Recommended Cutting Conditions

Cutting Speed

(inch)

	Work Material	No.	Hardness	Breaker	Cutting Speed for Different Grades **vc** (SFM)		
P					**MP6120**	**VP15TF**	**MP6130**
	Mild Steel	1	≦180HB	**M2**	655 (560−785)	590 (490−720)	525 (425−655)
	Carbon Steel Alloy Steel	2	180−350HB	**M2**	590 (460−720)	525 (395−655)	460 (330−590)
M					**MP7130**	**MP7140**	**VP30RT (VP15TF)**
	Austenitic Stainless Steel	1	≦200HB	**M2**	560 (395−655)	525 (330−590)	490 (395−590)
	Austenitic Stainless Steel	2	>200HB	**M2**			
	Ferritic and Martensitic Stainless Steel	3	≦200HB	**M2**			
	Ferritic and Martensitic Stainless Steel	4	>200HB	**M2**			
K					**VP15TF**		
	Gray Cast Iron	1	≦350MPa	**M2**	590 (490−720)	−	−
	Ductile Cast Iron	2	≦450MPa	**M2**	590 (490−720)	−	−
N					**HTi10**		
	Aluminum Alloy	1	Si<5%	**G1**	1640 (655−2625)	−	−
	Aluminum Alloy	2	5%≦Si≦10%	**G1**	330 (165−985)	−	−
	Aluminum Alloy	3	Si>5%	**G1**	330 (165−985)	−	−
S					**MP9120**		
	Titanium Alloy	1	−	**M2**	165 (100−230)	−	−
H					**VP15TF**		
	Hardened Steel	1	40−55HRC	**M2**	260 (165−395)	−	−

* Wet cutting is recommended for Titanium alloy.

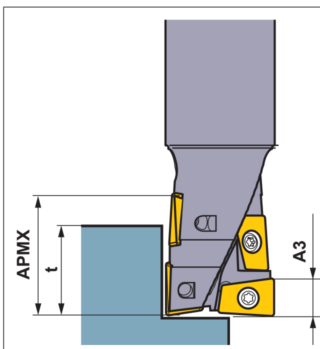
Cutting Conditions for Shoulder Milling

(inch)

	Work Material	No.	Hardness	φ.625", .672" φ16mm , 17mm			φ.750", .797" φ20mm , 21mm			φ1.000", 1.047" φ25mm , 26mm		
				ap	ae	f (IPR)	ap	ae	f (IPR)	ap	ae	f (IPR)
P	Mild Steel	1	≤180HB	≤.177	≤.315	.010	≤.236	≤ .394	.012	≤.295	≤ .492	.014
				.177−.472	≤.197	.006	.236−.551	≤ .276	.010	.295− .669	≤ .315	.011
				.472−.669	≤.118	.004	.551−.866	≤ .157	.007	.669−1.063	≤ .197	.008
	Carbon Steel Alloy Steel	2	180−350HB	≤.177	≤.315	.008	≤.236	≤ .394	.010	≤.295	≤ .492	.012
				.177−.472	≤.157	.006	.236−.551	≤ .236	.008	.295− .669	≤ .276	.010
				.472−.669	≤.079	.003	.551−.866	≤ .118	.006	.669−1.063	≤ .157	.007
M	Stainless Steel	1,2,3,4	≤270HB	≤.177	≤.315	.008	≤.236	≤ .394	.010	≤.295	≤ .492	.012
				.177−.472	≤.157	.006	.236−.551	≤ .236	.008	.295− .669	≤ .276	.010
				.472−.669	≤.079	.003	.551−.866	≤ .118	.006	.669−1.063	≤ .157	.007
K	Cast Iron	1,2	≤350MPa	≤.177	≤.315	.010	≤.236	≤ .394	.012	≤.295	≤ .492	.014
				.177−.472	≤.197	.006	.236−.551	≤ .276	.010	.295− .669	≤ .315	.011
				.472−.669	≤.118	.004	.551−.866	≤ .157	.007	.669−1.063	≤ .197	.008
N	Aluminum Alloy	1,2,3	−	≤.177	≤.433	.012	≤.236	≤ .551	.014	≤.295	≤ .492	.016
				.177−.472	≤.315	.008	.236−.551	≤ .394	.012	.295− .669	≤ .276	.013
				.472−.669	≤.197	.006	.551−.866	≤ .236	.009	.669−1.063	≤ .157	.010
S	Titanium Alloy	1	−	≤.177	≤.315	.006	≤.236	≤ .394	.007	≤.295	≤ .689	.008
				.177−.472	≤.157	.004	.236−.551	≤ .236	.006	.295− .669	≤ .492	.007
				.472−.669	≤.079	.002	.551−.866	≤ .118	.004	.669−1.063	≤ .295	.005
H	Hardened Steel	1	40−55HRC	≤.177	≤.197	.006	≤.236	≤ .236	.008	≤.295	≤ .276	.009
				.177−.472	≤.118	.004	.236−.551	≤ .157	.006	.295− .669	≤ .157	.007
				.472−.669	≤.039	.002	.551−.866	≤ .079	.005	.669−1.063	≤ .079	.006

