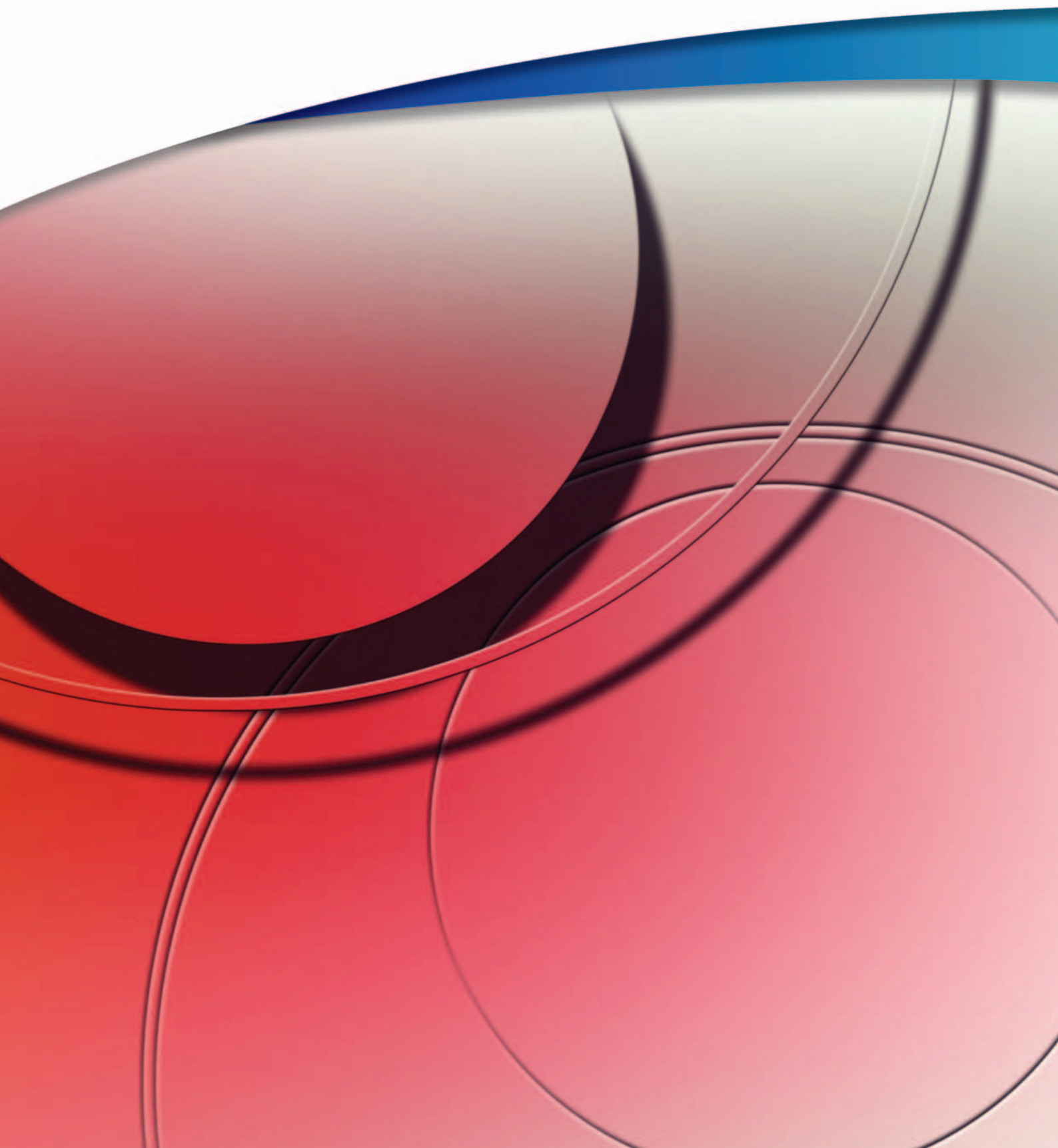
HitachiCable

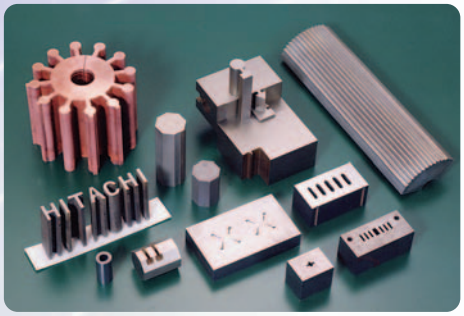
HITACHI

Electrical Discharge Machining Wire <EDM wire>

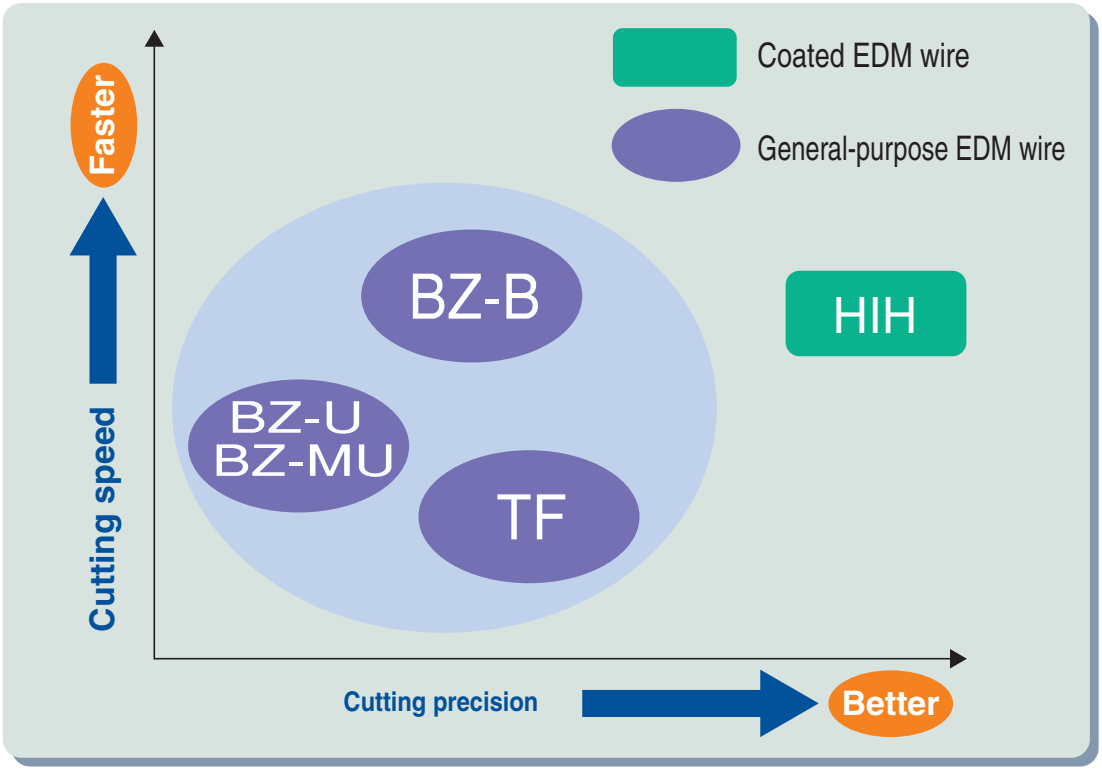


Electrical Discharge Machining Wire

We satisfy customer demands by implementing integrated production from casting to processing.



Positioning of each wire type



Cutting application of each wire type

Cutting application		Standard EDM wire		Special EDM wire				Coated EDM wire
		HBZ-U	HBZ-MU	HBZ-B	HTF	ABZ-AT	OFC*	HIH
Cutting purpose	Standard cutting	○	○	○	◎	–	–	◎
	Taper cutting	◎	◎	◎	◎	★	◎	◎
	Rough cutting	◎	◎	○	◎	–	–	◎
	High accuracy shape cutting	◎	◎	○	○	–	–	★
	Thick material cutting	◎	◎	◎	○	–	–	◎
	High surface accuracy cutting	◎	◎	◎	○	–	–	★
	High-speed cutting	◎	◎	○	◎			◎
	Automatic threading	★	★	◎	◎	–	–	○
	Poor jet flow cutting	◎	◎	◎	○	–	–	◎
	Copper adhesion less cutting	◎	◎	○	★	–	–	★
	Brass powder less cutting	○	★	◎	◎	◎	–	◎
Steel product	Aluminium	◎	◎	○	◎	–	–	◎
	Graphite	◎	◎	◎	◎	–	★	○
	Poly crystalline diamond (PCD)	◎	◎	◎	◎	–	–	★
	Tungsten carbide	◎	◎	○	◎	–	–	★
	Stainless steel	◎	◎	◎	◎	–	–	○
	Low conductivity materials	◎	◎	◎	◎	–	★	○
EDM machine	Agie-Charmilles (formerly Agie)	○	○	◎	◎	–	–	★
	Agie-Charmilles (formerly Charmilles)	○	○	◎	◎	★	–	○
