XEBEC Back Burr Cutter & Path™

Instruction Manual
For Combined Lathe

Table of Contents

Thank you for your purchase of XEBEC Technology "XEBEC Back Burr Cutter & Path".
Before use, please be sure to read the contents of this manual carefully and use the product correctly.
After reading, store in a safe place that is readily available for reference by the operator.

SAFETY PRECAUTIONS

Be sure to read.

The meanings of the indications and symbols related to matters which must be observed in order to ensure the safety of this product are as explained below.
Be sure to observe the contents of this manual.
Using the product in a way that is not consistent with the contents of this manual may result in serious injury or death.

⚠WARNING — **WARNING indicates a hazardous situation which, if not avoided, could result in death or serious injury**

NOTICE — **NOTICE is used to address practices not related to physical injury**

Symbols

⚠ **This is the safety alert symbol. It is used to alert you to potential physical injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.**

Operator Safety Protection

⚠WARNING

- **Check that the Cutter is free of any abnormalities before using it.**
  If there is chipping, significant wear, or other Cutter abnormality, there is the risk that it may be damaged and pieces may fly off during use.
- **<u>DO NOT</u> touch the Cutter while it is rotating.**
  Before rotating the Cutter, be sure to close the equipment door and take other necessary action.
- **If oscillation or other abnormality occurs during use, discontinue use immediately.**
  This is dangerous and there is the risk of Cutter falling off, breaking, or rupturing.
- **Use protective gloves and other protective gear when touching the Cutter.**
  There is a risk of injury and burns if the Cutter blade is touched with bare hands.

⚠ Use of protective equipment

Wear personal protective gear including goggles, masks, gloves, and earmuffs to prevent loss of sight, injury, or lung damage caused by damaged parts flying off the product.
Wear clothing with long sleeves or other clothing that does not expose the skin, and fasten the cuffs and hems tightly.

⚠ Precaution regarding cutting particles

Fragments, cutting particles, and other substances generated during work will be scattered into the surrounding area. Be sure to use a dust collector or other means to collect them.

⚠ Attention to the work area

- Install an enclosure so that persons other than the operator do not enter the work area, and ensure that all persons, if any, in the work area are wearing protective equipment.
- In particular be careful that children do not enter the work area.
- Keep the floor of the work area clean at all times to prevent the risk of slipping or tripping on dust, cutting particles, oil, water, or other substance.
- There is the risk of fire caused by heating, sparks, or other factor resulting from use of the product. Do not use the product close to a flammable liquid or in an explosive atmosphere. Also be sure to enact fire prevention measures.

SAFETY PRECAUTIONS

Be sure to read.

Setup and installation

⚠WARNING

- **Be sure to check the dimensions prior to use.**
  There is the risk of injury or burns if a person touches the Cutter blade directly with a hand.
- **During use, the workpiece must be fastened securely to the machine tool or jig so that it does not move.**
  If the workpiece moves during machining, there is the risk of damage to the Cutter or flying pieces of the workpiece.
- **Before performing actual machining, use no-load running, machining simulation software, or other means to check the operation until it is confirmed that there are no errors in the Path.**
  If there is an error in the Path, there is the risk of damage to the Cutter or workpiece.
- **Before use, the point group data of the Path set the tool geometry offset using the axis center and tip of the Cutter.**
  Use of a Path with tool geometry offset that does not use the axis center and tip of the Cutter is dangerous and there is the risk of Cutter breakage or machine accident.
- **Perform positioning correctly to minimize the accumulative error in the position and size of each hole.**
  There is the risk of breakage caused by interference with the Cutter head. In particular, set tool geometry offset using the center and tip of the Cutter.
  If you continue to use the product exceeding the accumulative error allowance, the Cutter may break.
- **When installing onto the milling holder, make the runout 0.01 mm or less.**
  If runout is large when the tool is installed, there is the risk of chipping and breakage when the tool starts rotating and when it cuts into the workpiece.
- **Use the incremental command mode to use the point group data.**
  Use point group data with the correct command type for the product type you are using. Unexpected operation of the machine may result in damage to the product, jig, and machine.

NOTICE

If you continue to use the product exceeding the accumulative error allowance, there may be a deterioration in the quality of the edge after removing burrs.

SAFETY PRECAUTIONS

Be sure to read.

Pre-work inspection

⚠WARNING

- **Select and use a coolant/cutting fluid that is suitable for the purpose.**
  Depending on the type of coolant/cutting fluid, there is the risk of fire caused by overheating, sparks, or other problem.If heating or sparks are expected, be sure to implement fire prevention measures.

NOTICE

- **Check in advance that the Cutter shank and milling holder do not contact the workpiece or other objects.**
  Select and install a Cutter with consideration for the movement path of this product.
- **If the product will be used for wet machining, adjust so that the coolant/cutting fluid properly contacts the blade tip.**
  If the amount of coolant/cutting fluid contacting the tip is not sufficient, the blade tip temperature will rise and its tool life may be shortened.
- **Suppress the size of burrs occurring at the previous machining process as small as possible.**
  If the burr root thickness from the previous process is larger than the depth of cut set in the Path, there is the risk that burrs will not be fully removed.

Precautions for use

⚠WARNING

- **DO NOT use at the excessive rotational speed.**
  The rotational speed for this product varies depending on the Cutter size. If used at excessive rotational speed, there is the risk of Cutter chipping or breakage.
- **DO NOT use the product rotating in the reverse direction.**
  This product is ordinarily used rotating clockwise. Using the product rotating counterclockwise is dangerous and the Cutter is certain to be damaged when it cuts into the workpiece.
- **DO NOT use this product with manual tools or similar equipment.**
  This product is a dedicated tool for use only with numerical control processing machines. Using the product with a manual tool or similar equipment is dangerous and there is the risk of injury resulting from damage to the Cutter.
- **DO NOT use this product for any purpose other than deburring or chamfering.**
  This product was designed for workpiece deburring and chamfering. If it is used for curved face machining or other machining which it was not designed for, there is the risk that the Cutter will be unable to withstand the load and will break.

NOTICE

- **If the location of deburring has an intermittent shape, check the condition of the Cutter blade carefully.**
  If there is a notch or other intermittent shape at the location of deburring, chipping of the blade will be more likely, and depending on the depth of cut the Cutter tool life may be significantly reduced.

Regular maintenance

- When changing the Cutter, remove any dirt from the tool holder grip and Cutter shank, and keep these parts clean.

Product overview

The XEBEC Back Burr Cutter and XEBEC Path for Back Burr Cutter are a dedicated cutter and dedicated path specifically for the purpose of removing burrs at crossing edges that are produced by hole drilling.

Notes when using the XEBEC Path for Back Burr Cutter

The XEBEC Path for Back Burr Cutter may be used only by those customers who at the time of purchase agreed to the terms of use. These terms prohibit use with any equipment other than the XEBEC Back Burr Cutter, and also prohibit the transfer or provision of the generated paths to another company.

Be sure to observe these terms of use.

Product contents

This product is composed of the following parts. Please check the product contents at the time of purchase.

- XEBEC Back Burr Cutter

- XEBEC Path for Back Burr Cutter (Delivery with data. Indicated in this manual as “XEBEC Back Burr Path”.)
- Path code sheet

Features

XEBEC Back Burr Cutter

- **Use of micro-grain cemented carbide**
  Higher cutting ability and longer tool life
- **Use of highly heat resistant AlTiCrN coating**
  Allows the product to be used with aluminum and other non-ferrous metals, as well as titanium, inconel, and other hard-to-cut material.
- **Optimal blade shape for deburring**
  A helical Cutter is used for better cutting performance and fewer secondary burrs.
- **Long under-head length**
  The regular type has an under-head length that is 5 times the spherical diameter, while the straight type has a length that is 15 times. This allows back deburring of deep holes.

XEBEC Back Burr Path

- **Generation of the optimal machining paths for deburring**
  Machining with the optimal cutting for 3D free curved surface edges suppresses the occurrence of secondary burrs. The best depth of cut for the designated cutting width is calculated to produce an uniform machining shape.
- **Capable of deburring a variety of deburring holes including orthogonal cross holes, off-center cross holes, and flat surface cross holes.**
  With orthogonal cross holes and off-center cross holes (examples: P6, Figure 2), a Path is generated that can deburr cross holes at the parts indicated by the red lines, which were previously difficult to deburr.
- **Longer tool life for lower running costs**
  The optimal machining path reduces the amount of cutting, reducing wear caused by heating. Machining is performed while changing the point that contacts the workpiece, extending the Cutter tool life.
- **Fast deburring with contour machining operation**
  Can complete deburring in 1/5 - 1/10 the machining time required with a spring-type deburring tool.
- **Can perform deburring at multiple locations with a single direction approach.**
  Thanks to the long under-head length, a Path is generated which allows 1 Cutter to deburr multiple locations with an approach from a single direction.

Supported machine tools

When machining with a XEBEC Path for Back Burr Cutter for XZY axes, use an NC lathe that has milling functionality that enables simultaneous 3 axis control of the XZY axes. When machining with a XEBEC Path for Back Burr Cutter for XZC axes, use an NC lathe that has milling functionality that enables simultaneous 3 axis control of the XZC axes and that permits commands for polar coordinate interpolation functionality.

Axial orientations compatible with XEBEC Back Burr Paths

As indicated in Figure 1, axis configuration are required that are able to insert the Cutter in the X direction for XZY axes and in the Z direction for XZC axes.

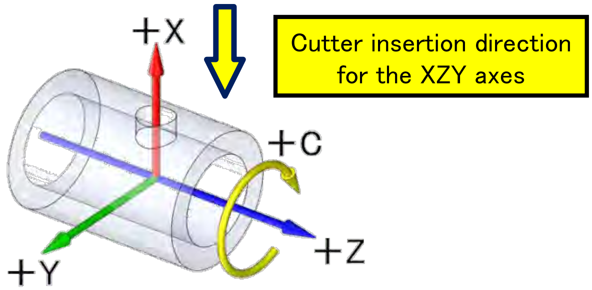


Figure 1-1

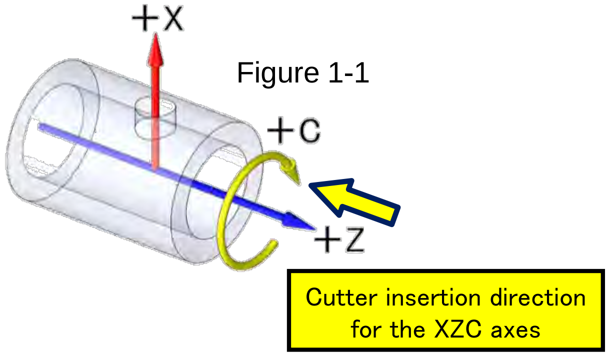
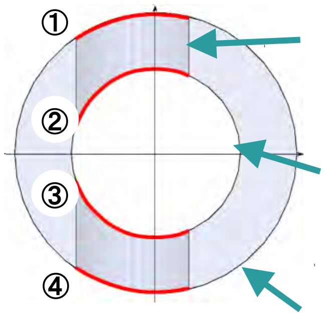


Figure 1-2

Deburring locations

The red lines in Figures 2 is example of the deburring locations.



