TOOLING SYSTEMS PROCESS OPTIMIZATION CONSULTING IN MILLING STRATEGIES

SLOTWORX®

... ANY GROOVE – IMPROVE YOUR CHIP-REMOVE

pokolm voha

PREMIUMTOOLS. WE KNOW HOW.

... ANY GROOVE – IMPROVE YOUR CHIP-REMOVE

Slotworx® from S to L offers to you a complete range of square shoulder face milling- and slotting end mills for universal applications: roughing and finishing of steel, aluminium, graphite, plastics as well as hardened materials and, in the meantime, for machining stainless steels also. For face-, groove-, pocket-, side- and shoulder-milling, outstandingly suitable for angular or circular plunging (ramping).
The Slotworx®-range is available with threaded shanks, plain shanks and clamping flats, shell type milling cutters and with our patent protected **DuoPlug®**-system for highest concentricity and maximum rigidity. These threaded shank milling cutter bodies in connection with our dense-antivibration adapters are extremely applicable for finishing operations. Exceptionally precision-manufactured cutter bodies guarantee excellent milling results.

Optimum coolant supply direct to the cutting edges avoids any chip built-up on the insert's cutting face and it ensures maximum process reliability and secure chip removal, also in difficult materials.

Small, but big in capability, the Slotworx®-"S" range features itself through exceptional easy cutting. Our Slotworx®-"M" range is for all-purpose usage. The Slotworx®-"L" range allows for cutting depths ap up to 14 mm and enables you to generate maximum possible machining rates from your machine capability available. There is always an appropriate tool for every possible machining process in our Slotworx®-product-range.

DuoPlug®

Threaded shanks

Shell type

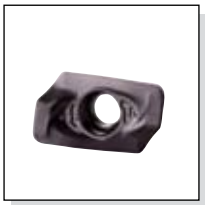
Our state-of-the-art helical cutting edges with positive rake angles lead to a constant good edge rigidity, easy cutting and outstanding surface finish for all possible kinds of milling operations, as well as 90° shoulder- or face-milling.

Through our patent-protected **incorporated insert-seats**, a smaller Torx-screw can be used . This results in less balancing errors and therefore to much smoother running of our **Slotworx®**-range. Even in deep cavities you have a possibility to mill 90°-shoulders, accurate and virbration-free with high cutting parameters. Smooth surface finish at the cavity's bottom is possible through inserts with intigrated finishing lands. In fact, cutting depths of ap = 14 mm are realisable and lead to extended chip volumes and increased velocity of your milling process.

... ANY GROOVE – IMPROVE YOUR CHIP-REMOVE

Maximum demands to precision and accuracy are secured by ground and polished indexable inserts. These intigrated finishing lands of our inserts care for outstanding surface finish in face-milling operations. Our high-accuracy indexable inserts however, offer an optimum relation between precision and efficiency. These inserts can also be used for fine finshing operations in minor applications. A distinct increase of tool life is achieved by new carbide substrates and coating technolgy.

