

# Engineering Report

## Tool Investment Analyzer

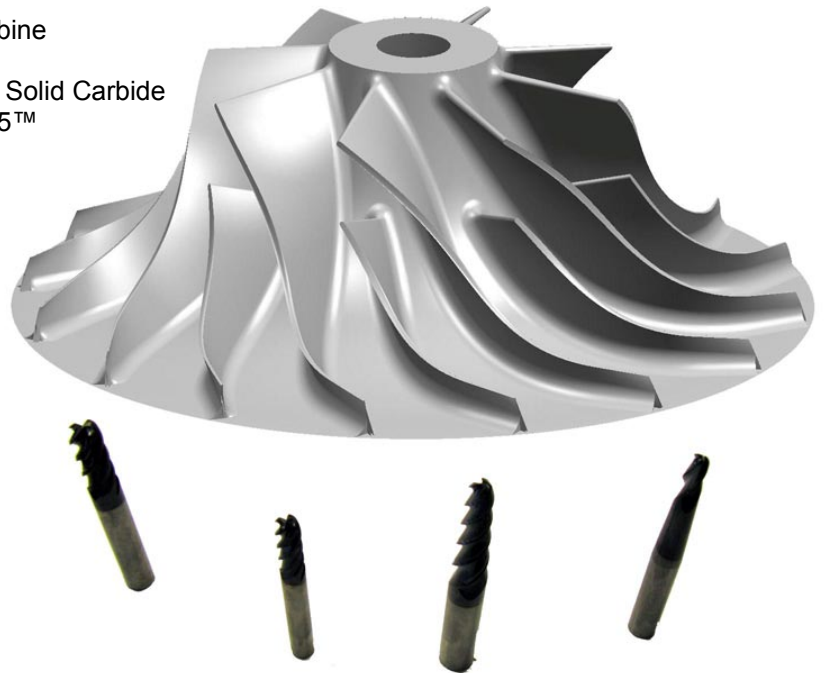
Created for:

### STEP Manufacturing Meeting - October 1-2, 2008

#### Impeller Machining Demonstration

Application: Compressor for Gas Turbine  
Machining Center: DMG DMU 70  
Tooling: Sandvik Coromant Plura Solid Carbide  
CAM Software: Concepts NREC's MAX-5™

Part Data:  
Diameter: 160 mm (6.3 inches)  
Number of blades/splitters: 8/8  
Blade height: 30 mm (1.2 inch)  
Spacing between blades: 8 mm (.31 inch)  
Hub cusp: 0.06mm (.0023 inch)  
Fillet R3.5mm (0.137 inch)  
Material: Ti6Al4V



Sandvik Coromant impeller

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**Project:** 1  
**Project Description:** T24 -CCAT  
**Creation Date:** 2008-07-30  
**Contact:** T24 - STEP Manufacturing

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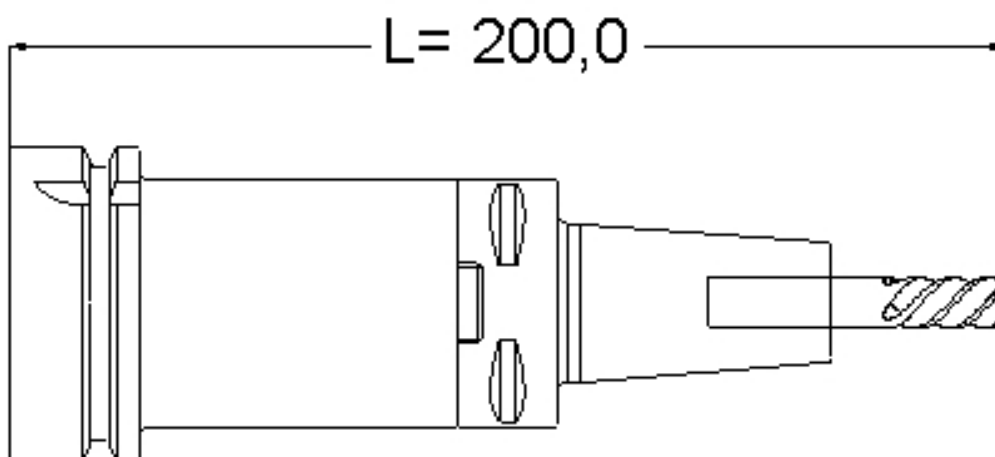
**Our contact:** Bengt Olsson, Sandvik