	Work Material	No.	Hardness	φ1.250", 1.297" φ32mm , 33mm			φ1.500" φ40mm		
				ap	ae	f (IPR)	ap	ae	f (IPR)
P	Mild Steel	1	≤180HB	≤ .374	≤.630	.016	≤ .472	≤.787	.020
				.374− .866	≤.433	.013	.472−1.102	≤.512	.016
				.866−1.378	≤.236	.010	1.102−1.732	≤.276	.012
	Carbon Steel Alloy Steel	2	180−350HB	≤ .374	≤.630	.014	≤ .472	≤.787	.016
				.374− .866	≤.394	.011	.472−1.102	≤.472	.013
				.866−1.378	≤.197	.008	1.102−1.732	≤.236	.010
M	Stainless Steel	1,2,3,4	≤270HB	≤ .374	≤.630	.014	≤ .472	≤.787	.016
				.374− .866	≤.394	.011	.472−1.102	≤.472	.013
				.866−1.378	≤.197	.008	1.102−1.732	≤.236	.010
K	Cast Iron	1,2	≤350MPa	≤ .374	≤.630	.016	≤ .472	≤.787	.020
				.374− .866	≤.433	.013	.472−1.102	≤.512	.016
				.866−1.378	≤.236	.010	1.102−1.732	≤.276	.012
N	Aluminum Alloy	1,2,3	−	≤ .374	≤.630	.018	≤ .472	≤.787	.022
				.374− .866	≤.394	.015	.472−1.102	≤.472	.018
				.866−1.378	≤.197	.012	1.102−1.732	≤.236	.014
S	Titanium Alloy	1	−	≤ .374	≤.906	.010	≤ .472	≤1.102	.011
				.374− .866	≤.630	.008	.472−1.102	≤.787	.009
				.866−1.378	≤.394	.006	1.102−1.732	≤.472	.007
H	Hardened Steel	1	40−55HRC	≤ .374	≤.315	.010	≤ .472	≤.394	.012
				.374− .866	≤.197	.008	.472−1.102	≤.236	.009
				.866−1.378	≤.079	.006	1.102−1.732	≤.079	.007

(Note 1) Please pay special attention on the depth of cut when using the short edge type.
(Note 2) When using the G1 breaker (VP15TF), please reduce the feed rate by 20%.
(Note 3) For more information on "No.", please refer to page 11 for cutting speed.

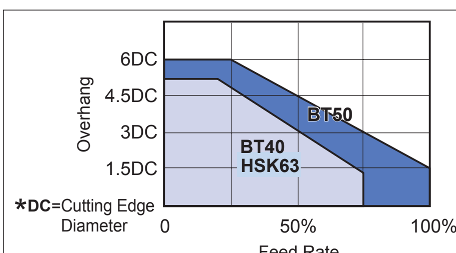


*Figures for A3 and APMX are shown in the table of holder standard.

- A3 is the depth of cut for the full dual blade portion at the end of the cutting edge.
- Beyond the range of A3 where overlapping occurs, there is an area where the cutting edge becomes single bladed, not forming full dual blade configuration. As such, please pay special attention to the relationship between depth of cut and feed.
- In general, the edge at the border of cut tends to suffer from damages. At large depth of cut operations, applying the following depth of cut (**t**), at which the edge is full dual bladed at the border of cut, is recommended to prevent damage to the cutting edge.

(inch)

Tool Diameter	Recommended Depth of Cut **t**
φ.625, .672	.472−.551
φ.750, .797	.551−.669
φ1.000, 1.047	.669−.866
φ1.250, 1.297	.866−1.102
φ1.500	1.102−1.378



- Chatter vibration and other problems tend to occur at operations where overhang length is large and/or machine rigidity is low, resulting in unstable machining.
- Please reduce feed accordingly, using the above chart as a guideline.