	Seibu	◎	◎	○	○	○	○	◎
	Sodick	○	○	○	○	–	–	○
	Fanuc	★	○	○	○	★	–	★
	Makino	○	○	◎	◎	–	–	○
	Mitsubishi	○	★	○	○	–	–	◎

★: Excellent ◎: Better ○: Good

*OFC (Oxygen-Free Copper)

Table: Equipment availability of wire with without paraffin

EDM machines		EDM wire		Note
Maker	Model	Paraffin	Non-paraffin	
Agie-Charmilles (formerly Agie)	100D	—	○	Non-paraffin products can be used for all models, regardless of size.
	200D	—	○	
	Evolution	—	○	
Agie-Charmilles (formerly Charmilles)	Robofil®	—	○	
Seibu	EW	—	○	
	MS	—	○	
	MA	—	○	
Sodick	A	○	—	For wire of 0.15 mmϕ or less, non-paraffin products improve positioning and accuracy.
	AP	○	—	
	AQ	○	—	
Fanuc	α	—	○	Non-paraffin products can be used for new models, α series or thereafter.
	Tape Cut	○	—	
Makino	EE	○	—	For wire of 0.15 mmϕ or less, non-paraffin products improve positioning and accuracy.
	EQH	○	—	
	EC	○	—	
Mitsubishi	F A	—	○	Non-paraffin products can be used for all models, regardless of size.
	R A	—	○	
	Q A	○	—	For wire of 0.15 mmϕ or less, non-paraffin products improve positioning and accuracy.
	F X-K	○	—	
	F X	○	—	
	CX,SX	○	—	
	DWC®	○	—	

Advantages of non-paraffin wire

If wire has excessive paraffin or contamination

- Wire may easily slip on a roller part, etc.
- Extraneous matter may remain on a roller part, etc.