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[www.coromant.sandvik.com/us](http://www.coromant.sandvik.com/us)  
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## Assembly description

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### CCAT -T07 HSK63 - Solid corner radius endmill



Pos	Ordering code	Qty	Description	Brand
1	C5-390.410-63 090C	1	DIN 69893 HSK-A/C	Sandvik Coromant
2	C5-391.19-10 075	1	Coromant Capto Shrink fit	Sandvik Coromant
3	R216.24-10050EAK22P CCAT	1	Solid corner radius endmill	Sandvik Coromant

T07 Tool assembly T07 /HSK63 shrink fit of D10 R2 endmill



Bill of material: T07-1. Holder: HSK63/Capto C5  
 T07-2. Shrink fit adapter: C5/D10  
 T07-3. Solid Endmill D10 R2

PROPERTY_SYMBOL	PROPERTY_NAME	Value	UNIT
UST	unit system	metric	identifier
DCSFMS	contact surface diameter machine side	63	mm
BD1	body diameter	24	mm
BD2	body diameter	32	mm
LB (1-2)	body length	55	mm
BD3	body diameter	50	mm
LB3	body length	26	mm
DCX	cutting diameter maximum	10	mm
DMM	shank diameter	10	mm
LUX	usable length maximum (=overhang)	35	mm
APMX	depth of cut maximum	22	mm
RE	corner radius	2	mm
LF	functional length (=set length)	200	mm
ZEFF	face effective cutting edge count	4	counter
FHA	flute helix angle	50	degrees
HAND	hand	R	identifier
CMAT	cutting edge substrate	carbide	identifier
WT	weight of item	2.28	kg

Boeing Symbol	Boeing_Name
Unit	a flag, indicating metric or imperial
Dh1	body diameter (taper start)
Dh2	body diameter (taper end)
Lh (1-2)	body length (taper)
Dh3	body diameter (machine adapter)
Lh3	body length (machine adapter)
Df	diameter at flutes
Dk	shank diameter
Lf+Lk	flute length + shank length
Lf	flute length
Ls	set length
Ah	helix angle

T07-1. Holder: HSK63/Capto C5

Code C5-390.410-63 090C  
 Brand Sandvik Coromant  
 Item Version 1

PROPERTY_SYMBOL	PROPERTY_NAME	Value	UNIT
UST	unit system	metric	identifier
DCSFMS	contact surface diameter machine side	63	mm
DCSFWS	contact surface diameter machine side	50	mm
BD	body diameter	50	mm
LB	body length	26	mm
LF	functional length	90	mm
WT	weight of item	1.47	kg

T07-2. Shrink fit adapter: C5/D10

Code C5-391.19-10075  
 Brand Sandvik Coromant  
 Item Version 1

PROPERTY_SYMBOL	PROPERTY_NAME	Value	UNIT
UST	unit system	metric	identifier
DCSFMS	contact surface diameter machine side	50	mm
DCB	connection bore diameter	10	mm
BD1	body diameter	24	mm
BD2	body diameter	32	mm
LB	body length	55	mm
LF	functional length	75	mm
WT	weight of item	0.695	kg