Cross hole
A hole that crosses the main bore.
Main bore
A hole drilled from the end face of a workpiece. (A hole whose hole axis is parallel to the Z-axis.)
Outer diameter
Outer diameter of the workpiece whose axis center is Z-axis and its inner diameter.

Figure 2

[Note]
Depending on the combination of holes, there is the possibility that a Path cannot be generated. For the restricting conditions and precautions, check the “Path Code Sheet” that was provided at the time of the order.

XEBEC Back Burr Cutter specifications

[Regular type] [Straight type]

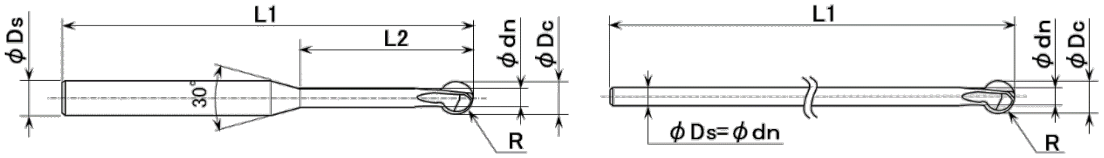


Figure 3

	Product code	Cutter radius R (mm)	Cutter diameter øDc (mm)	Head diameter ødn (mm)	Under-head length L2 (mm)	Full length L1 (mm)	Shank diameter øDs (mm)
Regular	**XC-08-A**	0.4	0.8	0.48	5	60	3
	XC-13-A	0.65	1.3	0.78	8	60	3
	XC-18-A	0.9	1.8	1.1	10	60	3
	XC-23-A	1.15	2.3	1.4	12.5	70	3
	XC-28-A	1.4	2.8	1.7	15	70	4
	XC-33-A	1.65	3.3	2.0	17.5	70	4
	XC-38-A	1.9	3.8	2.4	20	70	4
	XC-48-A	2.4	4.8	3.0	25	70	6
	XC-58-A	2.9	5.8	3.5	30	70	6
	XC-78-A	3.9	7.8	4.7	40	100	8
	XC-98-A	4.9	9.8	5.9	50	120	10
Straight	**XC-18-B**	0.9	1.8	1.1	-	50	1.1
	XC-23-B	1.15	2.3	1.4	-	60	1.4
	XC-28-B	1.4	2.8	1.7	-	70	1.7
	XC-33-B	1.65	3.3	2.0	-	80	2.0
	XC-38-B	1.9	3.8	2.4	-	85	2.4
	XC-48-B	2.4	4.8	3.0	-	105	3.0
	XC-58-B	2.9	5.8	3.5	-	120	3.5

Cautions regarding the settings for the XEBEC Back Burr Cutter

1. If machining is performed using the wrong size Cutter, considering the interference between the tool, workpiece, jig, and chuck, there is a risk of damage to the product, jig, and machine, so make sure you check the dimensions before use.
2. When installing the Cutter on a milling holder, set the appropriate projection for the location to be machined.
3. Secure the Cutter firmly in the milling holder so that it does not move during use.
4. After attaching the Cutter to the milling holder, confirm that the runout of the Cutter is 0.01 mm or less.
5. Point group data is calculated using the center and tip of the Cutter, so tool geometry offset should be set on the center and tip of the Cutter. (Refer to "Set position for tool geometry offset" on page 11)
6. There is a danger that there will be interference with the Cutter head, so care should be taken when positioning so that there is minimal accumulative error with the main bore and outer diameter, and the position and hole diameter of the cross hole.

XEBEC Back Burr Cutter standard machining conditions

				Aluminum alloy		Carbon steel	
	Product code	Cutter diameter øDc (mm)	Projection (mm)	Rotational speed n (min^{-1})	Feedrate Vf (mm/min)	Rotational speed n (min^{-1})	Feedrate Vf (mm/min)
Regular	XC-08-A	0.8	5Dc	48000	1600	43000	1300
	XC-13-A	1.3	5Dc	33000	1100	27000	800
	XC-18-A	1.8	5Dc	23000	800	19500	580
	XC-23-A	2.3	5Dc	18000	975	15000	750
	XC-28-A	2.8	5Dc	15000	1400	12500	1000
	XC-33-A	3.3	5Dc	12720	1270	10600	1060
	XC-38-A	3.8	5Dc	11000	1600	9200	1200
	XC-48-A	4.8	5Dc	8000	1600	7200	1100
	XC-58-A	5.8	5Dc	7000	1200	6000	900
	XC-78-A	7.8	5Dc	5400	1620	4500	1350
	XC-98-A	9.8	5Dc	4320	1300	3600	1080

- Rotational speed and feedrate are a guide for initial machining.
- To improve the machining conditions, take steps such as adjusting the rotational speed and feedrate, or changing to a Path with a different deburring amount.
- If oscillation or noise occurs, or if the rotational speed or feedrate does not satisfy the value in the standard machining conditions table, lower the rotational speed and feedrate by the same proportional amount.
- When machining with a XEBEC Back Burr Path for XZC axes, pay attention to the units used in commands for feedrate to be used. As the machining with the XZC axes is done in the polar coordinate interpolation mode, feedrate command includes feedrate of both the rotating axis and the straight axis (° /min).
  Convert feedrate of the straight axis (mm/min) to a feedrate that includes the rotating axis and the straight axis (° /min).
- Depending on the type of cross hole, care needs to be taken with the setting conditions, so refer to the pages for start points for the type of intersecting edge used in "Machining edge variation" (page 14).
- It is possible to reduce machining shape error by using functions such as advanced preview control.

POINT **Setting processing conditions**

Secondary burrs may occur depending on the state of the intersecting edges. Keep the tool projection as short as possible, set feedrate to 50% of the standard condition, and try starting from a small deburring amount.

XEBEC Back Burr Cutter standard machining conditions

				Aluminum alloy		Carbon steel	
	Product code	Cutter diameter øDc (mm)	Projection (mm)	Rotational speed n (min^{-1})	Feedrate Vf (mm/min)	Rotational speed n (min^{-1})	Feedrate Vf (mm/min)
Straight	XC-18-B	1.8	6Dc	9700	**480**	9700	**480**
			10Dc	4400	**220**	4400	**220**
			15Dc	2200	**110**	2200	**110**
	XC-23-B	2.3	6Dc	7900	**480**	7900	**480**
			10Dc	3500	**220**	3500	**220**
			15Dc	2200	**110**	2200	**110**
	XC-28-B	2.8	6Dc	6200	**620**	6200	**620**
			10Dc	2800	**220**	2800	**220**
			15Dc	2200	**110**	2200	**110**
	XC-33-B	3.3	6Dc	5400	**460**	5400	**460**
			10Dc	2400	**190**	2400	**190**
			15Dc	1900	**95**	1900	**95**
	XC-38-B	3.8	6Dc	4600	**460**	4600	**460**
			10Dc	2000	**160**	2000	**160**
			15Dc	1600	**80**	1600	**80**
	XC-48-B	4.8	6Dc	3600	**360**	3600	**360**
			10Dc	1600	**120**	1600	**120**
			15Dc	1300	**60**	1300	**60**
	XC-58-B	5.8	6Dc	3000	**300**	3000	**300**
			10Dc	1300	**100**	1300	**100**
			15Dc	1000	**50**	1000	**50**

- Rotational speed and feedrate are a guide for initial machining.
- To improve the machining conditions, take steps such as adjusting the rotational speed and feedrate, or changing to a Path with a different deburring amount.
- If oscillation or noise occurs, or if the rotational speed or feedrate does not satisfy the value in the standard machining conditions table, lower the rotational speed and feedrate by the same proportional amount.
- When machining with a XEBEC Back Burr Path for XZC axes, pay attention to the units used in commands for feedrate to be used. As the machining with the XZC axes is done in the polar coordinate interpolation mode, feedrate command includes feedrate of both the rotating axis and the straight axis (°　/min).
  Convert feedrate of the straight axis (mm/min) to a feedrate that includes the rotating axis and the straight axis (°　/min).
- Depending on the type of cross hole, care needs to be taken with the setting conditions, so refer to the pages for start points for the type of intersecting edge used in "Machining edge variation" (page 14).
- It is possible to reduce machining shape error by using functions such as advanced preview control.

POINT **Setting processing conditions**

Secondary burrs may occur depending on the state of the intersecting edges. Keep the tool projection as short as possible, set feedrate to 50% of the standard condition, and try starting from a small deburring amount.

Configuration of folders and point group data

XEBEC Back Burr Path is contained as shown in Figure 4, and the stored data is divided into a folder hierarchy.

- **First level**
  - Folder for each machining edge
- **Second level**
  - Incremental command data (INC)
  - Down cut machining (Down Cut)
  - Up cut machining (Up Cut)
- **Third level**
  - 5 types of deburring amount (Edge Break Amount) data
    □□_Edge Break Amount_ □□
- **Point group data**

Data information is indicated at the start
The deburring hole information and Path information are provided as comments in ( ).
Check that the XEBEC Back Burr Path point group data is correct for the purpose of use.

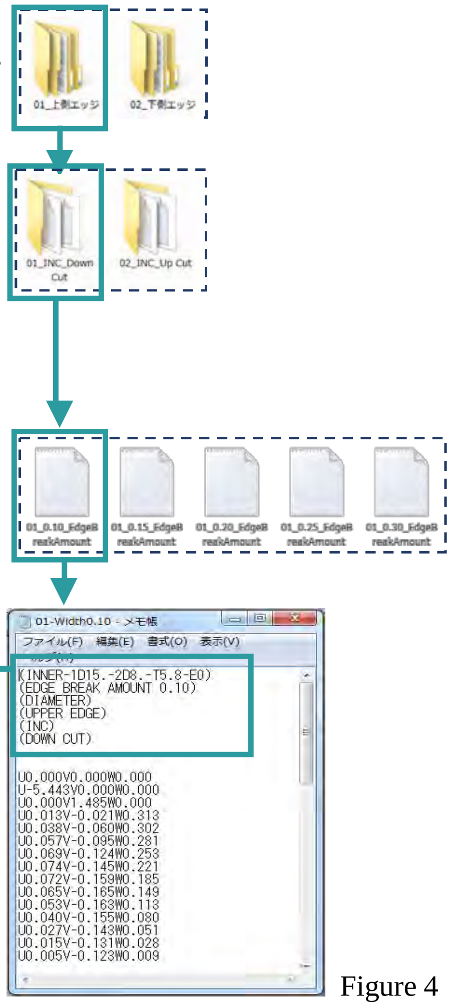


Figure 4

Data example

For example, for an inner diameter edge there are a total of 20 data types (2 types x 2 types x 1 type x 5 types).