Cutting Conditions for Slotting

(inch)

Work Material		No.	Hardness	ϕ.625", .672" ϕ16mm , 17mm		ϕ.750", .797" ϕ20mm , 21mm		ϕ1.000", 1.047" ϕ25mm , 26mm	
				ap	f (IPR)	ap	f (IPR)	ap	f (IPR)
P	Mild Steel	1	≤180HB	≤.177	.006	≤.236	.007	≤ .295	.008
				.177—.472	.004	.236—.551	.006	.295— .669	.006
				.472—.669	.003	.551—.866	.004	.669—1.063	.005
	Carbon Steel Alloy Steel	2	180—350HB	≤.177	.006	≤.236	.006	≤ .295	.007
				.177—.472	.004	.236—.551	.005	.295— .669	.006
				.472—.669	.002	.551—.866	.004	.669—1.063	.004
M	Stainless Steel	1,2,3,4	≤270HB	≤.177	.006	≤.236	.006	≤ .295	.007
				.177—.472	.004	.236—.551	.005	.295— .669	.006
				.472—.669	.002	.551—.866	.004	.669—1.063	.004
K	Cast Iron	1,2	≤350MPa	≤.177	.006	≤.236	.007	≤ .295	.008
				.177—.472	.004	.236—.551	.006	.295— .669	.006
				.472—.669	.003	.551—.866	.004	.669—1.063	.005
N	Aluminum Alloy	1,2,3	—	≤.177	.007	≤.236	.008	≤ .295	.009
				.177—.472	.005	.236—.551	.006	.295— .669	.007
				.472—.669	.004	.551—.866	.005	.669—1.063	.006
S	Titanium Alloy	1	—	≤.177	.004	≤.236	.005	≤ .295	.006
				.177—.472	.002	.236—.551	.003	.295— .669	.004
				.472—.669	.001	.551—.866	.002	.669—1.063	.003
H	Hardened Steel	1	40—55HRC	≤.177	.004	≤.236	.005	≤ .295	.006
				.177—.472	.003	.236—.551	.004	.295— .669	.005

Work Material		No.	Hardness	ϕ1.250", 1.297" ϕ32mm,33mm		ϕ1.500" ϕ40mm	
				ap	f (IPR)	ap	f (IPR)
P	Mild Steel	1	≤180HB	≤ .374	.010	≤ .472	.012
				.374— .866	.008	.472—1.102	.010
				.866—1.378	.006	1.102—1.732	.007
	Carbon Steel Alloy Steel	2	180—350HB	≤ .374	.008	≤ .472	.010
				.374— .866	.006	.472—1.102	.008
				.866—1.378	.005	1.102—1.732	.006
M	Stainless Steel	1,2,3,4	≤270HB	≤ .374	.008	≤ .472	.010
				.374— .866	.006	.472—1.102	.008
				.866—1.378	.005	1.102—1.732	.006
K	Cast Iron	1,2	≤350MPa	≤ .374	.010	≤ .472	.012
				.374— .866	.008	.472—1.102	.010
				.866—1.378	.006	1.102—1.732	.007
N	Aluminum Alloy	1,2,3	—	≤ .374	.011	≤ .472	.013
				.374— .866	.009	.472—1.102	.011
				.866—1.378	.006	1.102—1.732	.008
S	Titanium Alloy	1	—	≤ .374	.007	≤ .472	.009
				.374— .866	.005	.472—1.102	.008
				.866—1.378	.004	1.102—1.732	.006
H	Hardened Steel	1	40—55HRC	≤ .374	.006	≤ .472	.007
				.374— .866	.005	.472—1.102	.006

(Note 1) Please pay special attention on the depth of cut when using the short edge type.
(Note 2) When using the G1 breaker (VP15TF), please reduce the feed rate by 20%.
(Note 3) For more information on "No.", please refer to page 11 for cutting speed.