T07-3. Solid Endmill D10 R2

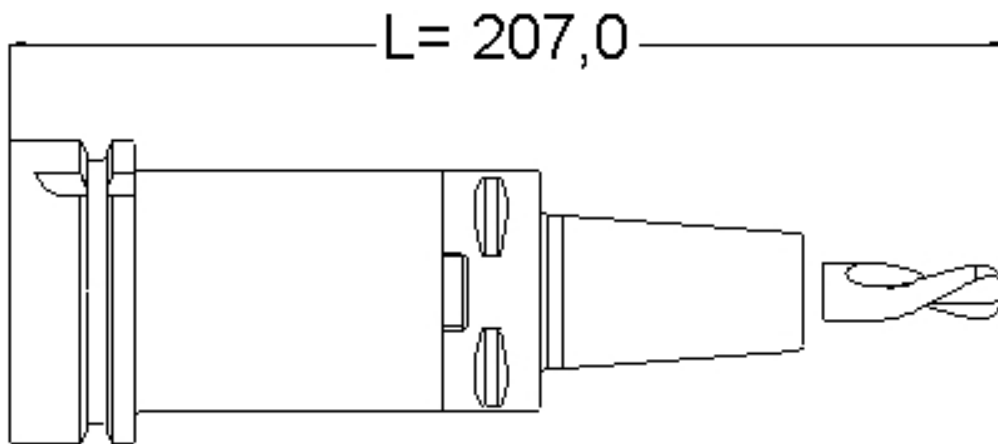
Code R216.24-10050EAK22P  
 Brand Sandvik Coromant  
 Item Version 1

PROPERTY_SYMBOL	PROPERTY_NAME	Value	UNIT	value limitation	Value
UST	unit system	metric	identifier		
DCX	cutting diameter maximum	10	mm		
DMM	shank diameter	10	mm	limits&fits	h6
LUX	usable length maximum	35	mm		
APMX	depth of cut maximum	22	mm		
RE	corner radius	2	mm		
LF	functional length	74.2	mm		
ZEFF	face effective cutting edge count	4	counter		
FHA	flute helix angle	50	degrees		
HAND	hand	R	identifier		
CMAT	cutting edge substrate	carbide	identifier		
BMAT	body substrate	carbide	identifier		
WT	weight of item	0.115	kg		

## Assembly description

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### CCAT -T08-T11 HSK63 - Solid ball nose endmill



Pos	Ordering code	Qty	Description	Brand
1	C5-390.410-63 090C	1	DIN 69893 HSK-A/C	Sandvik Coromant
2	C5-391.19-12 075	1	Coromant Capto Shrink fit	Sandvik Coromant
3	T08 T11 CONICAL BALLNOSE	1	Solid ball nose endmill	Sandvik Coromant

T08 Tool assembly T08 /HSK63 shrink fit of Solid R4 Ball nose, 12mm shank  
 T11



Bill of material: T08-1. Holder: HSK63/Capto C5  
 T08-2. Shrink fit adapter: C5/D12  
 T08-3. Solid R4 Ball nose, 12mm shank

PROPERTY_SYMBOL	PROPERTY_NAME	Value	UNIT
UST	unit system	metric	identifier
DCSFMS	contact surface diameter machine side	63	mm
BD1	body diameter	24	mm
BD2	body diameter	32	mm
LB (1-2)	body length	55	mm
BD3	body diameter	50	mm
LB3	body length	26	mm
DCX	cutting diameter maximum	8	mm
DMM	shank diameter	12	mm
LUX	usable length maximum (=overhang)	42	mm
APMX	depth of cut maximum	38	mm
RE	corner radius	4	mm
LF	functional length (=set length)	207	mm
ZEFF	face effective cutting edge count	3	counter
FHA	flute helix angle	40	degrees
HAND	hand	R	identifier
CMAT	cutting edge substrate	carbide	identifier
WT	weight of item	2.2	kg

Boeing Symbol	Boeing_Name
Unit	a flag, indicating metric or imperial
Dh1	body diameter (taper start)
Dh2	body diameter (taper end)
Lh (1-2)	body length (taper)
Dh3	body diameter (machine adapter)
Lh3	body length (machine adapter)
Df	diameter at flutes
Dk	shank diameter
Lf+Lk	flute length + shank length
Lf	flute length
Ls	set length
Ah	helix angle

