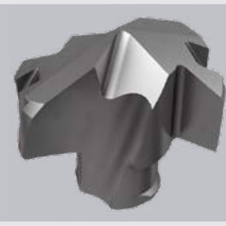
ICM
Exchangeable **SUMO-CHAM** drilling heads for machining ISO M and ISO S materials.



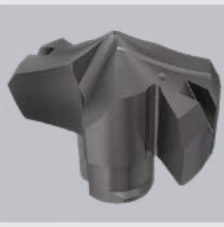
QCP-2M
Exchangeable double margin, self-centering **SUMO-CHAM** drilling heads, for ISO P materials with high surface finish results.



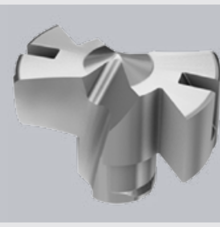
ICK
Exchangeable **SUMO-CHAM** drilling heads for machining ISO K materials.



ICK-2M
Exchangeable double margin **SUMO-CHAM** Drilling heads, for machining ISO K materials with high surface finish results.

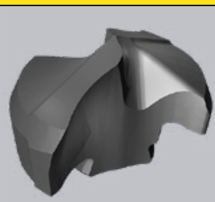


HCP-IQ
Exchangeable self-centering **SUMO-CHAM** drilling heads, for machining ISO P and ISO K materials.



FCP
Exchangeable flat bottom **SUMO-CHAM** drilling heads, for machining ISO P and ISO K materials.

Related Drilling Heads for DCT ...



IDI-SG
General use DCM drill heads.

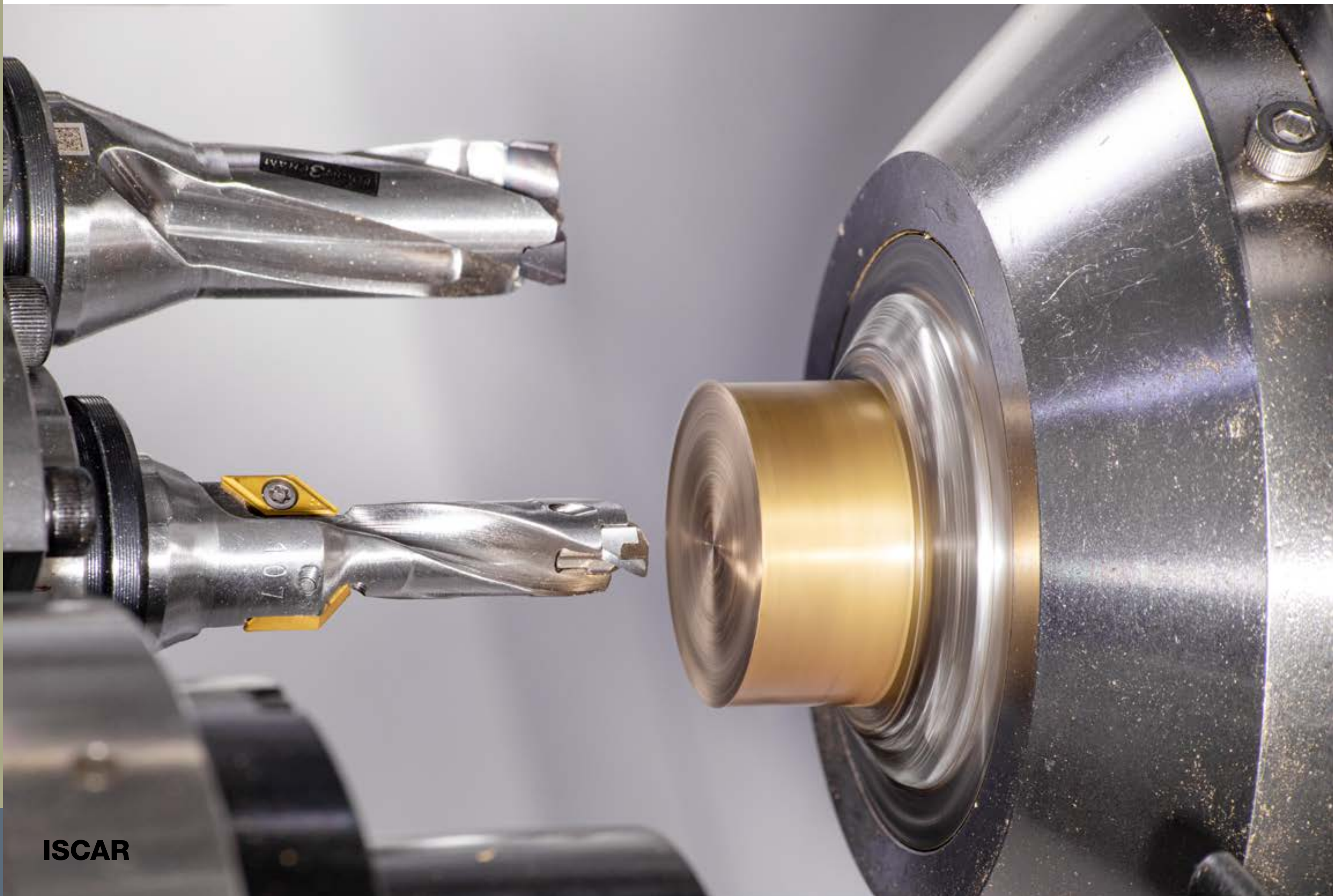
IDI-SK
DCM drill heads for cast iron.

Assembled combined drills belonging to the Pre-Thread line exist in two variations: with straight flutes and with spiral flutes. Drill with straight flutes designated DCT ... and carry interchangeable **CHAM-DRILL** drilling heads. Drill with spiral flutes designated DCNT ... and carry interchangeable **SUMO-CHAM** drilling heads. Straight flute drills are designed with a central coolant channel, while spiral fluted drills are designed with spiral coolant channels.

The Tables Below Provide Recommendations for Using the Assembled Combined Drills Belonging to the Pre-Thread Line.

DCNT ...

DCT ...



Pre-Thread DCT Metric Threads Recommended Diameters

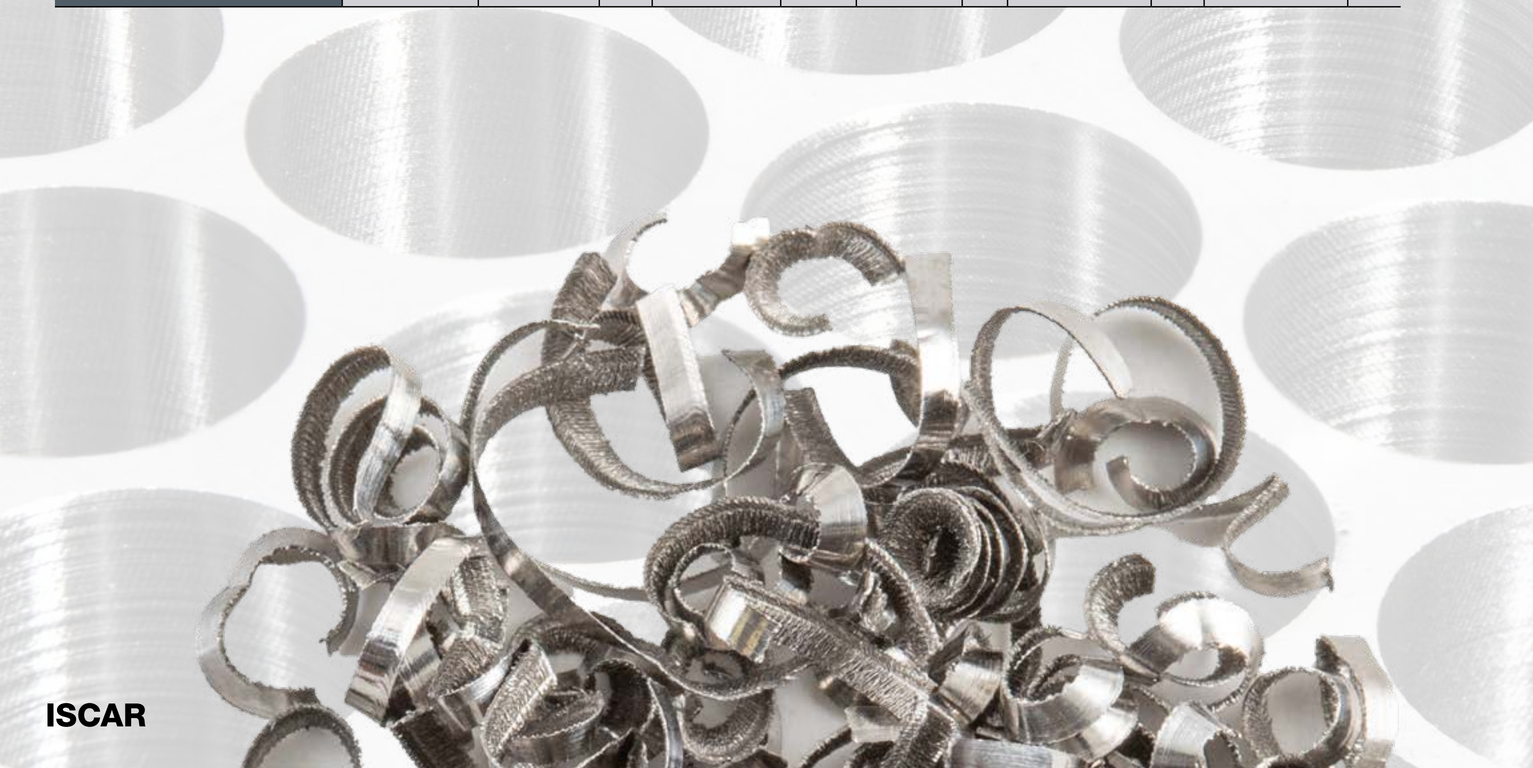
Drill Designation	Dia. Range	M Thread	Head Dia.	MF Thread	Head Dia.	TR Thread	Head Dia.	M Helicoil Thread	Head Dia.
DCT 068-021-14B-M8	6.80-7.49	M8	6.8	MF8X0.75	7.20	TR10X3	7.49		
				MF8X1	7.00				
DCT 085-026-14B-M10	8.30-8.99	M10	8.5	MF10X1	8.99	TR10X1.5	8.60	M8	8.40
				MF10X1.25	8.80				
DCT 102-030-14B-M12	10.0-10.99	M12	10.2	MF11X1	10.00	TR12X2	10.20	M10	10.50
				MF12X1	10.99	TR14X4	10.50		
				MF12X1.25	10.80				
				MF12X1.5	10.50				
DCT 120-035-16B-M14	12.0-12.99	M14	12.0	MF13X1	12.00	TR14X2	12.20	M12	12.50
				MF14X1	12.99	TR16X4	12.30		
				MF14X1.25	12.80				
				MF14X1.5	12.50				
DCT 140-039-18B-M16	14.0-14.99	M16	14.0	MF14X1	14.00	TR18X4	14.30	M14	14.99
				MF16X1	14.99				
				MF16X1.5	14.50				
DCT 175-042-20B-M20	17.3-17.99	M20	17.5			TR22X5	17.30		
				MF20X2	17.99				
DCT 210-048-25B-M24	21.0-21.99	M24	21.0	MF22X1	21.00				

Inch Threads

Drill Designation	Dia. Range	UNF Thread	Head Dia.	UNC Thread	Head Dia.	UNC Helicoil Thread	Head Dia.	BSW Thread	Head Dia.	BSF Thread	Head Dia.
DCT 085-026-14B-M10	8.30-8.99	UNF3/8-24	8.5			UNC5/16-18	8.4				
DCT 102-030-14B-M12	10.0-10.99			UNC1/2-13	10.8			BSW1/2-12	10.5	BSF1/2-16	10.99
DCT 120-035-16B-M14	12.0-12.99			UNC9/16-12	12.3					BSF9/16-16	12.50
DCT 140-039-18B-M16	14.0-14.99	UNF5/8-18	14.5								
DCT 175-042-20B-M20	17.3-17.99	UNF3/4-16	17.5								

Inch Threads

Drill Designation	Dia. Range	NPT Thread	Head Dia.	BSF Thread	Head Dia.	BSP Thread	Head Dia.	UNEF Thread	Head Dia.	UNJF Helicoil Thread	Head Dia.
DCT 085-026-14B-M10	8.30-8.99	NPT1/8-27	8.5			G1/8-28	8.8	UNEF3/8-32	8.7	UNJF3/8-24	8.6
DCT 102-030-14B-M12	10.0-10.99			BSF1/2-16	10.99						
DCT 120-035-16B-M14	12.0-12.99			BSF9/16-16	12.50						
DCT 140-039-18B-M16	14.0-14.99	NPT3/8-18	14.5					UNEF5/8-24	14.8	UNJF5/8-18	14.5
DCT 175-042-20B-M20	17.3-17.99	NPT1/2-14	17.5					UNEF3/4-20	17.8		



Pre-Threading Recommended Hole Diameters with DCNT Drills

<table>
<tr><th>Drill Designation</th><th>Dia. Range</th><th>M Thread</th><th>Head Dia.</th><th>MF Thread</th><th>Head Dia.</th><th>TR Thread</th><th>Head Dia.</th><th>M Helicoil Thread</th><th>Head Dia.</th></tr>
<tr><td>DCNT 068-021-12A-M8</td><td>6.5-6.99</td><td>M8</td><td>6.8</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="2">DCNT 085-026-12A-M10</td><td rowspan="2">8.5-8.99</td><td rowspan="2">M10</td><td rowspan="2">8.5</td><td>MF10x1</td><td>8.99</td><td rowspan="2">TR10x1.5</td><td rowspan="2">8.6</td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td>MF10x1.25</td><td>8.8</td></tr>
<tr><td rowspan="4">DCNT 102-030-16A-M12</td><td rowspan="4">10.0-10.99</td><td rowspan="4">M12</td><td rowspan="4">10.2</td><td>MF11x1</td><td>10.0</td><td rowspan="2">TR12x2</td><td rowspan="2">10.2</td><td rowspan="4">M10</td><td rowspan="4">10.5</td></tr>
<tr><td>MF12x1</td><td>10.99</td></tr>
<tr><td>MF12x1.25</td><td>10.8</td><td rowspan="2">TR14x4</td><td rowspan="2">10.5</td></tr>
<tr><td>MF12x1.5</td><td>10.5</td></tr>
<tr><td rowspan="4">DCNT 120-035-16A-M14</td><td rowspan="4">12.0-12.99</td><td rowspan="4">M14</td><td rowspan="4">12.0</td><td>MF13x1</td><td>12.0</td><td rowspan="2">TR14x2</td><td rowspan="2">12.2</td><td rowspan="4">M12</td><td rowspan="4">12.5</td></tr>
<tr><td>MF14x1</td><td>12.99</td></tr>
<tr><td>MF14x1.25</td><td>12.8</td><td rowspan="2">TR16x4</td><td rowspan="2">12.3</td></tr>
<tr><td>MF14x1.5</td><td>12.5</td></tr>
<tr><td rowspan="3">DCNT 140-039-16A-M16</td><td rowspan="3">14.0-14.99</td><td rowspan="3">M16</td><td rowspan="3">14.0</td><td></td><td>14.0</td><td rowspan="3">TR18x4</td><td rowspan="3">14.3</td><td rowspan="3">M14</td><td rowspan="3">14.99</td></tr>
<tr><td>MF16x1</td><td>14.99</td></tr>
<tr><td>MF16x1.5</td><td>14.5</td></tr>
<tr><td>DCNT 175-042-20A-M20</td><td>17.0-17.99</td><td>M20</td><td>17.5</td><td>MF20x2</td><td>17.99</td><td>TR22x5</td><td>17.3</td><td></td><td></td></tr>
<tr><td>DCNT 210-048-25A-M24</td><td>21.0-21.99</td><td>M24</td><td>21.0</td><td>MF22x1</td><td>21.0</td><td></td><td></td><td></td><td></td></tr>
</table>

Drill Designation	Dia. Range	UNF Thread	Head Dia.	UNC Thread	Head Dia.	BSW Thread	Head Dia.	BSF Thread	Head Dia.
DCNT 068-021-12A-M8	6.5-6.99								
DCNT 085-026-12A-M10	8.5-8.99	UNF3/8-24	8.5						
DCNT 102-030-16A-M12	10.0-10.99			UNC1/2-13	10.8	BSW1/2-12	10.5	BSF1/2-16	10.99
DCNT 120-035-16A-M14	12.0-12.99			UNC9/**16-12**	12.3			BSF9/16-16	12.5
DCNT 140-039-16A-M16	14.0-14.99	UNF5/8-18	14.5						
DCNT 175-042-20A-M20	17.0-17.99	UNF3/4-16	17.5						
DCNT 210-048-25A-M24	21.0-21.99								

Drill Designation	Dia. Range	NPT Thread	Head Dia.	BSP Thread	Head Dia.	UNEF Thread	Head Dia.	UNJF Helicoil Thread	Head Dia.
DCNT 068-021-12A-M8	6.5-6.99								
DCNT 085-026-12A-M10	8.5-8.99	NPT1/8-27	8.5	G1/8-28	8.8	UNEF3/8-32	8.7	UNJF3/8-24	8.6
DCNT 102-030-16A-M12	10.0-10.99								
DCNT 120-035-16A-M14	12.0-12.99								
DCNT 140-039-16A-M16	14.0-14.99	NPT3/8-18	14.5			UNEF5/8-24	14.8	UNJF5/8-18	14.5
DCNT 175-042-20A-M20	17.0-17.99	NPT1/2-14	17.5			UNEF3/4-20	17.8		
DCNT 210-048-25A-M24	21.0-21.99								

Explanation of Pre-Threading Drills Description

Example:

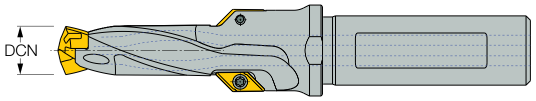
DCNT	085	-	026	-	12	A	-	M10
1	2		3		4	5		6

1 Designation of Drill

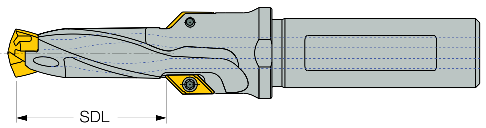
DCNT — **SUMO-CHAM** pre-thread drill with spiral flutes

DCT — **CHAM-DRILL** pre-thread drill with straight flutes

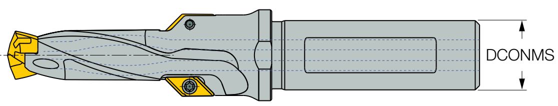
2 Minimum Pre-Thread Hole Diameter (DCN)



3 Step Diameter Length (SDL)



4 Connection Diameter Machine Side (DCONMS)



5 Shank Type

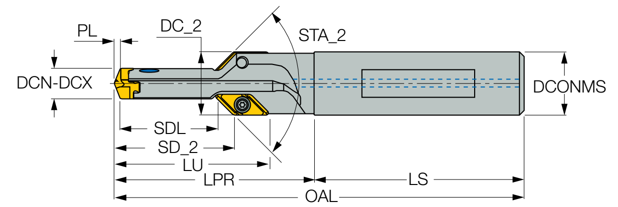
A — with flange, one flat shank

B — without flange, one flat shank

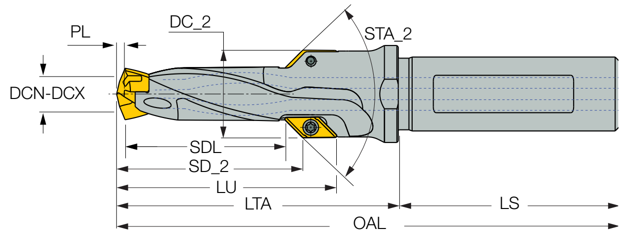
6 Adaptation for Thread Size

Basic Dimensions of Pre-Threading Drills

DCT



DCNT



DCN — minimum cutting diameter

DCN — maximum cutting diameter

DC_2 — counter bore cutting diameter

DCONMS — connection diameter machine side

SDL — step diameter length

LS — shank length

LPR — protruding length

OAL — overall length

STA_2 — step included angle

SD_2 — step distance

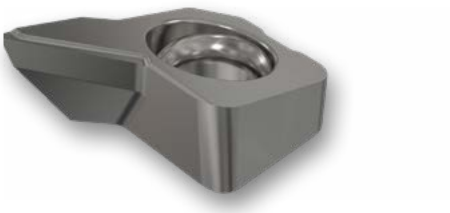
PL — point length

FTDZ — adaptation for thread size

Chamfering Ring

ISCAR's chamfering rings designated RING DCM... are additional elements that turn the **CHAM-DRILL** line drills to combined tools for drilling and countersinking. The chamfering rings are easily assembled on the **CHAM-DRILL** line drills, creating an efficient and rigid tool. **ISCAR**'s chamfering rings increase the versatility of **CHAM-DRILL** line drills and save time spent on small chamfering and deburring operations.

The ring carries an indexable insert designated XOGX ... for chamfering with an angle of 45° and recommended depth of up to 2 mm.

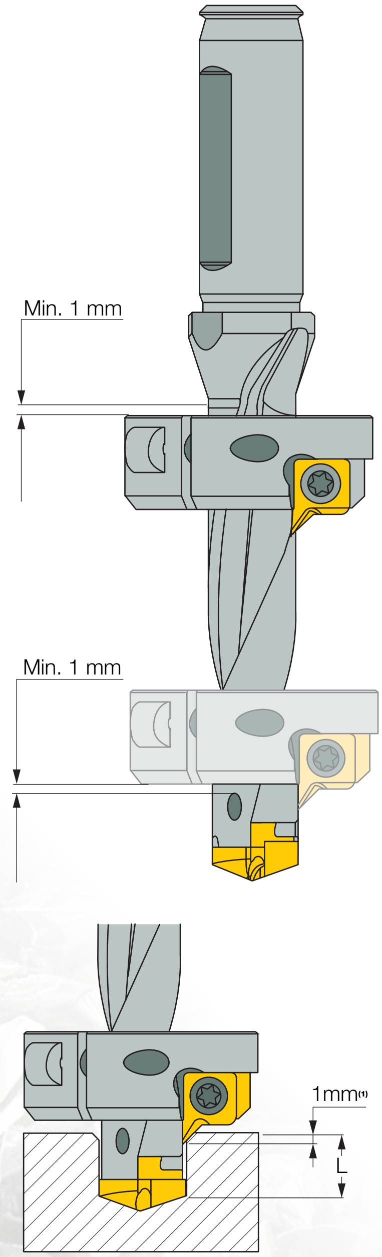


ISCAR's chamfering rings, RING DCM..., assembled on **CHAM-DRILL** line drills with a diameter range of 10 to 20 mm. The protrusion of the drill inserted into the chamfering ring can be adjusted for various drilling depths in blind and through hole (table 3.4.1).

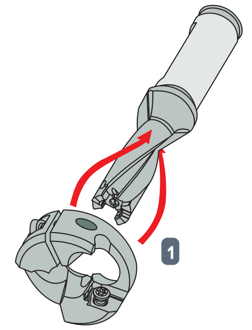
Chamfering Ring - Position Range (mm)

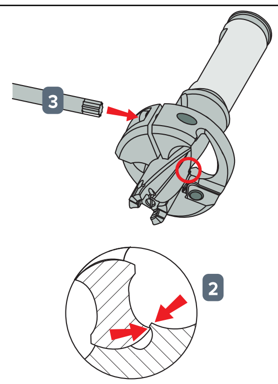
Drill Diameter	Drill Body 3xD L (min-max)	Drill Body 5xD L (min-max)
10	8-16	15-36
10.5	8-18	17-39
11	8-19	18-41
11.5	8-21	20-44
12	8-22	21-46
12.5	8-24	23-49
13	8-25	24-51
13.5	8-27	26-54
14	9-29	28-57
14.5	9-30	29-60
15	9-31	30-60
16	9-33	32-65
17	11-35	34-69
18	11-38	34-74
19	11-42	41-80
20	11-45	44-85

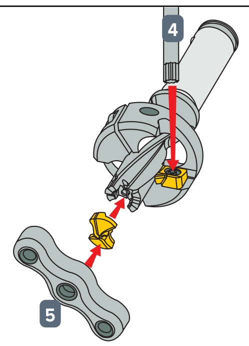
Note: the "L" dimension shown is relative to the common 1mm chamfer. For other sizes, adjust "L" accordingly.



Chamfering Ring Assembly Instructions







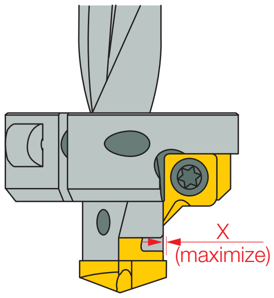
1. Insert the chamfering ring on the drill body and slide to the desired position[1].
2. Rotate the ring clockwise until the stopper engages the flute edge.
3. Tighten the ring screw according to the maximum tightening torque indicated on RING DCM spare parts.
4. Mount the chamfering insert.
5. Mount the **CHAM-DRILL** head.

Note that before drilling it is recommended to ensure:

- There is a very small gap between the chamfer insert and the drill body, without direct contact (i.e., the chamfer insert should not be in contact with the drill body).
- The cutting edge point (45°) is at the same level as the flute edge.

Recommendation for Better Stability

2 Use 3xD drill instead of 5xD, if possible.
3 Mount the chamfering ring as close as possible to the drill shank.
4 For better chamfering insert life, apply a coolant to the chamfering insert, in addition to the internal and/or external coolant.
5 A wider gap "X" between the drill and the head size is preferred (i.e. for head 14.6 mm, use body of 14 mm rather than of 14.5 mm). A slightly larger "X" dimension can dramatically increase the chamfering insert life.



[1] The "L" dimension shown is relative to the common 1 mm chamfer. For other sizes, adjust "L" accordingly.

Explanation of Chamfering Ring Description

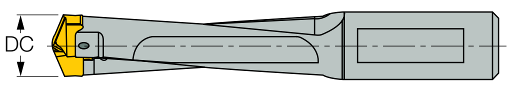
Example:

RING DCM	100
1	2

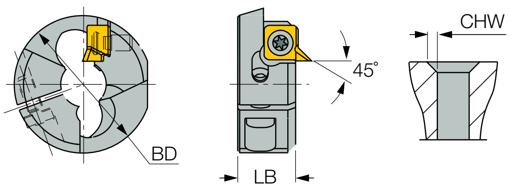
1 Designation

RING DCM — chamfering ring mounted on **CHAM-DRILL** line drills

2 Minimum Hole Diameter (DCN)



Basic Dimensions of the Chamfering Ring



BD — body diameter

LB — body length

CHW — chamfer width

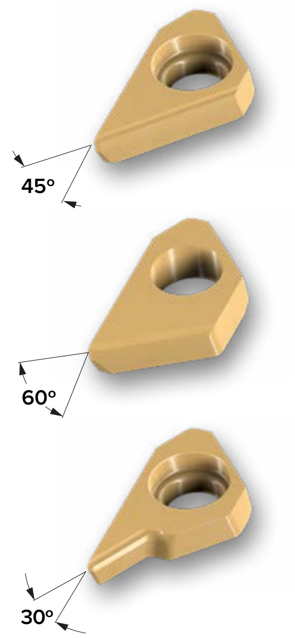
Chamfering Holder

ISCAR's chamfering holders, designated **CHAM-RING** ... were designed to offer standard chamfering options for producing 30˚, 45˚ and 60˚ chamfers around holes in the diameter range of 7.5 to 25.9 mm, using **ISCAR**'s standard **UNI-CHAM-DRILL** drill type.

SUMO UNI CHAM

UNICHAMDRILL

CHAMRING

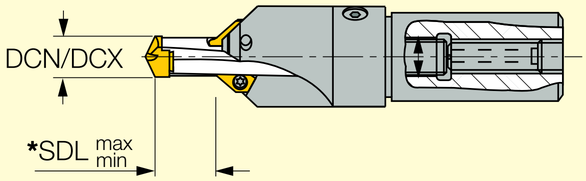


CHAM-RING Body Construction

The **CHAM-RING** has two chamfering inserts designated XCGT ... that provide a balanced and smooth cut during the chamfering operation for blind and through hole applications. The unique design of two chamfering inserts on the standard **CHAM-RING** enables a combination operation of drilling and chamfering.

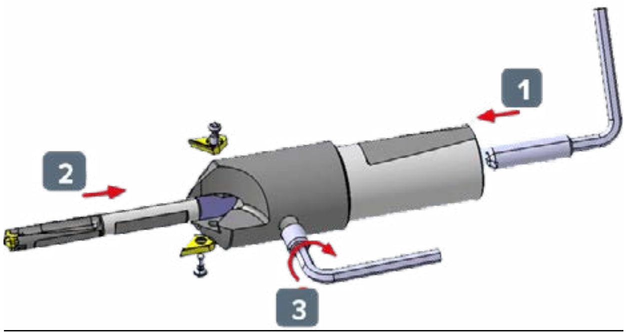
A constant speed and feed can be maintained during both operations, resulting in high quality of both the hole and the chamfer. The projection of the **UNI-CHAM-DRILL** inserted into the **CHAM-RING** can be adjusted for various drilling depths (table 3.5.1) in blind and through hole applications for the standard 30˚, 45˚ and 60˚ chamfers.

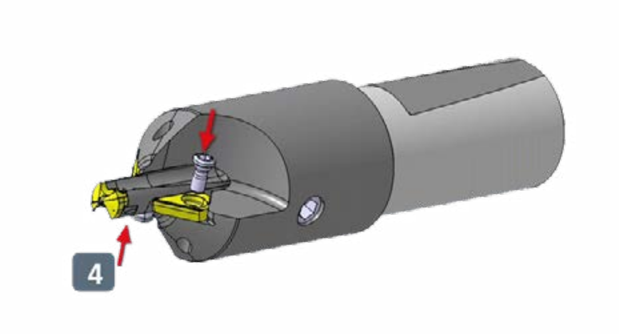
Chamfering Holder - Position Range (mm)

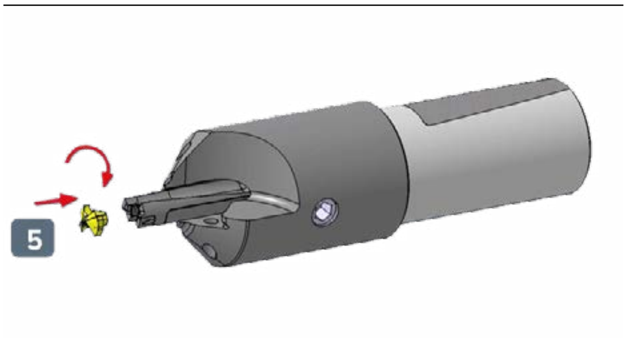


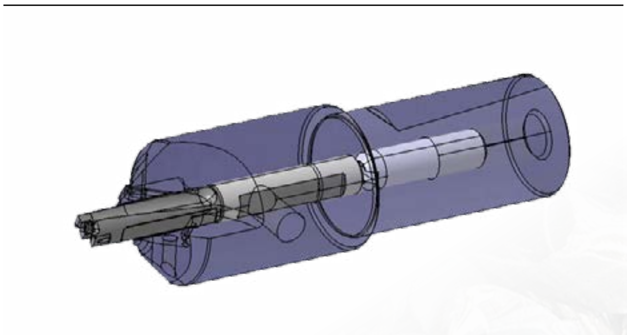
Dril Diameter	DCN	DCX	DCNS 3D L min	DCNS 3D L max	DCM 3.5D L min	DCM 3.5D L max	DCNS 5D L min	DCNS 5D L max
DC.. 075	7.5	7.9	12.7	18.6	12.4	21.9	15.7	33.6
DC.. 080	8	8.4	13.6	19.2	14	23	23.6	40.9
DC.. 085	8.5	8.9	12.3	21.1	15.1	26.6	18.7	38.1
DC.. 090	9	9.4	12.8	23.1	15.6	27.1	21.8	41.1
DC.. 095	9.5	9.9	12.2	22.8	17.2	29.2	26.8	42.2
DC.. 100	10	10.4	12.6	28.2	14.3	28.3	32.8	48.2
DC.. 105	10.5	10.9	13.9	29.8	14.4	29.4	31.7	50.8
DC.. 110	11	11.4	14.4	31.4	18	31	34.7	53.4
DC.. 115	11.5	11.9	14.1	31.4	15.6	33.1	34.0	54.4
DC.. 120	12	12.4	15.1	33.4	19.2	35.2	36.9	57.3
DC.. 125	12.5	12.9	15.6	35.8	19.3	37.3	40.6	60.8
DC.. 130	13	13.4	17.8	37.6	21.4	38.4	43.8	64.1
DC.. 135	13.5	13.9	16.1	38.2	19.5	39.5	42.8	65.2
DC.. 140	14	14.4	18.0	40.8	21.5	41.5	46.0	69.3
DC.. 145	14.5	14.9	16.4	39.7	20.1	42.1	45.3	68.7
DC.. 150	15	15.9	18.5	41.9	25.2	43.7	48.5	71.9
DC.. 160	16	16.9	26.2	51.6	26.3	49.3	58.2	83.6
DC.. 170	17	17.9	22.6	49.0	28.4	52.4	56.6	83.0
DC.. 180	18	18.9	25.1	52.5	31	57	61.1	88.5
DC.. 190	19	19.9	28.3	58.3	32.3	63.3	66.3	96.3
DC.. 200	20	20.9	38.3	68.4	36.6	67.1	78.3	108.3
DC.. 210	21	21.9	33.9	63.3			75.9	105.3
DC.. 220	22	22.9	37.3	66.7			81.3	110.7
DC.. 230	23	23.9	40.7	70.1			86.7	116.1

CHAM-RING Assembly Instructions





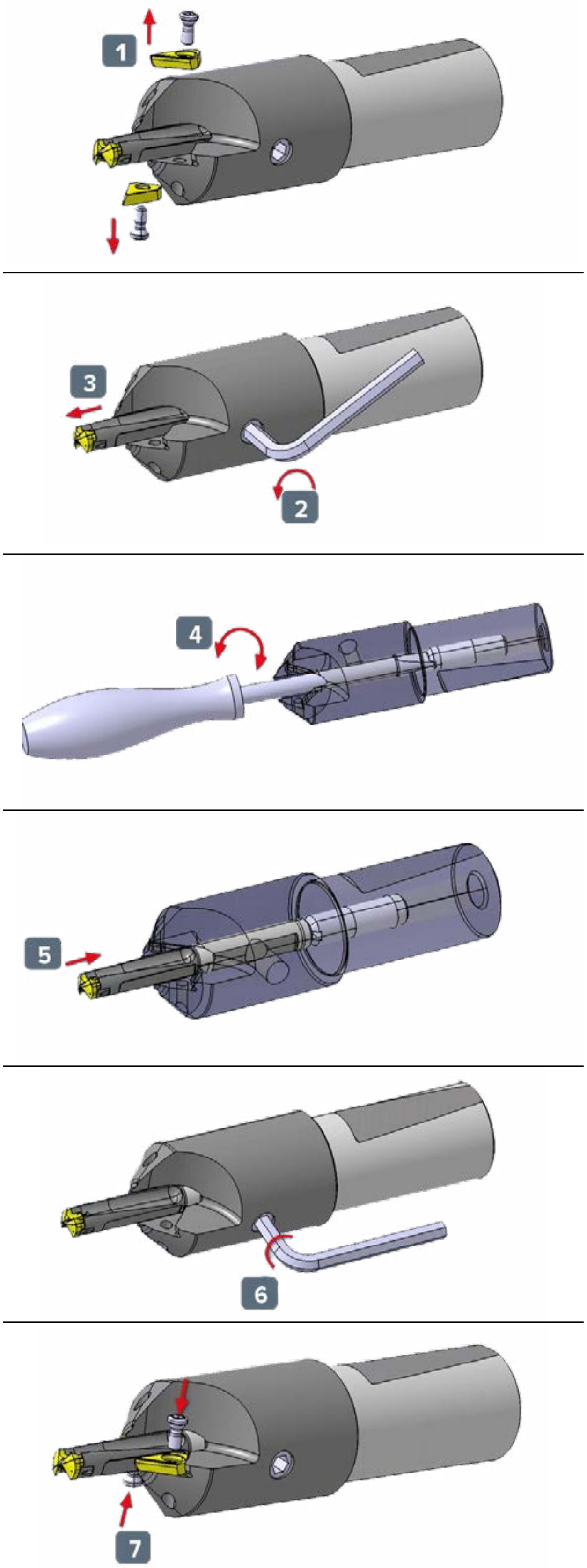




Steps:

1. Unscrew the **CHAM-RING** side locking and chamfering insert screws.
2. Insert the proper **UNI-CHAM-DRILL** into the **CHAM-RING** bore and push it against the back adjustment screw.
3. Slightly tighten the side locking screw for initial contact with the **UNI-CHAM-DRILL** clamping surface.
4. In order to achieve a symmetrical positioning of the chamfering inserts and to avoid edge fracturing, clamp the inserts gradually, alternating sides, before the final tightening. Ensure a tight clamping of the insert against the side walls of the **UNI-CHAM-DRILL** peripheral clearance guiding surfaces.
5. Clamp the **CHAM-RING** inside the drill's pocket.
6. Lastly, tighten the side clamping screw.
7. Clamp the required **CHAM-DRILL** head size into the **UNI-CHAM-DRILL** pocket.

Adjustment of UNI-CHAM-DRILL Protrusion

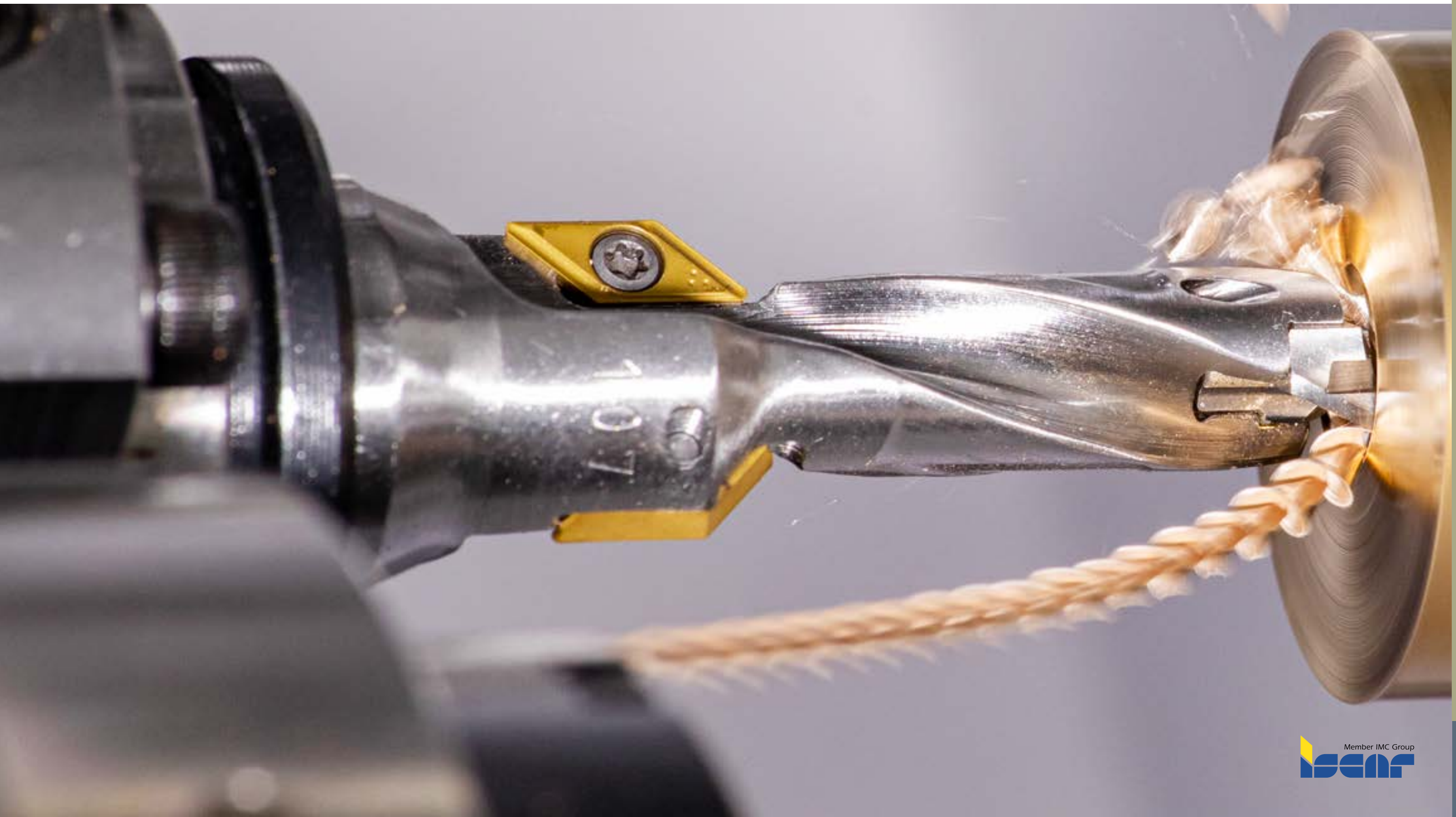


Steps:

1. Unscrew the chamfering insert screws.
2. Remove the chamfering inserts from their pockets.
3. Unscrew the **CHAM-RING** side locking screw.
4. Remove the **UNI-CHAM-DRILL** from the **CHAM-RING** holder.
5. Adjust the inner axial stopper screw to attain the required **UNI-CHAM-DRILL** projection, by inserting a flat screwdriver from the front or back of the **CHAM-RING** bore.
6. Insert the **UNI-CHAM-DRILL** into the **CHAM-RING** bore.
7. Slightly tighten the side locking screw for initial contact with the **UNI-CHAM-DRILL** clamping surface.
8. Attach the chamfering inserts into both pockets and tighten their clamping screws. Ensure a tight clamping of the insert against the **UNI-CHAM-DRILL** peripheral clearance guiding surfaces.
9. Clamp the required **CHAM-DRILL** head size onto the **UNI-CHAM-DRILL** pocket.
10. Verify that the required projection has been achieved.

Recommendation for Better Stability

2 It is recommended to use the same cutting conditions for both chamfering and drilling operations.
3 For optimal chip formation and to prolong chamfering insert edge life, it is recommended to use external coolant directed to the chamfering inserts, in addition to the **CHAM-DRILL**'s internal coolant.
4 The **UNI-CHAM-DRILL** projection should not be adjusted beyond the peripheral clearance guide surfaces on the **UNI-CHAM-DRILL** flutes.
5 The chamfering insert screws should not be tightened before the initial tightening of the **CHAM-RING** side clamping screw. Incorrect drill orientation can lead to breakage of the chamfering inserts.
6 In case vibrations occur during the chamfering operation, it is recommended to change the adapter to a more rigid one. If the vibrations continue, reduce the speed and increase the feed (in the chamfering operation only). This will reduce vibration without reducing productivity.
7 In case vibrations occur during the chamfering operation in a through hole application, it is recommended to reduce the speed.
8 The recommended chamfer size should not be exceeded.
9 Chamfering inserts should not be used for counterboring.
10 When machining the maximal chamfer size, the recommended cutting parameters must be reduced by 20%.
11 The chamfer size gets smaller proportionally when a larger **CHAM-DRILL** head is used. The maximal chamfer size is obtained when using the smallest **CHAM-DRILL** head.



Explanation of a Chamfering Holder Description

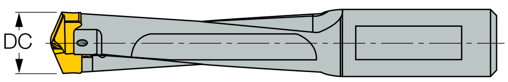
Example:

CHAM-RING	100	-	WN32	-	09
1	2		3		4

1 **Designation**

CHAM-RING — chamfering holder

2 **Minimum Hole Diameter (DCN)**



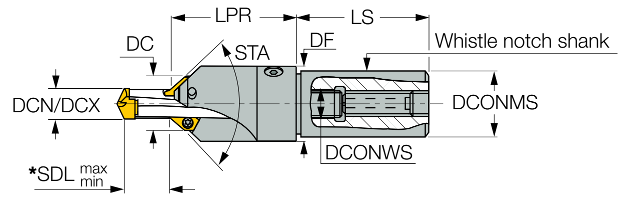
3 **Shank Type**

WN32 — whistle notch shank with a diameter of 32 mm

4 **Insert Size**

06 — XCGT 06...
09 — XCGT 09...

Basic Dimensions of Chamfering Holder



DCN — drilling diameter minimum
DCX — drilling diameter maximum
DCONWS — connection diameter workpiece side
DF — flange diameter
DC — cutting diameter
LPR — protruding length
LS — shank length
DCONMS — connection diameter machine side

SOLID-DRILL Solid Carbide Combined Drills

The ultimate solution for machining pre-threading small diameter holes is the use of solid carbide combined drills. Drills belonging to the **ISCAR SOLID-DRILL** line and described as SCDT ...-M... (Solid Carbide Drill Thread with corresponding M thread size) in the range of 2.5-8.5 mm, which are compatible with ISO M thread standard "M3" to "M10" pre-thread hole dimensions.

The dimensions of the SCDT ...-M... solid carbide pre-thread drills are designed according to DIN 6537 and the step length are according to DIN 8378. **ISCAR**'s solid carbide combined drills are capable of machining holes with chamfer or counterbore holes in one operation.

They provide maximum hole quality, reliable performance, and economic output.

SCDT ...-M... Drills - Main Design Characteristics:

- Internal coolant channels
- “m7” outer cutting drill point and step diameter tolerance
- Round shank according to “h6” tolerance
- Right-hand cut
- 140° head point angle
- 30° spiral flute helix
- 45° step
- Standard back taper
- Reinforced web thickness
- Straight cutting edge and pinpointed chisel geometry for ISO - P, M, K materials machining
- Submicron IC08 substrate with 10% cobalt content
- Latest IC900 TiAIN PVD coated grade

Recommendation for Better Stability

1 Use external coolant in addition to the SCDT ...-M... internal coolant for achieving prolonged edge life.

2 Use pre-thread solid carbide drills in rotating or stationary applications with a maximum of 0.02 mm outer cutting points or chisel runout for optimal performance. Larger runout will influence drill performance and hole quality.

3 In case of a stationary application, clamp the drill in an orientation that directs both outer cutting points parallel to the machine’s X-axis.

4 On stationary (lathe) applications, if there are misalignment problems use alignment devices such as the **ISCAR** /ETM GYRO device.

5 The SCDT ...-M... drills are recommended to be clamped into **ISCAR** tooling systems such as:
- **SHORT-IN** collet chuck adapters with AA super precision
- Power chuck adapters
- Hydraulic adapters
- Shrink collets or adapters

Explanation of Solid Carbide Combined Drills Description

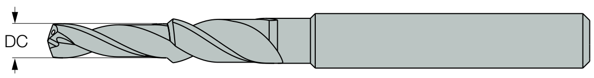
Example:

SCDT	025	-	009	-	060	-	M3
1	2		3		4		5

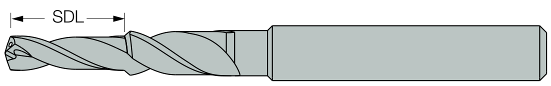
1 **Designation**

SCDT — Solid Carbide Drill Thread

2 **Drill Diameter (DC)**



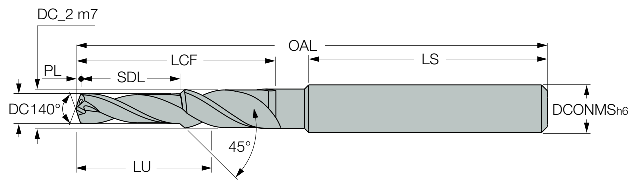
3 **Step Diameter Lendth (SDL)**



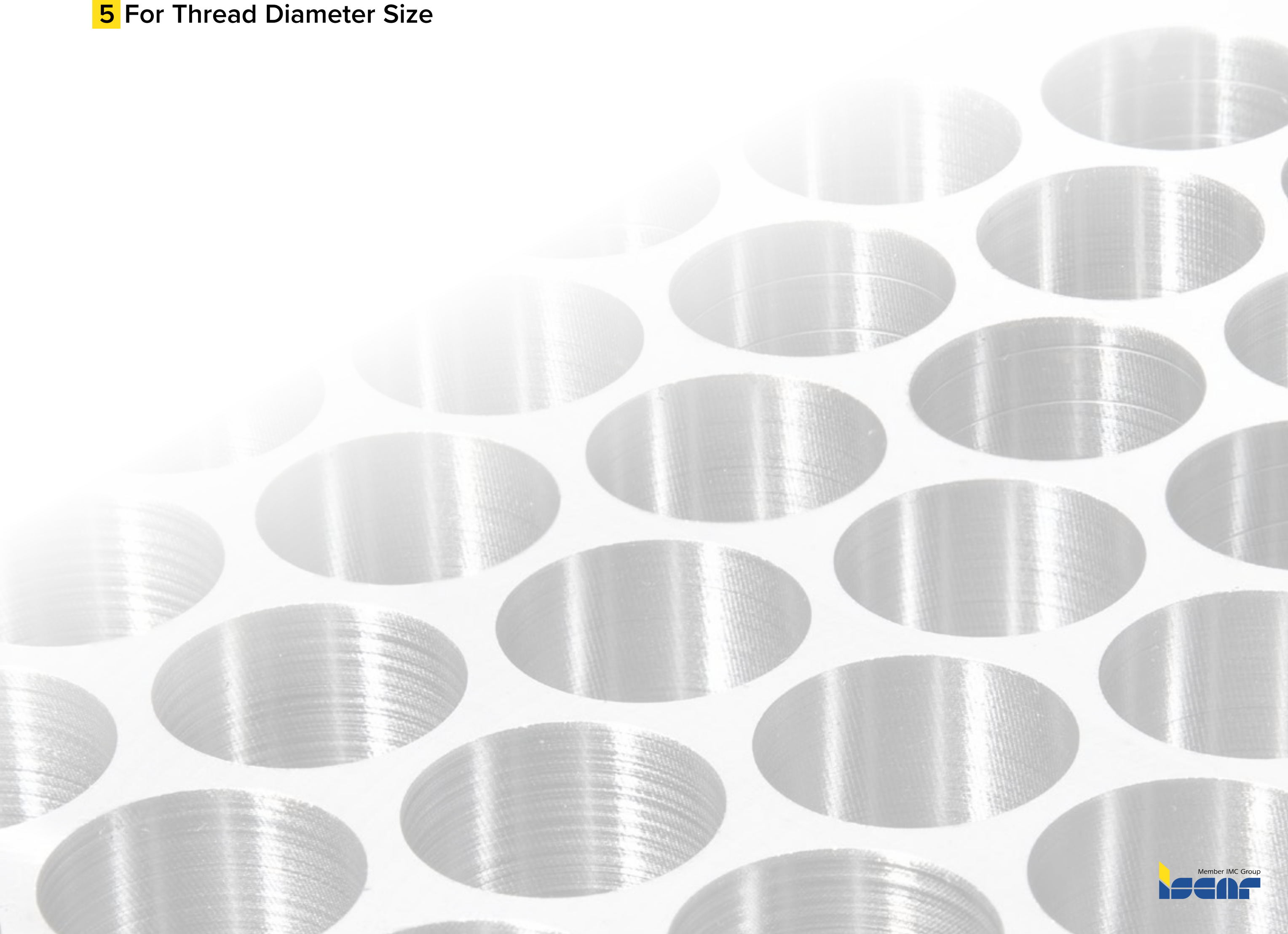
4 **Shank Size (DCONMS)**

5 **For Thread Diameter Size**

Basic Dimensions of Solid Carbide Drills with Chamfer Geometry

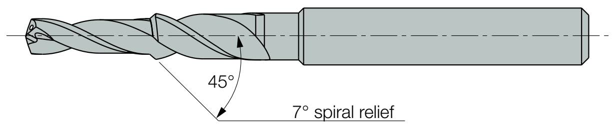


DC — drilling diameter
SDL — step diameter maximum
DCONMS — connection diameter machine side
DC_2 — drilling diameter
PL — point length
LU — usable length
LCF — length chip flute
OAL — overall length
LS — shank length

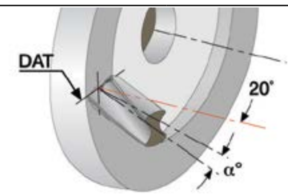


SOLID-DRILL Regrinding Instructions

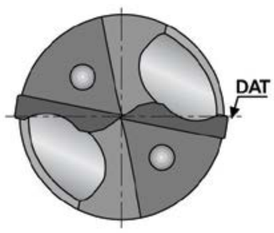
The solid carbide combined drills can be re-sharpened and re-coated at least 10 times.



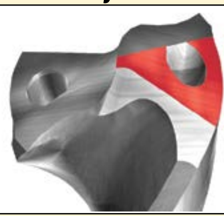
1 Primary Clearance

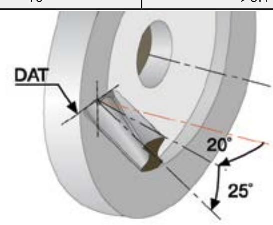


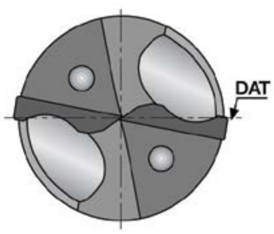
α°	D Range
7	0.8-6.0
10	>6.1



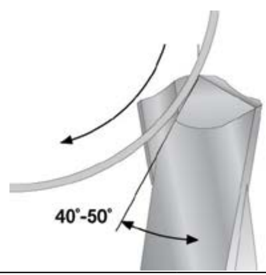
2 Secondary Clearance

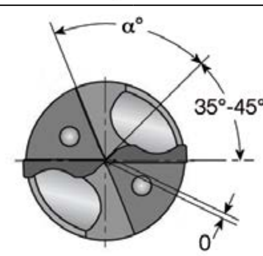






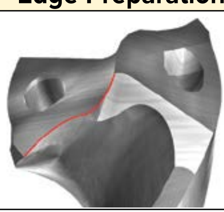
3 Chisel

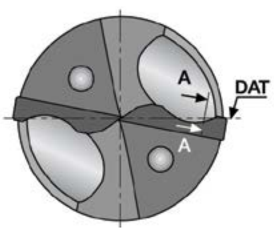


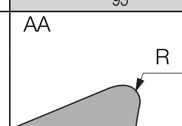


α°	D Range
100	3.0-4.8
105	4.9-10
95	10.1-20

4 Edge Preparation







R	D Range
0.02	0.8-6.0
0.03	6.1-18.0
0.04	18.1>UP

Notes:

- Recommended for each grinding operation:
  rotate the drill 180° and repeat the grinding procedure.
- Grinding wheel recommended specifications:
  - Diameter grinding wheel: GA2.
  - Grinding wheel bond: Synthetic resin.
  - Grit size: 325/400 mesh (45/38µ).
  - Diamond concentration: C-75 (3.3 carat/cm^3).
  - Cutting fluid emulsion 3%.

SOLID-DRILL Cutting Conditions

The main parameters of cutting conditions in drilling are cutting speed and feed. The value of cutting speed depends directly on the drilling depth while the value of feed directly depends on the drill diameter.

The cutting conditions must be chosen in a way to save the tool from premature wear while considering maximum productivity. The table below shows the initial recommended cutting conditions.

ISO	Material		Condition	Tensile Strength [N/mm²]	Hardness HB	Material No.[1]	Cutting Speed V_c m/min	Feed (mm/rev) Vs. Drill Diameter				
								Ø3-5	Ø5.1-8	Ø8.1-12	Ø12.1-16	Ø16.1-20
P	non-alloy steel and cast steel, free cutting steel	<0.25% C	annealed	420	125	1	80-120	0.10-0.18	0.15-0.25	0.2-0.30	0.20-0.35	0.25-0.40
		≥0.25% C	annealed	650	190	2	80-110	0.10-0.18	0.15-0.25	0.2-0.30	0.20-0.35	0.25-0.40
		<0.55% C	quenched and tempered	850	250	3	70-100	0.10-0.20	0.15-0.28	0.2-0.35	0.20-0.38	0.25-0.42
		≥0.55% C	annealed	750	220	4						
			quenched and tempered	1000	300	5						
	low alloy and cast steel (less than 5% of alloying elements)		annealed	600	200	6	70-90	0.10-0.18	0.15-0.25	0.2-0.30	0.20-0.35	0.25-0.40
			quenched and tempered	930	275	7						
				1000	300	8	60-80	0.10-0.18	0.15-0.25	0.2-0.30	0.20-0.35	0.25-0.40
				1200	350	9	50-70	0.10-0.20	0.15-0.28	0.2-0.35	0.20-0.38	0.25-0.42
	high alloyed steel, cast steel and tool steel		annealed	680	200	10	60-80	0.10-0.20	0.15-0.28	0.18-0.35	0.20-0.38	0.25-0.42
			quenched and tempered	1100	325	11	50-70	0.10-0.15	0.12-0.20	0.14-0.25	0.16-0.30	0.18-0.32
	stainless steel and cast steel		ferritic / martensitic	680	200	12	25-75	0.04-0.10	0.05-0.15	0.05-0.18	0.08-0.20	0.10-0.20
			martensitic	820	240	13	25-75	0.04-0.10	0.05-0.15	0.05-0.18	0.08-0.20	0.10-0.20
M	stainless steel and cast steel		austenitic, duplex	600	180	14	25-75	0.04-0.10	0.05-0.15	0.05-0.18	0.08-0.20	0.10-0.20
K	gray cast iron (GG)		ferritic / pearlitic		180	15	85-105	0.15-0.25	0.20-0.35	0.25-0.45	0.30-0.50	0.35-0.55
			pearlitic / martensitic		260	16	75-90	0.15-0.25	0.20-0.35	0.25-0.45	0.30-0.50	0.35-0.55
	nodular cast iron (GGG)		ferritic		160	17	65-80	0.12-0.20	0.15-0.25	0.20-0.35	0.25-0.40	0.30-0.45
			pearlitic		250	18						
	malleable cast iron		ferritic		130	19						
			pearlitic		230	20						
N	aluminum-wrought alloys		not hardenable		60	21	70-300	0.10-0.25	0.15-0.35	0.25-0.45	0.30-0.50	0.35-0.55
			hardenable		100	22	70-200					
	aluminum-cast alloys	≤12% Si	not hardenable		75	23	70-300	0.07-0.18	0.12-0.25	0.20-0.35	0.25-0.45	0.30-0.50
			hardenable		90	24						
		>12% Si	high temperature		130	25						
	copper alloys	>1% Pb	free cutting		110	26						
			brass		90	27						
			electrolytic copper		100	28						
	non metallic		duroplastics, fiber plastics			29						
			hard rubber			30						
S	high temperature alloys	Fe based	annealed		200	31						
			hardened		280	32						
		Ni or Co based	annealed		250	33						
			hardened		350	34						
			cast		320	35						
	titanium alloys		pure	RM 400		36						
			alpha+beta alloys, hardened	RM 1050		37	15-35	0.02-0.07	0.04-0.10	0.06-0.12	0.08-0.15	0.08-0.18
H	hardened steel		hardened		55 HRC	38	40-70	0.06-0.10	0.08-0.12	0.10-0.14	0.12-0.16	0.14-0.18
			hardened		60 HRC	39						
	chilled cast iron		cast		400	40						
	cast iron		hardened		55 HRC	41						

As a starting value, the middle of the recommended machining range should be used, then (according to wear results), conditions can be changed in order to optimize performance.

- When using external coolant supply only, reduce cutting speed by 10%
- Use internal coolant supply when machining austenitic stainless steel

SOLID-DRILL Machining Conditions

Recommended Machining Conditions for Solid Carbide Drills D=0.8-2.9 mm

ISO	Material		Condition	Tensile Strength [N/mm^2]	Hardness HB	Material No.(1)	Cutting Speed V_c (m/min)	Feed (mm/rev) Vs. Drill Diameter			
								Ø0.8-1.4	Ø1.5-1.9	Ø2-2.4	Ø2.5-2.9
P	non-alloy steel and cast steel, free cutting steel	<0.25% C	annealed	420	125	1	50-100	0.03-0.10	0.05-0.15	0.07-0.17	0.08-0.20
		≥0.25% C	annealed	650	190	2	40-100	0.03-0.10	0.05-0.15	0.07-0.17	0.08-0.20
		<0.55% C	quenched and tempered	850	250	3	40-85	0.03-0.10	0.05-0.15	0.07-0.17	0.08-0.20
		≥0.55% C	annealed	750	220	4	40-85	0.03-0.10	0.05-0.15	0.07-0.17	0.08-0.20
			quenched and tempered	1000	300	5	40-85	0.03-0.10	0.05-0.15	0.07-0.17	0.08-0.20
	low alloy and cast steel (less than 5% of alloying elements)		annealed	600	200	6	40-75	0.03-0.10	0.05-0.15	0.07-0.17	0.08-0.20
			quenched and tempered	930	275	7	40-60	0.03-0.10	0.05-0.15	0.07-0.17	0.08-0.20
				1000	300	8	40-60	0.03-0.10	0.05-0.15	0.07-0.17	0.08-0.20
				1200	350	9	40-60	0.03-0.10	0.05-0.15	0.07-0.17	0.08-0.20
	high alloyed steel, cast steel and tool steel		annealed	680	200	10	30-50	0.03-0.10	0.05-0.15	0.07-0.17	0.08-0.20
			quenched and tempered	1100	325	11	30-50	0.03-0.10	0.05-0.15	0.07-0.17	0.08-0.20
	stainless steel and cast steel		ferritic / martensitic	680	200	12	20-35	0.03-0.06	0.04-0.08	0.05-0.10	0.06-0.10
			martensitic	820	240	13	20-35	0.03-0.06	0.04-0.08	0.05-0.10	0.06-0.10
M	stainless steel and cast steel		austenitic, duplex	600	180	14	20-35	0.03-0.06	0.04-0.08	0.05-0.10	0.06-0.10
K	gray cast iron (GG)		ferritic / pearlitic		180	15	40-80	0.03-0.10	0.05-0.15	0.07-0.17	0.08-0.20
			pearlitic / martensitic		260	16	40-70	0.03-0.10	0.05-0.15	0.07-0.17	0.08-0.20
	nodular cast iron (GGG)		ferritic		160	17	40-95	0.03-0.10	0.05-0.15	0.07-0.17	0.08-0.20
			pearlitic		250	18	50-95	0.03-0.10	0.05-0.15	0.07-0.17	0.08-0.20
	malleable cast iron		ferritic		130	19	40-80	0.03-0.10	0.05-0.15	0.07-0.17	0.08-0.20
			pearlitic		230	20	40-80	0.03-0.10	0.05-0.15	0.07-0.17	0.08-0.20
N	aluminum-wrought alloys		not hardenable		60	21	80-150	0.03-0.10	0.05-0.15	0.07-0.17	0.08-0.20
			hardenable		100	22	80-150	0.03-0.10	0.05-0.15	0.07-0.17	0.08-0.20
	aluminum-cast alloys	≤12% Si	not hardenable		75	23	80-150	0.03-0.10	0.05-0.15	0.07-0.17	0.08-0.20
			hardenable		90	24	80-150	0.03-0.10	0.05-0.15	0.07-0.17	0.08-0.20
		>12% Si	high temperature		130	25	80-150	0.03-0.10	0.05-0.15	0.07-0.17	0.08-0.20
	copper alloys	>1% Pb	free cutting		110	26	80-150	0.03-0.10	0.05-0.15	0.07-0.17	0.08-0.20
			brass		90	27	50-150	0.05-0.12	0.07-0.15	0.08-0.18	0.09-0.18
			electrolytic copper		100	28	60-160	0.05-0.15	0.07-0.18	0.08-0.20	0.09-0.22
	non metallic		duroplastics, fiber plastics			29					
			hard rubber			30					
S	high temperature alloys	Fe based	annealed		200	31	10-20	0.02-0.04	0.03-0.06	0.04-0.07	0.04-0.08
			hardened		280	32	10-20	0.02-0.04	0.03-0.06	0.04-0.07	0.04-0.08
		Ni or Co based	annealed		250	33	10-20	0.02-0.04	0.03-0.06	0.04-0.07	0.04-0.08
			hardened		350	34	10-20	0.02-0.04	0.03-0.06	0.04-0.07	0.04-0.08
			cast		320	35	10-20	0.02-0.04	0.03-0.06	0.04-0.07	0.04-0.08
	titanium alloys		pure	RM 400		36	10-20	0.02-0.03	0.02-0.03	0.03-0.04	0.03-0.04
			alpha+beta alloys, hardened	RM 1050		37	10-20	0.02-0.03	0.02-0.03	0.03-0.04	0.03-0.04
H	hardened steel		hardened		55 HRC	38	10-20	0.01-0.02	0.01-0.02	0.02-0.03	0.02-0.03
			hardened		60 HRC	39	10-20	0.01-0.02	0.01-0.02	0.02-0.03	0.02-0.03
	chilled cast iron		cast		400	40	10-20	0.01-0.02	0.01-0.02	0.02-0.03	0.02-0.03
	cast iron		hardened		55 HRC	41	10-20	0.01-0.02	0.01-0.02	0.02-0.03	0.02-0.03

- For drill with lengh to diameter ratio larger than 6xD, reduce feed by 20%
- If the RPM exceeds 10,000, a dynamic balance should be done to the system
- Maximal radial and axial runout should not exceed 0.01 mm
- As a starting value, the middle of the recommended machining range should be used, then (according to wear results), conditions can be changed in order to optimize performance.

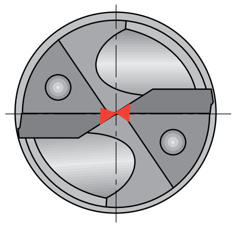
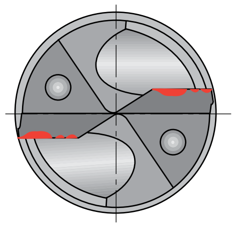
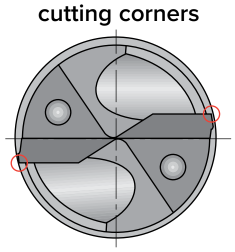
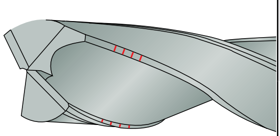
Recommended Machining Conditions for Solid Carbide Drills D=3.0-20.0 mm

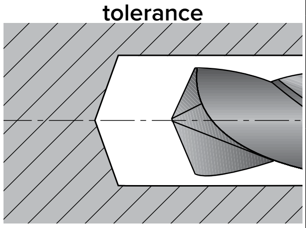
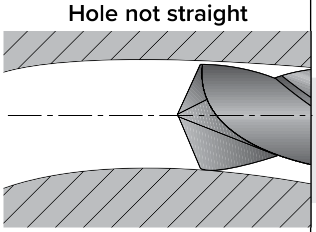
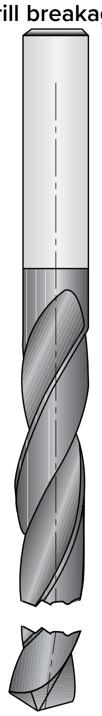
ISO	Material		Condition	Tensile Strength [N/mm²]	Hardness HB	Material No.(1)	Cutting Speed V_c m/min	Feed (mm/rev) Vs. Drill Diameter Ø3-5	Ø5.1-8	Ø8.1-12	Ø12.1-16	Ø16.1-20
P	non-alloy steel and cast steel, free cutting steel	<0.25% C	annealed	420	125	1	80-120	0.10-0.18	0.15-0.25	0.2-0.30	0.20-0.35	0.25-0.40
		≥0.25% C	annealed	650	190	2	80-110	0.10-0.18	0.15-0.25	0.2-0.30	0.20-0.35	0.25-0.40
		<0.55% C	quenched and tempered	850	250	3	70-100					
		≥0.55% C	annealed	750	220	4		0.10-0.20	0.15-0.28	0.2-0.35	0.20-0.38	0.25-0.42
			quenched and tempered	1000	300	5						
	low alloy and cast steel (less than 5% of alloying elements)		annealed	600	200	6	70-90	0.10-0.18	0.15-0.25	0.2-0.30	0.20-0.35	0.25-0.40
			quenched and tempered	930	275	7						
				1000	300	8	60-80	0.10-0.18	0.15-0.25	0.2-0.30	0.20-0.35	0.25-0.40
				1200	350	9	50-70	0.10-0.20	0.15-0.28	0.2-0.35	0.20-0.38	0.25-0.42
	high alloyed steel, cast steel and tool steel		annealed	680	200	10	60-80	0.10-0.20	0.15-0.28	0.18-0.35	0.20-0.38	0.25-0.42
			quenched and tempered	1100	325	11	50-70	0.10-0.15	0.12-0.20	0.14-0.25	0.16-0.30	0.18-0.32
	stainless steel and cast steel		ferritic / martensitic	680	200	12	25-75	0.04-0.10	0.05-0.15	0.05-0.18	0.08-0.20	0.10-0.20
			martensitic	820	240	13	25-75	0.04-0.10	0.05-0.15	0.05-0.18	0.08-0.20	0.10-0.20
M	stainless steel and cast steel		austenitic, duplex	600	180	14	25-75	0.04-0.10	0.05-0.15	0.05-0.18	0.08-0.20	0.10-0.20
K	gray cast iron (GG)		ferritic / pearlitic		180	15	85-105	0.15-0.25	0.20-0.35	0.25-0.45	0.30-0.50	0.35-0.55
			pearlitic / martensitic		260	16	75-90	0.15-0.25	0.20-0.35	0.25-0.45	0.30-0.50	0.35-0.55
	nodular cast iron (GGG)		ferritic		160	17	65-80	0.12-0.20	0.15-0.25	0.20-0.35	0.25-0.40	0.30-0.45
			pearlitic		250	18						
	malleable cast iron		ferritic		130	19						
			pearlitic		230	20						
N	aluminum-wrought alloys		not hardenable		60	21	70-300	0.10-0.25	0.15-0.35	0.25-0.45	0.30-0.50	0.35-0.55
			hardenable		100	22	70-200					
	aluminum-cast alloys	≤12% Si	not hardenable		75	23	70-300	0.07-0.18	0.12-0.25	0.20-0.35	0.25-0.45	0.30-0.50
			hardenable		90	24						
		>12% Si	high temperature		130	25						
	copper alloys	>1% Pb	free cutting		110	26						
			brass		90	27						
			electrolytic copper		100	28						
	non metallic		duroplastics, fiber plastics			29						
			hard rubber			30						
S	high temperature alloys	Fe based	annealed		200	31						
			hardened		280	32						
		Ni or Co based	annealed		250	33						
			hardened		350	34						
			cast		320	35						
	titanium alloys		pure	RM 400		36						
			alpha+beta alloys, hardened	RM 1050		37	15-35	0.02-0.07	0.04-0.10	0.06-0.12	0.08-0.15	0.08-0.18
H	hardened steel		hardened		55 HRC	38	40-70	0.06-0.10	0.08-0.12	0.10-0.14	0.12-0.16	0.14-0.18
			hardened		60 HRC	39						
	chilled cast iron		cast		400	40						
	cast iron		hardened		55 HRC	41						

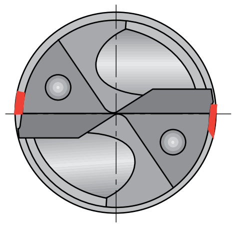
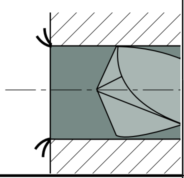
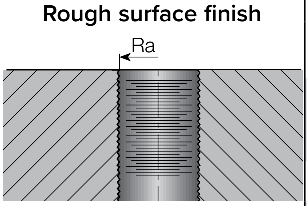
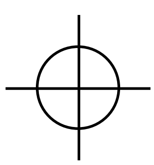
As a starting value, the middle of the recommended machining range should be used, then (according to wear results), conditions can be changed in order to optimize performance.