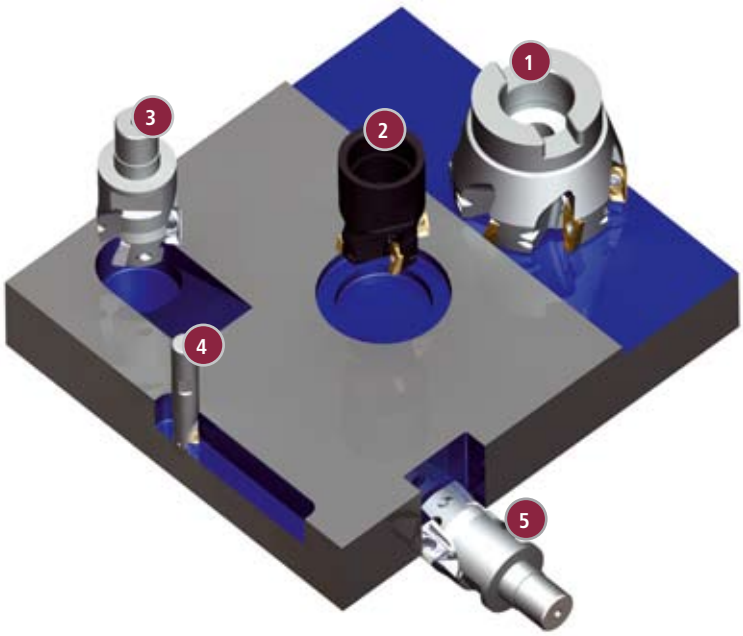
size „S“



size „M“

size „L“

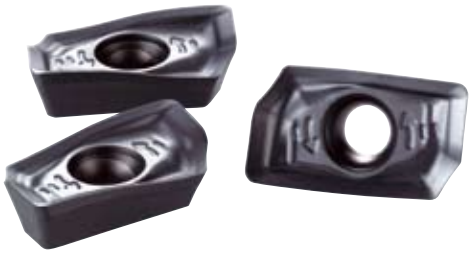
APPLICATION SPECTRUM



1. **Slotworx®** „L“ for face-milling
2. **Slotworx®** „M“ for circular ramping
3. **Slotworx®** „L“ for angular ramping
4. **Slotworx®** „S“ for side- and shoulder milling
5. **Slotworx®** „L“ for grooving

BRIGHT PROSPECTS...

M40 and PVST are the new features for efficient machining of stainless- acid- and heat-resistant materials. Optimized adapted rake angles and protective lands offer the best possible results for cutting edge stability and cutting capability. Extremely tough and high-temperature-resistant carbide together with our modified AlTiN-coating reduce built-up cutting edges, increase thermal stability and reduce frictional heat at the same time.



M40 PVST

...FOR MILLING STAINLESS MATERIALS

In case you need further information about our stainless range, you can download our current brochure from our homepage www.pokolm.com or ask by phone / e-mail under contacts (see back page) for this brochure.

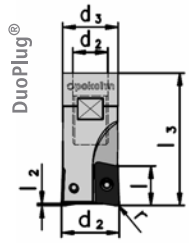
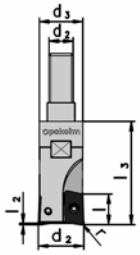
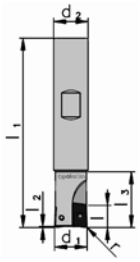
YOU PROFIT FROM THIS SUMMARY OF ADVANTAGES:

- from face to groove to pocket to side to shoulder-milling
- universal application possibilities: roughing and finishing of steel, aluminium, graphite, plastics as well as hardened-and stainless steels
- optimized coolant supply direct to the cutting edges
- new-style surface-finish of inserts for improved machining of aluminium
- these new tools replace up to 3 traditional tool styles:
  APKT, LDLX and ADEW through rigidity, accuracy, vibration-decrease and optimized geometries
- integrated finishing lands achieve outstanding surface finish

CONTENT

DIMENSIONS AND OPERATION DATA

The Slotworx® „S"-Range

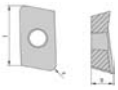
MILLING CUTTER BODIES	Catalogue No.	d_1	l_2	r	l_3	l_1	d_2	d_3	z	
Duo Plug®										
	4 16 256 SG	16	1,3	0,8	34,4	-	M 10	15	4	
	5 20 256 SG	20	1,3	0,8	32,4	-	M 12	18,5	5	
Threaded shank end mill bodies										
	2 10 256	10	0,7	0,8	22,5	-	M 5	9,5	2	
	3 12 256	12	0,7	0,8	27,5	-	M 8	11,8	3	
	4 16 256	16	1,3	0,8	27,5	-	M 8	13,8	4	
	5 20 256	20	1,3	0,8	27,5	-	M 10	18	5	
Plain shank end mills										
	15 10 156	10	0,7	0,8	16,7	55,6	10	-	2	
	15 12 156	12	0,7	0,8	17,5	60,5	12	-	3	
	40 16 156	16	1,3	0,8	42,5	90,5	16	-	4	