T08-1. Holder: HSK63/Capto C5

Code C5-390.410-63 090C  
 Brand Sandvik Coromant  
 Item Version 1

PROPERTY_SYMBOL	PROPERTY_NAME	Value	UNIT
UST	unit system	metric	identifier
DCSFMS	contact surface diameter machine side	63	mm
DCSFWS	contact surface diameter machine side	50	mm
BD	body diameter	50	mm
LB	body length	26	mm
LF	functional length	90	mm
WT	weight of item	1.47	kg

T08-2. Shrink fit adapter: C5/D12

Code C5-391.19-12075  
 Brand Sandvik Coromant  
 Item Version 1

PROPERTY_SYMBOL	PROPERTY_NAME	Value	UNIT
UST	unit system	metric	identifier
DCSFMS	contact surface diameter machine side	50	mm
DCB	connection bore diameter	12	mm
BD1	body diameter	24	mm
BD2	body diameter	32	mm
LB	body length	55	mm
LF	functional length	75	mm
WT	weight of item	0.684	kg

T08-3. Solid R4 Ball nose, 12mm shank

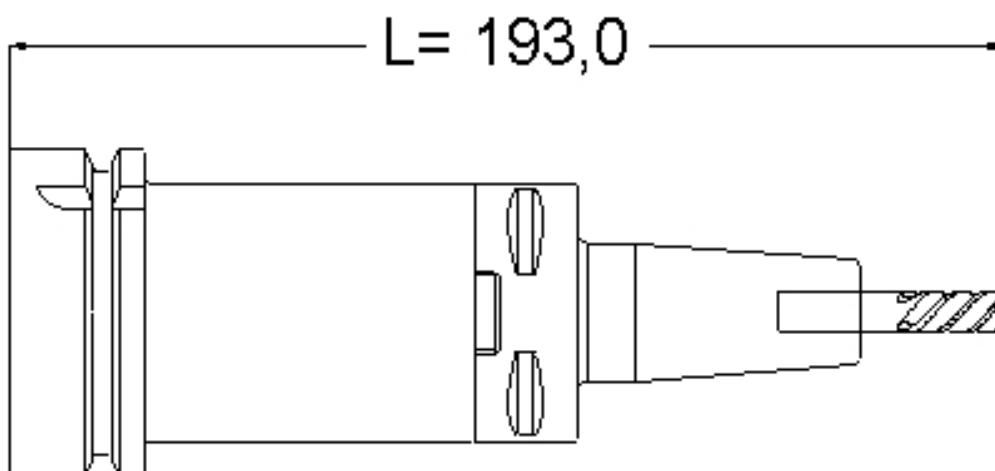
Code R216.54-08040-FAL40G  
 Brand Sandvik Coromant  
 Item Version 1

PROPERTY_SYMBOL	PROPERTY_NAME	Value	UNIT	value limitation	Value
UST	unit system	metric	identifier		
DCX	cutting diameter maximum	8	mm		
DMM	shank diameter	12	mm	limits&fits	h6
LUX	usable length maximum	42	mm		
APMX	depth of cut maximum	38	mm		
RE	corner radius	4	mm		
LF	functional length	84.2	mm		
ZEFF	face effective cutting edge count	3	counter		
FHA	flute helix angle	40	degrees		
HAND	hand	R	identifier		
CMAT	cutting edge substrate	carbide	identifier		
BMAT	body substrate	carbide	identifier		
WT	weight of item	0.07	kg		

## Assembly description

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### CCAT -T09 HSK63 - Solid corner radius endmill



Pos	Ordering code	Qty	Description	Brand
1	C5-390.410-63 090C	1	DIN 69893 HSK-A/C	Sandvik Coromant
2	C5-391.19-08 075	1	Coromant Capto Shrink fit	Sandvik Coromant
3	R216.24-08050EAK19P CCAT	1	Solid corner radius endmill	Sandvik Coromant