- When using external coolant supply only, reduce cutting speed by 10%
- Use internal coolant supply when machining austenitic stainless steel

Troubleshooting

Problem	Cause.	Solution.
Chipping on the chisel edge 	• Poor clamping of the chuck.	• Check the clamping. Use hydraulic clamping chuck, **MAXIN** power chuck or a shrink system.
	• Unsuitable cutting conditions.	• Decrease feed, increase coolant pressure.
	• Chisel runout.	• Check or replace the clamping adaptation.
	• Workpiece movement.	• Increase workpiece chucking force.
Chipping on the cutting edges / built-up edge 	• Poor clamping of the chuck.	• Check the clamping. Use hydraulic clamping chuck, **MAXIN** power chuck or a shrink system.
	• Unsuitable cutting conditions.	• Increase cutting speed, reduce feed rate.
	• Insufficient coolant.	• Check cooling lubricant. Increase coolant pressure. In the case of external coolant supply, improve jet direction and add cooling jets.
	• Rough application.	• Reduce feed rate by 30-50% during entry and exiting.
Excessive wear on the cutting corners 	• Insufficient coolant.	• Check cooling lubricant. Increase coolant pressure. In the case of external coolant supply, improve jet direction and add coolant jets.
	• Large runout.	• Check if the runout is within 0.02 mm T.I.R. (radial & axial).
	• Unsuitable cutting conditions.	• Reduce cutting speed, increase feed.
	• Rough application.	• Reduce feed rate by 30-50% during entry and exit.
	• Poor clamping of the chuck.	• Check the clamping. Use hydraulic clamping chuck, **MAXIN** power chuck or a shrink system.
Chipping on the lands 	• Workpiece movement.	• Increase workpiece chucking force.
	• Insufficient coolant.	• Check cooling lubricant. Increase coolant pressure. In the case of external coolant supply, improve jet direction and add coolant jets.
	• Wrong drill.	• Check drill type, drilling depth, cooling system and workpiece material.
	• Unsuitable cutting conditions.	• Increase feed. When spot drilling, reduce feed.

Problem	Cause.	Solution.
Hole diameter out of tolerance 	• Unsuitable cutting conditions.	• If hole size is too large, increase cutting speed or reduce feed. If hole size is too small, reduce cutting speed or increase feed.
	• Poor clamping of the chuck.	• Check the clamping. Use hydraulic clamping chuck, **MAXIN** power chuck or a shrink system.
	• Large runout.	• Make sure that the drill's runout is within 0.02 mm (radial & axial).
	• Worn out center point (chisel).	• Regrind cutting edge or replace the drill.
Hole not straight 	• Insufficient chip evacuation.	• Use pecking cycle.
	• Poor clamping of the chuck.	• Check the clamping. Use hydraulic clamping chuck, **MAXIN** power chuck or a shrink system.
	• Workpiece rigidity.	• Increase workpiece chucking force.
	• Worn out drill center point (chisel).	• Regrind cutting edge.
	• Unsuitable cutting conditions.	• Increase feed. When spot drilling, reduce feed.
Drill breakage 	• Poor clamping of the chuck.	• Check the clamping. Use hydraulic clamping chuck, **MAXIN** power chuck or a shrink system.
	• Workpiece movement.	• Increase workpiece chucking force.
	• Wrong drill.	• Check drill type and drilling depth, cooling system and workpiece material.
	• Insufficient coolant.	• Check cooling lubricant. Increase coolant pressure. In the case of external coolant supply, improve jet direction and add cooling jets.
	• Unsuitable cutting conditions.	• Reduce feed.
	• Worn out drill center point (chisel).	• Regrind cutting edge.
	• Insufficient chip evacuation.	• Use pecking cycle.

Problem	Cause.	Solution.
Chipping on the cutting corners 	• Poor clamping of the chuck.	• Check the clamping and adaptation. Use hydraulic clamping chuck, **MAXIN** power chuck or a shrink system.
	• Workpiece movement.	• Increase workpiece chucking force.
	• Wrong drill.	• Check drill type and drilling depth, cooling system and workpiece material. Possibly use longer drill.
	• Insufficient coolant.	• Check cooling lubricant. Increase coolant pressure. In the case of external coolant supply, improve jet direction and add cooling jets.
	• Unsuitable cutting conditions.	• Check cutting parameters, and possibly reduce feed.
	• Worn out or broken cutting corner.	• Replace drill or regrind cutting edge.
Problem: Burrs on exit 	• Unsuitable cutting conditions.	• Reduce feed by 30-50% during exit.
	• Worn out drill.	• Replace drill.
Rough surface finish 	• Unsuitable cutting conditions.	• Adjust feed to improve chip flow.
	• Large runout.	• Make sure that the drill's runout is within 0.02 mm (radial & axial).
	• Chip jamming.	• Reduce cutting speed.
	• .	• Increase coolant pressure.
	• .	• Apply pecking procedure.
Deviation of hole position 	• Large runout.	• Make sure that the drill runout is within 0.02 mm (radial & axial).
	• Poor stability.	• Check and improve drill and workpiece clamping rigidity.
	• Rough application.	• When drilling hard materials or sloped surfaces, reduce feed by 30-50% during entrance.
	• .	• Use a short pilot drill with 140° point angle.

Spot Drilling and Chamfering

Spot Drilling

Drilling an accurate hole is not always easy and can often be accompanied with difficulties. Material behavior, surface irregularities and drill point geometry can be factors leading to inaccurate holes. The purpose of spot drilling is to create a small divot to correctly locate the center of a drill when initiating a plunge. A spot drill, when used correctly will greatly reduce the chances of drill walking and help provide a more efficient and accurate hole.

The initial contact of the drill with the workpiece is one of the important factors in drilling. In most cases, it is recommended that the central protrusion (chisel edge) of the drill is the first point of contact with the workpiece.

Therefore, the spot drill should have a slightly larger point angle than the drill used.

If the angle of the spot hole is smaller than the drill point angle, then the drill can be damaged due to shock loading when the outer portion of its cutting surface contacts the workpiece before the drill chisel edge.

Using a spot hole angle equal to the drill point angle is acceptable, but far from optimal.

Figure 4.1 illustrates the described effect. For the top image named 'Proper Spot Angle', a drill is entering a previously drilled spot with a slightly larger angle than its point. For the image marked 'Improper Spot Angle', a drill is approaching an area with an angle that is far too small for its point.

In addition to its primary purpose, the spot drill can be used for countersink, chamfer milling, and deburring operations, Figure 4.2.

Figure 4.1

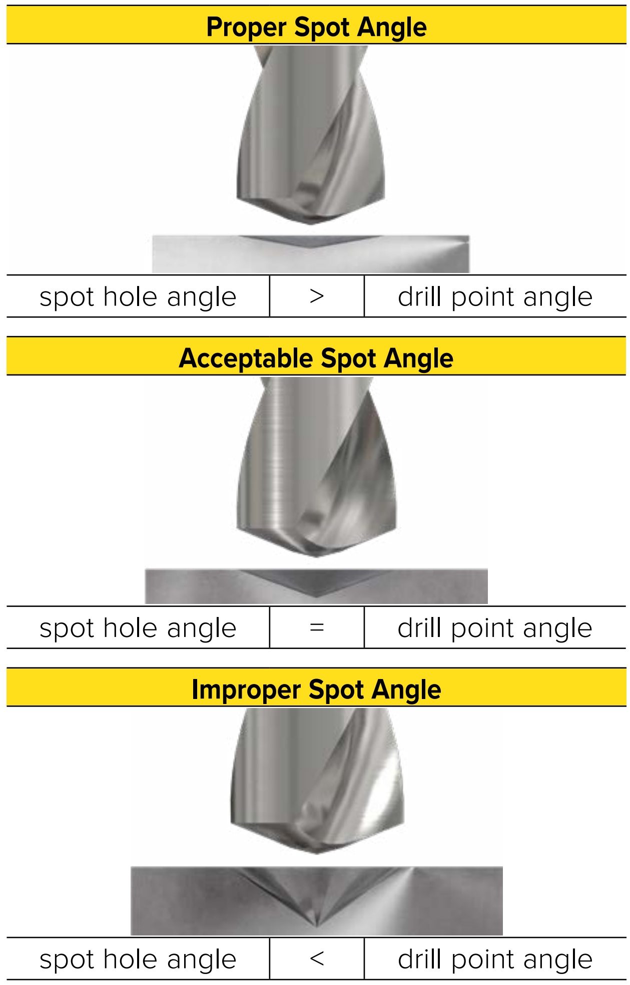
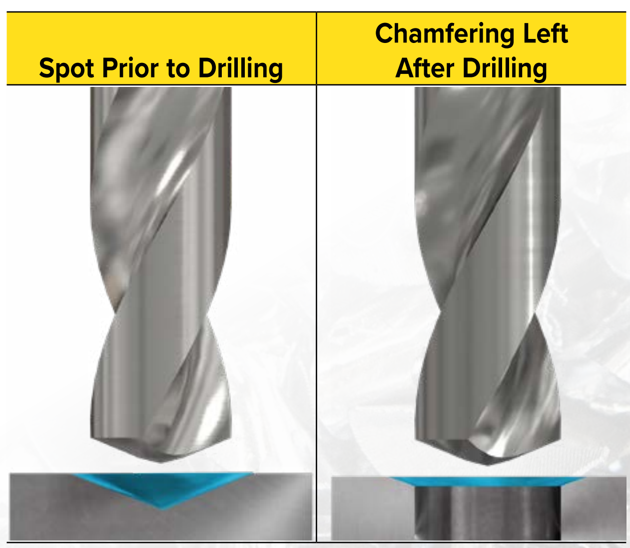
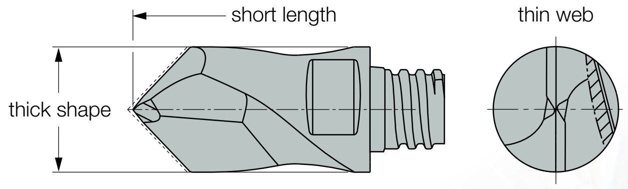


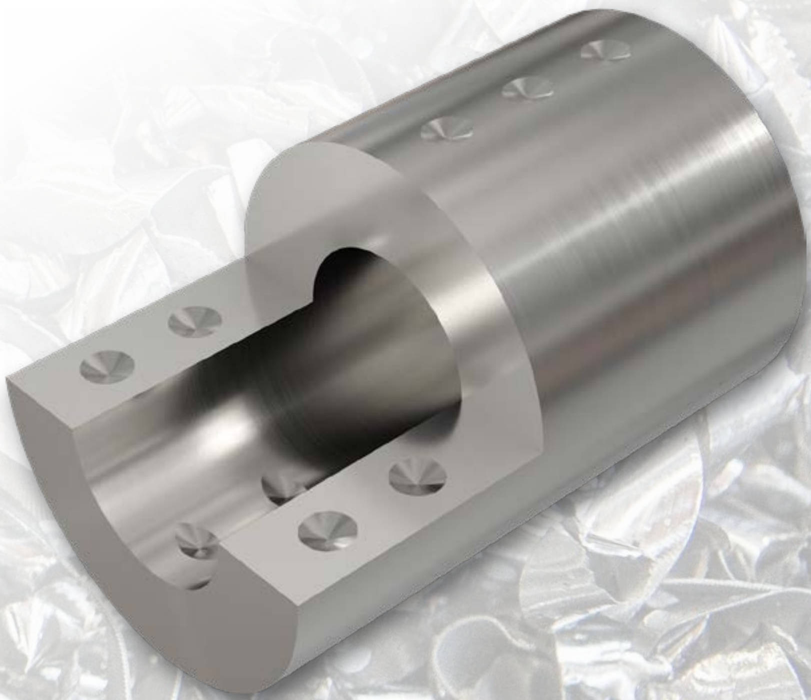
Figure 4.2



Spot Drill

The spot drill has a short and thick shape. These small drills are designed to be extremely rigid so they can pinpoint the location of the required hole. The spot drill is also characterized by a thin web at the point to prevent drill walking during machining. It is important to know that a spot drill has no land or body relief and is not designed to drill past the depth of the point angle, which is just enough to drill a “detent” or “dimple” in the workpiece.

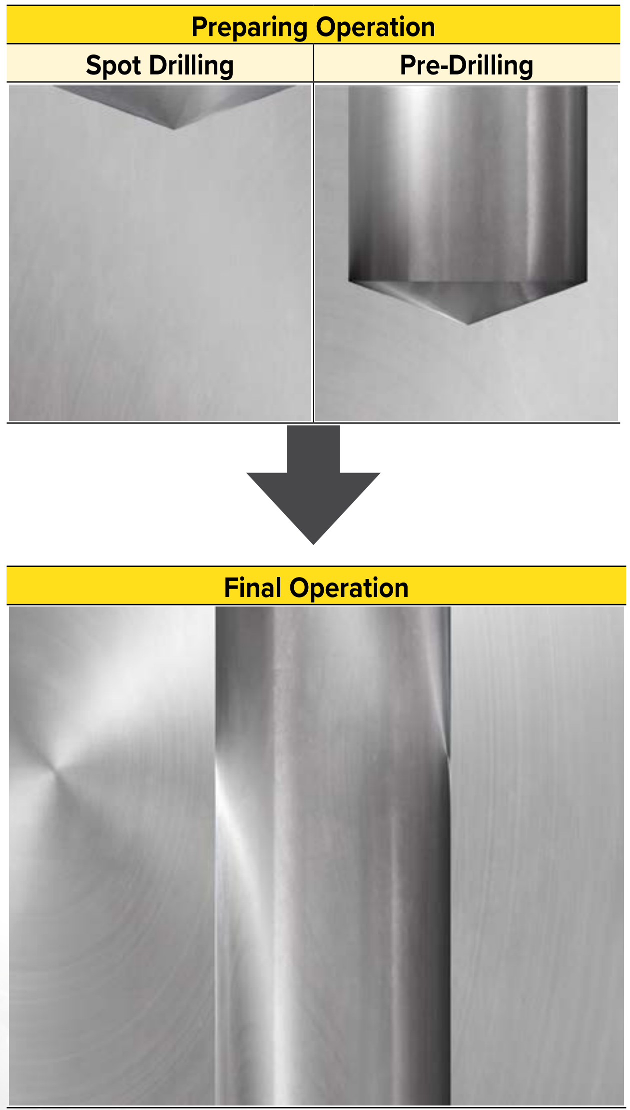




Spot Drilling vs Pre-Drilling

In some cases, the most common way to create a correct drill center location at the start of a plunge initiation is by spot drilling or pre-drilling. The dilemma often arises, which of these methods is preferable? Whether to create a pre-drilled hole using a short drill bit with a diameter similar to the required diameter or to create a dimple using a spot drill?

The answer is not always clear and depends on various parameters such as: availability of the tool in stock, workpiece form, workpiece material, requested hole requirements, machine center accuracy, operation stability, etc. Therefore, to select the correct method, it is necessary to consider each specific case separately.



The ISCAR Product Family for Spot Drilling

ISCAR provides various solutions for spot drilling in the following design configurations: replaceable **MULTI-MASTER** heads and solid carbide drills. In addition to spot drilling, these tools are suitable for countersinking, milling chamfers and removing burrs.

Spot Drilling

- MODULAR
  - Interchangeable Drilling Heads
    - MULTI-MASTER
- SOLID
  - SOLIDMILL

MULTI-MASTER Solution for Spot Drilling

MULTI-MASTER is a modular system containing a family of tools with shanks and unique interchangeable cutting heads for a variety of machining applications, among others, for drilling operations.

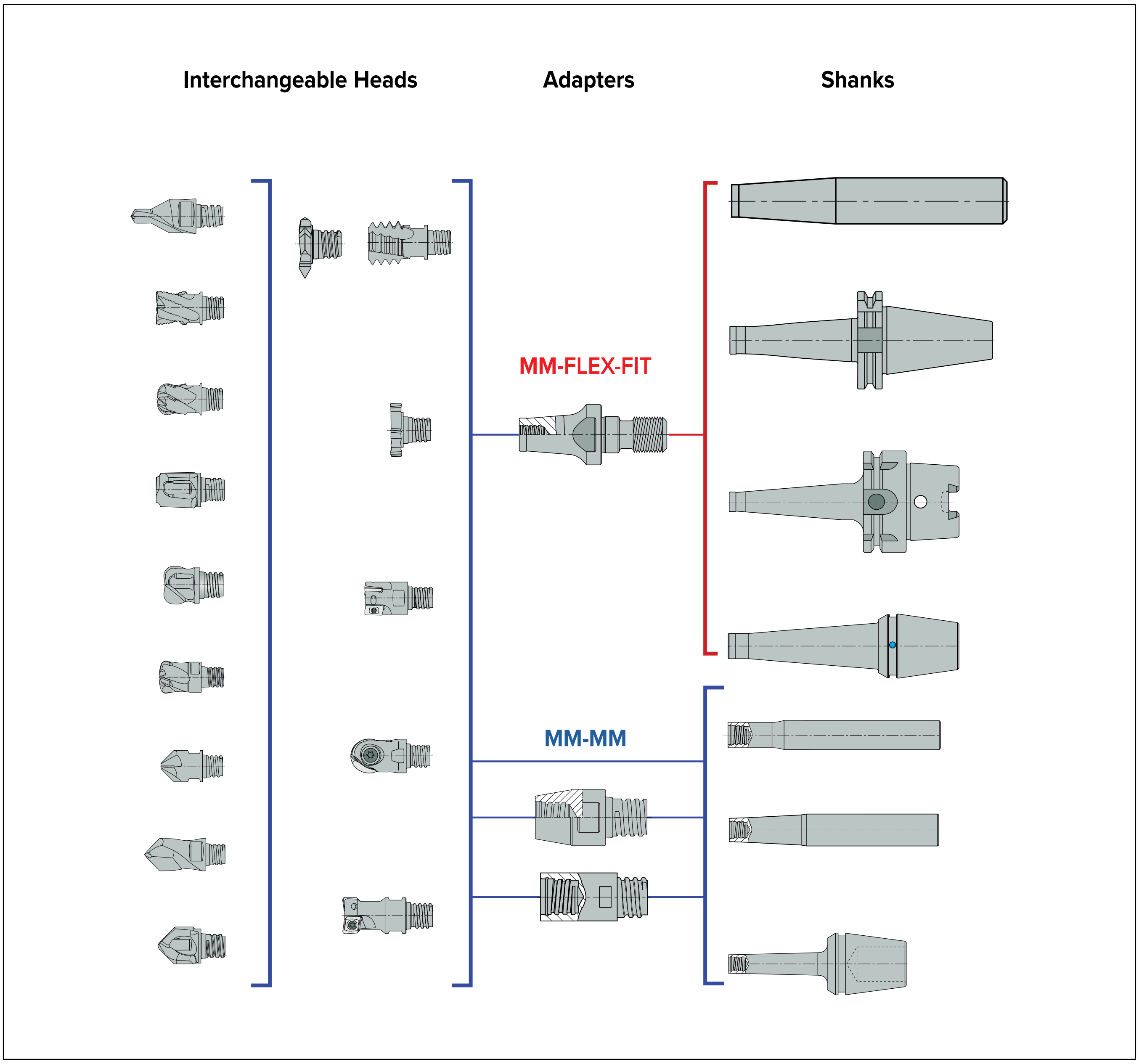
The **MULTI-MASTER** design approach is based on a special thread profile system (T-thread) accurately located at a short, precise taper and face contact.

The **MULTI-MASTER** drilling head has a cutting part and a back connection with an external thread and taper that screws into a shank with the corresponding internal thread and taper. The drilling head is finally secured when the back face of the head's cutting part makes contact with the shank face.

This principle of coupling ensures straight and rigid clamping of a wide range of interchangeable heads.

MULTI-MASTER tools meet the requirement of high accuracy because the geometry is finished by precise grinding, and the connection guarantees high concentricity within a very close limit. In addition, the tools are simple to operate since the heads are quickly replaced by easy rotation of an applied key. Moreover, they conform to strict repeatability requirements and replacing the heads does not require additional adjustment.

The basic concept of the **MULTI-MASTER** family is that a shank can carry heads of different shapes and accuracy, allowing dramatic increase of tool versatility and fewer needs for special tools. Resharpening of cutting edges is no longer needed because a worn-out cutting head is simply replaced. The family renders a possibility of numerous tools by an unlimited combination of the heads and the shanks, which answers any machining requirements and reduces procurement costs.



Features

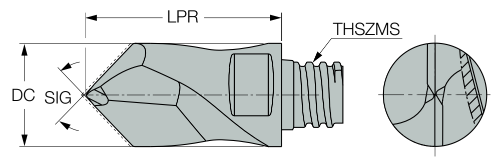
Modular system reduces stock cost by using the same head with different shank options. Enables machining with larger overhang. Same head can be mounted on metric and inch combinations.

MULTI-MASTER for Spot Drilling

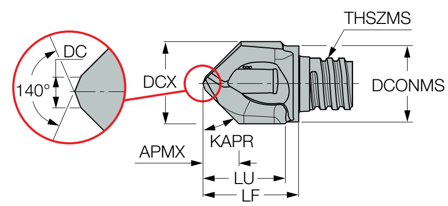
There are two kinds of **MULTI-MASTER** heads intended for spot drilling: MM ECD and MM HCD. Each type of drilling head has its own characteristics.

The MM ECD heads were originally designed for spot drilling with various point angles, whereas MM HCD heads were designed with point angles that match countersink standards: ANSI B18.3, ISO 5856, DIN EN 4072, IS 15437, MIL-STD-40007.

MM ECD



MM HCD



MM ECD

The interchangeable MM ECD heads with **MULTI-MASTER** connection are intended mainly for spot drilling to accurately locate a hole without using guide bushing or pre-drilling operations.
In the **MULTI-MASTER** standard product line, heads MM ECD are available with a point angle of 90° and 145°.

The MM HCD heads ware designed for a high chip load and suitable for most types of materials. Optional features of the MM ECD heads are milling chamfering, countersinking, and deburring.

Explanation of Drilling Heads MM ECD Description

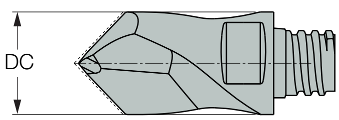
Example:

MM ECD	10	x	145	-	2	T06
1	2		3		4	5

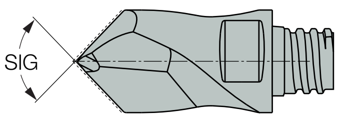
1 Designation of the Drilling Head

MM ECD – interchangeable head for spot drilling, chamfering and countersinking with **MULTI-MASTER** connection

2 Cutting Diameter Maximum (DC)



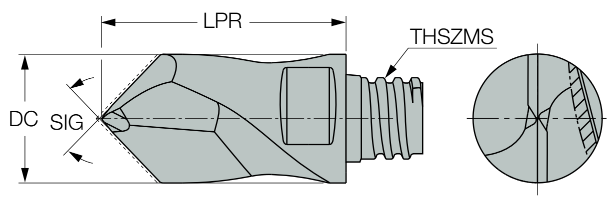
3 Point Angle



4 Number of Cutting Edges

5 MULTI-MASTER Connection Size

Basic Dimensions of Drilling Heads MM ECD



DC – cutting diameter

LPR – protruding length

THSZMS – connection thread designation

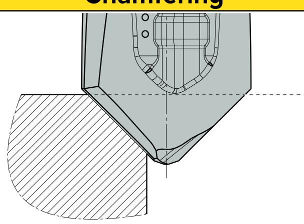
SIG – point angle

MM HCD

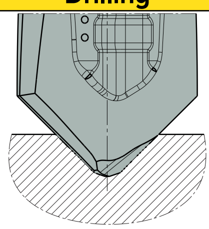
In the **MULTI-MASTER** standard product line, MM HCD heads have point angles of 60°, 80°, 90°, 100° and 120°. Such a variety relates mainly to the requirements of different standards for chamfers and countersinks for fasteners. For example, metric countersunk screws require a 90° countersink, but American National countersunk screws require 80° and aerospace rivets 100°. A typical chamfer features a 45° chamfer angle, although 30° and 60° chamfers are also common. This multiformity of required generated profiles defines the functional capabilities of the heads and explains their variety.

Although the MM HCD head was designed for a moderated chip load, this tool may also be suitable for spot drilling.

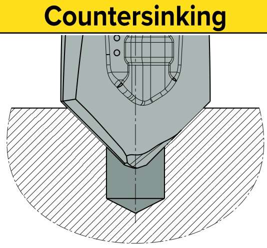
Chamfering



Drilling



Countersinking



Explanation of Drilling Heads
MM HCD Description

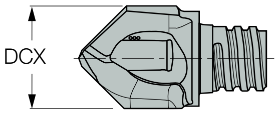
Example:

MM HCD	100	-	120	-	2	T06
1	2		3		4	5

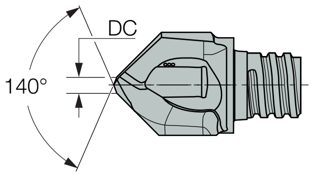
1 Designation of the Drilling Head

MM HCD – interchangeable 2 flute head for chamfering, countersinking and spot drilling with **MULTI-MASTER** connection

2 Cutting Diameter Maximum (DCX)



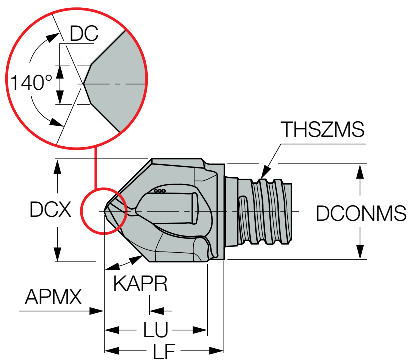
3 Point Angle



4 Number of Cutting Edges

5 MULTI-MASTER Connection Size

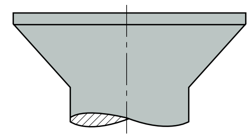
Basic Dimensions of Drilling Heads MM HCD

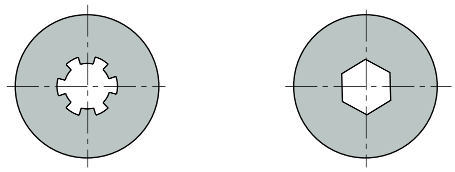


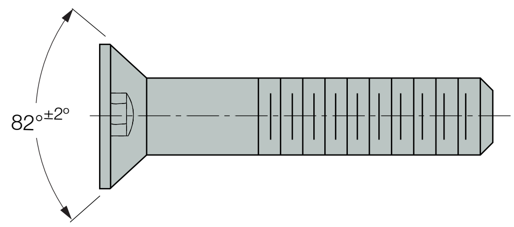
DC – cutting diameter
DCX – cutting diameter maximum
LF – functional length
LU – usable length
APMX – depth of cut maximum
DCONMS – connection diameter machine side
THSZMS – connection thread designation
KAPR – point angle

Usable Information

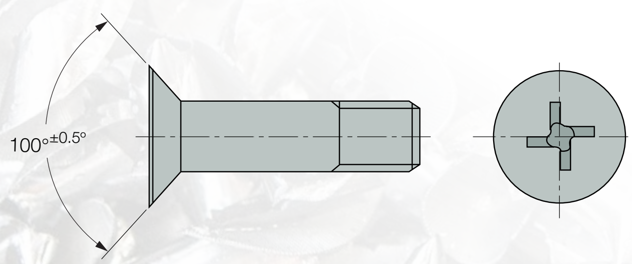
- MM HCD drilling heads with a point angle of 80° were designed mainly for the countersink according to standard ANSI B18.3 that define hexagon and spline socket flat countersunk head cap screws.



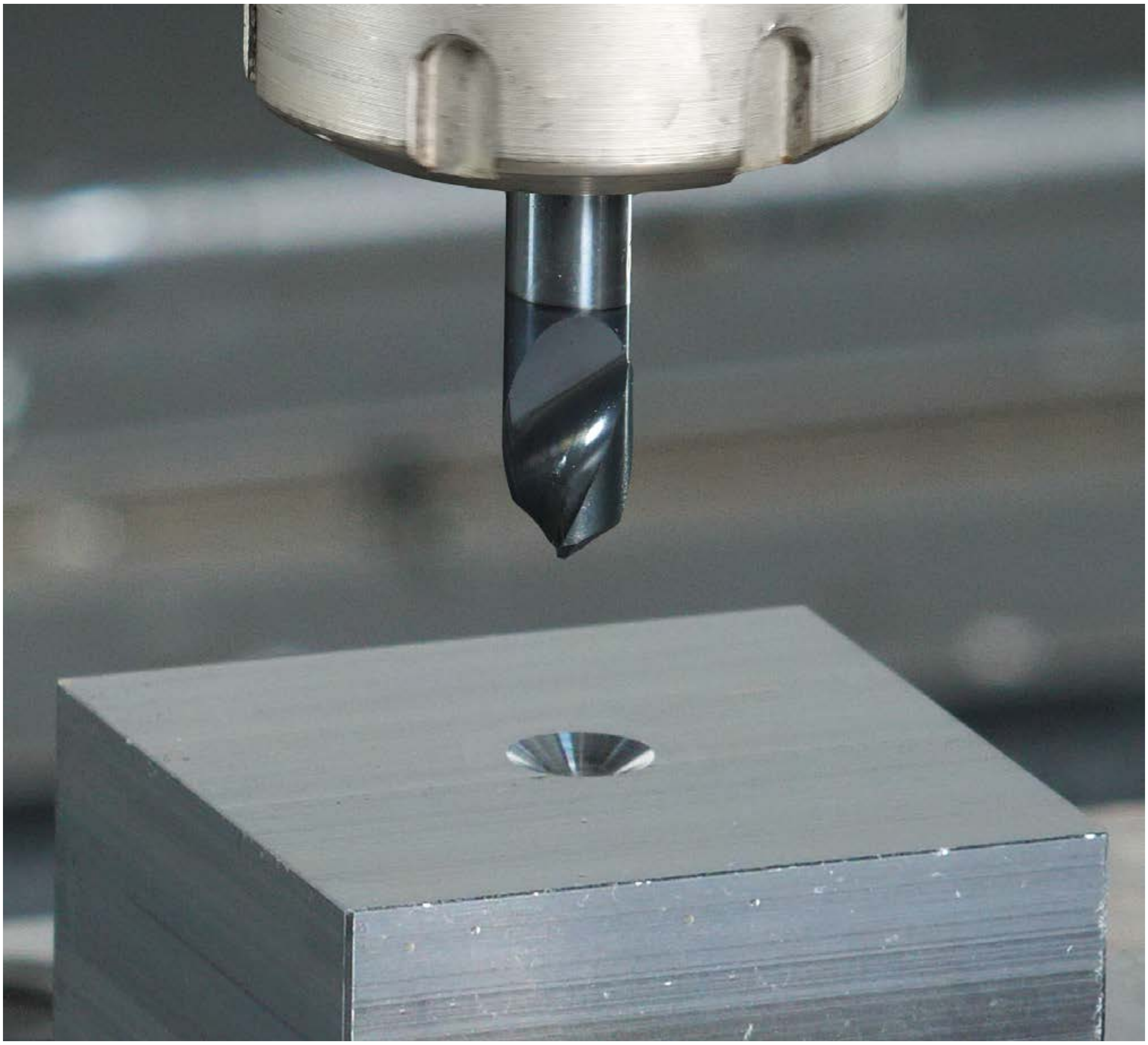




- The MM HCD heads with a point angle of 100° were designed mainly for countersink holes for head cap screws according to ISO 5856, DIN EN 4072, IS 15437; and for rivets according to MIL-STD-40007. These heads can also be applied for machining countersink holes for general-use 100° flat countersunk head machine screws, in accordance with ANSI B18.6.3-1972. Most aircraft countersunk screws require a 100° angle countersink.



Solid Carbide Drill Solution for Spot Drilling



Tools among the most common for spot drilling are solid carbide drills.
The one-piece drill design combined with short flutes and overall length increases rigidity and strength while reducing drill wander. Solid Carbide NC Spotting Drills can be used at higher speeds and feeds for accurate spotting on NC/CNC machines.

ISCAR's solid carbide drill for spot drilling describes ECD-S2 ... and is available uncoated (IC08) or AlTiN coatings (IC900), covering most workpiece materials.
Optional features of the ECD-S2 ... spot drills are milling chamfering, countersinking, and deburring.

Explanation of the Solid Carbide Spot Drill Description

Example:

ECD-S2	030	/	90	C	03	-	38
1	2		3	4	5		6

1 Designation of the Drilling Head

ECD-S2 – solid carbide drill for spot drilling, chamfering, and countersinking

2 Cutting Diameter (DC)

3 Point Angle

4 Shank Type

C - cylindrical

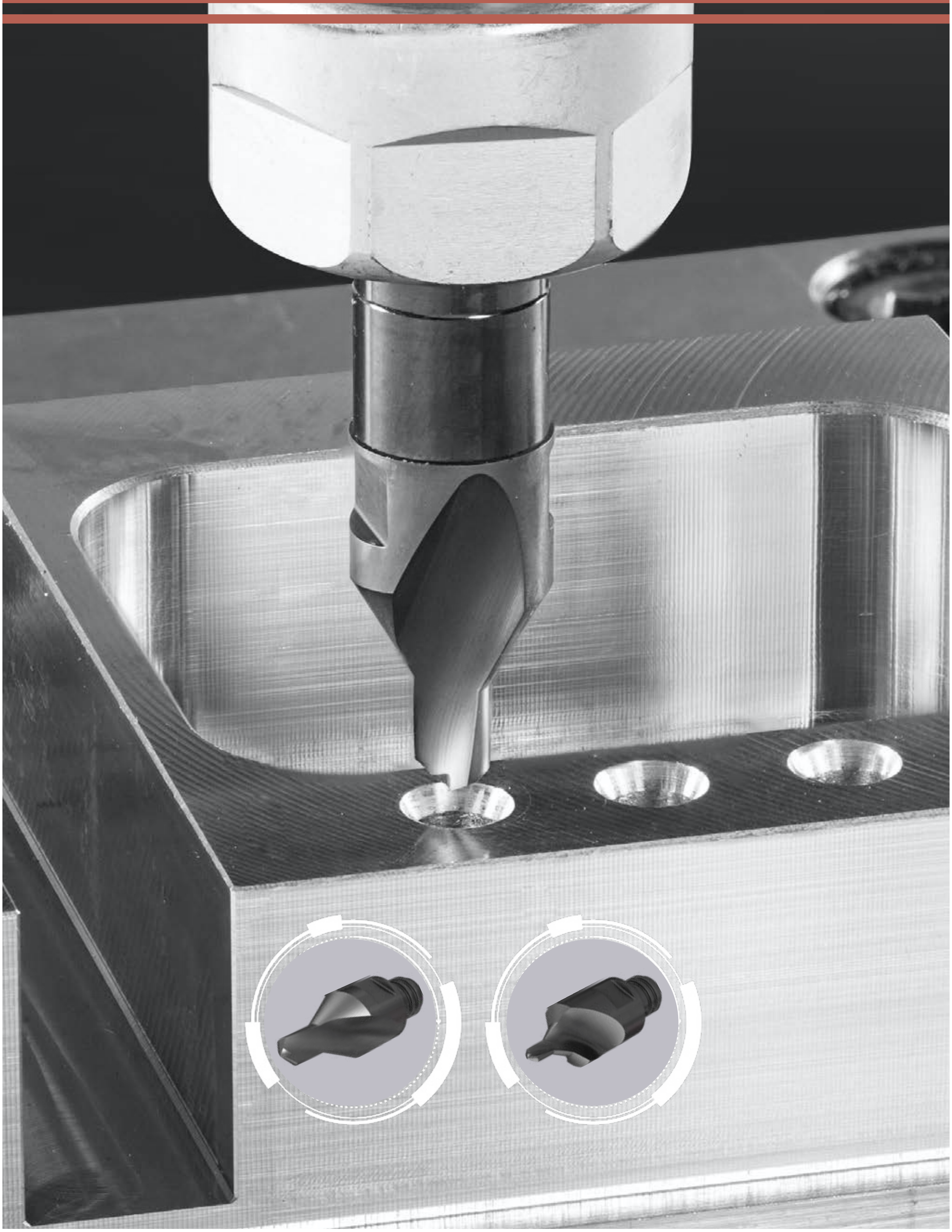
5 Shank Diameter (DCONMS)

6 Overall Length (OAL)

Basic Dimensions of the Solid Carbide Spot Drill

DC – cutting diameter
DCONMS – connection diameter machine side
OAL – overall length
APMX – depth of cut
LU – usable length
SIG – point angle

Center Drilling



Center drilling is a type of mechanical processing to produce centering holes. Center holes are purely technological elements and are used to provide support for parts that are machined between centers or with tailstock. There are different types of center holes. The form and dimensions of the center holes depend on the design of the part, technological machining operations, and part dimensions.

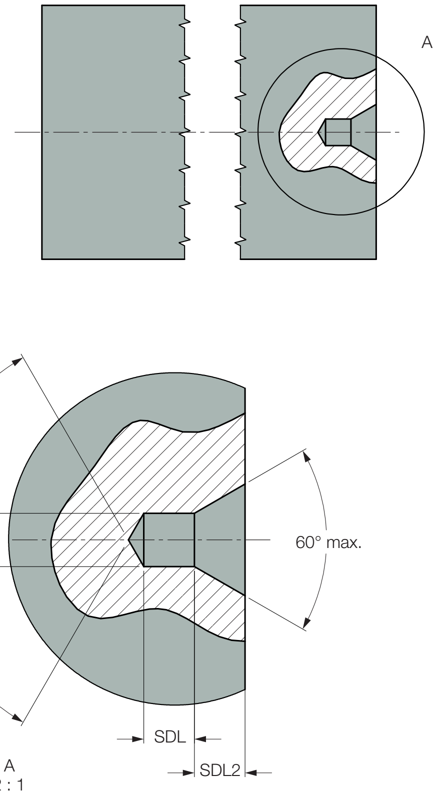
The most common types of center holes are:

Type A – also called "plain type" is a center hole with a single 60-degree chamfer. Figure 5.1

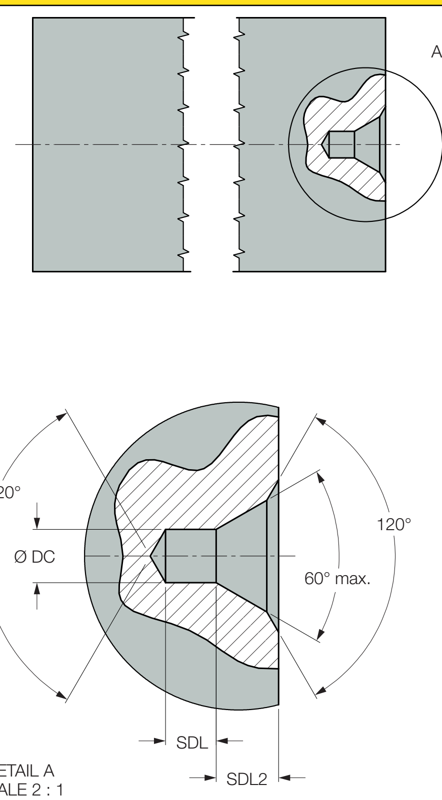
Type B – also called "bell type" is a hole with 2 chamfers, a 60-degree chamfer and additionally a 120-degree chamfer at the start of the hole. The 120-degree chamfer protects the main 60-degree taper from damage and deformation that can cause inaccurate centering of the tailstock center. Such center holes are necessary for machining parts with a large number of operations. Figure 5.1

Figure 5.1

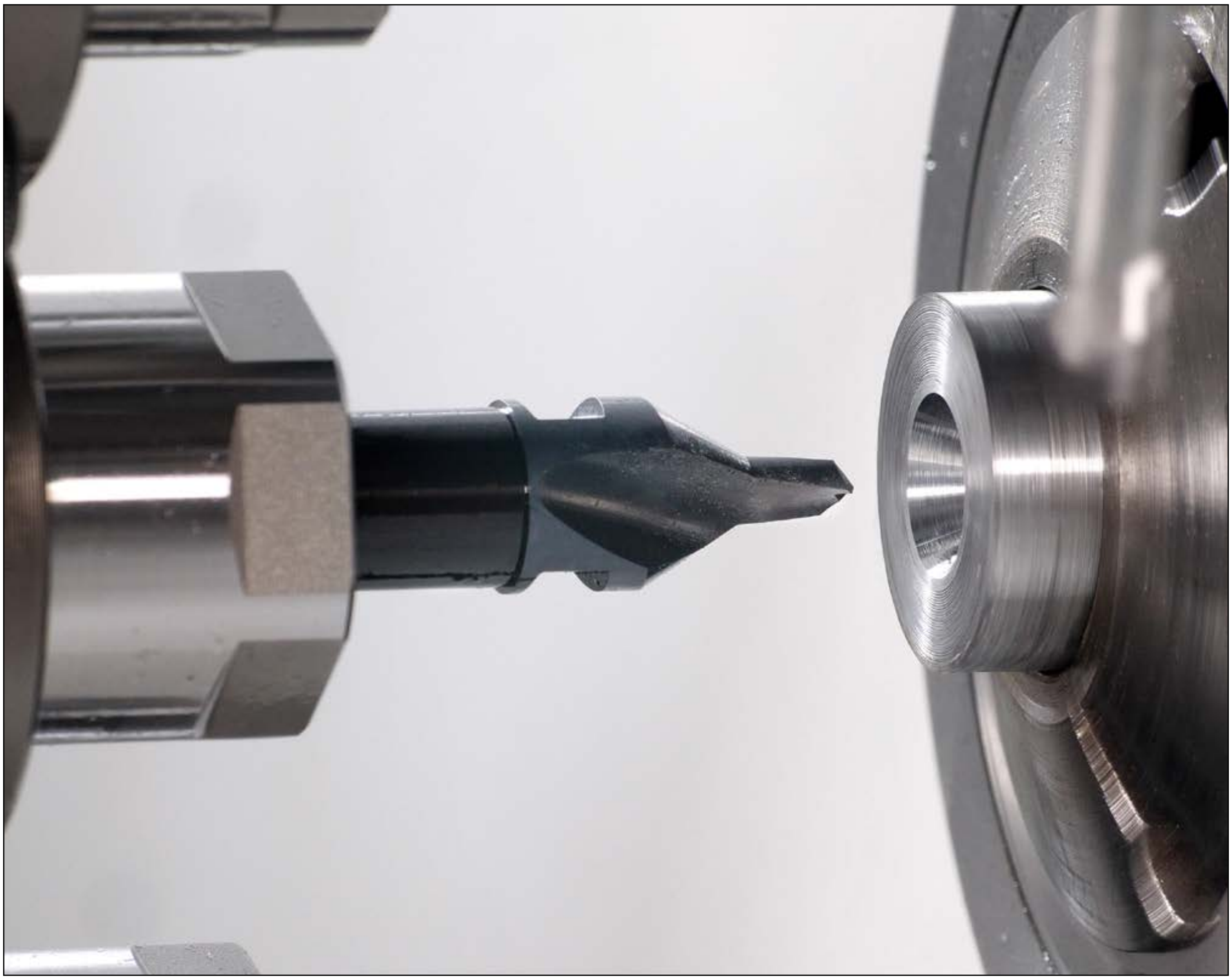
Type A – "Plain Type"
Without Protective Chamfer



Type B – "Bell Type"
With Conical Protective Chamfer



Center Drills



Center drills are profile drilling tools which were specially developed for machining centering holes. The center drill performs a combination of two operations simultaneously: drilling and countersinking. Therefore, the center drill is often referenced as a “combined countersink”. Another name for the center drill, although rarely used, is a “Slocombe drill”.

ISCAR center drills are designed according to DIN 333
for center holes according to DIN 332

Centering drills may differ in the following parameters:

- Construction – one or double-sided
- Material - the most common center drills are carbide and HSS
- Type – A, B, etc.
- Dimensions – depending on the workpiece’s features (overall dimensions, weight, etc.)
- Hardness – usually 63-66 HRc

Centering drills are selected based on the requirements for the centering hole in the design drawings.

Center Drills: Carbide vs HSS

High-speed steel (HSS) reversible center drill bits are the most popular tools for center drilling. The bits are simple, always available for purchase, and feature low price. This may raise the question: "Do the solid carbide bits offer a real alternative to the HSS bits?". A seemingly obvious answer may not be so evident, especially in the case of machining difficult-to-cut material (like Titanium, Inconel, etc.). The carbide bit ensures noticeable increases in cutting speed and feed, resulting in higher productivity and reduced machining cost. In addition, the tool life of solid carbide bit is much longer. Therefore, the correct answer requires brief economic calculations, which will show the actual situation for every specific case.

MM ECS Replaceable Solid Carbide Head for Centering Drilling

VS

High-Speed Steel (HSS) Reversible Center Drill Bits

ISCAR Product Family for Center Drilling

ISCAR offers an interchangeable drilling head for machining centering holes.

Center Drilling

MODULAR

Interchangeable Drilling Heads

MULTI-MASTER

MULTI-MASTER Solution for Center Drilling

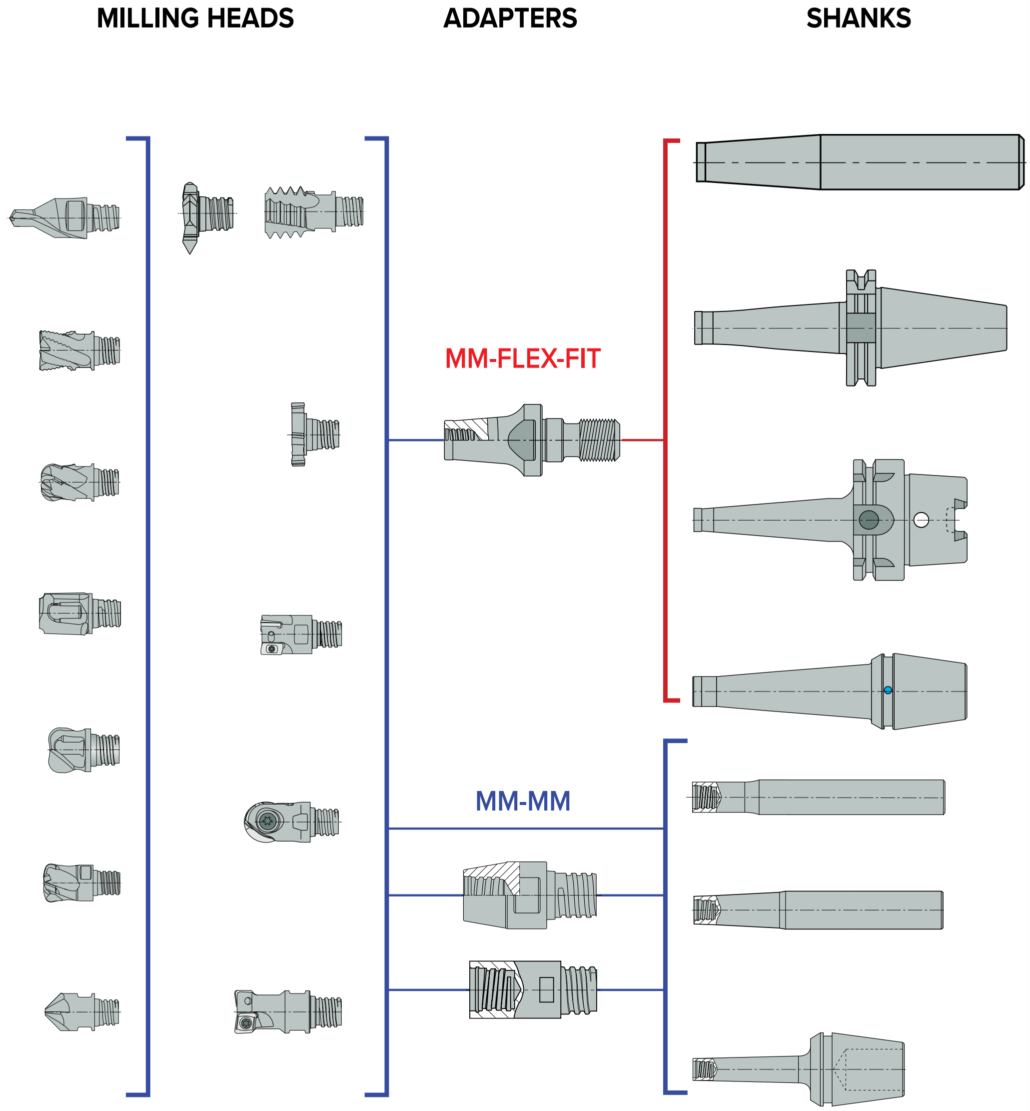
MULTI-MASTER is a family of tools with shanks and unique interchangeable heads for a variety of drilling, threading, milling, slitting, and slotting applications. Indexing is fast and convenient due to the unique threaded connection. Since the tool is not removed from the machine, there is no setup time for head replacement.

MULTI-MASTER is a high-tech substitute for HSS and solid carbide tools.

The **MULTI-MASTER** system guarantees excellent repeatability, and resharpening of tools is no longer needed. Interchangeable heads with **MULTI-MASTER** connection are available in various **ISCAR** grades that enable high speed machining with excellent toughness and wear resistance. **ISCAR**'s **MULTI-MASTER** can reduce your production costs through increased production efficiency.

40,000 Indexable Solid Carbide Endmill Options

MULTI-MASTER and FLEX-FIT Connection Options



Features

Modular system reduces stock cost by using the same head with different shank options. Enables machining with larger overhangs. Same head can be mounted on metric and inch combinations.

MULTI-MASTER for Center Drilling

The MM ECS **MULTI-MASTER** centering drills family consists of MM ECS-A... and MM ECS-B... drilling heads.

The MM ECS-A... designed for machining centering holes type A and the MM ECS-A... designed for machining centering holes type B. The MM ECS-A... items feature a cylindrical drill, followed by 60° conical edge and the B-type features an extra 120° protective chamfering facet that produces an improved centering hole geometry, which better protects tailstock centers.

MM ECS
Type A

MM ECS
Type B

Explanation of Drilling Heads MM ECS-... Description

Example:

MM ECS	-	A	4.00	x	10	-	2	T06
1		2	3		4		5	6

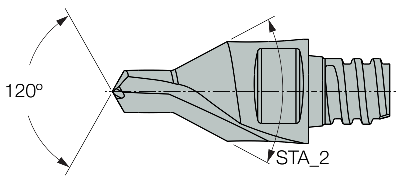
1 Designation of Drilling Head

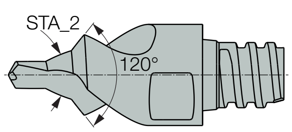
MM ECS – interchangeable head for centering drilling with **MULTI-MASTER** connection

2 Centering Hole Type

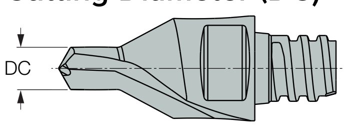
A – centering hole type a

B – centering hole type b

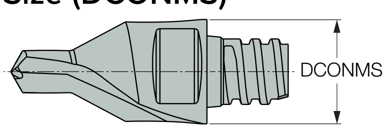




3 Cutting Diameter (DC)



4 Connection Diameter Machine Size (DCONMS)

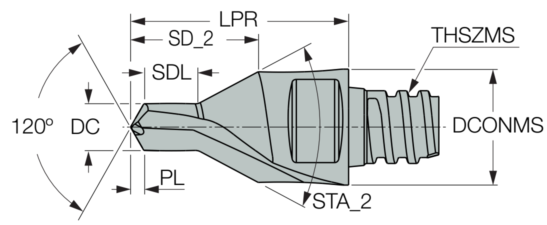


5 Number of Cutting Edges

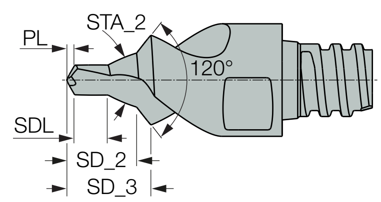
6 MULTI-MASTER Connection Size

Basic Dimensions of Drilling Heads MM ECS-...

Type A



Type B



DC – cutting diameter

DCONMS – connection diameter machine side

THSZMS – connection thread designation

LPR – protruding length

SDL – step diameter length

SD_2 – step distance

SD_3 – step distance

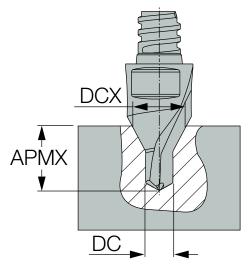
STA_2 – step included angle

PL – point length

MULTI-MASTER Cutting Conditions for Center Drilling

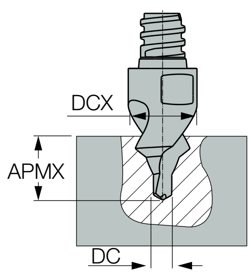
The main elements of the cutting conditions for centering drilling are cutting speed and feed. When drilling holes, it is important to select the right cutting conditions in which the tool will work normally, i.e., most efficiently to save the tool from premature wear, taking into account maximum productivity.

Recommended initial conditions are shown in the table below, according to chip breaker form and workpiece material.



		IC908						
		*V_c x F_z [m/min x mm/tooth]						
		MM ECS-A1.00X06-2T04	MM ECS-A1.60X06-2T04	MM ECS-A2.00X06-2T04	MM ECS-A3.15X08-2T05	MM ECS-A4.00X10-2T06	MM ECS-A5.00X12-2T08	MM ECS-A6.30X16-2T10
ISO		DCX=2.12, APMX=2.5	DCX=3.35, APMX=3.9	DCX=4.25, APMX=4.8	DCX=6.70, APMX=7.60	DCX=8.50, APMX=9.80	DCX=10.60, APMX=12.00	DCX=13.20, APMX=14.80
P	4340 24-29HRC	80x0.020	80x0.025	80x0.025	80x0.030	80x0.040	80x0.050	80x0.060
P	4340 38-42HRC	65x0.020	65x0.025	65x0.025	65x0.030	65x0.040	65x0.050	65x0.060
M	316L MAX-215 HB	50x0.015	50x0.020	50x0.020	50x0.025	50x0.030	50x0.040	50x0.040
S	Inconel 718	15x0.010	15x0.010	15x0.015	15x0.015	15x0.020	15x0.020	15x0.025

* V_c Calculated for ØDC



		IC908			
		*V_c x F_z [m/min x mm/tooth]			
		MM ECS-A3.15X12-2T08	MM ECS-A4.00X127-2T08	MM ECS-A5.00X19-2T12	MM ECS-A6.30X20-2T12
ISO		DCX=10.00, APMX=8.80	DCX=12.50, APMX=11.00	DCX=16.00, APMX=13.900	DCX=18.00, APMX=16.80
P	4340 24-29HRC	75x0.030	75x0.040	75x0.050	75x0.060
P	4340 38-42HRC	60x0.030	60x0.040	60x0.050	60x0.060
M	316L MAX-215 HB	45x0.025	45x0.030	45x0.040	45x0.040
S	Inconel 718	12x0.015	12x0.020	12x0.020	12x0.025

* V_c Calculated for ØDC

Deep Hole Drilling

Machining of high-precision holes by deep drilling is a widespread technological operation today in the field of metalworking.

Modern deep hole drilling methods were developed in the late 19th century and throughout the 20th century to meet the needs of the military industry.

In the 1870s, following the invention of smokeless powder by a French chemist (which increased power more than six times that of black powder), arose the need for much stronger rifle barrels. Before that, they were made by forging.

The steel sheet was cut into strips, the length of each segment corresponded to the length of the barrel and the width of each segment corresponded to the caliber. Each piece was heated and rolled into a tube. The resulting seam, in the area where the edges of the segment meet, was smoothed with hammer blows. Then the notches were made with a broach. By this method, the inner diameter was very accurate, but the smokeless powder tore apart the barrels after several shots.

The engineers decided to make the cannons by drilling solid rods.

The first development for deep drilling was the Gundrill. In the late 1800s, start the production of the first weapon with Gundrills: Mauser rifles made in Germany, Springfield rifles in England and USA.

During World War II, it became necessary to dramatically increase the production of warships and submarines. The STS (Single Tube System) was developed to produce naval guns, submarine periscopes and propeller shafts. The system enabled the work four times faster than Gundrills.

An Ejector system was developed in the 1950s. Unlike the STS, which required special machines, it was believed that the ejection system was adapted to conventional machines. The ejector system consists of two tubes, internal and external. The Ejector system, like the STS system, allows faster work than drilling with a gundrill, and ensures better accuracy.

Accuracy and Surface Quality

Deep Drilling Tolerance

Deep drilling configurations when used under recommended conditions can produce holes with tolerance of IT8-IT9 (Figure 6.1.1). When operating under optimal conditions, even better tolerance can be achieved.

Figure 6.1.1

Nonferrous Materials	Machinability of Metals									
Aluminum										
Tool Steel										
Cast Iron										
High Alloy Steel>800N/mm^2										
Hardened Steel										
Low Alloy Steel<800N/mm^2										
Carbon Steel										
Sintered Steel										
Drilling Quality	IT	13	12	11	10	9	8	7	6	5

Tolerance range under normal conditions

Tolerance range under optimal conditions

Surface Quality

Surface quality that can be achieved in deep drilling is defined in Figure 6.1.2.

Figure 6.1.2

		▼		▼▼				▼▼▼			▼▼▼▼		
		N12	N11	N10	N9	N8	N7	N6	N5	N4	N3	N2	N1
Indexable Drills													
Reaming													
Honing													
Deep Drilling													
Degree of Roughness	Mm	50	25	12.5	6.30	3.20	1.60	0.80	0.40	0.20	0.10	0.05	0.025
(Ra Roughness Index)	Min	2000	1000	500	250	125	63	32	16	8	4	2	1

Tolerance range under normal conditions Tolerance range under optimal conditions

Circularity

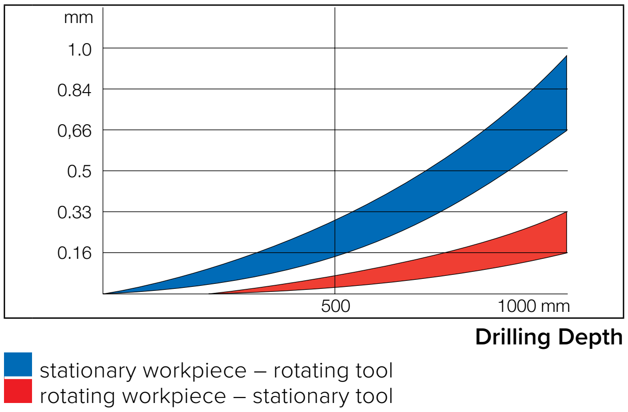
The geometric quality of bores obtained from deep hole drill bits is clearly higher than that obtained with the use of twist drills. It is possible to obtain precision with deviation of less than 4 µm (160 µinch).

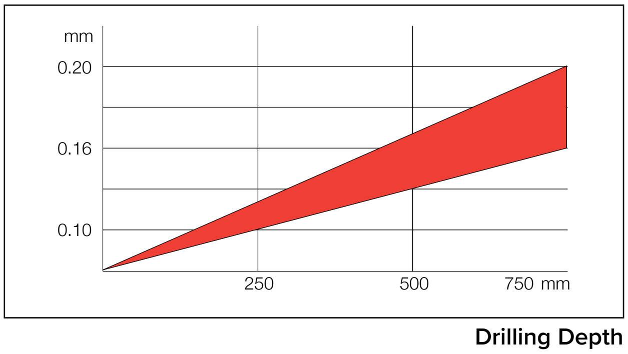
Concentricity and Straightness

The result quality depends on different factors such as:

- Drilling depth (Figure 6.1.3)
- Drilling diameter
- Type of machining and cutting parameters
- Quality and uniformity of the workpiece material
- Machine tool conditions
- Gundrill support (when using gundrill)

Figure 6.1.3





Deep Hole Drilling Features

Preliminary Centering of the Drill

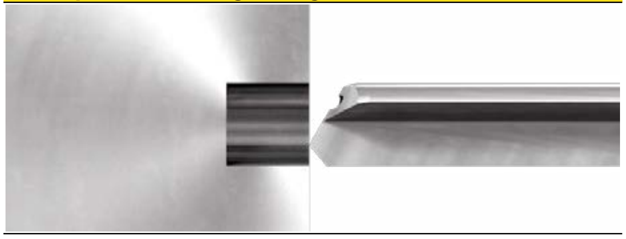
Deep hole drills are not a self-centering tool, and its radial rigidity is low (due to diameter to length ratio). In order to perform high-quality deep drilling with precision and accuracy, it is very important to ensure the correct direction of the drill at the very beginning of the processing. Therefore, an external means must be used to guide it to the point of entry into the workpiece. A guide bushing is an essential component for a proper deep hole drills operation. The function of the guide bushing is to direct the deep hole drills into the material during penetration. **ISCAR**'s guide bushing is based on modified DIN 179 standard. The internal diameter of guide bushing should be equal to drill diameter with tolerance H7. Dedicated deep hole drills machines are equipped with a guide bushing system.

An alternative method is a pre-drilled guide hole which is common for machining centers. Once the drill has been fully engaged into this hole, it continues to be self-guided.

Figure 6.2.1

Deep Hole Drilling Using Guide Bushing

Deep Hole Drilling Using Pre-Drilled Guide Hole

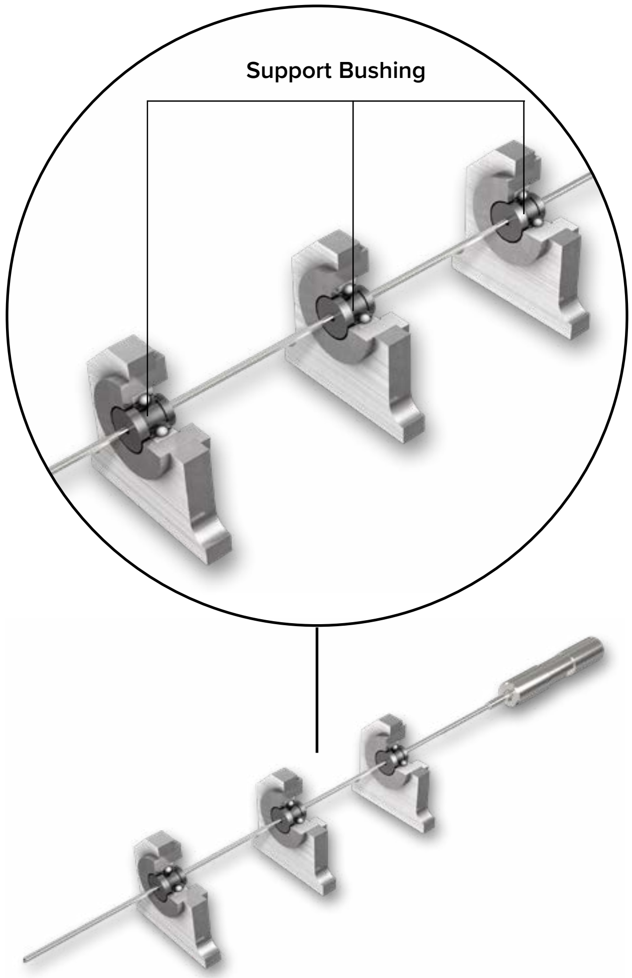


Support Bushing

Support bushing, also known as vibration damper or bar rest, is an element used to support and reduce vibration of the drill while drilling (Figure 6.2.2). Due to the large ratio of the diameter and depth of the drilling hole, as well as the high requirements for hole accuracy, it is necessary to support the drill during machining.

Therefore, in deep drilling operations, support bushing is used, which ensures the balance of cutting forces. Support bushing absorbs the torsional and flexural vibrations arising during the drilling process and dissipates them into the subsoil via the machine base.

Figure 6.2.2



Guide Pads

An integral part of the deep hole drill is the guide pad, which contributes to a high degree of calibration and provides burnishing of the drilled hole.

It is recommended that the machine tool be equipped with a means for guiding the deep hole drills, preferably during the entire drilling process.

Figure 6.2.3

Deep Hole Methods

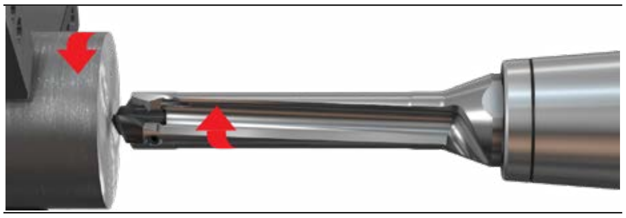
There are several methods used for deep drilling operations. Rotational motion can be produced by a part or tool, or by both a part and a tool. Linear movement is usually performed by the tool. The combination of these movements depends on the geometry and sizes of the workpiece, as well as on the available equipment.

Rotating Tool and Workpiece

Using this method, the workpiece and tool rotate in opposite directions; the tool while rotating also performs a linear movement for the drilling operation (Figure 6.3.1).

The recommended rotation ratio of a tool relative to the workpiece is 3-5:1, which means that for each revolution of the workpiece it is recommended that the tool perform 3-5 revolutions. The approximate deviation from straightness with counter-rotation of the drill and the workpiece can be 0.005-0.03 mm per 100 mm of hole depth. This method is great for drilling a hole in the center of cylindrical parts. If requested to drill a hole not in the center of the workpiece, or if the part is difficult to revolve due to its geometry or sizes, then this method is less suitable for the drilling operation.

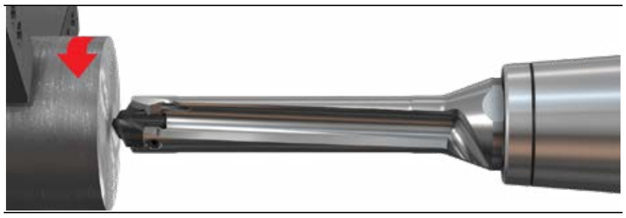
Figure 6.3.1



Rotating Workpiece

This method is based on the linear movement of the tool and workpiece rotation (Figure 6.3.2). When machining with a non-rotating tool, deviation from the straightness of the hole axis can be 0.03-0.06 mm per 100 mm of hole depth. This method can be useful in case the workpiece is machined on lathes or turning stations and required to drill a hole located in the center of the workpiece.

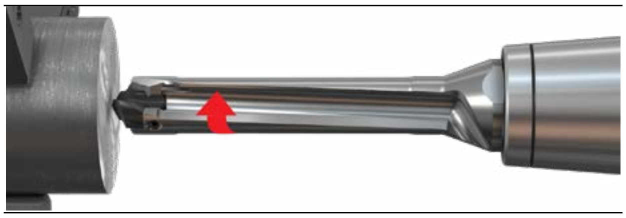
Figure 6.3.2



Rotating Tool

Using this method, the workpiece remains stationary while the tool performs rotational and linear motion (Figure 6.3.3). A rotating tool allows for relatively good straightness in drilling shallow holes, but when drilling deep holes, it is significantly degraded. The approximate deviation from straightness with a rotating drill can be 0.06-0.1 mm per 100 mm of hole depth. This method may be most suitable for drilling holes in a workpiece with complex geometries or in a workpiece with big sizes or when requested to drill several parallel holes or in cases where the required hole is not located in the center of the workpiece.