- **First level** (2 types)
  Upper edge and lower edge
- **Second level** (2 types x 1 type)
  Up cut and down cut data
- **Third level** (5 types)
  5 types of individual deburring amount data

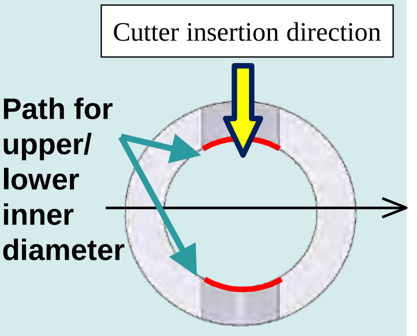


Figure 5

[Notice]
Depending on the edge type, only the upper edge data may be provided.
In this case, 10 data types are provided.

Comment examples

Orthogonal cross hole and off-center cross hole for XZY paths

```
(INNER-1D20-2D10-T5.8-E5);
(EDGE BREAK AMOUNT 0.10);
(DIAMETR);
(UPPER EDGE);
(INC) ;
(DOWN CUT);
```

Orthogonal cross hole for XZC paths

```
(INNER-1D20-2D10-T5.8-E5);
(EDGE BREAK AMOUNT 0.10);
(DIAMETR);
(UPPER EDGE);
(INC) ;
(DOWN CUT);
```

Explanation

INNER	: Inner edge deburring [OUTER: Outer edge deburring]
1D20	: Main bore or outer diameter ϕ20
2D10	: Cross hole diameter ϕ10
T5.8	: Cutter size ϕ5.8
E5	: Amount of shift The cross hole is off-center from the main bore or outer diameter by 5 mm
EDGE BREAK AMOUNT	: Deburring amount
DIAMETER	: Diameter mode [RADIUS: Radius mode]
UPPER EDGE	: Upper edge [LOWER: lower edge]
INC	: Incremental data
DOWN CUT	: Down cut deburring [UP CUT: Up cut deburring]

[Notice]
Other variations of XZY and XZC axes paths also conform to these comments.

Set position for tool geometry offset

The point group data for the XEBEC Back Burr Path is calculated using the center and tip of the tool. Set tool geometry offset for the XEBEC Back Burr Cutter using the center and tip of the Cutter so that it is as shown on the OK side in Figure 6.

NOTICE

Set the Path point group data using the tip of the Cutter.
Use of a path with tool length offset that does not use the tip of the Cutter is dangerous and there is the risk of Cutter breakage or machine accident.

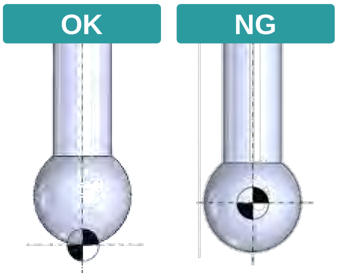


Figure 6

Accumulative error

The 5 deburring amounts (Figure 7: Surface width after burr removal by the Cutter) that are provided with XEBEC Back Burr Path must be selected with consideration for the accumulative error from previous machining.
Use a deburring amount Path that is suitable for the processing accuracy of the workpiece hole diameter, hole position, and other dimensions.

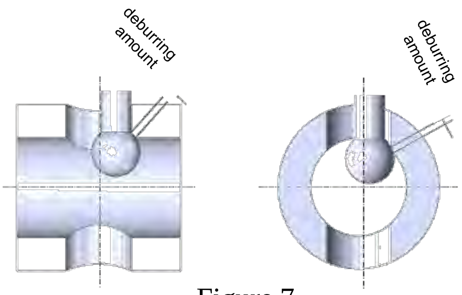


Figure 7

- If the Cutter does not contact the edge due to machining variation of hole position or excessive hole size, check using a Path with a larger deburring amount.
- If the deburring amount is too large because the actual dimension (diameter) of the machined hole is small, check using a Path with a smaller deburring amount.

Product code	Cutter diameter Dc (mm)	Deburring amount / Edge Break Amount (mm)					Allowable accumulative error (mm)
		①	②	③	④	⑤	
XC-08-A	0.8	0.02	0.04	0.06	0.08	0.10	**0.03**
XC-13-A	1.3	0.04	0.06	0.08	0.10	0.12	**0.05**
XC-18-A, XC-18-B	1.8	0.07	0.09	0.11	0.13	0.15	**0.08**
XC-23-A, XC-23-B	2.3	0.07	0.09	0.11	0.13	0.15	**0.09**
XC-28-A, XC-28-B	2.8	0.08	0.11	0.14	0.17	0.20	**0.10**
XC-33-A, XC-33-B	3.3	0.08	0.11	0.14	0.17	0.20	**0.11**
XC-38-A, XC-38-B	3.8	0.09	0.13	0.17	0.21	0.25	**0.12**
XC-48-A, XC-48-B	4.8	0.10	0.15	0.20	0.25	0.30	**0.15**
XC-58-A, XC-58-B	5.8	0.10	0.15	0.20	0.25	0.30	**0.18**
XC-78-A	7.8	0.10	0.15	0.20	0.25	0.30	**0.24**
XC-98-A	9.8	0.10	0.15	0.20	0.25	0.30	**0.34**

About the start points

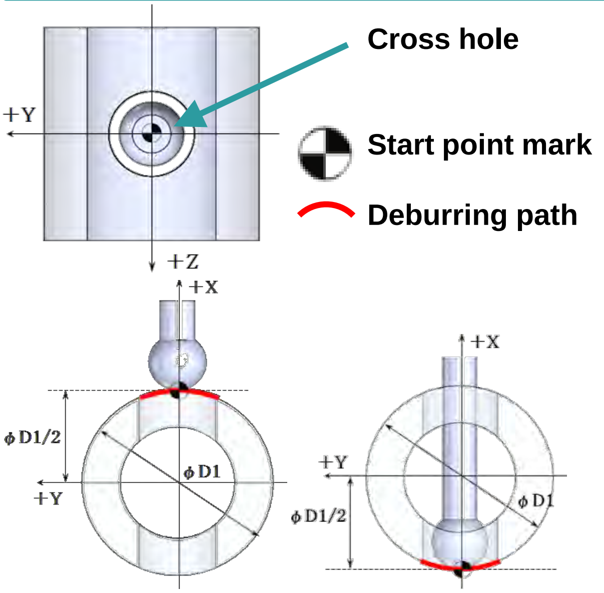
“Start point” refers to the machining start position where the Cutter is operated correctly based on the point group data in the XEBEC Back Burr Path. In the main program for machining the product, position the XEBEC Back Burr Cutter axis center and tip of XEBEC Back Burr Cutter at the start point in advance, and then immediately execute the XEBEC Back Burr Path.
When commanding the program, use command values suited to the controlling mode (diameter mode or radius mode) of the machine being used.

An example of the start point for outer diameter edge deburring for the XZY axes is shown below. (Figure 8: Example of orthogonal cross hole, Figure 9: Example of off-center cross hole)
For start points on other intersecting edges, refer to pages 14 and later.

POINT

The YZ axes start points is the coordinate of the center of the cross hole.
The X axis start points is the positions indicated in figures 8 and 9.

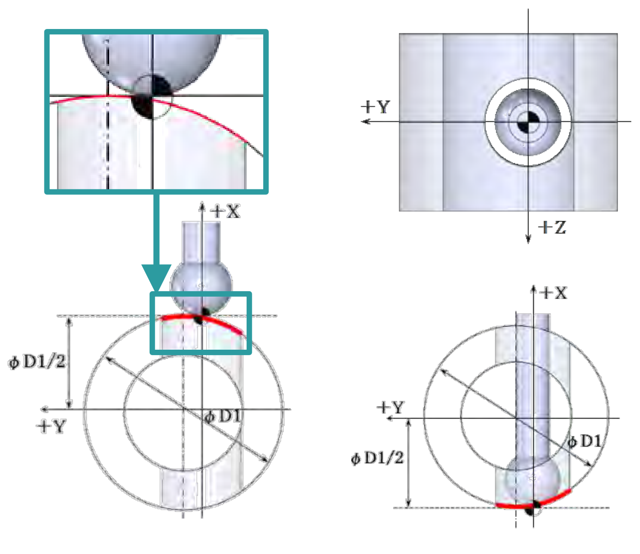
Example of orthogonal cross hole



Upper edge Lower edge

Figure 8

Example of off-center cross hole



Upper edge Lower edge

Figure 9

Procedure for implementing programs into the machine (Paths for the XZY axes)

The following is an example of incorporating the XEBEC Back Burr Path into the machining program. The control device conforms to the MELDAS system. Adjust the G codes and other details in the program to match the numerical control machine tool that is used.

Machining contents

- **Workpiece shape**
  Outer diameter φ30 x Inner diameter φ20
- **Previous machining**
  Drill a φ10 hole that is concentrically orthogonal to the material cylindrical axis.
- **Deburring locations**
  Use XEBEC Back Burr Cutter & Path to perform deburring of the edges (upper and lower) where the φ10 hole and φ20 inner diameter cross.