Accessories

ACCESSORIES	Catalogue No.	Description	Dimensions			
	18 500	Torxscrew	M 1,8	L 3,7	T 6	
	06 500	Torx screwdriver	T 6			

Starting torque for Torx® screw 18 500 M_d: 0,4 Nm

Slotworx®-Inserts Size „S“, DIN-Description: XOMX 060208 R

INDEXABLE INSERTS	Catalogue No.	DIN-Identification	Grade	Coating	l	s	r	M	
	02 71 840 R08	XOMX 060208 R	P40	PVML	6,94	2,45	0,8	1,8	

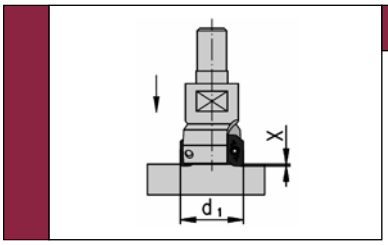
Cutting Speeds V_C in m/min

MATERIAL		r	l	Machining Rates	P40 PVML				
Steel		0,8	6,94	roughing finishing	120 – 250 150 – 300				
High-temperature alloys		0,8	6,94	pre-finishing	100 – 200				
Stainless Steel		0,8	6,94	pre-finishing	140 – 220				

Application data (f_z/a_p)

MATERIAL		r	l	Machining Rates	P40 PVML				
Steel		0,8	6,94	f_z (mm) a_p (mm)	0,02 – 0,17 0,1 – 2,5				
High-temperature alloys		0,8	6,94	f_z (mm) a_p (mm)	0,02 – 0,10 0,1 – 1,7				
Stainless Steel		0,8	6,94	f_z (mm) a_p (mm)	0,02 – 0,14 0,1 – 2,5				

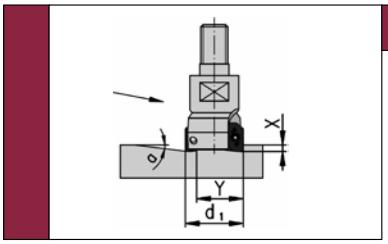
EXTENDED OPERATION DATA



axial plunging into solid block

x maximum plunge depth
f_z see operation data table, but reduce value to 30%

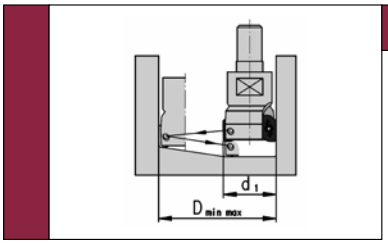
Cutter diam. ø d_1 mm	x max. mm
10 - 12	0,7
16 - 20	1,3



ramping

y minimum travel
x maximum plunge depth
a_p/f_z see operation data table

Cutter diam. ø d_1 mm	a°	y mm
10	10	3
12	6,5	5
16	4	9
20	2,5	13



circular milling into solid block

a_p/f_z see operation data table

Cutter diam. ø d_1 mm	D_{min} mm	D_{max} mm
10	13	20
12	17	24
16	25	32
20	33	40

D_{min} minimum bore diameter depending on cutter diameter
D_{max} maximum bore diameter depending on cutter diameter

FROM PRACTICE TO PRACTICE

JOB TITLE:

