

MillLine

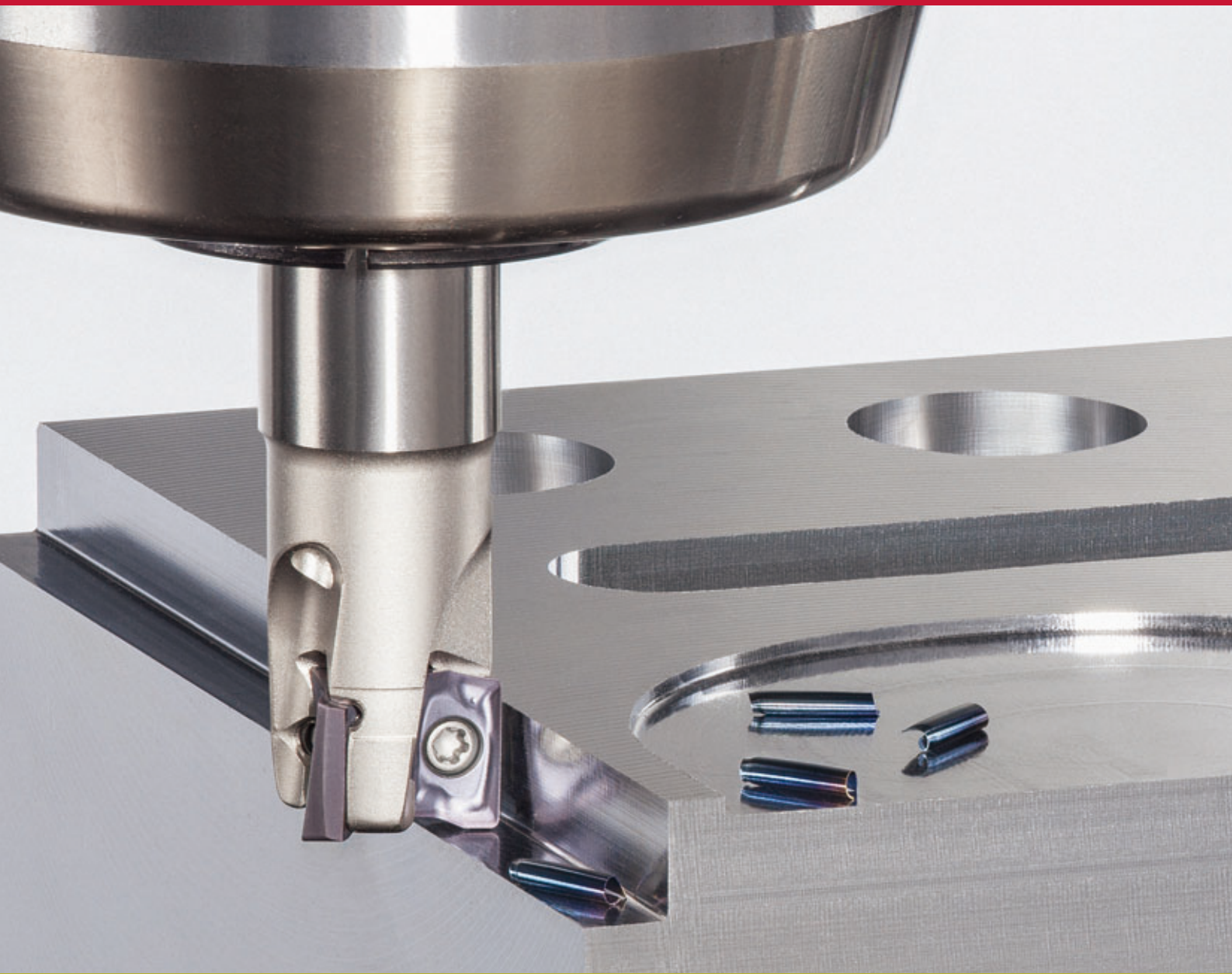
**TUNG**<sup>ORCE</sup>**FREC**

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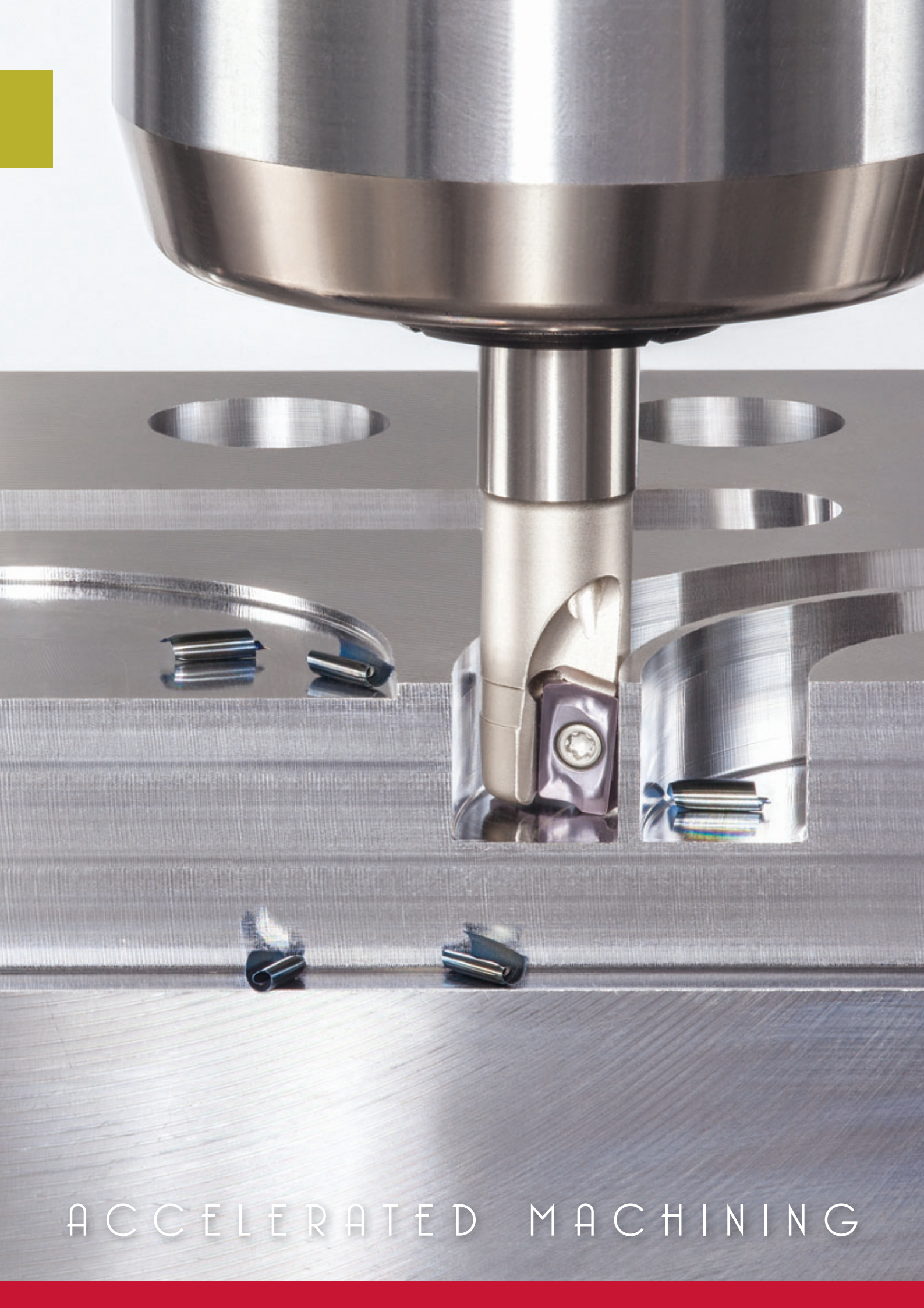
Tungaloy Report No. 506-G

TUNGFORCE-REC

# Miniature shoulder milling cutter with incomparable stability







ACCELERATED MACHINING



MillLine

**TUNG**<sup>ORCE</sup>**FREC**  
TUNGALOY



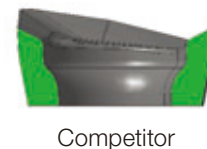
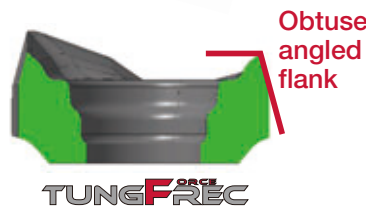
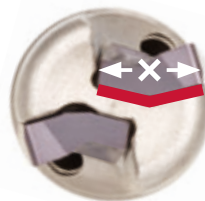
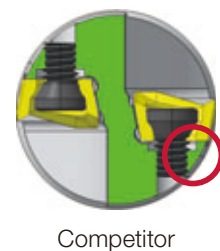
TungForce-Rec, a **new miniature shoulder milling series**, features a unique clamping system offering **exceptional stability** in machining small pockets and slots.

[www.tungaloy.com](http://www.tungaloy.com)

# Square shoulder milling endmills with small diameter **with exceptional stability and productivity**

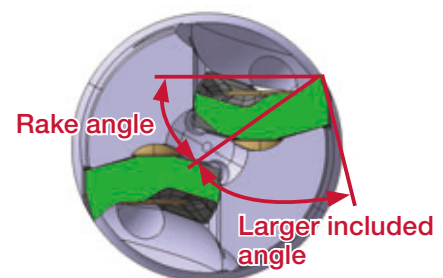
## Exceptional stability

- Unique shape of the Insert and its positioning on the cutterbody provides larger support below the insert.
- V shaped insert bottom avoids inserts movement during machining.
- Obtuse angled flank face of insert strengthens cutting edge and avoids chipping.
- Wider insert cross-section improves insert strength and allows larger screw size.
- Larger screw size of M2 compared to M1.8 reduces screw neck shears under high cutting forces.



## Precise machining

- Sharp cutting edge with large rake angle ensures smooth cutting.
- Periphery ground insert provides highly accurate machined wall and surface finish.