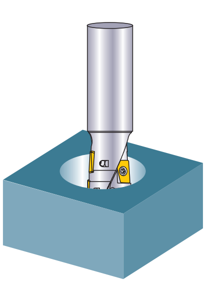
For Helical Cutting

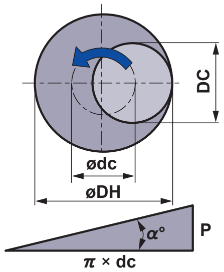
(inch)

	Work Material	No.	Hardness	ϕ.625", .672" ϕ16mm , 17mm				ϕ.750", .797" ϕ20mm , 21mm				ϕ1.000", 1.047" ϕ25mm , 26mm			
				DH	APMX	f (IPR)	P (inch/pass)	DH	APMX	f (IPR)	P (inch/pass)	DH	APMX	f (IPR)	P (inch/pass)
P	Mild Steel	1	≤180HB	.787	.315	.006	.017	.945	.394	.007	.017	1.181	.492	.008	.022
				.984	.472	.006	.039	1.181	.591	.006	.043	1.496	.748	.007	.056
				1.142	.630	.005	.056	1.417	.787	.006	.069	1.772	.984	.006	.087
	Carbon Steel Alloy Steel	2	180−350HB	.787	.315	.006	.013	.945	.394	.006	.013	1.181	.492	.007	.016
				.984	.472	.005	.029	1.181	.591	.006	.032	1.496	.748	.006	.042
				1.142	.630	.004	.042	1.417	.787	.005	.052	1.772	.984	.006	.065
M	Stainless Steel	1,2,3,4	≤270HB	.787	.118	.006	.009	.945	.157	.006	.009	1.181	.197	.007	.011
				.984	.197	.005	.019	1.181	.276	.006	.022	1.496	.354	.006	.028
				1.142	.315	.004	.028	1.417	.394	.005	.035	1.772	.492	.006	.043
K	Cast Iron	1,2	≤350MPa	.787	.394	.006	.022	.945	.551	.007	.022	1.181	.709	.008	.027
				.984	.512	.006	.048	1.181	.669	.006	.054	1.496	.827	.007	.070
				1.142	.630	.005	.070	1.417	.787	.006	.086	1.772	.984	.006	.108
N	Aluminum Alloy	1,2,3	–	.787	.394	.007	.017	.945	.551	.008	.017	1.181	.709	.009	.022
				.984	.512	.006	.039	1.181	.669	.007	.043	1.496	.827	.008	.056
				1.142	.630	.006	.056	1.417	.787	.006	.069	1.772	.984	.007	.087
S	Titanium Alloy	1	–	.787	.118	.004	.009	.945	.157	.004	.009	1.181	.197	.005	.011
				.984	.197	.003	.019	1.181	.276	.004	.022	1.496	.354	.004	.028
				1.142	.315	.003	.028	1.417	.394	.003	.035	1.772	.492	.004	.043
H	Hardened Steel	1	40−55HRC	.787	.118	.004	.009	.945	.157	.005	.009	1.181	.197	.006	.011
				.984	.197	.003	.019	1.181	.276	.004	.022	1.496	.354	.005	.028
				1.142	.315	.002	.028	1.417	.394	.003	.035	1.772	.492	.004	.043

	Work Material	No.	Hardness	ϕ1.250", 1.297" ϕ32mm , 33mm				ϕ1.500" ϕ40mm			
				DH	APMX	f (IPR)	P (inch/pass)	DH	APMX	f (IPR)	P (inch/pass)
P	Mild Steel	1	≤180HB	1.496	.630	.010	.026	1.890	.787	.012	.035
				1.890	.945	.009	.069	2.362	1.181	.010	.086
				2.283	1.260	.008	.112	2.835	1.575	.009	.138
	Carbon Steel Alloy Steel	2	180−350HB	1.496	.630	.008	.019	1.890	.787	.010	.026
				1.890	.945	.007	.052	2.362	1.181	.009	.065
				2.283	1.260	.006	.084	2.835	1.575	.008	.104
M	Stainless Steel	1,2,3,4	≤270HB	1.496	.236	.008	.013	1.890	.315	.010	.017
				1.890	.433	.007	.035	2.362	.551	.009	.043
				2.283	.630	.006	.056	2.835	.787	.008	.069
K	Cast Iron	1,2	≤350MPa	1.496	.866	.010	.032	1.890	1.102	.012	.043
				1.890	1.063	.009	.086	2.362	1.339	.010	.108
				2.283	1.260	.008	.141	2.835	1.575	.009	.173
N	Aluminum Alloy	1,2,3	–	1.496	.866	.011	.026	1.890	1.102	.013	.035
				1.890	1.063	.009	.069	2.362	1.339	.011	.086
				2.283	1.260	.009	.112	2.835	1.575	.009	.138
S	Titanium Alloy	1	–	1.496	.236	.006	.013	1.890	.315	.007	.017
				1.890	.433	.005	.035	2.362	.551	.006	.043
				2.283	.630	.004	.056	2.835	.787	.006	.069
H	Hardened Steel	1	40−55HRC	1.496	.236	.006	.013	1.890	.315	.007	.017
				1.890	.433	.006	.035	2.362	.551	.006	.043
				2.283	.630	.005	.056	2.835	.787	.006	.069