The company PFT – Präzisions-Fertigungstechnik GmbH from Erwitte/Germany manufactures high precision components according to designs and requirements of their customers for more than 10 years; on request from material-purchase, complete operation-cycle up to final assembly. During those operation-cycles, target-settings of tolerance-ranges are checked, measured and recorded on the basis of prooved process-capabilities. This fulfils several requests of their customers. PFT is a supplier for aircraft- and space-as well as automotive-industries. Up to the time of introducing our **Slotworx®**-S-tooling, supplementary flats like spanner flats, clearance-flats on devices etc. were machined with solid carbide end mills. These tools often had too long cutting lengths, the customer needed to stock increased quantities in order to recognize regrinding time and he had problems with a reduced product reliability due to very unstable components. For these exceptional obstinate operations, causing intense vibrations, combined with quick chipping of cutting edges due to brittle solid carbide end mills, we have tried our new **Slotworx®**-tools. Our new task was: machining joining flats for fastening elements, retaining rings and spanner flats on structural parts. Everywhere, when it was impossible to avoid vibrations through less optimum set-up and/or component's prevailing conditions, tools from our new **Slotworx®**-S-range can take advantages of its superiority.

The milling cutter body 4 16 256 (16 mm diam., r=0.8) could be compared easily with a solid carbide end mill, due to the same no. of teeth and equal cutting parameters.

MACHINE	MATERIAL	PROGRAMMING SYSTEM
Hermle C 800 U	1.7225	manual

Clamping flats on a rotationally symetrical component with a nominal width of 32 mm and a required depth of 16 mm have been machined in one cut. The component was clamped on the machine table of the Hermle milling machine, very unstably. Difficulties occurred not through the material itself, but the job title was, to machine this component process-reliable, with no cutting-edge chipping in sufficient surface accuracy, despite of vibrations, activated by inefficient clamping possibilities. The smallest milling cutter body from our **Slotworx®**-S-range could realize our expectations. Refurbishing was replaced through simple turning or changing of inserts.

EXAMPLE FROM PRACTICE:

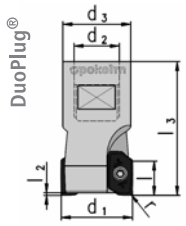
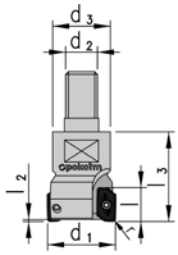
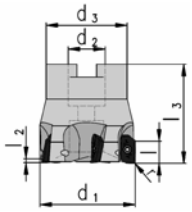
component:	spanner flats
material:	1.7225
arbor:	50 08 750 (M 8, SK 40)
extension:	none
cutter body:	4 16 256
	(16 mm diam., r = 0.8)
insert:	02 71 840, r = 0.8, P40
coating:	PVML
overhang:	78,5 mm
v_c (speed):	180 m/min
v_f (feed rate):	1.432 mm/min
S (revolutions):	3.580 1/min
f_z (feed per tooth):	0,1 mm
a_p (depth of cut):	2,0 mm
a_e (width of cut):	16,0 mm
chip volume:	45,8 cm³/min =2,18 cu.in./min

RESULT:

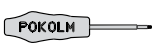
These spanner flats could be produced with increased process reliability and without interruptions. Vibrations, occuring during milling process have not caused any damage to the cutting edges. Due to the modular threaded shank-interface, this tool can be used also for other operations and machining opportunities. Costs for refurbishing of solid end mills and for increased availablility were avoided.

DIMENSIONS AND OPERATION DATA

The Slotworx® „M"-Range

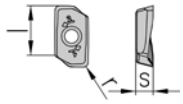
MILLING CUTTER BODIES	Catalogue No.	d_1	l	r	l_3	l_2	d_2	d_3	z	
Duo Plug®										
	2 16 267 SG	16	10	1	38	2,5	M 10	15	2	
	2 20 267 SG	20	10	1	40	2,5	M 12	18,6	2	
	3 25 267 SG	25	10	1	43	2,5	M 16	21,5	3	
Threaded shank end mill bodies										
	2 16 267	16	10	1	29	2,5	M 8	13,8	2	
	2 20 267	20	10	1	29	2,5	M 10	18	2	
	3 25 267	25	10	1	33	2,5	M 12	21	3	
	4 32 267	32	10	1	43	2,5	M 16	29	4	
	5 42 267	42	10	1	43	2,5	M 16	29	5	
Shell type milling cutter bodies										
	5 42 367	42	10	1	43	2,5	16	35	5	
	6 52 367	52	10	1	53	2,5	22	40	6	