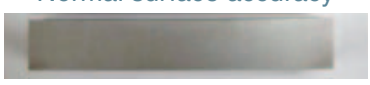
If paraffin wire is used on the EDM machine that is specifically calibrated for non-paraffin wire, the characteristics of electrical discharge machining may be adversely affected since the wire run system will become unstable due to sliding, etc. As cutting line wire marks occur frequently, particularly on the cutting surface, great care is needed for wire selection.

1. If extraneous matter or oil content may remain:

- Resulting unstable wire run may degrade the surface accuracy of the machined object.
- Automatic threading trouble and EDM machine stop may be triggered by blockage of guide dies.

Deteriorated surface accuracy

Normal surface accuracy



2. If insulation material remains on wire surface:

- Accuracy of tactile sense and positioning may deteriorate.
- Unstable to feeble electrical discharge is generated and feeding dies life is shortened.

General-purpose EDM wire

BZ-U wire

Capable of automatic threading

For hard material

- Hitachi Metal's standard brass wire
- High cutting speed due to its zinc-rich constitution
- Improved automatic threading capability due to its characteristic straightness
- Can be used in any company's EDM machine with automatic threading function

General characteristics of BZ-U wire

Type	Product name	Size (ϕ mm)	Wire Tolerance (mm)	Tensile strength		Elongation (%)
				(MPa)	(kgf/mm²)	
H (Hard)	BZ-U	0.10～0.33	±0.001	980 over	100 over	0.4 over

Note: 1. Please contact us for the production of special sizes (0.10 mm less, or 0.33 mm over).
2. This wire is manufactured for only H (hard) type.

General-purpose EDM wire

BZ-MU wire

Reduction of brass powder

Capable of automatic threading

For hard material

For soft material

- Significant reduction of brass powder
- Improved automatic threading capability due to its excellent straightness
- Can be used in all models of EDM machines equipped with automatic threading device in the form of pipe, jet or annealed systems.

General characteristics of BZ-MU wire

Type	Product name	Size (ϕ mm)	Wire Tolerance (mm)	Tensile strength		Elongation (%)
				(MPa)	(kgf/mm²)	
H (Hard)	BZ-MU	0.10～0.33	±0.001	980 over	100 over	0.4 over
A (Soft)	BZ			445 over	50 over	15 over

Note: 1. Please contact us for the production of special sizes (0.10 mm less, or 0.33 mm over).
2. In case of A (Soft) type, the product name is ABZ.

Special EDM wire

BZ-B wire

High-speed cutting

Reduction of brass powder

Improvement in surface accuracy

For hard material

For soft material

- **More Zinc-rich than BZ-U**
- **Improvement in cutting speed and surface accuracy**

General characteristics of BZ-B wire

Type	Product name	Size (ϕ mm)	Wire Tolerance (mm)	Tensile strength		Elongation (%)
				(MPa)	(kgf/mm²)	
H (Hard)	BZ-B	0.10～0.33	±0.001	980 over	100 over	0.4 over
A (Soft)				445 over	50 over	15 over

Note: 1. Please contact us for the production of special sizes (0.10 mm less, or 0.33 mm over).

Special EDM wire

TF wire

Breaking protection

Avoiding of brass adhesion

For hard material

For soft material

- **For cutting thick objects (can be used for material thickness of 100 mm or more)**
- **Significant reduction of brass adhering to cutting surface**

General characteristics of TF wire

Type	Product name	Size (ϕ mm)	Wire Tolerance (mm)	Tensile strength		Elongation (%)
				(MPa)	(kgf/mm²)	
H (Hard)	TF	0.10～0.33	±0.001	980 over	100 over	0.4 over
A (Soft)				445 over	50 over	10 over

Note: 1. Please contact us for the production of special sizes (0.10 mm less, or 0.33 mm over).

Special EDM wire

BZ-AT wire

Taper cutting

For ultra-soft material

- For taper cutting
- Stress is specifically demonstrated for wide-angle (20～45) taper cutting.

General characteristics of BZ-AT wire

Type	Product name	Size (ϕ mm)	Wire Tolerance (mm)	Tensile strength		Elongation (%)
				(MPa)	(kgf/mm²)	
A (Soft)	BZ-AT	0.20～0.30	±0.001	445 less	45 less	30 over

Note: 1. Please contact us for the production of special sizes (0.20 mm less, or 0.30 mm over).
2. This wire is manufactured for only A (Soft) type.