## Inserts

2 types of insert geometries cover wide variety of material machining from steel, stainless, cast iron, aluminum to heat resistant superalloys.

### MJ type

- Suitable for tough materials with appropriate cutting edge preparation allows well-balanced sharpness and toughness.
- 3 sizes of corner radii available,  $R = 0.2, 0.4, \& 0.8$  mm
- 2 types of grades are available;  
AH3135: Suitable for steel and stainless steel machining with high toughness  
AH120: Ideal for machining of cast iron and heat resistant alloy



**AVGT-MJ**

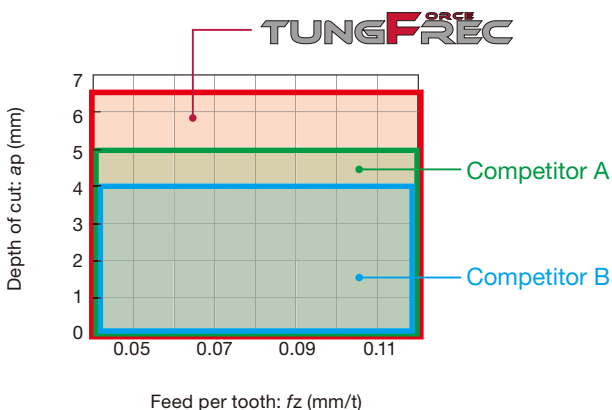
### AJ type

- Ideal insert for aluminum or non-ferrous metals machining.
- Precise ground flank face and polished rake surface creates excellent sharpness on the cutting edge.
- 3 sizes of corner radii available,  $R = 0.2, 0.4, \& 0.8$  mm
- Uncoated carbide grade, KS05F with fine grain cemented carbide has high wear resistance for non-ferrous machining.



**AVGT-AJ**

## APPLICATION RANGE

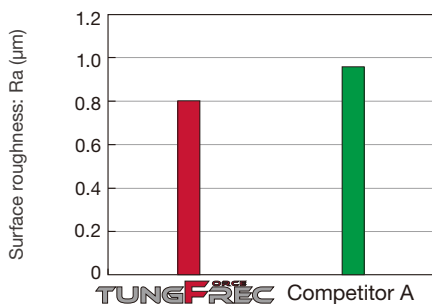


Cutter	: EPAV06M010C10.0R02 ( $\phi D_c = 10$ mm)
Insert	: AVGT060302PBER-MJ AH3135
Workpiece material	: S55C / C55
Cutting speed	: $V_c = 270$ m/min
Machining	: Slotting
Cutting width	: $a_e = 10$ mm
Coolant	: Dry
Machine	: Vertical M/C, BT40 18.5kW

**TungForce-Rec is applicable for a wider range of cutting condition than competitors'.**

## CUTTING PERFORMANCE

### Surface finish: Carbon steel

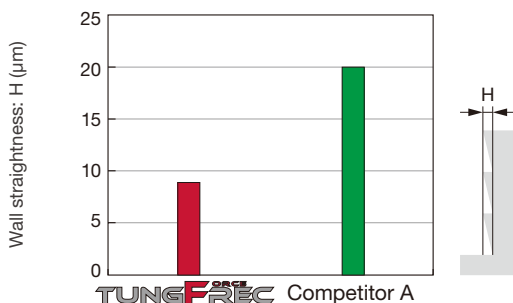


**P**

Cutter : EPAV06M010C10.0R02 ( $\phi D_c = 10$  mm,  $z = 2$ )  
 Insert : AVGT060302PBER-MJ AH3135  
 Workpiece material : S55C / C55 (180HB)  
 Cutting speed :  $V_c = 270$  m/min  
 Feed per tooth :  $f_z = 0.07$  mm/t  
 Depth of cut :  $a_p = 2.0$  mm  
 Cutting width :  $a_e = 7.0$  mm  
 Coolant : Dry  
 Machine : Vertical M/C, BT40

**TungForce-Rec provides good surface finish compared with the competitors.**

### Wall straightness: Carbon steel

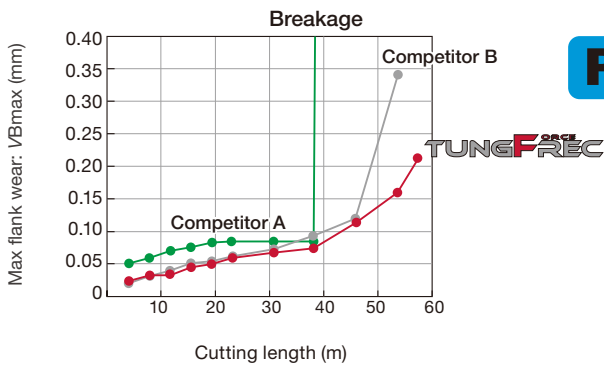


**P**

Cutter : EPAV06M010C10.0R02 ( $\phi D_c = 10$  mm,  $z = 2$ )  
 Insert : AVGT060302PBER-MJ AH3135  
 Workpiece material : S55C / C55 (180HB)  
 Cutting speed :  $V_c = 270$  m/min  
 Feed per tooth :  $f_z = 0.07$  mm/t  
 Depth of cut :  $a_p = 4.0$  mm x 3 pass  
 Cutting width :  $a_e = 0.5$  mm  
 Coolant : Dry  
 Machine : Vertical M/C, BT40

