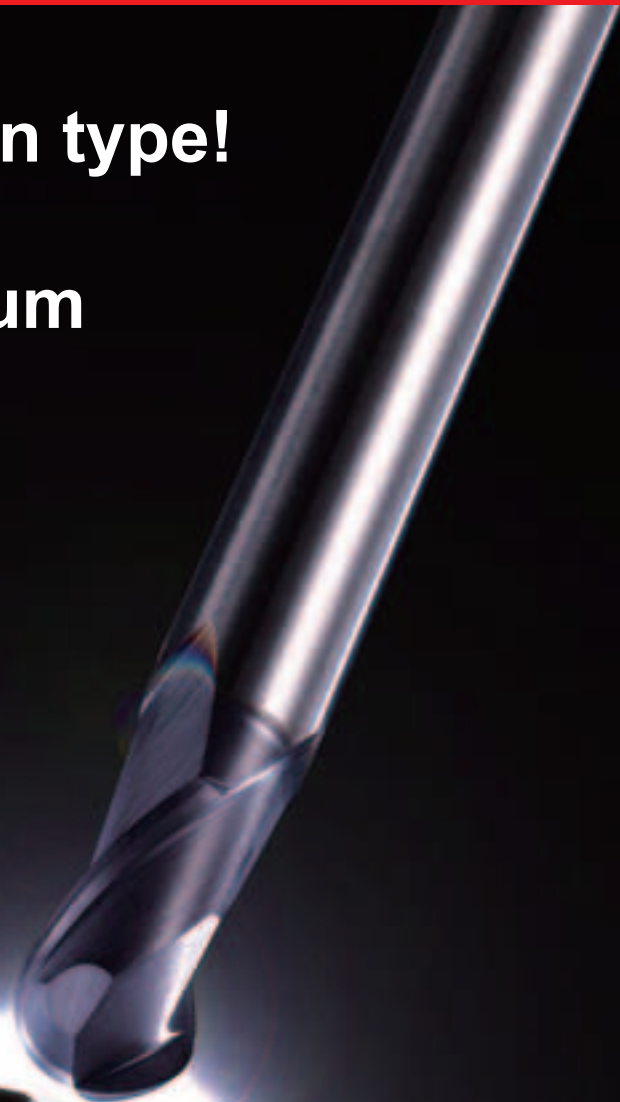
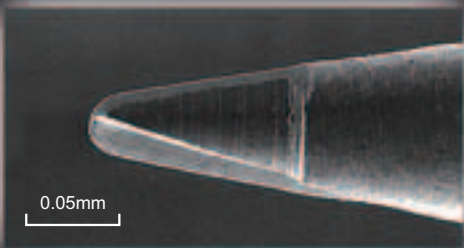


MIRACLE HIGH PRECISION BALL NOSE END MILLS

MIRACLE NOVA

Expand

Ultra high precision type!
A world first! *1
New added minimum
R0.02mm type. *2



**ULTRA HIGH
PRECISION**
[±0.002mm]

*1) According to a probe by our company.
*2) VC-2PSB-P type. Inspection report supplied.

HIGH PRECISION BALL NOSE END MILLS

MIRACLE NOVA

Ultimate choice for high precision finishing of moulds!

ULTRA HIGH
PRECISION
[± 0.002 mm]



Ultra high radial tolerance $\pm 2\mu\text{m}$!!

New developed minimum R0.02 type.

● We commercialized world first minimum R0.02 size allowed our original grinding technology.



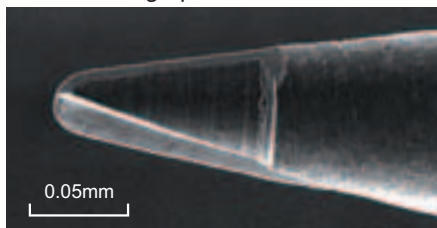
VC-2PSB-P

(Radial tolerance $\pm 2\mu\text{m}$ type) have a Inspection Report

VC-2PSB

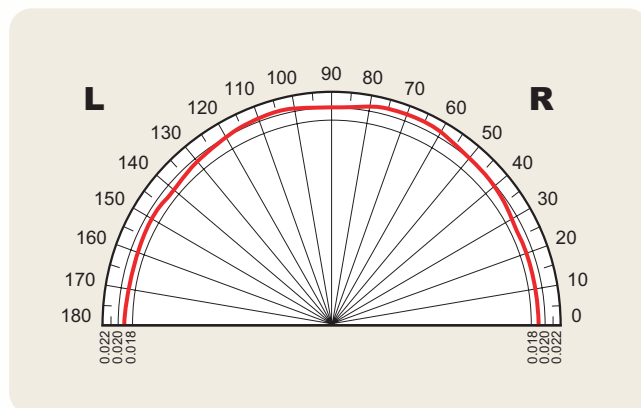
(Radial tolerance $\pm 6\mu\text{m}$ type)