T09 Tool assembly T09 /HSK63 shrink fit of D08 R2 endmill



Bill of material: T09-1. Holder: HSK63/Capto C5  
 T09-2. Shrink fit adapter: C5/D08  
 T09-3. Solid Endmill D08 R2

PROPERTY_SYMBOL	PROPERTY_NAME	Value	UNIT
UST	unit system	metric	identifier
DCSFMS	contact surface diameter machine side	63	mm
BD1	body diameter	20	mm
BD2	body diameter	27	mm
LB (1-2)	body length	55	mm
BD3	body diameter	50	mm
LB3	body length	26	mm
DCX	cutting diameter maximum	8	mm
DMM	shank diameter	8	mm
LUX	usable length maximum (=overhang)	28	mm
APMX	depth of cut maximum	19	mm
RE	corner radius	2	mm
LF	functional length (=set length)	193	mm
ZEFF	face effective cutting edge count	4	counter
FHA	flute helix angle	50	degrees
HAND	hand	R	identifier
CMAT	cutting edge substrate	carbide	identifier
WT	weight of item	2.2	kg

Boeing Symbol	Boeing_Name
Unit	a flag, indicating metric or imperial
Dh1	body diameter (taper start)
Dh2	body diameter (taper end)
Lh (1-2)	body length (taper)
Dh3	body diameter (machine adapter)
Lh3	body length (machine adapter)
Df	diameter at flutes
Dk	shank diameter
Lf+Lk	flute length + shank length
Lf	flute length
Ls	set length
Ah	helix angle

T09-1. Holder: HSK63/Capto C5

Code C5-390.410-63 090C  
 Brand Sandvik Coromant  
 Item Version 1

PROPERTY_SYMBOL	PROPERTY_NAME	Value	UNIT
UST	unit system	metric	identifier
DCSFMS	contact surface diameter machine side	63	mm
DCSFWS	contact surface diameter machine side	50	mm
BD	body diameter	50	mm
LB	body length	26	mm
LF	functional length	90	mm
WT	weight of item	1.47	kg

T09-2. Shrink fit adapter: C5/D08

Code C5-391.19-08075  
 Brand Sandvik Coromant  
 Item Version 1

PROPERTY_SYMBOL	PROPERTY_NAME	Value	UNIT
UST	unit system	metric	identifier
DCSFMS	contact surface diameter machine side	50	mm
DCB	connection bore diameter	8	mm
BD1	body diameter	20	mm
BD2	body diameter	27	mm
LB	body length	55	mm
LF	functional length	75	mm
WT	weight of item	0.632	kg

T09-3. Solid Endmill D08 R2

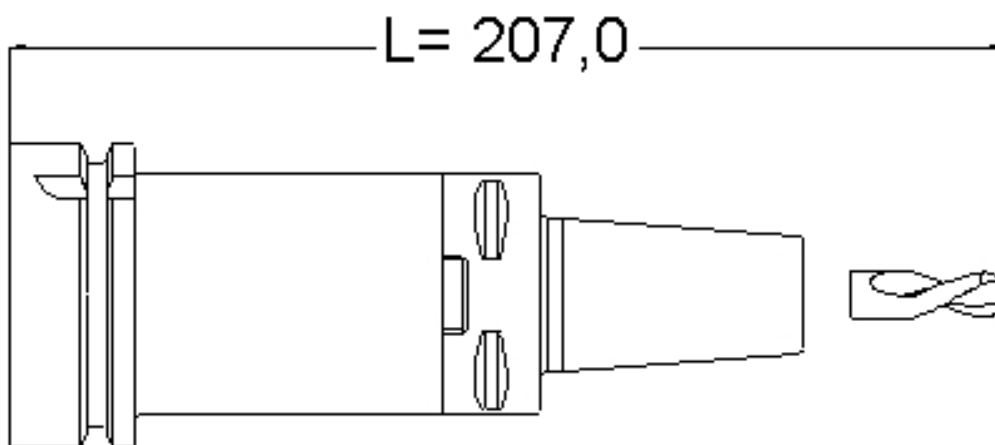
Code R216.24-08050EAK19P  
 Brand Sandvik Coromant  
 Item Version 1