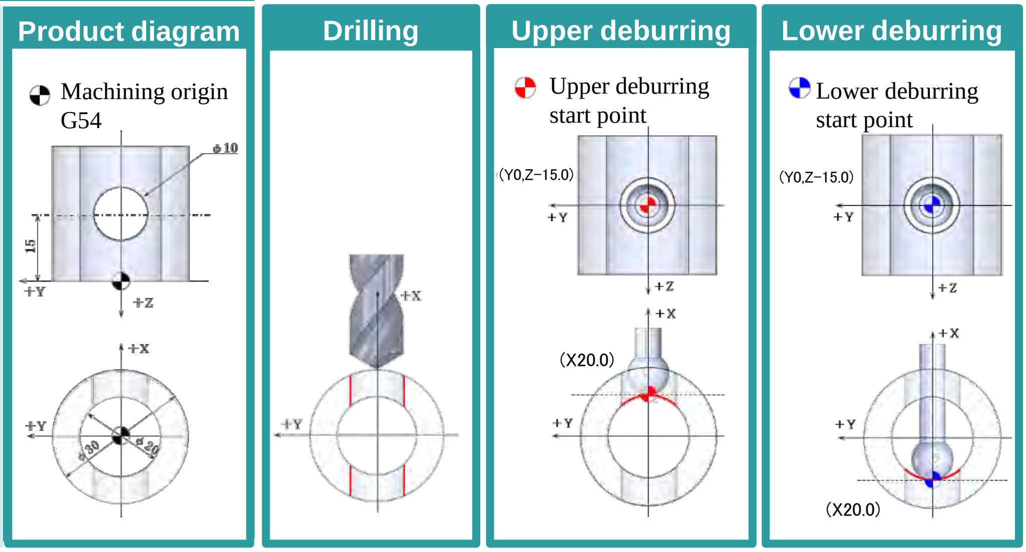


Figure 10

Program overview

Main program

```
O0001(MAIN PROG);
G0G18; ..XZ flat surface selection
N1(10DRILL/T1H1); ..φ10 drill machining process
M05;
M69; ..Main spindle unclamp
G98M45; .. Feed per minute and C axis engage
G00G28H0.0; .. C-axis 1st origin return
G28V0.0; .. Y-axis 1st origin return
G00T0101; .. Call T01 drill tool and No.1 tool offset
G54X40.0Z50.0C0.0; .. Select of G54 origin zero point and decide phase C0
G97S5000M13; .. Forward rotation of milling tool
Z-15.0Y0.0M08; .. Position ZY axes at center of hole
M68; .. Main spindle clamp
G83X-40.0R-2.0F500; .. Side spot drilling cycle G83
G80; .. Cancel drill cycle
G00X40.0Z50.0M69; .. Main spindle unclamp
G28U0.0W0.0M05; .. XZ axes 1st origin return
M09;
M01;

N2(5.8BURRS CUTTER/T0202); .. Back deburring process
M05;
M69; .. Main spindle unclamp
G98M45; .. Feed per minute and C axis engage
G00G28H0.0; .. C-axis 1st origin return
G28V0.0; .. Y-axis 1st origin return
G00T0202; .. Call T02 XEBEC Back Burr Cutter and No.2 tool offset
G54X40.0Z50.0C0.0; .. Select of G54 origin zero point and decide phase C0
G97S6000M13; .. Forward rotation of milling tool
Z-15.0Y0.0M08; .. Position upper deburring path start point on ZY axes
M68; .. Main spindle clamp
G01X20.0F3000; .. Position upper deburring path start point on X axis
F1000; .. Specify deburring feedrate
M98P0002; .. Call sub program O0002 (XEBEC Back Burr Path)
G01Z-15.0Y0.0F3000; .. Position lower deburring path start point on ZY axes
X-20.0; .. Position lower deburring path start point on X axis
F1000; .. Specify deburring feedrate
M98P0003; .. Call sub program O0003 (XEBEC Back Burr Path)
G00X40.0;
Z50.0M69; .. Main spindle unclamp
G28U0.0W0.0M05; .. XZ axes 1st origin return
M09;
M01;
M30;.. Machining end
```

Upper deburring sub program

```
O0002 (UPPER EDGE SUB PROG);
U0.000V0.000W0.000;
U−11.293V0.000W0.000;
U0.000V2.564W0.000;
U0.017V−0.027W0.434;
U0.046V−0.077W0.409;

U−0.072V0.126W0.390;
U−0.048V0.080W0.419;
U−0.017V0.028W0.442;
U0.000V−2.564W0.000;
U11.293V0.000W0.000;
M99; ..Return to main program
```

(Back Burr Path point group data)

Lower deburring sub program

```
O0003 (LOWER EDGE SUB PROG);
U0.000V0.000W0.000;
U−0.307V0.000W0.000;
U0.000V2.564W0.000;
U−0.017V−0.027W0.434;
U−0.046V−0.077W0.409;

U0.072V0.126W0.390;
U0.048V0.080W0.419;
U0.017V0.028W0.442;
U0.000V−2.564W0.000;
U0.307V0.000W0.000;
M99; ..Return to main program
```

(Back Burr Path point group data)

[Notice]

- When commanding the program, use command values suited to the controlling mode (diameter mode or radius mode) of the machine being used.
- The method for incorporating is also the same for XZC axis paths, but polar coordinate interpolation enable/disable commands should be placed before and after the Back Burr Path commands.

Examples of machining edge start points

Machining edge variation

For the machining edges (types) that are used, refer to the Path Code Sheet.

Type	Name	Specification	Corresponding edge(s)	Machine axes	Interpolation functionality	Reference destination
AY	Orthogonal cross hole: Outer diameter (Cross hole < Outer diameter)	On-/Off-Center	Upper/ lower	XZY	—	Page 15
BY	Orthogonal cross hole: Inner diameter (Cross hole ≤ Main bore)	On-/Off-Center	Upper/ lower	XZY	—	Page 16
CY	Flat surface hole	—	Back/front	XZY	—	Page 17
GY	Slotted hole parallel to main bore axis: Outer diameter	On-/Off-Center	Upper	XZY	—	Page 18
HY	Slotted hole parallel to main bore axis: Inner diameter	On-/Off-Center	Upper	XZY	—	Page 18
IY	Slotted hole perpendicular to main bore axis: Outer diameter	—	Upper	XZY	—	Page 19
JY	Slotted hole perpendicular to main bore axis: Inner diameter	On-/Off-Center	Upper	XZY	—	Page 19
KY	Orthogonal cross hole: Inner diameter (Cross hole > Main bore)	On-/Off-Center	Front/rear	XZY	—	Page 20
LY	Broken hole: Inner diameter (Cross hole ≤ Main bore)	Off-Center	—	XZY	—	Page 21
MY	Broken hole: Inner diameter (Cross hole > Main bore)	Off-Center	—	XZY	—	Page 22
AC	Orthogonal cross hole: Outer diameter (Cross hole < Outer diameter)	On-/Off-Center	Upper	XZC	Polar coordinate interpolation	Page 23
BC	Orthogonal cross hole: Inner diameter (Cross hole ≤ Main bore)	On-/Off-Center	Upper	XZC	Polar coordinate interpolation	Page 24
CC	Flat surface hole	—	Front/back	XZC	Polar coordinate interpolation	Page 25
GC	Slotted hole parallel to main bore axis: Outer diameter	—	Upper	XZC	Polar coordinate interpolation	Page 26
HC	Slotted hole parallel to main bore axis: Inner diameter	On-/Off-Center	Upper	XZC	Polar coordinate interpolation	Page 26
KC	Orthogonal cross hole: Inner diameter (Cross hole > Main bore)	On-/Off-Center	Upper/ lower	XZC	Polar coordinate interpolation	Page 27

[Notice]
Machining in the polar coordinate interpolation mode means synchronizing the 3 XZC axes and machining curved shapes.
After rotating the rotary tool, submit the G12.1 (G112) command to switch to the polar coordinate interpolation mode (this G code conforms with the MELDAS control device).
During the polar coordinate interpolation mode, it is possible to slowly rotate the main spindle (rotation of the C axis) and synchronize feeding of the X and Z axes of the tool.

● XEBEC Back Burr Path for Tapped Hole

Type	Name	Specification	Corresponding edge(s)	Machine axes	Interpolation functionality	Reference destination
PY	Orthogonal cross hole: Inner diameter (Cross hole ≤ Main bore)	On-/Off-Center	Upper	XZY	—	Page 28
QY	Flat surface cross hole	—	Back	XZY	—	Page 29
QC	Flat surface cross hole	—	Back	XZC	—	Page 30

Type AY: Orthogonal cross hole: Outer diameter for XZY paths (Cross hole < Outer diameter)

An example of the start point is shown below. (Figure 11: Example of on-center cross hole; Figure 12: Example of off-center cross hole)
The start point YZ coordinates are in the center of the cross hole. The X coordinate is shown in the diagram.

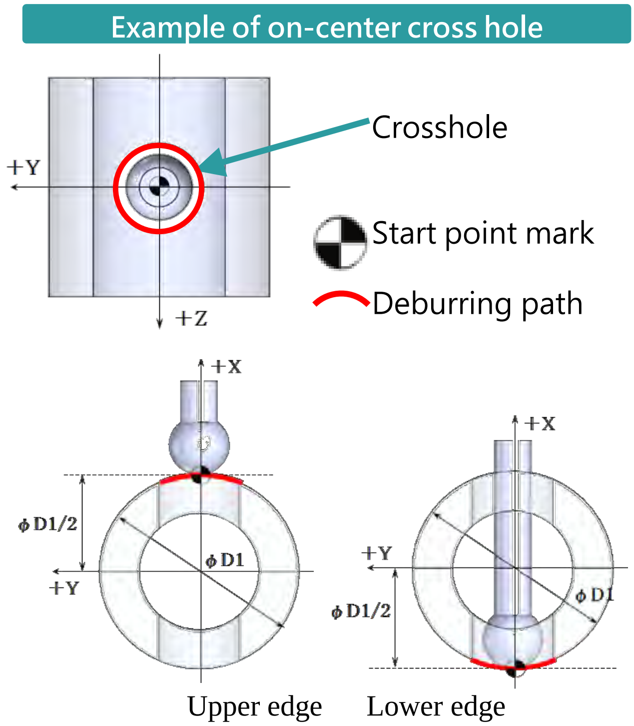


Figure 11

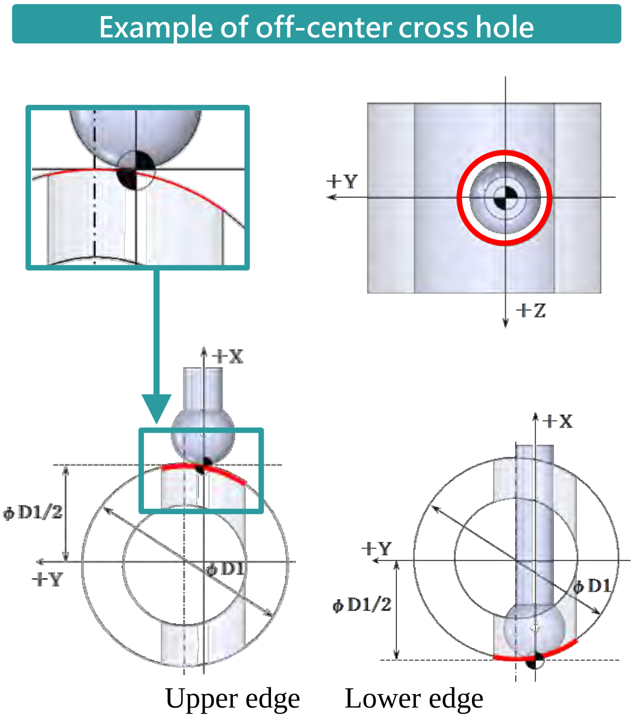


Figure 12

Type BY: Orthogonal cross hole: Inner diameter for XZY paths (Cross hole ≤ Main bore)

An example of the start point is shown below. (Figure 13: Example of on-center cross hole; Figure 14: Example of off-center cross hole)
The start point YZ coordinates are in the center of the cross hole. The X coordinate is shown in the diagram.