Helical grooving is strongly recommended for machining of tempered steel.
(Note 1) When using the G1 breaker (VP15TF), please reduce the feed rate by 20%.
(Note 2) For more information on "No.", please refer to page 11 for cutting speed.





● How to calculate the theoretical center of the cutter path.

Ø dc = Ø DH - DC
Theoretical center of the tool / Desired hole diameter / Cutting edge diameter

● Depth of cut for a pass.

P = π × dc × tan α°
* α° ≤ 3°

● Min. machined hole diameter at helical cutting : 1.2DC
Max. machined hole diameter at helical cutting : 1.8DC

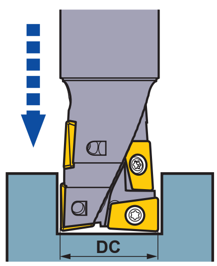
● For chip discharge, please always apply air blow.
(When aluminum cutting, please use coolant.)

● When helical cutting, it is recommended to reduce the feed rate by 40%.

● When using the G1 breaker (VP15TF), please reduce the feed rate by 20%.

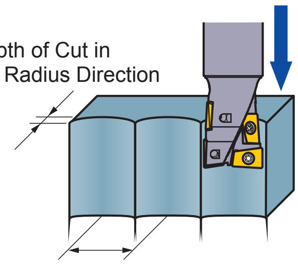
For Drilling and Plunging

● **Drilling**



- The recommended drilling depth is less than .5DC.
- Use step feed when drilling (.010−.020 inch) to ensure that the chips are effectively broken.
- Use internal or external cooling to ensure that the chips disposal is sufficiently achieved.
- The chips generated can discharge in any direction, so ensure that adequate safety precautions are taken.

● **Plunging**



- The feed for plunging is the same as the feed for drilling.
- No step feed necessary.
- Please refer to the following table for the depth of cut at plunging operations.

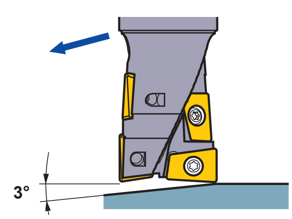
Depth of Cut in the Radius Direction	≤ .4DC
Peck Feed	≤ .5DC

(inch)

	Work Material	No.	Hardness	ϕ.625", .672" ϕ16mm , 17mm		ϕ.750", .797" ϕ20mm , 21mm		ϕ1.000", 1.047" ϕ25mm , 26mm		ϕ1.250", 1.297" ϕ32mm, 33mm, 35mm		ϕ1.500" ϕ40mm	
				f (IPR)	Step	f (IPR)	Step	f (IPR)	Step	f (IPR)	Step	f (IPR)	Step
P	Mild Steel	1	≤180HB	.001	.008	.002	.012	.002	.012	.002	.012	.002	.012
P	Carbon Steel Alloy Steel	2	180−350HB	.001	.008	.002	.012	.002	.012	.002	.012	.002	.012
M	Stainless Steel	1,2,3,4	≤270HB	.001	.006	.002	.010	.002	.010	.002	.010	.002	.010
K	Gray Cast Iron	1	≤350MPa	.002	.016	.002	.020	.002	.020	.003	.020	.003	.020
N	Aluminum Alloy	1,2,3	−	.002	.008	.002	.012	.002	.012	.003	.012	.003	.012
H	Hardened Steel	1	40−55HRC	.001	.006	.001	.010	.001	.010	.002	.010	.002	.010

Helical grooving is strongly recommended for machining of tempered steel.
(Note 1) When using the G1 breaker (VP15TF), please reduce the feed rate by 20%.
(Note 2) For more information on "No.", please refer to page 11 for cutting speed.

For Ramping



- When machining steel the recommended ramping angle is 3°. If a ramping angle larger than 3° is used, then the chips may not be broken effectively resulting in chips wrapping around the tool.
- When ramping, it is recommended to reduce the feed rate by 40%.