PROPERTY_SYMBOL	PROPERTY_NAME	Value	UNIT	value limitation	Value
UST	unit system	metric	identifier		
DCX	cutting diameter maximum	8	mm		
DMM	shank diameter	8	mm	limits&fits	h6
LUX	usable length maximum	28	mm		
APMX	depth of cut maximum	19	mm		
RE	corner radius	2	mm		
LF	functional length	64	mm		
ZEFF	face effective cutting edge count	4	counter		
FHA	flute helix angle	50	degrees		
HAND	hand	R	identifier		
CMAT	cutting edge substrate	carbide	identifier		
BMAT	body substrate	carbide	identifier		
WT	weight of item	0.0664	kg		

## Assembly description

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### CCAT -T10 HSK63 - Solid ball nose endmill



Pos	Ordering code	Qty	Description	Brand
1	C5-390.410-63 090C	1	DIN 69893 HSK-A/C	Sandvik Coromant
2	C5-391.19-10 075	1	Coromant Capto Shrink fit	Sandvik Coromant
3	T10 CONICAL BALLNOSE	1	Solid ball nose endmill	Sandvik Coromant



T10 Tool assembly T10 /HSK63 shrink fit of Solid R3 Ball nose, 10mm shank



Bill of material: T10-1. Holder: HSK63/Capto C5  
 T10-2. Shrink fit adapter: C5/D10  
 T10-3. Solid R3 Ball nose, 10mm shank

PROPERTY_SYMBOL	PROPERTY_NAME	Value	UNIT
UST	unit system	metric	identifier
DCSFMS	contact surface diameter machine side	63	mm
BD1	body diameter	24	mm
BD2	body diameter	32	mm
LB (1-2)	body length	55	mm
BD3	body diameter	50	mm
LB3	body length	26	mm
DCX	cutting diameter maximum	6	mm
DMM	shank diameter	10	mm
LUX	usable length maximum (=overhang)	42	mm
APMX	depth of cut maximum	12	mm
RE	corner radius	3	mm
LF	functional length (=set length)	207	mm
ZEFF	face effective cutting edge count	3	counter
FHA	flute helix angle	40	degrees
HAND	hand	R	identifier
CMAT	cutting edge substrate	carbide	identifier
WT	weight of item	2.3	kg

Boeing Symbol	Boeing_Name
Unit	a flag, indicating metric or imperial
Dh1	body diameter (taper start)
Dh2	body diameter (taper end)
Lh (1-2)	body length (taper)
Dh3	body diameter (machine adapter)
Lh3	body length (machine adapter)
Df	diameter at flutes
Dk	shank diameter
Lf+Lk	flute length + shank length
Lf	flute length
Ls	set length
Ah	helix angle

T10-1. Holder: HSK63/Capto C5

Code C5-390.410-63 090C  
 Brand Sandvik Coromant  
 Item Version 1

PROPERTY_SYMBOL	PROPERTY_NAME	Value	UNIT
UST	unit system	metric	identifier
DCSFMS	contact surface diameter machine side	63	mm
DCSFWS	contact surface diameter machine side	50	mm
BD	body diameter	50	mm
LB	body length	26	mm
LF	functional length	90	mm
WT	weight of item	1.47	kg