Photo macrograph R0.02



*Have a Inspection Report

■ Inspection Report R0.02mm (VC-2PSB-P)



Inspection report (For radial tolerance $\pm 2\mu\text{m}$ type)

● Inspection reports supplied with each high accuracy end mill (tolerance $\pm 2\mu\text{m}$).



Features


Ideal surface finishes achieved by using precision geometry and superior coating technology.

High Precision

- Tolerance combination. The highest radial tolerance ($\pm 2\mu\text{m}$), diameter tolerance ($0-10\mu\text{m}$), and a shank tolerance of h5. Ideal surface finishes achieved by the sharp cutting edge and seamless edge geometry.

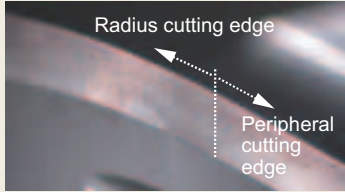
End cutting edge

Improved sharpness, short centre cutting edge.



Seamless geometry

The seamless ball and tangential side cutting edge geometry.



MIRACLE coating with increased lubricity.

Patent registered

- Lubricating elements added to the existing MIRACLE hard coating.

Coating properties comparison

	Hardness (HV)	Oxidation temperature (°C)	Adhesion (N)	Friction coefficient (800°C)
MIRACLE NOVA	3,100	1,100	100	0.42
(Al,Ti)N	2,800	840	80	0.53

Adhesion :

Measured by the critical load scratch test

Coefficient of friction :

Measured by ball-on-disc method

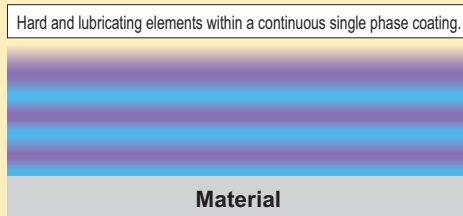
Counter gear :

SKD61 (52HRC)

Coating

MIRACLE NOVA coating

- ① A world first advanced coating technique that forms hard and lubricating elements in a continuous single phase coating.
- ② MIRACLE NOVA coating for long tool life and consistent, precision tool geometry compared to conventional (Al,Ti)N coating.



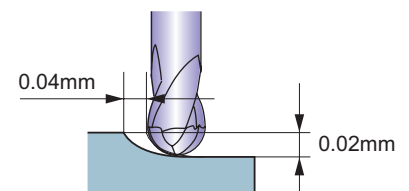
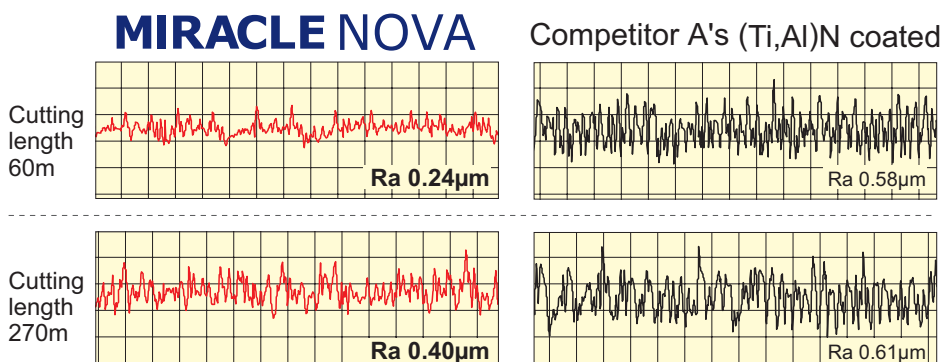
* Reference drawing

Hard element → **Improved wear resistance**
High resistance to wear and heat due to the superior film hardness and oxidation resistance.

Lubricating element → **Reduced welding**
High welding resistance due to the reduced friction coefficient during cutting.

Machining Example

- Prolonged tool life and ideal surface finish!