Accessories

ACCESSORIES	Catalogue No.	Description	for Ø	Dimensions			
	25 505 KP	Torx screw	16 - 25	M 2,5	L 5,6	T 8 Plus	
	25 505 P	Torx screw	32 - 52	M 2,5	L 7,3	T 8 Plus	
	08 500 P	Torx screwdriver	16 -52	T 8 Plus			

Starting torque for Torx® screw 25 505 M_d: 1,8 Nm

Slotworx®-Inserts Size „M“, DIN-Identification: (XDHT/XDMT) 10T310

INDEXABLE INSERTS	Catalogue No.	DIN-Identification	Grade	Coating	l	s	r	M	
	04 67 820	XDHT 10T310	K10	polished	10	3,59	1	2,5	
	04 67 837	XDMT 10T310	HSC05	PVFN	10	3,59	1	2,5	
	04 67 844	XDHT 10T310	P40	PVGO	10	3,59	1	2,5	
	04 67 848	XDMT 10T310	P40	PVGO	10	3,59	1	2,5	
	04 67 860	XDHT 10T310	K10	PVTi	10	3,59	1	2,5	
	04 67 860D	XDHT 10T310	K10	PVDiaN	10	3,59	1	2,5	
	04 67 896	XDMT 10T310	M40	PVST	10	3,59	1	2,5	

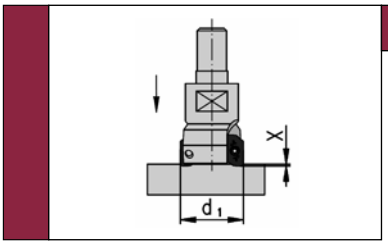
Cutting Speeds V_C in m/min

MATERIAL		r	l	Machining Rates	HSC05 PVFN	K10 polished	K10 PVTi PVDiaN	P40 PVGO	M40 PVST
Steel		1	10	roughing finishing				100 – 200 160 – 250	
High-temperature alloys		1	10	roughing finishing					20 – 50 30 – 80
Stainless Steel		1	10	roughing finishing					80 – 200 80 – 230
Cast Iron		1	10	roughing finishing				110 – 150 120 – 180	
Non-ferrous		1	10	roughing finishing		200 – 800 200 – 800	200 – 800 200 – 800		
Hardened Steel		1	10	roughing finishing	35 – 100 80 – 180				

Application data (f_z/a_p)

MATERIAL		r	l	Machining Rates	HSC05 PVFN	K10 polished	K10 PVTi PVDiaN	P40 PVGO	M40 PVST
Steel		1	10	f_z (mm) a_p (mm)				0,05 – 0,35 0,1 – 9	
High-temperature alloys		1	10	f_z (mm) a_p (mm)					0,08 – 0,35 0,1 – 9
Stainless Steel		1	10	f_z (mm) a_p (mm)					0,08 – 0,35 0,1 – 9
Cast Iron		1	10	f_z (mm) a_p (mm)				0,08 – 0,4 0,1 – 9	
Non-ferrous		1	10	f_z (mm) a_p (mm)		0,08 – 0,35 0,1 – 9	0,08 – 0,35 0,1 – 9		
Hardened Steel		1	10	f_z (mm) a_p (mm)	0,08 – 0,25 0,1 – 5				

