

SMART MIRACLE End Mill Series for Difficult-to-Cut Materials

VQ2XLB/HV RB/FDRBSeries
Addition

High Quality Machining of Components for Difficult-to-Cut Materials

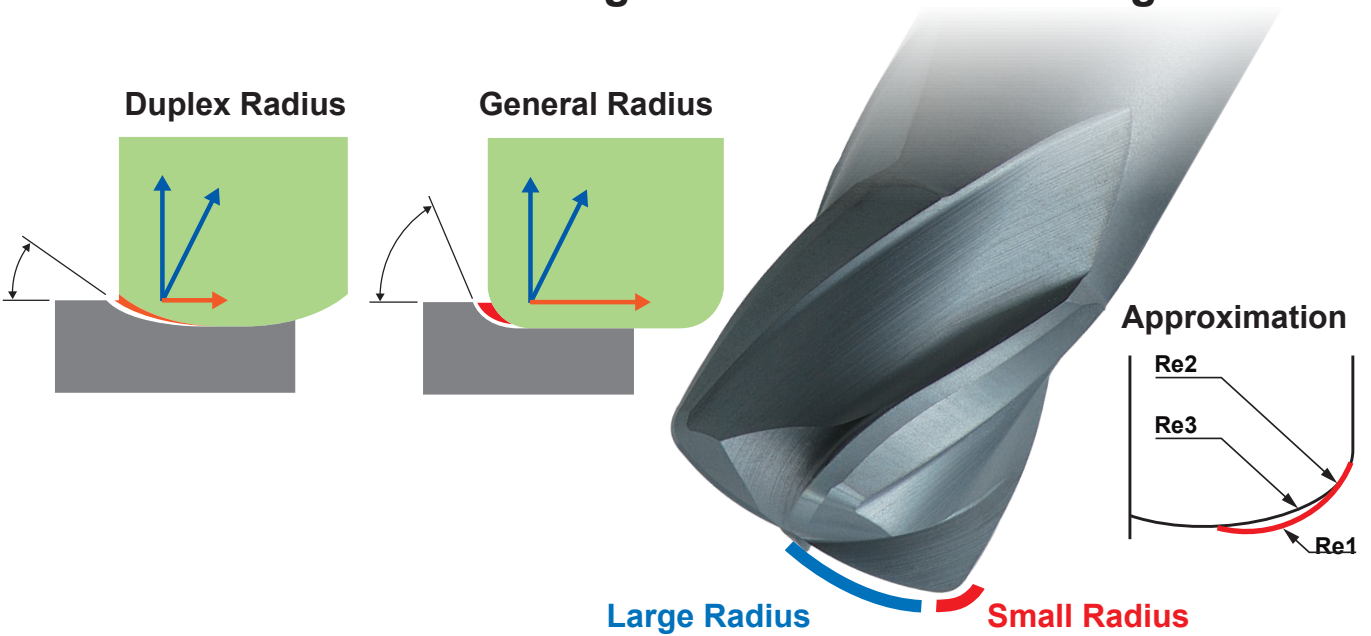


SMART MIRACLE End Mill Series for Difficult-to-Cut Materials

Duplex Radius End Mills **VQFDRB**

VQFDRB provides amazingly long tool life when machining Cobalt Chrome Alloy.

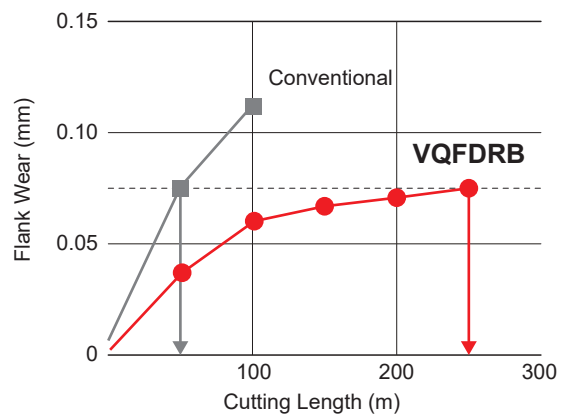
- Improved notch wear due to the reduced side contact of the duplex geometry.
- Reduced flank wear through the use of SMART MIRACLE coating and an ultra micro-grain cemented carbide.
- Provides stable machining with a low radial cutting force.