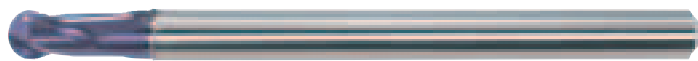
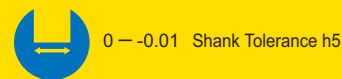


End mill	VC-2PSB R0.4
Work material	SKD61 (52HRC)
Revolution	18,000mm ⁻¹
Feed rate	1,500mm/min
Cutting method	Climb cutting, Air blow

MIRACLE END MILLS

VC-2PSB-P MIRACLE NOVA Expand

Ball nose slot drill, Short cut length, 2 flute, Ultra high precision



VC-2PSB-P type In supplies Inspection report.



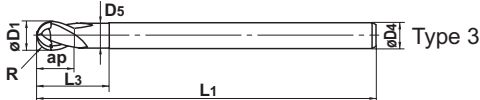
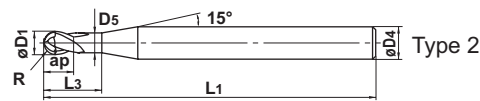
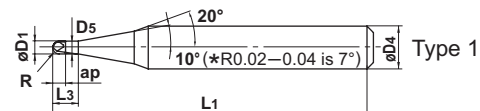
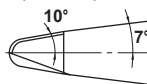
R<0.5

0.5≤R

R<0.5

0.5≤R

R0.02—R0.04
point shape



Unit : mm

- MIRACLE NOVA, radial tolerance of $\pm 0.002\text{mm}$, diameter tolerance $0 - -0.01\text{mm}$ and a shank tolerance of h5.

Order Number	Radius of Ball Nose R	Dia. D1	Length of Cut ap	Neck Length L3	Neck Dia. D5	Overall Length L1	Shank Dia. D4	No. of Flutes N	Stock	Type
* VC2PSBPR0002	0.02	—	0.06	—	—	50	6	2	<input type="checkbox"/>	1
* R0003	0.03	—	0.09	—	—	50	6	2	<input type="checkbox"/>	1
* R0004	0.04	—	0.12	—	—	50	6	2	<input type="checkbox"/>	1
R0005	0.05	0.1	0.2	—	—	50	6	2	<input checked="" type="checkbox"/>	1
R0010	0.1	0.2	0.2	0.5	0.17	50	6	2	<input checked="" type="checkbox"/>	1
R0015	0.15	0.3	0.3	0.8	0.27	50	6	2	<input checked="" type="checkbox"/>	1
R0020	0.2	0.4	0.4	1	0.36	50	6	2	<input checked="" type="checkbox"/>	1
R0025	0.25	0.5	0.5	1.3	0.46	50	6	2	<input checked="" type="checkbox"/>	1
R0030	0.3	0.6	0.6	1.5	0.56	50	6	2	<input checked="" type="checkbox"/>	1
R0035	0.35	0.7	0.7	1.8	0.66	50	6	2	<input checked="" type="checkbox"/>	1
R0040	0.4	0.8	0.8	2	0.76	50	6	2	<input checked="" type="checkbox"/>	1
R0045	0.45	0.9	0.9	2.3	0.86	50	6	2	<input checked="" type="checkbox"/>	1
R0050	0.5	1	1.5	2.5	0.94	50	6	2	<input checked="" type="checkbox"/>	2
R0060	0.6	1.2	1.8	3	1.14	50	6	2	<input checked="" type="checkbox"/>	2
R0070	0.7	1.4	2.1	3.5	1.34	50	6	2	<input checked="" type="checkbox"/>	2
R0075	0.75	1.5	2.3	3.8	1.44	50	6	2	<input checked="" type="checkbox"/>	2
R0080	0.8	1.6	2.4	4	1.54	50	6	2	<input checked="" type="checkbox"/>	2
R0090	0.9	1.8	2.7	4.5	1.74	50	6	2	<input checked="" type="checkbox"/>	2
R0100	1	2	3	5	1.9	50	6	2	<input checked="" type="checkbox"/>	2
R0150	1.5	3	4.5	7.5	2.9	70	6	2	<input checked="" type="checkbox"/>	2
R0200	2	4	6	10	3.9	70	6	2	<input checked="" type="checkbox"/>	2
R0250	2.5	5	7.5	12.5	4.9	80	6	2	<input checked="" type="checkbox"/>	2
R0300	3	6	9	15	5.85	80	6	2	<input checked="" type="checkbox"/>	3
R0400	4	8	12	20	7.85	90	8	2	<input checked="" type="checkbox"/>	3
R0500	5	10	15	25	9.7	100	10	2	<input checked="" type="checkbox"/>	3
R0600	6	12	18	30	11.7	110	12	2	<input checked="" type="checkbox"/>	3