Special EDM wire

OFC* wire

Copper wire

For hard material

For soft material

- This wire is effective for sintered materials (Graphite, etc) and vacuum cutting, such as with the old model of EDM machine.

General characteristics of OFC wire

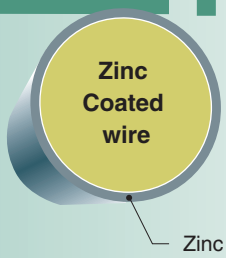
Type	Product name	Size (ϕ mm)	Wire Tolerance (mm)	Tensile strength		Elongation (%)
				(MPa)	(kgf/mm²)	
H (Hard)	1OFC	0.20～0.30	±0.001	445 over	50 over	0.4 over
A (Soft)				294 less	30 less	15 over

Note: 1. Please contact us for the production of special sizes (0.20 mm less, or 0.30 mm over).
*OFC（Oxygen-Free Copper）

Coated EDM wire

HIH wire

Improvement in surface accuracy | Reduction of zinc powder | Capable of automatic threading | For hard material



- For cutting focused on surface and shape accuracy
- Zinc (Zn) coating by electroplating method
- Reduction of heat-affected layer of the cutting surface, increased life of the press mold

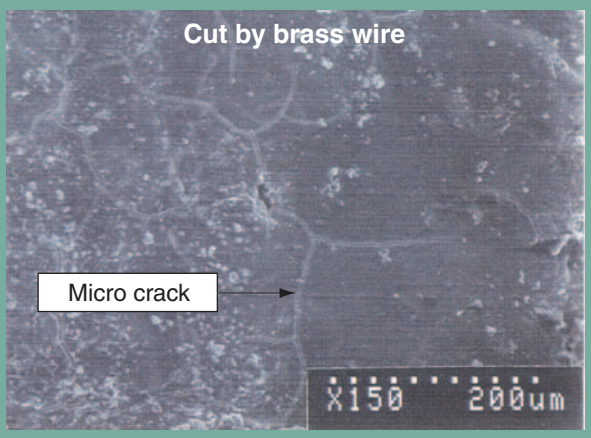
General characteristics of HIH wire

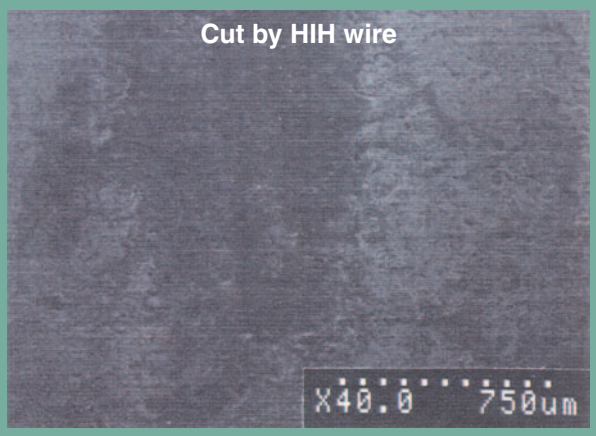
Type	Product name	Size (ϕ mm)	Wire Tolerance (mm)	Tensile strength (MPa)	Tensile strength (kgf/mm²)	Elongation (%)
H (Hard)	IH	0.10～0.30	±0.001	980 over	100 over	0.4 over

Note: 1. Please contact us for the production of special sizes (0.10 mm less, or 0.30 mm over).
2. This wire is manufactured for only H (Hard) type.

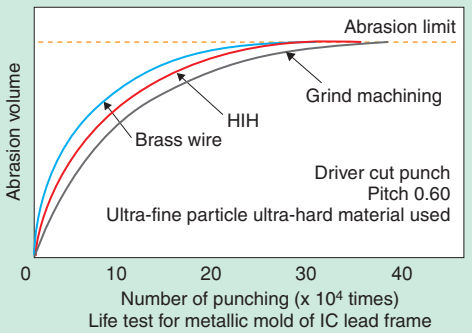
Difference of ultra-hard (Wc-Co) cutting surface

Cutting surface of ultra-hard material (Wc-Co)





Longer life of metallic mold

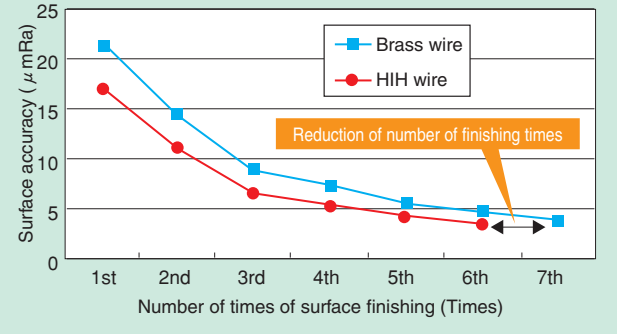


Life test for metallic mold of IC lead frame

The electrical discharge heat caused by cutting is dispersed by the surface coating of zinc. This reduces the heat-affected layer of the cutting surface, thus prolonging the life of the press metallic mold including IC lead frame.

※Especially in ultra-hard machining with general-purpose EDM wire, the hardness of the machining surface will fall and the press life will be shortened by melting of Co (cobalt), which is the binder.