Figure 6.3.3

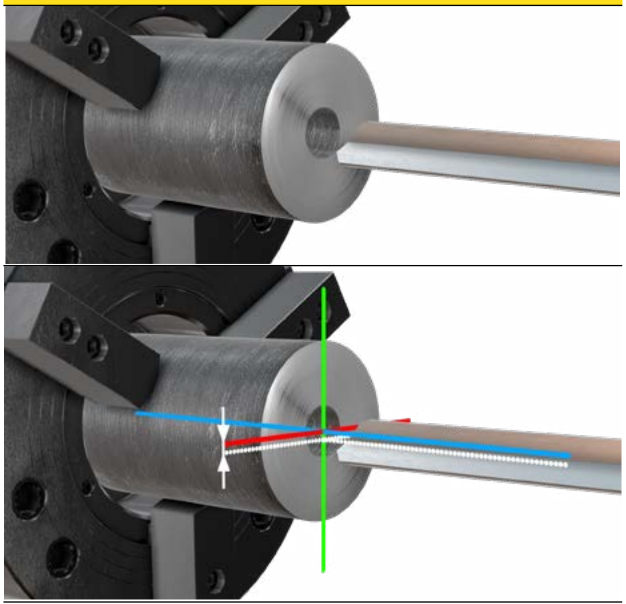


Practical Tips

The practical tips described below will in many cases help to achieve an optimal result when deep drilling.

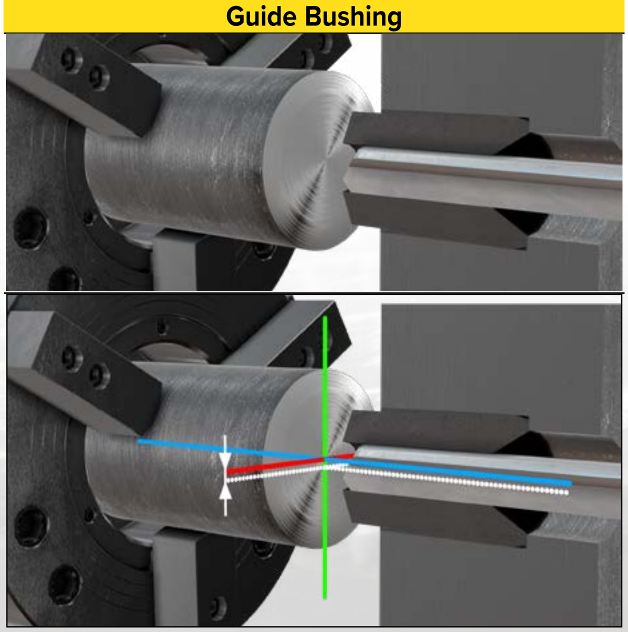
- The gap between the drill and the guide bushing or pre hole should be no more than 0.01 mm (0.0004 inches).

Pre Hole



GAP, max 0.01 mm (0.0004 inches)

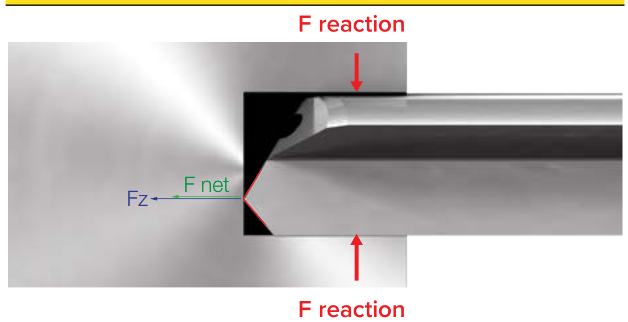
Guide Bushing



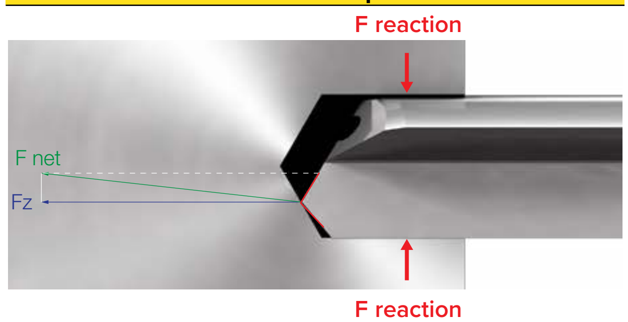
GAP, max 0.01 mm (0.0004 inches)

- The flat bottom of pre hole is preferable to the V shaped bottom of the
- pre hole in deep drilling operation.
A conical surface may cause the drill run-off ("walking") and reduce tool life.

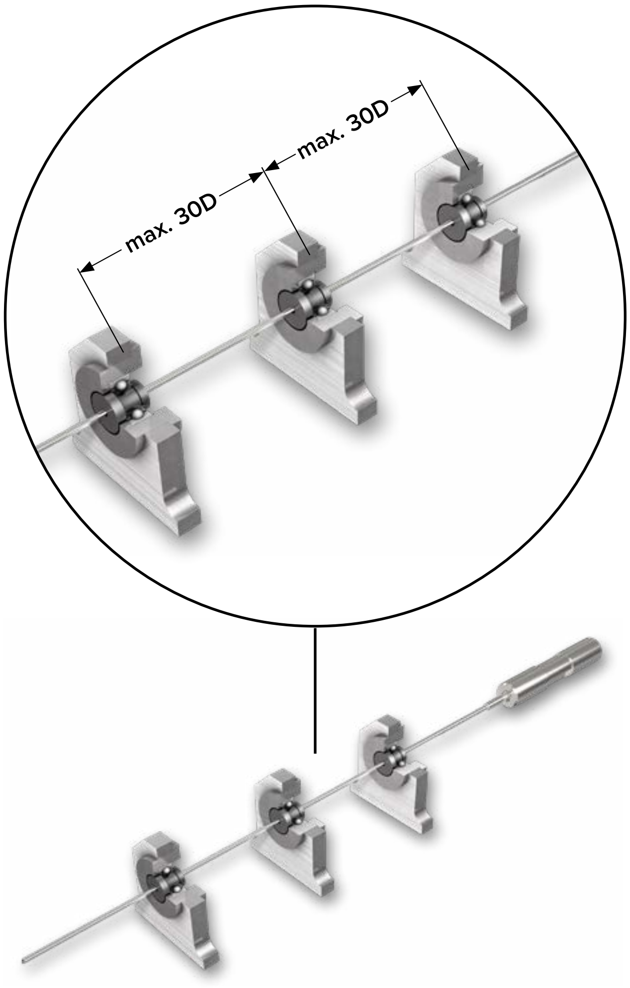
Pre Hole with Flat Bottom



Pre Hole with V Shaped Bottom



- The distance between the support bushings should be no more than 30D.



- The minimum depth of the pre hole, when drilling without support bushings, depends on the drill length:
  - for depth of hole up to 12D the pre hole should be 0.5D-1.0D
  - for depth of hole 20D-30D the pre hole should be 8D-12D
  - for depth of hole 40D-50D the pre hole should be 20D-25D
  - for depth of hole 60D-80D the pre hole should be 30D-40D
- Oil coolant in deep drilling is preferable over emulsion.
- To minimize drill runout, if possible it is preferable to drill on both sides of the workpiece.
- The drill length should be longer than the requested hole to guarantee enough space for machine accessories (guide bushing, support bushing, etc.).
- To increase drilling stability, it is advisable to use the shortest drill if possible.

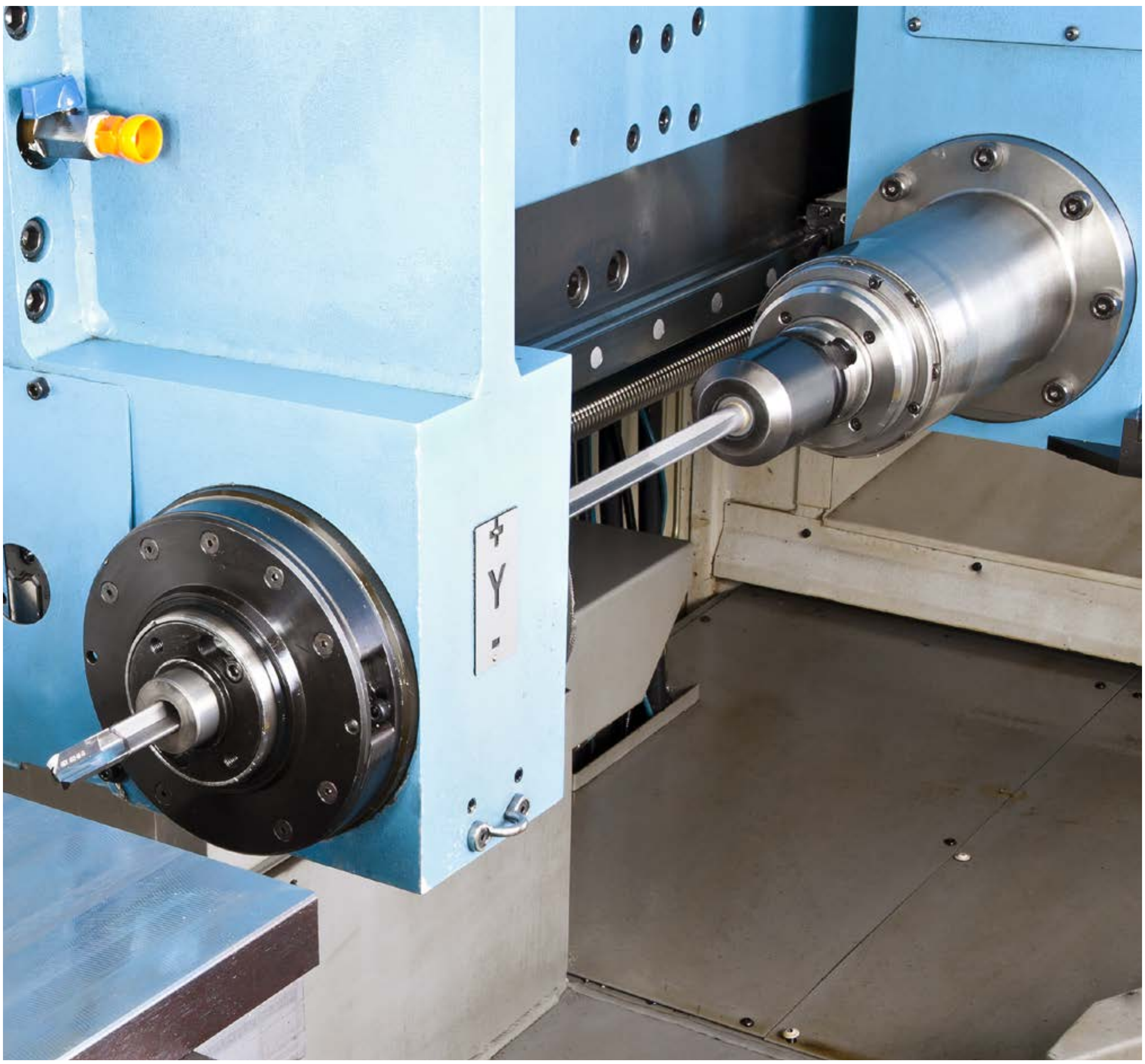
ELB System Gundrills

The ELB system, originated from the German name "Einlippenbohrer", is a single, straight fluted drill, also called the Gundrill. **ISCAR** provides Gundrills for drilling holes with an inner diameter of 0.9 mm to 40 mm and a depth of up to 440 drill diameters.

Gundrills came along with advances in weapon technology and were first scientifically researched at the end of the 18th century.

Earl Rumford, aka Benjamin Thompson, published his research at the Munich Arsenal in 1798.

Gundrills were originally used to drill the barrel of firearms. Today, gundrills are widely used in all branches of mechanical engineering, usually for drilling deep holes on dedicated machines for mass production.

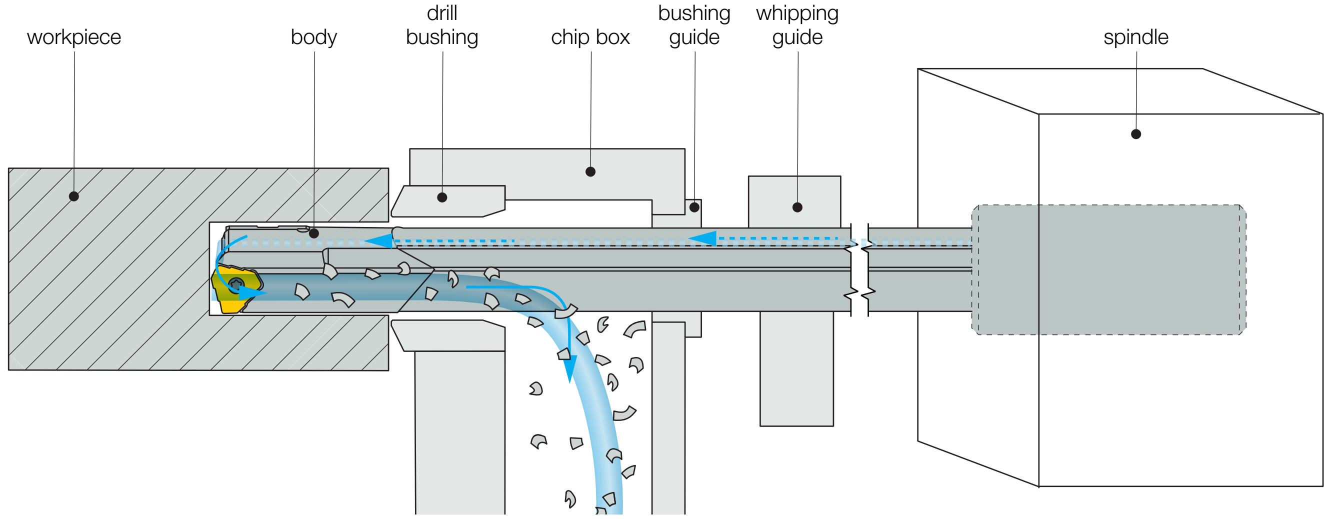


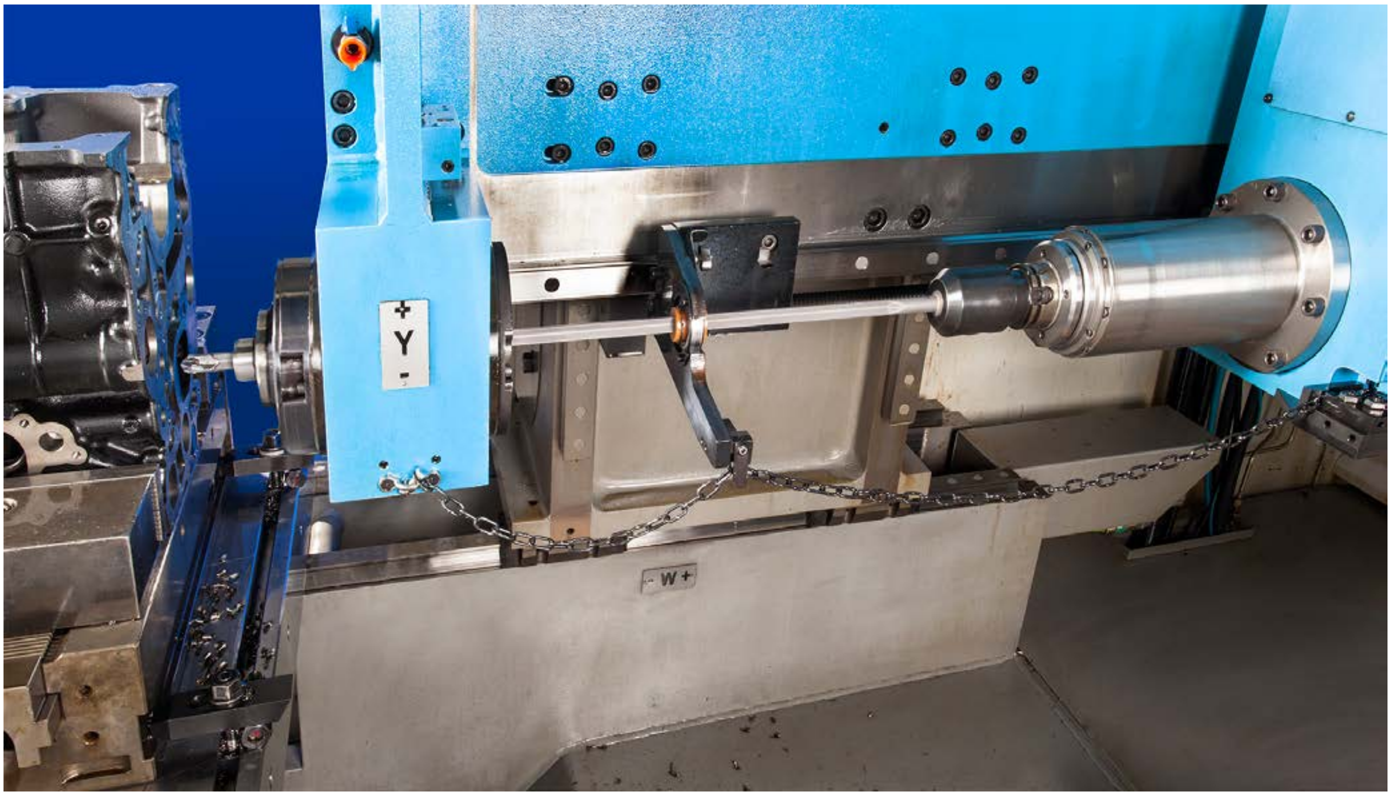
Method of ELB System Gun Drilling

The drilling method of a gundrill is quite simple. During the drilling process, high pressure coolant is supplied into the cutting zone through a channel in the shank, tube, and a hole in the tip.

Under the action of pressure, the chips are evacuated from the machining zone along a V-shaped external flute into the chip receiver of the machine (Figure 6.5.1.1). Gundrill_system.pdf

Figure 6.5.1.1



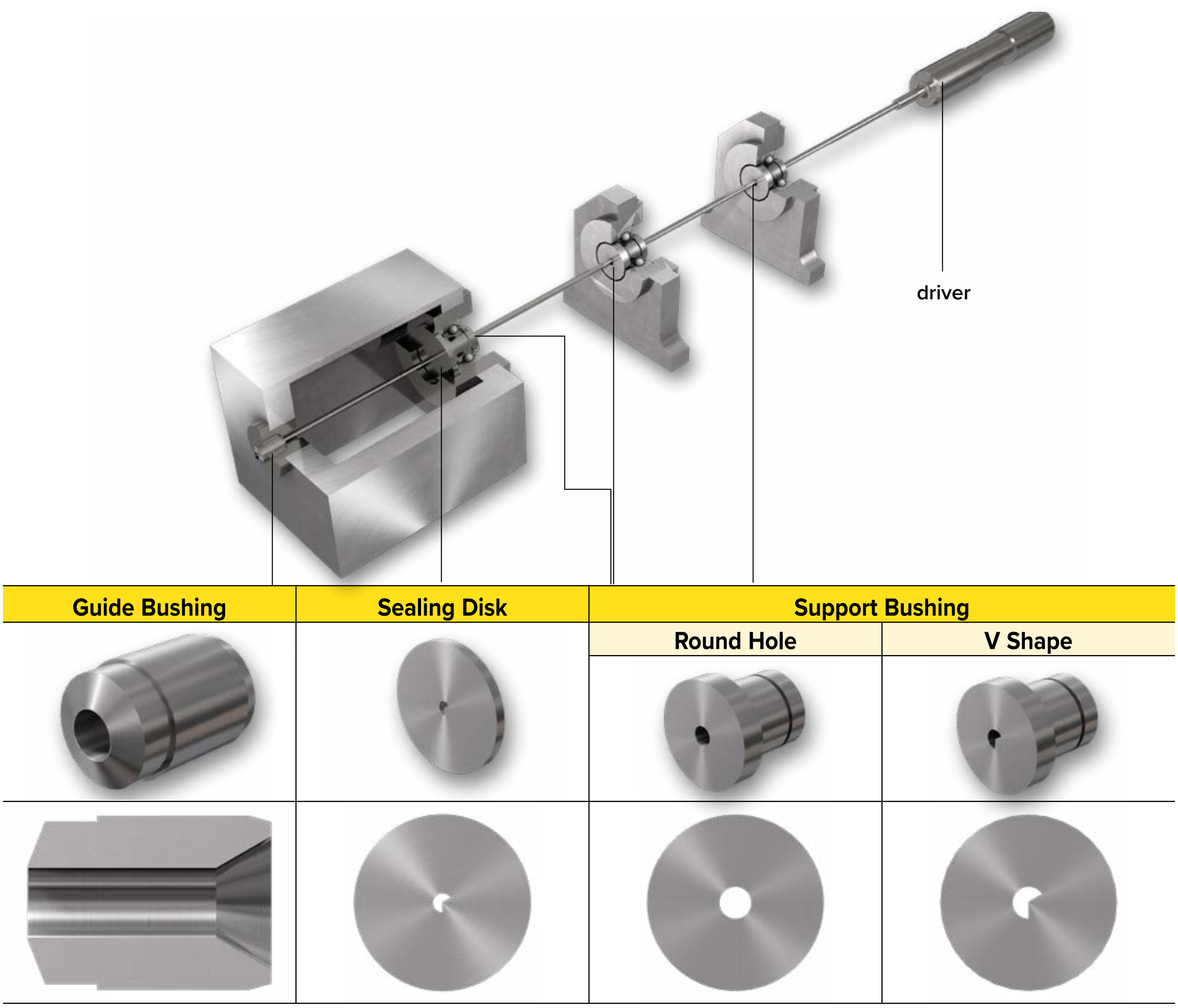


The gundrill is directed into the workpiece during penetration by guide bushing (Figure 6.5.1.2). An alternative to using guide bushing can be pre hole operation. During drilling, the movement can be done by the drill or by the workpiece. To minimize runout, the drill is supported by support bushing along the drill length. The hole in support bushing on which the drill is located can have two shapes, a round hole or a hole with a “V” shape that matches the cross section of the drill (Figure 6.5.1.2).

The sealed housing contains a sealing disk that deflects the swarf and directs it into the chip receiver of the machine (Figure 6.5.1.2). The swarf in the chip receiver filtered and separates the chips from the coolant.

Gundrilling machines are available in many variations, from single-spindle manual models to CNC units with multiple spindles of different designs. They can be integrated into transfer lines or be part of a machining or turning center. Gundrilling is also becoming popular as a retrofit package for both conventional and CNC machines.

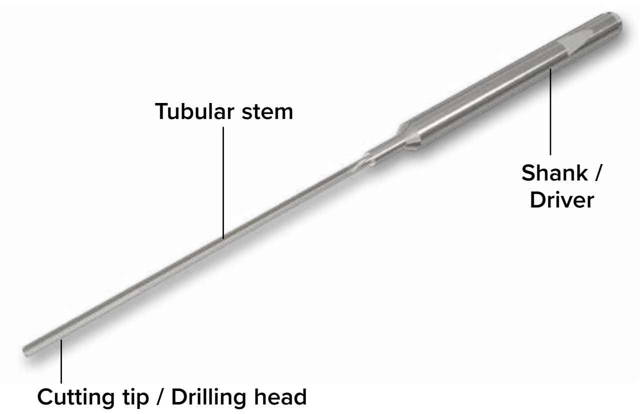
Figure 6.5.1.2



Gundrill Structure

A gundrill consists of three main elements: cutting tip, also called drilling head (working part), tubular stem with a V-shaped external groove, and shank also called driver (Figure 6.5.2.1).

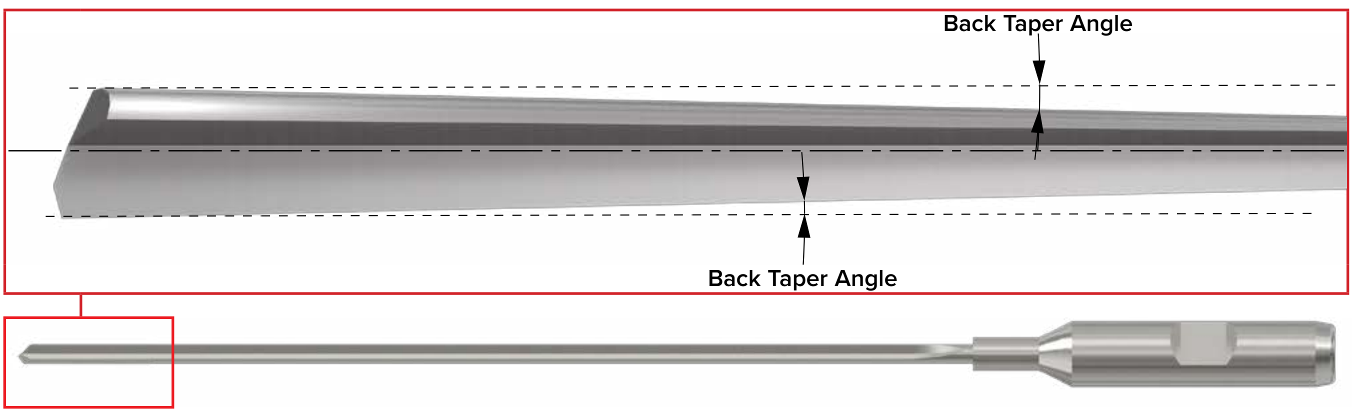
Figure 6.5.2.1



Cutting Tip / Drilling Head

The drilling head is tapered on its length to reduce friction (Figure 6.5.2.2). The taper angle depends on the type of material to be drilled. For high precision drilling, the taper should be reduced to a minimum. The low taper angle has very high straightness control and good surface finish, but at the same time, poor tool life and high risk of tip jamming in the hole. The high taper angle has better tool life (especially in shrinking materials) and a lower risk of tip jamming in the hole, but at the same time on bad straightness control. It should be noted that when the head is resharpened, the diameter of the drill changes, affecting the hole tolerance.

Figure 6.5.2.2



The key variables of a cutting tip are point location, nose angles, and pad form.

Point Angle Location

ISCAR standard products define a point angle location at a quarter of a drill diameter relative to the drill center axis (Figure 6.5.2.3). Changing the position of the point angle has a direct effect on the drilling process.

Approximating the position of the point angle to the central axis of the drill will cause good straightness, undersize hole, long chips, more power load (Figure 6.5.2.4).

Moving the position of the point angle from the central axis of the drill will cause better tool life, oversize hole, and bad straightness (Figure 6.5.2.5).

Figure 6.5.2.3

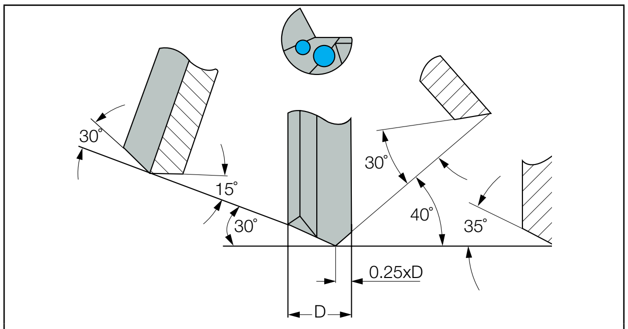
Figure 6.5.2.4

Figure 6.5.2.5

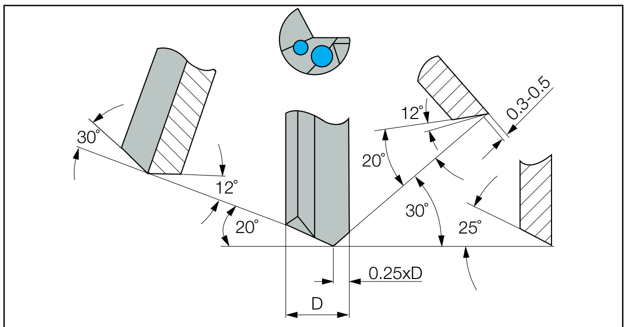
Nose Angles

Standard nose angles depend on the drill diameter (Figure 6.5.2.6).

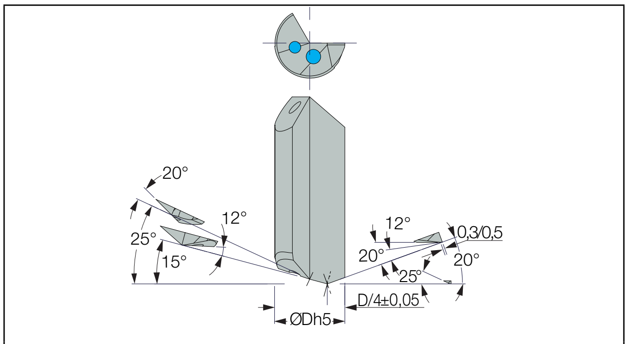
Figure 6.5.2.6



Standard sharpening for 0.9 to 4 mm drill diameters



Standard sharpening for 4 to 32 mm drill diameters



Standard sharpening for 32 to 40 mm drill diameters

Note: For special or semi-standard gundrills, special geometries will be offered to match the application.

The value of nose angles has an influence on both the drill and the drilled hole.

Increasing the outer angle and decreasing the inner angle will result in an undersized hole, good straightness, and bad tool life (Figure 6.5.2.7).

Decreasing the outer angle and increasing the inner angle will result in an oversized hole, bad straightness, and good tool life (Figure 6.5.2.8).

Figure 6.5.2.7

Figure 6.5.2.8

Pad Form

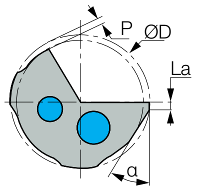
ISCAR's pad forms, also called drill profiles, were specially designed for specific machining applications (Figure 6.5.2.9).

The pad form defines the geometry of cutting tip at cross section.

All cross-section profile parameters such as P, La, must be precisely matched to the workpiece material properties.

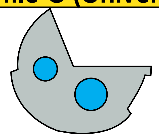
Figure 6.5.2.9

General Sketch



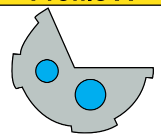
All cross section profile parameters such as: P, La and a must be precisely matched to the workpiece material properties.

Profile G (Universal)



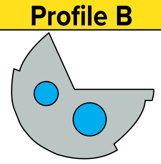
Standard form for most material types, particularly for materials with a tendency to shrink. Recommended for high precision bore tolerance and straightness. Maintains precise exit hole size. Recommended when extra burnishing is required.

Profile A



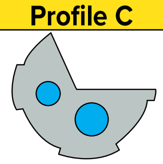
Suitable for cast iron (usually coated) and aluminum alloys. Can be used for cross drilling, angular entry or exit and for interrupted cut. Large coolant gaps between pads.

Profile B



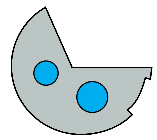
Excellent size control, for high precision hole tolerance. Used for cast iron and aluminum alloys.

Profile C



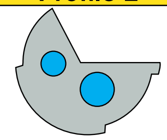
Used for angled entry or exit. Large back taper, for shrinking materials such as high temperature and titanium alloys and stainless steel. Large coolant gaps between pads.

Profile D



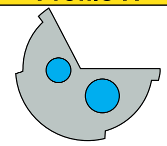
Suitable for cast iron only. Very effective in grey cast iron (usually coated).

Profile E



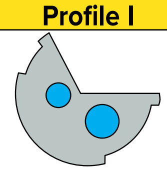
General use, for alloys and stainless steel.
This profile eliminates the problem of the tool sticking in the hole after the outer corner dulls. Especially suitable for crankshaft and other forged materials. Recommended for accurate hole straightness.

Profile H



Recommended for all nonferrous and cast iron materials up 5 mm diameter. Sometimes used for wood and plastic with larger back taper.

Profile I



Used for aluminum and brass for best hole finish.
For intersecting holes and interrupted cut or when extra outer diameter support and burnishing is required.

Coolant Hole

There are two types of cooling drills that depend on the diameter of the drill (Figure 6.5.2.10).

Kidney Hole

Standard for drill diameter less than Ø8mm

Two Holes

Standard for drill diameter equal or larger than Ø8mm

Tubular Stem

The cross section of the tubular stem is V-shaped with an internal coolant channel. Gundrill tubular stems can be solid carbide or steel.

In the first case, the cutting tip and tubular stem are made from a solid carbide rod, which is soldered to the steel shank (Figure 6.5.2.11). The advantages of this design are high strength and rigidity, which contributes to the ability of drilling at higher cutting conditions which has a positive effect on productivity.

In the second case, the drills consist of a cutting tip soldered to a steel tubular stem that is soldered to the shank (Figure 6.5.2.12).

The V-groove steel tubular stem is obtained by cold rolling of pipes.

The outer diameters of the tubular stem should be less than the diameter of the drill in order to exclude contact with the drilled hole surface.

Figure 6.5.2.11

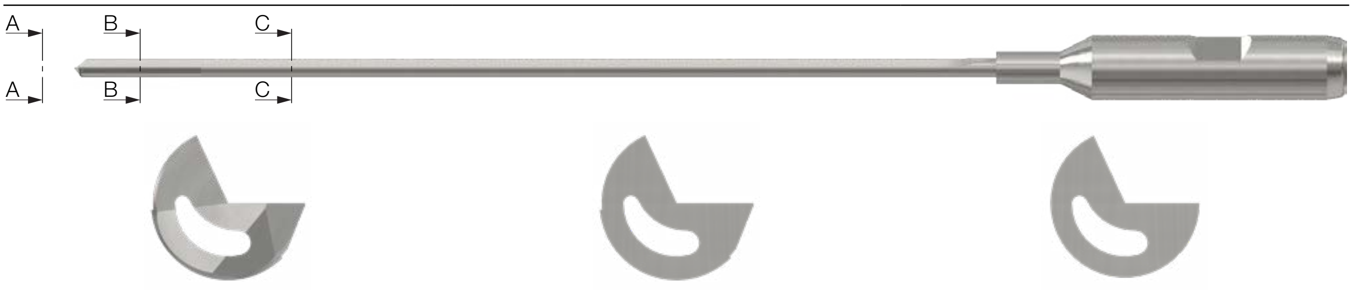
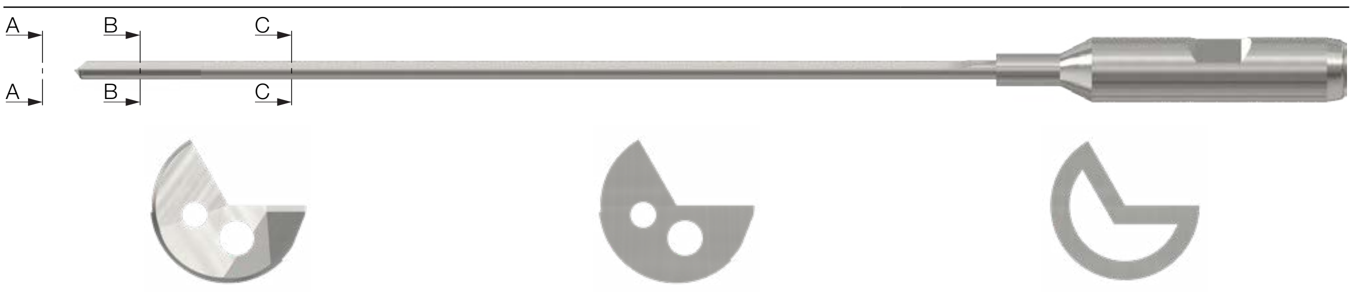


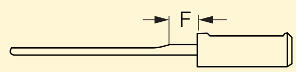
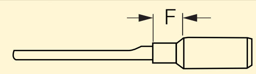
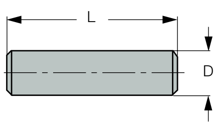
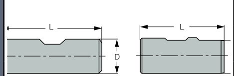
Figure 6.5.2.12



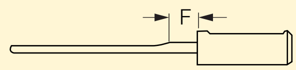
Shank

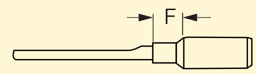
The shank, also called driver, is to ensure the connection between the gundrill and the machine tool. The types of drivers are shown in Figure 6.5.2.13.

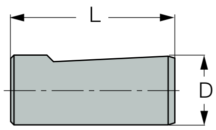
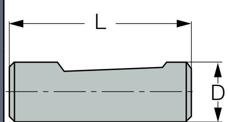
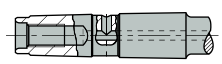
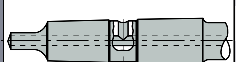
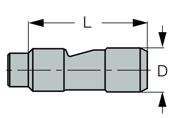
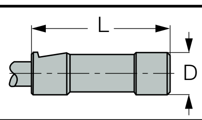
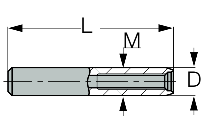
Figure 6.5.2.13

Driver Type	Drawing	DXL	Driver Code	Max. Cutting Diameter	 BRAZED GUNDRILL F = CYLINDRICAL TUBE: Equal Or Less Than max. Cutting Diameter	BRAZED GUNDRILL F = CYLINDRICAL TUBE: More Than max. Diameter	 SOLID CARBIDE GUNDRILL: F = Straightening Extension
Cylindrical DIN1835A DIN6535HA		4x28	N°1	2.749	10	20	18
		5x28	N°2	3.249	10	20	15
		6x36	N°3	4.249	10	20	14
		8x36	N°4	5.749	10	20	14
		10x40	N°5	7.299	10	20	15
		12x45	N°6	8.999	10	20	15
		.50x1.78″	N°94	9.699	10	20	15
		14x45	N°7	10.999	10	20	15
		16x48	N°8	12.399	10	20	15
		18x48	N°9	14.399	10	20	15
		.75x2.03″	N°95	14.899	10	20	15
		20x50	N°10	15.899	10	20	
		25x56	N°11	19.509	10	25	
		1.00x2.28″	N°96	19.509	10	25	
		1.25x2.28″	N°97	25.609	10	25	
		32x60	N°12	25.609	10	25	
		40x70	N°13	32.609	10	25	
		50x80	N°14	40	10	25	
		63x90	N°15	40	10	25	
Weldon DIN1835B DIN6535HB		6x36	N°16	2.749	10	20	15
		8x36	N°17	3.249	10	20	15
		10x40	N°18	7.299	10	20	15
		12x45	N°19	8.999	10	20	15
		.50x1.78″	N°98	9.699	10	20	15
		16x48	N°20	12.399	10	20	15
		18x48	N°21	14.399	10	20	15
		.75x2.03″	N°99	14.899	10	20	15
		20x50	N°22	15.899	10	20	15
		25x56	N°23	19.509	10	25	
		1.00x2.28″	N°100	19.509	10	25	
		1.25x2.28″	N°101	25.609	10	25	
		32x60	N°24	25.609	10	25	
		40x70	N°25	32.609	10	25	
		50x80	N°26	40	10	25	
		63x90	N°27	40	10	25	

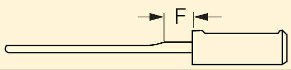
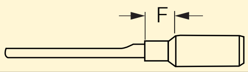
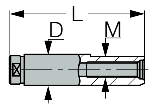
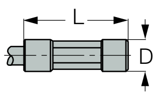
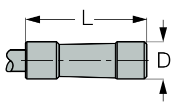
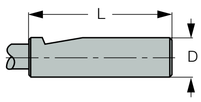
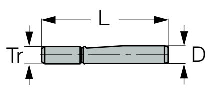
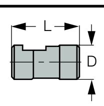
Continued





Driver Type	Drawing	DXL	Driver Code	Max. Cutting Diameter	BRAZED GUNDRILL F = CYLINDRICAL TUBE		SOLID CARBIDE GUNDRILL
					Equal Or Less Than max. Cutting Diameter	More Than max. Diameter	F = Straightening Extension
Whistle Notch DIN1835E		6x36	N°28	2.749	10	20	
		8x36	N°29	3.249	10	20	
		10x40	N°30	7.299	10	20	15
		12x45	N°31	8.999	10	20	15
		16x48	N°32	12.399	10	20	15
		18x48	N°33	14.399	10	20	15
		20x50	N°34	15.899	10	20	15
		25x56	N°35	19.509	10	25	
		32x60	N°36	25.609	10	25	
		40x70	N°37	32.609	10	25	
Whistle Notch DIN6535HE		6x36	N°38	2.749	10	20	15
		8x36	N°39	3.249	10	20	15
		10x40	N°40	7.299	10	20	15
		12x45	N°41	8.999	10	20	15
		16x48	N°42	12.399	10	20	15
		18x48	N°43	14.399	10	20	15
		20x50	N°44	15.899	10	20	15
DIN228AK		CM1	N°45	9.599	10	20	
		CM2	N°46	14.599	10	20	
		CM3	N°47	21.499	10	25	
		CM4	N°48	29.499	10	25	
DIN228BK		CM1	N°49	9.599	10	20	
		CM2	N°50	14.599	10	20	
		CM3	N°51	21.499	10	25	
		CM4	N°52	29.499	10	25	
Central Clamping Surface 15°		6x30	N°53	2.749	10	20	20
		10x40	N°54	7.299	10	20	15
		16x45	N°55	12.399	10	20	
		.750x2.75"	N°56	14.899	10	20	
		25x70	N°57	19.509	10	25	
		1.00x2.75"	N°58	19.509	10	25	
		1.25x2.75"	N°59	25.609	10	25	
		1.50x2.75"	N°60	32.609	10	25	
Frontal Clamping Surface 15°		16x50	N°61	12.399	10	20	
Cylindrical With Thread		10x50 M6X0.5	N°62	7.299	10	20	15
		10x60 M6X0.5	N°63	7.299	10	20	
		.50x1.97" M6x0.5	N°64	8.999	10	20	15
		16x80 M10X1	N°65	12.399	10	20	15
		25x100 M16x1.5	N°66	19.509	10	25	
		36x120 M24x1.5	N°67	30.609	10	25	

Continued

Driver Type	Drawing	DXL	Driver Code	Max. Cutting Diameter	BRAZED GUNDRILL F = CYLINDRICAL TUBE: Equal Or Less Than max. Cutting Diameter	BRAZED GUNDRILL F = CYLINDRICAL TUBE: More Than max. Diameter	SOLID CARBIDE GUNDRILL: F = Straightening Extension
							
VDI Design		10x68 M6x0.5	N°68	6.749	10	20	
		16x90 M10x1	N°69	10.799	10	20	15
		25x112 M16x1.5	N°70	19.509	10	25	
		36x135 M24x1.5	N°71	30.609	10	25	
Central Clamping Hexagonal		25x70	N°72	19.509	10	25	
		32x70	N°73	25.609	10	25	
Central Clamping Tapered		.50x1.50"	N°74	8.599	10	20	15
		16x70	N°75	12.099	10	20	15
		.75x2.75"	N°76	14.099	10	20	
		20x70	N°77	16.099	10	20	15
Frontal Clamping Surface 2°		.50x1.50"	N°78	9.699	10	20	
		.75x2.75"	N°79	14.899	10	20	
		1.00x2.75"	N°80	19.509	10	25	
		1.00x3.94"	N°81	19.509	10	25	
		1.25x2.75"	N°82	25.609	10	25	
		1.25x3.94"	N°83	25.609	10	25	
		1.50x2.75"	N°84	32.609	10	25	
		1.50x3.94"	N°85	32.609	10	25	
Trapezoidal Thread		16x112 Tr 16x1.5	N°86	13.599	10	20	
		20x126 Tr 20x2	N°87	17.099	10	20	
		28x126 Tr 28x2	N°88	25.599	10	25	
		36x162 Tr 36x2	N°89	32.599	10	25	
Spraymist Driver		16x40	N°90	12.399	10	20	
		25x50	N°91	19.509	10	25	
		35x60	N°92	26.599	10	25	

Gundrills Per Customer Request

In addition to standard geometries, shapes, profiles, dimensions of cutting tips, and standard gundrill lengths, **ISCAR** develops special gundrills according to customer requirements - the result of years of research and development in tool design.

ISCAR-GUNDRILLS Products

Currently, gundrills of various designs are used in mechanical engineering.
ISCAR offers 2 families of Gundrills for deep drilling, **ISCAR-GUNDRILLS** and **ISCAR TRI-DEEP**. Each family has its own uniqueness. **ISCAR-GUNDRILLS** offer a solution for Solid gundrills designed for drilling diameters of 0.9 mm to 16 mm and a solution of gundrills with a brazed tip that is designed for drilling diameters of 2.5 mm to 40 mm, while **ISCAR TRI-DEEP** offers a gundrill solution with indexable inserts that are designed for drilling diameters of 12 mm to 28 mm.

- GUNDRILLS
  - INDEXABLE INSERT DRILLS
    - TRI-DEEP
  - BRAZED TIP DRILLS
    - ISCAR-GUNDRILLS
  - SOLID-DRILLS
    - ISCAR-GUNDRILLS

BTA System STS

The BTA system (Boring and Trepanning Association), also called STS (Single Tube System), is a modified deep hole drilling method that was developed in the 1940s to minimize the disadvantages of the SBL system (gundrilling) such as chip contact with the hole surface and low torsional moment. The BTA system got its name in the 1950s. The development of the BTA system was dominated by the German company "Gebrüder Heller", which during the second world war combined its own developments with the developments of Burgsmüller and Beisner. Burgsmüller replaced the previously used grooved drill shaft with a tube and for the first time the chips were evacuated through the inside of the tube. Beisner improved the drill design and introduced oil as coolant.

Gebrüder Heller has introduced carbide cutting edges and guide pads into the BTA system.

The BTA system covers the largest range of drilling diameters in comparison with other systems (ELB and DTS).

ISCAR provides BTA drills for drilling holes with an inner diameter of 8 mm to 294 mm and a depth of up to 325 drill diameters.

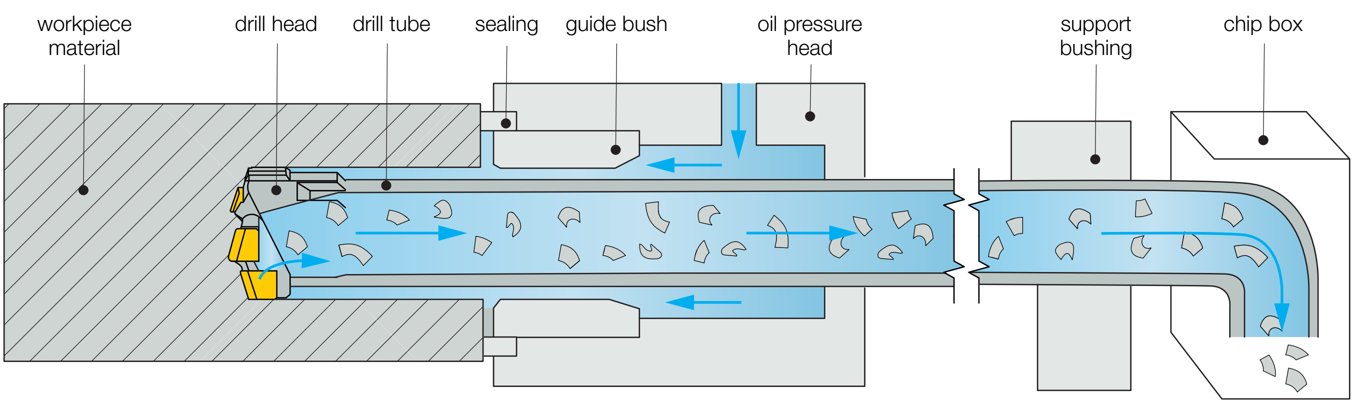
Method of BTA System STS

The BTA system is based on external coolant supply and internal chip evacuation through the hole in the drill (Figure 6.6.1.1). The BTA tool is directed into the workpiece during penetration by guide bushing, while a motor turns either the tool or the workpiece or both tool and workpiece. To minimize runout, the drill is supported by support bushing along the drill length. The diameter of the drill pipe (stem) is smaller than the diameter of the drill head, which provides an annular gap between the walls of the machined hole and the outer diameter of the drill pipe. This space is also known as "oil room" and in conjunction with a coolant induction unit or a pressure head. In addition, it makes it possible to direct filtered high volume coolant to the drill head cutting edge. Coolant is injected into the pressure head under high pressure. This feature of the coolant supply requires the use of a special hermetic seal between the workpiece and the pressure head.

The sealing between the pressure head and the workpiece is ensured by a sealing ring. This pressure head seals against the entry side of the workpiece to be drilled. Also, this directs the coolant to the detachable drill head; in other words, this coolant supply scheme allows the coolant to be delivered directly to the cutting edges, and large volumes of fluid (compared to the ELB drilling system) quickly remove the chips from the cutting area and send them through the hole in the stem to the chip receiver.

These factors determine the need to use specialized deep hole drilling machines. But despite the mandatory use of special equipment, tooling and technological methods, the technology of drilling deep holes with an external coolant supply solves the most complex problems of machining parts with deep holes, which are inaccessible for solution by any other technologies, and is recognized as the most advanced deep hole drilling technology.

Figure 6.6.1.1



BTA Drill Structure

Due to the large depth of holes to be drilled, the deep hole drilling tool is long. For ease of manufacture and operation, it is usually assembled in length. The BTA drill consists of a drilling head, which is assembled to the drill pipe (stem) using a rectangular thread with a coarse pitch - for fast and reliable fastening.

The thread on the drill head can be internal and external, one or four-start, depending on the type of drill and the diameter of the drilling (Figure 6.6.2.1).
The diameter of the drill pipe (stem) is smaller than the diameter of the drill head, which provides an annular gap between the walls of the machined hole and the outer diameter of the drill pipe.

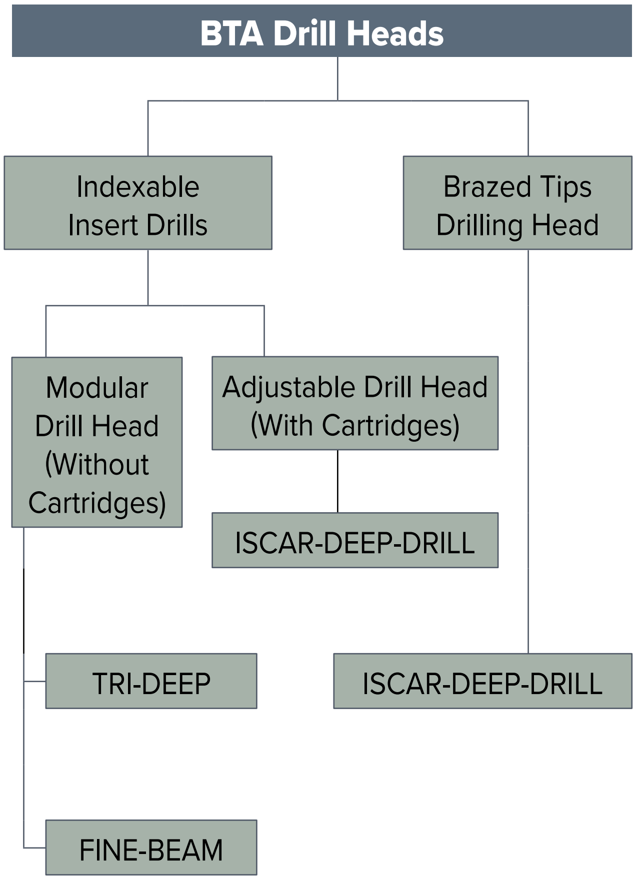
The stem of the tool, covering the length from the head to the end of the tool and serving to give the tool the required length, is the least rigid link in the deep hole drilling system. The profile and dimensions of its cross-section are chosen to ensure the highest possible rigidity while simultaneously performing the functions of supplying coolant to the cutting zone and removing chips by the coolant flow. The stems of the BTA system can be whole or composite in length.

Figure 6.6.2.1

Deep Single Tube Drills with External 4-Start Thread Connection

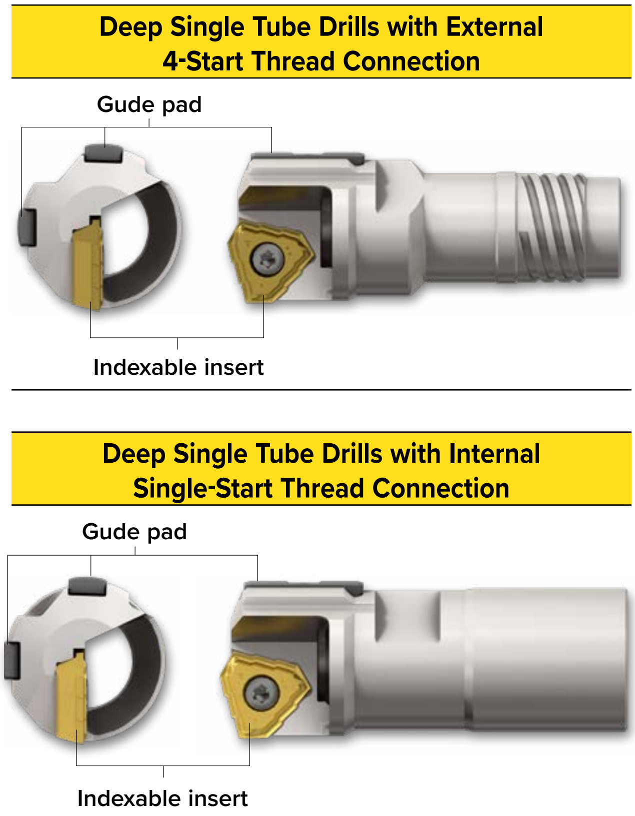
Deep Single Tube Drills with Internal Single-Start Thread Connection

BTA drill head designs are quite diverse and can be classified as follows:



The BTA drill head has a hollow cylindrical shape with single cutting edge. The cutting edge can consist of one or more indexable inserts or brazed tips, depending on the diameter of the drill head. The guide pads are positioned at the circumference of the drill head. The guide pads brace the tool against the machined surface, which is another distinctive feature of the BTA process and the tool.

Figure 6.6.2.2



ISCAR BTA Drill Products

Currently, drills of the BTA (Boring and Trepanning Association) system, also known as the STS (Single Tube System), are widely used for machining deep holes in various designs.

ISCAR offers three families of BTA system drills: **ISCAR TRI-DEEP**, **ISCAR FINE-BEAM**, and **ISCAR-DEEP-DRILL**. Each family can machine all types of materials, but each has its unique characteristics.

ISCAR TRI-DEEP provides a deep hole machining solution with an indexable insert featuring three cutting edges, suitable for drilling diameters ranging from 16 mm to 40 mm.

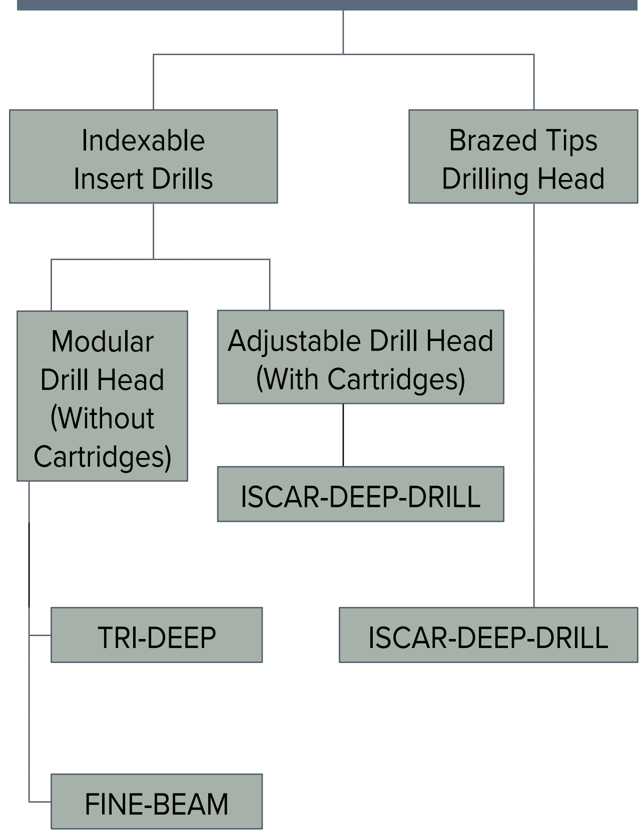
ISCAR FINE-BEAM offers a solution with indexable inserts for drilling diameters from 25 mm to 89 mm.

ISCAR-DEEP-DRILL offers a versatile solution with adjustable cartridges carrying indexable inserts designed for drilling diameters from 38 mm to 291.99 mm, as well as a brazed tip solution for diameters from 8 mm to 65 mm.

BTA system drilling heads with indexable inserts are available with both external four-start threads and internal single-start threads, guaranteeing IT10 hole diameter accuracy.

Drilling heads with a brazed tip up to a diameter of 14.79 mm come with an external single-start thread, while those above 14.79 mm feature external two or four-start threads, ensuring IT9 hole diameter accuracy.

BTA Drill Heads



Ejector System DTS

The ejector drilling system was developed in the 1960s and was first shown at the EMTE exhibition in 1965. The technology of ejector drilling of deep holes involves the use of a tool with two stems (two pipes); therefore, it is also called the DTS (Double Tube System). Ejector drilling provides practically the same results in terms of productivity, accuracy, and hole quality as deep drilling with internal and external coolant supply. An ejector system allows drilling on existing machining centers, horizontal boring machines, lathes, or turning centers, etc., by adding a pumping coolant station.

With ejector drilling, it is not required to seal the gaps between the workpiece and the tool system, which simplifies setup and maintenance of the machine.

Ejector drilling systems can be used to drill holes in a wide variety of workpieces, including interrupted holes such as crankshafts, track shoe, and more.

ISCAR provides DTS drills for drilling holes with an inner diameter of 18.4 mm to 184 mm and a depth of up to 325 drill diameters.

Method of Ejector System DTS

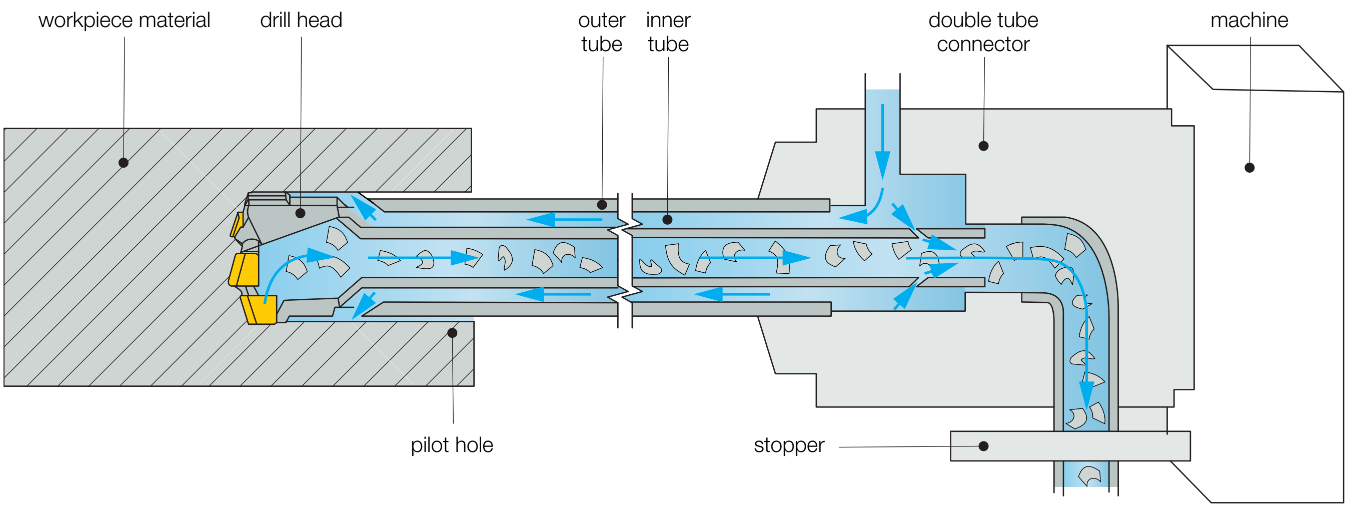
The ejector deep hole drilling system or double pipe system (DTS) is a system in which high pressure coolant is supplied to the machine spindle directly or through a connection adapter between the drilling tool and the machine (Figure 6.7.1.1).

The drilling tool consists of an outer tube and an inner tube that are connected to a high-pressure coolant supply on one side and to the drill head on the other side. High pressure coolant is supplied through the annular gap between the outer and inner pipe of the tool to the drill head.

Most of the coolant flow is directed through the coolant outlets around the circumference of the tool to the cutting edges of the drill head, allowing chips to be evacuated through the inner tube to the chip receiver.

A small part of the coolant is fed directly into the inner tube via a sloped slot in the inner tube, thereby creating an ejector effect. The coolant flow coming out of the slots is directed along the inner pipe hole axis to its outlet end and sucks in the swarf from the cutting area, thereby improving the conditions for chip removal. This system requires less coolant pressure than the single tube system (STS) and can be successfully used on existing machining centers without significant changes.

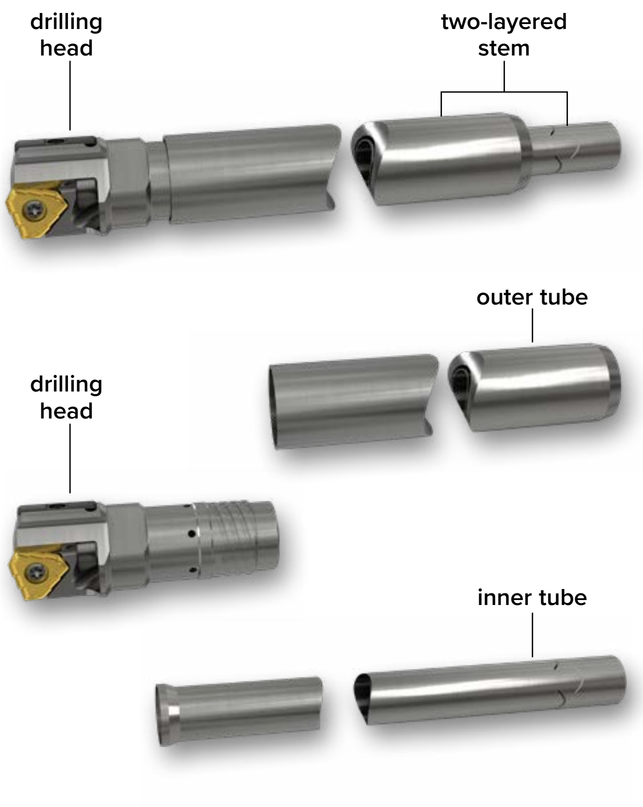
Figure 6.7.1.1



DTS Drill Structure

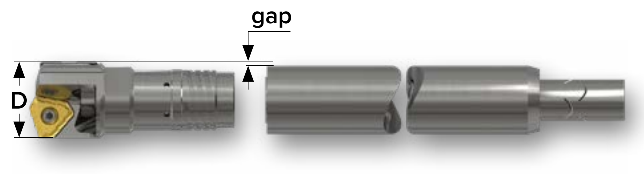
The DTS drill is an assembly tool for deep drilling.The main elements are the drilling head and a two-layered stem. The stem consists of an outer tube and an inner tube (Figure 6.7.2.1).

Figure 6.7.2.1



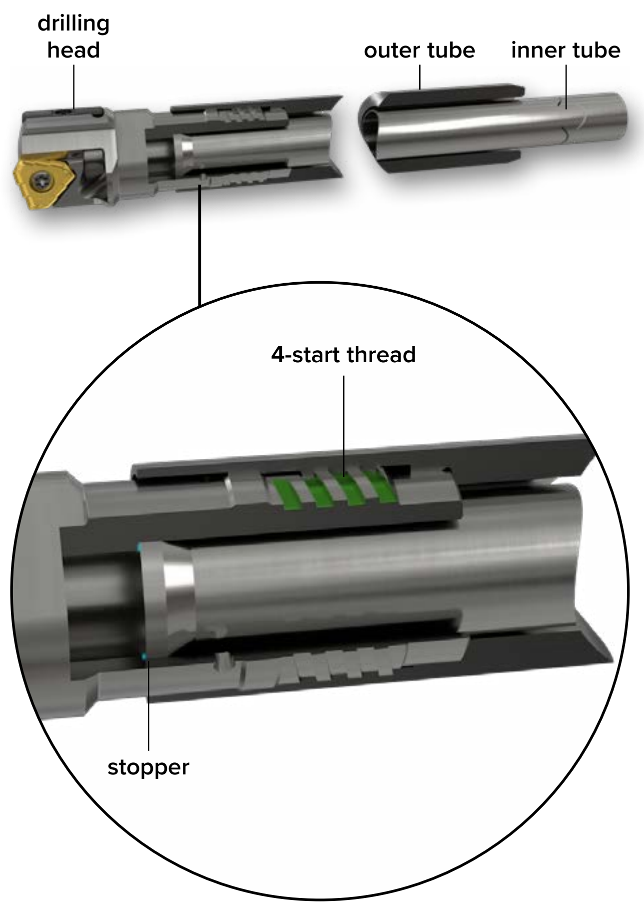
The drilling head is screwed on the outer pipe using a rectangular thread with a coarse pitch. The thread on the drill head and outer pipe can start one or four-start, depending on the type of drill and the diameter of the drilling. The diameter of the outer drill pipe is slightly less than the diameter of the drill head (Figure 6.7.2.2).

Figure 6.7.2.2



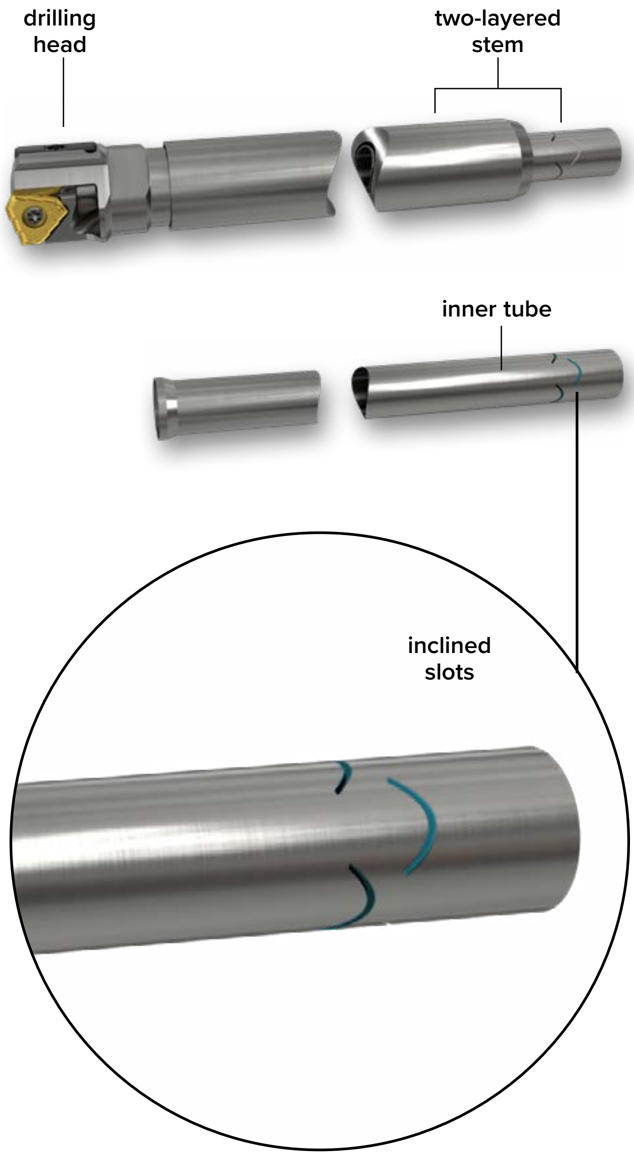
The inner pipe is inserted into the drilling head until it reaches the stopper (Figure 6.7.2.3).

Figure 6.7.2.3



Generally, sloped slots are located at the tail end of the inner tube. The location of the inclined slots on the inner pipe is not random since the efficiency and performance of the ejector drill system depend on its position (Figure 6.7.2.4).

Figure 6.7.2.4



The diametric dimensions of the inner and outer pipes affect two flow sections of a DTS drill: the size of the coolant supply channel and the diameter of the outlet channel.

DTS drill head designs are quite diverse and can be classified as follows:

Drill Heads

- Indexable Insert Drills
  - Modular Drill Head (Without Cartridges)
    - TRI-DEEP
    - FINE-BEAM
  - Adjustable Drill Head (With Cartridges)
    - ISCAR-DEEP-DRILL
- Brazed Tips Drilling Head
  - ISCAR-DEEP-DRILL

The DTS drill heads have a hollow cylindrical shape with a single cutting edge. The diameter of the drill head determines the possibility of using a particular design of the cutting part and the way it is assembled to the head body. The guide pads are positioned at the circumference of the drill head. A very important and distinctive feature of the DTS drill head is the coolant supply holes, which are located along the perimeter of the drill head body (Figure 6.7.2.5).

Figure 6.7.2.5

ISCAR DTS Drill Products

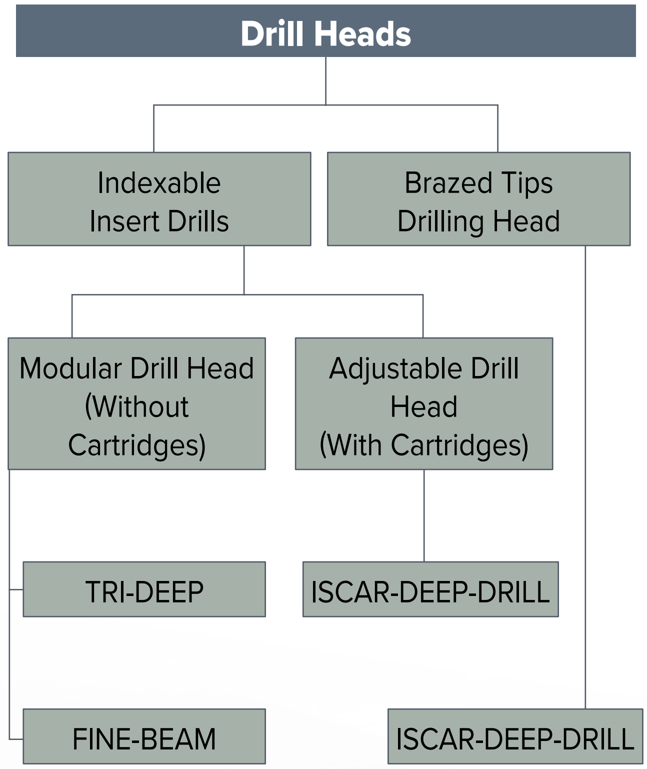
Drills utilizing the DTS (Double Tube System) system, are commonly used for deep hole machining in a variety of designs. **ISCAR** offers three distinct families of DTS system drills: **ISCAR TRI-DEEP**, **ISCAR FINE-BEAM**, and **ISCAR-DEEP-DRILL**. While each family is capable of machining all material types, they each have unique features.