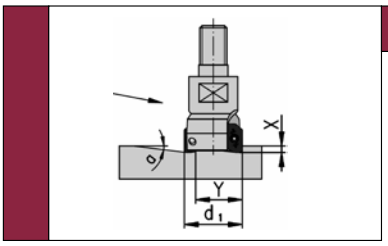
EXTENDED OPERATION DATA



axial plunging into solid block

x maximum plunge depth
f_z see operation data table, but reduce value to 30%

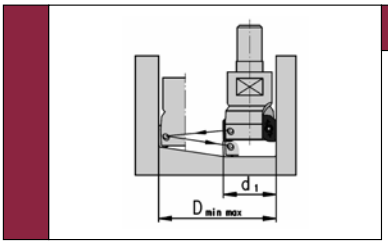
Cutter diam. ø d_1 mm	x max. mm
16 - 52	2,5



ramping

y minimum travel
x maximum plunge depth
a_p/f_z see operation data table

Cutter diam. ø d_1 mm	a°	y mm
16	< 24,5	5,3
20	< 14,5	9,3
25	< 8	14,3
32	< 5	21,3
42	< 3	31,3
52	< 2,5	41,3



circular milling into solid block

a_p/f_z see operation data table

Cutter diam. ø d_1 mm	D_{min} mm	D_{max} mm
16	21,3	32
20	29,3	40
25	39,3	50
32	53,3	64
42	73,3	84
52	93,3	104

D_{min} minimum bore diameter depending on cutter diameter
D_{max} maximum bore diameter depending on cutter diameter

FROM PRACTICE TO PRACTICE

JOB TITLE:

Producing absolutely accurate 90°-walls on holding blocks of injection moulding dies for plastics processing has always been a goal of the company Wonde from the town of Heiligkreuz-Steinach. Only a perfectly prepared holding block guarantees highest possible accuracy and durability for following production processes of all injection moulding dies. On this job, special attention was required for precision and economic efficiency regarding tool costs. Till now, the customer was using a 25 mm diam. multiple flute solid carbide end mill for this job. He was limited through given dimensions for reach and overall length of this end mill. For this particular and for many other applications, our new **Slotworx®**-range is the ideal compliment, where a solid carbide end mill reaches its limitation. This is a golden opportunity for our **Slotworx®**-style of end mills. Our new range, with precision-ground inserts, is ready to face these challenges –and, it has passed its examination in masterly manner and velocity.

MACHINE	MATERIAL	PROGRAMMING SYSTEM
Deckel Maho DMU 100 P	1.2312	Euklid

This holding block, which had to be machined, had a remaining stock of 1 mm all over, after roughing. This part had been programmed in a z-constant circular-pocket cycle with constant depth setting increments in radial and axial direction. We found a rigid set-up on that DMU 100P milling machine, a high-speed and dynamic 5-axis machining centre with vertical HSK-63A taper connection. All these conditions are ideal qualifications for using Pokolm-**Slotworx®**-milling cutters.

EXAMPLE FROM PRACTICE:

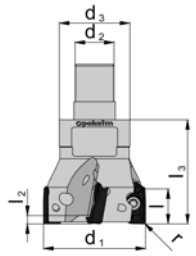
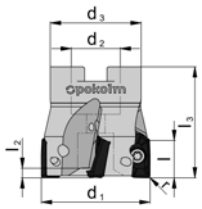
component:	holding block
material:	1.2312
arbor:	60 25 A63 S
	(25 mm diam., HSK 63)
extension:	75 16 603
cutter body:	3 25 267 SG
	(25 mm diam., r = 1)
insert:	04 67 844, P40
coating:	PVGO
overhang:	178 mm
v_c (speed):	314 m/min
v_f (feed rate):	2.000 mm/min
S (revolutions):	4.000 1/min
f_z (feed per tooth):	0,25 mm
a_p (depth of cut):	3,0 mm
a_e (width of cut):	0,1 mm

RESULT:

Expected and requested accuracy has been reached immediately to customer's satisfaction. Now, the customer is able to produce his holding blocks with those exceptionally required tool-overhangs of > 100 mm process-reliable and efficient in very short time. This kind of tooling is also avaible now for machining aluminium, and it is the right way for further success of Pokolm-Voha-tooling.