Example of on-center cross hole

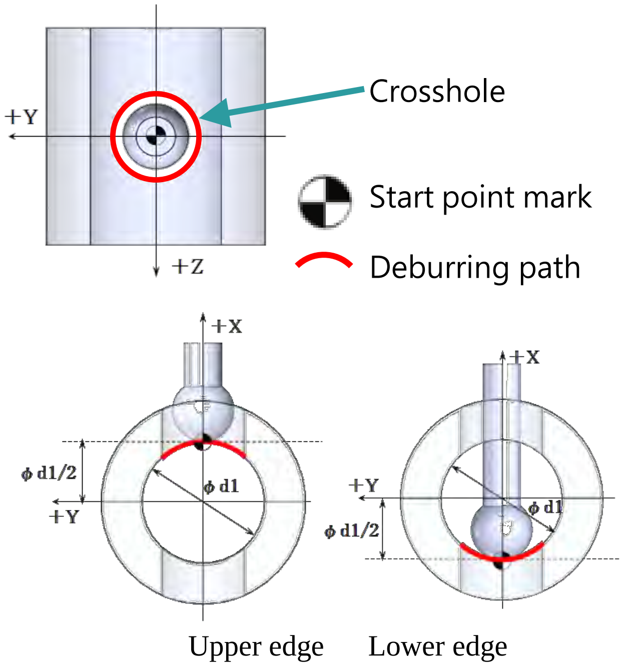


Figure 13

Example of off-center cross hole

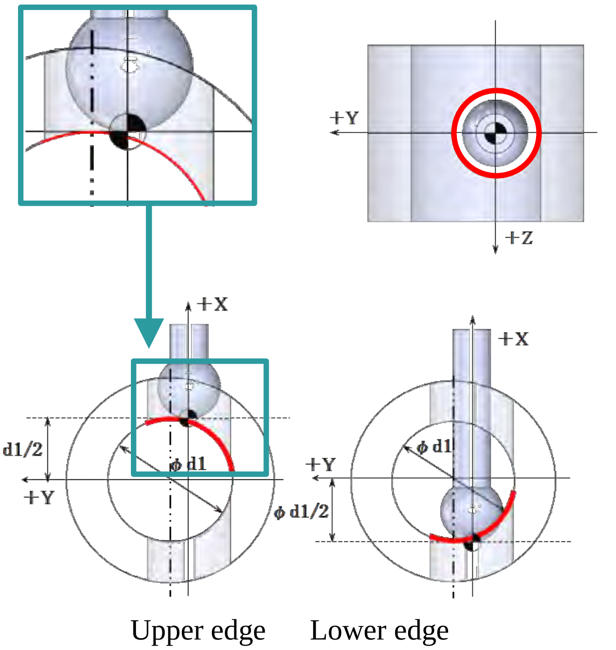


Figure 14

Type CY: Flat surface hole with Back and Front for XZY paths

An example of the start point is shown below. (Figure 15: Example of flat surface hole: Front/Back)
The start point YZ coordinates are in the center of the cross hole. The X coordinates are the positions on the surfaces shown in the diagram for front and back.

Example of flat surface hole: Front/Back

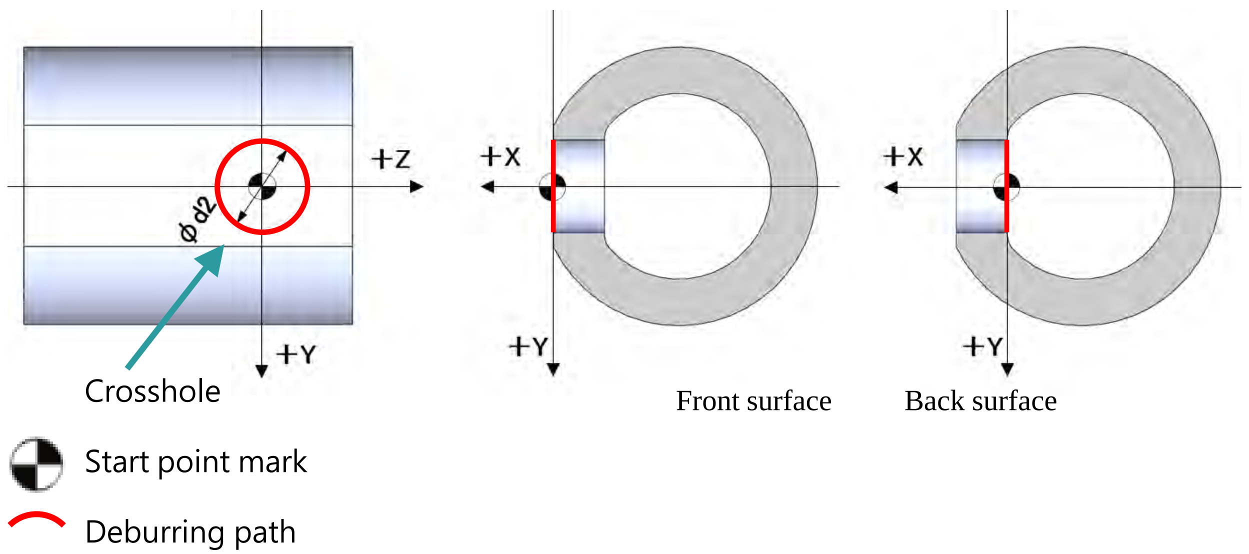


Figure 15

Type GY/HY: Slotted hole parallel to main bore axis:
Outer diameter (GY) and Inner diameter (HY) for XZY paths

An example of the start point is shown below. (Figure 16: Example of slotted hole parallel to main bore axis, outer diameter and inner diameter)
The start point YZ coordinates are in the R center position on the -Z side of the slotted hole. The X coordinates are as shown in the following diagram.

Example of slotted hole parallel to main bore axis, outer diameter and inner diameter

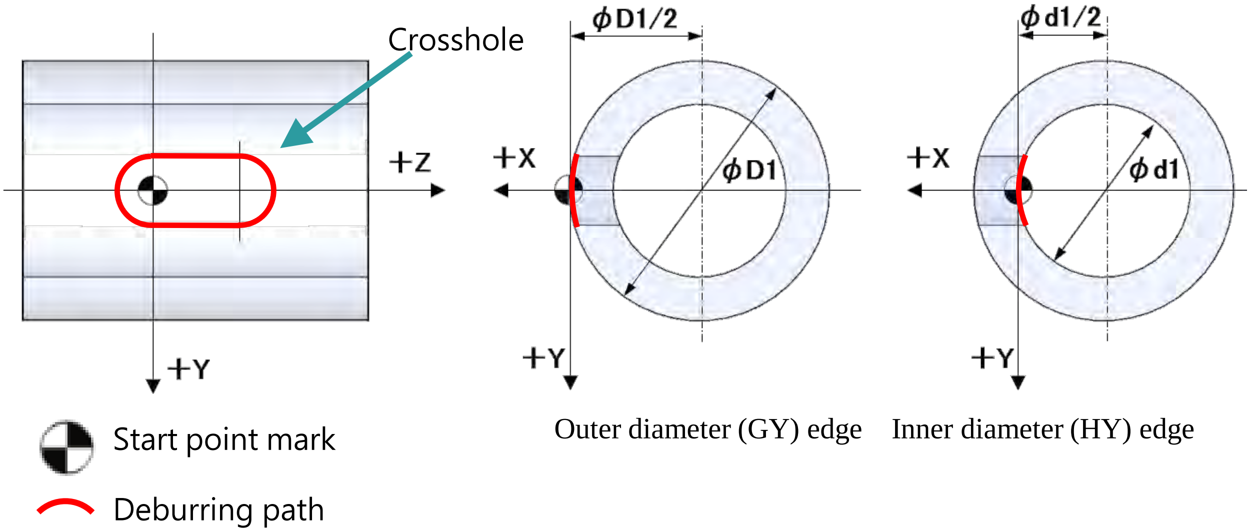


Figure 16

Type IY/JY: Slotted hole perpendicular to main bore axis: Outer diameter (IY) and Inner diameter (JY) for XZY paths

An example of the start point is shown below. (Figure 17: Example of slotted hole perpendicular to main bore axis, outer diameter and inner diameter)
The start point YZ coordinates are in the R center position on the +Y side of the slotted hole. The X coordinates are as shown in the following diagram.

Example of slotted hole perpendicular to main bore axis, outer diameter and inner diameter

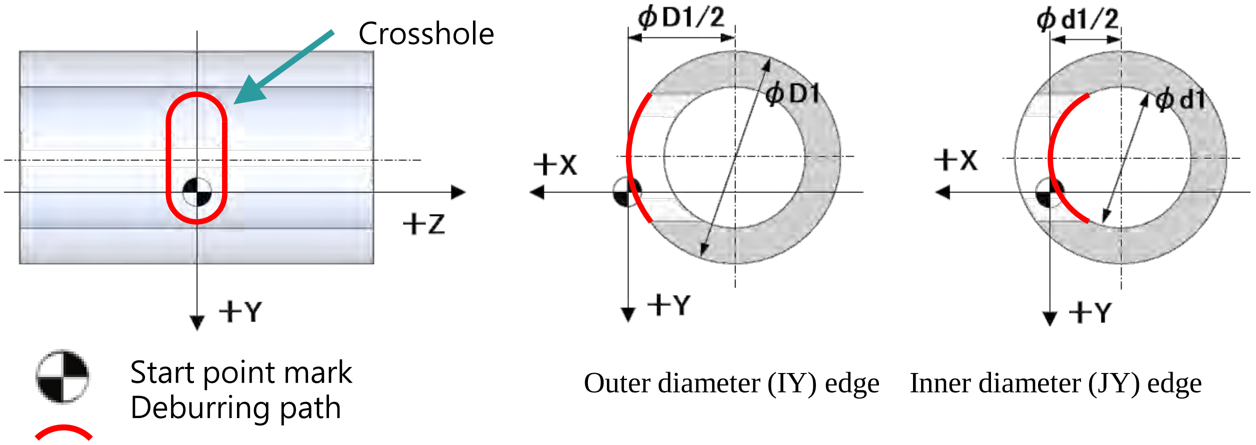


Figure 17

Type KY: Orthogonal cross hole: Inner diameter (Cross hole> Main bore) for XZY paths

An example of the start point is shown below. (Figure 18: Example of orthogonal cross hole, inner diameter (Cross hole > Main bore))
The start point YZ coordinates are in the center of the cross hole. The X coordinate is shown in the following diagram.