The **ISCAR TRI-DEEP** family provides deep hole machining solutions with indexable inserts that have three cutting edges, suitable for drilling diameters between 18.4 mm and 28 mm.

The **ISCAR FINE-BEAM** family, equipped with indexable inserts, is designed for drilling diameters from 25 mm to 65 mm.

The **ISCAR-DEEP-DRILL** family offers a flexible solution with adjustable cartridges carrying indexable inserts for drilling diameters from 38 mm to 183.99 mm, in addition to a brazed tip option for diameters from 18.4 mm to 65 mm.

DTS system drilling heads come with external four-start threads. DTS system drilling heads with indexable inserts provide IT10 hole diameter accuracy, while those with a brazed tip ensure IT9 hole diameter accuracy.

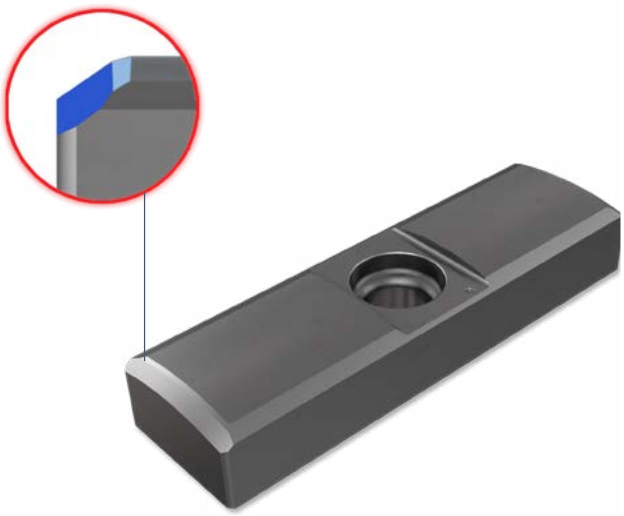


Guide Pads

The non-symmetrical design of deep hole drilling tools affects surface finish, hole accuracy, and tool life. The guide pads help reduce the negative effects that result from the non-symmetrical design of deep hole drills.

The **ISCAR** guide pads are designed with double chamfer at the edges (picture 6.8.1) that helps smooth entry into the machining hole, prevents premature wear, reduces the risk of guide pad damage, and improves surface finish by minimizing the risk of scratching the hole surface.

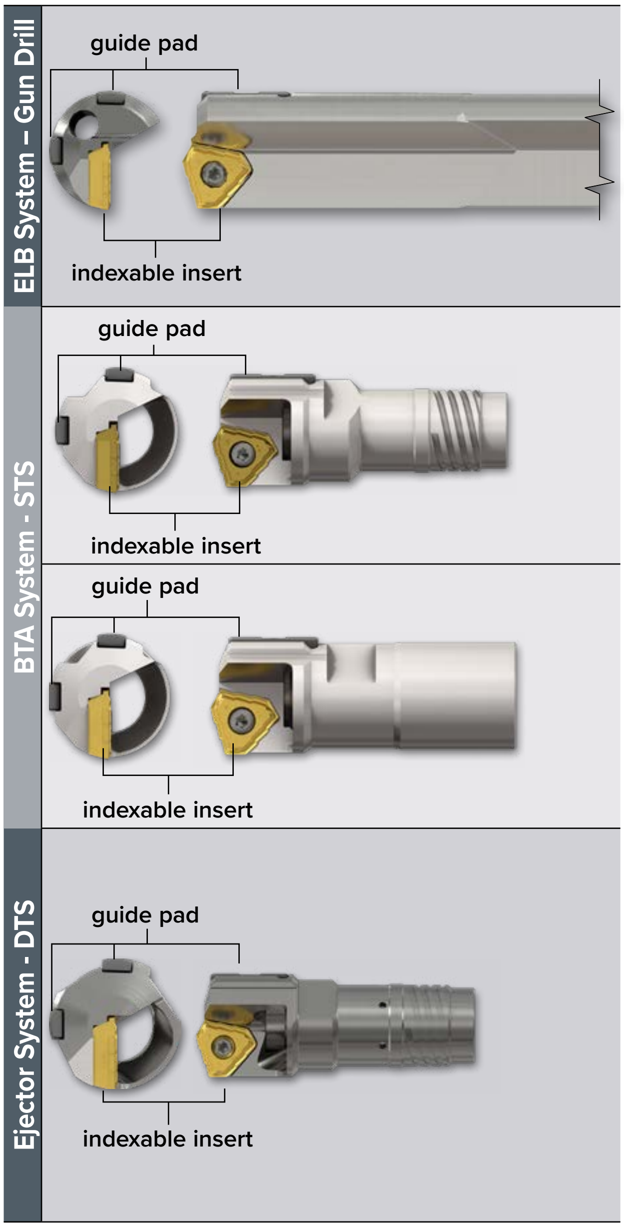
Picture 6.8.1



All **ISCAR** tools for deep drilling are equipped with two guide pads (picture 6.8.2).

The selection of a guide pad size will be in accordance with the recommendations that exists in each **ISCAR** deep drilling line, usually the size of the guide pad depends on the diameter of the drill.

Picture 6.8.2



Explanation of ISCAR Guide Pads Description

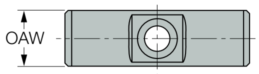
Example:

Gps	-	05	-	18	-	060	-	DC	-	IC908
1		2		3		4		5		6

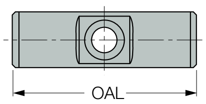
1 Designation of Guide Pad

GPS – guide pad for **ISCAR** drills

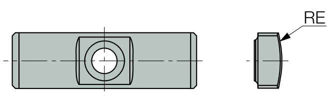
2 Guide Pad Width (OAW)



3 Guide Pad Length (OAL)



4 Corner Radius (RE)



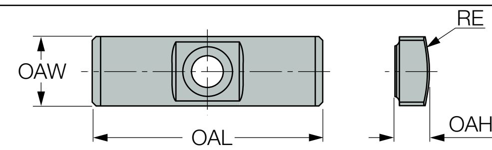
5 Shape

DC – double chamfering

6 Grade

IC908, IC928, IC950 – depends on the machined material

Basic Dimensions of ISCAR Guide Pads



OAW – guide pad width
OAL – guide pad length
RE – corner radius
OAH – guide pad thickness

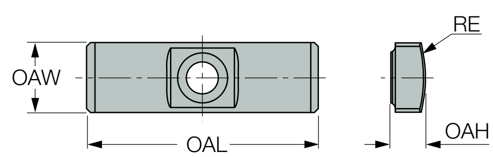
Grade Selection of an ISCAR Guide Pad

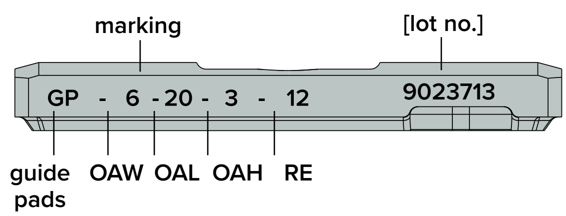
ISCAR guide pads are available with different grades depending on the machined material. The recommendation for guide pad selection should be in accordance with table 6.8.3.

Table 6.8.3

Guide Pad Grade Recommendation						
	Oil Coolant			Water Based Coolant		
Priority	1	2	3	1	2	3
ISO-P	IC950	IC908	IC928	IC928	IC908	-
ISO-K	IC950	IC908	IC928	IC928	IC908	-
ISO-M	IC928	IC908	IC950	IC928	IC908	-
ISO-S	IC928	IC908	IC950	IC928	IC908	-

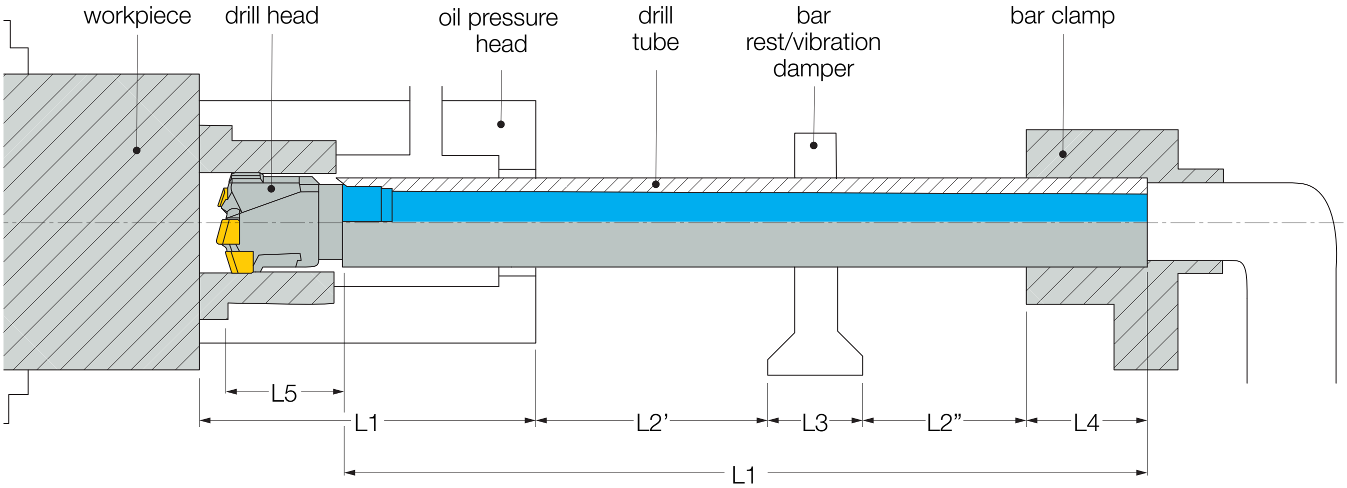
Universal Marking of the ISCAR Guide Pad





Calculation of Tube Length for BTA and DTS Methods

When drilling using the BTA or DTS method, the required pipe length should be calculated according to the following description.



Drill Tube Length
L = L1 + L2 + L3 + L4 - L5

L = drill tube length
L1 = oil pressure head length
L2 = drilling depth (L2′ + L2″)
L3 = bar rest/vibration damper length
L4 = drill tube clamping length Ls
L5 = end of drill tube to tip of peripheral insert

Note: Drill tubes with different lengths compared to standard drills, are availble upon request.

ISCAR Deep Drilling Products

Deep drilling technology is utilized across a wide range of industries to manufacture various parts that require precision and depth. This technology encompasses several drilling methods, each suited for different applications and material requirements.

The primary deep drilling methods include:

- ELB System - gundrills
- BTA System - STS (Single Tube System)
- Ejector System - DTS (Double Tube System)

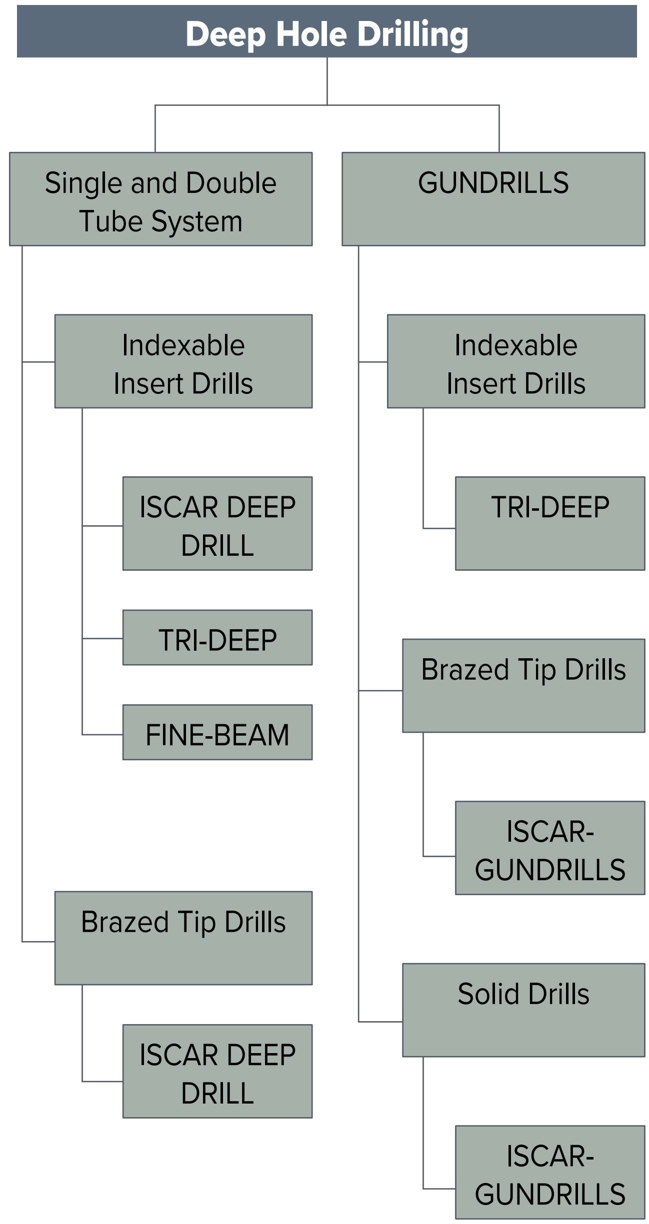
ISCAR offers comprehensive solutions for all these deep drilling systems, providing various types of drills tailored to meet specific drilling requirements. These solutions include:

- Indexable insert drills
- Brazed tips drilling head
- Brazed tip drills
- Solid drills

Each solution has its own unique characteristics and advantages, allowing **ISCAR** to provide tailored deep drilling solutions for various industrial applications.

Graph 6.10.1 illustrates the different **ISCAR** families/lines available for each deep drilling system, showcasing the breadth and versatility of **ISCAR**'s product offerings in the realm of deep drilling technology.

Graph 6.10.1



ISCAR-GUNDRILLS Solid Carbide Gundrills

The **ISCAR-GUNDRILLS** line provides solutions for deep drilling by Gundrill method with solid carbide drills. The solid carbide Gundrills are designed for conventional machines, machining centers, and lathes. This style of Gundrill is available from 0.9 mm to 16 mm with maximum flute length of 300 mm and can be used on various types of materials. It provides superior rigidity and optimal coolant flow rates.

STCGD-.... Standard Solid Carbide Drills

STCGD-... is a description of standard solid carbide gundrills belonging to the **ISCAR-GUNDRILLS** line. STCGD-... gundrills are capable of drilling holes of 0.9 mm to 16 mm in sequential steps of 0.1 mm. The sharpening of these gundrills depends on the diameter of the drill (table 6.11.1.1), and the profile is the same for all these gundrills ("General Sketch" according to table 6.11.1.2). The driver type can be selected according to table 6.11.1.3.

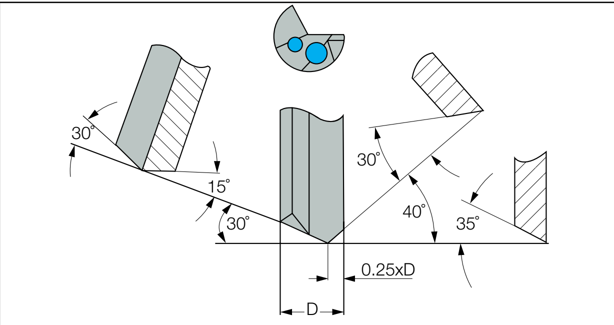
CGD-.... Semi-Standard Solid Carbide Drills

CGD-... is a description of semi-standard solid carbide gundrills belonging to the **ISCAR-GUNDRILLS** line.
CGD-... gundrills are capable of drilling holes of 0.9 mm to 16 mm in any sequential steps. Sharpening, profile, and driver type can be selected in any variant from standard tables respectively. There is an option for polishing and grade selection.

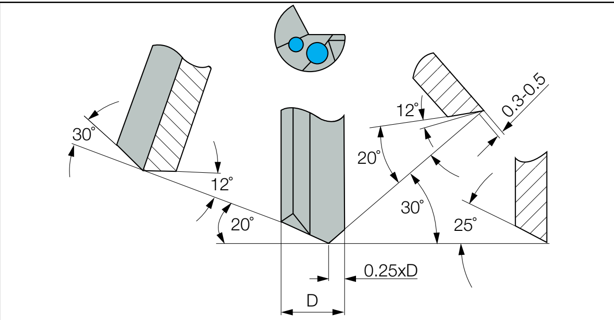
SPCGD-.... Special Solid Carbide Drills

SPCGD-... is a description of special solid carbide gundrills belonging to the **ISCAR-GUNDRILLS** line. SPCGD-... gundrills are capable of drilling holes of 0.9 mm to 16 mm in any sequential steps. Sharpening, profile, flute length and driver type can be selected in any variant. There is an option for polishing and grade selection.

Table 6.11.1.1 – Standard Sharpening



Standard sharpening for 0.9 to 4 mm drill diameters



Standard sharpening for 4 to 32 mm drill diameters

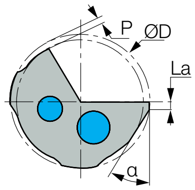
Table 6.11.1.2 – Drilling Head Profile

Standard Gundrill Head Profiles

Drilling capacity and finish of the drilled hole are dependent on the geometrical shape of the drill head. Both the profile and the sharpening must be matched to the workpiece material.

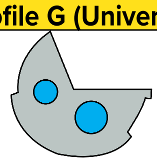
The profile is defined when the tool is manufactured. Although regrinding may change the cutting geometry, the profile should remain the same.

General Sketch



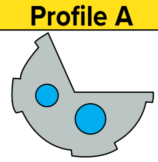
All cross section profile parameters such as: P, La and ‘a’ must be precisely matched to the workpiece material properties.

Profile G (Universal)



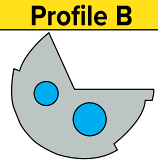
Standard form for most material types, particularly for materials with a tendency to shrink. Recommended for high precision bore tolerance and straightness. Maintains precise exit hole size. Recommended when extra burnishing is required.

Profile A



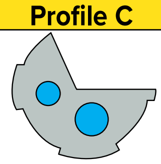
Suitable for cast iron (usually coated) and aluminum alloys. Can be used for cross drilling, angular entry or exit and for interrupted cut. Large coolant gaps between pads.

Profile B



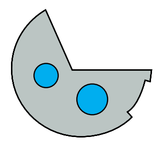
Excellent size control, for high precision hole tolerance. Used for cast iron and aluminum alloys.

Profile C



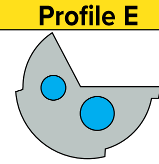
Used for angled entry or exit. Large back taper, for shrinking materials such as high temperature and titanium alloys and stainless steel. Large coolant gaps between pads.

Profile D



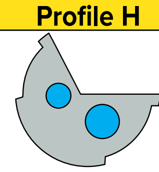
Suitable for cast iron only. Very effective in grey cast iron (usually coated).

Profile E



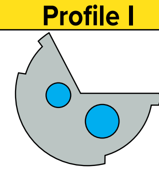
General use, for alloys and stainless steel.
This profile eliminates the problem of the tool sticking in the hole after the outer corner dulls. Especially suitable for crankshaft and other forged materials. Recommended for accurate hole straightness.

Profile H



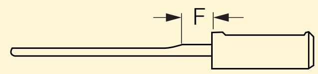
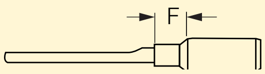
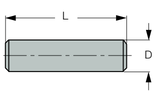
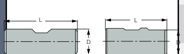
Recommended for all nonferrous and cast iron materials up 5 mm diameter. Sometimes used for wood and plastic with larger back taper.

Profile I

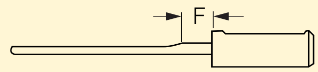
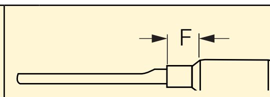
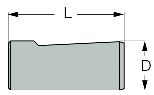
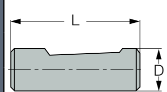
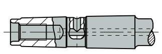
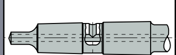
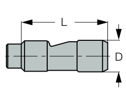
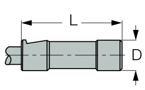
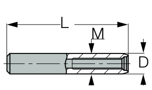


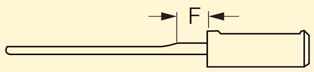
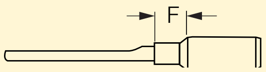
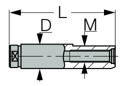
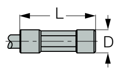
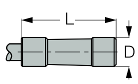
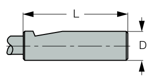
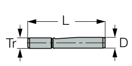
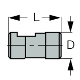
Used for aluminum and brass for best hole finish.
For intersecting holes and interrupted cut or when extra outer diameter support and burnishing is required.

Table 6.11.1.3 – Driver Type

							
				BRAZED GUNDRILL			SOLID CARBIDE GUNDRILL
					F = CYLINDRICAL TUBE		
Driver Type	**Drawing**	**DXL**	**Driver Code**	**Max. Cutting Diameter**	**Equal Or Less Than max. Cutting Diameter**	**More Than max. Diameter**	**F = Straightening Extension**
Cylindrical DIN1835A DIN6535HA		4x28	N°1	2.749	10	20	18
		5x28	N°2	3.249	10	20	15
		6x36	N°3	4.249	10	20	14
		8x36	N°4	5.749	10	20	14
		10x40	N°5	7.299	10	20	15
		12x45	N°6	8.999	10	20	15
		.50x1.78"	N°94	9.699	10	20	15
		14x45	N°7	10.999	10	20	15
		16x48	N°8	12.399	10	20	15
		18x48	N°9	14.399	10	20	15
		.75x2.03"	N°95	14.899	10	20	15
		20x50	N°10	15.899	10	20	
		25x56	N°11	19.509	10	25	
		1.00x2.28"	N°96	19.509	10	25	
		1.25x2.28"	N°97	25.609	10	25	
		32x60	N°12	25.609	10	25	
		40x70	N°13	32.609	10	25	
		50x80	N°14	40	10	25	
		63x90	N°15	40	10	25	
Weldon DIN1835B DIN6535HB		6x36	N°16	2.749	10	20	15
		8x36	N°17	3.249	10	20	15
		10x40	N°18	7.299	10	20	15
		12x45	N°19	8.999	10	20	15
		.50x1.78"	N°98	9.699	10	20	15
		16x48	N°20	12.399	10	20	15
		18x48	N°21	14.399	10	20	15
		.75x2.03"	N°99	14.899	10	20	15
		20x50	N°22	15.899	10	20	15
		25x56	N°23	19.509	10	25	
		1.00x2.28"	N°100	19.509	10	25	
		1.25x2.28"	N°101	25.609	10	25	
		32x60	N°24	25.609	10	25	
		40x70	N°25	32.609	10	25	
		50x80	N°26	40	10	25	
		63x90	N°27	40	10	25	

Continued

							
				BRAZED GUNDRILL			SOLID CARBIDE GUNDRILL
					F = CYLINDRICAL TUBE		
Driver Type	**Drawing**	**DXL**	**Driver Code**	**Max. Cutting Diameter**	**Equal Or Less Than max. Cutting Diameter**	**More Than max. Diameter**	**F = Straightening Extension**
Whistle Notch DIN1835E		6x36	N°28	2.749	10	20	
		8x36	N°29	3.249	10	20	
		10x40	N°30	7.299	10	20	15
		12x45	N°31	8.999	10	20	15
		16x48	N°32	12.399	10	20	15
		18x48	N°33	14.399	10	20	15
		20x50	N°34	15.899	10	20	15
		25x56	N°35	19.509	10	25	
		32x60	N°36	25.609	10	25	
		40x70	N°37	32.609	10	25	
Whistle Notch DIN6535HE		6x36	N°38	2.749	10	20	15
		8x36	N°39	3.249	10	20	15
		10x40	N°40	7.299	10	20	15
		12x45	N°41	8.999	10	20	15
		16x48	N°42	12.399	10	20	15
		18x48	N°43	14.399	10	20	15
		20x50	N°44	15.899	10	20	15
DIN228AK		CM1	N°45	9.599	10	20	
		CM2	N°46	14.599	10	20	
		CM3	N°47	21.499	10	25	
		CM4	N°48	29.499	10	25	
DIN228BK		CM1	N°49	9.599	10	20	
		CM2	N°50	14.599	10	20	
		CM3	N°51	21.499	10	25	
		CM4	N°52	29.499	10	25	
Central Clamping Surface 15°		6x30	N°53	2.749	10	20	20
		10x40	N°54	7.299	10	20	15
		16x45	N°55	12.399	10	20	
		.750x2.75"	N°56	14.899	10	20	
		25x70	N°57	19.509	10	25	
		1.00x2.75"	N°58	19.509	10	25	
		1.25x2.75"	N°59	25.609	10	25	
		1.50x2.75"	N°60	32.609	10	25	
Frontal Clamping Surface 15°		16x50	N°61	12.399	10	20	
Cylindrical With Thread		10x50 M6X0.5	N°62	7.299	10	20	15
		10x60 M6X0.5	N°63	7.299	10	20	
		.50x1.97" M6x0.5	N°64	8.999	10	20	15
		16x80 M10X1	N°65	12.399	10	20	15
		25x100 M16x1.5	N°66	19.509	10	25	
		36x120 M24x1.5	N°67	30.609	10	25	

Driver Type	Drawing	DXL	Driver Code	Max. Cutting Diameter	BRAZED GUNDRILL  F = CYLINDRICAL TUBE: Equal Or Less Than max. Cutting Diameter	BRAZED GUNDRILL F = CYLINDRICAL TUBE: More Than max. Diameter	SOLID CARBIDE GUNDRILL  F = Straightening Extension
VDI Design		10x68 M6x0.5	N°68	6.749	10	20	
		16x90 M10x1	N°69	10.799	10	20	15
		25x112 M16x1.5	N°70	19.509	10	25	
		36x135 M24x1.5	N°71	30.609	10	25	
Central Clamping Hexagonal		25x70	N°72	19.509	10	25	
		32x70	N°73	25.609	10	25	
Central Clamping Tapered		.50x1.50"	N°74	8.599	10	20	15
		16x70	N°75	12.099	10	20	15
		.75x2.75"	N°76	14.099	10	20	
		20x70	N°77	16.099	10	20	15
Frontal Clamping Surface 2°		.50x1.50"	N°78	9.699	10	20	
		.75x2.75"	N°79	14.899	10	20	
		1.00x2.75"	N°80	19.509	10	25	
		1.00x3.94"	N°81	19.509	10	25	
		1.25x2.75"	N°82	25.609	10	25	
		1.25x3.94"	N°83	25.609	10	25	
		1.50x2.75"	N°84	32.609	10	25	
		1.50x3.94"	N°85	32.609	10	25	
Trapezoidal Thread		16x112 Tr 16x1.5	N°86	13.599	10	20	
		20x126 Tr 20x2	N°87	17.099	10	20	
		28x126 Tr 28x2	N°88	25.599	10	25	
		36x162 Tr 36x2	N°89	32.599	10	25	
Spraymist Driver		16x40	N°90	12.399	10	20	
		25x50	N°91	19.509	10	25	
		35x60	N°92	26.599	10	25	

Explanation of Solid Carbide Gundrills Description

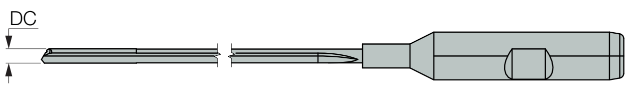
Example:

STCGD	05500	0200	05	–		IC908
CGD	05520	0200	05	C	P	IC908
SPCGD	05520	0500	02051-01	–		IC908
1	2	3	4	5	6	7

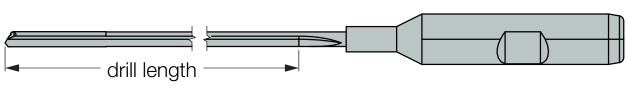
1 Designation of Drilling Head

STCGD – standard gundrill with brazed tip
CGD – semi-standard gundrill with brazed tip
SPCGD – special gundrill with brazed tip

2 Cutting Diameter (DC)



3 Drill Length



4 For STCGD or GD – Code of Driver Type

For SPCGD – drawing no.

5 Drilling Head Profile

According to table 6.11.1.2

6 Finishing Operation

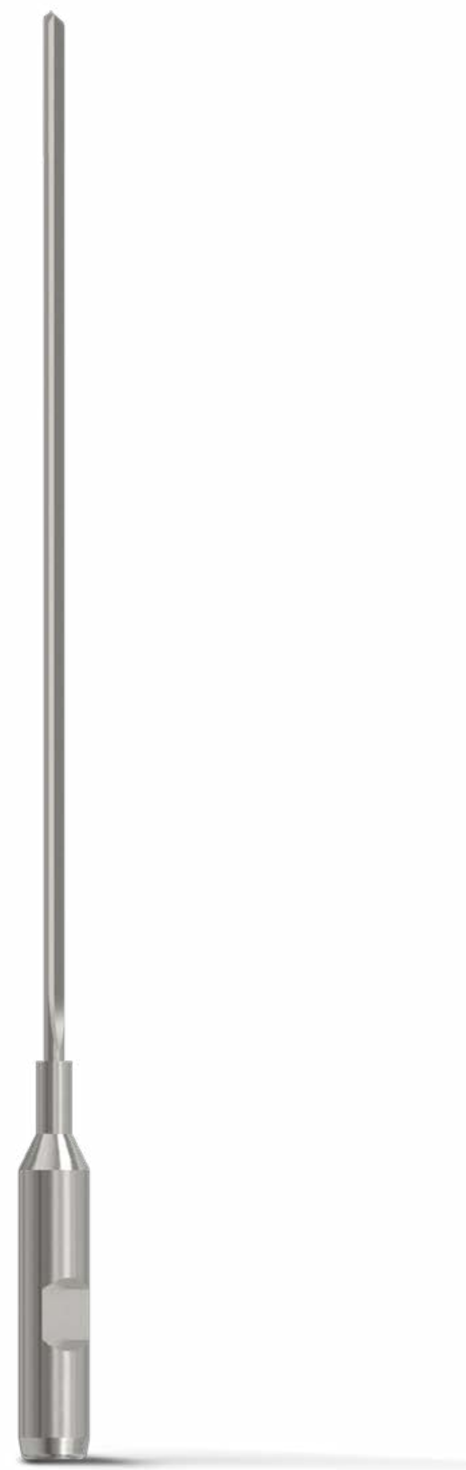
P = polish
R = rough

7 Carbide Grade

Available carbide grades:
IC08, IC908, IC508, IC308, IC208

Advantages of the Solid Carbide Gundrill:

- Drilling precision of IT7 to IT9
- Excellent straightness and concentricity
- Maintains high precision hole center alignment
- Surface roughness of 0.4-1.6 Ra is easily obtained
- Reboring operation is often unnecessary



ISCAR-GUNDRILLS Brazed Tip Gundrills

The **ISCAR-GUNDRILLS** line provides solutions for deep drilling by Gundrill method with brazed tip drills. This type of Gundrill consists of a solid carbide tip brazed to a steel shank. This style of Gundrill is available from 2.5 mm to 40 mm in different lengths according to table 6.11.2.1 and can be used on various types of materials.

Table 6.11.2.1

Drill Diameter (mm)	Max. Flute Length (mm)
2.50 to 3.09	1100
3.10 to 5.99	2500
6.00 to 11.39	3000
11.40 to 40.00	3500

STGD-.... Standard Brazed Tip Drills

STGD-... is a description of standard gundrills with a brazed tip belonging to the **ISCAR-GUNDRILLS** line. STGD-... gundrills are capable of drilling holes from 2.5 mm to 20 mm in sequential steps of 0.1 mm and holes from 20 mm to 40 mm in sequential steps of 1 mm. The sharpening of these gundrills depends on the diameter of the drill (table 6.11.2.2), and the profile is the same for all these gundrills ("General Sketch" according to table 6.11.2.3). The driver type can be selected according to table 6.11.2.4.

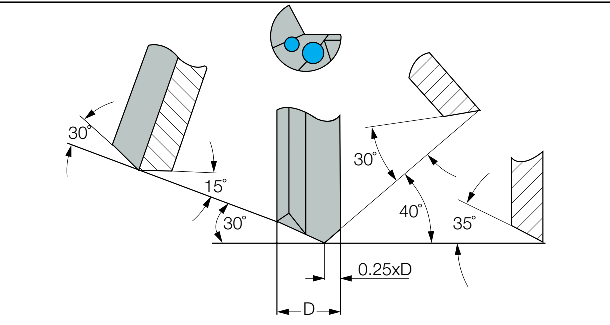
GD-.... Semi-Standard Brazed Tip Drills

GD-... is a description of semi-standard gundrills with a brazed tip belonging to the **ISCAR-GUNDRILLS** line. GD-... gundrills are capable of drilling holes from 2.5 mm to 40 mm in any sequential steps. Sharpening, profile, and driver type can be selected in any variant from standard tables respectively. There is an option for polishing and grade selection.

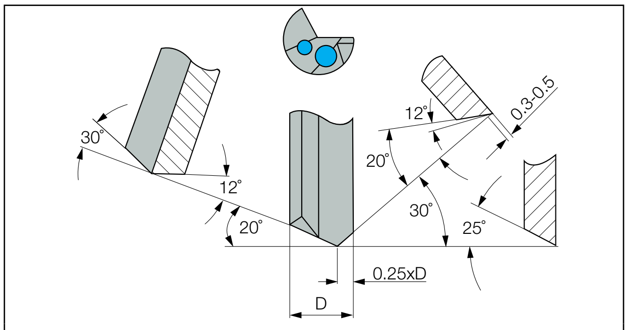
SPGD-.... Special Brazed Tip Drills

SPGD-... is a description of special gundrills with brazed tip belong **ISCAR-GUNDRILLS** line. SPGD-... gundrills are capable of drilling holes 2.5 mm to 40 mm
in any sequential steps. Sharpening, profile, flute length and driver type can be selected in any variant. There is an option for polishing and grade selection.

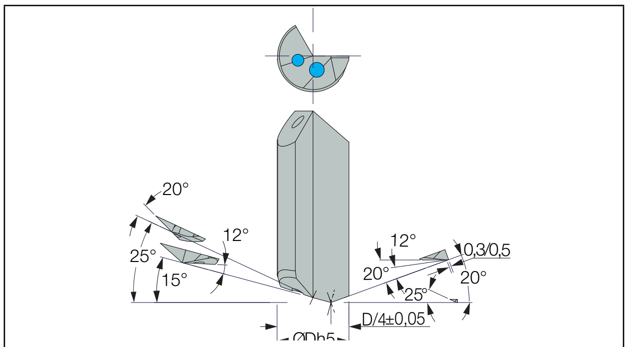
Table 6.11.2.2 – Standard Sharpening



Standard sharpening for 0.9 to 4 mm drill diameters



Standard sharpening for 4 to 32 mm drill diameters



Standard sharpening for 32 to 40 mm drill diameters

Note: For special or semi-standard gundrills, special geometries will be offered to match the application.

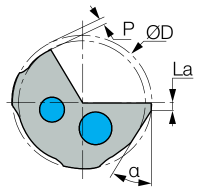
Table 6.11.2.3 – Drilling Head Profile

Standard Gundrill Head Profiles

Drilling capacity and finish of the drilled hole are dependent on the geometrical shape of the drill head. Both the profile and the sharpening must be matched to the workpiece material.

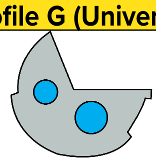
The profile is defined when the tool is manufactured. Although regrinding may change the cutting geometry, the profile should remain the same.

General Sketch



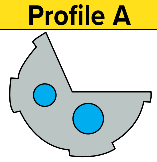
All cross section profile parameters such as: P, La and ʹaʹ must be precisely matched to the workpiece material properties.

Profile G (Universal)



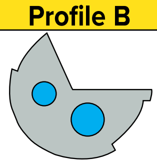
Standard form for most material types, particularly for materials with a tendency to shrink. Recommended for high precision bore tolerance and straightness. Maintains precise exit hole size. Recommended when extra burnishing is required.

Profile A



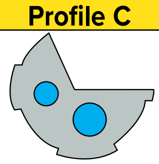
Suitable for cast iron (usually coated) and aluminum alloys. Can be used for cross drilling, angular entry or exit and for interrupted cut. Large coolant gaps between pads.

Profile B



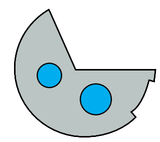
Excellent size control, for high precision hole tolerance. Used for cast iron and aluminum alloys.

Profile C



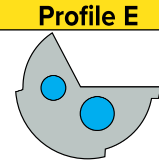
Used for angled entry or exit. Large back taper, for shrinking materials such as high temperature and titanium alloys and stainless steel. Large coolant gaps between pads.

Profile D



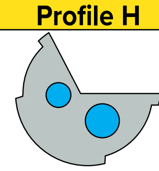
Suitable for cast iron only. Very effective in grey cast iron (usually coated).

Profile E



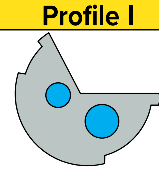
General use, for alloys and stainless steel.
This profile eliminates the problem of the tool sticking in the hole after the outer corner dulls. Especially suitable for crankshaft and other forged materials. Recommended for accurate hole straightness.

Profile H



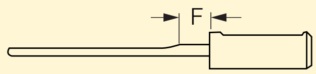
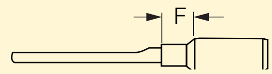
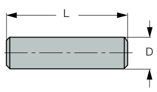
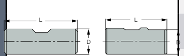
Recommended for all nonferrous and cast iron materials up 5 mm diameter. Sometimes used for wood and plastic with larger back taper.

Profile I

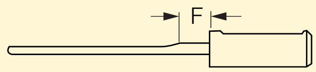
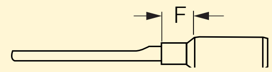
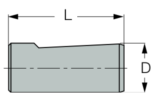
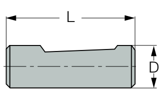
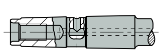
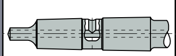
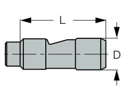
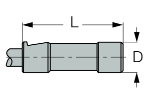
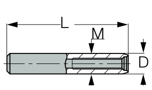


Used for aluminum and brass for best hole finish.
For intersecting holes and interrupted cut or when extra outer diameter support and burnishing is required.

Table 6.11.2.4 – Driver Type

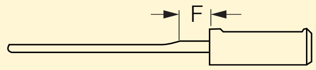
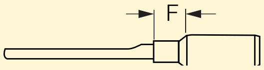
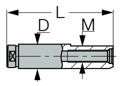
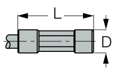
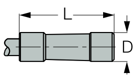
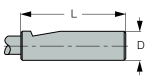
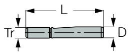
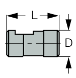
Driver Type	Drawing	DXL	Driver Code	Max. Cutting Diameter	BRAZED GUNDRILL  F = CYLINDRICAL TUBE: Equal Or Less Than max. Cutting Diameter	BRAZED GUNDRILL F = CYLINDRICAL TUBE: More Than max. Diameter	SOLID CARBIDE GUNDRILL  F = Straightening Extension
Cylindrical DIN1835A DIN6535HA		4x28	N°1	2.749	10	20	18
		5x28	N°2	3.249	10	20	15
		6x36	N°3	4.249	10	20	14
		8x36	N°4	5.749	10	20	14
		10x40	N°5	7.299	10	20	15
		12x45	N°6	8.999	10	20	15
		.50x1.78″	N°94	9.699	10	20	15
		14x45	N°7	10.999	10	20	15
		16x48	N°8	12.399	10	20	15
		18x48	N°9	14.399	10	20	15
		.75x2.03″	N°95	14.899	10	20	15
		20x50	N°10	15.899	10	20	
		25x56	N°11	19.509	10	25	
		1.00x2.28″	N°96	19.509	10	25	
		1.25x2.28″	N°97	25.609	10	25	
		32x60	N°12	25.609	10	25	
		40x70	N°13	32.609	10	25	
		50x80	N°14	40	10	25	
		63x90	N°15	40	10	25	
Weldon DIN1835B DIN6535HB		6x36	N°16	2.749	10	20	15
		8x36	N°17	3.249	10	20	15
		10x40	N°18	7.299	10	20	15
		12x45	N°19	8.999	10	20	15
		.50x1.78″	N°98	9.699	10	20	15
		16x48	N°20	12.399	10	20	15
		18x48	N°21	14.399	10	20	15
		.75x2.03″	N°99	14.899	10	20	15
		20x50	N°22	15.899	10	20	15
		25x56	N°23	19.509	10	25	
		1.00x2.28″	N°100	19.509	10	25	
		1.25x2.28″	N°101	25.609	10	25	
		32x60	N°24	25.609	10	25	
		40x70	N°25	32.609	10	25	
		50x80	N°26	40	10	25	
		63x90	N°27	40	10	25	

Continued

Driver Type	Drawing	DXL	Driver Code	Max. Cutting Diameter	BRAZED GUNDRILL F = CYLINDRICAL TUBE: Equal Or Less Than max. Cutting Diameter	BRAZED GUNDRILL F = CYLINDRICAL TUBE: More Than max. Diameter	SOLID CARBIDE GUNDRILL F = Straightening Extension
					 F		 F
Whistle Notch DIN1835E	 L D	6x36	N°28	2.749	10	20	
		8x36	N°29	3.249	10	20	
		10x40	N°30	7.299	10	20	15
		12x45	N°31	8.999	10	20	15
		16x48	N°32	12.399	10	20	15
		18x48	N°33	14.399	10	20	15
		20x50	N°34	15.899	10	20	15
		25x56	N°35	19.509	10	25	
		32x60	N°36	25.609	10	25	
		40x70	N°37	32.609	10	25	
Whistle Notch DIN6535HE	 L D	6x36	N°38	2.749	10	20	15
		8x36	N°39	3.249	10	20	15
		10x40	N°40	7.299	10	20	15
		12x45	N°41	8.999	10	20	15
		16x48	N°42	12.399	10	20	15
		18x48	N°43	14.399	10	20	15
		20x50	N°44	15.899	10	20	15
DIN228AK		CM1	N°45	9.599	10	20	
		CM2	N°46	14.599	10	20	
		CM3	N°47	21.499	10	25	
		CM4	N°48	29.499	10	25	
DIN228BK		CM1	N°49	9.599	10	20	
		CM2	N°50	14.599	10	20	
		CM3	N°51	21.499	10	25	
		CM4	N°52	29.499	10	25	
Central Clamping Surface 15°	 L D	6x30	N°53	2.749	10	20	20
		10x40	N°54	7.299	10	20	15
		16x45	N°55	12.399	10	20	
		.750x2.75"	N°56	14.899	10	20	
		25x70	N°57	19.509	10	25	
		1.00x2.75"	N°58	19.509	10	25	
		1.25x2.75"	N°59	25.609	10	25	
		1.50x2.75"	N°60	32.609	10	25	
Frontal Clamping Surface 15°	 L D	16x50	N°61	12.399	10	20	
Cylindrical With Thread	 L M D	10x50 M6X0.5	N°62	7.299	10	20	15
		10x60 M6X0.5	N°63	7.299	10	20	
		.50x1.97" M6x0.5	N°64	8.999	10	20	15
		16x80 M10X1	N°65	12.399	10	20	15
		25x100 M16x1.5	N°66	19.509	10	25	
		36x120 M24x1.5	N°67	30.609	10	25	

[←]

Continued

Driver Type	Drawing	DXL	Driver Code	Max. Cutting Diameter			
					BRAZED GUNDRILL		**SOLID CARBIDE GUNDRILL**
					F = CYLINDRICAL TUBE		**F = Straightening Extension**
					Equal Or Less Than max. Cutting Diameter	**More Than max. Diameter**	
VDI Design		10x68 M6x0.5	N°68	6.749	10	20	
		16x90 M10x1	N°69	10.799	10	20	15
		25x112 M16x1.5	N°70	19.509	10	25	
		36x135 M24x1.5	N°71	30.609	10	25	
Central Clamping Hexagonal		25x70	N°72	19.509	10	25	
		32x70	N°73	25.609	10	25	
Central Clamping Tapered		.50x1.50"	N°74	8.599	10	20	15
		16x70	N°75	12.099	10	20	15
		.75x2.75"	N°76	14.099	10	20	
		20x70	N°77	16.099	10	20	15
Frontal Clamping Surface 2°		.50x1.50"	N°78	9.699	10	20	
		.75x2.75"	N°79	14.899	10	20	
		1.00x2.75"	N°80	19.509	10	25	
		1.00x3.94"	N°81	19.509	10	25	
		1.25x2.75"	N°82	25.609	10	25	
		1.25x3.94"	N°83	25.609	10	25	
		1.50x2.75"	N°84	32.609	10	25	
		1.50x3.94"	N°85	32.609	10	25	
Trapezoidal Thread		16x112 Tr 16x1.5	N°86	13.599	10	20	
		20x126 Tr 20x2	N°87	17.099	10	20	
		28x126 Tr 28x2	N°88	25.599	10	25	
		36x162 Tr 36x2	N°89	32.599	10	25	
Spraymist Driver		16x40	N°90	12.399	10	20	
		25x50	N°91	19.509	10	25	
		35x60	N°92	26.599	10	25	

Explanation of Brazed Tip Solid Carbide Gundrills Description

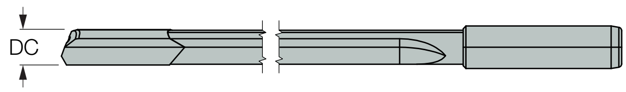
Example:

STGD	05500	0500	57	–		IC08
GD	05520	0500	57	E	R	IC908
SPGD	05520	0500	02051-01	–		IC908
1	2	3	4	5	6	7

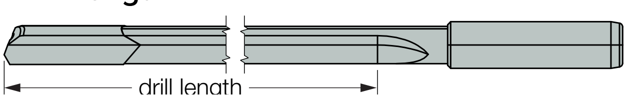
1 **Designation of the Drilling Head**

STGD – standard gundrill with brazed tip
GD – semi-standard gundrill with brazed tip
SPGD – special gundrill with brazed tip

2 **Cutting Diameter (DC)**



3 **Drill Length**



4 **For STGD or GD** – code of driver type
For SPGD – drawing no.

5 **Drilling Head Profile**

According to table 6.11.2.3

6 **Finishing Operation**

P = polish
R = rough

7 **Carbide Grade**

Available carbide grades:
IC08, IC908, IC508, IC308, IC208

Advantages of the Solid Carbide Gundrill:

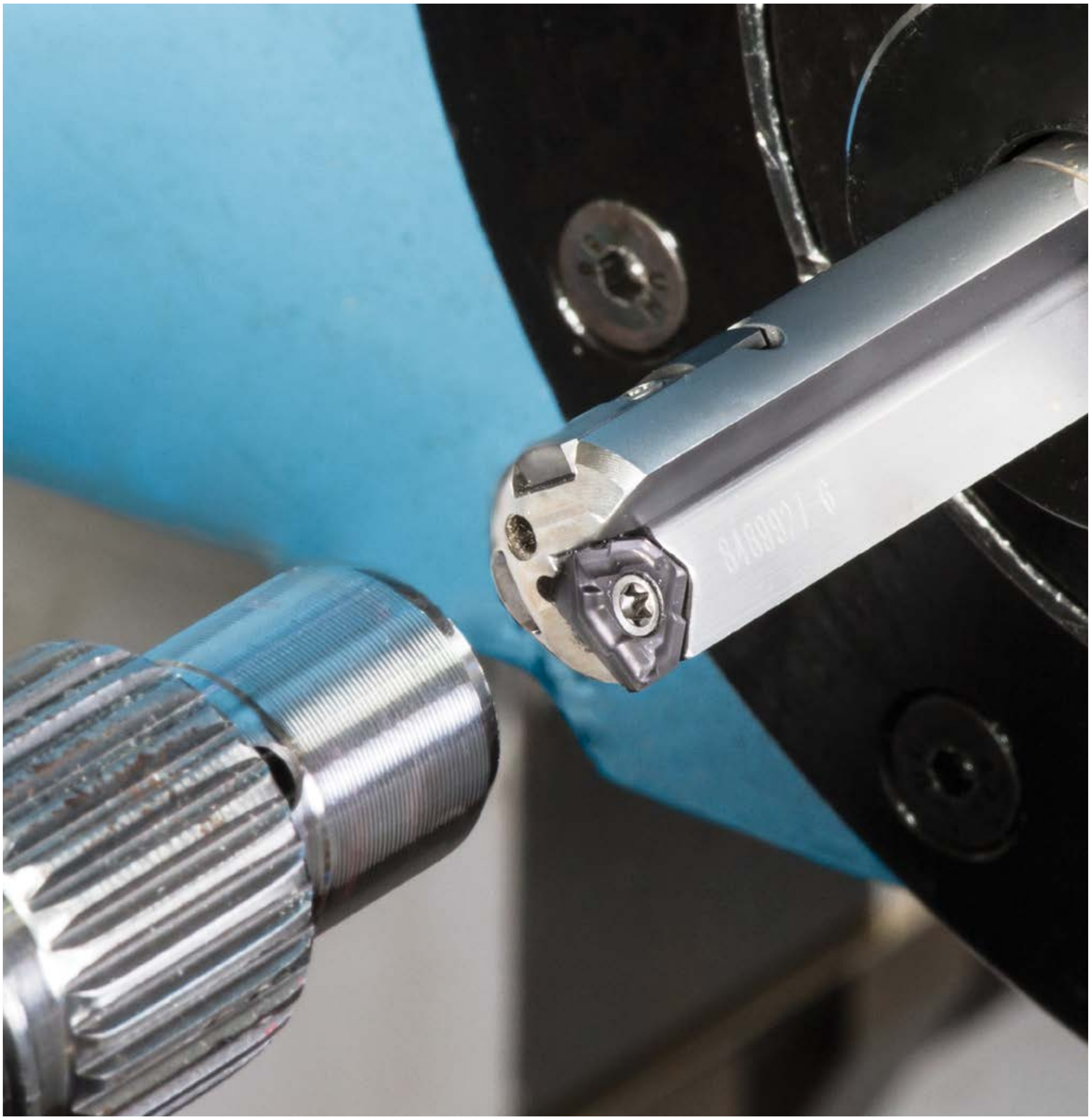
- Drilling precision of IT7 to IT9
- Excellent straightness and concentricity
- Maintains high precision hole center alignment
- Surface roughness of 0.4-1.6 Ra is easily obtained
- Reboring operation are often unnecessary

ISCAR-GUNDRILLS Cutting Conditions for Gun Drilling Methods

The main elements of cutting conditions for deep drilling are cutting speed and feed. When drilling holes, it is important to select the right cutting conditions in which the tool will work normally, i.e., most efficiently, in order to save the tool from premature wear, taking into account maximum productivity.

Recommended initial conditions are shown in the table below, according to insert size, chip breaker form, and workpiece material.

When using the small diameter drills, it is crucial to adhere closely to the recommended drilling parameters.



ISO	Material		Condition	Material Group No.	Cutting Speed V_c [m/min]	Feed vs.Drill Diameter [mm/rev] D=2.0-2.5	D=2.5-3.5	D=3.5-5	D=5-8	D=8-12.5	D=12.5-22.5	D=22.5-30	D=30 and more
P	non-alloy steel and cast steel, free cutting steel	<0.25% C	annealed	1	70-100	0.002-0.003	0.003-0.01	0.01-0.02	0.02-0.03	0.03-0.05	0.05-0.08	0.08-0.13	0.13-0.23
		≥0.25% C	annealed	2									
		<0.55% C	quenched and tempered	3									
		≥0.55% C	annealed	4									
			quenched and tempered	5									
	low alloy and cast steel (less than 5% of alloying elements)		annealed	6	60-80	0.002-0.003	0.003-0.008	0.008-0.02	0.02-0.03	0.03-0.05	0.05-0.08	0.08-0.12	0.12-0.2
			quenched and tempered	7									
				8									
				9									
	high alloyed steel, cast steel and tool steel		annealed	10									
			quenched and tempered	11	40-60								
	stainless steel and cast steel		ferritic / martensitic	12	40-60	0.003-0.004	0.004-0.007	0.007-0.02	0.02-0.03	0.03-0.05	0.05-0.09	0.09-0.13	0.13-0.18
			martensitic	13									
M	stainless steel and cast steel		austenitic, duplex	14	30-60	0.003-0.004	0.004-0.007	0.007-0.02	0.02-0.03	0.03-0.05	0.05-0.09	0.09-0.13	0.13-0.18
K	gray cast iron (GG)		ferritic / pearlitic	15	70-100	0.002-0.003	0.003-0.01	0.01-0.02	0.02-0.04	0.04-0.07	0.07-0.12	0.12-0.17	0.17-0.29
			pearlitic / martensitic	16									
	nodular cast iron (GGG)		ferritic	17									
			pearlitic	18									
	malleable cast iron		ferritic	19									
			pearlitic	20									
N	aluminum-wrought alloys		not hardenable	21	100-150	0.002-0.003	0.003-0.02	0.02-0.07	0.07-0.13	0.13-0.23	0.23-0.36	0.36-0.52	0.52-1.00
			hardenable	22									
	aluminum-cast alloys	≤12% Si	not hardenable	23									
			hardenable	24									
		>12% Si	high temperature	25									
	copper alloys	>1% Pb	free cutting	26	100-150								
			brass	27	80-120	0.003-0.004	0.004-0.01	0.01-0.02	0.02-0.04	0.04-0.07	0.07-0.11	0.11-0.16	0.16-0.3
			electrolytic copper	28									
	non metallic		duroplastics, fiber plastics	29									
			hard rubber	30	40-60	0.002	0.002-0.004	0.004-0.009	0.009-0.02	0.02-0.03	0.03-0.05	0.05-0.08	0.08-0.09
S	high temperature alloys	Fe based	annealed	31	25-50	0.002	0.002-0.004	0.004-0.009	0.009-0.02	0.02-0.03	0.03-0.05	0.05-0.08	0.08-0.09
			hardened	32									
		Ni or Co based	annealed	33									
			hardened	34									
			cast	35									
	titanium alloys		pure	36									
			alpha+beta alloys, hardened	37									
H	hardened steel		hardened	38	25-50	0.002	0.002-0.004	0.004-0.009	0.009-0.02	0.02-0.03	0.03-0.05	0.05-0.08	0.08-0.09
			hardened	39									
	chilled cast iron		cast	40									
	cast iron		hardened	41									

ISCAR-GUNDRILLS Inquiry Form for Gundrills

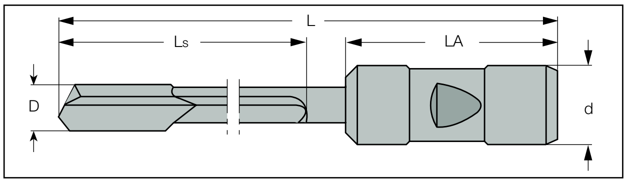
Gundrill Inquiry Form

1. Tool

Quantity ______________________________

Nominal diameter and tolerance ________________

Please fill in dimensions on the sketch below.



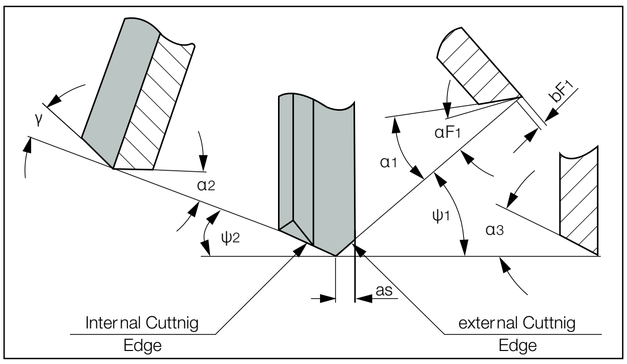
Driver

For standard drivers please use codes from page 253-255

☐ Code No.

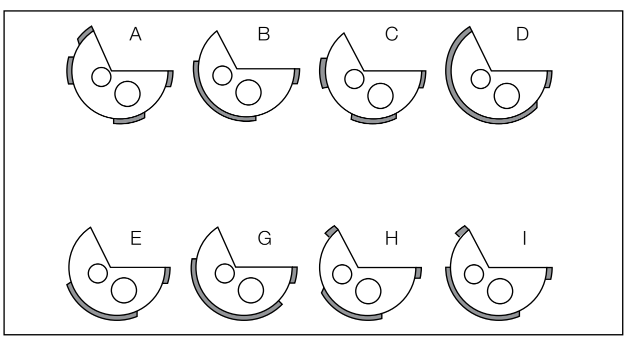
☐ Special, please attach sketch and specifications.

Grind: ☐ special (fill in the dimensions and angles below).



α1= ________	αF1= ________	Ψ1=________
α2= ________	bF1= ________	Ψ2=________
α3= ________	as= ________	γ= ________

☐ Standard (see page 252)



2. Workpiece

(If possible, please attach a drawing)

2.1 Material

Material description
(DIN material number or any other standard):

____

Hardness and properties:

____

☐ Short chips ☐ Long chips

2.2 Hole Type

☐ Blind hole ☐ Drilling into pre-hole

☐ Angled entry ☐ Drilling into solid

☐ Boring ☐ Angled exit

Drilling depth ________mm Hole tolerance ____________

2.3 Application:

Workpiece: ☐ Stationary ☐ Rotating

Tool: ☐ Stationary ☐ Rotating

3. Machine

3.1 Technical Data

Machine type. ______________________________

Power________________________kW

3.2 Cutting Data:

Cutting speed V_c ______________m/min

Revolutions Nmin ______________RPM, Nmax __________RPM

Feed Fmin____________________mm/rev,

Fmax ____________________mm/rev

Feed rate VF ______________mm/min

Coolant:

☐ Oil ☐ Soluble oil ☐ Other

Coolant pressure ________________bar

Sketch of drilling application

Note: It may be necessary to change several of the parameters that you indicated based on our experience with your application.

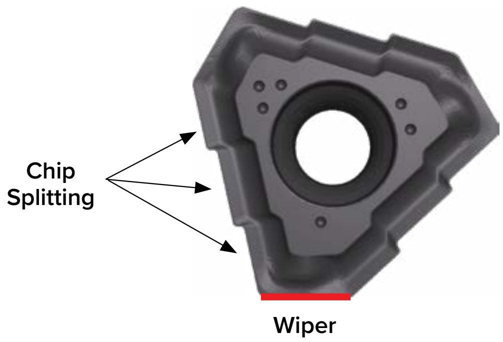
TRI-DEEP Indexable Inserts

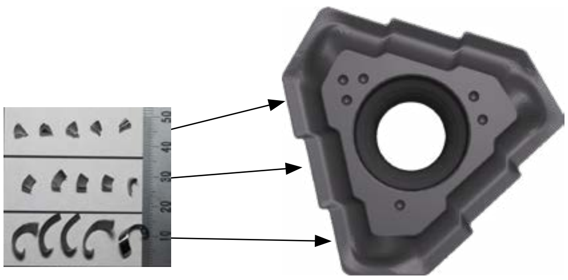
The **ISCAR TRI-DEEP** line provides solutions with indexable inserts for all deep drilling methods, such as: Gundrilling single and double tube systems.

The **ISCAR TRI-DEEP** line is based on two types of indexable inserts: TOGT with 3 cutting edges and LOGT with 2 cutting edges. The main features of this indexable solution are cost effectiveness and functionality.

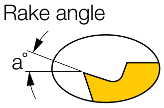
TOGT

The TOGT inserts features chip splitting cutting edges, a positive rake chip breaker, and a wiper for high hole surface quality.



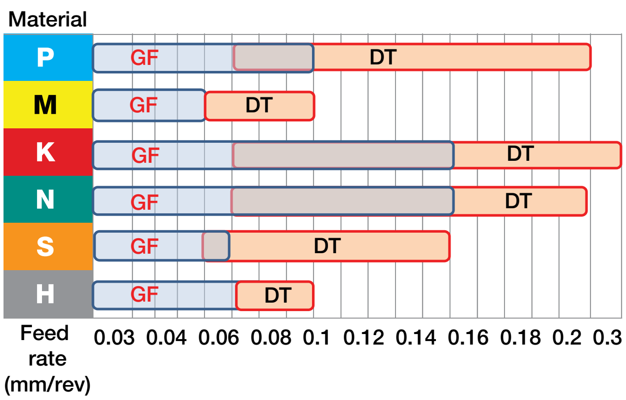


The TOGT inserts are available with 2 types of chipformers: TOGT...DT and TOGT...GF.

		GF	DT
1	Rake angle 	a°=25°	a°=20°
2	ID mark 	F 	T 

The selection of the GF or DT chipformer depending on the feed rates (mm/rev) according to the recommendations below:

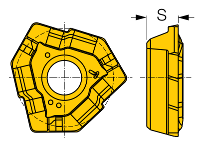
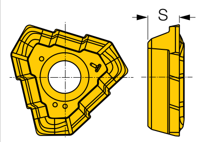
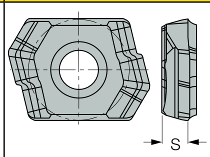
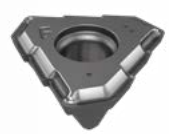
Recommended Feed Rate of Each Chipbreaker for Various Materials



LOGT

The LOGT inserts feature 2 chip splitting cutting edges, a positive rake chip breaker, and a wiper for high hole surface quality.

Basic Dimensions of TOGT and LOGT Inserts

TOGT	TOGT	LOGT
 S	 S	 S
		

IC – inscribe circle diameter
RE – corner radius
PL – point length
S – insert thickness

TOGT and LOGT Advantages

- Highly accurate peripherally ground insert, providing high hole diameter accuracy of IT10
- Produces narrow chips for effective chip evacuation, enabling higher feed rates compared to other Gundrills available in the market
- A wiper on the insert provides extra fine surface finish
- Direct insert mounting – no adjustment needed for accurate hole diameter

TRI-DEEP GF Chipformer Advantages

- Chipformer with positive rake results in an easy cut
- Advantageous for Gundrill machines with low motor torque that can run only with low feed rates
- Avoids long and curly chips that may jam in the drill gullets and damage the tool
- Helps improve surface quality due to small chips that are easily evacuated
- Effective chip control even at low feeds

TRI-DEEP Solution for Gun Drilling Methods

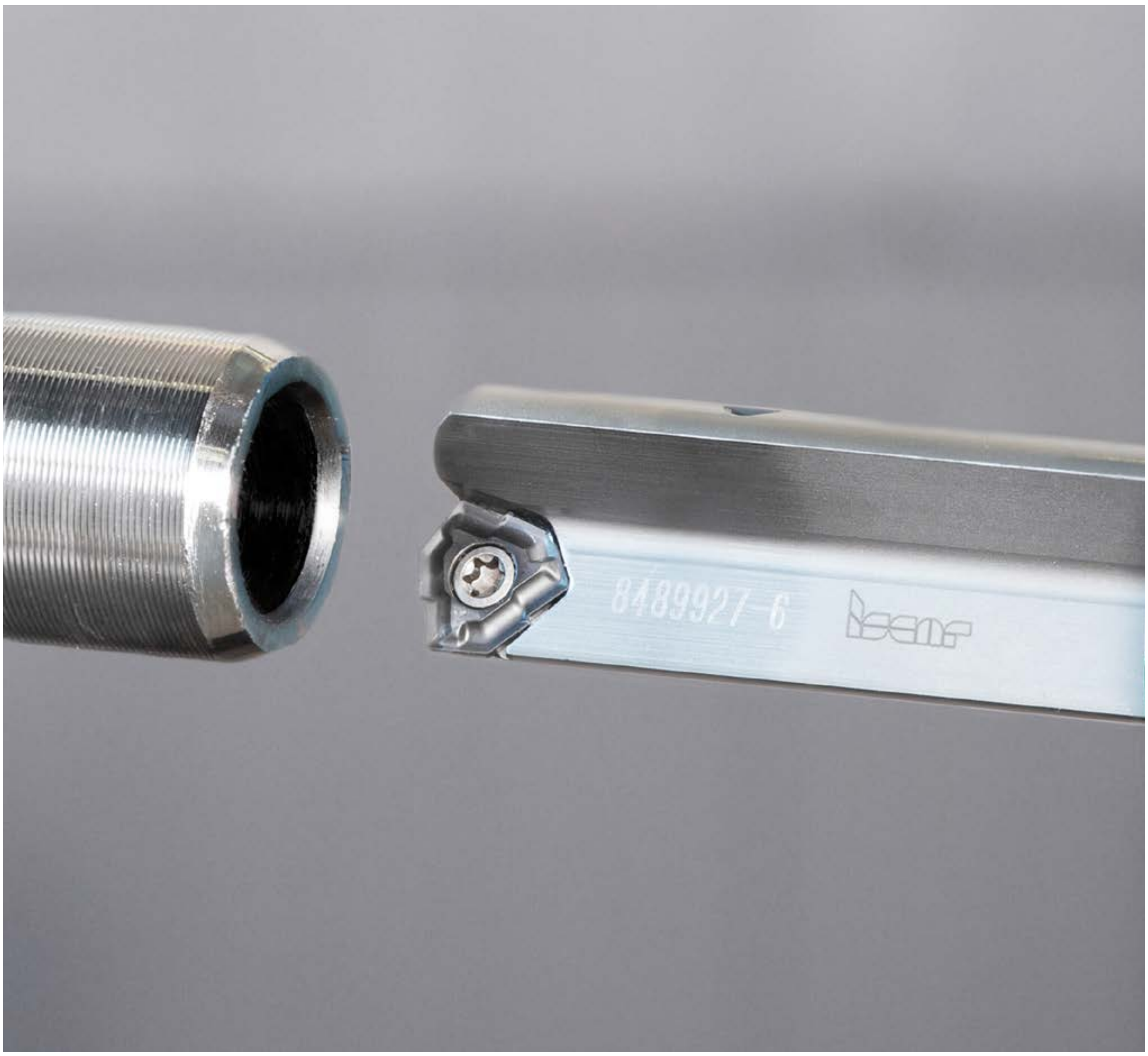
ISCAR TRI-DEEP includes Gundrills and brazed Gundrill heads with indexable inserts.

TRI-DEEP - Gundrills

GD-DH... is a description of gundrills belonging to the **ISCAR TRI-DEEP** family for deep drilling. GD-DH... gundrills are capable of drilling holes from 12 mm to 32 mm in diameter and are available with different driver types.

Gundrills GD-DH... up to a diameter of 13.5 mm are suitable for mounting LOGT inserts with 2 cutting edges for chip separation and are available in 15, 20, 25 drilling lengths to diameter ratios.

Gundrills GD-DH... from 14 mm diameter are suitable for mounting TOGT inserts that feature 3 chip splitting cutting edges and are available in 10, 15, 20, 25 drilling lengths to diameter ratios.



Explanation of Gundrills GD-DH... Description

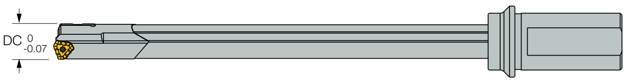
Example:

GD-DH	14.00	–	25D	–	M25	–	07
1	2		3		4		5

1 Designation of Drilling Head

GD-DH – gundrill for deep drilling

2 Cutting Diameter (DC)



3 Ratio of Drilling

length to diameter (LU/DC)

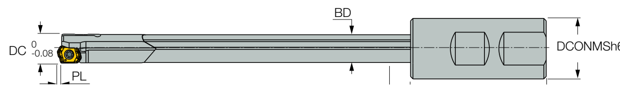
4 Driver Type

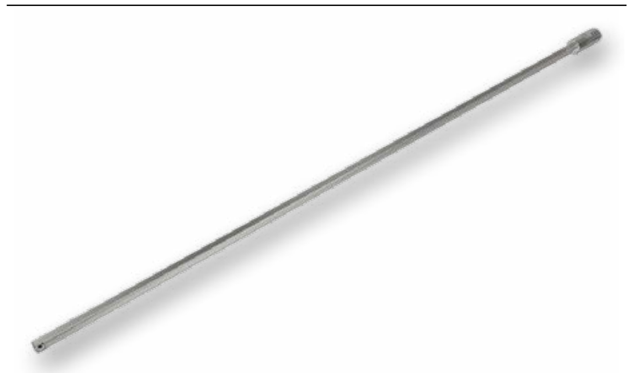
5 Insert Type

06 – LOGT 06...
07 – TOGT 07...
... – TOGT ...
13 – TOGT 13...

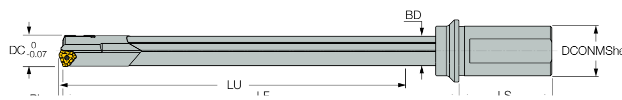
Basic Dimensions of Gundrill GD-DH...