DIMENSIONS AND OPERATION DATA

The Slotworx® „L"-Range

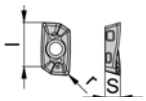
MILLING CUTTER BODIES	Catalogue No.	d_1	l	r	l_3	l_2	d_2	d_3	z	
Threaded shank end mill bodies										
	2 25 268	25	15	1	35	3	M 12	21	2	
	3 32 268	32	15	1	43	3	M 16	29	3	
	4 40 268	40	15	1	43	3	M 16	29	4	
	4 42 268	42	15	1	43	3	M 16	29	4	
Shell type milling cutter bodies										
	4 40 368	40	15	1	43	3	16	35	4	
	4 42 368	42	15	1	43	3	16	35	4	
	5 50 368	50	15	1	53	3	22	40	5	
	5 52 368	52	15	1	53	3	22	40	5	
	6 63 368	63	15	1	53	3	27	48	6	
	6 66 368	66	15	1	53	3	27	48	6	
	7 80 368	80	15	1	53	3	27	60	7	
	9 100 368	100	15	1	53	3	32	70	9	

Accessories

ACCESSORIES	Catalogue No.	Description	Dimensions			
	35 500	Torx screw	M 3,5	L 7,5	T 15	
	15 500	Torx screwdriver	T 15			

Starting torque for Torx® screw 35 500 M_d: 3,45 Nm

Slotworx®-Inserts Size „L", DIN-Identification: XDMT 155210

INDEXABLE INSERTS	Catalogue No.	DIN-Identification	Grade	Coating	l	s	r	M	
	05 68 848	XDMT 155210	P40	PVGO	15	5,2	1	M 3,5	
	05 68 896	XDMT 155210	M40	PVST	15	5,2	1	M 3,5	

Cutting Speeds V_C in m/min

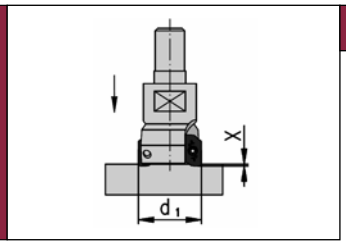
MATERIAL		r	l	Machining Rates	P40 PVGO	M40 PVST			
Steel		1	15	roughing finishing	110 – 200				
High-temperature alloys		1	15	roughing finishing		40 – 80 60 – 120			
Stainless Steel		1	15	roughing finishing		80 – 180 110 – 250			
Cast Iron		1	15	roughing finishing	100 – 200				

Application data (f_z/a_p)

MATERIAL		r	l	Machining Rates	P40 PVGO	M40 PVST			
Steel		1	15	f_z (mm) a_p (mm)	0,1 – 0,5 0,2 – 14				
High-temperature alloys		1	15	f_z (mm) a_p (mm)		0,08 – 0,3 0,1 – 14			
Stainless Steel		1	15	f_z (mm) a_p (mm)		0,08 – 0,5 0,1 – 14			
Cast Iron		1	15	f_z (mm) a_p (mm)	0,1 – 0,5 0,2 – 14				

EXTENDED OPERATION DATA

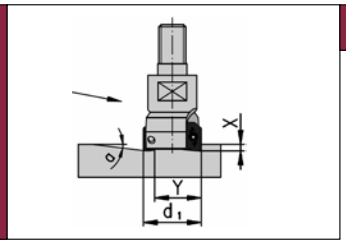
axial plunging into solid block



x maximum plunge depth
f_z see operation data table, but reduce value to 30%

Cutter diam. ø d_1 mm	x max. mm
25 - 100	3

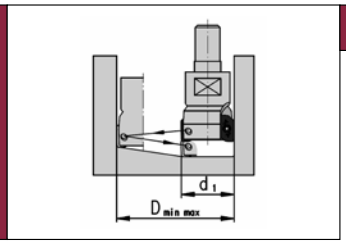
ramping



y minimum travel
x maximum plunge depth
a_p/f_z see operation data table

Cutter diam. ø d_1 mm	a°	y mm
25	< 8,3	17
32	< 5,9	24
40	< 4,4	32
42	< 4,2	34
50	< 3,3	42
52	< 3,2	44
63	< 2,5	55
66	< 2,4	58
80	< 1,9	72
100	< 1,5	92