Cutting Performance

VQFDRB gave 5 times longer tool life than a conventional duplex radius end mill when machining cobalt chrome alloy.

<Cutting Conditions>
 Workpiece Material : Co-Cr-Mo Alloy (ASTM F1537)
 Tool : VQFDRBD0300N080 (DC=ø3mm)
 Revolution : n=8600 min⁻¹(vc=80 m/min)
 Feed Rate : vf= 1300 mm/min (0.038 mm/t.)
 Depth of Cut : ap=0.2mm ae= 1.3mm
 Cutting Mode : External Coolant (Emulsion)

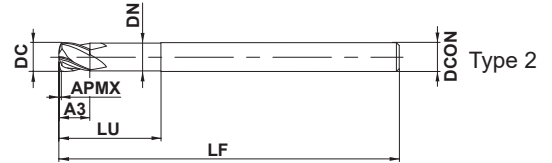
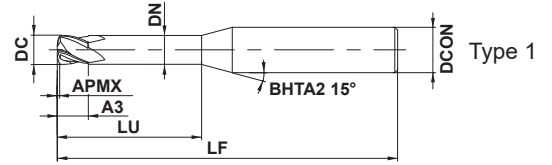
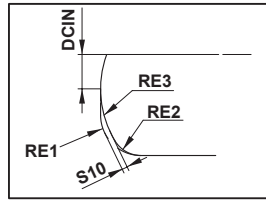


VQFDRB

Duplex corner radius end mill for high speed cutting



Carbon Steel, Alloy Steel, Cast Iron (<30HRC)	Tool Steel, Pre-hardened Steel, Hardened Steel (≤45HRC)	Hardened Steel (≤55HRC)	Precipitation Hardening Stainless Steel	Austenitic Stainless Steel	Cobalt Chrome Alloy, Heat Resistant Alloy	Titanium Alloy	Aluminium Alloy
					○	○	



$1 \leq DC \leq 4$				
0				
- 0.020				



DCON=6				
0				
- 0.005				

- Duplex corner radius type allows a more efficient higher feed.
- High feed cutting realized through the use of multiple cuts.

(mm)

Order Number	DC	*1 RE1	APMX	*3 A3	LU	DN	LF	DCON	*4 No. F	Multi-task radius part				*2 RMPX	Stock	Type
										S10	DCIN	RE2	RE3			
VQFDRBD0300N080	3	0.64	0.18	3	8	2.8	50	6	4	0.08	0.75	0.5	2	2.1°	●	1
VQFDRBD0300N120	3	0.64	0.18	3	12	2.8	55	6	4	0.08	0.75	0.5	2	2.1°	●	1
VQFDRBD0400N120	4	0.71	0.25	4	12	3.8	55	6	4	0.13	1.0	0.5	3	1.9°	●	1
VQFDRBD0400N160	4	0.71	0.25	4	16	3.8	60	6	4	0.13	1.0	0.5	3	1.9°	●	1
VQFDRBD0600N180	6	0.92	0.36	6	18	5.6	60	6	4	0.21	1.5	0.6	5	1.7°	●	2

*1 RE1 : Approx. R

*2 RMPX : Max. Ramping Angle

*3 A3 : Cutting Edge Effective Length

*4 Number of Flutes

DC = Dia.

APMX = Length of Cut

LU = Neck Length

DN = Neck Dia.

LF = Overall Length

DCON = Shank Dia.

● : Inventory maintained in Japan.

SMART MIRACLE End Mill Series for Difficult-to-Cut Materials

VQFDRB

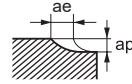
Duplex corner radius end mill for high speed cutting

Recommended Cutting Conditions

(mm)

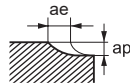
Workpiece Material	Titanium Alloys					Cobalt Chromium Alloys Precipitation Hardening Stainless Steels				
	Ti-6Al-4V ELI etc.					Co-Cr-Mo, SUS630, SUS631, 15-5PH, 17-4PH etc.				
DC	Revolution n (min ⁻¹)	Cutting Speed vc (m/min)	Feed Rate vf (mm/min)	Depth of cut ap	Width of cut ae	Revolution n (min ⁻¹)	Cutting Speed vc (m/min)	Feed Rate vf (mm/min)	Depth of cut ap	Width of cut ae
3	8500	80	2100	0.2	1.3	6400	60	3000	0.2	1.3
4	6400	80	2200	0.2	1.7	4800	60	2700	0.2	1.7
6	4200	80	1400	0.3	2.0	3200	60	2100	0.3	2.6