*Expand



VC-2PSB MIRACLE NOVA

Ball nose slot drill, Short cut length, 2 flute, High precision



±0.005



0 - -0.01 Shank Tolerance h5



R < 0.5



0.5 ≤ R

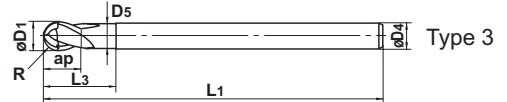
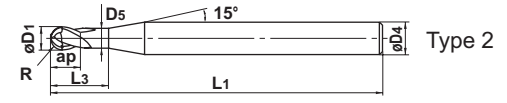
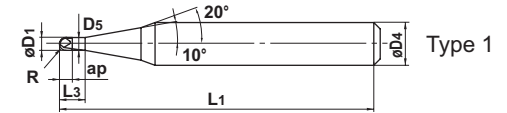


R < 0.5



0.5 ≤ R

- MIRACLE NOVA, radial tolerance of ±0.002mm, diameter tolerance 0 - -0.01mm and a shank tolerance of h5.



Unit : mm

Order Number	Radius of ball nose R	Dia. D1	Length of Cut ap	Neck Length L3	Neck Dia. D5	Overall Length L1	Shank Dia. D4	No. of Flutes N	Stock	Type
VC2PSBR0005	0.05	0.1	0.2	—	—	50	6	2	●	1
R0010	0.1	0.2	0.2	0.5	0.17	50	6	2	●	1
R0015	0.15	0.3	0.3	0.8	0.27	50	6	2	●	1
R0020	0.2	0.4	0.4	1	0.36	50	6	2	●	1
R0025	0.25	0.5	0.5	1.3	0.46	50	6	2	●	1
R0030	0.3	0.6	0.6	1.5	0.56	50	6	2	●	1
R0035	0.35	0.7	0.7	1.8	0.66	50	6	2	●	1
R0040	0.4	0.8	0.8	2	0.76	50	6	2	●	1
R0045	0.45	0.9	0.9	2.3	0.86	50	6	2	●	1
R0050	0.5	1	1.5	2.5	0.94	50	6	2	●	2
R0060	0.6	1.2	1.8	3	1.14	50	6	2	●	2
R0070	0.7	1.4	2.1	3.5	1.34	50	6	2	●	2
R0075	0.75	1.5	2.3	3.8	1.44	50	6	2	●	2
R0080	0.8	1.6	2.4	4	1.54	50	6	2	●	2
R0090	0.9	1.8	2.7	4.5	1.74	50	6	2	●	2
R0100	1	2	3	5	1.90	50	6	2	●	2
R0150	1.5	3	4.5	7.5	2.90	70	6	2	●	2
R0200	2	4	6	10	3.90	70	6	2	●	2
R0250	2.5	5	7.5	12.5	4.90	80	6	2	●	2
R0300	3	6	9	15	5.85	80	6	2	●	3
R0400	4	8	12	20	7.85	90	8	2	●	3
R0500	5	10	15	25	9.70	100	10	2	●	3
R0600	6	12	18	30	11.70	110	12	2	●	3