Example of orthogonal cross hole, inner diameter (cross hole> main bore)

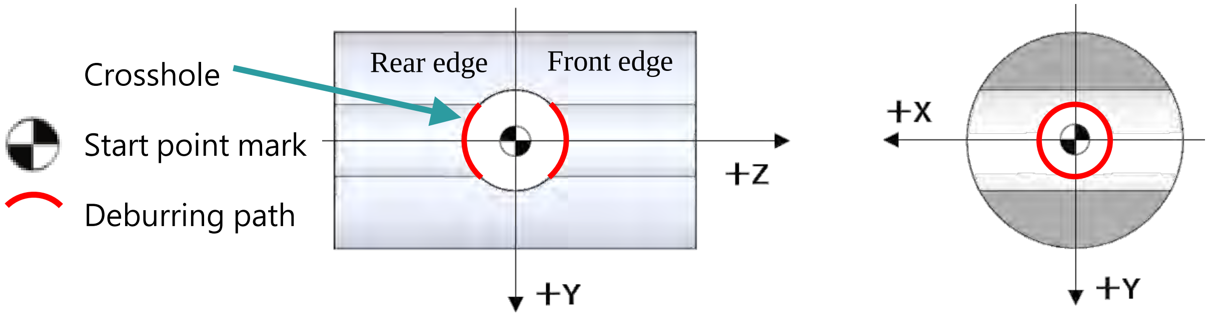


Figure 18

Type LY: Broken hole: Inner diameter (Cross hole ≤ Main bore) for XZY paths

An example of the start point is shown below. (Figure 19: Example of broken hole: Inner diameter (Cross hole ≤ Main bore))
The start point YZ coordinates are in the center of the cross hole. The X coordinate is shown in the following diagram.

Example of broken hole: Inner diameter (Cross hole ≤ Main bore)

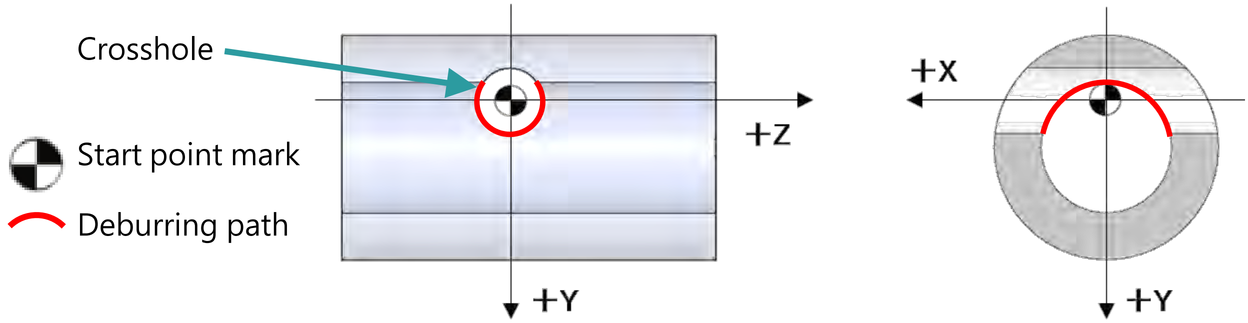


Figure 19

Type MY: Broken hole: Inner diameter (Cross hole > Main bore) for XZY paths

An example of the start point is shown below. (Figure 20: Example of broken hole: Inner diameter (Cross hole> Main bore))
The start point YZ coordinates are in the center of the cross hole. The X coordinate is shown in the following diagram.

Example of broken hole: Inner diameter (Cross hole> Main bore)

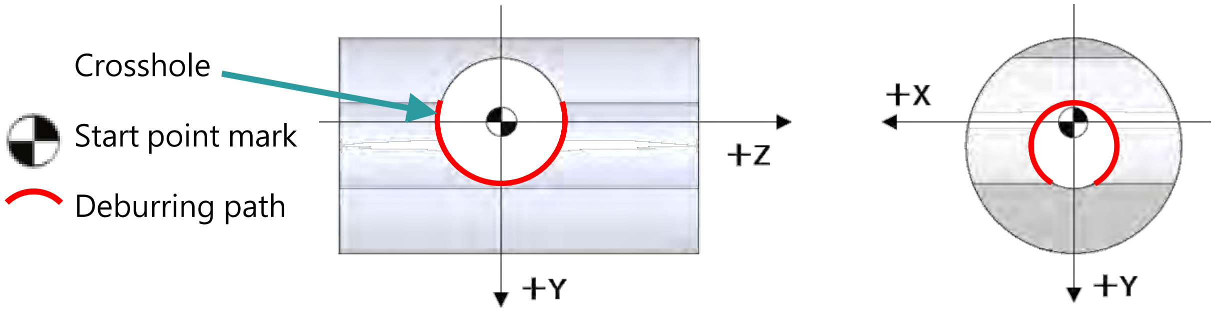
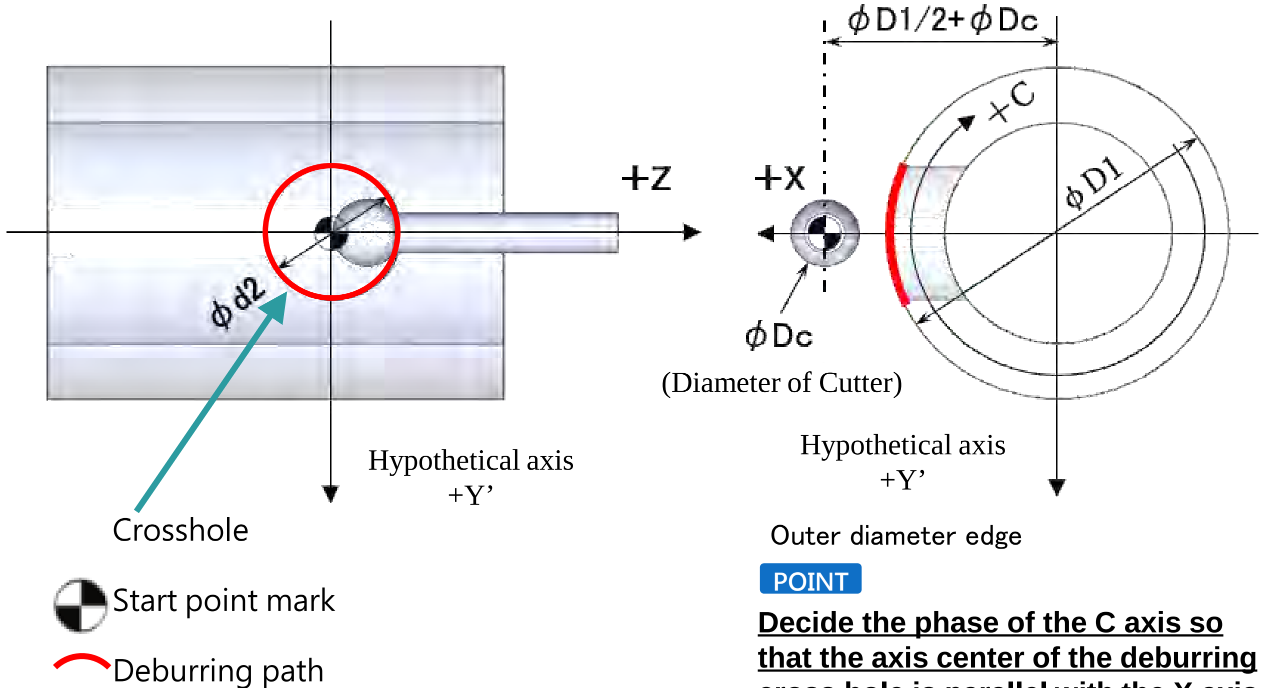


Figure 20

Type AC: Orthogonal cross hole: Outer diameter for XZC paths (Cross hole < Outer diameter)

An example of the start point is shown below. (Figure 21: Example of orthogonal cross hole, Outer diameter (Cross hole < Outer diameter))
The start point X coordinate is shown in the following diagram. The Z coordinate is the position where the tip of the Cutter is oriented on the central coordinate of the cross hole.
Also decide the phase of the C axis so that the axis center of the deburring cross hole is parallel with the X axis and in the X+ region.
For machining with a path for XZC axes, enable the polar coordinate interpolation mode.

Example of orthogonal cross hole, Outer diameter (Cross hole < Outer diameter)



POINT

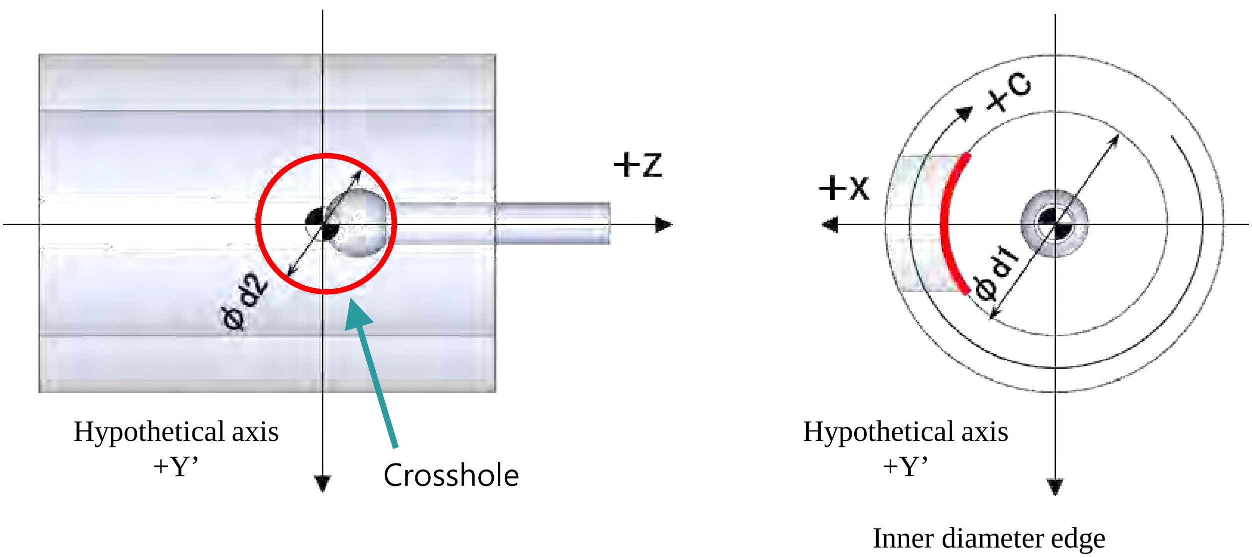
Decide the phase of the C axis so that the axis center of the deburring cross hole is parallel with the X axis and the location to be machined faces toward the plus X axis.