Gundrills Carrying the LOGT Indexable Insert





Gundrills Carrying the TOGT Indexable Insert



DC – cutting diameter
LU – usable length
DCONMS – connection diameter machine side
BD – body diameter
LF – functional length
PL – point length
LS – shank length
OAL – overall length
TH – thread designation

TRI-DEEP - Brazed Head for Gun Drilling

GDH- ...MKT is a brazed cutting head for gundrills belonging to the **ISCAR TRI-DEEP** family. GDH-... MKT heads open the possibility of replacing the drilling head by re-brazing without replacing the whole tool. GDH-... MKT brazed drilling heads are capable of drilling holes from 14 mm to 28 mm in diameter and are suitable for mounting TOGT inserts that feature 3 chip splitting cutting edges.

Explanation of Brazed Head for Gun Drilling GDH-...MKT Description

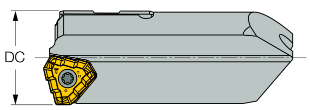
Example:

GDH	–	14.00	MKT
1		2	

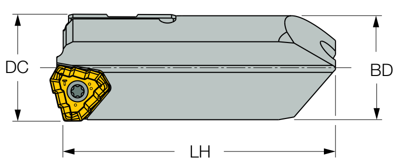
1 Designation of the Drilling Head

GDH – brazed cutting head for gundrills

2 Cutting Diameter (DC)



Basic Dimensions of Brazed Head for Gun Drilling GDH-... MKT



DC – cutting diameter
LH – head length
BD – body diameter

TRI-DEEP Drill Diameter Adjustment Shims for Gundrills

ISCAR TRI-DEEP includes sets of shims for gundrills easy and fast adjustment of drill diameter and helps minimize the need for special gundrill tools. The shims make it possible to increase the diameter of drills from 0.01 mm to 0.1 mm in sequential steps of 0.01 mm. The set of shims are adapted for Gundrills with diameters range of 12 mm to 28 mm. The shims need to be mounted under the guide pads that are assembled on the **TRI-DEEP** gundrills.

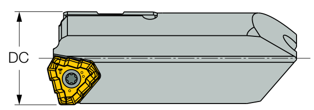
ISCAR TRI-DEEP shims ensure easy and fast drill diameter adjustment in a range of 0.01 up to 0.1 mm

Explanation of Shims for ISCAR TRI-DEEP Gundrills Description

Example:

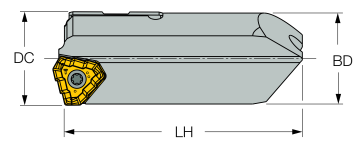
SHIMSET	GP04
	1

1 Shims Width (W)



GP04 – 4 mm width of shims
GP05 – 5 mm width of shims
GP06 – 6 mm width of shims

Basic Dimensions of Shims for ISCAR TRI-DEEP Gundrills



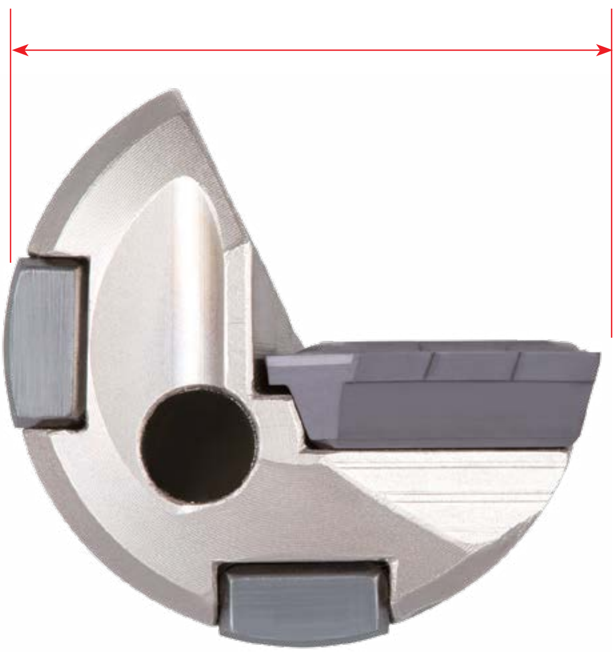
W – shims width
OAL – overall length

Assembly Instructions

Step 1

Measure the DTD drill diameter between the measuring guide pad and the insert's cutting edge. If a pre-setter is not available, use a micrometer or caliper.

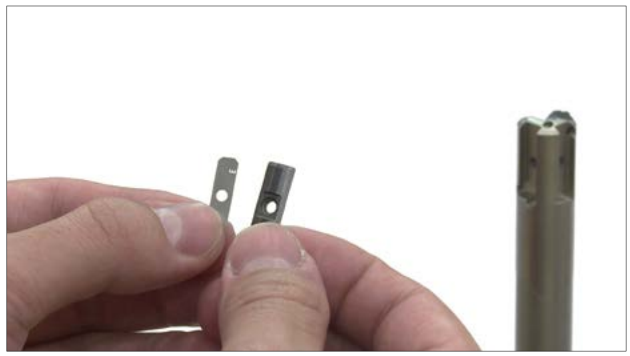
For a precise drill diameter measurement, it is recommended to test-drill a hole and measure the hole diameter.



Step 2

Select the shim combinations according to the recommended shim combinations for various diameters to obtain the required hole diameter.

Take into consideration that the actual diameter of the drilled hole tends to be slightly larger (usually +20 µm to +30 µm) than the drill's nominal diameter - i.e., add 20 µm - 30 µm to the measured drill diameter in Step 1 above before the final drill diameter.

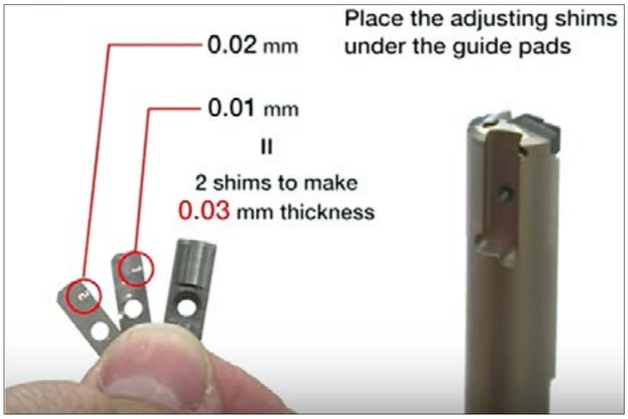


Step 3

Remove the guide pads

Step 4

Install the adjusting shims underneath the guide pads, respectively. Put the guide pads back on the tool.

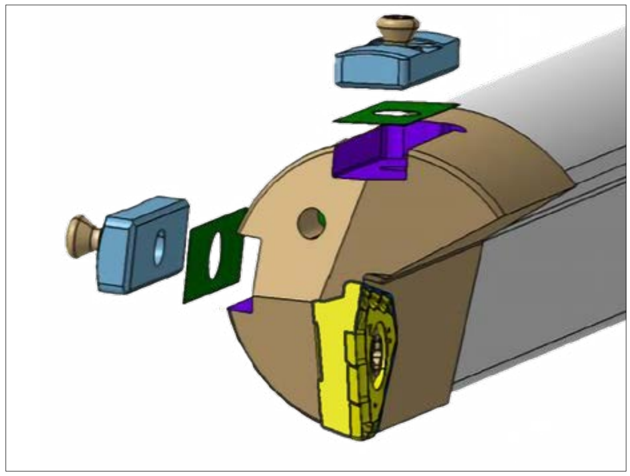


Step 5

Measure the drill diameter again to confirm that the required diameter is obtained on the DTD.

Step 6

Drill a hole to confirm that the required hole diameter is achieved.



Shim Combinations for Various Diameters

Diameter Adjustments (mm)	Shim (s) for Measuring Guide Pad	Shim [8] for Supporting Guide Pad	Number of Shim Sets Needed
+0.01	0.01	-	1
+0.02	0.02	0.01	1
+0.03	0.03	0.01+0.02	1
+0.04	0.04	0.02+0.03	1
+0.06	0.05	0.02+0.03	1
+0.06	0.01+0.05	0.02+0.04	1
+0.07	0.02+0.05	0.03+0.04	1
+0.08	003+0.06	0.04+0.04	2
+0.09	0.04+0.05	0.04+0.05	2
+0.10	0.05+0.05	0.04 +0.04 +0.01	2

TRI-DEEP Cutting Conditions for Gun Drilling Methods

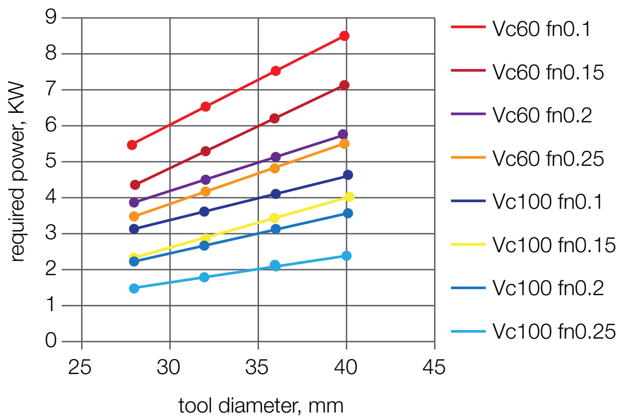
The main elements of the cutting conditions for deep drilling are cutting speed and feed. When drilling holes, it is important to select the right cutting conditions in which the tool will work normally, i.e., most efficiently, in order to save the tool from premature wear, taking into account maximum productivity. Recommended initial conditions are shown in the table below, according to insert size, chip breaker form and workpiece material.

ISO	Material		Condition	Tensile Strength [N/mm²]	Hardness HB	Material Group No.	TOGT V m/min	TOGT Feed per insert size "GF" & "DT" 06 07 08 mm/rev	TOGT Feed per insert size "GF" & "DT" 09 mm/rev	TOGT Feed per insert size "GF" & "DT" 10 mm/rev	TOGT Feed per insert size "GF" & "DT" 11 mm/rev	TOGT Feed per insert size "GF" & "DT" 12 13 mm/rev
P	non-alloy steel and cast steel, free cutting steel	<0.25% C	annealed	420	125	1	80-120	0.04-0.08 0.08-0.14	0.04-0.10 0.08-0.16	0.06-0.10 0.08-0.16	0.06-0.10 0.08-0.16	0.06-0.12 0.08-0.18
		≥0.25% C	annealed	650	190	2						
		<0.55% C	quenched and tempered	850	250	3						
		≥0.55% C	annealed	750	220	4		0.04-0.12 0.06-0.20				
			quenched and tempered	1000	300	5						
	low alloy and cast steel (less than 5% of alloying elements)		annealed	600	200	6						
			quenched and tempered	930	275	7						
				1000	300	8						
				1200	350	9						
	high alloyed steel, cast steel and tool steel		annealed	680	200	10		0.04-0.08 0.08-0.14	0.04-0.10 0.08-0.16	0.06-0.10 0.08-0.16	0.06-0.10 0.08-0.16	0.06-0.12 0.08-0.18
			quenched and tempered	1100	325	11						
	stainless steel and cast steel		ferritic / martensitic	680	200	12						
			martensitic	820	240	13						
M	stainless steel and cast steel		austenitic, duplex	600	180	14	50-100	0.02-0.06 0.04-0.12	0.02-0.06 0.04-0.12	0.02-0.06 0.04-0.12	0.02-0.06 0.04-0.12	0.02-0.06 0.04-0.12
K	gray cast iron (GG)		ferritic / pearlitic		180	15	50-100 80-120	0.03-0.15 0.08-0.25	0.03-0.15 0.08-0.25	0.05-0.18 0.08-0.25	0.05-0.18 0.08-0.30	0.05-0.18 0.08-0.30
			pearlitic / martensitic		260	16						
	nodular cast iron (GGG)		ferritic		160	17						
			pearlitic		250	18						
	malleable cast iron		ferritic		130	19						
			pearlitic		230	20						
N	aluminum-wrought alloys		not hardenable		60	21	80-160	0.03-0.15 0.08-0.20	0.03-0.15 0.08-0.20	0.03-0.18 0.08-0.20	0.05-0.18 0.08-0.20	0.03-0.18 0.08-0.20
			hardenable		100	22						
	aluminum-cast alloys	≤12% Si	not hardenable		75	23						
			hardenable		90	24						
		>12% Si	high temperature		130	25						
	copper alloys	>1% Pb	free cutting		110	26						
			brass		90	27						
			electrolytic copper		100	28						
	non metallic		duroplastics, fiber plastics			29						
			hard rubber			30						
S	high temperature alloys	Fe based	annealed		200	31	20-50	0.08-0.14	0.08-0.16	0.08-0.16	0.08-0.16	0.08-0.16
			hardened		280	32						
		Ni or Co based	annealed		250	33						
			hardened		350	34						
			cast		320	35						

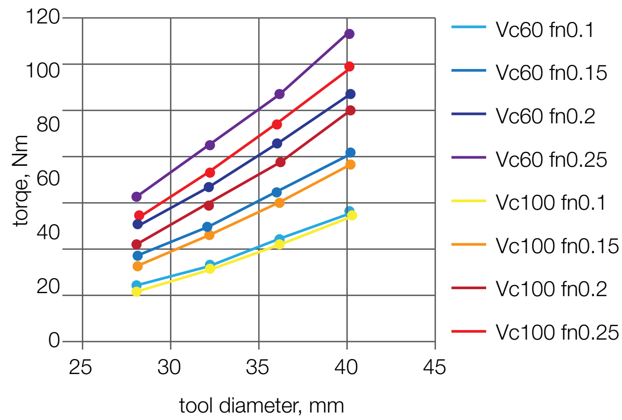
TRI-DEEP Machine Requirements for Gun Drilling Methods

Machine requirements for deep drilling by Gundrill methods using **TRI-DEEP** family tools are shown in the table below.

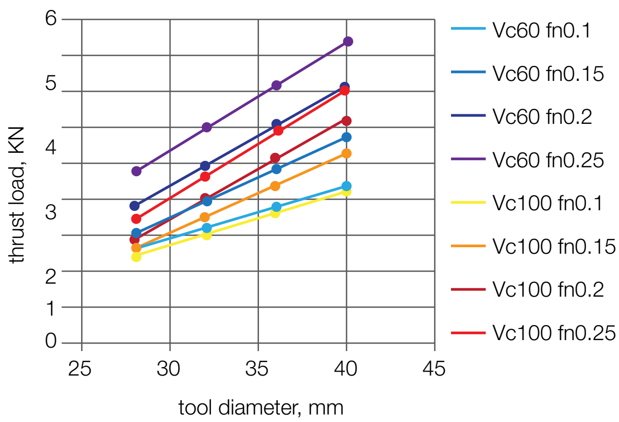
Net Power



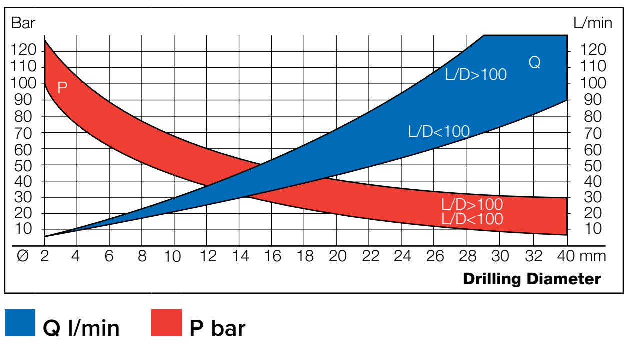
Torque



Feed Force



Coolant Pressure and Volume



TRI-DEEP Inquiry Form for Gundrills

Driver Codes and Technical Data

1. Tool

Quantity ______________________

Nominal diameter and tolerance ______________________

Please fill in dimensions on the sketch.

Driver
For standard drivers please use codes from from table below ______________________

☐ Code no.

☐ Special, please attach sketch and specifications.

2. Workpiece
(If possible, attach a drawing)

2.1 Material
Material description
(DIN material number or any other standard):

____

Hardness and properties:

____

2.2 Hole Type

☐ Blind hole ☐ Drilling into pre-hole

☐ Angled entry

☐ Drilling into solid ☐ Boring ☐ Angled exit

Drilling depth ________mm Hole tolerance ________

2.3 Application:

Workpiece: ☐ Stationary ☐ Rotating

Tool: ☐ Stationary ☐ Rotating

3. Machine

3.1 Technical Data

Machine Type ______________________

Power ______________________kW ________

Sketch of Drilling Application

Note: it may be necessary to change several of the parameters that you indicated, based on our experience with your application.

3.2 Cutting Data:

Cutting speed V_c ________m/min

Revolutions Nmin ________RPM, Nmax ________RPM

Feed Fmin ________mm/rev,

Fmax ________mm/rev

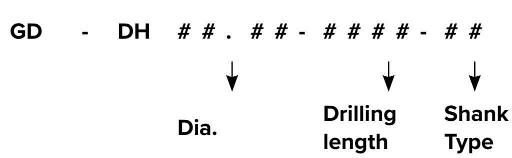
Feed rate VF ________mm/min

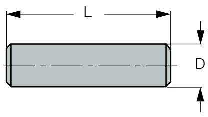
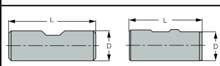
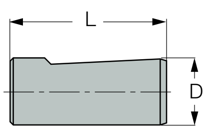
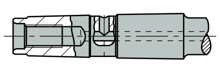
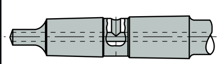
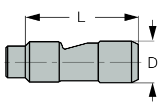
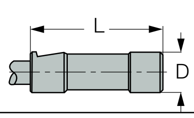
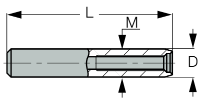
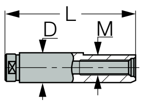
Coolant:

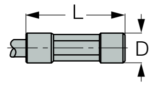
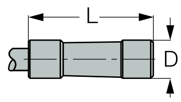
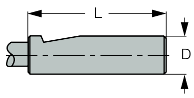
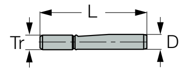
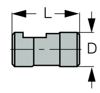
☐ Oil ☐ Soluble oil ☐ Other

Coolant pressure: ________bar

Specially Tailored TRI-DEEP Code Key



Driver Type	Drawing	ØD x L	Driver Code
Cylindrical DIN1835A DIN6535HA		.75x2.03″	95
		20x50	10
		25x56	11
		1.00x2.28″	96
		1.25x2.28″	97
		32x60	12
		40x70	13
Weldon DIN1835B DIN6535HB		.75x2.03″	99
		20x50	22
		25x56	23
		1.00x2.28″	100
		1.25x2.28″	101
		32x60	24
		40x70	25
Whistle Notch DIN1835E		20x50	34
		25x56	35
		32x60	36
		40x70	37
DIN228AK		CM1	45
		CM2	46
		CM3	47
		CM4	48
DIN228BK		CM1	49
		CM2	50
		CM3	51
		CM4	52
Central Clamping Surface 15°		.750x2.75″	56
		25x70	57
		1.00x2.75″	58
		1.25x2.75″	59
		1.50x2.75″	60
Frontal Clamping Surface 15°		16x50	61
Cylindrical With Thread		25x100 M16x1.5	66
		36x120 M24x1.5	67
VDI Design		25x112 M16x1.5	70
		36x135 M24x1.5	71

Driver Type	Drawing	ØD x L	Driver Code
Central Clamping Hexagonal		25x70	72
		32x70	73
Central Clamping Tapered		.75x2.75″	76
		20x70	77
Frontal Clamping Surface 2°		1.00x2.75″	80
		1.00x3.94″	81
		1.25x2.75″	82
		1.25x3.94″	83
		1.50x2.75″	84
		1.50x3.94″	85
Trapezoidal Thread		28x126 Tr 28x2	88
		36x162 Tr 36x2	89
Spraymist Driver		25x50	91
		35x60	92

TRI-DEEP Solution for BTA and DTS Drilling Methods

ISCAR TRI-DEEP includes drilling heads with indexable inserts for deep drilling using the Single and Double Tube System.

TRI-DEEP for Single Tube System

DSD...FT is a description of drilling heads belonging to the **ISCAR TRI-DEEP** family for deep drilling using single tube system. DSD... FT drilling heads are capable of drilling holes from 16 mm to 40 mm in diameter and are available with an external 4 start or internal single start thread connection. The DSD... FT drilling heads are suitable for mounting TOGT inserts that feature 3 chip splitting cutting edges.

TRI-DEEP for Double Tube System

DDD-EF...FT is a description of drilling heads belonging to the **ISCAR TRI-DEEP** family for deep drilling using double tube system. DDD-EF... FT drilling heads are capable of drilling holes from18.4 mm to 28 mm in diameter and are available with an external 4 start thread connection. The DDD-EF... FT drilling heads are suitable for mounting TOGT inserts that feature 3 chip splitting cutting edges.

Explanation of Drilling Heads DSD...FT and DDD-EF...FT Description

Example:

DSD	–	EF	–	25.50	–	FT
1		2		3		

1 Designation of the Drilling Head

DSD – drilling head for deep drilling using single tube system

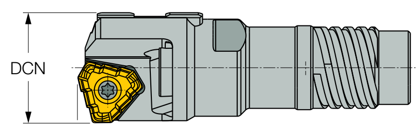
DDD – drilling head for deep drilling using double tube system

2 Connection Type

EF – external 4 start thread connection

IF – internal single start thread connection

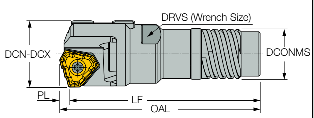
3 Cutting Diameter (DC)



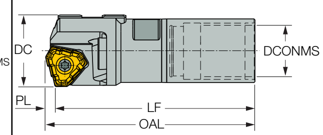
Basic Dimensions of Drilling Heads DSD...FT

Single Tube System

DSD-EF...FT
Deep drilling heads with external 4 start thread connection.

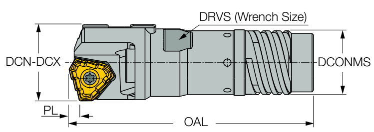


DSD-IF...FT
Deep drilling heads with internal single start thread connection.



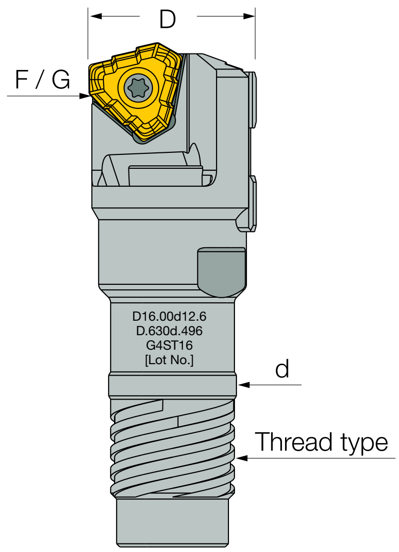
Double Tube System

DDD-EF...FT
deep drilling heads with external 4 start thread connection.



DC – cutting diameter
LF – functional length
OAL – overall length
PL – point length
DCONMS – connection diameter machine side
TH – thread designation

Universal Marking for Drilling Heads DSD...FT



D – cutting diameter
Metric – according to the example: D16.00
Inch – according to the example: D.630
D – pilot diameter
Metric – according to the example: d12.6
Inch – according to the example: d.496

Number of Inserts
F – 3-5 inserts
G – 1 insert
According to the example: G

Type of Connection
4ST – external 4 start thread connection
1ST – internal single start thread connection
According to the example: 4ST

Tube Dimeter
According to the example: 16 6.12.3.2

TRI-DEEP Cutting Conditions for BTA and DTS Drilling Methods

The main elements of the cutting conditions for deep drilling are cutting speed and feed. When drilling holes, it is important to select the right cutting conditions in which the tool will work normally, i.e., most efficiently, in order to save the tool from premature wear, taking into account maximum productivity. Recommended initial conditions are shown in the table below, according to the chipbreaker' s form and workpiece material.

ISO	Material		Condition	Tensile Strength [N/mm²]	Material Group No. (1)	Hardness (HB)	Chipbreaker	Cutting speed V_c (m/min)	Feed: f (mm/rev) Drill dia. (mm) Ø16-18	Ø18.01-40
P	non-alloy steel and cast steel, free cutting steel	<0.25% C	annealed	420	1	125	GF	50-100	0.03-0.10	0.03-0.10
							DT	80-140	0.05-0.10	0.05-0.10
		≥0.25% C	annealed	650	2	190	GF	50-100	0.03-0.10	0.03-0.10
							DT	80-140	0.05-0.10	0.05-0.10
		<0.55% C	quenched and tempered	850	3	250	GF	50-100	0.03-0.10	0.03-0.12
							DT	80-140	0.05-0.16	0.05-0.20
		≥0.55% C	annealed	750	4	220	GF	50-100	0.03-0.10	0.03-0.12
							DT	80-140	0.05-0.16	0.05-0.20
			quenched and tempered	1000	5	300	GF	50-100	0.03-0.10	0.03-0.12
							DT	80-140	0.05-0.16	0.05-0.20
	low alloy and cast steel (less than 5% of alloying elements)		annealed	600	6	200	GF	50-100	0.03-0.10	0.03-0.10
							DT	80-140	0.05-0.10	0.05-0.10
			quenched and tempered	930	7	275	GF	50-100	0.03-0.10	0.03-0.10
							DT	80-140	0.05-0.10	0.05-0.10
				1000	8	300	GF	50-100	0.03-0.10	0.03-0.10
							DT	80-140	0.05-0.10	0.05-0.10
				1200	9	350	GF	50-100	0.03-0.10	0.03-0.10
							DT	80-140	0.05-0.10	0.05-0.10
	high alloyed steel, cast steel and tool steel		annealed	680	10	200	GF	50-100	0.03-0.10	0.03-0.12
							DT	80-120	0.05-0.16	0.05-0.20
			quenched and tempered	1100	11	325	GF	50-100	0.03-0.10	0.03-0.12
							DT	80-120	0.05-0.16	0.05-0.20
	stainless steel and cast steel		ferritic/martensitic	680	12	200	GF	50-100	0.03-0.06	0.03-0.06
							DT	60-100	0.05-0.10	0.05-0.10
			martensitic	820	13	240	GF	50-100	0.03-0.06	0.03-0.06
							DT	60-100	0.05-0.10	0.05-0.10
M	stainless steel and cast steel		austenitic, duplex	600	14	180	GF	50-100	0.03-0.06	0.03-0.06
							DT	60-100	0.05-0.10	0.05-0.10
K	gray cast iron (GG)		ferritic/pearlitic		15	180	GF	50-100	0.03-0.15	0.05-0.18
							DT	80-140	0.05-0.25	0.05-0.3
			pearlitic/martensitic		16	260	GF	50-100	0.03-0.15	0.05-0.18
							DT	80-140	0.05-0.25	0.05-0.3
	nodular cast iron (GGG)		ferritic		17	160	GF	50-100	0.03-0.15	0.05-0.18
							DT	80-140	0.05-0.25	0.05-0.3
			pearlitic		18	250	GF	50-100	0.03-0.15	0.05-0.18
							DT	80-140	0.05-0.25	0.05-0.3
	malleable cast iron		ferritic		19	130	GF	50-100	0.03-0.15	0.05-0.18
							DT	80-140	0.05-0.25	0.05-0.3
			pearlitic		20	230	GF	50-100	0.03-0.15	0.05-0.18
							DT	80-140	0.05-0.25	0.05-0.3
N	aluminum-wrought alloys		not hardenable		21	60	GF	80-160	0.03-0.15	0.03-0.015
							DT	100-200	0.05-0.20	0.05-0.20
			hardenable		22	100	GF	80-160	0.03-0.15	0.03-0.015
							DT	100-200	0.05-0.20	0.05-0.20
	aluminum-cast alloys	≤ 12% Si	not hardenable		23	75	GF	80-160	0.03-0.15	0.03-0.015
							DT	100-200	0.05-0.20	0.05-0.20
			hardenable		24	90	GF	80-160	0.03-0.15	0.03-0.015
							DT	100-200	0.05-0.20	0.05-0.20
		>12% Si	high temperature		25	130	GF	80-160	0.03-0.15	0.03-0.015
							DT	100-200	0.05-0.20	0.05-0.20
	copper alloys	>1% Pb	free cutting		26	110	GF	80-160	0.03-0.15	0.03-0.015
							DT	100-200	0.05-0.20	0.05-0.20
			brass		27	90	GF	80-160	0.03-0.15	0.03-0.015
							DT	100-200	0.05-0.20	0.05-0.20
			electrolitic copper		28	100	GF	80-160	0.03-0.15	0.03-0.015
							DT	100-200	0.05-0.20	0.05-0.20
S	high temperature alloys	Fe base	annealed		31	200	GF	50-100	0.03-0.06	0.03-0.06
							DT	60-100	0.05-0.10	0.05-0.10
			hardened		32	280	GF	50-100	0.03-0.06	0.03-0.06
							DT	60-100	0.05-0.10	0.05-0.10
		Ni / Co base	annealed		33	250	GF	20-50	0.03-0.06	0.03-0.08
							DT	20-50	0.04-0.08	0.04-0.10
			hardened		34	350	GF	20-50	0.03-0.06	0.03-0.08
							DT	20-50	0.04-0.08	0.04-0.10
			cast		35	320	GF	20-50	0.03-0.06	0.03-0.08
							DT	20-50	0.04-0.08	0.04-0.10
	titanium alloys		pure	400	36		GF	30-60	0.03-0.10	0.03-0.12
							DT	30-60	0.05-0.13	0.05-0.15
			alpha+beta alloys hardened	1050	37		GF	30-60	0.03-0.10	0.03-0.12
							DT	30-60	0.05-0.13	0.05-0.15
H	hardened steel	≥ 40HRC	hardened		38		GF	40-100	0.03-0.08	0.03-0.08
							DT	50-100	0.04-0.08	0.04-0.10

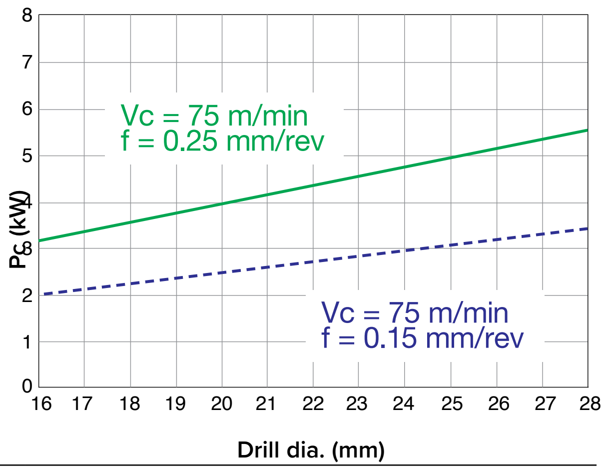
(1) For material groups see pages 495-524

TRI-DEEP Machine Requirements for BTA and DTS Drilling Methods

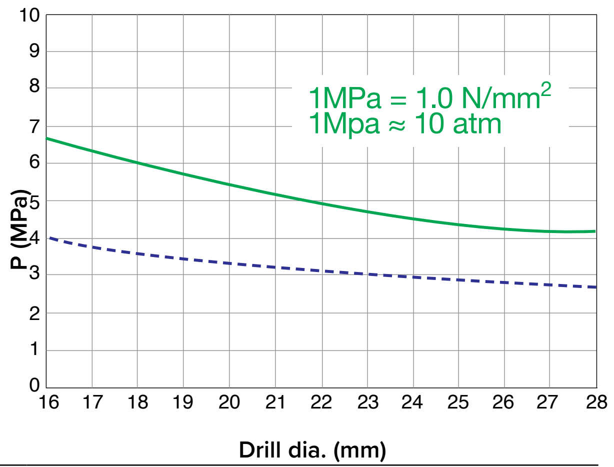
Machine requirements for deep drilling by BTA or DTS drilling methods using **TRI-DEEP** family tools are shown in the table below.

STS - Machine Setting for Single Tube System

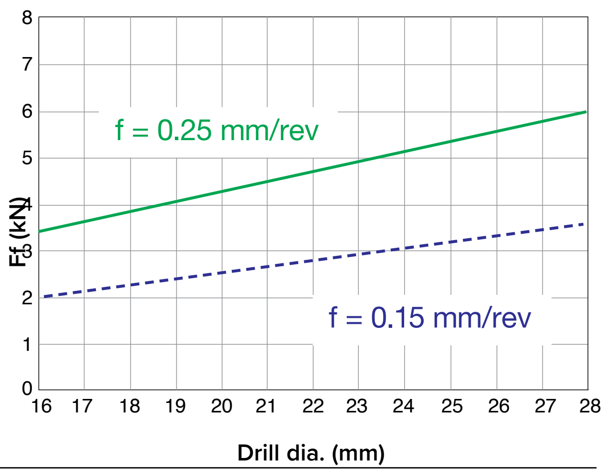
Net Power



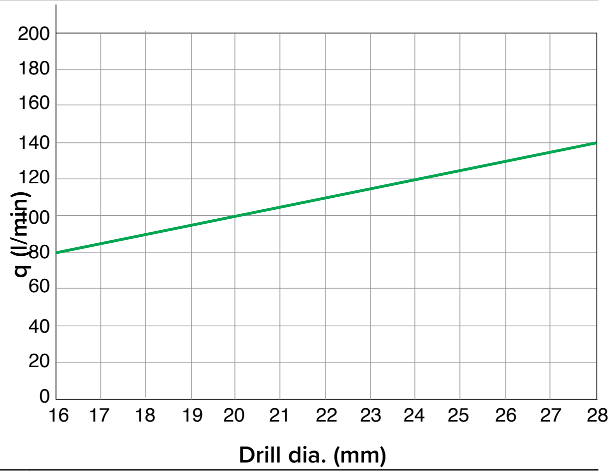
Coolant Pressure



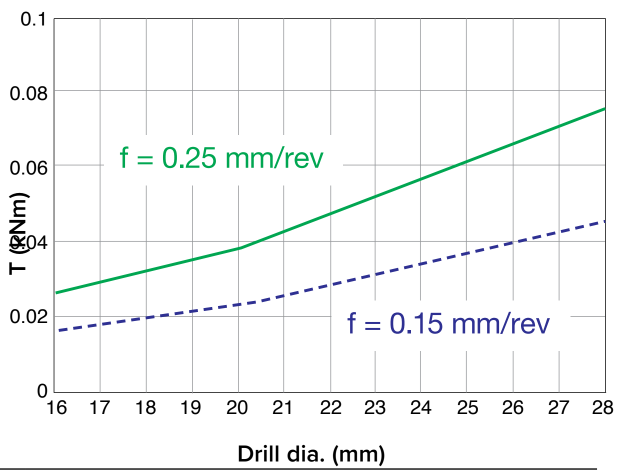
Feed Force



Coolant Volume



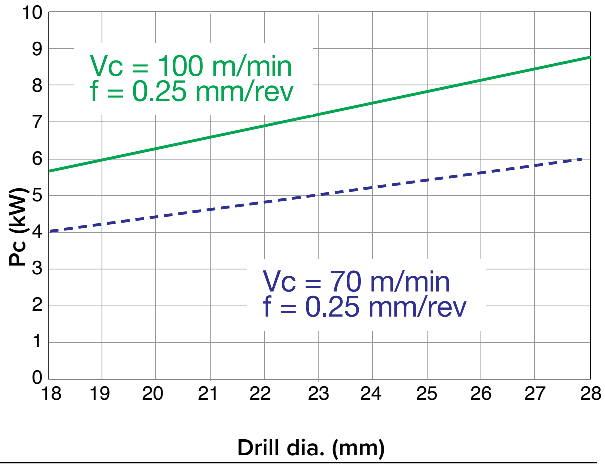
Torque



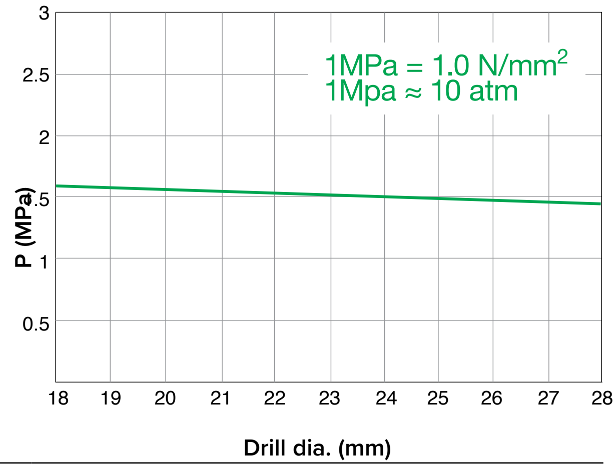
The above values should not be used as the exact recommendations.
They may need modification depending on the machining conditions, materials, etc.

DTS - Machine Setting for Double Tube System

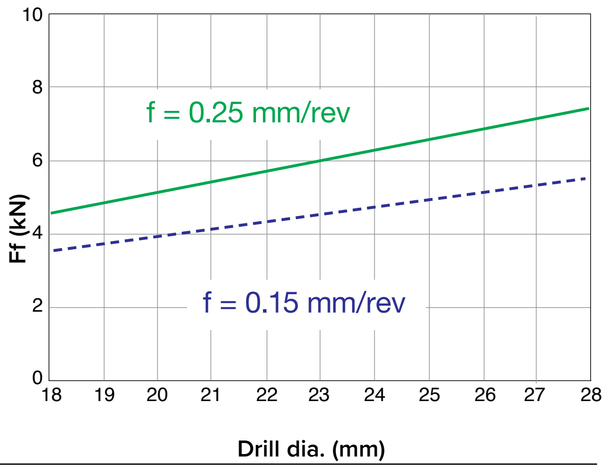
Net Power



Coolant Pressure



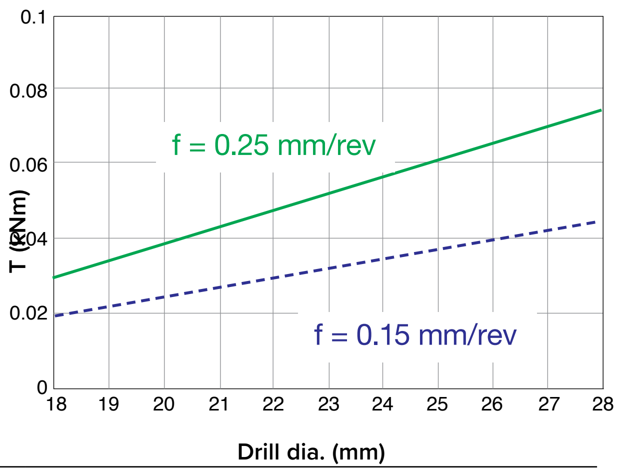
Feed Force



Coolant Volume

The above values should not be used as the exact recommendations.
They may need modification depending on the machining conditions, materials, etc.

Torque



FINE-BEAM Indexable Inserts

The **ISCAR FINE-BEAM** line provides solutions with indexable inserts for deep drilling methods, such as Single and Double tube system. The **ISCAR FINE-BEAM** line is based on peripheral indexable inserts NPHT with 2 cutting edges as well as internal and central indexable inserts NPMT with 2 cutting edges.

The main features of this indexable solution are cost-effectiveness and functionality.

All advantages of indexable solution are known and proven themselves over time

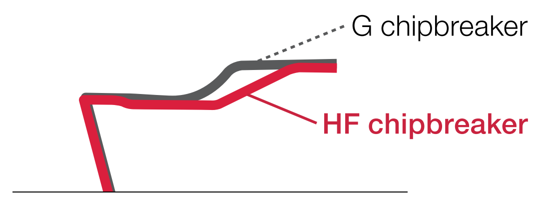
The high precision of the NPHT insert enables deep drilling with a diameter tolerance of IT10.

The NPMT insert exists in two forms: NPMT ...L and NPMT ...R. The NPMT ...L is a central insert designed to penetrate the material. The NPMT ...R is an intermediate insert designed for overlapping between the central and peripheral insert.

All inserts belonging to the **ISCAR FINE-BEAM** line are available with 2 types of chipformers - “G” and “HF”. The “HF” chipbreaker helps to stabilize the drilling process while using high feed, especially in difficult to machine materials such as ISO-M (Stainless steel and cast steel), ISO-S (High temp. alloys and Titanium alloys), and ISO-H (Hardened steel) materials. Selection of the GF or DT chipformer depends on the feed rate (mm/rev) according to the cutting conditions in the recommended table.

Chipbreaker Comparison

HF - provides drilling stability at high feed rates



chipbreaker cross-section

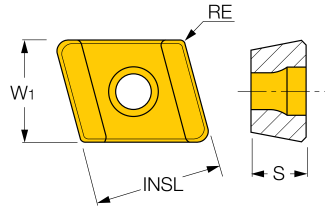
Note for mounting a drill head:
Please be sure to use a wrench for a drill head to be clamped firmly.

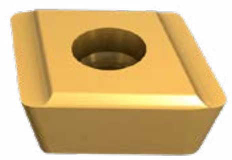
The **FINE-BEAM** line inserts are available in several grade types, such as: IC908, IC520, and IC806. Selection of an insert grade is recommended to perform according to the table below:

	NPHT		
	IC908	IC520	IC806
P	★★★	☆	☆☆
M	☆☆	☆	★★★
K	★★★		☆☆
N	★★★		☆☆
S	☆☆	☆	★★★
H	☆☆		★★★

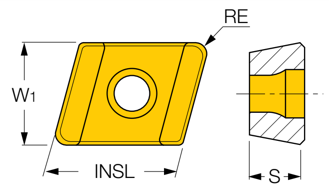
Basic Dimensions of NPHT and NPMT Inserts

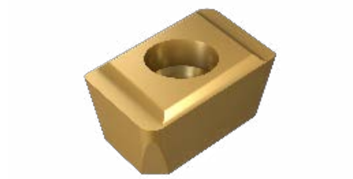
NPHT



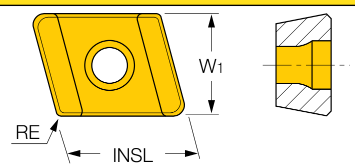


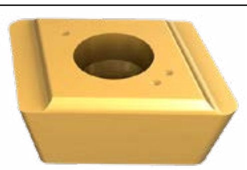
NPMT...L





NPMT...R





W – insert width
INSL – insert length
RE – corner radius
S – insert thickness

Explanation of NPHT and NPMT Inserts Description

Example:

NPHT	06	–	03	–	04	R	–	G	–	P	IC908
1	2		3		4	5		6		7	8

1 Insert Type

NPHT – peripheral insert (grounded)
NPMT – central and intermediate insert (pressed)

2 Insert Size (W)

3 Insert Thickness (S)

4 Corner Radius (RE)

5 Orientation

L – left
R – right

6 Chipbreaker Type

G – general
HF – high feed

7 Insert Position

P – peripheral
I – intermediate
C – central

8 Grade

FINE-BEAM Solution for BTA and DTS Drilling Methods

ISCAR FINE-BEAM includes drilling heads with indexable inserts for deep drilling using the Single and Double Tube System.

FINE-BEAM for Single Tube System

DSD-EF...FB and DSD-IF...FB are descriptions of drilling heads belonging to the **ISCAR FINE-BEAM** family for deep drilling using single tube system.
The drilling heads are capable of drilling holes from 25 mm to 89 mm in diameter. The DSD-EF...FB drilling heads are designed with an external 4 start thread connection and the DSD-IF...FB drilling heads are designed with an internal single start thread connection.

FINE-BEAM for Double Tube System

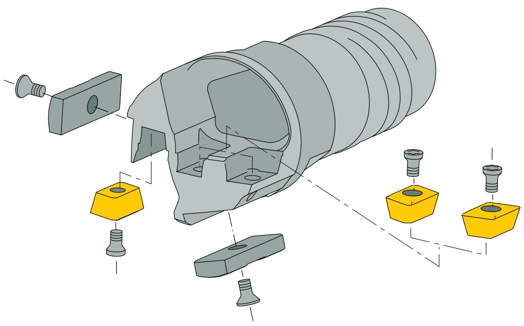
DDD-EF...FB is a description of drilling heads belonging to the **ISCAR FINE-BEAM** family for deep drilling using double tube system. DDD-EF... FB drilling heads are capable of drilling holes from 25 mm to 65 mm in diameter and are available with an external 4 start thread connection.

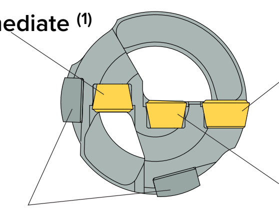
Design Features of the FINE-BEAM Drilling Head

The design of **FINE-BEAM** drilling head depends directly on the diameter of the drill.

Drill heads up to a diameter of 65 mm carry 3 inserts (1 peripheral insert, 1 central insert, 1 intermediate insert), picture 6.13.2.1.

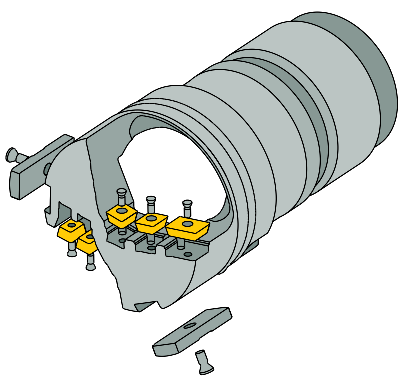
Picture 6.13.2.1 - Design of FINE-BEAM Drilling Head Up to a Diameter of 65 mm

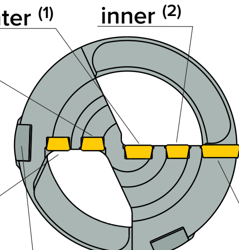




Drill heads over a diameter of 65 mm carry 5 inserts (1 peripheral insert, 1 central insert, 2 intermediate insert), picture 6.13.2.2.

Picture 6.13.2.2 - Design of FINE-BEAM Drilling Head Over a Diameter of 65 mm





Explanation of FINE-BEAM Drilling Heads Description

Example:

DSD	–	EF	–	25.50	–	FB
1		2		3		

1 Designation of Drilling Head

DSD – drilling head for deep drilling using single tube system

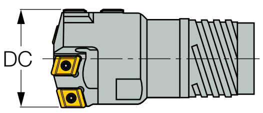
DDD – drilling head for deep drilling using double tube system

2 Connection Type

EF – external 4 start thread connection

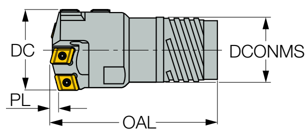
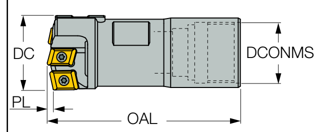
IF – internal single start thread connection

3 Cutting Diameter (DC)



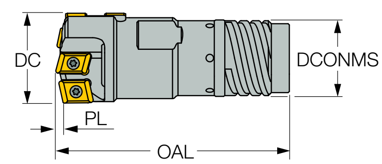
Basic Dimensions of Drilling Heads DSD...FT

Single Tube System

DSD-EF...FB Deep drilling heads with external 4 start thread connection	**DSD-IF...FB** Deep drilling heads with internal single start thread connection
	
	

Double Tube System

DDD-EF...FB
Deep drilling heads with external 4 start thread connection



DC – cutting diameter

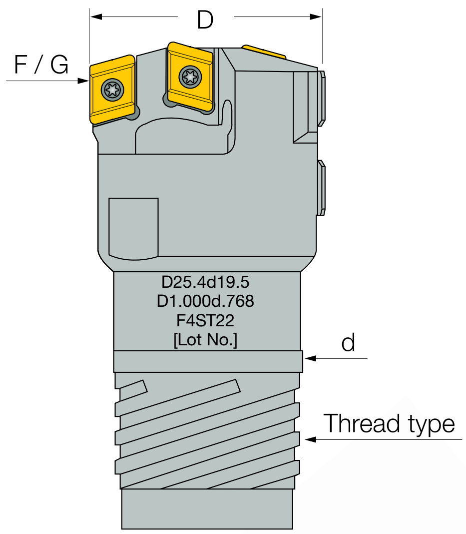
OAL – overall length

PL – point length

DCONMS – connection diameter machine side

TH – thread designation

Universal Marking for FINE-BEAM Drilling Heads



D – cutting diameter
Metric – according to the example: D25.4
Inch – according to the example: D1.000
D – pilot diameter
Metric – according to the example: d19.5
Inch – according to the example: d.768

Number of inserts

F – 3-5 inserts
G – 1 insert
According to the example: F

Type of connection

4ST – external 4 start thread connection
1ST – internal single start thread connection
According to the example: 4ST

Tube dimeter

According to the example: 22

FINE-BEAM Cutting Conditions for BTA and DTS Drilling Methods

The main elements of the cutting conditions for deep drilling are cutting speed and feed. When drilling holes, it is important to select the right cutting conditions in which the tool will work normally, i.e., most efficiently, in order to save the tool from premature wear, taking into account maximum productivity. Recommended initial conditions are shown in the table below, according to chipbreaker form and workpiece material.

ISO	Material		Condition	Tensile Strength [N/mm²]	Material Group No.(1)	Hardness (HB)	Chipbreaker	Cutting speed V_c (m/min)	Feed : f (mm/rev) Drill dia. (mm) 25.00 - 43.00	43.01 - 89.00
P	non-alloy steel and cast steel, free cutting steel	<0.25% C	annealed	420	1	125	HF	70 - 130	0.11 - 0.41	0.14-0.45
							G	70-130	0.10-0.30	0.12-0.35
		≥0.25% C	annealed	650	2	190	HF	70-130	0.11-0.41	0.14-0.45
							G	70-130	0.10-0.30	0.12-0.35
		<0.55% C	quenched and tempered	850	3	250	HF	70-130	0.11-0.41	0.14-0.45
							G	70-130	0.10-0.30	0.12-0.35
		≥0.55% C	annealed	750	4	220	HF	70-130	0.11-0.41	0.14-0.45
							G	70-130	0.10-0.30	0.12-0.35
			quenched and tempered	1000	5	300	HF	70-130	0.11-0.41	0.14-0.45
							G	70-130	0.10-0.30	0.12-0.35
	low alloy and cast steel (less than 5% of alloying elements)		annealed	600	6	200	HF	70-120	0.11-0.41	0.20-0.45
							G	70-120	0.10-0.30	0.12-0.35
			quenched and tempered	930	7	275	HF	55-110	0.11-0.41	0.20-0.45
							G	60-120	0.10-0.30	0.12-0.35
				1000	8	300	HF	55-110	0.11-0.41	0.20-0.45
							G	60-120	0.10-0.30	0.12-0.35
				1200	9	350	HF	55-110	0.11-0.41	0.20-0.45
							G	60-120	0.10-0.30	0.12-0.35
	high alloyed steel, cast steel and tool steel		annealed	680	10	200	HF	55-110	0.11-0.38	0.20-0.40
							G	70-130	0.10-0.30	0.12-0.35
			quenched and tempered	1100	11	325	HF	55-110	0.11-0.38	0.20-0.40
							G	70-130	0.10-0.30	0.12-0.35
	stainless steel and cast steel		ferritic/martensitic	680	12	200	HF	40-110	0.11-0.41	0.20-0.45
							G	70-130	0.10-0.30	0.12-0.35
			martensitic	820	13	240	HF	40-110	0.11-0.41	0.20-0.45
							G	70-130	0.10-0.30	0.12-0.35
M	stainless steel and cast steel		austenitic, duplex	600	14	180	HF	40-110	0.11-0.41	0.20-0.45
							G	70-130	0.10-0.30	0.12-0.35
K	gray cast iron (GG)		ferritic/pearlitic		15	180	HF	50-110	0.11-0.38	0.24-0.41
							G	50-110	0.10-0.25	0.12-0.35
			pearlitic/martensitic		16	260	HF	50-110	0.11-0.38	0.24-0.41
							G	50-110	0.10-0.25	0.12-0.35
	nodular cast iron (GGG)		ferritic		17	160	HF	50-110	0.11-0.38	0.24-0.41
							G	50-110	0.10-0.25	0.12-0.35
			pearlitic		18	250	HF	50-110	0.11-0.38	0.24-0.41
							G	50-110	0.10-0.25	0.12-0.35
	malleable cast iron		ferritic		19	130	HF	50-110	0.11-0.38	0.24-0.41
							G	50-110	0.10-0.25	0.12-0.35
			pearlitic		20	230	HF	50-110	0.11-0.38	0.24-0.41
							G	50-110	0.10-0.25	0.12-0.35
N	aluminum-wrought alloys		not hardenable		21	60	HF	65-150	0.09-0.33	0.24-0.35
							G	65-130	0.10-0.25	0.12-0.35
			hardenable		22	100	HF	65-150	0.09-0.33	0.24-0.35
							G	65-130	0.08-0.23	0.12-0.27
	aluminum-cast alloys	≤ 12% Si	not hardenable		23	75	HF	65-150	0.09-0.33	0.24-0.35
							G	65-130	0.08-0.23	0.12-0.27
			hardenable		24	90	HF	65-150	0.09-0.33	0.24-0.35
							G	65-130	0.08-0.23	0.12-0.27
		>12% Si	high temperature		25	130	HF	65-150	0.09-0.33	0.24-0.35
							G	65-130	0.08-0.23	0.12-0.27
	copper alloys	>1% Pb	free cutting		26	110	HF	65-150	0.09-0.33	0.24-0.35
							G	65-130	0.08-0.23	0.12-0.27
			brass		27	90	HF	65-150	0.09-0.33	0.24-0.35
							G	65-130	0.08-0.23	0.12-0.27
			electrolitic copper		28	100	HF	65-150	0.09-0.33	0.24-0.35
							G	65-130	0.08-0.23	0.12-0.27
S	high temperature alloys	Fe base	annealed		31	200	HF	20-55	0.09-0.30	0.20-0.33
							G	20-50	0.08-0.23	0.12-0.27
			hardened		32	280	HF	20-55	0.09-0.30	0.20-0.33
							G	20-50	0.08-0.23	0.12-0.27
		Ni / Co base	annealed		33	250	HF	20-55	0.09-0.30	0.20-0.33
							G	20-50	0.08-0.23	0.12-0.27
			hardened		34	350	HF	20-55	0.09-0.30	0.20-0.33
							G	20-50	0.08-0.23	0.12-0.27
			cast		35	320	HF	20-55	0.09-0.30	0.20-0.33
							G	20-50	0.08-0.23	0.12-0.27
	titanium alloys		pure	400	36		HF	30-60	0.09-0.30	0.20-0.33
							G	30-60	0.08-0.23	0.12-0.27
			alpha+beta alloys hardened	1050	37		HF	30-60	0.09-0.30	0.20-0.33
							G	30-60	0.08-0.23	0.12-0.27
H	hardened steel	≥ 40HRC	hardened		38		HF	30-60	0.09-0.30	0.20-0.33
							G	30-60	0.08-0.23	0.12-0.27

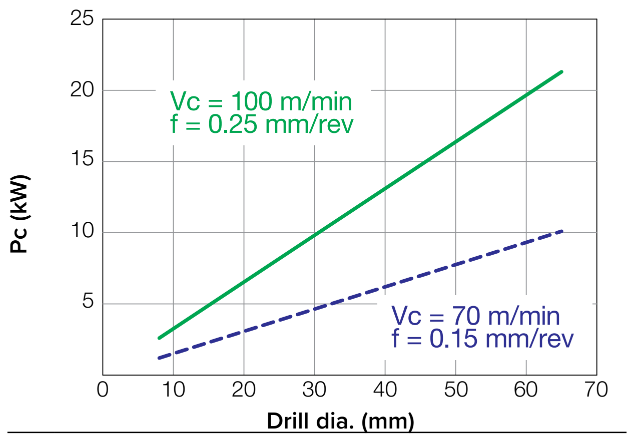
(1) For material groups see pages 495-524

FINE-BEAM Machine Requirements for BTA and DTS Drilling Methods

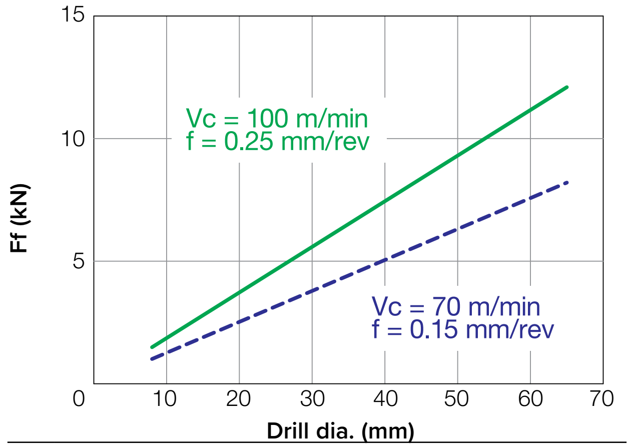
Machine requirements for deep drilling by BTA or DTS drilling methods using **TRI-DEEP** family tools are shown in the table below.

STS - Setting Guidelines for Cutting Loads, Fluid Pressure and Flow Rate During STS Operation

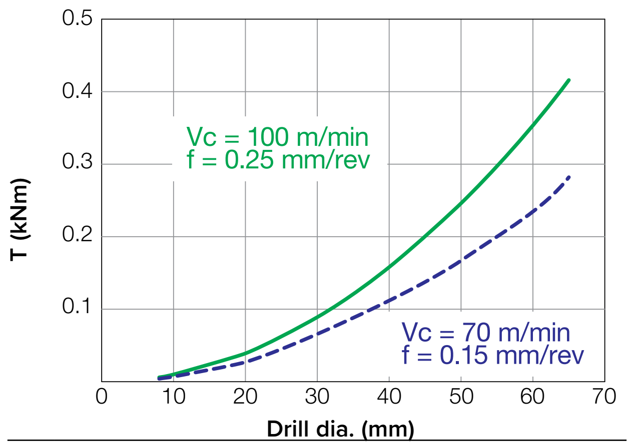
Net Power



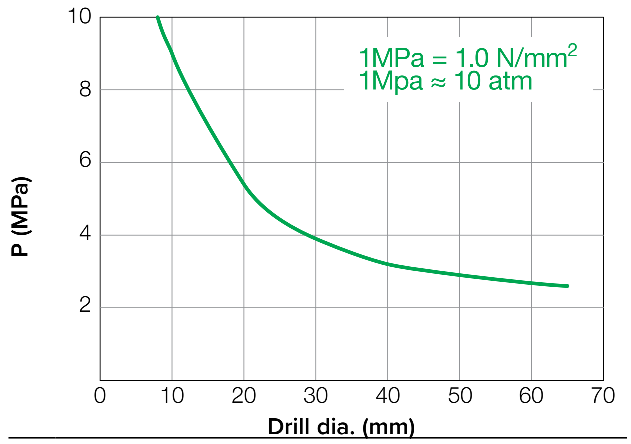
Feed Force



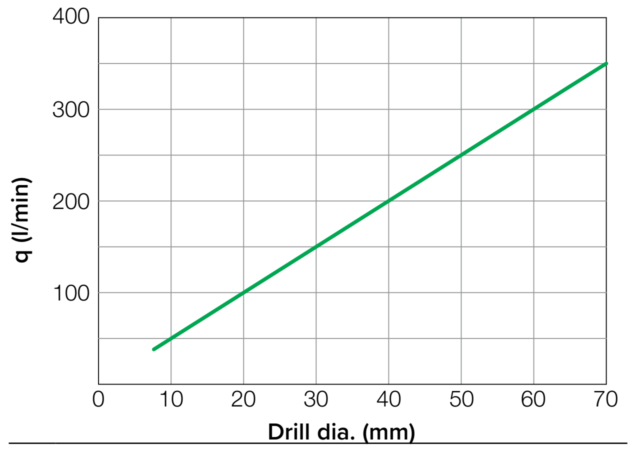
Torque



Coolant Pressure



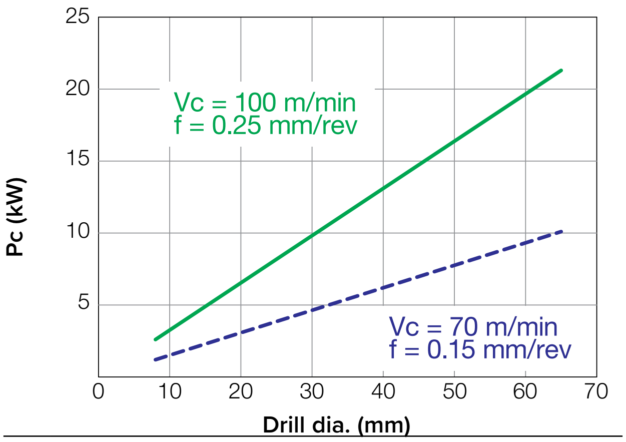
Coolant Volume



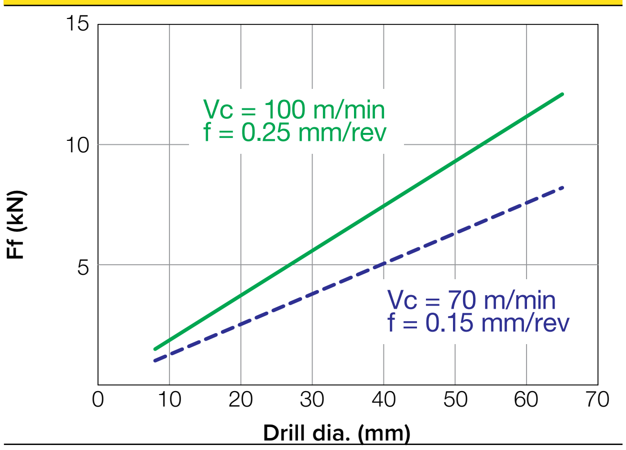
The above values should not be used as the exact recommendations. They may need modification depending on the machining conditions, materials, etc.

DTS - Setting Guidelines for Cutting Loads, Fluid Pressure and Flow Rate During DTS Operation

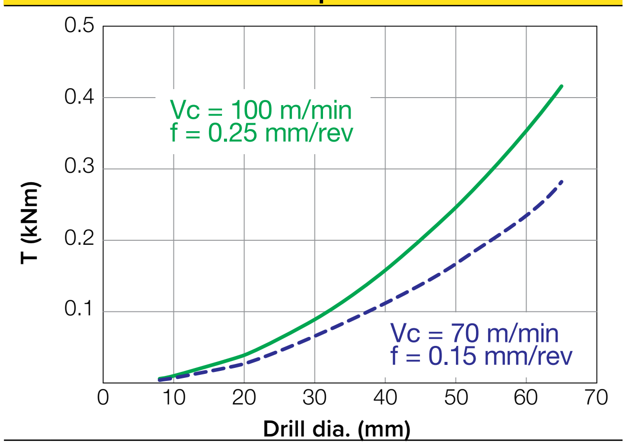
Net Power



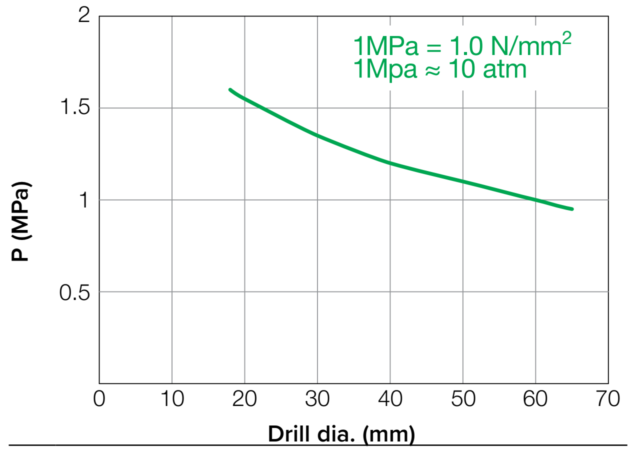
Feed Force



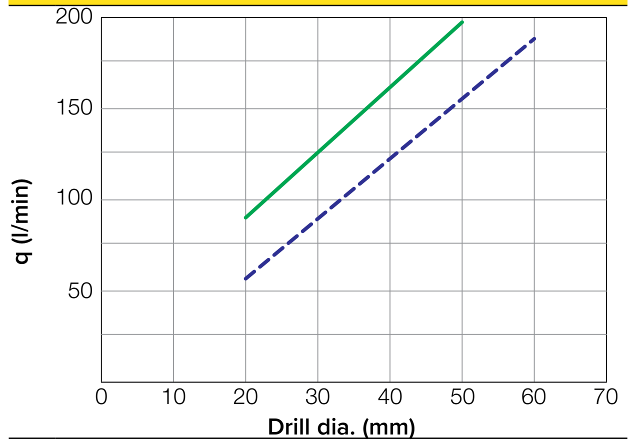
Torque



Coolant Pressure



Coolant Volume



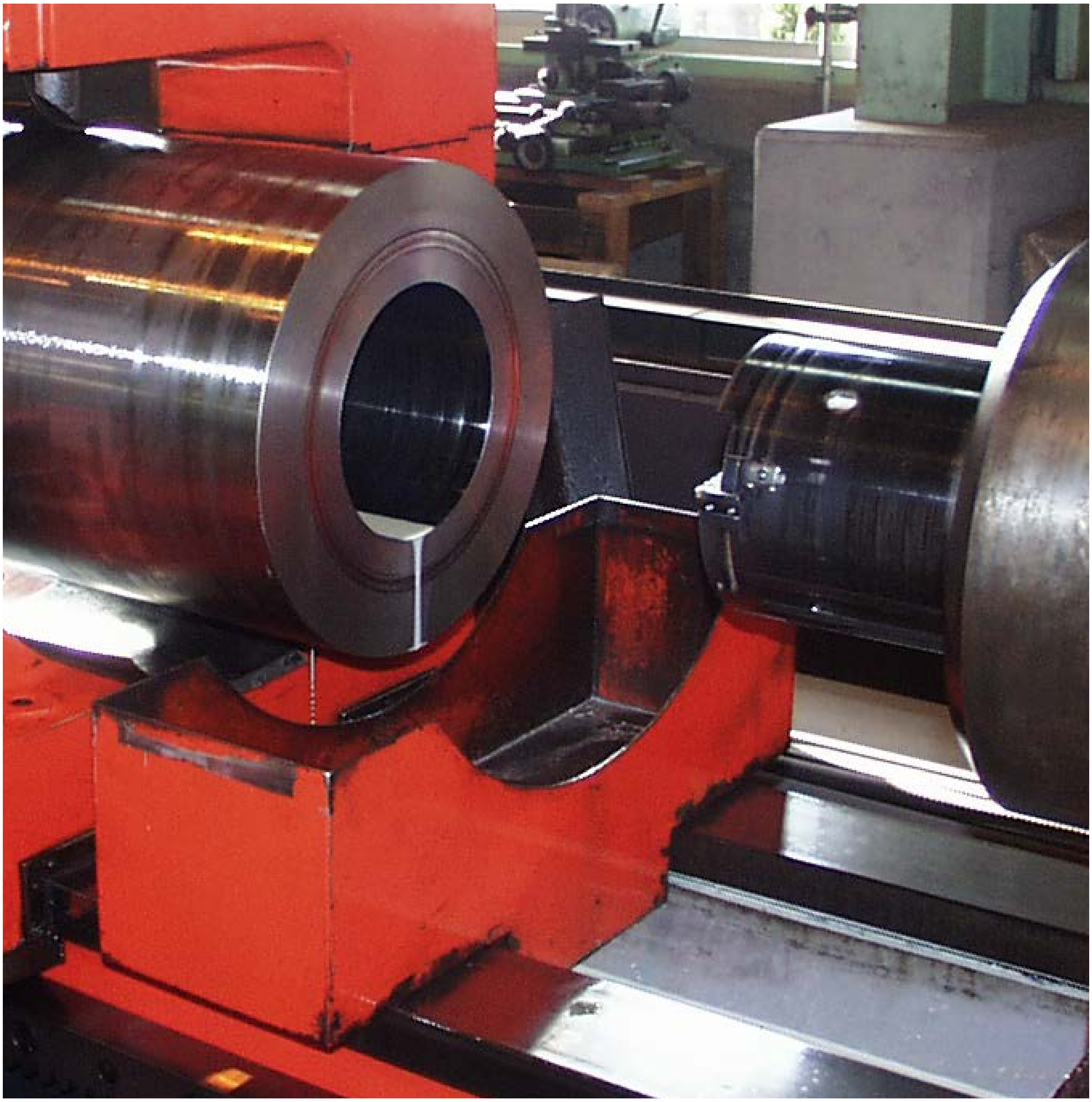
The above values should not be used as the exact recommendations. They may need modification depending on the machining conditions, materials, etc.

ISCAR-DEEP-DRILL Indexable Inserts

ISCAR-DEEP-DRILL family contains a line of tools with cartridges equipped with indexable inserts that provide solutions for deep drilling methods, such as: single and double tube system. The inserts that form the basis of this line are NPMX with two cutting edges and TPMX with three cutting edges.

The main features of this indexable solution are cost-effectiveness and functionality.

All advantages of the indexable solution are known and have proven themselves over time.



Double Tube System

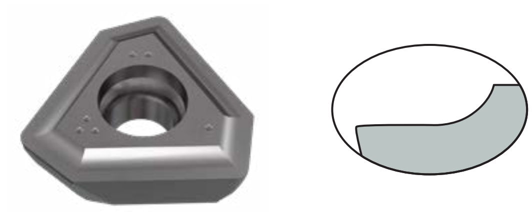
Single Tube System

The high precision of the NPMX and TPMX inserts enables deep drilling with a diameter tolerance of IT10 and surface finish of 3 µm.