Depth of Cut



Workpiece Material	Heat Resistant Alloys				
	Inconel 718 etc.				
DC	Revolution n (min ⁻¹)	Cutting Speed vc (m/min)	Feed Rate vf (mm/min)	Depth of cut ap	Width of cut ae
3	3200	30	770	0.2	0.6
4	2400	30	770	0.2	0.8
6	1600	30	520	0.3	1.3

Depth of Cut



Note 1) SMART MIRACLE coating has very low electrical conductivity; therefore, an external contact type of tool setter (electrically transmitted) may not work.

When measuring the tool length, please use an internal contact type (non-electrical type) or a laser tool setter.

Note 2) When cutting titanium alloys, the use of water-soluble cutting fluid is effective.

Note 3) If the depth of cut is smaller, the revolution and the feed rate can be increased.

SMART MIRACLE End Mill Series for Difficult-to-Cut Materials

Vibration Control Corner Radius End Mills

VQHVRB

Increased feed rates and large depths of cut are achievable with VQHVRB, resulting in highly efficient machining.

Variable Helix

Vibration control geometry for smooth, stable cutting.

Special Gash

Good chip disposal enables both increased feed rates and large depths of cut.

Smart Miracle Coating

Reduced flank wear through the use of SMART MIRACLE coating and an ultra micro-grain cemented carbide substrate.



Cutting Performance

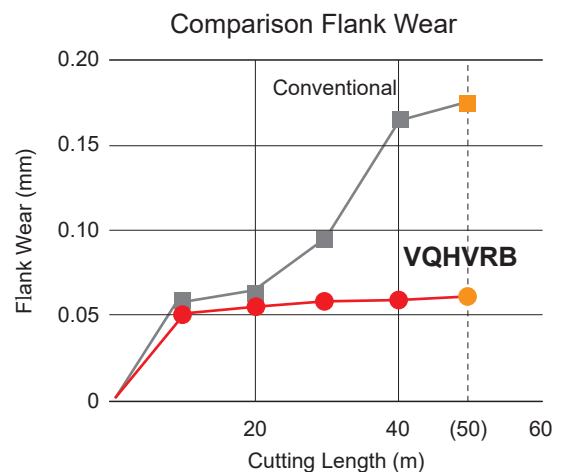
VQHRB wears less than the conventional end mill and provides a stable cutting action.

<Cutting Conditions>
 Workpiece Material : Titanium Alloy
 Tool : VQHRBD0300R05N180 (DC=ø3mm)
 Revolution : n=8600min⁻¹(vc=80 m/min)
 Feed Rate : vf=1300mm/min (0.05mm/t.)
 Depth of Cut : ap=0.2mm ae=1.3mm
 Cutting Mode : External Coolant (Emulsion)
 Cutting Length : 50m
 Machine : Vertical MC (BT30)

VQHVRB



Conventional



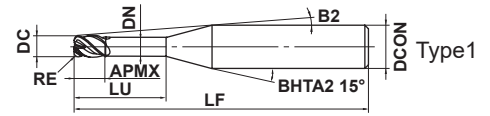
SMART MIRACLE End Mill Series for Difficult-to-Cut Materials

VQHVRB

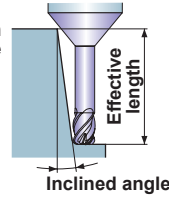
Corner radius, Short cut length, 4 flute, Irregular helix flutes



Carbon Steel, Alloy Steel, Cast Iron (<30HRC)	Tool Steel, Pre-hardened Steel, Hardened Steel (≤45HRC)	Hardened Steel (≤55HRC)	Precipitation Hardening Stainless Steel	Austenitic Stainless Steel	Cobalt Chrome Alloy, Heat Resistant Alloy	Titanium Alloy	Aluminium Alloy
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Effective length for inclined angle



$0.1 \leq RE \leq 1$			
± 0.01			



$1 \leq DC \leq 4$			
0 $- 0.02$			



DCON=6			
0 $- 0.005$			

● SMART MIRACLE corner radius end mill for high feed rates and efficient machining.