**TungForce-Rec provides high wall accuracy compared with the competitors.**

## Tool life: Carbon steel

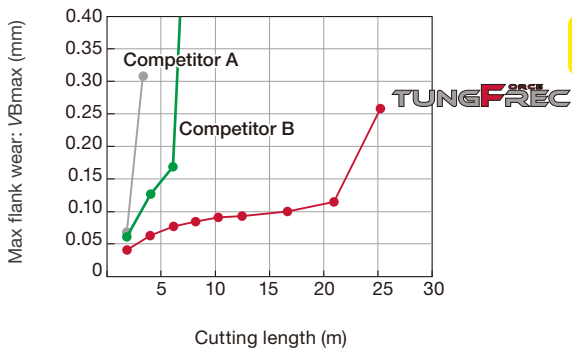


**P**

Cutter : EPAV06M010C10.0R02 ( $\phi D_c = 10$  mm,  $z = 2$ )  
 Insert : AVGT060302PBER-MJ AH3135  
 Workpiece material : S55C / C55 (180HB)  
 Cutting speed :  $V_c = 270$  m/min  
 Feed per tooth :  $f_z = 0.07$  mm/t  
 Depth of cut :  $a_p = 3.0$  mm  
 Cutting width :  $a_e = 2.7$  mm  
 Coolant : Dry  
 Machine : Vertical M/C, BT40

**Stable cutting edge and Premium GTec grade achieves higher tool life compared with the competitors.**

## Tool life: Stainless steel



**M**

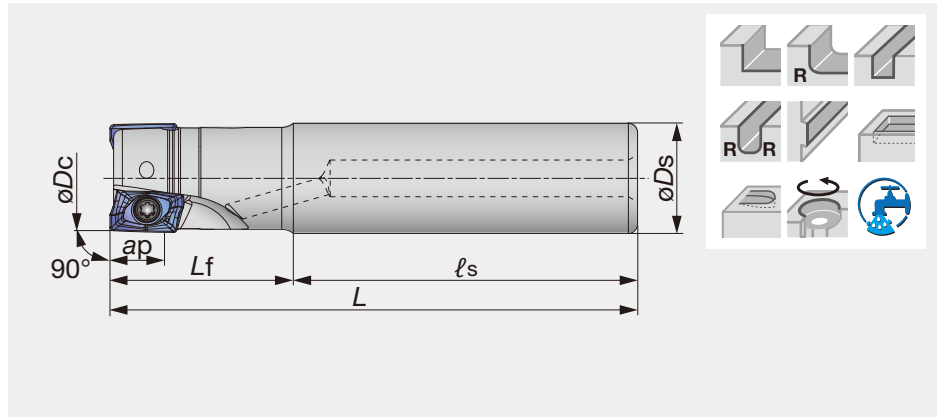
Cutter : EPAV06M010C10.0R02 ( $\phi D_c = 10$  mm,  $z = 2$ )  
 Insert : AVGT060302PBER-MJ AH3135  
 Workpiece material : SUS304 / X5CrNi18-9  
 Cutting speed :  $V_c = 260$  m/min  
 Feed per tooth :  $f_z = 0.07$  mm/t  
 Depth of cut :  $a_p = 3.0$  mm  
 Cutting width :  $a_e = 2.9$  mm  
 Coolant : Dry  
 Machine : Vertical M/C, BT40

**Sharper cutting edge and Premium GTec grade improves edge build up and reduces thermal crack increasing tool life.**

## Mini square shoulder milling cutter

### CUTTER - SHANK TYPE

TungForce-Rec EPAV



Designation	Max. ap	$\phi D_c$	z	$\phi D_s$	ls	Lf	L	Kg	Insert
EPAV06M008C10.0R01	6	8.00	1	10.0	60.0	20.0	80.0	0.04	AVGT06**
EPAV06M010C10.0R02	6	10.00	2	10.0	60.0	20.0	80.0	0.04	AVGT06**
EPAV06M010C10.0R02L	6	10.00	2	10.0	65.0	35.0	100.0	0.06	AVGT06**
EPAV06M012C12.0R02	6	12.00	2	12.0	60.0	20.0	80.0	0.06	AVGT06**
EPAV06M012C12.0R03	6	12.00	3	12.0	60.0	20.0	80.0	0.06	AVGT06**
EPAV06M012C12.0R02L	6	12.00	2	12.0	85.0	35.0	120.0	0.09	AVGT06**
EPAV06M016C16.0R03	6	16.00	3	16.0	70.0	20.0	90.0	0.12	AVGT06**
EPAV06M016C16.0R04	6	16.00	4	16.0	70.0	20.0	90.0	0.12	AVGT06**
EPAV06M016C16.0R03L	6	16.00	3	16.0	105.0	35.0	140.0	0.20	AVGT06**