The **ISCAR-DEEP-DRILL** family contains inserts with a variety of chipformer types. The chipformer type "G" is general and suitable for machining most materials. In order to improve performance, in some cases there are additional chipformer types, such as: "B", "BG", and "DT". The "B"-type chipformer has the ability to improve chip control for heat-resistant alloy, titanium, stainless steel, Inconel, etc. The "BG"-type chipformer can improve chip control for difficult-to-cut steel, carbon steel, non-alloy steel, etc. The "DT"-type chipformer is designed to reduce machine load and is recommended for use on low power machines.

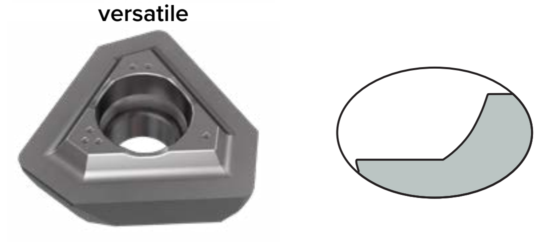
The NPMX inserts are mounted on drilling heads with diameters up to 45 mm and are available with 2 types of chipformers "G" and "B". The TPMX inserts are mounted on drilling heads with a diameter above 48 mm and are available with 4 types of chipformers "G", "B", "BG", and "DT". The tools with diameter ranges between 45 to 48 mm carry NPMX and TPMX inserts.

G



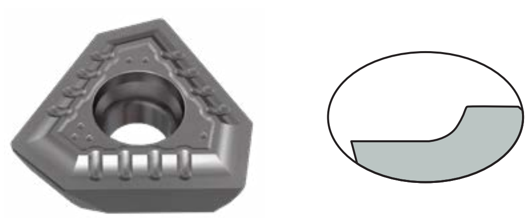
versatile

BG



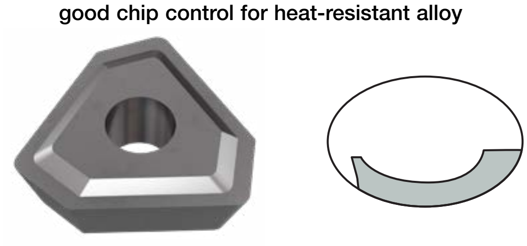
chip control for difficult-to-cut steel

B



good chip control for heat-resistant alloy

DT



to reduce machine load

The **ISCAR-DEEP-DRILL** indexable inserts are available in several grade types, such as: IC920, IC5500, IC9025, IC508, IC908, IC520, and IC806.

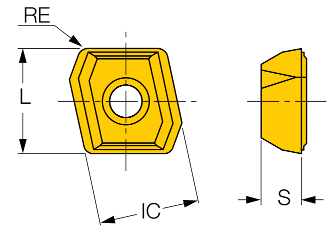
Recommendation for Insert Grade and Chipformer Type Selections

Selection of an insert grade and chipformer type recommended to perform according to the table below:

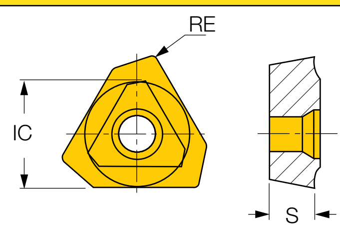
ISO	Material		Condition	Tensile Strength [N/mm^2]	Hardness HB	Chipbreaker First Choice	Chipbreaker Troubleshooting Fracure	Chipbreaker Troubleshooting Wear
P	non-alloy steel and cast steel, free cutting steel	<0.25% C	annealed	420	125	G IC908	BG IC806	B IC9025
		≥0.25% C	annealed	650	190			
		<0.55% C	quenched and tempered	850	250			
		≥0.55% C	annealed	750	220			
			quenched and tempered	1000	300			
	low alloy and cast steel (less than 5% of alloying elements)		annealed	600	200	G IC908	BG IC806	B IC9025
			quenched and tempered	930	275			
				1000	300			
				1200	350			
	high alloyed steel, cast steel and tool steel		annealed	680	200	G IC908	BG IC806	B IC9025
			quenched and tempered	1100	325			
	stainless steel and cast steel		ferritic / martensitic	680	200	G IC908	BG IC806	B IC9025
			martensitic	820	240			
M	stainless steel and cast steel		austenitic, duplex	600	180	G IC806	B IC908	B IC9025
K	gray cast iron (GG)		ferritic / pearlitic		180	G IC908	G IC806	B IC9025
			pearlitic / martensitic		260			
	nodular cast iron (GGG)		ferritic		160			
			pearlitic		250			
	malleable cast iron		ferritic		130			
			pearlitic		230			
N	aluminum-wrought alloys		not hardenable		60	G IC908	G IC806	B IC9025
			hardenable		100			
	aluminum-cast alloys	≤12% Si	not hardenable		75			
			hardenable		90			
		>12% Si	high temperature		130			
	copper alloys	>1% Pb	free cutting		110			
			brass		90			
			electrolytic copper		100			
	non metallic		duroplastics, fiber plastics					
			hard rubber					
S	high temperature alloys	Fe based	annealed		200	B IC806	B IC908	B IC9025
			hardened		280			
		Ni or Co based	annealed		250			
			hardened		350			
			cast		320			
	titanium alloys		pure	RM 400				
			alpha+beta alloys, hardened	RM 1050				
H	hardened steel		hardened			B IC806	B IC908	B IC908
			hardened					
	chilled cast iron		cast		400			
	cast iron		hardened					

Basic Dimensions of NPMX and TPMX Inserts

NPMX



TPMX



IC – inscribed circle diameter
RE – corner radius
S – insert thickness
L – cutting edge length

Explanation of NPMX and TPMX Inserts Description

Example:

TPMX	14	03	08	R	–	G	IC908
1	2	3	4	5		6	7

1 Insert Type

NPMX – insert with two cutting edges
TPMX – insert with three cutting edges

2 Insert Size (W)

3 Insert Thickness (S)

4 Corner Radius (RE)

5 Orientation

R – right
L – left

6 Chip Breaker Type

G – general
HF – high feed

7 Grade

ISCAR-DEEP-DRILL Solution for BTA and DTS Drilling Methods with Indexable Inserts

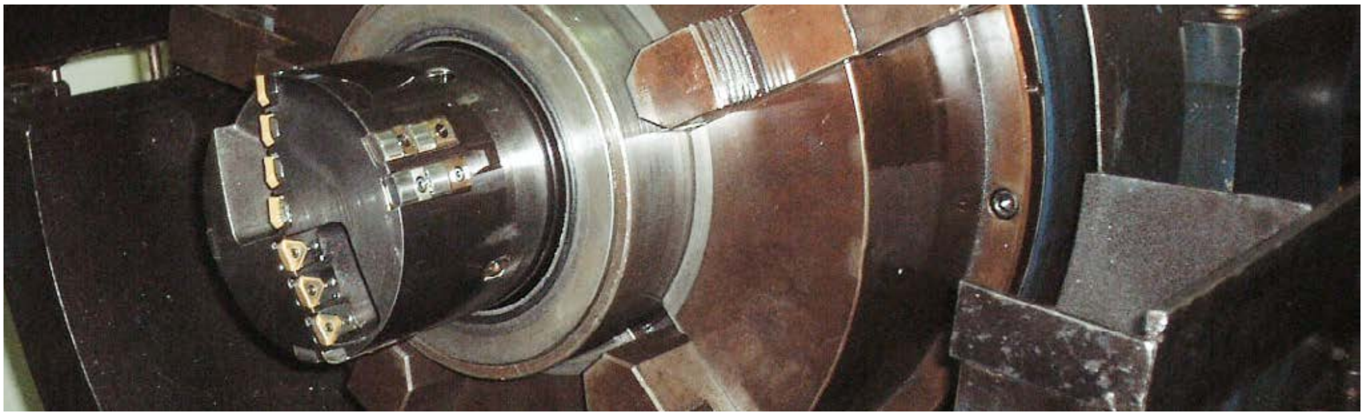
ISCAR-DEEP-DRILL includes drilling heads with cartridges equipped with indexable inserts for deep drilling using the Single and Double Tube System. **ISCAR-DEEP-DRILL** drilling heads with cartridges allow fine adjustment of tool diameter and by exchanging only the peripheral cartridge and guide pads, the original head diameter can be increased up to 5 mm.

ISCAR-DEEP-DRILL Heads with Cartridges Equipped Indexable Insert for Single Tube System

DSD-EC... and DSD-IC... are descriptions of drilling heads with cartridges equipped indexable insert belonging to the **ISCAR-DEEP-DRILL** family for deep drilling using single tube system. The drilling heads are capable of drilling holes from 38 mm to 294 mm in diameter.
The DSD-EC... drilling heads are designed with an external 4 start thread connection and the DSD-IC... drilling heads are designed with an internal single start thread connection.

ISCAR-DEEP-DRILL Heads with Cartridges Equipped Indexable Inserts for Double Tube System

DDD-EC... is a description of drilling heads with cartridges equipped indexable inserts belonging to the **ISCAR-DEEP-DRILL** family for deep drilling using double tube system. DDD-EC... drilling heads are capable of drilling holes from 38 mm to 184 mm in diameter and are available with an external 4 start thread connection.



ISCAR-DEEP-DRILL Cartridges for Single and Double Tube System

CAOD-... and CAID-... are descriptions of cartridges equipped. The same cartridges can be used in deep drilling heads for single and double tube systems belonging to the **ISCAR-DEEP-DRILL** family. The CAOD-... is a peripheral cartridge that carry peripheral inserts and allow fine adjustment of the drilling head diameter. The CAID-... cartridge is used as an inner or central cartridge and has no adjustments. Cartridges CAOD -... and CAID -... are designed in two versions depending on the diameter of the drilling head. The CAOD-... cartridge that is used in a drilling head up to Ø 40 mm carry an NPMX insert with two cutting edges, and a drilling head over Ø 40 mm carries a TPMX insert with three cutting edges. The CAID-... cartridge used in a drilling head up to Ø 48 mm carries an NPMX insert with two cutting edges, and in drilling head over Ø 48 mm carries a TPMX insert with three cutting edges.

The **ISCAR-DEEP-DRILL** family offers CAOD-...+... cartridges that can increase the diameter of the drilling head up to 5 mm. The CAOD-...+... is a peripheral cartridge that replaces the CAOD-... in case of need to increase the drilling head diameter.

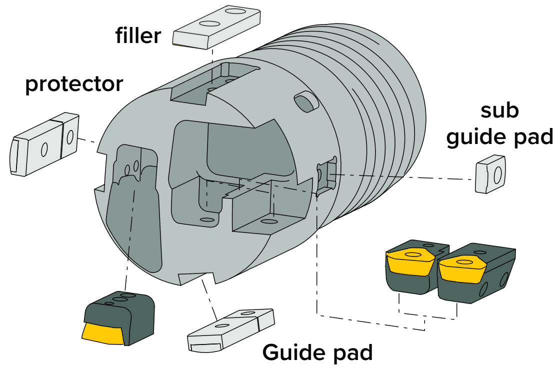
CAOD-...

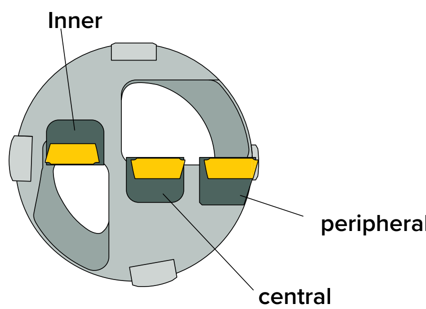
CAID-...

Design Feature of the ISCAR-DEEP-DRILL Drilling Head

The design of the **ISCAR-DEEP-DRILL** drilling head directly depends on the diameter of the drill and is divided into four diameter ranges in accordance with table 6.14.2.1.

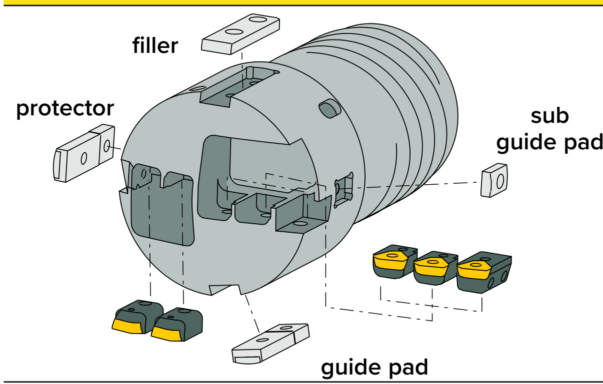
Ø38.00-106.99 mm

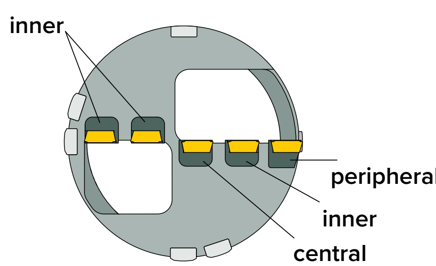




Part positions may vary depending on the drill size.

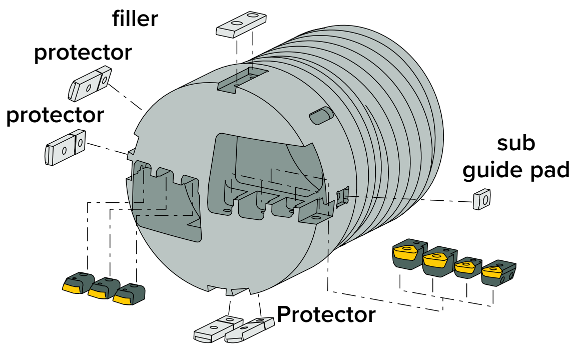
Ø107.00-168.99 mm

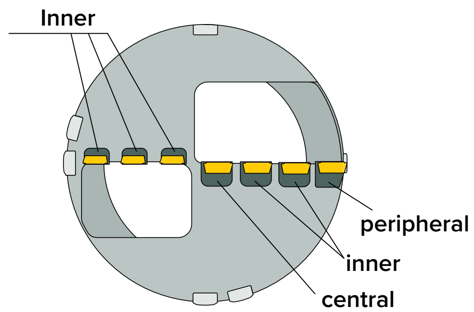




Part positions may vary depending on the drill size.

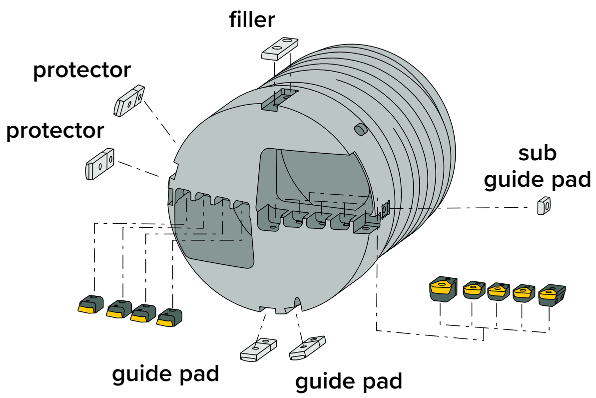
Ø169.00-232.99 mm

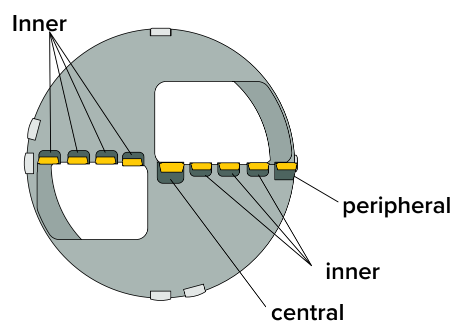




Part positions may vary depending on the drill size.

Ø233.00-291.99 mm





Part positions may vary depending on the drill size.

In addition to guide pads, the drilling heads that belong to the **ISCAR-DEEP-DRILL** family are equipped with sub guide pad, filler, and protector.

Sub guide pad - helps prevent breakage while pulling out the tool from hole/ cross-hole processing. These guide pads are made from soft steel to prevent damage to the surface.

Sub Guide Pad

Filler – protects the pocket of the guide pad from damage when drilling. This part does not work directly to drilling and is made with steel.

Filler

Protector – prevents damage of the guide pad when retracting the tool after drilling.

Protector

Explanation of ISCAR-DEEP-DRILL Drilling Heads with Cartridges Description

Example:

DSD	-	EC	65.50
1		2	3

1 Designation of Drilling Head

DSD – drilling head for deep drilling using single tube system

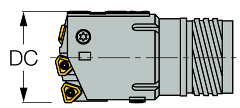
DDD – drilling head for deep drilling using double tube system

2 Connection Type

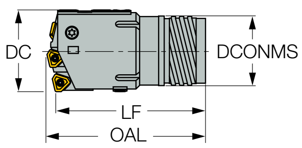
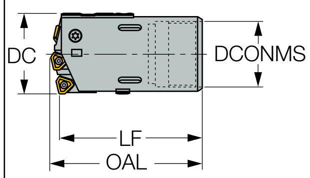
EC – external 4 start thread connection

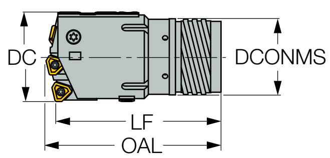
IC – internal single start thread connection

3 Cutting Diameter (DC)



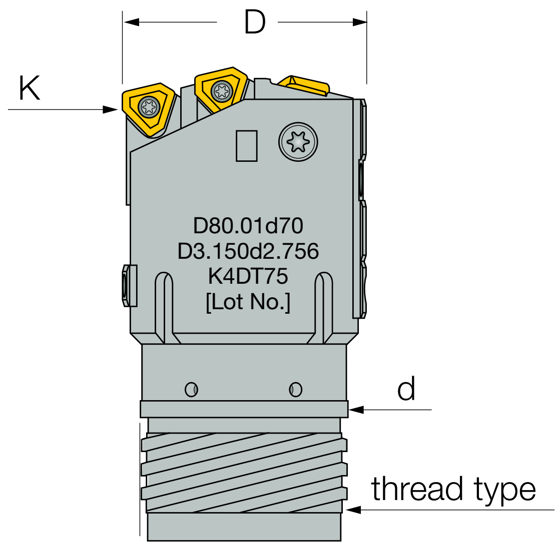
Basic Dimensions of ISCAR-DEEP-DRILL Drilling Heads with Cartridges

Single Tube System	
DSD-EC... Deep drilling heads with external 4 start thread connection	**DSD-IC...** Deep drilling heads with internal single start thread connection
	
	

Double Tube System
DDD-EC... Deep drilling heads with external 4 start thread connection



DC – cutting diameter
OAL – overall length
LF – functional length
DCONMS – connection diameter machine side
TH – thread designation

Universal Marking for ISCAR-DEEP-DRILL Drilling Heads with Cartridges



D – cutting diameter
Metric – according to the example: D80.01
Inch – according to the example: D3.150
D – pilot diameter
Metric – according to the example: d70
Inch – according to the example: d2.756

Tool Style
K – cartridge style drill head

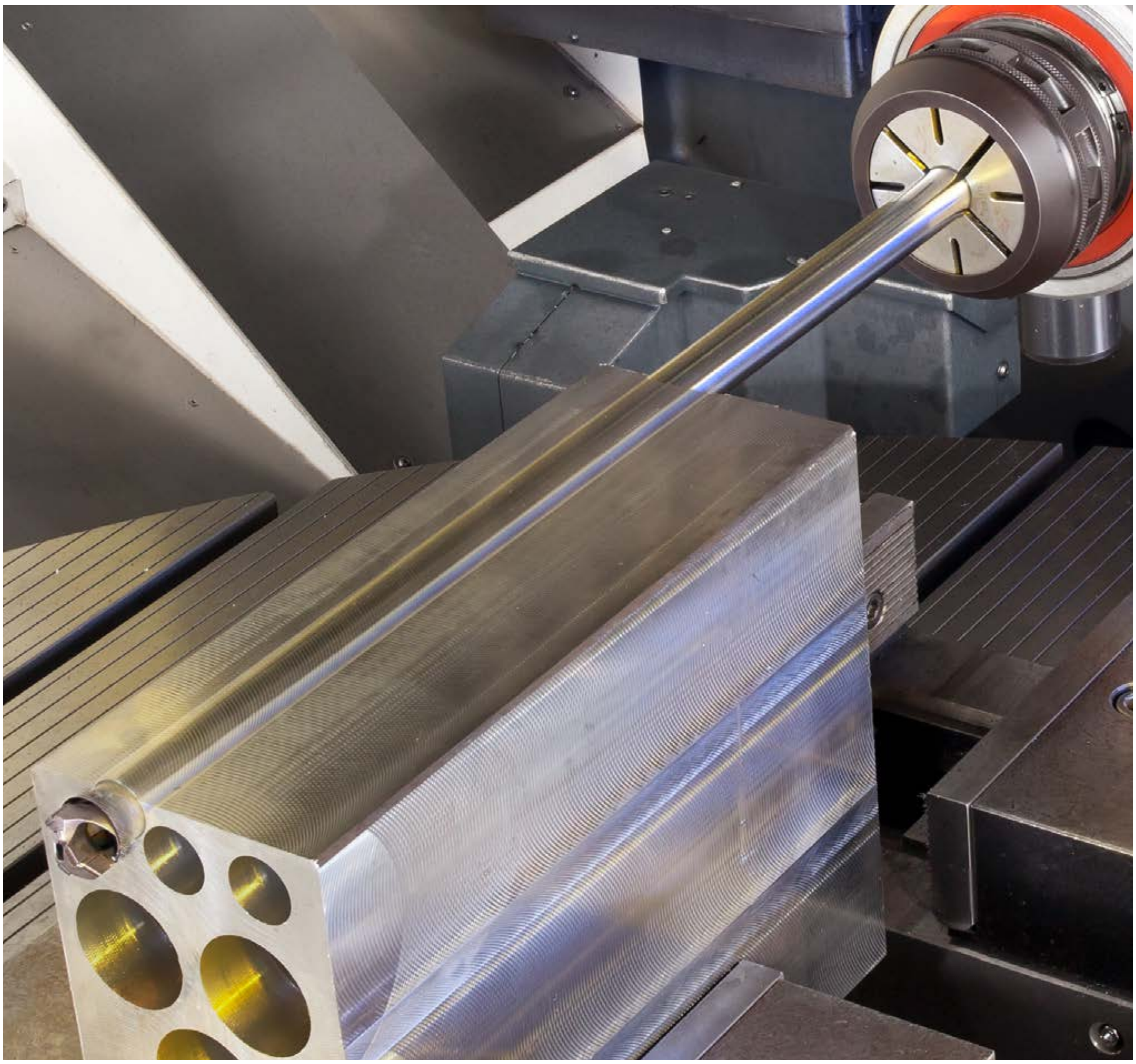
Type of Connection
4ST – external 4 start thread connection for single tube system
1ST – internal single start thread connection for single tube system
4DT – external 4 start thread connection for double tube system

According to the example: 4DT

Tube Dimeter
According to the example: 75

ISCAR-DEEP-DRILL Solution for BTA and DTS Drilling Methods with Brazed Tips

The **ISCAR-DEEP-DRILL** includes drilling heads with brazed tips for deep drilling using the Single and Double Tube System. **ISCAR-DEEP-DRILL** drilling heads with brazed tips allow drilling holes with IT9 accuracy and surface roughness of 2µm according to Ra parameter. This style of drilling head for deep drilling using the Single Tube System are capable of drilling holes from 8 mm to 65 mm in diameter and are available with an external 1, 2, 4 start thread connection. When using this style of drilling head for deep drilling by Double Tube System, it is then capable of drilling holes from 18.4 mm to 65 mm in diameter and are available with an external 4 start thread connection. **ISCAR-DEEP-DRILL** drilling heads with brazed tips can be used on various types of materials due to the variety of grades combined with different chip breakers.



Brazed Tip Types

Brazed tips are available in two types, with and without chip splitting. Brazed tips with chip splitting are usually mounted on deep drilling heads up to 20 mm in diameter. The chip splitting cutting edge causes breaking chips into small segments, thus ensuring proper and easy chip evacuation. Brazed tips without chip splitting are usually mounted on deep drilling heads of 12.6 up to 20 mm in diameter. All brazed tips are equipped with a DT chipbreaker to assist form chips during the drilling process.

Brazed Tip with Chip Splitting

Brazed Tip without Chip Splitting

Explanation of Drilling Heads with Brazed Tips Description

Example:

DSD	–	E3	23.55	DT	–	PZX2T
1		2	3	4		5

1 Designation of Drilling Head

DSD – drilling head for deep drilling using single tube system

DDD – drilling head for deep drilling using double tube system

2 Connection Type

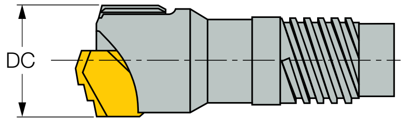
E0 – external single start thread connection carry single brazed tip

E1 – external 2 or 4 start thread connection carry single brazed tip

E2 – external 2 start thread connection carry 2 brazed tip

E3 – external 4 start thread connection carry 3 brazed tip

3 Cutting Diameter (DC)



4 Chipbreaker Type

All brazed tips are equipped with a DT chipbreaker

5 Available Carbide Grades:

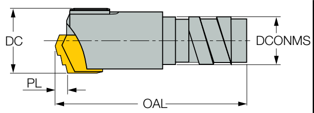
PZX2T, P1X2T, P0X2T, PZT, P1T, P0T, PZN, P1N, P0N, KZK, K1K, K0K

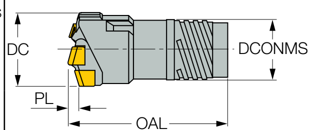
Basic Dimensions of Drilling Heads with Brazed Tips

Single Tube System

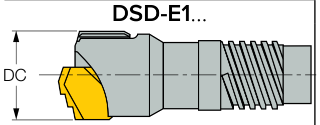
DSD-E0... **DSD-E1...** Deep drilling heads with external 4 start thread connection	**DSD-E2...** **DSD-E3...** Deep drilling heads with internal single start thread connection

DSD-E0...





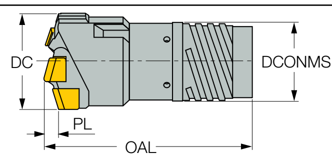
DSD-E1...



Double Tube System

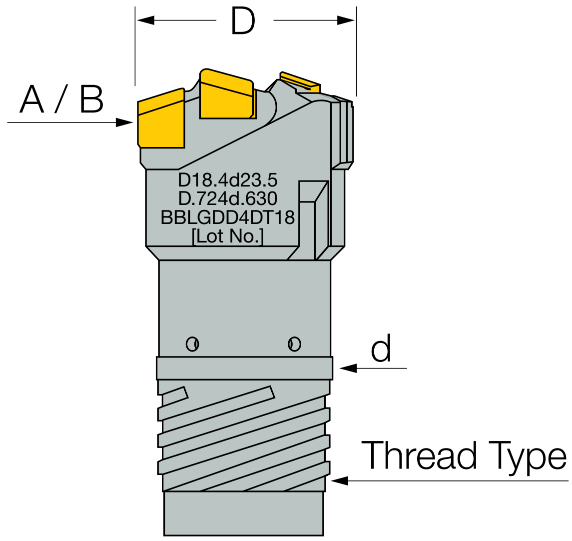
DDD-E3...

Deep drilling heads with external 4 start thread connection



DC – cutting diameter
PL – point length
OAL – overall length
DCONMS – connection diameter machine side
TH – thread designation

Universal Marking for Drilling Heads with Brazed Tips



D – cutting diameter
Metric – according to the example: D18.40
Inch – according to the example: D.724
D – pilot diameter
Metric – according to the example: d23.5
Inch – according to the example: d.630

Tool Style
A – single cutting edge
B – multiple cutting edges

Type of Connection
1ST – single start thread connection for single tube system
21ST – 2 start thread connection for single tube system
4ST – 4 start thread connection for single tube system
4DT – 4 start thread connection for double tube system

According to the example: 4DT

Tube Dimeter
According to the example: 18

ISCAR-DEEP-DRILL Cutting Conditions for BTA and DTS Drilling Methods

The main elements of cutting conditions for deep drilling are cutting speed and feed. When drilling holes, it is important to select the right cutting conditions in which the tool will work normally, i.e., most efficiently, in order to save the tool from premature wear, taking into account maximum productivity. Recommended initial conditions are shown in the table below, according to chipbreaker form and workpiece material.

ISO	Material		Condition	Tensile Strength [N/mm²]	Material Group No.(1)	Hardness HB	Ground Brazed Solid Drill Heads DSD-E0, DSD-E1, DSD-E3, DDD-E3, DSD-I1					
							Dia. Range	8.00-20.00	15.60-20.00	20.01-31.00	31.01-43.00	43.01-65.00
							V_c (m/min)	Feed Rate f (mm/rev)				
P	non-alloy steel and cast steel, free cutting steel	<0.25% C	annealed	420	1	125	70-120	0.05-0.13	0.08-0.15	0.1-0.17	0.13-0.2	0.16-0.3
P		≥0.25% C	annealed	650	2	190	70-120	0.05-0.13	0.08-0.15	0.1-0.17	0.13-0.2	0.16-0.3
P		<0.55% C	quenched and tempered	850	3	250	40-70	0.05-0.13	0.08-0.15	0.1-0.17	0.13-0.2	0.16-0.3
P		≥0.55% C	annealed	750	4	220	70-120	0.05-0.13	0.08-0.15	0.1-0.17	0.13-0.2	0.16-0.3
P			quenched and tempered	1000	5	300	55-100	0.05-0.1	0.08-0.12	0.1-0.15	0.13-0.17	0.15-0.28
P	low alloy and cast steel (less than 5% of alloying elements)		annealed	600	6	200	70-100	0.05-0.13	0.08-0.15	0.1-0.17	0.13-0.2	0.16-0.3
P			quenched and tempered	930	7	275	55-100	0.05-0.1	0.08-0.12	0.1-0.15	0.13-0.17	0.15-0.28
P				1000	8	300	55-100	0.05-0.1	0.08-0.12	0.1-0.15	0.13-0.17	0.15-0.28
P				1200	9	350	55-100	0.05-0.1	0.08-0.12	0.1-0.15	0.13-0.17	0.15-0.28
P	high alloyed steel, cast steel and tool steel		annealed	680	10	200	50-85	0.05-0.13	0.08-0.15	0.1-0.17	0.13-0.2	0.16-0.3
P			quenched and tempered	1100	11	325	55-100	0.05-0.1	0.08-0.12	0.1-0.15	0.13-0.17	0.15-0.28
P	stainless steel and cast steel		ferritic / martensitic	680	12	200	60-100	0.05-0.13	0.08-0.15	0.1-0.28	0.13-0.3	0.16-0.35
P			martensitic	820	13	240	60-100	0.05-0.13	0.08-0.15	0.1-0.28	0.13-0.3	0.16-0.35
M	stainless steel and cast steel		austenitic, duplex	600	14	180	60-100	0.05-0.12	0.05-0.12	0.08-0.25	0.1-0.28	0.15-0.33
K	gray cast iron (GG)		ferritic / pearlitic		15	180	80-100	0.05-0.13	0.08-0.15	0.1-0.17	0.13-0.2	0.16-0.3
K			pearlitic / martensitic		16	260	80-100	0.05-0.13	0.08-0.15	0.1-0.17	0.13-0.2	0.16-0.3
K	nodular cast iron (GGG)		ferritic		17	160	60-100	0.05-0.13	0.06-0.13	0.08-0.18	0.1-0.2	0.15-0.25
K			pearlitic		18	250	60-100	0.05-0.13	0.06-0.13	0.08-0.18	0.1-0.2	0.15-0.25
K	malleable cast iron		ferritic		19	130	50-100	0.05-0.13	0.06-0.13	0.08-0.18	0.1-0.2	0.15-0.25
K			pearlitic		20	230	50-100	0.05-0.13	0.06-0.13	0.08-0.18	0.1-0.2	0.15-0.25
N	aluminum-wrought alloys		not hardenable		21	60	65-130	0.05-0.13	0.08-0.15	0.1-0.2	0.15-0.25	0.16-0.3
N			hardenable		22	100	65-100	0.05-0.13	0.08-0.15	0.1-0.2	0.15-0.25	0.16-0.3
N	aluminum-cast alloys	≤12% Si	not hardenable		23	75	65-130	0.05-0.13	0.08-0.15	0.1-0.2	0.15-0.25	0.16-0.3
N			hardenable		24	90	65-130	0.05-0.13	0.08-0.15	0.1-0.2	0.15-0.25	0.16-0.3
N		>12% Si	high temperature		25	130	65-130	0.05-0.13	0.08-0.15	0.1-0.2	0.15-0.25	0.16-0.3
N	copper alloys	>1% Pb	free cutting		26	110	65-130	0.05-0.13	0.08-0.15	0.1-0.2	0.15-0.25	0.16-0.3
N			brass		27	90	65-130	0.05-0.13	0.08-0.15	0.1-0.2	0.15-0.25	0.16-0.3
N			electrolytic copper		28	100	65-130	0.05-0.13	0.08-0.15	0.1-0.2	0.15-0.25	0.16-0.3
N	non metallic		duroplastics, fiber plastics		29							
N			hard rubber		30							
S	high temperature alloys	Fe based	annealed		31	200	10-50	0.05-0.12	0.06-0.12	0.08-0.15	0.12-0.18	0.15-0.25
S			hardened		32	280	10-50	0.05-0.12	0.06-0.12	0.08-0.15	0.12-0.18	0.15-0.25
S		Ni or Co based	annealed		33	250	10-50	0.05-0.12	0.06-0.12	0.08-0.15	0.12-0.18	0.15-0.25
S			hardened		34	350	10-50	0.05-0.12	0.06-0.12	0.08-0.15	0.12-0.18	0.15-0.25
S			cast		35	320	10-50	0.05-0.12	0.06-0.12	0.08-0.15	0.12-0.18	0.15-0.25
S	titanium alloys		pure	400	36		30-50	0.05-0.1	0.05-0.1	0.08-0.12	0.1-0.15	0.12-02
S			alpha+beta alloys, hardened	1050	37		30-50	0.05-0.1	0.05-0.1	0.08-0.12	0.1-0.15	0.12-0.2
H	hardened steel		hardened		38							
H			hardened		39							
H	chilled cast iron		cast		40	400						
H	cast iron		hardened		41							

(1) For material groups see pages 495-524

ISO	Material		Condition	Tensile Strength [N/mm²]	Material Group No.[1]	Hardness HB	Chipbreaker			Adjustable Solid Drill Heads DSD-EC, DDD-EC, DSD-IC					
							First Choice	Troubleshooting		Dia. Range	38.00-39.99	40.00-51.99	52.00-63.99	64.00-84.99	85.00-293.00
								Fracture	Wear	V_c (m/min)	Feed Rate f (mm/rev)				
P	non-alloy steel and cast steel, free cutting steel	<0.25% C	annealed	420	1	125	G IC908	BG IC806	B IC9025	60-120	0.08-0.15	0.1-0.2	0.13-0.23	0.15-0.25	0.18-0.3
P		≥0.25% C	annealed	650	2	190				60-120	0.08-0.15	0.1-0.2	0.13-0.23	0.15-0.25	0.18-0.3
P		<0.55% C	quenched and tempered	850	3	250				60-120	0.08-0.15	0.1-0.2	0.13-0.23	0.15-0.25	0.18-0.3
P		≥0.55% C	annealed	750	4	220				60-120	0.08-0.15	0.1-0.2	0.13-0.23	0.15-0.25	0.18-0.3
P			quenched and tempered	1000	5	300				60-120	0.08-0.15	0.1-0.2	0.13-0.23	0.15-0.25	0.18-0.3
P	low alloy and cast steel (less than 5% of alloying elements)		annealed	600	6	200	G IC908	BG IC806	B IC9025	60-100	0.08-0.15	0.1-0.2	0.13-0.23	0.15-0.25	0.18-0.3
P			quenched and tempered	930	7	275				60-100	0.08-0.15	0.1-0.2	0.13-0.23	0.15-0.25	0.18-0.3
P				1000	8	300				50-100	0.08-0.15	0.1-0.2	0.13-0.23	0.15-0.25	0.18-0.3
P				1200	9	350				50-100	0.08-0.15	0.1-0.2	0.13-0.23	0.15-0.25	0.18-0.3
P	high alloyed steel, cast steel and tool steel		annealed	680	10	200	G IC908	BG IC806	B IC9025	60-120	0.08-0.15	0.1-0.2	0.13-0.23	0.15-0.25	0.18-0.3
P			quenched and tempered	1100	11	325				60-120	0.08-0.15	0.1-0.2	0.13-0.23	0.15-0.25	0.18-0.3
P	stainless steel and cast steel		ferritic / martensitic	680	12	200	G IC908	BG IC806	B IC9025	60-110	0.08-0.15	0.1-0.2	0.13-0.23	0.15-0.25	0.18-0.3
P			martensitic	820	13	240				60-110	0.08-0.15	0.1-0.2	0.13-0.23	0.15-0.25	0.18-0.3
M	stainless steel and cast steel		austenitic, duplex	600	14	180	G IC806	B IC908	B IC9025	60-110	0.08-0.15	0.1-0.2	0.13-0.23	0.15-0.25	0.18-0.3
K	gray cast iron (GG)		ferritic / pearlitic		15	180	G IC908	G IC806	B IC9025	80-140	0.20-0.30	0.20-0.30	0.24-0.32	0.24-0.32	0.25-0.40
K			pearlitic / martensitic		16	260				80-140	0.20-0.30	0.20-0.30	0.24-0.32	0.24-0.32	0.25-0.40
K	nodular cast iron (GGG)		ferritic		17	160				80-140	0.20-0.30	0.20-0.30	0.24-0.32	0.24-0.32	0.25-0.40
K			pearlitic		18	250				80-140	0.20-0.30	0.20-0.30	0.24-0.32	0.24-0.32	0.25-0.40
K	malleable cast iron		ferritic		19	130				80-140	0.20-0.30	0.20-0.30	0.24-0.32	0.24-0.32	0.25-0.40
K			pearlitic		20	230				80-140	0.20-0.30	0.20-0.30	0.24-0.32	0.24-0.32	0.25-0.40
N	aluminum-wrought alloys		not hardenable		21	60	G IC908	G IC806	B IC9025	100-200	0.08-0.2	0.1-0.25	0.13-0.28	0.15-0.3	0.18-0.33
N			hardenable		22	100				100-200	0.08-0.2	0.1-0.25	0.13-0.28	0.15-0.3	0.18-0.33
N	aluminum-cast alloys	≤12% Si	not hardenable		23	75				100-200	0.08-0.2	0.1-0.25	0.13-0.28	0.15-0.3	0.18-0.33
N			hardenable		24	90				100-200	0.08-0.2	0.1-0.25	0.13-0.28	0.15-0.3	0.18-0.33
N		>12% Si	high temperature		25	130				100-200	0.08-0.2	0.1-0.25	0.13-0.28	0.15-0.3	0.18-0.33
N	copper alloys	>1% Pb	free cutting		26	110				100-200	0.08-0.2	0.1-0.25	0.13-0.28	0.15-0.3	0.18-0.33
N			brass		27	90				100-200	0.08-0.2	0.1-0.25	0.13-0.28	0.15-0.3	0.18-0.33
N			electrolytic copper		28	100				100-200	0.08-0.2	0.1-0.25	0.13-0.28	0.15-0.3	0.18-0.33
N	non metallic		duroplastics, fiber plastics		29					60-130	0.08-0.2	0.1-0.25	0.13-0.28	0.15-0.3	0.18-0.33
N			hard rubber		30					60-130	0.08-0.2	0.1-0.25	0.13-0.28	0.15-0.3	0.18-0.33
S	high temperature alloys	Fe based	annealed		31	200	B IC806	B IC908	B IC9025	20-65	0.06-0.13	0.08-0.18	0.13-0.23	0.13-0.23	0.18-0.28
S			hardened		32	280				20-65	0.06-0.13	0.08-0.18	0.13-0.23	0.13-0.23	0.18-0.28
S		Ni or Co based	annealed		33	250				20-65	0.06-0.13	0.08-0.18	0.13-0.23	0.13-0.23	0.18-0.28
S			hardened		34	350				30-100	0.06-0.13	0.08-0.18	0.13-0.23	0.13-0.23	0.18-0.28
S			cast		35	320				30-100	0.06-0.13	0.08-0.18	0.13-0.23	0.13-0.23	0.18-0.28
S	titanium alloys		pure	400	36					30-60	0.06-0.13	0.08-0.18	0.13-0.23	0.13-0.23	0.18-0.28
S			alpha+beta alloys, hardened	1050	37					30-60	0.06-0.13	0.08-0.18	0.13-0.23	0.13-0.23	0.18-0.28
H	hardened steel		hardened		38		B IC806	B IC908	B IC908	30-80	0.06-0.13	0.08-0.18	0.13-0.23	0.13-0.23	0.15-0.28
H			hardened		39					30-80	0.06-0.13	0.08-0.18	0.13-0.23	0.13-0.23	0.15-0.28
H	chilled cast iron		cast		40	400				30-80	0.06-0.13	0.08-0.18	0.13-0.23	0.13-0.23	0.15-0.28
H	cast iron		hardened		41					30-80	0.06-0.13	0.08-0.18	0.13-0.23	0.13-0.23	0.15-0.28

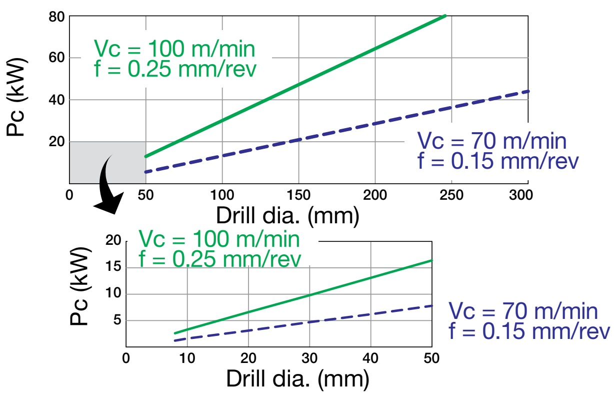
(1) For material groups see pages 495-524

ISCAR-DEEP-DRILL Machine Requirements for BTA and DTS Drilling Methods

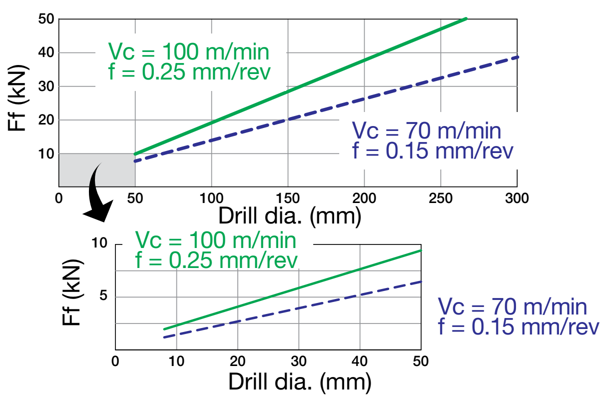
Machine requirements for deep drilling by BTA or DTS drilling methods using **TRI-DEEP** family tools are shown in the table below.

Setting Guidelines for Cutting Loads, Fluid Pressure and Flow Rate During STS Operation

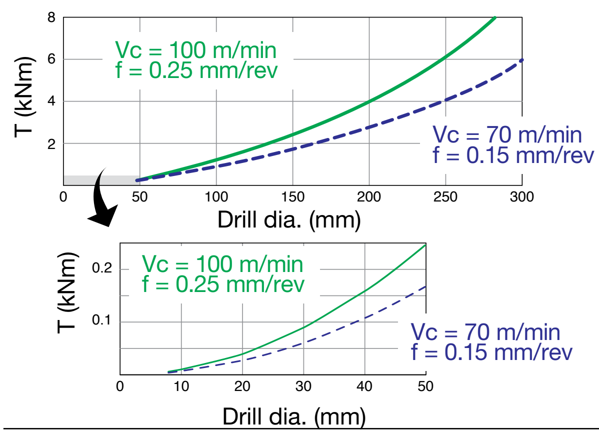
Net Power



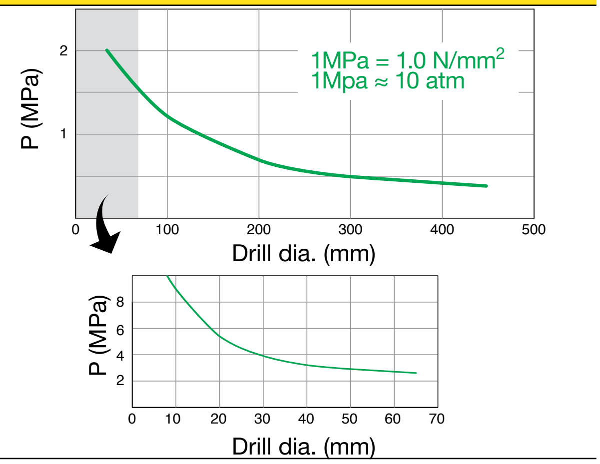
Feed Force



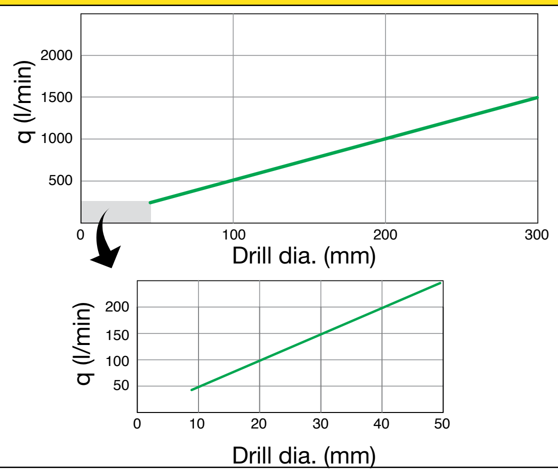
Torque



Coolant Pressure

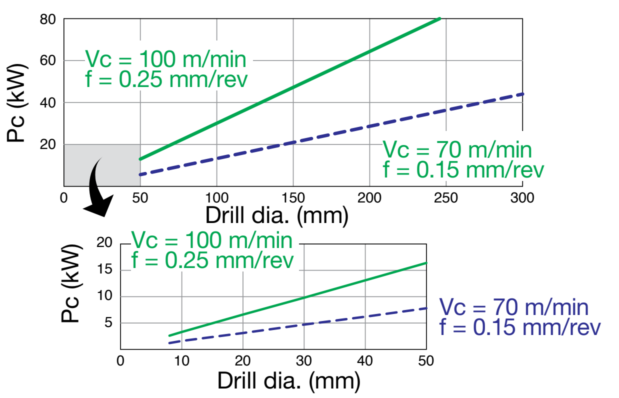


Coolant Volume

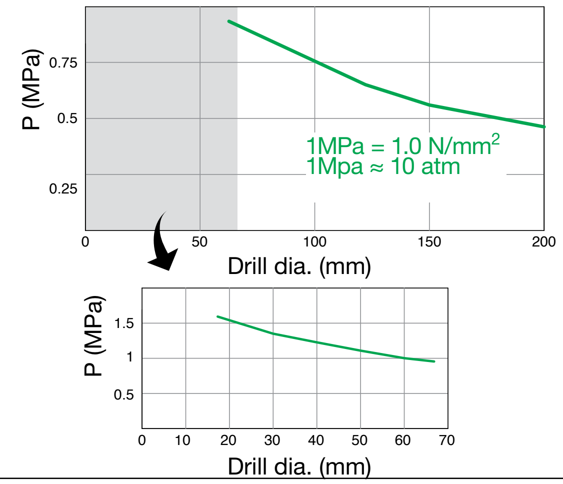


Setting Guidelines for Cutting Loads, Fluid Pressure and Flow Rate During DTS Operation

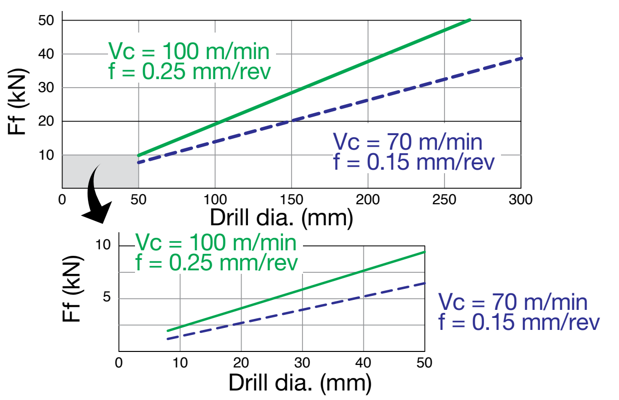
Net Power



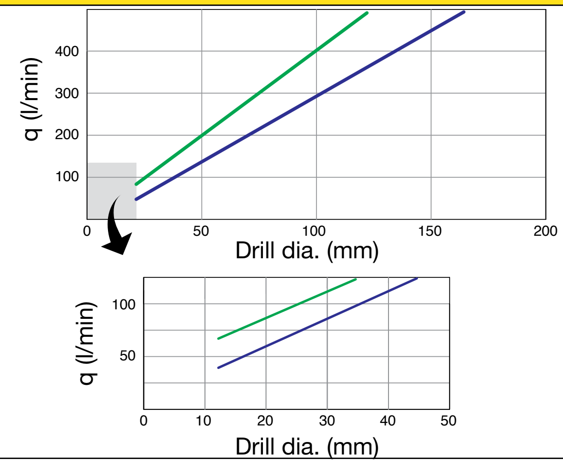
Coolant Pressure



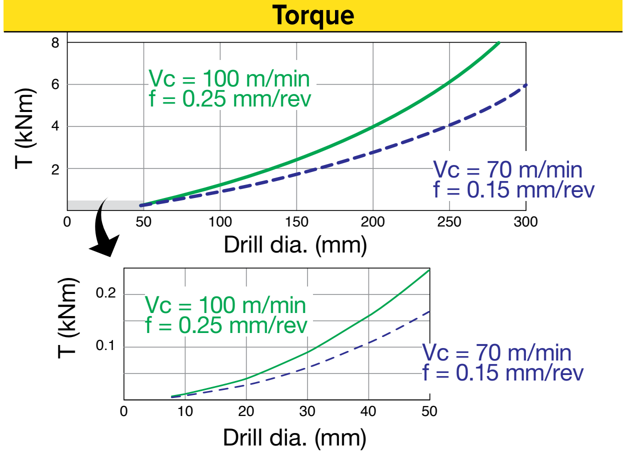
Feed Force



Coolant Volume



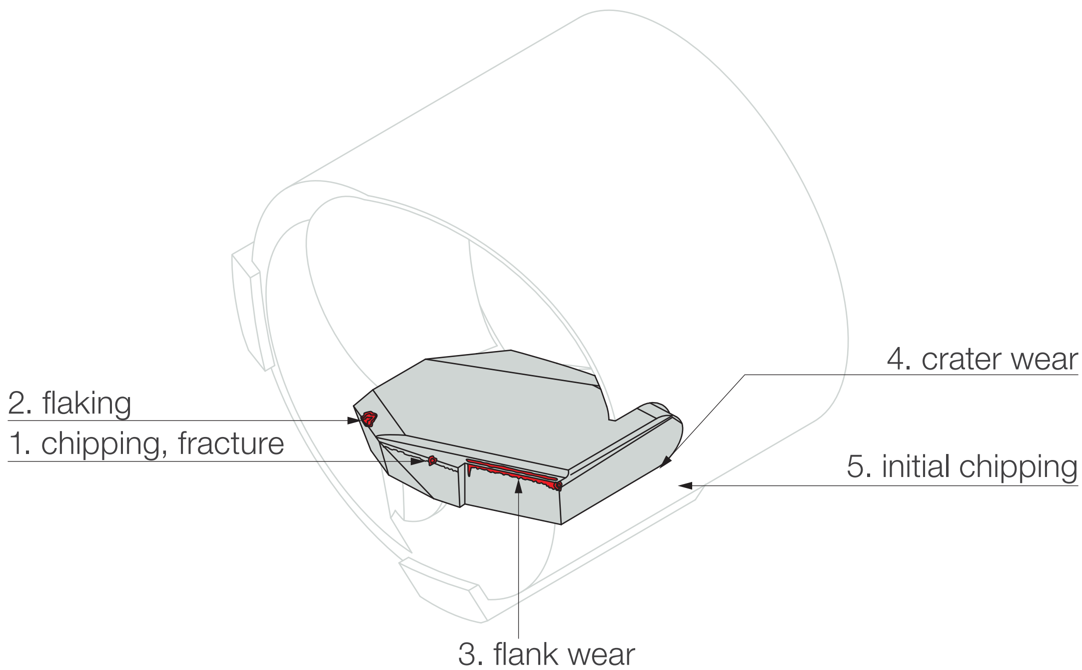
Torque



Troubleshooting

Problem	Possible Cause	Solution
The Drill Breaks Or Insert Chips	• Chip evacuation problems. Center misalignment of drill to workpiece.	• Check that the coolant passages are clear and that the Venturi slots are not damaged. Check center alignment of drill to workpiece. Check workpiece and drill clamping rigidity.
Poor Surface Finish	• Workpiece or drill clamping rigidity problem. Inadequate coolant oil. Cutting speed too low.	• Improve workpiece or drill clamping. Check the coolant oil and replace if necessary. Increase the cutting speed.
Excessive Leakage of the Coolant	• Chips block the fluid passages. The drill was incorrectly assembled, or the Venturi slots of the internal tube are located in the wrong direction.	• Clear the chips. Check all connections and the direction of the internal tube.
Insufficient Coolant Flow At the Cutting Zone, Despite Correct Fluid Supply	• Chips block the fluid passages. Worn bushing or sealing device. Venturi slots are too wide (worn). Internal tube shorter than the external tube.	• Clear the chips. Check the bushing and seal and replace if necessary . Replace the internal tube. Replace the internal tube to one with a correct length.
Chips Jam in the Front end of the Drill	• Insufficient coolant flow.	• Adjust the fluid flow by raising the pressure; check the filter and fluid quality.

Problem	Cause	Solution: Grade	Solution: Cutting Conditions / Other
Chipping, Fracture	• Excessive vibration or impact. • Torn away built-up edge.	• Use a tough grade.	• Reduce the feed rate. • Eliminate the vibration.
Flaking	• Excessive vibration or impact.	• Use a tough grade.	• Reduce the feed rate. • Eliminate the vibration.
Flank Wear	• Cutting speed too high. • Inadequate tool toughness.	• Use a grade with high wear resistance. • Use a coated grade.	• Reduce the cutting speed. • Reduce the feed rate. • Use coolant properly.
Crater Wear	• Cutting speed too high. • Feed rate too high. • Inadequate tool toughness.	• Use a grade with high wear resistance. • Use a coated grade.	• Reduce the cutting speed. • Reduce the feed rate. • Use coolant properly.
Initial Chipping	• Inappropriate guide bush or pilot hole. • Misalignment.	• Use a tough grade.	• Adjust or change the guide bushing or pilot hole. • Reduce the feed rate. • Correct the misalignment.



Special Request Form Deep Drilling

Requested Information Form for Deep Hole Drill Design

Company name ______________________ **Telephone no.** ______________________

Address ______________________ **Date** ______________________

Contact person ______________________ **Customer no.** ______________________

Workpiece

Product name: ______________________ Hole diameter: ______________________

Hole depth: ______________ No. of holes: Tolerance (of hole): ______________

Surface finish (Rz, Ra...): __________ Deviation (mm/100): __________ Straightness (mm/100): __________

Material

Material (DIN, AISI, JIS...): ______________________________________

Hardness (HB, HS, HRC...): ______________________________________

Condition: ☐ Quenched ☐ Tempered ☐ Cast ☐ Annealed

☐ Other ______________________________________

Machine

Machine supplier name: ______________________________________

Machine type/model: ☐ NC lathe ☐ Machining center ☐ Other ______________

Rigidity: ☐ Good ☐ Normal ☐ Poor

Spindle power (kW): ______________

Tool and/or workpiece rotation (TR/WR):

☐ Tool and workpiece ☐ Rotating workpiece (WR) ☐ Rotating tool (TR)

Type of Coolant

Water based: ☐ Soluble ☐ Emulsion ______________%

Oil based: ☐ Coolant Pressure (bar): ______________ Coolant Volume (L/min): ______________

Tool Drill Head

Drill diameter:______________________ (mm/inch)

Thread: ☐ Inner ☐ Outer ☐ Brazed

Indexable: ☐ Adjustable ☐ Direct mount Coating: ☐ Coated ☐ Uncoated

☐ Solid drilling ☐ Counterboring

Pre-drilled hole size: ______________________ (mm/inch)

Bottom finishing: ☐ Full ball R ☐ Flat bottom R ☐ Corner R ☐ Other ______________

Trepanning: ☐ Y ☐ N

Tube outer diameter: ______________________ (mm/inch) Core size diameter:______________________ (mm/inch)

Please fill in and return to your **ISCAR** representative.

Requested Information Form for Deep Hole Drill Design (Continued)

Tube

Outside diameter: ______________________ (mm/inch) Total Length: ______________________ (mm/inch)

Internal Thread: ______________________

External Thread: 4 ☐ Starts 2 ☐ Starts 1 ☐ Starts

Tube Thread: 1 ☐ End ☐ Both ends

Inner Tube Length: ______________________ (mm/inch)

Inner Tube Slit: 1 ☐ End ☐ Both ends

Drilling System & Boring Conditions

☐ Single Tube System: ☐ Blind Hole Drilling ☐ Double Tube System

☐ Cross Hole Drilling: ☐ Through Hole Drilling

Please Sketch Your Drilling Application

General Production Information

Quantity of parts per year: ______________________

Grade, tool life, etc.: ______________________

Perfomance expectation: V_c= ________ m/min N=________ RPM F= ________ mm/min f= ________ mm/rev

Cutting data: ______________________

Description of present system in use: ______________________

____

____

____

____

____

Please fill in and return to your **ISCAR** representative.

Formulas and Definitions

General Formulas and Definitions for Drilling Operations

Knowledge to calculate cutting speed and feed is of decisive importance for successful drilling. This section describes general formulas and definitions for drilling operations, in particular for calculating cutting speed, feed per revolution and specific cutting force.

Cutting Speed (v_c)

Cutting speed is the speed at which the cutting edge of the drill moves relative to the material being drilled. It is usually measured in meters per minute (m/min) or feet per minute (ft/min).

Formula:

$$v_c = \frac{\pi \times D \times n}{1000}$$

When:

v_c = cutting speed (m/min)
π = Pi (approximately 3.14159)
D = diameter of the drill (mm)
n = rotation velocity of drill (revolutions per minute, RPM)

Rotation Velocity of the Drill (n)

Rotation velocity of the drill or rotational speed of the spindle, measured in revolutions per minute (RPM).

Formula:

$$n = \frac{1000 \times vc}{\pi \times D}$$

When:

n = spindle speed (revolutions per minute, RPM)
v_c = cutting speed (m/min)
π = Pi (approximately 3.14159)
D = diameter of the drill (mm)

Feed Rate (v_f)

Feed rate or penetration rate is the speed at which the drill advances into the material, measured in millimeters per minute (mm/min) or inches per minute (in/min).

$$v_f = f \times n$$

When:

v_f = feed rate (mm/min)
f = feed per revolution (mm/rev)
n = rotation velocity of the drill (RPM)

Feed per Revolution (f_n)

Feed per revolution is the distance the drill advances into the material with each revolution of the spindle. It is typically measured in millimeters per revolution (mm/rev) or inches per revolution (in/rev).

Formula:

$$f_n = \frac{v_f}{n}$$

When:

f_n = feed per revolution (mm/rev)
v_f = feed rate (mm/min)
n = rotation velocity of the drill (RPM)

Material Removal Rate (MRR)

Material removal rate is the volume of material removed per unit time, usually measured in cubic centimeter per minute (cm^3/min) or cubic inches per minute (in^3/min).

Formula:

$$MRR = \frac{D \times f_n \times v_c}{4}$$

When:

MRR = material removal rate (cm^3/min)
D = diameter of the drill (mm)
f_n = feed per revolution (mm/rev)
v_n = cutting speed (m/min)

Net Power (P_{net})

Net power is the actual power required to perform the cutting operation, measured in watts (W) or horsepower (hp).

Formula:

$$P_{net} = \frac{F_c \times v_c}{60}$$

When:

P_{net} = net power (W)
F_c = cutting force (N)
v_c = cutting speed (m/min)

Torque (T)

Torque is the rotational force applied by the spindle to the drill bit, measured in Newton-meters (Nm) or pound-feet (lb-ft).

Formula:

$$T = \frac{F_c \times D}{2000}$$

When:

T = torque (Nm)
Fc = cutting force (N)
D = diameter of the drill (mm)

Specific Cutting Force (k_c)

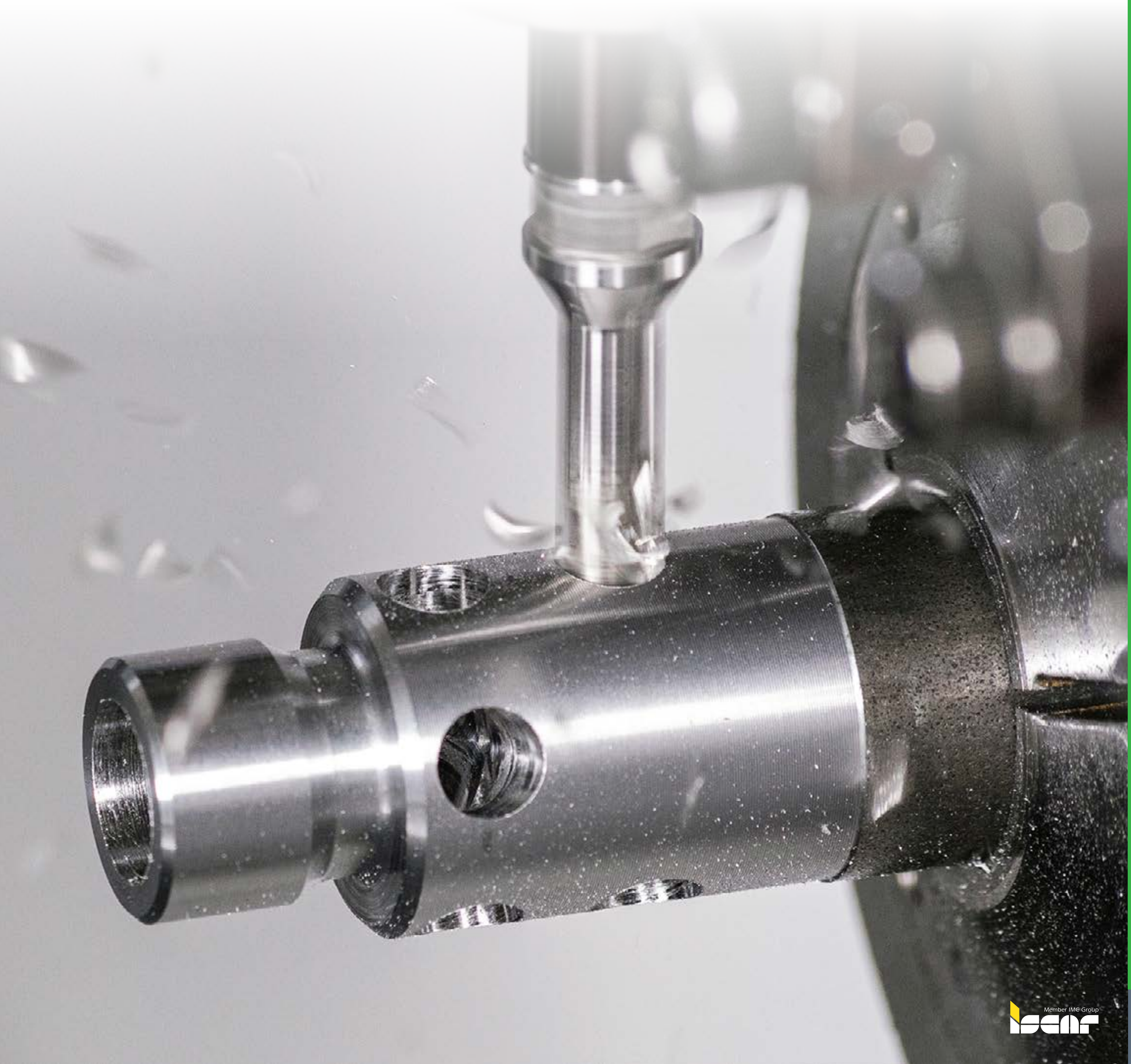
Specific cutting force is the force required to cut a material, measured per unit area of the material being cut. It is usually expressed in Newtons per square millimeter (N/mm²).

Formula:

$$k_c = \frac{F_c}{A_c}$$

When:

k_c = specific cutting force (N/mm²)
Fc = cutting force (N)
Ac = cross-sectional area of the cut (mm²)



Feed Force (F_f)

Feed force is the axial force required to advance the drill bit into the material, measured in Newtons (N).

Formula:

$$F_f = k_f \times A_C$$

When:

F_f = feed force (N)
k_f = specific feed force (N/mm^2)
A_C = cross-sectional area of the cut (mm^2)

Machining Time (t_c)

Machining time is the time required to complete the drilling operation, usually measured in minutes.

Formula:

$$t_c = \frac{l}{v_f}$$

When:

t_c = machining time (min)
l = depth of the hole (mm)
v_f = feed rate (mm/min)

Specific Energy Consumption (SEC)

Electricity consumption is a form of energy consumption in which electrical energy is used. When drilling, the power consumption is the actual energy demand created by the existing power supply for drilling holes.

Specific Energy Consumption (SEC)

Specific Energy Consumption (SEC) is a key metric in drilling operations, representing the amount of energy required to remove a unit volume of material. It is often expressed in Joules per cubic millimeter (J/mm^3). Understanding and optimizing SEC can lead to more efficient and cost-effective drilling processes.

The Specific Energy Consumption (SEC) in drilling can be calculated using the following formula:

$$\mathbf{SEC} = \frac{3 \times P_{net}}{50 \times MRR}$$

When:

SEC = specific energy consumption $\left(\frac{J}{mm^3}\right)$

$\mathbf{P_{net}}$ = net mean power demand (W)

MRR = material removal rate $\left(\frac{cm^3}{min}\right)$

Reducing energy consumption aligns with sustainability goals, lowering the carbon footprint of drilling operations.

Factors Affecting SEC

Material Properties: Harder materials generally require more energy to drill, increasing the SEC.

Tool Condition: Worn or dull drills can increase SEC as more energy is required to remove material.

Drilling Parameters: Feed rate, spindle speed, and lubrication can all impact the SEC.

By regularly measuring and analyzing SEC, drilling operations can be continuously improved, leading to significant savings in energy and operational costs.

Required energy (E_w)

Calculating the required energy (E_w) in a drilling operation is crucial for optimizing energy efficiency, reducing operational costs, and selecting appropriate machinery. This calculation also supports sustainability efforts by reducing energy consumption and environmental impact.

The required energy (E_w) in a drilling operation can be calculated using the following formula:

$$E_W = P_{net} \times t_c$$

When:

E_W = required energy in a drilling operation (J)

P_{net} = net mean power demand (W)

t_c = machining time (s)

Cutting Material Grades and Engineering Materials

Tool Material Grades

The indexable inserts, exchangeable heads and solid carbide tools for drilling are produced from different tungsten carbide grades.

The grade is defined by a combination of substrate type, coating type and post-coating treatment. If the indexable insert or solid carbide tool is not coated, then the grade will be defined by substrate type only.

ISCAR's products for hole machining are made from cemented carbide. Cemented carbides are very hard materials and therefore they can cut most engineering materials, which are softer. In most cases, to improve performance of thread cutting products when applied to machining a specific class of materials, the indexable inserts and solid carbide tools are coated. One of the most common methods of coating is by physical vapor deposition (PVD). PVD coatings have a wide distribution in indexable thread turning inserts and thread solid carbide tools because they leave the cutting edges sharp. PVD coatings are applied at relatively low temperature (about 500°C).

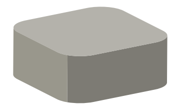
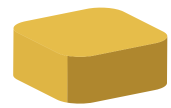
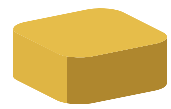
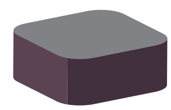
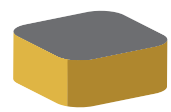
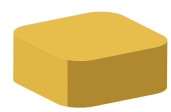
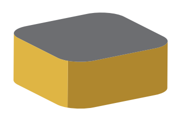
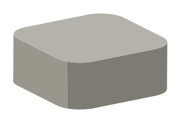
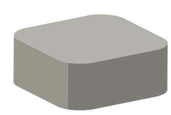
Nano layered PVD coating

PVD coatings were introduced during the late 1980's. With the use of advanced nanotechnology, PVD coatings performed a gigantic step in overcoming complex problems that were impeding progress in the field. Developments in science and technology brought a new class of wear-resistant nano layered coatings. These coatings are a combination of layers having a thickness of up to 50 nm (nanometers) and demonstrate significant increases in the strength of the coating compared to conventional methods.

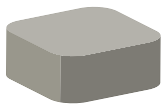
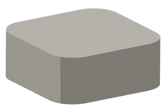
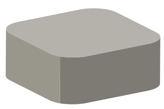
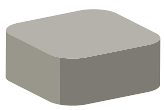
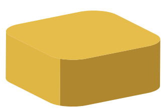
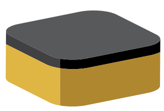
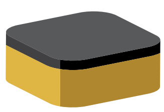
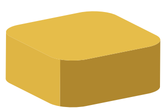
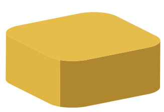
ISCAR offers a rich variety of carbide grades for indexable drilling inserts, exchangeable drilling heads and solid carbide drills.

Below are described in brief the most popular **ISCAR** grades for drilling operations.