(mm)

Order Number	DC	RE	APMX	LU	DN	B2	LF	DCON	*1 No.F	Stock	Type
VQHVRBD0100R01N080	1	0.1	1	8	0.94	8.2°	50	6	4	●	1
VQHVRBD0100R01N120	1	0.1	1	12	0.94	6.7°	55	6	4	●	1
VQHVRBD0200R02N120	2	0.2	2	12	1.9	5.9°	55	6	4	●	1
VQHVRBD0200R02N160	2	0.2	2	16	1.9	4.9°	60	6	4	●	1
VQHVRBD0300R05N100	3	0.5	3	10	2.9	5.6°	55	6	4	●	1
VQHVRBD0300R05N180	3	0.5	3	18	2.9	3.7°	60	6	4	●	1
VQHVRBD0400R10N120	4	1.0	4	12	3.9	3.9°	55	6	4	●	1
VQHVRBD0400R10N200	4	1.0	4	20	3.9	2.5°	60	6	4	●	1

*1 Number of Flutes

DC = Dia.
RE = Radius
APMX = Length of Cut
LU = Neck Length

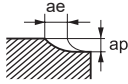
DN = Neck Dia.
LF = Overall Length
DCON = Shank Dia.

● : Inventory maintained in Japan.

Recommended Cutting Conditions

(mm)

Workpiece Material		Titanium Alloys Ti-6Al-4V ELI etc.					Cobalt Chromium Alloys Precipitation Hardening Stainless Steels Co-Cr-Mo, SUS630, SUS631, 15-5PH, 17-4PH etc.				
DC	LU	Revolution n (min ⁻¹)	Cutting Speed vc (m/min)	Feed Rate vf (mm/min)	Depth of cut ap	Width of cut ae	Revolution n (min ⁻¹)	Cutting Speed vc (m/min)	Feed Rate vf (mm/min)	Depth of cut ap	Width of cut ae
1	8	2500	8	500	0.030	0.1	2500	8	500	0.030	0.1
1	12	2500	8	350	0.030	0.1	2500	8	350	0.030	0.1
2	12	4800	30	600	0.075	0.3	4800	30	600	0.075	0.3
2	16	4800	30	340	0.075	0.3	4800	30	350	0.075	0.3
3	10	8500	80	2400	0.190	1.3	6400	60	2200	0.170	1.3
3	18	8500	80	2000	0.190	1.3	6400	60	1600	0.170	1.3
4	12	6400	80	2000	0.250	1.7	4800	60	1800	0.220	1.7
4	20	6400	80	2000	0.250	1.7	4800	60	1800	0.220	1.7

Depth of Cut	
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Note 1) SMART MIRACLE coating has very low electrical conductivity; therefore, an external contact type of tool setter (electrically transmitted) may not work.

When measuring the tool length, please use an internal contact type (non-electrical type) or a laser tool setter.

Note 2) When cutting titanium alloys, the use of water-soluble cutting fluid is effective.

Note 3) If the depth of cut is smaller, the revolution and the feed rate can be increased.

Note 4) The irregular helix flute end mill has a larger effect on controlling vibration when compared to standard end mills. However, if the rigidity of the machine or the workpiece material installation is poor, vibration or abnormal sound can occur.

In this case, please reduce the revolution and the feed rate proportionately, or set a lower depth of cut.

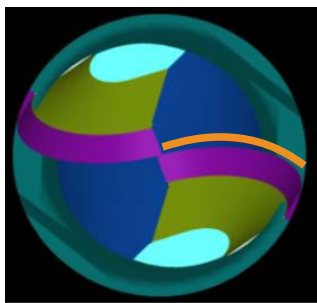
SMART MIRACLE End Mill Series for Difficult-to-Cut Materials

Long Neck Ball Nose End Mills **VQ2XLB**

VQ2XLB provides long tool life and stable cutting when machining cobalt chrome and titanium alloy.