#### SPARE PARTS



Clamping screw  
CSPB-2H

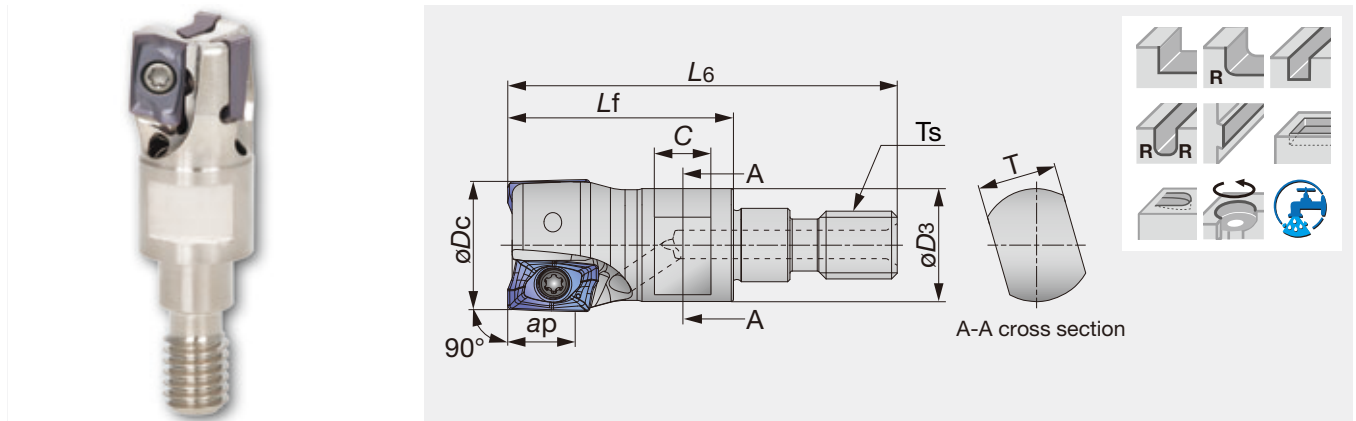
Mono block type wrench  
IP-6DB



## Mini square shoulder milling cutter

### CUTTER - MODULAR TYPE - METRIC THREAD

TungForce-Rec HPAV-M



Designation	Max. ap	øDc	z	L6	Lf	C	T	øD3	Ts	Kg	Insert
HPAV06M010M06R02	6	10.00	2	34.5	20.0	5.0	7.0	9.5	M6	0.01	AVGT06**
HPAV06M012M06R02	6	12.00	2	34.5	20.0	5.0	7.0	10.0	M6	0.01	AVGT06**
HPAV06M012M06R03	6	12.00	3	34.5	20.0	5.0	7.0	10.0	M6	0.01	AVGT06**
HPAV06M016M08R03	6	16.00	3	42.0	25.0	8.0	10.0	13.0	M8	0.03	AVGT06**
HPAV06M016M08R04	6	16.00	4	42.0	25.0	8.0	10.0	13.0	M8	0.03	AVGT06**