ISCAR Holemaking Grades Chart

	Grade	ISO	Grade Description	Coating Layers	Coating Color*
PVD COATED	IC328	P25-P40 M30-M40 S20-S30 	A tough substrate with PVD coating, suitable for wide range of applications on steel and stainless steel at low to medium speeds and medium to high feeds. The grade is recommended for interrupted cuts and machining under unstable conditions.	TiCN Base	
PVD COATED	IC508	P20-P40 M20-M30 K20-K30 N10-N30 S10-S25 H20-H30	A broad-spectrum grade with a tough-submicron fine grain substrate and PVD coating. Designed for machining main types of engineering materials at various cutting speeds. Features excellent notch wear and built-up edge resistance. Suitable for interrupted cutting and machining under unfavorable conditions.	TiN TiCN Base	
PVD COATED	IC520	 M10-M20 N10-N15 S10-S20 	A hard substrate PVD coated grade. Intended mainly for machining austenitic stainless steel, high-temperature alloys and Titanium.	TiN TiCN Base	
PVD COATED	IC806	P10-P20 M10-M20 K10-K25 	A hard submicron fine grain substrate, PVD coated grade followed by a SUMOTEC surface treatment. Applied mainly to machining heat- resistant superalloys at moderate cutting speeds.	TiAlN AlTiN Base	
PVD COATED	IC808	P15-P30 M20-M30 K20-K30 S10-S25 H20-H30	A tough, submicron fine grain size substrate with excellent chipping resistance, combined with a SUMOTEC PVD coating. Provides high wear resistance. Recommended for a very wide range of materials.	TiN TiAlN Base	
PVD COATED	IC808G	P15-P30 M20-M30 K15-K25 S10-S25 H10-H20	A tough, submicron fine grain size substrate with PVD coating. Features high resistance to chipping and abrasive wear. Designed for machining a wide variety of engineering materials.	TiN TiAlN Base	
PVD COATED	IC830	P20-P40 M25-M35 S15-S30 	A tough substrate with PVD coating and a special SUMOTEC surface treatment. Suitable for machining steel and stainless steel at low to medium cutting speeds and moderate to high feeds. The grade features high toughness and recommended for interrupted cuts and machining under unstable conditions. May be used on high temperature alloys at low cutting speeds.	TiN TiAlN Base	
PVD COATED	IC903	P10-P20 M15-M25 K10-K20 S10-S20 H10-H20	Ultra-fine grain size, PVD coated. High wear resistance and toughness. High speed, medium feed. Used for up to 62 HRC hardened steel, Titanium, nickel-based alloys and stainless steel.	AlTiN Base	
PVD COATED	IC907	P10-P20 M05-M15 K15-K30 S10-S20 H05-H15	A hard submicron grain size substrate with a PVD coating, suitable for a wide range of materials such as steels, alloy steels, hard steels, austenitic stainless steel and heat resistant alloys at moderate to relatively high cutting speeds under stable conditions. Features high wear resistance and plastic deformation durability.	TiAlN Base	

* For coated grades

	Grade	ISO	Grade Description	Coating Layers	Coating Color*
PVD COATED	IC908	P15-P30 M20-M30 K20-K30 S10-S25 H20-H30	A tough submicron grain size substrate with PVD coating, recommended for general use in a large variety of operations and materials such as steels, alloy steels, austenitic stainless steel and high temperature alloys at moderate cutting speeds. Features high wear resistance and chipping durability.	TiAlN Base	
PVD COATED	IC920	K10-K20 N10-N25	A PVD coated carbide grade that features good fracture toughness and high wear resistance. Used mostly for machining nodular cast iron at medium cutting speed.	TiAlN Base	
PVD COATED	IC928	P20-P40 M25-M35 S15-S30	A tough substrate with PVD coating, suitable for machining steel and stainless steel at low to medium cutting speeds and moderate to high feeds. The grade is recommended for interrupted cuts and machining under unstable conditions.	TiAlN Base	
PVD COATED	IC950	P15-P35 K15-K35	A PVD coated grade with excellent wear resistance. Generally used for heavy machining alloy steel and cast iron.	TiAlN Base	
PVD COATED	IC1008	P10-P20 M05-M15 K15-K30 S10-S20 H05-H15	A tough submicron grain size substrate with coating. Recommended for general use on a wide range of applications and materials such as steels, alloy steels, austenitic stainless steel and high temperature alloys at moderate cutting speeds.	TiN TiAlN Base	
CVD COATED	IC5500	P20-P35	A tough substrate with SUMOTEC CVD coating. Recommended for high speed drilling of steel. Provides excellent tool life.	TiN Al_2O_3 TiCN Base	
CVD COATED	IC8080	P10-P20 K10-K20	A submicron grain size substrate with SUMOTEC MTCVD coating. Features excellent chipping and wear resistance. Recommended for high speed drilling of cast iron and steel, to be used for the peripheral insert on DR drills.	TiN Al_2O_3 TiCN Base	
CVD COATED	IC9025	P20-P30 M15-M30	A tough substrate with a cobalt enriched layer combined with a multi-layer CVD coating. Recommended for general use machining of steel in a wide range of conditions, featuring high toughness and wear resistance.	TiN Al_2O_3 TiCN Base	
CVD COATED	IC9080	P10-P20 K10-K20	A submicron grain size substrate with a CVD coating. Features excellent chipping and wear resistance. Recommended for high speed drilling of cast iron and steel, to be used for the peripheral insert on DR drills.	TiN Al_2O_3 TiCN Base	

* For coated grades

Material Groups

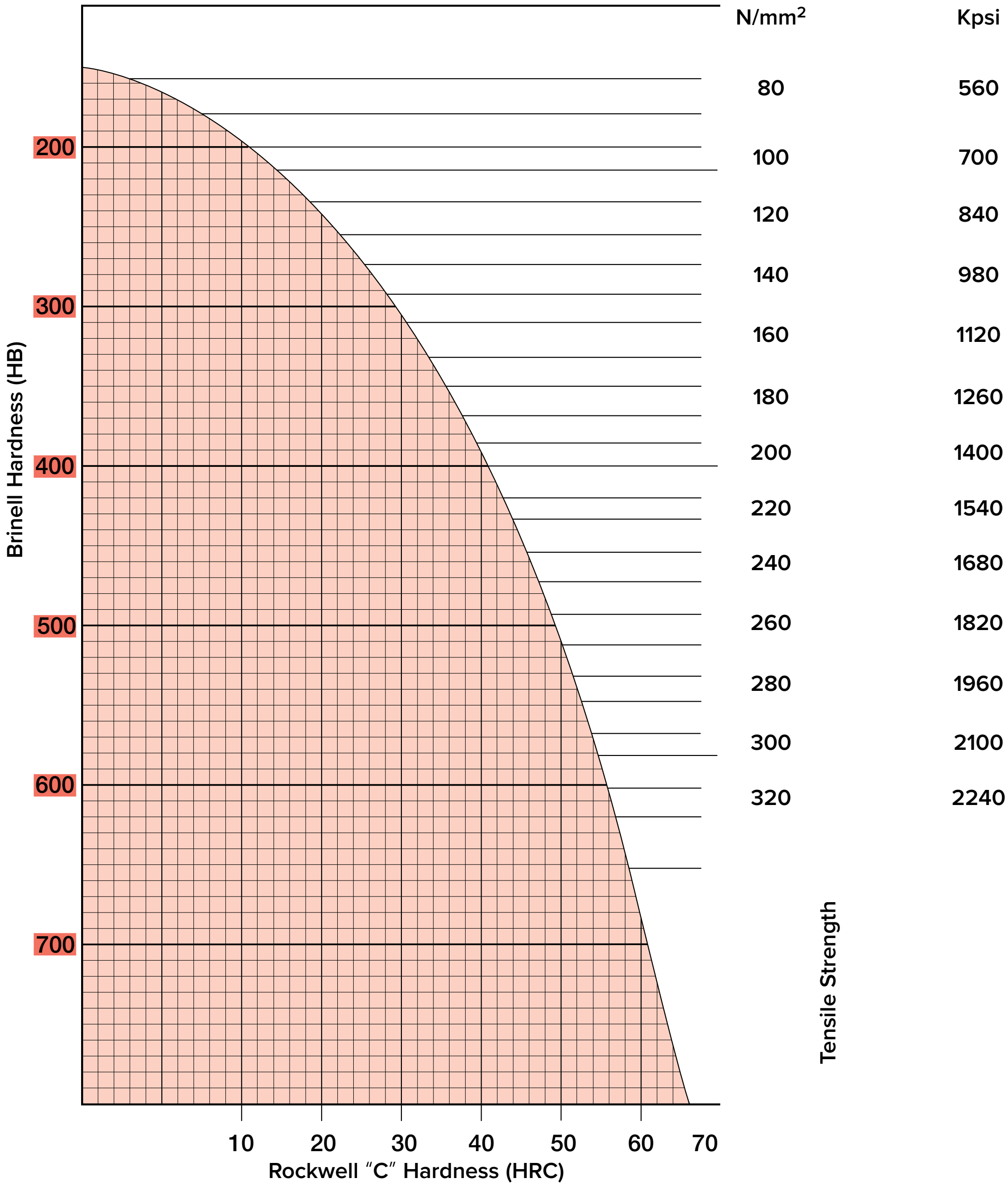
Material Groups
Based on ISO 513 and VDI 3323 Standards

ISO	Material		Condition	Tensile Strength [N/mm²]	Kc1[1] [N/mm²]	mc[2]	Hardness HB	Material Group No.
P	non-alloy steel and cast steel, free cutting steel	<0.25% C	annealed	420	1350	0.21	125	1
P		≥0.25% C	annealed	650	1525	0.22	190	2
P		<0.55% C	quenched and tempered	850	1675	0.24	250	3
P		≥0.55% C	annealed	750	1675	0.24	220	4
P			quenched and tempered	1000	1900	0.24	300	5
P	low alloy and cast steel (less than 5% of alloying elements)		annealed	600	1775	0.24	200	6
P			quenched and tempered	930	1675	0.24	275	7
P				1000	1725	0.24	300	8
P				1200	1800	0.24	350	9
P	high alloyed steel, cast steel and tool steel		annealed	680	2450	0.23	200	10
P			quenched and tempered	1100	2500	0.23	325	11
P	stainless steel and cast steel		ferritic / martensitic	680	1875	0.21	200	12
P			martensitic	820	1875	0.21	240	13
M	stainless steel and cast steel		austenitic, duplex	600	2150	0.20	180	14
K	gray cast iron (GG)		ferritic / pearlitic		1150	0.20	180	15
K			pearlitic / martensitic		1350	0.28	260	16
K	nodular cast iron (GGG)		ferritic		1225	0.25	160	17
K			pearlitic		1350	0.28	250	18
K	malleable cast iron		ferritic		1225	0.25	130	19
K			pearlitic		1420	0.3	230	20
N	aluminum-wrought alloys		not hardenable		700	0.25	60	21
N			hardenable		800	0.25	100	22
N	aluminum-cast alloys	≤12% Si	not hardenable		700	0.25	75	23
N			hardenable		700	0.28	90	24
N		>12% Si	high temperature		750	0.25	130	25
N	copper alloys	>1% Pb	free cutting		700	0.27	110	26
N			brass		700	0.27	90	27
N			electrolytic copper		700	0.27	100	28
N	non metallic		duroplastics, fiber plastics		200	0.20	70 Shore D	29
N			hard rubber		200	0.20	55 Shore D	30
S	high temperature alloys	Fe based	annealed		2600	0.24	200	31
S			hardened		3100	0.24	280	32
S		Ni or Co based	annealed		3300	0.24	250	33
S			hardened		3300	0.24	350	34
S			cast		3300	0.24	320	35
S	titanium alloys		pure	400	1160	0.24	190	36
S			alpha+beta alloys, hardened	1050	1245	0.24	310	37
H	hardened steel		hardened		4600	0.25	55 HRC	38
H			hardened		4700	0.25	60 HRC	39
H	chilled cast iron		cast		4600	0.27	400	40
H	cast iron		hardened		4500	0.27	55 HRC	41

- steel
- stainless steel
- cast iron
- non-ferrous metals
- superalloys and titanium
- hard materials

(1) Specific cutting force for 1 mm^2 chip section
(2) Chip thickness factor

Hardness Conversion Table



According to VDI 3323 Standard

Material Group No.	USA	Germany		U.K.	France	Sweden	Italy	Spain	Japan	Russia	EURONORM
	AISI/SAE/UNS/ASTM/AA	Werkstoff	DIN	BS	AFNOR	SS	UNI	UNE	JIS	GOST	EN
1	1020; G10200; K02301; K02595; K02596; K02597; K02598; K02599; K02702; K0300	1.0044	S275JR; St 44-2; Fe 430 B	EN 43 B; Fe 430 B FN; 43/25 HR; 43/25HS; 43 B; HFW4; HFS4; ERW 3	E 28-2	1411; 1412	Fe 430 B FN; Fe 430 B	AE 275 B; Fe 430 B FN	SN 400 B; SN 400 C; SN 490 B; SN 490 C; SS 400; STK 400; STKM 19 C; STKR 400; 19 C; SS 41; STK 41	St4ps; St4sp	S275JR
1		1.0050	E295; St 50-2; Fe 490-2; ST 50-2 G (E295+CR)	Fe 490-2 FN; 50 B	A 50-2	1550; 2172	Fe 490	A 490-2; Fe 490-2 FN	SS 490; SS 50	St5ps; St5sp	
1	K02404; K02702	1.0045	S355JR; Fe 510 B	50 B; 4360-50 B	E 36-2		Fe 510 B FN	AE 355 B	SN 400 B; SN 400 C; SN 490 B; SN 490 C; SS 490; SS 50		S355JR
1	K02702	1.0143	S275J0; St 44-3 U; Fe 430 C	43C; 4360-43C	E 28-3	1414-01	Fe 430 C FN	AE 275 D			S275J0
1		1.0130	P265S; SPH 265	164-400B LT 20	SPH 265; A 42 AP			SPH 265			P265S
1	A 619	1.0333	DC03G1; USt 3; USt 13	2 CR; 3 CR	E		FeP 02	AP 02	SPCD		DC03G1
1	K02601; K03000; A 573 Gr. 70; A 611 Gr.D	1.0144	S275J2G3 (S275J2); St 44-3 (Fe 430 D 1)	Fe 430 D1 FF; 4360-43 C; 4360-43 D	E 28-3; E 28-4	1411; 1412; 1414	Fe 430 B; Fe 430 C (FN); Fe 430 D (FF)	AE 275 D; Fe 430 D1 FF	SM 400 A; SM 400 B; SM 400 C; SS 400; STK 400; STKR 400; SM 41 A; SM 41 B; SM 41 C	St4kp; St4ps; St4sp	
1	1008; G10080; A 621	1.0330	DC01; DC 01; St 2; St 12	CR 4; CS 4	C; TC	1142	FeP 01; FeP 00	AP 11; FeP 01; AP 00	SPCC; CR 1		DC01 (FeP 05)
1	1015; G10150; K02401	1.0037	S235JR (Fe 360 B); St 37-2	Fe 360 B; 4360-40 B; ERW 3; CEW 3; 37/23 HR; 37/23 HS; 37/23 CR; 37/23 CS	E 24-2	1311	Fe 360 B; 1449 37/23 HR	AE 235 B; Fe 360 B	STKM 12 A; STKM 12 AC		
1		1.0035	S185 (Fe 310-0); St 33	Fe 310-0; 15 HR; 15 HS; 1449 15 HR; 1449 15 HS	A 33	1300	Fe 320	Fe 310-0; A 310-0	SGP; SS 330; SS 34	St0	S185
1	K02502	1.0034	E195; RSt 34-2	CEW 2; 34/20 HR; 34/20 HS; 34/20 CR; 1449 34/20CS	A 34-2 NE		Fe 330 BFN			St2ps; St2sp	E195
1		1.0334	DD12G1; UStW 23		2 C		FeP 12	AP 12	SPHD	10kp	
1	1006; G10060	1.0335	DD13; StW 24	1 CR; 1 CS; 1 HR; 2 HR; 2 HS; 2 CR; 2 CS	3 C		FeP 13	AP13	SPHE	08kp	DD13

Material Group No.	USA	Germany		U.K.	France	Sweden	Italy	Spain	Japan	Russia	EURONORM
	AISI/SAE/ UNS/ ASTM/AA	Werkstoff	DIN	BS	AFNOR	SS	UNI	UNE	JIS	GOST	EN
1	A 620	1.0338	DC04; St 4; St 14	CR 1; CR 2	ES	1147	FeP 04	AP 04; FeP 04	SPCE; HR 4	08JuA	DC04 (FeP 04)
1	K01700; K02001; K02200; K02201; K02203; K02503; K02601; K02801	1.0345	P235GH; HI; H I	141-360; 151-360; 154-360; 161-360; 164-360	A 37 CP	1330; 1331	FeE 235; Fe 360 1 KW; Fe 360 1 KG; Fe 360 2 KW; Fe 360 2 KG	A 37 Grado RA II; A 37 Grado RC I	SGV 410; SGV 450; SGV 480; SPV 235; SPV 450; SPV 490; SGV 42; SGV 46; SGV 49; SPV 24; SPV 46; SPV 50		P235GH
1	1010; G10100	1.0301	C10; C 10	040 A 10; 045 M 10; En 2 A; En 2 A/1; En 2 B; En 32 A; 10 CS	C10RR; XC 10; C 10; AF 34 C 10		1 C 10; C 10	F.151; F.151.A	S 10C	10	C10
1		1.0149	S275JOH; St 44-3 U; RoSt 44-2	43 C; 4360-43C	E 28-3	1412-04	Fe 430 C	Fe 430 C; AE 275 C			S275JOH
1		1.0226	DX51D; St 02 Z	Z2	GC	1151 10	FeP 02 G	FeP 02 G	SGC C		
1	A 1011 (SS Grade 36 (230) Type 2); A1011 (SS Grade 36 (250) Type 1)	1.0114	S235JO; St 37-3 U; Fe 360 C	40 C; 4360-40C	E 24-3		Fe 360 C FN	AE 235 C	SS 330; SS 34		S235JO
1	A572-60	1.8900	S380N; StE 380	4360 55 E		2145	FeE 390 KG		S 25 C		S380N
1	A 572 Gr. 65	1.0060	E335; St 60-2 (Fe 590-2 B)	En 55 C; Fe 590-2-FN; 55 E; 4360-55 E	A 60-2	1650	Fe 590; Fe 60-2	A 590; Fe 590-2 FN	SM 570; SM 58	St6ps; St6sp	E335
1		1.0028	S250G1T; USt 34-2		A 34-2		Fe 330; Fe 330 B FU		SS 330; SS 34		
1	K01700; K02200; K02801	1.0112	P235S; SPH 235	164-360B LT20; 1501-164-360B LT20	A 37 AP; SPH 235		Fe 360 C	AE 235 C			P235S
1		1.0722	10SPb20; 10 SPb 20		10 PbF 2		CF 10 SPb 20	10 SPb 20; F.2122			10SPb20
1	1108; 1109; 1111; B1111; B 1111; G11080; G11090	1.0721	10S20; 10 S 20		10 F 2		CF 10 S 20	10 S 20; F. 2121			10S20
1	12L13; 12L14; 12 L 13; 12 L 14; G12134; G12144	1.0718	11SMnPb30; 9 SMnPb 28	230 M 07 Pb; En 1A Pb	S 250 Pb	1914	CF 9 SMnPb 28	F.210.C; F.210.M; 11 SMnPb 28; F.2112	SUM 22 L; SUM 23 L; SUM 24 L		11SMnPb30
1	1213; 1215; G12130; G12150	1.0715	11SMn30; 9 SMn 28	230 M 07; En 1 A	S 250	1912	CF 9 S 22	F.210.A; F.210.L; 11 SMn 28; F.2111	SUM 22		11SMn30
1	1020; 1023; G10200; G10230	1.1151	C22E; Ck 22	055 M 15; 070 M 20; En 3 A; En 3 C; En 2	XC 25; XC 18; 2 C 22	1450	C 20; C 25	F.1120; C 25 K	S 20 C; S 20 CK; S 22 C	20	C22E

Member IMC Group

Material Group No.	USA	Germany		U.K.	France	Sweden	Italy	Spain	Japan	Russia	EURONORM
	AISI/SAE/ UNS/ ASTM/AA	Werkstoff	DIN	BS	AFNOR	SS	UNI	UNE	JIS	GOST	EN
1	A 1008 (HSLAS-F Grade 80 [550]); A 1011 (HLAS-F Grade 80 [550])	1.0986	S500MC; QStE 500 TM	60F55 HR; 60F55 HS; 60F55 CS	E 560 D; S 560 MC		FeE 560 TM				S500MC
1	A 1008 (HSLAS-F Grade 70 [480]); A 1008 (HSLAS Grade 70 [480] Class 1)	1.0984	S500MC; QStE 500 TM		E 490 D; S 490 MC	2662	FeE 490 TM				S500MC
1	A 1008 (HSLAS Grade 65 [450] Class 1); A 1008 (HSLAS Grade 65 [450] Class 2)	1.0982	S460MC; QStE 460 TM	1501-50F45; 50F45 HR; 50F45 HS; 50F45 CS							S460MC
1	A 1008 (HSLAS Grade 50 [340] Class 1); A 1008 (HSLAS Grade 50 [340] Class 2)	1.0976	S355MC; QStE 360 TM	46F40 HR; 46F40 HS; 46F40 CS	E 355 D	2642	FeE 355 TM				S355MC
1	A 1008 (HSLAS Grade 50 [340]); A 1008 (HSLAS Grade45 [310] Class 2); A 1011 (HSLAS-F Grade 50 [340])	1.0972	S315MC; QStE 300 TM	1501-40F30; 43F35 HR; 43F35 HS; 43F35 CS	E 315 D						
1	K01600; K02007; K02700; K02701; K02803; K02900; K03009; K03300; K11803; K12000; K12001; K12037	1.0562	P355N; StE 355	225-490A	FeE 355 KG N; E 355 R/FP; A 510 AP	2106	FeE 355; FeE 355 KG; FeE 355 KW	AE 355 KG; AE 355 DD	SM 490 A; SM 490 B; SM 490 C; SM 490 YA; SM 490YB STK 490 YB; STK 490; STK 500; SM 50 A; SM 50 B	15GF	P355N
1	1024; K03011; K03014; K12037; K12709	1.0570	S355J2G3 (S355J2); St 52-3 N (Fe 510 D1)			2132; 2134	fE 510	AE 355 D; Fe 510 D1 FF	SM 490 A; SM 490 B; SM 490 C; SM 490 YA; SM 490 YB; SM 520 B; SM 520 C; STK 490; STK 500; STKM 16 C	17GS; 17G1S	S355J2G3
1	K01600; K02302; K02700; K02701; K02803; K03301; K11803; K12037; K12609; A 299 (A); A 299 (B)	1.0566	P355NL1; TStE 355	225-490 A	A 510 FP	2107	Fe E 355 KT		SLA 365; STK 490; STK 500; SLA 37; STK 50; STK 51		P355NL1

Material Group No.	USA	Germany		U.K.	France	Sweden	Italy	Spain	Japan	Russia	EURONORM
	AISI/SAE/ UNS/ ASTM/AA	Werkstoff	DIN	BS	AFNOR	SS	UNI	UNE	JIS	GOST	EN
1	K01600; K02007; K02701; K02803; K117803; K12001; K12037; K12609	1.0565	P355NH; WStE 355	225/490; 225-490 A; 500 Nb	A 510 AP	2106	FeE 355-2; FeE 355 KW				P355NH
1	K12037	1.0549	S355 NLH; TStE 355	50 EE		2135	Fe 510 D	FeE 355 KTM			S355 NLH
1	K12000	1.0553	S355JO; St 52-3 U; Fe 510 C	50 C; 4360-50C	E 36-3		Fe 510 C FN	AE 355 C	SCC 3		S355JO
1	A 252 (1); A 252 (2); A 252 (3)	1.0547	S355JOH; St 52-3 U	50 C; 4360-50C	TSE 355-3; E 36-3		Fe 510 C	AE 355 C; Fe 510 C			S355JOH
1	K02502	1.0036	S235JRG1; S235JR; Fe 360 B; USt 37-2	Fe 360 B FU; Fe 360 B FN		1311; 1312	Fe 360 B; Fe 360 C; Fe 360 D	AE 235 B; Fe 360 B		16D; St3Kp	
1	1020; 1022; 1023; G10200; G10220; G10230	1.0402	C22	055 M 15; 070 M 20; En 3 A; En 3 B; En 3 C; En 2; 22 HS; 22 CS	AF 42 C 20; XC 25; 1 C 22	1450	C 20; C 21	F.112; 1 C 22	S 20 C; S 22 C	20	C22; 2C/2D
1	K01701; K02505; K02704; K02801	1.0425	P265GH; H II	151-400; 154-400; 161-400; 164-400	A 42 CP; A 42 AP	1431; 1430; 1432	Fe 410 1 KW; Fe 410 1 KG; Fe 410 1 KT; Fe 410 2 KW; Fe 410 2 KG	A 42 Grado RC I; A 42 Grado RC II; F.6306; F.6307	SG 295; SGV 410; SGV 450; SGV 480; SPV 315; SPV 355; SG 30; SGV 42; SGV 46; SGV 49; SPV 32; SPV 36	16K; 20K	P265GH
1	A27 65-35	1.0443	HX300PD; H300PD; H 300 PD		E 23-45 M	1305					HX300PD
1	K12000; K12037	1.0546	S355NL; TStE 355	50 EE; 4360-50EE	E 355 FP	2135; 2135-01	FeE 355 KT	AE 355 Grado KT			
1	K12709	1.0545	S355N; StE 355	50 E; 4360-50E	E 355 R	2134	FeE 355 KG	AE 355 Grado KG	SM 490 A; SM 490 B; SM 490 C; SM 490 YA; SM 490 YB; SM 50 A; SM 50 B; SM 50 C; SM 50 YA; SM 50 YB		S355N
1	K02705; K02305; K12709	1.0539	S355NH; StE 335 N	S355NH	S355NH; TSE 355-4	2134-04	Fe 510 B	Fe 355 KGN			S355NH
1	1213; 1215; G12130; G12150	1.0715	11SMn30; 9 SMn 28	230 M 07; 220 M 07	S 250	1912	CF 9 S 22	F.210.A; F.210.L; 11 SMn 28; F.2111	SUM 22		11SMn30
1		1.0722	10SPb20; 10 SPb 20		10 PbF 2		CF 10 SPb 20	10 SPb 20; F.2122			10SPb20

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	AISI/SAE/ UNS/ ASTM/AA	Werkstoff	DIN	BS	AFNOR	SS	UNI	UNE	JIS	GOST	EN
1	1215; G12150; A 29 (1215); A 108 (1215); A 510 (1215); A 510 (1215); A 519 (1215); A 521 (1215)	1.0736	11SMn37; 9 SMn 36		S 300		CF 9 Mn 36	12 SMn 35; F.2113	SUM 25		11SMn37
1	12L14; 12 L 14; G12144	1.0737	11SMnPb37; 9 SMnPb 36		S 300 Pb	1926	CF 9 SMnPb 36	12 SMnPb 35; F.2114			11SMnPb37
1	1010; G10100	1.1121	C10E; Ck 10	040 A 10; 045 M 10; En 2 A; En 2 A/1; En 2 B; En 32 A	C10RR; XC 10	1265	2 C 10; 2 C 15; 1 C 10; C 10	C 10 k; F.1510	S 09 CK; S 10 C	08; 10	C10E
1	1015; 1017; G10150; G10170	1.1141	C15E; Ck 15	080 A 15; 080 M 15; En 32 C	XC 12; XC 15; XC 18	1370	1 C 15; C 15	C 16 k; F.1511; F.1110; C 15 k	S 15 C; S 15 CK	15	C15E
1	1020; G10200; K02301; K02595; K02596; K02597; K02598; K02599; K02702; K03000	1.0044	S275JR; St 44-2; Fe 430 B	En 43 B; Fe 430 B; 43/25 HR; 43/25 HS; 43 B; HFW 4; HFS 4; ERW 3; CEW 4; SAW 4	E 28 A; NFA 35-501 E 28	1411; 1412	Fe 430 B FN	AE 275 B; Fe 430 B FN	SN 400 B; SN 400 C; SN 490 B; SN 490 C; SS 400; STK 400; STKM 19 C; STKR 400; 19 C; SS 41; STK 41	St4ps; St4sp	S275JR
1		1.0250	S320GD; StE 320-3 Z		S 320 GD				SGC 440; SZAC 440; SZAH 440; SGLH 440		S320GD
1		1.0453	P265NL; P 265 NL								P265NL
1		1.0338	DC04; St 4; St 14	CR 1; CS 2	ES	1147	FeP 04	AP 04; FeP 04	SPCE; HR 4	08JuA	DC04
1											
1	K02001; K02601; K02701	1.0116	S235J2G3 (S235J2); St 37-3 N; Fe 360 D 1	Fe 360 D1 FF; 37/23 CR; 37/23 CS; 37/23 HR; 37/23 HS; 40 D; HFW 4; HFS 4	E 24-3; E 24-4; E 24-U	1312; 1313	Fe 360 C; D; Fe 360 C FN; Fe 360 D FF; Fe 37-2		SS 330; SS 34	16D; St3sp	S235J2G3
1	1015; 1017; G10150; G10170	1.0401	C15; C 15	080 A 15; 080 M 15; En32 C; 17 CS; 17 HS	C18RR; XC 18; C 18; AF 37 C 12	1350	1 C 15; C15; C16	F.111	S 15 C		C15
1		1.0347	DC03; RRSt; RRSt 13	CR2; CR3; CS3; 1449 3 CR; 1449 2 CR	E	1146	FeP 02; FeP 03	AP 02; AP02; FeP03	SPCD; CR 3	08Ju	DC03
1	K01500; K01702; K02401; K02502; K03000; A570.36	1.0038	S235JR; S235JRG2; RSt 37-2; Fe 360 B	Fe 360 B FU; 37/23 CR; 37/23 CS; 37/23 HR; 37/23 HS; HFW 3; HFS 3; 40 B	E 24-2 NE	1312	Fe 360 B FN	AE 235 B FN; AE 235 B FU; Fe 360 B FN; Fe 360 B FU	SS 330; SS 34	St3ps; St3sp	S235JR

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	AISI/SAE/ UNS/ ASTM/AA	Werkstoff	DIN	BS	AFNOR	SS	UNI	UNE	JIS	GOST	EN
1	J03001	1.0446	GE240; GS-45	A 1					230-450; 230-450 W	25L-3	GE240
2	1035; G10350	1.0501	C35G; C 35 G	080 M 30; En 5; 080 M 36	C 35; AF 55; 1 C 35; XC 38	1572; 1550	C 35; 1 C 35	F.113	S 35 C; S 35 CM		C35G
2	1035; G10350	1.1183	C35G; C 35 G; Cf 35	080 A 35	XC 38 TS	1572	C 36; C 38	F.1130; C 35 k	S 35 C; S 35 CM	35	C35G
2	1039; G10390	1.1157	40Mn4; 40 Mn 4		35 M 5					40G	
2	1040; G10400	1.0511	C40; C 40	En 8; 080 M 40	AF 60; C 40; 1 C 40		C 40; 1 C 40	F.114.A			C40
2	1045; 1045 H; 1042; G10450; H10450; G10420	1.1191	C45E; Ck 45	080 H 46; 080 M 46	C45RR; XC 45; XC 48 H-1	1672	C 45	F.1140; F.1142; C 45 k; C48 k	S 45 C; S 45 CM; S 48 C	45	C45E
2	1025; G10250	1.1158	C25E; Ck 25	070 M 26	2 C 25; XC 25		C 25	F.1120; C 25 k	S 25 C; S 28 C	25	C25E
2	1043; 1045; G10430; G10450	1.0503	C45; C 45	080 M 46	C 45; AF 65; C 45; 1 C 45	1650	C 45; 1 C 45	F.114	S 45 C; S 45 CM	45	C45
2	1050; 1055; G10500; G10550	1.1213	C53G; C53E; Cf 53		XC 48 TS		C 53		S 50 C; S 50 CM	50	
2	1140; G11400	1.0726	35S20; 35 S 20	212 M 36	35 MF 4	1957		F.210.G; 35 MnS 6; F.2131			35S20; 8M
2	1139; 1146; G11390; G11460	1.0727	46S20; 45 S 20		45 MF 4						46S20
2	K12000	1.0553	S355J0; St 52-3 U; Fe 510-C	50 C	E 36-3		Fe 510 C FN	AE 355 C	SCC 3		S355J0
2		1.0551	S355JRC								S355JRC
2	K02700; K02803; K03103; K03300; K12437	1.0473	P355GH; 19 Mn 6		A 52 CP	2101; 2102	Fe E 355-2	A 52 RC I, RA II	SGV 410; SGV 450; SGV 480		P355GH
2		1.0416	C18D; GS-38		20-400 M	1306					C18D
2	K12447	1.0577	S355J2; S355J2G4; Fe 510 D2		A 52 FP	2107		A 52 RB II; AE 355 D			
2	1049; 1050; G10490; G10500	1.1206	C50E; Ck 50	080 M 50	XC 50; 2 C 50	1674	C 50			50	C50E
2	1330; 1527; G13300; G15270	1.1170	28Mn6	150 M 19; En 14 A; En 14 B	20 M 5		C 28 Mn		SCMn 1	30G	28Mn6
2	1034; 1035; 1038; G10340; G10350; G10380; C 1034	1.1181	C35E; Ck 35	080 M 30; En 5; 080 M 36	XC35RR; XC32; XC 35; XC 38 H 2; XC 38 H 1; 2 C 35	1572	C 35	F.1130; C 35 k	S 35 C; S 35 CM; S 38 C	35	C35E
2		1.1180	C35R; Cm 35	080 A 35	XC 38 H 1 u; Cm 35		C 35	F.1135; C 35 k-1			C35R

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	AISI/SAE/ UNS/ ASTM/AA	Werkstoff	DIN	BS	AFNOR	SS	UNI	UNE	JIS	GOST	EN
2	1030; G10300	1.1178	C30E; Ck 30	080 M 30; En 5	XC 32		C 30	2 C 30	S 30 C; S 30 CM		C30E
2	1049; 1050; G10490; G10500	1.0540	C50	En 43 A; 080 M 50	C50	1674	C 50	1 C 50	S 50 C		C50
2	1536; G15360	1.1166	34Mn5					TO.B	SMn 433 H; SMn 433 HRCH; SMn 433 RCH; SMn 1 H		
2	1025; G10250	1.0406	C25	070 M 26	1 C 25		C 25; 1 C 25				
2		1.0723	15S22; 15 S 20	210 A 15; 210 M 15		1922		F.210F; F.210.F	SUM 32		
2		1.1730	C45U; C45W; C 45 U; C 45 U								C45U
3	1045; 1049; G10450; G10490	1.1201	C45R; Cm 45	080 M 46	3 C 45; XC 42 H 1; XC 48 H 1 u	1660	C 45	F.1145; F.1147; C 45 k-1; C 48 k-1	S 45 C; S 45 CM	45	C45R
3	1040; G10400	1.1186	C40E; Ck 40	080 M 40; En 8	2 C 40; XC 42 H 1		C 40		S 40 C	40	C40E
3	1074; 1075; G10740; G10750	1.0614	C76D; C 76 D; D 75-2		XC 75		3 CD 75			75	C76D
3	1095; G10950	1.0618	C92D; C 92 D; D 95-2	95 HS; 95 CS	XC 90		3 CD 95				C92D
3	1086; G10860	1.0616	C86D; C 86 D; D 85-2	80 HS; 80 CS	XC 80		C 85; 3 CD 85				C86D
3		1.1165	G28Mn6; GS-30 Mn 5	A 5; A 6				30 Mn 5; AM 30 Mn 5; F.120.D; F.8211; F.8311	SCMn 2	27ChGSNMDTL; 30GSL	G28Mn6
3	K01700; K02001; K02200; K02201; A 516 Gr.70; A 515 Gr. 70; A 414 Gr.F; A 414 Gr.G	1.0481	P295GH; 17Mn4; 17 Mn 4	224-469 B	A 48 CP; A 48 AP	2102	Fe 295	A 47 RC I; RA II	SG 365; SGV 410; SGV 450; SGV 480; SPV 315; SG 37; SGV 42; SGV 46; SGV 49; SPV 32	14G2	P295GH
3	1043; 1045; G10430; G10450	1.0503	C45; C 45	080 M 46	C 45; AF 65; C 45; 1 C 45	1650	C 45; 1 C 45	F.114	S 45 C; S 45 CM		C45
3	1335; 1335 H; 1541; 1541 H; G13350; G15410; H13350; H15410	1.1167	36Mn5; 36 Mn 5	150 M 36	40 M 5; 35 Mn 5	2120		F. 1203-36 Mn 6; F. 8212-36 Mn 5	SMn 438; SMn 438H; SCMn 3	35G2; 35GL	36Mn5
3	1045; 1045 H; 1042; G10450; H10450; G10420	1.1191	C45E; Ck 45	089 H 46; 080 M 46	C45RR; XC 45; XC 48 H 1	1672	C 45	F.1140; F.1142; C 45 k; C 48 k	S 45 C; S 45 CM; S 48 C	45	C45E
3		1.1303	38MnVS6; 38 MnVS 6								38MnVS6

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	AISI/SAE/ UNS/ ASTM/AA	Werkstoff	DIN	BS	AFNOR	SS	UNI	UNE	JIS	GOST	EN
4	1055; G10550	1.0535	C55	070 M 55; En 9	C54; 1 C 55; AF 70; C 55	1655	C 55; 1 C 55	F.115	S 55 C; S 55 C-CSP; S 55 CM	55	C55
4	1055; G10550	1.1203	C55E; Ck 55	070 M 55; En 9	C50RR; XC 54; XC 50; 2 C 55; XC 55 H 1	1655	C 55	F.1150; C 55 K	S 55 C; S 55 C-CSP; S 55 CM	55	C55E
4	1060; G10600	1.0601	C60	060 A 62; En 43 D	C60; 1 C 60		C 60; 1 C 60		S 58 C; S 60-C-CSP; S 60 CM; S 65 C-CSP; S 65 CM	60; 60G	C60; 43D
4	1070; G10700	1.1231	C67S; Ck 67	060 A 67; 080 A 67; En 43 E	C68RR; XC 68	1770	C 67		S 70 C-CSP; S 70 CM	65GA; 68GA	C67S
4	1074; 1075; 1078; G10700; G10750; G10780	1.1248	C75S; Ck 75	060 A 78; 80	C75RR; XC 75	1774	C 75		S 75 CM	75A	C75S
4	1095; G10950	1.1274	C100S; Ck 101	95	C100RR; XC 100	1870	C 100		SK 95 -CSP		C100S
4	W112; W1; T72301	1.1563	C125U; C 125 W		Y2 120; C120E3U		C 120 KU	F.5123; C 120	SK 120; SK 120 M; SK 2; SK 2 M; TC 120	U12-1	C125U
4	1086; G10860	1.1269	C80S; Ck 85; C 85 E		C90RR; XC 90		C 85		SK 85-CP	85A	C80S
4	1055; G10550	1.1209	C55R; Cm 55	070 M 55; En 9	3 C 55; XC 55 H 1		C 55	F.1155; C 55 k-1			C55R
4	1074; 1075; G10740; G10750	1.0605	C75	060 A 78	C 75		C 75			75	
4	1070; G10700	1.0603	C67	060 A 67; 080 A 67; En 43 E; 1449 70 HS	C68; XC 65		C 67		S 70 C-CSP; S 70 CM		C67
4		1.1219	C56E2; Cf 54						C56E2; S55C		C56E2
5	1055; G10550	1.1220	C56D2; C 56 D 2		C 56 D 2						C56D2
5		1.1217	C90S; C 90 S	CS95	C90RR; XC 90; XC90; C90E2U				SK 95		C90S
5	1060; 1064; G10600; G10640	1.1221	C60E; Ck 60	060 A 62; 070 M 60; En 43 D	C60RR; XC 60; X 65; 2 C 60	1678	C 60		S 58 C; S 60 C-CSP; S 60 CM; C 65 C-CSP; C 60 CM	60GA	C60E
5	1055; G10550	1.1203	C55E; Ck 55	070 M 55; En 9	C50RR; XC 54; XC 50; XC 55 H 1; 2 C 55	1655	C 55	F.1150; C 55 k	S 55 C; S 55 C-CSP; S 55 CM	55	C55E
6	9260; G92600	1.5028	65Si7; 65 Si 7		60 S 7				50 P 7; SUP 6; SUP 6 M; SUP 7; SWOSM	60S2G	

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	AISI/SAE/ UNS/ ASTM/AA	Werkstoff	DIN	BS	AFNOR	SS	UNI	UNE	JIS	GOST	EN
6	9260 H; H92600; 9260; G92600	1.5027	60Si7	251 A 60; 251 H 60	60 S 7		60 Si 7	F.144.B; F.1441		60S2	
6	9255; G92550	1.5026	56Si7; 56 Si 7; 55Si7; 55 Si 7	251 A 58; En 45 A	55 S 7	2085; 2090	55 Si 7	F.144; F.144.A; 56 Si 7; F.1440		55S2; 60S2	565Si7; 55Si7
6	9255; G22550	1.5025	51Si7; 51 S 7		50S7; 51 Si 7		48 Si 7; 50 Si 7	F.145.B			51Si7
6		1.5024	46Si7		45 S 7; Y 46 S 7; 46 SI 7			F.1451			46Si7
6	G50986; ASTM Grade E50100; ASTM Grade G15116; SAE E50100	1.3501	100Cr2; 100 Cr 2	GCr6; B00040; GCr4	100C2					SchCh4	
6	K21390; K21590; ASTM A 182 F22	1.7380	10CrMo9-10; 10 CrMo 9 10	622; 622-490; 622/515; 622/690	12 CD 9-10; 10 CD 9.10	2218	12 CrMo 9 10	TU.H	SCMQ4E; SCMV 4; SFVA F 22.A; SFVA F 22.B; SFVCM F22B; STBA 24; STFA 24; STPA 24	12Ch8	10CrMo9-10
6	O2; T31502	1.2842	90MnCrV8; 90 MnCrV 8	BO 2; BO2	90 MnV 8; 90 MV 8		90 MnVCr 8 KU	90 MnCrV 8; F.5229			90MnCrV8
6		1.2550	60WCrV7; 60 WCrV 7	BS1; BS 1	55 WC 20	2710	55 WCrV 8 KU; 58 WCr 9 KU	60 WCrSiV 8; F.5242			60WCrV7
6		1.2241	51CrMnV4; 51 CrV 4; 50 CrV 4								
6	L2; T61202	1.2210	115CrV3; 115 CrV 3		100 C 3		107 CrV 3 KU	F.520.L; F.5125			115CrV3
6		1.2419	105WCr6; 105 WCr 6	105WC 13	105 WCr 5; 105 WC 13	2140	107 WCr 5 KU	F.5233; 105 WCr 5	SKS 2; SKS 2 M; SKS 3; SKS 31	ChW1G; ChWG	105WCr6
6	4820; 5120; 5120H; G48200; G51200; H51200	1.7147	20MnCr5; 20 MnCr 5	150 M 19	20 MC 5	2172	20 MnCr 5; Fe52	F.150.D	SMnC 420 H; SMnC 420 RCH; SMnC 21 H	18ChG	20MnCr5
6	9255; G92550	1.0904	55Si7; 55 Si 7	250A53	55 S 7	2085	55 Si 8	56 Si 7			
6	9254; G92550	1.0904	55Si7; 55 Si 7	250 A 53	55 S 7	2090					
6	9262; G95620	1.0961	HDT 450 F; S340 MGC		60 SC 6		60 SiCr 8	60 SiCr 8; F.1442		60S2; 55S2; 50ChFA	
6	4135; 4137; 4135H; 4137H; G41350; G41370; H41350; H41370	1.7220	34CrMo4; GS34 CrMo 4; G34 CrMo 4	708 A 30	34 CD 4; 34CrMo4RR; 35 CD 4;	2234	34 CrMo 4 KB; 35 CrMo 4	35 CrMo 4 DF; F.125.A; F.125.B; F.1254; F.1250	SCM 435 H; SCM 435 HRCH; SCM 435 M; SCM 435 RCH; SCM 435TK; SCM 3 H; STKS 3	35ChM; AS38ChGM	34CrMo4
6		1.5120	38MnSi4; 38 MnSi 4								
6	L3; T61203	1.2067	102Cr6; 102 Cr 6; 100Cr6	BL 3; BL3	100Cr6RR; 100 C 6; 100Cr6; Y 100 C 6		102 Cr 6 KU	F.5230; 100 Cr 6	SUJ 2	Ch	102Cr6
6	L1	1.2108	90CrSi5; 90 CrSi 5			2092	105 WCr 5				90CrSi5

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	AISI/SAE/ UNS/ ASTM/AA	Werkstoff	DIN	BS	AFNOR	SS	UNI	UNE	JIS	GOST	EN
6	P20; T51620	1.2330	35CrMo4; 35 CrMo 4	708 A 37	34 CD 4	2234	35 CrMo 4				35CrMo4
6	O1; T31501	1.2510	100MnCrW4; 100 MnCrW 4	BO1; BO0; BO 1; BO 0	90MnWCrV5; 90 MWCV 5; 8 MO 8	2140	95 MnWCr 5 KU; 10 WCr 6	F.522.A; F.5220; 95 MnCrW5; 105 WCr 5	SKS 31		100MnCrW4
6	S1; T41901	1.2542	45WCrV7; 45 WCrV 7	BS1; BS 1	45 WCrV 8; 45 WCrV 20	2710	45 WCrV 8 KU	F.524; F.5241; 45 WCrSi 8		5ChW25F	45WCrV7
6	L6; T61206	1.2713	55NiCrMoV6; 56NiCrMoV6; 55 NiCrMoV 6; 56 NiCrMoV 6	BH 224; BH 225	55 NCDV 7			F.520.S	SKT 4	5ChNM	55NiCrMoV6
6		1.2721	50NiCr13		55 NCV 6	2550		F.528			
6	E52100; G52986	1.3505	100Cr6; 100 Cr 6	2 S.135; 535 A 99	100Cr6RR; 100 C 6; 100Cr6	2258	100 Cr 6	F.131; 100 Cr 6; F.1310	SUJ 2; SUJ 4	SchCh 15	100Cr6
6	K11820; K12020; K12320; A204 Grade A; A182 Grade F1	1.5415	16Mo3; 15 Mo 3	1503-243 B	15 D 3	2912; 16Mo3	16 Mo 3 KG; 16 Mo 3 KW; 16 Mo 5 KG; 16 Mo 5 KW	F. 2601; 16 Mo 3	STBA 12; STFA 12; STPA 12		
6	4422; G44220; J12522	1.5419	G20Mo5; 20Mo4; GS-22 Mo 4	245; B 1; B1					SCPH 11		G20Mo5
6	A 350-LF 5; K13050; K21703; K22103	1.5622	14Ni6; 14 Ni 6		16 N 6		14 Ni 6 KG; 14 Ni 6 KT	F.2641; 15 Ni 6			14Ni6
6	3415	1.5732	14NiCr10; 14 NiCr 10		14 NC 11		16 NiCr 11	15 NiCr 11	SNC 415; SNC 415 H; SNC 415 M	12ChN3A	14NiCr10
6	3310; 3310 RH; 3312; 3316; 9315; E 3310; E 3316; E9315; G33106	1.5752	15NiCr13; 14NiCr14; 15 NiCr 13; 14NiCr14	655 M 13; 655 H 13; En 36 A	10 NC 12; 12 NC 15; 14 NC 12; 16 NC 12; 16 NCD 13			15 NiCr 11; F.1540	SNC 815 H; SNC 815 HRCH; SNC 815 RCH; SNC 22 H		15NiCr13
6		1.7262	15CrMo5; 15 CrMo 5		12 CD 4			12 CrMo 4; F.150.J; F155; F.1551	SCM 415 H; SCM 415 HRCH; SCM 415 M; SCM 415 RCH; SCM 415 TK; SCM 21 H		15CrMo5
6		1.6587	17CrNiMo6; 17 CrNiMo 6	820A16	18 NCD 6			14 NiCrMo 13			
6	9310; 9310H; 9310 RH; E 9310 H; G93106; H93100; H93106	1.6657	14NiCrMo13-4; 14 NiCrMo 13 4	832 H 13; 832 M 13; S.157; En 36 C	16 NCD 13		15 NiCrMo 13; 16 NiCrMo 12	14 NiCrMo 13; 14 NiCrMo 13-1; F.1560; F.1569			
6	5015; G50150	1.7015	15Cr3; 15 Cr 3	523 M 15	12 C 3; 15Cr2RR; 15 C 2				SCr 415; SCr 415 H; SCr 415 HRCH; SCr 415 RCH; SCr 21 H	15Ch	15Cr3
6	5132; 5132 H; G51320; H51320	1.7033	34Cr4; 34 Cr 4	530 A 32; 530 H 32; 530 M 32	32 C 4		34 Cr 4; 34 Cr KB	35 Cr 4; F.8221	SCr 430; SCr 430 H; SCr 430 HRCH; SCr 430 RCH; SCr 2 H	35Ch	34Cr4

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	AISI/SAE/ UNS/ ASTM/AA	Werkstoff	DIN	BS	AFNOR	SS	UNI	UNE	JIS	GOST	EN
6	5140; 5140 H; 5140 RH; G51400; H51400	1.7035	41Cr4; 41 Cr 4	530 A 40; 530 M 40; 530 H 40; En 18	42 C 4		41 Cr 4; 41 Cr 4 KB	41 Cr 4 DF; F.1211; F.1202	SCr 440; SCr 440 H	40Ch	41Cr4
6	5140; G51400	1.7045	42Cr4; 42 Cr 4	530 A 40	42 C 4 TS	2245	41 Cr 4	42 Cr 4	SCr 440		
6	5115; 5117; G51150; G51170	1.7131	16MnCr5; 16 MnCr 5	527 M 17; 590 H 17; 590 M 17	16MnCr5RR; 16 MC 5	2173	16 MnCr 5	F.1516		18ChG	16MnCrS5
6		1.7139	16MnCrS5; 16 MnCrS 5		BGH 7139; BOHLER E 411; VW 4221; OPEL QS1916; PROCONS 7139; E411; SES	2127					16MnCrS5
6	5155; 5155 H; 5150; G51550; H51550; G51600	1.7176	55Cr3; 55 Cr 3	525 A 58; 525 A 60; En 48	55 C 3; 55Cr3	2253	55 Cr 3	F.1431	SUP 9; SUP 9 A; SUP 9 M	50ChGA	55Cr3
6	4142; G41420	1.7223	41CrMo4; 41 CrMo 4		MOC 2; V320		41 CrMo 4	42 CrMo 4	SNB 22-1	40ChFA	
6	4140; 4140 H; 4140 RH; 4142; 4142 H; 4145; G41400; H41400; G41420; H41420; K14248; K14047	1.7225; 1.7227	42CrMo4; 42CrMo4V; 42 CrMo 4; 42 CrMo 4 V	708 M 40; 709 M 40; En 19; En 19 A	42 CD 4; 40 CD 4; 42CrMo4RR	2244; 42CrMo4	42 CrMo 4; 38 CrMo 4 KB; 41 CrMo 4	TO.D; TU.L	SCM 440 H; SCM 440 HRCH; SCM 440 M; SCM 440 RCH; SCM 440 TK; SNB 7 Class 2; SCM 4 H; SNB 22-1	40ChFA	42CrMo4
6	4147; 4147 H; 4150; 4150 H; 8650; 8650 H; G41470; G41500; G86500; H41470; H41500; H86500	1.7228	50CrMo4; 50 CrMo 4	708 M 40; 708 A 47		2512	653 M 31		SCM 445 H; SCM 445 HRCH; SCM 445 RCH; SCM 5 H		50CrMo4
6	8620; G86200	1.7321	20MoCr4; 20 MoCr 4			2625				BGH 7321; E320; SIQUAL 7321	20MoCr4
6	K11547; K11562; K11564; K11757; K11789; K12052; ASTM A182 F12	1.7335	13CrMo4-5; 13 CrMo4 4	620; 620-440; 620-470; 620-540; 621	15 CD 4-05	2216	14 CrMo 3; 14CrMo4 5	TU.E; TU.F; F.2631; 14 CrMo 4 5	SCMV 2; SFVA 12; STBA 22; STFA 22; STPA 20; STPA 22	12ChM; 15ChM	13CrMo4-5
6	K21390; K21590; ASTM A182 F22	1.7380	10CrMo9-10; 10 CrMo 9 10; GS-12CrMo9-10; GS-12 CrMo 9 10; G 12 CrMo9-12	622; 622-490; 622/515; 622/690; 1502-622	12 CD 9-10; 10 CD 9.10	2218	12 CrMo 9; 12 CrMo 10	TU.H	SCMQ 4 E; SCMV 4; SFVA F 22 A; SFVA F 22 B; SFVCM F 22 B; STBA 24; STFA 24; STPA 24	12Ch8	10CrMo9-10

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	AISI/SAE/ UNS/ ASTM/AA	Werkstoff	DIN	BS	AFNOR	SS	UNI	UNE	JIS	GOST	EN
6		1.7715	14MoV6-3; 14 MoV 6 3	1503-660-440				13 MoCrV 6			
6	E71400; K24065; K24728; A355 Class A	1.8509	41CrAlMo7-10; 41CrAlMo7; 41 CrAlMo 7	905 M 39; En 41 B	40 CAD 6.12	2940	41 CrAlMo 7	F.174; 41 CrAlMo 7; F1740	SACM 645; SACM 1	38Ch2MJuA	41B
6		1.6566	17NiCrMo6-4								17NiCrMo6-4
6	P20+S	1.2312	40CrMnMoS8-6		40 CMD 8 S						
6		1.7149	20MnCrS5; 20 MnCrS 5								20MnCrS5
6	P20+Ni	1.2738	40CrMnNiMo8-6-4; 40 CrMnNiMo 8 6 4		40 CMND 8					40Ch2GNM	40CrMnNiMo8-6-4
6		1.2311	40CrMnMo7; 40 CrMnMo 7		40 CMD 8		35 CrMo 8 KU	F.5302			40CrMnMo7
6		1.7238	49CrMo4; 49 CrMo 4								
6	4150; G41500	1.7701	52CrMoV4; 51CrMoV4; 51 CrMoV 4		51 CDV 4; 51CrMoV4		51 CrMoV 4				51CrMoV4
6		1.7337	16CrMo4-4; 16 CrMo 4 4				A 18 CrMo 45 KW		SCM 415 M; SCM 415; STBA 22; SFVA F12		
6		1.7242	16CrMo4; 16 CrMo 4		15 CD 3.5		18 CrMo 4	F.1550; 18 CrMo 4	SCM 418 H; SCM 418 HRCH; SCM 418 RCH; SCM 418 TK		16CrMo4
6	4419; 4419 H; 4520; G44190; H44190; G45200; K11522; K11820; K12020; K12023; K12320; K12821	1.5423	16Mo5				16 Mo 5 KG; 16 Mo 5 KW	TU.D; F.2602	SB 450 M; SB 480 M; SB 46 M SB 49 M		
6										30ChGSA	
6	HY-80; HY 80; HY80; K31820; MIL-S-21952										
6				605 M 36; En 16; En 16T							
7	4130; 4130 H; 4130 RH; G41300; H41300	1.7218	25CrMo4; 25 CrMo 4; GS-25 CrMo 4; G 25 CrMo 4	708 A 25	25 CD 4	2225	25 CrMo 4; 25 CrMo KB	F.222; F.1256	SCM 420 TK; SCM 430 M; SCM 430 RCH; SCM 430 TK; STKS 1	20ChM; 30ChM	25CrMo4
7		1.8070	21CrMoV5-11; 21 CrMoV 5 11				35 NiCr 9				
7		1.7755	GS-35 CrMoV 10 4; G35 CrMoV 10-4								
7		1.7733	24CrMoV5-5		20 CDV 6		21 CrMoV 5 11				
7	4340; 4340 H; 9850; G43400; G98500; H43400; K23028	1.6565	40NiCrMo6; 40 NiCrMo 6	817 M 40; En 24				F.1275; 40 NiCrMo 7	SNB 24-1; SNB 24-2; SNB 24-3; SNB 24-4; SNB 24-5; SNCM 439 RCH	40Ch2N2MA	40NiCrMo6

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	AISI/SAE/ UNS/ ASTM/AA	Werkstoff	DIN	BS	AFNOR	SS	UNI	UNE	JIS	GOST	EN
7	8640; 8640 H; 8740; 8740 H; 8742; G86400; G87400; G87420; H86400; H87400; K11640	1.6546	40NiCrMo2-2; 40 NiCrMo 2 2		40 NCD 2; 40 NCD TS		40 NiCrMo 2; 40 NiCrMo 2 KB	40 NiCrMo 2 DF; F.1205; F.1204; TO.E	SNCM 240; SNCM 240 RCH	38ChGNM	
7	8617; 8617 H; 8620; 8620 RH; 8620 H; 8617; G86170; G86200; H86170; H86200; K12147	1.6523	20NiCrMo2-2; 21NiCrMo2; 21 NiCrMo 2	805 H 20; 805 M 20; 806 M 20; En 362	20 NCD 2	2506	20 NiCrMo 2	20 NiCrMo 2; 20 NiCrMo 3-1; F.1522; F.1534	SNCM 220; SNCM 220 H; SNCM 220 HRCH; SNCM 220 M; SNCM 220 RCH; SNCM 21 H	20ChGNM	20NiCrMo2-2
7		1.5755	31NiCr14; 31 NiCr 14	653 M 31	18 NC 13						
7	3135	1.5710	36NiCr6; 36 NiCr 6	640 A 35	35 NC 6				SNC 236		36NiCr6
7	4340; G43400; 4337; G43370	1.6582	34CrNiMo6; 34 CrNiMo 6	816 M 6; 817 M 40	34 CrNiMo 8; 35 NCD 6	2541	35 NiCrMo 6 KB	F.1272		38Ch2N2MA	34CrNiMo6
7		1.8519	31CrMoV9; 31 CrMoV 9							30Ch3MF	31CrMoV9
7	8630	1.6545	30NiCrMo2-2; 30 NiCrMo 2 2		30 NCD 2		30 NiCrMo 2 KB				
7	4340; G43400	1.6580	30CrNiMo8	823 M 30	30 CND 8; 30 NCD 8			30 CrNi Mo 8	SNCM 431		
7	K01907	1.5217	20MnV6; 20 MnV 6 N	55 C; GR 55; Grade 55	20MV6; TS E 455 4; TU E 455 4						20MnV6; S460
7	300M; 4340M; K44220	1.6928	41SiNiCrMoV7-6	S 155							
8		1.8523	40CrMoV13-9; 39CrMoV13-9; 39 CrMoV 13 9	897 M 39			36 CrMoV 12				40CrMoV13-9
8		1.8515	31CrMo12; 31 CrMo 12	722 M 24	30 CD 12	2240	32 CrMo 12	F.1712; F.124.A			31CrMo12; 40B
8		1.8161	58CrV4; 58 CrV 4								
8		1.7361	32CrMo12; 32 CrMo 12	722 M 24	30 CD 12	2240	30 CrMo 12	F.124.A			32CrMo12
8	9840; G98400	1.6511	36CrNiMo4; 36 CrNiMo 4	817 M 37; 816 M 40	40 NCD 3; 35 NCD 5		39 NiCrMo 4; 39 NiCrMo 4 KB	F.128; F.1280; 35 NiCrMo 4	SUP 10	40ChGNM; 40ChN2MA	36CrNiMo4
8	6145; 6150; 6150 H; G61500; H61500	1.8159	51CrV4; 50CrV4; 50 CrV 4	735 A 50; 735 A 51; 735 H 51; 735 M 50; En 47	50CrV4RR; 50 CV 4; 51 CV 4	2230	50 CrV 4	F.143; F.143.A; 51 CrV 4; F.1430	SUP 10; SUP 10-CSP; SUP 10 M	50ChFA; 50ChGFA	51CrV4
8	3435	1.5736	36NiCr10; 36 NiCr 10		30 NC 11				SNC 631; SNC 631 H; SNC 631 M		
8	A128 Grade A; J91109; J91129; J91139; J91149	1.3401; 1.3403	X120Mn12; X 120 Mn 12; G-X120 Mn 12	BW 10	Z 120 M 12	2183	GX 120 Mn 12	F.240.A; F.240.A1; AM-X 120 Mn 12; F.8251	SCMnH 1; SCMnH 11	110G13L	
8	4142; G41420	1.2332	47CrMo4	708 M 40	42 CD 4	2244	42 CrMo 4	42 CrMo 4	SCM; SCM 440		47CrMo4

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	AISI/SAE/ UNS/ ASTM/AA	Werkstoff	DIN	BS	AFNOR	SS	UNI	UNE	JIS	GOST	EN
8	4140 H; 4140 RH; 4140 HT		42CrMo4+QT								
8											
8											
8		1.8705	21MnCr6-5								
8											
9		1.6659	31NiCrMo13-4	830 M 31		2534		F.270			
9		1.5864	35NiCr18								
9											
9											
9											
9		1.8715	17MnCr5-3								17MnCr5-3
10	K71340; K81340	1.5662	X8Ni9	1501-509; 1501-510; 502-650; 509-690	9 Ni; Z 8 N 09		X 10 Ni 9; X 12 Ni 09	F.2645; XBNi 09	SL9N520; SL9N590; STBL 690; STPL 690; SL9N53; SL9N60; STBL 70; STPL 70		X8Ni9
10	2515; A2515; 2517; E2517; K41583	1.5680	X12Ni5; 12Ni19;		Z 18 N 5; Z 10 N 05; 5 Ni				SL5N590; SL5N60		X12Ni5
10	D4; T30404; D6; T30406	1.2436	X210CrW12; X 210 CrW 12	BD6	Z 200 CD 12; Z 210 CW 12-01; X210CrW12-1	2312	X 215 CrW 12 1 KU	F.5213; X210 CrW 12	SKD 2		X210CrW12
10	H13; T20813	1.2344	X40CrMoV5-1; X40 CrMoV 5 1	BH 13	X 40 CrMoV 5; Z 40 CDV 5	2242	X 40 CrMoV 5 1 1 KU	F.5318; X 40 CrMoSiV 5	SKD 61	4Ch5MF1S	X40CrMoV5-1
10	A2; T30102	1.2363	X100CrMoV5; X100CrMoV5-1; X 100 CrMoV 5 1	BA 2	X 100 CrMoV 5; Z 100 CDW 5	2260	X 100 CrMoV 5 1 KU	F.536; F.5227; X 100 CrMoV 5	SKD 12		X100CrMoV5
10	H21; T20821	1.2581	X30WCrV9-3; X30WCrV9 3	BH 21	Z 30 WCV 9		X 30 WCrV 9 3 KU	F.5323; X 30 WCrV 9	SKD 5	3Ch2W8F	X30WCrV9-3; X30WCrV9 3
10		1.2601	X165CrMoV12; X 165 CrMoV 12			2310	X165CrMoW 12KU				X165CrMoV12
10		1.2316	X36CrMo17; X38CrMo16								X38CrMo16
10	M2; T11302	1.3343	HS6-5-2; HS 6-5-2; S 6-5-2	BM 2; BM2	Z 85 WDCV 06-05-04-02; 6-5-2; HS6-5-2	2722		F.550.A; F.5604	SKH 51	R6M5	HS6-5-2
10	H11; T20811	1.2343	X37CrMoV5-1; X38CrMoV5-1	BH 11	Z 38 CDV 5; X38CrMoV		X 37 CrMoV 5 1 KU	F.520.G; F.5137; X 37 CrMoSiV 5	SKD 6	4Ch5MFS	X37CrMoV5-1
10	H12; T20812	1.2606; 1.2605	X37CrMoW5-1; X 37 CrMoW 5 1; X35CrWMoV5; X 35 CrWMoV 5	BH 12	Z 35 CWDV 5; X35CrWMoV5		X 35 CrMoW 05 KU	F.537	SKD 62	5ChNM	X37CrMoW5-1; X35CrWMoV5
10	D2; T30402	1.2379	X153CrMoV12; X155CrVMo12-1; X155 CrVMo 12 1	BD 2	X 160 CrMoV 12; Z 160 CDV 12	2310	X 155 CrVMo 12 1 KU	F.520.A	SKD 10; SKD 11		X153CrMoV12
10		1.2085	X33CrS16; X 33 CrS 16		Z 35 V CD 17.S						X33CrS16
10		1.2162	21MnCr5; 21 MnCr 5		20 MC 5						21MnCr5
10		1.2767	X45NiCrMo4; 45NiCrMo16; X 45 NiCrMo 4		45 NCD 16		40 NiCrMoV 8 KU				X45NiCrMo4
10		1.2764	X19NiCrMo4; X 19 NiCrMo 4; GX19NiCrMo4								X19NiCrMo4

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	AISI/SAE/ UNS/ ASTM/AA	Werkstoff	DIN	BS	AFNOR	SS	UNI	UNE	JIS	GOST	EN
10	D3; T30403	1.2080	X210Cr12; X 210 Cr 12	BD 3	X200Cr12; Z 200 C 12		X 205 Cr 12 KU	F.521; F.5212; X 210 Cr 12	SKD 1	Ch12	X210Cr12
10		1.2367	X38CrMoV5-3; X 38 CrMoV 5 3								X38CrMoV5-3
10		1.6957	27NiCrMoV15-6; 26NiCrMoV14-5; 26 NiCrMoV 14 5								
10	501; 502; S50100; S50200; K41545	1.7362	X12CrMo5; X 11 CrMo 5; 12CrMo19-5; 12 CrMo 19 5					F.240.B; TU.J	SCMV 6; SFVA F 5 A; SFVA F 5 B; SFVA F 5 C; SFVA 5 D; SNB 5 Class 1; STBA 29; STFA 25; STPA 25		X12CrMo5
11	M33; T11333; M34; T11334	1.3249	HS2-9-2-8; S 2-9-2-8	BM 34				2-9-2-8; F.5611			
11	M41; T11341	1.3246	HS7-4-2-5; S 7-4-2-5		Z 110 WKCDV 07-05-04-04-02			F.5615; HS 7-4-2-5			HS7-4-2-5
11	M42; T11342	1.3247	HS2-10-1-8; S 2-10-1-8	BM 42	Z 110 DKCWV 09-08-04-02-01; 2-9-1-8; HS2-9-1-8	2716	HS 2-9-1-8	F.5617; HS 2-10-1-8	SKH 59		HS2-10-1-8
11		1.3207	HS10-4-3-10; S 10-4-3-10	BT 42	Z 130 WKCDV 10-10-04-04-03; 10-4-3-10; HS10-4-3-10		HS 10-4-3-10	F.550.B; F.5553; HS 10-4-3-10	SKH 57	R12F3K10M3-SCh	HS10-4-3-10
11	T15; T12015	1.3202	HS12-1-4-5; S 12-1-4-5	BT 15	HS12-1-4-5		HS 12-1-5-5	F.5563; HS 12-1-5-5		R13F4K5	
11		1.3243	HS6-5-2-5; S 6-5-2-5	BM 35	6-5-2-5; 6-5-2-5 HC; HS6-5-2-5; HS6-5-2-5HC; Z 85 WDKCV 06-05-05-04-02; Z 90 WDKCV 06-05-05-04-02	2723	HS 6-5-2-5	F.550.C; F.5613; HS 6-5-2-5	SKH 55	R6M5K5	HS6-5-2-5
11	M7; T11307	1.3348	HS2-9-2; S 2-9-2		Z 100 DCWV 09-04-02-02; 2-9-2; HS2-9-2	2782	HS 2 9 2	F.5607; HS 2-9-2	SKH 58		HS2-9-2
11	T4; T12004	1.3255	HS18-1-2-5; S 18-1-2-5	BT 4	Z 80 WKCV 19-05-04-01; HS 18-1-1-5		HS 18-1-1-5	F.5530; HS 18-1-1-5	SKH 3		HS18-1-2-5
11	T1; T12001	1.3355	HS18-0-1; S 18-0-1	BT 1	18-0-1; HS 18-0-1; Z 80 WCV 18-04-01	2750	HS 18-0-1	F.5520; HS 18-0-1	SKH 2	R18	HS18-0-1
11											
11											
11											
11											
11											
11											
11			X10NiMoCrV6								
12	430 F; S43020	1.4104	X12CrMoS17; X 12 CrMoS 17		Z 13 CF 17	2383	X 10 CrS 17	F.3413	SUS 430 F		X12CrMoS17
12	S31500	1.4417	GX2CrNiMoN25-7-3			2376					GX2CrNiMoN 25-7-3