Reduction of finishing times



Conventionally, metallic molds achieved a surface accuracy by performing surface finishing many times. Now, however, it is possible to acquire the same surface accuracy by using HIH wire, while reducing the number of times of surface finishing, thus also reducing the machining time.

※This wire is effective for high-accuracy metallic mold cutting, etc. including plastic molds.

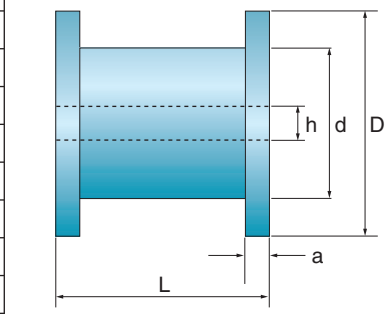
Definition of description of product, others

Product specifications

Product category	Type	Product name	Standard size (ϕ mm)	Wire tolerance (ϕ mm)	Tensile strength (MPa)	Elongation (%)	Conductivity (%)
General-purpose EDM wire	H (hard)	BZ-U	0.10～0.33	±0.001	980 over	0.4 over	20 over
	H (hard)	BZ-MU					
	A (soft)	BZ			445 over	15 over	
Special EDM wire	H (hard)	BZ-B			980 over	0.4 over	20 over
	A (soft)				445 over	15 over	
	H (hard)	TF			980 over	0.4 over	17 over
	A (soft)				445 over	10 over	
	A (ultra-soft)	BZ-AT	0.20～0.30		445 over	30 over	20 over
	H (hard)	1OFC	0.20～0.30		445 over	0.4 over	90 over
	A (soft)				294 over	15 over	
Coated EDM wire	H (hard)	IH	0.20～0.30	±0.001	980 over	0.4 over	20 over

Bobbin name and dimensions

(mm)

Bobbin name	Flange diameter: D	Barrel diameter: d	Outer width: L	Flange thickness: a	Arbor hole diameter: h	Standard winding volume (kg)	Bobbin dimensions
P-1JT	140	70	39	4.5	12.5	1.5	
P-1FT	140	70	39	4.5	46	1.5	
P-3RT	130	80	110	10	20	3	
P-5RT	160	90	114	12	20	5	
P-10TW	200	110	134	12	25	10	
P-15L	250	125	140	15	34	20	
P-30	280	200	220	20	73	30	
P-50	320	162	217	20	34	50	
K-125	125	80	125	12.5	16	3	
K-160	160	100	160	16	22	6	
K-200	200	125	200	20	32	15	

Packaging method

Bobbin name	Standard winding volume (kg)	Boxed number (pcs/box)	Cardboard box size L x W x H (mm)
P-1JT	1.5	10	370×290×200
P-1FT	1.5		
P-3RT	3	6	
P-5RT	5	4	
P-10TW	10	2	300×210×290
P-15L	20	1	
P-30	30		310×250×320
P-50	50		475×325×405
K-125	3	4	370×290×200
K-160	6	2	
K-200	15	1	300×210×290

Specifying description of product

General-purpose EDM wire **Special EDM wire**

□ □□□ □ □□ □□ — □□□

- Bobbin name
- Wire size (Actual diameter x 100)
- Paraffin classification: Indication of (N) for non-paraffin wire
- Product name
- Type

(Example) In case of non-paraffin wire

H | BZ-U | (N) | 2 | 0 | P | — | 5 | R | T

Plated EDM wire

□□□ □ □□ □□ — □□□

- Bobbin name
- Wire size (Actual diameter x 100)
- Paraffin classification: Indication of (N) for non-paraffin wire
- Product name

(Example) In case of HIH20 wire

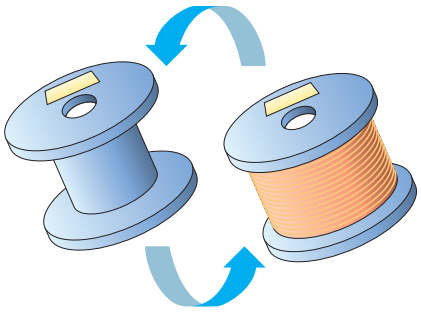
HIH | 2 | 0 | P | — | 5 | R | T

Recycling

The post-use empty bobbins are collected free of charge as part of our environmental protection program for industrial waste reduction, and customer service activities. We encourage you to take advantage of this opportunity.

- We only collect empty bobbins that come from our company.
- We pick up the empty bobbins, that are placed in the some empty cartons in which they were delivered. The empty bobbins are reused, so we ask that you cooperate with the free collection service by keeping the bobbins clean and undamaged.
- Please understand that the contractor collecting the empty bobbins may refuse to take them if they are dirty, damaged, or their storage condition is unacceptable.