For details of metric shank, please refer to TungFlex series in TR413 TungHold

#### SPARE PARTS



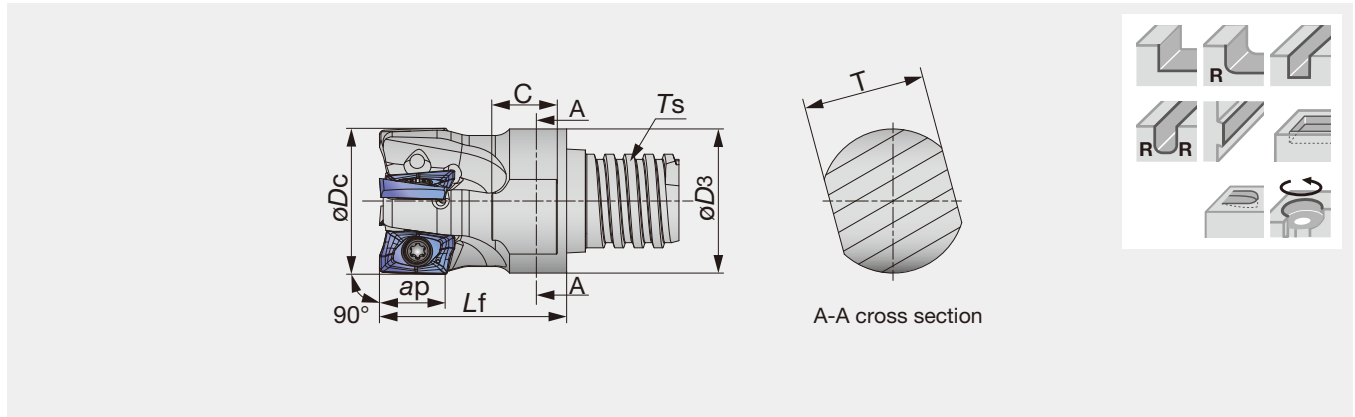
Clamping screw  
CSPB-2H

Mono block type wrench  
IP-6DB

## Mini square shoulder milling cutter

### CUTTER - MODULAR HEAD - TUNGMEISTER THREAD


TungForce-Rec HPAV06-S



Designation	Max. ap	$\phi D_c$	z	$L_f$	C	T	$\phi D_3$	Ts	Kg	Insert
HPAV06M010S06R02	6	10	2	16	5	8	9.8	S06	0.01	AVGT06**
HPAV06M012S08R02	6	12	2	18	5	10	11.7	S08	0.02	AVGT06**
HPAV06M012S08R03	6	12	3	18	5	10	11.7	S08	0.02	AVGT06**
HPAV06M016S10R03	6	16	3	20	7	13	15.4	S10	0.03	AVGT06**
HPAV06M016S10R04	6	16	4	20	7	13	15.4	S10	0.03	AVGT06**

- For details of shanks, please refer to TR381 TungMeister  
Shank types: VSSD, VTSD, VSC, VSTD

- For connections between metric shank and TungMeister thread, please use VAD-M type connector

Spanner for clamping	Cat. No.	Connection screw size
	KEYV-S06	S06
	KEYV-S08	S08
	KEYV-S10	S10

Optional- to be ordered separately.

#### SPARE PARTS

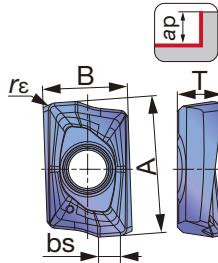


Clamping screw	Mono block type wrench
CSPB-2H	IP-6DB

## INSERTS

AVGT-MJ

AVGT-AJ



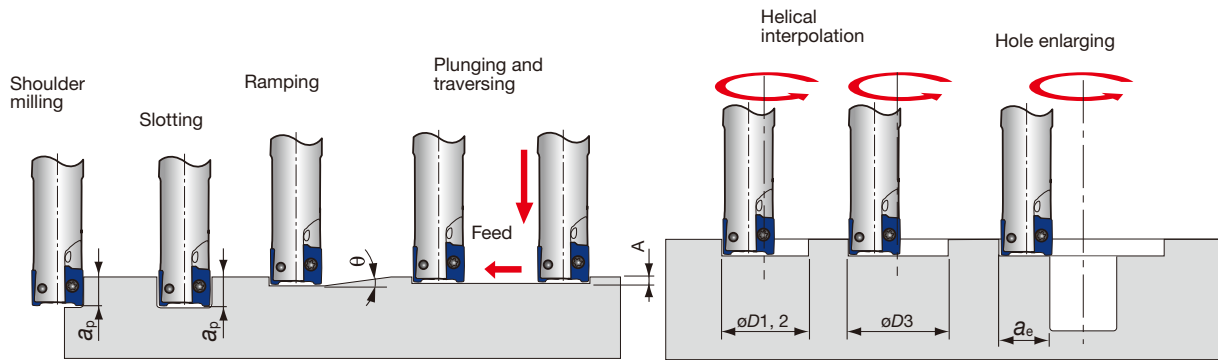
Designation	Max. ap	A	B	T	r <sub>ε</sub>	bs	AH3135	AH120	KS05F
AVGT060302PBER-MJ	6	8	5	2.7	0.2	1.5	● ● ● ● ●	○ ● ● ● ●	●
AVGT060304PBER-MJ	6	8	5	2.7	0.4	1.3	● ● ● ● ●	○ ● ● ● ●	●
AVGT060308PBER-MJ	6	8	5	2.6	0.8	0.9	● ● ● ● ●	○ ● ● ● ●	●
AVGT060302PBFR-AJ	6	8	5	2.7	0.2	1.5	● ● ● ● ●	○ ● ● ● ●	●
AVGT060304PBFR-AJ	6	8	5	2.7	0.4	1.3	● ● ● ● ●	○ ● ● ● ●	●
AVGT060308PBFR-AJ	6	8	5	2.6	0.8	0.9	● ● ● ● ●	○ ● ● ● ●	●