Figure 21

Type BC: Orthogonal cross hole: Inner diameter for XZC paths (Cross hole ≤ Main bore)

An example of the start point is shown below. (Figure 22: Example of orthogonal cross hole, inner diameter (cross hole ≤ main bore))
The start point X coordinate is shown in the following diagram. The Z coordinate is the position where the tip of the Cutter is oriented on the central coordinate of the cross hole. Also decide the phase of the C axis so that the axis center of the deburring cross hole is parallel with the X axis and in the X+ region.
<u>For machining with a path for XZC axes, enable the polar coordinate interpolation mode.</u>

Example of orthogonal cross hole, Inner diameter (Cross hole ≤ Main bore)



POINT

<u>Decide the phase of the C axis so that the axis center of the deburring cross hole is parallel with the X axis and the location to be machined faces toward the plus X axis.</u>

Figure 22

Examples of machining edge start points (continued)

Type CC: Flat surface hole with Back and Front for XZC paths

An example of the start point is shown below. (Figure 23: Example of flat surface hole)
The start point XC coordinate is the center position of the main bore. The Z coordinate is the position where the tip of the Cutter is oriented on the coordinate of the end face to be deburred.

Example of flat surface hole

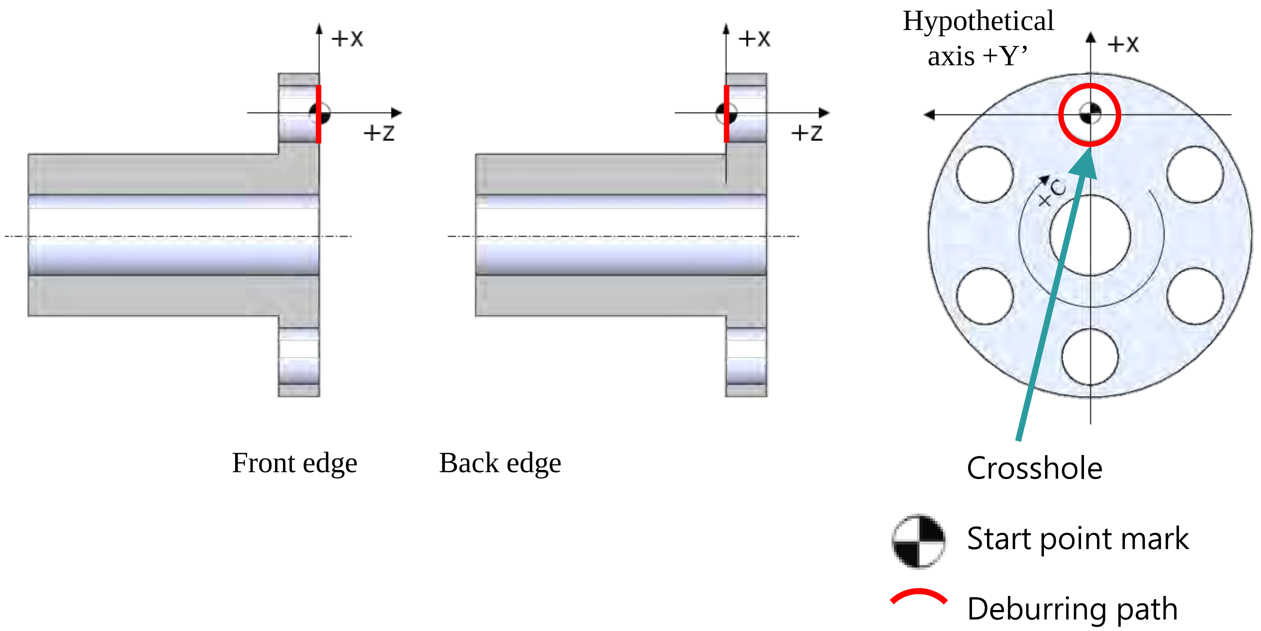


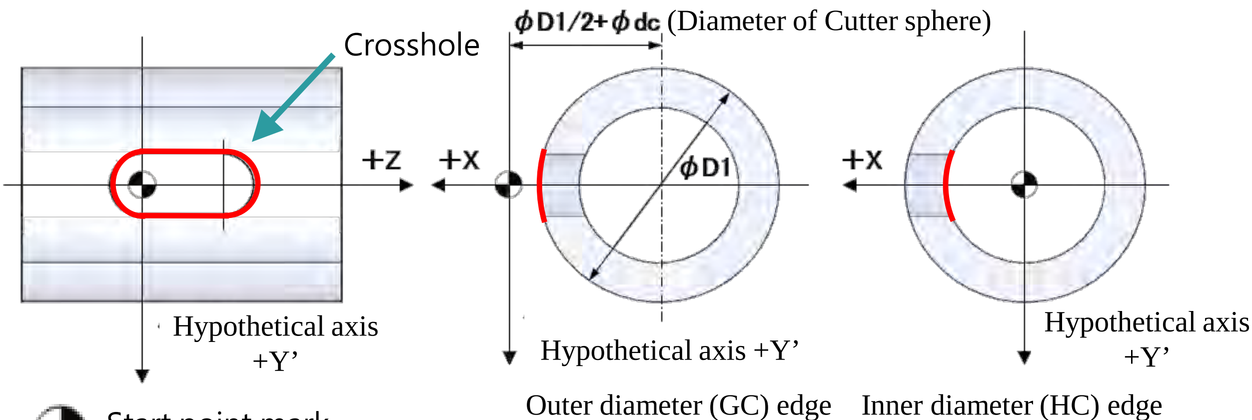
Figure 23

Type GC/HC: Slotted hole parallel to main bore axis, Outer diameter (GC) and Inner diameter (HC) for XZC paths

An example of the start point is shown below. (Figure 24: Example of slotted hole parallel to main bore axis, outer diameter and inner diameter off-center elongated hole)

The start point X coordinate is shown in the following diagram. The Z coordinate is the R center position on the -Z side of the slotted hole. Also decide the phase of the C axis so that the axis center of the deburring cross hole is parallel with the X axis and so that the location to be machined is in the X axis+ region.

Example of slotted hole parallel to main bore axis, outer diameter and inner diameter



Start point mark

Deburring path

POINT

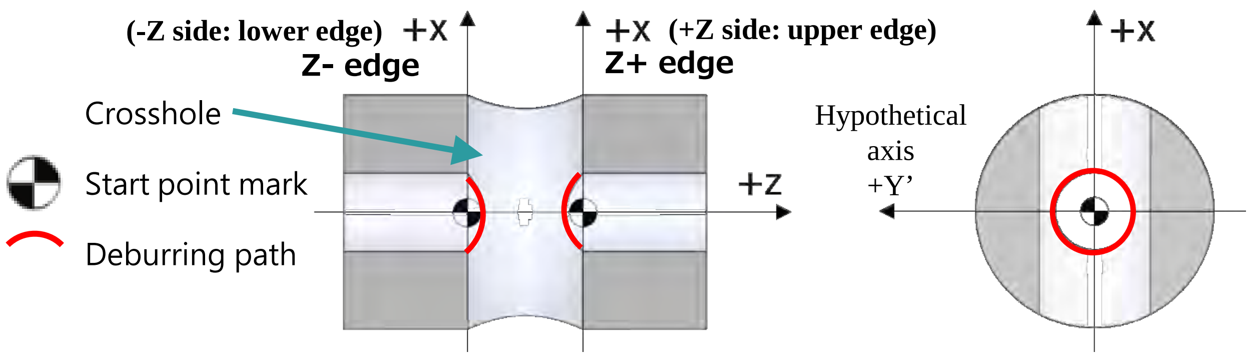
Decide the phase of the C axis so that the axis center of the deburring cross hole is parallel with the X axis and the location to be machined faces toward the plus X axis.

Figure 24

Type KC: Orthogonal cross hole: Inner diameter (Cross hole > Main bore) for XZC paths

An example of the start point is shown below. (Figure 25: Example of orthogonal cross hole, inner diameter (Cross hole > Main bore))
The start point X coordinate is in the center of the main bore. The Z coordinate is shown in the following diagram. Also decide the phase of the C axis so that the axis center of the cross hole is parallel with the X axis.

Example of orthogonal cross hole, inner diameter (cross hole> main bore)



POINT

Decide the C axis phase so that the axis center of the cross hole is parallel with the X axis.

Figure 25

Type PY: Orthogonal cross hole: Inner diameter (Cross hole ≤ Main bore)

An example of the start point is shown below. (Figure 26: Example of orthogonal cross hole, inner diameter (Cross hole ≤ Main bore))
The start point Y/Z coordinates are in the center of the cross hole. The X coordinate is shown in the diagram.