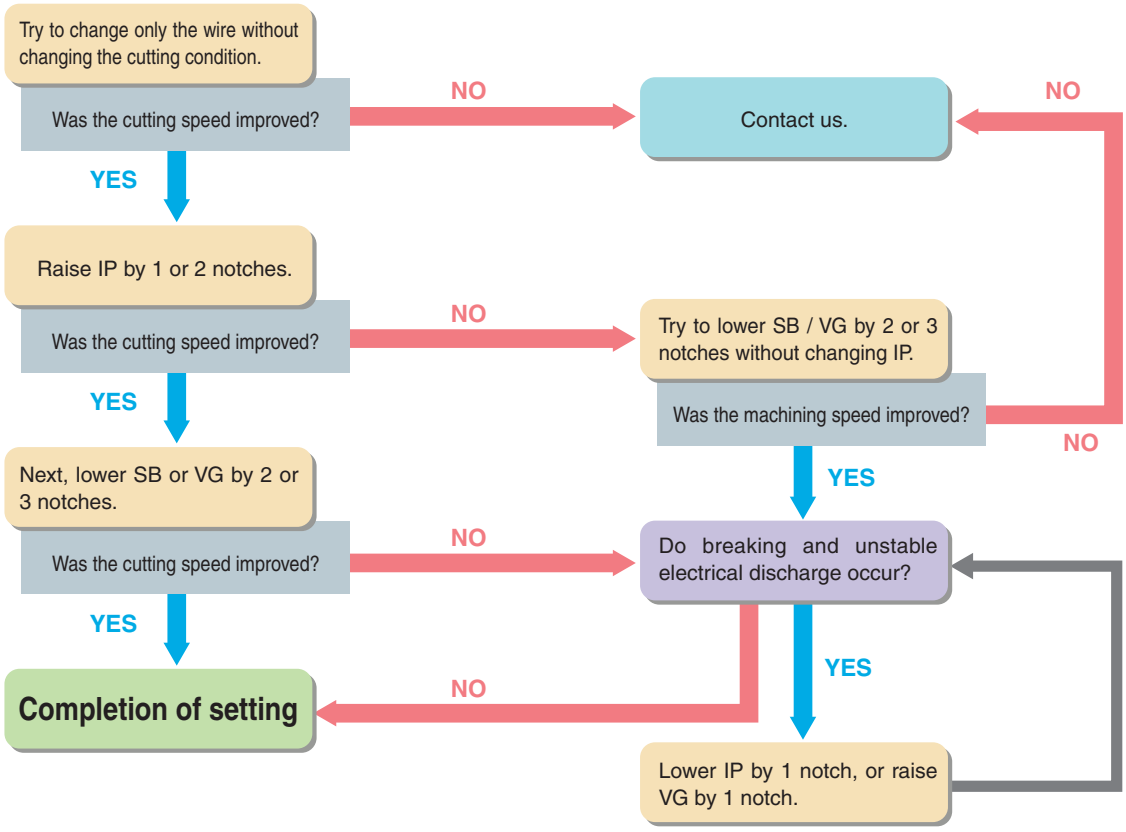
Wound with wire



Bobbin collection (for reuse)

■ Setting cutting conditions (Conditions to improve cutting speed)

(Example) Tuning an EDM machine manufactured by Mitsubishi Electric



[Parameters for EDM machine manufacturers]

EDM machine makers	Discharge energy setting	Off time setting
Agie-Charmilles (formerly Agie)	P, T	TD
Agie-Charmilles (formerly Charmilles)	A, IAL	B, Aj
Seibu	I	OFF
Sodick	IP, ON	MA, OFF
Fanuc	ON	OFF, SV
Makino	Peak current, ON	OFF
Mitsubishi	IP	SB, OFF

●Reference: How much the electrical discharge energy can be raised depends on the material thickness. Good cutting conditions for thick sheet can be obtained by revising the settings as follows.

Material thickness	Setting point
20 mm less	• In general, electrical discharge energy will be weaker for a thinner object. • Since a thin board cannot raise the energy significantly, the increase in speed will be relatively low. • In case of a material thickness of 10 mm or less, the increase of electrical discharge energy is small.
20～60 mm	• If the state of a high-pressure jet stream is good, the cutting efficiency will be improved. • In case of flat plate cutting, the nozzle should be placed as close to it as possible. • Since the discharge of machining sludge improves with the thickness, machining with higher electrical discharge energy will be possible.
60 mm over	• In general, the wire becomes exhausted and breaks more easily with a thicker object. • If the wire speed is raised somewhat, the increase in cutting speed will be greater than expected. • Since the machining of this board thickness may demonstrate a significant difference compared with brass wire machining, please try making significant changes to the conditions.

Note:The setting point is specifically set depending on your processing conditions and other factors, so use this information as a reference for revising the settings to match your conditions. Please contact us if you have any questions.