● First choice

## STANDARD CUTTING CONDITIONS

ISO	Workpiece materials	Hardness	Priority	Grades	Chip-breaker	Cutting speed V <sub>c</sub> (m/min)	Feed per tooth f <sub>z</sub> (mm/t)	
<b>P</b>	Low carbon steel (S15C / C15E4, SS400 / E275A, etc.)	- 300 HB	First choice	AH3135	MJ	230 - 430	0.07 - 0.12	
	Carbon steel and alloy steel (S55C / C55, SCM440 / 42CrMo4, etc.)	- 300 HB	First choice	AH3135	MJ	150 - 350	0.07 - 0.12	
	Prehardend steel (NAK80, PX5, etc.)	30 - 40 HRC	First choice	AH120	MJ	100 - 230	0.07 - 0.12	
<b>M</b>	Stainless steel (SUS304 / X5CrNi18-9, SUS316 / X5CrNiMo17-12-3, etc.)	-	First choice	AH3135	MJ	150 - 220	0.06 - 0.1	
<b>K</b>	Grey cast iron (FC250 / 250, FC300 / 300, etc.)	150 - 250 HB	First choice	AH120	MJ	200 - 330	0.07 - 0.12	
	Ductile cast iron (FC400, FCD600 / 600-3, etc.)	150 - 250 HB	First choice	AH120	MJ	150 - 240	0.07 - 0.12	
<b>N</b>	Aluminium alloys (Si < 13%)	-	First choice	KS05F	AJ	650 - 1000	0.07 - 0.12	
<b>S</b>	Titanium alloys (Ti-6Al-4V, etc.)	-	First choice	AH120	MJ	70 - 90	0.06 - 0.10	
	Superalloys (Inconel718, etc.)	-	First choice	AH120	MJ	45 - 65	0.06 - 0.09	
<b>H</b>	Hardened steel	(SKD61 / X40CrMoV5-1, etc.)	40 - 50 HRC	First choice	AH120	MJ	45 - 70	0.05 - 0.08
		(SKD11 / X153CrMoV12, etc.)	50 - 60 HRC	First choice	AH120	MJ	40 - 65	0.04 - 0.06

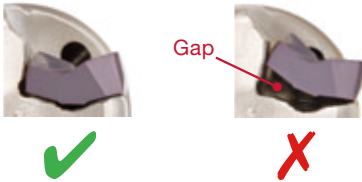
## MACHINING APPLICATIONS



Designation	$\phi D_c$	Max. depth of cut $a_p$	Max. ramping angle $\theta$	Max. plunging $A$	Min. machining $\phi D_1$	Max. machining $\phi D_2$	Max. machining $\phi D_3^*$	Max. cutting width in enlarging $a_e$
EPAV06_008...	8	6	-	-	-	-	-	-
EPAV/HPAV06_010...	10	6	3°	0.3	15	19	18	9.5
EPAV/HPAV06_012...	12	6	3°	0.5	18	23	22	11.5
EPAV/HPAV06_016...	16	6	2.5°	0.6	25	31	30	15.5



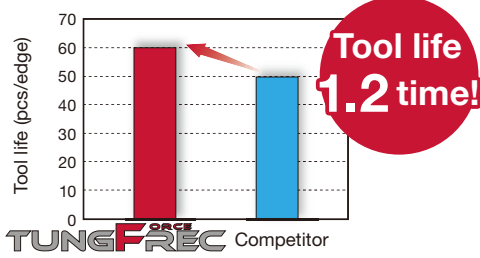
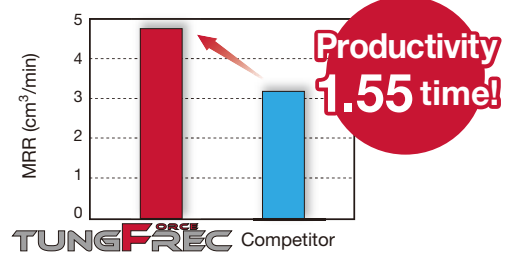
\*Flat bottom hole

When clamping the insert, please confirm that there is no gap between the cutter body and the insert as shown in the picture.

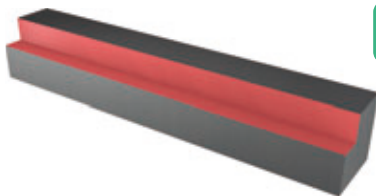

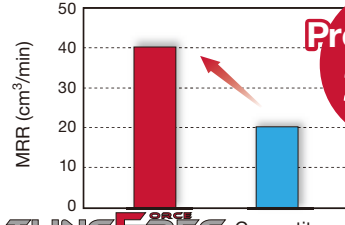
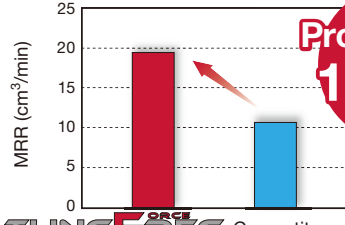