circular milling into solid block



a_p/f_z see operation data table

D_{min} minimum bore diameter depending on cutter diameter
D_{max} maximum bore diameter depending on cutter diameter

Cutter diam. ø d_1 mm	D_{min} mm	D_{max} mm
25	42	50
32	56	64
40	72	80
42	76	84
50	92	100
52	96	104
63	118	126
66	124	132
80	152	160
100	192	200

FROM PRACTICE TO PRACTICE

JOB TITLE:

Optimizing of machining a component from Cu-HCP (CW021A) (best selected copper min.99.5% purity), with a tensile strength of approx. 300 N/mm² only, but a breaking elongation of over 40%. The metal removal volume for this component was 55%, for a quantity of 48 pieces. Previously, this component with unmachined dimensions of 258 mm long, 123 mm wide and 211 mm high was machined with a Square Shoulder Face- and Slot Milling Cutter with inserts having 0.8 mm corner radius. But with this tool, maximum cutting depth of ap = 3 mm could be realized, otherwise the component started vibrating under the enormous cutting pressure. This was a very negative influence to the roughing operation. Although the customer had rated the tool life of the inserts as satisfying, this was not our valuation at all.

The no. of components was increasing constantly , and regarding production capacity, a decision had to be made. A solution for better machining possibilities was found by our applications engineers immediately. The new milling cutter body from our **Slotworx®**-L range 5 52 368 (52 mm diam., r = 1) should be suitable outstandingly for this application, and it was selected together with our new indexable inserts 05 68 896, specially developed for cutting corrosion- acid- and heat-resistant materials, having sharp, but slightly radiused cutting edges and our special coating with lubrication additives. This special coating avoids chip-built-up of this best selected copper and cares together with a sufficient coolant supply for optimum chip removal.

MACHINE	MATERIAL	MACHINE CONTROL
OKUMA	Cu-HCP	manual

This component has been produced countour-parallel in z-constant cycle in climb milling as well as conventional milling. Regarding machining time, the feed rate and thus the chip volume has been increased by 4 times. This results in a reduction of the previous machining time from approx. 30 minutes to slightly more than 6 minutes. Through the special design of the minor cutting edge of these **Slotworx®**-L inserts we could achieve very good surface smoothness and minor waviness in the vertical parts of the component, even in cutting depth ap of 5 mm.

EXAMPLE FROM PRACTICE:

component:	slot
material:	Cu-HCP, CW021A
arbor:	50 22 710 (22 mm diam., SK 50)
cutter body:	5 52 368 (52 mm diam., r = 1)
insert:	05 48 896, M40
coating:	PVST
overhang:	103 mm
v_c (speed):	571 m/min
v_f (feed rate):	4.000 mm/min
S (revolutions):	3.500 1/min
f_z (feed per tooth):	0,229 mm
a_p (depth of cut):	5 mm
a_e (width of cut):	32 mm
chip volume	640 cm³/min =39 cu.in./min
machining time	06:07 min

RESULT:

Machining time of this component has been reduced from 5 to 1.5 hours. This results – for 48 components and a calculated machine hour rate of 50€/hour – in savings of approx. more than 8000 €. Plus an increased machine availablility of 168 hours, which represents working hours of a complete month anyhow. This time saving can be used for other projects.

SLOTWORX®

PV-F-SW-E 0808

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