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	AISI/SAE/ UNS/ ASTM/AA	Werkstoff	DIN	BS	AFNOR	SS	UNI	UNE	JIS	GOST	EN
12		1.4742	X10CrAlSi18; X10CrAl18		Z 12 CAS 18			F.3113; X 10 CrAl 18	SUS 21	15Ch18SJu	X10CrAlSi18
12		1.4724	X10CrAlSi13; X10CrAl13; X 10 CrAl 13				X 10 CrAl 12	F.3152; X 10 CrAl 13		10Ch13SJu	X10CrAlSi13
12	434; S43400	1.4113	X6CrMo17-1; X 6 CrMo 17 1	434 S 17	Z 8 CD 17-01	2325		F.3116	SUS 434		X6CrMo17-1
12	HNV-6; HNV6; S65006	1.4747	X80CrNiSi20; X 80 CrNiSi 20	443 S 65	Z 80 CSN 20-02		X 80 CrSiNi 20	F.320B	SUH 4		
12	446; S44600	1.4762	X10CrAlSi25; X10CrAl24; X 10 CrAl 24		Z 10 CAS 24	2322		F.3154	SUH 446		X10CrAlSi25
12	EV 8; S63008	1.4871	X53CrMnNiN21-9; X 53 CrMnNiN 21 9	349 S 52	Z 52 CMN 21-9 Az		X 53 CrMnNiN 21 9	F.3217	SUH 35, SUH 36	55Ch20G9AN4	X53CrMnNiN21-9
12		1.4001	X7Cr14; X 7 Cr 14; G-X 7 Cr 13		Z 8 C 13 FF				SUS 4105		X7Cr14
12	440 B; S44003	1.4112	X90CrMoV18		X 89 CrMoV 18-1			SUS 440B			X90CrMoV18
12	410 S; 403; S41008; S40300	1.4000	X6Cr13; X 6 Cr 13	403 S 17	Z 8 C 12	2301	X 6 Cr 13	F.3110	SUS 403; SUS 403 FB; SUS 410 S	08Ch13	X6Cr13
12	410; S41000; S41001; CA-15	1.4006	X12Cr13; GX12Cr13; X 12 Cr 13; X 10 Cr 13	410 S 21; ANC 1 grade A; En 56 A	Z 10 C 13; Z 13 C 13	2302	X 12 Cr 13 KG; X 12 Cr 13 KW	F.3401	SUS 410; SUS 410 FB; SUS 410 TB; SUS 410 TKA; SUS 410 TKC; SUS F 410-A; SUS F 410-B; SUS F 410-C	12Ch13; 15Ch13L	X13Cr13
12	405; S40500	1.4002	X6CrAl13; X 6 CrAl 13	405 S 17	Z 8 CA 12		X 6 CrAl 13	F.3111	SUS 405; SUS 405 TB; SUS 405 TP		X6CrAl13
12	416; S41600	1.4005	X12CrS13; X 12 CrS 13	416 S 21; En 56 AM	Z 11 CF 13	2380	X12 CrS 13	F.3411	SUS 416		X12CrS13
12		1.4015	X8Cr17								
12	430; S43000	1.4016	X6Cr17; X 6 Cr 17	430 S 17; 430 S 15; 430 S 18	Z 8 C 17	2320	X 8 Cr 17	F.310.D; F.3113	SUS 430; SUS 430 TB; SUS 430 TKA; SUS 430 TKC; SUS 430 TP	12Ch17	X6Cr17
12		1.4027	GX20Cr14	ANC 1 grade B; ANC 1 grade C; 420 C 24; 420 C 29	Z 20 C 13 M				SCS 2	20Ch13L	
12	420 F; S42020	1.4028	X30Cr13; X 30 Cr 13	420 S 37; 420 S 45; En 56 C; En 56 D	Z 33 C 13 Cl; Z 33 C 13; Z 30 C 13	2304	X 30 Cr 13	F.3403	SUS 420 F; SUS 420 J 2; SUS 420 J 2-CSP; SUS 420 J 2 FB; SUS 420 J 2 TKA	30Ch13	X30Cr13
12		1.4086	GX120Cr29; G-X 120 Cr 29	452 C 11							
12		1.4340	GX40CrNi27-4; G-X 40 CrNi 27 4								
12		1.4720	X20CrMo13; X 20 CrMo 13								
12	439; 430 Ti; S43035; S43036; XM 8	1.4510	X3CrTi17; X 6 CrTi 17		Z 4 CT 17		X 6 CrTi 17	F.3115; X 5 CrTi 17	SUS 430 LX; SUS 430 LXTB; SUS XM8TB	08Ch17T	X3CrTi17
12	446-1	1.4749	X18CrN28		Z 12 C 25						X18CrN28

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	AISI/SAE/ UNS/ ASTM/AA	Werkstoff	DIN	BS	AFNOR	SS	UNI	UNE	JIS	GOST	EN
12		1.4511	X3CrNb17; X 6 CrNb 17		Z 4 CNb 17		X 6 CrNb 17	F.3122; X 5 CrNb 17	SUS 430 LX; SUS 430 LXTB		X3CrNb17
12	409; S40900	1.4512	X2CrTi12; X 6 CrTi 12	LW 19; 409 S 19	Z 3 CT 12		X 6 CrTi 12	F.3121	SUH 409 L; SUS 409 LTB; SUS 409 TB		X2CrTi12
12		1.4418	X4CrNiMo16-5-1; X 4 CrNiMo 16 5		Z 6 CND 16-04-01	2387					X4CrNiMo16-5-1
12	420; S42000	1.4021	X20Cr13; X 20 Cr 13	420 S 37; 420 S 29; En 56 C	Z 20 C 13 Cl; Z 20 C 13	2303	X 20 Cr 13	F.310.J; F.3402	SUS 420 J 1; SUS 420 J 1 FB; SUS 420 J 1 TKA	20Ch13	X20Cr13
13	420; S42000; S42080	1.4031	X39Cr13; X 38 Cr 13		Z 40 C 14 Cl; Z 40 C 14	2304	X 40 Cr 14	F.3404; X40 Cr 13	SUS 420 J 2	40Ch13	X39Cr13
13		1.4922	X20CrMoV11-1; X20CrMoV12-1; X 20 CrMoV 12 1	BS 762		2317	X 20 CrMoNi 12 01				X20CrMoV11-1; X20CrMoV12-1
13		1.4923	X22CrMoV12-1; X21CrMoNiV12-1; X 22 CrMoV 12 1								X22CrMoV12-1; X21CrMoNiV12-1
13	420; S42000	1.4021	X20Cr13; X 20 Cr 13	420 S 37; 420 S 29; En 56 C	Z 20 C 13 Cl; Z 20 C 13	2303	X 20 Cr 13	F.310.J; F.3402; X 20 Cr 13	SUS 420 J 1; SUS 420 J 1 FB; SUS 420 J 1 TKA	20Ch13	X20Cr13
13	420; S42000	1.4034	X46Cr13; X 46 Cr 13		Z 44 C 14 Cl; Z 44 C 14; Z 38 C 13 M		X 40 Cr 14	F.3405; X 40 Cr 13		40Ch13	X46Cr13
13	431; S43100	1.4057	X17CrNi16-2; X 20 CrNi 17 2; X 22 CrNi 17	431 S 29; En 57	Z 15 CN 16.02 Cl; Z 15 CN 16-02	2321	X16 CrNi 16	F.313; F.3427; X 19 CrNi 17 2	SUS 431; SUS 431 FB	14Ch17N2; 20Ch17N2	X17CrNi16-2
13	CA 6-NM; S41500; J91540	1.4313	X3CrNiMo13-4; X 4 CrNi 13 4		Z 6 CN 13-04; Z 6 CN 13-4; Z 4 CND 13.4 M	2384					X3CrNiMo13-4
13		1.4122	X39CrMo17-1; X 35 CrMo 17				X 39 CrMo 17-1				X39CrMo17-1
13	422; S42200	1.4935	X20CrMoWV12-1; X 20 CrMoWV 12 1								X20CrMoWV12-1
13	HNV 3; S65007	1.4718	X45CrSi9-3; X 45 CrS 9 3; G-X 45 CrNi 9 3	401 S 45; En 52	Z 45 CS 9		X 45 CrSi 8	F.322; F.3220	SUH 1	40Ch9S2; 4Ch9S2	X45CrSi9-3
13		1.2083; 1.2083 ESR	X40Cr14; X 42 Cr 13		X40Cr14; Z 40 C 14	2314	X 41 Cr 13 KU	F.5263; X 40 Cr 13	SUS 420 J 2		X40Cr14
13	CA 6-NM; J91540	1.4317	GX4CrNi13-4; G-X 5 CrNi 13 4	425 C 11; 425 C 12	Z 4 CND 13 4 M		GX 6 CrNi 13 04		SCS 6; SCS 6X		GX4CrNi13-4
13	S13800; XM-13	1.4534	X3CrNiMoAl 13-8-2; X 3 CrNiMoAl 13 8 2	FE-PM1503							X3CrNiMoAl 13-8-2
14	15-5PH; 15-5 PH; XM-12; S15500; J92110	1.4545; 1.4545.9	X5CrNiCuNb15-5		Z 7 CNU 15-05						X5CrNiCu15-3
14	329; S31260; S32900	1.4460	X3CrNiMo27-5-2; X 4 CrNiMo 27 5 2		Z 3 CND 25-07 Az; Z 5 CND 27-05 Az	2324		F.3552; F.3309; X 8 CrNiMo 27-05; X 8 CrNiMo 26 6	SUS 329 J 1; SUS 329 J 1 FB; SUS 329 J 1 TB; SUS 329 J 1 TP	10Ch26N5M	X3CrNiMo27-5-2
14	321; S32100	1.4541	X6CrNiTi18-10	321 S 31; LW 18; LW 24; LWCF 18; LWCF 24; 321 S 12; 321 S 50; 321 S 51; 321 S 50-490; 1010; 1115	Z 6 CNT 18-10	2337	X 6 CrNiTi 18 11; X 6 CrNiTi 18 11 KG; X 6 CrNiTi 18 11 KW; X 6 CrNiTi 18 11 KT	F.332; F.3523; X 6 CrNiTi 18 10	SUS 321	06Ch18N10T; 08Ch18N10T; 09Ch18N10T; 12Ch18N10T	X6CrNiTi18-10

Material Group No.	USA	Germany		U.K.	France	Sweden	Italy	Spain	Japan	Russia	EURONORM
	AISI/SAE/ UNS/ ASTM/AA	Werkstoff	DIN	BS	AFNOR	SS	UNI	UNE	JIS	GOST	EN
14		1.4425	X2CrNiMo18-13-3								
14	316; 316H; 316 H; S31600; S31609	1.4401	X5CrNiMo17-12-2; X 5 CrNiMo 18 10	316 S 31; 316 S 33; 316 S 17; 316 S 19; 316 S 40; 316 S 41; 845	Z 6 CND 17-11; Z 6 CND 17-11-02-FF; Z 7 CND 17-11-02; Z 7 CND 17-12-02	2347	X 5 CrNiMo 17 12; X 5 CrNiMo 17 12 KG; X 5 CrNiMo 17 12 KW	F.310.A; F.3534; X 5 CrNiMo 17 12 2	SUS 316; SUS 316 A; SUS 316 FB; SUS 316 HFB; SUS 316 HTB; SUS 316 HTP; SUS 316 TB; SUS 316 TBS	08Ch16N11M3	X5CrNiMo17-12-2
14		1.4821	X20CrNiSi25-4		Z20CNS25.04						X20CrNiSi25-4
14	J92701	1.4312	GX10CrNi18-8	ANC 3 grade A; ANC 3 A; 302 C 25	Z 10 CN 18.9 M				SCS 12; SCS 13A	10Ch18N9L	
14	J92605; J93005	1.4823	GX40CrNiSi27-4; G-X 40 CrNiSi 27 4						SCH 11 X		GX40CrNiSi27-4
14		1.4585	GX7CrNiMoCuNb18-18; G-X 7 CrNiMoCuNb 18 18				X 6 CrNiMoTi 17 12				
14	347; J92640; J82710	1.4552	GX5CrNiNb19-11; G-X 5 CrNiNb 18 9	347 C 17; 821 grade Nb	Z 4 CNNb 19.10 M; Z 6 CNNb 18.10 M			AM-X 7 CrNiNb 20 10; F.8413	SCS 21; SCS 21 X		GX5CrNiNb19-11
14		1.4500	GX7NiCrMoCuNb25-20; G-X 7 NiCrMoCuNb 25-20		23 NCDU 25.20 M						
14	304; S30400	1.4301	X5CrNi18-10; X 5 CrNi 18 9	304 S 15; 304 S 31; LW 13; LW 15; LW 21; LWCF 13; LWCF 15; 302 S 17; 304 S 16; 304 S 17; 304 S 40	Z 4 CN 19-10 FF; Z 5 CN 17-08; Z 6 CN 18-09; Z 7 CN 18-09	2333; 2332	X 5 CrNi 18 10; X 5 CrNi 18 10 KG; X 5 CrNi 18 10 KW; X 5 CrNi 18 10 KT	F.3504; X 5 CrNi 18 10	SUS 304; SUS 304 A; SUS 304-CSP; SUS 304 FB; SUS 304 TB; SUS 304 TBS; SUS 304 TKA; SUS 304 TKC	08Ch18N10	X5CrNi18-10
14	304L; 304 L; S30403; J92500; J92600	1.4306; 1.4309	X2CrNi19-11; GXCrNi19-11	304 S 11; LW 20; LWCF 20; S.536; T.74; 304 C 12; 305 S 11	Z 1 CN 18-12; Z 2 CN 18-10; Z 3 CN 19.10 M; Z 3 CN 18-10; Z 3 CN 19-11; Z 3 CN 19-11 FF	2352	X 3 CrNi 18 11; X 2 CrNi 18 11; GX 2 CrNi 19 10	F.310.G; F.3503; X 2 CrNi 19 10; AM-X 2 CrNi 19 10; F.8412	SCS19	03Ch18N11	X2CrNi19-11; GXCrNi19-11
14	304H; 304 H; CF-8; J92590; J92600; J92650; J92710	1.4308	GX5CrNi19-10; G-X 6 CrNi 18 9	304 C 15	Z 6 CN 18.10 M; Z 6 CN 19.9 M			AM-X 7 CrNi 20 10; F.8411	SCS 13; SCS 13 A; SCS 13 X	07Ch18N9L	GX5CrNi19-10; 58E
14	J92701	1.4312	GX10CrNi18-8; G-X 10 CrNi 18 8	ANC 3 grade A; ANC 3 A; 3025 S 25	Z 10 CND 18.9 M				SCS 12	10Ch18N9L	GX10CrNi18-8
14	S32304	1.4362	X2CrNiN23-4; X 2 CrNiN 23 4		Z 3 CN 23-04 Az	2327					X2CrNiN23-4
14	201; S20100	1.4372	X12CrMnNiN17-7-5		Z 12 CMN 17-07 Az				SUS 201		X12CrMnNiN 17-7-5
14	316; S31600	1.4436	X3CrNiMo17-13-3; X 5 CrNiMo 17 13 3	316 S 31; 316 S 33; LW 23; LWCF 23; 316 S 19; 316 S 40; 316 S 41; 1.4436	Z 6 CND 18-12-03; Z6 CND 18-13; Z 7 CND 18-12-03	2343	X 5 CrNiMo 17 13; X 8 CrNiMo 17 13	F.3538; X 5 CrNiMo 17 13 3	SUS 316; SUS 316 A; SUS 316 FB; SUS 316 TBS; SUS 316 TKA; SUS 316 TKC; SUS 316 TP		X3CrNiMo17-13-3

Material Group No.	USA	Germany		U.K.	France	Sweden	Italy	Spain	Japan	Russia	EURONORM
	AISI/SAE/ UNS/ ASTM/AA	Werkstoff	DIN	BS	AFNOR	SS	UNI	UNE	JIS	GOST	EN
14	316L; 316 L; S31603; J92700; J92800	1.4404	X2CrNiMo17-12-2; X2CrNiMo17-13-2; X 2 CrNiMo 17 12 2; X 2 CrNiMo 17 13 2	316 S 11; 316 S 13; 316 S 14; 316 S 30; S.161; S.537; T.75	Z 2 CND 17-12; Z 3 CND 17-11-02; Z 3 CND 17-12-02; Z 3 CND 17-12-02 FF; Z 3 CND 18-12-03	2348	X 2 CrNiMo 17 12	F.310.K; F.3533; F.3537	SUS 316 L; SUS 316 LFB; SUS 316 LTBS; SUS 316 LTP; SUS 316 F 316 L		X2CrNiMo17-13-2
14	316LN; 316 LN; S31653	1.4406	X2CrNiMoN17-11-2; X2CrNiMoN17-12-2; X 2 CrNiMoN 17 12 2	316 S 61; 316 S 63	Z 2 CND 17-11 Az		X 2 CrNiMoN 17 12	F.3542; X 2 CrNiMoN 17 12 2	SUS 316 LN; SUS F 316 LN		X2CrNiMoN 17-11-2
14	CF-8M; J92900	1.4408	GX5CrNiMo 19-11-2; G-X 6 CrNiMo 18 10	ANC 4 grade B; ANC 4 B; 316 C 16; 845 grade B				AM-X 7 CrNiMo 20 10; F.8414	SCS 14; SCS 14 A; SCS 14 X	07Ch18N10G2S2M2L	GX5CrNiMo 19-11-2
14	S32750	1.4410	X2CrNiMoN25-7-4; X 10 CrNiMo 18 9		Z 5 CND 25-06 Az	2328					X2CrNiMoN 25-7-4
14	316LN; 316 LN; S31563	1.4429	X2CrNiMoN17-13-3; X 2 CrNiMoN 17 13 3	316 S 63; 1.4429	Z 3 CND 17-12 Az	2375	X 2 CrNiMoN 17 13	F.3543; X 2 CrNiMoN 17 13 3	SUS 316 LN; SUS F 316 LN		X2CrNiMoN 17-13-3
14	316L; 316 L; S31603; J92800	1.4435	X2CrNiMo18-4-3; X 2 CrNiMo18 14 3	316 S 13; 316 S 11; 316 S 14; 316 S 31; LW 22; LWCF 22; 845 B	Z 3 CND 17-12-03; Z 3 CND 18-14-03	2353	X 2 CrNiMoN 17 13; X 2 CrNiMoN 17 13 KG; X 2 CrNiMoN 17 13 KW	F.3533-X2 CrNiMo 17 13 2	SUS 316 L; SUS 316 LFB; SUS 316 LTBS; SUS 316 LTP; SUS F 316 L	O3Ch17N14M3	X2CrNiMo18-4-3
14	S31726	1.4439	X2CrNiMoN17-13-5; X 2 CrNiMoN 17 13 5		Z 3 CND 18-14-05 Az			F.3544; X 2 CrNiMoN 17 13 5			X2CrNiMoN 17-13-5
14	317; S31700	1.4449	X3CrNiMo18-12-3	317 S 16			X 5 CrNiMo 18 15		SUS 317; SUS 317 TB; SUS 317 TP; SUS F 317		X3CrNiMo18-12-3
14	329; S31260; S32900	1.4460	X3CrNiMoN27-5-2; X 4 CrNiMoN 27 5 2		Z 5 CND 27-05 Az; Z 3 CND 25-07 Az	2324		F.3552; F.3309; X 8 CrNiMo 27-05; X 8 CrNiMo 26 6	SUS 329 J 1; SUS 329 J 1 FB; SUS 329 J 1 TB; SUS 329 J 1 TP	10Ch26N5M	X3CrNiMoN27-5-2
14	S31803; S31260; S32900	1.4462	X2CrNiMoN22-5-3; X 2 CrNiMoN 22 5 3	318 S 13; 1.4462	Z 2 CND 24-08 Az; Z 3 CND 25-06-03 Az; Z 3 CND 25 -05 Az	2377			SUS 329 J 3 L; SUS 329 J 3 LTB; SUS 329 J 3 LTP		X2CrNiMoN22-5-3
14	631; 17-7PH; 17-7 PH; S17700	1.4568; 1.4564; 1.4504	X7CrNiAl17-7; X 7 CrNiAl 17 7	301 S 81	Z 9 CNA 17-07; Z 8 CNA 17-07	2388		X 2 CrNiMo 17 12	SUS 631; SUS 631 J 1; SUS 631-CSP	09Ch17N7Ju1	X7CrNiAl17-7
14	443; 444; S44300; S44400	1.4521	X2CrMoTi18-2; X 2 CrMoTi 18 2		Z 3 CDT 18-02; Z 3 CDT 18-2	2326		F.3123; X 2 CrMoTiNb 18 2	SUS 444; SUS 444 TB; SUS 444 TP		X2CrMoTi18-2
14	904L; 904 L; N08904	1.4539	X1NiCrMoCu25-20-5; X 1 NiCrMoCuN 25 20 5	904 S 13	Z 2 NCDU 25-20	2562					X1NiCrMoCu 25-20-5
14	630; 17-4PH; 17-4 PH; S17400	1.4542	X5CrNiCuNb16-4; X 5 CrNiChNb 17 4		Z 7 CNU 15-05; Z 7 CNU 16-04; Z 7 CNU 17-04				SUS 630; SUS 630 FB; SUS F 630		X5CrNiCuNb16-4
14	S31254	1.4547	X1CrNiMoN20-18-7			2378					X1CrNiMoN 20-18-7
14	631; 17-7PH; 17-7 PH; S17700	1.4568	X7CrNiAl17-7; X 7 CrNiAl 17 7	301 S 81	Z 9 CNA 17-07; Z 8 CNA 17-07	2388		X 2 CrNiMo 17 12	SUS 631; SUS 631 J 1; SUS 631-CSP	09Ch17N7Ju1	X7CrNiAl17-7

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	AISI/SAE/ UNS/ ASTM/AA	Werkstoff	DIN	BS	AFNOR	SS	UNI	UNE	JIS	GOST	EN
14	316 Ti; S31635	1.4571	X6CrNiMoTi17-12-2; X 6 CrNiMoTi 17 12 2	320 S 31; 320 S 18	Z 6 CNDT 17-12	2350	X 6 CrNiMoTi 17 12; X 6 CrNiMoTi 17 12 KG; X 6 CrNiMoTi 17 12 KW	F.310.B; F.3535; X 6 CrNiMoTi 17 12 2	SUS 316 Ti; SUS 316 TiTB; SUS 316 TiTP	08Ch16N11M3T; 08Ch17N13M2T; 10Ch17N13M2T	X6CrNiMoTi 17-12-2
14	309S; 309 S; 309; S30908; S30900	1.4833	X12CrNi23-13; X 7 CrNi 23 14	309 S 24	Z 15 CN 23-13; Z 15 CN 24-13		X 6 CrNi 23 14		SUS 309 S; SUS 309 S TB; SUS 309 S TP		X12CrNi23-13
14	S30415	1.4891	X4CrNiSiN18-10; X 4 CrNiSiN 18 10			2372					X4CrNiSiN 18-10
14	S30815	1.4893	X9CrNiSiNCe21-11-2; X 8 CrNiSiN 21 11			2368					X9CrNiSiNCe 21-11-2
14	304H; 304 H; S30409; S30480	1.4948	X6CrNi18-10; X6CrNi18-11; X 6 CrNi 18 11;	304 S 50; 304 S 51; 801 grade A	Z 5 CN 18-09				SUS 302		X6CrNi18-10
14		1.4581	GX5CrNiMoNb19-11-2; G X 5 CrNiMoNb 18 10	ANC 4 grade C; ANC 4 C; 318 C 17; 845 grade Nb	Z 4 CNDNb 18.12 M		GX 6 CrNiMoNb 20 11		SCS 22		GX5CrNiMoNb 19-11-2
14	303; S30300	1.4305	X8CrNiS18-9; X 10 CrNiS 18 9	303 S 31	Z 8 CNF 18-09	2346	X 10 CrNiS 18 09	F.310.C; F.3508; X 10 CrNiS 18-09	SUS 303	30Ch18N11	X8CrNiS18-9; 58M
14	304L; 304 L; S30403	1.4306	X2CrNi19-11; X 2 CrNi 19 11	304 S 11; LW14; LW 20; LWCF 14; LWCF 20; S.536; T.74; 304 C 12; 304 S 11	Z 1 CN 18-12; Z 3 CN 18-10; Z 3 CN 19-11; Z 3 CN 19-11 FF	2352	X 2 CrNi 18 11; X 3 CrNi 18 11	F.310.G; F.3503; X 2 CrNi 18 10	SUS 304 L; SUS 304 LFP; SUS 304 LTB; SUS 304 LTBS; SUS 304 LTP; SUS F 304 L	03Ch18N11	X2CrNi19-11
14	301; J 230; S30100; S30200	1.4310	X10CrNi18-8; X 12 CrNi 17 7	301 S 21; 301 S 22	Z 11 CN 17-08; Z 11 CN 18-08; Z 12 18-09	2331	X 12 CrNi 17 07	F.3517; X 2 CrNiN 18 10	SUS 301; SUS 301-CSP; SUS 302; SUS 302 FB	12Ch18N9	X10CrNi18-8
14	304LN; 304 LN; S30453	1.4311	X2CrNiN18-10; X 2 CrNiN 18 10	304 S 61	Z 3 CN 18-10 Az; Z 3 CN 18-07 Az	2371	X 2 CrNiN 18 11	F.3541; X 2 CrNiN 18 10	SUS 304 LN; SUS F 304 LN		X2CrNiN18-10
14	304B1; 304B2; 304B3; 304 B1; 304 B2; 304 B3; S30461; S30462; S30463	1.4350	X5CrNi18-9	304 S 31	Z 6 CN 18.09	2332; 2333	X 5 CrNi 18 10	F.3551			58E
14	317L; 317 L; S31703	1.4438	X2CrNiMo18-15-4; X2 CrNiMo 18 16 4	317 S 12	Z 2 CND 19-15-04; Z 3 CND 19-15-04	2367	X 2 CrNiMo 18 16	F.3539; X2 CrNiMo 18 16 4	SUS 317 L; SUS 317 LFB; SUS 317 LTB; SUS 317 LTP; SUS F 317 L; SUS Y 317 L		X2CrNiMo18-15-4
14	321H; 321 H; S32109	1.4878	X12CrNiTi18-10; X 12 CrNiTi 18-9	321 S 31	Z 6 CNT 18-10	2337	X 6 CrNiTi 18.11	F.3553	SUS 321; SUS 321 HFB; SUS 321 HTB; SUS 321 HTP; SUS 321 TKA; SUS 321 TP; SUS F 321; SUS Y 321		X12CrNiTi18-10; 58B

Material Group No.	USA	Germany		U.K.	France	Sweden	Italy	Spain	Japan	Russia	EURONORM
	AISI/SAE/ UNS/ ASTM/AA	Werkstoff	DIN	BS	AFNOR	SS	UNI	UNE	JIS	GOST	EN
14	347; 348; S34700; S34800	1.4550	X6CrNiNb18-10; X 6 CrNiNb 18 10	347 S 31; ANC 3 grade B; ANC 3 B; 347 S 20; 347 S 40; 347 S 50; 347 S 51	Z 6 CNNb 18-10	2338	X 6 CrNiNb 18 11; X 6 CrNiNb 18 11 KG; X 6 CrNiNb 18 11 KW; X 6 CrNiNb 18 11 KT	F.3524; X 6 CrNiNb 18 10	SUS 347; SUS 347 FB; SUS 347 HTB; SUS 347 TB; SUS 347 TKA; SUS 347 TP; SUS F 347	08Ch18N12B	X6CrNiNb18-10; 58F;
14	318; S31803	1.4583	X10CrNiMoNb18-12; X 10CrNiMoNb 18 12		Z 6 CNDNb 18-12		X 6 CrNiMoNb 20 11				
14	310H; 310 H; 310S; 310 S; S31008; S31009	1.4845	X8CrNi25-21; X 12 CrNi 25 21	310 S 16; 310 S 24; 310 S 25; 310 S 31	Z 8 CN 25-20; Z 12 CN 25-20; Z 12 CN 26-21	2361	X 6 CrNi 25 20 (X 6 CrNi 25 20)	F.331	SUS 310 S; SUS 310 FB; SUS 310 STG; SUS 310 STP; SUS310 TB; SYS Y 310 S	10Ch23N18; 20Ch23N18	X12CrNi25-21
14		1.4465; 1.4466	X1CrNiMoN25-22-2; X 2 CrNiMoN 25 22 7								X1CrNiMoN 25-22-2
14	309; S30900	1.4828	X15CrNiSi20-12; X 15 CrNiSi 20 12	309 S 24	Z 9 CN 24-13; Z 17 CNS 20-12		X 16 CrNi 23 14	F.3312; X 15 CrNiSi 20-12	SUH 309; SUS 309 TB; SUS 309 TP	20Ch20N14S2	58C; X15CrNiSi20-12
14	HK; J94203; J94204; J94224	1.4848	GX40CrNiSi25-20; G-X 40 CrNiSi 25 20	310 C 40; 310 C 45			G X 40 CrNi 26 20	AM-X 40 CrNi 25 20; F.8452	SCH 21; SCH 22; SCH 22 X		GX40CrNiSi25-20
14	HK 30; J93503; J94003; J94013; HH	1.4837; 1.4848+Nb	GX40CrNiSi25-12; G-X 40 CrNiSi 25 12	309 C 30			G X 35 CrNi 25 12		SCH 13; SCH 13 A; SCH 13 X; SCH 17; SCS 17	40Ch24N12SL	GX40CrNiSi25-12
14	310; 314; S3100; S31400; S31500	1.4841	X15CrNiSi25-21; X 15 CrNiSi 25 20	314 S 25	Z 15 CNS 25-20		X 16 CrNiSi 25 20	F.3310; X 15 CrNiSi 25-20	SUH 310; SUS 310 TB; SUS Y 310	20Ch25N20S2	X15CrNiSi25-21
14		1.4849	GX40NiCrSiNb38-19; G-X 40 NiCrSi 38 18								GX40NiCrSiNb 38-19
14	S32760; SA351/995; 25Cr-7Ni-Mo-N	1.4501	X2CrNiMoCuWN25-7-4	1.4501	Z 3 CNDU 25-06 Az						X2CrNiMoCuWN 25-7-4
14	348; S34800	1.4546	X5CrNiNb18-10	2 S.130; 2 S.143; 3 S.144; 3 S.145; S.525; S.527							
14		1.4544; 1.4544.9		S.524; S.526; 2 S 129	Z 10 CNT 18-11; 9160/C 63; 9160C201		X 6 CrNiTi 18 11			08Ch18N12T	FE-PA 13
14		1.6900	X12CrNi18-9; X 12 CrNi 18 9								
14		1.4829	X12CrNi22-12; X 12 CrNi 22 12								
14		1.4882	X50CrMnNiNbN21-9		Z 50 CMNNb 21.09						X50CrMnNiNbN 21-9
14	316N; 316 N; J92804	1.4409	GX2CrNiMo19-11-2; G-X 2 CrNiMo 19 11 2		Z 3 CND 19.10 M		GX2 CrNiMo 19 11	AM-X 2 CrNiMo 19 11; F.8415	SCS 16 A; SCS 16 AX SCS 16 AXN		GX2CrNiMo 19-11-2
14	304L; 304 L J92500; J92620	1.4309	GX2CrNi19-11	304 C 12	Z 3 CN 19.10 M		GX 2 CrNi 19 10	AM-X 2 CrNi 19 10; F.8412	SCS 19; SCS 19 A		GX2CrNi19-11
15	A48 25 B; Class 25; No 25 B	0.6015	EN-GJL-150; GG 15; EN-JL 1020	Grade 150	Ft 15 D; R 15 D	01 15-00	G 14; G 15	FG 15	FC 15; FC 150	SCh 15	EN-GJL-150; EN-JL 1020
15	A48-30 B; Class 30, No.30 B	0.6020	EN-GJL-200; GG 20; EN-JL 1030	Grade 220	Ft 20 D	01 20-00	G 20; Gh 190	FG 20	FC 20; FC 200	SCh 20	EN-GJL-200; EN-JL 1030

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	AISI/SAE/ UNS/ ASTM/AA	Werkstoff	DIN	BS	AFNOR	SS	UNI	UNE	JIS	GOST	EN
15	A48-20 B; Class 20; No 20 B	0.6010	EN-GJL-100; GG 10; EN-JL 1010		Ft 10 D	01 10-00	G 10	FG 10	FC 10; FC 100	SCh10	EN-GJL-100; EN-JL 1010
16	A48-45 B; Class 45; No 45 B	0.6030	EN-GJL-300; GG 30; EN-JL 1050	Grade 300	Ft 30 D	01 30-00	G 30	FG 30	FC 30; FC 300	SCh 30	EN-GJL-300; EN-JL 1050
16	A48-50 B; Class 50; No 50 B	0.6035	EN-GJL-350; GG 35; EN-JL 1060	Grade 350	Ft 35 D	01 35-00	G 35	FG 35	FC 35; FC350	SCh 35	EN-GJL-350; GG 35; EN-JL 1060
16	A48-60 B; Class 60; No 60 B	0.6040	EN-JLZ; GG 40	Grade 400	Ft 40 D	01 40-00				SCh 40	EN-JLZ
16	A48-40 B; Class 40; No 40 B	0.6025	EN-GJL-250; GG 25; EN-JL 140	Grade260	Ft 25 D	01 25-00	G 25	FG 25	FC 25	SCh 25	EN-GJL-250; EN-JL 140
17		0.7033	EN-GJS-350-22-LT; GGG 35.3	350/22 L 40	FGS 370-/17	0717-15	GS 370-17	FNG 38-17	FCD 350-22L	VCh42-12	EN-GJS-350-22-LT
17	60-40-18; A536 60-40-18	0.7043	EN-GJS-400-18; EN-GJS-400-18-LT; GGG-40.3; EN-GJS-400-18A-LT	370/7; SNG 370/17	FGS 370-17	0717-15	GSO 400-12			VCh 42-2	EN-GJS-400-18; EN-GJS-400-18-LT; EN-GJS-400-18A-LT
17	60-40-18; A536 60-40-18	0.7040	EN-GJS-400-15; EN-JS 1030; GGG-40	420/12; SNG 420/12	FCS 400-12	0717-02	GS 400-12	FGE 38-17	FCD 40	VCh 42-12	EN-GJS-400-15; EN-JS 1030
17	65-45-12; A536 65-45-12	5.3107	EN-GJS-450-10	450/10; SNG 450/10	FGS 450-10		GS 400-12	FGE 42-12	FCD450	VCh 45	EN-GJS-450-10
18	65-45-12; A536 65-45-12	0.7050	EN-GJS-500-7; EN-GJS-500-7A; EN-JS 1050; GGG-50	500/7	FGS 500-7	0727-02	GS 500/7	FGE 50-7	FCD 50; FCD 500; FCD 500-7	VCh 50-2	EN-GJS-500-7; EN-GJS-500-7A; EN-JS 1050
18	80-55-06; A536 80-55-06	0.7060	EN-GJS-600-3; EN-GJS-600-3A; EN-JS 1060; GGG-60	600/3	FGS 600-3	0732-03	GS 600/3	FGE 60-2	FCD 60; FCD 600; FCD 600-3		
18		0.7652	GGG-NiMn 13 7	S-NiMn 13 7	S-NM 13 7	07 32-03	GGG 60	GGG 60			
18	100-70-03; A536 100-70-03	0.7070	EN-GJS-700-2; EN-JS 1070; GGG-70	700/2; SNG700/2	FGS 700-2	0737-01	GS 700-2	FGE 70-2	FCD 70; FCD 700; FCD 700-2	VCh 70-2	EN-GJS-700-2; EN-JS 1070
18	A439 Type D-2	0.7660	GGG-NiCr 20 2	S-NiCr 20 2	S-NC 20-2						
18	A439 Type D-2 B	0.7661	GGG-NiCr 20 3	S-NiCr 20 3	S-NC 20 3						
19	A47-32510; A47 Class 32510; A47 Grade 32510; 32510	0.8135	EN-GJMB-350-10; EN-JM 1130; GTS-35-10; GTS-35	B 340/12; 310 B340/12	MN 35-10; A32-702 MN 350-10	0810	B 35-10	GTS 35; 36114 Type A	FCMB 340; G5703 FCMB 340	KCh 35-10	EN-GJMB-350-10; EN-JM 1130
19	A47-35018, A47 Class 35018; A47 Grade 35018				MN 380-18; A32-702 MN 380-18					KCh 37-12	
19	A47-22010; A47 Class 22010; A47 Grade 22010; UNS F22200			B 32-10; 6681 B 32-10					FCMB 310	KCh 33-8	
20	A220-50005; A220 Class 50005; A220 Grade 50005	0.8155	EN-GJMB-550-4; EN-JM1160; GTS-55-04	P 55-04; P 510/4	MP 60-3; A32-703 MP 60-3; Mn 550-4	0856-00	P 55-04	Type C; 36116 Type C	FCMP 540	KCh 55-4; KCh60-3	EN-GJMB-550-4; EN-JM1160

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	AISI/SAE/ UNS/ ASTM/AA	Werkstoff	DIN	BS	AFNOR	SS	UNI	UNE	JIS	GOST	EN
20	A220-70003; A220 Class 70003; A220 Grade 70003	0.8165	EN-GJMB-650-2; EN-JM1180; GTS-65-02	P 65-02; 6681 P 65-02; P 570/3	Mn 650-3	0862-030	GMN 65		FCMP 590	KCh 63-3	EN-GJMB-650-2; EN-JM1180
20	A220-70003; A220 Class 70003; A220 Grade 70003	0.8170	EN-GJMB-700-2; EN-JM1190; GTS-70-02	P 70-2; 6681 P 70-2; P 690/2	MP 70-2; A 32-703 MP 70-2; Mn 700-2	0862-03	P 70-2; GMN 70	36116 Type A	FCMP 690	KCh 70-2	EN-GJMB-700-2; EN-JM1190
20	A220-45006; A220 Class 45006; A220 Grade 45006 A220-45008; A220 Class 45008; A220 Grade 45008	0.8145	EN-GJMD-450-6; EN-JM1140; GTS-45-06; GTS-45	P 45-06; 6681 P 45-06	MP 50-5; A32-703 MP 50-5	0854-00	P 45-06	Type E; 36116 Type E		KCh 45-7	EN-GJMD-450-6; EN-JM1140
20	A220-80002; A220 Class 80002; A220 Grade 80002			P 70-2	MN 700-2	854			FCMP 70; FCMP 700	KCh 80-1.5	
20	A220-90001; A220 Class 90001; A220 Grade 90001										
20	A220-60004; A220 Class 60004; A220 Grade 60004										
20	A220-40010; A220 Class 40010; A220 Grade 40010					0852-00					
20		0.8040	EN-GJMW-400-5; GTW-40-05	W 40-05	MB 400-5		W 40-05	36113 Type A	FCMW 370		EN-GJMW-400-5; EN-JM1030
20		0.8035	EN-GJMW-350-4; GTW-35-04	W 35-04	MB 35-7		W 35-04	36113 Type B	FCMW 330		EN-GJMW-350-4; EN-JM1010
21	AA5005; AA5006; A95005; A95006; 5005; 5005A; 5006	3.3315	AlMg1; AlMg1C	N41	A G0-6	144106	L3350		A5005	1510; AMg1	AlMg1C; 5005A
21	AA1050; A91050; 1050; 1050A	3.0255	Al99,5; Al99.5	1B	A5	14407	9001/2	L-3051		AD0	Al99.5; Al99,5; 1050A
21	AA1200; A91200 ; 1200; 1200A	3.0205	Al99,0; Al99.0; Al99	1C	A4	144010	Al99.0	L-3001	A1200	A0	Al99.0; AL99,0; 1200
22	AA2017; A92017; 2017; 2017A	3.1325; 3.1124	AlCu2,5Si(A); AlCu2.5Si(A); AlCuMg1		A-U4G			L-3120		V65	AlCu2,5Si(A); AlCu2.,5Si(A); 2017A
22		3.2315	AlMgSi1	H30	A-SGM0.7	144312	9006/4	L-3453		AD35	AlSiMgMn; 6082
22		3.4345	AlZnMgCuO,5; AlZnMgCuO.5								AlZnMgCu0.5; AlZnMgCu0,5; 7022
22		3.1655	AlCu6BiPb; AlCuBiPb	FC1	A-U5PbBi	144355	9002/5	L-3192	A2011		AlCu6BiPb; 2011

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	AISI/SAE/ UNS/ ASTM/AA	Werkstoff	DIN	BS	AFNOR	SS	UNI	UNE	JIS	GOST	EN
22	AA7075; A97075; 7075	3.4365; 3.4364	AlZn5,5MgCu; AlZn5.5MgCu; AlZnMgCu1,5; AlZnMgCu1.5	7075; L95; L96	A-Z5GU		9007/2	L-3710	A7075	B95	AlZn5.5MgCu; AlZn5,.5MgCu; AW-7075; 7075
22	AA2024; A92024; 2024	3.1355; 3.1354	AlCuMg2	2024; 2L97	A-U4G1		9002/4; 3583	L-3140	A2024	D16	AlCu4Mg1; 2024
22		3.4335	AlZn4,5Mg1; AlZn4.5Mg1	H17	A-Z5G	144425	9007/1	L-3741			AlZn4.5Mg1; AlZn4,5Mg1; 7020
22	AA6061; A96061; 6061	3.3211; 3.3214	AlMg1SiCu	H20	A-GSUC		9006/2	L-3420	A6061	AD33	EN AW-6061; EN AW-AlMg1SiCu; AlMg1SiCu
23		3.3261	G-AlMg5Si; GK-AlMg5Si; AlMg5Si; VDS 245	LM5		144163				AL13	EN AC-51400; EN AC-AlMg5Si; G-AlMg5Si; AlMg5Si
23		3.2982	GD-AlSi12(Cu); G-AlSi12(Cu); AlSi12(Cu); VDS 231 D		A-S12U		3048				EN AC-47100; EN AC-AlSi12C; G-AlSi12Cu; AlSi12Cu; AlSi12Cu1(Fe)
23	520.0; AA 520.0; A05200				A-G10S		3056	L-2310	AC7B	A18	
23	222.0; AA 222.0; A02220			LM12			3041	L-2110			
23	518.0; AA 518.0; A05180	3.3292	G-AlMg9; GD-AlMg9; AlMg9; VDS 349								EN AC-51200; EN AC-AlMg9; G-AlMg9; AlMg9
23	203.0; AA 203.0; A02030	3.1754	G-AlCu5Ni1,5; G-AlCu5Ni1.5		AU5NKZr						
23	ER4047; A94047	3.2585	SG-AlSi12	4047A; NG2		144262					SG-AlSi12; EL-AlSi12
23	712.0; AA 712.0; A07120		G-AlZn10Si8Mg; GK-AlZn10Si8Mg; AlZn10Si8Mg; VDS 108		A-Z5GF		3602				EN AC-71100; EN AC-AlZn10Si8Mg; G-AlZn10Si8Mg; AlZn10Si8Mg
23	514.0; 514.1; AA 514.0; AA 514.1; A05140; A05141	3.3561	G-AlMg5; GK-AlMg5; AlMg5; EN AC-51300; VDS 244		A-G6		3058	L-2331		AL28; AMg5Mz;	EN AC-51300; EN AC-AlMg5; G-AlMg5; AlMg5
23	B413.0; AA B413.0; A24130; B213.0; AA 213.0; A22130	3.2581; 3,2582	G-AlSi12; GK-AlSi12; GD-AlSi12; AlSi12	LM6	A-S13	144261	4514	L-2520	AC3		EN AC-44200; EN AC-AlSi12; G-AlSi12; GD-AlSi12; AlSi12
23		3.2211	G-AlSi11; GK-AlSi11; AlSi11								EN AC-44000; EN AC-AlSi11; G-AlSi11
23	A444.0; AA A444.0; A14440									AK7	
23		3.3541	G-AlMg3; GK-AlMg3; GF-AlMg3; AlMg3; VDC 244	H20	A-G3T	144224	3059	L-2341	ADC6		EN AC-51100; EN AC-AlMg3; G-AlMg3; AlMg3

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	AISI/SAE/ UNS/ ASTM/AA	Werkstoff	DIN	BS	AFNOR	SS	UNI	UNE	JIS	GOST	EN
24	515.0; AA 515.0; A05150	3.3241	G-AlMg3Si; GK-AlMg3Si; GF-AlMg3Si; AlMg3Si; AlMg3Si1								G-AlMg3Si1; AlMg3Si
24		3.2373	G-AlSi9Mg; GK-AlSi9Mg; AlSi9Mg		A-S9G		3051		AC4A	AK9	G-AlSi9Mg; AlSi9Mg
24	A356.0; AA A356.0; A13560; A356.2; AA A356.2; A13562	3.2371	G-AlSi7Mg; GK-AlSi7Mg; GF-AlSi7Mg; AlSi7Mg	2L99	A-S7G03			L-2651	AC4CH	AL9	G-AlSi7Mg; AlSi7Mg
24	204.0; AA 204.0; A02040	3.1371	G-AlCu4TiMg; GK-AlCu4TiMg; GF-AlCu4TiMg; AlCu4TiMg		AU5GT			L-2140	AC1B		EN AC-21000; EN AC-AlCu4TiMg; G-AlCu4TiMg
24	A333.0; AA A333.0; A13330	3.2161	G-AlSi8Cu3; GK-AlSi8Cu3			144163				AL13	EN AC-AlSi8Cu3; EN AC-AlSi8Cu3; G-AlSi8Cu3
24	380.0; AA 380.0; A03800	3.2163	G-AlSi9Cu3; GD-AlSi9Cu3; AlSi9Cu3; VDS 226	LM24	A-S9U3	144252	3610	L-2630	AC4B	AK8M3; AK8	EN AC-46200; EN AC-AlSi8Cu3; G-AlSi9Cu3; AlSi8Cu3
24	365.0; AA 365.0; A03650		G-AlSi10MnMg								EN AC-43500; EN AC-AlSi10MnMg; G-AlSi10MnMg
24	319.0; AA 319.0; A03190	3.2151	G-AlSi6Cu4; GK-AlSi6Cu4; AlSi6Cu4; VDS 225	LM21	A-S5UZ	144230	7369/4	L-2620	AC2B	AK5M	EN AC-45000; EN AC-AlSi6Cu4; G-AlSi6Cu4; AlSi6Cu4
24		3.2383	G-AlSi10MgCu; GK-AlSi10MgCu; G-AlSi10Mg(Cu); GK-AlSi10Mg(Cu); AlSi10MgCu; AlSi10Mg(Cu)		A-S10UG						
24		3.2381; 3.2385	G-AlSi10Mg; GK-AlSi10Mg; GD-AlSi10Mg; AlSi10Mg; VDS 239		A-S10G	144253					EN AC-43000; EN AC-AlSi10Mg; G-AlSi10Mg; AlSi10Mg
24		3.1841	G-AlCu4Ti; AlCu4Ti							AL19	EN AC-21100; EN AC-AlCu4Ti; G-AlCu4Ti; AlCu4Ti
25	390.0; AA 390.0; A03900		G-AlSi17Cu4Mg	LM30		4282					EN AB-48100; EN AC-48100; G-AlSi17Cu4Mg; AlSi17Cu4Mg
25	393.0; AA 393.0; A03930		G-AlSi20CuMgNi; AlSi20CuMgNi	LM29						AK21M2N2	
25			G-AlSi18Cu1MgNi; AlSi18Cu1MgNi	LM28							
26	C36000	2.0375	CuZn36Pb3	CZ124	CuZn36Pb3		12167		C3600; C3601; C3602		CuZn36Pb3; CW603N
26	C83810	2.1098	CuSn3Zn8Pb5-C; G-CuSn2ZnPb	LG1							CuSn3Zn8Pb5-C
26	C83600	2.1096; 2.1096.01	CuSn5Zn5Pb5-C; G-CuSn5ZnPb; Rg 5	LG2	CuPb5Sn5Zn5; UE5; U-E 5 Pb 5 Z 5	5204-15			H5111; H2203	BrO5Ts5S5	CuSn5Zn5Pb5-C

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	AISI/SAE/ UNS/ ASTM/AA	Werkstoff	DIN	BS	AFNOR	SS	UNI	UNE	JIS	GOST	EN
26	C93200	2.1090	CuSn7Zn4Pb7-C; G-CuSn7ZnPb; GC-CuSn7ZnPb; GZ-CuSn7ZnPb; Rg 7	GC 493K	CuSn7Pb6Zn4; UE7; U-E 7 Z 5 Pb 4						CuSn7Zn4Pb7-C
26	C93800	2.1182	CuSn7Pb15-C; G-CuPb15Sn; GC-CuPb15Sn; GZ-CuPb15Sn	LB1	U-Pb15E8; U-Pb 15 E8			C-3300			CuSn7Pb15-C; CC496K
26	C93700	2.1176	CuSn10Pb10-C; G-CuPb10Sn; GC-CuPb10Sn; GZ-CuPb10Sn	LB2	U-Pb10						CuSn10Pb10-C
27	C22000	2.0230	CuZn10; Ms90	CZ101	U-Z10; CuZn10		P-CuZn10; P-OT90		C2200	L90	CuZn10; CW501L
27	C86200; SAE 430A	2.0596	CuZn34Mn3Al2Fe1-C; G-CuZn34Al2; GK-CuZn34Al2; GZ-CuZn34Al2	HTB 1	U-Z36N3; CuZn19Al6Y20				HBSC4; H5102/class 3; H5102/class 4	LTs23A; LTs23A6Zh3MTs2	CuZn34Mn3Al2 Fe1-C; CC764S
27	C27200	2.0335	CuZn36; Ms64	CZ108	U-Z36; CuZn 36		C 2700			L63	CuZn36; CW507L
27	C27400	2.0321	CuZn37; Ms63	CZ108			P-CuZn37; P-OT63		C2720	L63	CuZn37; CW508L
27	C86400	2.0592	CuZn35Mn2Al1Fe1-C; G-CuZn35Al1; GK-CuZn35Al1; GZ-CuZn35Al1; G-Ms60	HTB 1					HBSC1; CAC301		CuZn35Mn2Al1 Fe1-C; CC765S
27	C46400	2.0530	CuZn38Sn1As; CuZn38Sn1	CZ112			P-CuZn39Sn1		C4640	LO60-1	CuZn38Sn1As; CW717R
27	C23000; 85Cu-15Zn	2.0240	CuZn15 ; CuZn 15	CZ102	U-Z15; CuZn15	5112-02; 5112-04; 5112-05			C2300		CuZn15; CW502L
27	C24000; 80Cu-20Zn	2.0250	CuZn20; CuZn 20; Ms80	CZ103	CuZn20	5114-02; 5114-04; 5114-05			C2400		CuZn20; CW503L
27	C26000; CA260	2.0265	CuZn30; CuZn 30	CZ106	CuZn30				C2600		CuZn30; CW505L
28	C63000	2.0966	CuAl10Ni5Fe4; CuAl 10 Ni 5 Fe 4	CA 104	U-A10N; CuAl9Ni5Fe3		P-CuAl10Ni5Fe5		C6301	BrAD; BrAZhN10-4-4; N10-4-4	CuAl10Ni5Fe4; CW307G
28	C90700	2.1050	CuSn10-C; G-CuSn 10; SnBz10	CT1	CuSn8						CuSn10-C; CC480K
28	C90800; C91700	2.1052; 2.1052.01; 2.1052.04; 2.1052.03	CuSn12-C; G-CuSn12; GZ-CuSn12; SnBz12, Gbz12	PB2	UE12P				CAC502C; PBC2C		CuSn12-C; CC483K
28	C95800; C95810	2.0975	G-CuAl10Fe5Ni5-C; G-CuAl 10 Ni; NiAlBz-F60		CuAl10Fe5Ni5 Y70				CAC703C		CC333G
28	C11000	2.0060	Cu-ETP; E-Cu57; E Cu 57	C101	Cu-B		Cu-DHP	C11020	C1100	M1	Cu-ETP; E-Cu57; CW004A
28	C81500	2.1292	G-CuCrF 35	CC1-FF	U-Cr0.8Zr						
28	C10300	2.0070	Cu-HCP; Cu-PHC; SE-Cu						C103	LS60-2	Cu-HCP; CW020A; Cu-PHC; CW021A
28	C10100; C10200	2.0040	Cu-OF; OF-Cu	C103; C110	Ci-c1; Cu-c2			C-1120	C1011; C1020	M0b	Cu-OF; CW008A
28	C86550	2.0590	G-CuZn40Fe; G-SoMsF30								G-CuZn40Fe
28	C18100; C18150	2.1293	CuCr1Zr; CuCrZr	CC102	U-C1Z; U-Cr0.8Zr						CuCr1Zr; CW106C

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	AISI/SAE/ UNS/ ASTM/AA	Werkstoff	DIN	BS	AFNOR	SS	UNI	UNE	JIS	GOST	EN
28	C11000; C12200	2.0090	Cu-DHP; E-Cu58; E Cu 58 SF-Cu	C106	Cu-B				C1100; C1220	M1f	Cu-DHP; E-Cu58; CW024A
28	C95500	2.0971	CuAl9Ni3Fe2		UA9					BrA10Zh4N4L	
28	C61000	2.0920	CuAl8; Cu Al 8		CuAl8					BrA7	CuAl8
29											
29											
30											
30											
31	330; N08330	1.4864	X12NiCrSi35-16; X12NiCrSi36-16; X12 NiCrSi 36 16	NA 17; INCOLOY alloy DS	Z 20 NCS 33-16; Z 12 NCS 37-18; Z 12 NCS 35-16			F.3313	SUH 330		
31	N08002; N08004; N08005; N08030	1.4865	GX40NiCrSi38-19 GX40NiCrSi38-18; G-X40 NiCrSi38 18	330 C 11; 330 C 40; 331 C 40			GX 50 NiCr 39 19		SCH 15; SCH 16		GX40NiCrSi38-18
31		1.4558	X2NiCrAlTi32-20; X2 NiCrAlTi 32 20	NA 15					NCF 800		X2NiCrAlTi32-20
31	N08031	1.4562	X1NiCrMoCu32-28-7; X1 NiCrMoCu 32 28 7								X1NiCrMoCu 32-28-7
31		1.4958	X5NiCrAlTi31-20; X5 NiCrAlTi 31 20	NA 15					NCF 800 H; NCF 718		X5NiCrAlTi31-20
31	N08811	1.4959	X8NiCrAlTi32-21; X8 NiCrAlTi 32 21	NA 15; NA 15 H	Z 8 NC 33-21; Z 10 NC 32-21						X8NiCrAlTi32-21
31	N08028	1.4563	X1NiCrMoCu31-27-4; X1 NiCrMoCu 31 27 4		Z 2 NCDU 31-27; Z 1 NCDU 31-27-03	2584				EK77; ChN30MDB	X1NiCrMoCu 31-27-4
31	B 163; N08800; N08810; N08332; N08811	1.4876	X10NiCrAlTi32-21; X10NiCrAlTi32-20; X10 NiCrAlTi 32 20	NA 15; NA 15 H	Z 10 NC 32-21; Z 8 NC 33-21			F.3314; F.3545	NCF 800; NCF 800 TB; NCF 800 TP		X10NiCrAlTi32-21
32	S590; J 467	1.4977	X40CoCrNi20-20; X40 CoCrNi 20 20		Z 42 CNKDWNb						
32	660; S66286	1.4980	X6NiCrTiMoVB25-15-2; X5NiCrTi26-15 X6 NiCrTiMoVB 25 15 2; X5 NiCrTi 26 15	HR 51; HR 52	Z 3 NCT 25; Z 6 NCTDV 25.15 B						X6NiCrTiMoVB 25-15-2; X5NiCrTi26-15
32		1.4943; 1.4944	X4NiCrTi25-15; X5NiCrTi26-15	HR 51	Z 6 NCTDV 25-15 B	2570					X4NiCrTi25-15; X5NiCrTi26-15
32	661; R30155	1.4971	X12CrCoNi21-20; X12 CrCoNi 21 20								X12CrCoNi21-20
32	Haynes 556; R30556										
33	Incoloy 825; N08825;	2.4858	NiCr21Mo	NA 16	NC 21 Fe DU					ChN38VT	
33	Hastelloy C-4; N06455	2.4610	NiMo16Cr16Ti								
33	Nimonic 75; N06075; AMS 5715	2.4630; 2.4951	NiCr20Ti	HR 5; HR 203-4	NC 20 T						
33	Inconel 625; N06625; AMS 5666	2.4856	NiCr22Mo9Nb	NA 21	NC 22 FeDNb						
33	Inconel 690; N06690	2.4642	NiCr29Fe		NC 30 Fe						
33	Monel 400; N04400	2.4360; 2.4361	NiCu30Fe	NA 13	NU 30						

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33	Hastelloy X; N06002; 5390A; AMS 5754; AMS 5536	2.4603; 2.4665	NiCr30FeMo; NiCr22Fe18Mo; NiCr21Fe18Mo9	HR 6	NC 22 FeD						
33	Inconel 617; N06617; AMS 5887	2.4663a	NiCr23Co12Mo		NC 14 K 9 T 5 DWA						
33	Nimonic 90; N07090; AMS 5829	2.4632; 2.4969	NiCr20Co18Ti; NiCr 20 Co 18 Ti	HR 2; HR202; HR 402; HR 501; HR 502; HR 503	Z 8 NCDT 42						NiCr20Co18Ti
33	Haynes 214; NO7214	2.4646	NiCr16Al								
33	Rene 41; N07041; AMS 5712; AMS 5713	2.4973	NiCr19Co11MoTi; NiCr 19 CoMo		NC 19 KDT						
33	Hastelloy B2; N10665	2.4617; 2.4616; 2.4615	NiMo28; EL-NiM29; SG(UP)-NiMo27						YNiMo-7		NiMo28
33	Udimet L-605; R30605	2.4964	CoCr20W15Ni								
33	Monel R-405; N04405	2.4360; 2.4361	NiCu30Fe	NA 13	NU 30						
33	Inconel 600; N06600; AMS 5665	2.4816	NiCr15Fe8; NiCr 15 Fe	NA 14	NC 16 FeT					ChN78T	NiCr15Fe8
33	Inconel 601; N06601	2.4851	NiCr23Fe15A; NiCr 23 Fe		N C 23 FeA					ChN60Yu	NiCr23Fe15A
33	Nimonic 263; N07263; AMS 5872; AMS 5886	2.4650	NiCo20Cr20MoTi; NiCo 20 Cr 20 MoTi MoTi	HR 10; HR 206; HR 404	NCK 20 D						NiCo20Cr20MoTi
34	Haynes 188; Jetalloy 209; R30188; AMS 5772	2.4964	CoCr22W14Ni		KC22WN						
34	Monel K-500; N05500	2.4375	NiCu30Al3Ti; NiCu 30 Al	NA 18	NU 30 AT						NiCu30Al3Ti
34	Inconel 718; N07718; AMS 5596; AMS 5589	2.4668	NiCr19Nb5Mo3; NiCr 19 NbMo; NiCr19Fe19Nb5Mo3	HR 8	NC 19 Fe Nb						NiCr19Nb5Mo3
34		2.4955	NiFe25Cr20NbTi; NiFe 25 Cr 20 NbTi		NiFe25Cr20NbTi						NiFe25Cr20NbTi
34	Incoloy 925; N09925	2.4670									
34	Nimonic 901; N09901; AMS 5660; AMS 5661	2.4662	NiFe35Cr14MoTi; NiCr13Mo6Ti3; NiCr 13 Mo 6 Ti 3		Z8 NCDT 42						
34	Udimet 500; N07500; AISI 684	2.4983	NiCr18Co18MoAlTi		NCK 19 DAT						NiCr18Co18MoAlTi
34	Nimonic 80A; N07080	2.4631; 2.4952	NiCr20TiAl; NiCr 20 TiAl	HR 401; HR 601	NC 20 TA				NCF 80 A	ChN77TYuR; ChN56VMTYu	NiCr20TiAl
34	Jetalloy 209; AMS 5772		CoCr22W14Ni		KC 22 WN						
34	Altemp S-816	2.4989	CoCr20Ni20W							Altemp S-816	
34	MAR-M 246	2.4675	NiCr23Mo16Cu; NiCr 23 Mo 16 Cu								NiCr23Mo16Cu
34	Inconel 722; N07722; AMS 5411										

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34	Waspaloy; N07001; AISI 685; AMS 5704; AMS 5706; AMS 5708; AMS 5544	2.4654	NiCr20Co13Mo4Ti3AL; NiCr 19 Co 14 Mo 4 Ti		NC 20 K 14						NiCr20Co 13Mo4Ti3AL
34	Rene 80				NC14 K9 T5 DWA						
35	5388C; N30002; CW-12MW;	2.4883	G-NiM16CrW								
35	N7M; N-7M; N30007	2.4685	G-NiMo28		ND 30 M						
35	N12MV; N-12MV; N30012	2.4882; 9.4810; 2.4810/9.4810	G-NiMo30								
35	Nimocast PK24; N13100; AMS 5397	2.4674	G-NiCo15Cr10AlTiMo	HC 204	NK 15 CAT						
35	Jethete M-252; N07252; AMS 5551	2.4916	G-NiCr19Co; G-NICR 19 Co								
35	Nimocast 713; N07713; AMS 5391; Inconel 713LC	2.4670	G-NiCr13Al6MoNb	HC 203	NC 13 AD						
35	M-35-1; N214135	2.4365; 2.4365/9.4365	G-NiCu40Nb						NiCuC		
36	Titanium Grade 1; R50250; ASTM GR. 1	3.7024; 3.7025	Ti 1; Ti 99.8	TA1	T-35		Ti1-Type 1	Ti-PO1	Class 2; Gr-1	VT1-00	Ti 99.8
36	Titanium Grade 2; R50400; AMS 4902; AMS 4941; AST M Gr. 2	3.7034; 3.7035; 3.7036	Ti 2; Ti 99.7	TA2; TA3; TA4; TA5	T-40		Ti1-Type 2	Ti-PO2	Class 2; Gr-2	VT1-0	Ti 99.7
36	Titanium Grade 3; R50500; ASTM Gr. 3	3.7055; 3.7056	Ti 3; Ti 99.6	DTD 5023, DTD 5273	T-50		Ti1-Type 3		Class 3; Gr-3		Ti 99.6
36	Titanium Grade 4; R50700; ASTM Gr. 4	3.7064; 3.7065; 3.7066	Ti 4; Ti 99.5	TA7; TA8; TA9	T-60		Ti1-Type 4		Class 4; Gr-4		Ti 99.5
36	Titanium Grade 7; R52400; Ti-0.15Pd	3.7235					Ti2Pd-Type 7		Class 13; Gr-13		
37	Titanium Grade 5; R56400; Ti-6Al-4V	3.7165; 3.7164	Ti6Al4V	TA10; TA11; TA12; TA13; TA 28; TA56; Ti-Al-V	TA6V; T-A 6 V; Ti-P.63		TiAl6V4-Type 5	Ti-P63	Class 6 0; Gr 6 0; SAT-64	VT6	Ti6Al4V
37	Titanium Grade 6Al-2Sn-4Zr-2Mo; R54620; 6Al-2Sn-4Zr-2Mo	3.7145; 3.7144	TiAl6Sn2Zr4Mo2							VT25	TiAl6Sn2Zr4Mo2
37		3.7175; 3.7174	TiAl6V6Sn2								

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37	Titanium Grade 9; R56320; Ti-3Al-2.5V	3.7195; 3.7194	Ti6Al2.5V				TiAl3V2.5-Type 9		Class 6 1; Gr 6 1	PT-3V	Ti6Al2.5V
37		3.7124	TiCu2	TA 21; TA22; TA23; TA24	T-U2			Ti-P11			
37		3.7185; 3.7184	Ti4Al4Mo2Sn; TiAl4Mo4Sn4Si0.5	TA45; TA46; TA47; TA48; TA49; TA50; TA57	T-A4DE			Ti-P68			
37	Titanium Grade 6; R54520; Ti-5Al-2.5Sn	3.7115.1; 3.7115	TiAl5Sn2.5; TiAl 5 Sn 22	TA14; TA17	T-A5E; Ti-P.65				SAT-525	VT5-1	TiAl5Sn2.5
37	R56410; Ti-10V-2Fe-3Al										
37	Titanium grade 23; R56401; Ti-6Al-4V-ELI		Ti6Al4V ELI	TA11			TiAl6V4ELI-Type 5.1		Class 6 1; Gr 6 1		
37										VST 5553	Ti5Al5V5Mo3Cr; Ti-5Al-5V-5Mo-3Cr
37	Ti-4Al-3Mo-1V				T-A4D3V					VT14	
37										VT22	
38		1.2762	75CrMoNiW6-7; 75 CrMoNiW 6 7								75CrMoNiW6-7
38	W1; T72301	1.1625	C80W2; C 80 W2	BW 18				F.520.U; F.5107; C 80	SK 75; SK 85; SK 85 M; SK 5; SK 5 M; SK 6	U8-1	C80W2
38	W110; T72301	1.1545	C105U; C 105 W 1; C 105 U		C 105 E 2 U; Y1 105; C105E2U	1880	C 100 KU	F.515; F.516	SK 105; SK 3; TC 105	U10A-1; U10A-2; U11-1	C105U
38		1.6746	32NiCrMo14-5; 32 NiCrMo 14-5	832 M 31	35 NCD 14			F.1262-32 NiCrMo 12			32NiCrMo14-5
38	W210; T72302	1.2833	100V1; 100 V 1	BW 2	C 105 E 2 UV 1; Y1 105 V; 100 V 2		102 V 2 KU		SKS 43		100V1
38	6145; 6150; 6150 H; G61500; H61500	1.8159	51CrV4; 50CrV4; 50 CrV 4	735 A 50; 735 A 51; 735 H 51; 735 M 50; En 47	50CrV4RR; 50 CV 4; 51 CV 4	2230	50 CrV 4	F.143; F.143.A; 51 CrV 4; F.1430	SUP 10; SUP 10-CSP; SUP 10 M	50ChFA; 50ChGFA	51CrV4
38	P20; T51620	1.2330	35CrMo4; 35 CrMo 4	708 A 37	34 CD 4	2234	35 CrMo 4				35CrMo4
38											
38											
38											
38											
38		1.8721	26MnCr6-3								26MnCr6-3
38											
38											
38											
38		1.2083; 1.2083 ESR	X40Cr14; X 42 Cr 13		X40Cr14; Z 40 C 14	2314	X 41 Cr 13 KU	F.5263; X 40 Cr 13	SUS 420 J 2		X40Cr14
38	300M; 4340M; K44220	1.6928	41SiNiCrMoV7-6								S 155

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	AISI/SAE/ UNS/ ASTM/AA	Werkstoff	DIN	BS	AFNOR	SS	UNI	UNE	JIS	GOST	EN
38										30ChGSA	
39	A2; T30102	1.2363	X100CrMoV5; X100CrMoV5-1; X 100 CrMoV 5 1	BA 2	X 100 CrMoV 5; Z 100 CDW 5	2260	X 100 CrMoV 5 1 KU	F.536; F.5227; X 100 CrMoV 5	SKD 12		X100CrMoV5
39	D2; T30402	1.2379	X153CrMoV12; X155CrVMo12-1; X155 CrVMo 12 1	BD 2	X 160 CrMoV 12; Z 160 CDV 12	2310	X 155 CrVMo 12 1 KU	F.520.A	SKD 10; SKD 11		X153CrMoV12
39	D3; T30403	1.2080	X210Cr12; X 210 Cr 12	BD 3	X200Cr12; Z 200 C 12		X 205 Cr 12 KU	F.521; F.5212; X 210 Cr 12	SKD 1	Ch12	X210Cr12
39	L3; T61203	1.2067	102Cr6; 102 Cr 6; 100 Cr 6	BL 3; BL3	100Cr6RR; 100 C 6; 100Cr6; Y 100 C 6		102 Cr 6 KU	F.5230; 100 Cr 6	SUJ 2	Ch	102Cr6
39	M1; H41; T11301; T20841	1.3346	HS2-9-1; S 2-9-1	BM 1	HS 2-8-1; Z 85 DCWV 08-04-02-01						HS2-9-1
39	T1; T12001	1.3355	HS18-0-1; S 18-0-1	BT 1	18-0-1; HS 18-0-1; Z 80 WCV 18-04-01	2750	HS 18-0-1	F.5520; HS 18-0-1	SKH 2	R18	HS18-0-1
39	O2; T31502	1.2842	90MnCrV8; 90 MnCrV 8	BO 2; BO2	90 MnV 8; 90 MV 8		90 MoVCr 8 KU	90 MnCrV 8; F.5229			90MnCrV8
39	H13; T20813	1.2344	X40CrMoV5-1; X40 CrMoV 5 1	BH 13	X 40 CrMoV 5; Z 40 CDV 5	2242	X 40 CrMoV 5 1 1 KU	F.5318; X 40 CrMoSiV 5	SKD 61	4Ch5MF1S	X40CrMoV5-1
39											
39											
39											
39											
39											
39	440C; S44004; S44025	1.4125	X105CrMo17; X105 CrMo 17		Z 100 CD 17 Cl; Z 100 CD 17				SUS 440 C	95Ch18; 110Ch18M-SChD	X105CrMo17
40	A 532 III A 25% Cr	0.9650	G-X 260 Cr 27	Grade 3 D		0466-00				ChWG	
40	Ni-Hard 4	0.9630	G-X 300 CrNiSi 9 5 2								
40	Ni-Hard 1	0.9625	G-X 330 NiCr 4 2	Grade 2 B		0513-00					
40	A 532 III A 25% Cr	0.9655	G-X 300 CrMo 27 1	Grade 3 E						20Ch25N20S2	
40	Ni-Hard 2	0.9620	G-X 260 NiCr 4 2	Grade 2 A		0512-00					
41	A532 IID20%CrMo-LC	0.9645; 5.5609	G-X 260 CrMoNi 20 2 1	Grade 3C							EN-GJN-HV600(XCr23)
41	A532 IIC15%CrMo-HC	0.9635; 0.9640	G-X 300 CrMo 15 3; G-X 300 CrMoNi 15 2 1	Grade 3A; Grade 3B							EN-GJN-HV600(XCr14)

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