■ Problems and troubleshooting

Name of trouble	Trouble state	Cause	Check item/Solution
1. Wire breaking	①Breaking around feeding plate	・Feeding plate is in friction	Check feeding plate and replace periodically
		・Water of feeding plate nozzle does not touch feeding plate	Clean nozzle of feeding plate and check water pressure
	②Breaking around wire guide	・Wire guide is dirty	Maintain periodically
		・Holding force on the wire guide is too strong	Adjust holding force optimally
		・Position of wire guide is inaccurate	Reset positioning accuracy
	③Breaking at idling	・Poor wire hooking	Check wire hooking position
		・Wires are crossed (tangle/evasion)	Replacing wire, or off-winding
	④Breaking just after starting machining and within length of 5 mm	・Air bubbles in the machining liquid (air breaking)	Wash for degreasing of material because the cutting condition is too strong
		・Cutting target tilted	Check water pressure of machining liquid
			Start cutting after plumbing
	⑤Breaking after machining of length of over 5 mm	・Pressure of cutting liquid is low	Check for position error of cutting liquid nozzle and abrasion
		・Cutting condition is not adequate	Check for dirt of suction opening of cutting liquid supply tank
		・Presence of foreign matter or a pinhole in material	When cutting a complicated shape, ensure adequate supply of cutting liquid
		・Wire is defective	Replace wires
		・Poor wire run	Check for friction, cracks and dirt on polyurethane rubber roller
			Adjust setting error of wire tension
2. Accuracy error of cutting	①Shape defect	・Insufficient pressure of wire guide and positioning error	Adjust pressure setting of wire guide and position
		・Insufficient wire tension	Ensure proper setting of wire tension
		・Large ambient temperature change	Remove material distortion (stress)
		・Uneven cutting materials	Plumbing error of wire
		・Improper offset	Clean and maintain guide dice, etc.
3. Accuracy error of surface	①Rough surface	・Cutting condition is not adequate (uneven electrical discharge)	Increase wire sending speed
	②Wire mark on cutting surface	・Insufficient wire tension	Increase cutting speed
	③Instability of cutting speed	・Cutting speed is slow	Replace resin ion-exchange and stabilize water ratio resistance
		・Degradation of resin ion-exchange	Clean and maintain the wire run system (guide system)
		・Run-failure	Check for dirty, consumption of electrode and the cleaning and maintenance
		・Friction, crack or contamination of polyurethane roller	
		・Improper wire tension	
4. Cutting speed error	①Cutting speed does not go up	・Cutting condition is not adequate (improper material, board thickness, and size)	Adjust cutting condition by instruction manual Check for position and abrasions of upper and lower nozzles
5. Curl failure	①Wire runs wild in scrap box (forms a permanent wave shape)	・Uneven remnant stress of wire	Try to increase applied current by 1 TAP (higher cutting speed)
		・Uneven abrasion of conveyor roller / belt	Replace it when uneven abrasion exceeds 1/3 of wire diameter
		・Positioning error of conveyor roller / belt	Consult with maintenance contractor of EDM machine
		・Improper pressing force of conveyor roller / belt	Run wire with pressing force suitable for wire used
		・Curly shape of wire	Replace with wire having high degree of straightnes

Name of trouble	Trouble state	Cause	Check item/Solution
6. Failure of automatic threading (insertion failure)	①Automatic insertion is not performed to guidance and lower hole	・Guidance has dirt and blockage	Maintain periodically
		・Lower hole diameter (work side) is too small	Check minimum lower hole diameter of EDM machine
		・Pressure and volume of jet water are declining	Adjust water pressure valve manually
		・Positioning error of upper head and lower hole	Check program and perform central positioning
		・Curly shape of wire	Replace with wire having high degree of straightness
7. Failure of automatic threading (cutting failure)	In case of cutter cutting	・Uneven abrasion and insufficient cutting power of cutter	Replace it if wire mark exists, and check pressing pressure of cutting
	①Cannot cut well	・Rolling up at cutting end of wire	Replace it with new cutter
	②Not inserted into lower hole	・Wire has large carl	Replace with wire having high degree of straightness
	In case of annealed cutting	・Inputting error of wire diameter	Change to material and characteristics of wire recommended by EDM makers
	①Cannot cut well	・Improper wire material	Input wire diameter to be used
	②Cutting position varies	・Wrong wire type	
8. Winding failure (wire evasion)	①Evasion of wire end	・Take wire end away (cause is human factor)	Thoroughly check wire evasion after rewinding
	②No problem during use, but evasion occurs in middle of bobbin 		Customer should thoroughly treat wire end (when setting bobbin to EDM machine)
9. Winding failure (winding loose)	①Winding is loose, and wire has play 	・Wrong adjustment of winding tension (Unstable dancer)	Set it to winding tension of every wire diameter
		・Play due to vibration of rewinding machine	Firmly tighten installation
		・Change of bobbin core with rewinding machine	Check bobbin shape and its setting condition on the rewinding machine
10. Winding failure (uneven winding)	①Uneven winding (uneven) occurs in flange part of bobbin 	・Wrong adjustment of traverser of rewinding machine	Adjust traverser, and check periodically when rewinding
		・Deformation of bobbin	Change return control motor
			Bring traverse pulley as close to winding middle diameter as possible
			Check bobbin shape

■ Optimization of cutting condition (Example) In case of an EDM machine manufactured by Mitsubishi

[Case of rough cutting (1st cut)]