T10-2. Shrink fit adapter: C5/D10

Code C5-391.19-10075  
 Brand Sandvik Coromant  
 Item Version 1

PROPERTY_SYMBOL	PROPERTY_NAME	Value	UNIT
UST	unit system	metric	identifier
DCSFMS	contact surface diameter machine side	50	mm
DCB	connection bore diameter	10	mm
BD1	body diameter	24	mm
BD2	body diameter	32	mm
LB	body length	55	mm
LF	functional length	75	mm
WT	weight of item	0.7	kg

T10-3. Solid R3 Ball nose, 10mm shank

Code R216.54-06040-FAL12G  
 Brand Sandvik Coromant  
 Item Version 1

PROPERTY_SYMBOL	PROPERTY_NAME	Value	UNIT	value limitation	Value
UST	unit system	metric	identifier		
DCX	cutting diameter maximum	6	mm		
DMM	shank diameter	10	mm	limits&fits	h6
LUX	usable length maximum	42	mm		
APMX	depth of cut maximum	12	mm		
RE	corner radius	3	mm		
LF	functional length	83.6	mm		
ZEFF	face effective cutting edge count	3	counter		
FHA	flute helix angle	40	degrees		
HAND	hand	R	identifier		
CMAT	cutting edge substrate	carbide	identifier		
BMAT	body substrate	carbide	identifier		
WT	weight of item	0.1	kg		

## PARAMETERS FOR FEED SPEED OPTIMIZATION

### CUTTING DATA FOR THE D10mm R2mm CUTTER (T7) -cylindrical endmill

=====

Speed:

Cutting speed: 60m/min (1910rpm)

Feed:

Recommended chip thickness per tooth:

-for full slot milling (radial engagement of 51%-100%), the recommended **chipthickness is**

**0.05mm**

-for flank milling (radial engagement of up to 50%), the recommended **chipthickness is 0.07mm**

### CUTTING DATA FOR THE D8mm R2mm CUTTER (T9) -cylindrical endmill

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Speed:

Cutting speed: 60m/min (2387rpm)

Feed:

Recommended chip thickness per tooth:

-for full slot milling (radial engagement of 51%-100%), the recommended **chipthickness is**

**0.035mm**

-for flank milling (radial engagement of up to 50%), the recommended **chipthickness is 0.06mm**

### CUTTING DATA FOR THE D12mm R4mm CUTTER (T8 and T11) -3 degree conical ball nose mill

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Speed:

Cutting speed: 60m/min (1910rpm)

Feed:

Recommended feed per tooth:

-for full slot milling (radial engagement of 51%-100%), the recommended **feed/tooth is 0.05mm**

-for flank milling (radial engagement of up to 50%), the recommended **feed/tooth is 0.07mm**

### CUTTING DATA FOR THE D10mm R3mm CUTTER (T10) -3 degree conical ball nose mill

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Speed:

Cutting speed: 60m/min (2387rpm)

Feed:

Recommended feed per tooth:

-for full slot milling (radial engagement of 51%-100%), the recommended **feed/tooth is 0.035mm**

-for flank milling (radial engagement of up to 50%), the recommended **feed/tooth is 0.06mm**

### Original machining times at IMTS 2008

Operation	Tool	Flutes	Feed MM/IN	RPM	Time
Roughing	10mm Bullnose R2	4	787 / 31.0	1910	2.9 min
Roughing	8mm Bullnose R2	4	857 / 33.8	2387	1.3
Blades Semi	10mm Bullnose R2	4	458 / 18.0	1910	0.9
Blades Semi	8mm Ball 3 deg taper	3	298 / 11.7	1989	1.4
Hub Semi	8mm Ball 3 deg taper	3	573 / 22.5	3183	2.9
Lead Edges	8mm Ball 3 deg taper	3	637 / 25.0	3183	1.3
Hub Finish	8mm Ball 3 deg taper	3	716 / 28.0	716	4.3
Blades Finish	8mm Ball 3 deg taper	3	119 / 4.7	119	3.4
Fillet Finish	6mm Ball 3 deg taper	3	430 / 16.9	430	2.7
Total for 8 pockets					2.9 hours