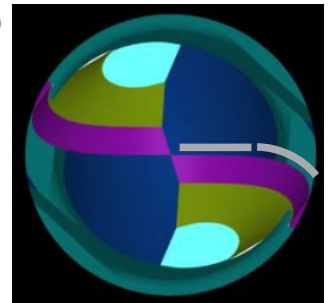
- A new cutting edge geometry provides improved resistance to chipping.
- SMART MIRACLE coating providing better wear resistance when machining difficult-to-cut materials.

VQ2XLB



Strong S

General (For Moulds)



Normal Curve

Tooling Example

Workpiece Material : Co-Cr-Mo Alloys

● Customer Comment

“Machined surface roughness is better than conventional tools under normal conditions”

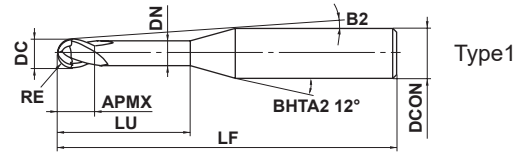
Process	Rough 1	Rough 2	Finish 1	Finish 2
Tool	VQ2XLBR0150N140 Ø3 (RE1.5)	VQ2XLBR0150N140 Ø3 (RE1.5)	VQ2XLBR0100N100S06 Ø2 (RE1.0)	VQ2XLBR0050N080N06 Ø1 (RE0.5)
Cutting Speed vc (m/min)	80	79.8	75.4	62.8
Revolution n (min ⁻¹)	6400	8500	12000	20000
Feed Rate vf (mm/min)	800	960	800	660
fz (mm/t.)	0.063	0.057	0.033	0.017
Depth of Cut	ap (mm)	0.15	0.1	0.05
	ae (mm)	1.0	0.3	0.08
Cutting Time (min)	400	60	90	150
Wear Condition	Good	Good	Good	Good

VQ2XLB

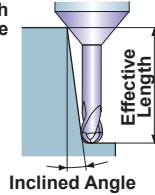
Ball nose, Short cut length, 2 flute, Long neck



Carbon Steel, Alloy Steel, Cast Iron (<30HRC)	Tool Steel, Pre-hardened Steel, Hardened Steel (≤45HRC)	Hardened Steel (≤55HRC)	Precipitation Hardening Stainless Steel	Austenitic Stainless Steel	Cobalt Chrome Alloy, Heat Resistant Alloy	Titanium Alloy	Aluminium Alloy
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Effective Length for Inclined Angle



$0.05 \leq RE \leq 1.5$

± 0.005



$4 \leq DCON \leq 6$

0
 $- 0.005$

● SMART MIRACLE coating providing better wear resistance when machining difficult-to-cut materials.

(mm)

Order Number	RE	DC	APMX	LU	DN	B2	LF	DCON	*1 No.F	Stock	Type
VQ2XLBR0050N080	0.5	1	0.75	8	0.94	6.4°	50	4	2	●	1
VQ2XLBR0050N100	0.5	1	0.75	10	0.94	5.6°	50	4	2	●	1
VQ2XLBR0050N080S06	0.5	1	0.75	8	0.94	8.3°	50	6	2	●	1
VQ2XLBR0050N100S06	0.5	1	0.75	10	0.94	7.5°	55	6	2	●	1
VQ2XLBR0050N120S06	0.5	1	0.75	12	0.94	6.8°	55	6	2	●	1
VQ2XLBR0075N100S06	0.75	1.5	1.1	10	1.44	7.2°	55	6	2	●	1
VQ2XLBR0075N120S06	0.75	1.5	1.1	12	1.44	6.5°	55	6	2	●	1
VQ2XLBR0100N100	1.0	2	1.5	10	1.9	4.5°	50	4	2	●	1
VQ2XLBR0100N100S06	1.0	2	1.5	10	1.9	6.9°	55	6	2	●	1
VQ2XLBR0100N120	1.0	2	1.5	12	1.9	3.9°	50	4	2	●	1
VQ2XLBR0100N120S06	1.0	2	1.5	12	1.9	6.1°	55	6	2	●	1
VQ2XLBR0150N120	1.5	3	2.3	12	2.9	5.3°	55	6	2	●	1
VQ2XLBR0150N140	1.5	3	2.3	14	2.9	4.7°	60	6	2	●	1
VQ2XLBR0150N160	1.5	3	2.3	16	2.9	4.3°	60	6	2	●	1

*1 Number of Flutes

DC = Dia.
RE = Radius
APMX = Length of Cut
LU = Neck Length

DN = Neck Dia.
LF = Overall Length
DCON = Shank Dia.