Problems	Countermeasures	When not using PM control
Frequent wire breakage during 1st cut Frequent short circuit during 1st cut Cutting speed is slow during 1st cut	Use PM control	①Raise SE by 1 notch ②Lower SA by 1 notch ①Raise VG by 2 to 8 notches ②Raise SE by 1 notch ①Lower SB by 1 to 3 notches ②Lower VG by 2 to 5 notches ③Lower IP by 1 notch
Wire breaks in guide pipe	①Lower WT by 1 or 2 notches ②Contact the service engineer	

[How to change cutting conditions]

In case of cutting SKD-11, 60 t with ϕ0.2 wire ＊This is a reference table. [AE: 21 notches, SE: 1 notch used]

Types of material / Setup condition		Standard value	Adjustment value						
		SKD-11 (quenching)	NAK/ HPM®	SK-3/ S45C	Stainless steel	Aluminum	Copper	Tungsten carbide copper tungsten	Graphite
Voltage open	Vo (Notch)	12	0	0	0	0	0	0	+4
Power setting	IP (Notch)	9	0	-1	0	0	-1	-1	-2
Off time	OFF(Notch)	1	0	0	0	0	0	0	0
Stabilizer A	SA (Notch)	3	0	0	0	0	0	0	-2
Stabilizer B	SB (Notch)	10	+2	+2	+2	+3	0	0	+4
Wire tension	WT (Notch)	8	0	0	0	0	0	0	-1
Voltage gap	VG (V)	39	0	0	+2	0	+8	+5	+15
Actual cutting speed	FA (%)	100	90	85	85	200	85	50	40

Types of material / Setup condition		Standard value	Adjustment value						
		SKD-11 (quenching)	Upper or lower nozzle separated	Both nozzle separated	Stepped workpiece	Taper 3 degrees	Taper 5 degrees	Taper 10 degrees	Taper 15 degrees
Voltage open	Vo (Notch)	12	0	0	0	0	0	0	0
Power setting	IP (Notch)	9	-1	-1	-2	0	0	-2	-2
Off time	OFF(Notch)	1	0	0	0	0	0	0	0
Stabilizer A	SA (Notch)	3	0	0	0	0	0	0	-1
Stabilizer B	SB (Notch)	10	+2	+2	-1	+2	+2	+3	+3
Wire tension	WT (Notch)	8	0	0	0	-1	-1	-2	-3
Voltage gap	VG (V)	39	0	+4	+4	0	+5	+5	+10
Actual cutting speed	FA (%)	100	80	60	60	90	85	70	50

＊Wire breakage can be reduced by raising the SE notch from 1→2→3→4→5.

■ Optimization of cutting condition (Example) In case of an EDM machine manufactured by Mitsubishi

[Improvement of cutting precision] (For punch shape)

●Center is concave		①Raise 2nd cutting speed	(Lower 2nd SB by 1 to 4 notches) (Lower 2nd Vo by 1 to 2 notches) (Lower 2nd VG by 2 to 5 notches)
●Shape is concave and there is a difference in upper / lower dimensions		①Raise 2nd cutting speed ②Raise wire feeding speed	(Same as above) (Raise WS by 2 to 4 notches)
●There is a difference in upper / lower dimensions		①Raise wire feeding speed ②Increase approach amount to 1st to 2nd	(Raise WS by 2 to 4 notches) (Raise by 2 to 7 μm)
●Bullet shaped and there is a difference in upper / lower dimensions		①Decrease approach amount to 1st to 2nd	(Raise by 2 to 10 μm)
●Center is swollen		①Lower 2nd cutting speed	(Lower 2nd VG by 2 to 5 notches) (Lower 2nd SB by 1 to 3 notches)

[When lines are formed on cutting surface]

[When short circuit occurs] →
①Decrease approach amount between Ip:4 and Ip:3 by 1 to 5 μm
②Raise VG of Ip:4 by 1 to 5 notches
③Raise V_0 of Ip:4 by 2 to 4 notches
④Perform the "Plus-One" cutting (see the following item)

[When FC=0 occurs] →
①Lower VG of cutting condition where FC=0 occurs by 3 to 8 notches
②Decrease the approach amount between 1st to 2nd by 5 to 10 μm

＊During thick plate (60 mm or more) cutting with the upper / lower nozzles separated, set the dielectric fluid flow rate for the 2nd and following cuts to 1.5 to 2.0 L. (to prevent short circuits and speed drop at IP:3 or less)

[Points for finish cutting (Point to check during cutting)]

Cutting speed falls compared with [1st] standard cutting	When slow →	· Raise Ip by 1 notch · Raise SB by 1 to 2 notches
Optimal [2nd] cutting speed is 1.5 to 2.3 times of FA	When slow →	· Raise Vo by 1 to 2 notches · Lower SB by 1 to 4 notches
Optimal [3rd] cutting speed is 2.0 to 2.5 times of FA Ip:3 (Stable when cutting voltage V is VG +3 to +15 V)	When slow →	· Raise Vo by 2 to 4 notches · Lower VG by 2 to 5 notches
Optimal [4th] cutting speed is 2.0 to 2.5 times of FA Ip:2 (Stable when cutting voltage V is VG +5 to +15 V)	When slow →	· Raise Vo by 2 to 4 notches · Lower VG by 2 to 5 notches

＊When cutting speed is too high, take opposite measures to the above.

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