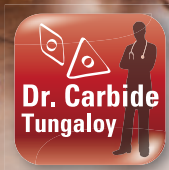
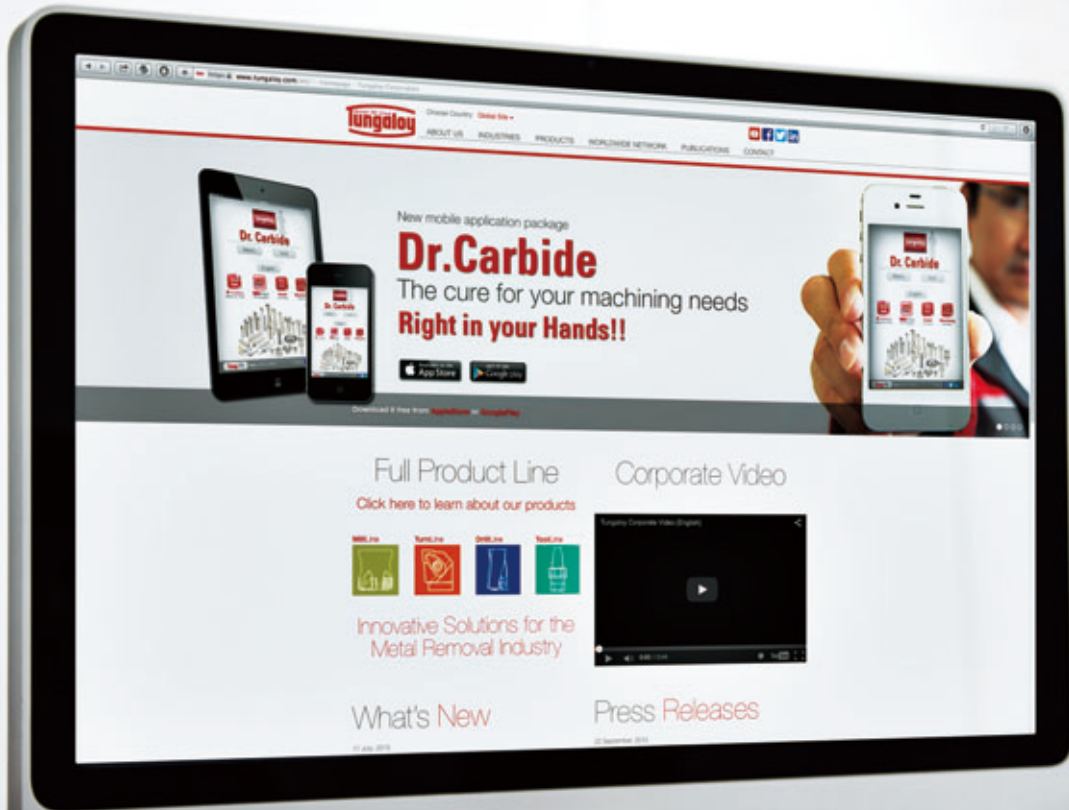
## PRACTICAL EXAMPLES

Workpiece type	Guide shift	Spindle	
<b>Cutter</b>	EPAV06M010C10.0R02 ( $\phi 10$ , $z = 2$ )	EPAV06M012C12.0R03 ( $\phi 12$ , $z = 3$ )	
<b>Insert</b>	AVGT060304PBER-MJ	AVGT060304PBER-MJ	
<b>Grade</b>	AH3135	AH3135	
<b>Workpiece material</b>	S45C / C45 (HRC25)	SCM415 (HRC30)	
	 <b>P</b>	 <b>P</b>	
<b>Cutting conditions</b>	<b>Cutting speed: <math>V_c</math> (m/min)</b>	151 (Competitor: $V_c = 60$ )	143 (Competitor: $V_c = 72$ )
	<b>Feed per tooth: <math>f_z</math> (mm/t)</b>	0.05	0.04
	<b>Feed speed: <math>V_f</math> (m/min)</b>	481 (Competitor: $V_f = 382$ )	601 (Competitor: $V_f = 382$ )
	<b>Depth of cut: <math>a_p</math> (mm)</b>	0.1	1
	<b>Width of cut: <math>a_e</math> (mm)</b>	2.5	1.6
	<b>Machining</b>	Shoulder milling	Shoulder milling
	<b>Coolant</b>	Wet	Dry
	<b>Machine</b>	Vertical M/C, BT40	Vertical M/C, BT30
<b>Results</b>	 <p><b>Tool life increased by 20% compared to competitor.</b></p>	 <p><b>Acceleration at 1.55 times due to stable clamping.</b></p>	

## PRACTICAL EXAMPLES

Workpiece type	Machine parts	Bracket	
<b>Cutter</b>	EPAV06M016C16.0R04 (ø16, z = 4)	EPAV06M016C16.0R03L (ø16, z = 3)	
<b>Insert</b>	AVGT060403PBER-AJ	AVGT060304PBER-MJ	
<b>Grade</b>	KS05F A5025	AH120 FC250 / 250 /GG25	
<b>Workpiece material</b>			
<b>Cutting conditions</b>	<b>Cutting speed: Vc (m/min)</b>	251	200 (Competitor: Vc = 145)
	<b>Feed per tooth: fz (mm/t)</b>	0.1	0.08 (Competitor: fz = 0.06)
	<b>Feed speed: Vf (m/min)</b>	1998 (Competitor: Vf = 999)	955 (Competitor: Vf = 554)
	<b>Depth of cut: ap (mm)</b>	2	5.0
	<b>Width of cut: ae (mm)</b>	10	4
	<b>Machining</b>	Shoulder milling	Shoulder milling
	<b>Coolant</b>	Wet	Dry
	<b>Machine</b>	Vertical M/C, BT40	Horizontal M/C, BT40
<b>Results</b>	 <p><b>Productivity 2 time!</b></p> <p>Sharp cutting edge reduced build up &amp; stable clamping improved productivity by 2 times.</p>	 <p><b>Productivity 1.6 time!</b></p> <p>Higher stability also delivers higher productivity at 60%.</p>	

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