Example of orthogonal cross hole, inner diameter (cross hole ≤ main bore)

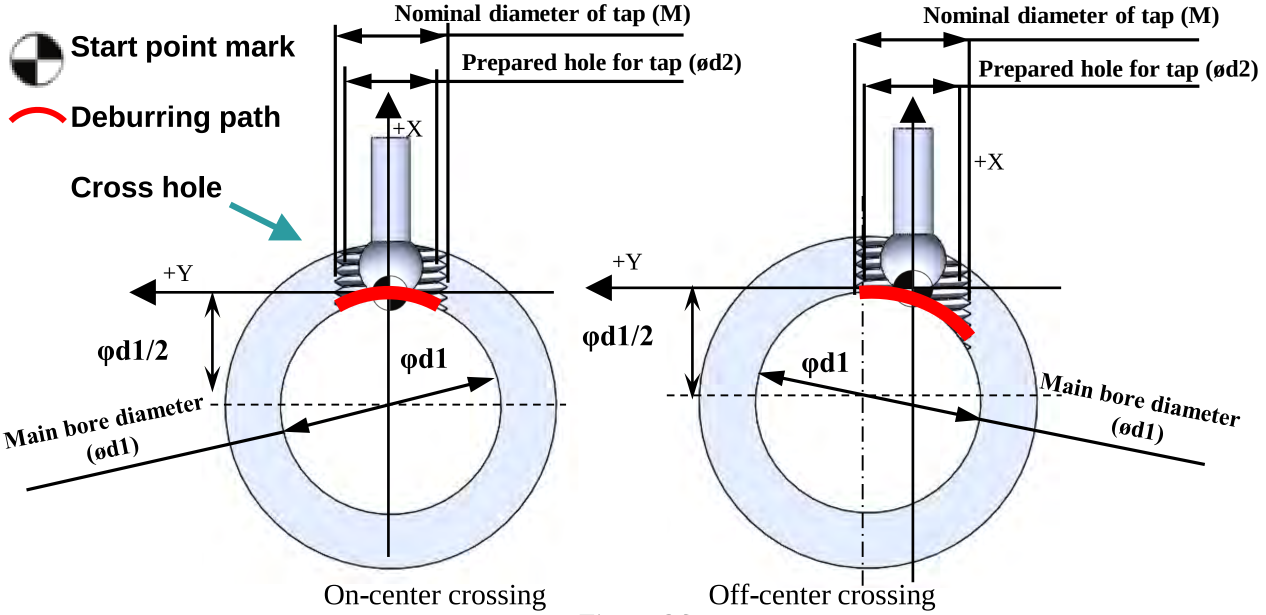


Figure 26

Content of included program

- **Path for chamfering before tapping: Pre**
  - This performs larger chamfering on the edge at the intersection between the exit surface and the prepared hole for tapping.
  - Cutting is divided into 3 parts to alleviate cutting resistance.
- **Path for chamfer finishing after tapping: Finish**
  - Finishing at a depth of cut of 0.02mm is applied after tapping.
  - Use when secondary burrs occurs due to the machining done with the Pre path.

NOTICE

Use only the Pre path if roll taps are used.
As the inner diameter gets smaller if the Finish path is used on roll tap machined areas, the Cutter head will interfere with the expanding inner diameter, presenting the risk of breakage. Do not use the Finish path on roll tap machined areas.

Path integration sequence (basic sequence)

① Machining of prepared hole for tap
② Chamfering with the Pre path before tapping
③ Tapping
④ Chamfer finishing with the Finish path after tapping

Path integration sequence (to reduce cycle time)

① Machining of prepared hole for tap
② Chamfering with the Finish path
③ Tapping

POINT

When omitting the Pre path and processing only with the Finish path, reduce feedrate when cutting, then change to the normal feedrate for processing.

Type QY: Flat surface hole back edge

An example of the start point is shown below. (Figure 27: Example of flat surface hole back edge)
The start point Y/Z coordinates are in the center of the cross hole. The X coordinate is the back surface shown in the diagram.

Example of flat surface hole back edge

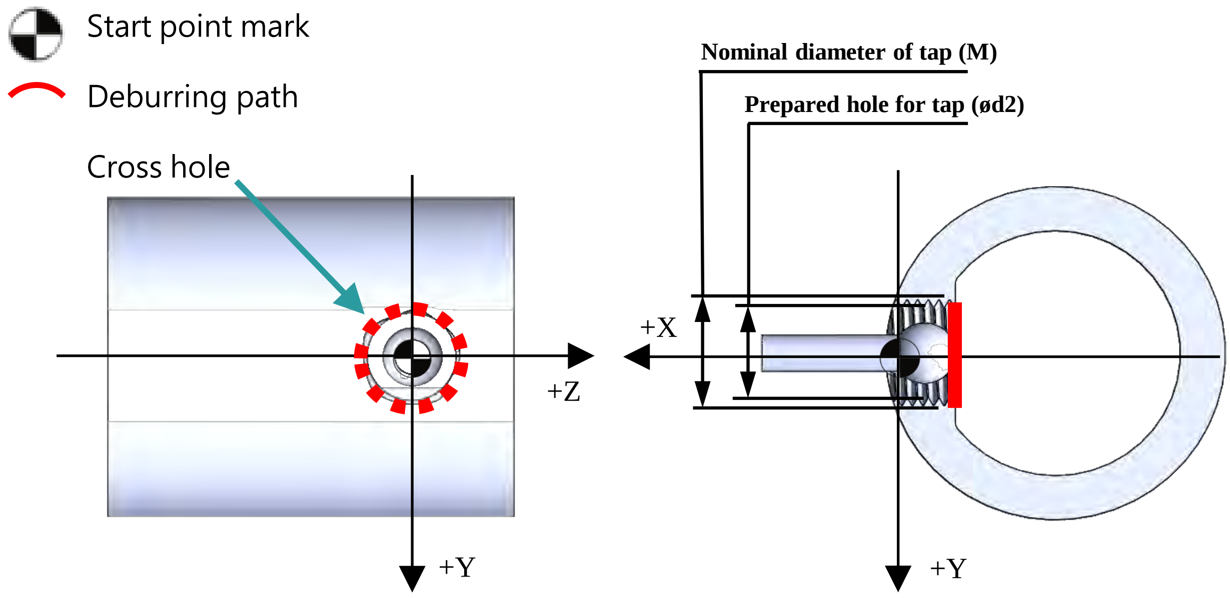


Figure 27

Content of included program

- Path for chamfering before tapping: Pre
  - This performs larger chamfering on the edge at the intersection between the exit surface and the prepared hole for tapping.
  - Cutting is divided into 3 parts to alleviate cutting resistance.
- Path for chamfer finishing after tapping: Finish
  - Finishing at a depth of cut of 0.02mm is applied after tapping.
  - Use when secondary burrs occurs due to the machining done with the Pre path.

NOTICE

Use only the Pre path if roll taps are used.

As the inner diameter gets smaller if the Finish path is used on roll tap machined areas, the Cutter head will interfere with the expanding inner diameter, presenting the risk of breakage. Do not use the Finish path on roll tap machined areas.

Path integration sequence (basic sequence)

① Machining of prepared hole for tap
② Chamfering with the Pre path before tapping
③ Tapping
④ Chamfer finishing with the Finish path after tapping

Path integration sequence (to reduce cycle time)

① Machining of prepared hole for tap
② Chamfering with the Finish path
③ Tapping

POINT

When omitting the Pre path and processing only with the Finish path, reduce feedrate when cutting, then change to the normal feedrate for processing.

Examples of machining edge start points (continued)

Type QC: Flat surface hole back edge

An example of the start point is shown below. (Figure 28: Example of flat surface hole back edge)
The start point XC coordinate is the center position of the main bore. The Z coordinate is the position where the tip of the Cutter is oriented on the coordinate of the end face to be deburred.

Example of flat surface hole back edge

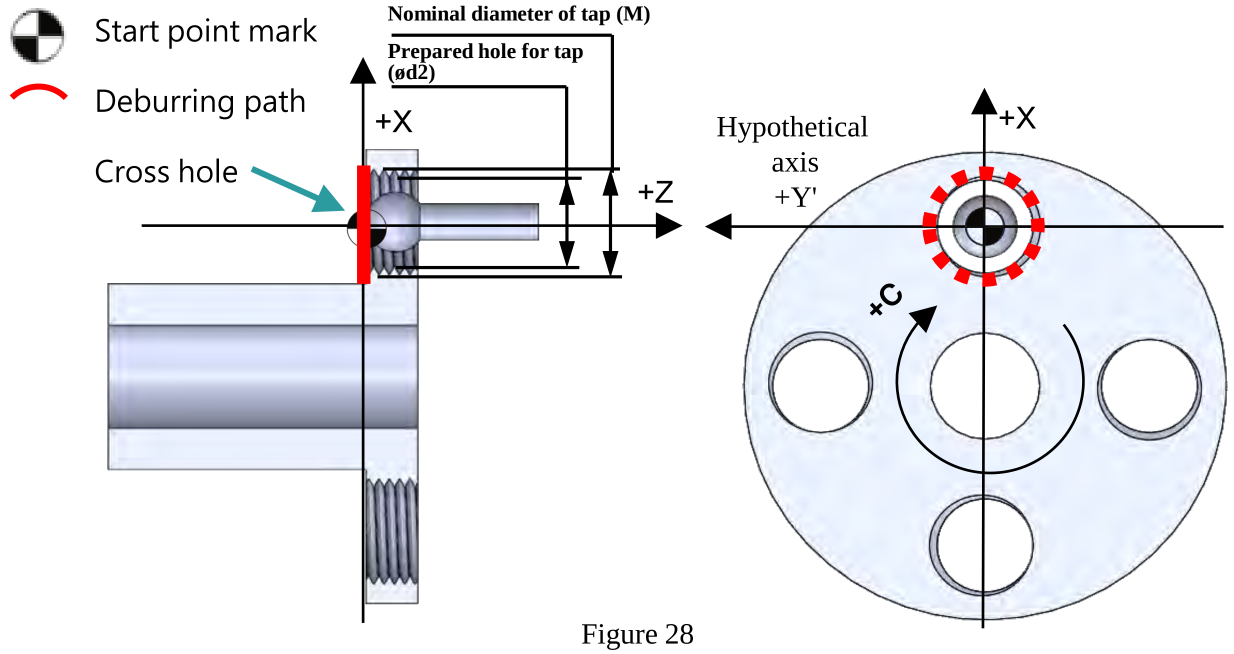


Figure 28

Content of included program

- Path for chamfering before tapping: Pre
  - This performs larger chamfering on the edge at the intersection between the exit surface and the prepared hole for tapping.
  - Cutting is divided into 3 parts to alleviate cutting resistance.
- Path for chamfer finishing after tapping: Finish
  - Finishing at a depth of cut of 0.02mm is applied after tapping.
  - Use when secondary burrs occurs due to the machining done with the Pre path.

NOTICE

Use only the Pre path if roll taps are used.

As the inner diameter gets smaller if the Finish path is used on roll tap machined areas, the Cutter head will interfere with the expanding inner diameter, presenting the risk of breakage. Do not use the Finish path on roll tap machined areas.

Path integration sequence (basic sequence)

① Machining of prepared hole for tap
② Chamfering with the Pre path before tapping
③ Tapping
④ Chamfer finishing with the Finish path after tapping

Path integration sequence (to reduce cycle time)

① Machining of prepared hole for tap
② Chamfering with the Finish path
③ Tapping

POINT

When omitting the Pre path and processing only with the Finish path, reduce feedrate when cutting, then change to the normal feedrate for processing.

XEBEC TECHNOLOGY CO.,LTD.
Fuerte Kojimachi 1・7 Building 8F, 1-7-25, Koujimachi, Chiyoda-ku, Tokyo, 102-0083, Japan
TEL. +81-3-3239-3481 FAX. +81-3-5211-8964

Created in Dec. 2018