● : Inventory maintained in Japan.

SMART MIRACLE End Mill Series for Difficult-to-Cut Materials

VQ2XLB

Ball nose, Short cut length, 2 flute, Long neck

Recommended Cutting Conditions

(mm)

Workpiece Material		Titanium Alloys					Cobalt Chromium Alloys				
		Ti-6Al-4V ELI, ASTM F136, etc.					ASTM F75: Casting, F1537: Wrought Bar, F799: Forgings, etc.				
RE	LU	Revolution n (min ⁻¹)	Cutting Speed vc (m/min)	Feed Rate vf (mm/min)	Depth of cut ap	Width of cut ae	Revolution n (min ⁻¹)	Cutting Speed vc (m/min)	Feed Rate vf (mm/min)	Depth of cut ap	Width of cut ae
0.5	8	32000	100	2500	0.05	0.1	25000	80	2000	0.05	0.1
0.5	10	24000	75	1500	0.05	0.1	19000	60	1500	0.05	0.1
0.5	12	24000	75	1500	0.03	0.1	19000	60	1500	0.03	0.1
0.75	10	21000	100	2100	0.13	0.3	17000	80	1700	0.08	0.1
0.75	12	16000	75	1500	0.13	0.3	13000	60	1200	0.08	0.1
1	10	16000	100	1800	0.20	0.5	13000	80	1500	0.2	0.5
1	12	16000	100	1800	0.20	0.5	13000	80	1500	0.2	0.5
1.5	12	10000	100	1600	0.30	0.8	8500	80	1300	0.3	0.8
1.5	14	10000	100	1600	0.30	0.8	8500	80	1300	0.3	0.8
1.5	16	10000	100	1600	0.30	0.8	8500	80	1300	0.3	0.8

Depth of Cut	$\leq 0.10RE$ ($RE \leq 1$) $\leq 0.20RE$ ($RE > 1$)

RE : Radius

Workpiece Material		Pure Titanium				
		Ti etc.				
RE	LU	Revolution n (min ⁻¹)	Cutting Speed vc (m/min)	Feed Rate vf (mm/min)	Depth of cut ap	Width of cut ae
0.5	8	27000	80	1600	0.08	0.1
0.5	10	19000	60	1200	0.08	0.1
0.5	12	19000	60	1200	0.04	0.1
0.75	10	25000	120	2000	0.13	0.2
0.75	12	21000	100	1600	0.13	0.2
1	10	32000	200	2500	0.32	0.8
1	12	29000	180	1700	0.32	0.8
1.5	12	21000	200	1600	0.48	1.2
1.5	14	21000	200	1600	0.48	1.2
1.5	16	21000	200	1600	0.48	1.2

Depth of Cut	$\leq 0.10RE$ ($RE \leq 1$) $\leq 0.20RE$ ($RE > 1$)

RE : Radius

Note 1) SMART MIRACLE coating has very low electrical conductivity; therefore, an external contact type of tool setter (electrically transmitted) may not work.

When measuring the tool length, please use an internal contact type (non electrical type) or a laser tool setter.

Note 2) When cutting titanium alloys, the use of water-soluble cutting fluid is effective.

Note 3) If the depth of cut is smaller, the revolution and the feed rate can be increased.

Memo

A series of horizontal dashed lines for writing, spanning the width of the page.



SMART MIRACLE End Mill Series for Difficult-to-Cut Materials

VQ2XLB/HVRB/FDRB

For Your Safety

●Don't handle inserts and chips without gloves. ●Please machine within the recommended application range and exchange expired tools with new ones in advance of breakage. ●Please use safety covers and wear safety glasses. ●When using compounded cutting oils, please take fire precautions. ●When attaching inserts or spare parts, please use only the correct wrench or driver. ●When using rotating tools, please make a trial run to check run-out, vibration and abnormal sounds etc.

 **MITSUBISHI MATERIALS CORPORATION**

MITSUBISHI MATERIALS CORPORATION

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(Tools specifications subject to change without notice.)

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