MIRACLE END MILLS

VC-2PSB-P MIRACLE NOVA

Ball nose slot drill, Short cut length, Ultra high precision

VC-2PSB MIRACLE NOVA

Ball nose slot drill, Short cut length, 2 flute, High precision

Work material	Alloy steel, Tool steel, Pre-hardened steel (-45HRC) AISI H13, AISI D2, NAK				Hardened steel (45-55HRC) AISI H13			
	$\alpha \leq 15^\circ$		$\alpha > 15^\circ$		$\alpha \leq 15^\circ$		$\alpha > 15^\circ$	
	Revolution (min^{-1})	Feed rate (mm/min)	Revolution (min^{-1})	Feed rate (mm/min)	Revolution (min^{-1})	Feed rate (mm/min)	Revolution (min^{-1})	Feed rate (mm/min)
R0.05	40,000	200	—	—	40,000	170	—	—
R0.1	40,000	600	40,000	400	40,000	600	40,000	400
R0.15	40,000	900	40,000	600	40,000	900	40,000	600
R0.2	40,000	1,000	40,000	700	40,000	1,000	40,000	700
R0.25	40,000	1,500	40,000	1,000	40,000	1,500	40,000	1,000
R0.3	40,000	2,000	40,000	1,500	40,000	2,000	40,000	1,500
R0.35	40,000	2,800	40,000	2,100	40,000	2,800	37,000	1,800
R0.4	40,000	2,800	40,000	2,100	40,000	2,800	35,000	1,800
R0.45	40,000	3,200	38,000	2,200	38,000	3,000	32,000	1,800
R0.5	40,000	3,200	35,000	2,200	35,000	3,000	30,000	1,800
R0.75	40,000	3,600	30,000	2,300	32,000	3,000	25,000	1,800
R1	35,000	3,500	25,000	2,200	28,000	2,800	20,000	1,700
R1.5	30,000	3,400	23,000	2,200	24,000	2,600	16,000	1,500
R2	25,000	3,400	20,000	2,200	20,000	2,600	14,000	1,500
R2.5	23,000	3,400	17,000	2,200	18,000	2,600	12,000	1,500
R3	20,000	3,400	15,000	2,200	16,000	2,600	10,000	1,400
R4	15,000	3,000	12,500	2,000	10,000	2,000	7,500	1,200
R5	12,000	3,000	10,000	2,000	8,000	2,000	6,000	1,200
R6	10,000	2,600	8,300	1,800	6,600	1,700	5,000	1,100

Depth of cut

R:Radius

- 1) α is the inclination of the machined surface.
- 2) Please use VC-2SB or VC-4MB for workpieces of 55HRC or above.
- 3) If the rigidity of the machine or the workpiece installation is very low, or chattering and noise are generated, please reduce the revolution and the feed rate proportionately. When high machining accuracy is needed, we recommend lowering the feed rate.
- 4) Cutting conditions may differ considerably due to the overhang (milling depth and neck length), depth of cut and machine tool condition. Please use the above table as a standard starting point.
- 5) VC-2MDB is recommended when using an end mill with a long overhang, for deep slotting with low rigidity or high hardness material milling.
- 6) If the depth of cut is shallow, the revolution and feed rate can be increased.
- 7) When using the smallest diameters, we recommend using mist coolant.

MITSUBISHI tooling for highly efficient and precision milling of hardened materials.

For high precision, radius end milling

High Precision Radius End Mill

MIRACLE ORBIT VC-PSRB

- MIRACLE ORBIT high radial tolerance of $\pm 10\mu\text{m}$, diameter tolerance 0- $-10\mu\text{m}$.
- For machining walls and flat surfaces of moulds.
- Reduction of end mill inventory.
Highly efficient and precision milling.

For high efficiency machining

MIRACLE High Feed Corner Radius End Mills VC-HFRB

- Newly developed cutting edge with excellent chipping resistance. Possible to cut at over 10,000 mm/min feed rate.
- Wide range of end mills. Short, long neck, taper neck and long shank types available.

For reliable and efficient milling of high hardness materials.

IMPACT MIRACLE End Mill Series

- Newly developed "Impact Miracle Coating".
- Improved cutting edge geometry, the superior chipping resistance allows higher speeds for reliable milling of high hardness materials.

MIRACLE NOVA



MIRACLE NOVA is manufactured in a high quality control environment.

Environment

Climate controlled manufacturing environment to improve product quality.

Inspection

Manufacture of smaller and more sophisticated cutting tools relies on the use of precision measurement technology to ensure accuracy and reliability.

Technology

Advanced technology enables us to provide the cutting tools that achieve efficient and high precision milling.



MITSUBISHI MATERIALS KOBE TOOLS



JQA-2522
JQA-EM0941

**MITSUBISHI MATERIALS CORPORATION
MARKETING DEPT.**

KFC bldg., 7F, 1-6-1, Yokoami, Sumida-ku, Tokyo 130-0015, Japan
TEL 81-3-5819-8772 FAX 81-3-5819-8774

MMC HARTMETALL GmbH

Comeniusstr.2, 40670, Meerbusch GERMANY
TEL 49-2159-9189-0 FAX 49-2159-50462

**MITSUBISHI MATERIALS U.S.A. CORPORATION
Headquarters**

17401, Eastman Street, Irvine, California, 92614, USA
TEL 1-949-862-5100 FAX 1-949-862-5180

MMC METAL SINGAPORE PTE LTD.

10, Arumugam Road, #04-00 Lion Industrial Bldg., 409957, SINGAPORE
TEL 65-6743-9370 FAX 65-6749-1469